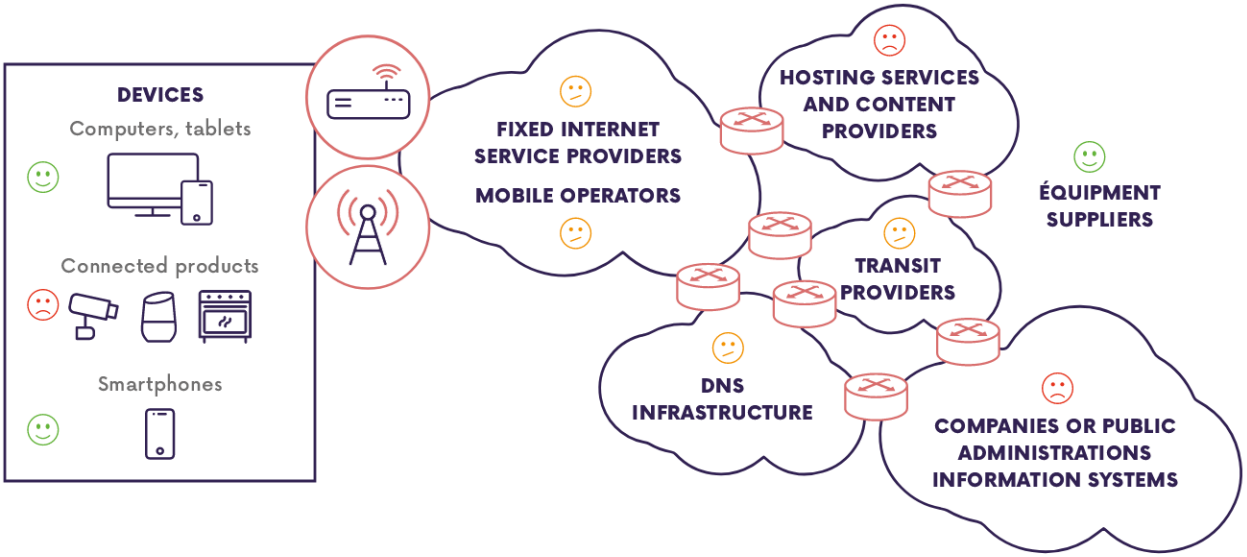
2. Barometer of the transition to IPv6 in France

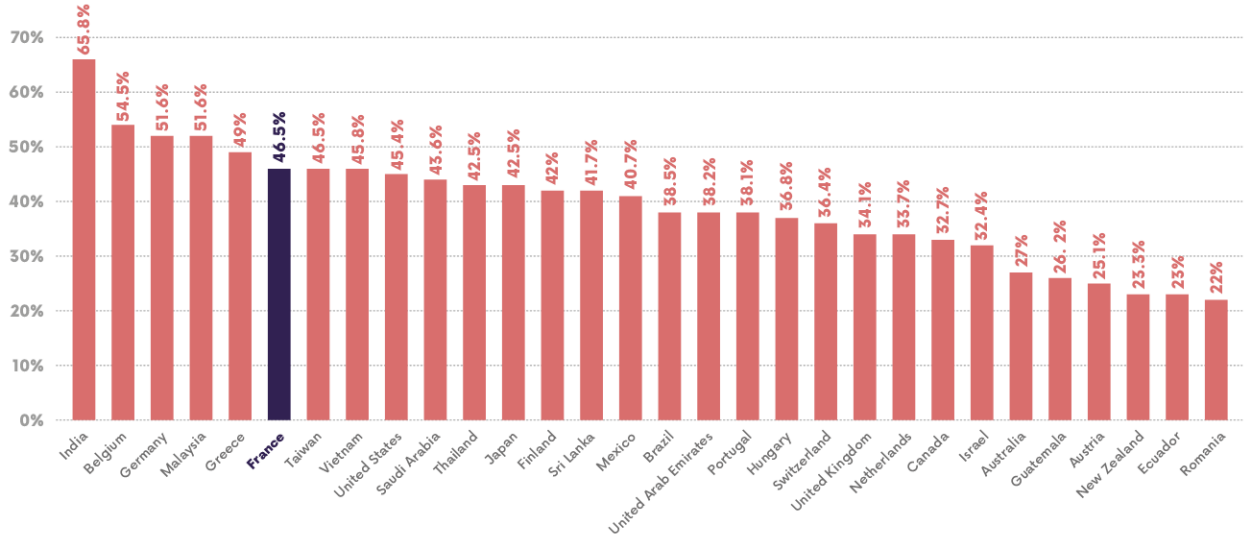
STATUS OF THE TRANSITION TO IPv6 OF THE DIFFERENT LINKS IN THE TECHNICAL CHAIN



Full or high compatibility with IPv6 Partial compatibility with IPv6 Little or no compatibility with IPv6

Source: Arcep

TOP 30 COUNTRIES IN TERMS OF IPv6 ADOPTION



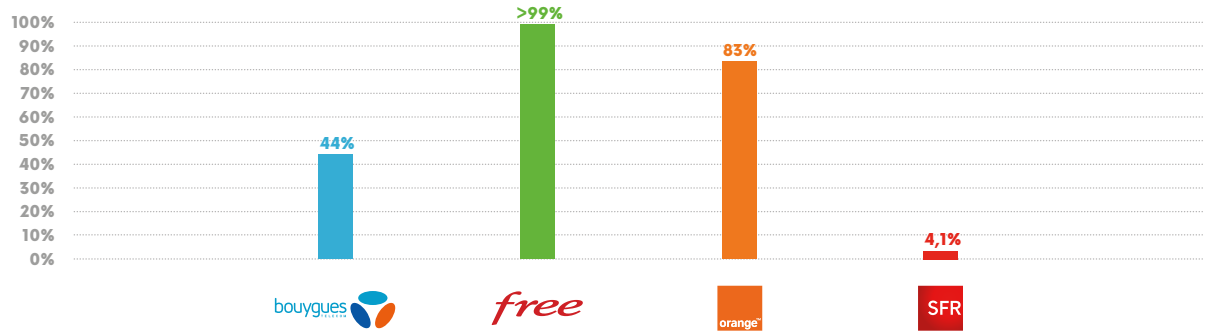
Source: median of "Google IPv6 adoption", "Akamai IPv6 adoption", "Facebook IPv6 adoption", "Apnic IPv6 adoption" data from October 2020. Pertains only to the 100 countries with the most internet users.

The purpose of this annual barometer is to keep users informed in an ongoing fashion. The barometer compiles data produced and provided by third parties (Cisco, Google and Afnic) and data that Arcep collects directly from the main operators in France[26]. Arcep published the 2021 edition of the barometer on 29 November 2021. As detailed here below, not all stakeholders are at the same stage of the transition.

This 2021 edition of the barometer revealed substantial progress on IPv6 with a rate of adoption that reached close to 50%[27]. France has significantly improved its place in the global IPv6 adoption rankings, going from tenth place at the end of 2020 to sixth place today, according to the median score of the four main sources of publicly available data assessing IPv6 adoption: Google, Akamai, Facebook and Apnic[28]. France ranks fourth in Europe, behind Belgium, Germany and Greece.

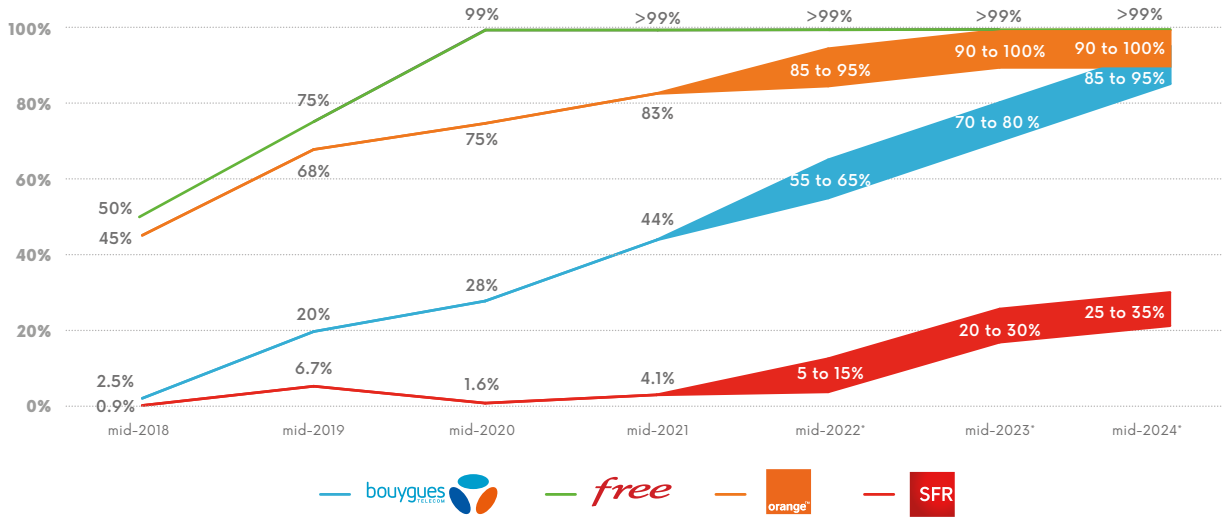
The barometer shows in detail the status of the transition for the Internet ecosystem's different stakeholders. Find IPv6 statistics on the top 100 countries in number of web surfers, updated every two months on Arcep website.

FIXED NETWORK: PERCENTAGE OF IPv6-ENABLED CUSTOMERS



Source: data as of the end of June 2021, collected by Arcep from operators.

FIXED NETWORK: PERCENTAGE OF IPv6-ENABLED CUSTOMERS EVOLUTION



* Figures subject to change

Source: data as of the end of June 2021, collected by Arcep from operators.

26. Arcep Decision No. 2021-0375 on implementing surveys in the electronic communications sector.
27. Based on "Google IPv6 adoption".
28. Based on the median of "Google IPv6 adoption", "Akamai IPv6 adoption", "Facebook IPv6 adoption", "Apnic IPv6 preferred" data from October 2021. Aggregation of national data is prorated based on the number of Internet users (source: Wikipedia, data as of 09/08/2021). The median of the four sources is calculated country by country, before being aggregated on a pro-rated basis, according to the number of Internet users in each region.

2.1. Fixed Internet service providers

The following charts provide a snapshot of the current status of IPv6 deployment, along with forecasts for the main operators' fixed network in France.

On the fixed networks, Arcep notes significant disparities between the main telecom operators in their transition to IPv6:

- - The percentage of IPv6-enabled SFR customers, all technologies combined, rose from 1.6% by mid-2020 to 4.1% by mid-2021. As upcoming activations also remain insufficient (between 20% and 30% by mid-2023 and between 25% and 35% by mid-2024), SFR is being urged to accelerate the transition to IPv6 on its fixed network substantially, in particular on FttH, and to begin this transition on cable. Because the vast majority of users will not take the initiative to enable IPv6 manually, Arcep is encouraging SFR to systematically perform this configuration by default.
- - Although deployment efforts have been observed (around 44% of customers activated by mid-2021 compared to 28% by mid-2020), Bouygues Telecom is once again being urged to continue and to step up deployment efforts on its fixed network.
- - On fixed networks, the current percentage of Free and Orange customers who are IPv6-enabled is relatively high (approximately more than 99% and 83% respectively) and have increased. The projections for mid-2024 for Orange are encouraging (between 90% and 100%).
- - Bouygues Telecom, Free and Orange are being urged to begin the transition on 4G fixed wireless as soon as possible. SFR in particular, whose 4G fixed wireless customers are all IPv6-ready, is being encouraged to perform IPv6 activation by default on this technology.

Several initiatives amongst operators with between 5,000 and 3 million customers on fixed networks are encouraging, notably those taken by Orne THD which had already migrated all of its customers by 2019 and Vialis which started its transition last year (1% by mid-2020) and already 88% of its customers are IPv6-enabled. Zeop meanwhile went from 0.1% IPv6-enabled customers in mid-2020 to 21% by mid-2021. The percentage of IPv6-enabled customers for Coriolis (72%), KNet (17%) and OVH Télécom (19%) has decreased compared to last year, which is cause for concern.

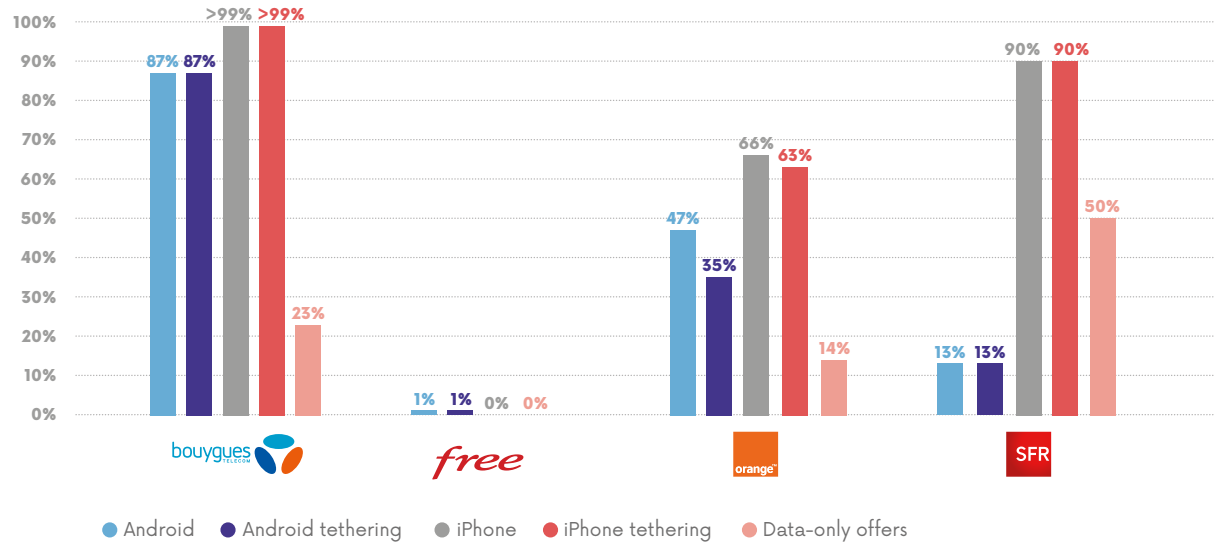
Alsatis, bigblu, Nordnet, Ozone, SFR Caribbean, SFR Réunion Mayotte, VidéoFutur and Wifirst, on the other hand, have not initiated their transition to IPv6 and do not yet plan to do so. K-Net and OVH Télécom were unable to provide their deployment forecasts. Even if several operators planned to accelerate their transition in 2021 (Coriolis Telecom, Vialis and Zeop) and that two additional operators (Canal+ and Tubéo) plan to start their transition this year, the rate of deployment still seems largely insufficient to deal with the shortage of IPv4 addresses[29].

To improve its monitoring of the transition to IPv6, Arcep expanded its information gathering to include operators who market solutions designed for business customers – aka "Pro" plans – on their fixed network. Arcep notes that the deployment of IPv6 continues to fall short, and urges operators to include IPv6 in their plans for businesses[30].

2.2. Mobile operators

The following charts provide a snapshot of the current status of IPv6 deployment, along with forecasts for the main operators' mobile network in France.

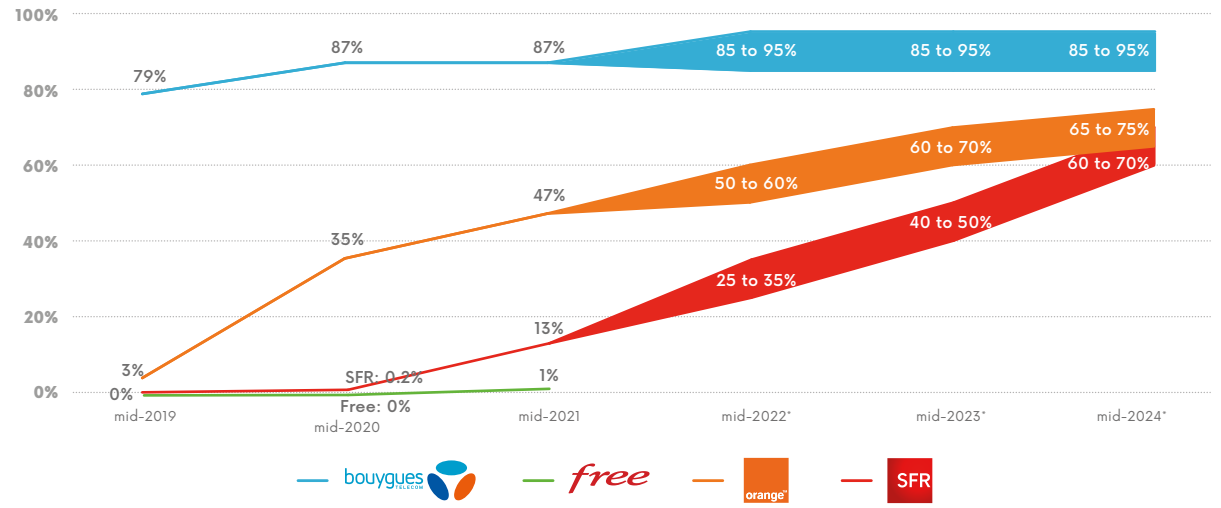
MOBILE NETWORK: PERCENTAGE OF IPv6-ENABLED CUSTOMERS



Source: data as of the end of June 2021, collected by Arcep from operators

29. 2021 Arcep IPv6 Barometer, "Operators with between 5,000 and 3 million customers on fixed networks". Click here.
30. 2021 Arcep IPv6 Barometer, "Operators providing 'Pro' plans on their fixed networks". Click here.

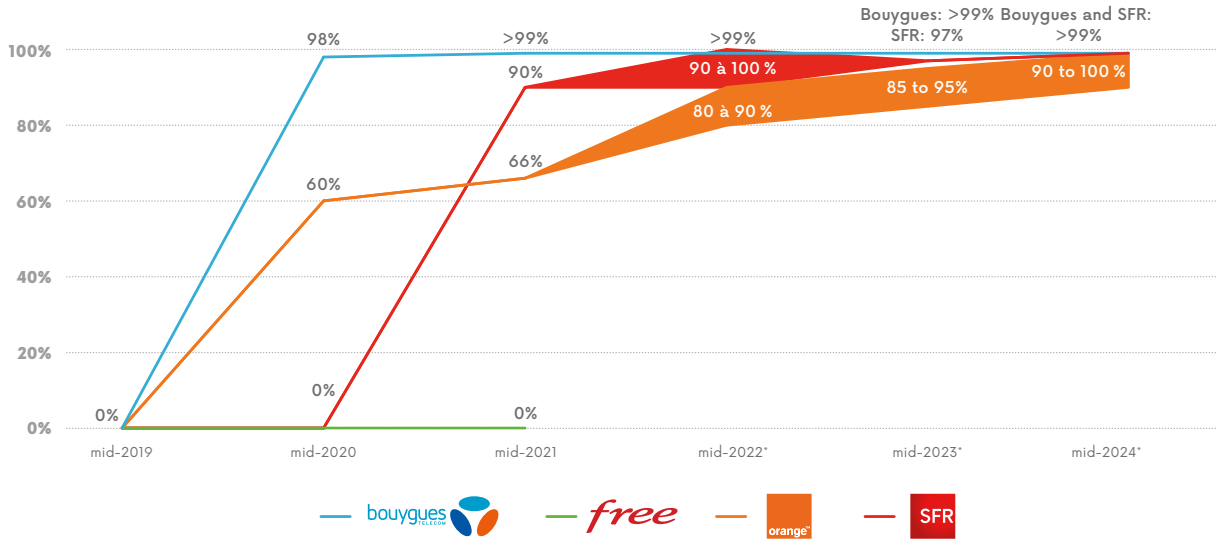
ANDROID: PROGRESSION OF IPv6-ENABLED CUSTOMERS



* Figures subject to change

Source: data collected from operators by Arcep, as of end of June 2021

iPHONE: PROGRESSION OF IPv6-ENABLED CUSTOMERS



* Figures subject to change

Source: data collected from operators by Arcep, as of end of June 2021

Arcep notes significant progress in the deployment of IPv6 on mobile networks but invites operators to continue their efforts to accelerate full support for IPv6 in their various plans:

- Bouygues Telecom has achieved a noteworthy deployment on mobile networks, with 87% of Android customers and more than 99% of iPhone customers IPv6 enabled in mid-2021.
- IPv6 on the Orange mobile network is also worth noting (47% of Android customers and 66% of iPhone customers IPv6 enabled). Orange is invited to continue its IPv6 activation of mobile devices.
- SFR has carried out a remarkable IPv6 push for its iPhone customers. The rate of iPhone IPv6-enabled customers has increased from 0% in mid-2020 to 90% by mid-2021. As the rate of Android IPv6-enabled customers as of mid-2021 (13%) and deployment forecasts for Android appear insufficient to cope with the IPv4 shortage, SFR is urged to step up the pace of providing IPv6 support for Android devices.
- It is particularly regrettable that Free Mobile does not support IPv6 by default for its mobile network plans, which has resulted in a very low percentage of IPv6-enabled customers (1% for Android and 0% for iPhone), and that the operator was unable to provide forecasts for upcoming support plans.
- Operators are all being called on to accelerate the pace of IPv6 deployment on their “data only” plans.

In order to better monitor the transition to IPv6 by the various mobile operators in France, and by the full-MVNOs[31] already included in the previous editions of this barometer, Arcep has broadened its collection of information to include light-MVNOs[32].

In Metropolitan France, thanks to the deployment of IPv6 within the main operators' networks, mobile operators with between 5,000 and 3 million customers that directly operate these operators' network access protocols (NAP) can provide their customers with IPv6 support. However, some of the operators with their own NAPs (China Telecom CTExcelbiz, Coriolis Telecom, Lebara Mobile, Lycamobile, Syma Mobile and Transatel) have not yet begun their transition and are not considering doing so.

In the French overseas departments and territories (DROM), Zeop is the only mobile operator with between 5,000 and 3 million customers that has begun to enable IPv6 on its network (30% in mid-2021) and has a target of between 35% and 45% of customers IPv6-enabled by mid-2022. The remaining operators do not plan to have deployed IPv6 by mid-2022. Further details are available in the IPv6 barometer[33].

There are sizeable disparities between perators when it comes to IPv6 deployment on their mobile network "Pro" plans. Operators are invited to begin and accelerate IPv6 deployment on all of their "Pro" plans. Further details are available in the IPv6 barometer.

IPv6-compatibility obligation for operators awarded 5G frequency licences

Arcep introduced an obligation to support IPv6 when awarding new frequencies:

- Metropolitan France: for operators that are awarded 5G frequencies in the 3.5 GHz band: "The licenceholder is required to make its mobile network compatible with the IPv6 protocol as of 31 December 2020" (excerpt from Decision No. 2019-1386).
- Réunion: for operators that are awarded frequencies in the 700 MHz and 3.5 GHz bands: "The licenceholder is required to make its mobile network compatible with the IPv6 protocol as of 31 December 2022" (excerpt from Decision No. 2021-0590).
- Mayotte: for operators that are awarded frequencies in the 700 MHz band: "The licenceholder is required to make its mobile network compatible with the IPv6 protocol as of 31 December 2022" (excerpt from Decision No. 2021-0591).

As stipulated in the reasons, the goal is to ensure services' interoperability and not hinder the use of services that are only available in IPv6, at a time when the number of user devices continues to grow and RIPE NCC has a shortage of IPv4 addresses.

This obligation is driven by the emergence of online services that are only available in IPv6 (no IPv4 connectivity). Some hosting solutions no longer offer IPv4 by default[1] and IPv6 is the only possible solution for accessing the NAS[2] of a customer connected to an ISP that uses CG-NAT. Which is why it is crucial that all customers be able to enable IPv6 on their mobile, to be able to access the entire Internet .

In its public consultation on the assignment of new frequencies (700 MHz, 900 MHz, 2.1 GHz and 3.5 GHz bands) in the French overseas territories, Arcep also proposed an IPv6-compatibility obligation:

- Guadeloupe and Martinique: for operators that are awarded frequencies in the 700 MHz and 3.5 GHz bands: "The licenceholder is required to make its mobile network compatible with the IPv6 protocol as of 31 December 2022" (excerpt from the public consultation).
- Saint-Martin: for operators that are awarded frequencies in the 700 MHz and 3.5 GHz bands: "The licenceholder is required to make its mobile network compatible with the IPv6 protocol as of 31 December 2022" (excerpt from the public consultation).
- Saint-Barthélemy: for operators that are awarded frequencies in the 700 MHz, 900 MHz, 2.1 GHz and 3.5 GHz bands: "The licenceholder is required to make its mobile network compatible with the IPv6 protocol as of 31 December 2022" (excerpt from the public consultation).
- Guiana: for operators that are awarded frequencies in the 700 MHz and 3.5 GHz bands: "The licenceholder is required to make its mobile network compatible with the IPv6 protocol as of 31 December 2023" (excerpt from the public consultation).

1. Example with the contribution from Ikoula in the 2020 report on the State of the Internet in France.
2. See lexicon.

31. See Lexicon
32. See Lexicon
33. 2021 Arcep IPv6 Barometer, "Operators with between 5,000 and 3 million customers on mobile networks". Click here.

Tutorial

How to activate IPv6 on your mobile phone ?

On its website, Arcep provides a step-by-step tutorial on how to activate IPv6 on your Android smartphone. iPhones do not currently allow users to modify the protocol themselves: your operator needs to ask Apple to perform the operation.

Reminder: the main operators' IPv6 activation policies are as follows[1]:

MOBILE NETWORK: IPv6 ACTIVATION POLICY

	bouygues	free	orange	SFR
IPv6-enabled by default on Android	YES Samsung S7 or newer Other manufacturers: new products from March 2018	NO Double activation of IPv6 by the customer required: on their Free customer area and on their Android device	YES Samsung S10 or newer Other manufacturers: new products from May 2020	YES SSamsung: S21 or newer Other manufacturers: new products from March 2021
IPv6-enabled by default on Android, with a shared connection			YES Samsung S20 or newer Other manufacturers: new products from January 2021	
IPv6-enabled by default on iPhone	YES iPhone 5S or newer, with iOS 12.2 or higher	NO Require iPhone 6S or newer, with iOS 15.4 or higher and an activation by the customer on their Free customer area	YES iPhone 7 or newer, with iOS 13.0 or higher iPhone 6S, 6S Plus and 6SE, with iOS 15.4 or higher	YES iPhone 6S or newer, with iOS 14.3 or higher
IPv6-enabled by default on iPhone, with a shared connection			YES iPhone 7 or newer, with iOS 14.0 or higher iPhone 6S, 6S Plus and 6SE, with iOS 15.4 or higher	
IPv6-enabled by default on data plans only	YES Progressive update of compatible devices	N/A	YES New products from January 2021	YES New products from March 2021

Source: data as of end of March 2022, collected by Arcep from operators.

When your mobile notifies you of an available update, do not hesitate to install it: in addition to correcting security flaws to increase your protection against being hacked, the update could enable IPv6 on your phone.

Go to the Arcep website for instructions on how to activate IPv6 on your Android smartphone, depending on your operator: https://www.arcep.fr/demarches-et-services/utilisateurs/activer-ipv6-mobile.html (in French).

1. More detailed information is available in the 2021 barometer of the transition to IPv6 in France.

2.3. Web hosting

Web hosting services continue to constitute one of the main bottlenecks in the migration to IPv6: only 29% of the most popular websites in France (compared to 26% in October 2020), according to Alexa rankings, are IPv6-enabled[34]. A site is considered IPv6-enabled if its domain name is mapped as being IPv6 (AAAA) in the DNS server record.

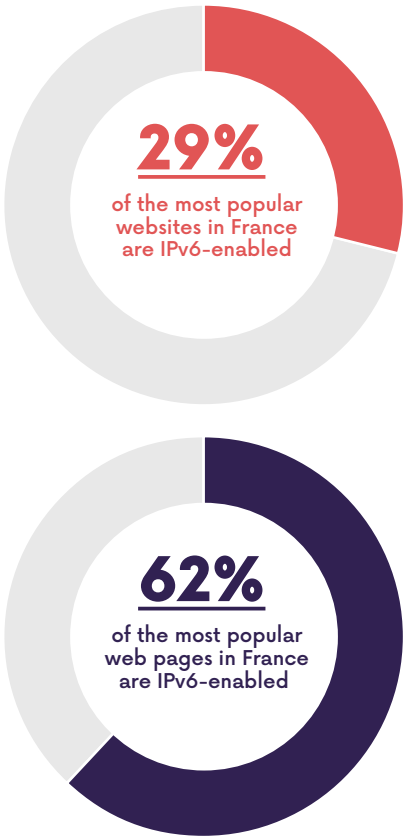
Note that the percentage of web pages that are IPv6-enabled (IPv6 content) is significantly higher than that (62%)[35]. The reason is that many of the smaller content providers operate websites (generally small number of pages viewed) that are not IPv6-compatible.

The percentage of IPv6-enabled sites stands at a mere 20% when looking at the 3.52 million .fr, .re, .pm, .yt, .tf, and .wf[36] websites. This percentage has been increasing since 2015, but the pace of this increase appears far from fast enough to enable a complete transition in the next few years.

Even if the vast majority of websites accessible in IPv6 are also accessible in IPv4 (the servers are configured in dual-stack with IPv4 + IPv6), a sharp increase in the number of websites accessible in IPv6-only can be noted. Some hosts do indeed offer IPv6-only solutions, charging extra for IPv4 compatibility. The sites hosted on these single stack IPv6-only servers are therefore not accessible to clients of IPv4-only operators. This situation testifies to the need to switch to IPv6 to avoid the development of an Internet split in two, with IPv4 on one side and IPv6 on the other.

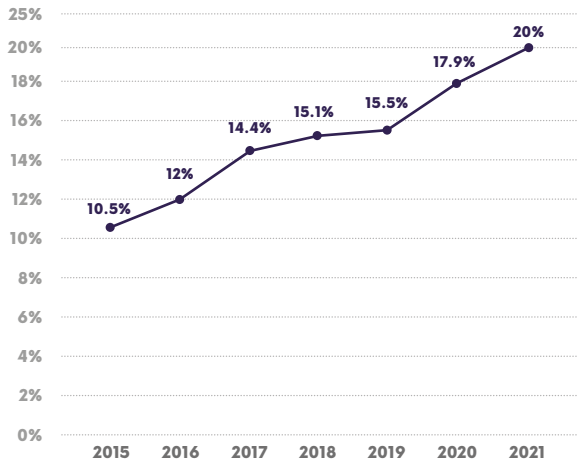
In September 2021, there were 1,028 domain names in .fr, .re, .pm, .yt, .tf and .wf accessible only in IPv6[37]. This number has doubled compared to 2020 (514 domain names), but remains very limited.

Even if several hosting services include IPv6 support in their solutions, the percentage of websites accessible in IPv6 is very low for all of the Top 10 web hosting services (in number of domain names) as it is not enabled by default. Among that Top 10, only IONOS 1&1 and Cloudflare[38] have more than three quarters of their sites IPv6 enabled, which make them standard bearers for the transition.



Source: 6lab Cisco as of 11/02/2021 (6lab.cisco.com). Data of the top 730 websites in France as ranked by Alexa (www.alexa.com/topsites/countries)

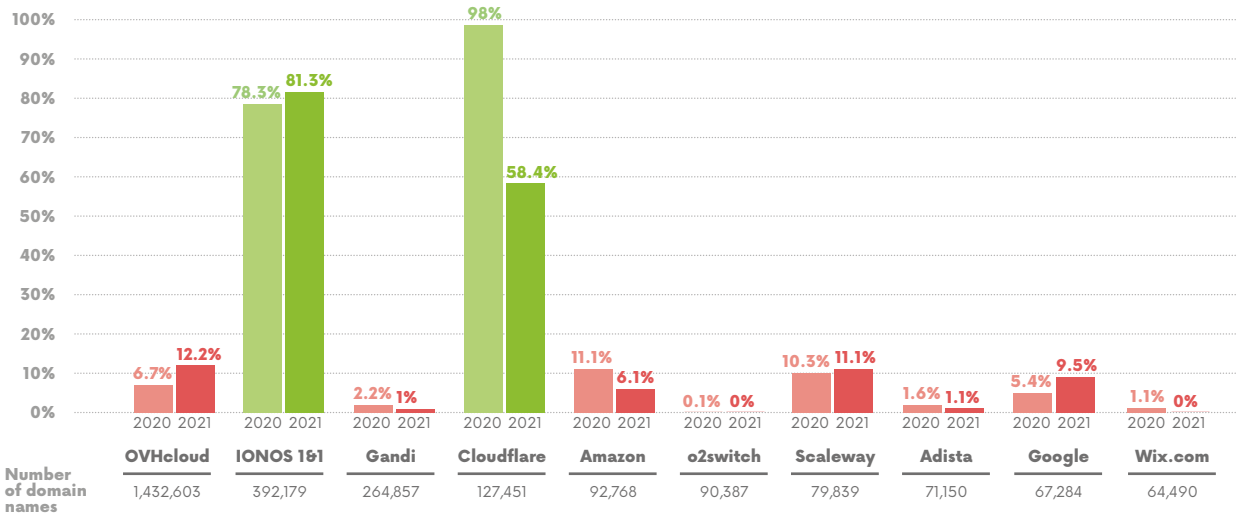
PROGRESSION OF IPv6-ENABLED WEBSITES on .fr, .re, .pm, .yt, .tf and .wf domain names



Source: Afnic data august 2021

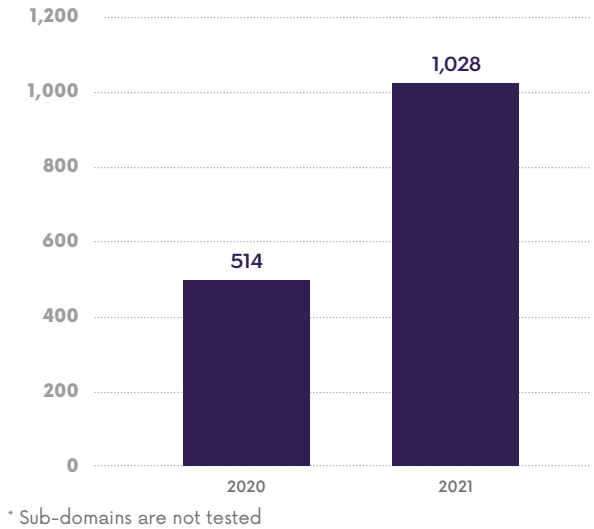
34. 6lab Cisco as of 31/10/2021. Data on the top 731 websites in France, Alexa rankings
35. Ibidem
36. Afnic data, August 2021. Data based on DNS zone information and analysis of A, AAAA, MX, and NS records configured on a domain name. The analyses of the DNS zones were carried out with the Zonemaster tool using an Afnic server. For each IP address retrieved, the MaxMind database was used to find the AS announcing this IP address.
37. This analysis is limited to the root domain: a subdomain accessible in IPv6-only will not be counted if the root domain is available in IPv4.
38. The percentage of IPv6-enabled websites at Cloudflare has fallen sharply (98% in mid-2020 compared to 58% in mid-2021). This can be explained by the partnership between Cloudflare and Shopify which resulted in Cloudflare supporting Shopify IP addresses which are IPv4 only.

PERCENTAGE OF IPv6-ENABLED WEBSITES on .fr, .re, .pm, .yt, .tf and .wf domain names



Source: Afnic data, August 2021

NUMBER OF IPv6-ONLY WEBSITES on .fr, .re, .pm, .yt, .tf and .wf domain names*



* Sub-domains are not tested

Source: Afnic data,September 2021

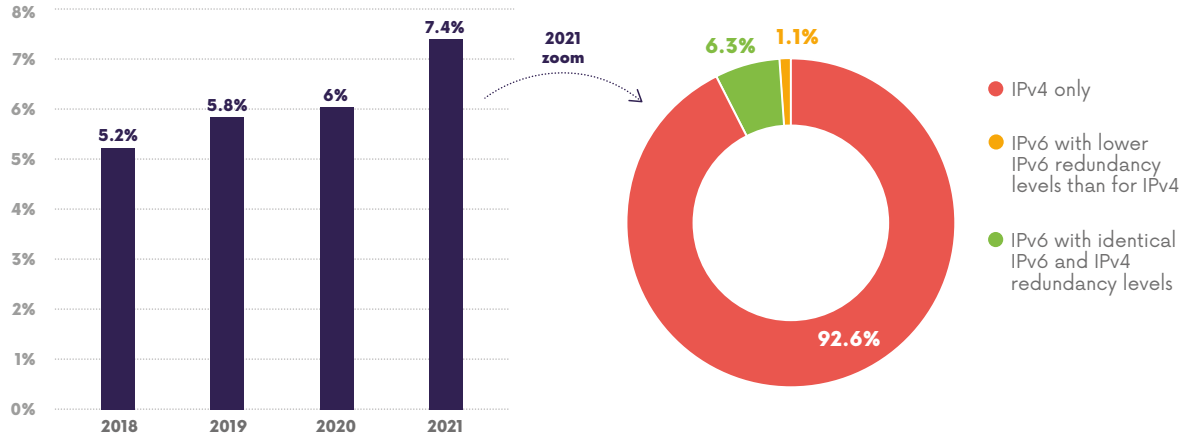
2.4. Mail hosting

The transition of the main mail hosting services is also proving very slow: only 7.4% of mail servers on .fr, .re, .pm, .yt, .tf and .wf domain names are currently IPv6-enabled (compared to 6% at mid-2020). It should also be noted that on a number of them, there is an IPv6 redundancy level that is below the one provided for IPv4, which is likely to create resilience issues[39].

Once again this year, the lack of IPv6-readiness amongst mail hosting services is alarming. If it is not remedied in the next few years, the protracted lag on this link in the Internet value chain could force IPv4 to be kept for longer than planned, with all the resulting costs. Only Google stands out here, with more than 95% of domain names for mail using IPv6.

39. Afnic data, August 2021.

PERCENTAGE OF IPv6-ENABLED MAIL HOSTING on .fr, .re, .pm, .yt, .tf and .wf domain names

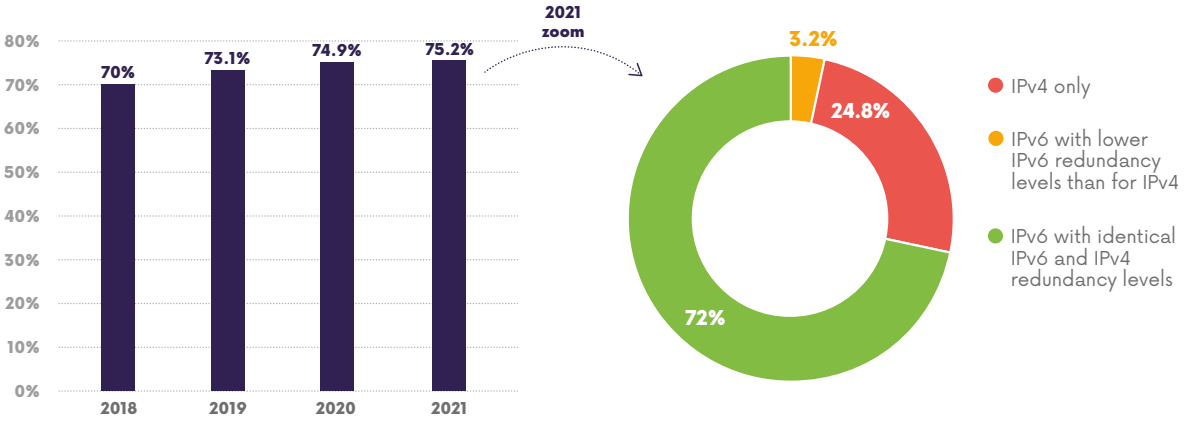


Source: Afnic data, August 2021

2.5. DNS Infrastructure

DNS infrastructure makes it possible to translate a domain name, e.g. www.arcep.fr, into an IP address. This is currently the sector that is the most advanced in the transition to IPv6, with around 73% of authoritative name servers supporting IPv6. Around 72%[40] of DNS servers guarantee an IPv6 resilience equivalent to IPv4 (identical redundancy levels).

PERCENTAGE OF IPv6-ENABLED DNS SERVERS on .fr, .re, .pm, .yt, .tf and .wf domain names



Source: Afnic data, August 2021

2.6. Government websites and online services (.gouv.fr)

Since having the government lead by example is one of the most important paths to an accelerated transition, the barometer has been enhanced with indicators on the progression of this transition to IPv6 by French government websites and online services. The current study pertains to the 243[41] sites with the .gouv.fr suffix and available in HTTPS[42].

DNS servers' transition to IPv6 is relatively well advanced and has progressed since last year, with 55% of them being IPv6-enabled, linked in particular to the IPv6 switchover of DNS hosting managed by Orange and Cegedim.cloud. Mail hosting, on the other hand, is still entirely in IPv4 and the percentage of government websites using IPv6 stands at only 2.9% for the main websites[43] and 0.9% for secondary ones[44].

40. Afnic data, August 2021.
41. There was an error in the 2020 edition of IPv6 barometer: only 145 sites (domain names starting with the letter «a» to the letter «l») had been taken into account.
42. Of the 1,009 existing domain names ending with .gouv.fr in August 2020, only the 243 whose HTTPS response has a valid TLS certificate were taken into account, and so excluding from the analysis domain names that are not being maintained or that are not attached to a website.
43. Main site: the site suggested/linked to by default by a search engine.
44. Secondary site: site that redirects to the main site (if the main site has the "www" prefix, the secondary site does not, and vice-versa).

Even if some sites are available in IPv6, it is regrettable that the vast majority are still using only IPv4 and that the progress has been very limited compared to last year, particularly given the goal of leading the transition to IPv6 by example. More attention could be paid to IPv6 compatibility when upgrading existing websites and when drafting specs for calls to tender to create new online services.

For more information on the status of IPv6 deployment, the barometer of the transition to IPv6 is available on the Arcep website.

The next barometer will be published in the second half of 2022.

3. IPv6 task force galvanising the Internet ecosystem

3.1. The IPv6 task force is open to the entire ecosystem

Arcep and Internet Society France have set up a task force dedicated to IPv6 that is open to all Internet ecosystem stakeholders (operators, hosting services, businesses, government agencies, etc.). Its purpose is to accelerate the transition to IPv6 by enabling participants to discuss specific issues and share best practices.

The most pressing issue the task force identified was encouraging businesses to make the transition to IPv6. To this end, it published a handbook that explains to businesses why it is important for them to adopt IPv6.

3.2. Handbooks for businesses: "Enterprises: why switch to IPv6?" and "Enterprises: how to switch to IPv6"

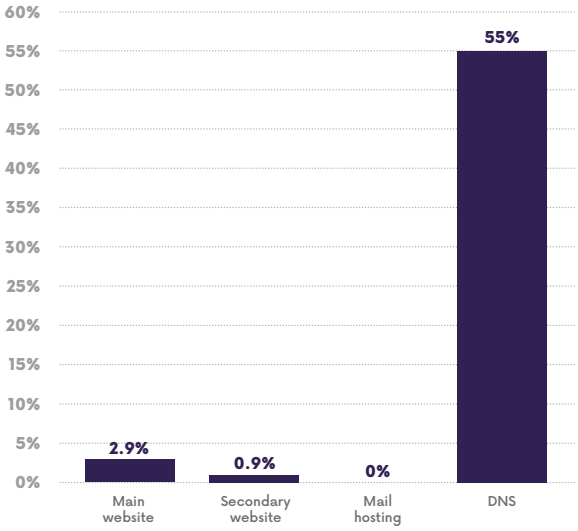
In December 2020, the IPv6 task force published a first handbook[45] which purpose is to increase businesses' awareness of how vital it is to switch to IPv6, and answers the most frequently asked questions:

- What are the drawbacks if I keep my local network in IPv4 or if the company website remains in IPv4?
- How long will it take to switch my company over to IPv6?
- What parts of the company infrastructure do I need to switch over to IPv6?
- Do the internal computers and servers need to be deployed in dual stack or in IPv6-only?

The handbook also includes four testimonials from companies that have already completed or are in the process of making the transition to IPv6:

- French power company, EDF, is an example of IPv6 migration undertaken for the information system of a corporation with 18 million IP addresses, and which has exhausted its pool of private IPv4 addresses. Rather than continue to "tinker" with ways to recover IPv4 addresses, EDF decide to switch some parts of its network to IPv6-only;
- Schneider Electric, a major manufacturer that is considering switching its internal network to IPv6 as some of its branch offices need to access IPv6-only Internet resources, and security issues have been reported on the LAN connections of Internet routers that are IPv6-enabled;
- Digdeo, a freeware services company that has committed to no longer relying on IPv4 NAT networks. The transition to IPv6 allowed it to resolve NAT issues for staff that needs to access backend resources;
- Olympique Lyonnais, an SME that was able to incorporate the migration to IPv6 into the larger project of building the new Olympic stadium in Lyon, which allows more than 60,000 people to communicate simultaneously during a match.

RATE OF IPv6 ADOPTION ON GOVERNMENT WEBSITES AND ONLINE SERVICES (.gouv.fr and available in HTTPS)



Source: tests performed by Arcep in November 2021, based on Afnic data.

In November 2021, the task force published a second handbook "Enterprises; how to deploy IPv6?" aimed chiefly at companies' IT experts and CTOs, to help them make the transition to IPv6. Its purpose is to assist them in defining their IPv6 needs, planning the protocol's implementation, and deploying it in-house.

3.3. Join the IPv6 task force

The task force will continue to work on helping businesses achieve this transition, and is producing a handbook on "How to deploy IPv6" which will be available soon.

People who want to contribute to this work, share feedback or set up IPv6 in their company are invited to communicate their interest in joining the task force to Arcep, by scanning the QR code.

45. N.B. This publication in no way constitutes a formal position from Arcep on the relevance, feasibility or priority of workstreams. It simply describes the information imparted by the different members of the IPv6 task force. The priority actions to be implemented will be decided in concert with the community of participants.

Open floor to

JEAN-CHARLES BISECCO
Network architect

THE 12 LABOURS OF IPV6

"It's 2022. And this offputtingly long-string address protocol finally reached more than 50% of access lines in the country this past winter. Little by little, it is invading every stratum of the country, both fixed and mobile. Every one? No! A group of Legacy IP diehards is holding out, and still resisting the switch to hexadecimal. And life isn't easy for the legions of IPv4 packets skirmishing through the hands of subscriber IP-sharing advocates that are 4rd, MAP-T/E and other IPv4aaS technologies."

This could be a fitting introduction to a future issue of a famous comic book explaining why IPv4 is no longer a native feature for most operators, but still being offered as an encapsulated service on a native IPv6 network. A comic book that could be titled: The 12 Labours of Aypeeveesix.

Instead of a comic book, Arcep's IPv6 task force opted for a handbook to help businesses migrate the different parts of their information systems to the new protocol, after having established their strategy.

And this because, unlike with top Internet companies, IPv6 is still very little deployed in the fringes of most businesses' information systems, i.e., their websites, messaging systems for more private services such as access to the corporate VPN or proxy, allowing staff to surf the web.

But behind this handful of examples of services, there are entire swaths of the system involved. For instance, filtering, configuration management tools, log collection, all building blocks where the deployment sequence needs to be established meticulously.

It would be hard to find a topic that is any more vast, as the verticality of a company IS and the uniqueness of the applications it contains mean that an effective transition will take time. One thing is certain: we cannot go backwards.

IPv4 is such a scarce resource that some are already billing extra for it, such as hosting service providers. A practice that will probably spread.

Changes in IPv4 traffic are becoming legion and will steadily make the protocol less effective than IPv6 on the Internet for every connection initiated by individuals, customers and remote workers alike. Changes driven by the scarcity of the resource and the need to share public IP addresses, which are bundled together under the monikers Address + Port (A+P) approach or IPv4aaS.

Let us pause on this last one, which shows that the IP transport industry no longer views IPv4 as a compulsory foundation, and that it has become a mere service marketed on top of the new Internet protocol. A service that is bound to become obsolete.

Others may also seize the opportunity beyond the Internet issue, namely large structures that have come to the end of private IPv4 RFC 1918 addressing internally, and now overlapping addresses.

Here too, the handbook provides answers and helps you map out your direction.

It also contains security recommendations, practices for streamlining address management, and many other things besides.

The handbook is designed to evolve over time, so do not hesitate to ask questions, suggest changes or additions, and especially to join Arcep's IPv6 Task Force so that we can work together on tackling the challenges of this Great Crossing over to a new paradigm.

Find here the handbook "Enterprises: how to switch to IPv63"

LEXICON

Afnic (Association française pour le nommage Internet en coopération):
France's domain name registry. A nonprofit organisation (under France's law of 1901) whose mandate is to manage toplevel domain names in France (.fr), Reunion (.re), France's southern and Antarctic territories (.tf), Mayotte (.yt), Saint-Pierre-etMiquelon (.pm) and Wallis-et-Futuna (.wf).

ADEME:
Agence de l'environnement et de la maîtrise de l'énergie.

Android:
mobile operating system developed by Google.

API:
Application Programming Interface that enables two systems to interoperate and talk to one another without having been initially designed for that purpose. More specifically, a standardised set of classes, methods or functions through which a software programme provides services to other software.

APN (Access Point Name):
identifier that enables a mobile phone user to connect to the Internet.

Arcom:
French regulatory authority for audiovisual and digital communication.

BEREC (Body of European Regulators for Electronic Communications):
independent European body created by the Council of the European Union and the European Parliament, and which assembles the electronic communications regulators from the 27 European Union Member States.

Cable networks:
electronic communications networks made up of an optical fiber network core and coaxial cable in the last mile. Originally designed to broadcast television services, these networks have also made it possible to deliver telephone and Internet access services for several years, by using the bandwidth not employed by TV broadcasting.

Cache server:
dedicated network server that saves Internet content locally, and so making that content available to users more quickly.

CAP:
content (web pages, blogs, videos) and/or application (search engine, VoIP applications) providers.

CDN (Content Delivery Network):
Internet Content Delivery Network.

CGN (Carrier-grade NAT):
largescale Network Address Translation (NAT) mechanism, used in particular by ISPs to diminish the quantity of IPv4 addresses used.

Codec:
a device or computer program that encodes or decodes a digital data stream.

Cross-traffic:
the traffic generated during a QoS and/or QoE test by an application other than the one being used to perform the test, either on the same device or on another device connected to the same box. Cross-traffic decreases the bandwidth available for the test.

Crowdsourcing:
crowdsourcing tools refer to instruments that centralise the QoS and/or QoE tests performed by volunteer users (aka "the crowd").

DNS (Domain Name System):
mechanism for translating Internet domain names into IP addresses.

Dual-stack:
assigning both an IPv4 address and an IPv6 address to a device on the network.

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ePrivacy:
European Parliament and Council Directive 2002/58/EC of 12 July, concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications). A draft revised ePrivacy Directive intended to replace the current one is currently being debated, and pertains in particular to the use of cookies and associated practices, as well as obtaining Internet users' consent.

Ethernet (cable):
common name for an RJ45 connector that supports the Ethernet packet communication protocol.

Firewall:
a hardware or software security mechanism used to filter and/or block traffic streams based on predetermined security rules.

FttH (Fiber to the Home) network:
very high-speed electronic communications network, where fiber is pulled right into the customer's premises.

Full-MVNO:
MVNO which manages its addressing plan and which takes control of the core network and service platforms, while leasing radio capacity from host operators.
Hardware probe: tool for measuring QoS and/or QoE which typically takes the form of a box connected to an ISP's box with an Ethernet cable. A hardware probe usually tests the Internet line automatically, in a passive fashion.

GDPR (General Data Protection Regulation):
Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data throughout the European Union.

HTTP (Hypertext Transfer Protocol):
client-server communication protocol developed for the World Wide Web.

HTTPS:
HTTP Secured thanks to the use of SSL (secure socket layer) or TLS (transport layer security) protocols.

Interleave:
a method that consists in cutting data packets into smaller bits and then, rearranging them so that data that were previously contiguous are now more widely spaced to form a non-continuous stream. In this mode, when a disturbance occurs, it usually affects a single bit per byte, even if it occurs in a large number of bytes.

iOS:
mobile operating system developed by Apple for its mobile devices.

IP (Internet Protocol):
communication protocol that enables a single addressing service for any device used on the Internet. IPv4 (IP version 4) is the protocol that has been used since 1983. IPv6 (IP version 6) is its successor.

IPv6-enabled:
device or connection that actually transmits and receives traffic using IPv6 routing, either thanks to activation by the customer or activation performed by the operator.

IPv6-ready:
device or connection that is compatible with IPv6, but on which IPv6 is not necessarily activated by default.

IS (Information system):
organised set of resources for collecting, storing, processing and disseminating information.

ISP:
Internet Service Provider.

IXP (Internet Exchange Point), ou GIX (Global Internet Exchange):
physical infrastructure enabling the ISPs and CAPs connected to it to exchange Internet traffic between their networks thanks to public peering agreements.

LAN (Local Area Network):
For residential users, this is the network made up of the ISP's box (router) and any peripheral devices connected to it, either via Ethernet or Wi-Fi.

Latency:
the time it takes for a data packet to travel over the network from source to destination. Latency is expressed in milliseconds.

Light-MVNO:
MVNO which entrusts their host operator with the operational management of the network.

Linux:
broadly speaking, refers to any operating system with a Linux kernel. The Linux kernel is used on hardware ranging from mobile phones (e.g. Android) to supercomputers, by way of ordinary PCs (e.g. Ubuntu).

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macOS:
operating system developed by Apple for its computers.

Multi-connection speed test:
test for measuring Internet connection speed by adding together the speeds of multiple simultaneous connections, making it possible to estimate the link's capacity.

MVNO (Mobile Virtual Network Operators):
operators that do not have their own wireless network, and who therefore rely on the services of one or more mobile network operators (of which there are currently four in France: Bouygues Telecom, Free Mobile, Orange and SFR) by purchasing wholesale communications from them, to be able to then market mobile communication services to their own subscribers.

NAS (Network Attached Storage):
autonomous file storage server that is attached to a network.

NAT:
Network Address Translation mechanism for remapping one IP address space to another, used in particular to limit the number of public IPv4 addresses being used.

NRA (National Regulatory Authority):
an organism or organisms that a BEREC Member State mandates to regulate electronic communications.

On-net CDN:
CDN located directly in an ISP's network.

OS (Operating System):
software that runs a peripheral device, such as Windows, Mac OS, Linux, Android or iOS.

OTT (Over-The-Top):
used to refer to electronic communications services that CAPs provide over the Internet.

Peering:
the process of exchanging Internet traffic between two peers. A peering link can be either free or paid (for the peer that sends more traffic than the other peer). Peering can be public, when performed at an IXP (Internet Exchange Point), or private when over a PNI (Private Network Interconnect), in other words a direct interconnection between two operators.

Port:
every Internet connection emanating from an application is associated with UDP or TCP session, which is identified by a port number using a 16-bit coding scheme.

Preliminary questions:
a legal term that refers to a procedural rule that arises when it appears to a court that a particular question of law must first be resolved by the usual court of competent jurisdiction before the seised court can rule. This procedure is provided for in European Union Law, whereby Courts in Member States refer questions of interpretation of a treaty, or an act of secondary legislation to the Court of Justice of the European Union (CJEU), before ruling on a case in which said act is invoked.

QoE (Quality of Experience):
in Chapter 1, quality of the user's Internet experience, for a given application. It is measured by performance indicators such as web page load time or video streaming quality.

QoS (Quality of Service):
in Chapter 1, quality of service on the Internet as measured by "technical" indicators such as download or upload speed, latency and jitter. The term QoS is often used to refer to both technical quality and quality of experience (QoE).

RFC (Request For Comments):
official memorandum that describes the technical aspects and specifications that apply to the working of the Internet or to different computer hardware.

SDN (Software-Defined Network):
a network architecture model that is based on centralised control of network resources, centralised orchestration and virtualisation of physical resources.

Specialised service:
electronic communication service(s) that are distinct from Internet access services, and which require specific quality of service levels.

Single connection speed test:
test for measuring the speed via a single connection, which makes it possible to have a representative flow of an Internet use.

Speed:
Also referred to as throughput. Quantity of digital data transmitted within a set period of time. Connection speeds or bitrates, are often expressed in bits per second (bit/s) and its multiples: Mbit/s, Gbit/s, Tbit/s, etc. It is useful to draw a distinction between the speed at which data can be:
- received by a piece of terminal equipment connected to the Internet, such as when watching a video online or loading a web page. This is referred to as download or downlink speed;
- sent from a computer, phone or any other piece of terminal equipment connected to the Internet, such as when sending photos to an online printing site. This is referred to as upload or uplink speed.

TCP (Transmission Control Protocol):
reliable, connected mode, transport protocol developed in 1973. Most Internet traffic uses TCP as an upper layer transport protocol, on top of IPv4 or IPv6.

Test server (for QoS measurement):
A server that does not store data, but is able to deliver data at very high speeds and allows the connection's speed to be measured.

Tier 1:
a network capable of interconnecting directly with any Internet network (i.e. via peering) without having to go through a transit provider. There were 18 Tier 1 operators in 2019: AT&T, CenturyLink/ Level 3, Cogent Communications, Deutsche Telekom AG, Global Telecom & Technology, Hurricane Electric, KPN International, Liberty Global, NTT Communications, Orange, PCCW Global, Sprint, Tata Communications, Telecom Italia Sparkle, Telxius/Telefónica, Telia Carrier, Verizon Enterprise Solutions and Zayo Group.

TLS (Transport Layer Security):
used for encrypting Internet exchanges and server authentication.

Transit provider:
company that provides transit services.

Transit:
bandwidth that one operator sells to a client operator, that makes it possible to access the entire Internet through a contractual and paid service.

UDP (User Datagram Protocol):
simple, connectionless (i.e. no prior communication required) transmission protocol, which makes it possible to transmit small quantities of data rapidly. The UDP protocol is used on top of IPv4 or IPv6.

VoD (Video on Demand):
an interactive technique for distributing digital video content over wireline (Internet) or nonwireline networks. SVoD = subscription VoD services.

VoIP (Voice over IP): technology to transport voice on IP compatible networks through the Internet.

VoTLE (voice over LTE): main voice transport technique used on 4G LTE mobile telephone networks.

WAN (Wide Area Network):
in this report, WAN refers to the Internet network, as opposed to a LAN (local area network).

Web tester:
tool for measuring QoS and QoE which is accessed through a website.

Wehe:
Android and iOS application, developed by Northeastern University in partnership with Arcep, to detect traffic management practices that are in violation of net neutrality rules.

Wi-Fi:
wireless communication protocol governed by IEEE 802.11 group standards.

Windows:
proprietary operating system developed by Microsoft, which powers the majority of computers in France.

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xDSL (Digital Subscriber Line):
electronic communications technologies used on copper networks that enable ISPs to provide broadband or superfast broadband Internet access. ADSL2+ and VDSL2 are the most commonly used xDSL standards in France for providing consumer access.

Zero-rating:
a pricing practice that allows subscribers to use one or more particular online applications without the traffic being counted against their data allowance.

4G:
the fourth generation of mobile telephony standards. It is defined by 3GPP Release 8 standards.

5G:
the fifth generation of mobile telephony standards. It is defined by 3GPP Release 15 standards.

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MANIFESTO

NETWORKS AS A COMMON GOOD ARCEP

Internet, fixed and mobile telecom, postal and print media distribution 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, postal and print media distribution 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.