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The Spectrum Decision: 6G, IMT-2030 and the Road to WRC-27

6G will not be decided by a clever waveform. It will be decided in a conference room in 2027, over which slices of the 7-to-15 gigahertz "golden band" the world agrees to hand to mobile — and which satellites and sensors have to make room. A field guide to the three clocks that must mesh.

AUTHOR
5G/6G Academy Research

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The Spectrum Decision: 6G, IMT-2030 and the Road to WRC-27

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***Abstract*—Every generation of mobile is, underneath the marketing, a spectrum decision — and 6G's is being made now. This closing paper in our series separates the three processes the industry routinely blurs. ITU-R defined what 6G must be in Recommendation M.2160: the IMT-2030 framework, with six usage scenarios and fifteen capabilities, and — tellingly — sustainability, security and resilience, connecting the unconnected and ubiquitous intelligence elevated to first-class design principles. 3GPP is building the radio across Release 20 (studies; the pivotal TR 38.914 on 6G scenarios is approved this month) and Release 21 (the first normative 6G specifications, with a functional freeze targeted for December 2028). And the World Radiocommunication Conference is deciding the spectrum: WRC-23 set the agenda and identified the upper 6 GHz band; WRC-27, under Agenda Item 1.7, will weigh identifying parts of 4.4–4.8, 7.125–8.4 and 14.8–15.35 GHz for mobile. The centre of gravity is the upper mid-band — the so-called FR3 or golden band — because it is the last place on the dial with mmWave-scale bandwidth and propagation a network can still afford. The honest conclusion, drawn from every prior paper in this series: 6G is less a technological break than 5G-Advanced's themes made native, and its hardest problem is not engineering but the decibels it must negotiate away from the satellites, weather sensors and space-research systems already living in the bands it covets.**

1. What 6G Actually Is (and Isn't)

Begin by deflating the word. "6G" is not, on present evidence, a clean technological break the way the move from 4G to 5G introduced a new radio. It is the next IMT generation, and the International Telecommunication Union has already written down what it must be — Recommendation ITU-R **M.2160**, the **IMT-2030 framework**, approved in late 2023 [1]. Read it and a pattern jumps out: most of 6G is the agenda of 5G-Advanced, made native and mandatory.

M.2160 defines **six usage scenarios**. Three are grown-up versions of 5G's: *Immersive Communication* (enhanced mobile broadband), *Massive Communication* (enhanced machine-type), and *Hyper-Reliable and Low-Latency Communication* (enhanced URLLC). Three are new: **Ubiquitous Connectivity**, **Artificial Intelligence and Communication**, and **Integrated Sensing and Communication** [1]. Each new scenario is something this series has already watched take its first steps under 5G-Advanced — ubiquitous connectivity is the non-terrestrial story of N°08; AI-and-communication is the air-interface machine learning of N°04 and N°09; integrated sensing is the ISAC work that N°09 found still sitting at "requirements and a channel model." 6G is where these graduate from features bolted onto a 5G core to first principles of the design.

The framework also lists **fifteen capabilities** — nine enhanced from IMT-2020 (peak and experienced data rate, spectrum efficiency, area traffic capacity, connection density, mobility, latency, reliability, and — newly promoted — security and resilience) and six new ones: coverage, sensing, applicable AI capabilities, sustainability, interoperability and positioning [1]. And it elevates four **overarching aspects** to design principles rather than afterthoughts: *sustainability*, *security and resilience*, *connecting the unconnected*, and *ubiquitous intelligence* [1]. That sustainability sits among them is the quiet lesson of N°07 written into the constitution: energy is now a first-class requirement, not a feature you switch on later.

2. The Three Clocks

The single most useful thing an engineer can do with "6G" is stop treating it as one timeline. There are three, run by three different bodies, and they must mesh (Fig. 1). **ITU-R** owns the requirements and the finish line: M.2160 in 2023, a requirements-and-evaluation phase through 2027, a call for technology proposals in early 2029, and final specification submissions by mid-2030 [1], [2]. **3GPP** builds the actual radio: Release 20 opened the first 6G studies in 2025, the pivotal TR 38.914 ("6G scenarios and requirements") is being approved this month, Release 21 carries the first normative 6G specifications with a functional freeze targeted for December 2028, and commercial systems are expected around 2030 [3], [5], [6]. And the **World Radiocommunication Conference** decides the spectrum.

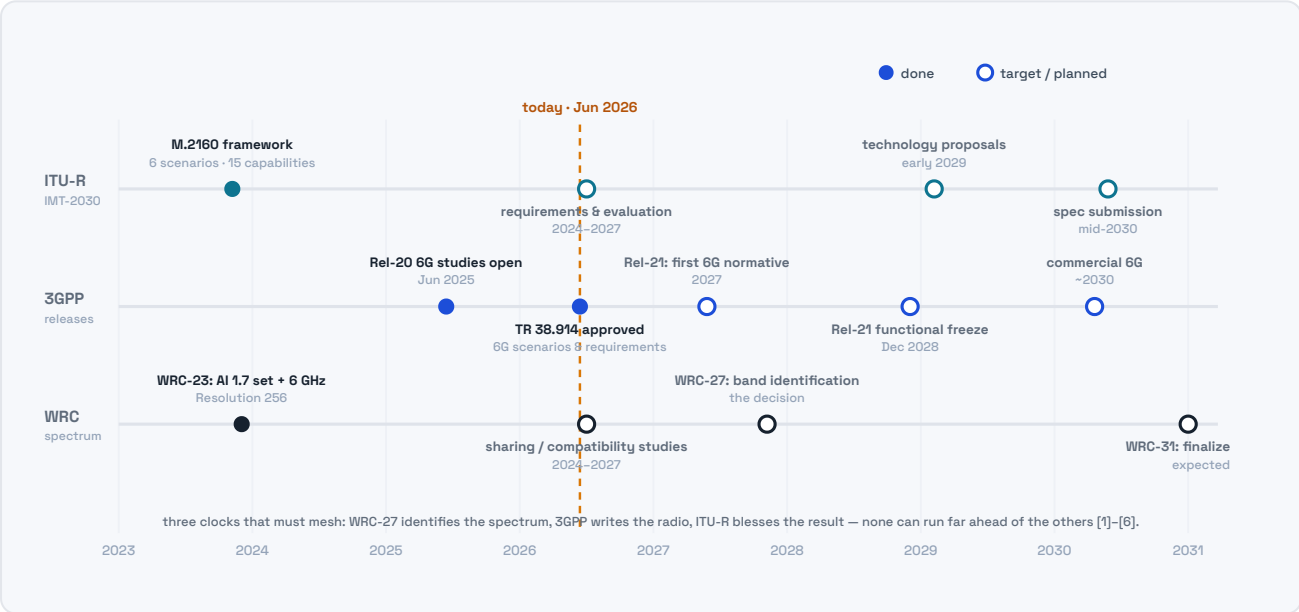

Fig. 1. The three clocks of 6G, 2023–2031. Filled markers are complete; hollow are targets. The dependency runs left to right within each band of time: studies feed identification feeds specification feeds submission. WRC-27 is the gating event the other two clocks are timed around [1]–[6].

Notice what this picture says that press coverage does not: **WRC-27, in 2027, is the real 6G milestone** — earlier than the Release-21 freeze, and far more consequential. A standard with no globally harmonized band is a radio with nowhere to transmit. This is why the industry's spectrum energy is spent not on 2030 but on a conference eighteen months away — and why a planner who wants to know whether 6G is on schedule should watch the WRC, not the trade-show keynote.

3. The Golden Band

Why is so much riding on one conference? Because 6G needs new spectrum and there is exactly one attractive place left to put it. Fig. 2 lays out the dial. Low bands carry far but hold little data. The C-band around 3.5 GHz is the 5G workhorse — a good compromise, and already full. Millimetre-wave (FR2) offers enormous bandwidth but propagates so poorly that it never escaped hotspots, as a decade of 5G mmWave deployments learned the hard way. Sub-terahertz, the favourite of 6G hype, is bandwidth heaven and coverage hell — a research frontier, not a coverage layer.

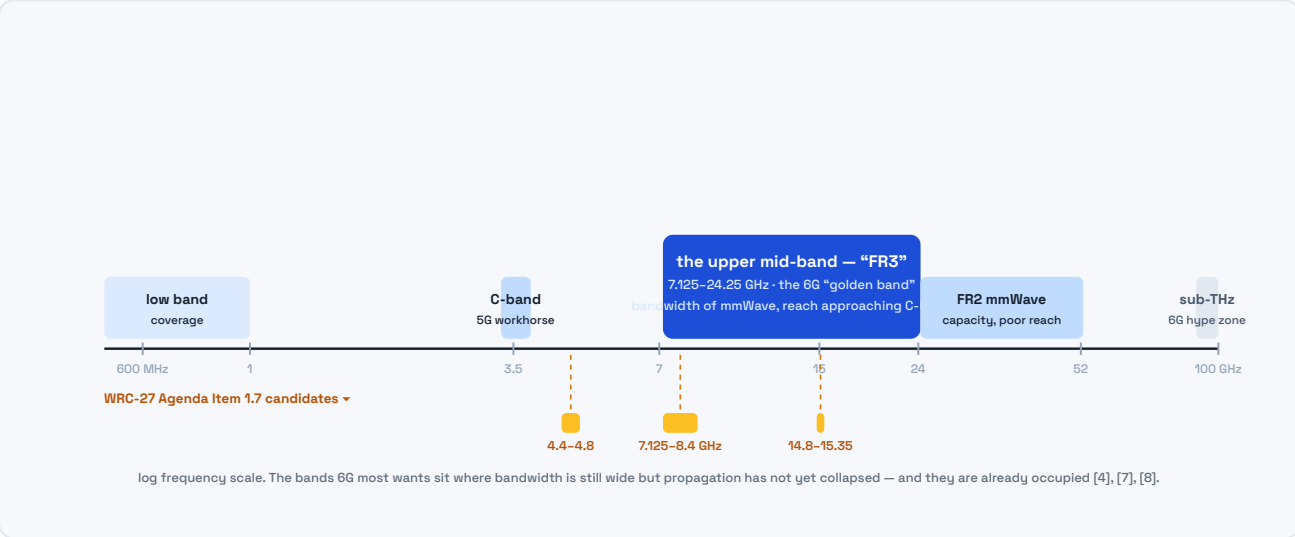

Fig. 2. The spectrum landscape on a log scale. The upper mid-band — FR3, roughly 7.125–24.25 GHz — is highlighted because it is the one region with mmWave-class bandwidth and propagation a network can still afford. The amber markers are the WRC-27 Agenda Item 1.7 candidates; note that they fall squarely inside occupied territory [4], [7], [8].

That leaves the **upper mid-band** — increasingly called **FR3**, roughly 7.125 to 24.25 GHz, with the 7-to-15 GHz centimetric stretch the prize. It is being called the "golden band" for a simple reason: it sits between the coverage of sub-6 and the capacity of mmWave, offering wide channels while still propagating well enough to build a real network [7], [8]. The engineering that makes it viable is a direct extension of 5G's massive MIMO — the antenna arrays grow from "massive" toward "gigantic," hundreds of elements forming pencil beams sharp enough to compensate for the higher path loss, and the working goal in 2026 trials is **coverage parity from existing C-band grids**, so operators can reuse sites rather than build new ones [7]. If the golden band cannot reuse the C-band grid, its economics collapse; if it can, it becomes 6G's primary capacity layer. That single question is what the trials are really testing.

4. WRC-27 and the Decibels You Have to Negotiate

The catch is that the golden band is not empty. It is full of services that were there first, and identifying it for mobile means proving — band by band, in years of sharing-and-compatibility studies — that International Mobile Telecommunications can coexist without harming them. That is the entire substance of **WRC-27 Agenda Item 1.7**, mandated by **Resolution 256** at WRC-23 [4]. Table 1 lays out the candidates and their sitting tenants.

TABLE 1 · WRC-27 Agenda Item 1.7 — the candidate bands and who already lives there [4], [8]

Band	Regions (per Res. 256)	Rough width	Incumbents to protect	Why mobile wants it
4400–4800 MHz	Regions 1 & 3	400 MHz	aeronautical mobile telemetry; fixed-satellite (FSS)	extends C-band coverage economics upward
7125–8400 MHz	Regions 2 & 3 (Region 1: 7125–7250 + 7750–8400)	up to ~1.3 GHz	FSS, MSS, Earth-exploration (EESS), meteorological & space-research (SRS), fixed links	the heart of the golden band — wide and contiguous
14.8–15.35 GHz	all three Regions	550 MHz	fixed service; space research; radio astronomy in adjacent bands	added high-capacity layer where antennas stay small

The tenants are formidable. The 7125–8400 MHz range — the contiguous core everyone wants — hosts fixed-satellite and mobile-satellite links, **Earth-exploration satellites** (the sensors behind weather and climate data), meteorological and **space-research** systems, and terrestrial fixed links [4]. The 14.8–15.35 GHz band brushes up against radio astronomy. None of these can simply be evicted, and the scientific incumbents in particular have no commercial alternative. So the WRC-27 fight is not really about technology; it is about *how many decibels of protection* the incumbents require and whether IMT can live inside that envelope — the same "you buy the saving in decibels" logic this series met in the link budgets of Nº08 and the antenna cuts of Nº11, now playing out at the scale of a global treaty. WRC-27 will likely *identify* bands with conditions; the detailed regulatory finishing may run to WRC-31 around 2031. Spectrum identification is the start of availability, not the end.

One more honest note: identification is regional. WRC-23 already split the upper 6 GHz unevenly — broadly identified for IMT in Region 1, only the top slice (7025–7125 MHz) in Region 3, and by individual-country footnote in the Americas [4], [9]. The realistic WRC-27 outcome is therefore a patchwork, not a single global 6G band — which means early 6G devices may face the same band-fragmentation tax that has dogged every prior generation.

5. What 3GPP Is Actually Building

While the spectrum is negotiated, 3GPP writes the radio — and its 6G is being designed to be, from day one, what 5G-Advanced became only by addition. The studies opening in Release 20 and the specifications of Release 21 point at an air interface that is **AI-native** rather than AI-retrofitted: recall from Nº09 that 5G's two-sided CSI-compression machine learning — encoder in the device, decoder in the network — was the use case 3GPP judged too hard for interoperability and explicitly deferred to Release 20. 6G is where that bet is meant to pay off, with learning assumed in the design of the physical layer rather than bolted onto it [3], [6].

The same is true of the other new IMT-2030 scenarios. Integrated sensing — the network as radar, measuring range, velocity and angle — moves from the requirements-and-channel-model status Nº09 documented toward a native capability. Non-terrestrial access, the orbital story of Nº08, is expected to be a designed-in part of the 6G architecture rather than a Phase-2 addendum. And sustainability, per Nº07, is now a capability the specification must meet, not a software option. The concrete near-term marker is unglamorous and real: **TR 38.914**, the 6G scenarios-and-requirements report, approved by 3GPP's radio group this month, June 2026 — the document that turns the ITU's vision

into engineering targets the working groups can build against [5], [6]. After it come the Release-21 work items, the December 2028 freeze, and an initial 6G specification timed precisely to feed the ITU's mid-2030 submission window [3], [6].

6. The Honest Part: A Spectrum Decision Wearing a Technology Costume

Strip away the keynotes and three sober truths remain. **First, 6G is not close.** The first normative specifications freeze at the end of 2028; commercial networks are a 2030 proposition at the earliest, and history's freeze-to-field lag — the two-year rule this series documented in Nº09 and Nº11 — suggests meaningful scale is a 2031–2032 story. Anyone selling "6G" hardware in 2026 is selling a roadmap. **Second, the hard problem is spectrum, not silicon.** The waveform will look much like NR's; the genuinely unresolved question is whether WRC-27 hands mobile usable, harmonized slices of the golden band over the objections of satellite and science incumbents — and whether the result is global or a regional patchwork. **Third, sub-terahertz is over-promised.** It will matter for fixed point-to-point and niche hotspots; it will not be a 6G coverage layer this decade. The physics that confined mmWave to hotspots is harsher still above 90 GHz.

What is genuinely new — and genuinely good — is the framing. By writing sustainability, resilience, connecting the unconnected and ubiquitous intelligence into M.2160 as design principles, the industry has at least committed on paper to a 6G that is judged on energy and reach, not only on peak rate [1]. Whether that survives contact with commercial pressure is the open question of the next five years. But it is a better starting constitution than 5G had.

7. What to Watch — and a Word to Close the Series

Five markers will tell a planner where 6G truly stands. **(1) TR 38.914**, approved this month — the first concrete engineering target; read it [5]. **(2) The WRC-27 outcome in 2027** — which bands, which regions, which protection conditions; this is the real scoreboard [4]. **(3) The Release-21 functional freeze, targeted December 2028** — slippage here moves the whole 2030 picture [3], [6]. **(4) FR3 coverage-parity trials** — whether the golden band can genuinely reuse C-band grids, which decides its economics [7]. **(5) Regional fragmentation** — watch whether the major regions converge on common band edges or repeat the upper-6-GHz split [9].

And a closing word, because this is the twelfth and final paper of the series. We began with the architecture of 5G-Advanced and end at the threshold of 6G, and the throughline has been the same discipline applied to every topic: separate what is specified from what is shipping, attribute every number to where it actually came from, and respect the difference between a press release and a measurement. 6G will arrive draped in superlatives. The engineer's job — yours and ours — is to keep asking the unglamorous questions: which release, which band, which region, against what baseline, at whose expense. The radio keeps getting more capable. Reading it honestly is the one skill that does not go out of date. Thank you for reading the series.

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