VIEWPOINT

ARTHUR D LITTLE
2026

450 MHZ — THE SPECTRUM PHOENIX

A major 1G footprint, once sidelined, now indispensable for resilience

As wireless connectivity shifted to higher frequencies over the past 30 years, 450 MHz retained a distinct advantage with its wide propagation of affordable coverage and resilience. The 450 MHz spectrum embodies a clear paradox: modest bandwidth with high strategic importance. While it offers little glamour compared to the mass-market and high-speed bands of public mobile operators, its reach and reliability make it indispensable for wide-area, mission-critical communications. In this Viewpoint, we examine the evolution of the 450 MHz band and its promising opportunities.

AUTHORS

Christoph Uferer

Matyas Weber

Arvind Rajeswaran

Jatin Jain

Gösta Kallner,
450 MHz Alliance

Carsten Ullrich,
450 MHz Alliance

IN PARTNERSHIP WITH:

450 alliance.org

THE EVOLVING LIFE OF 450 MHZ

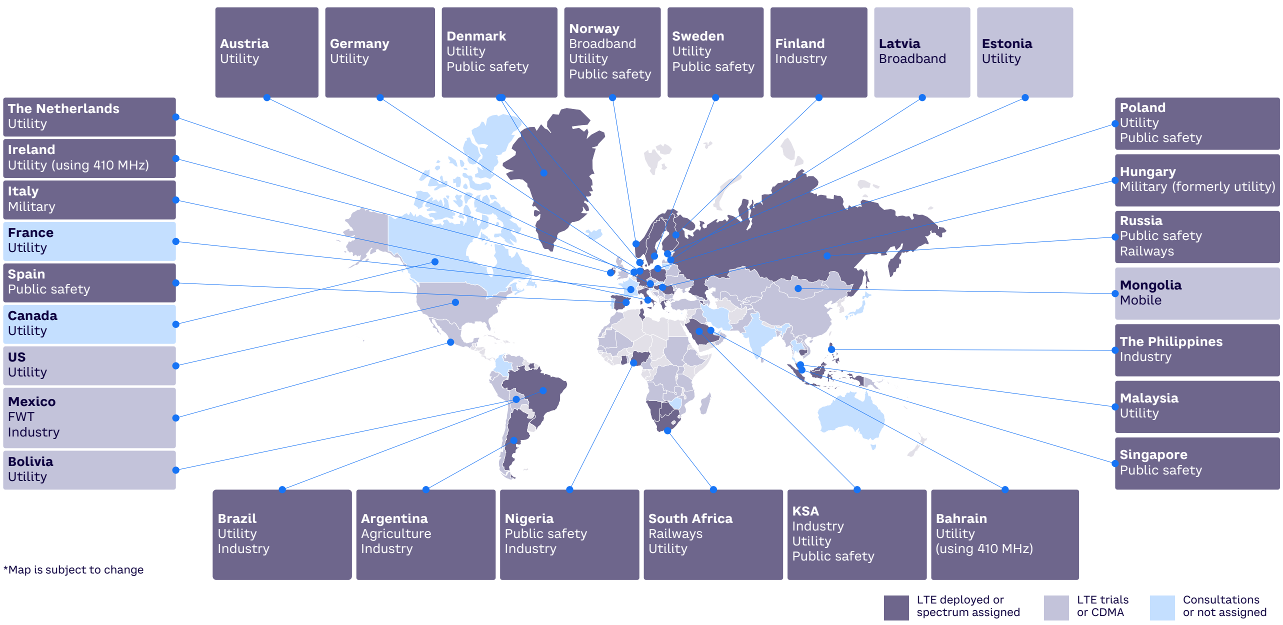
During the 1980s and early 1990s, 450 MHz was the spectrum band used for first-generation mobile networks by most countries in Europe and Asia. These networks primarily used the NMT-450 standard for analog mobile telephony. The 450 MHz band was an obvious choice, as its long wavelength provided exceptional coverage with low infrastructure costs, necessitating significantly fewer base stations compared to higher spectrum bands.

In the 1990s, 450 MHz lost competitiveness when GSM (2G) expanded into the 900 MHz band and shifted to low-cost rural coverage as a result of limited capacity and a weak device ecosystem. CDMA450 revived the band in 2001; consequently, many NMT-450 operators in Europe and Asia migrated, with new networks launching in Africa and South America. However, the 2x5 MHz limit and inadequate device support kept 450 MHz uncompetitive in capacity-driven markets, leaving viable use mainly in rural connectivity and Public Protection and Disaster Relief (PPDR) communications, where low device volumes further weakened vendor support.

Beyond the spectrum limitation, the 450 MHz ecosystem faced three hurdles: (1) adopting mainstream technology; (2) achieving sufficient device volumes; and (3) finding use cases that leveraged the band's strengths as public mobile networks expanded. Then LTE support resolved the technology dilemma and utilities became the anchor segment, requiring resilient communications for grid operations and millions of smart meters driving demand for devices. In 2015, CDMA450 deployments in the Netherlands and Germany started validating this model, with the Netherlands alone deploying around 3 million devices.

LTE 450 standardization increased momentum as the band offered secure, low-cost connectivity, while legacy private mobile radio (PMR) systems reached end-of-life, and Internet of Things (IoT) digitization created device volumes at scale. Large utility deployments in Germany and Poland accelerated ecosystem maturity. Adoption spread globally: by 2025, LTE in the 450/410 MHz range was live in 20+ countries (see Figure 1), with additional licensing underway, supported by standardized LTE bands in the 380-512 MHz range.

Figure 1. Global adoption of LTE 450 MHz



Source: Arthur D. Little, 450 MHz Alliance

450 MHZ WAS THE SPECTRUM BAND USED FOR FIRST-GENERATION MOBILE NETWORKS BY MOST COUNTRIES IN EUROPE AND ASIA

Nowadays LTE 450's continuous growth is supported by a broad vendor ecosystem. Network suppliers include Airspan, Ericsson, Huawei, Nokia, and ZTE, while mainstream chipset, module, and device providers include Cisco, GE, Hitachi, Hytera, Motorola, Qualcomm, Quectel, Simcom, and Telit. Support from these entities has enabled diverse use cases. Public safety organizations rely on 450 MHZ for resilient communications, while utilities remain the dominant segment, using 450 MHz for grid management and smart metering, driving the largest equipment volumes, particularly through advanced metering deployments.

THE RIGHT APPROACH: OPTIONS & IMPLICATIONS

As 450 MHz grows in strategic importance across critical utilities, public safety, and other domains (see Figure 2), its developmental path now faces three challenges: (1) technology trajectory, (2) spectrum ownership, and (3) national positioning.

Each challenge, explored in detail below, reflects the push and pull between the band's inherent capabilities and the shifting expectations of the market. While commercial spectrum (e.g., 3.7 GHz to 4.2 GHz) has been adopted globally by mobile operators, 450 MHz sits at a strategic fork as an essential enabler for applications constrained by bandwidth limitations and regulatory fragmentation.

Figure 2. Market trends and application status

Source: Arthur D. Little, 450 MHz Alliance

Technology trajectory

LTE continues to anchor new 450 MHz deployments, but in a landscape where 5G is the new commercial reference, is a shift to 5G relevant for the band?

Guiding questions

Persistent questions pertain to the technology trajectory of the band. Should it undergo a shift to 5G, or should the industry double down on LTE investments? While LTE offers reliability, 5G — complemented by the expanding role of 5G RedCap — is establishing itself as the key commercial reference point (see Figure 3).

But before we evaluate the band's standing and future positioning, we must ask a series of guiding questions:

1. **Is LTE 450 MHz future-proof enough to sustain industrial and digital grid requirements as use cases evolve beyond 2030?**

   - *Use cases require long-term consistency.* LTE 450 supports NB-IoT and LTE-M matching the 15-to-20-year technology cycles of utilities and PPDR. These networks prioritize stability and long-term availability over adopting the latest technology since replacing millions of devices is costly (similar to TETRA or GSM-R systems). The German 450connect commitment to operate LTE 450 until 2040 demonstrates viability, with long-term vendor support contractually achievable.
   - *No negative push from standardization.* Spectrum is generally assigned on a technology-neutral basis, so choices depend on performance needs and ecosystem outlook. Standardization bodies have not sidelined LTE; IMT-2020 explicitly includes LTE, NB-IoT, and LTE-M within the 5G family, ensuring continued support through the 5G Core, even as traditional 4G services are retired.
   - *Functional adequacy.* For grid use cases (e.g., SCADA, outage management, telemetry), LTE already offers mature reliability and penetration. Whether 5G adds real incremental value must be assessed on a per-use-case basis; only high-device-density scenarios, such as 5G RedCap, may require future support.

Figure 3. Technology comparison

	CDMA (410, 450)	LTE (410, 450)	5G (410, 450)
Coverage	Very wide (30-40 km) rural applications	Wide area (15-30 km), utilities, IoT applications	Wide area (10-20 km)
Latency	~50-100 ms (legacy voice)	30-50 ms	<15 ms (URLLC applications)
Capacity/bandwidth	2x1.25 MHz limited throughput	2x5 MHz moderate throughput	2x5 MHz bandwidth-constrained throughput, with higher spectral efficiency than LTE
Reliability	Moderate with rural focus	High, compliant with 3GPP MCX criteria	High potential, but unproven use cases remain (e.g., slicing)
System availability	Limited ecosystem support	Broader maturity with sufficient device choices	Developing, use cases awaiting action
Resource requirements	Highly cost-efficient	Proven economics with utilities, IoT	Higher CAPEX, viable only if RedCap scales

URLLC = ultra-reliable low-latency communication
Source: Arthur D. Little, 450 Alliance

- *Ecosystem bottlenecks with device and module maturity are still uneven.* LTE 450 has a solid ecosystem for routers, gateways, and fixed industrial devices, but gaps remain in rugged handhelds critical to utilities and public safety. These gaps create dependency risks and limit innovation.

2. **Can the 5G ecosystem (especially NR RedCap or Release 18) become effective in this band?** LTE already meets most throughput and latency needs, with LTE-M covering low-power IoT. 5G RedCap fills the gap between LTE-M and full 5G NR and is now standardized for 450 MHz, removing spectrum-related barriers to ecosystem growth. Vendor support is continuously increasing as well, with new multi-band RedCap chipsets that include LTE fallback enabling dual-mode devices and a smooth evolution path. With this setup, LTE 450 infrastructure remains in place, but devices can operate across LTE 450 and public networks. Dual-connectivity architectures are already used in energy networks (LTE 450 + public LTE). As public operators move to 5G only, RedCap will enable this evolution to continue seamlessly.

3. **Are there specific use cases (e.g., defense logistics, rail comms) where 5G adds substantial value over LTE 450; if so, is 450 MHz capable of capturing value on its own?** Release 18 introduced a 3 MHz 5G channel, which improved suitability for utilities, rail, and public safety. This channel strengthens current use cases, but advanced applications, like slicing and augmented/virtual reality surveillance, still require full 5G performance. The core constraint is spectrum; operators cannot run LTE and 5G efficiently in parallel with only 2x3-2x5 MHz, making 5G migration dependent on retiring LTE devices or obtaining more spectrum. Network slicing is also limited by narrow bandwidth and becomes practical only when 450 MHz is aggregated with additional low- or mid-band spectrum, such as 700 MHz. This would typically need to materialize via partnerships with telecom operators since most 450 MHz licensees are utilities or public safety organizations. In future greenfield deployments, however, operators will be far more able to implement pure 5G use cases, as 5G Core and RAN are already available, and 450 MHz 5G devices will emerge.

Technology trajectory — Our take

The move from CDMA to LTE in the 450 MHz band was a natural step that extended the band's relevance for more than a decade. LTE still meets the long-cycle needs of utilities and critical infrastructure, offering stability, coverage, and cost-efficiency. Operators can already adopt a 5G Core running LTE radios while introducing 5G RedCap devices with LTE fallback to begin their 5G transition. Full 5G RAN deployment, supported by Release 18 and RedCap advances, enables selective higher-value, latency-sensitive, or integrated industrial use cases.

At the same time, deploying 5G in the RAN is limited by spectrum: LTE and 5G can share a base station (if 5G-ready and software-upgradable) but cannot share the small 450 MHz bandwidth efficiently.

Therefore, most operators must choose whether 5G is relevant. LTE remains the practical baseline, supporting mission-critical and IoT workloads, especially given the large installed base of LTE devices that will remain for years.

Still, operators must prepare for evolution by **building neutral, interoperable platforms aligned with 5G standards and ecosystems** — starting with moving to a 5G Core and introducing 5G RedCap devices as soon as viable. This strategy preserves 450 MHz as a resilient foundation for critical communications while enabling gradual evolution to LTE as the workhorse, targeted 5G where justified, and a path toward 6G capabilities, such as integrated sensing, native IP, and SIM-less IoT connectivity.

Spectrum ownership

Should 450 MHz spectrum be licensed to telecom operators or industrial stakeholders?

Overall trends

Globally, 450 MHz spectrum is increasingly licensed to industrial players, primarily utilities, which deploy it as dedicated private networks. These networks meet mission-critical needs: coverage, resilience, and deterministic performance that public mobile networks cannot ensure. Incentives and deployment priorities are naturally aligned, as license holders are also the end users (e.g., grid automation, field operations, pipeline monitoring, industrial IoT). This alignment has underpinned successful programs like 450connect in Germany and Aramco Digital's 450 MHz network in the Kingdom of Saudi Arabia, where ownership and operations sit directly with the industrial beneficiaries.

By contrast, **450 MHz licenses awarded to telecom operators have struggled** due to the lack of an inherent customer base. Even successful telco-led deployments operate more like utility-grade parallel networks than extensions of consumer mobile services. The 450 MHz band follows a different business logic: nationwide deep coverage, low device density, and high reliability, none of which fit traditional mobile retail or wholesale models. Consequently, very few telco-driven consumer propositions in this band have succeeded.

Past precedents from telco-led licensing

In Germany, the 450 MHz band was split between Inquam and Deutsche Telekom from 2004, but both failed to establish a viable business due to limited spectrum. Sustainability emerged only when Inquam (later 450connect) began collaborating with utilities from 2016 to build regional CDMA450 networks, creating momentum for a national LTE 450 platform tailored to utility needs.

450 MHz SPECTRUM IS INCREASINGLY LICENSED TO INDUSTRIAL PLAYERS, PRIMARILY UTILITIES

Responding to this alignment, regulator BNetzA prioritized critical infrastructure use, launching a 2020 process that awarded the band to 450connect in 2021. German mobile network operators did not bid, viewing the market as niche, politically sensitive, spectrum-constrained, and commercially unviable for them.

A similar pattern played out in Brazil. Mobile operators held but did not use 450 MHz licenses, prompting regulator Anatel to revoke or reassign them due to prolonged nonuse and the need to support mission-critical and utility applications. Litigation briefly slowed the process, but by 2023–2024, the market converged on a new model: private network authorizations for utilities, including Neoenergia's April 2024 authorization and new station licensing and pilots by CEMIG and others.

These cases illustrate a clear regulatory trajectory: **when 450 MHz is not tied to committed industrial use cases, regulators tend to reallocate it** to players capable of deploying mission-critical networks.

However, when use cases and strategic partnerships are in place from the outset, **telcos can be highly effective stewards of the 450 MHz band.** The KPN-Alliander model in the Netherlands is a strong example: KPN deployed a dedicated 450 MHz network specifically to serve Alliander's utility-grade requirements, combining the telco's operational expertise with the industrial player's clear use-case leadership. Similarly, we see other cases where telcos maintained their leading role over time in 450 MHz deployment.

When backed by industrial partnerships and long-term commitments, telco-led models can be both successful and sustainable; for example:

- **Ice Norge,** a Norwegian telecom operator, holds the exclusive 450 MHz (Band 31) license, granted by the national regulator Nkom. The license spans 20 years, expiring in 2040. Ice Norge leverages this spectrum primarily to enhance mobile broadband coverage in rural and remote regions, where higher-frequency bands would require significantly greater base station CAPEX to match the same footprint. Beyond broadband, the band also supports defense-related communications and machine-to-machine applications (e.g., remote monitoring and fleet management).
- **Polkomtel Plus,** in Poland, uses the 450 MHz spectrum to reinforce its mobile network, highlighting the band's strategic value across the region.

WHEN USE CASES AND STRATEGIC PARTNERSHIPS ARE IN PLACE FROM THE OUTSET, TELCOS CAN BE HIGHLY EFFECTIVE STEWARDS OF THE 450 MHz BAND

In general, a telco needs to have advanced commitments or high certainty of customer buy-in for its ownership and operator role. Otherwise, telcos risk deploying networks that have no business case.

Spectrum ownership — Our take

Successful 450 MHz deployments are consistently characterized by **alignment between spectrum rights, investment incentives, and clearly defined use cases.** When this alignment exists, the band has been deployed efficiently and at scale. In many markets, alignment comes when industrial stakeholders — who are also the primary users — hold the spectrum, as they can commit to long-term demand.

In other cases, telecom operators have successfully fulfilled this role when spectrum awards were coupled with binding obligations, anchor-tenant commitments, or strategic partnerships. The decisive factor is therefore not whether the licensee is an industrial player or a telecom operator, but whether the governance and commercial model can ensure the band's sustained utilization.

National positioning

Should 450 MHz evolve into a national "lifeline" layer serving public safety, utilities, and other use cases, or will public safety requirements demand a fully sovereign carve-out?

The evolution of 450 MHz networks increasingly reflects the tension between cost-efficient shared layers and sovereignty-driven bespoke stacks.

Shared layer

PMR networks in the 400 MHz band were once deployed per user, but operators are increasingly shifting to multi-tenant national LTE 450 platforms designed for utilities and other mission-critical sectors (e.g., agriculture, transport, public safety).

In Germany, 450connect is the flagship case. Backed by utilities, it holds the band until 2040 and runs a single national LTE 450 network, offering nondiscriminatory critical infrastructure services. Ireland's ESB is following a similar model, using a geo-redundant LTE 450 network built for grid operations but designed for wholesale access.

Industry coalitions (450 MHz Alliance, UBBA [Utility Broadband Alliance], EUTC/UTC [European Utilities Telecom Council/Utilities Technology Council]) are expanding device ecosystems to support multi-sector adoption.

The rationale: a shared 450 MHz lifeline layer provides wide-area, low-cost coverage and a resilient business case by pooling demand among critical operators. With GCF-certified LTE 450 devices and 3rd Generation Partnership Project (3GPP) features, such as enhanced traffic management, quality of service (QoS), and mission-critical services (MCX), operators can securely host logically separate tenant services on one platform.

Bespoke stack

Public safety communities continue to push for sovereign carve-outs. This surfaced during Germany's 2018–2020 consultations and again in Hungary in 2024, where the 450 MHz band was assessed for dedicated government networks and ultimately assigned to defense.

The argument for those pushing bespoke stack: even virtual isolation on shared platforms leaves residual risks, which include commercial governance exposure, shared vendor stacks, and potential single points of failure. Public safety and defense workloads require higher redundancy, independent governance, and sovereign control of encryption and key management.

These needs are not always compatible with wholesale or multi-tenant models. EUTC cautions against over-commercialization, similarly stressing that sub-500 MHz bands succeed only when focused on critical use cases.

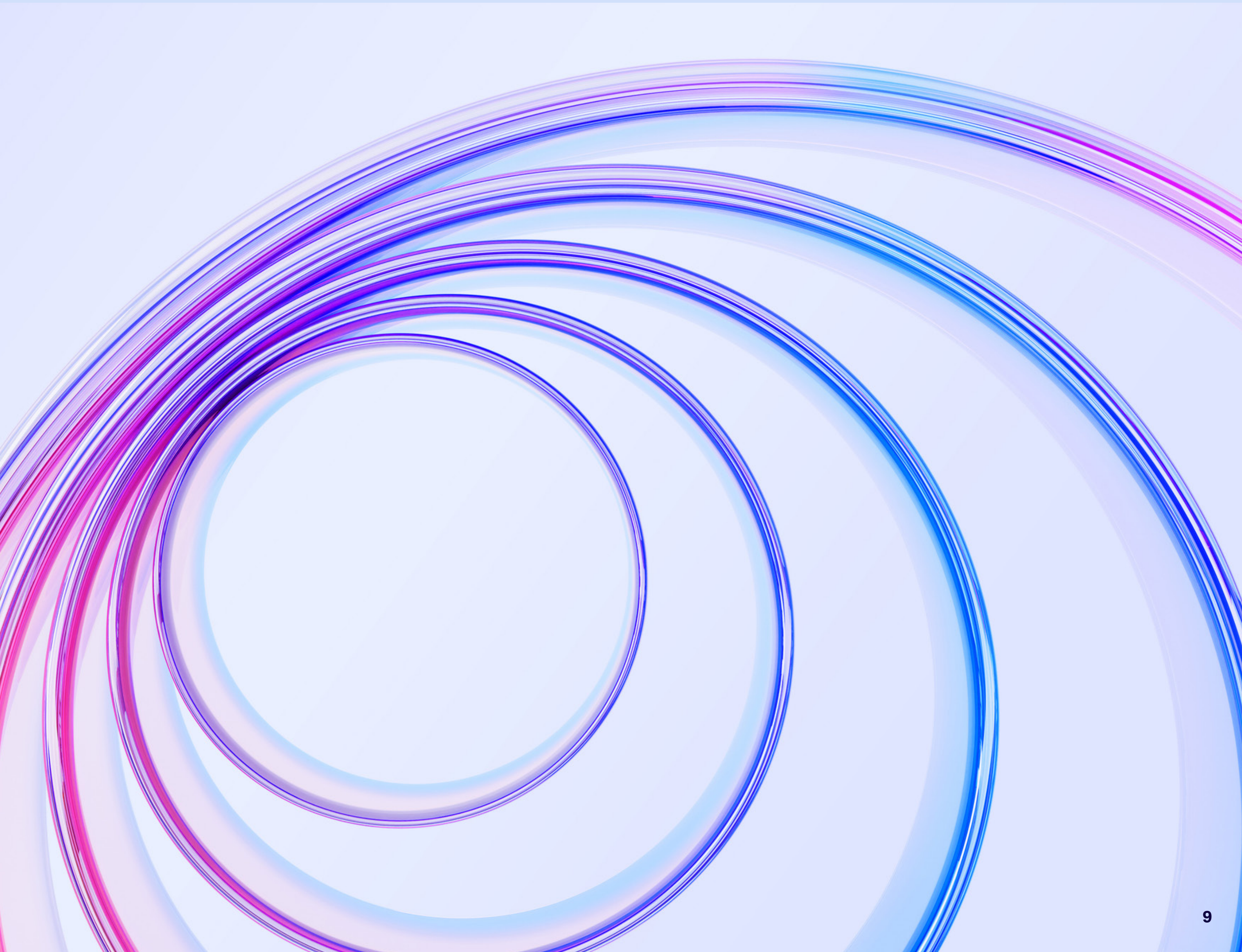
History echoes this: Nordic NMT allowed civil use of 450 MHz while reserving defense priority during mobilization. But today's far higher data and availability demands make such shared-priority models difficult; the limited 450 MHz band cannot carry both civil-critical and PPDR workloads at scale.

As spectrum scarcity increases, the challenge shifts from separation to orchestration — ensuring PPDR sovereignty while enabling efficient use for other critical sectors through multi-band coordination. This means extending the practical boundaries of 450 MHz via industry collaboration and alignment with complementary bands (380 MHz for public safety, 410 MHz, or aggregation with low or mid bands). Ice Norge serves as a recent example. It deployed a 5G standalone core with Mavenir to provide a sovereign military slice while also serving utilities, made possible by combining 450 MHz with higher-band spectrum. Such orchestration will rely on national-level partnerships among 450 MHz operators, telcos, and PPDR authorities.

National positioning — Our take

The 450 MHz band is a strategic national asset. Its value extends beyond operational efficiency for individual operators; **it underpins digital resilience and can be effective at a macro level.** To achieve this, in most markets, 450 MHz must evolve toward supporting multiple MCX use cases, potentially including PPDR. Still, PPDR remains a special case. While modern technologies like slicing, dedicated QoS, and prioritized traffic management can technically create virtual isolation within shared networks (although at the expense of efficiency loss), public safety institutions continue to demand dedicated environments for security and governance reasons.

Leaping forward, 450 MHz spectrum holders must expand the effective boundaries of the band by driving industry-wide strategic collaborations, including efficient coordination with complementary frequencies of 380, 410 MHz, or carrier aggregation with other low- or mid-band ranges. This scaling can enable dedicated focus on PPDR, without jeopardizing other use cases and without suffering too much from the inevitable capacity loss triggered by the network dedication. **The imperative is clear: 450 MHz is too strategic to remain underutilized.** Operators must use every available mechanism — technical, collaborative, and regulatory — to enable its full contribution to PPDR and other users.



CONCLUSION

450 MHZ EMERGING AS CRITICAL LIFELINE LAYER

FULL 5G RAN ADOPTION SHOULD WAIT FOR SPECTRUM AND DEVICE MATURITY

LTE remains the practical backbone for 450 MHz. Operators will be able to evolve via 5G Core and RedCap devices as a gradual path toward full 5G and later, 6G. Full 5G RAN adoption should wait for spectrum and device maturity, while focus should be placed on neutral, interoperable platforms in the interim. Some key takeaways:

1. **Successful deployments are anchored in clear industrial use cases and investment cases,** with telecom operators often acting as build, operations, and integration partners. Strongest outcomes will be achieved where license holders carry explicit deployment commitments.
2. **As a critical national asset, 450 MHz should support MCX,** potentially including PPDR, which would require coordination with adjacent bands.
3. **Maximizing the value of 450 MHz requires targeted evolution and strong partnerships,** as the band is too valuable to remain underused.

ARTHUR D LITTLE

Arthur D. Little has been at the forefront of innovation since 1886. We are an acknowledged thought leader in linking strategy, innovation and transformation in technology-intensive and converging industries. We navigate our clients through changing business ecosystems to uncover new growth opportunities. We enable our clients to build innovation capabilities and transform their organizations.

Our consultants have strong practical industry experience combined with excellent knowledge of key trends and dynamics. ADL is present in the most important business centers around the world. We are proud to serve most of the Fortune 1000 companies, in addition to other leading firms and public sector organizations.

For further information, please visit www.adlittle.com.