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The application of blockchain technology in the programmatic advertisement ecosystem

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Programmatic Advertisement and BladTech

1.1 Programmatic Advertisement

Programmatic advertising defines the process of buying and selling online advertising automatically by combinations of technology and audience data, which allows brands to deliver personalized online ads to the right target audience at scale [1].
Programmatic marketing is based on two fundamental elements:

- The possibility for advertisers to extract and elaborate user's data to real-time targeting advertising campaigns.
- The automated process of selling and buying ad spaces through suitable platforms.

The process is data-driven because data are leveraged in all steps of the advertising process and it also requires a balanced combination between system automation and digital specialists involvement to be effective and work at best.
Automation increases efficiency and allows for a more effective strategy. It creates an opportunity to streamline online advertising efforts and keep everything under one roof [2].

1.2 Background

Before programmatic marketing, ad space was bought and sold by humans instead of machines. The process was slow and inefficient, taking RFPs, meetings, and negotiations before an advertisement could be manually published.
Traditionally, media planners allocated budgets across vary and different media channels both online and offline in the so called 'Direct Sales' mechanism, which is completely manual.

It involved a hard and long process constituted by great human effort with the aim of satisfying client needs, making negotiations, and back-and-forth communication.
The traditional model of buying ads can involve large costs and time spent by organizations and, at the same time, there is a high chance of encountering and dealing with human error.
In direct selling, impressions are sold to customers who are willing to have their ads seen in a specific context, such as on a website or platforms like Facebook.
Under the classic model, packages of advertising inventory were sold to customers at a predetermined price or a fixed CPM rate - 'Click per Month Rate' is one of the most widely used pricing models in digital advertising today - and then placed in the advertising space in the immediate future.
The main characteristic of direct sale is the assurance, which means that the advertiser is guaranteed to be displayed in the publisher space and at the same time the advertiser is guaranteeing inventory for clients. The parties, in this sense, make stable and predictable contract because the pay exchange is known ahead of time, and advertisers are basically paying for the certainty that ads are being delivered to specific audiences [3].
In this context, the advertisers and companies can have a broad control and security about the placement of their ads. Big and medium organizations could be prone to paid higher prices in order to display their ads on premium sites.

1.3 Evolution of Digital Marketing

The world in the last 20 years drastically changed. Social Network like Facebook, Twitter and Instagram entered into people's everyday life. Smartphone helped the evolution of social, with easy and fast access to the internet.
With the advent of the Internet, the world of advertising has shifted completely and organizations have had to adapt their approach to digital marketing.
At the beginning of the web, online publishers and premium advertisers such as newspapers and blogs and then content distributors based their advertisement business model on paid subscription. In few years the technological development opened doors for the exploit of social media which changed the paid subscription model into advertising data-based business models.
The old model was not a tenable business option and, from that point on, the development of the web content has been inherently linked to the development of the digital advertising industry, therefore to its dynamics and technological evolution.
The whole obsolete chain has been substituted by Programmatic Advertising (PA), which consists in an intensive and productive use of data, technologies and artificial intelligence in marketing with the common goal of boosting marketing efficiency in real time.
Programmatic sales use algorithms to purchase ads. The nascent technology have reduced the communication and interaction between parties in the ecosystem, which means that the entire

process is carried out by artificial intelligence.
The manual process is replaced by machines giving lot of benefit if compared to the traditional model. PA saves time and money for organizations and companies, moreover, the human error is drastically reduced. Since the process is faster than ever, many of the components of a campaign, such as reporting and optimization, can be tended to almost immediately.
Programmatic differs from the old system in the way each impression are taken, profiled and evaluated in the nanoseconds it takes for a page to load. Simultaneously with the loading of the wed page, an auction takes place, and the highest bidder is chosen to place their advertisement in the available space. In direct selling, advertisers only pay for the place where their ads appear, while in programmatic, advertisers bid for their targeted audience. [3].
The first banner has been published by Global Network Navigator in 1993 for a lawyer society, and from that moment, the digital advertising industry constantly evolved driven by the continuous technological development [4].

Fig.1 - First banner displayed by GNN in 1993

1.4 PA Principals

PA is a data-driven technology that has played a crucial role as a game-changer in the digital world in just a few years.
It is the result of a combination of different technological developments that have enabled adequate performance and better results and have provided market access in new and unexplored areas. The main factors that contributed to this growth can be resumed in:

- Massive computing power: The Artificial Intelligence development and innovative algorithms permits that data can be analyzed and processed in few milliseconds.
- Inexpensive data storage: Billions of data are generated each day all over the world.

Recent IT infrastructures insure that the great part of anonymous data can be re-used to forecast other campaigns.

- Science: Marketers and experts, exchanged and mixed knowledge with mathematicians and quantum physicists. This joint work created new applications.
- Stock exchange structures for ad space: Real-time supply and individual ad impression opportunity make markets more dynamic.
- Globalization of advertising markets: Standardization and global infrastructure.
- Customization: Logins and permissions enable dialogues to be conducted across multiple devices.

PA cannot be defined as an isolated discipline or marketing instrument within the organization, but instead it includes multiple grounds and knowledge area with the aim of reduce complexity and reach substantial business development goals.
Ads creation, trading and data information have to be exchanged in real time in order to guarantee the best performance which means that real-time interactions are fundamental and essential features of the rising technology.
The famous marketer Oliver Busch of the interactive advertising bureau IAB descried PA as:

"...an automated serving of digital ads in real time based on individual ad impression opportunities."

The citation highlights the core characteristics of PA, such as Granularity and Automation alongside real-time functionalities [2].

Granularity is the elementary feature that provides advertisers with a new way to optimize budget efficiency using comprehensive scientific forecasting methods for the purpose of select, evaluate and create individual ad impression opportunities. The goal here is to create long-term value.

Automation make possible to organizations and individuals to dealing with single ad impression opportunities in a far more extensive decision-making process during the course of entire campaign. The automation of complex manual processes also promises cost savings for companies.

Media management traditionally takes place locally in individual markets. Programmatic advertising platforms create an entirely new approach to managing online campaigns without being tied to a specific location. With programmatic advertising, an agency worldwide can acquire inventory internationally without borders.

Companies have started to explore the ecosystem of programmatic advertising and have found excellent benefits, such as [5]:

- Real Time Measurement: programmatic advertising offers the possibility of exactly measuring campaign performance as soon as the campaign is launched, i.e. it is not necessary to wait until the end of the campaign to get reports.
- Greater Efficiency: the general efficiency of digital advertising is greatly improved with the ability to measure a campaign in its entirety. The optimization ensures that each campaign is executed accurately, achieving only the ideal targeting customers and using the budget effectively.
- Greater Targeting Capabilities: with the increased flexibility of programmatic advertising, advertisers can directly reach their ideal consumers of any target. Examples include IP targeting, geolocation targeting, contextual keywording and continuous listing. With retargeting, marketers and advertisers can reach the majority of consumers to encourage them to convert.
- Increased Audience: another significant advantage of programmatic advertising is the potential audience reach. At any one time, there are 3.5 billion people on the Internet. This considerable potential reach is not only impressive, but instantly traceable. As soon as a display advertisement is seen, advertisers know how many impressions has been provided and much more.

1.5 Functionality and Actors

The whole mechanism of buying and selling ads in the programmatic advertisement ecosystem involves different actors and parties. Advertisers and Publishers have to work and deal with others third-party platforms.
The entire process is principally carried out by two actors: Supply-side Platform (SSP); Demand-side Platform (DSP).

- DSP is a type of programmatic platform for the advertiser side of the process used for the acquisition of online ad space. They allow advertisers to purchase ad inventory from multiple publishers. The DSP ensures that ads are aimed at the right audience through the use of a data management platform (DMP).
  Advertisers make their bids to a DSP and the platform combines information with bids from advertisers. It takes into account the content and the cost of the ad to the advertiser as the highest bidder winning. Bids run automatically so that the best ad can be shown to the correct audience [6].

- SSP is used by a publisher to sell ad space. It provides to the publisher with all ad opportunities and details of each advertisers based on the specified conditions. The objective is to maximize the value that the publisher receives from an impression.

  The SSP runs an auction among its buyers. The action takes place in real-time as the user access the website. SSP are also connected to other platforms as Ad Server and Ad Network - used for the repository of all the content material.

The programmatic ecosystem includes many other actors that are less relevant respect the two main platform (DSP and SSP), but essential for making the network work at its best:

- Data Management Platform (DMP) collects, analyzes and sorts relevant data for advertisers and publishers to optimize the exchange of ad inventory. DMP holds all first party data coming from Customer Relationship Management (CRM) and third-party data, which are available on the market.

  These platforms transform user data into real-time measure. Data are used to target the right audience taking a variety of factors into account, such as location, demographics, user's behavior and online activity.

- Ad Server is a software system used for the management and distribution of online advertising and report. The server, at the appropriate time, sends the campaign (in advance stored on the platform) on a specific browser or app.

- Ad Network are platforms that story inventory of different editor segmented and sell them through bidding mechanism in the market. They act as intermediaries between seller and buyer.

- Media Agencies collaborate with advertiser for brand promotion. In the last years, lot of them specialized on digital marketing and programmatic advertisement.

There exist different mechanisms for PA process: Open Auction, Real-time Bidding (RTB), Preferred Deal, Programmatic Guaranteed, Audience Guaranteed. The most used bidding mode is Real-Time Bidding, that allows advertisers to buy ad spaces in real-time through an automatized process.
To get started, the users have to access the website of the publisher and then, through the use of SSP, the publisher sends the user information to DSP.
On the other side, the advertiser or the corresponding media agency sets the bid price for each target consumer on DSP. Before place any price, SSP and DSP communicate with DMP.
In this moment, the negotiation starts in the Ad Exchange. The highest bid for the selected user will win. The banner of the winner is sent to publisher through AdServer.
The entire process from creating an ad impression opportunity to evaluating, selling, processing and serving an ad to users generally takes approximately fifty milliseconds.

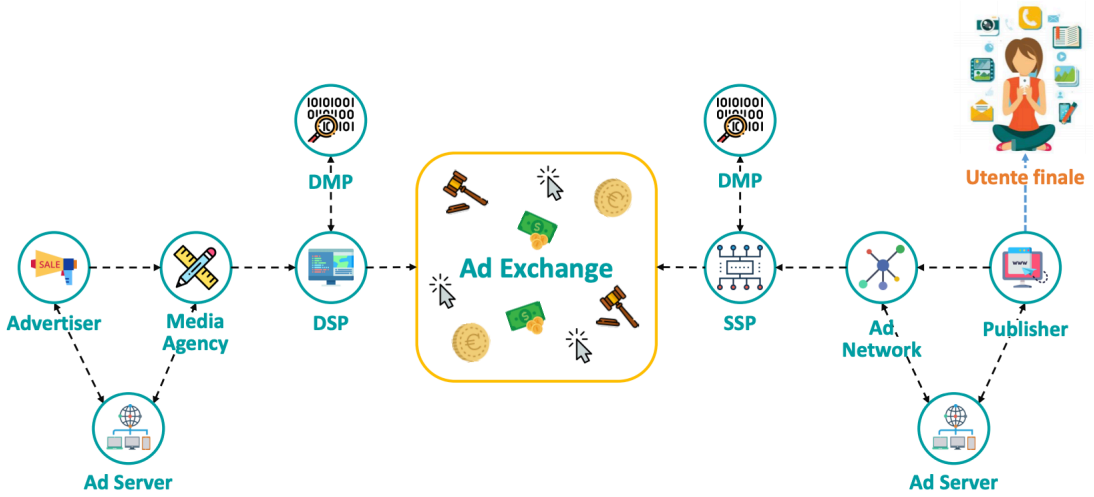


Fig 2 - The whole PA process. Source: IAB,2018

1.6 Header Bidding

The programmatic market is a highly technological oriented system and, consequently, it faces a constant evolving market. The critical issues and inefficiencies found in programmatic advertising are the driving force for the continuous development of a new resource. Among these, header bidding certainly stands out

The cascade or RTB model provides that the bid request is forwarded to the SSPs according to an access priority criterion. The publisher must prioritize only one exchange at time and then, if the first transaction is not successful, it must move on to the following ones [7].

The most relevant prior criterion is the "average historical yield": based on this criterion,the asked first SSP will be the one who will have historically guaranteed the publisher the highest revenues.

The mechanism is called "pass-back". The publisher's goal is to maximize the revenue generated by the sale of this space - it will try to get in touch with the source of demand that guarantees it a higher income - and to avoid that part of the inventory remains unsold - as the transition from one SSP to the next one proceeds, the price floor may decrease.

This cascade setup had several drawbacks:

- The priority of access to their inventory is based on historical performance data, which means that sometimes the most profitable offer never reaches the publisher. Not all sources of demand are in fact considered to participate in the auction, but some advertisers are willing to offer a higher price running the risk of not even having access at the auction.

- Lower-tier networks (SME) would often lose the bid to a higher-tier network (Big Companies), even if they were willing to pay more. As long as the higher-tier network met the floor price, they won the bid, often leaving money on the table. Additionally, offering ad

spaces to one network at a time caused latency with page load times [8].

- The fill risk indicates the percentage of impressions actually sold out on the total number of "ad calls" made – Fill Risk. The target user may in fact not be of interest to advertisers or the bid amount may be lower than the price floor defined by the publisher for that space.

Header Bidding is a programmatic sales approach that differs from the RTB. The main difference consists in the possibility for the publisher to simultaneously query multiple sources of demand (SSP), without having to prioritize one over another.
The header bidding technology has had a major impact on the programmatic market, bringing numerous benefits [7].
From the publisher perspective: increment of ad space sold – maximize profit - and fill rate.
From the advertiser perspective: access to premium inventory, greater control of adspace, more accurate data for marketing measures.
There are two versions of header bidding, client-side and server-side.

- The client-side solution reduces page loading speed, generating latency and damaging the user experience but certainly has benefits compared to the waterfall sales method.
- The server-side version has become increasingly popular, more suited to the new ad formats traded on exchanges. This version of header bidding allows you to manage the auction outside the user's browser avoiding latency [9].

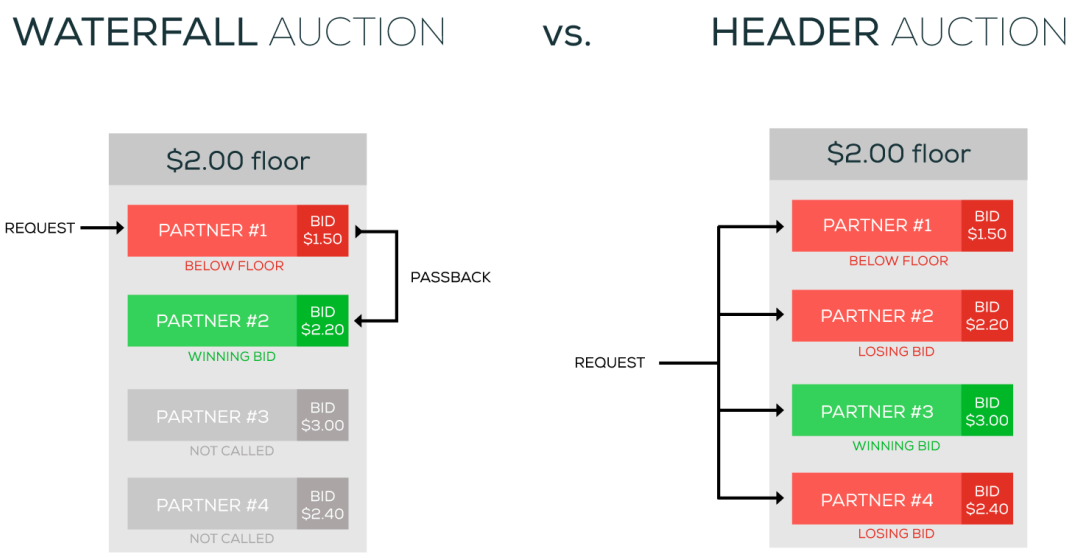


Fig.3 - Auction at comparison: Header Bidding vs RTB mode. Source: Cormack,2017

However, the Header bidding process presents some default and problems of various kinds, which could have a negative impact on the ecosystem.

- Header bidding helps to reduce pass-backs, but the client-side version can slow down the loading speed of website and impact negatively the organization. The latency problem is reported to be mentioned by 50% of publisher [7].
- The increase in competition generates greater revenues for the publishers but on the other hand, to win impressions the advertisers must exceed the offers of a higher number of competitors.
- DSPs find themselves having to manage multiple bid requests relating to the same advertising space. This considerably increases the hardware / infrastructure costs necessary to duplicate and manage all requests in time.

1.7 Business Implication

Programmatic Advertising (PA) is a multi-billionaire business that uses web-based technologies to deliver highly personalized adverts to prospective consumers in real time.
Many experts researched about the economic and social aspect of PA.
The spending on programmatic digital ads in the US grew by 10.4% in 2020. This projection, according to Digital Research, is planning to continue to grow into 2022, with $96.59B [10].
The IAB PA Final Report states that the programmatic advertisement gravitates on a 'Early Majority' phase. This statement shows the deep evolution status of the industry translated on the ability of organizations to make predictions on risk and opportunity without the limit imposed by new technology and behavior of players.

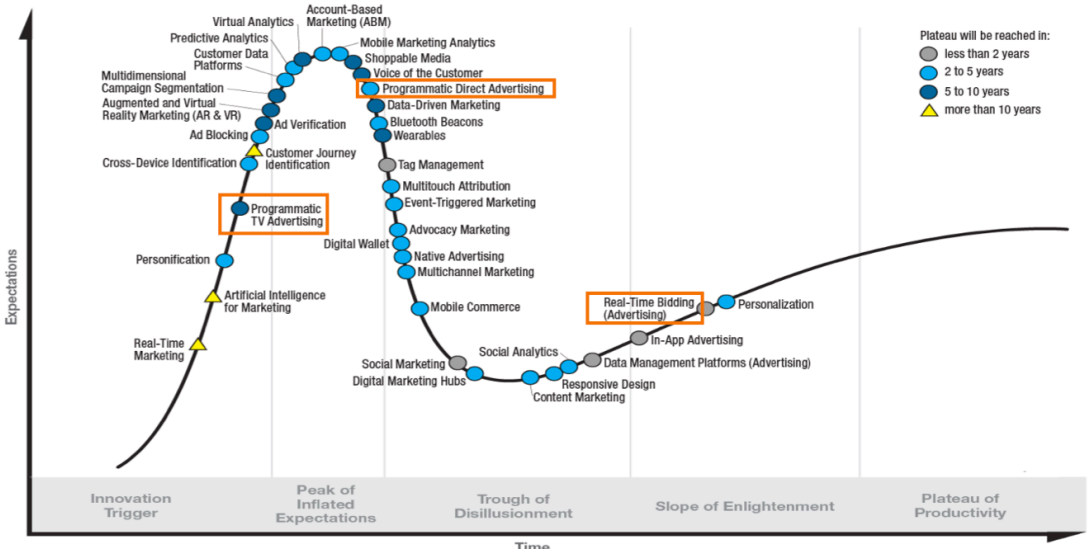


Fig.4 - Gartner Hype Cycle. Source: Gartner

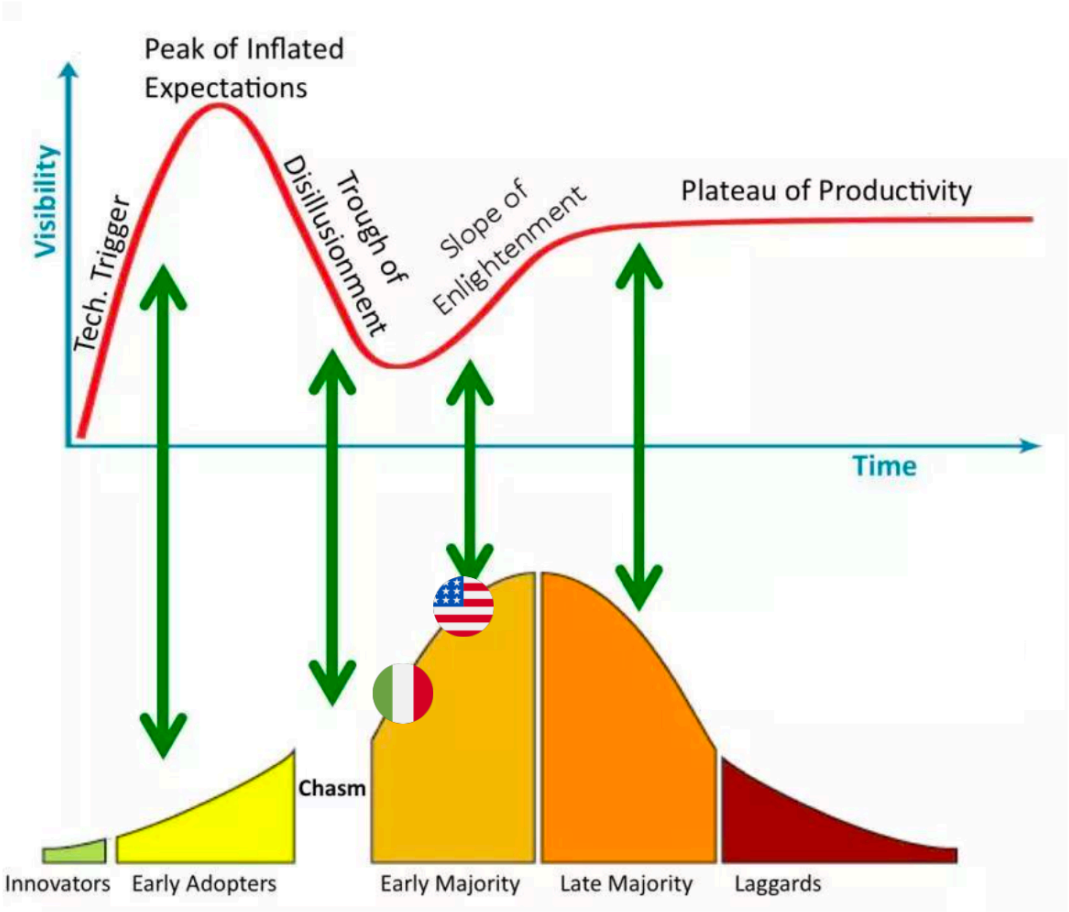


Fig.5 - IAB adaption to Gartner. Source: IAB

This stage of life has been reached with the help of incumbent phenomena in the PA ecosystem. In particular, the last years have been characterized by acquisition and concentration of value-chain actors into solid and bid entity [7].

An E-Marketer research analyzed the impact of the recent COVID-19 pandemic in the programmatic ad ecosystem, stating that consumers leaned into a lot of digital media. Advertisers took advantage and employed automation wherever they could. Companies sought greater control and certainty through programmatic direct and private marketplace (PMP) buys [11].

In Italy PA is much used by the main part of entrepreneurs in fact, according to IAB report the 25% of advertisers spend more than half digital marketing budget in programmatic advertisement. The trend seems to be in line with the international flow, for instance in Italy, PA holds 16% of digital expenditure, proving to be the most significant driver for the development of the digital advertising industry.

Today, organisations have to deal with new sales channels based mainly on programmatic logic.

Each channel and advertising space requires different formats and content. This results in the formation of different formats to compete in the market.

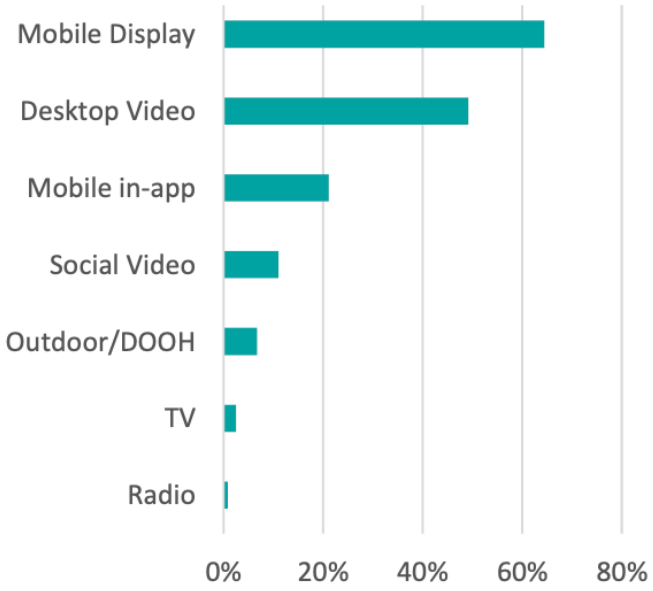


Fig.6 - Most frequent format. Source: IAB

Mobile display is currently the most popular format and this is due to the use of the smartphone, which is now the most widely used device in the world.
Video is definitely the most similar format to classic TV advertising and has also been proven to attract more user attention. In addition, the various streaming platforms that are becoming increasingly popular have enabled the development of the video type format.
Programmatic TV and radio are still in the development phase and are not widely adopted.

Despite multiple innovative formats, sales channels and platforms, the market may be slowed down. For example, advertisers face many problems due to the lack of integration between technology platforms, which penalizes the company trying to buy as much advertising space as possible.
For example, there are SSPs that only specialize in a particular channel or DSPs that only offer a limited format [7].

1.8 Programmatic TV

With the advent of Connected TV (CTV) - all TVs connected to the internet – marketers and experts start to explore the Addressable TV [12].
The word addressable indicates the opportunity to deliver the advertisement to a target defined

by the habits of individual families or individuals connected to the device with their account. Programmatic TV (PTV) is the same process with the difference that in this case we want to specifically indicate the possibility of purchasing advertising space available on CTV in programmatic mode - automated.

At the moment the scenario is still very fragmented: although the data tells us that advertising spending on CTV is increasing, it is not possible to centralize the purchase of large volumes yet.
The programming TV industry is at its early stage. In USA many brands started to develop and operate programmatic advertisement.
The slow development of Programmatic TV comes from the lack of scalability due to the scarcity and fragmentation of inventory [7].

If the PTV finally took off, brands could independently and centrally manage their campaigns in an increasingly cross-platform way, with the possibility of measuring and optimizing performance in real time and would expand their portfolio of channels especially for formats like video of increasing use and success in the digital world.

The market landscape is more tricky when it concerns the TV world. Unlike digital, TV is limited by time slots, which greatly affects the selling price of advertising.
The content and quality offered by the advertiser must be verifiable and impeccable to be broadcast on national networks. In addition, both in Europe and in the US, TV companies are national giants and many times state-owned corporations, which earn more money through systematic and traditional sales.

1.9 Blockchain in Digital Marketing

Blockchain technology and in particular the cryptocurrency Bitcoin have become very popular in recent years.
The Blockchain ecosystem is constantly evolving in various sectors and due to its nature, it seems to be perfectly suited to Digital Advertising.
The media and advertising industries are not far behind and there are numerous startups and companies looking to transfer their innovative business models to Blockchain solutions [13].
Blockchain-based technologies aim to support the creation of next generation programmatic advertising platforms. These new solutions provide advertisers, publishers and all the actors in the industry with a level of security and reliability with high quality standards.
Advertisers will be able to optimize their programmatic advertising campaigns (measurability, brand safety) and publishers will be able to optimize their sales strategies.

The main advantages of blockchain-based solution in Media Marketing are:

- Auction Security - The auction process and related data are visible, verifiable and immutable by all stakeholders involved. This increases the transparency of the procedure and increases its security.
- Data Security - The data and information relating to the target audience are anonymized and secured in order to ensure the privacy.
- Transparency of Contracts - An advertising contract could be 100% based on the Blockchain that ensure the execution of the payment of services which greatly reduces waiting times.
- Blacklist for Fraudulent User - Blockchain-based solutions aim to drastically reduce fraudulent traffic and the bot activity. Companies can create shared blacklists (based on IP addresses) to optimize target achievement in a distributed network.
- Reduction of Operating Costs - Blockchain-based solutions aim to eliminate hidden costs, resulting in greater efficiency and a significant reduction in operating costs.

Blockchain technology allows transactions to be executed at the same time as the service is delivered. This important feature has the potential to overcome the long payment terms that exist today.

- Reduction of Payment Times - The programmatic supply chain can be affected by blockchain. The nascent technology can measure and evaluate the performance provided by the various actors. Smart Contracts would help to drastically reduce supplier payment times.
- Creation of Credit Lines on Blockchain - Instead of expensive bank lines of credit, it is also possible to create blockchain-based shared lines of credit, which optimize the flow of campaigns.
- Instant Payments - Already today it is possible to obtain instant payments for lent supplies when the process is end-to-end on the blockchain.

Existing blockchain-based technology solution concerning media are been developed in a way that users can be remunerated with cryptocurrencies or token for the display of advertisements. Those solutions that allow the user to be actively involved within the advertising chain, are newsworthy for user engagement.
Decentralized system configuration and the support of some ad-techs give the possibility to track the users while is watching the advertising and then remunerate him adequately reducing the possibility of fraud or opportunistic behavior.

Blockchain application offers easy management of copyright and intellectual property. The

system recognizes the ownership of a document or content in an automatic process.
Fake news can be recognized through initiatives that make it possible to recognize if the news is truthful or not.

Users can still be involved through crowdsourcing activities like the creation of the content and the remuneration for the opera.
Sony and Sony Music Entertainment have also developed a rights management system for digital content that takes advantage of Blockchain technology.

Distributed Ledger needs to overcome certain computational, functional and legal limitations before it can be adopted by numerous mainstream sectors.
Scalability and performance are currently the two most prominent technological hurdles. Experts and technicians are working to address them both in public and private platforms.
Startups based on blockchain technology could support the legislation through the introduction and proposal of regulatory frameworks to help the diffusion of technology and help decision makers correctly outline the framework in order to develop homogeneous blockchain applications.
The blockchain technology ecosystem still suffer from a lack of actors involved in. The system will become more relevant as the greater number of actors participate.
The systemic approach gives a greater boost to the necessary network effect required to make the most of the potential of the technology. The creation of standards and interoperable protocols will be fundamental to avoid risks of fragmentation, that reduce or eliminate the benefits brought by blockchain technology. Nowadays there are many existing blockchains that deal with single use cases and are based on different development platforms.

IBM, MadHive, and TEGNA in 2018 founded AdLedger, a nonprofit consortium working to build rules and standards for the application of blockchain and cryptography to media and advertising [14].The project aims to further transparency and accountability through collaboration and research of the largest publishers, brands, agencies, and forward-thinking technology providers.

The first blockchain video campaign has been developed by OMD Italia for Henkel Italia and Dixan. Thanks to the use of the open source CryptoRTB solution developed by AdLedger, the agency was able to launch a campaign based on this pioneering technology for advertising. CryptoRTB solution allowed to identify bid requests with specific cryptographic keys: origin guaranteed, authenticity and integrity are the main benefits of this system. All of the impressions were verified with their origin and privacy compliance, validation took place in real time

and no latency problems were found in the campaign experience, neither from desktop nor from mobile [15].

Mediaocean one of the most influent and used service provider in the digital advertising industry developed a private blockchain-type platform in collaboration with IBM iX, one of the world's largest digital agencies and global business design partners. A pilot program that will allow brands, agencies and publishers to better follow their campaigns on digital channels, but also TV and print. The network records how the transactions and payments are spread over the entire digital ecosystem which reduce the time spent on audit. IBM created the network based on private custom blockchain on MediaOcean campaign management platform. The network will initially focus on authorizing transactions between marketers and agencies before expanding through the supply chain with publishers and measurement companies [16].

Chapter 2

Research Problem

2.1 Media Transparency

Digital marketing and programmatic advertisement are governed by many actors in a complex and evolving ecosystem.
The existence of unclear dynamics that interest the relationships between the various players involved in the value chain and the underlying technological complexities are highlighted by Marc Pritchard Chief Brand Officer of PG [1]:

> *"We serve ads to consumers through a non-transparent media supply chain with spotty compliance to common standards, unreliable measurement, hidden rebates and new inventions like bot and method fraud. We realize there is no sustainable advantage in a complicated, non-transparent, inefficient and fraudulent media supply chain."*

this statement is strengthened by Bob Liodice, CEO of ANA [2].

> *"..programmatic buying remains complex and often non-transparent. Our study revealed that this lack of transparency makes it difficult for advertisers to manage, measure, and audit programmatic media investments with the same rigor as traditional media investments."*

Nowadays, transparency is the biggest risk felt by companies regarding digital advertising. Organizations and platforms in the ecosystem do not allow a clear and safe control of all the procedures.

In 2017 The Times of London posted a study regarding the displaying of ads on Youtube before racist contents videos concerned some big companies. The news made the rounds of national media around the world very quickly and caused a loss of advertisers from the google platform. Organizations feared that the placement of their advertisements was superficially controlled [3].

Transparency was the recurring theme at the Digiday Programmatic Marketing Summit Europe in Estoril, Portugal, where experts agreed that the problem was very difficult to be solved. The issues of the system were shared by the members of commission. Moreover, organizations where amazed by the case of Duracell, that has created and developed an hybrid platform in collaboration with a DSP and a brand protection vendor in order to delete the high hidden fees of PA service [4].
The various programmatic players have conflicting opinions about the extent and relevance of the ecosystem transparency problems.
The 2018 IAB Programmatic Advertisement report researched across different Italians industry of PA chain, asking about the most problematic aspect of PA within their organization.
Advertiser, SSP and Media agency are the industries that require an urgent solution to transparency. All Companies and organizations involved are worried regarding [2]:

- Quality of Service: Ad viewability, Ad fraud, Brand safety
- Price of Service: Fees and tariffs applied by third-parties

2.2 Ad Fraud

Fraud has long been known to be one of the most troublesome problems on the Internet, especially in the digital marketing domain where programmatic advertising is the biggest victim.
Ad Fraud is the practice of generating illegitimate traffic designed to tamper with companies' advertising budgets.
Actually, the problem is hard to detect and address. At the beginning of the buying and selling process the exposure to the risk is difficult to identify and at the end of the practice the percentage of genuine traffic compared with fraudulent traffic cannot be determined.

Numerous researches have been carried out to assess the impact of this phenomenon. Recent studies conducted by ANA reported that 40% of programmable technology operators believe that this issue is currently among those with the greatest impact on the entire industry.
The Association of National Advertisers announced that marketers wasted $7 billion globally in 2016, buying online advertisements that clients never seen [5].
The ANA findings showed that display and video advertisements bought using automated systems have a significantly higher level of fraud compared with advertisements that were purchased directly through human sales forces.
Moreover, the study found that media campaigns with higher cost per thousand impressions (CPMs) were more vulnerable to bots because these platforms provide a stronger economic incentive for botnet operators to commit malicious activity.

Much of today's advertisement fraud occurs because of the so-called invalid traffic (IVT), that works in a way that receives advertising impressions paid for by the advertiser, but in reality a human never actually sees the advertisement. Fraudsters succeed by creating their own websites and then through the use of fake audiences to attract advertisers or by charging legitimate publishers to direct invalid traffic to their sites.
Invalid traffic generates problems of different nature for the organizations:

- IVT does not have an economic return. Invalid Traffic generates loss of money for advertiser and can damage brand reputation of publisher.
- IVT damage metrics and KPI. Invalid traffic is not excluded from measurements which implies that all key performance indicators are infected. From this point of view, companies who allocate a consistent part of capital in the big data sector are the most damaged.

IVT are classified into two principal categories: general IVT and sophisticated IVT
Sophisticated IVT consists in bots able to operate in more difficult-to-detect situation. In this case it's required advanced analytics and immediate human intervention to identify IVT.
Types of IVT include:

- Traditional bots: systems designed to mimic human users and drives up advertising impressions.
- Adware and browser "hijacks": A hijacker is a type of malware that modifies web browser's settings without users' permission, usually to inject unwanted ads into the browser or redirect to scam sites to achieve the tamperer' goal: make money from fake traffic.
- Ad injectors: programs that maliciously insert illegitimate advertisements into websites.
- Domain laundering: low-quality sites that impersonate a high-quality publisher to steal advertisement sales.
- Data-center traffic: Fake data originating from data-center devices without human users.

For media buyers, invalid traffic practice is disruptive and create a sort of missed opportunity for advertisements to have be effective. Firstly, the wasted advertisement spending brings decreased return on investment (ROI).

For media sellers, we find a similar and disruptive situation. IVT causes lack of trust in the value of their inventory translated into a loss of money and loss of revenue to long-tail sites on the open exchanges. The damage is mainly linked to the relationships with buyers [6].

2.3 Market Dynamics and Dominant Players

In the online advertising market, publishers and social media platforms compete for share of audience and advertising expenditure. Major US internet companies have market leading positions in terms of advertising and intermediary services, whilst the media agency services market is split between six major global holding companies.
Google and Facebook are the leader of digital market industry and are threatened only by Amazon that could impose as the third leader.

Google is the principal leader of the market, providing different platform like:

- Ad Manager: In June 2018, Google announced new branding for a range of their advertising products. With this initiative, they merged their DoubleClick For Publishers or (DFP) ad server with their Google Ad Exchange advertising source into a unified platform called Google Ad Manager or GAM. The platform runs all types of campaigns on programmatic logic. It also provides optimized competition features that maximize ad inventory yield across auctions and deals [7].
- Analytics: Google Analytics is a web analytics tool that analyzes website traffic [8].
- Google Chrome: Web browser most used in the world. Dominant position in the market.
- Android: Operating system which has more than half market in the mobile industry.
- YouTube: Online video platform with more than one billion users. Hundreds of hours of video content are uploaded to YouTube servers every minute. YouTube gives Google a strong position in search, display media.

Facebook is the most used social media in the world and it principally works as an advertising network since it is the main source of income. The advertisement system based on pixel tracking – Facebook Manager platform – allows many SME to deliver advertise in a cheaper and faster way than ever. Manager Platform and Private Marketplace dominate the market in display media.

Amazon currently has a smaller share of online advertising market than both Google and Facebook but it is growing strongly. Amazon has developed a DSP and a head-bidding solution called Unified Ad Marketplace. The bidding system runs on Amazon server. The server-side platform guarantees unique demand and low latency. The strength of this project is the ability to use the extensive data made available by Amazon [9]. This solution could scare off the two big companies and result in Amazon taking a major chunk of the market and it's predicted that it will gain 9.7% of the US advertising market by 2021. [10]

Google, Facebook and Amazon (GFA) are distinguished by [11]:

- Large scale of owned advertising inventory - GFA have access to large quantities of advertising inventory generated by their owned and operated services. About 77% of total UK online search and display advertising spending is on GFA advertising inventory.
- Well-developed advertising technology platforms - GFA intermediate in the purchase of advertising on third-party media owner services, leveraging their technology and data.
- Extensive proprietary data - GFA have unique user data at scale gathered from across their portfolios of services. Google has extensive search data that provides insight into user intent, as well as behavioral data from services such as Gmail and Google Maps. Facebook has access to highly granular data about user social networks, interests and behaviors. Amazon has data about product searches and purchases conducted on its shopping platform which is valuable to advertisers seeking to target users making purchasing decisions.

Google Facebook and Amazon hold more than 70% of the market share and are the main responsible for sector growth.
Advertiser and publisher have shown their opposition to some GFA behaviour at the Marketing Summit Europe in Portugal. Participants indict the big players of high lack of transparency pointing to grow in market.
The fraud mechanism and the lack of transparency have led to brand safety issues and uncontrolled increases in supply chain tariffs. The disruptive situation in PA has incredibly advantaged these large international companies, which have increased their market share.

With regard to data trade, European legislation has been expressed in the GDPR directive.
The GDPR, is a regulation to guarantee the privacy and security of the user. The legislation could slow down investments based on data with the risk of favoring the GFA [12].

2.4 Pricing Value chain and hidden fees

According to PA ecosystem, a suitable and efficient buying and selling process requires that the advertiser must be enabled to purchase advertising space and the publisher that must be able to supply it.
The programmatic advertising industry - especially when delivered in RTB mode - is mainly based on a pricing model that consists in the application of tariffs that each organization applies in cascade to all the programmatic players. Each intermediary, for the service offered, retains a percentage of the amount initially invested by the advertiser; as a result, the publisher's final

revenue will be equal to the amount spent by the advertiser net of the fees applied by the intermediaries during each step.

The complexity and lack of technological interoperability of the large number of players on the supply chain together make financial flows difficult to read.
The lack of transparency stems from intermediaries who often simply charge their clients for the full cost of the service offered, without specifying in granular detail the nature or structure of the fees charged and the 'fair price' at which the impression was sold. Furthermore, in many cases the functioning of the auction is not strictly defined. These practices not only feed the doubts of some of the actors involved, but also do not allow advertisers to accurately analyze the economic results of campaigns and neither to adopt strategies to optimize spending or publishers to maximize their revenues.
We refers to this cost as hidden fees.

The digital budget allocated by organizations is distinguished as working and non-working spend [13].

- Working spend is the amount of money reserved to the distribution of marketing content across different channels. The more working spend the more ad distribution.
- Non-working spend are the cost associated to production of content and measure of its effectiveness. Those costs are necessary for the correct implementation of the ads but here, the more you spend the more will be the total cost. Non-working spend represents the 40% of the average advertisement budget and 20% of the average marketing budget. Moreover, in PA industry non-working spend are the 40% of the cash flows.

This problem is of fundamental importance because it is symptomatic of fraudulent activity in the whole value chain. If there is a lack of transparency on these processes, it is not because the state of the art of advertising technology is inadequate, but because information are not shared.

The AdTech Tax is the spending on programmatic display ads which goes to tech and software intermediaries. This tax usually is the principal part of non-working spending [14].
GroupM estimated that, demand-side platforms (DSPs) and supply-side platforms (SSPs) each take about a 10% cut of the ad spend flowing through their platforms. This means that these vendors receive about one-fifth of the overall spend advertisers send to publishers whenever they purchase their inventory.
Warc estimated that the total "tech tax" accounted for 55% of all programmatic spend worldwide.
According to a study done by the Association of National Advertisers (ANA), Association of Canadian Advertisers (ACA), Ebiquity and Ad/Fin in May 2017, about 40 cents of every ad

dollar goes to tech fees [15].
Programmatic fees vary depending on the type of transaction and factors like CPM or inventory quality.
Nicole Perrin, principal analyst at eMarketer announced that

"Advertisers and publishers alike have known for years that a significant chunk of programmatic spending doesn't end up in publishers' pockets. We wanted to provide the market with a better sense of how much spending does go to publishers and how much is available to ad tech partners, especially as the market continues to consolidate around leading players"

Hidden fees are just one of the problems regarding pricing in this sector.
In an industry where the buying and selling of impressions happens in milliseconds, the speed of invoice payments cannot be said to follow the same pace. A supplier's payment in this industry can reach over 90 days, with estimated peaks of 400 days. The complexity of the entire ecosystem and, in particular, the existence of multiple layers between the advertiser and the publisher is undoubtedly the main cause of this trend. This dynamic makes the balance between the various players involved precarious and often ends up affecting their financial performance [2].

2.5 Viewability and Brand Safety

According to a study from activist group Avaaz in 2017, some of the biggest companies in the world are funding climate misinformation by advertising on YouTube.
In particular, more than 100 brands had adverts running before and during YouTube videos whose content were actively promoting climate misinformation [16]. The interested companies wasted no time pulling their ads from the content they deemed inappropriate.
This event once again triggered a storm around Youtube who had to recur to new rules on their ads sales plan [17].
The main part of YouTube revenues are ads. The platform gives the opportunity to monetized channel to make money from ads. The requirement to monetize from channel are 1,000 subscribers and 4,000 watch hours in the last 12 months.
However, videos can have ads also if the channel is not monetized.

In 2018, YouTube restricted the monetized channels in order to prevent potentially inappropriate videos from monetizing. Companies can blacklist certain channels and use a "sensitive subject exclusion" filter. It works by block ads from appearing on distinct channels or video content.

Sedlarcik, Havas Media's chief data officer, says [18]:

"Any marketer that has anything less than a high brand-safety risk tolerance needs to be working with their agencies, publishers and content platforms to actively and consistently manage whitelists, blacklists and everything in between"

Sedlarcik stressed the importance of collaboration between platforms and users since only by joining forces will it be possible to have greater control from a content perspective.

Brand safety failures affect brands in at least three ways.

- Most of the time that organizations or advertisers who learn of this failure often interrupt advertising campaign on YouTube, at least for a few months. The abandonment of ad campaign prevents the brand from reaching young viewers and new generations who are less attracted to television broadcasting.
- In case brand's pre-roll ad appears in front of unappropriated content video, the concerned YouTube channel gets income from that advertising. In some sense, the brand gives economic sustain to a dangerous channel that could be terrorist group with opposing values. The support may be unintended, but any single instance could have a substantial negative effect on the brand's reputation if it were widely publicized [19].
- Watching the short video content after the ad could negatively affect pre-roll ad effectiveness.

Bellman at Al. in 2018 investigated the third brand safety effect, measured by brand recall, recognition, ad liking, brand attitude and purchase intention, as well as by biometrics measures of emotional response to help to understand controversial content effects. The results reported that the content seen after a pre-roll ad does not interfere with processing that ad, even controversial content following. Video content had no interference effects on ads seen before program content. A brand's reputation might suffer negative effects from pre-roll advertising in other ways, however.
Journalists could report that the brand has (accidentally) supported extremist groups with pre-roll ad income. This would be a brand scandal effect via the media rather than an effect on the consumers who saw the ad before the extremist content [20].
The study was limited to isolated single viewers. At the moment no research tested the effects of video content on pre-roll advertising when viewed in groups on a large screen.

Chapter 3

Design Research

3.1 Introduction to Research

Organizations and companies are increasingly concerned of the actual state of digital advertising. Fraud, transparency and fees are the current main issues. On the other hand, users and consumers are worried regarding their privacy and data security.
Private marketplaces will tend to be increasingly used in the future because they protect advertisers from fraudulent traffic, offer greater privacy to all participants, minimize the involvement of intermediaries and provide access to higher quality inventory.
This trend negatively affects a large number of small advertisers and publishers who cannot afford the high cost of participating or managing a private marketplace.

At the same time, in the last decade, a new digital currency called Bitcoin has generated many discussions and attentions. The Bitcoin are based on the blockchain technology which is a distributed public ledger of cryptographically signed transactions.
The main goal of Satoshi Nakamoto – pseudonymous of Bitcoin inventor - was to eliminate intermediaries in a peer-to-peer system [1].
Organization around the world discovered benefits of the blockchain technology:

- Decentralization: Core concept. There is no need for a trusted third party; a consensus mechanism is used to agree on the validity of transactions.
- Transparency and trust: Blockchains are shared, this allows the system to be transparent. As a result, trust is established.
- Immutability: Once the data has been written to the blockchain, it is extremely difficult to change it back.
- High availability: Even if some nodes leave the network or become inaccessible, the net-

work as a whole continues to work, thus making it highly available.

- Highly secure: All transactions on a blockchain are cryptographically secured and thus provide network integrity.
- Faster dealings: Blockchain does not require a lengthy process of verification and clearance because a single version of agreed-upon data is already available on a shared ledger.
- Cost saving: As no trusted third party is required in the blockchain model, this can massively eliminate overhead costs in the form of the fees which are paid to such parties.

Blockchain is being widely adopted in different industries and has now made its way into the AdTech space with the potential of changing how the digital advertising industry works: today it seems to be a suitable solution for the programmatic environment.
Termed as BladTech, blockchain's implementation in Ad Tech has enormous potential [2].
Blockchain-based hybrid solutions will create a next-generation marketplace that will protect all participants from fraudulent traffic, low-visibility offers and spam ads.

3.2 Similar Research and Early Application

In the last years experts developed many platforms based on blockchain – Dapps - each one with different features and purpose, in particular, they are based on Ethereum - the most famous blockchain-based platform.

To meet modern business demands, IBM joined with other companies to collaboratively develop an open source, production-ready, business blockchain framework.
Hyperledger Fabric supports distributed ledger solutions on permissioned networks for a wide range of industries giving access at the integration of different sectors.
Its modular architecture and the programmable feature permits to modify and adapt the system in the best possible solution maximizing the confidentiality, resilience and flexibility of blockchain technology.
Hyperledger is aiming to build new blockchain platforms that are driven by industry use cases and its evolving into a protocol for business transactions.

Regarding the digital marketing and media, recently, researcher have studied new possible system and architecture for a blockchain-based system. B2DAM is a blockchain-based digital advertising media system. It has been implemented with Hyperledger and integrates distributed ledger, multi-chain, smart contracts, and consensus mechanisms to ensure decentralization and multi-party maintenance of data [3].

Other research focused on double-blind E-bidding system based on blockchain. The system uses Hyperledger Fabric based on consortium blockchain and chaincode for business logic. It meets the security requirements of confidentiality, immutability and anonymity [4].

In 2018 the co-founder of Mozilla and Firefox released the paper of the BAT token.
The native token is based on Ethereum and used the Brave web browser.
Developers aim to improve the security, fairness, and efficiency of digital advertising with the use of blockchain technology. The system is user oriented, it tracks media consumers' time and attention on websites and stores this data on users device in order to ensure privacy and anonymity. The advertising money are distributed between advertisers, publishers, and readers of online marketing content and ads [5].

3.3 The Actual PA Ecosystem Issues

The study aims to resolve the media transparency and hidden fees issue that cover the actual state of buying and selling process. At the same time, this research covers the privacy problem that concern users.

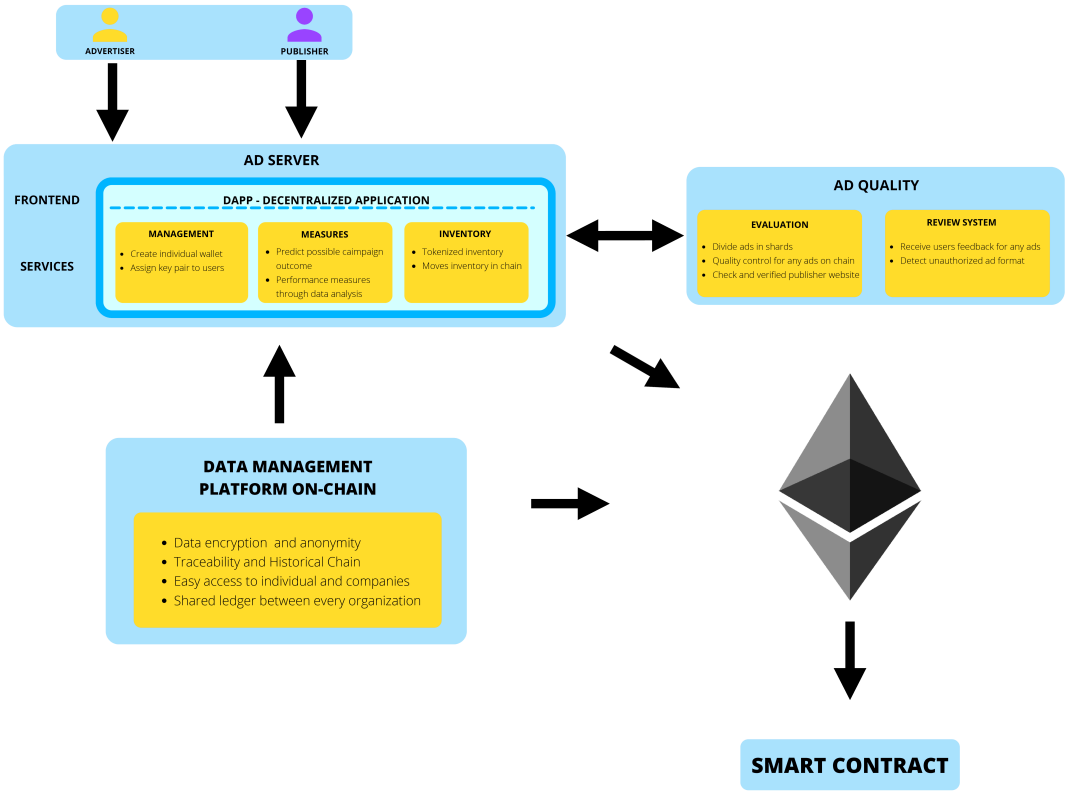
Firstly, the main problem regards the great amount of players that participate for selling and buying of ads. This system is carried on by advertisers and publishers which are mainly organizations that try to have more visibility on the web. The problem is that they are the parties which gain less from all the process being the first and the last users. From the advertiser point of view there are too many transaction fees and intermediaries that increase the cost of ads. On the other hand, the publisher is damaged by late payments. IAB estimates that a supplier's payment in this industry can exceed 90 days with estimated peaks of 400 days. From this perspective, the publisher is hurt the most by late payments being located at the bottom of the chain.

Transparency is identified as another important issue that covers this ecosystem. Advertisers are more alarmed by the lack of prior knowledge of the positioning of ads and by the scarce visibility of them. Transparency is a problem of considerable impact and is often seen as the main cause of the low effectiveness of campaigns. Here publishers are less worried but they still has to face hidden cost which seems to be not always clear.

3.4 Design Process and Decision

In such big ecosystem, the objective of the research is to construct a profitable framework of PA from the point of view of advertiser and publisher. The blockchain technology can be applied on different fields and industries, but it appears to be best suitable for activities that involve a great amount of data and the programmatic advertisement environment could benefit a lot from the application of smart contract and tokenized asset.

The purpose of this study is to implement a design framework for the programmatic advertisement ecosystem based on blockchain technology.



The proposed framework requires the whole process to be executed within a decentralized application. The bidding process ends with the stipulation of smart contract that, in case of ads contract, could be executed instantaneously reducing the payment time.

The principal and only actors of this artifact are advertisers and publishers represented mainly as organizations that want to operate without third parties agency.

The process is managed by three principal entities – AD Server; AD Quality; DMP blockchain-based – which have distinct and specified roles.

3.4.1 AD Server

This is the core object of the framework. It works as a Dapp which is decentralize and permits organization to work without third parties. Advertiser and publisher can sign up and create a wallet. The server will guarantee the double cryptographic keys to members to execute transaction.
Inventory and ads are added to the chain as tokenized inventory and passed to the AD Quality for review and evaluation. Then the add is ready to be published.
The Dapp can also make analysis and extract measure from ads, predictable outcomes that are allowed by the use of data analysis.

3.4.2 AD Quality

In a decentralized system the free circulation of ads without any control would result in unappropriated contents and low quality.
The entity that supervises the feature and categorize ads is the AD Quality.
In this framework it is studied as a separate chain system where ads have to be validated through a consensus mechanism.
This server requires that publisher and advertiser collaborate to maintain the network through a sort of mining activity that will make possible:

- Divide Ads into shards according to category
- The detection of malicious member
- Quality of Ads related to some fundamental standards

The AD Quality system in order to work at best should cooperate with a web browser. Each time an ad is displayed, the users could review the ads content and quality through the browser. The score and comment will facilitate advertisers to improve their ads and at the same time can prevent publisher to display unappropriated ads on their web site.

3.4.3 Data Management Platform on-chain

Blockchains are datastores based on immutable ledger. Its nature seems to be perfect suitable for data governance. In particular, data management platforms, those who play the most important role in the actual programmatic ecosystem could move to blockchain-based solution. In this artifact DMP has been constructed as an entity which operate and share data on a distributed ledger and this data can be accessed by users and organizations.
The benefits from the application of blockchain in DMP are [6]:

- Transparency – Distributed ledger guarantees that every single data or transaction is stored on chain and people who have access can read them.

- Quality of Data – Consensus mechanisms can ensure high standard of data. Each node can make a quality analysis before verify data.
- Sharing Environment – Data today are most controlled by big companies and organization sick to find valuable data. The decentralized nature of blockchain allows data to be easily shared between organizations, which are also able to control who can have access. Information can be stored on a distributed ledger in a blockchain platform that individuals and companies can access online.
- Immutability - The ledger is immutable which means that there is no possibility to modify or disrupt data.
- Real-time Data Analysis - Performing data analysis in real time and monitoring changes as they occur is a great benefit to any organization with data resources.

Chapter 4

Evaluation

The proposed framework has been constructed following different studies with the scope of eliminate intermediaries and ensure transparency compared to the actual environment.
The study shows that in this hypothetical structure the number of participants is drastically reduced. Advertiser and publisher remain the principal actors, but they will gain more from their activity in effectiveness and economic terms.
Another plus point for adopting blockchain solutions is the removal of barriers to entry for anyone who accepts the principles of transparency, fraud prevention and trust. Thousands of small and medium-sized advertisers and publishers will return to the programmatic market when these solutions are released.
The new blockchain platforms will offer solutions to take back control of both inventory and ad campaigns. The blockchain paradigm and the token economy are maturing into trusted platforms. The shift from the programmatic approach as we know it today to the blockchain-based approach will bring with it numerous innovations.

Transparency benefits - The distributed ledger is the fundamental core of the artifact. It allows advertiser and publisher to benefit in terms of transparency.
All stages of the auction process and related data are visible, verifiable, and immutable by all parties involved in the transaction. This increases the transparency of the procedure, improves its security and allows immediate verification of data.
The idea behind this framework is to adopt a permissioned or private ledger.
The individual transaction in private blockchain provides unique properties such as being fully protected from non-participants authorized and keep all transaction data private, which are only accessible by participants in the ledger.
Given the limited number of nodes, the number of transactions on private ledgers is significantly higher than that on public ledgers.

In public blockchains user's identities are to be considered pseudonyms and transactions are visible in the distributed ledger while in the private blockchains, the participants are well defined.
In this way all the transactions will be recorded in the ledger and the advertiser or publisher will be able to verify the activity process in transparent manner.

Ad Fraud Detection - Blockchain-based solutions aim to dramatically reduce fraudulent traffic and so-called bot-net activity. For this reason, companies can create shared blacklists (based on IP addresses) to optimize targeting.
The blacklist and whitelist will be recorder on the ledger and will be available to be read by all the organization involved.
In order to achieve a common consensus on possible malicious practices the blockchain technology use a consensus mechanism which is a set of steps that are taken by most or all nodes in a blockchain network to agree on a proposed state or value.
All consensus mechanisms are developed to deal with faults in a distributed system and to allow distributed systems to reach a final state of agreement.
The consensus algorithms available today and researched in the context of blockchain, are different.
In this framework the most suitable consensus algorithm is the Proof of Stake (PoS).
The idea is that every organization participates as node with an adequate stake in the system, which means that the companies have invested enough in the system so that any malicious attempt by that user would outweigh the benefits of performing such an attack on the network.
The stake is a portion of money or token that a company would freeze for better system operation. It sounds like an investment that would completely return back if the organization act respecting the environment rules.

New pricing value chain - One of the main economical issues is the long price value chain.
The programmatic advertising industry is based on a pricing model that consist in the application of tariffs that each organization applies in cascade to all the programmatic players.
In this framework the value chain is drastically reduced. Only publisher and advertiser are part of it and they will spend only for special fee in order to maintain the network stable.
The fairness of the system is ensured by the smart contract which is a secure and unstoppable computer program representing an agreement that is automatically executable and enforceable.
The fundamental principle is that code is law, meaning that there is no need for an arbitrator or a third party to control or influence the execution of the smart contract.
Smart contracts are self- enforcing as opposed to legally enforceable. Moreover, they are secure and unstoppable, which means that these computer programs are required to be designed in a way that they are fault-tolerant and executable in a reasonable amount of time.

With the introduction of smart contract, the organizations that participate in the programmatic environment are required to pay immediately after the contract has been validated by the network reducing late payments.

Brand Safety - Companies and organizations care a lot about their image and try to appear to users in the best contexts.
Cases like Youtube have frightened many firms that require a more reliable system to avoid being associated with inappropriate or false content.
In order to perform at its best, the system requires a control by a server - AD Quality - which has the function of verifying the quality of the ads and can also validate the reliability of the contents of the publisher's website. This server should also interact with the end users, those who view the ads, to ensure a total and complete evaluation. According to the blockchain principle the system is decentralized which means that should be maintained by community members through an accurate consensus system.

Market Evolution - The biggest hurdle to overcome is undoubtedly the presence of GFAs, whose dominate the market and offer unlimited resources to companies.
These market dynamics are detrimental to advertisers and publishers. The adoption of blockchain systems requires a long process of study and implementation.
In order to maintain the network of this artifact in an effective way, members should spend a substantial part of money, resources and time to adapt and transform their current technologies into a decentralized blockchain-based system.
Additionally, companies should begin educating their employees and customers about blockchain technology and the possible benefits each individual would gain from it.

The sustainability of the network can mutate into big environmental problems. The amount of energy spent by miners and community member is very high. In a typical blockchain system with many actors and players the cost and production of energy would be unsustainable.

The main technological challenge remains performance and scalability. PA ecosystem involves thousands of transaction and contract execution in few minutes and seconds which at the moment is almost impossible using blockchain solution. By the way, new private system are developed to overcome this main problem that seems to be solved with the lasts consensus algorithms and software release.

Chapter 5

Conclusion

The scope of this thesis is to construct a possible and efficient programmatic advertisement ecosystem entirely based on blockchain technology. Companies and organizations spend a great part of their resources for digital marketing and most of them are reserved for programmatic advertisement. The actual PA environment present many issues and in particular, advertiser and publisher are those business that are most affected by the lack of transparency and the high fee.

Managers and experts have started to evaluate the potential of blockchain in media advertising. The main features of the nascent technology ensure a reduction in fraud and direct sales contract between advertiser and publisher without the involvement of intermediaries.

The proposed framework aims to drastically change the current scenario by affecting the number of players and the relevance of each member.

The economic and social potential of this framework can only be found with a high number of participating users and organizations adapting their technology resources to the blockchain world.

Despite the many benefits related to the application of blockchain, there are some technical issues such as scalability and performance that should be solved by new versions or software.

Today there exists different projects and ideas that have been developed in the digital marketing area, but there is a lack of interoperability between system and software. The blockchain programmatic ecosystem will effective only when the most part of functional software will be able to cooperate.

The legal aspect is also of paramount importance as there is currently no legislation regarding blockchain or digital assets. New entrants and startups should work together to create a legal and economically efficient system for all.

At the end, companies and organization are attracted by this new technology and they know that they could profit from it, but it is necessary to solve and adjust some dynamics and mechanisms that still delay full adaptation.

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