

The study was prepared for the Ministry of Industry and Trade in October 2024.

## AT A GLANCE

Study 19 analyses the current state and outlook for 6G standardisation and reviews what is known about the spectrum bands above 100 GHz (the sub-THz range) being considered for mobile networks. It traces the path from 5G via 5G-Advanced to 6G, assesses the physical properties and suitability of bands above 100 GHz, and forecasts realistic use cases, benefits, weaknesses and possible licensing routes.

## What the study covers

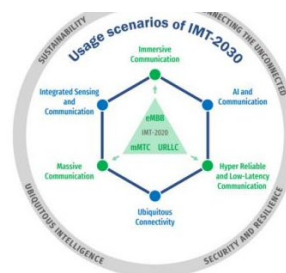
The study is built around three parts:

- **6G networks** — the issues involved and the gradual evolution from 5G through 5G-Advanced.
- **Bands above 100 GHz** — the potential of these frequencies, taking their specific propagation properties into account.
- **Outlook & licensing** — a forecast of how the bands might be used, weighing benefits, weaknesses and possible licensing models.

It draws on international standardisation bodies, scientific literature and the compilers' own experience. It was prepared by experts from the Faculty of Electrical Engineering, Czech Technical University in Prague, in close cooperation with the Czech Telecommunication Office.

## Why it matters — the 6G timeline

- **5G-Advanced** specification is nearing completion; its first features already point toward 6G.
- **~2028** — a full 6G network is likely to be standardised (3GPP Release 21).
- **~2030** — practical deployment and use is expected across Europe.
- **2031** — per WRC-23 resolutions, preparatory work on bands above 100 GHz must be ready for the World Radiocommunication Conference that will be key to opening them commercially.



ITU-R IMT-2030 usage scenarios — the framework guiding 6G development (Source: study Fig. 1, ITU-R M.2160-0).

## What 6G is being designed to deliver

### Immersive & real-time communication

Higher capacity and data rates, wider coverage and far greater device density — the basis for XR and always-on services.

### AI woven into the network

AI/ML deployed across the radio interface and the core, with efficient training, data handling and trustworthiness built in.

### Integrated sensing & positioning

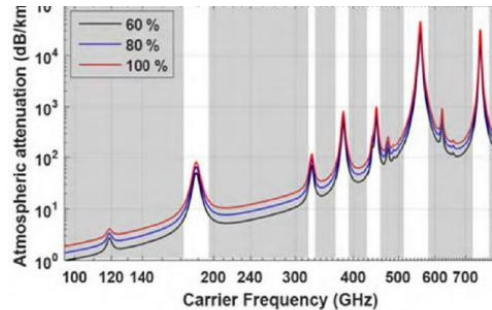
Short wavelengths enable much more accurate localisation and object detection as a secondary function of the network.

### Energy efficiency & resilience

A focus on lower energy use and CO<sub>2</sub>, longer battery life, plus stronger security, integrity, availability and fast recovery.

## Spectrum above 100 GHz

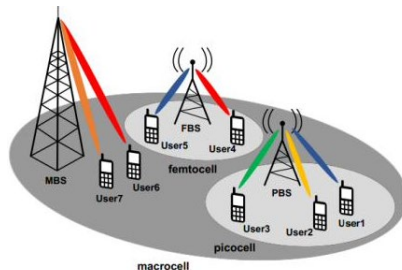
- Bands above 100 GHz up to ~1 THz are **millimetre to sub-millimetre waves**; current thinking focuses on bands up to a little over 300 GHz (sub-THz).
- Today they are largely allocated to **passive services** — radio astronomy, Earth-exploration satellite and space research — and several sub-bands are off-limits to transmission.
- WRC-23 **Resolution 255** flags 102–109.5, 151.5–164, 167–174.8, 209–226 and 252–275 GHz for mobile services; **Resolution 721** covers the adjacent 275–325 GHz.



Atmospheric attenuation vs. carrier frequency at different humidity levels — note the absorption peaks (~183, 325, 380, 450, 550, 760 GHz) and the usable windows between them (Source: study Fig. 6).

## Propagation reality

- Very limited range: propagation is **line-of-sight dominated** with high environmental attenuation, and rain and other hydrometeors add further loss.
- With small antenna arrays (short wavelengths), use will centre on **indoor coverage and small bounded outdoor areas** (stadiums, squares) plus direct device-to-device links (D2D, V2V).



Layered coverage: macro-cells provide area coverage while femto/pico-cells densify local hotspots (Source: study Fig. 11).

## Licensing — two basic modes

- **License-free (general authorisation)** — for low radiated power with advanced active antenna systems; likely workable for many 6G applications.
- **Individual authorisation** — for higher-power applications where the risk of mutual interference would be unacceptable to users.

Bands above 100 GHz will sit closest to the 26 GHz band already assigned to 5G, with vertical and local (campus/industrial) use as the main near-term opportunity.

### FOUR RECOMMENDATIONS FOR POLICYMAKERS

1. **Track and contribute** — follow developments closely and engage actively in international fora (ITU-R, WRC, RSPG, CEPT).
2. **Form a national strategy in good time** — a 6G introduction strategy for the Czech Republic, with 2025/26 looking like the right window.
3. **Watch demand, not just technology** — monitor use of current bands and evolving customer and service needs, and revisit the case for >100 GHz against expected investment and real return.
4. **Fund the research pipeline** — 2025–2027 theoretical and experimental work by academia; 2028–2030+ applied research with industry on concrete use cases and products.

### KEY TAKEAWAY

Bands above 100 GHz are a genuine long-term frontier for 6G — but not an immediate priority. Their physics confines them to short-range, indoor and hotspot use, with high-precision sensing as a bonus. Expect real relevance only once the 26 GHz band is fully exploited — realistically beyond 2035–2040 in the Czech Republic. The near-term task is preparation: standards engagement, strategy and research.