DSA

DYNAMIC • SPECTRUM ALLIANCE

How do **Europeans connect** to the **internet?** 2022

AS IT CARRIES THE VAST MAJORITY OF INTERNET TRAFFIC IN EUROPE, WI-FI USES SPECTRUM MUCH MORE EFFICIENTLY THAN MOBILE

As Europe embraces the joint digital and green transition, it is aiming to bring gigabit fibre connectivity to all households in the region, and 5G to all populated areas.

These two priorities highlight the complementary role of fixed and mobile networks in delivering broadband connectivity to EU citizens, enterprises and SMEs, schools and hospitals. While mobile networks, such as 4G and 5G, deliver internet access to people on the move, the vast majority of users rely on fixed networks and Wi-Fi to access the internet – or their company's intranet – at home, in the office, in school, and in other buildings. Figure 1 depicts how Wi-Fi and fixed networks work together to deliver a variety of services to users.

The allocation of spectrum should take into account the distinct roles fixed and mobile networks play in delivering broadband to Europeans.

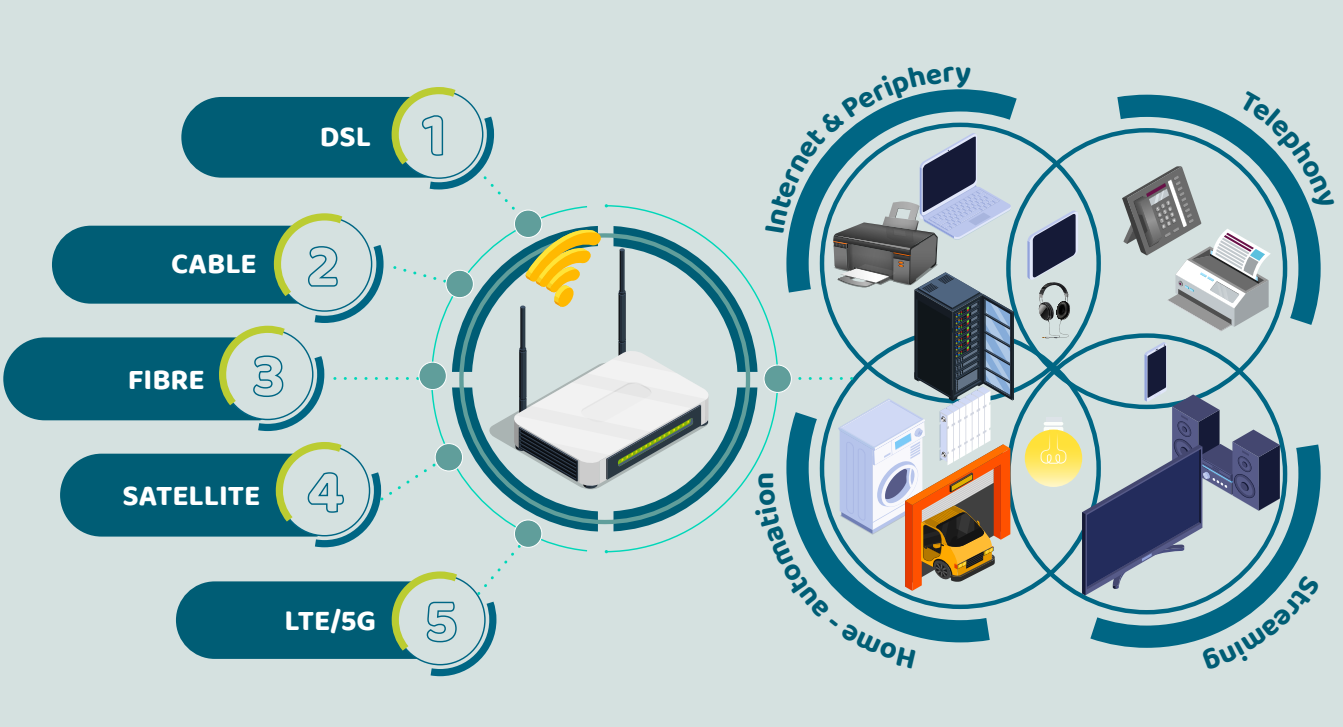

Figure 1: How most people connect to the internet.

FIXED NETWORKS TYPICALLY DELIVER MORE THAN 95% OF OVERALL DATA TRAFFIC

Although mobile data traffic continues to grow steadily, the vast majority of data traffic in Europe is actually delivered over fixed networks, as data from national regulators demonstrates.

Every year, Germany's Bundesnetzagentur (BNetzA) publishes its

"Tätigkeitsberichte Telekommunikation" providing both the total volume of data delivered by fixed networks and by mobile networks. The rapid increase of data transferred over fixed networks is apparent in the Figure 2 below. Mobile traffic is growing too, but it remains a small fraction of fixed traffic.

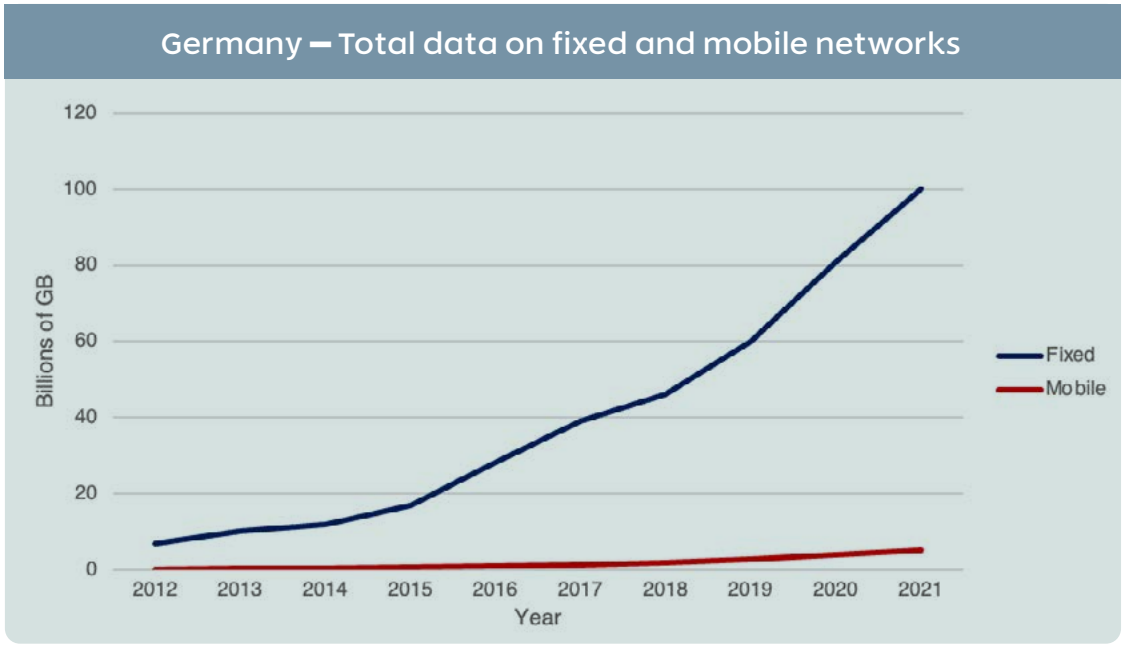

Figure 2: Germany - Total data on fixed and mobile networks. Source: BNetzA.

The data reported by BNetzA clearly indicates that the vast majority of traffic occurs over the fixed network. Figure 3 below provides more context, detailing the evolution of the relative volume of the mobile and fixed data traffic in the period 2012-2020.

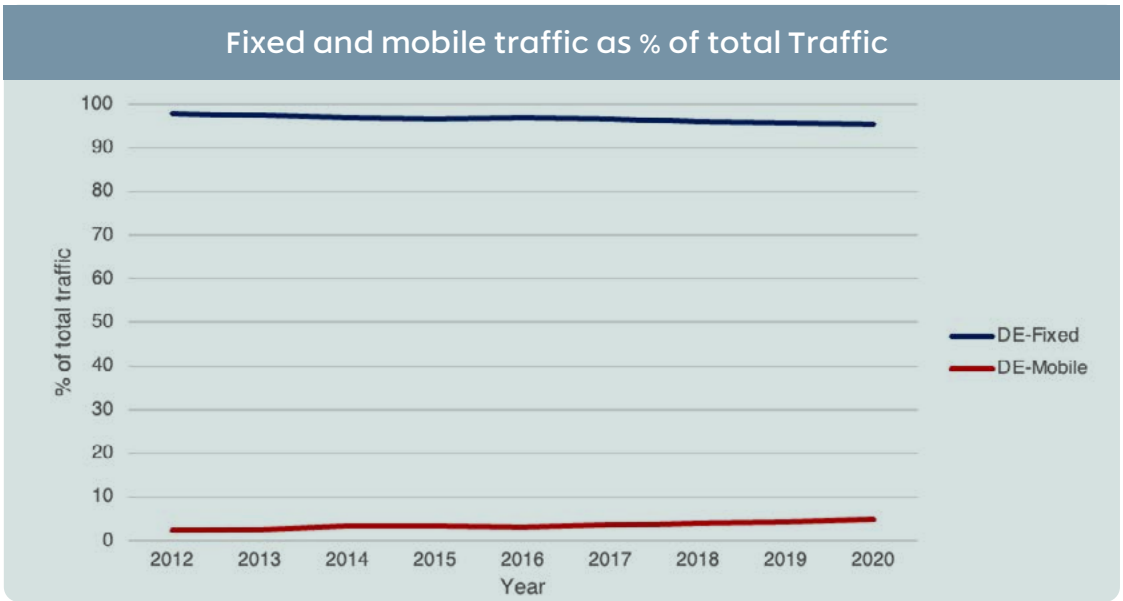

Figure 3: Historical fixed and mobile traffic as % of total traffic. Data source: BNetzA.

IS GERMANY AN ISOLATED CASE?

The data from BNetzA was selected as it allows for direct comparison between mobile and fixed traffic in volume. Many other reports provide indicative volume of data per user (for mobile networks) or per subscriber (for fixed access), which does not allow for a direct comparison. Nevertheless, such data from OFCOM UK (see Annex 1) and from the industry (see Annex 2) confirms the trend observed by Germany's BNetzA: both fixed and mobile traffic are growing fast, but mobile traffic remains a very small fraction of the total traffic.

WHAT IS THE ROLE OF WI-FI?

From personal experience, we are all used to accessing our fixed network mostly through Wi-Fi, either at home or at work[1]. A plethora of devices connect wirelessly (e.g., smartphones, notebooks, tablets, audio/video streaming devices, TV sets, etc.) as do innovative new devices, such as AR/VR headsets. The data supports the intuition that most fixed data is delivered over Wi-Fi.

The ASSIA "State of Wi-Fi" report breaks down how fixed traffic reaches end users. It shows that 45.1 GB of fixed traffic is delivered via Wi-Fi every day, and only 3.8 GB via other technologies, such as Ethernet. In other words, the data from ASSIA indicates that Wi-Fi relays 92.3% of the overall fixed broadband traffic in Europe. For the remainder of this paper, we will assume conservatively that Wi-Fi represents 90% of the overall fixed broadband traffic.

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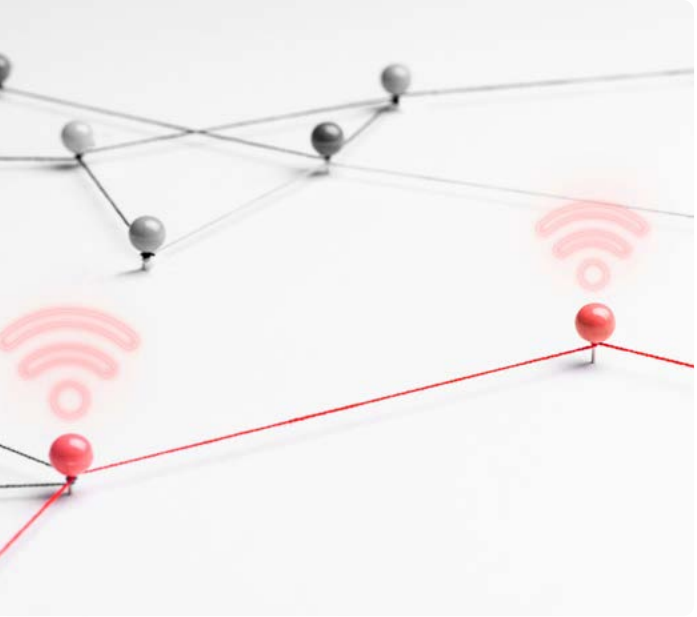

Increasing the capacity of Wi-Fi

Delivering gigabit connectivity over fibre and Wi-Fi will directly impact the bulk of EU citizens' internet activities and progress towards the objectives of the EU Digital Decade. It is, therefore, important to ensure that Wi-Fi has access to sufficient spectrum to support the growth of the traffic, especially given the high levels of bandwidth that fibre-to-the-home (FTTH) connectivity enables.

At the same time, ensuring that populated areas are covered by 5G will enable people to stay connected while on the move – the primary role of mobile networks. The regulatory priority for mobile networks should be to increase coverage, so as to enable new use cases that rely on mobility. The multiple lower frequency bands (sub 3 GHz) that have been identified for IMT are well suited to this purpose. But delivering indoor mobile coverage via (outdoor) macro-cells can be challenging and inefficient (both technically and commercially).

1 This includes the case where broadband is delivered through 4G/5G FWA, as access is provided via Wi-Fi.

Increasing the capacity of public mobile networks in urban areas – i.e., areas with excellent fibre and Wi-Fi connectivity – would only marginally improve the overall internet experience of EU citizens. On the other hand, increasing the capacity and speed of Wi-Fi would have a direct positive impact on our digital lives.

WHAT INTERNET ACCESS METHOD USES SPECTRUM MOST EFFICIENTLY?

One key regulatory objective is to ensure efficient spectrum use, i.e., making sure scarce spectrum resources are used as efficiently as possible.

It can be challenging to compare spectrum efficiencies for different use cases. For example, what is the correct metric to compare the efficiency of a radar and the efficiency of a wireless communication technology? On the other hand, it is straightforward to compare the efficiency of mobile networks and Wi-Fi networks.

The actual spectrum efficiency of Wi-Fi and mobile networks[2] can be best estimated based on the data published by BNetzA, since it provides the overall data delivered without requiring assumptions on the number of users or the number of access points. Mobile networks in Germany delivered 5.2 GB per Hz of spectrum allocated in 2021. By comparison, Wi-Fi, operating exclusively in the 2.4 GHz and 5 GHz bands during 2021, delivered approximately 167 GB[3] per Hz during 2021, i.e. was 32 times more spectrum efficient than mobile networks.

The low and mid-band spectrum dedicated to IMT is shown in Table 1 (wireless signals in high frequency spectrum only travel short distances, limiting their ability to provide extensive coverage). Table 1 makes conservative assumptions, by excluding mobile bands, such as the L-band, the 2.3-2.4 GHz band and the 2.6 GHz TDD band, which are not extensively used by mobile operators. The total amount of spectrum identified for IMT in Region 1 between 700 MHz and 5 GHz is actually 1348 MHz, but Table 1 only includes 1000 MHz of this.

Table 1: Assumptions about total low and mid-band spectrum available for mobile.

Bands	700 **MHz**	800 **MHz**	900 **MHz**	1800 **MHz**	2100 **MHz**	2500 **MHz**	3400 - 3800 **MHz**	Total
Spectrum **(MHz)**	60	60	70	150	120	140	400	1000

2 This estimate assumes that 90% of the fixed-line traffic recorded by BNetzA travels over Wi-Fi.

3 Defined as the amount of data delivered per year divided by the amount of spectrum available for respectively Wi-Fi and mobile networks.

For Wi-Fi, traffic is currently delivered primarily over the 2.4 GHz and the 5 GHz bands, i.e., over 538 MHz of spectrum. As ECC Decision (20)01 opened the 5945-6425 MHz band (the 'lower 6GHz band') for Wi-Fi, and devices that can operate in this band are commercially available, a further 480 MHz has been made available for licence-exempt use. Finally, the 6 GHz capable Wi-Fi equipment available in Europe is actually restricted by firmware, but technically supports the full 5925-7125 MHz band that is available to Wi-Fi in many countries, including the USA, Canada, South Korea, Brazil and Saudi Arabia. This means that if we consider access to 2.4 GHz, 5 GHz, lower 6 GHz, and upper 6 GHz (6425-7125 MHz) bands, the amount of spectrum available for Wi-Fi is 1718.5 MHz, as indicated in Table 2.

Table 2: Assumptions about total low and mid-band spectrum available for Wi-Fi.

Bands	2.4 **GHz**	5 **GHz**	Lower 6 **GHz** (5945-6425 **MHz**)	Upper 6 **GHz** (6425-7125 **MHz**)	Total
Spectrum **(MHz)**	83.5	455	480	(700)	1718.5 (1018.5 today in Europe)

If Germany was to open the full 6 GHz band to licence-exempt use and Wi-Fi traffic did not increase (which is a highly unlikely scenario), Wi-Fi spectrum efficiency would still be 52 million GB per MHz per year, i.e. 10 times more than that of mobile networks without access to 6 GHz, and 17 times more if the 6 GHz band were to be identified for IMT use (see blue bars in Figure 4).

If the upper 6 GHz band were to be identified for IMT, then mobile operators would be unable to make the best use of it. Public cellular networks, which are typically deployed outdoors, primarily use mid-band spectrum to provide capacity. However, given the increased building attenuation losses at 6 GHz compared to 3 GHz, it is unlikely mobile operators would use the 6 GHz band for outdoor-to-indoor coverage, even though 70% of IMT usage is indoors[4].

If the use case for the upper 6 GHz band is to provide outdoor-to-outdoor mobile services, then interference with fixed satellite services would be a major issue. On the other hand, it wouldn't be economic for IMT small cells to use the upper 6 GHz band indoors, as they wouldn't be competitive with Wi-Fi, which is the dominant indoor technology.

4. See Table 7-2 of Annex 4.4 to ITU-R Document 5D/716.

All the above suggests that the spectrum efficiency of the 6 GHz band for mobile would be considerably lower than for the 3 GHz band. This is the reason why Figure 4 shows the potential future spectrum efficiency with the 6 GHz band to be similar to the spectrum efficiency of today's data traffic without the 6 GHz band (green bar on the left).

By contrast, making the 6 GHz band available on a licence-exempt basis, would likely increase the spectrum efficiency of Wi-Fi over time. The additional spectrum will reduce congestion and since only new Wi-Fi equipment will be able to use the 6 GHz band, they will experience wider channels and no congestion at all. As a result, Wi-Fi spectrum efficiency is likely to increase once the Wi-Fi traffic fills up the new capacity (see the green bar on the right in Figure 4).

What is certain, is that, should Europe open the full 5945-7125 MHz to Wi-Fi, the Wi-Fi spectrum efficiency would remain at least 10 times higher than the mobile spectrum efficiency.

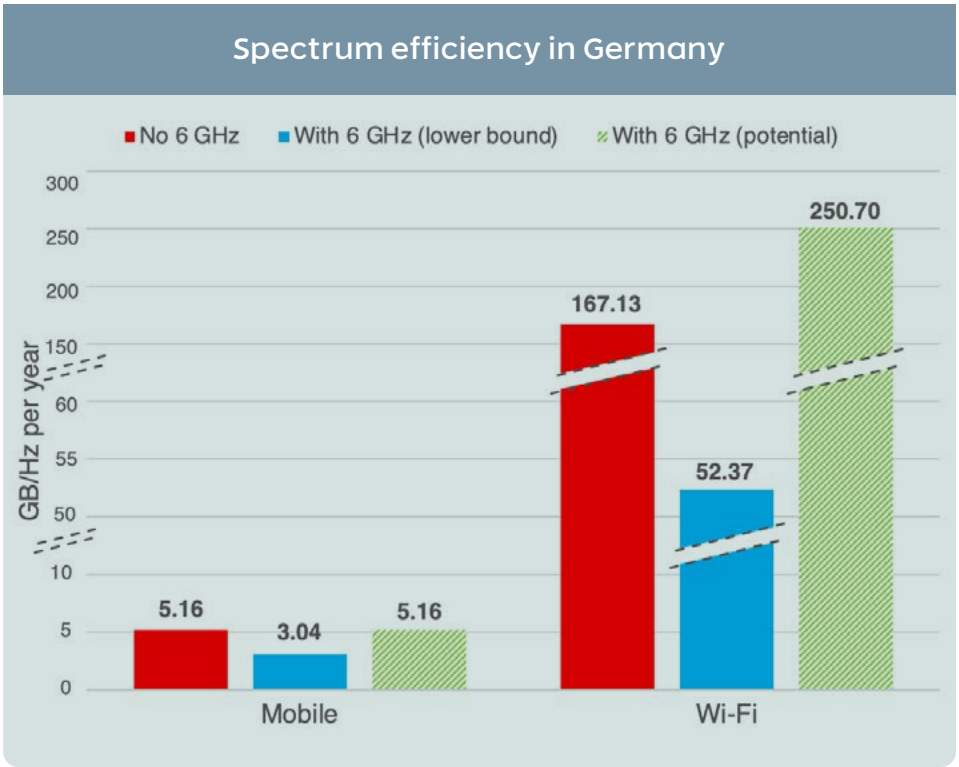

Figure 4: Estimates for overall spectrum efficiency of mobile networks and Wi-Fi in Germany, using traffic data from 2021.

What is certain, is that, should Europe open the full 5945-7125 MHz to Wi-Fi, the Wi-Fi spectrum efficiency would remain at least 10 times higher than the mobile spectrum efficiency.

This discrepancy is not related to the technology, but much more to the network topology (wide area macro cells for mobile, local area access points for Wi-Fi) and the underlying regulatory regime. Licence-exempt spectrum removes the deployment hurdles, enabling unparalleled network density. Increasing the network density does not only increase the capacity of the network, but it also allows the spectrum to be used and reused more often, increasing the spectrum efficiency.

Allowing Wi-Fi in the upper 6 GHz band will improve the quality of service of about 90% of internet access in Europe, amounting to a more efficient use of spectrum than mobile networks.

CONCLUSIONS

An analysis of the Wi-Fi and mobile data demonstrates that:

- Wi-Fi handles over 90% of fixed network traffic, i.e. the vast majority of internet traffic in Europe,
- Mobile networks only deliver traffic equivalent to 5% of the fixed network traffic, i.e. is not relevant from a capacity standpoint,
- Wi-Fi is an order of magnitude more spectrum-efficient than mobile networks, and will continue to be, even if the full 6 GHz band is allocated to Wi-Fi.
- Allowing Wi-Fi in the upper 6 GHz band will improve the quality of service of about 90% of internet access in Europe, amounting to a more efficient use of spectrum than mobile networks.

RECOMMENDATIONS

- IMT identification of the 6425-7125 MHz band is not required nor desirable: providing additional 700 MHz for mobile, which only carries 7% of wireless internet traffic, is not an efficient use of spectrum.
- Europe should authorise operation of licence-exempt RLANs, such as Wi-Fi, in the 6425-7125 MHz band so that the region can benefit from the extensive ecosystem already serving the entire 6 GHz band.
- Europe should focus on harnessing mobile connectivity to support mobility and develop strategies – including on spectrum – to increase the coverage of mobile networks in line with the policy goals of the EU Digital Decade.

ANNEX 1: OFCOM'S FIXED AND MOBILE TRAFFIC

Every year, UK regulator OFCOM publishes its Communication Market Report providing both the average fixed broadband data use per month per subscriber and the average monthly data volumes by mobile data user. The rapid increase of data over fixed networks is apparent in Figure 5 below. The volume of mobile traffic per user remains very limited – even though its growth is comparable to the growth of the fixed traffic – because it was starting from such a low overall value.

The data reported by both BNetzA and OFCOM clearly indicates that the vast majority of internet use occurs over fixed networks. Figure 6 below provides more context, detailing the evolution of the relative volume of the mobile and fixed data traffic in the period 2012-2020.

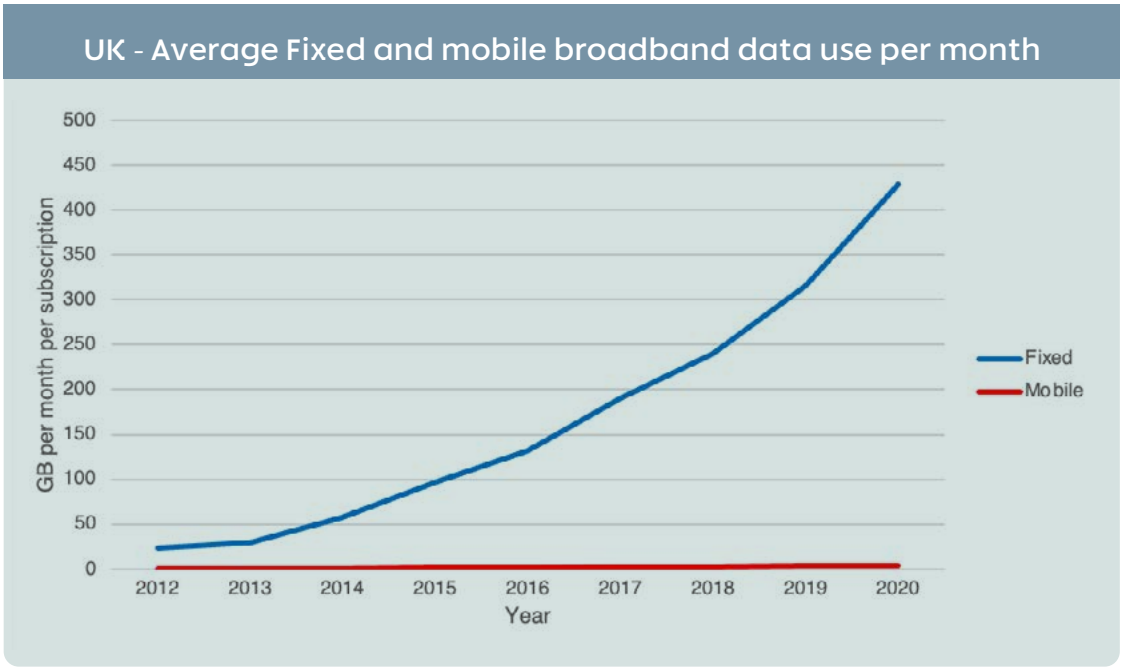

Figure 5: UK average fixed and mobile broadband data use per month. Data source: OFCOM.

Figure 6 suggests slightly different situations between Germany, where the mobile traffic is very slowly increasing as a % of the total traffic – although still at a near negligible value, and the UK, where the % seems relatively stable and negligible. This may be due to the uncertainty in the UK values due to the metrics used (traffic per user/ traffic per access point).

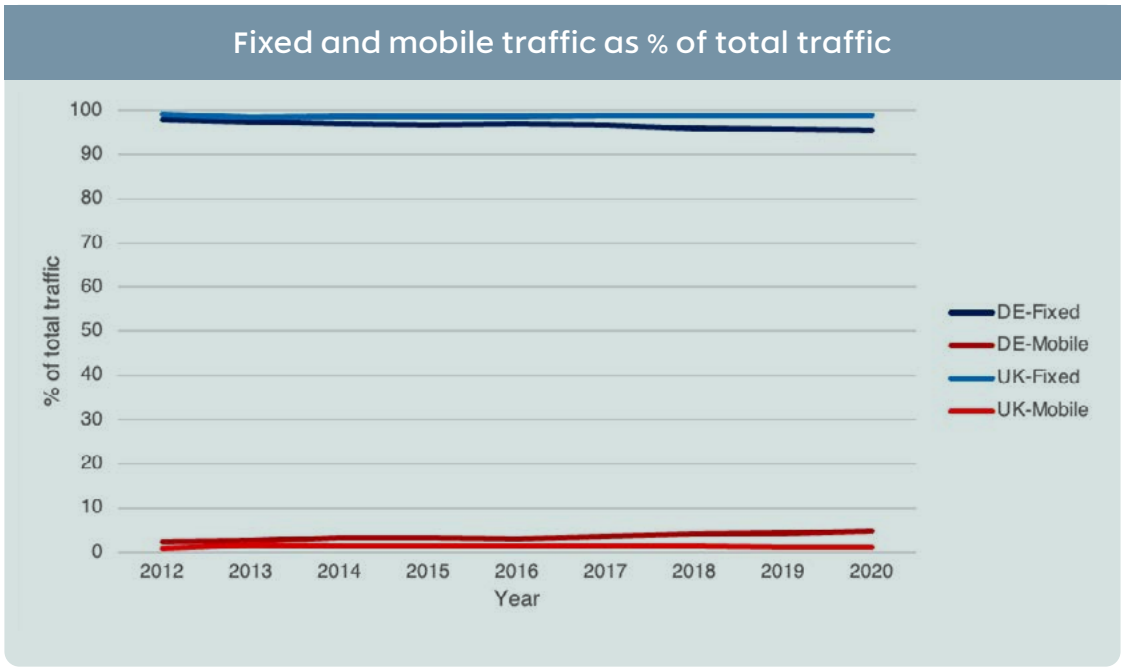

Figure 6: Historical fixed and mobile traffic as % of total traffic. Data source: OFCOM and BNetzA.

Overall, data from both the UK and Germany indicates that mobile traffic remains a tiny fraction (less than 5%) of the total traffic.

ANNEX 2: ERICSSON MOBILITY REPORT AND ASSIA STATE OF WI-FI REPORT

While OFCOM and BNetzA provide accurate and reliable data, focusing on these examples raises the question of whether these countries are typical or more outliers.

Industry sources provide a wider geographical view. Ericsson's mobility report estimated the average traffic per smartphone worldwide as 11.4 GB per month at the end of 2021, while ASSIA measured European Wi-Fi traffic per access point at about 240 GB per month in the 5 GHz band in June 2021. In the 2.4 GHz band, the average traffic per access point was about 160 GB per month. Figure 7 illustrates this data.

Although the metrics (data per users versus data per access point) do not allow for direct comparison, the difference in volume is so large as to make it clear that the differential in the UK and Germany is also the case elsewhere.

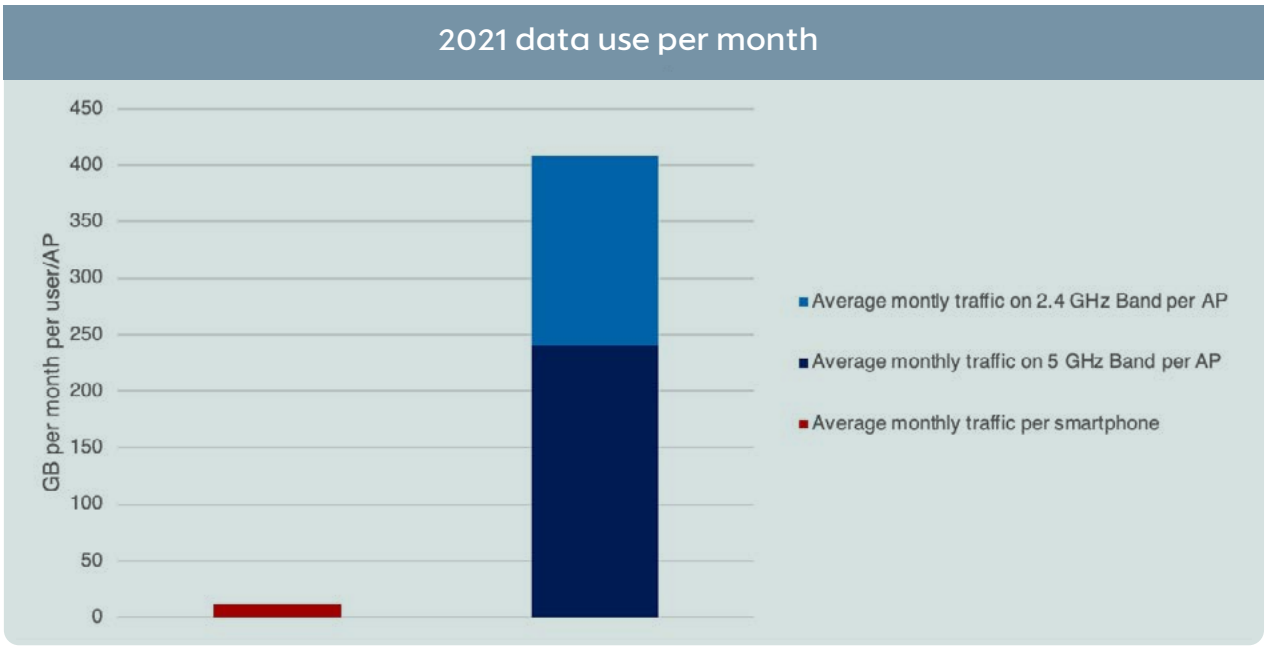

Figure 7: Comparison of 2021 average data use per month, per user (mobile) and access point (Wi-Fi). Sources: Ericsson and ASSIA.

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