Next Wave of Mobile Innovation

Advanced mobile infrastructure accelerates industry transformation, in economies with high aspirations

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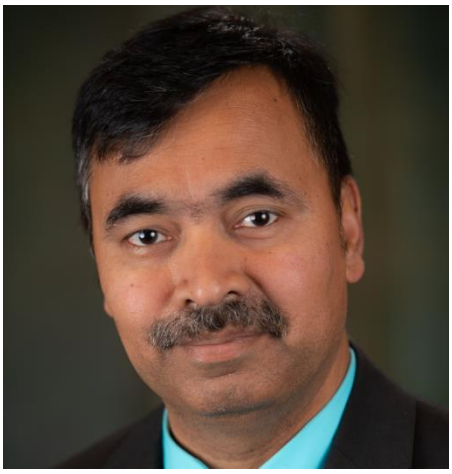

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5G has been the fastest industry deployment with over 2 billion subscriptions in 5 years.[1] The remarkable pace of consumer adoption has been evident in the US, China, India, South Korea, and Japan. Additionally, new services such as Fixed Wireless Access (FWA) have completely transformed the broadband competitive landscape in the US gaining almost all net-adds for the last couple of years.

Despite this breakneck growth, the full promise of 5G remains unrealized because most operators are still relying on non-standalone (NSA) deployments. Only 26% of global operators—163 out of 633[2]—have invested in standalone (SA) 5G, the architecture that unlocks the full capabilities of the technology. Without SA, operators are leaving value on the table: automation at scale, ultra-low latency, network slicing, and mission-critical reliability that industries need to transform their workflows.

While headlines celebrate explosive 5G growth, they're masking a critical reality: the transformative power of full 5G remains largely untapped. The staggering 42%[3] growth in overall 5G subscribers in 2024 creates a dangerous illusion of progress, obscuring the fact that 5G Standalone deployments is required to unlock 5G's revolutionary potential.

This isn't just a technology gap—it's a strategic chasm that's reshaping global competitiveness. With >90% of SA customers concentrated in just three markets—China, India, and the US—entire regions are being left behind in the race for next-generation digital infrastructure. The operators and nations moving decisively on SA today aren't just building networks; they're securing their position in the future economy while their competitors remain trapped in yesterday's technology, mistaking 5G marketing for 5G reality.

As we go into the second half of 5G, countries and operators must focus on building SA and 5G Advanced capabilities that help expand and embed 5G in the workflow of industries. Operators who have done that are benefiting from new revenue streams, building sustainable businesses that will last more than a decade, and instituting competitive advantage that will stand the test of time. Countries that develop expertise in absorption of 5G as a general-purpose technology across their industry verticals are going to benefit from 5G and adjacent technologies the most. On the flip side, nations that don't invest in building this capability will be left behind. This has significant policy implications on how nations and their respective ecosystem endeavors to adopt and implement new technologies like 5G and AI to accelerate GDP growth.

The paper discusses the strategic roadmap with actionable pathways for wireless industry leaders to capture maximum market value between 2025-2030, while establishing the essential foundation for 6G leadership. Analysis of first-mover markets demonstrates how targeted investments in Fixed Wireless Access (FWA) and advanced Mobile Broadband (MBB) solutions have consistently delivered superior customer satisfaction and revenue growth in the enterprise segment. As a result, FWA will grow from 11% of all fixed broadband lines in 2024 to 18% this decade.

Drawing from global success patterns across US, China, India, Singapore, UK, Australia, Sweden, and Japan, we identify specific enterprise opportunities that consistently yield sustainable high single-digit growth through strategic vertical integration and infrastructure optimization. This paper addresses three critical priorities for wireless industry executives: sustainable revenue growth, competitive differentiation, and strategic positioning for next-generation technologies.

[1] The Mobile Economy 2025
[2] 5G Stand-alone April 2025, GSA
[3] Ericsson Mobility Report, June 2025

Our findings reveal a clear correlation between early enterprise vertical specialization and long-term market dominance.

The paper discusses a novel Mobile Infrastructure Maturity Index that shows how leaders are made by timely policies, the embrace of new technologies that translate into real revenue, and a strategic mindset to keep on innovating. The position on the index has a direct impact on industrialization maturity of the country, which translates into GDP growth, employment opportunities, and future-proofing the country in a fast-evolving landscape. The case studies present the analysis across diverse industrial segments such as ports, hospitals, venues, manufacturing, emergency services, and mining. They help us connect the dots from 5G investments to new billion-dollar revenue streams and nation's consistent GDP growth.

Nations and operators who miss the opportunity to shape their strategy to take advantage of 5G are in danger of missing the cycle all together. Once you get behind, the supply-chains shifts can be permanent and the damage everlasting.

Each country has its own set of industries that drive their economy. We use different examples to highlight this point. One doesn't need to imitate what others are doing but rather understand how their local industries and economy can be transformed by the technology tools like 5G and AI. The diffusion of 5G is of paramount importance to the sustainability of domestic industries or else the production will move to more efficient markets.

By integrating global best practices and leveraging emerging technologies, this paper aims to guide stakeholders in capturing more value in the tech value chain and secure connectivity leadership through 2030 and beyond by working on a strategy that will become a necessary platform for launching 6G.

Industrial 5G as a part of fundamental telco strategy is the essential component of the digital transformation. But without new capabilities coming in, value will flow out. We expect industrial 5G/6G to generate trillions of dollars over the next decade and the savviest operators will be active participants in this new revenue stream. Operator's growth and destiny is tied to their industrial 5G strategy more than ever before.

Global Success for Industrial 5G

5G marks an important departure from earlier mobile technology cycles. Unlike earlier generations, with 5G the emphasis is as much on new access technologies as on the transformation of the core network. Perhaps, more importantly, it marks a change in the very conceptualization of the network as a platform that invites and anchors the transformation of other industries in the economy.

The biggest opportunity in front of the industry is Industrial Automation @ scale[4] and 5G has an important role to play. Together with other synchronous S-curve technologies, 5G can accelerate the workflow automation process. 5G must not be considered in isolation but as an important tool aiding in the industrial roadmap worldwide. When players have used 5G as the enabling tool for automation along with AI, Edge, Robotics, etc., they have generally succeeded in integrating 5G into the fabric of industrial workflow. However, when the sales team went into the enterprise selling 5G, it received cold shoulder or less than desirable outcomes.

Mobile operators can also evolve with the enterprise offering more sophisticated solutions as enterprises mature in their automation journey. For the operators, beyond providing connectivity, the next natural step is to offer cloud and edge

[4] Monetizing the 5G Killer Feature: Industrial Automation @scale, 2024

solutions along with private networks. Further, operators can provide and/or host AI/ML models for enterprises that are vertical or enterprise specific. In some of the vertical areas, operators can provide solutions like China Mobile in mining, NTT DoCoMo in logistics, AT&T in connected cars, Verizon in public safety, Vodafone in tracking and trace, Telus in healthcare, etc.[5] This progression will align well with the enterprises who move from basic to significantly advanced automation, compute, and connectivity solutions. The revenue share for operators will depend on how deeply they choose to engage in a given vertical. For the enterprise, the more they automate, the higher the efficiency gains.

5G is already being integrated into various facets of the enterprise supply chain. From basic connectivity to a full suite of applications that run on 5G, the market for Enterprise 5G for the mobile operators is already several billion dollars. Here are some examples:

- **5G Ports:** Over 80-90% of the global trade is conducted through seaports. So, it is essential for any nation with ports to be highly efficient in turning ships around and load/unload containers as cost effectively as possible. The leading ports like Tianjin, Singapore, Kandla, and Rotterdam have automated operations that involve heavy cranes and self-driving electric vehicles carrying containers. Tianjin port is amongst the top ten ports globally in terms of Twenty-foot equivalent units (TEU) – a measure of who many containers are being processed at the port. Tianjin Port has achieved substantial gains in operational efficiency and throughput. The operating efficiency of a single crane has increased by over 40% and with the help of technologies like 5G, Private Networks, Edge Computing, and AI, the port is achieved 100% automation.[6]

- **5G Ambulance:** India was late to 5G but that didn't deter it from starting with industrial projects right away. Launching 5G networks in Q4 2022, the mobile operator Airtel partnered with the renowned Apollo hospitals to start 5G ambulances. The state-of-the-art equipment in the ambulance has the patient monitoring applications, telemetry devices, cameras, and body cams of the paramedic staff and all is connected to the hospital on a 5G network.

- **5G Mining:** Mines are often the harshest environments to work under, and the role of connectivity and data is paramount. The mining industry has been one of the earliest adopters of 5G, private networks, and edge computing. They are using it for not only making their workers safe but also fundamentally changing their operations by using autonomous vehicles and remote operations using robotics. Mining operators in Brucutu and Carajas, Brazil; Luanchuan, China; Kiruna, Sweden; and Pilbara, Australia are using the new tools to automate and streamline their operations.

- **5G Hospitals:** The first commercial 5G private network in a medical facility was launched in Sichuan, China in late 2019. Since then, 5G powered hospitals have come online in South Korea, Thailand, UK, Israel, India, and the US. Hospitals deal with some of the most strenuous data and latency requirements. A combination of high-bandwidth private network connectivity paired with edge computing nodes provides significantly more flexibility in existing operations but also introduction new therapies like VR-based pain mitigation, remote surgery assistance, and next-generation telemedicine.

- **5G Schools:** The pandemic laid bare the disparity in broadband infrastructure in many countries because students were forced to study from home without easy access to the Internet. 5G fixed wireless arrived at the right time and has been providing students and schools with the necessary consistent connectivity. This was true not only for the rural areas but also the urban centers of large cities.

[5] 5G and 4th Wave – An Update, 2022

[6] 5G Monetization and Operational Excellence, 2024

- **5G Factories:** Manufacturing is an exciting area for 5G. Emerging sectors like cloud robotics, which harness the capabilities of cloud computing, AI, robotics, and 5G networks, are poised to significantly influence both corporate and consumer electronics sectors. In our society, there is a substantial discourse concerning the role of automation and robotics within manufacturing, and the subsequent ramifications for employment. Nonetheless, for nations that lack access to an affordable labor workforce or are grappling with worker shortages, such as Japan, the amalgamation of 5G technology and robotics holds the promise of introducing a novel era in manufacturing.

The scholars of the Long Wave thesis like Nikolai Kondratieff,[7] Joseph Schumpeter,[8] and Carlota Perez[9] have brilliantly articulated the role of creative destruction in rejuvenating the economic process by "industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one." We have seen this basic cyclical structure of the economy repeat itself over the last three centuries. More recently, we have lived through the evolution of the Internet, Mobile Broadband, and Cloud Computing.

5G is creating new opportunities and if the last cycle was any indication, digital will be at the center of the ecosystem revenue expansion. If 4G enabled the digital growth curves, 5G will be defined by them. If operators are not sanguine about how they run their networks and operations, their role in the 5G stack will be a diminished one despite enabling it.

To maximize their growth, mobile operators must pursue a dual strategy of staying on their 5G deployment roadmap and building enterprise offerings. On the 5G front, they should deploy advanced 5G capabilities that enable enterprise applications and services such as standalone 5G, edge computing fabric, private network offerings, features such as slicing, and 5G advanced upgrades to support low latency and massive IoT applications. Additionally, on the enterprise front, mobile operators need to develop expertise both on the enabling layer (platform, distribution, APIs, analytics, security, etc.) as well as the application and services layers. This will necessitate investing in system integration expertise and gaining experience in deploying automation solutions using 5G and AI.

Three Pillars of Economic Engine Growth – Infrastructure, Policies, and Diffusion

The notion of "Infrastructure as a catalyst of economic growth" is as old as mankind itself. Ancient civilizations of Mesopotamia, Egypt, Romans all invested in infrastructure to drive growth and employment. The same is true in the modern world. Internet restructured economies and served as a great equalizer in bringing industries and economies on a path to modernization. The emergence of LTE, Cloud, and Smartphones shaped the past 15 years. Similarly, AI, 5G, Edge Computing, Cloud, Autonomous Systems, etc. are transforming the workflows, the processes, and giving tools to business operators that help them reimagine their ecosystem and customers.

A progressive unencumbered infrastructure plan is table stakes. The foundational infrastructure layer acts as an economic multiplier. This must be supported by pro-growth and pro-innovation policies that foster new ideas to take shape and encourage the adoption of technologies that give an economy its backbone. Infrastructure and

Policies cannot reach full potential unless there is single minded execution on the diffusion front. It is the diffusion of technologies which empowers the economy.[10]

So, the infrastructure, policies, and diffusion working in concert gives an economy the boost it needs to accelerate the transformation of the

[7] The Kondratiev Cycle
[8] Long Waves in Economic Development
[9] Technological Revolutions and Financial Capital, Carlota Perez, 2002
[10] 5G Diffusion, Density, and Scale, 2025

industries. We have seen this play out on the global stage. Some segments of the market are bolstered by free market economics and demand like the US consumer market, FWA that dramatically reshaped the US broadband market, 5G diffusion in venue operations and emergency response. Other segments require a tight linkage of policies and diffusion execution for industries to move forward.

China and India have the greatest number of ports in top 100 of the Container Port Performance Index (CPPI) that measures the performance of seaport operations.[11] China has the most number of factories in the global lighthouse network.[12]

Each country has its own set of important industries. As such, their strategy to architect the economy will be slightly different but the alignment of the underlying framework of infrastructure, policies, and diffusion remains the fundamental basis for growth. When these pillars are in-sync, the value chain thrives, and new concepts and micro-economies emerge. This will be the basis of growth and global competitiveness.

[11] CPPI Index, 2024

[12] Global Lighthouse Network, 2025

Mobile Infrastructure Maturity index

The maturity of mobile infrastructure varies materially between countries, and thereby the role mobile infrastructure can play in supporting the digital transformation initiatives in a country.

To better understand how far a country has advanced and how competitive its mobile infrastructure is, you can gauge maturity by combining a set of key parameters and ranking the maturity for each parameter on a scale of 1 to 5.

We have selected six parameters as anchors to gauge the Mobile Infrastructure Maturity, where the chosen parameters are leading indicators for how ready the mobile infrastructure is to support the digital transformation of business- and mission-critical applications.

	1	2	3	4	5
Network/Industries	Enhanced mobile broadband	Fixed Wireless Access/ Wireless Access Network	Private cellular networks	Virtual private cellular networks	Mission-critical networks
Differentiated connectivity	Best effort	Fixed Wireless Access slice	Enterprise slices	Consumer slices	Network API enabled
Software maturity	Rel-15	Rel-16	Rel-17	Rel-18	Rel-19
Adoption of standalone architecture	5G-EPC	5GC	Standalone trials	Standalone launch	Commercial standalone services
Midband population coverage	<30%	30–50%	50–70%	70–90%	>90%
Midband spectrum allocations	0–199 MHz	200–399 MHz	400–599 MHz	600–749 MHz	>750 MHz

Figure 1. Framework for developing the Mobile Infrastructure Maturity Index

The parameters below are the foundation for our ranking and are also well-suited for self-assessments by communication services providers and countries.

The first parameter is about how the **allocation of new mid-band-spectrum for 5G** has advanced, and if a market has enough licensed full power spectrum to support the 5G capacity growth this decade. New midband spectrum for 5G is the main differentiator between countries, and a topic that has been analyzed well since 2022. The scale used is as follows: 0-199MHz (1), 200-399 (2), 400-599 (3), 600-749 (4) >750 (5).

Parameter 2 covers **midband population coverage**. The further that 5G coverage in midband spectrum has evolved, the greater the potential is for industrial adoption outdoors, indoors in urban areas, and for supporting small and medium businesses in rural areas. The scale used for 5G mid-band population coverage is: <30% (1), 30-50% (2), 50-70% (3), 70-90% (4), and >90% (5).

Adoption of 5G Stand-Alone (SA) architecture is the third parameter, representing a capability divider. Networks limited to 5G Non-Stand-Alone (NSA) limit the value proposition to enterprises and governments to 5G coverage and capacity. The transition to SA enables the addition of dynamic network slicing and 5G Advanced capabilities. The transition to SA is learning-intensive, and the earlier you move, the more experience you gain in the process. The scale for SA adoption covers a few vital evolution steps:

5G-EPC (1), Commercial 5GC (2), SA Trials (3), SA Commercial launch (4), and Commercial SA offerings (5).

The fourth parameter addresses the **SW maturity in the networks** by defining the most recent 3GPP software release in commercial operation. 3GPP R15 was the first release introducing 5G. Notable additions in subsequent releases are 5G SA (R16) and 5G Advanced (R18, R19, and R20). The actual release in use also gives a clear indication about a market's eagerness in adopting the latest opportunities to evolve network capabilities and the associated monetization potential. The scale adopted range from R15 (1), up to R19 (5).

Parameter 5 **covers mobile connectivity differentiation**. A gradual evolution from universal best effort connectivity to quality on demand to support experience innovation. These capabilities are ranked as Best Effort (1) One slice for FWA (2), Enterprise slicing (3), Consumer slicing (4) and API based differentiation (5).

The sixth and final measure defines the maturity for which networks/industries networks can support. A gradual evolution from mobile and fixed broadband to mission-critical communication. Ranked as Enhanced Mobile broadband (1), Fixed Wireless Access (2), Private Cellular networks (3), Virtual Private Cellular Networks (4) and Mission-Critical Networks (5).

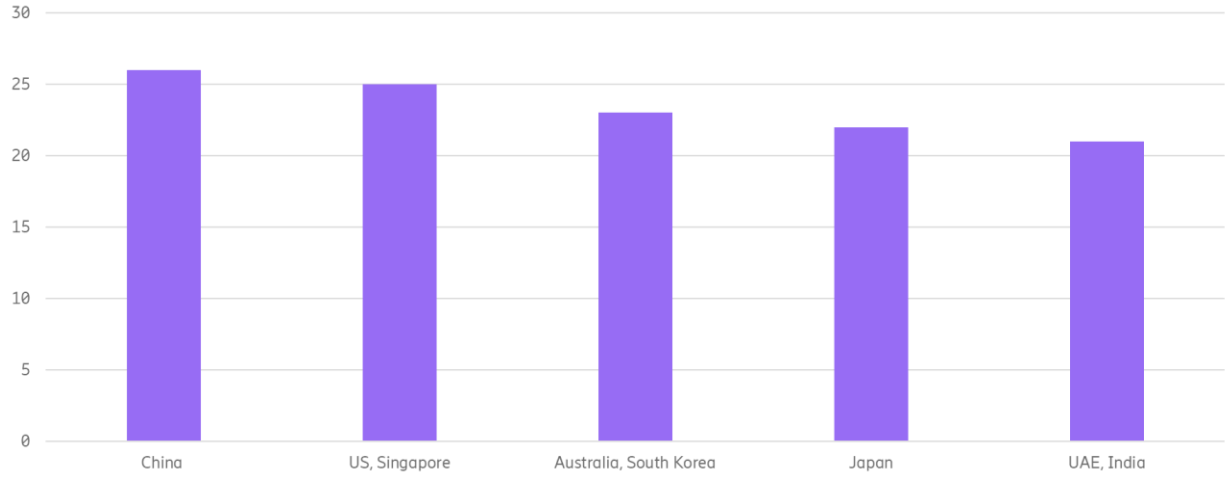

Figure 2. 2025 Mobile Infrastructure Maturity for advanced 5G markets

The most advanced markets all rely on a mature combination across all six parameters. A higher score represents a higher degree of readiness to support the digital transformation of industries leveraging the 5G infrastructure.

Licensed mid-band spectrum allocations and actual use vary between advanced markets, ranging from 200 to >750 MHz.

5G Mid-band population coverage[13] varies greatly, with Singapore, US, China, India, South Korea, and UAE exceeding 90%.

26% of operators investing in Public 5G networks invest in 5G SA capabilities[14]. A share that has been growing moderately since 2022.

Early adopters of 5G SA drive the adoption of differentiated connectivity and the expansion to serve new industries and networks.

Advanced markets already deploy 5G Advanced.

This model is well suited for self-assessment and benchmarking with advanced markets.

[13] Ericsson Mobility Report, June 2025

[14] 5G Stand-alone April 2025, GSA

5G Consumer success in the United States

The US has been very successful in growing Mobile and Fixed Broadband services since the launch of 5G. A market served by a handful of Tier 1 providers pursuing dual play Broadband strategies[15] with 5G mid-band population coverage exceeding 90%.

Mobile Broadband to Smartphones

91% of US adults have a smartphone, up six percentage points from 2021[16]. Leaving 9% of a mobile digital divide gap to close.

5G Mid-band and Massive MIMO have delivered big leaps in performance.

5G represented 70% of US smartphone subscriptions by the end of 2024. Reaching this milestone two years quicker than it took for 4G.

The three tier-1 mobile providers have grown revenues at a 3% CAGR over the last three years.

Multiple Service Operators offers MVNO-based smartphone services, bundled with cable broadband, and captures 40% of the net adds for post-paid smartphone subscriptions.

The monthly churn rates for post-paid smartphone subscriptions in the US are below 1%

Ericsson has forecasted North American 5G Smartphone penetration to reach 91%, with 43 GB/Month of average traffic by 2030.

Fixed Wireless Access (FWA)

FWA has historically seen a performance gap compared to wired network alternatives. 5G is the first wireless technology competing successfully with broadband over wires.

The US value proposition for FWA is a reinvention based on simplicity for offering/value, short delivery times, easy installation, and support.

During the last 3 years, FWA has captured all fixed broadband net additions, fiber growth has offset the DSL decline, and cable Broadband has gone from flat to declining[17].

There is a big delta in US Fixed broadband NPS and trajectories between FWA (44, +9), Fiber (25, -10), cable (17, flat), and Copper/Satellite (6, flat) between 2023-06 to 2024-12[18].

FWA in Verizon's network generated an average of 524 GB/month in 2023[19]. This is ~85% of the 640 GB/month generated in Verizon's fiber network (FiOS) at the same time.

81% of US adults had access to fixed broadband at home in 2024[20], a figure increasing by just two percentage points since 2021.

Conclusion

Mobile broadband has been an essential driver for expanding midband coverage, adopting SA architecture, and for introducing network slicing. All these factors enable a foundational mobile infrastructure for enterprise and industrial applications.

FWA is poised to continue to play the primary role for fixed broadband growth, with the potential to play an even bigger role in closing the fixed digital divide when expanding 5G rural mid-band coverage.

FWA is a significant success that encourages replication for enterprise and industrial applications.

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[15] How US providers compete with Dual play broadband strategies
[16] Mobile Fact Sheet, PEW Research
[17] Tier 1 service provider earnings calls and CTIA
[18] Fixed Wireless is Americas preferred next internet connection, Recon analytics
[19] Verizon 2023 Consumer Connections Report
[20] Internet, Broadband Fact sheet, PEW research

Industrial Use Cases – Impact and Lessons

In the first half of 5G, the industry hasn't been standing still as far as the industrial use cases are concerned. However, one must dive deeper into the operations to fully understand if the introduction of new technologies is making material gains or not. Operation managers will only continue to invest if they find tangible benefits that makes their KPIs better. First there is impactful case studies across countries and across industries. Secondly, with the benefit of time, we have had insights into how and why the introduction of 5G is enabling workflow transformation. We have selected eight use cases across different countries and vertical segments that provide meaningful insights into the transformation that can be measured and deliver ROI. The use cases are:

- Fully Automated Seaports – Netherlands
- Automation in Hospitals – Singapore
- Automotive Manufacturing – UK
- Sports & Entertainment Venues – US
- First Responders – US
- Mining – Australia

The following sections discuss each of these case studies in detail.

Fully automated seaports (RWG, Netherlands)

Efficient seaports are the backbone of modern shipping. Increasing terminal efficiency is a constant chase for better utilization of quays, cranes, and vehicles, and a reduction in the environmental impact. The Rotterdam World Gateway (RWG) is the world's first fully electric and carbon-neutral container terminal and a port taking advantage of advanced 5G infrastructure.

Problem statement

Quays, berths, and waterways supporting the world's largest ships – 400 meters long, 60 meters wide, and carrying >24,000 Twenty-foot Equivalent Units (TEUs) containers

Reduce environmental impact from port operations – global shipping contributes to 3% of total CO emissions.

Reduce risk exposure for port workers – for offloading containers and for transporting containers from ships to trucks.

Shippers needing control of containers from offload from the ship to on-load on a truck.

Target outcomes / validated outcomes

RWG handles an average of 7,064 containers daily, one every 12 seconds[21]

Remotely operated cranes and vehicles – manual interventions managed from safe and secure locations.

Fully automated operations – 24/7 year-round

Net Zero environmental impact from all port operations – Terminals are already CO2 neutral, and the next step is for environmentally friendly power for ships at berth.

Transparent information handling to shippers for all steps in the port handling process.

Solution overview

16 remotely operated Quay cranes – each lifting >440 containers per day

64 Electric Automated Guided Vehicles – each handling .100 containers per day

5G Network solution insights

- A private cellular network eliminates previous connectivity challenges.

[21] RWG Premium Terminal Data

- Launched with 4G and evolved to 5G as spectrum is released.
- Redundant radio configurations.
- 9 years in operation using private cellular networks.

Data communication via ruggedized tables between container stands and reference areas.

Connected MIFI devices with private 4G SIM cards to laptops.

Data communication between the customer application server and the Automated Guided Vehicle (AGV)

Conclusion

The outdoor nature of ports, and the importance of automating operations of quay cranes and automated guided vehicles, make private cellular networks an optimal choice.

The digital maturity varies between berths in the same port and the network evolution at ports from 4G to 5G depends on the availability of spectrum.

There is a >300X gap in the size of ports that embrace 5G for their automation journey.

Connected Healthcare/Hospitals (NUH Singapore)

5G is revolutionizing the healthcare industry by enabling advanced connectivity solutions, improving surgeries and care in hospitals, and extending the hospital care to homes

As the leading hospital in the National University Health System (NUHS), the National University Hospital (NUH) in Singapore has adopted 5G as the advanced connectivity solution to develop innovative healthcare solutions to improve patient experience and proactively enhance healthcare availability, accessibility, and efficiency.

Problem statement

Enhance patient experience by adopting new technologies during advanced surgeries and patient care in hospitals.

Complex surgeries are very time-consuming and depend on a few highly skilled surgeons with specialist competence.

To apply new technology such as holomedicine, NUH evaluated different connectivity solutions in the hospitals (Wi-Fi, 4G, and 5G) to identify the most consistent high-speed, high-bandwidth, and low-latency connectivity solutions. This evaluation aims to facilitate surgeons in improving surgery accuracy and shortening surgery time by applying holographic and AR headsets. Validations have proven 5G to be the most suitable solution for holomedicine.

Nurses are in short supply and represent a bottleneck for care.

Target outcomes / validated outcomes: Increase quality and success rate for complex surgeries.

Trials on a 5G-powered robotic nurse have been ongoing since the end of 2024, with the ambition to reduce the time nurses spend on routine tasks executed daily for all patients, like monitoring conditions, and distributing medicine

5G is used to validate the precise positioning of where robots are to secure that patients get their medicine.

Validated outcomes after 2 years in operation

- About 20-30% faster surgeries, when assisted.
- Ongoing validation of Robot nurses taking over 30% of nurses' routine tasks.

Solution overview

Virtual private 5G solution leveraging Public 5G network coverage extended into an existing hospital, with small cells in surgery rooms with restricted access.

An experienced surgeon at the lead hospital is doubling as the national innovation lead—an approach ensuring that innovation initiatives are well-anchored in the challenges that matter the most.

To promote the best practices for 5G in healthcare and drive ecosystem readiness, an international initiative, Global Health Innovation Network (GHIN), has been launched by NUHS, Ericsson, Sahlgrenska, and AstraZeneca. 2024[22].

Microsoft HoloLens supported surgeons during long and complex surgeries

"MiSSi Robots" (30) introduced at NUH for operational trials to take over part of nurses' routine tasks[23]

Evolution: Continue to evolve the 5G solution at NUHS, considering new healthcare use cases such as seamless connectivity for healthcare staff, 5G advanced features, and planning of new hospitals.

Conclusion

Adopting 5G as the advanced connectivity solution in hospitals can create well-connected hospitals, proven to enhance patient experience and improve productivity for both doctors and nurses.

The virtual private 5G solution leverage the 5G public network coverage and capacity, enhanced with dedicated in-door coverage and capacity. It has proven to be efficient to both provide dedicated advanced connectivity solution for the operating rooms and ensure advanced connectivity for patients and care givers wherever they are from operating rooms, other hospital premises, and to the patient's home when needed.

To accelerate the 5G adoption in healthcare and empower more hospitals with new and advanced digital solutions, continuous collaborations among hospitals, technology providers, and other players in the ecosystem are vital to accelerate the digitalization of healthcare and enhance healthcare quality, availability, and accessibility.

Automotive manufacturing (JLR UK)

Manufacturing is an industry that has taken advantage of private 5G networks early in the adoption cycle, especially for automotive manufacturing.

The Jaguar-Land Rover plant in Solihull, UK, has adopted private 5G and offers valuable insights.

Problem statement

The productivity in any automotive factory depends on having all materials and all tools in the right place as planned and expected. Minimizing deviations from plans is a central KPI.

Previous wireless networks have been unreliable and have not reached all parts of the factory.

Reconfiguration of wired networks, for tools connected with wires, at model changes takes multiple weeks to execute.

Cars are loaded with market-specific software after final assembly, often involving manual processes.

The quality assurance depends on logging significant volumes of data points from sensors and tools throughout the production process.

[22] Ericsson support Global Health Innovation Network in Singapore

[23] Robot nurses that monitor patients' condition, issue medicine to be piloted at NUH in 2025

Target outcomes / validated outcomes

Overall productivity in an automotive plant comes from minimizing downtime, costing $50k per minute.[24]

Wirelessly connected tools that eliminate the network reconfiguration times at model changes. Turning weeks into seconds.

Extending network coverage to hard-to-reach areas, like the paint shop and the lot holding all assembled vehicles waiting to be shipped.

Market-specific vehicle software is uploaded over-the-air without manual intervention after final assembly.

Capturing performance data from tools and machinery.

Prepare for self-driving cars that can drive off the production line by themselves, and drive to their designated spot on the lot before shipment.

Solution overview

JLR in the UK has taken advantage of regional 5G innovation funds to accelerate the option of private 5G networks[25]

Ericsson has provided a private 5G network[26]with gradual expansion across the buildings in the plant.

Using 3.8-4.2 GHz (band n77) licensed directly by JLR, delivering speeds at about 900Mbps[27]

Ecosystem partners for native, and non-native 5G devices and manufacturing applications.

Conclusion

The large size and significant potential productivity gains make automotive manufacturing a suitable target for large-scale 5G network builds.

WEF recognizes 189 factories as global light house factories[28] out of which 17 are automotive factories, the second largest category after electronics.

Business operations at Sports and Entertainment venues in the US

5G was first introduced to US fans at sports and entertainment venues at the beginning of 2020 and is today widely established as the way for fans to connect at significant events.

Beyond the public 5G networks that fans can access, private 5G networks and slices of public 5G networks have started to transform business operations at sports and entertainment venues. Applicable to permanent venues with frequent events as well as the largest yearly events. Here are examples from the United States.

Problem statement

Business operations at major sports and entertainment venues are multifaceted, with multiple areas going through a digital transformation.

There is a need for efficient ticket screening and security clearance at venue entry.

Increased requirements on quality, camera angles, and reduced delivery times for different types of media productions.

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[24] Thomas
[25] Department of Science, Technology and Innovation, UK
[26] Ericsson Private 5G to support JLR's Digital Manufacturing Transformation
[27] TechInformed
[28] The global lighthouse network is comprised of 189 lighthouses, World Economic Forum

High sales volumes for food, beverages, and merchandise.

Target outcomes / validated outcomes

Prioritized connectivity for business operations at sports and entertainment venues[29].

Rapid and secure payments with smartphones, tablets, and wireless payment terminals[30].

Secure real-time data capture and transmission from competition equipment to teams for analysis[31]

Connecting TV cameras from media production without wires[32], enabling flexibility and more creative media productions at sports events and concerts, and new reality TV formats

Reduce the lead times for sports photographers from capturing moments, via editing, to published pictures[33]

5G networks enable efficient transmission of data for real-time information on available parking spots, restrooms, and concession stands[34]

Priority connectivity for first responders in case of emergencies at venues.

Solution overview

Private 5G network or slice of a public 5G network at sports and entertainment venues, as a complement to the public 5G networks for fans.

Permanent radio installations in frequently used venues, and temporary radio network capacity augmentations at racetracks and golf courses, with one or a few but well-attended events per year.

Network slices in combination with dynamic quality of service on demand through QoD APIs offers an opportunity to tailor services to serve different business operations and applications.

Ericsson-Cradlepoint edge routers installed on sailboats transmitting sensor data and video from competing sailboats to onshore crews and broadcasters.

5G data transmitters[35] connecting TV cameras and mirrorless cameras for still pictures.

Conclusion

5G is well established at sports and entertainment venues in the US, both for serving fans and for supporting business operations.

Connecting US First responders

Upgraded mobile infrastructure can support mission-critical applications, and US first responders have proven the viability of 4G and 5G infrastructure for mission-critical use.

Problem statement

The post-mortem of the 9/11 tragedy in the US in 2001 concluded that there was a significant opportunity to align communication capabilities across agencies. These insights triggered the creation of FirstNet, a nationwide network using mobile technologies to serve first responders.

Legacy bespoke networks for voice and messaging services for first responders have reached the end of life; they have too low capacity and lack sufficient coverage of the US land mass.

Network and technology limitations for emergency missions reducing the expected success rate

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[29] Racing gets an upgrade, Verizon F1 case study
[30] Racing gets an upgrade, Verizon F1 case study
[31] Sail GP selects Ericsson as global Technology supplier for the 2025 season
[32] T-Mobile powers one of the most connected Majors ever at 2025 PGA Championship
[33] T-Mobile to debut new 5G-fueled fan experiences at Formula 1 Heineken Silver Las Vegas Grand Prix
[34] 5G & Sports and Entertainment, AT&T Business
[35] 5G Portable Data Transmitter, Sony

Target outcomes / validated outcomes

Network coverage in all areas where first responders operate. Mobile infrastructure in the US currently covers 3.0 out of 3.5 million square miles of land[36], representing 99% of all first responders.

Increase capacity to support video and data services in addition to text and messaging services. Initially supported with 4G and now evolving to 5G.

Add new types of purpose-built devices and variants of existing devices optimized for use in very rough environments.

Priority access to network resources during emergencies, when first responders compete with consumers and other agencies for resources.

Solution overview

Mission-critical applications are supported by adding capabilities to existing mobile infrastructure, rather than new bespoke networks.

First responders in the US have two main options:

- FirstNet: A dedicated extension to AT&T's mobile network for first responders, with a $6.5 Billion[37] initial investment and a recent $8B extension[38].
- Slices of public 5G Networks: T-Priority by T-Mobile selected by the city of New York[39] and Verizon Frontline launched in 50 cities[40].

Low-band spectrum prioritized to maximize the network reach from existing tower infrastructure, combined with "extensification" to close reach gaps with new towers.

Battery backup at the radio site to secure network availability, as power outages are common during some emergencies.

Hardened devices and applications to meet first responder needs, on the ground and in the air.

Network slicing prioritizes the available capacity for first responders and between agencies where the need is highest.

NTN as a complement for network coverage of the last 500,000 square miles of US land that is outside the mobile grid.

Conclusion

Mobile network infrastructure serves mission-critical applications, and US service providers have shown the way for all mission-critical use, such as utilities and rail.

Mining (Newmont, Australia)

Mining can take advantage of 5G both underground and in open-pit mines[41].

Newmont Mining Corporation in Australia has taken advantage of private 4G and 5G networks since 2019 and gained valuable insights in the process[42].

Problem statement

Increase safety and efficiency when operating heavy equipment in an open pit setting.

Network equipment located in the open-pit mine requires frequent relocation and manual interventions when relocating.

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[36] FirstNet by the Numbers
[37] AT&T Lands $6.5B FirstNet contract
[38] FirstNet Authority and AT&T 10-year extension
[39] T-Mobile unveils big moves for T-priority that put first responders first
[40] Verizon Frontline network slice now available nationwide
[41] A journey to cellular and the safer, smarter and sustainable mine
[42] 5G innovation delivers safer and smarter dozer operations

Down-time issues with alternative wireless solutions are hampering productivity.

Coverage limitations with alternative wireless solutions.

Target outcomes / validated outcomes

Reduce dependency on physical wiring, increase flexibility, and simplify safety and operational workflows.

Removing workers from high-risk areas, i.e., in the open-pit.

High throughput level and stable connectivity, enabling remote operations. Remove constraints on types of and number of connected devices in a given area; 132 Mbps uplink capacity is required for fully equipped operations.

Improve the remote operations experience to be more like in-cabin experiences.

Reducing downtime due to instability and connectivity loss

Ability to scale fleet as demand for productivity gains increases

Solution overview: Allows for 5G-enabled equipment in mines to reduce physical wiring, increase flexibility, and simplify safety and operational workflow

Remote-controlled heavy earth equipment over 5G, Massive MIMO, and beamforming/steering

Private 5G network with one single radio providing enough coverage and capacity for an open pit mine, by delivering 100Mbps uplink over distances up to 3km/2mi

Directional real-time sound, video, and haptic integration can improve driver efficiency and responsiveness while reducing training times.

Directional real-time sound, video, and haptic integration can improve driver efficiency and responsiveness while reducing training times.

Allows for 5 G-enabled equipment in mines to reduce physical wiring, increase flexibility, and simplify safety and operational workflow

A 5G platform that can accommodate any throughput requirement at any point in the mine.

Conclusion

The mining industry operates in harsh conditions where the availability and reliability of cellular solutions are key to efficient remote operations.

Infrastructure to Diffusion: Connecting the Dots

For business leaders, the conversation around 5G—or any transformative infrastructure—always comes down to ROI and TCO. Network speed, latency, and coverage are meaningless unless they translate into operational metrics executives can measure: cost reduction, process acceleration, quality improvements, and flexibility in scaling operations.

The use cases outlined earlier in this paper—from AI-guided surgeries to autonomous logistics fleets—are not simply technological novelties. They are operational breakthroughs made possible **only** by the underlying digital infrastructure that delivers low-latency connectivity, real-time intelligence, and high-reliability communications. Without that foundation, these solutions remain prototypes; with it, they become production-ready engines of competitive advantage.

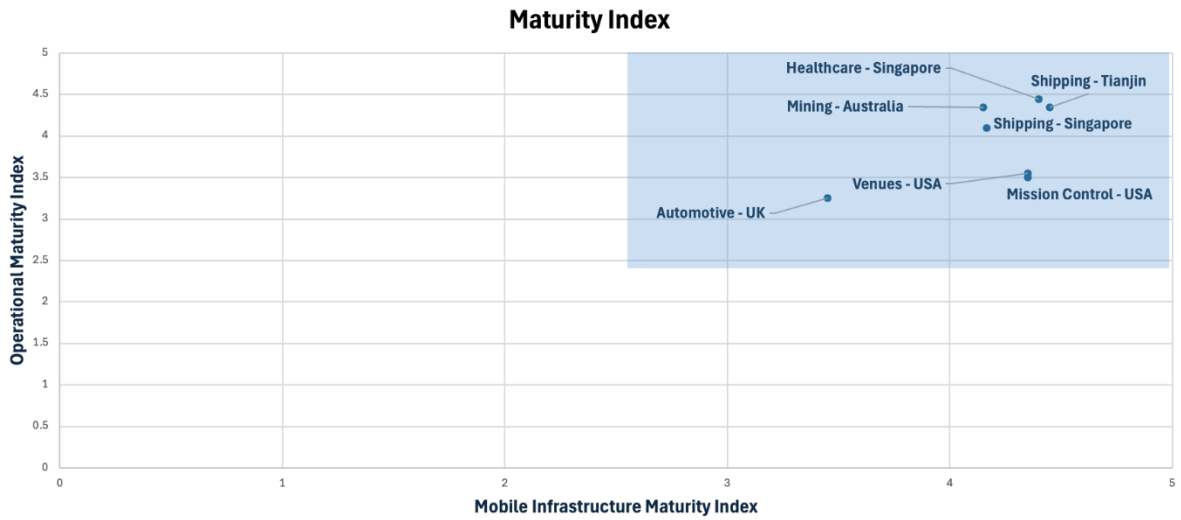

Figure 3. Connecting Dots between indexes

To quantify this readiness, we introduce the Operational Maturity Index (OMI), which synthesizes four critical dimensions:

1. **Cost Efficiency** – measurable savings or avoidance of waste;
2. **Solution/Service Maturity** – stability, uptime, and resilience in daily operations;
3. **Productivity Gains** – output per unit of input, whether in time, labor, or resources;
4. **Flexibility** – adaptability to different environments, scales, and workflows.

Comparing use cases across industries is inherently complex—a 30% reduction in surgery time in a hospital is not directly comparable to a $10,000 savings per vehicle in an automotive plant, though both have profound operational consequences in their respective domains. However, by normalizing metrics across these four dimensions, we can meaningfully compare maturity levels and assess where investments are producing outsized returns.

Figure 3 visualizes this relationship by mapping Operational Maturity against Infrastructure Maturity. It is more illustrative than precise. What emerges is telling: the most impactful industrial use cases—smart ports, automotive manufacturing, connected hospitals —cluster in the top-right quadrant. That's not by accident. These environments demonstrate a tight alignment between infrastructure investment, supportive policy frameworks, and active diffusion strategies. When these three forces converge, industries transition from trial deployments to scaled, repeatable impact.

The takeaway for policymakers, operators, and enterprise leaders is clear:

- Infrastructure without diffusion is an underperforming asset—a sunk cost that fails to deliver full economic potential.
- Attempts at Diffusion without robust infrastructure results in stalled pilots and unmet expectations.
- Only when infrastructure, policy, and industrial adoption strategies move in lockstep do economies unlock the full productivity promise of 5G, AI, and beyond.

In the context of industrial transformation, this isn't just theory — it's competitive survival. The countries and companies that master this alignment today will not only dominate 5G-era use cases but will have a decisive head start in the 6G world, where the complexity and economic stakes will be even higher.

Conclusions and Future Work

The global rollout of 5G has been unprecedented in speed, but true value lies not in connection counts or coverage maps—it lies in how deeply the technology is embedded into the industrial fabric of the global economies. The real story of 5G's impact is written in factories, ports, mines, energy grids, logistics hubs, and research labs across the globe.

From NUH Hospital in Singapore where physicians are deeply involved in using technology to transformation operations and outcomes to the UK's Jaguar Land Rover factory integrating ultra-low latency robotics, and smart mining operations in Australia using private 5G to enable real-time equipment monitoring, the lesson is clear: industrial use cases define the frontier of 5G's economic potential.

Yet, the path to these outcomes varies sharply by nation. The United States' market-driven model has yielded rich ecosystems for private enterprise innovation—think precision agriculture in Iowa[43] using 5G-linked drones, or AR-assisted maintenance for aircraft in aerospace hubs—but faces barriers in network density and consistent spectrum policy that slow scale in heavy industries. India, propelled by fierce competition among operators, has democratized consumer access at record speed and begun introducing industrial pilots—like 5G-enabled textile quality control systems in Surat, but still contends with high spectrum costs and insufficient fiber backhaul to unlock full enterprise potential.

Across high-, middle-, and low-income countries, a stark divide is emerging: those that focus merely on infrastructure deployment risk stalling at the threshold of transformation, while those aligning spectrum policy, industrial strategy, and workforce development are pulling ahead in creating real economic value. The persistence of Non-Standalone (NSA) networks and the slow ramp-up of advanced B2B solutions illustrate that without a deliberate push into industrial verticals — energy, manufacturing, healthcare, transportation — the promise of 5G remains underrealized.

The window for 5G leadership is rapidly closing. Early adopters don't just gain a competitive edge—they capture the entire economic ecosystem, creating a powerful gravitational pull that draws talent, investment, and innovation directly to them. As these pioneers establish market dominance, they generate compounding advantages: deeper expertise and ecosystems, stronger partnerships, and premium positioning that becomes nearly impossible to replicate.

For late-movers, the cost of delay can be irreversible. Once the skilled workforce, venture capital, and industry attention concentrate around the early leaders, trying to catch up becomes exponentially more expensive—if it's even possible at all. The 5G diffusion rewards the bold and punishes the hesitant, leaving no room for a second-place strategy in tomorrow's digital economy.

We hope that this paper provides a framework for assessing where a country or a case study maps with the world's best and in understanding what it will take to narrow the gaps. It also discusses a range of use cases from around the world with enough operational details and performance metrics for industries and nations to develop their own blueprints. Thus, this paper is a living document to track both the progress as well as provide concrete use cases as they become available.

The lesson from 5G diffusion is decisive: national strength in general-purpose technologies comes from being fastest and most capable at scaling them across the economy. As the world moves toward 6G, the countries that will lead are those already laying the groundwork today — investing in comprehensive ecosystems that unite policy, capital, and industrial integration. For them, the

[43] Making the 5G precision agriculture connection

story of 5G will not be about the number of towers built, but about the number of industries transformed. And that transformation will determine not just GDP growth, but geopolitical influence for decades to come.