

market opportunity overview The Advent of Private LTE and 5G Networks



Smart Systems and Internet of Things Growth Strategy



The worlds of sensors, automation, machine learning, computing and communications are each changing rapidly, while at the same time converging into an entirely new competitive arena: Smart Systems and the Internet of Things.

The forces at work in these sectors make strategic decision-making extremely difficult. The velocity of change conspires with the number of variables in play to overtax many managers' ability to make confident and informed decisions.

This has two crucial effects on strategists: First, they need better analytic methods and frameworks for decision-making. Second, while they are more likely to consult with outside advisors, they also need more effective modes of interaction with them.

Smart Systems technologies are creating significant discontinuities in the marketplace. Knowing which applications and use cases to focus on, which business model to pursue, and which market relationships to create are critical in today's rapidly evolving marketplace.

Harbor's services combine research, strategy and design with collaborative facilitation processes to provide clients with unparalleled perspective and applied methods for developing new business opportunities.

Market Opportunity Overview

Private IoT Market Opportunity



Summary of Key Takeaways for the Private Network Opportunity

High Performance Networks are a Key Enabler of Smart Systems and Mission Critical IoT Deployments

Whereas today's network environment is a patchwork of dedicated and siloed systems to support specific device types and use cases, future networks will be seamlessly integrated and managed to achieve the complete value of Smart Systems for enterprises.

Private LTE Networks Solve Key Technical & Operational Challenges, and Set the Stage for Future 5G Deployments

New technical and business model innovations are enabling 4G LTE to be deployed as a private WLAN network. Soon, private 5G networks will be able to offer even higher performance, achieving similar latency, bandwidth, reliability and security as traditional wired networks.

The Opportunity for Private Networks in IoT is Massive, Driven by New Levels of Operational Performance

The revenue opportunity for private networks and related IoT enablement, software and services will be over \$200 billion by 2025, as they address coverage, security, latency, reliability, and cost issues associated with applying existing wired and wireless networks to IoT.

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The Networks Ecosystem is Rapidly Evolving, as Many Suppliers Jockey for a Controlling Position in Private Networks

Providing a complete private network solution requires hardware, software, service and support. Mobile Network Operators are well-positioned to offer private networks; however, they are threatened by DIY enterprises and peers expanding into managed services.

To Successfully Capture the Opportunity, Suppliers Must Consider Technical & Business Model Adjustments

While some players are expanding their capabilities with software-enabled service innovations, many are opting for partnerships to build out an end-to-end offering. Beyond new capabilities, successful strategies require engaging different channels with new business models.

smart systems design **Harbor Research**



Framing the Private LTE and 5G Networks Market Opportunity

Networks Must Evolve to Address Increasingly Complex Applications

Higher performance networks are required enable a new generation of applications, giving rise to an increasingly complex set of interactions of data between device, machine and human processes



Increasing Solution Complexity





The Current Network Landscape is Fragmented & Uncoordinated

Today's fragmented landscape creates barriers to adoption riddled with proprietary device networks, cautious users and buyers, and broken promises about the potential of wireless technologies





Remote Assets / High Coverage

 Substation Monitoring **Oil Rig Monitoring**

- **Electricity Metering**
- Weather/soil Monitoring

High Bandwidth / Mobile Assets

Agriculture Vehicles **Off-Road Construction** Surface and Sub-terrain Mining Streaming Video

Mission-Critical / Control

 Automation / Process Control Machine and Equipment Monitoring

Short-Range, Lower Data Rate Environment Monitoring

 Wireless Sensor Monitoring Mesh Network Diagnostics



Integrated, Hybrid Network Services Enable Seamless Orchestration

Private network services will will act as an abstraction and orchestration layer to link existing networks and optimize the way data moves between systems

Current State of Wireless Networks

- Limited device and data interactions
- Simple use cases
- Inefficient bandwidth usage
- Complex, uncoordinated management



Key Enablers

- Network Slicing
- Multi-Access Edge Computing
- Dynamic Spectrum Access
- License-assisted Access
- Listen before talk
- Traffic Prioritization
- Open, Virtualize RAN
- Automated Orchestration

Future State of Hybrid Network Services

- Greater visibility of network usage
- Autonomous, distributed use cases
- Optimized bandwidth usage and computing limits
- Increased control over connected devices





Satellite





Emergence of 5G Promises to Solve Wireless Performance Issues

Technologies like 5G introduce new services capabilities to extend wireless into previously untapped industries and operations, enabled by networking innovations such as network slicing and dynamic spectrum access technologies







5G: Differentiated Network Capabilities

- Ultra Reliable Low Latency Communications (URLLC)
- Enhanced Mobile Broadband (eMBB)
- Massive Machine Type Communications (mMTC)

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Private Network Technologies

- Dynamic Spectrum Access
- Network Slicing
- Virtualized, Open Radio Access
- Multi-Access Edge Computing

Private LTE Networks Play a Key Role in Future IoT & 5G Adoption

Private wireless networks are cellular networks **dedicated to a specific enterprise, venue or** geographic area, leveraging flexible spectrum access technologies with the ability to operate over unlicensed, shared and licensed spectrum







Private Networks Harness Untapped Value, Addressing Key Challenges

The benefits of Private and Neutral Host networks directly address challenges such as device density, user mobility, infrastructure and ongoing management costs, and network security



Networking Challenges

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Private Network Benefits

ance	LTE performance in terms of capacity and throughput reaching between 2-4 times that of 802.11ac, yielding superior payloads than Wi-Fi
e nent	Quickly set up and provision devices to the network without expensive licenses – like Wi-Fi deployment
ess ty	Seamless mobility to support service continuity between small cells and other networks
ence	Efficient co-existence with other spectrum users such as Wi-Fi (and more diverse networks in the future)
ve	Fewer required nodes while supporting enhanced interference management capabilities, thereby reducing costs with a greater network footprint per access point



Private Networks Create New Revenue Opportunities

Near-term addition in environments with high network performance needs catalyze market growth and create demand for new network services

Private Wireless Networks TAM (SUSD Millions)

(Percentage of Network Services Revenues)



\$250,000









Players are Organizing To Capture Value of High-Performance Networks

While some operators are taking initiatives to expand into adjacent network services, only a short-list of players are addressing the need to fully manage and operate high performance, wide area networks & emerging private LAN



Cloud) which is segmented into Value-Added Applications given their proximity to AI, ML and other apps



systems

Stakeholders are Innovating Around New Spectrum Access Technologies

Network ownership and management varies across the three spectrum deployment scenarios with ownership shifting towards the enterprise and managed service providers (e.g. Neutral host vendor)





Collaboration With Ecosystem is Critical to Network Innovation

Critical partnerships spanning the value chain are driving the R&D needed to actualize end-to-end, holistic wireless solutions

Hardw	vare	Software & Platforms			
Silicon & Modules	Network Equipment & Infrastructure	Connectivity Services	Software & Platform Se		
 Key enabling components for smart devices and machinery Integrated processing to support distributed intelligence 	 Backbone for connected service driving robust connectivity platforms within and across operational sites 	 Pipeline to facilitate the exchange of data Managed services ensuring network uptime and performance optimization 	 Data transformation and v added services driving the monetization of distribute device and equipment net 		
(intel)	ERICSSON	Ericsson's initiative to drive partnerships and alliand the strategic development of network and equipm the next generation of smart value added	ce with OEMs illustrative ent integration to drive d applications.		
QUALCONN	NOKIA	While challenges around proprietary functionality, the Predix platform services with emerging Private LTE and drive adoption with easy, simple integration with i	e orchestration of GE's d 5G technologies will ndustrial systems.		
	ERICSSON	The partnership with Ericsson and alliance s Innovation Lab will support ecosystem collab connectivity solutions for haptic feedb	surrounding the 5G Industrial poration to identify and specify pack and cloud robotics.		
	Conne evolve	ectivity hardware specified for data intensive, mission crit cloud based solutions for machine control and automati	ical robotics applications will help on over flexible wireless networks.		
	ERICSSON	Ericsson struck a deal to acquire CENX, a serv provider, to bolster its automation capabilities ahead with virtualization with aims to autom	ice orchestration as operators move ate 5G networks.		
	HUGHES.	Pivotel implemented Expension allow trucks to roam betwee at the mine site and public continuous monitoring of	eto's Nextworking solution to een a private mobile network mobile networks, providing asset location and telemetry.		



Operational Device





Private LTE & 5G Networks Market Model Elements

Devices & Sites	Regions	Years	Revenue Opportunity Categories	I
 Devices Shipped Nor (New & Retrofitted Equipment) Asia ROV Devices Installed (Existing Equipment) Sites 	 North America Europe Asia Pacific ROW 	 2019 2020 2021 2022 2023 2024 	 Enablement/Connectivity Wired WWAN CBRS (North America only) LTE Private 5G Multefire 	• Consur o Cons • Healtho o Heal Clinic o Mob
P		 2024 • WPAN WLAN Computing Professional Services (Design/Installation, Maintenance/Upgrades) Network Services Wired WWAN CBRS (North America only LTE Private 5G Multefire WPAN WLAN 	 WPAN WLAN Computing Professional Services (Design/Installation, Maintenance/Upgrades) Network Services 	 Retail Ware Distri Industri Discri Hybri Proce
Pr			 Wired WWAN CBRS (North America only) LTE Private 5G Multefire WPAN WLAN 	 Smart (Trans Infras Resour Minin Oil & Agric Wete
Priva	ite loT TAM		 System Applications & Value-Added Applications 	 Wate Powe Transpondence

Market Opportunity Overview

Private IoT Market Opportunity

Market Segments

mer

sumer IT Devices

care

th Delivery (Hospitals, Labs & cs) ile/Personal Healthcare

ehousing ribution & Logistics

rial Manufacturing

rete rid/Converting æss

Cities

sportation & Pedestrian structure

rces

ng

Gas

culture

er Utilities

er Utilities

ortation

Professional IT



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Harbor Research has over thirty years of experience working with clients on growth strategy and new business creation. At the core of Harbor's approach is a deep understanding of the core technologies, markets and business characteristics as well as the management and organizational challenges companies face adopting and developing digital and smart systems technologies. We strive to generate deep insight into how emergent technologies drive value creation and competitive advantage in our clients' businesses and the economy as a whole.

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