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RESTART

TECHNO-ECONOMIC VIEW OF THE FUTURE OF TELECOMMUNICATIONS

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Project Team:

Edoardo Meraviglia, Mattia Magnaghi, Antonio Capone, Marta Valsecchi, Luca Dozio, Irene Rinaldi, Luca Dell'Anna, Nicola Blefari Melazzi, Ivano Asaro, Claudio Conti, Giulia Asquer

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Executive summary

Abstract

This white paper provides a comprehensive and systemic analysis of the future evolution of the European telecommunications ecosystem. It highlights how technological innovation, economic pressures, and regulatory choices are jointly reshaping roles, business models, and value creation mechanisms. Through a layered ecosystem model and the application of technology and strategic foresight methodologies, the study identifies four alternative future scenarios up to 2040 and assesses their implications in terms of economic value, competitive dynamics, and technological development.

A core contribution of the white paper is the quantitative estimation of the current and future value of the European telecommunications ecosystem, showing that overall growth is positive but highly uneven across layers. While traditional connectivity-related activities tend toward a lower growth, the strongest contribution to the whole ecosystem growth concerns the enabling technologies such as cloud, artificial intelligence, cybersecurity, and data analytics. The paper concludes by identifying key strategic crossroads for industry players and policymakers, underlining that industrial and regulatory choices will be decisive in steering Europe toward more sustainable, innovative, and sovereign digital futures.

The study

This white paper represents the final outcome of a multi-year research effort carried out within the RESTART programme, aimed at understanding and anticipating the evolution of the telecommunications ecosystem in Europe. The study is rooted in the observation that the ecosystem is undergoing a prolonged phase of structural stress, marked by declining revenues for traditional telecom operators, increasing fragmentation of European markets, rising investment requirements for next-generation networks and price competition, and growing competitive pressure from global digital platforms.

The analysis starts with an in-depth assessment of the current market context, highlighting the mismatch between the exponential growth of data traffic and digital service demand, and the limited ability of telecom operators to capture value from this growth. At the same time, telecommunications infrastructures are becoming increasingly strategic for the digital transformation of industries, public administrations, and society at large.

To address these challenges, the white paper adopts a conceptual framework based on the notions of business model, value network, and ecosystem. This approach allows the analysis to move beyond linear value chains and to capture the complex interdependencies among heterogeneous actors operating across different layers of the telecommunications ecosystem.

The research is structured around two complementary perspectives. The AS-IS analysis maps the current European telecommunications ecosystem, identifying activities, actors, business model archetypes, and market valuation. The TO-BE analysis applies strategic and technological foresight methodologies to explore how the ecosystem might evolve under different combinations of technological, economic, and regulatory drivers.

By integrating qualitative insights, quantitative market estimations, and scenario analysis, the white paper does not aim to predict a single future, but rather to define a space of plausible futures. In doing so, it provides a decision-support tool for both industry stakeholders and policymakers, helping them to understand the long-term consequences of present strategic choices.

The layered ecosystem model and market valuation

A central pillar of the white paper is the introduction of a layered model of the European telecommunications ecosystem, designed to represent the full set of activities involved in the creation, delivery, and capture of value. The model is structured into **five interconnected layers**.

At the base lies the **international backbone infrastructure**, which includes global interconnection assets such as submarine cables. This layer is highly capital-intensive, geopolitically relevant, and characterized by a limited number of global players.

Above it, the network infrastructure layer encompasses **wired, wireless, and IT infrastructures**. This includes passive and active access networks, transport networks, towers, data centers, and Internet Exchange Points. This layer is increasingly affected by infrastructure sharing, the emergence of specialized infrastructure providers, and new forms of separation between ownership and service provision.

The third layer consists of **network management, provisioning, and integration activities**. It includes core network functions, network orchestration, virtualization, and IT integration. This layer is undergoing profound transformation due to cloud-native architectures, software-defined networking, and the introduction of artificial intelligence in network operations.

The fourth layer covers **connectivity services and enabling technology services**. In addition to traditional fixed and mobile connectivity, it includes services based on cloud computing, artificial intelligence, IoT, cybersecurity, data management, and edge computing. This layer increasingly represents the interface between connectivity and higher-value digital services.

Finally, the top layer is composed of **digital services and applications linked to connectivity**, often developed for specific industry verticals. These services integrate connectivity with industry-specific knowledge to support advanced use cases in manufacturing, mobility, healthcare, energy, and public services.

Alongside the structural model, the white paper provides a detailed quantitative estimation of the **value and growth dynamics of the European telecommunications ecosystem within a horizon of 5 years till 2030.**

The overall value of the European telecommunications ecosystem is estimated at **€1,142 billion in 2024**, with an expected **compound annual growth rate (CAGR) of around 8%** until 2030. This aggregate figure, however, masks strong asymmetries across ecosystem layers and activities.

The **infrastructure layer** as a whole shows positive but moderate growth, close to **7%**. Within this layer: **wired network infrastructures** account for approximately **€84 billion**, with an estimated annual growth rate of **6.7%**; **wireless network infrastructures** are valued at around **€56 billion**, growing at **6.9%**; **IT infrastructure**, including data centers and interconnection facilities, represents a significantly larger component, with a value of about **€105 billion** and a growth rate of **6.8%**.

By contrast, the **network management, provisioning, and integration layer** shows signs of stagnation or slight contraction. Specifically: **network management and provisioning activities** amount to roughly **€139 billion**, with **zero net growth** expected; **Integration activities** represent about **€20 billion**, with an estimated decline of **-0.6%**. This reflects the increasing perception of these activities as cost centers rather than sources of differentiated value, driven by automation, standardization, and vendor consolidation.

The **connectivity services and enabling technologies layer** grows remarkably. Within this, the **connectivity service** block of activities is valued at approximately **€306 billion**, with an average annual growth rate of **6.8%**. Among these activities, however, **traditional fixed and mobile connectivity services are largely stable**, while **specialized connectivity services**, **IoT services**, and **terminals and chipsets markets** exhibit more dynamic growth patterns.

The most significant growth is concentrated in the **enabling technology services layer**, which includes **cloud computing, IoT platforms, artificial intelligence, data, analytics, cybersecurity, and edge computing**. This layer is valued at approximately **€329 billion** and is expected to grow at a remarkable annual rate of **14.2%**, thus becoming the main driver of value creation within the ecosystem.

Finally, **digital services and applications linked to connectivity** account for around **€103 billion**, but a relatively modest growth rate of only **1.4%** is expected. This indicates that, despite their strategic importance, these services have not yet fully realized their economic potential within the European telco context, instead the value is captured by other non-telco players which develop enterprise services exploiting connectivity as a means to offer digital applications to specific industrial verticals.

Overall, the market analysis highlights a structural shift in value creation: growth is increasingly decoupled from traditional connectivity and instead driven by enabling technologies and integrated digital services, where European telecom actors are currently underrepresented.

Future scenarios and foresight approach

The second part of the white paper is dedicated to a structured **foresight exercise** aimed at exploring how the European telecommunications ecosystem could evolve toward 2040 under different configurations of **technological, economic, and regulatory forces**. The underlying assumption is that traditional forecasting techniques are inadequate for long-term horizons characterized by high uncertainty and structural discontinuities. Instead, the study adopts a strategic and technological foresight approach, which emphasizes the construction of multiple plausible futures and the identification of levers that can steer the ecosystem toward more desirable outcomes.

The methodological process begins with the systematic identification of **signals of change** through extensive desk research, semi-structured interviews with experts, and continuous interaction with the RESTART research community. These inputs are analyzed and synthesized into a broad set of technological, business, regulatory, and societal trends. Rather than treating these trends in isolation, the research aggregates them into sixteen megatrends that capture deeper, long-term forces shaping the ecosystem.

These **megatrends** include, among others, the diffusion of AI-based and cloud-native networks, the increasing integration of terrestrial and non-terrestrial (satellite) infrastructures, the convergence of fixed and mobile networks, the platformization of connectivity through open and programmable network interfaces, and the growing relevance of sustainability, resilience, and energy efficiency. Particular attention is devoted to megatrends that directly affect the distribution of roles and power within the ecosystem, such as infrastructure sharing, network–service separation, mergers and acquisitions, and new forms of collaboration between telco and non-telco actors.

Building on this analytical foundation, the white paper defines **four alternative future scenarios**. These scenarios are not forecasts, but stylized representations that explore how different combinations of megatrends, amplified to their extremes, could reshape the ecosystem and they together delimit the space of possible futures based on the study. The first two scenarios are more conservative and not so far from the current ecosystem situation and short-term trends, whereas the third and fourth scenarios are more innovative and disruptive.

The first scenario describes a slow evolution path, in which current dynamics persist (and, indeed, worsen) and **connectivity becomes increasingly commoditized**, eroding the strategic role and profitability of traditional telecom operators and their ability to sustain significant investments in the coming years. The second scenario envisions a **transition toward a true European single market**, enabled by consolidation (not only at the national level) and the emergence of large, pan-European players capable of sustaining investment and innovation at scale.

The third scenario explores a more structural transformation, characterized by **the rise of infrastructure-centric players** and the diffusion of open, interoperable platforms. In this configuration, the separation between infrastructure and services becomes more pronounced, enabling new business models such as Network-as-a-Service and fostering competition and innovation at the service layer. The fourth scenario further radicalizes this logic by assuming **full infrastructure separation and the widespread adoption of shared platforms** as the backbone of the ecosystem, supported by strong regulatory coordination at the European level that stimulates also the creation of European consortium for digital services within a digital sovereignty strategy.

Each scenario is analyzed along multiple dimensions, including internal value redistribution among ecosystem actors, the overall value generated by the ecosystem, the capacity to expand into adjacent digital markets, and the degree of technological disruption. This comparative assessment highlights that scenarios involving deeper structural change tend to generate higher long-term value and greater technological autonomy for Europe, albeit at the cost of increased complexity in governance and coordination in the short-term.

Importantly, the analysis stresses that the future ecosystem is unlikely to correspond exactly to any single scenario. Instead, it will emerge as **a hybrid configuration shaped by strategic decisions**, regulatory interventions, and external shocks. The scenarios therefore serve as a strategic tool to understand trade-offs, anticipate unintended consequences, and support informed decision-making by both industry players and policymakers.

Strategic crossroads

The final part of the white paper focuses on the **key strategic crossroads** that will critically influence the future configuration of the European telecommunications ecosystem. These crossroads do not represent isolated decisions, but interdependent choices whose combined effects will shape investment incentives, market structures, and Europe's position in the global digital economy.

A first crucial issue concerns **investment in next-generation infrastructures**. The deployment of fiber networks, 5G and future 6G systems, edge computing, and integrated terrestrial–satellite architectures requires sustained and long-term capital commitments. The analysis highlights a tension between the strategic importance of these investments and the weakening financial capacity of traditional telecom operators under current market conditions. Addressing this tension will require new investment models, greater infrastructure sharing, and potentially revised regulatory frameworks that better balance competition with investment sustainability.

Market consolidation emerges as a second strategic crossroads. On the one hand, consolidation can improve economies of scale, reduce fragmentation, and strengthen the ability of European players to compete globally. On the other hand, excessive or poorly governed consolidation risks reducing competition and innovation. The white paper emphasizes that the impact of consolidation critically depends on the broader ecosystem configuration, particularly on whether infrastructure and service layers remain vertically integrated or become increasingly specialized.

A third crossroads relates to the creation of a genuine **single European telecommunications market**. Despite decades of policy efforts, Europe remains fragmented along national lines, particularly with respect to spectrum management, regulatory practices, and wholesale access conditions. The analysis suggests that greater harmonization at the European level could significantly enhance the efficiency and global competitiveness of the ecosystem, but would require strong political commitment and coordination among member states.

Technological sovereignty constitutes another central theme. The growing dependence on non-European providers for critical technologies such as cloud platforms, artificial intelligence, and advanced network equipment raises concerns about strategic autonomy, resilience, and value capture. The white paper discusses the potential role of coordinated European initiatives, such as a European Cloud and AI consortium, in mitigating these dependencies, while acknowledging the substantial challenges involved in building credible alternatives at scale.

Finally, the **decomposition and recomposition of the ecosystem between infrastructure and services** represents a structural crossroads with far-reaching implications. Moving toward greater separation can foster specialization, innovation, and transparency, but also requires robust governance mechanisms to ensure fair access, interoperability, and long-term investment incentives. The analysis underscores that no single organizational model is universally optimal; rather, the effectiveness of different configurations depends on how well they align with technological trajectories and regulatory objectives.

In conclusion, the white paper argues that the future of European telecommunications depends on coherent strategic and policy choices made today, as well as on sustained research and innovation. Addressing challenges such as regulatory, legislative, and policy constraints, high spectrum costs, and market fragmentation must be accompanied by targeted R&D efforts that deliver tangible developments and real-world applications. Telecommunications should be viewed not merely as an ecosystem under stress, but as a foundational enabler of Europe's digital transformation. Steering the ecosystem toward scenarios that combine innovation, sustainability, and strategic autonomy will be essential to ensure long-term economic growth, competitiveness, and social cohesion across the European Union.

Foreword

In a context marked by persistent economic challenges and rapid technological acceleration — placing significant pressure even on major industry players — it becomes essential to explore plausible future scenarios. This white paper aims to examine the evolution of the European telecommunications ecosystem through to 2040, taking into account not only business models and market structures, but also the associated technological and regulatory implications.

The analysis is the outcome of a multidisciplinary effort by management and telecommunications engineers, who combine their expertise to deliver a comprehensive and integrated perspective. Each scenario is presented with an appropriate level of detail, examining all key variables to enable a thorough understanding of its implications. This approach aims to provide market participants and policy makers with the most complete possible view of future developments in the telecommunications ecosystem, from both strategic and economic perspectives.

The objective is not merely to identify future scenarios, but to map potential development pathways and help industry players prepare for forthcoming change. Prospective analysis enables the assessment of the long-term consequences of current decisions, the identification of emerging challenges and opportunities, and the formulation of effective risk management and growth strategies. Moreover, it supports decision-makers in navigating potentially disruptive situations by offering guidance on how to steer the ecosystem toward scenarios considered more favourable or desirable.

Finally, we wish to highlight the importance of this work in promoting a foresight effort on other European ecosystems as well, so as to replicate the same methodology used in this project with common goals for the future of whole European Union. Indeed, the importance of imagining a future and trying to direct its realisation is an act that must be undertaken to restore value and relevance to a Europe of 450 million citizens[1], 32 million companies[2], and €18 trillion GDP[3], making it the world's third largest economy.

[1] https://it.wikipedia.org/wiki/Unione_europea
[2] https://www.infodata.ilsole24ore.com/2024/01/06/quante-aziende-operano-nellue-leconomia-europea-in-numeri/
[3] https://european-union.europa.eu/principles-countries-history/facts-and-figures-european-union_it

1. The state of the telecommunications market

The telecommunications value network is undergoing major technological, business, and regulatory transformations. With this project, the RESTART research program aims to identify the most likely future evolution scenarios of the telecommunications industry in Italy and internationally, beginning with the identification and analysis of ongoing changes.

The first chapter of this white paper provides background information on the telecommunications market and its dynamics, based on different perspectives. Initially, the narrative describes market trends at the global and European levels, and lastly at the Italian level. This is followed by an analysis of the level of competition and market dynamics. the chapter ends with some considerations on the impact of the various digital markets in the telecommunications sector.

1.1. Global market evolution in recent years

According to estimates by the Mediobanca Research Are[4], the revenues of global telecommunications operators in 2020 amounted to EUR 1176.4 billion, and grew in four years by +8%, thus reaching a value of EUR 1269.8 billion in 2024, a figure that is growth compared to the previous year (2.2%).

From a revenue composition perspective, 2024 clearly highlights the transformation currently underway in the sector. Voice services grew by only 1.4%, device sales by 0.9%, while wholesale revenues increased by 1.8%. The only truly dynamic component is represented by ICT services, which recorded a 5.4% increase, confirming their role as the main driver of future growth. This trend indicates that telco growth no longer stems from the traditional core business, but rather from the ability to evolve toward models closer to those of technology companies, integrating cloud, cybersecurity, data centers, IoT, and advanced digital solutions for enterprises and public administrations.

The Asia-Pacific region grows the most, rising from 418.0 billion in 2020 to 523.8 billion in 2024, registering +25% growth. It is also the region with the highest growth rate in 2024, reaching +3.8% over 2023. The positive results continue, albeit weakened, in the first half of 2025, which marks a +2.5% year-on-year increase.

The EMEA (Europe, Middle East and Africa) region increases its value by +10% in 4 years. In 2020, it was worth EUR 358.0bn compared to EUR 393.4bn in 2024, essentially stabled compared to 2023. However, ASM estimates a pro-forma trend of +1.5% year-on-year. The increase continues in the first half of 2025 (+2.8%)

In the same period (2020-2024), Americas Telco revenues fell from 400.4 to 352.6 in 4 years. 2024 shows a positive rate (+0.8%) compared to 2023.

[4] Le maggiori telco mondiali (2020 – 2025), ASM, 2025

1.2. The market situation in USA and China

In the United States, telecom revenues continue to reflect a structurally stronger ability to generate value compared with other mature markets, supported by a concentrated market structure, higher ARPU levels, and more effective monetization of data services. In 2024, the two largest US operators alone generated revenues comparable to those of entire regional markets: Verizon reported revenues of €129.7 billion, while AT&T reached €117.8 billion, ranking second and third globally among telecom operators by turnover.

Revenue growth in 2024 was modest but positive, driven primarily by mobile service revenues, fixed wireless access, and enterprise solutions, while traditional voice services continued their structural decline. Pricing discipline, limited competitive fragmentation, and the widespread adoption of premium and unlimited plans allowed US operators to partially offset cost inflation and sustain margins. Importantly, the United States stands out for its earlier and more effective monetization of 5G, particularly in business-to-business applications and broadband substitution via fixed wireless access.

In the first half of 2025, revenue trends in the US market remained broadly positive (+2.5%), though increasingly characterized by maturity rather than acceleration. Service revenue growth continued at low single-digit rates, supported by enterprise demand, network upgrades, and value-added services, while consumer mobile revenues showed signs of deceleration due to market saturation. Net subscriber additions slowed, shifting operators' strategic focus from customer acquisition to retention, upselling, and ARPU stabilization. Investment dynamics in early 2025 also played an indirect role in revenue quality. Capital expenditure increased by approximately 6.6% year on year, with spending concentrated on stand-alone 5G networks, network densification, and enterprise-oriented solutions.

China represents a fundamentally different revenue model, shaped by scale, regulation, and strategic policy objectives rather than pure profit maximization. In 2024, Chinese operators dominated global revenue rankings in aggregate, with China Mobile generating €137.2 billion in revenues, making it the world's largest telecom operator by turnover. China Telecom followed with €69.8 billion, while China Unicom recorded €51.4 billion. Combined, the three major operators account for a revenue base that exceeds that of any other national telecom market.

Despite this scale, revenue growth in China remains structurally moderate. The market is already highly penetrated, with limited room for subscriber expansion, and ARPU levels are significantly lower than in the United States. Revenue growth in 2024 was therefore driven less by customer additions and more by service mix evolution, including cloud services, industrial internet solutions, data services, and government-driven digitalization projects. Traditional consumer mobile revenues continued to grow only marginally, reflecting intense price discipline and regulatory oversight.

A key distinguishing feature of the Chinese revenue model is the deep integration between telecom operators and the broader digital and industrial ecosystem. Telecom revenues increasingly reflect upstream and downstream linkages with cloud computing, smart manufacturing, logistics, energy management, and public-sector digital infrastructure. This contributes to revenue stability, albeit at the cost of lower margins compared with US peers.

In the first half of 2025, Chinese telecom revenues continued to grow at measured, low single-digit rates (+0,4%), consistent with a market that is both mature and strategically managed. The ongoing expansion of 5G stand-alone, which now accounts for roughly 77% of 5G connections, supports incremental revenue generation from enterprise and industrial applications rather than mass-market consumer services. Growth in cloud, data centers, and sector-specific digital platforms partially offset the stagnation of traditional mobile services. From a financial perspective, the first half of 2025 confirms that Chinese telecom revenues are stable, predictable, and policy-aligned, rather than growth-maximizing. Operators continue to prioritize network coverage, technological leadership, and national digital objectives, accepting lower ARPU and margin profiles in exchange for scale, resilience, and long-term strategic relevance.

1.3. The market situation in Europe

Compared with the United States and China, Europe represents the structurally weakest revenue environment among major global telecom markets, which reached around €246 billion of revenues in 2024[5], despite its large population base and advanced infrastructure. In 2024, European telecom revenues showed low growth, reflecting a combination of intense price competition, market fragmentation, regulatory constraints, and limited pricing power. While some national markets experienced modest recovery, overall revenue dynamics remained subdued and significantly below those observed in the US and Asia-Pacific.

One of the defining characteristics of the European market is its extreme fragmentation. With approximately 593 million inhabitants, Europe is served by 34 mobile network operators (MNOs) and more than 350 MVNOs, resulting in highly competitive national markets with limited scope for economies of scale. This structural feature continues to exert downward pressure on ARPU and restrict operators' ability to translate traffic growth into meaningful revenue expansion. As a result, even in 2024, revenue growth was largely nominal and insufficient to offset inflation and rising network costs. Consumer mobile and fixed revenues remained broadly flat, while wholesale revenues increased only marginally. As in other regions, the most dynamic component was represented by ICT and enterprise services, although from a significantly smaller base compared with the United States and China.

The first half of 2025 confirmed these trends rather than reversing them. European telecom revenues continued to grow at very low single-digit rates (+1.1%), with marked differences across countries. Markets with more consolidated structures or supportive regulatory frameworks showed slightly better performance, while highly competitive markets remained under pressure. Overall, the

[5] State of Digital Communications, Connect Europe, 2025

European revenue trajectory in early 2025 can be characterized as fragile stabilization rather than recovery**.**

A critical factor limiting revenue growth in Europe is the slow monetization of 5G. Despite high levels of capital expenditure in both mobile networks and fiber infrastructure, the economic return on these investments remains weak. In the first half of 2025, only about 2% of European mobile users were connected via 5G stand-alone, compared with 25% in the United States and 77% in China. This technological lag constrains the development of advanced, high-value use cases—particularly in industrial automation, mission-critical communications, and low-latency services—and keeps European operators largely reliant on traditional connectivity revenues.

From a strategic perspective, European operators increasingly view enterprise and ICT services as the primary avenue for revenue diversification and growth. However, progress in this area remains gradual. Scale limitations, fragmented demand, and competition from global cloud and technology providers restrict the ability of telcos to fully capture value along the digital services chain. As a result, while ICT revenues continue to grow faster than traditional services, they are not yet sufficient to materially alter the overall revenue profile of the European sector.

In financial terms, the first half of 2025 also highlighted the continued tension between high investment requirements and limited revenue growth**.** European operators maintain elevated CapEx levels to support fiber rollout, 5G coverage obligations, and network modernization, yet the corresponding revenue uplift remains modest. This dynamic weighs on free cash flow generation and constrains balance sheet flexibility, reinforcing the structural gap between Europe and more profitable telecom markets such as the United States.

As shown in Connect Europe's 2025 report, different levels of fixed coverage can be found in different global areas, with Europe offering FTTH*(Fibre to the Home*) coverage to 70.5% of the population in 2024, and 82.5% in the case of all Gigabit-capable networks. In terms of FTTH coverage, Europe remains at a higher percentage than the United States (54.8%) and South Korea (67.4%). However, it is still a long way from the results achieved by China, which managed to achieve 99% coverage of the population thanks to a law implemented in 2013 requiring new buildings to have FTTH access. Lower results are also achieved for the mobile network. Europe will achieve 5G coverage of 87 per cent of the population in 2024, while the other areas reach significantly higher levels (USA 98 per cent, South Korea 99 per cent, Japan 97 per cent and China 90 per cent)[6].

It is useful to note that 5G coverage is not always "stand-alone in nature, i.e. with a Core Network based entirely on 5G technology but is developed on the former 4G ePC*(evolved Packet Core*) Core Network. This does not guarantee to exploit the full potential offered by 5G, such as low latency and high reliability, nor to develop advanced connectivity services such as traffic quality differentiation and *slicing* (division of the network into virtual "slices" with their own services and transmission resources). The deployment of such networks can be estimated at significantly less than 40% of the

[6] State of Digital Communications, Connect Europe, 2025

EU's populated areas (lower than 91% in North America and 45% in the Asia-Pacific area)[7]. According to a study by the European Commission[8], regarding the investments required for European infrastructure development, an investment of around EUR 200 billion will be needed to reach the Digital Decade targets for Gigabit and 5G connectivity. Respectively, EUR 148 billion to develop a stand-alone fixed and mobile 5G network, and between EUR 26-79 billion for full coverage of transport corridors such as roads, railways and maritime lines. In addition to terrestrial connectivity, further investments are needed for the integration of advanced satellite services that provide complementary solutions for the relaying of mobile radio stations*(backhaul*), the connectivity of devices in remote areas not covered by terrestrial technologies, and to ensure continuity of service in the event of crises or disasters.

Narrowing the focus to the major European countries only, and comparing the results of the 2010-2024 period, the Asstel Report on the Telecommunications Sector 2025 shows that between 2010 and 2024, the main European countries saw a general decline in revenues, albeit to different degrees. In 14 years, Spain loses EUR 8 billion (-23%), France EUR 6.1 billion (-11%) while on the other hand Germany and UK recorded revenue growth of €0.1 billion (+0.1%) and €1.1 billion (+1.0%), respectively. Italy, on the other hand, lost EUR 13.9 billion in revenues, a drop of around 33% compared to the levels reached in 2010. In the same timeframe, no country records worse results. Moreover, in the last three years, France and Germany, show signs of recovery in revenues, while Italy recorded an overall +3% increase in revenues[9].

In 2024, the various countries show a growth. Spain is the country that grows the most and reaches EUR 26.6 billion in revenue. France and Germany grew by +1% and reach EUR 47.1 billion and 61.1 billion, respectively. The United Kingdom recorded a growth of +1.5% on the previous year, reaching revenues of GBP 34 billion.

[7] State of Digital Communications, Connect Europe, 2025
[8] https://digital-strategy.ec.europa.eu/en/library/investment-and-funding-needs-digital-decade-connectivity-targets
[9] The figure for 2024 is not directly comparable with those of previous years, as from 1 July 2024 the separation of network activities between TIM and FiberCop was completed. FiberCop is the company responsible for the management and development of the secondary fiber-optic network infrastructure (last mile). This change altered the consolidation perimeter of the data, as until 2023 revenues generated by FiberCop towards TIM were not accounted for, being within the same group

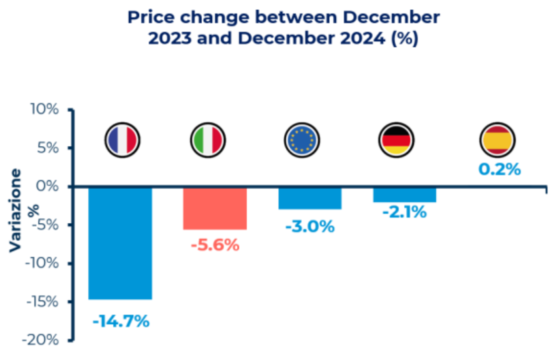

Figure 1a - % change Dec. 24/Dec. 23

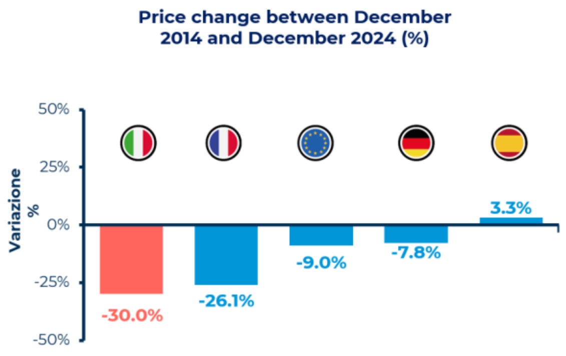

Figure 1b – % change Dec. 24/Dec. 14

Another figure of particular interest is the price trend in the various countries, although this is not directly linked to the dynamics of the ARPU, as it may depend on price reductions by only a few market players. According to AGCOM data[10], prices for electronic communications in the main European countries (Figure 1a) saw a general upward trend between December 2024 and December 2023, with Spain registering the largest increase (+0.2%) and France the steepest decline (-14.7%). Italy also recorded a decrease with -5.6%. Extending the time horizon to 10 years (Figure 1b), in fact, Italy is the country that saw the sharpest contraction (-30%), which is much higher than the EU average (-9%).

1.4. The market situation in Italy[11]

As already mentioned, and as the Asstel Telecoms Report well highlights, Italy's situation is particularly critical.

Considering the operators' gross revenues (Figure 2), which include both consumer and business customers' expenditure and intra-operator revenues, in 2024 Italy records an overall +3%, with the fixed market managing to offset the losses recorded by the mobile market. In 2024, a total value of just over EUR 28 billion is therefore reached[12].

On the fixed market, the physiological reduction in "voice" revenues continues to have an impact, which is countered by a slight growth in revenues from data and interconnection services between Operators. It is, however, the other revenues item (in particular ICT services) that has the greatest growth (+19%), providing the impetus for market recovery.

[10] Osservatorio sulle Comunicazioni N.1/2025, AGCOM
[11] Rapporto sulla Filiera delle Telecomunicazioni in Italia 2025, Asstel, Osservatori Digital Innovation
[12] The figure for 2024 is not directly comparable with those of previous years, as from 1 July 2024 the separation of network activities between TIM and FiberCop was completed. FiberCop is the company responsible for the management and development of the secondary fiber-optic network infrastructure (last mile). This change altered the consolidation perimeter of the data, as until 2023 revenues generated by FiberCop towards TIM were not accounted for, being within the same group

The decrease in the mobile market, which loses around EUR 300 million compared to 2023, is mainly related to the strong competition that has caused further price reductions and the repositioning of customers on bundle offers that lead to a lower overall ARPU level or more services for the same price. In percentage terms, the mobile market continues to account for about 42% of the total.

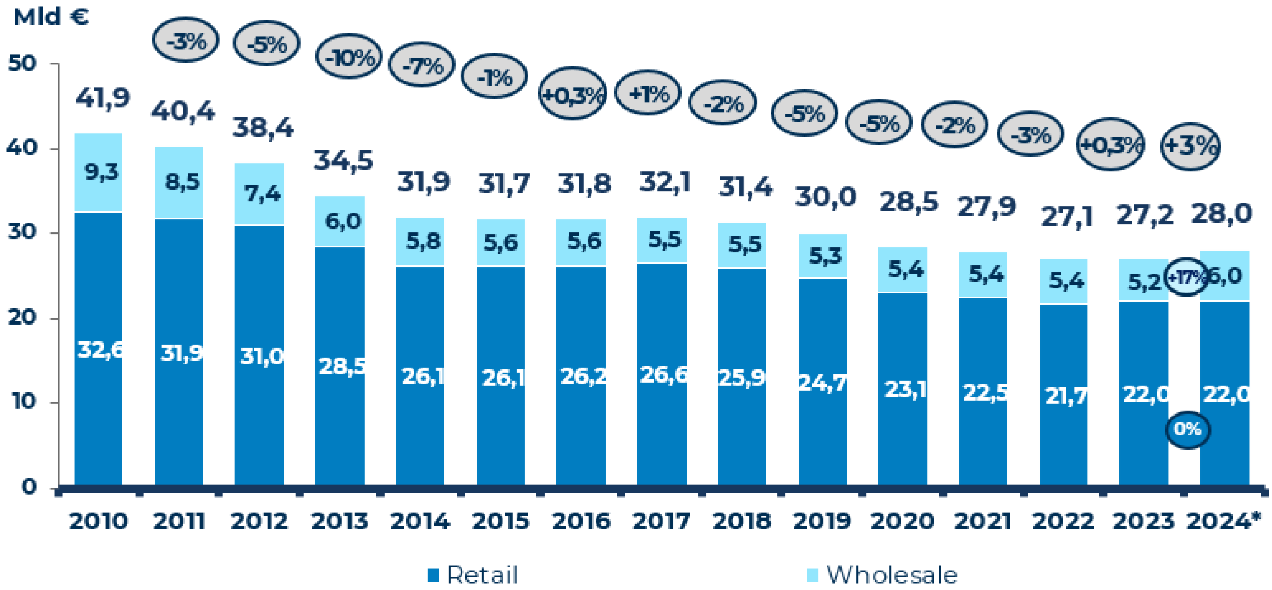

Figure 2 – TLC Operators' gross revenues in Italy: Retail vs Wholesale

If revenues are split between an intra-operator intermediate services component and a retail component, there is respectively a growth and a stability over 2023. The intermediate services component grew by 17%, mainly driven by fixed network revenues following FiberCop's entry as a wholesale operator, which, after the carve-out, also included TIM in its customer portfolio. Net of the effects of this transaction on the overall figures, growth in the fixed market would have been much more limited. The retail component amounted to €22.0 billion and showed a stabilization driven by opposing dynamics. Fixed retail revenues increased, supported in particular by growth in data services and ICT services revenues; by contrast, the mobile market continued to record a decline, mainly due to the competitive environment, which led to further price reductions and to the repositioning of customers toward bundled offers with a lower overall ARPU (or more services at the same price). The retail component lost more than EUR 10.5 billion since 2010, or 33% of the initial value. In this case, the reduction in fixed telephony consumption and the reduction in prices (and consequently in ARPU) caused by competition, which is particularly relevant in the mobile sector, have an impact on revenues.

A further element weighing on the sector is the increase in costs, which experience a higher growth than that of revenues and increase by +3% in 2024, reaching a total value of EUR 20.3 billion. The cost dynamic is due to several factors. A first aspect is related to an increase in costs for the purchase of raw materials, due to higher purchase volumes of goods and equipment, and in costs for services such as, for example, marketing costs and, even more relevant, energy costs. Also weighing on the sector is the high inflation recorded in Italy, which also affects operators' CapEx*(Capital Expenditures*) investments. Looking back over the last 14 years, the amount of costs fell by around EUR 5 billion compared to 2010 (-20%), with a smaller contraction in revenues. The higher revenue growth in 2024 leads to a slight increase in EBITDA *(Earnings Before Interest, Taxes, Depreciation, and Amortisation*), which rises to €7.7 billion (+2.5%).

In this context of a struggling market, telcos have continued to invest, although in recent years there has been a decline in private investment. Up to 2023, telcos nevertheless managed to keep the CapEx-to-revenue ratio stable at 26%. In 2024, a 4% drop in private investment is recorded, bringing it to €6.5 billion and reducing the CapEx/revenue ratio to 23%. If not only private investments but also those co-financed by public funds—such as the PNRR—were taken into account, the value of investments in 2024 would amount to €7.7 billion (up 10% compared to €7 billion in 2023). These investments are necessary for the realisation of the broadband infrastructure with VHCN*(Very High Capacity* Networks) and 5G networks, which is essential for developing the country's connectivity. In addition, they create revenue and support employment for other players in the chain.

If the full value of investments borne by operators were considered (including both private investments and those advanced by operators but supported by public funds and reimbursed over several years), the EBITDA – CapEx indicator would show a declining trend, highlighting how operators' entire margins are being absorbed by investments. In 2010, the sector had more than €10 billion available (the result of EBITDA minus CapEx), equal to 21% of revenues, for servicing financial debt, paying taxes, and remunerating shareholders. Over the past 14 years, this figure has fallen by 99%, reaching €0.02 billion.

The stabilisation of investments can be attributed to the conclusion of some of the work on mobile networks begun in previous years, offset by investments in the modernisation of fixed networks and the development of networks with FTTH technologies. Making an overall estimate since 2010, telecommunications operators have invested EUR 101 billion in the development of the country's broadband infrastructure. This figure rises to almost EUR 115 billion if investments for the purchase and renewal of licences are also taken into account. To get a clear picture of the operators' margins, it is useful to compare EBITDA and CapEx. In 2024, the EBITDA – CapEx indicator (including both private investments and those advanced by operators but supported by public funds and reimbursed over several years), show a downward trend, with a value of EUR 0.02 billion. These values clearly highlight the difficulties in generating margins for operators, who are struggling to cope with the investments required to adapt the infrastructure to the new technological paradigms, which require not only infrastructural investments, but also investments in IT for the digitisation and evolution of internal processes. If in 2010, therefore, the sector had more than EUR 10 billion (EBITDA – CapEx result), equal to 21% of revenues, to service financial debt, pay taxes and remunerate shareholders, the figures of the last three years show a situation that poses strong question marks over prospective sustainability.

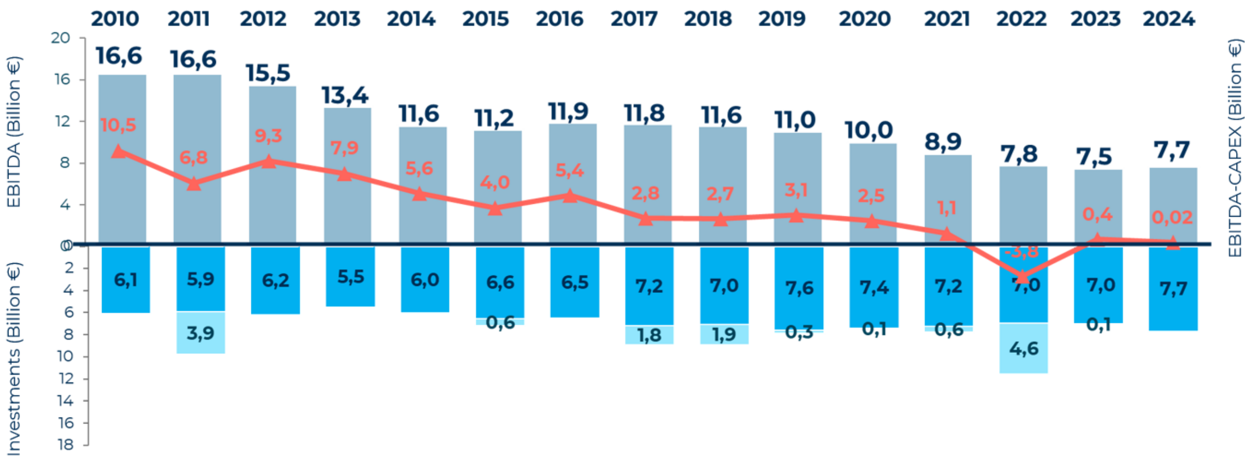

Figure 3 – EBITDA and CapEx of Telecom Operators in comparison

In a trend completely opposite to that of revenues, data traffic volumes continue to grow in Italy, both on fixed and mobile, with the former growing by +12% and the latter by +14% over the previous year. Over the years, mobile data traffic has greatly increased its weight on the total, rising from 4% in 2010 to 21% in 2024, and this percentage continues to grow over the years. The progressive traffic trend highlights the importance of investing in infrastructure that can guarantee availability and quality of broadband service.

1.5. The competitive scenario in the telecommunications market

The spread of digital services and continuous technological innovation are expanding the competitive scope of the industry, with companies from different sectors entering the telecommunications market. The telecommunications sector is at the center of society's digitization process and becomes an enabler of this transformation, not only having to provide the infrastructure on which connectivity is based, but also designing and developing new digital services that can meet society's needs. The entry of new global players from other sectors has contributed to intensifying competition, altering the industry balance and causing extensive supply chain transformations. The current telecommunications market scenario has driven an expansion of supply chain offerings that extend beyond mere connectivity into digital services. The changes affect both upstream and downstream portions of the supply chain. On the one hand, upstream changes involve infrastructure sharing, *network slicing*, and software transformation of network architecture that open the door to new cost optimization opportunities. On the other, downstream changes include broadening the role of operators in digital markets that places them before new challenges in terms of competition. Indeed, the convergence of telecommunications and digital markets causes the potential entry of other players, such as Big Techs, into the core telecommunications services market and, conversely, forces operators to face competition in the digital markets they decide to enter.

A comparison on revenues over the 2012-2021 decade (Figure 4), highlights an opposite trend between revenues from global telecommunications and from large digital platforms operated mainly by leading CAPs (Content and Application Providers), also known as OTTs (Over The Top) and of which Big Techs are the largest players. It is clear from Figure 4 that while the telecommunications market has remained more or less stable over the years, slight fluctuations notwithstanding, the digital platforms market has grown rapidly, with a high point certainly boosted by the two-year pandemic period but that was already underway before 2020[13]. These global players have changed the dynamics of the market, deeply influencing its evolution.

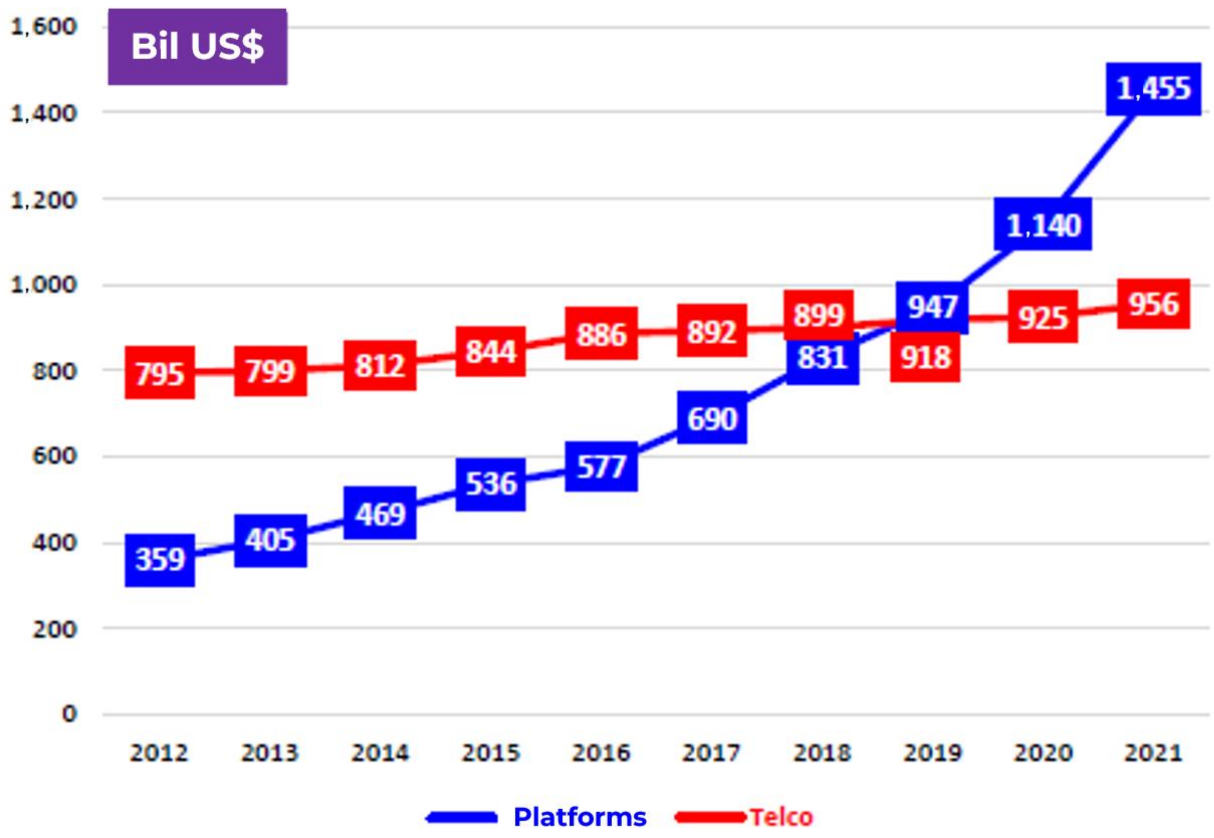

Figure 4 – Telecommunications and digital platform revenues compared

The effects of the entry of these players on the industry are not limited to a potential increase in competition within the sector, but also result in a sharp increase in demand for connectivity that causes pressure on the infrastructure. So while telecom operators and Big Techs are competitors, they should be able to generate a beneficial cycle of events that currently remains unseen. Indeed, ideally OTTs

[13] Digital platforms and Telcos "worldwide" Consolidated economic equity and income evidence, AGCOM, 2022

should develop innovative network-based services, helping to generate consumer demand for connectivity services. In this way operators could reinvest their revenues to innovate infrastructure, providing new opportunities for OTTs and starting a new cycle. However, due to various circumstances at the moment there is no equitable redistribution of value, but there are strong imbalances in favour of the OTTs[14].

This positive interaction does not occur in Europe mainly for two reasons: uneven bargaining power between the two parties and a lack of a consistent regulatory framework. Regarding the first aspect, it is important to highlight strong size disparity. In recent years, digital platforms have grown tremendously in terms of revenue and market capitalization, offering services that have now become an integral part of consumers' everyday life. Needless to say that as regards market capitalization, Google, Facebook, Apple, and Amazon are each larger than the entire European telecommunications industry. In addition to the imbalances regarding size, is also the fact that *retail* network operators are forced to cope with increasing consumer demand for data-intensive OTT services, for which, however, they cannot respond to by raising prices and, on the wholesale side by increasing traffic for such services. Therefore, once again, network operators cannot act on prices whereas service providers may decide to avoid the increase by diverting their data traffic to other operators[5].

The imbalance in bargaining power is at least partly attributable to the lack of a consistent regulatory framework between telecom operators and OTTs. Strong competition in the EU retail telecommunications markets, in combination with regulatory actions at the wholesale and, to some extent, at the retail level, has contributed in lowering the profit margins of traditional telecommunications revenue streams. Direct or indirect regulatory constraints leave network operators with little or no opportunity to raise prices for retail services to address increased production and investment costs. In contrast, up to now OTTs have not been governed except through measures aimed primarily at regulating the dynamics with users, as, for example, in the recent Digital Markets Act[15].

In terms of market fragmentation, as mentioned in Section 1.1, the levels vary depending on the area, which also has effects on competition within the various markets and consequently, on the results achieved. In the Chinese context, for example, there are only three state-owned operators controlling the entire domestic market. The European market, by contrast, is heavily regulated in the opposite direction and consolidation within the market is arduous because it is often prevented by regulatory authorities. As a result, the composition of the sector is quite different than in other similarly advanced economies. The fixed line broadband market is also highly regulated and offers multiple entry opportunities for operators that do not invest in proprietary infrastructure. This elevated fragmentation hinders the development of operators struggling to make the necessary investments

[14] Europe's internet ecosystem: socio-economic benefits of a fairer balance between tech giants and telecom operators, Axon Partners Group, 2022

[15] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/digital-markets-act-ensuring-fair-and-open-digital-markets_en

and the increasingly strong competition against global players traditionally beyond the telecom perimeter.

The fragmentation within the Italian context is among the highest in Europe. In fact, in Italy, even after Fastweb acquired Vodafone Italia, there are 4 infrastructure operators and 20 MVNOs (Mobile Virtual Network Operators). Operators that, although they do not hold licenses to access and use spectrum, provide mobile services by relying on the networks of others. The fixed line market is also becoming increasingly crowded with recent entries including Iliad (January 2022), Virgin Fibra (October 2022) and Enel (June 2023)[16]. High fragmentation and the continued downward trend of prices, particularly significant in the mobile market, have led to a dramatic reduction of operator profitability. In addition, with such affordable prices for consumers, mobile connectivity becomes a competitor for the fixed line network as well: with packages that provide unlimited GBs, consumers may decide to go for only mobile connectivity, with no need for a more stable and high-performance connection such as a fixed line.

1.6. The impact of new digital technologies on the market

As we have seen, new digital technologies are increasingly entwined with the telecommunications sector, opening up new market areas for operators. Within this digital transformation, operators serve as enablers of this change in their capacity as connectivity providers, but they often find it difficult to capture market value. How technological changes contribute to changes in the telecommunications ecosystem will be addressed in Chapter 4. Here we simply list some market data and considerations of how new technologies already play an important role.

One of the technologies on which the telecommunications industry has placed high expectations with the arrival of 5G is Mobile Private Networks (MPNs). Implementation of this type of network is growing globally, with 537 networks registered through the second quarter of 2023. According to estimates by the 5G & Beyond Observatory of the Politecnico di Milano[17], Europe is also witnessing the development of private 5G and LTE networks, with 117 such projects registered, mainly implemented in the manufacturing sector, particularly automotive and logistics. Italy is also starting to invest in this area, with 7 new MPN network projects identified in 2023. In this field, telecommunications take pride on a number of distinctive features and specific assets that make it a center of expertise that cannot be easily replaced and grants a competitive advantage that constitutes a great opportunity for expansion.

Cybersecurity is also a market of potential interest for the telecommunications industry. Due to the increased risks of data breaches resulting from the growing spread of digital services, the cybersecurity services market is expanding: a 13% CAGR (Compound Annual Growth Rate) is estimated for the global market between 2022 and 2028, while a 12% CAGR is expected for the

[16] Major worldwide Telcos (2018 – 2022), ASM, 2023
[17] https://www.osservatori.net/it/ricerche/osservatori-attivi/5g-beyond

European market over the same period[18]. The intensification of cyber-attacks and the increase of business awareness on these issues results in the growth of the potential market, also opening up to new solutions. In addition, the presence of specific regulations for enterprises and the PS (Public Sector) bodies also drives the growth of a competitive market, with numerous both global and local service providers. To enter this sector, highly specialized skills are necessary to address evolving cyber threats. The Italian context is also expected to grow between 2022 and 2028, and a 15% CAGR is estimated. In this market, telecommunications is well positioned within the MSS (Managed Security Services) context and plays a strategic role in the field of integration services of different security components.

A third area of potential development is the Cloud market. This again, is a healthy market for which growth is expected both globally (CAGR at 17 % between 2022 and 2028)[19] and in Europe (CAGR at 15 % over the same period)[8]. Currently, the market is focused on three major global players (Google, Amazon, and Microsoft) that control the Cloud development environments on which most software innovation is developed. One opportunity in this area lies in the development of the new Edge-Cloud segment, which is appealing to large global players. For the development of this technology, telecom operators are optimizing their infrastructure through investments in the micro and mini data centers required for its implementation. The Cloud is also confirmed as a growing market within the Italian market. In this case, a CAGR of 14 % is estimated, slightly lower than in Europe. There are several opportunities for telecommunications in this sector. Firstly, through Edge-Cloud development, on the one hand there is the possibility of expanding solution offerings for end customers and, on the other is the opportunity to optimize the internal infrastructure. In addition, telecommunications operators can provide traditional Cloud services while also having the opportunity to serve as an antitrust authority within national borders for the proper management of the large volumes of data used in the development of AI (Artificial Intelligence) algorithms.

The continuous increase in the flow of available data that registers a 28% growth over 2021, and the rigid legislation on the collection and management of end-user data contribute to the development of the Big Data & Analytics market. Worldwide, a CAGR of 14% is estimated between 2022 and 2028, whereas observations of the European market estimate the CAGR at 16% in the same time frame. Also contributing to the development of this sector is the recent focus on AI, whose algorithms require large amounts of input data for the learning phase. The Italian market is estimated to grow in line with the European market (CAGR at 16 % between 2022 and 2028). In this sector, because telecommunications manages the infrastructure over which traffic is transmitted, it has sole possession of network data and therefore holds a privileged position over other players. Furthermore, precisely by starting from the data in its possession, it has the possibility of developing solutions enabling full leverage.

[18] Statista, 2023
[19] Statista, Maximize Market Research, 2023

1.7. Searching for new stability

Persistent financial difficulties of telecommunications operators that have played a central role for the industry so far and swift technology changes seem to have brought the telecommunications market to a point of breaking the balance that has ruled so far.

The necessity of acknowledging change and the need to seek new balance is at the heart of the European Commission's recent white paper "*How to master Europe's digital infrastructure needs?*"[20] based on the results of a public consultation in view of a possible "Digital Network Act," the definition of which, however, has been postponed and put on the table of the new Commission.

Europe is certainly the epicentre of the system readjustment movements specifically due to its position, pressed between the world's two major technology warfare blocs and the evident difficulties of asserting the strength of a large market comprising nearly 450 million people. Within Europe, Italy's situation is certainly the most critical and is in danger of becoming a testing laboratory in the quest for new balance.

This project aims to help delineate possible future scenarios of the telecommunications ecosystem. The analyses and results obtained so far will be presented in the next chapters.

[20] https://digital-strategy.ec.europa.eu/en/library/white-paper-how-master-europes-digital-infrastructure-needs

2. Research goal and methodology

As highlighted in the previous chapter, the dynamics of the telco market in recent years reveal a period of turbulence and the need for a transformation of the sector. Despite economic difficulties, telecommunications are at the center of the digitization of society, playing a key role not only in providing infrastructure but also in developing digital services to meet new needs. Therefore, it is critical to carefully examine the changes underway and strategically assess how the players involved intend to innovate their business models.

For this reason, *Challenge 0* of the RESTART research and development program, the first among 19 Grand Challenges of this MUR-funded initiative under the European Union's Next Generation EU program, aims to outline the most likely evolution scenarios for the telecommunications sector, in Italy and at international level, and to identify the elements and choices that are likely to impact the implementation. In particular, the purpose is to investigate the role of the various players to understand how potential business innovation models combined with other external factors (e.g., legislation and technology evolutions) can outline different evolution scenarios.

Therefore, work was organized in two phases: the first focuses on the analysis of the main players' business models (*AS-IS*), while the second consists of an in-depth analysis of possible developments in terms of industry reconfiguration (*TO-BE*).

Specifically, the objectives of the AS-IS analysis mainly concern:

1.1. Identifying the roles of key players in the telecommunications industry by mapping their business models;
1.2. Studying the changes underway at the business model level of the players involved, due to discontinuities such as (i) the introduction of enabling technologies (e.g., 5G, Edge-Cloud, AI); (ii) major changes in the market structure (e.g., the dynamics related to network and service separation); and (iii) regulatory changes (at the national and European level);
1.3. Examining the impact of major technology and network architecture changes and the development of value-added services on advanced connectivity.

Once the current picture has been mapped out and the role and activities of individual players have been defined, the objectives of the TO-BE analysis include:

2.1. Identifying possible future scenarios resulting from innovation in the business models of the players involved;
2.2. Identifying factors that could steer the market toward different scenarios (market structure, evolution of the legislative-regulatory environment, etc.);
2.3. Quantitative assessment of the economic value generated by the European telecommunications ecosystem in 2024.

To achieve these goals the route began with a thorough analysis of academic and scientific literature. This enabled to select the most relevant theories to explore in depth the key issues concerning the future development of the telecommunications industry. Specifically, the "*business model*" and "*value network*" (or, in other terms, "*ecosystem*") concepts were identified to trace the AS-IS analyses and set up the TO-BE analyses of the various scenarios.

The application of these models to the specific context of telecommunications primarily involved qualitative exploratory research based on semi-structured interviews with key players and industry experts. The interview outline was first discussed internally and then tested through a set of pilot interviews. The information thus collected was then cross-checked with secondary sources. More than forty different secondary sources (reports, websites, events) were consulted to prepare the current model. Preliminary results were then presented at the RESTART Plenary Dissemination Workshop in Bologna in late January 2024 and subsequently discussed on numerous occasions with industry experts in periodic alignment checks.

In the first and second white papers, the work had focused on AS-IS objectives 1.1, 1.2, 1.3 and on TO-BE objectives 2.1. white paper. With this third and last white paper, we want to conclude the project started two years ago with a focus on the 2.2 and 2.3 TO-BE objectives. Overall, we developed a model to map the telecommunications ecosystem and categorize the current business models of the actors based on the activities performed, the value network of the ecosystem, which represents the network of relationships among actors, four future alternative scenarios of the European telecommunications ecosystem in 2040, and a quantitative economic model to understand which are the layers and activities that contribute most to the ecosystem growth.

2.1. Business model, value network, and ecosystem

Often with the rise of new technologies, focus falls back on investigating the technical features and the enormous potential that can result from the use of such innovations. Sometimes, this comes at the expense of analyses with a more strategic slant. As pointed out by Chesbrough (2010)[21], gaining a competitive advantage in today's digital world does not come down to just leveraging the best available technologies, but to be able to develop an appropriate business model that enables the best use of technological innovation. To answer our research questions, an analysis of academic management literature related to "business model," "value network," and "ecosystem" concepts was conducted to analyze the changes occurring in the telecommunications industry from a strategic perspective.

2.1.1 Business model

The origins of the "*business model*" concept date back to the late 1990s, a period of strong technological innovation. The business model can be defined as "*a coherent framework that takes technological characteristics and potentials as inputs and converts them through customers and*

[21] Chesbrough, H. (2010). Business model innovation: Opportunities and barriers. *Long Range Planning*, *43*(2–3). https://doi.org/10.1016/j.lrp.2009.07.010

markets into economic outputs" (Chesbrough and Rosenbloom, 2002, p. 532)[22]. In other, more simple words, Teece (2010)[23] defines a business model as a conceptual model of how a company creates, distributes, and captures value.

The business model has been widely incorporated into strategic management theory (Teece, 2010)[19] as a valuable tool that bridges the gap between formulating and implementing a strategy through business processes, resources, and relationships (Osterwalder, 2004)[24]. A number of authors have suggested various interpretations of the constituent dynamics of a business model that most revolve around the following four dimensions: (i) value proposition, (ii) value creation, (iii) value delivery, and (iv) value capture.

Value creation includes all the activities, resources, and partnerships that are necessary for the development of products and/or services that constitute the company's value proposition which addresses different customer segments. Value delivery relates to how the company is organized to reach its customers and partners and thus concerns elements such as customer relationships, sales, and distribution channels. Lastly, value capture explains how a business organization captures value and generates profit. It includes revenue generation and sharing mechanisms among partners as well as investment, financing, and cost structures.

2.1.2 Value network and ecosystem

The concept of "*ecosystem*" (Adner, 2017[25]; Jacobides et al., 2018[26]) and "*value network*" (Normann and Ramírez,1993[27]; Stabell and Fjeldstad, 1998[28]) are the two main currents that served as precursors to discussions on what are known as "interconnected business models" (Jocevski et al., 2020)[29]. These research threads converge on the need to investigate how different players can co-create value, particularly in contexts characterized by the continuous spread of technological innovations generating uncertainty. Thus, the value network model extends the *value chain model* (Porter, 1985),[30] highlighting the concept of network of relationships and interdependencies that a company develops outward of its boundaries. The concept of a business model therefore enables the adoption of different perspectives. From the standpoint of the individual enterprise - the dominant one throughout the years - enables to focus on a single player and their unique value architecture. From a value network-oriented perspective, some academic studies have defined it as "*a relational*

[22] Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, *11*(3). https://doi.org/10.1093/icc/11.3.529
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[25] Adner, R. (2017). Ecosystem as Structure: An Actionable Construct for Strategy. *Journal of Management*, *43*(1). https://doi.org/10.1177/0149206316678451
[26] Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal*, *39*(8). https://doi.org/10.1002/smj.2904
[27] Normann, R., & Ramírez, R. (1993). From value chain to value constellation: designing interactive strategy. *Harvard Business Review*, *71*(4).
[28] Stabell, C. B., & Fjeldstad, Ø. D. (1998). Configuring value for competitive advantage: On chains, shops, and networks. *Strategic Management Journal*, *19*(5). https://doi.org/10.1002/(sici)1097-0266(199805)19:5<413::aid-smj946>3.3.co;2-3
[29] Jocevski, M. (2020). Blurring the Lines between Physical and Digital Spaces: Business Model Innovation in Retailing. *California Management Review*, *63*(1). https://doi.org/10.1177/0008125620953639
[30] Porter Michael, E. (1985). Competitive Advantage: Creating and sustaining superior performance. *The Free*.

aggregator" to explain the value architecture that stems from the various relationships between different players" (Jocevski et al., 2020, p. 1062)[25].

To support a value network-oriented vision, the authors used a variety of methodological approaches and references from different literature streams on the interconnection of players. Some have incorporated the value network element into current business model definitions, while others have associated it to the ecosystem concept, a topic also much discussed in contemporary academic literature and often used in scientific publications and in the business context. The difference between ecosystem and value network is therefore not unambiguous, and in fact some players have treated the terms almost as synonyms while others have sought to highlight the differences between them. In general, compared to the value network concept, the ecosystem approach seeks a wider variety of participants (e.g., regulators, policymakers, etc.). Adner (2017, p. 40)[21] claims that "*The ecosystem is defined by the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize*". The ecosystem concept is thus characterized by its potential to extend across various sectors and players, and by the existence of a set of connections that are established at the group level by specific complementarities (Jacobides et al., 2018)[22].

As regards our research objective, the concept of business model and ecosystem (intended as a natural evolution of the value network concept described above) helps particularly in problem modelling and in defining units of analysis.

Regarding the first phase of the work (AS-IS), the theoretical framework of the business model helps to define value creation, delivery, and capture mechanisms for each player involved.

2.2. Defining the scope of analysis

Before proceeding with the presentation of the first results and after clarifying the terminology used to talk about business model and ecosystem, it is appropriate to indicate our scope of analysis.

Within the telecommunications industry (mobile and fixed line) we consider all players with a role in the production, distribution, and management of communications equipment, and infrastructure, and in managing telecommunications services, Internet access, data transmission, and network services, in both consumer and industrial sectors.

This industry has undergone several technological transformations, resulting in significant changes (Kuo and Yu, 2006[31]; Funk, 2009[32]; Ghezzi et al., 2015[33]; Oughton et al., 2018[34]), in particular for mobile. Since the first mobile network generation - 1G - deployed in the 1980s to provide analog

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[31] Kuo, Y. F., & Yu, C. W. (2006). 3G telecommunication operators' challenges and roles: A perspective of mobile commerce value chain. *Technovation*, *26*(12). https://doi.org/10.1016/j.technovation.2005.08.004
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[33] Ghezzi, A., Cortimiglia, M. N., & Frank, A. G. (2015). Strategy and business model design in dynamic telecommunications industries: A study on Italian mobile network operators. *Technological Forecasting and Social Change*, *90*(PA). https://doi.org/10.1016/j.techfore.2014.09.006
[34] Oughton, E. J., Usher, W., Tyler, P., & Hall, J. W. (2018). Infrastructure as a Complex Adaptive System. *Complexity*, *2018*. https://doi.org/10.1155/2018/3427826

voice services, networks have come a long way and have reached their current technologic peak with the commercial release of 5G, that began in 2019. The transition to 5G networks has been referred to in literature as a "momentous change" (Knieps e Bauer, 2022)[35]. Because of its peculiarity, some academics have used the definition General-Purpose Technology (*GPT*) (Bresnahan and Trajtenberg, 1995)[36] to describe 5G (Knieps and Bauer; 2022)[31]. In a 2017 Qualcomm press release Teece said "*I've spent many years studying the impact of general purpose technologies, and it's clear that 5G will propel mobile into that category, assuring the technology's long-term impact on society and continued growth for decades*." (Qualcomm, Press Release, 2017, San Diego).

The GPT concept was introduced by Bresnahan and Trajtenberg[32] in 1995 to denote pervasive, technically advanced technologies that promote the development of other innovations in a variety of application areas. In other words, GPTs affect the entire economy, improve over time, and create opportunities in multiple domains. Some of the examples of GPTs that Lipsey and colleagues (1998)[37] describe as "*clear and dramatic*" cover printing, electricity, the internal combustion engine, lasers, and the Internet. The scope of definition of GPT includes a very narrow set of inventions, which is why Teece (2018)[38] has "*downsized*" the concept of GPT to "*Enabling technology*" or, in other words, "*junior GPT*," indicating those technologies that potentially aspire to be GPT but have not yet had a significant economic impact. For this reason, although it is an innovative and promising technology in several industries, 5G is best classified as a "*junior GPT*" as it has not yet achieved the desired economic impact (Teece, 2017 a,b[39]; Rathje and Katila, 2021[40]).

In any case, given the many opportunities that this technology promises in a variety of sectors, the distinction between the perimeter defining the telecommunications industry and that of other industries is becoming increasingly less marked. For example, with the third (*3G*) and fourth generation (*4G*), the distinction between mobile communication and information technology (*IT*) had become blurred. Cell phones have gradually evolved from calling devices to mobile computing devices with advanced processors and flexible features (Li and Malerba, 2024)[41]. As a result, vertical links between mobile communication and upstream sectors have increased. The blue horizontal arrow in Figure 5 represents the links between the 3G and 4G phases. Lastly, with 5G, vertical links between mobile communications and downstream sectors (e.g., manufacturing, automotive) have increased further for the reasons just mentioned (Li and Malerba, 2024)[37].

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[35] Knieps, G., & Bauer, J. M. (2022). Internet of things and the economics of 5G-based local industrial networks. *Telecommunications Policy*, *46*(4). https://doi.org/10.1016/j.telpol.2021.102261
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[37] Lipsey, R.G., C. Bekar, and K. Carlaw (1998). \The Consequences of Changes in GPTs". In Elhanan Helpman (ed.), General purpose technologies and economic growth. Cambridge and London: MIT Press.
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[41] Li, D., & Malerba, F. (2024). Technological change and the evolution of the links across sectoral systems: The case of mobile communications. *Technovation*, *130*. https://doi.org/10.1016/j.technovation.2023.102936

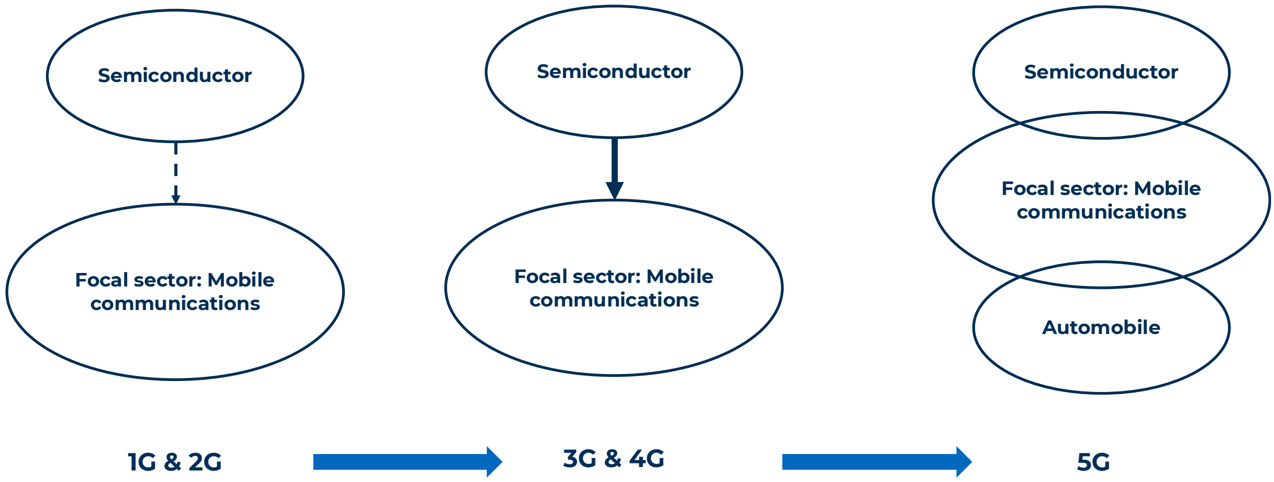

Figure 5 – Evolution of the telecommunications industry's links with other industries – Li and Malerba, 2024, Technovation

For this reason, other systems that traditionally do not belong to the telecommunications industry have been included in recent scientific publications (Jia et al., 2018)[42], such as the system revolving around the Internet of Things (IoT) and industrial connectivity for vertical industries. This approach furthers the debate in literature on the need to represent the value network emerging among different players, unlikely to be captured using the traditional value chain model (Ricciotti, 2020)[43]. In fact, the latter emphasizes the concept of competition without adequately considering the intricate horizontal and vertical relationship networks that exist between firms. Additionally, such interdependencies are often far from linear and can be staged across several layers. In particular, Bauer and Bohlin (2022)[44], to outline the possible diverse players within the 5G ecosystem, differentiate four different layers and place the various players according to their core competences and business strategies. In the lower part are the passive and active infrastructure layers that make up the physical layer of the network. In the upper part instead, there are the application service layers. On the final layer is the end user. Similarly, Teece (2021)[45] identifies three layers; in particular, the author differentiates between layer zero, called "*enabling technology*," layer one, forming the "*physical infrastructure*," and layer two, labeled "*implementation of network equipment and service*".

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[42] Jia, W., Liang, D., Li, N., Liu, M., Dong, Z., Li, J., Dong, X., Yue, Y., Hu, P., Yao, J., & Zhao, Q. (2019). Zebrafish microRNA miR-210-5p inhibits primitive myelopoiesis by silencing foxj1b and slc3a2a mRNAs downstream of gata4/5/6 transcription factor genes. *Journal of Biological Chemistry*, *294*(8). https://doi.org/10.1074/jbc.RA118.005079

[43] Ricciotti, F. (2020). From value chain to value network: a systematic literature review. *Management Review Quarterly*, *70*(2), 191–212. https://doi.org/10.1007/s11301-019-00164-7

[44] Bauer, J. M., & Bohlin, E. (2022). Regulation and innovation in 5G markets. *Telecommunications Policy*, *46*(4). https://doi.org/10.1016/j.telpol.2021.102260

[45] Teece, D. J. (2021). Technological Leadership and 5G Patent Portfolios: Guiding Strategic Policy and Licensing Decisions. *California Management Review*, *63*(3). https://doi.org/10.1177/00081256211007584

In both cases, there is a clear distinction between the network and the implementation of the service, thus also implying the need for different players to develop each of these elements.

Consistent with these approaches, we too will consider other sectors related to the traditional telecommunications industry and to make the scope of analysis explicit. In the next section the "layers" identified so far, and the main players involved are presented.

2.3. The tiered model

In keeping with what emerges from the management literature analyzed, this model is also designed to represent the telecommunications industry according to "*value network*" and ecosystemic logic (Peppard and Rylander, 2006[46]; Pujol et al., 2016[47]) rather than as a linear sequence of activities (e.g. Cricelli et al., 2011)[48]. Furthermore, the goal is to consider both fixed and mobile networks so that all the changes underway can be studied, bearing in mind that some players play an important role in both. This could further contribute to the literature by providing a model that maintains a holistic view not focused exclusively on mobile and in particular 5G (e.g. Bauer and Bohlin, 2022[40]; WP5 5G-VINNI Ecosystem Modelling and Evaluation, 2019[49]), or relative to some players (e.g. Peppard and Rylander, 2006[42]; Camps-Aragó et al., 2019[50]). Consistently with the papers analyzed (e.g. Pujol, 2016[43]; Teece, 2021[41]; Bauer and Bohlin, 2022[40]) the model was arranged in layers, from more "infrastructural" to those related to service delivery; however, a greater level of granularity was aimed for in defining activities, contributing to the literature in this respect.

The model consists of five different layers (Figure 6), ranging from the macro infrastructure components to those required for service delivery. The first two layers concern the physical infrastructure and have been divided into backbone infrastructure and wireless, wired and IT infrastructure. Next is the layer relating to network deployment in terms of functionality and networking. Instead, the last two layers concern the delivery of connectivity and enabling technology-based services and the so-called "*digital services and applications* ". The latter refer to a set of activities to develop specific applications that go beyond the pure connectivity offering.

[46] Peppard, J., & Rylander, A. (2006). From Value Chain to Value Network:. Insights for Mobile Operators. *European Management Journal*, *24*(2–3), 128–141. https://doi.org/10.1016/j.emj.2006.03.003
[47] Pujol, F., Digiworld, I., Salah, F., Elayoubi, E., Markendahl, J., & Salahaldin, L. (2016). Regulation and Competition Mobile Telecommunications Ecosystem Evolutions with 5G. In *Digiworld Economic Journal, No* (Vol. 102). www.comstrat.org
[48] Cricelli, L., Grimaldi, M., & Levialdi, N. G. (2011). The competition among mobile network operators in the telecommunication supply chain*International Journal of Production Economics*, *131*(1), 22–29. https://doi.org/10.1016/j.ijpe.2010.02.003
[49] *Deliverable D5.1 Ecosystem analysis and specification of B&E KPIs*. (n.d.).
[50] Camps-Aragó, P., Delaere, S., & Ballon, P. (2019). 5G Business Models: Evolving Mobile Network Operator Roles in New Ecosystems. *2019 CTTE-FITCE: Smart Cities and Information and Communication Technology, CTTE-FITCE 2019*. https://doi.org/10.1109/CTTE-FITCE.2019.8894822

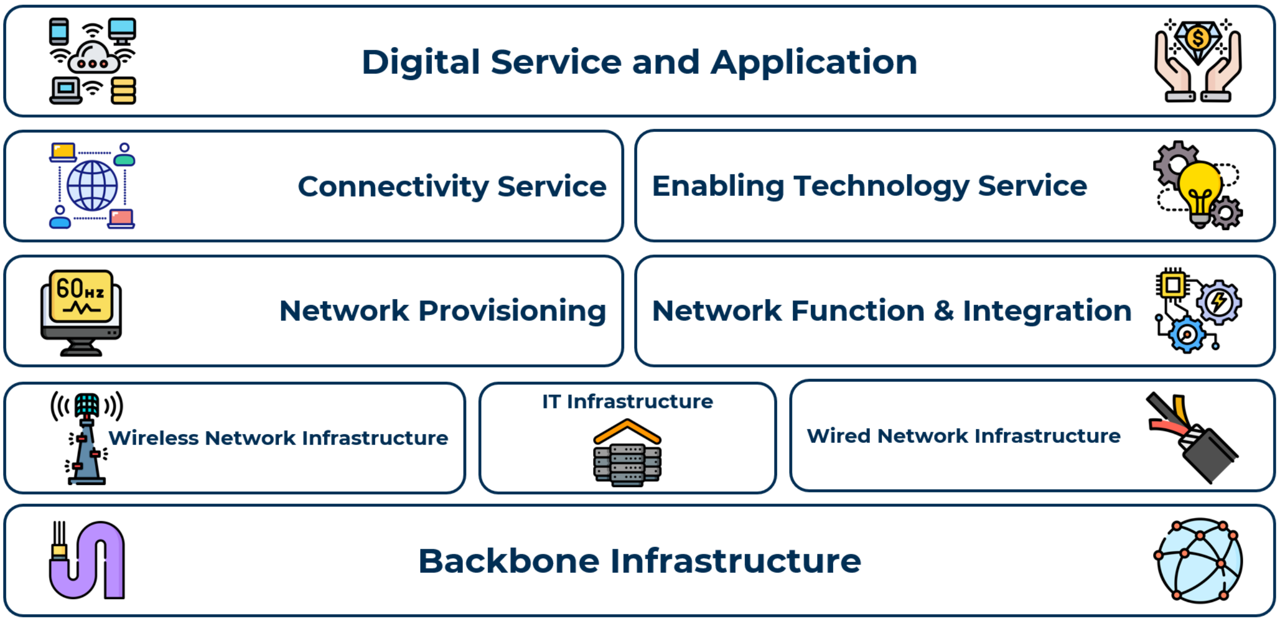

Figure 6 – Architecture of the telecommunications ecosystem

Starting from the bottom, the so-called *Backbone Infrastructure* layer (Figure 7) refers to the global, interconnecting network that links the access and transport networks operated by operators. It includes a number of components that ensure reliable and fast connectivity between different geographical locations (e.g. between different continents, countries, or within the same country). Therefore, the main activities mapped concern the construction of international and national submarine cables and their procurement and management. Considering the huge investments required for the development of these infrastructures and the related geopolitical aspects, in this layer it is difficult to expect significant evolutions in the coming years or the entry of new players, although the impact of the investments of the so-called *Hyperscalers* in the recent past should be considered. One example is Google, which owns around 8.5% of the world's submarine cables. For the sake of completeness, it has therefore been included as the first layer in the basis of the model, as 97% of global internet traffic passes through this infrastructure[51].

Figure 7 – First Layer – Backbone Infrastructure

[51] https://www.ispionline.it/it/pubblicazione/geoeconomia-dei-cavi-sottomarini-33004

Immediately above this layer, there are the wireless (terrestrial and non-terrestrial), wired and IT infrastructures, which we have defined as the *Network Infrastructure layer*. In this layer we have mapped all the activities concerning wireless and wired access network infrastructures, from the passive to the active part, distinguishing between activities for public networks and/or dedicated to specific areas, and those specific to architectural components that are typically managed by different actors. As far as the IT infrastructure is concerned, we refer mainly to data centres, given the key role they could play in terms of the strategic positioning of certain actors belonging to the telecommunications chain and beyond. For the sake of simplicity, considering that the actors involved are different, even graphically the wireless, wired and IT infrastructures have been separated although they conceptually belong to the same layer. This is the only layer that presents a division of activities between the three components: wireless, wired and IT. In the subsequent layers, however, this distinction has not been made, because the differences between these activities are less significant.

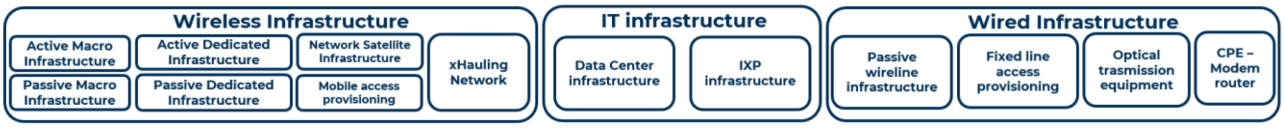

Figura 8 – Second layer – Network Infrastructure

In the layer above, referred to as the Network Function *layer,* we have mainly classified the activities concerning network provisioning and network function integration activities. In fact, in this layer we assume the spectrum access elements for access service provisioning (mobile and fixed). The Network Function layer represents the bridge between what is needed for the physical infrastructure and what is needed to actually deliver connectivity services.

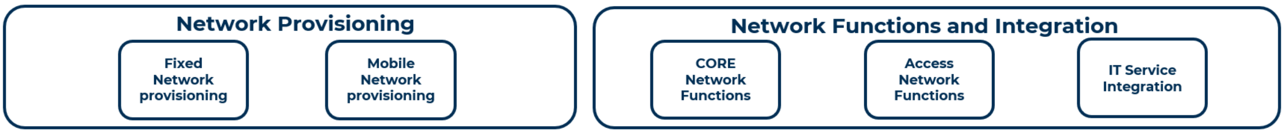

Figure 9 – Third layer – Network Function

The fourth layer, called the *Connectivity and Enabling Technology Service layer*, includes all activities related to the provision of connectivity and enabling technology-based services to the end user, also referring to the definition of technical requirements, the provision of components and devices, service operation and maintenance, and content distribution. This layer represents the traditional value proposition of the telecommunications supply chain, thus oriented towards the offer of a connectivity service or the offer of standard *(off-the shelf*) solutions and services based on various General Purpose ICT technologies.

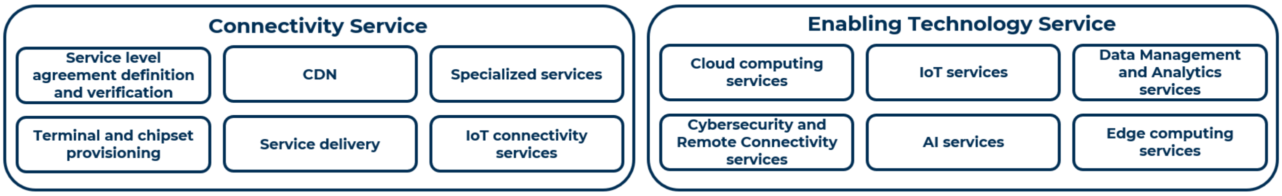

Figure 10 – Fourth layer – Connectivity and Enabling Technology Service

The last layer concerns the so-called Digital Service and Application. This layer includes a series of activities useful for developing specific applications for companies in the different industry verticals, where not the classic connectivity offer is proposed, but a specific connectivity strategy is defined to develop business cases useful to the customer's objectives. In addition, this last layer is crucial for the development of applications enabled by mobile network technologies, such as 5G, that enable the growth and increased competitiveness of European companies.

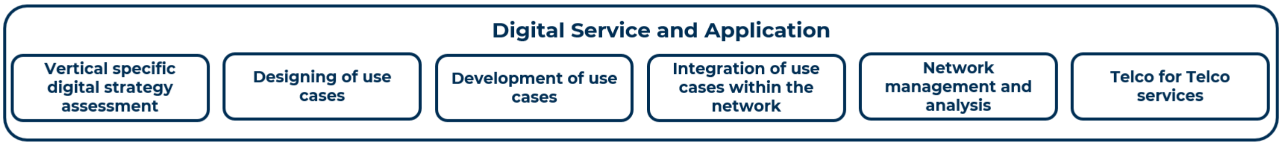

Figure 11 – Fifth layer – Digital Service and Application

To continue with our analysis, it is appropriate to give a definition of an industry vertical, so that we are clear on the concept and understand what we are referring to.

An industry vertical describes a specific sector of the economy that focuses on a particular type of product or service, targeting a specific market niche. Also called vertical markets, industry verticals include everything from 3D printing to eSports.[52].

In Chapter 3, the activities of the layers just described will be presented in more detail along with the business models of the AS-IS analysis of the various actors in the telecommunications ecosystem. In the next section, however, the categories of actors that were considered in our mapping will be defined.

2.4. Identification of players involved

The telecommunications ecosystem consists of a variety of players that constitute its backbone. Some have a long-standing presence in this industry, while others came from adjacent markets, leading to increased competitiveness and changes in the ecosystem's architecture and organization.

[52] https://pitchbook.com/what-are-industry-verticals

The process of defining the categories of players to be considered began by identifying the boundaries of the telecommunications industry (section 2.2), and thus the players operating in it. Next, we grouped them into different categories based on common characteristics, such as activities performed to create value, and customer segment.

At the end of the process described above, we identified sixteen categories of players operating in the telecommunications ecosystem, defined as follows:

- **Global Backbone Provider**: International operators involved in the implementation and operation of large global connectivity infrastructure consisting mainly of submarine fiber optic cables. These links are used to transport large amounts of data over long distances, such as between continents and/or countries and are therefore preferably laid on the ocean floor. Some examples of players in this category are *Sparkle, AT&T, DTGC, Liberty Global, Lumen, PCCW Global, Cogent, Arelion, Huawei Marine Networks*;

- **National Backbone Provider**: National infrastructure operators responsible for laying the copper or fiber optic cables that constitute the national Backbone network. Some examples of players in this category are incumbent telecommunications operators in various countries as well as operators of large infrastructure such as railway and road networks;

- **Network Infrastructure Provider**: Telecommunications infrastructure providers including antennas and towers distributed across the territory, installation of radio base station binding networks, cabling, and supply of fiber optic and copper cables. In addition, some players own IT infrastructure (e.g., data centers), and, in rare cases, are involved in providing IoT services. Examples of players in this category include *EiTowers*, *Cellnex, Vantage Towers, GD Towers, Inwit, TOTEM*;

- **Infrastructure System Integrator**: Providers and installers of passive network infrastructure, mainly fiber optic cables and physical infrastructure for radio access networks. Some players also offer digital solutions such as Cloud services or consulting on General Purpose digital technologies. Some examples of players in this category are *Sirti, Exatronics, Nexans, Telebit, Valtellina, Sielte*;

- **Fixed line Access Network Infrastructure Wholesaler**: Players that operate a fixed line fiber or point-to-point radio network infrastructure that they then resell to telecommunications retailers that in turn provide connectivity services. They are characterized by an "*Equivalence of Input* " model. Some examples of players in this category are *Openfiber and Openreach*

- **IT Infrastructure Provider**: IT infrastructure managers and providers (e.g., Data Center Providers and Internet Exchange Points) that may also offer Cloud services. Some examples of players in this category are, among the IXP: *DE-CIX, AMS-IX, LINX LON, EPIX, Namex, Mix*; among Data Center Providers: *Digital Reality, Equinix, Vantage, Aruba, Retelit*;

- **IT Technology Provider**: IT infrastructure suppliers, providing equipment such as servers and networking devices to implement and manage data centers. Some examples of players in this category are *Dell, HP, Supermicro, and Lenovo*;

- **Network Equipment and Software Supplier**: Providing network equipment and solutions through hardware devices and software features. In some cases they also provide Cloud services and IT integration enabling to operate the network. Some examples of players in this category are *Nokia, Ericsson, Huawei, Samsung, ZTE, Mavenir, NEC, Fujitsu, Qualcomm, JMA Wireless, CISCO, Juniper Networks, Rakuten Mobile, Tiesse*;

- **Mobile and Fixed Network Operator** Fixed line and mobile telecommunications operators that offer connectivity services to both consumer and business clients. They own the active network infrastructure and hold licenses for the use of fixed line and mobile frequency spectrum. In addition, they can offer Cloud computing and cybersecurity services due to their ICT expertise. Some examples of players in this category are *TIM, Vodafone, Orange, DT, Telefonica, Telia, SFR, British Telecom*;

- **Mobile Virtual Network Operator**: Virtual mobile operators that do not own either network infrastructure or access to frequency spectrum but provide connectivity services using the networks owned by Mobile and Fixed Network Operators. Some examples of players in this category are *Poste Mobile, Coop Voce*, *Lyca Mobile, Ho Mobile, 1nce*;

- **Satellite Network Operator**: Connectivity system operators that leverage a satellite network infrastructure and can have access to mobile frequency spectrum. Some examples of players in this category are *Starlink, Lynk Global,* and *Oneweb*;

- **Specialized ICT Service Company**: Specialized ICT service providers ranging from Content Delivery Network, to security, and virtualization and computing platforms. Some examples of players in this category are *Cloudflare, Akamai, Fortinet, VMware, IBM, HPE*;

- **Over-The-Top (OTT)**: Operators providing digital content, mostly streaming, and leverage telecommunications networks without owning any infrastructure assets, except CDN caches (*Content Delivery Network*). Some examples of players in this category are *Tiktok, BeReal, Spotify, Disney+*;

- **Hyperscaler**: Operators providing digital content, mostly streaming, and Cloud computing through their own telecommunications infrastructure, such as submarine cables and parts of infrastructure for content distribution. Some examples of players in this category are *Google, Amazon, Microsoft, Meta, Netflix*;

- **IT System Integrator**: Players that support clients with consulting and integration services to jointly develop IT services that meet the needs of industrial users. Some examples of players in this category are *Accenture, Italtel, MaticMind, Net-Reply, and Capgemini*;

- **Industrial Connectivity Provider**: Providers of network and connectivity services and integrations for businesses and public sector bodies with different technologies (such as industrial wired network technologies, WiFi, LoRaWAN, etc.). Some examples of players in this category are *Unidata, Acantho, A2A Smartcity, and Actility*.

- **Artificial Intelligence Provider**: Players who specialize in offering AI-based services (e.g., GenAI). Some examples of players in this category are: *OpenAI, Mistral AI.*

These categories of players, in addition to being different from each other for the characteristics described above, are also different in terms of the number of activities conducted. In particular, we find ourselves on a continuum where at one extreme we find players who are very focused on few activities, in rare cases just one, also on one single layer, while at the other extreme we find other players performing a variety of different activities on almost all layers displaying a vertical integration approach.

The categories of players we have identified cover almost all the types within the telecommunications ecosystem. Nevertheless, like all research that attempts to frame reality into a model, this study is not without limitations. In fact, this research, which is based on a qualitative approach, is by nature prone to subjectivity. This has led to omitting some types of players among those listed in this section that can be classified as hybrids.

3. Value network activities and archetypes

This chapter presents the research results related to the components of the value network model and the methodology used to map the different types of players within the ecosystem. Specifically, it describes all the activities identified for each layer of the ecosystem model introduced in the previous chapter. The concept of "business model archetypes" is then introduced - representative types of players that carry out a subset of the activities across the various levels. For the sake of model sustainability, these archetypes are not intended to be exhaustive or to capture the full complexity of the current ecosystem, where players often exhibit hybrid characteristics and perform more activities than those typically associated with their reference archetype.

3.1. Activities in the model layers

After defining the model that describes the architecture of the telecommunications ecosystem (Figure 12), consisting of five layers, the activities within each layer have been identified and described. These activities were determined through qualitative data collection methodologies, drawing on both primary sources (interviews with players and ecosystem experts) and secondary sources (news articles and reports).

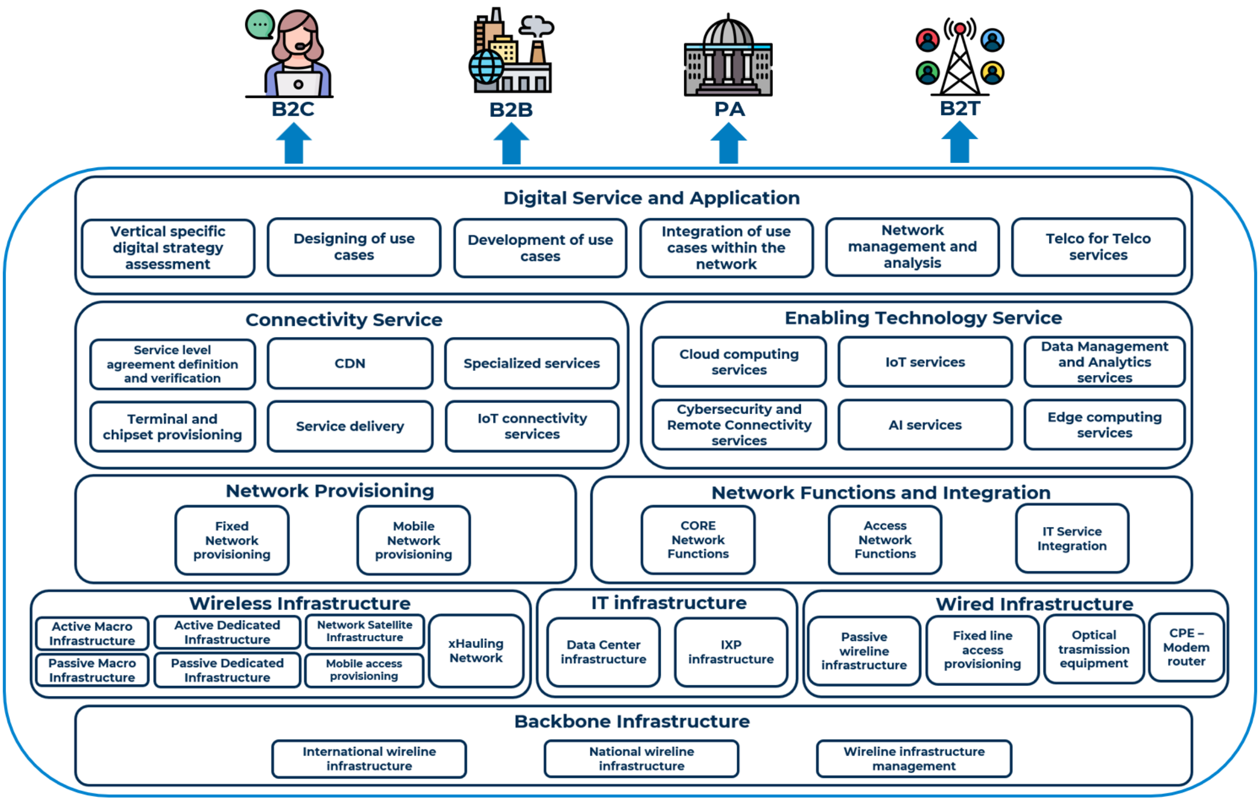

Figure 12 – Layered architecture of the telecommunications ecosystem

Listed and described below:

- **Backbone Infrastructure**
  - **International Wireline Infrastructure**: Cabling and laying international telecommunications cables connecting continents and countries; typically submarine fiber optic cables;
  - **National Wireline Infrastructure**: Cabling and laying national fiber optic cables that make up the national telecommunications backbone;
  - **Wireline Infrastructure Management**: Purchase, management of domestic and international network backbones, and supply of associated connectivity services.

- **Network Infrastructure**
  - **Wireless Network**
    - **Passive Macro Infrastructure**: Installation of antennas and cell towers distributed throughout the territory. This passive part of the infrastructure includes all those devices/facilities that play a passive role (tower, cables connecting to the tower, power supply, units that enable maintenance operations, and the cabin located at the base of the tower) that serve as support for the active part (antenna, radio unit, baseband unit, front-/mid-/back-haul) that transmits and receives the signal;
    - **Active Macro Infrastructure**: Development, supply and management of mobile network active technology components, such as: integrated base station, Small Cell, disaggregated RAN components (Radio Unit, Distributed Unit, Central Unit, Radio Intelligent Controller, etc.), and associated software, servers and components;
    - **Passive Dedicated Infrastructure**: Installation and management of equipment components and passive antennas used to provide shared public radio coverage or within a specific area (highway tunnels, subways, etc.);
    - **Active Dedicated Infrastructure**: Management of active radio network components (donor base stations for DAS systems[53], Small Cell systems) used to provide shared public radio coverage within a specific area (highway tunnels, subways, etc.) or to create private mobile networks (MPNs) and their integration with the rest of the public network;
    - **Network Satellite Infrastructure**: Creation and operation of satellite networks providing connectivity and telecommunication services. This type of infrastructure is used to provide connectivity to isolated areas of the world where it has not yet been possible to connect a backbone infrastructure to provide access to the Internet and telecommunications systems, or in sparsely populated areas not yet covered

[53] Distributed Antenna System

by fibre/copper networks. We also include all HAPS infrastructures[54] (High-altitude platform system);
    - **Mobile Access Provisioning**: management of mobile network access for resale to operators - telecommunications retailers;
    - **xHauling Network**: Implementation of binding networks (front-/mid-/back-haul) of radio base stations in the RAN;
- **Wired Network**
    - **Passive Wireline Infrastructure**: Supply and wiring of fiber optic and copper cables;
    - **Optical Transmission Equipment**: Design and manufacture of optical transmission and networking equipment;
    - **CPE – Modem Router**: Design and manufacture of interconnection equipment necessary to deliver the service to end users (e.g., optical home gateways, CPE for fixed line wireless access);
    - **Fixed line Access Provisioning**: Fixed line network access management for resale to operators - telecommunications retailers;
- **IT Infrastructure**
    - **Data Center Infrastructure**: Development and management of the physical data center infrastructure; from building to actual physical installation of hardware equipment for data storage and management and to the link among servers and with the network;
    - **IXP Infrastructure**: Implementation and management of the IXP infrastructure that enables the various Internet Service Providers to exchange Internet traffic between each other;

➢ **Network Function**
- **Network Provisioning**
    - **Fixed line Network Provisioning**: Providing fixed line connectivity services for residential and business users through available technologies (copper, optical fibre, and radio);
    - **Mobile Network Provisioning**: Providing mobile line connectivity services for residential and business users and management of the radio spectrum required;
- **Network Functions and Integration**
    - **Core Network Functions**: Development and management of the Core Network components required to deliver the connectivity services and features necessary for basic and advanced service management and VAS (such as phone top-ups, rewards, “call me back,” anonymized location, etc.);

[54] Radio stations located at a fixed point 20-50 kilometres above the Earth. They can be used to provide both fixed broadband connectivity to end users and transmission links between mobile and core networks, used for backhauling traffic.

- **Access Network Functions**: Development and management of software components to operate the access network (as in the case of disaggregated and virtualized mobile network);
- **IT Service Integration**: Development and management of network IT services and systems (centralized and distributed data centers with servers, storage, and management systems) required for Core Networks, virtualized access networks, private mobile networks (MPNs), etc.;

- **Connectivity & Enabling Technology Service**
  - **Connectivity Service**
    - **Service Delivery**: Managing the operation and maintenance of mobile and fixed line connectivity services;
    - **Terminals and Chipsets Provisioning**: Supply and sale of components and devices for user terminals (e.g., smartphones, tablet, PC desktop, PC laptop, wearable, communications and specialized systems such as point of sale and networking equipment);
    - **Specialized Services**: Specific and specialized services that go beyond traditional basic communications, encompassing all activities that provide quality assured service (e.g., Network slicing, 5G Mobile Private Networks);
    - **Service Level Agreement Definition and Verification/Assurance**: Definition, implementation, monitoring and assurance of compliance with the technical requirements for the specific dedicated connectivity service;
    - **Content Delivery Network**: Installation and management of the network and components, for the distribution of content aiming for greater speed and efficiency in bringing them closer to end users;
    - **IoT Connectivity Services**: Design and supply of IoT connectivity services (such as those used by LoRaWAN and NB-IoT) and Wi-Fi, to create private enterprise and smart city networks;
  - **Enabling Technology Service**: Offering ICT services "*off the shelf*" based on enabling technologies such as Cloud computing, IoT (such as IoT service platforms), Data Management and Analytics, Cybersecurity and Remote Connectivity Services (such as SD-WAN and Security Access Service Edge), Artificial Intelligence and Edge computing, for consumer, enterprise, PA and telco customers. By all these technologies, especially Artificial Intelligence, we mean services and applications that, in addition to being offered to customers, are also introduced within telecommunications networks (e.g. AI for network management, AI for resource optimisation);

- **Digital Service and Application**
  - **Vertical Specific Digital Strategy Assessment**: Consulting activities aimed at identifying the customer's requirements through a gap analysis, in order to define the most suitable digitisation and connectivity strategy for the company;

- **Designing of the Use Cases**: Technical design of the specific use case where all the technical characteristics required to develop it correctly are identified;
- **Development of Use Cases**: Development and testing of use cases through software platforms (may or may not be proprietary depending on the companies developing the use cases);
- **Integrations of Use Cases within the Network**: Integration activities of use cases into the company's private network;
- **Network Management and Analysis**: Management and analysis of data flowing through the network to improve services and network management;
- **Telco for Telco Services**: Consultancy services provided by telecommunications operators for other, often smaller, telecommunications operators (e.g. virtual operators want to enter the mobile or fixed connectivity service market).

After the representation of the architecture of the telecommunications ecosystem, our model is completed by adding the end customers to whom the different offers are addressed. The categories of actors we found are: end consumers (B2C), private companies (B2B), public administrations (PA) and telecommunication companies (B2T). Due to the way our model is structured, connectivity service offerings, those based on enabling technologies, and vertical applications target either the B2C, B2B, PA, and B2T customer segments.

3.2. Mapping business model archetypes

After configuring the model using the methodologies mentioned previously, the different business model archetypes have been outlined, defining the various categories of players identified. Players' archetypes do not claim to capturing the variety of business strategies and activities conducted by the companies operating in the market, but aim to ideally represent the category, although actual players can then conduct other activities according to relatively common hybridization strategies.

In addition, at the moment, activities that go beyond the traditional perimeter of the telco supply chain, such as the sale of insurance services or electricity & gas, that could constitute a "*strategy beyond the core*" to diversify the value offer, have not been mapped.

Up to now the mapping concerned only the activities used by players to create value for clients; henceforth, value capture and distribution activities will also be added for a more complete model, enabling prospective assessments of possible future changes involving role variations, the entry of new players, and the development of new activities.

To define business model archetypes for each category of players, the business models of the main companies belonging to each group were analyzed and compared to identify the "*core*" activities that may be representative of the category and instrumental to the analysis of the ecosystem and its evolutions.

In more detail, the mapping was performed highlighting all the activities conducted in each layer by individual players within the analyzed category. A solid colour was used to highlight the activities common to all the companies considered, whereas the shade used for others conducted by only a part of the sample were more graded. The former represent the "*core*" activities for that category of player, while the latter constitute the "*additional*" activities that only some of the mapped players perform. Listed below are the different business model archetypes of the previously mentioned categories of players.

Global Backbone Provider

The players in this category manage assets and conduct capital intensive activities such as owning submarine cable laying vessels. This type of player usually also manages the international infrastructure and provides associated connectivity services. Companies are often large corporations or can be part of large telecommunications groups.

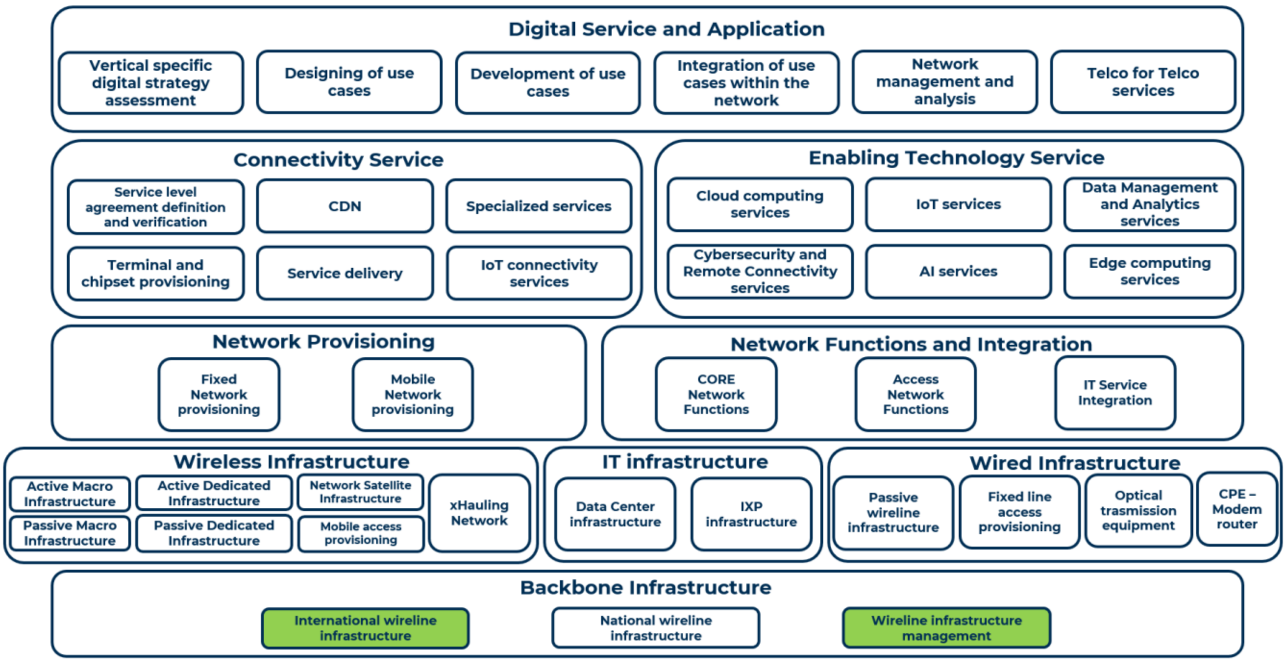

Figure 13 – Global Backbone Provider Business Model

National Backbone Provider

The national infrastructure operators are in charge of laying backbone cables at national level and of managing the geographical interconnection infrastructure. They are often part of groups of national telecommunications operators or international companies present in multiple countries. In some cases they are a part of the activities of companies that manage activities related to other network infrastructures (such as railways, roads, and energy networks) and in this case they can also be installers and operators of passive infrastructure for mobile networks for special uses (e.g. radio networks for signalling and railway management or dedicated radio systems for managing roads and highways). Clearly, telecommunications are not the core business for this sub-type of players, that are important for the development of the entire ecosystem because they could invest in infrastructure useful for the development of the network, particularly mobile. Given their strategic importance, in some cases stakeholders include public entities.

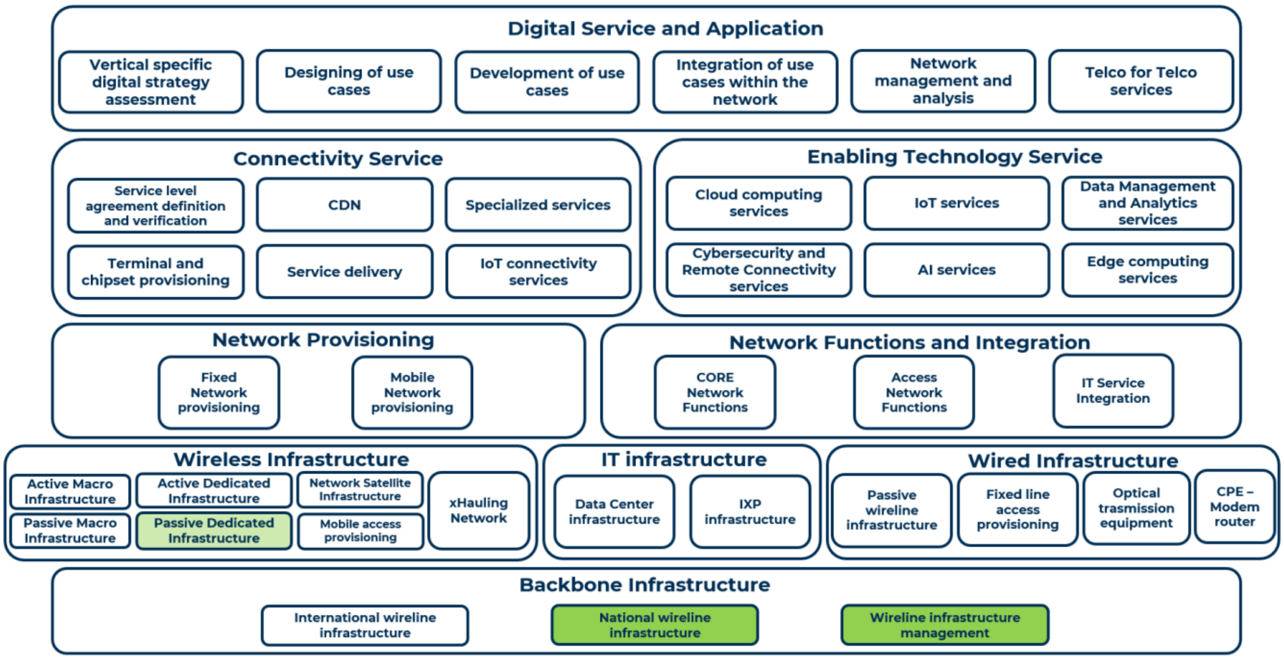

Figure 14 – National Backbone Provider Business Model

Network Infrastructure Provider

Currently this category of players is mainly referred to Tower Companies, but in the future could embrace other types of subjects. These would be players with expertise in the design and installation of passive mobile network infrastructure, such as towers and signal transmission antennas. The activities of these players are concentrated in the mobile network portion, in which they are highly specialized. The number of players in this category is generally small per country, due to the massive investment in infrastructure required. For example, in Italy the market is made up of some players divided into Tower Companies operating in the mobile part of the network, and others that operate mainly in the radio-television broadcasting part. Some of these players stem from Joint Ventures between different operators or are separation of Mobile and Fixed Network Operators or are highly established companies in the market. In some cases they perform other activities, such as managing data center IT infrastructure and offering ICT services.

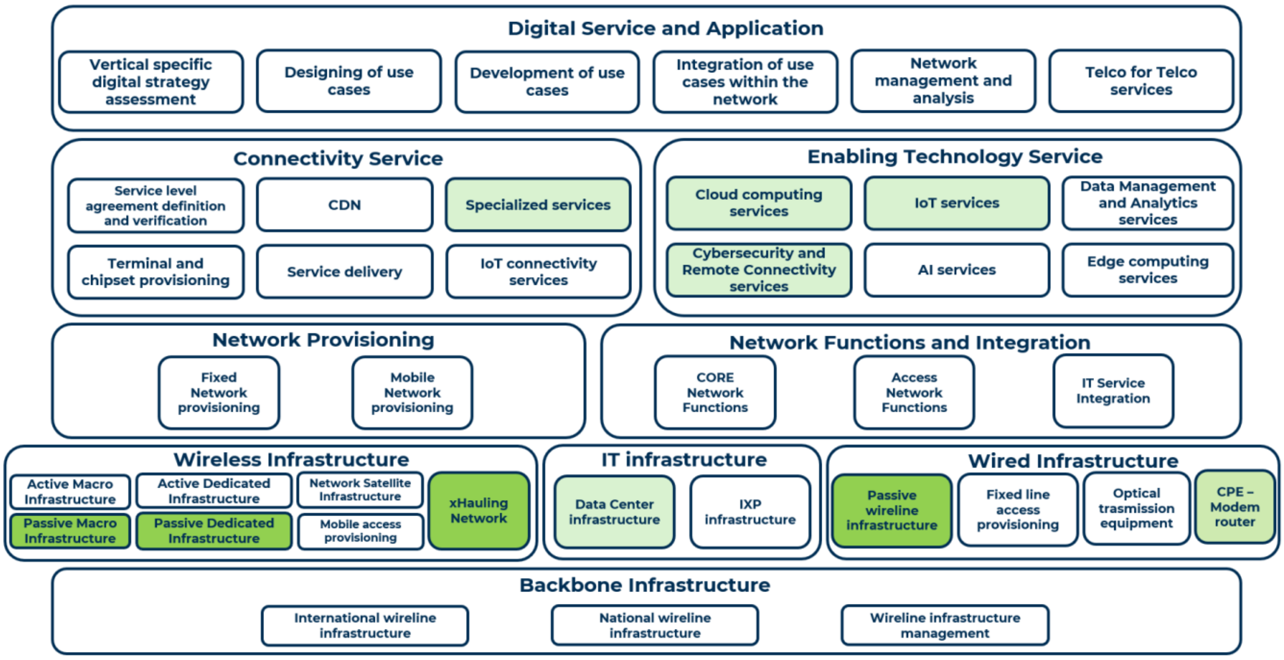

Figure 15 – Network Infrastructure Provider Business Model

Infrastructure System Integrator

Infrastructure System Integrators are a type of players deeply rooted in the telecommunications ecosystem, having been present in this sector for many years. They are historically characterized by long-term experience and competence in laying cables. In fact, the activities they perform most are related to the laying and cabling of fibre optic/twisted pair cables for passive or xHauling fixed line networks. Over time they have acquired a role in the design and management of sites for the construction of mobile networks for which they also provide design and design support services, and, in some circumstances, they provide support for end-user CPE installations.

Recently, some of the players in this category have been conducting new activities in other layers of the ecosystem, including the integration of IT services and providing value-added services such as Cloud, cybersecurity, and IoT. Here too, category players are few and very well established in the market.

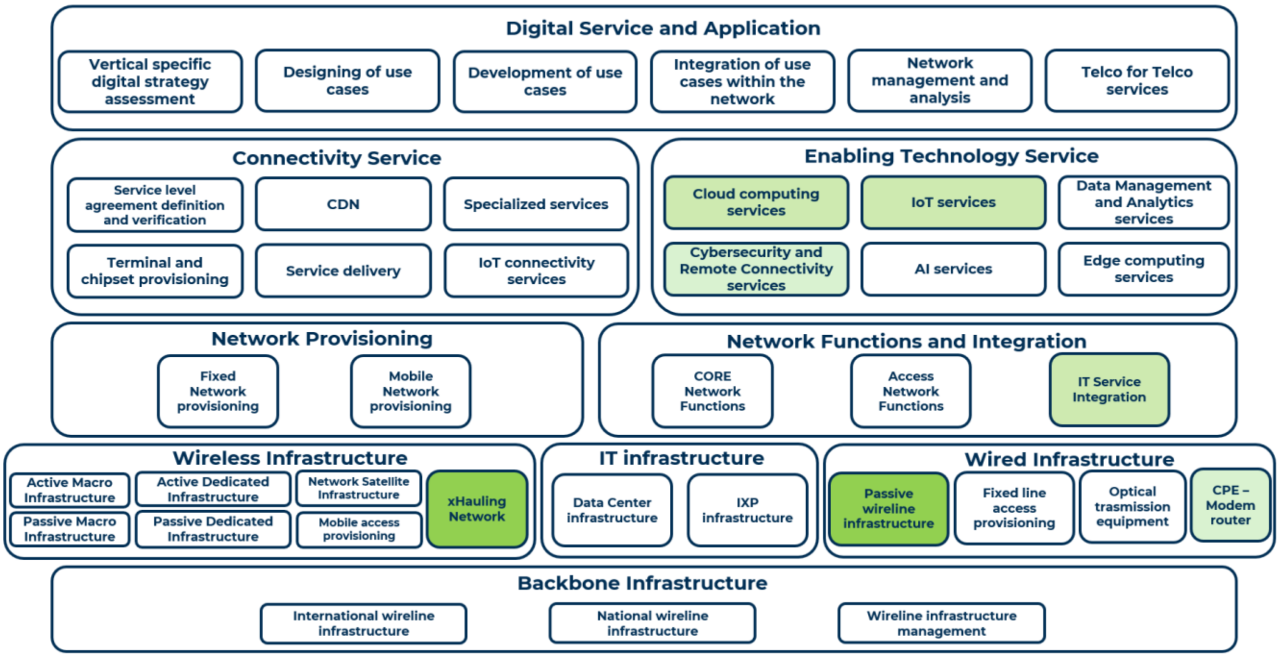

Figure 16 – Infrastructure System Integrator Business Model

Fixed Access Network Infrastructure Wholesaler

"Wholesale only", are a type of players introduced at the end of the last century, representing one of the youngest types of players of the telecommunications ecosystem. They emerged due to the need to have operators deploying and managing access network infrastructure (currently only cases of fixed line access infrastructure) indiscriminately sold to telco retailers (Mobile and Fixed Network Operators). The service management model is the "*Equivalence of Input*" model, which is the exact opposite of the "*Equivalence of Output*" model adopted by telecommunications operators.

These players are not vertically integrated, and therefore do not compete with retailers of telecommunications services but only manage the infrastructure on which they will then resell their services. Often, they are companies controlled partly by municipalities or government bodies. In some cases, this type of players also stemmed from fixed line network spinoffs from Mobile and Fixed Network Operators, as in the case of Openreach with British Telecom or Chorus with Spark in New Zealand. Wholesale primarily provides fixed line network access management; therefore, their activities mainly concern the infrastructure layer. Together with Infrastructure System Integrators, they play a role in the design and implementation of passive network infrastructure.

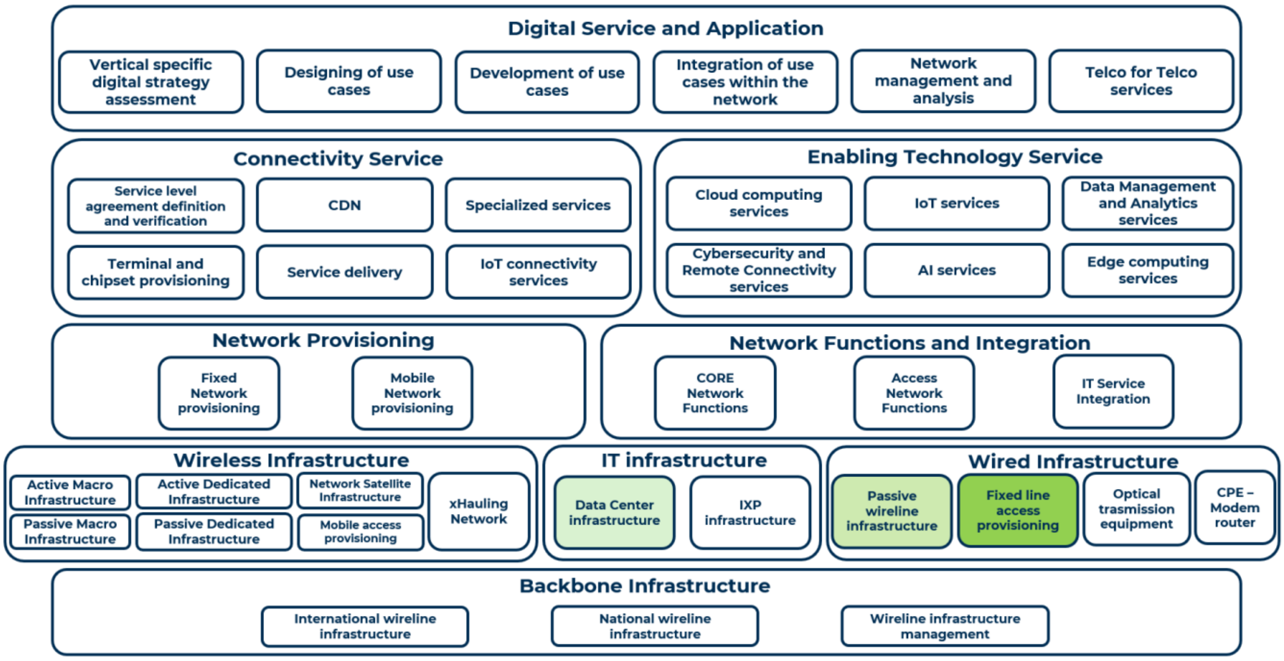

Figure 17 – Fixed Access Network Infrastructure Wholesaler Business Model

IT Infrastructure Provider

IT Infrastructure Providers mainly include two sub-categories of players: Internet Exchange Point and Data Center Providers.

The former are highly specialized in providing the required infrastructure to enable Internet Service Providers (*ISPs*) to exchange Internet traffic among themselves, while the latter provide space to host the IT infrastructure of companies (*colocation*), and in some cases also offer Cloud services. The number of IXP Providers largely depends on the characteristics of the interconnectivity network architecture that has developed over time in various countries but are usually just a few in each country. At the European level there are large IXPs in some countries that play a role at the continental level and not only in the countries where they are located, therefore managing large volumes of traffic (e.g. AMS-IX and DE-CIX).

For Data Center Providers the situation is slightly different, with a larger number of players still characterized by a high market concentration in subjects that manage large numbers. There is usually a close link between IXP and Data Center Providers due to the obvious interconnectivity needs of data centers, but IXPs are known for their independence.

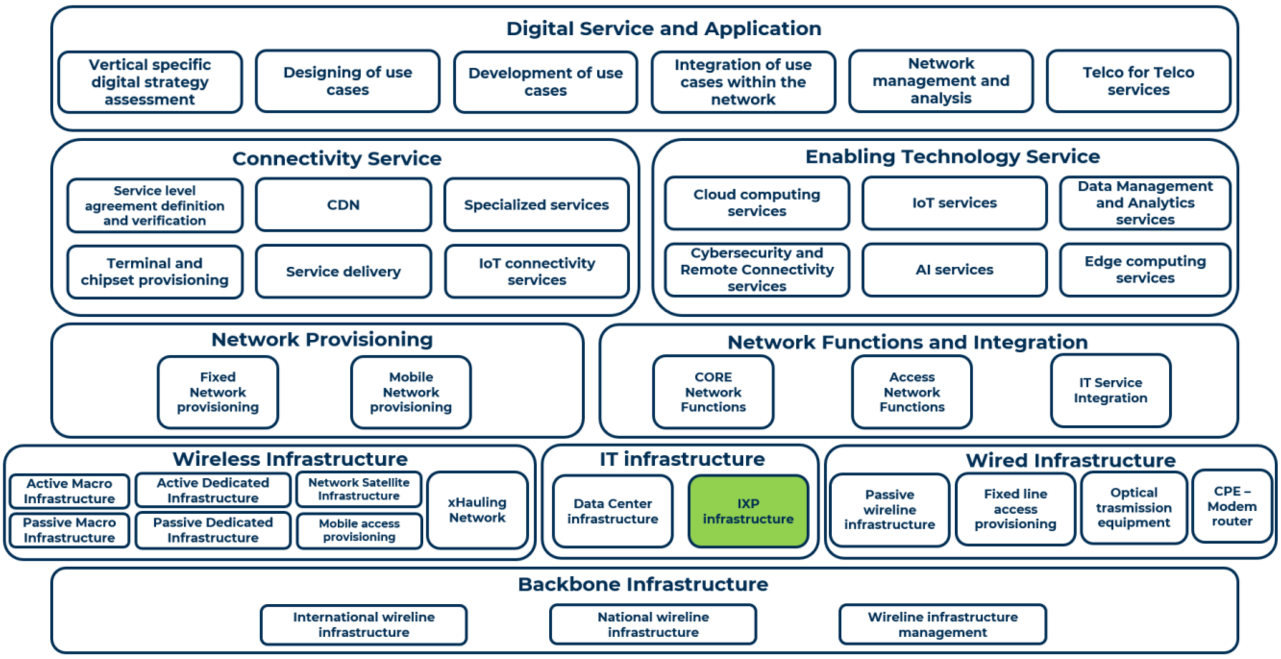

Figure 18 – IT Infrastructure Provider – IXP Business Model

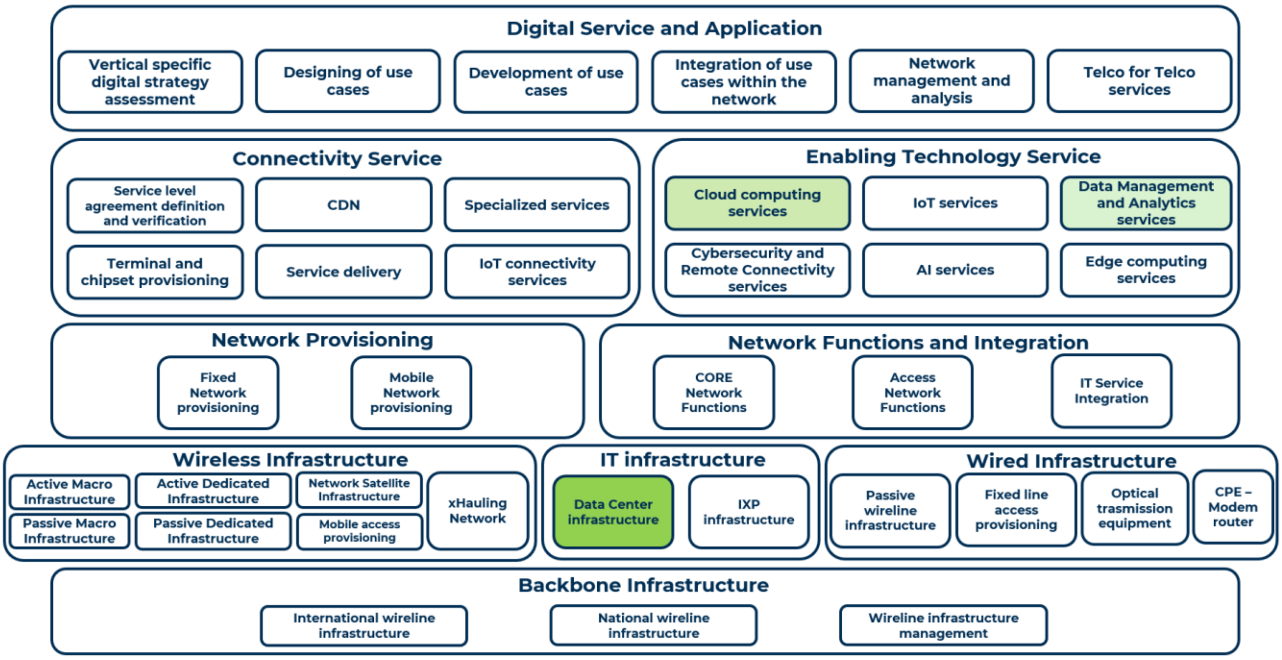

Figure 19 – IT Infrastructure Provider – Data Center Provider Business Model

IT Technology Provider

This type of players is characterized by a high level of technology expertise, as they originally provided ICT services and products such as personal computers and software. Telecommunications are not their core business, but they provide components and services that are essential for the operation of the network infrastructure. The activities they mostly perform include managing network functions such as remote servers and radio units, and offering Cloud services, and in some cases cybersecurity. Some players also provide data center IT infrastructure.

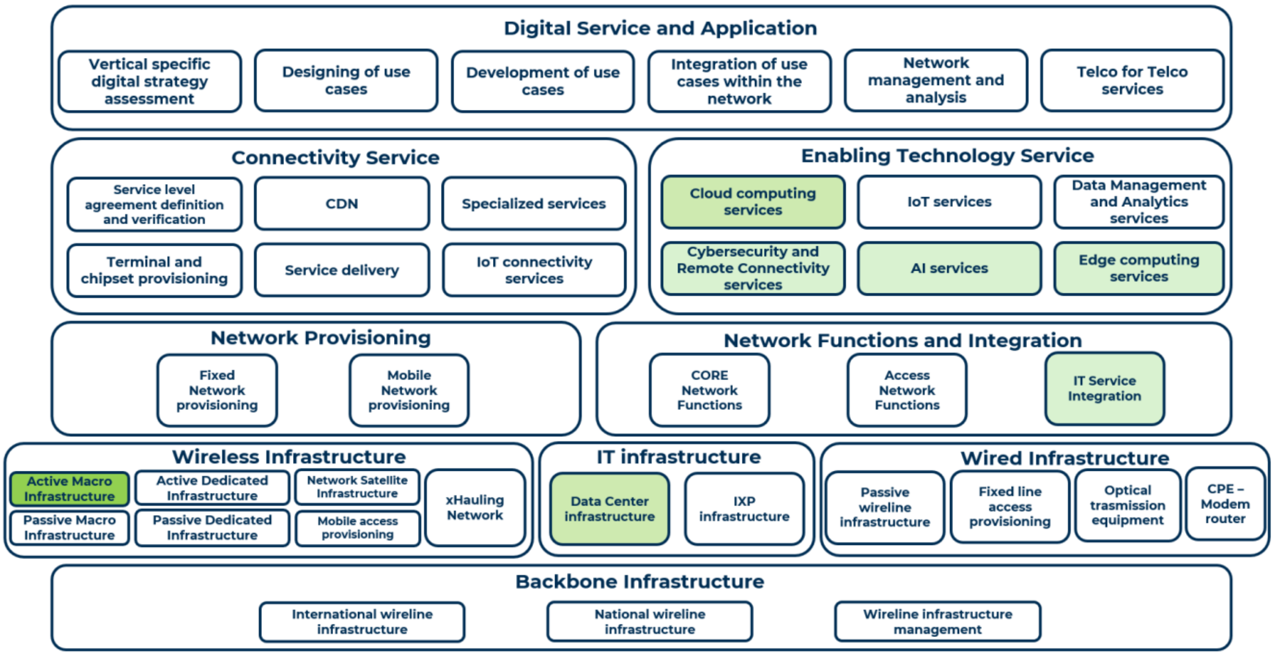

Figure 20 – IT Technology Provider Business Model

Network Equipment and Software Supplier

These players are characterized by strong ICT expertise. They are key players in the telecommunications ecosystem, providing software and hardware devices enabling network management. Some players also offer IT integration and Cloud services. They are well established in the infrastructure and network functions layer.

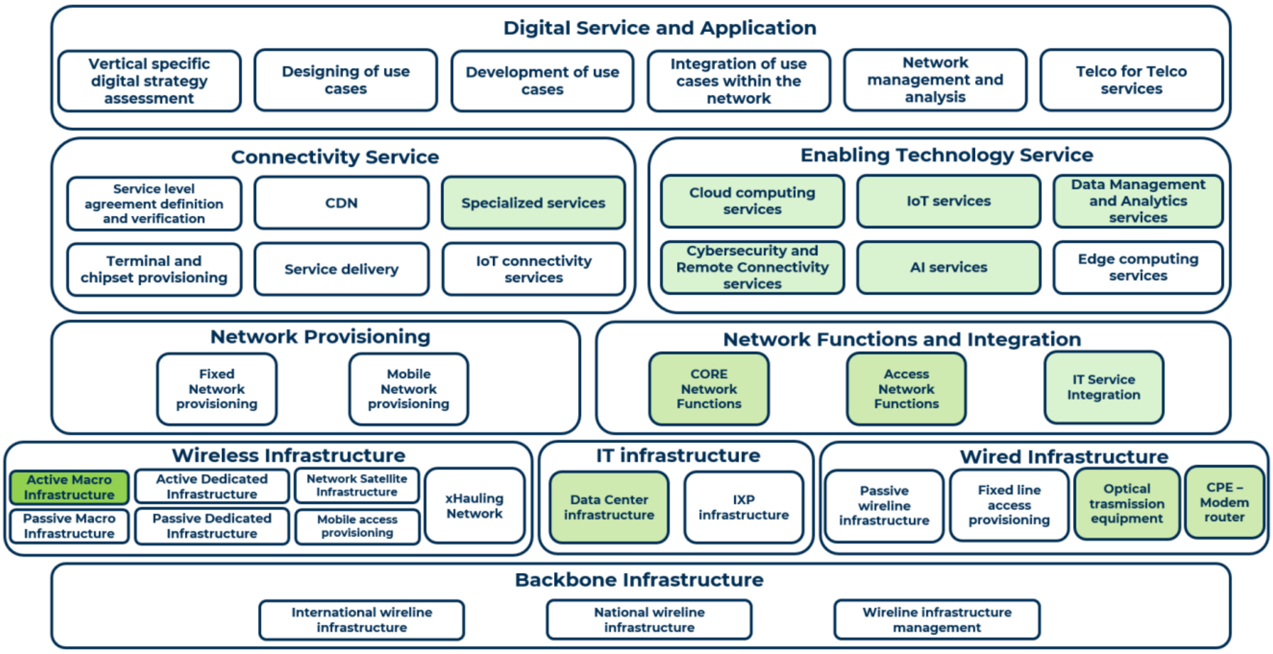

Figure 21 – Network Equipment and Software Supplier Business Model

Mobile and Fixed Network Operator

Mobile and Fixed Network Operators are telecom operators and traditionally, the key players in the telecommunications ecosystem. These players have a central role in the ecosystem in that they provide services to end customers, both consumer and business, and own large telecommunications infrastructures, from fibre optic cables to antennas for signal transmission. In addition, they have always adopted a vertical integration approach and cover all layers of the ecosystem and perform a variety of activities.

Telecommunications operators are players that have always been in this industry, and in the past, they have shaped the entire telecommunications ecosystem through the implementation of infrastructure and services. Given their strategic importance, some of them have State participation in the Board of Directors. These are the players that are being most affected by the transformations of the industry, and in the near future will necessarily have to change their business model to innovate and be able to capture value from the services they offer.

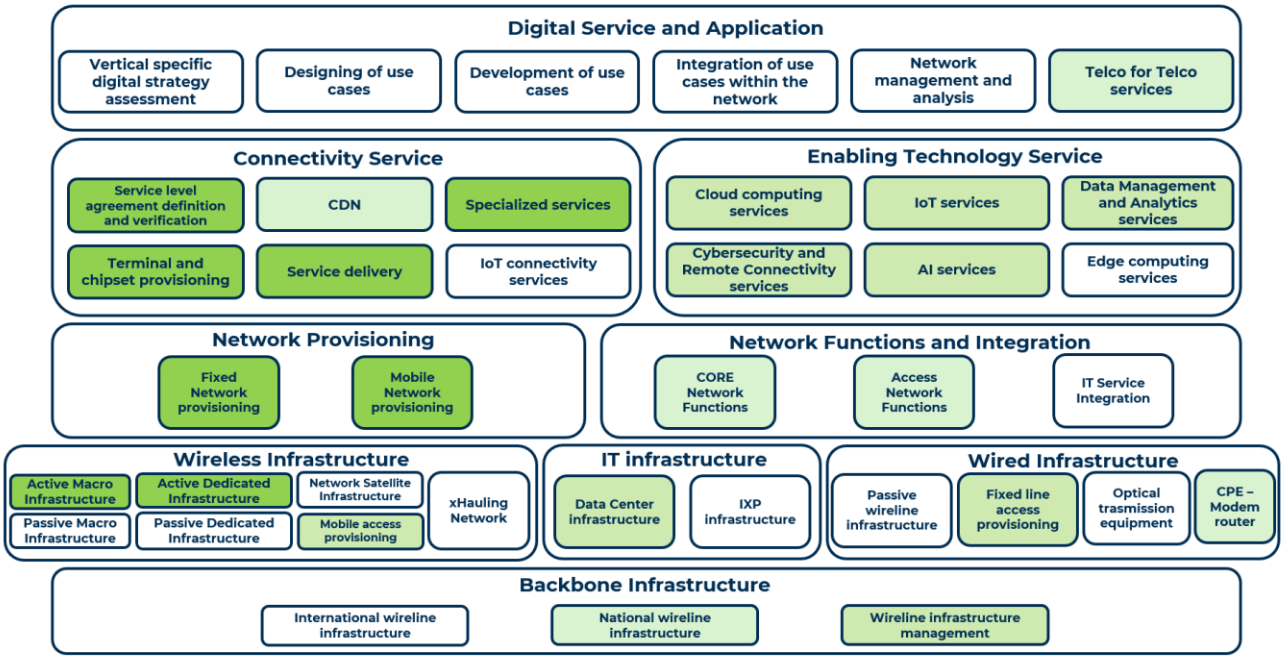

Figure 22 – Mobile and Fixed Network Operator Business Model

Mobile Virtual Network Operator

The business model of this type of player has been specifically designed to leverage the network infrastructure and frequency spectrum of Mobile and Fixed Network Operators, and subsequently only conduct service delivery activities. Some virtual operator models also include running their own dedicated Core Network (full mobile virtual network operator model), which enables to customize services and provide differentiated advanced services of the operator providing the access infrastructure. Although originated in a different context, the virtual operator model could be a point of reference in the future, aiming to separate the management of infrastructure from the provision of connectivity services.

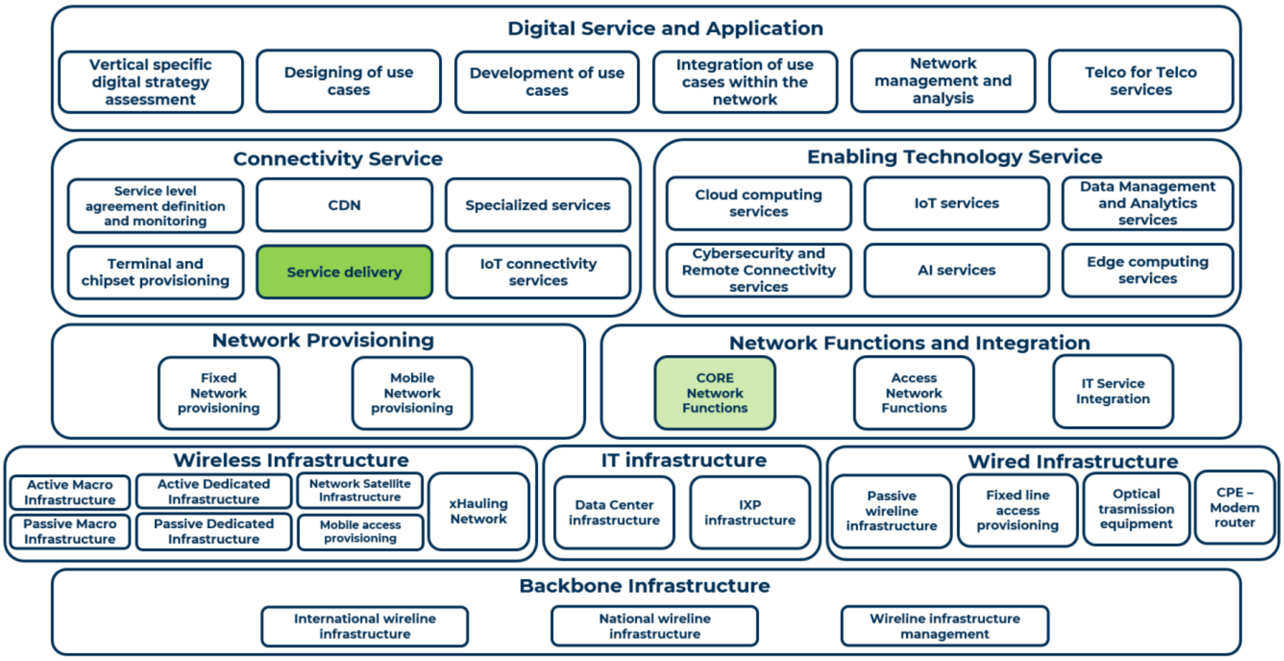

Figure 23 – Mobile Virtual Network Operator Business Model

Satellite Network Operator

This type consists of a small number of players that offer connectivity services by leveraging their infrastructure network consisting mostly of Low-Earth-Orbit (LEO) satellites. The small satellites that make up this network provide Internet access and voice services in rural areas of the planet where fiber optic networks have not yet arrived or where it is very complicated to connect that area to a network cable providing adequate coverage. These players have emerged in recent years, driven by the rapid growth of the New Space Economy market. In addition, these players can have access to the mobile frequency spectrum and also provide connectivity services.

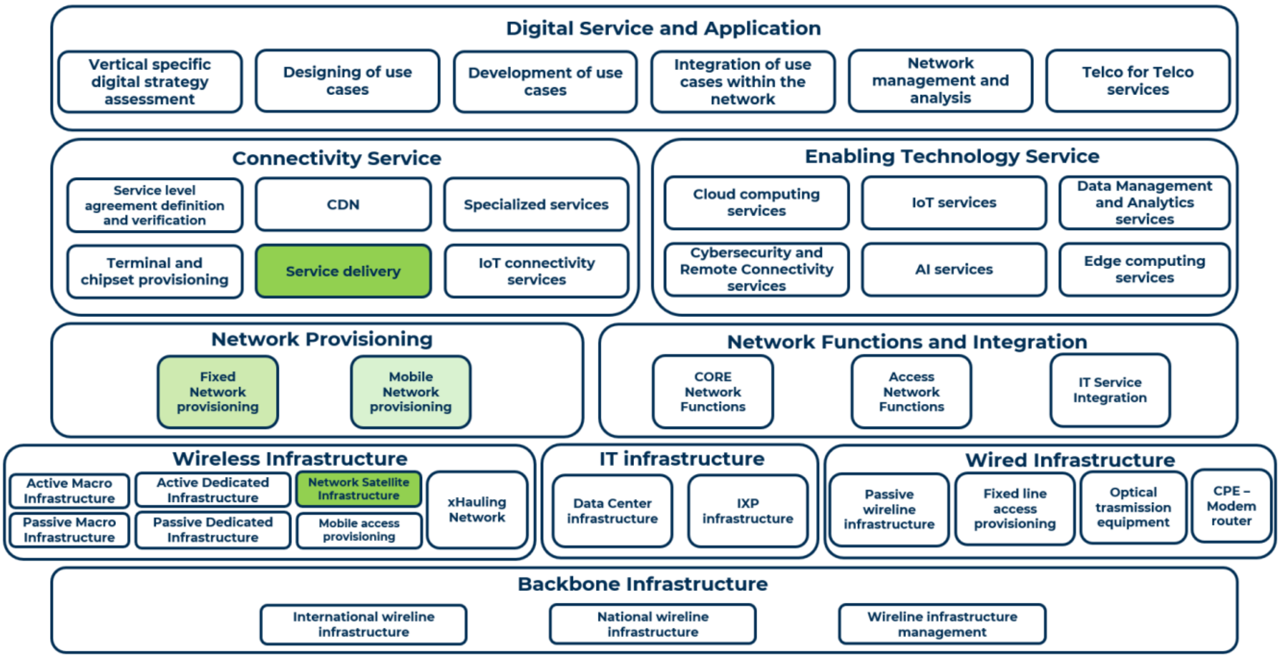

Figure 24 – Satellite Network Operator Business Model

Specialized ICT Service Company

These players are characterized by a high degree of specialization in providing Content Delivery Network services and virtualization of computing platforms. They emerged at the end of the past century to address the need to manage network content delivery more efficiently. In some cases they also offer Cloud and Cybersecurity services.

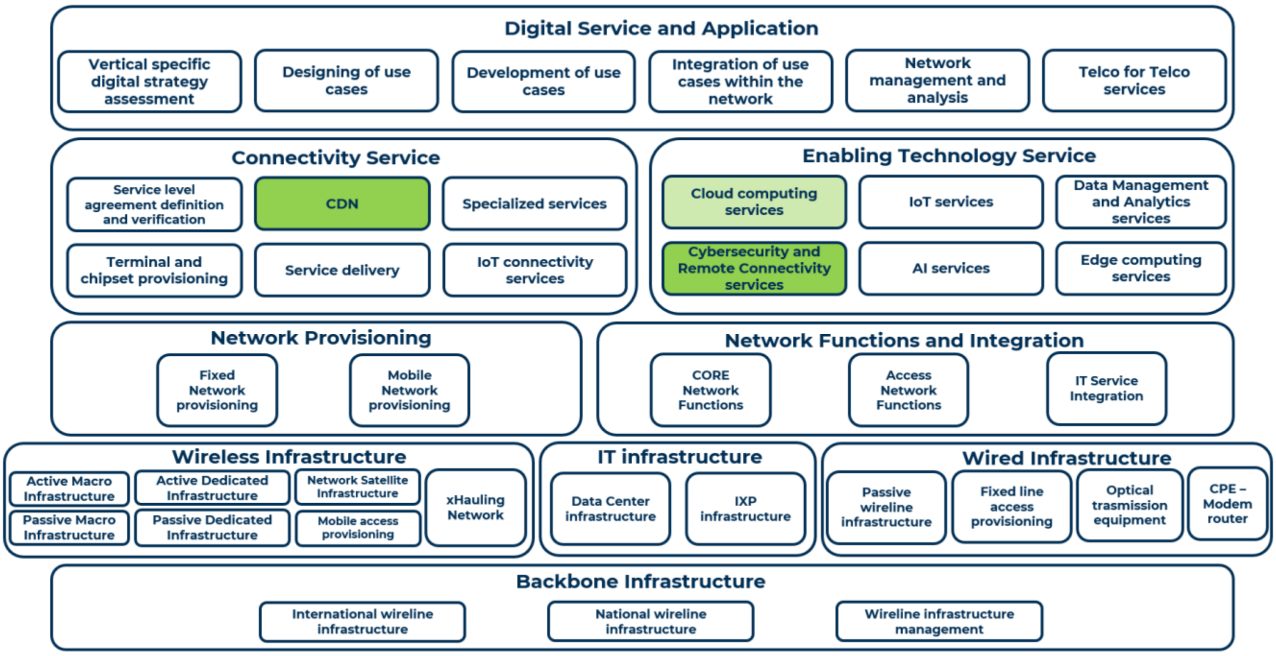

Figure 25 – Specialized ICT Service Company Business Model

Over-The-Top

"OTTs" are a category of players that use telecommunications networks provided by other players, in that they do not have their own network infrastructure to offer multimedia services and applications such as streaming platforms or social networks. They have a role in managing content distribution networks (CDNs), sometimes using their own infrastructure and other times through third-party providers.

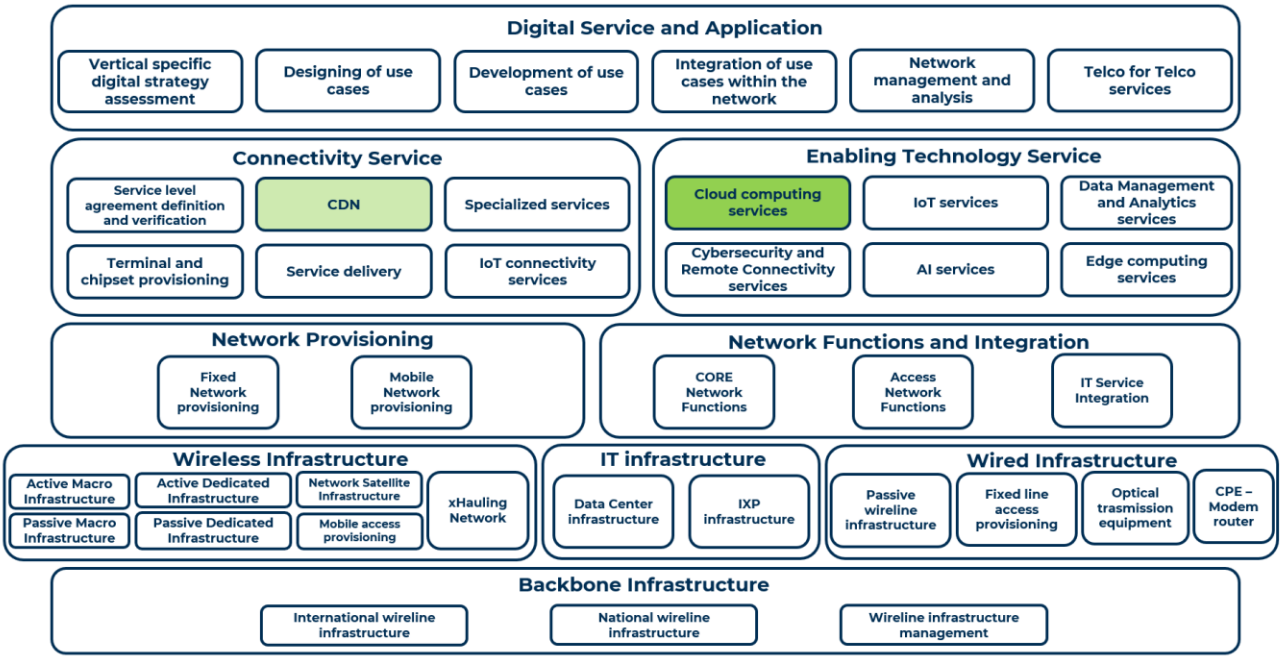

Figure 26 – Over-The-Top Business Model

Hyperscaler

This type of player consists of what are known as "Tech-Giants." These players offer Cloud computing services worldwide and own parts of the upstream and downstream network infrastructure. Some of them are also specialized in providing Content Delivery Network services, and in offering hardware and software solutions for private 4G/5G networks. Their strengths also include owning international network infrastructures that connect the continents over which Internet data transits, and being present with their own equipment in the vast majority of IXPs across the world by being able to route traffic directly into the access networks of telecommunications operators.

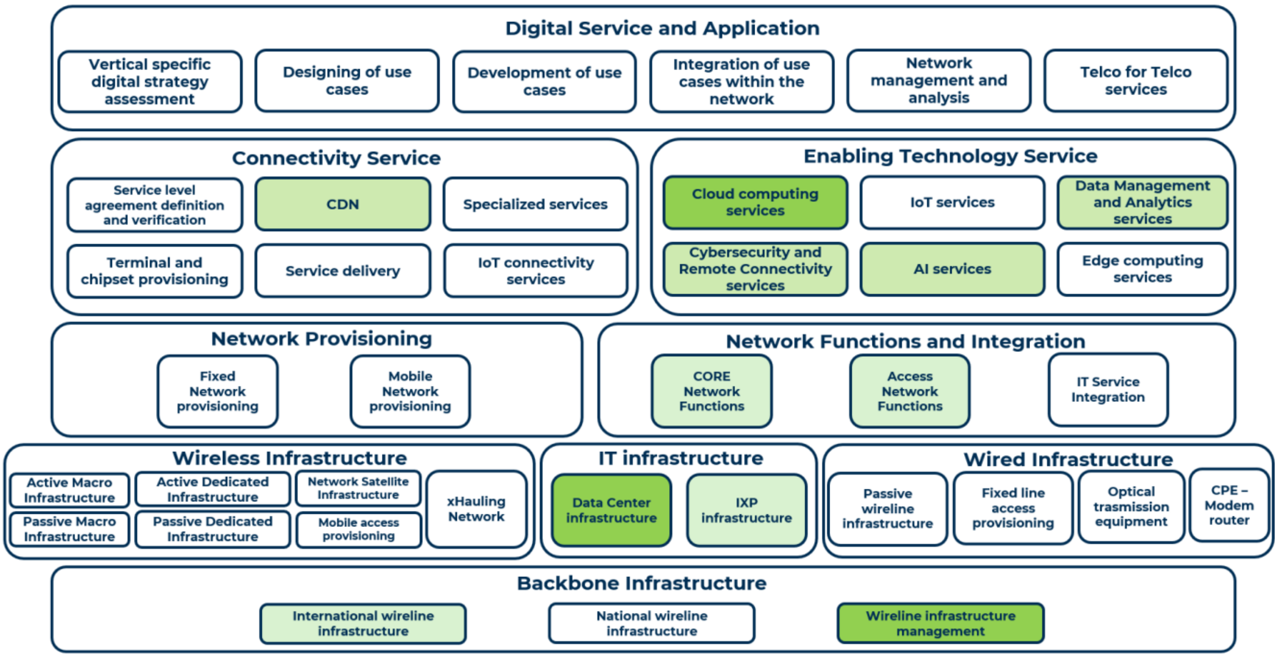

Figure 27 – Hyperscaler Business Model

IT System Integrator

This type of player offers value-added consulting and integration services and specific use cases for various industry verticals such as manufacturing, logistics, mining, etc.

Very often these players provide consulting to several other players in the telecommunications ecosystem, thus indirectly playing a role in many of the activities that have been identified in the value network. However, the model representation is limited to showing only the activities that are conducted independently and not for others, providing support and manpower.

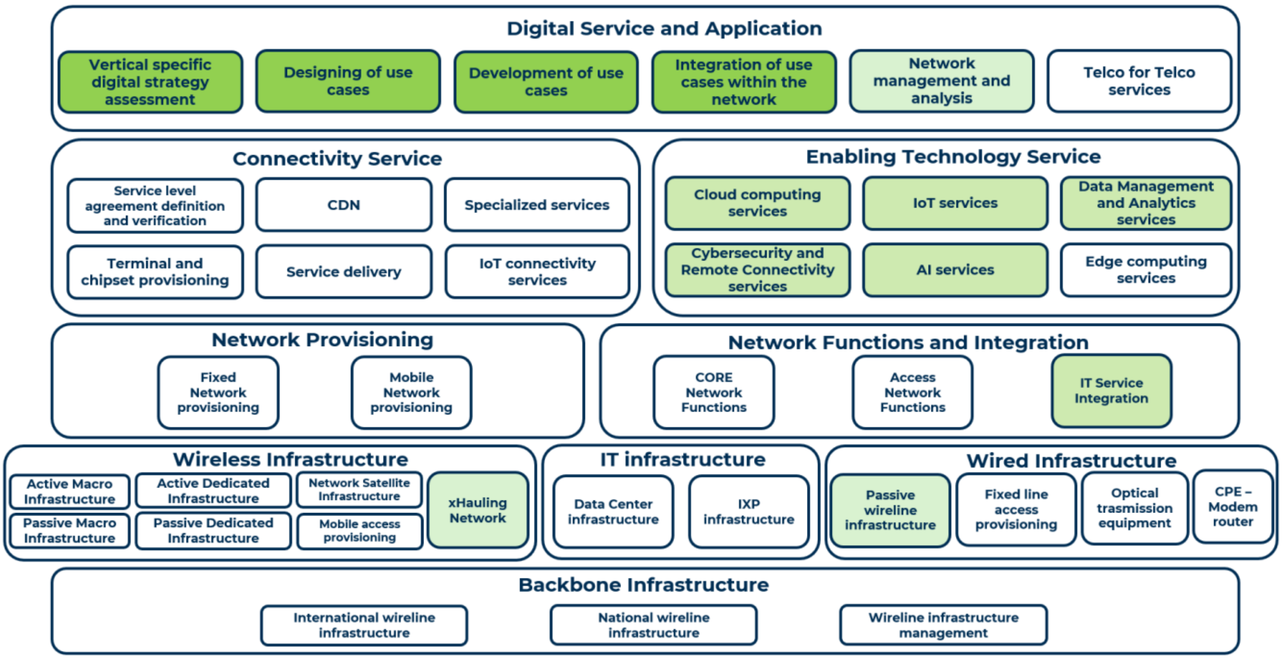

Figure 28 – IT System Integrator Business Model

Industrial Connectivity Provider

Industrial Connectivity Providers are players that offer connectivity services and private network integrations for enterprises and public sector bodies using different technologies (such as industrial wired network technologies, Wi-Fi, LoRaWAN, etc.). Some of them also possess a data center infrastructure to provide Cloud services.

Some of the companies representing this type of business model focus primarily on this role, but in many other cases, by companies in the ecosystem that also have other roles in the ecosystem.

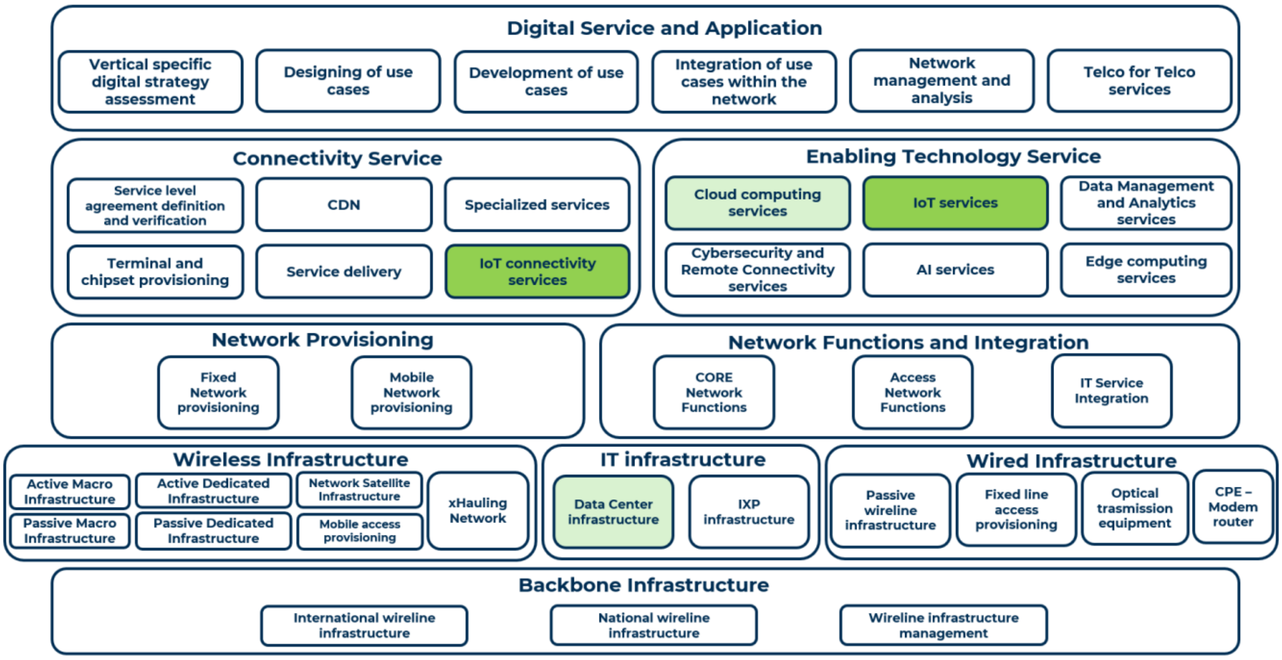

Figure 29 – Industrial Connectivity Provider Business Model

Artificial Intelligence Provider

Artificial Intelligence Providers are a type of actor that is becoming increasingly established in the digital landscape, offering services that are currently geared primarily toward consumers, with potential expansion to business users. These tools are generally based on Generative Artificial Intelligence (GenAI), but may also include other forms of AI. AI providers may develop their own Large Language Models (LLMs) to power AI-based services, while others may rely on LLMs developed by third parties. As early entrants in the AI services market, these actors hold a competitive advantage over newer players, both in terms of brand recognition and technological capability, including learning and performance.

Given their experience in developing AI-based solutions, these new players can easily enter the telecommunications ecosystem offering services to several other players, including communication infrastructure providers and their customers.

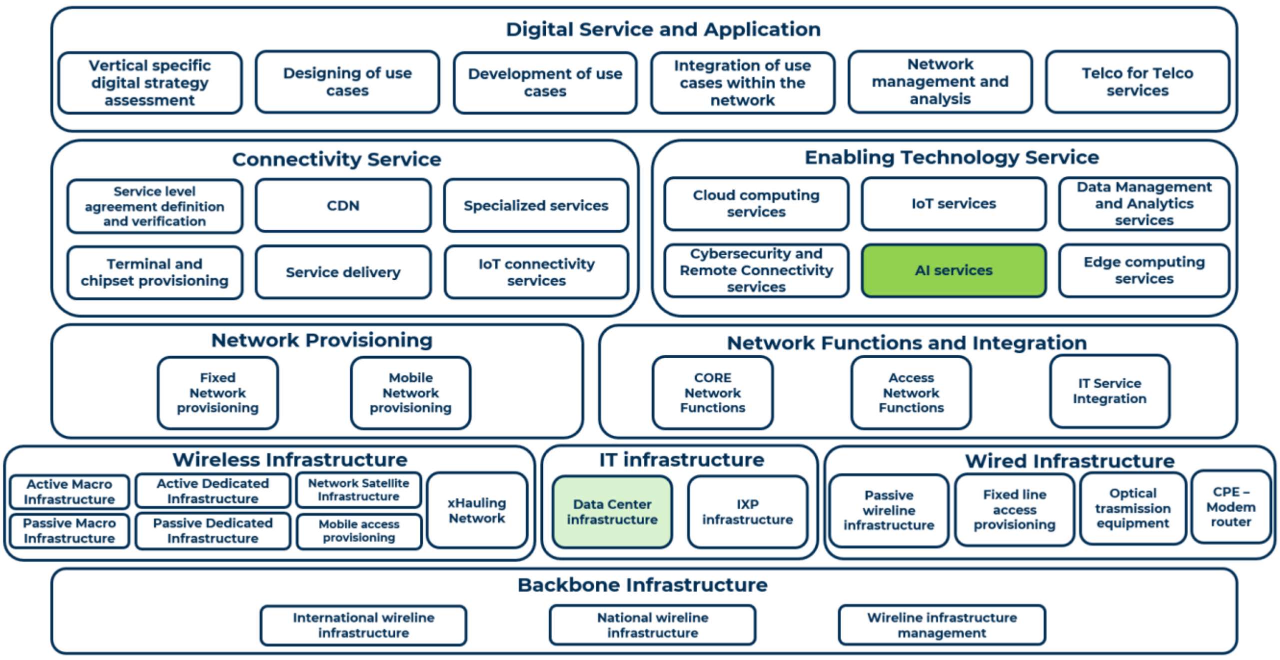

Figure 30 – Artificial Intelligence Provider Business Model

An overview of the seventeen different business model archetypes is represented in the following Figure.

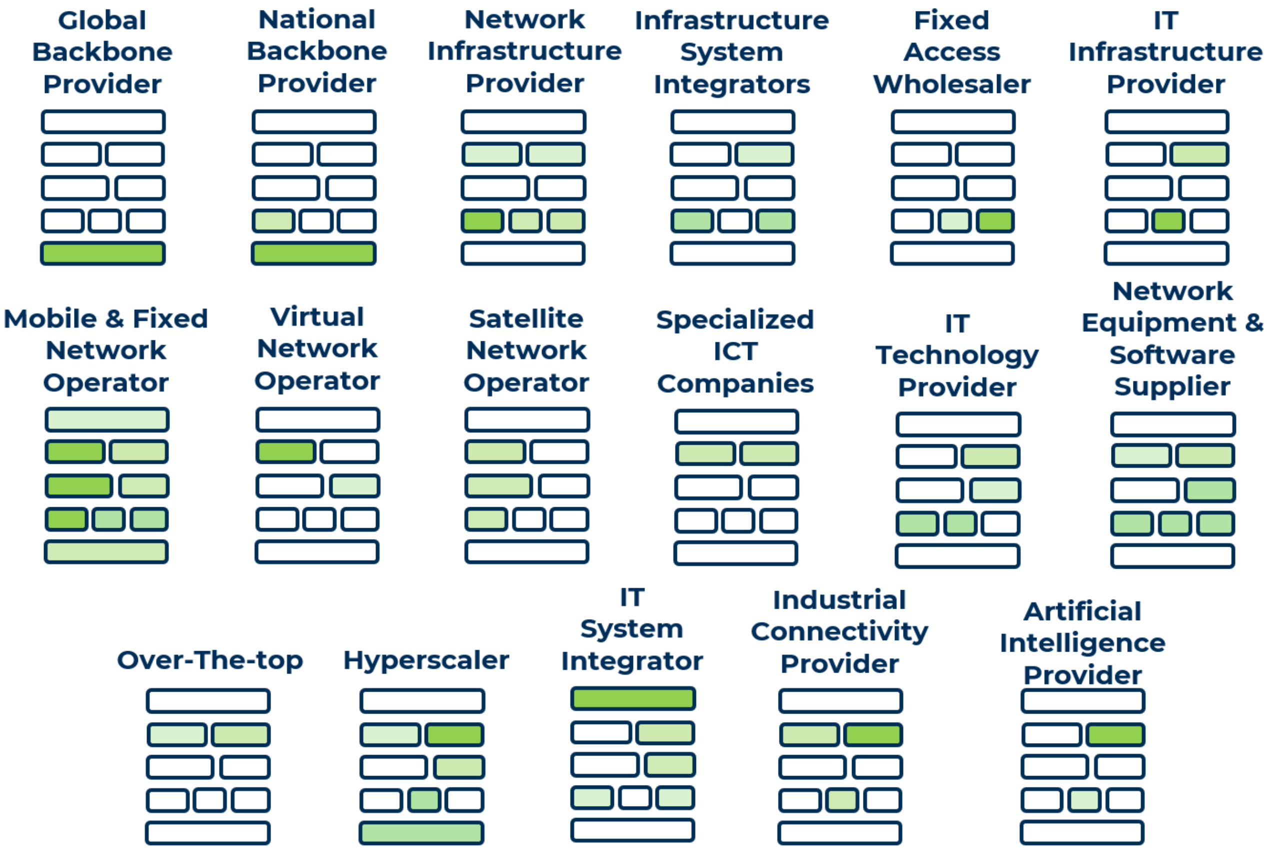

Figure 31 – Business model archetypes overview

3.3. The representation of the value network

As we described in section 2.1.2, thanks to the methodologies and research presented, we were able to map the entire value network of the telecommunications ecosystem, highlighting the relationships between actor archetypes. This activity was useful for: getting a clear view of the resources currently exchanged in the ecosystem; and understanding how the dynamics that will be described in the identified scenarios may change these relationships from the current situation.

For the sake of space and clarity, the representation of the value network can be viewed interactively through this link, while a simplification of it can be viewed in the figure below.

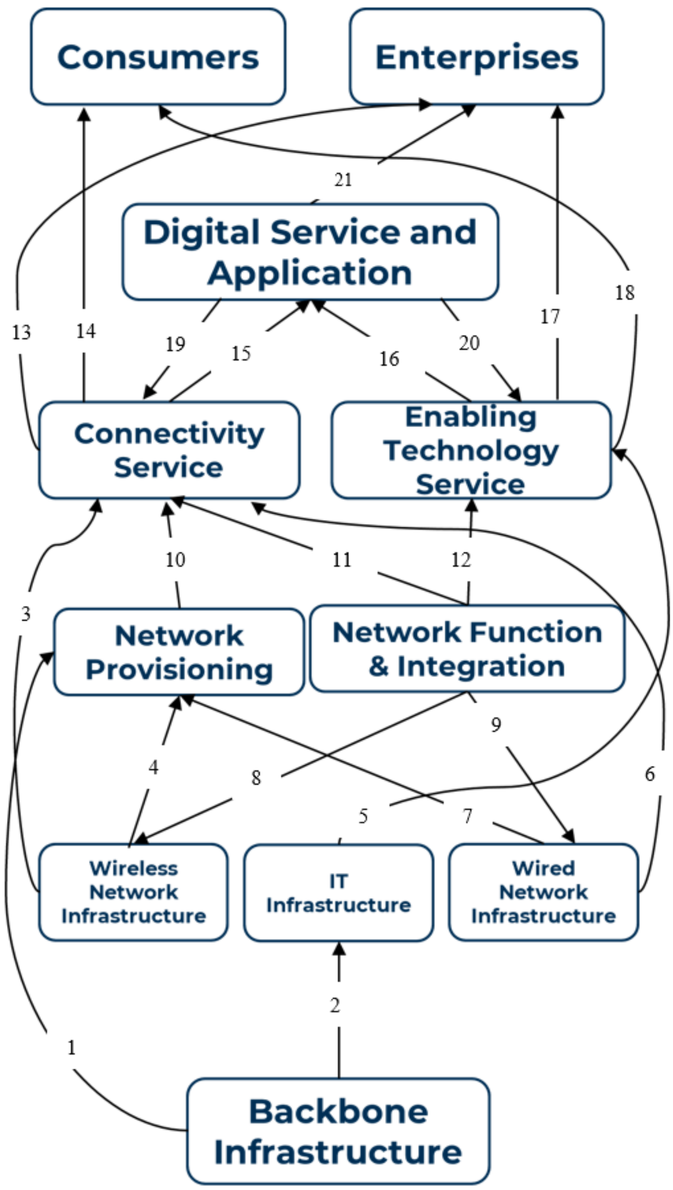

Figure 32 – Telecommunications value network

Report number	Resources exchanged in the report
1	Supply of wholesale Internet connectivity services by Global Backbone Providers to Fixed and Mobile Network Operators.
2	Supply of wholesale Internet connectivity services by National Backbone Providers to IXPs and Data Centre Providers.
3	Supply of infrastructure and connectivity services, by Network Infrastructure Providers, for coverage beyond the public network (e.g. special coverage).
4	Supply of space on their passive infrastructures (e.g. towers) by Network Infrastructure Providers to host the active equipment of Fixed and Mobile Network Operators.
5	Offering the storage and computing space of IT infrastructures (e.g. servers) to Hyperscalers, OTT or Fixed and Mobile Network Operators for the provision of digital services to consumers and businesses.
6	Wholesale sale of access to its fibre-optic network infrastructure.
7	Wholesale sale of access to its fibre-optic network infrastructure.
8	Supply of services and equipment for the operation of the mobile network infrastructure.
9	Supply of services and equipment for the operation of the wired network infrastructure.
10	Supply of connectivity service in wholesale mode to Mobile Virtual Network Operators.
11	Supply of services and equipment for the operation of the wireless and wired network infrastructure of Fixed and Mobile Network Operators and of the CORE Network to Full-Mobile Virtual Network Operators.
12	Supply of services and equipment for the operation of the industrial network infrastructure created by Industrial Connectivity Providers.
13	Supply of connectivity services to consumers.
14	Supply of connectivity services to enterprise users.
15	Co-creation of connectivity and value-added offerings, between Fixed and Mobile Network Operators and IT System Integrators, for enterprises to

	develop use cases enabled by technologies beyond the pure connectivity offering.
16	Co-creation of connectivity and value-added offerings, between Hyperscaler and IT System Integrators, for enterprises to develop technology-enabled use cases beyond the pure connectivity offering.
17	Supply of services based on enabling technologies (e.g. AI, Cloud, etc.) to enterprises.
18	Supply of services based on enabling technologies (e.g. AI, Cloud, etc.) to consumers.
19	Co-creation of connectivity and value-added offerings, between Fixed and Mobile Network Operators and IT System Integrators, for enterprises to develop use cases enabled by technologies beyond the pure connectivity offering.
20	Co-creation of connectivity and value-added offerings, between Hyperscaler and IT System Integrators, for enterprises to develop technology-enabled use cases beyond the pure connectivity offering.
21	Supply of specialised services on the development of industrial use cases specific to each industrial vertical.

Table 1 – Resources exchanged between ecosystem actors

3.4. Current and future market valuation of the European telecommunications ecosystem

In order to give an economic perspective of the present European ecosystem situation, we conducted a market valuation for each of the activities included within the ecosystem layered architecture model showed in this chapter. The assessment regarded the market size related to 2024, since the market data have been gathered till September 2025. Each of the activities has been categorized as a real market or as the total turnover of ecosystem telecommunications actors in a specific layer or as a source of costs or investments for ecosystem telecommunications actors. For some of these activities we used data from Polimi Digital Innovation Observatories – due to the high quality and goodness of the market valuation of this research center – while for the rest of the activities we collected data from market reports, database and financial statements of the actors, which we used to calculate the exact economic value for that specific activity. Moreover, to validate the calculation, we conducted some interviews with experts to have their feedback on the economic values. A detailed assessment of the Italian market was carried out and, to estimate the European value, modelling tools were developed employing suitable proxies calibrated to the scale of the Italian market where necessary. For each of these activities we calculated the European market valuation in 2024 and the CAGR (Compound Annual Growth Rate) between 2025 and 2030.

From this market valuation emerges that the European telecommunications ecosystem is valued at €1,142 billion in 2024, with an expected CAGR of approximately 8% between 2025 and 2030. However, this positive aggregate trend masks significant asymmetries, as growth will not be uniform across the board. The analysis highlights a structural shift where value creation is increasingly decoupled from traditional connectivity, moving instead towards connectivity integrated with digital services and applications.

The Network and IT Infrastructure layer shows positive but moderate growth as a whole, close to 7%. Specifically, wired network infrastructures account for approximately €84 billion with an estimated prospective annual growth rate of 6.7%, while wireless network infrastructures are valued at around €56 billion, growing at 6.9%. A significantly larger component is represented by IT infrastructure, including data centers and interconnection facilities, which is valued at about €105 billion and is expected to grow at a rate of 6.8% annually over the next few years. While traditional CapEx for wireless and wired networks shows signs of decline, with an expected CAGR of -1.9%, the layer's growth is guided by Data Center infrastructures and Active Dedicated infrastructures, such as DAS and 5G MPN. Indeed, the CAGR of the latter is 19.7% for the next five years. Even the wholesale fixed and mobile network market is set to expand, with an expected CAGR of 11.54%, driven by the continuous infrastructure investments also with public contribution. For 2024, the European market valuations are respectively, €21.9 billion for Mobile Access provisioning and €45 billion for Fixed line Access provisioning. Furthermore, although still small in scale, around €1 billion in 2024, satellite infrastructure is also set to grow with a CAGR of 13.6%, thanks to technological advances that we will see in the coming years, such as D2D (direct-to-device).

In contrast, the Network Provisioning, Management, and Integration layer contributes the least to ecosystem growth, showing signs of stagnation or slight contraction. Network management and provisioning activities amount to roughly €139 billion with zero net growth expected, while integration activities represent about €20 billion, with an estimated decline of -0.6%. This trend reflects the increasing perception of these activities as cost centers rather than sources of differentiated value. While a decrease in OpEx related to telecommunication networks is expected due to infrastructure optimization and automation, even though they represent the biggest part – in terms of economic value – of this layer, the sector faces a cyclical demand for RAN and CORE software related to future developments like 6G. Indeed, the prospective CAGR for these two markets are respectively, 1.4% for Core Network functions – with a market valuation of €427 million in 2024 – and 0.1% for RAN functions – with a market valuation of €11.3 billion in 2024. Currently, however, this layer represents high costs for operators without being perceived as added value for the end customer.

The Connectivity Services layer represents the traditional core of telecommunication operators and is valued at approximately €306 billion in 2024, with a CAGR of 6.8%. Although this is a growing and big market, it expands at a slower pace than the ecosystem as a whole. Traditional mobile and fixed line connectivity services remain substantial but are largely stable, constrained by high user coverage saturation and the difficulty of increasing ARPU. Indeed, these two markets represents a huge part of the entire layer, with a market valuation of respectively, €105 billion for Mobile Service Delivery and €65 billion for Fixed line Service Delivery. Even though these considerable dimensions, the growth is stable and under the total growth of the Connectivity Service layer, respectively 0.4% for the former and 1.9% for the latter. Conversely, dynamic growth patterns are observed in specific segments such as IoT services, specialized services, Content Delivery Network (CDN) services, and the terminals and chipsets market. Except for the latter, which is valued €81 billion in 2024, the rest of the markets represent a small part of the entire layer, but with very high expected growth for the next five years. Specialized services market is the one with the highest growth rate (40%), although the smallest market value of less than €100 million in 2024. This is due to the current low development of connectivity services beyond the traditional basic connectivity, such as network slicing and other types of quality assured connectivity services, which could grow exponentially in the next years. For the other markets, the CAGR are higher than the total growth of the layer (6.8%). Respectively, 10.2%, 28.1% and 9.2%, for Terminals and Chipsets provisioning, CDN services and IoT Connectivity services. This means that, the most important percentage of growth in the Connectivity Services layer is not anymore related to the traditional telco operators value proposition, but to the other connectivity services which are perceived as value added activities by the enterprise and consumer segments.

The most significant value creation is concentrated in the Enabling Technology Services layer, which includes cloud computing, IoT platforms, artificial intelligence, data analytics, cybersecurity, and edge computing. Valued at approximately €329 billion, this layer is expected to grow in next years at a remarkable annual rate of 14.2%, confirming that the future of the telecommunications ecosystem will be heavily focused on the development of technological services. This layer acts as the main driver of ecosystem growth; however, it is also the area where telecommunications operators are currently least present, often limited to partnership agreements or isolated integrated initiatives rather than holding a dominant market position. Indeed, except for rare initiatives, often focused just on their national markets, telco operators do not own a complete stack to offer property technological services such as cloud computing or artificial intelligence services. For this reason, almost all the European telco operators created strategic or commercial partnerships with American cloud providers, such as Google, Microsoft and AWS. Moreover, the competitive advantage of the American Big-Tech companies lies in the property of the biggest LLMs (Large Language Models) for the development of AI services and applications. According to the Artificial Intelligence Index Report 2025[55], the gap related to the development of Frontier Models[56] among USA, China and Europe is larger than expected. USA is the uncontested leader with 40 Frontier Models developed, and a complete ecosystem, composed by companies such as Nvidia, Google, OpenAI, Anthropic, Meta, etc., which allow the American companies to exploit the full potential of this technology, from the chipsets and infrastructures to the applications and services. To highlight this leadership, 75% of

[55] https://hai.stanford.edu/ai-index/2025-ai-index-report
[56] https://www.iguazio.com/glossary/frontier-model/

the global computation AI capacity is controlled by the USA. On the other hand, there is China, with 15 Frontier Models developed in the last years by companies such as DeepSeek, Tencent, Alibaba, etc. China's models are constantly growing and are reducing the gap with USA, even though the gap is, however, considerable. China adopted a different approach for the development of these Frontier Models, focused on efficiency and open-source logic despite the limits for the development of specific hardware such as GPU to train these models. Indeed, the leadership of the hardware remains in the hand of American companies. In third position there is Europe with just 3 Frontier Models developed by companies such as Mistral and Aleph Alpha. The reason of this huge gap, compared to USA and China, lies in the completely different approach adopted by European companies: focused on high-quality, privacy-compliant and sovereignty models. In this way, Europe is positioning as a "neutral" alternative to USA and Chinese giants. Thanks to this situation, with the presence of few European and many non-European players in the AI field, the European AI service market will grow exponentially in the next five years with a CAGR of 26.3%, followed by Edge computing services with an extimated CAGR of 20.6% and Cloud computing services with 16.3%. The latter represents the biggest market of the European telecommunications ecosystem, with €149.6 billion in 2024 and an estimated value of €369.8 billion in 2030. For what concern the other markets of this layer, related to Cybersecurity, IoT platforms and Data Management and Analytics, they represent the part of the Enabling Technologies with a more contained growth rates, respectively: 5.6% for Cybersecurity, 9.2% for IoT platforms, and 7.8% for Data Management and Analytics.

Finally, Digital Services and Applications linked to connectivity account for around €103 billion, yet a relatively modest growth rate of only 1.4% is expected. This indicates that, despite their strategic importance, these services have not yet fully realized their economic potential within the European telco context. Growth is currently hindered by the lack of maturity in companies regarding the integration of connectivity strategies for business development use cases. Consequently, much of the potential value is currently captured by non-telco players developing enterprise services for specific industrial verticals exploiting connectivity as a means to offer them. However, should corporate maturity increase and offerings evolve to provide an adequate value proposition. This layer could represent a crucial turning point for telecommunications operators which may exploit their current assets, such as a huge network of commercial relationships, to offer beyond connectivity services positioning themselves as a unique touchpoint for the enterprises.

Below it is possible to find the detailed market valuation for all the activities which made up the ecosystem layered model in terms of present, future contribution and growth to the ecosystem value.

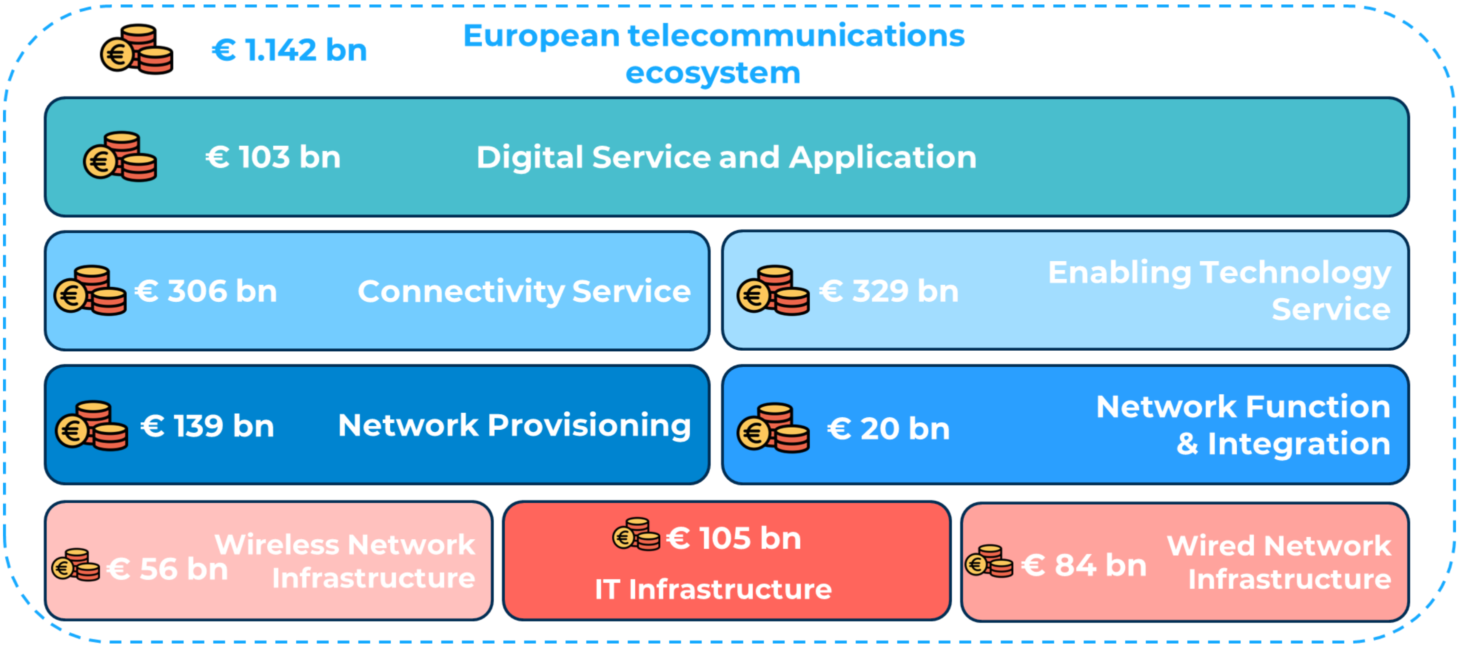

Figure 33 - Market size (2024) of the European telecommunications ecosystem

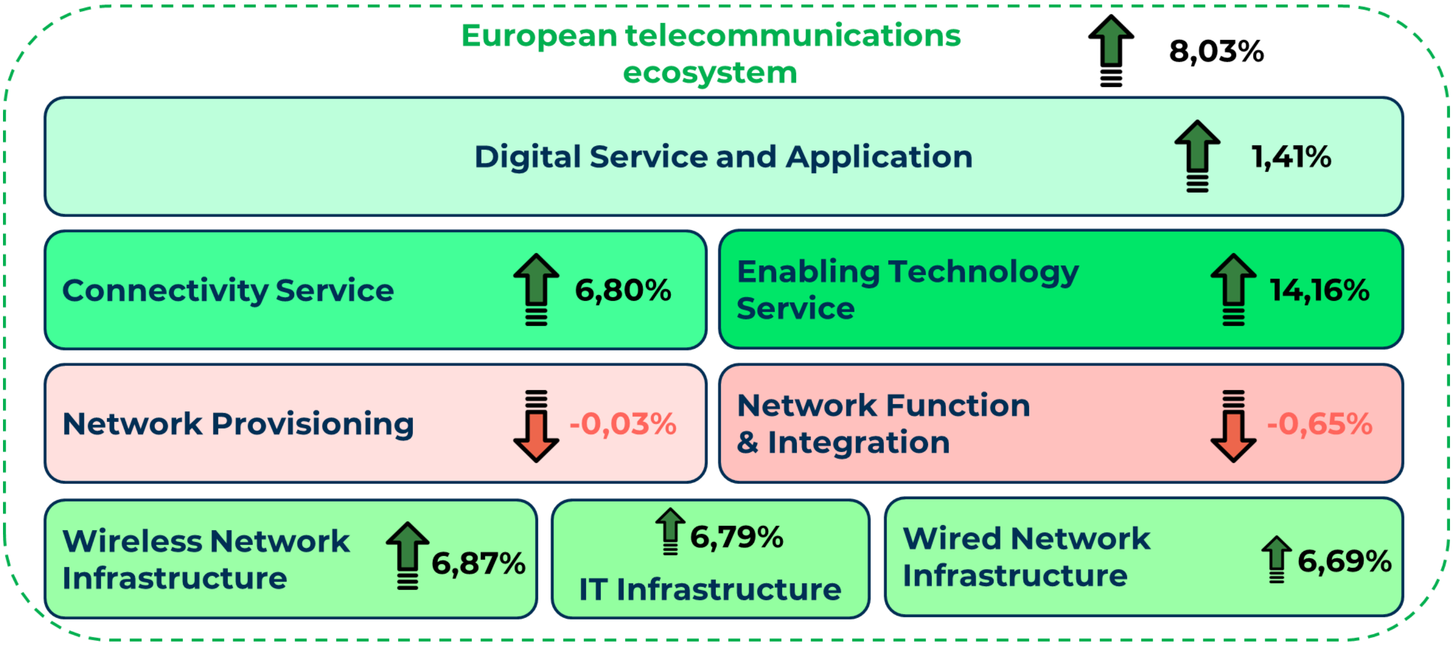

Figure 34 - Market growth (CAGR 2025-2030) of the European telecommunications ecosystem

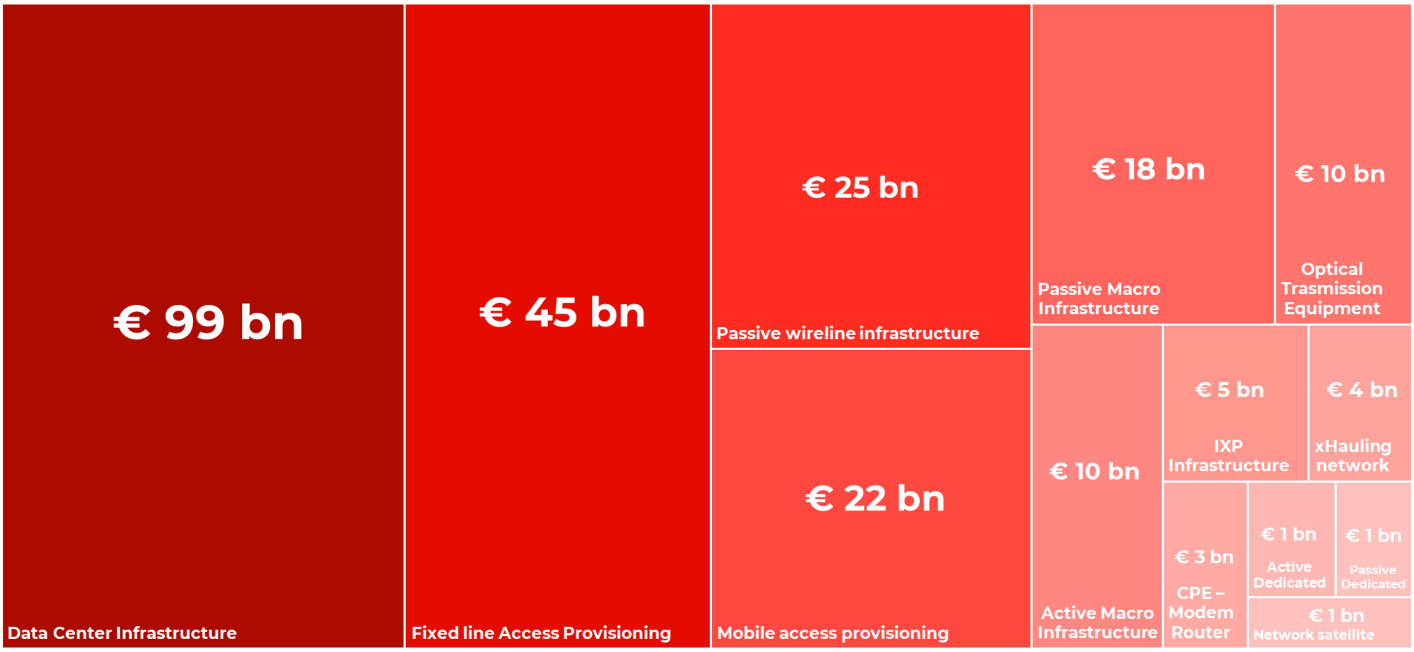

Figure 35 - Network Infrastructure layer - Market size (2024)

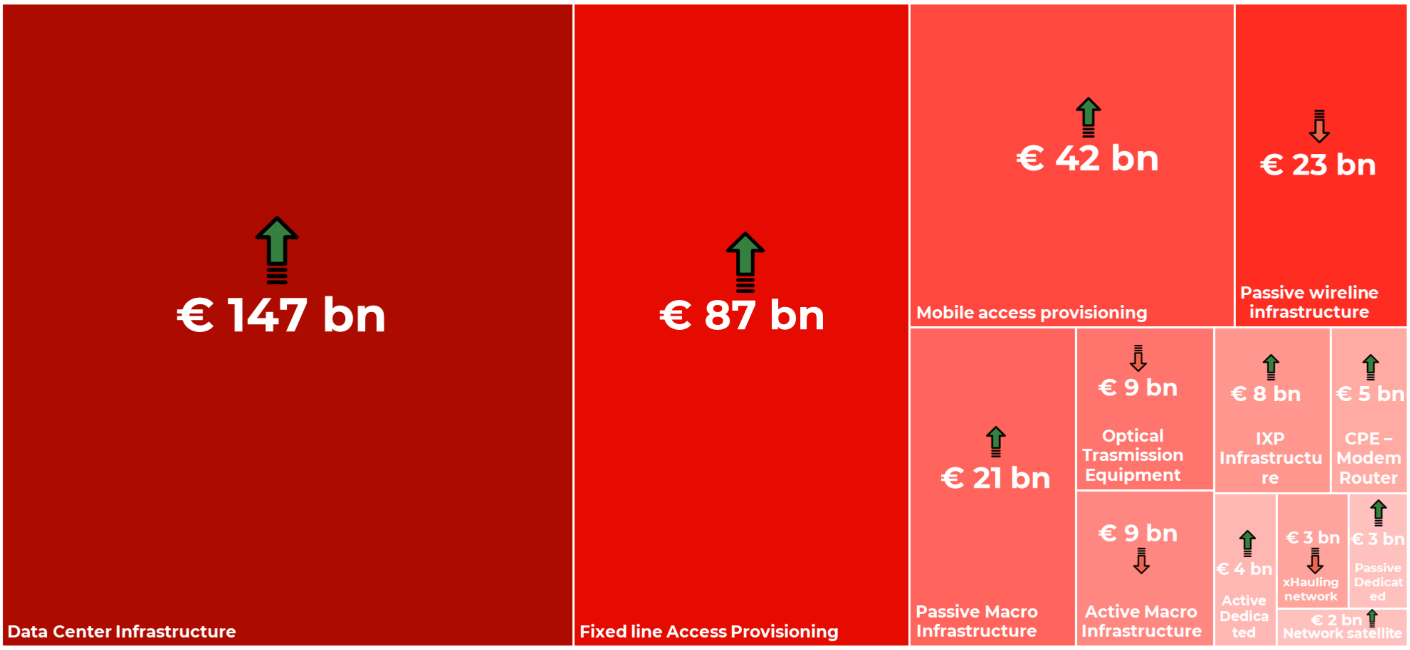

Figure 36 - Network Infrastructure layer - Market size and growth (2030)

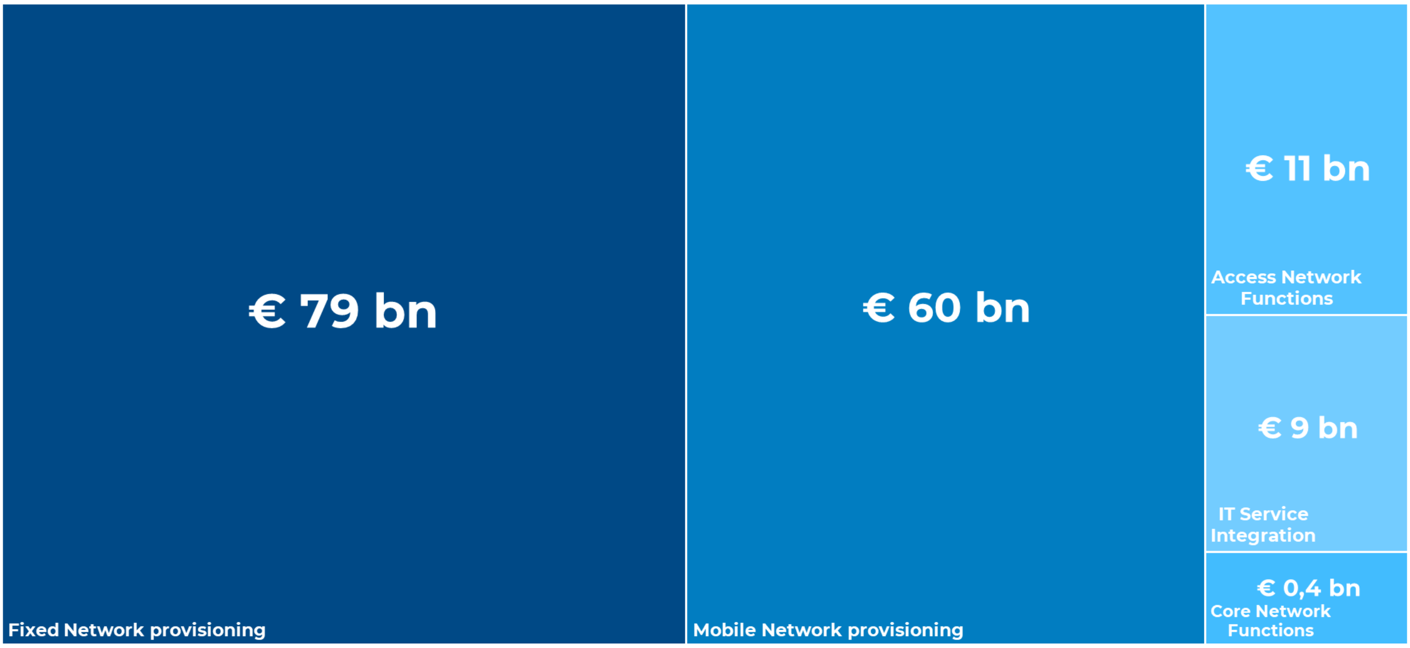

Figure 37 - Network Functions layer - Market size (2024)

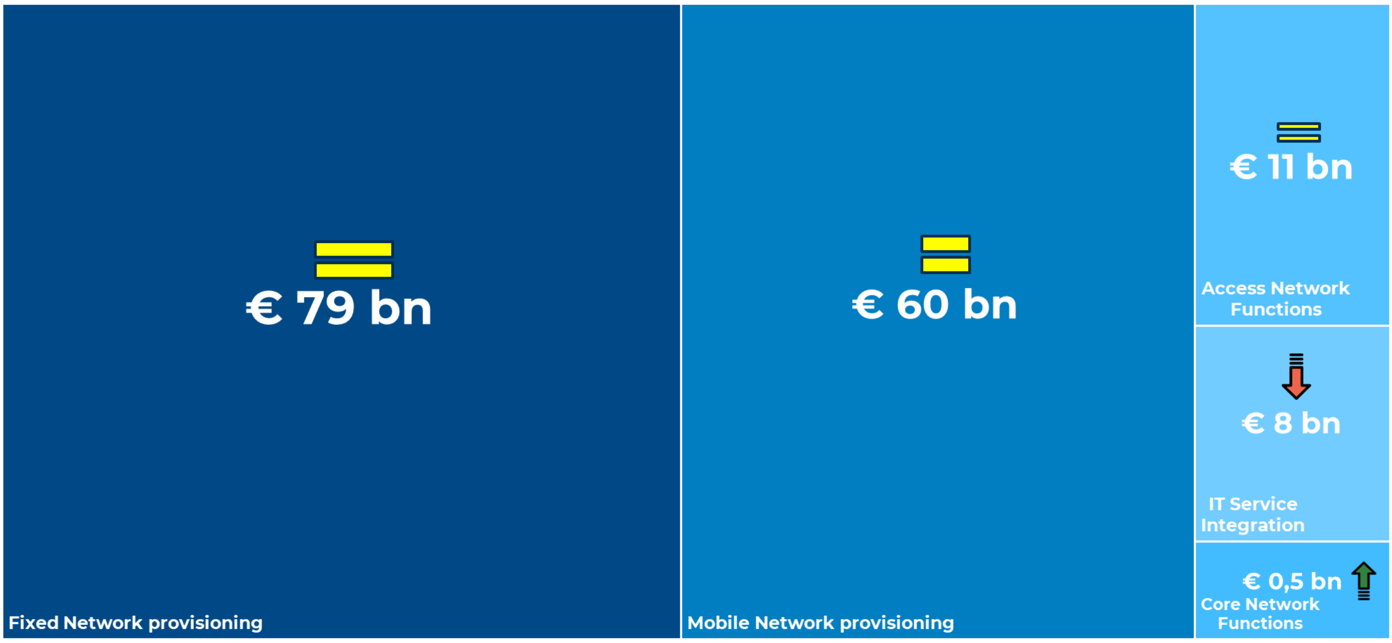

Figure 38 - Network Functions layer - Market size and growth (2030)

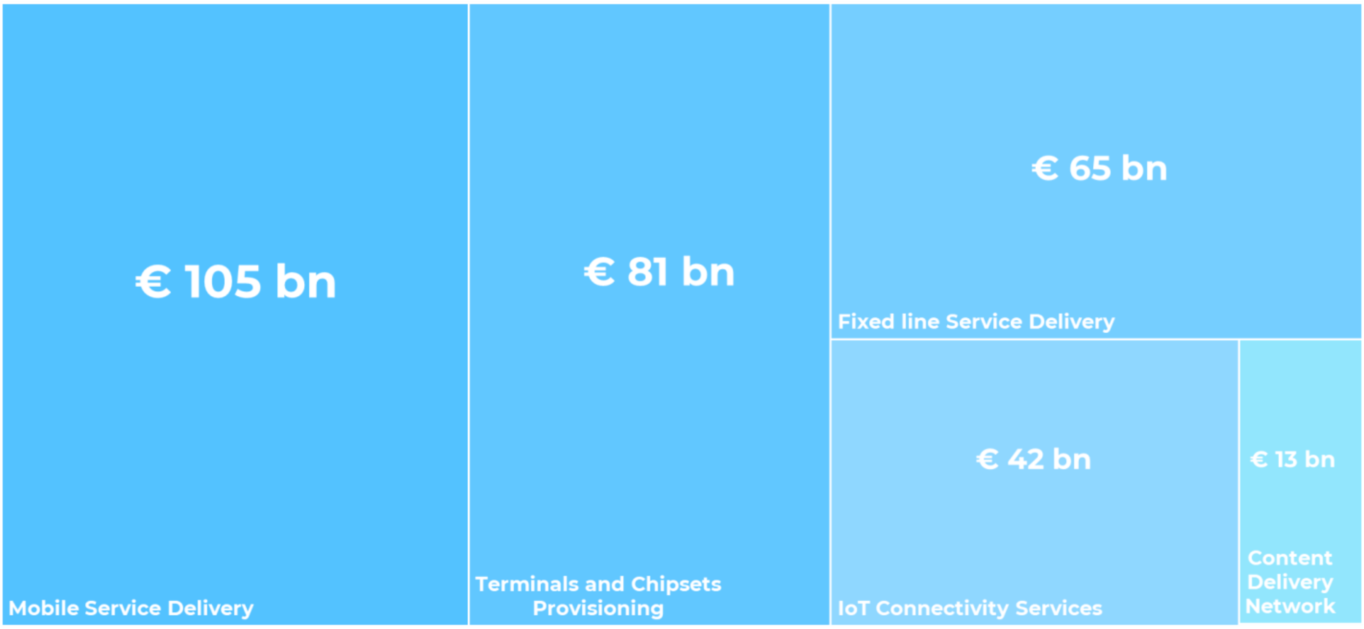

Figure 39 - Connectivity Service layer - Market size (2024)

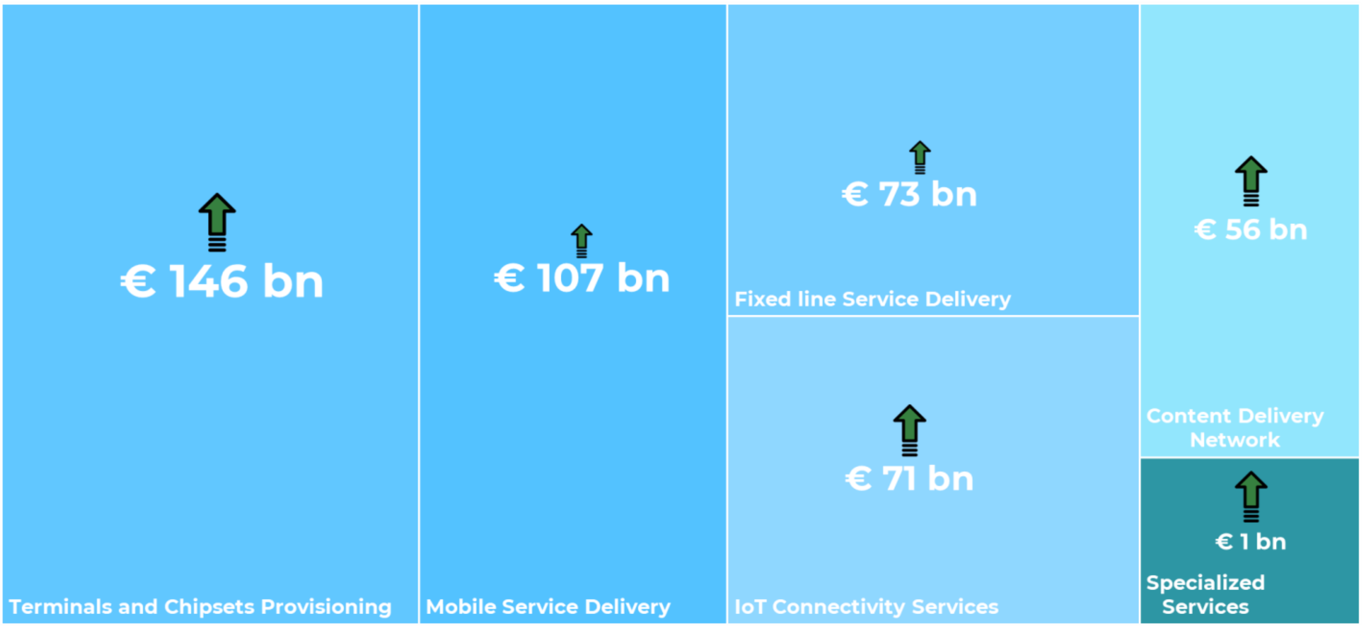

Figure 40 - Connectivity Service layer - Market size and growth (2030)

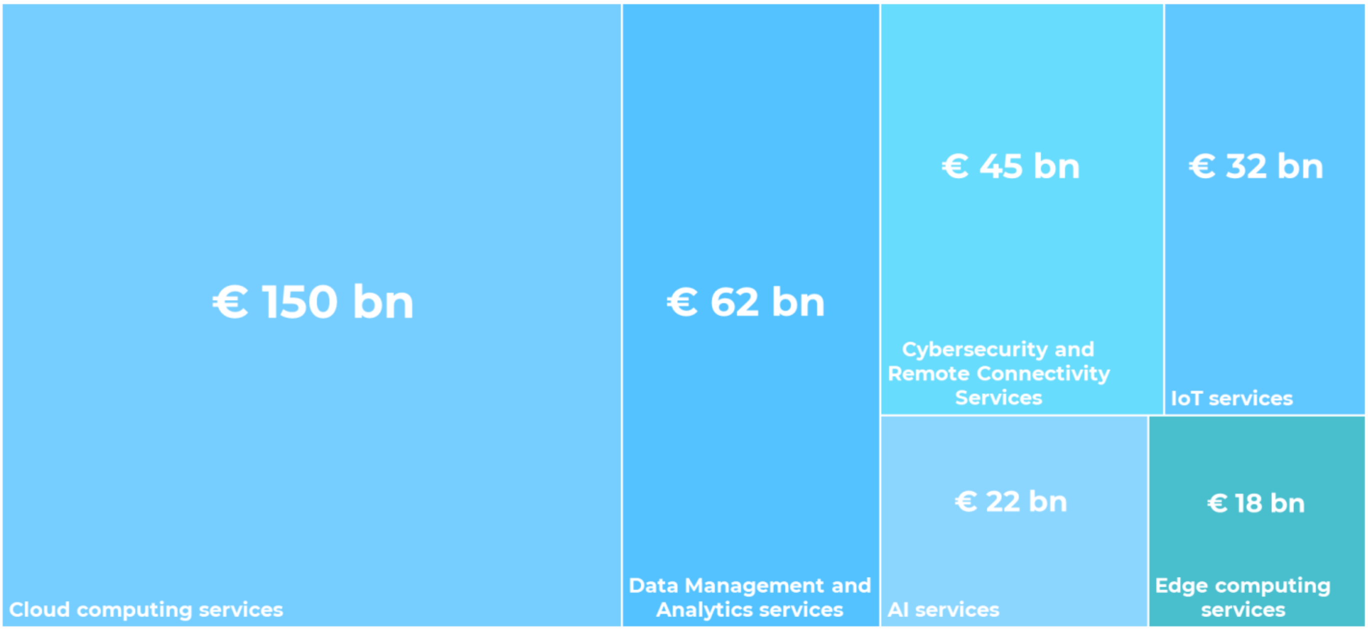

Figure 41 - Enabling Technology Service layer - Market size (2024)

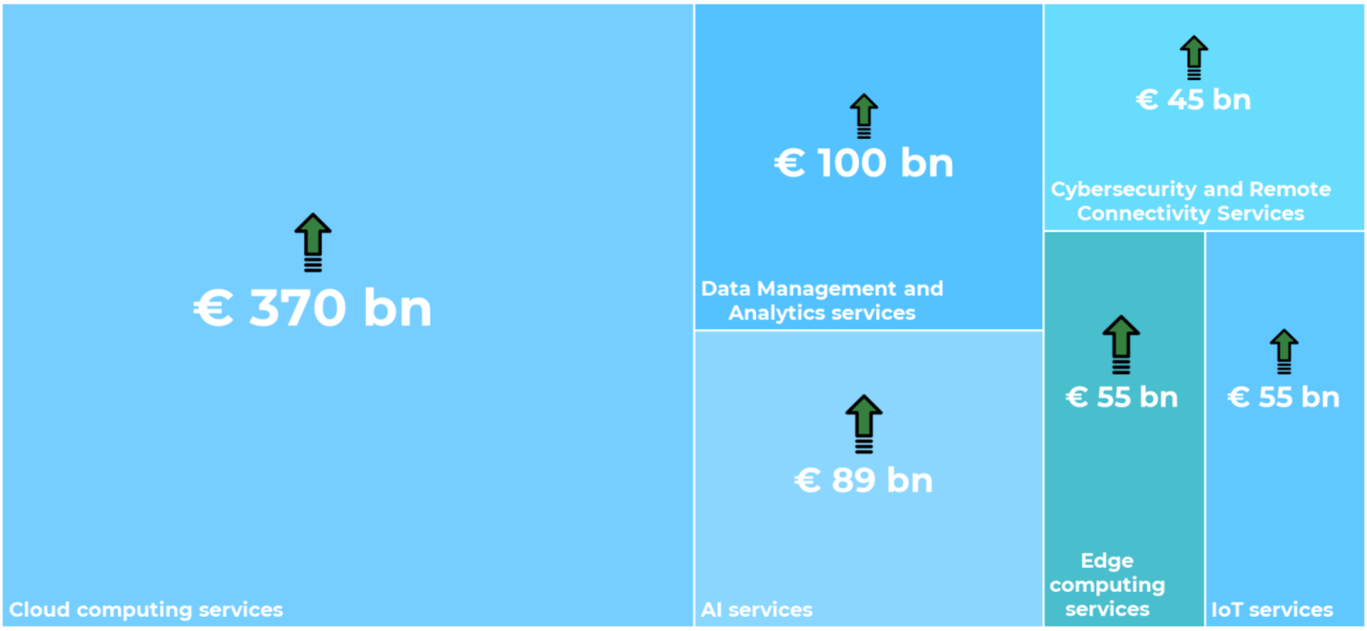

Figure 42 - Enabling Technology Service layer - Market size an growth (2030)

4. The methodology for identifying future scenarios

The dynamism of the current economic, social and technological environment makes the typical *forecasting* approach[57] no longer suitable for forecasting the long-term future (more than 10 years). Instead, this approach is still used for short-term strategic planning (less than 3 years), where a high degree of forecast accuracy is required. To overcome this obstacle, a new method has emerged, in which planning is based on the existence of multiple possible future scenarios and defines proactive actions with respect to the context[58]. This approach, which goes by the name of *foresight*, challenged the assumptions underlying forecasting as its natural evolution. Foresight has been defined as an approach to identify, observe and interpret the factors that induce change, determine the possible implications specific to the organisation and/or ecosystem and activate appropriate organisational responses[59].

The strategic foresight process consists of three macro-phases. Firstly, the framing of the objectives of the entire foresight process, which are: the definition of the domain and geographical scope, the time horizon to be covered and which stakeholders to involve[60]. Secondly, observing, perceiving and capturing the forces of change. Commonly referred to as the scanning or exploration phase, this process involves the systematic identification and understanding of factors that may drive future changes (technological, business, social and political trends)[61]. This phase generally includes a subsequent analysis to assess the relevance and potential time horizon of these changes.[62]. Third, the description of alternative futures scenarios. This phase involves using the knowledge gained during the scanning phase to develop and articulate various possible futures. Scenarios have been defined as script-like narratives or descriptions that outline fundamentally different paths leading to alternative futures[63].

Even if in this study we mostly adopted the classic foresight methodology, we gave it an original twist, by anchoring the analysis and the discussions with experts not only on technology trends, but also on their deep interconnections with the business models of market players and their possible evolutions. The new layered model of the telecommunications ecosystem and the set of archetypes of the market players, described in previous sections, have been used to stimulate the discussions and analysis towards understanding how both layers and players can evolve.

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4.1. The framing of the objectives

For this research, the chosen domain is the entire telecommunications ecosystem, which, as we defined in section 2.2, has been extended to include both wireless and wired infrastructures as well as actors with a role in the production, distribution and management of communication equipment and infrastructures, as well as in the management of telecommunication services, Internet access, data transmission and network services, both in the consumer and industrial spheres. Furthermore, the time horizon and geographical scope are set at the European level in 2040. Finally, the stakeholders involved in the entire forecasting process are industry experts from both companies and institutions, professors from leading universities with a background in engineering and telecommunications, and journalists. All these stakeholders were involved in order to get a more comprehensive and holistic view of the entire telecommunications ecosystem and the changes taking place.

4.2. Data Collection

Data collection for this research was conducted by integrating primary and secondary sources to ensure triangulation of information. Primary sources include semi-structured interviews that were coded afterwards to understand emerging topics, trends and weak signals that only experts and professors with a background in this field can give[64]. These interviews were conducted both with impartial experts and with experts working for companies within the telecommunications ecosystem. However, in order to better guide the interviews and their opinions, they were supported by various strategic tools, such as PEST analysis, SWOT analysis or broader concepts such as the actors' Business Model. These tools and their derivatives are used to enable experts to express their qualitative opinions on relevant forces of change.

Secondary sources, on the other hand, include YouTube videos and podcasts, reports and academic articles. These sources play a key role in triangulating the information gathered from primary sources and, in many cases, in adding knowledge to the research. The amount of primary and secondary sources analysed is shown in the table below.

Primary sources	45 semi-structured interviews with experts (approx. 2600 minutes)		
Secondary sources	**YouTube videos and podcasts**	**Reports**	**Academic articles**
	23 YouTube videos and 15 podcasts	50	31

Table 2 – Data Collection

Moreover, a co-creation workshop was held with the entire community of the 32 RESTART programme projects[65] to receive feedback on the trends collected, the scenarios identified and to add

[64] Marjamaa, M., & Mäkelä, M. (2022). Images of the future for a circular economy: The case of Finland. Futures, 141, 102985. https://doi.org/10.1016/j.futures.2022.102985

[65] https://www.fondazione-restart.it/it/progetti/

technological trends concerning the programme projects, which would have been difficult to intercept otherwise. This workshop took place over a full day in which we alternated between moments of explanation of the progress of our work and moments of interaction with the participants through interactive activities in plenary and in working groups. To conclude, after the publishing of the second version of the white paper, beside the increase in the number of primary and secondary sources analysed, we receive a high number of feedbacks from experts which helped us in the fine tuning of the future scenarios.

4.3. Data analysis

After the data collection phase, the research continued with the analysis and interpretation of the data. The objective of our analysis was the understanding of factors that may drive future changes, or in other words: the mapping of trends[66]. In this research, we mapped 75 trends divided into: business, technological, political and social/environmental trends. In addition, seven wild cards were identified in this first phase of analysis. These wild cards refer to high-impact and high-uncertainty events that alter the trajectory of realisation of one future event with respect to another[67].

After identifying these two sets of elements, they were grouped into sixteen megatrends - presented in Chapter 5 – to better understand how each individual trend interacts with the others. Megatrends are long-term and far-reaching trends, consisting of the combination of several trends together, influencing several sectors and areas of society.

The last stage of analysis concerns the identification of alternative scenarios, which are imaginative representations of a possible series of future events or situations that could occur under certain circumstances. The most commonly used materials for communicating and working on scenarios include verbal text, which facilitates the creation of stories about the future, and/or illustrations and pictures. To concretise alternative scenarios, we combined the sixteen identified megatrends in order to better understand their interactions and the dynamics emerging from the intersection of different trends. This led to the definition of four alternative scenarios, presented in Chapter 6.

[66] Inayatullah, S. (2013). Future studies: Theories and methods [online]. 〈http://www.metafuture.org/library1/FuturesStudies/Futures-Studies-theories-and-methodspublished- version-2013-with-pics.pdf〉. (Accessed 21 December 2020).
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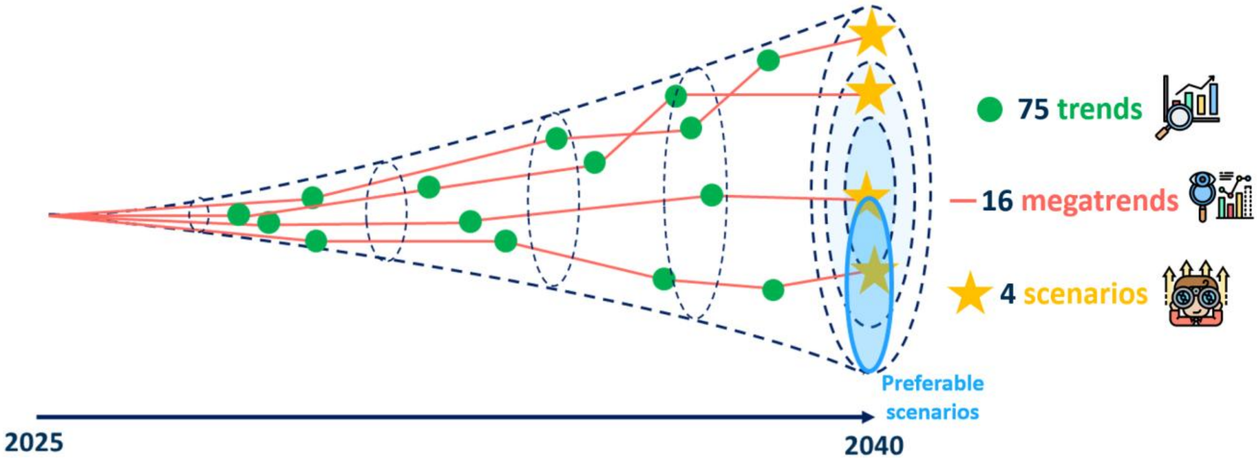

Figure 43 – Futures cone – Gall et al., 2022

5. Megatrends and future scenarios of the European telecommunications ecosystem

5.1. Identified megatrends and wild cards

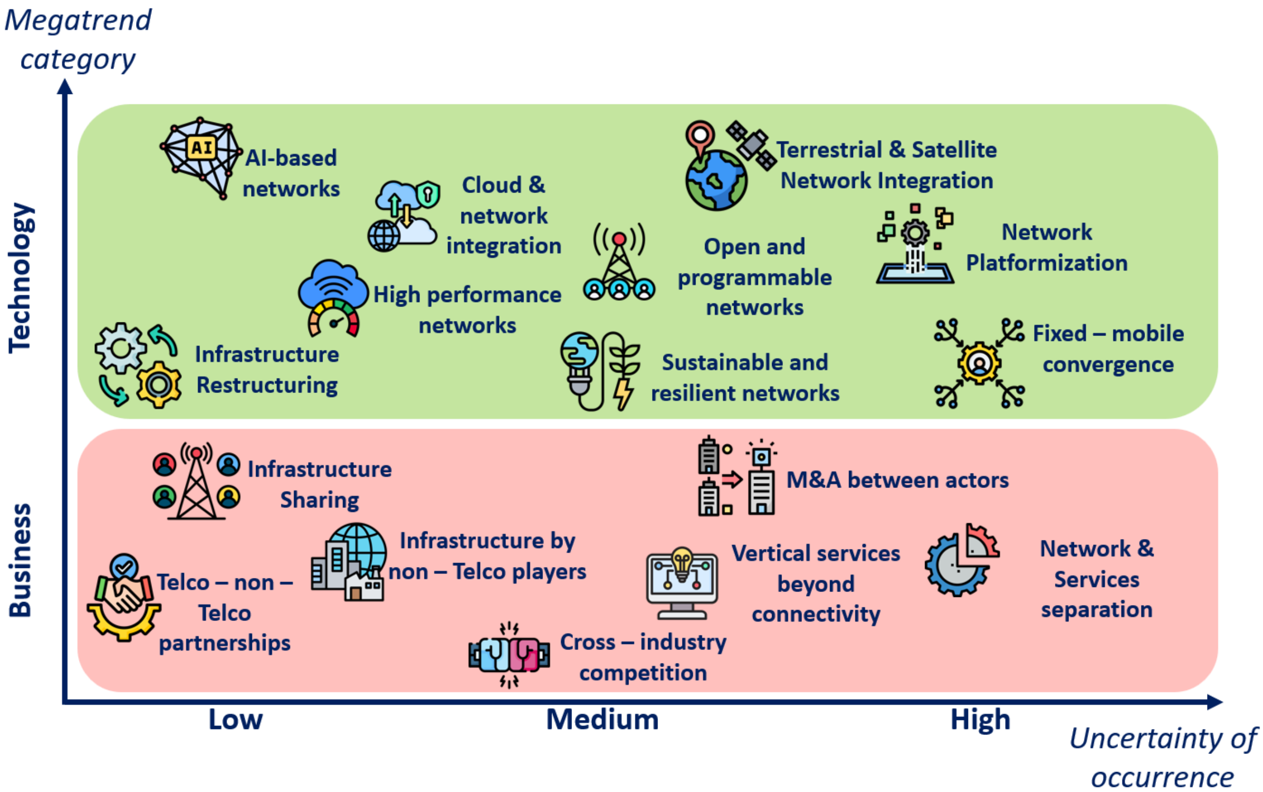

Figure 44 – Megatrends map

This chapter introduces the sixteen identified megatrends and seven wild cards. As for the megatrends, a matrix that ranks the megatrends was created according to their degree of uncertainty of occurrence and their depth of impact relative to the configuration of the current ecosystem (Figure 45). In other words: how radical is the impact of a given megatrend with respect to the current situation from the perspective of business, technology, society, and politics? Instead, regarding the uncertainty of occurrence, we need to consider the number of wild cards that could affect a given megatrend and its remoteness in time; in this case, these two variables will make it more uncertain if they have a high value.

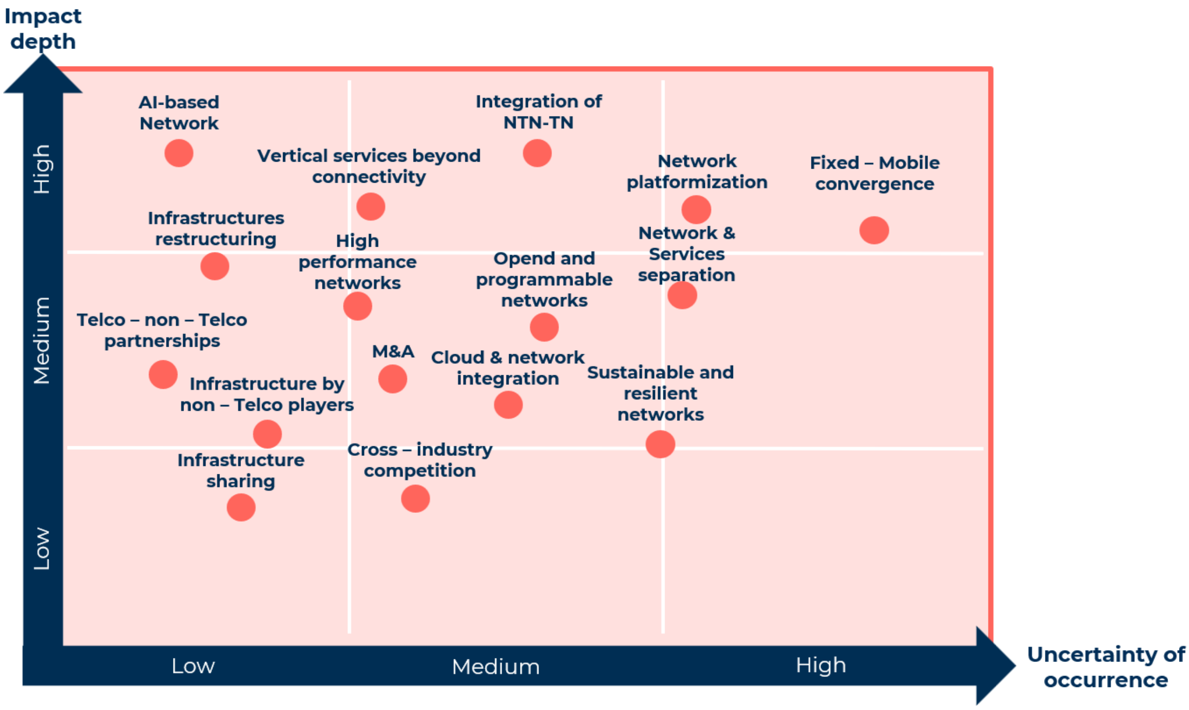

Figure 45 – Megatrends matrix

The sixteen megatrends are concisely described in the following:

- **AI-based networks**: radical and profound introduction of artificial intelligence within telecommunications networks with resource management and efficiency mechanisms completely managed by AI algorithms;
- **Cloud & network integration**: integration of Cloud-native software in the network, managed in the Cloud with generic hardware, instead of specific software and hardware installed on-premises;
- **Cross – industry competition**: competition on the development side of value-added connectivity services for consumers and businesses from companies that come from other digital and non-digital supply chains with a multi-utility approach;
- **Fixed – mobile convergence**: convergence of mobile (wireless) and fixed (wired) networks into a single network providing ubiquitous and pervasive connectivity services without ever disconnecting from it;
- **High performance networks**: development of high-performance networks thanks to technological innovations both physical, such as hollow core fibre optics, and software-related innovations that manage the network, such as SDN (Software Defined Network) and network slicing;
- **Infrastructure by non – Telco players**: development of network infrastructures by actors from other industries, such as Energy & Utility or civil infrastructures to apply Neutral Host models;

- **Infrastructures restructuring**: restructuring of existing infrastructures to create new value offers by exploiting innovative technologies such as Edge computing. In this case, existing network infrastructures could be repurposed to propose Edge computing service offerings for enterprises, industrial districts and municipalities (e.g. Smart cities);
- **Infrastructure sharing**: sharing of wired and wireless network infrastructures between several telecommunications operators or third-party entities. For mobile infrastructure, we refer to the MOCN (Multi-Operator Core Network) and MORAN (Multi-Operator Radio Access Network) sharing technologies;
- **Integration of NTN-TN**: integration of terrestrial networks (TN) with satellite networks (NTN) to create a single pervasive, ubiquitous and more high-performance network than the separate (terrestrial and satellite) networks;
- **M&A**: mergers and acquisitions between players in the telecommunications ecosystem that aim to consolidate and strengthen the positions of individual players within the ecosystem and with other ecosystems;
- **Network platformization**: creation of an open, interoperable and accessible network platform for third parties and developers to create innovative digital services for consumer and enterprise segments;
- **Network & Services separation**: organisational separation of actors managing the physical part of the network (NetCo[68]) from the service development part (ServCo[69]). An example we can see today are the separation of network from services, where a company that manages both, splits into two separate organisations, where one of these manage, as its core business, the network infrastructure, and the other manages and creates the services associated with it;
- **Sustainable and resilient networks**: creation of increasingly sustainable telecommunications networks, with lower electricity consumption and a low environmental and social impact;
- **Vertical services beyond connectivity**: offering vertical services in the telecommunications ecosystem based on general purpose digital technologies, such as AI, Cloud computing and Cybersecurity, that go beyond the pure offer of classic connectivity services of the telecommunications world;
- **Open and programmable networks**: adoption of network technologies based on open and programmable interfaces such as, for example, OpenRAN;
- **Telco – non – Telco partnerships**: creation of collaborations between telco and other digital ecosystem players to develop services for both consumer and enterprise customers. Already today, there are a number of collaborations between telco actors and actors from other digital sectors that cooperate to create valuable services for end users.

Instead, the following are the seven **wild cards** that could alter the realisation trajectories of future events:

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[68] Network Company
[69] Service Company

- **Supporting the creation of a European Cloud and AI consortium**: targeted actions by European institutional bodies for the creation of a consortium, or a company more generally, to develop a European Cloud infrastructure to stimulate the adoption of digital solutions for the development of services different from those of the US and China;
- **European management of auctions for frequency spectrum assignment**: centralisation of the management of frequency assignment from national to European level, ensuring uniform rules for all actors operating in Europe. This would also lead to lower frequency costs in order to encourage investment in upgrading infrastructure;
- **Liberalisation of a portion of the spectrum for private use**: allocation of a portion of frequency spectrum for private purchase and use, i.e., by companies from different vertical sectors, for the implementation of private industrial-type networks without the need for cooperation with a telecommunications operator to access these frequencies;
- **Regulator does not incentivise M&A**: the regulator does not incentivise or block mergers and acquisitions between telco players aimed at strengthening the positions of individual companies within the ecosystem;
- **Regulator incentivises M&A**: the regulator incentivises and promotes mergers and acquisitions between telecoms players aimed at strengthening the positions of individual companies within the ecosystem;
- **Regulator does not incentivise network unbundling**: the regulator does not incentivise network separation from services by telco players within the ecosystem;
- **Regulator incentivises network unbundling**: the regulator incentivises network separation from services by telco players within the ecosystem.

As explained in Chapter 4, these megatrends and wild cards are necessary to clearly define possible future scenarios for the telecommunications ecosystem, which will be described in the next chapter.

5.2. Future scenarios of the European telecommunications ecosystem

After analysing all the data collected and identifying the megatrends and wild cards that will influence the realisation of future events, we defined four alternative scenarios by combining the sixteen different megatrends explained in the previous chapter. This methodology has the advantage of showing more clearly, compared to other methodologies for defining scenarios (e.g. uncertainty matrix and technological disruption gradient), the interactions that occur through the combination of megatrends that may, on the surface, be disconnected from each other, but when combined give rise to realistic scenarios.

Each of these four future scenarios has the characteristic of describing the ecosystem by taking to extremes some of the variables that can describe the ecosystem at European level in 2040. Each of these extremes includes different components, which have been analysed in depth to understand the real impact they may have in the future. Consequently, the realization of each scenario is not deterministic but stochastic, as it depends on multiple interacting components and decisions, some of which may prevail at the expense of others. The scenario that will be realised is unlikely to coincide exactly with one of those described in this white paper. Rather, it will be a combination of elements drawn from different scenarios. Therefore, the chosen scenarios serve to delimit a space of possible futures and to identify the elements that, taken to extremes, draw their boundaries. The identified scenarios depict the European telecommunications ecosystem as it might appear in 2040, with titles chosen to reflect the changes in the business models of the market player archetypes most affected in each case.

We have also summarized the characteristics of the four scenarios considering four main variables:

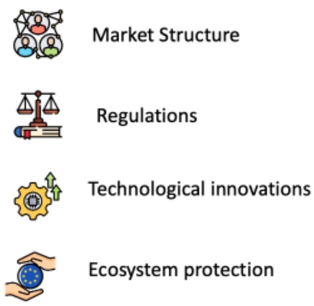

Figure 46 – Descriptive variables

5.3. Scenario A: Slow evolution with telco commoditization

In this scenario, the main market variables and regulations governing the European telecommunications ecosystem remain essentially unchanged. However, the prolonged stress on traditional players over time tends to exacerbate certain negative effects. Competition intensifies among a large number of operators unable to differentiate their services, and connectivity becomes definitively commoditized, even in the B2B domain. Technological development does not come to a halt, but is primarily driven by large global players best positioned, both economically and technically, to innovate. From a regulatory standpoint, no significant measures are taken to promote protection or innovation within the European telecommunications ecosystem.

Telecommunications operators undergo a business restructuring, operating with reduced revenues and shifting their focus toward cost optimization. They continue to serve other players—such as IT system integrators—that deliver services to end customers, thereby losing part of their direct control over the market and contributing only a limited portion of the overall value proposition. This further intensifies competition among connectivity providers, which is increasingly based on price rather than on the differentiation of service type or quality. Business users are not incentivized to adopt mobile technologies licensed through traditional telecommunications operators, opting instead for alternative and more flexible solutions, such as Wi-Fi or LoRaWAN, or leveraging the option to purchase portions of the radio spectrum for private local use.

The role of telecommunications operators becomes increasingly marginal, with their focus shifting almost entirely to the B2C segment. In this area, cellular mobile network technologies remain essential; however, the lack of significant innovation limits the momentum for technological advancement and service evolution. End users, while benefiting from lower costs, will experience reduced service quality and variety. This dynamic leads to a continuous decline in operator revenues, which can be offset only through aggressive cost-cutting or potential public subsidies. These subsidies aim to ensure infrastructure development, as the players responsible for it have limited financial capacity. Only a few actors maintain a sustainable long-term business model, typically characterized by lean organizational structures and minimized cost bases.

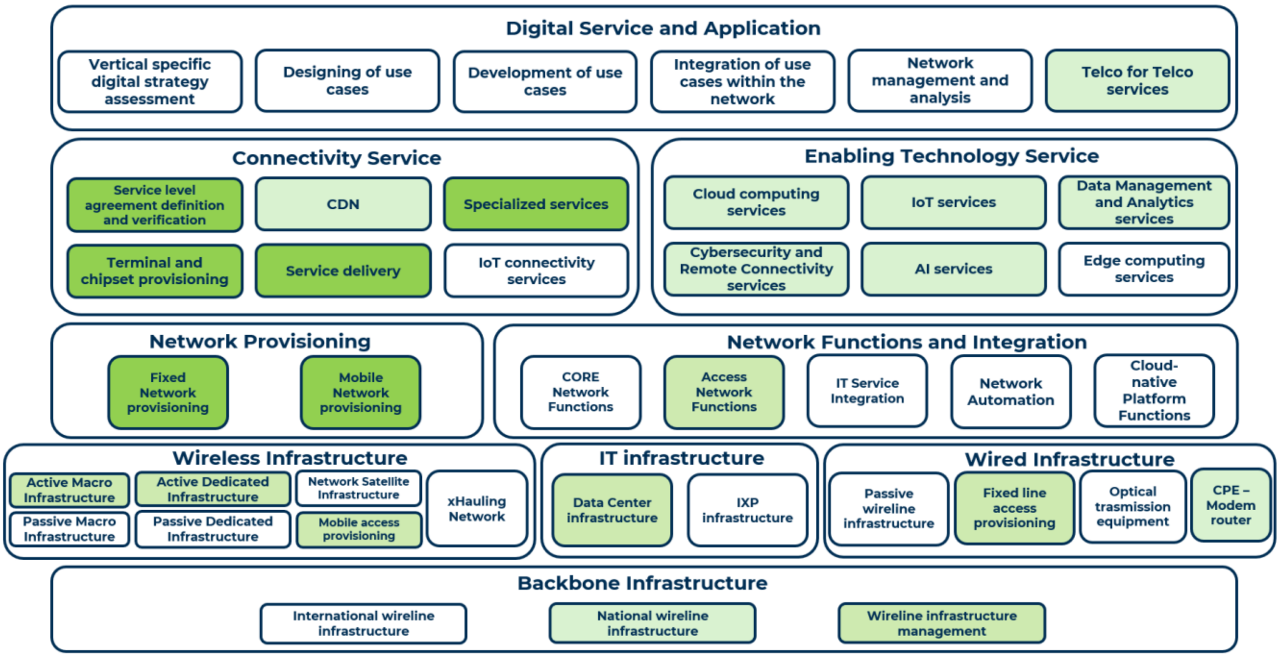

Figure 47 – Business Model Change – Mobile and Fixed Network Operator

To contain costs, infrastructure sharing among operators is increasing significantly, enabling them to leverage synergies and reduce operating expenses. This trend is supported by technologies such as MORAN and MOCN, which are being adopted by a growing number of operators. While infrastructure sharing offers clear cost advantages, it also presents numerous challenges—particularly in terms of design complexity and the time required to reach agreements that satisfy all parties involved. From this perspective, telecommunications operators with larger, shareable network infrastructures gain a competitive advantage. Additionally, AI is increasingly employed in networks to reduce operational costs and minimize the need for human intervention in network maintenance, thereby lowering OpEx. This drives technological innovation in the development of AI algorithms for network management and optimization. However, such advancements are primarily led by large international, non-European players such as Hyperscalers, who already possess the necessary expertise. European companies, by contrast, tend to remain users of these technologies rather than active drivers of change.

In this business environment, satellite telecommunications operators, mostly non-European, find greater opportunities to emerge, capitalizing on the struggles of terrestrial operators, who face unsustainable business models and intense competition. Satellite providers are better positioned to efficiently serve large or hard-to-reach areas (e.g., regions far from urban centers), offering connectivity to users underserved by terrestrial networks. This growing presence of satellite services further erodes the market share of terrestrial operators.

The development of network platforms, designed to enable the creation of innovative digital services, continues, but these platforms lack interoperability and are primarily developed by major technology giants (e.g., Hyperscalers) that impose their own models and approaches. As a result, platform development remains fragmented and is driven by a few dominant players from the broader digital ecosystem, rather than from within the telecommunications sector. Similar to Cloud computing, each platform has its own unique features and differentiators, leading service and application developers to choose one over another based on specific needs. The evolution of connectivity technologies, more in general, is no longer steered by ecosystem actors, but is instead shaped solely by market demand.

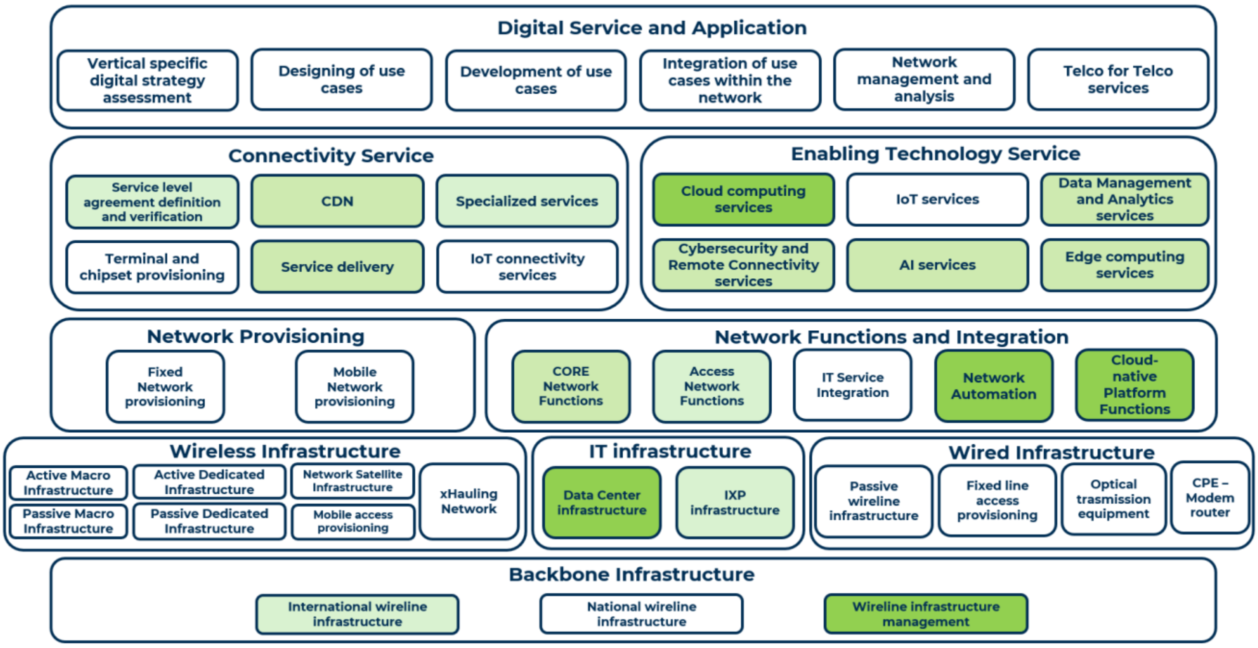

Figure 48 – Business Model Change – Hyperscaler

In this context, some Hyperscalers, driven by interest in some local markets, consider the acquisition of telecommunications operators to more efficiently expand into new business segments. At the same time, operators' Core Networks are increasingly hosted and managed within Hyperscalers' Cloud infrastructures, leaving operators with responsibility only for the access network, the most costly part accounting for over 70% of total network expenses. As a result, Core Network services become progressively integrated with the functions offered by Hyperscalers' Cloud platforms. This integration enables Hyperscalers to attract new customers by combining connectivity services with their broader Cloud and digital offerings, which continue to dominate the market (Figure 48).

Even from a regulatory standpoint, the scenario remains largely unchanged, reflecting a low level of protection for the European telecommunications ecosystem. This is due to the absence of common, harmonized policies across member states, such as a unified framework for radio spectrum allocation, and the lack of a clear strategy for developing adequate infrastructure and services. Moreover, the failure to establish a true European single market for services contributes to market fragmentation. As a result, the small scale of national operators limits their ability to invest in the technological innovation needed to close the digital services gap between Europe and global leaders like the United States and China.

Regulation continues to follow a preventive ex-ante approach, which limits the ability of European players to develop and deliver digital services, thereby allowing Hyperscalers to dominate this space. Furthermore, strict antitrust rules preserve a high level of competition among ecosystem players, benefiting consumers through lower connectivity prices, but often at the cost of reduced service quality.

A summary of the main characteristics of Scenario A is presented in the following Figure.

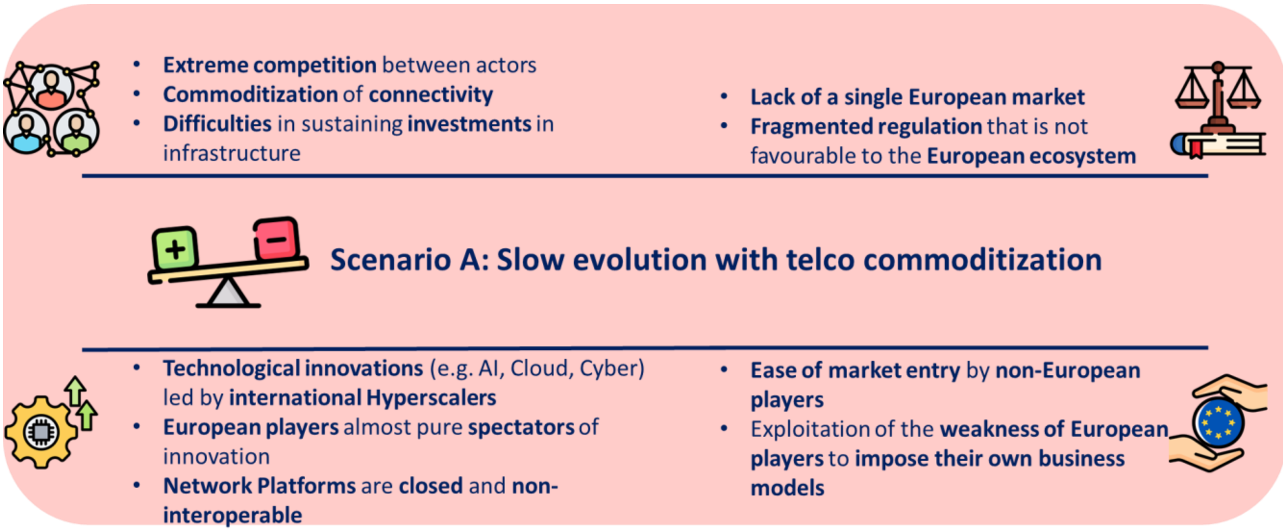

Figure 49 – Summary of Scenario A

5.4. Scenario B: Towards single European market and service platforms

In this scenario, the European telecommunications ecosystem tend to be dominated by a few large players, formed through mergers and acquisitions among operators, mostly at a pan-European scale. Technological development is led by these newly consolidated entities, in collaboration with Hyperscalers and network and equipment software suppliers. This progress is supported by policies designed to strengthen the European telecommunications sector, leveraging the advantages of a unified single market.

Consolidation among telecommunications operators begins at the national level and gradually extends across Europe, resulting in a relatively small number of players operating at a pan-European scale. This consolidation enhances the sustainability of business models and strengthens operators' capacity for investment. In this context, telecommunications ecosystem players regain a central role in driving digital service development and technological innovation. Their efforts are further supported by collaboration with technologically advanced actors, such as Hyperscalers and network and equipment software suppliers.

Within the telecommunications ecosystem, players such as network and equipment software suppliers and IT system integrators continue to play their established roles, maintaining a key position in developing solutions and services for various vertical sectors. Telecommunications operators, meanwhile, are increasingly assuming the role of "project managers" and providers of "technology building blocks", leveraging their business expertise and collaborating with IT system integrators, network and equipment software suppliers, and Hyperscalers to deliver high-value solutions tailored to each sector.

These new pan-European telecommunications operators (Figure 50) offer a broad spectrum of services, ranging from basic connectivity to advanced solutions built on technologies such as AI, cybersecurity, 5G/6G, IoT, big data, and Edge-Cloud. A key development is the creation of joint offerings with major technology players, enabling integrated packages that combine connectivity, digital services, and a high degree of customization for end users. This approach supports the development of a value proposition centered on value-added services enabled by technological building blocks, mitigating the risk of connectivity becoming a mere commodity if positioned as the sole focus of the offering. In addition to leveraging their traditional expertise, telecommunications operators can draw on the specialized knowledge of traditional industrial sectors, fostering the creation of new applications that more effectively address specific industry needs. Furthermore, given the complexity of these projects, having a single point of contact can enhance customer relationship management and streamline service delivery with a multi-utility platform approach.

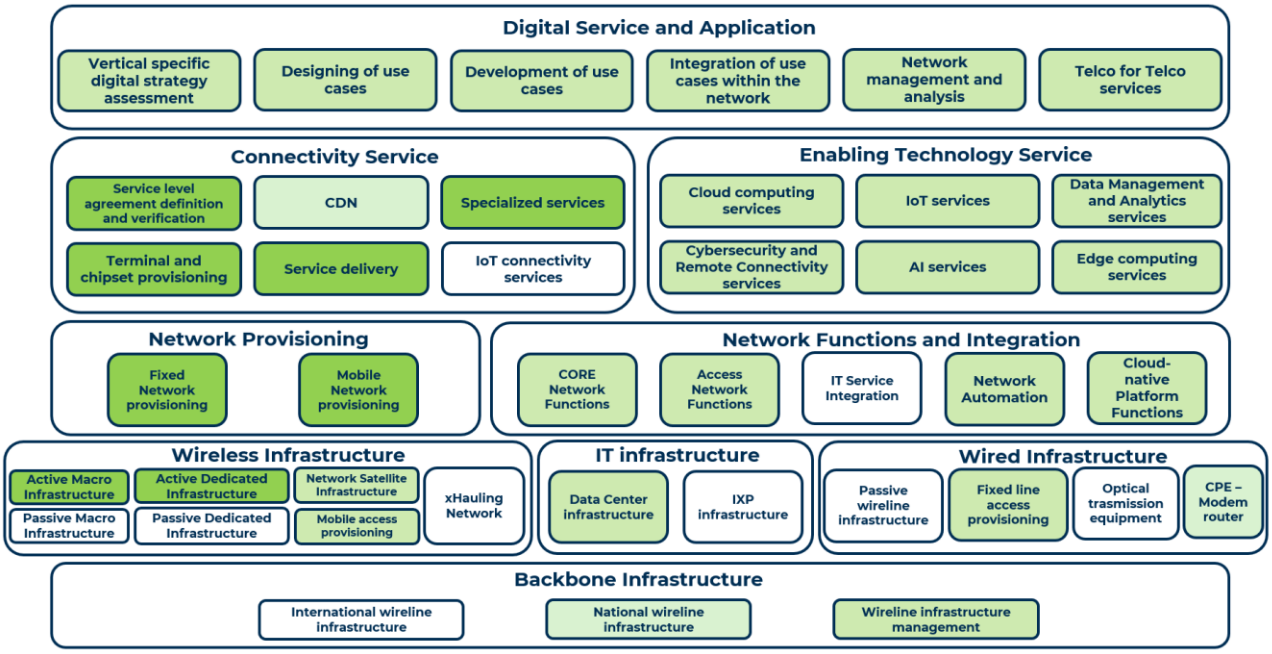

Figure 50 – Business Model Change – Mobile and Fixed Network Operator

At the same time, major players within the ecosystem are increasingly investing in satellite networks, entering into competition with incumbent satellite telecom operators. However, this trend represents not only a direct challenge, but also an evolution toward a complementary model in which terrestrial and non-terrestrial networks coexist and collaborate through strategic partnerships and technological innovation. Terrestrial operators, benefiting from greater investment capacity, have the opportunity to expand into the satellite domain, contributing to the consolidation of a more integrated and high-performance connectivity ecosystem.

Leveraging their greater investment capacity, ecosystem players upgrade existing infrastructures and developing new service models, particularly those targeting businesses and end users through Edge computing technologies. Edge computing, in fact, requires data centers to be located close to data sources, such as residential neighbourhoods or industrial districts. These investments are paving the way for the deployment of advanced digital applications, including autonomous vehicles, next-generation eHealth, extended reality, and Industry 5.0 solutions.

On the technological front, collaboration between telecommunications operators and more technology-driven players, such as Hyperscalers, network and equipment software suppliers, and IT system integrators, has led to the development of multiple network platforms. However, these platforms tend to be closed and non-interoperable, each aiming to attract customers through unique features and differentiated network APIs that developers can use to deliver digital services to enterprises. At the infrastructure level, virtualized network functions and telco Edge Cloud solutions are being developed to enable greater flexibility in resource sharing, leveraging innovation to increase efficiency and reduce costs.

In terms of network architecture, there is a gradual convergence of fixed and mobile networks, along with their integration with satellite systems. This evolution is leading to the creation of a single, ubiquitous, pervasive, and ultra-high-performance network, designed to support the development of digital services across all areas of the globe, from densely populated urban centers to the most remote rural region.

All these developments have been enabled by a European industrial strategy focused on building a competitive digital ecosystem, one capable of rivaling other global players in terms of economic value creation and technological innovation in both services and infrastructure. The relaxation of antitrust regulations to support market consolidation has led to a wave of mergers and acquisitions among existing telecommunications operators. This, in turn, facilitated the creation of a unified European telecommunications market by removing internal barriers. Moreover, there has been a regulatory shift from an ex-ante to an ex-post approach, emphasizing service equivalence among digital market players and introducing a framework better aligned with the presence and influence of Hyperscalers.

A summary of the main characteristics of Scenario B is presented in the following Figure.

Figure 51 – Summary of Scenario B

5.5. Scenario C: The rise of infrastructure providers and new platforms

In this scenario, the European telecommunications ecosystem is characterized by a diverse mix of connectivity players—some formed through mergers and acquisitions of telecom operators, others through the structural separation of network infrastructure and service provision. All players operate with a pan-European perspective, leveraging a unified, open, and interoperable Cloud-native network platform. Regulatory frameworks are more flexible, accompanied by a strong commitment to safeguarding the European ecosystem and fostering innovation in both services and infrastructure.

In this context, there has been no deliberate push toward consolidation or structural separation of networks. Instead, the market structure has evolved organically, shaped by actors adopting different strategies based on their specific conditions and objectives. Consolidation has occurred progressively, first at the national level, and subsequently at the European level, mirrored by similar developments in network separation. In some cases, companies that separated infrastructure and service functions pursued acquisitions of counterparts occupying equivalent positions within the ecosystem. For example, there have been mergers and acquisitions involving NetCos or ServCos (Figure 52) from different countries. Additionally, some NetCos have merged wired and wireless assets, giving rise to fully integrated infrastructure players. In this scenario, entities such as TowerCos and fixed network wholesalers play a central role by providing services and access to their infrastructure.

As a result, the European telecommunications ecosystem in this scenario includes a mix of pan-European players: some are vertically integrated, while others specialize either in service provision using third-party infrastructure or in infrastructure ownership and related services.

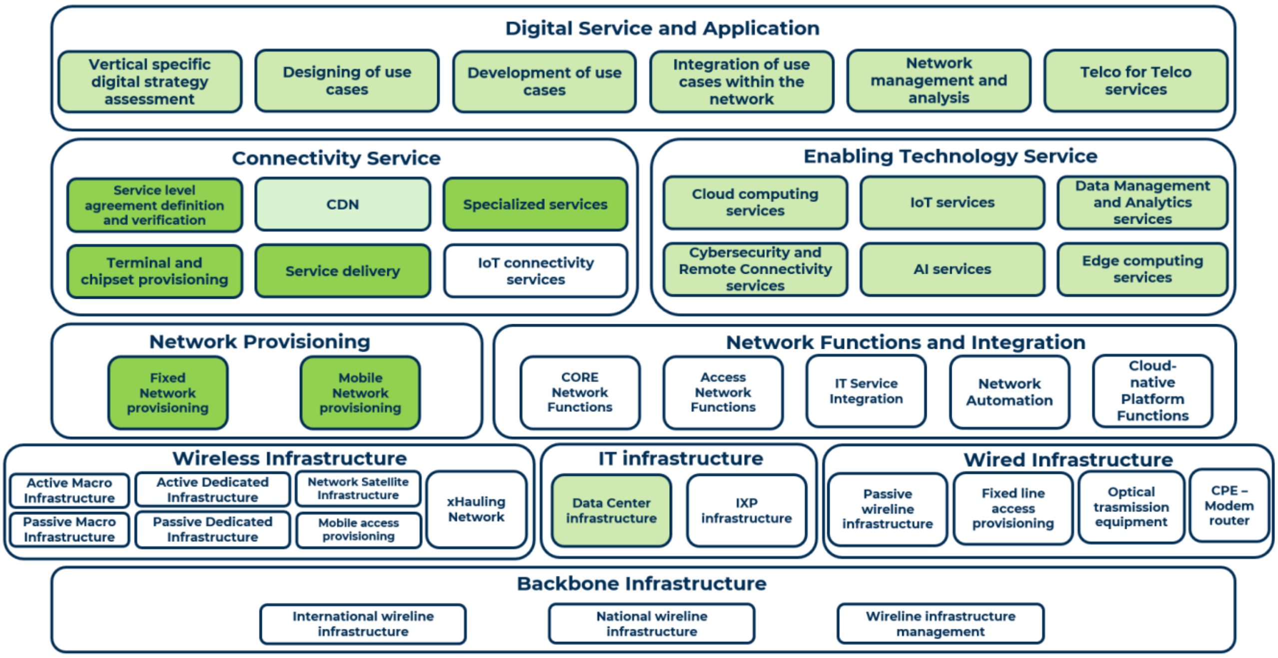

Figure 52 – Introduction of the new Business Model – ServCo

In some cases, new players, so-called Neutral Hosts (Figure 53), have entered the ecosystem, introducing innovative business models based on the Network-as-a-Service (NaaS) paradigm. In this model, both the network infrastructure and the Cloud-native platform, enabling the development of applications through open network APIs, are made available to customers for the creation of customized services, whether for internal use or for B2B and B2C markets. This approach offers greater operational flexibility for companies, allowing them to shift their focus from infrastructure management to service delivery.

As a result, the industry has begun transitioning from a CapEx-driven model, historically typical of telecommunications, to an OpEx-oriented model. In other words, from a cost structure based on large, upfront infrastructure investments to one based on variable costs linked to service usage.

Other key players in the ecosystem—such as network equipment and software suppliers, IT system integrators, Hyperscalers, and IT technology providers—continue to play a vital role in delivering digital services to businesses and consumers. These actors have benefited from the new market structure, which has fostered stronger collaboration with telecommunications operators. Enabled by this new setup, telecom operators now have greater capacity and expertise in managing and driving digital innovation, increasingly taking on the role of "service orchestrators".

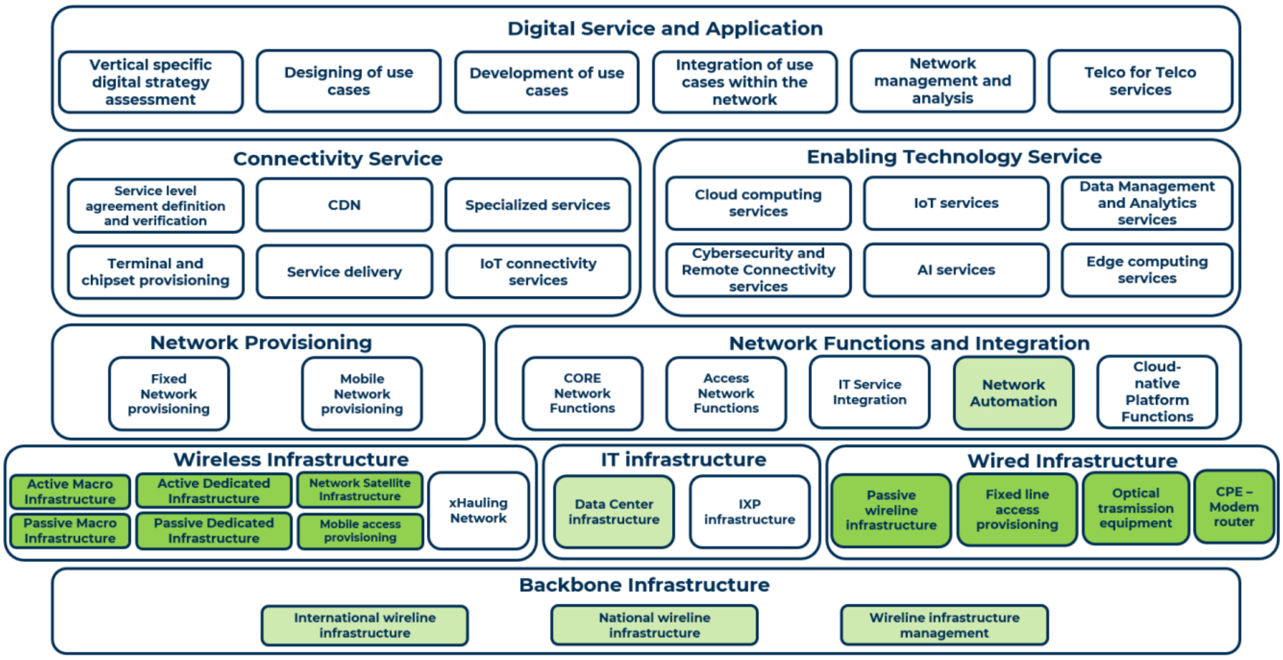

Figure 53 – Introduction of the new Business Model – Neutral Host

As a result, the European telecommunications ecosystem has become both diverse and competitive in the global digital services landscape, helping to narrow the productivity gap in digital services that Europe has historically faced compared to China and the United States.

In terms of network infrastructure, there is growing complementarity and integration between terrestrial and satellite networks, developed by both European and non-European players. In some cases, however, satellite telecommunications operators directly compete with terrestrial or other satellite providers, increasing the level of internal competition within the ecosystem. This competition is managed through appropriate regulatory measures that aim to strike a fair balance between competitive service offerings and business sustainability.

Additionally, similar to the terrestrial domain, satellite Neutral Host actors have emerged, offering their infrastructure to other players based on the NaaS model. Technologies originally developed for terrestrial networks have been extended to satellite networks to ensure continuity of service and, most importantly, ubiquitous connectivity across all regions of the globe.

In this scenario, the European Union has played a central role in fostering a diversified yet innovative ecosystem by supporting the creation of a European Cloud and AI Consortium. This initiative aims to reduce reliance on major American Cloud providers and establish a degree of technological sovereignty. Much like the emergence of Airbus in the aviation sector as a competitor to Boeing, the consortium has positioned itself to compete globally with leading non-European Hyperscalers.

The Cloud-native network platform provided by this consortium stands apart from those of major American providers: it is open and interoperable, designed to maximize the development of innovative digital services reducing the digital gap with non-European Hyperscaler platforms. These services not only enhance the quality of life for citizens and businesses but also promote environmental and social sustainability across the European community.

This initiative has not only protected the European telecommunications ecosystem but also revitalized it, positioning Europe as a global competitor in the digital technology landscape. The consortium was formed through the unification of multiple existing initiatives across the ecosystem, with the objective of integrating network infrastructures into a cohesive platform capable of competing at scale with the infrastructures of American and Chinese Hyperscalers. Besides institutional investments, to foster the creation of this European Consortium, there have been many private investments from European VC funds, family offices and other investment funds, which believed in these initiatives to reduce the financial dependency from non-European players.

In addition to unifying existing infrastructure, the consortium has invested in the development of new assets to build a dense, pan-European network. This has supported the emergence of new service models—particularly those leveraging Edge computing technologies for both businesses and end users. As a result, Europe has seen significant advancements in digital services such as autonomous driving, remote surgery, extended reality, and Industry 5.0.

From a regulatory standpoint, institutions have chosen to ease the previously stringent rules governing the telecommunications sector, creating more space for market-driven initiatives—including both acquisitions and network separation. In the case of network separation, particular attention was given to regulating wholesale mechanisms to ensure fair access and the continued development of network infrastructure. At the same time, the European Union actively supported the creation of the European Cloud and AI Consortium, not only by providing incentives and investment, but also by protecting it from aggressive strategies by dominant global Cloud providers seeking to block its establishment. This support proved critical, as the consortium's emergence contributed to a notable erosion of these providers' market share within Europe.

A summary of the main characteristics of Scenario C is presented in the following Figure.

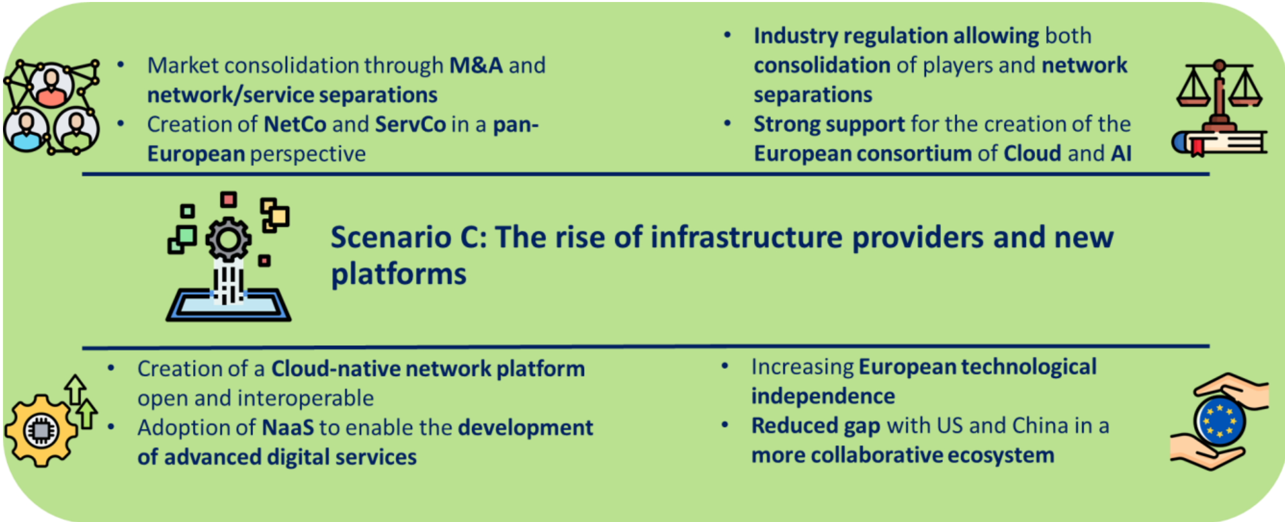

Figure 54 – Summary of Scenario C

5.6. Scenario D: Full infrastructure separation and shared platforms

In this last scenario, the European telecommunications ecosystem is defined by a fundamentally different approach compared to the United States and China. Unlike those regions, where infrastructure and service development are often closely intertwined and centralized, Europe has embraced a model based on role stratification and multi-level competition, fostering clear separation between infrastructure and service dynamics. The difference with the Scenario C regards the way in which the separation between infrastructure and service occur. In this scenario, the separation is strongly incentivized by institutions following a clear European strategy.

Indeed, the strategies of market players, supported by regulatory frameworks, have shaped a unique digital services environment, distinct from other global models and firmly rooted in European values such as democracy, human rights, and social responsibility. This foundation supports a model of technological development that not only benefits users but also respects the principles of an ethically and culturally advanced society.

Within this ecosystem, a relatively large number of actors operate under a separation of network and service roles, all functioning within a pan-European space and leveraging a unified, open, and interoperable Cloud-native network platform. Regulation continues to play a strong role, maintaining a high level of oversight to safeguard the European ecosystem while promoting sustained investment and innovation in services and infrastructure.

Network separation from services initially took place at the national level and was later followed by mergers and acquisitions at the European level, both among infrastructure providers and, in some cases, among service providers from different countries. TowerCos and fixed network wholesalers played a pivotal role in initiating this transformation, expanding their scope and enabling the development of advanced services on top of their infrastructure.

Cross-border mergers involving NetCos and ServCos have been carefully regulated under antitrust frameworks, which have served to both protect the European telecommunications ecosystem and preserve healthy competition. Particular attention has been paid to ensuring the long-term sustainability of business models, whether focused on infrastructure or on services. As a result, the ecosystem has become more fragmented and competitive, yet also more specialized, with a high level of expertise in the development of next-generation infrastructure and services for both businesses and consumers. With this market structure, the full separation of network and services led to a slow decrease of the margin related to the lease of the infrastructures, but increased significantly the stability of the ecosystem in the long run.

In this scenario, as in the previous one, the presence of Neutral Host players with NaaS business models has continued to grow. These models make network infrastructure and Cloud-native platforms available to customers, enabling the development of applications through open network APIs. This empowers businesses to create customized services for internal use or for external clients (B2B or B2C). Such an approach offers greater operational flexibility, allowing companies to shift their focus from infrastructure management to service delivery. Consequently, the traditional CapEx-driven model that has long characterized the telecommunications sector is giving way to an OpEx model, one based on variable costs tied to actual service usage, rather than fixed costs from large upfront infrastructure investments. In this context, operators share passive and active infrastructures – owned by a Neutral Host – of the telecommunication networks with the MOCN model and the pooling of frequencies to increase the quality of service for the customers. Thanks to this model, there has been a decrease of the network costs for telecommunication operators that freed them for the management of high CapEx and OpEx compared to the past years.

Other key players in the ecosystem - such as network equipment and software suppliers, IT system integrators, Hyperscalers, and IT technology providers - continue to play a vital role in delivering digital services to both businesses and consumers. These actors have benefited from the new market structure, which has fostered more effective collaboration with telecommunications operators. Thanks to their increased specialization, telecom operators now possess advanced capabilities in managing and driving digital innovation, taking on the role of "co-orchestrators of services" alongside other technology providers, particularly within specific industry verticals.

Despite heightened competition among players, the European telecommunications ecosystem has retained a strong global position in the development of digital services, helping to close the digital productivity gap that has historically separated Europe from China and the United States. To achieve this, telecommunications operators have established strategic partnerships with technology providers, combining their strengths to deliver high-value services to both enterprise and consumer markets.

Also in this scenario, in terms of network infrastructure, there is increasing complementarity and integration between terrestrial and satellite networks, developed by both European and non-European players. However, in many cases, satellite telecommunications operators compete directly with terrestrial and other satellite providers, capitalizing on the relatively low barriers to entry resulting from a highly competitive ecosystem. This has made it essential to regulate the market through appropriate policies that strike a fair balance between healthy competition and the long-term sustainability of business models.

As with terrestrial networks, satellite Neutral Host actors have emerged, offering infrastructure to third parties under NaaS models. Technologies commonly used in terrestrial networks have been extended to satellite systems to ensure service continuity and, above all, ubiquitous connectivity across all regions of the globe. Given the fragmented nature of the ecosystem and the growing number of players, it became necessary to establish a European consortium composed of multiple satellite operators (Figure 55). This initiative not only enables the provision of services across EU member states but also allows European satellite infrastructure to be positioned competitively on the international stage. As a result, European solutions are increasingly presented as viable alternatives to those offered by non-European providers—particularly American companies that have heavily invested in satellite technologies in recent years.

As in Scenario C, the European Union played a pivotal role in establishing a European Cloud and AI Consortium (Figure 56), aiming to reduce dependence on major American Cloud providers. Formed through the consolidation of various industry initiatives, the consortium unified network infrastructures into a single platform capable of competing with American and Chinese Hyperscalers in scale and capacity.

Alongside this effort, new infrastructure was deployed to ensure comprehensive coverage across Europe—crucial for supporting emerging service models like Edge computing for both businesses and consumers. The resulting Cloud-native platform is open and interoperable, designed to foster innovation, enhance citizen and business well-being, and promote environmental and social sustainability. This initiative not only safeguarded the European telecommunications ecosystem but also marked a strategic opportunity for global competitiveness.

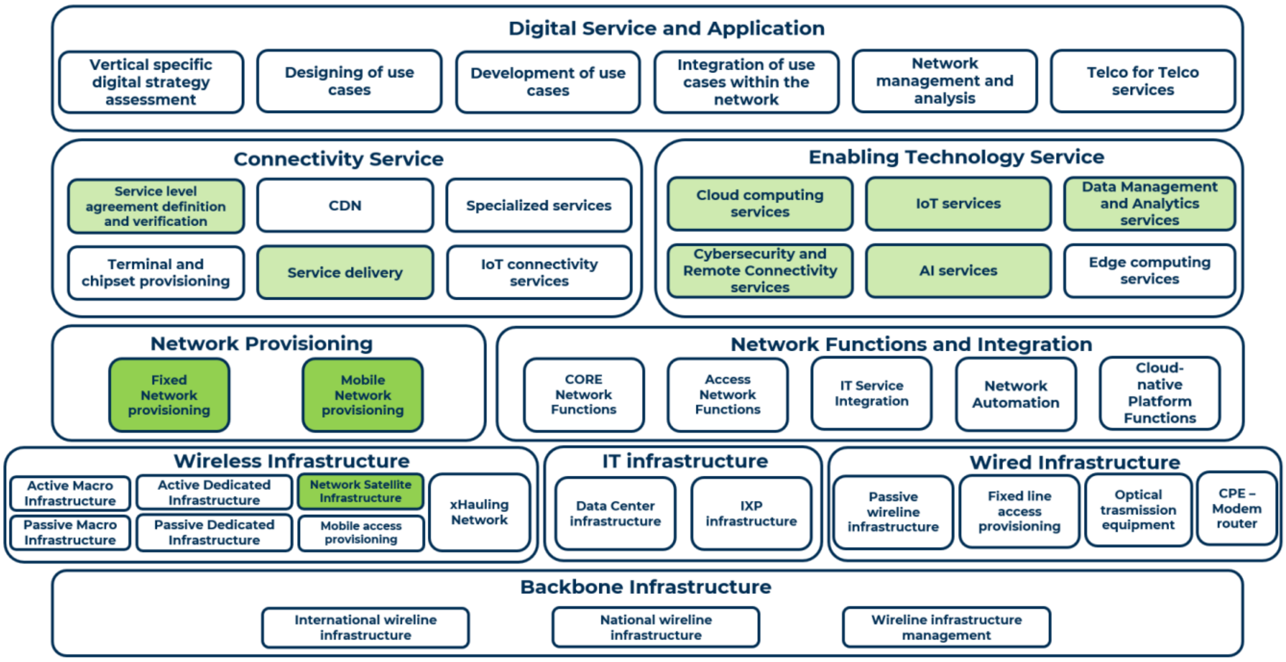

Figure 55– Introduction of the new Business Model – European Satellite Telecommunications Consortium

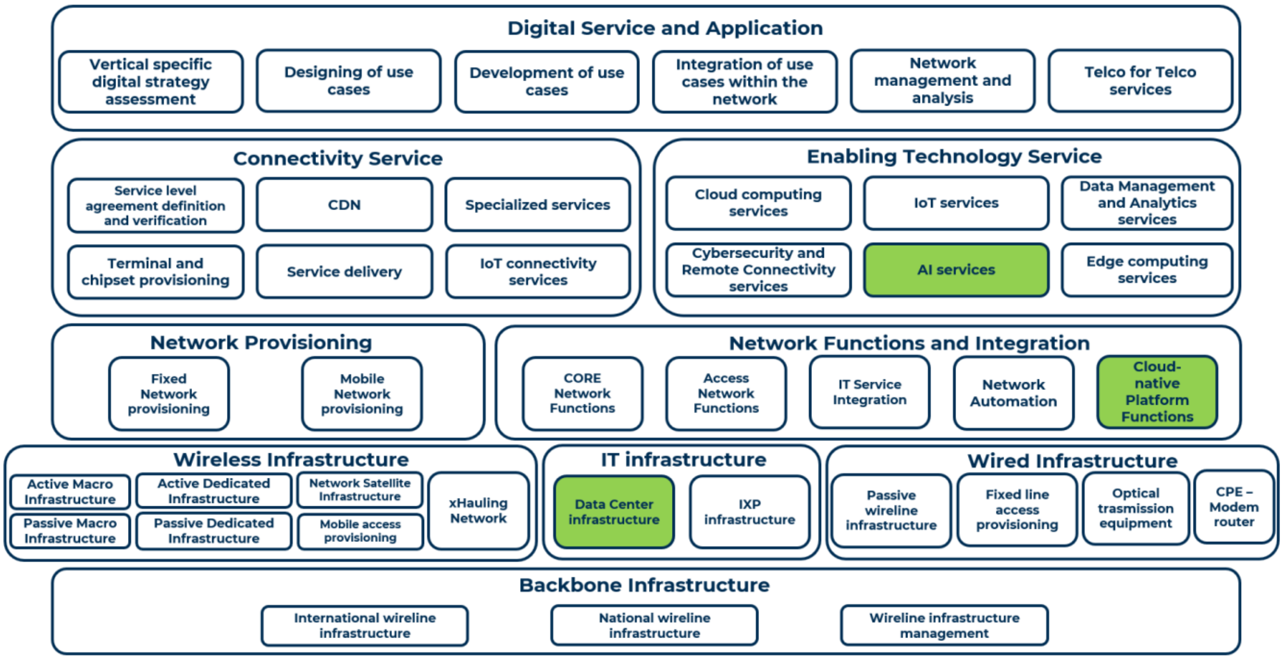

Figure 56 – Introduction of the new Business Model – European Cloud and AI Consortium

From a regulatory standpoint, European institutions opted to encourage network separation over mergers and acquisitions, the latter being largely constrained by antitrust regulations—except in a few exceptional cases. Particular attention was given to regulating wholesale mechanisms to ensure fair access and to support the sustainable development of network infrastructure avoiding the margin squeeze adopted in past years by some vertical integrated operators. Moreover, there has been the creation of a real European single market thanks to the harmonization of the spectrum, interceptions, and core networks management rules across all the member states of European Union.

The European Union played an active role in promoting the European Cloud and AI Consortium, investing substantial resources and implementing protective policies to shield it from the aggressive tactics of dominant global Cloud providers seeking to obstruct its growth amid their declining market share in Europe.

In parallel, EU institutions outlined a clear industrial strategy aimed at safeguarding the European telecommunications ecosystem from the influence of large international players. This strategy also supports the growth of smaller, nationally rooted companies that demonstrate strong innovation potential and long-term business sustainability.

A summary of the main characteristics of Scenario D is presented in the following Figure.

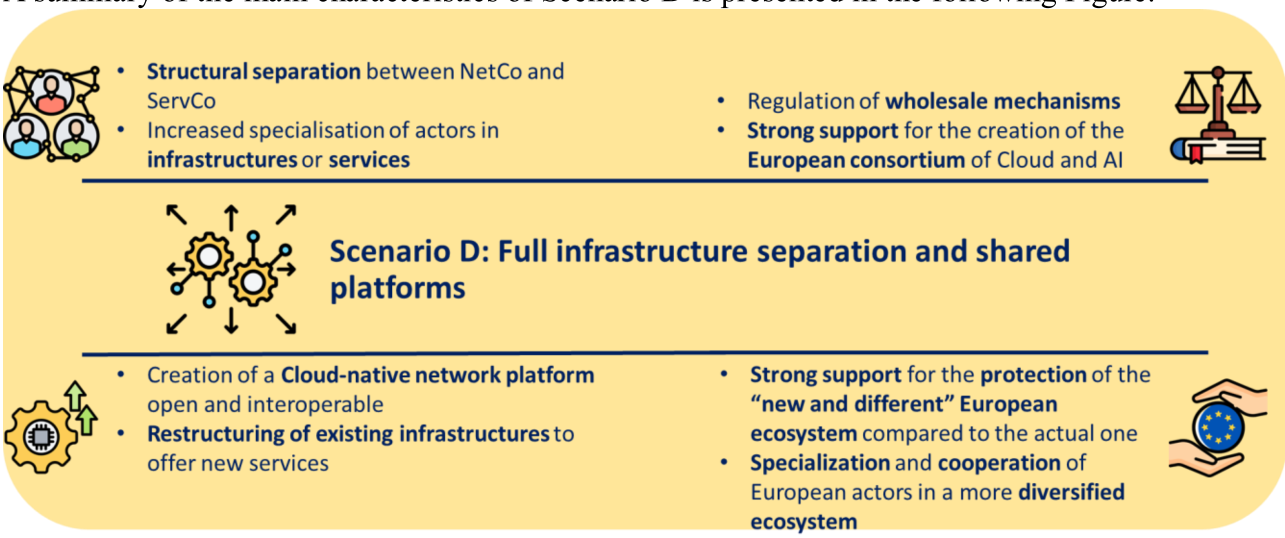

Figure 57 – Summary of Scenario D

5.7. New activities within the architecture of the telecommunications ecosystem

The model we developed (Figure 12), originally used to describe the current ecosystem and the scenario-driven transformations within it, has been updated to map the emerging business models of new actors and the technological innovations they have introduced — reflected in the megatrends outlined in Section 5. Indeed, the scenarios described in this chapter may lead to an evolution of the current layered model of the European telecommunications ecosystem, with the introduction of new activities related to the networks transformation we expect.

In particular, we have added two new activities to the "Network Functions" layer to better represent the evolving roles of key new players: the European Cloud and AI Consortium and the Neutral Hosts. These additions help capture the structural and functional shifts in the ecosystem driven by these entities.

Below are the newly introduced activities along with their descriptions:

- **Network Automation**: development and management of network functions related to network automation using AI algorithms that make it more efficient and intelligent to manage advanced services for users and businesses;
- **Cloud-native Platform Functions**: development and management of a Cloud-native network platform that, through the exposure of Network APIs and other network functions, enables the development of advanced services by third parties.

5.8. Overview of the scenarios and their characteristics

As previously mentioned, we designed the scenarios pushing to the extreme some of the descriptive variables that characterize them so as to delimit a space of possible futures considering the main trends from a technology and business point of view. Strategic decisions, as well as internal and external forces can drive the ecosystem towards a future that most likely will be a combination of those presented here.

An overview of the four scenarios and their characteristics is presented in the following Figure.

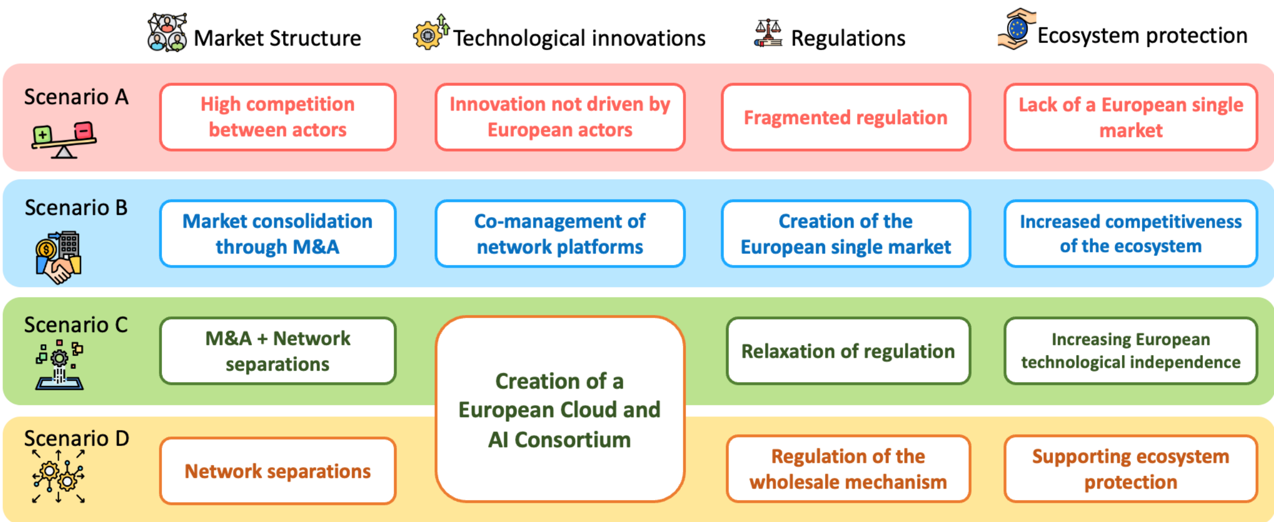

Figure 58 – Scenarios overview

6. The qualitative assessment of scenarios

Once the scenarios were defined, they were assessed qualitatively by identifying three core areas, from which a set of descriptive variables was derived. These variables are intended to provide readers with a structured and schematic understanding of the strengths and weaknesses of each scenario. The core areas and their associated descriptive variables are outlined below:

- **Market**:
  - Level of competition on services between ecosystem actors
  - Level of infrastructure competition between ecosystem actors
  - Entry/Creation of new players in the ecosystem
  - Degree of business transformation (in terms of price dynamics and relationships between ecosystem players)
- **Technology**:
  - Degree of technological disruption of infrastructure and services (i.e. the degree of technological innovation brought about by European players)
  - Level of digital service enablement/development of digital services
- **Regulation**:
  - Degree of regulation of the ecosystem (understood as the degree of influence of the regulator in the management of business and infrastructure technology innovations)
  - Degree of protection of the European ecosystem

These variables were assessed using a qualitative rating scale, as the objective of this phase is to summarize the possible changes that would be brought by each scenario to the European telecommunications ecosystem in 2040. The rating scale is as follows: Low, Medium-Low, Medium, Medium-High, High. Two tables are given below: the first is dedicated to ecosystem aspects, and the second to technological and regulatory aspects. Each table shows the qualitative assessment of each scenario.

	Level of competition on services between ecosystem actors	*Level of infrastructure competition between ecosystem actors*	*Entry/Creation of new players in the ecosystem*	*Degree of business transformation*
Scenario A – Telco commoditization	High	Medium	Medium	Low
Scenario B – Telco consolidation	Low	Medium	Low	Medium
Scenario C – Rise of infrastructure providers	Medium	Medium-Low	Medium	Medium-High
Scenario D – Ecosystem decomposition and recomposition	Medium-High	Low	High	High

Table 3 – Qualitative assessment of scenarios: ecosystem aspects

	Degree of technological disruption of infrastructure and services	*Degree of enablement/ development of digital services*	*Degree of regulation of the ecosystem*	*Degree of protection of the European ecosystem*
Scenario A – Telco commoditization	Medium-Low	Low	High	Low
Scenario B – Telco consolidation	Medium-High	Medium	Medium	High
Scenario C – Rise of infrastructure providers	Medium	High	Medium	Medium-High
Scenario D – Ecosystem decomposition and recomposition	Medium-High	High	Medium-High[70]	Medium

Table 4 – Qualitative assessment of scenarios: technological and regulatory aspects

Having defined the four scenarios and their descriptive variables, we provide in the following paragraphs a comparative analysis of their potential impact on the European telecommunications ecosystem. The comparison focuses on three key aspects: (i) the internal redistribution of value within the telco ecosystem, (ii) the total value generated by the telco ecosystem, and (iii) expansion into other markets.

6.1. Internal redistribution of value

With this variable, we aim to understand which activities are managed by different players and the consequences in terms of value capture. Therefore, we want to highlight which players are likely to capture the largest share of the value generated within the telco ecosystem. In the first two scenarios (A and B), for reasons that will be discussed shortly, internal value redistribution is less pronounced. By contrast, in Scenarios C and D, it becomes progressively more significant.

In Scenario A – Telco commoditization, the evolution unfolds within the current dynamics, including existing rules and regulations, but it does not maintain the current equilibrium. The commoditization of connectivity erodes margins and reduces the scope of activities for telco operators. The contraction of value created by the private market leads to a redistribution of public resources towards the sector, making the sustainability of infrastructure increasingly dependent on state subsidies rather than organic revenues. The need for economic efficiency shifts the value of infrastructure assets toward TowerCos and Wholesale operators, with the risk that infrastructure management itself could be taken over by Hyperscalers, effectively turning telcos into simple access channels without strategic control.

Technological dependence results in a cash outflow from European telcos to non-EU technology providers for the purchase of the AI and cloud capacity required to manage networks. By contrast,

[70] In the case of scenarios where network and service separation take place, regulation is medium-high, however, because it will be crucial to regulate the wholesale mechanism in order to also ensure innovation and infrastructure upgrades

this dynamic is expected to be much more limited in Scenario B – Telco consolidation, which is characterized by the creation of a unified European market and consolidation among operators. The consolidation into large, vertically integrated pan-European players allows traditional operators to better control key strategic layers, redistributing value across the European ecosystem and reducing dispersion toward marginal or external players. Even though telco players can benefit by this value redistribution, they need to establish strategic partnership with Hyperscalers and Big-Tech companies more in general for the development of digital services. In this way, telco operators can capture more value, than the current situation, in the higher-growth layers (Enabling Technology and Digital Services) by acting as the unique touchpoint for connectivity and digital services.

The creation of a single market strengthens the bargaining power of telcos with respect to Hyperscalers, leading to a more balanced distribution of value within partnerships and limiting the margin erosion typical in the current scenario. Thanks to network platforms developed in partnership with Hyperscalers and/or IT system integrators, value is also redistributed in favour of European telco players. The reduction in internal competitive pressure allows telco operators to recover and retain value in the traditional connectivity service layer, thus preventing further commoditization that had been undermining value creation.

Moreover, compared to Scenario A, the role of TowerCos wholesale-only operators, and infrastructure owners becomes more prominent due to the growing need to share assets and simplify relationships with third parties, such as building owners. IT integrators and software companies also gain importance as suppliers of platforms and AI components for European operators.

Moving toward Scenario C – Rise of infrastructure providers, regarding this last point, value is significantly redistributed in favour of large infrastructure providers, such as integrated NetCos, advanced TowerCos, wholesale fiber operators, and neutral hosts, which play a central role in managing the shared technology base. The structural separation between infrastructure and services leads to a more open and competitive market, reducing the influence of vertically integrated operators while strengthening the position of infrastructure players. At the same time, cloud-native platform providers and network-as-a-service vendors become key, operating new interoperable platforms that enable vertical services and new types of orchestration. Telco operators move toward a service-oriented and orchestration-focused role, sharing value with Hyperscalers, software vendors, and IT integrators. As a result, both consolidation and the separation of networks and services increase the system's investment capacity and reduce price competition. This also enables operators to regain ground in digital markets. In addition, the creation of a European Cloud & AI Consortium helps ensure that some of the value remains within the European ecosystem, partially offsetting dependence on non-EU platforms.

Within the fourth scenario (D), with the complete separation between infrastructure and services, value is clearly redistributed. The structural separation polarizes value redistribution between pan-European NetCos, which consolidate returns from stable infrastructure assets, and ServCos, which compete to capture the high-potential value of innovative digital services. The value linked to connectivity shifts almost entirely to regulated wholesale models, reducing unit margins but expanding the overall market for services. Neutral terrestrial and satellite hosts play an essential role, especially from an NTN-TN perspective. The European Cloud & AI Consortium becomes a central point of value, enabling open platforms and retaining shares of value that would otherwise go to global Hyperscalers. The outcome is a broader and more fragmented value distribution, with a strong specialization of roles.

6.2. Total value generated by the telco ecosystem

Using this variable, we compared the four scenarios in terms of the potential value generated and the growth of value across the different layers of our model relative to the AS-IS estimation. In this context, Scenario A is characterized by a very limited overall increase, falling short of the AS-IS estimation. By contrast, Scenario B shows a more pronounced increase in value creation, mainly driven by an enhanced capacity for value appropriation through more balanced partnerships. Nevertheless, the ecosystem remains partly dependent on the growth dynamics of non-European technology players. Along this dimension, Scenarios C and D generate the highest levels of value. A more detailed discussion of these considerations is provided below.

In Scenario A – Telco commoditization, the overall increase in the value of the ecosystem remains below current AS-IS estimation, even though growth is mainly supported by the natural rise in demand, with no significant deviation from the status quo. Value creation is held back by the inability of the European telco ecosystem to capture revenue streams linked to high-impact technologies such as GenAI and Cloud, relegating operators to a marginal role as connectivity providers, while value shifts toward global ecosystems. The decline in infrastructure investments in Europe further slows the development of advanced vertical services structurally limiting the economic growth potential of the European ecosystem and widening the digital divide compared to more dynamic regions.

In Scenario B – Telco consolidation, however, the creation of a single European market reduces internal price competition and shifts the focus toward service quality, resulting in a higher overall market value thanks to increased global competitiveness. The recovery in investment capacity by telco operators, supported by cost optimization and economies of scale, leads to higher overall revenues compared to the past and new infrastructure investment, such as in supercomputing. The value generated from connectivity increases moderately but is enhanced by the development of premium services with higher margins, such as those based on guaranteed QoS and Edge computing, which break away from commoditization. European players are thus able to generate and capture more value by structuring comprehensive, integrated service offerings that, by leveraging pan-European scale, allow them to compete on equal footing with major global players. While the ability to retain wealth is improved through more balanced partnerships, the ecosystem remains partly dependent on the growth dynamics of non-European technology players.

In Scenario C – Rise of infrastructure providers, the diversification of players between NetCos and ServCos reduces internal friction and focuses investment, allowing the former to upgrade infrastructure and the latter to innovate in high-value-added digital services, leading to an increase in the total value created on both fronts. The widespread adoption of shared network infrastructure lowers barriers to entry, unlocks the value of existing physical assets, and enables the creation of new service markets that were previously not economically viable. The development of a single, open, and interoperable network platform significantly accelerates innovation in industrial verticals such as Industry 5.0, healthcare, and mobility, generating new high-margin revenue streams. The restoration of technological sovereignty through the Cloud & AI Consortium and the integration of terrestrial and NTN TN satellite networks make the European ecosystem more globally competitive, enabling it to capture and retain a greater share of the value from technological innovation.

In Scenario D – Ecosystem decomposition and recomposition, with full infrastructure separation and the creation of shared platforms, functional specialization between NetCos and ServCos maximizes efficiency and innovation on both sides, generating a further increase in the overall value of the ecosystem. ServCos can generate more value through their service offerings, while NetCos achieve greater efficiency in infrastructure management. The strengthening of European digital sovereignty, driven by the Cloud & AI Consortium, makes it possible to retain all the value from innovation within European borders, increasing the value generated by services developed on the network platform. The platformization of the network and the exposure of open and interoperable Network APIs enable the creation of new service markets, currently not envisaged, structurally expanding the scope of value generated beyond connectivity alone. Competition shifts from infrastructure to services, which in turn drives the development of high value-added vertical digital services, transforming the European ecosystem into a dynamic growth engine capable of competing globally.

6.3. Expansion into other markets

Using this third variable, the four scenarios are compared in terms of their potential to expand the boundaries of the traditional telecommunications ecosystem into other markets. In this dimension, Scenario A is characterized by progress toward adjacent markets being driven primarily by Hyperscalers, whereas in Scenarios B, C, and D traditional telco players have opportunities to explore new markets, mainly through the development of new services, with each scenario following a different dynamic.

In Scenario A – Telco commoditization, expansion into adjacent digital markets is almost exclusively driven by non-European players, such as Hyperscalers and OTTs. This prevents the European ecosystem from entering new business areas and capturing the value generated through diversification. Telco operators are unable to achieve real strategic expansion and are limited to tactical cross-selling initiatives, for example in energy or security, which do not alter the business structure or allow for meaningful entry into new markets. External players, such as IT system integrators, refrain from expanding into the telco domain or from deeply integrating it into their own offerings, as connectivity services offer margins that are too low to justify significant strategic investment. The result is a fragmented and inconsistent expansion strategy among different market players, lacking a systemic vision to enable decisive entry into new market segments for the European ecosystem.

In Scenario B – Telco consolidation, the presence of telcos in the enabling technology services market increases, allowing the ecosystem to play a role in strategic digital segments and capture additional value, although technological leadership remains partly shared with international big tech companies. The evolution of networks into application platforms, even if not fully interoperable, enables expansion into software and application development, allowing operators to access the digital services market with growing penetration potential. Thanks to growth in IT and cloud services, there is expansion into adjacent markets that have already been partly targeted by European telcos. However, entry into sectors fundamentally different from the traditional value chain remains limited, since the most disruptive innovations still tend to originate outside the telco ecosystem. In this context, telco operators define a new purpose, positioning themselves as multi-utility service platforms.

In Scenario C – Rise of infrastructure providers, infrastructure managers such as NetCos and Neutral Hosts can directly enter adjacent markets like smart cities, energy, and logistics, transforming shared assets into platforms for integrated services and expanding the revenue base beyond basic network access. Instead, ServCos are free from infrastructure management responsibilities and can expand vertically, acting as service orchestrators and capturing value from the complex and specialized management of industrial segments. The creation of a European Cloud & AI Consortium also enables the ecosystem to expand into strategic sectors such as healthcare, public administration, and mobility, supporting the provision of innovative applications that are independent of non-EU players. The distinction between vertically specialized and horizontally oriented players transforms the telco ecosystem into a systemic enabler of European digital transformation, providing a far greater expansion capacity compared to the current market configuration.

In Scenario D – Ecosystem decomposition and recomposition, the specialization of ServCos, enabled by full infrastructure separation, allows the market to expand with ServCos acting as digital enablers for specific verticals that go beyond those currently addressed. The adoption of a single, open, and interoperable network platform enables the ecosystem to enter emerging markets, such as XR and immersive gaming, positioning ServCos as a key platform for Europe’s digital transformation. Support from the European Cloud & AI Consortium, along with the adoption of protective policies, encourages structural expansion into related digital markets, ensuring technological sovereignty and reducing dependence on major non-European players.

6.4. Influence of scenarios on technology development

In technology foresight exercises, innovation is often treated as an independent variable, with the assumption that ecosystems adapt in order to exploit new opportunities. In this view, essentially evolutionary, technology advances autonomously, forcing successive generations of market actors to adapt and evolve. However, this perspective overlooks the fact that technological innovation is itself shaped by research and by the dynamics of the ecosystem. Alongside basic scientific research, there is also technological research, which not only applies existing knowledge but also generates new innovations in close interaction with users. Its direction is strongly influenced by market structures and the strategic interests of actors, and investment decisions in both research and commercialization determine which technological pathways are pursued.

In the field of digital infrastructures and applications, this bidirectional influence between ecosystem dynamics and technological development is particularly evident, although often underestimated. For example, the development of the app economy in Western countries followed a "wild west" trajectory of unregulated growth dominated by pioneering American firms, while in China, a more protected ecosystem led to the rise of the mini-app model[71].

In our study, beyond applying the traditional foresight methodology, we also discussed with experts how ecosystem equilibrium may influence technological development and how different actors may benefit from or be disadvantaged under alternative future scenarios.

A first example concerns the relationship between AI technologies and network infrastructures. In current trends and in futures that perpetuate today's dynamics such as Scenario A, AI is used mainly as a defensive strategy to reduce operating costs through network automation. This is consistent with much of the research literature, which explores AI-based solutions for network planning, traffic and performance monitoring, anomaly detection and response, parameter optimization, and related tasks[72][73]. In this context, more advanced AI applications that create new end-user services are typically developed independently of the network, following an "over-the-top" approach similar to that of digital app ecosystems. By contrast, in scenarios that alter today's balances more radically, such as Scenario C and Scenario D, AI applications can evolve in closer integration with networks. This enables synergies such as machine-to-machine information exchange, distributed learning and inference, AI-optimized coding schemes[74][75], or even the emergence of radically new solutions and paradigms for networks, user devices and applications.

A second example concerns technological solutions for network platforms, such as orchestration of virtualized networks and services, or digital twins of physical networks and their resources[76][77]. In conservative scenarios, these remain internal tools of vertically integrated operators, used mainly to

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[77] Y. Pan, L. Lei, G. Shen, X. Zhang and P. Cao, "A Survey on Digital Twin Networks: Architecture, Technologies, Applications, and Open Issues," in IEEE Internet of Things Journal, vol. 12, no. 12, pp. 19119-19143, 15 June15, 2025.

optimize internal processes and resource management. However, in more disruptive scenarios, platforms can become the foundation of new business models. Platform-based economics has transformed many service ecosystems, yet connectivity has remained relatively untouched so far. The separation of networks and services, as envisaged in Scenarios C and D, creates the conditions for open technological platforms to emerge between infrastructure and services, enabling new relationships among actors and supporting services that have struggled to develop in proprietary environments.

Similar reflections apply to all the technological megatrends identified in this study. Figure 59 summarizes some of the directions on how different scenarios may shape the development and use of technologies in the European telecommunications ecosystem.

Some final considerations concern sustainability. As global sustainability commitments intensify, the telecommunications sector must integrate environmental and social objectives into its long-term transformation. This entails deploying energy-efficient network technologies, adopting circular-economy approaches to reduce e-waste, and contributing to broader agendas such as digital inclusion and social equity. In addition, energy and sustainability should be seen not only as environment concerns but also as important economic constraints with a direct impact on profitability: sustainability is now a financial necessity.

Technological innovation — including AI, cloud-native architectures, and advanced automation — can play an important role in these efforts. AI-driven network management can significantly reduce energy consumption by optimizing traffic flows, resource allocation, and predictive maintenance, while cloud-native infrastructures support more efficient, scalable, and flexible use of computing resources. Moreover, the adoption of renewable energy in data centers and across network operations represents a key pathway for mitigating the environmental footprint of expanding digital services.

Across the four scenarios, sustainability emerges as a cross-cutting theme, though its realization differs depending on ecosystem dynamics. In the more conservative trajectories (Scenarios A and B), sustainability benefits are likely to derive mainly from technological efficiencies and from initiatives led by adjacent sectors, with telecom operators playing a complementary role. In contrast, in the more transformative trajectories (Scenarios C and D), the telecom sector, supported by open platforms, shared infrastructures, and stronger coordination — can become an active driver of sustainability, enabling innovative digital services and infrastructures that enhance the efficiency and environmental performance of the broader economy.

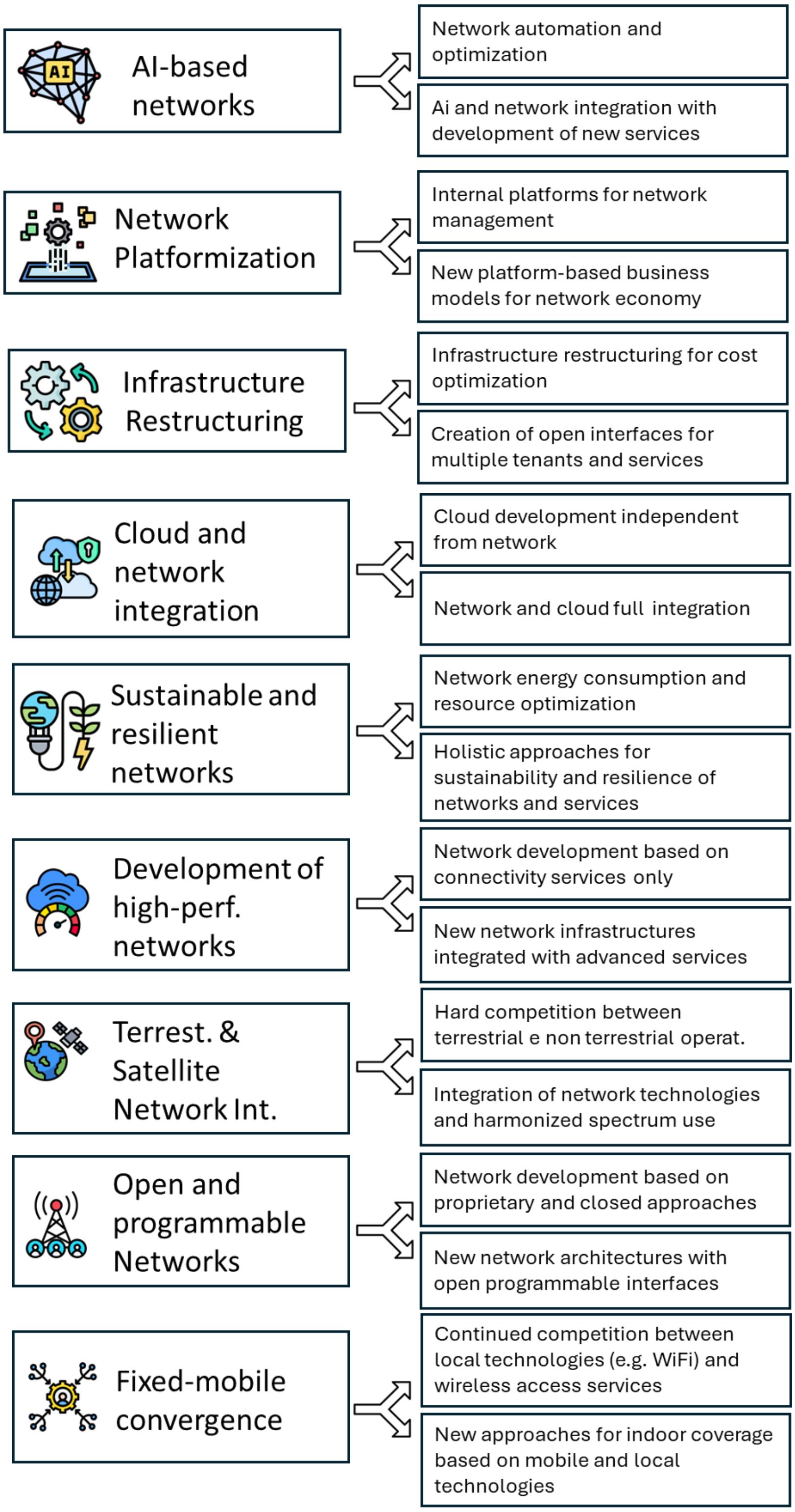

Figure 59 – Summary of possible impacts of future scenarios on technological megatrends

6.5. Impact of future scenarios on non-European markets and ecosystems

As the telecommunications landscape evolves, the implications extend beyond the European context to global markets, including the UK, the USA, and China. While these regions are deeply interconnected with Europe through economic, technological, and regulatory channels, each faces distinct challenges and opportunities in adapting to the future scenarios presented in this paper.

The UK, post-Brexit, operates outside the EU regulatory framework, which places it in a unique position regarding the adoption of European-driven strategies. While maintaining strong economic ties with the EU, especially in digital infrastructure and telecom services, the UK's market is now subject to its own regulatory landscape. This separation from the EU means that while the UK can potentially benefit from some of the innovations driven by EU policies, it will not fully participate in all initiatives, such as the EU's collective spectrum management or pan-European digital service platforms.

In scenarios where Europe strengthens its regulatory frameworks and consolidates telecom services, the UK may find itself in a position of limited participation, needing to negotiate bilateral agreements to maintain access to European digital services and cross-border infrastructure investments. The UK's ability to innovate in network infrastructure and telecom services will rely heavily on its domestic policies, which could either encourage competition or lead to further consolidation among UK telecom providers. Additionally, partnerships with US and Asian tech giants may increase as the UK seeks alternative collaborations outside the EU.

The United States, a key player in the global telecommunications ecosystem, faces its own set of dynamics. The US market is characterized by advanced infrastructure, widespread adoption of 5G technologies, and heavy investments from Hyperscalers and tech giants. However, its regulatory environment remains more market driven even if the recent policies of the Trump administration have also introduced some level of protection not only of commerce but also of digital services dominated by American players. Nevertheless, in all four future scenarios, the US is expected to remain a technological leader, with significant advancements in AI, cloud-native networks, and 5G/6G deployment.

China presents a contrasting model, driven by state-led initiatives and massive infrastructure investments. In the scenarios that involve the creation of shared platforms or the integration of terrestrial and satellite networks, China's ecosystem is likely to benefit from its centralized planning and government support. China's telecom giants will play a central role in shaping the future of telecom networks, especially in the deployment of next-generation 6G infrastructure.

However, the geopolitical tension between China and Western powers, especially regarding the use of Chinese telecom infrastructure in critical markets, could become a significant barrier. The creation of a European Cloud and AI Consortium or other sovereignty-driven initiatives could limit Chinese participation in some global markets. Still, China will continue to innovate and expand its telecom ecosystem, focusing on advancing AI integration, digital sovereignty, and expanding its influence in emerging economies through strategic investments in telecom infrastructure.

6.6. Key Performance Indicators to monitor the European ecosystem evolution

After the quantitative and qualitative analysis of these scenarios, and all the considerations related to the ecosystem impacts on technology and on other non-European ecosystems, European players can prepare themselves to manage the described changes with some strategic choices that will be described in the next chapter. Besides these choices, for European institutions, it will be fundamental to monitor the progress towards the realization of one scenario compared to another. Indeed, it is not sufficient to choose the preferred scenario and implement some strategic moves and regulations to guide its realisation; it is equally important to monitor, using Key Performance Indicators (KPIs), whether the strategic moves and regulations adopted are yielding the expected results. For this reason, we developed a KPIs dashboard which may be helpful for institutions:

- **Number of cross-border operators with relevant retail activities in at least 3 EU countries**: this indicator is the most suitable for assessing whether the market is genuinely moving towards a European dimension or if it remains confined to national fragmentation;
- **Number of pan-European M&As within the European telecommunications ecosystem**: this metric is useful for understanding if the market is consolidating at a European level, which is crucial for long-term sustainability, as opposed to national consolidations that often yield only short-term financial benefits;
- **Share of revenues of European players derived from services beyond basic connectivity** (Cloud/Edge, Cybersecurity, IoT platforms, data/AI, managed services, network APIs, etc.): monitoring this indicator allows for a simple evaluation of whether the sector is successfully escaping the "commoditization trap" by generating value through advanced digital services;
- **Increase of Neutral Host/Wholesale-only actors (NetCo) and pure service providers (ServCo), and their economic value (in terms of revenues)**: tracking these actors helps determine if the ecosystem is effectively moving towards a structural separation of the network and a new configuration of the entire ecosystem;
- **Availability of European network platforms with open APIs**: by measuring the extent to which the network is effectively used as a platform to enable third-party digital services (banks, PA, industry, developers). This indicator helps understand the ecosystem's capacity to develop innovative solutions and new revenue sources;
- **Percentage of usage of European Cloud platforms**: this indicator is useful to identify whether technological development is remaining within the hands of European actors or is controlled by non-EU players;
- **Number of partnerships between operators and tech giants (EU vs. non-EU)**: this metric helps to understand the strategic direction of collaborations within the ecosystem, distinguishing between alliances with European technology players versus those with non-European giants;

- **Uniformity of the application of European regulations across all EU member states**: monitoring regulatory consistency is essential to measure the progress toward a unified implementation of rules, which is necessary to overcome market fragmentation;
- **Number of specific rules for the TLC sector vs. rules imposed on digital markets**: this comparison highlights the regulatory balance between traditional telecommunications and the broader digital market, indicating potential disparities in the competitive landscape;
- **Number of countries limiting the scope of net-neutrality**: this indicator tracks the regulatory environment's allowance for the differentiation or blocking of specialized services, ensuring the possibility of offering guarantees for specific service types.

7. Key strategic crossroads for the future European telecommunications ecosystem

The analysis developed throughout this white paper highlights that the future evolution of the European telecommunications ecosystem cannot be assessed solely through the lens of market and economic dynamics or technological trajectories. At its core, the sustainability and competitiveness of the ecosystem depend on the ability to develop, finance, and govern a robust telecommunications infrastructure that is fit for long-term economic, social, and geopolitical challenges.

Across the four scenarios outlined, infrastructure emerges not merely as a technical foundation, but as a strategic asset that underpins economic growth, security, and Europe's capacity to compete globally. Moreover, the digital independence, from non-European providers, is a central and relevant aspect on which institutions and private companies must focus on. Indeed, as mentioned in the previous chapters, the most important gap between European Union, USA and Chinese companies is not related to manufacturing production or other traditional industries, but it is related to digital services productivity. The following reflections aim to synthesize the main strategic implications related to infrastructure and digital investments, drawing attention to their systemic role and to the responsibilities shared by private actors and public institutions.

7.1. Investments for a reliable telecommunications infrastructure

A reliable, high-performance telecommunications infrastructure is the foundational layer upon which the European digital economy, industrial competitiveness, and societal resilience ultimately depend. Across all the scenarios explored in this white paper, infrastructure consistently emerges as the structural enabler or constraint of long-term ecosystem sustainability. Without sustained and well-directed investment in networks, the potential of advanced digital services, industrial digitalisation, artificial intelligence, and data-driven innovation cannot be fully realised.

In the European context, the challenge is not limited to the overall volume of investment, but concerns its strategic orientation, timing, and coordination. Next-generation fixed and mobile networks require continuous capital expenditure to cope with exponential traffic growth, increasingly stringent performance requirements (latency, reliability, security), and the transition toward cloud-native, software-defined, and AI-enabled architectures. These investments are capital intensive, characterised by long payback periods, and therefore highly sensitive to regulatory uncertainty and market fragmentation.

A key insight emerging from the analysis is related to the infrastructure investments which can no longer be treated as a purely incremental extension of existing assets. The evolution toward integrated terrestrial and non-terrestrial networks, edge computing, and programmable network platforms requires an important and strategic shift in investment logic. Infrastructure must be designed not only to deliver connectivity, but also to enable new functionalities and service models — such as network slicing, exposure of network APIs, and deep integration with cloud and AI capabilities. This implies investing simultaneously in physical assets, software platforms, cybersecurity, and operational transformation.

Insufficient or fragmented investment strategies lead to structural fragility. In market environments dominated by intense price competition, limited scale, and rigid regulatory constraints, infrastructure investments tend to be postponed or narrowly optimised for short-term cost reduction. Over time, this results in declining network quality, reduced resilience, and growing dependence on non-European technology providers for critical components and operational intelligence. Such dynamics reinforce the commoditization of connectivity and weaken Europe's capacity to support advanced digital services and innovation.

At the same time, the current geopolitical context adds a further strategic dimension to infrastructure investment. As highlighted by the AREL Single Market Lab in *Much More than a Network – Telecoms as the Bedrock of European Defence*, modern security and defence capabilities increasingly rely on civilian telecommunications infrastructures, including fibre networks, advanced mobile systems, satellite connectivity, data centres, and cloud and edge platforms. Defence-driven requirements raise the baseline expectations for reliability, redundancy, cybersecurity, and interoperability, reinforcing the need for robust, resilient, and trusted networks operating at a European scale. In this sense, investments in telecommunications infrastructure contribute not only to economic performance, but also to collective security and strategic autonomy. This implies that future network infrastructure investments must be decide and incentivized at European level to overcome the fragmentation obstacle which characterized the past years and the realization of the present and weak European ecosystem.

In parallel, recent signals from financial markets suggest a renewed interest by investment banks and long-term financial investors in telecommunications infrastructure[78]. This shift reflects a growing recognition of telecom networks as strategic, long-duration assets, essential to the functioning of the digital economy and increasingly aligned with public-interest objectives such as security, resilience, and technological sovereignty. According to recent analyses by Oliver Wyman, this renewed attention is also driven by expectations of a structural reconfiguration of the European telecommunications market, including greater consolidation among operators and a clearer separation between infrastructure-intensive activities and service-based competition. From an investor perspective, a more consolidated market structure is seen as a prerequisite for restoring sustainable returns, reducing excessive competitive pressure, and enabling long-term investment planning.

Alongside private capital, however, the strategic role of telecommunications infrastructure calls for a revaluation of the role of public investment. Historically, European state aid rules have allowed public intervention in the telecom sector primarily in clearly defined cases of market failure, most notably to support fibre deployment in rural or underserved areas. While this approach has contributed to extending basic connectivity, it is increasingly insufficient in a context where telecommunications

[78] https://www.gruppotim.it/it/archivio-stampa/corporate/2024/CS-Closing-NetCo-1-luglio.html

infrastructures are required to support advanced public services, critical digital applications, and strategic functions for society at large.

In an environment characterised by intense competition, structural financial pressure on operators, and rapidly expanding societal demands for high-performance connectivity, public investment should be seen as a complement to private capital rather than as a substitute for it. New approaches are required to support strategic layers of infrastructure — such as edge computing facilities, resilient mobile and fixed networks, and secure connectivity platforms — where the social and economic returns extend beyond what can be fully internalised by private investors. Carefully designed public co-investment mechanisms, aligned with clear performance and access obligations, can help de-risk long-term projects, crowd in private capital, and ensure that the levels of connectivity required for economic development, public service innovation, and social inclusion are effectively delivered.

Ultimately, the message emerging from this analysis is that future reliable telecommunications infrastructure is not a by-product of market dynamics, but the outcome of deliberate and coordinated investment choices set at European level. Aligning industrial strategies, regulatory frameworks, and public and private financial incentives around a shared understanding of infrastructure as a strategic asset, serving economic, societal, and security objectives, is a necessary condition for ensuring that Europe’s telecommunications ecosystem remains viable, competitive, and resilient over the coming decades.

7.2. Market consolidation as a response to structural pressure

The growing pressure for consolidation in the European telecommunications sector reflects a set of structural imbalances that have accumulated over time. Declining revenues, persistent price-based competition, rising investment requirements, and increasing strategic responsibilities have collectively weakened the economic sustainability of many operators. In this context, mergers and acquisitions have progressively emerged as the most visible and immediate response to a sector widely perceived as being under strain.

A central assumption underpinning the push for consolidation is that the current number of infrastructure-based operators (Mobile and Fixed Network Operators based on the archetypes presented in this white paper) in many EU countries is no longer economically viable. Fragmented national markets, characterised by multiple players deploying and operating parallel networks, tend to intensify competition primarily along the price dimension, also due to the strict sectoral regulation hindering quality of service differentiation for connectivity or customer care. While this dynamic has historically benefited consumers through lower tariffs, it has also compressed margins and reduced the capacity of operators to generate sufficient returns to sustain long-term investment in network quality, coverage, and technological evolution.

From the perspective of telecom operators, consolidation is therefore seen as a means to rebalance market dynamics. By reducing the number of infrastructure-based competitors, operators expect to improve revenue predictability, and restore a level of financial stability compatible with the capital-intensive nature of the industry. In this narrative, consolidation is not portrayed as an end in itself, but as a necessary precondition for maintaining investment capacity and avoiding a progressive degradation of network performance and innovation.

Recent transactions across several European markets suggest that this logic is already shaping strategic decisions. Operations such as the acquisition of Vodafone Italia by Swisscom and its subsequent integration with Fastweb, the merger between Orange and MásMóvil in Spain, and the sale of Vodafone Spain to Zegona illustrate an emerging trend toward market reconfiguration at national level. These transactions typically aim to combine fixed and mobile assets, achieve operational synergies, and strengthen market positions within individual countries, rather than to pursue cross-border scale.

However, the renewed momentum toward consolidation clashes with the long-standing approach of European competition policy. Historically, antitrust authorities have prioritised maintaining high levels of competition at national level, largely with the objective of protecting short-term consumer welfare through low prices. Over time, this approach has translated into a de facto benchmark — often implicit rather than formal — according to which a minimum number of infrastructure-based operators per country is considered desirable. In past merger cases that reduced this number, remedies have frequently included measures to facilitate the entry of new players, reinforcing a highly competitive market structure.

While there are growing expectations among operators that this stance may evolve, uncertainty remains high. Competition authorities continue to rely on traditional indicators such as aggregate investment levels and innovation proxies, which do not always capture the qualitative dimensions of sectoral health. Even where investment volumes appear stable, they may conceal a more problematic reality: investments increasingly driven by necessity — such as fibre deployment and 5G rollout — rather than by strategic ambition, and often undertaken at the expense of margins.

Moreover, a less visible but potentially more damaging consequence of prolonged financial pressure has been the erosion of innovation capacity. Over time, many operators have downsized or dismantled internal R&D and engineering functions, becoming progressively more dependent on external technology vendors. This shift has reduced their ability to shape technological trajectories, experiment with alternative architectures, or develop differentiated service models, reinforcing a position of structural weakness within the broader digital ecosystem.

Finally, consolidation raises a broader and unresolved issue concerning the scale at which the telecommunications market is organised. Although mergers are often assessed as having European relevance, the effective reference market remains national. As a result, consolidation processes tend to reshape domestic markets without addressing the deeper fragmentation of the European telecommunications landscape. In the absence of genuine cross-border integration, national consolidation risks producing a patchwork of rebalanced local markets rather than enabling the emergence of pan-European players capable of competing globally.

This tension highlights a fundamental ambiguity: consolidation may alleviate some short-term financial pressures, but on its own it cannot resolve the structural limitations imposed by the lack of a fully integrated European Single Market for telecommunications. Whether consolidation becomes a stepping stone toward deeper European integration or remains a defensive response to national-level pressures will be a decisive factor in shaping the future trajectory of the sector. This issue is explored further in the following section.

7.3. Towards a European single market for telecommunications: an uncertain path

The completion of a genuine European Single Market has re-emerged as a central priority in the debate on Europe's long-term competitiveness. Recent strategic reflections, most notably the Draghi and Letta reports, have consistently identified three sectors as critical enablers of European economic strength and strategic autonomy: finance, energy, and telecommunications. These are also the sectors where the incomplete integration of the Single Market has been most clearly identified as a structural constraint on growth. In this context, the President of the European Commission has set 2028 as the target date for completing the reforms required to deliver a fully integrated European market across these domains.

While in finance and energy the growing awareness of the costs of fragmentation appears to be translating — albeit gradually — into concrete policy initiatives and institutional reforms, progress in telecommunications remains significantly more hesitant. Despite repeated declarations on the importance of a European telecom market, tangible steps toward deep integration are limited, and the sector continues to operate largely along national lines.

The absence of a true Single Market for telecommunications is rooted in a complex set of structural and institutional factors, many of which lie at the heart of Member States' sovereign prerogatives. Key among these are national responsibilities related to security, lawful interception, and control of network access. These competencies make it extremely difficult to operate access networks in multiple countries under a single European Core Network and unified service platforms, as critical functions are still required to remain under national jurisdiction.

Indeed, a critical issue regards the possibility, for a future pan-European operators, to centralize the Core Network in one country and benefitting of economies of scale. In the present situation this centralization is not possible, due to the regulation for the telephone tapping, and this negatively impacts the possibility of reducing costs for telecommunication players which operate at European level. For this reason, it is not sufficient to break the barriers to European Single Market, but it is necessary to incentivize economies of scale for European network infrastructures.

Additional fragmentation arises from the management of radio spectrum, which remains largely a national competence. Differences in allocation procedures, licence durations, coverage obligations, and pricing mechanisms significantly complicate cross-border operations and undermine the economic logic of pan-European network deployment. More broadly, the current ecosystem does not offer clear and quantifiable economies of scale that would make the creation of pan-European operators economically compelling under existing regulatory and governance frameworks.

Yet the potential benefits of a European Single Market for telecommunications extend well beyond traditional economies of scale. While efficiency gains could indeed be achieved through more coordinated management of network innovation, infrastructure resources, and operational processes, the most significant advantages lie elsewhere. Continental-scale operators would be better positioned to invest in long-term innovation, shape technological trajectories, and compete in advanced digital services markets where competitors typically operate at global scale. In a digital ecosystem increasingly dominated by global platforms, the lack of European actors with comparable scale represents a major strategic weakness.

Despite this, the stance of many telecommunications operators toward the Single Market agenda remains cautious and, in some respects, short-term oriented. Operators tend to endorse the European-level debate on the need for change, while implicitly prioritising outcomes that favour more permissive antitrust treatment of consolidation within individual Member States. This reflects a widespread perception that the path toward a fully integrated European market is long, uncertain, and politically complex, whereas national consolidation offers more immediate and tangible benefits.

There is also a more explicit concern among operators that, lowering barriers between Member States, could trigger downward price convergence across Europe, eroding Average Revenue Per User (ARPU) in countries where more favourable market conditions had previously been preserved. From this perspective, deeper integration is seen as carrying asymmetric risks, particularly in the absence of mechanisms that would allow operators to differentiate services and capture value beyond basic connectivity.

Overcoming this impasse therefore requires more than the technical removal of barriers to market integration — an objective that is already complex in itself. It also demands a shift in incentives and expectations for market actors. New regulatory frameworks and industrial policies are needed to clearly favour supranational scale, rewarding operators that invest in cross-border integration, shared infrastructures, and European-wide service platforms. Without such an explicit rebalancing, there is a risk that the Single Market agenda remains formally endorsed but substantively stalled.

In this sense, the European telecommunications ecosystem stands at a crossroads. Continuing along the current path risks reinforcing a model based on fragmented national markets, defensive consolidation, and limited strategic ambition. Moving toward a genuine Single Market, by contrast, would require accepting short-term adjustment costs and political complexity in exchange for long-term gains in competitiveness, innovation capacity, and strategic autonomy. Whether Europe is willing to make, this trade-off remains one of the most consequential open questions for the future of the European ecosystem.

7.4. Digital technological autonomy as a strategic imperative for Europe

One of the most widely discussed findings of the Draghi report is the substantial productivity gap between Europe and the United States, to the clear advantage of the latter. What has received far less attention, however, is the sectoral nature of this gap. Productivity differences are not evenly distributed across the economy: they are overwhelmingly concentrated in digital services, while in most other sectors the performance gap between Europe and the United States is far more limited.

This observation has profound implications for Europe's long-term competitiveness. It suggests that the core of Europe's structural weakness does not lie in traditional industries or manufacturing capabilities, but in its limited ability to create, scale, and capture value in digital services. Addressing this gap, therefore, requires more than a usual evolution in connectivity infrastructures and services or regulation; it calls for a broader reflection on Europe's technological autonomy in the digital domain.

In public debates on global technological competition, European policymakers and industry representatives often point out that two of the world's leading network equipment providers — Ericsson and Nokia — are of European origin. While this remains an important asset, it offers limited reassurance in economic and strategic terms. The most significant value creation in the digital economy no longer takes place primarily at the level of network equipment, but at the level of digital platforms, cloud services, artificial intelligence, and data-driven ecosystems. In these domains, European companies are almost entirely absent, while the Western digital landscape is dominated by American Hyperscalers.

Moreover, even Europe's remaining strengths in network technology are increasingly decoupled from the European market itself. Ericsson and Nokia operate as global players, with limited dependence on European demand and growing exposure to international capital markets. So, their strategic decisions, obviously, are progressively shaped by global competitive dynamics rather than by European industrial or technological priorities.

China offers a sharply contrasting example. Over the past two decades, it has pursued a deliberate strategy of technological decoupling, enabling the emergence of a digital ecosystem based on platforms that are structurally alternative — and in many respects radically different — from those developed in the United States. This approach has been supported by a vast domestic market and by strong state coordination. Replicating such a model in Europe is neither feasible nor desirable, given

Europe's political, economic, and institutional context. Nevertheless, ongoing geopolitical shifts and changing economic incentives increasingly point toward the need for a distinct European path to greater digital sovereignty.

In this context, initiatives such as EuroStack[79] represent a critical attempt to foster a European industrial ecosystem capable of delivering competitive digital services. The development of European consortium focused on cloud, artificial intelligence, and digital platforms is one of the key structural transformations identified in the future scenarios outlined in this white paper. It is also the area where the need for a change of pace is most urgent and where the gap between ambition and implementation remains widest.

The obstacles to this transformation are substantial and should not be underestimated. The first is often framed as a technological gap between European companies and their American and Chinese counterparts. In reality, this gap is not primarily due to the absence of individual technological components. Europe hosts companies operating across many layers of the digital stack, often with world-class expertise in specific domains. What is missing is effective integration: the ability to offer customers — both consumer and enterprise — complete, reliable, and seamlessly integrated solutions that can serve as credible alternatives to those provided by Hyperscalers.

This lack of integration significantly increases adoption costs and risks for users. Fragmented solutions require complex system integration, introduce uncertainties in performance and accountability, and place a heavier burden on customers compared to the vertically integrated offerings of global digital platforms. As a result, even when European technologies exist, they struggle to gain traction in the market.

A second major obstacle lies on the demand side. There is currently limited momentum behind an effective "buy European" strategy in the digital domain. Many organisations — public and private alike — perceive European digital solutions as less mature, more complex to adopt, and often less economically attractive than those offered by Hyperscalers. This perception reinforces a self-reinforcing cycle: low adoption limits scale, limited scale slows technological maturation, and slower maturation further weakens demand.

Breaking this cycle requires deliberate action to gain a comprehensive understanding of the needs of demand-side companies and to stimulate demand. Large enterprises with strategic, regulatory, or security-driven incentives can play a crucial role as early adopters of European digital solutions, helping to validate technologies, accelerate learning curves, and support the development of more integrated offerings. An equally important role lies with the public sector and publicly controlled companies across Europe. Through procurement strategies, technical standards, and long-term digital

[79] https://eurostack.eu/

policies, public actors can create anchor demand for European solutions and reduce market uncertainty for suppliers.

Ultimately, greater technological autonomy in the digital domain will not be achieved through protectionism or isolation, but through the construction of credible, competitive European alternatives. This requires coordination across industrial policy, public procurement, regulation, and market incentives. Without such a coordinated effort, Europe risks remaining structurally dependent on external digital platforms, with lasting consequences for productivity, innovation, and strategic autonomy.

7.5. Decomposing and recombining the telecommunications ecosystem

The structural tensions affecting the European telecommunications sector suggest that the current configuration of the ecosystem may have reached its limits. Persistent financial pressure, diverging investment needs, and growing asymmetries between infrastructure and service-based activities indicate that incremental adjustments within existing models may no longer be sufficient. Against this backdrop, a more radical — but increasingly relevant — option is the decomposition and recomposition of the European telecommunications ecosystem.

At the heart of this alternative approach lies the separation between network infrastructure and services. Rather than organising the ecosystem around vertically integrated operators responsible for both asset-heavy networks and fast-evolving digital services, this model proposes a clearer functional distinction between infrastructure-centric actors and service-oriented companies. Such a separation does not imply fragmentation, but rather a reconfiguration of roles, incentives, and market mechanisms within a more modular European ecosystem with pan-European players.

Changing the "playing field" in this way has important strategic implications for Europe. By redefining how value is created and captured, it becomes possible to compete on different terms in the digital economy — terms that may be better aligned with Europe's institutional framework, regulatory culture, and industrial strengths. In this perspective, European rules and regulatory constraints, often seen as a competitive disadvantage in platform-dominated markets, could instead become an enabling factor for alternative ecosystem architectures based on openness, interoperability, and shared infrastructure.

A key element of this reconfiguration is the growing emphasis on infrastructure sharing and the expanding role of infrastructure providers and neutral hosts. Initially focused on passive assets, such as towers and fibre networks, neutral host models are increasingly extending into the active layer of the network, and in rare cases also into the frequencies spectrum[80]. This evolution allows multiple

[80] https://www.mobileeurope.co.uk/ghanas-wholesale-5g-network-strategy-springs-surprises/

service providers to operate over shared physical and logical infrastructures, reducing duplication of assets, improving capital efficiency, and raising overall network utilisation. In markets characterised by near-universal coverage, such sharing is not only economically rational but increasingly unavoidable.

This structural shift reflects the fundamentally different investment dynamics that characterise infrastructure and services. Network infrastructure requires ever-larger, capital-intensive investments, with long payback periods and relatively stable but moderate returns. Its economic sustainability depends on scale, utilisation rates, and predictable regulatory frameworks. Digital services, by contrast, are marked by rapid innovation cycles, higher uncertainty, and significantly different risk–return profiles. Investments in services are typically less capital intensive but more volatile, with the potential for high returns alongside a high probability of failure.

Attempting to manage these two logics within a single organisational and governance structure has become increasingly problematic. The traditional telco model — built around selling connectivity at progressively lower prices through economies of scale and infrastructure optimisation — struggles to coexist with the need to develop innovative, differentiated, and riskier digital services. As a result, operators often find themselves underinvesting in both domains: constrained in infrastructure by financial pressure, and cautious in services due to cultural and organisational inertia.

A more decomposed ecosystem allows each segment to follow its own optimal logic. Infrastructure providers can focus on efficiency, resilience, and long-term investment, operating in wholesale connectivity markets with clear access and remuneration mechanisms. Service companies, freed from the burden of infrastructure ownership, can concentrate on innovation, customer experience, and the development of advanced digital services, leveraging connectivity as an input rather than as a strategic bottleneck.

Such a transformation, however, is not purely structural or regulatory. It also implies a profound change in leadership, managerial capabilities and internal expertise. Infrastructure businesses and service-driven digital companies require different skills, governance models, and strategic mindsets. Managing capital-intensive assets with long-term horizons is fundamentally different from competing in fast-moving, innovation-driven service markets. Successfully exploiting the diversity of these business models requires the introduction of new organizational structure to better manage and exploit innovation either in infrastructure and service businesses.

In this sense, the decomposition and recomposition of the telecommunications ecosystem should be seen not as a loss of coherence, but as an opportunity to restore strategic clarity. By aligning investment models, organisational structures, and competitive dynamics with the intrinsic nature of infrastructure and services. In this way, Europe may unlock new paths for sustainability, innovation, and digital competitiveness — paths that are difficult to pursue within the constraints of the traditional vertically integrated telco model.

8. Conclusions – A future still to be written

The analysis developed throughout this white paper points to a clear conclusion: the European telecommunications ecosystem is approaching a decisive crossroads. The structural pressures affecting the sector — financial fragility, stalled integration, non-European technological dependence, and increasing strategic responsibilities — can no longer be addressed through incremental adjustments or defensive strategies. What is at stake is not merely the future of a single industry, but Europe's ability to remain competitive, autonomous, and resilient in an increasingly unstable global environment.

Periods of deep crisis are often moments of greatest opportunity. When established equilibrium break down, solutions that once seemed politically unfeasible or economically unrealistic can suddenly become necessary — and possible. The current international context has eroded long-standing certainties, not only with respect to geopolitical alignments, but also regarding the technological trajectories that were previously assumed to be inevitable. In this environment, postponing decisions or relying on inherited models is no longer a neutral choice: it is a strategic risk.

The European telecommunications ecosystem exemplifies this dilemma. Persisting with the current market structure — fragmented, nationally bounded, and built around vertically integrated operators struggling to reconcile incompatible business logics — risks locking Europe into a path of gradual decline. Consolidation alone, if confined to national markets, may alleviate some financial pressure in the short-term but will not resolve the deeper structural weaknesses highlighted in this report. Similarly, invoking the Single Market without addressing the political, regulatory, and industrial barriers that have prevented its realisation for decades risks turning integration into an empty slogan.

At the same time, the growing dependence on non-European digital platforms exposes a fundamental vulnerability. Europe's productivity gap is not a matter of manufacturing capacity or traditional industries, but of digital services and platforms. Without credible European alternatives in cloud, AI, and data-driven ecosystems, investments in connectivity alone will not translate into sustained economic growth or strategic autonomy. Digital technological autonomy must therefore be treated as a core objective of European industrial and economic policy, not as a secondary or symbolic ambition.

This white paper argues that changing the trajectory of the sector requires more than regulatory fine-tuning. It requires a willingness to rethink the architecture of the telecommunications ecosystem itself. The separation between infrastructure and services, the development of wholesale connectivity markets, the growing role of Neutral Hosts, and the emergence of specialised service companies are not marginal experiments. They represent a coherent alternative framework capable of aligning investment incentives, fostering innovation, and enabling Europe to compete on different—and potentially more favourable — terms in the global digital economy.

Such a transformation will not happen spontaneously. It demands political leadership, regulatory courage, and a new industrial vision. It also requires a change in mindset among market actors, moving beyond opportunistic strategies focused on short-term protection or national consolidation, toward a collective effort to build scale, integration, and capability at the European level. Public investments, procurement policies, and strategic demand creation must play an active role alongside private capital in supporting this transition.

The moment to act is now. Delaying decisions in the hope that market forces alone will restore balance is no longer a viable option. The choices made in the coming years will determine whether Europe remains a passive consumer of digital technologies developed elsewhere or becomes an active shaper of its own digital future. The future of European telecommunications — and with it, a significant part of Europe's economic and strategic destiny — is still to be written. But the window for shaping it is rapidly narrowing.

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