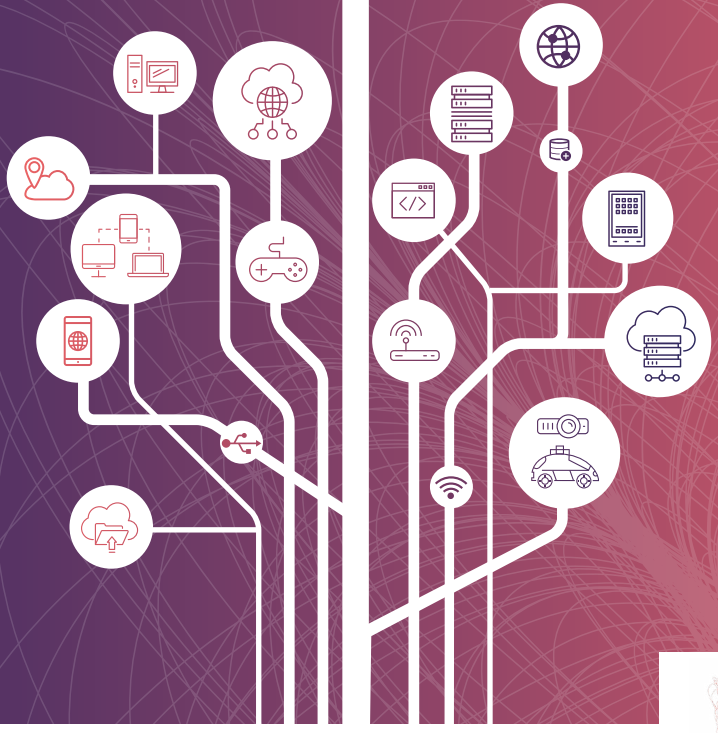
RÉPUBLIQUE FRANÇAISE

May 2017

The state of internet in France

2017 EDITION



arcep

The state of internet in France

2017 EDITION

Contents

Arcep provides hereby an unofficial translation of its report on the state of Internet in France. In case of discrepancy, the French version shall prevail.

WHY PRODUCE A REPORT ON THE STATE OF INTERNET IN FRANCE?

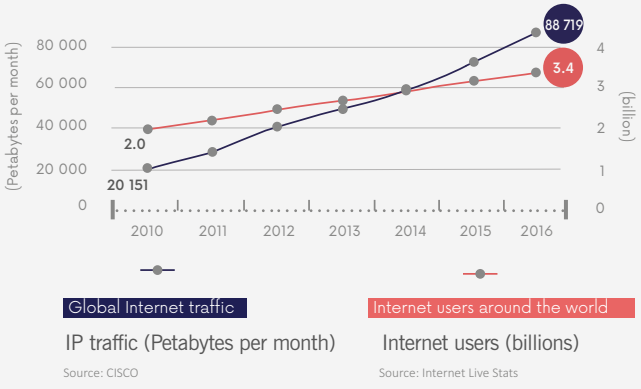
Internet has become a collective good and *«infrastructure of freedom»*: freedom of expression and communication, freedom of access to knowledge and sharing, and also freedom to engage in business and innovate.

As such, it is important to ensure its accessibility, proper functioning and neutrality.

The Internet is a bridge between billions of human beings, and tomorrow it will connect even more machines and objects. It has enabled an unprecedented release of exchanges such that it has transformed and continues to deeply transform society and economy. Today, Internet plays a crucial part in the everyday lives of the French, not only serving the leisure-related dimension but forming a key component of economic and administrative life.

Well aware that a new state of affairs has settled in, European and French lawmakers have considerably strengthened the provisions that will guarantee an open Internet and armed the regulator to deal with these new challenges. Several key texts have been adopted recently: Regulation (EU) 2015/2120 establishing measures relating to open Internet acces [1], Law No. 2016-1321 of 7 October 2016 for a Digital Republic and Law No. 2017-55 of 20 January 2017, establishing the regulations applicable to the independent

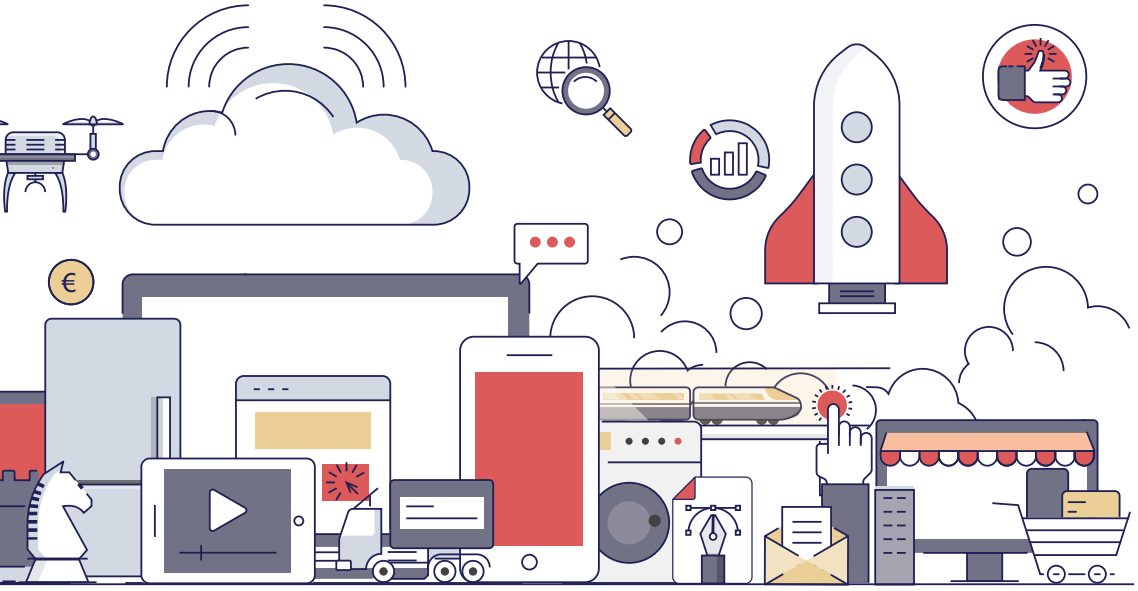
// **Growth in traffic and number of Internet users** worldwide



Source: CISCO

Source: Internet Live Stats

[1] Regulation (EU) 2015/2120 of the European Parliament and of the Council of 25 November 2015 establishing measures relating to open Internet access and amending Directive 2002/22/EC on universal service and users' rights with regard to electronic communications networks and services and Regulation (EU) No. 531/2012 concerning roaming on public mobile communications networks within the Union.



administrative authorities and independent public authorities. With these transformations to the legal framework, Arcep is now more than ever the guardian to the networks, responsible for ensuring compliance with the essential principles so as to preserve users' exchange capacity. Arcep sees to their proper operation and must protect against possible violations of Net neutrality.

By virtue of the European Regulation, Arcep must publish an annual Activity Report on its initiatives to monitor Net neutrality and the findings resulting from them. Further, the 20 January 2017 Law has, in Article 30, established that by 1 June of each year at the latest, *"the activity report prepared by the French Regulatory Authority for Electronic and Postal Communications): […] 3° shall draw up a situational analysis of the state of the Internet, including issues related to the neutrality of the Internet and the use of IPv6 addressing technologies; […] ».*

Arcep wanted to meet these two requirements by publishing a report on the State of Internet in France. An integral part of the Activity Report, this situational analysis includes all the themes on which Arcep focuses, relating to the proper functioning and openness of the Internet in the broad sense:

- quality of service [2];
- data interconnection;
- transition to IPv6;
- Net neutrality;
- platform openness, with a focus on terminals.

In order to reach all audiences, this report comprises two major parts:

- a summary, enabling quick access to the key aspects of the report, particularly for the general public and decision-makers (Chapter 2);
- a detailed relation of Arcep's work, to which experts on each of the themes can refer (Chapter 3). ■

[2] Taking into consideration the territory's development objectives including mobile network coverage and quality, these sections are addressed in the report on GRACO's work (Exchange Group between Arcep, Local Authorities and Operators).

IN BRIEF : OVERVIEW OF ISSUES AND WORKSTREAMS

THIS CHAPTER CAN BE READ EASILY BY THE GENERAL PUBLIC AND DECISION-MAKERS AND OFFERS A RAPID INROAD TO THE AUTHORITY'S MAIN FINDINGS.

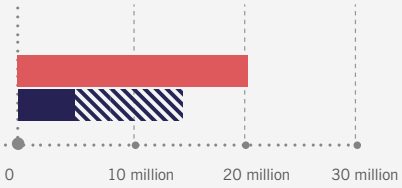
In it, Arcep presents a factual mapping of the market, issues and workstreams. It also describes the foundations of public action and changes in its policy and mode of action on each of the topics addressed.

2.1 Observe and acknowledge trends and changes in uses

Coverage of the territory by access networks to electronic communications services is progressing, on both fixed and mobile. This expansion is accompanied by the deployment of new and ever more effective generations of access technologies, particularly in terms of speeds and latency.

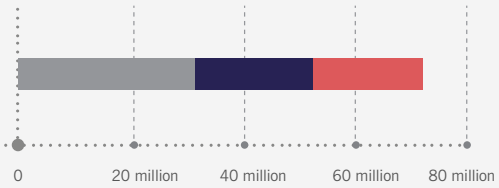
In 2016, Internet access terminal penetration rate was on the verge of catching up with, and soon exceeding, that of today's main information and communications vectors: TV and traditional phone (limited to phone services).

// **Increase in Internet** coverage and access technologies



FIXED INTERNET PENETRATION

Broadband Subscribers
NGA Subscribers
NGA Coverage

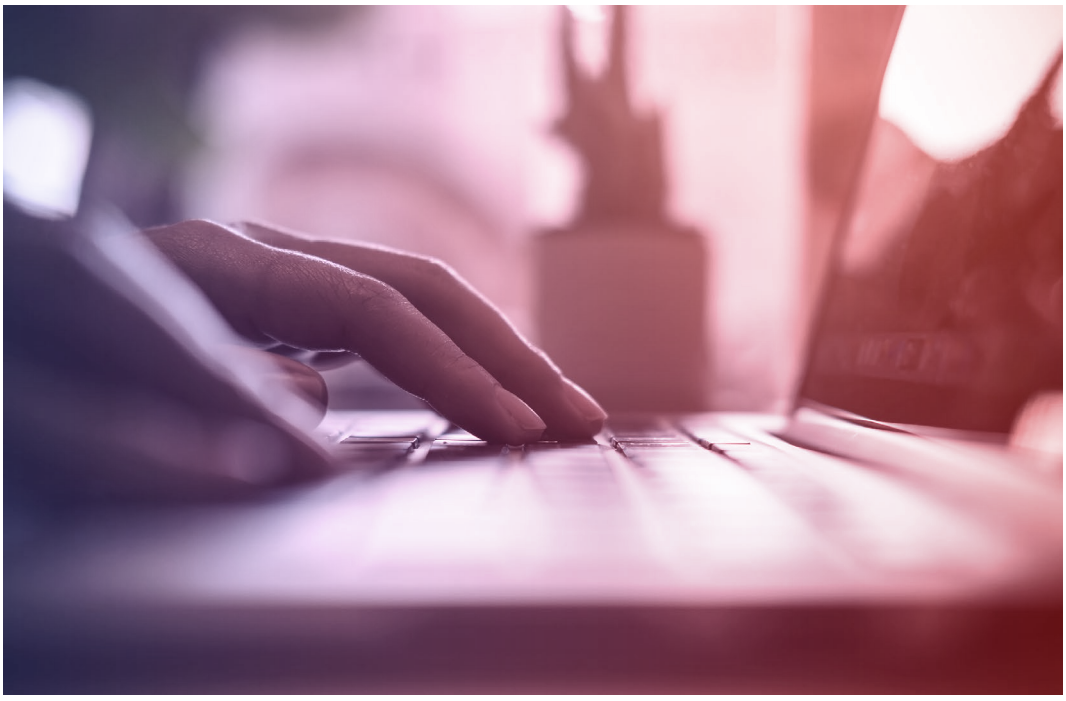


MOBILE INTERNET PENETRATION

SIM cards active up to 4G
SIM cards active up to 3G
SIM cards active on 2G

Source: Arcep Observatory

French population estimated at 67 millions inhabitants as at 1 January 2017



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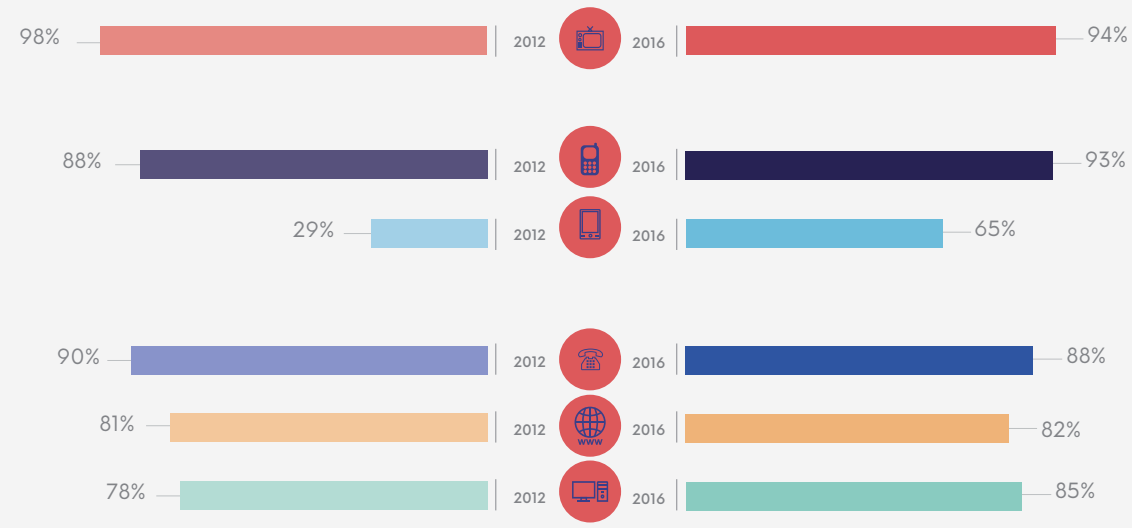
Consequently, 82% of the French now have a computer at home and 85% enjoy fixed Internet access, making the penetration level almost equivalent to that of landline telephony (88%) [3]. Where mobile is concerned, 92% of the French have their own mobile device, two-thirds of which are smartphones. The latter, which contribute to the spread of Internet usage via mobile phones [4], accounted for 84% of sales of mobile terminals in France in 2015.

// **Increase in** Internet-driving equipment



Source: Baromètre du numérique 2016 (CREDOC on behalf of Arcep, CGE and Agence du Numérique)

[3] "Baromètre du numérique" [Digital Measuring Stick Survey], November 2016.

[4] "Conditions de vie et aspirations" [Living Conditions and Aspirations], CREDOC, June 2016.

DID YOU KNOW?

e-COMMERCE

The French are among the leading consumers in Europe in terms of online purchases, as well as for carpooling or video on demand (VOD) [10]. E-commerce revenues in France have reached 72 billion euros, after a decade of double-digit growth, making it the fifth largest market in the world [11].

PERSONAL USES

Amongst European users, certain Internet uses can be found in all individuals with relatively little distinction: emailing (86% of Internet users), looking for information about products or services (80%) and reading news media (70%). Other uses are, to the contrary, more segmented depending on the user's age. To wit, the majority of those under age 25 read social media networks (88%, compared with 38% of those over 55), video, radio or music services (approximately 80% as compared to less than 40%), and voice or video-phone communication platforms (54% versus 30%). In contrast, they are less likely than their elders to make use of medical information (a practice common in 60% of those over age 55, compared with 50% of those under 25), banking services (around 60% versus 44%) and those relating to travel (around 50% compared with 40%) [12].

PROFESSIONAL USES

The digital transition of French companies is still far from complete: while 99% of companies report having used an internet connection in 2015, only 67% of them had a website and 28% could be found on a social network [13]. Similarly, many services remain little used: e-mailing campaigns (28%), e-commerce (23%), videoconferencing (20%), broadcasting of audiovisual content on online platforms (16%) and Cloud computing (12%) [14].

[10] *"Etat des lieux numériques de la France"* [Situational Analysis of Digital in France], Roland Berger / Google, January 2017.

[11] *"Etude sur le marché du colis transfrontière"* [Study on the cross-border parcel market], Arcep, May 2017.

[12] "Internet Access and Use Statistics –Households and Individuals", Eurostat, January 2017.

[13] *"Etat des lieux numériques de la France"* [Situational Analysis of Digital in France], Roland Berger / Google, January 2017.

[14] *Etude marché entreprise* [Market and Businesses Study], IFOP on behalf of Arcep, 2016.

In addition to personal access devices, many studies report skyrocketing volumes in connected objects across the world: it is projected that, by 2020, the number of devices in use will range anywhere from 26 to 80 billion [5]. While these figures are to be taken with caution, given the still-emerging nature of the market and the widely-varying scopes considered, they are a harbinger of a strong increase in usage related to the Internet of Things.

With Internet accessibility progressing (both network coverage and end-user equipment), in 2016, 88% of the French used Internet, compared to 82% of Europeans [6] and more than half of the world's population [7]. Now, 74% of the French population uses Internet daily, one out of two Internet users saying they cannot spend two or three days without it, and 70% of those under 60 deeming that the Internet is important to feel integrated in society [8].

Concerning offers, the data volumes included in tariff plans, whether fixed or mobile, are continually on the rise. Moreover, whilst already able to choose from a variety of unlimited offers on fixed Internet since 2002, the French have enjoyed the same opportunities on mobile since early 2017. With ever-higher data-caps, consumers have become freer in the way they enjoy the Internet.

For instance, the French now spend an average of 18 hours per week on the Internet, compared to 20 hours spent in front of a TV. Furthermore, they hold themselves back less and less when using services that generate very high volumes, such as online video viewing, which now accounts for the majority of traffic in France (cf. 3.2.1c).

Combined, these factors have given rise to a steady and regular increase – which, furthermore, appears likely to continue – in data traffic on networks. Thus, overall traffic (i.e. fixed and mobile combined) is currently growing by around 20% per year [9].

[5] Sources: IDATE, CISCO, Gartner.

[6] "Internet Access and Use Statistics –Households and Individuals", Eurostat, January 2017.

[7] "Digital, social, mobile: the 2017 figures", We Are Social, January 2017.

[8] "Baromètre du numérique" [Digital Measuring Stick Survey], Arcep, November 2016.

[9] "Cisco Visual Networking Index", 2016

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The trend is particularly prominent on mobile. While Arcep observed a doubling in volumes in 2016 [15], Cisco estimates that the average increase will be 53% per year by 2020.

This increase in traffic has made it necessary for operators to very regularly resize their networks. That resizing implies keeping up relatively constant investments over time – in addition to the investments dedicated to each generational jump in the deployment of new access technologies, whereby the required outlay is one order of magnitude higher.

Electronic communications service providers are furthermore faced with increasing disintermediation on the part of content and application providers, which now offer comparable online services that can potentially replace operators' traditional electronic communications services: for example, on telephony, with the development of voice over IP and instant messaging, or likewise on video or television, to name only a few.

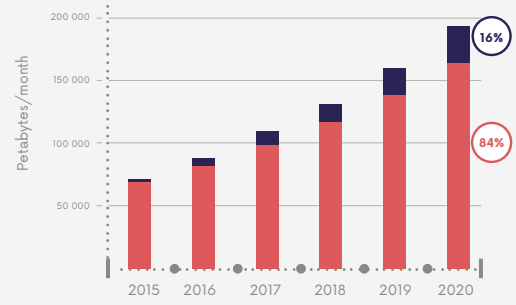
Against this backdrop, Arcep considers it more necessary than ever to monitor the development of markets and usage, through its various observatories, surveys and studies.

"Innovation on the Internet is based [...] on the preservation of an open [...] expanse in which competition is not limited to vying between established players [...]"

TECH IN France
page 48

[15] Arcep Observatory, March 2017.

// Projected growth in **IP traffic worldwide**



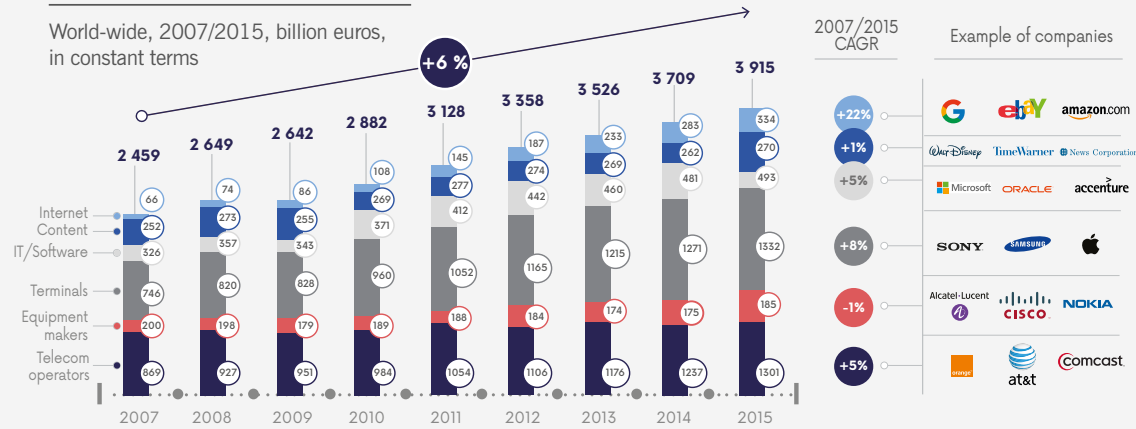
Compound annual growth rate 2015-2020:

Fixed networks + 19% per year

Mobile networks + 53% per year

Source: CISCO

// **Digital ecosystem** revenues



Source: Annual FFT Report

2.2 Ensuring Internet's proper functioning

In view of the increasingly central role played by Internet in society, Arcep positions itself, as invited to do so by the law, as a guarantor to the proper functioning of all networks that form the Internet.

In the short term, this implies a three-fold role:

- measuring and contributing to improving network performance (section 2.2.1);
- monitoring IP interconnection – and taking action, if necessary (section 2.2.2);
- promoting and supporting the transition to IPv6 (section 2.2.3).

2.2.1 Fostering improved quality in Internet access services

Measuring and publishing quality indicators on Internet access services have become one of the priorities of many regulators around the world.

In this undertaking, the regulators are driven by two objectives:

- enabling all users to reliably assess the performance of their Internet access and compare them with those observed with other technologies, other Internet access providers or other offers, in order to guide the competitive dynamic towards more investment and not only towards lower prices;
- identifying any practices that may call into question Internet openness, such as a decline in the overall quality of Internet access services to the benefit of specialised services, or a differentiation in routing conditions for certain categories of services or applications.

In France, Arcep has been working on this issue for several years [16]. This work is now included in the Authority's data-centric regulatory system approach. Through data, users will be able to make enlightned choices, and thereby to create a healthy pressure on the market thanks to competition. In this approach, Arcep does not hold a monopoly on information, it better sees itself as potential facilitator and

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[16] Since 2010, in fixed Internet access services. See 7th of the September 2010 "Proposals and Recommendations, on monitoring Internet quality of service".

coordinator of the Internet access quality measurement ecosystem.

a) On the road to participatory production (crowdsourcing)

In 2016, the Authority decided to enhance its quality of service observatories to offer to the users enriched measurements which are more representative to the user experience. For this purpose, it has decided to lean on crowdsourcing tools. Through them, each user can assess the performance of his or her individual access, and contribute to Arcep's data collection effort. This enables Arcep to build a rich collective information base through which possible market malfunctions can be identified.

> It should be noted that while the Authority takes a single approach to the quality of both fixed and mobile services, the Arcep's work on the coverage and quality of mobile networks is not elaborated upon in this report. As their issues are closely connected with those of territorial development, Arcep invites readers to refer for more information on this point to the report on the GRACO (exchange group between Arcep, the local authorities and operators).

b) Findings from the controlled-environment system

Given these new guidelines, Arcep proceeded to make adjustments to the regulatory framework with Decision no. 2017-0126 [17].

In particular, this decision repealed the provisions relating to the quality of fixed Internet access and telephony services, as from Second Half 2017. These provisions had given rise to the first Arcep observatory on Internet access quality of service, based on measurements made in a controlled environment (dedicated lines deployed in datacenters).

Arcep has capitalised on this observatory which is the result of a significant design, construction and operation effort involving operators, consumer associations, and independent technical experts – together on a technical committee that meets several times a year – under its aegis. The many lessons learned through this process, both on the substance and the surface, have been used by Arcep in its new undertakings.

"Information to consumers needs to be seen broadly, and not be limited to speeds measurements alone."

UFC-Que Choisir
page 27

These lessons are listed in the body of the report (section 3.1.2). Examples include:

- Where governance is concerned, it is important that all stakeholders be involved, in order to guarantee transparency, as well as to compare and contrast often complementary viewpoints. It is in this spirit of building close and constructive dialogue with all players that Arcep sees the development of new and more efficient systems.

- The Committee's discussions have resulted in the publication of a public technical reference manual. The development and drafting process brought to light many technical lessons, which can inspire any actor involved in measurement.

- So as to ensure the general public can understand the indicators and draw concrete consequences in their purchasing decisions, the usage indicators reflecting real users practices and presented in visual form in a tangible unit are to be fostered (e.g. loading time for a popular web page, stated in seconds)

c) Partnerships

For 2017, the Authority is giving priority to implementing close and regular work with actors already

[17] Decision adopted by Arcep dated 31 January 2017, approved by Ministerial Order on 30 March 2017 from the Ministry in charge of electronic communications.

working to measure coverage and quality of service, or centralising user reports. Consequently, a call for partnerships was conducted in the summer of 2016, in response to which some twenty measurement providers made their submissions to Arcep.

With their active contribution, the Arcep embarked on two studies in First Half 2017 aimed at mapping the different crowdsourcing tools currently available on the market. These first studies attest to the wide range of methodological approaches used and the heterogeneity of the results measured.

More specifically, the first study compared the methodologies deployed by each tool and confirmed that the ecosystem for measuring the quality of fixed services in crowdsourcing is rich, diversified and promising. However, significant work from the entire community – ISPs, measurement providers, academics, civil society, regulatory authorities, international bodies, etc. – remains to be done, particularly around the following topics:

- Sharing best practices in measurement methodologies;
- Characterising the user environment;
- Improving statistical representativeness (panel and number of measures);
- Fighting fraud;
- Developing usage indicators;
- Ensuring the trust-worthiness and impact of publications aimed at the general public.

Arcep will focus its attention on these points in the coming months. It invites ecosystem actors to explore varied and creative avenues that meet these objectives in order to assess their value and feasibility. Within this context, Arcep intends to position itself as coordinator to an ecosystem of a different kind, as a facilitator, to promote the best possible quality in information provided to users. In other words, as a trusted third-party that builds lasting unity within the community and stimulates

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the ecosystem's work around subjects of general interest (standardisation of measurement methodologies, dissemination of good practices, etc.).

The second study compared the results of speed measurements and latencies from various online testers and revealed the heterogeneity of the measured data. For instance, when it comes to the average download speed on a same fibre line, two tools can be seen to differ by a factor of five. The Authority has run a first-level analysis of the data gathered and presents some of its findings in Section 3.1.3. More in-depth analysis to highlight their causes – particularly measurement methodologies – remains to be carried out and forms the Arcep's road map of for the coming months.

d) Initiatives undertaken at the European level

Alongside this, the quality of Internet access services has been the focus of work carried out for several years at European level. These undertakings are complementary

"Quality of service measurements have become increasingly relevant to regulators."

BEREC
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"The main challenge in this project is to benchmark and visualize the broad variety of initiatives' data in one mapping application."

European Commission
page 41

to the partnership approach taken by Arcep, which plays an active role in them. They aim to promote harmonisation in measurement methodologies at the European level.

Consequently, in 2017, BEREC plans to publish a report recommending a methodology for measuring the quality of fixed and mobile Internet access service, and technical specifications for a tool concretely enabling measurement. The tool will also be used to detect possible traffic management practices within Internet access.

As to the European Commission, it continues its efforts to set up an open collaborative platform on which any actor carrying out quality of service measurements is invited to share the methodology and results of its studies.

2.2.2 Monitoring data interconnection market

In September 2012, in its report to Parliament and the Government on Net neutrality, Arcep had noted, regarding data interconnection, *"As a result of rising traffic, decreasing costs and the strategies being employed by stakeholders, the interconnection market is undergoing rapid changes and has become a source of tension between the players. Thus risks of anti-competitive discrimination by some big players may emerge. Arcep nevertheless considers that the current state of the market […] does not warrant a more stringent regulatory framework at this stage. Thanks to the Decision adopted on 29 March 2012 on regular campaigns for gathering information from the players, the Authority will be able to monitor market trends, analyse them and take them into account when performing its duties, particularly when settling disputes. […]"*

In order to develop an in-depth and up-to-date knowledge base of the routing and data interconnection markets, Arcep has set up information-gathering campaigns on data interconnection and routing on the Internet [18]. Thanks to this, Arcep exchanges on a daily basis with field experts (international conferences, bilateral meetings, etc.) and shares its market's vision with its European counterparts

[18] Decision no. 2012-0366, as modified by Decision no. 2014-0433-RDPI.

within BEREC, which will publish a report on IP interconnection practices in 2017.

In light of the latest developments, Arcep continues to deem that the interconnection market is functioning adequately, despite occasional tensions [19]. Thus, it does not appear necessary to intervene through an *ex ante* regulating decision. In contrast, supervision will continue to be useful as, on the one hand, it allows Arcep to react quickly if any problem happens ,and on the other hand, it encourages players to engage in virtuous behaviour.

In the report herein, Arcep is making public previously unpublished results from the aforementioned data interconnection gathering campaigns, for the technical community dealing with interconnection issues.

In order to keep a maximum efficiency level, Arcep intends to produce in late-2017 a revised version, of its decision to collect information on data interconnection and routing. It has become clear that the said collection should now take into account:

1. the notable increase in traffic from hosted cache servers, which is a new means for injecting traffic directly into the ISP network, alongside traditional interconnection modes (transit and peering).

2. the transition to IPv6, which is now well initiated.

This could also be an opportunity to simplify the decision, on certain points.

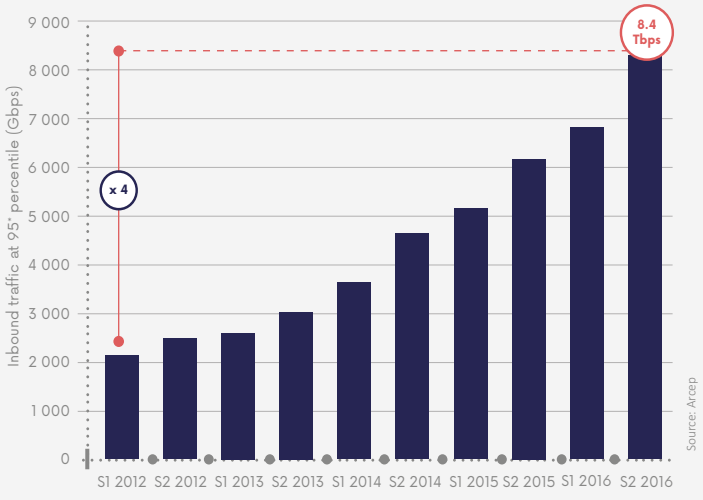
2.2.3 Encouraging the transition to IPv6

In response to a request for opinion dated 11 January 2016, Arcep submitted to the Government, on 30 June 2016, its report on the state of IPv6 deployment in France, produced with the cooperation of Afnic (the French acronym for «Association Française pour le Nommage Internet en Coopération» i.e. the French Network Information Center). This report, which has been made public, includes a six-action plan to speed up the transition to IPv6.

In order to promote the coordination between internet players and to share information of public interest on the state of the transition in France, Arcep released, on 9 December 2016, an Observatory of the Transition to IPv6.

This observatory, updated on 31 March 2016, confirms the increase in IPv6 use rate in France (+1.2 points over three months, from December 2016 to March 2017). This increase is due mainly to the migration actions already undertaken, for their fixed subscribers, by Free in 2007 and by Orange in 2016. The observatory also highlights the role of content providers in the transition to IPv6, which have remained around 50% in terms of IPv6 deployment.

// **Inbound traffic to main ISPs**
in France between 2012 and 2016



[19] See the dispute between Cogent and Orange before the French Competition Authorities, concluded in 2012, or the administrative investigation on several companies, including Free and Google, regarding the technical and financial conditions of traffic routing, run by Arcep in 2012-2013.

© NicoElNino

The Arcep observatory will be augmented at the end of 2017, using data collected directly from the main ISPs in France, regarding their fixed and mobile networks. These data will include in particular:

- the number of available IPv4 addresses and the percentage of these addresses already assigned;
- the IPv4 address sharing implemented mechanisms;
- the percentage of IPv6 enabled subscribers;
- the percentage of IPv6 traffic;
- the current IPv4 and IPv6 address allocation policy;
- the IPv6 transition programme.

Lastly, in order to foster reflections on IPv6 advocacy events, Arcep presents a selection of major events across the world that promote the transition to IPv6.

2.3 Safeguarding Net neutrality

Arcep is now responsible for safeguarding Net neutrality, enshrined as a principle by the European Open Internet Regulation.

2.3.1 A new framework and a roadmap for Arcep

From the subject's very emergence in the European legislative debate in 2009, with the overhaul of the telecommunications package, Arcep was intent on studying Net neutrality in detail and informing the public, the legislator and other stakeholders. Thanks to previous contributions [20] it is able to trace back the historical evolution of the practices concerned, on the one hand, and the doctrine and framework for regulating Net neutrality in France and Europe on the other.

The European Open Internet Regulation [21], which has been in effect since 30 April 2016, marks a change in dimension for public action: the European legislator now subjects Internet Service Providers (ISP) to obligations which national regulators are required to control and sanction if necessary. The progress made by this regulation is presented in section 3.4.1c).

Following the adoption of the Law for a Digital Republic and the BEREC guidelines that further

[20] See part 3.4.3 for more details.

[21] Regulation (EU) 2015/2120 of the European Parliament and of the Council of 25 November 2015 establishing measures relating to open Internet access and amending Directive 2002/22/EC on universal service and users' rights with regard to electronic communications networks and services and Regulation (EU) No. 531/2012 concerning roaming on public mobile communications networks within the Union.

detail the Open Internet Regulation, Arcep now has a clear roadmap and updated powers to fully enforce the neutrality of Internet.

This roadmap quickly came into being through an initial diagnostic phase, during which the practices falling within the scope of the Regulation in France were identified: technical practices on the operators' networks as well as commercial and contractual practices, in the description and general terms and conditions of their offers.

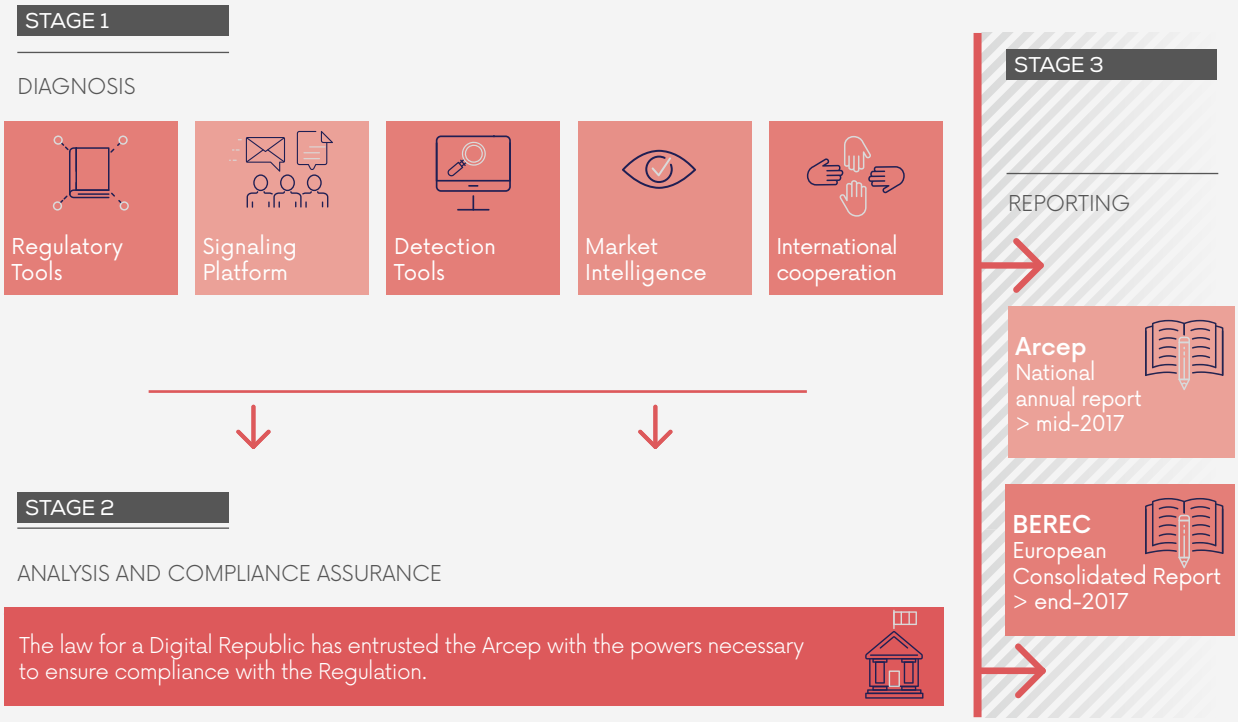
Several tools, presented in section 3.4.2b) and 3.4.2c), have been added to enhance the Arcep's diagnostic capacities, such as monitoring and international cooperation. Others will supplement them in the coming months (signaling platform, detection tools, etc.).

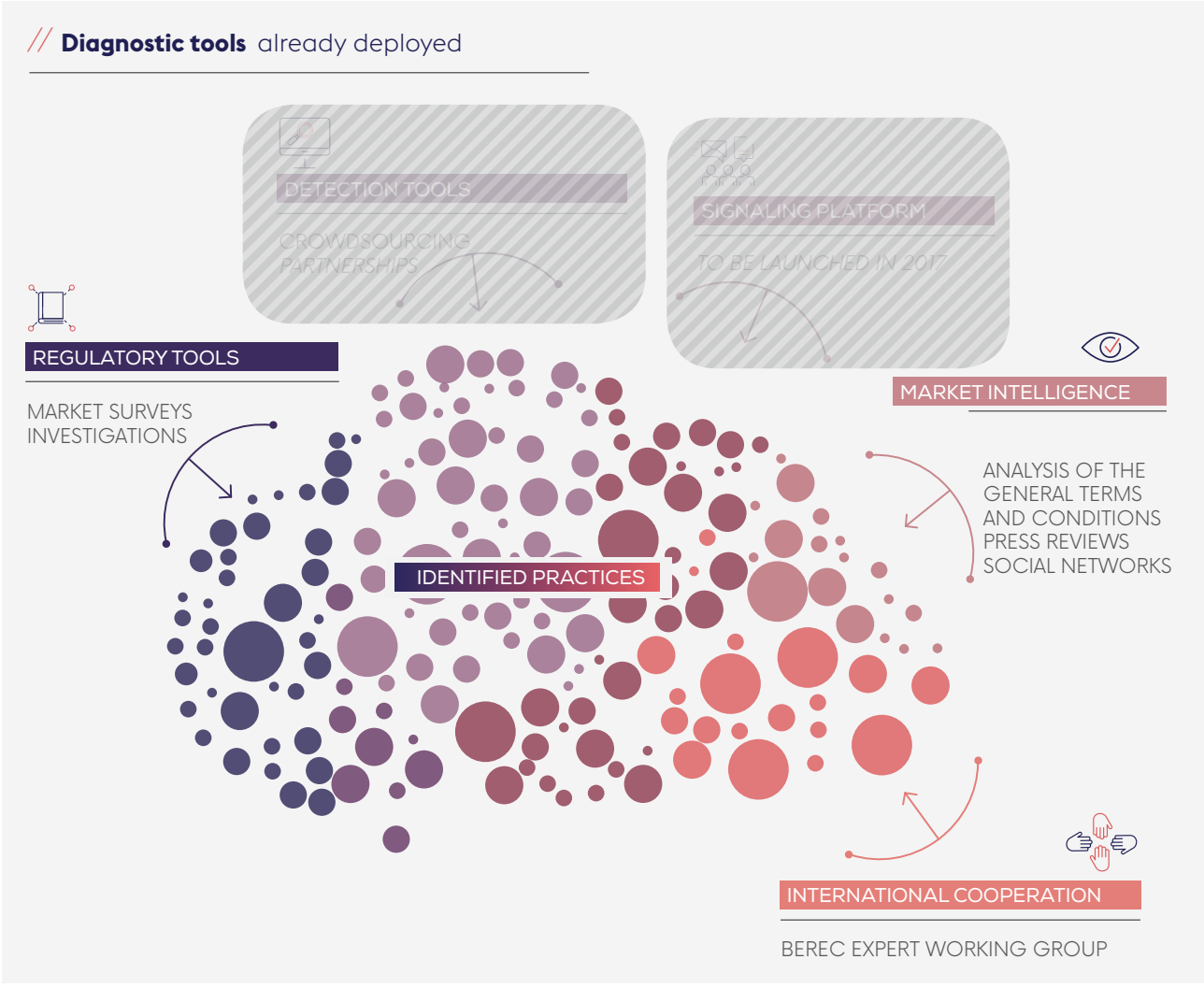
Alongside the described diagnostic effort, Arcep's board, in its proceedings and investigation formation, has initiated a proactive dialogue with ISPs and other stakeholders, in order to compare the analysis of the Authority's services and the interpretation of the European rules made by the ISPs. This dialogue aims at ensuring ISPs adjust their practices to make them compliant with the provisions of the regulation.

Considering that this framework is new and wide-reaching, this approach seemed more appropriate, before considering, after case-by-case analysis, compliance proceedings for specific practices pursuant to Arcep's powers of sanction.

This proactive dialogue has made it possible to detect, in particular - and to remove – terms and conditions that were blocking specific services and types of use (such as a ban on peer-to-peer, VoIP

// **Arcep roadmap** for the enforcement of the Open Internet Regulation





or newsgroups), which would clearly go against the neutrality of Internet.

2.3.2 After an initial one-year cycle applying the European regulations on the open Internet, the time has come for Arcep to review

Arcep has completed an initial census of practices and offers on the market.

Where commercial practices are concerned, the observation of practices over the last 5 years shows a significant change in offers in the retail market. For instance, for many years, service blockages existed, for instance to peer-to-peer, newsgroups, or even video streaming, as did bans on certain types of use, such as tethering. These blockages have become a rarity and Arcep, via its appointed formation, will see to it that the Regulation is enforced, through case-by-case analysis of the practices.

As regards *zero-rating*, Arcep closely followed the first decisions of other European regulators on the subject, and took due note of the diversity in situations which it reflects. Arcep wishes to reiterate, as is stated in the BEREC guidelines, that: *"Any agreements*

"Our sector is that of dialogue and interaction. [...The] Arcep initiative to involve all stakeholders [...] is something we see as more than natural [...]"

French Telecommunications Federation
page 64

"Arcep prefers to work through proactive dialogue rather than regulation. It may be a little effective, but the role of the regulator is also to regulate, without having to wait for civil society complaints."

La Quadrature du Net
page 64

or practices which have an effect similar to technical blocking of access (see paragraph 55) are likely to infringe Articles 3(1) and 3(2), given their strong impact on end-user rights." (§48) and *"In case of agreements or [commercial] practices involving technical discrimination, this would constitute unequal treatment which would not be compatible with Article 3(3)."* (§55). Thus, subject to case-by-case analysis, commercially promoting a product or service may influence end-user access to content and applications.

Furthermore, operators seem to have effectively sized up the implications of the regulation on traffic management and the possibilities it leaves open.

As a result, a few exceptions to the rule of equal and non-discriminatory traffic treatment can be seen. For instance, several ISPs operating in overseas France apply exceptional traffic management measures when the submarine cables serving the relevant territories are down. As this type of unforeseeable event causes a sudden drop in network capacity, a congestion management policy capable of restricting certain traffic flows in order to ensure the correct quality of the most critical services appears justified.

"We feel it is difficult to establish a list of 'specialized services' or to give a technical definition thereof, as it may be obsolete within a few years."

Highlighted quote
AFNUM page 65

Lastly, ISPs have presented the routing conditions specific to voice over broadband and linear broadcasting television over IP , as specialised services. As the BEREC guidelines specify, these services do appear to be *"typical examples of specialised services provided to end-users* [...] *with specific quality of service requirements, subject to them meeting the requirements of the Regulation, in particular Article 3.5 first subparagraph"*.

2.3.3 Work schedule for next full-year cycle

For the future, Arcep intends to enhance its diagnostic capacities. In particular, new crowdsourced tools will provide the Authority with a more comprehensive and instantaneous view of market practices:

- One initial tool will be built around an on-line signaling platform - to open in Second Half 2017 - for end-users wishing to call Arcep's attention, for instance, to specific practices which they deem to be non-compliant with the European Open Internet Regulation.

- Another online tool, accessible to all and across the territory, will measure quality of service and detect traffic management practices.

It is important that end-users take up these new tools to power the Authority's surveillance, in a good-citizen gesture.

Arcep furthermore intends to work with the DGCCRF [22] in a co-construction effort involving operators and consumer associations, regarding the heightened transparency commitments, in particular on upload/download speed, which ISPs must contractually make in application of Article 4.1 of the Open Internet Regulation (transparency measures for ensuring open Internet access).

These undertakings are intended to build toward international cooperation. In late 2017, the BEREC Working Group on Net neutrality will publish a report on supervision tools and methods, which might enrich Arcep's existing mechanisms. This report will be based on the concrete experience of national regulators, as well as on an external

[22] Directorate-General for Competition Policy, Consumer Affairs and Prevention of Fraud.

study presenting the tools used by extra-European regulators.

BEREC will also, by compiling national regulators' reports, make an overall appraisal of how the European Open Internet Regulation has been applied thus far. It is expected that this work will bring out joint observations, echoing the work undertaken during the drafting of the Net neutrality guidelines.

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2.4 Beyond the networks, contribute to platform opening, with a focus on end user devices

While it does broadly introduce an open Internet principle, the European regulation consists primarily of measures focused on the neutrality of Internet service providers' networks. Yet the ability to access the Internet and offer content on it involves a wider chain, in which other actors also play a significant role. As essential software or hardware interfaces, online platforms have the power to limit the ability of end-users to access or supply certain content and services. Hence the question under debate for several years on the regulation of platforms.

In its dual role as communications network architect and guardian, Arcep wanted to focus more specifically on end user devices, which have adjacencies with access networks and whose uses have changed significantly over the past few years, with the emergence of a platform-type model. Arcep thus chose to initiate a project on how terminals influence the Internet openness. In this process, it looked not only at their physical layers, but also at their possible operating systems, browsers and app stores. Parallel to the present document, it is publishing a study comprising an initial diagnostic on the role of the end user devices and calls upon all the players to respond to it, by expressing, in particular, their forward-looking vision on the subject. This first stage opens up a cycle of several months and will lead, in 2018, to the publication of a more comprehensive report. ■

"[The] platforms [are] essential social infrastructures, the functioning of which must be able to be called into question democratically."

CNNum
page 83

3 IN DETAIL AND IN FIGURES: WORK AND MAIN LESSONS

This chapter sets out detailed information that may respond more specifically to the needs of informed readers and experts.

Structured into different themes, it presents details of Arcep's work as well as the main lessons learned, both qualitative and quantitative.

3.1 Fostering improved quality in Internet access services

Up to this point, Arcep's work on the quality of fixed network services was largely based on a system operating in a controlled environment. It thus offered the advantage of guaranteeing very high comparability between the various operators. This comes from the fact that several parameters were common to the lines they deployed in this context: location of test servers, user environment, length of xDSL lines, etc.

However, this system also had a number limits: in particular, it failed to adequately represent the wide variety of situations involved, lacked geographic relevance, and suffered from a high risk of fraud. As the costs entailed by corrective measures such as increasing the number of lines and regular audits would not compensate for the benefits derived, the Authority decided to terminate this system. With Decision no. 2017-0126 [23], approved on 30 March 2017 by the Minister for Electronic Communications, thus abrogated the provisions relating to the quality of fixed Internet and telephone access services found in Decision no. 2013-0004, which had instituted the controlled-environment system.

As a result, the mechanism will no longer make measurement as of 30 June 2017; Arcep, meanwhile, will not produce any new summary reports: the last was published on 28 November 2016, and focused on measurements taken in First Half 2016.

Paragraph 3.1.1 summarises Arcep's new approach to studying the quality of Internet access services. Sections 3.1.2 and 3.1.3, aimed at experts, sets out in a concrete and detailed manner how this approach can be seen in the Authority's works in First Half 2017. Lastly, Paragraph 3.1.4 presents the workstreams carried out by BEREC and by the European Commission.

[23] Decision adopted by Arcep dated 31 January 2017, approved by Ministerial Order on 30 March 2017 from the Ministry in charge of electronic communications.

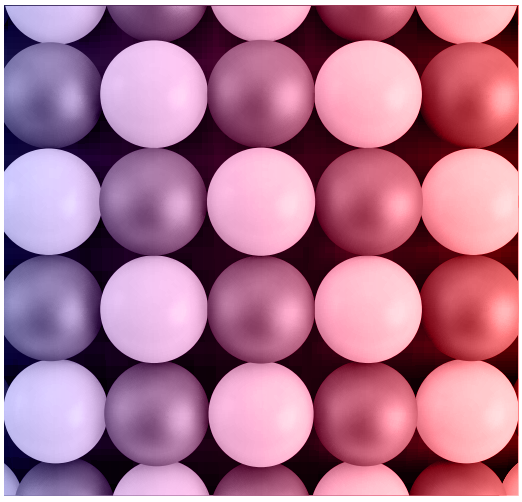
3.1.1 On the road to participatory production (crowdsourcing)

When the conclusions of its strategic review were published last in January 2016, Arcep took the opportunity to affirm its desire to be part of the overall approach to modernising public action in the digital era. Through "data-based" regulation, Arcep wishes to use information, by creating an alliance with the multitudes, to guide the market in the right direction and empower the user population. Improving the quality of data collected and distributed implies encouraging competition that plays out not only in the prices, but also by maximising the impact of investments in the networks.

This new mode of action is intended as a supplement to the regulators' traditional tools, according to a State-platform logic. It is primarily implemented regarding the coverage and quality of networks and services, including Internet access service.

Generally speaking, data can be produced in 3 different ways:

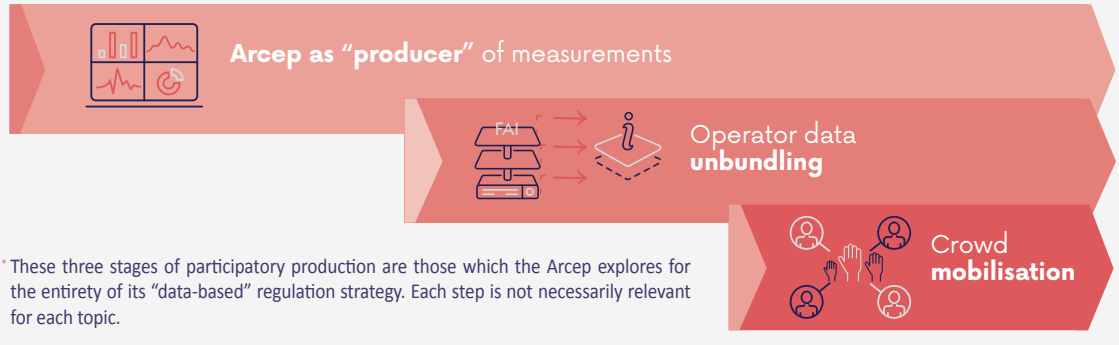
- by Arcep, as it does through its observatory reports and surveys;
- by operators, in which case Arcep's role consists of recovering and distributing the said data (data unbundling);
- by the multitudes, by mobilising the user through crowdsourcing solutions, either developed directly by Arcep, or derived from a partnership with other producers within the ecosystem.


© D.R.

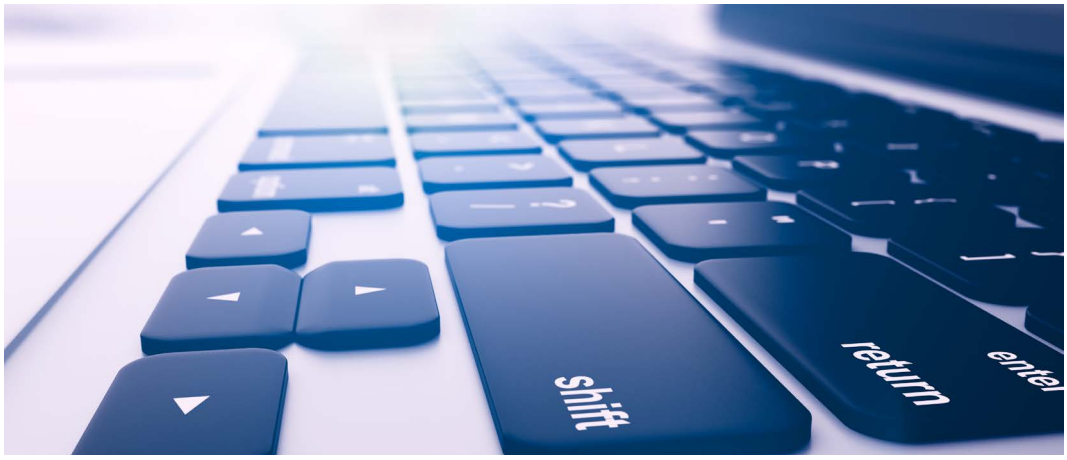
In terms of cost, responsiveness and reliability, crowd mobilisation has become the best-suited solution when it comes to monitoring the quality of fixed service. The Authority is thus striving to ramp up the number of crowdsourcing formats.

For this first stage, Arcep will post a consumer complaint plateform online, in 2017, open to all users. This will make it possible for them to call attention to the problems they encounter with their operators, particularly those pertaining to quality of service and Net neutrality. Subsequently, the regulator will assess the opportuneness of developing other crowdsourcing solutions in order to supplement those reports from the ground.

// Participatory production* **step by step**



* These three stages of participatory production are those which the Arcep explores for the entirety of its "data-based" regulation strategy. Each step is not necessarily relevant for each topic.



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Concurrently, the Authority embarked on a participatory, decentralised production approach. At the end of 2016, it issued a call for partnerships, through which it was able to identify stakeholders with an interest in data production, reliability-assurance, processing or distribution in connection with network quality of service data.

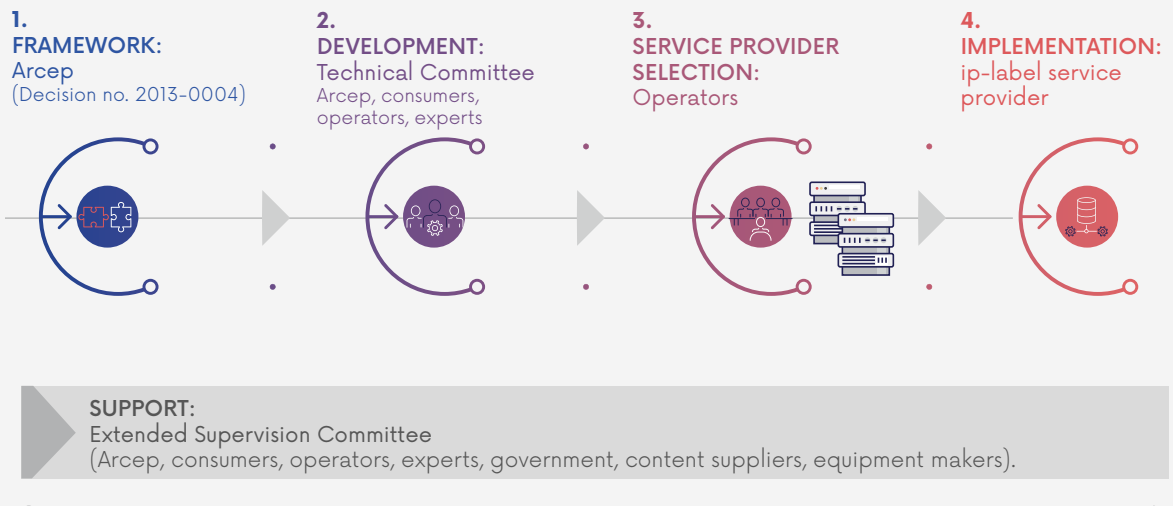
Building from those contacts, it mapped out, both in terms of methodology and quantified results, a variety of tools dedicated to measuring the quality of fixed networks based on the crowdsourcing currently available on the market. These findings are detailed in the following sections.

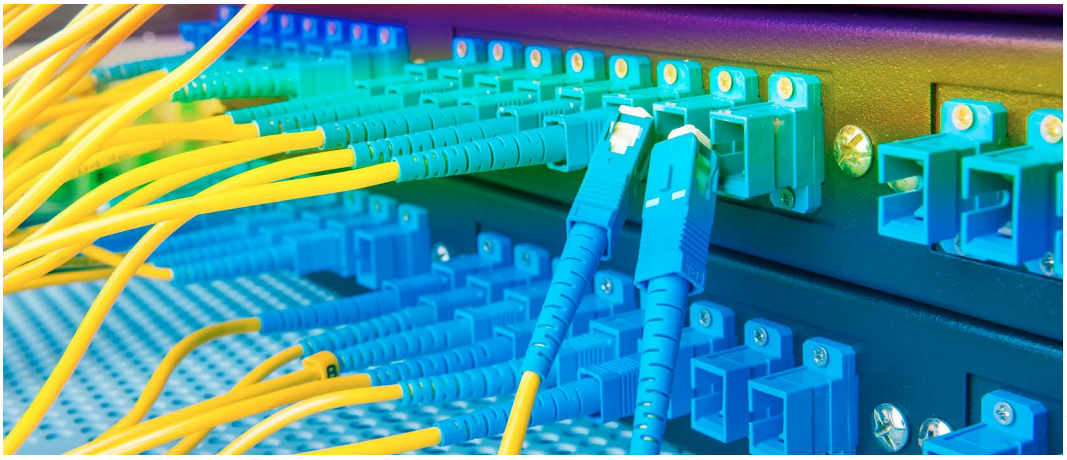
The Authority will now step up its work with these players and determine, in the second half of 2017, the collaboration methods to which it will give priority alongside them.

3.1.2 Arcep observatory review in a controlled environment: conclusions

The controlled environment observatory was born of a large-scale design, construction and operation effort spanning 3 years, involving operators, consumer associations, independent technical experts and Arcep services. From these, lessons were derived and will feed Arcep and the ecosystem in its future undertakings.

// **Governance diagram** for controlled environment system





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a) *Findings from the controlled-environment system*

The fact that the system was managed in a controlled environment, from start (defining the methodology) to finish (publication of results) first made it possible to draw conclusions about the form and how to work on quality of service.

Where governance is concerned, it is important to bring all stakeholders into the process. The Technical Committee, which brings together operators, consumer associations and independent technical experts several times per year under the aegis of Arcep, has, in the same vein, made it possible to guarantee the transparency of the work undertaken, compare and contrast often complementary points of view and quickly identify the best practices, practices to avoid and the research angles to prioritise. Other players were also called upon more occasionally to oversee the design, implementation and monitoring of the system, as part of an expanded steering committee: equipment suppliers, content suppliers, DGE [24] and DGCCRF.

Arcep intends to maintain a very close dialogue with all stakeholders, adopting an efficient cooperation format, including the largest possible number of players and targeting tangible results. One of the main challenges lies in the diversity of the players involved: academics, civil society, consumer associations, small measurement services providers and independent experts often have significant added value to offer, but limited time and resources available.

This considerable effort on the part of the participants has also made it possible to develop a public technical reference base. This document, refined over time and thanks to the feedback from the technical committee, can be of inspiration to any measurement sector player in its efforts.

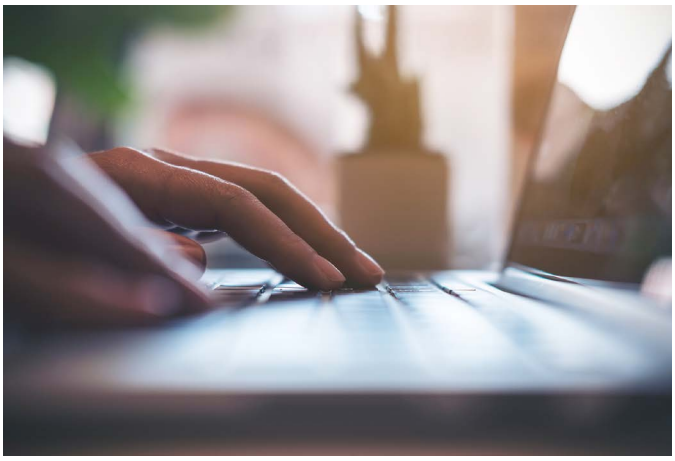
A variety of parameters were discussed and have resulted in formal findings, for example:

- where technical indicators are concerned, it appears preferable to give priority to capacity-measurement over speed-measurement This is because speed measurement is too similar to certain usage indicators (e.g. file download) defined for other purposes (representativeness of usages in particular), creating difficulties in interpretation. In this context, it is better to simulate a pure technical indicator, by saturating the link.

- on an TCP session, packet loss (or rather packet distribution) indicator is very difficult to interpret and connect to other indicators that are more compelling for the user.

- effective environmental management is one of the key challenges in making an appropriate

[24] Directorate General for Enterprise.



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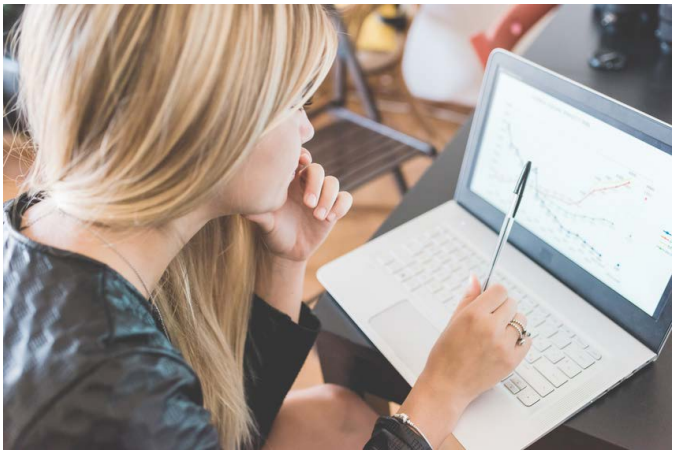
comparison of Internet access performance between ISPs. A Wi-Fi modem connection as opposed to a RJ45 cable connection, an operating system or a web browser when not updated can have a major impact on results. We will come back to this in the following section.

- hardware and the operating system can also have a considerable impact on flow indicators: up to 50% on a target with 15ms latency.

Lastly, the way in which results are communicated is particularly important in enabling the general public to understand, interpret and draw concrete consequences in their choice of technology, provider and access offer. In particular, the following should be encouraged with respect to the broader public:

- usage indicators, reflecting actual user practices (video streaming, P2P download, web navigation, etc.).



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- tangible units that are close to user perception (e.g. number of seconds to open a popular page rather than the corresponding average flow).

- a graphical, or even interactive, presentation of data. It was in this spirit that the enhanced mobile coverage maps published online by Arcep in March 2017 were produced.

b) Lesson learned on fixed QoS in France

As to the results of the measurement campaigns carried out for almost three years, as part of the controlled environment system, they have been educational in many respects, bringing out and putting into perspective trends on the quality of fixed service in France. A few examples are given below.

First, the system has highlighted – and put into perspective – the very clear hierarchy between Internet access technologies. To wit, on upload/download speeds and on latency, the performance of fibre to the home is significantly better than those of coaxial cable and, still more, copper (short, medium and long xDSL lines).

Secondly, it emerged that xDSL performance has progressed steadily between 2014 and 2017, whether on short, medium or long lines.

In this respect, one of the concerns often expressed by civil society, in the context of debates on Net neutrality, was that ISPs could be tempted to downgrade the overall quality of the Internet access service over time to offer, within a relatively short timeframe, pay (or more expensive) services of a more satisfactory quality. The above curves do not seem to attest to this.

In addition, the charts show the proportion due to the introduction of VDSL (in November 2014) on the ADSL lines of the device that supported it. This technology has enabled significant gains (statistical/non-predictive, in line with the theory), particularly on the shortest lines. The mechanism also highlighted that the VDSL lines were, in return, the cause of some instability in performance, on the VDSL lines themselves and on the neighbouring lines.

Lastly, the controlled-environment system made it possible to quantify the impact of the distance of the test servers on performance. The results are obviously highly dependent on the chosen location. In the system in question, the shift from close to distant test servers caused a deterioration of more than a third on the download speed and by more than 50% on the upload speed. The latency recorded on distant test servers was almost triple the value measured on nearby test servers.

3.1.3 Partnerships

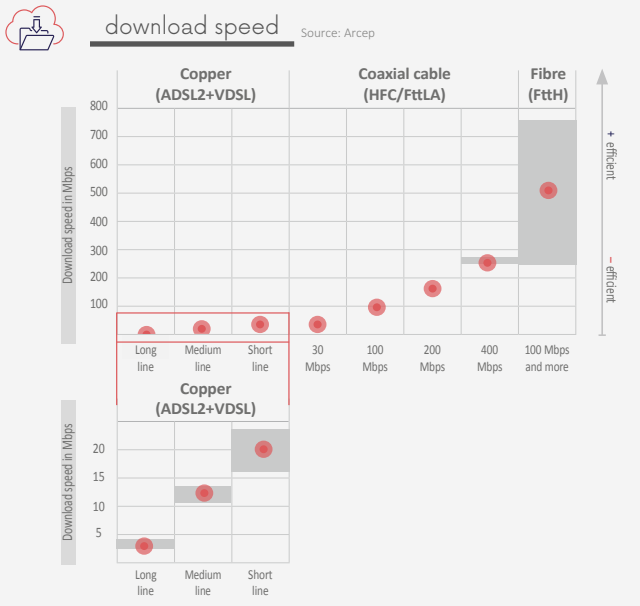
Many crowdsourcing-based measurement tools focusing on the quality of fixed services can already be found on the market. The responses to the call for partnerships showed the dynamism of the players who developed these tools, the variety of services offered and the willingness of these players to strengthen their ties with the Authority. It invites its potential partners to mobilise their expertise to design innovative collaboration formats usable and beneficial to all, in a spirit of general interest.

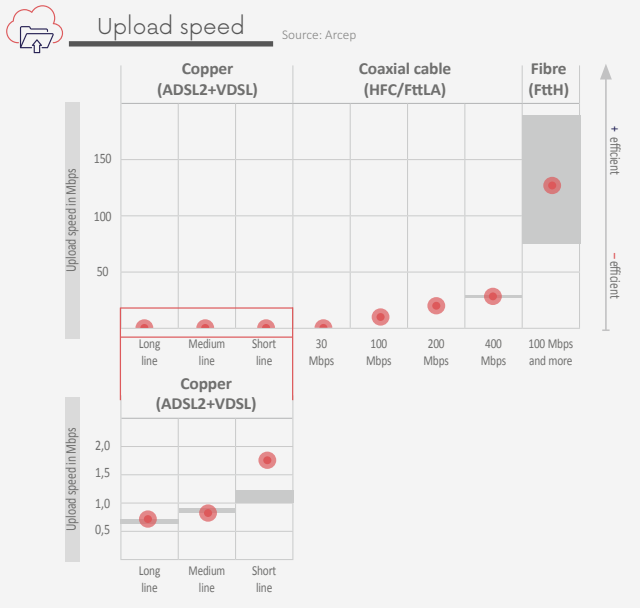
Meanwhile, in order to assess diversity and better understand the impact of the methodological choices on the quantified results of the measures performed, the Authority conducted two studies aimed at drawing up a situational analysis of the existing situation, described below. They broach technical aspects for quality of service experts interested in improving crowdsourcing-based measurement.

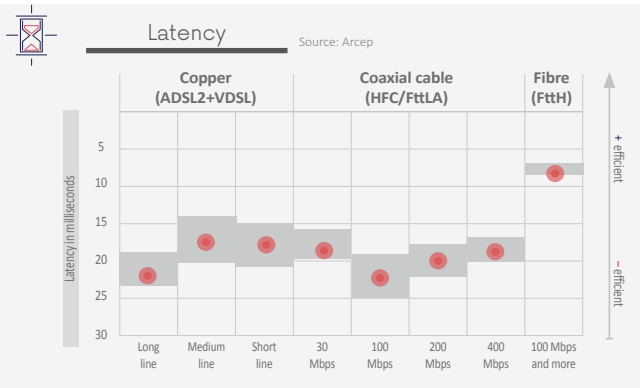
This first situational analysis report is not exhaustive: any public or private player with a crowdsourcing-based measurement tool looking at the quality of fixed services and interested in participating is welcome to join. Similarly, the observations presented below and the first conclusions derived from them are intended to be clarified and enhanced with the participation of the entire ecosystem.

The already-edifying lessons from this situational analysis will enable the Authority to detail its partnership strategy with regard to the quality of fixed services. They attest to the wide range of

// Access technology **rankings**



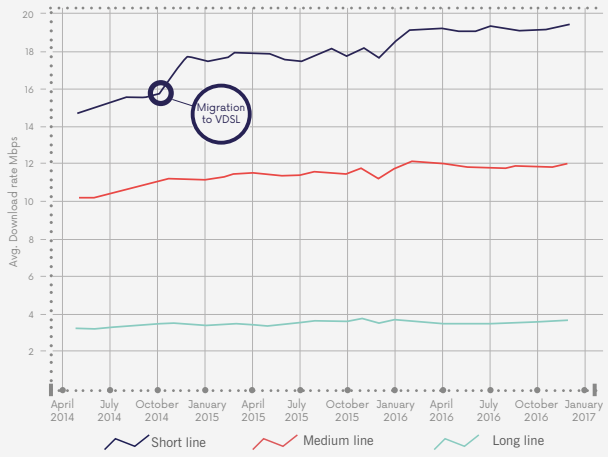




// **Improvement in quality** of service on copper

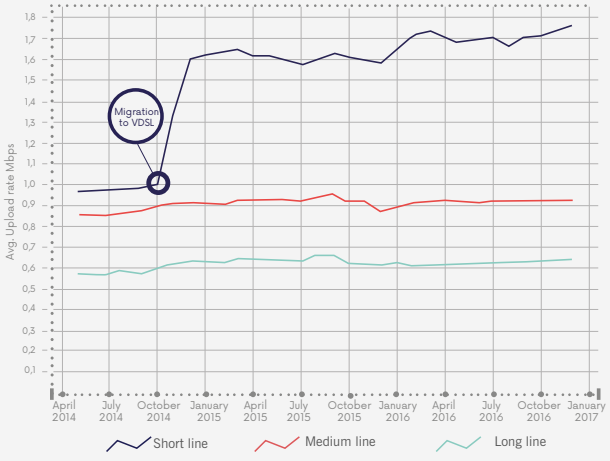
Download speed

Source: Arcep



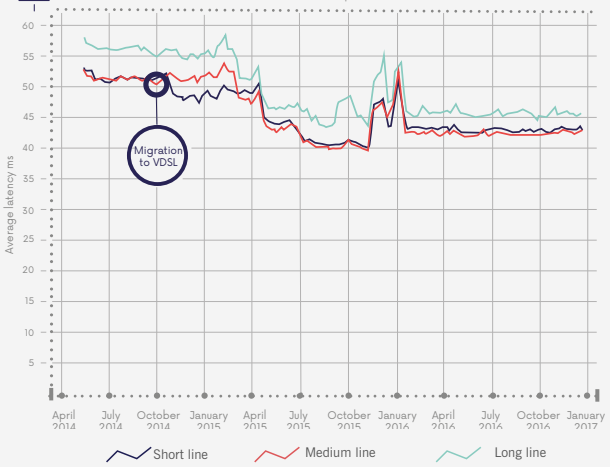
Upload speed

Source: Arcep



Latency

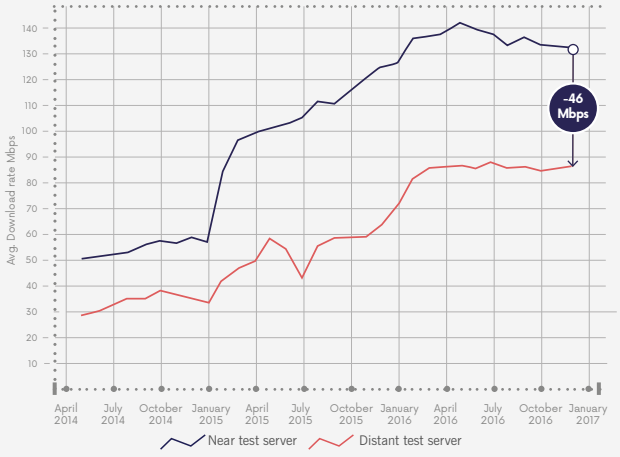
Source: Arcep



// **Impact of targeted** test server

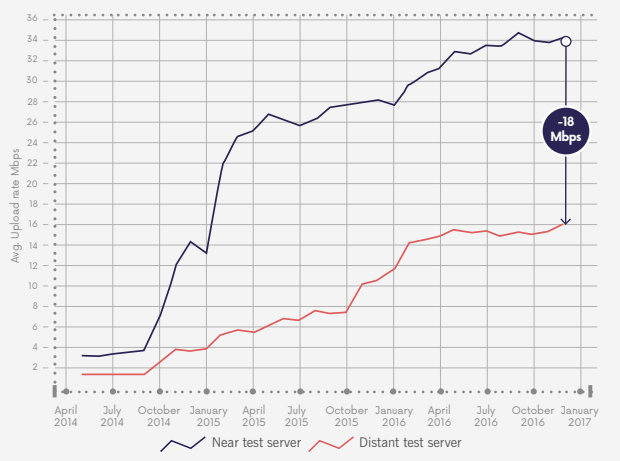
Download speed

Source: Arcep



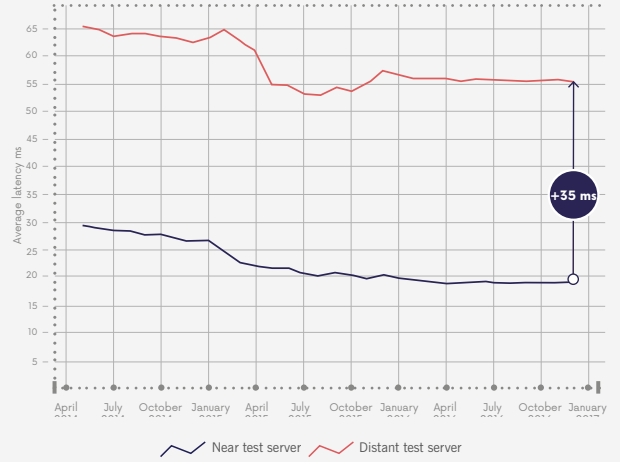
Upload speed

Source: Arcep



Latency

Source: Arcep



Three QUESTIONS TO

UFC-Que Choisir (French consumer association)

Antoine AUTIER, *Deputy Manager of UFC-Que Choisir*

QUALITY OF SERVICE, from the perspective of UFC-Que CHOISIR

1 UFC-Que Choisir publicly paid tribute to the discontinuation of the controlled environment: could you review the reasons for this with us?

In and of itself, a controlled environment can offer advantages, particularly by focusing on the quality of networks as such, and by removing from analysis some biases stemming from the wide variety of ways in which consumers use the Internet. That being said, this type of device becomes an issue when the investigation protocol associated with it is known to the Internet service providers (ISPs) tested. The risk that they will optimise the lines tested cannot be ruled out, and as a result, the test results could conceivably overestimate the actual capacities of the networks. However, the mechanism recently stopped by Arcep gave the ISPs too prominent a role in the protocol's development, hence UFC-Que Choisir's strong reservations from the start as to the mechanism selected.

> The major benefit of crowdsourcing lies in the fact that it enables all consumers to send data that reflect their user experience.

2 What do you see as the advantages and limits of the crowdsourcing method?

The major benefit of crowdsourcing lies in the fact that it enables all consumers to send data that reflect their user experience; consequently, the results at the end of the chain are actually connected with the wide variety of consumer realities, enabling them to compare not only ISPs, but also all Internet technologies. What's more, the tool on which crowdsourcing is based can enable each consumer to access indicators on the quality of his or her connection and, if desired, be able to compare and contrast them with information on the alleged quality of the advertising campaigns.

As such, crowdsourcing is not without shortcomings, however. For example, if the number of consumers using the crowdsourcing tool is not high enough, this comparison may lack relevance, as the results from the ground are not representative of all situations possibly encountered by consumers.

Furthermore, and even though these biases were raised by widespread use of the tool by consumers, questions about the quality of information processing could persist.

3 How can technical results be conveyed to consumers in a clear and educational way manner?

Along with the price charge for Internet access, the quality of service provided to consumers is a key factor on the basis of which they choose their Internet access offer. It is therefore essential that they be able to access clear and relevant information on the quality of service for all fixed Internet offers. This information needs to be seen broadly, and not be limited to speeds alone. For example, the quality of the home Wi-Fi, which is currently widely used, must be carefully addressed. Similarly, IPTV quality tests of can no longer be overlooked. Furthermore, given the high stakes involved in interconnection, the quality of the Internet services espoused by consumers deserve to be the focus of a special explanatory effort.

At the same time, this approach opens up the risk of flooding customers with information, and thus muddling their understanding. It is for this reason that, beyond technical results, it is important to decrypt information and make it intelligible for consumers. This is one of UFC-Que Choisir's abiding aspirations. ■

methodological approaches used and the heterogeneity of the results measured. More often than not, this diversity is explained by the varying objectives sought by the various tools.

That being said, a harmonisation in the measurement methodology is important. Without minimal standardisation, it is difficult to draw up comparisons between geographical zones or between operators, analyse changes in performance over time, or allow an end user to formally compare the actual performance of his/her Internet access with those indicated in his or her contract.

This is the challenge raised at the European level by the BEREC working groups and the European Commission mapping project. Arcep takes an active part in this, contributing knowledge that will fuel the reflections of these bodies through its work at the national level and by regularly interacting with European stakeholders.

a) *Ecosystem mapping: tools available on the market*

The ecosystem of crowdsourcing metrology on the quality of fixed services is far-reaching and diverse. The following study is based on responses from ten existing players to a questionnaire sent out by the Authority as part of its call for partnerships open to any interested organisation.

The players were assigned to one of three more or less uniform groups:

The "hardware sensors": sensors located on the client side (on the box, operating an Ethernet bridge or simulating a terminal) that automatically perform quality of service measurements.

"Web testers": testers accessible online by the general public, also referred to as "speedtests", which makes it possible to measure the flow (or latency, etc.) of its fixed Internet connection.

"Other software solutions": a broader category that includes both server solutions (mscore), software agents embedded in boxes (cloudcheck) or on web pages (Radar script).

Many of the players have developed a variety of solutions and could fall into multiple categories. This is true, for example, of Gemalto, which in addition to the hardware probes owns an online tester intended for companies. For the sake of concision, the study will focus hereafter on each player's main tools, as defined in the mapping above.

Where existent, the diagram indicates, below each player's name, the commercial name of the associated tools, which are sometimes more well-known to the public.

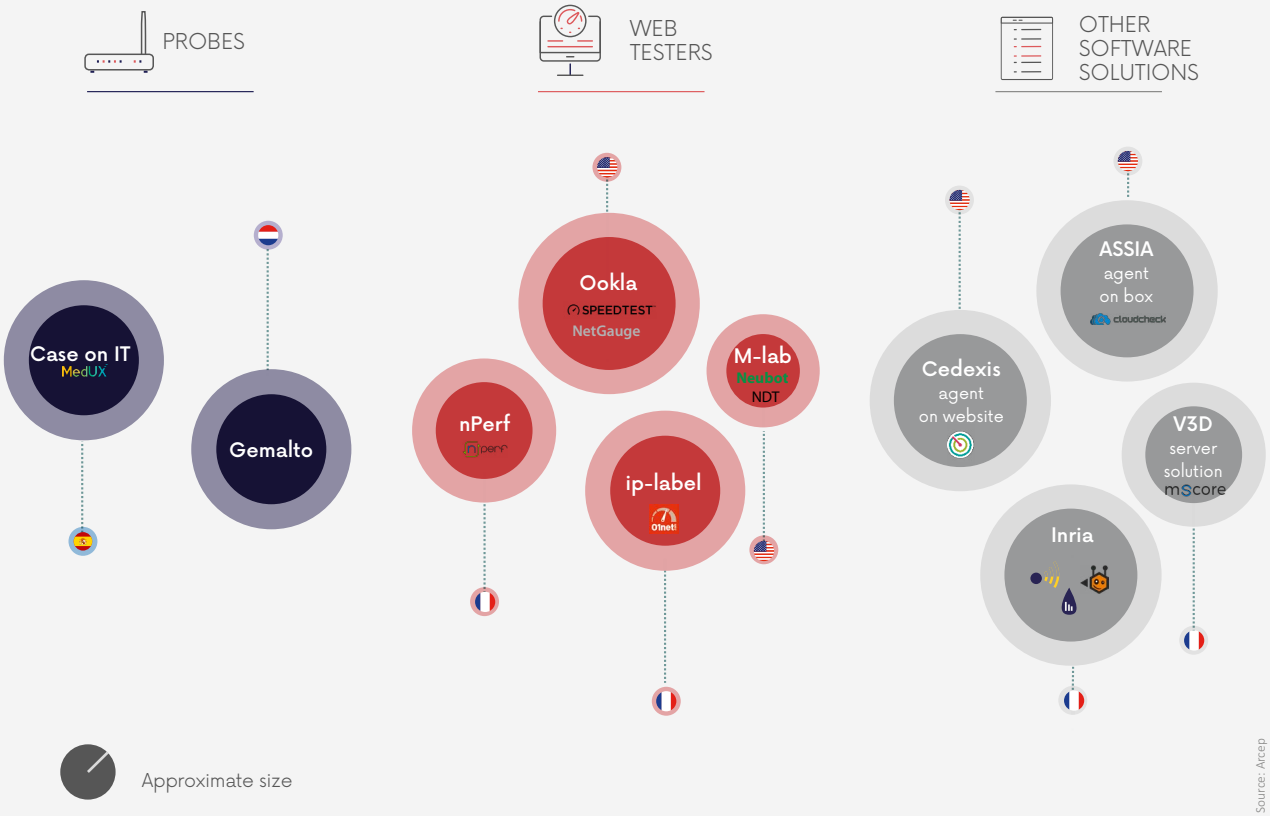
The scope of research at Inria and M-lab goes well beyond quality of service of electronic communications networks. Similarly, quality of service accounts for only a small part of the Gemalto Group's activity. On the other hand, the activity of the seven remaining players is entirely dedicated to those topics (in the broad sense). The size of the bubbles roughly reflects the size of the relevant player in approximate number of employees working on quality of service. It does not prejudge the intrinsic value of the solutions proposed.

Most of the players shown are for-profit companies. Their core business and their positioning on the value chain vary widely. Although all players operate a B2B model (business to business), some of their tools are known to the general public via regular publications of their figures and analyses, as a result of which they can often gain visibility from their corporate clients.

Five of the eight for-profit companies included in the study earn turnover that comes in very large part from ISPs; two of them report moderate to low dependency on ISPs; one (Cedexis) is almost not dependent on them at all.

M-lab and Inria, in contrast, are non-profit organisations. They develop technology offered in open-source mode and report their data in open data (for most of their tools).

// A rich and varied **ecosystem**



The table below shows the main sources of revenue for players participating in the study.

The column "sales of quality of service or experience data" encompasses two types of scenarios: data sold and subsequently collected by players via their tools; and sales of marketing claims or data licensing (which make it possible for an ISP to communicate the results published by a given tool). In both cases, the data belongs to the tool that has produced them.

In other situations, players do not sell data directly but rather the metrology service, i.e. a technology or infrastructure that can, for example, be offered on white label.

Some companies also offer to manage and optimise their clients' network. These can be ISPs (this is the case of ASSIA) or content providers (this is the case of Cedexis). Cedexis's core business is quite different from that of other players: the company offers its customers the opportunity to improve the availability and speed of their website by directing their traffic to CDN platforms, clouds or data centres that show the best performance – estimated by Radar tests or other external measurement sources – at a given time and location.

Lastly, there are also other sources of income not shown in the previous table. This includes the sale of advertising inserts on websites of certain online testers.

▶ **Note:** *Inria owns 4 tools dedicated to measuring the quality of the distinct fixed services that serve different objectives (ACQUA, APISENSE, Fathom, Hostview). As their methodologies vary widely, in order to remain brief, we will not detail them hereafter in this publication.*

// Quality of Internet **access service**

Benchmarking of existing tools: methodological section

Type of activity		Commercial			Non-commercial
		Sale of QoS/ QoE sales	Sale of metrology services	*Network monitoring*	R&D
	Case on IT		●●		
	Gemalto		●●●		
	Ookla	●●●	●		
	nPerf	●●	●●		
	ip-label		●●●		
	M-lab				●●●
	ASSIA			●●●	
	V3D		●●●		
	Cedexis	●		●●●	
	Inria				●●●

Source: Arcep

Tests conducted and methodology employed

There are two major types of performance indicators: technical indicators (speed, latency, jitter, etc.) and usage indicators, which refer to actual uses (web browsing, video playback in streaming, peer-to-peer download, telephone/voice on IP, etc.).

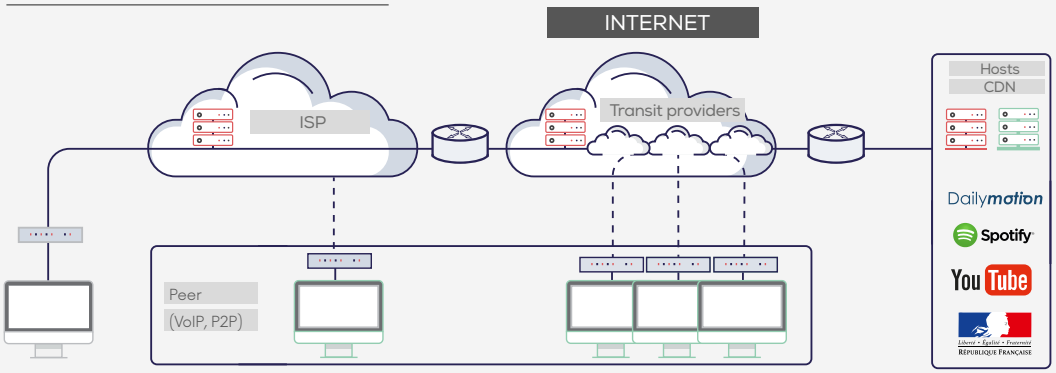
By definition, the test server on usage indicators are located at the level of the content provider's (Youtube, Skype, etc.) host. The test servers on technical indicators can be located within varying distances of the user. The closer the test server, the more the quality indicator depends only on the ISP's network performance. The controlled-environment system also showed the considerable impact of the servers' location on the indicators (more than 30% on the download speeds and over 50% on upload speeds – see section 3.1.2 b).

Technical indicators

In addition to their location, the connectivity of the test servers required to measure the technical indicators can influence the outcome of the measurement. If inadequately sized, the speed measurements will be artificially capped. The test servers of the various systems taking part in this study showed relatively similar connectivity levels: approximately 100 Mbps for the old generation servers, 1 Gbps for the current servers, and 10 Gbps for the next-generation servers, which are designed to respond to the risk of saturation that could arise when performing simultaneous tests based on very high-speed technologies.

However, the total number of servers varies greatly from one tool to the next. While the ip-label device contains only one server, nPerf and Ookla have more than 300 and 6,000 across the world respectively.

// **Location** of the test servers



Key

- Test servers for technical indicators
- Test servers for usage indicators

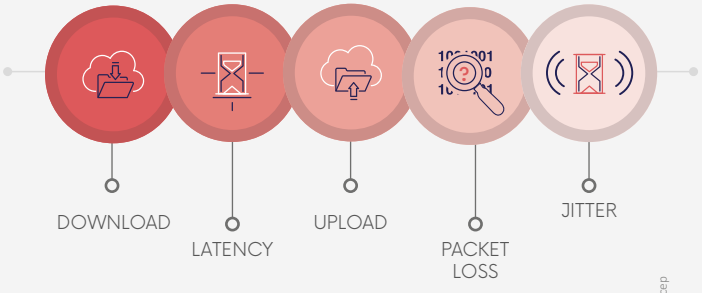
The vast majority of devices select, by default, the server that is closest to the user – toward which latency is the lowest. Mechanically, the larger the number of servers, the more the server selected by default is likely to be located in the user's ISP network. When servers are located outside of the ISP networks, it is important to ensure that the servers have a similar connection between the different ISPs, to avoid possible discrimination. Each of these factors contributes to explaining the differences in results between the systems.

The tools most frequently measure the same technical indicators: download speed, upload speed (except at Cedexis), the latency (and sometimes its derivative, jitter), and packet loss (measured in all players except nPerf, ip-label and Cedexis).

The throughput is calculated by dividing a volume of data sent from the server to the customer (download speed) or from the customer to the server (upload speed) by the total transmission time.

File transmission can take place in monothread or in multithread (parallel use of individual threads or "simultaneous sessions"). While the measurement in monothread is closer to a usage indicator (download of a file that would be hosted on the test server), that in multithread can help saturate the link and therefore estimate the capacity of the line.

// Most measured **technical indicators**



The lighter the bubble, the less common the indicator

Source: Arcep

It is important that a variable be set to limit the duration of the test, whether the volume of the file transmitted or the transmission time. The technology tested (which is rarely known in advance) is of importance. If the file volume is very large but the test is performed via long xDSL lines, for example, the test will be very lengthy and tend to discourage the user initiating it. Reciprocally, if the file is small and a very high-speed technology is tested, it will be downloaded very quickly, and the flow curve will not exceed the phase known as slow-start (gradual flow increase planned by the TCP protocol): the measured speed will thus not be representative of the actual speed available. When the test duration is pre-set, it is necessary to determine the time needed to reach

// Types **of tests**

Benchmarking of existing tools: methodological section

Speed measurement methodology		Protocol	Encrypted flow	Monothread or Multithread	Fixed variable	Displayed value(s)	Slow-start included in the result displayed (respectively)
	Case on IT	FTP ; HTTP	yes*	Mono*	conf.	Avg; Max	no; no
	Gemalto	IP	yes	Multi	t = 10 sec*	Min; Avg; Max	yes* ; yes* ; no
	Ookla	TCP; HTTP	no*	Multi	conf.	Avg**	no
	nPerf	TCP	yes	Multi	t = 15 sec	Avg; Peak***	yes; no
	ip-label	TCP	yes	Multi	t = 7 sec*	Max	no
	M-lab	TCP; HTTP	yes*	Mono	t = 10 sec	Avg*	yes*
	ASSIA	TCP	no	Multi	t = 5 sec*	Avg 98e percentiles* max	yes; no; no
	V3D	TCP; UDP	no*	Mono*	V = 5 Mb* or t = 10 sec*	Avg 10e et 90e percentiles	conf.
	Cedexis	TCP; HTTP	conf.	Mono	V = 100 ko	percentiles	yes

Source: Arcep

Key

conf. : configurable

* Recommended or default value (the variable is configurable).

** Average calculated on a dataset excluding rates in the fastest 10% and the slowest 30%.

*** The peak speed is defined as the average of the rates calculated on 30% of the test, the window selected being the best (generally at end of test).

cruising altitude, without discouraging the user. The slow-start phase, very often included in the measurement, can then be taken into account or excluded subsequently from the calculation of the average flow computed over the duration of the test (in which case the listed speed is higher). The question does not arise when, for example, the maximum speed reached over the period is displayed. The choice of exposure value is of major importance when the results are intended to be presented to the general public, often highlighting only one number in particular.

While all the tools measure round-trip latency, some use the TCP protocol and measure the time elapsed between sending a request and receiving the tracing request (Round Trip Time or RTT) [25], others use the UDP protocol and measure the time

[25] Except Cedexis, which measures the time between the start of an HTTP request and the start of receipt of the query, on a query where DNS resolution and the establishment of the TCP connection are already established.

// Types **of tests**

Benchmarking of existing tools: methodological section

LATENCY measurement methodology		Protocol	One-way or round-trip?	Time-out	Number of samples	Displayed value(s)
	Case on IT	ICMP	Round-trip	conf.	min. 1	Min; Avg; Max
	Gemalto	ICMP ; TCP; UDP		5 sec*	10*	Min; Avg; Max
	Ookla	TCP; HTTP	Round-trip	20 sec	approx. 10	Min
	nPerf	TCP		3 sec	approx. 20	Min; Avf
	ip-label	TCP		Conf.	approx. 10	Min
	M-lab	TCP		Conf.	approx. 100	Min
	ASSIA	TCP	Round-trip	5 sec	5*	Avg; 98e percentile*; Max
	V3D	TCP		Conf.	10*	Min; Avg; Max
	Cedexis	TCP; HTTP		4 sec	1**	N.A.**

Source: Arcep

KEY
conf. : configurable
* Recommended or default value (the variable is configurable)
** The case of Cedexis is somewhat unique in that a Radar session records only one measure per CDN, Datacenter, or Cloud tested, but then aggregates all the samples into its reporting in percentiles (10th, 25th, 50th, 75th, 90th, and 95th percentiles).

between sending a message and receiving the same message after server or client reflection, and some use the Ping command to launch a ICMP query.

The number of samples from which the displayed value (minimum, average, percentiles or maximum) is derived varies depending on the tools. To make this choice, the decision must once again be made between statistical representativeness and test duration (likely to discourage users). Time-out, or the point at which a query is considered to have failed, also has its importance: the later it comes, the more the latency tests are included in the sampling, and the higher the result displayed.

Usage indicators

Usage indicators offer significant interest. Based on actual practices, they are more representative of the user experience, and therefore more intelligible and likely to effectively inform choices on access technology or ISP. The observation is shared by most of the tools included in the study: while speed remains a factor that counts, but what matters most

to consumers is whether the services they use are working properly.

Five of the devices presented measure usage indicators: hardware sensors (Case on IT, Gemalto) and three software solutions (Cedexis, Inria, V3D).

As each tool has defined its own approach, measurement methodologies are still highly varied. Not only can usage as such (web browsing, voice on IP, streaming video, etc.) be simulated or real, but the associated performance indicators also differ. While some tools continue to be based on the indicators referred to hereafter (mainly speed), others are used with new measures directly connected with evaluated use (time required to load a web page, fluidity of voice on IP or video streaming, etc.).

Measurements made on streaming-based video playback illustrate this.

For example, mscore (V3D) simulates, from a test server, a data stream comparable to a video stream, by setting a variety of parameters: average speed, inter-packet time, buffer depth, etc. It then evaluates service deterioration caused by introduced by the end-to-end crossing of the digital network on the simulated flow, by measuring technical performance indicators. These indicators are then grouped together as a single rating, using a configurable scoring method.

In contrast, other tools choose a given YouTube video imposing minimum quality and duration criteria. Some pure (video) usage indicators are collected: time required for the video to initially load before its launch, number and duration of the stalling episodes.

The indicators measured by the tools developed using Case on IT and Cedexis are relatively similar to those shown above. However, the Cedexis measurements come from all pages displaying videos players that would have deployed the Radar client, rather than from a single YouTube video. Furthermore, additional indicators are measured: time required to load video chunks delivered to users, their latency and their speed. These are then correlated with the usage indicators measured elsewhere in order to quantify the impact of these QoS metrics on the user experience.

Data processing, analysis and transmission

Once the measurements have been completed, reprocessing rules can be applied to the data collected: deleting measurements outside predefined thresholds, in the event of test server unavailability, by robots, etc.

Most of the time, measurement service providers leave their clients to make their own adjustments based on their needs. Generally speaking, with the exception of a few tools, little action is undertaken to drastically combat fraud.

The question of data transmission is twofold.

Each tester is not automatically provided with its individual data. Indeed, only one third of the tools allow access to test history. Once again, the existence or absence of this access is not determined by the nature of the tool.

The distribution of third-party data to a client and/or the general public (through the publication of observatories) raises the key question of aggregation the data, and the basic requirements for respect for privacy to be respected. It raises the problem of the representativeness of the data aggregated in this manner. The question takes on all the more meaning when the data collected is used to produce publications for the general public that can influence operators' behaviour, as is in particular the case for most web testers. To address the issue of representativeness, two main and complementary areas are to be developed:

- the volume of data collected, the order of magnitude of which is highly dependent on the nature of the mechanism deployed: tens or hundreds of thousands, where hardware sensors are concerned; a few tens or hundreds of millions, as concerns web testers; a few billion when it comes to software developed on web pages such as Radar.

- the characterisation of the data collected (geolocalisation, access technology, modem, terminal, used in the measure - see next section)

In many cases, the mechanisms used to collect a large volume of data do not make it possible to control, with any greater degree of detail – or characterise – the user environment, and *vice versa*.

Characterising the user environment

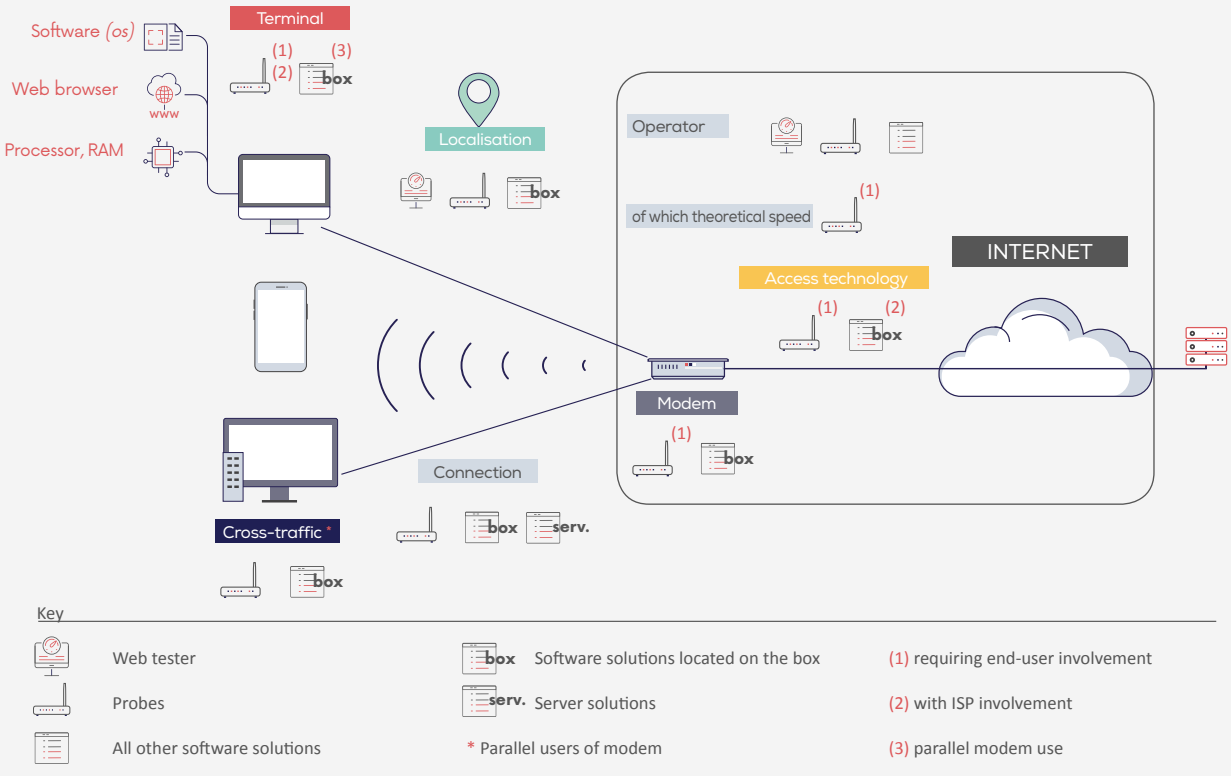
The term "user environment" covers a range of parameters some of which are more difficult to identify than others. Detection is highly dependent on the type of tool used. For instance, hardware sensors and software agents on boxes are often more able to identify them than software agents deployed in web pages or online testers.

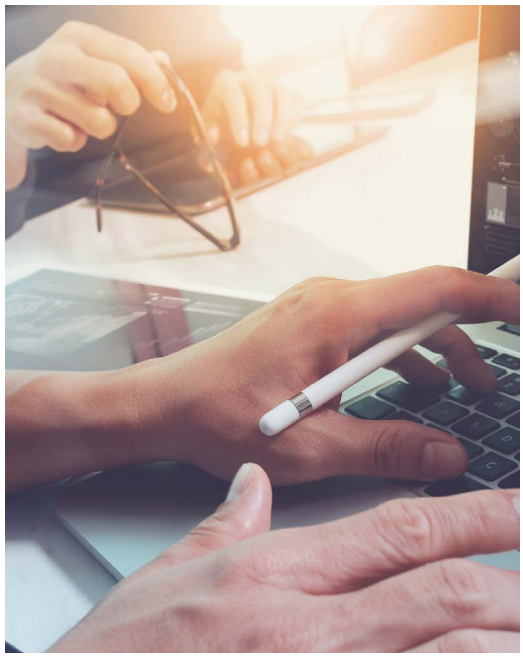
The operator and user location can both be detected by all tools, correlating the IP address of the tester and the existing databases. Other parameters are far more sensitive to identify: access technology (xDSL, coaxial cable, fibre, but also satellite); box-to-terminal connectivity (Wi-Fi, RJ45 cable, etc.); use of access by different terminals in parallel (cross-traffic); offer characteristics (theoretical speed), modem, terminal (web browser, software, processors, RAM).

In some cases, for the hardware sensors, the user's environment settings are not detected but are fixed. For example, in the Case on IT set-up, the terminal features and its connection to the modem (cable or Wi-Fi) are pre-determined as the terminal is the MedUX probe.

It sometimes also happens that detection requires end-user participation (reporting questionnaire) or involvement on the part of the access provider (databases). In itself, all tools could therefore escalate this information if they requested it from the user and if the latter were able to respond reliably

// Characterising **the user environment**





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to their request. However, because of their model, certain tools such as probes have much more direct access to end users (which, as a downside, are fewer in number) and do report this information.

Some tools focus in particular on the home network and the considerable deterioration in performance resulting from a Wi-Fi connection. This is in particular true of Case on IT, Gemalto, Ookla – which now makes it possible to launch Speedtest from one terminal to another – and ASSIA – which allows measurement of both the box to a test server and box to one or more terminals.

More broadly, a quantified evaluation of the often considerable impact of the various parameters listed – use of an obsolete version of the web browser or operating system, parallel login uses, etc. – would be greatly beneficial for the entire metrology ecosystem as well as for end users.

Mapping study conclusion

The crowdsourcing-based quality measurement ecosystem for fixed services is already very broad, and the diversity of approaches and models promising. However, significant work on the part of the entire community – ISP, measurement providers, academics, civil society, regulatory authorities, international bodies, etc. – remains to be done, particularly around the following topics:

- Sharing best practices in measurement methodologies;
- Characterising the user environment;
- Improving statistical representativeness (panel and number of measures);
- Fighting fraud;
- Developing usage indicators;
- Ensuring the trust-worthiness and impact of publications aimed at the general public.

As regards user environment control, Arcep invites in particular:

- measurement service providers to develop solutions to identify the various parameters of the user environment and incorporate them into their reporting;
- ISPs to raise their customers' awareness of the simple means available to them to optimise their network performance;
- academics to precisely quantify the impact of different user environment parameters on network performance.

Arcep also encourages the ecosystem to explore the avenues mentioned over the course of discussion exchanges with market players in order to assess their benefits and feasibility. Among the ideas suggested, it sees the implementation of random test exercises as a means of deterring fraud, and the opening of box APIs or certain operator databases to private players (measurement service providers) or public entities (regulators) to facilitate the identification of the user environment as particularly worthy of attention.

In this context, the Authority will act as a facilitator and trusted third-party to unite the community over time and stimulate the ecosystem's work around topics of general interest.

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b) Comparison of the measurement results obtained from several online speedtests

In order to inform its thinking as it moves to crowd-sourcing, the Authority carried out a study designed to analyse the indicators measured by several popular online speedtests.

- Akostest - provided by Slovenian regulator AKOS: https://www.akostest.net/en/
- Journal du net (JDN) : http://www.journaldunet.com/test-connexion/
- M-lab's Network Diagnostic Test (NDT): https://www.measurementlab.net/tools/ndt/
- Netztest - carried out by Austrian regulator RTR: https://www.netztest.at/en/
- nPerf : https://www.nperf.com/fr/
- Ookla Speedtest: http://www.speedtest.net/fr/settings
- 01-net, put in place by ip-label: http://5g-token.col.ip-label.net/html/

Test procedure and protocol

The study was carried out over a two-week period on two test sites located in Paris and La Garenne-Colombes, and initially set up as part of the Arcep observatory on the quality of service of fixed networks. Through these dedicated lines, the various characteristics of the user environment were totally under control. The measurements were carried out directly from the boxes via Microsoft Internet Explorer 11 over the lines available on the test sites - long ADSL lines, cable (30 Mbps and 100 Mbps) and fibre, from Bouygues Telecom, Free, Orange and SFR. For each tool and over each line, data were collected on upload speeds, download speeds and latency [(26)].

Most tools are updated regularly. For example, Ookla launched a new version of its tool while the tests were being carried out, and Netztest (the RTR's tool) will be updated mid-2017. M-Lab hosts the measurement developed by the recently updated Internet2 consortium to support HTML5 testing. Moreover, it isinteresting to note that the Akostest, Netztest and 01-net speedtests are based on the same technology and methodology, which was developed by RTR, the only difference being the server testers and certain configurable elements.

[(26)] Whenever available (all performance testers except *Journal du net*).

As stated in the previous study, the location of the test servers has a significant impact on the results. All the testers choose a server by default based on an algorithm which is specific to each tooland often tends to minimise latency and/or maximise the speed achieved. When the tool has only deployed one server, this server is automatically chosen by default. The state of the network or the servers deployed at the time of the test may justify that the default test server is not always the same over time even though the test site is the same - this is, in particular, the case for the nPerf and Ookla performance testers.

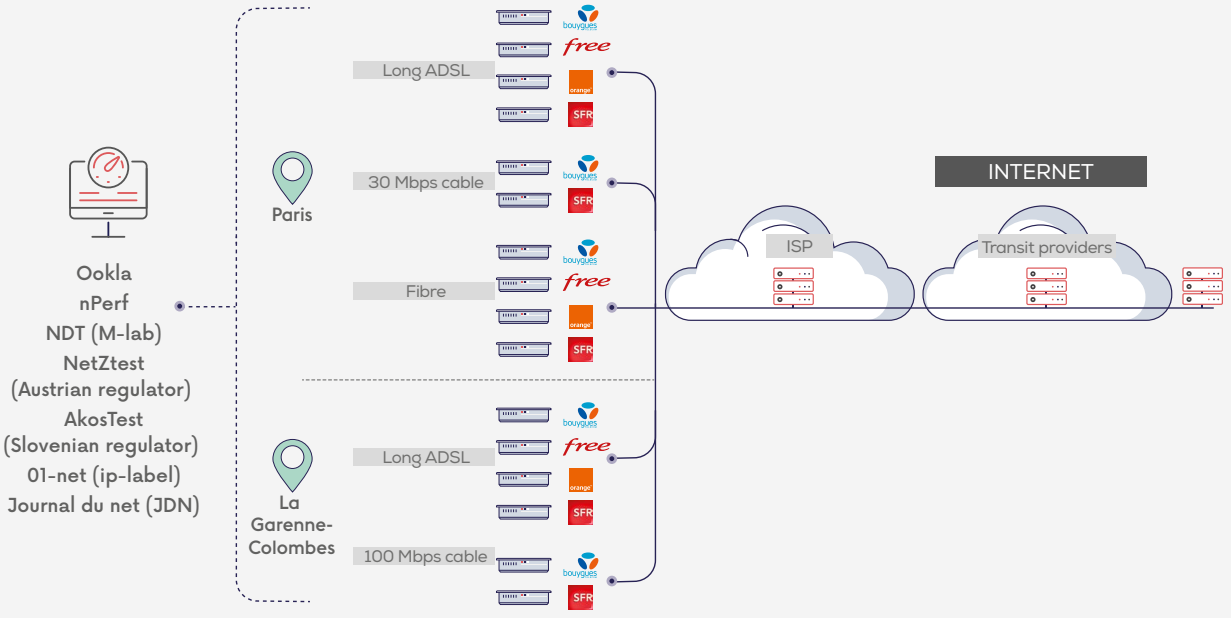
These two testers allow users to choose which test servers will be used to start the test. As can be seen in the following table, various locations were chosen in order to compare data from the largest possible number of tools by isolating the impact of the location of the test server. When the testers allowed for this, some test servers were chosen within the ISP network ("Bouygues Telecom", "Free", "SFR", "Orange") in order to analyse the possible impact on the results.

First Analysis

The Authority implemented a first level analysis. Some of the important initial findings of which are presented below. A more detailed analysis designed to show the reasons behind these findings – in the light of the measurement methodologies for example – still needs to be carried out. Subject to the agreements of the various measurement providers, the figures collected during this study will be examined over the course of workshops with all the stakeholders and may set in motion the Authority's co-construction approach.

As presented on the following graph, the median download speeds averaged over all the ISPs and obtained over fibre lines to the default test server vary significantly depending on the tool chosen. The lowest average (165 Mbps) and the highest average (901 Mbps) vary by a factor of more than 5. The values of the speeds presented by ISP (not averaged) show the same dispersion between the various tools. However, the classification of the four ISPs by download speeds over fibre remains

// Study **device**



// Test **servers**

	France								Europe				International	
Pattern generator location	Ile-de-France	Lyon	Strasbourg	Bouygues Telecom	Free	Orange	SFR	Other	Austria	Slovenia	Ireland	Other	United States	Thailand
Ookla	D	S	S	S	S	S		D	S	S	S		S	S
nPerf	D	S	S			S	S	D	S	S	S	D	S	S
NDT	D													
01-net	D													
netZtest									D					
AkosTest										D				
JDN	D													

Source: Arcep

Légende D : Default test server
S : Selected test server

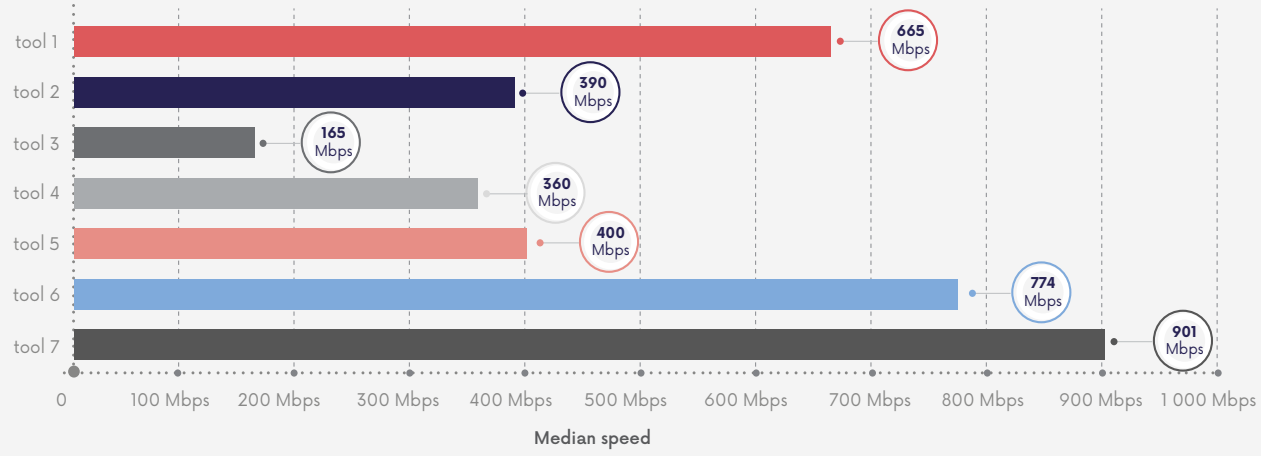
relatively stable - five of the seven tools show the same ranking, whereas the other two invert two ISPs.

The variation of the absolute values of the upload speeds over fibre is also significant - a factor of 8 is noted between the average of the median speeds of the speedtest with the lowest values and that of the one with the highest values. Contrary to the download speed, the order of the ISPs by upload speeds is not the same between the tools.

The spreads in upload speeds and download speeds observed over cable and ADSL are less than on fibre (approximately 20%). Although, as with fibre, the ISP rankings by download speed is relatively stable over ADSL, the ISP rankings by upload speeds differs depending on which tool is used. On cable, the ISP classification ranking by upload speed and by download speeds differs depending on the tool used.

// **Median download speed** depending on tool

Configuration: fibre to the home, all operators combined, test server by default



Source: Arcep

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The considerable difference in upload and download speeds over fibre is explained in part by the location of the test server chosen by default - the further away it is, the slower the speeds will be.

Variations can also be identified with test server located in similar places. Thus, when they are at locations distant from the test site (in Europe or elsewhere in the world), the spread remains of the same order of magnitude. On the other hand, if the test server are located in France, the difference in speed is significantly less (in the region of 30%).

The choices regarding methodology appear to be an important factor. Indeed, when the comparison is limited to tools using a similar technology, the speeds measured are significantly closer.

Finally, as expected, test server located within an ISP's network often appear to advantage the host ISP – to the detriment, sometimes notable, of the other ISPs. The host ISP improves sometimes by up to two places in the ISP rankings by download speeds over fibre for example.

In addition to the average values, it is also useful to examine *ad hoc* values. Indeed, the measurements generated using certain tools show significant short-term variations.

3.1.4 Undertakings at the European level: on the road to a common measurement tool for fixed QoS

The quality of Internet access service is one of the priorities of many international regulators. It is also the focus of numerous undertakings at the European level, in which Arcep is deeply involved.

The European Commission, via its Directorate-General for Communications Networks, Content & Technology (DGConnect), launched the ambitious broadband mapping project in early 2016 (broadband mapping project). Its aim is to produce an online tool that centralises data from all public and private initiatives measuring the coverage and quality of fixed and mobile services from 31 European Union and European Economic Area countries. The main challenge lies in combining the different datasets into groups that use uniform and comparable methodologies. For this purpose, the Commission is working in close conjunction with BEREC.

As to BEREC, it continues its work on quality of service as part of its working group on Net neutrality, the two topics being closely intertwined. The quality of service workstream is divided into two sub-groups (see diagram page in section 3.4.2).

First of all, BEREC plans to publish a report that will help in developing a common methodology for measuring the quality of service and proposing methods for detecting possible traffic management practices within Internet access. In this context, as suggested by the open Internet regulation, BEREC offers avenues for certifying a performance monitoring mechanism for Internet access service (Art. 4.4 of the Regulation). It would enable any consumer to verify the actuality of the

Mapping of broadband services IN EUROPE

European Commission

Hervé DUPUY, *Head of Unit, Investment in High Capacity Networks*

In January 2016 the European Commission has launched an ambitious 3-years project for the "Mapping of Broadband Services in Europe" aimed at the development of an interactive online mapping application that allows the visualization of Quality of Service (QoS) and Quality of Experience (QoE) delivered by fixed and mobile broadband networks for all EU and EEA Member States.

The platform is building on existing data sets which are gathered from national authorities and private crowdsourcing initiatives and mapped for the first time on a European scale. Fixed and mobile data from theoretical calculations as well as measurements are taken into account.

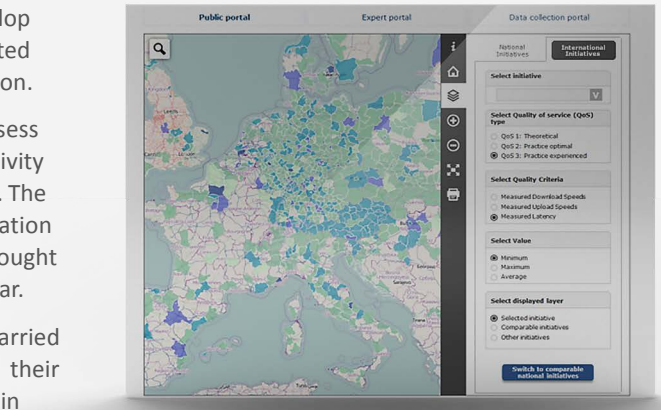
TÜV Rheinland has been commissioned to develop the mapping application and carry out the associated data collection on behalf of the European Commission.

The project constitutes a crucial instrument to assess and monitor the achievement of the new connectivity goals in the framework of the Digital Single Market. The initiative is furthermore creating a central information hub on broadband services in Europe and has brought together more than 150 relevant stakeholders so far.

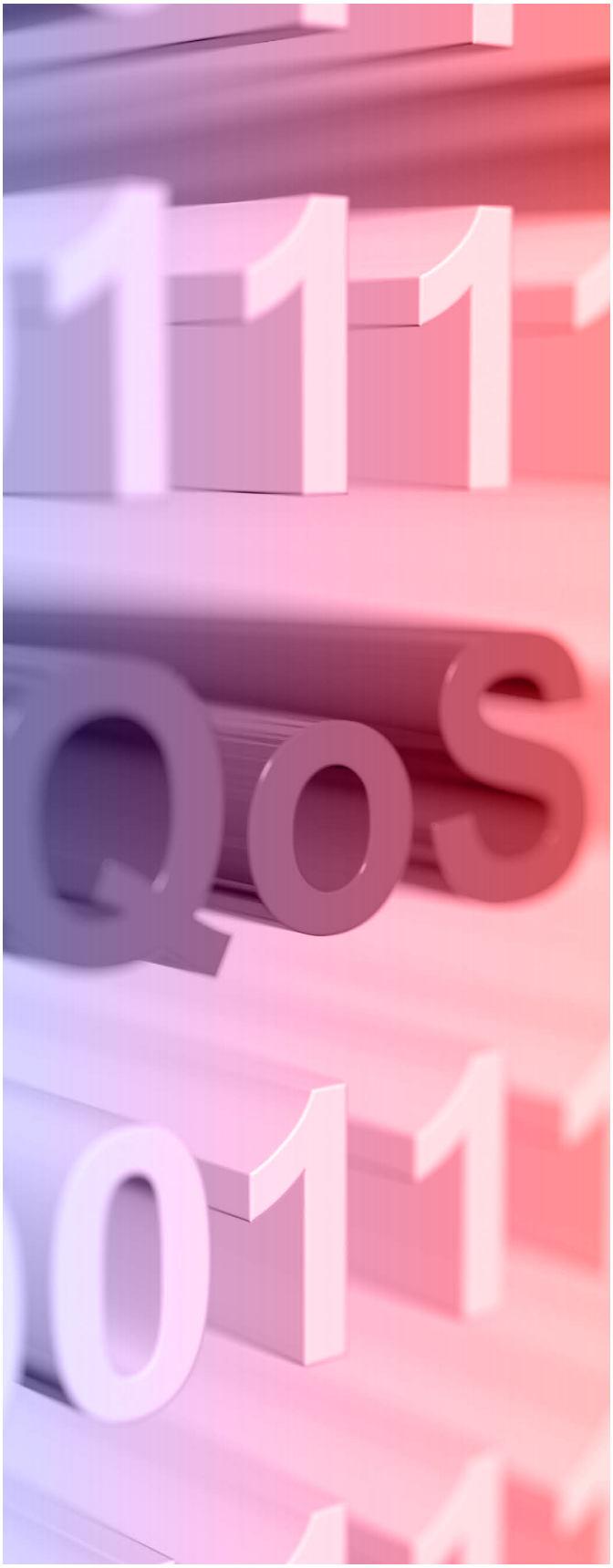
Data provision to the project is voluntary and is carried out continuously. Suppliers retain full control of their data and can define scope of data to be published in a Memorandum of Understanding.

The main challenge in this project is to benchmark and visualize the broad variety of initiatives' data in one mapping application. Data differs in terms of initiatives' methodology approaches and collected values. Furthermore it is difficult to find a common ground for spatial resolution for the heterogeneous data sets. These challenges are tackled in close cooperation with experts from national authorities (including NRAs and relevant Ministries), European level bodies (relevant BEREC working groups), research institutes and key international organizations (ITU, IETF) responsible for mapping initiatives or relevant technical work in the same field.

The data collection campaign started in October 2016. The mapping platform is likely to be progressively open to the wider public sometime in 2018. The application is continuously further developed, taking into account feedback from Stakeholder Consultations. The next Consultation workshop with data providers will take place in Brussels on 6 June 2017. ■

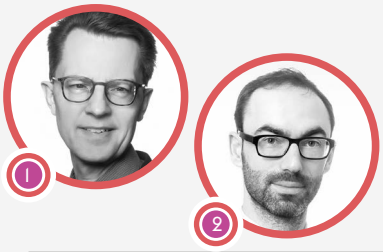


Excerpt from speech on the development of the "Broadband Mapping" platform: https://www.broadbandmapping.eu/ (indicative data)



speed to which he or she is entitled under the contractual commitments made by the operators in application of the same regulation (art. 4.1): see Section 3.4.3 d) for further details.

Secondly, it sets out technical specifications for a common European tool based on the recommended methodology, and whose adoption by the States would take place on a voluntary basis. The decision to implement the tool will be made by the end of 2017.



QUALITY OF SERVICE in the context of Net neutrality

Body of European Regulators for Electronic Communications
BEREC

① Frode SØRENSEN / ② Michiel VAN DIJK,
Co-chairs of the BEREC Net neutrality working group (from Norway / the Netherlands)

The goal of the European Net neutrality rules is to "safeguard equal and non-discriminatory treatment of traffic in the provision of internet access services and related end-users' rights." Furthermore, the regulators have an obligation to "closely monitor and ensure compliance" with the rules. This leads to a situation where regulators are in the need of reliable methods and tools for performing quality of service measurements of internet communications.

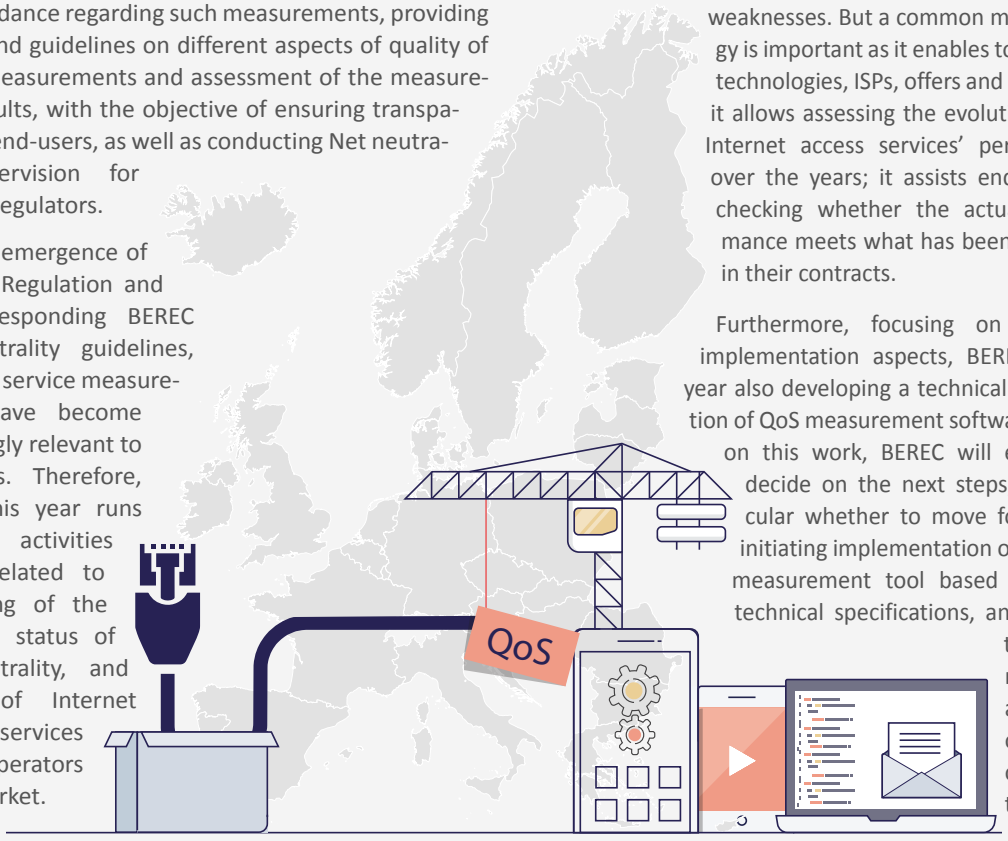
BEREC has already had a long tradition in providing regulatory guidance regarding such measurements, providing reports and guidelines on different aspects of quality of service measurements and assessment of the measurement results, with the objective of ensuring transparency to end-users, as well as conducting Net neutrality supervision for national regulators.

With the emergence of the new Regulation and the corresponding BEREC Net neutrality guidelines, quality of service measurements have become increasingly relevant to regulators. Therefore, BEREC this year runs parallel activities closely related to monitoring of the European status of Net neutrality, and quality of Internet access services among operators in the market.

In 2017 BEREC is developing a QoS regulatory assessment toolkit in the context of Net neutrality, in order to support the implementation of the Net neutrality provisions of the Regulation. This toolkit contains a methodology aiming at measuring and assessing the performance of Internet access services, on the one hand, and detecting traffic management practices applied to or impacting those services, on the other hand.

Defining a common methodology is not an easy project as each methodology comes with its own strengths and weaknesses. But a common methodology is important as it enables to compare technologies, ISPs, offers and countries; it allows assessing the evolution of the Internet access services' performance over the years; it assists end users in checking whether the actual performance meets what has been specified in their contracts.

Furthermore, focusing on practical implementation aspects, BEREC is this year also developing a technical specification of QoS measurement software. Based on this work, BEREC will eventually decide on the next steps, in particular whether to move forward to initiating implementation of a quality measurement tool based on these technical specifications, and analyze the governance aspects of operation of such a tool. ■



3.2 Monitoring the data interconnection market

▶ **NOTE:** *for more details on technical terms used below, Arcep invites the reader to refer to Appendix 6 of the report to Parliament and the Government on Net neutrality published in September 2012..*

3.2.1 Information-gathering

a) Review: history and framework of half-year regulatory compilation

Arcep adopted, on the basis of Article L. 32-4 of the French Postal and electronic communications code, CPCE, the Decision no. 2012-0366 of 29 March 2012. This Decision sets up the implementation of periodical campaigns for gathering information on the technical and pricing terms of IP interconnection and routing. The aim of this Decision was to expand the Authority's knowledge of the IP interconnection markets.

Based on feedbacks from the first three semesters of data collection and the conclusions of the inverstigations conducted by Arcep in this field, Arcep modified the 2012 Decision by adopting on the 8 April 2014 the Decision no. 2014-0433-RDPI.

This modification provided three major improvements:

- distinguishing installed capacity from and configured capacity, on each interconnection link covered by the Decision;
- enabling the Authority to request further information on an ad-hoc basis in order to assess interconnection links' congestion extent;
- reducing the volume of data provided by operators and the number of relationships covered by the Decision.

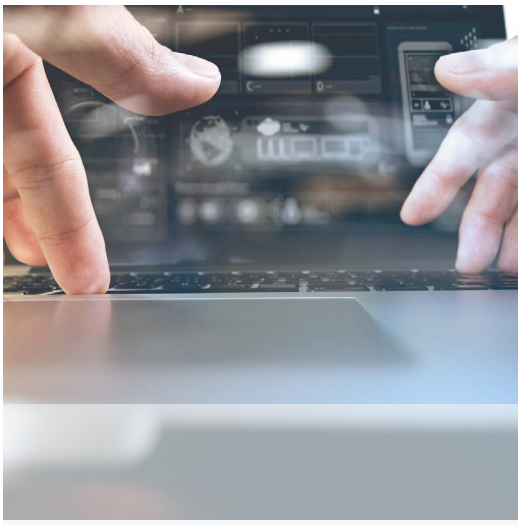
The data collected during these information gathering campaigns have enabled Arcep to consolidate its knowledge of the interconnection market in France and to understand its developments. This supervision is useful as on the one hand, it allows Arcep to react quickly if any problem happens ,and on the other hand- it encourages players to engage in virtuous behaviour. Arcep could thus exercise the powers granted to it by the legislator if difficulties persist (in particular in administrative investigation or in dispute settlement).

In contrast, in view of the figures and trends presented below, it still does not appear necessary for Arcep to intervene directly by means of an *ex ante* regulatory Decision.

b) Other sources of information

The information gathering cycles have enabled Arcep not only to strengthen the expertise of its agents of interconnection market and its developments, but also to develop its contacts network: experts and stakeholders of the entire value chain.

© STILLFX



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INTERCONNECTION
REGULATORY
FRAMEWORK

Punctually – in France as elsewhere in the world –, an Internet player can observe a deterioration in quality of experience for only part of its customers who use a given ISP. The cause of this deterioration can be ascribed to congestion in the interconnection between the said ISP and an operator routing part of the relevant player's traffic.

Generally speaking, thanks to the information gathering campaigns on IP interconnection and routing, Arcep has the needed information to form an initial assessment of the situation.

The Authority could exercise dispute settlement powers granted to it by the legislator if difficulties arise.

Lastly, even if interconnection is not identical to Internet access and is not covered as such by the open Internet regulation, practices using interconnection to restrict specific flows and therefore limit users' rights could be analysed from the perspective of these regulations (on the powers of Arcep to ensure compliance with its provisions, see "The Contribution of the Law to a Digital Republic", page 63).

Cf. Considering section 7 of the Open Internet Regulation and considering sections 5 and 6 of the BEREC guidelines (reference texts provided in section 3.4.1).

Thanks to this, Arcep is now one of the most active regulators within the BEREC working group on IP interconnection: this working group will, in Second Half of 2017, publish an update to its 2012 report on IP interconnection in the context of Net neutrality.

In order to better examine this interconnection market, Arcep also carries out occasional researches and studies based on public data and *ad hoc* questionnaires results; it furthermore organises regular meetings with the various Internet players in France. In particular, in early 2017, Arcep sent a questionnaire on traffic composition and internal traffic injection within the ISP network to the four main ISPs in France *(cf. infra)*.

c) Update on new market trends

As part of its market surveillance activities, Arcep has been able to detect certain important market trends, presented below.

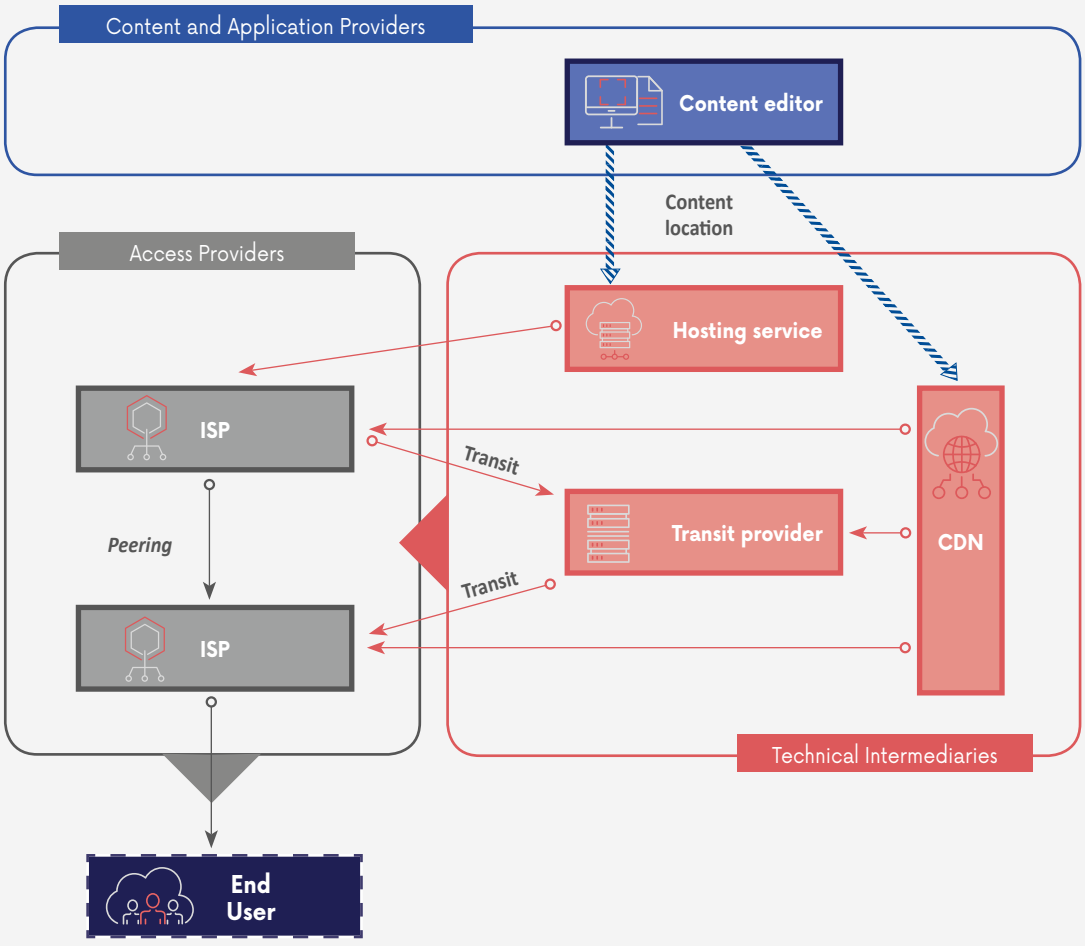
First of all, Arcep observes a notable increase in traffic from hosted cache servers, which are a new means of injecting traffic directly into the ISP network, alongside traditional interconnection modes (transit and peering).

These CDNs/internal cache may either belong to the ISP or to third-party content providers. They can be located in the operator's network or at the outer edge of its network (though may not belong to another network).

According to the early 2017 questionnaire responses, it appears that internal traffic injection now accounts for 11% of traffic feeding the four main ISPs in France. As these ISPs have very different strategies in this area, the proportion may vary significantly from one to the other.

Furthermore, the inbound/outbound traffic ratio on internal cache servers is between 1:8 and 1:25, depending on the ISP. In other words, each content stored there once is consulted between 8 and 25 times on average.

// Example of internet traffic interconnection **modes**



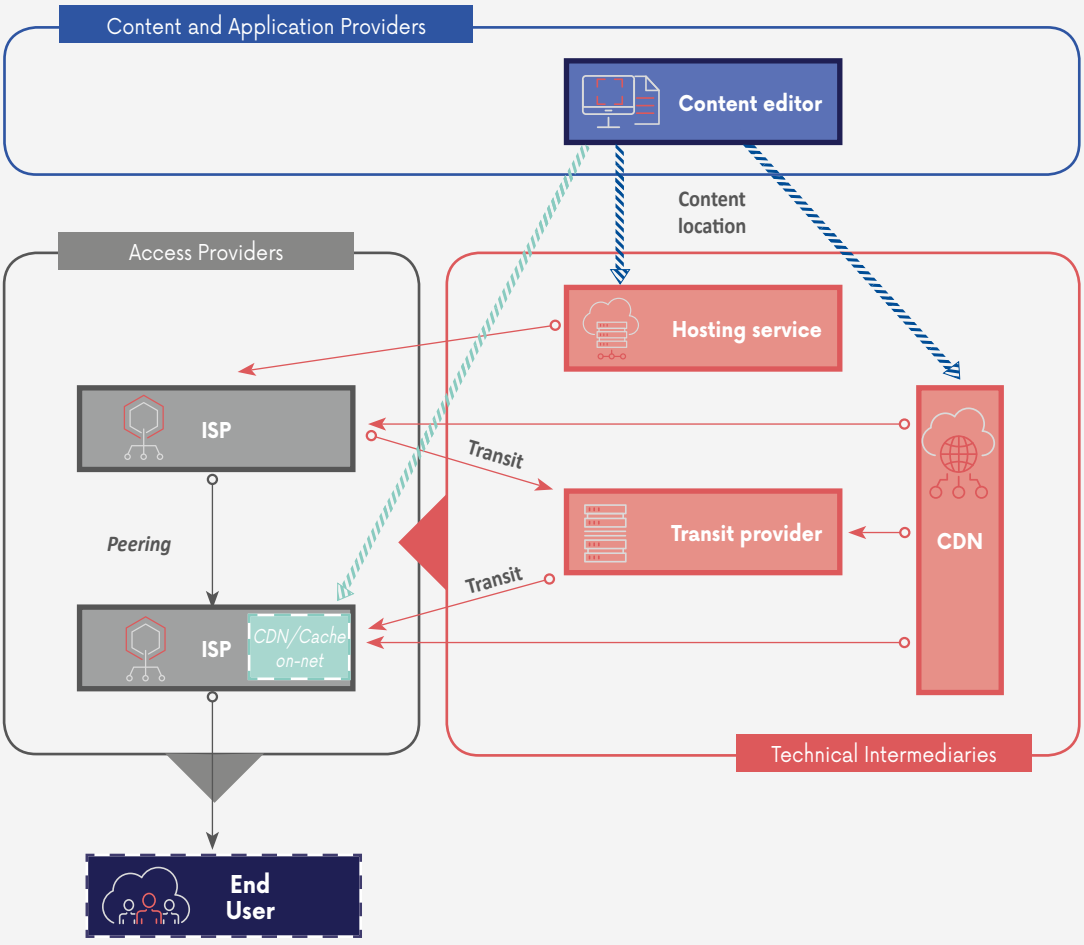
The questionnaire allowed also to estimate the breakdown of traffic by origin. It thus emerged in particular that the five main content providers (Google, Netflix, Facebook, Akamai [27], Canal+) now account for 55% of traffic entering the networks of the main ISPs in France. This attests to an increasing concentration of traffic between a small number of players, whose position in the content market is strenghened.

Furthermore [28], an older study had allowed Arcep to assess traffic breakdown by the type of application. For example, web navigation has decreased very much, overtaken in particular by audiovisual flows, which are very large consumers of bandwidth. To wit, video streams are taking off to such an extent that they now account for more than half the traffic carried, and have become its main growth driver.

[27] This is a CDN that aggregates the content of multiple mid-sized CAPs.

[28] Source: responses to questionnaire on the structure of bandwidth for Internet access networks in French, July 2015.

// Example of internal (on-net) **modes**



According to Cisco estimates, the share of online video in traffic would be even higher at the global level. It is estimated at 71% in 2016 and this proportion could reach 82% by 2020.

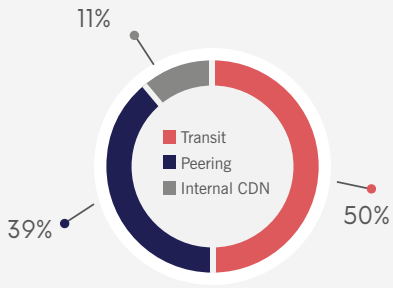
Another trend followed closely by Arcep is the evolution of Internet exchange points (IXP). They play an important role in the interconnection market, particularly for smaller players, which improve their Internet connectivity there.

The largest IXPs in Europe are located in Frankfurt (DE-CIX), Amsterdam (AMS-IX) and London (LINX). While France is still home to around fifteen of them (of modest size and fairly geographically spread), the France-IX associative exchange point has been created with the aim of uniting them and achieving a critical size. It now exceeds 700 Gbps in traffic exchange during peak hours [29] and is (gradually) catching up with the European leaders.

[29] See overall traffic statistics for France-IX.

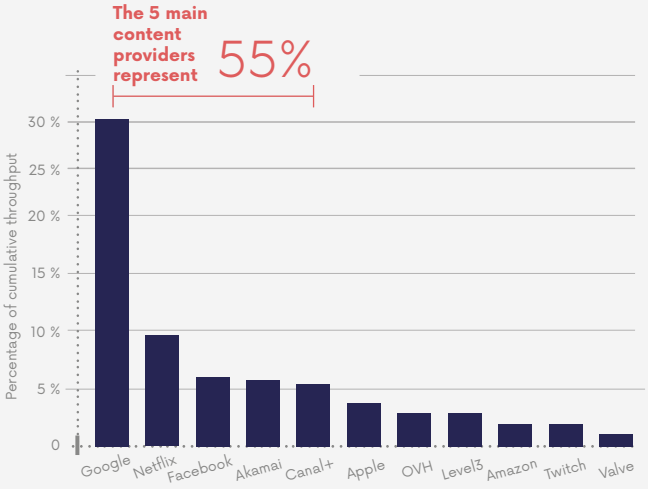
// **Breakdown of traffic in France**
by interconnection type (end-2016)

Source: Arcep



// **Breakdown of traffic in France**
by origin (end 2016)*

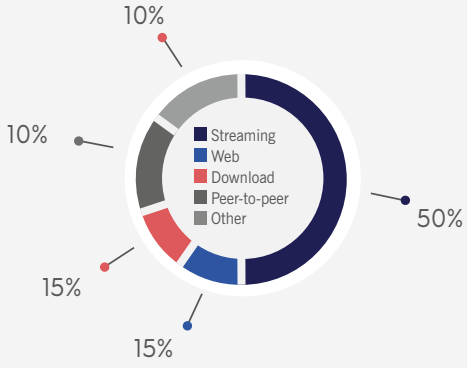
Source: Arcep



* *Orange, SFR and Bouygues Telecom data*

// **Breakdown of traffic in France**
by type of use (July 2015)

Source: Arcep



Arcep has observed a regionalisation of IXPs, as exemplified by the extension of France-IX in Marseille. In addition to improving the resilience of France-IX, deployed primarily in the Paris region up to that point, the Marseille interconnection point plays a major part in interconnecting with players in the Middle East, Africa and Asia. To better understand the issues related to this expansion, Arcep has met Franck Simon, President of France-IX.

d) Upgraded information collection to take into account new trends

In light of the above, Arcep intends, in second half 2017, to begin to work on a new version of its IP interconnection information gathering Decision.

In particular, the aim will be to take into consideration the growing place of internal CDNs, as a new way of injecting traffic directly into the ISPs' network, in addition to traditional interconnection modes: transit and peering.

Another upgrade to the Decision could involve incorporating the concept of addressing – IPv4 or IPv6 – into the questionnaire. The operators would thus have to provide information regarding the nature of the addressing used in accordance with the considered interconnections. This allows to determine, if necessary, whether the interconnection forms a bottleneck in the transition to IPv6. It will also be possible to publish this information as part of the corresponding Arcep observatory.

More generally speaking, Arcep is open to any suggestion for improvements of the information gathering campaigns. The players in the sector will have the opportunity to share these suggestions with Arcep at a public consultation that will be held during the presentation of the modifying draft Decision.

3.2.2 First-time release of the findings

Thanks to the information gathering campaigns, Arcep now has a large corpus of data on IP interconnection

Three QUESTIONS TO

FRANCE-IX

Franck SIMON, *President*

FRANCE BOOSTS ITS VISIBILITY on the Internet exchange points map

1 What is your opinion on the general state of interconnection in France?

Whereas, up to 2010, France had not been capable of positioning itself as one of the strategic Internet exchange points at the international level, it is now in the process of doing so. While the Internet's global players previously preferred to rely on the exchange points located in Frankfurt, Amsterdam or London, when it came to Europe, the availability of a stable, long-term and sophisticated offer in France has enabled us to move our country into the top positions on the continent in this area: as an upshot, it is now home to two major international interconnection points, namely France-IX and Equinix, in a trend also visible in other European countries, enabling diversity and resilience while allowing critical mass to build in each.

Alongside these IXPs, there is not only SFINX, which has persisted, but also Internet exchange points such as the Sudix and the initiatives carried by Rezopole in the south-east of France, TOUIX and GirondIX in the south-west, OuestIX in the north-west, EuroGIX and LILLIX in the north-east, MassifIX in the central regions, as well as REUNIX, MAYOTIX, GUYANIX and MARTINIX in the French overseas regions and territories.

2 What part does France-IX play in this context and what are its ambitions?

France-IX continues to serve its initial mission purpose: facilitating the exchanges and transfers of data, communications and transactions on Internet, and bringing together the internet community in France, thanks, in particular, to its neutrality and independence.

This community, is made up of operators and hosting services (e.g.OVH or Online.net), but also, most predominantly, of global content distribution networks (called CDN, Content Delivery Networks). It generates significant traffic exchange that is exponentially growing. The CDNs (e.g., Akamai, Limelight or Cloudflare) find a solid response to their access needs as end users' with France-IX. Players such as Microsoft, Google, or new content services, such as Netflix, are also becoming major interconnection consumers. While social networks, video, or online replay options offered by TV channels and online video games are new major consumers, the development of Cloud usages for businesses or the general public is quickly gaining speed in 2017.

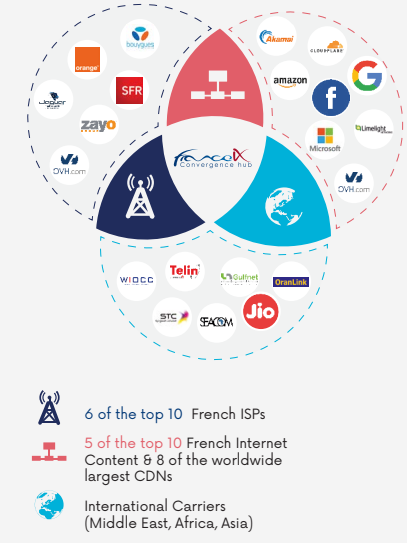
France-IX provides a high-availability interconnection and services platform: this requires regular infrastructure upgrade, with the integration of very high density equipments offering 100 Gbps and the determination to offer the best possible price ratio to the community. Lastly, the aim of France-IX is to provide a simple and obvious response to the question "which exchange point should I choose to exchange with the largest possible number of partners in France?"

3 Why has France-IX decided to deploy in Marseille and what are your expectations for this IXP?

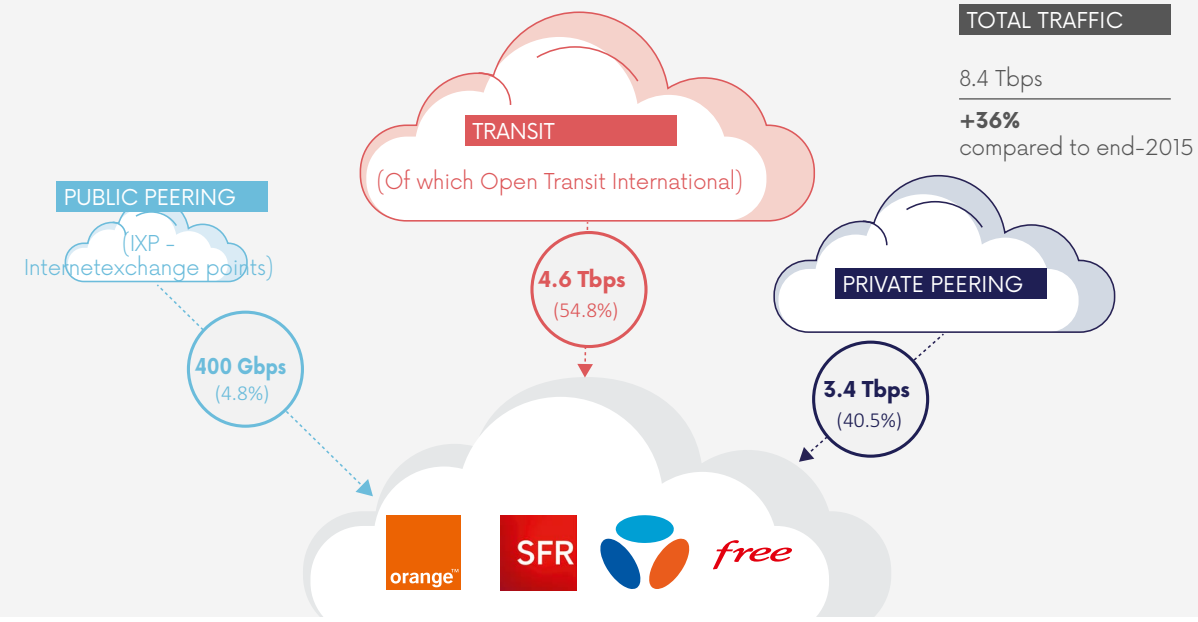
The city offers an alternative to members already connected in Paris and contributes to the provision of more resilient services in France. The expansion of the France-IX network in Marseille was one of the pillars of its development. More than 35 networks are already in Marseille: the ecosystem is composed of such players as content suppliers and global content distribution networks, and French and international (mainly from the Middle East, Africa and Asia) operators and ISPs.

The much-awaited activation of submarine cables SEA-ME-WE 5 in December 2016 and AAE-1 in spring 2017 offers international capacity of around 1 Tbps for many new operators wishing to join Europe or the African continent via Marseille.

France-IX anticipated this growth and has upgraded its infrastructures in Marseille accordingly, enabling operational connections for the first members at 100 Gbps by the end of 2016. Presently, Marseille is one of France-IX's four largest points in terms of traffic volumes, and at this rate will become one of the top two by the end of 2017. ■



// **Breakdown of inbound traffic (at 95th percentile)** of the network of the 4 main ISPs in France (end of 2016)



from 2012 on. These data make it possible to detect certain trends in the interconnection market; they are therefore likely to hold significant value for players in the sector. With this report, Arcep will be disclosing some of the lessons learned from this gathering process. For confidentiality reasons, only agregated results are published.

The participation of all operators in France is essential in order to have accurate information and to be able to describe the actual state of the interconnection market in France. Consequently, Arcep calls on all relevant ISPs to be punctual and precise in their semestrial responses, so that the Authority's work can continue under good conditions.

a) *Inbound traffic*

As at end-2016, traffic to the four main ISPs [30] in France reached 8.4 Tbps, i.e. an increase of more than 36% compared to the end of 2015. This traffic comes primarily from transit links (54.8%).

From mid-2012 to end-2016, inbound traffic to the four main ISPs increased at an exponential pace. It has experienced an increase of around 40% on average every year (almost doubling traffic every two years). We also note that the increase in inbound traffic is more significant in the second half of each year.

b) *Installed capacity*

An increase in interconnection capacities of the same magnitude was observed during this period.

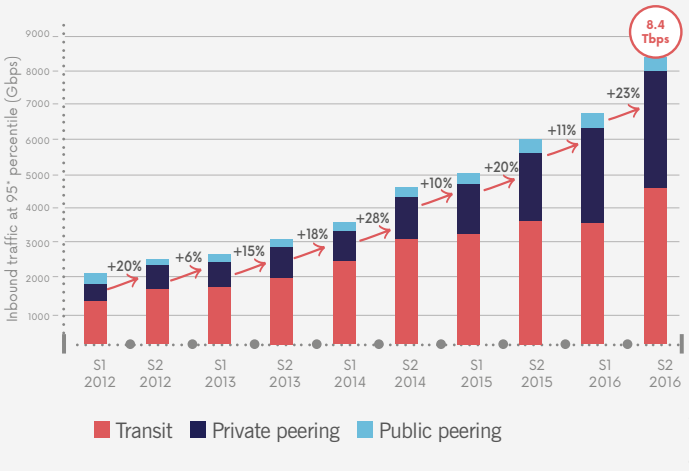
Overall, although installed capacity significantly exceeds inbound traffic (20.3 Tbps as compared to 8.4 Tbps, or a 2.4 factor), occasional cases of congestion may occur upon interconnection between two given players. More fine-grained analysis, link by link, would be needed to identify them.

c) *Interconnection types*

Moreover, the share of transit decreased between 2012 and 2016 for the 4 main ISPs, mainly due to a massive increase in installed private peering capacities with the main content suppliers.

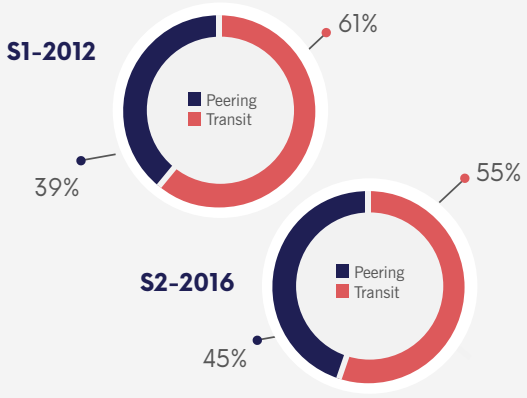
[30] Incoming traffic to AS5410 (Bouygues Télécom), AS12322 (Proxad – Free), AS3215 (RBCI – Orange) and AS15557 (SFR).

// **Inbound traffic** to main ISPs in France between 2012 and 2016



Source: Arcep

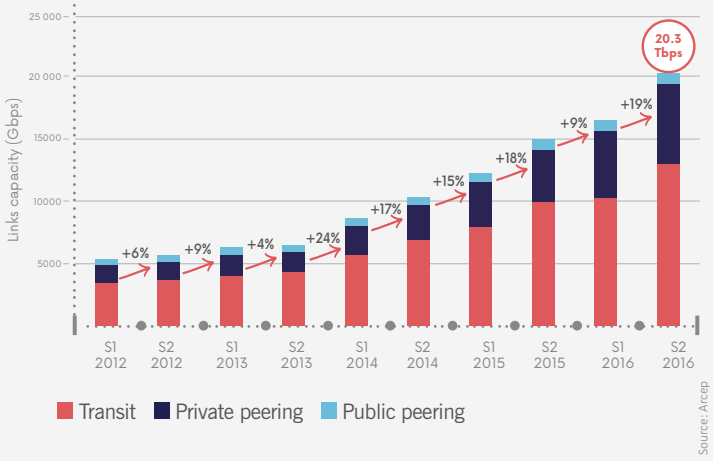
// **Evolution of peering and transit** for main ISPs in France*



*In proportion of inbound traffic volume.

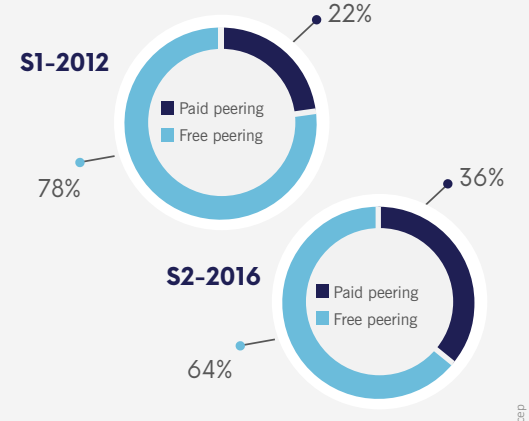
Source: Arcep

// **Interconnection links capacities** of main ISPs in France between 2012 and 2016



Source: Arcep

// **Evolution of paid peering parts** for main ISPs in France*



*In proportion of inbound traffic volume.

Source: Arcep

Concerning the share of public peering, it remains stable overall. It continues to cover approximately 5% of total traffic.

ISPs have different interconnection strategies. Those strategies are described a reference document, known as peering policy, generally public [31] .

According to the information collected by the Authority, most of private peering at the main ISPs in France is a paid peering. The increase in the percentage of private peering thus automatically leads to an increase of *paid peering* during the same period.

d) Costs

Furthermore, the information collected on IP interconnection and traffic routing conditions has also made it possible to draw a number of conclusions regarding interconnection costs.

[31] Examples of peering policies: AS5410 (Bouygues Télécom), AS12322 (Proxad – Free), AS3215 (RBCI – Orange) et AS15557 (SFR).

For instance, the tariffs for transit services purchased by ISPs in France have experienced a steady decrease since 2012. They can currently be purchased within a range of between €0.10 plus VAT and several euros plus VAT per month and per Mbps, depending on exchanged volumes, (flow rate measured at 95th percentile) upon interconnection. Considering the volumes exchanged, the size of the transit market in France is estimated at around 4 million euros per year.

The paid peering tariffs applied by certain ISPs in the event of a marked asymmetry between incoming and outgoing traffic, ranged between around €0.25 plus VAT to several euros plus VAT per month and per Mbps, as at end 2016.

e) Smaller ISPs

Furthermore, Arcep has observed that most other ISPs in France belong to the Tier 3 operator class: they mainly use transit to access Internet. They have relationships with multiple transit providers, for redundancy purposes; their number is generally between 2 and 3, or even 4 in some cases. These operators are also most often interconnected with the main Internet exchange points in France. Due to their lower traffic volumes, the transit prices applied to them are higher.

Other information could be used for upcoming publications, including quantitative information on medium-sized or small players.

3.3 Encouraging the transition to IPv6

The IPv4 protocol, which has been used on the Internet since its beginning, offers an addressing space of nearly 4.3 billion IP addresses.

However, the Internet's success, the ever-increasing number of uses and the multiplication of connected objects have directly resulted in the gradual exhaustion of available addresses. Some regions of the world are more affected than others.

Due to this shortage, the transition to a new protocol is unavoidable. Too much delay in the transition would result in harmful consequences, such as:

- an explosion in costs due to the need to managed the shortage in IPv4 addresses;
- dysfunctioning in certain service categories.

In addition, the IPv6 protocol provides a practically unlimited addressing space to cover all current and expected needs. It makes it possible to assign to each terminal or network node an individual IP address to make it accessible directly from any point of the Internet; prospectively, it even offers the opportunity to identify several "hardware or software objects" within a given terminal or server.

Beyond its adressing aspects, this new version of the IP protocol integrates new functionalities, in particular enabling the simplification of certain network layer functions, such as routing and mobility, or natively guaranteeing better security of exchanges.

More broadly speaking, the transition to IPv6 offers strong potential for innovation and competitiveness. By offering more freedom to users and publishers, it allows them to overcome limitations introduced by intermediaries and to develop future innovations.

3.3.1 Situation analysis

On 11 January 2016, the Government called upon Arcep to produce an opinion on the state of IPv6 deployment in France, inviting the Authority to draw up a precise situation report on the deployment of IPv6 in France, to identify the difficulties and obstacles associated with this transition, to suggest a series of measures and initiatives capable of encouraging and providing support to users and businesses and, lastly, to set up an annual observatory on the IPv6 transition in France making it possible to assess the transition's progress.

IPV6 COMPATIBILITY FOR TERMINAL EQUIPMENTS

The Law for a Digital Republic provides, in Article 42, that as of 1 January 2018, any new terminal equipment intended for sale or rental in France must be compatible with the IPv6 standard.

In its report – drawn up with the assistance of Afnic (the French acronym for "Association Française pour le Nommage Internet en Coopération" i.e. the French Network Information Center) submitted to the Government on 30 June 2016 and made public on 30 September 2016, the Authority suggests multiple

// Observatory
on the transition to IPv6

Read the observatory
in French on Arcep website

actions likely to promote and support the transition to IPv6.

3.3.2 Arcep Observatory

a) First version of the observatory

On 9 December 2016, Arcep also set up an observatory on the transition to IPv6. This interactive observatory describes the status of IPv6 protocol deployments in France and tracks the evolution of its adoption over time. Hence, it allows to promote coordination between Internet stakeholders in order to enhance deployment (Action no. 4) and to provide users with information that may be considered of public interest on the state of the transition in France.

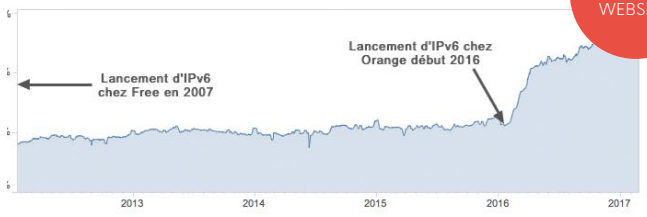
Arcep selected a number of indicators reflecting the level of deployment at various levels: access providers (fixed and mobile), content providers and technical intermediaries, equipment manufacturers and DNS infrastructure. The complementarity of these indicators

OBSERVATOIRE DE LA TRANSITION VERS IPv6 EN FRANCE
31 MARS 2017

Voir l'observatoire

ARCEP
WEBSITE

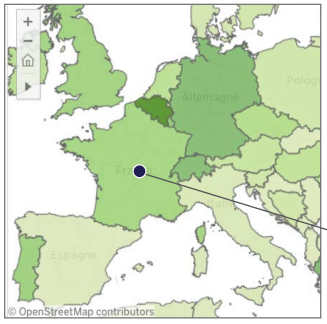
Evolution du taux d'utilisation d'IPv6 en France, tel qu'observé par Google
Source : Cisco - 6Lab



Etat de la transition IPv6 en France à différents maillons de la chaîne technique

Maillon	Source	Taux d'IPv6
Equipementiers	Questionnaire Arcep (2016)	100%
Fournisseurs d'accès internet (fixe)	Google (2017)	15%
Fournisseurs d'accès internet (mobile)	Arcep (2016)	0%
Fournisseurs de contenus	Cisco (2017)	50%
Infrastructure DNS	Observatoire de la résilience de l'Internet français (2015)	60%
Intermédiaires techniques	Cisco (2017)	70%

Etat de la transition IPv6 dans le monde au 31/03/2017
(Taux d'utilisation)
Source: Cisco - 6Lab



Sélectionnez l'indicateur à visualiser sur la carte Utilisation d'IPv6

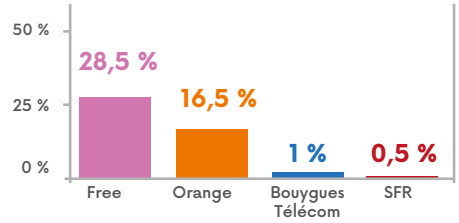
Utilisation d'IPv6 : *Taux d'utilisation d'IPv6, tel qu'observé par Google.*

Contenus IPv6 : *Taux de sites web accessibles en IPv6 parmis les sites web les plus visités dans chaque pays.*

Intermédiaires IPv6 : *Taux d'intermédiaires techniques (par ex. transitaires) empruntés utilisant IPv6, pour chaque pays.*

Pays **France**
Utilisation d'IPv6 : **14,60 %**

Taux d'utilisation d'IPv6 sur les principaux réseaux fixes en France au 31/03/2017
Source: World IPv6 Launch données recueillies par l'Arcep



En France, Free a été le premier opérateur fixe majeur à proposer une connectivité IPv6 à ses clients. Ce déploiement remonte à 2007.
Orange a été le second opérateur à faire bénéficier ses clients fixes d'IPv6, début 2016. La grande majorité de ses clients FttH et VDSL est désormais dotée d'une connectivité IPv6 par défaut.

makes it possible to gain broad view of the state of the deployments.

In the first version of the observatory, Arcep has mainly used data produced and made available by third parties.

b) Lessons learned

The current observatory was updated on 31 March 2017. It confirms the increase in IPv6 use rate in France between December 2016 and March 2017. This increase was mainly due to the migration initiatives already undertaken by Free in 2007 and by Orange in 2016, both for their fixed subscribers only.

The observatory also highlights the role of content providers in the transition to IPv6. CAPs, which remain at around at 50% in terms of IPv6 deployment, have a responsibility in the global transition process to IPv6. In order to benefit from this protocol, all stakeholders must jointly migrate.

Arcep wishes to specify that this 50% rate, calculated as a weighted average, masks the fact that many medium-sized or small CAPs have not yet migrated to IPv6. It invites these players to initiate the transition.

c) Enhancing the observatory

Arcep intends to extend its transition to IPv6 observatory to include data and information directly collected from the main fixed and mobile ISPs [32] in France – as part of Arcep's annual survey [33].

These data will include in particular:

- the number of available IPv4 addresses and the percentage of these addresses already assigned;
- the IPv4 address sharing implemented mechanisms;
- the percentage of IPv6 enabled subscribers;

[32] This applies to ISPs that manage their IP addressing plan and have more than 1 million active subscribers.

[33] Arcep Decision no. 2017-0290 dated 7 March 2017 on the implementation of surveys in the electronic communications sector.

AFNIC SERVING
the development of a secure, stable, innovative and inclusive internet

afnic

Association française pour le nommage internet en coopération i.e. the French Network Information Center

AFNIC, recognised for its expertise on IPv6 for more than 15 years, was pleased to work with Arcep, in particular in the series of hearings and consultations organised with companies and digital players involved in the transition.

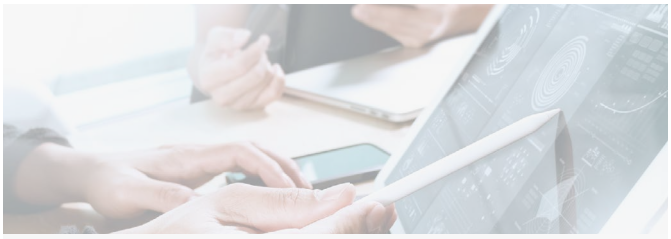
The extremely rewarding process made it possible to draw up a situational report and diagnostic review reflecting as accurately as possible the realities of IPv6 in France. The results produced by the hearings and consultations provided fodder for exploratory discussions, followed by the proposals for a six-action plan to accelerate the IPv6 transition.

Another benefit of this collaboration is the sharing of expertise with a view toward creating the IPv6 observatory. Exchanges focused on identifying the most appropriate measurement criteria and indicators, as well as organisations with data sources able to supply material for those indicators, particularly those related to the publication of services in the DNS.

Furthermore, AFNIC, as an Office in charge of domain names in .fr, has committed to fight digital exclusion. As such, it pays 90% of the profits of .fr at the Afnic Foundation for Digital Solidarity, created in 2015. From its very first year, the Foundation financed 35 projects all over France.

Lastly, for the five years to come, AFNIC has set itself the goal of providing support to the one million French VSE/SMEs still absent from the Internet. Since 2014, the Réussir-en.fr programme has helped them to initiate their digital transformation and develop their online presence through a diagnostic review and practical tools and advice.

AFNIC also offers field teaching by participating in fairs dedicated to entrepreneurs and by co-organising educational workshops on digital technology throughout France (Les Foliweb).



Towards IPv6-Only: Microsoft example

Recently, some CAPs have migrated (partially or totally) to IPv6. Microsoft transition to IPv6 should be mentioned. Because of its new acquisitions (Nokia, Azure, etc.), Microsoft has consumed almost all the private IP adresses it had; it also faced overlaps in address ranges. Taking into account the increased complexity in operating the two protocols side-by-side, Microsoft decided to experiment a migration to IPv6-only. The deployment has begun slowly and a number of difficulties have been encountered: heterogeneous needs between regions and institutions, incompatibility of certain protocols with systems in place, unavailability of functionalities within certain platforms, etc. Despite these difficulties, Microsoft believes that the gains associated with solving the two problems (IPv4 address shortages and the duplication of private addresses) are higher than the costs generated: in the medium term, it will benefit from having a simplified network management structure and will be able to focus on its core business.

- the percentage of IPv6 traffic;
- the current IPv4 and IPv6 address allocation policy;
- the IPv6 transition programme.

This enhanced version of the observatory report will be published in Second Half 2017.

3.3.3 Contribution to the creation of advocacy events

In order to enable better sharing of information – and best practices – on the deployment of IPv6 within the digital community in France (action No. 3), Arcep wishes to foster reflections on IPv6 advocacy events.

A preliminary study of IPv6 promotion actions has been conducted. By casting the spotlight on a number of major events organised in the past, it becomes possible to better identify the specific objectives, scope, contacts and messages to convey at these advocacy events.

IPv6 World Day
8 June 2011

IPv6 World Day was one of the first events of global dimension held in this area. It helped bring greater visibility to the IPv6 transition issue. Bringing together several global pstakeholders (Facebook, Yahoo), its aim was to make participating sites accessible in IPv6. It helped coordinate efforts as the set deadline approached and bring to light the challenges and issues that remain to be addressed for global deployment.

V6 World Congress
Paris, March 2015

After a number of events held independently, the V6 World Congress, organised in Paris, was incorporated into a broader framework comprising all of the network's issues. An event of international magnitude, it brings together over 1,500 participants from more than 65 countries representing industry leaders around themed presentations and can lay claim to having a concrete impact on the initiated transition.

Conférence ION, ISOC
Bucharest, 12 October 2016

Dynamic in format, this conference held by the ISOC* has mobilised players in the form of interactive round-table around their respective transition successes. Organised on the same day as an event aimed for operators and network regulators, it brought together a diverse audience and offered feedback on the Deploy360 programme.

* *Internet Society*

UK IPv6 Council
London, 31 October 2016

By organising a day of presentations on the challenges and deployment strategies related to the protocol deployment, the UK branch of the IPV6 Forum brought together more than 100 participants from various backgrounds (national stakeholders, universities, multinationals, etc.) who shared their valuable perspective on more technical issues, long-term views and obstacles to deployment.

IPv6 Business Conference
Zurich, 16 June 2016

The *IPv6 Business Conferences*, held annually, are hailed as one of the key events in Europe. Organised by the Swiss IPv6 Council, they offer presentations by recognised speakers both in the economic sphere and in the technical community. It is thus a forum for mutual sharing of experiences and best practices, and in this regard, a regular update on the progress of the transition.

IPv6 Council - Belgium
Antwerp, May 4, 2016

The Belgian branch of the IPv6 Forum held a meeting between IPv6 migration stakeholders by offering a perspective on national performances. This annual event had a very positive effect on the deployment of IPv6 in the country – among the best-equipped in Europe – as many large companies made their transition following this session.

Three QUESTIONS TO

Internet Society France

Nicolas CHAGNY, *Président*

Internet Society

IPv6, THE PILLAR for the future of Internet and innovation

1 Where are we in the transition to IPv6 in France and across the world?

In France, Arcep has launched an observatory that has already offered significant learnings. It will complement the measurement tools launched by the Internet Society at the global level, at the worldipv6launch.org website.

We are pleased with the growing awareness of IPv6, in particular through the Minister in charge of the electronic communications and through Arcep. We remain concerned about the timorous deployment of IPv6. Yet it is a key prerequisites if real-time services are to take off and for the deployment of the Internet of Things. We feel that the government must set the example by imposing IPv6 in all its infrastructure and public procurement dimensions.

This awareness also implies training and a degree of "evangelisation", so that the subject does not remain the domain of a handful of geeks.

2 How is the Internet Society organized and what role does it play in this transition?

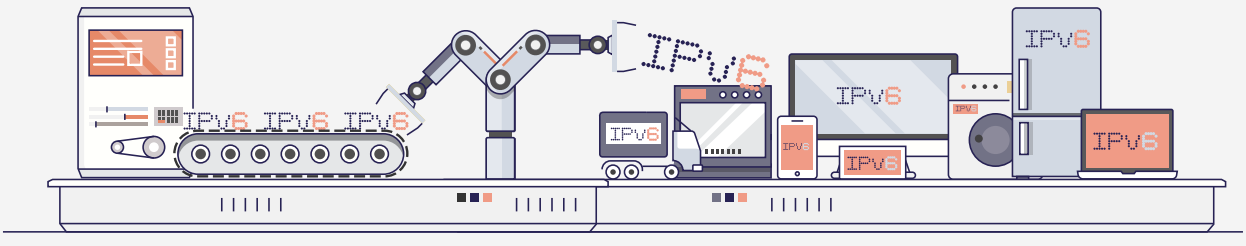
The Internet Society has always been strongly mobilised around IPv6. Historically, because we are the organisation hosting IETF's activities, which is the main source of the Internet standards. And then, because we are careful and vigilant that internet access is the same for everyone, all over the world.The Internet Society has produced a number of White Papers and launched an "IPv6 Day", a one-day end-to-end trial of IPv6. As a result, in 2012, this led us to create a global "World IPv6 Launch" event, as a way of affirming that IPv6 is no longer a utopia.

We are thus creating an environment through which we can evangelise IPv6, and are maintaining a set of measures with operators.

> We remain concerned about the timorous deployment of IPv6. Yet it is a key prerequisites if real-time services are to take off and for the deployment of the Internet of Things.

3 Which other Arcep issues is the Internet Society interested in addressing?

The Internet Society is very sensitive to topics related to Net neutrality and we will be happy to work on this topic with Arcep. ■



3.4 Safeguarding Net neutrality

3.4.1 An overview of the new legal framework

The concept of Net neutrality echoes the original concept of the Internet, built around simple and egalitarian traffic management. Consistently with the "end-to-end" principle, as the "intelligence" is located at the end nodes of the network, the latter must accurately transmit the signals it carries. Beyond the purely technical standpoint, neutrality also refers to a number of essential economic and social issues: freedom of expression, innovation capacity, open competition, non-discrimination, etc.

Before describing the actions of Arcep in protecting Net neutrality, we must review the conditions from which this concept emerged and present the debates that followed, in order to understand how a European legal framework was shaped – in a unique manner, on the international stage –laying down strong principles and concrete obligations for ISPs and national regulators.

a) The foundations of Net neutrality

As stated in section 2.1 of this report, the explosion in types of uses and integration of Internet as an essential tool for everyday life (in terms of personal expression, information and leisure, but also administrative procedures and economic activity – through the development of e-commerce and the digital transformation of production structures) make it all the more important today that the Internet's societal function is not challenged by private interests of certain Internet market players.

Yet the Internet value chain comprises a large number of players: ISPs, equipment vendors and terminal suppliers, developers of operating systems and software, providers of content and applications (especially the most significant of them, which have gained the status of a platform for accessing to third-party content), etc. All of these intermediaries are players who might have incentives to take advantage of their position to interfere with signal transmission.

Attention was first called to this risk in the early 2000s, by lawyers, in the context of the American market (and in a differentiated manner between landline and mobile access networks, given the still underdeveloped mobile uses of the time). The nature of the risk was clarified thereafter: there is a risk of inefficiency if intermediaries breach their primary signal transmission function. Sprouting in the United States, the concept of Net neutrality then spread and has been driven in a proactive manner in the European context.

If there is a broad concept of Net neutrality (encompassing the entire internet value chain), it is first and foremost the neutrality of the networks (a tighter definition of the term that is focused on Internet access networks) which has been depicted as the first essential step. It thus calls for an examination of the practices of ISPs on their networks, but also in their relationships with certain content and application providers.

b) A first form of legal supervision on the subject

In Europe, Arcep has been one of the first regulators to carry out in-depth analysis on Net neutrality, taking up this issue very early.

The beginning of the 2010s was a pivotal period for Net neutrality, and the recent years have seen an acceleration of reflections in this area.

At the end of a public debate and a cycle of hearings organised during 2009, substantive work was started on this topic. Arcep went on to publish, in September 2010 [34], a first set of ten recommendations that were widely followed by market players: freedom and quality in Internet access, non-discrimination of traffic flows, a framework for traffic management mechanisms, increased transparency toward end-users, monitoring of traffic management practices, monitoring of Internet access quality of service, monitoring of the IP interconnection market, an appeal for greater consideration for the role of content providers and greater neutrality in terminals.

[34] "Neutrality of the Internet and networks: Proposals and Recommendations", September 2010.

// **Milestones of regulation and ARCEP publications** in the field of Net neutrality

ARCEP NEWSLETTER :
"Network neutrality called into question?»"
July 2009

ARCEP INTERNATIONAL SYMPOSIUM
on network neutrality, *April 2010*

ARCEP REPORT
«Neutrality of Internet and the networks: Proposals and recommendations», *September 2010*

INFORMATION REPORT
by the Economic Affaires Commission of the French National Assembly on the neutrality of the Internet and the networks, *April 2011*

ARCEP REPORT
to the Parliament and the government on Net neutrality,
September 2012

ARCEP REPORT
"Summary of the Net neutrality regulation",
September 2015

REGULATION (EU) 2015/2120 OF THE EUROPEAN PARLIAMENT AND THE COUNCIL LAYING DOWN MEASURES CONCERNING OPEN INTERNET ACCESS [...],
25 November 2015

BEREC GUIDELINES
on the Implementation by National Regulators of European Net Neutrality Rules
August 2016

LAW NO 2016-1321
pour une République numérique,
7 October 2016

1st ARCEP REPORT
«State of Internet in France», *May 2017*

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Since 2011 and the transposition of the third Telecoms Package of 2009, Arcep is able to intervene, at the request of one of the parties, to settle disputes on reciprocal technical and commercial conditions for traffic exchange between an operator and providers of electronic communication services to the public. In addition, in order to prevent service deterioration, obstruction or slower traffic on the network, the Authority may set minimum quality of service requirements.

Arcep has submitted its first assessment on Net neutrality to the Government and Parliament in 2012 [35].

By the same time, a parliamentary information report by members of Parliament Corinne Erhel and Laure de la Raudière [36], concluding with concrete proposals for legislative action, has called for Net neutrality to be enshrined as a political objective in France, as has the National Council on Digital Technology (Conseil National du Numérique). However, this momentum was interrupted by the emergence of a legislative debate at European level, the European Commission having launched the so-called "Digital Single Market" initiative [37] in September 2013.

[35] Report to the French Parliament and Government on Net neutrality, September 2012.

[36] Information report by the Economic Affairs Commission on neutrality of the Internet and networks, April 2011.

[37] As the legislative process and amendments were made, the draft regulation underwent multiple change in name or abbreviation: Single Digital Market, Connected Continent, Single Telecoms Market, and lastly, the Open Internet regulation.

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In this initial framework, Arcep has launched projects aimed at deepening its knowledge of the market and anticipating possible violations of the principles of Net neutrality: quality monitoring surveys on mobile services (which since 2006 have included indicators concerning mobile Internet) and on fixed Internet access services (since 2014), regular questionnaires to ISPs on traffic management, and a semestrial data collection on IP interconnection since 2012.

Furthermore, Arcep has actively contributed to the work of BEREC (which has been endowed with a working group specifically dedicated to Net neutrality) [38], as much on issues in transparency and consumer information as on monitoring traffic management practices (study on existing practices in Europe, so-called *Traffic management investigation* – or TMI, carried out in 2012) or measuring the quality of service.

c) The turning point of the European Open Internet Regulation and BEREC guidelines

On September 11, 2013, the European Commission issued a proposal for a regulation laying down measures concerning the European single market for electronic communications and to achieve a Connected Continent. This initiative resulted in the adoption of Regulation (EU) 2015/2120 of the European Parliament and of the Council laying down measures concerning Open Internet Access on 25 November 2015 . [39].

This regulation ushers in the following advances:

- It introduces for the first time in European legislation the major principles of Net neutrality: the right for all end-users to share and access information and content of their choice (Article 3.1), first, and the obligation for ISPs to handle Internet

[38] Previous BEREC works on the subject of Net neutrality:
- Guidelines on Transparency in the scope of Net neutrality, 2011.
- A framework for Quality of Service in the scope of Net neutrality, 2011.
- Traffic Management Investigation, 2012.
- Guidelines for quality of service in the scope of Net neutrality, 2012.
- Differentiation practices and related competition issues in the scope of NN, 2012.
- An assessment of IP interconnection in the context of Net neutrality, 2012.
- Overview of BEREC's approach to Net neutrality (4 pages), 2012.
- Summary of BEREC positions on Net neutrality (12 pages), 2012.
- Monitoring quality of Internet access services in the context of NN, 2014 and Annex.
- How consumers value Net neutrality (Ecodem), 2015.

[39] Regulation (EU) 2015/2120 of the European Parliament and of the Council of 25 November 2015 establishing measures relating to open Internet access and amending Directive 2002/22/EC on universal service and users' rights with regard to electronic communications networks and services and Regulation (EU) No. 531/2012 concerning roaming on public mobile communications networks within the Union.

traffic in an equal and non-discriminatory manner (article 3.3).

- It furthermore sets out a framework for traffic management by ISPs, as reasonable traffic management by service providers of Internet access is accepted only under limitative conditions, which do not include commercial considerations (Article 3.3, Paragraph 2).

- The deterioration or blocking of traffic (or a specific category of traffic) is prohibited, except in strictly defined situations. Only a limited number of case scenarios can justify these practices: a legal obligation or court ruling, a breach of network security, imminent and exceptional congestion of the network (Article 3.3, Paragraph 3).

- ISPs (or content providers, where applicable) may offer services other than Internet access services, which require optimised routing, provided that this does not come at the detriment of the availability or overall quality of the Internet access services provided (Article 3.5).

- ISPs' business practices are now under regulatory surveyance, especially those aimed at promoting one or more online services. The national regulator has a right of say on the characteristics of these offers (Articles 3.2 and 5).

- The transparency obligations to which operators are subject have been stepped up. This pertains in particular to the information included in the contracts, now more detailed: impact of any traffic management measures implemented by the operator, concrete impact of limitations (volume, speed, etc.) on offer, information on speeds, etc. (article 4).

This regulation also innovates in its form, by making BEREC responsible for drafting the enforcement guidelines (Article 5.3 of the regulation) [40]. The regulation and its guidelines thus form an indivisible whole, setting out both the broad principles and translating them into concrete and harmonised actions for national regulators.

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The drafting of these guidelines was the main task of the BEREC working group on Net neutrality in 2016. Initiated when the Regulation was adopted, in second half 2015, the formulation required a large number of meetings up to final adoption of the text on 30 August 2016. The draft guidelines were submitted for public consultation in June 2016. This consultation gave rise to an exceptionally large volume of responses: BEREC received nearly 500,000 contributions, a sign of the importance of the matter in the eyes of citizens and stakeholders. The drafting team dedicated the entire summer of 2016 to summarising the responses and incorporating them into the final version of the guidelines, through several amendments presented in the public consultation report produced by BEREC [41].

The BEREC guidelines follow the same structure as the regulation and detail its provisions point by point, so that they can be consistently enforced.

[40] BEREC Guidelines on the Implementation by National Regulators of European Net neutrality rules, August 2016.

[41] BEREC Report on the outcome of the public consultation on draft BEREC Guidelines on the Implementation by National Regulators of European Net neutrality rules, August 2016.

They reflect the joint conclusions reached by European regulators during the preparatory work leading up to their development, in particular concerning:

- the characteristics of reasonable traffic management and the criteria with which ISPs must comply in this area, as well as guidance on possible exceptions to this principle;
- a case-by-case approach for the evaluation of ISPs' commercial practices, in order to assess whether they limit end customers' freedom of choice;
- criteria defining optimised services and the safeguards to be respected so that such a service does not constitute a circumvention of the Regulation;
- information to be published by ISPs as part of their contractual commitments on transparency.

Their content will be developed in Section 3.4.3 of the report.

d) Advances enabled by the Law for a Digital Republic

By virtue of its nature (as a regulation, rather than a directive), the provisions of the European Open Internet Regulation apply directly to each Member State and do not require transposition into internal law. Nonetheless, in France, new legislative provisions were needed at the national level to entrust the regulator with the power to ensure due enforcement of the regulation's provisions.

In this respect, the Law for a Digital Republic [(42)], promulgated on 7 October 2016, brought the principle of Net neutrality into the national framework and put Arcep in charge of protecting it (Article 40). It further extends its investigative (Article 43) and disciplinary (Article 53) powers, so that it can fully serve its mission.

Henceforth and in consequence, the Code on Postal and Electronic Communications:

- explicitly lists Net neutrality, i.e., guaranteeing open Internet access as defined in the European regulation as one the mandatory conditions to be provided for by parties setting up or operating networks open to the public or providing electronic communications services to the public, (Article L. 33-1);
- provides that Arcep and the minister in charge of electronic communications may adopt measures to ensure compliance with Net neutrality as referred to in Article L. 33-1 (Article L. 32-1);
- makes it possible to carry out administrative investigations and collect information in order to ensure compliance with the neutrality of the Internet as referred to in Article L. 33-1; this article has also been updated to specify the concrete procedures for administrative investigations initiated by the Authority (Article L. 32-4);
- empowers Arcep to resolve disputes between operators and providers of content and applications, based on the European Open Internet Regulation , by examining technical and commercial conditions of traffic exchange and routing, including traffic management (Article L. 36-8).
- enables Arcep to sanction violations of the European Open Internet Regulation (Article L. 36-11).

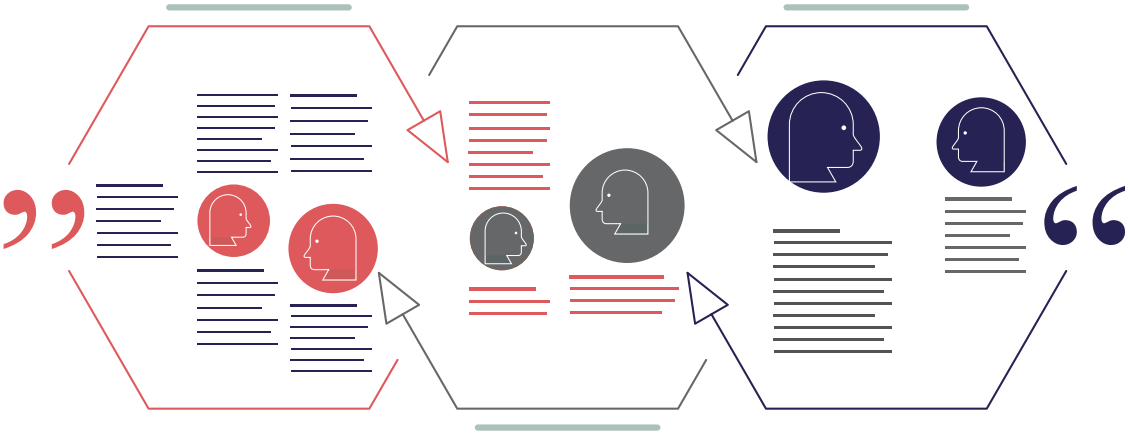
Furthermore, while Arcep is responsible for ensuring due enforcement of the Regulation's provisions, it should be noted that Article 4 on the ISPs' obligations with regard to transparency - and therefore on the contracts of end users - must be approached in connection with the DGCCRF's competencies in this area [(43)]. The topic of transparency will be developed in Section 3.4.3.d of this report.

[(42)] LAW 2016-1321 of 7 October 2016 for a Digital Republic.

[(43)] Article 53 of the Law for a Digital Republic amended Article L. 224-30 of the Consumer Code in order to incorporate the transparency obligations provided for in Article 4 of the Open Internet Regulation.

TESTIMONIALS

OPEN INTERNET REGULATION: intersecting perspectives, one year down the line



As this report comes out, concluding the first year with the Open Internet Regulation in effect, Arcep wanted to collect first-hand testimonials from digital ecosystem stakeholders on their experience with the new legal framework. Four representative associations, which had already responded to the call for contributions from Arcep during the drafting of the BEREC guidelines, and had debated during the Authority's workshop on the Open Internet in May 2016, wished to share their views, informed by one year's experience, on the effects of the regulation on the sector and their expectations for the coming year.

Federation FDN and La Quadrature du Net

Civil society was strongly mobilised throughout the Open Internet Regulation's [1] legislative pathway, then later during drafting of the guidelines. Arcep's message, during the guideline-drafting process, was clear: be patient, and judge us on our deeds.

One year down the line, our overall impression is one of dissatisfaction. We would like to call attention in particular to three points:

- The situation has deteriorated in several Member States. For example, the zero-rating, accepted by the Belgian regulator and Dutch courts, goes against the spirit that prevailed throughout the preparation of the Regulation. Operators select what citizens are supposedly allowed to view on an unlimited basis, thereby appropriating unwarranted influence over the way in which the public accesses information. We expect a clear message from Arcep, which is chairing the BEREC in 2017.
- In France, managed services that have online equivalents are always given the priority by operators (VOD, at the expense of other players such as FramaTube, VOIP, etc.). Arcep prefers to work through "proactive dialogue" rather than regulation. It may be a little effective, but the role of the regulator is also to regulate, without having to wait for civil society complaints.
- Because of the lack of an IP address that is at least public, and ideally static, the majority of Internet accesses today do not offer self-hosting of content and services. The emergence of "Fixed 4G" in certain areas, obviously the least densely-populated, shows that the problem is, in fact, getting worse: the boil is spreading. The regulator knows what needs to be done: shift to IPv6 - yet progress in that area is slow. The situation is in stark contradiction with the Regulation, and following on the observatory report produced by Arcep, more binding and authoritative decisions need to be provided.

[1] http://eur-lex.europa.eu/legal-content/FR/TXT/?uri=CELEX%3A32015R2120

Michel COMBOT, *Managing Director*
French telecommunications federation

By nature, our sector is one of dialogue and interaction. Consequently, Arcep's initiative to involve all market stakeholders in the exploratory discussions on the orientation of regulation, is more than natural in our view - it is vital.

This applies all the more when, as was the case one year ago, one of the key themes of our sector for the coming decades is in the focus. At stake at the time - as is still the case today - was the ability to put France and Europe at the forefront of the digital revolution once again. There is no way of achieving this objective without first striking that fragile balance between differing but never antagonistic imperatives: developing uses and financing deployments, protecting consumers all the while promoting innovation. At stake is the common interest. Toward this end, the regulation must be flexible, proportionate and open, so as to establish itself into the long-term. Its priority must be to ensure the network's security, resilience and stability.

It must take into account all user situations and types and cover the entirety of the value chain. It must leave contractual freedom and innovation all the room they deserve. In particular, the regulation on open internet access must allow both technological (specialised services, NFV, etc.) and commercial innovation. Lastly, it must achieve the balance between consumer protection and operators' obligations.

One year down the line from the Arcep workshop and as the European Electronic Communications Code comes up for review, these priorities remain in the fore.

Loïc RIVIÈRE, *General Delegate*
TECH IN France

Europe is equipped with a regulatory framework that protects Net neutrality, while the regulatory authorities have the guidelines needed to enforce it. This European basis protects us from the instability that the United States are experiencing on the subject, where after being protected by the regulatory authorities, the neutrality of Internet now seems threatened.

Regulatory instability cannot be conducive to investments in innovation. Economic players expect regulators to insert their action in a long-term strategic vision that is a source of stability and sustainability for investments. They expect the regulation to preserve competition and innovation.

Innovation on Internet is based precisely on the preservation of a perfectly open expanse in which competition is not limited to vying between established players, and is instead sustained by the arrival of new incoming players. No form of "pragmatism" can justify casting those principle aside. By preserving that openness, regulation cannot be an obstacle to innovation, and instead will preclude any attempt to misuse the rules for the benefit of a chosen few. One players' freedom of enterprise stops where that of others begins... That of a large corporation cannot hinder that of a start-up. Preserving innovation and preserving freedom of enterprise means preserving Net neutrality.

Stéphane ELKON, *Delegate General*
AFNUM - Alliance Française des Industries du Numérique

Generally speaking, AFNUM is very pleased with Arcep's approach when it comes to open Internet, which establishes a constructive dialogue with the players involved. It is still too early to assess the impact of the European regulation on the sector. The effects are yet to be felt. BEREC guidelines have made it possible for us to gain a better understanding of the European Open Internet Regulation. However, they have also created shadow areas on how the ARNs will take action. Moreover, some provisions appear too precise to stand the test of time.

We look forward to seeing the regulators take a pragmatic and scalable approach to implementation. The European regulation and guidelines must leave room for agility and not slow down innovation. It is also essential that they take into account the user experience and technological developments. For instance, we feel it is difficult to establish a list of 'specialized services' or to give a technical definition thereof, as it may be obsolete within a few years. What's more, we believe that the regulator will not be able to monitor everything, such that self-assessment by the relevant stakeholders will need to be enabled.

We thank the Authority for listening to the stakeholders and AFNUM is ready to make helpful contributions to any future discussions.

3.4.2 The Arcep approach: tools and methodology

Arcep wished to reflect the structural changes detailed above in its organisation. It thus formed a new unit, the Open Internet Unit, composed of four agents, dedicated to the scope of the regulation's actions and in charge of ensuring the market's proper functioning.

It has established a general approach to Net neutrality, making the distinction between three major phases:

- diagnosis;
- analysis and, where applicable, enforcement and compliance assurance;
- reporting (see scheme in section 2.3.1).

a) Action plan in three stages

Phase 1 : Diagnostic Review

Firstly, an inventory of ISPs' practices within the scope of the European Regulation must be conducted. This census, which can be conducted using a variety of tools, is aimed at stirring operators to raise questions on the compliance of their practices with the Regulation. For further details see points b) and c) of this section.

The regulator may also, in the context of its monitoring mission, collect general information from ISPs on the management rules they apply to their networks and their capacity, before seeking to address more specific practices on traffic management or commercial differentiation (article 5).

Incidentally, it should be noted that the regulation on the open Internet enjoys a very broad scope of application, on the scale of an ISP's operations, which allows Arcep to collect information of great depth and breadth, which can then be redistributed to the competent authorities (CNIL, DGCCRF, etc.).

Phase 2 : Analysis and Compliance Assurance

Subsequently, the practices identified must be analysed to determine their degree of compliance with the requirements of the European regulation and with regard to the recommendations of the BEREC guidelines.

In the distinctive context of an emerging new legal and regulatory framework, Arcep has asserted its willingness to support operators in the proper implementation of the European regulation. The Arcep board in charge of investigations and proceedings (RDPI formation [44]) thus initiated a proactive dialogue with the ISPs during the months following the adoption of the guidelines, in particular through a questionnaire designed to develop a census of market practices.

This willingness to facilitate dialogue is intended as pragmatic; it is explained by the novelty of the exercise and the margins of interpretation inherent to the regulation, adopted recently. Through this dialogue, Arcep's RDPI formation has been able to produce the first census of market practices and offers. Some raise questions and may, should it prove necessary, be considered in the compliance assurance phase.

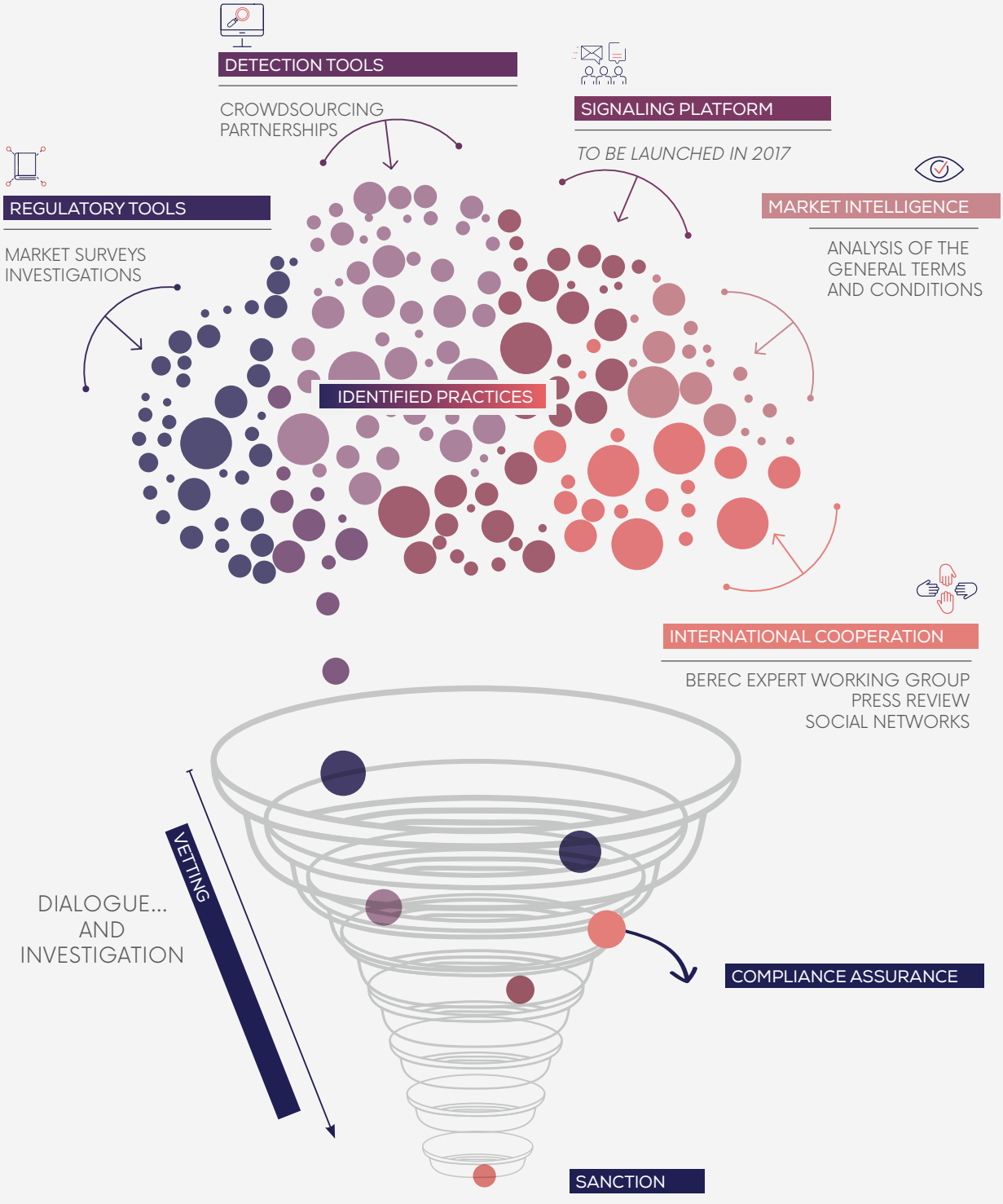
Furthermore, Arcep's departments have been able to interact with other players than the ISPs active in France (representatives of consumer and citizen associations, manufacturers from the telecommunications sector, and content and applications providers) on the impact of the regulation on their practices. This led them to raise questions about their own practices and, in some cases, make adjustments to them. For example, when the French national rail company decided to experiment with its Wi-Fi offer on certain high-speed lines, it was able to turn to Arcep's offices to ensure that its offer complies with the Net neutrality provisions.

Phase 3 : National and European reporting

Lastly, as noted at the beginning of this report, the Regulation provides (Article 5.1) that the national

[44] Dispute Settlement, Proceedings and Investigation Formation.

// **Compliance assurance phase:** proactive dialogue



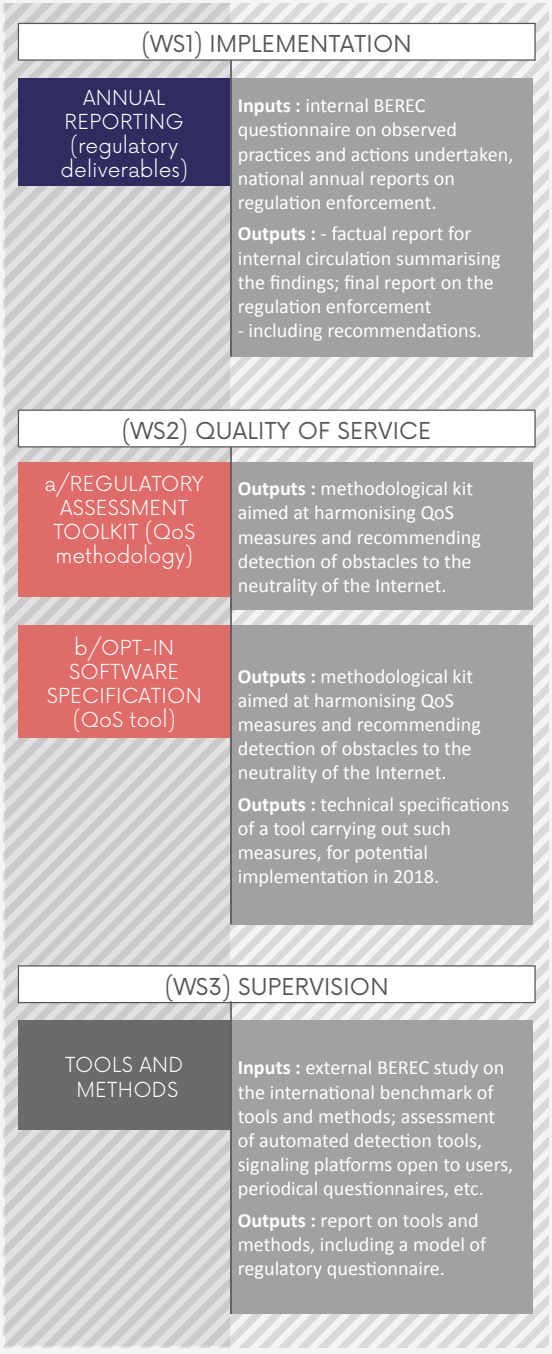
regulatory authorities shall produce an annual report recalling the monitoring actions undertaken under Articles 3 and 4 of the Regulation and presenting the findings made through them.

This report offers the opportunity to inform citizens and consumers of developments on the topic of Net neutrality, a strong expectation of public opinion, and to help them gain full awareness of the related issues. It also makes it possible for the legislator to remain informed of market developments and to anticipate a need for additional legal initiatives. Lastly, it makes it possible to bring forward harmonised enforcement of the Regulation across the internal market, by strengthening interaction between European regulators.

BEREC wanted to further expand this European dimension in its 2017 work programme, adding to the national reports of each regulatory authority a second joint report at the European level, produced by the end of the year. This report will summarize all the national contributions and suggests analyses and recommendations in order to progress toward effective and harmonised enforcement of the regulation.

As a supplement to this document, the BEREC working group is also preparing a thematic report, the release of which is also scheduled for late-2017, which will carry out a review of the tools and methodologies available to regulators in order to best fulfil their responsibilities when it comes to monitoring Net neutrality. It will rely on a benchmark study currently underway, aimed at comparing the practices of extra-European regulators on the subject of Net neutrality and at identifying potential tools available on the market as well as best practices. This report may also derive useful components from the BEREC "quality of service" workstream, detailed in section 3.1 of this report, which contains definitions of tools monitoring certain violations of Net neutrality. Finally, this report will offer regulators the template of a regulatory questionnaire for their surveys to identify practices with operators, comparable to that carried out in France in early-2017.

// BEREC 2017 work programme on Net neutrality



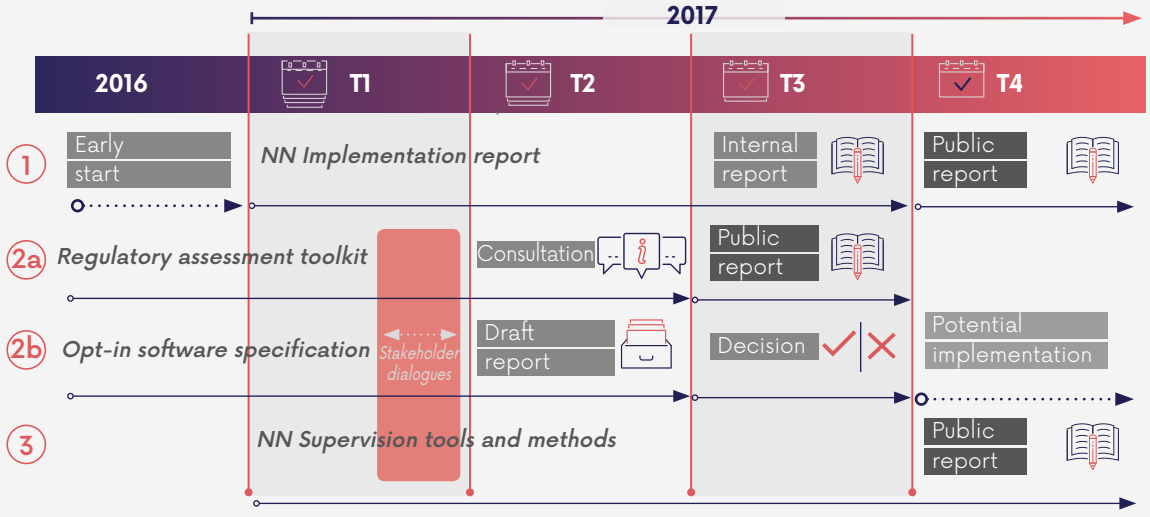
Key

WS1. Implementation of Regulation 2015/2120 and Guidelines on Net neutrality (NN)

WS2. Regulatory assessment of QoS in the context of Net neutrality (QoS)

WS3. Net neutrality supervision tools and methods (NN)

// **BEREC agenda** on Net neutrality



Thereafter, BEREC will have a complete architecture for its action on neutrality. During a typical one-year cycle, Arcep will collect information nationwide using its diagnostic tools (i) will share them with the BEREC working group dedicated to the topic as they become available (giving priority to the most emblematic cases) (ii), and contribute to more comprehensive and formal reporting that will provide material for BEREC's annual report (iii).

b) *Existing census tools*

Chronologically, the first tool developed by Arcep for its surveillance mission was the questionnaire. This exercise draws on the experience of the two previous questionnaires sent out by Arcep on the theme of Net neutrality: the TMI study carried out with BEREC and the European Commission in 2012, and an informal version of the questionnaire conducted in 2015.

A first iteration of a new version of the questionnaire was produced in January 2017, making it possible to collect responses from the main ISPs – in mainland France and overseas – and to bring the Authority's knowledge up to date on relevant practices for the scope of the European Open Internet Regulation. This exercise offers the benefit of being able to ask very detailed questions about technical and commercial practices of operators, on their networks or with respect to their customers, and to get discussion underway.

Two other tools have made it possible to round out the diagnostic system in this first year of enforcement: market intelligence and European cooperation.

Where intelligence is concerned, Arcep's offices regularly run verifications on the terms and conditions of all ISPs offers. Over the past year, this action has made it possible to identify certain clauses that clearly did not comply with Net neutrality principles, and secure their removal: for example clauses blocking services and types of use (such as the ban on engaging in peer-to-peer, VoIP or newsgroups).

As regards European cooperation, Arcep was actively involved in the BEREC expert working group on Net neutrality. This group was active in particular during the guideline drafting phase (from November 2015 to August 2016) and continues to shape its work programme around the

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enforcement of the Open Internet Regulation. As such, BEREC's 2017 programme specifically stated that the working group must serve as a forum of exchange on practices covered by the open Internet Regulation, and thus urged European regulators to share their observations and regulatory actions. This interaction is crucial toward bringing about awareness of the existence or extent of certain relevant practices and bringing forward regulatory analysis about them. It is an essential source of support for Arcep's diagnostic capacity, which is expected to be kept up over time, and a guarantee that the application of the framework will take place in a harmonised manner across Europe.

c) Developing new diagnostic tools

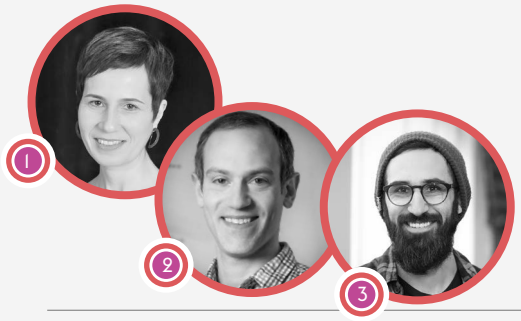
Two other diagnostic mechanisms are under development and are expected to evolve in 2017: a signaling platform on the Authority's website and crowdsourced measurement tools.

The signaling platform will enable end users to more easily call Arcep's attention to the concrete problems they encounter in all the electronic and postal communications markets. The existence of this service is of particular importance for the theme of open Internet. Given the multitude of offers and types of Internet access existent in France, it is very difficult for Arcep to be able to effectively detect, from outside, practices that can raise questions regarding Net neutrality. Consequently, Arcep wants the citizens and users concerned to be able to call its attention to the issues they face in a simple manner: this can range from flawed quality on the line or insufficient speed up to the awareness of a blockage or a throttling on a particular offer . The Authority will be vigilant on these user feedbacks, which, after examination, may, where appropriate, lead to more in-depth investigations. It should also be noted that over the past year, several users have taken it upon themselves to report certain practices to Arcep via the social networks, and that these cases were duly investigated by the Authority's services.

Lastly, as part of its collaborative approach with the actors producing or using quality of service measurement solutions (cf. 3.1.1), the Authority would like to identify distributed measurement tools (crowdsourcing) that make it possible for every end-user to detect practices likely to be in violation of Net neutrality (similar to what is offered, for instance, by the Austrian regulator and its tool RTR Netztest).

This component of Arcep's action is a major line of action toward the empowerment of network users, and must come along with an educational effort so that everyone can correctly understand the various tools found on the market and how to interpret the results of the measurements performed.

The development of diagnostic tools at Arcep is planned as a long-term project, open to



When academics address TRAFFIC MANAGEMENT DETECTION

1 **Renata CRUZ TEIXEIRA** – *Research Director, INRIA (Paris Research Centre)*
2 **David CHOFFNES** – *Professor at the College of Computer and Information Science, Northeastern University*
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Traffic differentiation can be used by an ISP to throttle or optimize the performance of an application or application class (e.g., Netflix or all video streaming services). Typically, in order to do this, ISPs inspect the content of network traffic to determine the application (for example, looking for "netflix.com" to identify Netflix video traffic). Thus, to verify whether an ISP practises differentiation, analysis must focus on network traffic that comes from the targeted applications.

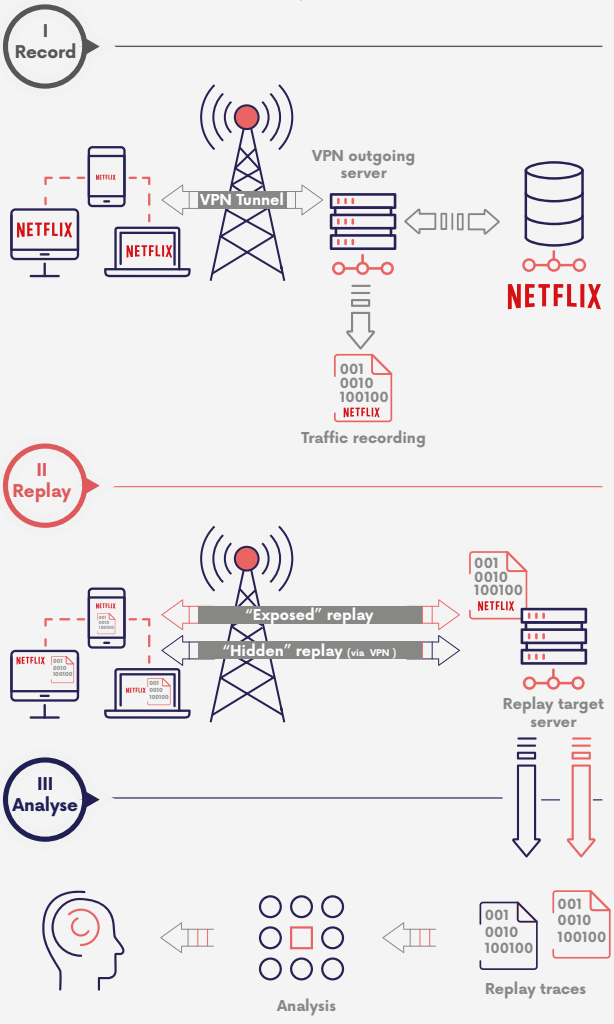
We developed a technique called "record and replay" to detect this practice. First, we record network traffic produced by real applications such as YouTube and Netflix. We then use our software to reproduce traffic that has the same characteristics as application traffic. This is the "replay", which we then send to the ISP network that we want to test. If this ISP differentiates the applications on its network, our replay traffic will be affected in the same way as the traffic of the actual applications. Concurrently, we send the replay traffic again, but this time encrypted, so that the ISP cannot detect its nature. We call this "hidden replay" traffic, in contrast to the previous one, which is called "exposed replay". If the performance of the exposed replay traffic and cache replay traffic differ, then we can conclude that this ISP discriminates this application. One key challenge is to reliably determine that differences in performance between the exposed replay and cache replay are attributable to differentiation by the ISP, as opposed to other confounding factors such as normal bandwidth variations over wireless cellular technologies. To address this, we have developed rigorous statistical tests to rule out such factors.

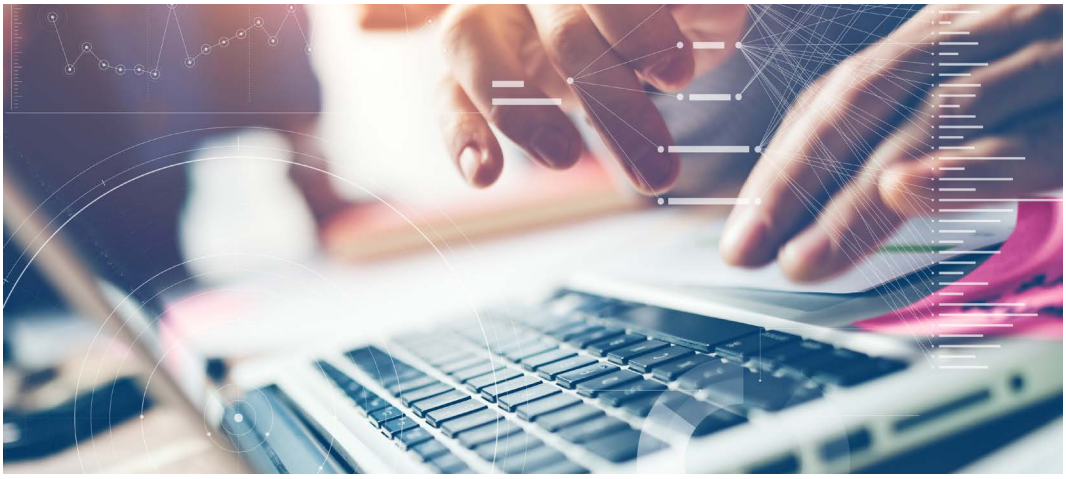
We used this technique to identify video throttling, transcoding, and other forms of differentiation and interference in the United States. The Android application making it possible to perform the test is available free at:http://dd.meddle.mobi .

The challenge for wider deployment is to have a sufficient number of "replay" servers in various locations to bear the load brought in by new users. We are working with M-Lab to find a solution to this problem, and having additional partners will further help us scale.

As part of our future work, we are investigating how to pinpoint the root causes of the observed performance. By providing tools that reveal the responsibility of all parties (ISPs, domestic networks, content providers) in the observed performance, we hope to offer better transparency to users, providers and regulators.

We believe that regulators should insist on such an independent auditing of ISP behaviour, driven by rigorous scientifically-validated measurement techniques. ■





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innovation from all stakeholders. This workstream will also be conducted at the European level, with all European regulators being required to identify the same types of practices, covered by the Open Internet Regulation.

3.4.3 Thematic lines of the Regulation and Arcep action

This section shows how the approach set out above has been cast into concrete actions. To facilitate understanding, Arcep has grouped its comments into four main thematic fields, suggested by the structure of the regulation:

- commercial and contractual practices;
- traffic management practices (within Internet access);
- specialized services;
- transparency measures.

For each theme, the framework of the Regulation, the actions carried out by the Authority and its observations will be recapitulated, as well as its first conclusions.

For each practice envisioned, Arcep hopes to be able to rely on "bottom-up feedback" to round out its own census, which will be made all the easier by the implementation of new user-friendly tools (the signaling platform and the distributed measurement tools). Any stakeholder concerned by any of these practices may make contact with Arcep, in the context of the proactive dialogue currently underway, in order to assess compatibility with the legal framework.

By way of clarification on the scope of practices that will be analysed more in detail by the Authority, it should be noted that:

- monitoring pertains to the practices implemented on the residential market and the corporate market, whether for current offers or previous offers still found in the operator's customer base;
- it applies to the practices implemented on all operator IP traffic, particularly on the Internet access service and specialised services;
- it concerns the measures implemented within the network, as opposed to those implemented within the service platforms (email, web, etc.).

a) Commercial and contractual practices

Firstly, the Authority is committed to analysing the commercial and contractual practices of ISPs. These are generally the "easiest" practices to monitor as they are generally explained in the terms and conditions of sale of the ISPs' offerings.

As a reminder, according to the Regulation (Article 3.2), there is a framework for analysing these practices,: while ISPs and end-users are

free agree about *"commercial and technical conditions"* such as *"prices, data volumes or speed"*, contractual conditions and commercial practices should not limit "*the exercise of the rights of end-users laid down in paragraph 1"* (i.e. their freedom to access information and other content). The Authority therefore commits to monitor more precisely the practices likely to limit the exercise of end-user rights in terms of freedom of choice of content, type of access, and upload and download capacity in general (whether these practices are followed by technical consequences or not).

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On this topic, the BEREC guidelines specify several points in particular:

- the Regulation prohibits by principle the clauses by which the ISP prevents the use of specific content or applications (§37 of the guidelines), except in the cases exhaustively listed in the regulation in Article 3.3 (legal obligations, security requirements, exceptional congestion of the network);

- the Regulation also addresses practices that may influence the choice of a rational consumer by changing the price of data for selected content e.g. *zero-rating* (§40);

- the guidelines establish the principle of a review on a case-by-case basis (§32 et seq); on *zero-rating*, the analysis grid can allow for relatively strict regulation of practices (analysis of the effect on the content market, examination of the data volumes included in the packages, choice of users, etc.) (§41 et seq);

- an offer that blocks or slows down only part of the applications once the data-cap is reached would be contrary to the regulation (§41);

- in contrast, the guidelines give examples of commercial practices that are technically acceptable as far as neutrality is concerned: a *zero-rating* offer that does not charge, in an agnostic manner, the data volume for all applications and services in a given period; or free access to customer service applications (§35).

As part of proactive dialogue, the RDPI formation of Arcep's board has collected a number of findings, deriving initial learnings from them:

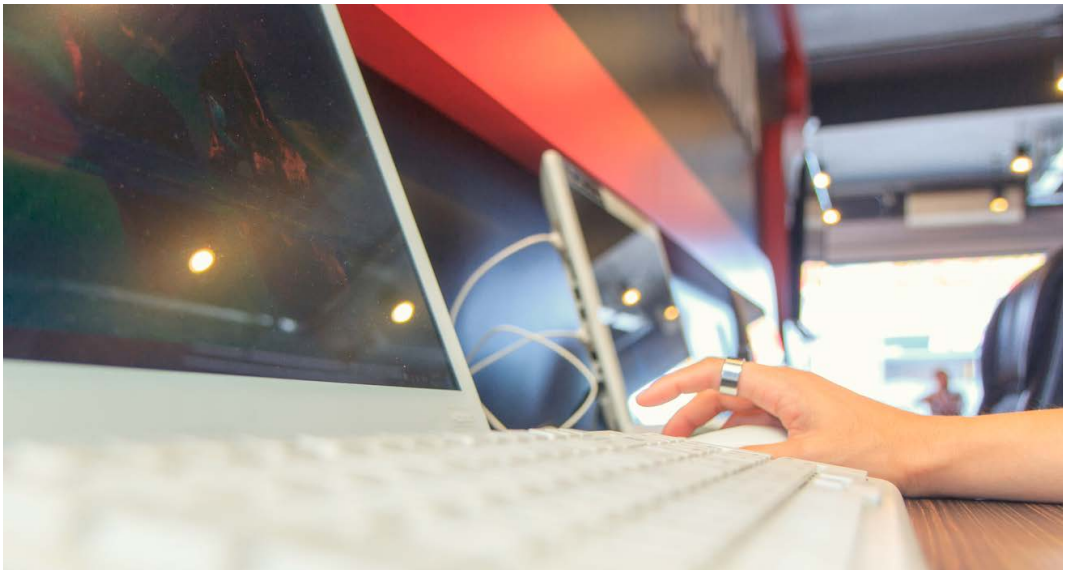
1 Commercial conditions specifically applicable to terminals

The Regulation requires that ISPs offer complete freedom of choice as regards the terminal. The removal of old contract clauses of ISPs requiring the choice of a terminal or limiting the possibility of using it (e.g. by prohibiting tethering on a smartphone) is an important point raised during the dialoguewith operators.

2 Special showcasing of content in the access offers, via *zero-rating* (differentiated pricing), sponsored data (consumption of data paid by a third party) and bundling (coupling of internet access with access to content) [45].

As a reminder, the Regulation does not ban in itself an offering that differentiates the commercial treatment (if not followed by technical effects) of certain types of content; it bans only those that, after analysis of the national regulatory authority,

[45] For further details on these types of commercial practice, the reader may refer to definitions in the situational report on the regulatory framework published in September 2015.



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limit the freedom of choice of the end-user. The BEREC's guidelines developed this point, noting the need to analyse each practice on a case-by-case basis. While basic coupling of offers seems unlikely to create a real constraint on end customer's rights, *zero-rating* practices may be a problem.

Zero-rating practices in Europe have led to recent interventions by several European regulators – sometimes following the entry into effect of national legislative provisions governing *zero-rating* offers. Nevertheless, some of the regulatory decisions taken against the *zero-rating* have been contested in court, ISPs deeming that the interpretation made by their regulatory authorities in these decisions exceeded the provisions of the regulation, for example by totally prohibiting the practice.

At the current time, only the Dutch courts have ruled these issues, in their 20 April 2017 Order. In this case, the Dutch regulatory authority had ordered the ISP T-mobile to stop providing a music streaming service without counting the data consumption of its users, pursuant to the Dutch telecommunications law, which prohibits any practice of *zero-rating*. T-Mobile challenged this provision, arguing that a total ban on *zero-rating* was contrary to the European open Internet Regulation, which the Rotterdam Court confirmed.

The Swedish, Hungarian and Belgian regulatory authorities have also had to come out on *zero-rating* practices since the Regulation came into effect, and some of these decisions are currently being appealed. It should be noted that national judges, ordinary judges under European Union law, if not adequately equipped to ensure effective and uniform application of the regulations, have the option of referring the matter to the European Court of Justice, seeking a preliminary ruling in order to verify compliance in the Regulation's enforcement by national authorities.

For the time being, no decision has been made in France. Arcep will take into account European developments on a judicial or regulatory level in analysing similar practices.

3 Bans on services or uses

It has happened in the past that ISPs' commercial conditions incorporate a varied range of bans, for example on peer-to-peer protocol, the use of VoIP services or newsgroups. In the questionnaires conducted by the Authority in 2011 and later in 2015, such prohibitions were still relatively common. Today, however, given the very clear terms of the regulation (Article 3.1), it is expected that these prohibitions, subject to case-by-case analysis, will have disappeared by the end of the dialogue phase.

b) *Traffic management practices (within Internet access)*

The Authority is also interested in the practices that take place within the network and which are often not visible to the end-user. This section covers all aspects relating to traffic management, i.e. all rules and procedures for accessing and routing data from or intended for end users, implemented by the operators in both the core and at the periphery of their network. This includes, in particular, differentiated processing of flows taking into account the nature of traffic, or the identity or quality of its source or its destination; and the non-specific treatments (to a particular type of traffic) to maintain operational conditions and network optimization in the network.

The Regulation institutes a major principle of neutrality: *"providers of internet access services shall treat all traffic equally, when providing internet access services, without discrimination, restriction or interference "* (Article 3).

However, the regulation recognises 2 forms of traffic management (Article 3.3):

- reasonable traffic management, which meets several cumulative criteria, set out in paragraph 2: it must be transparent, non-discriminatory, proportionate, based not on commercial considerations but on objective differences between technical requirements regarding the quality of service of specific categories of traffic. It must not pertain to the monitoring of specific content or be maintained longer than necessary;

- exceptions in three specific cases: legal obligations, security requirements, exceptional network congestion.

Regarding the reasonable traffic management measures and exceptions provided for in the regulations, the BEREC guidelines specify several important points:

- any category of traffic subject to a reasonable traffic management measure must present objectively different quality of service requirements (§62 to 67 of the guidelines) and must not stem from a commercial interest (§68);

- a reasonable traffic management measure can be applied to a category of traffic – without discrimination between applications within this category, if they justify identical technical needs (application agnosticism) (§63 and §66);

- practices involving blocking or deterioration of routing conditions are prohibited if they do not fall under one of the three categories of exceptions provided for in the regulation (§77).

As part of proactive dialogue, the RDPI formation of Arcep's board has collected a number of findings, deriving initial learnings from them:

1 Blocking or throttling of services, content, applications, etc.

This points encompasses all ISP action designed to stop or limit the free flow of targeted traffic, in full or in part. This type of action, which is inconsistent with the principle of reasonable traffic management, may, on the other hand, be substantiated based on the exceptions provided for in the Open Internet Regulation, if this intends to respond to a legal injunction or a security imperative. The Authority must therefore be in a position to verify the due justification of the measures employed.

2 Reasonable traffic management as part of Internet access

This refers to practices aimed at improving routing of the targeted flow, as needed (e.g. by granting priority). This type of action must be reconciled with the above criteria determining reasonable traffic management practices. In practice, there are few instances in which this type of reasonable traffic management can be observed today, most traffic being distributed between specialised services and Internet traffic routed on a *"best effort"* basis.

3 Modification in the content of the flows routed

This refers to any alteration of data beyond the IP layer; for example, compressing images or rewriting HTML pages. Some forms of image compression can still be seen in France on mobile networks. Recital 11 of the Open Internet Regulation specifies that compression of this kind must be carried out without any deterioration of content. Arcep aims to ensure that this last requirement is satisfied, as in the case of compression carried out by certain overseas networks on the transit via submarine cable.

4 Special measures related to prevention or management of bottle-necks

Growth in the digital ecosystem is mechanically reflected in a strong yearly traffic growth, requiring ISPs to regularly extend the capacity of their Internet access networks. This capacity constraint could generate an economic incentive for ISPs to deploy strategies that delay the extension of capacity, via traffic management policies.

The regulation, however, tightly delineates the opportunities for ISPs to prevent imminent and exceptional congestion (i.e. unforeseeable and punctual) by using traffic management. The Authority must therefore verify the framework in which anti-congestion measures are used, when these exceed the principle of reasonable traffic management (for example by blocking or throttling certain types of traffic to maintain sufficient quality of service on functions deemed essential to the network).

As a reminder, the regulation specifies that each reasonable traffic management practice must be intrinsically justified, in particular by the technical needs of the service or the content for which it has been deployed (Article 3). Therefore, traffic management must not, in absolute terms, be used to compensate for an ISP's lack of extension capacity.

The regulation also states (Article 5.2) that Internet access providers shall provide regulatory authorities with information regarding their network capacity and traffic management practices, as well as justifications of the traffic management measures applied.

In fact, while few measures specially designed to manage congestion are currently in place, an example of the efforts to counter exceptional congestion is offered by overseas providers. Several of them have implemented exceptional traffic management measures activated in the event of submarine cables breakdown, whereby the capacity of the backhaul network suddenly plunges; in these cases of *force majeure*, restrictive traffic management to regulate the use of bandwidth between services appears warranted (subject to more in-depth analysis).

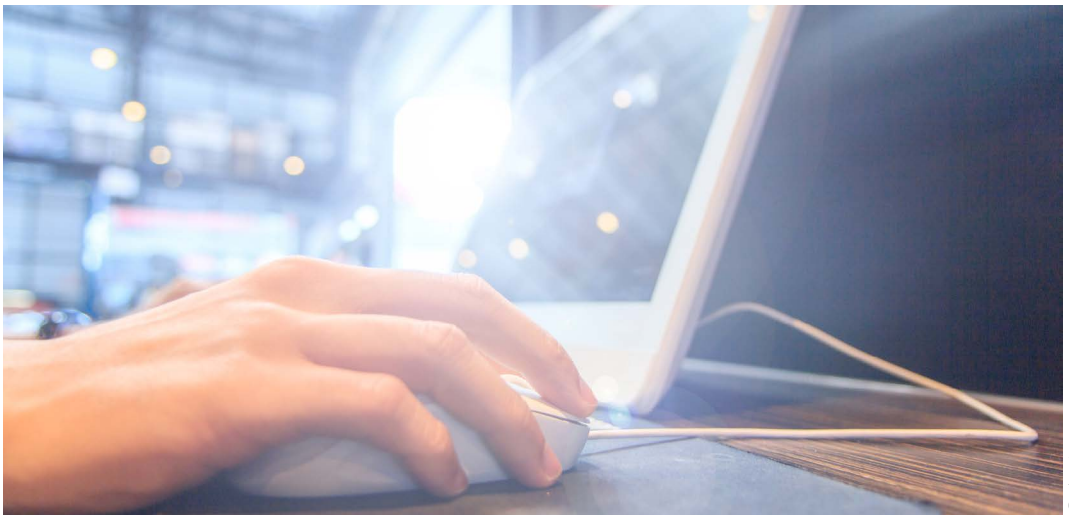
c) *Specialised services*

Lastly, the Authority, via its formation in charge of proceedings and investigations, works to verify compliance with the regulation as regards the provision of specialised services.

Specialised services are described as "services other than Internet access services which are optimised for specific content, applications or services" (Article 3.5). The regulation specifies that in order to benefit from this provision, the inherent need for the service to be transmitted with optimised quality must have been demonstrated, and the provision of the service must not be carried out at the expense of Internet access: at the request of the NRA, the operator must be able to demonstrate the necessity of this optimisation.

The guidelines specify that ISPs (or CAPs, where applicable) are free to offer specialized services:

- "where the optimisation is necessary in order to meet requirements of the content, applications or services for a specific level of quality" (§106 et seq. of the Guidelines);
- not sold as a substitute for Internet access (§126);
- not offered to the detriment of the availability



and general quality - of shared parts of the backhaul network - of internet access services for end-users (§116 et seq).

As part of proactive dialogue, the RDPI formation of Arcep's board has collected a number of findings, deriving initial learnings from them:

1 Linear audiovisual services

"Linear" IPTV television (in other words, live broadcast), provided by most ISPs as a supplement to their offer, is part of the services for which BEREC has asserted the existence of specific requirements on quality of service and stated they were de facto subject to compliance with the Regulation's requirements (in particular those in Article 3.5, Paragraph 1). Where France is concerned, the conditions for broadcasting television via IP, in multicast, appear compatible with the criteria of optimised service. They also offer the advantage of being more efficient in network resources than individual distribution, in *"unicast"* mode.

2 Telephony

The telephone services offered by ISPs on fixed and mobile networks, known as "voice over broadband" or "voice over IP", also appear to fulfil the criteria defining optimised service. In particular, voice over broadband traffic currently accounts for less than 1% of all traffic circulating on the networks in France, such that the impact of its optimisation on the rest of the traffic is marginal.

3 Business VPN

The BEREC guidelines specifically assert the potential compatibility between VPN services for enterprises with optimised service. However, the concrete technical execution of these services being more complex and varied than the specialised services mentioned above, this form of VPN calls for case-by-case analysis by the Authority before a definitive opinion can be given on the regulation of business offers. It should be noted, however, that to date they have very little impact on offers to the general public, due to their volume of traffic and their dedicated architecture (in most of the cases).

d) Transparency measures

The Open Internet Regulation requires operators to show greater transparency about the performance of their access services and their traffic management practices. In particular, some performance indicators become contractual commitments to the end-user.

The indicator that is probably the most frequently considered will be access speed; in entering a contract with an ISP, end-users should not be content with commitments covering only a theoretical global speed as advertised by the

// BEREC Guidelines **regarding new contractual commitments on speed** [art. 4.1 d)]

	Fixed networks	Mobile networks
Minimum speed	Lowest speed threshold, barring discontinuation of service (§143)	–
Normally available speed	Speed available for a significant part of the day (§148)	–
Maximum speed	Maximal speed actually reachable via the specified access (§145)	Maximum estimated speed for a given location (§153)
Advertised speed	Speed restricted by realistic maximal speed (§151)	

ISPs; as specified by the guidelines, several speed indicators should be published concurrently.

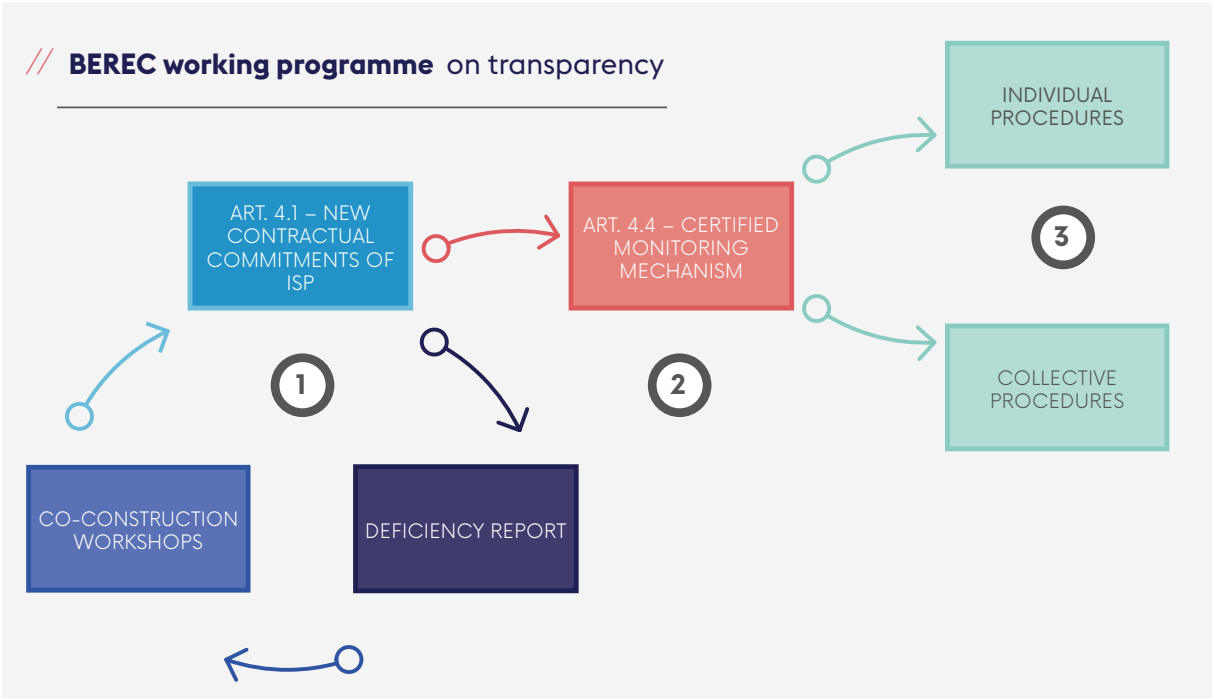
In addition, the Regulation provide that ISPs shall include at least the following information in their contracts:

- a clear and comprehensible explanation as to how any volume and speed limitations may have an impact on the use of content, applications and services;
- a clear and comprehensible explanation of how specialised services may have an impact on the internet access services provided;
- a clear and comprehensible explanation of the possible impact of traffic management and any other practices on open access to content for end-users.

Since the adoption of the Law for a Digital Republic, Article L.224-30 of the Consumer Code, which lays down the information that must *a minima* be found in any contract taken out by a consumer with an electronic communications service provider, also lists the transparency commitments arising from the Open Internet Regulation, in particular:

- the explanations required by Article 4.1 (d) of Regulation (EU) 2015/2120, i.e., where fixed networks are concerned, the minimum, normally available, maximum and advertised speeds, for download and upload traffic, or, in the case of mobile networks, the maximum estimated and advertised speed for download and upload traffic (see table above);
- the procedures instituted by the ISP to measure and direct traffic in such a way as to avoid saturating or overloading a network line, and their consequences as regards quality of service, protection of privacy and personal data, as well as the impact of limitations on volume, speed or parameters on Internet access quality, in particular the use of content, applications and services, including those with optimised quality.

Finally, the Open Internet Regulation provides that any permanent or recurring discrepancy between the actual performance and that advertised by the ISP, when this discrepancy is observed by a certified monitoring mechanism, is to be deemed constitutive of non-conformity of performance for the purposes of triggering the remedies available to the consumer (Article 4.4). The ties established with



market players following the call for partnerships organised by Arcep in 2016 should help to assess whether the available monitoring tools are able to formally establish performance gaps, or other shortcomings in consumer information.

While the guidelines do provide some additional clarification on how the competent authorities can enforce this article, the nature and format of the transparency commitments required from ISPs remains to be stated at the national level, with a view toward securing harmonised commitments from ISPs. Few European regulators have yet carried out this work.

In France, Arcep intends to work with the DGCCRF to lay down the foundations of a co-constructed framework, by bringing together a variety of stakeholders: Arcep, DGE, ISPs, consumer associations and independent experts. Arcep will, to whatever extent necessary, provide its technical and legal expertise on this matter.

3.5 Contributing to platform opening, with a focus on end user devices

Beyond Internet service providers' networks (subject only to the provisions of the open Internet regulation), other players have the ability to limit the actual end user access to certain online services and applications. This is true of online platforms and terminal equipments.

3.5.1 Analysis of the influence of terminals on Internet access

The end user devices are positioned at the ends of the networks to which Arcep serves as architect and guardian. Insofar as they form essential hardware and software links in the technical Internet access chain, end user devices and in particular their operating systems could call into question Internet openness.

This risk increases with the rapid spread of smart terminals: for instance, as regards mobile, 65% of the French population had a smartphone in 2016, a figure expected to increase in the next few years.

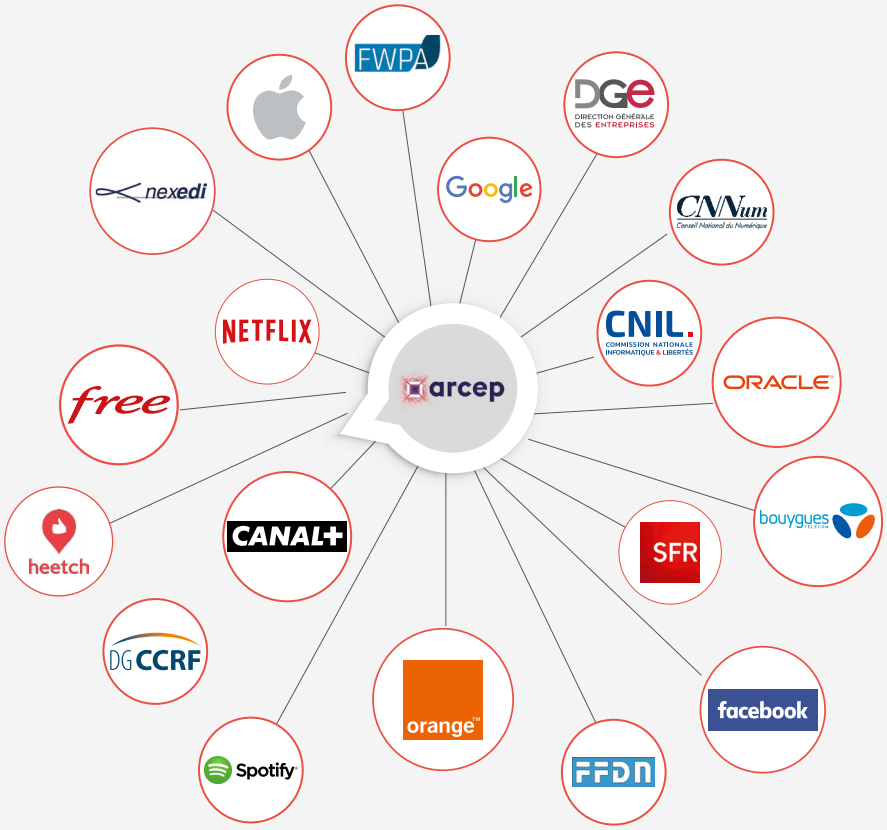
Given this landscape, Arcep decided to extend its exploratory reflections to the role of end user devices in preserving Internet openness, to which it is guarantor. Following its strategic review, it launched an exploratory workstream on the issue of end user devices openness.

The Authority's aim is first and foremost to develop a common understanding on this subject by identifying and analysing any limits to Internet openness resulting from end user devices. The end user devices are considered as a whole, i.e. for both their hardware and software layers.

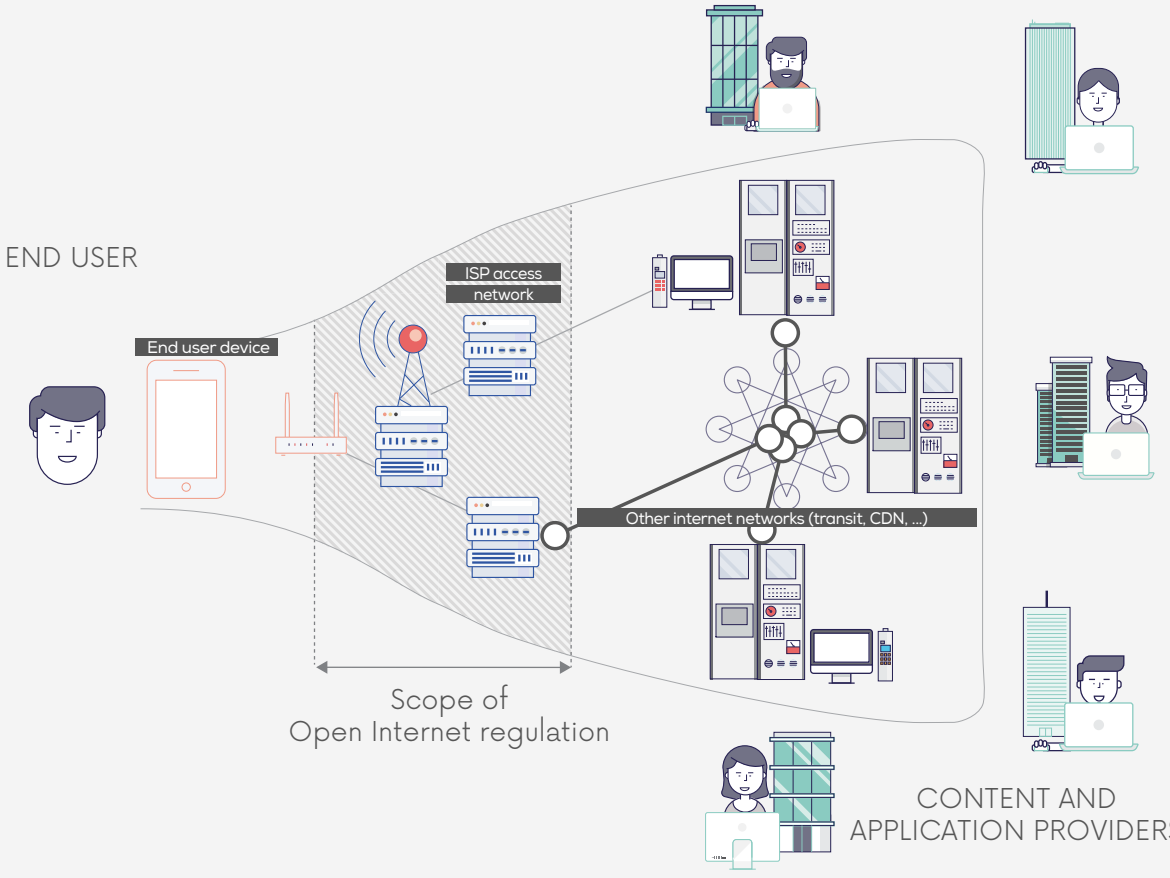
To carry out this project, Arcep has organised a series of interviews with the players directly involved in the subject: content publishers, device manufacturers, operating systems developers, operators, and consumer representatives. It has also met with players with a more cross-cutting perspective, such as representatives of the national administration, consultants, lawyers or academics.

Arcep has developed an initial listing of any limits created by devices in terms of access or content provision to end-users, which can take on a variety of forms. Before continuing its exchanges with the sector, Arcep seeks to share its first diagnostic on the limits created by end user devices and publishes together with this document, a study including the mapping it has been able to produce.

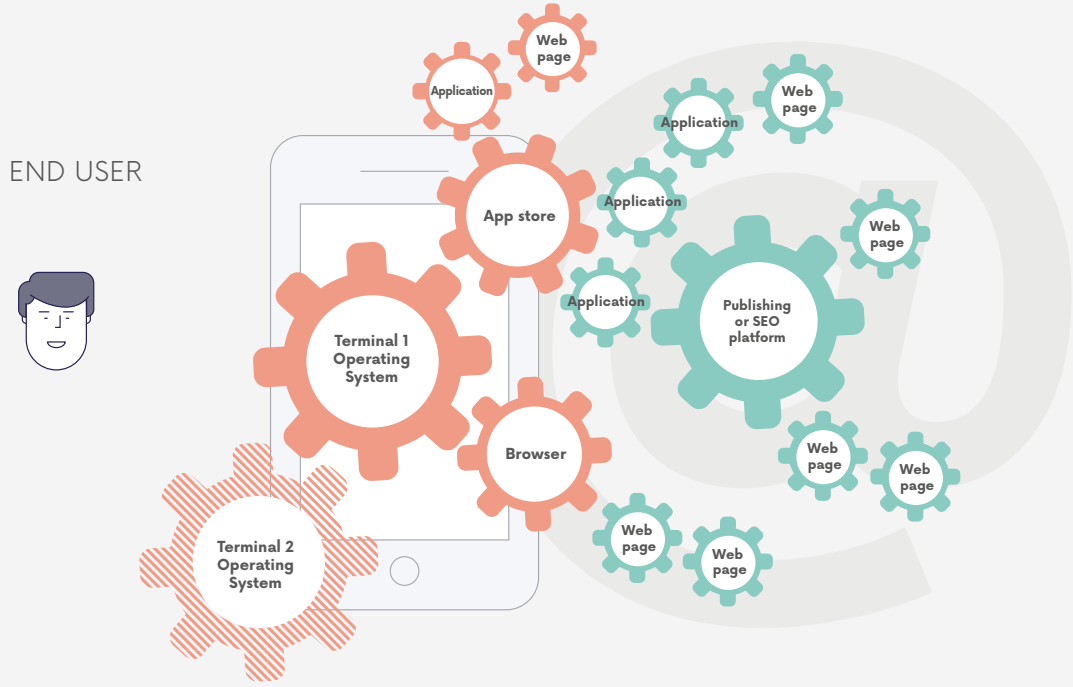
// **The actors** heard



// **Hardware links** between end user and internet



// **Software links** between end user and content



This will enable all players to respond to these initial conclusions and share their forward-looking perspective on the topic with Arcep. This process will continue with an in-depth analysis of the limits and the rationale substantiating them.

3.5.2 Assessment of platform loyalty

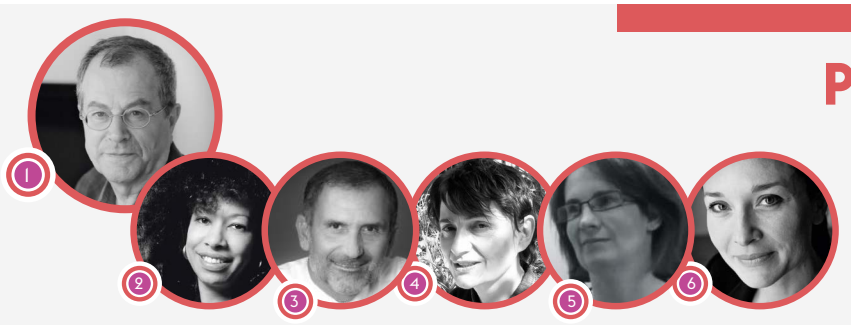
In December 2016, the French Digital Council (CNNum) was called upon by the government to run an in-depth study on the conditions for analysing platform loyalty. Following on from several previous CNNum opinions [46] , this work will, in particular, make it possible to extend the scope of the reflections open by the Law for a Digital Republic, and provide material for ongoing work at the European level.

The general aspiration is to help develop new methods of analysis and evaluation of practices taking into account criteria on:

- **transparency:** does the platform make it possible to clearly understand its operating principles?
- **auditability:** are there means to verify what is published on the platform?
- **societal impact:** what is the impact of the platform's activity on society? How does it take these key aspects into account?
- and then constructively use **the reputation lever** to encourage players to develop virtuous practices?

CNNum has agreed to present its work in greater detail. Arcep will be providing technical cooperation in this process. ■

[46] 2013 Opinion on Net neutrality, 2014 Opinion on Platform Ecosystems, 2015 Report on Digital Ambition.



Platform loyalty: A MUST FOR DEMOCRACY

CNNum
Conseil National du Numérique

① **Marc TESSIER** – *Head of the Working Group on platform loyalty*
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The rise of digital platforms has set off a profound transformation in our economy. The controversies between Uber and private chauffeuring companies, Booking.com and hotel owners or Amazon and its suppliers are symptomatic of paradigm changes, the implications of which we still struggle to model.

Some of these concerns call to mind the difficulties encountered in major retail, i.e., the fierce competition, power plays between intermediaries and producers, or value sharing. Indeed, as digital uses grow, some platforms are becoming critical access points and turn into formidable competitors when they use their offers to take over the upstream or downstream markets.

However, this likeness only partly reflects the issues at stake, as the economic processes at work have repercussions that go beyond business considerations. By organising the networking of individuals and organizations, platforms help shape their access to varied sources of information or cultural content, as well as their ability to express themselves and be heard. Furthermore, the largest platforms have been able to become paragons of productivity by optimising the externalities generated by the various contributors to their markets. This model has become an inspiration to many companies, civil movements and even States. This wave of "platformisation" is all the more likely to bring about change in work, employment and redistribution forms.

These characteristics are turning platforms into essential social infrastructures, the functioning of which must be able to be called into question democratically. It is for this reason that the seemingly technical nature of these topics should not lead players to delegate them to short-sighted expert groups. Quite to the contrary, these questions call for parallel and complementary approaches to be deployed.

The first consists of building, at the European level, forward-looking capacity and a modernised regulatory framework, a process currently stalled by the speed, cross-functionality and meshing of the transformations described above. What does the consumer optimum encompass in these areas where the borders between consumers, producers and citizens fade? How can we take timely action without cancelling out potential for innovation? How can we effectively reconcile the varying objectives in play? To fuel the exploratory scope of reflections, CNNum wishes to develop exchanges with other Member States' digital ecosystems.

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The second approach stems from the need to stimulate interdisciplinary research to produce technical tools capable of auditing the systems governing the platforms – procedures, rules, design, ranking and personalization algorithms, etc. – and assess their impact. This is one of the key objectives of the cooperation between CNNum and Inria through the Transalgo initiative on algorithmic systems.

The third is aimed at innovating to lower the barriers to stakeholder participation in these discussions, so that they can voice their objectives and challenges; then identify and collectively promote best practices. Society now abounds in initiatives and proposals of this kind, and CNNum wishes to help them realise their potential.

Far from weakening the role of regulators, these approaches bolster their legitimacy. With this in mind, the work which the CNNum plans to conduct in 2017 will help lay down the first milestones of a contributory space to define, in collaboration with the platforms themselves, an open method for dealing with the most complex subjects.

THIS DOCUMENT HAS BEEN WRITTEN BY ARCEP

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THANKS

We express our gratitude to all people heard for their dynamism and valuable inputs.

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ISSN : n° 2258-3106

May 2017

ARCEP, COMMUNICATIONS NETWORK ARCHITECT AND GUARDIAN

Internet, fixed and mobile telecom and postal networks constitute the **"Infrastructures of freedom"**. Freedom of expression, freedom to communicate, freedom to access knowledge and to share it, but also freedom of enterprise and innovation, which are key to the country's ability to compete on the global stage, to grow and provide jobs. Because it is essential in all open, innovative and democratic societies to be able to enjoy these freedoms fully, national and European institutions work to ensure that these networks develop as a **"common good"**, regardless of their ownership structure, in other words that they meet high standards in terms of accessibility, universality, performance, neutrality, trustworthiness and fairness.

Democratic institutions therefore concluded that independent state intervention was needed to ensure that no power, be it economic or political, is in a position to control or hinder users' (consumers, businesses, associations, etc.) ability to communicate with one another.

The electronic communications and postal regulatory authority (Arcep), a neutral and expert arbitrator with the status of quasi autonomous non-governmental organisation, is the **architect** and **guardian** of communication networks in France.

As network architect, Arcep creates the conditions for a plural and decentralised network organisation. It guarantees the market is open to new players and to all forms of innovation, and works to ensure the sector's competitiveness through pro-investment competition. Arcep provides the framework for the networks' interoperability so that users perceive them as one, despite their diversity: easy to access and seamless. It coordinates effective interaction between public and private sector stakeholders when local authorities are involved as market players.

As network guardian, Arcep enforces the principles that are essential to guaranteeing users' ability to communicate. It oversees the provision of universal services and assists public authorities in expanding digital coverage nationwide. It ensures users' freedom of choice and access to clear and accurate information, and protects against possible Net neutrality violations. From a more general perspective, Arcep fights against any type of walled garden that could threaten the freedom to communicate on the networks, and therefore keeps a close watch over the new intermediaries that are the leading Internet platforms.