# Mobile and Wi-Fi in Upper 6 GHz

## Why hybrid sharing matters

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# Overview

In this document we set out a vision of how shared use of the Upper 6 GHz spectrum band could maximise its future value by enabling both Wi-Fi and commercial mobile services, while also safeguarding incumbent use as much as possible.

This paper builds on our July 2023 consultation and October 2023 update on stakeholders' responses. Since that time, we have continued to develop our thinking on how best to achieve "hybrid sharing" between mobile, Wi-Fi and incumbent users. We have been actively promoting a shared framework for the band in international spectrum management fora.

As spectrum becomes more crowded, it only makes sense to design for sharing and coexistence by default, to allow for flexibility in meeting as many deployment scenarios as possible in the most flexible manner. A "sharing by design" philosophy should be built into future equipment standards. Hybrid sharing in Upper 6 GHz is a first step in this direction. We will build on this to ensure future wireless broadband growth (towards 6G) is delivered through harmonised, sharing-native solutions with embedded flexibility to address different coexistence challenges.

# Why hybrid sharing?

Our aim is to get the greatest benefit from future use of the Upper 6 GHz band, regardless of how it is used, including preserving as much as possible of the benefits already provided by existing uses of the band.

Both mobile network operators (MNOs) and Wi-Fi networks want access to the band. This is important additional spectrum that will help these networks cope with future growth in demand for advanced wireless broadband services. This need was recognised internationally when WRC-23 identified it for mobile (IMT) whilst also acknowledging its importance for Wi-Fi (WAS/RLAN).

However, there are some differences in where and how mobile and Wi-Fi networks would like to use the band, and there is a good deal of uncertainty over the exact level of future demand for both mobile and Wi-Fi. In addition, demand can be highly localised with very different growth rates in individual areas.

An appropriate framework for sharing the band could open the possibility of combining the best of what mobile and Wi-Fi can offer, and potentially provide a way of optimising use and adapting to changes in the relative levels of future demand between the two, including at a localised level. However, to achieve this, industry and regulators must cooperate in developing technical coexistence approaches and accept that these should support sharing of the band on an equitable basis, optimised to the needs of specific environments.

MNOs would like to use the Upper 6 GHz band to provide extra capacity from existing macro site networks, in locations with the highest density of users. Our *Connected Nations 2023* report already shows a similar pattern with use of the 3.5 GHz band, which is currently the main 5G capacity band. However, 3.5 GHz is deployed outdoors covering only 30%–60% (depending on the MNO) of UK premises, with coverage indoors even lower than this. Although the MNOs are likely to roll out more 3.5 GHz base stations over time, the mobile industry has indicated that they expect Upper 6 GHz will be needed to add extra capacity to a proportion of the busiest of these base stations.

Conversely, Wi-Fi networks are predominantly deployed indoors in almost every home and office, and Wi-Fi makes intensive use of spectrum in enterprise environments and high-density residential buildings. However, there is very little use of Wi-Fi outdoors. We expect Upper 6 GHz to be especially needed to provide Wi-Fi capacity in the busiest indoor and enterprise environments.

For most users, it is connectivity itself that matters, more than whether wireless broadband is delivered over mobile or Wi-Fi networks specifically. Seamless integration between Wi-Fi and mobile will become more important to ensure the best consumer experience, regardless of frequency band. This should be one of the goals of future mobile and Wi-Fi standards.

There will be places where both mobile and Wi-Fi would be likely to use the spectrum intensely, such as dense urban areas like central London. Coexistence mechanisms will be essential to manage these "overlaps", and these mechanisms should also take into account coexistence with existing uses of the band.

# What we want from a hybrid sharing framework

There are many potential ways to implement hybrid sharing. Below we describe a set of factors that could help to assess which implementations are most promising.

## Most important

1. **Achieve greatest overall consumer benefits**. From the point of view of either mobile or Wi-Fi, having to manage potential clashes with the other may introduce some loss in the benefits of using the spectrum compared to either being the sole user of the band. However, from the point of view of the consumer, the highest overall benefits should be achieved if the sharing framework can realise **most of the benefits from both uses**. This test will indicate whether any hybrid approach delivers a better overall result for consumers.
2. **Commercially attractive**. Getting mobile and Wi-Fi sharing in the band requires innovation and investment from industry. International harmonisation is essential, as well as ensuring that there is sufficient certainty of spectrum availability. Without this, manufacturers and users will not invest. MNO's have emphasised that they need to use the band on macro sites, whilst Wi-Fi proponents are keen to leverage existing standards (i.e., Wi-Fi 7) rather than having to wait for a future release. The sharing framework should take this into account.
3. **Coexisting with current users**. The sharing framework should enable coexistence with current users, allowing them to continue using the band where feasible. These users bring value, clearing them from the band would be costly, and it would take time. However, in locations where consumer demand for mobile and Wi-Fi is very high, there might be a case for changes that affect current uses, **as long as this enables greater overall benefits**. In such cases, the impact on existing users would need to be carefully managed.

## Highly desirable

4. **A phased approach**. Some of the technologies needed for hybrid sharing may need time to be fully developed and implemented in equipment standards. It would be desirable to identify coexistence measures that could be implemented early, allowing the spectrum to be used in the shorter term **as long as we can avoid creating legacy issues** that would restrict the efficiency of sharing in the future.
5. **Flexibility to recognise national/local priorities** while still maintaining an internationally harmonised approach (e.g., some countries might want to allow higher powers for mobile more broadly than others). While harmonisation is essential, an approach that is inherently flexible to allow for different countries, or areas within a country, to reflect local priorities is also important.

# Examples of implementation and trade-offs

Wi-Fi traffic is almost exclusively indoors, and it carries more than 10 times the total data volume that is carried on mobile networks. Mobile networks on the other hand are located outdoors, but a large proportion of the data they carry is to or from devices that are indoors.

The Upper 6 GHz band is not the most promising band for getting signals into or out of buildings; lower frequencies are much better at this. However, this can also be an advantage in isolating services such as Wi-Fi being delivered indoors from mobile services being delivered outdoors, reducing the risk of the two interfering with each other.

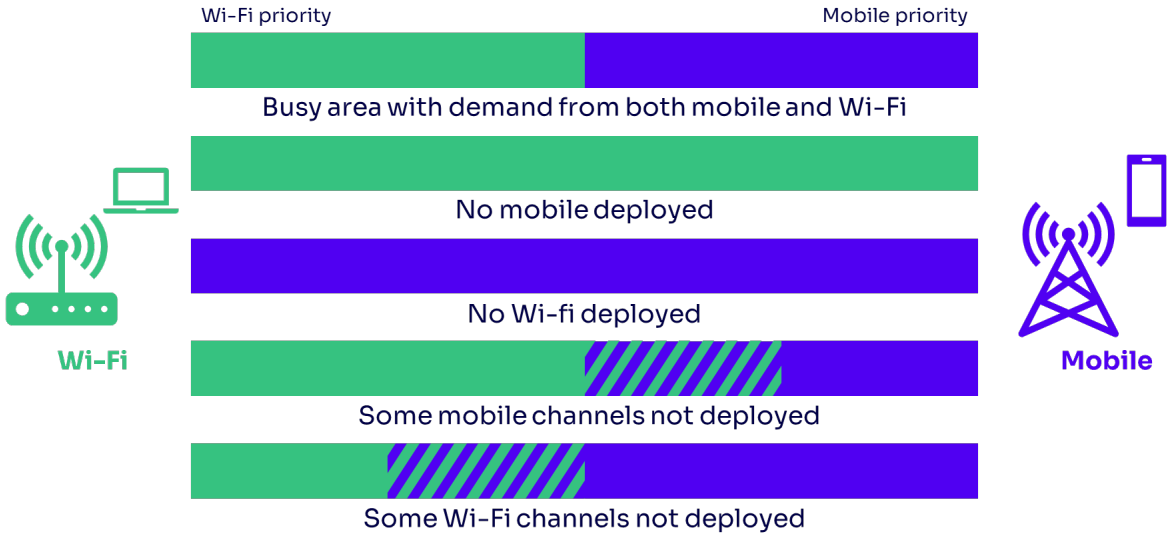
An effective sharing framework between mobile and Wi-Fi has the potential to maximise consumer benefits by combining the benefits of the very large number of Wi-Fi access points indoors and the extensive outdoor mobile networks.

We are working intensely with industry and our European counterparts to develop ideas for a hybrid sharing framework and the necessary coexistence solutions. For this reason, **it is too early to identify a single preferred approach; instead, we explore two possible elements that could form part of the sharing framework and some of the trade-offs that may be required**.

## A – Variable spectrum split

The Upper 6 GHz band would be split into two parts: a priority portion for Wi-Fi and a priority portion for mobile. Both Wi-Fi and mobile would be allowed to freely deploy in their respective priority portions.

Both systems would be able to use other parts of the band, in channels and places where the other service is not present. For this to be possible, each would have to implement "sense and avoid" techniques for the other service. For example, Wi-Fi would be able to use the mobile priority portion of the band, in locations where it can sense that mobile is not deployed. It would need to move away from those channels once mobile is deployed. The opposite would be true for mobile use of the Wi-Fi priority portion.




To make "sense and avoid" work effectively, we may want mobile and/or Wi-Fi to transmit a specific signal that the other technology can sense easily. For instance, Wi-Fi might be fine decoding a normal 5G signal, but on the other hand, it might work better if mobile could transmit a signal specifically designed for Wi-Fi to sense.

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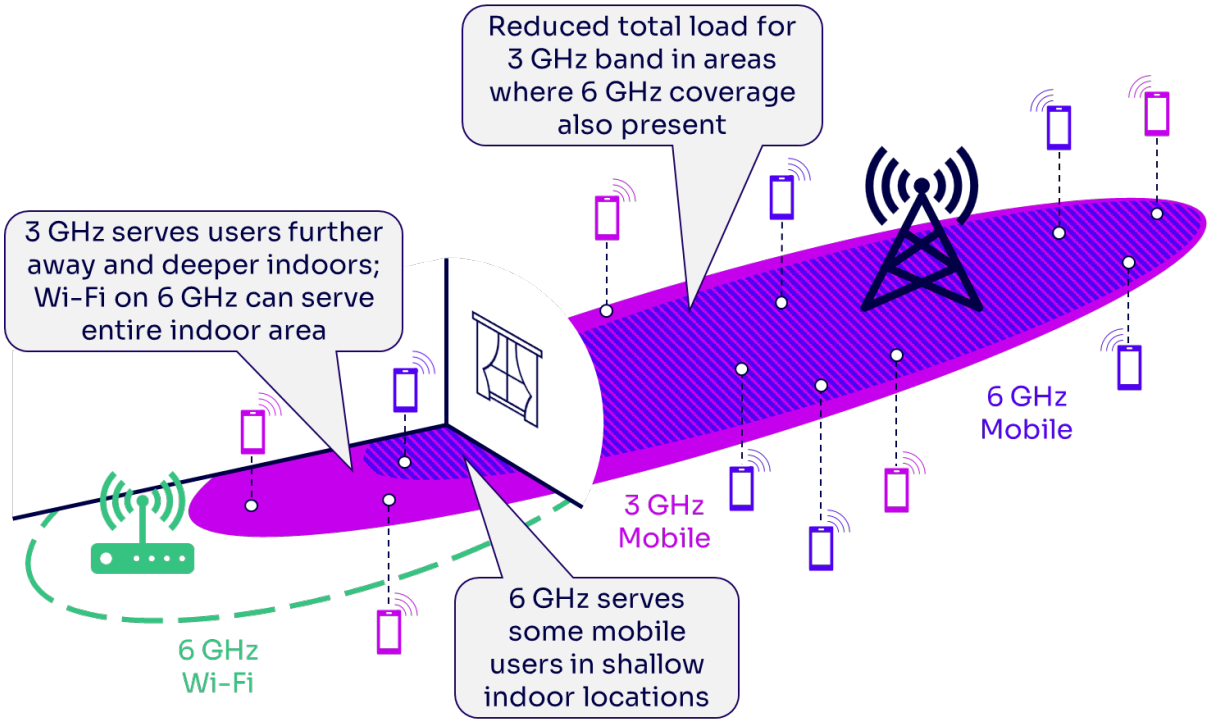
| **1: Greatest overall consumer benefit** | Both services can utilise the full band where the other has not deployed; where there is partial deployment, the other service can use any unused channels. Priority portions would always be available. |
| **2: Commercially attractive** | Priority portions allow certainty for both services. High power mobile use could be possible, at least in the mobile priority portion. Use of priority portions should also be possible with existing technologies, or simple modifications to these. |
| **3: Coexisting with current users** | Will require additional work, especially to manage coexistence with high power mobile. |
| **4: Phased approach** | Both Wi-Fi and mobile deployments might be able to start using their priority portions early, and expand later once the sensing is fully developed. Access to spectrum might be abundant early on, decreasing over time as deployments become denser. |
| **5: Recognise national/local priorities** | This type of mechanism could reflect national or local priorities in some circumstances, depending on the size and location of the respective priority portions. |

## B – An indoor/ outdoor split supported by other mobile bands

Managing the amount of overlap between mobile and Wi-Fi is important to simplify the hybrid mechanisms that might be needed to ensure equitable access for both technologies. Using building entry losses to help isolate mobile and Wi-Fi networks could be critical to enabling both services to operate in the same geographical areas. Adjusting the power of mobile base stations, to some degree, may help to limit the overlap further. This would reduce the need for sharing spectrum resources in time or frequency between mobile and Wi-Fi at those overlap locations.

We need to better understand the trade-off between the simplicity of mechanisms that might be needed by both mobile and Wi-Fi, and the impact that constraining mobile power may have on the usability of the spectrum by mobile. Where a phased approach can be implemented this may allow time for more complex sharing approaches to be developed and established.

Considering the variety of mobile bands available to it, an MNO could rely on other (lower frequency) bands to support most indoor mobile users, especially those in harder to reach locations. This approach could allow it to use Upper 6 GHz on its macro network to provide extra capacity for outdoor and shallow indoor users, leaving more spectrum resources free for Wi-Fi indoors.

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| **1: Greatest overall consumer benefit** | Mobile would use Upper 6 GHz for outdoor and some shallow indoor capacity; this would free up resources in other mobile bands which could then be used to provide capacity in harder to reach locations (e.g., deep indoors). Wi-Fi would have more spectrum resources indoors. |
| **2: Commercially attractive** | The significant gains for both services and relative simplicity of a "sensing" mechanism should provide good incentives for deployment provided that mobile use is not overly constrained. |
| **3: Coexisting with current users** | Will require some additional work to manage coexistence with current users, but some mobile power constraint will likely lead to fewer deployment constraints when considering current users. |
| **4: Phased approach** | Initial solutions would need to avoid creating problems later on. For example, Wi-Fi could be deployed without full sensing, but **only if we can avoid legacy issues for mobile deployments later**. For example, this could be done as part of a managed deployment where firmware could be updated as mobile starts using the spectrum. |
| **5: Recognise national/local priorities** | There could be some variation in the power allowed for mobile. For example, countries that want to prioritise mobile could allow somewhat higher power, while keeping it to a level that still allows Wi-Fi in neighbouring countries (or indoors). |

# Looking forwards

The current CEPT work in ECC PT1 on this topic is scheduled to produce an ECC Report in early 2025. We're hoping that this will inform the development of harmonised technical approaches and coexistence mechanisms and encourage the development of suitable equipment that is sharing-native.

The European Commission is considering a draft mandate to CEPT to study possible shared use of the Upper 6 GHz band by RLAN and mobile broadband in the EU, followed by development of harmonised technical conditions. The target dates for CEPT to provide its reports on these tasks are expected to be later than the planned publication date of the ECC Report, partly due to the wider scope of the mandate.

The UK Government's Department for Science, Innovation and Technology is funding several spectrum sharing sandboxes, which will explore new spectrum sharing techniques that could enable hybrid mobile and Wi-Fi spectrum use and test them in real-world environments. The sandboxes will also undertake computer simulation and economic assessment of the potential net benefits of the solution. These sandboxes run from April 2024 to March 2025, and should provide some early insights. The results of these sandbox trials will help inform the development of our approach to shared use of the band.

We will, of course, consult before making any decisions on future use of the Upper 6 GHz band. We will publish a document in 2025 setting out further details on how we intend to make the band available in the UK.