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The outlook for 5G in 2030 in France and Europe

A report from the Cigref - Futuribles International
working group

June 2021

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EXECUTIVE SUMMARY

THE GOALS OF THE APPROACH

5G network technology is seen as a structuring trend for the next 10 years. It is presented as “the answer” to the economy and society’s growing communication needs.

5G is currently being rolled out around the world and offers several features that complement the previous 2, 3, and 4G generations, including very high speed, low latency and the guarantee of a specific quality of service per function (slicing). These characteristics pave the way for new industrial applications and are accompanied by multiple promises and upheavals in functions and markets. However, 5G raises security, geopolitical, health and environmental concerns that have been widely relayed in the media and social networks.

In this context, companies and public administrations must make strategic structural choices for the future in telecommunications. More than ever, they need a perspective that allows them to take advantage of this technological opportunity while reducing the risks to their activities, without compromising their social responsibility in terms of telecommunications.

To tackle these challenges, Cigref and Futuribles International have joined forces to study and forecast 5G’s future in 2030 with the goal of highlighting potential trajectories and providing members with the information, or at least some of the information, needed to take decisions.

KEY MESSAGES

There are five key takeaways from this study that will structure the future of 5G.

- 1) First of all, **5G is an illustration of the close links that exist today between global geopolitical stakes and national or even ultra-local problems**, which were highlighted by the Covid-19 crisis. This technology, like others, has been the subject of power struggles between major state powers on the international stage. But 5G, its rollout and functions, also reflect strategic choices and socio-economic and physical realities (infrastructure, etc.) that are specific to each country. Thus, governments, in their role as regulators and strategists, are faced with the need to organise these difference scales, not without difficulty.
- 2) Secondly, **5G foreshadows the international power struggles that will structure the next ten years and, undoubtedly, beyond**. The United States and China, of course, are the two countries most invested in this fight to be the world leader. This is demonstrated by their current investments for the next versions of 5G or 6G technology, even though 5G is just in the early stages of deployment. But the race that we are seeing around 5G and the subsequent technology also reveals the growing power of non-state actors who do and will continue to play a major role in the global geo-economic landscape. The links forged between companies and governments around these technological innovations (Huawei in China, for example), the large consortia of firms and university centres to develop new tools (Hexa-X project in Europe), as well as the key role of investment funds in financing research, development and production of all types of technical solutions, already show where the international decision-making centres will be located in the future (the Neuberger Berman fund, to name just one, dedicated a full portfolio to 5G in [May 2020](#)).
- 3) Furthermore, **there is a paradox in 5G that reveals the current tensions between technological progress and the preservation of the environment**. 5G is a tool to limit and reduce the environmental

impact of industries or cities. However, the new functions promised by 5G could cause negative externalities for the environment. But, without these new functions, 5G is no more advantageous than existing networks. 5G, therefore, confronts the world with an equation of its environmental constraints. Resolving it requires developing the innovative devices needed to reap the benefits of 5G while limiting its energy costs.

- 4) Thirdly, **beyond the purely technological aspects, 5G is a reminder of the fundamental importance of people.** Without competent human resources to implement the possibilities opened up by technology, the tool is useless. France and Europe still lack manpower in the scientific fields to exploit the range of applications and develop the promises of 5G. There is a great need for training and research. In addition, 5G, like any new technology, arrives with its vulnerabilities and industrial risks. These are mainly presented from a cybersecurity standpoint at this point because 5G is perceived as an amplifier of exposure to cyber risks. Again, new skills will be needed to prepare for it.
- 5) Finally, **without equal access to this technology within France and Europe and, therefore, without a common strategy between the Member States, 5G will necessarily exacerbate social and economic divides in Europe and in France.**

PROPOSED METHODS AND SCENARIOS

The study and outlook for 5G out to 2030 was carried out during six workshops that brought together more than thirty members with three external contributions, guided by Futuribles' outlook analysis method. This allowed us to sketch several potential pathways for 5G in France and Europe. **This report lays out the five scenarios retained within the framework of this study to provide food for thought and prepare companies for several potential futures.**

These scenarios offer different hypotheses that come from the six key variables of 5G technology:

- Variable 1:** the speed of deployment and functions of 5G,
- Variable 2:** whether or not economic players adopt 5G,
- Variable 3:** the risks in terms of infrastructure resilience, cybersecurity and data protection on 5G networks,
- Variable 4:** the reaction of public opinions to 5G,
- Variable 5:** 5G regulations and governance,
- Variable 6:** the interactions between global geopolitical issues and 5G technology.

The proposed outlook scenarios are not intended to predict the future but to offer markers of how the deployment of 5G in Europe could play out by 2030. Rather than trying to draw up an exhaustive list of scenarios, we chose to identify five:

1. **Transatlantic 5G - France lines up behind the United States against Chinese power.**
In this scenario, 5G is deployed unevenly among business sectors and among French regions. France and Europe have been weakened by the Covid crisis and by the shortages of raw materials to produce their own 5G technology. The United States is pressuring its historic allies to curb China's rise to power in Europe.

2. **Sustainable 5G - Innovation for the environment and regions in France.**

France and Europe have invested in 5G so it can serve the common good by using it as a tool for regions and individuals. This strategic choice, which forces operators to offer equal access to the service and limits the negative environmental externalities of the technology, is part of the European Union's independence mindset.

3. **5G as a vector of power - Europe and France in the geopolitical race.**

After the Covid crisis, Europe has chosen to free itself from all foreign influence and to establish its leadership at the international level by massively funding research and industrial initiatives in order to impose its standards and norms. However, the deployment of 5G, driven by an economic and productivist philosophy, is rejected by a part of the population, which slows down its adoption in certain regions.

4. **Asian 5G - The Chinese model spreads in Europe.**

5G is deployed to increase productivity and competition, and therefore rolled out unevenly in France. Regional disparities lead to marked discontent within the population, with a hardening of oppositions. Weakened by the Covid crisis, the European Union is unable to assert its technological independence, and leaves room for foreign players, including the Chinese.

5. **Forgotten 5G - European differences, limited innovations in France.**

With a lack of resources in a context of economic crisis linked to Covid-19, French operators and manufacturers have not been able to deploy 5G very widely in the country. This delay to telecom infrastructure has an impact on France's economic vibrancy, amplified by the massive deployment of 5G internationally. The public has other concerns and is not opposed to this technology. The European Union traverses a deep institutional crisis and is not able to give directives of common regulations or develop a united industrial strategy: industrial autonomy versus alliance with China and the United States. This division leads to many cyber crises, and France has no weight.

ACKNOWLEDGEMENTS

From December 2020 to March 2021, [Futuribles](#) and [Cigref](#) co-piloted the forecast approach for 5G in 2030 to compare the views between forecasting experts and digital technology practitioners.

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This working group met six times from December 2020 to April 2021 to discuss the scope of the approach, the variables and the scenarios proposed. Research and studies from open sources were carried out to back up this forecasting approach. All the sources consulted can be found in the relevant section of this document.

This document was written by Marie Ségur and Marine de Sury with the contribution of the leaders Anne Lucas, Djilali Kies and Gilles Lévêque.

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EDITORIAL

In its 2020 strategic orientation report "[The age of reason...what's next?](#)"¹, Cigref mentions the deployment of 5G as one of the structural trends for the period 2020 - 2030 to meet society and the economy's need for ever denser and faster communication.

Indeed, the digital transition has led to the massive digitalisation of business processes and generates an exponential increase in the volume of information to be processed. New offerings of digitalised services are constantly appearing as well, supply and demand thus pulling each other up. This strong trend encourages companies and public organisations to analyse and objectify the promises of 5G in terms of capacity and speed to meet the challenges that arise from the hyper-connectivity of people and things.

However, for several months, media coverage of 5G in Europe has been dominated by the security and geopolitical fears that arise from this technology, with, in the foreground, the techno-trade war waged by the United States and China. At the same time, some are speaking up with worries about possible health risks against a backdrop of fears about electromagnetic waves as well as about the environmental degradation that could arise from the deployment of antennas.

Given this context of sometimes legitimate concerns about new technologies and their impact, in addition to the severe health crisis whose consequences, notably in terms of the economy, remain uncertain, it is difficult to try to make predictions in France and Europe. The precise timetable for the deployment of 5G and its adoption by civil society as well as by economic and political actors cannot be foreseen.

However, despite the current uncertainty, companies and public administrations must make strategic choices regarding this new technology, which determines their future. So, while we make assumptions and are not looking to be comprehensive, it seemed useful that we lead a forward-looking study that would shed light on potential pathways for 5G to be deployed in Europe to help our members take decisions and respond to the growing need to prepare for several alternative futures. Finally, it became apparent to us during this process that 5G could also serve as a prism to launch a broader study of the current and future place of technology in our societies.

We are happy to have been able to carry out this work in association with Futuribles International to take full advantage of their methodological contributions. We hope you enjoy reading this forecasting analysis.

The managers, Anne Lucas, Gilles Lévêque, Djilali Kies.

¹ [See the 2020 strategic orientation report: "The age of reason... what next?" – Cigref](#)

METHOD

The working method we used for this forecast for 5G in Europe in 2030 was the creation of scenarios by morphological analysis. This is broadly structured as follows:

- Identification of the subject's key variables (6 variables),
- Construction of hypothetical forecasts (19 hypotheses) covering the range of possibilities for each of the variables,
- Construction and selection of scenarios (5 scenarios) by combining the various hypotheses.

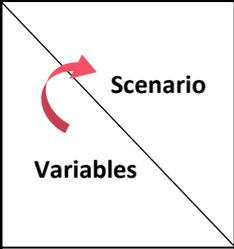
The study was carried out at three scales: French, European and global. However, the scenarios focus on the French and European scales.

First, a so-called “morphological” table presents the different variables and specific assumptions used in each of the scenarios to show how they were constructed. A matrix with the two axes that appear to drive the future of our topic offers a way to simplify and summarise these five scenarios.

The first part of the document presents each of the five “scenarios for the future of 5G in Europe by 2030”. They are developed as a story of the chain of events and the main evolutionary trajectories that structure them.

In the second part of the document brings together the sheets used to develop the scenarios. These short forecasting sheets present the analyses and assumptions made for each of the key variables that served as the basis for this overall construction.

MORPHOLOGICAL TABLE

	Scenario 1 Transatlantic 5G. France lines up behind the United States against Chinese power	Scenario 2 Sustainable 5G. Innovation for the environment and the regions in France.	Scenario 3 5G as a vector of power. Europe and France in the geopolitical race	Scenario 4 Asian 5G. Expansion of the Chinese model in Europe.	Scenario 5 Forgotten 5G. European differences, limited innovations in France
Assumptions used in each variable to construct the scenarios					
Variable 1 5G deployment and functions	V1 - Assumption 1 5G for smart cities and B2B, sights set on 6G.	V1 - Assumption 2 5G for the common good	V1 - Assumption 1 5G for smart cities and B2B, sights set on 6G.	V1 - Assumption 1 5G for smart cities and B2B, sights set on 6G.	V1 - Assumption 3 5G prevented
Variable 2 Adoption by economic actors	V2 - Assumption 1 Marginal and/or forced adoption	V2 - Assumption 3 Gradual and cooperative adoption	V2 - Assumption 2 Competitive adoptions	V2 - Assumption 2 Competitive adoptions	V2 - Assumption 1 Marginal and/or forced adoption
Variable 3 Public opinions and adoption	V3 - Assumption 1 5G adoption is little discussed	V3 - Assumption 3 Consensual adoption	V3 - Assumption 2 Strong polarisation, hardening of oppositions	V3 - Assumption 2 Strong polarisation, hardening of oppositions	V3 - Assumption 1 5G adoption is little discussed
Variable 4 Cyber risks	V4 - Assumption 3 Emergence of a European regulatory platform (non-exclusive)	V4 - Assumption 2 Controlled risks, massive and beneficial research efforts across the cyber field	V4 - Assumption 3 Emergence of a European regulatory platform (non-exclusive)	V4 - Assumption 1 High risks, serial crises	V4 - Assumption 1 High risks, serial crises
Variable 5 Regulations and governance	V5 - Assumption 3 Geopolitical and cyber priorities	V5 - Assumption 2 Green and egalitarian interventionism	V5 - Assumption 3 Geopolitical and cyber priorities	V5 - Assumption 1 Simple market regulators	V5 - Assumption 1 Simple market regulators
Variable 6 Geopolitical issues and sovereignty	V6 - Assumption 2 Growing Sino-American tensions, degraded global context.	V6 - Assumption 3 The EU carves out its place	V6 - Assumption 3 The EU carves out its place	V6 - Assumption 1 Chinese supremacy, Europe forced to align	V6 - Assumption 4 Europe disorganised, France out of the game

01

Scenarios for 2030

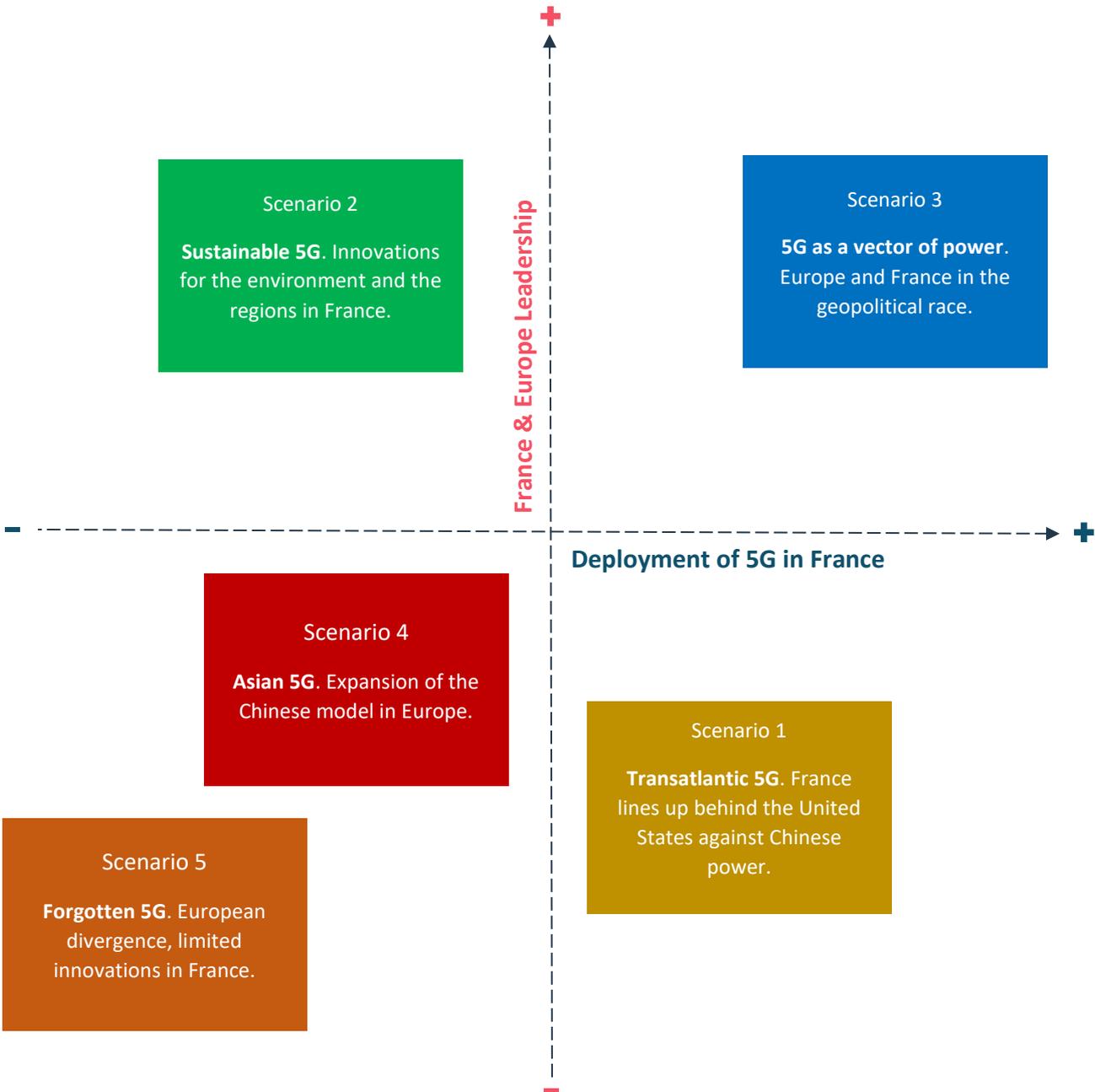
MATRIX OF SCENARIOS

Matrix of scenarios according to the axes of uncertainty: the speed of deployment of 5G in France and the degree of leadership in France and Europe. Source Cigref / Futuribles

NB.: This schematic representation aims to summarise the five scenarios that the working group produced. It is not the method that was used to construct the scenarios.

It lays out the scenarios according to two axes of uncertainties, which appear to be driving forces for our thinking up to 2030:

- What will be the extent of Europe and France’s leadership in terms of 5G? (vertical axis)
- What will be the extent of 5G’s deployment in France in 2030, both in terms of territorial coverage and functions? (horizontal axis)



Point of view

“For an observer of international digital affairs, 5G technology is fascinating in that it struck the geopolitical field before it was even deployed. For Europeans, several lessons can be drawn from the period of international tensions with China that was started almost three years ago by former US President Donald Trump.

First, 5G - like artificial intelligence, in fact - is an extension of the digital field, of which it amplifies the characteristics and shortcomings in its own way: domination by a small handful of actors, fear of data capture, shift of the technological centre of gravity towards Asia, etc. European actors must truly take up this observation both diplomatically and geo-economically if they want to keep their margins for action in the world which is emerging - a world that isn't standing around, waiting for them.

Secondly, 5G represents a risk for Europe of being subjected to competition between China and the United States, which has become the main way of looking at the technological, economic and military spheres in the world. How can we not get swept up in the—obviously dangerous—adventure of “technological uncoupling” that began under the former US administration and has continued under the present one? Therein lies a point of friction that could potentially lead to misunderstandings and even transatlantic tensions.

Finally, 5G questions the balance and the future of the relationship between the global interdependencies and the stated ambitions of sovereignty or strategic autonomy in technological matters. The recurring debates on digital sovereignty, rather than covering up the logics of interdependence that are the hallmarks of our time, should instead focus on our ability to choose our interdependencies.

The European Union's ability to take action in the technological sphere, often relegated to the background, should be the alpha and the omega of the Old Continent's strategy “in motion” in this matter. Fortunately, this is a prospect which seems to be emerging for the European executive which, by identifying its critical dependencies in sectors considered strategic for Europe, is preparing to develop measures to protect European interests. In the face of predatory strategies from third countries, the time is right. In its own way, the issue of 5G has been a wake-up call for a Europe that wants to abandon technological subservience and face its vulnerabilities over time.”



Julien Nocetti,

*Associate researcher at the French Institute of International Relations
and professor at the Saint-Cyr Coëtquidan Military Academy*

SCENARIO 1: TRANSATLANTIC 5G. FRANCE LINES UP BEHIND THE UNITED STATES AGAINST CHINESE POWER.

KEY POINTS OF THE SCENARIO

- In France:
 - 5G develops for smart cities and B2B,
 - Economic actors marginally and/or are forced to adopt 5G in certain sectors,
 - Take-up of 5G is little discussed in public opinions.
- In Europe and in the world:
 - A European regulatory platform emerges to harmonise standards between Member States,
 - European Union geopolitical and cyber priorities,
 - A geopolitical context of growing Sino-American tensions, rejection of Chinese technologies, especially from equipment manufacturers.

THE SITUATION IN 2030

In 2030, 5G is **unevenly deployed** in France. **Rural areas and small cities still do not have access**, lack antennas and devices, even if operators continue to promise it. **Big cities benefit** from it more widely. In some cities, operators have set up new antennas supplied by Nokia and Ericsson, (Huawei being banned from operations on European territory), allowing for phase 2 of the deployment and functions of 5G to be initiated by exploiting the 26 GHz band. At the same time, some manufacturers see this as an opportunity for development in certain segments and sectors (transport routes, productivity gains in factories, fluidity and security of communications between teams, etc.) and therefore equip themselves to deploy it on their sites. However, the economic crisis that Europe is traversing due to the Covid-19 crisis **limits the economic investments from companies and public authorities**. For the most part, both private and public organisations remain content with existing infrastructure. However, some are becoming more and more fragile (aging wired network). But the government's priority is to support other sectors of activity still in difficulty after the strong economic slowdown of the early 2020s. Since the allocation of 5G frequencies in 2020, French regulators have paid little attention to this technology.

For most people, **5G has not changed much**. For a segment of the population, the new packages offered by carriers making 5G more accessible have nonetheless come to meet the growing needs for speed. These needs result from the growth of remote working and distance training since the health crisis and, more generally, from the increase in the use of virtual services, in the field of leisure for example. UHD videos, virtual reality games... the growing number of applications from carriers and service and digital leisure companies meet with great success. Thus, **public opinions are little opposed to the technology**, which meets the consumer expectations of the people that have access to technology. **A few activist groups remain**, seeking to demonstrate the networks' vulnerability through hard-hitting actions. But the **cybersecurity of 5G infrastructures is managed at European level via the Inspire5Gplus platform, which harmonises security standards between Member States**. Therefore, there are few large-scale cyber crises over the period.

HOW DID WE GET HERE?

The deployment of 5G infrastructures in France and in Europe has largely been **orchestrated by the United States**. Between 2020 and 2030, the Americans put pressure on their historic allies to slow down China's rise to power by first emphasising the importance of preserving the democratic values of Europe and America. 5G has not escaped this fierce techno-trade war, which is dividing international markets into two blocs. Thus, as early as 2022, the United States and European regulators come to an **agreement on the alignment of European and American technologies and carriers, with relative European autonomy enshrined in legislation**. This agreement is inspired by the tricontinental alliance already signed between the United States, the United Kingdom and Japan. Member States have undertaken not to enter into contracts with Chinese equipment manufacturers (mainly Huawei) to build their 5G antennas and to limit their technological supplies from China. In return, the Americans financially support certain European research projects (in particular on open-source technologies and the [Hexa-X project on 6G](#)). They also source their supplies from leaders in the 5G sector in Europe (Nokia and Ericsson) and from their Japanese counterparts (NEC and Fujitsu). However, this strategic choice slows down the deployment of 5G in Europe and France, areas still economically fragile due to the Covid crisis and which are sometimes victims of shortages of raw materials that hinder the production of their own technologies. Thus, in 2030, 5G is not a revolutionary technology for end users, whether they are companies, regions or ordinary individuals. Above all, 5G remains the subject of geo-economic struggles. Moreover, with a lack of its own 5G manufacturers, the United States is already engaged in research on new types of networks (6G and beyond) and new technologies, with the aim of beating China where it is not yet strongly positioned.

What is 6G?

As its name suggests, 6G is the sixth generation of mobile networks which should logically succeed 5G. While 5G is just beginning to be deployed, the United States, China, Japan, South Korea as well as Europe are already investing in 6G technologies. The contours of how it will operate and be regulated, however, remain very vague, since the international telecoms regulatory committee (3GPP) has not yet ruled on its certification. According to announcements made in April 2021 by Huawei, one of the leaders in the sector, 6G should allow speeds 50 times greater than those of 5G by relying on terahertz frequencies, open up even wider coverage thanks to satellite relays, and be available from 2030. Therefore, it would be based on infrastructure different from those put in place for 5G. For the time being, this technology is first and foremost the subject of political struggle between nations, which are seeking to establish their technological leadership on an international scale.

SCENARIO 2: SUSTAINABLE 5G. INNOVATION FOR THE ENVIRONMENT AND THE REGIONS IN FRANCE.

KEY POINTS OF THE SCENARIO

- In France:
 - 5G develops for the common good: products, services and regional coverage designed to improve people's way of life,
 - Gradual adoption by and cooperation from economic actors,
 - The public relatively agrees to take-up.
- In Europe and world-wide:
 - Cyber risks kept under control, massive and beneficial research efforts across the cyber field, funded by Europe,
 - Green and egalitarian interventionism from the French government and Europe,
 - The EU carves out a place for itself: it gradually asserts an alternative path to Sino-American polarisation.

THE SITUATION IN 2030

In France in 2030, many players have invested heavily in 5G to make it **a tool to serve people and regions**. As planned in the government's timetable, almost all of the sites are covered by 5G. The government supervises these 5G functions, which notably forces operators to ensure people have **equal access to the service** and also **limits the technology's negative externalities** in environmental matters. Concretely, **beyond the large cities that have had several 5G antennas since 2022**, the many applications of 5G developed by industry as well as local authorities contribute to a **progressive revitalisation of rural areas**. Furthermore, some regions, even isolated ones, are starting to test the applications made possible by using the 26 GHz band. Access to public services is increasingly guaranteed. Since 2025, telemedicine has been deployed in a well-thought-out way and compensates for the shortcomings in certain rural deserts. Remote working is improved, making it possible to attract new talent outside large cities. Remote learning is encouraged. Several regions are also taking this opportunity to improve their resilience (for example, in the face of natural hazards), their agricultural yields and their attractiveness.

At the same time, companies and carriers (Orange, Free, etc.) have innovated and created new economic models to reduce the environmental impacts of 5G technology. Some operators offer reduced-price packages for the users who are most concerned about their negative externalities using the same model as car insurance, which rewards their most cautious customers ("Pay as you drive"). Applications similar to Yuka (which evaluates the quality of food products) allow users to monitor the environmental impact of their network usage. The energy consumption of the antennas and relays themselves is optimised (power adaptation, standby, radio relays switch off when the demand for bandwidth decreases, etc.). When kept under control in this way, in 2030 5G truly helps to speed up the environmental transition (limitation of travel, sensors measuring emissions, optimisation of electrical networks, etc.).

HOW DID WE GET HERE?

In 2021, the French government entrusted ARCEP with a **new role of regulating the environmental footprint of telecom networks**. The government also created a **steering committee for digital innovation** which brings together ARCEP, ANSSI, major manufacturers and French and European operators and granted it a substantial budget. These players are committed to reducing the negative externalities of their technology and how it is used. Together, they come up with the best solutions to preserve the environment. This committee promotes “sandbox” systems. Companies that want to offer new functions via 5G can test them on **cooperative platforms** and **pool their networks**. Then, they can deploy these services on a large scale, once the steering committee has confirmed that the energy cost-benefit ratio is balanced. Large and small companies join forces in these spaces, for example, to jointly optimise their industrial production by pooling technical know-how, technologies and resources. The government and private sector work towards a more reasonable development of technologies in France, and European equipment manufacturers and French carriers get involved to make the technology progressively more available, even in the most isolated areas. This allows for **5G to be relatively well accepted by the French public**.

In terms of **cybersecurity**, from 2021 public authorities take great care to **protect the network and hold carriers and equipment manufacturers responsible** in case of failure. However, overall 5G shows that it improves cybersecurity thanks to its data encryption function and the integration of firewalls in network infrastructure by design, which also fosters take-up.

This enlightened development of 5G is part of a broader context of a European desire to open a third, alternative path of technological development that helps to preserve the environment. 5G is seen as one tool among others to achieve these goals. Therefore, the EU funds numerous research programmes to encourage the adoption of greener technologies, including among its leading 5G OEMs Nokia and Ericsson, which it supports. BEREC sees its mission expanded to ensure homogeneous regulation at European level. This **planned adoption of 5G therefore takes place on a slower timeline than in other regions**. This is a **strategic choice that fits the European Union’s goal of independence** in the long term. For this reason, the time for deploying 5G is longer in this scenario given the specific norms, rules and standards that need to be implemented in accordance with the New Green Deal and Europe’s stimulus plan.

SCENARIO 3: 5G AS A VECTOR OF POWER. EUROPE AND FRANCE IN THE GEOPOLITICAL RACE.

KEY POINTS OF THE SCENARIO

- In France:
 - 5G develops for smart cities and B2B,
 - Private actors compete, fostering proactive adoption in the major business centres,
 - Civil society puts up major challenges.
- In Europe and in the world:
 - Cyber risks are high, but Europe invests heavily to regulate risks within Member States,
 - The European Union and France assert their technological leadership strategy to position themselves at the international level, to the detriment of other priorities (environmental in particular).

THE SITUATION IN 2030

In France in 2030, carriers have massively deployed 5G in large cities and in nodal points (infrastructure, transport). To meet the demand of large French companies that want to use 5G to optimise their industrial processes and offer new services to their customers, carriers have entered into partnerships with foreign equipment manufacturers, particularly Japanese. For the moment, purely European equipment manufacturers are not powerful enough to cover all the needs for antennas and devices, but the massive investments put in place by the EU and France should boost their growth in the years to come. At the same time, French regulators intervene rarely in the deployment of 5G, only constraining carriers at the margin, which leaves many regions disconnected. In fact, carriers focus on the development of 5G's phase 2, i.e. the exploitation of the 26 GHz frequency bands, rather than on covering the entire nation, thus deviating from their specifications. This strategy benefits large companies located in major cities. They use the higher bandwidth and the reduced latency time to develop connected robotics in their production chains and to control a large number of operations remotely, including technical or even sensitive operations thanks to the better possibilities offered by virtual reality. Thus, large French companies gain in wealth and power. **Public opinions become polarised** over the importance given to the economy and production. **A section of the population is strongly opposed to this use of technology and denounces "greenwashed" growth, with harmful impacts on the environment and human health.** This fragmentation of public opinions towards 5G slows take-up in some French regions. Antennas are regularly burnt down. Some green mayors refuse to issue building permits. Tensions in French society crystallise around this subject.

HOW DID WE GET HERE?

After the Covid-19 crisis, Europe chooses to establish its leadership on an international scale by getting involved in the global race for new technologies. The European Union thus seeks **to impose its standards and norms and promote its sovereignty.** It **massively finances research and industrial initiatives** to counter foreign influences.

Starting in 2022, it also launches **a major training programme for engineers and promotes scientific fields in Europe** to fight against brain drain to China or the United States. With financial support, consortia of European private players (equipment manufacturers and operators in particular) have been trained to align their R&D strategies on the model of the Hexa-X project, which brings together the heavyweights of the European network sector, Nokia and Ericsson at its head, as well as Siemens in Germany and the French group Atos, telecoms companies Orange (France), Telefonica (Spain) and TIM (Italy), and the CEA as well as numerous university research centres. These investments are made to the detriment of environmental and social issues, which take second place. In fact, some polluting manufacturing is gradually brought back to Europe. Ultimately, **Europe's ambition** is to **free itself from foreign influence** and to **open a third way on the international stage**, but one that **does not offer an alternative to the deregulated growth** already pursued in China and the United States.

Point of view

“I was lucky enough to be able to manage major infrastructure projects such as Linky for Enedis and energy sector transformation projects such as the opening up of residential electricity markets to competition within EDF. If I dare to make this comparison with 5G, it is because I have been confronted with navigating through rough seas and have been subjected to others’ positions on topics as strong as cybersecurity, personal data protection, media coverage of the impacts on health or even competing views on local versus national democracy. My favourite subject is to understand and act on the resources needed to establish confidence in major projects. They are often subject to political opportunism and pot-shots from some people on social networks and the media.

Stakeholder confidence is “key” to success. This is created, among others, by the consultations carried out ahead of and during the project, by the quality of the information made available to all and by taking into account other peoples’ challenges and aspirations. Confidence must be an obsession for a project leader. This trust acts as a shock absorber to overcome crises generated by social networks, for example. Obviously, we do not measure the quality of project management by its results on social networks, but they reveal valuable information for the project.

The prospective approach offered here should contribute to consultations with its objective and respectful considerations. It gives meaning, content and perspective to thinking. Carried out with rigour and openness, it allows everyone to develop their own view of the subject. This approach also seeks to shed light for the various managers in their decision-making.

I find it very interesting, in the scenarios developed from the forecasting, to find a deployment of 5G that serves the general interest, which emphasises in particular the need to consider the digital divide. The general interest is a key point to making large infrastructure projects acceptable. These major projects seem to me essential to achieving our climate ambitions, in particular.”



Bernard Lassus,
Former Linky Programme Director

SCENARIO 4: ASIAN 5G. EXPANSION OF THE CHINESE MODEL IN EUROPE.

KEY POINTS OF THE SCENARIO

- In France:
 - 5G develops only in high-activity centres (urban hubs, logistics centres, etc.),
 - Strong polarisation within the population, hardening of oppositions.
- In Europe and in the world:
 - A European regulatory platform emerges to develop shared cybersecurity standards,
 - France and the EU remain in their roles as market regulators,
 - China emerges victorious on an international scale; Europe forced to align.

THE SITUATION IN 2030

In France, 5G is **rather unevenly deployed throughout the country**. The biggest companies continue to think in terms of productivity, increased yields and competition. They prefer solutions in the heart of large urban areas and nerve centres (ports, airports, highways). Some cities invest in video surveillance and population control solutions that are improved using 5G technology in order to make public spaces safer. Thus, telecoms companies focus their efforts where demand is greatest, leaving rural areas behind. They turn to Chinese equipment manufacturers in the absence of French or European regulation which would seek to protect the markets from Asian influence. These regional disparities lead to **pronounced discontent within public opinion**. Opposition hardens in the face of 5G projects perceived as invasive and representative of the domination of political powers over citizens, or even as tools aimed at developing mass surveillance similar to that which exists in certain Asian countries. The negative perceptions of 5G technology have been aggravated by the Covid-19 crisis, which has caused a large number of controversies (health passport with QR code, mRNA vaccines causing mistrust, etc.).

HOW DID WE GET HERE?

Between 2020 and 2030, the rise of China has crushed any possibility for other American or European leaders to assert themselves (in 5G as well as other technologies). China, **influential in international standardisation forums, imposes its standards**, with which some of the middle and great world powers comply. Thus, China brings about **a new multilateralism centred around its interests**.

Weakened by the Covid-19 crisis, **the European Union does not take forceful action to orchestrate the development of 5G, or even reverses certain decisions concerning Huawei, leaving room for foreign players**. However, it does not want to deprive itself of the most cutting-edge technologies, and while relations with the United States are at a standstill, the European Union **forges increasingly close partnerships with China and Chinese private players**, in particular the equipment manufacturer Huawei, which is largely dominant. The Chinese firm is also on the verge of signing a partnership with Nokia, in financial difficulty, which would allow Huawei to further extend its influence in Europe. Entangled in other issues (economic and social), the Member States do not assert their technological independence.

SCENARIO 5: FORGOTTEN 5G. EUROPEAN DIFFERENCES, LIMITED INNOVATIONS IN FRANCE.

KEY POINTS OF THE SCENARIO

- In France:
 - 5G's deployment is very limited throughout the country, economic/industrial players adopt the technologies only marginally,
 - There is no controversy over 5G in French public opinion; other areas of concern are more significant.
- In Europe and in the world:
 - However, cyber-attacks are increasing (on 5G networks and others),
 - The French and European authorities stick to their role as market regulators,
 - Industrial strategies and European regulatory directives are disorganised, heterogeneous or even non-existent. France is out of the game.

THE SITUATION IN 2030

In 2030 in France, **5G is deployed and used only in large cities**. The country lags behind in terms of innovation. Companies struggle to attract engineers, in particular experts in cybersecurity, IoT, or data scientists, all specialties essential to successfully deploying 5G. Therefore, functions remain very limited despite the availability of 5G in certain dense areas. Most people don't even have compatible devices. Given the economic crisis, **the cost of investments** for telecoms companies and manufacturers have **prevented it from being more widely deployed throughout the country**. Phase 2 has not yet started due to a lack of resources to deploy new antennas and devices that are too expensive. Many private companies prefer to use cheaper technologies (Wi-Fi 6 in particular). This delay in improving telecommunications has an impact on France's economic vitality compared to other international powers, who continue to invest massively. Without 5G, the 4G network sometimes finds itself saturated. Remote working is still complicated in some isolated areas. For certain groups of individuals, however, this "unchosen" technological underdevelopment can also be a way of choosing another, simpler social and economic model in which the low-tech has pride of place. Elsewhere, **6G is already being deployed**.

HOW DID WE GET HERE?

Over the decade, **the European Union goes through a deep crisis of its institutions** as a consequence of the Covid-19 crisis. Therefore, it is not able to develop a common strategy to face **international challenges, crystallised in particular by 5G**. Member states adopt **different, varying strategies depending** on the country, its ambitions, and its international relations. Some countries decide to **bring back industrial production of components, including pollution, to ensure their self-sufficiency**; others choose to **bind themselves to China or the United States**. In this context, cyber crises are numerous, testifying to struggles and clashes between players.

WILD CARD: 2025-2030. A LARGE-SCALE CYBER CRISIS VIA 5G NETWORKS.

This wild card could occur in all scenarios, but it is more likely in scenarios in which there are high geopolitical stakes and clashes between great powers and the deployment of 5G is significant.

The dematerialisation of wired networks, replaced by 5G, and the development of software to operate connected objects multiply the points of contact for routing traffic, thereby weakening the entire 5G infrastructure. Controlling cyber security throughout the chain is perilous, and a single unsecured area can compromise other parts of the network. Especially if 5G becomes a critical infrastructure for governments and large companies (management of energy and water networks, health systems, transport, etc.), it could then become a target for malicious actors.

By 2030, we can therefore envisage a large-scale cyberattack which could temporarily paralyse the economic activities of a country or a group of countries, or even politically destabilise them. This attack could be carried out by other countries or by autonomous or coalitions of hackers. This could lead public and private players, even public opinion, to reject 5G and lead them to look for alternatives to make networks secure.

02

Scenario building

02 - SCENARIO BUILDING

This second part presents all the material that was used to develop the scenarios. Each of the six key variables which served as the basis for this overall construction is presented as a short forecast sheet. They are all built on the same framework: define the variable, the structural trends, the major uncertainties, emerging events, and finally, the forecast assumptions used to build the scenarios. Let us take a moment to recall the vocabulary of forecasting.

- ❖ **Structural trend:** A phenomenon with high inertia in the medium to long term, and very structural for the subject studied. The slow evolution could change course.
- ❖ **Major uncertainty:** An open question that is decisive for the future of the variable, but for which there is no answer today. The various answers available might lead to different scenarios for the future.
- ❖ **Emerging events:** New phenomena which can change the course of or discontinue a major trend, or give birth to a new trend. Emerging events can be preceded by a “weak signal” and are often linked to the appearance of new actors, to a change in the role of an actor in the system, to new modes of behaviour or sociability, to discoveries that have gone unnoticed, and so on.
- ❖ **Forecast assumptions:** Possible answers to questions raised by uncertainties.

VARIABLE 1: 5G DEPLOYMENT AND FUNCTIONS.

DEFINITION

This sheet aims to compare the promises made by the promoters of 5G with the real technical capabilities that this technology offers. The objective is therefore to detail the new offerings that could be made as a result of 5G, specifying their beneficiaries and their possible deployment timelines. 5G appears to be an accelerator of digital trends that are already present, in particular because it can be deployed on existing bands and on the core of the existing 4G network. However, it paves the way for disruptive new services by offering new functionalities (such as the ability to manage a large number of connected objects, ultra-reliable connection management, differentiated management of the network in the form of virtualised slices) and the addition of new frequency bands (the 3.5 GHz frequency range, close to that of 4G, and a new range around 26 GHz).

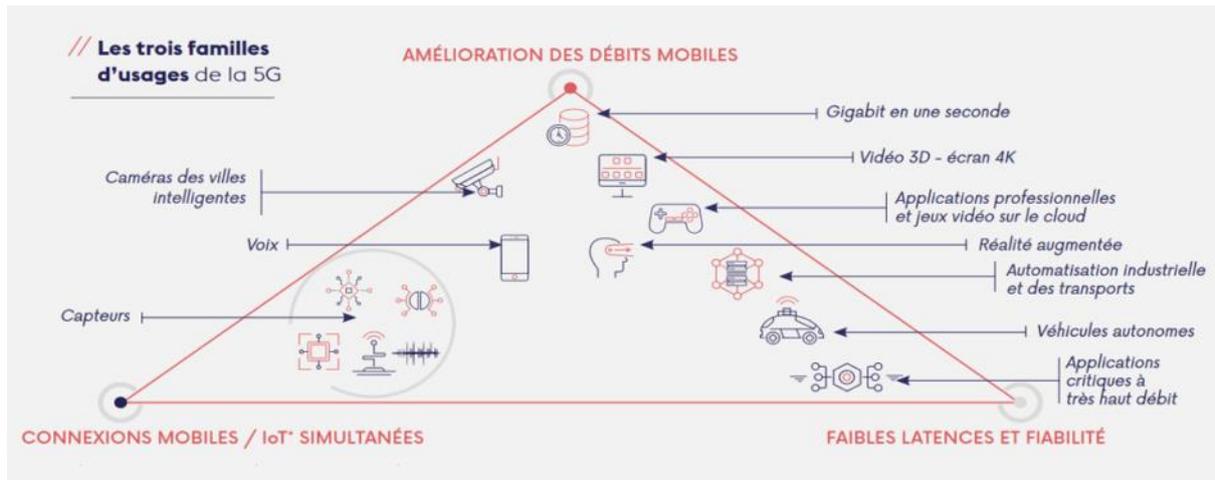
5G should also be considered in the general context of telecoms evolution, in particular the generalisation of fibre, from which it is inseparable. In fact, 5G antennas will be connected by fibre to begin with. Furthermore, outside mobility scenarios, functions that require high performance will prioritise wired fibre connections. For the final connection, wireless standards are possible, such as Wi-Fi and the very low consumption Internet of Things, sometimes called 0G. In addition, technological developments such as virtual reality, or changes in functions such as remote working, are developments concomitant with the evolution of mobile telephony towards 5G. In all these fields, 5G, which makes it possible to converge radio-mobile, wired, and long-range networks for IoT and Wi-Fi by offering a standard for all types of functions, constitutes an additional facilitator.

STRUCTURAL TRENDS

- **5G accelerates practices and offers that already exist, just like the mobile networks which preceded it (1, 2, 3, 4G, etc.):**
 - Remote working, augmented and virtual reality, remote medical consultations...5G will make it possible to avoid network saturation in dense areas and, therefore, maintain the experience of 4G (smoothness, speed) as it existed at its inception for a larger number of users. 5G's contribution should not stop there: data bandwidth will increase sharply in areas sized accordingly where the antennas will be deployed, and the latency will then decrease locally, ensuring real-time responses for existing services. These services will be improved, just like the function of monitoring sensitive locations.

- **5G opens up the possibility of better synchronisations/convergences between devices, between architectures, and in terms of data processing:**
 - 5G is based on a "smart" network that offers differentiated performance according to targeted functions ("network slicing"). It is able to offer an ultra-reliable communication service with very low latency. (Source²)
 - The very low level of latency offered by 5G opens up prospects for interactivity and remote control of precision connected objects used to manage robots, autonomous vehicles, production lines, even surgical instruments.

² <https://www.tactis.fr/5g/>



The possible functions of 5G. Source: Arcep.

- Finally, in its new frequency band at 26 GHz, more connected objects will communicate simultaneously with each other in a given area to optimise decision-making in factories or in connected cities, in particular for transport, security, management of networks, etc. Thus, some town halls are starting to accept the opening of 5G networks because cities have identified use cases for the “smart city”. This is the case of Montpellier, which expected to deploy fifty-four 5G antennas by the end of December 2020, with the goal of optimising the response to fires in the city using autonomous drones, among other things. Likewise, the city of Nice wishes to offer new tourist services using 5G and has obtained special permission from the government to install the first antennas provided by Huawei, despite the political controversies around the Chinese equipment manufacturer. [Source 1](#)³. [Source 2](#)⁴.
- **The promises of new functions in the industrial sector are significant and affect all areas of activity, from logistics to agriculture:**
 - In terms of communication between individuals within the same organisation, the convergence of devices that 5G promises should make it possible to provide employees with a single device for all networks (and thus replace the use of walkie-talkies, etc.). This is a real promise of savings and agility for the teams who constantly exchange information (construction sites, airports, ports, etc.).
 - It should be possible to remotely monitor, control and reconfigure industrial machines and robotic production lines quickly, easily and dynamically. Logistics and industrial production should therefore be greatly improved, especially in large yard nodes. More and more teams, especially workers, will be able to work remotely.
 - 5G promises to foster remote operations of all kinds (e.g. in the field of mining, operations in sensitive or dangerous areas, health in special cases, etc.) thanks to low latency and UHD video image exchange.
 - In the field of agriculture, the increased number of connected sensors will allow farmers to precisely track herds and control agricultural machinery remotely, in particular in difficult areas, thus improving yields.

³<https://www.francebleu.fr/infos/societe/montpellier-sera-couverte-pas-la-5g-fin-decembre-avec-l-operateur-orange-1605884533>

⁴<https://www.linfordurable.fr/technomedias/nice-premiere-ville-couverte-par-la-5g-21484>

- **For the general public, the promises of new functions currently concern a diversification of training and entertainment offerings.**
 - Downstream and upstream streaming of UHD videos,
 - 360° virtual reality in wireless connectivity that applies to many functions (for example, games, education, vocational training, tourism, etc.),
 - Remote monitoring of manual training, monitoring handwriting, monitoring hand movements, etc.
 - Help teachers to improve their relationships with students in lockdowns.

The general public will also be able to benefit from the safety and health services allowed by 5G applications from public actors.

- **However, the real benefit of these new digitalised services remains questionable for a certain number of them, in particular in the field of education.**
- **For local and national authorities, 5G offers the possibility of optimising services thanks to the widespread collection of usage data and the real-time management of infrastructures.**
 - High-speed, low-latency connectivity for vehicles and transport infrastructure (e.g. for connected vehicles, for entertainment, etc.),
 - Retrieving data from the “smart city” of the future to check road traffic and the various levels of pollution, for example, and more collective and efficient management of energy resources (production and consumption).

	Particuliers	Industries	Collectivités
Augmentation des débits	<ul style="list-style-type: none"> • Technologies immersives (ex. réalité virtuelle) • Vidéo Très haute définition 	<ul style="list-style-type: none"> • Utilisation intensive du logiciel en tant que service (SaaS) y compris en situation de mobilité • Technologies immersives (réalités augmentée, virtuelle ou mixte) • Vidéo Très haute définition 	<ul style="list-style-type: none"> • Vidéosurveillance très haute qualité (définition et fiabilité) • Téléassistance vidéo des secours
Réduction de la latence	<ul style="list-style-type: none"> • Jeux connectés 	<ul style="list-style-type: none"> • Robotique connectée (ex : convoyeurs en usine ou entrepôts) • Pilotage de lignes de production 	<ul style="list-style-type: none"> • Mobilité connectée • Véhicule autonome • Services de secours
Densifications des connexions	<ul style="list-style-type: none"> • Domotique 	<ul style="list-style-type: none"> • Connexion de l'outil de production • Objets connectés (Internet of Things « IoT ») 	<ul style="list-style-type: none"> • Pilotage de la <i>smart city</i> à travers des objets connectés (cf. fiche 4)

Functions by user category - Source: [Banque des territoires](#), 2020.

- **However, at this document’s time of writing and in the current state of the needs of economic and public players, several other technologies can meet the same needs as 5G.**
 - Thus, the oft-cited example of self-driving cars is not totally relevant since several vehicles driven by artificial intelligence have already been able to function without 5G. For example, the Google Car, launched in 2010, has travelled several million kilometres using its on-board radars and cameras and a powerful computing system, all without a 5G network (source IHEST 2020). Moreover, the particularity of an autonomous vehicle is not to be dependent on its connectivity, which would be much too dangerous. However, it should be noted that connectivity improves performance and allows the car to have visibility into what is happening in its immediate environment using V2V (Vehicle to Vehicle) or V2I (Vehicle to Infrastructure) connections, and 5G can play an important role in these improvements.
 - Likewise, solutions adapted to the low-bandwidth Internet of Things already exist, such as the Lora standard, and are being deployed by several companies such as Sigfox, the start-up Be-bound and telecoms operators. These use a frequency with a lower bandwidth and, while they are less powerful and process less information, they already cover almost the entire country, perhaps even the world.
- **The lockdown of more than half the world’s population has led to a boom in the use of digital technology. However, this sudden growth in consumption has not saturated existing networks, although they have been severely tested. Sobriety mechanisms have also been implemented. Thus, the argument whereby the deployment of 5G is inevitable because the networks will necessarily be saturated remains debatable.**
- **Finally, the promised new functions will only be made possible gradually as 5G sites are deployed.**
 - For new applications to be properly implemented on a wide scale, we will have to wait for technological developments to be deployed, in particular in network core developments, which are only planned in a second stage.
 - For widescale use, 5G coverage will also need to be more widespread. Access to 5G for two thirds of the population is not expected until 2025, and then only on the 3.5 GHz bandwidth.
 - **Therefore, telecoms operators have two challenges: the development of 5G as a technology and complete coverage of regions. These two challenges require significant financial investments from carriers.**

	2020	2022	2024	2025	2027
Exigences de déploiement de sites 3,5 GHz	Au moins 2 communes ¹³ pour chaque opérateur	3 000 sites déployés ¹⁴	8 000 sites déployés ¹³	10 500 sites déployés ¹³	100% des sites en 2030
			Couverture des sites olympiques	Couverture des grands centres urbains et des axes autoroutiers (16 642 km)	Couverture des routes principales (54 913 km)
				Accès à la 5G pour les deux tiers de la population	

5G deployment schedule in France. Source: [Banque des territoires](#).

MAJOR UNCERTAINTIES

Beyond questions of timing, the promises of 5G come up against many uncertainties that we can already identify:

- **How can we densify networks outside urban areas, particularly with a view to regional equality?**
 - **Today:** Not all regions even have 4G yet. Some are even in a “white area”, i.e. no mobile network is available there. In addition, we already know that the deployment of 5G antennas will take time, and that dense areas (metropolitan areas, airports, etc.) will take priority, in particular for the ultra-dense network of future antennas operating at 26 GHz. The latter may be integrated into street furnishings, for example.
 - **Tomorrow:** In fact, the dynamics of access to 5G will differ depending on the geographical area in France. What regional developments will the central government and local authorities make to meet this challenge? Doesn't this phenomenon risk reinforcing inequality and accentuating not just the digital divide, but also the economic and social divide between regions?
- **How to finance the massive deployment of 5G?**
 - **Today:** The investments required to deploy 5G are substantial and will remain so, for both carriers and manufacturers. There is strong competition to find sources of funding from future users.
 - **Tomorrow:** Could the massive deployment of 5G as envisaged in France for 2030 be hampered for economic reasons? In this case, which players or users would be privileged? Conversely, could 5G take precedence over the deployment of fibre for wired connections? This possibility raises the question of the energy consumption of “wireless” compared to that of fibre, which consumes less energy.
- **How will we ensure coverage inside buildings, especially because of the limited range of millimetre waves, which are sensitive to obstacles?**
 - **Today:** Carriers promise that 5G will revolutionise industrial functions, in particular by allowing the rise of Industry 4.0. However, installing 5G indoors poses many technical problems.
 - **Tomorrow:** could 5G be limited to outdoor use? In this case, could manufacturers give up on the promises of improved performance and yields from 5G-connected objects? Note, however, that cellular repeaters may help resolve some of these issues.
- **What impacts will conflicts of use have on the spread of 5G to the masses?**
 - **Today:** 5G has already been shown to interfere with other technologies, including critical ones. Thus, the use of 5G would be compromised in certain key areas, such as airports, where the 3.7-3.9 gigahertz band it uses creates a “major risk” for planes' radio altimeters, which also pass through these frequencies.⁵ Likewise, the World Meteorological Organization has sounded the alarm: it fears that 5G will disrupt atmospheric analyses by emitting interference on the frequencies used by weather models.⁶

⁵ <https://www.lesechos.fr/tech-medias/hightech/5g-les-operateurs-telecoms-sont-furieus-apres-le-veto-des-aeroports-1266848#xtor=CS1-3046>

⁶ <https://www.tameteo.com/actualites/actualite/la-5g-risque-t-elle-de-perturber-les-previsions-meteo.html>

- **Tomorrow:** Do these conflicts of use risk limiting the deployment of 5G and, therefore, of its innovative functions? Can 5G reuse certain frequency bands currently dedicated to 3G and 4G to avoid these conflicts?
- **What impact will 5G have on the environment?**
 - **Today:** 5G promises to reduce environmental impacts based on the fact that a 5G cell consumes less in relative value than a 4G cell and that the energy consumption for each bit of data sent is lower than that of 4G. But it will take more 5G cells to cover the same area as 4G, due to the lower radio frequencies. In addition, one of the main promises of 5G in terms of new services is that it allows several objects to connect simultaneously. However, the proliferation of these objects in service will, in fact, greatly increase the flow of data and, therefore, overall energy consumption. According to The Shift Project, the deployment of 5G could multiply citizens' data consumption by 10 and, therefore, mobile operators' energy consumption by 3 in five years, i.e. a 2% increase in national electricity consumption, before we even consider the need for devices compatible with this technology. The environmental cost of 5G would then be much higher than that of fibre or ADSL, in part due to this proliferation of functions ([Source](#)⁷).
 - **Tomorrow:** if 5G's environmental consequences are too great, could the development of this technology be impeded? This question appears crucial, since it is the new functions promised by 5G that could be responsible for these negative externalities, but without these new functions, 5G is no more advantageous than the networks that already exist.
- **What risks will 5G have to health/biology?**
 - **Today:** To date, there is no serious scientific publication on the potential impacts of the higher frequency bands (around 26 GHz) that 5G technology will use. However, these risks are very real, as ANSES reminds us ([Source](#)⁸). Some experts are already pointing out that 5G could have effects on certain surface tissues (skin, eye or eardrum); however, they do not specify which ones ([INSERM](#)⁹). The Internet of Things concomitant with the deployment of 5G should also increase individuals' overall exposure to waves.
 - **Tomorrow:** if the harmful consequences of 5G on health were to be proven, could the development of 5G be stopped by 2030?
- **What progress will users really see?**
 - **Today:** currently, most of the promises of 5G benefit the industrial sector. For individuals, 5G is first and foremost a leisure technology. On the most revolutionary promises (telesurgery, self-driving vehicles, training in techniques, for example), it is still difficult to say if it will bring a real improvement in users' daily life or if it will lead to more problems (including adoption) than progress.
 - **Tomorrow:** in 2030, will the use of 5G be limited to certain sites, certain cities, or only to the industrial sector?

⁷ <https://blog.ariase.com/mobile/dossiers/5g-environnement>

⁸ <https://www.anses.fr/fr/content/la-technologie-5g>

⁹ <https://www.inserm.fr/actualites-et-evenements/actualites/ondes-electromagnetiques-faut-il-craindre-5g>

EMERGING EVENTS

In the short and medium term, there are already high added-value possibilities for the application of 5G, which could promote take-up:

- **In the field of teaching and learning.** South Korean telephone operator SK Telecom announced in September 2020 that it was ready to deploy an online class service using 5G infrastructure by March 2021, which would allow students to:
 - access high quality videoconference courses,
 - interact live and more smoothly with teachers,
 - use artificial intelligence for voice recognition, allowing for numerous exercises and exchanges between a greater number of participants ([Source](#)¹⁰).

5G could also promote the implementation of virtual and augmented reality services, which could lead to many new functions in distance learning. ([source](#)¹¹)

- **To improve safety at work.** 5G could quickly allow work vehicles to be driven remotely in difficult and dangerous conditions, involve a greater number of robots that are more interconnected and reactive than those already in place in at-risk areas (e.g. nuclear plants, mines, etc.).
- **To optimise corporate telecoms.** 5G is based on a smart network core that could be interconnected with the IT systems of certain large customers to allow real-time optimisation of services/functions.

FORECAST ASSUMPTIONS FOR 2030

Assumption 1. 5G reserved for smart cities and B2B, sights set on 6G.

In this scenario, 5G is unevenly deployed in France, and priority is given to nerve centres (transport axes, industries, cities). Private players seize on the opportunity to develop offers on frequency bands that public authorities are not promoting as heavily because they generate less income. In this assumption, 5G could just be a step on the path to 6G.

Assumption 2. 5G for the common good

In this assumption, on the other hand, priority is given to regional coverage and providing services beneficial to the common good (remote working, telemedicine, etc.). 5G helps to revitalise rural areas. These policies are supported by the European Union, which has similar regulatory objectives. In this assumption, however, 5G would develop at different speeds depending on the player and sector; expanding coverage to the entire country would not be done as quickly as the development of 5G networks within industries, for example.

Assumption 3. 5G prevented

In 2030, the environmental consequences of 5G, new scientific discoveries in health, a growing number of unsolvable conflicts of use and the colossal cost of investments for operators and manufacturers have severely hindered the deployment of 5G in the country. The technology therefore remains very marginal, having suffered from numerous scandals and a deteriorated economic context. Other issues take precedence.

¹⁰ <https://www.koreatechtoday.com/sk-telecom-to-launch-5g-based-ai-interactive-remote-education-service/>

¹¹ <https://www.semanticscholar.org/paper/5G-Technology-for-Augmented-and-Virtual-Reality-in-Barat%C3%A8-Haus/4e9029debf04a919fe892d262c7461e91f1d12e4>

VARIABLE 2: ADOPTION OF 5G BY ECONOMIC ACTORS.

DEFINITION

This variable proposes to assess the benefits and incentives that French and European economic players have to adopt 5G. Conversely, it also seeks to assess the technical, hardware, human, health, energy and environmental obstacles that could hinder take-up. This raises the question of the cost of this new technology as well as the value it adds, in particular by replacing the pre-existing technologies, and of its place in the expected overall increase in connectivity.

STRUCTURAL TRENDS

- **The Covid-19 health crisis has put French and European companies under great strain.**
 - These economic constraints should persist or even increase in the years to come, both nationally and globally. The WHO does not foresee a return to normal state of health before the end of 2022. While there has not yet been a major economic or financial crisis, such situations cannot be ruled out. Finally, certain sectors are more heavily and lastingly affected, in particular those which depend on the international flows of people and goods (tourism and certain industrial sectors, etc.).
 - This situation could limit the take-up of 5G by economic players given their difficulties in investing, leading them to prioritise the improvement of existing tools over deploying new ones.
 - In fact, in 2020 in France, few manufacturers and economic players seemed to take up the issue of 5G, as evidenced by the interviews carried out by IHEST with the digital department of MEDEF and the heads of the Lille and Plaine Commune local authorities. The management of Bouygues and SFR themselves stated in April and June 2020 that there was no urgent need to deploy ultra-high-broadband mobile in France (Le Figaro, IHEST 2020). Economic uncertainty is one of the main reasons given to explain this reluctance.
- **The increasingly pronounced damage to the environment, the evolution of public opinion in favour of preserving it, and the increased significance in companies' business models of the extent of their negative externalities (investor and regulator positions)** encourage private actors to adapt their business and operating methods to take the environment into better account.
- **At the same time, however, many telecommunications devices are now reaching the end of their use cycle in industrial environments.** Companies will necessarily have to replace them in the coming years. These new devices could then encourage take-up of 5G. 5G's wireless functionality also responds to an expectation of smoothness of use within organisations. This phenomenon differs, however, depending on the sector. Finally, devices in many work environments will also need to be updated to meet new security standards, which also implies a slower deployment schedule.
- **Likewise, the boost in speeds and the increase in the amount of data transferred should continue in the years to come; current mobile networks would be insufficient to handle them.** The average

consumption of digital data has increased by 30% per year nationwide since 2016. According to Nicolas Guérin, President of the French Telecoms Federation, 4G networks could be saturated by 2022. (Source¹²)

- **In addition, economic actors' desire for independence and sovereignty over their network is also a major trend, in a context of strong economic competition and cost control.** The deployment of on-site 5G networks could allow certain manufacturers to control their communications and data transfers by structuring their own networks for encrypted exchanges between devices.
- **Finally, companies are understandably driven by the desire to constantly improve their production conditions, to increase efficiency and speed, and reduce costs.**
 - Thus, the possibilities offered by Industry 4.0, which allows the various stages of production to be tracked in real time, could encourage companies to invest in 5G and in connected sensors as a way to improve productivity.
 - Economic players could also be inclined to develop 5G to avoid falling behind on issues related to Industry 4.0 and ensuring they stay competitive.

MAJOR UNCERTAINTIES

- **What will 5G's place be in new communications networks? What level of interoperability between the networks of the different technologies will be achieved and when?**
- **To what extent will private companies and organisations (public agencies, local authorities, etc.) abandon other technologies in favour of 5G when it is adopted, deployed, usable?**
 - **Today:** Certain technologies remain comparable to 5G, in particular Wi-Fi 6. This solution has its benefits because developing it will not require a change of devices. The cost of 5G equipment, on the other hand, is colossal because installing them requires a complete overhaul of the devices, not a simple adaptation (Source¹³). Finally, usage costs could increase under 5G, in particular due to the proliferation of sensors and data storage issues.
 - **Tomorrow:** will the benefits of 5G be sufficient to convince economic players to replace the technologies and infrastructures they currently use?
- **What 5G implementation models will companies use? What impact will this have on the probability and speed of take-up?**
 - **Today:** 5G cannot be deployed uniformly across enterprises, so it will have to coexist with the networks already in place. Companies will only replace technologies they have deployed after they have been amortised, unless 5G brings enough value to justify a faster change. Additionally, the issue of interoperability between private industrial networks and other public networks accessible to individuals remains a key point that is crucial in terms of cybersecurity. Finally, the proliferation of access points on company premises could generate interference.

¹² <https://blog.ariase.com/mobile/dossiers/5g-environnement>

¹³ <https://www.azenn.com/content/131-wi-fi-6-et-5g>

- **Tomorrow:** Will operators offer a homogeneous and clear 5G deployment policy to promote take-up by manufacturers?

- **What technical skills will be needed to take full advantage of the opportunities offered by 5G?**
 - **Today:** France already lacks engineers and technicians. The structural understaffing was estimated at 4% in 2019 ([Source](#)¹⁴). Companies are struggling to attract process engineers, designers (including BIM designers), BIM managers, IoT architects, cybersecurity experts, and even data scientists, all specialties essential to the deployment of 5G.
 - **Tomorrow:** Will companies suffer from a lack of manpower in the years to come? Or will they have to set up specific training programmes, which will increase their costs of adopting 5G?

- **How much security, autonomy and flexibility will companies have from 5G carriers?**
 - **Today:** Companies' independence remains one of their major concerns. An increasing number of European companies are looking for alternative solutions to single-supplier options, particularly when it comes to data storage platforms. In addition, companies are looking to secure their networks and information in a context of increasing and worsening cyberattacks.
 - **Tomorrow:** 5G's dematerialisation of networks will make them flexible because they will adjust according to demand and how they are used. The network operator model of sending technicians to sites will be less and less necessary. This is why network virtualisation will facilitate the management of services' life cycles (service offer on demand) and interoperability between players and reduce the time to market. However, this potential flexibility raises the question of the dependency links between 5G operators and companies. To what extent will companies be able to control their networks?

- **Will companies want to bet on the development of 5G without the certainty of having a real return on investment?**
 - **Today:** It is certain that 5G will lead to increased speeds and thus meet certain business expectations. On the other hand, it is difficult to conduct wide-scale tests on other functions that 5G promises, such as robotics.
 - **Tomorrow:** Will companies begin deploying 5G without a certain visibility on the economic benefits they could derive from it?

¹⁴ <https://www.usinenouvelle.com/article/l-ingenierie-francaise-en-danger-a-cause-du-manque-d-ingenieurs-et-de-techniciens.N798460>

EMERGING EVENTS

- **Several manufacturers (including foreign ones) are already testing the potential of 5G, particularly in the context of Industry 4.0: production units made modular by wireless connections, optimised technical management of buildings and quality control management.** France has already set up 14 experimental platforms, including the Lyon-Part-Dieu train station, for companies who want to test functionality. (Source Arcep¹⁵)
 - In France, we can cite the example of LACROIX Group, a listed family-based mid-sized company, which is currently deploying 5G with Orange to test the modular factory concept and improve technical building management. To do this, the reliability of wireless connectivity is evaluated in order to provide more flexibility in the organisation of electronic production machines. Production units in the plant may eventually be moved according to demand and the desired type of production. The reliability of 5G will also allow for better control of production quality. By taking high-resolution photos on electronic processes, for example, real-time verification can be carried out on the quality of the welds and the presence of components.
- **6G already.** While some Asian countries may have been disappointed with 5G (in South Korea¹⁶, for example, where it has not yet reduced latency as expected due to an insufficient number of deployed antennas and where its energy cost has led to the shutdown of certain antennas), several governments and private players are already positioning themselves for 6G. Samsung is announcing it for 2028, while China has already sent a 6G satellite into orbit. This additional step far exceeds the performances promised by 5G (latency times reduced to 1/10th of what 5G promises, for example). This race for progress, driven by Asian players, could put pressure on European companies anxious about losing their competitive edge, and push them to adopt 5G faster. (Source¹⁷)
- **European relocation and reindustrialisation.** The Covid-19 crisis has shown the importance of national sovereignty over the production of a number of critical products and services. 5G could offer Europe a way to tackle the challenges of relocation and reindustrialisation by providing added value that could encourage economic players to adopt it.

FORECAST ASSUMPTIONS FOR 2030

Assumption 1. Forced and marginal adoption.

In 2030, 5G is not widely adopted by French/European economic players. The economic depression that Europe is experiencing limits companies' investments since they prefer to make do with existing infrastructure. Only a few private players have deployed 5G under international constraints to avoid losing their competitive advantages, but the workforce is lacking and the potential of 5G goes under-used.

¹⁵ <https://www.arcep.fr/cartes-et-donnees/nos-publications-chiffrees/experimentations-5g-en-france/tableau-de-bord-des-experimentations-5g-en-france.html>

¹⁶ <https://www.courrierinternational.com/article/technologie-en-coree-du-sud-la-5g-na-pas-encore-convaincu>

¹⁷ <https://sweden-science-innovation.blog/seoul/south-koreas-plans-for-6g/>

Assumption 2. Competitive adoptions

In 2030, companies remain in a mindset of productivity, increased yields and competition. 5G is deployed unevenly according to players' investment capacity. It depends on who deploys the most efficient and hermetic network possible and/or the best 5G services with little thought to cooperation. Thus, large companies get stronger, while small businesses find themselves greatly weakened.

Assumption 3. Gradual and cooperative adoption

In 2030, 5G is deployed in a mindset of cooperation between companies, in particular to cope with international pressure from foreign companies, but also to provide a coordinated response to environmental issues. Networks are shared between companies who want to use 5G to optimise their industrial processes or offer new services. On these shared networks, several test platforms are open to allow even small players to test new functions before deploying them on a larger scale. Europe is a pioneer in the generalisation of Industry 4.0, in particular in terms of training, reasserting the value of engineering careers and making them more widely accessible. Interoperability takes precedence; conflicts of use are well managed. However, these cooperative demands slow down the 5G deployment timetable. Therefore, in 2030, not all regions are covered equally.

VARIABLE 3: THE REACTION OF PUBLIC OPINIONS TO 5G

DEFINITION

This variable examines the various reactions of public opinions to 5G and how it may evolve. Public opinion is defined as all the judgements, beliefs, convictions and values shared by at least part of a given public. Given the diversity of sides and groups that make up our societies, we will talk about public opinions in the plural to take into account the contrasting points of view that may influence 5G's development and take-up. At the time of writing, an increasing number of voices (political ecology, associations, as well as citizens) are speaking out against 5G technology, denouncing a headlong rush in the face of an increasingly damaged environment or fears of impacts on people's health. However, other technologies experienced similar reluctance but were nevertheless widely adopted in time.

STRUCTURAL TRENDS

In recent years, we have seen a rise in citizen movements in Europe and France against never-ending technological progress in general and against 5G in particular. There are several reasons for this opposition.

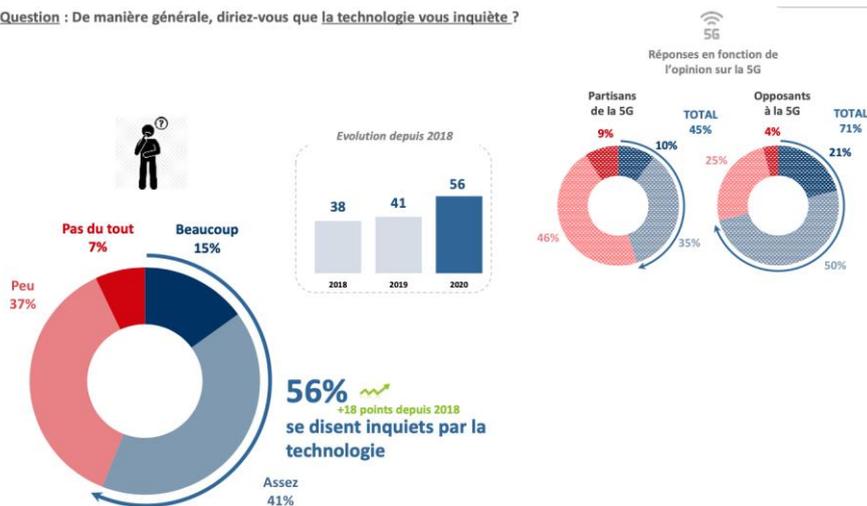
- **First, questions of the environmental impact of technologies and issues of digital sobriety are becoming more and more prominent in the public debate. Awareness of the impact of digital technology on the environment is recent, and 5G is a catalyst.**

Climate change ranked second in the French public's concerns in 2019, when it was only 6th in 2018 (IRSN study). The public polled is increasingly less willing to tolerate damage to the environment, which technology can exacerbate. In the same survey in 2019, we can also see a significant increase in expectations towards public authorities and experts in terms of how they justify the decisions they take to manage risk and the concrete response strategies. The Ipsos poll on the relationship of the French public to technology confirms how important transparency is for new technologies to be properly accepted, since 58% of respondents consider themselves ill-informed, and 56% of this same sample say they are worried.

- **Furthermore, several associations highlight the risk that 5G could represent to health.** Thus, associations for the protection of the environment (*Agir pour l'environnement* and *Priartem*) lodged an appeal with the French Council of State on the health risks associated with 5G waves in October 2019.
- **Another worry related to 5G is that it may open the door to a surveillance society and public control which is seen as a risk to freedom in light of Chinese experiments (source¹⁸).** Networks of cameras, drones and motion detectors, processing and sending data ten times faster, and creating ultra-responsive and automated surveillance environments will undoubtedly be very effective for the planet's security services, be they public, private or military. In October 2020, 72% of residents of large cities felt that 5G will allow for a greater collection of personal data by private and public actors (Ipsos survey for Lemon).
- **Finally, the deployment of 5G is part of the French public's lasting and growing crisis of confidence in technology.** According to an Ipsos poll in October 2020, 56% of them said they are worried about technology, an increase of 18 points over 2018.

¹⁸ <https://reporterre.net/5G-Xavier-Niel-a-menti>

Question : De manière générale, diriez-vous que la technologie vous inquiète ?



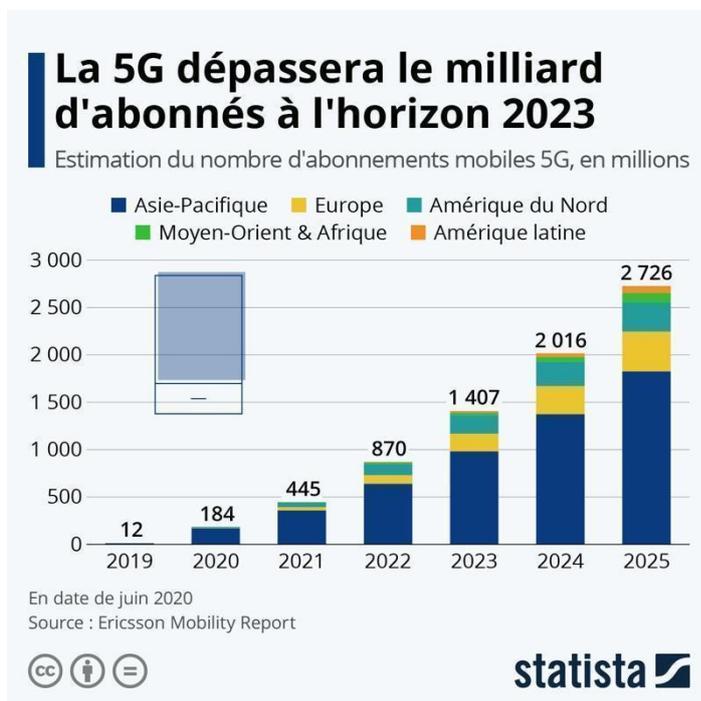
Etude Opinion Way pour l'Académie des Technologies réalisée par questionnaire auto-administré en ligne du 24 au 26 octobre 2018, auprès d'un échantillon de 1081 personnes représentatif de la population française âgées de 18 ans et plus.

Opinion Way study on the public's concerns over 5G

This feeling appears to be shared in Europe, as evidenced by the arson of 5G antennas in the United Kingdom, Switzerland and Belgium, countries which then had to slow down their work. On 25 January, 28 April and 4 May 2020 in The Hague, several international demonstrations against 5G took place, admittedly small but which are part of the same trend.

- **The public reluctance, rejection and/or blockages in the face of technological developments are in fact a historical trend.** The notion of “progress” itself is called into question. Fears expressed in the face of innovation have marked the history of technology. There are many examples in the medical field, transport, etc.
- **But today: thanks to social networks, individuals have a much greater ability to express their fears, to be heard and to create movements.** We can see this, for example, in the Yellow Vests movement, which was built online without a leader and which influenced the political debate in 2018 and 2019. At the same time, social networks, by their very structure, promote user radicalisation and expression. The “symbolic halo” (Simondon) that social networks can give to a subject can distract Internet users from reasoned thinking and from the intrinsic reality of technology. In the physical world, these fears and these oppositions can be reflected in a passive (online exchanges of information, fake news) but also active way (burning of antennas, for example).
- **There are two points that should draw our attention, however, and shed light on the diversity in these public opinions:**
 - The crisis of confidence that the country is experiencing and the fears that technology can arouse are very socially pronounced. 60% of the unemployed say they do not have confidence in the technology in general. The most fragile socio-professional categories, populations in the most deprived regions are more likely to develop a strong mistrust towards strong figures of power, who are also those responsible, in legal and political terms, for the deployment of technologies within the country.

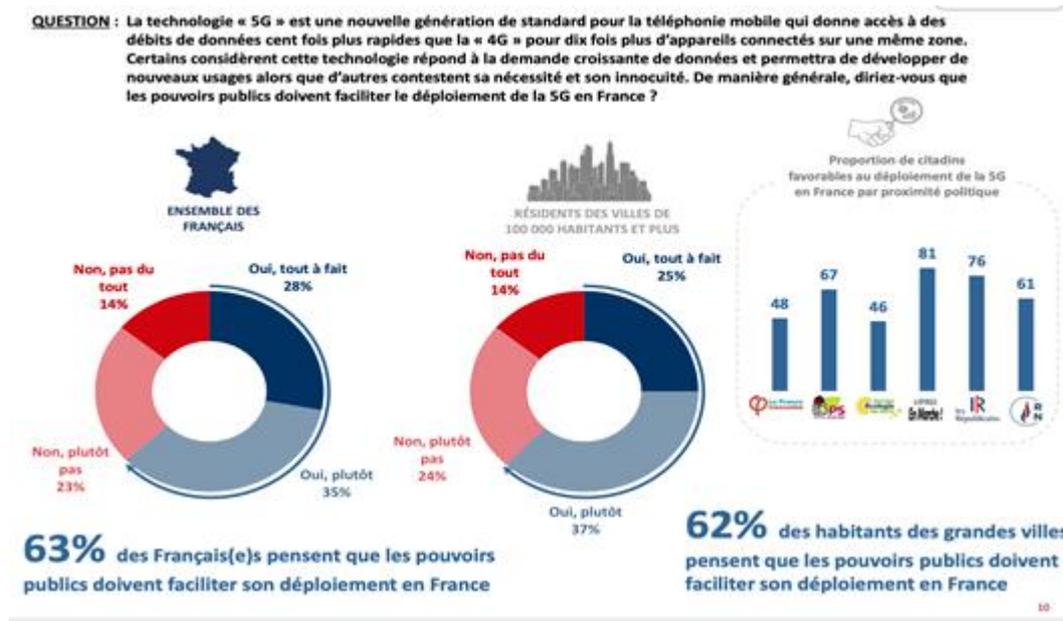
- Furthermore, ecological, political or health awareness is not necessarily shared by all citizens. Individuals also aspire to “convenience”, that is to say to enjoy smooth, efficient services, optimised to their needs, without necessarily worrying about issues related to individual freedoms or the environment. According to an international study carried out by consulting firm Experian in January 2019, 70% of the consumers surveyed would be “ready to share more personal data” with private digital businesses if the service provided brings a “greater convenience”. If we draw a parallel with 5G, it is possible to imagine that a certain number of people could accept the spread of this technology if the associated benefits are visible, practical, etc. According to a 2018 Ericsson study (therefore, take it with caution), 73% of French people say they are interested in 5G applications, 45% are ready to equip themselves to make use of it three years after its adoption ([Source¹⁹](#)). Therefore, the deployment of 5G could meet consumer expectations, particularly in the leisure area. Globally, Ericsson expects mass adoption of 5G by 2025.



5G adoption by 2023 - Source Ericsson

These studies are apparently confirmed by the results of the 2020 Ifop survey for Lemon since 63% of respondents actually think that the public authorities should promote the growth of 5G in France (see illustration below).

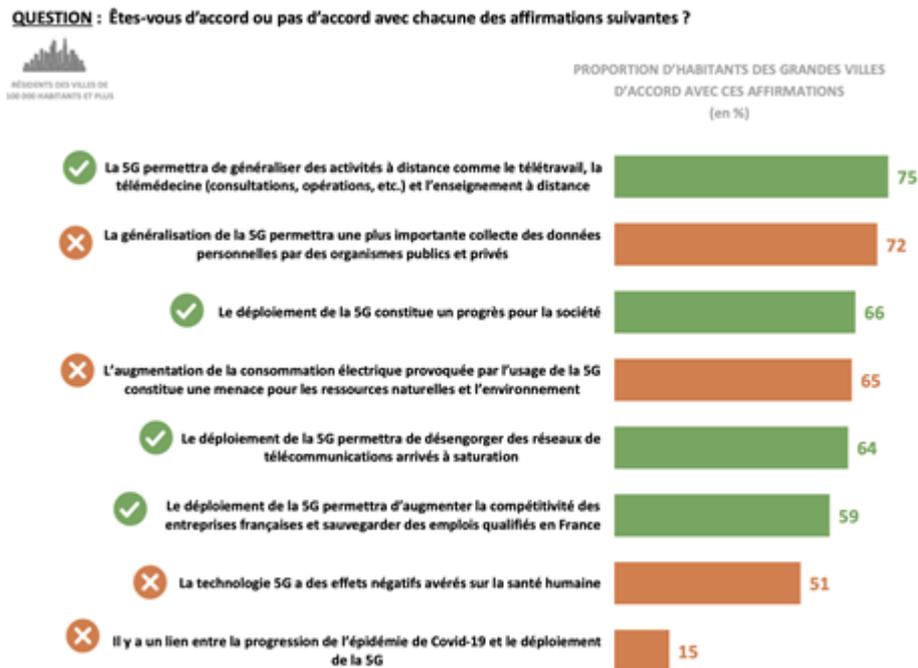
¹⁹ <https://vipress.net/etude-ericsson-ce-que-les-francais-attendent-de-la-5g/>



2020 Ifop survey for Lemon

MAJOR UNCERTAINTIES

- Are some of the promises of 5G desirable for society? Can they become so?
 - Today: People are struggling to understand the real benefits that 5G can bring to their daily lives. Highly publicised applications such as telesurgery and telemedicine arouse more fear than an inclination to test them. Nevertheless, the 2020 Ifop survey shows that residents of large cities already feel that the spread of 5G will bring a number of benefits, including generalised remote working, telemedicine (in particular consultations) and remote education (75%), decongested telecommunications networks (64%) and improved competitiveness for French companies (59%).



Ifop survey for Lemon, 2020

- Tomorrow: Could we see the emergence of mixed uses, which could be beneficial for businesses and society as a whole and thus help drive acceptance of 5G?
- **How will society and users be trained and supported in certain developments linked to 5G to make them desirable?**
 - Today: 5G technology seems to suffer from a lack of communication, explanations and examples of what it does, how to use it, and of simple, everyday functions that are available to all. This could explain the reluctance to adopt it in Europe. In addition, communications on the subject are mainly made at carrier and government level. Few local actors take up the subject to demonstrate the benefits to the public.
 - Tomorrow: is 5G doomed to remain a technology for privileged big companies and city-dwellers? Could there be more communication to educate the public about this technology at more a more local scale and, if so, by whom?
- **To what extent can the public oppose 5G and its deployment?**
 - Today: individuals who protest against the deployment of 5G are protesting on social networks. Some have gone so far as to burn down the first infrastructures rolled out, in the United Kingdom for example, but this remains in the minority. Since the government has begun the process of deploying 5G in the country, what could the public do to prevent it, if they so wished?
 - Tomorrow: will there be movements against 5G as coordinated as those implemented against GMOs?

- **What is the balance between ecological awareness and individuals' appetite for convenience?**
 - Today: many of the positions of 5G's opponents are tinged with environmental and health arguments. But we have also seen that individuals can be won over by a smooth, efficient service that meets their consumer expectations.
 - Tomorrow: will 5G end up being integrated into people's daily lives, in particular through the gradual distribution of compatible smartphones, without generating major opposition? Will the deterioration of current 4G services drive take-up of 5G to keep the service smooth? Or conversely, will environmental awareness continue to grow to the point that individuals will agree to limit their use of technology?

EMERGING EVENTS

- **The phenomenon of fake news, while it has existed for a few years now, is growing as the influence of social networks on the making of public opinion spreads. False information is estimated to spread six times faster than verified information.** For the take-up of 5G, this phenomenon could have a strong impact on public mobilisation against the deployment of 5G, even if this only represents a minority.
- **The Covid-19 crisis has and will have significant impacts on individuals' economic resources.** Beyond questions of acceptance of technology, the precariousness of a growing part of the population may limit public adoption of 5G, particularly in terms of being able to purchase new, compatible devices (smartphones, etc.).
- **The pandemic has also accentuated the divide between the "anti-" and "pro-" technological progress camps,** some denouncing an unnecessarily ultra-digitalised society and others solving our ills exclusively by the development of new technologies. Mistrust of political and scientific authorities has also worsened.
- **The divides between the American, Chinese and European models are more and more pronounced,** ranging from public surveillance on the one hand, to ultra-liberal trade across the Atlantic, to the defence of ecological and human responsibility. The competition between these models could influence French and European public opinions on 5G, depending on their desirability.

FORECAST ASSUMPTIONS FOR 2030

Assumption 1. 5G adoption is little discussed

In 2030, 5G is widely deployed and adopted in France and Europe. The gradual penetration of compatible devices has encouraged individuals to adopt this new technology, which contributes to the continuous improvement of public and private services (smoothness, speed) and meets the consumer expectations of a major part of the public. The debates have gradually died down. However, some activist groups continue to fight against 5G and its use, informally or within the framework of associations that carry out hard-hitting actions seeking to demonstrate the vulnerability of 5G networks and the risks they pose to the public. This assumption also works in a scenario where 5G is little deployed in France. In this case, the technology would be relatively forgotten in favour of more pressing issues.

Assumption 2. Pockets of resistance

In 2030, people resistant to 5G continue to strongly oppose its development. This is particularly the case in medium-sized towns, small towns and rural areas where we see many antennas vandalised as well as the development of groups of citizens who take possession of a place to defend it and prevent telecoms operators from beginning works. Several green mayors have joined this fight and refuse to issue the building permits needed for the antennas. In this tug-of-war, disparities grow between large metropolises, where 5G is more widely accepted, and less populated areas. The negative perceptions of 5G technology have been worsened by the Covid-19 crisis, which has caused a large number of controversies (health passport with QR code, mRNA vaccines causing mistrust, etc.). There are widespread fears that the infrastructure will be used for private or state mass surveillance.

Assumption 3. Consensual adoption.

In 2030, 5G is still being deployed, but a number of measures to control how it is used have been put in place thanks to the activism of environmental associations and public mobilisation. Public authorities regulate the networks. In some areas, the antennas are periodically put on standby to reduce their consumption. In others, 5G has not been deployed in order to preserve the visual and electromagnetic landscape. Several applications similar to Yuka (which evaluates the quality of food products) allow users to monitor the environmental impact of their network usage. Some operators even offer reduced-price packages for users who are most concerned about their negative externalities on the same model as auto insurance which rewards their most cautious customers (“Pay as you drive”).

VARIABLE 4: NEW RISKS IN TERMS OF INFRASTRUCTURE RESILIENCE, CYBERSECURITY AND DATA PROTECTION ON 5G NETWORKS.

DEFINITION

This variable addresses the risks of cyberattacks, hacking of critical infrastructure or of personal, industrial and surveillance data, whether of criminal origin or perpetrated for geopolitical purposes. The objective of this sheet is to assess the advantages of 5G in terms of security in order to respond to the new risks that this technology can cause.

This question appears to be a major issue, since 5G is a strategic infrastructure. The number of connected objects should increase, and these objects could be critical (e.g.: PLCs in factories, self-driving vehicles, etc.), so there is compromising on security.

STRUCTURAL TRENDS

5G, with its characteristics, brings many advantages in terms of cybersecurity.

- **It allows for the integration of firewalls and protection systems in network infrastructures by design** (security by design).
- **It allows for better data encryption.** In its protocol, 5G includes the possibility of implementing end-to-end encryption, in other words to create a communication system in which only the people who communicate with each other can read the messages they exchange. Combined with its decentralised approach (which notably involves the concept of cloud computing, where remote computer servers are used to store data sent from another location), the technology could therefore make it more difficult to intercept communication given the lack of a “focal point” to target an attack.
- **It is based on a division of the network.** Isolating carriers from each other and slicing networks will isolate infected portions and may provide better visibility and control over threats.
- **It uses key encryption, which will help** to strengthen network security.

But 5G technology is also a source of major concern for cyberthreats:

- The dematerialisation of networks and the deployment of software solutions that accompany 5G lead to performance gains in terms of bandwidth and the creation of new functions, but they also **bring IT vulnerabilities to the telecoms industry. Networks prior to 5G had fewer points of contact to communicate with hardware, which made security checks and maintenance easier.** Dynamic 5G software systems have many more routing points for traffic. In order for all of these points to be completely safe, they must be monitored. As this could prove difficult, any unsecured area could compromise other parts of the network. Convergence and pooling of networks represent a risk. The risk is linked to the complexity of managing a range of components (RAN, Edge, core network, cloud computing, third-party applications) and to the control of security aspects throughout the chain for these critical functions. The proliferation of lines of code makes the network more vulnerable and more complex to secure.

- In addition, given its importance and all the opportunities it opens up (particularly in terms of smart cities, management of energy and water networks, transport, health, etc.), 5G is destined to become **critical infrastructure for governments** and, therefore, a target for malicious actors.
- **The volume of threats will increase** as 5G develops due to the proliferation of the number of objects connected on the network. In particular, DDoS attacks could be increasingly numerous and effective. The risks that weigh on personal and industrial data are indeed significant.
- According to a report by Gilles de Kerchove, European coordinator of the fight against terrorism, 5G would make it difficult for national security services to legally listen in on communications because of the “encryption of communications and the virtual and fragmented architecture of 5G”.
- **Accessibility of relay antennas.** The need to deploy a significant number of relay antennas for 5G to operate and, therefore, the need to increase the number of accessible structures makes the network highly vulnerable to attacks.
- **All the risks of dependence on 5G infrastructure, on equipment manufacturers and, more broadly, on wireless connectivity, are a source of concern.**

MAJOR UNCERTAINTIES

- **Who will regulate cyber risks and how?** Today, the lack of technical, legal, predictive and reactive tools and the lack of awareness among the public, companies and governments concerned, explains the difficulties encountered by actors subject to cyber risks. There is also a difficulty in regulating cyberspace through international law following the failure of multilateral negotiations on the qualification of attacks and the right to retaliation.
- **How will carriers and suppliers be audited? What is their responsibility? What do they owe?** Governments torn between competing interests do not align themselves on the objectives and struggle to empower businesses to fight cyber threats.
- **What other network could act as a backup if the 5G network became unreachable or unusable for one reason or another?**

EMERGING EVENTS

The platform Inspire-5GPlus²⁰, funded by the European Commission, aims to participate in the cyber improvement of 5G networks by offering an innovative architecture that is secured end-to-end. It promises concrete applications for connected vehicles and Industry 4.0. In fact, it has not yet been launched, and the terms of access to this tool are not very explicit.

²⁰ <https://www.inspire-5gplus.eu/>

FORECAST ASSUMPTIONS FOR 2030

Assumption 1. High risks, serial crises

5G is seen as a strong risk factor. During the initial years of its deployment, many major attacks strain the confidence of private actors as well as public actors who have suffered a series of attacks since the pandemic (hospitals and clinics). This creates a reluctance to adopt 5G.

Assumption 2. Controlled risks, massive and beneficial research efforts across the cyber field

In the medium term, 5G proves that it can help limit cyber risk overall. Massive research efforts are made in France and in Europe. The adoption of 5G is encouraged.

Assumption 3. Emergence of a European regulatory platform (non-exclusive)

5G encourages a common EU-wide regulatory platform to emerge. This platform promotes the homogenisation of infrastructure and data protection standards. In this context, private actors are also mobilised. In this assumption, foreign companies (China, United States, etc.) could offer effective cybersecurity solutions to European companies and institutions, on the condition that they agree to comply with the requirements set by the EU.

VARIABLE 5: 5G REGULATIONS AND GOVERNANCE

DEFINITION

The purpose of this sheet is to:

- Identify the actors in charge of the governance of the deployment of 5G in France and in Europe and to present their strategies as well as their modes of action.
- Identify the competent regulatory bodies, their regulatory history and the orientations they could take over the next ten years, in connection with the strategies of the governance authorities.
- Identify the major uncertainties and emerging events on all of these issues.

Like any new technology, 5G raises many new regulatory issues:

- Market regulation: authorised carriers, the choice of equipment manufacturers, the places where 5G is deployed, etc.
- Regulation of usage: environmental impacts, health impacts, etc.
- Regulation to counter cyber risks: organised crime, state and para-state threats, etc.
- Regulation to protect consumers.
- Regulation to protect the public: individual rights, surveillance, protection of privacy, etc.
- Regulation to protect manufacturers and businesses: protection of industrial data, international independence.

The question of who regulates what, and how, is therefore crucial. However, to date, in France as in Europe, there is a certain lack of transparency on what carriers and manufacturers do, how and with what data. The interactions between players appear complex.

This document is intended to be a simple summary to offer a clear perspective on existing regulations and to explore some elements of foresight. It focuses primarily on infrastructure issues rather than on functions, which is governed by regulations specific to each sector and to each of the digital platforms (GDPR, DSA, DSM, etc.). Some parallels can be drawn, however, if they are relevant.

STRUCTURAL TRENDS

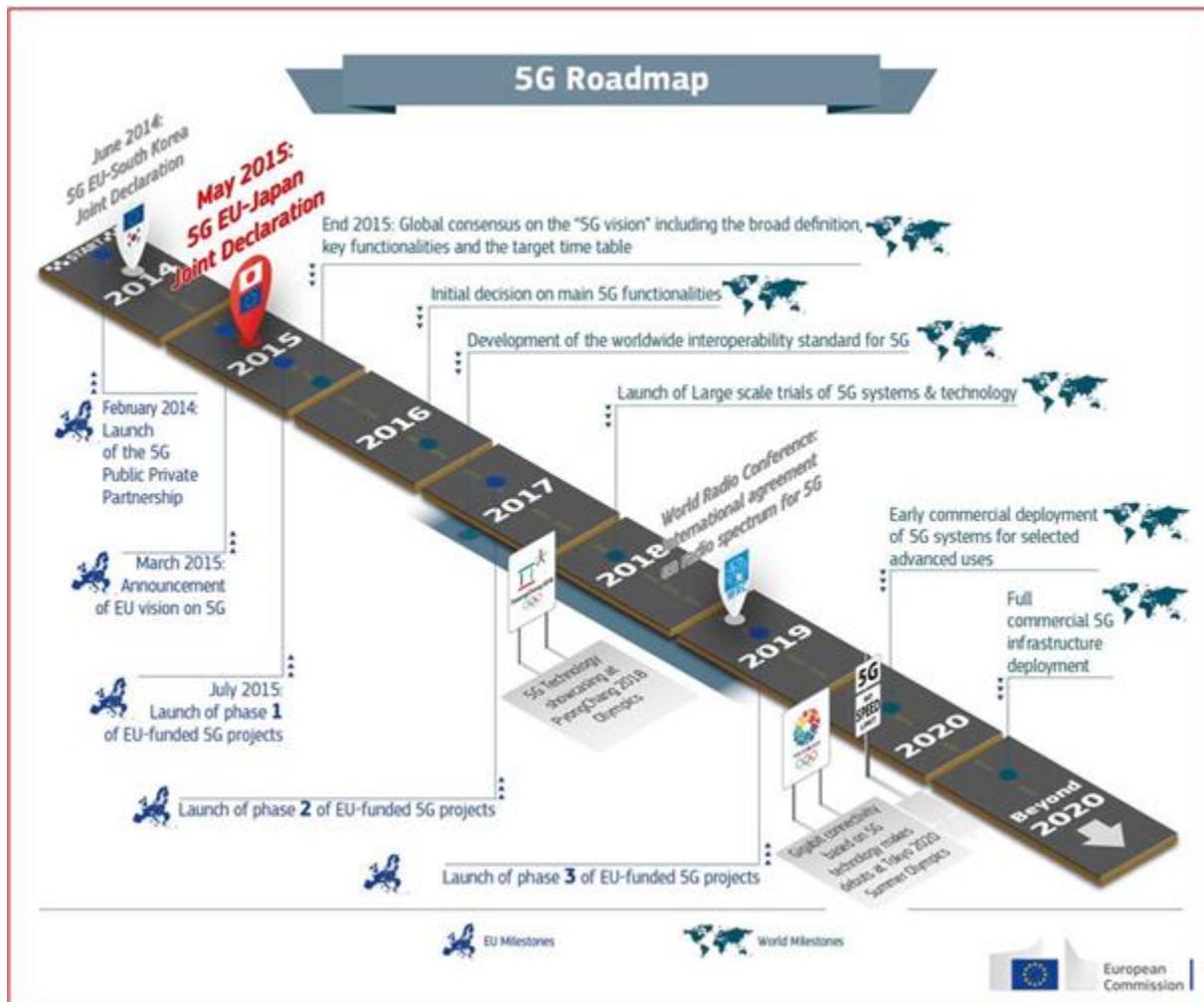
The governance of telecommunications networks is historically structured at three levels: international, European and national (for France).

International framework

At the international level, there are two regulatory bodies responsible for telecommunications:

- The International Telecommunication Union (ITU), which is the historic United Nations body in charge of the geographical distribution and allocation of frequency bands and the regulation of information and communication technologies. It is made up of 193 Member States and over 700 industry representatives.
- The World Trade Organisation (WTO), whose main competence is to regulate the markets. The telecommunications market is a complex market, generating a lot of income and which has undergone profound restructuring in recent years, in particular under the influence of new entrants.

European framework



European Commission action plan for 5G - Source ARCEP

At the European level, two bodies play a coordination role in telecommunications, without the legitimacy to impose regulation on the Member States:

- The Body of European Regulators of Electronic Communications (BEREC),
- The Post and Telecommunications Conference, which provides a space for exchanges and debates on these subjects between the Member States.

While these bodies do not have prerogatives over the States, in Europe there is indeed legislation on telecommunications imposed on all the Member States. It is based on the provisions concerning the internal market (Article 26(2) of the TEU, free movement of goods and services). In 2000, the Commission proposed a complete overhaul of the Community texts governing the field of telecommunications, which was reflected in the 2002 adoption of the Telecoms Package²¹, consisting of five directives. **The Telecoms**

²¹ https://fr.wikipedia.org/wiki/Paquet_T%C3%A9l%C3%A9com

Package simplified community texts governing the telecommunications sector in Europe. But above all, it was this regulation's content that was important and innovative:

- It defined a harmonised regulatory framework for all electronic communications networks (audiovisual and telecommunications); the services provided on these networks remain subject to separate regimes,
- it established an entirely new mechanism for the regulation of traditional carriers based on concepts of competition law,
- it abolished carrier authorisations and replaced them with simple declarations,
- it regulated the conditions under which Member States designate the carriers responsible for universal service,
- finally, it considerably strengthened the protective provisions for end-users in terms of data, provided for by previous European texts.

In 2009, the Telecoms Package was revised by two directives, which do not call into question the initial principles, but make notable changes in several areas:

- The coordination of the actions of national regulatory authorities, in particular with the creation of BEREC,
- the protection of consumers of telecommunications services,
- network security,
- protection of network users' privacy,
- universal service,
- network neutrality.

French framework

Telecommunications governance follows this pattern in France:

- International and European legislation,
- transposed into French law by the legislator,
- regulations are implemented under the control of the regulator (ARCEP),
- in conjunction with ANFR (frequencies) and ANSSI (security).

For coordination reasons, ARCEP participates in BEREC.

Therefore, France's stated ambitions are to guarantee these three principles:

- Internet neutrality,
- protection of networks and personal data,
- equality of territories.

The **law for a digital republic** is a French law initially proposed by Secretary of State for Digital Technologies Axelle Lemaire and promulgated on 7 October 2016. This is a full part of France's ambitions, since the government has two objectives: "Give France a head start in the digital field by promoting a policy of open data and knowledge" and "adopt a progressive approach to digital technology, one which relies on individuals, to strengthen their power to act and their rights in the digital world". To do this, the law is organised around three lines: the circulation of data and knowledge, the protection of individuals in the digital society and access to digital technology for all.

This history of regulation is not, however, fully suited to 5G because it raises new issues which, while not specific to it, are particularly accentuated by it:

- Technological challenges (convergences of communications networks, proliferation of functions with self-driving vehicles, industry 4.0, cyber risks, etc.).
- Trade and competition issues, in particular with the structuring of strong foreign competition which is sometimes more innovative and efficient than European players.
- Ethical and environmental issues.
- Geopolitical issues (sovereignty issues, protection of national and European interests, the international role of France and the EU in terms of technological development and control of critical infrastructures, etc.).

Finally, the software-ification that 5G implies and the possibilities for pooling (physical and virtual infrastructure, frequencies, etc.) also require changes to the regulation.

MAJOR UNCERTAINTIES

Strong uncertainty about functions

- What can 5G be used for, especially in the 26 GHz band? To what extent will it be relevant for companies/vertical players and, therefore, which players and what functions will need to be regulated?
- Is the proliferation of antennas in urban areas likely to pose a problem?
- Will the convergence between 5G and other technologies (AI, IoT) require new, specific regulations?
- Will 5G only be a preparatory step for 6G, as 3G was for 4G?

Strong uncertainty about the impacts of 5G

- The environmental impact is currently being assessed, and the laws may change to restrict the development and use of digital infrastructures.
- The health impact is not yet well understood, and the discoveries to come on this subject could be crucial in the evolution of the deployment of 5G.

What harmonisation of coverage should there be between the regions?

- Once again, 5G raises the question of territorial equality, between urban and rural areas. It risks accentuating the geographical divide in the quality of the available networks.
- The pace of 5G coverage requested of carriers suggests that coverage will not equal 4G until 2030.

What harmonisation should there be with other regulations?

- There is potential for harmonisation between telecoms regulations and the Digital Service Act as well as the Digital Markets Act.
- For the moment, the French government is sticking to a role of market regulator. Will it extend its prerogatives to 5G with requirements on environmental, health and ethical standards?

Uncertainty about the role of public opinion, the EU and national policies

- Will public opinion become an obstacle or, on the contrary, a major driver of regulation(s)? (See sheet 3 on the evolution of public opinions)
- What will be the EU's role on national policies and on actors/carriers with an international dimension? To what extent will it be able to forge coherent regulations, in particular on ecological impacts?

EMERGING EVENTS

New political constraints appear along with an increased desire to regulate the functions, content and impacts of technology on the environment in the future

- In France, Law N2019-810 of 1 August 2019 grants the government the necessary power to restrict, prohibit or impose obligations or conditions for the supply, deployment and operation of 5G equipment by requiring authorisation from the Prime Minister before the installation of said equipment, for reasons of security and national defence.
- The proposed law aimed at reducing the environmental footprint of digital technology in France, adopted by the Senate in January 2021, could also be a game-changer. Its ambition is to regulate the behaviour of “all digital players”, from professionals to consumers so that its development and uses are more “sober, responsible and environmentally virtuous”. In particular, it plans to limit the replacement of devices and orient industrial development towards less energy-consuming infrastructure.
- Finally, ARCEP's “Platform for sustainable digital technology” is another example of innovative measures that could emerge and provide an additional regulatory aspect that includes objectives for the environment.

FORECAST ASSUMPTIONS FOR 2030

Assumption 1. Simple market regulators

The French and European regulatory bodies intervene little in the field of telecommunications; the legal provisions remain relatively heterogeneous depending on the Member States. Private actors act as they wish within the limits of competition law. The European Commission favours reduced governance with the aim of boosting the European market.

Assumption 2. Green and egalitarian interventionism

The French government and Europe are increasingly forcing carriers and economic players to measure their health and environmental impacts, as well as to cover the regions equally.

Assumption 3. Geopolitical and cyber issues are priorities, environmental issues are neglected

The EU orchestrates stricter regulation of 5G infrastructures to ensure its sovereignty. Some foreign players are even denied access to European territory for the sake of preserving the competitiveness and sovereignty of Europe. Problems related to the environment are rather neglected in favour of geopolitical (carving out its place of leadership in technological matters) and cyber considerations (guarding against risks, including espionage).

VARIABLE 6: INTERACTIONS BETWEEN GLOBAL GEOPOLITICAL ISSUES AND 5G

DEFINITION

In this variable, new interstate conflicts and new alliances that could strengthen or emerge in connection with 5G technology are studied. 5G is seen as an important issue of economic competitiveness as well as an issue of political dependence, with all the risks this entails (blackmail, pressure tactics, interruption of services, etc.). Here, it will be a question of studying the interactions of the players and identifying potential changes, with a particular focus on what this implies for the European Union and France.

STRUCTURAL TRENDS

- **5G is a critical infrastructure and technology.**
 - **5G is a part of the historical reorganisation of how players interact on an international scale and the diversification of the instruments nations have to establish their geopolitical power. Thus, it is already provoking significant reactions, despite having yet to be deployed uniformly internationally.** “Telecommunications are a matter of national security. For a nation, not having its own equipment in this area is like not having an army,” Huawei founder Mr. Ren Zhengfei said in an interview with then-Chinese President Jiang Zemin in 1994.
 - **The race for technological innovation goes well beyond the sole issue of 5G.** Having efficient networks represents a structural challenge for the economy and industry for a country that focuses on global competitiveness. While all 5G’s advantages over existing technologies have yet to be determined (see fact sheet 1 and 2), 5G could nevertheless become, for some countries, the key to massively deploying the Internet of Things as well as artificial intelligence thanks to the mass of data collected. In terms of (cyber)defence, it could also become a cornerstone of many tactical and strategic changes.
- **5G is the catalyst for unprecedented geo-economic tensions with a very pronounced China-United States polarisation.**
 - The globalised economy is increasingly a place for countries to assert their strength. The control of critical materials, essential for the production of new technological tools, is becoming a strategic issue. Interdependencies in rare earths or semiconductors, for example, are being weaponised to weaken competitors.
 - China and the United States, through their technological power, their alliances as well as their normative and legal provisions, are the two adversaries who orchestrate this system internationally.
 - **The two powers are clashing in a trade as well as a diplomatic war.** In their national security strategy in 2017, the Americans referred to China as a “strategic competitor”. In June 2018, the

two countries began a trade war with the first increase in customs duties decided by D. Trump. Shortly thereafter, the company Huawei was put on the Commerce Department's blacklist, which prohibited it from working with American companies. Nevertheless, the United States is in a weak position vis-à-vis China since it does not have a leader in 5G equipment. Thus, the Americans are seeking to counterbalance Chinese dominance in this sector, in particular by structuring new strategic alliances and by investing early in 6G.

- **5G crystallises a struggle between two opposing socio-political models. This struggle is embodied by the deployment of norms and standards, with growing Chinese confidence.**
- **Europe, as both a geopolitical player and a market of choice, is at the heart of these intersecting ambitions.**
 - Despite a growing awareness of the risks, Member States fail to agree on a common strategy and to support their national champions. Yet, the United States is waiting for the Europeans to make a choice and is campaigning for historic alliances to be revived.
 - **In telecoms, a tricontinental alliance against Huawei has been in place since January 2021.** It brings together the **United States, United Kingdom and Japan**, three of the countries most hostile to the Chinese telecoms equipment manufacturing giant and which have agreed to work together to foster new alternatives to Huawei in 5G and, perhaps, even in a larger scope. This alliance could help Japanese OEMs NEC and Fujitsu to make a comeback on the market.
 - **The EU shares the concern of the possible capture of data and, therefore, of industrial and political espionage by the Chinese firm Huawei via the installation of “back doors” in their antennas.** However, the EU has the advantage of having two companies offering 5G services, Nokia and Ericsson, while the United States has no such companies. While these two companies lag behind in the deployment of 5G, they nevertheless remain competitive, particularly Nokia which is able to offer the same range of services as Huawei and **covers the entire 5G network deployment and operation chain, from access to submarine cables, including transport and optical transmission.**
- **However, government support for national equipment manufacturers is very different in China and in the West.** There is, in fact, a major difference between the support which Nokia and Ericsson receive from the EU and that which Huawei receives from China, whether in terms of financial and diplomatic support or in terms of deployment coverage. Nokia and Ericsson compete in terms of technology, registered patents or contributions to the 3GPP standard, but neither enjoys the support of a powerful government to support its deployment efforts, both financially and diplomatically. Unlike Huawei in China, they are not able to deploy their technologies over a large territory. Meanwhile, the United States is not in a position to compete with Huawei, even if they started developing these technologies today. In 2018, Huawei held 29% of the global mobile infrastructure market²², and today it is the company that offers the most sophisticated equipment by far. Thus, the Chinese company could very well be tempted to take hold of at least one of these two companies, either through a collaborative form by offering the support of its economic, financial and geographic power, or through a more offensive approach that dispossesses Europe of its champions.

²² http://www.senat.fr/rap/18-579/18-579_mono.html

- **Tentative European coordination.** Here, as in many areas, Europe tries to coordinate its efforts in terms of developing and securing 5G networks. However, while the European Commission gives its directives on the subject, the Member States remain free to develop their own strategies, which leads to strong disparities between the countries.²³
- **In this context, France looks for the power to influence new technologies (AI, cloud computing, content management on networks, etc.) and seeks to position itself as a leader in these areas, including 5G and 6G.** The Hexa-X project, a consortium of key European industrial players to which the EU allocated 80 billion euros at the start of 2021, is a perfect example, as France is widely represented through Atos, CEA, and Orange. In 2019, France was also at the top of European investments²⁴ in the artificial intelligence sector.

MAJOR UNCERTAINTIES

How will relations between China and the United States evolve, especially in terms of dependence on raw materials and rare metals?

- Could we see China develop an expansionist strategy through alliances with Russia and African countries that would be a game-changer for Chinese power and influence?
- In this context, Europe remains a strong strategic issue for the Americans and the Chinese. How will these two countries' diplomatic strategy towards the EU evolve? Will it be seen as a full partner or as a market to expand into at all costs?

What will be Europe's strategy for telecommunications networks, and what resources will it have to achieve it?

- Europe already is heavily dependent not only on American power, but also on Russian and Chinese power in various fields. It also has difficulties in harmonising its policies between the Member States and has sometimes limited legitimacy and prerogatives in these areas. At the same time, the European Union seems to be greatly weakened by the Covid-19 crisis, which could greatly affect its capacity for innovation and leadership in technological fields by 2030.
- Will Europe manage to develop a coherent shared response in the area of telecommunications networks by 2030?
- Or could we see varying alliance positions depending on the European country, which would be likely to weaken Europe?
- If Europe decided to remove itself from this technological race, this would allow it to free itself from its dependencies on countries that supply raw materials or critical components. But it would also deprive itself of a series of technological innovations, thus losing ground in a geopolitical context where technological innovations are at the heart of power relations.

²³ <https://theconversation.com/les-enjeux-geopolitiques-de-la-5g-146494>

²⁴ <https://www.maddyness.com/2019/11/04/france-leader-investissements-ia/>

Are we heading towards a diversity of national/regional standards over the next 10 years? (and its consequences on communication capabilities between countries)

- Control over standards is a basic element to guarantee innovation that makes it possible to reach a key market share in a critical technology.
- Among infrastructure providers, Huawei holds the most patents for 5G technologies with 1,554 patents, followed by Nokia with 1,427, Samsung with 1,316, ZTE with 1,208 and Ericsson with 819.
- Huawei spent \$15.3 billion on research and development (R&D) in 2018, while Nokia and Ericsson spent \$4.6 billion and \$4.1 billion, respectively. Samsung plans to invest \$22 billion in 5G and other areas of technology over three years.

Are we moving towards the emergence of new non-state actors that are more powerful than governments?

- Carriers are becoming major players in cybersecurity. Certain non-governmental or transnational organisations have considerable funding capacities which could replace those of certain governments.

EMERGING EVENTS

- **6G is already being deployed in the United States and China.** In this context, 5G would only be one step in a technological race where the heart of world leadership could quickly shift. However, the Chinese continue to be far ahead, including in these new technologies.
- In addition to the issue of controlling the technology itself, the issue of **access to the rare earths and raw materials needed to produce this technology's equipment arises more and more openly.** Here again, China has much greater access to resources than its competitors.

FORECAST ASSUMPTIONS FOR 2030

Assumption 1. Chinese supremacy, Europe forced to align

China is definitely the world leader in terms of technologies and standards. The EU aligns. Strong dependence.

Assumption 2. Growing Sino-American tensions, degraded global context.

China/USA opposition worsens. A bloc of alliances coalesces to oppose China (US, Japan, South Korea, India, etc.). The EU joins this bloc, which invests in open-source solutions and prepares the next generation (6G). Within the European Union, industrial alliances are structured, but only at a minimum.

Assumption 3. The EU carves out a place for itself

Either through proactive strategies and fierce competition, depending on the geo-economic environment, or by promoting a unique European model (green, egalitarian, etc.), which may take more time.

Assumption 4. Europe disorganised, France out of the game

No common strategy in Europe, Member States do what they want/can. A certain number of European carriers delegate their skills in terms of infrastructure to foreign manufacturers, even at the risk of losing their sovereignty over these services. France fails to assert itself.

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