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D6.4: Initial Market and Business Opportunities Analysis

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0.1	2020.07.06	TID	Initial ToC, content guidelines and sample text
0.2	2020.07.12	IBM, UMU, FBK, ICOM, NXW, TID	Updated roles and plans for the identified partners
0.3	2020.07.20	ATOS, UW, MCA, ALB, CODI, TID	Updated roles and plans for the identified partners. Regulatory and industry at large perspectives. Initial general framework analysis
0.4	2020.07.26	I2CAT, IBM, ALB, TID, FBK	Final version (almost) ready for review. Only specific parts on individual plans missing, to be completed in parallel to the review
0.5	2020.07.28	NXW, MCA, TID	Update exploitation plans and spectrum matters in section 2.1. Address initial review comments
1.0	2020.07.29	BTL, CODI, TID	Completed exploitation plans. Address comments on section 4

1.1	2021.08.04	TID	Additional content, following reviewer comments after first project review
1.2	2021.08.13	I2CAT	Final review and refinement.

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Executive Summary

This document contains an initial analysis of the aspects in the industrial ecosystem the 5GZORRO research can potentially impact. The report is structured around the business opportunities derived from the scenarios and use cases identified in D2.1, and it covers three main technology axes of the project consolidated as the ones structuring the 5GZORRO value proposition, namely the application of:

- Shared trustworthy data (data lake + DLT) to better manage network infrastructure and services.
- Smart contracts based on the above data to mediate the business relationships in these scenarios.
- Trusted execution environments to support the above and enhance network security in general.

Industrial impact opportunities are first analysed in a general framework, considering the reduction of Total Cost of Ownership (TCO) in capital and operational expenditures required for 5G consolidation and its further evolution. The 5GZORRO value proposition lies on the application of multi-operator and secure data-driven management procedures to enable more powerful and dependable automation functionalities. These functionalities guarantee, at the same time, essential security and trust properties together with multi-stakeholder operations that reflect the diversity in the networking ecosystem demanded by pervasive 5G service deployments. The requirements for supporting such a data-driven management paradigm (open, dynamic, distributed, elastic, secure and dependable) are briefly described and different opportunities for generating industrial impact of all nature are introduced accordingly.

Further on, early individual exploitation plans for the different industrial and academic partners are presented. These plans are discussed in the framework of the roles identified in the analysis provided by D2.1, with partners describing their mapping on these roles according to a classification of the particular influence in the industry through each role. Finally, we take advantage of the specific nature of the 5GZORRO consortium, which includes also a regulator (MCA) and a digital media company (CoDi), to analyse key aspects regarding the industrial impact of 5GZORRO research results beyond the evolution of telecommunications technologies, i.e. the regulatory implications of the 5GZORRO solutions and the impact of 5GZORRO on media, AI, finance/banking and other sectors.

1. Introduction

Next-generation networks, and more specifically the current trail towards 5G pervasiveness, imply unprecedently complex chains of end-to-end services, based on infrastructure provided by different resource providers, and relying on virtualization techniques to make it viable by allowing the sharing of resources of all kinds among the different players. These resources include compute, storage, data forwarding, radio and spectrum, but also access to high-level services in the form of specific functions, structured by means of platforms, and in all cases following a dynamic, as-a-service consumption pattern. This substantial virtualization effort is intended to follow the path already initiated in the IT industry with *clouds*, adapting them to the telecommunications environment as the only way to make a sustainable approach to 5G and beyond, avoiding the infrastructure duplication strategies followed in the past. This scenario goes well beyond the traditional restricted, bilateral business models adopted by operators for working with their providers, peers and consumers, and demands a multi-party distributed model supporting dynamic interactions among a large group of parties, with the highest levels of security and trust.

In the multi-party scenario for 5G, built on advanced virtualization technologies and able to provide equally sophisticated virtualized connectivity services by end-to-end network slicing, security and trust become essential assets to initiate and ensure a dependable operational environment. While any kind of Operation, Administration and Management (OAM) activity on a network requires a flow of trustworthy and relevant data about network status and usage, and this have been the foundation for the many management data and telemetry mechanisms developed so far, the evolution of networking in general and mobile networks in particular requires further advancements in these trustworthy data flows and the management applications they enable.

The growing complexity of networks and their nature of increasingly critical infrastructures demand more powerful and dependable automation functionalities, while at the same guaranteeing essential security and privacy properties, supporting multi-stakeholder operations that reflect the networking ecosystem diversity, and providing all actors, from providers at all levels to end users, a high degree of usability and traceability. The networking industry is evolving along these axes and opening interesting opportunities for the trusted distributed data-enabled environment that constitute the base proposition of 5GZORRO.

1.1. Document organization

The report on initial analysis of market and business opportunities related to 5GZORRO project provided by this document starts with Section 2, where the framework analysis for this analysis is introduced in relation to D2.1 and a preliminary mapping of the major intended stakes towards the identified value chain by the partners in the 5GZORRO consortium is included.

A preliminary transposition of these intended roles in value chain into individual exploitation plans is provided in Section 3, aimed to define the initial strategy to be implemented to capture these business opportunities. Individual exploitation plans are presented at first, followed by initial sketches of joint exploitation opportunities the project can pursue once the planned solutions mature in terms of development and validation activities.

Section 4 provides two relevant additional perspectives to the Telco business opportunity analysis, specifically targeting the regulation aspects and other industries different from telecommunications.

Finally, conclusions are drawn in Section 5.

2. Analysis Framework

2.1. General 5GZORRO framework

5G roll-out requires high investments in terms of capital and operational expenditures. Thus, telecom operators are concerned about raising Total Cost of Ownership (TCO). 5GZORRO specifically addresses these two cost factors as summarised below:

- On CAPEX, the 5GZORRO shared spectrum trading approach can enable the use of virtualised infrastructure of trusted third parties, and flexibly control licensing costs.
- On OPEX, the 5GZORRO framework for smart contracts and the application of AI-driven efficient and automated network operation across domains can reduce operational expenses, improve the usage of resources and ease pervasiveness of 5G services in the network.

A study by Mckinsey [1] in one EU country with 3 operators following a conservative approach to 5G investment (i.e. delay 5G investments as long as possible while existing networks are upgraded), predicts that TCO for RAN would increase significantly in the period 2020-2025, compared to the expected 2018 level (see Figure 2-1). For instance, in a scenario that assumes 25% annual data growth, TCO would rise by about 60%, with 5G macro-cell and small cells accounted for at least one-third of TCO.

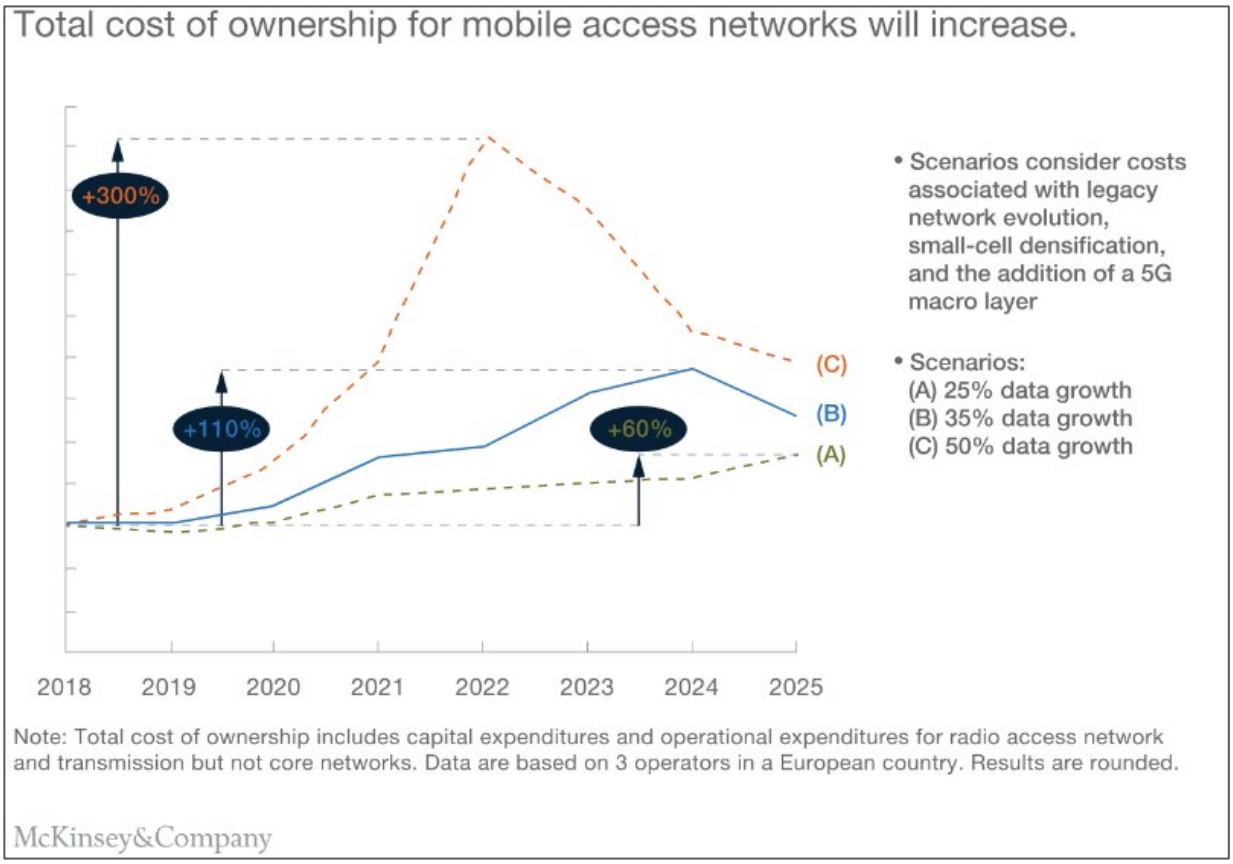


Figure 2-1: TCO for mobile access in a reference EU country (Source: McKinsey&Company)

By demonstrating these ambitions in three concrete use cases, 5GZORRO brings a disruptive proposal to the telecommunications business, and intends to show how this proposal can be applied within the service and value chain ecosystem, directly and indirectly benefitting all groups of stakeholders, from the telecom

operators themselves to telecom service providers. The 5GZORRO framework is initially focused on the following value proposition to the telecom market:

- Cross-domain, data-enabled network reliability and service scalability with security and trust.
- Reduced cost of development, maintenance, and operation of network resources with zero-touch automation.
- Best practice in spectrum management and trading, with impact on 5G spectrum capital expenditure and revenue.
- Cross-sector opportunities and open innovation from multiple parties enabled by trusted environments and smart contracts.

As such, 5GZORRO value proposition can directly impact on the 5G roll-out costs and required investments, thus providing means for the EU economy and competitiveness growth by enabling new business opportunities, and supporting the establishment of a trusted environment among parties which allows sharing costs and maximising the use of resources. We have structured the discussion of the general framework of business opportunities for the project around the industry trends identified in the requirement analysis reported in D2.1 [2].

2.1.1. Shared Trustworthy Data for Zero-Touch Automation

Data about different aspects of networking – from infrastructure metrics to the information provided by network functions, measurements of any nature and accounting records – have been collected and utilized for different purposes since the first telecommunication networks were deployed more than one century ago. The evolution of data technologies has made it possible to increase the number of sources, quality, volume, and detail of data. However, data-enabled network operation and management in multi-party environments such as 5G is not possible without establishing proper roots of trust and enabling secure interoperability when applying data technologies for any particular purpose.

Current trends in the telecommunication industry call for advancements in data-enablement technologies to support zero-touch management, autonomous network operations and the application of AI algorithms, and require a novel operational data platform that is:

- **Open**, so different data sources, processors, and consumers can collaborate on this platform.
- **Dynamic**, so sources, processors and consumers can be added, activated, suspended or deleted on demand.
- **Distributed**, to support the geographical and management span of current networks.
- **Elastic**, to accommodate the vast amount of raw and derived data, alerts and insights.
- **Secure**, properly controlling access according to participant roles and supporting third-party independent audits, while preserving privacy of all participating entities, and especially of end users.
- **Reliable**, to ensure data is trustworthy and relevant, and disallowing fraud data injection into the system.

In addition to the above, the 5GZORRO data platform will be specialized to the intrinsic properties of the 5G operational environments, e.g. to 5G-specific data types and sources, business models, and orchestration tools. The 5GZORRO project addresses these requirements by combining three major technology trends: data lakes, AI-based operations (AIOps), and Distributed Ledger Technologies (DLT) as a basis for creating its operational data platform. The combination of these technologies positions the project results to address opportunities related with:

1. The Network Data Layer (NDL) concept, as originally identified in the NGMN whitepaper [3], and the related standards mechanisms described by 3GPP (UDR, UDSF).

2. The provisioning of 3GPP Network Data Analytics Function (NWDAF), responsible for providing analysis information upon request from network functions, on demand or by means of a subscription interface.
3. Data support to autonomic networks, as pursued in IETF's ANIMA [4].
4. The consolidation of distributed infrastructures and in-network computing mechanisms, as sought by IETF's DINRG [5] and COINRG [6].
5. The application of AI-based systems to network OAM, as proposed by ETSI ENI [7], and the automation of E2E network OAM towards zero-touch operation, as intended by ETSI ZSM [8].

Each of the three technologies we base the 5G operational data platform on presents a huge market opportunity of its own, according to recent technology trends and analyst reports. 5GZORRO innovations in these areas will enable individual partners to improve their positioning in the relevant markets as outlined in Section 3. Here we introduce these business and market opportunities in more detail.

For AIOps, according to Gartner's *Market Guide for AIOps Platforms* [9] updated in 2019, the market is still growing and there is a 25% increase in demand for the technology from the end users. According to Gartner, AIOps strategy covering the three aspects of Observe (Monitoring), Engage (Analytics) and Act (Automation), has a potential to greatly increase the value of traditional IT Service Management (ITSM) systems through introducing data and AI technologies. In addition, Gartner's report specifically points out the advantage of domain specific AIOPS systems over the generic ones. While AIOps paradigm is generic and is applicable to any complex IT infrastructure, its specialization to the 5G domain is relatively new and only started to be explored in recent research projects.

For data lakes, initial scepticism has given place to growing interest in their applications. A recent Gartner's report called *Building Data Lakes Successfully* [10] states that data lake is beneficial to many IT and organizational use cases but very challenging to build and provides architectural guidance for building successful data lakes. In addition, analysts emphasize [11] that at 2019 Gartner's Data and Analytics Summit [12], data lake was talked very frequently about as an important building block in modern data architecture that is going to be around for the foreseeable future.

A recent Accenture report for the TMF [13] identifies four main future values for the application of DLTs in the telecommunication industry, related to AI, IoT, 5G and edge computing. The report makes special emphasis on how they will help securely expand AI implementation's access to data across organizations, by providing the highest level of certainty that the data have not been altered or tampered. In addition, the use of DLTs will make hacking systems and stealing sensitive data and information more difficult, forming a "double shield" against cyberattacks

An additional relevant market addressed by 5G operational data is network telemetry and monitoring. Although related both to AIOps, as part of Observe (Monitoring) and to data lakes, as a special type of data and data sources, this a separate thriving market very relevant to 5G, with high demand and competition. The sheer proliferation of network monitoring tools, as seen in multiple sources, e.g. the CNCF Cloud Native Interactive Landscape [14], in a recent Gartner survey [15], and in a survey by G2 [16], demonstrate that there are still plenty of challenges and opportunities in this market, especially as older tools fail to cope with demands and requirements of modern network environments such as cloud and 5G.

2.1.2. Smart Contracts

The evolution of networking technologies has brought new opportunities, allowing operators to dynamically lease services and infrastructure resources among them, and from third specialized parties in their provisioning of end-user services. This comes with the need for much more agile mechanisms to establish business relations within the evolving service and infrastructure ecosystem, well beyond the current rigid, centralized settlement models applied for network service provider collaboration.

The CBAN [17] organization, in which two 5GZORRO partners (BARTR and TID) already collaborate, aims at ensuring industry-wide adoption of services that will transform the settlement of traffic among global communications providers by facilitating the collaborative development of an automated settlement platform based on DLT and the execution of smart contracts, creating value in six main aspects:

1. Commercial settlement and netting between parties with limited trust and automatic validation of agreements.
2. Automating commercial interactions by automatically enforcing adherence to the contracts as programmed.
3. Managed transparency, with cryptographical attest to information, while maintaining privacy by controlling which data is shared and with whom.
4. Reputation management, creating a neutral record without requiring a third party nor revealing its identity.
5. Real-time inventory, through rapid distribution of information across multilateral ledgers
6. Performance monitoring and SLAs, collecting information from the supply chain and correlating, interpreting and disclosing it to agreed commercial terms

CBAN is currently focused on addressing current collaboration patterns around traffic agreements and 5GZORRO results will be useful to prove the CBAN concepts, recommended standards and best practices, and even as a reference implementation. The project ambition is to go beyond the current approach and demonstrate additional opportunities around the 5GZORRO advanced use cases on resource and function provisioning, consumption and accounting.

2.1.3. Trusted Execution Environments

Trusted Execution Environments (TEE) play a double role in the 5GZORRO solution space. On the one hand, TEEs are an essential element to support the operation of DLT nodes and the execution of smart contracts, providing much better roots of trust, applicable in highly distributed elastic infrastructures as the ones 5GZORRO is committed to run onto. On the other, TEEs support models of resource sharing and data processing that would not be possible without them, enabling trustworthy data management.

5GZORRO will constitute an ideal environment for TEE applications, leveraging and contributing to initiatives such as:

- The ENARX [18] project, focused on producing an application deployment system enabling applications to run within TEEs without rewriting them for particular platforms.
- The TEE provisioning mechanisms defined by IETF's TEEP[19], and the remote attestation protocols developed by IETF'S RATS[20].
- The GSMA's OPG [21] commitment to provide third-party edge application providers with a portable, trusted environment across different operator edge clouds.

2.1.4. Best Practice Spectrum Management and Trading Impact on 5G CAPEX

Spectrum is an essential but scarce resource underpinning wireless communications technologies and services which deliver fundamental socio-economic benefits at large. Its scarcity, but also the benefits that spectrum generates, led to oversight and licensing mechanisms to ensure its most efficient and effective use.

The evolution of wireless broadband technologies, particularly 5G, places further emphasis on the importance of managing spectrum resources efficiently and effectively with a view of maximising social capital and economic growth. In the pursuit of these benefits, the prevailing regulatory frameworks seek to facilitate access to licensed spectrum through competitive assignment procedures, whilst ensuring predictability, transparency and non-discrimination. These frameworks also recognise the benefits of

secondary trading, providing flexibility to the market to transfer some of its rights of use to another spectrum user. Such flexibility seeks to put into better use unused spectrum, addressing, for example, temporary or location-based scarcity or specific needs. Within the context of 5G, spectrum trading may provide flexibility to balance the needs of industry verticals and national operators or to meet demands of a regional or temporary nature.

The benefits linked to the use of radio spectrum must be balanced with the associated obligations. Such obligations are necessary to ensure that the transfer of such rights still meets the objectives underpinning efficient and effective use, to protect against market distortion from contrasting obligations and to ensure the transparency innate to effective regulation and oversight.

Initiatives that seek to mitigate spectrum scarcity, whilst providing flexibility and speed in secondary trading may ultimately benefit all stakeholders by providing increased cost-efficiencies when securing rights to use spectrum. Such is the value proposition of 5GZORRO, and its spectrum marketplace will enable trading through the use of digital ledger technologies and smart contracts. The application of these innovative technologies within the 5GZORRO marketplace aims to facilitate market-based spectrum trading, whilst ensuring compliance to spectrum rules and obligations.

2.1.5. The 5GZORRO Software Platform in the Context of Use Cases

The 5GZORRO concept is based on the premise that available management architectures and solutions have not yet been completely adapted to the multi-domain scenarios and the heterogeneous ecosystems present in the target 5G deployments. These architectures and solutions need to be evolved in order to be capable to support resource offerings and consumption for multiple stakeholders, and this dynamic resource sharing must be data-driven, with automation mechanisms tackling the complexity of the operations required to deal with the number and levels of heterogeneity of the resources to be managed.

The 5GZORRO software platform aims to allow smart discovery, registration and allocation of resources and service onboarding across different technological and administrative domains. The 5GZORRO platform focuses on enabling seamless use and composition of different virtualized at different network segments, on allowing more flexible and dynamic allocation of spectrum resources, and on simplifying resource management by means of AI and ML techniques leveraging infrastructure and service monitoring data.

The 5GZORRO software platform will run in each operator domain, relying on different technological enablers, such as Artificial Intelligence engines (based on machine learning frameworks and algorithms), Distributed Ledger Technologies (DLTs), Service Meshes and Data Lakes. It will follow a service based architecture design to offer different types of services, including smart-contract management, resource discovery and brokering, intelligent virtual resource selection, spectrum trading, and secure SLA monitoring.

Based on these principles, the 5GZORRO software platform is expected to address the considered use cases by:

- Applying smart contracts for ubiquitous virtual resources, providing means for the implementation of DLT-anchored smart contracts and oracles, and enabling the establishment of decentralized trust to support multi-party interactions and SLA management.

- Supporting dynamic spectrum allocation, based on blockchain-enabled spectrum markets, where the holders of shared spectrum rights can trade these rights for specific areas and time slots, thus enhancing spectrum efficiency while enforcing quality of service requirements.

- Enabling the delivery of scalable, pervasive vCDN services including HQ video streaming in situations with significant variations in the service context (e.g. video sharing in stadiums or demonstrations, sharing breaking news live feeds, etc.), taking advantage of spectrum resource trading and virtual resource multi-domain smart allocation and orchestration.

2.2. Partner Mapping onto 5GZORRO Actors

The main 5GZORRO roles for the core business stakeholders have been defined in deliverable D2.1 and summarised in the following figure.

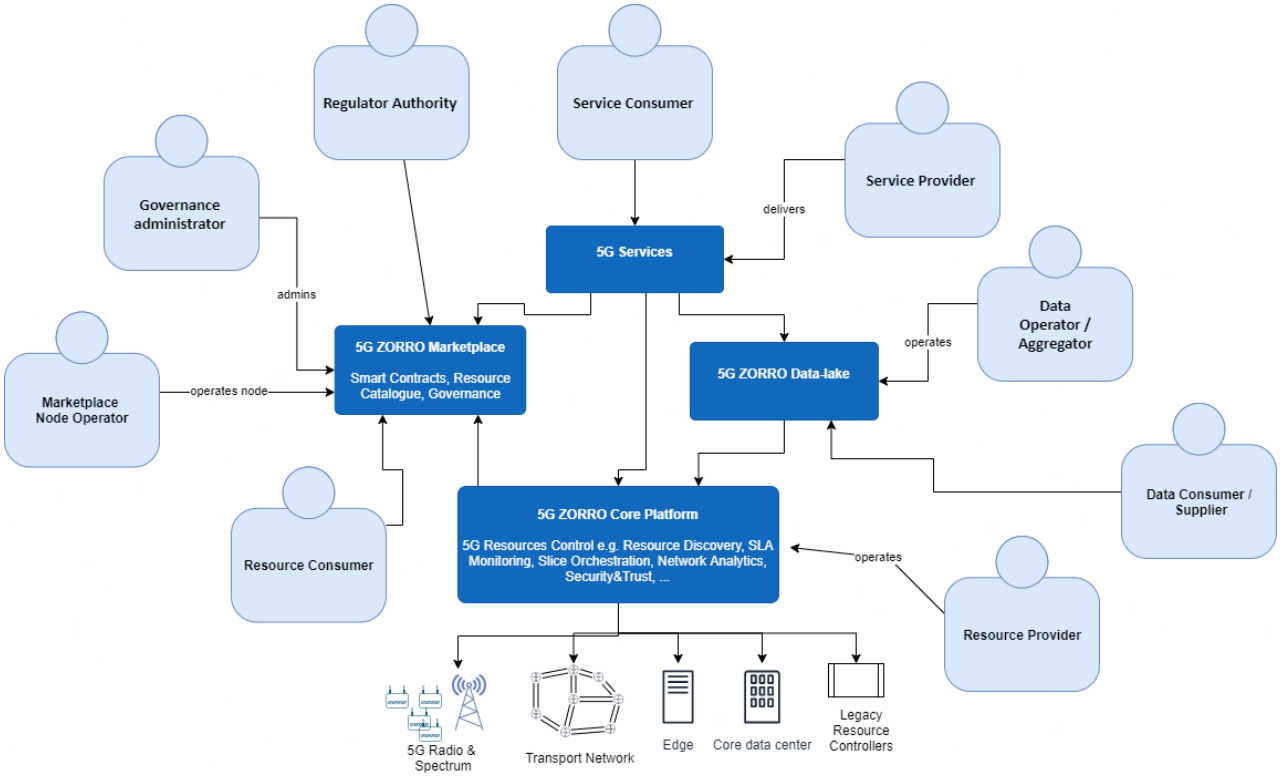


Figure 2-2: 5GZORRO roles

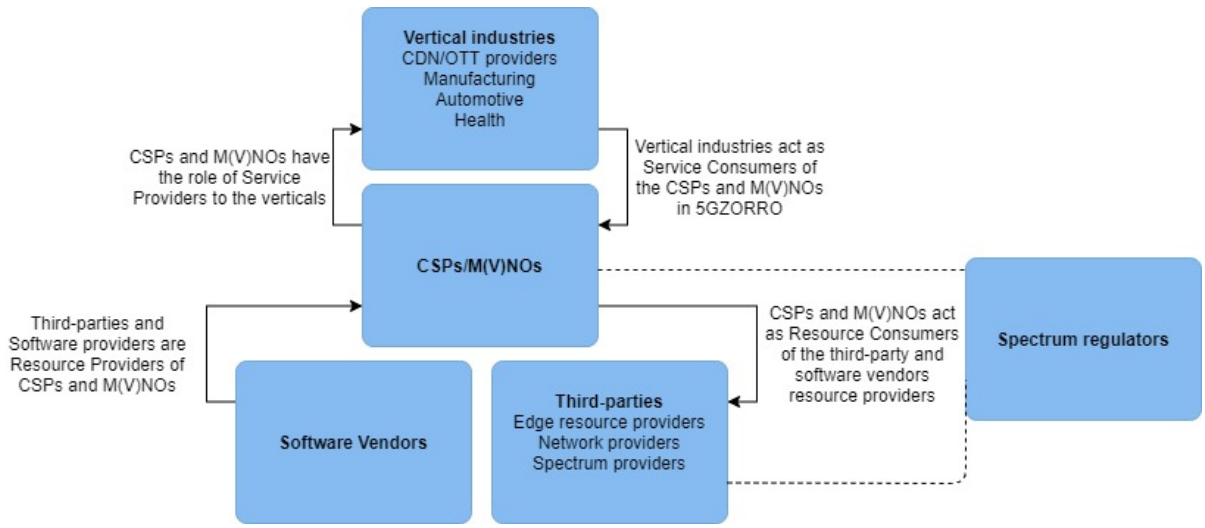


Figure 2-3: 5GZORRO stakeholders

The following table lists the actors identified in the project use case scenarios, with all partners identifying their potential involvement as such actors, according to the following keys:

- **D** implies a direct involvement as stakeholder, or in a particular role.
- **A** identifies a stakeholder or role involvement for an affiliate organisation.
- **I** indicates a position of influence on actual actors, via contacts with the public sector, collaboration with industrial consortiums, innovation ecosystems, etc.

Table 2-1: 5GZORRO partners and their actor (role and stakeholder) involvement

	NXW	IBM	TID	UW	BTL	ALB	ICOM	ATOS	I2CAT	FBK	UMU	MCA	CODI
Vertical Industry	I			I	A, D, I		I					I	I
CSP/(V)MNO	I		A	A, I	A, D, I	A	I	I		I		I	
Third-Party Resource Provider	I	I	A, I	A	A, D, I	A, I			I	I	I	I	I
Software Vendor	D	D	D, I	D, I	A, D, I	D, I	D	D	D	I	I		
Regulation Authority					I							D	I
Data Operator / Aggregator	I	I	A, I	I	A, D, I	A, I					I		
Data Consumer / Supplier	I	I	D, I	I	A, D, I	D, I	I				I		
Marketplace Node Operator	I		A	A, I	A, D, I	A			I				
Governance Administrator			I		I	A						I	I

In the following sections, partners describe the business opportunities and early exploitation in the framework of these actor mapping.

3. Business Opportunities and Early Exploitation Plans

3.1. Industrial Partners

3.1.1. Nextworks

Nextworks in its role of technology provider SME, has solid stakes in 5G Management and Orchestration solutions, with active research lines on zero-touch automation, AI-based network optimization and network slicing, design and assembly of Network Applications (NetApps) for vertical industries, specifically in Industry 4.0 sector. The 5GZORRO research can generate various business opportunities in relation to these specific company's strategic assets in particular for what concerns:

- Design and validation of solutions for multi-operator 5G network slice orchestration with zero-touch automation and security (from the application layer to core/edge and radio segments).
- Analytics and AIOps for improved 5G network management.
- Solutions for VNF eContracting, eLicensing and attestation in virtualised 5G networks.
- VNF/CNF co-existence and zero-touch stitching, extended from network to application layer virtualised functions (VxF).

The target market for NXW remains the Telco business, but more in the private 5G sector (i.e. enterprise cellular for Industry 4.0 and factory automation) than the public 5G networks (i.e. nation-wide or even regional networks operated by network operators for business to customer services). In fact, this sector can better intercept the current company market proposition on automated IoT platforms for smart environments (Symphony Building Management System [22]). Moreover, it is expected that the integration between application layer platforms (e.g. IoT), virtualization, cloud and network service meshing among involved components will be highly in demand to implement the factories of the future. To further support this strategy, a recent research by ABI Research presented at 5G Technology Summit foresees that in nearly 15 years from now enterprise cellular will overcome expenditures of public cellular with a very significant stake taken from deployments using shared spectrum.

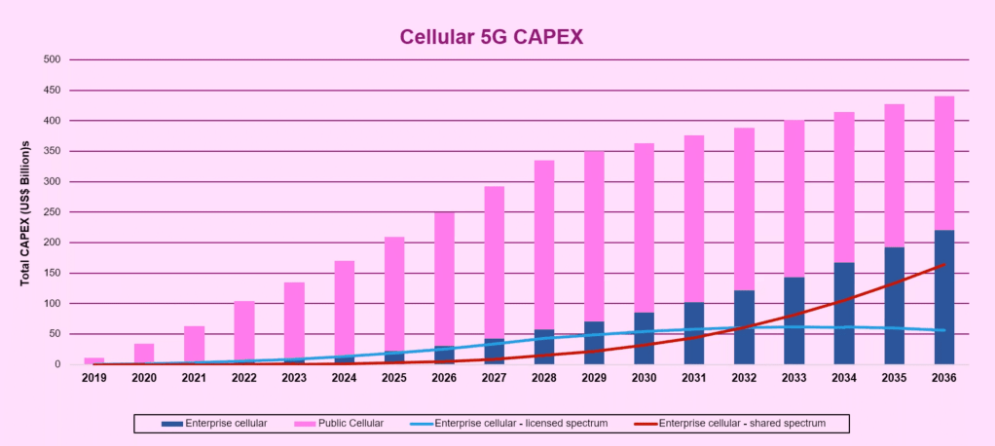


Figure 3-1: Cellular 5G CAPEX and enterprise cellular rise (source ABI Research)

Based on this operating context, some preliminary specific actions have been planned by NXW as summarised below:

As a first step, in parallel:

- Continue involvement in standardization activities at ETSI (ETSI OSM hackfests, ETSI NFV Plugtests, ETSI ENI Proof of Concept and ISG involvement at MEC, NFV, ZSM, ENI, PDL) to keep the pace of technology evolution on zero-touch MANO, AI-based network slicing, MEC/NFV architectures and interfaces, and update Knowledge Division service portfolio
- Continue pursuing consulting activities towards wholesale telecom operators and system integrators for Vertical markets and Telco in order to start capitalizing on know-how about 5G Network slicing, MANO, NFV/MEC through the offering of specialised training courses on new technologies and joint innovation projects.
- Continue liaisons for joint research on 5G and beyond 5G with technology and research performers in EU, to capture new innovation streams/topics, e.g. for Smart Network and Services, 6G and new Vertical services.

As the second step, analyse the market interest in orchestrated NetApps technologies and needs for MANO toolkits and e-licensing solutions and formulate a company market proposition of IoT products by Nextworks and MANO solutions for virtualised network. At the moment the plan is to start from potential new products/consultancy services for the Industry 4.0 sector, where private 5G networks, virtualization services and VNF licensing mechanisms by 5GZORRO could be innovative value propositions.

3.1.2. IBM

The 5GZORRO project can generate multiple opportunities for IBM as briefly summarised in the following:

- Influence an IBM product, Watson for IT [23], that aims to provide data-driven operational analytics for customers' software deployments. Watson for IT product is offered on top of IBM Cloud Pack for Data, that is currently based on OpenShift. As part of 5GZORRO we expect to create value add extensions that will help position Watson for IT among customers in telecommunications markets.
- Impact internal cloud infrastructure operations. The research team taking part in 5GZORRO is involved in internal activity targeting data-driven improvements to IBM's own cloud infrastructure operations. The research activity, named AIOPs for IBM Cloud Infrastructure, is well connected with Cloud operations teams, more specifically in developing AI methods for automating networks operations.
- Liaison with the team developing IBM solutions for 5G and edge computing [24] is two ways – 1. Validate the ability of 5G edge platform prototypes developed by IBM research to be used in 5GZORRO testbeds and use cases and 2. Introduce the 5GZORRO data-driven methods, especially the operational data lake, into the IBM 5G/Edge platform solutions and offerings.

We envision the contributions to be delivered through relevant open source projects[25][26][27].

3.1.3. TID

As the research and innovation branch of a multinational network service provider, TID has direct contact with a number of CSPs in Europe and worldwide, and responsible of running *transformation projects* to define the lines of evolution for network infrastructures and services in the Telefónica Group. TID plans to incorporate results from the different use cases into this transformation projects, in particular in what relates to improving network service lifecycle management (applying the results of 5GZORRO use case 1, "Smart Contracts for Ubiquitous Computing/Connectivity") and to the enhancement of the provision of third-party edge applications (from 5GZORRO use case 3, "Pervasive Virtual Content Distribution Network Services). The spectrum case in 5GZORRO use case 2 ("Dynamic Spectrum Allocation") is currently subject to internal discussion, as it is perceived as politically sensitive.

The application of data-driven operation and management and the use of enhanced mutual trust between infrastructure and workloads by means of TEEs are currently active in the innovation roadmap of the Telefónica OBs, with running initiatives that can benefit from 5GZORRO results. The participation of Telefónica in the CBAN [17] initiative will support the demonstration and further internal and external exploitation of results related to the application of smart contracts in the telecommunications sector.

The Telefónica Group has several companies providing different infrastructure services, both to third parties and internally to support all ICT activities, and TID has already identified a growing interest in DLT-mediated and smart discovery to enhance their IaaS or even PaaS. This includes not only the aspects discussed in UC1 and UC3 (again, UC2 is subject to internal discussion), but also disintermediation aspects related to SLA conflict resolution, extended auditability and more agile business models.

The span of the potential applications of these patterns for the consumption of resources of all natures (pure cloud, network functions, network platforms, etc.) goes beyond the scope of the Telefonica OBs providing such services. On the one hand, TID is an active contributor to GSMA's OPG [21], that constitute a relevant field for further application of these concepts at all levels, whether platform resource provisioning, platform service consumption or platform federation. On the other, TID is an active participant in the WAYRA [28] innovation ecosystem, where many (if not all) of the start-ups are potential consumers and/or providers of these kinds of services.

TID leads the open-source community building the Telefonica's reference implementation for network orchestration, Open Source MANO (OSM)[29], one of the key pieces in the Group's strategy for network transformation, connected as well to the initiatives in OPG and WAYRA described above. TID will incorporate relevant results to the OSM future releases, building consistent mechanisms for data-enabled network orchestration.

In direct connection to OSM evolution, the TID team involved in the project is working in mechanisms to enhance monitoring data processing and aggregation, with the idea of providing an elastic data fabric able to connect different data sources, deployed across the network, with potential data consumers of all nature. These mechanisms are based on the use of *metadata models*, supporting discovery and on-demand processing. The application of trusted data, as sources and consumers, envisaged by the 5GZORRO architecture, is a key enabler for the consolidation of these mechanisms, currently being developed within other H2020 projects, such as 5G-VINNI [30], 5GROWTH [31] and 5G-CLARITY [32], and considered in several internal and joint initiatives [33].

There two particular internal initiatives that can be considered directly related to the provisioning of trusted data and the explicit application of DLTs in a networking environment. The *Mouseworld* [34] is an OSM-based framework for the generation of synthetic data to be used in the development and validation of data-enabled network management applications (AI, analytics…), committed to preserve privacy and to guarantee reproducibility and repeatability. *TrustOS* [35] is an abstraction layer for DLT networks, based on Hyperledger Fabric [36], and built with the aim is of simplifying the development and deployment of DLT-based applications.

Finally, the participation of Telefónica in the Alastria [37], an industrial non-profit association promoting the development of DLTs, will allow TID to bring project results to the ledger infrastructure supported by the association, both in terms of addressing 5GZORRO use cases within this infrastructure and by contribution to the improvement of the infrastructure operational procedures.

3.1.4. Ubiwhere

Ubiwhere has been involved in various 5G RDI initiatives such as NFV, SDN and MEC to power both innovative solutions currently being designed and also already commercially available ones. Being a software company providing solutions in the smart cities and telecom area, Ubiwhere has been exploring the concept of leveraging smart urban furniture to, among others, facilitate the deployment of 5G networks in the most scalable and cost-efficient manner. For this reason, Ubiwhere has been working on the concept of a City

Nervous System [38] which relies on this smart urban furniture to provide ubiquitous communications and distributed computing power at the edge (Edge Computing). This has already resulted in the creation of a new joint venture called Smartlamppost [39]. To this end, Ubiwhere has been working mostly on the neutral hosting capabilities of such solution, having designed and implemented a web-based centralised marketplace for smart urban furniture – through this platform, tenants such as M(v)NOS may browse the different offerings such as lampposts, benches or bus stops which may be equipped with telecom equipment (small cells, networking gear such as switches, etc.) and establish a contractual arrangement (lease) with such site owners. At the moment, existing customers may do so at an infrastructure level only: rent space, power and embedded equipment (small cells and telecom antennas, for instance). Parties wishing to monitor how the equipment is performing and the overall level of quality of the network may need to do so using either external tools and rely on other metrics provided by third-party actors.

For this reason, through 5GZORRO, Ubiwhere intends to expand its knowledge and go beyond the current state of its Neutral Hosting marketplace, by exploring the added value of using key building blocks such as DLT and the principles behind automated zero-touch network and service management. Going past the current marketplace which acts mostly at an infrastructure level will allow stakeholders from the 5G ecosystem to engage in more complex business relationships, cutting deals on resource usage such as small cells and edge computing elements for multiple purposes. If SLAs can be assured at this level, by monitoring specific KPIs and proactively reacting whenever needed to ensure business compliance, new stakeholders can be targeted such as verticals (service providers in need for connectivity and an edge cloud to deploy their services), Resource providers and consumers (connected equipment such as small cells exposing qualitative metrics) and even data providers and consumers, as trusted entities focused on the acquisition and processing of such qualitative parameters to derive the QoS and, possibly, SLAs.

Aligned with the company's roadmap to expand the current neutral hosting platform capabilities, Ubiwhere will focus on the web-based 5GZORRO marketplace with plans to incorporate some functionalities and findings related to SLA-driven multi-party trusted business interactions. For this reason, emphasis on the application of DLT in the broader 5G ecosystem will be given, as a way to facilitate and unlock new business opportunities.

3.1.5. Bartr

Bartr Group – Bartr Holdings, Bartr Connect and Bartr Technologies - comprises both traditional global wholesale telecommunications operations at Bartr Connect (BCL) – voice, data and SMS (SIGTRAN, VoIP, TDM, SS7, Satellite) – with proprietary next-generation data insights and automation tools designed and developed by Bartr Technologies (BTL).

The core technology modules incorporated in BTL SaaS products provide real-time insights for CSPs and intermediary wholesale market participants.

The significant overlap of the 5GZORRO project roadmap and the BTL products and services roadmap provide for commercial deployment being "baked in" to both roles of BTL as both a market and project participant and contributor.

BTL SaaS modular products and services provided to the global CSP and telecoms wholesale marketplace incorporate much of the elemental technical architecture of the 5GZORRO project. These include smart contract and DLT deployments, consumed and implemented first by BCL as the operating sister company of BTL.

This virtuous operational and technical iterative feedback loop will see market actors and stakeholders from across the global telecommunications exposed to much of the project deliverables work. Essentially, BTL's sister company, BCL, will apply, through its use of the proprietary products and services, smart contract, DLT and automation features and functions also present in 5GZORRO architecture.

BCL has a large and growing interconnection portfolio with CSPs and pure B2B wholesale voice, data and SMS intermediaries. These market participants and stakeholders will benefit from the operational efficiency made possible in part by the work BTL is contributing to the 5GZORRO project.

3.1.6. Altice Labs

As responsible for the R&D and Innovation in the Altice Media and Telecommunications Group, 5G is in our innovation pipeline with top priority. Altice Labs will exploit 5G ZORRO results to support Altice Group to exploit new 5G business opportunities powered by Distributed Ledger Technology (DLT) and data lake technologies with special emphasis on 5GZORRO Marketplace including monetization of available 5G resources in a DLT powered Marketplace and the automation of 5G resource management according to zero-touch principles.

These two lines of work will impact ALB's portfolio of products in the OSS/BSS areas. We are planning at least a couple of webinars in which we will explain the related Business Units the 5GZORRO concepts and approaches, to further understand how these concepts can affect their portfolio items and trim the concrete areas they want us to deeper address in the project.

3.1.7. Intracom

Intracom Telecom intends to integrate project results into its telecommunications products and services (wireless and network systems, telco software, and ICT services and solutions) and to promote them together to its customers or potential customers.

It plans to integrate 5GZORRO results to its fs|cdn® Anywhere platform [40]. The end-to-end fs|cdn® Anywhere platform enables service providers to deliver high-quality video to any television, computer, smartphone or tablet. It smoothly bundles middleware and conditional access offering live TV, video on demand, restart TV, network DVR and TV anywhere over any managed or unmanaged network. The corresponding 5GZORRO results and experiences will be communicated to the Telco SW Business Division, so as to actively contribute to the extension of the existing fs|cdn® Anywhere features. Extensions shall include hooks for dynamic SLA establishment, as well as MANO primitives for service/session migration, adaptive network slicing and corresponding monitoring capabilities.

Moreover, it plans to promote 5GZORRO results to the network operators which commercially operate its fs|cdn® Anywhere platform or plan to install it. It is expected that 5GZORRO results will help network operators to monitor and manage in real-time resources and thus provide guaranteed Quality of Service (QoS) to their customers - users of the fs|cnd Anywhere system in a more efficient and economical way and with less investment in infrastructure. 5GZORRO AI mechanisms for resource usage forecasting and SLA breach prediction cover an immediate need that has become apparent in all installations of fs|cdn® Anywhere to different network operators.

Intracom Telecom, having a clearly extroverted character is already successfully active in many markets for the promotion of products and services It has a network of subsidiaries and offices in a number of countries (indicatively: Russia, Saudi Arabia, South Africa, USA), which will mobilize to take advantage of the project results.

The main customers of fs|cnd Anywhere are located in the USA (where a subsidiary also operates) and this is an important channel for promoting 5GZORRO results to network operators of this country.

In general, 5GZORRO is expected to enhance Intracom Telecom's activities in the media and entertainment sector, providing the technological expertise for the evolution of the current services to future multi-stakeholder, decentralized and distributed environments. In this context, Intracom Telecom aims to establish the technological primitives for the realization of solution offerings, towards 5G operators and media service providers, that will leverage on the cross-domain, intelligent MANO capabilities for the support of rapid, zero-touch offloading of service components in a broader computational environment.

3.1.8. Atos

3.1.8.1. Business Opportunities in the Identified Roles

In the context of 5GZORRO, Atos is positioned as IT service provider and system integrator for CSPs, helping them deploy new services to generate more business value from their networks. Additionally, Atos can also leverage its expertise and act as software vendor of innovative VNFs. In fact, over 220 telecommunications companies, including many tier 1 carriers and telco service providers (Telefónica, Orange, Vodafone, MásMóvil…), are clients of Atos.

The link between the Atos Research and Innovation (ARI) group participating in 5GZORRO and the Atos business units (BU) is played by the Innovation Hub (IH). The Innovation Hub unit was born in 2018 inside ARI to foster and facilitate innovation in Atos. In order to achieve such mission, about twenty business consultants of the IH work in collaboration with researchers, technicians and managers in ARI innovation projects to support them in finding the best way to approach their technological results to the market, to envisage the impact that future research may have and to facilitate the transfer of generated innovative results to the Atos BUs. The IH has the vision, on the one side, of the business activities and general strategy of the company and, on the other, of all research projects that are being developed in ARI. The IH is constantly monitoring them to find synergies and possibilities to reuse and enhance their results in view of new business opportunities.

The Innovation Hub defines an asset as any project outcome owned partially or totally by Atos which can be reusable and exploitable. Reusable as it can be easily reused in a future project or in a commercial solution; exploitable as it can be monetized as service, product or consultancy. Atos expected main asset deriving from its participation in 5GZORRO is the VNF eLicensing. Together with the technical group involved in the project, the IH, that has been involved in the project even from the proposal stage, has detected this opportunity and is planning the exploitation path to follow.

As OSS provider for CSPs, Atos sees a clear commercial opportunity in interfacing the VNF eLicensing component with the NFV MANO to allow the trade of software resources from different entities (multiple software vendors). With the VNF eLicensing functionality, different parties can interact in a reliable manner and assure that all the agreements linked to the VNFs are monitored. Incorporating the VNF eLicensing in their OSS, would give a competitive advantage to CSPs that will not need to install any licensing server in their private networks. Besides, VNFs vendors will benefit from a non-repudiable mechanism for keeping full track of the proprietary resources that have been used, which is indeed another added value of CSPs offering this capability as it establishes a trusted relationship between the software vendors and the Software Resource Consumers.

To materialize this objective, Atos is planning a 5GZORRO exploitation roadmap with different stages and activities. This exploitation plan is supported by a sound communication campaign, during the project lifetime and beyond, to raise awareness and engage with stakeholders, both externally as well as internally in our own company.

3.1.8.2. 1st Stage – Engage with the BU (Already Started)

Make the Telecom Business Unit aware of the latest developments and opportunities in relation to 5GZORRO VNF eLicensing component and support them in designing sales materials and communication messages with their clients.

- Twitter account with key messages that highlight the value proposition of the asset
- Internal Blogs about topics in relation to 5GZORRO liked to the functionalities of the asset
- Internal meetings with the BU where the concrete capabilities of the asset are explained, and potential use cases are identified
- Workshops with clients where these use cases are discussed

3.1.8.3. 2nd Stage – Developing the Assets (To Start when Assets are Ready, Near the End of the Project)

Transferring the research results to generate new business in the company is essential to demonstrate the innovative capacity of Atos. The objective of this stage is then to get internal support for developing the asset further, bring it to a market-ready stage and incorporate it to the sales portfolio, this is the creation of what we call "Shuttle".

Shuttles support the incubation of ARI assets to evolve them to become market solutions reusable for commercial projects. This incubation process entails the assets maintenance and evolution according to a business plan which includes a technical roadmap, estimation of costs and incomes, commercial plan, software repository, set up infrastructure, IP management and a marketing plan.

According to this, the main activities within a shuttle towards creating a market solution are the support to commercial offers and tenders where assets have a role; the support in pre-sales activities, external events or internal ones (like the Atos Digital Show [41] or Atos Innovation Week), workshops, visits to clients; the development of consultancy projects related to the assets technology; pilots development both internal or with clients and, finally, the training to Atos business units and the support to big delivery projects based on the assets.

3.1.8.4. Shared Trustworthy Data

Trust and automation are the main pillars of 5GZORRO project. Trust provided by the DLT enhances the VNF eLicensing asset, facilitating trustworthy management of the licences attached to the VNFs. The VNF eLicensing is based on the metric-based control of the proprietary VNFs in the different domains. In this way, during the operational cycle in the CSP, any action susceptible to be tracked will be added to the DLT. These actions may vary depending on the licensing agreements related to the VNF, such as:

- Deployment/Decommission of the VNF
- Scaling in/out
- Storage GB used >= X GB
- Number of recently active users >= X users
- Active database connections >= X connections

For persisting these actions, the DLT will use a consensus algorithm to achieve agreement on the actions produced among the lifecycle of the VNF. This consensus enables each vendor and service provider to trust on VNF reporting data, which is a key aspect in any commercial transaction.

3.1.8.5. Smart Contracts

When applying zero-touch 3rd-party resource trading and automated network slice adaptation and service instantiation between two or more domains, there are software licensing terms that need to be considered in the agreements between parties. Smart contracts record all terms and conditions in explicit detail, including the licensing agreements and automatically enforce them.

In the VNF eLicensing component, from the vendor perspective, smart contracts permit the establishment of different business models that provide these vendors with enough flexibility to allow the convenient onboarding of the licensing terms. Examples of such business models include:

- Flat: CSP contracts the VNF vendor for a part (or the complete set) of features of the VNFs.
- Pay-as-you-Grow: In this model, the price varies based on one or several parameters of usage of the VNFs (such as the number of instances of VNFs, the number of rules in a firewall, etc).
- Subscription: CSP contracts the right to use the VNF for a period of time.

From the CSP point of view, smart contracts will support:

- Service composition of VNFs from different vendors.
- Vendor independent license token to manage location independent VNFs from third-party edge to core data centre.

These enhanced features empowered by the smart contracts will provide the CSPs with the capability of using their leased products with other proprietary software in all of their premises without extra management, which is an added value for them.

3.1.8.6. Other Applications

Atos Research and Innovation will also investigate opportunities related to improve the efficiency and smart connectivity in the deployment mechanisms and will contribute to the extensions to the NFVO to automate the overall service lifecycle management with seamless use of heterogeneous virtualization platforms. Also, we will contribute providing to 5GZORRO system with the possibility to create service meshes that will allow, in the same service, the utilization of different virtualization method depending on the requirements of the service using NMS to support the heterogeneous network configuration and security. All this knowledge acquired, and experience will position Atos in a relevant place for further projects' proposals and commercial actions.

Besides, we expect to be in a position to influence and align activities with 5G PPP actors and projects, standardization bodies and open source communities to ensure interoperability, and the forefront alignment of our commercial solutions. For instance, Atos is a member of the Technical Steering Committee of Open Source Mano (OSM), so we would be in a position to take 5GZORRO enhancement to this community.

Finally, the integration and (re)use of the results derived from 5GZORRO in further research projects are of key importance for the company, not to mention the key relationships that will be forged during the course of the project, leading to new joint proposals.

3.2. Research Partners

3.2.1. i2CAT

Fundació i2CAT is a non-profit technology centre that promotes R&D and innovation activities in the field of Information and Communication Technologies and the Future Internet. The strategic objectives of i2CAT are: (i) to integrate research, development and innovation; (ii) to foster co-creation using the Quadruple Helix model; (iii) to develop activities within hybrid international and regional framework; and (iv) to create networking and multimedia infrastructures and advanced experimental platforms.

Two research areas, namely Software Networks (SN) and Mobile Wireless Internet (MWI) are actively involved in 5GZORRO project. Right from the beginning of the project, i2CAT plans a multi-pronged approach towards the exploitation of its potential results.

1. The enhancement of its knowledge and competence in the field of ICT with the goal to improve industrial collaborations and attract more research funding for developing innovative solutions (i2CAT assets), in particular enhancing 5GBarcelona testbed for 5G scenarios.
2. The spreading of the knowledge through educational and industry-oriented courses, contribution to open source communities and preparation of specialized teaching material.
3. The improvement of its know-how and IPR portfolio with a long-term plan to attract capital investments and even create new start-up companies.

i2CAT's exploitation plans are focused around the different development activities in 5GZORRO by making improvements on the different modules, which are and will be part of the 5G assets catalogue of i2CAT. These enhancements and new features touch on several areas described next.

One of the i2CAT asset is the 5G Slice Orchestration Engine (SOE) which will be enhanced with new features related to automation, security and support for new technologies to manifest the beyond 5G network vision as per 5GZORRO project. SOE will support for cloud-native container-based VIMs to be able to establish networking across different platforms. New extensions will be added to the Resource Manager, so that it can retrieve (or produce) monitoring data coming (or going to) from a private data lake, for automated data-driven resource management. i2CAT will work on the development of an API to enable registration of resources and service requests onto the native Blockchain, thus enabling 5GZORRO's autonomous interaction with a DLT system. i2CAT will also participate on the deployment and provisioning of the DLT infrastructure. Still in the area of security, and particularly in the Trusted Execution Environment (TEE), i2CAT will participate in the development of a module that will enforce trusted analysis on raw data sources, to conclude observation at all service levels, ensuring secure SLA monitoring. This achieved knowledge will allow to acquire and integrate a TEE which can be deployed in the 5GBarcelona infrastructure. i2CAT plans to develop the extensions required to embed security & trust framework measures at MANO/Slice Mgmt. level to achieve Security and Trust Orchestration. Furthermore, i2CAT will work on the use of secure communications (VPN) across domains (VIM level connectivity) and TEE support at VIM level. I2CAT is a member of ETSI community and will put effort to disseminate the results to related working groups in ETSI, more specifically to ETSI ZSM and ETSI OSM.

I2CAT also plans to develop the concept and initial prototype for spectrum sharing management. By leveraging DLT/Blockchain technologies, the spectrum market platform can provide enhanced interoperability, automation, privacy and trust; key facets to a solution that spans opaque potentially distrusting organisations. Transactional immutability provided by smart contracts that backs the automated trading and monitoring of assets is at the heart of giving rise to these properties of the solution whilst providing stakeholder privacy assurances and legal enforceability.

In order to enforce the smart contracts that determine how acquired spectrum can be used by a stakeholder, a radio configuration and management framework are necessary. Further, a spectrum monitoring and enforcement system will have to be implemented that will take care of contrasting the use of spectrum defined in smart contracts with the actual usage made in infrastructure.

The RAN controller developed by I2CAT, *RACOON,* will be evolved to meet the requirements of the 5GZORRO project. The joint operation of *RACOON* with the aforementioned network slicing and orchestration solution is envisioned to provide full end-to-end 5G resource slicing. *RACOON*'s slicing mechanism could be used to enforce a specific configuration of the RAN when setting up a smart contract, as long as the infrastructure is managed by *RACOON*. As such, it could be demonstrated that *RACOON* is a useful asset, as it reduces the risk of SLA breaches by setting up and controlling the RAN elements with high levels of trust.

I2CAT is currently working on the development of a global scheduler, which forms a basic component for the slicing of the RAN. Beyond this, new features will be evaluated to keep track of the spectrum usage of the RAN equipment and to enable the fulfilment of smart contracts issued by the 5GZORRO platform. All the developments on the RAN controller will be integrated in I2CAT's street-level infrastructure so they are usable in 5GBarcelona or by other/future 5G testbeds.

The above-mentioned enhancements related to automation and security and use of advanced technologies such as artificial intelligence and Blockchain, will not only allow i2CAT to improve its 5G asset catalogue but also the skill set of its team members to meet the demands of beyond 5G market needs.

3.2.2. FBK

Fondazione Bruno Kessler (FBK) pursues innovation among its key objectives, with a vision for the Artificial Intelligence of the future, which is the mission of the FBK Strategic Plan for the decade 2018-2028. FBK acts

as a scientific and technological hub with its premises and platforms hosting a lively ecosystem of co-located ventures, spin-offs, projects and training opportunities. FBK is already working on several spin-offs coming from past framework research projects. Local public bodies are supporting these initiatives, and through the EIT ICT Labs involvement, FBK has been able to attract angel investment for its start-ups.

Research and development activities within the 5GZORRO project will allow FBK to develop 5G experimental platforms focusing on Cognitive Autonomous Network Management comprising both single and multiple domains. The broad spectrum of competencies offered by the consortium and the focus on DLT and data lakes as technology enablers in the context of 5G systems will harness FBK competencies both in terms of theoretical know-how and experimentation platforms. FBK will exploit such competencies to reinforce the collaborations within the local Trentino territory, particularly with local ISP providers (e.g., Trentino Networks) to offer consultancy and transfer of knowledge for better integration between the existing architecture and the future networks.

FBK will exploit 5GZORRO results for:

1. Promoting FBK in the relevant communities through publications and participation in conferences and international journals.
2. Generating Intellectual Property Rights (IPRs) by exploring the patenting of innovative algorithms and approaches developed during the project.
3. Leveraging the implementation activities within 5GZORRO to further strengthen the FBK's 5G infrastructure platform for experimenting with various vertical solutions.
4. License the exploitation of results to third parties.

3.2.3. UMU

UMU has a strong innovation strategy as part of its daily activity. It is usually conducted by technicians of the TTO (Technology Transfer Office) at UMU in collaboration with research groups as the one present in 5GZORRO. As part of our strategy, some significant results from national and international research projects have been developed as POCs (TRL 6-7) and later transferred to the industry. As a result, our team has been developing +20 R&D contracts totalling +2M€ in the last ten years.

In 5GZORRO, all the efforts on trust management, security evaluation, TEEs, secure data processing, and distributed identities applied to Beyond 5G networks in any of the three use cases will be the target of our innovation strategy.

The target audience already identified is composed of agencies and companies at regional, national, and international levels. To introduce the results, UMU will be taking its role as a collaborator or active member in different organizations like the Isaac Peral regional foundation (with top industries in Murcia), RENIC (the national Network of excellence on cybersecurity R & D & I), and various European PPPs.

It is also worth considering the high involvement of the UMU team in the cyber-defence sector, with strong links at national and international levels, including different MoD's, the EDA and NATO, especially regarding the dual-use of technologies as the ones UMU is researching and developing in 5GZORRO.

3.3. Joint Exploitation Opportunities

The individual exploitation plans depicted in the above sections allows us to identify several opportunities for joint exploitation, in addition to current peer relationships that would leverage the collaboration within the project, such as IBM or Atos as Telefonica's solution providers in the IT area, the Joint Research Unit between TID and i2CAT, directly connected with the project goals, or the cross-collaboration in other research projects, in the 5GPPP and the Horizon 2020 programme at large (such as 5GaaS – a product-oriented H2020 FTI project with i2Cat, Nextworks and Ubiwhere, whose focus is also on bringing DLT to the

Telecom space, while fostering interoperability among vendors). These additional exploitation opportunities are related to:

- The collaboration within the ETSI OSM open-source community. ETSI OSM has become the reference network orchestration stack for many European research projects, the community has a long and fruitful experience of cooperating with these projects, and at least five partners are active contributors to ETSI OSM. Reliable data-driven orchestration, integration with smart contracts and security enhancements are the key fields for contributions to ETSI OSM, and their further commercial exploitation.
- The contribution to ETSI standardization activities that can be used to foster different products and product enhancements based on 5GZORRO results. The ETSI groups that combine the participation of a sufficient number of project partners and focus areas within the project targets are ENI and PDL Industry Specification Groups. Trustworthy data sources and processing is a key issue for ENI, focused on data-driven network management, while (permissioned) DLT operational requirements and procedures are the core of PDL. The nature of these ETSI groups makes them welcome not only specific contributions to specifications but exploratory and demonstrative proofs of concept and interoperability assessments, where 5GZORRO software and procedures could be applied since their early stages.
- At least two partners are currently active in the CBAN initiative, and more may join during the project lifetime, as one of the focal points for applying smart contracts within the telco industry. As said above, CBAN initiative aims at ensuring industry-wide adoption of smart contracts along six main paths initially focused to transform current settlement practices among operators, and 5GZORRO results would not only be useful to prove the CBAN recommendations but also demonstrate additional opportunities around resource and function provisioning, consumption and accounting.

Finally, it is worth noting that partners have already idenfitied (in M12) some specific opportunites for joint exploitation as a result of the analysis of the proposed use cases and the components planned to be validated with them. These opportunities include:

- The use of AI-enabled tools for the discovery and selection of third-party resources, applying ranking algorithms on trustworthy data for the automated classification and selection of the most appropriate resources for the target services. This maps to 5G Marketplace with Smart Discovery module in the architecture. The partners involved in this activity include NXW, i2CAT, Bartr, TID, IBM and ALB.
- An intelligent cross-domain slicing solution to enable cloud native, workflow-based declarative approach to service orchestration in 5G. This maps to ISSM & Vertical Slicer modules in the architecture and it involves IBM, NxW, and i2CAT.
- A decentralized identity management solution based on distributed identifiers (DID) and W3C Verifiable Credentials (VC) to manage global and unique identifiers in Telco ecosystem. This activity is part of the 5GZORRO security and trust framework. The partners involved in this activity include ALB and Bartr.

The aforementioned exploitation opportunities are to be intended as preliminary major areas of focus for innovation management and joint exploitation planning of the project.

The Innovation and Exploitation Committee (IEC) of the project will keep updated the aforementioned list in alignment with the project design & prototyping activities, in order to pursue effective exploitation paths for 5GZORRO software artifacts and solutions as well as for their application scenarios in relation to the identified 3 use cases. Future deliverables from WP6 and WP5 will address the business applicability and will report on results of the undertaken actions.

3.4. Impact of Use Case Validation on Business Opportunities

The validation of the use cases considered in the project will allow to refine the opportunities described above, and likely to identify new opportunities that would shape further exploitation of project results. Regarding the proposed use cases and their scope, it is worth nothing that the two first one (on virtualization and spectrum resource allocation and management) are more focused on system validation and platform verification, and they will provide inights the base technologies for resource sharing and multi-domain security and trust. The third case, on pervasive vCDN, is oriented to more holistic scenario, allowing to explore opportunities for vertical applications.

The first use case, on virtualized resource sharing, will focus on validating the implementation of smart-contract oracles and smart-contract libraries, and the capabilities facilitating multiparty resource discovery and allocation processes throughout the 5GZORRO platform. This would translate in a better understanding of how decentralized catalogues of virtualized resources can be builit, holding collections of product offers available to be traded among providers and consumers. What is more, it would be possible to consider extreme situations where resources from end-users (e.g. residential 5G routers) can be also tokenised, facilitating single catalogues where end-customers simultaneously manage 5G service consumption and 5G resources offers.

Spectrum sharing aspires to validate a novel solution, more flexible and easier to manage comparable to previous, centralized approaches, by introducing the novel concept of *spectokens*. Spectokens are non-fungible tokens represent the rights to use spectrum in a location over a duration of time and will be available for sale and trading by appropriately permissioned users. The use of spectokens should not only allow for optimized use of the spectrum, but also enable near real-time, on-demand contracting with an optimal price for the resources being traded. The validation of this second use case will allow to identify the bounds and technical limitations for proofs of trust, and the logic bounds of smart-contract implementations. Several aspects will be evaluated, such as whether to rely on permissioned or permission-less ledgers.

As said above, the third use cases on vCDN service can be considered as an all-encompassing use case that inherits the results from the previous two use cases and further considers some additional ones to validate. The first one includes the evaluation of business models based on zero-touch resource discovery, with infrastructure owners and service providers using a decentralized catalogue. This will be complemented by the applicability of smart resource selection and consumption, and the use of smart contracts for these interactions. In addition, this use case will allow to evaluate licensing schemes of the vCDN service in virtualized environments, and the use of decentralised, tokenised approaches for supporting these schemes.

4. Additional Perspectives

4.1. On Regulation Opportunities

Spectrum is a scarce public good that is paramount to today's societal needs and economic growth. Despite its scarcity, demand for spectrum is constantly on the rise, fuelled by technological and service innovations that leverage the wireless-nature of radio spectrum. Developments in distributed ledger technologies and smart contracts present new promising approaches to spectrum sharing and secondary trading which promote higher market flexibility and speed whilst safeguarding spectrum oversight principles, such as those aimed at promoting competition, trust and transparency.

Spectrum trading creates a market-based process which seeks to ensure that the radio spectrum is used by those who most value it, leading to higher socio-economic gains. Spectrum trading also balances the long-term predictability of competitive awards with incentives that provide flexibility and address dynamic market developments. This may lead to various benefits, including spectrum accessibility to smaller operators and start-ups, opportunities to address shifting demand dynamics and ultimately better consumer choice.

The 5GZORRO approach to spectrum sharing seeks to deliver flexibility and speed to meet dynamic market demand for spectrum through the use of distributed ledger technologies and smart contracts. From a regulatory and compliance perspective, these technologies may also enable more effective oversight. Processes related to the monitoring of interference may benefit from the real-time information and immutable nature of distributed ledgers, promoting trust in the information regarding the actual use of spectrum and the relevant rights and obligations of the respective spectrum users. Smart workflows may also streamline the regulatory processes that may be necessary for the approval of secondary trading, including measures aimed at protecting against market distortion or the illicit use of spectrum.

5GZORRO services may further support competent authorities in maximising the efficient and effective use of spectrum. The 5GZORRO platform and services may also support competent authorities in carrying out their compliance and enforcement procedures. Ultimately, regulators or other competent authorities leveraging innovative technologies such as those enabled by distributed ledger technologies may benefit from enhanced regulatory capabilities, providing an edge in the oversight of this fast and dynamic industry.

4.2. On Impacting the Industry at Large

For the specific activities carried out by Comunicare Digitale in the media, new digital technologies, in the industry digital transformation, in the innovation and efficiency processes for new business models, applied especially in communication actions, events and special initiatives organization, the 5GZORRO project is of particular interest for specific research purposes and 5G applications in the sectors of blockchain, artificial intelligence and data lake.

The 5G sector is considered a strategic point for the main industrial countries, having full awareness that every element of distinction and strength for a large-scale proposition can move very high interest flows, in consideration of the strong demand for services, applications, and cutting-edge solutions for widespread use in industry and on the consumer market.

The natural environment for Telco operatros is that of "coopetition", where they both compete and cooperate with each other. On the one hand, operators compete with each other by trying to win the consumer or wholesale business. On the other hand, they often rely on complementing their own portfolio with certain elements of service that they acquire from their competitors, and on their interoperability with these other operators. The management of such supply chain in an environment coopetition makes natural the introduction of decentralized intermediation systems.

What is more, such an approach does not require to have a single intermediation system but, on the contrary, it allows to consider the extension of this coopetition models to the interconnection of the individual distributed intermediation systems. This would translate into the arbitrary extension of marketplaces, established by whatever the initial agreements among a number of operators, infrastructure owners and regulators, integrating them with other marketplaces applying the same decentralized, coopetition models.

In the following sections we will see how the financial, banking, personal data managed by central institutions, like in the case of the European Parliament, the World Health Organization or the International Monetary Fund, the cross-platform media and primary product markets represent areas of greatest expansion for the expected results of the 5GZORRO project.

5GZORRO purpose of "distributing trust and security" is of strong appeal in different areas of application, as discussed below

4.2.1. Media

Practical examples tied to the interest of effective solutions to improve the business are represented by:

- Reduce significantly copyright infringements.
- Reduce significantly unauthorised access to platforms.
- Exchange of cross-platform content in a safe and rapid way.
- Exchange of information and data ensuring total protection.
- User profiling for offering personalized services, including advertising or third-party services.
- Applications on e-commerce services, SVOD and VOD, subscriptions, and commercial relations with customers.
- Data protection on social platforms and conference solutions

Video traffic on the Internet today represents 71% of the total traffic exchanged; in 2022 it will rise to 82%, representing the real killer application for the future uses of technologies on new generation networks, as for immersive and augmented reality applications.

Thus, in view of the decrease of video offer through terrestrial and satellite platforms, greater penetration of fibre and cable solutions will foster the growth of 5G proposal. It is presumable to foresee that the proposals covered by the 5GZORRO project should obtain a strong interest, precisely in responding to market demands. Otherwise, the market could suffer a strong weakening, as it has already happened in Australia, UK, and Switzerland.

4.2.2. Finance / Banking System

The issue of security is fundamental, threaten by continuous actions that put the entire sector under stress. This happens on the issue of system sustainability, and on data protection, from both, the banking and the end-customers side.

The Banking sector is very worried for two reasons: the continuous updates to guarantee the protection of the system and the costs that are assumed for the necessary updates.

An emblematic case was registered in 2015 by Unicredit in Italy which suffered an important data theft that affected over 3 million customers. The name, surname, phone number and email information were stolen during a hacker attack. The banking institution realized what had happened very late and only in 2019 informed its customers. Even more serious was the fact that Unicredit considered the theft of the "personal phone number and e-mail" as irrelevant data. A low-security attitude emerges, without investment in research and with a considerable margin for improvement.

The development given by security and by the exchange of sensitive information applied to 5G can generate a strong interest on the part of the financial system, to increase trust in its systems and solutions, thanks to effective solutions to create a protected system on operations.

Financial institutions and the main world banks look with interest to these solutions, to offer greater security in operations and data protection, also due to the exponential increase in fraud.

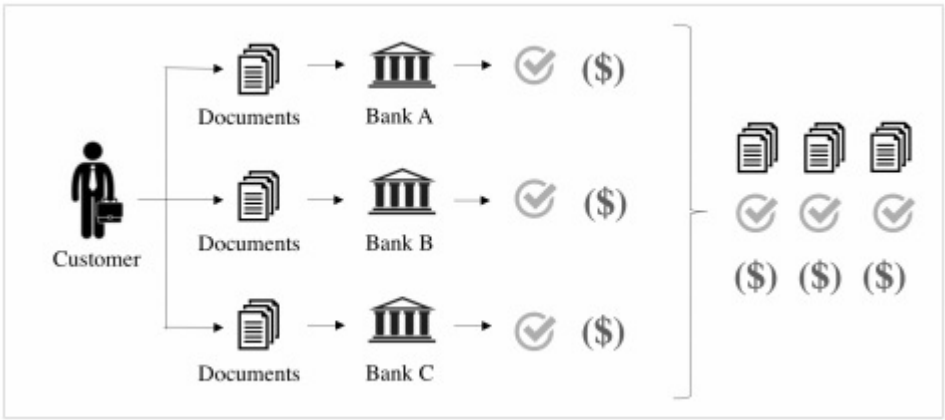
According to the estimates of the European Central Bank, banks have invested over 48 billion euros in the issue of security with priority on data management, "open banking", enhancement of digital channels, infrastructures, management and mitigation of the risks related to intrusion in operations.

41% of these operations took place on mobile platforms, which are not yet ready to "recognize" the protected system that must be guaranteed to the clients.

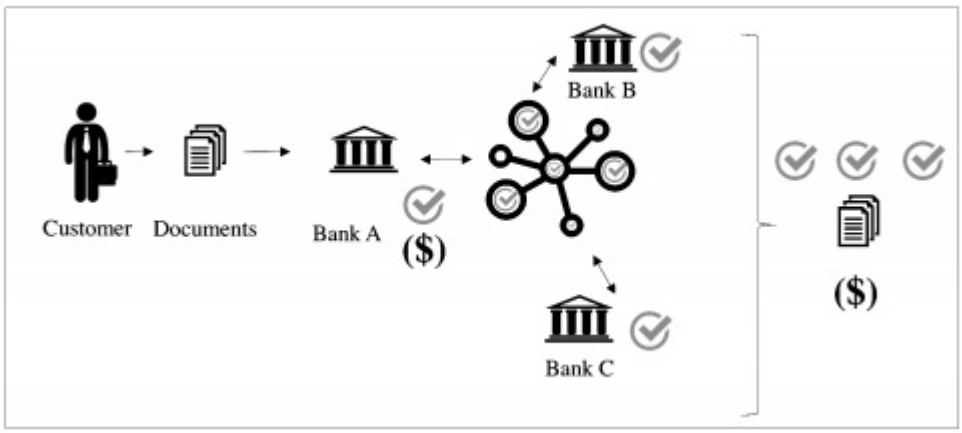
A safe, stable, fast, direct, protected system provided by the telco system, being able to take advantage of 5G solutions, can be the perfect solution to fill an important gap.

For KYC (know your customer), the industry spends $ 540 million per bank every year. A huge figure if we consider all the institutions in the world. There is a strong demand and need to see these costs decreasing while increasing protection and trust in the system.

Work has begun on DLT solutions to guarantee the system reaches these objectives, which can be summarized with these examples:



Current process and KYC costs



New process with DLT application to reduce KYC costs

Figure 4-1: KYC verification based on DLTs

The financial and banking system is confident that "blockchain solutions" will have enormous impact potential in the sector, including payments, contracts and interbank agreements, on electronic identity and profiling, between the various applications.

While the banks are rethinking a new way of organizing, the processes and development of the market, the DLT and the results that the 5GZORRO project will be able to offer with effective solutions will bring the whole sector to converge on these results. These results can make sure the complexity of the activities we carry out online through the security of its encryption, the protection of operations and the security offered in an extended trust environment.

It is clear that the use of DLT represents an improvement compared to other possible technologies, in terms of auditing and tracking. At the same time, this system allows collaboration between financial institutions that do not necessarily trust each other.

With the recent announcement that Quant Network and SIA [42] successfully tested blockchain interoperability to enable cross-platform applications and services in Europe and globally, a DLT business applications era started. Prospects that could bring great benefits to the system

4.2.3. Institutions

The relationships between the main national and regional, supranational, control, surveillance and regulatory institutions are based on the representativeness of the world communities, which must be guaranteed even stronger security, rapid decision-making, and constant control of data. The exchange of sensitive information is also crucial to avoid leaks and thefts with serious risks for people.

In the newly published BEUC [43] document, work must be done to guarantee “the active cooperation among the relevant enforcement authorities, as well as between public and private enforcement bodies."

The recent decision of the European Court of Justice on the Privacy Shields (Europe's Top Court Dismisses EU-US Data Sharing Pact as Invalid 16.07.2020) confirms that it has become fundamental to create trust between the main entities, through shared, collaborative and secure systems, which start precisely by cutting-edge technological solutions, such as DLT, blockchain and artificial intelligence, also because the mass of available information that has increased considerably and accurate control of information is necessary.

By 2025, it is estimated that 463 exabytes of data will be created each day globally. The question is simple: how the European Union is able to offer the security of all processes - from economic to legislative, from industrial sectors to political ones, also in terms of participation, in a "safe, reliable, fast, controlled and protected" way?

The main institutions are looking for a reliable, safe and guaranteed solutions, which excludes cloud and repository models, to start "dedicated data highways" in which the different actors can share sensitive information, in a protected system, controlled and in total safety.

The results of 5GZORRO will be able to demonstrate that in a system of multi operators, between different subjects and differently localized, by country and size, it is possible to obtain important results in terms of response, efficiency and sharing of results, with effects on the real economy, on support for SMEs, on security and trade.

Examples of contrasting unfair commercial practices, for example, have been recorded in Croatia and Greece, where the lack of information sharing, also for language barriers, has created widespread damage to the countries of the European Union.

4.2.4. AI

Although AI is a topic well discussed and presented, there is a long way to go, mainly for two reasons:

- There is not a mature knowledge of artificial intelligence.

- There is not a clear application of AI in production systems.

In the "AI Maturity Survey" [44] report commissioned by Avanade and conducted between 2018 and 2020 by the independent research company Vanson Bourne, that interviewed 1,700 senior IT business decision-makers from 15 countries and five business sectors, were reached important conclusions:

- Only a small part of the companies, despite the mix of higher productivity, efficiency and cost reduction guaranteed by Artificial Intelligence systems, can be defined as "mature for AI".
- Companies that manage to fully integrate AI into their systems can obtain a Roi up to five times higher than the average.
- 95% of respondents believe that AI is fundamental, but only 9% are seriously thinking about it, while 35% are looking for professional figures who can bridge this important gap.

The most disheartening result is that only 1% of companies are truly ready for the challenge.

It is all too clear that those solutions that will be developed especially in terms of "usability and functionality" will determine a great success in the 5G sector.

In addition to the relevant factor of providing greater dissemination and promotion of AI applications in the 5G system, which will allow a deeper knowledge of the applications that will be possible in the various sectors at each level, 5GZORRO can demonstrate that it uses zero-touch automation solutions to obtain various benefits:

- Speed up and fully automate service enabling processes.
- Considerably decrease costs.
- Launch real-time solutions, even to take faster decisions.

Trust is the cornerstone of AI-based automated systems, the most important challenge for 5GZORRO will be evaluating a strong solution that guarantees all-round safety for the multiple operators involved.

4.2.5. Other Sectors

Comunicare Digitale has estimated that:

- For the world museum sector, applications could increase turnover by 34% before 2023 (also calculating the heavy effects of the COVID19 crisis).
- The auction houses could return to surplus after the heavy falls of 2018 and 2019 (- 18% and - 24%) also for main events such as Art Basel, Tefaf Maastricht and Frieze London, considering that the same operators admit that "without blockchain is difficult to open new markets and increase customers."
- The patent sector would have a more effective and faster control in verifying patent infringements (as in the case of VP9 and AV1 in the audio/video sector) in order to guarantee both research and compliance with license payments at a global level.
- Personalized shopping through boundless AR will stimulate the new frontier in the retail market, as shown in the picture.

Figure 4-2: AR Shopping (Source: Qualcomm)

5GZORRO solutions have the potentiality to be applied in different sectors, making an important impact in various strategic industries. In this context, Comunicare Digitale can offer important support to stimulate project awareness, acceptance, and implementation. Comunicare Digitale maintains contact with various stakeholders in the above-mentioned sectors and receives daily requests regarding actual needs from various sectors, to obtain real benefits and strengthen their positions in a competitive market place.

It is necessary to put in place excellent communication initiatives for the sectors of blockchain, artificial intelligence, zero-touch automation, for the numerous requests for new skills and updates in Europe, which are of interest to Comunicare Digitale.

All these also represent areas of greatest expansion for the expected results of the 5GZORRO project. Considering the applications of 5G, the sectors of use extended in the IoT, health, transport, tourism, school, it is obvious that the mission assumed by the 5GZORRO project has an important dimension, with significant impacts, that can generate medium to long term benefits.

5. Conclusions

This document provides an initial analysis of the potential industrial impact of 5GZORRO, structured around the identification of roles and stakeholders, and the main technology trends, identified in the architectural analysis provided by D2.1.

The general framework for industrial contributions along the three technology axes has been described at all the possible levels, including market situation and trends, opportunities for formal standardization, contributions to relevant open source communities, and other industrial collaborative initiatives. The value proposition of 5GZORRO is related to this framework.

Partners have been mapped to the actor roles identified in D2.1, classifying the different types of connections they have with these actors, qualified as a direct actor, as involved through an affiliate organisation, or as being in a position of influence on actual actors. Partners provide their initial exploitation plans within the framework of these actor roles and their mapping on them. Finally, the document analyses two key aspects regarding industrial impacts: the regulatory implications of the 5GZORRO proposals, and the impact on industrial fields beyond telecommunications.

This document sets the ground for further exploitation and dissemination efforts and will facilitate the industrial impact of 5GZORRO during the lifetime of the project and beyond.

Work on consolidation and further expansion of exploitation plans , both for individual partners and jointly within the Consortium, will continue in the project, to capture and quantify emerging business opportunities for 5GZORRO solutions and to maximise use and impact of the developed zero-touch orchestration, trust and security and marketplace solutions.

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