AXON

Excellence in Business

Europe's internet ecosystem: socio-economic benefits of a fairer balance between tech giants and telecom operators

Axon Partners Group

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Contents

Executive Summary

Over the last decade, Internet use has become essential in the daily life of millions of Europeans, with data traffic consumption growing at double digits annually. This evolution has been supported by a massive transformation of fixed and mobile telecom networks, from the prevalent copper and 3G-based solutions of the early 2010s, to much more advanced Very High-Capacity Networks ('VHCN'), including FTTH and 5G, consumers can now benefit from.

This network transformation has not, however, come without a substantial effort and cost: according to ETNO's reports, network operators have invested over €500 billion during the last ten years in the development of their fixed and mobile telecoms networks in Europe.

It is worth noting, however, that most of the data traffic growth over the last decade has been driven by a small number of leading Over-The-Top (OTT) providers, with little or no economic contribution to the development of national telecom networks, who now account for over 55%[1] of all network traffic. A recent study by Frontier[2] has estimated that – just looking at the picture today - traffic driven by OTTs could generate costs of up to €36-40 billion per year for EU telcos.[3]

Telecom network operators are in no position to negotiate fair commercial terms for their networks' ever-increasing use by the leading OTTs: their offerings are now indispensable to users; their market dominance is ever more entrenched; and there are no economic, regulatory or policy mechanisms in place to help restore a more level playing field. This situation is undermining many network operators' ability to make a viable return on their investments and, if sustained further, could threaten some of the European Commission's "Digital Decade" connectivity targets.

Our analysis in Section 3 of this Report shows that remedying this situation could bring substantial socio-economic benefits. As an illustrative example, an annual contribution of €20 billion by OTTs to the development of telecoms infrastructure in the EU would raise

1 Sandvine, "The Mobile Internet Phenomena Report", 2022; Available at: https://www.sandvine.com/phenomena

2 Frontier economics. "Estimating OTT traffic-related costs on European telecommunications networks", 2022. Available at: https://www.telekom.com/resource/blob/1003588/384180d6e69de08dd368cb0a9febf646/dl-frontier-g4-ott-report-stc-data.pdf

3 This impact is expected to worsen over time unless proper regulatory action is taken.

GDP by as much as €72 billion by 2025, with a parallel increase in employment of up to 840,000 jobs annually; positive effects on both user experience and innovation levels; and a steep reduction of energy consumption and carbon emission levels.

A solution to this problem therefore seems necessary and consistent with the European Commission's recent commitment to developing adequate frameworks so that "*all market players benefiting from the digital transformation (…) make a fair and proportionate contribution to the costs of public goods, services and infrastructures*".[4]

Against this background, Section 4 of this Report refers, in broad terms, to some of the options that could help the EU meet this objective. A choice between any of these options must also consider that while IP transit agreements can offer an opportunity for a direct contractual interface between OTTs and network providers, the bulk of OTT-related costs on the network side is concentrated on the most capillary part of the national networks. A solution to the current asymmetry should thus rely on a more holistic approach.

Among possible solutions, tools for a contribution of OTTs to network costs could preferably be based on a regulated mechanism for direct agreements with network operators. The scope of such tools could also be limited to just a few, very large OTTs, in line with the EU approach taken for the regulation of "gatekeepers" under the Digital Markets Act, and "very large online platforms" under the Digital Services Act.

On substance, the tools to be adopted could work ex post and/or ex ante, and include principles of fair and proportionate compensation, and an enforcement or dispute resolution mechanism. A direct compensation mechanism, be it through an ex ante or ex post approach, would seem to combine an effective solution with some commercial flexibility. By contrast, indirect compensation solutions would probably be more complex to set up and could risk being misdirected or abused, thus missing the intended benefits.

Finally, any such mechanisms could be complemented with regulatory obligations for OTTs to manage their traffic more efficiently, so as to minimize unnecessary volume increases, without affecting quality of service. At the same time, such solutions will contribute to the achievement of EU energy efficiency and Green Deal targets by reducing energy consumption.

4 European Draft Declaration on Digital Rights and Principles for the Digital Decade, COM (2022) 28 final, 26.1.22

1. Introduction

Axon Partners Group Consulting S.L.U. ("Axon") has been commissioned by the European Telecommunications Network Operators' Association ("ETNO") to carry out a study on the implications of an unbalanced IP traffic market on European socio-economic welfare.

This study is structured as follows:

- **Section 2** provides an introduction to the problems experienced in the IP traffic market, recapitulates the overall situation in that market, quantifies the costs OTT-driven traffic may be generating on EU network operators, and discusses the root causes and potential consequences of the problems identified.
- **Section 3** assesses the socio-economic implications of resolving the current market imbalances between network operators and OTTs on various factors such as GDP, employment, innovation or energy consumption.
- **Section 4** discusses a number of high-level alternatives that could be followed in the EU to mitigate the problems deriving from the current situation and thus ensure that "*all market players benefiting from the digital transformation (…) make a fair and proportionate contribution to the costs of public goods, services and infrastructures*".

Axon thanks ETNO and its members for their support and contributions in the preparation of this report.

2. Analysis of the problem at hand

2.1. The EU telecommunications market today

The explosive growth of Internet traffic in the last 20 to 30 years, the ubiquitous presence of smartphones, and the development of ever faster electronic communications networks have led to the development of a digital economy with new high value-added services to citizens. This digital economy now represents 4-9% of the GDP in European countries, according to European Commission ("EC") data, showing some signs of growth since 2015.[5] However, considering that most economic activities nowadays rely on digital processes and an underlying digital infrastructure, the real GDP impact driven by digitization can be expected to be even higher than these figures.

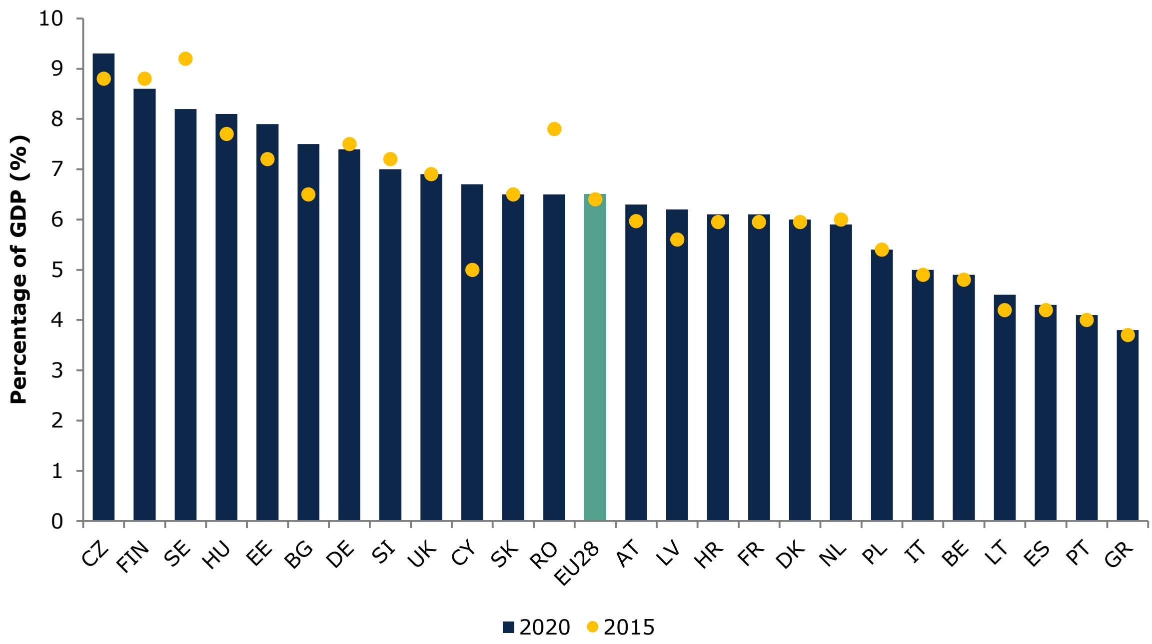

Exhibit 2.1: The digital economy as a percentage of GDP in 2015 and 2020 [Source: Axon, based on data from the European Commission]

An important share of digital services to users is provided by Internet enterprises, with market leaders among them now occupying an ever-present role in consumers' daily lives.

5 European Central Bank, "The digital economy and the euro area", 2020; Available at: https://www.ecb.europa.eu/pub/economic-bulletin/articles/2021/html/ecb.ebart202008_03~da0f5f792a.en.html

Leading examples of such Internet giants and household names include Facebook (now Meta), Amazon, Netflix and Google (a group commonly referred to as "FANG").

All these enterprises rely on the public Internet and fixed or mobile telecommunications networks to reach their customers. As the services of Internet enterprises need to run on top of existing telco infrastructures, the enterprises in question are commonly referred to as OTTs (Over-the-top).

Although there is no standard definition of OTTs and their services, there is a degree of consensus on the meaning of these terms, as illustrated in the below examples of the definition of "OTT services" proposed by international organisations:

- **ITU**[6]: An application accessed and delivered over the public Internet that may be a direct technical / functional substitute for traditional international telecommunications services.
- **BEREC**[7]**:** Content, a service, or an application that is provided to the end-user over the public Internet.
- **Council of Europe**[8]**:** OTT services refer to the delivery of audio, video, and other media over the Internet without the involvement of a network operator in the control or distribution of the content.

Overall, the Exhibit below provides a simplified value-chain for the provision of Internet services, illustrating the role of OTTs, network operators and end-users:

[6] ITU, "Economic impact of OTTs on national telecommunication/ICT markets", 2021; Available at: https://www.itu.int/dms_pub/itu-d/oth/07/23/D07230000030001PDFE.pdf

[7] BEREC, "BEREC Report on OTT services", 2016; Available at: https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/5751-berec-report-on-ott-services

[8] Council of Europe (European Audiovisual Observatory), "VOD, platforms and OTT: which promotion obligations for European works?", 2016; Available at: https://rm.coe.int/1680783489

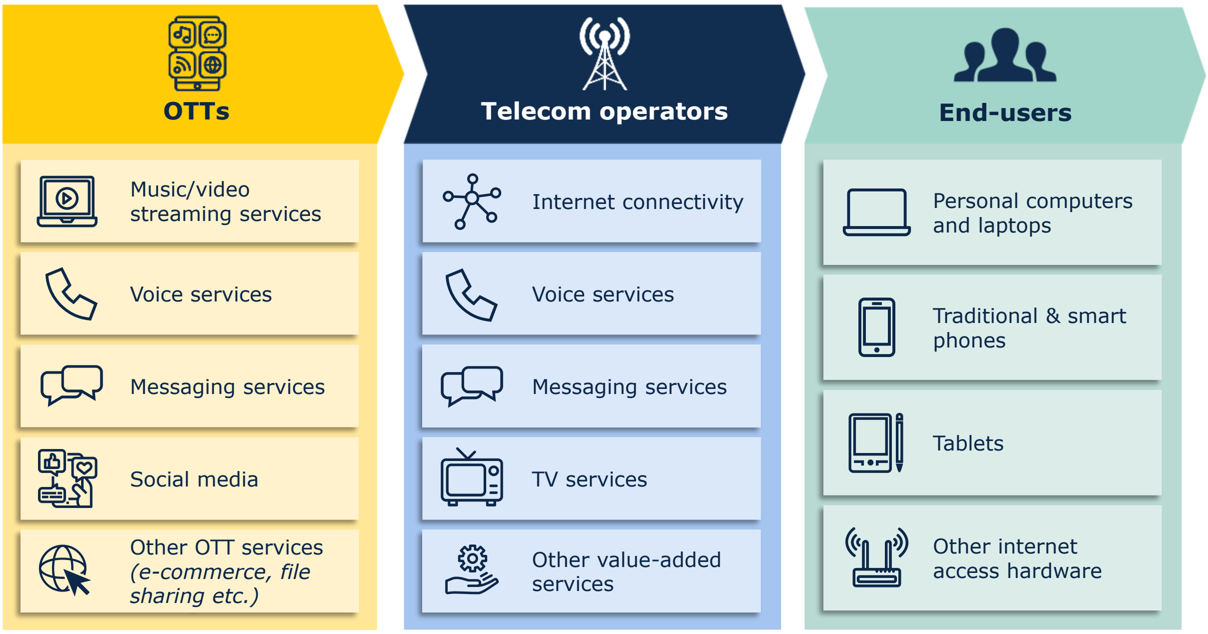

Exhibit 2.2: OTT-telco service provision value chain [Source: Axon]

As can be seen in this value chain, and despite some competition between network operators and OTTs for particular services (e.g., voice, TV), their respective services and roles are also complementary, with important synergies:

- OTTs develop value-added services, which end-users seek out for multiple reasons, to the benefit of the overall economy;
- Telecom network operators provide the underlying infrastructure, as the fabric needed to bring both these and telcos' own services to end-users. What's more, these telco operators make important network investments (e.g., very high-capacity core and access networks, including 5G and FTTx, etc.) so that the services provided by the OTTs can grow and improve in quality.[9] In return, users benefit from these networks to access the latest OTT services, as well as basic government, educational and health services.

From one perspective, this should be a mutually beneficial relationship, spurring a virtuous cycle, and benefiting all links in the value chain, as illustrated below.

[9] While OTTs do also contribute to the deployment of ICT infrastructure, they are only focused on CDNs and submarine cables, and not on the most capillary – and expensive - part of the network.

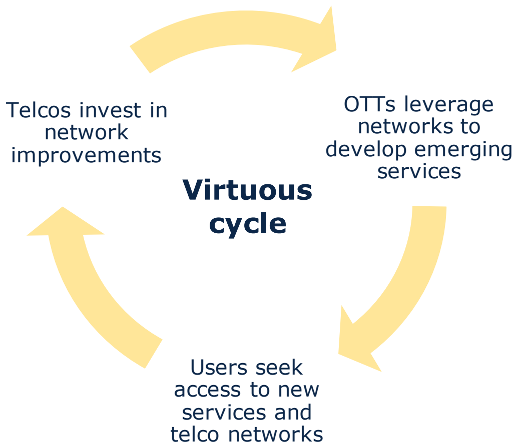

Exhibit 2.3: Investment and adoption virtuous cycle in telco/OTT [Source: Axon]

However, for a number of reasons, such a virtuous cycle does not yet fairly and proportionately benefit all links in the chain, with resulting asymmetries in the outcomes for telcos and OTTs.

On the one hand, it is apparent that the rise of OTTs over the last years has not led to any significant increase of consumer demand for telecommunications services, in terms of either subscriber numbers or ARPU:

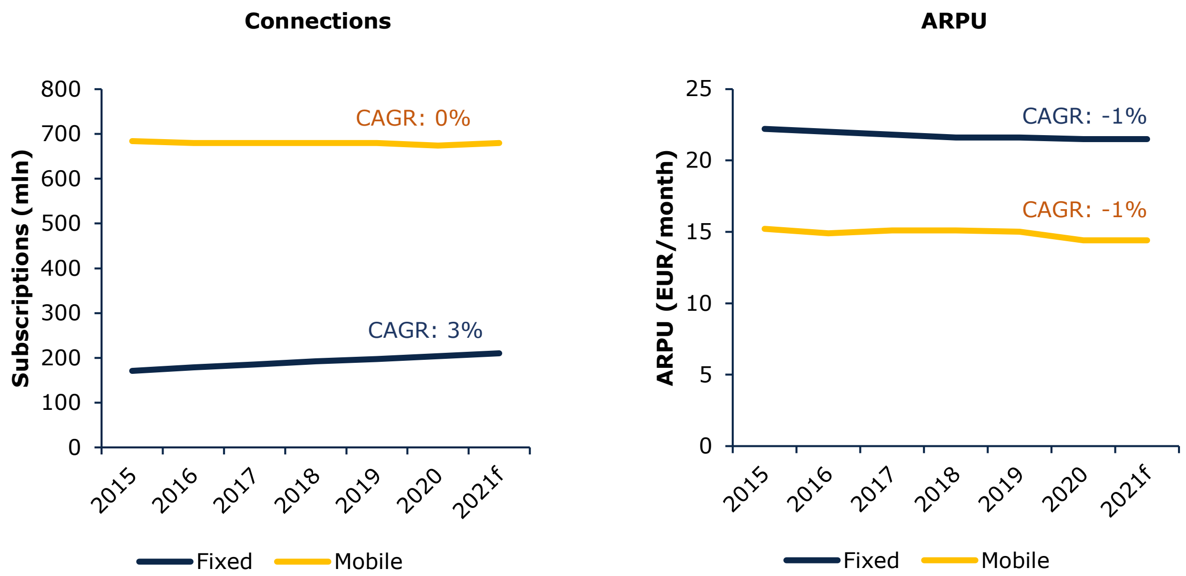

Exhibit 2.4: Evolution of EU telcos' subscriptions and ARPU since 2015 [Source: Axon based on data from ETNO and GSMA]. Note: Mobile subscriptions refer to total SIM connections (excluding licensed cellular IoT) while fixed subscriptions refer to fixed broadband connections.

On the other hand, the breakdown of this virtuous cycle is also apparent when comparing the financial performance of OTTs with that of network operators, as illustrated in the below exhibit.

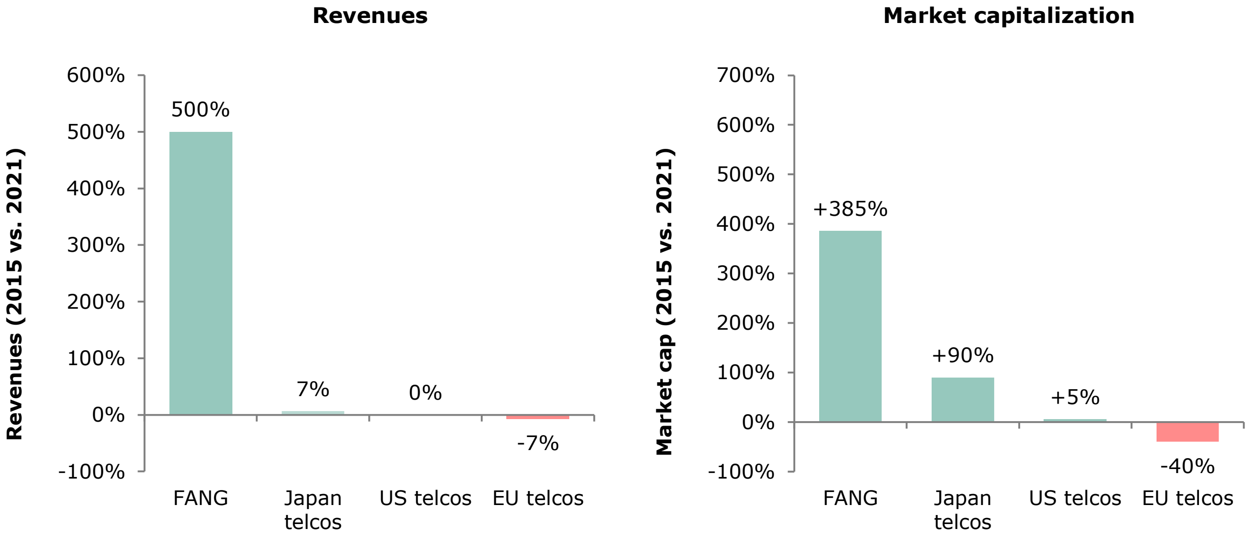

Exhibit 2.5: Revenue growth and market capitalization growth of European telcos, Japan telcos, US telcos, and FANG (2015 vs. 2021) [Source: Axon based on operator financial reports[10], ETNO[11], STOXX® Europe 600 Telecommunications, Nasdaq]

Arguably, some differences between the performance of these players could be expected due to underlying market dynamics. For instance, OTTs generally (and FANG, in particular) tend to be global enterprises, with virtually unlimited space for growth, advantages in the scalability of their business model (as compared, e.g., to a fixed telecoms network), and limited need for "sunk" investments compared to telcos. These aspects are reflected in the respective market capitalization and revenue growth of OTTs and telcos. At the same time, one must also recognize that, as shown in the previous exhibit, the situation for telcos in some other jurisdictions has been better than that of their EU peers, in terms of both revenues and market capitalization.

Revenue decline and the overall worsening of the financial situation of EU telcos is also having an important impact on their investments. In particular, EU telcos are forced to push the accelerator in terms of capital intensity (measured as yearly investments over total yearly revenues), in order to keep up with the necessary investments required to

10 FANG revenues include all revenues in the financial statements of Facebook and Netflix and only OTT-related revenues in the financial statements of Amazon ('AWS' and 'Subscription services') and Google ('YouTube ads', 'Google Cloud', and 'Google other').

11 ETNO, "The State of Digital Communications 2021", 2021; Available at: https://etno.eu/downloads/reports/the%20state%20of%20digital%20communications%202021.pdf

achieve connectivity targets and cope with traffic increase. In turn, capital intensity for EU telcos (which has been, historically, much higher than for their peers in other jurisdictions) is becoming higher than ever:

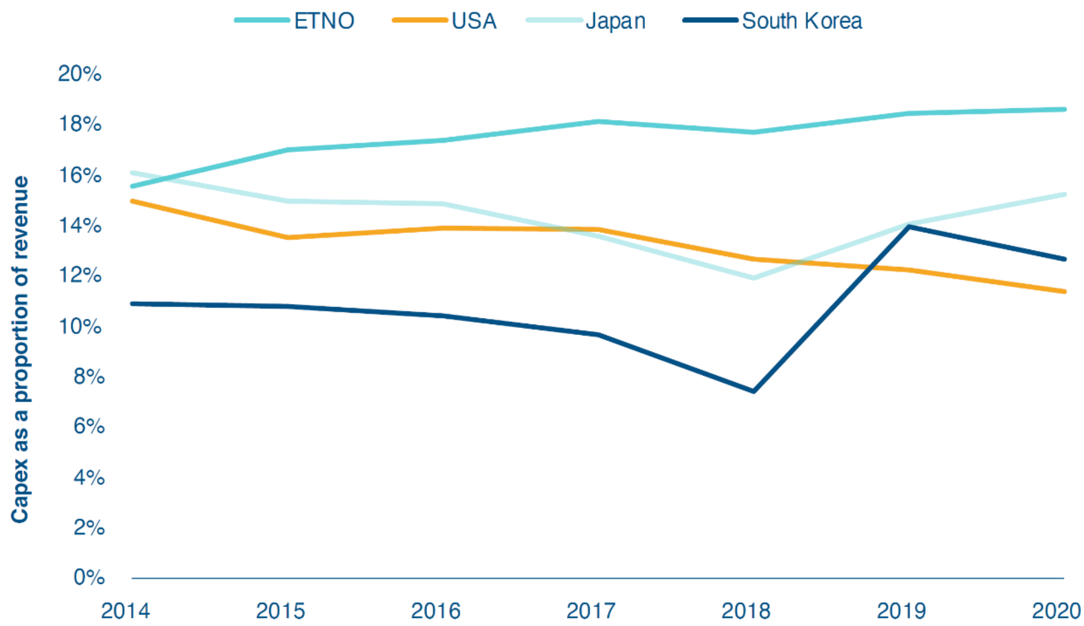

Exhibit 2.6: Capital intensity in home markets from ETNO members, and comparable leading operators in the USA, Japan and South Korea [Source: ETNO]

Despite this extra effort, the EU telco market, as a whole, is still lagging behind other world regions in the deployment/availability of new technologies.

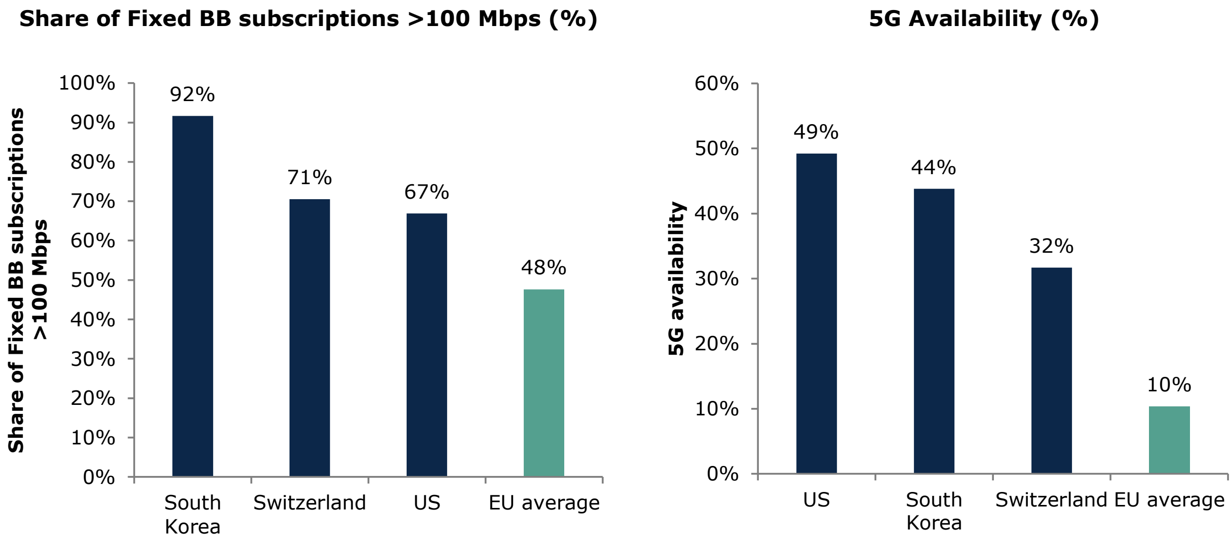

Exhibit 2.7: Comparison of the status of fixed VHCN networks and 5G availability in the EU[12] compared to other leading countries [Source: Axon based on data from OECD[13] for the share of fixed BB subscriptions >100 Mbps and Ookla[14] for 5G availability]

In the absence of any change to the current situation (this report does not explore the contribution of the current market structure and regulatory framework to the problem at hand), the gap between EU and other leading markets may only be expected to broaden, while EU telcos' financial health is being increasingly undermined, due to – among other factors - the capital investments required to deal with exponential traffic growth[15].

2.2. Analysis of traffic handled by EU telcos

One of the main global features of telecommunications network traffic in the last 10-20 years has been its radical shift from voice-centric to data-centric. This shift has accelerated in the last 5 years. Moreover, as discussed below, this trend is expected to continue, and indeed become even more pronounced in the years to come.

12 Due to the lack of data for some countries, the data presented for the "EU Average" are not representative for all countries in the EU-27. In particular, 23 countries are considered in the fixed broadband data and 17 countries are considered in the 5G availability data.

13 See the report "2.1. Fixed broadband subscriptions per 100 inhabitants, per speed tiers (June 2021)" available at https://www.oecd.org/sti/broadband/broadband-statistics/.

14 Ookla, "Growing and Slowing: The State of 5G Worldwide in 2021", 2021. Availablet at: https://www.ookla.com/articles/state-of-worldwide-5g-2021

15 E.g., see Ericsson's mobile data traffic outlook: https://www.ericsson.com/en/reports-and-papers/mobility-report/dataforecasts/mobile-traffic-forecast.

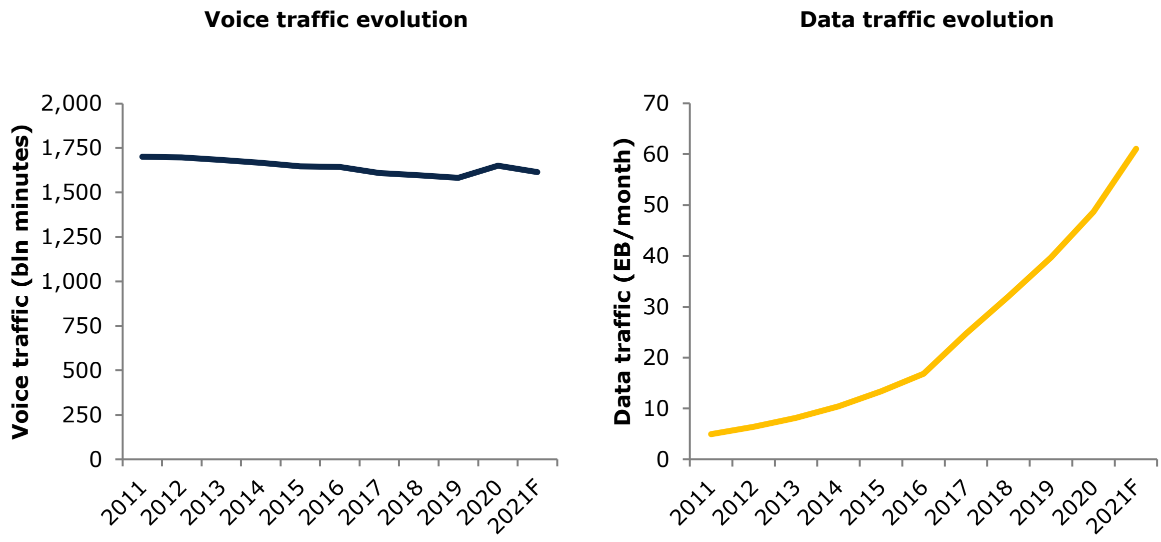

Exhibit 2.1: Evolution of voice and data traffic growth in Europe [Source: Axon based on data from ETNO[16] and Cisco[17]]

It is easy to draw a link between this shift and OTTs as the main generators of the data flooding today's electronic communications networks. However, OTTs do not all play a similar role in this context: some applications are much more data intensive than others, by virtue of their number of users, frequency of use and type of data they handle.

Indeed, we can observe that a major part of the data traffic today can be attributed to just a few major tech players, such as Meta (Facebook, Instagram, WhatsApp), Alphabet (Google search, YouTube), Apple (iTunes, iCloud, AppStore), Amazon (AWS, Amazon Prime), Microsoft (MS Office, Xbox), and Netflix. Combined, these six players alone accounted for over 56% of all global data traffic (including fixed and mobile networks) in 2021, as shown below:

16 ETNO, "State of Digital Communications 2022", 2022; Available at: https://etno.eu/component/attachments/attachments.html?task=download&id=8165

17 Cisco Virtual Networking Index Reports.

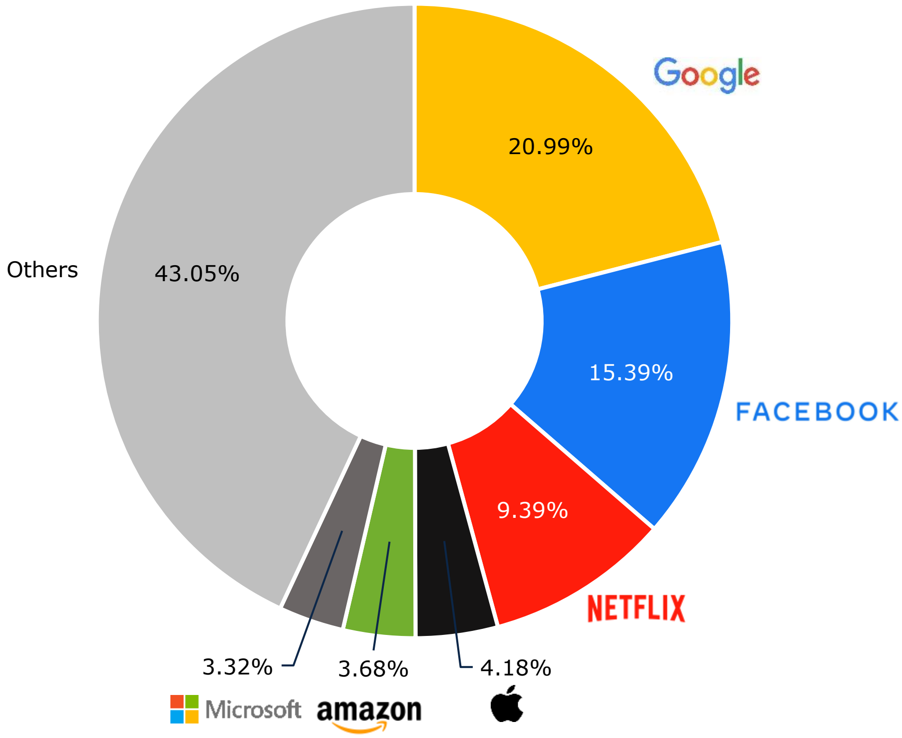

Exhibit 2.2: Global traffic share of OTTs, 2021 [Source: Axon based on Sandvine[18]]. Note: The players specifically highlighted in this exhibit are the same as in Sandvine's report.

From a different perspective, video, social and gaming platforms alone account for over 70% of the global internet traffic, as the exhibit below illustrates:

[18] Sandvine, "The Mobile Internet Phenomena Report", 2022; Available at: https://www.sandvine.com/phenomena

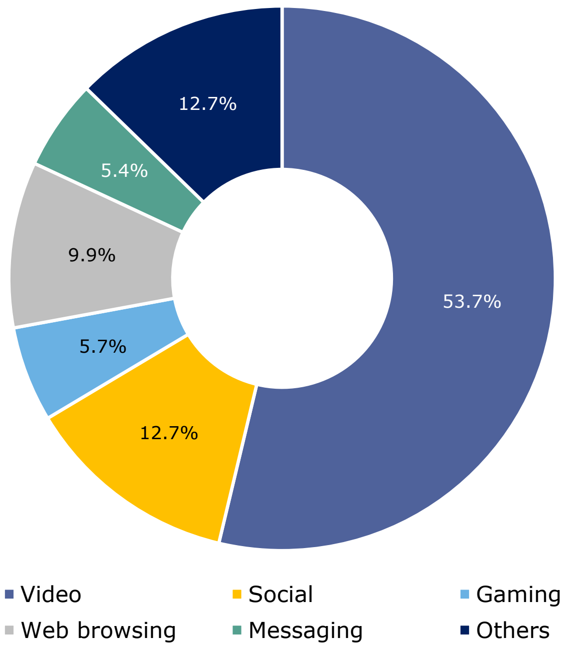

Exhibit 2.3: Global traffic share of different OTT services/platforms, 2021 [Source: Axon based on Sandvine[19]]. Note: Others include marketplace, file sharing, cloud, VPN, etc.

Furthermore, data growth is not expected to stop. The average mobile user is expected to use 16.2 GB/month in 2023, compared to 8.5 GB/month in 2021, while a fixed broadband line is expected to use 454 GB/month in 2023 compared to 293 GB/month in 2021[20]. There are a number of reasons behind this trend:

- Increasingly data-intensive content, such as higher-quality video streaming and online gaming;
- Proliferation of high-speed access networks including, in particular, Fibre-to-the-home (FTTH) and 5G;
- Rise in smartphone subscriptions, with improved device capabilities (e.g., 5G-ready devices);
- Digitalisation of the European society, with emergence of various new applications and services using the Internet (e.g., AR/VR, metaverse).

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[19] Sandvine, "The Mobile Internet Phenomena Report", 2022; Available at: https://www.sandvine.com/phenomena

[20] ETNO, "State of Digital Communications 2022", 2022; Available at: https://etno.eu/component/attachments/attachments.html?task=download&id=8165

While consumers are understandably eager to unlock the full potential of OTT services and experience their benefits, it may be argued that some portion of this traffic is not optimally generated or handled, as the consumer is not directly involved in the OTT traffic generation (i.e., not generating it consciously) but still consumes traffic as if he/she effectively is. Typical examples may include:

- During the first days of the COVID-19 pandemic, acknowledging the surge in traffic in operators' networks due to users' increased online activities (e.g., video conferencing, gaming, remote learning), the European Commission and European regulators called on streaming services, telecom operators and end-users to cooperate in a collective effort to prevent network congestion.[21] In response to this call, several tech giants (e.g., Netflix, YouTube, Amazon) took steps to voluntarily adjust the quality of their streaming services for a period of time, such as by cutting the streaming rate by around 25 percent or setting the default quality to standard definition.[22] Despite the resulting supposedly lower quality streaming, consumers did not report any significant difference in their quality of experience. Moreover, notwithstanding the surge in demand, the associated electricity consumption is reported to have remained flat. This is a clear example that higher bandwidth is not always indispensable for the benefit of the end-users, and that OTTs could do a better job at optimising or render more efficient the way they deliver their traffic to EU telcos.
- The video auto-play feature is now quite common across major OTT platforms. It allows next video content to be loaded and played without the user's engagement. The pioneer of this was Facebook, which launched its video auto-play feature in 2013 for the US. Since then, videos immediately start playing when users scroll through their feed. With the addition of this feature, Facebook experienced a 200% increase in US Facebook fixed data traffic and a 60% increase in mobile data traffic compared to the previous year. The vast share of this extraordinary growth was attributed to the auto-play feature.[23] Similarly, Netflix and YouTube also have episode / video auto-play on by default (consumers can turn it off manually). This may result in users generating unnecessary data traffic if they forget to stop streaming.

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21 European Commission, "Commission and European regulators calls on streaming services, operators and users to prevent network congestion", 2020; Available at: https://digital-strategy.ec.europa.eu/en/news/commission-and-european-regulators-calls-streaming-services-operators-and-users-prevent-network

22 mLex, "Netflix, YouTube cut bandwidth use in Europe with Covid-19 crisis; Asia, US stand firm", 2020; Available at: https://mlexmarketinsight.com/news-hub/editors-picks/area-of-expertise/technology-media-telecoms/netflix-youtube-cut-bandwidth-use-in-europe-with-covid-19-crisis-asia-us-stand-firm

23 Sandvine, "Global Internet Phenomena Report", 2014; Available at: https://www.sandvine.com/hubfs/downloads/archive/2014-2h-global-internet-phenomena-report.pdf

- "Pre-fetching" practices allow OTTs that monetize their services through ads to download the content in the ad's link when this first appears on the user's screen, even before the user clicks on it. If the user clicks on the ad afterwards, the linked page is loaded from the initial cache. In those cases where the user does not click on the ads shown to him/her, the traffic generated to pre-fetch the content is simply useless.

At the same time, we can observe that OTTs do, indeed, take some steps towards increasing the efficiency of the media they use, e.g., through the use of latest high-efficiency protocols and encoding techniques, and Content Delivery Networks (CDN) and/or caches. However, as seen already, these measures are not enough: data traffic keeps increasing exponentially, leading to higher costs for EU telcos, especially in the most capillary part of their networks.

The fact remains, therefore, that without any monetary incentives for OTTs to ensure an optimal generation of traffic (i.e., traffic that is essentially demanded by the end user), these perceive traffic offloading to EU telcos as being free of charge, thus generating a "tragedy of the commons" problem.

For this reason, we believe it is important to establish a price signal that will, on the one hand, allow telecom operators to increase their investment in very high-capacity networks and, on the other hand, create incentives for OTTs to optimize their traffic volumes, especially by reducing inefficiently generated traffic. The need for such adjustments, while not sufficient to solve the problem at hand, is evident in light of the present situation's serious costs for telcos – as described in the next subsection – and its broader negative externalities in the form of increased energy consumption and CO_2 emissions.

2.3. Quantification of costs borne by EU telcos from OTT traffic

As may be inferred from the previous subsection, given the high share of data traffic concentrated in the hands of a small number of OTT players, these might logically be expected to contribute to a significant portion of EU telcos' costs to manage and deploy the networks conveying such traffic. This is consistent with the "beneficiary pays" model that is largely followed in most infrastructure markets (e.g., energy, water and transportation).

In order to quantify this statement, Frontier Economics has recently performed a study[24] on behalf of Deutsche Telekom, Orange, Telefónica and Vodafone to estimate the costs that OTT traffic generated for fixed and mobile networks across the EU (EU-27 plus the United Kingdom) in 2021. This study calculates the total and incremental costs that OTT-driven traffic generates on EU network operators based on the current market situation and the methodology depicted below:

1. We first calculate annualised total and incremental traffic-related costs for each operator / jurisdictions.
2. We then identify the proportion of these traffic-related costs that can be assigned to OTTs based on the proportion OTT traffic vs total traffic
3. We then calculate annualised total and incremental OTT cost per subscriber for each operator / jurisdiction. This allows us to calculate a weighted average cost across all operators / jurisdictions.
4. Finally, we apply this weighted average to the total number of subscribers in Europe to obtain a Europe-wide incremental and total costs for fixed and mobile.

Exhibit 2.4: Methodology followed by Frontier to calculate OTT-driven costs for EU telcos [Source: Frontier Economics]

The results produced by Frontier are shown below:

Network type	Incremental costs[25]	Total costs[26]
Fixed networks	€ 2-6 bln	€ 8-10 bln
Mobile networks	€ 13-22 bln	€ 28-30 bln
TOTAL	**€ 15-28 bln**	**€ 36-40 bln**

Exhibit 2.5: Total and incremental OTT-driven costs for EU telcos [Source: Frontier Economics]

[24] Frontier economics. "Estimating OTT traffic-related costs on European telecommunications networks", 2022. Available at: https://www.telekom.com/resource/blob/1003588/384180d6e69de08dd368cb0a9febf646/dl-frontier-g4-ott-report-stc-data.pdf

[25] Described in Frontier's report as the "total OTT costs that vary with traffic".

[26] Described in Frontier's report as the "total costs that can be attributed to OTT traffic", which "include some costs which network operators incur to deliver traffic but which do not vary as the level of traffic increases".

2.4. Root sources of the problems identified

The problems discussed in the previous subsections result from an asymmetric bargaining power between major OTTs and telecommunications network operators in their commercial negotiation of the terms of transporting IP traffic. As will be discussed below, this asymmetry reflects the weak negotiating power of telcos vis-à-vis OTTs, and cannot be addressed through normal market mechanisms, without appropriate regulatory or policy measures that could help redress it.

As a direct result of this asymmetric negotiating position, large OTTs do not contribute (and are under no pressure to contribute) to the costs associated with investment in higher telecommunications network capacity and performance enabling the conveyance of OTT data traffic to end customers while maintaining QoS levels, despite this investment's fundamental and direct contribution to OTT services' growth and success. This situation raises questions that have been mirrored by the European Commission in its recent call for the development of adequate frameworks so that "*all market players benefiting from the digital transformation (…) make a fair and proportionate contribution to the costs of public goods, services and infrastructures*".[27]

The root of the problem has two, closely interrelated aspects, which are discussed below, namely:

1. Asymmetric bargaining power of the players involved, and
2. Lack of a level regulatory playing field

2.4.1. Asymmetric bargaining power of the players involved

The last few years have witnessed a tremendous growth of large digital platforms' revenues and market capitalization as their services and products started to become vital in the lives of users. As a result, nowadays, Google, Facebook, Apple and Amazon are, each, larger (in terms of market capitalization) than the entire EU telco sector combined.

[27] European Declaration on Digital Rights and Principles for the Digital Decade, COM (2022) 28 final, 26.1.22.

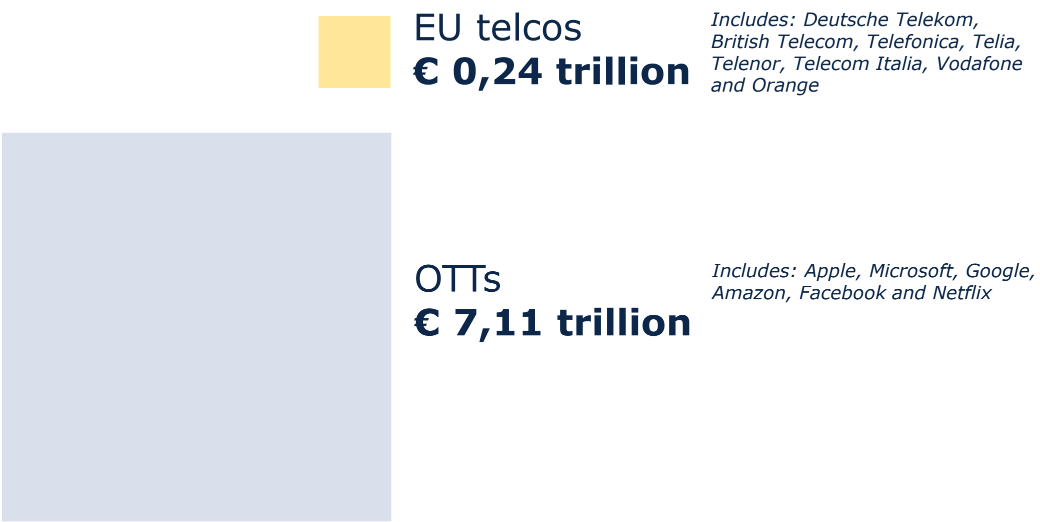

Exhibit 2.8: Comparison of OTTs and EU telco market capitalization [Source: Axon based on Bloomberg]

Such large differences in market capitalization already have important implications for OTTs' bargaining power vis-à-vis EU telcos, but they are not even the main cause of the relevant asymmetry, as this is more structural in nature: In essence, network operators are caught between increasing consumer demand for data-intensive OTT services on the retail side, to which they cannot respond with higher retail service prices (because of the competitive and regulated nature[28] of the market), and increasing traffic volume for such OTT services on the wholesale side, leading to additional costs for them, with no possibility to recover such costs through higher IP transit prices, as OTTs have the possibility to route their data via other operators, thereby circumventing direct interconnection in response to any such attempt.

More specifically, on the retail side, given the ever-increasing success of OTT content services, consumers consider them a must-have. In fact, certain OTT content services have become so indispensable that telecom networks cannot afford not to deliver them to their subscribers in a good quality, as these may otherwise immediately switch to another telco - an easy process in today's competitive retail telecoms markets in Europe.

On the wholesale side, OTTs are not strictly dependent on any specific network operator to deliver their services to consumers; alternatives are readily available. For instance, if a telecom operator attempts to negotiate a direct interconnection with large OTT content

[28] Even if indirectly, through margin squeeze / economic replicability ex-ante or ex-post tests.

providers, at prices that could remunerate the telecom operator's extra costs, such OTTs can readily leverage the availability of alternative, and free, routes for their traffic, which are connected to the same telco's network. This may result in a quality degradation of the relevant OTT services, which consumers generally attribute to their network operator.

This is because Internet traffic is rooted mainly through peering agreements between operators that were originally supposed to be of similar size and handle symmetrical traffic. Telecom network operators have no choice but to rely on such (free) peering agreements for at least a large part of their Internet traffic, and OTTs can thus reroute their traffic through any telco's peering agreement instead of negotiating a direct interconnection transit agreement, at a fee, with that telco.

Moreover, in such a rerouting scenario, OTT traffic can enter the telco's network through interconnection gates that are not properly designed for such extra OTT traffic. This can lead to the congestion of all incoming traffic and hence the risk of serious damage to the telco concerned, as its subscribers will be suddenly confronted with a deteriorated user experience - and will place the responsibility for this deterioration on the network operator. The risk of such situations has been expressly acknowledged by some competition authorities in the past.[29]

Moreover, the asymmetry in bargaining power results in a vicious circle: the more successful/dominant OTT content platforms are, the stronger their bargaining power and indispensability as a commercial partner, but also the higher their consumption of telecoms network capacity and hence the resulting costs for network operators.

Common market mechanisms that can normally help redress such asymmetries are not available here for the reasons explained in the subsection below; nor are there any regulatory mechanisms in place to address this problem, which thus suggests a form of market failure. The basic economic principle that those benefitting most from the usage of an infrastructure must also cover the costs they are causing does not apply to IP transport services.

As a result, EU telcos are placed at a serious disadvantage in negotiating their legitimate commercial interests when these are at odds against those of OTT providers. This situation

[29] See Decision 12-D-18 of the French Competition Authority of 20 September 2012 on practices concerning reciprocal interconnection services in the area of Internet connectivity.

tilts the scale radically towards the benefit of OTTs and does not allow network operators to negotiate fair terms with regard to their network costs.

This situation is not specific to EU telcos, and similar concerns are being voiced elsewhere. For example, in South Korea, Netflix and SK Broadband (SKB) are in the midst of a court dispute, with SKB claiming that its legacy free peering relationship cannot be sustained, and that Netflix must contribute a reasonable amount in line with those paid by local Korean content providers (e.g., Naver or Kakao). A June 2021 ruling found against Netflix, accepting two requirements to SKB, namely that (i) network use is essentially a cost; and (ii) it could be possible for SKB to ask Netflix for payment, even if SKB has not done so in the past. While Netflix has announced that it would appeal the court's decision and the procedure is not yet concluded, there are some obvious similarities between SKB's position and that of telecoms network operators in Europe or elsewhere.

It is interesting to note that, in other circumstances, even Netflix accepts contributing directly to the cost of its services' delivery to consumers: we understand that in the US areas with insufficient broadband coverage, which cannot support streaming services, Netflix delivers its content on DVDs. In those cases, customers pay Netflix for the DVDs, but Netflix pays the US Mail for the DVDs' delivery to its customers.

2.4.2. Lack of a level regulatory playing field

The market imbalance discussed under the previous heading is at least partly the result of the lack of a level regulatory playing field between OTTs and telecom network operators.

Today, strong competition on the EU retail telecommunications markets, in combination with regulatory intervention on the wholesale, and partly on the retail, level have contributed to a decline of profit margins for telcos' traditional retail revenue streams. Direct or indirect regulatory constraints leave network operators with little to no possibility of increasing retail service prices so as to reflect their increased production and investment costs.

Until now, OTTs have been exposed to competition law on an ex post basis only. This is about to change for some OTTs services, which will soon be governed by the Digital Markets Act (DMA) agreed recently by European co-legislators. But while the DMA's rules rightly aim at introducing a more balanced situation between gatekeepers and their users based on fairness, they are a horizontal regulation that will not tackle the specifics of the described bargaining power asymmetry between OTTs and telcos in any attempt to negotiate a fair agreement for the network investment and operational costs telcos bear to convey OTT traffic to end customers. This is, therefore, a regulatory void that remains to be addressed.

As another example of regulatory asymmetry, Internet service providers (ISPs) in the EU have a regulatory obligation to provide access to every public IP address worldwide (under the Open Internet Regulation). OTTs, on the other hand, are not obliged by any regulation to ensure their services' availability to every network in the EU.

The current EU regulatory and policy landscape thus constrains the margin for action by EU telcos, narrowing down their ability to engage in genuinely commercial and more flexible partnerships with OTTs with regard to IP transport. This situation may be harming not just EU telcos, but also the overall sustainability of the investment cycle necessary to increase the quality of digital products and services to EU citizens in the long term.

Going forward, the current unsustainable asymmetry between OTTs and telecoms network operators could be addressed through regulatory and policy tools such as those we discuss, at a high level, in Section 4.

2.5. Potential consequences of the problem identified

The combination of the factors presented in Section 2.4 have led to a situation which, while seemingly sustainable in the past, shows alarming prospects for the future. In particular, if data forecasts suggesting an exponential growth of the data traffic moving forward become true, the future development of the EU telecoms sector may be at risk, as a result of the ever-growing investments EU telcos will be forced to make to accommodate exponential traffic growth without being able to recover the specific costs generated from OTT services – and this with EU telcos' retail revenues steadily falling year over year. The end result may have important economic, social and environmental implications, as described further in this Report, which could materialise taking into consideration the following parameters:

- **Investments required for FTTH and 5G networks**. EU telcos are investing heavily in Very High-Capacity Networks ('VHCN') for the provision of fixed (FTTH) and mobile (5G) services. These investments are indispensable in order to meet the ambitious targets set in the Digital Decade, which aims for gigabit connectivity for every household and 5G in every populated area of Europe by 2030. The investment required to meet these targets is substantial. It has been estimated that an additional €150 billion is needed for full 5G rollout in Europe, while another €150 billion is required to upgrade fixed infrastructure and roll out FTTH to gigabit speeds in Europe.[30] Even Meta acknowledges that the grand ambition of building the ultimate "metaverse" will not be possible if there are no drastic improvements in today's telecoms networks.[31] From an economic point of view, investments for new fixed and mobile access network technologies (i.e., 5G and FTTH), are shown to bring significant uplift to GDP and employment levels. These economic benefits can be attributed to the enhanced efficiency and productivity levels supported by these new technologies, and the industry-wide adoption of their various use-cases. If, at the same time, EU telcos have to cope with increased OTT-driven traffic without fair and proportionate compensation, these benefits to the European economy may be delayed, which may represent an important opportunity cost.

- **Investment in quality of service and innovation**. This situation also extends to other operators' initiatives that aim to spur digital innovation, and which may not receive sufficient capital (such as the development of edge and cloud solutions). This, in turn, suggests a negative impact on EU Member States' innovation perspectives, and ultimately on consumers, who are deprived of an opportunity of earlier access to new and innovative technologies.

- **Environment and sustainability**. Increased data traffic comes with important negative externalities for sustainability. In particular, some argue that the substantial growth envisaged for data traffic could drive higher energy use in telco networks, with important ramifications for greenhouse gas (GHG) emissions. To minimize the impact, telecom operators are developing a wide range of actions to optimise their network functions, develop a circular economy and use renewable energy, and they are investing heavily to phase out energy-intensive legacy networks in favour of greener technology to increase network efficiency. While efforts in this area have been widely successful in the last few years, the International Energy Agency argues that significant investments in R&D on efficient next generation computing and communications technologies will be needed to keep up with growing data demand.[32] While the main OTT players have launched a number of green initiatives to improve their footprint on the planet,[33] it is also true that the increasing data traffic they are responsible for is the main driver for the increasing energy use; and yet the negative externalities of energy expenditure or CO_2 emissions are not passed on OTTs, thus

30 ETNO, "Connectivity & Beyond", 2021; Available at: https://etno.eu/component/attachments/attachments.html?task=download&id=8050

31 CNBC, "Meta says its metaverse ambitions won't be possible without better cellular networks", https://www.cnbc.com/2022/03/02/meta-says-todays-cellular-networks-arent-ready-for-the-metaverse.html

32 IEA, "Data Centres and Data Transmission Networks". www.iea.org/reports/data-centres-and-data-transmission-networks

33 E.g., see sustainability.fb.com or sustainability.google.

providing them with no incentive for a more efficient data traffic generation, which could be implemented through “green algorithms” from the design stage. If investment efforts are to be focused on sustaining OTT-traffic growth, the progress to be made in the reduction of energy consumption and, therefore, CO_2 emissions, is likely to move forward at a more sluggish pace.

Overall, we can observe that EU telcos are already engaging in an enormous investment effort to maintain a high quality of service. Nevertheless, it would be against all economic logic to believe they can further increase capital intensity in a landscape of diminishing revenues. Meanwhile, investment requirements on (i) core and access networks to cope with OTT traffic, (ii) next-generation access networks for all EU citizens, and (iii) innovation and sustainability are all expected to keep increasing in the coming years. This situation suggests that the current relationship between EU telcos, OTTs and EU citizens, far from evolving into a virtuous cycle, is currently unsustainable. Given the tight margins of EU telcos’ operations, a further deterioration of the current situation (e.g., a continuation of the surge in data traffic under the current setup) is bound to have significant negative socio-economic consequences moving forward.

3. Socio-economic impact assessment

The primary objective of this section is to assess the potential impact, on key sustainability indicators, of a proportionate participation of OTTs in the costs of the traffic they induce on telecoms networks, insofar as these costs relate to the development of the necessary telecommunications infrastructure (i.e., 5G and FTTH). As quantifying such a proportionate participation falls outside this study's scope, and for the sake of illustration only, this section explores the impact of a €20 billion/year hypothetical participation from OTTs[34] in network infrastructure deployment – a rounded, purely indicative, base reference as an example for the order of magnitude discussed in section 2.3. The conclusions at the end of this section then summarise the socio-economic implications of alternative levels of participation of OTTs, ranging from €10 billion up to €30 billion, along the levels discussed in section 2.3.

The impact analyses presented in this section are economic, social and environmental.

3.1. Analysis of the economic impact

The impact on the economy can be looked at from multiple angles, but the two most prominent ones, which are discussed below, include Gross Domestic Product (GDP), and Employment.

3.1.1. Impact on GDP

Background

ETNO[35] estimates that 5G alone can bring €113 billion annual uplift on European GDP by 2025 (stemming from four distinct verticals[36] and environments[37]). It also estimates that communities with more than half of the population connected to FTTH broadband, with speeds of at least 1 Gbps, had a per capita GDP of 0.9 to 2.0 percent higher than those without fibre broadband.

34 As suggested in section 4, we would expect such participation to come only from a handful of OTT providers – those generating the vast majority of data traffic.
35 ETNO, "Connectivity & Beyond", 2021; Available at: https://etno.eu//downloads/reports/connectivity%20and%20beyond.pdf
36 First-order benefits for Automotive, Healthcare, Transport, Utilities verticals.
37 Second-order benefits for Smart City, Non-urban, Smart Home and Workplace environments.

Impact analysis (5G)

To reach the potential benefits of 5G, the same ETNO report estimates that €150 billion of investment is required to build the necessary infrastructure to unlock the full potential of 5G in Europe.

Since the introduction of 5G to Europe in 2019, there has been a rapid increase in the coverage metrics. As such, ETNO's figures show that 62% of the European population was covered by at least one 5G network by the end of 2021, which was twice the coverage of 2020.[38]

However, as ETNO recognizes, achieving full coverage will not be sufficient to unlock the full potential of 5G networks, as currently many developments mostly leverage on the low bands (i.e., 700 MHz band), which still do not suffice to unlock all the potential of 5G networks. A large proportion of the investment needed from operators will involve the deployment of capacity-based 3.5 GHz spectrum cells, which is more capital intensive.

Since the initial 5G deployments in Europe in 2019, operators have invested a total of approximately €7.1 billion in the rollout of 5G networks out of the total €50.5 billion invested in mobile networks between 2019-2021. Over time, we expect that more and more of the CapEx in mobile networks will be allocated to 5G. The exhibit below presents our relevant estimates, based on historical patterns on investments for 5G and other mobile technologies.

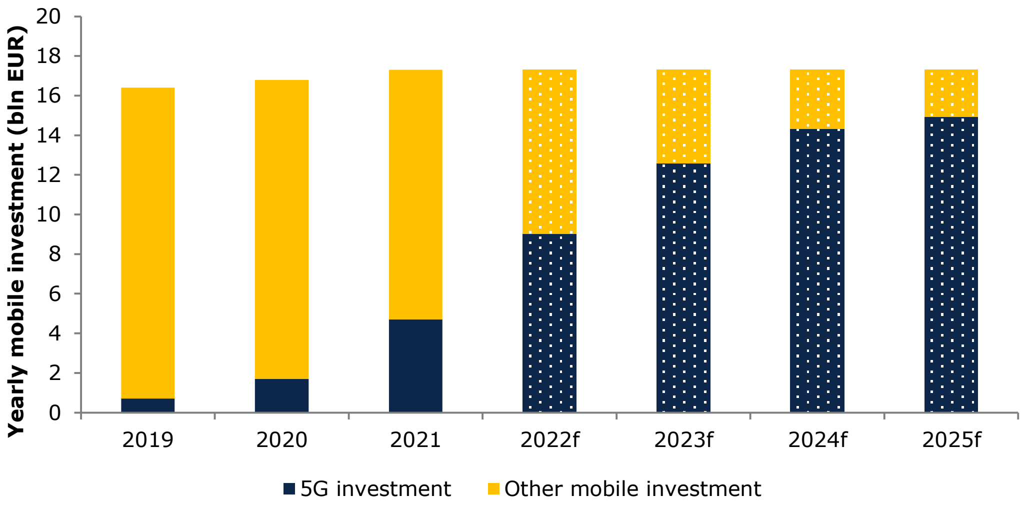

Exhibit 3.1: Historic and forecasted evolution of EU telcos' investments in mobile networks, broken down by 5G and other mobile technologies [Source: Axon based on data from ETNO]

38 ETNO, "The State of Digital Communications 2022", 2022; Available at: https://www.etno.eu/downloads/reports/state_of_digi_2022.pdf

We also estimate that, under the current trend, EU telcos will be able to invest roughly €51 billion more in 5G by 2025, reaching a cumulative total of €58 billion, but still falling short of the €150 billion required to unlock all the benefits stemming from 5G.

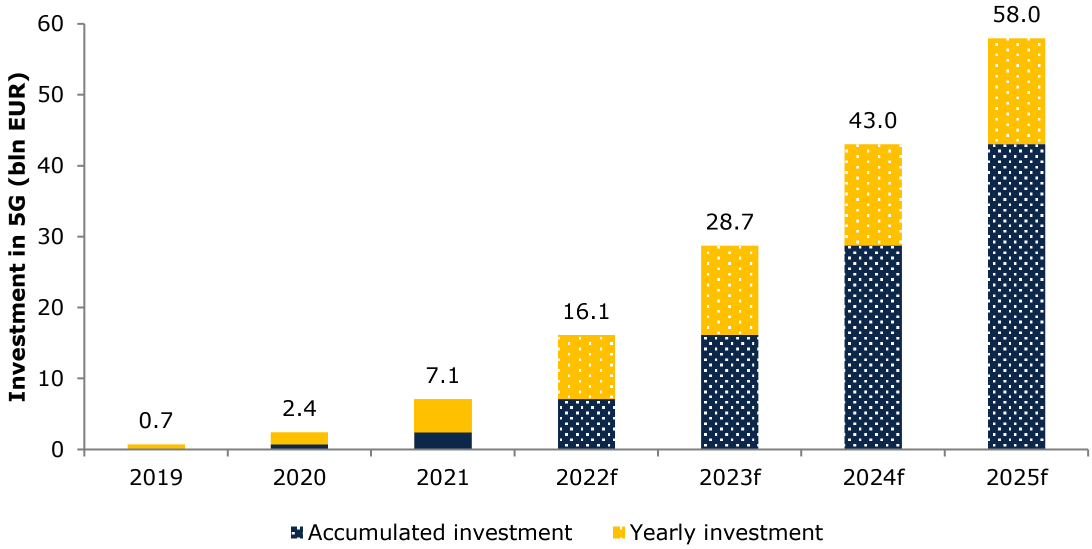

Exhibit 3.2: Historic and forecasted evolution of EU telcos' investments in 5G [Source: Axon based on data from ETNO]

However, if more funds were available, this would support operators getting closer to this target. Assuming a contribution of €20 billion per year from the OTTs, and assuming that 60% of this would be allocated to the deployment of 5G networks based on EU network operators' historic share of investments between mobile and fixed networks, the investment gap would be reduced by €48 billion by 2025. This additional investment could serve to increase the capillarity of networks and optimise the performance of 5G in particular, ensuring that its benefits reach more and more consumers and businesses all over the EU.

Assuming that the potential benefit to be extracted from 5G can be linearly related to the percentage of the investment incurred, OTTs' participation in infrastructure deployment costs would be expected to result in a potential increase of Europe's GDP by €36.16 billion in 2025.

Impact analysis (FTTH)

ETNO estimates that the migration to FTTH gigabit networks across Europe will require an additional investment of €150 billion.[39] However, if investments were to continue at current levels (at a rate of roughly €10 billion per year), operators would not be expected to reach the required €150 billion to bring FTTH to all citizens until at least 2033.

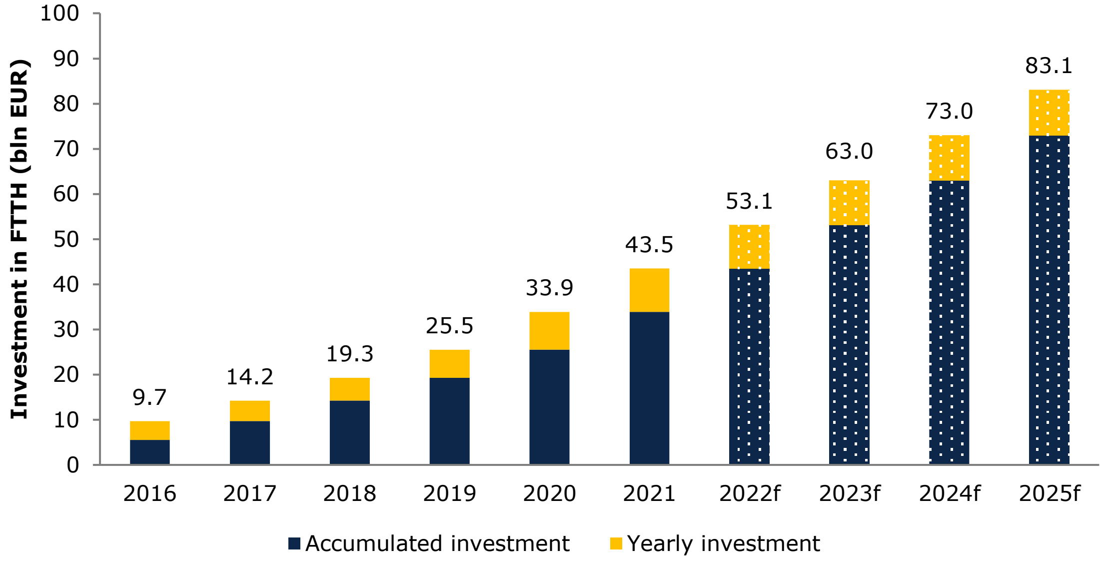

Exhibit 3.3: Historic and forecasted evolution of EU telcos' investments in FTTH [Source: Axon based on data from ETNO]

Based on data published by ETNO,[40] 51% of the European households had access to FTTH networks in 2021, which have necessitated a cumulative investment of €43.5 billion by network operators. Based on past observations on the relationship between FTTH coverage levels and cumulative investment in FTTH networks, and considering ETNO's estimate of €150 billion required to reach 100% FTTH coverage, we can draw the following projection on the ratio between FTTH investment and FTTH coverage:

39 ETNO, "Connectivity & Beyond", 2021; Available at: https://etno.eu//downloads/reports/connectivity%20and%20beyond.pdf

40 ETNO, "The State of Digital Communications 2022", 2022; Available at: https://www.etno.eu/downloads/reports/state_of_digi_2022.pdf

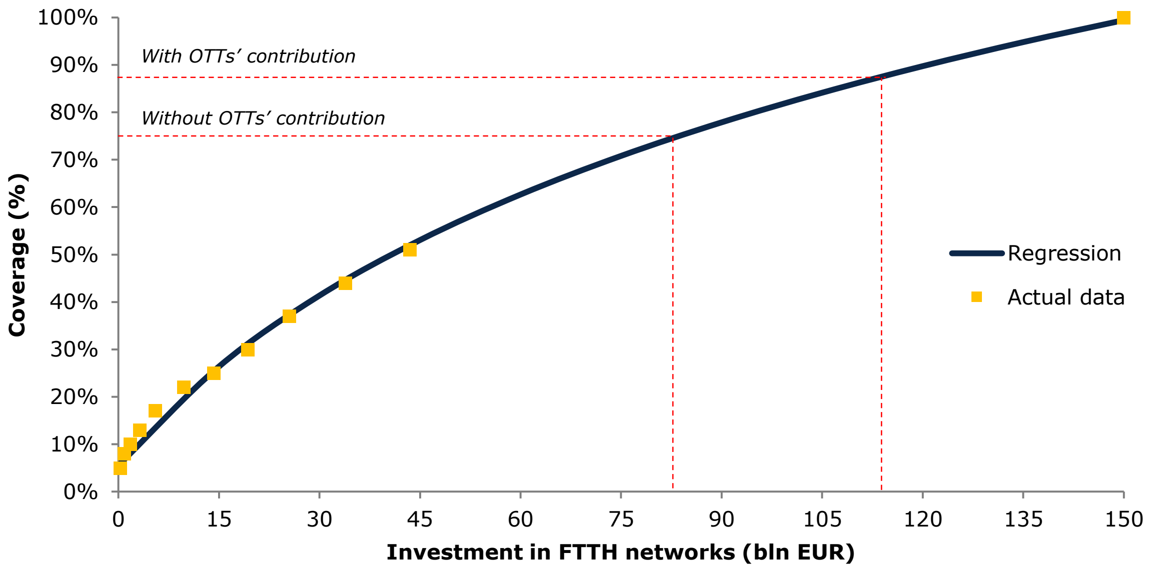

Exhibit 3.4: Relationship between FTTH investment and coverage [Source: Axon based on data from ETNO]

As the above exhibit shows, if the current investment trend is maintained over the following years (reaching a cumulative investment of €83.1 billion by 2025), EU network operators would achieve a 74.8% FTTH coverage. On the other hand, if one assumes a contribution of €20 billion per year by OTTs (of which 40% was allocated to FTTH deployment), 88.0% FTTH coverage would be achieved by 2025 – representing an improvement of coverage levels by 13.2 percentage points.

If we consider the GDP impact of increased FTTH broadband availability levels (uplift of 0.9% to 2.0% in GDP per capita), a contribution from OTTs could lead to somewhere between €16.29 and 36.20 billion[41] in value creation for the EU's GDP.

Conclusion

In sum, if OTTs participated with €20 billion per year in the deployment costs of 5G and FTTH networks, GDP could be expected to raise by somewhere between €52 and 72 billion in 2025 in the EU27 (+UK).

41 Calculated as the additional population covered thanks to OTTs' contribution (13.2%) times EU's GDP (€13,690 bn) times the 0.9 – 2.0% GDP uplift.

3.1.2. Impact on employment

Background

Generally, increasing investment in any given industry is expected to have a direct and indirect impact on employment. The 5G-driven impact on employment was already measured by the European Commission in its report on the *Identification and quantification of key socio-economic data to support strategic planning for the introduction of 5G in Europe.*[42]

The European Commission considered direct and indirect multiplier effects based on data from Eurostat and the OECD to determine the potential impact that an increase in investment on 5G could have on direct and indirect employment. In particular, based on the outcomes of this report, the EC expected that an increase of €1 billion in 5G investment would generate 42,000 direct and indirect jobs (FTEs) in the EU.

Based on the methodology used in that report – the Leontief's inputs-outputs multipliers – equivalent results would be obtained for FTTH-related investments.

Impact analysis

As inferred from the EC's study, we may conclude that OTTs' €20 billion yearly contribution in infrastructure usage costs (5G + FTTH) would result in the generation of 840,000 direct and indirect jobs (FTEs) annually.

3.2. Analysis of the social impact

For present purposes, social impact will be measured from two perspectives: quality of service and innovation. The subsections below discuss each of these aspects in detail.

3.2.1. Impact on quality of service

Background

5G and FTTH bring a number of well-known benefits for consumers and enterprises, including faster speed, lower latency, and better reliability.

[42] European Commission, "Identification and quantification of key socio-economic data to support strategic planning for the introduction of 5G in Europe", 2016; Available at: https://connectcentre.ie/wp-content/uploads/2016/10/EC-Study_5G-in-Europe.pdf

As digitalisation of our society is ongoing, new value-added services, including those offered by OTT players, will continue to develop, calling for improved connectivity to be provided by EU network operators. This is highlighted, for example, in the European Commission's *2030 Digital Compass: the European way for the Digital Decade*:

> "*By the end of this decade, new digital communications features and capabilities such as high-precision, holographic media, and digital-senses over the networks, are expected to provide a whole new perspective to a digitally enabled society underpinning the need for gigabit connectivity. Well before the end of the decade, businesses will need dedicated Gigabit connections and data infrastructures for cloud computing and data processing, in the same way as schools and hospitals will need this for eEducation and eHealth. High performance computing (HPC) will require terabit connections to allow real-time data processing*."[43]

To meet these objectives and provide better quality of service to consumers, telecom operators must invest heavily in upgrading their network infrastructure, and develop 5G and FTTH networks.

Impact analysis

On the mobile front, we can see a positive correlation between 5G availability and average mobile download speeds. As more people have access to 5G networks, the average mobile downlink speeds increase accordingly, improving overall QoS. For instance, according to empirical benchmarks, 5G improves video quality of experience by 10-20% and download speed by a factor of 5 to 8 compared to 4G.[44]

This evolution takes place not only thanks to the increased speed that 5G networks provide, but also because a faster migration of users from 4G to 5G networks reduces congestion on 4G networks, thus leading to greater speeds.[45]

Evidence from countries with more mature 5G networks shows that 5G working at full capacity could deliver average mobile download speeds of 134 Mbps.[46] Meanwhile, in the EU, we observe an average download speed of 55.7 Mbps in mobile networks.

Therefore, OTTs participation in network usage costs should be expected to support investment in 5G networks, directly or indirectly, by releasing investment capacity and

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43 European Commission, "2030 Digital Compass: the European way for the Digital Decade", 2021; Available at: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52021DC0118

44 OpenSignal, "Benchmarking the Global 5G Experience — November 2021", 2021; Available at: https://www.opensignal.com/2021/11/30/benchmarking-the-global-5g-experience-november-2021

45 OpenSignal, "5G Impact on the global mobile network experience", 2021; Available at: https://www.opensignal.com/sites/opensignal-com/files/data/reports/pdf-only/data-2022-02/202202_opensignal_5gimpactonglobalmobileexperience_0.pdf

46 Speedtest, "Speedtest Global Index", 2022; Available at: https://www.speedtest.net/global-index

hence helping improve the users' experience, by means of, among other metrics, faster download speeds.

A similar relationship may be described for FTTH. Currently, in the EU, the average fixed download speed sits at around 78 Mbps, whereas countries with widespread FTTH coverage (e.g., Singapore) are reaching average speeds of around 200 Mbps. It is thus possible to conclude that any contribution to the costs of FTTH networks usage in Europe will undoubtedly improve the investment path and the quality of service (in terms of download/upload speeds, latency, jitter, etc.) for end users.

3.2.2. Impact on innovation

Background

Both 5G and FTTH networks provide ultra-fast connectivity for users and businesses, with a beneficial effect for innovative activity. They jointly bring significant direct benefits to the European society by providing a smart digital infrastructure that will constitute a fabric for delivering new innovative services.

5G brings a series of enhancements compared to older generation mobile networks, including higher bandwidth, lower latency, enhanced reliability, and greater terminal device densities.

These improvements will enable the evolution of a broad range of services (e.g., massive IoT, industrial automation, VR, AI, etc.), applications, and use cases across various industries or verticals, including automotive, healthcare, industry 4.0, gaming and media, amongst many others.

Beyond specific applications, 5G also allows for new possibilities in business model design, which could result in more disruptive and transformational innovation.

As such, 5G is expected to spur innovation by supporting and significantly improving existing services, applications, and business models or create new, previously unthought, ones. Similarly, fibre networks are said to contribute significantly to countries' innovative prospects, as they support growth in demand for, and innovation of, online services and applications by incentivising digital service providers to produce more innovative services.

Impact analysis

Quantifying the innovativeness of countries can be a challenging exercise as it is a function of multiple factors, some of which cannot be reduced to incontestable metrics.

However, the World Intellectual Property Organization (WIPO) attempts to do just that by developing a Global Innovation Index (GII) and publishing the results each year. The GII provides annual innovation performance rankings of a total of 130 economies.

In particular, the framework of the GII consists of five innovation input sub-indices and two innovation output sub-indices. Under the infrastructure sub-index, various other pillars are taken into account for score calculation, including the Information and Communication Technologies (ICT). Within this pillar, ITU's ICT access and ICT use scores are used as key inputs.

These two scores would be positively affected by additional financial capabilities available to EU telcos to deploy 5G and FTTH. This would indirectly improve the innovation capabilities of the countries in the EU.

3.3. Analysis of the environmental impact

The two key aspects of the environmental impact discussed in this study include energy consumption and carbon footprint. This section is not aimed at forecasting the evolution of energy consumption or carbon emissions in the short, mid or long term (i.e., whether these will go up or down over time), but rather at evaluating the impact of a fair and proportionate contribution of OTTs to network usage costs on these indicators by 2025.

The subsections below discuss each of these aspects in detail.

3.3.1. Impact on energy consumption

Background

There is a rich and ongoing debate on the impact of 5G and FTTH networks on energy consumption. While some of the relevant studies focus on the change in total energy consumption with the introduction and further uptake of 5G and FTTH, others investigate the energy efficiency gains from these new types of technologies.

For instance, according to InterDigital/ABI Research,[47] 5G-related energy consumption, mainly driven by IoT/M2M end-devices, is forecasted to increase by 160% from 2020 to 2030.

The surge in data traffic in the upcoming years could lead to increased overall energy consumption as more devices are connected via 5G technology. However, some studies argue that, in time, energy-saving techniques (e.g., use of intelligent networking equipment that enters sleep mode during idle time, artificial intelligence (AI), new cooling

[47] ABI Research Interdigital, "Environmentally Sustainable 5G Deployment: Energy Consumption Analysis and Best Practices", 2020. Available at: https://www.interdigital.com/download/5fc4474dcd829e04839e8d77

techniques, etc.) will be introduced and applied rapidly at each layer of the 5G value chain, and help reduce energy consumption.[48]

The studies that investigate the energy efficiency aspect (i.e., energy consumption per unit traffic in Gigabits) are arguably more reliable since they do not deal with the big unknown of the extent of overall 5G take-up. They mainly argue that 5G networks are designed to be more efficient than legacy mobile networks since they make use of low-power antennas and much more energy efficient transmission technologies.

For instance, Nokia[49] and Telefónica[50] claim that 5G networks are up to 90% more energy efficient per unit of traffic than older 4G networks. In other words, 5G requires only one tenth of the energy that 4G requires to transmit 1 GB of data.

Also, according to Orange[51], *"because they have integrated the energy-efficiency issue from the outset, 5G technologies are expected to divide the energy consumption per gigabit transported by a factor of 10 compared to 4G once they reach maturity by 2025, and then by a factor of 20 by 2030."*

On the fibre front, Telefónica notes that fibre provides 85% more energy efficiency compared to copper networks, by reducing energy consumption per unit traffic on the fixed access network equipment.[52]

Therefore, in general, we can conclude that both 5G and FTTH networks are more energy efficient than former generations of fixed and mobile access networks.

Impact analysis (5G)

As seen in section 3.1.1, increasing investment in 5G networks will lead to faster deployments and (likely), a higher share of traffic being coursed by more efficient 5G networks.

Ericsson currently estimates that, by 2025, 46.5% of mobile data traffic will be delivered through 5G networks, whereas 53.5% will be coursed through 4G and other legacy

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48 451 Research, "Telco Industry Hopes and Fears, From energy costs to Edge computing transformation, (2019), 2019; Available at: https://www.vertiv.com/globalassets/documents/white-papers/451-research-paper/10648_advisory_bw_vertiv_266274_0.pdf

49 Nokia, "Nokia confirms 5G as 90 percent more energy efficient" 2020; Available at: https://www.nokia.com/about-us/news/releases/2020/12/02/nokia-confirms-5g-as-90-percent-more-energy-efficient/#:~:text=Espoo%2C%20Finland%20%E2%80%93%20A%20new%20study,(RAN)%20in%20Telef%C3%B3nica's%20network

50 Frontier for ETNO, "Shaping Policies to Support Investment in Very High Capacity Networks", 2021; Available at: https://www.etno.eu/component/attachments/attachments.html?task=download&id=8164

51 Orange, "5G: Energy efficiency by design", 2020; Available at: https://hellofuture.orange.com/en/5g-energy-efficiency-by-design/

52 ETNO, "The State of Digital Communications 2022", 2022; Available at: https://etno.eu/component/attachments/attachments.html?task=download&id=8165

networks.[53] This forecast assumes that the current levels of investment for 5G networks will be maintained by EU telcos.

If OTTs were to contribute with, e.g., €20 billion per year to the costs of usage of telecom infrastructure in Europe, and assuming 60% of it were to be allocated to the 5G networks (in line with the considerations mentioned in section 3.1.1), we could expect faster levels of take-up of 5G networks. Based on historical data, we can observe a relevant correlation between 5G user take-up and the share of 5G traffic. Extrapolating this relationship, by considering the increased reach that 5G networks, as a whole, would have with increased investment (see section 3.1.1 for further details), we could expect that the percentage of traffic in the EU's 5G networks could be increased to represent 71.5% of all mobile traffic in 2025.

Considering that 5G networks are expected to be 10 times more efficient, this would lead - in a steady-state situation - to an overall reduction of 38.7% in total energy consumed in the EU's mobile access networks in 2025[54].

Meanwhile, in the core network, data traffic efficiency is not expected to be substantially better than with 4G. If we assume a 20% improvement in energy efficiency,[55] following the same logic as for access networks, we could observe a decrease of 5.5% in energy consumption[56].

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53 Ericsson, "Ericsson Mobility Visualizer", 2022; Available at: https://www.ericsson.com/en/reports-and-papers/mobility-report/mobility-visualizer?f=8&ft=2&r=1&t=1,20&s=4&u=3&y=2021,2026&c=3

54 This is calculated based on the following considerations:

- No contribution from OTTs: Considering 5G to be 10 times more energy efficient than its predecessors, and considering 46.5% of traffic handled in 5G, we could estimate an energy consumption factor of 1x46.5% + 10x(1-46.5%) = 5.8
- Contribution from OTTs: Considering 5G to be 10 times more energy efficient than its predecessors, and considering 71.5% of traffic handled in 5G, we could estimate an energy consumption factor of 1x71.5% + 10x(1-71.5%) = 3.56

As a result, with a €20 billion contribution from OTTs, energy consumption would drop by 38.7%.

55 Anders S. G. Andrae and Tomas Edler, "On Global Electricity Usage of Communication Technology: Trends to 2030", 2015; Available at: https://www.mdpi.com/2078-1547/6/1/117/pdf

56 In this case, the energy consumption factors would look as follows:

- No contribution from OTTs: 8x46.5% + 10x(1-46.5%) = 9.1
- Contribution from OTTs: 8x71.5% + 10x(1-71.5%) = 8.6

In total, considering that 85% of the energy is consumed in the access network (and 15% in the core network),[57] in a steady-state situation, we could expect an overall decrease in the energy consumed by mobile networks of 31.5% in 2025[58].

Impact on energy consumption	Percentage of energy savings
RAN	-38.7%
Core	-5.5%
Total	**-31.5%**

Exhibit 3.5: Impact on energy consumption on mobile telecommunications networks considering traffic total volume steady-state situation [Source: Axon]

Impact analysis (FTTH)

As presented in section 3.1.1, operators have been investing in FTTH for several years already, but there is still a long way to go. Currently, 51% of the households in Europe are covered by FTTH networks,[59] and this is expected to grow to around 75% by 2025 if the current investment levels in FTTH (roughly €10 billion per year) are maintained.

However, with a €20 billion participation per year to the usage costs of networks, (of which we would consider 40% to be allocated to FTTH deployment), we estimate that FTTH coverage could reach 88% in 2025, which represents an increase of around 13 percentage points from the base case in the same year[60].

Given that FTTH networks are expected to be 85% more efficient than other types of fixed networks[61], following the same logic described in the previous subsection, we could expect a reduction of 30.8%[62] in energy consumption in the EU's fixed access networks in 2025 – assuming legacy networks are progressively switched off as the FTTH footprint grows.

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57 ABI Research Interdigital, "Environmentally Sustainable 5G Deployment: Energy Consumption Analysis and Best Practices", 202; Available at: https://www.interdigital.com/download/5fc4474dcd829e04839e8d77 ABI Research Interdigital, "Environmentally Sustainable 5G Deployment: Energy Consumption Analysis and Best Practices", 202; Available at: https://www.interdigital.com/download/5fc4474dcd829e04839e8d77 ABI Research Interdigital, "Environmentally Sustainable 5G Deployment: Energy Consumption Analysis and Best Practices", 202; Available at: https://www.interdigital.com/download/5fc4474dcd829e04839e8d77 ABI Research Interdigital, "Environmentally Sustainable 5G Deployment: Energy Consumption Analysis and Best Practices", 202; Available at: https://www.interdigital.com/download/5fc4474dcd829e04839e8d77

58 Calculated as:
- No contribution from OTTs: 85% x 5.8 + 15% x 9.1 = 6.3
- Contribution from OTTs: 85% x 3.6 + 15% x 8.6 = 4.3

The reduction is thus 31.5%.

59 ETNO, "The State of Digital Communications 2022", 2022; Available at: https://www.etno.eu/downloads/reports/state_of_digi_2022.pdf

60 Refer to Section 3.1.1 for further details on these calculations.

61 ETNO, "The State of Digital Communications 2022", 2022; Available at: https://etno.eu/component/attachments/attachments.html?task=download&id=8165

62 Obtained based on the change in FTTH coverage with and without the contribution of OTTs in 2025.

In this case, we do not expect any significant improvement in the efficiency of the core network. Assuming that 15% of the energy is consumed in the core network, we can expect an overall decrease in the energy consumed by EU's fixed telecommunication networks of 20.8% in 2025.

Impact on energy consumption	Percentage of energy savings
Access	-30.8%
Core	-
Total	**-20.8%**

Exhibit 3.6: Impact on energy consumption on fixed telecommunications networks considering traffic total volume steady-state situation [Source: Axon]

Conclusion

The ITU[63] estimates that, by 2025, at a global scale, mobile networks will be responsible for an energy consumption of 170 TWh, and fixed networks will add another 100 TWh.

Considering that the EU would represent roughly 14% of mobile data traffic and 13% of fixed broadband subscriptions in 2025,[64] we can estimate that European mobile operators would consume around 23.3 TWh in 2025, with fixed operators consuming around 13.5 TWh, a figure which is reasonably aligned with the latest information provided by ETNO.

Based on these figures, we can estimate that, in total, when considering both fixed and mobile networks, a €20 billion contribution from OTTs to the costs of network usage could result in a reduction of 10.1 TWh in energy consumed by EU telcos by 2025 (27.6% reduction).

3.3.2. Impact on carbon footprint

Background

The ICT sector, and telecommunications operators in particular, have a vital role to play in combatting global climate change by reducing their carbon footprint in the medium to long run. GHG emissions are commonly grouped under three distinct layers:

- **Scope 1:** Direct emissions from owned or controlled sources (e.g., operator facilities, company vehicles, etc.)

63 ITU, "Greenhouse gas emissions trajectories for the information and communication technology sector compatible with the UNFCCC Paris Agreement", 2019; Available at: https://www.itu.int/rec/T-REC-L.1470-202001-I/en

64 Based on data from World Bank and Ericsson.

- **Scope 2:** Indirect emissions related to energy consumption / efficiency (e.g., for fixed and mobile access networks)
- **Scope 3:** Emissions across the complete value-chain (e.g., capital goods, transportation and distribution, etc.)

Telecom operators have less control over their Scope 3 emissions but have accelerated their plans to reduce Scope 1 and 2 emissions.[65] As outlined in the latest annual report of ETNO, many members of ETNO have already announced ambitious plans to achieve zero emissions or carbon neutrality on Scopes 1 and 2 and subsequently on all three Scopes.

Operator	Target date for zero emissions in Scope 1 and 2	Target date for net zero emissions (Scopes 1, 2 and 3)
Deutsche Telekom	2025	2040
TDC	2028	2030
BT	2030	2045
KPN	2030	2040
Telenor	2030[66]	
Telia Company	2020 (achieved)	2030
TIM Group	2030	2040
Orange	2040	2040
Telefónica[67]	2025	2040

Exhibit 3.7: Selected Scope 1 & 2 and 3 emission reduction targets, ETNO members, group level [Source: ETNO[68]]. Note: net zero and carbon neutrality definitions used by companies differ; they may not be entirely comparable.

Reaching the net zero or carbon-neutral targets set by the EU and those set by telecom operators requires telcos to increase energy efficiency and renewable energy technologies in their networks. Ultimately, increasing energy efficiency and energy consumption from renewable sources will lead to lower carbon footprint of the sector, benefitting the environment.

65 ETNO, "The State of Digital Communications 2022", 2022; Available at: https://etno.eu/component/attachments/attachments.html?task=download&id=8165
66 For European operations only: https://www.telenor.com/sustainability/responsible-business/environment-and-climate/climate-impact/
67 Telefonica data for Scope 1 and 2 refers to its main markets: Spain, Germany and Brazil.
68 ETNO, "The State of Digital Communications 2022", 2022; Available at: https://etno.eu/component/attachments/attachments.html?task=download&id=8165

In this context, there is already a declining trend in Scope 1 and 2 GHG emissions by telecom operators, as reported by ETNO.[69] In 2020, ETNO members' Europe-only Scope 1 and 2 GHG emissions stood at 2.77 thousand tonnes of Carbon Dioxide equivalent (tCO_2e), a decline of 22% from the previous year.

This is also driven by European telecom operators' migration of their power sources from non-renewable to renewable sources to reduce their carbon footprint. As such, the same source shows that 62.2% of Scope 1 and 2 energy consumption of ETNO members (at a group level, including operations outside Europe) were from renewable sources in 2020, up from 44.4% in 2017. At Europe-only level, this figure was 75.3% in 2020, up from 60.4% in 2017.

Impact analysis

The ITU has forecasted that mobile networks around the globe would emit 92.0 Mt CO_2e in 2025, and fixed networks would emit 41.8 Mt CO_2e in 2025.[70] Out of that, 73.0 Mt CO_2e in mobile networks will be derived from energy consumption; the equivalent figure will be 35.2 Mt CO_2e for fixed networks. Considering the share of mobile data and fixed broadband lines in Europe, we could estimate that around 4.8 Mt CO_2e will be emitted from fixed networks and 10.0 Mt CO_2e from mobile networks in the EU, just from electricity needs.

[69] ETNO, "The State of Digital Communications 2022", 2022; Available at: https://etno.eu/component/attachments/attachments.html?task=download&id=8165

[70] ITU, "Greenhouse gas emissions trajectories for the information and communication technology sector compatible with the UNFCCC Paris Agreement", 2020; Available at: https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-L.1470-202001-I!!PDF-E&type=items

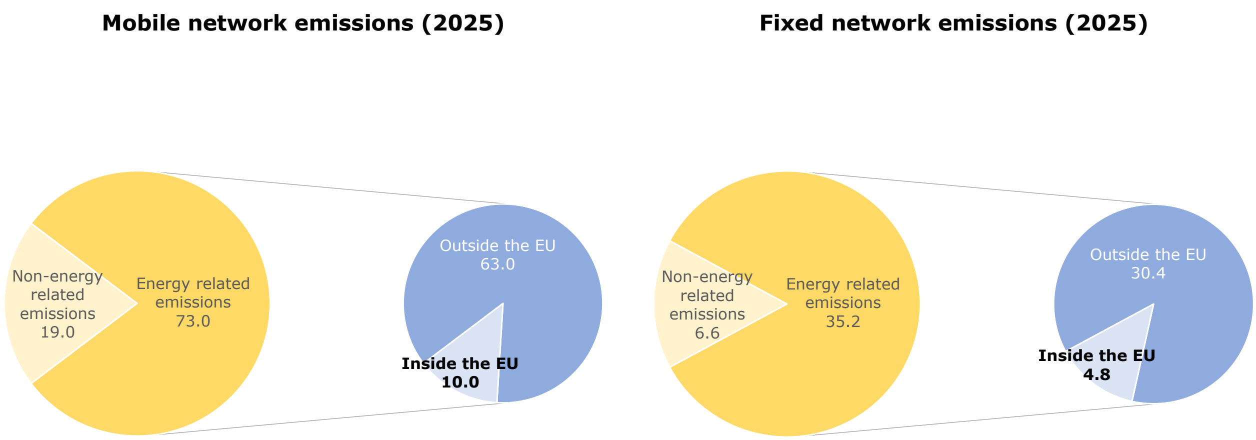

Exhibit 3.8: Breakdown of forecasted mobile and fixed network emissions in 2025 [Source: Axon based on data from ITU]

However, not all electricity needs of European telcos will be carbon-emitting. Actually, operators in the EU right now secure around 75% of their current power needs through renewable energy sources. This is equivalent, currently, to a renewable capacity of 10.1 TWh for fixed networks and 17.5 TWh for mobile networks.

Assuming operators were to maintain the current share of renewables by 2025, we observe that a total consumption of 9.2 TWh of non-renewable energy would be required:

Energy capabilities from European telcos *(without OTTs participation)*	Expected energy consumption in 2025 [TWh]	Renewable capacity [TWh]	Non-renewable capacity [TWh]
Mobile networks	23.3	17.5	5.8
Fixed networks	13.5	10.1	3.4
Total	**36.8**	**27.6**	**9.2**

Exhibit 3.9: Expected energy consumption, and renewable and non-renewable capacities of mobile and fixed networks in the EU by 2025 [Source: Axon]

As seen in the previous section, if OTTs were to contribute €20 billion per year to the costs of usage of 5G and FTTH, we could expect the energy consumption of mobile and fixed networks to be reduced. In turn, this situation would allow for a higher portion of telcos' energy needs to be covered by their existing renewable capacities.

Energy capabilities from European telcos *(with OTTs participation)*	Expected energy consumption in 2025 [TWh]	Renewable capacity [TWh]	Non-renewable capacity [TWh]
Mobile networks	15.9	17.5	-
Fixed networks	10.7	10.1	0.6
Total	**26.6**	**27.6**	**0.6**

Exhibit 3.10: Expected energy consumption, and renewable and non-renewable capacities of mobile and fixed networks in the EU with additional investments from telcos by 2025 [Source: Axon]

While this analysis already projects a 94% reduction in carbon emissions, it is likely that even a small increase in the share of renewables by 2025 – which is expected by most network operators – could result in a 100% transition to renewable energies by 2025.

Conclusion

We may thus conclude that a yearly participation of €20 billion from the OTTs to the costs of usage of telecom networks in the EU (+UK) could reduce alone the energy consumption from non-renewable sources by up to 22.9%. In other words, this could mean a reduction of 13.8 Mt CO_2, representing a circa 93.8% reduction in total carbon emissions in 2025.

Assessing environmental impact of network evolution is a complex challenge. While many factors have been quantified to assess a faster migration to more energy efficient networks (5G and FTTH), two highly relevant drivers are more difficult to assess:

- By setting a price signal for data traffic, agents will have an incentive to generate traffic more efficiently with the potential impact of reducing expected traffic growth; this potential lower traffic growth has not been considered in the current environmental impact analysis.
- The most relevant environmental impact of the innovations taking place in the telecom sector is not going to come from the improvement in the energy efficiency of network equipment, but rather from its role as enabler of the green economy. Telecom networks are the backbone of major CO2 reductions enabled by digitalization, across different sectors of the economy and society. As this impact is not the objective of this study, the environmental impact across sectors of the economy and society due to the acceleration in 5G and FTTH network deployment resulting from OTTs contribution to network operational and deployment costs has not been analysed.

3.4. Conclusions

As shown in the previous subsections, an illustrative €20 billion yearly participation from OTTs in the costs of usage of the telecommunications infrastructure in the EU would bring positive economic, social and environmental benefits to the European ecosystem. The exhibit that follows provides a summary of the impacts observed and an overview of the implications on each of these pillars of different participation scenarios from the OTTs, ranging from €10 billion up to €30 billion (along the cost levels discussed in section 2.3).

Impact area	Impact of different scenarios of OTTs' participation		
	€10 billion	€20 billion	€30 billion
Economic impact			
Gross Domestic Product	+€27-37 billion	+€52-72 billion	+€77-106 billion
Employment	+420,000	+840,000	+1.26 million
Social impact			
Quality of service	Improved QoS levels for fixed and mobile broadband (the higher the contribution, the higher the impact on QoS).		
Innovation	Indirect improvement of the innovation capabilities of EU countries		
Environmental impact			
Energy consumption	-15%	-28%	-38%
Carbon footprint[71]	-61%	-94%	Zero emissions

Exhibit 3.11: Summary of the impact of different participation levels from OTTs [Source: Axon]

71 Refers to Scope 1 and Scope 2 CO_2e emissions of EU telcos.

4. Potential regulatory and policy measures to create positive impact

We now propose to discuss, at a high level, the type of regulatory and policy measures that could help unlock the positive economic, social and environmental benefits uncovered in the previous section. This discussion takes into consideration, in particular:

- The relevant regulatory and policy backdrop, and the sources of the problem we discussed in Section 2;
- The distribution of the OTT traffic impact across different telecoms network levels and different types of wholesale services benefitting OTTs today, in order to be able to assess the relative merits of each of the solutions we examine;
- Any additional pros and cons of these solutions, e.g., in terms of their adoption process, complexity, stakeholders involved, etc.

Briefly, for the reasons discussed below, a direct implementation tool to ensure OTTs contribute fairly and proportionately to the costs of their use of telecom operators' networks would appear to be a more efficient and appropriate answer to the issues at stake, compared to any possible indirect implementation tools. The latter, such as the creation of a fund or a new taxation scheme, would seem too complex to set up and implement, and could risk being misdirected to unrelated objectives.

4.1. Implications of OTT traffic at different network levels

The impact of OTT traffic is felt at various levels of a typical telco network and affects different types of wholesale services provided to the OTTs benefit, (directly or indirectly), by the network operator.

At the highest network level, OTT traffic impacts IP peering, disrupting the principle of a relative traffic symmetry which is supposed to underpin this type of traffic exchange between ISPs. However, while this asymmetry might provide a justification for alternative fee arrangements, e.g., through IP transit agreements, as mentioned already, the actual cost impact of additional OTT traffic at that level is likely to be only a small part of the overall problem.

On the other hand, direct IP peering or transit agreements between OTTs and telcos, where available, also offer a potential direct OTT/telco contractual interface for a fair compensation, whose scope could, in theory at least, (e.g., in a more balanced negotiation relationship and/or as a result of possible future regulatory obligations) extend beyond IP peering/transit services and cover the OTT/telco commercial relationship more holistically. IP peering/transit is also essentially unregulated, which means that policy options for that level of traffic could be adopted with no need to amend existing EU legislation.[72]

As illustrated in Frontier's report, the bulk of OTT-driven costs is concentrated in the national **backbone networks (for fixed & mobile) and access networks (for mobile[73])**. This is a fact that should be reflected in any fair compensation solution, regardless of the level of traffic handover to which it (at least nominally) refers, and regardless of the specific mechanism to be put in place.

4.2. Possible tools for a direct compensation

4.2.1. The OTTs concerned

A fair solution for a direct compensation would most probably be more credible, practicable and likely to find acceptance if its mandatory scope were **limited to OTT players of a certain size**, based on a targeted approach, e.g., their volume of traffic, turnover threshold, number of users or other criteria, as those bigger players are those that create the need for additional capacity investment into networks.

As discussed earlier in this report, the impact of OTT traffic on European telecommunications networks is very asymmetric: it is just a handful of OTTs that generates the lion's share of OTT traffic. Hence extending a direct compensation solution to all OTTs would be inherently more difficult to implement and monitor. Moreover, larger OTTs can benefit from a much stronger negotiating power, economies of scale, and vast resources. Therefore, they would also be more likely to find ways to circumvent solutions applying to all OTTs, regardless of market power, while smaller OTTs may have no means to do so.

Limiting the scope of the policy and/or regulatory solution to larger OTTs based on certain easily verifiable criteria would also echo the current precedent of the regulation of

72 As a reminder, BEREC also accepts that IP interconnection falls outside the scope of the Open Internet Regulation's Article 3(3) on net neutrality: see paragraph 50 of the BEREC Guidelines on the Implementation of the Open Internet Regulation, BoR (20) 112. More generally, this applies to all of the scenarios we discuss in this Section, as they concern solely the commercial interface between OTTs and ISP/telcos, and not the one between ISPs and consumers.

73 Fixed access networks are commonly accepted to be non-traffic sensitive

"gatekeepers" under the proposed Digital Markets Act, and the additional obligations for "very large online platforms" under the proposed Digital Services Act.

4.2.2. Substantive elements of the policy/regulatory tool

To achieve its goal, the relevant tool should define a clear obligation for the OTTs concerned (i.e., only the largest among them) to negotiate the conclusion of a direct agreement with ISPs/telcos upon request, and to accept to pay a fair and proportionate contribution to network usage costs, and other conditions in such an agreement.

The conclusion of these agreements should be based on procedures and substantive principles that should be described in this tool, with a relevant supervisory and enforcement body, and they should support an overall balanced approach, and otherwise ensure consistency with the general objectives of EU law and policy.

4.2.3. Procedure and dispute resolution

While the procedure for the negotiation of any such agreements should be subject to basic procedural guarantees (e.g., good faith and a prescribed timeline for the conclusion of an agreement), perhaps the most important condition for the instrument's success in practice will be an effective and compulsory dispute resolution mechanism, as the two sides' interests are unlikely to be aligned at the start of the overall process.

Effective dispute resolution, while not necessarily excluding other fora, should preferably focus on a special arbitration/mediation body described in the proposed instrument, with its own, effective and timely, procedure and the power to adopt a binding decision. Moreover, to avoid a "cacophony" of parallel procedures and a bottleneck of cases by a multitude of ISPs and several OTTs before the same body, one of the available options could be to vest this body's decisions with a legally binding effect *erga omnes.* Thus, for instance, any principles set out in their decisions as to what constitutes a "fair and reasonable compensation" should also apply to any parallel disputes on similar issues between the same or other OTTs, and other ISPs in the EU.

Apart from the many examples of arbitration and mediation found in international practice, EU legislation already includes precedents that could serve as a model here. For example:

- The **European Electronic Communications Code (EECC**) refers in its article 26 to a dispute resolution between undertakings for disputes in connection with obligations enshrined in the Code; the national regulatory authorities in the various Member

States are empowered to adopt binding decisions within a maximum of 4 months (except in exceptional circumstances);

- The **Broadband Cost Reduction Directive** (2014/61/EU) refers to a "competent national dispute settlement body" (DSB) for the resolution of disputes on access to existing infrastructure – in most cases, this is the NRA for electronic communications. Interestingly for present purposes, BEREC remarks, in its 2021 Opinion on the Revision of the Broadband Cost Reduction Directive, that "[t]*he mere effect that there is a mandatory dispute settlement process can apparently solve problems, even without a formal decision of DSB*." Further, "*other parties may settle their disputes in cases similar to those where the DSB already issued a decision. In these constellations, the binding decision of the DSB provides guidance to market participants beyond the specific case (better defined as 'regulation by litigation') by setting references for fair and reasonable terms and conditions (e.g., on prices and on the technical suitability of the physical infrastructure to which access has been requested). Therefore, under the assumption that the cases being brought to a DSB are the rather difficult and complex ones, a decision of the DSB can create a kind of guardrails and hereby help to facilitate a high number of future successful negotiations*."
- The **Copyright Directive's**[74] Article 21 refers to a possible voluntary, alternative dispute resolution procedure.
- In its 2017 Communication "**Setting out the EU approach to Standard Essential Patents**", the European Commission highlighted the advantages of alternative dispute resolution (ADR) mechanisms such as mediation and arbitration for a swifter and less costly dispute resolution. More recently, in February 2022, the Commission has launched a public consultation on standard-essential patents, as a preparatory step towards the adoption of specific EU legislation, and an effective alternative dispute resolution is set to be one of the key outcomes of this process.

Relevant examples on an international level include, e.g., Australia, which has recently adopted a "**News Media and Digital Platforms Mandatory Bargaining Code**",[75] to address bargaining power imbalances between digital platforms (such as Google and Facebook) and Australian news businesses. The Code makes it possible for news businesses to bargain with digital platforms, individually or collectively, over payment for the inclusion of their news on the platforms concerned. The Australian Communications and Media Authority is empowered to appoint mediators and, in some cases, arbitrators

74 Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on copyright and related rights in the Digital Single Market and amending Directives 96/9/EC and 2001/29/EC.

75 Australian Government, "News Media and Digital Platforms Mandatory Bargaining Code", 2021; Available at: https://www.legislation.gov.au/Details/C2021A00021

for the resolution of disputes if news media and digital platforms cannot reach an agreement.

In the present regulatory environment, the role of a mediation/arbitration body could be given to each Member State's NRA or to a separate competent body at the national or EU level. Under both scenarios, the legal instrument setting out the relevant rules should also anticipate and address potential cases of the involvement of multiple jurisdictions, a factor that might speak against entrusting such dispute resolution to the NRA or other body of a single EU Member State, unless a mechanism for the allocation of the case to a "lead" NRA/other national body can be also included. **Article 27 of the EECC** provides an example of such a cross border dispute resolution mechanism in EU law, which could serve as a model.

Overall, dispute resolution through a mediation/arbitration body would offer a relatively swift and simple solution to address the current imbalance of negotiation power between OTTs and ISP/telcos. Furthermore, while the first of such dispute resolution cases would need to start from scratch (or almost), precedent-setting could lead to consistent price-setting standards and a more stable commercial relationship for the parties concerned.

4.2.4. Ex post vs ex ante solutions

An instrument addressing the problems identified in this report could apply ex post (i.e., through targeted regulatory intervention, ex officio or upon request, once a dispute has arisen), ex ante or perhaps as a combination of both. An ex ante mechanism could mimic price regulation under the existing electronic communications legislation. Arguments in favour of such an ex ante solution would include the existence of regulatory high-level precedents and mechanisms to rely on, at least as a source of inspiration, and a relative ease of implementation, (once decided), instead of prolonged discussions and disputes in each case. The disadvantage of an ex ante tool would be that it would be more intrusive, by nature, and could risk causing inefficiencies by prescribing solutions that would be more static and less efficient than commercially negotiated outcomes.

As an alternative, ex post solutions could grant more commercial flexibility to market players. As a downside, they could lead to uncertainty on the appropriate criteria for the resolution of disputes and, in particular, a prolonged phase of appeals and other litigation.

Finally, an intermediary solution could combine "soft law" (e.g., in the form of guidance from the European Commission and other bodies, for a broader representation of the industry), a few high-level legal principles, and an arbitration mechanism along the lines described above, as a solution of last resort.

4.3. Other options

The solutions described above would all involve a form of direct negotiation and, hopefully, an agreement between ISP/telcos on the one hand and OTTs on the other, acting individually or perhaps even collectively (subject to compliance with competition law safeguards).

Other solutions could include a form of indirect compensation, e.g., through a special fund or a form of digital taxation. However, while seemingly more neutral, such a solution would likely also raise serious concerns. For example, a new fund would be difficult to set up, inherently controversial, and could risk being misdirected to other, unrelated, objectives. Similarly, any solution involving a new tax on digital services could create negative public perceptions about its purpose, at both the European and international level.

As a complementary solution (even if it is not sufficient to fully address, by itself, the problem at hand), traffic optimisation offers an obvious area for improvement. Recent experience at the outset of the Covid pandemic has shown that OTTs are technically in a position to limit their traffic volume substantially, without any noticeable impact on the quality of their service. Nevertheless, the effects of such voluntary solutions are bound to be short-lived, especially as long as OTTs have limited financial or other incentives to extend them, because traffic reductions are likely to be outpaced, sooner or later, by the intrinsic growth in demand for OTT data traffic.

It can be reasonably assumed that, if any of the direct compensation mechanisms discussed is adopted, that should already give OTTs a financial incentive to optimise their traffic management. In addition, however, such mechanisms could be reinforced through regulatory requirements for OTTs to manage their traffic in a way that minimizes unnecessary volume increase, with reporting and associated obligations.

The main advantage of such a solution is that, if the willingness to act is there, OTTs are in pole position to optimize their own traffic volume. At the same time, however, they are far more likely to do so with a commercial incentive rather than without one, which is why such traffic management obligations would be more effective as a complementary rather than as a stand-alone obligation.

Annex A. Glossary

Term	Definition
BEREC	Body of European Regulators for Electronic Communications
DMA	Digital Markets Act
EC	European Commission
ETNO	European Telecommunications Network Operators' Association
EU	European Union. Unless otherwise stated, it is assumed to include the UK as well.
FANG	Facebook, Amazon, Netflix, Google
FTE	Full Time Equivalent
FTTH	Fibre To The Home
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GII	Global Innovation Index
IP	Internet Protocol
ISP	Internet Service Provider
ITU	International Telecommunication Union
NGA	Next Generation Access
OECD	Organisation for Economic Co-operation and Development
OTTs	Over The Top content providers
QoS	Quality of Service
VHCN	Very High Capacity Networks