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5G in Europe:
Time to Change Gear!

NOTE MAY 2019

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There is no desire more natural
than the desire for knowledge

SUMMARY

RAPPORTEURS

- **Achour Messas,** Partner, Member of the Executive Committee, Mazars France
- **Julien Huvé,** Partner, Mazars France
- **David Luponis,** Partner, Mazars France
- **Laurent Inard,** Partner, Mazars France

Note written under the supervision of **Gilles Babinet,** Digital Advisor for Institut Montaigne

INTRODUCTION

THE DEPLOYMENT OF 5G NETWORKS, ILLUSTRATION OF THE COMPETITION FOR GLOBAL DIGITAL LEADERSHIP

Current economic tension between the USA and China, against a background of concern over the new silk roads, has recently peaked with the issues of sovereignty related to the deployment of 5G networks. The USA thus suspects Huawei's 5G devices of acting as Trojan Horses for the Chinese government, providing access to all the data that will transit via future 5G networks. The USA has therefore decided to ban the use of Huawei devices within its territory, a move quickly replicated by its closest allies. European Member States are aware of the stakes of these new networks, but so far, their actions have not been coordinated.

Aside from an economic power balance between two nations, the weight of each one must be defined within the ecosystem that will develop alongside new 5G usages. The control, use and monetisation of data will be one of the key stakes. In this context, France and Europe's capacity to support the emergence of alternative actors from this ecosystem is probably one of the *sine qua non* conditions for guaranteeing our sovereignty.

The threats concerning network integrity and communication security are nothing new, but the issue has gained particular importance with the advent of 5G networks. Their deployment will bring profound changes to our economies and societies. Network security will be all the more critical as our dependence on the new services proposed also increases.

These security issues arise within a context of high pressure at both national and European levels concerning the development of territory connectivity. In 2016, the European Commission presented new strategic objectives for 2025 concerning connectivity as part of its strategy for a Digital Single Market. In spite of a private-public partnership agreement, 5G PPP, with €700 M funding from the European Union, to be completed by private investments of around €3.5 Bn by 2025, the ambitious goals set by the European Union may not be met in time.

The main strategic objectives of the European Commission: "Connected Europe: 2025 objective"

- The main socio-economic drivers, schools, universities, research centres, transport platforms, public service providers - such as hospitals and public administrations -, as well as the companies that depend upon digital technologies, will all require very high speed gigabit connections (enabling users to send and receive one gigabit of data per second).

- All European homes, regardless of whether they are in rural or urban areas, will need access to a connection offering a download speed of at least 100 Mbps (100 megabits of data per second), compatible with conversion to a gigabit connection. The French network regulator (ARCEP) notes that by the end of the 4th quarter 2018, very high speed connection only represents 31% of all internet access in France, including 4G and optical fiber connections.[1]

- All urban areas and the main road and rail routes must have uninterrupted 5G, the fifth generation of wireless communication systems. As an intermediary objective, 5G must be available on the market in at least one major city in every country of the Union by 2020.

[1] Arcep, 2018, *Observatoire haut et très haut debit : abonnements et déploiements (T4 2018).* Available at: https://www.arcep.fr/cartes-et-donnees/nos-publications-chiffrees/observatoire-des-abonnements-et-deploiements-du-haut-et-tres-haut-debit/hd-thd-t4-2018.html

5G NETWORK DEPLOYMENT: WHAT ARE THE STAKES?

Key usages to transform our economies and societies

1. Breakthrough technology

While 3G and 4G were the trigger point for smartphones, resulting in significant changes in our private and personal lives, 5G is expected to affect economic players primarily. It opens the field for new, ambitious and disruptive applications, to which both user industries and companies, as well as solution providers, must be prepared. What is at stake here is the creation of a whole new ecosystem, whose potential is still difficult to estimate because of the multiple usages that remain to be invented.

5G is a breakthrough technology, bringing transformation possibilities in multiple sectors. This is due to three reasons:

1. High speed and very low latency. 5G offers better performance than 4G. This enables us to imagine applications that are more demanding in terms of responsiveness (autonomous cars, remote-surgery, etc.);

2. Decentralisation. A local network core is placed on each antenna. This notably enables the development of edge computing (i.e. data processing without involving a data centre distant from the actual site on which the data are processed);

3. Slicing capacity. 5G enables network use to be separated according to the demands of a user - such as a company that processes a lot of data - according to usage. This means that cloud computing applications can be deployed (functions ensured via the cloud and therefore independently of the performance of the terminal - telephone, computer, etc.), while maintaining regular use of the network for basic functions.

2. New uses

Its strong growth will therefore enable the massive development of the internet of things (IoT), which will play a fundamental role in the fields of mobility, augmented reality, industrial product and energy networks. Edge computing and artificial intelligence (machine learning and deep learning) will enable operators to propose new services to the general public and industrial customers (maintenance assistance via augmented reality, real-time modification of production tools - development of farms of industrial robots -, autonomous vehicle services, virtualisation of the gaming offer, etc.).

In industry, the 5G network architecture offers the possibility for a "client" (application, company, etc.) to ask directly for virtual network resources to meet its specific requirements (data speed, latency, etc.). For example, a mobility service provider could obtain specific network resources to guarantee the stability of its connection and very low latency to enable the deployment of a fleet of autonomous vehicles.

At the same time, certain business models will evolve, turning towards high added value services. This is due to the fact that the production of material goods will be transformed by the emergence of shared, flexible and more responsive production tools. Car manufacturers, for example, will be able to concentrate on the development and design of mobility services when car production is completely transformed by the development of 5G. Future development possibilities include platforms able to adjust car production lines in real time and create models on demand.

In civil society, 5G will enable the development of solutions to ensure territorial connectivity and access to public services. If this technology achieves a sufficient level of penetration and adoption, the new telecommunications networks will overcome the constraints of physical and geographic installation, providing higher added value services to the whole territory in fields such as healthcare and education, for example. Using augmented reality tools, whose efficiency is improved by 5G, we can imagine that healthcare professionals located throughout the territory could perform complex interventions requiring specific expertise, under remote supervision by experts in regional centres.

3. The importance of rapid development

In a globally competitive environment, our sovereignty depends on our ability to act quickly to encourage the development of new networks. Europe and France must therefore make sure that the conditions of developing a usage ecosystem are fulfilled. This initially implies a capacity for experimentation, bringing together industrialists, users and solution developers to foster and refine both functions and usages.

Investment and coordination at the scale of the European community are fundamental. It is important to remember that the Chinese and American economies have sizeable domestic markets to enable their national champions to develop these activities and to make considerable headway immediately. Any delays in deploying territorial connectivity will have a knock-on effect, delaying the development of the 5G ecosystem by European players. Such a delay may prove impossible to catch up, in view of the resources implemented by our competitors. The rapid deployment of 5G networks represents a major competitivity challenge for our industries, infrastructures and territories.

4. A risk of losing the value generated by low latency

As we have shown, low latency is a key element of 5G that will foster the development of new usages. However, most of the value generated by low latency could be captured by global players, affording them a dominant position thanks to their widespread computation capacity and the absence of specific regulations. In other words, increasing network rapidity increases the value of the services proposed on these networks. Today, these services are dominated by foreign players (IBM, Google, Microsoft and, to a certain extent, Amazon Web Services and for Asia, Alibaba and Huawei). This raises the question of national sovereignty with respect to control over the data generated in each country's territory, as well as the capacity of operators to guarantee the security of their networks (see the section on security below).

An innovative network architecture[2]

5G networks will be deployed gradually, with the launch of

- 5G NSA (non stand alone) networks initially: during 2020, these networks will fulfill the capacity needs of the current networks, without providing all 5G functions;

- followed by 5G SA (stand alone) networks, covering all the expected usages by offering low latency, high stability and massive connectivity.

A 5G network is a combination of a physical infrastructure and a software infrastructure, whose function is to adapt the network's response to customer usages. For example, this adaptation will enable the large computation capacities required for video games to be used on the same network as the massive connectivity required for the industrial IoT.

The difference between the architecture of a 5G network and the conventional telecommunication network as we know it, is this separation between the different systems making up the physical network infrastructure (relays, antennas, etc.) and the software architecture. "Superior" level functions (data processing, computation capacity, artificial intelligence, etc.) are performed separately from the physical infrastructure transporting the data. This is known as network slicing.

The 5G network service will therefore be supplied via two technologies: NFV (Network Function Virtualisation) and SDN (Software Defined Network).

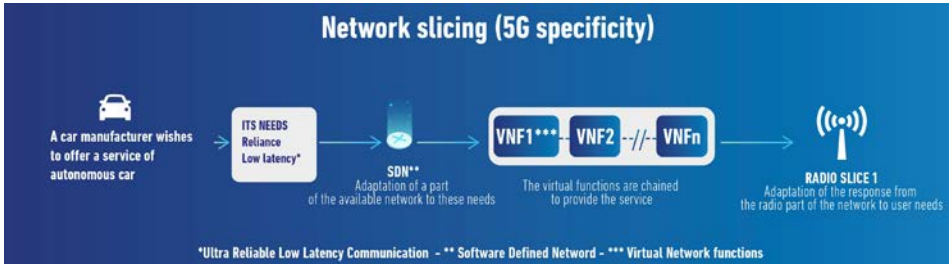
- The virtual network layer - composed of VFN (Virtual Network Functions) developed within the framework of NFV - translates user requirements into instructions that can be used by operators to exploit, if necessary, sections of the physical infrastructure.

- The physical layer of the infrastructure is managed by the SDN. This enables network control, which previously relied on fixed hardware components, to be centralised in the form of software on more powerful servers, free[3] of the constraints related to the physical infrastructure (control plan, network configuration, etc.). Therefore,

[2] Edward M. Roche, Benjamin H. Dickens-Jr. and Walker Townes, "La prochaine génération de téléphonie mobile (5G) et ses implications (Infrastructure, Réglementation)" *(The next generation of mobile telecommunications (5G) and its implications (infrastructure, regulation), Netcom* [on-line], 32-1/2 | 2018, posted 18 December 2018, consulted 4 February 2019. URL: http://journals.openedition.org/netcom/2869; DOI: 10.4000/netcom.2869)

[3] See the Arcep website: https://www.arcep.fr/uploads/tx_gspublication/rapport-enjeux-5G_mars2017.pdf

the virtual infrastructure adapts to usages, and even several different usages, with their different characteristics and requirements at the same time, by segmenting the network.



This network slicing must enable the industrialisation of offer segmentation and the development of new economic opportunities: infrastructure sections reserved for specific companies or applications, some IoTs such as industrial sensors, etc.

Performance management and real-time adaptation of the 5G network is essential to ensure demands are prioritised correctly. Artificial intelligence could be able to manage the volume of decisions necessary at the same time to distribute flows within the physical architecture, to manage the modification of its use according to the services provided, to ensure monitoring and optimisation of network performance, to implement security functions and to respond appropriately to failures or other incidents on the network.

Data at the heart of the challenges of sovereignty

For member States, the question of protecting sensitive industrial information is related to that of data management, confidentiality and security.

1. The concentration of cloud computing players

In theory, 5G networks provide an opportunity for operators to enter the cloud computing market they failed to enter throughout the 2000s. However, whilst they can offer control over the network, it is not sufficient to convince companies and digital actors to hire operators to manage and process their data. Thus, the value created by 5G networks could be transferred to the current dominant players outside of Europe.

The involvement of technologies using the cloud raises the question of the security of data passing through, stored in or processed by the cloud. At present, and aside from measures taken in Europe notably concerning the processing of private data via the General Data Protection Regulation (GDPR), there is no regulatory framework governing these activities and the uses made of the data collected. There is also no norm concerning the way technological implementations (API, containers, etc.) should be undertaken to allow interoperability between equipments and services on the market. On a market dominated by foreign players (mainly Amazon Web Services, Microsoft and Google), and with the implementation of legal measures, such as the Cloud Act, Europe and France could, in theory, soon find themselves in a position of dependency and vulnerability.

These stakes are also relevant to 5G, which will enable the development of cloud services by further improving network performance.

2. The security of Internet of Things (IoT)

According to Cisco, there will be more than 12 billion mobile devices and connected objects worldwide by 2022 (compared with 9 billion in 2017), and 5G will be the support for 422 million mobile connections (3% of mobile connections) with 5G connections growing exponentially.[4]

In parallel to the deployment and implementation of security measures for the software and telecommunications components of 5G, the threats related to the elements connected to them must also be considered. In other words, as well as malfunctions or attacks affecting the heart of the network, the threat could come from the multiplication of devices or connected systems, which cannot guarantee faultless security themselves this is a topic the French regulator (Arcep) has identified and regularly adresses in publications.

With 5G, entire sectors of activity and new usages will be highly dependent on network availability, thus offering a whole new playing field for hackers. For example, thanks to the contribution of 5G and connected objects, tomorrow's smart cities could have new services or usages based on real-time network/object interaction (real time energy calculation, traffic measurement, automatic waste management, etc.). It will therefore become essential to ensure an appropriate level of security to prevent these objects or services from being taken over by cyber-attackers.

[4] Cisco Visual Network Index : Forecast and Trends, 2017-2022 White Paper.

3. The stakes of monitoring and sovereignty

As well as the technical aspects of cybersecurity, debates on the topic of 5G are raising a number of central questions.

Will this technology represent a cybersecurity risk for the countries, particularly for France?
Opinion is divided on this topic and solutions are being developed. As for 3G and 4G devices, the core environments of 5G will have to be approved by France's national cybersecurity agency (ANSSI). This mandatory approval should offer some reassurance for decision-makers and organisations, as is already the case for 3G/4G devices.

Will it be possible for a device manufacturer to switch off an entire network (shut-down) or to spy on data in transit on its components?
Today, this risk concerns the possibility of a device manufacturer inserting a "back door" into its programming code. In the worst-case scenario, this would enable the network to be shut down remotely. As for any telecommunications or information systems product, the source code can be reviewed by specialists to guarantee appropriate operation. However, manufacturers must want to share this information which, just like the physical quality of their devices, represents an element of their manufacturing secrets and value. Furthermore, code is updated regularly. Occasional access to the code is therefore ineffective to guarantee control over security issues. Systematic validation before each use is also unrealistic.

Concerning access by device manufacturers to data on the network, it is theoretically possible that a device could pass on information autonomously from the network to a third party. However, the operators have visibility of the data entering and leaving their core network (even if this core is decentralised, as is the case with 5G). In other words, an operator can see if there is a data leak on its systems. The operators must develop tools to monitor the data flows transiting via the devices on their networks. The systems required to guarantee data security must be upgraded. It is also important to remember that cloud solutions, as indicated above, will be used intensively, thus increasing the concentration of information and the associated risks.

However, edge computing increases the resilience of computational systems. For example, autonomous vehicules are designed to work even if the network is shut down.

II

RESPONDING TO THE CHALLENGES OF 5G NETWORK DEVELOPMENT

The sovereignty and security of the member States, companies and civil societies in the context of 5G network deployment will necessarily involve a regulatory, economic and political response. So far, Europe has failed to offer a concerted response, in spite of the essential nature of the stakes and the limited time available for action. Our recommendations are as follows:

Proposal 1: encourage the harmonisation of European regulations

French legislation offered the first response to the potential threat represented by 5G device with the amendment 874 of the PACTE law. This strengthens ANSSI's role (France's cybersecurity agency) in the approval of 5G devices.

To be able to face up to the players supported by huge domestic markets, minimise costs and thus avoid delays, a coordinated European response must be found, ensuring a high level of exigence in all Member States. European players cannot be the most efficient and responsive if they are required to comply with different regulations in each of the areas in which they operate. This response must include the definition of authorities charged with issuing 5G deployment authorisations for the European territory (ANSSI in France), defining device selection criteria and conducting the tests required for the entire Single Market.

Proposal 2: use the issue of 5G licences as an economic lever to accelerate network development and security

Operators will have to invest heavily in equipment and infrastructures to ensure the security of 5G networks. The French public authorities have already shown, through their own commitments and those of the telecommunications operators for the mobile coverage of the territories (the New Deal Mobile), that the issue of frequency usage authorisations constitutes a significant lever to support public policy with regard to connectivity and digital technology.

In response to the important challenge of rapidly developing 5G networks and ecosystems, the upcoming allocation of 5G frequencies represents a powerful means for the State to control and ensure the security of network deployment, while guaranteeing the fulfilment of its objectives. The recent experience of 5G frequency allocation in Italy has certainly provided insight into the risks represented by auctions aimed at maximising the sales price rather than rapid deployment.

5G in Italy

Key figures concerning the attribution of 5G frequencies in Italy:

- The auction raised €6.55 billion - the Italian government's initial objective was €2.5 billion;
- Frequencies sold for 7 times more than in Spain, and 3 times more than in the UK (in MHz per inhabitant);
- The auction lasted for 14 days;
- Three-quarters of the total amount was paid by two operators: Telecom Italia (TIM) and Vodafone.

Consequences and challenges of the development of 5G networks in Italy:

- Operators are in a debt situation: increased debt ratios in a context of falling mobile prices in Italy;
- Fears that major savings plans will be required to compensate for the high price of frequencies.

Proposal 3: develop the sharing of passive infrastructures

In an environment in which operators' investment efforts will be significant, solutions must be found to reduce these expenses. The savings generated would help to ensure network security and develop infrastructures rapidly, thereby achieving the connectivity objectives. In this situation, the attribution of frequency

use authorisations is one key element, but the sharing of passive infrastructures is another possibility that should be given serious consideration.

Implementing a 5G network requires densifying existing radio sites, which requires massive investments estimated at €56 M by 2020 for the 28 member States of the European Union.[5] The emergence of passive infrastructure managers able to make this investment and provide the sites to operators could help to accelerate deployment, while preserving the competitive balance necessary to innovation.

Proposal 4: support the development of European R&D

The current organisation of competition within the European Union and its policy, which has long been directed towards a short-term low price objective to benefit consumers, does not seem appropriate for the preparation of solution development for tomorrow. Our non-European competitors have domestic markets that guarantee a much higher average return per user (ARPU), and they use these resources to invest in research in a highly competitive environment. A clear, forward-looking European policy must be implemented to create the conditions of a real level playing field in Europe, within the framework of strict competition rules, and to guarantee symmetry between market conditions within Europe and outside.

Proposal 5: encourage the development of a French and European ecosystem based on 5G usages

We must also encourage the development of a dynamic and innovative ecosystem based on 5G usages. The usage battle is of the utmost importance. 5G will cause some players to disappear and new champions, proposing disruptive models, to emerge. Indeed, if Europe is lagging behind in some of the technologies essential to 5G (cloud solution for example), this technological revolution also creates an opportunity to reshuffle the cards. Actors within a specific industry who understand and develop new uses specific to 5G may introduce disruptive models that may upset established positions. Thus, in this battle over 5G uses, the first players to benefit from an environment and use cases to develop their services will take a decisive lead in imposing their solution at the global level.

The race to develop an ecosystem concerns the fundamental economic players and must enable European operators to capture some of the value created. Today,

[5] "European Commission: Benefits From 5G Deployment in Europe Estimated to Reach €113.1bn Annually by 2025", Interdigital, 2016, available at: http://ir.interdigital.com/file/Index?KeyFile=36051369

they are trapped between non-European device manufacturers (notably Huawei), which have colossal R&D resources thanks to captive domestic markets, and cloud infrastructure operators, mostly American, which are already several steps ahead. The case of Huawei and its place in European markets is analysed in a separate note by Institut Montaigne.

CONCLUSION

In 2021, 5G will be entering phase 2 (Stand Alone 5G) and will become a technology that transforms our understanding of cybersecurity, placing data management and flow supervision at the heart of all concerns. It will transform our economy and accelerate the evolution of civil societies.

In this environment, European independence and sovereignty will depend on Europe's capacity to support R&D efforts by European device manufacturers and operators. A strong political commitment is also required to ensure the development of an innovative and dynamic ecosystem able to compete in the race for usages.

In addition to the potential problems of espionage by telecommunications device manufacturers, our entire system to control data use must be redesigned. The challenge is to guarantee national sovereignty, the competitive advantage of our industries and the security of our fellow citizens, but also to define the role of France and the European Union within this new, growing digital economy.

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Rapporteurs

- **Achour Messas,** Partner, Member of the Executive Committee, Mazars France
- **Julien Huvé,** Partner, Mazars France
- **David Luponis,** Partner, Mazars France
- **Laurent Inard,** Partner, Mazars France

Note written under the supervision of **Gilles Babinet,** advisor on digital issues, Institut Montaigne

Interviewees

- **Javier Albares,** Director of Innovation and Digital Transformation, GSMA
- **Laurent Allard,** Senior Advisor, Partech
- **Viktor Arvidsson,** Head of Governement & Industry relations and Innovation, France, Belgium, Luxembourg, Algeria and Tunisia, Ericsson
- **Bruno Bernard,** Head of Government Affairs France, Cisco
- **François Bichet,** Chief Technology Strategist, Dassault Systèmes
- **Anne Bouverot,** Senior Advisor, TowerBrook Capital Partners
- **Didier Casas,** Executive Vice-President, Bouygues Télécom
- **Vincent Cuvillier,** Deputy Managing Director, Cellnex France
- **Patrick Duprat,** Managing Director, Cellnex France
- **Eric Hamel,** Senior Systems Architect, Cisco
- **Mari-Noëlle Jégo-Laveissière,** Deputy CEO, Technology and Global Innovation, Orange

- **Oliver Kleinhenz,** Vice-President Global Market Telecom, Media & Technology, Atos
- **Emmanuel Lugagne Delpon,** Director, Orange Labs Networks
- **Sébastien Massart,** Head of Strategy, Dassault Systèmes
- **Sébastien Soriano,** Chairman, Autorité de Régulation des Communications Électroniques et des Postes
- **Arnaud Vamparys,** Senior Vice President, Radio Networks, Orange

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THERE IS NO DESIRE MORE NATURAL THAN THE DESIRE FOR KNOWLEDGE

5G in Europe: Time to Change Gear!

5G is a technological leap. It will affect industrial production, public services, the health sector, the management of water, gas and electricity distribution. 5G will also create new consumer services, ranging from the development of virtual reality solutions to that of the Internet of Things, with applications culminating in connected, and later on, autonomous cars.

What are the stakes behind the development of 5G networks? What should be the French and European strategy to build a robust 5G ecosystem? Institut Montaigne answers these questions based on interviews undertaken with operators, telecom manufacturers and public authorities.

4G allowed the emergence of Internet giants that benefitted from mobile communications and the range of services it made possible. By changing the rules, 5G fosters the emergence of new digital actors: those that master its usages. The value these players will thus create will give them the strength to compete with current technology giants. The study presents five recommendations to encourage experimentation and make sure European companies can become leaders in tomorrow's digital world.

Institut Montaigne
59, rue La Boétie - 75008 Paris
Tél. +33 (0)1 53 89 05 60
www.institutmontaigne.org

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