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Advanced Technologies for Industry - Sectoral Watch

Technological trends in the telecommunication industry

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Section 1

1. Introduction

This sectoral report has been prepared in the framework of the 'Advanced Technologies for Industry' (ATI) project, initiated by the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and Small and Medium-sized Enterprises Executive Agency.

It analyses trends in the generation and uptake of advanced technologies, as well as related entrepreneurial activities and skills needs in the telecommunication sector. It interprets data from a list of data sources, compiled to monitor advanced technologies and their applications in industry across Europe and key competitor economies.

The starting point of this analysis has been 16 advanced technologies that are a priority for European industrial policy, which enable process, product and service innovation throughout the economy and hence foster industrial modernisation. 'Advanced technologies' are defined as recent or future technologies that are expected to substantially alter the business and social environment, and include advanced materials, advanced manufacturing, artificial intelligence, augmented and virtual reality, big data, blockchain, cloud technologies, connectivity, industrial biotechnology, Internet of Things, micro- and nanoelectronics, mobility, nanotechnology, photonics, robotics and security.

The relevance of these specific technologies in the telecommunication sector has been explored through the analysis of market trends, data on private equity investments, skills and technology uptake. The full methodology behind the data calculations is available here: https://ati.ec.europa.eu/reports/eu-reports/advanced-technologies-industry-methodological-report.

This report is structured as follows:

- The first section sets the industrial context.
- The second section analyses technological trends in advanced technologies applied in the telecommunication sector.
- The third section presents findings about private equity investment and start-up/spinoff activity in the area of telecommunication.
- The fourth section explores the supply and demand of skills related to advanced technologies.
- The fifth chapter concludes with a short future outlook.

Section 2

2. Setting the scene: industrial context

Europe's telecommunication industry is continuing to show mild positive trends in both the number of connections and service market values. At the same time, the increasing deployment of advanced technology to the sector is poised to make the telecommunication value chain more complex as virtualised networks and edge computing encourage the development of new business models and partner ecosystems for telecommunication services.

Among businesses, governments and other organisations, telecommunication services remain critical for the operation of nearly all sectors with advanced technologies expected to play an increasingly important role in banking/finance, retail, transport & logistics, media and manufacturing sectors.

While the number of companies in the telecommunication sector increased for much of the last decade, employment has waned as the industry is increasingly automating its businesses and reducing headcounts. From 2010 to 2019, employment in the sector in the EU's 27 Member States fell by a CAGR of 2.7% from 1 086 000 to 850 000 units.

2.1 Sectoral changes

The telecommunication value chain

Connectivity is at the heart of our modern society and economy. It enables our entertainment, communication, flexible working, modern commerce/stockmarket trading, online shopping, remote health monitoring, remote schooling, emergency response systems, and much more. Connectivity is considered by some to be a human right. This same connectivity is the core product of the telecommunications industry. Without telecommunications service providers (telcos) to enable this pervasive connectivity, society would not be the same.

By the end of 2020, there were more than 1.2 bn mobile device connections in Europe.[1] At the same time there were also 238 m fixed voice connections and 257 m fixed data connections in the region.[2] All together that is more than 1.7 bn connections in a region with a population of 747 m according to UN figures.[3] That is equivalent to around 2.3 connections per person in the geographical region of Europe. In 2020 the total value of the European market for telecommunications services was estimated to be €123.8 bn – this compares to the same market in North America at €182.9 bn, and €66 bn in China[4].

Growth trends for both connections and telecommunication service market value are marginally positive. The market for connectivity services is considered to be fairly mature, and while data consumption increases very rapidly year on year, the associated revenue growth is very small in comparison. There are some new opportunities for growth as telcos explore new business models and new accessory services.

Telcos typically provide and charge for network connectivity, along with voice, data and audio/video content (especially television) services over the network. They provide these services to the vast majority of consumers and organisations. In some cases, telcos provide and/or rely on wholesale services, which can include, for example, network connections over long-distance transit networks, metropolitan area networks or local distribution networks ('the last mile').

Major fixed-line telcos with 'significant market power'[5] are typically required by National Regulatory Authorities (NRAs) to allow access to their infrastructure at wholesale rates deemed reasonable to allow competition. Likewise, major mobile network operators (MNOs) are generally required to allow resellers to use their mobile networks on the basis of wholesale agreements, thus allowing the resellers to operate as mobile virtual network operators (MVNOs). Such wholesale agreements allow competition in the provision of telecommunications services, without requiring every competitor to undertake the costly construction of the physical network infrastructure or to acquire its own spectrum licenses. These alternative operators have often applied competitive pressure on the major infrastructure-owning telcos, but even after more than two

[1] https://www.idctracker.com/technology/TSDB/query
[2] Ibid.
[3] https://www.unfpa.org/data/world-population-dashboard
[4] https://www.idctracker.com/technology/TSDB/query
[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018XC0507(01)

decades since the liberalisation of the sector in 1998, market power is concentrated among a small number of operators that maintain the largest fixed-line (including cable television networks) and mobile networks.

As broadband Internet connectivity on both fixed and mobile networks has become widespread, telcos have faced challenges from third-party companies offering a range of services 'over-the-top', some of which compete with the services offered by the telcos. For example, messaging applications have emerged in competition with the SMS and MMS messaging offered by mobile operators, while streaming music and video on demand services compete with similar services offered by some telcos and account for a significant share of the traffic transmitted over the telcos' networks.[6,7]

Telcos are in turn served by network and software vendors. This part of the market can be seen as highly consolidated, especially on the network vendor side where the market is dominated by three large global players – Nokia, Ericsson and Huawei, with the first two being based in Europe. The market for telecoms software and support services is more varied, with somewhat lower barriers to entry making it slightly more open. However, the very specialised nature of large parts of telecoms operational software has led to some consolidation, with large global players dominating the market.

Current trends in the market are shifting much of the previously specialised telecommunication infrastructure to much more virtualised systems, increasingly using cloud-based infrastructure. This shift is opening the door to some new players supplying the telcos.

The complex telecommunication value chain is poised to become even more complex as technology developments like virtualised networks and edge computing encourage the development of new business models and partner ecosystems for telco services.

Growth trends in application areas

Consumers typically use personal mobile connections, as well as household broadband connections that may include paid television services. Fixed-line household telephone lines have been in decline throughout Europe for more than a decade, with the number of such connections in all of Europe falling at a compound annual growth rate (CAGR) of -3.2% from 248 million in 2011 to 187 million in 2020.[8] These lines are largely being replaced by household broadband connections and by personal mobile connections. The number of household broadband connections has risen at a CAGR of 4.2% from 2011 to 2020 to reach 217 million connections.[9] And although mobile connections have changed dramatically in recent years with high-speed 4G network connections, high-definition video streaming and dynamic social media applications, the number of connections used by consumers has remained little changed over the past decade, rising from 917 million across all of Europe in 2011 up to 940 million in 2015 before falling back to 925 million in 2020.[10]

Among businesses, governments and other organisations, telecommunication services remain critical for the operation of nearly all sectors, though the mix of services utilised varies. For example:

- Nearly all organisations require core office network connectivity, using broadband Internet access, IP VPNs and/or SD-WAN to enable communication between employees at different locations and to enable various enterprise applications to function between sites, data centres, cloud computing infrastructure, as well as with customers, suppliers and partners.
- Banking/investment companies use a wide range of network services from traditional VPN and SD-WAN networks to connect business sites and branches (with a high level of use of redundant access lines for backup/resilience), to mobile and low-speed fixed connections for remote/non-branch ATMs, to specialised high-capacity, extremely-low-latency links co-located with financial exchanges for high-frequency trading.
- Retail companies increasingly utilise SD-WAN connections to establish and manage branch connectivity remotely, and to enable reliable and secure transmission of transaction data, supply chain management, inventory tracking, staff identification, security systems, dynamic displays and other operations.
- Transport/logistics companies use low-cost mobile/cellular/satellite IoT solutions supported by real-time data and analytics to help optimise vehicle routing and detect anomalies. This addresses the major concerns of logistics companies: fleet- and fuel-related cost, safety, fleet/freight integrity and supporting sustainability/green initiatives.
- Media companies use a diverse mix of network services across the broadcast supply chain: fibre, mobile, satellite, microwave for content acquisition; high-

[6] https://www.bbc.com/news/technology-45745362
[7] https://www.theverge.com/2020/3/19/21187078/netflix-europe-streaming-european-union-bit-rate-broadband-coronavirus
[8] IDC's Semiannual Telecom Services Tracker, November 2020, https://www.idctracker.com/technology/TSDB/query
[9] Ibid.
[10] Ibid.

capacity optical/Ethernet services for production; and satellite, content delivery networks, Internet and traditional broadcast for multi-platform distribution.

- Manufacturers require high-capacity connectivity between sites, often using MPLS IP VPNs. They are also embracing public and private cloud, edge computing and private 5G networks to enable them to increase automation of their production environments and facilities, including more extensive use of robots and autonomous guided vehicles.

Thus while there are commonalities in the types of telecommunication services used across sectors, and telecommunication services are a critical enabler of all industries, the specific mix of services varies.

Employment in the telecommunication industry

Across Europe, each national telecommunications market is usually served by around 3-4 large telecommunication service providers, or telcos, with a handful of smaller players that focus on particular regions or specialised services. There are some large regional groups that own operations in multiple countries in the region, such as Orange, Telefonica, Vodafone and Deutsche Telekom. However, the European market remains geographically fragmented, with each country market featuring a slightly different set of major players, and even the international groups allow their national subsidiaries significant autonomy.

The current market has taken shape over a period of more than two decades since market liberalisation that was completed in the late 1990s in most of the EU, and in the early 2000s in Central and Eastern Europe. Liberalisation enabled a rush of new players into the fixed-line market. Over time, the market settled, with many of the newer entrants consolidating into a smaller set of players that challenged the large incumbent players, while rarely threatening to surpass them. On the mobile side, each national regulator has tended to license spectrum to between three and five major mobile operators. Regulators have frequently tried to entice additional competitors, while operators have often sought to merge and reduce competition.

In addition to the small number of major players in each country market, there are thousands of smaller companies active in the telecoms sector operating on a much smaller scale. These include, for example, MVNOs, resellers and independent providers of services to office complexes and housing estates. Throughout the 28 Member States of the EU prior to 2020, there were 47 625 businesses active in the telecoms sector, a figure that has been rising gradually from around 41 400 in 2011.[11]

While the number of companies in the telecommunication sector increased for much of the last decade, employment has waned. Telcos are increasingly automating their businesses and reducing headcounts. Their move toward automation is taking place in several parts of the telco organisations. For example, they are automating the operation of the networks, as well as automating service activation, customer support, sales and other functions. As a result, telcos are able to operate with even fewer employees.

From 2010 to 2019, employment in the sector in the EU's 27 Member States fell by a CAGR of 2.7% from 1.086 million employees to 850 000.[12] During that time, telecoms services had one of the lowest rates of growth of employment of all industries in the EU. Only mining of coal and lignite, printing and reproduction of recorded media, and extraction of crude petroleum and natural gas saw declines in employment even greater than that experienced in the telecoms sector. With the automation of the telecoms sector and the accompanying decline in employment, the share of employment in the telecommunications sector in the EU-27 fell from 0.59% of total employees in 2010 to 0.44% in 2019.

[11] Eurostat, Structural Business Statistics, https://ec.europa.eu/eurostat/databrowser/view/sbs_na_1a_se_r2/default/table?lang=en

[12] Eurostat, employment by sex, age, and economic activity, https://ec.europa.eu/eurostat/databrowser/view/lfsa_egan2/default/table?lang=en

Section 3

3. Technological trends

Advanced technologies will enable Europe's telecommunication providers generate additional revenue thus diversifying and reconstructing their market position.

Advanced technologies and the use of 5G can play a key role in terms of cost reduction for telecommunication operators, especially considering the spread of COVID-19 which has served to the deployment of Artificial Intelligence in the expansion and upgrade of telecommunication networks to the 5G.

European telecommunications are putting efforts in developing a series of innovations in network technology which are expected to generate revenue streams while using advanced technologies like IoT, 5G in line with enterprise solutions providers and new business models.

3.1 Technology evolution in the telecommunication industry

Advanced technologies are playing a growing role in the operations of Europe's telecommunication service providers given the need to transform operations and deliver new services.

Telcos face significant competitive pressures. Their major rivals have similar service offerings and value propositions for customers. These rivals have access to the latest technologies, like 5G mobile networks, that allow them to provide dramatically improved services – much higher bandwidth; greater capacity; much higher reliability and much lower latency. As a result, telcos must upgrade, lest they fall behind their rivals. At the same time, over-the-top providers are winning the battle for most content services, limiting the telco's options. Faced with challenges and enormous network investment requirements, European operator's financial results have deteriorated in recent years.

In Europe, cumulative annual revenue of telecommunication service providers declined 24% from 2007 to 2018, compared with growth of 18% registered by large, listed companies of 18%[13] over the same period, according to McKinsey. In contrast, the North American telecommunication industry revenue grew 20% over the same time period, far stronger than the European market, and yet still weak compared to the economy overall, which saw 48% growth in revenue across all sectors over the same timeframe.

The impact of COVID-19 on telcos, such as lower roaming revenue as mobile phone users remain in territory, will likely extend well into this year as Europe is still grappling with the pandemic. The unenviable circumstances underscore the need for mobile network operators to cut costs so they can try to reverse the trend of dwindling profitability the sector has faced for years. The telecommunication industry in Europe and North America experienced six and seven percentage point declines, respectively, in earnings before interest, taxes, depreciation and amortisation (EBITDA) margin from 2007 to 2018, according to McKinsey.[14] That means further rationalisation of their businesses involving cost reductions with the aim of maintaining healthy profit margins.

To that end, telcos are incorporating advanced technologies into operations by recreating their business systems and by lowering the cost of transport in the case of 5G networks. Telcos also want to reconstruct their market position by featuring innovative, new offerings and experiences for consumers and businesses. Telecommunication operators are adopting automation technology, multi-channel approaches and personalisation services to create a better customer experience, which improves asset utilisation. They are incorporating advanced technologies into operations to generate new revenue streams in the context of Europe's digital economy.

Telcos are in a unique position to generate additional revenue as their networks play a critical role enabling the digital economy, as their assets and information can be used to power new initiatives such as connected cars.

Advanced technologies that telcos could use to create digital ecosystems, such as artificial

[13] McKinsey, 2019 https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/telecom-operators-surviving-and-thriving-through-the-next-downturn

[14] McKinsey, 2019, https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/telecom-operators-surviving-and-thriving-through-the-next-downturn

intelligence, the Internet of Things and 5G networks, provide greater potential for telcos to reconstruct their market position. That is because said technologies can collectively help a telco create open platforms that will create new opportunities for telcos to compete in the digital economy by creating shared orchestration, monetisation and administration tools to offer new service bundles. Telcos can diversify away from being providers of telecommunication and ICT services by creating platforms to host tenants that pay to use their infrastructure and foster a marketplace whereby companies use their infrastructure and create innovative service bundles and channels to reach new market segments.

3.2 Telco cost savings involving advanced technologies

In the meantime, cost reduction is an imperative for telcos in Europe given the industry's lower profitability and the need for heavy investment in new technology just to maintain roughly stable revenue. As a consequence, management of expenses is becoming a core competency for telecommunication service providers. The UK's BT Group, for example, is just one example of a telco that regularly highlights the progress of its transformation programme to investors designed to refurbish the business during its quarterly earnings calls.

Advanced technologies can play key roles for telecommunication service providers that have embarked upon such ambitious corporate overhauls. Artificial intelligence (AI), is an example of an advanced technology that service providers are employing to better understand and even predict their client needs and preferences resulting in compelling offers, potentially lowering costly customer churn and cost of acquisition charges involved in the recruitment of new customers.

In terms of cost reduction, the cost of traffic transport can be dramatically lowered with the help of 5G networks. One of Europe's largest mobile operators has indicated that data transfer costs over 5G networks, with the help of MIMO antenna technologies (multiple input, multiple output)[15], can be reduced to a tenth of the cost of data transfer over 4G networks, thanks to greater spectral efficiency of their networks.

Mobile operators will be able to use the higher spectral efficiency of 5G to reduce operating expenditures by potentially using the spectrum they are licensing for 5G more efficiently; and they are also able to make more efficient use of their previously-licensed spectrum by reducing the amount that they use for older generations of mobile networks and - pending government approval - deploying 5G in that spectrum instead, a process referred to as 'spectrum re-farming'.

5G networks also allow mobile network operators to deliver cost savings in concert with AI to automate network monitoring, management and maintenance processes, which are currently carried out by personnel. This topic has been underscored by the world's largest network equipment producers who have highlighted integrated AI as a key benefit of their respective 5G product portfolios, for the purposes of functions such as radio-resource optimisation.

However, the main benefit of 5G in its early phases will be the extra capacity that comes with next-generation networks, enabling mobile network operators to keep pace with the growth of data traffic in their networks.

To that end, telcos need to expand coverage of 5G networks that have been introduced in Europe over the past two years starting with Swisscom in April 2019. Building and expanding networks is a significant challenge, given difficulties with site acquisition, limited access to offices and lower employee capacity due to the work-from-home policies that followed the spread of COVID-19 last year. The pandemic has served to exacerbate the noted longstanding issues involving networks rollouts and expansion - 5G or otherwise - and the optimisation of fibre which is essential to the success of deployments. Artificial intelligence technology can also be deployed to help telcos expand and upgrade their networks to 5G. AI will assist with automated planning to allow telcos optimisation of fibre and 5G network planning and deployment.

Similarly, customer service is another area where telcos are applying artificial intelligence. AI helps them to lower costs by reducing service problems and thereby eliminating the costs incurred in handling customer requests and complaints. Telcos also seek to lower customer service costs that are driven by the considerable number of resources that need to be available during peak hours.

3.3 Telco revenue generation involving advanced technologies

Conversely, European operators are expanding their efforts to transform advanced technologies into new revenue. Some of the larger European operators, such as Orange Business Services (OBS), are developing more sophisticated, solution-oriented, approaches to their enterprise

[15] MIMO (multiple input, multiple output) is an antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver).

service portfolios, often through a dedicated enterprise division.

A series of innovations in network technology is allowing telcos, like OBS, to develop such initiatives. Other network technology innovations, notably mobile edge computing (MEC), network function virtualisation (NFV) and software-defined networking (SDN) can lead to greater opportunities for telcos. Mobile edge computing (MEC), for example, can provide lower network latency, enabling new behaviour such as remote command & control and cloud-centric smartphone apps. Network function virtualisation (NFV) and software-defined networking (SDN) can, in combination, provide customers with virtual instances of the physical network, enabling new behaviour such as just-in-time ordering and self-provisioning.

However, the transformation of advanced technologies into commercial propositions for the purposes of additional revenue is in its early stages. There are early examples of telcos turning artificial intelligence into revenue-generating activities, however. For example, this could be accomplished by profiling and analysing conversion rates of subscriber content usage trends and network activity. The use of analytics and machine learning make the systems intelligent and more automated, enabling predictive and near-real-time actions. Telefonica's O2 operations in the UK are aiming to leverage said technologies with a service called Aura that allows the telco to potentially sell on data gathered from the AI algorithm to third parties with the customer's permission.

Other advanced technologies, such as IoT, have proven to be critical elements in the digitisation efforts of enterprises in Europe and are thus attractive propositions for telcos.

In the case of 5G networks, enhanced mobile broadband is the feature available today in most countries in Western Europe, which with limited coverage makes revenue generation more difficult given the constrained benefits to the enterprise or consumer. The main impact so far of this enhanced mobile broadband, where available, is improved reliability. Admittedly, that is a significant benefit, and it potentially makes next-generation mobile networks more attractive to consumers. However, many industry players expect that new 5G-specific applications will be the main driver of new revenues, and few such applications have yet been launched commercially.

Private mobile networks (PMNs), that aim to improve a company's site connectivity, are emerging potential source of revenue for the industry. PMNs have emerged as the most exciting use case to date. The application of technologies available in public mobile networks for company-specific purposes offer enterprises several advantages for site connectivity, in comparison with traditional enterprise networking technologies, making them attractive to enterprises in a variety of sectors. The benefits include increased flexibility, higher reliability, higher capacity and a reduction in the number of network access points required. Such networks can support a company's digitisation efforts.

One factor that will work in operators' favour in this respect is the higher value that 5G, especially standalone 5G networks — networks that have both 5G radio base stations and a 5G core — will bring to connectivity as a component of the overall solution. By implementing the advanced capabilities of 5G, and by turning those capabilities into a development platform by making them available to third parties via APIs (Application Programming Interface), mobile network operators will earn themselves an expanded and more dynamic role in the partner ecosystem.

To realise the full potential of new revenue streams from 5G, European telcos have to make further progress in the direction of becoming enterprise solutions providers, experiment with new business models and to develop innovative services for the enterprise segment.

To ensure telcos can generate revenue from advanced technologies, digital transformation needs to go hand in hand with network transformation. The pandemic has not fundamentally changed the situation in that regard. The Future Enterprise will still require a 'Digital Native Network' - an application-centric network that supports the right end-user experience for each application and user and brings better security, flexibility, scalability, manageability and cost effectiveness.

Telcos need to form partnerships and co-operative efforts with leading technology suppliers to assist with such transformations and the delivery of digital solutions to enterprises.

Some of Europe's largest service providers are already doing just that. Vodafone, for example, is working with VMWare to move its network functions into the cloud. The telco also announced at its annual industry analyst summit in 2019 that it is bringing IT development back in-house as part of its effort to transform its network.

In the coming years, telcos should play an even larger role in Europe as 5G technology becomes more appealing to enterprises and consumers. In particular, 5G promises to provide enterprises with unprecedented, real-time visibility, insights and control over their assets, products and services. It can also provide new opportunities to radically

transform the way they operate and deliver new products and services as can other advanced technologies do.

Section 4

4. Private equity investment and startup creation

Connectivity technologies have become essential for industry, businesses and their workforce during the COVID pandemic and the subsequent lockdowns enabling remote working and online communication. Nevertheless, the level of private equity investment in the telecommunication sector remained limited compared to other sectors or technological domains. Private equity and venture capital (VC) investments are mainly located in Spain, France and Italy although total VC and private equity funding of telecommunications companies in Europe surpass the US market.

With the highest number of telecommunication startups located in the Netherlands, startup activity is addressing all aspects of the rapidly changing telecommunication industry including the Internet of Things, advances in networks, network automating and managing, and marketing and customer service tools.

4.1 Private equity and venture capital investment

Venture capital (VC) investment in Telecommunication was tracked using a combined set of Crunchbase and Dealroom data. From the joint database, companies were selected by filtering for the category and also searching in the business descriptions of companies active in this sector. Crunchbase provides information on venture capital-backed innovative companies. Dealroom contains the same type of information but with a better coverage for Europe. The investment figures presented in this section refer only to the funding rounds where a value has been disclosed.

The analysis reveals that 66% of the private investment went into firms headquartered in Spain, France and Italy. More than €2 bn in funding went to telecommunication companies in each of those three countries between 2015 and 2020. While the cumulative funding levels in the top three countries were similar, the funds were distributed across over 200 funding rounds in France, 100 in Spain and 35 in Italy. Other countries with high investment volume in telecommunication include Finland, Germany, the Netherlands, Ireland, Belgium and Sweden.

The distribution of VC funding in telecoms startups differs from that seen in some other industries. For example, Germany has the largest share of cumulative VC-funding for companies in the finance sector and in machinery[16], while being fifth on the list in telecommunications. However, when measured by rounds of funding, Germany is second only to France.

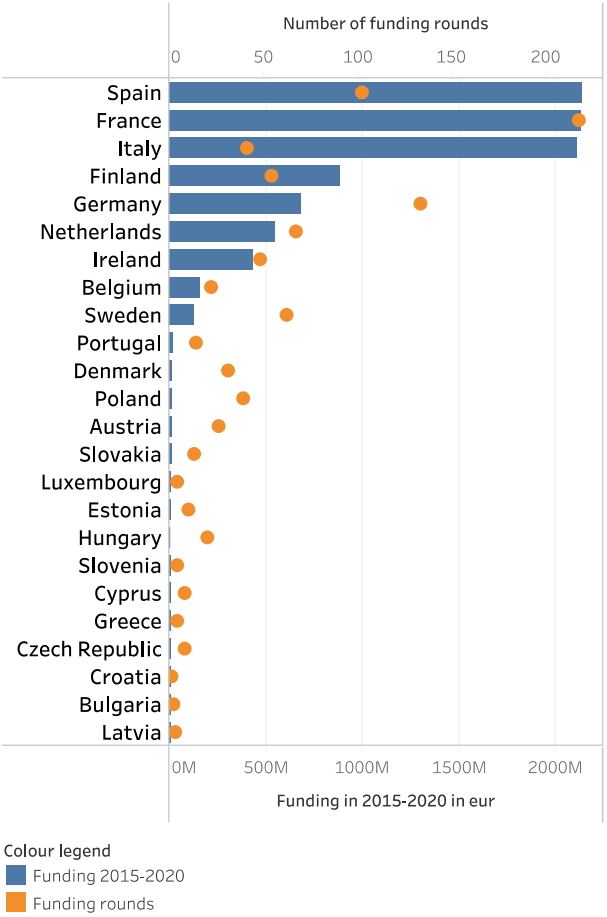
The largest post-IPO funding was concluded with the 'Italian Infrastructure Wireless', or Inwit, the Spanish Cellnex telecommunication and Finnish Nokia. The Inwit investment accounts for a large share of the total in Italy.

The recent analysis of the Financial Times concluded that the value of listed telecommunication companies has dropped almost 20% on average in 2020, which indicates that the sector has become out of fashion for investors[17].

[16] From the ATI Sectoral Watch Technological trends in the financial services and the banking sector, https://ati.ec.europa.eu/reports/sectoral-watch/technological-trends-financial-services-and-banking-sector; Technological trends in the machinery industry, https://ati.ec.europa.eu/reports/sectoral-watch/technological-trends-machinery-industry

[17] Financial Times, September 18, 2020 available at: https://www.ft.com/content/fa4f6094-ea31-454b-b3c4-b62cbc012a40

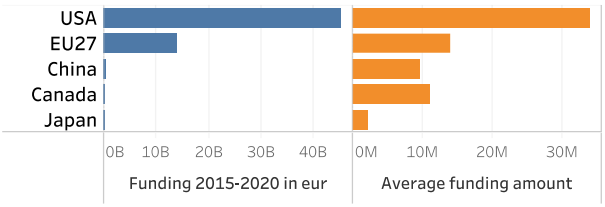
Figure 1: Private equity and VC investment in telecommunication (excluding M&As), 2015-2020



Source: Technopolis analysis based on Crunchbase and Dealroom data

Total VC and private equity funding of telecommunications companies in Europe lags significantly behind that in the US, as does average funding per company. Nonetheless, the funding of telecommunications companies in the EU27 far exceeds that observed in China, Canada and Japan.

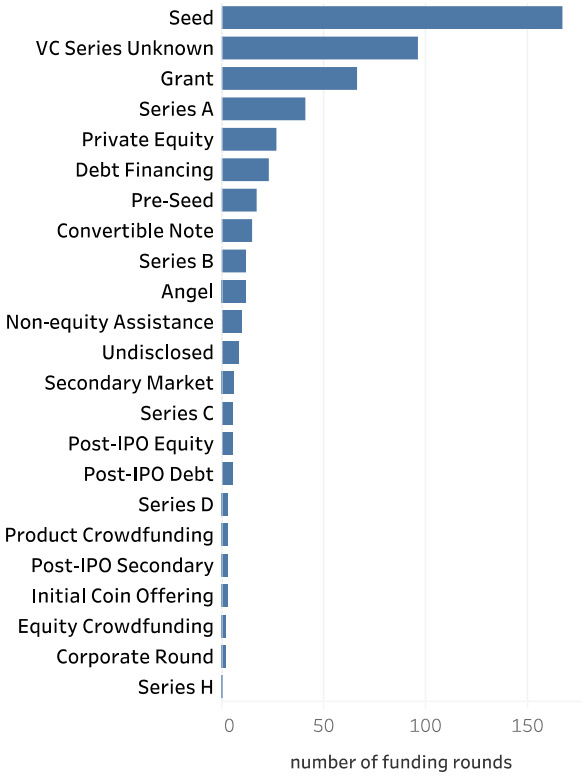
Figure 2: Total VC and private equity funding in telecommunication, in international comparison in billion € total and million € average (in the period 2015-2020)



Source: Technopolis analysis based on Crunchbase and Dealroom data

The figure below shows the prominence of different funding types in telecommunication industry within the EU27 countries from 2015 until 2020.

Figure 3: Type of funding in telecommunication sector (2010-2019)



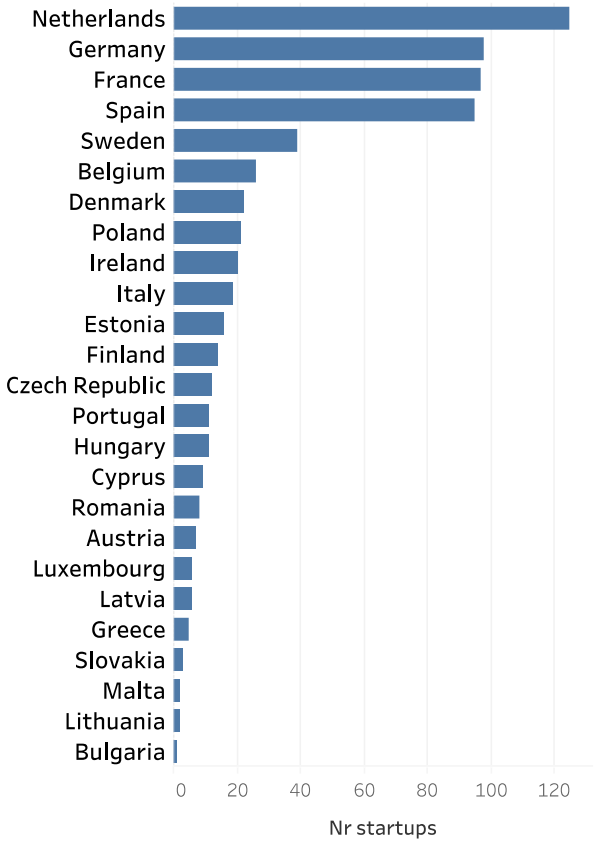
Source: Technopolis analysis based on Crunchbase and Dealroom data

The largest number of funding has been seed capital, which indicates that most funding was allocated to getting new business started in the first place. This is followed by VC and Series A funding, which helped to strengthen and further scale businesses.

4.2 Startup hubs in telecommunication

The figure below presents the number of startups in the EU27 with the highest number of startups on the top. The results differ slightly from the figure showing cumulative investment above. Whereas Netherlands and Germany were in 6th place and 5th place respectively in cumulative private equity and VC investments above, they are 1st and 2nd in the number of startups in telecommunication. France and Spain are close behind Germany.

Figure 4: Number of startups in telecommunication, by EU Member State (2015-2020)



Source: Technopolis analysis based on Crunchbase and Dealroom data

The telecommunications startups span a wide range of technologies and strategies. As Figure 5 shows, the most common technology areas are messaging, mobile applications and collaboration tools. These are some of the rapidly evolving services that are often delivered over the top of telecommunications networks or directly by telecommunications service providers.

Beyond the services delivered to end customers, startup activity has also emerged to address all aspects of the rapidly changing telecommunication industry. That includes emergent parts of the telecoms industry, such as IoT.

Figure 5: Type of startups, per category (2015-2020)

Source: Technopolis analysis based on Crunchbase and Dealroom data

Europe has seen a proliferation of IoT-oriented startups in recent years. These include Sigfox, based in France, which is a leader in global IoT networks. Many startups have formed within the Sigfox ecosystem to deliver sensors, devices, management software, applications and complete solutions leveraging the Sigfox network. Likewise, many startups have taken advantage of the LoRaWAN protocol, which rivals Sigfox, as an alternative IoT ecosystem. Many startups also aim to address new possibilities enabled by 5G networks. And others have aimed to address emerging opportunities using NB-IoT, LTE-M, short-range wireless and satellite connectivity.

Startup activity is also addressing the full range of technologies needed to build and manage the telecommunication operator of the future. These include key advances in networks, such as software-defined networks and new antenna solutions; key functions for automating and managing the networks, using AI and analytics; and a variety of tools for managing the evolving telecommunication service provider business, such as marketing and customer service tools.

Section 5

5. Skills supply and demand

Linkedin data show that technological skills in the telecommunication sector across the EU27 are being led by cloud technologies, representing the highest share while the share of advanced technology professionals employed in telecommunications within the total number of professionals is represented by Artificial Intelligence and Big Data.

Advanced technological skills presenting the highest growth of professionals in the EU27 relate to Connectivity followed up by Blockchain while emerging technological skills linked to Artificial Intelligence and IoT are becoming more and more critical.

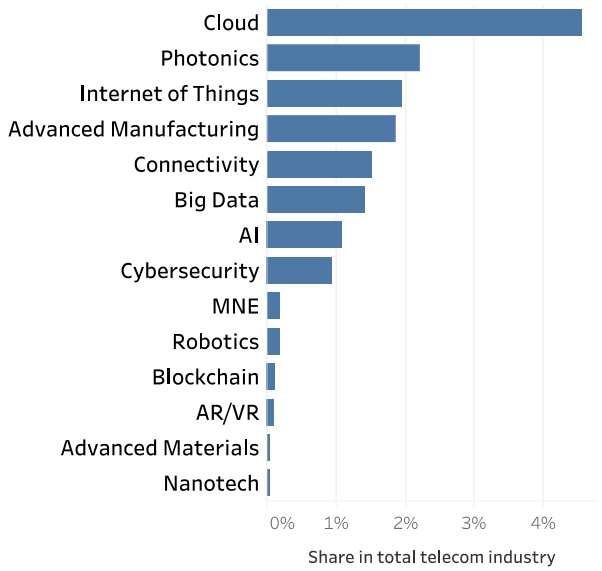
5.1 Availability of new technological skills

This report explored the supply and demand of technology professionals employed in the telecommunication sector based on data from the self-reported skills of professionals in LinkedIn, a widely used and accepted online job platform. The database provides a unique opportunity to enrich our understanding of the supply of skills with a level of granularity that is not available in any of the traditional data sources. The number of skilled professionals employed across different economic sectors can also give some indication about the level of technology uptake in industry.

Figure 6 visualises the share of professionals with advanced technological skills employed in the telecommunication sector in 2020 based on the analysis of LinkedIn[18] data. Within the registered professionals, **Cloud technologies** represent by far the highest share in the EU27, reflecting a particularly important role of this field of technology for this sector.

Cloud is followed by Photonics, Internet of Things and Advanced Manufacturing.

Figure 6: Share of professionals with advanced technological skills in the telecommunication sector, EU27, 2020

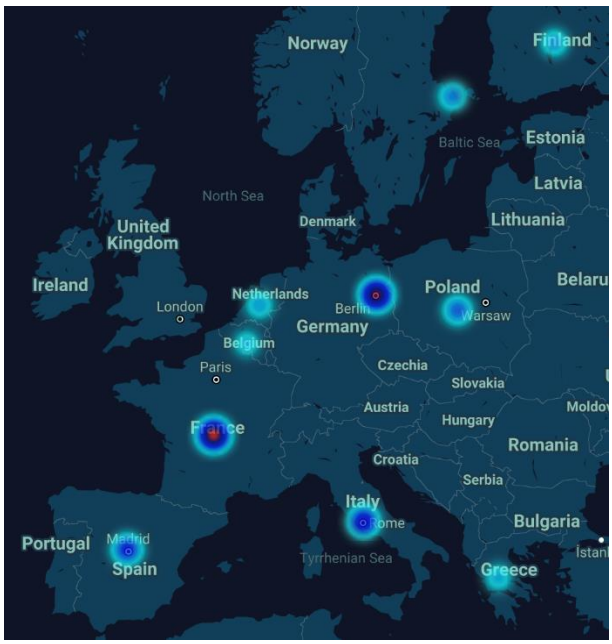


Source: Technopolis Group based on LinkedIn analysis

While Figure 7 illustrates the distribution of technological skills in the telecommunication sector across the EU27 countries that are above the median, Figure 8 displays all EU countries ranked by their share of advanced technology professionals employed in telecommunications within the total number of professionals in the sector.

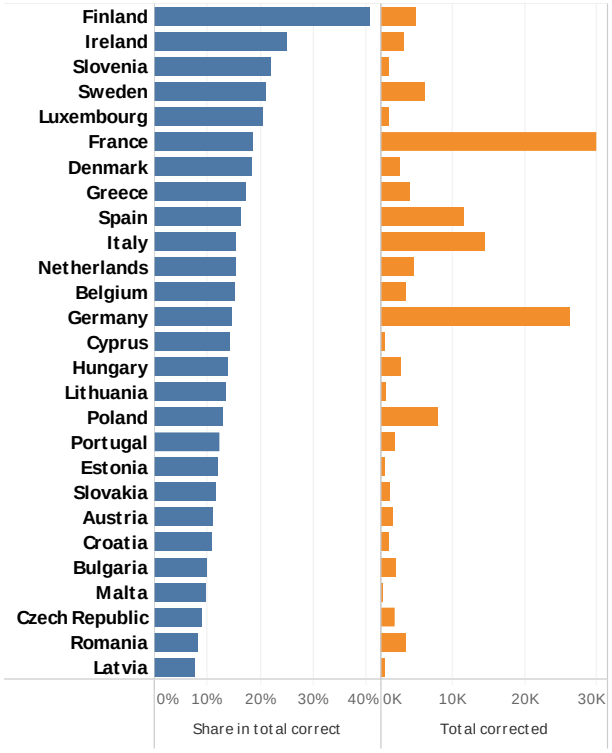
[18] To harvest the data from LinkedIn, keywords capturing skills by advanced technology have been defined and reviewed by technology experts. Queries have subsequently been constructed to filter the database by location and industry. To capture the telecommunication sector the 'telecommunication and wireless' categories have been used. In order to capture the number of professionals working in the sector, occupations related to telecommunication have been taken into account. Please note that the total industry figure does not represent the full employment of the industry.

Figure 7: Concentration of professionals with advanced technology skills in the telecommunication sector in the EU27, 2020



Source: Technopolis Group based on LinkedIn analysis

Figure 8: Share of advanced technology skilled professionals within total sector on LinkedIn employed in the telecommunication sector, 2020

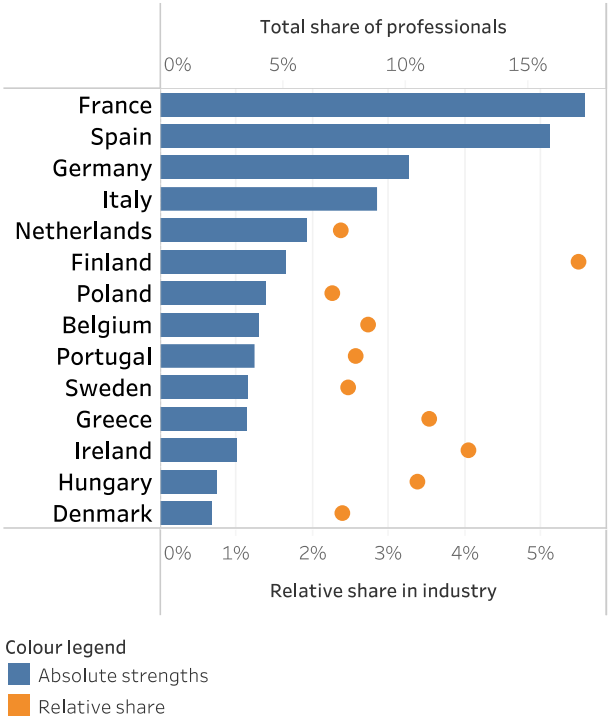


Source: Technopolis Group analysis based on LinkedIn

Note: Only countries with above median total industry professionals are displayed

Zooming in, Figure 9 demonstrates the allocation of the most represented technological skills' supply related to **Artificial Intelligence** across top performing EU countries. In terms of the absolute number of AI and Big Data professionals employed in telecommunication and registered on LinkedIn, France, Spain and Germany are on the top of the country ranking. In terms of the relative shares within the total telecommunication sector professionals (accounting for the size of the sector in the country), Finland is leading the list, followed by Ireland and Greece.

Figure 9: Telecommunication sector professionals with Artificial Intelligence skills, 2020

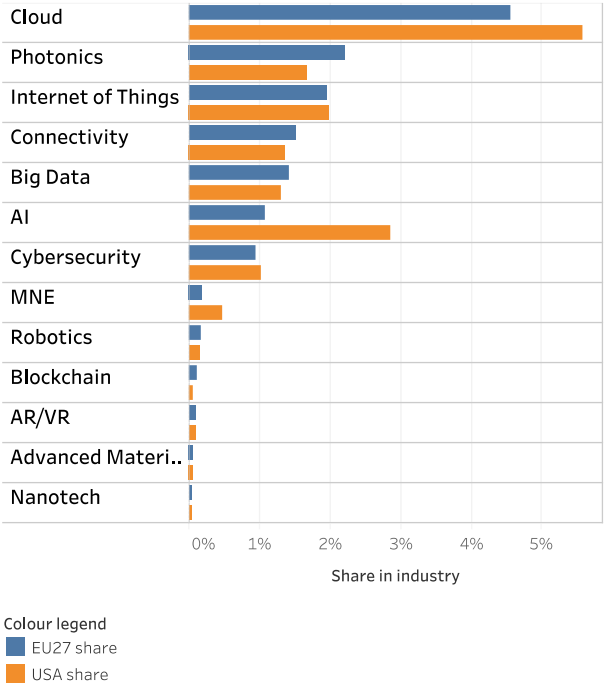


Source: Technopolis Group based on LinkedIn analysis

LinkedIn data also allow the comparison of the telecommunication sector in terms of skilled professionals in the EU27 and the US. After taking the share of professionals with advanced technology skills employed in the telecommunication sector within the total number of professionals in the sector, it can be observed that the **EU27 has a lower share of professionals in Cloud technologies, Artificial Intelligence, Big Data and Micro-and nanoelectronics than the US** as depicted in Figure 10.

Nevertheless, the EU27 has a higher share of professionals in Photonics, Blockchain, Connectivity and close to the same share in Internet of Things.

Figure 10: Telecommunication sector professionals with skills in advanced technologies in the EU27 and US



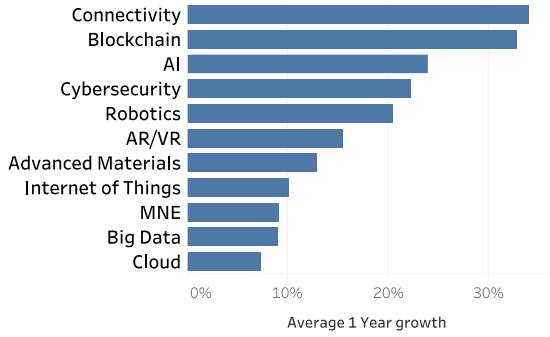
Source: Technopolis Group based on LinkedIn analysis

5.2 Demand for new skills

After analysing the availability of technological skills in the telecommunication industry, it is also important to look at which skills have been the most common in the recent hires. To measure this demand, first, the 1-year growth rate of technological skills has been analysed by comparing the skills indicated in 2019 and its change to 2020.

Figure 11 visualises the advanced technological skills that showed the highest growth within the last year (from 2019 to 2020). We see **Connectivity on top followed up by Blockchain.** Note that connectivity is growing at the fastest rate, despite already accounting for a significant share of professionals in Figure 10. The growth in blockchain professionals is rapid, but growing from a much smaller base.

Figure 11: 1-year growth of advanced technological skills in the telecommunication sector (from 2019 to 2020)



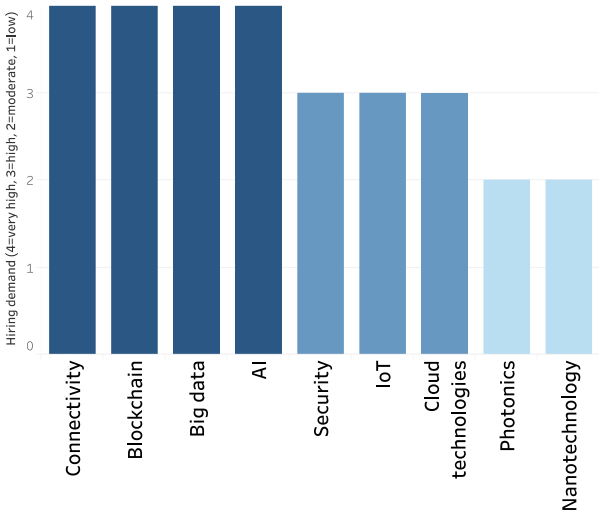
Source: Technopolis Group based on LinkedIn analysis

Emerging technological skills linked to **Artificial Intelligence** are becoming more critical. AI is increasingly relevant throughout many parts of the telecommunication industry, from customer service to network management. That is the reason that AI already accounts for a significant share of telecommunication professionals, as well as the third-fastest growth rate.

Similarly, Internet of Things has established itself as a key part of the telecommunication sector, requiring technology development in many areas, and this technology space is still in early stages of development. As a result, Internet of Things accounts for both a large share of professionals in telecoms presently (third on the list in Figure 10) and moderately strong growth from a large base in Figure 11.

Based on the skills requirements of the online job advertisements posted on LinkedIn by European banking sector firms, we observe that the fields with 'very high hiring demand' as captured in LinkedIn data and analysis includes several of the advanced technologies relevant for the industry: Connectivity, Blockchain, AI and Big Data. Hiring demand is defined as the share of job ads published on LinkedIn and requiring specific skills (see Figure 12).

Figure 12: Hiring demand in the telecommunication sector by advanced technology (from 2019 to 2020)



Source: Technopolis Group based on LinkedIn analysis

Section 6

6. Future outlook: challenges and opportunities

The telecommunication sector has achieved incredible technological advances over the last few decades, bringing significant new capabilities like ultra-low-latency mobile broadband connectivity, enabling such services as streaming movies on a phone in the subway, operating automated guided vehicles in a warehouse or providing predictive maintenance on an automobile.

However, the telecommunication service providers face challenging economics. They are racing to enable these incredible new capabilities, launch new services and automate their systems faster than the service prices fall. As part of this race, telcos are steadily reducing headcount, becoming an ever smaller part of the workforce.

Though the telecommunication sector plays an ever smaller role in employment within the European economy, it provides the critical infrastructure that enables every other part of the economy to innovate and prosper. It is a critical enabler of all parts of the society and economy.

A crucial role of this enabling capacities is played by advanced technologies which are already helping Europe's telecommunication providers generating additional revenue and diversifying and reconstructing their market position. Indeed, advanced technologies and the use of 5G can contribute to significant cost reductions for telecommunication operators, especially considering the spread of COVID-19 which has served to the deployment of Artificial Intelligence in the expansion and upgrade of telecommunication networks to the 5G. As a result, European telecommunication companies are putting efforts in developing a series of innovations in network technology which are expected to generate revenue streams while using advanced technologies like IoT, 5G in line with enterprise solutions providers and new business models.

The telecommunication sector has proved to be essential for industry, businesses and their workforce during the COVID-19 pandemic and the subsequent lockdowns enabling remote working and online communication. Nevertheless, the level of private equity investment in the telecommunication sector remained limited compared to other sectors or technological domains. Private equity and Venture Capital (VC) funding in telecommunication startups in Europe look different from other industries. Our analysis has demonstrated how VC investments are rather concentrated (mainly located in Spain, France and Italy) although total VC and private equity funding of telecommunications companies in Europe exceed those in the US market. What is more, the European Union boosts a large number of telecommunication startups, thus addressing all aspects of the rapidly changing telecommunication industry including the fast-changing evolution of the Internet of Things, as well as the advances in networks, network automating and managing, and marketing and customer service tools.

As for the most necessary and widespread skills in use by the European telecommunication sector, our analysis showed that professionals with cloud technologies skills represent the highest share of professionals employed in the sector, followed by professionals with Artificial Intelligence and Big Data skills. Among these groups of skills, those presenting the highest growth of professionals in the EU27 relate to Connectivity followed up by Blockchain while emerging technological skills linked to Artificial Intelligence and IoT are becoming more and more critical in Europe.

Notwithstanding these challenges, European telcos are continuing their race to deploy new advanced technologies, in order to further automate, to introduce new services and to weather the competitive pressures that they face. Those that are most effective in cost-cutting, service improvement or development of new services stand to reap significant rewards, though it is the wider European economy that will benefit most of all from the availability of cutting-edge critical infrastructure and innovative new services.

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About the 'Advanced Technologies for Industry' project

The EU's industrial policy strategy promotes the creation of a competitive European industry. In order to properly support the implementation of policies and initiatives, a systematic monitoring of technological trends and reliable, up-to-date data on advanced technologies is needed. To this end, the *Advanced Technologies for Industry* (ATI) project has been set up. It provides policymakers, industry representatives and academia with:

- Statistical data on the production and use of advanced technologies including enabling conditions such as skills, investment or entrepreneurship;
- Analytical reports such as on technological trends, sectoral insights and products;
- Analyses of policy measures and policy tools related to the uptake of advanced technologies;
- Analysis of technological trends in competing economies such as in the US, China or Japan;
- Access to technology centres and innovation hubs across EU countries.

You may find more information about the 16 technologies here: https://ati.ec.europa.eu.

The project is undertaken on behalf of the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and Small and Medium-sized Enterprises Executive Agency (EISMEA) by IDC, Technopolis Group, Capgemini, Fraunhofer, IDEA Consult and NESTA.

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