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The bridge to possible

The Evolution of Access Technologies for Industrial IoT

Patrick Grossetete

BRKIOT-2008

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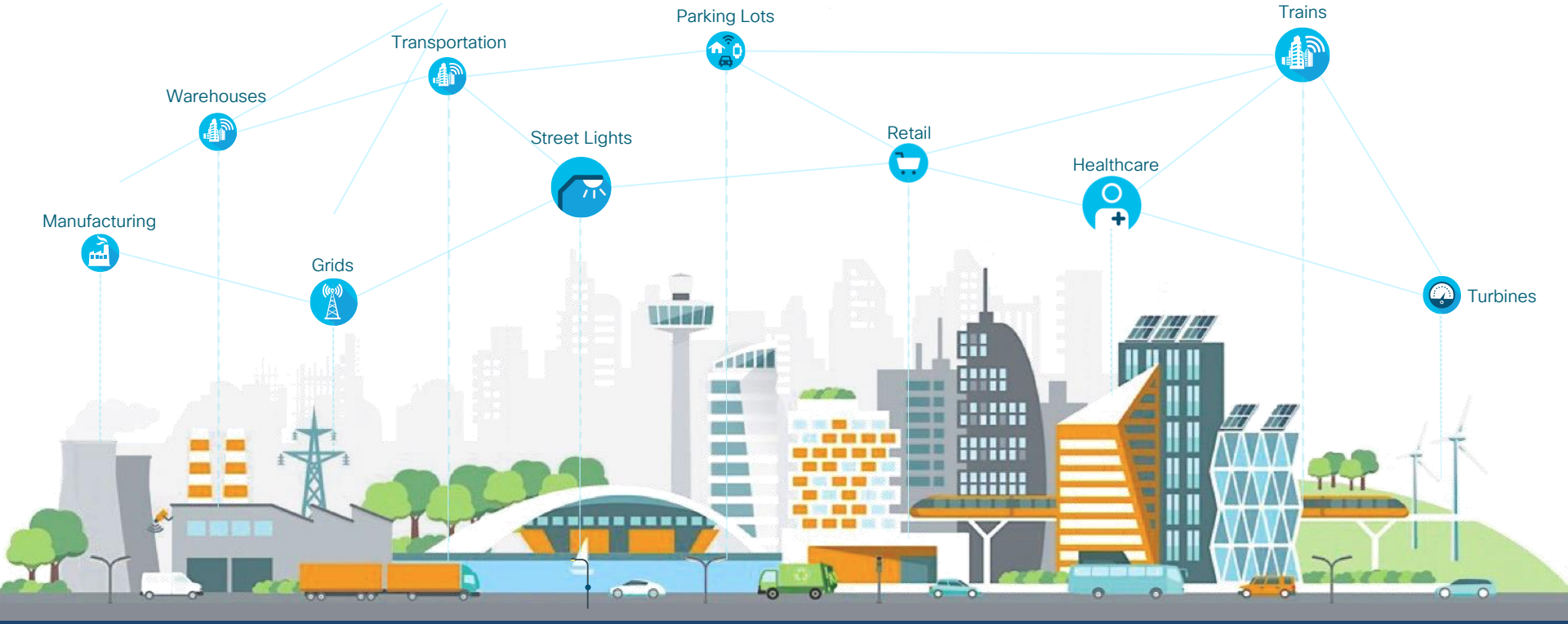
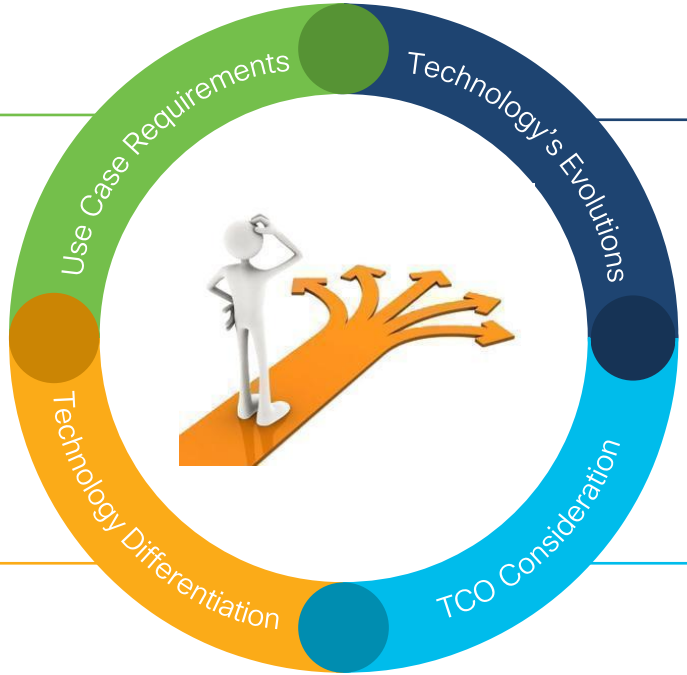
Infrastructure Expansion for IIOT



Securely connecting Things in IP world → Enables business outcomes

Market Trends and Technology's Impacts in IIOT

- Indoor/Outdoor use cases
- Fixed/Mobile Devices Flexibility
- Best Effort/Mission Critical
- Public/Private



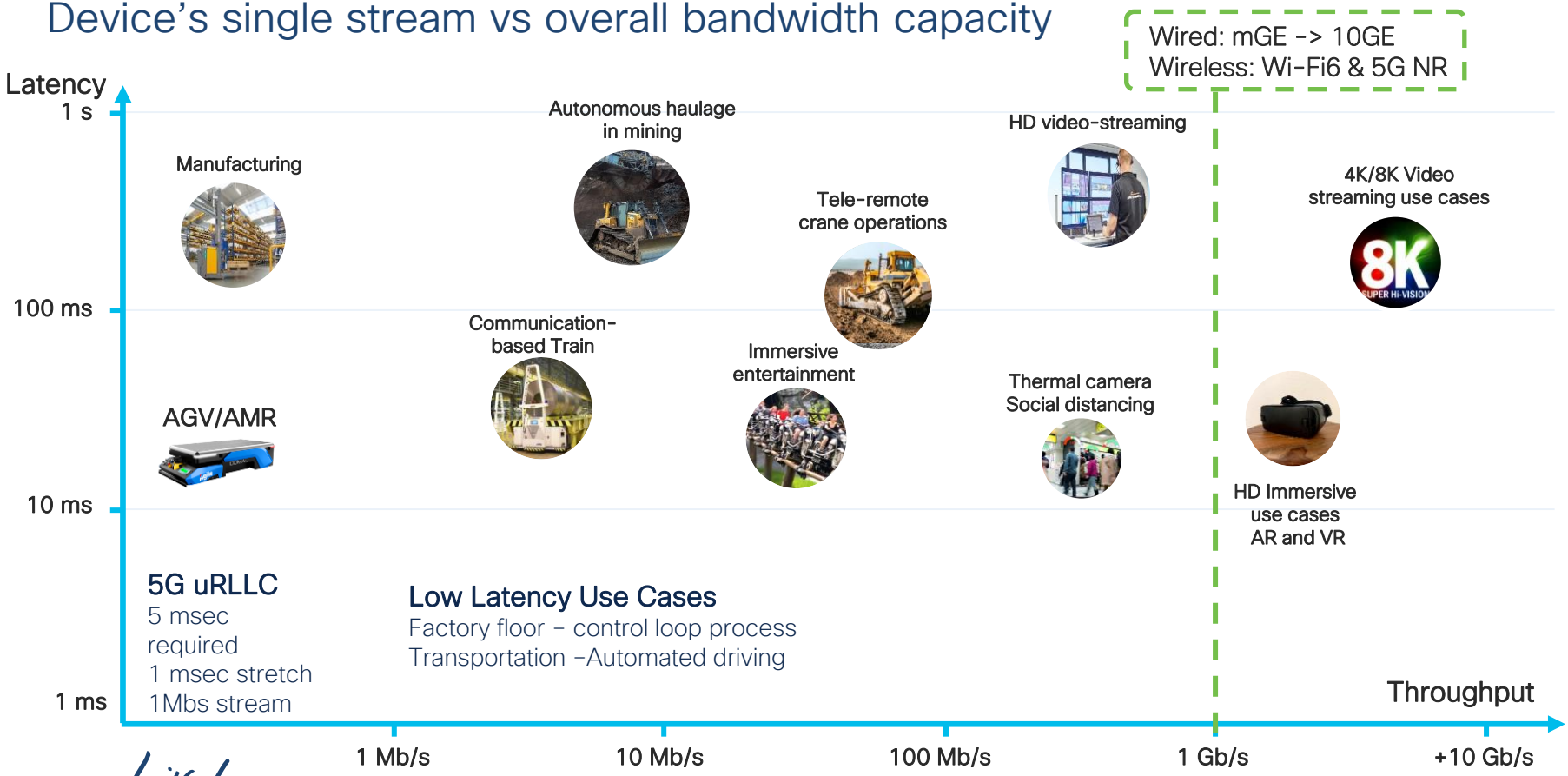
- Sunset of PSTN services
- High data rate wireless
- New spectrum regulations
- Private cellular

- Wired and wireless
- Owned or managed services
- Standards, interoperability & certification
- Eco-system
- Scalability

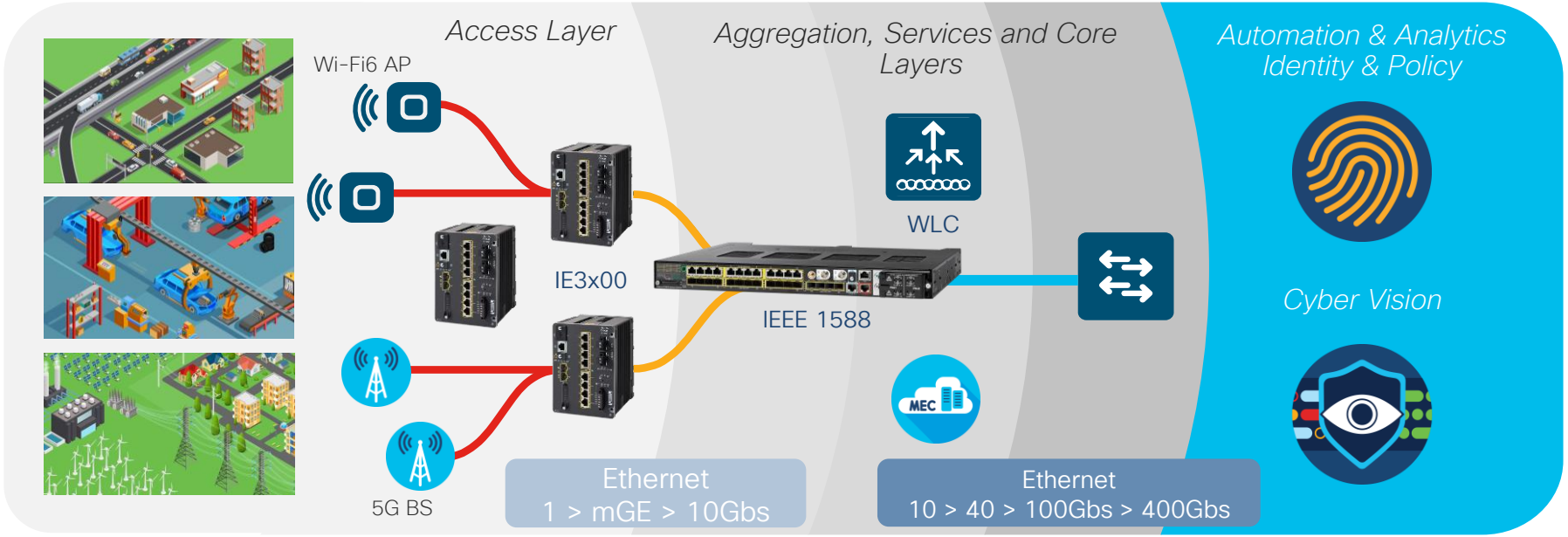
- Capex & Opex
- Legacy devices and Backward Compatibility
- Ease of operations
- Cybersecurity

Use case & Devices dictates Technology's requirements

Device's single stream vs overall bandwidth capacity



Planning for 10Gbs path in Industrial IOT



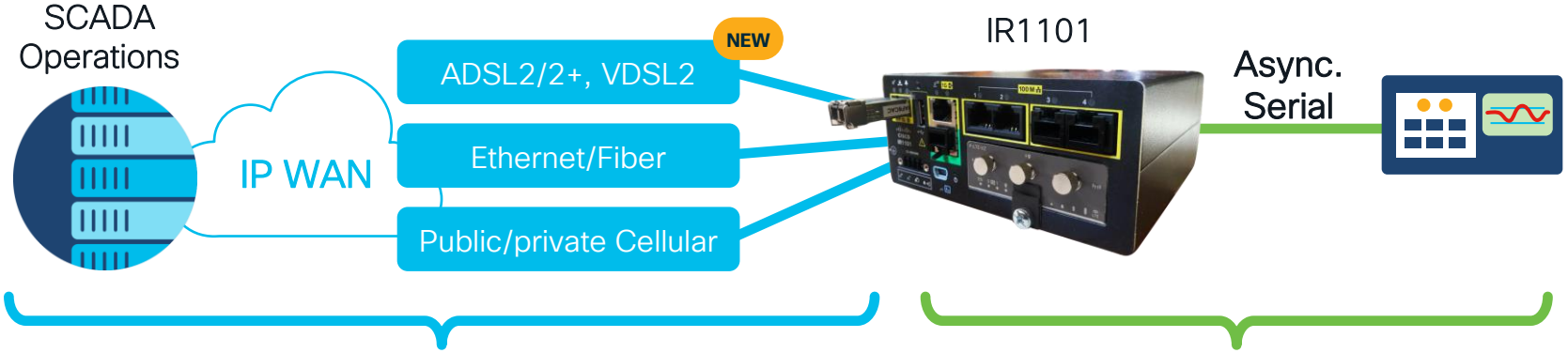
End to End IP Flows

Security

Automation

Analytics

Managing the Sunset of PSTN Services



SCADA Protocol Translation
(IOS or IOx protocol translation)

or

Raw Socket
(IP Serial redirection on SCADA server)

No Change

Use Cases — Transportation — Utilities — Communities — Oil & Gas

Autonomous and Connected Devices In Today's Life

Wireless technologies are key pillars of IoT, but *one size does not fit all*

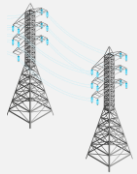
While Ethernet has always been the foundation for wired connectivity in industrial IoT spaces, how to select the appropriate wireless technologies?

Wireless provides the flexibility and agility to upgrade, deploy and reconfigure a network with less operational downtime, while integrating autonomous devices.

As organizations expand their IoT deployments, the need to manage multiple access technologies will grow.

Manufacturing

Parking Lot



Utilities

Gas Station

Kiosk

Warehouse

Roadways

Oil & Gas

Airport

Fleet

Seaport

Distribution Center

Industry and use-case driven technology selection criteria


MFG


Transportation


Mining


Utilities


Roadways

Customer Use Case:
AGV/AMR, Train to Trackside, Autonomous mining, Remote Crane operations

1 What are the devices to connect?

Devices

Local and global Eco-system

Handhelds, AGV/AMR, Dozer, Cranes, Rail

2 What are the applications requirements?

Resiliency

Latency, Reliability, Scalability, Ease of operations, throughput…

3 Deployment Scenarios?

Deployment

Regional regulations: spectrum ?
Specify Environment: Indoor / Outdoor
Access / backhaul
Cyber-security

4 What are the potential technology options?

Technology

Wired: Ethernet, serial,DSL
Wireless: Wi-Fi & Fluidmesh, Cellular, Wi-SUN, LoRaWAN,…
Spectrum:
Unlicensed, Licensed: Private, Public, Shared

5 What are the CapEx and OpEx Implication?

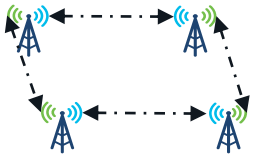
TCO

Product costs?
Operational costs?
Complexity?
Training?
Backward compatibility?

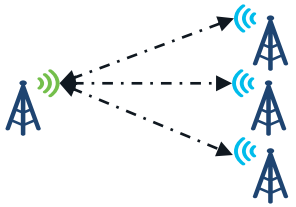
Topology Options

Backhaul	*and/or*	Access
Indoor	*and/or*	Outdoor
Private	**Infrastructure** *or*	Public
Licensed	**Spectrum** *or*	Unlicensed

Point-to-Point

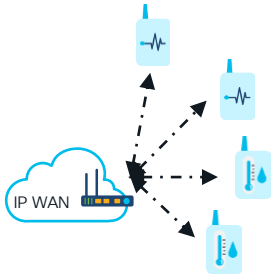


Mesh or Ring

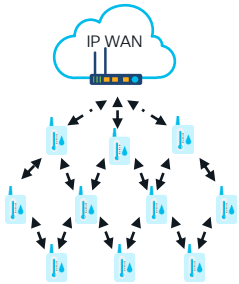


Point-to-Multi-Point

On-the-Move



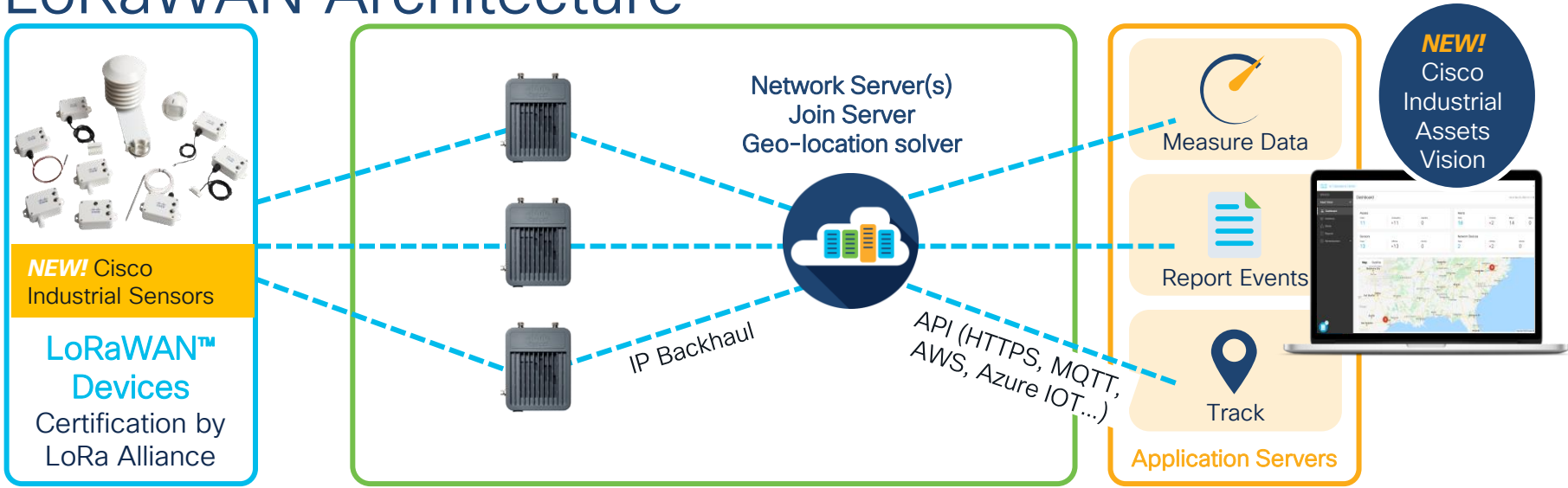
Star

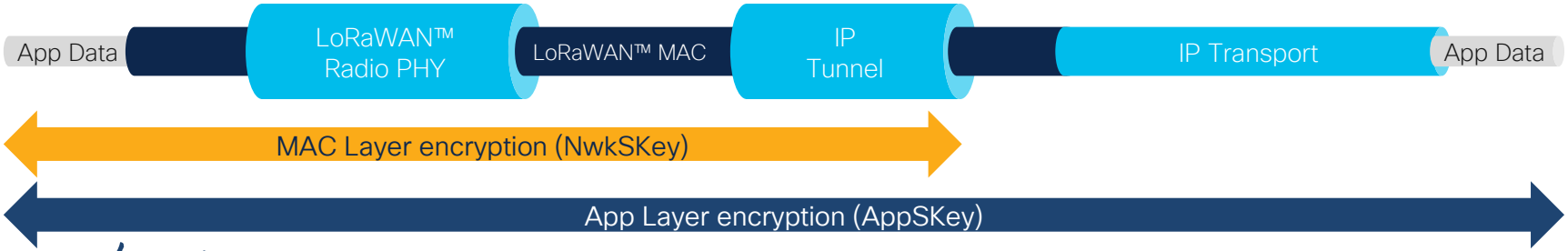


Mesh

Infrastructure: Public & Private
Spectrum: unlicensed sub-GHz ISM bands (EU868)
Data rate: 250 bit/sec – 5.4 kbit/sec (EU868),
Use cases: batteries

LoRaWAN Architecture





WirelessHart & ISA100 Overview

Industrial measurements use cases

	WirelessHart	ISA100.11a
Frequency bands	IEEE 802.15.4-2006 2.4GHz, 16 channels	IEEE 802.15.4-2006 2.4GHz, 16 channels
Data Rate	250kbs	250kbs
Standard	IEC 62591	IEC 62734
Topology	TDMA/CSMA based wireless mesh	TDMA/CSMA star, mesh, star-mesh topologies
Channel hopping	fixed channel hopping table 10 msec time slot	multiple channel hopping tables variable slot time, default 10 msec
	Based on HART addressing	6LoWPAN, IPv6 and UDP
Vendors	Emerson, ABB, Siemens, Endress+Hauser	Honeywell, Yokogawa, GE
Specifications	https://fieldcommgroup.org/hart-specifications	https://www.isa.org/store/products/product-detail/?productId=118261

IW 6300

Mesh architecture support based on 802.11 AC Wave 2

WirelessHart and ISA100 as add-on module from partners

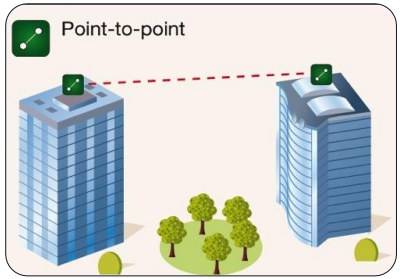
WirelessHart on IW6300

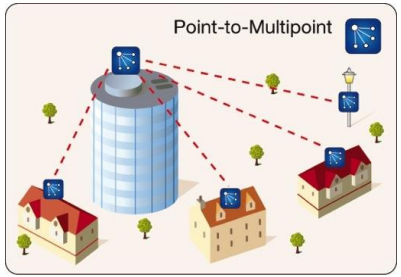
ISA100 on IW6300

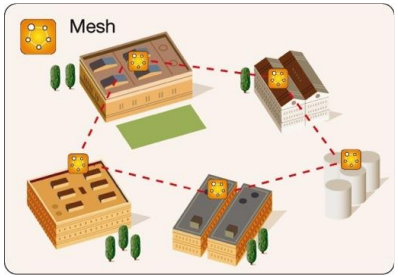
Introducing Fluidmesh Technology

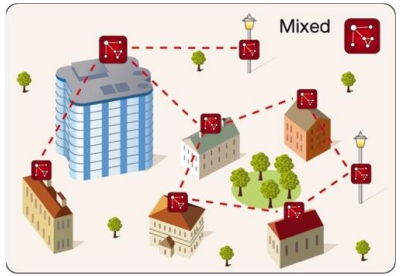
Extend networks infrastructure through innovative wireless backhaul technologies

FIXED Architecture

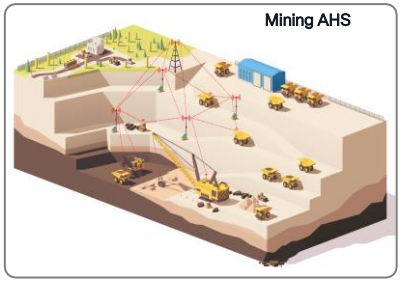


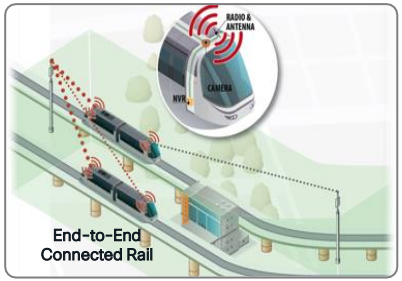


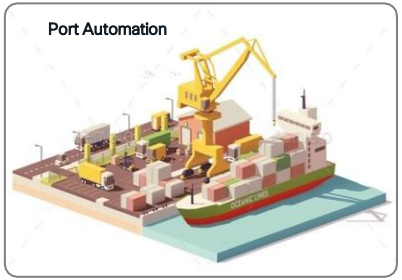


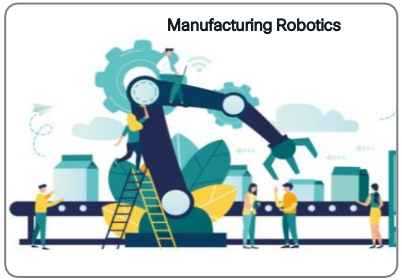


MOBILITY Architecture





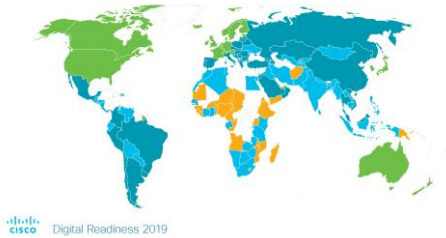




Where will it be deployed?

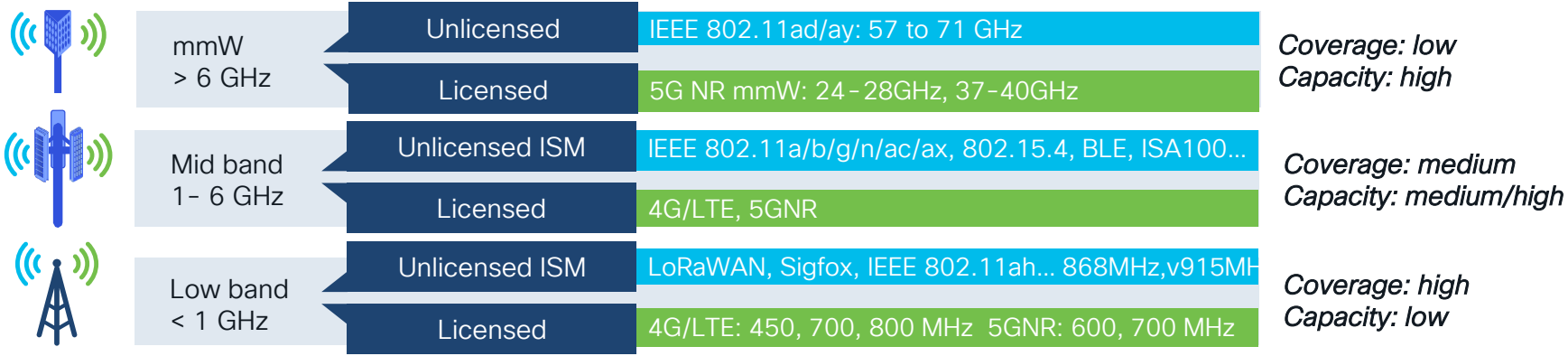
1. Country? Spectrum? Regulations? Certifications, Compliancy?
2. Scale – number of sites? Size?
3. Industry – compliance, certifications, hardening?
4. Eco-system – existing devices, cost?

Country of deployment → Unlicensed spectrum regulations Licensed frequency bands → Product availability And certification → Scale

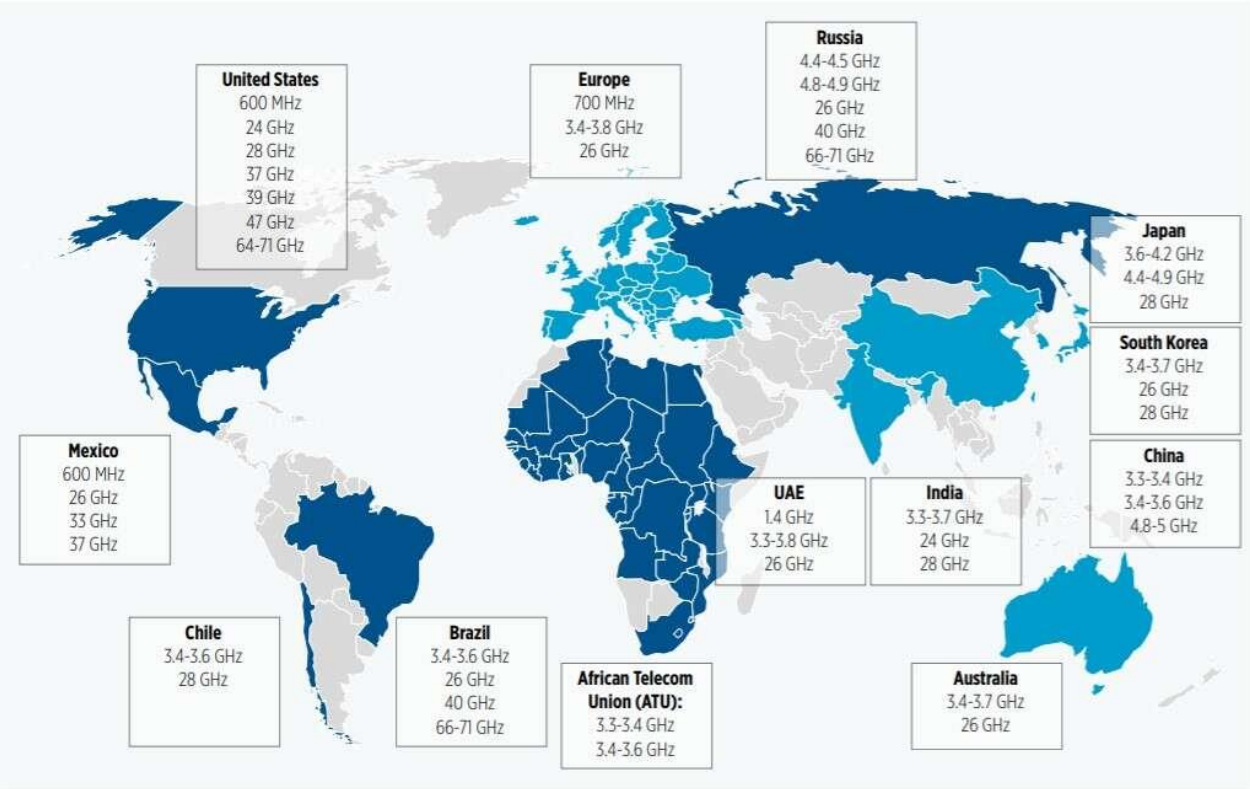


Wireless Technologies – Spectrum

- Unlicensed: also known as ISM bands, generally free of charge, public, and private infrastructures, but regulated.
  - Shared between technologies; co-existence definition in specifications
- Licensed: dedicated to SP (public services) or industries (private, critical infrastructures, i.e. U.S. Firstnet,…), paid license, allocated for several years.
  - Including Shared license model.

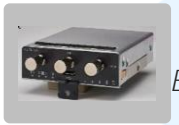


5G Spectrum Landscape



Source: TMG/GSMA

Snapshot of LTE Bands when deploying Globally



P-LTEA-EA (Cat 6)
(Multicarrier – U.S, Canada, Europe), B1-5, 7, 12, 13, 20, 25, 26, 29, 30, and 41

P-LTEA-LA (Cat 6)
(APJC, LATAM)
B1, 3, 5, 7, 8, 18, 19, 21, 28, 38, 39, 40, and 41

P-LTE-US (Cat 4)
(AT&T) B2, 4, 5,12 & 3G

P-LTE-VZ (Cat 4)
(Verizon) B4 and 13

P-LTE-GB (Cat 4)
(Europe) B1, 3, 7, 8, 20, 28 & 3G, 2G

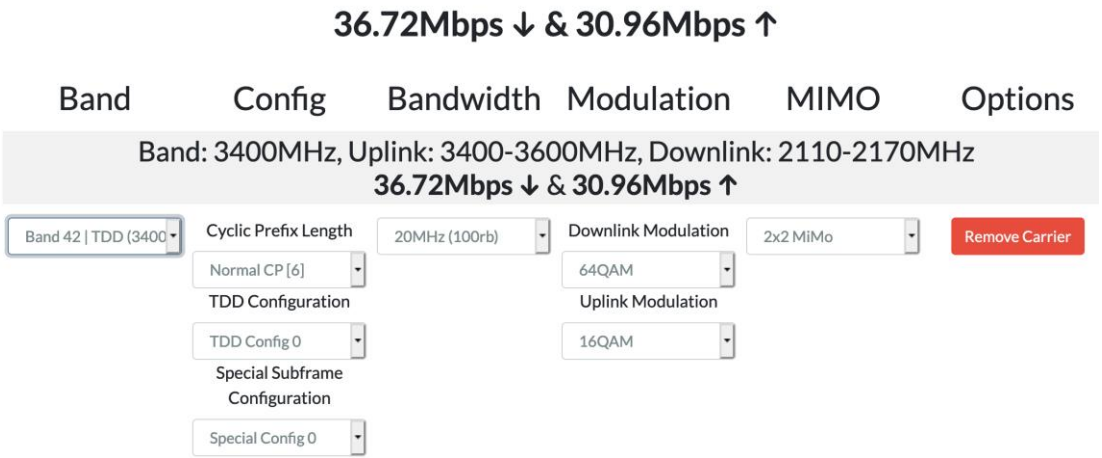
Cisco IR1101
Auto-SIM
Carrier Aggregation
Private LTE
U.S. FirstNet

P-LTE-MNA (Cat 4)
(Multicarrier-US)
(Multicarrier – Global)
B2,B4,B5,B12,B13,B14(FirstNet),17,66

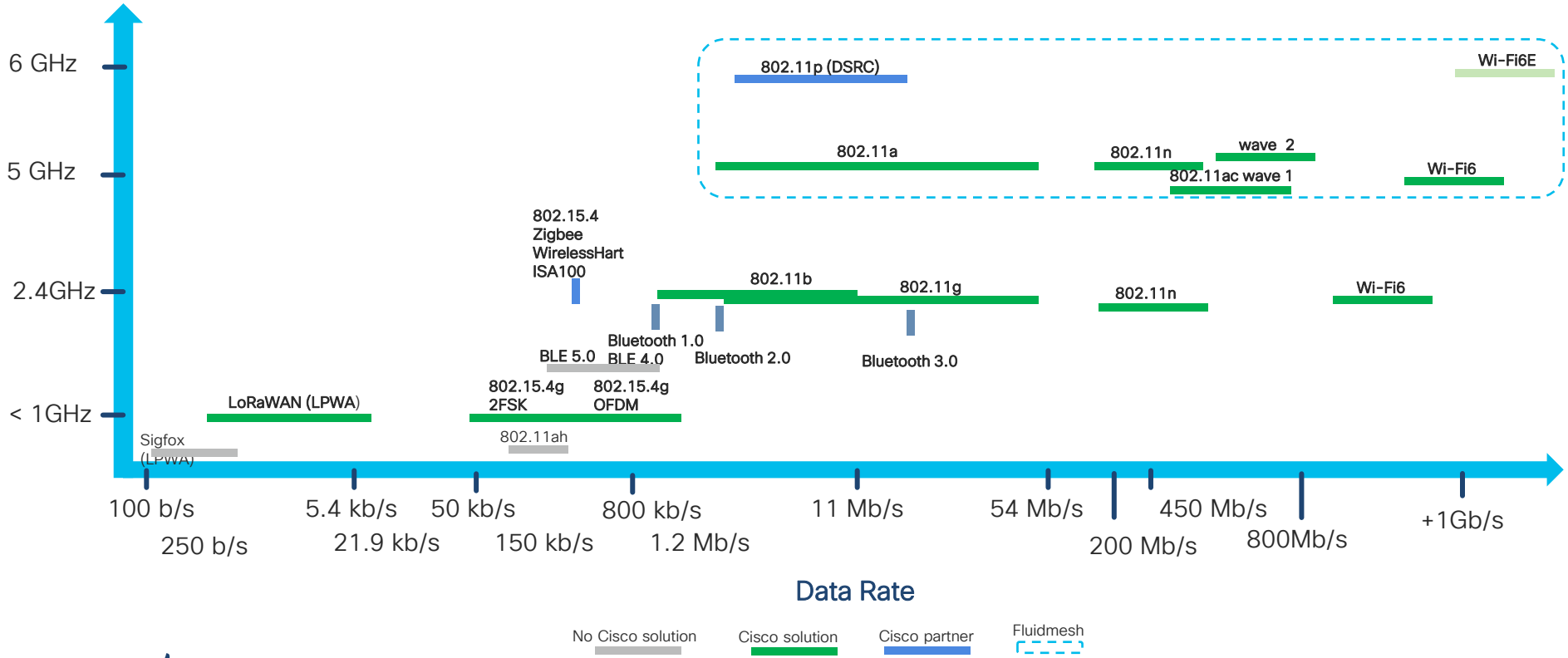
P-LTEAP18-GL (Cat 18)
(Multicarrier – Global)
B 1, 2, 3, 4, 5, 7, 8, 12, 13, 14 (FirstNet) 17, 18, 19 20, 25, 26, 28, 29, 30, 32, 38, 39, 40, 41, 42, 43, 46, 48 (CBRS), 66, 71

Evaluating Cellular Throughput Capacity

- Throughput capacity is dependent from several characteristics
  - band, configuration, bandwidth, modulation, MiMo, options…
- Cellular capacity is mostly asymmetric
  - Downstream greater than upstream

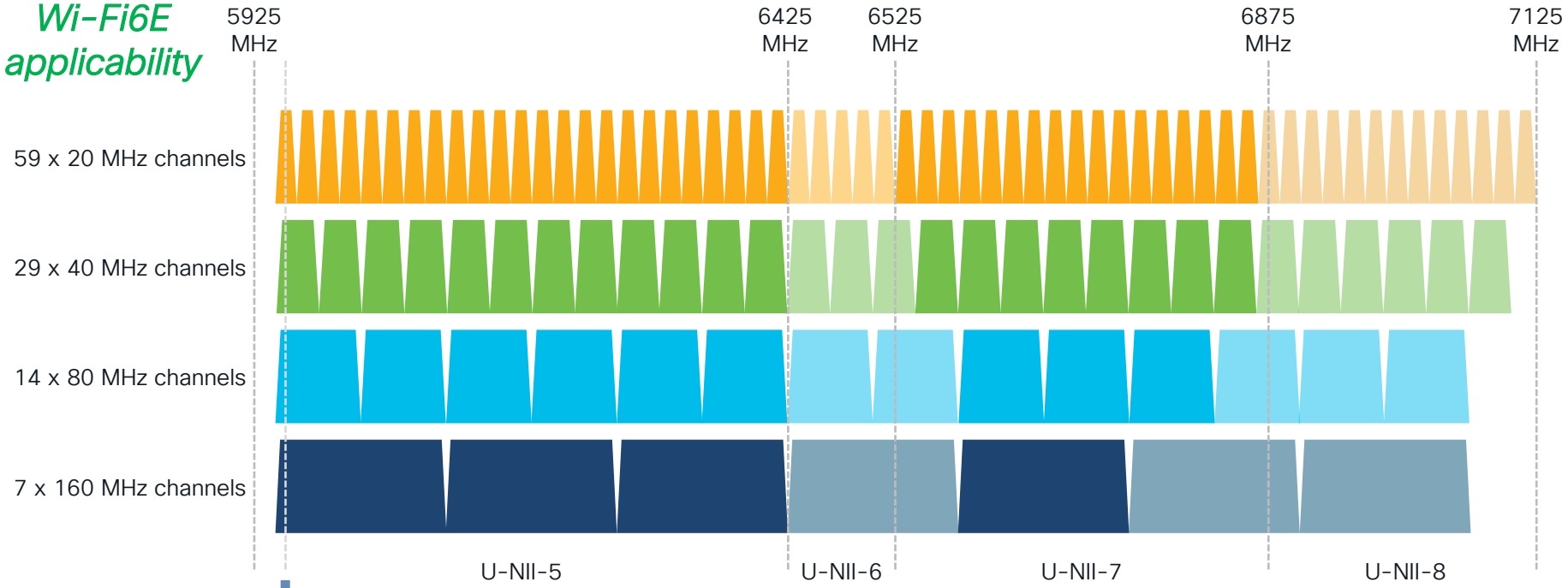


IOT Wireless Technologies in Unlicensed Bands



FCC added 1200MHz to Unlicensed Spectrum

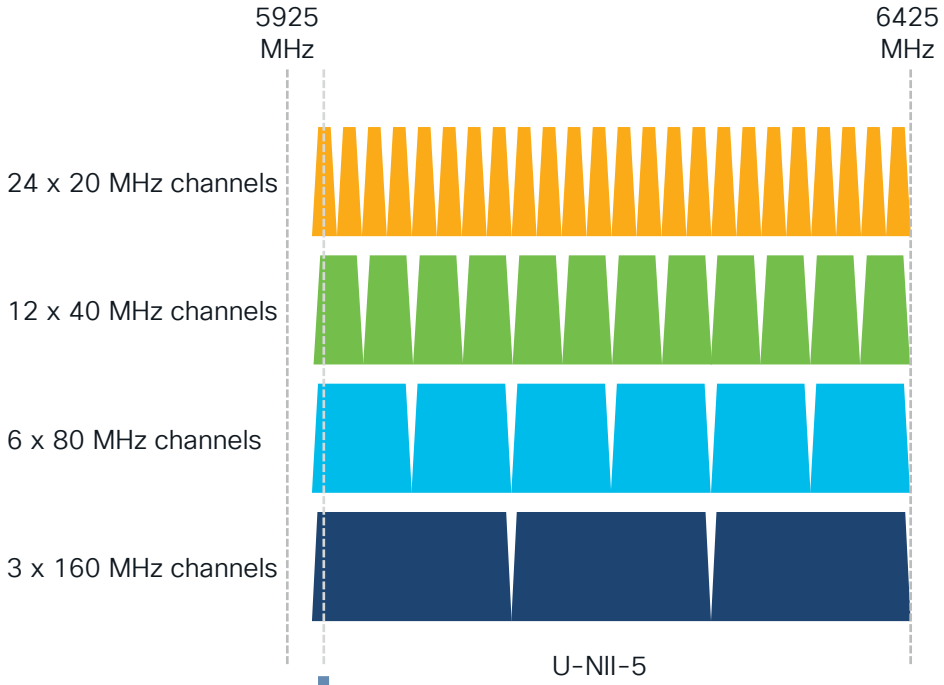
Wi-Fi6E applicability



5955 MHz : 1st 20MHz channel frequency

- Start at 5925 MHz + 20 MHz guard band + 10 MHz to be at central of 20 MHz channel

Wi-Fi6E and CEPT – 500MHz in 6GHz Band



CEPT Report 75 – Nov. 2020

5955 MHz : 1st usable frequency center
➔ Start: 5925 MHz + 20 MHz guard channel + 10 MHz to get the center of the first 20 MHz channel

Private LTE/5G Network Framework

Managed Services

Fully Private

Site A

5G NR RAN (Radio Access Network)

RRU
(Remote Radio Units)

DU
(Distributed Units)

CU
(Centralized Unit)
CU-Control Plane
CU-User Plane

CU User Plane

UPF
(User Plane Function)
Intermediate

MEC
(Multi-Access Edge Computing)

Local Application Server

Cisco 5G UE

Control Plane Function
(CPF)
AMF, SMF, Many Others

UPF
(User Plane Function)
Anchor

Internet

Data Center

Internet/Intranet data flow

Local data flow for low latency

Peer-to-Peer data Flow

Cisco Autonomous Mobile Robot (AMR) Testbed

- Enabled with dual path connectivity:
  - WiFi 6
  - Private LTE (CBRS B48)
  - 5G NR and Fluidmesh upgrade coming soon
- Achieve higher reliability with dual path in industrial venues that may suffer from interference

View demo at:
https://www.youtube.com/watch?v=M1LuTkgG4yU&feature=youtu.be

Blog:
Testing Wi-Fi 6, Fluidmesh, private LTE, 5G – with the help of robots

IoT Networking + Security Portfolio

Industrial Switching
1K, 2K, 3200, 3300, 3400, 3400H, 4K, 5K, CGS, ESS

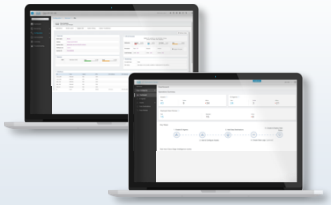
Industrial Routing
IR8XX, IR1101, CGR1120, CGR1240, CGR2010

Embedded IoT
ESS, ESR, ESW, Resilient Mesh

Industrial Wireless
Fluidmesh, IW6300, IW3702, IR5XX, IXM Gateway

Industrial Security
ISA 3000, Cyber Vision

Edge Intelligence
IOx



Full-stack as a Service
Industrial Asset Vision

Management & Automation
Field Network Director, Industrial Network Director, IoT Operations Center

Cisco Secured Industrial IOT Networks Baseline

Born for IP

Richest IPv4 & IPv6 feature set
Next Gen Crypto HW Crypto acceleration
Multi-access layers neutrality

Operations at Scale

Automation
Segmentation and isolation
Protocols' optimization
Telemetry

Secure

Trusted Devices
Secure OS
Network security
Apps environment
Cyber security
CSDL
PSIRT

Edge-to-Cloud Operations

Zero Touch Deployment
Sensors
Workflows mgnt
eCVD
Support & Services

Innovate

Cisco HW design
Cisco IOS-XE
Cisco IOx
Wi-SUN, TSN
Cybervision
Edge Intelligence
Fluidmesh

Cisco IOT Networking Hardware - Built for Harsh Environments

Size, weight, form factor, shock, vibration, temperature (-40 - +75°C), fanless, industry certifications & compliances…

Industries and IOT Wireless

From bits/sec to gigabits/sec

Industries	Use Cases	Wireless Technologies Access (A) or Backhaul (B)
Manufacturing, Warehouse, Distribution Center	Industrial automation, industrial security, plant efficiency, workforce enablement	LoRaWAN (A), Wi-Fi(A/B), 4G (B), 5G (A/B)
Transportation	Passenger experience, data operations, operational efficiency, safety and compliance, traffic operations, roadway safety, sustainable mobility, sensor modernization	LoRaWAN (A), Wi-Fi (A/B), DSRC (A), Fluidmesh (B), 4G (B), 5G (A/B)
Cities	Cities operations, public safety and security, citizen services, economic sustainability	LoRaWAN (A), Resilient Mesh (A), Wi-Fi (A/B), Fluidmesh (B), 4G (B), 5G (B)
Mining	Field operations, industrial security, workforce enablement	LoRaWAN, (A) WirelessHart (A), ISA100.11a (A), Wi-Fi (A/B), Fluidmesh (B) 4G (B), p-LTE (A/B), 5G (B)
Oil & Gas	Plant and field operations, industrial security, workforce enablement	LoRaWAN, (A) WirelessHart (A), ISA100.11a (A), Wi-Fi (A/B), Fluidmesh(B) 4G (B), p-LTE (A/B), 5G (B)
Utilities	Connected substations, distribution grid management, workforce enablement, grid safety, production plants	LoRaWAN (A), Resilient Mesh (A), Wi-Fi (A/B), 4G (B), P-LTE (B), 5G (B)

https://www.cisco.com/c/m/en_us/solutions/industries/portfolio-explorer.html

To Conclude

Use Case Driven	Need to start from the problem use cases are looking to solve, not force-fit technology
Technology Differentiation	Every technology has its best applicable domain, but overall End-to-End is IPv4/v6 traffic
TCO Matters	Need to consider both Opex and Capex
Multiple Technologies Will Coexist	Diverse use cases will often lead to multiple wireless technologies – even in a single enterprise

References

Additional Resources

5G and Wi-Fi 6 IOT Papers

- Testing Wi-Fi 6, private LTE, and soon, 5G – with the help of robots
- For your industrial IoT deployment: A four-step guide to selecting a wireless
- How 5G/Wi-Fi 6 will transform multi-access networks in industrial IoT
- What-does-5g-look-like-for-industrial-iot

Alliances

- LoRa https://lora-alliance.org/
- Wi-Fi https://www.wi-fi.org/
- Wi-SUN https://www.wi-sun.org/
- CBRS https://www.cbrsalliance.org/

The bridge to possible

Thank you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