arcep
autorité de régulation
des communications électroniques,
des postes et de la distribution de la presse

FRENCH REPUBLIC

ANNUAL BAROMETER OF THE TRANSITION TO IPv6 IN FRANCE

15 NOVEMBER 2019

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1. Accelerating the transition to IPv6: a major issue for competitiveness and innovation[1]

IPv4, which stands for Internet Protocol version 4, has been used since 1983 to allow the Internet to function: each device or machine that is connected to the Internet (computer, phone, server, etc.) has an IPv4 address. The protocol is technically limited to 4.3 billion addresses. However, the Internet's success, coupled with the diversity of uses and the growing number of connected objects has resulted in a **steady decrease in the number of available IPv4 addresses,** with some parts of the world being more heavily affected than others. By the end of June 2019, the top four operators in France (Bouygues Telecom, Free, Orange and SFR) had already **assigned between roughly 94% and 99% of** their IPv4 addresses, as of end of June 2019[2].

IPv6 specifications were finalised in 1998. They incorporate functions for increasing security by default and optimising routing. Above all, IPv6 delivers almost an infinite number of IP addresses: **667 million IPv6 for each square millimetre of the earth's surface**.

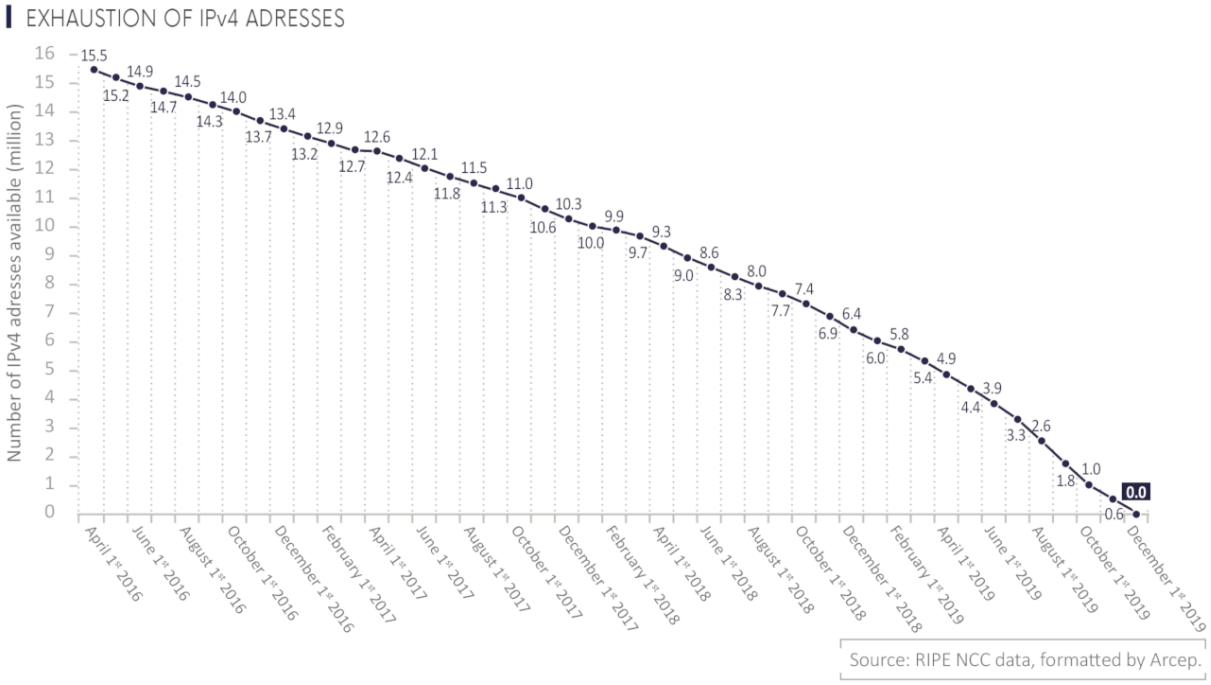
But the complexity of today's Internet makes it impossible to achieve the transition from IPv4 to IPv6 in one fell swoop, overnight (i.e. flag-day). It must therefore take place gradually, starting with a period of cohabitation with IPv4. Once every player has migrated to the new protocol, IPv6 will fully replace IPv4 (switch-off phase).

The transition to the IPv6 protocol began in 2003. Despite which, in 2019, **the Internet is still only at the beginning of the cohabitation stage. IPv4 and IPv6 protocols will coexist as long as IPv6 is not widespread in all parts of the Internet value chain.**
Europe is currently experiencing a **shortage of IPv4 addresses**. The regional registry for IP addresses, which is tasked with allocating IPv4 addresses in Europe and the Middle East, RIPE-NCC announced that the number of IPv4 addresses awaiting allocation exceeds the number of remaining IPv4 addresses. **By the end of 2019, the supply of available IPv4 addresses will almost certainly have run out**[3].

[1] ARCEP specifies that the observations and work mentioned in this document concern only the Internet and do not apply to the private interconnection between two actors, in particular the interconnection of the networks of two operators for the termination for voice calls in IP mode.
[2] Data collected from ISPs by Arcep, in accordance with Decision No. 2019-0287.
[3] There is a waiting list for IPv4 addresses that come back to the RIPE-NCC, but few of them do.

The sluggish pace of this transition could, on the one hand, prevent **certain types of Internet service** (controlling smart home systems, online gaming, etc.) **from functioning properly** because of the systems used for sharing IPv4 addresses between several customers to deal with the dearth of IPv4 addresses. On the other hand, it is likely to **create a barrier to entry for newcomers to the market.** IPv4 will continue to be necessary as long as the entire technical chain has not fully switched over to IPv6. Otherwise, a site that is not able to have an IPv4 address could not be accessed by users who subscribe to an ISP that does not provide IPv6 addresses. This situation is already driving a significant increase in the price of IPv4 addresses, which have become the scarce resources of the 21st century Internet. **This high price creates a sizeable barrier to entry for new entrants, and increases the risk of seeing the Internet split in two, with IPv4 on the one side and IPv6 on the other.**

Because of this expected shortage and the risks it entails, **making the transition to this new Internet protocol has become a key to ensuring competitiveness and innovation.**



2. DIFFERENT PLAYERS AT DIFFERENT STAGES IN THE TRANSITION

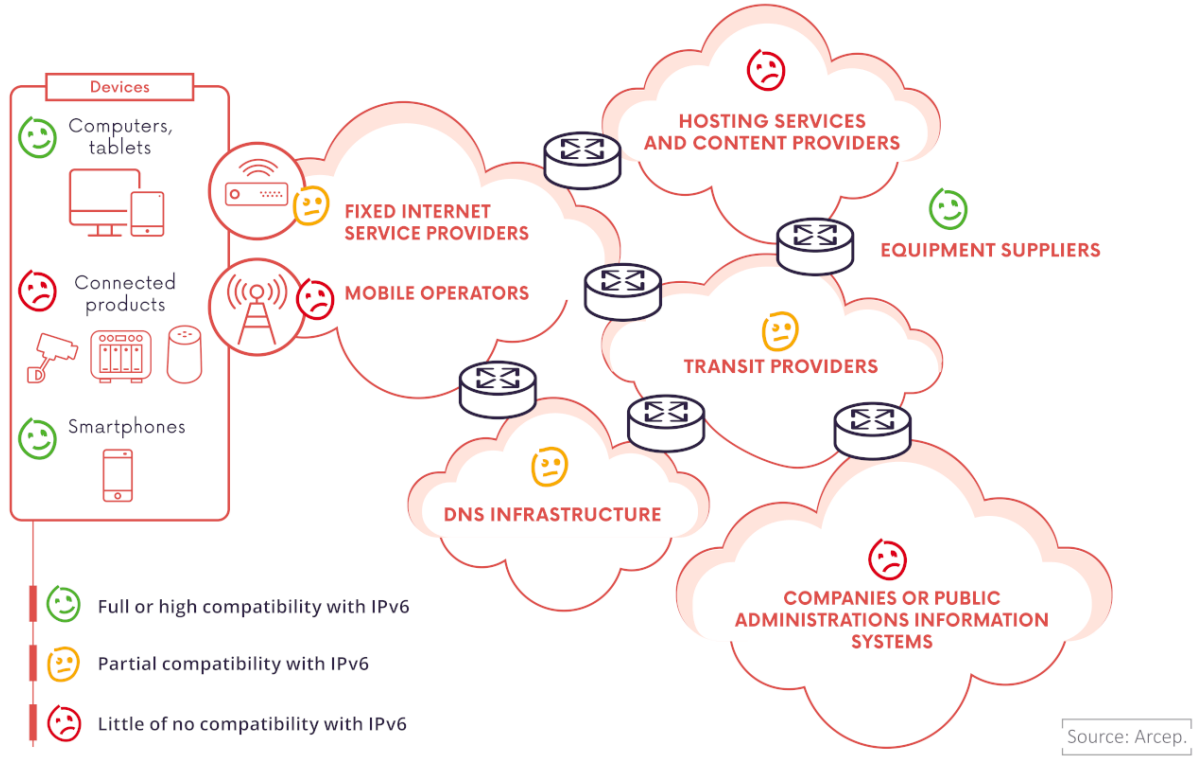
To ensure IPv6 protocol functions from end to end, migration needs to cover all of the links along the Internet value chain simultaneously.

Arcep has employed several indicators in order to evaluate the status of IPv6 deployment in France for the various stakeholders involved in the transition. These indicators are calculated using data collected by Arcep in accordance with Decision No 2019-0287, as well as third-party data[4], for the Internet ecosystem's different stakeholders:

- fixed Internet Service Providers (ISPs);
- mobile operators;
- hosting services and content providers;
- DNS infrastructure;
- equipment suppliers;
- transit providers;
- devices.

These additional indicators make it possible to have an overview of the status of IPv6 deployment, which today, is as follows:

STATUS OF THE TRANSITION TO IPv6 FOR THE DIFFERENT ECOSYSTEM ACTORS



Source: Arcep.

[4] Cf. exact source in the sections devoted to each type of player.

3. Fixed Internet service providers (retail services)

Four conditions need to be met for a fixed line to be able to transmit and receive traffic in IPv6:

- the **fixed network** used must be IPv6-compatible;
- the hardware of the **box** being used must be IPv6-compatible, and its firmware must be capable of managing the protocol. If most of operators' boxes in 2019 are IPv6-compatible, some have not yet upgraded their firmware to be able to handle IPv6.

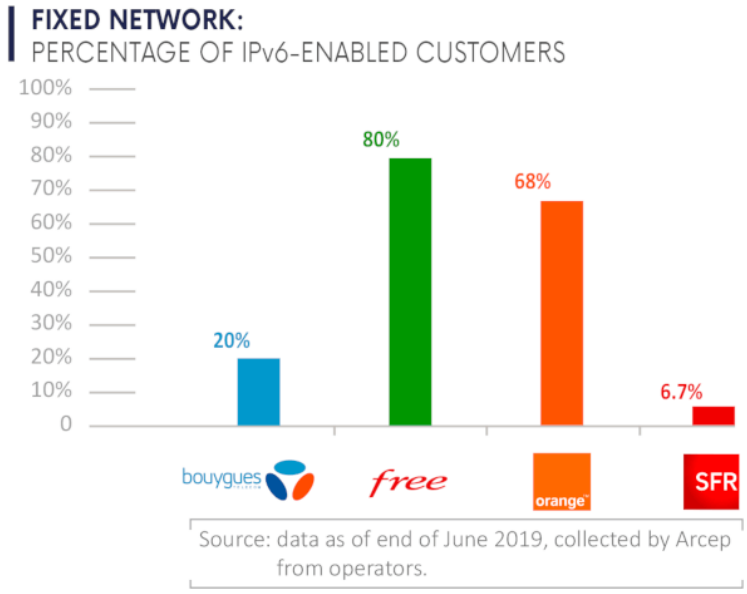
When both the network and the box are IPv6-compatible, a customer is said to be IPv6-ready (cf. table below).

- The operator needs to **remotely configure the customer's box** for it to be IPv6-enabled (cf. table below). If the customer is IPv6-ready but the operator has not enabled IPv6, the customer can configure his/her own box manually for it to be IPv6-enabled. Nevertheless, because the vast majority of users don't take the initiative to do so, it is the action taken by ISPs that will drive the transition.
- The **device's operating system** must be IPv6-compatible and enabled (cf. section on Devices below).

Thus:

- **a customer is said to be "IPv6-ready"** if they are able to activate IPv6 themselves on their own box (both the network and the box are IPv6-compatible);
- **a customer is said to be "IPv6-enabled" if their box** actually sends and receives IPv6 traffic, either through manual activation performed by the customer themselves, or through activation performed by the operator.

3.1. Operators with over 3 million customers on fixed networks



FIXED NETWORK:
PERCENTAGE OF IPv6-READY AND IPv6-ENABLED CUSTOMERS

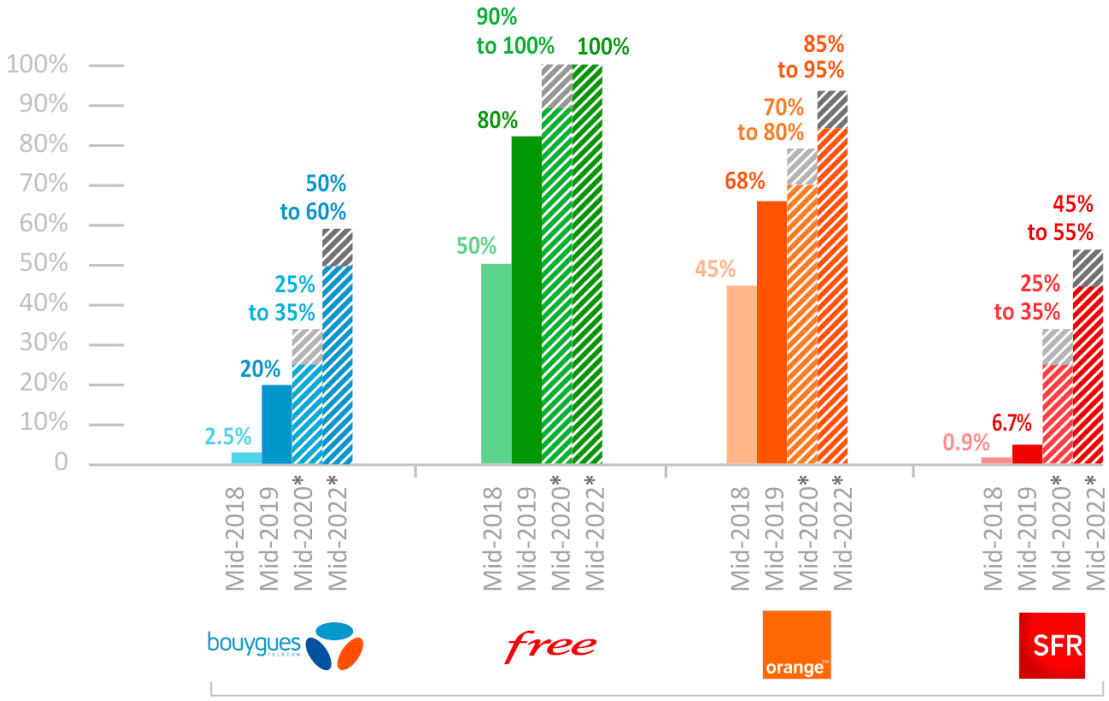
		bouygues		free		orange		SFR	
		IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled
xDSL	Own network	35%	35%	100%	75%	60%	59%	100%	1.5%
	Backhaul network	0%	0%	0%	0%	n/a		100%	1.5%
	Whole network	25%	25%	99%	75%	60%	59%	100%	1.5%
Cable	Own network	n/a		n/a		n/a		0%	0%
	Backhaul network	0%	0%	n/a		n/a		n/a	
	Whole network	0%	0%	n/a		n/a		0%	0%
FttH	Own network	2%	2%	100%	100%	100%	97%	60%	38%
	Backhaul network	n/a		n/a		n/a		60%	38%
	Whole network	2%	2%	100%	100%	100%	97%	60%	38%
4G fixed wireless	Own network	0%	0%	n/a		0%	0%	0%	0%
Total	Own network	24%	24%	100%	80%	70%	68%	64%	6.7%
	Backhaul network	0%	0%	0%	0%	n/a		64%	6.7%
	Whole network	20%	**20%**	99%	**80%**	70%	**68%**	64%	**6.7%**

Source: data as of end of June 2019, collected by Arcep from operators.

The disparities between the percentage of customers who are IPv6-ready and the percentage of customers who are actually IPv6-enabled (transmitting and receiving IPv6 traffic) can be explained by the main operators' different IPv6 activation policies.

The four main operators have also provided forecasts for the percentage of customers that will be IPv6-ready and IPv6-enabled one year and three years from now (cf. annex for more details).

FIXED NETWORK:
PERCENTAGE OF IPv6-ENABLED CUSTOMERS EVOLUTION



* Figures subject to change.

Source: data as of end of June 2019, collected by Arcep from operators.

They have also detailed their IPv4 sharing practices and IPv6 activation (cf. annex).

Unlike Bouygues Telecom, Orange and SFR customers, some Free fixed network customers have a shared IPv4 address. However, Free offers a dedicated and free IPv4 address upon request.

In addition, Bouygues Telecom, Free and SFR enable IPv6 by default, if the customer is IPv6-ready. SFR customers should activate IPv6 themselves by configuring their box. SFR is, however, gradually beginning to activate its FttH customers by default.

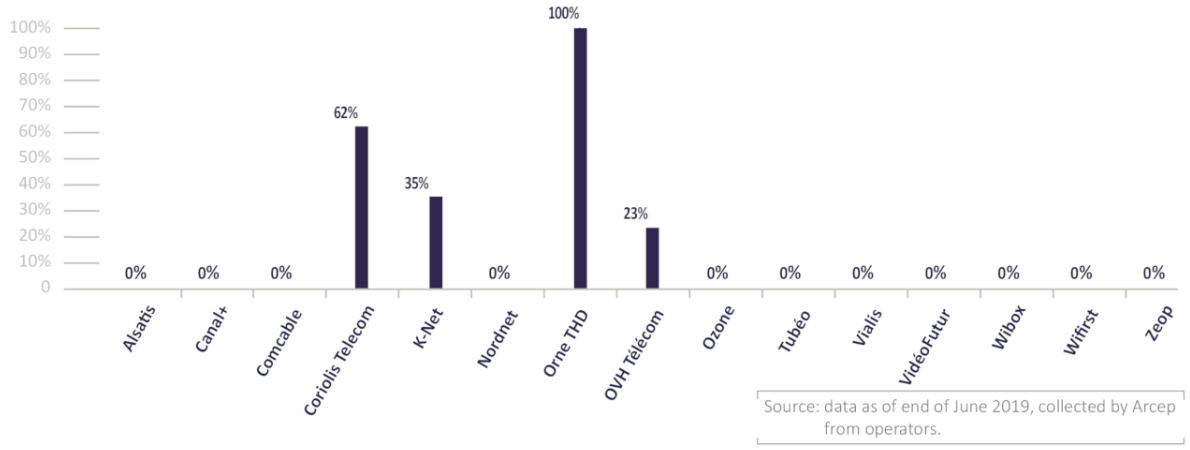
On fixed networks, Arcep has observed progress amongst the main telecom operators in France, but is calling on them to step up their efforts:

- 100% of SFR customers are already IPv6-compatible on xDSL, 60% on FttH and 0% on cable. There has been notable progress on making FttH customers IPv6-ready, even if their numbers remain small (fewer than 7%, all technologies combined). Upcoming activations also remain inadequate: between 25% and 35% by mid-2020 and between 45% and 55% by mid-2022. Because the vast majority of users will not take the initiative to enable IPv6 manually, Arcep is urging SFR to perform this configuration by default, as most other operators are doing.
- Bouygues Telecom has also made deployment efforts on its fixed networks (around 20% of customers were IPv6-ready as of mid-2019 compared to 2.5% in mid-2018) although IPv6 compatibility is still very low. Forecasts also remain far from sufficient (between 50% and 60% by mid-2022) to handle the shortage. Bouygues Telecom is being urged to increase the number of IPv6-ready customers, and to step up deployment efforts on its fixed network.
- The percentage of Free and Orange customers who are IPv6-ready is relatively high (around 80% and 68%, respectively) in addition to having increased. Projections for mid-2022 are encouraging (100% for Free and between 85% and 95% for Orange) but the shortage of IPv4 addresses requires an even greater acceleration in their transition.
- Arcep welcomes Free's installation of new firmware on the vast majority of its boxes in May 2019, and the removal of the ability to deactivate IPv6, which significantly increases the use of IPv6 in France.
- All four operators are invited to make their products for businesses IPv6-compatible, and to begin the transition on fixed 4G as soon as possible.

3.2. Operators with between 5,000 and 3 million customers on fixed networks

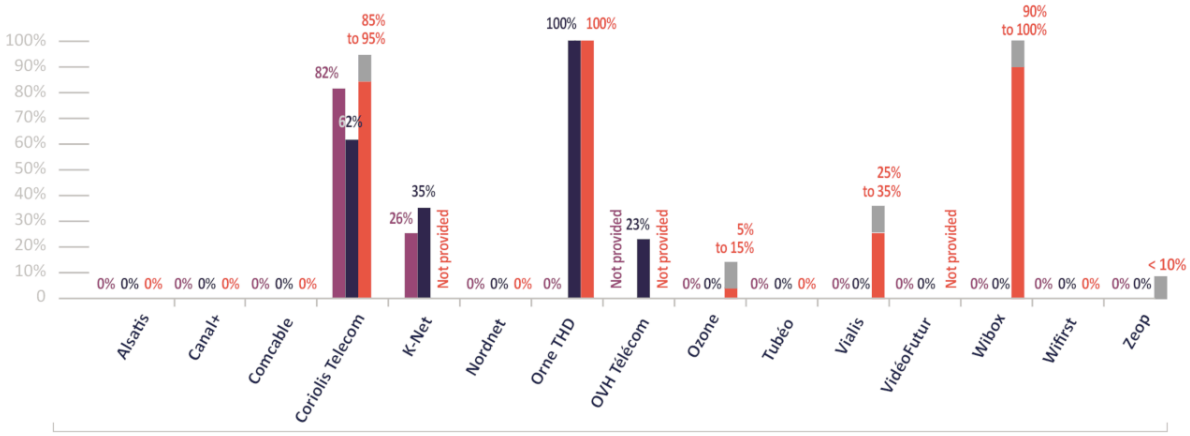
To improve monitoring of the transition to IPv6, Arcep has expanded data collection to include operators with between 5,000 and 3 million customers on the fixed network.

FIXED NETWORK:
PERCENTAGE OF IPv6-ENABLED CUSTOMERS



Source: data as of end of June 2019, collected by Arcep from operators.

FIXED NETWORK:
PERCENTAGE OF IPv6-ENABLED CUSTOMERS EVOLUTION



Source: data as of end of June 2019, collected by Arcep from operators.

The number of operators that have begun their transition is still small, even if Arcep welcomes the initiative of several operators, such as Coriolis, K-Net and OVH Telecom which continue the transition to IPv6 they started several years ago, as well as that of Orne THD which has already migrated all of its customers to the new protocol. Even though four other operators plan to begin their transition by 2020, the pace of deployment seems insufficient to handle the shortage of IPv4 addresses

Operators also detailed their IPv4 sharing practices and IPv6 activation (cf. annex).

Canal+, Comcable, Coriolis Telecom, K-Net, Nordnet, Orne THD, OVH Télécom, Ozone, Wibox and Zeop all provide each customer with a dedicated IPv4 address, while Alsatis, Tubéo, Vialis, VidéoFutur and Wifirst use IPv4 address sharing for some or all of their customers.

Coriolis Telecom, Orne THD and Wibox folllow adhere to the best practice of enabling IPv6 by default, without the possibility of disabling the protocol.

Even though Europe is currently experiencing a shortage of IPv4 addresses, some operators still have no plans to deploy IPv6 on their fixed networks which, as indicated above, would seem problematic.

4. Mobile operators (retails services)

Four conditions need to be met for a mobile line to be able to transmit and receive traffic in IPv6:

- The **mobile network** used must be IPv6-compatible, in other words the Access Point Name (APN) must be capable of managing the IPv6 protocol (cf. table below). When the APN is IPv6-compatible, the customer is said to be "IPv6-ready". It should be noted that some operators have an APN for tethering which is different from the APN used for the terminal's internet access. In which case, it is possible that only one of the two APN is IPv6-ready;
- The **device's operating system** must be IPv6-compatible (cf. section on Devices below). If this is already the case for almost all recent smartphones (Android 5 and more recent, iOS 12 and more recent), a substantial number of 4G routers being sold in 2019 are still not IPv6-compatible. Among those routers that are IPv6-compatible, the lack of support for some IPv6 standards could cause some applications to malfunction with an "IPv6-only" APN[5];
- The operator must **remotely enable the mobile device** before it can use IPv6. With Android, the APN can be configured manually to be made IPv6-compatible. However, because the vast majority of users will not take the initiative of activating IPv6 themselves, it is actions taken by ISPs that will drive the transition. This could require an upgrade by the mobile device's manufacturer. iPhone users cannot enable IPv6 manually.

Thus:

- **a customer is said to be "IPv6-ready"** if they are able to activate IPv6 themselves[6] on their own device (the network is IPv6-compatible) ;
- **a customer is said to be "IPv6-enabled" if their device** actually sends and receives IPv6 traffic, either through manual activation performed by the customer themselves, or through activation performed by the operator.

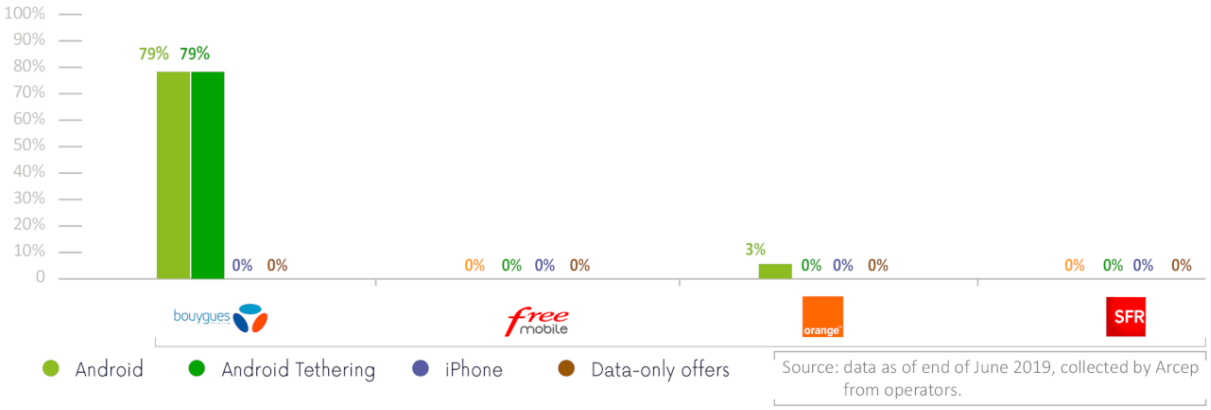
[5] Three types of connection are possible on a mobile device:

- IPv4-only: The device is connected to the network only by an IPv4 address. Such is the case with IPv4-only plans;
- IPv4/IPv6: The device is both IPv4 and IPv6-enabled. This is the most common by type of connection on fixed networks with IPv6;
- IPv6-only: The device is connected to the network only by an IPv6 address. This is the most common type of connection for smartphones. Mechanisms such as NAT64, DNS64 and 464XLAT are put into place to ensure that the handset can the IPv4-only, internet using an IPv6 device.

[6] If you are a Bouygues Telecom or Orange customer, simply activate IPv6 on your Android 5+ smartphone: Go to "Settings" => "Connections" => "Mobile networks" => "Access Point Name", change the default APN by switching the "APN Protocol" from IPv4 to IPv6. iPhone owners are currently not able to alter the APN protocol manually.

4.1. Operators with over 3 million customers on mobile networks

MOBILE NETWORK:
PERCENTAGE OF IPv6-ENABLED CUSTOMERS



Source: data as of end of June 2019, collected by Arcep from operators.

MOBILE NETWORK:
PERCENTAGE OF IPv6-READY AND IPv6-ENABLED CUSTOMERS EVOLUTION

		bouygues		free mobile		orange		SFR	
		IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled
Android	Mid-2019	100%	79%	0%	0%	100%	3%	0%	0%
	Mid-2020*	100%	80-90%	Not provided		100%	15-25%	0%	0%
	Mid-2022*	100%	85-95%	Not provided		100%	45-55%	100%	25-35%
Android Tethering (Mobile access point)	Mid-2019	100%	79%	0%	0%	0%	0%	0%	0%
	Mid-2020*	100%	80-90%	Not provided		100%	0-10%	0%	0%
	Mid-2022*	100%	85-95%	Not provided		100%	15-25%	100%	25-35%
iPhone (iOS 12+)	Mid-2019	100%	0%	0%	0%	100%	0%	0%	0%
	Mid-2020*	100%	80-90%	Not provided		100%	45-55%	0%	0%
	Mid-2022*	100%	85-95%	Not provided		100%	55-65%	100%	25-35%
Data-only offers (4G dongles, tablets, computers, etc.)	Mid-2019	0%	0%	0%	0%	0%	0%	0%	0%
	Mid-2020*	0%	0%	Not provided		100%	0-10%	0%	0%
	Mid-2022*	100%	15-25%	Not provided		100%	15-25%	100%	25-35%

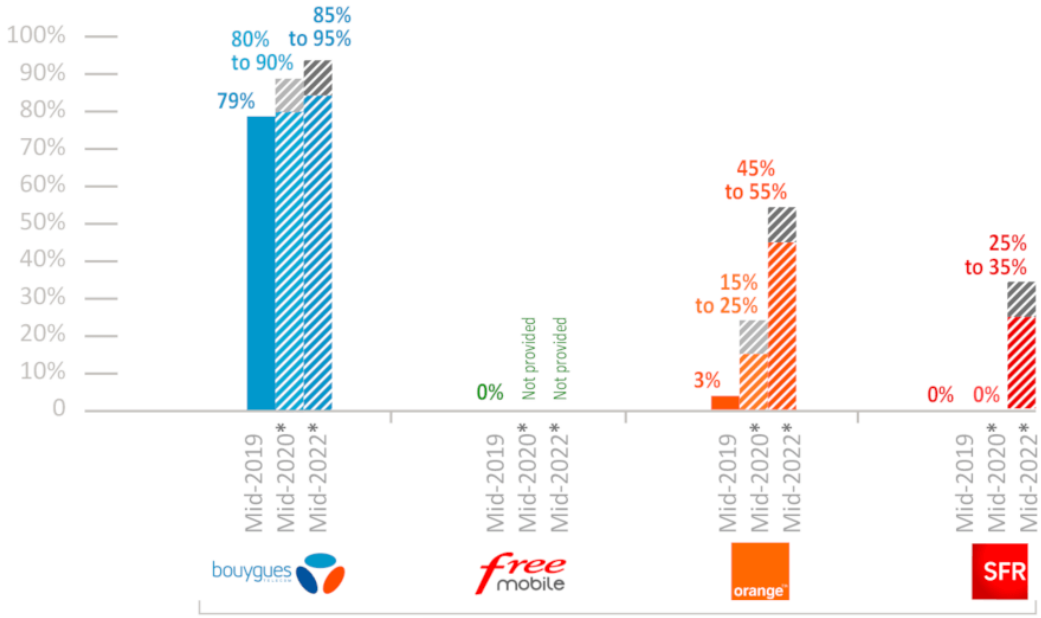
* Figures subject to change.

Source: data as of end of June 2019, collected by Arcep from operators.

The disparity between the percentage of customers who are IPv6-ready and the percentage of customers who are actually IPv6-enabled (transmitting and receiving IPv6 traffic) can be explained by the main operators' different IPv6 activation policies.

Regarding the different operators' plans for upgrading their mobile network to IPv6 one year and three years from now[7]:

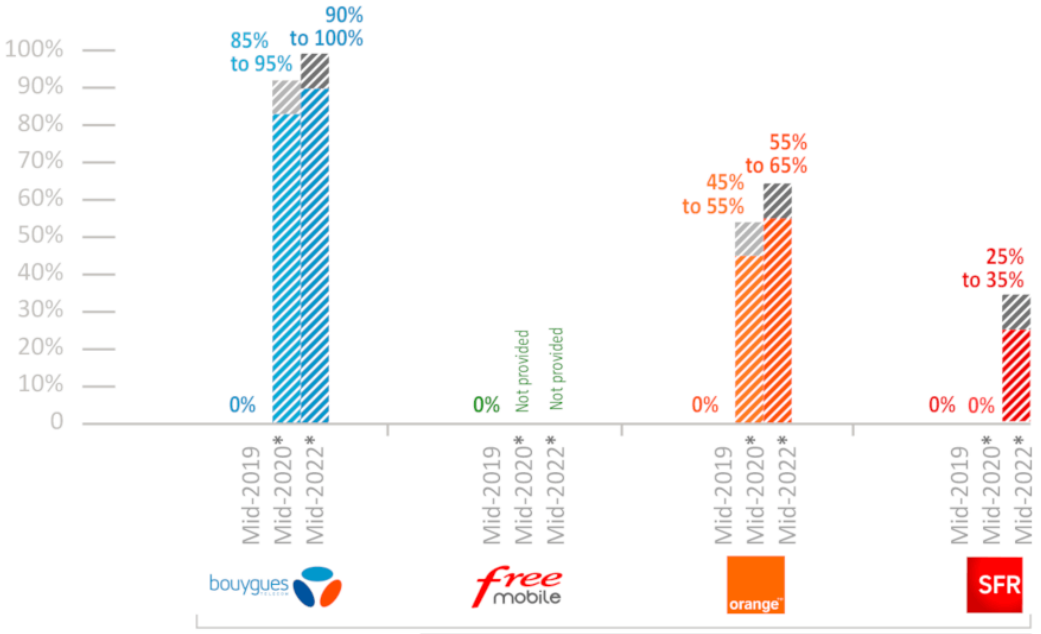
ANDROID:
PERCENTAGE OF IPv6-ENABLED CUSTOMERS EVOLUTION



* Figures subject to change.

Source: data as of end of June 2019, collected by Arcep from operators.

iPHONE:
PERCENTAGE OF IPv6-ENABLED CUSTOMERS EVOLUTION



* Figures subject to change.

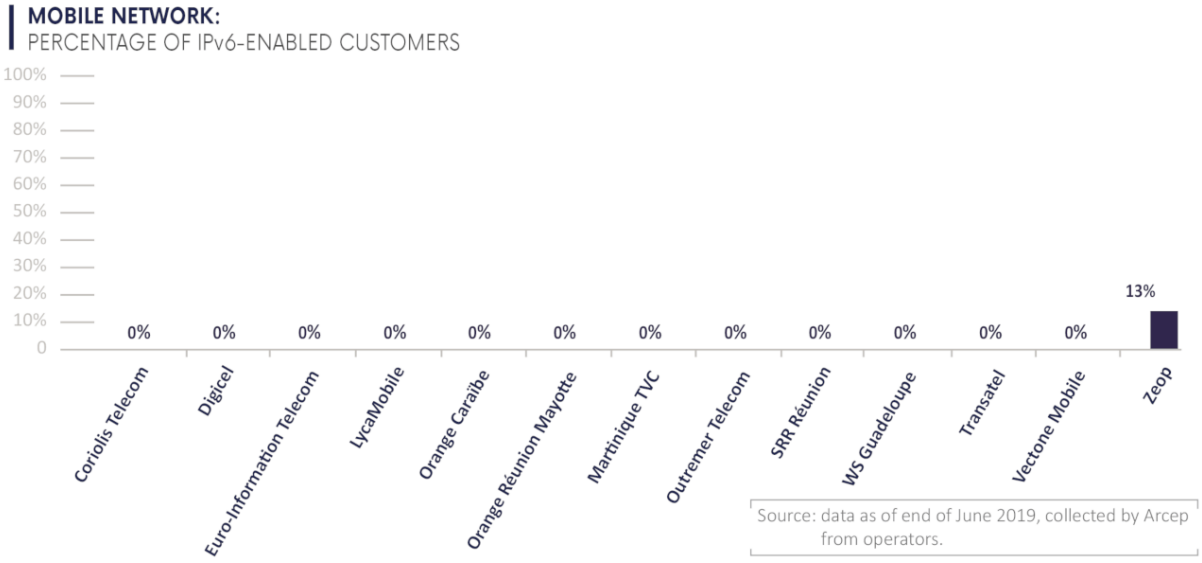
Source: data as of end of June 2019, collected by Arcep from operators.

[7] Data collected in 2018 were aggregated and can therefore not be compared by 2019 data by individual device category.

On mobile networks, Arcep is sending operators a warning about the sluggishness of their IPv6 deployments, and urges them to take the necessary steps to respond to the dearth of IPv4 resources:

- Bouygues Telecom continues its mobile network deployments, with 79% of Android customers now IPv6-ready.
- Orange forecasts for Android customers are worth noting (between 15% and 25% by mid-2020 and between 45% and 55% by mid-2022) even if the operator is being urged to increase the number of IPv6-compatible devices.
- Bouygues Telecom and Orange made a remarkable push on iPhones in September 2019: 68% and 30% IPv6-ready, at the end of October 2019.
- Despite SFR's forecasts for 2022, Arcep believes the pace of deployment and the targets are insufficient.
- It is particularly regrettable that that Free Mobile was unable to supply its forecasts.
- Operators are being called on to begin IPv6 deployment on all of their products, notably "data only" plans and those aimed at businesses.

4.2. Operators with between 5,000 and 3 million customers on mobile networks[8]



Zeop is the only mobile operator with between 5,000 and 3 million customers which has begun to enable IPv6 on its network. Other operators do not plan to have deployed IPv6 by mid-2020.

Even more than on fixed networks, the pace of mobile networks' future IPv6 deployments is very likely to slow down the transition to IPv6.

[8] As with the fixed access market, Arcep expanded the scope of its data collection to include operators with between 5,000 and 3 million residential mobile customers.

4.3. IPv6-enabled smartphones as of the end of September 2019

Operators are changing the APN configuration, to make their "IPv6-ready" customers "IPv6-enabled" ones, which typically takes the form of an update by the mobile device's manufacturer.

The devices that are IPv6-enabled, in their latest software update, are the following:

MOBILE NETWORK:
LIST OF IPv6-ENABLED SMARTPHONES AS OF END OF SEPTEMBER 2019

	Manufacturer	Model
Bouygues Telecom	Alcatel	Alcatel 1 ; Alcatel 1X ; Alcatel 3L
	Apple	iPhone 5s ; iPhone 6 ; iPhone 6 Plus ; iPhone 6s ; iPhone 6s Plus ; iPhone SE ; iPhone 7 ; iPhone 7 Plus ; iPhone 8 ; iPhone 8 Plus ; iPhone X ; iPhone XR ; iPhone XS ; iPhone XS Max ; iPhone 11 ; iPhone 11 Pro ; iPhone 11 Pro Max
	Asus	ZenFone 4 ; Zenfone 4 Max ; ZenFone 5 ; ZenFone Max M1
	BlackBerry	KEY2 LE
	Crosscall	Action-X3 ; Core X3 ; Trekker M1 Core ; Trekker X3 ; Trekker X4
	Fairphone B.V	Fairphone 3
	Google	Pixel 3 ; Pixel 3 XL
	Honor	Honor 7X ; Honor 8 Pro ; Honor 10 ; Honor 10 Lite ; Honor 20 ; Honor 5C ; Honor 7A ; Honor 8 ; Honor 8A ; Honor 8X ; Honor 9 ; Honor 9 Lite ; Honor view 20
	Huawei	Mate 10 Lite ; Mate 10 Pro ; Mate 20 ; Mate 20 lite ; Mate 20 Pro ; P smart ; P smart 2019 ; P smart Plus 2019 ; P10 plus ; P20 ; P20 lite ; P20 Lite 2019 ; P20 pro ; P30 ; P30 Lite ; P30 Pro ; P8 Lite 2017 ; P9 Lite ; Y5 2018 ; Y5 2019 ; Y6 2018 ; Y6 2019 ; Y7 2018 ; Y7 2019
	LG	LG G6
	Motorola	moto c plus ; moto e4 plus ; moto g6 ; moto g7 power ; moto z ; moto z2 play ; moto z3 play
	Nokia	Nokia 3 ; Nokia 3.1 ; Nokia 4.2 ; Nokia 6 ; Nokia 6.1 ; Nokia 7 Plus ; Nokia 7.1 ; Nokia 8 ; Nokia 9 Pureview
	OnePlus	OnePlus 7 ; OnePlus 7 Pro ; OnePlus 7T ; OnePlus 7T Pro
	Oppo Mobile	Oppo A5 2020 ; Oppo A9 2020 ; Oppo Reno ; Oppo Reno 10x Zoom ; Oppo Reno Z ; Oppo RX17 Neo ; Oppo Reno 2 ; Oppo Reno 2Z
	Samsung	Galaxy A3 2016 ; Galaxy A3 2017 ; Galaxy A5 2016 ; Galaxy A5 2017 ; Galaxy A6 ; Galaxy A7 2018 ; Galaxy A8 ; Galaxy A10 ; Galaxy A20e ; Galaxy A40 ; Galaxy A50 ; Galaxy A70 ; Galaxy A80 ; Galaxy Fold ; Galaxy J1 ; Galaxy J3 ; Galaxy J3 2016 ; Galaxy J4 Plus ; Galaxy J5 2017 ; Galaxy J6 ; Galaxy J6 Plus ; Galaxy J7 ; Galaxy J7 2017 ; Galaxy Note 8 ; Galaxy Note 9 ; Galaxy Note 10 ; Galaxy Note 10+ ; Galaxy S5 ; Galaxy S5 4G+ ; Galaxy S5 Mini ; Galaxy S6 ; Galaxy S6 EDGE ; Galaxy S6 EDGE Plus ; Galaxy S7 ; Galaxy S7 Edge ; Galaxy S8 ; Galaxy S8 plus ; Galaxy S9 ; Galaxy S9+ ; Galaxy S10 ; Galaxy S10+ ; Galaxy S10e ; Galaxy Tab A 10,1 2019 4G ; Galaxy XCover 4 ; Galaxy XCover 4s
	Sony	Xperia 1 ; Xperia 10 ; Xperia 10 Plus ; Xperia 5 ; Xperia L1 ; Xperia L3 ; Xperia X ; Xperia X Compact ; Xperia X Performance ; Xperia XA1 ; Xperia XA1 Ultra ; Xperia XA2 ; Xperia XA2 Plus ; Xperia XA2 Ultra ; Xperia XZ ; Xperia XZ2 ; Xperia XZ2 Compact ; Xperia XZ3 ; Xperia XZ3 DS
	Wiko	Sunny 3 ; Tommy 3 ; View 3 ; WIM Lite ; Y50 ; Y60
	Xiaomi	MI 9 ; Mi 9 Lite ; Mi 9 SE ; Mi 9T Pro ; Redmi 6 ; Redmi 7 ; Redmi Go ; Redmi Note 5 ; Redmi Note 7
Free	No terminal is IPv6-enabled	
Orange	Apple	iPhone 7 ; iPhone 7 Plus ; iPhone 8 ; iPhone 8 Plus ; iPhone X ; iPhone XR ; iPhone XS ; iPhone XS Max ; iPhone 11 ; iPhone 11 Pro ; iPhone 11 Pro Max
	Samsung	Galaxy A5 2017 ; Galaxy A6 ; Galaxy A7 2018 ; Galaxy A8 ; Galaxy A10 ; Galaxy A20e ; Galaxy A40 ; Galaxy A50 ; Galaxy A70 ; Galaxy J6 ; Galaxy Note 9 ; Galaxy Note 10+ ; Galaxy S8 ; Galaxy S8 plus ; Galaxy S10 ; Galaxy S10+ ; Galaxy S10e
SFR	No terminal is IPv6-enabled	
Coriolis Telecom	No terminal is IPv6-enabled	
Digicel	No terminal is IPv6-enabled	
Euro-Information Telecom	No terminal is IPv6-enabled	
LycaMobile	No terminal is IPv6-enabled	
Orange Caraïbe	No terminal is IPv6-enabled	
Orange Réunion Mayotte	No terminal is IPv6-enabled	
Martinique TVC	No terminal is IPv6-enabled	
Outremer Telecom	No terminal is IPv6-enabled	
SRR Réunion	No terminal is IPv6-enabled	
WS Guadeloupe	No terminal is IPv6-enabled	
Transatel	No terminal is IPv6-enabled	
Vectone Mobile	No terminal is IPv6-enabled	
Zeop	Apple	iPhone 5s ; iPhone 6 ; iPhone 6 Plus ; iPhone 6s ; iPhone 6s Plus ; iPhone SE ; iPhone 7 ; iPhone 7 Plus ; iPhone 8 ; iPhone 8 Plus ; iPhone X ; iPhone XR ; iPhone XS ; iPhone XS Max ; iPhone 11 ; iPhone 11 Pro ; iPhone 11 Pro Max

Source: data as of end of September 2019, collected by Arcep from operators.

4.4. Introducing an obligation of IPv6 compatibility in mobile networks

In July 2019, Arcep launched a public consultation on its draft procedure for awarding licences to use frequencies in the 3.4 – 3.8 GHz band, in Metropolitan France, which will be used for 5G.

In the draft decision published for consultation, Arcep proposed an obligation of IPv6 support for operators applying for frequencies: "The license-holder must make its mobile network compatible with the IPv6 protocol by 31 December 2020". As detailed in the statement, the goal is to ensure the interoperability of services and not to slow down the use of services available only in IPv6, at a time when the number of devices in use continues to grow and given the shortage of IPv4 addresses available from RIPE NCC.

5. Hosting services and content providers

Five conditions need to be met for a hosting service to be able to transmit and receive in IPv6:

- The **hosting service network** must be IPv6-compatible;
- The **server's operating system** must be IPv6-compatible and its IPv6 stack enabled. It is the case for all currently used servers' operating systems;
- The hosting service must **preconfigure the server**, to use IPv6 addressing.

Once these three conditions have been met, the hosting service can then enable IPv6 at the server level (cf. see diagram in Part 1).

- The content provider must use **server applications** (web, mail, etc.) that can manage the IPv6 protocol. It is almost already the case by default;
- The content provider must **configure the DNS** by adding an IPv6 record, so that the domain name points towards an IPv6 address.

Once all of these conditions are met, the hosted service can be IPv6-enabled.

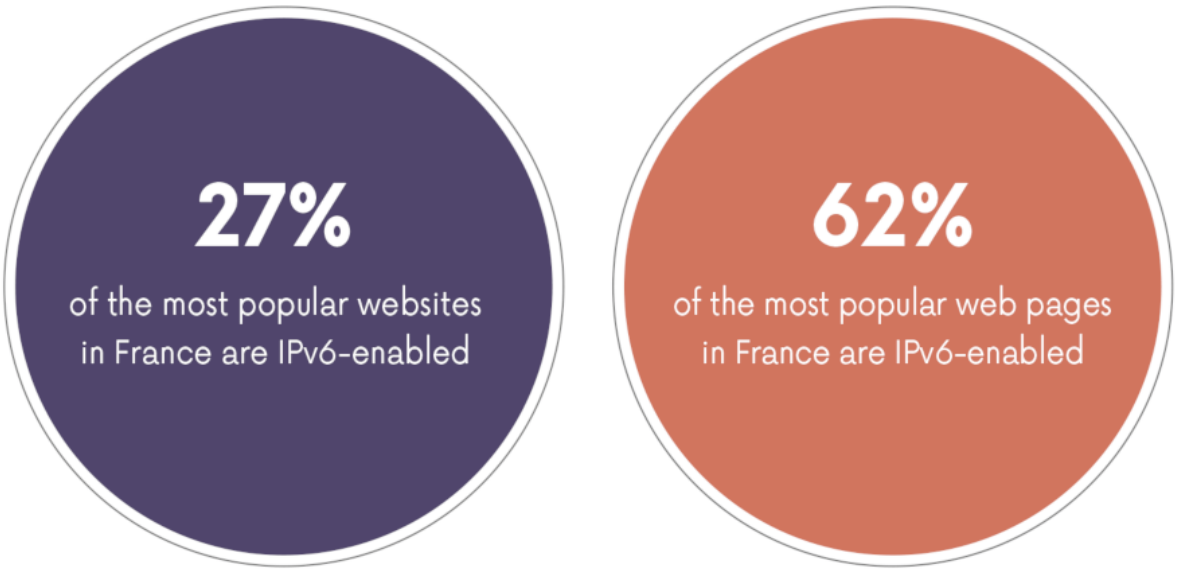
Thus, unlike an ISP that can enable IPv6 remotely, without requiring any action from its customers (i.e. end users), a hosting service's customer (i.e. content provider) must take several steps before IPv6 can be used end-to-end.

In the next part of this section, we take a look at two types of applications: **web and mail**.

5.1. Web hosting

Web hosting services continue to constitute **one of the main bottlenecks** in the migration to IPv6: of the most popular websites in France according to Alexa rankings, only 27% are IPv6-enabled[9]. 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%[10]). The reason is that many of the smaller content providers operate websites (generally small number of pages viewed) that are not IPv6-compatible.

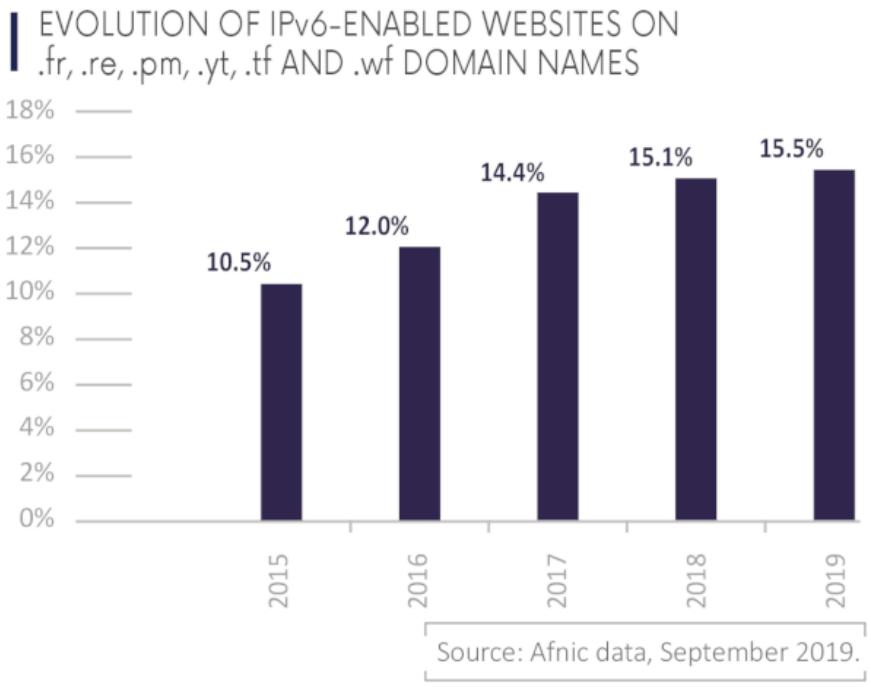


Source: 6lab Cisco as of 10/28/2019 (6lab.cisco.com).
Data on the top 730 websites in France, as ranked by Alexa

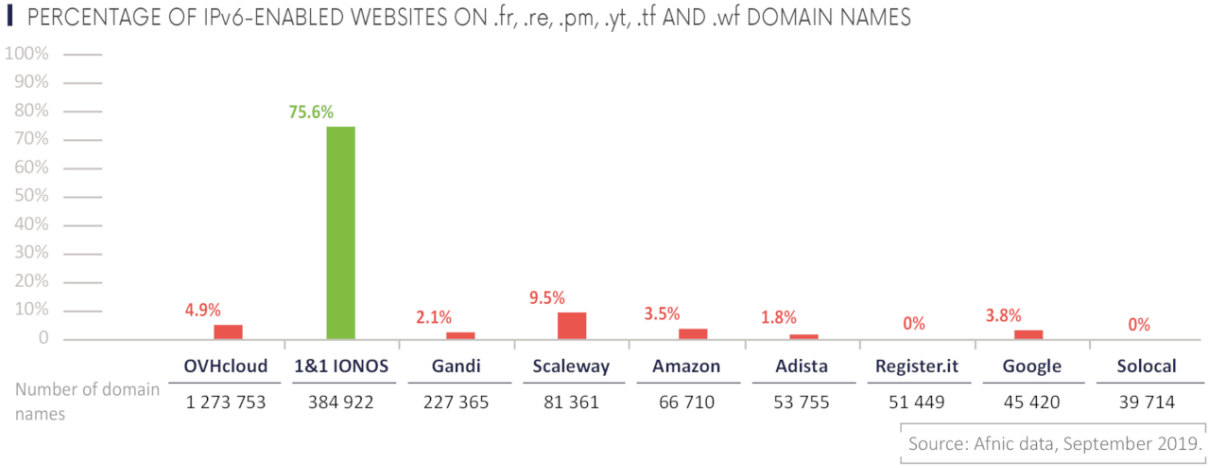
[9] Cisco 6lab as of 10/28/2019 (**https://6lab.cisco.com**); Data on the top 730 websites in France, Alexa rankings: **https://www.alexa.com/topsites/countries**

[10] *Ibidem.*

The percentage of IPv6-enabled sites stands at a mere 15.5% when looking at the 3.5 million .fr, .re, .pm, .yt, .tf, and .wf[11] 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 though several hosting services offer IPv6, **the percentage of IPv6-enabled websites is very low** amongst the Top 10 **because it is not enabled by default**. Of the Top 10 players, only 1&1 IONOS is leading by example, with more than three-quarters of websites IPv6-enabled.



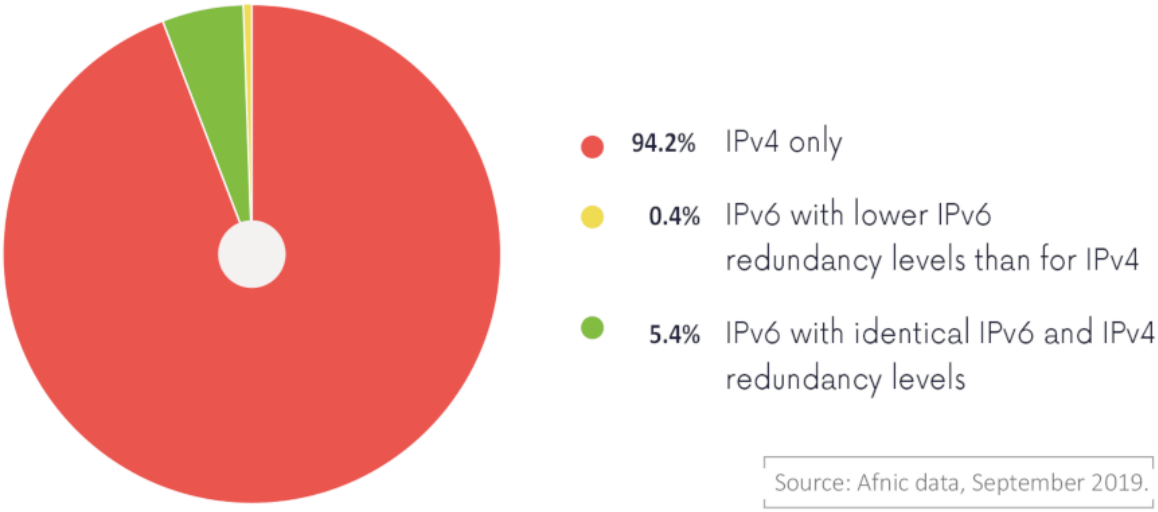
Further details on the top 30 hosting services are available in annex.

[11] Afnic data, September 2019. For these data, the Top 10 and Top 30 are defined in terms of the number of domain names hosted.

5.2. Mail hosting

The transition of the main mail hosting services is also proving **very slow**: only 5.8% of mail servers on .fr, .re, .pm, .yt, .tf and .wf domain names are currently IPv6-enabled (compared to 5.2% at mid-2018). 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[12].

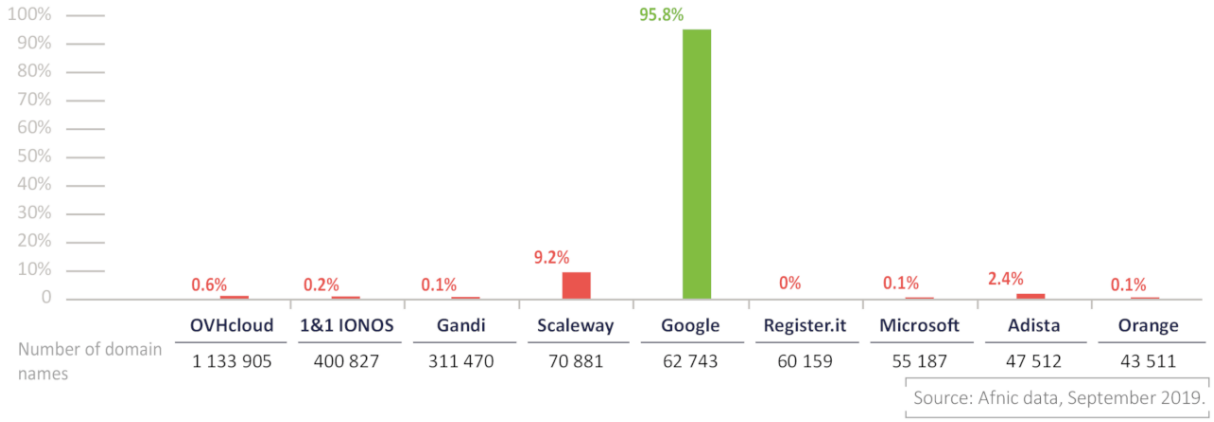
PERCENTAGE OF IPv6-ENABLED MAIL HOSTING ON .fr, .re, .pm, .yt, .tf AND .wf DOMAIN NAMES



Source: Afnic data, September 2019.

This lack of IPv6-readiness percentage for mail hosting is alarming, as a protracted lag on this section of the internet value chain could force IPv4 to be kept for longer than expected, with all the resulting costs. Only Google stands out here, with more than 95% of domain names for mail in IPv6 (cf. annex for more details on the Top 30).

PERCENTAGE OF IPv6-ENABLED MAIL HOSTING ON .fr, .re, .pm, .yt, .tf AND .wf DOMAIN NAMES



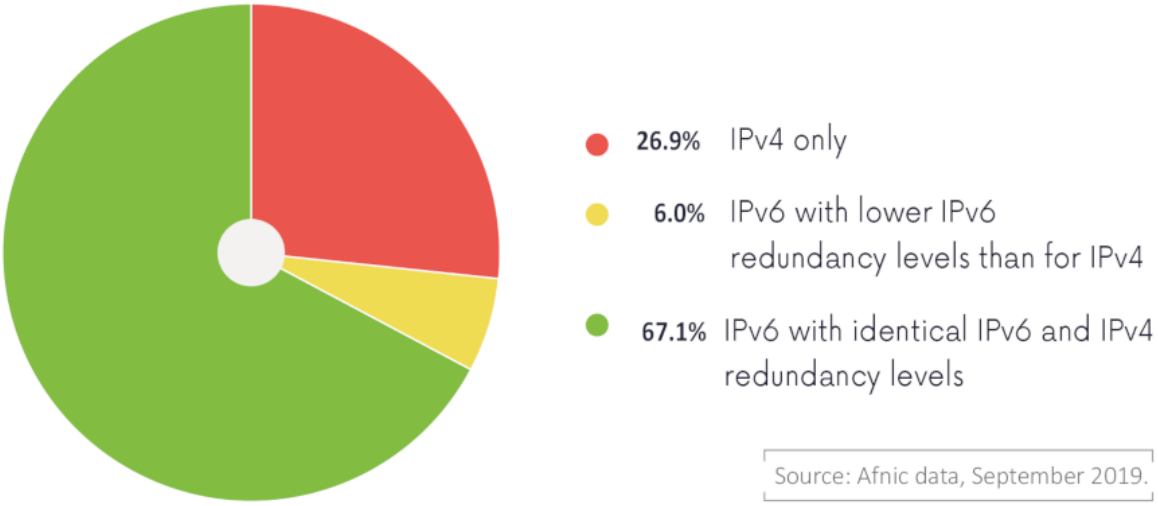
Source: Afnic data, September 2019.

[12] Afnic data, September 2019.

6. 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[13] supporting IPv6. Around 67%[14] of them guarantee equivalent resilience to IPv4 (identical redundancy levels). Also noteworthy is that only a small handful of players provide authoritative DNS (domain name server) hosting[15].

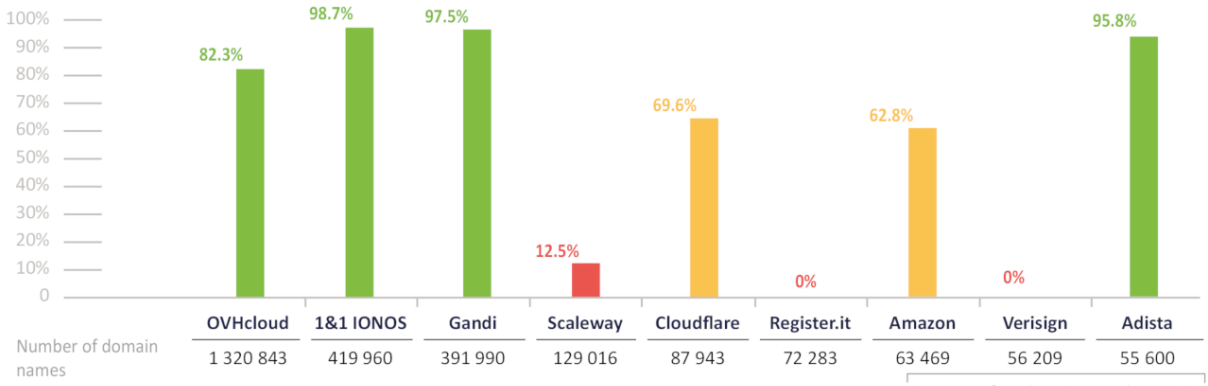
PERCENTAGE OF IPv6 ACCESSIBLE DNS SERVERS ON .fr, .re, .pm, .yt, .tf AND .wf DOMAIN NAMES



Source: Afnic data, September 2019.

It is worth noting the tremendous disparity in the Top 10 hosting company rankings, with four players (OVHcloud, 1&1 IONOS, Gandi and Adista) virtually systematically activating IPv6, contrary to the other six (cf. Annex for details on the Top 30).

PERCENTAGE OF IPv6 ACCESSIBLE DNS SERVERS ON .fr, .re, .pm, .yt, .tf AND .wf DOMAIN NAMES



Source: Afnic data, September 2019.

[13] An authoritative DNS (domain name server) is the primary DNS server for a domain, in other words the one that holds the domain name resolution information.
[14] Afnic data, September 2019.
[15] The French Internet Resilience Observatory, 2014, ANSSI:
https://www.ssi.gouv.fr/uploads/2014/10/rapport_observatoire_2014_en.pdf

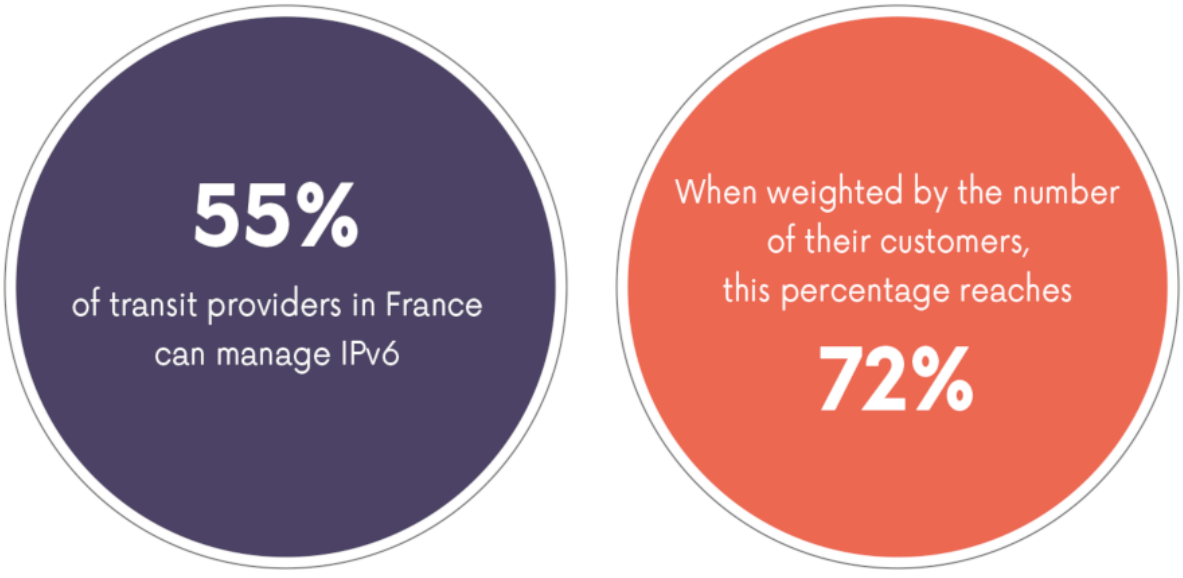
7. Equipment suppliers

All of the major equipment suppliers (Cisco, Juniper and Nokia) have indicated that all the network solutions they sell (routers, etc.) are **systematically made IPv6-compatible**[16].

This compatibility does not necessarily guarantee that traffic will be routed in IPv6, as this would require each player (ISPs, hosting companies, transit providers etc.) to have configured IPv6 routes at the router level.

8. Transit providers

55% of transit providers[17] operating in France (i.e. 143 of 262 transit providers) can manage IPv6 traffic, compared to 27% as of mid-2018. When weighted by the number of transit providers' customers, this percentage climbs to 72%, compared to 71% as of mid-2018. This means that a large percentage of small transit providers does not route IPv6 traffic[18].



Source: 6lab Cisco as of 10/28/2019 (6lab.cisco.com).

[16] Arcep 2016 questionnaire.
[17] The methodology employed by Cisco's 6lab stipulates that "*all AS that appear on an AS path of BGP table (and that are not the origin AS or the destination) are considered Transit AS*".
[18] 6lab Cisco as of 10/28/2019: **https://6lab.cisco.com**

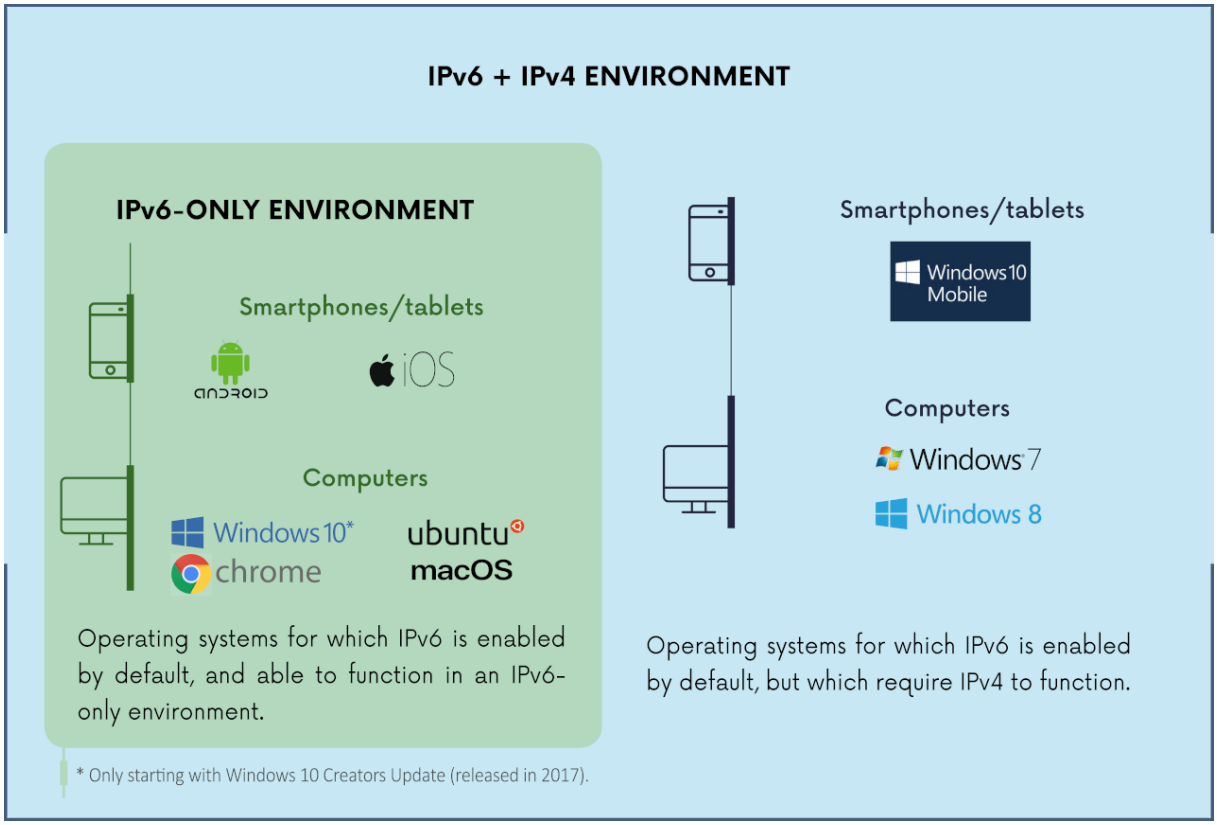
9. Devices

For a device to be able to transmit and receive IPv6 traffic, the operating system (OS) must be IPv6-compatible, and IPv6 must be enabled by default.

In the many connected objects (alarm systems, televisions, etc.), **IPv6 is integrated into the OS but has not been enabled by the connected object's manufacturer.**

Only the versions of operating systems that are preinstalled on retail market computers, tablets and smartphones, and still maintained (i.e. for which security updates, etc. are still provided) are examined below.

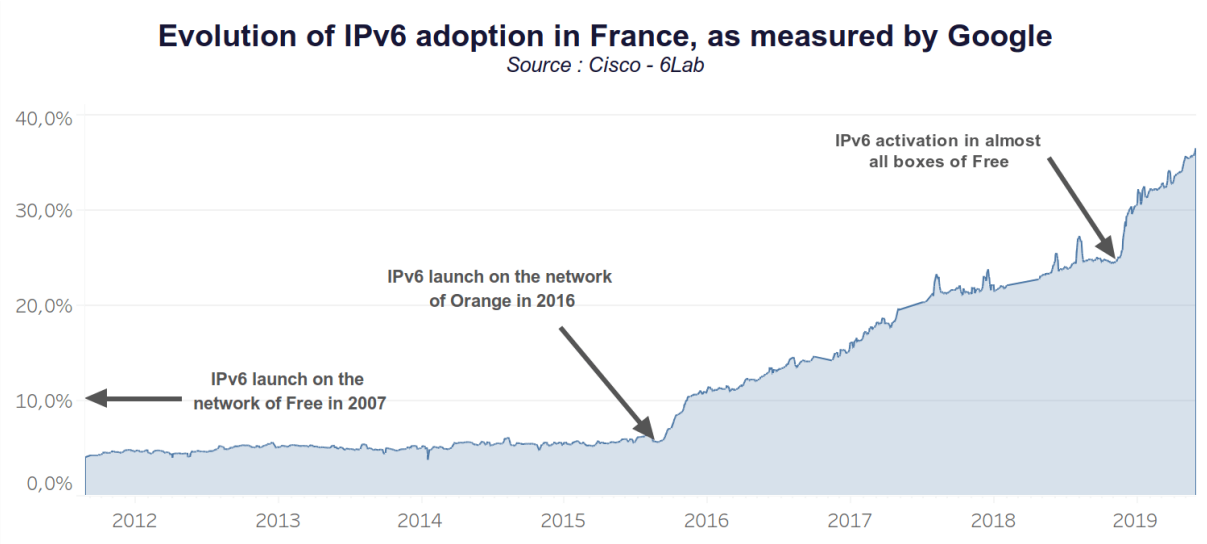
All of these operating systems are compatible with IPv6, which has been enabled by default for several years now (for instance, IPv6 has been enabled by default in Windows since Windows Vista in 2007). However, some OS cannot work properly in IPv6 without an IPv4 address (i.e. when IPv6 is the only protocol available) as they do not include support for the RFC 8106 Neighbor Discovery Protocol RDNSS.



10. Where does France stand?

The **IPv6 adoption rate** represents the percentage of users measured at a hosting service level (service proposing already IPv6). This therefore gives an idea of the status of the transition amongst devices, ISPs and mobile operators, and by other technical intermediaries when the hosting service in question makes use of transit providers.

As measured by Google, this rate currently stands at more than 36% in France.

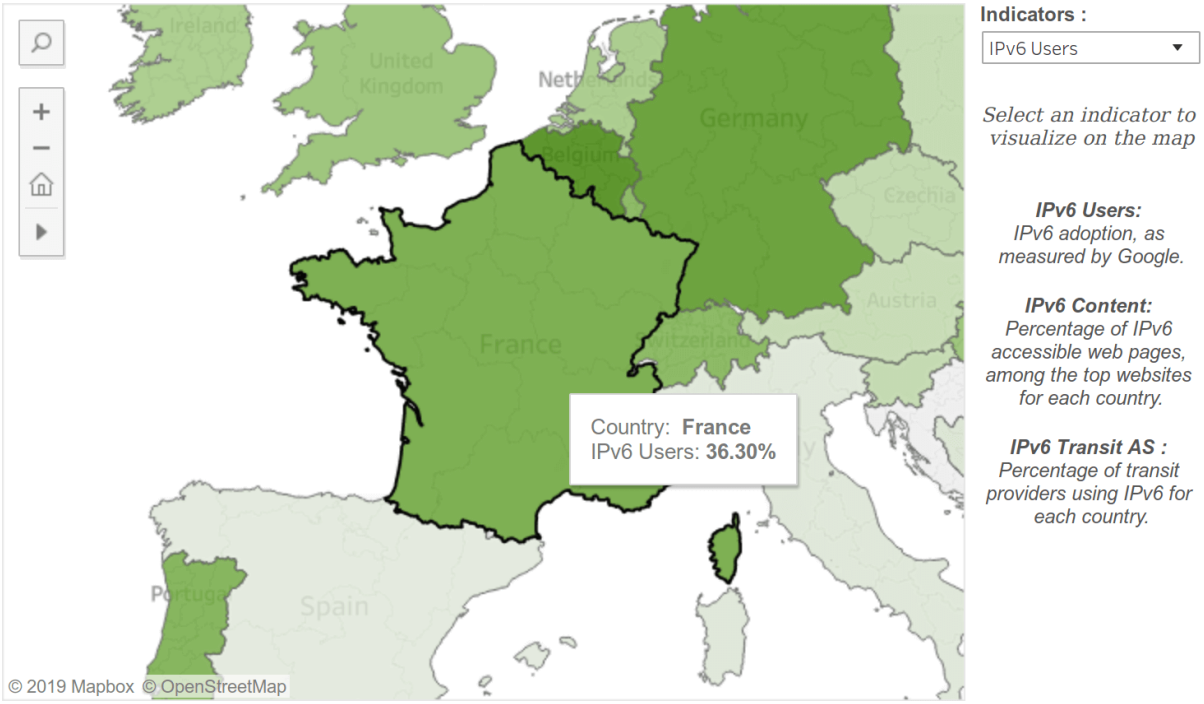


Because Google servers are typically located close to end users, this indicator gives an only partial view of the actual situation (the **percentage of transit providers that have adopted IPv6** has a direct influence on the number of IPv6-initated Internet connections in France, but is marginally taken into account by this indicator). It is also important to know how many web hosts are actually able to provide IPv6, by measuring the **percentage of web pages that are accessible through IPv6 (or content).**

The following map provides a comparison of the different countries around the world for the three indicators listed above. In terms of IPv6 users in Europe, **France – which had an average score last year – is now in fourth position** behind Belgium, Germany and Greece.

State of the transition to IPv6 in the world as of 28/10/2019

Source: Cisco - 6Lab



Annex: more information on the transition to IPv6

3. Fixed Internet service providers (retail services)

3.1. Operators with over 3 million customers on fixed networks

FIXED NETWORK:
PERCENTAGE OF IPv6-READY AND IPv6-ENABLED CUSTOMERS EVOLUTION

		bouygues		free		orange		SFR	
		IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled
xDSL	Mid-2018	2.5%	2.5%	99%	Not provided	40%	39%	100%	1.3%
	Mid-2019	25%	25%	99%	75%	60%	59%	100%	1.5%
	Mid-2020*	30-40%	30-40%	90-100%	90-100%	60-70%	60-70%	100%	10-20%
	Mid-2022*	55-65%	55-65%	100%	90-100%	75-85%	75-85%	100%	15-25%
Cable	Mid-2018	0%	0%	n/a		n/a		0%	0%
	Mid-2019	0%	0%	n/a		n/a		0%	0%
	Mid-2020*	0%	0%	n/a		n/a		0%	0%
	Mid-2022*	0%	0%	n/a		n/a		5-15%	5-15%
FttH	Mid-2018	1%	1%	100%	99%	90%	87%	60%	1.5%
	Mid-2019	2%	2%	100%	100%	100%	97%	60%	38%
	Mid-2020*	20-30%	20-30%	100%	100%	100%	90-100%	85-95%	85-95%
	Mid-2022*	45-55%	45-55%	100%	100%	100%	90-100%	85-95%	85-95%
4G fixed wireless	Mid-2018	0%	0%	n/a		0%	0%	0%	0%
	Mid-2019	0%	0%	n/a		0%	0%	0%	0%
	Mid-2020*	5-15%	5-15%	Not provided		Not provided		45-55%	5-15%
	Mid-2022*	30-40%	30-40%	Not provided		Not provided		100%	30-40%
Total	Mid-2018	2.5%	**2.5%**	99%	**50%**	46%	**45%**	64%	**0.9%**
	Mid-2019	20%	**20%**	99%	**80%**	70%	**68%**	64%	**6.7%**
	Mid-2020*	25-35%	**25-35%**	90-100%	**90-100%**	75-85%	**70-80%**	65-75%	**25-35%**
	Mid-2022*	50-60%	**50-60%**	100%	**100%**	85-95%	**85-95%**	65-75%	**45-55%**

* Figures subject to change.

Source: data as of end of June 2019, collected by Arcep from operators.

FIXED NETWORK:
IPv4 SHARING PRACTICES AND IPv6 PREFIX

		Technologies	bouygues	free	orange	SFR
IPv4	Percentage of customers with a shared IPv4 address	xDSL	0%	5%	0%	0%
		Cable	0%	n/a	n/a	0%
		FttH	0%	65%	0%	0%
		4G fixed wireless	0%	n/a	0%	0%
IPv6	Size of IPv6 prefix assigned by default to IPv6 customers	xDSL, FttH	60 bits	60 bits	56 bits	56 bits
	Frequency of IPv6 prefix update *(subject to change on the access or backhaul network)*	xDSL, FttH	Fixed	Fixed	Dynamic	Fixed
	IPv6 enabled per default *(subject to eligibility)*		Yes	Yes	Yes	No
	Possibility for the customer to disable IPv6 in the box	xDSL, FttH	Yes	No	Yes	Yes

Source: data as of end of June 2019, collected by Arcep from operators.

3.2. Operators with between 5,000 and 3 million customers on fixed networks

FIXED NETWORK:
PERCENTAGE OF IPv6-READY AND IPv6-ENABLED CUSTOMERS

	Technologies	Mid-2018		Mid-2019		Mid-2020*	
		IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled
Alsatis	FttH	0%	0%	0%	0%	0%	0%
	Radio	0%	0%	0%	0%	0%	0%
	Whole network	0%	**0%**	0%	**0%**	0%	**0%**
Canal+	FttH	0%	0%	0%	0%	0%	0%
	xDSL	0%	0%	0%	0%	0%	0%
	Whole network	0%	**0%**	0%	**0%**	0%	**0%**
Comcable	FttH	0%	0%	0%	0%	0%	0%
	Cable	0%	0%	0%	0%	0%	0%
	Whole network	0%	**0%**	0%	**0%**	0%	**0%**
Coriolis Telecom	FttH	82%	**82%**	62%	**62%**	85-95%	**85-95%**
K-Net	FttH	73%	**26%**	82%	**35%**	Not provided	Not provided
Nordnet	FttH	0%	0%	0%	0%	0%	0%
	xDSL	0%	0%	0%	0%	0%	0%
	Radio	0%	0%	0%	0%	0%	0%
	Whole network	0%	**0%**	0%	**0%**	0%	**0%**
Orne THD	Cable	0%	**0%**	100%	100%	100%	**100%**
OVH Télécom	FttH	100%	Not provided	100%	3.5%	100%	Not provided
	xDSL	100%	Not provided	100%	23%	100%	Not provided
	Whole network	100%	Not provided	100%	**23%**	100%	Not provided
Ozone	FttH	0%	0%	0%	0%	5-15%	5-15%
	xDSL	0%	0%	0%	0%	0%	0%
	Radio	0%	0%	0%	0%	10-20%	10-20%
	Whole network	0%	**0%**	0%	**0%**	5-15%	**5-15%**
Tubéo	FttH	0%	**0%**	0%	**0%**	0%	**0%**
Vialis	FttH	0%	0%	0%	0%	25-35%	25-35%
	Cable	0%	0%	0%	0%	25-35%	25-35%
	Whole network	0%	**0%**	0%	**0%**	25-35%	**25-35%**
VidéoFutur	FttH	0%	**0%**	0%	**0%**	Not provided	Not provided
Wibox	FttH	0%	**0%**	0%	**0%**	90-100%	**90-100%**
Wifirst	Radio	0%	**0%**	0%	**0%**	0%	**0%**
Zeop	FttH	0%	0%	93%	0%	90-100%	0-10%
	Cable	Not provided	1%	75%	1%	70-80%	0-10%
	Whole network	Not provided	**0%**	88%	**0%**	85-95%	**0-10%**

* Figures subject to change.

Source: data as of end of June 2019, collected by Arcep from operators.

FIXED NETWORK:
IPv4 SHARING PRACTICES AND IPv6 PREFIX

Technologies		IPv4	IPv6			
		Percentage of customers with a shared IPv4 address	Size of IPv6 prefix assigned by default to IPv6 customers	Frequency of IPv6 prefix update. *(subject to change on the access or backhaul network)*	IPv6 enabled per default for new customers *(subject to eligibility)*	Possibility for the customer to disable IPv6 in the box
Alsatis	FttH	100%	–	–	–	–
	Radio*	50%	–	–	–	–
Canal+	FttH	0%	/64	Fixed	–	–
	xDSL	0%	/64	Fixed	–	–
Comcable	FttH	0%	–	–	–	–
	Cable	0%	–	–	–	–
Coriolis Telecom	FttH	0%	/56	Fixed	Yes	No
K-Net	FttH	0%	/56	Fixed	Yes	Yes
Nordnet	FttH	0%	–	–	–	–
	xDSL	0%	–	–	–	–
	Radio*	0%	–	–	–	–
Orne THD	Cable	0%	/56	Fixed	Yes	No
OVH Télécom	FttH	0%	/56	Fixed	No	Yes
	xDSL	0%	/56	Fixed	No	Yes
Ozone	FttH	0%	Under study	Under study	–	–
	xDSL	0%	–	–	–	–
	Radio*	0%	Under study	Under study	–	–
Tubéo	FttH	100%	–	–	–	–
Vialis	FttH	90%	/56	Under study	–	–
	Cable	50%	/56	Under study	–	–
VidéoFutur	FttH	100%	Under study	Under study	–	–
Wibox	FttH	0%	/56	Under study	Yes	No
Wifirst	Radio*	100%	–	–	–	–
Zeop	FttH	0%	/56	Fixed	No	Yes
	Cable	0%	/56	Fixed	No	Yes

* Radio technologies: 4G fixed wireless / Wi-Fi / WiMAX

Source: data as of end of June 2019, collected by Arcep from operators.

4. MOBILE OPERATORS (RETAILS SERVICES)

4.2. Operators with between 5,000 and 3 million customers on mobile networks

MOBILE NETWORK:
PERCENTAGE OF IPv6-READY AND IPv6-ENABLED CUSTOMERS EVOLUTION

	Mid-2018		Mid-2019		Mid-2020*	
	IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled	IPv6-ready	IPv6-enabled
Coriolis Telecom	0%	0%	0%	0%	0%	0%
Digicel	0%	0%	0%	0%	0%	0%
Euro-Information Telecom	0%	0%	0%	0%	0%	0%
LycaMobile	0%	0%	0%	0%	0%	0%
Orange Caraïbe	0%	0%	0%	0%	0%	0%
Orange Réunion Mayotte	0%	0%	0%	0%	0%	0%
Martinique TVC	0%	0%	0%	0%	0%	0%
Outremer Telecom	0%	0%	0%	0%	0%	0%
SRR Réunion	0%	0%	0%	0%	0%	0%
WS Guadeloupe	0%	0%	0%	0%	0%	0%
Transatel	0%	0%	0%	0%	0%	0%
Vectone Mobile	0%	0%	0%	0%	0%	0%
Zeop	n/a		100%	13%	100%	Not provided

* Figures subject to change.

Source: data as of end of June 2019, collected by Arcep from operators.

5. HOSTING SERVICES AND CONTENT PROVIDERS

5.1. Web hosting

PERCENTAGE OF IPv6-ENABLED WEBSITES ON .fr, .re, .pm, .yt, .tf AND .wf DOMAIN NAMES

Hosting service	AS number	Number of domain names	Percentage of IPv6
OVHcloud	AS 16276	1 273 753	4.9%
1&1 IONOS	AS 8560	384 922	75.6%
Gandi	AS 29169	227 365	2.1%
Scaleway	AS 12876	81 361	9.5%
Amazon	AS 16509	66 710	3.5%
Adista	AS 16347	53 755	1.8%
Register.it	AS 39729	51 449	0.0%
Google	AS 15169	45 420	3.8%
Solocal	AS 13034	39 714	0.0%
NordNet	AS 8362	35 851	0.0%
o2switch	AS 50474	35 451	0.1%
Cloudflare	AS 13335	34 265	97.2%
CSC	AS 19574	27 938	0.0%
GoDaddy	AS 26496	26 484	0.1%
Magic Online	AS 35393	25 585	0.1%
Shopify	AS 62679	25 163	1.0%
InterNetX	AS 47846	20 447	0.0%
Free	AS 12322	20 156	64.3%
infomaniak	AS 29222	19 627	24.1%
PlanetHoster	AS 53589	17 879	0.1%
TransIP	AS 20857	13 028	57.3%
Nameshield	AS 20756	12 759	0.7%
One.com	AS 51468	11 845	86.4%
Orange	AS 3215	11 266	1.8%
Amazon	AS 14618	10 308	0.8%
SafeBrands	AS 34173	9 680	0.0%
Ikoula	AS 21409	8 864	8.9%
Automattic	AS 2635	8 846	0.1%
Team Internet	AS 61969	8 760	0.0%
Strato	AS 6724	7 880	93.8%
Others		845 823	7.1%

Source: Afnic data, September 2019.

5.2. Mail hosting

PERCENTAGE OF IPv6-ENABLED MAIL HOSTING ON .fr, .re, .pm, .yt, .tf AND .wf DOMAIN NAMES

Hosting service	AS number	Number of domain names	Percentage of IPv6
OVHcloud	AS 16276	1 133 905	0.6%
1&1 IONOS	AS 8560	400 827	0.2%
Gandi	AS 29169	311 470	0.1%
Scaleway	AS 12876	70 881	9.9%
Google	AS 15169	62 743	95.8%
Register.it	AS 39729	60 159	0.0%
Microsoft	AS 8075	55 187	0.1%
Adista	AS 16347	47 512	2.4%
Orange	AS 3215	43 511	0.1%
NordNet	AS 8362	36 168	0.0%
Magic Online	AS 35393	31 682	0.0%
o2switch	AS 50474	27 502	0.0%
Rackspace	AS 27357	21 796	0.0%
Rackspace	AS 19994	21 785	0.0%
SFR Completel	AS 12670	18 607	0.0%
Linode	AS 63949	17 469	0.4%
SafeBrands	AS 34173	16 446	0.0%
Amazon	AS 16509	14 776	0.1%
Nameshield	AS 20756	14 776	0.2%
Eurafibre	AS 35625	14 694	29.9%
NTT	AS 2914	14 246	0.0%
Lightboud	AS 7332	14 124	100.0%
PlanetHoster	AS 53589	13 513	0.0%
Infomaniak	AS 29222	12 705	98.5%
One.com	AS 51468	12 222	0.1%
GoDaddy	AS 26496	11 818	0.0%
Tucows	AS 32491	11 598	0.0%
SFR	AS 15557	11 267	0.1%
Sewan	AS 8399	9 969	0.0%
NetNames	AS 34922	9 744	0.0%
Others		370 368	17.5%

Source: Afnic data, September 2019.

6. DNS INFRASTRUCTURE

PERCENTAGE OF IPv6 ACCESSIBLE DNS SERVERS ON .fr, .re, .pm, .yt, .tf AND .wf DOMAIN NAMES

Hosting service	AS number	Number of domain names	Percentage of IPv6
OVHcloud	AS 16276	1 320 843	82.3%
1&1 IONOS	AS 8560	419 960	98.7%
Gandi	AS 29169	391 990	97.5%
Scaleway	AS 12876	129 016	12.5%
Cloudflare	AS 13335	87 943	69.6%
Register.it	AS 39729	72 283	0.0%
Amazon	AS 16509	63 469	62.8%
Verisign	AS 10515	56 209	0.0%
Adista	AS 16347	55 600	95.8%
Verisign	AS 20362	53 800	100.0%
Verisign	AS 32651	52 765	100.0%
Verisign	AS 20172	50 788	0.0%
Google	AS 15169	44 079	34.5%
NordNet	AS 8362	43 646	0.0%
Choopa	AS 20473	38 703	15.7%
Nameshield	AS 20756	33 075	52.8%
o2switch	AS 50474	32 015	0.0%
GoDaddy	AS 26496	29 969	5.6%
Orange	AS 3215	29 551	73.9%
Free	AS 12322	29 307	95.8%
Infomaniak	AS 29222	24 266	99.6%
Magic Online	AS 35393	24 170	27.6%
Hetzner Online	AS 24940	21 810	79.3%
Solocal	AS 13034	19 873	0.0%
Oceanet	AS 20926	19 468	0.0%
PlanetHoster	AS 53589	19 427	0.0%
Sedo	AS 47846	19 425	0.0%
TransIP	AS 20857	19 299	96.7%
Jaguar-Network	AS 30781	19 083	74.9%
Neustar	AS 12008	17 489	97.0%
Others		817 912	32.5%

Source: Afnic data, September 2019.