SYNTHESIS REPORT

5G in data value chains – The technological and industrial challenge ahead of us

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EXECUTIVE SUMMARY

Since 2017, we have examined the foundations of an industrial policy for the digital age, identifying strategic adoption levers to help businesses make the shift. Our work is based on a techno-economic approach to the digital transformation, hence, it characterizes digital technologies and the economic mechanisms that shape their adoption.

Working group members' wide range of skills and specialities informed our forward-looking assessment of 5G (fifth-generation of broadband cellular networks) in (industrial) data value chains. **While most of the technological and industrial challenges lay head, for industrial companies, 5G constitutes a unique gateway to digital platformization.** This report presents the analysis that leads to this observation, takes a close look at how 5G is distributed in value chains, and identifies potential political and strategic avenues.

THREE LESSONS LEARNED FROM THE ANALYSIS, THREE POTENTIAL AVENUES FOR POLICIES AND BUSINESS

1. *Hyperscalers* wield considerable market power in industrial data value chains when 5G is involved. Their substantial, cutting-edge skills make their involvement indispensable, including for telecom operators. Yet it is vital to remember that **cloudification and platformization are not the same thing.** A variety of digital plaformization avenues are open to French and European manufacturing companies. Companies that use 5G could regain control of their own data ecosystems, because it will equip them with their own network infrastructures. This control, via 5G, gives businesses an opportunity to organize agreements with other users in their own data value chains. **5G facilitates this virtuous circulation of data between companies in a business ecosystem, provided they have access to core competences in technologies of trust.** The performance and strategic autonomy of European cloud providers are not the only key factors in the business transformation represented by platformization. **Also indispensable are industrial policy measures that organize favourable framework conditions, based on a solid understanding of the technical issues involved. One of the key targets of these measures should be to enable companies in the same business ecosystem to establish agreements thanks to a framework.**

2. 5G still faces a number of technical difficulties – challenges that the European research and innovation ecosystem is well placed to overcome. **Providing strong support to the underlying technological research,** which is often public-private, **constitutes an important policy direction. Accelerated public support for technological research could focus on two complementary areas,** i.e. improvements in radiofrequency for **ultra-reliable low-latency communication** (uRLLC) infrastructures; and improvements in the virtualization underlying the division of the 5G network into non-public "slices", by working on the main technical components of the operating network's computing architecture (second-generation cloud computing). Once again, **the latency-reducing capacity** will be decisive here. Additional efforts will be required to take full advantage of these **advances in 5G towards real time.** At this stage, we can identify an evolution in the nature of data, in the nature of software equipped to process these data, in the nature of the services thus provided, and in the architecture employed to divide tasks between terminals, edge servers and central clouds.

3. Digital platforms' positioning, and even their adherence to inter-organizational and intergovernmental codes, are not sufficient proof of transparency. The description of general terms and conditions of sale, and membership of codes of good conduct, simply amount to promises that engage only the parties that accept them. Given their market power and resulting technological domination, hyperscalers, as key resources for 5G and partners of telecom operators and manufacturers, cannot be considered like normal competitors. In the digital sphere in particular, domination goes hand in hand with a risk of anticompetitive practices (self-referencing and differentiated treatments). **An analysis of the impacts of 5G uses clearly illustrates that the only basis for a truly protective guarantee lies in an auditing procedure and the delivery of a certificate by a competent, independent authority. Our work thus indicates that an industrial policy on digital technology should make platforms auditable** by integrating the benefits of competition law and the innovation economy.

These three lessons are the result of the following analysis.

5G is considered to be a technological building block whose functions and uses are defined in interaction with platformization. In other words, **5G relies on a computer architecture in which network equipment is replaced by specialized servers and software.** This major new feature allows the **virtualization** of these network resources to be used for a growing share of the functions and services of industrial telematics. A judicious combination of the virtualization of several network functions and the optimized use of high and very high frequency communications (millimetre waves) works to the benefit of platformization. **From 2023/2025, 5G will begin to have a profound impact on usages within industrial data chains** in the described framework. Virtualization helps to reduce latency and makes it possible to "slice up the network". Dynamic slicing means the network can be orchestrated and automated from end to end. **Companies that use 5G will thus become the operators of their own network infrastructures on equipped sites. Combinations of cloud and edge computing operating with 5G** are already on offer from new **competitors like telecoms operators and cloud providers,** and more will be available in the future. These competitors are forming complex alliances, one of the objectives of which is to share value that is still largely theoretical. The contractual agreements that have already been made indicate that the main three cloud service providers, also known as hyperscalers, are extending their domination to take in 5G services.

Several usage scenarios are envisaged and analysed in this report, with a focus on the potential for creating value in industrial data chains thanks to 5G. We point out the discriminating factors, which also constitute levers on which to concentrate action. **The usage contexts with high added value authorized by 5G will necessarily result from a process of B2B joint innovation (clients-suppliers/operators).** The technical and organizational changes triggered by **5G will take place in a range of specific ecosystems, each of which be organized to correspond to the data value chains concerned.** A typical situation is likely to involve a collective activity with a high level of expertise, such as specialized teamwork taking place remotely in real time, requiring extremely precise spatial-temporal exchanges with a high level of safety and operating security. Nevertheless, this ideal setup will not reflect most usage situations, only the most advanced, accomplished cases. Most usages will correspond to more standard, less demanding constraints. We take a close look at three of them in particular:

- **5G is in the process of being extensively adopted by the entire healthcare ecosystem as a step in its digital platformization, which aims to establish 4P medicine (personalized, preventive, predictive and participatory).** In France, this move is supported by several policies including "MaSanté 2022", launched in 2018. The plan centres on facilitating the sharing of data useful for improving technical standards while maintaining confidentiality and security. The success of this initiative, which is ongoing, is based on collaborations between public operators, both with each other and with technology companies and telecoms operators, and the development of latest-generation '5G-ready' medical equipment. This open, controlled circulation of pertinent healthcare data is the foundation of the digital platformization of healthcare and makes optimal use of 5G.

- **For manufacturing companies, 5G represents an opportunity to make their production processes even more flexible.** Infrastructure companies, including public ones, can also use it to develop new services.

- The third situation involves **smart cities, which can specialize in providing certain integrated urban services (health, tourism, mobility) thanks to 5G.** Given 5G's qualities as a "network good", connected urban areas represent a pertinent timeframe for the platformization of public services.

Our exploration of these three usage scenarios identifies three points of interest. **The application developer community needs to benefit from wide-ranging, flexible access to 5G** so that it can develop **microservice building blocks on platforms operating on 5G.** In addition, 5G will promote the **remote use of specialized expertise** by making accessible an enriched context of the event that requires diagnosis. The economic, regulatory and legal consequences of these new remote expertise situations would benefit from detailed analysis. The use cases envisaged will require mobilizing considerable volumes of data (videos are high consumers); **millimetre waves will be subject to systematic operational use. As a result, the small-cell base station density of the network represents a potential distribution bottleneck.**

Lastly, trust is a crucial ingredient in the adoption of 5G as a fundamental building block of digital platformization for businesses. In actual fact, 5G improves security of usage at the same time as increasing the attack surface, which brings a greater risk in terms of cybersecurity. The evolution of relations in data value chains in the different ecosystems is shaped by significant changes in economic relationships between technology suppliers. Uses, technologies and industrial organization evolve together. On this scale, 5G is likely to play an integrating, reliability-enhancing role for data. We identify six **distinct, often complementary approaches to trust when 5G is involved.** When relevant, recommendations are indicated, taken from the latest specialized literature.

INTRODUCTION

In the short life of the fifth generation of mobile communications (5G), 2020 will probably have been its most important year. It was the year that frequencies were purchased in France, and 5G was rolled out in most European states; it was massively rolled out in China, with at least 600,000 antennae and 50 million 5G subscriptions, and applications on numerous sites including hospitals. 2020 was also the year that the US launched an economic war against one of the leading 5G equipment providers, which also happens to be one of the main producers of mass-market devices, Huawei. These circumstances put a whole new emphasis on the notion of technological sovereignty, now an obligatory feature of political speeches. Due to the COVID-19 pandemic, the issues raised by the arrival of 5G, and its real added value, have become all the more pressing; indeed, telecommunicating includes a guarantee of non-contamination. The telematic shift that has marked a great number of commercial, professional and entertainment activities thus raises the question: do we need 5G now?

Despite this inroad, in reality 5G largely remains a terra incognita. Immense technical challenges will need to be overcome before it can manifest its most innovative benefits: benefits whose consequences on potential uses, all of which involve organizational changes related to data value chains, remain uncertain.

When we started our work, the forward-looking timeframe was set for end 2019 – early 2020. We are continuing to explore the digital transformation, which we have chosen to call platformization, and the ways in which industrial policy could make the most of it, for both France and Europe. Our understanding considers digital platformization as the paradigm shift that is affecting contemporary socioeconomic dynamics, which makes deciphering it indispensable (cf. *Pour une politique industrielle du numérique, [For an industrial digital policy]* ANRT, 2018; *Data price and value in digital platformization,* ANRT, 2019). Digital platformization is having a major impact on relations between companies and final consumers, between companies, and between public authorities and the socioeconomic sphere. Properly understood, it represents an exciting opportunity for industrial policy.

Following previous work, our goal was to analyse the consequences of 5G uses on data value chains in such a context. This was an ambitious, premature objective. Ambitious because the indispensable structuring of cooperative agreements between stakeholders, business value chain by business value chain, source of possible value creation, is more of a hope than an observation. Immature because from an industrial development point of view, it is difficult to observe today the impacts of 5G uses that are not expected to take off until 2023.

The approach adopted, which is holistic and based on detailed observation, involves the identification of several questions and structuring issues for the future. 5G[1] is considered to be a technology whose trajectory is drawn in interaction with the dynamics of the paradigm shift, i.e. digital platformization. To understand the nature of the impacts of 5G on platformization, it is thus necessary to look at it through a techno-economic lens. Which is exactly what this report does, thanks to exchanges within the working group, coupled with moderate use of the relevant professional literature.

Following this introduction, the report is organized into four sections. We begin by presenting the technological content of 5G, in terms of both technical infrastructure and services. In particular, we point out the new features of this technological building block. Next, we describe the key evolutions that will take place in the platformization of B2B using 5G, according to different specialities and socioeconomic themes. The third part is devoted to the central dimension of B2B platformization when 5G is mobilized, i.e. trust. Finally, the report draws the main lessons from this work and evokes questions that remain open.

1- 5G features on the list of “key technologies” determined by the European Commission, along with processors, satellite constellations for Internet access, quantum cryptography, edge computing, and cloud computing.

1 TECHNOLOGICAL CONTENT OF 5G

INFRASTRUCTURE & SERVICES

Because it is difficult to understand the uses, or even the consequences, of using a technology without looking at its characteristics, this first part mentions the key elements, based on our exchanges in the working group. The use of specialist vocabulary is restricted to an essential minimum.

The fifth generation of mobile technologies (5G) will transmit voice and data about ten times faster than the previous generation (4G) with a significantly lower latency of between 1 and 10 ms, which is ten times lower than for 4G. The speed corresponds to the transmission channel's capacity to transmit a quantity of information, or the quantity of data per unit of time; latency is the time delay between the moment when the information is emitted by a device and the point that it reaches its destination. This information is relayed over radio waves. For telecommunications, this involves a mix of electronics, computing, optical and electromagnetic fields. While the specific challenges facing 5G concern the exploitation and optimization of high, and sometimes very-high, frequencies, its implementation relies on a computing architecture in which the network equipment is replaced by specialized servers and software. This is a key new feature.

1.1 5G INFRASTRUCTURES

The infrastructure of the 5G network[2] comprises macro- and small-cell base stations with edge computing capacities. The macro-cells correspond to the existing towers and cover a wide area. In 5G networks, numerous network functions will become virtual, i.e. they will take place as software (computing sphere), providing the services of a "private wireless network"[3]. Up to 4G, network functions took place entirely on material equipment (telecom sphere). During a three- to four-year transition period, most operators will continue to use the existing 4G LTE[4] radio access networks (RAN). 5G antennae will start to be rolled out alongside 4G antennae that will continue to operate for years. In the meantime, and this is one of the major advances of 5G, these new antennae will make it possible to precisely target the transmission of waves towards relays and devices; so-called 4G antennae have a broad spectrum and emit over a wider area. During the period when the new physical infrastructure is being built, operators will be able to start offering improved services, a kind of "4G++[5]".

To sum up, the 5G infrastructure will evolve from non-autonomous 5G (or "radio-5G") to full- blown 5G, called autonomous. The first, transitional version will partly rely on the existing 4G LTE infrastructure and core network, while bringing improvements to services thanks to new technologies like 5G New Radio (NR).

The autonomous 5G infrastructure will comprise "access equipment", RAN (which includes NR), and a "5G Core" network. 5G Core will rely on a "service-based" infrastructure with virtualized network functions. These new connectivity services will have greater bandwidth, massive IoT capacity, very low latency and ultra-high reliability. The following improvements are expected[6]:

- An average speed three to four times faster

2- The most recent version of the reference standard, produced by 3GPP, dates from October 2019 and is accessible here: https://www.etsi.org/deliver/ etsi_tr/121900_121999/121915/15.00.00_60/tr_121915v150000p.pdf
3- Note that the lowest-level functions of the physical layer will continue to be carried out by special processors, at least for several years. Private network services will be possible, but may not be necessary. In particular, they will not be available for mass market services that do not require a particular QoS.
4- Long-Term Evolution (LTE) is a standard for wireless broadband communication for mobile devices and data terminals. The application of this standard increases capacity and speed by using a different radio interface and improving the central network.
5- 4G+ is the commercial name for the use of LTE Advanced and has existed since 2015.
6- A substantial part of the developments that follow – in particular when mentioning the company Orange – are inspired by the presentation given by Eric Hardouin (Orange) on 12 February 2020.

than 4G, and up to ten times in the long term, and thus speeds of several Gpbs in areas covered by millimetre waves (e.g. 26 GHz).

- Reliability of 99.999%, which designates the success rate of error-free transmission of a data packet in a 1 ms window.
- Latency of between 1 ms and 10 ms.

Moreover, when using equipment, energy savings are expected to double by 2021, and by as much as a factor of ten or even 20 by 2025. This greater energy efficiency corresponds to the savings expected by telecoms operators[7].

These savings will partly come from a new multiplexing technique, the new organization of access to the mobile network, and a concentration of equipment.

According to the roadmap of the main national operator, 2023 will mark the shift to autonomous 5G. For Orange, 2020 and 2021 are the continuation of a phase known as "joint innovation" on 5G. During this period, real-size experiments are being carried out and extended with industrial clients, which are lead users. Trials with new frequencies, 3.5 GHz or 26 GHz, started in 2018 when ARCEP allocated test spectrums. In late 2020, ARCEP allocated spectrums in the 3.4 – 3.8 GHz band to the following operators: Bouygues Telecom, Free Mobile, SFR and Orange.

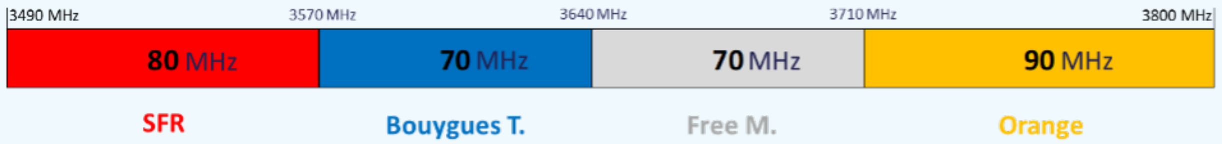
Box 1 – 5G spectrum allocation to French operators, 2020

The main auction for allocating the 3.4 to 3.8 GHz band took place from 29 September to 1 October 2020 and determined the spectrum quantities obtained by each of the winners. The "positioning" auction, which served to determine the spectrum positions of each winner in the 3.4 to 3.8 GHz band, took place on 20 October 2020.

The result of the positioning auction was as follows:

Candidate	Bouygues Telecom	Free Mobile	Orange	SFR	Total
Positioning in the band, bottom-up	2	2	4	1	-
Amount to be paid following the positioning auction	0 €	3 096 245 €	0 €	0 €	3 096 245 €

The final result of the allocation procedure was as follows:



The table below shows the frequencies in the 3.4 to 3.8 GHz band that ARCEP will allocate to each winner and the amounts that they will need to pay:

Candidate	Bouygues Telecom	Free Mobile	Orange	SFR	Total
Spectrum	3570 – 3640MHz	3640 – 3710MHz	3710 – 3800MHz	3490 – 3570MHz	-
Amount of spectrum	70MHz	70MHz	90MHz	80MHz	310MHz
Financial sum	602 000 000€	605 096 245€	854 000 000€	728 000 000€	2 789 096 245€

Source ARCEP website, 4 November 2020.

7- Operators know little about any potential benefits for user terminals, and these are the subject of a large number of studies that have not yet been endorsed by a standard.

In the second half of 2020, 11 European cities were concerned by Orange's joint-innovation 5G (version 4G++), five of them in France, three in Romania, two in Poland and one in Belgium.
4G and its successive upgrades will continue to operate until at least 2030.

1.2 VIRTUALIZATION, KEY BREAKTHROUGH OF 5G: LOW LATENCY AND "NETWORK SLICING"

The primary technical characteristic of 5G is that it drastically reduces latency. As mentioned above, latency is the delay in milliseconds between when a message is sent and received. With 5G, it is theoretically possible to reduce this time lapse to almost nothing: between 1 and 10 ms. The reduction of latency allowed by 5G results from increased efficiency at both the user terminal and for equipment[8]. User terminals will make gains thanks to more efficient chips. For equipment, the major changes made to network architecture will have the effect of diminishing latency; this change combines developments in the "core" and in the radio access network (RAN[9]). The latter, to achieve low latency, will need to be flexibly reconfigured by software: a virtualized, dynamic, configurable RAN is therefore crucial here. The radical improvement of latency brought about by 5G therefore involves the virtualization of an essential link in the network: the RAN.

In addition, thanks to 5G "network slicing", operators can offer individual customers a "slice of the network", on the same (physical) infrastructure. It is as if customers get access on demand to their own wireless network, isolated from end to end, to meet the requirements of a specific application.

Telecommunications are thus becoming more computerized: software is taking the place of material equipment and enabling certain functions on virtualized networks, corresponding to "network slices". This reflects the former principles used in computing in shared-time situations, where several users use the same computer at once. Employing the same physical infrastructure, "private" network slices will be produced for customers on demand.

This sharing means that "private networks" will theoretically be available at much lower prices than those involving dedicated physical networks. Concretely, the speed at which the slices can be produced is crucial; once virtualization is fully up and running, you will be able to obtain your own network on demand, "push-button" style. According to Orange's forecasts, from 2023-2025, semi-dynamic slicing will be established, with 5G cores and a limited number of potential slices, configured manually or semi-automatically. Starting from 2025, dynamic slicing will be available, making it possible to orchestrate and automate end-to-end slicing, and thus to dynamically produce and manage slices.

The full advantages of 5G will be attained after 2025, when operators will dynamically (rapidly) split physical networks into several virtual networks from end to end. Each of these virtual networks, including the edge, will logically be isolated, meaning that access, transmission and the main network can be used for services with different characteristics. This split into private, dynamically managed dedicated slices will foster a new data economy for specific types of information and contexts.

1.3 THE DIFFERENCE BETWEEN "PRIVATE" AND "NON-PUBLIC" NETWORKS AND ITS CONSEQUENCES

In addition to allocating spectrums, ARCEP provides companies with support to roll out 5G. The regulating authority has for example taken the initiative of supporting pilot projects on industrial sites. Their action began in early 2018, in the 3400 - 3800 MHz frequency band, with nine pilot sites, and since January 2019 in the 26GHz band, with 11 pilot sites (for durations up to three years). Up to now in France the political strategy has been not to reserve part of the spectrum for industrial uses, unlike other European countries. Companies will probably not therefore have the capacity to deploy their network on their own in-house 5G frequencies for another decade, according to some of our working group participants.

Typically, to ensure communications of critical

8- Interested readers may refer to a very instructive website, the "EMF Explained Series". EMF refers to ElectroMagnetic Field. This informative website, which draws from the resources of national and international health agencies, was developed by the Australian Mobile Telecommunications Association (AMTA) in collaboration with GSM Association (GSMA) and the Mobile & Wireless Forum (MWF). http://www.emfexplained.info/fra/; most of the content is available in five languages. For our subject, see http://www.emfexplained.info/?ID=25916.
9- RAN: Radio access network.

functions with the security level required "for private use", companies implement standard technologies like Ethernet, fibre, Wifi, WiMAX, Bluetooth, and land mobile radio (LMR). However, despite noteworthy improvements, these systems have limitations. As companies digitize their industrial processes, their needs and requirements increase (Industry 4.0). At the same time, 5G appears to be a solution capable of overcoming these new challenges, for example as a support for IoT. Mobile technologies (3G, 4G and 5G) are considered to be alternative solutions that for critical functions offer the sought-after characteristics (high reliability, low latency, improved security).

Regarding standard technologies, user companies deploy a "private network". With mobile technologies, when a user company wants to satisfy its critical wireless communication needs, with the desired security level, the official 3GPP term is "non-public network" (NPN). These non-public, meaning private, networks are based on physical or virtual cellular systems. Private networks are entirely in the hands of the user organization; for non-public networks, the user organizations can employ a dedicated part of the public network infrastructure for their own purposes. The level of security in a non-public 5G network is therefore different, and the nature and quality of security protocols (software sphere) needs to be adapted accordingly.

The technical options available to companies that want to take advantage of the possibilities opened up by these advanced networks are therefore more varied. Consequently, solutions should be chosen following an analysis that considers the specific business features and needs regarding the type and speed of data circulation and the investment required. 4G LTE solutions are still the preferred option in numerous industrial processes, since they are adequate to satisfy most communication issues.

1.4 THE SEARCH FOR MILLIMETRE WAVES

The operation of the future 5G mobile network will involve a combination of three radio frequency (RF) bands, including a new very-high frequency band. Each RF band has different properties: high frequencies are fast but the range is smaller, while low frequencies are slower but more far-reaching.

4G uses the 700 MHz[10] band. To start with, 5G will be rolled out at 3.5 GHz and then move on to the 26GHz bands and beyond. R&D studies are being carried out on 140GHz, for example, which is likely to end up being used for 6G. CEA-Leti is running on-site experiments on 26GHz and looking closely at Extremely High Frequencies (EHF). The EHF band extends from 30 to 300 GHz, which is a wave length of 1 cm to 1 mm, known as millimetre waves. The millimetre wave procedure is based on contactless radar technology and permits remote sensing and telecommunication. The technology was originally created to detect objects and provide their range, speed and angle. The downside of this precision is the low range of millimetre wave technologies: less than 5 km to date. Consequently, it is used mainly for last-mile connections in residential areas, or on industrial sites where optical fibre would be complicated and expensive to put in place. The high demand in stations, airports and very busy streets makes these places contenders for being equipped as "hot spots". For example, Orange, along with SNCF and Nokia, is experimenting with 5G 26 GHz in Rennes train station in France.

In this race for 5G hyper connectivity (objects, machines and people), French and European players possess key competencies at every level.

10- The frequency unit is hertz (Hz), which corresponds to one cycle per second. One MHz is one million cycles per second, and one GHz is a thousand.

Box 2 – CEA-Leti "Wireless communications systems and networks"

One hundred and twenty (120) people are developing research on the three main components in these RF systems: architectures, antennae and the design of integrated circuits. The work done by Leti contributes to opening up the possibilities of 5G in the following main areas of application: connected autonomous vehicles, satellite communications, infrastructures (like antennae), and local applications (in particular for the medical sphere).

The systematic exploration of technologies using millimetre waves should ultimately lead to exploiting the full potential of 5G: more bandwidth for higher frequencies; greater connectivity for IoT; and ultra-reliable low-latency communications (uRLLC). In this area, numerous obstacles remain for which Leti (and a handful of other European actors) enjoys a technological lead. These efforts are part of an active ecosystem of French and European companies that have the advantage over their Asian and American competitors.

Significant improvements still need to be made to the RF component of 5G, which therefore includes software like the Software-Defined Wireless Transceiver for IoT. At each level of the infrastructural system of 5G, technical obstacles to drawing out its full potential remain. The main ones are:

- Connected assets (~IoT): increase long-term energy autonomy
- User terminals: increase connection capacity and data speed
- Access points: considerably improve mid-range communications to move towards very high performance (infrastructure and user connections)
- Infrastructure: move towards very high capacity

Source: Based on the presentation by Eric Mercier (CEA-Leti) on 28 May 2020.

This infrastructure quality makes it possible to attain autonomy throughout the chain: from the integrated circuit to terminals and right up to the infrastructure, including the software layers involved. 5G represents one of the solutions to the inevitable growth in data exchange needs. There is still room for European companies, provided that they are supported by an appropriate industrial policy. Given this competitive advantage, the right industrial policy would produce and disseminate the corresponding standards. Which is all the more reason for encouraging greater participation by research organizations and concerned companies in standardization committees.

1.5 THE COUPLING OF 5G AND EDGE COMPUTING LEADS TO TWO APPARENTLY ANTAGONISTIC OFFERS

On close inspection, 5G appears to alleviate the constraint for computing on the edge of the network at the same time as fostering its development. This paradoxical evolution in fact concerns two different types of offer. With 5G, telecoms operators intend to offer more access to the cloud, while cloud service providers will do the opposite, by offering edge computing. They constitute key partners of telecoms operators for 5G.

The sharp, rapid increase in communications and the associated data processing needs has accelerated the development of network edge solutions. 5G will include very low latency (ranging from 1 ms to 10 ms) and high reliability, coupled with faster speeds and bandwidth. This will enable almost-instantaneous exchanges between terminals (mobile, IoT) and a remote storage and processing space (in the cloud). In other words, thanks to 5G, there will be less need for edge computing because it will be possible to continue exchanges, thanks to the near-absence of transmission delays, on a shared remote processing site. This point is important: in relation to the performance required by uses, 5G makes it possible to continue enjoying the advantages of the cloud, and at the same time reduces the need to implement complementary edge computing. Telecoms operators[11] can justifiably extol the virtues of a cloud that, thanks to them, preserves the control of data by users.

Providers of cloud services[12] on the other hand intend to take advantage of 5G rollout to offer edge-computing 5G services. In practice, the services that they provide are already largely based on virtualization, which is a standard technique for remote computing. 5G therefore constitutes a strategic opportunity within their investment range that poses them no particular risks or difficulties. The leading cloud platforms already offer 5G packages for edge computing services: AWS Wavelength and Wavelength Zones from Amazon, with the operator Vérizon in the USA; Azure Edge Zones and Azure Private Edge Zones from Microsoft, with the operators AT&T, NTT Communications, Telefonica or Vodafone Business; Global Mobile Edge Cloud (GMEC) from Google Cloud Platform (GCP) and Anthos for Telecom, with AT&T for the 5G. These new deals respond more closely to the actual needs of customers (including operators). With this package, cloud service providers gain new control of the essential performance link in the network represented by radio signal processing. Interactions between relay antennae and mobile objects and machines operate like exchangers and providers of immense volumes of data (networks). Optimizing them becomes a key to performance, perfectly adapted to machine learning. The same companies are making huge investments in this area and are already one step ahead. For *hyperscalers*[13], controlling the edge in terms of locating applications' data processing offers a powerful tool for obtaining knowledge of the real world – here the way that mobile networks operate. This link in the data value chain, the optimization of the operation of 5G networks, will consequently be invested by these same computing companies. By adding this new "string to their bow", they will boost their market performance.

The new competition between telecoms operators and cloud providers encourages them to initiate agreements with each other, in particular on edge computing. Through these agreements, telecoms operators intend to gain access to a cutting-edge computing skill that is present at the biggest CSPs. These agreements involve sharing a value about which very little is currently known, including by future user companies, which will be the real value creators via the platformization associated with 5G. Among the main uses evoked, there is particular interest in the conception, production and implementation of digital twins in a great number of domains, in order to take advantage of predictive analytics. One example is applications in the healthcare field. More generally, the effective exploitation of industrial data presupposes the low latencies that will clearly be promoted by the combination of 5G and edge computing.

11- Cf. for example https://www.orange-business.com/fr/mediatheque/livre-blanc/edge-computing-re-distribuer-puissance-informatique-et-etendre-frontieres
12- Amazon AWS, Microsoft Azure and Google Cloud are the main three, and at the end of 2020 represented respectively, 33%, 20% and 7% of the global market share, or 60% for all three combined.
13- The three above-mentioned companies are among about twenty firms that, at a global scale, correspond to this definition. Hyperscale is a computing term that qualifies the capacity of an architecture to scale up sufficiently to match increased demand. Hyperscalers are companies that offer this type of service, in particular for cloud computing.

2 BUSINESS PLATFORMS ENRICHED WITH 5G

The French agency in charge of regulating telecommunications in France (Autorité de Régulation des Communications Électroniques et des Postes - ARCEP) defines three main groups of 5G usage from a technical standpoint[14]. This division respects the idea of a progression of usage levels over time, with a passage from the first (eMBB) to the third (uRLLC). Enhanced mobile broadband (eMBB) corresponds to applications and services that require a faster connection, e.g. for ultra-high (8K), virtual or augmented reality. Next come massive machine-type communications (mMTC), mainly involving uses related to the Internet of Things. These services require extensive coverage, contained energy consumption, and relatively low speeds. Lastly, ultra-reliable low-latency communications (uRLLC) correspond to applications requiring extremely fast reaction and a very high guarantee of message transmission. This interpretation of uses is based on the network's capacity to fulfil certain functions with increasing efficiency. Knowledge of this aspect has proved useful for busines developers, entrepreneurs, innovators and public deciders. Although this technical forecasting fulfilled its purpose in an initial phase, at the present time, its socio-economic adoption is becoming a major issue that will rely on the clear explanation of convincing use cases. Our work has focused on producing food for thought in this area and on identifying a number of use cases.

2.1 CONTEXTS OF USE WITH HIGH ADDED VALUE

Collective activities with a high level of expertise, like the work done by a specialized team operating remotely in real time, require exchanges of extreme spatial-temporal precision, and high levels of operating safety and security. This is the type of situation that comes to mind when imagining mature usage of 5G. However, this kind of usage, on non-public networks sufficiently flexible and powerful to meet demand and mobilizing all ad hoc busines applications, will probably not be available until 2025. And even in 2025, it is highly unlikely that they will constitute a substantial share of demand. Until then, a variety of "more standard'" activities remain that are collective to different degrees. Unless they are adopted by sufficient numbers of individual, private users, economic profitability thresholds will be difficult to attain. If the transitory version of 5G, i.e. "4G++", is not sufficiently profitable, for standard uses benefiting from faster speeds, cutting-edge applications will be compromised in contexts of use with higher added value.

The higher-added value uses made available thanks to 5G will be co-created in B2B setups (customers-suppliers/operators) over the next few years. Specific ecosystems will have to organize themselves around the value chains of the data concerned. The potential for technical change associated with 5G will take shape through its adoption by ecosystems, with their specific features.

These include remote surgery, some functions of autonomous and connected vehicles including in mass transportation, maintenance and production operations on industrial sites, and certain functions provided by cities during their transformation into "smart cities".

The technical choices open to companies that want to take advantage of advanced networks

14- Les enjeux de la 5G [5G challenges], ARCEP, March 2017.

in their industrial processes (in terms of highly secure broadband and capacities to do so simultaneously) are therefore much greater than before. Ultimately, choices are based on an evaluation that considers the specific features of the business in terms of the type of data circulation speed and the increased efficiency associated with the investments required. The economics and requirements of a private hospital carrying out certain surgical operations are difficult to compare with those of a network operating (private or public) utilities supplying electricity, gas or water.

2.2 NEW STAGE OF PRODUCTION FLEXIBILITY

The adoption of 5G in manufacturing could boost production flexibility by speeding up the reconfiguration of factories to correspond to production constraints. In such cases, 5G would drastically reduce the quantity of cables and the number and level of communications required, which would take place through the mobile network. Equipment could be reconfigured faster and more easily to correspond to changes in the production line. This use of mobile technologies (4G++ and 5G) with wireless NPN opens up new business perspectives for utilities serving their industrial production clients. Here, specific knowhow and technical skills on the installation of industrial cabling (or for urban networks) could be mobilized as a lever via 5G. New services with high added value could be offered to customer companies. For example, when appropriate, they could replace cables with a 5G network.

5G NPNs can foster the development of new services for existing stakeholders, both operators and infrastructure companies (utilities). Orange is not only a network operator, it is also an integrator of customized solutions on private networks, and an infrastructure operator.

2.3 MOVE TOWARDS E-HEALTH

The operations of most medical setups would be greatly improved by the additional connectivity and digitization promised by 5G. Ambulances and their embedded equipment will thus be converted to improve patient care. This digital upgrading of equipment and ambulances will only reach its full potential if the patients themselves (via their medical records) and the road and urban infrastructures are also digitized. The need to share patient data within the healthcare system is immense. The potential for transforming the healthcare system thanks to digital solutions, here including the adoption of 5G by healthcare professionals, is all the greater.

Medical infrastructures "boosted" by 5G are for example likely to contribute, via artificial intelligence (AI), to improving the modelling employed in diagnoses and surgery. Each category of healthcare data involves different sharing, storage, hosting and processing conditions corresponding to specific safety and security requirements. Conformity with legislation requirements (GDPR) is essential. If these requirements are respected, health data constitute mass, high-quality learning material. Consequently, if a healthcare data value chain were established and organized, modelling would be better calibrated and thus more efficient. The inherent difficulty in establishing these agreements, which clarify the place of the different parties involved in a given business in line with their particular area of interest, therefore represents an obstacle in the adoption of 5G.

At national level, the strategy "Ma Santé 2022" (My Health 2022) launched in September 2018 by the French President, aims to make the most of digital technologies to improve the healthcare system. The digital component of the "Ma Santé 2022" roadmap was presented in April 2019; it recognizes the crucial role played by connectivity in the sharing of useful data and the limits of an approach that has traditionally been too centralized. The number of collaborations with technological companies and telecoms operators needs to be increased in order not to hold back the development of latest-generation "5G-ready" medical equipment to satisfy current and future needs.

The Dossier Médical Partagé (cf. www.dmp.fr, the French electronic health record (DMP) features the history of a patient's healthcare automatically stored by the health insurance system; a list of any diseases and allergies; medical treatment and care; hospital and consultation reports; examination results; advance directives for the end of life, etc. Its software usability is being gradually improved to integrate the results of business applications, medical imaging, vaccination records, etc. The list continues to grow, as does the list of doctors and healthcare facilities that feed into it and consult it.

Professionals want to be able to automatically access DMP data in emergency situations, similar to the organ transplant system, where individuals are required to opt out. At present, the only way to access patients' data is following direct authentication using the Carte de Professionnel de Santé (healthcare provider's card, CPS), which is only rarely used in healthcare facilities. In addition to automatic consent in certain circumstances, the rapid implementation of alternative access methods by indirect authentication would be useful.

The rollout of 5G therefore raises expectations for e-health applications. The entire ecosystem concerned, including patients, strongly requires that the access and use of data that need to be shared are made secure. Thus, in the therapeutic interest of patients, speed and reliability are prerequisites. While improved speed and reliability are likely to encourage adoption of 5G, guarantees of security have not yet been provided. Attaining a high degree of trust in the security of the new system, which combines virtualization, cloud and edge computing, is a major hurdle in the dissemination of 5G.

The general public's level of trust in e-health applications is currently low. In France, consent is not granted easily. This is illustrated by the low take-up rate of the StopCovid[15] tracking scheme, based on doubts about the security of exchanges, even though the application was developed by the government.

The almost generalized adoption by companies of storage solutions (and calculation and application capacity) in the cloud in fact constitutes a risk for telecoms operators established in Europe. The virtualization on which autonomous 5G is based encourages a move towards the offers available from Amazon, Microsoft and Google (or even Alibaba). Cloud service providers use 5G in addition to other shared resources already on offer.

The generalized use of 5G in the healthcare system, in line with the development of P4 medicine[16], will make it easier to develop telemedicine and carry out some examinations, and even operations, remotely. The section below headed "Smart Cities *with chosen specializations*" features a case in an urban area, here the city of Rennes, where 5G is fundamentally changing the healthcare pathway. Beyond individual zones, the extensive rollout of 5G will bring specialized medicine closer to disadvantaged areas[17], diminish diagnosis errors, avoid unnecessary journeys for people with reduced mobility who sometimes forego healthcare because of difficult access, and permit early diagnoses if only due to faster directing to remotely consultable specialists. 5G will also make it easier to remotely control machines, thus reducing the need for the continuous presence of a specialist onsite.

2.4 E-HEALTH'S NECESSARY EMBRACING OF DEVOPS

The intrinsic qualities of 5G make it attractive to healthcare stakeholders. Yet for the moment, the technology is struggling to attract the application developer community, whose role in the adoption of 5G will nevertheless be crucial. Demand from the general public for 5G will correspond to the availability of apps that make the most out of low latency, precision, and exchanges that are secure despite their speed. Developers need to be able to count on high flexibility when using this technology, which needs to become a community tool for DevOps[18] so that microservices[19] can be developed on a wide range of platforms operating with 5G.

Deep-seated reform aimed at e-health, a key component of which is clearly MaSanté 2022, will lead to substantial savings for the health system. This transformation involves significant investments. To date we lack cost/benefit evaluations of the impact that 5G will have on

15- Version 2, TousAntiCovid, has had a higher take-up rate.
16- P4 medicine puts the focus on predictive, personalized, preventive and participatory aspects.
17- A point emphasized by Mr Mollo, medical director at Pfizer France, at numerous meetings, including on 12 February 2020.
18- DevOps, from software development (Dev) and IT operations (Ops); computer engineers who deal with both software development (dev) and infrastructure administration (ops).
19- Computer scientists talk about microservice architecture to explain that the resulting applications are organized into loosely coupled services, structured around business capacities. These services employ a range of program languages, databases, material environments and software, depending on what is most relevant.

different stakeholders in the e-health system. Notions like fee-for-service and refunds for healthcare pathways are typical components of e-health. 5G could make these two developments easier to implement. It could be interesting to reverse the logic and consider these economic and organizational means as conditions for achieving e-health in France.

2.5 SMART CITIES "WITH CHOSEN SPECIALIZATIONS"

As shown by the case of e-health – in which much remains to be done – in order to gain a foothold 5G requires more marked, proactive adoption by public stakeholders. Like previous generations of communication technologies, 5G is subject to a "network effect": its utility, i.e. the value of the service it provides, increases in proportion to the square of the number of users. As a result, its wide adoption by local authorities and cities would have considerable impacts. Cities would benefit from a clear opportunity to improve the quality of their connection infrastructures. The urban area constitutes an ideal scale for experimentation (and deployment) for a connection-based services technology. Cities are prime examples of connection areas, since most urban area amenities ultimately depend on this connecting capacity. The platformization of public services at this local level therefore seems to constitute a suitable horizon: 5G as a proximity technology. It is worth pointing out that this move to 5G would also create the conditions for reinforcing platformization to serve the community, based on a short channel rationale (cf. *Pour une politique industrielle du numérique*, [*For an industrial digital policy*] ANRT, 2018; Data price and value in digital platformization, ANRT, 2019).

The European project 5G-TOURS[20] intends to demonstrate 5G's capacity to operate effectively when several areas of use – media, health, mobility, etc. – are simultaneously mobilized on the same infrastructure.

Box 3 – 5G-TOURS, the demonstrator that uses the 5G European validation platform

The 5G architecture for 5G-TOURS is based on 5G-EVE (5G European Validation platform for Extensive trials), pre-commercial equipment in compliance with the latest version of 3GPP. It is one of the three PPP 5G infrastructure projects launched on 1 July 2018. The aim is to implement and test advanced 5G infrastructures in Europe.

More specifically, 5G EVE should lay the foundations for the extensive rollout of end-to-end 5G networks in Europe. 5G-EVE provides 5G experimenters with an end-to-end 5G installation that they can use to validate their KPIs and network services.

Providing reliable end-to-end 5G network solutions is crucial for all actors in the 5G value chain, from network operators and suppliers to vertical industries and SMEs.

5G-EVE will develop and interconnect four existing European sites to create a single end-to-end 5G installation. The four interoperating sites are located in Greece, Spain, France and Italy. They are backed up by advanced laboratories such as the Ericsson laboratory in Kista, Sweden. The installation will be offered to vertical industries to carry out and validate pilots. Access will take place via a single operating API.

The installation of end-to-end 5G EVE will allow experimentation and validation with complete sets of 5G capacities. They will initially correspond to version 15 and by the end of the project will correspond to version 16 of 3GPP specifications.

Sources : based on the websites https://5gtours.eu/architecture/ and https://5g-ppp.eu/5g-eve/

20- 5G-TOURS is a project financed by the H2020 European framework programme, in the 5G-PPP category. Member companies of the European consortium are listed at this address: http://5gtours.eu/; FutuRIS and working group participants that contributed to this report include Orange, Nokia, Nokia Bell Labs, Philips and Atos.

Most municipalities do not need to choose between health services and urban mobility, electric network quality and waste collection, etc. Their transformation into "smart cities" can be achieved via a pilot dominant characteristic. This dominant characteristic will depend on the identity of the city and its development choice. For example, at 5G-TOURS, a real-size demonstrator of 5G in Europe, several options are being put in place. Grouped into three user cases corresponding to urban systems, 5G-TOURS comprises a total of 13 illustrations[21].

Smart cities can be "touristic".
Athens is interested in developing services that enhance the tourist experience by using 5G. The adoption of 5G by the city is expected to include features like telepresence, museum visit assistance thanks to a robot guide, high-quality video distribution services, and even the production of remote and distributed video. Visitors to museums and open-air attractions will use 5G-based applications to improve their experience during their trip to the city. This includes VR/AR applications (virtual reality/augmented reality) to complete the physical visit with supplementary content involving interactive tactile communications. Visitors' experience will also be improved by robot-assisted services, telepresence to allow remote visits, and live events activated by mobile communications like concerts involving several people.

Smart cities can be "safe". The city of Rennes has developed remote health monitoring and automatic notification of emergency situations, teleguidance for diagnoses and support for medical interventions, wireless operating rooms, and assistance for optimal ambulance transit. 5G can contribute to improving the quality of healthcare and private medicine by facilitating healthcare monitoring, throughout the healthcare pathway: health monitoring for prevention and early detection, diagnosis and intervention, ambulance, surgery, wireless operating theatres in hospitals (Rennes university hospital).

Remote health monitoring and notifications of emergency situations in real time thanks to 5G are the gateway to predictive medicine. This is a crucial issue for older people and sufferers of chronic disease. Predictive computing enables early identification of events at the origin of a possible deterioration in a patient's health. This constitutes a fundamental shift in the avenue to P4 medicine, with numerous associated "patient benefits".

With teleguidance for diagnosis and intervention support, optimal ambulance transit, and wireless operating rooms, 5G networks foster the continuity of patients' treatment chain, and its optimization. Ambulances become the first room in the hospital. In the ambulance, the first measurements are taken to back up the diagnosis, with remote, real-time access to a doctor or surgeon, while key elements of the exact context are shared with the physician. For example, thanks to on-site usage of an ultrasound apparatus, whose real-time interpretation is left to the hospital doctor, or even the future operating surgeon, once the patient has been brought by the fastest route to the hospital best equipped to treat him or her. Access to remote expertise is a relevant contribution of 5G that is likely to have a major impact on the effectiveness of medical care.

The technological research institute b<>com[22] is participating in the wireless operating theatre project. One of the key challenges is to smoothly communicate the wide range of technologies involved in an operating theatre. According to the approach adopted by b<>com, 5G acts as an interoperability standard for communication between equipment (often produced by different manufacturers).

Smart cities can employ "smart mobility".
Athens is developing smart management services for airport carparks, improved traffic circulation by video, faster reaction times for emergency evacuation from airports, and "enhanced" bus excursions thanks to augmented reality and virtual reality. All journeys into and within the city are made more efficient and comfortable by the use of 5G. This "smarter" city requires collecting information and exploiting and processing it to improve navigation systems and parking. Thanks to AR/VR, public transport passengers enjoy

21- What follows was inspired by the presentation made by Pascal Allain on 16 July 2020, for which we thank him. Any errors or omissions are the responsibility of the author.
22- https://b-com.com/fr

greater comfort. 5G gives airport operators the means to ensure their transformation into spaces with greater logistical fluidity.

The examples above underline a more developed use of augmented reality and virtual reality with 5G. Used together, these applications enrich the capacities of doctors, specialists and surgeons for apprehending reality. They become crucial for real-time healthcare to improve the experience of doctors, and facilitate and improve training and the preparation of operations. Through training and by bringing in the appropriate equipment, the range of tasks for which nurses are responsible can also evolve towards more qualitative contributions.

2.6 ON CLOSE INSPECTION, TWO FOCAL POINTS

These developments will make it possible to consult experts remotely in conditions suitable for carrying out business as usual. Wherever they are, experts will get access to an enriched context of the event that will allow them to make remote diagnoses. This deep-seated change to the expert profession, with slight differences reflecting the specialities involved, has not to date received the attention it deserves. In particular, the legal and regulatory consequences have not been sufficiently analysed and anticipated. Up to what point are experts liable? To what extent are they protected by a work contract and a service contract between the company employing them and the customer? What part will the use of technological supports play in the establishment of quality insurance protocols?

Lastly, technical issues remain concerning the dissemination and adoption of 5G. The use cases mentioned mobilize massive volumes of data that very often feature images and video, which are high consumers of broadband. Exploiting the properties of millimetre waves in acceptable industrial conditions is therefore crucial, and so is controlling them. The density of small-cell base stations in the network constitutes a potential bottleneck. More precisely, from urban areas to the middle of the countryside, antenna networks will respond to different constraints and adapt the coverage accordingly. The financial investments for the rollout of small cells to implement 26 GHz bandwidth will also depend on this; cells will only be deployed where necessary. For example, in hospitals, there could be an access point for each operating block. In factories, the number of access points required would depend on the surface area and the configuration of the buildings.

3 - 5G AND THE ISSUE OF TRUST IN B2B PLATFORMIZATION

3.1 AMBIGUOUS IMPACTS

5G affects platformization in more ways than one, as covered in detail above. Our work shows that the impact of 5G on usages is expressed through trust. Its influence is characterized by two effects moving in different directions that simultaneously transform platformization and 5G.

On the one hand, the level of trust that can be placed in a system, in the processes carried out, increases in proportion with the platform's use of 5G. The considerable reduction of latency theoretically available can generate a substantial acceleration in the speed of calculations; thus, 5G makes it possible to employ more powerful security algorithms (encryption or otherwise). Communication standards are viewed as safer.

On the other hand, 5G comes with a greater security risk. Its widespread use in a great number of situations involving data exchanges increases the size of the attack surface. The virtualization process will require telecoms operators to make significant changes. The security guaranteed by telecoms operators for communications via 5G will in fact constitute software security for software applications. In other words, more at the level of intervention by computer engineers, with technical competencies incorporated into the equipment employed by operators. This new setup involves delegating cybersecurity to the equipment manufacturers that enable their networks to operate. This means that network operators' freedom to act (contractual) and their aptitude for action (competencies) vis-à-vis their equipment manufacturers will be crucial. To what extent will operators be able to test (by adopting the point of view of their customers) the quality of embedded security software in their 5G contracts? To what extent can cybersecurity software solutions be audited by operators? Are operators in a position to demand auditability? Will they be able to mandate an independent organization to carry out tests and checks?

Whether 5G makes uses more secure, or conversely brings about greater cybersecurity risks, developing relationships of trust between stakeholders remains vital. Adoption of 5G by users goes hand in hand with the disruption of relationships between technology providers. Uses, industrial organization, and technologies all evolve at the same time. The IoT building block, for example, remains fragile and vulnerable to specific flaws[23]; it is therefore necessary to protect the security of sensitive data with potentially very high value. In terms of industrial organization, which reflects the organization of a value chain subject to profound reconfiguration, fragmentation dominates and is likely to persist. Some think that 5G could play a role in making data more integrated and reliable.

3.2 A VARIETY OF TECHNOLOGIES OF TRUST

The analysis of interactions between 5G and platformization cannot simply be reduced to a technical problem. All of the developments in this text show that the question is about economics just as much

23 - Cf. https://csrc.nist.gov/publications/detail/white-paper/2020/09/08/trusted-iot-device-network-layer-onboarding-and-lcm/draft, for example.

as technical issues. Sometimes the technical aspect hinders the capacity for agreements between stakeholders in the data value chain; sometimes, the economic side slows down the dissemination of appropriate technical responses. Trust as the result of a combination of technical choices involves several types of response.

APPLYING THE RECOGNIZED, STATE-OF-THE-ART METHODS OF ENISA

Building up confidence involves adopting (and controlling) various high-standard security methods, which are themselves auditable. The European cybersecurity agency, ENISA[24] analyses and disseminates such rules. Its rich repertoire includes the following:

Threat Landscape for 5G Networks[25] presents an overview of the threats, concerning for example new features, and in particular 5G architecture and developments in standards. It provides a precise, exhaustive list of the sources of vulnerability along with specific information on the exposure of architecture assets. Lastly, it makes a set of recommendations addressed to (1) European-level decision-makers, (2) 5G market players (suppliers, mobile network operators, service operators, standardization bodies, 5G test laboratories, etc.), and (3) national organizations competent in the field of 5G cybersecurity (e.g. national cybersecurity centres, national regulators, national 5G test centres, etc.). The following items fit in with the line taken in this report and are worth noting. Thus, vulnerabilities in the virtualization layer can generate risks like unauthorized access to functions and data. The known vulnerabilities of virtualization include:

- Inadequate access privileges in virtualized environments.
- A key management system inadequate to deal with encrypted virtual components.
- An absence of mechanisms to guarantee a trusted root.
- Cloud technology employed to implement virtualization that is fragile.
- The use of hypervisors can lead to crossed contamination of shared resources.

Among the recommendations, we report those that correspond most closely to the content of this part:

1. It is essential that the European Union continue to facilitate the definition of common security standards for 5G networks and its use cases by supporting cooperation and information sharing between Member States.

2. Given that the proliferation of AI algorithms has reached components used in the 5G ecosystem, the recommendation is to evaluate the exposure to threats of these functions in all components in the entire 5G ecosystem (devices, software, sensors, actuators, etc.).

3. The analysis of threats has shown that work remains to be done in describing the profiles of 5G threat agents and identifying potential means of attack. Although a comprehensive description is premature at this stage, it is considered a priority for future versions of the threat landscape for 5G, given the increasing availability of information on threat agents and attack routes.

4. The specification of 5G provides a solid basis for the security of the entire system. Nevertheless, the final level of security will be highly dependent on implementation/coding practices. The development of good practices and guidelines for secure implementation of network operations is a key step towards maintaining the level of specification security in the resulting code base. Such guidelines do not exist yet.

24- Acronym of its name at the time of creation in 2004: European Network and Information Security Agency.
25- ENISA Threat Landscape for 5G Networks Report, ENISA, December 2020, https://www.enisa.europa.eu/publications/enisa-threat-landscape-report-for-5g- networks/at_download/fullReport

Encrypted Traffic Analysis[26] explores the current situation regarding the analysis of encrypted traffic, and in particular the research and methods employed in six use cases. These are cases of identification of applications, network analysis, identification of user information, detection of encrypted malware, fingerprinting of files/devices/websites/locations, and DNS tunnel detection. The report discusses recent research on TLS[27] practices and identifies current incorrect practices; it suggests simple but effective counter-measures such as validation and certificate pinning, the reduction of the volume of data exposed on HTTP redirections, the use of appropriate private keys and the latest TLS versions (i.e. 1.2 and 1.3), while insisting on the use of certificates signed by a trustworthy certification authority.

Advancing Software Security in the EU[28] examines several key elements of software security and gives a concise overview of the most pertinent approaches and existing standards. The document identifies some of the most common shortfalls associated with developing secure software. Lastly, the report provides practical considerations concerning several aspects of software development in the new EU cybersecurity certification framework and the EU's cybersecurity certification systems. Regarding the latter point, three caveats are of note:

- EU cybersecurity certification systems for products, services and processes should as far as possible include not just requirements for the final product/service/process, but an insurance of the engineering process, stipulating directives for the development, maintenance and operation of software.

- In the establishment of the EU's cybersecurity certification systems, conformity assessment methods for the level of basic insurance should be considered in response to the fragmented landscape of software development and maintenance.

- Software developers and product manufacturers should make use of their experience and expertise to promote the adoption of the EU's cybersecurity certification systems.

LOGICAL ACCESS CONTROL

Some security issues can be resolved by data segmentation in order to guarantee an architecture with safe access rights. In practice, this specific component in resolving the data confidentiality/security problem can and should be clearly explained to users (thinking of patients and healthcare professionals). Access control methods, a priority in this case, are well known and include passwords, authentication tokens, double authentication with a unique password or biometrics. These constitute the best example of platform security that can be accessed by users.

SAFETY ACCORDING TO CLOUD SERVICE PROVIDERS

An additional type of security issue needs to be handled by computing engineers interacting with the ecosystem of cloud service providers (CSPs). Data pass through several CSPs, which have to share data encryption keys and other data characteristics. Throughout the entire chain comprising production, the range of processing, and data sharing, different techniques are combined to maintain data security/confidentiality. These techniques include, among other things, security by design, which is directly incorporated into the source code of components and equipment; and encryptions, including functional encryption, homomorphic encryption, secure multi-party computation techniques, and the design and use of secure enclaves.

26- https://www.enisa.europa.eu/publications/encrypted-traffic-analysis/at_download/fullReport
27- Transport Layer Security (TLS) is a widely adopted encryption protocol to guarantee the security of communications on computer networks.
28- https://www.enisa.europa.eu/publications/advancing-software-security-through-the-eu-certification-framework/at_download/fullReport

Cosmian[29], a French cybersecurity company that participates in our working group, explains these four techniques using the following simple terms. Functional encryption transforms encrypted data into results in clear text while requiring mathematical consent on the calculations; entirely homomorphic encryption operates encrypted data processing and restores them as encrypted results; secure multi-party computation involves sharing calculations without sharing data; lastly secure enclaves protect proprietary algorithms even when they are run in insecure environments. Thanks to this combination of techniques, security is maintained while running and processing.

TRUST AS A FOUNDING PRINCIPLE: GAIA-X

In addition to this set of local solutions to establish and maintain trust through a combination of techniques, a group of companies in Europe have developed a meta-solution. Initially set up in Germany before becoming Franco-German, the GAIA-X Foundation intends to provide this type of end-to-end trust agreement at European scale. In early 2021, the federation of sovereign clouds counts 200 to 300 members, most of them from the cloud ecosystem (providers). It also includes several large user clients. Through the connectivity enabled by this architecture shared between platforms and some specialized technical contributors, the objective is "data sovereignty". This cloud federation pledges that holders will maintain total control of their data. The principles adhered to by members of the foundation include European values applied to computing such as interoperability, portability, transparency, protection and security of data. These principles are gathered into a set of common standards, a kind of smallest common set of technical requirements. Auditability needs to be put forward as a rule at every level of the architecture, for both infrastructure and applications. At this stage, GAIA-X does not deliver certificates of compliance or quality labels for its members to guarantee that they respect the policy rules that lie at its foundations. GAIA-X has worked for several years with the International Data Spaces Association[30], created by Fraunhofer-Gesellschaft. However, technical committees featuring its members need to be set up to collectively establish the targeted sovereign practices.

The ambition of GAIA-X consists in producing de facto standards based on principles recognized by the main industrial companies in the field. This quest to produce a set of standards shared by the profession aims to help create digital autonomy at European scale.

INTERNATIONAL STANDARD AND EUROPEAN CODE OF CONDUCT

All cloud platforms respect the ISO/IEC 27001[31] standard, which defines a methodology to identify cyberthreats, control the risks associated with crucial data, and set up protection measures to ensure the confidentiality, availability and integrity of data. This international standard describes the requirements of an information security management system, specifies good practices for stakeholders, and lists appropriate security controls to manage information-related risks.

In addition, platforms aim to set out their own code of good practice, thus specifying the prerequisites that underly auditability. The European Union has published a code of good practices aimed at CSPs called the EU Cloud Code of Conduct[32], whose object is to demonstrate respect for the GDPR, while stipulating how to achieve it. This code of conduct aims to make it easier for cloud customers (SMEs, administrations) to determine whether the cloud services on offer are suitable for them. In addition, "the transparency created by the Code will contribute to an environment of trust and create a high default level of data protection in the European cloud computing market."

29- Cosmian, https://cosmian.com/ proposes "confidential collaborative data processing" services.
30- Cf. IDSA position paper, "GAIA-X and IDS , Janvier 2021. https://internationaldataspaces.org/download/19016/
31- Cf. https://www.iso.org/fr/isoiec-27001-information-security.html
32- The EU Cloud Code of Conduct is the only code to have been drawn up in collaboration with European Union authorities. The Code was developed during four years of collaboration between the European Commission, represented by DG Connect, and the cloud computing community, including industry. In addition, the participation and advice of the DG Justice and the contribution of the "Article 29" working group, which represents the national authorities responsible for data protection, contributed to the high level of expertise apparent in the code. https://eucoc.cloud/en/ home.html

Through adhering to standards and international codes of conduct, CSPs demonstrate their capacity and aptitude to respect rules that protect their clientele. Thus, Google Cloud follows the ISO 27001 standard, while Ali Baba is one of the first to follow the EU code of conduct.

3.3 FROM THE "PERSONAL" NATURE OF DATA TO THE RECONFIGURATION OF THE VALUE CHAIN TRIGGERED BY ADOPTION OF 5G

All data of a personal nature are subject to the GDPR in European Union Member States[33]. In France, the Commission nationale de l'informatique et des libertés (CNIL) is the regulatory body overseeing data privacy. Three key words characterize potential data processing: consent, purpose and responsibility. The entity responsible for processing must respect the principles stipulated in Article 5[34] and demonstrate that it respects them with regard to the purpose of the processing. "The purpose of the processing is the main objective of the use of personal data. Data must be collected for a clearly determined, legitimate goal and not processed at a later date in a way that is incompatible with this initial objective. This principle of purpose restricts the manner in which the entity responsible for the processing may use or reuse such data in the future. Examples of purpose include the management of recruitment, pay, customers, satisfaction surveys, and the surveillance of premises." Note: "(…) processing at a later date for the purposes of archiving in the public interest, scientific or historic research, or for statistical purposes is not considered (…) to be incompatible with the initial purposes."

A data value chain corresponds to the logical and economic sequence of parties involved at different stages of data's transformation and processing, specific to a particular business. The use of data for exploitation by artificial learning algorithms is only one of the links in this chain, rarely the first, and clearly not the last. It is however the point on which most attention tends to be focused. Nevertheless, even before the annotation (if necessary) of data that precedes exploitation, operations are carried out for cleaning, ensuring compliance, verification, guarantees, pseudonymization, etc. Each of these processing stages corresponds to a link in the value chain on which specialized companies are positioned. The data economy takes shape at the scale of these links in the value chain. 5G contributes to establishing new conditions for exchanging industrial data and expressing expertise. In addition to mass processing, a field of deep data analysis is opening up, in hyper-rich spheres that are nevertheless closed and in proximity.

It is worth repeating: maintaining data ownership is perfectly compatible with ensuring access to data for processing purposes. Technical solutions exist that maintain the rights of data owners while permitting processing. This mix of combined, technical solutions fosters trust. Trust-building solutions (security, respect for the private nature of data) merit an informative presentation, in particular when 5G is involved[35].

As we have seen, 5G authorizes the creation of wireless, non-public networks – the user company "privatizes" for its own use a part of the operator's "public" network. On a conceptual level, the user company therefore becomes its own mobile operator within a clearly delineated geographic area. The three big hyperscalers have understood this by developing a package aimed at this clientele (cf. Part 1). Companies that use their non-public 5G networks will become operators of the 5G network infrastructure[36]; they thus obtain total control over their data exchanges. Insofar as their data are processed separately from those on the

33 – The GDPR is the general regulation on data protection, or "Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)".
34- https://www.cnil.fr/fr/reglement-europeen-protection-donnees/chapitre2#Article5
35 - Cf. as mentioned above, ENISA Threat Landscape for 5G Networks Report, ENISA, December 2020, https://www.enisa.europa.eu/publications/enisa-threat-landscape- report-for-5g-networks/at_download/fullReport

public network, the protection of the confidentiality of data linked to processes and production theoretically becomes total.

As companies start to adopt 5G, the data value chains concerned will be subject to major reconfigurations. In terms of wireless, wifi is well managed by computer engineers, whether “in house”, outsourced or subcontracted, who have been familiar with security protocols for a long time. When wireless is operated on non-public 5G networks, security issues in theory move away from computer engineers to end up in telecoms. Security comes into the hands of the operator. If data security moves to telecoms operators, customer companies will need to adjust and make changes to their organisation and skills. Consequently, the operators in place will need to develop a new argument for their customers, setting out the prerequisites of trust. Digital platforms operating under B2C have from the start structured all of their offers around signs of trust. They are now ready to emulate this knowhow by integrating a 5G offer aimed at companies.

The mastering of signs of trust, which they have developed with their B2C customers since the start, constitutes one of the distinctive competencies of GAFAM. This unique competency, based on the exceptional technological mastery of their infrastructure, explains why in 2020 industrial companies and European operators massively chose these same GAFAM to operate their business data. The strategic partnership agreements announced in July 2020 between Renault and Google Cloud[37], and between Orange and Google Cloud[38] are two illustrations[39]:

- “A recognized contributor to Industry 4.0, Groupe Renault has been developing its own digital platform since 2016 to connect and aggregate industrial data from 22 Group sites worldwide (representing 76% of vehicle production) and more than 2,500 machines. This new partnership with Google Cloud aims, among other things, at optimizing Groupe Renault’s wholly-owned and independently operated industrial data management platform.

Google Cloud’s solutions and experience in smart analytics, machine learning (ML) and artificial intelligence (AI) will enable Groupe Renault to improve its supply chain and manufacturing efficiency, its production quality, and the reduction in environmental impact through energy savings.
These improvements will ultimately foster the development of new vertical solutions for the automotive industry.”

- “The partnership [between Orange and Google Cloud] will also work on the development of future edge computing services as 5G networks are rolled out across Europe and cloud computing increasingly benefits from integration into the network. Edge computing is set to become key in the race to meet new consumer and enterprise requirements for low-latency and high-speed services. The cooperation will combine the strengths of Google Cloud and Orange to provide flexible, secure and cutting-edge solutions for the B2B, Wholesale and B2C markets. It will contribute to the enhanced connectivity offerings that Orange provides to its wholesale, B2B and retail customers.”

Unlike the predictions underlying the latest legislative changes at European scale[40], and inaugurated by the Communication “A European strategy for data” in February 2020, and in contrast with our own forecasts[41], specialist B2B digital platformization also comes into the scope of GAFAM. This is illustrated by the fact that they have joined the European cloud federation GAIA-X.

36 – Without obviously becoming an operator in the sense established by ARCEP (article L.32 of the code on electronic posts and communication) which designates “(...) any physical or moral entity operating an electronic communication network open to the public or providing an electronic communication service to the public”. Nothing open to the public in a “non-public” network.
37 - Cf. https://en.media.groupe.renault.com/news/groupe-renault-and-google-cloud-partner-to-accelerate-industry-4-0-4fde-989c5.html
38 - Cf. https://www.orange.com/en/newsroom/press-releases/2020/orange-and-google-cloud-form-strategic-partnership-data-ai-and-edge
39 – French industrialists and operators are however no different from their European partners: for the Germans examples include Volkswagen and Amazon Web Services to develop Industrial Cloud, VW, 27.03.2019, and Google Cloud and T-Systems Announce Strategic Partnership for Cloud Innovation, T-Systems, 3.05.2020
40- Cf. The two EU regulations, the DSA (Digital Services Act) and the DMA (Digital Markets Act), submitted by the Commission to the Council and the European Parliament in an ordinary legislative procedure on 15 December 2020.

Proof of the success of GAIA-X according to its promoters, Google Cloud (Google Ireland), AWS (Amazon Europe Core S.a.r.l in Luxembourg) and Azure (Microsoft NV) have joined the association. Other members include Alibaba Cloud and Haier Cosmo IoT Ecosystem Technology, along with several other US giants in the cloud ecosystem such as Palantir Technologies, Salesforce, Snowflake and CISCO. The leading hyperscalers, who are way ahead of their European competitors, including industrial companies, operators and cloud service providers, have made 5G one of their winning weapons. Unless there is a collective, coordinated reaction, which could be triggered by European regulations and national initiatives, the key links in the industrial data value chain could slip through the fingers of European companies.

41- Cf. Value and price of data in digital platformization, ANRT, October 2019.

4 LESSONS LEARNED AND OPEN QUESTIONS

4.1 "CLOUDIFICATION" DOES NOT MEAN PLATFORMIZATION

The close attention paid to the way that 5G transforms data value chains has highlighted a key point, i.e. the strong trend that is seeing industrial companies turn to cloud service providers (CSPs) to digitize a growing number of their processes should not be confused with platformization itself.

When companies employ 5G to guarantee their own proximity services, as we have seen, it turns them into infrastructure operators. If an industrial company adopts 5G, it can therefore constitute a vector of its own platformization; in which case, it involves a transformation of the company's interactions with its ecosystem (B2B, B2C and B2G[42]). The capacity of the main cloud service providers to offer 5G services, in association with operators, is only a consequence of their extreme market domination. **Digital platformization primarily assumes a deliberate change in industrial organization, a reconsideration of the company's own value chains and the role that data play in relation to them. Depending on the place occupied by data economics in a company, the relations it needs to form with its ecosystem will vary.** This is a strategic organization decision that relates to the company's business model. The fact that a company relies on IaaS, Paas, and SaaS[43] or even 5G-MEC from hyperscalers for part of this digital transformation does not solve the issue. In particular since the latter are not the only providers of cloud services. Along with Amazon Web Services (AWS), Microsoft Azure and Google Cloud Platform, which are infrastructure providers, software developers offer comparable services on the cloud, such as: operating systems, databases, security and various other applications. Examples are SAP, Salesforce and the Apache Foundation. This can involve SaaS offers; the underlying infrastructure can be owned and managed by the software developer itself, or it can have contracts with an infrastructure provider. In some cases, the software provider uses a combination of owned and rented servers. For example, Heroku[44] by Salesforce, a PaaS product, operates on the basis of Amazon's IaaS (AWS). Thus, when a company purchases a Heroku licence, the price includes the use of Salesforce-AWS. In cases where PaaS or SaaS offers employ their own infrastructures, they can likely be integrated into the products managed by infrastructure providers as they grow, while to extend to new regions, they will need to sign new contracts with infrastructure providers.

5G is part and package of platformization for industrial companies in Europe. Thanks to 5G, they will be able to get the most out of their IoT, and thus redefine some data value chains, optimize certain processes, and create more value. However, this business transformation does not only depend on the performance or autonomy of European cloud companies. Industrial policy for the digital age primarily encourages, thanks to favourable framework conditions, the establishment of agreements between companies in the same business ecosystem. Only agreements like these are likely to guarantee that the crossing of data from different sources fosters value creation. Supporting the development of cloud service providers will not automatically result in digital platformization beneficial to industrial companies. Increasing public efforts to support the underlying technological research, which is often private-public by nature, appears to be a stronger option. In fact, technical sticking

42- B2B business-to-business, involving transactions between companies; B2C: business-to-consumer, involving transactions between companies and their final customers; B2G: business-to-government, trade between companies and state services.
43- IaaS: Infrastructure as a Service; PaaS: Platform as a Service; SaaS: Software as a Service.
44- https://www.heroku.com/

points remain for which European players possess strong specific competencies.

4.2
TECHNO-ECONOMIC CHALLENGES

At the time of writing in early 2021, most discussions on 5G relate to the speed of rolling out the network. This speed is considered to be insufficient: the argument is that it holds back industrialists' development of European components, equipment and infrastructures. And that it prevents significant adoption by potential users. Following this argument, operators, who do not invest enough, and states, which do not provide them with enough support, are implicitly singled out. It is worth going beyond this static analysis by looking at the problems that remain to be resolved, and which offer opportunities to the European ecosystems concerned. Thus, according to our work, two areas still require strong mobilization in terms of technological research.

On the one hand, the strongest impact of 5G will come from improvements in the domain of radiofrequencies (cf. the search for millimetre waves). For example, ultra-reliable low-latency communications. More precisely, in practice, uRLLC will need to meet with the following requirements:

- An 'over-the-air' latency of less than one millisecond and end-to-end latency of 5 ms between the user's device and the base station.
- A packet error rate of less than 10^{-5}.
- Low to average data speeds that are compatible with high-speed mobility.

In terms of radiofrequencies, obstacles remain concerning every layer of the 5G infrastructure, including notably the following (cf. participation of CEA-Leti in the WG):

- Connected assets (~IoT): increase energy autonomy.
- User terminals: increase connection capacity and data rates.
- Access points: significantly improve mid-range communications to move towards very high performances (infrastructure and user connections).
- Infrastructure: move towards high capacity[45], which involves in particular high power transmission coupled with fast data rates; this involves installing hundreds of thousands of units.

The presence of an ecosystem of companies and public research laboratories specialized in these domains, which will also be on the frontline for 6G[46], represents an opportunity for Europe.

Moreover, not all of the questions raised by virtualization associated with splitting the 5G network into "non-public slices" have been solved[47]. These developments, sometimes referred to as the second cloud computing wave, are based on the virtualization of 5G networks. The main technical components of the network's operating software architecture are Software Defined Networking (SDN), Network Function Virtualization (NFV) and 5G-MEC (Mobile Edge Computing).

Box 4 - 5G-MEC

Multi-access edge computing (MEC), formerly known as mobile edge computing, is a network architecture concept defined by the ETSI* that enables cloud computing capacities and an IT service environment at the edge of the cellular network and more generally at the edge of any network. The basic idea behind MEC is that by running applications and processing tasks as close as possible to cellular customers, network congestion is reduced and applications work better.
MEC technology is designed to be implemented at cellular base stations or other edge nodes, and enables flexible, rapid deployment of new applications and services for customers. Combining elements of information technology and telecommunications networks, MEC also allows cellular service operators to open up their own radio access networks (RAN) to authorized third parties, such as application developers and content providers.

Source : https://en.wikipedia.org/wiki/Mobile_edge_computing. / *ETSI : European Telecommunications Standards Institute

45- An infrastructure is called high capacity if it supports latency in ms and speeds of between 1 and 100 Gbps.
46- Or sixth-generation wireless communication systems.

This change in 5G corresponds to the move from material platforms to software platforms. Without getting into too many technical details, we here point out only some of the main challenges, concentrating on 5G network slicing[47].

Network slicing involves simplifying the simultaneous handling of several services or applications on the same infrastructure by slicing up the network. This dynamic sharing of resources between different slice tenants improves the performance of network resources. However, it comes up against a problem of resource allocation between these slices, which is dealt with by intelligent planning algorithms. Things become even more complicated given that management is required, both for the slices and between the slices. All the more so given that to ensure that the 5G network is fully efficient will require resolving problems related to the placing of network functions in a slice, the orchestration of the slicing, or the slicing up of services between domains. According to the authors of "5G network slicing using SDN and NFV"[47], computer research is still required on these aspects. The associated problems include the isolation of slices from each other, with performance and service quality requirements for each slice... independently from network congestion and the performance levels of other slices. Lastly, complementary developments and research are necessary regarding interfaces for information flows to provide "network as a service" to third parties.

4.3
CAN THE BATTLE FOR INDUSTRIAL DATA BE WON IN EUROPE THANKS TO 5G ?

The group of high-level experts established in 2018-2019 looked at price and data value mechanisms in platformization at B2B level. The synthesis report produced following this work featured three key results for industrial policy. The first two directly concern data value in industrial processes, and are relevant in terms of business strategy. The third has political implications.

Firstly, the initial condition of value creation is the establishment of a common understanding of the interests and sources of real advantages for each party in a given business data value chain ["not all on the same link"]. This condition results from the empirical observation by which the value of data is an increasing function of the crossings they may be subject to. No business data producer/user possesses all of the data that it needs to optimize its own processes, supply the best service quality, or create value intrinsic to its speciality.

Secondly, the value of data is positively correlated to the protection that users endow it with. While protection comes second to circulation, it is an indispensable ingredient of trust. This second condition, which is complementary to the first, makes the virtuous circulation of data a prerequisite, and makes protection efforts an upshot and a high-return investment.

An in-depth understanding of these two conditions and of their practical consequences can clarify expectations in terms of public policies. The potential for creating data value thus depends on the platformonomics in which public policies must take part. In Europe in particular, the area for common action remains largely to be drawn between economics and competition law in the context of platformization. The self-regulating character much vaunted by structuring platforms is not up to the job: general terms and conditions of sale and codes of good conduct are signs of transparency that only engage those who accept them. As we have already pointed out, these signs of transparency totally correspond to anti-competitive practices. For example a company that prefers to put its own services or products in its ecosystem (self-referencing), or a company that creates barriers to access digital markets (different behaviour).

Only the possibility of an audit procedure and the delivery of a certificate from a competent independent authority can provide the basis of a really protective guarantee. Our work indicates that industrial policy, by integrating the benefits of competition law and the innovation economy, should therefore contribute to making platforms auditable.

47- Cf. Alcardo A. Barakabitze et al., 2020, "5G network slicing using SDN and NFV: A survey of taxonomy, architectures and future challenges", Computer Networks, 167.

The defence of the European general interest, and therefore also that of companies and consumers, has guided the European legislator. This is how the two European regulations, DSA (Digital Services Act) and DMA (Digital Markets Act) were presented by the European Commission to the Council and the European Parliament on 15 December 2020. Put another way (cf. the proposal for the DMA[48], Explanatory statement, p.3) : « (...) the present proposal [should] allow platforms to unlock their full potential by addressing at EU level the most salient incidences of unfair practices and weak contestability so as to allow end users and business users alike to reap the full benefits of the platform economy and the digital economy at large, in a contestable and fair environment."

The Commission's approach is based on an attempt to re-establish technological sovereignty on digitized industry through an integrated set of measures aimed at structuring platforms. The major new feature, in competition law, consists in taking into account the highly changeable nature of rules that these large platforms establish themselves. Thus, the DMA defines illegal practices from the start (ex ante) as opposed to an examination of results of action (ex post), as was the case for all previous rules regulating digital markets. This gives the regulator a greater capacity for intervention: more dynamic, in advance, and more adaptive (differentiated), and subject to the test of time. The repressive approach is included from the start by devising a priori solutions to combat any systematic infractions of the regulations on digital markets.

Nevertheless, this approach does not answer the question that guides us here: to what extent will this new regulatory environment constitute a strength for European industrial companies undertaking platformization? To what extent will the supposed advantage in terms of industrial data in Europe be strengthened? Will European companies' industrial information system be based on 5G networks whose underlying infrastructures essentially incorporate European companies' technologies? Nothing is certain at this point.

At the same time, following Germany and France, the Commission has discerned the GAIA-X association, the initiative of a group of companies in the European cloud ecosystem[49]. According to the Commission's analysis, the cloud and edge represent market opportunities in Europe, which explains and justifies the efforts made by stakeholders and the Commission's support for GAIA-X. According to the EC representative, Europe can count on solid industrial expertise in the underlying infrastructure technologies: industrial IoT systems, business applications, telecom/6G sector, and in terms of systems integration. The call for initiatives for common business data spaces is based on these technological foundations, in addition to adherence to European rules and values. In France alone, a dozen of these business data spaces are being actively developed[50]. Although the potential for developing these value chains by deploying industrial information systems boosted by 5G is not currently on the cards, a number of the necessary applications could very well benefit from it.

48- Cf. https://eur-lex.europa.eu/legal-content/en/TXT/?qid=1608116887159&uri=COM%3A2020%3A842%3AFIN
49- Cf. The presentation by Pierre Chastanet (DG Connect, EC) at the first plenary meeting of the French hub of GAIA-X on 21 January 2021, https://www. cigref.fr/premiere-pleniere-pour-le-french-gaia-x-hub. His presentation can be found here: https://www.cigref.fr/wp/wp-content/uploads/2021/01/22012021_pleniere_french_gaiax_hub.pdf
50- Examples are insurance finance "dataspaces", energy transition, mobility, space, aerospace industry, health, "green deal" and agriculture.

NOTES

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