Supervising data interconnection

What you need to know:

Inbound traffic to the main ISPs in France increased by around 21.5% YoY, to reach **43.2 Tbit/s at the end of 2022.**

54% of traffic to the customers of France's main ISPs come from five providers: Netflix, Google, Akamai, Meta and Amazon.

In 2022, video streams accounted for **65.93%** of global IP traffic transiting on electronic communications networks, according to Sandvine*.

* Sandvine, January 2022, The global internet phenomena report.

1. WHAT IS DATA INTERCONNECTION?

The internet is a network of networks: when an end user watches a video, it is routed over the Content and Applications provider's (CAP) network to the user's Internet Service Provider's (ISP) network. By the same token, emails travel over the sender's network to the recipient's network. To achieve this, the two networks (the CAP's and the ISP's in the case of a video) either need to be directly interconnected, or for there to be a chain of interconnected third-party networks providing the ability to connect them. On the internet, every network (called an autonomous system, or AS) is interconnected with a host of other networks belonging to content providers or other telecom operators.

Interconnection[1] therefore refers to the technical-economic relationship established between different parties to connect to one another and exchange traffic. It guarantees the network's global mesh and enables end users to communicate with another[2]. These relationships can take different forms (public or private peering, transit, CDN) all of which are detailed in the Interconnection Barometer[3].

A range of major stakeholders interconnect within the internet ecosystem:

- Content and applications providers (CAP): the owners of the content who rely on multiple intermediaries to carry their content to end users;
- Web hosting companies[4]: the 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 carrying traffic;
- Internet Exchange Points (IXP): 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 (CDN): networks that specialise in delivering large volumes of traffic to multiple ISPs, in different geographical areas and thanks to the use of cache servers located near end users, to optimise routing while improving performances and reducing costs;
- Internet Service Providers (ISPs): network operators that are responsible for carrying traffic to end users.

1 Definitions for the technical terms relating to interconnection that are used here can be found in the Barometer of Data Interconnection in France.

2 N.B. this report pertains solely to IP interconnection, or data interconnection (i.e. exchange of data on the Internet), and does not cover the interconnection of two operators' networks for the purpose of voice call termination.

3 ARCEP, June 2023, *Interconnection Barometer*.

4 More specifically, Article 6-1-Para. 2 of Act 2004-575 of 21 June 2004 on Trust in the digital economy defines web hosting companies as natural or legal persons that ensure, even free of charge, the storage of signals, written data, images, sounds or messages of any nature, provided by the service's addressees, for availability to the public via public online communication services.

IXPS, MEETING POINTS THAT ARE VITAL TO THE INTERNET'S WELLBEING

From a concrete standpoint, interconnection refers to a link between two machines belonging to different networks, inside a data centre. The challenge for smaller operators is to be able to connect with as many other players as possible, in a cost-effective fashion, notably by reducing the number of points of presence (PoP). This is where Internet eXchange Points (IXP) come in, providing every operator with an intermediary network that gives them the ability to connect their machines to machines belonging to every other IXP member entity at a single point of presence. This is what is known as public peering.

IXPs also contribute to the local internet mesh: they create links between operators at the local level (e.g. on a regional scale) and enable interconnection – including between the smallest players. These are dedicated exchange points between operators, CAPs and transit providers.

There are some 20 IXPs in France, spread out across the country (including overseas territories). They are managed by not-for-profit associations or companies.

The four main operators in France (Orange, SFR, Bouygues, Free) are all present on IXPs, which represent a total of around 0.2 Tb/s of outbound and around 0.9 Tb/s of inbound traffic, according to the data collected from these operators by Arcep. The two largest IXPs in France are France IX and Equinix.

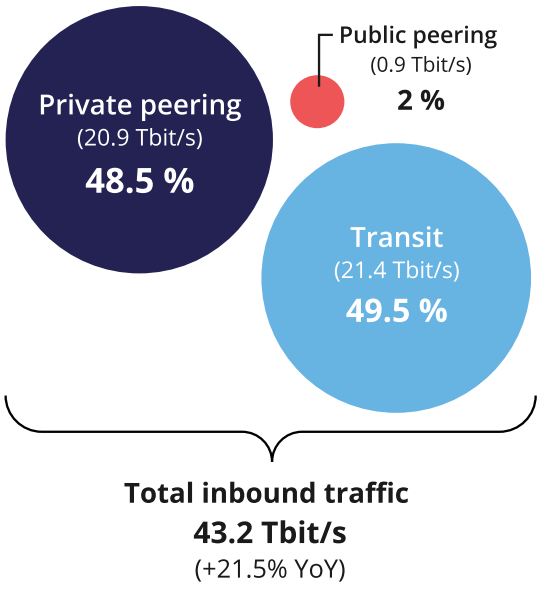
2. STATE OF INTERCONNECTION IN FRANCE

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 the second half of 2022. For confidentiality reasons, the published findings[5] are the aggregated results only of the main ISPs in France[6]. The detailed analysis is published in the Interconnection Barometer every year, of which a summary of the 2022 edition can be found below.

2.1. Inbound traffic

Inbound traffic to the four main ISPs in France increased from 35.6 Tbit/s at the end of 2021 to 43.2 Tbit/s at the end of 2022, which translates into an increase of 21.54% YoY. Half of this traffic comes from transit links. This relatively high rate of transit is due in large part of 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 carry traffic to the ISP's end customers. This ratio is much lower for the country's other ISPs who do not operate as transit providers, and so make greater use of peering.

BREAKDOWN OF INBOUND TRAFFIC AT THE INTERCONNECTION POINT, ON THE NETWORKS OF THE MAIN ISPS IN FRANCE (END OF 2022)

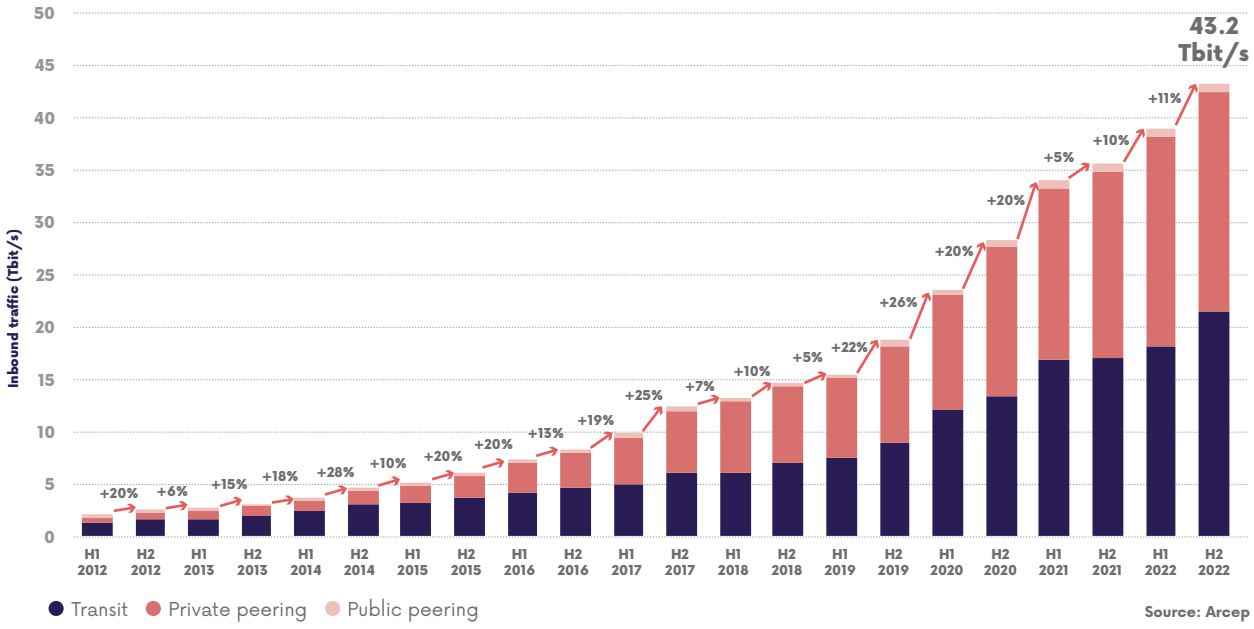


* Bouygues, Free, Orange, SFR.

5 Results obtained from operators' responses to information gathering on the technical and financial conditions of data interconnection and routing, whose scope is detailed in Arcep Decision 2017-1492-RDPI.

6 Figures for H2-2020 were amended slightly compared to 2020 figures following a change in methodology.

PROGRESSION OF INBOUND TRAFFIC AT THE INTERCONNECTION POINT TO THE MAIN ISPS IN FRANCE, FROM H1-2012 TO H2-2022



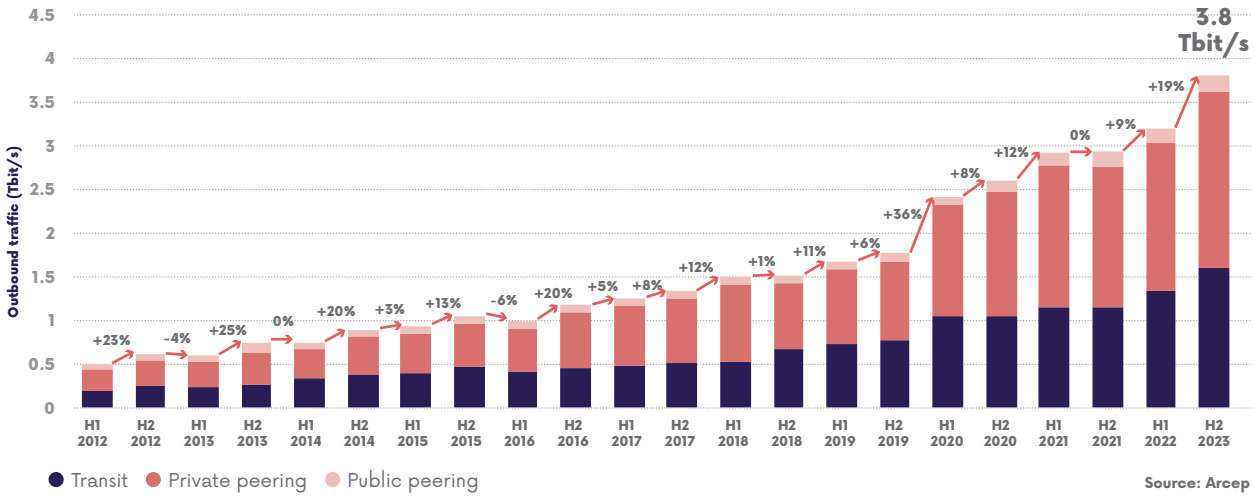
N.B.: corrections were made to certain calculations, amending data for 2016 and 2019. While not altering the observed trends, these corrections do explain the differences between this graph and the one from previous editions of the Report on the State of the Internet in France.

2.2. Outbound traffic

By the end of 2022, outbound traffic on the networks of France's four main ISPs stood at around 3.8 Tbit/s, or 30% more than at the end of 2021. This traffic increased by roughly sevenfold between 2012 and 2022.

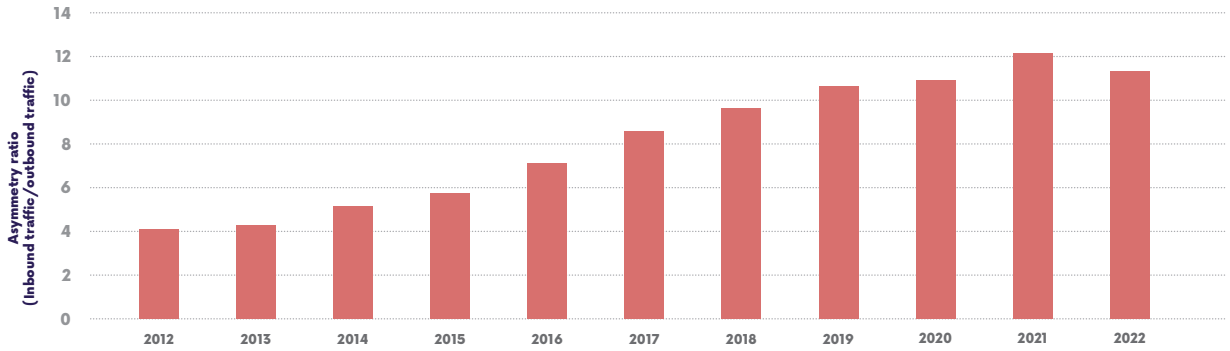
Outbound traffic is well below incoming traffic. Moreover, the asymmetry between the two has increased from a ratio of 1:4 in 2012 to one of more than 1:12 in 2021. This widening gap is due chiefly to the increase in the amount of multimedia content (audio and video streaming, downloading large media files, etc.) customers consume.

PROGRESSION OF OUTBOUND TRAFFIC AT THE INTERCONNECTION POINT FROM THE MAIN ISPS IN FRANCE, FROM H1-2012 TO H2-2022



N.B.: corrections were made to certain calculations, amending data for 2016 and 2019. While not altering the observed trends, these corrections do explain the differences between this graph and the one from previous editions of the Report on the State of the Internet in France.

ASYMMETRY RATIO BETWEEN INBOUND AND OUTBOUND TRAFFIC AT THE INTERCONNECTION POINT FOR THE MAIN ISPS IN FRANCE BETWEEN 2012 AND 2022



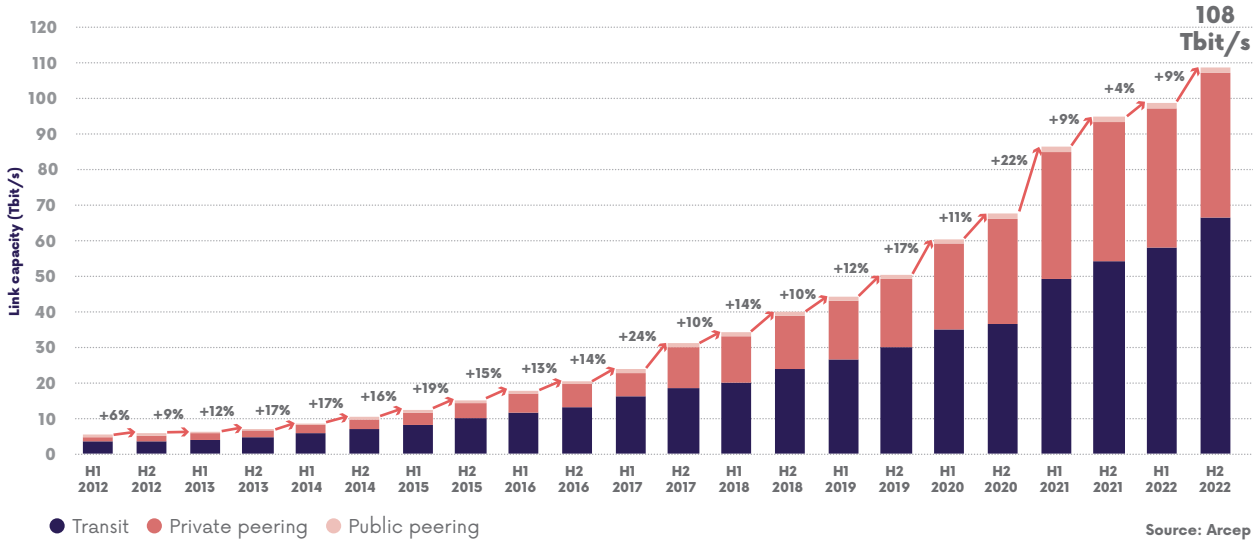
Source: Arcep

In 2022, the asymmetry ratio narrowed slightly to 1:11. In addition to traffic stream compression and optimisation efforts made by CAPs, which has reduced inbound traffic to ISPs, this decreased ratio can be attributed in part to the development of new peer-to-peer video traffic transport methods that increase outbound traffic (cf. sub-section 2.5.4. video traffic delivery).

2.3. Evolution of installed capacities

Installed interconnection capacities have increased at the same pace as inbound traffic. Installed capacity at the end of 2022 is estimated at around 108 Tbit/s, or 2.7 times the volume of inbound traffic. This ratio does not exclude occasional congestion incidents, which can occur between players on a particular link or links, depending on their status at a given moment in time.

PROGRESSION OF INTERCONNECTION CAPACITIES FOR THE MAIN ISPS IN FRANCE BETWEEN H1-2012 AND H2-2022



Source: Arcep

N.B.: corrections were made to certain calculations, amending data for 2016 and 2019. While not altering the observed trends, these corrections do explain the differences between this graph and the one from previous editions of the Report on the State of the Internet in France.

2.4. Evolution of interconnection methods

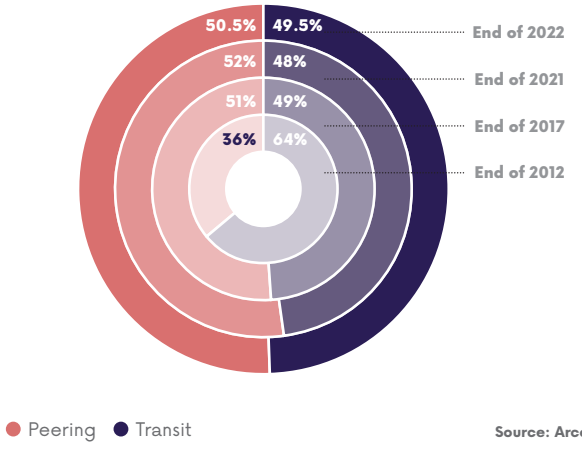
a. Peering vs. Transit

Generally speaking, peering's share of the total traffic volume has been increasing steadily, due chiefly to the increase in installed private peering capacities between ISPs and the main content and applications providers.

However, between the end of 2020 and the end of 2022, peering's share has been decreasing: from 53% at the end of 2020 to 52% at the end of 2021, and down to 50% at the end of 2022. The situation is due, on the one hand, to the increase in transit traffic (including traffic from Open Transit International) and, on the other, to some of the peering traffic being replaced by traffic coming from on-net CDNs.

The terms "internal" or "on-net" CDN refer to an agreement between service providers (CAP, CDN) and ISPs whereby the CAP or CDN installs cache servers on the ISP's network, to store their content on cache servers located inside the ISPs' network, thereby optimising quality of service by bringing content closer to end users[7]. These on-net CDN can either belong to the operator that hosts them, or to a third party. The most notable examples are the Netflix OCA (Open Connect Appliance)[8] and Google Global Cache (GGC) servers. In addition to bringing content closer to end users, the use of an on-net CDN installed inside an ISP's network creates the ability to upload video content to servers during off-peak times, instead of waiting to satisfy user requests for it during peak hours. Arcep has observed an expansion of on-net CDNs since 2016[9].

PROGRESSION OF PEERING VS. TRANSIT VOLUMES FOR THE MAIN ISPS IN FRANCE
(in proportion of inbound traffic volume)

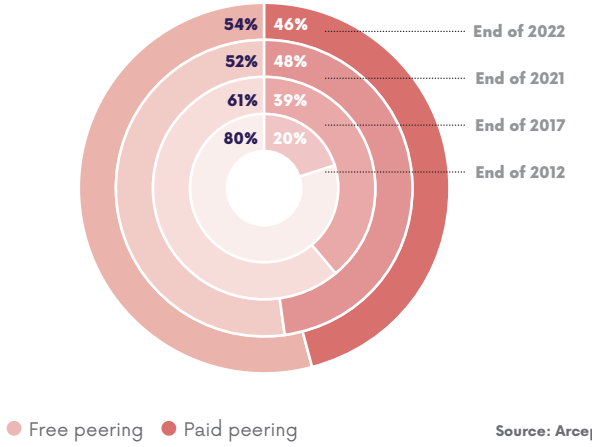


Source: Arcep

b. Free vs. paid peering

Like last year, peering's share of the total traffic volume changed very little for the four main ISPs in France, going from 48% at the end of 2021 to 46% at the end of 2022. This decrease can be explained, on the one hand, by the increase in free peering (private peering between players of comparable sizes and public peering) and, on the other, by the transfer of paid peering traffic between CAPs and ISPs to on-net CDNs.

PROGRESSION OF PEERING VOLUMES, WHETHER OR NOT SUBJECT TO A FEE AGREEMENT, FOR THE MAIN ISPS IN FRANCE
(in proportion of inbound traffic volume)



Source: Arcep

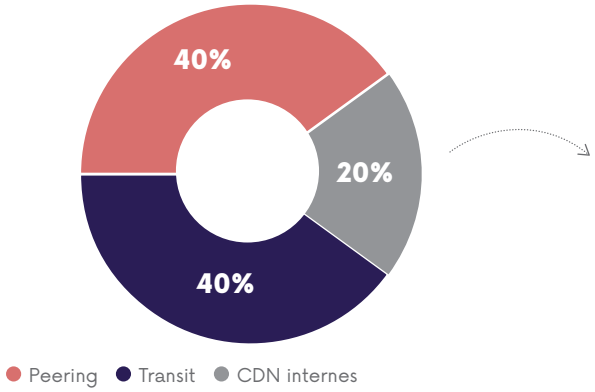
2.5. Traffic breakdown by interconnection type

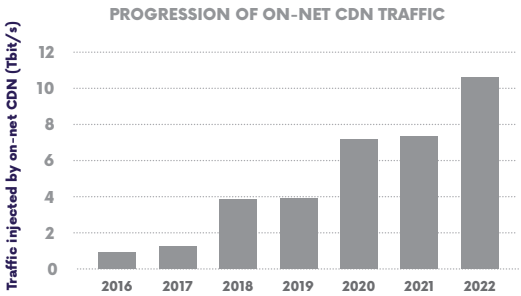
Between the end of 2021 and the end of 2022, traffic coming from on-net CDNs to the top four ISPs' customers continued to increase, to reach around 10 Tbit/s. If peering and transit remain ISPs' two most widely used interconnection methods, this year the percentage of traffic from on-net CDNs (20%) appears to have increased slightly compared to last year.

This percentage varies considerably from one ISP to the next: for some ISPs, inbound traffic from on-net CDNs represents around 6% of their traffic to final customers, while for others it accounts for more than a third (almost half) of the inbound traffic being injected into their networks. In addition, the ratio of inbound to outbound traffic still ranges from 1:8 and 1:15 depending on the ISP. In other words, data streams made available through on-net CDNs are viewed between eight and fifteen times, on average.

7 This trend is explained in the Interconnection Barometer, Chapter 1.3. See also: Stéphane Bortzmeyer, *L'interconnexion pour les nuls (interconnection for dummies)*.
8 Cf. https://openconnect.netflix.com/en_gb/ for further information.
9 Cf. Arcep, june 2022, Interconnection Barometer, Chapter 2.6.

BREAKDOWN OF TRAFFIC BY INTERCONNECTION TYPE (END OF 2022)





Source: Arcep

2.6. Video traffic delivery

In 2022, video streams accounted for 65.93% of global IP traffic transiting on electronic communications networks, according to Sandvine[10]. Video content is also found in other categories in this ranking, including social media which accounts for 5.26% of global traffic, online gaming (5.58%) and messaging solutions such as WhatsApp, Zoom, Microsoft Teams, Messenger, etc. (2.3%), still according to Sandvine. Video's substantial share of total online traffic can be attributed to the proliferation of sources (live/linear viewing online, replay and catch-up services, subscription video on demand services, social media, video chats on instant messaging, widespread use of video advertising, etc.). It is also due to the increased resolution of online videos, even though their efficient encoding can help limit growth of the volume of traffic they represent[11].

France is no exception here, and is part of this global trend. As indicated in the Barometer of Data Interconnection in France, the main content and applications providers – i.e. Netflix, Google, Meta and Amazon – account for a substantial portion of traffic, along with content transport companies that provide CDN services, such as Akamai and Lumen (which carry third parties' data).

2.7. Traffic breakdown by origin

Based on the data collected from ISPs[12], Arcep estimates the percentage of total aggregated traffic that content and applications providers and content transport providers (notably CDN) represent, when they can be identified[13].

It should be noted that data on interconnection and analysed traffic concern direct relationships between players, so content hosted via a CDN or third-party hosting company where there is no direct interconnection declared to the Authority would not be visible in the graph below. For instance, it is possible that a content provider that generates a significant amount of outbound traffic does not appear in this graph because it uses third parties to carry its traffic to the ISPs in question.

At the end of 2022, around 54% of all traffic to the customers of France's main ISPs come from five providers: Netflix, Google, Akamai, Meta and Amazon. This testifies to the increasingly clear concentration of traffic around a small number of players.

The relative size of several CDN providers in the traffic breakdown presented below, combined with the surge of certain players such as Lumen (which has gone from representing around 3% of inbound traffic to around 6%), confirms the major role these players have in the routing of internet traffic. For example, Disney+ appears in this ranking through its various CDNs (which include Akamai[14]).

10 Sandvine, January 2023, The global internet phenomena report.

11 Streaming content in UHD generates eight times more data traffic than high definition (HD) streaming, using identical encoding levels. Source: CGE, December 2019, *Reducing digital's energy consumption*.

12 Here too, aggregated data cover only the four biggest commercial ISPs in France.

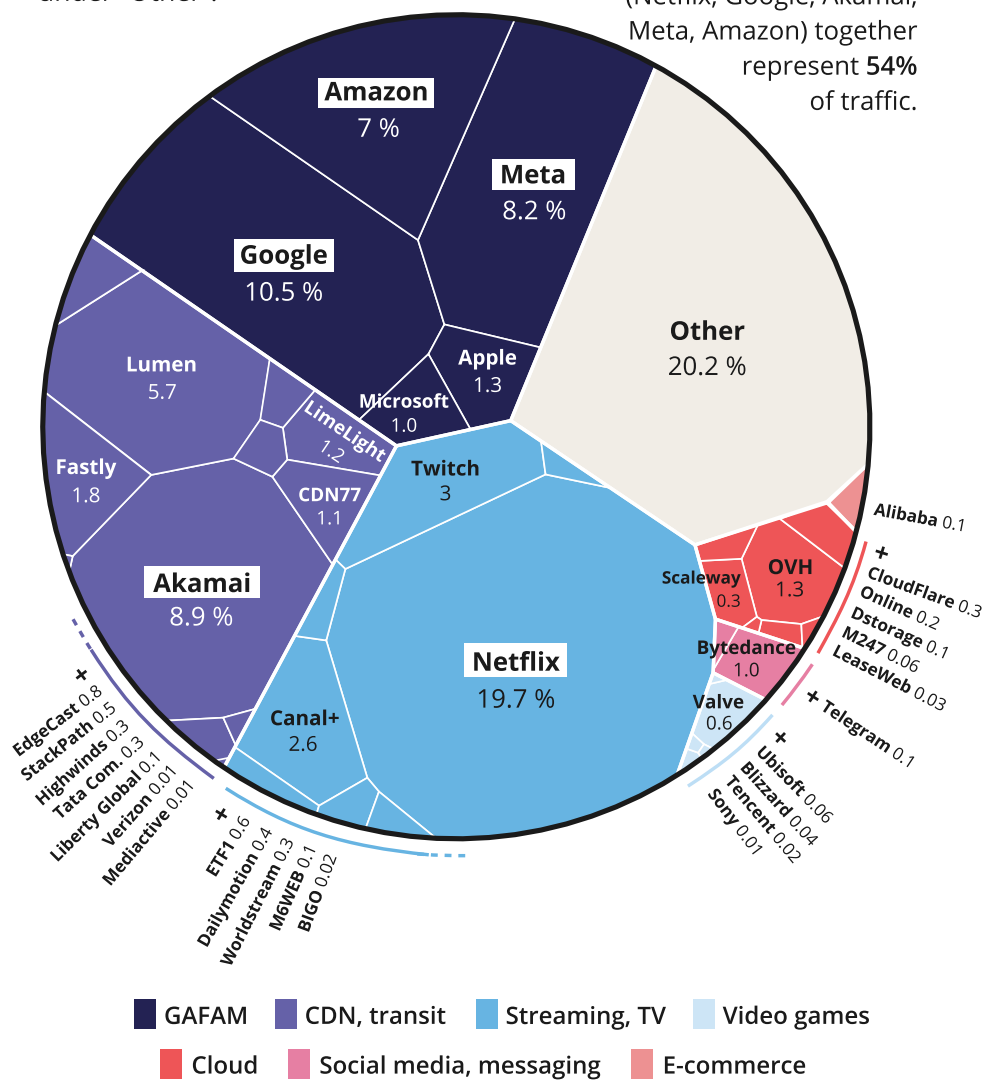
13 Transit providers and peering between ISP are not shown in the graph below.

14 *Le Parisien*, 10 February 2022, "Disney+ has close to 130 million subscribers, far more than expected".

BREAKDOWN BY ORIGIN OF TRAFFIC TO CUSTOMERS OF THE FOUR MAIN ISPS IN FRANCE (END OF 2022)

Percentage of inbound traffic at the interconnection point from 39 transport or content production companies, as reported by the main ISPs at the end of 2022. The remaining traffic is shown under "Other".

Top 5 companies (Netflix, Google, Akamai, Meta, Amazon) together represent **54%** of traffic.



* Bouygues, Free, Orange, SFR.

2.8. Price changes

Even if price ranges are the same by and large (from under 5 eurocents to a few euros, excl. VAT, per month and per Mbit/s), the fees charged for transit services decreased slightly in 2022 – in keeping with the observed trend of the past 10 years.

For paid peering, prices continue to range from around €0.20 (excl. VAT) to several euros (excl. VAT) per month and per Mbit/s.

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

CONTRIBUTION TO SPENDING ON INFRASTRUCTURE AND THE FUTURE OF NETWORKS

In early 2022, the European Commission published a proposed Declaration of Digital Rights and Principles which calls for the establishment of *"adequate frameworks so that all market actors benefiting from the digital transformation assume their social responsibilities and make a fair and proportionate contribution to the costs of public goods, services and infrastructures, for the benefit of all people living in the EU"*. This objective was confirmed by European Commissioners, Margrethe Vestager and Thierry Breton in May 2022: the Competition Commissioner stated that the issue of fair contribution to the networks should be considered *"with a lot of focus"*, while the Commissioner for Internal Market announced a legislative proposal on the matter[1].

These announcements echo a request from European operators, initiated by ETNO (European Telecommunication Network Operators Association). In May 2022, the association published a study by the consulting firm Axon, which analyses the annual increase in traffic and resulting investment needs. This publication highlights the role that leading content providers play in this growth[2]. Drawing on this study, ETNO asked that these companies increase their investments in the networks, reiterating a request made to regulators in 2012. Other operator associations then took a position on the matter, including the ECTA (European Competitive Telecommunications Association) which published its contribution to the debate in September 2022. This association stresses the need to safeguard the existing competition framework, stating that as data traffic continues to grow, *"any action leading to "Energy Sobriety", must be encouraged collectively by the entire digital ecosystem,"* which could include regulatory or financial incentives[3].

In December 2022, BEREC drafted a preliminary assessment of the proposed mechanism of direct financing for the networks from the largest content and applications providers in Europe. In this document, BEREC concludes that, given the current state of the interconnection market, such a mechanism is not justified, and underscores that broader analyses of large content providers' role in the future of the networks could prove useful.

Several other publications have since been produced by stakeholders. Content providers, for instance, have provided additional details on their own investments[4]; the Euro-IX association, representing IXPs in Europe, sent a letter to the Commissioner in charge of the matter on the potential impact of such a scheme, particularly for public peering[5]; academics too have shared their views on the subject[6]; and the Dutch government commissioned the firm Oxera to produce a study on one of the possible scenarios[7].

In February 2023, the European Commission launched a broad, 12-week exploratory consultation as part of the Connectivity Package, in the form of a questionnaire. Going beyond the original debate over large content providers' contribution to network financing, the questionnaire seeks to query stakeholders on the future of networks in Europe and its infrastructures. It focuses on four topics in particular: (1) technological and market developments; (2) fairness for consumers; (3) barriers to the Single Market and (4) a fair contribution by all digital players.

BEREC is contributing to the debate in 2023 by participating in this consultation and in European discussions on these topics.

1 Sébastien Dumoulin, Derek Perrotte, 3 May 2022, "Bruxelles veut faire payer les réseaux télécoms aux Gafam", *Les Echos*.
2 Etno, 02 May 2022, *Europe's internet ecosystem: socio economic benefits of a fairer balance between tech giants and telecom operators*.
3 ECTA, 13 September 2022, *Ecta statement on suggested contribution to network investment* ("fair contribution" debate)
4 Analysys Mason, October 2022, *The impact of tech companies' network investment on the economics of broadband ISPs*.
5 Euro-IX, January 2023, *'Fair share debate and potential impact of SPNP on European IXPs and Internet ecosystem'*.
6 For instance: Barbara van Schewick, 14 April 2022, *Comments on Draft BEREC Guidelines on the Implementation of the Open Internet Regulation in response to BEREC's Public Consultation*. Annie Blandin, Patrick Maillé, Bruno Tuffin, 2022, *Un revirement européen sur la neutralité du net ?* Bruno Jullien and Matthieu Bouvard, March 2023, *Fair cost sharing: big tech vs telcos.*
7 Oxera, 30 January 2023, *Proposals for a levy on online content application providers to fund network operators. An economic assessment prepared for the Dutch Ministry of Economic Affairs and Climate*.