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TOWARD A MULTILATERAL INDUSTRIAL POLICY? EUROPEAN TECHNOLOGY POLICY FOR THE DEPLOYMENT OF 5G

Final Thesis of Political Science

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Abstract

The development of the idea of a more intensive involvement of the EU in industrial matters in order to enhance its ability to produce innovation raise the question of the interaction between technology and actors of World politics. The EU Industrial Policy was promoted in order to develop the technological endowment of Europe to acquire knowledge in the "4th Industrial Revolution" and in the deployment of Infrastructure of the Digital Single Market, intertwined technologies though as able to further the role of the EU in the globalization and developing its actorness in the global economy. One application of this paradigm is the 5G Infrastructure Public Private Partnership, established by the European Commission in 2013 in collaboration of the 5G Infrastructure Associations, a group of European ICT industries, in the wider framework of the "Horizon 2020" strategies in the 8th Framework Programme. To analyze this institution, we developed the concept of Multilateral Industrial Policy. Indeed, this paradigm came from the reorientation of technology policy and competition policy toward industrial objectives, focused essentially on public-private strategic coordination and implementation of horizontal and sectoral industrial policy to foster the EU wide System of Innovation. This thesis consequently aimed at demonstrating that the 5G PPP illustrate that innovation and globalization in the 21st century have triggered the institutionalization of a Supranational Industrial Policy in the EU. The academic literature highlights the reflective nature of the international public policy regarding innovation and highlight that innovation policy meaning and substance in the context of a global competition is socially constructure. Hence, both globalization and innovation are not given of the analysis but have to be analyzed through the lens of actors which promote policy to act upon them. The EU industrial policy of the 2000's and 2010's, crystalized by the 5G PPP, came from a specific history, which path the way of its institutionalization through neoliberal principle. A historical institutionalist analysis of the 5G PPP allow us to demonstrate that the 5G technology was promoted as an answer to the structural challenge the EU was facing and as a way to enhance its position in the global economy. This analysis shows that the institutionalization of the 5G PPP was built by strategy and idea of both actors from the public and private sphere, which shape the contour and deployment of this multilateral industrial policy for the development of ICT technologies. On one hand, the private sphere aimed at finding public support and regulations which will help its R&D effort. On the other hand, the EU commission aimed at developing its actorness in the global economy by fostering its technological endowment, allowing it also to support wider societal and political objectives such as the digital and green transition. Both side of the PPP negotiate and cooperate to influence the institutional design and building of the International Public Policy for 5G development and deployment. It triggers the reorientation of public policy for ICT from technology and competition policy toward a supranational industrial policy aiming to endow Europe with this "key enabling technology", and it shift the authority of the development of the System of Innovation for 5G technologies from nation-state level to the supranational level. This thesis aimed at bringing a new perspective on the International Organizations economic policy and their ability to participate in the development and deployment of innovation.

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1. Introduction.

In January 2014, The Commission issued a communication "For a European Industrial Renaissance"[1], which called for "to recognize the central importance of industry for boosting competitiveness and sustainable growth in Europe" and to be a driver of technological changes and innovation. The recent history of European Industry is marked by crises and the need to find a new way out of deindustrialization and instability, as well as the urgent need to enhance the role of the EU in the global economy. The strategy of the European Institutions is highly fashioned by the challenge globalization is putting on its Economy, as well as the political risk associated with technological backwardness. The development of the globalization of industrial value chains pushed Europe to reimagine its role in the manufacturing sector, and in its R&D apparatus in particular. The will to develop policy frameworks in key industrial sectors to build new technologies in order to foster the competitiveness of the eurozone was framed both as an opportunity to face structural challenge the European economy is facing and to enhance its actorness in the global economy. This problematic is especially connected with the low growth rate and the persistent high level of unemployment, but also to position Europe in the race toward the digital and green transition. This context was nevertheless saw as a possible springboard to rethink the role of the European institutions to enhance stability and development of the European Industries by developing technology of the 4th industrial revolution, and to complete the implementation of the Digital Single Market. This situation raised consequently the following question: how an International Organization, in our case the European Union, is affected by technological innovation, and how such organization affects back these technological changes. Indeed, the effects of technological changes on International Public Policy deserve to be investigated scientifically. This question is particularly interesting in a context where new technologies stimulate and enhance globalization by deepening interconnection between society. Globalization cannot be dissociated from a set of technologies and innovation who allow it to exist. On the other hand, globalization pressures public organizations to reimagine their role in improving the technological endowment of their political community in order to be more competitive, as it is currently the case with the European Union. Consequently, by meddling in the system of innovation (which is the overall architecture of a political economy which enables it to produce innovation and knowledge), public institutions trigger new innovation and new uses of technology, which affect back the nature and feature of globalization. We understand here that this dialectic innovation-globalization is a potential major driver of change in world politics, and it is then critical to study scientifically how actors of the international relations are shaped and shape this dialectic through their action and their idea

However, in order to study scientifically how the European Union answers this dynamic of globalization and innovation, we cannot use the classical framework of the rationality of actors. Indeed, the public policy of the European Union to promote and develop the technologies of the 4th industrial revolution

[1] European Commission (2014) "For A European Industrial Rennaissance" (communication) [online the 19.09.2021] : https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0014&from=DE

and the digital single market, in a context of global competition, which have to be historically and socially situated. On one hand, technologies are not neutral artefact, and the way technological change is perceived by actors will frame to the construction of its social reality, channeling consequently the way challenges and opportunities such technology will be both interpreted and addressed. For instance, nuclear power plant technology can be both an economic opportunity bringing decarbonated and cheap energy, or a major security risk which have to be highly mitigated. The definition and perception of technologies will then be a source of political competition and negotiation between actors, which will aimed at promoting their vision for strategic purposes. On the other hand, all public organizations have different tools and resource to act upon technological changes. Their endowment in capability to act and to organize system of innovation and the production of knowledge is specific and depend in the political history of their institutionalization. System of Innovation are complex apparatus involving a very large number of actors, such as universities, public and private institutions, governmental institutions, multinational corporations or start up and SMEs. The ability to create rules and platform of interaction by a public organization among all these actors as well as the type of policy that will shape this public intervention have then to be historically situated. We have then to keep both in mind that the way technology is perceived, and the resources of the collective answer to this technology are contingent from a certain historical contingency which are specific to each public organization. The objectives, tools and ideas that support this policy cannot be taken for granted.

Hence, we have to consider that the driver of the public intervention in the effort to the strengthen and improve the efficiency of a System of Innovation cannot be dissociated from the general interpretation of the late stage of world politics as being the set of a global competition. Because it has both the quality to consider the problematic of the global competition and the thematic of the technological upgrade; and because the promoters of this policy had the political leverage to promote this policy, Industrial Policy came at the center of the stage of the European Economic policy for the development of innovation. This new industrial policy is an adaptation of the already existing economic regime based on neoliberal principles and focused essentially on public-private strategic coordination which would implement structural adjustment affecting not only the economic growth and competitiveness of the EU, but which will also have an impact on social and civil development through technical progress. We understand here that the development of this specific international public policy cannot be dissociated from a historical trajectory that have framed it. The dialectic between technological change and world politics transformation throughout the 20th and 21st century did influence and shape the European international regime regarding innovation policy, and the last outcome of this dynamic have been the institutionalization of what we will call a “Multilateral Industrial Policy” for the development and promotion of a European wide System of Innovation.

European Industrial policy is highly flexible and dynamic and is the fruit of a historical contingency which saw its design and target continuously reimagined, reinterpreted, and renegotiated by actors throughout the time. The idea of Multilateral Industrial Policy concept will help us to seize the institutional adaptations

of the EU industrial policy regime in the beginning of the 21st century by endogenous perceptions of change in world politics and innovation, as well as the institutionalization of multilevel and multistakeholder model of governance that lies at core. Multilateral Industrial Policy is consequently multilateral in the sense that the purpose, targets, and scale of the EU industrial policy is defined by a multitude of actors and crystalize their interaction and their reflexive understanding of the challenge and opportunity of both globalization and innovation. Then, we have to keep in mind through this thesis that the design of this policy is the fruit of collaboration and concurrence of ideas and interpretation of different actors from the public and private sphere regarding the challenges and opportunities innovations and globalization creates. Such policy is implemented via a combination of horizontal and sectoral policy affecting the production of knowledge and technological artefact, which will be executed through a coordination of different actors such as Member-States, Business Associations and European institutions. One application of this paradigm is the 5G Public Private Partnership, a large-scale government-backed industrial and academic projects, established by the European Commission in 2013 in collaboration of the 5G Infrastructure Associations, a group of European actors of the ICT industries, in the wider framework of the objective of the "Horizon 2020" strategies in the 8th Framework Programme for Research and Technological Development. This organization is designed to develop knowledge on the 5G rollout, to coordinate interaction among industrial actors and EU institutions and to organize funding of the deployment of next generation telecommunication infrastructure.

This new technology is depicted as the basis of economic development and most notably with its ability to revolutionized Internet of Thing and bring new application for next generation manufacturing, increasing life conditions in societies, as well as helping positioning EU's industries in an increasingly competitive global market. Furthermore, through its potential to shift very large amount of data, the 5G network is see as the perfect technology to help the competition of the digital single market and stimulating the competitiveness of the EU economy at large thanks to the development of good and services associated with the digital economy. However, the deployment of the 5G Infrastructure Public Private Partnership have to be understood in a specific historical context. Indeed, as we saw, the 5G Public Private Partnership cannot be seen as a natural answer to innovation nor globalization, it is the fruit of a specific vision of actors building the European Industrial Policy, and a specific Institutionalization of this public policy, build upon specific resource with a specific legitimacy and a specific purpose, and those cannot be extract from historical contingency. This study will aim at contributing to the understanding of this phenomenon by analyzing how an International Organization see its International Public Policies being influenced by challenges and opportunities triggered by technological changes, and how those opportunities and challenge are seized by International Organization to promote and enhance innovation policy in the context of a increasing globalized economy. More precisely, we will orient our focus on how a technology of the 4th Industrial Revolution and the Digital Revolution, the 5G Mobile Network, triggers political and economic challenges and opportunities for the European Union, and how it answers to those challenge through the tools of multilateral industrial policy. Understanding how

the European Union is increasing its role as an Industrial Actors thanks to the coming "4th Industrial Revolution" and the Infrastructure of the Digital Economy matters, because it helps us understand and size both the changing nature of the European politics regarding its ability to get involve in manufacturing, technological upgrades, and the world economy. It also allows us to understand how economic changes and new technologies gives International Organizations new legal, administrative, and political resources to act retroactively upon them. We will consequently study one crystallization of the dialectic between innovation and globalization: the development of a Supranationalization of Industrial Politics in Europe for the development and deployment of next generation ICT infrastructure. The research question that this thesis tries to address is the following:

> How have technological and international changes in the 21st century triggered an internationalization of Industrial Politics.

To sustain this problematic, we will study the case of the EU industrial policy for development and deployment of 5G technologies. This final thesis will be outlined by several hypotheses:

- The 5G PPP shows that the European Research and Technology Policy and the European Competition Policy are becoming more oriented toward an horizonal and sectoral policy which suits Industrial objectives of the Multilateral Industrial Policy paradigm.
- The interpretation of the global position of the EU in the 2010's has triggered the reimagination of the involvement of the EU regarding industrial objectives, making the 5G deployment a strategic objective requiring active role of the EU commission.
- Actors from the ICT industry and the European Commission had developed sets of interaction which had developed this reorganization of the neoliberal competition oriented industrial policy towards a multilateral industrial policy.
- The 5G PPP catalyze feature of an Industrial Politics above nations-states to enforce the digital single market while enhancing the EU actorness in the global economy regarding enabling technologies of the 4th industrial revolution and the digital economy.

To understand how 5G Industrial policy of the EU is highlighting how the dialectical dynamic between technological changes and transformation of world politics triggered an Internationalization of Industrial Politics in the European Union, we have to frame this problematic in a specific historical context. At the European level, new concerns regarding industrial politics and the role of European institution for the development of key technologies in horizontal infrastructure start to be articulate in the concrete problematic of the "manufacturing renaissance" in the beginning of 2000's. Indeed, concern were raised about both the role of industry in the European economy (as a driver for technological upgrade and growth), but also the place of European industry in the context of globalization (challenged by both America and Asia) and the perception of the single market as the best level to implement such infrastructure in order to benefit economy of scale.

This paradigm shift has been complemented by a new trend in academic studies in the field of Industrial Politics in the 2000's and 2010's. This context of emerging concern regarding EU role in setting up supranational industrial politics open the door to new priorities and role for European policy regarding the implementation, founding, and regulation on matter such as enabling technologies and infrastructure which is perceived as enabler of a new industrial revolution and a driver of the digital single market. If the European economy has dramatically changes since the Treaty of Rome, its influence on the role as well as the substance of the European Industrial Politics is not the result of purely functionalist considerations. It needs to be understood as a political construct shape by actors and ideas, sculpted by adaptation and with the evolution of technologies, globalization, and political ideas. We need to size the creation and the policy of the 5GPPP as being one of the outputs of a change of paradigm regarding industrial policy since the creation of European institution in the 1950's. However, we need to analyze what theoretical tools and analysis have been developed in the literature concerning International Technological Politics and the relationship between technological change and Public Policies of International Organizations. We will also have a look to academic works which focused on Industrial Politics which will guide our understanding of the history of European Industrial Politics in the context of globalization of economies. Historical institutionalist (HI) theories highlight that past institutionalization generate new specific sets of interaction among actors as well as their interests, strategy, and structural challenge and opportunities. This will influence how the institution will adapt to structural changes. Hence, the timing and sequencing of institutionalization of multilateral industrial policy matter because its foundation will structure the constraints and opportunities for next institutional creation. The development and implementation of the 5G PPP will be study as an outcome of the trajectory of the 2000's paradigm regarding the role of the EU in industrial policy. The economic and financial crisis of 2007-2008 reinforced the fear of European actors to be marginalized by the global market, and the increasing deindustrialization of Europe was seen as a catalyzer of the crisis in the single market. To face these new challenges, the EU institutions based their hope in a new paradigm regarding industrial innovation: the "4th Industrial Revolutions" and the development of digital economy. The 4th Industrial Revolution can be defined as the development of a new dimension of industry and manufacturing structured around innovations in digital and Internet technologies, which dramatically reorganize interaction between humans, between machines, and between humans and machines. The digital economy can be defined by a reorganization of supply and demands of goods and services through the tools of the digital technology. The 5G mobile networks is a technology which can both enhance those two elements of the economy of the future.

This final thesis will consequently be structured firstly by a review of the literature regarding the question of the relationship between international politics and technological changes, and a historical background to understand the trajectory of the institutionalization of the Multilateral Industrial Policy in the EU. Then a theoretical framework will be set up, where we will gather tools of Historical Institutionalism to understand better how to structure our study of the 5G PPP and our methodology. We will then operationalize

our methodology in a case study of the 5G Public Private Partnership in three parts: the development and implementation of the policy and organizational design of the 5G PPP in a first time; a study of the interaction and vision of the Public and Private actors in the Phase 1 of the PPP in a second time; and an inquiry of the adaptation and realization of the 5G PPP in the phase 2 and 3 of the PPP in a third time. To study the gradual institutionalization of the 5G PPP in the broad framework of development of the multilateral industrial politics of the EU, we will have to study empirically the formal document provided by Institutions of the EU industrial policy institutions, and to frame how actors from the European Union and from the Business associations shape their strategy to frame the contour of this 5GPPP as an artefact of the Multilateral industrial policy, and their discursive and political resource they use to advocate for their vision of the EU industrial policy.

2. State of the Art.

2.1. Introduction.

We want to have a better understanding of the development of the Industrial Policy of the European Union during the first decades of the 21st century, and how this policy is the fruit of a shift of technological toward the tools and objectives of the Industrial policy. We need consequently to frame how the literature studied and analyze the link between technological changes and changes in world politics. Indeed, we cannot dissociate our object of study from a broader perspective the dialectic between innovation and globalization dynamics: as we will see, if the Industrial Policy of the EU is an economic policy tool to enhance the economy Europe by improving its technological endowment, it is also a reaction to both challenges and opportunities that brought globalization and technological innovation. More precisely, our aimed in this first part of this state of the art is to guide us toward a more accurate understanding of the debate about the way International Organizations use international public policy to shape System of Innovations, and what theoretical and methodological tools we can pick out of those discussions to apply for our research. This conversion will lead us toward a more precise investigation of industrial policy. Industrial policy is both a paradigm of economic policy, a tool of public policy and an object of study of Economic Sciences. Understood as both a combination of horizontal and vertical (sectoral) economic policy, as an action giving forms and substance to a System of Innovation, and as a platform institutionalizing the strategy, interests and idea of private and public actors, this inquiry will allow us to ground the concept we will introduce in this thesis: the multilateral industrial policy.

2.2. International Organizations' responses to technological changes.

Technological changes have been a powerful driver for societal and economic changes throughout history, with increasingly improved productivity, access to communications and transportation, but also as enhancing means of destruction in wartime as well as enabling us to have a tremendous impact on our environment and biodiversity. However, technological change has been narrowly studied by International Relations scholars. Moreover, fewer scholars to have studied the dialectical role and responses international organizations have regarding technological changes: "[Technology] clearly is not the only factor involved in explaining change. It is however a potent one. Moreover […] it is a factor that has too often been ignored or defined away by those who seek to explain International Relations and International Political Economy"[2]. In this section, we will explore what have been done in the academic regarding the way technology had affected International Public Policy and World Politics in general, but also how the literature can help us conceptualize International Public Policy's influence technological change itself. We will have a special emphasis on

[2] Talalay M, Tooze R, Farrands C. (1997) *Technology, Culture and Competitiveness: Change and the World Political Economy*, Routledge, London, p. 2.

academic literature framing the development of Innovation System through Industrial Politics in the European Union.

2.2.1 Technological Change: an endogenous phenomenon that have to be framed as a social construct.

When incorporated in the analysis, technological changes are often studied as an exogenous element of world politics. This position may conceptually create two problems we can consider as fundamental: 1) it tend to present technological changes as a social force living outside the world and lead to a technological determinism which do not allow us to understand how its dynamic is socially produces; 2) it does not allow the understanding of the retroactive effect that world politics also have on technological change itself. For instance, James Rosenau's[3] work, focused on systemic changes and world order, analyzes technological upgrades as the main driver of the transformation of international relations. The main effect of technological change on international relations is the shift form a "State Centric World" toward a "Multicentric World", since technological change increase the number and the quality of actors affecting transnational relations. However, this change seems to not have any influence on technological change itself: technology is exogenous from world politics for Rosenau, meaning that technological changes is not influenced by change in world politics itself: the production of knowledge is the same in a state centric world or in a multicentric world. This position was empirically demonstrated as wrong by Maximilan Mayer, Mariana Carpes and Ruth Knoblich[4] in their detailed analysis on the intertwined link between several technological artefacts, such as oil production, nanotechnologies, nuclear warhead, drones, peak oil, cyberspace, supercomputers, and biomedical technologies:

- firstly, world politics give a sense to what technologies are (or should be, if we consider R&D work produced by actors of the international system produce anticipation and speculation by actors linked with international security or national position in the world economy);
- and secondly world politics help to design the use and practices of new technologies, which cannot be dissociate from international agreement socially construct (the example of mass destruction weapon being the target of multiple international agreement being the most prominent example).

Consequently, the approach analyzing technologies as *social products* elaborated by Robert Cox[5] in 1987 seems more reasonable. Indeed, for Cox, technologies are only understandable within a specific political economic framework and is, by definition, endogenously connected with global politics: "it is more realistic to see technologies as being shaped by social forces at least as much as it shapes theses forces (p. 21) and that "technology itself is a product of society and society's power relations'" (p. 313). Consequently, technology

[3] Rosenau J. (1990) *Turbulence in World Politics*, Harvester-Wheatsheaf, London, 504 p.
[4] Mayer M., Carpes M., Knoblich R. (2014) *The Global Politics of Science and Technology – Vol 1: Concepts from International Relations and Other Disciplines*, Routledge, London, 284 p.
[5] Cox R. (1987) *Production, Power and World Order: Social Forces in the Making of History*, Columbia University Press, New-York, p. 500

is not only an artefact, or machine driven by the logic of scientific and technological possibility, nor the product of these artefact and machine. It is a social construct only understandable within the broad context of the patterns and structures the digitalized-globalized neoliberal capitalist area of the early 21st century, where the specific superstructure and infrastructure of our societies give the real meaning of what constitutes, for us, the technological realm. We have to look at technology as any other social phenomena. Technology is a part of our social reality and have meaning only when view through the lens of social terms and norms: it is a materialized result of cultural, political, economic, and social structures and power, and not as an autonomous entity with its own rationality[6]. "Technological system can be both a cause and an effect; it can shape or be shaped by society. As they grow larger and more complex, systems tend to be more shaping of society and less shaped by it. […] The social constructivists have a key to understanding the behavior of young systems; technical determinists come into their own with the mature ones"[7].

However, another step needs to be made if we want to seize the dialectic between world politics and technological changes, and such step include an analysis the actors. Indeed, analyzing who interpret and act upon technological change, as well as their and their place, purpose, and vision, and what are the type of interaction and power relations allow us to understand how global politics affect technological changes. If technology is socially construct, and if it is endogenous to world politics, we have to conceptually place the practices and interactions that allow such phenomenon to be social constructed. As described by Archibugi and Michie[8], innovation is "more than just a series of isolated event shaped by enlightened inventors […] the process which nurture and disseminates technological change involves a complex web of interaction among a range of different subject and interactions". However, we can claim that this logic of interaction constructing socially technological change is by essence a product of Global Politics. On one hand, politics give the normative orientation to technological politics, and, from an International Relations perspective, such process depends not only on domestic environments, but 1) they are driven by policies that try to incentives and appeal foreign research potential, hence giving a transnational nature to innovation process[9], and 2) technological change are affect by what is considered as strategic regarding economic or military competition and cooperation among actors of world politics[10]. On the other hand, technologies allow such interactions to exist at a global level: "Between technological and societal elements of interaction capacity the former is both prior and more basic. Technology determines the level of interaction in a very fundamental sense. Without a substantial impact from technology on levels of interaction it is difficult to see how or why common norms

[6] Kaplan, D. M. (2004) *Reading in the philosophy of Technology*, Rowman & Littlefield Publishers, Lanham, p. 602
[7] Hughues, T.P. (1994) *Does Technology Drive History? The Dilemma of Technological Determinism*, MIT Press, Cambridge, p. 112.
[8] Archibugi D., Michie J. (1997) "Technological Globalization and National Systems of Innovation: An introduction", in Archibugi D., Michie J. *Technology, Globalization and Economic Performance*, Cambridge University Press, Cambridge, 322 p.
[9] Metcalfe S. (1997) "Technology Systems and Technology Policy in an Evolutionary Framework", in in Archibugi D., Michie J. *Technology, Globalization and Economic Performance*, Cambridge University Press, Cambridge.
[10] Fransman, M. (1997) "Is Technology Policy Obsolete in a Globalized World? The Japanese Response", in in Archibugi D., Michie J. *Technology, Globalization and Economic Performance*, Cambridge University Press, Cambridge.

and communal institutions could develop other than in geographically limited subsystems. Once they do develop, however, they become an important element of interaction capacity"[11]. Consequently, technology allowed globalization, world politics and its actors to exist, and its actors have a retroactive effect on technology. The actor traditionally studied by IR/IPE, the relationship between technology and politics is under investigation, is of course the Nation-State, and less often, Multinational Corporations.

However, the role of International Organizations has been the big absent of most of studies connecting world politics and technological changes. This thesis also aimed at fulfilling this gap. Two authors have however directly studied the answers of international organizations to technological change: Ruggie and Skolnikoff.

2.2.2. Ruggie, technologies and international régimes.

One of the first scholar of International Relations which studies how international systems manage industrial and technological change is John Gerard Ruggie in his article of 1975[12]. This article states that, since scientific and technological advances and their applications are increasingly internationally embedded, one change in the system will be widespread and have consequences in the system entirely. For Ruggie, the consequence of such statement is that the state of the 1975's international regime does not suit the administration of new technologies and scientific upgrades: "the scope and the complexity of new scientific and technological developments are outpacing the capacity of our systems of international organization to manage them" (p. 557). Consequently, Ruggie aimed at studying how international organizations can help societies to coop with the development and the result of technological changes, since that, for him, the nation-states system has structural problems to do it.

Firstly, the author states that technological changes affect international organizations and vice versa, but the link of causalities among the two have to be studies in a scientific way since no determinism can emerge out of their contact[13]. Then, the author understands the international organizations' relations to technology as a *complex product* created and by the intersection of two axes. The first axe defined the *situation*, the line defining tension between consensual knowledge of cause/effect relation (science) and normative purposed, negotiated priorities and available capacity (politics). The second axe defined the *response*, where take place the tension between the objective necessity for States to find collective management regarding collective problems and opportunities (internationalization), and States' wish for autonomy and flexibility by

[11] Buzan B., Charles J., Richard L. (1993) *The logic of Anarchy: Neorealism to Structural realism.* Columbia University Press, New-York, p. 69

[12] Ruggie, J G. (1975) "international Response to Technology: Concepts and Trends", *International Organization*, vol 29, n°3, pp. 557-583.

[13] "When it comes to the international management of technology there is a hole in the technological whole, one which can be filled only by introducing political purposes" (p. 558).

doing so (national control). Ruggie understand consequently the international management of new technologies as a matrix of *collective situations* and *collective responses*.

The *collective situation,* understood as a "social milieu", emerges out of patterns of international dependances and dominations, depict the *problematic* to which States responds. It presents four analytical dimensions that have to be consider.

1) the increasingly politicization of matter before considered only as being from the realm of nature and sciences[14]. Technological upgrades and Scientific knowledge increase the number of topics that human have a control over (for example, the discovery of the atoms and its technological and industrial application created a new political issue of its management), hence allowing the process where natural phenomena become a subject of the public domain, and where its future course will be shaped according to "public" consideration[15]. Furthermore, this process also induces the dynamics where the phenomena is brought to the collective arena, increasing the role of the states and international organization, since this conversion from the natural to the public realm initiate new purposes and role for the legislators (to keep the example of the atom, its technological implication created several public instruments, protocols, and institutions for its management, from military to civil applications). In other words, science and technology allow the recognition that collective situation exists.

2) the type of policy interdependence[16] among states that politicized issues raised. Here, Ruggie states that such interdependence can be of several types: i. *cognitive,* where isolation is recognized as being inefficient (generally, where the interaction between technology and policy is not deep); ii. *Opportunity costs*, where isolation is identified as being more expensive than collective actions (the prototypical case include collaboration in research and development); iii. *Contingencies*, where isolation creates too many uncertainties for other players and hence become a threat to all (like nuclear proliferation); iv. *Constraints,* where isolation creates privations of opportunities for some players whereas collective actions have the capacity to create positive sum game situations (Ruggie used here the example of the Law of the Sea, but some could add the Law of Outer Space regarding the prohibition of outer space appropriation); v. *Deprivation*, where isolation creates unfair privation of rights and goods, while collective action can allocates such goods for mutual benefits (we could site the space junk mitigation problems).

3) The Loci of interdependences[17], which the author distinguishes from a situation *external* (where the interdependence is the result of a choice and where "the link between the situation of interdependence and

[14]"The application of science and technology to human concerns has progressively made "nature" an object of public authority and public choice; that is, "nature" has become politicized" (p. 560)
[15] Wolin S. (1960) *Politics and Vision: Continuity and Innovation in Western Political Though,* Princeton Classic, Princeton University Press, Princeton, pp. 792
[16]"How policy making in one polity is perceived by participants as affecting, and as being affected by, that same process in other polities" (p. 562).
[17]"The term describes how directly the domestic policy pursuits of States are linked to the situation of interdependence" (p. 564).

domestic scene is indirect and must be deliberately established"), *external manifestations* (where interdependence do not affect the internal nature of the use, but where international cooperation are privilege for technical reasons, like weather forecast or the use of frequency spectrum. The rationality here is to create compatible behaviors rather than directly imposing behaviors), *commons* (where situation of interdependence resulted in the attribution of property rights in the international commons, distinguishing what becomes domestic to each nations and what should be the property of none, like outer space), and *Domestic* (where interdependence is the consequence of "situations in which domestic policies and activities in one state have recently come to be linked to those in others" (p. 565). What is at stake is the regulation of what countries should allow to do domestically and can be describes by the economic notions of mitigation of negative externalities). Hence, if the *type* of interdependence raised by the politicization of matters through technological upgrades describes the *character* of the international problematic, and if the *locus* of interdependence describes the type of link this politicized matter tied between countries, the combination of the two provides a measure of the interdependence among players in the international arena.

4) The distribution of interdependence among concerned players. Indeed, the cost of leaving a specific locus of interdependence as well as the perception of the constraints that an interdependence will creates will not be symmetrical among players: "the extent to which a situation of interdependence is more or less shared by those affected by it is a function of the capabilities states possess and the objectives they pursue in *the sector concerned*" (p. 566). As an example, the American technological hegemony after 2WW in the civil nuclear sector gave them the ability to set the agenda for standardization as well as the parameter of scientific debates. Consequently, even countries wishing to establish their own alternative program for the nuclear civil sector, like the European EURATOM, had to rely on US information and expertise. Furthermore, the reliance on the US technologies for this sector was also motivated by the will for European to mitigate the domination of France in this program, since the French expertise in this sector outweighed other European by far.

The *collective situation* is defined by asymmetrical access to scientific knowledge defined the international-organizational responses to newly politicized questions raised by technological upgrades, as well as the weight of interdependence among players, which is defined by the locus and the type of interdependence among them. We understand here that they are inherently unstable, since change in scientific and/or normative knowledge can change the substance, characteristic as well as the meaning of the relation of interdependence among nations.

Secondly, the "collective response" illustrates "the international institutionalization of certain aspects of national behavior which results from the responses of states" (p. 568) and can be roughly designated by the institutionalized answer to *collective situation*. They are not *only* international organizations, but rather a continuum where international organizations represent the most institutionalized collective response. Ruggie differentiate two other level of institutionalization. Firstly, Epistemic Communities, which, when they derive from national representation in the international realm, translate *only* the need to compensate for the

imperfection of the nation-state system. Hence, they should not create greater costs on states than those of the situations they are supposed to answer and are almost not institutionalized. Secondly, international regimes, "refers to a set of mutual expectations, rules, and regulations, plans, organizational energies, and financial commitments, which have been accepted by a group of states […] International regimes may be further differentiated by the purposes they serve, the instrumentalities they use and the functions those instrumentalities actually perform" (p. 570-571). Such basic purposes can be the procurement of new capabilities; the development of uses of already existing capabilities; the management of consequences of the uses of capabilities. Different instrumentalities vary function of the degree of integration of national policies and what is left of their autonomies. Institutionalizations are situation specific, and like *collective situation, collective response* are the result of bargaining and influence among players, and hence are unstable.

To sum up, Ruggie view International Organizations answer to technological change as socially construct. Firstly, it is construct by the way technology allow new problematics to emerge as political problematics, this this new political problematic have the potential to create more or less profound patterns of interdependence among nations which will condition nation's response to this situation of interdependence. Function of how collaboration will develop political opportunities, how this situation of interdependence will alter their autonomy and what dissymmetry of power this situation will create, Nation-States will create specific type of bound and agreement to manage collectively such interdependence. This will be, potentially, translate through the form of International Organizations. Such correspond to the most institutionalized collective answer to situation of mutual interdependence brought by technological change. Here Ruggie have an interesting position regarding the shift of sovereignty that those are supposed to create: indeed, for him, because *some* technologies are operational *only* when managed collectively, it is wrong to assume that the international management of technological consequences *have to* translate a loss of sovereignty, since some specific issue is not by definition able to be managed by states themselves. It is also interesting to note that, for Ruggie, International Organizations are the direct product of technological changes. International Organizations in hence the *most concrete* for of institutionalized answer to technological changes, they are constituted and shaped by interdependence patterns shaped by technologies, and the asymmetrical power among actors tied in those interdependence patterns as well as the characteristics of world politics[18]. However, for Ruggie, International Organizations cannot be dissociated by the international regime they serve: "any international organization may be visualized as operating within a *three-dimensional policy space* whose axes are defined by the purposes, instrumentalities, and functions of regimes it serves […] Apart from this broader policy space, international organizational tasks are meaningless parts in an indeterminate whole" (p. 573). Finally, Ruggie identified three types of tasks International Organizations perform inside these political spaces: 1) they can implement *facilitative task*: "planning for the regime is carried out within the organization, but decision making and implementation are not"; 2) *enabling task*: planning and decision-making tasks for

[18] Cox, R. W., Harold, K. J. (1973) *The Anatomy of Influence*, Yale University Press, New Haven, 504 p.

the regime are made by the international organization, but implementation are left to member states; 3) *operational task*: in this case, planning, decision-making as well as implantation is carried out by the international organizations.

2.2.3. Skolnikoff, a realist approach to technological changes and transformation of governance scheme.

Another important contribution to the understanding of International Organizations relationship with technological change is Eugene Skolnikoff in the Chapter 6[19] of his book *The Elusive Transformation: Science, Technology, and the Evolution of International Politics*.

Skolnikoff start its argumentation with the idea that technological change, since the late 20th century, have dramatically creates new frameworks of the time-space nexus of polities. Indeed, on one hand and from a geographical view, technological upgrades have organized, through revolution in telecommunication and in production patterns of goods and knowledge, a global dependence among nations which is reorganizing governance models of a wider variety of policies that have been before managed by states autonomously. On the other hand, from a temporal view, governments have to manage and implement policies for matter which become increasingly instantaneous, like the 24h-working computerized financial system, supersonic missiles; as well as phenomenon which require consideration and commitment to a temporal horizon of several decade, like the global warming, and even millennia, like the management of radioactive wastes. Hence, technologies have to be understood as being a dynamic, integral, and *constitutive* element in international relations analysis: "the inextricable and pervasive involvement of scientific and technological factors in so many issues in international affairs […] means simply that those factors must be sensibly included in policy processes" (p. 206). It is noticeable however that Skolnikoff warns against a misleading conception that technologies have the potential to solve each social problem, a technophilic behavior which does become an additional problem with the misunderstanding of the role of technologies in policy settings. Indeed, not all desired technological upgrades are achievable, not all existing technologies are available for everyone, but mostly, no social problem can be solving by technological means alone: "technology can contribute, but social problems require social solutions" (p. 207).

The author also raises several implications from the technological change in the governance patterns of world politics:

i. Uncertainty increase: new technologies and scientific data do not, paradoxically, give us more precise vision about our environment, but create unpredictable changes regarding the number of actors concerned, scale of social problem induced by new technologies, as well as new types of threats upon which government have limited knowledge (cybercrimes, disaster induced by climate changes, nuclear

[19] Skolnikoff, E. (1993) "Practical Problems of Governance: Institutions and Processes", in *The Elusive Transformation: Science, Technology and the Evolution of International Politics,* Princeton University Press, Princeton, pp. 202-2019.

accidents, epidemic which have reach unprecedented scales with the development of transport among nations etc.).

ii. Excessive information: if new tools to gather and analyze data are available for governments, such do not overcome the problem of "information glut": "for technology cannot separate in advance the important from the merely relevant without sacrificing to the programmer the decision as to what *is* and *will be* important" (p. 216). Hence, because the development of artificial intelligence and technology associated will be connected to the development of proliferation global issues, no satisfactory solution for this problem are envisaged by the author.

iii. Process for North-South Transfer of Resources: the mitigation of technology-induced problem requires the creation of international platform to transfer technologies from rich countries to poor countries in order to allow them to develop in the most cost-effective way regarding the concerned problem. However, such require a level of solidarity from the North that the author depict as incompatible with so-called national interests of the concerns, as well as an unlikely shift from development-aid policy logic.

iv. Dependence on Large Technological Systems: functioning of societies depends more and more on large scale communications, computing, electricity-distribution grids, railroad and productive networks, and the more networks growth, the more exposed to breakdown they are. Breakdowns are then ever more difficult to prevents, but the consequences of such breakdown on populations are also increasing.

v. Public Involvement and Political Fragmentation: "One of the major consequences of the greater public availability of formation that accompanies the spread of information technologies is increased public involvement in policy process" (p. 218). If such can be an opportunity to develop democratic process in our societies, the author also sees it as possible engine for the creation of interested group around single topics and the mushrooming of pressure group having the ability to gridlock policy process.

Regarding more specifically the role of technologies in the different level of the governance of world politics, the author identifies three different level in which technologies alter the governance of world politics: the role of Foreign Offices, the role of International Cooperation, and the role of International Organization. For the role of Foreign Offices, one of the more dramatic changes induced by technological upgrades Skolnikoff identified is their undermined ability to sustain their traditional dominance in the design and implementation of foreign policy: "the portion of government formerly concern almost exclusively with domestic affairs – agriculture, industry, health, environment, and education, for example – are increasingly engaged in matters that directly affect international relations and a nation's foreign policy" (p. 209). Hence, in the setting of the foreign policy of a government, the Foreign Office is now one player among others. Regarding international cooperation, the author identifies as its main driver nation-states' own interests: "at least, the process skews the consideration of international issues by underrepresenting the stakes of affected

foreign parties or of the broader global community; at worst, it results in a parochial, nationalistic view that gives little weight to broader concerns" (p. 211). Consequently, uncoercive action allowing the implementation of collective actions regarding collective issues induced by technologies, climate change for instance, may be less likely than the implementation of such action through the influence of a hegemonic power. Hence, cooperation in science and technology, which require extensive commitment of financial and human resources as well as result sharing are necessarily altered by the nation-states system.

Finally, concerning International Organizations, Skolnikoff describes their increasing number as well as their extensive scale as a direct consequence of the need to institutionalized governance pattern to coop with international consequences of technologies or to deepen the benefits of existing or about to exist technologies. The history itself of these types of actors are directly link with technological and scientific developments, since number of International Organizations have been implemented in the 19th century as organs of standardizations to increase the scope of at the time innovations, like the creation of the International Bureau of Weights and Measures in 1875, or their industrial applications, like the International Telecommunication Union in 1865 (this story stay true for the 20th century with its connected innovations, such as the International Civil Aviation Organization or the International Atomic Energy Agency for instance). But if it was thought that International Organizations would gradually carry out "essential" international function in the governance of world politics, while the autonomy and authority of nation-states would be eroded, the author state that such delegation of functions cannot be translated as an erosion of States power: "National policies toward Inter-Governmental Organizations are conditioned by the same factors as are policies toward international cooperation in general, making them hostage to domestic interests in nationally based policy processes" (p. 213). Hence, for Skolnikoff, attitude of Nation-States vis-à-vis International Organizations are largely dependent on if such International Organizations serve their domestic goals or not. Consequently, one fundamental requirement for the existence of International Organizations is Nation-States recognitions that they are essential for their polity and that they could not achieve their domestic and international goal without them and their necessary autonomy which allow them to work[20]. The author accepts however the exception of the European Community: grouping of politically compatible and economically similar Nation-States have indeed made progress toward a truly delegation of power toward the European Commission[21].

To sum up, Skolnikoff works help us to identify how technological changes alter the nature of governance, and the vision actor of governance, especially states, have of technologies. Technologies change the relations that governments have with their social reality, it change the nature they have to time and space, to uncertainty,

[20] Skolnikoff here, however, raise the question that, if continuous aggravation of the global climate or economic threats impose enough pressure on them, Nation-States would accept to delegate substantive amount of their power and autonomy to international organization in order to coop with such problem. Following a realist state-centric approach, the author states that it seems more likely that a group of hegemonic power would lead the policy through traditional mean of power to resolve such matters rather than multilateral institutions.

[21] Nugent, N. (1989) *The Government and Politics of the European Community*, Duke University Press, Durham, p. 368.

to information, to interdependence and potential threat upon societies. Technologies also change role of actors in the world governance, as we saw with Foreign Office and actors of International Cooperation. The view that Skolnikoff have on International Organizations is a functional one: for him, they mostly carried out specific function, even if they have a positive effect and enable the development of innovations. Skolnikoff keep an understanding of relation technology-international politics as being still state-centric: "The fundamental of nation-state system have not been altered as much as most rhetoric would lead us to believe" (p. 7).

2.2.4. Preliminary Conclusion.

As we saw, the academic potential of an intertwined study of both technological changes and international relations carried out the prospective to open very interesting doors. However, to propose an interesting analysis of this phenomenon, we saw that a specific definition of technology have to be used, which is to understand technology as a social construct, which have meaning inside the social realm of world politics, and which development is endogenous to this social realm. This thesis aimed at developing and analyzing what can be the role of international organizations in this dialectic where technology and world politics influence each other. We saw that Ruggie proposed a detailed analysis of how technology is socially constructed and allow to transform natural issues into political one, how they create pattern of interdependence among states. Such patterns of interdependence, in turn, establish international regimes, and the way these patterns institutionalized collective responses help us to understand how they are framed into International Organizations inside the political space of those regime. However, Ruggie approach do not offer the second step needed to complete our dialectic, and Ruggie do not see how International Organizations shape in return technological changes. On the other hand, Skolnikoff a more detailed analysis on the consequences that technologies carried upon actors and policies of the world governance, and in the way, technologies have change how actors perceive and do their tasks as well as the retroactive effects those can have upon technological changes itself. However, Skolnikoff do not proposes an analytical framework which allow us to consider the role of International Organizations in this process, since that for him only states are relevant actors of this dialectic. We have consequently to explore the tools and the modalities of action through which they affect technological change.

2.3. Multilateral Industrial Policy? International Organizations actions, tools, and strategies upon technological change.

We need to seize the opportunity to develop an alternative path and to understand how international public policy influence the development of innovations and trigger technological changes. In this part we will analyze how the academic literature have frame the way public policies have shape instruments and institutions that have affected innovations, and which of those tools are available to International Organizations. We will see that of these political instruments are multiple, but Industrial Policy have been a powerful instrument

through which public agents, often in partnership with private actors, have driven technological changes. However, since our study is focus on International Organization with a case study of the EU, this section will aim at defining the contour of what we will describe by Multilateral Industrial Policy. What elements have been developed in the literature which can help us give meaning to this concept?

2.3.1. How can we think the way through which International Public Policy act upon technological change?

Innovation Policy can be defined as the main driver through which public authority affect technological changes. More specifically, Marzenna Weresa[22] describes Innovation Policy as main tool impacting technological changes and bringing improvement in innovative performance of the economy. Innovation Policy is characterized as the interface of Science Policy, Research and Development Policy, Technology Policy, and Industrial Policy, all having specific goals and target regarding technological development in general. Those tools, usually categorized by the broad notion of Economic policy, cannot be only framed by the traditional purpose of correcting market failure, as they are traditionally describing. Indeed, the development of sciences and technology have indeed large impacts on societies and can cover multiple societal, cultural, or psychological elements, and their rational can cover technological backwardness or systemic failures[23]. Furthermore, their definition and categorization are defined by blurred limits. Their labeling also participated in in the social construction of the reality (i.e., the political meaning) of the political objective targeted by the public policy in technological changes, as well as actors participating in those policy. If the action upon technological change is carried out through the vocabulary and instrument of Science Policy, political action will target the development of scientific knowledge with specific instrument like financing public research organizations, including universities; if the action is made through Research and development policy, the objectives will be to produce and implement scientific knowledge, which include public aid to private sector in a precompetitive fashion[24] and incentives to firms to support their R&D activities as well as the protection of Intellectual Property Rights; if the action are made through Technology policies, the target of the public instrument will be the development and commercialization of sectorial technical knowledge through the public support to development of strategic technologies, and capabilities; and finally Industrial policies aim at shaping industrial complex and structure of a political community through public procurement, public support to strategic sector and standardization. Obviously, the differentiation between those different tools and objectives are socially constructed and in most case is interconnected. Their spectrum of interests as well as their target are overlapping, and their meaning, scale, purpose, and actors are always negotiated and renegotiated throughout the economic history of each political communities. It is however useful to keep those

[22] Weresa, M. (2017) "Research and Development Policy, and Industrial Policy: an Interface", in Ambroziak A. A. (Ed.) in *The New Industrial Policy of the European Union*, Springer, New-York, pp. 187-204.
[23] Lundvall B-A, Borra´s S (1997) "The globalizing learning economy: implications for innovation policy". DG XII Commission of the European Union, Brussels, p. 41.
[24] Usually justified with a compromise between the idea that public intervention should not create market distortion but also that public intervention is needed to stimulate

differences because they inform the cognitive universe actors are referring while they project their wish to act upon technological changes.

For the same reason Technological Changes cannot be analyze exogenously, the way public policy act upon technologies also has to be understood as an endogenous phenomenon of world politics. It is wrong to assume that economic policy tools associated with the general objective of technological development have its own independent dynamic. Actors framing such public policies do so also through a specific interpretation of their position in the world and a specific interpretation of the world itself. Indeed, the driver of the public intervention in the effort to upgrade each political communities' technological endowment cannot be dissociated from the general interpretation of the late stage of world politics as being the set of a global competition. Indeed, the emphasis to be "internationally competitive" which drive the way resources public authorities allocate to technological upgrades are substantially historically constructed by political actors, academics, and by corporate life in general. Lukas Linsi[25] describes the development of the primacy of the global competition in economic debate in the 1990's as being an extension of the neoliberal discourse of the 1980's, which was more focused on subordination of domestic politics to domestic markets rather than on the ability to position one's economy in the global market itself: "resulting discourse, which became very prominent in the aftermath of the Cold War, portrays the global economy as a game that revolves around national economies which stand in direct competition with each other for the attraction of globally footloose multinational firms" (p. 863). Let's consider that the technological development, especially in the field of telecommunication, was the driver of internationalization of economies in the 1990's and can be described, partly, as a driver of this change in the neoliberal discourse[26], however, let's also not dissociated it with the managerial orientation that academic and political through have gave to those new technological development, which created the framework through which globalization flourished at the time. Consequently, the policy orientation of public authorities regarding technological upgrade in the framework of international competition have been characterized by the aimed to develop what have been describe as "System of Innovation"[27], defined as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies"[28] or "all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring—the production system, the

[25] Linsi, L. (2020) "The discourse of competitiveness and the dis-embedding of the national economy", *Review of International Political Economy*, 27:4, 855-879
[26] Baldwin, R. (2016). *The Great Convergence: Information Technology and the New Globalization*, Harvard University Press, Cambridge, 344 p.
[27] Archibugi, D., Michie, J., Lockwhood Howells, J. R. (1999) "Innovation Policy in a Globalized Economy", *Technology Analysis & Strategic Management,* vol 11, n°4, pp. 527-539.
[28] Freeman, C. (1995) "The National System of Innovation in historical perspective", Cambridge Journal of Economics, 19, pp. 5–24

marketing system and the system of finance present themselves as sub-systems in which learning takes place"[29].

Consequently, we need to have a closer look at the way International Organizations have contributed to the development of those System of Innovation. International organizations are developing specific framework to facilitate the implementation of some Innovations policies. Atkinson and Ezell[30] focused on the role of global economic institutions in developing technological change and innovation. They state that Nations-States are developing "innovation mercantilism", creating a suboptimal global development of innovation, which directly influence the way policy implemented by International Institutions for economic governance: "As a result, the world produces significantly less innovation than is possible and is needed. The major challenge for the community of nations, therefore, is to create a robust global innovation system with considerably higher rates of win-win innovation and considerably lower rates of win-lose innovation" (p. 339). The authors attributed this problem to the fact that major global economic institutions are developed to suits to benefits of their creators, i.e., the world richer countries with the higher capacity to invest and develop in new technologies. If their analysis is definitely prescriptive in nature, it helps us to understand how the IMF, World Bank and World Trade Organization develop and implement de facto innovation policies. For the authors, The International System of Innovation supported by the IMF, the World Bank and the WTO substantially based on the international division of labor supported by the liberalization of trade, in particular, based on a division between Scientific and Technologic policy implemented in Western Economies and an Industrial Policy developed by Emerging Economies, China in particular. Firstly, the International Monetary Fund, established after the Second World War with the task to supervising the international monetary system and the mission to promote exchange rate stability and the progressive elimination of exchange restriction that hampered international trade. More specifically, the 2010 Article IV consultation of IMF's Executive Board praised the division between the subsidized industrial policy implemented by China and the Scientific and Technologic policies implemented by Western Economies through the way China undervalued its exchange rate. Secondly, the World Bank provided in 2008 $2.4 billion in loans to China which partly funded highway and freight rail projects, enabling Chinese industrial actors to import their products and to develop the Global Supply Chain and aimed at boosting the growth of both China and the West by boosting comparative advantages. Finally, the World Trade Organization, organizes the international rules to smooth the implementation such International Innovation System.

If the main purpose of those organizations is not to implement policies to develop and further technological changes, we can understand that their work creates in fact a specific type of international network of public and private actors, whose interactions modify the global stage of technological knowledge and affect

[29] Lundvall, B. A. (1992), *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, Pinter, London, 350 p.
[30] Atkinson R, Ezell S (2012) "Creating a Robust Global Innovation System", in *Innovation economics. The race for global advantage*. Yale University Press, New Haven and London, pp. 338-366

process of learning, searching, and exploring as well as the production pattern that emerge out of this process. Those institutions' interpretation and projection upon the world is the one of a global economy organized through a specific international division of innovation labor, where the Developed Countries produce knowledge, which can be exploited cheaply in Developing countries. By doing so, developing economies can consequently catch up the technological gap and improve their standards of living. However, it would be argued that those impact on technological changes are mostly indirect, and in fact they are, since those three institutions have not clear mandate regarding innovation policy. As we saw earlier, they rather serve a specific international regime, as described in the world of Ruggie. None of those organizations have the ability, resource, or purpose to act directly upon technological change and to truly implement an Innovation System at the Global level, but they participate to the creation of expectations, organize rules, and regulations as well as commitment which have been accepted by a group of states and which have been integrated in this specific global value chain of the production of knowledge and new technology.

Another, more interesting example is the Innovation Policy implemented by the European Union. The European Union implemented an innovation polity since its early years, which was mostly characterized by the tools and the target of technology policy and Research and Development Policy[31]. However, as we will see more in details in the third part of this final thesis, the contour of the European Innovation policy shift gradually toward the institutionalization of what we will describes as a Multilateral Industrial Policy. Before having this historical investigation, we need to first have a look at how the literature have studied and analyzed Industrial Policy, which will give us material to have an in depth understanding on the substance of the Innovation Policy that the EU have developed in its recent history.

2.3.2. Multilateral Industrial Politics (1): what is industrial policy?

As we saw, industrial policy is not only about technological upgrade, nor Technological policy involve necessarily industrial actors. However, the recent development of the literature on the Theory of Industrial Policy increasingly shapes this policy tools as a powerful driver for technological upgrades used by public authorities: technological progress, the development of economies of scale and the enhancement of the knowledge infrastructure are substantial driver for the re-emergence of political rediscovery of the Industrial politics by academic and public authorities[32]. Furthermore, the border of the concept of Industrial Politics are increasingly shaped by strategic consideration regarding technological changes. There is, also, an extensive literature viewing the European Union as an International Organization gaining extensive role in the matter.

The substance of industrial policies implemented by public authorities has varied over the history. It has gain new meaning, substances, and actors through the changes of international economic environment as

[31] Nugent, G, Paterson, W.E., Wright V. (1998) "Introduction", in Nugent, G, Paterson, W.E., Wright V (eds) *Technology Policy in the European Union*, MacMillan Press LTD, London, pp. 280
[32] Alcorta L, Szirmal A, Naudé W, *Pathways to Industrialization in the Twenty-First Century: New Challenges and Emerging Paradigms*, Oxford 2013.

well as the technological changes that supported it. Historically, national governments where the main actors of the modern industrial policy and its original main goal was to protect infant industries, "picking the winners" as well as channeling financial subsidies to private firms[33]. If today's mainstream economics are often skeptical about industrial policy since it can facilitate the implementation of market distortion and artificially impact prices, other scholars gradually consider it as an essential tool for the facilitation of industrial transformation, technological upgrades, and the improvement of social conditions[34]. As we saw, Industrial Policy is socially construct and thus, its definition of scope, scale, actors, and objectives are merely impossible to define objectively, and depend on the context in which it flourishes. Furthermore, the level of development of political communities will also give clue about the nature of industrial policy: "In less advanced economies, the main aim is to choose and establish a particular path of catching up, and the choice of vertical policies is in some sense easier, as developmental patterns across various sectors of industry have been well studied. In contrast, in advanced economies the future development patterns with regard to new industrial activities, new products and new technologies constitute uncharted territory."[35] Consequently, the idea of Industrial Politics is highly controversial, as Chang states: "Not just its effectiveness and generalizability, but also its definition and very existence have been debated"[36] (p. 83).

The economic foundations debate upon Industrial Politics can be divided into two categorizations established by Inoanna Glykou and Christos N. Pitelis[37]: the neoclassical market-failure based Industrial politics; and the systemic resource-creation industrial politics. The first one assumes that public authorities intervention is only needed to carry out specific and punctual case of market failure: "the main economic question raised by this perspective is how the decisions of firms operating in industries, over output and prices, impact on the efficient allocation of resources such as capital and labor, and therefor on the 'optimality' of the market economy" (p. 462). This perspective involves a specific set of methodological assumption such as the 'optimizing behavior' regarding the accumulation of profits and its main political policy project consist in reforms and instrument which allow the implementation of a "perfect competition". Such include mostly the public intervention to address the problem created by monopolistic situation, which creates by definition misallocation of resources, and are implemented through political tools such as anti-trust and competition policy. However, some authors argue that even in oligopolistic situation, industrial private actors will tend to behave through the modality of competition if the threat of potential competition exist in the mind of

[33] Hannon E, Monks K, Conway E, Kelly G, Flood P, Truss K, Mastroeni M (2011) "The state and industrial policy in Ireland: a case study of the Irish pharmaceutical sector". Int J Hum Resour Manage 22(1):3692–3710.
[34] Lin JY (2014) "Industrial policy revisited: a new structural economics perspective". China Econ J 7 (3):382–396
[35] Ambroziak A. A. (2017) "Review of the Litterature on the Theory of Industrial Policy", in Ambroziak A. A. (Ed.) in *The New Industrial Policy of the European Union*, Springer, New-York, pp.3-38.
[36] Chang, H.-J. (2011). "Industrial policy: can we go beyond an unproductive confrontation? In Annual World Bank Conference on Development Economics" (pp. 83–109).
[37] Glykou, I. Pitelis, C. N. (2011) "On the political economy of the state, the public-private nexus and insutrial policy", *Policy Studies*, 34:4, 461-478.

managers[38]. This perspective has as however a major issue: it focuses on *static allocative efficiency*, i.e. which do not explain how market structure and agents behavior are transformed by knowledge and innovation and consequently do not allow a dynamic analysis of objective of economic agents to improve their condition over time (what Glykou and Pitelis call inter-temporal performance). On the other hand, the resource creation industrial politics emphasis industrial policy analysis through the notion of "Public-Private nexus", a space the objective, nature and constraints of Industrial Politics are complementary established by states, firms, and the market. This perspective allows how the state and state's actors frame decision making regarding industrial politics, as well as the nature, objective, and structural constraint the public sector face regarding its relationship with the private sector. Two main branches are described in the article of Glykou and Pitelis: the neoclassical theory of the state, and the Marxist school. The first one, inspired by the work of Douglass North[39] state that state's agent follow a utility maximizing behavior pattern, especially regarding fiscal resource; and the second will study more in depth the relationship between states apparatus bureaucrats and capitalist collusion to analyze how the power of the later is legitimized by state apparatus. More broadly, this approach allows to see that Industrial Policy is also shaped by political considerations and strategy implemented by public and private actors regarding specific interest which have to be investigated. Moreover, it reflects the empirical evidence that market creation is not the *only* driver of public authority action in that matter.

Furthermore, we can argue that Industrial Policy is not *only* about industry (i.e. manufacturing): Rodrick[40] explained that policies generally described as industrial policy can target primary or tertiary sector since the type of market failures that call for industrial policy action are not specific to the industrial or manufacturing sector: "the right way of thinking of industrial policy is as a discovery process—one where firms and the government learn about underlying costs and opportunities and engage in strategic coordination" (p. 3). Another interesting approach can to industrial policy is proposed by Bianchi and Labory[41]: their observation on industrial policy allow them to propose a broad definition of it, which they frame as being a set of instruments which will have the purpose to implement structural adjustment process that would have an effect not only on the economic growth of countries, but which will also have an impact on their social and civil development. In a previous work[42], they also refer to Industrial policy as an effort from a political community to reorganize pattern of industrial specialization, which here allow us to open the door of the broad relationship between Industrial Policy and the World Innovation System. Consequently, for the author, Industrial Politics also produce political equilibrium, both within countries and between them. Wren[43] took a step further by propose a broad approach to industrial policy since he observes that: i. macroeconomic policy

[38] Baumol, W.J. (1982) "Contestable markets : an uprising in the theory of industry structure", *American Economic Review*, 72 (1), pp. 1-15.
[39] North, D. (1981) *Structure and Change in economic history*, Norton, London.
[40] Rodrik D (2004) Industrial policy for the twenty-first century. Faculty Research Working Papers Series, Harvard University
[41] Bianchi P, Labory S (2011b) "Economic crisis and industrial policy in the Union: the need for a long-term vision of industrial development". In: Posta PD, Talani LS (eds) Europe and the financial crisis. Palgrave Macmillan, London
[42] Bianchi P, Labory S (2006) "Empirical evidence on industrial policy using state aid data". Int Rev Appl Econ 20(5):603–621
[43] Wren C (2010) "The industrial policy of competitiveness: a review of recent development in the UK". Reg Stud 35(9):847–860

measures which have the purpose to stabilizing the economy can be include in the framework of industrial policy if they include measure which aimed at promoting some segment of the production; ii. Public policies which concentrate their action on specific company, distinguishing them from other broad sectors or industries, can also be framed as industrial policy; iii. Policies which have an unintentional impact or influence on the industrial structure can also be understood as being industrial policy. This approach, if interesting, seems however too wide since it does not allow us to discriminate specifically what Industrial policy affect the development of System of innovation in a political community.

Finally, we will hold on to the definition provided by Ambroziak, which will help us set the basis of an industrial policy targeting the transformation of the innovation system: "On one hand, industrial policy concerns all objectives, activities, and tools and their effects on industry *per se*. On the other hand, due to substantial changes in business models, consumers' needs and expectations, and access to new techniques and technologies, including digital platforms, traditional industry has evolved into a new industry. This phenomenon is characterized by less focus on manufacturing and the ownership of goods and is much more interested in access to them. This access is offered by service providers, who were formerly only manufacturers or recently established middlemen between producers and consumers. Therefore, the traditional approaches to industrial policy are outdated and not relevant to the present economic and social situation in the market"[44]. To sum up, Industrial Policy regarding the Innovation System in Developed Countries are all public policy which will have the possibility to impact the economy through technical upgrade. It will aim to implement structural change in the production pattern and the access to knowledge and to foster the global economic performance of an innovation system in the global competition. By doing it, it will also reorganize its specialization pattern in the global technological division of labor while producing sociopolitical development goal at large, which will be negotiated in function of the actors involved and the interpretation of the possibility offer by the technological upgrade.

We should now have a look at an International Organization which successfully build a specific type of industrial policy for the development of a system of innovative: the European Union.

2.3.3. Multilateral Industrial Policy (2) the development of a European Industrial Policy in the literature and its link with Innovation System.

Authors will help us to understand how to conceptualize the recent development of the European Industrial Policy, such will consequently help us to frame of this very specific type of policy aim to act upon the European Innovation System.

[44] Ambroziak A. A. (2017) "Review of the Literature on the Theory of Industrial Policy", in Ambroziak A. A. (Ed.) in *The New Industrial Policy of the European Union*, Springer, New-York, p. 33.

Firstly, Heinz Zourek[45] connect the technological policy objective of the European Union to its industrial objective goal, since 80% of EU private sector research and development are focused on manufacturing sector: "industries therefore provide the major impetus for the development and adoption of new technologies, and they are a key driver of productivity growth". If we also consider the share of manufacturing product in international trade being far larger than the share of services, and that manufacturing is a key driver of the creation of jobs and growth, the author state that the European Union cannot dissociate itself with this policy instrument. The author describes EU industrial politics as the implementation of policy which would "to provide the right framework conditions for enterprise development and innovation and to help manage the process of industrial change […] In addition, industrial policy has a key role to play in addressing market failures and complex coordination issues where technological development, standard setting, and the generation of wider benefits to society are linked" (p. 286). Consequently, for Zourek, European Industrial Policy cover three main elements: firstly, it implements and improve horizontal framework conditions. This can concern competition policy and R&D policy for instance. Secondly, EU policy enhance sectoral framework conditions by implementing suitable regulatory structure for specific sectors, involving both national and EU level, in order to promote EU position in the global competition. Thirdly, the implementation of sectoral specific policies which aimed at fixing market failure linked to externalities or coordination problems. The author insist that this activist approach is more likely to be more important for technology development policy, especially regarding standard setting and the purchasing of public goods. European Industrial Politics are designed to give answer to two major challenges that technological changes have brought. On the first hand, technological changes transform industrial processes and productive system at large, challenging traditional manufacturing methods and pressing them to be more flexible and to reduce costs. On the other hand, technological changes, mostly linked with the falling communication and transport costs, allow the implementation of global value chains and global production networks, which are challenging European industries too. Hence, technological upgrade and globalization are opportunities as well as obstacles for the European Industries. The European Industrial Policy have then also the task to help the European Economies to take the best outcome out of those two trends. The approach elaborated by Zourek allow us to designate the broad line of action the EU have regarding Industrial Policy and how those influence technological changes and is influenced technological changes. However, we can argue that such is very descriptive and do not allow us to understand the social construction of the European Industrial Policy nor the way world politics gives meaning to it.

Another less descriptive approach has been development by Aiginger and Sieber[46] through the notion of "matrix approach" to analyze the European Industrial Politics. The first time the term "matrix approach"

[45] Zourek, H. (2007) "The European Commission's New Industrial Policy in an Integrating and Globalizing World", J Ind Compet Trade, n°7, 285-295.
[46] Aiginger, K. and Sieber, S., "The matrix approach to industrial policy," International Review of Applied Economics, vol. 20, no. 5, pp. 573–603, 2006.

appear was in a Background Report wrote by the authors in 2005[47]. In addition to globalization and technological changes, the authors describes also different trend that have push the an regain of interest for the development of an Integrated Europe wide industrial politics: the decelerating growth rates, the stagnating unemployment at high level, the fear of loss of core industries which would accelerate the already alarming trend of deindustrialization of European economies, as well as the integration of new member states creating a relatively high wealth imbalance between old member and new member was also core reason why political actors agreed to rethink how to frame the action of the EU to foster industry. However, the most decisive change was a "basic philosophical change": "On the one hand, the primarily horizontal approach has been maintained, i.e. measures are general and provide for a favorable competitive environment (that is, they are not industry-specific, selective, or conducive to the deceleration of structural change). On the other hand, it is acknowledged that the effects of broad horizontal policies can vary significantly from industry to industry, that competitiveness needs specific policy mixes for specific sectors, and that some sectors may require complementary measures that are not necessary or relevant in other sectors" (p. 8). The concept of Matrix approach of industrial policy refers consequently to this dual horizontal-vertical policy to act upon industrial sector. This New Industrial Policy cannot be dissociated from the Lisbon Strategy, an action and development plan for the European Union to enhance growth (the objective was to achieve 3% of growth rate in the European Single Market) and employment at the horizon 2010[48], with a specific emphasis on research and development as well as industry, since this strategy establish as a goal 3% of GDP expenditure for R&D, which should boost the flexibility and the resilience of European productive system facing global competition. Furthermore, the author states that the role of industrial policy in the broad economic policy and economic strategy of the EU seems increasingly strengthening: "Many elements of the New Integrated Guidelines for Growth and Jobs, which since 2005 have been seeking to integrate macroeconomic policy, labor market policy and the Lisbon Strategy (European Commission, 2005B), refer to industrial policy issues: open and competitive markets, an attractive business environment, entrepreneurial spirit, investment into R&D, ICT, and strengthening the industrial base" p. 30). In another article, Aiginger[49] introduce the concept of "Systemic Industrial and Innovation Policy". This article is very prescriptive in its substance, and the author aimed at providing a framework to develop an European wide industrial strategy that would enhance European economy in the context of the "2020 strategy", since the Lisbon Strategy have mostly failed to meet its targets (Aiginiger estimate that the top-down approach designed by the commission was not flexible enough for the governance model of the EU and that it was not connected to industrial strategy of its member states). Consequently, the idea to implement a "systemic" industrial refers to the idea that such industrial policy has

[47] Aiginger, K., Sieber, S., (2005) "Towards a renewed industrial policy in Europe, Background Report of the Competitiveness of European Manufacturing", WIFO.
[48] https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/00100-r1.en0.htm
[49] Aiginger, K. (2012) : "A Systemic Industrial Policy to Pave a New Growth Path for Europe, WIFO Working Papers", No. 421, Austrian Institute of Economic Research (WIFO), Vienna

to derive from the goals of the society itself, i.e. it is pushed by global competition and technological challenges and pull by a specific vision for growth driven by societal goals.

Finally, Julie Pellegrin, Maria Letizia Giorgetti, Camilla Jensen and Alberto Bolognini[50] elaborated the idea of a "Platform Model of Industrial politics", which describe the multistakeholder and multilevel governance model of the EU industrial policy. Since the New Industrial Politics approach elaborated by the literature since 2000 is wider in its scope, and consequently wider in the number of actors it involves. EU Industrial politics should, consequently, be elaborated with a special emphasis on the interests of this multitude of actors as well as institutions where these interests are catalyzed, but also to mediated the diverging perception of those actors regarding, the scoop, scale, goals and tools such policy would imply: "The hypothesis is that besides rational arguments defended by economists, experts and informed observers, the positions of relevant stakeholders determined by the perceived gains and losses expected from policy shifts, are fundamental factors impinging on the future development of an EU industrial policy" (p. 49). Industrial politics have then the task not only to propose and implement policy which will have a direct effect on the productive system of an economy, or like in our case study, on its Innovation System, but should also organize platform where the interest, perception, and the will of both actors from the public and private sphere can converge. From the business, point of view, the target of EU industrial politics has to be link with measure that will enhance business friendly environment able to catalyze and stimulate private investments. From the policymakers interviewed, they elaborate a position about the EU industrial politics in which its primarily mission consist with the implementation of a political space which allow the completion of societal and political goals across member states: "the EU is expected to ensure complementarity and cooperation between different countries and regions. Instead of duplicating efforts, the objective is to cooperate on the basis of territorial specificities. One facet of this is the distinctive role of "knowledge platform" that the EU can play" (p. 53). To sum up, EU industrial policy is balance between its role in term of "levelling the playing field", promoted by business association, and more extensive approach from public policies actors willing to promote the knowledge-broker role of the EU. Finally, member states actors promote an industrial policy which will allow their economies to be more connected to the production system of the EU: "Peripheral" Member States dependent on Cohesion Policy, for example, place high expectations on an EU industrial policy. The fact that these countries were hit hardest by the crisis and that they are experiencing relatively more rapid de-industrialization calls for specific attention and possibly distinct approaches in their cases." The study of EU industrial policy is, by essence a study on its actors and their space of interaction.

[50] Pellegrim, J. Giorgetti, M. L. Jensen, C. Bolognini, A. (2015) "EU Industrial Policy : Assessement of Recent Developments and Recommendations for Future Policies", Study for the ITRE Committee, European Parliament, Brussels.

2.3.4. Preliminary Conclusion.

International Organization implement international public policy in order to influence the development of innovations and trigger technological changes. As Archibugi, Michie and Howells have describes such public policy target essentially the structure of a System of Innovation, and the driver of the public intervention in the effort to upgrade a System of Innovation cannot be dissociated from the general interpretation of the late stage of world politics as being the set of a global competition, an interpretation which is not a natural given, but which is historically construct and institutionalized by actors reflexiveness. The European Union implemented an innovation polity which has shift toward the universe of Industrial Policy. Indeed, the recent development of the literature on the Theory of Industrial Policy increasingly view this policy tools outside of its 20th century "pick the winner" or market-failure mitigation devices paradigm. Increasingly, industrial policy is analyzed and understand as an instrument of innovation policy, since it targets technological progress, the development of economies of scale by productivity upgrades, and the enhancement of the knowledge infrastructure. Consequently, the EU industrial policy have been characterized by technological objectives, and several authors tried to develop framework to analyze the contour of this international public policy. Zourek distinguished the goal to improve horizontal framework conditions, enhance sectoral framework conditions, and to develop sectoral specific conditions. Aiginger and Sieber, on the other hand, integrated all those public policy into a comprehensive one they call "matrix approach" of industrial policy, since for them horizontal and sectoral approaches cannot be dissociated from each other. Finally, for Pellegrin et al., they develop the idea of "platform model of industrial policy", framing the matrix approach into the multistakeholder and multilevel governance giving a meaning and a purpose to industrial policy. However, for our study of industrial policy as an endogenous adaptation regarding globalization and technological changes, we need to elaborate a reflexive approach to the institutionalization of platform model of industrial policy. Like technological change and globalization, Industrial Policy, understood as an answer to those phenomena, is socially construct. Its definition of scope, scale, actors, and objectives are merely impossible to define objectively, and depend on the context in which it flourishes. Thus, the institutionalization of an European Industrial Policy is framed by the as an answer to globalization challenge, which tried to be overcome by technological upgrades.

2.4. Conclusion of the State of the Art.

This review of the literature shows us major points which will be structural in our study. We saw that technological changes have to be understood as a social construct, which gain meaning and develop its dynamic in the social realm of world politics. Technological changes never have sense in itself, but gain meaning through the interpretation of actors. One of the types of actors, which is influenced by, and which influences technological change, are International Organizations. Indeed, technological change create specific types of interdependence, and such types of interdependence allow the institutionalization of collective

responses in the form of International Organizations. Such institutions which will have a specific agenda as well as resource and modalities of actions which will defines International Organizations' actorness in Global Politics. In turn, International Organization establish public policies which act on technological change, since it will develop and favor specific Systems of Innovation. These public policies will be framed through a specific interpretation of actor on technology as well as world politics. Consequently, economic policy tools and institution associated with the general objective of technological development have not an independent dynamic, but is, like technology itself, are socially construct by actor through their interpretation of their global and local contexts. We saw that, since the 1990s, such context is defined through the modality of international economic competition, and, in the specific case of the EU, by structural challenge that the European economy and the single market is facing. We saw that the driver of the public intervention in the effort to upgrade each political communities' technological endowment have been characterized by the aimed to develop a "System of Innovation" defined as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" or "all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring—the production system, the marketing system and the system of finance present themselves as sub-systems in which learning takes place". International organizations are developing specific framework to facilitate the implementation of some Innovations policies which will strengthen their innovation system in regards of the international competition. Some International Organizations having a global reach can implement policies which will facilitate the development of a Worldwide Innovation system.

The policy tools to enhance Innovation system are multiple, and their scope, and substance cannot follow an objective categorization. Furthermore, the instrument used as well as their meaning depends on the way actors interpret international and local context in a specific point in their history. However, such policy tools have, in the European context, more and more been categorized in the literature and by actors through the notion of Industrial policy. Industrial policy, in the first decades of the 21st century, have been framed as a policy promoting the development of Innovation system which will improve economies' technological endowment and hence its competitiveness in the global market. Recent Industrial politics implement in Developed economies cannot be dissociated with the improvement of technological endowment. Industrial politics of the 21st century have been shaped gradually as a driver for technological upgrades. Furthermore, it is wrong to assume that industrial politics is only about manufacturing. Indeed, now it concerns all sector of the economy, and it is also wrong to assume that Industrial policy only target market failures. Industrial policy is a set of instruments which will have the purpose to implement structural adjustment process that would have an effect not only on the economic growth of countries, but which will also have an impact on their social and civil development. Industrial policy can also be described as an effort from a political community to reorganize pattern of industrial specialization, which will have an impact in the way its Innovation System will (or will not) be connected to a Global Innovation System. More broadly, the recent development of the literature on

the Theory of Industrial Policy increasingly views this policy tools as an instrument of innovation policy, since its objective are always oriented toward technological progress: it can aim at improving productivity, enhancing knowledge infrastructures, developing strategic industries, upgrade the position of the political economy in the global value chains etc.

The European Union is an example of an International Organization which use the cognitive universe, the tools and the actors traditionally associated with Industrial Policy, in order to enhance the development of European wide Innovation system. Such policy is implemented in order to make Europe more competitive in the global economy as well as enhancing socioeconomic conditions of European societies. The approach elaborated by Zourek allow us to designate the broad line of action the EU have regarding Industrial Policy and how those influence technological changes and is influenced technological changes. However, we can argue that such is very descriptive and do not allow us to understand the social construction of the European Industrial Policy nor the way world politics have provided meaning to it. Aiginger and Sieber, through the notion of "matrix approach" to Industrial Politics, allow us to understand European Industrial policy thanks to a cognitive change that happened regarding the attitude of the International Organization with economic policy and technological change, which was pushed by a specific interpretation by actors regarding the late stage of the European economies, characterized by structural challenge regarding growth, unemployment, and deindustrialization. Consequently, to coop with those challenge, the EU used a combination of sectoral industrial policy, which target specific part of the productive system and specific industries, as well as horizontal industrial policy, more interested by the general business environment. Finally, Pellegrin et al. elaborate the idea of a "Platform Model of Industrial politics", which describe the multistakeholder and multilevel governance model of the EU industrial policy. Industrial politics have then the task not only to propose and implement policy which will have a direct effect on the productive system of an economy, or like in our case study, on its Innovation System, but should also organize platform where the interest, perception, and the will of both actors from the public and private sphere can converge. We will however criticize this approach, since it does not allow to think the historical dynamic shaping the institutionalization of the European Industrial Policy. Indeed, the development of the EU industrial policy of the 21st, targeting technologies of the 4th industrial policy, had been shaped by the history of the European integration, the history of technology and the history of globalization.

To categorize the European Industrial Policy through the concept of "Multilateral Industrial Politics". Such notion is supposed to combine the multi-level and multi-stakeholder substance of the European Industrial Politics, as well as the dynamic and reflexive nature of that have shaped these policies, which based its objectives and instruments with an interpretation of the stage of the world and the opportunities technologies offers. Furthermore, we will acknowledge that such policy consists not only of providing platform where actors confront their interest and definition of the situation, but also establish actorness of the European Union vis-à-vis technological change and world politics. Multilateral Industrial Politics is a crystallization the

dialectic transformation brought by innovation and globalization, it is a product and a producer of transformation in technological and international realm. This idea will also allow us to recognize the specific historical trajectory of the European Industrial Policy, which we will analyze in the next section. The way industrial politics is construct as a tool to further the Innovation System in the at the beginning of the 21st century is historically construct. Indeed, the history of the European Industrial Policy, that we have categorized as a multilateral industrial policy, have been institutionalized thought the history of the European integration in a particular way that have shape its current design. We have to study more in depth how actors have interpreted political opportunities to oriented European Economic Policy toward the modalities of Industrial Politics, and how this Industrial Politics have been established as a driver for the enhancement of the European Innovation system in which the 5G Infrastructure policy have flourished.

In the next part of this final thesis, we will stress three major periods regarding the role of European institution in industrial politics: the first decades are characterized by attempts to found a classic sector-oriented industrial policy at the supranational level; the second as being a market-oriented and competition-driven industrial policy as an adaptation of the previous failures of the vertical industrial policy, and we will see lastly how the industrial Renaissance takes roots in an attempt of synthesis competition-oriented industrial policy with a more interventionist approach, in which the creation of the 5G PPP found its foundation. Indeed, the shift in paradigm imply a cognitive equilibrium between competition and market-oriented policy, which is at the core of the DNA of the EU institution regarding economic policy matters since the 1980s's, and a pragmatic approach seeing the market as being unable to fully manage its dysfunctionality and to implement large scale infrastructure.

3. Historical Dynamic: The path toward a European Multilateral Industrial Politics.

3.1. Introduction.

The history of the creation of an integrated System of Innovation at the European level and the history of the public policy that have shaped it by European actors cannot be dissociated from the History of European political economic integration at large. The role, tools, and scale of the Industrial policy for the development of the European Innovation system is linked with the particular history of the 1990's and 2000's. Before that, attempt to implement industrial policy at the level of the EU were linked to traditional sectoral and dirigiste objective, which, as we will see, failed for structural reasons. Indeed, when we think about the role of the European Institution in the realm of the economy since Schuman's Declaration in 1950, Industrial politics is not an issue that seems central. Indeed, if the European Union ancestor, the European Coal and Steel Community, was primarily based on industrial cooperation and coordination, the path toward the European economic integration shift dramatically from common industrial objective toward other objectives such as the construction of the common market, the enlargement, the single currency, and the Common trade policy. Indeed, if in the 1960's and 1970's, there was both an inclination to converge towards a Common European industrial policy at the institutional level as well as an intellectual attractiveness for such concept. However, due to multiple failure, the contour of the European Industrial Politics left its sectoral approach for an horizonal one, more focus to develop a sound environment to help the development of Industrial Actor. Such horizontal approach gradually took gained substance throughout the 1980's and 1990's, where EU actors implemented both a competition-oriented economic policy aiming at developing a true competitive single market, as well as a technology policy, aiming at promoting cooperation and coordination of research and development at a precompetitive stage of production. In a context of "manufacturing renaissance" in the 2000's, such policy paradigm was challenge and actors had to rethink how the EU could approach industrial policy through a what we have described as a multilateral industrial policy, which will allow to handle both the pressure of globalization and to catch up technological backwardness. A close examination of those industrial policy paradigms and their evolution will help us frame the institutionalization of the multilateral industrial policy paradigm in which the 5G PPP is built upon, as well as understand how the European Union adapt its innovation policy answers to dynamic change of the innovation-globalization dialectic. Balanced between competitive oriented policy, technological policy, and pressure from the global economy to find new ways to boost the competitiveness of the EU economy through technological upgrades, the 5G PPP is the fruit of a specific institution that we have to investigate in depth if we want to seize the true heuristic value of an investigation of this policy.

3.2. European policy: from 1950-1975.

To analyze the prehistory of European Industrial policy, we need to take a closer look to three major International Organization which set up the core of what would be a European Common Industrial politics for the first decades of the European Construction. Their emergence came from the development of technologies, and how actors have interpreted that those technologies established interdependence among them. Such pattern of interdependence has also been shaped by political considerations: the prehistory of the European Industrial Policy is also, as we saw in the State of the Art, a prehistory of an Integrated Innovation System, elaborated by a specific interpretation of the place of Europe in the World politics. However, as we will see, those institution had a loose impact on the development of such innovation system, also because the Industrial Policy of the time was more oriented by the production of commodities than knowledge[51]. This was a period where European states implemented extensive interventionist policies in industrial sector and the manufacturing in particular. No specific political pattern or a common feature regarding strategy adopted can be underlined in all countries. "Rather, industrial policy was based on variety of mechanisms and directed towards different fields ranging from the promotion of specific technologies, the creation of infrastructures, energy policies or a distinctive protection of certain branches"[52].

3.2.1. 1950-65: structural difficulties highlighted by the first European Institutions.

The Treaty establishing the ECSC mattered because it was the first time that an International Organization, here the Hight Authority, had the ability to deliver binding decision regard industrial matter (Art. 14) in one of the most strategic industry of the member state at the time, especially in the context of the reconstruction (which was not achieve yet in 1951)[53]. The Treaty of Paris provided a lot of competences to the High Authority regarding market regulation (For example, the Art. 61 include in the jurisdiction of the High authority the ability to set Maximum and Minimum prices, and the Art. 66 gives it the power to regulate "merger, acquisition of share, asset, loan, contract or any mean of control") and market structuration (the art. 54 giving it the ability to carrying out "investment programs by granting loans to enterprise or by giving its guarantee to loan which may obtain elsewhere"). However, the Hight authority had a very cautious approach regarding its power. For, the example of the 1958-1959 crisis in the Belgium mines, where a sharp rise in coal stocks accompanied by falling demand resulted in the closure of a number of mines[54], the six member-states did not allow the High Authority to execute its proposed industrial policy measures[55]. However, if the effectivity of the ECSC as an economic level is surely lower than what the founding father intended, it has

[51] Sauter W. (1997), *Competition Law and Industrial Policy in the European Union*, Clarendon Press, Oxford.
[52] Grabas, C., Nützenadel, A. (2013) "Industrial Policies in Europe in Historical Perspective" , WWWforEurope Working Paper, No. 15, p. 7.
[53] Bussière, E. (2007), 'Chapter XXIII. L'improbable politique industrielle', in: Michel Dumoulin (ed.), *La Commission européenne, 1958–1972. Histoire et mémoire d'une institution*, Brussels: Office de publication des Communautés européennes, pp. 471–485
[54] Anonym, (1959) "The Coal Crisis in Europe", *The Economic and Political Weekly*, vol. 11. April 4 1959.
[55] Leboutte, R. (2009), *Histoire économique et sociale de la construction européenne*, Brussels: Lang, pp. 408–416.

probably another merit. Indeed, such institution provided "the psychological space"[56] for the newborn European Community to move forward with a collective will and imagination which had fueled the integration process beyond the sole goal to create a true supranational industrial policy.

Euratom was the other truly industry-oriented European institution from the first decade of the European integration. Created by the Treaty of Rome of 1957 as a sectorial organization to develop the civil nuclear energy, here again including theoretically large autonomy of the organization in order to implement policy (the Chapter 4 of the treaty establishing ERATOM provided the organization the ability to publish investment plan, or the art. 74 establishing special right for the commission to establish policy regarding transfer, import or export of fissile materials, especially uranium). However, the scale of the success of this institution was remarkably low: Common research centers were established – the main one being located in Ispra (Italy) – but they took care only marginal of activities and low budget were attributed. This was due to two conjunctural problems: the low price of oil during the 1960's made the civil nuclear energy less attractive compared to other fossil energy, but also the vanishing of the initial support from France during the Gaullist area, which decided that this technology should be better implemented at the national level due to political reason[57].

Finally, the Organization of European Economic Cooperation, established in 1948, considered as the most successful institution regarding European economic integration, was based mostly on free market rules and normative harmonization among Member States (the best known of such policy was the establishment of the four liberties of circulation). The spirit of this institution largely inspired the treaty of Rome, which created the European Economic Community as being the major framework of the supranational politics until the Maastricht treaty of 1992. Following this free trade fashion, the only mention regarding industrial policy were linked to competition policy, the monitoring of state aid (articles 92 to 94 EEC), and only industrial sector mentioned was shipbuilding (article 92 C), but also with a stress put on the limitation of state aid. The absence of industrial policy the EEC Treaty is connected to the fact that a free-trade provisions and on regulating liberalism constituted the lowest common denominator among European member state regarding the European cooperation. Indeed, the three biggest industrial power of the EEC had different vision of the target and the manner to implement industrial policy: France was a promotor of planification, but was reluctant to give power to supranational organization[58]; Italy's aim for industrial policy was design to target a regional policy founds for the Mezzogiorno and not necessarily to stimulates its economy; and West Germany was concerned about a model of Industrial policy which would be compatible with its "social market economy", then rejecting de facto interventionist policy.

[56] Judt, T. (2005), Postwar. A History of Europe Since 1945, Penguin, Part I,chap. 2, Retribution, p. 158.
[57] Leboutte R. Ibid. pp. 439–441.
[58] Warlouzet, L. (2011), « Le choix de la CEE par la France », in Warlouzt L. *L'Europe économique en débat de Mendès-France à de Gaulle (1955–1969)*, Paris: Cheff, pp. 30–35, 39–43.

3.2.2. 1965-1975: intellectual rise of common industrial policy with few concrete applications.

If the first years of the European construction seems to give few concerns regarding industrial policy, the 1960's gave rise to a shared questions regarding the matter. Moral entrepreneur raised the issue especially regarding international competition. Indeed, the Kennedy round of the GATT (1964-67) reduced European and American tariff by 35%, creating big concerns by European industrial actors and intellectual about the ability of the European industries to compete with the American ones. The Union des Industries de la Communauté Européenne published a memorandum comparing the size of the most important company across the Atlantic. The purpose of this document was to show that Europeans private actors did not have comparative advantages to scale up as American companies. In these spirits, they advocate to increase the legal integration of the EEC single market in order to consolidate European base industries through fiscal incentive and legal provision allowing them to merger more easily inside the new born European market[59].

In the same vein, the book *Le Défi Americain*[60] by French Journalist Jean-Jacque Servan-Schreiber supported the creation of a strong common European industrial policy in order to build large-scale high technology manufactures able to compete with American industries. In his view, such policy should be implemented through the creation of a favorable environment for European mergers, but also by the development of genuinely supranational policies for research and high technology (and not just the coordination of national initiatives as it was already the case). The book *European advanced technology: a programme for integration*[61] wrote by the British Christofer Layton advocate too for a strong common policy regarding scientific and technological cooperation. Here too, the author stressed the challenge of the competition between European Industries with American ones, but had a more programmatic stands. Indeed, Layton solution was more concerned about the creation of forum creating true cooperation in technological innovations field (it is noticeable that Layton will have a strong influence in EEC politics since he will be the advisor of Spinelli when he will be Commissioner of Industrial affairs in 1970).

The supranational industrial solution was also advocate by several European state, which were receptive toward such concern, and attempt were tried to implement an active European Industrial policy. Firstly, and before the empty chair crisis stopped those projects, France tried to implement a working program which included two main goals: the development of common status of European company (facilitating intra-European mergers) and the coordination of technical and scientific research program implemented at the national level. Secondly, the Minister of Foreign Affair of Italy Amintore Fanfani proposed in 1966 to create a US-Europe program of technological cooperation through a "technological Marshall Plan", a proposition

[59] EUA, BAC 26/1969/601, letter from H. J. de Koster (UNICE) to Walter Hallstein, 3 March 1965, in Warlouzet, L. (2014), "Towards a European Industrial Policy? The European Economic Commuinty (EEC) debats, 1957 – 1975", in C. Grabas, A. Nütenadel *Industrial Policy in Europe After 1945, Wealth, Power and Economic Development in the Cold War.* Palgrave Macmillan, New York, pp. 219.
[60] Servan-Schreiber, J-J. (1967), *Le défi américain*, Paris: Denoël, 343 p.
[61] Layton C. (1969) *European advanced technology: a programme for integration*, Routledge, pp. 296

supported by British Prime Minister Harold Wilson who lunched the theme of a "European Technological Community" (an attempt also to support the integration of the UK in the EEC). In West Germany, the new SPD-CDU coalition lead by Chancellor Kiesinger, less free market oriented than his predecessor, was also more open to such proposition in order to mitigate the technological gap between continental Europe and the United Kingdom.

At the level of EEC officials, some French and Italian commissioners tried to implement a more interventionist interpretation of European treaties, influenced by the planning tradition of those two-industrial power, in order to curb the German market-oriented interpretation of the 1957-65 period. We can take the example of commissioner Robert Marjolin who tried to implement a European planning with the creation of the medium-term economic policy committee in 1964. If this attempted failed, the legacy of the spirit of this project remains, especially during the 1967 merger of the EEC Commission, the ECSC High Authority and the EURATOM Commission. In the internal structure of this new merged commission, a new DG III "Industrial affairs" and DG XII "General and Technological Research" was created, with clear mandate regarding industrial cooperation and policy at the European level. After this milestone, four key proposals, based on the 1967's Memorandum "sur la politique industrielle de la Communauté", were developed by the European commission in order to deeper its role in Industrial policy. The first one intended to progressively remove fiscal and technical barriers to trade that remained after the removal of custom duties, in order to increase competition in industrial sector while completing the implementation of the single market, which will be a constant concern of the EEC commission until its implementation by the Single Act of 1986. The second and third proposals intended to promote a European-wide concentration of capital in manufacturing sector through the removal of fiscal and legal barriers while to expanding research and development thanks to a common technological and scientific policy. The fourth proposal aimed at implementing sectoral policies, both for high-technology and for declining sectors, matter already with national interventionism in all EEC countries.

None of those initiatives were finally implemented, due to a triple problematic at the level of Member States: divergent view on the economic model to adopt (linked with different national tradition), divergent view on the role of the EEC institution (as a coordinator or as a supervisor of such policy), and divergent view of the geographical scale of those policy (with the hot topic of the integration of the United Kingdom and the United States in those policy). To sum up, it is the "inability to agree both on the institutional and economic issues"[62] that trigger the failure to implement a truly effective industrial politics, a problematic that were already present during the difficulties to give effect to power of European institution during the 1950's. On

[62]L. Warlouzet (2014), "Towards a European Industrial Policy? The European Economic Commuinty (EEC) debats, 1957 – 1975", in C. Grabas, A. Nütenadel *Industrial Policy in Europe After 1945, Wealth, Power and Economic Development in the Cold War.* Palgrave Macmillan, New York, pp. 213-235.

the first matter, West German government was cautious toward any interventionist policy due to doctrinal issue, and the French government was reluctant to delegate power to EEC institution while being skeptic of the involvement of the UK and US, countries holding key technologies and knowledge without which any progress would have been made. Moreover, major legal issues arise regarding the creation of a European company status: Deprived of a single legal framework shared by all Member States, corporations located in countries with a less flexible legal environment would merge with another corporation in countries more liberal on the matter to escape their national obligations (creating, for instance, problem for German business which would avoid representation of worker in the management at the core of *Mitbestimmung* system).

3.3. European policy: from 1975 – 1992, the triumph of Horizonal Industrial Policy to manage the European Innovation System.

As we saw, if the question of the creation of an industrial policy during the first years of the European construction existed and was theoretically supported by intellectual, Member States official and European civil servants. Those initiative were supported by the interpretation that the outside competition of the American Economy created the need to reorganize the Industrial production system in order to be more competitive. It was also implemented to seize political and economic opportunities that the implementation of new technologies in the industries could bring. However, the pattern of independence of such policy was weak and margin were left to countries to keep national interest in track. The multiple failure to build interventionist institutions to managed industrial policy at the European level will open the door to another approach managed through the tools of negative integration, e.g., competition policy[63], but also though ad hoc intergovernmental initiative, like Airbus, Ariane, Tornado etc. Furthermore, institutions were implemented at the EEC level with the purpose to promote European industrial performance in the high technology sector, mostly through research and development policy.

3.3.1. Reasons of declines of interventionist attempts.

We then need to size the decline of dirigiste sectorial industrial policy attempt at the EEC level through three main drivers: failure of previous efforts to implement it, a decline of the manufacturing sector after the oil shocks, and the increasing attractiveness of neoliberal policy since the end of the 1970's. Problems of concrete application as well of clashes among actors of European policy occurred regarding the tools, methods and purposes of such policy, as the conflict upon research policy between the Altiero Spinelli and Ralf Dahrendorf exemplified. Dahrendorf, commissioner in charge of research (DG XII), was an advocate of the intergovernmental role of EEC institutions and was in favor of ad hoc solution regarding the implementation of research and scientific cooperation among Member States, somehow disconnected from industrial policy. For him, research policy should not be focus on industrial application (he was more concerned with

[63] Goybet, C. (1991), 'La CEE a-t-elle une politique industrielle?', Revue du Marché Commun n°352, pp. 753–755

fundamental research), neither being framed in the EEC institutions. Spinelli, on the other hand, advocate for a more positive and ambitious fashion, suggested the creation of European Research and Development Committee dedicated to founds and structure administratively a forum for a common Research policy, with the ability to coordinate expert groups and which would serve as a basis for the European Commission to suggest common action to the European Council. For him, the research policy should strengthen the European industrial base while having a social and environmental orientation. The outcome of this conflictual view over the interpretation of the targets, the scales and institution framing the research policy can be stress as the model of the industrial policy of the EU in general after 1975: the CERD was finally created in 1973, but only as a consultative agency without programmatic or financial power[64]. This story should also highlight the emergence of Research and Development Policy over Manufacturing Policy in the mindset of European institutions. Indeed, this trend will be increasingly important throughout the 1970's and 1980's as the export-oriented economies of South-East Asia and Japan will ship the focal point of global competition toward ICT and other capital-intensive technologies.

At the international level, the oil shock consequences on the productive system of Member States raised intellectual concerns about the ability of interventionist policy to manages industrial policy while weakening the power of Industrial actors in EEC institutions regarding financial ones. The increase of the price of oil from 3 to 12 US$ a barrel between October 1973 and March 1974[65], which further led to a stock market crash in 1973-1974. Consequently, a global economic recession triggered a purchasing power worldwide. Oil price shocks transmitted through supply channels especially in the industries with high oil and energy intensities, and other industries experience oil price shocks through reduction in demand[66]. The global market could no longer absorb all of the products manufactured worldwide leading to a production crisis in the European manufacturing sectors. This event was the raised questions regarding the very core of the planification strategies and interventionist policy in general, saw as not flexible enough to adapt to the instability of the global market[67], which was increasing in importance in the mind of private and public actors. The ideological solution which appeared was a direct consequence of that particular period. If industrial policy did lose its institutional dynamics of the 1965-1975 period, interventionist policy also lost progressively its intellectual attractiveness: Friedrich Hayek receive the Nobel Prize in 1975 and Milton Friedman in 1976, putting neoliberal principles under the spotlight in the academic realm and start to find its way at the institutional level, promoting an industrial policy limited to competition policy. David Harvey[68] described this new paradigm with four major trends: 1) public utility and social provision are increasingly privatized, 2) finance

[64] Van Laer, A. (2010), « Vers une politique de recherche commune, Du silence du Traité CEE au titre de l'Acte Unique », in C. Bouneau, D. Burigana, A Varsori *Les trajectoires de l'innovation technologique et la construction européenne*, pp. 77-96.
[65] Yergin, D., (2008) *The Prize: The Epic Quest for Oil, Money and Power*, New York: Simon and Schuster.
[66] Jo. S., Karnizova, L., Reza, A. (2019) "Industry effects of oil price shocks: A re-examination", *Energy Economics* n°82, pp. 179-190.
[67]Bošković, G.,Stojković A. (2014) "Industrial Policy As the European Union Competitiveness factor on the Global Market", *Economic Themes*, 52 (3), pp. 297-312.
[68] D. Harvey (2007), *A Brief History of Neoliberalism*, OUP Oxford, Oxford, 254 pp.

become central in wealth creations, 3) economic instability are normal, 4) resource are increasingly flowing from the lower to the upper classes. The direct effect of this paradigm shift was the Europe gradual elimination of the institutions traditionally supporting dirigiste style of industrial policies through different legal and political tools. Indeed, state-owned enterprises were privatized; Member States lost many legal powers over monopolies and mergers to the European Commission but also lost legal powers to support selected suppliers (as legal monopolies were ended), competition was enshrined in law as a major principle and objective of policy and the powers of the EU. Both national and EEC ability to set and implement industrial policies then was limited by the legal and political framework of the internal market[69].

3.3.2. New tools and institutions of the EU industrial policy (I): Collaborative platform for research-based industrial development, from ESPRIT to Framework Programmes.

If the concern regarding international competitiveness of European was traditionally oriented toward the performance of the US industrial complex, their consideration also turned to Japan. The policy implemented by the Ministry of International Trade and Industry (MITI) in 1975, the Very Large-Scale Integration program, developed an approach of industrial policy based on an institutionalized partnership between the government, industrial actors, and universities. The VLSI initially was set up to create cooperation space between Japanese electronics companies in order to gather resources in R&D, which was especially necessary to develop chip production, but gradually was expanded to other High-Tech sectors. During the 1980s several economists in the from both side of the Atlantic, worried about the strategy took by Japanese companies were creating huge competition in industries formerly ruled by western actors (Americans in particular for the sector of computing and micro-conductor). It was argued then that an industrial program along in the same spirit as the Japanese one's was crucial to mitigate a long-term weakening in capital intensive sectors[70]. Such policy was considered as answering problematics that a lot of European nations were facing, especially regarding the market falling shares of European technology producers (American firms had captured 80% of European market for computer by 1982)[71]. Indeed, Japanese-style inter-company cooperation in high-technology industries was considered as a possible path for European industrial actors to upgrade in the global value chain but also to improve European productivity in the global market[72].

This is the spirit in which the European Strategic Programme for Research in Information Technologies (ESPRIT) was created. This program was firstly introduced by a discussion between Étienne Davignon, Commissioner for Industry and the 'Big 12 Roundtable" (heads of Europe's leading

[69] Thatcher, M. (2014) "From old to new industrial policy via economic regulation". *Rivista della regolazione dei mercati*, 2 . pp. 6-22.
[70] Magaziner, I.C., Reich, R.B. (1982) Minding America's Business: The Decline and Rise of the American Economy. New York: Harcourt Brace Jovanovich, Publishers, pp. xii – 387.
[71] Woolcock, S. (1984) "Information Technology: The Challenge to Europe", *Journal of Common Market Studies* n°22 (4), pp. 315-31.
[72] Owen, G. (2012) : "Industrial policy in Europe since the Second World War: What has been learnt?", ECIPE Occasional Paper, No. 1/2012, European Centre for International Political Economy (ECIPE), Brussels

computer and telecommunications equipment manufacturers) in the beginning of 1980. Industrial private actors of the sectors largely lobbied national government for the creation of projects that would be financed cooperatively by industry and by European Institutions[73]. The logic for ESPRIT was inspired by Japanese MITI's policy leading to the trust in collaborative research: bringing together companies, universities, and research institutes across Europe in order to develop European research and help European industry catch up with their American and Asian competitors. The program was finally introduced in 1982 with 11.5 million ECUs allocated by the European institutions funding for R&D projects involving companies from at least two Member States[74]. Other collaborative programs were set up on the same model as ESPRIT, such as the RACE (Research into Advanced Communications for Europe) and the BRITE (Basic Research in Industrial Technologies for Europe). It is crucial to note that the focus of the ESPRIT program, as with the following ones, was on pre-competitive research, ensuring that the industrial actors would not contravene the Community's rules on competition, as it was settled in a block exemption from Articles 85 and 86 of the Treaty of Rome prohibiting firms from collusive actions[75].

All these activities were eventually brought together in what was called the Framework Programme. The first Framework Programme (FP1) was implemented from 1984 to 1987, with a budget of 3.75 billion ECUs, by the Council resolution of the 25 July 1983. This programme is still one of the most important European Commission's instrument to funds and organize collaborative research and industrial policy program until now. This activity start having an explicit legal basis only with the second framework program of 1987 with to the ratification of the European Single Act at the article 130. The SEA stipulated a clear decision-making procedure which be approved unanimously by Member States in a package that defines its total budget but also the main scientific and technological targets of those programs (art. 130. q. 1). This rule of unanimity will create problem regarding the scale of implementation of the Framework II program due to West Germany and United Kingdom expressed concerns regarding EEC management of their R&D activities as well as to blunt increase of budget of the program[76]. Furthermore, the review board led by Pierre Aigrain of 1989 reiterated the commitment to through the structure of the Framework Programme only pre-competitive R&D, as it stressed that Downstream R&D should either be financed by industrial actors or by non-EU programs.

[73] Peterson, J. (1991) "Technology Policy in Europe: Explaining the Framework Programme and EUREKA in Theory and Practice", *Journal of Common Market Studies*, n°29 (3), pp. 269-290.
[74] Peterson, J. (1996) "Research and Development Policy", in H. Kassim, A. Menon *The European Union and National Industrial Policy*, 1st edition, Taylor and Francis.
[75] Peterson, J.Sharp, M. (1998) "Chapter 4: Davignon, Esprit and the Single European Act", in *Technology Policy in the European Union*, MacMillan Press LTD, London, pp. 67-89
[76] Guzzetti, L (1995) "A Brief History of European Union Research Policy". Brussels, European Commission, DG XII.

3.3.3. New tools and institutions of the EU industrial policy (II): Legal framework establishing competition-oriented industrial policy.

If the Single European Act institutionalized multistakeholder cooperation at the supranational level, it also and mostly developed tools establishing competition inside the integrating single market as the main industrial policy at the European level. In this spirit, it is notifiable than the SEA was described as described as "Mrs Thatcher's baby"[77], since the reform implemented was clearly in line with the political agenda of the UK's conservator government. The spirit of this initiative will be developed further by the 1989 European Community Merger Regulation (ECMR) and then by the Maastricht treaty. One of the biggest achievements of the SEA is the removal of non-tariff barrier and the promotion of competition in sector which was still able to be under the protection of Member States according to the treaty of 1958. This reform was established to give a new impulse to the European integration, but also to increase the competition of European firms which was previously protected by non-tariff barriers. The gains were supposed to be the decrease of the production costs under the pressure of more competition but also thanks to the economies of scale that such framework would make possible, allowing an increase of efficiency within companies. These dynamics would be even further developed thanks to the comparative advantage of Member States inside the internal market, increasing the efficiency of resources distribution as well as an increase of resource allocated to innovation. Stricter rules on financial support prohibited Member States from protecting their national champions. the Commission enforced governments and implemented independent regulators to make sure that governments open their markets to new entrants, especially in public utility industries, a sector which historically was backed by public authorities, like the telecommunication sector. Some analysts even describe these reforms as part of the development of a new stage of the economic system toward a "regulatory capitalism"[78].

The 1989 treaty establishing the European Community Merger Regulation was another step toward the Europeanization of market-oriented industrial policy, since it gave the Commission the power to evaluate, review and allow (or forbid) all mergers of 'European dimension', i.e., all merger involving companies which could have a market share beyond a certain level authorized by the Commission[79] (the rule then was that the level all aggregate worldwide turnover of more than 5 billion ECU should be notified to the commission, a level which will be reduce to 2.5B ECU in 1997). This law allows the European commission to develop an "integrationist merger policy" regarding industrial objectives, in the sense that the commission uses this legal framework in order to facilitate intra-European mergers of industrial companies with the aim to favor scale-

[77] Gillingham, J. (2003) *European integration 1950-2003*, Cambridge, p231.
[78] LEVI-FAUR. JORDANA (2005) "The Rise of Regulatory Capitalism: The Global Diffusion of a New Order", *The Annals of the American Academy of Political and Social Sciences*, 598 /1, pp. 12-32.
[79] Warlouzet, L (2016). "The Centralization of EU Competition Policy: Historical Institutionalist Dynam-ics from Cartel Monitoring to Merger Control (1956-91)". JCMS: Journal of Common Market Studies, 54 (3), pp.725-741.

upgrading but also economic integration within the single market[80]. The success of the creation of this treaty should be attribute to the internal institutional dynamics of the EC to further implement competition policy, the commitment of member state to create the single market, but also the pressure for supranational regulation by Interest groups, especially the EC industrialists' UNICE, to set rules so to implement a unique authority to gain clearance for mergers[81]. Even though analysts as describes the implementation of this rule as a purely neoliberal competition-oriented policy, we need to stress that this tool was also used to foster a "negative industrial policy" by private actors. Indeed, commission's decisions, while targeting at deepening the legal framework of the single market, also aimed at enhancing the creation of European "champion" able to compete in the global market against American and Japanese actors, however, while avoiding all type of direct involvement public sector which could cause what was perceived as market distortion. This strategy was consistent with the intellectual atmosphere of the time: a 1987 OECD study pointed out that even apparent market failure did not in itself justify government action, as for the case of unwillingness of private companies to invest in capital intensive high-technology investment "It is necessary to ascertain beforehand that such action can be more effective than the market solution, however imperfect, and that the appropriate means can be mobilized"[82]. However, we can find example of mercantilist use of the ECMR when the competition policy favors European companies by weaken the position of foreign companies, as the ban of the merger between the European aircraft company ATR with the Canadian De Havilland in 1991 established.

Finally, the ratification of the Maastricht Treaty in 1992 further enhance the trend toward an Industrial policy oriented by the tools of the competition policy and the legal framework of the single market. We should also note that the inspiration regarding manufacturing management shift from Japan to the USA, also in the context of the stagnation of the Japanese economy at the time. Consequently, the industrial policy inspired by the Japanese MITI's management style was not a model anymore. The paper published in 1992 by the Commission set out an approach that was purely American-inspired neoliberal in its approach: "In the 1970s industrial policy was characterized by a dirigiste and sectoral approach. Today it is recognized that public interventions in this area must take the form of horizontal activities to achieve the right climate and balance for maximizing the productivity and competitiveness of European industry"[83]. The Maastricht Treaty recognized however the industrial policy as one of the six new most important areas for the European Union in the future, especially in the context of rising concern regarding "horizontal industries". This was formally established by the Article 157 of the Treaty Establishing the European Community: "the Community and the Member States shall ensure that the conditions necessary for the competitiveness of the Community's industry exist". This article provide a legal basis for Horizontal Industrial politics since that the article follows: "For

[80]Thatcher, M. (2014) "European Commission merger control: combining competition and the creation of larger European firms". *European Journal of Political Research*, 53 (3). pp. 443-464.
[81] Bulmer, S. (1994). "Institutions and Policy Change in the European Communities: The Case of Merger Control". Public Administration 72(3): 423-444.
[82] Vinde, P. (1987) "Structural adjustment and economic performance", *The OECD Observer* n°149, p234
[83] EC (1992) Research after Maastricht: an assessment, a strategy, Communication from the European Commission to the Council and European Parliament, Bulletin supplement 2/92, p 22

that purpose, in accordance with a system of open and competitive markets, their action shall be aimed at: - speeding up the adjustment of industry to structural changes, - encouraging an environment favorable to initiative and to the development of undertakings throughout the Community, particularly small and medium-sized undertakings, - encouraging an environment favorable to cooperation between undertakings, - fostering better exploitation of the industrial potential of policies of innovation, research and technological development".

3.4. European policy: from 1992-2010: toward an "industrial renaissance"?

The recent history of institution of industrial policy at the European level need to be size in the framework of what is called a "manufacturing renaissance"[84], i.e., the re-discovering of manufacturing fundamental role of manufacturing in promoting economic growth and technological innovation. The establishment of the European Single act, and then the Maastricht treaty was driven by the will to further the creation of a European market, but critics argued that those initiative will not by themselves allow the constitution of a productive system of the size of the European Community[85]. These concerns were hesitantly raised even before the Maastricht treaty in November 1990 by the European Commission in the document "Industrial policy in an Open and Competitive Environment: Guidelines for a Community Approach". The document, in its conclusion, approve the idea that "industrial problems at the regional or sectoral level should increasingly be resolved by horizontal measure", a theme which will be central for the European industrial policy in the 1990's onward, since sector-oriented industrial policy of the past was seeing as creating market distortions. This document still advocates for the central role of the internal market as well as the global market in "building a favorable economic environment" in a competition-oriented fashion, since "the role of public authority is above all as a catalyst and path-breaker for innovation […] the main responsibility for industrial competitiveness must lie with firms themselves". But, if we have a look at other document of the beginning of the 2000's, the change of attitude regarding European industrial policy dramatically changed. A bridge opened after the 1990's and will open the way toward the new industrial policy of the 2010's.

3.4.1. The intellectual and institutional awakening regarding the limits of competition policy to manage industrial policy in the 1990's.

The 1990's, contrary of the 1980's, saw the implementation and diffusion of ideas related to active industrial policies in the economic and political sciences field. If traditionally the mainstream economic literature justification the use of public policy as a need to compensate market failure (hence, the existence of greater "government failure" justified that public authority does not intervene), authors developed theories

[84] Ambroziak, A. A. (2014) "Renaissance of European Union's Industrial Policy", Yearbook of Polish European Studies, n°17, pp. 37-58.
[85] Muldur, [1988] : « Le développement des fusions et acquisitions: causes et conséquences », Revue d'économie financière, n° 4, mars

which justified public use for a larger variety of output[86]. Because academics increasingly studied empirical evidence of exceptions to the rule of functioning market, theories start to emerge analyzing market failures not as exceptions but as a general rule of the market economy. This conclusion alone allowed some scholar to justify the use of active industrial policy[87], in total dissonance with the cautious orthodox approach that have prevailed since the 1970's. Following this idea, New Growth Theory (NGT) and Strategic Trade theory rediscussed the framework of competitive-driven industrial policy by criticizing the foundation of neoliberal economic policy theory. The NGT explains that the main determinant of growth is not capital accumulation, as the orthodox growth theory explains, but investment in R&D and the degree of appropriability of innovation[88]. This justifies public investment in R&D by improving the capacity of economic agent to adopt innovations by education or other channels, manage by a public authority. The Strategic trade policy theory also based its foundation on the evidence of the imperfect competition in market economy. Because in some strategic industries imperfect competition arise naturally, oligopolistic companies can realize surplus of profits, pay higher wages, and have higher investment in R&D[89]. The States then have incentive for strategic reason to subsidies those sectors in order to foster the position of the national firms in the global market in order to keep its dominant position (and it is practically what European countries have done with Airbus and the aeronautic sectors outside the European institutions framework). This rational also apply to infant-industry when the sector within the national border is not mature enough to compete in the international market. By protecting and investing in those emergent sectors, the states allow to increase the competitivity and decrease production costs through a learning-by-doing-effects and eventually increase the national welfare[90]. Furthermore, and from another academic perspective, evolutionary economics (which studies innovation systems through a cluster approach) and systemic approaches (studying the link between microeconomic environment and business performance) gave a new argument in favor of bold innovation policy. For instance, Dunning[91] emphasized on the role of pro-competitive knowledge sharing among actors of an industrial sectors is crucial to establish growth in the context of globalization, opening the door for public monitoring of cooperative research projects. More generally, the key suggestion of those academics frameworks is that if industrial policy aimed at increasing the productivity of R&D and the industrial competitiveness, it has to emphasis on the specifics context of knowledge creation and adaptation of every sectors. The consequence of such consideration is a shift from mitigating market failure, as the competitive industrial policy, toward the

[86] Nararro L (2003) "industrial policy in the economic literature, Recent theorical development and implications for EU policy", *Enterprise Papers* n°12, 23.
[87] De Bandt J., (1995) "Quelles conceptions des entreprises, des systèmes et des processus productifs inspirent quelles politiques industrielles", Revue d'Economie Industrielle, n°71, 1er semestre
[88] Baumol, W. J. (2002) *The free-market innovation machine: analysing the growth miracle of capitalism,* Princeton University Press
[89] Brander, J. A., Spencer, B.J. (1983) "International R&D rivalry and industrial strategy" Review of economic studies 50.
[90] Leahy D. and J.P. Neary, (1995), "International R&D rivalry and industrial strategy without government commitment", CEPR Discussion Paper 1199.
[91] Dunning, J. H., (1997) *Alliance capitalism and global business,* Routledge, London

mitigation of “systemic imperfection”, i.e., establishing a cost-effective functioning of each constituent part of the productive system[92].

Regarding the institutional context, the revolution of information and communication technologies, as well as the development of international competition with new actors in Asia open the path to reorganize the global value chain and the development of the late phase of the global capitalism[93]. These create new impulse to the question of the European policy regarding network infrastructure and the role of public authority to foster industrial development in general. This question was already revealed in 1984 by the European Round Table of Industrialists in its report “Writing the Script”, calling for a European management of network infrastructure as a ‘Missing links’ of the European policy. But the question regarding Transnational Infrastructure network were even more problematic with the ICT revolution. It created a new impulse in Horizontal Industries and then new question regarding their regulation, financing, and development at the European level. The question for horizontal EU industrial policy refers to the question developed by Jacques Pelkmans: “whether the EU level should be involved to ensure or at least foster a European perspective and the development of "European" infrastructure in the sense of missing links, greater overall (EU) network efficiency and cross-border (seamless) interconnections for network industries sharpening competition in such former 'national' utilities”[94]. The 1990’s saw an increasing interest at the European level regarding such problematics, with several document calling for a European framework to mitigate and implement such infrastructure. The shift to horizontal EU industrial policy began with the Bangemann report (1990), which propose to rethink the way government intervention could be useful in order to facilitate the static and dynamic efficiency of markets in Europe and what market institutions might be of help to establish network infrastructure of European scale. Application of this report only took forms with the EC White Paper on Growth and Competitiveness of December 1993, which included the first economic foundation of the Trans-European Network approach. These include 5 majors points: in which the fourth point is of particular interest. Indeed, it targeted information technology infrastructure network, and it is notable that it is one of the first document which sets the importance for the European Council for such technology. Furthermore, it develops the methodologies to organize its rollout: the report established that the private sector should be the primary agent to implement such Trans-European Network for information technology notably regarding its financing. However, the report acknowledges the central role of member state and European institutions in their role “in backing up this development by giving political impetus, creating a clear and stable regulatory framework (notably as regards access to markets, compatibility between networks, intellectual property rights, data protection and copyright) and by setting an example in areas which come under their aegis” (p. 131).

[92] Edquist C., (2001) “The systems of innovation approach and innovation policy: an account of the state of the art”, Paper presented at the DRUID conference, Aalborg, June 12-15
[93] Baldwin, R. (2016). *The Great Convergence*, Harvard University Press. pp. 344
[94] Pelkmans J. (2006) « European industrial Policy », *Bruges European Economic Policy Briefings* n°15.

3.4.2. First step toward Horizon 2020 in the context of the 2000's: (I) The implementation of enabling institution of the 5G PPP.

Even if the 1990's did not saw the direct implementation of bold European policy even regarding Horizontal industrial, the concerns raised at the time, the intellectual shift regarding active industrial policy and the beginning of institutional attitude regarding the matter set up the trends of the events of the 2000's. The result was the birth of a new industrial policy approach see as a device to foster innovation and the competitiveness of industrial actors, in the fashion of the recent academic development we saw in the state of the art. Such new industrial policy had two key targets: the first to address economic restructuring of horizontal industries and the role of ICT in general; the second, to promote R&D and the creation of a knowledge-driven economy[95]. Those were set up in programmatic "Lisbon Agenda", a ten-year strategy (2000-2010) which aimed at modernizing the European economic and social model through, notably, investment in R&D and coordination of technology policy. Those were completed with the Barcelona objectives which set up the target to have 3% of the European GDP by 2010, with the public sector investing one third of this investment. "The Lisbon strategy proposed a concerted action that involved all the policy lines already experienced and constituted an important innovation in the decision-making method of industrial development policies"[96]. The Lisbon strategy was founded on two pillars. The first one concerns the implementation of a market competition in the single market based on knowledge economy and on new technologies. The second one concerns the enhancing of the competitiveness of European firms in the global market. Such would be done mostly through research and innovation policy as well as horizontal industrial policy reorganizing the business environment of the single market. Other structural policies were implemented and directed to less developed areas of the Union. Both pillars operate on "trans-national aggregative factors", with the promotion of networking between firms and institutions ultimately aiming at creating an environment favorable to industrial growth, which outline the fact that the EU start, in the beginning of the 2000's, to have a real strategy regarding the implementation of a more integrated Innovation System which will enhance its position in the world economy.

The document "Industrial policy in an Enlarged Europe" of 2002 of the European Commission can be identified as the first document implementing the spirit of the New Industrial policy that European institution will develop. Indeed, it is one of the first document which refer to Industrial Policy not only through the tools of competitive policy, but as a systemic output of several policy: "Industrial policy also has to ensure that other policies contribute to the competitiveness of Europe's industry. It therefore covers a very wide field, while many of its instruments are the instruments of other policy fields. Industrial competitiveness depends on policies such as competition, the internal market, research and development, education, trade and sustainable development". Furthermore, globalization, view as an opportunity, is also depicted as a challenge

[95] Mosconi F (2015) "The New Industrial policy of Europe a decade after (2002-2012)", in Yülek M. *Economic Planning and Industrial Policy in the Globalizing Economy, Concepts, Experience and Prospects.* Springer, pp. 207-238
[96] Bianchi, P. Labory S. (2010), « Economic Crisis and Industrial Policy », Revue d'économie industrielle, 129-130, document 13, p. 318

which requires an integrate approach of knowledge policy: “As Europe cannot compete on cost alone, knowledge has a central role to play in helping industry adjust to the pressures of globalization, in all sectors - whether high technology or not.” For this matter, the document advocate for the implementation of collaboration between European Member States for the establishment of common standards and technical regulations in order to establish real cooperation among actors of horizontal industries, ICT in particular. Furthermore, and in a shift of attitude vis-à-vis sectoral application of industrial policy, advocating for the need “to consider the specific needs and characteristics of individual sectors. It therefore needs to be applied differently, according to the sector”. This position will have two major ramifications. The First one can be seen in the speech of the President of the European commission Romano Prodi in 2003 advocates for the creation of ‘European Champion’, in the total contradiction with the stand took by the European Institution in the 1980’s. The second one can be seen in the communication “Implementing the Community Lisbon Programme: A Policy Framework to strengthen manufacturing. Towards a More Integrated Approach for Industrial Policy” of 2005 take a step even further regarding the target of horizontal industrial policy, but also regarding sectoral industrial policy. For the late one, the document stands: “our industrial policy to be effective, account needs to be taken of the specific context of individual sectors. Policies need to be combined in a tailor-made manner on the basis of the concrete characteristics of sectors and the particular opportunities and challenges that they face.” Following this statement, individual sectors were grouped into broad categories allowing to establish “seven cross sectoral policy initiatives” and “seven new sector specific initiatives”. Those were concentrated in high value added and high-tech sectors which were judged to be highly relevant for the competitiveness of Europe in the World Economy: ICT, energy, defense, space, biotechnology and pharmaceutical. To develop, those sectors require high level of financial resources, and high level of qualification of the human resources. The development of sectoral-industrial policy in the 2000’s was then led to the specificity of the sectors that have been targeted as being highly relevant regarding the position of Europe in the global competition.

In the meantime, new policy tools implemented through “technology policy” at the EU level matched the need of those industries and were applied to them in a sector-oriented industrial policy. The research and technology policy has notably the target of European policies in order to create platform allowing the communication and cooperation among stakeholders and to channel finances of high value technological product and R&D in the context of the Lisbon strategy: the ETP and the ERA. The first example is the European Technology Platforms (ETP), created in order to address the problem of fragmentation of research and the increasing role of the private sector in financing it. Combined with the Barcelona objective, the Commission suggest the implementation of a Public Private Partnership for the ETP, a policy tool which will be implement for other sectors. In its communication “more research for Europe: Towards 3% of GDP”, the European commission advocate to create a technology platform at the European level in order to intensify science-industry relation and international cooperation of public investment in R&D. Such policy also was

supposed to mobilized previous instrument, notably the Framework Programme: "With a budget of €17.5 billion, the Community Framework Programme for R&D 2002-2006 will be a powerful instrument to support public-private partnerships in trans-European networks of excellence and integrated projects." The council of the European Union approved this project in march 2003[97]: "creating European technology platforms bringing together technological know-how, industry, regulators and financial institutions to develop a strategic agenda for leading technologies […] (and) fully utilizing the potential of the 6th Framework Programme and of national programs in support of the European Research and Innovation Area, with particular attention to cooperation with European intergovernmental research organizations and activities to enhance participation of SME's in research and innovation" (p. 14). By June 2004, the European Commission decided that the development of Strategic Research Agenda of ETPs need a better legal approach as well as a pan European approach with dedicated EU founding: the Joint Technology Imitative replaced then the ETPs. The second example is the European Research Area (ERA), found its historical roots in the communication "Towards a European Research Area" which defined the idea of a European Research Area with the problem of "fragmentation, isolation and compartmentalization of national research systems' and "the lack of coordination in the manner in which national and European research policies are implemented". Financing by the 6th Framework Programme, as stated by the Commission, this institution targeted research infrastructures, joint programming, mobility of researchers, and the international openness to the world. However, even if the ERA became the main reference of the European research policy, the initiative was not practically supported by Member States in the first four years of its implementation. A new framework where then developed within the 7th Framework Programme, which put an emphasis on "research themes in areas where the EU should reinforce and better exploit its knowledge base" and "is tailored to better meet industry's needs" and with a budget of 50.5 billion of €, three time more than the 6th Framework Programme. Five JTIs were created under the 7th framework programme. It is also important to notice that new rule evaluating them were implemented, leading to a significant development of their legal framework.

3.4.3. First step toward Horizon 2020 in the context of the 2000's: (II) Cognitive shift blurring the line between technology policy and industrial policy at the EU level.

We saw in the State of the Art that extensive academic literature starts to emerge following the Lisbon Strategy about the development of a truly Integrated Industrial Policy, linked mostly with the dual objective to enhance Europe's endowment of new technologies. Such, as we saw, were based on a specific interpretation about the globalization being the stage of global competition. This interpretation was further In October 2005, when the European Commission announced a new industrial policy with a Communication entitled "Implementing the Community Lisbon Programme: A Policy Framework to Strengthen EU Manufacturing—Towards a More Integrated Approach for Industrial Policy". This identified two clear challenges for EU

[97] European Council (2003) "Presidency Conclusion of the 20 and 21 March 2003) [online the 19.09.2021] https://www.consilium.europa.eu/media/20858/75136.pdf

industrial policy. First, the nature of manufacturing production continues to change profoundly. The second challenge for EU industrial policy is globalization, which is here to stay. However, another idea that sustain the industrial renaissance was also the vision that such policy would be a wonderful driver for technological progress, economies of scale and learning and innovation in industrial activities[98]. The competitive objective, as we saw, cannot be disconnected from the objective to upgrade in the technological endowment of the concerning political community. This fact was highlighted by the Directorate-General for Enterprise and Industry of the European Commission supported a "Competitiveness Report" in 2002 which highlighted the "productive gap" that was raising between the USA and the EU since the mid 1990's, which were attributed mostly to the development of new technologies in the ICT sector. Such declaration opens the door to an action plan in 2003[99] "Investing in Research" which states "In order to close the gap between the EU and its major competitors […] there must be a significant boost in the overall R&D and innovation effort in the Union, with a particular emphasis on frontier technology" (it was also in this action plan that the effort to dedicate 3% of the overall EU GDP to R&D that we saw earlier were established). However, this objective were not achieve, and the EU in the 2000's did not find its way to really implement an integrated Innovation System. Pisani-Ferry and Sapir[100] emphasis that failure can be attributed to "the lack of coordination at various levels of the research and technological development activities, programs and strategies in Europe" were a major weakness of such policy at the time. However, we understand that here that the EU throughout the 2000 understand and framed its industrial policy by orienting it clearly toward technological objectives, a fact that will find a special renewal and strength in the next decade with the Europe 2020 objectives[101]. Another proof which outlined the idea that the EU technological policy and the EU industrial policy were increasingly intertwined in the mind of the EU actors is the Sapir Report of 2003, which aimed at establishing the importance to implement policy which would stimulate "knowledge investments" because "innovation is the driver of growth". Such stimulus was thought not only through horizontal industrial policy, especially regarding the development of Educational programs for excellent sciences, but also some sectoral applications in order to stimulate the R&D of key technologies in strategic industrial sectors. The 2005's communication from the EU Commission established consequently that "for industrial policy to be effective, account needs to be taken of the specific context of individual sectors. Policies need to be combined in a tailor-made manner on the basis of the concrete characteristics of the sectors and the particular opportunities and challenges that they face". The emphasis this communication establishes on Industrial politics targeting high-value-added and high-tech sectors (including pharmaceutical, biotechnology, defense industry of ICT) reflect this convergence of technological and

[98] Szirmal, A.,Naud, W., Alcorta, L (2013), *Pathways to Industrialization in the Twenty-First Century: New Challenges and Emerging Paradigms*, Oxford University Press. Oxford

[99] European Commission (2003) "Communication : Investing in Research", [Online the 19.09.2021] https://ec.europa.eu/invest-in-research/pdf/download_en/investing_en.pdf

[100] Pisani-Ferry, J., Sapir, A. (2006) "Last Exit to Lisbon", *Bruegel Policy Brief*, Issue 2006/02.

[101] Mosconi, F. (2015) "Chapter 4: Drawing the third side of the triangle, reshaping EU 'technology policy'", in *The New European Industrial Policy, Global Competitiveness and the manufacturing renaissance.* Routledge, London, pp. 137-171.

industrial objectives in order to transform European economy in order to boost its ability to compete in the global political economy[102].

3.5. Conclusion of the historical background.

This review of the historical background of the Multilateral Industrial Policy of the EU of the 2000's is critically important for our study of the 5G Infrastructure Public Private Partnership. Indeed, the 5G PPP is an institution of the multilateral industrial policy, and an investigation of the historical path that led toward the development of this paradigm inform us with the way the EU institutionalized policy for the development of the technologies of the 4th industrial policy. Indeed, the 5G Public Private Partnership cannot be seen as a natural answer to innovation nor globalization, it is the fruit of a specific vision of those phenomena, build upon specific resource with a specific legitimacy and a specific purpose, and those cannot be extract from historical contingency. We saw that the early years of the history of the European Industrial policy was not *per* se dedicated to technological innovations. The treaty establishing the ECSC was the first European institution instituting a binding supranational authority regarding industrial matters, but it did not affect the establishment of a European wide System of Innovation. The same way for EURATOM, which only create a supernational structure for innovation in nuclear civil activity with relatively low level of integration, and the treaty of Rome did not include any article regarding the role of the EU for industrial matters. In the 1960's and 1970's, however, there was both an inclination to converge towards a Common European industrial policy at the institutional level as well as an intellectual attractiveness for such concept, link with the development of international competition, especially from the United States. This approach did not find any institutional reality due to a triple structural problematic at the level of member states: a divergence linked with the economic model to implement; a divergence of position vis-à-vis the role of European Institutions, and a divergence linked with the states that should be included in such policy. With the decline of Keynesian-like interventionist economic policy paradigm around the world, associated with a general decline of the share of manufacturing in the economy of developed nation as well as the development of neoliberal approach to economic policy, the delineation of the European Industrial Politics left its sectoral approach for an horizonal one, more focus to develop a sound environment to help the development of Industrial Actor. Such horizontal approach gradually took gained substance throughout the 1980's and 1990's, where EU actors implemented both a competition-oriented economic policy aiming at developing a true competitive single market, highlighted by the implementation of the European Single Market, as well as a coordinated technology policy, aiming at promoting cooperation and coordination of research and development at a precompetitive stage of production, as the implementation of the first Framework Programme showed. This step has need to be understood as foundational for the development of the multilateral industrial policy, because such paradigm developed upon this neoclassical period which both implemented the legal framework upon which will be based the industrial

[102] Mosconi, F. (2015) "Chapter 1: The New European Industrial Policy: an overview'", in *The New European Industrial Policy, Global Competitiveness and the manufacturing renaissance.* Routledge, London, pp. 10-55.

renaissance of the EU and the System of Innovation that this industrial renaissance will aim at enhancing. Indeed, the Lisbon Strategy, based on a renewal interest from political and economic sciences field, adapt the tools and frameworks of the neoclassical industrial policy of the previous period to adapt them to new challenges, without totally abrogated them. The context of "manufacturing renaissance" in the 2000's, actors had to rethink how the EU could approach industrial policy through a what we have described as a multilateral industrial policy, which will allow to handle both the pressure of globalization and to catch up technological backwardness. On one hand, instrument of the EU research and technology policy has been reoriented to make them suites the need of technology intensive sectors though the creation of platform allowing the communication and cooperation among stakeholders and to channel finances and knowledge, such as the European Technology Platform and the European Research Area. Furthermore, we observe a dramatic increase in budget allocated to Framework Programme, from € 16.3 billion invested in the 6th Framework Programme (2002-2006) to € 50.5 billion in the 7th Framework Programme (2017-2013). The Framework Programme see, in addition to its spectacular budget growth, also saw the development of several Public Private Partnership with Industrial Private Actors.

We understand that the institutionalization of the multilateral industrial policy in the 2000's path the way for its development in the 2010's in which the 5G Infrastructure Public Private Partnership flourished. This historical investigation brings us naturally toward theoretical and methodological question that will have to be consider in our study of the 5G PPP and the application of the multilateral industrial policy applied for the development of technology of the 4th industrial revolution. To seize both the reflexive answer to the dialectic between globalization and innovation that this policy crystalizes, as well as the historical trajectory from which this policy is developed, we need to turn our look toward the Historical Institutionalism approach in Political Sciences to study the 5G PPP as an institution of the multilateral industrial policy.

4. Theory and Methodology.

4.1. Introduction.

Thanks to the analysis of the State of the Art and this historical background, we have now a more detailed overview of the historical dynamic that have shape the phenomenon of the development of a multilateral industrial politics in the European Union in the 21st century. Those two preliminary studies are essential to understand and to analyze the 5G PPP. Indeed, such analysis require to catch both the way Social and Political Sciences had framed the dialectical relation between innovation and globalization, and also to understand how the European Union institutionalize public policy to mitigate and act upon this dialectic. An inquiry of Historical Institutionalist approach will provide us tool to seize better how the 5G PPP illustrate the supranationalization of industrial politics as an answer to innovation and globalization challenge, and how actors and their reflexivity have built this artefact of the multilateral industrial policy.

4.2. What is the theoretical contour to frame the dynamic construction of the EU industrial policy?

The way technological change is perceived by actors participates to the construction of the social reality of challenges and opportunities that such technology, and the transnational questions it associated with it, will bring to an International Organization. As Skolnikoff showed, new technologies create uncertainties, change International Organizations' ability to channel and analyze data, create asymmetry of power between actors, as well as interdependence among them through networks system that have to be mitigated collectively, and can create political fragmentations that generates political instability. However, if technology complexify the world for International Organizations, it is also what have allowed them to exist in the history of modernity. Because technological upgrades problematic which can be perceived and analyzed as being transnational, new technologies create new patterns of governance which allow them to act back on technologies through Innovation Policy. Skolnikoff viewed that States was central actors in the realm of world politics but acknowledge the increasing role of international organizations since they help to manage the transnational effect of technological change by implement innovation policy at the supranational level. Since technological upgrades increase the quantity and quality of transnational matters, the role and relevance of international organizations are expected to enhance (Skolnikoff here have a linear vision of technological progress. While they manage such transnational effect, International Organizations implement more or less extensive innovation policy. Indeed, even when the scope of their action and their fundamental purposes are not directly oriented toward innovation itself, International Organizations have an impact on the use and perception of technologies. We saw, for instance, that because technological change enhances the scale and substance of global trade throughout the second half of the 20th century (especially thanks to the development of ICT), this have enhanced the role of the World Trade Organization, which had, in turn, favorized a specific System of

Innovation, following the pattern of global value chains. In Europe, since the 2000's, the definition, scale, scope and target of this innovation policy have gradually shift from R&D technology policy toward the universe of Industrial Policy. This shift has been possible because of a specific interpretation of the challenges that brought World politics (i.e. Europe is not competitive enough to face and gain from the global market), and a specific interpretation of the way technological upgrade can bring solution to this challenges (by improving Europe's technological endowment, the single market will be able to transform globalization challenges into opportunities). Because the competition-oriented and the horizontal industrial policy tools was understood as being not efficient enough to achieve this objective, political actors have provided new solutions: enhancing the scope and scale of the European Industrial Policy. As we saw, this was support by a new academic understanding of Industrial politics, support from Infrastructure Association, member states and European bureaucracy. Consequently, if we cannot underestimate to weight of competition among actors to frame the solution to this specific historical context, we have to keep in mind that the driver of the public intervention in the effort to the strengthen and improve the efficiency of the Innovation system cannot be dissociated from the general interpretation of the late stage of world politics as being the set of a global competition.

Because it has both the quality to consider the problematic of the global competition and the thematic of the technological upgrade (we saw that such was thought as providing answers to the structural challenge the EU economy was facing); and because the promoters of this policy had the political leverage to support this idea (we saw that the thematic of industrial policy founded a renewed interest in the beginning of the 2000's), Industrial Policy had the chance to come back at the center of the stage of the European Economic policy. Furthermore, actors have advocate for the development of an innovation policy which is an industrial policy which suits the new objectives and challenges Europe faces since the beginning of the 21st century (low growth rate, structural unemployment, competition of the single market) while being compatible with the neoliberal paradigm, which was still relevant at the time. This new industrial policy is consequently more an adaptation than a revolution in the economic policy of the EU. Its definition is less oriented toward mercantilist or protectionist objectives, and more focus in public-private strategic coordination in order to implement structural adjustment process that would have an effect not only on the economic growth and competitiveness, but which will also have an impact on social and civil development through technical progress. The late stage of the EU multilateral industrial policy can be framed as a middle ground between three approaches to industrial policy identify by Cohen[103], each of which corresponded to a particular area within industrial policy: (a) the neoclassical approach, where the debate is over market failures; (b) the structural approach, where the debate is over the conditions for global competitiveness; and (c) the pragmatic approach, where the debate is over the practical conditions for making public and private actors better able to face the challenges of the new economy (Cohen 2006, p. 85). We assist here at a phenomenon of path dependance: the market oriented

[103] Cohen E (2006) "Theoretical foundations of industrial policy". EIB Papers 11(1):84–106

economic policy paradigm elaborated in the 1980's-1990's creates a political space in which the debate over industrial policy should focus on market failure, which will be mitigated by horizontal policy in order to avoid government failure. Structural challenge, brought by change in the political economy of globalization, challenge the hegemony of actors promoting the neoclassical approach, and give more voice and legitimacy to the tenants of a structural approach of industrial policy. However, the neoclassical paradigm is not challenged at its core, and the structural approach do not aim at overtaken it but give new dimension to it. Finally, under continuous internal and external challenge, the neoclassical structural-oriented approach finally open itself to a "pragmatic approach": in order to survive, the idea open itself to sectoral oriented policy through public-private partnership in the industrial development, the neoclassical approach had to mutated by incorporating vertical industrial policy element, against which it was developed. Consequently, the core DNA of the multilateral industrial policy is the adaptative answer, modeled by global technopolitical challenges throughout the 1990's, 2000's, of the neoclassical approach of industrial policy. The institutionalization of industrial policy in Europe is then historically construct by actors, and their strategic use of the technological upgrade and globalization challenges to gradually enhance the scope, scale, and substance of the EU role in that matter.

We saw that the first attempt to build a truly integrated industrial policy goes back to the history of the European integration itself. Indeed, moral entrepreneurs from the academic, business, and political field advocated for the implementation of an Innovation System that would enhance European companies' ability to contest American multinational enterprises, in order to be competitive and to mitigate the economic influence of the growing American hegemony. However, due to divergence of definition, vision, and goals from nation-states regarding industrial strategy, and conflicting tradition regarding such policy, the International Organization could not propose a policy which would create a pattern of interdependence acceptable for actors. Furthermore, the bound between Nation States' economy were less strong since the integration of the European Single market was only at its early stage. To take back the vocabulary of Ruggie, the question of the supranationalization of European Industrial policy was politicized in the 1960's-1970's, but the type of interdependence was only *cognitive,* (isolation was indeed recognized as being inefficient), and the loci of interdependence was analyzed as being *external* (the attempt for implementation of an industrial policy was the result mostly of a political choice rather than an economic imperative). We can add that the structural decline of the manufacturing sector in the European economy lowers the scale or interdependence needed as well as the political weight of Industrial actors (the financial sector was, at the time, gaining in visibility). It became increasingly less urgent to create political space to deal with the role of Europe in setting industrial target, also because such policy was out of fashion in the academia to the advantage of market-oriented policy. European Institutional action had consequently their focus and agenda were gradually oriented toward other matter like the establishment of the single market. Furthermore, when needed, like in Aerospatiale sector, international cooperation where implement outside the scope of the EEC institutions, like

the Airbus, Ariane, Tornado initiatives highlight. In the second phase, we can say that the type of interdependence was characterized by *Opportunity Costs*: the pursuit of only domestic industrial policy (especially regarding the production of knowledge) was understood as being more expensive than cooperation at the EU level; and the loci of interdependence was only characterized by *external manifestation*: the domestic industrial policy pursuit of state was not affected directly by the interdependence, but cooperation was indeed implemented regarding technical matters). This phase saw the rise of an interpretation of technological policy and industrial policy as being crippled by government failure, however, the rise of global competition coming from Asia, Japan in particular, path the way to rethink EU involvement in Industrial policy through horizontal approach. Such Horizontal approach, influenced by the VLSI initiative, aimed at integrating further the Innovation System in Europe at precompetitive stage of the production (i.e., a bolder approach regarding the production of scientific knowledge), which will also focus on creating space of interaction among actors of the scientific and industrial realm through the establishment of Framework Programme. We also need to stress that actors interpretated such policy in the broad framework of the neoliberal paradigm, which in its early phase focuses on the establishment of market driven industrial policy. Such framework, if acknowledge the global competition, is more concern about the implementation of a sound competition than realizing a bold innovation policy able to improve technological endowment of Europe (such position was translated in the Singla Market Act, as we saw). Finally, the third stage that we identify in the history of the EU industrial policy corresponds to a situation of *constraint*, where the isolation regarding industrial objective was thought as creating a privation of technological upgrades opportunities, which will spill-over into an lack of resource to endows Europe in the Global Competition; and the loci of interdependence become gradually (without being fully) *domestic*, where the Innovation System at the EU level start to be progressively interconnected and where the situation of each single member states are more and more associated to each other, creating transnational network of innovations. The pressure from the outside world made rethink the way European actors though about industrial policy, which was understood as being a sound driver to grant Europe with new technology, in the ICT sector in particular, in order to face global competition and emerging market in particular. The Lisbon Strategy highlight this shift, and correspond to a soft multilateral industrial policy, since include both Horizontal and sectoral measure to boost the development of industrial actors while gathering actors from all the different stage of production of knowledge until manufacturing of high-tech products. We call soft multilateral industrial policy, because the level of commitment demanded from nation states was still rather low, a commitment which will increase with the 2020 Strategy in with the 5G PPP flourished.

We framed this policy as being a Multilateral Industrial Policy. This idea reflect 1) the fact that the EU industrial policy is framed as an effort to institutionalize network gathering public and private sectors in order to develop and diffuse new technologies in the production system, with the target to realize societal objectives which suits both the private and public sphere, 2) that such policy is implemented via a combination of horizontal and sectoral policy affecting the production of knowledge and technological artefact, which will be

implemented through a coordination of different actors as Member-States, Business Associations and European institutions, 3) the design of this policy is the fruit of interaction and concurrence of ideas and interpretation of different actors (from the public and private sphere) regarding the challenges and opportunities technologies and globalization creates, 4) the fact that European Industrial policy is highly flexible and dynamic, and is the fruit of a historical contingency which saw its design and target continuously reimagined, reinterpreted, and renegotiated by actors throughout the time. This historical background highlights the fact that interpretation of the stage of the system of innovation in Europe, as well as political idea and actors' analysis or world politics give meaning to the type of innovation policy, as well as its scale, scope, target, and substance this policy will have. The dialectic between technological change and world politics transformation throughout the 20th and 21st century did influence and shape the European international regime regarding innovation policy: it creates a mutual expectation, rules, and regulations to set up a policy able to produce horizontal and vertical economic policies to further Europe's business ability to get access to new technologies. This business oriented international regime flourished because actors thought private companies was the driver structural change that would coop with Europe's structural economic issues while improving their competitiveness in the global market. The way the European Union organized cooperation to improve its technological endowment and its position in the world competition, was the fruit of a reflexive interpretation of the political effect of this dialectic: the concern global competition had in the mind of European politicians were lower in the 1960's than in the 2000's. This overview of the institutionalization of a multilateral industrial policy provides us the context to fully analyze the phenomenon of the 5GPPP, which is indeed a product of this gradual transformation. Before having an in-depth analysis of this policy, we need to stress some methodology which will allow us to understand this policy in the broad context of the institutionalization of the EU multilateral industrial policy. Indeed, we need to elaborate a methodological and theoretical framework which allow to consider the gradual institutionalization of supranational industrial policy through the history, and how it helps us understand how the 5G PPP was established as an avatar of this multilateral industrial policy. Historical Institutionalism, as we will see, can bring us tools to frame the development of the 5GPPP in a specific historical setting: "Historical institutionalism offers a perspective that stresses the importance of time and timing in causal processes, recognizing both the constitutive nature of institutional contexts and the critical role of unanticipated consequences in driving future policy change"[104] (Farrell, Newman, 2010. p. 611).

[104] Farrell, H. Newman A.L. (2010) "Introduction: making global markets: historical institutionalism in international political economy", *Review of International Political Economy*, vol. 17, no°4, p. 609-638.

4.3. Historical Institutionalism, an approach to study the emergence of the of political institution.

In their famous article[105], Hall and Taylor propose a description of the historical and theoretical contour of the Historical institutionalism. The historical institutionalism is an approach of the "new institutionalism", which found its origin to the reaction to the behavioral perspective in political science which had a hegemonic position in the 1960's and 1970's and seek create a new framework to understand and frame the role of institutions in the creation of political phenomena. "Historical Institutionalism" is a term coined by Sven Steinmo and al.[106] and was developed more specifically as a critic to structural-functionalism theory in political sciences. Historical Institutionalism based its approach on the following principle: if the disagreement between rival groups for limited resources lies at the heart of policy, the institutional design of polity and economic structure provides a framework in which the outcome of such disagreement will be *somehow* determined. Furthermore "the historical institutionalists were also influenced by the way in which structural functionalists saw the polity as an overall system of interacting parts. They accept this contention but react against the tendency of many structural functionalists to view the social, psychological or cultural traits of individuals as the parameters driving much of the system's operations"[107]. Hence, historical institutionalism is a paradigm where the relation between behavior and institutions are complex but have to be studied scientifically. If Historical Institutionalists took to their account the structuralist approach, they were critics of the "functionalist" positions since they view institutional organization or the political economy as the main element configuring collective behaviors rather than individual rationality. Consequently, the political environment in which actors interact cannot be seen as neutral anymore, but as constitutive of the analysis. That is also why the first historical institutionalists focus primarily on the State, which is no longer understood as a neutral network shaped by competitive interests, but as "a complex of institutions capable of structuring the character and outcomes of group conflicts"[108].

According to Hall and Taylor, the Historical Institutionalism differ from other "new intuitionalism" (Rational Choice and Sociological Institutionalism being the two other school of thought associated with this movement) because of different theoretical axioms:

1) Institutions influence the actions of actors in the way it frames opportunities and uncertainties, but also provide actors specific meaning and interpretation of situations, which will marginally determine the scope and substance of their strategy and objectives. In other words, institution and policies structure social

[105] Hall, P. A., Taylor, R. C. R. (1996) "Political Science and the Three New Institutionalism", *Political Studies*, XLIV, pp. 936-957.
[106] Steinmo, S. et al (1992) *Structuring Politics : Historical Institutionalism in Comparative Analysis*, Cambridge University Press, New-York.
[107] Hall & Taylor, ibid. p. 937
[108] Hall & Taylor, ibid. p. 938

behavior and change them into an "object of strategic action"[109]. Institution will also provide political resource and position, and the legitimacy and influence actors will gain through their competition and cooperation will be channel by social definition provided by the institution. Consequently, the rationality of actors does not exist outside the definition of the situation institutions provide, the institutional dynamic cannot be understood outside the actions of actors which compete to improve their endowment of political resource.

2) Institutions shape and are shaped by asymmetry of power among actors in a dynamic fashion. Firstly, institution distribute power in an unequal way among actors, in a way which will favorized the one who had promoted this specific institutional architecture, by providing specific power such as the setting of the institutional agenda[110]. Secondly, those hegemonic actors will not only affect enhance their ability to maintain their position, but the institution will also promote their cognitive universe and their understanding and interpretation of political situation. Mahoney and Thelen[111] (2010b) propose four modes of action successful actors uses to stabilize institutional changes that suits their strategic advantage: *displacement* (the deletion of old rules and the creation of new ones); *layering* (the creation of new rules which will be more important and superposed on the old ones); *drift* (change the weight of old rules by putting them in a new context); and *conversion* (change the substance of a rules through a strategic use of it).
3) Historical Institutionalism tend to analyze institutional change and adaptation through path dependance[112], a concept which describes the stability of institution. Such stability is attributed to the way institution influence the distribution of resources and incentives of actors to the development of "institution specific assets such as skills, privileges knowledge or procedures and networks with other actors"[113]. However, action of actors, even hegemonic ones, carried almost all the time unintended consequences: if institution favorized certain group among other by providing excessive resources and power, this new configuration will always create institutional blind spot that can be exploited by competitors to gain influence. Consequently, if the power relations among actors tend to be stable, it is never exactly fixed or immovable, and will always have to adapt in order to perpetuate in the time. Applied to public policy *per se*, the translation of this axiom explain that past lines of policy will influence the repertoire of action to resolve

[109] Hall, P. (2010b). Politics as a process structured in space and time. Paper presented at the Annual Convention of the American Political Science Association, Washington, DC.
[110] Pierson, P. (2015). "Power and path dependence". In J. Mahoney & K. Thelen (Eds.), *Advances in comparative historical analysis*. Cambridge, UK: Cambridge University Press, pp. 123-146
[111] Mahoney, J. Thelen, K. (2010). "A Theory of Gradual Institutional Change." In *Explaining Institutional Change: Ambiguity, Agency, and Power*, ed. James Mahoney and Kathleen Thelen. New York: Cambridge University Press, 1–37
[112] David, P.A. (1994) "Why are institutions the 'carriers of history'?: Path dependance and the evolution of conventions, organizations, and institutions". *Structural Change and Economic Dynamics*, vol. 5, Issue 2, pp. 205-2020.
[113] Pierson, P. (2004). *Politics in time*. Princeton, NJ: Princeton University Press, pp. 30-35.

new political challenges[114], but which will necessarily produce unexpected consequence and inefficiency (link to the gap between past solution and new challenge)[115].

4) Historical Institutionalism do not see institutional change as the only determining factor of political transformation through time, and a special emphasis is drawn the influence of other kind of factors, such as the diffusion of ideas, can have in the creation of resource, opportunities, or uncertainties, altering or reinforcing the current state of power asymmetry among actors. However, as Capoccia reminds us, institutional changes are endogenous[116] and depends on actors actions within it (including how they use new ideas and opportunities to enhance their strategy), which can help us understand another consequence of institutionalization: "the effect of institutions on their ideational underpinnings is likely to be partial. Perhaps the main reason that compliance with institutions and rules is never perfect is that the target population is always exposed to social and ideational forces that are broader than any single institution or set of connected institutions" (Capoccia, 2016, p. 1103). Consequently, institutional change cannot be dissociated with ideational change (or "rule defection and reinterpretation", in Capoccia's article) that supported the institution. The role of idea can also have different effects on institutions: they can be institutionalized themselves[117], participate to the creation of routine[118] and policies[119], can influence the content and interpretation of norms and identities within the institution[120].

Regarding the relation agent-structure (or behavior-institution) relation, we have to take a distance with the approach proposed by Hall and Taylor. Indeed, for them, to answer this question, Historical Institutionalism take systematically either a 'calculus approach' or a 'cultural approach', which tend to amalgamate this approach as a middle ground between Rational Choice Institutionalism, and Sociological Institutionalism, and hence imply that this approach has no proper interpretation of the social realm nor a specific methodology. This perspective has been highly criticized by Hay and Wincott[121]. Indeed, other scholar like Thelen and Steinmo (Ibid.) have rejected the idea of rational actor on which the calculus paradigm of Hall and Taylor is based, because actors cannot be assumed to have predetermined and stable set of preferences. Furthermore, once the hypothesis of Rational Choice has been abandoned, the Historical Institutionalism still have its own political ontologies which cannot be fully associated with the Sociological Institutionalism paradigm. Consequently, for Historical institutionalism, "Actors are strategic, seeking to realize complex,

[114] Weir, M. Skocpol, T. (1985) "State structures and the possibilities for 'Keynesian' responses to the Great Depression in Sweden, Britain and the United States", in Evans, P.B. et al (eds), *Binging the State Back In*, Cambridge University Press, Cambridge, pp. 107-163.
[115] March, J. Olsen, J. (1984) "The new institutionalism: organizational factors in political life", *American Political Science Review*, n°78, pp. 734-749.
[116] Capoccia, G. (2016) "When do Institutions 'Bite'? Historical Institutionalism and the Politics of Institutional Change", *Comparative Political Studies*, vol. 49 (8), pp. 1095-1127.
[117] Berman, S. (2001). "Path dependency and political action". Comparative Politics, 30, 379-400.
[118] Campbell, J. (2004). *Institutional change and globalization*. Princeton, NJ: Princeton University Press.
[119] Blyth, M. (1997). "Any more bright ideas? The ideational turn of comparative political economy". Comparative Politics, 29, 229-250.
[120] Béland, D., & Cox, H. (2011). Introduction. In D. Béland & H. Cox (Eds.), *Ideas and politics in social science research* (pp. 3-20). Oxford, UK: Oxford University Press.
[121] Hay, C. Wincott, D. (1998) "Structure, Agency, and Historical Institutionalism", *Political Studies*, XLVI, pp. 951-957.

contingent and often changing goals. They do so in a context which favors certain strategies over others and must rely upon perceptions of a context which are at best incomplete and which my very often reveal themselves inaccurate after the event […] institutions are understood less as functional means of reducing uncertainty, so much as structures whose functionality or dysfunctionality is an open – empirical and historical – question" (Hay, Wincott, 2010, p. 954). The author further that the investigation of the strategy of individual and its effect on them and in the institution itself. Individual, if they are not *rational,* are however "knowledgeable and reflexive" and they establish prospective effort to monitor their actions and the consequences of their actions assessing their prior strategies and prior experience vis-à-vis this new situation. This strategic approach have several advantage regarding the cultural or rational approach, since 1) structure and agency relationship integrated a "complex duality linked in a creative relationship", which allow us to understand better institutional innovation and the dynamics of power relationship between actors composing such institution; 2) Institutional innovation and changes occur in a specific and context "which is structured in complex and constantly changing ways which facilitate certain forms of intervention whilst militating against others" (p. 956). 3) What is achievable, acceptable, doable, and advantageous are designed by the institutional environment but also by political idea[122]. Existing paradigms and worldviews are conceptualized and assessed by cognitive filter and strategic conduct within the institution, which will be interpreted and negotiated in a dynamic process. Consequently, Historical institutionalism must have a specific attention to the role of ideas which will have an impact in determining institutional trajectories.

Historical Institutionalism, however, if it was a powerful driver of the study of statecraft and the creation of State institution[123], did not only focus on the nation states since its development in the 1990's and is seen more and more for its ability to provide an approach able to connect subfield of political sciences[124]. Indeed, the focus and object of Historical institutionalist has increasingly shift away to purely state-centric studies to be used extensively to explore other field of political science, such as International Relations[125], or International political economy, to study institutional design and effect on other political space such as the global market regulation[126], international cooperation[127] or international organizations[128]. Consequently, we have to look more specifically to the way historical institutionalism can help us understand supranational governance, since our study focus on the multilateral industrial policy of the EU. The chapter by

[122] Lieberman, R. C. (2002). "Ideas, Institutions, and Political Order: Explaining Political Change." American Political Science Review 96 (4): 697–712.
[123] James, T. S. (2016) "Neo-Statecraft Theory, Historical Institutionalism and Institutional Change" *Government and Opposition*, vol. 51. n°1, pp. 84-110.
[124] Fioretos, O. Falleti, T.G. Sheingate, A. (2016) "Historical Institutionalism in Political Science", in Fioretos, O. Falleti, T.G. Sheingate (eds.) *The Oxford Handbook of Historical Institutionalism*, Oxford University Press, Oxford, pp. 17-49.
[125] Katznelson, I. Shefter M (2002). *Shaped by War and Trade: International Influences on American Political Development*. Princeton, NJ: Princeton University Press.
[126] McNamara, K (2009) "Of Intellectual Monocultures and the Study of IPE", *Review of International Political Economy,* 16: 72-84.
[127] Farrell, Henry and Abraham L. Newman (2010). "Special Issue on Market Regulation." Review of International Political Economy 17 (4).
[128] Barnett, Michael and Martha Finnemore. (2004). *Rules for the World: International Organizations in Global Politics*. Ithaca, NY: Cornell University Press

"Supranationalism" by Büthe[129] will help us understand the theoretical and methodological contour of a historical institutionalist approach to supranational economic policy such as the 5G PPP. He develops an "agent-centric approach" to study the supranationalization of EU law, which he defines as follow: "Agent-centric historical institutionalist theory would explain how and why these changes occurred by specifying the preferences of proponents and opponents of supranationalism and identifying how the broader institutional context empowers some actors vis-à-vis others—and how that context enables and constrains institutional development" (p. 10).

4.4. Historical Institutionalism approach to supranational phenomena.

Historical Institutionalism have start to flourish in the International Relation academic field since it provides a framework to analyze and understand changes. Indeed, "although we are living in a period of unprecedented change, our understanding of change is very inferior to our understanding of fundamental long term regularities" (Keohane 2008, p. 710)[130], which lead Fioretos[131] to state that this intellectual approach provide interesting toolbox and constitutes a powerful driver to study hot topics in International Relations, such as the dynamic of world orders or institutional change in global economies, while allowing bridge between IR/IPE and other disciplines of Social Sciences. However, as Henry Farrell and Martha Finnemore[132] explained, an historical institutionalist inquires of global politics require more than an investigation of national bureaucracies effort to shape global politics. Study International Relations through the lens of Historical Institutionalism requires a theorization of global organization themselves. Indeed, many incentive structure that are studied within nation states bureaucracy have no, or only weak, equivalent at the supranational level: there is no "global government" able to ensure authority upon "global commons", hence, the International Organization ability to manage transnational questions, as well as the politicization of a social problem as being a transnational problem (i.e. which require international cooperation) is the fruit of more extensive negotiation and conflict among a greater number of actor than we can find in a Nation-State bureaucracy. Furthermore, the governance structure of an international organizations has to face incentives that have no equivalence in member states: indeed, the weight of voters or democratic deliberations is marginal (even in the case of the EU, the weight of the European Parliament in the decision making and rule process cannot be compared to one of a States. Even if trend tend to challenge this assumptions, we cannot says that the EU political system tend to be the one of a states, and is still another version of an international organization), there is no external legislators able to write back statues or rules nor an executive branch enforcing those rules,

[129] Büthe, T. (2016) "supranationalism", in Fioretos, O. Falleti, T.G. Sheingate (eds.) *The Oxford Handbook of Historical Institutionalism*, Oxford University Press, Oxford.
[130] Keohane, R. O. (2008). "Big Questions in the Study of World Politics". In *The Oxford Handbook of International relations*, edited by Christian Reus-Smit and Duncan Snidal, 708-15. New York: Oxford University Press.
[131] Fioretos, O. (2011) "Historical Institutionalism in International Relations", *International Organizations*, Spring 2011, vol. 65. No°2, pp. 367-399.
[132] Farrell, H. Finnemore, M. (2016) "Global Institution without a Global State", in Fioretos, O. Falleti, T.G. Sheingate (eds.) *The Oxford Handbook of Historical Institutionalism*, Oxford University Press, Oxford

but secretariat general and administrators chose for their technical skills more than for their political views, managing budget in a way and in a scale which cannot be compared by the budget of a State Bureaucracy. Those two assumptions lead the author to state that "One consequence of the structures of IOs and of absent states is that international organizations often use means and methods that are understudied by historical institutionalists" (p. 5). International Organizations are more than norms providers, they also spread values and gain power through classification of knowledge, fixing meaning of a political situation, and they diffuse norms and behaviors in the world politics[133].

One way to develop an Historical Institutionalist approach to International Organizations is the actor-centered approach of supranationalism developed by Büthe. Firstly, Büthe express that "political authority is supranational when consequential decisions are made by legislative, executive, or adjudicative bodies of several countries, jointly or by a single body above the level of nation-state. Supranationalism, then is the *process* of creating or strengthening such authority, either do novo, or by shifting authority from national to the supranational level" (p. 1). Consequently, and following what we saw earlier, a historical institutionalist approach to supranationalism should focus on the institutionalization of political space above nations and how those institution influences the actions of actors both at national and supranational level since it framed new opportunities, new uncertainty and new interpretation of ideas and situations. Supranational institution has consequently the feature of a political space which internationalize the object of strategic actions and catalyze new sources of legitimacy as well as resistance for actors at the level of national institutions. To do so, the author propose an "agent-centric historical institutionalism" in order to take into account the process of institutional change at the supranational level: "An agent-centric historical institutionalist analysis requires the analyst to identify the key stakeholders and determine the interests that such potential actors are likely to pursue, then theorize how those actors, their interests, and the way in which they pursue those interests will be affected by the opportunities and constraints of the broader institutional configuration and by institutional feedback" (p. 5). Such theoretical framework all the research to not assume the preference of actor for the supranationalization, but to integrate supranationalization as a part of actors strategy and interest as well as an institutional change that give institutional answer to institutional constraints. From perspective, Büthe extrapolate several theoretical rules for the historical institutionalist study of supranationalism:

1) The institutional position of the supranational bodies alters their fundamental interests to provide technical features to national institutions, hence converting their will to be reliable (hence, legitimizing its self-preservation and existence) into a strategy of power accumulation and influence improvement by accumulating tasks and gradually position itself as being essential for the pursue of the set of public policy

[133] Barnett, N., Finnemore, M. (1999) "The politics, Power, and Pathologies of International Organizations", *International Organization*, vol 53, n°4, p. 706

they carry[134]. By doing so, they also produce supporter of the supranationalism allowing its competences to potentially spillover.

2) The role of the member states is still essential since they provide the legal framework of such supranational institution via international treaties. Consequently, they are essential agents of institutional changes and are what allow supranational organizations to carry new competences. Hence, institutional adaptations of supranational bodies are always *a minima* negotiated by representative of member states and institutional adaptation will always depends on strategy of member states actor (and then their idea and representation of the situation).
3) Supranational organizations influence the work of international public officials which will have interest to promote the agenda of the supranational organization. Indeed, such can influence of career incentives, professional norms or ideological commitments, or specific interpretation of transnational phenomena. Furthermore, Büthe explains that those international civil servants will support supranationalism even further if the prospect to enhance to power and influence such organizations will compensate the loss of national autonomy, as Ruggie explained for the institutionalization of international organization regarding the management of technological change.
4) National and transnational private actors have to be integrated in the analysis of the supranationalization since they are important change agent of their institutionalization. Indeed, private actors can, especially in a context of growing economic interdependence, influence both national and supranational institutions since this political space will potentially directly affect their core activities. Furthermore, the institutionalization of supranational organization will offer several "political opportunities structures"[135], i.e. create opportunities for those actors to gains resources, legitimacy or to promote their views in an environment less institutionalized and more malleable than nation-states. "In other words, the EU allows sub-national private actors to pursue their interests through inter- or supranational rather than (only) domestic political institutions. It provides an opportunity to achieve with a different political coalition at the European level what they may be politically too weak to achieve at the domestic level" (p. 8).

The actor-centric approach developed by Büthe explores consequently how historical institutionalism can develop a framework to understand and analyze the creation of supranational organizations as being the fruit of conflict and bargaining between actors. Promotors of supranationalization, in this negotiation, tend to develop an argumentation which frame the development of such authority as being apolitical, presenting supranationalism in terms of efficiency regarding economic, administrative, or technical issues. Moreover, the author states that the general dynamics of institutionalization of supranational organizations tend to be oriented towards the development of the resource and authority of such supranational organizations rather than a

[134] Pollack, M. A. (1994). "Creeping Competence: The Expanding Agenda of the European Community." Journal of Public Policy 14 (2): 95–145.
[135] Kitschelt, Herbert P. (1986). "Political Opportunity Structures and Political Protest." British Journal of Political Science 16 (1): 57–85

reversal toward less integration. Indeed, on one hand, the opposition of supranationalization often lack the transnational structure to frame and promote their disagreement to such institutionalization, and consequently, struggle to translate the demand for less supranational governance into practical institutional change. On the other hand, member-states opportunities to reverse supranational institutionalization also lack structural resource to be implement. Indeed, even if a country has a democratic popular support to face such institutionalization, this domestic support cannot necessarily be translated into bargaining power within an intergovernmental arena, in which can gridlock in case unanimity among member states cannot be reached. A faction of member-states governments has consequently the ability to safeguard the new status quo, even if they did not have the political leverage to provoke such impasse in a classical intergovernmental bargain. We have, however, to criticizing the way Büthe seems to forget the development of coalition advocacy group in the institutionalization of supranationalism. Indeed, in those bargaining, actors are not atomized, but constitute group in order to create, maintain, or change institutions. Patrick Emmenegger[136] : "agency plays a key role in the creation and maintenance of social coalitions that stabilize or challenge institutions. Without such agency, no coalition can be created or maintained. Similarly, without a supporting coalition, no institution can survive" (Emmenegger, 2021, p. 608). The institutionalization of supranationalism cannot be dissociated to the work of "institutional entrepreneurs"[137], which seize challenge and opportunity that can bring the institutionalization of organization able to mitigate the effect of transnational matters.

Historical institutionalist (HI) theories highlight that past institutionalization and interdependence generate new transnational actors, interests, strategy, and structural challenge and opportunities that will influence how the institution will adapt to structural change in global politics. Hence, the timing and sequencing of institutionalization of international organization matter because its foundation will structure the constraints and opportunities for next institutional creation. Regarding the development of international institution, Voeten explain that "The broader theoretical implication is that in order to understand the design of the rules for the global economy, we have to understand not only domestic firm interests and capabilities but also how these interests were institutionalized domestically and the trajectory by which international and domestic actors sequence their moves. Institutional design results from a series of previous actions that may or may not have been purposive" [138] (Voeten, 2019, p. 156). This Historical Institutionalism do not consist in listing causal factors, but in framing those causal factors in a specific social and historical context, which give sense to the strategy of actors in their effort to compete and cooperate in the setting of institutional design[139]. An inquiry regarding analytical tools of Historical Institutionalism applied to Supranational Organization have

[136] Emmenegger, P. (2021) "Agency in historical institutionalism: coalitional work in the creation, maintenance, and change of institutions", *Theory and Society*, n°50, pp. 607-608.
[137] DiMaggio, P. J. (1988). Interest and Agency in Institutional Theory. In L. G. Zucker (Ed.), *Institutional patterns and organizations: Culture and environment*. Cambridge: Ballinger. pp. 3–21
[138] Voeten, E. (2019) "Making Sense of the Design of International Institutions", *Annual Review of Political Science*, n°22, pp. 147-163.
[139] Boychuk, G. W. (2017) "Studying Public Policy: Historical Institutionalism and the Comparative Method", *Canadian Journal of Political Science*, 49:4, pp. 743-761.

been developed by Rixen, Zürn, and Viola[140]. In the introduction of their book, they describe three broad categories to explain international institutional development. Firstly, they explain that the principal explanatory success of Historical Institutionalism analyzing international organization is its ability to grasp its dynamic change within history. To do so, three concept are highly relevant: path dependencies, that we already saw, but also critical juncture and sequencing. Critical junctures are event which catalyze and overturn radical change and rupture of the path dependance process, creating institutional instability[141]: "The notion of critical juncture brings another element of dynamism into understanding institutional development, as these are moments of relative structural indeterminism in which agency matters and choices are possible. Critical junctures also provide a way to think about the difference between rapid changes and gradual ones. Critical junctures, like the notion of punctuated equilibrium, imply a model of change in which long periods of stasis are disrupted by short bursts of change which are, in turn, followed again by long periods of path dependence" (Rixen, Zürn, and Viola, 2016, p. 13). Sequencing, on the other hand, are an analytical posture situating event in a historical chain which allow to understand relation of causality between event developing the institutionalization of in international organizations, an idea referring also as "reactive sequence"[142]: "Subsequent institutional choices are to some extent constrained by prior choices, and they enjoy a lower degree of freedom. Often, arguments based on sequencing look at the effects of intersections of events, or causal chains, and point to cumulative causal logics. While path dependence can be considered a case of sequencing, sequencing can also characterize other dynamic processes which may not be characterized by increasing returns, but for which the exact order of the unfolding of decisions or events matters for the outcome" (ibid. p. 13). Path dependence, critical junctures and reactive sequence allow us to develop a framework to study endogenous sources of change or stability. For the authors, change have three fundamental qualities: *speed,* (the rate of change), as well as its magnitude, which itself is decomposed between the *scope* of change (the number of institutional features affected by institutional transformation) as well as the *depth* of change (the degree to which those institutional features differ qualitatively from their previous forms).

4.5. Conclusion: contour of a Historical Institutionalism methodology for the study of multilateral industrial politics and the 5G PPP

This part of our thesis allows us to frame the methodological contour of our Historical Institutionalist study of the 5G PPP by framing it as an institutionalization of Multilateral Industrial Policy in the EU. The development and implementation of the 5G PPP will be study as an outcome of the trajectory of the 2000's paradigm regarding the role of the EU in industrial policy. We saw that the Lisbon strategy already path the way for a soft multilateral industrial policy. If this paradigm did not produce major effect in the 2000's, new

[140] Rixen, T. Viola, L.A. Zürn M. (2016) *Historical Institutionalism and International Relations. Explaining Institutional Development in World Politics.* Oxford University Press, Oxford, pp. 249.
[141] Capoccia, G., and Kelemen, R. D. (2007). "The Study of Critical Junctures: Theory, Narrative and Counterfactuals in Institutional Theory." World Politics, 59(3): 341–69
[142] Mahoney, J. (2000). "Path Dependence in Historical Sociology." Theory and Society, 29(4): 507–48.

structural challenges will give a new impulse: the 2007-2008 economic and financial crisis. This crisis, or, as we saw, critical juncture, reinforced the fear of European actors to be marginalized by the global market, and the increasing deindustrialization of Europe was seen as a catalyzer of the crisis in the single market. To face these new challenges, the EU institutions will base their hope in a new paradigm regarding innovation policy: the "4th Industrial Revolutions". The 4th Industrial Revolution, also called through the German slogan "Industry 4.0", can be defined as follow: "Industry 4.0 is a new sphere of industry, which appeared as a result of emergence and distribution of new technologies—digital technologies and Internet technologies—which allow developing fully automatized production processes, in which only physical objects that interact without human participation take part. Industry 4.0 creates traditional industrial products and new industrial products, which cannot be manufactured in other spheres of the real sector economy"[143] (Sukhodolov, 2019, p. 8). Because the 5G Mobile technology is a key technology to develop this paradigm of industrial economy (it is an essential element of the Internet of Things, but not only), and because the prospect of this technology was promoted as provider of economic growth, technological upgrades, employment etc., and because the world was starting a race to develop and implement this technology, the EU created, through the 8th Framework Programme, Horizon 2020, a public-private partnership in order to develop a platform to discuss and implement horizontal and structural policies which will favor the development of the 5G.

To study such institutionalization of the 5G PPP, we will use the toolbox of the historical institutionalist approach:

- We will analyze how actors from the EU but also from the European ICT industry, provided specific meaning to the challenges the EU was facing at the beginning of the 2010's, and how they negotiated to determine to role and scope of an Industrial policy which will favors their interests.
- We will see how the previous EU industrial policy had favor some actors and their paradigm of EU industrial policy, and how those actors had promoted their vision of the multilateral industrial policy, which influenced the institutional design of the 5G PPP as well it participates to the supranationalization of industrial politics. We will see that the institutionalization of the multilateral industrial policy participates to the legitimation of the EU as being an industrial actor, able to shape a truly integrated innovation system.
- We will outline the path dependence process that the 5G PPP outline, but also the institutional innovation that it has produce, especially regarding the way businesses associations find its way to promote its agenda, interests, and definition of the situations. This will help us define the sequencing of the institutionalization of the 5GPPP, and hence the speed, scope and depth of institutional change that happened in the EU industrial policy.
- We will define what idea was mobilized by actors in order to promote their vision of a multilateral industrial policy for the rollout of the 5G technology, how this institution summarize the struggle between

[143] Sukhodolov, Y.A. (2019) "The Notion, Essence, and Peculiarities of Industry 4.0 as a Sphere of Industry", in Popkova, Ragulina, Bogoviz (eds.) *Industry 4.0: Industrial Revolution of the 21th Century,* Springer, pp. 3-11.

a neoclassic approach of industrial policy focuses on precompetitive questions, a structural approach, focus on the condition to place ICT industries in the global competition, and pragmatic approach, which focus on the link ICT industries and European actors should interact in order to implement the best policy possible.

Consequently, to study the gradual the 5G PPP in the broad framework of the institutionalization of the multilateral industrial politics of the EU, we will have to study empirically the formal document provided by Institutions of the EU industrial policy institutions, and to frame how actors from the European Union and from the Business associations shape their strategy to frame the contour of this 5GPPP as an artefact of the Multilateral industrial policy, and their discursive and political resource they use to advocate for their vision of the EU industrial policy.

Such study will be conduct with a special emphasis on strategies of actors, by studying their formal position in official documents, and to frame them in the global context of the institutionalization of Industrial policy for the 5G. those documents will allow us to understand power relationship in the institutional design of the 5G PPP, how actors frame their cooperation and competition over the institutional innovations by understanding their reflexive interpretations of the situation. Such situation, as we will see, is also set up by a specific narrative over the dialectic technology-globalization, from both EU official and representative of business associations, that actors will try to mobilize and promote in order to improve their positions. Those actors, through the establishment of coalition, will compete, negotiate, create space to promote their vision of the 5G and the global race upon it, and its societal and economic benefit. They will also agree upon the development of a specific industrial policy which will target the implementation of a System of innovation they see as favorable to the development of 5G technologies, which will be defined by a public-private partnership. The analysis of the institutional design of the 5G PPP will provide us precious information about the distribution of labor between EU actors, Nations States actors, and private actors in the System of Innovation of the 5G.

However, we should use the tools proposed by the Historical Institutionalism for our study of the 5GPPP with parsimony, since it can provide evident bias. For instance, Drezner stress that the methodology of Historical Institutionalism can draw an excessive attention to one causal process, which can blind the investigation to the possibility of another substitutable causal processes, or that of the intertwined effect of several causalities. Furthermore, the author states that "HI approach lacks an explanation for how domestic bureaucratic politics affects both the power and preferences of national actors on the global state"[144] (Drezner, 2010 p. 798). We understand then that, to study the institutionalization of the 5G PPP through a historical Institutionalist analysis, have to consider multiple space of institutionalization of the EU Industrial policy regarding the implementation of an innovation policy for the deployment of technologies of the 4th industrial revolution. We

[144] Drezner, D. W. (2010) "Is historical institutionalism bunk?", *Review of International Political Economy*, vol 17, n°4, pp. 791-804.

should also consider how the transnationalization of networks of actor of this institutionalization emerged and performed, and how those transnational coalition performed to find purposes and resources. Furthermore, if historical institutionalism can be credited for its critiques of the "atomistic and anything-goes orientations" of rational choice approaches, Ira Katznelson[145] articulated the risk for historical institutionalism to not have a critical assessment of the sociological tradition too. Indeed, if we only consider contextual analysis, he suggested, the research could be influence by an over interpretation of the role of idea and social interpretation over the materialist weight of structure and institutions. Katznelson (1997, 104) however concluded that by this problem can be solved by adopting a relational perspective that saw "particular clusters of preferences, interests, and identities ... not just as causes; but as causes as well as products," (p.8) historical institutionalism was "crossing the divide between structure and agency without ... eliminating the heuristic distinction between the two" (p. 104). Consequently, if we have to study the reflexive understanding of innovation and globalization by actors and understand their relational connections in order to understand how such ideas are positioned in the institutionalization process, how they are transformed by actors and by new information and new understanding of the institutionalization process.

[145] Katznelson, I. (1997). "Structure and Configuration in Comparative Politics." In (ed.) Irving, M., Lichbach, Zuckerman, S.A. *Comparative Politics: Rationality, Culture, and Structur*e. New York: Cambridge University Press, 81–112.

5. 5G PPP. Analysis of the implementation of a Multilateral Industrial Policy of the 21st Century.

5.1. Introduction.

The 5G Infrastructure Public Private Partnership is a joint initiative between the European Commission and European ICT industrial actors. As we saw, the involvement of European institution for the development of European industries started to be more and more relevant in at the end of the 2000's. Indeed, the question of a more direct intervention of the European institutions in new technologies' industries became more and more appropriate, since intellectuals and policy makers started to develop the idea that competition oriented industrial policy could not be the only responses provided by the European institutions to boost industrial development. This idea was furthermore developed after the economic and financial crisis, were question of the decrease of European production system as well as systemic problems that the EU will have to face in the future was thought to be answered in a systemic and coherent way.

5.2. The context of the implementation of a European Industrial policy in the aftermath of the financial crisis: toward the promotion of industry, innovation, and ICT.

The 3rd of March 2010, the EU Commission launch a long-term strategy in its communication "Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth"[146]. This communication establishing a way out of the economic and financial crisis context, which was still hitting the EU at the time: EU GDP dropped by 4% in 2009; the industrial production is at its lowest since the beginning of the 1990's and 10% of the active population was unemployed. Furthermore, the crisis highlighted the threat of long-term problem Europe could face in the future: a growth rate structurally stagnating; an aging population which will fragilize European social and economic cohesion and an unemployment rate which can, if not handle strongly, affect those two mentioned issues even further. Since the crisis exposed structural weakness of the EU economy, the document establishes different priorities to reinforce the economic position of Europe by targeting three key priorities which was considered as critical for the coming decade. Those "three mutually reinforcing priorities" are 1) Smart Growth, to develop an economy founded on knowledge and innovation; 2) Sustainable Growth, to promote a green and competitive economy; 3) Inclusive Growth, to promote employment and territorial cohesion. To achieve those, the EU Commission established "headline targets" for 2020:

- 75% of the population aged 20-64 would have a job.

[146]European Commission (2010) "Europe 2020 : A strategy for Smart, Sustainable and Inclusive Growth" (communication) [online the 20.09.2021] https://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf

- 3% of the EU's GDP should be channeled toward R&D.
- The "20/20/20" climate/energy targets should be met.
- The share of early school leavers should be under 10% and at least 40% of the younger generation should have a tertiary degree.
- 20 million less people should be at risk of poverty.

Furthermore, to catalyze progress under each of those targets, the EU Commission has established seven "flagship initiative" which will bind both EU institutions but also Member States : 1) Innovative Unions; 2) Youth on the move; 3) A digital agenda for Europe; 4) Resource efficient Europe; 5) An Industrial policy for the globalization era; 6) An agenda for new skills and jobs; 7) European platform against poverty. EU level instruments to help for the implementation of project under those flagships are fully envisioned by this document, especially regarding single market, financial levers, and external policy tools. The governance model for the delivering of those priorities and goals are based on two pillars: EU level policy which involve thematic approach combining priorities and headline targets, and Nation States level reporting with a support from EU institutions to help countries to develop their strategy to meet objective established by this document.

Three of those flagships are highly relevant for our understanding of the European Industrial policy regarding 5G Internet Infrastructure rollout and the 5G Public-Private Partnership in particular. Firstly, the flagship "A digital agenda for Europe" have a particular importance in the documents: in the priority "smart growth", the EU Commission commit to use this flagship to provide a legal framework to catalyze finance, from the private sector as well as from nation states and EU founding, to develop an advance spectrum policy, to reinforce the R&D sector to support ICT industries but also the development of key technology, and finally to create a true European Digital single market for online content and services. Regarding the flagship "Innovative Union", the EU also aimed at using it as a tool for the priority "Smart Growth" to foster the European Research Area in strategic research agenda, especially in the development of network infrastructure of the future, to promote a safe and sound environment for entrepreneur by developing a European Patent and specialized Patent Court; to promote European Innovation Partnership between EU and Member States, but also between EU and private sector and academic sector. Finally, the flagship "An Industrial Policy for the Globalization era", developed in the framework of the priority "Sustainable growth", defines the role of the EU level as an enabler for the establishment of horizontal approach to industrial policy, to improve business environment (especially by creating partnership and innovation cluster with private actors, in particular SMEs), to promote network infrastructure to develop the single market as a tool to enhance industrial development; to cooperate internationally to create and develop standards and norms which will allow internationalization of SMEs and industries. Later during the year 2010, three distinct documents complete the vision and the scope of each of those flagships.

Later, the European Commission decided to develop the idea of "A Digital Agenda for Europe" in a communication the 19th of May[147] with the "overall aim to deliver sustainable economic and social benefits from a digital single market based on fast and ultra-fast internet and interoperable applications". This document aimed at establishing a long-term goal to use internet and digital economy to foster EU economy and achieve social progress as well as foster to tackle key problematic as the aging of the population, the competitiveness of European industries, the position of Europe in the technological race as well as its position of the in global affairs. Furthermore, the ICT sector in Europe is a key driver of its productivity growth (20% from ICT sector and 30% from ICT investments). However, some key obstacles restrain the ICT sector to fully develop in Europe, and the specific task of this flagship will be to find solution to those challenges:

- Fragmentation of the digital market of Europe make it highly ineffective because it is constituted as a patchwork of national online markets and not an European one.
- The lack or interoperability among ICT technology within the EU, due to weakness in standard setting, public procurement, and coordination between public authorities, create huge problem to establish the infrastructure of the Digital Single Market.
- The rising cybercrime and risk of low trust in networks creates problem of suboptimal use of the ICT system and constitute an obstacle to the commercial deployment of activity of the digital economy.
- The lack of investment in networks create the need to establish incentives to stimulate private stakeholders to invest in new generation network as well as targeted public investments.
- The insufficient research and innovation efforts which need to be meet by building innovation ecosystem where European ICT industries and SMEs can develop new product and compete in the global market.
- The lack of digital literacy and skills in the European population create low incentive for company, especially SMEs, to invest in the digital economy since the demand is lowered by underutilization of digital devices.
- The missed opportunities in addressing societal challenges through digital solution have also to be addressed, since the mitigation key issues such as the climate change, ageing of the population, the rising health costs… can partly be addressed by such digital transition.

The Digital Agenda is then a clear tool to develop an industrial policy at the level of the EU to foster the digital economy but mostly to complete the digital single market. This document envision instrument to establish this Digital Agenda as the simplification of the copyright clearance, the competition of the Single Euro Payment Area, the implementation of the eSignature Directive which would provide legal framework for Europe wide eAuthentication system, the review of the EU data protection regulatory framework, the establishment of rules on implementation of ICT standards, the reinforcement of network and information security policy and the

[147] European Commission (2010) "A Digital Agenda for Europe]" (communication) [online the 20.09.2021] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0245:FIN:EN:PDF

fight against cybercriminals, enhance private investment through a strategic use of precommercial procurement and public private partnership etc.

The 6th of October, the EU Commission publish the communication "Europe 2020 Flagship Initiative: Innovation Union" which precise the scale of this instrument. If the document highlights the great culture of innovation in the continent, it also highlights crucial fragility such as the under-investment in knowledge foundation comparing to the USA and Japan, the poor framework conditions link to unsatisfactory access to finance, high cost of intellectual property rights and the fragmentation of use of resource for R&D. It is then crucial, highlight the document, to adopt a "strategic approach" to innovation working on a cooperation between EU institution and Member States. By doing so, Europe would develop its own approach on innovation based on 1) the focus on innovation addressing global and societal challenged and strengthen European leadership in key technologies; 2) following a broad concept of innovation which would be both research-driven and business-driven, strengthening Europe's capacity to compete in the global market as well as to develop technology needed its society of the future; 3) creating a systemic and inclusive approach in which all actor of the public field (from the regional entity to European ones) and private field (from the smallest SMEs and this bigger industrial champions). This commitment to create a "Innovation Union" through an integration approach are based on several action that the documents describe. Those include the training of researchers and the creation of attractive employment conditions in public research institutions; the creation of European Research Area framework supporting mobility and cooperation among research centers; the development of European research infrastructures; the implementation of financial instruments to better channel private finance in research which would allow to close the market gaps in R&D investment; to ensure that venture capital funds established in a Member States can function and invest in the EU, favoring cross border initiatives; the creation of a European Industry Alliance legal framework to better create partnership between the public and the private sector etc.

Finally, the Communication "An integrated Industrial policy for the globalization Era, Putting Competitiveness and Sustainability at the Center State"[148] frame directly the problem and challenge brought by globalization and the answer digital technology could provide them. Firstly, this document states that industry is a key component to tackle the recover from the financial crisis and to drive the objective to build a smart, sustainable, and inclusive growth. Since one out of four jobs in the private sector in the EU comes from manufacturing industry, and another one out four comes from services connected to the manufacturing industry, developing and strengthen the European Industrial complex is more than a political objective to reach 2020 goals, but an existential problematic that EU policy makers need to address. This communication aimed then at developing a strategic framework for an integrated industrial policy which would develop a strong,

[148] European Commission (2010) "An integrated Industrial Policy for the Globalization Era. Putting Competitiveness and Sustainability at the Center State" (communication) [online the 20.09.2021] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0614:FIN:EN:PDF

competitive, and diversified Industrial value chain that would foster the EU position in the global market as well as being a springboard to reach employment target in the Europe 2020 framework. This approach on industrial policy aimed at, firstly, having an impact on cost, price, and innovative competitiveness of industries as well as individual sectors through standardization, innovation policies and sectoral policies targeting the development of R&D in individual sectors; and secondly, consider policy initiatives, such as energy, network infrastructures consumer protection, single-market policy and trade policy, in a systemic way to frame their competitiveness added values. In addition to sector-specific dimension, this communication develops five cross-sectoral dimensions of this new integrated industrial policy.

- "Improving Framework Conditions for Industry" target the development of a "smart regulation" having two dimensions: the systematic evaluation of policy proposal's impact on competitiveness, and the ex-post evaluation of those implemented policy on competitiveness. Furthermore, this communication targets the access to finance for business as a target of this initiative, also to develop a more resilient and more efficient financial markets.

- "Strengthening the Single Market" aimed at developing the opportunities that the single market would carry for the manufacturing sectors as well as developing a legal framework enforcing intellectual property rights. This would require developing the tools of the competition policy to enhance the competitiveness of European industrial actors, as well as their ability to innovate and to seize the opportunity of the global market as well as an effort of standardization allowing a sound and harmonized legal environment to develop business. Furthermore, it also requires the development integrated infrastructure but also the expansion R&D ensuring Europeans' ability to develop next generation infrastructures.

- "A New Industrial Innovation Policy" focuses the need to encourage the development and commercialization of goods and services. This strategy was already set up in the flagship "Innovative Union" which aims the implementation of a coordinated, systemic, and integrated approach to R&D, and in the communication "Preparing for our future: developing a common strategy for key enabling technologies[149]" which prioritized key technologies for the development of the industry of the future. The development of ICT sectors in order to foster competitiveness, resource optimization and innovation are also being integrated in this systemic approach as developed in the "Digital Europe Flagship".

- "Capitalizing on Globalization" goal is to expand the idea that trade policy and an growth policy based the access of international markets are a key element for the industrial policy of the 21th century. It is then crucial to build international regulatory initiatives aiming at cooperating with European major trading

[149] European Commission (2009) "Preparing for our future: Developing a common strategy for key enabling technologies in the EU" (communication) [online the 20.09.2021] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0512:FIN:EN:PDF

partners to follow any new or existing international programs (with an active role of the World Trade Organization) and to develop globally compatible rules and standards.

- "Promoting Industrial Modernization" target the transition of European industries to low carbon and energy efficient means of production. To achieve this, the Commission would implement a long-term strategy to stimulate energy-efficient investment in all sectors of EU's industries, as well as the funding of private and public research following this objective.

In brief, we understand that the financial crisis highlighted structural weakness of the European economy. Those open the door for a debate at the EU level to plan a decade long plan to shape and change the EU economy in order to make it more resilient and more competitive in a global context where Europe is increasingly losing its technological and industrial position. Those documents imagining what could, and should be, the economy of Europe 2020 gave a central role for the ICT technologies and industries. Indeed, ICT technologies are depicted as a cornerstone of the future manufacturing, growth, and the completion of the single market. Hence this new intellectual legitimacy allowed to reimagine the role of public interventions in the industrial sector since the competition-oriented industrial policy since to have reach serious limits. In particular, huge concerns were raised about the inexistence of ICT champions in Europe, making it lag behind concerning key technologies which were already depict as the avantgarde of the future economic grow. It was consequently decided to seize the coming 8th Framework Programme to channel policy support for the industry, but preliminary discussion about the nature of the problem the sector was facing had to be raised.

5.3. Prehistory of the 5G Public Private Partnership.

The history of the implementation of a Public Private partnership implementing the infrastructure of the internet of the future was firstly imagined through meetings organized by the European Commission and where the private sector where invited. Such events where the key moment in the way it created the target and the scale of a possible partnership between the European Commission and the Private sector. Indeed, the future of internet infrastructure was not fully a target of the previous 7th Framework Programme since its Future Internet PPP targeted mostly application rather than network infrastructure.

5.3.1. Step 1. The Competitiveness Week.

The idea of the creation of partnership between public and private actors regarding the future of internet infrastructures started in the Competitiveness Week set up by the DG CONNECT of the European Commission in September 2012. Since the 7th Framework Programme as well as the ICT Policy Support Programme were arriving at their term, and because structural problems regarding the growth to the ICT European sector were still not solved yet, EU Commission seized this event to gather actor of the ICT industries in order to outline the possible policy respond to those issues. This event aimed consequently to gather European based industry

for a discussion regarding the coming 8th Framework Program in order to establish the most promising research project to develop ICT industries, as well as legal and financial framework to enhance the competitiveness of ICT European actors in the global market. Furthermore, the event also reviews sectoral and non-sectoral strategies "for how to regain European leadership in the ICT"[150]. The 17 September were dedicated to Cross-cutting issues, including framework condition for ICT competitiveness, access to finance for innovative companies, smart specialization and its local dimension and digital skills. The 18, 19, and 20 September were dedicated to sector specific issues, including Electronic Components and systems, Advanced Computing, Manufacturing, Health application, Full Electric Vehicle, or smart Cities. Four reports were established following each workshop of the 17th of September, which set the basis of recommendation from the ICT private sector to the DG CONNECT in prevision of the coming policy development regarding industrial and research and development program at the EU level.

- The Report "The role of Taxation, and State Aid in EU ICT competitiveness"[151] highlighted the increasing cost of manufacturing in new technologies sectors. Panelists showed that in order to implement a leading-edge microchip factory in 2012, its initial cost would be over $1 billion only to purchase the first toolset. This discussion, which lead to this report, aimed at defining specific measures that could be implemented by European policy makers to sustain ICT entrepreneurship (since key emerging technologies have a major role in supporting all sectors of the digital economy). The participant to the report points out that the mains barriers to the development of the ICT industries is 1) the fragmentation of the internal market creating incompatibility between sectors, especially in the transport, health and energy; 2) a fragmented process to channel public aids to private actors, involving multiple actors among the level of the region, nation-state, and the EU, creating the need of a one-stop-shop process (like the Singaporean Economic Development Board) as well as a strategic planning and recognition of the value of foreign investment (like United States' strategy for semiconductor highlighted); 3) the rigidity of tax rules, which should allow tax deferrals to more security for long-term investment in capital intensive technologies; 4) the lack of a European Intellectual Property Right base, stressing that the lack of EU copyright system could jeopardize growth in sector where protections of patents are central.

- The Report "Innovative companies: making Europe the best place to grow highly innovative ICT SMEs"[152] pointed that very few European SMEs became industry leaders and had the tool to compete in the global market, demonstrating that the use of the single market does not fulfill its role as springboard to develop

[150] Executive summary of the "ICT Competitiness week" September 2012. https://ec.europa.eu/digital-single-market/sites/digital-agenda/files/ICT_Competitiveness_for_Europe_-_Executive_Summary.pdf (Accessed the 16.07.2021).
[151] DG CONNECT (2012) "The role of taxation, IPR and State aid in EU ICT competitiveness, report of a High level Panel Discussion", (Online the 20.09.2021). https://ec.europa.eu/digital-single-market/sites/digital-agenda/files/1._Framework_Conditions_report_Final.doc.pdf
[152] DG CONNECT (17.09.2012) "Innovative companies: making Europe the best place to grow highly innovative ICT SMEs, report of a high level panel discussion" (Online the 20.09.2021). https://ec.europa.eu/digital-single-market/sites/digital-agenda/files/2._Innovative_companies_Report_Final.doc.pdf

growth and jobs in the ICT sector. Indeed, if the single market creates an opportunity to target half a billion costumers, most companies do not trade across borders. Furthermore, the report mentioned a lack of international culture in the mindset of European entrepreneurs: "Many European entrepreneurs have a strong tendency to feel comfortable about the size of their company, and to remain owner and founder of a business until retirement. This is a mind-set which often results in stagnant companies". This attitude vis-à-vis entrepreneurship result in a huge problem for ICT companies, which relied on scale upgrade and international opportunities. This report state that Europe should be more involve in providing financial means to SMEs, allowing them to grow. Indeed, 50% of all venture capital investment are ICT investment (from digital infrastructure to rapidly scalable internet-based business). This represents a major shift in the need of investment since the sector mostly move away from institutional investor to government agencies (causing an increase in corporate investment). Europe need to step in, since the European VC founds average at only €16 million, which is not enough to scale up technologies nor the seize of the company substantively. The report then advice the commission to create a series of market-oriented Funds of Funds (more attractive for institutional investors), with large capacity to invest in VC to support capital intensive and internet-based business.

- The report from the "Smart specialization (local/regional dimension): role of innovation Ecosystems and Clusters workshop"[153] was based on the ways to "establish realistic and sustainable" local or regional innovation ecosystem. This, involving stakeholder and infrastructure development, should have the support of EU program, since this document refer directly to the coming Horizon Europe as a framework for deployment. The document refers to the acknowledgment of the diversity of actors in the development of ICT industries has led to the development of an "ecosystem-based policy approach", but also

- cite the objective of "smart specialization" as an upgrading of the methodology for the Structural Founds programs to support local economies. In this context, panelist state that the European research policy could enhance the jointly the local economic development and ICT ecosystem advancement as well through a smart specialization. Taking the perspective of the implementation of Horizon 2020, the report states that "New ways of engaging the Public and Private sectors by creating Innovation Partnerships between the European institutions, national and regional authorities and business is of particular interest". Since the policy focus for industrial development has been reinforced by the concern R&D has took in the mind of policy makers, engaging in public-private partnership would then have the benefit to benefit to local economies since it would further strengthen the role of local SMEs the innovation ecosystem.

[153] DG CONNECT (17 September 2012) "Smart Specialization (local/regional dimension): Role of Innovation Ecosystems and Clusters workshop" (online the 16.07.2021). https://ec.europa.eu/digital-single-market/sites/digital-agenda/files/3._Smart_Specialisation_report_Final.doc.pdf

- Finally, the report from the "Digital skills (Business, skills, and digital skills gaps) Workshop"[154] express the concerns regarding possible ICT workers shortage, since the number of graduates in the sector is not enough to match the increasing demand in the industry. The report then established strategies in order to ensure value-oriented supply of digital and ICT skills, and to make ICT jobs and industry attractive to young generations. More specifically, the panels promote the role of the DG CONNECT in order to promote R&D founding mechanisms which would also be channeled toward ICT training, but also to promote ICT careers into the general public and in business schools by the creation of partnership between the industry and management's school curriculum.

We understand that those four reports articulate a certain need to establish a close partnership among the ICT industries and the agencies of the European Commission, since a lot of the recommendations involve reforms of the role of regions, public aids finance, educations, reforms of the internal markets, tax rules, reform of the Intellectual property rights etc. In sum, reforms which goes way beyond the portfolio of the DG CONNECT and even the one of the Internal Market Commission. The Competitive Week can be understanding as a direct consequence of the intellectual shift at the EU level regarding Industrial policy and the role of the ICT in particular. Indeed, documents establishing an agenda for Digital Europe and the others related to Smart, Sustainable and Inclusive Growth include widely the participation of private actors to the implementation of different flagships and objectives established since 2010. Consequently, the Competitive Week can be analyzed as a forum establishing contact pathing the way toward an officialized partnership between private industrial actors and the EU commission.

5.3.2. Step 2. The Mobile World Congress.

The year 2013 was crucial in the development of discussion regarding policy tools to foster the development of ICT infrastructure and helps to the ICT sector in general. Indeed, question of the implementation of the Connecting Europe Facility, a European Union found for infrastructure investment, with digital projected to support the competition of the Digital Single Market, started to emerge in order to evaluate the level of finance allocate to digital infrastructure projects. However, other issues than finance had to be raised before the setup of the 8th Framework program. The orientation discussions of the Competitiveness Week identified collaboration between private actor of the ICT industries and the European Commission as a clear path to tackle general issues that the single market fragmentation could create. Those find most notably an echo at in the position of the Vice President of the EU Commission. Indeed, the 26 February 2013 at the Mobile World Congress in Barcelona, Neelie Kroes deliver a speech named "Smashing Barrier and Thinking Big"[155] which aimed at putting light on a clear the path toward the creation of a Public-Private-Partnership for the development of ICT infrastructure actors Europe. In this speech, the vice president of the commission takes

[154] DG CONNECT (17 September 2012) "Digital skills (Business, skills and digital skills gaps) Workshop" (Online the 16.07.2021) https://ec.europa.eu/digital-single-market/sites/digital-agenda/files/4._Digital_Skills_Report_Final.doc.pdf.
[155] European Commission (2013), Speech/13/159 "Smashing Barriers and thinking Big", Mobile World Congress 2013/Barcelona.

back some remarks we found in the reports of the actors of the wireless industries that were raised in September.

The concern of the fragmentation of the internal market, the uncertainty about the creation of shared infrastructure, uncoordinated research that create inefficient allocation of resources etc. creates a divergence in mobile broadband penetration across Europe, and consequently does not allow the economic development that digital network infrastructure could create. Furthermore, this environment makes hard for actor of the industry to plan across border, to safeguard their investment in network infrastructure, or to collaborate in join up services allowing end-to-end quality. The increasing demands of European public and companies for ICT have then to be matched, creating consequently the urgent need to catch up industrial development and their competitiveness to satisfy this demand. In this context, the Vice President of the Commission explained that the substance of a future wireless action plan needs to be holistic, from the development of spectrum, ease investment framework, new way to think infrastructure ecosystem in order to foster as much as possible the European Digital policy. To implement this, Neelie Kroes made a call to Private actors present at the event for the creation of a public private partnership which would tackle all those challenges and be at the core of the development of 5G infrastructures in the European Union, allowing the competition of the Digital Single Market: "I call on EU industry and other partners to join us in a Public-Private partnership in this area. An open platform that helps us reach our common goal more coherently, directly, and quickly. European 5G is an unmissable opportunity to recapture the global technological lead. And I hope you will be able to support and join us". This speech does not only speak about the problem of mismatch supply of ICT technologies that challenge of fragmentation creates. The spirit of the strategy aimed at making ICT industrial actors "think big". In a sort of historical legacy, European industries had to grow because "Europe used to lead the world in wireless", actors of the sector have the duty to reclaim their position in the world economy dominated "by the east and the west" and to lead the race to 5G.

This call for the creation of a Public and Private cooperation for the development of 5G infrastructure was followed by a group of major industry companies and R&D centers. A group were creating in order drive the voice of the private sector in the discussion related to the creation of this partnership during the year 2013. In April 2013, the European Commission informed the Net!Works European Technology Platform (ETP) and industries about its agreement for the formal creation with a partnership between industrial actors and the European Commission. This group has continuously been expanded during preparatory phase of the 5G Infrastructure PPP in Horizon 2020 thanks to the involvement of SME and of the research community. Technical part of the proposal of the Public Private Partnership was developed one month later between the 10th of May and the 27 of May at the Future Internet Assembly 2013 held in Dublin. The results of this event were gathering in the book *The Future Internet Assembly 2013, Validated Results and New Horizons*[156] and

[156] Galis. A, Gavras. A (2013) *The Future Internet Assembly 2013, Validated Results and New Horizons*, Springer, pp. 401.

describes challenge that the sector will be face and that involves the intervention of the European public authority, including for instance the creation of security agency for next generation internet infrastructure or the development of international standard to support network interoperability.

We understand by this review of document from those two events that the months preceding the implementation of the Horizon 2020 Framework Programme and the implementation of the 5G PPP had stage the work of moral entrepreneur from both public and private sector for the creation of a public private consortium regarding the implementation of the future internet infrastructure. If the speech of the Vice President of the European Commission show a more cautious approach regarding the scale and portfolio that this partnership would involve (the private sector advocating for a partnership which would lead to a in depth reform of the data protection rights, new taxation model, especially regarding financing, and a direct involvement of the education sector), we see some common ground on the spirit and the substance of this to be born institution. Those include the problem of the fragmentation of the digital market, the need to coordinate more closely the precompetitive research apparatus of the ICT sector, and to find more transparent and less complex system of public financing need to be address in the future public private partnership. Moreover, we can stress the believe that Europe has the natural resource to stage the innovation of the future of ICT and that the European Industrial Policy, implemented by the private sector, should align actors with knowledge capacity that the single market have to offer.

5.4. Implementation of the 5G infrastructure PPP and Horizon 2020.

The spirit of the call of the vice president of the European Commission but also the recommendation of the private sectors had furnished the ground of the creation and implementation of the 5G PPP which found its legal basis in the European Law establishing Horizon 2020 as well as the contract and, in large part its annex, establishing the 5G PPP and signed by a representation of the ICT industrials and the European Commission.

Firstly, we need to have a quick look at the document "Horizon 2020 Work Programme 2014-2015"[157]. Adopted on 10 December 2013, this document has been updated in a new document the 22 July 2014, which sets bold objective regarding industrial policy and the role of the ICT to develop new industrial technologies. This document also shows how the Framework Programme is use, in its 8th edition, as a tool for industrial planification by the European Institutions. If the introduction of this work program emphasis the ecological and social orientation that this Framework Programme will support, it also stresses the role of digital economy in the progress of productivity and efficient in all sectors of the European economy and in the manufacturing in particular. To maximize the impact of this Framework Programme, this workpaper consequently highlight dedicated instruments to develop European industries and SMEs: 1) by "boosting industry engagement

[157] European Commission (2014) "Horizon 2020 Work Programme 2014-2015" (Decision) [online the 20.09.2021] https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-intro_en.pdf

through partnership", which concerns the "early implementation of innovation driven public-private partnership" in order to channel private and public investment for the development and implementation of key enabling technologies "with a particular emphasis on systems integration, validation, piloting and demonstration activities". This part also focusses on the role of SMEs, European Innovation Partnership, and Industry Driven European Technology Platforms to create technological emulation and boost the development of industries based on an industrial ecosystem. Secondly, another part of this document "Boosting the industrial development of enabling technologies" highlight that the FP8 Horizon Europe will provides extensive research and innovation boost to EU industries by developing the development and implementation of key enabling technologies in the manufacturing sector: "The goal of Horizon 2020 is to provide support to capture a large share of the rapidly expanding markets of KETs, to ensure the best use of these technologies to generate value across the economy and enable innovative solutions to societal challenges". One of this KET that the working program depict concern new generation internet infrastructure: "Under the first Horizon 2020 work program, ICT activities will focus on the integration of advanced networks, of cloud computing with huge data processing capabilities, of high-performance computing and of sensing and communicating devices to build smart connected environments to enable new classes of applications with high impact." If this document does not mention directly the 5G Public Private Partnership, not the 5G technology in particular, it is still worth mentioning since it stress how the Horizon 2020 Framework Programme stress the role of ICT sector for the development of industries and growth, but also the role of Partnership between private and European institutions coalition and with European Technological Platform gathering industrial actors, elements which will be central in documents establishing the role, purpose and organizational feature of the 5G Public Private Partnership.

The First key step of the implementation of the 5G PPP is the vote of the regulation establishing Horizon 2020 – the Framework Programme for Research and Innovation was finally signed the 11 December 2013, which complete the Council decision of the 3 December 2013 establishing the specific Programme implementing Horizon 2020. The first document defines in its article 4 public-private partnership as "a partnership where private sector partners, the Union and, where appropriate, other partners, such as public sector bodies, commit to jointly support the development and implementation of a research and innovation program or activities". This document also paths the way for the establishment of criteria and legal basis of the Public-Private-Partnership in the research and innovation through the article 25, which have been used to create the 5G PPP. The article 25§1 state that "Horizon 2020 may be implemented through PPP where all the partners concerned commit to supporting the development and implementation of precompetitive research and of innovation activities of strategic importance to the Union's competitiveness and industrial leadership or to addressing specific societal challenges". The Article 25§3 identified criteria for the implementation of PPP: 1) the target PPP should demonstrate of the added value of the action at the EU level and the instrument to be used; 2) it should scale its impact on industrial competitiveness, job creation, sustainable growth and socioeconomic

issues; 3) it should clearly set the long-term commitment of partner and their common vision regarding their contribution to Horizon2020; 4) it should be transparent regarding the scale of resource involved and the leverage effect EU funding are supposed to generates; 5) the PPP need to show how each partner will contribute to the competition of Key Performance Indicators over the period of engagement; 6) the complementarity with other project link with horizon2020 and alignment with EU policy research and innovation strategy. Furthermore, the annex of the document identifies the ambition for the development of the European ICT sector. The EU policy should orient the industrial development toward a single market perspective in order to reach economies of scale and scope. The annex suggests then that collaboration around common, open technology platforms and new generation network infrastructure with spill-over the ability for the ICT to reach the best competition environment: "Successive evaluations of ICT activities in the Seventh Framework Programme have shown that focused ICT research and innovation investment undertaken at Union level has been instrumental in building industrial leadership in areas like mobile communications and safety-critical ICT systems". In a broader way, the European Council document develop the idea of an integrated approach to develop Key Enabling Technologies (KETs)[158] as an industrial policy tool to produce technological leaps. This integrated approach includes a strong involvement of the private sector in the form of public-private partnership.

Another direct response of the call by Commissioner Kroes it the publication of the document setting a proposition for the establishing of an advanced 5G Network Infrastructure PPP in Horizon 2020. This document will later constitute the annex of the Contractual Arrangement "Setting Up A Public-Private Partnership in the Area of Advanced 5G Network infrastructure For the Future Internet Between the European Union and the 5G Infrastructure Association" was published in November 2013 through the document "Creating a Smart and Ubiquitous Network for the Future Internet"[159], and constitute the backbone of the about the be implemented 5G Infrastructure PPP regarding its purposes, targets, and governance model. Before having an in depth look on this document, we need to see the substance of the contract between the newly created 5G Association and the European Commission. The Group of representatives of ICT industries, driven by five founding father (Alcatel-Lucent, Ericsson, NSN, Orange and SES) gather in a legal entity by a Decree of the Belgian King the 15 December 2013 under the name 5G Infrastructure Association, which would correspond to the private branch of the 5G Infrastructure PPP. The EU Commission signed a Public Private Partnership Contractual with the representative of this new legal entity the 17 December 2013[160], signed by Vice President Neelie Kroes and Board representative Hossein Moiin and Marcus Weldon, and which stipulate that the application of the arrangement enters into force the 1 January 2014 until the 31 December 2020. This

[158] micro- and nanoelectronics, photonics, nanotechnology, biotechnology, advanced materials and advanced manufacturing systems.
[159] 5G Infrastructure PPP (2013) "Advanced5G Network Infrastructure for the Future Internet: Creating a Smart Ubiquitous Network for the Future Internet" [online the 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2014/02/Advanced-5G-Network-Infrastructure-PPP-in-H2020_Final_November-2013.pdf
[160] 5G Infrastructure PPP (2013) "Contract Preparation" [online the 20.09.2021] https://5g-ppp.eu/contract/

contract states as general objective the support of Horizon 2020 Framework Programme and the EU industrial policy in 1) the research and innovation effort, including in sustaining the development of standards that will form the foundation of the 5G infrastructure; 2) the support for progress in technologies of next generation of network technologies build around societal challenges identified by the European Commission; 3) the strengthening of the European ICT actors' aptitude to compete with 5G technologies on the global markets; 4) the introduction of groundbreaking business model based on open network; 5) the support for the implementation of international standard allowing interoperability and fair competition among actors of the global market; 6) addressing regulatory issues and spectrum availability; 7) the validation of technologies from a practical and commercial perspective thanks to the implementation of precommercial trials; 8) the progress of a range of essential intellectual property right protection to sustain the global position of European industries; 9) to develop skills and knowledge for European worker in the field of Internet infrastructure of the future and in advance communication networks; 10) offering reliable ICT infrastructure thanks to the development of security tools against cyber-attack on critical infrastructure. This contract furthermore set as a specific commitment for the European commission to dialogue and to consider inputs and advice from the Infrastructure Association regarding the financing of research and innovation activities in the Horizon 2020 Framework Programme. Regarding the commitment of the private side, they have to provide inputs and advice for the achievement of this partnership, but also have broader commitment regarding investment of private participants in the PPP, the definition of Strategic Research and Innovation Agenda, to ensure the an average SME's participation level of 20%, to act "as one stop shop EU interface toward other 5G initiative in the world", to implement international cooperation strategy regarding global standard and spectrum allocation, the organize public consultation on ethical issues with the broad public.

Those two documents constitute the spirit as well as the legal tools that constitute the implementation of the 5G PPP, however, the annex of the contract between the 5G Association and the EU Commission will give us a better look to the purpose, feature, and governance model of the 5G PPP that they implement.

5.4.1. Purpose of the future 5G Infrastructure PPP identified in the annex.

Firstly, the annex states that the 5G will be a turning point in the development of European industrial sector at large. Indeed, this Key Enabling Technologies have the potential to redefines value chains and innovation opportunities by bringing the Internet of Things (and its industrial application to a new scale) but also, to introducing virtualization and software-based network functionalities. Hence, there is a requirement for European institutions to "take action now to stimulate the development of this advanced network infrastructure for Future Internet to ensure the long-term competitiveness of the European network industry at large and of all the industrial sectors requiring advanced ICT services as part of their competitive profile". Furthermore, internet connectivity is an enabling technology as well as a critical infrastructure since it supports many services like the delivery of energy, water, transportation, or health. The ICT market was also provider of 5%

of the EU GDP, and the sector was depicted as a fast growing one since the application to other sectors increase the productivity of economy globally (the European Information Technology Observatory report of 2012, cited by this document, depicted the ICT sector as the most promising for the economic development of the EU since the number of user worldwide will only increase in the coming years, increasing the contribution of the industry to employment and public founding through taxes).

The document develops the strategies to implement the "internet infrastructure of the next decade" by a Public Private Partnership Program. The activity of this program will be framed by Key Performance Indicators (KPI), which will guide the implementation if the 5G infrastructure:

- "Providing 1000 times higher wireless area capacity and more varied service capabilities compared to 2010".
- "Saving up to 90% of energy per service provided. The main focus will be in mobile communication networks where the dominating energy consumption comes from the radio access network".
- "Reducing the average service creation time cycle from 90 hours to 90 minutes".
- "Creating a secure, reliable, and dependable Internet with a "zero perceived" downtime for services provision".
- "Facilitating very dense deployments of wireless communication links to connect over 7 trillion wireless devices serving over 7 billion people".
- "Enabling advanced User controlled privacy".

Regarding the strategic objectives of the PPP, this annex sets that the 5G PPP has the status of the "Industrial Leadership priority in Horizon 2020", and in particular "under the Information and Communication Technologies (ICT) industrial and technological leadership challenge 'Future Internet: Infrastructures, Technologies and Services'". Societal, economic, and operational objectives are defined. Regarding societal objectives, those include the mitigation of the digital divide in Europe between densely populated areas as well as rural areas; democratize the use of ICT technologies in Europe; improve the implementation of protection of critical communication infrastructures. For economic objectives, those consist of enhancing the global competitiveness of the ICT European industries and reinforce European leadership in network and information systems. Finally, operation objectives refer to the creation of governance model to create a European wide industrial platform policy which fulfils the need of transparency and representativeness.

5.4.2. Key Stakeholders and targets of the policy of the 5G Infrastructure PPP annex.

In this document, the future Advanced 5G network PPP is supposed to "organize and structure the research so that it is clearly business relevant, creates a critical research mass and involves relevant partner from the entire value chain". Hence, in the sector of advanced 5G network infrastructure, key stakeholders identified as being the target of the 5G PPP include manufacturers in the network, IT, and microelectronic

domains; communication service providers; research community (including universities); SMEs; application developers; international standardization bodies; regulatory bodies.

In particular, the documents establish that, for the implementation of the 5G infrastructure to be totally successful, the participation of SMEs is critical. Indeed, the ICT European sector being characterize by fragmentation of production, and SME are naturally part of the production ecosystem of larger players. Moreover, the document expect that new entrepreneurs will independently provide new applications of the infrastructure, testing devices, and create value added to the 5G infrastructure. The document expects then to create inside the 5G PPP space for SMEs to raise their voices, and they will be represented in a stakeholder board in a Public-Private-Partnership Association alongside with network operators, application and content providers, and end users of new technologies. In general, the deployment of 5G required an ecosystem of cooperation between industries, SMEs and research community: "Industry will play a major role in the PPP with respect to the necessary long-term investment in global standardization and the integration of all technological contributions into complex interoperable systems. Communication network manufacturers and communication service providers contribute significantly to the research and development of new global systems and standards. The continuous dialogue between both stakeholder groups is essential to define appropriate new system capabilities with respect to user experience and cost". Since the ICT sector is one of the most research-intensive sectors of industries, the tools developed in the matter by EU institutions, especially the European research policy is depicted as a key framework to boost the work of the 5G Infrastructure PPP. Europe is expecting to provide integrated multilayer solutions to structure the market and create favorable environment for the deployment of private action in the 5G infrastructure deployment. Its actions also aimed at targeting the development of skilled jobs in this industry through major investment in education, but also of globally accepted standards in order to ensure interoperability and economies of scale. Those actions require the coordination with private players in order to join forces for the early phase of research to develop new concepts, systems, technologies, and algorithms that can later be transformed into global standards and be the basis of the training of future engineer of the sector in schools.

5.4.3. Governance model of the 5G Infrastructure PPP identified in the annex.

The proposed legal framework of the 5G PPP established by this annex is the Contractual Public Private Partnership approach. This new legal framework was supposed to be beneficial for the establishment of partnership among actors in the way:

- It secures the commitment of the EU Commission as well as actors of the industries (especially regarding investments) to meet long term social and industrial objectives (the annex set the period of 10 years).
- It allows a holistic cooperation and management among different European research programs which are relevant for the implementation of the 5G infrastructure, creating consensus especially in the field of standards and patents.

- It creates a flexible commitment for a large number of actors of the ICT industries, especially the smaller one, to participate in the project without create bureaucratic inertia.
- It emphasis clear objectives and priorities with the establishment of roadmaps which structure programs and individual projects, providing the adequate synergies among all research priorities.

The governance model proposed by the document is a collaboration platform between an Infrastructure Association and the European commission in the PPP Contract, monitoring research and technology development, progress of roadmaps as well as the endorsement of Strategic Research and Innovation Agendas (SRIA). More specifically, the organizational structure considers three entities: the Association, the Net!Works ETP, and the 5G Initiative.

The Association represents the ICT industrial community as well of the Net!Works ETP which will develop the PPP roadmap and research action in the framework of the SRIA. Each member is represented in a General Assembly, and a board which have as a task to represent ICT industries at the EU commission. The general assembly endorse and update the SRIA and the roadmap and elect and dismiss member of the board. By doing this, the Association have the task to analyze European related R&D investment in target sectors in order to monitor leveraging factor for further investment. It is expected that there would be a huge leverage effect from publicly funded collaborative research to private investment, which are supposed to path the way to private investment in 5G infrastructure ten times bigger than the one invested by public bodies. Indeed, the report "The 2012 EU Industrial R&D Investment Scoreboard"[161] established by the Directorate-General for Research and Innovation stated that the annual R&D investments by major communication industry aggregates more than 10 billion € in collaborative research program of the EU, compared to the 1 billion € investment made by the EU Commission. However, if the volume of investment made by the private sector is substantially higher than the public one, it is also established that those investment are at large triggered by collaborative research framework implemented by the public sector. Monitoring of R&D investment would be only done by an "independent trusted research organization of market research organization". It will collect such data from industrial actors on an anonymized basis form and evaluated in function of "whether the PPP is working according to its roadmap and is achieving the expected leveraging effect".

The Net!Works ETP is an organization which existed before the discussion related to the creation of the 5G PPP, since it existed already as an advisory and technical bodies working for different project in the 7th Framework Program. For the 5G PPP, it has the task to represent of the wider ICT sector via its subsidiary link with the Association. It's mission is to develop position papers on technological, research oriented and societal issues; but also, to pursue between decision makers in the public domain and the industry and research community in order "to bridge the gap between research and innovation and the expectations from the

[161] DG Research and Innovation (2012) "EU R&D Scoreboard. The 2012 EU Industrial R&D Investment Scoreboard", [online the 20.09.2021] http://www.eurosfaire.prd.fr/7pc/doc/1354893182_sb2012_final_draft.pdf

European society". The Net!Works also have to regularly and establish and updated SRIA an open process, i.e., in collaboration with the Association General Assembly, in order "to guide industrial and long-term oriented research". It also seeks to provide methods for future economic development in global standards and the extensive implementation of communication systems and networks. It is organized by a General assembly (which include all member of the organization), a Steering Board, which main tast is to implement the Net!Works Platform and other workgroup related to the activities of the organization (which represent the industry domain with 18 members with voting rights, SMEs domain with 6 members with voting rights, research domain with 6 member with voting rights, Observer with one voting rights, and the EU Commission and the European Space Agency with both one member with voting rights).

Finally, 5G Initiative, realized through 5G Infrastructure Collaboration Agreement among partners involved, includes designated projects under the PPP umbrella in all program phases. Its governance model includes 1) an industry advisory group of senior representatives of the ICT industry, which will delivers global strategic guidance and feedback on economic relevant on current approaches to partnership initiative and strategic planning and discussions (this group would be also part of the Association) ; 2) The 5G Initiative Steering Board includes the project managers of active projects in the PPP, supervising the daily administration of the partnership initiative ; 3) The 5G Initiative Technology Board**,** composed by the Technical Managers of the active projects in the PPP, manage technical matters across PPP projects and build and update the roadmap based upon input from its subcommittees (the EU Commission have an observatory status there).

5.5. Conclusion: Historical Institutionalism analysis of the organizational design of the 5G PPP.

The actor-centric approach developed by Büthe helps us how historical institutionalism can develop a framework to understand and analyze the implementation of 5G PPP as being the competitive ideas and bargaining between actors of the ICT industry and the European Commission for the implementation of multilateral industrial policy for the deployment of 5G. An agent-centric historical institutionalist analysis of the 5G PPP requires to hence identify the key stakeholders and determine the interests that such actors are likely to pursue, then theorize how those actors, their interests, and the way in which they pursue those interests will be affected by the opportunities and constraints of the broader institutional configuration and by institutional feedback. We understand that the development of the 5G PPP came from a critical juncture which find its source from the interpretation of the effect and the answer to bring to the aftermath of the financial crisis in the beginning of the 2010's reflected in the "European 2020" communication of the European Commission. The flagship associated with this communication demonstrate that actors of the European Commission want to use the opportunity of the reorganization of the economic policy of the EU to further the supranationalization of the Industrial Policy in order to face the consequences of the crisis and of the global competition. Hence, the actors of the European Commission aimed at using the tools and frameworks of the

Research and Development Policy to provide a legal framework to catalyze finance to strengthen the ICT industry, as well as to develop an integrated System of Innovation in the sector of advance digital technologies. We can also add some other socioeconomic target that this policy was supposed to produce such as create a true European Digital single market for online content and services. EU actors justified those reorientations of the technology policy with the argument of the structural challenge the EU economy were facing, both internationally and internally. Consequently, the need to improve business environment (especially by creating partnership and innovation cluster with private actors, in particular SMEs) and to promote network infrastructure to develop the single market as a tool to enhance industrial development is depicted in technocratic terms. Indeed, promotors of this supranationalization of the ICT industrial policy develop an apolitical argument: the development of an integrated approach for the development an innovation policy for digital technology is depicted as being a logical answer to pressure of the globalization. Here, the European Union is more than a norm provider in the technological field. It uses its power and resources to fixe meaning to the challenge well as the political answer that need to be implemented in order to overcome this challenge. As we saw, neither innovation or globalization are neutral or given element of world politics, but social phenomena interpreted by actors which construct meaning to them and institutionalize answer to handle them.

We understand that we are facing supranationalization of the ICT industrial policy, since, as Büthe have explain, we can observe the *process* of creation and or strengthening of the authority of the EU in this matter. It gradually fixed the orientation and the instrument of the policy to implement, and the ICT industrial policy is gradually shifted from a Nation-State problematic toward an European one. This strategy was further developed by the "Digital Agenda for Europe" establishing a long-term goal to use internet and digital economy to foster EU economy and to tackle key problematic that the financial crisis has highlighted. The Digital Agenda have developed a vision regarding industrial objective in the ICT sector targeting in a holistic way the competitiveness of the digital single market as an enhancer of the competitiveness of the EU as a whole. Consequenlty, the Innovation policy for digital technology is not an issue for the ICT sector, but a stake for the entire EU economy. With "Europe 2020 Flagship Initiative: Innovation Union", the EU Commission precise the scale of this instrument. If the document highlights crucial fragility such as the under-investment in knowledge foundation as well as the poor regulatory framework, high cost of intellectual property rights and the fragmentation of use of resource for R&D, it also states that solution have to be implemented as an support of the position of the EU in the world economy. Internal problem should also provide international solutions. Finally, the Communication "An integrated Industrial policy for the globalization Era, Putting Competitiveness and Sustainability at the Center State" directly connect the problem and challenge brought by globalization and digital technology. Those open the door for a debate at the EU level to plan a decade long plan to shape and change the EU economy in order to make it more resilient and more competitive in a global context where Europe is increasingly losing its technological and industrial position.

In this context, the development of an EU multilateral industrial policy for the 5G technology start to emerge. Actor of the European ICT industry and the EU Commission gather and negotiated about the contour of such policy in different business forum, the Competitiveness Week, and the Mobile World Congress in particular. We can observe that during those events, private actors deploy a strategy to enhance their position by framing and providing technical answer and solution to the problematic they see as relevant to them. This strategy aimed at defining and promoting their understanding of the situation, and what policy should be implemented to develop the innovations needed for the EU to answer those challenges. The temporality of those event was crucial since multilateral industrial policy for the promotion of a European 5G was clearly framed within the 8th Framework Program for Research and Technological Development. During these events, private actors developed their proposition for horizontal and vertical industrial policy that the EU commission could implement in order to strengthen their position in the ICT global market, including the mitigation of the fragmentation of the internal market and the development procedure to channel public aids to private actors as well as a strategic planning. In addition, they also advocated for the recognition of the value of foreign investment, the reform of tax rules and of the European Intellectual Property Right base. The ICT industry developed a specific vision of a multilateral industrial policy which sustain the development of European System of Innovation that they characterize though the lens of "smart specialization": horizontal and sectoral industrial policy should be implemented to allow the private sector to flourish and be more resilient in front of the global market, but those the target of those policy is the development of a research and development network among actors of the ICT knowledge value chains. The System of Innovation sustained by this industrial policy aimed consequently at mitigating the fragmentation of the digital market as well as strengthening the existing actors in order to make them more resilient thanks to the development of a sound business environment and by the innovation boosts that such is supposed to develop.

The call from Vice President of the EU Commission Neelie Kroes highlight the multilateral development of this EU industrial policy for the development of ICT technology, since she takes back the proposition developed by private actors, as well as their concerns and proposition to foster the ICT sector. Consequently, this System of Innovation for 5G was though as an institutionalization of vision of a smart specialization developed by the private sector, articulated around the political objectives of the EU Commission actors. A business association were implemented in order drive the voice of the private sector in the discussion related to the creation of this partnership during the year 2013, and the European Commission informed the Net!Works European Technology Platform (ETP) and industries about its agreement for the formal creation with a partnership between industrial actors and the European Commission. Consequently, the development of the Horizon 2020 Framework Programme was also use as an instrument to foster this multilateral industrial policy for the development of an integrated System of innovation for ICT sector. The main instrument for the development of this policy is the use of a public private partnership among industrial and EU actors, a statue that the regulation establishing the Horizon 2020 FP clarify. The implementation of

the 5G Infrastructure Public Privat Partnership is consequently defined by the objective and the scope of this status, which was accepted by 5G Infrastructure Association, corresponding to the private branch of the 5G Infrastructure PPP. The document “Creating a Smart and Ubiquitous Network for the Future Internet” and its annexes develop further the purposes, the actors and the governance model of the 5G PPP. The purpose of the 5G PPP is developed through objective indicators which will be monitored by the European Commission and implemented by the private side of the partnership but embedded within the overall vision that Europe should find back its strategical leadership in ICT industries. This policy, aiming as institutionliazing a European System of Innovation for 5G, include different stakeholders from the ICT industry which should be organized in a way allowing all private actor to raise their voice, which is translate in the governance model of the Partnership. This governance model is based on the commitment of the EU Commission and actors of the ICT industries to meet long term social and industrial objectives while implementing a holistic cooperation in the framework of a System of innovation that would allow the distribution of tasks manage the coordination of among different European research programs which are relevant for the implementation of the 5G infrastructure. It set up a flexible integration of a large number of actors of the ICT industries, with a special inclusion of SMEs while distributing responsibilities and putting actors in competitions for implementation of research and development initiatives. This structure stress clear technical and social objectives and priorities with the establishment of roadmaps which structure programs and individual projects, as well as an evaluation methodology based on Key Performance Indicators. Such allow the European Institutions to monitor the development of technologies and innovations that the Horizon 2020 Framework Program help to fund and regulate.

We understand here that the institutional position of the European Union alters its fundamental interests and strategy, hence converting its approach to industrial policy from a soft multilateral industrial policy, as implemented by the Lisbon Strategy, toward a more active one as the Horizon 2020 strategy highlight. This allow us to observe a change of the EU approach toward technological change, from a position where it is solely a knowledge broker toward the implementation of policy tools developing its ability to be a knowledge creator. We can even develop the argument that, for the ICT industrial policy, the EU bypasses the will of member states, since their approbation of the project of implementing a multilateral industrial policy for the 5G intervene only when the Horizon Framework Programme were approved by the European Union Council. Hence, the EU and the ICT industry were the most relevant actors of the implementation of the 5G PPP, and Member States as a marginal role in the policy design of this institutions. Furthermore, we understand that the role of transnational network of private actors are a major driver of the institutionalization of the 5G PPP policy, as the theory of Büthe have showed.

6. The 5G PPP in 8th Framework Programme: Institutional transformation, and adaptation of a European Industrial policy for the 4th industrial revolution and the Digital Single Market.

6.1. Introduction.

We understand that the development of the 5G PPP is directly linked to the development of the multilateral industrial policy in a context of double challenge and opportunity brought by globalization and innovation. The 5G PPP was though and implemented throughout the 8th Framework Program by three stages: the Phase 1, implemented between 2014 and 2018, gather public private initiatives which aimed at developing the standards and fundamental knowledge of the 5G technology that could be useful for the ICT industry and for the achievement of Key Performance Indicators that have been set up by the European Commission. However, before the formal lunching of the Phase 1, actors involved in the 5G PPP negotiated and promoted their vision of the 5G PPP in order to boost their strategical interests.

6.2. Early phase and implementation of the 5G PPP: exploratory phase to understand detailed requirement on 5G system and identity most promising functional architecture.

After the formal implementation of the 5G PPP, the new ETP NetWorld2020 (ex-Net!Works which had merged with the ISI ETPs in October 2013 to create this new entity and align it more closely with the objective of Horizon 2020) launched a series of meeting from its expert advisory group in order to set up a joint white paper regarding priorities for the 5G PPP.

6.2.1. Defining the situation: what are the actors defining of the scale and scope of the future action of the 5GPPP: the vision of the NetWorld2020 ETP.

The first months of the 5G PPP was consequently dedicated to the implementation of meetings among partners of the 5G Infrastructure Association and the NetWorld2020 ETP over technical issues that would need to be addresses by the 5G PPP. The first meeting took place in Stuttgart the 5 and 6 February aimed at identity and settle what would be the challenge over future network technologies and decided what would be the more appropriate research strategy to overcome them. A second Expert Advisory Group meeting took place the 23 June 2014 in Bologna, collocated with EUCNC'14, a private conference sponsored by the IEEE Communication Society and by the European Association for Signal Processing. The Goal of this second workshop was to give a formal status of the coming whitepaper as well as having an oversight of topics included in it. Finally, the document "5G: Challenges, Research Priorities, and Recommendations. Joint White

Paper"[162] was published in September 2014 by the NetWorld2020 ETP, based on the work of the two previous meetings.

The rational of this document established that Europe, through its 5G PPP, have the capacity to establish a pan-EU 5G infrastructure which would catalyze innovations toward a connected society and orchestrates efforts of all stakeholders to achieve the implementation a true digital single market. The 5G infrastructure is depicted as an enabling technology which will provide an "universal communication environment" having the ability to transform all aspect of the contemporary society, from transport to manufacturing, health, energy food production etc. To achieve this, the document states that stakeholder need to rethink how are designed the ICT system and reconfigure the value chains in a "real time" fashion. Hence this whitepaper discusses the challenges for a future 5G infrastructure and aimed at defining research priorities that would be needed to support a roadmap of "orchestrated efforts within the 5GPPP and its surrounding research and development efforts. The vision of 5G depicted in previous documents of the EU commission as well as other organ of its industrial policy and the 8th Framework Programme outlines several challenges: "5G strives to provide a universal ICT infrastructure that addresses wider societal challenges through a flexible alignment of stakeholder incentives by virtue of being truly programmable, secure, dependable, privacy preserving, and flexible, while minimizing the costs per bit by efficiently harnessing all communication capabilities and reducing the system power consumption by harvesting any kind of accessible energy from the environment". In addition to the very large number of stakeholders this vision encompasses, it also aimed at connecting old technology infrastructure with new generation ones, making the 5G Infrastructure Multi-Technology as well as multi-tenants. This document aimed then at connecting those technical problematics with the issues raised by the Key Performance Indicators developed by the document "internet infrastructure of the next decade" with the concept of "Key Performance Challenges":

- The question of throughput, aimed at providing 1000 times more available data in aggregate and 10 times more speed to individual end users.
- The question of latency, aimed at creating a service level down to 1ms for tactile internet.
- The question of energy efficiency, aimed at achieving 90% of energy efficiency in the ICT energy usage compared to 2010 level.
- The question of Service creation time, aimed at enabling very fast user experiences for the application through an individually participating network.
- The question of battery lifetime, aimed at increasing 10 times the battery time for low throughput solutions.
- The question of the coverage, aimed at having the biggest number of people connected to the 5G network possible.

[162] NetWorld2020 ETP (2014) "5G: Challenges, Research Priorities, and Recommendations Joint White Paper" [online the 20.09.2021] https://www.networldeurope.eu/wp-content/uploads/2015/01/Joint-Whitepaper-V12-clean-after-consultation.pdf

- The question of the costs of ownership, targeting the control of prices of communication services among all the segment of the 5G ecosystem.

In addition to those key performance challenges, this whitepaper establishes 18 system-level challenges, which include legal question regarding the ownership of data produces within the 5G ecosystem as well as its security managements, the question of the density of users and their access to the network, the question of flexibility of the mechanism of control and protocol for relocation of functions etc. The question of flexibility is from a critical importance given the number of stakeholder incentives and requirements. To accomplish the required flexibility of 5G systems, the document expects "a high degree of programmability of otherwise standard network-enabled hardware components". Since problems of incentives conflicts are push to the later deployment phase (and not anymore at the early deployment phase like classical network infrastructure), this programmability drives the resolution of incentive problems from several days to minutes or even seconds. The programmability also delivers the capacity to control and oversee the usage of resources across the network, enabling the envisaged flexible incentive alignment across several stakeholders. The programmability would also allow flexible resource management of computing, storage, volatile memory, and bandwidth. Furthermore, the white paper established that "the envisioned programmability of the network will also facilitate solutions for the aforementioned guaranteed challenge at the system level by allowing for optimizing across all these resource dimensions towards a single deployed solution". Consequently, by mixing flexibility and programmability in future 5G infrastructure ecosystems would allow to build "complex, mission-critical services with specific requirements in terms of service quality, where a dedicated physical infrastructure would be normally required". Consequently, the whitepaper establishes research priorities regarding new radio waveforms, new joint access/backhaul designs, integration of satellite into the wireless subsystem, new routing solutions for backhaul and core networks, new caching solutions for reducing service-level latency, new low throughput solutions for sensor deployments into four research priorities: the converged connectivity ; the wireless subsystem; wired subsystem; and virtualization. Finally, the document establishes a roadmap of different technical requirement and objective to further enhance those Key Performance Challenges and System-Level Challenge at the horizon 2015; horizon 2015 until 2020 and after 2020. Other documents regarding technical requirement and sectorial opportunities related to the 5G infrastructure technologies will be produced in the months after the publication of the White Paper of the NetWorld2020 ETP, also through industrial private gatherings and institutions.

6.2.2. Defining the situation: what are the actors defining of the scale and scope of the future action of the 5GPPP: the vision of Business Association.

The 22nd of December 2014; the Next Generation Mobile Networks (NGMN) Alliance, an association of mobile operators, vendors, manufacturers, and research institutes, produced a white paper under the 5G

Initiative umbrella[163]. This document provides a recommendation for 5G definition and design on a business-oriented fashion. Firstly, the document provides a 5G "business context", characterized by "changes in business, technology, and operator contexts". On the side of consumer, the demand for devices, including smartphones and tablets, will increase in quantity and quality, since new technologies like cloud technology and the Internet of Thing will bring new uses and applications. This trend will apply to the side of companies: manufacturing ecosystem technologies and specialized equipment will open new doors for vertical integrations in the industries, providing a tremendous competitive advantage for EU manufacturing system. More generally, the 5G technology implementation is expected to blur the line between the purely "digital economy" and the "traditional economy", since business opportunities from both worlds will intertwined and the relations between personal and enterprise usage of devices will be less and less fragmented. This business context consequently shapes the "5G vision" of the NGMN: "5G is an end-to-end ecosystem to enable a fully mobile and connected society. It empowers value creation towards customers and partners, through existing and emerging use cases, delivered with consistent experience, and enabled by sustainable business models." The requirements to implement the 5G is based on this specific vision and are regrouped in six categories:

- User Experience: "5G system should be able to deliver a consistent user experience over time for a given service everywhere the service is offered""
- System Performance: "The network should be able to serve a massive number of human and Machine-Type Communication (MTC) devices."
- Device Requirement: "Smart devices in 5G era will grow in capability and complexity as both hardware and software, and particularly the operating system will continue to evolve."
- Enhanced Service: which encompasses the constant access to Radio Access Technologies, Network security for "highly heterogenous environment", identity and protection of user and their information.
- New Business Models: "5G should be designed from the beginning such that network operator is able to create large variety of relationships between its network infrastructure and customer/service provider".
- Network Deployment, Operation and Management: "It is fundamentally essential to ensure that operators will be able to provide 5G services in an economically sustainable way. 5G should be designed with the objective to minimize the Total Cost of Ownership (TCO) of the network infrastructure and the cost of devices, for any given service offering."

The rest of the document is complemented with technical consideration regarding technology, network infrastructure, spectrum allocation, but also a roadmap from the implementation detailed requirement, in the Q1 of 2016, until the 5G deployment for the Q3 of 2020. Another document completes these two rather technical whitepapers is the "5G Vision: the 5G Infrastructure Public Private Partnership: the next generation

[163] NGMN Alliance (2014) "5G White Paper – Executive Version" [online at 20.09.2021] https://cdn3.scrvt.com/fokus/4e60fae4cbe2fea0/2fc1cf8cd1e9ad0c4c3f883ed9f181ad/141222_NGMN-Executive_Version_of_the_5G_White_Paper_v1_0.pdf

of communication network and services"[164] elaborated by the 5G Infrastructure Association in order to "give an overview of the 5G vision of the European ICT sector" and indicate the success of Phase 1 projects regarding the implementation of pre-standardization consensus through the standardization submission. This document has been produced and released in February by the European Commission and the 5G Infrastructure Association on the behalf of the 5G PPP at the Mobile World Congress 2015 in Barcelona. The GSMA Mobile World Congress 2015 need to be understood was a major turning point for the 5G PPP in the way the organization has institutionalized in dept links with vertical sectors, which was detailed in a whitepaper[165] developing the technical requirements to develop future internet technologies in those sectors. Indeed, the 5G technologies is depicted as an enabler for industrial development and for the enhancement of the digital single market broadly the same way as all other document we already reviewed. The vision of the 5G depicted in the document is however more precise regarding the "what" to achieve thanks to the 5G infrastructure: "Our vision is that in ten years from now, telecom and IT will be integrated towards a common very high-capacity ubiquitous infrastructure. In order to assure the required scalability and flexibility, the network functions will be more and more "virtualized" on general purpose, programmable and specific high-performance hardware that will offer resources for data transport, routing, storage and execution". The 5G infrastructure should, according to this text, be "scalable" and "sustainable", in the sense that the Infrastructure Association pretend to anticipate the growth of terminal devices and the intensification of data flows which could increase dramatically the energy consumption of the ICT sectors with the 5G rollout. Hence the deployment of the 5G network should bring an energy efficiency. Furthermore, the 5G ecosystem being larger and more open to new private actors, the deployment of the network will allow the economic strengthening of SMEs and new start-ups (also since 5G network service will technically relay on software, creating consequently massive opportunities for the sector). Also, because new societal changes will be brought by this technology, since 5G will cover human-to-human, human-to-machine, and machine-to-machine communications, leading to "all-encompassing smart connectivity" including smart cars, smart cities, smart factories etc. the 5G IA demand the European institutions to have an oversight about the regulation and norms in order to frame the social implication of the deployment of this technology. We understand that the vision of the 5G rollout in Europe is then intrinsically viewed through the rhetoric of the Sustainable and Inclusive growth depicted by the European Commission since the 2010. Due to the promising future this technology could provide, the 5G IA see then as essential the implementation of large-scale, multilayered collaboration projects sustained by the 5G PPP: "In addition to the private continuous effort, it is of vital importance that public authorities and the private sector develop effective policies with regard to spectrum, pre-standardization and international collaboration […] . The EU can play an important role in consolidating and building on the most important

[164]5G Infrastructure PPP (2015) "5G Vision : the 5G Infrastructure Public Private Partnership: the Next Generation of Communication Networks and Services" [online the 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2015/02/5G-Vision-Brochure-v1.pdf

[165] 5G Infrastructure PPP (2015) "5G empowering vertical industries" [online the 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf

research and innovation results attained in previous research programs, gathering resources for 5G tests, proof of concept and large-scale trials, and bringing the right stakeholders even beyond the ICT sector on board, notably vertical industries." Furthermore, this document cites the work of Office of Communications of the United Kingdom "Spectrum above 6GHz for future mobile communications"[166]: since the 5G infrastructure is also radio based, effort need to be done regarding the use of spectrum already assigned to terrestrial mobile service and the capacity to use new bands to assist new capabilities. Hence three topics are judged by this workpaper as relevant concerning spectrum allocation management for 5G technology: 1) trends in spectrum requirement for mobile broadband access and backhaul, to manage the increasing mobile data traffic; 2) Consideration for new wireless broadband spectrum above 6GHz, in order to support conditions needed to implement a "wide contiguous bandwidths […] enabling very efficient frequency reuse over a given geography" ; and 3) Spectrum management methods, to preserve a constant and foreseeable network environment among terrestrial and satellite operators and services providers. Finally, the document provides a timeline for the implementation of research, development, and innovation phases from 2015 until 2020 (document 1 below). This timeline state that the commercial deployment of 5G infrastructure system would be initiate after 2020, beyond the scope of the 8th Framework Programme. The work of the 5G PPP, according to the 5G IA, should then focus on R&D and norms and standards implementation (at European and global scale).

6.2.3. Result of institutionalization of research program for industrial development of the ICT industry: Public-Private design of industrial policy for the competition of the Digital single market.

The last document providing a programmatic feature of the 5G PPP in the early months of its deployments is "The 5G Infrastructure Public Private Partnership (5G PPP). First Wave of Research & Innovation Projects"[167] published in October 2015. This document corresponds to the presentation of the 5G PPP Phase 1 Projects, which answer the roadmap established by the 5G IA as its first milestone of encompassing research and development phase as well as standardization settings. This document also sets out the two other phases planned until 2020: the optimization stage (2017-2018) and the large-scale trials stage (2018-2021). More specifically this document presents the 19 projects selected "addressing a rich cross section of the research challenges leading to a 5G infrastructure by 2020", and are depicted as a way to respond in a holistic way to technical challenges regarding the efficiency of wireless interface, resource optimization (including spectrum and energy), network security and resilience, heterogenous network management etc. The document also serves as a global context for four other sectorial white paper published between September and October 2015:

[166] Ofcom (2015) "Spectrum above 5GHz for Future Mobile Communication" [online the 20.09.2021] https://www.ofcom.org.uk/__data/assets/pdf_file/0023/69422/spectrum_above_6_ghz_cfi.pdf
[167] 5G Infrastructure Association (2015) "The 5G Infrastructure Public Partnership: First Wave of Research and Innovation project" [online the 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2015/10/5GPPP-brochure-final-web.pdf

- "5G and e-Health"[168], published in September, recognized as a priority of the European Digital Agenda due to the increasing cost of healthcare in Europe (10% of European GDP in 2015), and because the digitalization and virtualization of care "have been considered a major driver towards the transition of healthcare from a hospital based, specialist driven system towards a distributed, patient centered care model with the point of care shifting to the periphery". This transition would allow a more efficient use of health data and hence a more efficient use of health resources (allowing to deliver treatment outside hospitals, holistic approach to health through lifestyle and wellbeing etc.). Consequently, the document evaluates areas for future development of ICT in Healthcare sector. Such areas include: (i) Wireless patient monitoring, (ii) Mobile system access, (iii) Medical devices, (iv) Smart Pharmaceuticals, (v) Robotics, (vi) Tele-healthcare, (vii) Ambient Assisted Living (viii), prevention, (ix) lifestyle and wellbeing (p. 4). Consequently, the 5G technology will provides healthcare system management tools (since it would permit to track assets and to develop a more efficient planning of intervention), new robotic technology as remote surgery and cloud service robotics for assisted living, and remote monitoring of health and wellness data (allowing a more efficient prevention of disease, and smart medication). In addition of business model transformation and policy adaptation, technical requirements for the development of 5G technology in the health sector include the mitigation of latency, the enhancement of reliability, the amelioration of mobility which application should achieve specified reliability and increase positioning accuracy.
- "5G and Energy"[169], published in September, envisioned 5G technology as a driver for the transformation of vertical markets including especially the energy industry, hence the need to assesses the needs of the energy vertical, both from the technical and business perspective, and proposes measures to achieve a win-win situation needed for a successful adoption of 5G". 5G technology will allow to address a lot of future use cases in the energy sector, developing the creation and the analysis of data at a scale never reach in this industry. Consequently, new application will be developed: the document provided the example of Smart Grid Communication networks which will be supported by this technology to enhance dramatically the efficiency of energy distribution management. The requirement in terms of R&D is the improvement on latency, the reliability boost of the communication network; the development of new types of business model; the security and resilience of the system; new technologies in the use of unlicensed spectrum; the development of massive machine-type communication; and finally accurate time synchronization technologies.
- "5G and the Factories of the Future"[170], published in October, states that the off shoring of production in low wage countries should be replaced by solution provided by the fourth industrial revolution, as it has

[168] 5G Infrastructure Association (2015) "5G an e-Health" [online the 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2016/02/5G-PPP-White-Paper-on-eHealth-Vertical-Sector.pdf
[169] 5G Infrastructure Association (2015) "5G and Energy" [online the 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2014/02/5G-PPP-White_Paper-on-Energy-Vertical-Sector.pdf
[170] 5G Infrastructure Association (2015) "5G and the Factories of the future" [online the 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2014/02/5G-PPP-White-Paper-on-Factories-of-the-Future-Vertical-Sector.pdf

the potential to establish more sustainable business strategies. The Fourth Industrial revolution, based on cyber-physical-system and internet-of-things technologies, will be essentially based on reliable and heterogenous communication systems "capable of dealing with an increase in several orders of magnitude the number of assets, volume, variety of information and reaction times in future manufacturing systems". Consequently, 5G technology is one of the key technologies which will allow the manufacturing of the future since it has the capacity to unlock those technology requirements. Moreover, 5G will provide a major contribution to the development of European industries since it will be a catalyzer of the trend of "servitization of manufacturing" (the trend corresponding to the shift from only selling produced merchandises to delivering added value services together with either connected (smart) or non-connected goods). Five main technical requirements are elaborated by this work paper: 1) communication latencies below 1ms to develop time-critical process optimization of manufacturing systems; 2) indoor coverage and high availability in order to allow non time-critical optimization inside factory (making possible flexibility of the plant); 3) increased capacity to develop 3D virtual reality, hence the remote maintenance and control (to reduce the cost of operation); 4) flexible, reliable and seamless connectivity would permit to develop intra and intercompany communications and the monitoring of assets distribution across very wide value chains. 5) ultra-low-power and ultra-low-cost communication platform, finally, would enable the development of connected good and then facilitated the creation of new services as we saw above.

- "5G Automotive Vision"[171], finally, published in October 2015, explores the implication of the 5G technology for the automotive industry (it is noticeable that representative form Volkswagen, Volvo and PSA Peugeot Citroen have participated to the creation of this working paper, companies not usually involved in the work of the 5G PPP). This white paper starts by outlining key changes that are expected to happen in the automotive industry: "the introduction of automated driving, the provision of road safety and traffic efficiency services, and the digitalization of transport and logistics". The introduction of such technologies would allow new types of business models such as the "Pay as you drive" (which aimed at identifying the costs of consumer driving service with its actual vehicle usage), "Mobility as a Service", "Predictive maintenance" etc. new service which could theoretically help the European auto industry to reached growth through new services while mitigating the use of raw material and help maintaining a better life expectancy of vehicles. Consequently, in order to develop network efficiency and expand it to new use relevant for the automotive industry, the automotive industry and the ICT sector are "looking for a single shared network infrastructure". Hence, specific technical requirements and Key Performance Indicators need to be reached in order to develop this technology in the automobile sector, including better performance regarding end-to-end latency; reliability; data rate, communication range; node mobility;

[171]5G Infrastructure Association (2015) "5G Automotive Vision" [online the 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2014/02/5G-PPP-White-Paper-on-Automotive-Vertical-Sectors.pdf

network density positioning accuracy and security… applied to vehicle-to-vehicle communications as well as vehicle-to-pedestrian and vehicle-to-infrastructure communications.

The first phase of the implementation of the 5G PPP resulted in the translation of the goal fixed by Horizon Europe into real action regarding planification of research and development at the EU level involving private actors in a framework given by the European Commission and by forum gathering private actors of the ICT industries. The rational of those documents established that Europe, through an active partnership among industrial actors and among industrial actors and public European authorities, could implement a pan-EU 5G infrastructure which would catalyze the growth of the European economy by stimulating the development of new applications and new business models. The common feature among this publication, more than being business and private oriented, orient the view on technological progress and innovations toward a new model of capitalism and the development of a truly connected society. In order to achieve this technological uprising that the 5G network technology would allow, the actors of the 5G PPP call for an orchestrates efforts of all stakeholders to achieve the technical requirement which would allow the implementation a wider digital single market. We understand that the technical requirement, in broad lines, concerns problems inherent to this new model of communication which involve the need to rethink how are conceived the ICT system (regarding its scalability and its flexibility) and a reconfiguration of value chains production and digital services toward in a "real time" and virtual fashion. Furthermore, we understand that if actors of the 5GPPP include technologies that did not exist in the years 2014-2015 per se, they also provide a major role in their reflexion regarding the new application and configuration of old communication networks that would be include in the next generations of communication infrastructures (including satellites, cables or classical radio communications), hence providing a vision of this technology multi-Technology as well as multi-tenants. Furthermore, if the 5G technologies is depicted as an enabler for industrial development and for the enhancement of the digital single market, this technology should also be framed as enabler to further the societal objectives that the 8th Framework Programme established regrading inclusion of SMEs, energy consumption mitigations, best access to health, more responsible use of single automobiles, and a more scalable and sustainable manufacturing network in Europe.

This vision is developed by the Communication of the European Commission "A Digital Single Market Strategy for Europe"[172]. This communication is central for our study since it develops a comprehensive vision of business opportunities highlighted by the 5G IA and the technical problematic of the Horizon2020 EPT while framing them in a political objective developed by the European Commission: enhance the implementation of the digital single market. This objective was already developed in the priority n°2 of the

[172] European Commission (2015) "A digital Single Market Strategy for Europe" (Communication) [online the 20.09.2021] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0192&from=EN

Political Guidelines of the next European Commission "A New Start for Europe"[173] by Jean-Claude Juncker in July 2014, and cited by the Communication, which state that "By creating a connected digital single market, we can generate up to € 250 billion of additional growth in Europe in the course of the mandate of the next Commission, thereby creating hundreds of thousands of new jobs, notably for younger job-seekers, and a vibrant knowledge-based society". Consequently, the communication of the commission aimed at developing a strategy based on the growth potential of the single market and the technical development which could allow such growth. This strategy is based on the three pillars: "Better access for consumer and business to online goods and services across Europe" (requiring transnational harmonization of legal condition for e-commerce and common data protection and cybersecurity management); "Creating the right conditions for digital networks and services to flourish" (necessitating a common policy to manage ICT technology such as spectrum management, scaling of networks and investment incentives, but also common online media and platform regulations) ; and "maximizing the growth potential of our European Digital economy" (enhancing both the scientific and technological requirement for the implementation of the infrastructure of the digital single market, as well as sectoral and horizontal policy allowing the development of ICT industry and business). This last point is highly relevant for the 5G PPP, since it provides an official dimension to the strategy developed both by the 5G IA and the Networld2020 ETP: "Standardization has an essential role to play in increasing interoperability of new technologies within the Digital Single Market. It can help steer the development of new technologies such as 5G wireless communications, digitization of manufacturing (Industry 4.0) and construction processes, data driven services, cloud services, cybersecurity, e-health, e-transport and mobile payments. The EU Rolling Plan for ICT Standardization is an essential instrument in this regard […] Currently, industry stakeholders decide 'bottom-up' in which areas to develop standards, and this is increasingly taking place outside of Europe, undermining our long-term competitiveness. We need to define missing technological standards that are essential for supporting the digitization of our industrial and services sectors (e.g. Internet of Things, cybersecurity, big data and cloud computing) and mandating standardization bodies for fast delivery)" (EC, 2016, p. 15). These documents open the door to the work of the European Commission regarding the implementation of an Action Plan to establish the 5G infrastructure that will be developed in 2016 and 2017.

[173] Juncker, J-C. (2015) "A New Start for Europe: My Agenda for Jobs, Growth, Fairness and Democratic Change" [online the 20.09.2021] https://www.eunec.eu/sites/www.eunec.eu/files/attachment/files/pg_en.pdf

6.3. Early phase and implementation of the 5G PPP Phase 1 (2014-2017) Setting up technical problematics and experimental trails: Involvement of the European Institutions and implementation of research on backbone and core network system.

The second part of the phase 1 of the 5G PPP is marked by a deeper implication of the European Commission in the setup of strategies and vision regarding this public private partnership. If the year 2016 saw the continuation of effort took in 2014 and 2015 regarding technological development coordination at the European level, it also saw the seizing of the problematic of the 5G technology as European industrial policy issue. The question of the development of the Digital Single Market also became a part of the EU legislation, thanks to the adoption of the European Parliament Resolution "Toward a Digital Single Market Act"[174] the 19 January 2016. Through this document, the European Parliament emphasized the role of private investment in technology and network of the internet of the future for the development of the digital single market. The Parliament consequently developed a regulatory framework in order to allow stakeholder to invest in all the area of the digital single market, including in infrastructure in the rural areas. Furthermore, this regulation highlight the commitment of member states to develop the condition for the deployment of the 5G technology in Europe: the §54 states "(The EU Parliament) reminds the Member States of their commitment to reach by 2020 full deployment of at least minimum target speeds of 30 Mbps; calls on the Commission to evaluate whether the current broadband strategy for mobile and fixed networks, including targets, is future-proofed, and to meet the conditions for high connectivity for all to avoid the digital divide for the needs of the data-driven economy and the rapid deployment of 5G and ultra-fast broadband". The development and realization of the 5G PPP until this event have consequently to be framed in this vision of the Innovation policy that the EU aimed to developed for the 5G technology.

6.3.1. Work of the private side of the 5G PPP concerning technical parts.

The 7 January 2016 was released the white paper "Research Beyond 5G"[175] by the NetWorld2020 ETP, preparing the research environment of the next generation network infrastructure beyond the framework of the 8th Framework Programme, hence projecting what could be the 5G infrastructure at the end of Horizon2020. The document consequently raised several technical evolutions expected to occur in the sector that will constitute challenges for the Communication System beyond 2020 ("Beyond 5G Network"):

- Terabytes / second Communications: massive volume of dada being a possible target to be reached through more spectrum, better spectrum efficiency and having a large number of small cells. This would require solutions such as Massive Multiple Input – Multiple Output (MIMO), Device-To-Device Communication,

[174] European Parliament (2016) "Toward a Digital Single Market Act" (resolution) [online the 20.09.2021] https://www.europarl.europa.eu/doceo/document/TA-8-2016-0009_EN.pdf
[175] NetWorld2020 ETP (2019) "White Paper for Research Beyond 5G" [online the 20.09.2021] https://www.networldeurope.eu/wp-content/uploads/2016/03/B5G-Vision-for-Researchv-1.1b_final-and-approved.pdf?x70854

Wireless and Optical Fronthaul and backhaul (new design principle improving spectral efficiency in small cell systems).

- Spectrum and Radio Management: this problematic include new paradigm to the allocation of spectrum license, new relation between private operator and public authorities, and also require overcoming the challenges that rural areas are facing regarding its spectrum coverage and the digital divide in Europe with urban centers.
- System Design: includes proposal for network beyond 5G design and architectural objectives. This type of design pattern for integration and specific design patterns would be particularly useful to overcome of extremely rural digital inaccessibility. This kind of system design would require "native flexibility" and "integrated system design".
- Alternative technologies and Designs: this part stress the need for the development of a new architectural patterns, basic techniques and new communication paradigms that complement these patterns and studies some promos tics regarding what the future of the ICT sectors could be.

More than for its technical features, this document is also interesting in the way it stresses the role of the public authorities in the promotion of 5G and next generation communications systems in rurales areas. With the development of 5G systems, but also previous generation such as 3 and 4G, the question of integration of rural areas in Europe and in the world have to be addressed (the document cite report from the ITU: "At the same time, ITU estimates that 3G currently covers 69% of the world's population and hence a staggering two billion people still have no coverage. On a global scale, and widely recognized today, Internet connectivity is still urban in nature. The digital divide is widening and is arguably of much larger concern than a local tenfold capacity increase in dense urban locations" (p.24). Furthermore, the ICT industry lack enthusiasm to address the problem to 5G coverage in remote area: the white paper wrote by the NGMN stress many possibilities and applications for 5G in urban area, while almost no mentioned of the rural area. Indeed, rural area face the problem that its potential revenue per square mile is almost 1000 times less important as for urban areas[176]. However, developing ICT networks in rural areas have the advantage of mitigating urbanization by creating added value to those regions, but also to improve public safety, and develop e-health or the application of 5G in the agricultural areas.

Two months later, the NetWorld2020 ETP issued another document "NetWolrd2020 ETP, 5G Experimental Facilities in Europe"[177], a white paper edited by Roberto Verdone from the company UniBO and Antonio Manzalini from Telecom Italia, which took the technical recommendations sets in the January's document to stress the need for Europe to develop a "critical mass" of 5G experimental facilities to overcome

[176]Kovacs A. M, "Regulation in Financial Translation: Will the Incentive Auction Increase Mobile-Broadband Competition in Rural America?", May 2014.
[177] NetWorld2020 ETP (2016) "White 5G Experimental Facilities in Europe" [online the 20.09.2021] https://www.networldeurope.eu/wp-content/uploads/2016/03/5G-experimentation-Whitepaper-v11.pdf?x70854

the fragmentation of 5G experimental activities. Indeed, the existing facilities is divided among 58 different research center and universities in Europe, consequently, "From the infrastructure side, this "critical mass" of experimental facilities should increase collaboration on interoperability testing of different architectural approaches (e.g., SDN, NFV), their deep integration with Cloud/Edge/Fog Computing […] and the interworking of new operations processes" (p. 7). The document's recommendation states that the European Commission, European ICT Industries should invest in facilities able to create synergies and collaborations both inside Europe but also with other countries' initiative; more resources allocated by universities and academia for experimental research, especially in training of new researchers; and finally to create an experimental ecosystem which would include SMEs and entrepreneurs from different sectors to be involved in this new facilities allowing critical mass experiments. The same month, another document[178], published by the 5GPPP and edited by Michal Maternia (from Nokia) and Salah Eddine El Ayoubi (from Orange telecom) regarding the use cases and performance evaluation models for early evaluation of different 5G radio access network concept designed by 5G PPP phase 1 projects. 5GPPP projects are classified into six use case families: Dense urban; Broadband everywhere; Connected vehicle; Future smart office; Low bandwidth IoT; Tactile internet / automation. This classification into use case families permits the 5G PPP to have a broad vision on the specific use cases and their technical constraints and the way they indicate how progress have been established regarding those. Furthermore, the 5G PPP used in its business case definition a "vertical industry driven approach", following the white paper of October 2015, where "each business case describes a specific vertical need and its requirement", the target vertical industries being the automotive, e-health, energy, media& entertainment, and factories of the future. The evaluation is then based on the technical development of each associated business in vertical industries and the use case families, allowing then to understand what use case family cover what specific business case (ex. "Dense urban" use case family cover business case "Remote monitoring of health data" and "smart medication" from the e-health industry, "grid access" from energy, "on-site live event experience" from Media, and "time critical process optimization inside factory to support zero-defect manufacturing" from factories of the future, to name few). Finally, the metric used to quantify the evolution of each 5GPPP project are the Key Performance Indicators developed by the European Commission at the end of 2013 before the formal implementation of the 5G PPP.

Another White paper was published in June[179] "Service Level Awareness and open multi-service internetworking – Principles and Potential of an evolved Internet ecosystem" and recognized the limits of the performance of the current internet based on the inter-domain networking and the single-traffic mode operations. The white paper recommends key principles and characteristic of future open multi-service

[178] 5G Infrastructure PPP (2016) "5G PPP Use cases and Performance evaluation models" [online 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2014/02/5G-PPP-use-cases-and-performance-evaluation-modeling_v1.0.pdf
[179] NetWorld2020 ETP (2016) "Service Level awareness and open multi-service internetworking" [online the 20.09.2021] https://www.networldeurope.eu/wp-content/uploads/2016/07/NetWorld2020_WP_Service-Level-Awareness_Final_June-16.pdf?x70854

internetworking which have the ability to offset problems link with the functioning of the current one. Indeed, single-traffic-mode internetworking approach is an inherent feature of the existing internet system. However, multiplicity of constraints as well as the variety of future applications and services cannot be providing with the current internet network technologies. The need to create such technologies is based on three technical needs: 1) ensuring customer choice by expanding the capacity of different producer to sell on digital market while decreasing the cost of internet-based trade of good and services, 2) attaining developed efficacy in the use of resources in the network, in particular the energy consumption and the storage of data; and 3) Providing any end-point to any end-point on the Internet unbridling innovation possibilities regarding value added and end-to-end guaranteed connectivity services. To develop those need, this whitepaper recommends key principles and properties of a future open multi-service internetworking approach. In particular, a key idea of this white paper is that Service Level Awareness must become "an essential part of future access and connectivity services, application services and their offerings […] Service Level Indicators should eventually be directly or indirectly available, even in real-time, to properly inform the customers regarding service offerings, availability and what choices are available to them to better serve their needs".

Those three documents from the Networld2020 ETP form the basis of the Strategic Research and Innovation Agenda[180] of September 2016 on "Pervasive Mobile Virtual Services", which established the roadmap and the research strategy of the 5G PPP for the period before 2017, between 2017 and 2022 and after 2022. The document also presents research priorities, with network sofwarization, through new technologies like the Network Function Virtualization (NFV) or Software-Denied Networking (SDN) being one of the most important issue to cover, "where some network functionalities are shifted from specific hardware to commercial off-the-shelf devices" (p.8). This SRIA also established recommendation on the basis of a studies conducted on the past year research development on the ICT sector:

- Virtualized Networks and Services: the security of those new types of infrastructure as well as their scalable organic network architecture design need to be address. Those would, as we saw, be enhance by the full development of SDN and NFV technical potential.
- Radio Networks and Signal Processing: developments have to be implemented regarding the efficiency of radio networks infrastructure, especially regarding the progress in radio protocol and signal processing, design of Satellite Communications Components, the development of Software based and "cognitive radio" tools compatible with new frequency bands.
- Optical Networks: this technology is seen as an enable for the creation of a "ubiquitous digital environment", providing the "heavy duty task of providing the necessary interconnection between remotely located places" (we can keep in mind the objective to rollout new generation communications networks in rural areas established by the report of the NetWorld2020 earlier this year).

[180] NetWorld2020 ETP (2016) "Strategy Research and Innovation Agenda" [online the 20.09.2021] https://www.networldeurope.eu/wp-content/uploads/2014/02/SRIA_final.pdf?x70854

- Experimentation with verticals: which raised the need to develop interdisciplinary research, de-verticalize experimental facilities, specific focus regarding safety of testbeds etc.

The 7th July, the 17 5G IA representative from operator, equipment vendor and satellite operators an open letter "5G Manifesto for timely deployed of 5G in Europe"[181] addressed to the European Commissioner for Digital Economy and Society Günther Oettinger. At the time of its publication, we can frame the purpose of this document with the double objective to officialize the partnership between ICT and vertical industries, but also to set the 5G IA recommendation of the about to be published 5G Action Plan (the Commissioner call for it in February and was published in September). This manifesto aimed to foster "effective interactions and collaboration" with industry verticals and intends to create a research and development ecosystems with those industrial partner as well as the development and implementation of an investment-centric policy framework which would help "bringing together the key levers to ensure European digital leadership in 5G and beyond". Indeed, the trend regarding development of industrial technology in vertical sector as well as public sector is defied by an increasing digitalization. Since 5G can be a key technology enhancing this digitalization of the European economy at large, the manifesto states that a close collaboration among vertical industries and telecom sector have to be developed. Hence, the 5G IA calls for ecosystem-forming initiative to develop and implement standard, financial instrument and research and development facilities (pan European 5G trial in particular) which would include actor of horizontal industries and European policymakers.

6.3.2. 5G: Ambition from the European Commission.

The year 2016 is very important for the history of the 5G rollout in Europe and for the role this technology, and public policies associated, have developed. Indeed, three communications was issued this year from the European Commission: "Digitalizing European Industry, Reaping the full benefits of a digital single market"[182], the 19 April 2016, "Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society"[183] and "5G for Europe: An Action Plan"[184].

The First Communication provides the idea that progress in ICT technologies and in the digital domains, combined with other key enabling technologies, would allow the development of a fourth industrial revolution. More specifically, the document aimed at presenting measure to strengthen the innovation and industrial pillar of the digital single market strategy. It is consequently critical for the EU institutions and for

[181] 5G Infrastructure Association (2016) "5G Manifesto for timely deployment of 5G in Europe" [online the 20.092021] https://telecoms.com/wp-content/blogs.dir/1/files/2016/07/5GManifestofortimelydeploymentof5GinEurope.pdf
[182] European Commission (2016) "Digitalizing European Industry. Reaping the full benefit of a Digital Single Market" (Communication) [online the 20.09.2021] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0180&from=EN
[183] European Commission (2016) "connectivity for a competitive digital single market – towards a European gigabit society" (Communication) [online the 20.09.2021] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0587&from=en
[184] European Commission (2016) "5G for Europe: An Action Plan" (Communication) [online the 20.09.2021] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0588&from=FR

the European industries to seize fully the opportunity that the progress of the digital sector could offer in term of the new generation manufacturing. Furthermore, the development of the digital single market is a precondition for channeling investment in digital innovations and for the enhancement of ICT industries. Consequently the completion of the single market is not anymore only a tool to boost competitiveness inside the EU economy, it is also a complementary instrument of the European Industrial Policy aiming at developing and implementing the technologies of the fourth industrial revolution: "The DSM strategy, especially the pillar on "maximizing the growth potential of the digital economy", contains all the major levers for improving industry digitization with actions in areas such as the data economy, IoT, cloud computing, standards, skills and e-government". This document is filled by recommendation from the 5G PPP, even if it does not explicitly mention it: this document refer to the future internet infrastructure as a sectorial game changer, allowing growth and new development for the health, automotive, industry and energetic sector, as well as a geographical and economic integration of SMEs and rural areas in the European economy. It is also noticeable that this document is complemented by three other documents:

- The Communication on Priorities for ICT Standardization[185] which "sets out a comprehensive strategic and political approach to standardization for priority ICT technologies that are critical to the completion of the Digital Single Market".
- the European Cloud Initiative[186], which aimed at "complemented by further action under the Digital Single Market strategy covering cloud contracts for business users and switching of cloud services providers, as well as by the Free Flow of Data initiative".
- the E-Government Action Plan[187] ; and
- the Staff Working document on the internet of things[188].

The European Commission aimed, with this document, to explore policy tools to establish an integrated approach to both enhance industries and the digital single market, and "to reinforce the EU's competitiveness in digital technologies and to ensure that every industry in Europe, in whichever sector, wherever situated, and no matter of what size can fully benefit from digital innovations" (p. 6). Such tools include 1) the creation of a framework for co-ordination of initiative for digitizing industry, which would include a biannual high-level roundtable of representative of Member States initiatives and industry leader, which would include representatives of Public-Private Partnership initiatives, as well as a yearly European stakeholder Forum. 2)

[185] European Commission (2016) "ICT Standardization priorities for the Digital Single Market" (Communication) [online the 20.09.2021] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0176&from=EN
[186] European Commission (2016) "European Cloud Initiative – Building a competitive data and knowledge economy in Europe" (Communication) [online the 20.09.2021] https://www.kowi.de/en/Portaldata/2/Resources/fp/2016-COM-European-Cloud-Initiative.pdf
[187] European Commission (2016) "EU eGovernment Action Plan 2016-2020: Accelerating the digital transformation of governemnt" (Communication) [online the 20.09.2021] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0179&from=EN
[188] European Commission (2016) "Advancing the Internet of Things in Europe" (Communication) [online the 20.09.2021] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016SC0110&from=EN

Co-investing in boosting Europe's digital innovation capacities, with the same logic established for the 5G PPP where the European Union's investments are seen as a leverage provider boosting investment from the private sector in innovation, but also to establish cluster facilitating coordination of the fragmented R&D effort of key stakeholders. Here the commission recommend to "strengthening the coordination role of the Public Private Partnerships (PPPs) established in H2020 so that they become real aggregation frameworks and ecosystems for digital industrial innovations." 3) Providing the appropriate regulatory framework conditions, which requires to answer to establish the "necessary trust and legal certainty for industry in Europe" that the fast track of technological development of the digital sectors as well as the need to establish and finance new types of formation to develop the digital literacy of the European workers.

The second and third document analyzed in this part of the thesis are both published the 14 September 2016. The Communication on the European Gigabit Society start by enumerating the persistence of the problem of the fragmentation of the electronic communication markets in the European Single Market, which create problem of competition but also problem for the deployment of new technologies and the growth they have the potential to brought: "This Communication confirms the importance of Internet connectivity for the Digital Single Market and the need for Europe to deploy now the networks for its digital future. To this end, it sets out a vision for a European Gigabit society, where availability and take-up of very high capacity networks enable the widespread use of products, services and applications in the Digital Single Market" (p. 2). To operationalize this vision, the commission envisioned three objectives in the spirit of the 2010's goals regarding Smart, Sustainable and Inclusive Growth that should be reach at the year 2025:

- a "Gigabit connectivity for places driving socio-economic development", i.e., the deployment of growth-oriented policy to develop business oriented digital access, but also to digitalize other socioeconomic drivers (school, transport hubs, public services). The document also establishes the wish of the Commission to shape digital hub in all public services, where free Wi-Fi would be provided in order to integrated citizen in the digital single market.
- the deployment of 5G in all major European cities and terrestrial transport path (with the intermediary objective to implement, in at least one city in each Member States, 5G connectivity as a complete commercial service) ;
- to connect all European households with an internet connection which would offer at least 100 Mbps (the 2010's Digital Agenda for Europe flagship gave the objective of 50% subscription rate for such internet connection for 2020, objective reached in 2015, but with huge disparity across the single market).

The European Commission hence suggested different initiatives which aim to implement an environment where private actors could invest in such network of the future internet and in envisioned the digital society. Such include reform of the regulatory framework for electronic communications (which will take shape in

2018 in a directive of the European Commission that will study below), policy and financial measures as well as an "Action Plan for 5G", which is established in a second document published at the same time as this one. The emphasis on the 5G infrastructure network have to be link with the publication of a studies[189] carried out for the European Commission by the DG Connect and Tech4i2, RealWirelss, the Trinity College Dublin and InterDigital (all partner of the 5G PPP), which estimates that the 5G rollout could provide directly € 113 billion in benefits and 2.39 million of jobs in the European automotive, healthcare, transport, and utilities sectors alone. Considering a meta-analysis of the results from the 19 EC supported 5GPPP projects, identified three capabilities which are key capabilities supporting a successful rollout of 5G infrastructure in Europe (50Mbps have to be available everywhere; the development of scalable solutions for sensor networks; the development of ultra-tactile internet permitting a radio-based network to be used for operational tasks). Regarding financial need and the regulatory framework to further develop the Digital single market and implementing concretely this vision of a "gigabit society", the commission estimated an investment of €500 billion until 2025 (155 billion more than what was dedicated until now for that matter) to be required. Furthermore, "the rules for the next decade will simplify regulatory intervention where possible and do more to bring about stable and consistent conditions for investors, operators and service providers in the internal market" (p. 8); here, the communication path the way toward the implementation of a Code of electronic communication the European Commission was, in 2016 working on, as a regulatory framework for the digital single market, completing the 2002 EU Telecom regulatory framework which established EU wide competition in the ICT sector. Hence European regulator do not anymore only focus on competition, but on the creation of an environment which would suite the international investors community as a provider of finance to implement new generation telecommunication network and new technologies in particular. However, thanks to the work of Networld2020 ETP, the document acknowledges that in rural areas infrastructure-based competition is a suboptimal strategy. It is then established that such investment for low scale infrastructure or for infrastructure development in remote area will be cover jointly through co-investment between public and private actors in order to pool costs and to reduce investment risks: "The Connecting Europe Facility and the European Fund for Strategic Investment provide customized financial instruments to small and large broadband projects respectively or can be combined to support dedicated funds and platforms" (p. 12). In this Communication, the Commission advocate for Member States' commitment and European ICT sector' involvement in the implementation of policy and the promotion of reform of the regulatory and financial frameworks that would establish this vision of a gigabit society. Consequently, the EU Commission ask for the European Council and the European Parliament to approve the strategic objectives for this Internet connectivity targets in order to complete the Digital Single Market as well as to enhance legislative debates for the European Electronic Communications Code with the

[189] European Commission (2016) "Identification and quantification of key socio-economic data to support strategic planning for the introduction of 5G in Europe" (Final report) [online the 20.09.2021] https://connectcentre.ie/wp-content/uploads/2016/10/EC-Study_5G-in-Europe.pdf

target to achieve political consensus by the end of 2017 in order to have a full implementation by Member States by 2020.

The 5G Action plan have to be read as the crossroad between the document of April on the future industries and the document of September on the Gigabit society, where the need to establishes a bold plan to implement 5G network infrastructure is critical for the success of both those communication (we need to stress that this action plan was discussed already by the document of April, but its substance and scale take shape by confronting it with the other communication of September). Indeed, the 5G infrastructure technology have the double potential, as established by the document of the 5GPPP of 2014 and 2015, to complete both the objective of the digital single market and the technical requirement for a fourth industrial revolution. This document start by enumerated the reason why the deployment of the 5G technology will open prospect for the digital economy and new business model associated "5G is seen as a game changer, enabling industrial transformations through wireless broadband services provided at gigabit speeds , the support of new types of applications connecting devices and objects (the Internet of Things), and versatility by way of software virtualization allowing innovative business models across multiple sectors". Hence, this communication aimed at completing the objective set by the communication on gigabit society, especially its proposition for a European communication code, with different target actions which would give Europe the status of "home market" for 5G technology. Those target actions are clearly identified as the results of 5GPPP's events, survey, studies, and recommendation, and are understood as the extension of the work of the 5GPPP: "research efforts alone will not be sufficient to ensure Europe's leadership in 5G. A wider effort is needed to make 5G and the services that will flow from it a reality, in particular for the emergence of a European "home market" for 5G" (p.2). Hence, it is clear that the 5GPPP is central in the establishment of a European Industrial Policy for the Digital economy and new manufacturing objective since the Commission's 5G action plan for well-timed and synchronized rollout of the 5G network in the Single Market is clearly based on the recommendation of this institution. Eight Actions are identified in this document:

- The Commission, in partnership with Member States and private actors of the 5GPPP, will set up of a common timetable for the introduction of early 5G infrastructure network by the end of 2018 and for the beginning of commercial 5G services in the Single Market by 2020, as the Communications on Gigabit society and 5GPPP roadmaps indicated.
- The Commission and Member States will recognize a list establishing the settlement of spectrum bands dedicated to early launch of 5G services, based on the work of the radio spectrum policy group and the 5GPPP.
- The commission will "agree by end of 2017 on the full set of spectrum bands (below and above 6 GHz) to be harmonized for the initial deployment of commercial 5G networks in Europe" and work "towards a recommended approach for the authorization of the specific 5G spectrum bands above 6 GHz".

- the Commission in partnership with private actors and the Member States will establish roll-out and quality objectives to oversight the development of key fiber and cell rollout scenarios. This would allow the commission to in order to reach the goal of the implementation of a continuous 5G coverage in at least all urban areas and all major terrestrial transport paths by 2025. The commission will also determine a list of forthwith actionable best practices which would "increase the consistency of administrative conditions and time frames to facilitate denser cell deployment, in line with the relevant provisions of the proposed European Electronic Communications Code" (p.7).
- To ensure the interoperability of the global telecommunication network and standardization tasks regarding key 5G technologies and architecture network in particular, the action of the EU Commission will target the availability of initial 5G global standards until 2020 through a "holistic approach" approach "encompassing both radio access and core network challenges", following the path open by the Communication *ICT standardization priorities* from April.
- To promote the advent of digital ecosystems based on 5G connectivity, the commission and the industry will establish a plan for key technological experiments in order to attest the added value of 5G technologies for key industrial sectors. Those would have to be implement and be tested as early as in 2017 following the roadmap of the Networld2020. The commission will then establish a detailed timetable by March 2017. Regarding the implementation of advanced pre-commercial trials to be promoted at EU level.
- The Commission will advocate for the use of 5G network technologies for the enhancement of the security level of communication regarding service of public safety and security in member states.
- The Commission will work with private actors and the European Investment Bank Group, including the European Investment Found, to implement a sets of goals, agreement, and legal standards for the creation of a venture financing facility, potentially associated with other digital start-up actions. The practicality associated with this projected was supposed to be assessed by the end of March 2017, considering the leverage opportunity provided by EU public founding (from the European Fund for Strategic Investment and other instrument to catalyze private financing).

6.4. Conclusion: Historical Institutionalist approach of the 5GPPP phase 1: the setting up of the situation between structural challenges and political opportunities.

We can conclude this part by reminding the conclusion of the 5G PPP annual journal of 2016[190] published in October 2016, which is the first of an annual series of report of the global development of the agenda of the 5GPPP in the context of a global race for the implementation of 5G infrastructure technologies. It starts by summarizing the work already achieve and the need to further the implementation of the 5G

[190] 5G Infrastructure PPP (2016) "The European 5G Annual Journal 2016" [online the 02.09.2021] https://bscw.5g-ppp.eu/pub/bscw.cgi/d117642/Euro%205G%20Annual%20Journal%202016.pdf

research and development apparatus in Europe, to complete the digital single market strategy but also to trigger innovations in verticals industries and leverage societal changes and growth targeted by the Horizon 2020 framework program. The most important challenge of the 5G PPP being the implementation of the 5G infrastructure at the horizon 2020, the 5G PPP have to implement the groundwork based on the need and expectation of industries to create the good environment for such rollout until then. For this outcome, the 5GPPP highlighted ten results and success, which concerns mostly international and European level standardization work of the European Commission with the technical expertise from the 5G IA and other private stakeholders (a memorandum of understanding being signed by the 5GPPP and 5G America, the Chinese IMT-2020, the Japanese 5GMF and the Korean 5G Forum regarding standards, future 5G ecosystem growth, as well as the organization of a biannual "Global 5G Events"). The first years of the 5G PPP was crucial and help us to understand the evolution of strategy of actors for the development of a 5G Public Private Partnership which suits their interests and their understanding of globalization and innovation.

After the critical juncture of the economic and financial crisis which further the institutionalization of the multilateral industrial paradigm, we observe that one of its ramifications, the 5G PPP, start to gain critical importance for key issues of the European politics: the digital single market and the 4th Industrial revolution. However, the development of the 5G PPP in its early years of its implementation see competition and negociation among major component of its institutional design to further their definition of the situation and the policy tools associated to it. Indeed, the formal implementation of the 5G PPP, actors developed their vision of the policy, such in function of purely technical problematics, but also in function of their interests. The Networld2020 ETP is an interesting case, because it is a network bringing both actors from the private sector and from the public sphere and is focused on scientific and technical development. Hence, the issue at stake for this organization is to maintain its relevance, which require to develop objective progress in the field of 5G technologies and scientific knowledge associated to the ICT world. This network of actor can hence act as a counterbalance between the position of the 5G Infrastructure Association, a cluster of Industrial Private actors which can have a vision purely frame by capitalist objectives, and the European Commission, a public organization which do not have necessarily the technical knowledge and is drive by political objective (as we saw, drove by the external challenge of globalization and the internal challenge of fragmentation of the single market). Consequently, during the first two years of the phase 1 of the 5G PPP, the Networld2020 ETP depicted a technocratic and science-oriented vision of the 5G PPP. We saw, for instance that this institution highlighted technical requirements, linked with research priority for the development of the 5G, and focus less on the stake connected with the globalization, or rather, only the technical outcome that such globalization embedded. Indeed, its recommendation see the multi-tenant and multi-technology feature of the 5G infrastructure as being the main challenge for the rollout of this technology in Europe, and it occults most of problematic linked with world politics. On the other hand, the 5G Infrastructure Association depicted a vision of the 5G PPP in a more business-oriented fashion. More focused on the evolution of demand of ICT products

and the supply problematic which need to be overcome accordingly, the 5G IA emphasize the changes that 5G technology will bring in the economy of Europe in the way it will blur the line between traditional and digital economy. Furthermore, the 5G IA started to develop its network in order to integrated other sector of the economy which could benefit from the deployment of the 5G infrastructure technology, as the declaration at the 2015 Mobile World Congress have depicted. It is interesting to note that the deployment of transnational private networks through those international industrial events for the 5G technology allow the 5G IA to gain in importance and in relevance. This strategical diffusion of the ties of the 5G IA are justified by societal developments: for instance, the link between the ICT industry and the Manufacturing will promote the productivity of Europe; the link with energy industry will develop a more energy efficient consumption of society; the link with health industry will allow to enhance healthcare and wellbeing of Europeans. We can highlight here one aspect depicted by historical institutionalism: the institution influence the actions of actors and frames opportunities and uncertainty, and provide actors specific meaning and interpretation of the situations. Consequently, the 5G PPP, as we just saw, design the role, resources, and purpose of the NetWorld2020 ETP and the 5G IA, which frame also the way they can deploy their strategy to gain influence within the organization: for the ETP, gaining legitimacy and resource to conduct technological experiments; for the business association, gaining public funding and support for their R&D projects.

It is consequently a symbiosis of the vision of the Networld2020 ETP and the 5G Infrastructure Association that the European Commission implemented through the phase 1 of the 5G PPP, since both the vision of the ETP and the business association were compatible together, but also compatible with the political objectives of the European Commission. The 19 projects were selected for their ability to address research challenges leading to a 5G infrastructure rollout by 2020. They are depicted as a project able to respond in a holistic way to technical challenges while addressing the needs of horizontal industries that could benefit from the 5G deployment: e-Health, Energy, Manufacturing, Automotive. Hence, active partnership among industrial actors and public European authorities, promoted by the 5G PPP, could implement a pan-EU 5G infrastructure which would catalyze the growth of the European economy by stimulating the development of new applications and new business models. More than being business and private oriented, the view on technological progress and innovations are oriented toward the definition of a new model of capitalism and the development of a truly connected society. This vision is enhanced by the Digital Single Market Strategy of the EU Commission. In order to achieve this technological uprising that the 5G network technology would allow, the actors of the 5G PPP orchestrated a System of Innovation gathering privates and public stakeholders to achieve the technical requirement which would allow the implementation a wider digital single market, and the development of business through the development of digital economy. This public policy for 5G developed the role of the European authority in ICT matters, since it was acknowledged throughout the Phase 1 project that a public authority is needed to promote the 5G system rollout: such in order to create and rule the market of the digital economy, providing rules, finance for infrastructure deployment (especially in rural areas), and

organize knowledge and innovation production among stakeholders. After the adoption the "Toward a Digital Single Market Act", which gave a legal statue to the strategy implemented by the European Commission, its involvement in the 5G PPP were more active. Indeed, it was more and more recognized that the involvement of the European Commission was central in certain topics related to the activity of the 5G PPP, such as the development of next generation infrastructure in remote area or the implementation of a critical mass of experimental facilities which would allow to reach the objectives of the Phase 1 and technical requirement highlighted by the 2016 Strategic Research and Innovation Agenda. On the side of the private sector, the "5G Manifesto for timely deployed 5G in Europe" produced by the 5G IA can be see as a strengthening of the strategy of the private side of the 5G PPP to enhance the involvement of actors of other vertical industries, in reaction of the increasing involvement of the European Commission. This manifesto also aimed at developing a vision of the System of Innovation sustained by the 5G PPP in a business-oriented fashion, but also to enhance the horizontal integration of other segment of the European economy in the innovation infrastructure produced by the 5G PPP. The manifesto states that a close collaboration among vertical industries and telecom sector have to be developed if we want to develop the growth potential of the 5G technology and vitalizing the innovation ecosystem and strengthen the multilateral industrial policy of the EU. Hence, the call from the 5G IA for the development of an ecosystem involving other vertical industries under its umbrella, in order to develop and implement standard, financial instrument and research and development facilities participate to the development of the influence of the private side of the 5G PPP. To take back the vocabulary of Mahoney and Thelen, we can observe a strategy of layering from the side of the European Commission, and a strategy of drift from side of the 5G IA. Indeed, the European Commission create new rules for the development of the digital single market and for the industrial development of the ICT sectors which will be superposed to the previous one, still implemented within the 5G PPP, which will give new substance and objective that this institution would have to perform. On the other hand, the 5G IA aimed at using the resource it already possesses, but with the aimed at applying them through a greater number of industries and actors in order to gains new possibilities and new relevance.

The different communication from the European Commission highlights consequently a symbiosis between the vision of the 5G PPP developed its public and private side regarding both the digitalization of European industries, the development of the digital single market and the 5G Action plan which sustain both those objectives to position the EU in the global race for competitiveness. The achievement of the single market is here both a tool for to boost competitiveness inside the EU economy and a complementary instrument of the European Industrial Policy aiming at developing and implementing the technologies of the fourth industrial revolution. On the other hand, the development of digitalization of the European industries is depicted as a requirement to boost the development of the digital single market itself. This strategy shows a symbiosis of the objectives of the ICT industries, which aimed at gaining public support for its digital transition, and the European Institutions, which aimed a completing this dimension of the single market to

face globalization. The 5G Action plan is hence the product of this symbiosis: because the 5G technology have both the potential to boost the digitalization of the industries and to provide infrastructure enabling the development of the digital single market, it is then critical for all actors, public and private, to boost the development of a European based 5G network technology.

7. 5G PPP Phase 2 and 3, from optimization until large scale trials in the last years of the Horizon 2020 Framework Programme.

7.1. Introduction.

The last three years of the 8th Framework Program regarding 5G activities were marked by more active legislative and political activities in which the 5GPPP and its actors had a major impact. Indeed, in addition to the gradual implementation of the 5G Action plan we saw, the EU was also working on the development and implementation of the European Electronic Code, a European Directive which stress new rules regarding ICT sector and, of course, the implantation of the 5G network in Europe. The phase 2 of the 5G PPP entitle "Second Wave of Research & Innovation project" started in June 2017, was focused "on demonstrating and validating the developed technology and explicitly trying to integrate use cases from vertical industries beyond classical telecommunications", while the phase 1 "focused on fundamental 5G research driving central 5G technical issues though pre-standardization consensus through to standardization submission"[191]. The phase 3, which started in July 2018, aimed at providing the conditions for a deployment of the 5G network in Europe in the 2020's.

7.2. Preparation work of the Phase 2 and definition of challenges by private and public actors.

The year 2017 start by the publication of documents preparing the coming second phase of the 5GPPP. The 5G Infrastructure Association proposed a "5G Pan-European Trials Roadmaps Strategy"[192], prepared by the Trial Working Group of the 5G IA and published in February 2017, constitutes the basis for the coming 5G first version of the comprehensive Trials Roadmap document, which would be published at the 3rd 5G Global Event, organized in June 2017 in Tokyo. This roadmap, following the strategy elaborated by the 5G Action plan of the European Commission, target several objectives: to promote the global leadership of Europe regarding the 5G technology, network deployment and business model; to promote the advantage for public and private sector the 5G technology could bring; develop the major step toward the rollout of this technology; to enhance the 5G Action Plan; to complete private actors and member states' actors own initiative by providing expertise needed. Consequently, the document state that "Before 2018 (before the first 5G standard release by the 3rd Generation Partnership Project (3GPP)) it is envisaged to have technology trials run by independent trial consortia in various countries, independent of the status of standardization, to demonstrate and validate the new 5G capabilities as well as foster an ecosystem around the new 5G capabilities. Vertical industries will already be involved in this trials phase and the trials will demonstrate key 5G functionalities

[191] Barani, B. (2017) "Second Wave of Research & Innovation Projects", 5GPPP document. p. 4.
[192] 5G Infrastructure Association (2017) "5G Pan-European Trials Roadmap Strategy. Short document – 28 February 2017", 5G Public-Private Partnership.

and technical / technological enablers […] These trials will aim to demonstrate wider interoperability and support for vertical use-cases in order to claim global public attention" (p. 2). The 5G Pan-EU Trials Roadmap is organized in six different "streams", corresponding to their application, actors implementing those trials as well as end-used targeted by the trials:

- 5G Private Trials Stream, correspond to trials implemented by private actors on bilateral basis (Network operator and Manufacturer), or multilateral basis (including vertical stakeholders in addition to network operator and manufacturer). Consequently, the Trial Working Group of the 5G Infrastructure Association will have the task to collect data and analyze the added value of the trial regarding its benefit for stakeholders on the basis of the 5G Action Plan, Key Performance Indicators, and Standardization.
- 5G Action Plan Events Stream, which will implement trials and analyze their outcome on the basis of specific event organized between 2017 and 2020+ in order to explain and determine 5G applications and uses. The document foreseen the European Football Championship as being a good candidate event to implement trials regarding 5G technology applications in the entertainment sector.
- 5G Platforms Stream, which aimed at using 5G platform to assist 5G trials : "Due to the high diversity of platforms, use cases, trials and maturity stages of technology, 5G Platforms can be classified in three different levels: Research, E2E Trials, and pre-Commercial […] However, because the standardization of 5G is an ongoing activity, 5G Platforms will have to evolve from existing and new platforms, requiring further investments. In such scenario, cooperation between platforms is a way to rapidly adapt to changes/improvements to standards, to reduce costs, permit large trials, and even to interconnect with sites in other regions" (p. 4).
- 5G Vertical Pilots Stream, focused on vertical applications use cases, frame trials which could connect private trial and 5G platform. "The selection of vertical pilots should take into account the sectors already mentioned in the 5G Manifesto, including, but not limited to the media and entertainment, public safety, eHealth, automotive, transport and logistic sectors" (p. 4). This task will be achieve by the Trial Working Group based on the definition and categorization of the vertical sectors, the use case the trials will address for the vertical sector targeted, the technical requirements as well as technologies such trial involves.
- 5G International Trial Cooperation Stream, which will take into account and assess the empirical results trials in other countries in the world can bring, such in order to evaluate interoperability and standardization added value they can bring to European project. Furthermore, "Specific joint experimentations and trials could be developed in the context of these Memorandum of Understanding. On the public side, institutional funding to partially support the development of these EU-X joint trials between regions is of paramount importance" (p. 4).

The 5G Infrastructure Association also published a white paper in March, "5G Innovation for New Business Opportunities"[193] emphasizing the technological innovations developed in the 5G Public Private Partnership and the business opportunities that those technologies have the capacity to support. For the 5G IA, the main challenge, and uncertainties that 5G technology ecosystem currently face is related to the way Network Service Providers integrate 5G in their business models and the special services they will offer: "Telecom operators are currently facing several dilemmas with respect to business model evolution, multi-stakeholder coordination, alignment of incentives, regulation and competition. A fruitful evolution of the telecom operator-oriented business models towards integration of verticals in win-win partnerships is instrumental in bootstrapping and enabling the ecosystem evolution. The major challenge for the NSP is to deliver the needed level of service to a vertical while keeping the control of its own and whole infrastructure" (p. 5). Furthermore, with 5G network business find new role and responsibilities, while new actors from the public and private sphere emerge as becoming more central in the field of the ICT. On one hand, the increasing involvement of vertical industries stakeholders in the 5G value chain as what the document call "Online Service Providers" complexify relationship among actors, their responsibility, and the mitigation of use related challenge, in the 5G network as a whole. On another hand, the introduction of cloud computing model into telecom industry also brings actor from the IT world in the global 5G value chain, complexify even more the management of the network. To summarize, "new business opportunities emerge for telecom/network operators, manufacturers, and solution providers as well as for a range of new stakeholders […] These opportunities are conditioned by the ability of 5G technologies to provide the targeted performance levels that convince vertical stakeholders and allow the creation of this new dynamic ecosystem around 5G networks" (p. 5). Such complications regarding the management architecture of the 5G network as a whole also bring the question of the security, reliability, and the orchestration of platform of the operation of 5G related services, especially in vertical industries.

The 5G IA promote a "holistic orchestration platform" vision integrating networking, computing and storage resources, which involve the implementation of "flexible multi-tenant architecture" where "computing resources are distributed within the network including sites of the vertical industry stakeholders, within the base stations, in edge clouds at central offices, in regional and central clouds, and managed by different stakeholders" (p. 10). This paradigm also requires new approaches for network security and resilience, which is a challenge for the public sector but also for the private sector, since the adoption by the public and industry of the 5G network will also depend on the level of trust this technology is capable of creating. The 5G IA propose consequently a security management framework relying on "autonomic network management", which allow real-time analytics of threats and actuation of resource to minimize the scale of a possible attack on the network, preventing it to spillover throughout the whole system. However, the 5G IA here perceive the

[193] 5G Infrastructure PPP (2017) "5G Innovations for New Business Opportunities" [online the 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2017/01/5GPPP-brochure-MWC17.pdf

implementation of this paradigm as being a commercial service: “5G networks support new business models, enhanced connectivity services and enriched network functionality based on a combination of network operator and vertical industry stakeholder assets and capabilities. In many new business models, the role of a virtual network operator may be fulfilled by a vertical industry-focused organization such as a manufacturer or a health care provider. Such organizations may not have the capability of managing network security and may not want to invest in acquiring expertise in areas outside their core business. Security services are therefore needed in conjunction with virtualized network provisioning services to support virtual network operators manage their networks” (p. 11). This white paper concludes with the policy recommendation to harmonized approach and the promotion of investment which will support paradigm regarding management model and security framework.

On the side of the European Commission, the last document publish before the beginning of the Phase 2 of the 5G PPP is the Horizon 2020 Work Programme 2014-2016”, published in April 2017, and the Final Report “A framework for the monitoring of the impact of 5G Public Private Partnership and associated Key Performance Indicators (KPIs)”[194]. From the first document, we will focus only on its 5th part related to Information and Communication Technology[195]. This document starts by introducing a certain vision of the Internet and digital related technologies: “Internet has become an engine for innovation, economic growth, job creation and social progress. It is accelerating innovation, reshaping established industries, facilitating new ways of doing business, and transforming social behaviors. At the same time, this increasing diversification of usage patterns and of applications, is posing stronger requirements on the underlying networking and computing infrastructures. User privacy and data protection also emerge as technology drivers. The aim is to provide an integrated response to the technology challenges and to the innovation needs, in order to position Europe at the forefront of the Internet developments” (p. 23). Here, the 5G PPP is positioned as a central institution for the development of the internet of the future, alongside with the development of software technologies and other devices promoting experimentation and innovation. This document also frames the Phase 2 of the 5G PPP initiative under the umbrella of the “Leadership in enabling and industrial technologies”, which officially outline the industrial oriented feature of the 5G technology. If it was already outline before, this initiative officially crystalizes the development of the 5G as being not only a driver for the development of the ICT sector, but also as being a strategic industrial device promoting the development of the manufacturing as a whole. The European Commission follow by developing specific challenge the 5G PPP need to overcome:

[194] European Commission (2017) “A framework for monitoring the impact of 5G public private partnership and the associated key performance indicators (KPIs)” [online 20.09.2021] https://op.europa.eu/en/publication-detail/-/publication/2ce7b58e-4675-11e7-aea8-01aa75ed71a1/language-en

[195] European Commission (2017) “Horizon 2020 Work Programme 2016-2017” [online the 20.09.2021] https://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-leit-ict_en.pdf

- The first challenge is to “eliminate the current and anticipated limitations of network infrastructures, by making them capable of supporting a much wider array of requirement than is the case today and with capability of flexibly adapting to different "vertical" application requirements” (p. 24). The scope of this challenge regarding the research and innovation action backed by the EU Commission will, as already mentioned in document of the 5GPPP, be focused on action aimed at covering wireless access and radio network architecture technology such as novel air interface technologies, hardware architecture technologies and Radio networks functional architecture. Action oriented toward the development of optical network and software network should also be emphasized. To implement such policy, the Commission commit to support administrative tasks of the 5GPPP, such as monitoring PPP process, and organization of stakeholder events, as well as a portfolio of € 3 million attributed to this specific issue.
- The second core challenge of the 5G PPP concern 5G Convergent technology: “Network and service providers are faced with increasing challenges to manage convergence technologies. On the one hand, technological versatility increases service provision capabilities […] On the other hand, convergence technologies are getting increasingly complex, with ever larger integration of multiple technological heterogeneous hardware and software components, and more difficult properties to characterize at scale. The challenge thus tackles scalability and usability of mixed network technological approaches that can benefit from previous research, towards validation of deployment at scale” (p. 30). To overcome this challenge, the commission commits to back the development of Ubiquitous 5G access leveraging optical technology and flexible network applications with a financial contribution of € 2.5 million, but also by representing EU research and development action of the European 5G sector (telecommunication operator as well as verticals industries which benefit from it) at the International Telecommunication Union, especially in the Radiocommunication sector of the ITU.
- The third challenge identified by the EU is called “Networking research beyond 5G” and refer to the development of telecommunication technologies of the future, requiring prospective research of the technological innovation which could be raised after the 5G, like, for instance, the 6G technologies. Hence, the scope of the research and innovation action proposal covers project like R&D for radiotechnology use spectrum above 90Ghz communication technologies, research for alternative 5G architectures, etc.

This general orientation for the future research and development work or the 5G PPP need to be frame in the other document published by the EU Commission that we cited above. This document, elaborate in collaboration with Tech4i2, a UK technology consultancy company and Trinity College Dublin, in order to elaborate a framework helping EU authority to evaluate the impact of the 5G PPP regarding the objective of the Key Performance Indicators. Such indicator is divided, into three groups:

- Operating KPIs (task A), “relate to the activities being undertaken now and over the duration of the 5G PPP contractual period by the organizations involved in the 5G PPP projects. Many of the proposed Task A KPIs are factual (SME participation, leverage, and skills development etc.). Others relate to KPIs that

will be achieved over the lifetime of the study (market share, influence on standards, creation of IPR etc.), for most this is a three-year duration" (p. 24). This category gathers seven KPI under three area, which are the operational aspects of project (i.e. the creation and monitoring of partnership), the contribution to the development of standards, and the dissemination of R&D results.

- Performance KPIs (task B), "largely relate to the technological capability developments or outputs from 5G PPP projects. These are only likely to come to fruition towards the end of the 36 months (maximum) period for which most projects run" (p. 25). It gather a high number of related KPIs, link with very specific technical objective. The EU Commission have then the task to create comprehensive classifications while being sure to not let any progress unmonitored.
- Societal KPIs (Task C), "relate to the outcomes and impacts that will arise from the utilization of 5G technical capabilities (developed by 5G PPP projects and subsequently brought to market) by consumers, businesses, government and other organizations. They will arise in verticals (industries) and different environments (cities, semi-urban, rural, workplaces, homes, public buildings and other locations)" (p. 25). Such category includes ten KPI designed around long term strategy and expectation the 5G technology is supposed to bring, such as the development of a new digitalized economy, enhance network security, develop the competitiveness of the single market, develop industries etc.

Such would be implanted in order to quantify the overall performance of 5GPPP regarding its tasks and to ensure and monitor research and development agenda in a more precise way than the KPI developed in 2013-2014, which are designated in this document as "high level KPIs". Then, the classifications of "lower level KPIs" that we just saw are designed to monitor more precisely the impact of the 5G on actors of the ICT and vertical industries, but also its overall performance regarding technical criterial and the observation of the impact 5G PPP activities create in the EU. To do this analysis, the EU adapt the model used by the other International Organization to review public policy: the OECD "evaluating development activities"[196] of 2013; the UN's *Results-based management handbook*[197] of 2011 and the ILO *evaluation manager handbook*[198] of 2013 are cited by the report. Such model of review is based on the following chronology: the review of inputs (the resource needed and used for an initiative), outputs (the product of an initiative), outcomes (the direct and indirect changes generated by specific areas of the targeted initiative) and impact (the broad and long-term changes induced by an initiative). We understand then the correspondence between this methodology and the categorization of the KPI we saw above, Operating KPIs being reviewed through inputs; Performance KPIs through outputs, and Social KPI being analyzed through the lenses of outcomes and impacts they creates. Finally, the report proposes to create an independent organization which will monitor the work and

[196] OECD (2013) "Evaluating development activities" [online the 22.09.2021] https://www.oecd.org/dac/peer-reviews/12%20Less%20eval%20web%20pdf.pdf
[197] United Nation Development Group (2011) "Result based management handbook" [online the 22.09.2021] https://unsdg.un.org/sites/default/files/UNDG-RBM-Handbook-2012.pdf
[198] International Labor Organization (2013) "evaluation manager handbook" [online the 22.09.2021] https://www.ilo.org/wcmsp5/groups/public/---ed_mas/---eval/documents/publication/wcms_168289.pdf

development of the activities of the 5G PPP: "We believe that it is possible to develop a new approach to monitoring and evaluation by creating an independent 5G Observatory that should gather 5G PPP monitoring results and information from other studies and use this as a catalyst for debate and interaction between the 5G PPP projects and those who will utilize 5G capabilities. The proposed monitoring methods for the observatory will achieve two key impacts. It will maximize outputs and the exploitation of 5G PPP project results by catalyzing European and global stakeholder engagement with potential 5G users and other stakeholders. Importantly the observatory should actively support projects to commercialize their technologies and IP by providing training and support and inviting potential investors to workshops. This should help to ensure Horizon 2020 support has a commercial impact […] The Observatory should monitor 5G market and technology forecasts to provide 5G-PPP projects and policymakers throughout EU28 Member States with up-to-date insights to 5G market requirements, market potential and new business models, and insights to the economic and societal impacts of 5G." (p. 60).

To conclude this part, we understand that the last month of the Phase 1 of the 5G PPP was dedicated to creating framework to implement roadmap and evaluation methodology of the Phase 2, dedicate to research and development for the application of 5G technology to horizontal industries. The division of labor between the public and private actors seems clears, since the 5G Infrastructure Association have the upper hand regards to *what* to experiment (what technology, for what sector and what wider economic outcome) and the European Commission have the upper hand on the *how* (how to assess the development of the experimentation, how should they be financed). In addition, the EU commission also review the global objectives and the long-term strategy the 5G PPP projects need to follow, creating for this purpose a new organization within the broad 5G PPP infrastructure: the 5G Observatory. This 5G Observatory can be seen as the institutionalization of the scientific and academic side of the 5G PPP. Its task is to monitor and assess the results and added value of European wide trials, as well as national initiative regarding 5G and to enhance best practices and technical data.

7.3. Implementation of phase 2 and 3, and the creation and implementation of the European Electronic Code.

7.3.1. Overview of the accomplishment of Phase 1 and the development of Phase 2.

The first major document introducing the Phase 2 of the 5G PPP is the "European 5G Annual Journal 2017"[199], published in September, two months after the launching of the phase 2, and which summarize the accomplishment of the Public-Private Partnership regarding the overall objective of Horizon 2020 Framework program as well as the future development regarding 5G technologies in the Phase 2 and 3. On June 1st, 2017,

[199] 5G Infrastructure PPP (2017) "The European 5G Annual Journal 2017" [online the 20.09.021] https://bscw.5g-ppp.eu/pub/bscw.cgi/d204796/Euro%205G%20Annual%20Journal%202017-web.pdf

the 5GPPP selected new projects and launched as part of phase 2 of the 5G PPP for their contribution to their R&D effort to develop the vertical industrial involvement for enabling 5G scenarios, chosen among 101 proposals. After reviews them one by one, the document assesses five thematic chapters:

- "Assessing the 5G research and development investment leverage factor" review the methodology and its biased regarding the analysis of R&D expenses in 5G technology in Europe and worldwide, especially regarding the declared R&D figures of key ICT industries and the share of investment allocated to 5G technologies projects in those R&D figures. "So we made conservative assumptions on what the 5G activities share of their worldwide R&D was – usually in the order of 10% and then we further reduced that to reflect what European share of the 5G activities as part of the total R&D expenses could be – typically we ended up with a figure of about 5% of global R&D […] These proportions of 5G research of total research expenses will increase as 5G moves into full standardization, development and production over the next few years and future iterations of these assessments will take account of this" (p. 64). The document established that one of the main biases in assesses the R&D investment for 5G technology in the ICT industry is link with the fact that R&D expenditure are, most of the time, considered as a critical information, which is then not available for the public, and differ largely from company to company worldwide. The document then estimates that the 5G PPP Phase 1 funding was about € 125 million, which let the EU commission state that this assessment "demonstrates that the European ICT sector is achieving, and most probably exceeding, the planned level of investment leverage expected in the 5G PPP Contractual Arrangement" (p. 64).
- "SME Participation and success stories in 5G" assess the role of SMEs in the 5G PPP initiative and development, as preliminary documents of 2013 and the official document of 2014 promoted. The 5G PPP depict the result of initiative to establish survey destinated to SMEs member of the NetWorld2020 community, in order to create a platform to facilitate the involvement of small companies in 5G related projects. The result of this survey, called "Find the SME you need!", has been transformed into a webpage, that serve also as a platform for SME to share expertise regarding their involvement in the 5G value chain, and increased their exposure in the 5G PPP: "As a result, SME participation in 5G PPP has been increasing since the inception of the program. In 5G PPP Call 1 projects, started in 2015, 29 % of beneficiaries are SMEs, with a budget share of 16.2%12. Preliminary information on Call 2 shows that 30% of the beneficiaries are SMEs, with a budget share of 22.2%. The total share in budget so far in the 5G PPP is therefore 19.4%, almost reaching the objective of 20% participation, which is one of the Key Performance Indicators set for the 5G PPP. In Call 2, 156 organizations are new to the 5G PPP with respect to Call 1. Among those organizations, 49 are SMEs, i.e. 31% of the new beneficiaries are SMEs" (p. 66).
- "European 5G trials roadmap: technical aspect & innovations", present the work and vision elaborated by the 5G PPP, especially in the document "5G Pan-European Trials Roadmap", and its main objectives concerns the EU global leadership for 5G technology, enhancing the industrial development of vertical

sector, answer the objective of the 5G Action Plan, and complement trials implemented by the private sector as well as member states initiatives.

- "Summary 'golden nuggets'", review the approach of the PPP projects and program 'golden nuggets', imitated mid-2016, "reviewed at program level (Technology Board) before the European Commission Year 1 annual review, to develop a 360° understanding of the overall Phase 1 projects portfolio achievements and allow the different projects to fully understand their individual contributions inside these global Phase 1 achievements […] The implementation of the program and projects Golden Nuggets on the PPP and projects websites is on-going in July 2017. It is planned to also possibly include and hyperconnected the related key achievements from the Working Groups" (p. 70)
- "Spectrum aspect for 5G", one of the key technical issue to manage in order to deploy 5G technology. The work group of the 5G Infrastructure Association dedicated to this work have addresses several issues: firstly, the establishment of pioneer bands, necessary to get access to spectrum for company to start commercial trials, which were establish at 700 MHz for low band, 3.4-3.8 GHz for middle band and 24.25-27.5 GHz for high band: "The coverage is very important where the low band provides it for wide area and indoor, the middle band is useful for urban areas, and the high band for hot-spots. Europe expects to be deploying trials in each of the three pioneer bands in the 2018 - 2020 timeframe" (p. 72). Secondly, the research and development regarding the use of millimeter wave bands have also been central, "spectrum demand will obviously vary from use case to use case, as also indicated in last year's journal. It may be very demanding and range from 5 to 15 GHz for an eMBB application as virtual reality office such as and for dense urban society it may be about 7 GHz" (p. 72). Finally, work have been done regarding Spectrum authorization and sharing, since spectrum management is at core of the several use case of the 5G technology.

Two months after the publication of this 5G annual Journal, the 5G Infrastructure Association issued a document presenting the 5G Initiative for the second phase of the 5G PPP Program: "The 5G Infrastructure PPP, Second Wave of Research and Innovation Projects"[200]. 21 new projects will be financed and conduct under the umbrella of the second phase of the 5GPPP, which aimed at being focus on "demonstrating and validating the developed technology and explicitly trying to integrate use cases from vertical industries beyond classical telecommunications" (p. 5). If it won't be useful to describes the 21 projects in this document, we can describe one to understand the scale and scope of project of the Phase 2 of the 5GPPP. For instance, the Initiative 5G Car is coordinated by Mikael Fallgreen from ERICSSON, gather different partner including Huawei, Bosh, The CENTRE TECNOLÒGIC DE TELECOMUNICACIONS DE CATALUNYA, The CENTRO TECNOLÓGICO DE AUTOMOCIÓN DE GALICIA, the Chalmers University of Technology, King's College London, Merben, Nokia, Orange, PSA Group Sequans, Viscoda, Volvo Cars. The main

[200] 5G Infrastructure PPP (2017) "Second Wave of Research & Innovation Projects" [online the 20.09.021] https://5g-ppp.eu/wp-content/uploads/2017/11/5GPPP-brochure-phase2-final-web.pdf

objectives of 5G Car initiative aimed to "Develop an overall 5G system architecture providing optimized end-to-end V2X (vehicle-to-everything) network connectivity for highly reliable and low-latency V2X services, which supports security and privacy, manages quality-of-service and provides traffic flow management in a multi -RAT and multi -link V2X communication system" (p. 8), but also develop specific technology and business model which would enhance the application of 5G technology to automobile industries. This consortium is supposed to impact the general standardization effort in vertical industry in order to make them suits application in car industry while contributing to effort to develop better 5G application to V2X radio access.

7.3.2. Phase 2 Project, implementation of Phase 3 and the Implementation of the European Electronic Code.

The year 2018 start with the implementation of Phase 2 of the 5G PPP trials and several study on 5G deployment for vertical sector. This period highlight a specific relationship between the ICT industry and the different vertical industries in the framework of the 5G PPP.

1. *The interaction of the 5G IA and vertical industry for the production of business knowledge associated with the 5G network.*

For instance, the 5G PPP Automotive Working Group issued a study in February "A Study on 5G V2X Deployment"[201], which state that if effort in standardization reached the required objective, there is still huge effort to provide regarding rollout investments, the elaboration of business models, and an assessment of the about to be create Intelligent Transport Services (ITS). The white paper aimed consequently to establish policy orientation for those challenges, especially by establishing a modelling framework which will all cost and revenue analysis for 5G technology applied for Automotive industry and the ITS. Regarding technical problem, the document assesses that "the way to achieve the ultimate goal is to deploy the so-called 5G digitalized highways, which is a prerequisite for a large number of 5G-based Connected and Automated Driving (CAD) solutions" (p. 2). The working group establish that 5G technology applied in Automotive sector involve specific business model and specific relation among actors which have to be considering if we want to understand the specificity of a deployment this technology in this sector. Indeed, actor involved for V2X technology involve the 5G Industry and automotive industry, but also Standards Developing Organization, road infrastructure operators, policy makers and users, each of those actors having specific ties and relationship among each other. This configuration also requires specific investment and business model: "The main drivers to generate revenues from automotive applications are advertising, one-time payment and subscription, which is similar to what happens in the mobile market […] this approach can boost the adoption of smart-connected vehicles and reduce operational costs of V2X enablers" (p. 8). Regarding the financial

[201] 5G Infrastructure PPP (2018) "A study of 5G V2X Deployment" [online the 20.09.021] https://5g-ppp.eu/wp-content/uploads/2018/02/5G-PPP-Automotive-WG-White-Paper_Feb.2018.pdf

reward for investment, such are directly connected to the ratio of user on the highway that 5G infrastructure are implemented: consequently, the white paper established that the early use case of the 5G in automotive industry will be focused on road with a high density of vehicle, which will allow to cover further the rest of the network, and it connected and automated driving are accessible to a large public enough to cover the cost of the unitary vehicle, allowing economy of scale for both the vehicle and the infrastructure. The Working Group consequently conclude: "as the number of users that can be served is limited by the road capacity, the success of investment will also depend on the affordable charging level for CAD services. Hence, a positive business case enabling profit has been observed. Although the above findings are more qualitative, rather than quantitative, the overall message is that a positive business case can be expected, even if CAD services shall be fully provided over the network infrastructure and the user penetration rate grow slowly over time" (p. 13).

2. *The 5G IA and the development of technical knowledge for the commercial application of 5G network: example of the 5G architecture and the 5G network security.*

Two other whitepapers were issued until the lunch of the third phase of the 5G PPP: the second version of the "5G PPP 5G Architecture White Paper"[202] in December 2017 and the "5G PPP Security Landscape"[203] in June 2017, we will review them quickly since they are not central in highlighting the dynamic of the second phase of the 5G PPP but are still interesting concerning the development of the 5G technology and how project from phase 1, 2 and 3 communicate and reinforce each other while operating.

The first paper review key 5G architecture design proposal which have been tested during the phase 1 which can offer baseline architecture for project in Phase 2 and Phase 3. It also investigated late trends and technological enabler in the field of 5G Architecture, as well as proposing harmonization initiatives that were highlight in different 5G projects: "the 5G system has the ambition of responding to the widest range of services and applications in the history of mobile and wireless communications categorized in (i) enhanced mobile broadband (eMBB), (ii) ultra-reliable and low-latency communications (URLLC) and (iii) massive machine-type communications (mMTC). In responding to the requirements of these services and applications, the 5G system aims to provide a flexible platform enabling new business cases and models integrating vertical industries, such as, automotive, manufacturing, energy, eHealth, and entertainment" (p. 13). Based on those assumption, the document affirm that *network slicing* can be seen as the most encouraging solution to frame to those technological and business needs. "To achieve this goal, network slicing needs to be designed from an end-to-end perspective, spanning over different technology domains (e.g., core, transport, and access networks) and administrative domains (e.g., different mobile network operators) including management and orchestration functions. Furthermore, security architecture shall be natively integrated into the overall

[202] 5G Infrastructure PPP (2017) "View on 5G Architecture" [online the 20.09.021] https://5g-ppp.eu/wp-content/uploads/2018/01/5G-PPP-5G-Architecture-White-Paper-Jan-2018-v2.0.pdf
[203] 5G Infrastructure PPP (2017) "5G PPP Phase 1 Secutiry Landscape" [online the 20.09.021] https://5g-ppp.eu/wp-content/uploads/2014/02/5G-PPP_White-Paper_Phase-1-Security-Landscape_June-2017.pdf

architecture, satisfying the requirements of services and applications pertaining to safety-critical use cases" (p. 13).

The other whitepaper, also from phase 1 project, address network security issues related to 5G technology and review major threat that have to be mitigated in order to support such integrated network. Indeed, the security paradigm for classical network are inefficient for the 5G infrastructure network: "In 5G networks, reliability does not only refer to availability or up-time of the network infrastructure but also to ensuring high connectivity, infinite capacity and coverage (and other promised 5G features) anytime and anywhere. This implies a security makeover of how confidentiality, integrity, and availability will be maintained and managed in 5G networks". Furthermore, the softwarization and virtualization of network create also specific security issues which have to be mitigated. Consequently, the whitepaper identify eight major security risk: 1) Unauthorized access or usage of assets, link with the multilevel and heterogenous nature of 5G networks, which can result in the unauthorize access to data and protocols; 2) Weak slices isolation and connectivity, which refer to a security breach in one segment of the network which can widespread in the whole system; 3) traffic embezzlement due to recursive/additive virtualization, which mean that inconsistency between Orchestrator abstraction, Software Denied Networking control abstraction and physical resources can authorize a third party to alter and capture control plane and user plane; 4) Insufficient technology level readiness, concerns about the commercialization of technics and services which have not been sufficiently test before regarding security matters; 5) Difficulties to manage vertical Service Level Agreement (SLA) and regulation compliance, link with the multiple users of the same network using different regulatory framework in an integrated network; 6) Slicing VS Neutrality, which pose a problem for since those concept seems technically incompatible, and grey zone in the EU law could create problem of responsibility regarding security management. 7) Trust management complexity; 8) Provision to facilitate change of service provider domain lock-in: "The lack of common security standards and guarantees across multiple domains could lead to provider lock-ins, a slice owner being unable to easily and flexibly migrate all or parts of its virtual service infrastructure from one provider to the other, without affecting or degrading the security requirements and the expected levels of security SLAs" (p. 11).

3. 5G IA and the industrial planification of the research and development for the deployment of the 5G.

From a more general point of view regarding the trial of the second phase of the 5G PPP program, the 5G Infrastructure Association developed a third version of the 5G Pan European Trials Roadmap[204], which include the objective and the late finding of the 5G PPP. This version of the Trial Road map was published in May 2018 but broadcast for public at the 5th Global 5G Event in Austin the 16 and 17 June 2018. In addition to summarize the late news of the 5G PPP program, this roadmap also specificities the vision and strategy of

[204] 5G Infrastructure Association (2018) "5G Pan-European Trials Roadmap Version 3.0" [online the 20.09.021] https://5g-ppp.eu/wp-content/uploads/2018/05/5GInfraPPP_TrialsWG_Roadmap_Version3.0.pdf

the deployment of the 5G for vertical industries: “In the context of the European 5G strategy for vertical industries, validating the stability and performance of 5G technologies in specific vertical environments and across vertical industries is key to bring 5G to the market. This approach can prevent the development and deployment of platforms that each is specialized for one sector and supports the development of a generic platform that can flexibly accommodate and support multiple verticals requirements. From a business point of view, pilots that embrace several verticals are needed” (p. 7). Consequently, the 5G PPP established several vertical clusters structure to implement and analysis large scale trial for relevant for the different vertical industries targeted by the 5G technology. Regarding the 5G for UEFA EURO 2020, the 5G PPP plan to use this event as an opportunity to test 5G network technology in the field of entertainment: “The City of Amsterdam, with the Amsterdam Arena as host stadium, together with several other playing cities, are forming a Vanguard group of EURO 2020 playing cities that not only execute a 5G trial around UEFA EURO 2020, but also develop a trial program towards the events itself that can link to several verticals. They are committed to getting as many of playing cities and stadiums involved as possible. For each of the playing cities, an operator, with one or more vendors, needs to be involved to provide 5G network coverage for the 5G trials. For each playing city, an agreement with (at least one) operator needs to be found to ensure there will be 5G coverage on which the intended 5G services can be trialed. The concept of trialing the same 5G services in different cities demands for test infrastructure that can be easily replicated in the different cities” (p.11). This roadmap for the EURO 2020 has also to be frame in a broader roadmap regarding 5G Trials for connect cities: “The private trials, lay the foundation to city trials, forming the basis of commercial 5G deployment and use in city environment. In addition to private trials, the large scale publicly supported open test networks and trial environments are foreseen as the first platforms to conduct the city trials and public service piloting. These test network environments (such as 5G Barcelona, 5G Test Network Finland, UK 5G Hub…), bring together both commercial technology vendors, operators and service providers as well as public authorities and academia, setting the initial ecosystem for further commercial deployment of 5G networks and services” (p. 12).

4. Globalization and planification of research and development for 5G technology.

In June 2018 was released before the beginning of the Phase 3 of the 5G PPP and review the achievement made during the phase 2 and the planification of the phase 3, as well as the official closing of the project of the phase 1 during the year 2018. In the foreword of the document, Jean-Pierre Bienaimé, Secretary General of the 5G Infrastructure Association, emphasize the role of the 5G IA in the representation the 5G PPP in global event, such as the 4th Global 5G Event, organized by the Koran PPP 5G Forum, in Seoul, the Mobile World Congress 2018, in February at Barcelona, and the fifth Global 5G Event organized by 5G America in Austin. He states that “In the field of international cooperation, let’s highlight the signature of a Memorandum of Understanding (MoU) between 5G-IA and TSDSI – Telecommunications Standards Development Society, India – in April 2018, thus completing the map of key 5G industry regional partnerships

around the world… In the field of verticals, the 5G-IA signed a cooperation agreement in May 2018 with PSCE – Public Safety Communication Europe – in view of ensuring that 5G will bring the necessary developments to the security and safety communications for improving the activities of the PPDR community. Moreover, at the end of 2017, the Board of the 5G IA established a task force, with the aim to define and implement a strategy for supporting verticals engagement in the various industrial sectors" (p. 11). Indeed, the globalization of policy oriented toward the standardization and commercialization of the 5G technology can be seen as important feature of the Second phase of the 5G PPP. The 3GPP release 15 "Non-Stand-Alone" review in the month of December 2017 alone regarding international cooperation among main player in the world and their trials to test their 5G technologies. The document states that the EU support international cooperation and the establishment of a global consensus for 5G technology through global event which allow delegation from industrial association and policy makers to sign Memorandum of Understanding in order to establish international standards and to share knowledge and expertise. In particular, Europe increased its collaboration with Korea, which implemented the first functional and operational 5G prototype in 2018 for the Pyeongchang Winter Olympic Games. Furthermore, the 5G PPP were largely under the spotlight during key international event, such as the Mobile World Conference 2018, where 5G PPP project's vision and results were broadcast, or at the 5G Global Event of Seoul under the theme "5G Accelerating the 4th Industrial Revolution" where transnational relations among 5G actors where deepened. In Europe, during the second phase of the 5G PPP, more than 100 5G test and experiment were implemented in Europe by the private sector, most notably by network operators, manufacturers, and vertical industries. "The main target of the current trials is to demonstrate the high data rates and low latency communications, which are key features for 5G technology. In 2017 there were only a few 5G Private trials including vertical stakeholders. Trials in 2016-2017 were focused on enabling technologies related to the radio interface (high throughput, millimeter-waves and other new large spectrum bands, antenna technologies…), the network architecture (virtualization, cloudification, network slicing, edge computing…) and the introduction of new technologies dedicated to specific use cases (technologies for IoT, for automotive…) (p. 14). Hence this document also reviews the achievement of Phase 1 Projects, evaluated "Performance KPIs" system we saw earlier. For instance, the 5G-PPP SESAME initiative, implement in order to reinforce R&D for small cells coordination for multitenancy and edge services, is estimated with its contribution to reduce latency of average service creation time cycle, ensure lower energy consumption, address the challenge of 1000 times higher traffic data, increase network coverage and support solution for the challenge of automatic network management. Regarding the assessing of 5G research and development investment factor, the European Commission estimates that "that the most conservative assessment of 2% of the Global R&D spend being invested in 5G would increase in a leverage factor of 21 considering the whole 5G PPP 2017 investment (Phase 1 third year and Phase 2 first year). The 5G PPP funding for phase 1 and phase 2 projects was about 70 M€ for bigger industry, which facilitated projects with a value of around 30 M€ per year – allowing for projects with different durations (between 24 to 26 months). The total funding budget for 5G PPP Call 1 was 125 M€. It was 150 M€ for phase 2" (p. 88).

7.4. Phase 3 and look toward the next of the Horizon Europe Framework Program.

The phase 3 started in July 2018 and is the last phase of the 5GPPP. Its works include the large-scale trials for the implementation of the 5G technology network, but also the preparation of the 9th Framework Programme "Horizon Europe", in which the European Innovation System and the tools of the Multilateral Industrial Policy will be applied for further implantation of next generation telecommunication networks. The SRIA "Smart Networks in the context of Next Generation Internet"[205] of the Networld2020 ETP published in September 2018 exemplify this spirit: "ICT in general and networks (mobile and fixed) in particular is a fundamental enabler of a modern society. The Smart Networks of the future will be the nervous system of the Next Generation Internet and other commercial networks and are the platform for driving the digital transformation. Future communication systems and networks (Smart Networks) are the foundation of the Human Centric Internet. […] Such infrastructures are the enabler for the future data economy. By virtualization and strict policies, they will foster a free and fair flow of data which can be shared whilst at the same time protecting the integrity and privacy of data which is confidential or private: Users should be able to control their environment in the Internet and not be controlled by the Internet" (p. 4).

7.4.1. European Electronic Communications Code and implication of the 5G PPP.

One of the main legislative changes that the 5G PPP faced during the year 2018 where the introduction of the Directive establishing the European Electronic Communications Code (EECC)[206] the 11th of December. This document constitutes a reform of the entire EU regulatory framework for the telecommunications sector. It revoked and substituted the Framework Directive, the Authorization Directive, the Access Directive, and the Universal Services Directive. One crucial aspects of the EU regulatory framework for electronic communications is the regulation regarding broadband access infrastructures – including the 5G infrastructure network – which constitute the backbone and the foundation allowing the development of a digital economy, and consequently the competition of the Digital Single Market. In the context of increasing international pressure to digitalize economy, as the vision of the European Commission indicate in this Horizon 2020 Framework Programme. The idea to develop this European Electronic Communication Code have been, as we saw, described by a communication from the European commission in September 2016. This communication code not only answer the strategic need to enhance the broadband infrastructure network in a comprehensive law, but it also give a new legal substance to the Multilateral Industrial Policy in the telecommunications industry.

[205] NetWorld2020 ETP (2018) "Smart Networdks in the Context of NGI" [online the 20.09.021] https://www.networldeurope.eu/wp-content/uploads/2018/11/networld2020-5gia-sria-version-2.0.pdf?x70854
[206]European Parliament (2018) "Directive Establishing the European Electronic Communication Code" [online the 20.09.2021] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972

Firstly, the European Commission stipulate the multitasked management style that have to be implemented for 5G should serve as a model for other future internet network technology. Concerning the 5G technology more specifically, the EECC dedicated a several article for this technology. If it does not cite it directly, the EECC based its approach on 5G clearly through the work of the 5G PPP. In the Article 54 dedicated to the "coordinated timing of assignment for Specific 5G Band", the directive took back the results of the roadmap developed by the 5G Infrastructure Association, since it established in §1 that "By 31 December 2020, for terrestrial systems capable of providing wireless broadband services, Member States shall, where necessary in order to facilitate the roll-out of 5G, take all appropriate measures to: (a) reorganize and allow the use of sufficiently large blocks of the 3,4-3,8 GHz band; (b) allow the use of at least 1 GHz of the 24,25-27,5 GHz band, provided that there is clear evidence of market demand and of the absence of significant constraints for migration of existing users or band clearance", an objective fixed by the 5G PPP and based on several whitepaper we saw above. The 5G technology is more often cited in the foreword of the directive. Firstly the §12 of the foreword stipulate that the development of the 5G wireless communications environment should be included in the regulatory framework based on Article 7 of Directive 2014/53/EU : "Member States shall allow the putting into service and use of radio equipment if it complies with this Directive when it is properly installed, maintained and used for its intended purpose. Without prejudice to their obligations under Decision No 676/2002/EC and to the conditions attached to authorizations for the use of frequencies in conformity with Union law […] Member States may only introduce additional requirements for the putting into service and/or use of radio equipment for reasons related to the effective and efficient use of the radio spectrum, to the avoidance of harmful interference, to the avoidance of electromagnetic disturbances or to public health"[207]. Consequently, the rule establishing member states application of 5G technology in vertical industries as well as other service or use of 5G radio equipment should reflect the principles of the internal market.

The European Electronic Communication code also provide an official dimension to the effort of the European Commission to monitor reviews and evaluation progress of implementation of standard, infrastructure and assessment regarding 5G technology vis-à-vis Key Performance Indicator of April 2017: "Progress towards the achievement of the general objectives of this Directive should be supported by a robust system of continuous assessment and benchmarking by the Commission of Member States with respect to the availability of very high capacity networks in all major socio-economic drivers such as schools, transport hubs and major providers of public services, and highly digitized businesses, the availability of uninterrupted 5G coverage for urban areas and major terrestrial transport paths, and the availability to all households in each Member State of electronic communications networks which are capable of providing at least 100 Mbps, and which are promptly upgradeable to gigabit speeds" (§24). Furthermore, the EU Commission attributes itself,

[207] European Parliament (2014) "Directive on the harmonization of the laws of the Member States relating to the making availability on the market of radio equipment and repealing directive 1999/5/EC" [online the 20.09.0221] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0053&from=FR

through the Radio Spectrum Policy Group, the role to monitor problem linked to attribution of 5G radio spectrum system when different member states face this particular problem simultaneously. This decision is motivated by the idea that diverging solution by member states could jeopardize the internal market in equipment, and hence delay the rollout of a pan European 5G network (§123).

However, one crucial feature of the European Electronic Communication code is the way it officialized the Multilateral Industrial Policy frameworks for the development of telecommunication technologies, which is a direct contribution from the paradigm that sustain the Horizon 2020 framework program and the 5G PPP in particular. Regarding financial obligations: "given the high levels of investment that a comprehensive Next Generation Access broadband network (NGA) deployment requires, providing sufficient investment incentives remain essential. Furthermore, if we consider all the market developments to date related to actual NGA coverage and adoption patterns in most EU member states, it cannot be assumed that the existing market and competition conditions will result in broad-scale coverage – including rural areas – with NGA infrastructures and high take-up of NGA services in the foreseeable future. Assuming that NGA deployment indeed goes hand in hand with substantial welfare gains, the question thus arises as to which regulatory policies enhance (or diminish) investment incentives […] the EC not only fortifies its belief in the strategic importance of broadband infrastructures and services for economic development, but especially set ambitious coverage and adoption goals. In working towards the envisaged goals, the EC first and foremost aims at strengthening the incentives of private companies to invest in both the deployment of high-capacity broadband infrastructures and to enhance adoption on the demand side through the design and implementation of appropriate regulatory frameworks"[208] (Briglauer, Cambini, Fetzer, Hüschelrath, 2017, p. 949).

7.4.2. 2019-2020: last technical challenges before the end of the Horizon 2020 Framework Program.

The last two years of the Horizon 2020 framework program was dedicated to the competition of the Phase 2 project and the launch of large-scale trials of the phase 3. Those two years are characterized by a strong activity of the 5G PPP, since 14 technical whitepapers have been issued by the 5G PPP in collaboration with the 5G Infrastructure Association and 7 reports from the Networld2020 ETP and 10 report from the 5G Observatory.

A good example of those series of technical document can be found in the first document issued in the year 2019 was the white paper from the 5G PPP Automotive Working Group "Business Feasibility Study for 5G V2X deployment"[209], which aimed at establishing business models among a variety of stakeholders, as the previous document of the working group highlighted from 2018. Following the result of this previous

[208] Briglauer W., Cambini C., Fetzer T., Hüschelrath K, (2017) "The European Electronic Communications Code: A critical appraisal with a focus on incentivizing investment in the next generation broadband networks", *Telecommunications Policy* n°41, pp. 948-961.
[209] 5G PPP (2019) "Business Feasibility Study for 5G V2x Deployment" [online the 20.09.2021] https://bscw.5g-ppp.eu/pub/bscw.cgi/d293672/5G%20PPP%20Automotive%20WG_White%20Paper_Feb2019.pdf

document, the automotive working group describe the management challenge of a 5G V2X ecosystem among shareholder, requiring specific sharing models of infrastructure and investment. For the Working Group, the investment model for 5G highways have the potential to lead to positive business case in itself, but the question of feasibility regarding the highways and roads investment are yet to be assessed. In June, the Test, Measure, and KPI Validation Working Group issued the whitepaper "Validating 5G Technology Performance, Assessing 5G architecture and application Scenarios"[210]. Those last two years highlight, as we saw, the full implementation of the third phase of the 5G PPP initiative, such as established by the 4th version of the 5G Pan-European Trials Roadmap[211], following a commitment of the EU institution in the GSMA Mobile Economy Europe 2018 report[212]; which states that "We expect Europe to reach 203 million 5G connections by the end of 2025, accounting for 29% of total connections in the region. The largest advanced mobile markets, such as the EU5, will drive much of the take-up". The report also established that "more coordinated rollouts of 5G services, compared to the staggered approaches of 4G, will result in coverage and adoption levels increasing at a faster pace in Europe in the first few years after launch than with the previous technology generation" (p. 12). Consequently, those pan-European trials have target which goes beyond the 8th Framework Programme, but also the preparation of the role of the 5G PPP in the 9th Framework Programme called Horizon Europe, which started the 1st January 2021, as exaplains Peter Stuckmann, Head of the Unit Future Connectivity System of the PPP in the foreword of the Annual Journal of 2019[213]: "This year, we will also start preparing the programs under Horizon Europe, the new Research and Innovation program proposed for the next EU long-term budget starting in 2021. We are happy to see that the 5G Infrastructure Association has developed a first concept for a new partnership on Smart Networks and Services under Horizon Europe. Partnerships involving a broad range of stakeholders, including Member States and industry, will play an important role under Horizon Europe, as they did under Horizon 2020" (p. 9).

Internationally, 5G was some milestone achievement during this 2018-2019 period, with a phone call using 5G network in June 27th between Estonian minister of Economy and the Finish minister of economy; the lunch of big scale trials in USA in Houston, Sacramento, Indianapolis and Los Angeles in 2018. Furthermore, the Mobile World Congress of 2019 see different telecommunication manufacturers, like Samsung, Huawei, LG, Xiaomi, OnePlus, Oppo and ZTE will produce 5G smartphone for the beginning of the year 2020. Institutionally, actors of the 5G PPP, especially the 5G IA, find new partnership within the European Institutional apparatus. For instance, in December 2018, Luigi Rebuffi, Secretary General of the European Cyber Security Organization (ECSO), and Colin Willcock, Chairman of the Board of the 5G IA co-

[210] 5G PPP (2019) "Test, Measurement, and KPIs Validation Working Group" [online the 20.09.2021] https://5g-ppp.eu/wp-content/uploads/2019/06/TMV-White-Paper-V1.1-25062019.pdf
[211] 5G Infrastructure PPP (2019) Trial Roadmap version 4.0" [online the 20.09.2021] 5GInfraPPP_TrialsWG_Roadmap_Version4.0 (5g-ppp.eu)
[212] 5G Infrastructure Association (2019) "5G Pan-European Trials Roadmap version 4.0" [online the 20.09.2021] https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/03/GSMA_MobileEconomy2020_Europe.pdf
[213] 5G PPP (2019) "The European 5G Annual Journal 2019" [online the 20.09.2021] https://bscw.5g-ppp.eu/pub/bscw.cgi/d302069/Euro%205G%20PPP%20Annual%20Journal%202019-web.pdf

signed a Memorandum of Understanding in Vienna with the which target the development of cooperation in the field of cyber security and 5G communication networks. The same month, another memorandum of understanding was signed with the Alliance for Internet of Things Innovation. This Memorandum of Understanding aimed at developing opportunities of new combinations of IoT applications and next generation digital infrastructures. The two organizations co-signed of a "Joint Vision on Future Networks, Services and Applications"[214] in March 2019. This document indicates a first vision on how a partnership between the 5GIA and the AIOTI with the EC under Horizon Europe Framework Programme could create a synergy among stakeholder and substantially be benefit for the enhancement of the technological endowment of Europe and further the effort to boost the competitiveness of the European Economy in the world market. This collaboration is envisaged to encourage programs and projects that are most appropriate to develop the digitization of Europe. Finally, partnership between the European Space Agency and the 5G Infrastructure Association signed a joined statement[215] for the development of Satellite for 5G: "The Signatories share the willingness to combine certain efforts in the field of Satellite for 5G (hereinafter referred to as "the Concerted Efforts") pursuant to the following objective: To develop and demonstrate the added value that Satellite brings in the context of 5G in facilitating Pan-European and global coverage, resilience, mobility and security for the provision of 5G services and as enabler of innovative infrastructure and services. For that purpose, priority will be given to Verticals in which satellites can have a prominent role, such as transport, media and entertainment, public safety, without precluding additional relevant Verticals and use cases" (p. 3).

7.5. Conclusion: Institutional development of the 5G PPP before the Horizon Europe Framework Programme.

This study of the last years of the 5G PPP in the 8th Framework Programme allow us to understand better how the multilateral industrial policy paradigm is implemented by the European Union in order to boost its position in the context of the globalization by developing a technology which can both endow Europe with the tools of the 4th industrial revolution and help the completion of the European Digital Single Market. The Historical Institutionalist analysis of the 5G PPP will help us to understand its metamorphosis and the way an institution of the multilateral industrial policy of the EU evolve over time.

Here again, the institutional changes and adaptation that the 5G PPP were facing during the period 2017-2020 are linked to the promotion of idea and strategy of both the public and the private sector in the definition of challenge and opportunity within the Phase 1, 2 and 3 of the PPP. The 5G IA, through its roadmap

[214] 5G Infrastructure Association & Alliance for the Internet of Things Innovation (2019) "Joint 5GIA-AIOTI Vision on Future Networks, Services and Applications" [20.09.2021] https://bscw.5g-ppp.eu/pub/bscw.cgi/d293954/Vision%20on%205GIA-AIOTI%20partnership%20v1.0.pdf

[215] 5G Infrastructure Association & European Space Agency (2019) "Joint Statement between the EA and the European Space Industry on their Concerted Efforts on Satellite for 5G"[online 20.09.2021] https://artes.esa.int/sites/default/files/20170621%20Joint%20Statement%20%20-%205G%20-%20Le%20Bourget%202017%20-%20original%20signatories.pdf

proposition to promote the global leadership of Europe regarding the 5G technology, network deployment and business model as well as to enhance the 5G Action Plan. However, the 5G IA still promote technical issue related to the reality of the business exploitation of the 5G infrastructure. Indeed, we saw that the main challenge and uncertainties that 5G technology ecosystem face is related to the way Network Service Providers integrate 5G in their business models and the special services they will offer. Indeed, it is the coordination and the distribution of responsibilities and benefits among a large number of stakeholders that have to be defined as a priority for the 5G IA within the framework of the 5G PPP. This organization advocated to the implementation of a "holistic orchestration platform" which would coop with this coordination problematic, which would allow the distribution of responsibilities, also in matter connected with cybersecurity and network resilience. Such matter as we saw, should be deal through an "autonomic network management", i.e. the segmentation of the network in order to contain threats and enable trust among stakeholders, but implemented by private actors as being a commercial service. We understand that the 5G IA push for the development of a new market of the cybersecurity for the 5G network, justified the added value of a market-oriented management for this matter. Hence, the development of the 5G innovation triggers new goals and new opportunities for actors involved in this PPP, allowing us to adjust their strategy and gain from those developments.

On the side of the European Commission, effort was put to find technic of evaluation of the impact of the 5G PPP (and, hence, the activities of the 5G IA within it) regarding the evolution and implementation of research and development for 5G, which gain more and more importance in the eyes of European policy makers. Since internet has become a major driver of the development of System of Innovation, enabling the spreading of information among a large number of stakeholders, its development within the framework of the digital single market should consequently be a major component of the European Industrial policy, which should have enough tools to mitigate the development of its infrastructure by private actors. Here, the 5G infrastructure technology is positioned as a central feature of the development of the internet of the future, alongside with the development of software technologies and other devices promoting experimentation and innovation. Hence, the 5G PPP initiative crystalizes the development of the 5G as being not only a driver for the development of the ICT sector, but also as being a strategic industrial device promoting the development of the manufacturing as a whole, and by developing a new segment of the System of Innovation through the digital single market (which require then a public policy able to coop with specific challenges related to this technology, such as the limitation of network infrastructures, the 5G technology convergences, the future of network beyond 5G, as we saw). Consequently, the development of evaluation methods and process, able to mitigate the development of 5G research and development through different qualitative and quantitative instrument, such as Operating, Performance, and Technical Key Performance Indicators, and a sequencing of their development by an analyze of their inputs, outputs, outcomes, and impact.

We understand that the development of the institutionalization of the 5G PPP is the fruit of conflicting interests among the European Commission and the 5G Infrastructure association, but also by a cooperation and coordination which allow the production and implementation of research and technological development of a European 5G. We assist consequently within the phase 2 and 3 of the 5G PPP to a specific institutionalization of a System of Innovation where the division of labor between the public and private actors in which the the 5G IA have the upper hand regards to *what* to experiment (what technology, for what sector and for what wider economic outcome) and the European Commission have the upper hand on the *how* (how to assess the development of the experimentation, how should they be financed, how it is integrated to the wider strategy the EU is developing to face globalization). In addition, the EU commission also review the global objectives and the long-term strategy the 5G PPP projects need to follow, creating for this purpose a new organization within the broad 5G PPP infrastructure: the 5G Observatory. By the implementation of this new organ of the 5G PPP, the European Commission ambition to regains specific control over the development and activity of the Partnership, in which the 5G IA have gain great significant since it catalyzes the position of the ICT, but also other vertical industries interested in the deployment of this technology. We also saw that the formal implementation of the Phase 2 of the 5G PPP were not only linked with the development of problematic linked with the 5G application in vertical industry: indeed, the 5G IA pursue a strategy consisting of promoting the problematic linked with issues the 5G technology ecosystem and its commercial applications and the distribution of legal responsibility regarding security issues.

The competition of the phase 1, 2 and 3, being the outcome of this specific division of labor within the System of Innovations institutionalized by the 5G PPP, have been review in the different documents we reviewed and analyzed until now, help to raise the concrete problematic that the institution has implemented throughout the horizon 2020 framework program. We saw that the different European 5G Annual Journal raise a particular focus on the leverage effect the EU funding have allow to implement for R&D in 5G technology and experiments. We also saw that the "multilateral" feature of industrial policy for the 5G development also the concerns of the involvement of the Small and Medium Enterprises in the different initiatives of the 5G PPP, the wish of the European Institutions to implement a specific planification and to keep an informed eye on the activity of the private sector within the Partnership, and to overcome particular technical challenge associated with the particularity of the 5G technology, such as the spectrum management.

The phase 2 highlight the increasing participation of vertical industries' concern and demands, channeled by the 5G IA, as the example of the "Initiative 5G Car" have highlighted. Regarding automotive industry 5G PPP enable actors both of the ICT industry and Automotive industry to raise technical question and establish standards to develop the implementation of the 5G technology for cars, but it also helps developing specific business model, as the approach based on the lowering of the technology costs thanks to digital economy (targeted advertising, one-time payment, subscription etc.), and help gather all the need and demand of the private sector (both the ICT and automotive) in order to raise their voice and enter in contact

with the public authority, in our case the European Commission. Different technical solution emerge out of the interaction of the Phase 1 project, focused on fundamental research for 5G technology, and Phase 2 and 3, respectively focused on industrial application and large scale trials. We see that the 5G IA Architecture Working Group developed the concept of "network slicing" for the 5G technology, in order to mitigate the issued raised with multitenant feature of the 5G network. We also see that the 5G IA Security Working Group developed the concept of "softwareization" and "virtualization" of networks, which allow different actors involved in such networks to coop with specific security threats linked with those features of the 5G system. Furthermore, the roadmap implemented by the 5G IA which seek to put the organization in the position of knowledge broker for research and development and large-scale trials regarding 5G applications to vertical industries. The materialization of this strategy was the development of vertical research cluster and the administration of trials in different city during the UEFA Euro 2020. This position of knowledge broker is coupled with a specific position of the 5G IA in International Business Meeting (the Global 5G event in Seoul and in Austin, the Mobile World Congress in Barcelona etc.) in order to develop a private diplomacy with other global actors of the 5G race and sign Memorendum of Understanding on the behalf of the 5G PPP regarding international standardization and knowledge sharing among countries and helping the development of international cooperation and the establishment of a global consensus for 5G technology.

The phase 3 was implemented in the same moment that the implementation of the European Electronic Communications Code. This regulation is implement rules regarding broadband access infrastructures – including the 5G infrastructure network – which constitute the backbone and the foundation allowing the development Digital single market, and provide a legal authority of the multilateral industrial policy in the way it establishes that ICT networks management should be based by Public and Private Partnership officializing the multistakeholder and multitenant natures of the governance of those technologies, an approach experiment thanks to the 5G PPP. Furthermore, this directive officialize the the effort of the European Commission to monitor reviews and evaluation progress of implementation of standard, infrastructure and assessment regarding 5G technology vis-à-vis Key Performance Indicator and establishes that member states application of 5G technology in vertical industries as well as other service using 5G radio equipment should reflect the principles of the internal market. Consequently, the EECC implement the authority of the European Commission for the rules of deployment of the 5G technology and the rules of utilization of this technology. In addition, the EU Commission attributes itself, through the Radio Spectrum Policy Group, the role to monitor problem linked to attribution of 5G radio spectrum system when different member states face this particular problem simultaneously. The implementation of the phase 3 large scale trials was market by a huge effort in technological improvement and in research and development, and the deployment of the first network in some European cities. Regarding the effort of the 5G IA, the strategy it deploy during this 3rd Phase corresponds to the development of partnership with other Public organizations to improve its relevance and its influence, as

the example of the partnership signed with the European Cyber Security Organization, the Alliance for Internet of Things Innovation or the European Space Agency.

We understand that the two organization pursue their strategy and mode of actions to implement institutional change that was already developed in the first years of the 5G PPP: the 5G IA implement a strategy of drift: the development of its network toward new actors which allow it to develop and enhance the influence of its vision of the 5G technology, toward vertical industrial actors, but also toward other agencies of the European Union and its System of Innovation. On the other hand, the European Commission still develop a strategy of layering: it develops new rules, especially regarding the evaluation of the performance and development of the activity of the private sector vis-à-vis 5G objectives and roadmap, and its ability to implement new directives which will give new meaning and value to the rules it aimed at implementing. The phase 2 and 3 of the 5G PPP corresponds to a change of attitude vis-à-vis globalization: from the challenge vision developed between 2010 and 2016, globalization, and innovation become increasingly an opportunity which will allow to stimulate de development of the digital single market and the 4th industrial revolution. We assist to the competition of an institutionalization of political space above nations regarding ICT new technologies and their development. The 5G PPP is an institution which gradually influences the actions of actors both at national and supranational level since it framed new opportunities for R&D, standards, finance, and international representation, and new interpretation of ideas and situations regarding the state of the European System of Innovation and global competition which challenges it. The 5G PPP has consequently the feature of a political space which internationalize the object of strategic actions of ICT actors and European Commission and catalyze new sources of legitimacy for the development of new generation of internet infrastructure.

8. Conclusion.

This final thesis allows us to seize the metamorphosis of the public policy of an International Organization through the development of globalization and innovation and the interpretation of both those phenomena. Indeed, the underlining philosophy of this final thesis is that International Organizations need to be investigate outside the lens of market liberalization that they often involve, and also to seize their ability to affect the production system of political communities they involve, in our case, their System of Innovation. Actors, through their interaction and understanding of the late stage of global politics, can modify, reorient, implement institutions of International Organizations to make them suits their strategic interest and their perception of opportunity and challenge that the innovation-globalization dialectic creates. The role as well as the substance of International Public Policy is not the result of purely functionalist considerations. It needs to be framed as a political construct shape by actors and ideas, sculpted by adaptation and with the evolution of technologies, globalization, and political ideas. We have demonstrated in the first part of this thesis that technological change is an endogenous factor of change in World Politics, but also that actors of World Politics are not passive vis-à-vis those technological changes. We have raised with an empirical demonstration that an actor of World Politics, which is not a Nation-States, produces public policy which affects back innovations. In our case, we stress the idea that technological changes and the development of globalization induced by it have triggered the development of a European Union Industrial policy for the establishment of a System of Innovation for telecommunication innovation. Such public policy was able to produce both the technical knowledge in the field of the internet of the future and the industrial production of such infrastructure in the European Union, but also the strategic use of those technology to enhance the actorness of the EU within the globalization.

Consequently, the 5G Infrastructure Public Private Partnership illustrates that innovation opportunities as well as pressure of global competition in the second decade of the 21st century triggered the institutionalization of a supranational industrial politics in the EU for the development and deployment of a next generation ICT technology. As Skolnikoff showed, the development of 5G create uncertainties, because it is a catalyzer of a reorganization of demand (through the digital market) and a reorganization of supply (through the innovation in manufacturing and in vertical industry that it involves). The development of an industrial policy of the 5G PPP also have changed European Union's ability to channel and analyze data related to the development and deployment of 5G by actors of the telecommunication sector, and its understanding of the development of the Digital Single Market and the 4th industrial revolution. The 5G PPP also created asymmetry of power between actors, in particular an increasing influence of the actors of the ICT industry which seize the control of the representation of all the supply chains involved in the 5G development and deployment, such as vertical industry. It also created interdependence among actors of the 5G PPP, in particular, interdependence between the 5G Infrastructure Association, which require the public support to leverage funding and to develop regulation favorizing its activity, and the European Commission, which rely

on the private sector for the deployment of a technology which have the potential to foster its role in the global economy and to mitigate its structural problematics. We also understand that the case of the 5G validated one hypothesis of Skolnikoff: 5G is a technological upgrade which had raised problematic which have been perceived and analyzed as being transnational. The 5G have created a new pattern of governance, the 5G PPP, which allow the European Union to act back on technologies through Innovation Policy: in our case the Multilateral Industrial Policy. If Skolnikoff viewed that States was central actors in the realm of world politics, the case of 5G showed the increasing role of the European Union it helps to manage the transnational effect of 5G by implement innovation policy at the supranational level. Since technological upgrades increase the quantity and quality of transnational matters, the role and relevance of the European Union have been enhanced thanks to the deployment of an EU wide industrial policy. To take back the vocabulary of Ruggie, the question of supranationalization of European Industrial Policy for 5G was politicized in the beginning of the 2010's, because it was though that such technology would have the ability to enhance both the ability of the EU to act upon globalization and innovation. The type of interdependence among actor for this technology can be characterized as a *deprivation* because isolation of European States for the development and deployment of 5G creates unfair privation of the outcome of the digital economy and the technology of the 4th industrial revolution, and the collective action would allocate such outcome in a mutual beneficial way. The Loci of interdependence for 5G is *domestic* because the interdependence of EU member-states is a consequence of a situation in which each nation's policy for 5G are linked with the activity of others through the ties and networks European industries have developed through the 5G PPP.

To have a more in-depth analysis of the way innovation and globalization have trigger an internationalization of the industrial policy in Europe for the development and deployment of 5G technology, we can review the different hypotheses that we have stress in our introduction with the element that we have empirically studies in our thesis.

- **The 5G PPP shows that the European Research and Technology Policy and the European Competition Policy are becoming more oriented toward an horizonal and sectoral policy which suits Industrial objectives, embodied in a paradigm we can defined as "multilateral industrial policy".**

Indeed, the 5G PPP embodied the institutionalization of a paradigm of the EU Public Policy regarding its involvement for the development of a System of Innovation oriented toward digital technology and technologies of the 4th Industrial revolution. This paradigm of economic policy for the promotion of technology has to be situated in a specific history of the European Union since its creation. The development of an industrial policy for the development of system of innovation founded its path from the failure of interventionist sectoral oriented industrial policy at the European level throughout the 1960's and 1970's. It was also organized around institution and paradigm elaborated by the market-oriented and research and development policy of the EU for the new technologies' industries in the 1980's and 1990's, which emphasis a role of the private sector for the development of industrial development as well as precompetitive research

and development cooperation among actors of the System of Innovation. Hence, this past paradigm path the way of the institutionalization of a more interventionist policy in the 2000's and 2010's in the context of a "manufacturing renaissance", that we have characterized as being a "multilateral industrial policy". The multilateral industrial policy is then an adaptation of this neoliberal innovation policy, which was challenged firstly by the pressure of globalization which demonstrated the fragility of the R&D apparatus in the productive system of Europe (hence the implementation of the Lisbon Strategy, which can be characterized as a soft multilateral industrial policy). In a second time, the economic and financial crisis can be seen as a catalyzer of the effort to institutionalize more deeper use of multilateral industrial policy. Those two critical junctures, to take back a notion of historical institutionalism, enable the multilateral industrial policy to be put at the center of the instrument of the EU policy for the development of a System of innovations able to produce technological changes.

Regarding the 5G PPP more precisely, we saw that this institution embodied the symbiosis of the technology policy and the market-oriented policy within the multilateral industrial policy of the 5G. Indeed, the 5G technology can integrated both element of the single market policy, since it has the ability to enhance the digital single market by increasing dramatically amount of data which travel around the single market, and the manufacturing policy, since it is a key technology of the development of Internet of Thing and hence of "manufacturing 4.0". We saw in the first part of our analysis of the 5G PPP that EU actors justified those reorientations of the technology policy and single market policy throughout the 2010's with the argument of the structural challenge the EU economy were facing: the urgent need to rise in the technological raise for the rollout of 5G network and the need to develop technologies which would further the comparative advantage of the EU regarding other actors of the global economy. Those created the need to improve the business environment for actors of the ICT which participate in the development of 5G technology, especially by implementing horizontal industrial policy enabling the development innovation cluster between private actors and public research institutes. Furthermore, an active sectoral industrial policy was also implemented with the idea that the promotion the deployment of a 5G network infrastructure would help the creation of the digital single market. Because such policy was implemented and though as a tool to enhance industrial development, thanks to the competition it would induce in the digital economy and stimulate actors to innovate, we can seize a particularity of the multilateral industrial policy: the blurring of the frontier between horizontal and sectorial industrial policy. Indeed, the different sectoral industrial policy targeting the ICT sector was implemented in order to enhance the competitiveness of the European economy as a whole; and the horizontal measure implemented to favorize business environment, usually associated with the horizontal industrial policy, was implemented in order to boost the competitiveness of the ICT sector in particular.

The major feature of the multilateral industrial policy paradigm, institutionalized by the 5G PPP in hence this reconfiguration and delimitation of both competition policy, which justify the use of Public Private Partnership for the development of research and deployment of 5G; and technology policy, which justify the

use of instrument and policy, such as European Technology Platform, Framework Programme for Research and Development, European Research Area etc. for the development of 5G innovations and technologies. This symbiosis is particularly visible with the development of the Contractual Public Private Partnership within the Horizon 2020 Framework Programme. Consequently, the development of the Horizon 2020 Framework Programme has to be understood as an instrument to foster this multilateral industrial policy for the development of an integrated System of innovation for ICT sector with, formalized by a the 5G PPP, a contractual Public Private Partnership among actors of the ICT industry and the European Commission for the research and deployment of 5G technologies. The governance model of the 5G PPP is based this dual competition policy and technology policy spirit inherited from the industrial policy of the EU developed in the 1980's and 1990's: on one side, it formalized the commitment of the EU Commission and actors of the ICT industries to meet long term social and industrial objectives through the organization of competition among different initiatives, which would be selected for their possible contribution to Key Performance Indicators, and hence get access to public finance. One the other hand, this partnership aimed at implementing a holistic cooperation in the framework of a System of innovation that would allow the distribution of tasks manage the coordination of among different European research programs which are relevant for the implementation of the 5G infrastructure.

This specific institutionalization of the competition policy and the technology policy toward the line of the multilateral industrial policy have been empirically observed in the position of the different major actors of the 5G PPP through the different phase of the Partnership. In the Phase 1, the vision of the Networld2020 ETP, European Commission and the 5G Infrastructure Association converge. 19 initiatives were selected for their ability to both address technological problematic and scientific challenges enabling the development of the 5G technology, but also for their ability to further the competitiveness within the single market by addressing issues linked with market entry of business in the digital economy, but also to develop new services related to the digitalization of vertical industry, such as the application of the 5G in the Health, energy, manufacturing, and automotive. Consequently, the 5G PPP orchestrated a System of Innovation gathering privates and public stakeholders to achieve the technical requirement which would allow the implementation a wider digital single market, and the development of business through the development of digital economy. This make us understand that the objective of those technology policy cannot be understood within the framework of the technological improvement only, but within a specific vison of innovation oriented toward the contour of a new model of capitalism in a digitalized society that the multilateral industrial policy is enhancing. Within the phase 2 and 3, the symbiosis of the technology policy and the competition policy is highlighted by the institutionalization of a System of Innovation where the division of labor between the public and private actors. The private side of the 5G PPP design policies regarding what to experiment, i.e. technology and knowledge which would be useful primarily from a market perspective and commercial application; and the public side of the PPP design the way such experiment would be conduct, defining the criteria of success

and failure of initiative, as well as the financial instrument to be used and the long term impact such experiment is supposed to produce on the European Economy at large.

Consequently, the phase 1, 2 and 3 of the 5G PPP demonstrate that the multilateral industrial policy is the fruit of a symbiosis of tools and objectives of both the competition policy and the technology policy of the European Union.

- **The interpretation of the global position of the EU in the 2010's has triggered the reimagination of the involvement of the EU regarding industrial objectives, making the 5G deployment a strategic objective requiring active role of the EU commission.**

This thesis also highlights that effect of this innovation on public policy is not neutral nor natural, but the fruit of a specific interpretation and reflexive action from actor to give them meaning in a specific context. The outcome of the development of the 5G technology by the European Union were motivated by a specific vision of world politics. The promotors of the supranationalization of the industrial policy for 5G advocate for the institutionalization of such policy because such technology was saw as an asset for the EU to compete in the globalization. This vision of technology as being a driver of the competitiveness of the EU in the global economy does have an influence on the policy and organizational design of the industrial policy implemented by the EU for the development of 5G. Hence, we demonstrate that the driver of the public intervention in the effort to the strengthen and improve the efficiency of a System of Innovation for the development and deployment of 5G technology cannot be dissociated from the general interpretation of the late stage of world politics as being the set of a global competition, which will shape the way and strategic importance of the development of the digital single market and the development of the new generation of industrial technologies.

Firstly, the trigger of the involvement of a more advanced multilateral industrial policy in the 8th Framework Programme was drove by the effect of the financial crisis on the manufacturing sectors, which fueled the paradigm that industrial policy should be implemented in the European Union in order to foster the System of Innovation and enhancing the competitiveness of the European economy in the globalized economy. Consequently, the development of an integrated approach for the development of digital technology and internet infrastructure innovations was depicted as being an answer that the EU could provide in order to make its economy more resilient and more attractive in the global market. The European Union, hence, have used its power and resources to fixe meaning of the structural challenge the financial and economic crisis have triggered, and the political answer that need to be implemented in order to overcome this challenge: enhance the ability of the European economy to produce innovation in order to gain relevance in a world economy where the main driver of growth is understood as the ability of a political economy to produce technological upgrades. Hence, the action and policy implemented by the 5G PPP in its different phase were oriented toward the development of knowledge and technology which would further both the European ICT industry in the world, to enhance the European vertical industry by developing their digitalization thanks to application of the

5G technology in their domain, and to stimulate the competition within the European economy thanks to the deployment of the digital single market, making the European economy as a whole more attractive for international investors.

Secondly, this vision creates a path dependence for the institutionalization of the 5G PPP and for its action regarding research and deployment of the 5G technology. The Phase 1 of the 5G PPP is consequently characterized by a vision of globalization as being a challenge. The 5G Action Plan institutionalized this configuration of the EU policy toward 5G within the scope of globalization. Because the 5G have the ability to deploy a major backbone of the digital single market and the 4th industrial revolution, the research and development of this technology do not only matter for commercial outcome or technological achievement but have the feature of a strategic stake enabling a major boost competitiveness inside the EU economy in the global economy. Furthermore, as we saw earlier, the development of digitalization of the European industries is depicted as a requirement to boost the development of the digital single market itself. The 5G Action plan is hence the product of this symbiosis: because the 5G technology have both the potential to boost the digitalization of the industries and to provide infrastructure enabling the development of the digital single market, it is then critical for all actors, public and private, to boost the development of a European based 5G network technology and to build a System of Innovation which would allow the deployment of such technology. The different actors of the 5G PPP have then develop roadmap, trials, whitepapers which aimed at fulfilling the technical and innovation requirements to endow the EU ICT sector, and with it the EU vertical industry, reinforce the actorness of the EU in the globalization, with the goal to make EU the leader of the ICT sector, a position that have been in some document depicted as an historical responsibility.

Thirdly, we saw a change in attitude regarding globalization with the deployment of the Phase 2 and 3 of the 5G PPP. Indeed, between 2016 and 2020, we saw that globalization become increasingly a provider of opportunities for the development of 5G, especially regarding the development of international standardization activities of the 5G PPP that happened during the different international meeting and congress for the development of 5G in the world. However, the different actors of the 5G PP still depicted the challenge and opportunities of globalization through the lens of their own interests: the 5G IA outline the business imperative that such competition include and the support the public sector should bring to the private one; the European Commission highlight the geoeconomics and geopolitics assets that could be gained from a European leadership in 5G technology, requiring then an alignment of the private sector to the public objectives.

- **Actors from the ICT industry and the European Commission had developed sets of interaction which had developed this reorganization of the neoliberal competition oriented industrial policy towards a multilateral industrial policy.**

As the actor centric approach of historical institutionalism developed by Büthe have shown, the fundamental characteristic of the industrial policy of the EU for the 5G, that we have described with the notion

of multilateral industrial policy, is its ability to gather a large number of actors of the System of Innovation for the ICT research and development sector, both public and private. Hence, an inquiry of the European public policy for the 5G need to consider the interaction and strategy of actors within the 5G PPP. We have seen that the organizational design of the 5G PPP gather three fundamental structures: the Networld2020 ETP, the 5G Infrastructure Association, and the European Commission. Those three institutions compete and negotiate to define and put forward their vision and cognitive understanding of the challenge the EU economy is facing and the technological answer that could be developed to coop them.

We saw that, in the years preceding the implementation of the 5G PPP, a prototype in partnership among public and private actors at the European level have been established in the form of professional and business event in which the actor of the ICT industry had the opportunity to raise their concerns regarding the state of the European industry in the beginning of the 2010's, and to establish connections with actors of the European Commission to coined what could be a public policy aiming at enabling European ICT actors to develop the technology of the future communication and information networks. During these events, private actors developed their proposition for a combination of horizontal and sectoral industrial policy that the EU commission could implement in order to support their position in the global market. We saw that such policy recommendations also coincide with different concerns of the EU commission, such as the alleviation of the fragmentation of the digital single market and the technological upgrades of European industries. However, the private sector also framed their interventions in a fashion which would outsource their research and development efforts outside of scope of their responsibilities. Indeed, one major wish of the European ICT sector as to switch the problematic of the R&D in ICT from a private to a public concern. Such, as we saw, took in particular the form of the advocacy for the public funding of private initiatives for trials and research in 5G technology, but also in horizontal policy which would facilitate the international private fund to invest in the innovation in this sector of the European economy, and a reform of the European Intellectual Property Right that would protect the patents ownership of the ICT industry. We saw that the ICT promoted a specific idea of a multilateral industrial policy which support the implementation of a European System of Innovation characterized by the notion of "smart specialization". This idea depicts a specific application of the multilateral industrial policy in which horizontal and sectoral industrial policy would enhance the private sector's ability accumulate innovation resources in order to be both more resilient in front of the global market, and to develop further the profitability of investment in the infrastructure of the digital single market, driving consequently its implementation. The 5G IA pushed this strategy throughout the institutionalization of the 5G PPP. Furthermore, we saw that the 5G IA implemented a strategy of drift regarding the development of the 5G PPP: the 5G IA aimed at using the resource it already possesses, but with the aimed at applying them through a greater number of industries and actors in order to gains new possibilities and new relevance. We saw several materialization of this strategy, such as was the development of vertical research cluster with other vertical industry (health, automotive, energy, and manufacturing), the involvement of the 5G IA in different

International Business Meeting in order to develop a private diplomacy with other global actors of the 5G race and sign Memorendum of Understanding on the behalf of the 5G PPP, and also, in the last years of the 8th Framework Programme, with other institutional actors, such as the European Space Agency, the Alliance for the Internet of Things Innovations, and the European Cyber Security Organization.

On the side of the public side of the 5G PPP, we observed a strategy of layering from the European Commission : The European Commission create new rules for the development of the digital single market and for the industrial development of the ICT sectors which will be superposed to the previous one, still implemented within the 5G PPP, which will give new substance and objective that this institution would have to perform. For instance, the ability to transform strategy in European regulation allow the European Commission to make up the space in which the ICT industrial actors can operate, such with regards to the technical issues directly linked with the 5G PPP, such as spectrum policy, financial regulations, patents regulations etc. but also the long-term strategy and the global vision of the outcome the 5GPPP and its actors have to align themselves with. In addition, the EU commission also create for itself the ability to review and evaluate the global achievement and the alignment of the activity of members of the 5PPP with its the long-term strategy by developing evaluation protocols, and then, by creating a special organization for this purpose within the broad 5G PPP organizational set up: the 5G Observatory. By the implementation of this new organ of the 5G PPP, the European Commission ambition to regains specific control over the development and activity of the Partnership, in which the 5G IA have gain great significant since it catalyzes the position of the private actors of the whole value chains within the System of Innovation as we saw earlier. We understand that the two organization pursue their strategy and mode of actions to implement institutional change in a way that suits their interest, but also their vision of both innovation and globalization that they developed throughout the deployment of the 8th framework program. 5G IA implement a strategy of drift: the development of its network toward new actors which allow it to develop and enhance the influence of its vision of the 5G technology. On the other hand, the European Commission still develop a strategy of layering: it develops new rules, especially regarding the evaluation of the performance and development of the activity of the private sector vis-à-vis 5G objectives and roadmap, and its ability to implement new directives which will give new meaning and value to the rules it aimed at implementing.

The Networld2020 ETP, another major organization of the 5G PPP, integrated element from both the public and the private sector and is focused on scientific and technical development. This position will put this organization in a particular position, since it is not totally drive by the need to generate profitability and penetration in new markets, nor totally dedicated to the social and political orientation of the European Commission regarding the development of 5G technologies. The Networld2020 ETP is a mechanism representing of the System of Innovation for 5G technology itself, and the major problematic that this organization have to deal with is based on maintaining its relevance in the knowledge production apparatus. These tasks require for the organization to develop objective and quantifiable progress in the field of 5G

technologies and scientific knowledge associated to the ICT world. Consequently, during the phase 1, 2 and 3 of the 5G PPP, the Networld2020 ETP depicted a technocratic and science-oriented vision of the 5G PPP and its objectives. We saw, for instance that this institution highlighted technical requirements, linked with research priority for the development of the 5G .Indeed, its recommendation see the multi-tenant and multi-technology feature of the 5G infrastructure as being the main challenge for the rollout of this technology in Europe, and it occults most of problematic linked with world politics. However, like the 5G PPP, the Networld2020 ETP is also shaped by the rivalry and cooperation among the private pole and the public pole of the 5G PPP. Indeed, its activity will be balanced both by the strategy of the business association which aimed at gradually integrating and aligning other segment of the European vertical industry to its vision of the 5G; and the European Commission strategy to develop tools and instrument controlling the activities of the 5G PPP in order to align it with its societal vision of the digital single market as well as its strategy to enhance the position of the European economy in the globalization.

- **The 5G PPP catalyze feature of an Industrial Politics above nations-states to enforce the digital single market while enhancing the EU actorness in the global economy regarding enabling technologies of the 4th industrial revolution.**

The institutionalization of the 5G PPP can be analyze as a supranationalization of the ICT industrial policy, since, as Büthe have explain, we can observe the *process* of creation and or strengthening of the authority of the EU in this matter related to 5G industrial research and deployment. The general orientation of and the instrument of the policy to implement, as well as the involvement of actors, both from public and private sector, gradually take shape in within the European Union. The ICT industrial policy is gradually shifted from a Nation-State problematic toward a European one since actors both of this supranationalism advocate successfully for this institutionalization. This strategy was first frame developed by the "Digital Agenda for Europe" establishing a long-term goal to use internet and digital economy to foster EU economy and to tackle key problematic that the financial crisis has highlighted by the European Commission.

We have saw that the advocate of this supranationalization also push the idea that implementing an Innovation policy for digital technology at the EU level is a problematic linked with ICT sector only but is an issue having the ability to change the entire EU economy, making it more resilient against globalization and more able to enhance its technological endowment. For instance, we saw that the "Europe 2020 Flagship Initiative: Innovation Union", highlights crucial fragility that the ICT sector is facing, such as the under-investment in knowledge foundation as well as the poor regulatory framework, high cost of intellectual property rights and the fragmentation of use of resource for R&D etc. But the solutions to overcome those challenge make sense only if we put them in the perspective of the increasing involvement of the EU in the industrial policy setting: by pushing forward the idea that solution to problem facing the ICT industry have to be implemented as an support of the position of the EU in the world economy, the EU commission also aimed at increasing its legitimacy as an actor of the industrial policy. This strategy is also clear in the the

Communication “An integrated Industrial policy for the globalization Era, Putting Competitiveness and Sustainability at the Center State”, which connect the problem and challenge brought by globalization and digital technology. We saw that, before the formal implementation of the 5G PPP, the European Commission successfully put at the center of the stage the debate of a the EU level multilateral industrial policy able to plot a decade long plan to shape and change the EU economy in order to make it more resilient and more competitive in a global context where Europe is increasingly losing its technological and industrial position. The System of Innovation sustained by this industrial policy proposal aimed at both mitigating the fragmentation of the digital market as well as strengthening the existing industrial actors in order to make them more resilient thanks to the development of a sound business environment and by the innovation boosts that such policy is supposed to develop.

The institutionalization of this of this System of Innovation for 5G above Member-States was though as an institutionalization of vision of a smart specialization developed by the private sector, articulated around the political objectives of the EU Commission actors. The development and institutionalization of a business association within the 5G PPP organizational design were implemented in order drive the voice of the private sector in the discussion related to the development and deployment of the 5G. The European Commission informed the Net!Works European Technology Platform (ETP) and industries about its agreement for the formal creation with a partnership between industrial actors and the European Commission, which do not contain formal representation of nation states interests. We understand here that the institutional design of the 5G PPP help the European Union to promote and strengthen its approach to industrial policy. We saw that the contour of the multilateral industrial policy already existed within the framework of the Lisbon Strategy, that we have characterize as being a soft multilateral industrial policy. The European Commission took back this paradigm and push further its involvement in the Horizon 2020 strategy: since Nation States did not comply with the objective of the Lisbon Strategy, the Horizon 2020 strategy require a more in-depth involvement of European Institution themselves, motivated even further by the effect of the economic financial crisis upon the European economy. We observed consequently a change regarding the EU approach toward innovation, from a position where it is solely a knowledge broker toward the implementation of policy tools developing its ability to be a knowledge creator. Indeed, the European Commission do not aim at gathering different national innovation system, but to create an integrated one at the European level for the development and production of knowledge in ICT industry. We even argued that, for the ICT industrial policy, the EU bypasses the will of member states, since their involvement for implementing a multilateral industrial policy for the 5G intervene only when the Horizon Framework Programme were approved by the European Union Council. The EU and the ICT industry were the most relevant actors of the implementation of the 5G PPP, and Member States had a marginal role in the policy design of this institutions. The fact that they are almost not cited in the different work paper of the 5G PPP also illustrated this fact. The institutionalization of a multilateral industrial policy for 5G was based both on the European Union position to strengthen its position within the globalization

in order to produce innovation, and by a transnational network of private actors, aiming at finding public support for its R&D activities.

As we saw, the gradual institutionalization of the 5G PPP see evolution of the role of public and private actors. Since internet has become a major driver of the development of System of Innovation, enabling the spreading of information among a large number of stakeholders, its development within the framework of the digital single market has become a major component of the European Industrial policy objectives. Secondly, since internet technologies are a major component of development of the 4th Industrial Revolution, especially through the Internet of Things, the development of this technology is from a strategic importance of the European authority. Hence, we saw two regulations implemented at the EU level in order to foster the role of the EU in this matter, institutionalizing further the multilateral industrial policy and its function in digital and internet infrastructure technology.

Firstly, the issue of the development of the Digital Single Market also became a part of the EU legislation with the adoption of the European Parliament Resolution "Toward a Digital Single Market Act". European Union emphasized the role of private investment in technology and network of the internet of the future for the development of the digital single market. The Parliament consequently developed a regulatory framework in order to allow stakeholder to invest in all the area of the digital single market, including in infrastructure in the rural areas. This regulation highlights the commitment of member states to develop the condition for the deployment of the 5G technology in Europe, by European level instrument and platforms. The development and realization of the 5G PPP until this event have consequently to be framed in this vision of the Innovation policy at the EU level that member states agreed to implement in order to developed for the 5G technology. Secondly, the European Electronic Communications Code implemented rules of the ICT industrial policy which officialized the European wide nature of the material industrial policy for 5G. Indeed, it fixed rules and protocols regarding broadband access infrastructures, which constitute a precondition for the true deployment of digital single market. It also provides a legal authority of the multilateral industrial policy in the way it establishes that ICT networks management should be based by Public and Private Partnership. This regulation give an official feature of the multistakeholder and multitenant natures of the governance technologies associated with the 5G PPP and officialize the distribution of task between the public and the private side of the partnership: on one hand, the effort of the European Commission to monitor reviews and evaluation progress of implementation of standard, infrastructure and assessment regarding 5G technology vis-à-vis Key Performance Indicator and establishes that member states application of 5G technology in vertical industries as well as other service using 5G radio equipment should reflect the principles of the internal market. On the other hand, the private sector implements trials and roadmaps complying with the objectives of the European Commission regarding development and deployment of 5G technologies, as well as funding and enhancing R&D expenditure, linked with the leverage effect the EU funding were supposed to developed. We assist to the competition of an institutionalization of political space above nations regarding ICT new

technologies and their development. The 5G PPP is an institution which gradually influences the actions of actors both at national and supranational level since it framed new opportunities for R&D, standards, finance, and international representation, and new interpretation of ideas and situations regarding the state of the European System of Innovation and global competition which challenges it. The 5G PPP has consequently the feature of a political space which internationalize the object of strategic actions of ICT actors and European Commission and catalyze new sources of legitimacy for the development of new generation of internet infrastructure.

To conclude, we understand that the 5G PPP shows that the European Research and Technology Policy and the European Competition Policy are becoming more oriented toward Industrial objectives, embodied in a paradigm we have defined as "multilateral industrial policy". This reorientation has been driven by a specific interpretation of the global position of the EU in the 2010's, which has triggered the reimagination of the involvement of the EU regarding industrial objectives, making the 5G deployment a strategic objective to both endow the EU with a technology of the 4th industrial revolution and of the development of the digital single market. This industrial policy has been defined by interaction, confrontation, and negotiation of actors from the ICT industry and the European Commission which have help the development of a Multilateral Industrial Policy developing a European System of Innovation above nation-states. Their ideas and strategies have been structural element of the institutional adjustment and stabilization throughout the 2010's and have developed a specific division of labor between the private and the public side of this partnership. The 5G PPP have then to be understood with the feature of an Industrial Politics above nations-states to enforce actorness of an International Organization in the global politics and in the production of innovation. This study shows that, by putting international public policy in their historical context, and the understanding of the cognitive universe and strategy of actors political and economic sciences, we can seize an essential aspect of the late development of World Politics: the ability of international organization to get involves in the production of innovation. Our study, guided by the Historical Institutionalist paradigm, aimed at bringing the strategy of actors in the historical context of this late development in world policy. Technological changes matter if we want to seize the dynamic of international relations and globalization. International Organizations matter if we want to apprehend how technological change reorganize the production of knowledge and innovation and its potential supranational trends. International Industrial Policy matter if we want to understand how International Public Policy have a positive and extensive role in the organization of System of Innovation above states. In a world were systemic problems, such as climate change, pandemic outbreaks, global poverty alleviation, the digitalization of societies etc. will require bold policy to further innovation and technological ability to coop with such challenge, it is important to understand the ability of all actors of the World Society to develop and enhance those solutions.

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10. Annex: Summary of the thesis

1. Introduction.

In the context of the structural economic difficulties the EU was facing after the 2007-2008 crisis, institutional voices start to emerge to rethink the role of European institution to enhance stability and development of the European Industries as it was thought as being the main driver of the development technological upgrades. This situation raised consequently the following question: how an International Organization is affected by technological innovation, and how such organization affects back these technological changes. This question is particularly interesting in a context where new technologies stimulate and enhance globalization by deepening interconnection between society, and where globalization pressures public organizations to reimagine their role in improving the technological endowment of their political community in order to be more competitive.

Because it has both the quality to consider the problematic of the global competition and the thematic of the technological upgrade; and because the promoters of this policy had the political leverage to advocate for this policy, Industrial Policy came at the center of the stage of the European Economic policy for the development of innovation. This new industrial policy is an adaptation of the already existing economic regime based on neoliberal principles and focused essentially on public-private strategic coordination which would implement structural adjustment affecting not only the economic growth and competitiveness of the EU, but which will also have an impact on social and civil development through technical progress. The dialectic between technological change and world politics transformation throughout the 20th and 21st century did influence and shape the European international regime regarding innovation policy, and the last outcome of this dynamic have been the institutionalization of what we will call a "Multilateral Industrial Policy" for the development and promotion of a European wide System of Innovation. Multilateral Industrial Policy is multilateral in the sense that tits purpose, targets, and scale is defined by a multitude of actors and crystalize their interaction and their reflexive understanding of the challenge and opportunity of both globalization and innovation. Such policy is implemented via a combination of horizontal and sectoral policy affecting the production of knowledge and technological artefact, which will be executed through a coordination of different actors such as Member-States, Business Associations and European institutions.

One application of this paradigm is the 5G Public Private Partnership, a large-scale government-backed industrial and academic projects, established by the European Commission in 2013 in collaboration of the 5G Infrastructure Associations, a group of European actors of the ICT industries, in the wider framework of the objective of the "Horizon 2020" strategies in the 8th Framework Programme for Research and Technological Development. This new technology is depicted as the basis of economic development and most notably with its ability to revolutionized Internet of Thing and bring new application for next generation manufacturing, increasing life conditions in societies, as well as helping positioning EU's industries in an increasingly competitive global market. Understanding how the European Union is increasing its role as an Industrial

Actors thanks to the coming "4th Industrial Revolution" and the Infrastructure of the Digital Economy matters, because it helps us understand and size both the changing nature of the European politics regarding its ability to get involve in manufacturing, technological upgrades, and the world economy. The research question that this thesis tries to address is the following:

> How have technological and international changes in the 21st century triggered an internationalization of Industrial Politics?

To sustain this problematic, this final thesis will be outlined by several hypotheses:

- The 5G PPP shows that the European Research and Technology Policy and the European Competition Policy are becoming more oriented toward an horizonal and sectoral policy which suits Industrial objectives of the Multilateral Industrial Policy paradigm.
- The interpretation of the global position of the EU in the 2010's has triggered the reimagination of the involvement of the EU regarding industrial objectives, making the 5G deployment a strategic objective requiring active role of the EU commission.
- Actors from the ICT industry and the European Commission had developed sets of interaction which had developed this reorganization of the neoliberal competition oriented industrial policy towards a multilateral industrial policy.
- The 5G PPP catalyze feature of an Industrial Politics above nations-states to enforce the digital single market while enhancing the EU actorness in the global economy regarding enabling technologies of the 4th industrial revolution.

To understand how 5G Industrial policy of the EU is highlighting how the dialectical dynamic between technological changes and transformation of world politics triggered an Internationalization of Industrial Politics in the European Union, we have to frame this problematic in a specific historical context. This final thesis will consequently be structured firstly by a review of the literature regarding the question of the relationship between international politics and technological changes, and a historical background to understand the trajectory of the institutionalization of the Multilateral Industrial Policy in the EU. Then a theoretical framework will be set up, where we will gather tools of Historical Institutionalism to understand better how to structure our study of the 5G PPP and our methodology. We will then operationalize our methodology in a case study of the 5G Public Private Partnership in three parts. To study the gradual institutionalization of the 5G PPP in the broad framework of development of the multilateral industrial politics of the EU, we will have to study empirically the formal document provided by Institutions of the EU industrial policy institutions, and to frame how actors from the European Union and from the Business associations shape their strategy to frame the contour of this 5GPPP as an artefact of the Multilateral industrial policy, and their discursive and political resource they use to advocate for their vision of the EU industrial policy.

2. State of the Art.

Our state-of-the-art will review two elements which are the foundation of our object of study: link between actors of world politics and their adaptation to technological changes, in particular International Organization, and their reaction to technological changes through innovation policy, and in particular the Industrial policy.

To propose an interesting analysis of phenomenon of the link between innovation and international relations, a specific definition of technology have to be used, which is to understand technology, as Robert Cox[216] highlight, as a social construct, which have meaning inside the social realm of world politics, and which development is endogenous to this social realm. This thesis aimed at developing and analyzing what can be the role of international organizations in this dialectic where technology and world politics influence each other. Two authors are important to study this phenomenon. Firstly, Ruggie[217] proposed a detailed analysis of how technology is socially constructed and allow to transform natural issues into political one, how they create pattern of interdependence among states. Such patterns of interdependence, in turn, establish international regimes, and the way these patterns institutionalized collective responses help us to understand how they are framed into International Organizations inside the political space of those regime. However, Ruggie approach do not offer the second step needed to complete our dialectic, and do not see how International Organizations shape in return technological changes. Secondly, Skolnikoff[218] proposed a more detailed analysis on the consequences that technologies carried upon actors and policies of the world governance, and in the way, technologies have change how actors perceive and do their tasks as well as the retroactive effects those can have upon technological changes itself. However, Skolnikoff do not proposes an analytical framework which allow us to consider the role of International Organizations in this process, since that for him only states are relevant actors of this dialectic.

We have consequently to explore the tools and the modalities of action through which they affect technological change. As Archibugi, Michie and Howells[219] describe, such public policy target essentially the structure of a System of Innovation. The European Union implemented an innovation polity which has shift toward the universe of Industrial Policy. Indeed, the recent development of the literature on the Theory of Industrial Policy increasingly view this policy tools outside of its 20th century "pick the winner" or market-failure mitigation devices paradigm. Increasingly, industrial policy is analyzed and understand as an instrument of innovation policy, since it targets principally technological progress, the development of economies of scale by productivity upgrades, and the enhancement of the knowledge infrastructure.

[216] Cox R. (1987) *Production, Power and World Order: Social Forces in the Making of History,* Columbia University Press, New-York, p. 500

[217] Ruggie, J G. (1975) "international Response to Technology: Concepts and Trends", *International Organization,* vol 29, n°3, pp. 557-583.

[218] Skolnikoff, E. (1993) "Practical Problems of Governance: Institutions and Processes", in *The Elusive Transformation: Science, Technology and the Evolution of International Politics,* Princeton University Press, Princeton, pp. 202-2019.

[219] Archibugi, D., Michie, J., Lockwhood Howells, J. R. (1999) "Innovation Policy in a Globalized Economy", *Technology Analysis & Strategic Management,* vol 11, n°4, pp. 527-539.

Consequently, the EU industrial policy have been characterized by innovation objectives, and several authors tried to develop framework to analyze the contour of this international public policy. Zourek[220] distinguished the goal to improve horizontal framework conditions, enhance sectoral framework conditions, and to develop sectoral specific conditions. Aiginger and Sieber[221], on the other hand, integrated all those public policy into a comprehensive one they call "matrix approach" of industrial policy, since for them horizontal and sectoral approaches cannot be dissociated from each other. Finally, for Pellegrim[222] et al., they develop the idea of "platform model of industrial policy", framing the matrix approach into the multistakeholder and multilevel governance giving a meaning and a purpose to industrial policy. However, we need to elaborate a reflexive approach to the institutionalization of platform model of industrial policy. Like technological change and globalization, Industrial Policy, understood as an answer to those phenomena, is socially construct. Its definition of scope, scale, actors, and objectives are merely impossible to define objectively, and depend on the context in which it flourishes. Thus, the institutionalization of a European Industrial Policy is framed by the as an answer to globalization challenge, which tried to be overcome by technological upgrades.

We categorize the European Industrial Policy through the concept of "Multilateral Industrial Politics". Such notion is supposed to combine the multi-level and multi-stakeholder substance of the European Industrial Politics, as well as the dynamic and reflexive nature of that have shaped these policies throughout history. Furthermore, we will acknowledge that such policy consists not only of providing platform where actors confront their interest and definition of the situation but is fundamentally a reorientation, in the first decades of the 21st century, of the technology policy of the EU toward industrial objectives in order to enhance the actorness of the European Union vis-à-vis technological change and world politics. Multilateral Industrial Politics is a crystallization the dialectic transformation brought by innovation and globalization, it is a product and a producer of transformation in technological and international realm.

3. Historical Dynamic: The path toward a European Multilateral Industrial Politics.

The Multilateral Industrial Policy of the EU of the 2000's is critically important for our study of the 5G Infrastructure Public Private Partnership. Indeed, the 5G PPP is an institution of the multilateral industrial policy, and an investigation of the historical path that led toward the development of this paradigm inform us with the way the EU institutionalized policy for the development of the technologies of the 4th industrial policy enabling to foster both the productivity of the European economy and to develop and complete the digital single market. Indeed, the 5G Public Private Partnership cannot be seen as a natural answer to innovation nor

[220] Zourek, H. (2007) "The European Commission's New Industrial Policy in an Integrating and Globalizing World", J Ind Compet Trade, n°7, 285-295.
[221] Aiginger, K. and Sieber, S., "The matrix approach to industrial policy," International Review of Applied Economics, vol. 20, no. 5, pp. 573–603, 2006.
[222] Pellegrim, J. Giorgetti, M. L. Jensen, C. Bolognini, A. (2015) "EU Industrial Policy : Assessement of Recent Developments and Recommendations for Future Policies", Study for the ITRE Committee, European Parliament, Brussels.

globalization, it is the fruit of a specific vision of those phenomena, build upon specific resource with a specific legitimacy and a specific purpose, and those cannot be extract from historical contingency.

The early years of the history of the European Industrial policy was not *per* se dedicated to technological innovations. The treaty establishing the ECSC was the first European institution instituting a binding supranational authority regarding industrial matters, but it did not affect the establishment of a European wide System of Innovation. The same way for EURATOM, which only create a supernational structure for innovation in nuclear civil activity with relatively low level of integration, and the treaty of Rome did not include any article regarding the role of the EU for industrial matters. In the 1960's and 1970's, however, there was both an inclination to converge towards a Common European industrial policy at the institutional level as well as an intellectual attractiveness for such concept, link with the development of international competition, especially from the United States. Several attempts were proposed by member states and EEC officials to enhance the development of a European wide sector oriented industrial policy. This approach did not find any institutional reality due to a triple structural problematic at the level of member states: a divergence linked with the economic model to implement; a divergence of position vis-à-vis the role of European Institutions, and a divergence linked with the states that should be included in such policy.

With the decline of Keynesian-like interventionist economic policy paradigm around the world throughout the 1970's, associated with a general decline of the share of manufacturing in the economy of developed nation as well as the development of neoliberal approach to economic policy, the European Industrial Politics left its sectoral approach for an horizonal one, more focus to develop a sound environment to help the development of Industrial Actor. Such horizontal approach gradually took gained substance throughout the 1980's and 1990's, where EU actors implemented both a competition-oriented economic policy aiming at developing a true competitive single market, highlighted by the implementation of the European Single Market, as well as a coordinated technology policy, aiming at promoting cooperation and coordination of research and development at a precompetitive stage of production, as the implementation of the first Framework Programme, inspired by the Japanese industrial program of the MITI. This step has need to be understood as foundational for the development of the multilateral industrial policy, because such paradigm developed upon this neoclassical period which both implemented the legal framework upon which will be based the industrial renaissance of the EU and the System of Innovation that this industrial renaissance will aim at enhancing.

Indeed, the Lisbon Strategy, based on a renewal interest from political and economic sciences field, adapt the tools and frameworks of the neoclassical industrial policy of the previous period to adapt them to new challenges, without totally abrogated them. The context of "manufacturing renaissance" in the 2000's, actors had to rethink how the EU could approach industrial policy through a what we have described as a multilateral industrial policy, which will allow to handle both the pressure of globalization and to catch up technological backwardness. On one hand, instrument of the EU research and technology policy has been reoriented to make them suites the need of technology intensive sectors though the creation of platform

allowing the communication and cooperation among stakeholders and to channel finances and knowledge, such as the European Technology Platform and the European Research Area. Furthermore, we observe a dramatic increase in budget allocated to Framework Programme, from € 16.3 billion invested in the 6th Framework Programme (2002-2006) to € 50.5 billion in the 7th Framework Programme (2017-2013). The Framework Programme see, in addition to its spectacular budget growth, also saw the development of several Public Private Partnership with Industrial Private Actors.

We understand that the institutionalization of the multilateral industrial policy in the 2000's path the way for its development in the 2010's in which the 5G Infrastructure Public Private Partnership flourished. This historical investigation brings us naturally toward theoretical and methodological question that will have to be consider in our study of the 5G PPP and the application of the multilateral industrial policy applied for the development of technology of the 4th industrial revolution. To seize both the reflexive answer to the dialectic between globalization and innovation that this policy crystalizes, as well as the historical trajectory from which this policy is developed, we need to turn our look toward the Historical Institutionalism approach in Political Sciences to study the 5G PPP as an institution of the multilateral industrial policy.

4. Historical Institutionalism as a paradigm to study the multilateral industrial policy for 5G in Europe.

Those two preliminary studies are essential to understand and to analyze the 5G PPP. Indeed, such analysis require to catch both the way Social and Political Sciences had framed the dialectical relation between innovation and globalization, and also to understand how the European Union institutionalize public policy to mitigate and act upon this dialectic. An inquiry of Historical Institutionalist approach will provide us tool to seize better how the 5G PPP illustrate the supranationalization of industrial politics as an answer to innovation and globalization challenge, and how actors and their reflexivity have built this artefact of the multilateral industrial policy.

This new industrial policy is an adaptation of the already implemented technology policy and competition-oriented industrial policy of the 1980's and 1990's. Its definition is less oriented toward mercantilist or protectionist objectives, and more focus in public-private strategic coordination in order to implement structural adjustment process that would have an effect not only on the economic growth and competitiveness, but which will also have an impact on social and civil development through technical progress. This shift has been possible because of a specific interpretation of the challenges that brought World politics (i.e. Europe is not competitive enough to face and gain from the global market), and a specific interpretation of the way technological upgrade can bring solution to this challenges (by improving Europe's technological endowment, the single market will be able to transform globalization challenges into opportunities). The development and implementation of the 5G PPP, studied as an outcome of the trajectory of the 2000's paradigm regarding the role of the EU in industrial policy. We the Lisbon strategy already path the way for a soft multilateral industrial policy. If this paradigm did not produce major effect in the 2000's,

new structural challenges will give a new impulse: the 2007-2008 economic and financial crisis. This crisis is a moment of critical juncture, reinforcing the fear of European actors to be marginalized by the global market, and the increasing deindustrialization of Europe was seen as a catalyzer of the crisis in the single market. Because the 5G Mobile technology is a key technology to develop a new paradigm of industrial economy (it is an essential element of the Internet of Things, but not only), and because the prospect of this technology was promoted as provider of economic growth, technological upgrades, employment etc., and because the world was starting a race to develop and implement this technology, the EU created, through the 8th Framework Programme, Horizon 2020, a public-private partnership in order to develop a platform to discuss and implement horizontal and structural policies which will favor the development of the 5G.

To study such institutionalization of the 5G PPP, we will use the toolbox of the actor-centric historical institutionalist approach to study supranationalism phenomena. Büthe[223] explain this idea with this formulation: the agent centric historical institutionalism describes supranationalism as the process in which the political authority and consequential decisions are made above the level of nation-state. Indeed, such paradigm allow us to frame the path dependance dynamic of the institutionalization of multilateral industrial policy and its application for 5G deployment, and the strategy and idea that actors deployed to support such institutionalization. The market oriented economic policy paradigm elaborated in the 1980's-1990's creates a political space in which the debate over industrial policy should focus on market failure, which will be mitigated by horizontal policy in order to avoid government failure. Structural challenge, brought by change in the political economy of globalization, challenge the hegemony of actors promoting the neoclassical approach, and give more voice and legitimacy to the tenants of a structural approach of industrial policy. From this statement, several theoretical rules can be extrapolate: 1) The institutional position of the supranational bodies alters their fundamental interests and transform their role and identity; 2) The role of the member states is to provide the legal framework of such supranational institution via international treaties; 3) Supranational organizations influence the work of international public officials which will have interest to promote the agenda of the supranational organization; 4) National and transnational private actors are important agent of changes and enhancer of supranationalism because it creates opportunities for those actors to gains resources, legitimacy or to promote their views in an environment less institutionalized and more malleable than nation-states.

This part of our thesis allows us to frame the methodological contour of our Historical Institutionalist study of the 5G PPP by framing it as an institutionalization of Multilateral Industrial Policy in the EU. The development and implementation of the 5G PPP will be study as an outcome of the trajectory of the 2000's paradigm regarding the role of the EU in industrial policy. Because the 5G Mobile technology is a key technology to develop this paradigm of industrial economy (it is an essential element of the Internet of Things, but not only), and because the prospect of this technology was promoted as provider of economic growth,

[223] Büthe, T. (2016) "supranationalism", in Fioretos, O. Falleti, T.G. Sheingate (eds.) *The Oxford Handbook of Historical Institutionalism*, Oxford University Press, Oxford.

technological upgrades, employment etc., and because the world was starting a race to develop and implement this technology, the EU created, through the 8th Framework Programme, Horizon 2020, a public-private partnership in order to develop a platform to discuss and implement horizontal and structural policies which will favor the development of the 5G. The actor-centric approach developed by Büthe helps us how historical institutionalism can develop a framework to understand and analyze the implementation of 5G PPP as being the competitive ideas and bargaining between actors of the ICT industry and the European Commission for the implementation of multilateral industrial policy for the deployment of 5G. An agent-centric historical institutionalist analysis of the 5G PPP requires to hence identify the key stakeholders and determine the interests that such actors are likely to pursue, then theorize how those actors, their interests, and the way in which they pursue those interests will be affected by the opportunities and constraints of the broader institutional configuration and by institutional feedback.

5. 5G PPP. Analysis of the implementation of a multilateral industrial policy of the 21st century.

The development of the 5G PPP came from a critical juncture which find its source from the interpretation of the effect and the answer to bring to the aftermath of the financial crisis in the beginning of the 2010's. The "European 2020" communication of the European Commission, and its flagship associated illustrates that actors of the European Commission want to use the opportunity of the reorganization of the economic policy of the EU to further the supranationalization of the Industrial Policy in order to face the consequences of the crisis and of the global competition. Hence, the actors of the European Commission aimed used the tools and frameworks of the Research and Development Policy to provide a legal framework to catalyze finance to strengthen the ICT industry, as well as to develop an integrated System of Innovation in the sector of advance digital technologies.

In this context, promotors of this supranationalization of the ICT industrial policy develop an apolitical argument: the development of an integrated approach for the development an innovation policy for digital technology is described as being a logical answer to pressure of the globalization. Here, the European Union is more than a norm provider in the technological field. It uses its power and resources to fixe meaning to the challenge well as the political answer that need to be implemented in order to overcome this challenge. We understand that we are facing supranationalization of the ICT industrial policy: the EU gradually fixed the orientation and the instrument of the policy to be implemented, and the ICT industrial policy is gradually shifted from a Nation-State problematic toward a European one. This strategy was further developed by the "Digital Agenda for Europe" establishing a long-term goal to use internet and digital economy to foster EU economy and to tackle key problematic that the financial crisis has highlighted. The Digital Agenda have developed a vision regarding industrial objective in the ICT sector targeting in a holistic way the competitiveness of the digital single market as an enhancer of the competitiveness of the EU as a whole. The Communication "An integrated Industrial policy for the globalization Era, Putting Competitiveness and

Sustainability at the Center State" directly connect the problem and challenge brought by globalization and digital technology.

In this context, the development of an EU multilateral industrial policy for the 5G technology start to emerge. Actor of the European ICT industry and the EU Commission gather and negotiated about the contour of such policy in different business forum, the Competitiveness Week, and the Mobile World Congress in particular. We can observe that during those events, private actors deploy a strategy to enhance their position by framing and providing technical answer and solution to the problematic they see as relevant to them. This strategy aimed at defining and promoting their understanding of the situation, and what policy should be implemented to develop the innovations needed for the EU to answer those challenges. The temporality of those event was crucial since multilateral industrial policy for the promotion of a European 5G was clearly framed within the 8th Framework Program for Research and Technological Development. During these events, private actors developed their proposition for horizontal and vertical industrial policy that the EU commission could implement in order to strengthen their position in the ICT global market. The ICT industry developed a specific vision of a multilateral industrial policy which sustain the development of European System of Innovation that they characterize though the lens of "smart specialization": horizontal and sectoral industrial policy should be implemented to allow the private sector to flourish and be more resilient in front of the global market, but those the target of those policy is the development of a research and development network among actors of the ICT knowledge value chains.

The call from Vice President of the EU Commission Neelie Kroes at the Mobile World Congress of Barcelona in 2013 highlight the multilateral development of this EU industrial policy for the development of ICT technology, since she takes back the proposition developed by private actors, as well as their concerns and proposition to foster the ICT sector. Consequently, this System of Innovation for 5G was though as an institutionalization of vision of a smart specialization developed by the private sector, articulated around the political objectives of the EU Commission actors. A business association were implemented in order drive the voice of the private sector in the discussion related to the creation of this partnership during the year 2013, and the European Commission informed the Net!Works European Technology Platform (ETP) and industries about its agreement for the formal creation with a partnership between industrial actors and the European Commission. Consequently, the development of the Horizon 2020 Framework Programme was also use as an instrument to foster this multilateral industrial policy for the development of an integrated System of innovation for ICT sector.

The main instrument for the development of this policy is the use of a public private partnership among industrial and EU actors, a statue that the regulation establishing the Horizon 2020 FP clarify. The implementation of the 5G PPP is consequently defined by the objective and the scope of this status, which was accepted by 5G Infrastructure Association, corresponding to the private branch of the 5G PPP. The document "Creating a Smart and Ubiquitous Network for the Future Internet" and its annexes develop further the purposes, the actors, and the governance model of the 5G PPP. The purpose of the 5G PPP is developed

through objective indicators which will be monitored by the European Commission and implemented by the private side of the partnership but embedded within the overall vision that Europe should find back its strategical leadership in ICT industries. This policy, aiming as institutionliazing a European System of Innovation for 5G, include different stakeholders from the ICT industry which should be organized in a way allowing all private actor to raise their voice, which is translate in the governance model of the Partnership. Another institution, the Networld2020 ETP, will gather scientific network from both public and private sphere in order to develop roadmap and Strategic Research and Innovation Agenda for 5G.

We understand here that the institutional position of the European Union alters its fundamental interests and strategy, hence converting its approach to industrial policy from a soft multilateral industrial policy, as implemented by the Lisbon Strategy, toward a more active one as the Horizon 2020 strategy highlight. This allow us to observe a change of the EU approach toward technological change, from a position where it is solely a knowledge broker toward the implementation of policy tools developing its ability to be a knowledge creator. We can even develop the argument that, for the ICT industrial policy, the EU bypasses the will of member states, since their approbation of the project of implementing a multilateral industrial policy for the 5G intervene only when the Horizon Framework Programme were approved by the European Union Council. Hence, the EU and the ICT industry were the most relevant actors of the implementation of the 5G PPP, and Member States as a marginal role in the policy design of this institutions. Furthermore, we understand that the role of transnational network of private actors are a major driver of the institutionalization of the 5G PPP policy, as the theory of Büthe have showed.

6. The 5G PPP in the 8th Framework Programme: Institutional Transformation, and adaption of a European Industrial Policy for the 4th industrial revolution and the digital single market.

5G PPP annual journal of 2016 published in October 2016 summarize well the development of the institution between 2014 and 2017. It starts by summarizing the work already achieve and the need to further the implementation of the 5G research and development apparatus in Europe, to complete the digital single market strategy but also to trigger innovations in verticals industries and leverage societal changes and growth targeted by the Horizon 2020 framework program. The most important challenge of the 5G PPP being the implementation of the 5G infrastructure at the horizon 2020, the 5G PPP have to implement the groundwork based on the need and expectation of industries to create the good environment for such rollout until then. For this outcome, the 5GPPP highlighted ten results and success, which concerns mostly international and European level standardization work of the European Commission with the technical expertise from the 5G IA and other private stakeholders (a memorandum of understanding being signed by the 5GPPP and 5G America, the Chinese IMT-2020, the Japanese 5GMF and the Korean 5G Forum regarding standards, future 5G ecosystem growth, as well as the organization of a biannual “Global 5G Events”). The first years of the 5G PPP was crucial and help us to understand the evolution of strategy of actors for the development of a 5G Public Private Partnership which suits their interests and their understanding of globalization and innovation.

The development of the 5G PPP in its early years of its implementation see competition and negotiation among major component of its institutional design to further their definition of the situation and the policy tools associated to it. Indeed, the formal implementation of the 5G PPP, actors developed their vision of the policy, such in function of purely technical problematics, but also in function of their interests. The Networld2020 ETP is an interesting case, because it is a network bringing both actors from the private sector and from the public sphere and is focused on scientific and technical development. Hence, the issue at stake for this organization is to maintain its relevance, which require to develop objective progress in the field of 5G technologies and scientific knowledge associated to the ICT world. This network of actor can hence act as a counterbalance between the position of the 5G Infrastructure Association, a cluster of Industrial Private actors which can have a vision purely frame by capitalist objectives, and the European Commission, a public organization which do not have necessarily the technical knowledge and is drive by political objective (as we saw, drove by the external challenge of globalization and the internal challenge of fragmentation of the single market). Consequently, during the first two years of the phase 1 of the 5G PPP, the Networld2020 ETP depicted a technocratic and science-oriented vision of the 5G PPP.

On the other hand, the 5G Infrastructure Association depicted a vision of the 5G PPP in a more business-oriented fashion. More focused on the evolution of demand of ICT products and the supply problematic which need to be overcome accordingly, the 5G IA emphasize the changes that 5G technology will bring in the economy of Europe in the way it will blur the line between traditional and digital economy. Furthermore, the 5G IA started to develop its network in order to integrated other sector of the economy which could benefit from the deployment of the 5G infrastructure technology, as the declaration at the 2015 Mobile World Congress depicted. It is interesting to note that the deployment of transnational private networks through those international industrial events for the 5G technology allow the 5G IA to gain in importance and in relevance. This strategical diffusion of the ties of the 5G IA are justified by societal developments: for instance, the link between the ICT industry and the Manufacturing will promote the productivity of Europe; the link with energy industry will develop a more energy efficient consumption of society; the link with health industry will allow to enhance healthcare and wellbeing of Europeans.

It is consequently a symbiosis of the vision of the Networld2020 ETP and the 5G Infrastructure Association that the European Commission implemented through the phase 1 of the 5G PPP, since both the vision of the ETP and the business association were compatible together, but also compatible with the political objectives of the European Commission. The 19 projects were selected for their ability to address research challenges leading to a 5G infrastructure rollout by 2020. They are depicted as a project able to respond in a holistic way to technical challenges while addressing the needs of horizontal industries that could benefit from the 5G deployment. More than being business and private oriented, the view on technological progress and innovations are oriented toward the definition of a new model of capitalism and the development of a truly connected society. This vision is enhanced by the Digital Single Market Strategy of the EU Commission. In order to achieve this technological uprising that the 5G network technology would allow, the actors of the 5G

PPP orchestrated a System of Innovation gathering privates and public stakeholders to achieve the technical requirement which would allow the implementation a wider digital single market, and the development of business through the development of digital economy.

After the adoption the "Toward a Digital Single Market Act", which gave a legal statue to the strategy implemented by the European Commission, its involvement in the 5G PPP were more active. Indeed, it was more and more recognized that the involvement of the European Commission was central in certain topics related to the activity of the 5G PPP, such as the development of next generation infrastructure in remote area or the implementation of a critical mass of experimental facilities. On the side of the private sector, the "5G Manifesto for timely deployed 5G in Europe" produced by the 5G IA can be seen as a strengthening of the strategy of the private side of the 5G PPP to enhance the involvement of actors of other vertical industries, in reaction of the increasing involvement of the European Commission. This manifesto also aimed at developing a vision of the System of Innovation sustained by the 5G PPP in a business-oriented fashion, but also to enhance the horizontal integration of other segment of the European economy in the innovation infrastructure produced by the 5G PPP. The call from the 5G IA for the development of an ecosystem involving other vertical industries under its umbrella, in order to develop and implement standard, financial instrument and research and development facilities participate to the development of the influence of the private side of the 5G PPP. To take back the vocabulary of Mahoney and Thelen[224], we can observe a strategy of layering from the side of the European Commission, and a strategy of drift from side of the 5G IA. Indeed, the European Commission create new rules for the development of the digital single market and for the industrial development of the ICT sectors which will be superposed to the previous one, still implemented within the 5G PPP, which will give new substance and objective that this institution would have to perform. On the other hand, the 5G IA aimed at using the resource it already possesses, but with the aimed at applying them through a greater number of industries and actors in order to gains new possibilities and new relevance.

The different communication from the European Commission highlights consequently a symbiosis between the vision of the 5G PPP developed its public and private side regarding both the digitalization of European industries, the development of the digital single market and the 5G Action plan which sustain both those objectives to position the EU in the global race for competitiveness.

7. 5G PPP Phase 2 and 3: from optimization until large scale trials in the last years of the Horizon 2020 Framework Programme.

The institutional changes and adaptation that the 5G PPP were facing during the period 2017-2020 are linked to the promotion of idea and strategy of both the public and the private sector in the definition of challenge and opportunity within the Phase 1, 2 and 3 of the PPP. The 5G IA proposed the implementation of a roadmap to promote the global leadership of Europe regarding the 5G technology, network deployment and

[224] Mahoney, J. Thelen, K. (2010). "A Theory of Gradual Institutional Change." In *Explaining Institutional Change: Ambiguity, Agency, and Power*, ed. James Mahoney and Kathleen Thelen. New York: Cambridge University Press, 1–37

business model as well as to enhance the 5G Action Plan while emphasizing on the business exploitation of the 5G infrastructure. Indeed, for this organization, the main challenge, and uncertainties that 5G technology ecosystem face is related to the way Network Service Providers integrate 5G in their business. Indeed, it is the coordination and the distribution of responsibilities and benefits among a large number of stakeholders that have to be defined as a priority for the 5G IA within the framework of the 5G PPP. This organization advocated to the implementation of a "holistic orchestration platform" which would coop with this coordination problematic, allowing the distribution of responsibilities. In matter connected with cybersecurity and network resilience the 5G IA advocate for an "autonomic network management", i.e. the segmentation of the network in order to contain threats and enable trust among stakeholders, but implemented by private actors as being a commercial service.

On the side of the European Commission, effort was put to find technic of evaluation of the impact of the 5G PPP (and, hence, the activities of the 5G IA within it) regarding the evolution and implementation of research and development for 5G, which gain more and more importance in the eyes of European policy makers. Since internet has become a major driver of the development of System of Innovation, enabling the spreading of information among a large number of stakeholders, its development within the framework of the digital single market should consequently be a major component of the European Industrial policy, which should have enough tools to mitigate the development of its infrastructure by private actors. Here, the 5G infrastructure technology is positioned as a central feature of the development of the internet of the future. Hence, the 5G PPP initiative crystalizes the development of the 5G as being not only a driver for the development of the ICT sector, but also as being a strategic industrial device promoting the development of the economy as a whole. Consequently, the development of evaluation methods and process, able to mitigate the development of 5G research and development through different qualitative and quantitative instrument, such as Operating, Performance, and Technical Key Performance Indicators, and a sequencing of their development by an analyze of their inputs, outputs, outcomes, and impact, become a critical matter to ensure the sound deployment of such technology.

We understand that the development of the institutionalization of the 5G PPP is the fruit of conflicting interests among the European Commission and the 5G Infrastructure association, but also by a cooperation and coordination which allow the production and implementation of research and technological development of a European 5G. We assist consequently within the phase 2 and 3 of the 5G PPP to a specific institutionalization of a System of Innovation where the division of labor between the public and private actors in which the 5G IA have the upper hand regards to *what* to experiment (what technology, for what sector and for what wider economic outcome) and the European Commission have the upper hand on the *how* (how to assess the development of the experimentation, how should they be financed, how it is integrated to the wider strategy the EU is developing to face globalization). In addition, the EU commission also review the global objectives and the long-term strategy the 5G PPP projects need to follow, creating for this purpose a new organization within the broad 5G PPP infrastructure: the 5G Observatory. By the implementation of this new

organ of the 5G PPP, the European Commission ambition to regains specific control over the development and activity of the Partnership, in which the 5G IA have gain great significant since it catalyzes the position of the ICT, but also other vertical industries interested in the deployment of this technology.

The completion of the phases 1, 2 and 3 help us to address the concrete problematic that the institution has implemented throughout the horizon 2020 framework program. The phase 2 highlight the increasing participation of vertical industries' concern and demands, channeled by the 5G IA. For instance, the "Initiative 5G Car" enable actors both of the ICT industry and Automotive industry to raise technical question and establish standards to develop the implementation of the 5G technology for connected cars, but it also helps developing specific business model, as the approach based on the lowering of the technology costs thanks to digital economy, and help gather all the need and demand of the private sector in order to raise their voice and enter in contact with the public authority, in our case the European Commission. The phase 3, focused on large scale trials, allowed actors of the 5G IA to develop roadmaps which seek to put the organization in the position of knowledge broker for research and development and large-scale trials regarding 5G applications to vertical industries. This position is coupled with a specific ability of the 5G IA to represent its interest in International Business Meeting (the Global 5G event in Seoul and in Austin, the Mobile World Congress in Barcelona etc.) in order to develop a private diplomacy with other global actors of the 5G race. The 5G IA sign Memorendum of Understanding on the behalf of the 5G PPP regarding international standardization and knowledge sharing among countries and help the development of international cooperation and the establishment of a global consensus for 5G technology. The implementation of the phase 3 large scale trials was market by a huge effort in technological improvement and in research and development, and the deployment of the first network in some European cities. Regarding the effort of the 5G IA, the strategy it deploys during this 3rd Phase also include the development of partnership with other public organizations to improve its relevance and its influence, as the example of the partnership signed with the European Cyber Security Organization, the Alliance for Internet of Things Innovation or the European Space Agency highlight.

The implementation of the European Electronic Communications Code in 2018 is implement rules regarding broadband access infrastructures – including the 5G infrastructure network – which constitute the backbone and the foundation allowing the development Digital single market, and provide a legal authority of the multilateral industrial policy in the way it establishes that ICT networks management should be based by Public and Private Partnership officializing the multistakeholder and multitenant natures of the governance of those technologies, an approach experiment thanks to the 5G PPP. Furthermore, this directive officialize the effort of the European Commission to monitor reviews and evaluation progress of implementation of standard, infrastructure and assessment regarding 5G technology vis-à-vis Key Performance Indicator and establishes that member states application of 5G technology in vertical industries as well as other service using 5G radio equipment should reflect the principles of the internal market. Consequently, the EECC implement the authority of the European Commission for the rules of deployment of the 5G technology and the rules of utilization of this technology. In addition, the EU Commission attributes itself, through the Radio Spectrum

Policy Group, the role to monitor problem linked to attribution of 5G radio spectrum system when different member states face this particular problem simultaneously.

8. Conclusion.

We understand that the two organization, the 5G IA and the European Commission, pursue their strategy and mode of actions to implement institutional change that was already developed in the first years of the 5G PPP: the 5G IA implement a strategy of drift: the development of its network toward new actors which allow it to develop and enhance the influence of its vision of the 5G technology, toward vertical industrial actors, but also toward other agencies of the European Union and its System of Innovation. On the other hand, the European Commission still develop a strategy of layering: it develops new rules, especially regarding the evaluation of the performance and development of the activity of the private sector vis-à-vis 5G objectives and roadmap, and its ability to implement new directives which will give new meaning and value to the rules it aimed at implementing. The phase 1, 2 and 3 of the 5G PPP highlight the change of attitude vis-à-vis globalization: from the challenge vision developed between 2010 and 2016, globalization, and innovation become increasingly an opportunity which will allow to stimulate de development of the digital single market and the 4th industrial revolution. We assist to the competition of an institutionalization of political space above nations regarding ICT new technologies and their development. The 5G PPP is an institution which gradually influences the actions of actors both at national and supranational level since it framed new opportunities for R&D, standards, finance, and international representation, and new interpretation of ideas and situations regarding the state of the European System of Innovation and global competition which challenges it. The 5G PPP has consequently the feature of a political space which internationalize the object of strategic actions of ICT actors and European Commission and catalyze new sources of legitimacy for the development of new generation of internet infrastructure.

To conclude, we understand that the 5G PPP shows that the European Research and Technology Policy and the European Competition Policy are becoming more oriented toward Industrial objectives, embodied in a paradigm we have defined as “multilateral industrial policy”. This reorientation has been driven by a specific interpretation of the global position of the EU in the 2010’s, which has triggered the reimagination of the involvement of the EU regarding industrial objectives, making the 5G deployment a strategic objective to both endow the EU with a technology of the 4th industrial revolution and of the development of the digital single market. This industrial policy has been defined by interaction, confrontation, and negotiation of actors from the ICT industry and the European Commission which have help the development of a Multilateral Industrial Policy developing a European System of Innovation above nation-states. Their ideas and strategies have been structural element of the institutional adjustment and stabilization throughout the 2010’s and have developed a specific division of labor between the private and the public side of this partnership. The 5G PPP have then to be understood with the feature of an Industrial Politics above nations-states to enforce actorness of an International Organization in the global politics and in the production of innovation. This study shows that, by

putting international public policy in their historical context, and the understanding of the cognitive universe and strategy of actors political and economic sciences, we can seize an essential aspect of the late development of World Politics: the ability of international organization to get involves in the production of innovation. Our study, guided by the Historical Institutionalist paradigm, aimed at bringing the strategy of actors in the historical context of this late development in world policy. Technological changes matter if we want to seize the dynamic of international relations and globalization. International Organizations matter if we want to apprehend how technological change reorganize the production of knowledge and innovation and its potential supranational trends. International Industrial Policy matter if we want to understand how International Public Policy have a positive and extensive role in the organization of System of Innovation above states. In a world were systemic problems, such as climate change, pandemic outbreaks, global poverty alleviation, the digitalization of societies etc. will require bold policy to further innovation and technological ability to coop with such challenge, it is important to understand the ability of all actors of the World Society to develop and enhance those solutions.