Private LTE networks create new opportunities for industrial IoT

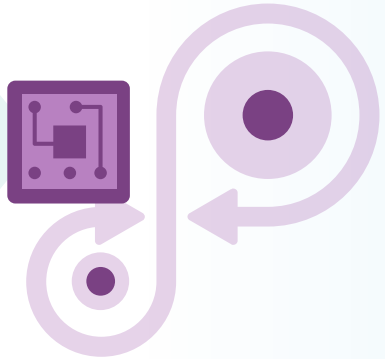
Qualcomm Technologies, Inc.

October, 2017

Transforming our world

Through intelligent connected platforms

Mobile



IoT

Technology leadership in system on chip, systems design, and connectivity

Last 30 years

Interconnecting people

Next 30 years

Interconnecting their worlds

*Qualcomm Technologies, Inc. data, as of Apr. 20, 2016; Includes products from Qualcomm Technologies, Inc. and Qualcomm Technologies International, Ltd..

Megatrends in wireless interconnectivity, intelligence, automation create significant global economic value

Health
~$400-700B

Home
~$200-350B

Office
~$70-100B

Retail
~$400-500B

~$6-8 Trillion

2025-2030 potential economic impact

Autonomous cars
~$2.0-2.5T

Smart cities
~$1.0-1.2T

Logistics
~$500-800B

Manufacturing
~$1.4-1.7T

Note: Directional projections based on many long-term assumptions; estimates vary significantly based on adoption assumptions across verticals and use cases;
Numbers may not sum due to rounding Source: World Economic Forum, McKinsey Global Institute, Economist Intelligence Unit, GSMA, Morgan Stanley, team analysis and estimates

The next industrial revolution is underway

Industrial trends

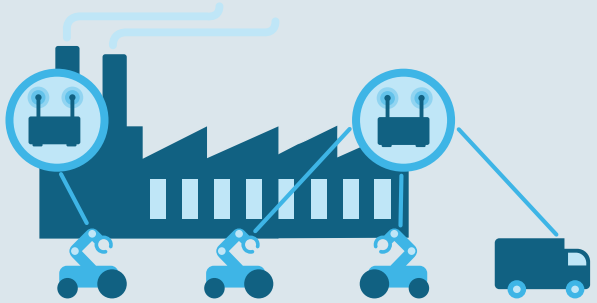
Shift to selling products as services

Predictive and preventative maintenance

Reconfigurable factories with full mobility

Big data analytics with increased automation

Solution



Private LTE networks

Connectivity requirements

Keeping data local for better security

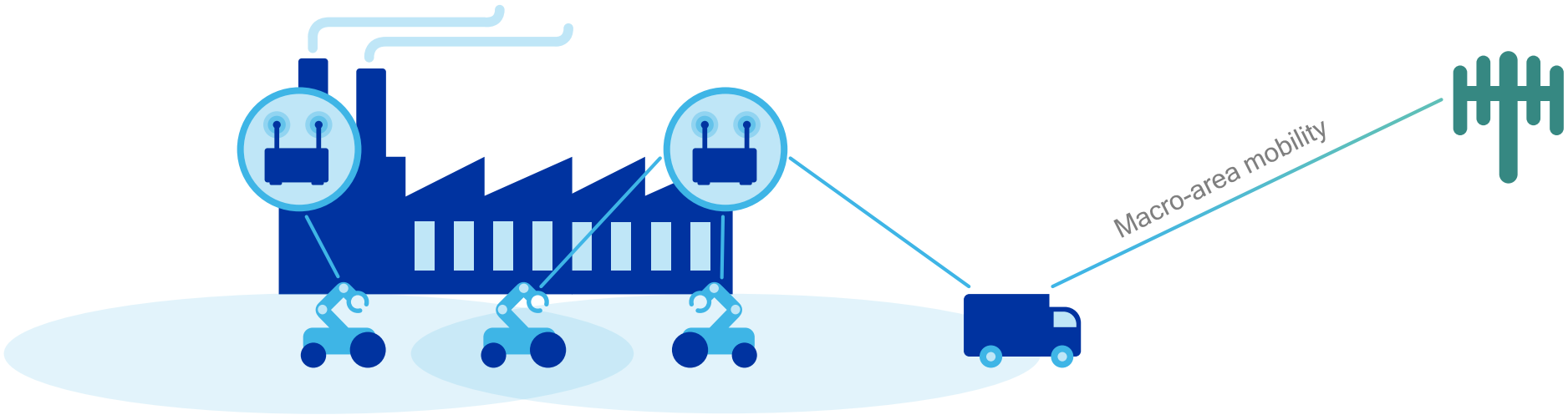
Control and reliability of end-to-end system

Global ecosystem with interoperability

Advanced wireless devices: AGV, AR helmets…

Robust connectivity is critical to the next industrial revolution

Private LTE networks offer key benefits for Industrial IoT



Dedicated

Independent network with dedicated radio equipment, sensitive data stays local

Optimized

Network tailored for industrial applications, e.g., quality-of-service, latency

Readily deployed

Spectrum available, hosted or self-contained core network, self-organizing network

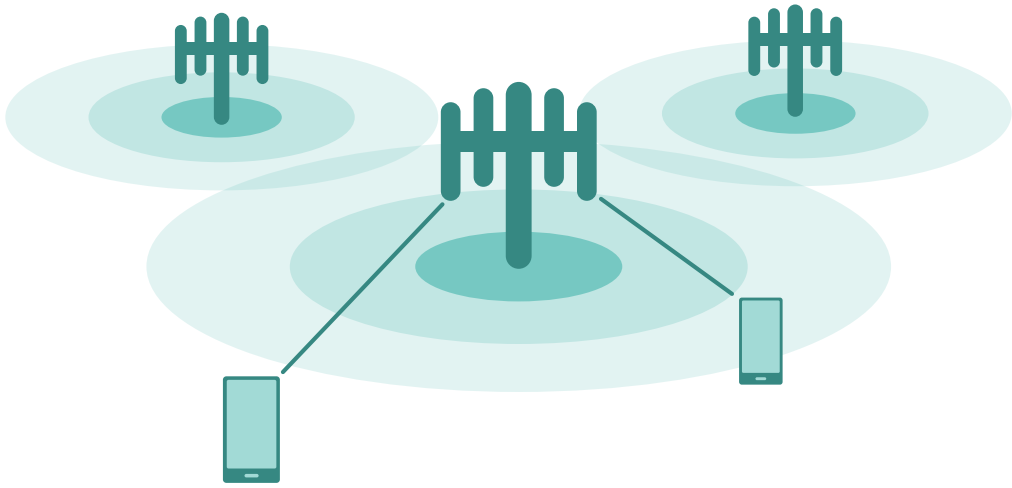
Private LTE networks for local and customized services

Private LTE Networks

- Managed locally
- Dedicated equipment
- Local coverage
- Optimized for local services

Public LTE Networks

- Managed by service provider
- Equipment shared with other traffic
- Wide-area coverage
- Generic voice / data services



LTE is the high-performance choice for industrial IoT

Capacity
Low to high data rate applications, large number of devices

Reliability and low latency
Industry grade reliability, customized quality of service, guaranteed latency

Coverage
Superior range, both indoors and outdoors

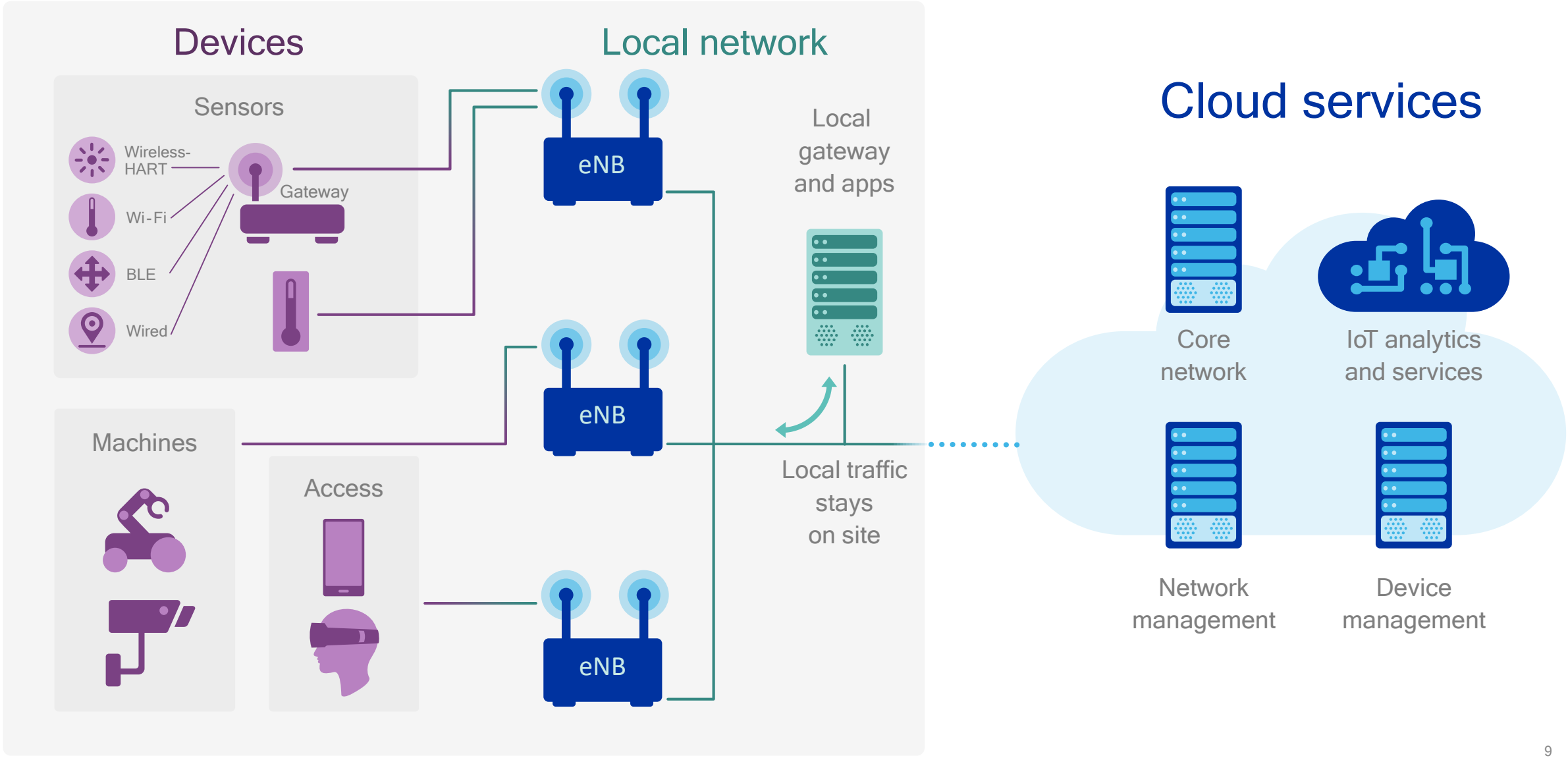
Cellular based security
Both SIM and non-SIM credentials, locally routed traffic for privacy

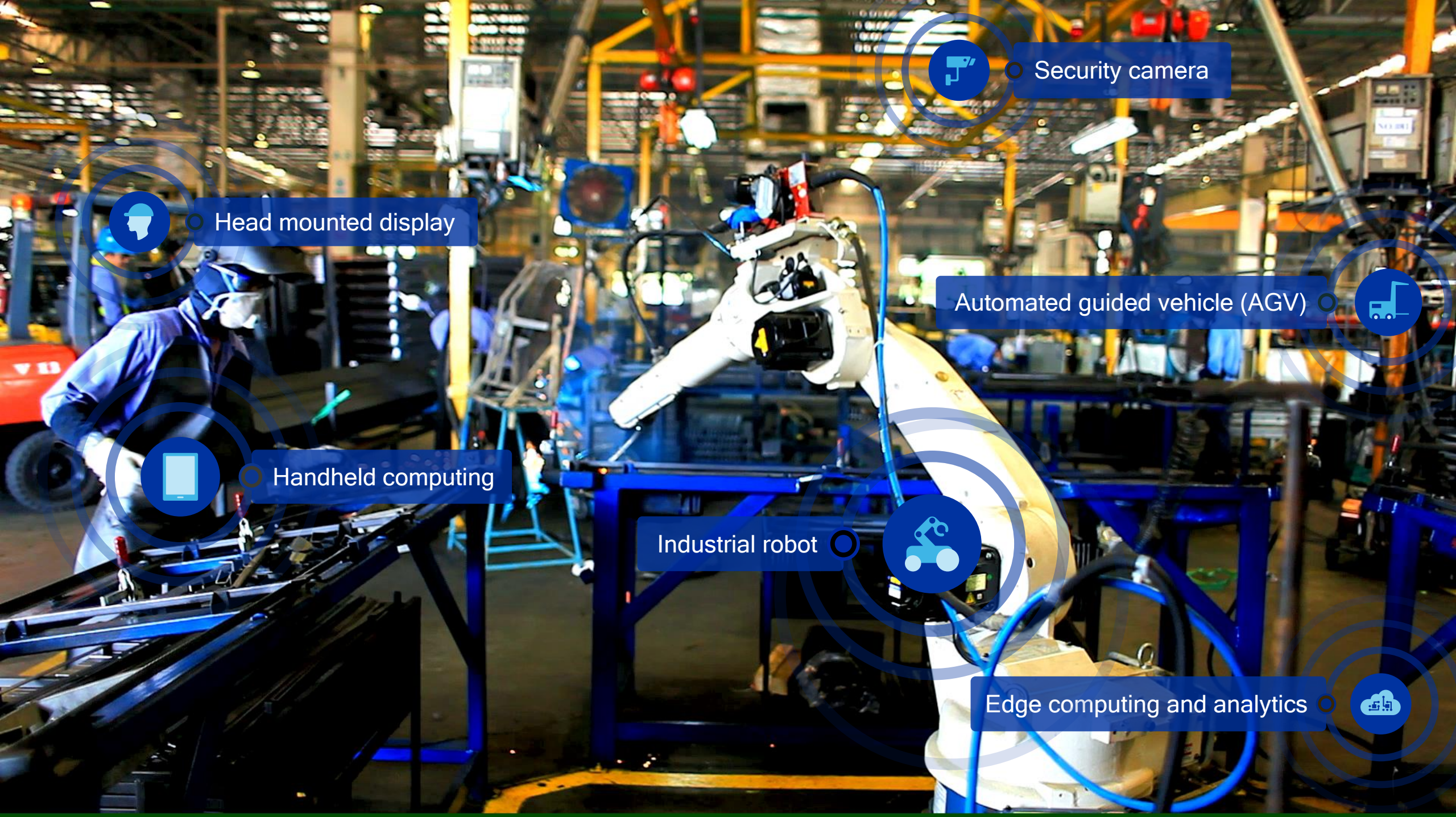
Seamless mobility
Seamless handovers, high mobility devices, service continuity with WAN

Future proof
Rich LTE roadmap and evolution to 5G, including ultra-reliable low latency comm.

Interoperability
Global standard and certification enable interoperability between suppliers

Scalable network architecture keeps local traffic on site




Security camera
Head mounted display
Automated guided vehicle (AGV)
Handheld computing
Industrial robot
Edge computing and analytics


Updating entertainment system
Ground/flight crew access
Uploading engine data
Updating aircraft logs
Interactive maintenance


Turbine sensor
Drone inspection
Blade sensors
Vehicle tracking
Environmental sensors
Handheld computing

Wide area of industries addressable by private networks

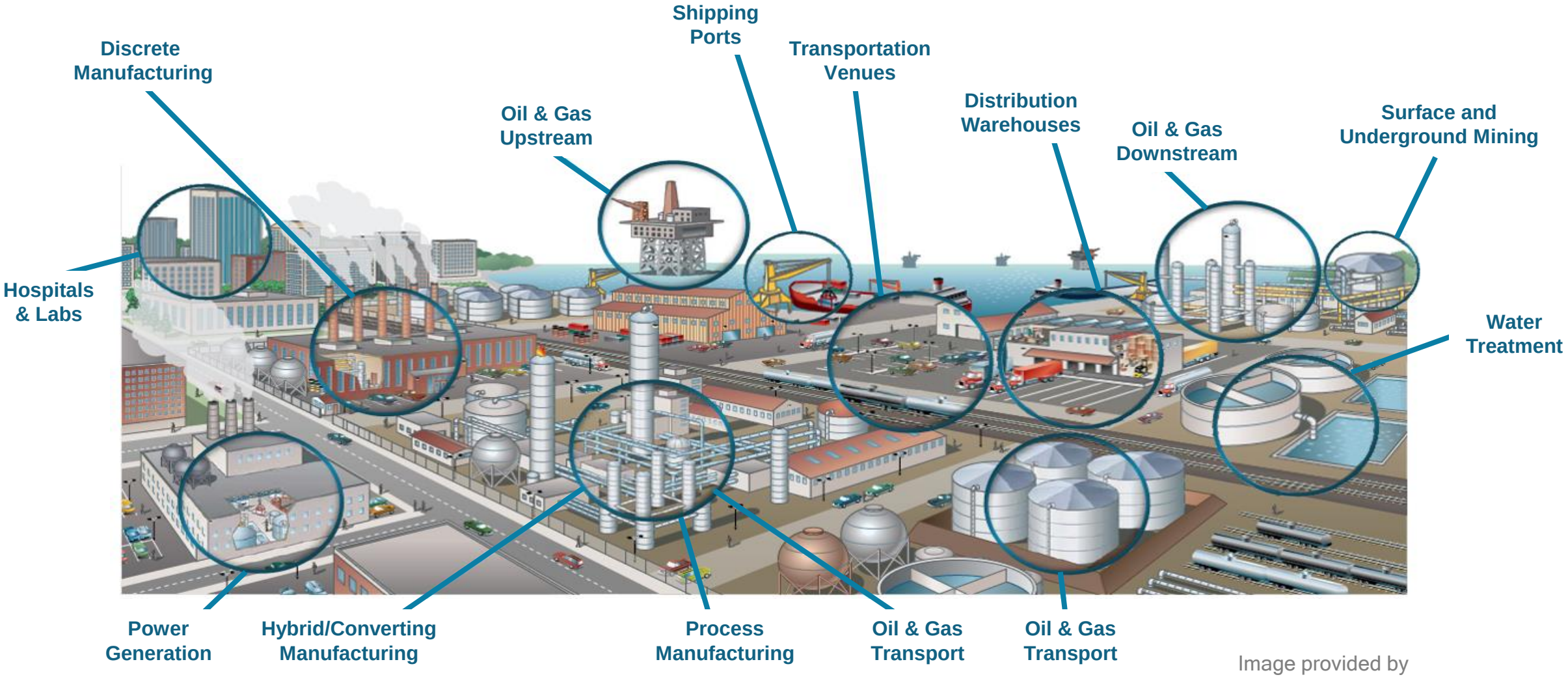


Image provided by Harbor Research

Spectrum is available to deploy private LTE networks

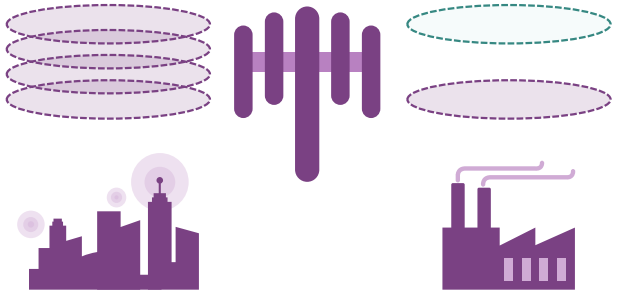
Dedicated by operator
Licensed Spectrum

3.5 GHz (USA)
Shared Spectrum

5 GHz (Global)[1]
Unlicensed spectrum

1) MulteFire can be deployed in any unlicensed spectrum utilizing listen-before-talk and additional spectrum bands will be supported in the future.

Private LTE Networks—an opportunity for mobile operators

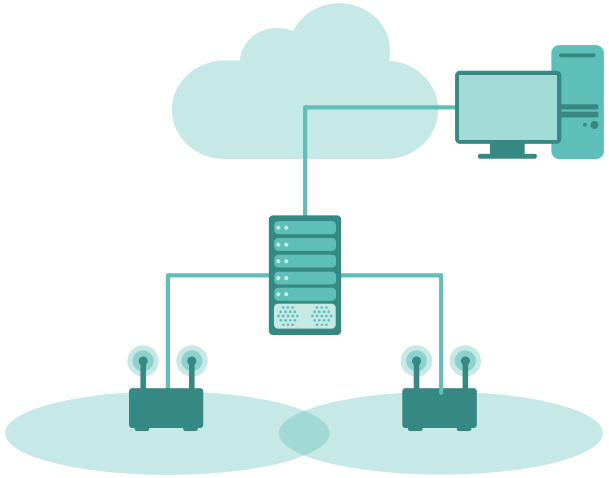


Licensed spectrum assets

Dedicate a portion for private LTE networks

Provides predictable performance

Spectrum often under-utilized in industrial areas

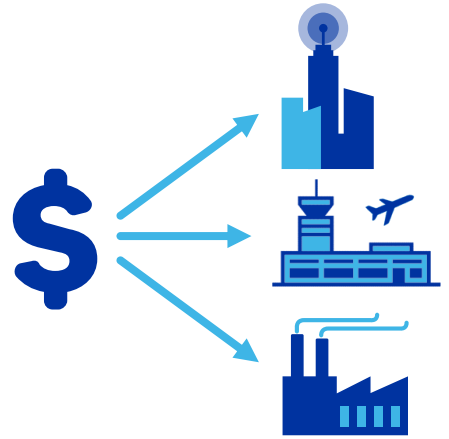


Expertise in mobile networks

Expertise in deploying and operating mobile networks

Existing relationships with vendors

Leverage existing mobile network assets



Existing sales channels

Already provide services to many industrial customers

Extend with private LTE network

Multiple options, including selling private LTE network as a service

CBRS

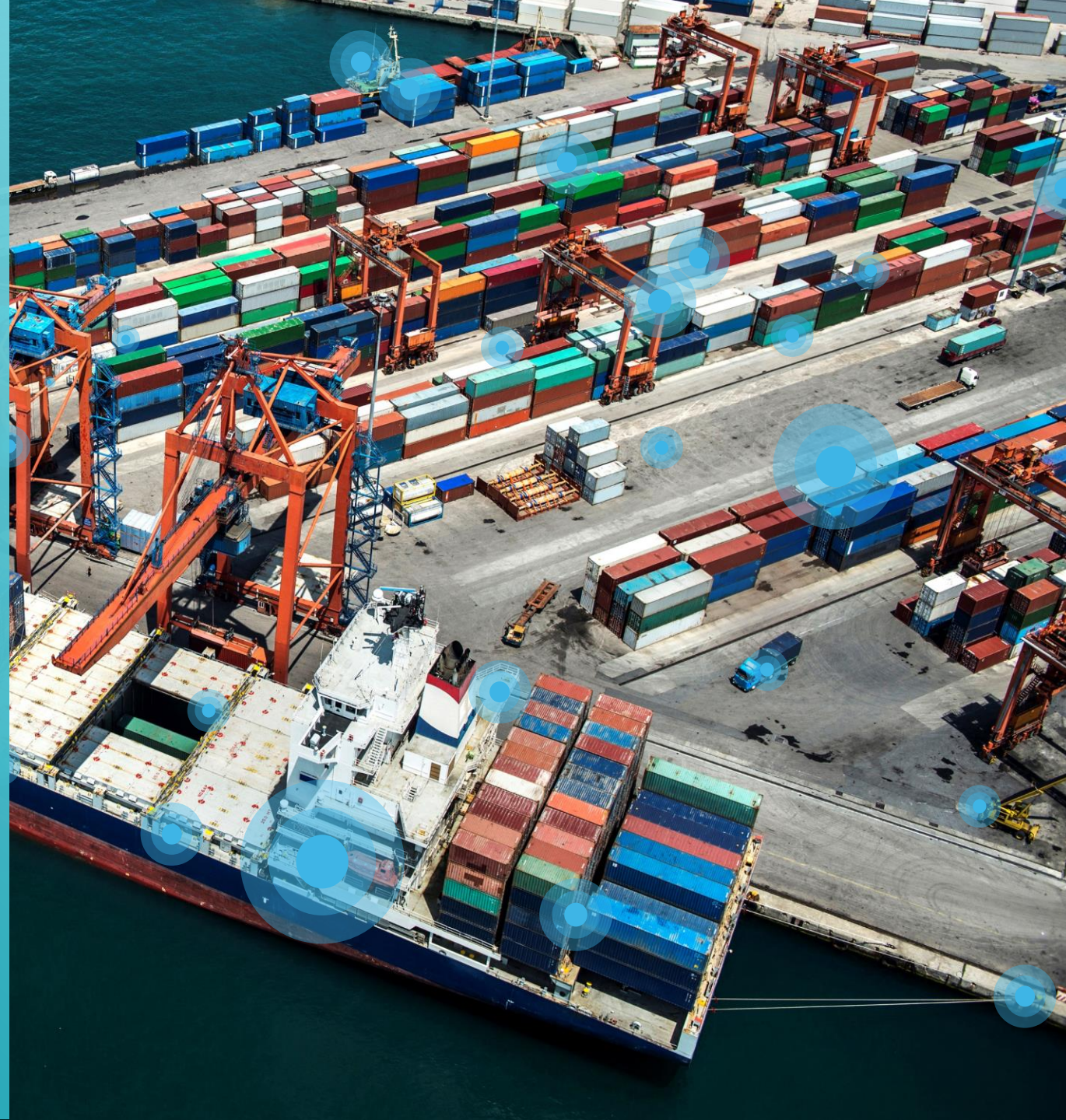
Citizens Broadband Radio Service

- 150 MHz shared spectrum in 3.5GHz USA
- Spectrum sharing with 3-tier priorities

CBRS Alliance

- 75+ members
- Promote LTE solutions for CBRS
- Multiple trials and certification in progress
- Deployments expected early 2018

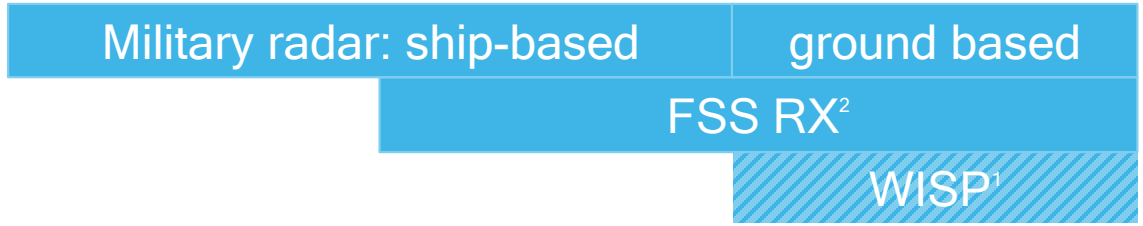
www.cbrsalliance.org



CBRS introduces a 3-tiered shared spectrum in the US

Opens up 150 MHz spectrum for new use without interrupting incumbents

Tier 1
Incumbents

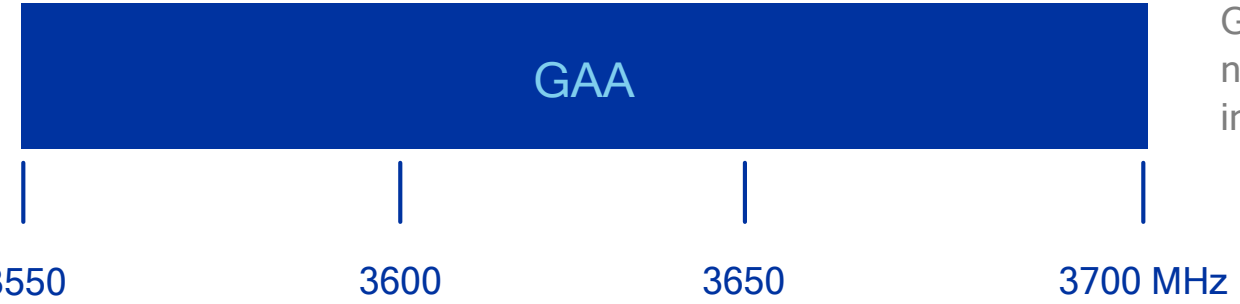


Incumbents are protected from interference from PAL and GAA

Tier 2
Priority Access Licenses (PAL)

PAL has priority over GAA, licensed via auction, 10 MHz blocks, up to 7 licenses

Tier 3
General Authorized Access (GAA)



GAA can use any spectrum not used, yields to PAL and incumbents

1) Wireless ISP transitioning from incumbent to PAL/GAA after 5 years; 2) Fixed satellite service - receiving only; 3) Citizen Broadband Radio Service (CBRS)

Private LTE-based networks already demonstrated

Demo: Private LTE network in CBRS shared spectrum (Feb. 7, 2017)

First demo of a private LTE network in CBRS providing a 360° race car experience

Industry collaboration: Qualcomm Technologies, Nokia, and Alphabet's Access Group

Shows how venues and enterprises can deploy a private LTE network for customized services

Demo: Private LTE-based networks for Industrial IoT (Feb. 22, 2017)

MWC demo of private LTE network over CBRS for Industrial IoT

Industry collaboration: Qualcomm Technologies, Nokia and GE, demonstrating end-to-end IoT

Local control and optimization for industrial applications

MulteFire™

LTE-based technology

- Stand-alone in unlicensed spectrum
- Listen-before-talk (LBT)
- Supports 5GHz globally

MulteFire Alliance

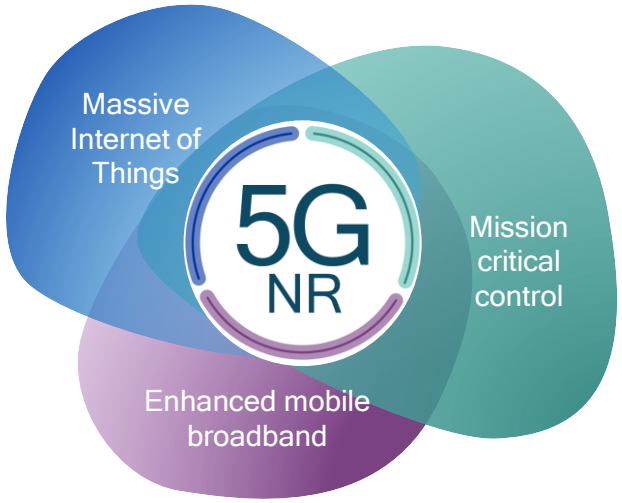
- 35+ Members
- Release 1.0 published
- Trials expected early 2018
- Adding IoT enhancement in release 1.1

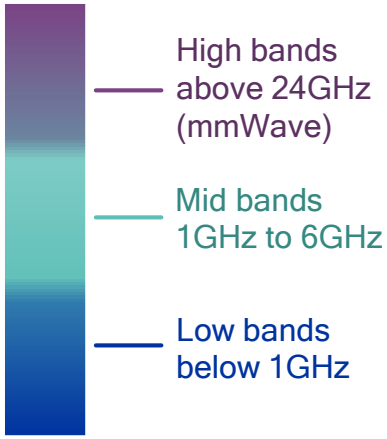
www.multefire.org

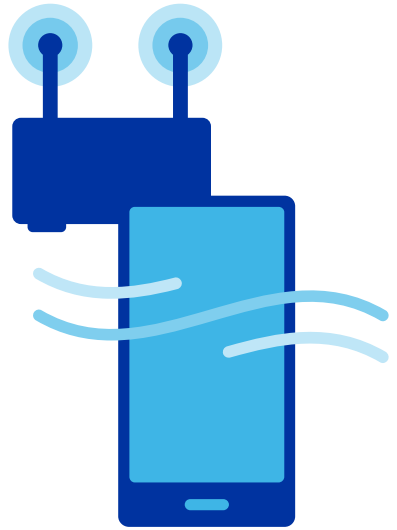
First MulteFire multi-node over-the-air demonstration

- Live over-the-air demonstration Feb. 2017
- Seamless handover in a multi-node deployment
- Shares the spectrum fairly with Wi-Fi
- Significantly longer range than Wi-Fi

Evolution to Private 5G Networks in 3GPP







New capabilities

NR will provide both enhanced and new capabilities, such as ultra-reliable and low latency communications

More spectrum

Designed for all spectrum bands from below 1GHz to mmWave. Natively supports licensed, shared and unlicensed spectrum

New study areas

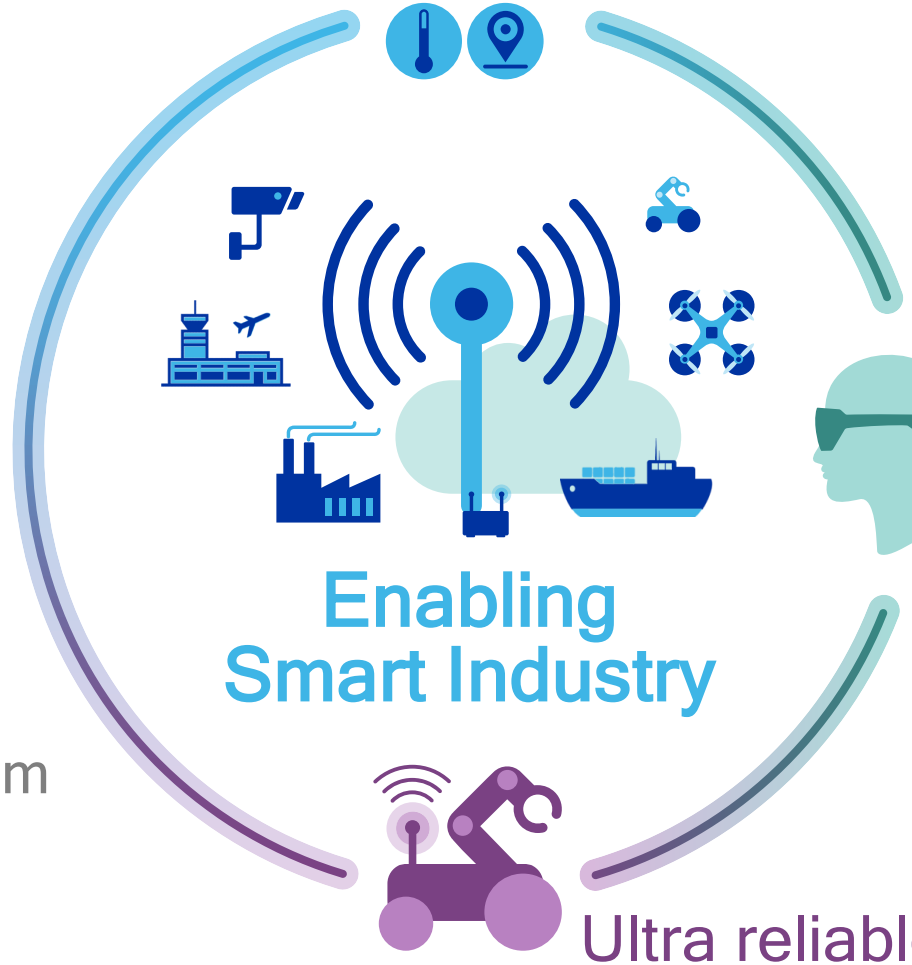
3GPP started studies on NR operating in unlicensed spectrum, 5G for automation in vertical domains, and LAN support in 5G

Private LTE network roadmap to 5G

Global eco-system

Single 5G/LTE network

Licensed and unlicensed spectrum



Massive IoT

Power efficient, low complexity, long range

Fiber-like speeds

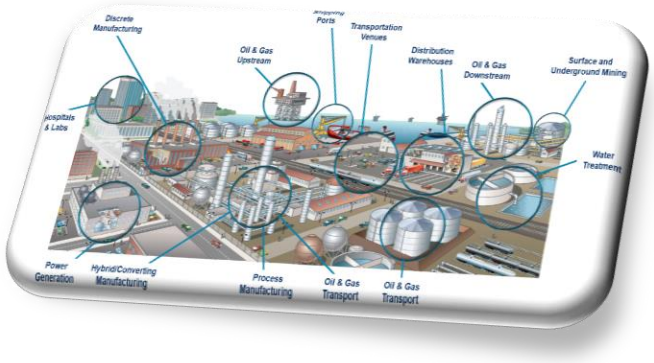
New devices, big data uploads

Ultra reliable and low latency

Mission critical, Industry 4.0

Private LTE networks for Industrial IoT

Large addressable market with many verticals



LTE is the high-performance choice for a wide range of industry verticals from factories, ports to power plants

Spectrum available with MulteFire and CBRS

ALLIANCE cbrs

3GPP™ A GLOBAL INITIATIVE

MULTEFIRE™

MulteFire in 5GHz globally, LTE-based CBRS in 3.5GHz USA, dedicated spectrum with operators

Path to private 5G NR networks

5G™

Private 5G NR networks will enable Industry 4.0 with reconfigurable production, mobile robots and AR

Learn more at www.qualcomm.com/private-LTE

Thank you

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