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

FRENCH REPUBLIC

BAROMETER OF DATA INTERCONNECTION IN FRANCE

25 JUNE 2020

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1. Understanding data interconnection

1.1. What is data interconnection?

Interconnection is the cornerstone of the internet. It refers to the technical-economic relationship that is established between different actors to connect and to exchange traffic. It guarantees the global mesh of the network and allows the end users[1] to communicate with each other[2].

1.2. Involved stakeholders

Several stakeholders interact in the Internet ecosystem:

- Content and application providers (CAPs): content owners that employ several intermediaries to deliver their content to end users;
- Hosting services[3]: owners of the servers that host the content managed by third parties (CAPs or individuals);
- Transit providers: managers of international networks that act as intermediaries between CAPs and ISPs for relaying traffic;
- Internet Exchange Points (IXPs): infrastructures that enable the different players to interconnect directly, through an exchange point, rather than going through one or several transit providers;
- Content Delivery Networks (CDNs): networks that specialise in relaying large volumes of traffic to several ISPs, in various geographical locations and thanks to cache servers installed in proximity to end users;
- Internet service providers (ISPs): network operators that are responsible for relaying traffic to end customers.

EXAMPLES OF INTERNET STAKEHOLDERS

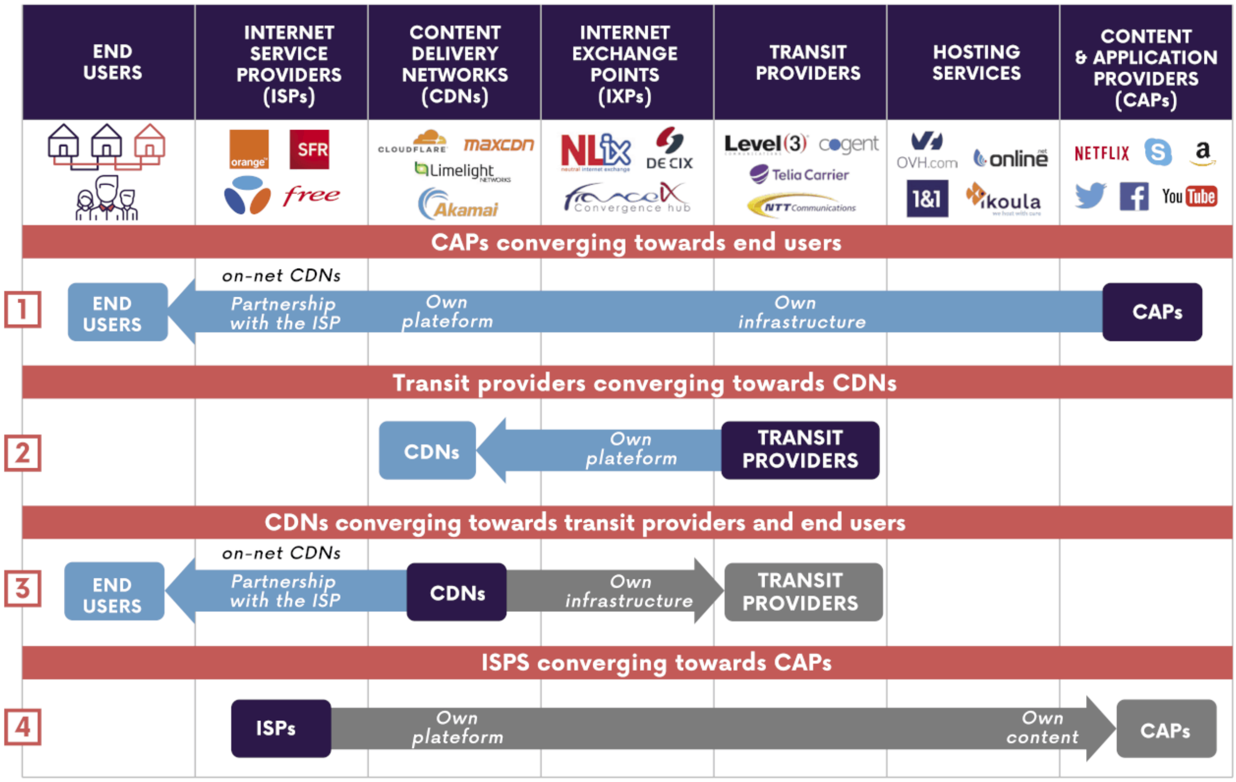
[1] Individuals who use their own equipment and subscribe to an ISP's plan to be able to access content online.
[2] Arcep indicates that the present barometer concerns only data interconnection in the Internet network and does not apply to the interconnection between the networks of two operators for voice call termination.
[3] More specifically: Article 6-1 Par. 2 of the Act of 2004-575 of 21 June 2004 on confidence in the digital economy, which defines web hosting companies as physical or legal entities that store, on behalf public online communication services, signals, writings, images, sounds and messages of any kind, provided by the recipients of those services, for the purposes of making them available to the public, even for free.

1.3. Evolution of the interaction between the different stakeholders

As the following diagram illustrates, the current market trend is one of convergence between the different players. Several vertical integration scenarios are occurring, both in the top and bottom half of the value chain:

1. In order to get closer to end customers and to improve the resilience and quality of their services, CAPs are deploying their own network infrastructure and their own CDN platforms;
2. In addition to their transit services, transit providers employ their existing infrastructure to develop CDN products and host third-party content;
3. On the one hand, CDNs are behaving more and more like network operators by deploying their own infrastructure around the globe. On the other hand, they are establishing partnerships with ISPs to deploy their servers on the latter's network, and so be as close to end customers as possible;
4. ISPs are diversifying their businesses by creating their own content, and distributing it themselves through their own platforms.

INTERNET ECOSYSTEM STAKEHOLDERS CONVERGENCE



1.4. Interconnection issues

The possible divergence of the respective interests of the ecosystem stakeholders can lead to a difference in point of view, or even occasional tensions.

A failure of negotiations between two interconnected actors may for example lead to a degradation of the quality of service or the disruption of the interconnection (and thus make it impossible for users - partially or totally – to access, or to use applications and services of their choice). Interconnection could also be used for anti-competitive discrimination regarding the source, the destination or the content of the transmitted information[4].

Depending on the technical and tariff conditions applied, the interconnection is thus likely to influence in various ways the investment in the networks, the quality of service perceived by the end user or even the pace of innovation in the services, contents and applications.

Data interconnection for dummies, *by Stéphane Bortzmeyer.*

1.5. Interconnection methods

The interconnection takes place between two different AS (Autonomous Systems)[5]. For the information to be exchanged from one point to another of the Internet, it must be routed from AS to AS, and within each AS, from router to router, the router being the basic equipment ensuring the referral of data packets within the internet. To do this, each AS announces to the other AS with which it is physically interconnected the routes[6] to the network equipment and end users it serves.

There are two main forms of interconnection: **transit and peering.**

1.5.1. Transit

How it works

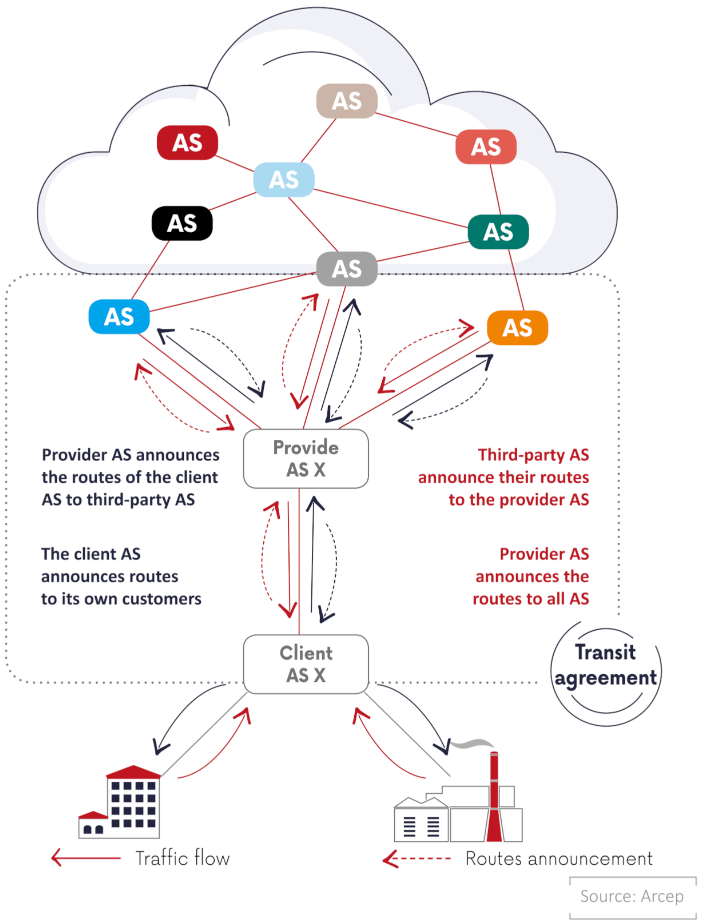
Transit is a service whereby an operator (provider) supplies global connectivity to another operator (client) and relays the traffic going to or coming from this client operator, regardless of the traffic's initial origin or final destination – unless there are restrictions bound by an agreement between the parties, in terms of the offer's geographical footprint, for instance.

[4] See part 1.7.

[5] Set of networks managed by the same administrative authority and having relatively homogeneous routing protocols. Example of some ASs in France: AS5410 (Bouygues Télécom), AS12322 (Proxad – Free), AS3215 (RBCI – Orange), AS15557 et AS21502 (SFR), AS16276 (OVH), AS12876 (Online), etc.

[6] Each AS advertises IP prefixes, with each IP prefix referring to a group of IP addresses.

HOW A TRANSIT AGREEMENT WORKS



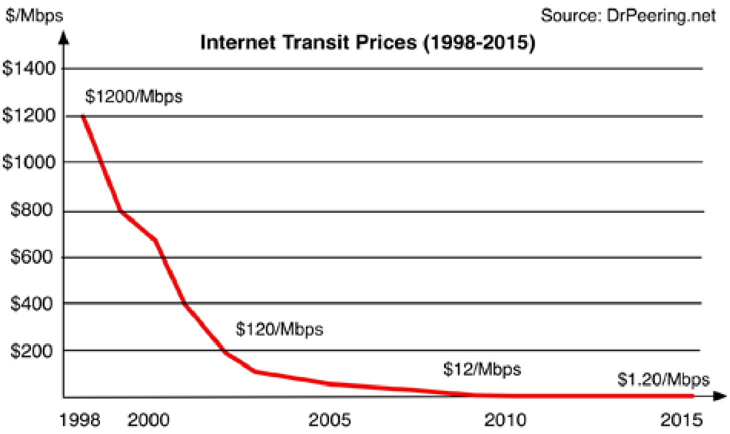
Transit cost

In order to interconnect two networks, an interconnection link with a given capacity is set up. The transit service is usually billed based on the traffic on this link in Mbit/s calculated at the 95th percentile.

95th percentile corresponds to the maximum rate at which the client will be billed, ignoring the top 5% of the samples taken

Moreover, a minimum threshold of traffic (called "commit") and a commitment period can be established by the transit provider, which on the one hand guarantees him a minimum income.

The observed transit services prices have decreased steadily over time due to the combination of increased traffic volumes, lower equipment costs and competitive pressure.



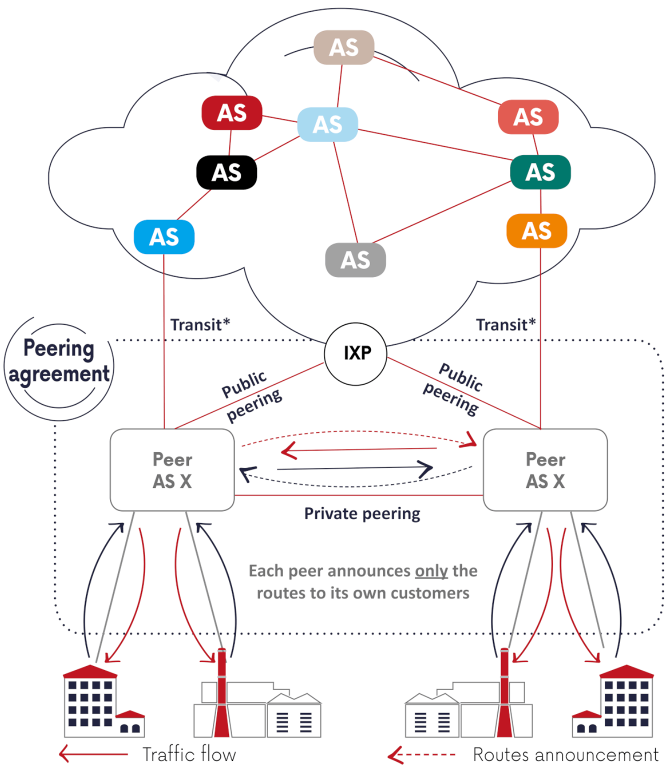
1.5.2. Peering

How it works

Peering is a type of interconnection agreement that allows two operators to exchange the traffic being routed to their own customers directly. Under a peering agreement, actor gives only access to its network which means the link between them can only be used by the traffic of their own customers.

Because peering has traditionally been a mutually beneficial relationship between two operators with similar profiles (hence the term peers), up until now this type of agreement has usually been for free, aside from the cost of installing the switches and lines needed to connect the networks.

HOW A PEERING AGREEMENT WORKS



* The fact of having a peeing relationship does not necessarily exclude the need for transit solutions as well, in order to be able to connect to the rest of the Internet

Source: Arcep

Paid Peering

Although peering agreements are usually for free, the emergence of an imbalance in the interests of the parties involved, or in the traffic being exchanged between two peers has resulted in the development of paid peering, i.e. transit agreements.

These agreements are used in particular, although not exclusively, to govern recent direct interconnection agreements between certain large CAPs and certain ISPs (and possibly between ISPs and/or transit operators).

Peering agreements

Operators have very different strategies for interconnection. Those strategies are described in a reference document, known as the "peering policy", which is generally public[7] and in which the traffic asymmetry ratio, the minimum level of exchanged traffic, the geographical distribution of interconnection points, etc. are defined in particular.

However, in practice, peering agreements are often established in a relatively fast and informal manner: a large majority of them are not covered by a written contract and are subject to a simple agreement between the two peers, in respect of their possible peering charts. According to PCH[8], about 99.9% of the peering agreements were done informally around a handshake.

Some actors impose the implementation of a contract even in the case of a free peering in order to establish conditions such as the minimum traffic and the respect of an asymmetry ratio: in case of non-compliance with a condition, the contract automatically switches to paid peering.

Internet Exchange Points

Peering (direct interconnection between AS) can be physically performed:

- in one of the peer's premises;
- in a third-party actor premises (Datacenter);
- at an exchange point: a dedicated site to interconnection which can be either carrier neutral or managed by a specific operator (carrier specific).

Exchange points allow the parties to sharing hosting and connection costs, in addition to providing an efficient system for managing a great many peering and transit relationships. Being present at an Internet exchange point allows an undertaking to interconnect with all the other AS that are present at this exchange point – provided, of course, an agreement exists between the parties (which is often secured through a fast and verbal process).

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[7] Peering policies examples : **AS5410 (Bouygues Telecom)**, **AS12322 (Proxad – Free)**, **AS3215 (RBCI – Orange)** et **AS15557 (SFR)**.

[8] Packet clearing House, Survey of Internet Carrier Interconnection Agreements (2016): https://www.pch.net/resources/Papers/peering-survey/PCH-Peering-Survey-2016/PCH-Peering-Survey-2016.pdf

Public and private peering

There are two main types of peering:

- bilateral mode, also called private peering, that can be located either in one of the peer's premises or within a Datacenter;
- multilateral mode, also known as public peering, located within an IXP.

Private peering is generally employed when the interconnection capacity between the two peers is large enough to make a dedicated interconnection viable. It may also offer advantages in terms of maintenance and interconnection security.

Public peering was developed to make direct interconnection for smaller volumes of traffic economically viable, by having several peers share interconnection capacities by pooling switching equipment.

Why choose peering instead of transit?

Using a transit service or setting up a peering agreement to exchange traffic with another operator's customers depends both on the bargaining power of the parties and on a techno-economical arbitrage, the parameters of which include the relative costs of the different options and the quality of service.

On the one hand, ISPs seek to establish peering relationships (free or discounted) with other ISPs to reduce transit costs. These relationships reduce the traffic load on transit services, which are often expensive.

On the other hand, peering uses direct circuits or regional exchange points that allow end users to obtain better performance. Without direct interconnection, client traffic may have to go through multiple networks, over large distances and therefore with high latency, before reaching a given service.

If peering is of obvious interest, some small players with weak bargaining power have no choice but to pay one or more transit providers to connect their customers.

1.6. Internet hierarchy

Internet players are generally classified into three groups, according to the nature of their interconnection relationships:

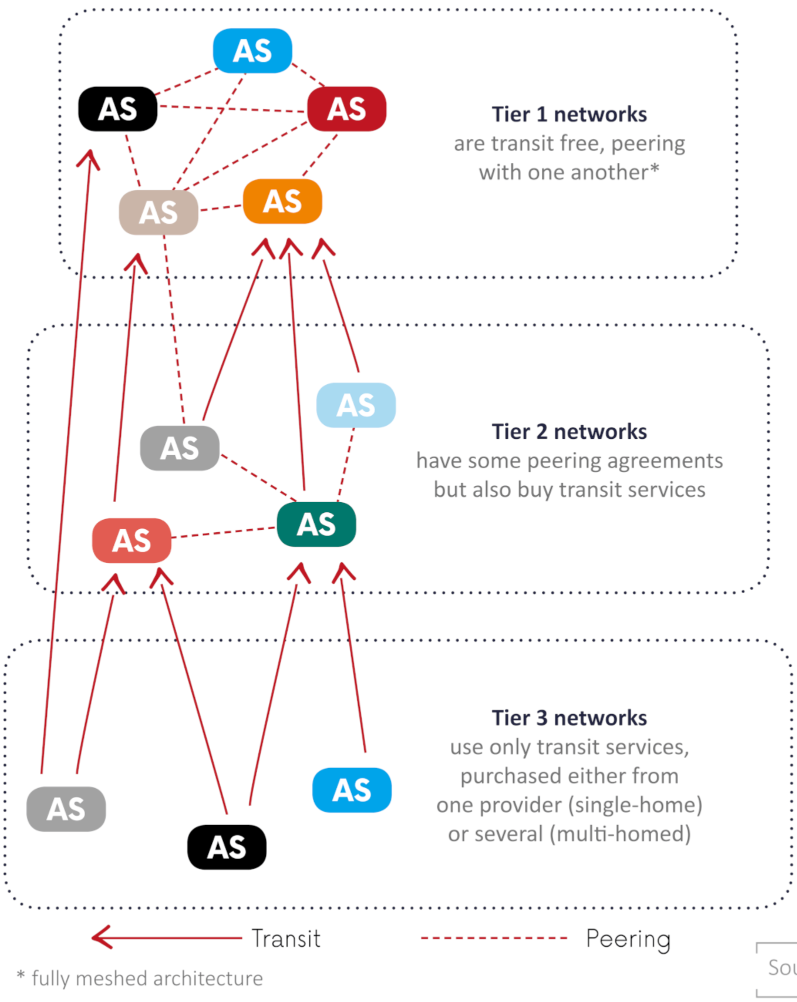
- **Tier 1**: operators that have built long-haul networks that are directly interconnected with other global, major operators. They don't pay any other network for transit yet still can reach all networks connected to the Interne. To ensure global connectivity, Tier 1 operators need to all be connected to one another through peering agreements. It is thanks to these peering agreements that Tier 1 operators are able to supply transit services to operators lower down the hierarchy[9].

[9] According to a more restrictive definition, a Tier 1 operator must not only be transit free, but also not have to pay for peering to achieve worldwide connectivity.

Tier 1[10] list : 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.*

- **Tier 2:** mid-size operators. They have peering agreements with other Tier 2 operators in their geographical area, but need to purchase transit services to achieve worldwide connectivity.
- **Tier 3:** operators which are smaller and rely entirely on transit services for their connectivity.

THE INTERNET HIERARCHY



Source: Arcep

Tier 2 and 3 operators, which use transit to connect to the whole of the Internet, can chose to use only a single transit operator, in which case they are referred to as "single homed", or several transit operators, in which case they are referred to "multi-homed".

[10] Some actors tend not to consider Cogent and Hurricane Electric as Tier 1 because they do not advertise all Internet routes in IPv6 due to conflicts between actors. Moreover, if Hurricane Electric is Tier 1 in IPv6, it is Tier 2 in IPv4. (Source : lafibre.info)

This hierarchy does not remain fixed. Indeed, by developing its peering agreements, a Tier 3 can become a Tier 2. Moreover, a Tier 2 can enter into a peering relationship with Tier 1, become a transit provider and possibly have the status of Tier 1 after the implementation of peering agreements with all Tier 1. Such a strategy of evolution appears today followed by some large CAPs and CDNs, which are trying to deploy their own infrastructure and climb this hierarchical structure.

1.7. Interconnection regulatory framework

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

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

In addition, public network operators are required to grant other public network operators interconnection requests submitted in order to provide the public with electronic communications services. The interconnection request may be refused only if it is justified by the applicant's needs on the one hand and the operator's ability to satisfy it. Any refusal of interconnection must be justified.

If difficulties arise, the Authority could exercise the powers granted to it by the legislator[11], either through an *ex ante* regulating decision, or by a dispute settlement decision at the request of an actor[12].

Lastly, even if interconnection is not identical to Internet access and is not covered as such by the open Internet regulation, practices using interconnection to restrict specific flows and therefore limit users' rights could be analysed from the perspective of these regulations[13].

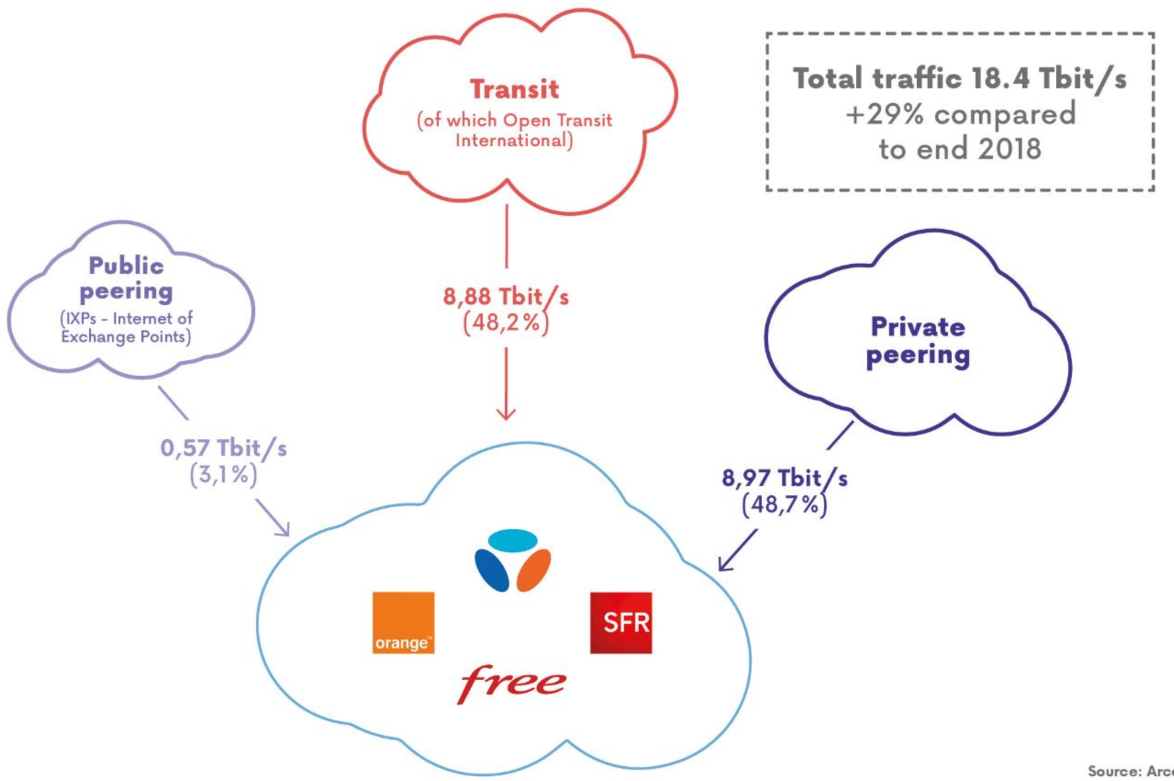
[11] Article L. 34-8 of the French postal and electronic communications code
[12] Procedure provided by the article L. 36-8 of the French postal and electronic communications code
[13] Cf. Considering section 7 of the Open Internet Regulation and considering sections 5 and 6 of the BEREC guidelines

2. Status of data interconnection in France

Thanks to the information gathering it does on data interconnection and routing, Arcep has technical and financial data on interconnection from the first half of 2012 to second half of 2019. For confidentiality reasons, the published findings[14] are only aggregate results.

2.1. Inbound traffic

BREAKDOWN OF INBOUND TRAFFIC (95TH PERCENTILE) ON THE NETWORKS OF THE MAIN ISPs IN FRANCE (END OF 2019)



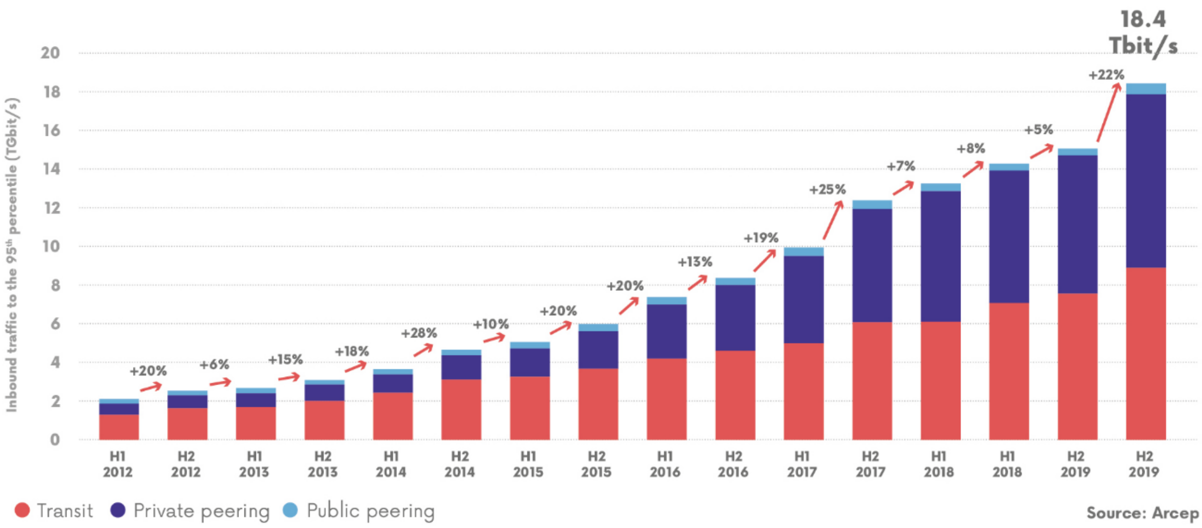
Source: Arcep

Inbound traffic to the four main ISPs in France has increased from more than 14.3 Tbit/s at the end of 2018 to 18.4 Tbit/s at the end of 2019, which translates into a 29% increase in a single year. Half of this traffic comes from transit links. This relatively high rate of transit is due in large part to transit traffic between Open Transit International (OTI), a Tier 1 network belonging to Orange, and the Orange backbone and backhaul network (RBCI), which makes it possible to relay traffic to the ISP's end customers.

This rate of transit is much lower for other ISPs which do not have a transit provider business, and so make much greater use of peering.

[14] Results obtained from operators' response to the information gathering campaigns on the technical and financial conditions of data interconnection and routing, which scope is described within the decision 2017-1492-RDPI

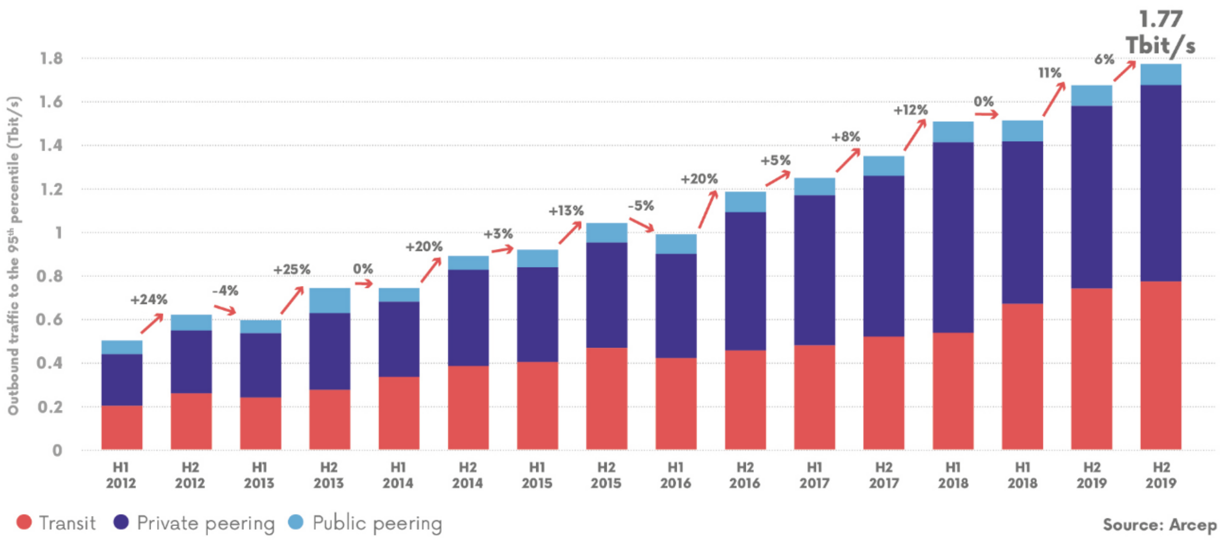
INBOUND TRAFFIC AT INTERCONNECTION LEVEL TO THE MAIN ISPs IN FRANCE, FROM H1-2012 TO H2-2019



2.2. Outbound traffic

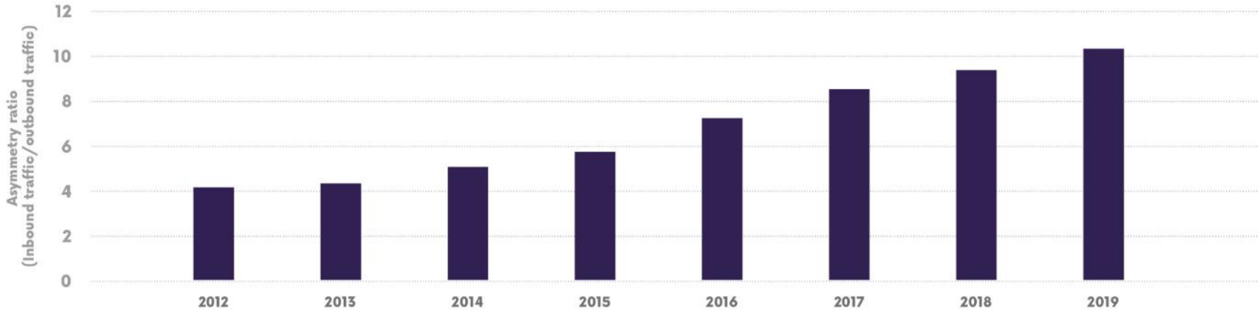
By the end of 2019, outbound traffic on the networks of France's four main ISPs stood at around 1.8 Tbit/s, or 17% more than at the end of 2018. This traffic quadrupled between 2012 and 2019.

OUTBOUND TRAFFIC AT INTERCONNECTION LEVEL FROM THE MAIN ISPs IN FRANCE, FROM H1-2012 TO H2-2019



Outbound traffic is well below incoming traffic. Moreover, the asymmetry between these two traffics increased from 1:4 in 2012 to more than 1:10 in 2019. This increase is due in particular to the increase in the multimedia content consulted by the customers (streaming audio video, downloading large content, etc.).

ASYMMETRY RATIO BETWEEN INBOUND AND OUTBOUND TRAFFIC AT INTERCONNECTION LEVEL FOR THE MAIN ISPs IN FRANCE BETWEEN 2012 AND 2019

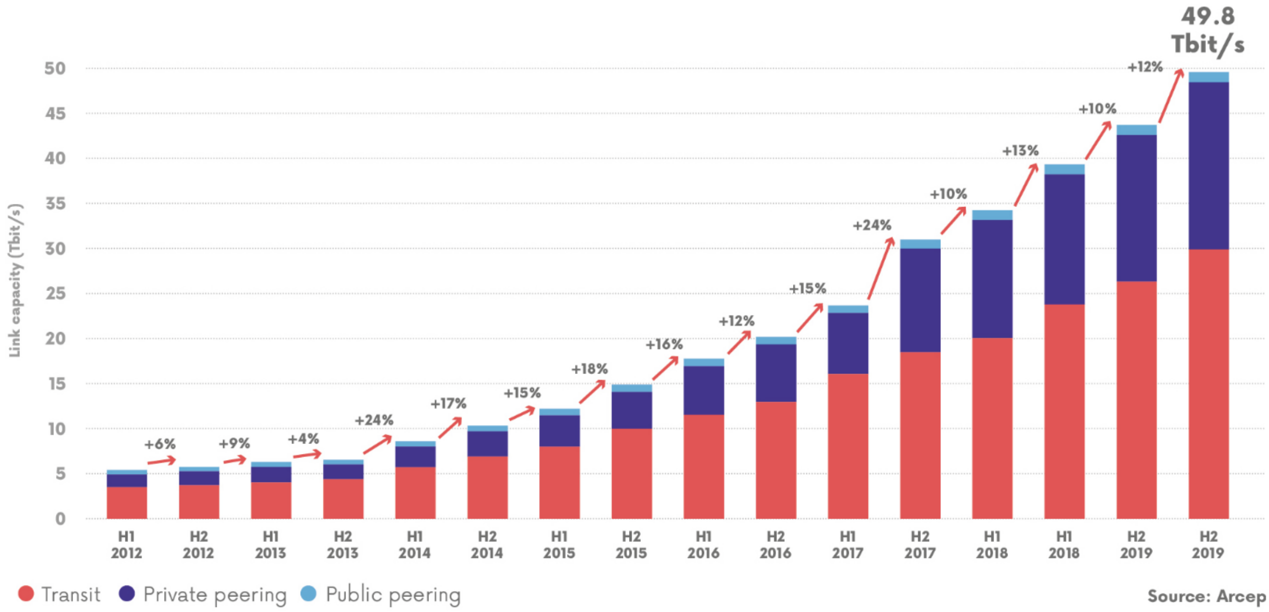


Source: Arcep

2.3. Evolution of installed capacities

Installed interconnection capacities have increased at the same pace as inbound traffic. Installed capacity at the end of 2019 is estimated at 49.8 Tbit/s, or 2.7 times the volume of inbound traffic. This ratio does not exclude occasional congestion incidents, which can occur on a particular link or links, depending on their status at a given moment in time, especially during peak traffic times.

INTERCONNECTION CAPACITIES OF THE MAIN ISPs IN FRANCE BETWEEN H1-2012 AND H2-2019



Source: Arcep

2.4. Evolution of interconnection methods

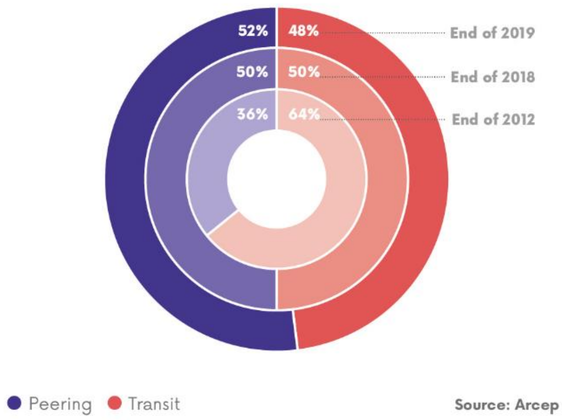
Peering vs. Transit

As mentioned earlier, there are two kinds of interconnection: peering and transit. The overall trend has been a sharp rise in peering's share of interconnection link, due chiefly to the increase in installed private peering capacity between ISPs and the main content providers.

Peering's share increased slightly last year, going from 50% at the end of 2018 to around 52% at the end of 2019. This rise can be attributed to the increase in private peering traffic, and of public peering traffic to a lesser extent. Private peering's relative share rose from 47.5% at the end of 2018 to 48.7% at the end of 2019, while public peering's has gone from 2.5% to 3.1%.

EVOLUTION OF PEERING AND TRANSIT FOR THE MAIN ISPs IN FRANCE

(in proportion of inbound traffic volume)



Source: Arcep

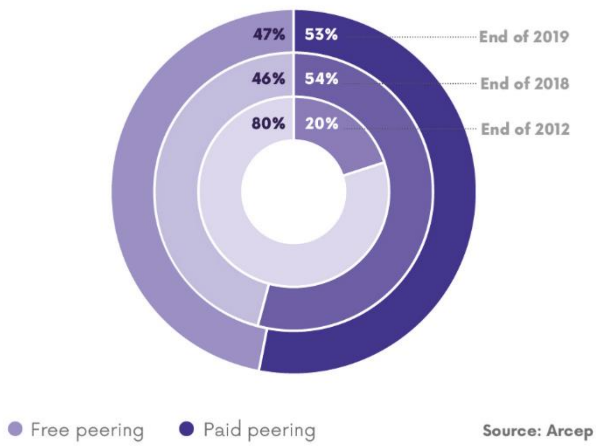
Free vs. paid peering

Both public and private peering can be paid peering.

Paid peering's percentage of interconnection traffic has remained relatively steady (54% at the end of 2018 vs. 53% at the end of 2019). This situation can be attributed to the concomitant increase of private peering traffic – of which a substantial percentage is paid, notably when there are considerable traffic asymmetries – and of peering between companies of a comparable size, which remains free, by and large.

EVOLUTION OF PAID PEERING PARTS FOR THE MAIN ISPs IN FRANCE

(in proportion of inbound traffic volume)



Source: Arcep

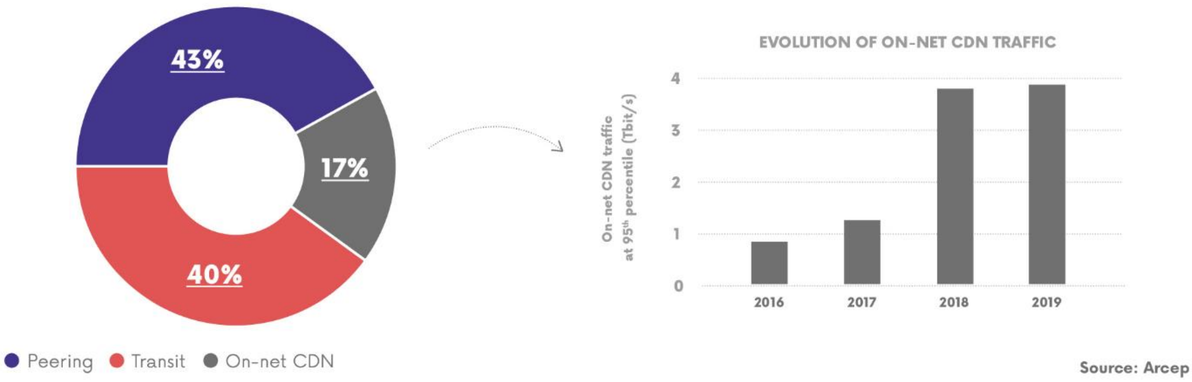
2.5. Traffic breakdown by interconnection type

As explained before, CAPs are working more and more to forge closer ties with end customers. To this end, they are creating partnerships with ISPs to host their content in cache servers in operators' networks. These on-net CDNs can either belong to the operator that hosts them or to a third party. In France, Google and Netflix are the two main players that incorporate servers in certain operators' network.

Between the end of 2018 and the end of 2019, traffic coming from on-net CDN to the top four ISPs' customers increased slightly to reach 3.9 Tbit/s. The percentage of traffic coming from on-net CDN (17%) is down compared to last year (21%), which confirms that operators continue to make heavy use of both peering and transit. This percentage varies considerably from one ISP to the next: for some operators this traffic represents not even 1% of their traffic to final customers, while for others it accounts for more than a third of the inbound traffic being injected into their networks.

In addition, the ratio of inbound to outbound traffic ranges from 1:5 and 1:14 depending on the operator. In other words, data made available through on-net CDN are viewed between five and fourteen times, on average.

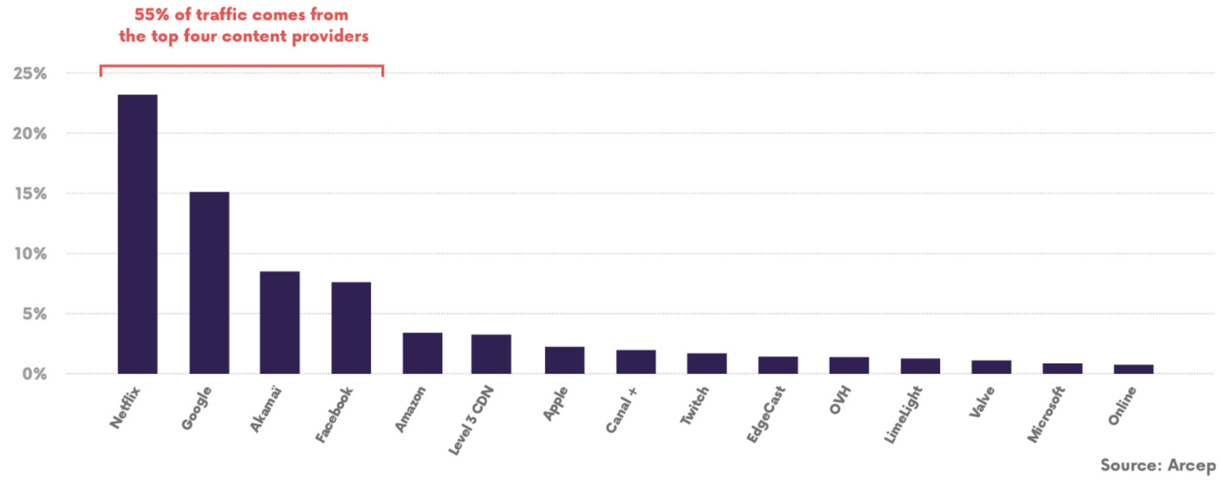
BREAKDOWN BY INTERCONNECTION TYPE OF TRAFFIC TO CUSTOMERS OF THE MAIN ISPs IN FRANCE (END OF 2019)



Source: Arcep

2.6. Traffic breakdown by origin

BREAKDOWN BY ORIGIN OF TRAFFIC TO CUSTOMERS OF THE MAIN ISPs IN FRANCE (END OF 2019)



More than half (55%)[15] of all traffic to France's main ISPs' customers comes from four providers: Netflix, Google, Akamai[16] and Facebook. This testifies to the increasingly clear concentration of traffic around a small number of players, whose position in the content market is more and more entrenched. Added to which, the gap in the volume of traffic coming from Netflix compared to other service providers is actually widening.

2.7. Evolution of costs

The range of transit and peering fees has not changed since last year. Based on collected data, the negotiated price of transit services still ranges from below €0.10 (excl. VAT) and several euros (excl. VAT) per month and per Mbit/s. For paid peering, prices range from between €0.25 (excl. VAT) and several euros (excl. VAT) per month and per Mbit/s.[17]

On-net CDNs are free in most cases. They can be charged for, however, as part of a broader paid peering solution that the CAP has contracted with the ISP.

[15] Traffic coming from the top four content providers accounted for 53% of all Internet traffic at the end of 2018.
[16] Akamai is a CDN that distributes content for several CAPs.
[17] Price ranges only reflect the prices paid by the operators that took part of the data interconnection gathering campaign of Arcep for transit, peering or on- net CDN services.

