GSMA

Harnessing Spectrum Diversity

GSMA Public Policy Paper
on Licensed and Unlicensed
(or Licence-exempt) Spectrum

Copyright © 2024 GSMA

GSMA™

The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry, and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

We invite you to find out more at www.gsma.com

Follow the GSMA on Twitter/X: @GSMA

Contents

	Executive summary	2
1.	Licensed and unlicensed spectrum play important roles in broadband connectivity	4
2.	Mobile network operators offer services using unlicensed and licensed spectrum	7
3.	Where demand on spectrum is high for unlicensed usage, it is typically high for licensed mobile	9
4.	Seamless connectivity promotes digital transformation and SDGs uptake	11
5.	Mobile service prevalence and quality removes the need for public Wi-Fi Access Points	12
6.	Unlicensed spectrum needs are mostly defined by the speed of the internet access	12
7.	Private mobile networks may require licensed and unlicensed spectrum	13

Executive summary

The mobile ecosystem is a broad and diverse enabler of social development and economic growth. It has evolved through research and innovation across multiple industries, strengthening its role in serving connectivity over the globe through the united efforts of different sectors. This paper outlines the roles played by licensed and unlicensed (also known as licence-exempt) spectrum in providing reliable services to consumers. It highlights the essential issues that must be taken into account when considering these two mechanisms for spectrum use.

Licensed and unlicensed models for spectrum usage are both necessary and can be complementary. These two spectrum models help ensure connectivity for a wide range of use cases so that consumers can benefit seamlessly from wireless internet applications.

Mobile network operators (MNOs) use licensed spectrum in core frequency bands to provide services to industry, governments, and consumers. This spectrum has guaranteed rights of use and helps provide secure, reliable, and good quality service for end-users. Licensed spectrum also provides certainty, incentivises investment, and gives predictability for MNOs to develop long-term plans, knowing that they will have access to a certain band for the length of time guaranteed in their spectrum licence.

Unlicensed spectrum, often used by consumers and industry for WAS/RLAN applications such as Wi-Fi, is also an important mechanism for providing internet connectivity. Unlicensed spectrum provides access connectivity to user equipment in localised fixed locations and can be an important component of communications infrastructure. Unlicensed access is dependent on connecting to a wide-area network – wired or wireless – in order to provide connectivity.

Communications service providers do not tend to rely on one spectrum model to provide services to consumers. ISPs and cable providers may offer MVNO services while, in many countries, MNOs are also the major providers of fibre connectivity. They thus offer fixed services to end-users combined with unlicensed spectrum to provide the final access connection, as well as using licensed for their mobile connectivity.

The GSMA highlights different principles in licensed and unlicensed spectrum:

01. Licensed and unlicensed spectrum play important roles in broadband connectivity

Licensed and unlicensed spectrum are required to deliver most of the online activity in the world today. The two spectrum models play complementary but distinct roles.

02. Mobile network operators offer services using unlicensed and licensed spectrum

Mobile network operators offer hybrid services. Some of these are fixed services using unlicensed spectrum for Wi-Fi access, as well as mobile services. MNOs use both licensed mobile and unlicensed WAS/RLAN connectivity as part of their suite of services offered to final users.

03. Where demand on spectrum is high for unlicensed usage, it is typically high for licensed mobile

High data demand is driven by digital uptake, network speeds, and local consumer expectation. In highly digitalised markets, data demand is typically higher across both fixed and mobile. This means that assigning more spectrum for unlicensed applications does not eliminate the need for licensed mobile spectrum.

04. Seamless connectivity promotes digital transformation and SDGs uptake

As nations move towards UN Sustainable Development Goals (SDGs) and universal and meaningful connectivity, broadband connections must be available everywhere for everyone.[1,2] This requires governments and regulators to have an integral and balanced vision for mobile networks, securing quality of service, low latency, reliability and socio-economic benefits to their citizens.

05. Mobile service prevalence and quality removes the need for public Wi-Fi Access Points

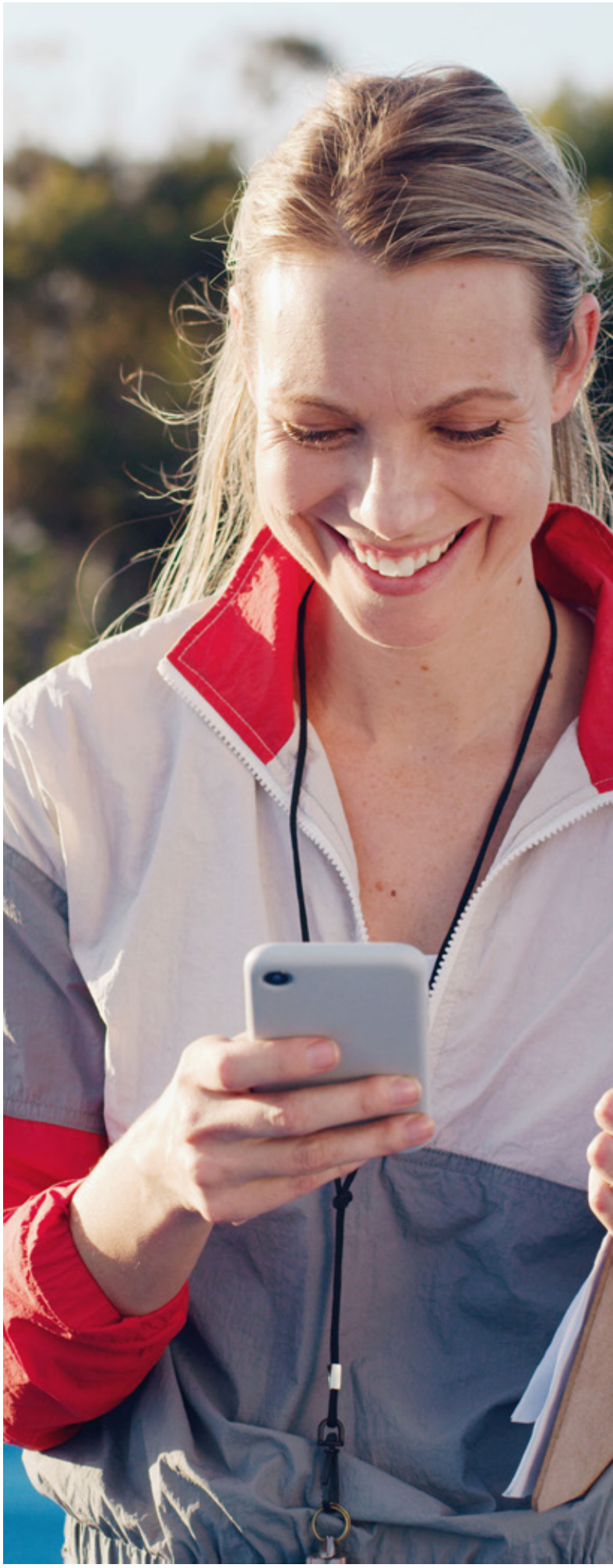
As the quality and speed of mobile networks increases and as the MByte cost of data decreases in mature markets, the need for public Wi-Fi access points decreases. This has been noted in different markets since the advent of 5G.

06. Unlicensed spectrum needs are mostly defined by the speed of the internet access

Unlicensed spectrum requires last-mile connectivity from the RLAN access point, whether through a fibre network, FWA, or other connection to the internet. The existing and planned broadband infrastructure in a market determines the maximum speeds achievable over a Wi-Fi connection and, therefore, the amount of unlicensed spectrum required.

07. Private mobile networks may require licensed and unlicensed spectrum

Digitalising industry is a priority for all governments and the connectivity required for Industry 4.0 comes from different forms of spectrum licensing. Private mobile networks (PMNs) may have spectrum needs for licensed or unlicensed spectrum, with or without dedicated network equipment.



1 2030 Agenda for Sustainable Development, UN
2 Universal & Meaningful Connectivity, ITU



01. Licensed and unlicensed spectrum play important roles in broadband connectivity

Licensed and unlicensed spectrum are both required to deliver most of the online activity in the world today. The two spectrum models play complementary but distinct roles. Licensed spectrum is typically used to cover wide areas and reach a high number of users. Meanwhile, applications serving local operations in a specific location, with the correct fixed or fixed wireless connectivity to a public network, can use unlicensed spectrum normally at lower powers to provide access to UEs.

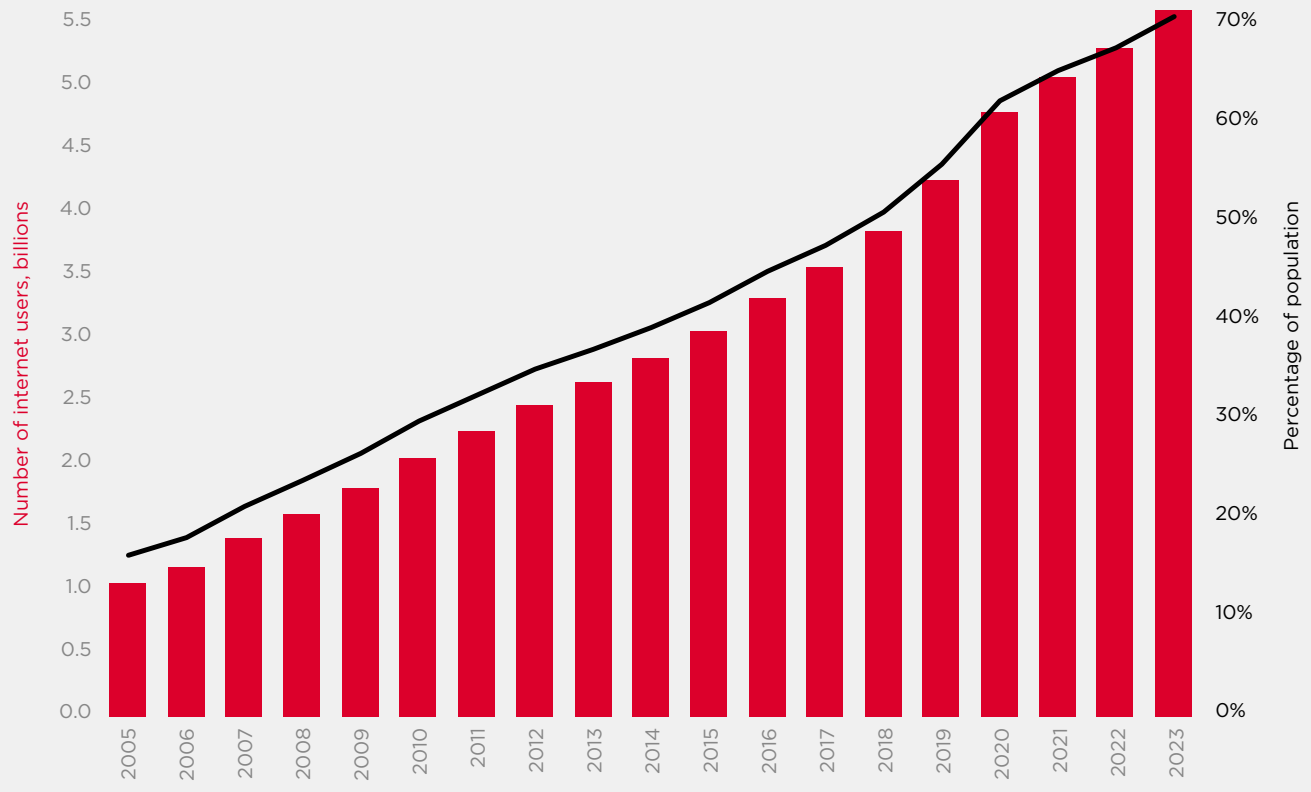
Since the onset of 3G and Wi-Fi adoption into mass-market products in the late 1990s, mobile and Wi-Fi ecosystems have formed the backbone of global connectivity. Their use has been interlinked throughout the smartphone era as handsets support both technologies and users move seamlessly between licensed and unlicensed connections.

Licensed spectrum is the critical component necessary to deliver mobile services because of the long-term certainty it gives to network operators, as they are able to rely on continued and guaranteed access to frequency bands. Such certainty allows confidence that investment in networks can be amortised. Guaranteed spectrum access helps deliver secure, quality connectivity and the typically higher-power use of licensed spectrum allows operators to provide greater coverage and more sustainable networks.

Unlicensed spectrum, meanwhile, allows users to connect wherever there is a fixed or fixed wireless broadband connection. Network speeds and quality are largely linked to the capability of that connection with the unlicensed element supporting lower-power and shorter-range access connectivity. Unlicensed access most commonly uses Wi-Fi technologies coupled with fibre or other broadband connection to provide internet access in distinct local areas such as homes, offices, and other commercial places.

"57% of the world's population, or 4.6 billion people are using mobile internet".[3]

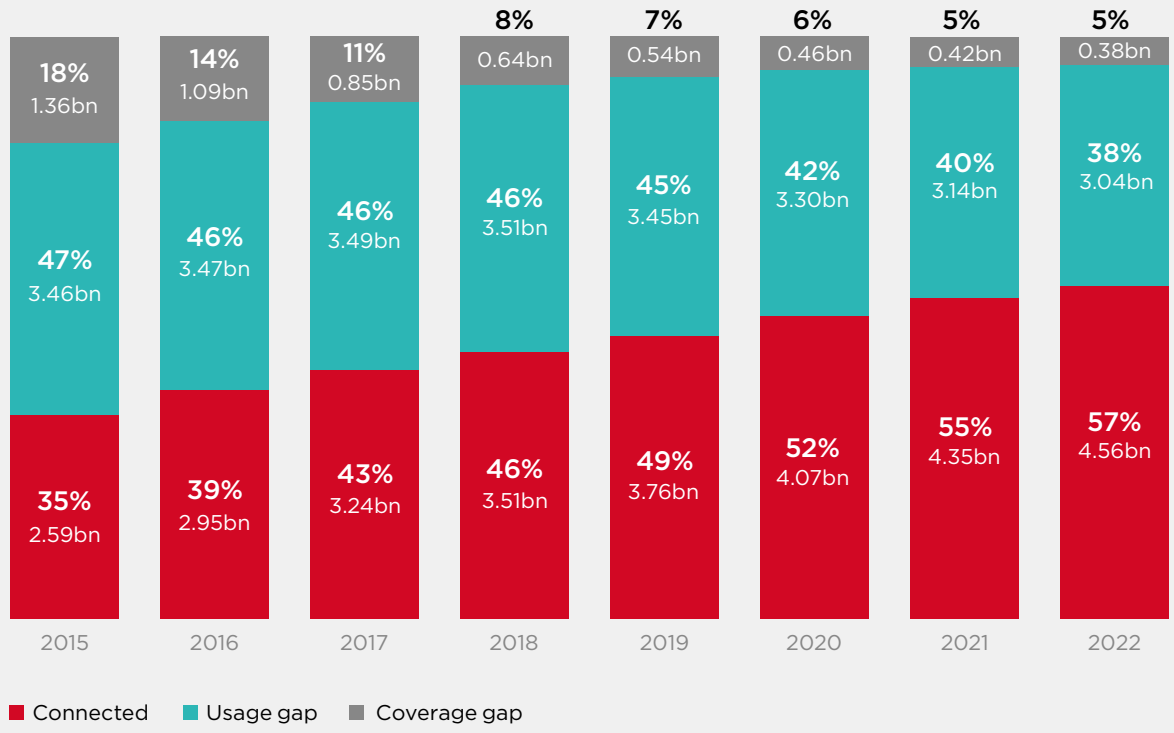
Figure 1: Individuals using the internet



Source: ITU[4]

3 The State of Mobile Internet Connectivity, GSMA, 2023
4 Facts and Figures, ITU, 2023

Figure 2: Global mobile internet connectivity, 2015–2022



Source: GSMA Intelligence[5]

IMT and WAS/RLAN at WRC-23

The roles of WAS/RLAN applications, including Wi-Fi, and those of wide-area macro-cell IMT, came under close scrutiny in the World Radiocommunication Conference 2023 (WRC-23) during discussions over the 6 GHz band. Developers of applications and equipment using both technologies expressed a requirement for additional spectrum going into the WRC and this band was sought after by both unlicensed and licensed proponents.

The 6 GHz band sits at 5.925-7.125 GHz and is a total of 1200 MHz of spectrum of which the upper part of the band at 6.425-7.125 GHz was on WRC-23 agenda for IMT identification; during the conference this was finally identified for IMT. While some countries will use the whole of it as unlicensed spectrum, and the path is still open for countries to use the whole band for licensed mobile, most of the support at WRC-23 was for a balanced decision which encouraged both spectrum models.

The WRC-23 decision reflects the importance of both licensed and unlicensed applications.

5 The State of Mobile Internet Connectivity, GSMA, 2023



02. Mobile network operators offer services using unlicensed and licensed spectrum

Mobile network operators offer hybrid services. Some of these include fixed services using unlicensed spectrum for Wi-Fi access, some are mobile services using licensed spectrum. MNO customers use both licensed mobile and unlicensed WAS/RLAN connectivity as part of their suite of services offered to them. As such, MNOs focus on the best means of getting localised connectivity to the end-user.

For example, the largest providers of fibre-to-the-home (FTTH) services in France, Germany and the UK are Orange, Vodafone and BT respectively, all of which are also major mobile operators. All of these use licensed spectrum for mobile connections, provide FTTH as well as fixed wireless access (FWA) services and use unlicensed spectrum through Wi-Fi access points for on-premise UE connectivity.

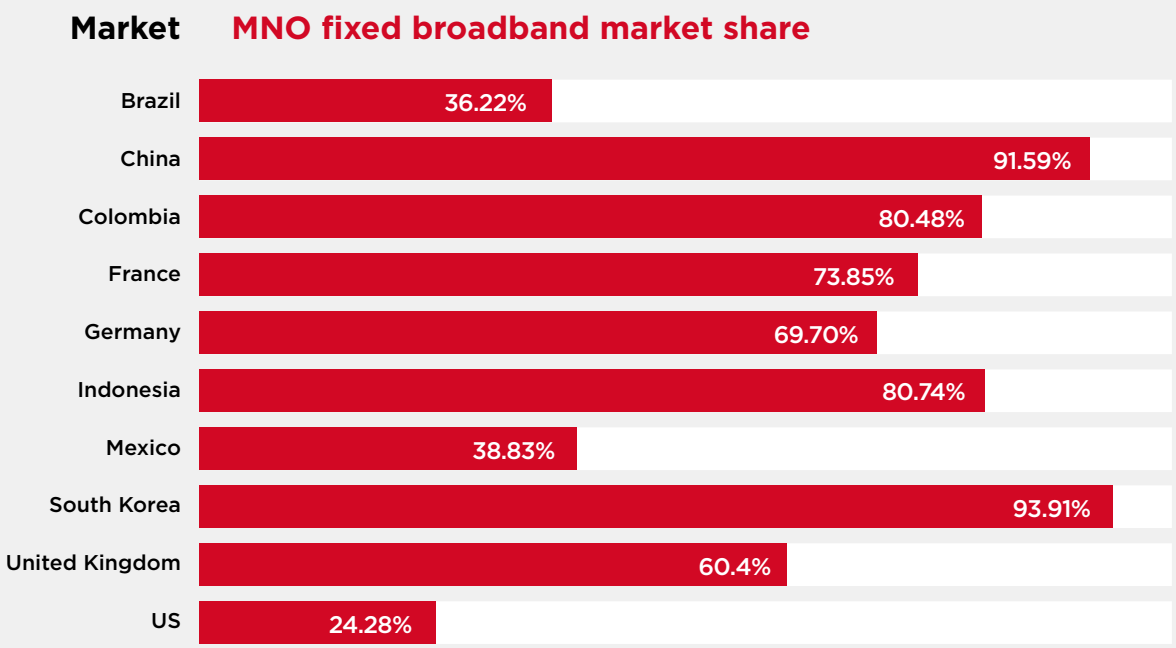
The same applies in other regions where major telecoms groups offer both FTTH and mobile services. In countries with less dense fibre networks the relationship is even clearer, where FWA will provide connectivity to buildings using licensed spectrum and then an unlicensed band will be used with Wi-Fi to provide access throughout a premises. When licensed internet access is provided, unlicensed spectrum allows users to connect different terminals and smart devices such as TVs, tablets, speakers, and others to a local network.

Complementarity between licensed and unlicensed spectrum applications has been essential to provide connectivity to end users.

Licensed and unlicensed use in practice

The symbiosis between licensed and unlicensed spectrum use is made clear in the service portfolios of many telecommunications companies, which depend on both to offer fixed services, mobile services, and Wi-Fi access. Analysis of ten markets shows the prevalence of mobile telcos in the fixed broadband market.

Figure 3: 2023 market share of total fixed broadband connections held by mobile operators



Source: GSMA Intelligence



03. Where demand on spectrum is high for unlicensed usage, it is typically high for licensed mobile

High data demand is driven by digital uptake, network speeds, and local consumer expectations. In highly digitalised markets, data demand is typically higher across both fixed and mobile. This means that assigning more spectrum for unlicensed applications does not take away the need for licensed mobile spectrum.

Markets with high fixed broadband penetration, where unlicensed spectrum is required for access, have an equally high need for licensed mobile spectrum.

Ensuring balance between the two spectrum models supports user demand for more data. If too much spectrum is allocated to one service, and not enough is subsequently available to others, the market will become imbalanced. Imbalance may mean that regulators will begin enforcing technology choices on consumers as the quality of one service improves while the other degrades.

The demand for data in both fixed and mobile locations increase is based on available network speeds, market digitalisation and local consumer habits. The amount of spectrum available for licensed mobile services has a direct impact on the speeds that can be offered to consumers since the bandwidth available directly impacts speed.

Where fibre to the home (FTTH) is limited, however, demand for licensed spectrum may increase for serving both fixed and mobile technologies if fixed wireless access (FWA) is a solution for connectivity. In countries with less dense fibre networks, FTTH may be substituted either by mobile or FWA services using licensed mobile spectrum. In the case of FWA, users can then utilise unlicensed WAS/RLAN connectivity within a building.

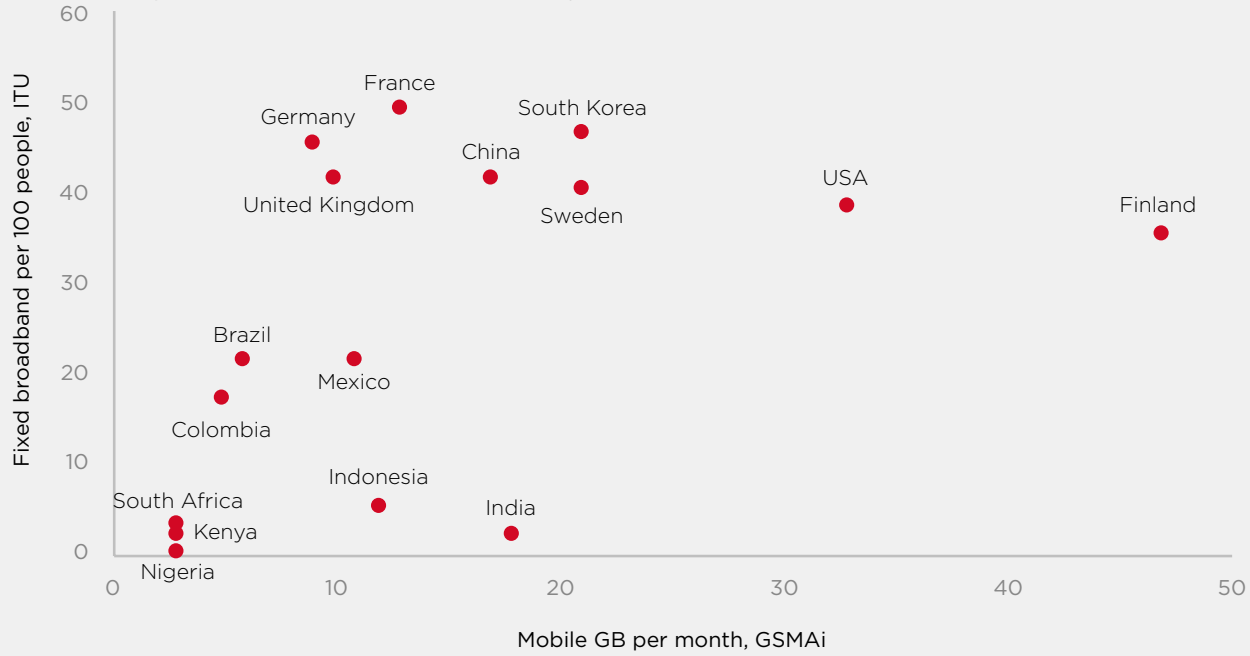
Some LMIC markets may thus have higher licensed spectrum demand because the mobile network is the sole means of broadband connectivity. This may initially supress the need for WAS/RLAN capacity.

However, as markets mature both technologies will require sufficient spectrum and balance between them is important.



Figure 4: Fixed broadband vs mobile data

High fixed-line penetration is associated with higher mobile data use.



Source: ITU and GSMA Intelligence[6]

6 Total data traffic transferred over the mobile network, per connection per month in 2023

04. Seamless connectivity promotes digital transformation and SDGs uptake

As nations move towards UN Sustainable Development Goals (SDGs) and universal and meaningful connectivity, broadband connections must be available everywhere for everyone.[7,8] This requires governments and regulators to have an integral and balanced vision for mobile networks securing quality of service, low latency, reliability and socio-economic benefits to their citizens.

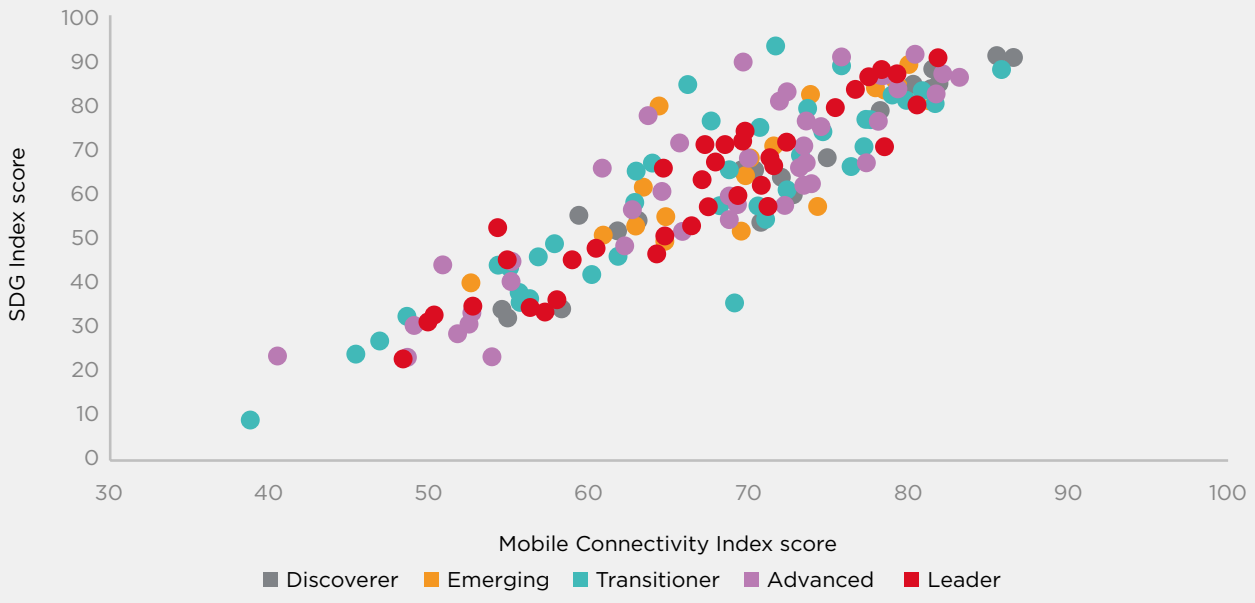
> "Mobile is the primary (in some cases, only) way most people in low- and middle-income countries (LMICs) access the internet".[9]

To ensure the benefits of digitalisation, mobile and fixed networks should be complementary, the speed and quality of both networks must be comparable, while the transitions between them must be seamless. It requires solutions for different geographies and different economies, meaning balanced licensed and unlicensed spectrum access is vital to providing the seamless connectivity required to deliver this target.

Technologies using unlicensed spectrum are typically deployed indoors or at specific locations, while mobile is required and expected to provide connectivity over wide areas, indoors and outdoors. Spectrum imbalance which favours unlicensed applications over licensed mobile can prolong reliance on fixed technologies rather than allowing users to seamlessly shift between them. This could impact digital uptake and the positive enablement effect that connectivity has on carbon emission reduction.

Consumers require connectivity through technologies that deliver affordability and sufficient data speeds. Limiting these to a single case – fixed or mobile – will lower the use of digital technologies. This is one reason why high mobile connectivity usage is linked to realising UN sustainability goals (SDGs).

Figure 5: Countries with high mobile connectivity index scores do better on the SDG index



Source: Mobile Industry Impact Report: Sustainable Development Goals, 2023[10]

7 2030 Agenda for Sustainable Development, UN
8 Universal and Meaningful Connectivity, ITU
9 SDG Report, GSMA
10 Ibid

05. Mobile service prevalence and quality removes the need for public Wi-Fi Access Points

As the quality and speed of mobile networks increases and as the Mbyte cost of data decreases in mature markets, the need for public Wi-Fi access points decreases. This has been seen with the advent of 5G in e.g. South Korea, or recently demonstrated in the Qatar World Cup where 80% of stadium connectivity was carried out across the 5G networks[11].

Wi-Fi offload was a significant factor at the start of the smartphone era as either lower mobile network speeds or higher price points led to consumers connecting to a Wi-Fi network wherever they sat down. However, with the lower price per Mbyte in the 5G era, and higher mobile network speeds, the number of Wi-Fi points that people are connecting to has reduced, typically to home and work.[12]

Public Wi-Fi access points require investment, either from governments or from property developers in certain locations such as sports stadia, to be deployed and maintained. The high-traffic scenarios that aim to serve may also be better suited for mobile operating in licensed mmWave spectrum.

Security of unlicensed networks also impacts take-up of public Wi-Fi access points as user concerns grow over the safety of connecting to an unknown network. Users are also increasingly wary of divulging personal information to unknown network providers as opposed to their known mobile operator. They may also find that the process of ascertaining login information and connecting to a variety of Wi-Fi networks becomes unnecessary when the quality and affordability of the wide area network is sufficient.

06. Unlicensed spectrum needs are mostly defined by the speed of the internet access

Unlicensed spectrum requires last-mile connectivity from the RLAN access point, whether through a fibre network, FWA, or other connection to the internet. The existing and planned fixed or mobile broadband infrastructure in a market determines the maximum speeds achievable over a Wi-Fi connection and therefore, the amount of unlicensed spectrum required.

Technologies operating in unlicensed spectrum, such as Wi-Fi, are only as capable as the network that they are connected. Wi-Fi access spectrum cannot by itself provide additional capacity. The mesh of the Wi-Fi system and the backhaul system it is connected to must be capable of providing high throughput to the access point in the first place, at which point the quantity of unlicensed spectrum may or may not become a bottleneck depending on the speed required.

During the negotiations of WRC-23 (see box on page 6) there was significant scrutiny of the necessary volumes of spectrum for both unlicensed WAS/RLAN and IMT applications. WAS/RLAN proponents suggested that significant increases in unlicensed spectrum were necessary to accommodate multiple 320 MHz channels of unlicensed spectrum. However, the opposition view was that very few applications necessitate such channels and that increasing WAS/RLAN spectrum was only needed in instances where fibre to the premises needs exceeded 10 Gbps, which again was stated as a rarity.

A regulatory impact assessment to ascertain the relationship between unlicensed access spectrum and the quality of any fixed network is thus an important tool when defining spectrum needs for unlicensed technologies in any market.

11 Ooredo

12 The socioeconomic benefits of the 6 GHz band Considering licensed and unlicensed options, GSMAi, 2022



07. Private mobile networks may require licensed and unlicensed spectrum

Digitalising industry is a priority for all governments and the connectivity required for Industry 4.0 comes from different forms of spectrum licensing. Private mobile networks (PMNs) may have spectrum needs for licensed or unlicensed spectrum, with or without dedicated network equipment.

Typically, licensed spectrum may be used to provide certain use cases requiring guaranteed connectivity conditions. These include ultra-reliable low-latency (URLLC) use cases, as well as certain massive IoT (mIoT) and enhanced mobile broadband applications.

A PMN can be standalone with private spectrum, it can use national licensed spectrum, or it can use unlicensed spectrum, depending on the applications employed. For URLLC applications, connected vehicles and logistics, precision operational technologies, or any service requiring high security or mobility, licensed mobile is required.

However, for some data transmission cases, especially where guaranteed throughput is less crucial, unlicensed technologies may be used.

Wi-Fi, which can use the 2.4 GHz, 5 GHz and 6 GHz spectrum bands, is designed for indoor and local area networks, but industrial networks require highly reliable connectivity both indoors and outdoors, which 5G mobile technology is able to provide.

Larger locations, whether they are ports and transport hubs, campus networks or mining facilities, thus tend to use licensed spectrum through either dedicated equipment or a dedicated network slice of the public network.

Private networks using unlicensed spectrum are expected to be one of the applications that may make use of the unlicensed form of 5G (5G NR-U) either in bands typically used for WAS/RLAN applications such as Wi-Fi or in shared access spectrum.

GSMA Head Office
One Angel Lane
London, U.K.
EC4R 3AB
United Kingdom
Tel: +44 (0)20 7356 0600
Fax: +44 (0)20 7356 0601

