The bridge to possible

Designing IoT Wireless Networks

Wireless backhaul for Fixed and Mobile systems

Igor Moiseev & Andrei Timis
Guest Speaker: Greg Leonard

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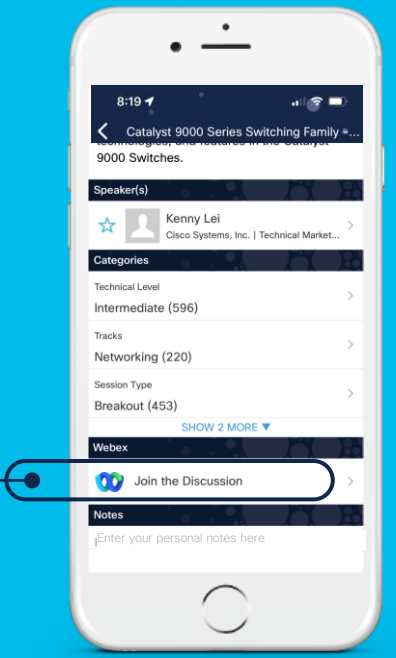


Agenda

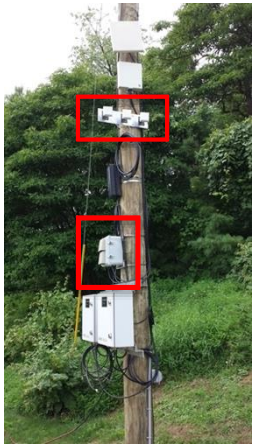
- Introduction to IoT Wireless Backhaul
  - Multi-Access Wireless (MAW) definition within IoT
  - Wireless technologies and frequencies that are used
  - Approach design opportunities with a ”hybrid” approach
  - IoT Wireless vertical summary on where it can be used
  - Products overview
- Site Surveys – Tips and Tricks
  - Desktop, Physical and RF Surveys: Differences and best practices
    - Desktop vs. Field
  - Tools and design documentation
  - Typical assets and design considerations per vertical

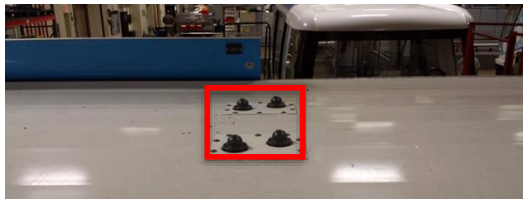
Agenda

- Deep Dive: Outdoor Fixed Infrastructure
  - PtP/PtMP, WiFi, LoRaWAN, and 4/5G installs
- Deep Dive: Outdoor Mobility
  - Train to Ground, Mining, and Ports/Terminals
- Deep Dive: Offshore Windfarms
  - Scottish Power
- Deep Dive: Indoor Mobility
  - Entertainment dark rides and Manufacturing AGVs
- Physical and RF Spectrum Analysis Demo/Video
- CURWB Fluidity and Fixed Backhaul Demo

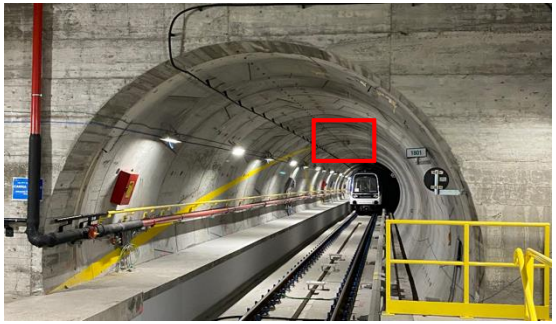
Speaker Intro – Igor Moiseev

- 4 years as a Cisco/Fluidmesh IoT Wireless TSA
  - Came over as part of the Fluidmesh (now CURWB) acquisition in June 2020
  - 9 years prior experience in the transportation industry (engineer, trainer, field engineer)
    - Focusing on Train to Ground CBTC and non-safety IP communications
  - Introduced to Cisco and CURWB during wireless testing in 2012 (Bombardier/Alstom)

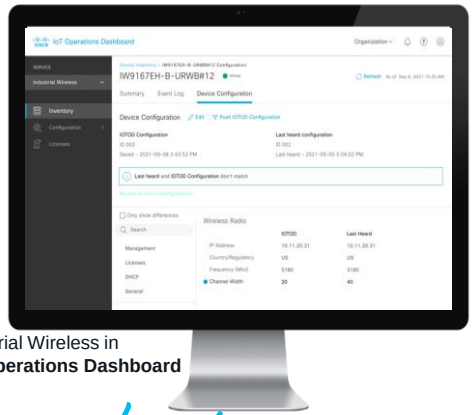




Speaker Intro – Andrei Timis



- 1 year as a Cisco IoT Solution Architect
  - 2 years as a Cisco Technical Marketing Engineer
  - Came over as part of the Fluidmesh acquisition in June 2020
  - 7 years prior networking experience, enterprise and industrial vertical markets (network engineer, field engineer)
    - Focusing on Mining, Terminal & Ports and Train to Ground CBTC and non-safety IP communications
  - Moved to Cisco and Fluidmesh after a multi-year experience in a Cisco Partner S.I.



Industrial Wireless in
IoT Operations Dashboard

IoT Wireless Intro

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Manufacturing

Warehouse

Gas Station / Kiosk

Oil and Gas

Utilities

Wireless technologies are key pillars of the Internet of Things but… one size doesn't fit all.

Parking Lot

Roadways

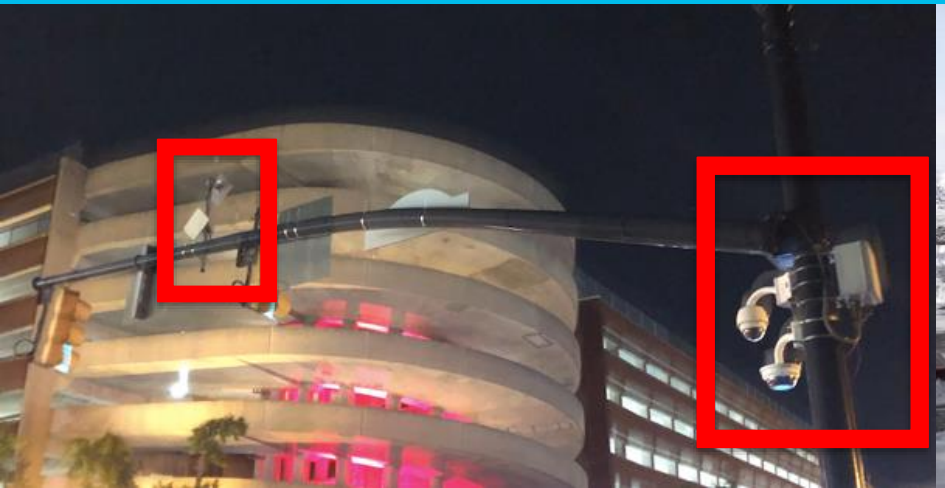
Distribution Center

Fleet

Seaport

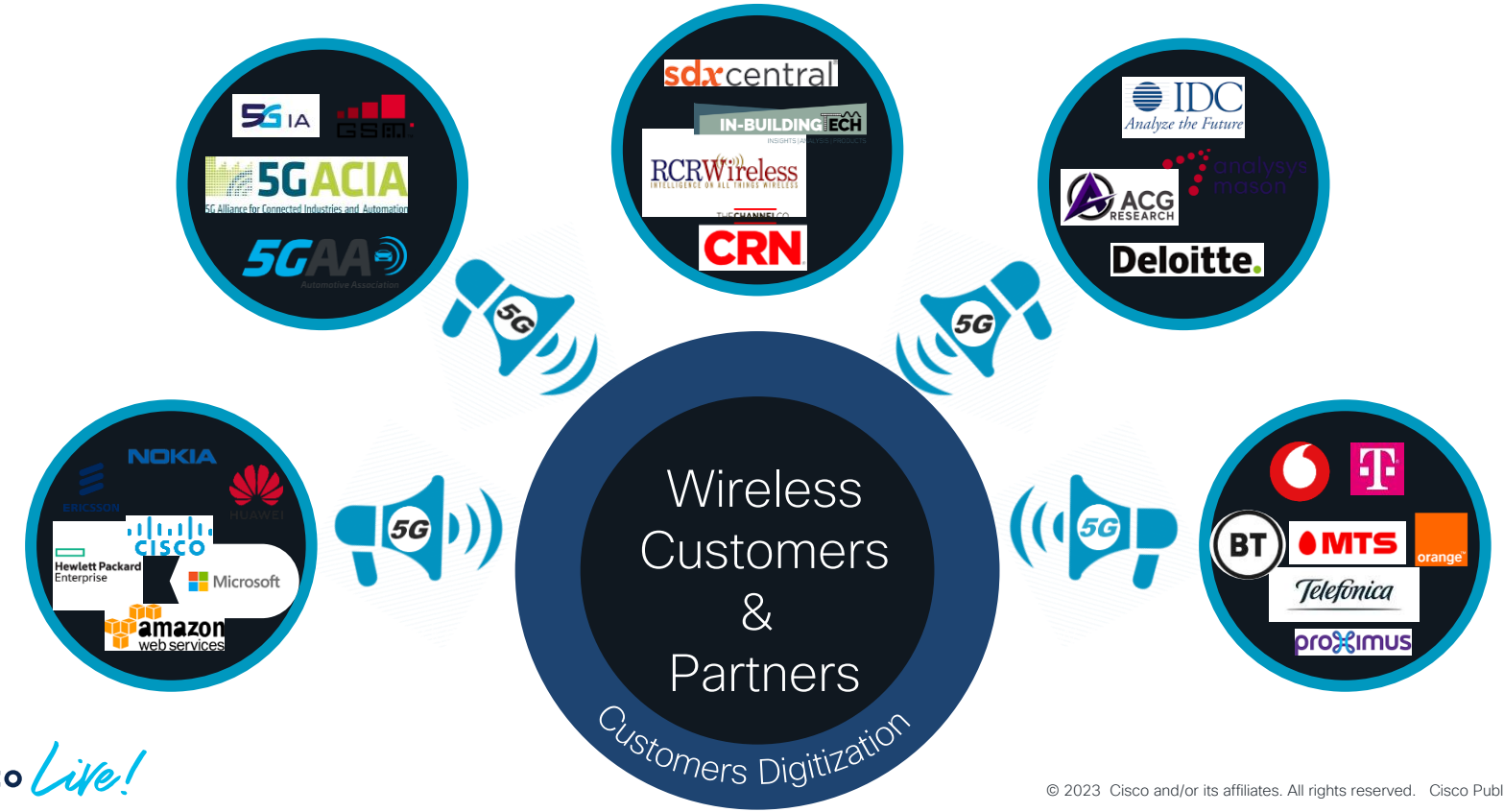
Airport

ENTERPRISE INDUSTRIES ARE ASKING FOR NETWORK CONNECTIVITY OUTDOORS



VEHICLES ARE GETTING AUTONOMOUS AND CONNECTED MORE THAN EVER

The noise / hype is deafening



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.

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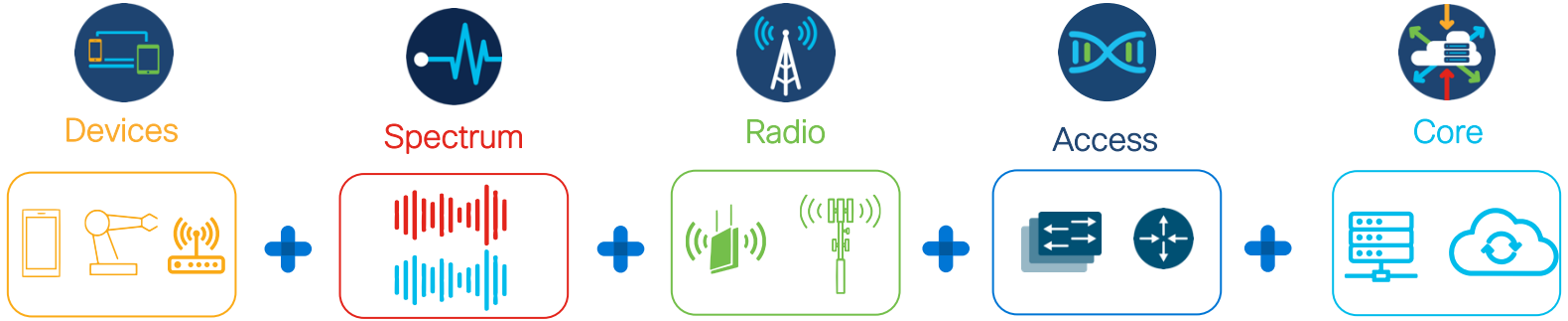
Attributes of a wireless network

Wireless network are defined by their purpose-built end-devices, RF engineered to carry the device's traffic over a licensed or unlicensed radio spectrum, eventually interfacing to the Access/Core network



Typical End-Devices

CURWB vehicle/client radio
IR WiFi/4G/5G modules
5G or p5G phone/tablet/pc
WiFi6 phone/tablet/pc
LoRaWAN sensor
WPAN/SUN sensor

Licensed Spectrum
4G and 5G tech

Unlicensed Spectrum
Wifi 5/6
CURWB
LoraWAN
WPAN/SUN

Radio Network

WiFi APs, 4G/5G Basestations
CURWB Headend, LoRaWAN Gateway
Design/Simulate for necessary coverage
Choose the right antennas
Understand End-Device receivers

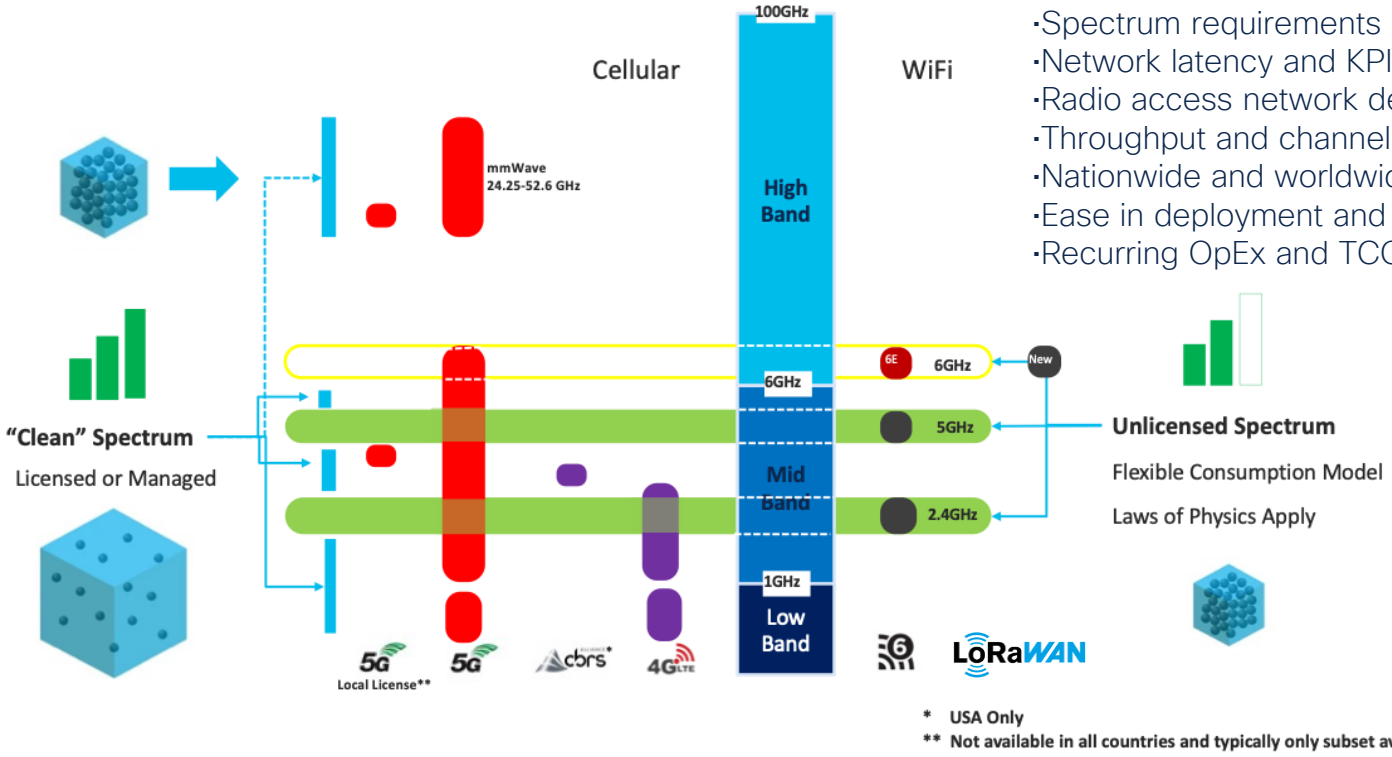
Access Network

Enterprise LAN & WAN
Industrial LAN & WAN
Carrier 4G/5G

Packet Core

Security Policy & Control
IoT/EN/Cloud interfaces
Integration to other systems

IoT Spectrum and Technology Summary



- Understand client's User Equipment (UE)
- Spectrum requirements and licensing
- Network latency and KPIs tradeoffs
- Radio access network design
- Throughput and channel requirements
- Nationwide and worldwide regulations
- Ease in deployment and management
- Recurring OpEx and TCO

* USA Only
** Not available in all countries and typically only subset available

Multi-Access wireless alternatives in IoT

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

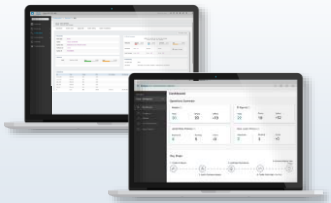
Industrial Routing
IR1101, IR1800, IR8100, IR8300, CGR1120, CGR1240, CGR2010, IoT Gateways (IG21, IG21R, IG31R)

Embedded Networking
ESS, ESR, ESW, Resilient Mesh

Industrial Wireless
Cisco Ultra-Reliable Wireless Backhaul FM, IW6300, IW9167, IW9165, IR5XX, IXM Gateway

Industrial Cybersecurity
Cyber Vision, ISA3000 Firewall

Data Control and Exchange
Edge Intelligence, IOx



Industrial Sensor Solution
Industrial Asset Vision

Management & Automation
Field Network Director, IoT Operations Dashboard, Cisco DNA Center

Wireless Technologies in Cisco IOT

LTE and 5G | Wi-Fi 5 and 6e | Sub-GHz ISM

Wide Mobility and High Throughput

Local Mobility and High Throughput

Massive Scale and Broad Coverage

IoT Gateways -> Industrial Routers

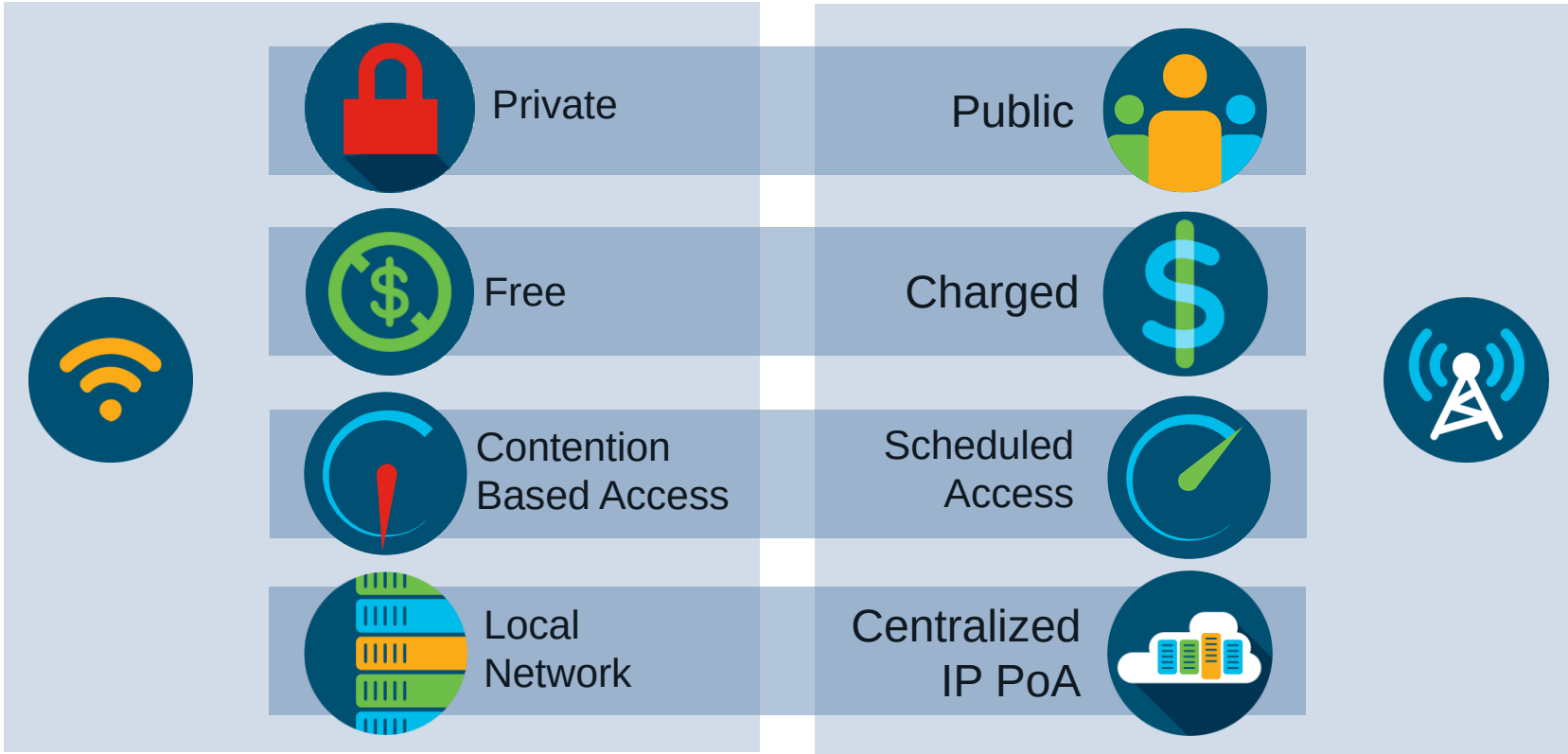
Industrial Wi-Fi

Cisco Ultra-Reliable Wireless Backhaul

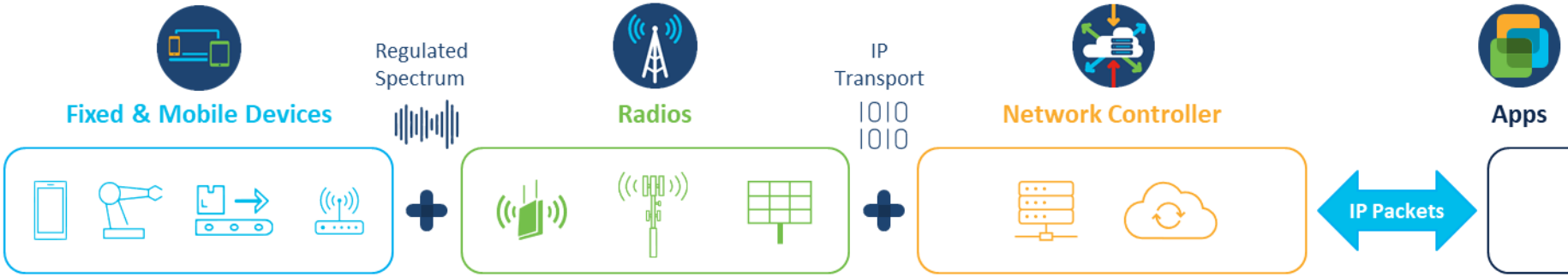
Resilient Mesh

LoRaWAN Industrial Asset Vision

The Future: 5G, Wi-Fi, CURWB, LoRaWAN Public & Private
Boundaries are blurring, Convergence has started



Wi-Fi and 5G Comparable Architectures



User Equipment
Device with a Wi-Fi Radio Interface

Unlicensed Spectrum
2.4 GHz
5 GHz
6 GHz

Access Points (AP)
Radio Antennas and Control Functions
Wi-Fi6 = OFDMA

Enterprise
IBN / DNA
SD-WAN
SD-Access

Wireless LAN Controller
User session Policy and Control
Scale to Thousands of Devices

Enterprise

10s to 50 Thousand

10s of Feet to 100s of Miles

User Equipment (UE)
Device with a 5G Radio Interface

Licensed Spectrum
Shared or Private
20-50 GHz
1 – 7 GHz
Sub 1 GHz

Radio Access Network (RAN)
Radio Antennas and Control Functions
5G = OFDMA

Service Provider or Enterprise
Optical
Segment Routing
MPLS L2/L3 VPN

Mobile Packet Core
User session Policy and Control
Scale to Millions of UEs

IT/OT Interfaces Outcomes

Internet / Enterprise

10s to > 1 Trillion

10s of Feet to 10,000s of Miles

Open Architecture with Could Native Decentralized and Distributed Network Functions

Mobile Edge Compute (MEC) and Distributed Application Architectures

Multi-Access Wireless (MAW) – better together!

Cellular, CURWB, Wi-Fi 6, and LoRaWAN are complementary – always better together

Cellular (4G/5G)	CURWB	Wi-Fi 6 (802.11ax)
Broad geographic coverage	Zero loss – sub ms latency and seamless roaming	Applications focused on capacity, client density, mobility, "guest" access, BYOD

Mission Critical Applications

Wide Area Coverage

Process Automation

Industrial Robots

Fixed Backhaul

Remote Expert

Digital Campus

Performance | IOT Scale | Capacity | Security

IoT Wireless is making news!

The Newsroom Innovation + Impact Inside Cisco Press Room Blogs Explore Cisco

Press Release

Cisco and General Motors Combine Forces for the Future of Connectivity in Cars

INDY AUTONOMOUS CHALLENGE NOV. 11, 2022 POWERED BY CISCO

INDY AUTONOMOUS CHALLENGE OCT. 23, 2021 POWERED BY CISCO

Innovation + Impact Inside Cisco Press Room Blogs Explore Cisco

Cisco Fuels Innovation and Critical Connectivity at the Indy Autonomous Challenge

Secure and Smart Cities Market – Why We Fit

ENVIRONMENT	CHARACTERISTICS	SERVICES		
OUTDOOR	• City wide networks • VOIP and access control • Backhaul for Temporary Data APs • CCTV	MANAGEMENT PLATFORM	DELIVERY SERVICES	FLUIDCARE & CUSTOMER SUCCESS

DESCRIPTION	NETWORK REQUIREMENTS
Utilities and Smart Grids • AMI/AMR collectors • Distribution and Substation Automation • Water Treatment and distribution	· Backhauling for 900 MHz mesh LoRaWAN and WiSUN. · Reliable alternative to cellular backhauling. · High-bandwidth backhaul for capacitors banks, switches, transformers, distributed generators
Public Safety • Municipalities • Law Enforcement • Military	· Video-Surveillance · Streaming from moving vehicles · VoIP connections · Tactical Communication · Drone/UAV Remote Control
Education • Digital Divide • Campuses and dorms • University • K12	· Remote building connectivity · Wi-Fi backhaul · Parking lot security · Network extension · Video security · Emergency Phones · Public Addressing (PA)
Residential and Healthcare • Residential • Healthcare • Enterprise	· Old building retrofit · Covert surveillance · Mass notification · Gate and perimeter controls · Wi-Fi infrastructure · Remote Patient Monitoring
Connected Roadways - DOTs • Traffic Lights Monitoring • Situational Awareness • Travel time/issues optimization • Digital Signage	· Facilitate safety, mobility and efficiency on roadways. · Smoother flow of traffic, reducing congestion and collisions · Better fuel/energy consumption

Rail Market – Why We Fit

ENVIRONMENT	CHARACTERISTICS	SERVICES		
		MANAGEMENT PLATFORM	DELIVERY SERVICES	FLUIDCARE & CUSTOMER SUCCESS
MAIN TRACK	• Fast Roaming • High Throughput • Make before Break handoff • Ultra High-Availability			
DEPOT	• Load Balancing • Prioritization • Multi Frequency • Auto-sensing			
INTER-CAR	• Intercar ad-hoc bridging • Loopback protection • Association threshold • Shuffling Algorithm			

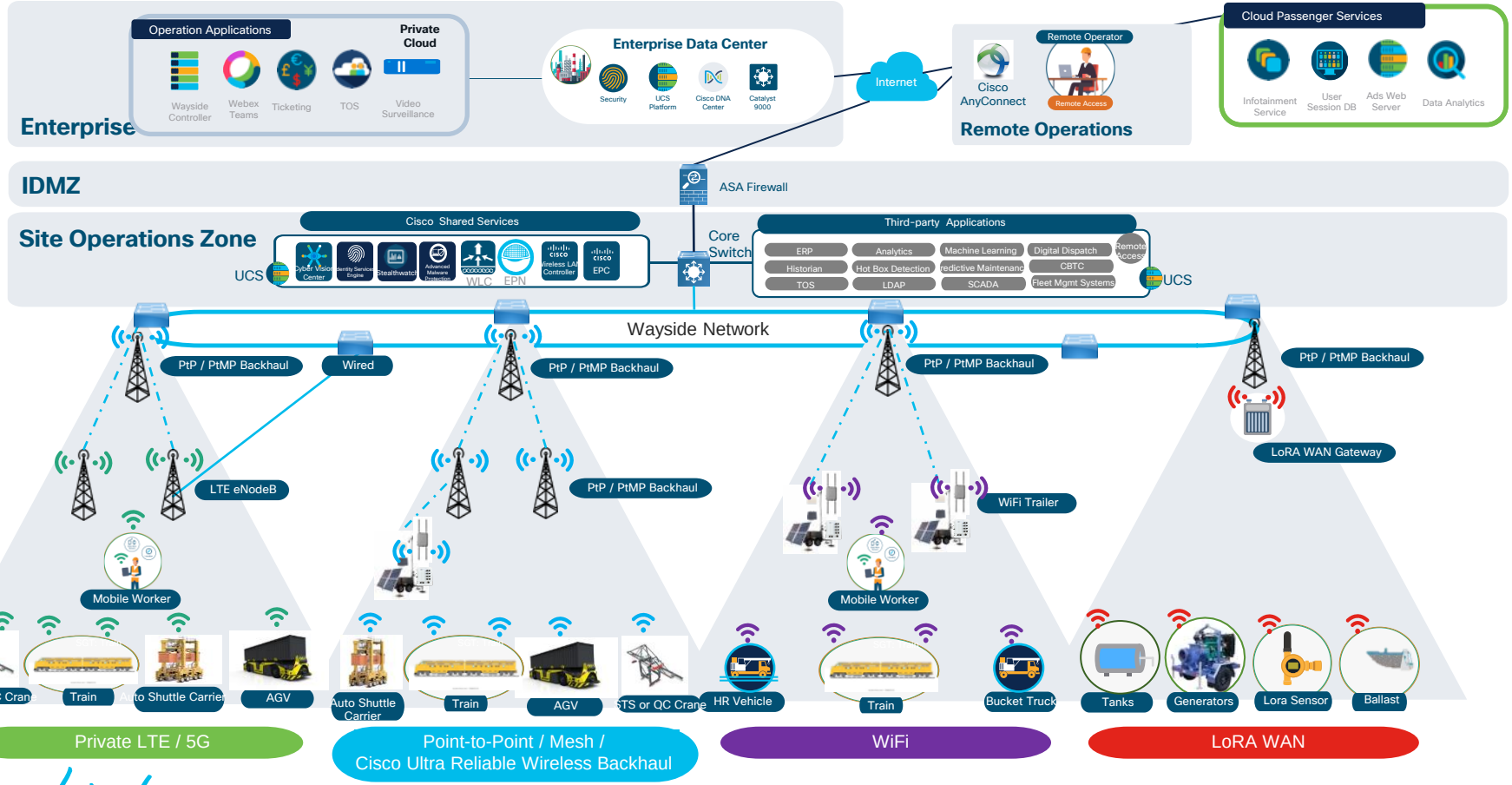
DESCRIPTION	NETWORK REQUIREMENTS
Vital Communications: Communications Based Train Control (CBTC) PLC and Safety Controls	450 Kbps to 5 Mbps Fast Failover < 500ms Fault tolerant (HA) and L3 support Mobility up to 225mph/360kmh 100% redundant RF coverage QoS ready, up to few ms of latency
Non-Vital Communications: CCTV, Wi-Fi backhaul, PA/PIS, VoIP, SCADA	5-500 Mbps Variable traffic Mobility up to 225mph/360kmh 100% RF coverage not guaranteed/needed QoS ready, up to few ms of latency
Depot Offloading: Onboard CCTV NVR offloads, PA/PIS content uploads, Advertising uploads, Onboard system upgrades	1 to 500 Mbps Variable traffic Mobility less than 20mph/40kmh 100% RF coverage not guaranteed/needed QoS ready, up to few ms of latency
Inter-Car Connectivity: CBTC car, Wi-Fi AP, CCTV camera, VoIP, femptocell connectivity and backhaul aggregation points for train-to-ground	150 Mbps to 500 Mbps Variable traffic Car shuffling algorithms Loopback prevention algorithms QoS ready, up to few ms of latency

Ports & Terminal Market – Why We Fit

ENVIRONMENT	CHARACTERISTICS	SERVICES		
MAIN TRACK	• Compatible with, and validated by all main market vendors (Kalmar, Konecranes, ZPMC) • Supports PROFINET and CIP safety • Uptime 99.999% • Low latency • Seamless roaming (handoff) • TITAN (fast failover) • High bandwidth • Load-balancing • Easy installation • Multi-frequency capability with 0 m/s handoff	MANAGEMENT PLATFORM	DELIVERY SERVICES	FLUIDCARE & CUSTOMER SUCCESS

DESCRIPTION	NETWORK REQUIREMENTS
Terminal Operating System (TOS): terminal tractors, reach stackers, RTGs & similar applications + supporting systems	450 Kbps to 1 Mbps Variable traffic Good coverage Up to 1 second of latency
Optical Charter Recognition (OCR) TOS server integrated into OCR system	15 Mbps to 20 Mbps Constant traffic 100% coverage 50 ms latency
Autonomous and tele-remote RTGs	30 Mbps for AutoSC 60 Mbps for RTG Constant PLC traffic Constant Video traffic 0 ms handover Coverage across the working area 50 ms latency
Autonomous Horizontal Transport (Automation For PLC applications)	1 Mbps for AutoSC/AGV Constant PLC traffic 0 ms hand over Overlapping coverage at the working area 50 ms latency

Cisco Multi-Access Wireless for Rail and Ports



Mining Market – Why We Fit

ENVIRONMENT	CHARACTERISTICS	SERVICES		
OPEN PIT and UNDERGROUND	• Wide areas to be covered • Elevation challenges • Ultra High-Availability • PROFINET • FMS + ADS + AHS	MANAGEMENT PLATFORM	DELIVERY SERVICES	FLUIDCARE & CUSTOMER SUCCESS
RAIL/PORT PROCESSING OPERATIONS	• Stackers and Reclaimers Networks • Ship loaders Backhaul Networks • Train-to-Ground Trackside communication • Remote Controlled Locomotive Communication • PLC Backhaul for Belt Systems • Remote Controlled Dozers for Bulk Cargo			

DESCRIPTION	NETWORK REQUIREMENTS
Fleet Management System (FMS) (Modular, MineStar, Hexagon, Wenco) and supporting systems	450 Kbps to 1 Mbps Variable traffic 100% coverage not guaranteed Up to seconds of latency
Autonomous Haulage System (AHS) + FMS + supporting systems	5 Mbps to 10 Mbps Constant traffic 0 ms handover 100% coverage 50 ms latency
Autonomous Drilling System + Teleremote	10 Mbps to 20 Mbps Constant traffic 0 ms handover Full coverage on the mining pit 50 ms latency
Tele-remote	10 Mbps to 20 Mbps Constant traffic 0 ms handover Full coverage on the working area 50 ms latency
Fix / Nomadic Wireless Backhaul	1 Mbps to 100 Mbps Constant traffic

Entertainment Market – Why We Fit

ENVIRONMENT	CHARACTERISTICS	SERVICES
INDOOR	• Extreme Latency and Jitter Requirements • Ultra High-Availability • High Client Density • PROFINET / QNET / CANBUS support • RF Attenuators and Omni antennas	MANAGEMENT PLATFORM DELIVERY SERVICES FLUIDCARE & CUSTOMER SUCCESS
OUTDOOR	• VOIP and access control • Backhaul for Temporary Data APs • CCTV	

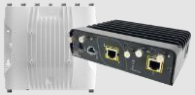
DESCRIPTION	NETWORK REQUIREMENTS
Dark Rides / Attractions	On-board PLC for Vehicle Control (Safety Protocol) Ride Control Protocol Show control (audio/visual sync with vehicle movement) On-board Video Surveillance
Parades	On-board PLC for Float Control (Safety Protocol) Show control (audio/visual sync with float movement) On-board Video Surveillance
Live Shows	Show control Special effects Lighting Performer Flying System Trolley/Float control
Security & Wi-Fi Backhaul	Video surveillance Access Control Wi-Fi Temporary Data AP VoIP Audio Broadcasting

Multi-access Wireless Examples

Theme and Amusement Parks

Better together

5G



Cisco URWB

Wi Fi 6

Connectivity in motion

CURWB

- Zero loss – low latency – high speed connectivity
- Support for rides in motion and dark ride connectivity with automated people movers

High density wireless

Wi Fi 6

- Leverage hi-density / high throughput wireless in customer congregation areas
- Supports application pushes across private networks
- Supports non-5G devices via 802.11

5G Pervasive 5G connectivity

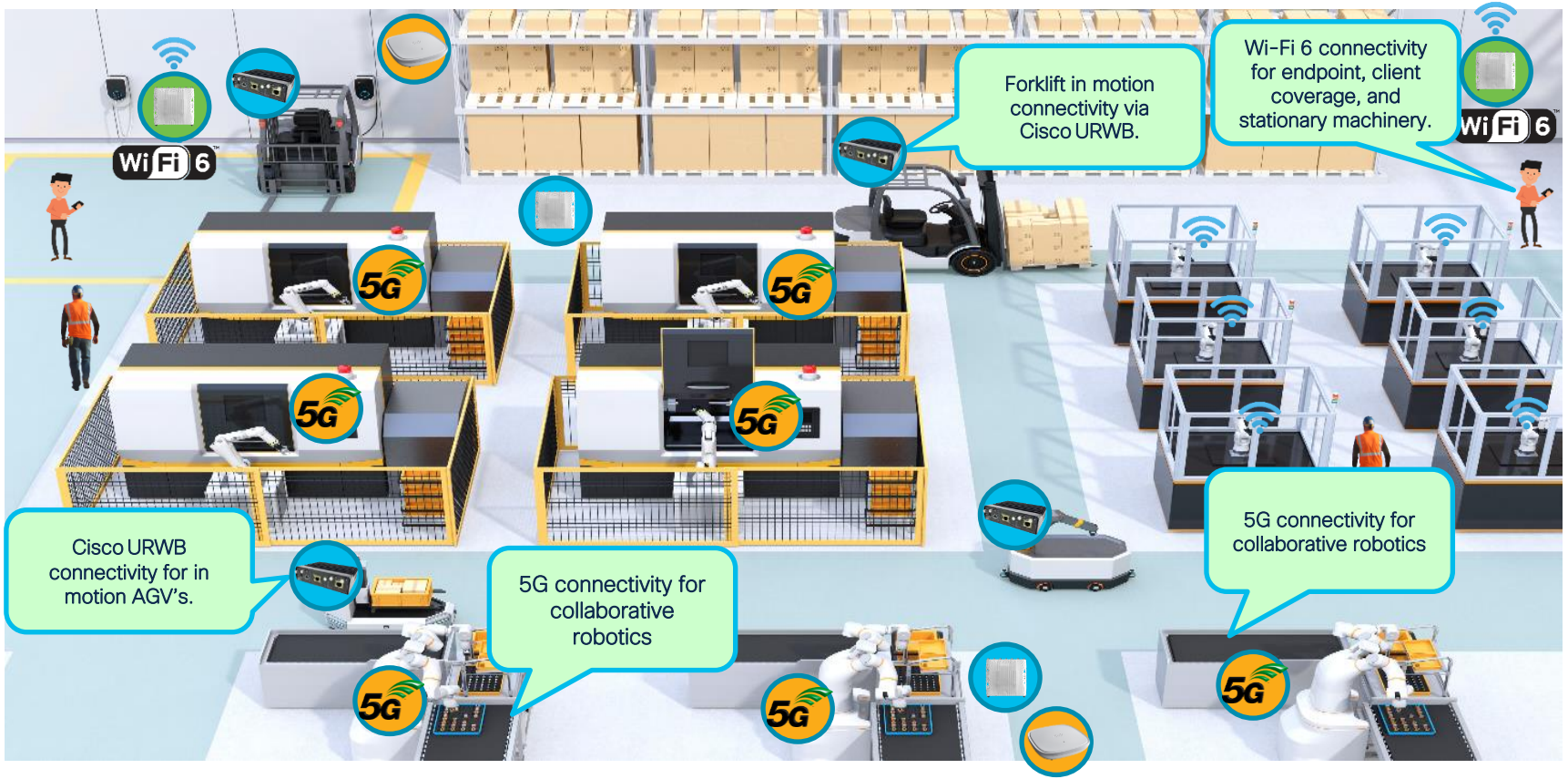
- Pervasive private 5G for park-wide business critical use cases
- The ability to cover large areas of the park without congestion with a private network
- Leveraging Cisco URWB for 5G edge devices without cabling

Factory Automation – Why We Fit

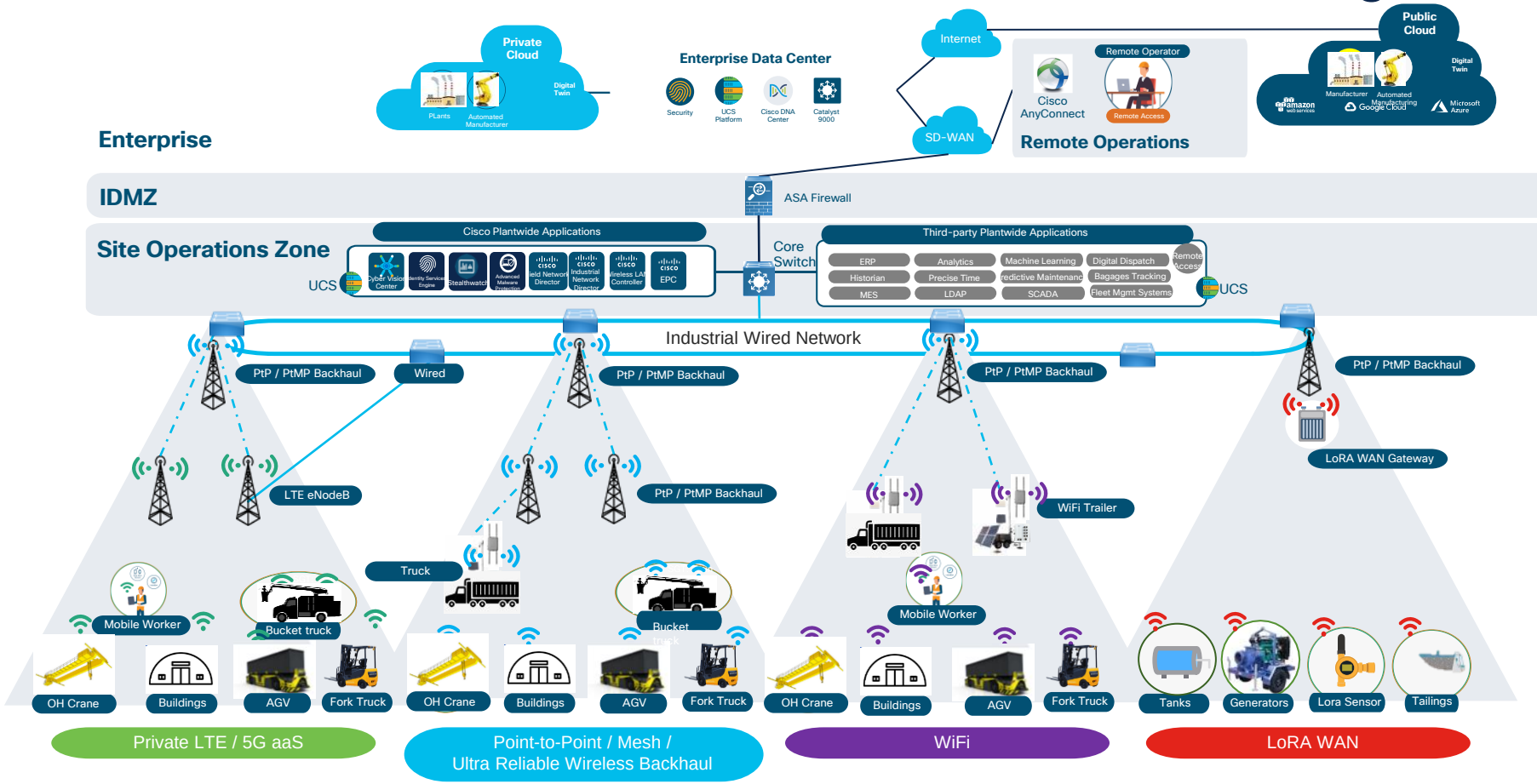
ENVIRONMENT	CHARACTERISTICS	SERVICES
INDOOR	• AGVs, Robotics • Extreme Latency and Jitter Requirements • Ultra High-Availability • High Client Density • PROFINET / Modbus TCP support • RF Attenuators and Omni antennas • Seamless roaming • Lossless handoffs	MANAGEMENT PLATFORM DELIVERY SERVICES FLUIDCARE & CUSTOMER SUCCESS
OUTDOOR	• Harsh environments • Overhead Cranes • AGVs	

DESCRIPTION	NETWORK REQUIREMENTS
AGVs	On-board PLC for Vehicle Control (Safety Protocol) Navigation Info PLC control (control sync with vehicle movement) On-board Video Surveillance
Robotics	On-board PLC for Control (Safety Protocol) Cell connectivity (PLC or CNC) On-board Video Surveillance
Overhead Cranes	Motion control Collision avoidance communication Lighting Gantry / Trolley control Boom control
Data Collection	Sensor aggregation Vision systems Backhaul PLC-to-PLC communications Industrial protocol support (Profinet, Ethernet/IP, Modbus TCP)

Multi-Access Wireless Examples in Manufacturing

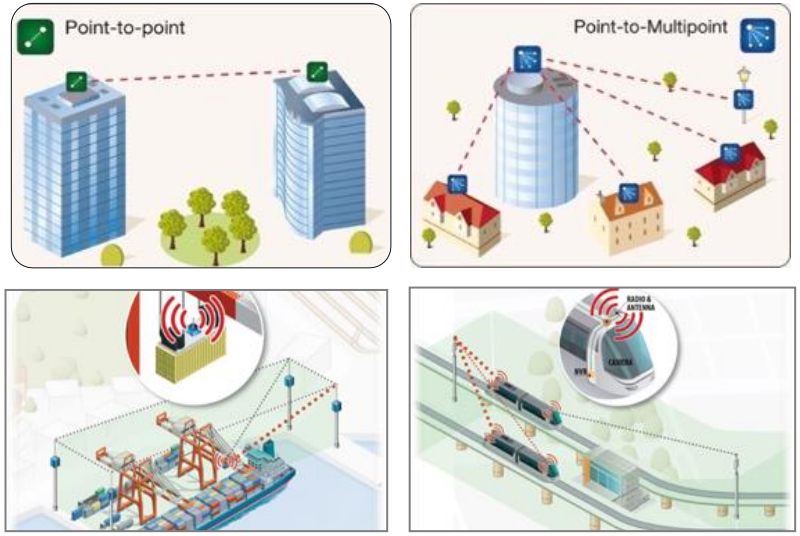


Cisco Multi-Access Wireless for Manufacturing



Cisco Ultra-Reliable Wireless Backhaul (CURWB)

Wireless Fiber-Like Connectivity
Extending highly reliable network connections where wired Layer 1 can't go.



Long Range High Bandwidth Connectivity
multiple miles (EIRP limited) @ 500 Mbps current gen, 1200+ Mbps with next gen.

Fast and Accurate Roaming for Mobility
(up to 225 Mph)

Support for real-time sensitive traffic. Zero Loss-Low Latency.

Pay as you go bandwidth consumption model.

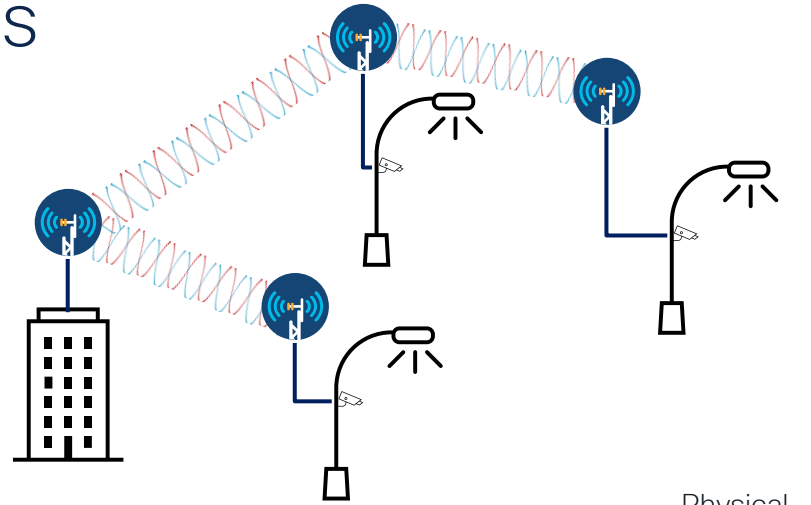
Support multiple backhaul topologies – Point to Point, Point to Multipoint, and Mesh

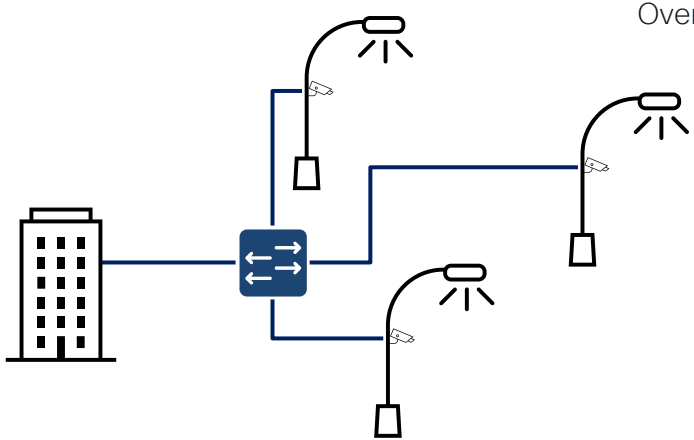
Secure MPLS based proprietary protocol with QoS support

Cisco Ultra-Reliable Wireless Backhaul

What is Cisco URWB?

- ✓ Cisco URWB is an customised MPLS overlay technology that emulates a virtual switch over wireless links
- ✓ Extends your network to fixed locations and mobile assets
- ✓ Supports VLANs, QoS and Industrial protocols as Profinet, QNET.





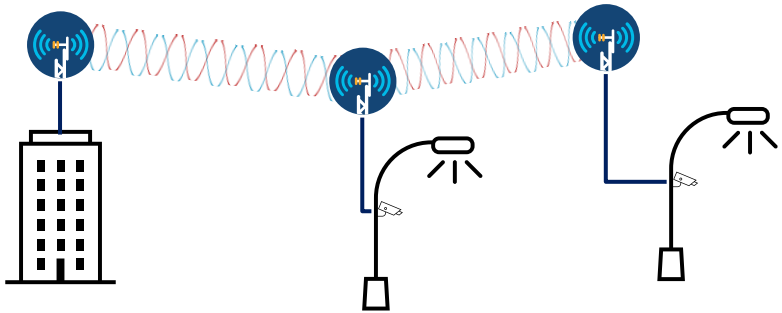
cisco Live!

Cisco Ultra-Reliable Wireless Backhaul (CURWB)

Backhaul modes of operation

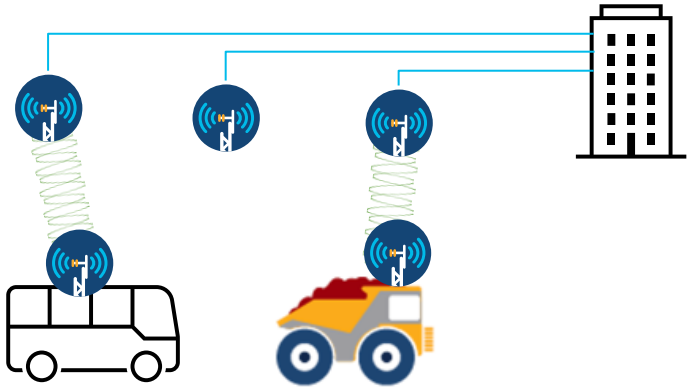
Fixed Infrastructure

Connect wired networks between static or nomadic locations



Mobility Infrastructure

Extension of fixed functionality to optimize connectivity for mobile assets with predictive handoffs



The next generation of **Outdoor and Industrial Wireless** is upon us.

IW9165E

IW9165D

IW9167E

Introducing Cisco Catalyst IW9167E Access Point

One hardware, two wireless technologies

Industrial and outdoor

Wi-Fi 6/6E access point

Manage with Cisco Catalyst 9800 Series Wireless Controllers

OR

Cisco Ultra-Reliable Wireless Backhaul (Cisco URWB)

Deploy and manage with Cisco IoT Operations Dashboard

- Built-for outdoor and industrial spaces
- Security you can trust from Cisco
- Improved sustainability via platform flexibility

Tri-radio
2.4 GHz, 5GHz, 5/6GHz

4x4
4 spatial streams

Multigigabit
RJ45, M12 or SFP+

PoE+, UPOE & DC power

GNSS, BLE, Scanning Radio

Meeting the needs of operations and IT - Learn more, see product and demo at the IoT WoS

Catalyst IW9167E Overview

Catalyst® IW9167E Access Point

Tri-Radio Architecture in Heavy-Duty Design

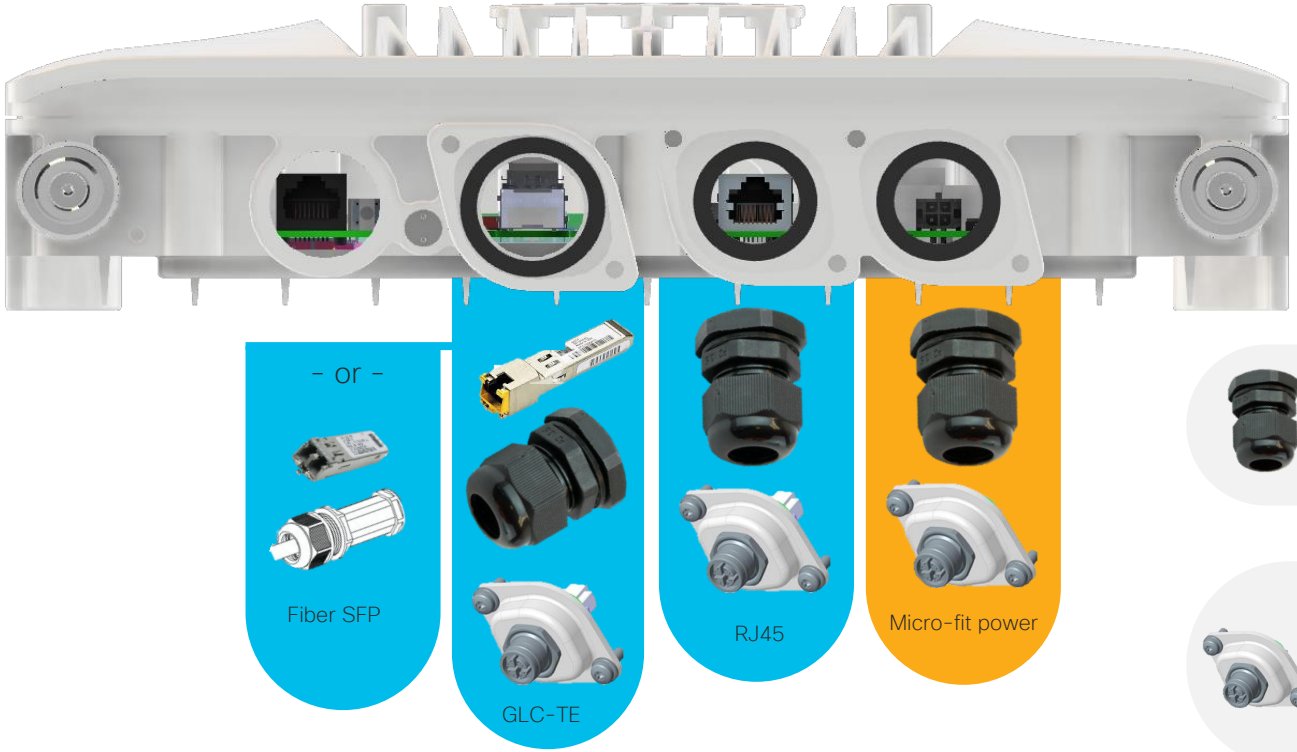
- Wi-Fi 6/6E *, 802.11AX, MU-MIMO, OFDMA
- External antenna – 8 x Type N
- Tri-Radio architecture
  - 2.4-GHz, 4x4:4SS, up to 20MHz
  - 5-GHz radio, 4x4:4SS, up to 80 MHz
  - 5/6-GHz radio, 4x4:4SS, up to 160 MHz
- Dedicated scanning radio for spectrum intelligence
- 2.4-GHz IoT radio
- Built-in GNSS with TNC connector

Wireless backhaul (Cisco URWB) **OR** Wi-Fi 6/6E access point

* 6E ready

Catalyst IW9167E

One hardware, multiple weatherproofing options

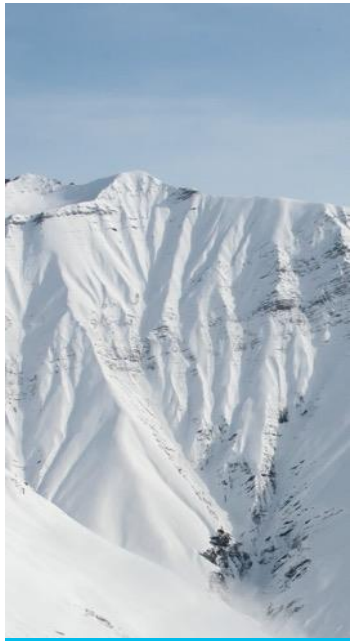


Cable Glands
- Maintain IP67 rating
- Optional accessory

M12 Adapter
- Maintain IP67 rating
- Vibration rated for rail (EN50155)
- Optional accessory

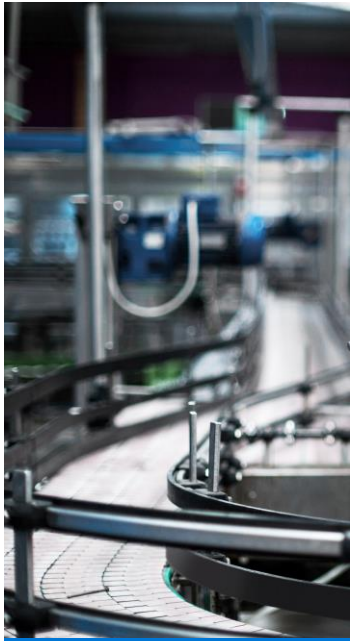
Catalyst IW9167E Heavy Duty Access Point

Your network goes wherever you need it



- 50C

+75C



Shock / Vibration

Water

Dust

Catalyst IW9165E Rugged access point and wireless client

The wireless client that connects mobile industrial assets

Autonomous robots and vehicles for manufacturing, ports, logistics

Rail and light-rail rolling stock

EN50155 certified for rail operations

Connect more machines to your network
Compact form factor for integration in existing assets

Get more from your industrial assets
BLE, GNSS, GPIO capabilities for advanced use cases

Connect moving vehicles to your systems
Ultra low latency and zero packet loss during handoff

High performance and modular wireless
Dual 802.11ax radio with wide choice of antenna

Works with your Wi-Fi infrastructure
Supports WGB or URWB. Evolve as your needs change

Ultra-reliable broadband wireless connectivity for moving machines and vehicles

Catalyst IW9165D Heavy Duty Access Point

Wireless backhaul that's easy to deploy where fiber is not an option

Building-to-building, smart cities, intersections, roadways, railway, mining

Easily extend your network anywhere
Built-in directional antenna for long range connectivity

Fixed and mobile use cases simultaneously
External antennas enable future usages as needs evolve

Connect moving vehicles to your systems
Ultra low latency and zero packet loss during handoff

Build for harsh outdoors environments
IP67 rated enclosure, -40 to +70C, optional M12 adapters

High performance and modular wireless
Dual 802.11ax radio for PTP, PTMP, and mobile applications

Ultra-reliable broadband wireless connectivity for moving machines and vehicles

Cisco Catalyst industrial wireless portfolio – next generation

Purpose-built dedicated wireless client

Catalyst IW9165E Rugged Access Point and Wireless Client

Cisco URWB

WGB

Wireless backhaul that's easy to deploy

Catalyst IW9165D Heavy Duty Access Point

Cisco URWB

Premier outdoor and industrial access

Catalyst IW9167E Heavy Duty Access Point

Cisco URWB

Wi-Fi 6/6E-ready*

WGB

*Wi-Fi 6E subject to regulatory agencies regulations and approvals

Connect more devices. Wirelessly. Reliably. Even on the move.

Catalyst industrial wireless portfolio – next generation

NEW Cisco Live Amsterdam

IW9165E

NEW Cisco Live Amsterdam

IW9165D

IW9167E

	IW9165E	IW9165D	IW9167E
Application	Wireless client for mobile assets	Wireless backhaul for fixed and mobile assets	Wireless backhaul for fixed and mobile assets
Radio	2 x 802.11ax radios (5GHz, 5/6GHz)	2 x 802.11ax radios (5GHz, 5/6GHz)	3 x 802.11ax radios (2.4GHz, 5GHz, 5/6GHz)
Antenna	4 x RP-SMA	Built-in directional plus 2 x N-Type	8 x N-Type
Modulation	2x2 MIMO	2x2 MIMO	4x4 MIMO
Wireless Mode	WGB or URWB	URWB	WGB, URWB, or Wi-Fi AP
Ethernet	1 x 2.5Gbps + 1 x 1Gbps RJ45 Optional M12 adapter	1 x 2.5Gbps + 1 x 1Gbps RJ45 Optional M12 adapters	1 x 5Gbps RJ45 + 1 x SFP+ Optional M12 adapters
Expendability	BLE, GNSS, GPIO	BLE, GNSS	BLE, GNSS
Certifications	IP30, EN50155 -20C to +50C	IP67 -50C to +75C	IP67, EN50155 -50C to +75C

CURWB FM Radio Portfolio: 4.9-5.9GHz Solutions

FM PONTE

- Throughput: Max 50 Mbps
- Support: PtP Bridge Only
- Tx Power: Max 27 dBm
- MIMO Support: 2x2:2
- Integrated antenna: 17dBi
- H-Beam: 33 deg
- V-Beam 17 deg
- Primary Power: 24VDC PoE
- Ethernet: 2x 10/100 RJ45

50Mbps

FM1200 VOLO

- Throughput: Max 100 Mbps
- Support: PtP, PtMP
- Tx Power: Max 27 dBm
- MIMO Support: 2x2:2
- Integrated antenna: 17dBi
- H-Beam: 33 deg
- V-Beam 17 deg
- Primary Power: 24VDC PoE
- Ethernet: 2x 10/100

100Mbps

FM3200 BASE

- Throughput: Max 150 Mbps
- Support: PtMP Master (typ.)
- Tx Power: Max 27 dBm
- MIMO Support: 2x2:2
- Integrated antenna: 18dBi
- H-Beam: 120 deg
- V-Beam 10 deg
- Primary Power: 48VDC PoE
- Ethernet: 2x GBE RJ45

FM4200 FIBER

- Throughput: Max 150 Mbps
- Support: PtP, PtMP, Fluidity
- Tx Power: Max 27 dBm
- MIMO Support: 2x2:2
- External antennas: 3-29dBi
- PoE Power: 48VDC PoE
- DC Power: 24-60VDC
- Ethernet: 1x GBE M12; 1x SFP

150Mbps

FM3500 ENDO

- Throughput: Max 500 Mbps
- Support: PtP, PtMP, Fluidity
- Tx Power: Max 30 dBm
- MIMO Support: 2x2:2
- External antennas: 3-29dBi
- Primary Power: 48VDC PoE+
- Ethernet: 2x GBE RJ45

FM4500 MOBI

- Throughput: Max 500 Mbps
- Support: PtP, PtMP, Fluidity
- Tx Power: Max 30 dBm
- MIMO Support: 2x2:2
- External antennas: 3-29dBi
- PoE Power: 48VDC PoE+
- DC Power: 24-60VDC
- Ethernet: 2x GBE M12

FM4500 FIBER

- Throughput: Max 500 Mbps
- Support: PtP, PtMP, Fluidity
- Tx Power: Max 30 dBm
- MIMO Support: 2x2:2
- External antennas: 3-29dBi
- PoE Power: 48VDC PoE+
- DC Power: 24-60VDC
- Ethernet: 1x GBE M12; 1x SFP

500Mbps

Quick Reference – Steps to BOM

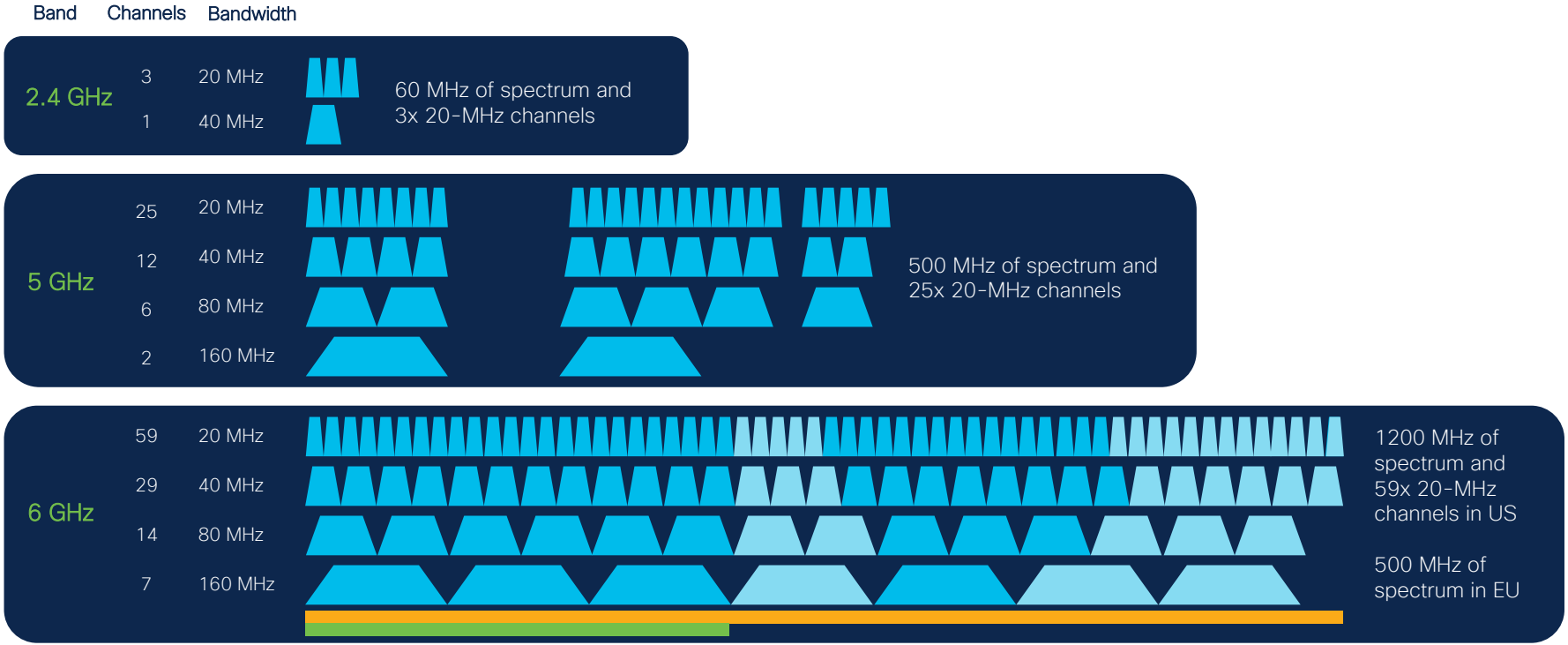
Network Type	Radio	Antenna	Accessories & Cables	Licenses	Support and Warranty
Fixed Infrastructure Point to Point Point to Multi-Point	 FM1200 VOLO Up to 100 Mbps	Integrated	Included	Included	Not Applicable
	 FM3200 BASE Up to 150 Mbps	Integrated	Choose optional mounting accessories	Choose feature and throughput licenses (optional) Cisco URWB IW Network Essentials/Advantage/Premier*	Add Extended Warranty (no longer orderable after 31 Aug 2022)
	 IW9165D	Integrated	Choose optional mounting accessories		Add Technical Support and Extended Warranty (no longer orderable after 31 Aug 2022)
	 FM4200 Up to 150 Mbps FM3500/4500 Up to 500 Mbps	Choose antenna	Choose antenna cables and optional mounting accessories		
Mobility Fluidity	 IW9167E & 9165			Choose feature (optional) and throughput licenses	

Order in CCW

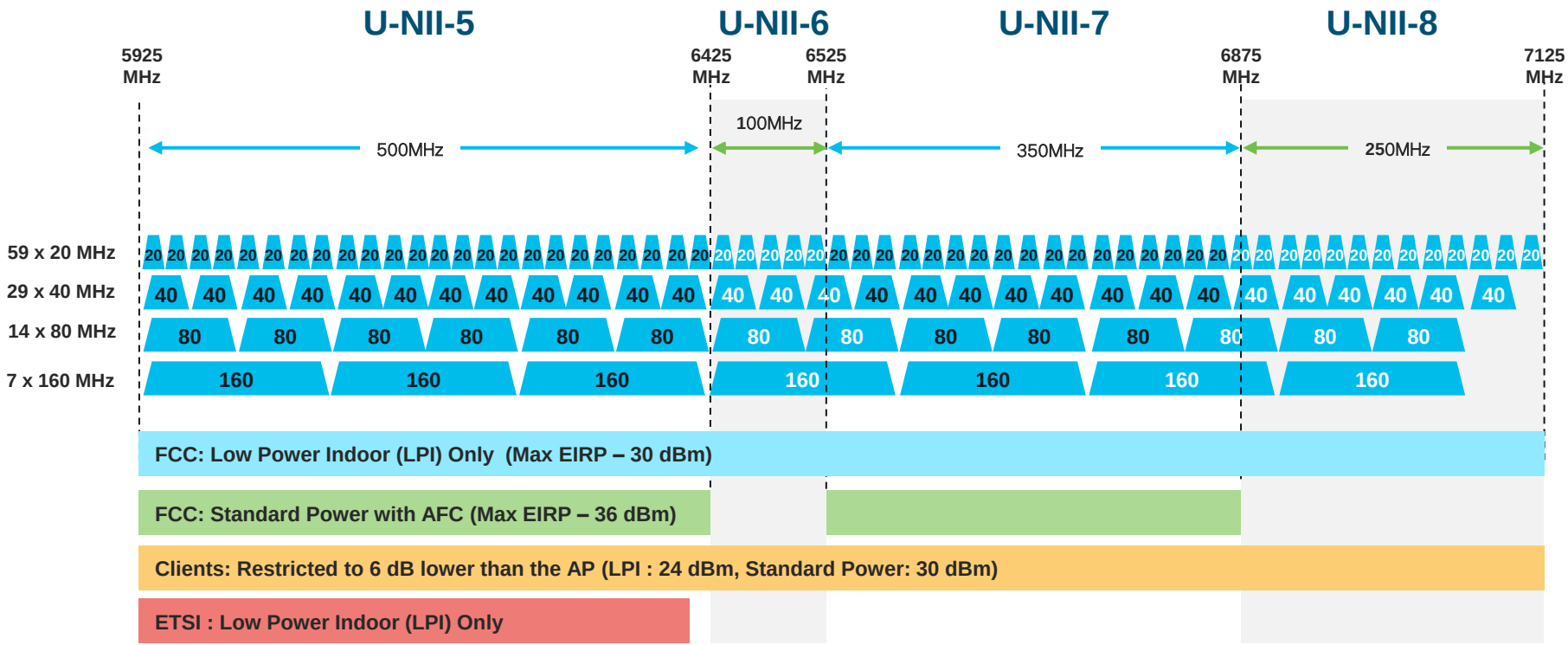
Consider adding a gateway for management of larger networks and MONITOR for network monitoring

*next generation license model

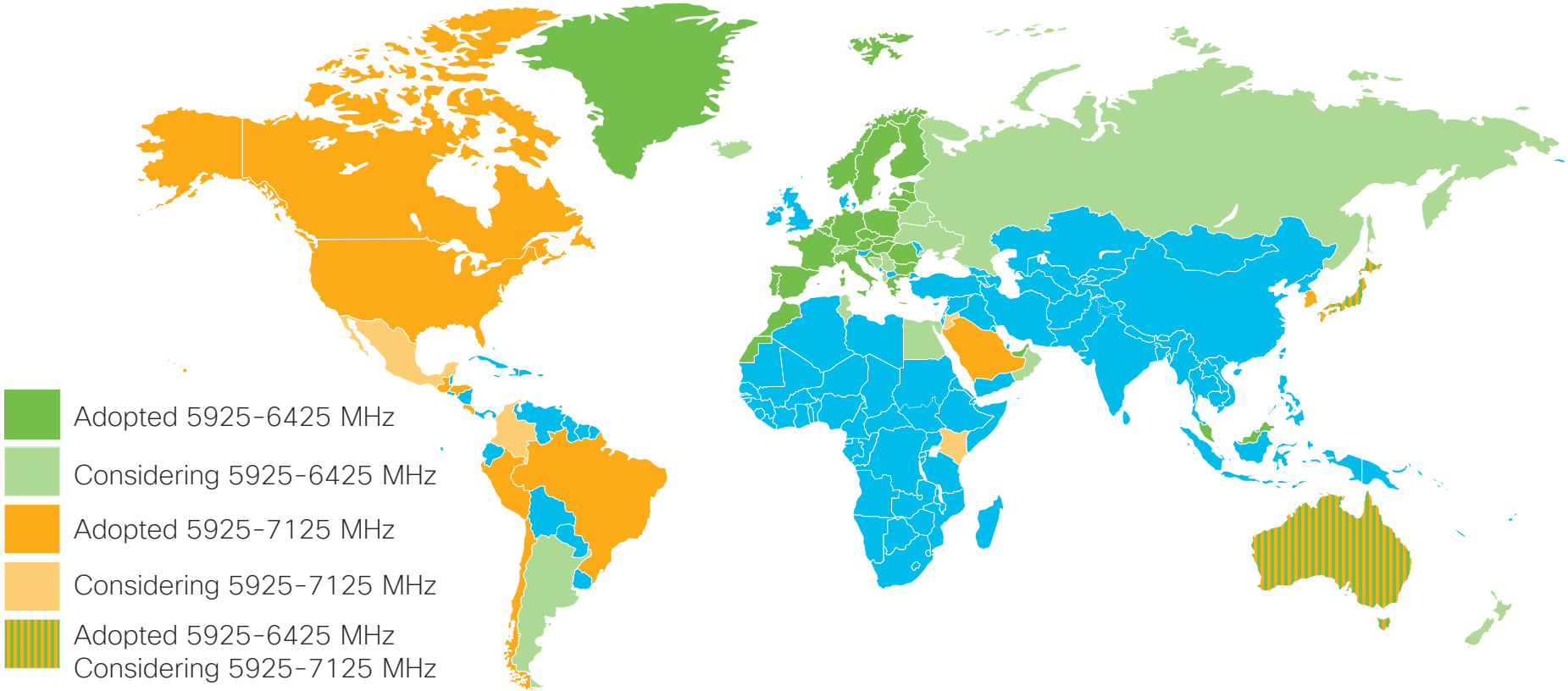
6 GHz is the biggest Wi-Fi spectrum expansion ever



6GHz spectrum biggest Wi-Fi spectrum expansion ever



Countries enabling Wi-Fi 6E

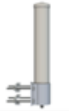


Antennas: 5GHz-rated, 2x2 MIMO

OMNIDIRECTIONAL


FM-OMNI-3


FM-OMNI-5-KIT


FM-OMNI-10


FM-OMNI-12

UNI-DIRECTIONAL


FM-TUBE-14


FM-PANEL-19 or 22


FM-PANEL-9


FM-DISH-29

HORN / SECTOR


FM-HORN-90


FM-HORN-60


FM-HORN-30


FM-SECTOR90-16HV


FM-SECTOR90-16DS

SHARK (T2G)


FM-SHARK-DUAL-13


FM-SHARK-14


FM-SHARK-16


FM-ATT-06-N

Antennas: Tri-Band (2.4/5/6GHz-rated)



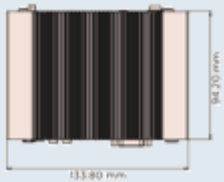


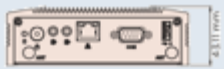
Model	AIR-ANT2513P4M-N AIR-ANT2513P4M-NS	AIR-ANT2588P4M-NS	AIR-ANT2568VG-N AIR-ANT2568VG-NS	AIR-ANT2547V(G)-N AIR-ANT2547VG-NS	IW-ANT-OMNI-TRI-VN
Ports	4	4	1	1	1
Type	Directional	Directional	Omnidirectional	Omnidirectional	Omnidirectional
Environment	Indoor/outdoor	Indoor/outdoor	Indoor/outdoor	Indoor/outdoor	Indoor/outdoor
Gain, 2.4 GHz	13 dBi	8 dBi	6 dBi	4 dBi	4 dBi
Gain, 5 GHz	13 dBi	8 dBi	8 dBi	7 dBi	7 dBi
Gain, 6 GHz					7 dBi
Dimensions	14.5” x 20.0”	12” x 7”	14.8” (L) x 1.25” (D)	11.1” (L) x 1.3” (D)	

CURWB Portfolio – Turnkey Wireless Solution

Radios

Gateways



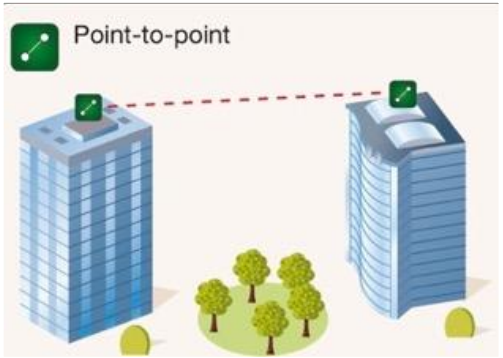


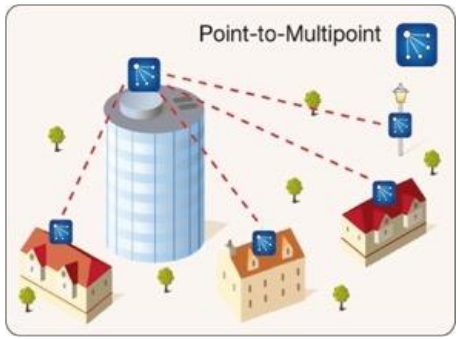
Antennas

Tools

CX / Pro Services

Fixed Infrastructure: VOLO, ENDO, BASE, IW





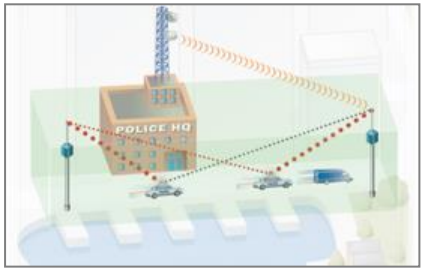
SUPPORTED ARCHITECTURES

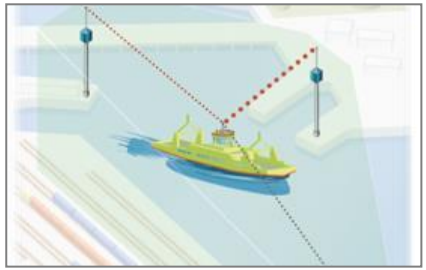
POINT TO POINT
POINT TO MULTIPOINT
MESH
MIXED

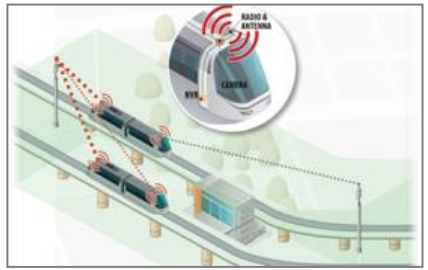
Mobility(Fluidity): MOBI, FIBER, ENDO, IW

SUPPORTED ARCHITECTURES

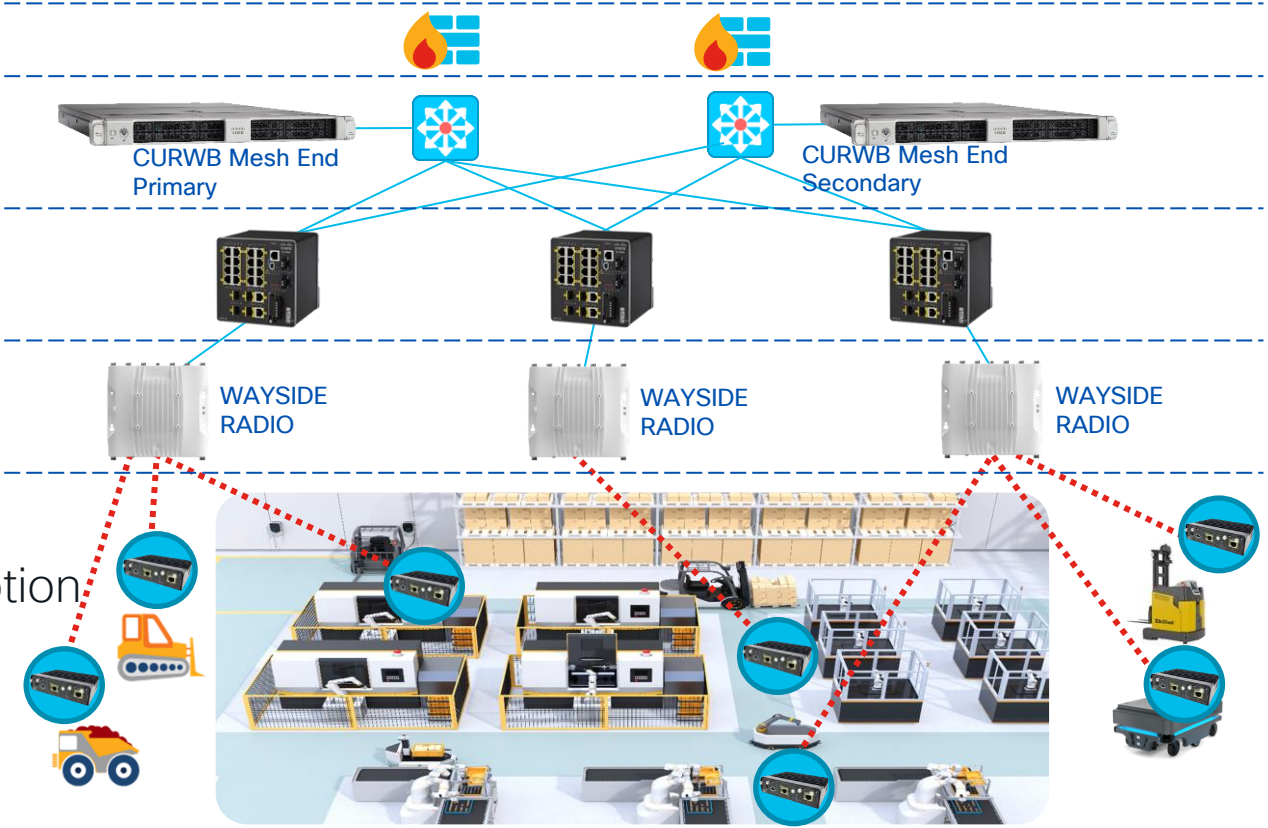
- POINT TO POINT
- POINT TO MULTIPOINT
- MESH
- MIXED
- FLUIDITY







Fluidity Layer 2: typical network topology



- Connectivity in motion
- Low latency
- Zero loss

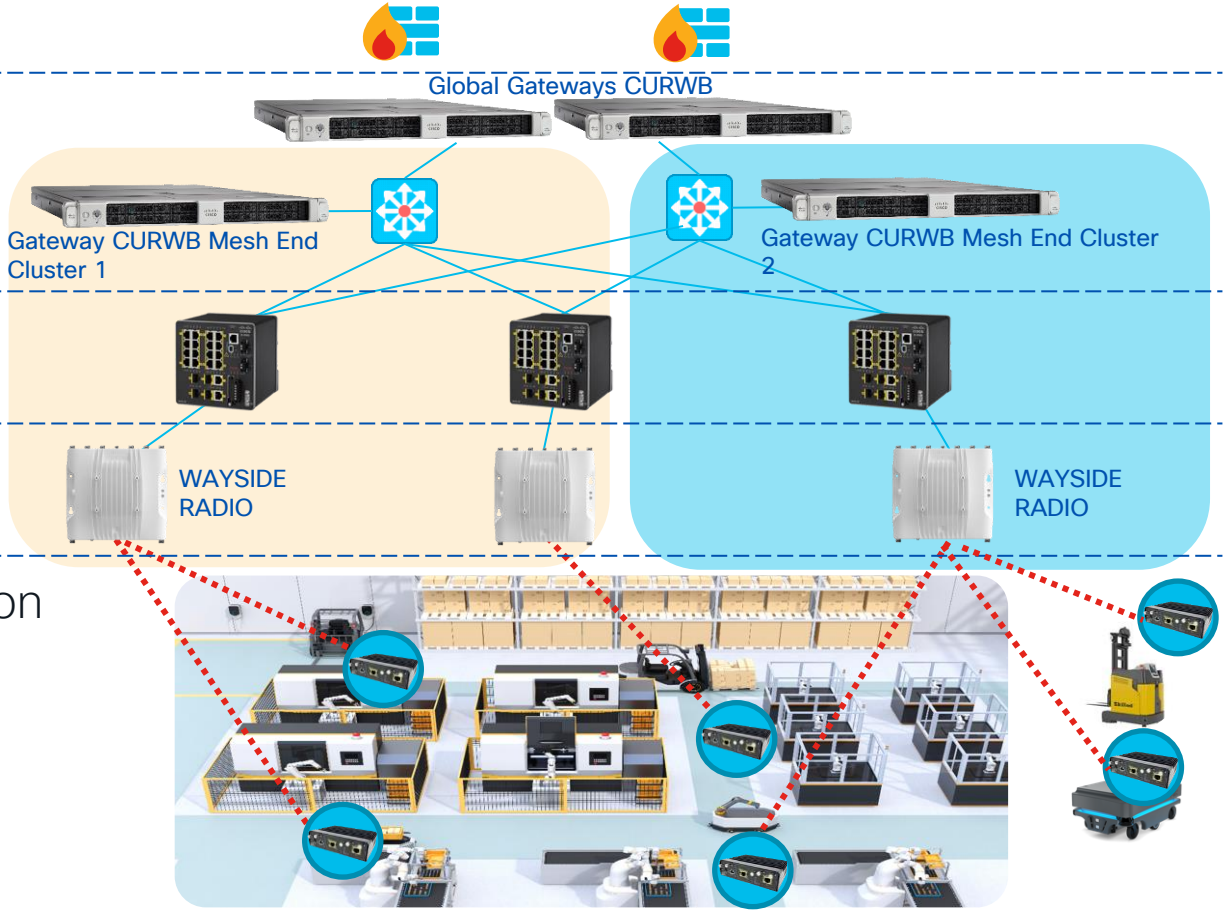
Fluidity Layer 3: typical network topology

DMZ/Firewall

Core Network

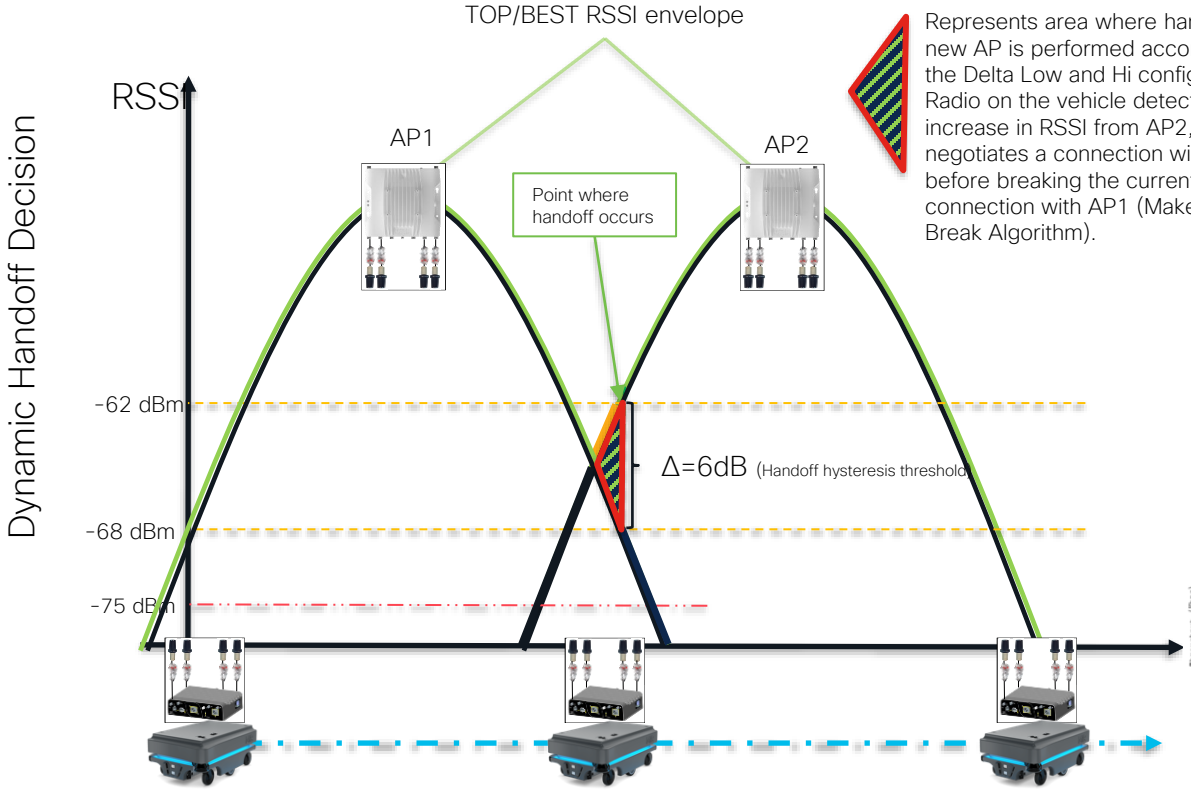
Access Network

Access Layer Radios

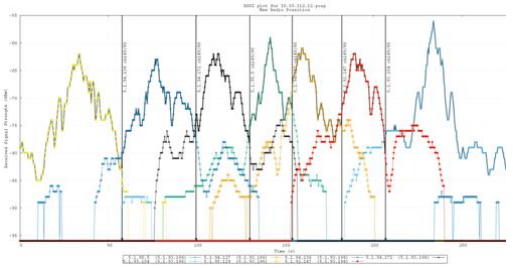


- Connectivity in motion
- Low latency
- Zero loss
- Scalability

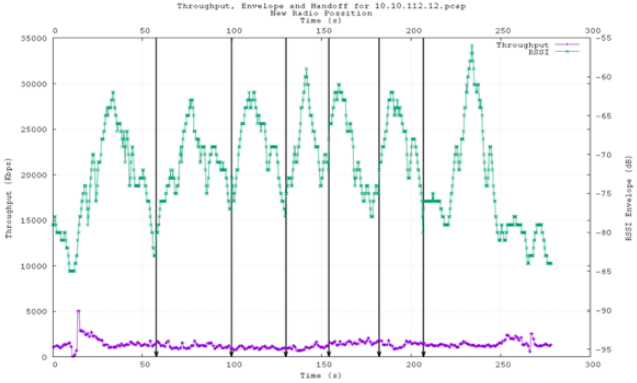
Fixed Infrastructure: Fluidity Coverage



Represents area where handoff to a new AP is performed according to the Delta Low and Hi configuration. Radio on the vehicle detects an increase in RSSI from AP2, where it negotiates a connection with AP2 before breaking the current connection with AP1 (Make-Before-Break Algorithm).



Radios always operate on the top line (RSSI Envelope), handing over to the next available AP as soon as the RSSI level is better than a designated delta value



Catalyst IW6300 Heavy Duty Series Access Points

Cisco®
Catalyst®
IW6300
Heavy Duty

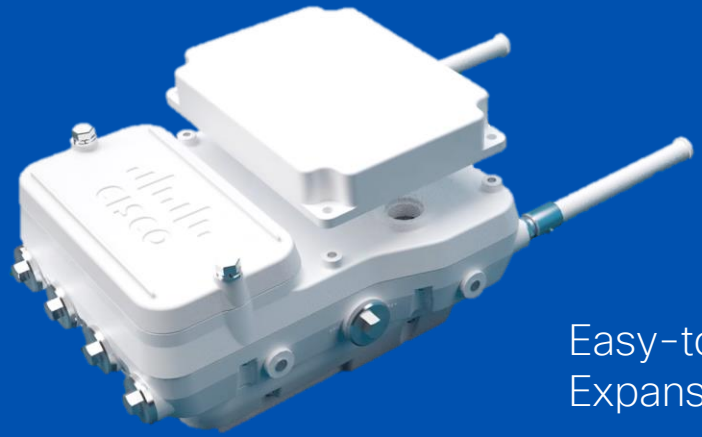
- Hazloc certified: Class I, Division 2/Zone 2
- Simpler deployment with light and more compact design
- 802.11AC Wave 2
- IoT module for enhanced capability
- Cisco® Digital Network Architecture (Cisco DNA) ready

Extend Intent-Based Networking to Hazardous Environment

Cisco Catalyst IW6300 IoT Partner module

Enabling partners to provide enhanced capabilities for their customers

Go further in your digital transformation. Connect to Wireless HART, ISA100 and more.



Easy-to-install
Expansion modules

WirelessHART | ISA.100 | GPS* | Bluetooth Low-Energy* | Zigbee*

- Future-proof your deployments
- Industrial IoT multi-lingual access brings IoT devices together
- Extend value to hazardous locations

*potential

Outdoor and Industrial Access Points Comparison

Parameter	IW-6300H	IW9167E	9124AXE
Wi-Fi standards	Wi-Fi 5	Wi-Fi 6/6E	Wi-Fi 6
Radio type	2.4 GHz (2x2:2SS) + 5 GHz (2x2:2SS)	2.4 GHz (4x4:4SS) + 5 GHz (4x4:4SS) + 5/6GHz (4x4:4SS)	2.4 GHz (4x4:4SS) + 5 GHz (4x4:4SS) or 2.4 GHz (2x2:2SS) + 5 GHz (2x2:2SS) + 5GHz (2x2:sSS)
Max Combined Data Rate	867 Mbps	7.8 Gbps	2.5 Gbps
Max Tx power	Up to 27 dBm	Up to 30 dBm	Up to 29 dBm
RF ports	x4 N-type female	x8 N-type female	x6 N-type female
Other radios	WirelessHart/ISA100 with IoT module	Built-in GNSS, IoT radio	IoT radio
Network interface(s) (PD - Powered Device PSE - Power Sourcing Equipment)	x1 GE SFP x1 GE PD port x2 GE PSE ports	X1 5G mGig PD port x1 SFP/SFP+ port M12 as optional accessories	x1 2.5G mGig PD port x1 SFP port x1 GE PSE ports
Power Options	AC/DC/PoE	DC/PoE	DC/PoE
PoE output	802.3at (30 Watts)	None	802.3af (15.4 Watts)
Industrial certification	Explosion-proof (IECEx, ATEX, UL)	Rail	N/A
Dimensions (W x H x D)	9.7” x 11” x 5.6”	11.3” x 10.5” x 2.8”	10.2” x 9.2”x 3.2”
Weight (lbs)	13.7	9.9	7
Operating temperature range[1]	-50 to +75°C	-50 to +75°C	-40 to +65°C

[1]Without solar loading and still air

Introducing Cisco's new Industrial Router portfolio

Impacting downtime, efficiencies and productivity

- ✓ Flexible
- ✓ Secure
- ✓ Scalable

Industrial Router – Complete Portfolio

Secured and optimized for *every* use case

Demanding, mission critical deployments

ATMs, low voltage substations, roadside traffic cabinets

Remote monitoring, streetlights, utility meters, intersections

Fleet, first-responders, pipelines

Factory, high voltage substations

Cisco Catalyst IR1101 Rugged Series Router

New 17.7.1

FIRSTNET. Built with AT&T READY

IR1101

- P-LTE-MNA Module: FirstNet Band 14
- P-5GS6-GL: 5G NSA

Deploy at scale with FirstNet SIM today!

Rugged

Secure

Modular

FirstNet®

5G

Edge Compute

IoT Operations Dashboard

Control Center

Cisco IR1101 – Modular Public/Private UEs

A unified platform, future-proofed for 5G

New
P-LTE-MNA
Band14(FirstNet)

Module	LTE Category	FCS
P-LTE-US *(AT&T)* ***LTE***, *Band 2, 4, 5 and 12* ***UMTS***, *Band 2, 4 and 5*	CAT4	16.10.1
P-LTE-VZ *(Verizon)* ***LTE***, *Band 4 and 13*	CAT4	16.10.1
P-LTE-GB *(Europe)* ***LTE,*** *Band 1, 3, 7, 8, 20 and 28* ***UMTS,*** *Band 1 and 8* ***2G,*** *900 and 1800 MHz*	CAT4	16.10.1
P-LTE-MNA(*Multicarrier-US)* ***LTE****,Band 2,4,5,12,13,****14(FirstNet)****,17,and 66* ***UMTS****:Band 2,4,and 5*	CAT4	17.1.1
P-LTE-EA(*Multicarrier-North America ,Europe)* ***LTE:*** *Band 1-5, 7, 12, 13, 20, 25, 26, 29, 30, and 41*	CAT6	16.11.1
P-LTEA-LA(*APJC, LATAM)* ***LTE:*** *Band 1, 3, 5, 7, 8, 18, 19, 21, 28, 38, 39, 40, and 41*	CAT6	16.11.1

Cellular Pluggable Interface Modules for Industrial Routers

Cellular Interface Modules

								
P-LTE-GB Cat4	P-LTE-US Cat4	P-LTE-VZ Cat4	P-LTE-MNA Cat4	P-LTE-IN Cat4	P-LTE-JN Cat4	P-LTEA-EA P-LTEA-LA Cat6	P-LTEAP18-GL Cat18	P-5GS6-GL 5G Sub-6GHz
↓ 150 Mbps ↑ 50 Mbps	↓ 150 Mbps ↑ 50 Mbps	↓ 150 Mbps ↑ 50 Mbps	↓ 150 Mbps ↑ 50 Mbps	↓ 150 Mbps ↑ 50 Mbps	↓ 150 Mbps ↑ 50 Mbps	↓ 300 Mbps ↑ 50 Mbps	↓ 1.2 Gbps ↑ 150 Mbps	↓ 3.5 Gbps ↑ 500 Mbps

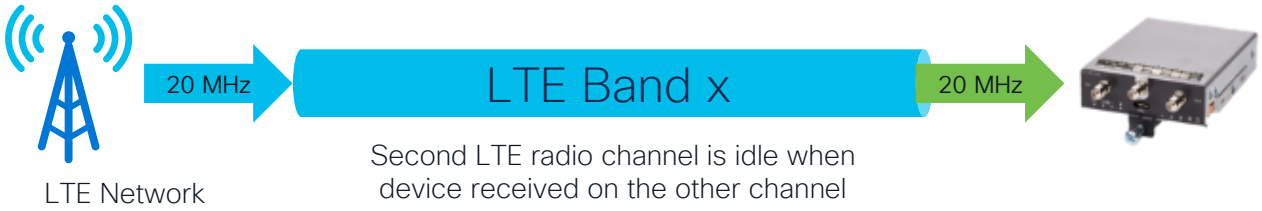
IR1101

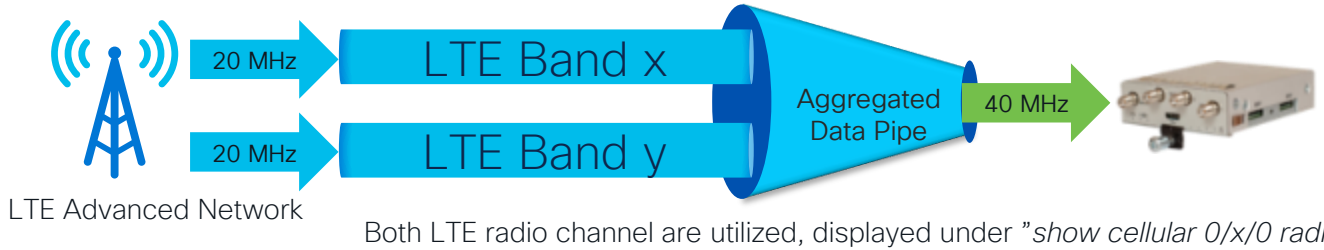
IR1821, IR1831, IR1833, IR1835

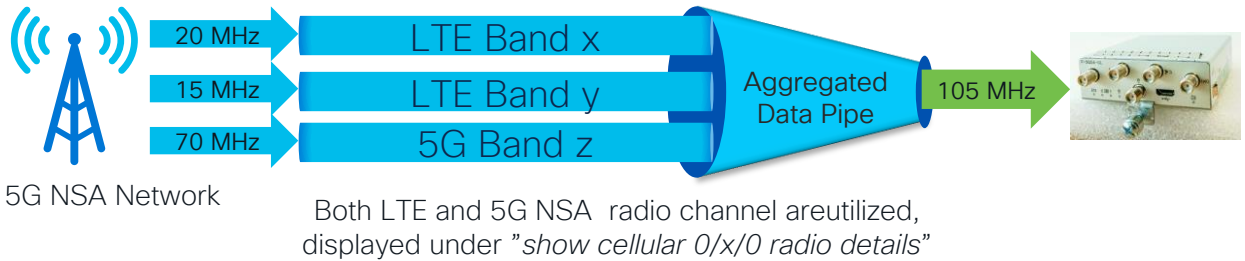
IR8100

IR8300

What is Carrier Aggregation?



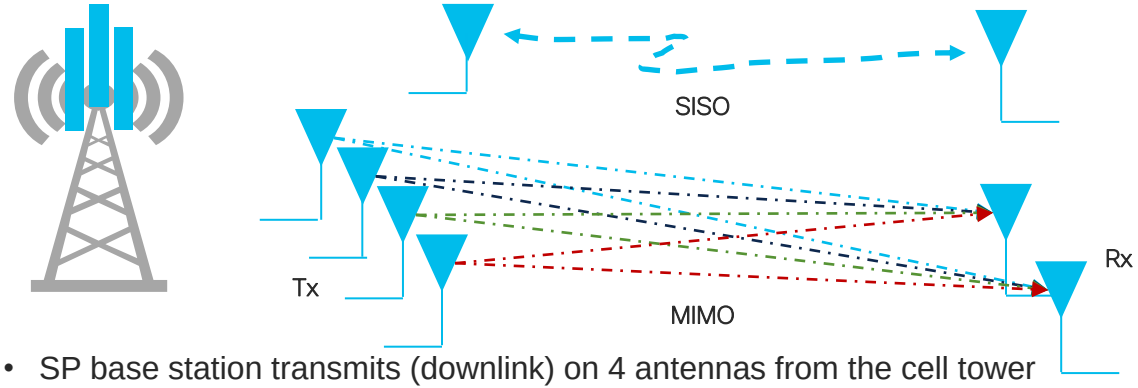




Modules	LTE Version	Carrier Aggregation
P-LTE-US	LTE	-
P-LTE-VZ	LTE	-
P-LTE-GB	LTE	-
P-LTE-MNA	LTE	-
P-LTE-EA	LTE Advanced	✔
P-LTE-LA	LTE Advanced	✔
P-LTEAP18-GL	LTE Advanced Pro	✔
P-5GS6-GL	LTE Advanced Pro And 5G NSA	✔

- P-LTEAP18-GL can achieve 1.17 Gbps with 3cc carrier aggregation, 20 MHz channel and 4X4 MIMO under ideal channel conditions.
- P-LTEAP18-GL band combinations for 2cc, 3cc, 4cc, and 5cc differ based on active Firmware

What is Cellular Downlink MIMO?



- SP base station transmits (downlink) on 4 antennas from the cell tower
- Cisco IR series receive on 2 antennas, hence 4 x 2 MIMO,

(or 2 x 2 MIMO if the service provider uses older infrastructure)

- Cisco IR series transmits (uplink) on a single antenna, not MIMO

- SISO: Single Input Single Output – single antenna that is only 1 input/output
  - Antenna's type such as LTE-ANTM-D or ANT-4G-OMNI-OUT-N
- MIMO: Multiple Input Multiple Output – multiple antennas are needed for MIMO, such as
  - Cisco IR with 2 x LTE-ANTM-D or ANT-4G-OMNI-OUT-N on IR series
  - Cisco IR829 with ANT-3-4G2G1-O or ANT-2-4G2-O or ANT-5-4G2WL2G1-O that incorporates multiple antenna elements inside under a single radome

IR Series with Main/Div antennas

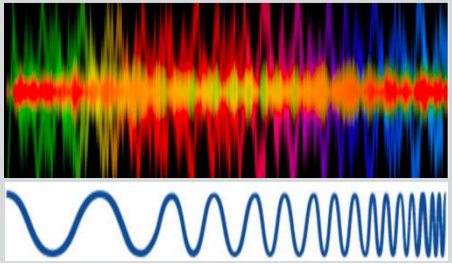
- SISO uplink (Main antenna)
- MIMO (4x2 or 2x2) downlink

5G New Radio (NR) – The Highlights

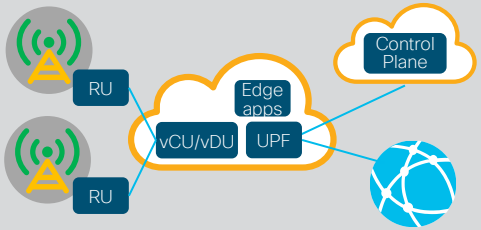
P-5GS6-GL
5G Sub-6GHz

↓ 3.5 Gbps
↑ 500 Mbps

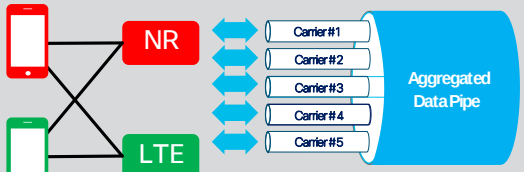
Expanded Spectrum: NR new bands



RAN Decomposition: Towards vRAN

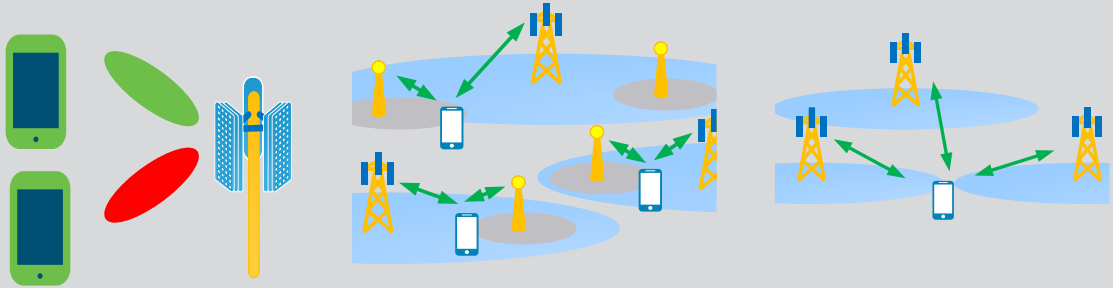


Multiband connectivity



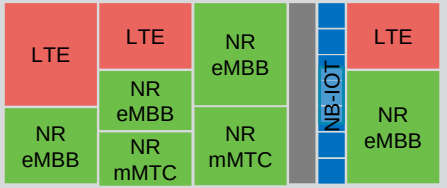
CA & DC options

Advanced Radio Techniques



Orthogonal Frequency-Division Multiple Access, Multi-User Multi Input Multi Output, Beam Formation

DSS & Flexible NR Protocol



Dynamic Spectrum Sharing (share spectrum 4G & 5G)
5G Bandwidth parts optimized for different service types / slices

Cisco WAN Portfolio For Flexible Connectivity

4G

LTE

CAT 4
150 Mbps
DL

LTE Advanced

CAT 6
300 Mbps
DL

CAT 11
600 Mbps
DL

LTE Advanced Pro

CAT 18
1.2 Gbps
DL

5G

5G
6.5 Gbps
DL

Integrated Solutions

C8K/ISR4K/ISR1K

Network Modules

4G/Cat18 (PIM)

5G/sub-6 (PIM)

Cellular Gateways

Meraki MG41
(5G target '22)

4G/Cat18

5G/Sub-6

5G/mmWav
e

Differentiators in Cellular Gateways

IP Passthrough with only single PDN

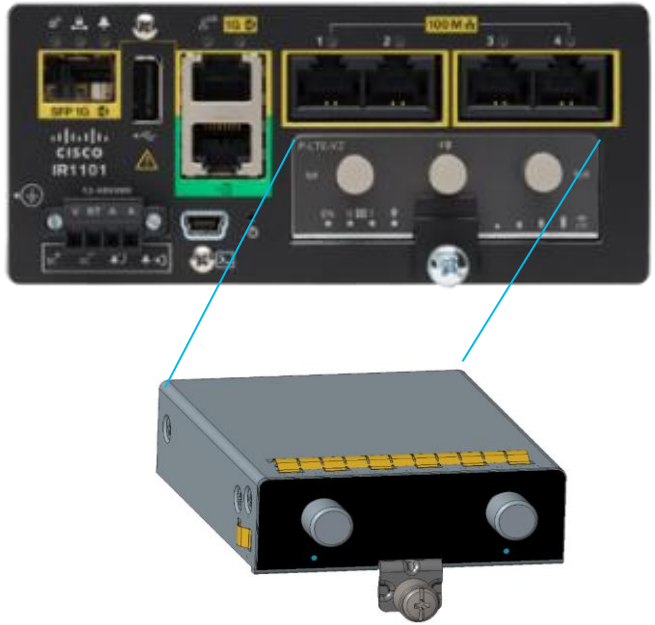
Failure Recovery with Dying Gasp

mGig Support

Out-Of-Band Management

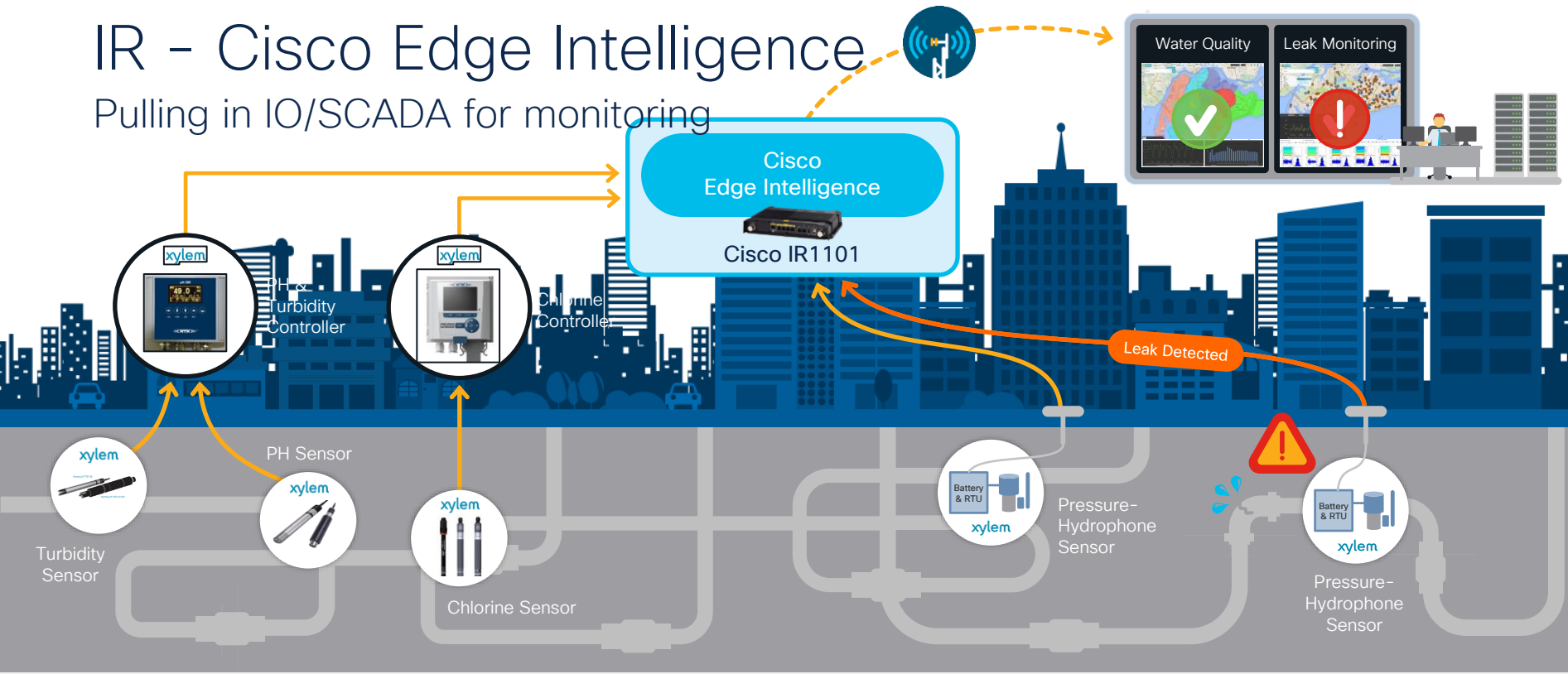
LoRaWAN PIM

- LoRaWAN Pluggable Interface Module for IR1101
  - Base and extension module
  - Other IR support in future, i.e. IR1800
- 2 SKUs
  - P-LPWA-900 for US915, AS923 and AU915
  - P-LPWA-800 for EU863, RU864 and IND865
- Based on Semtech SX1303
  - LoRaWAN Class A, B and C support
  - 8 channels
- IOS-XE 17.10 support – LoRa Forwarder as a container application
  - Actility Thingpark LRR
  - Semtech Basic Station (Common Packet Forwarder (CPF))
- Antennas: LoRaWAN and GNSS



IR – Cisco Edge Intelligence

Pulling in IO/SCADA for monitoring

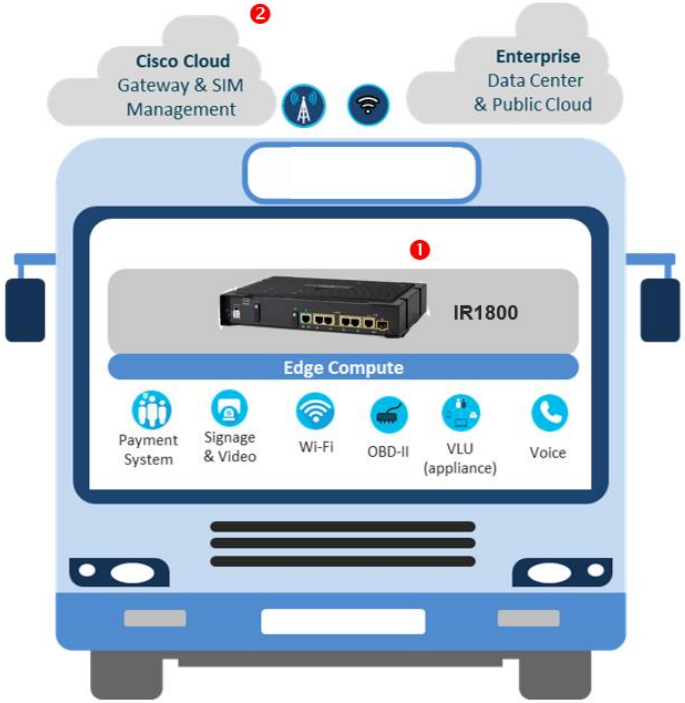


Use Case
Water Distribution

- MQTT, UPCAA
- Water quality monitoring
- Real-time water leakage detection

Transportation Use Case

Public Cellular w/Passenger WiFi + CURWB (optional)



<12 mo. **Average Customer Payback**

"Cisco was furthest along with respect to a true end-end solution for our smart bus program"

—customer

Challenge

1. Need to deploy more passenger services, faster.
2. 1,000s of assets, multiple gateways, disjointed systems, weak cybersecurity.
3. Difficult for mechanics to deploy and operate.

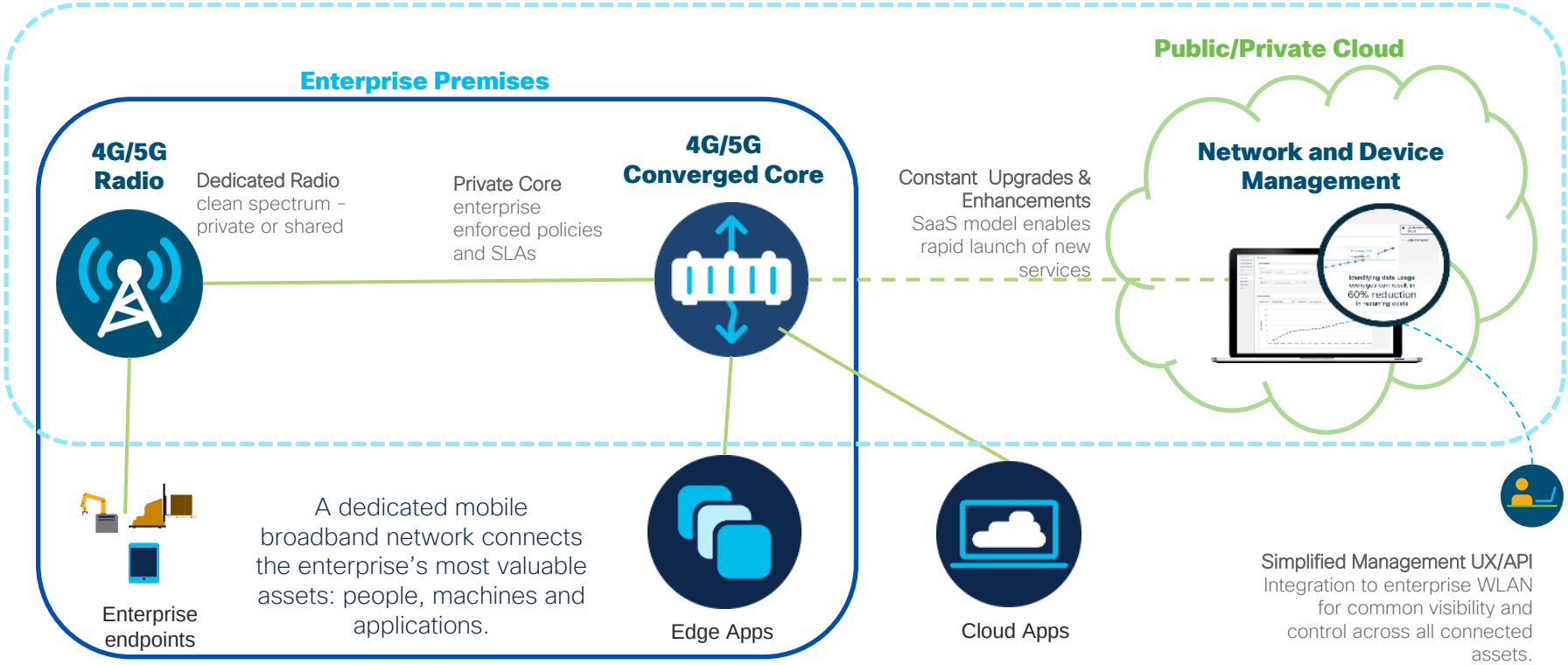
Solution

1. Secure gateway with native edge compute.
2. Mechanic-friendly gateway and SIM management.

Outcomes

- **Simple** transit operations, zero-touch.
- **Scalable** & secure infrastructure for consolidated communications.
- **Flexible** edge compute for native support of application services.

Cisco Private 5G Architecture



US Private Spectrum (typ.) - CBRS Band 48 (3.5GHz)

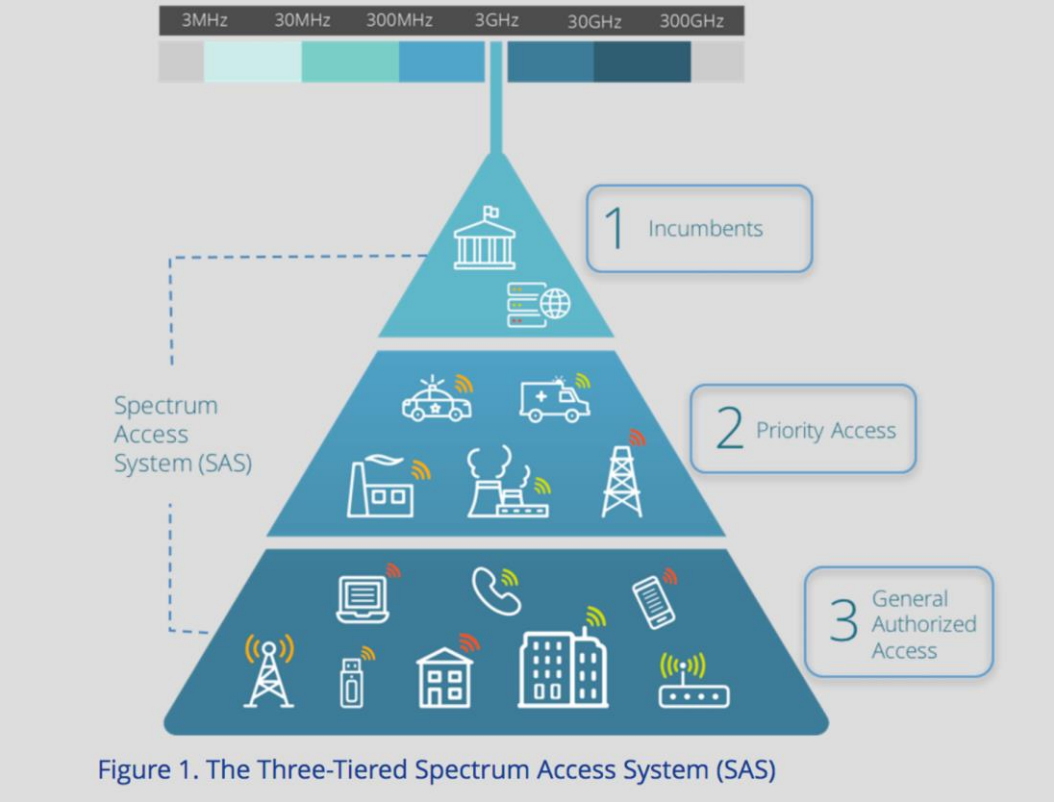


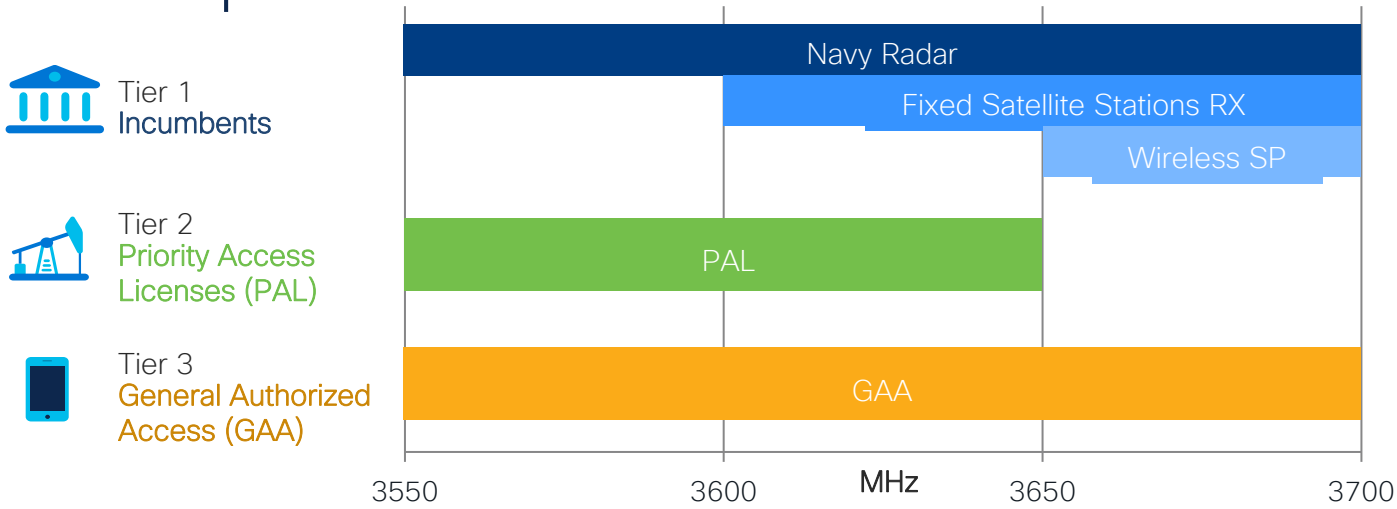
Figure 1. The Three-Tiered Spectrum Access System (SAS)

1) Incumbents:
Existing users (e.g. US Naval Radar, DoD personnel) get permanent priority as well as site-specific protection for registered sites.

2) Priority Access Licenses (PAL): Auction ~ June 2020
Organizations license up to four (10MHz) PALs in a limited geographic area (county) for three years. Only the lower 100 MHz of the CBRS band will be auctioned off; with a max of seven concurrent 10 MHz PALs allocated within the same region.

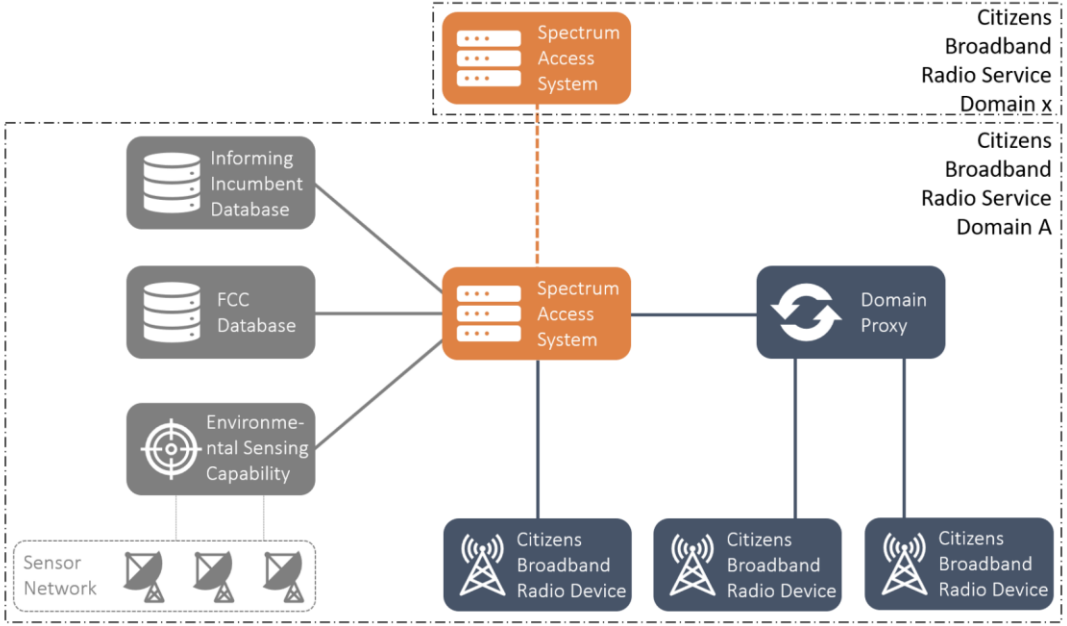
3) General Authorized Access (GAA):
The rest of the spectrum will be open to GAA use and coexistence issues will be determined by SAS providers for spectrum allocation.

Locally Shared Licensed Band – U.S. CBRS Example

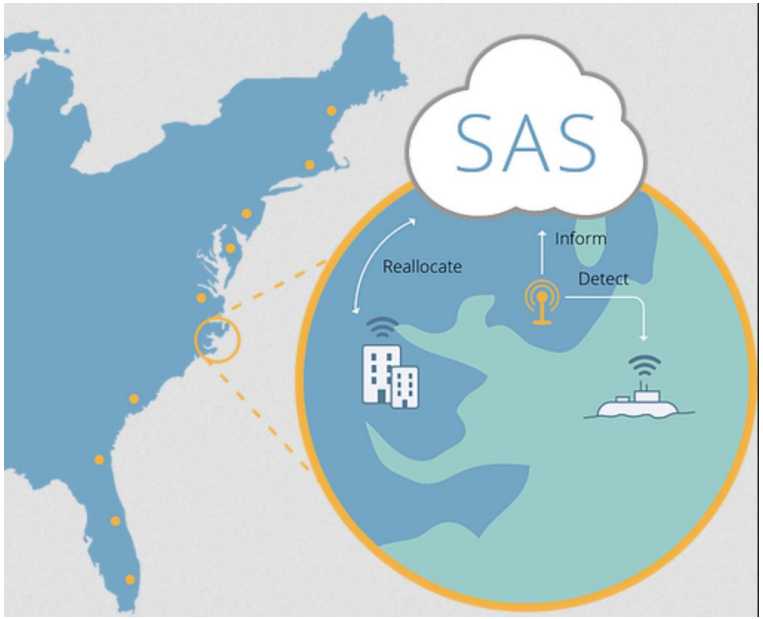


- Citizens Broadband Radio Service (CBRS) is a 150 MHz of the 3.5 GHz band (3550 MHz to 3700 MHz or band 48) in the U.S. – Management done through Spectrum Access System (SAS).
  - CBRS alliance https://www.cbrsalliance.org/ and OnGo certification
  - Class A (up to 1W) indoor and outdoor (antenna 6m high) and Class B (up to 50W) outdoor eNodeB
- ETSI has similar proposal on 2,300 MHz – 2,400 MHz, but not yet endorsed by countries who may open different bands
- EU Bands n77 and n78 (3.4-4.2GHz Range), France b28 opened recently

CBRS SAS (Spectrum Access Server) – Sync and Sensing

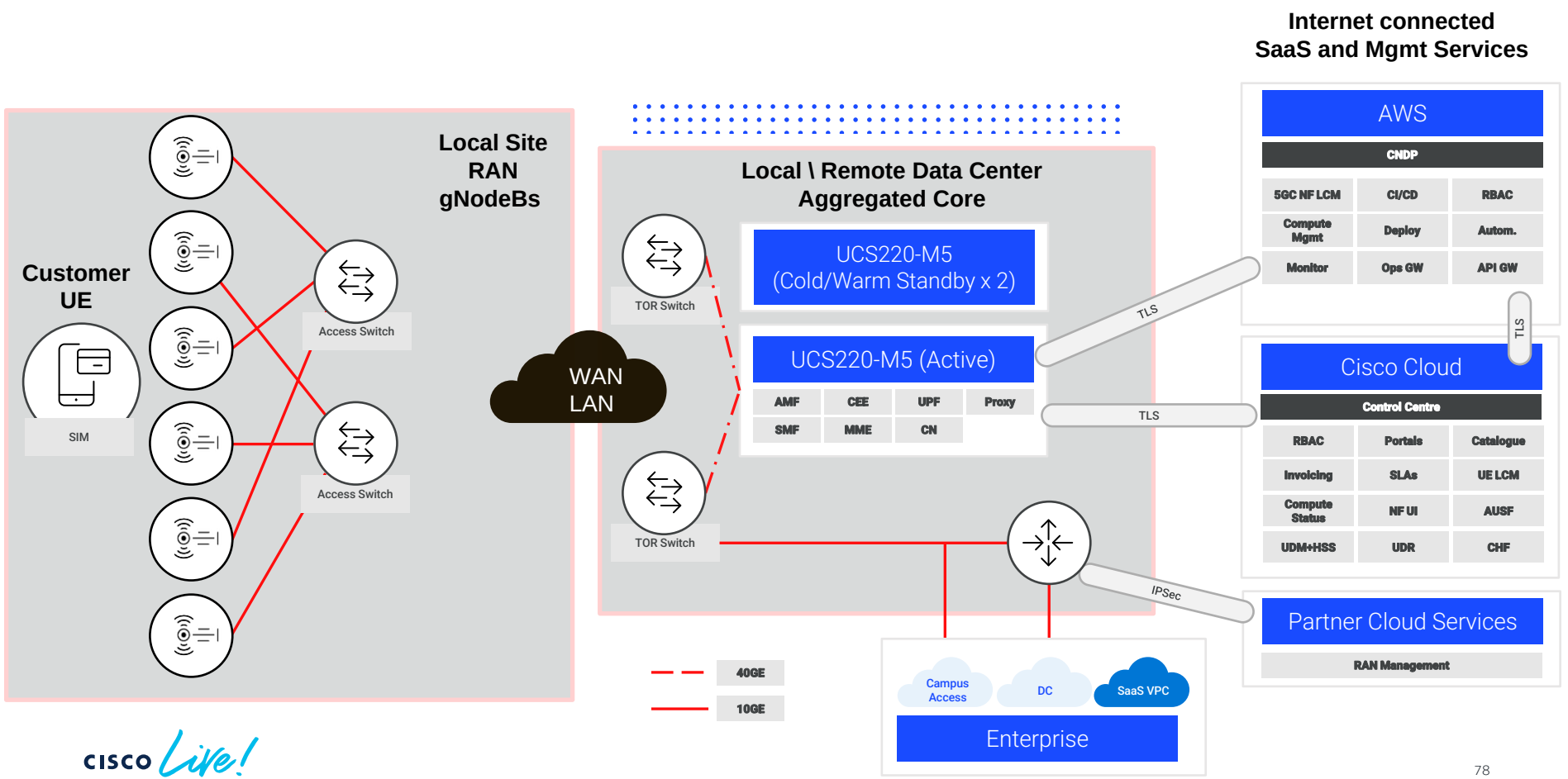


The Citizens Broadband Radio Service (CBRS) Control Architecture



- Typical sync interval is 4 minutes between the RAN and SAS network
- Internet or network delays may cause service disruptions
- Cannot operate on a closed off Private LAN, and must be connected to the SaaS services via the Internet

Private Cellular – Architecture Components



Private Cellular – Architecture Components

Cisco Control Center Subscription

1. Monthly Radio Fee
2. Monthly Client Fee

Cisco Control Center
UX & API interface, Cisco Cloud hosted core NF

+

On-premise Cisco Components

- Cisco UCS Server
- Identity Services
- Umbrella and Thousand Eyes

Cisco Packet Core Server

+

Radio Partners (RAN)

Airspan

JMA WIRELESS

Radio

+

End User Equipment

CISCO inseego ZEBRA cradlepoint SAMSUNG

Cisco ISE Umbrella SecureX

CISCO Managed Services

Cloud Management Instantiation
SIM onboarding
Solution Activation
Cisco Core Components
- Tier1/2/3 support
- Performance KPI analysis
- 5G Core Optimizations

Partner Managed Services

Enterprise Network Management
RAN Components Management
- Tier1/2/3 support
- Performance KPI analysis
- Ongoing Management
- RMA support
- RAN Optimization

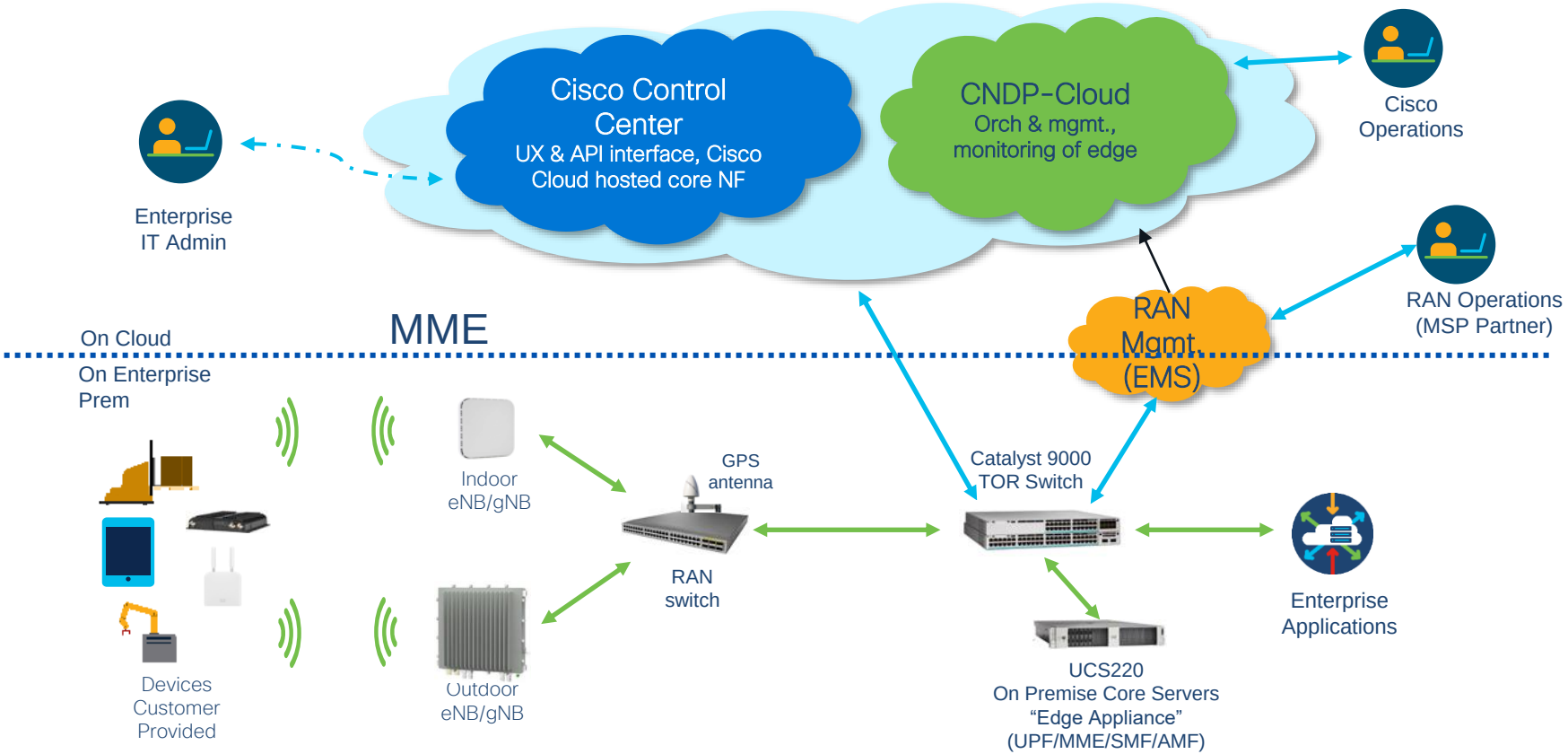
Spectrum Management
SIM management

Private Cellular – Architecture Components

Cisco	Airspan / JMA RAN	Partner Services		Customer

• Support solution Integration (RAN, Core, Cloud)
• Cloud Management Instantiation
• SIM onboarding
• Solution Activation
• For Cisco Core Components
  • Tier 1/2/3 support
  • Performance KPI analysis
  • Ongoing Management
  • RMA support
  • 5G Core Optimization
	• Support Pre-launch solution Validation
	• For RAN Components
	  • Tier 1/2/3 support
	  • Performance KPI analysis
	  • Ongoing Management
	  • RMA support
	  • RAN Optimization
		• Site Preparation
		• Order Solution components
		• Organize Spectrum
		• SIM management
		• Staging
		• Creating of customer profiles
		• Core & RAN Installation
		• Core NF configuration
		• Pre-launch Solution validation
		• SLA Management
		• 24x7 Helpdesk, 2nd & 3rd Level, triage & coordination
			• RMA Management
			• Solution Optimization
			• Application & Device Integration
			• Customer Care & Service
			• Spectrum application
			• End Customer Service Portal
			• 24x7 Helpdesk 1st level Support
			• Transport Network Managed Service
				• Spectrum application (Support)
				• SIM Installation in UE
				• UE validation (optional)
				• Self-service management of UEs

Cisco Private 5G Offer – Architecture



What is LoRaWAN? – Long Range WAN

A disruptive wireless technology for low data rate secure communication

RF unlicensed spectrum (900MHz)

Long Distance Connectivity (15+ km)

Low Data Rate (kbps)

Low Power Solution (Battery)

LoRaWAN End-to-End Architecture

Pressure
Flow Rate
Power
Pulse Input
Humidity
Temperature

LoRaWAN™ Devices
Certification by LoRa Alliance

IXM Gateways

LoRaWAN Network Server(s)
Geo-location solver

IP Backhaul

API (HTTPS, MQTT, AWS, Azure IOT...)

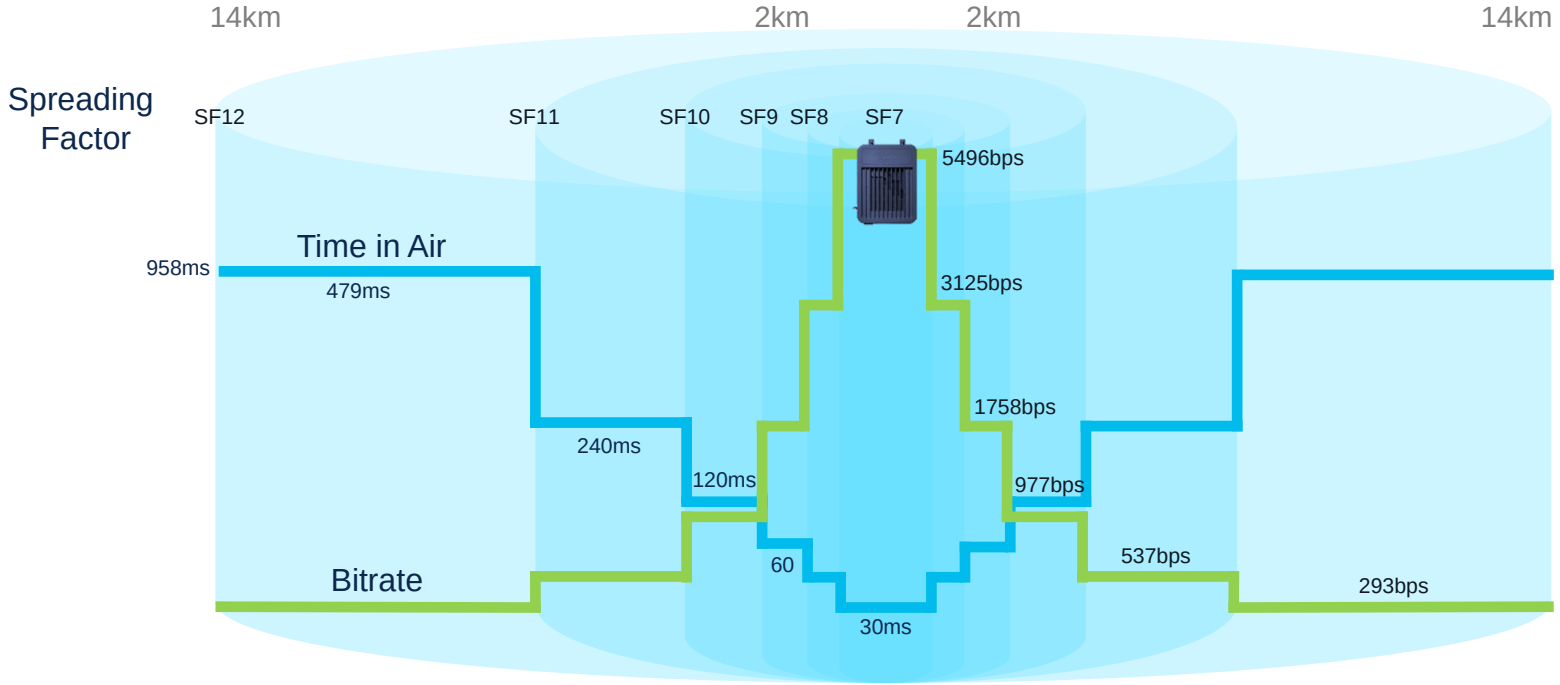
Measure Data
Report Events
Track
Application Servers

App Data | LoRaWAN™ Radio PHY | LoRaWAN™ MAC | IP Tunnel | IP Transport | App Data

MAC Layer encryption (NwkSKey)

App Layer encryption (AppSKey)

LoRaWAN Adaptive Data Rate (ADR)



- ADR maximises battery life overall & network capacity
- ADR manages the data rate and RF output for each device

LoRaWAN – ADR, Better design, better battery life

Spreading Factor	Data Rate (bit/s)	Time on Air (ms)	Maximum Payload Size	End-device sensitivity (dBm)
SF12	250	1400	59 bytes	-137
SF11	440	740	59 bytes	-135
SF10	980	370	59 bytes	-133
SF9	1760	200	123 bytes	-130
SF8	3125	100	250 bytes	-127
SF7	5470	28	250 bytes	-124

EU 863-870MHz Frequency band, 125kHz channels

US915 Frequency band, @125kHz channels Upstream

IXM Accessories

- Most minimal configuration (perfect for lab or internal use):
  - IXM powered via PoE+ or injector (AC-to-DC injector: AIR-PWRINJ6)
  - One 1.5dBi ANT-WPAN-OD-OUT-N, directly connected to IXM
  - Optionally, add a second antenna for Rx Diversity; not likely to see much improvement for indoor environments.
  - Connection to GPS antenna is optional

- Outdoor configuration:
  - IXM powered via PoE+ or injector (rugged DC-to-DC injector: PWR-INJDC-30)
  - One 5dBi ANT-LPWA-DB-O-N-5, connected to IXM via cable (AIR-CAB010LL-N); this antenna cannot be directly connected to the IXM.
  - Optionally, add a second antenna/cable for Rx Diversity
  - Connection to GPS antenna is optional
  - For more permanent installation (ie. on a rooftop), consider lightning/surge protection equipment.
    - PoE surge protector: ACC-SP-POE-GE
    - Antenna lightning arrestor: ACC-LA-H-NM-NF
    - GPS lightning arrestor: ANT-GPS-OUT-TNC

- When only a single antenna is used, make sure to connect it to antenna port #1 (labelled on the top of the IXM).

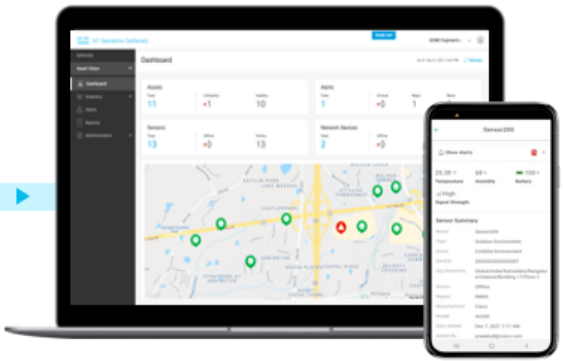
An all-in-one industrial sensor solution

Industrial Asset Vision helps operations teams address digital blind-spots and improve preventative maintenance

Cisco industrial sensors

Cisco IXM Gateway (LoRaWAN)

Cloud-based dashboard & mobile app



- ***NEW!*** **Industrial Sensor Bridge**
  Connects to any third party sensor with analog or Digital output (4-20mA, 0-10V DC)
- ***NEW!*** **Industrial Vibration Sensor**
  Machine health condition monitoring

Affordable connectivity over large areas

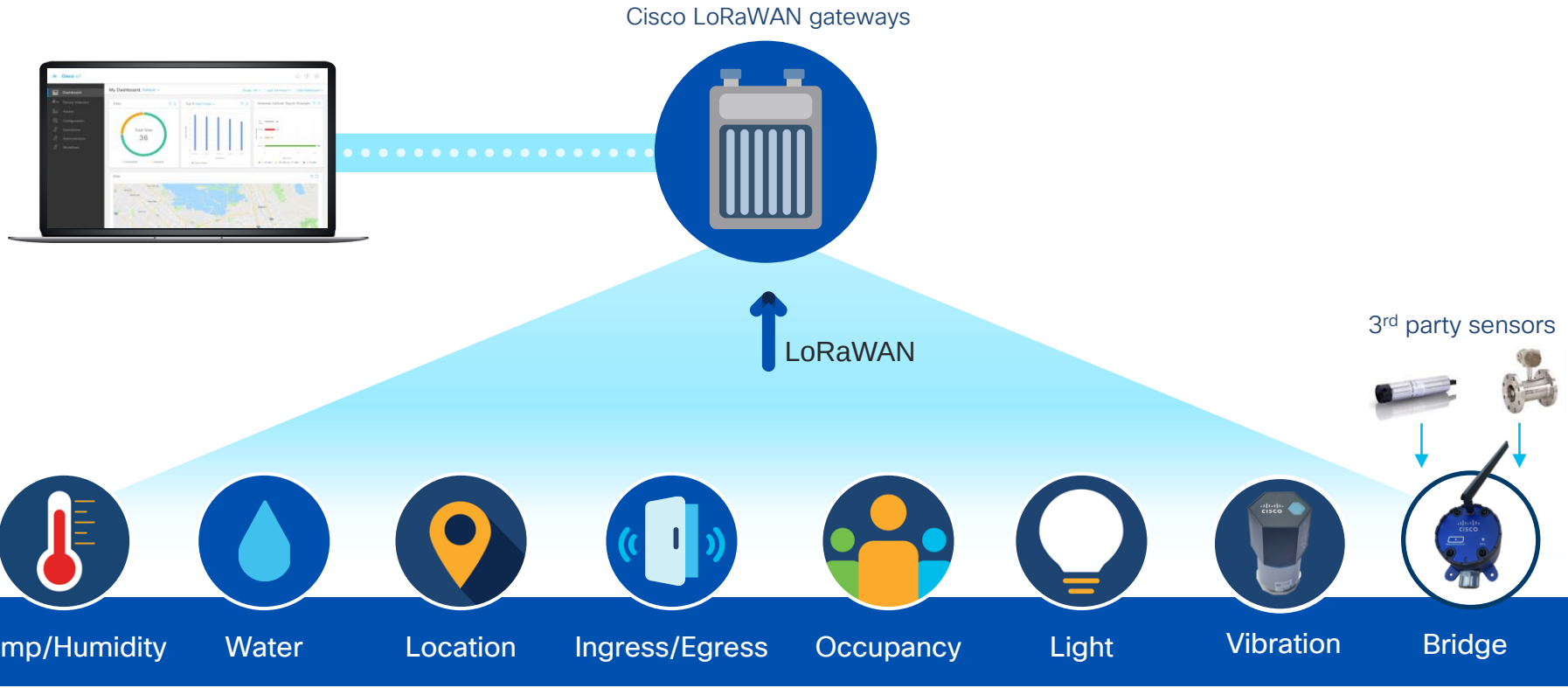
Deep signal penetration

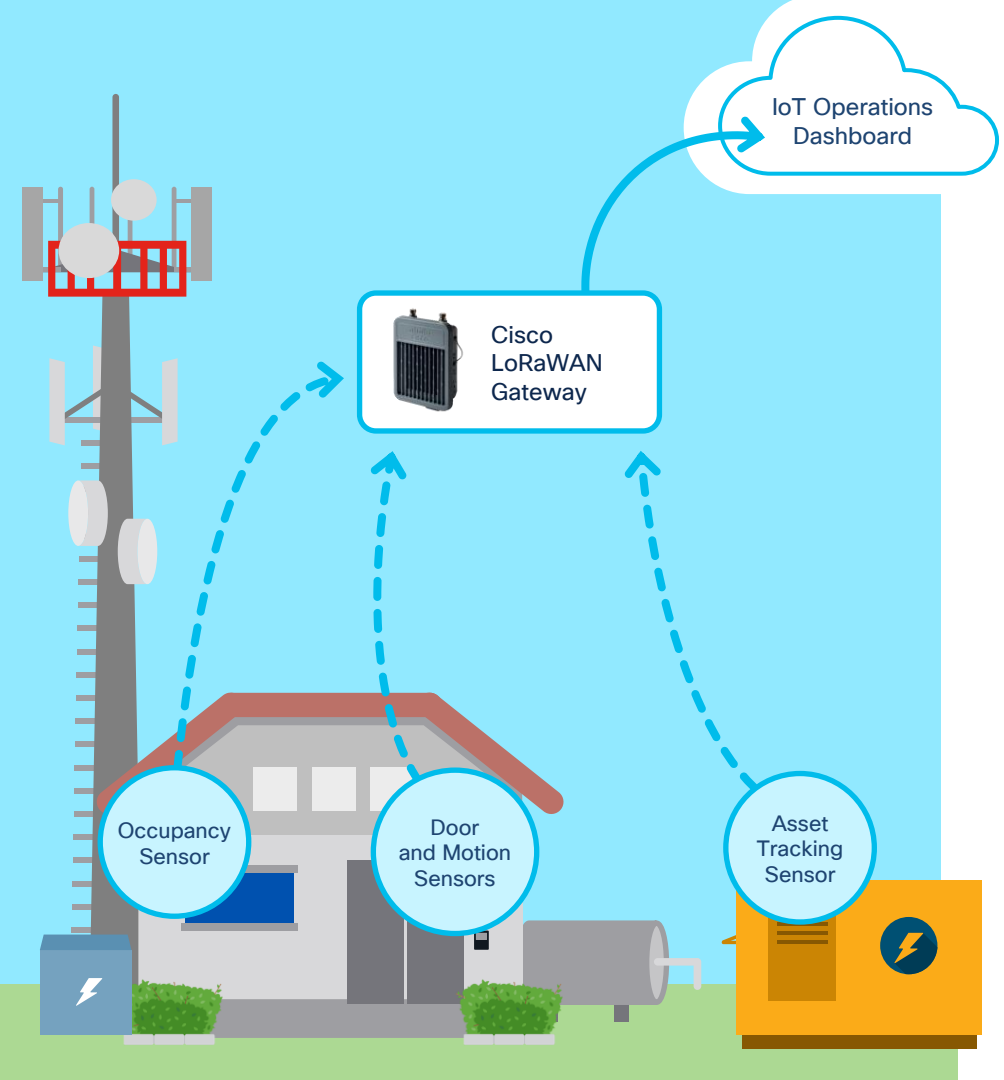
Low power consumption

Connectivity to high device densities

Industrial Asset Vision sells Gateway and Sensors

Cisco sensors plus 3rd party sensors via Cisco Industrial Sensor Bridge





Remote Facility Monitoring

Industrial sites and remote facilities

Key Problems To Be Solved

- Distributed locations that are unmanned or don't have right skillset to fix problems
- Theft or equipment loss
- Unnecessary site visits, problems are often unknown until arrival

Solution

- IoT Operations Dashboard
- Industrial Asset Vision + Sensors

Business Outcomes

- Optimized service calls and work
- Improved efficiencies and safety with visibility across site, equipment and workers
- Lower costs
- Higher uptime

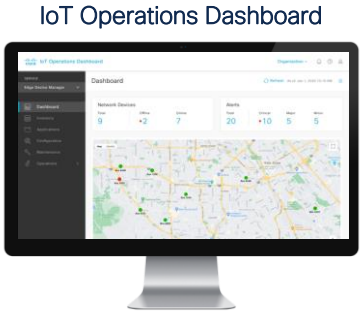
Cisco Industrial Sensor Bridge

What Can be Connected to It?

PID: AV400-BRI-EU/US; list price: 1388$

IoT Operations Dashboard

A cloud platform of OT services to connect, maintain and secure industrial assets and gain insights



Deploy and monitor industrial networks

- Routers
- Wireless backhaul (URWB)
- LoRaWAN

Secure Equipment Access

Secure remote access to industrial assets

Cyber Vision

Visibility into asset inventories and security posture

Edge Intelligence

Collect and manage data

Industrial Asset Vision

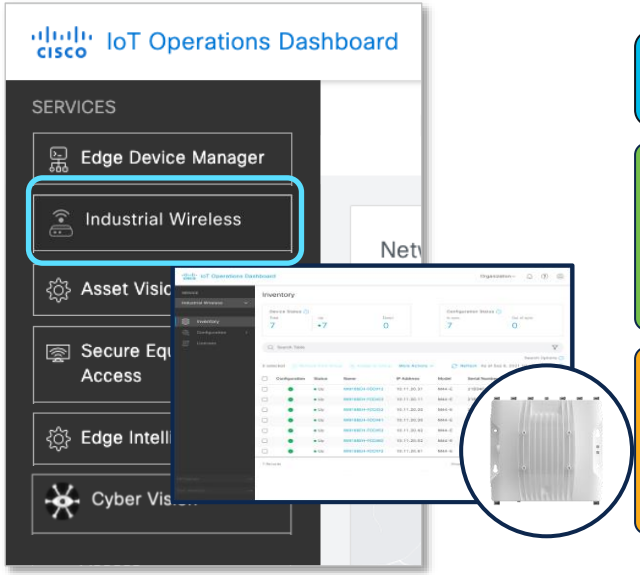
Industrial sensors

Edge application management

Manage applications across the network

Cisco Industrial Wireless Backhaul

Industrial Wireless in IoT Operations Dashboard
Centralized configuration, deployment, provisioning, and monitoring of IW URWB devices



Visibility across your industrial wireless backhaul network, with ability to drill down to device details

IoT Operations Dashboard Online or offline

- Onboard, configure and deploy IW devices for wireless backhaul
- Inventory check and control
- Template configuration
- IW Monitor capability to troubleshoot the network

IoT Operations Dashboard

- Centralized Management
- Firmware Update
- Zero-Touch Provisioning

IW9167E 

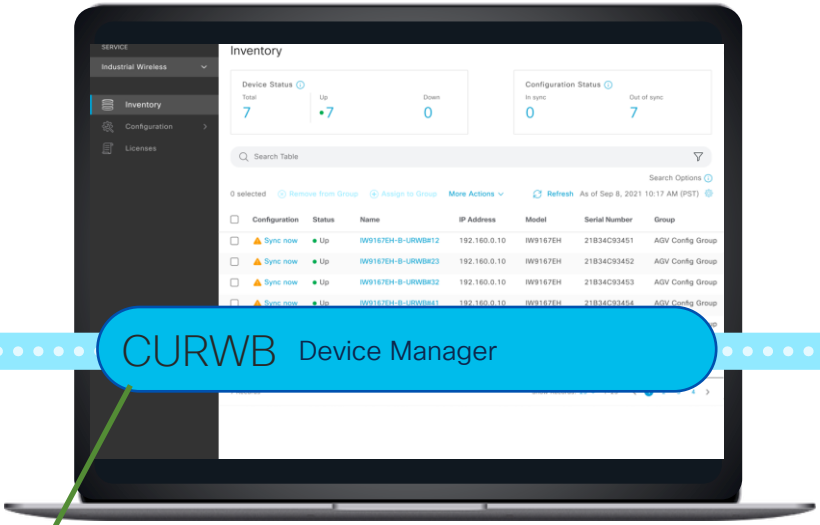
IW9165E 

IW9165D 

IEC6400 Edge Compute Appliance 

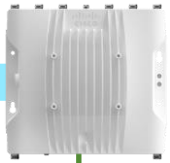
Spring 2023: IW Service

Easy Management of the Cisco IW9167EH



CURWB Device Manager

Cisco IW9167EH



Note: IW Service supporting IW9167EH CURWB mode only

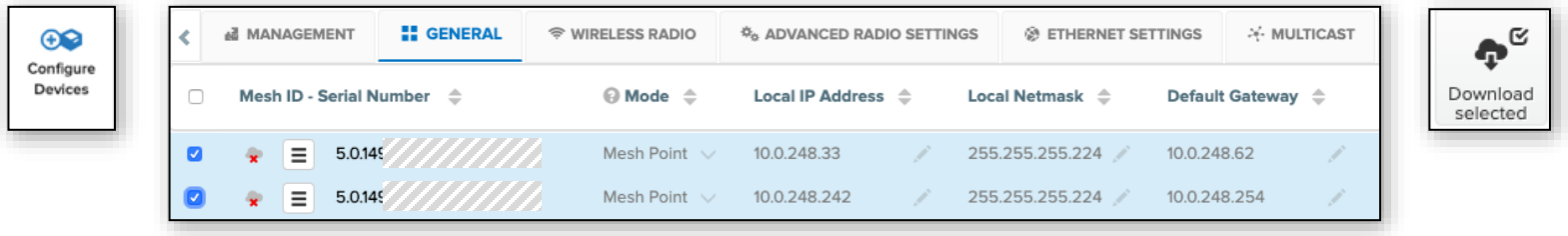
- Template based configuration supporting both air-gap and cloud connected deployments
- Firmware updates
- Device monitoring (future releases)
- Location tracking (future releases)

Easy, zero-touch installation

On vehicles, sites, cabinets, sub-stations, …

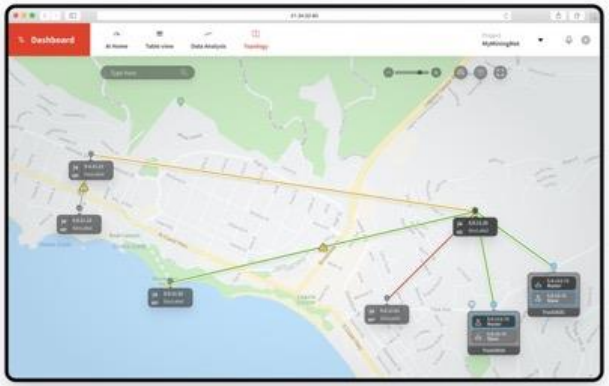
Management/Monitoring: RACER, FM-MONITOR, FM-QUADRO

RACER: Provisioning/Configuration

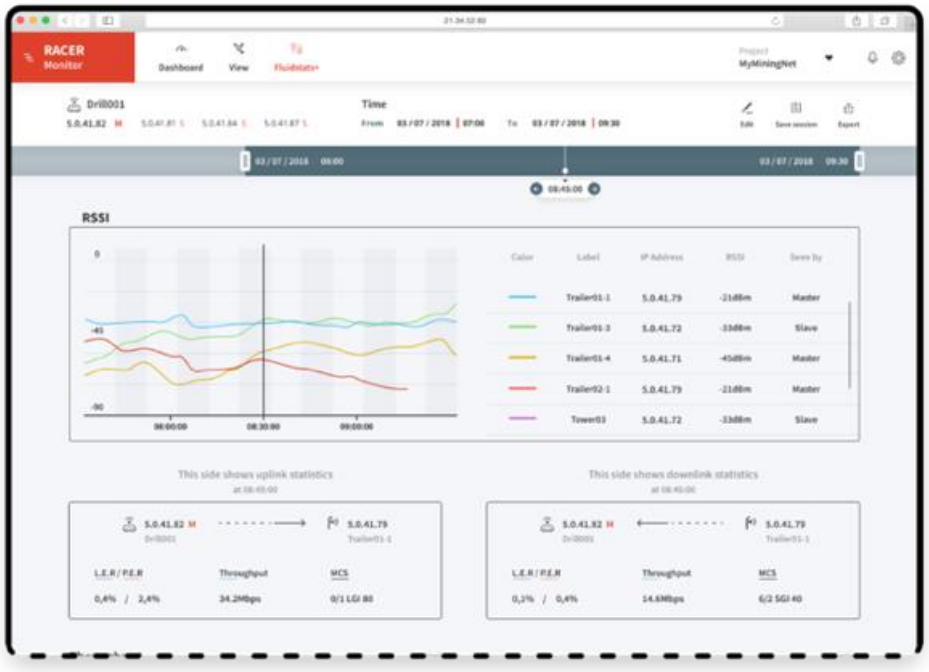


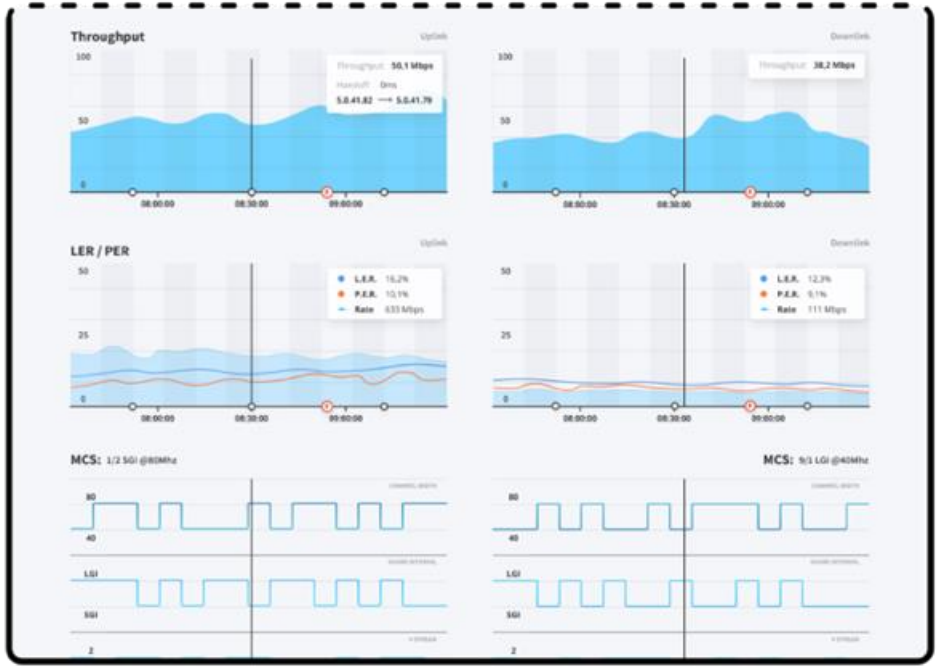
FM-Monitor: Monitoring/Key Performance Indicators (Live and history)

FM-QUADRO: Visualization

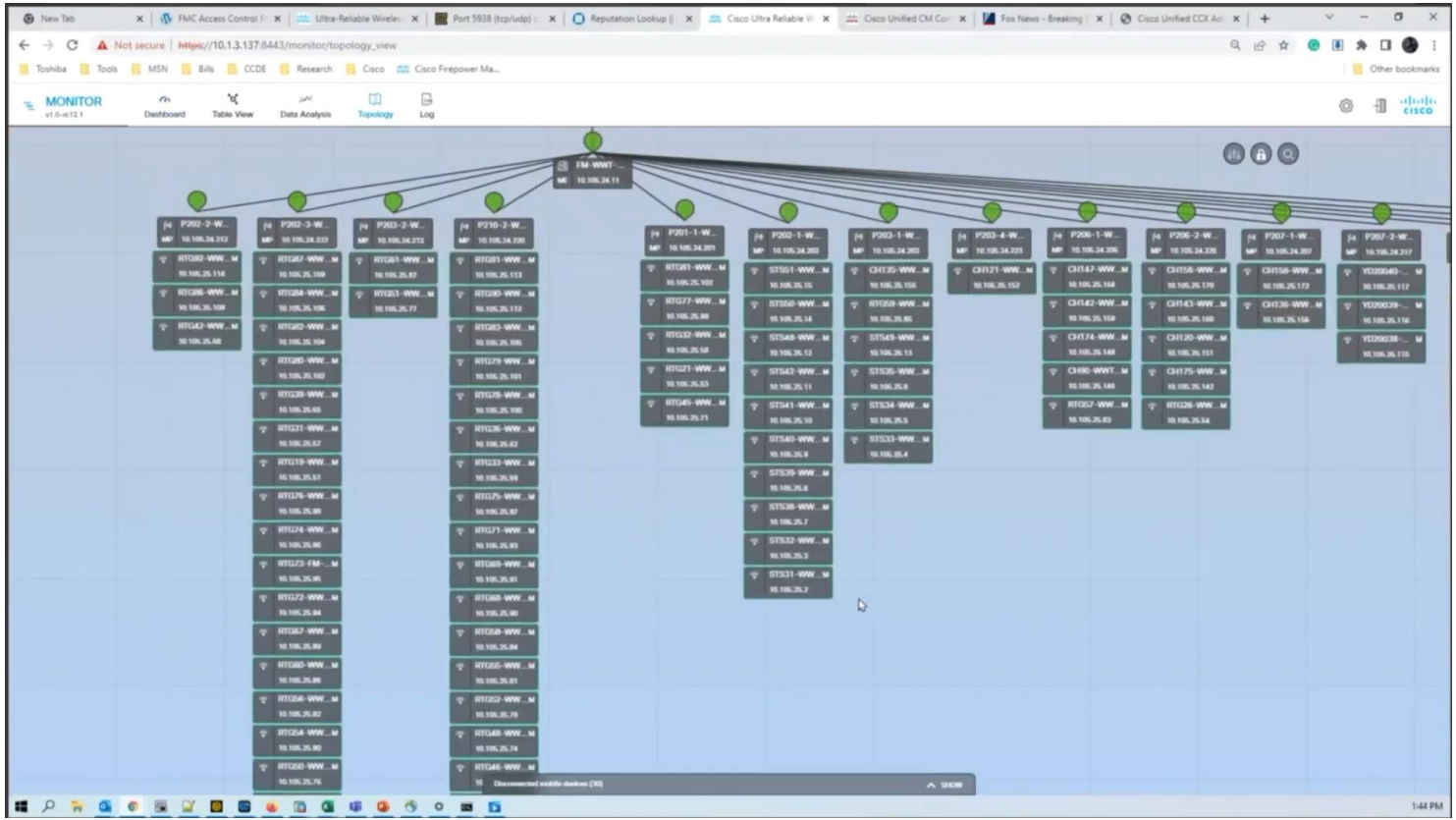


Management/Monitoring: RACER, FM-MONITOR, FM-QUADRO

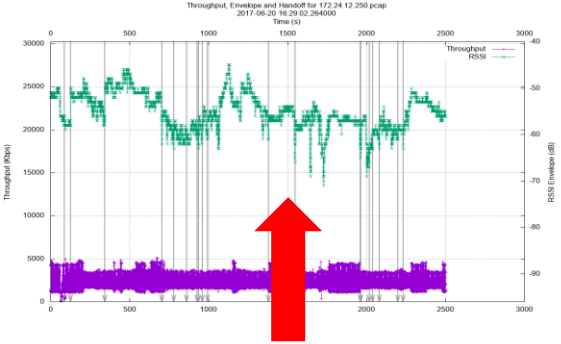




CURWB Monitor: Fluidity Connectivity Summary



Gathering Fluidity Wireless KPIs w/GPS + Fluidstats



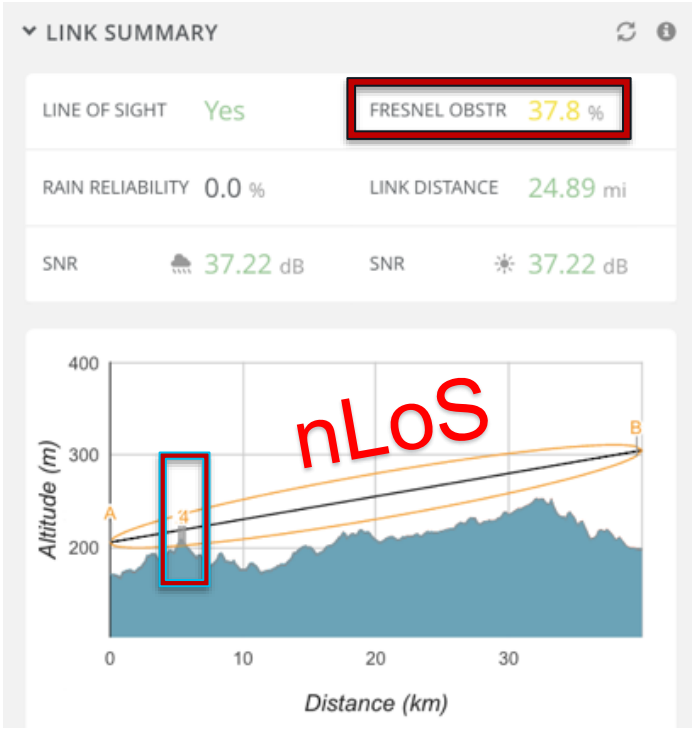
Post-Processed Outputs

Live PCAP Captures w/GPS

Wireless Site Surveys: Tips and Tricks

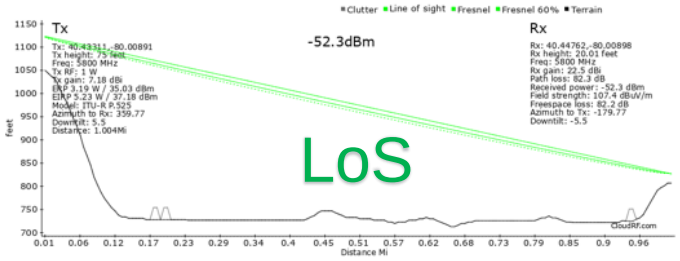
Near Line of Sight (nLoS) Technology

- Low-Band technology (typ. <1GHz) can operate in an nLoS
- Even though it can operate in nLoS, the performance is typically much worse than LoS
  - Lower data-rates and RSSI, but still acceptable for certain use-cases
- LoRaWAN and Low-Band 4G/5G, with low throughput requirements and high latency tolerance
  - SCADA and Voice traffic (low-throughput connectivity)
  - LoRaWAN, communicates with battery powered sensors



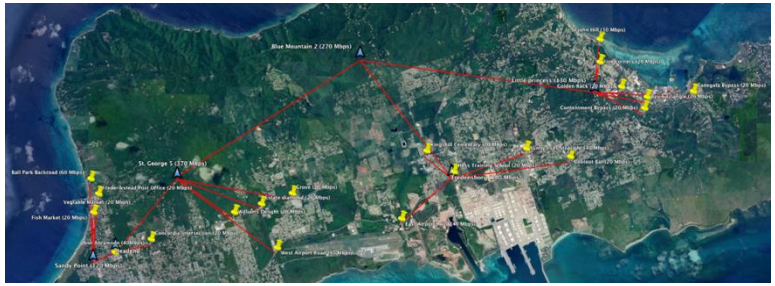
Line of Sight (LoS) Technology

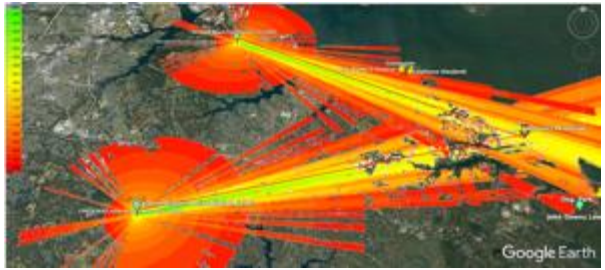
- Most high-performance wireless technology is typically a LoS technology
- What this means is that we need visual and radio (i.e. Fresnel Zone) L
- Similarly to designing with CCTV cameras and LED signage
- Place wireless devices in locations that maintain LoS one end to the other
- Maintain a clear Fresnel Zone around the LoS path
  - This will ensure maximum RF transmission and reception
  - Reduces/eliminates multipath reflections, shadowing, and fading if clear



Site Survey Best Practices – CURWB/WiFi/LoRaWAN/p5G

- Desktop Survey
  - Google Earth design and plots
    - Pins and Lines
    - Street views to see assets and obstructions
  - CloudRF simulations
    - Emulate RF coverage at certain Tx/Rx radio heights
    - Overlays with Google Earth

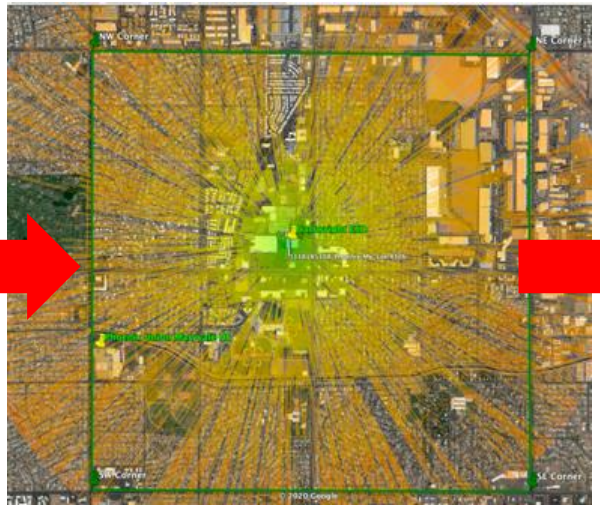




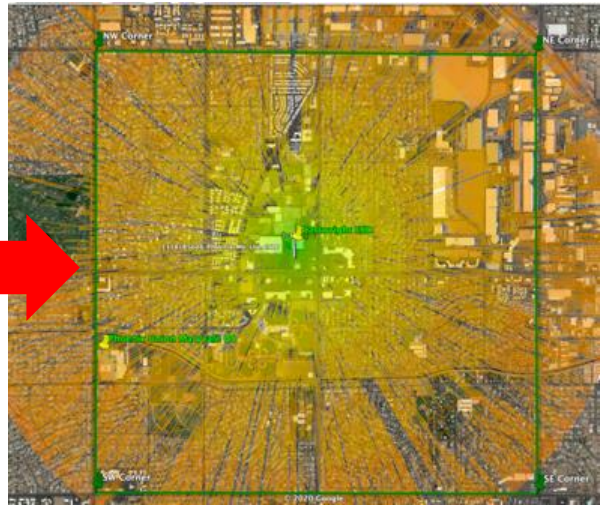
Line of Sight (LoS) and Fresnel Zone – Above Ground Level (AGL)

- Example LoS coverage from a tall tower (30, 90, 150ft) and 20ft Receiver

30ft AGL
~35% Coverage



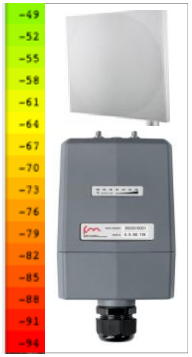
90ft AGL
~65% Coverage



150ft AGL
~85% Coverage

Cloud-RF™

Decomposing the Link Budget Equation

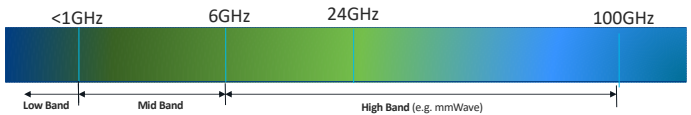


RSSI (dBm)

=

$$P_{RX} = P_{TX} + G_{TX} - L_{TX} - L_{FS} - \cancel{L_M} + G_{RX} - L_{RX}$$

$$FSPL = 20\log_{10}(d) + 20\log_{10}(f) + 32.44$$



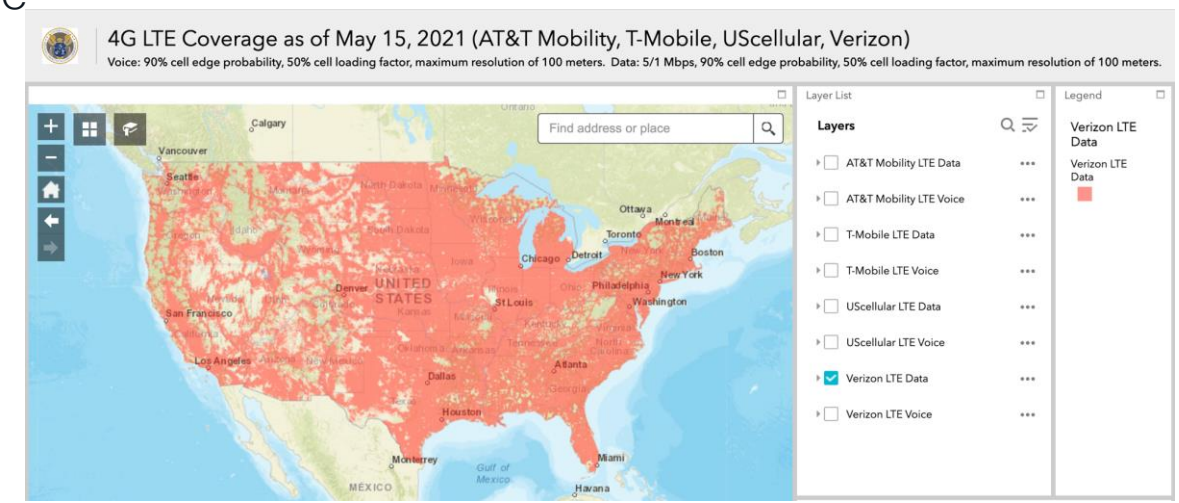
$$P_{RX} = P_{TX} + G_{TX} - L_{TX} - L_{FS} - \cancel{L_M} + G_{RX} - L_{RX}$$

where:

- P_{RX} = received power (dBm)
- P_{TX} = transmitter output power (dBm)
- G_{TX} = transmitter antenna gain (dBi)
- L_{TX} = transmitter losses (coax, connectors...) (dB)
- L_{FS} = path loss, usually free space loss (dB)
- $\cancel{L_M}$ = miscellaneous losses (fading margin, body loss, polarization
- G_{RX} = receiver antenna gain (dBi)
- L_{RX} = receiver losses (coax, connectors...) (dB)

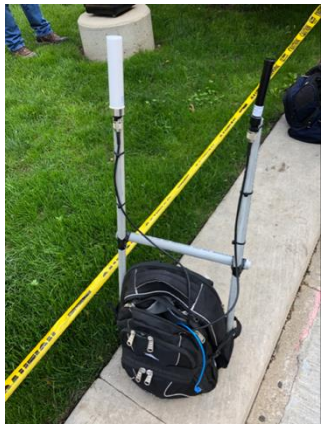
Site Survey Best Practices – Cellular

- Desktop Survey
  - Understand data and voice coverage from all carriers
  - Overlay with location of proposed opportunity
    - Determines quality of services from “public” carriers
  - Up to date maps available
    - FCC’s website



Site Survey Best Practices – CURWB/WiFi

- Field Survey – Active RF Survey
  - Validate desktop survey, and red-line/modify as needed
  - Testing Gear
    - Analyses real signal
    - Perform spectrum analysis
    - PoE Batteries
    - Radios
    - Temporary stands

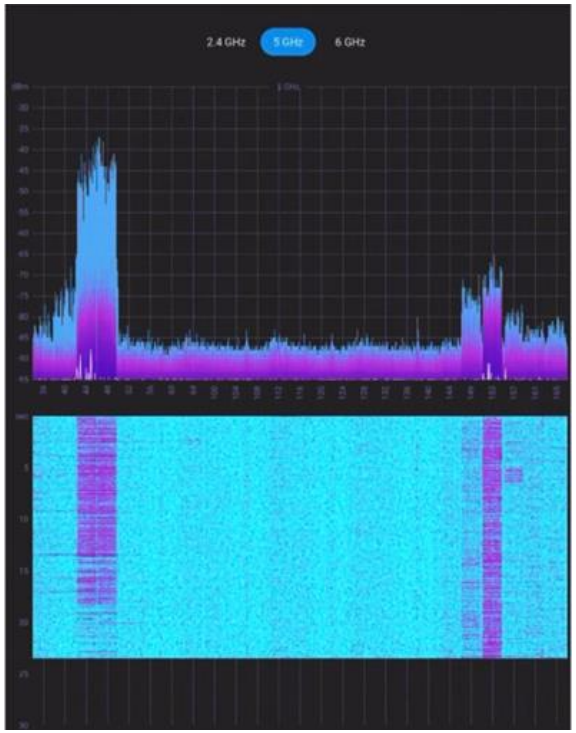


Site Survey Best Practices – CURWB/WiFi

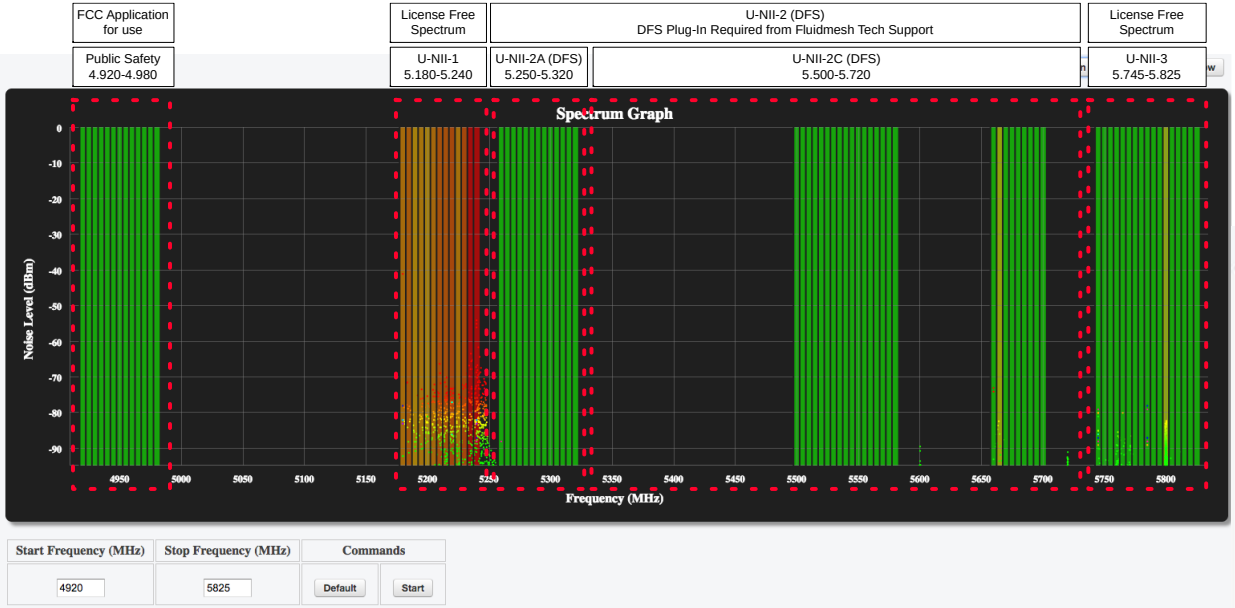
- Field Survey – Passive RF Survey
  - Spectrum Analyzers
    - HW tuned and sensed to operating frequencies
    - Different models (typ) between cellular and unlicensed bands
  - Passively scan and display known RF energy in a particular spectrum

Ekahau Sidekick

Anritsu Site Master

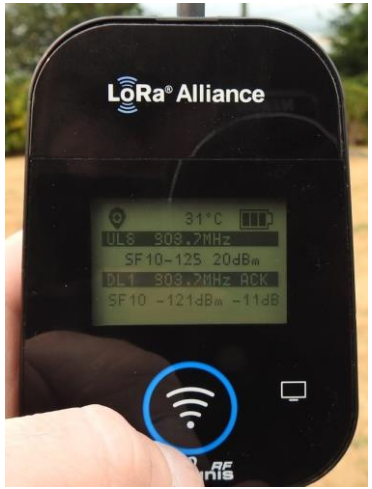


Spectrum Scan: 4.9-5.9GHz (Unlicensed)



Site Survey Best Practices – LoRaWAN

- Field Survey – Active RF Survey
  - LoRaWAN signal tester
  - Tests signal reach from IXM Gateway
  - Validates desktop survey, post-installation



Site Survey Best Practices

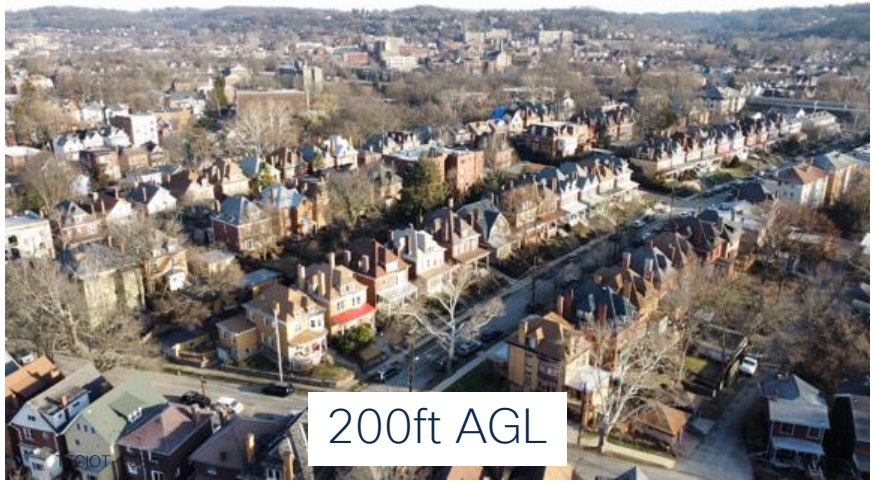
- Field Survey – General/Physical Survey
  - Binoculars
  - Camera
  - Drones

Portable Drone + 4K Camera
- Great for onsite surveys
- Can reach~300ft high

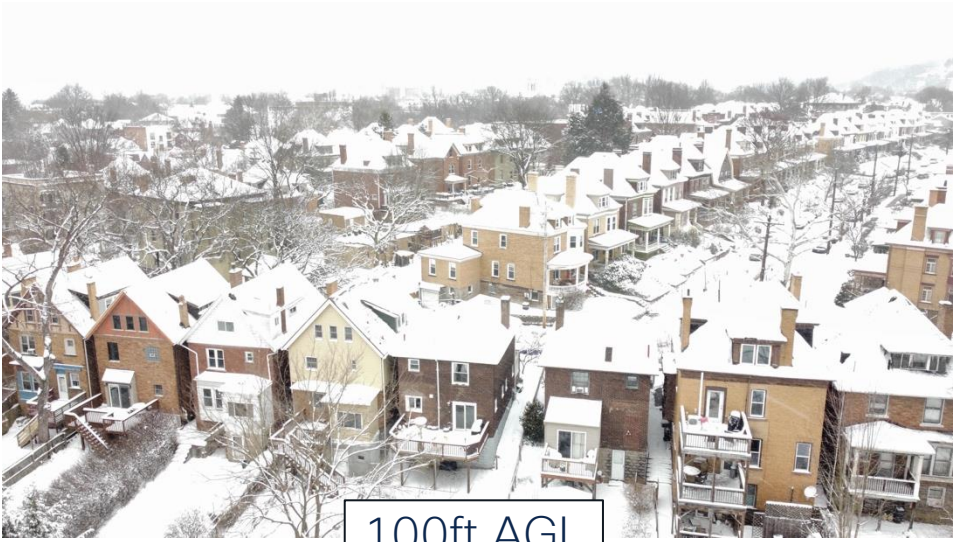
Altitude Sensor
- Measure Above Ground Level (AGL)

Validates RF Line of Sight (LoS)
- Quick validation for Digital Divide, local municipality, and utility use-cases

Line of Sight (LoS) and Height



Line of Sight (LoS) and Height



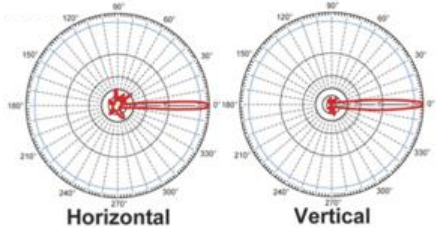
100ft AGL

225ft AGL

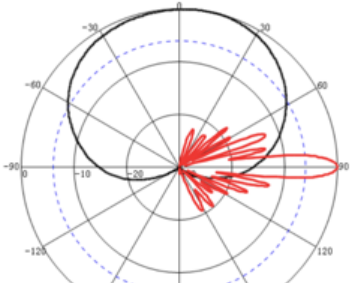
Design within EIRP limits and antenna specs Understanding H/V beamwidths, gains, directivity

- Within EIRP limitations, clear radio LoS, now we select the proper antenna type
  - PtP and PtMP radios installed within vertical and horizontal beamwidths
  - PtP = more directive antennas (i.e. higher dB gain), which results in a narrower beamwidth
  - PtMP = semi-directive, sector, or omni-directional beamwidths, with lower gains (typically)
  - With Fluidity, understand the desired coverage areas, and vehicle's range of motion
  - Vertical and horizontal beamwidths vary drastically, depending on the antenna selected
  - Simple geometric measurements or on-site antenna surveys/alignments will find antenna's sweet spot
    - Antenna Boresight is the highest gained area on the antenna
      - Typically the mid-point of the vertical and horizontal beamwidth
    - Antenna sweet spot is the range around the -3dB beamwidth, which is indicated as blue/dotted-blue circles below

DISH-like antennas



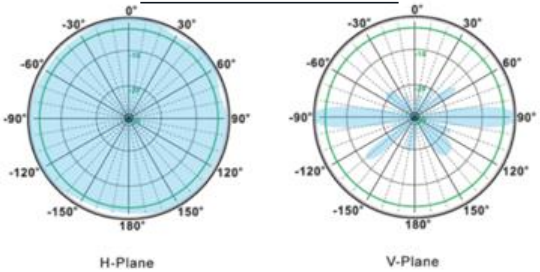
SECTOR-like antennas



HORIZONTAL BEAMWIDTH

VERTICAL BEAMWIDTH

OMNI-like antennas



Key Design Elements

Collecting the info and finalizing the design

- Always look for Clear radio Line of Sight (LoS) for all wireless links. One poor link can compromise a large portion of the network.
- Combination of high installation points at the street poles, and very tall assets at fiber locations.
- Nothing beats a physical site-survey, with actual RF measurements at the AGL heights.
- Understand the local RF congestion in the 5GHz & 6GHZ frequency spectrum.
- Design CURWB other wireless networks (if applicable) on separate, non-overlapping frequencies.
- Are we using PoE Switches at each location, or networking via PoE Injectors, etc.?

cisco Live!

Deep Dive: Fixed Infrastructure Site Survey

Extending LAN, CCTV security, VoIP, and WiFi reach

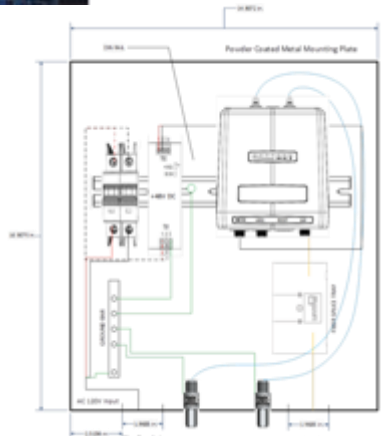
- LAN, SD-WAN extensions
- Video surveillance
- Access control
- Wi-Fi connection for Point-of-sale
- Temporary data Access Point
- Audio Broadcasting
- VoIP

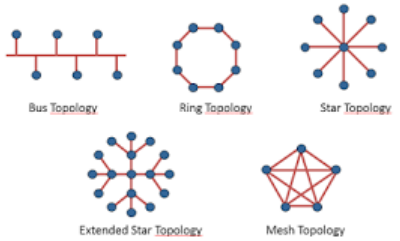
Vertical Asset Survey

- Identify wireless head-end, relay, and end-point locations where radios will sit.
- Communication towers, water towers, tall buildings, street-lights, utility-poles, and traffic lights are all suitable assets.
- Who owns these assets? City, municipality, school, or public utility?
- What is the max Above Ground Level (AGL) height at each asset location? Any restrictions?
- What kind of AC/DC power, Copper/Fiber network requirements at each asset location, and any OpEx for power, leasing, and network connectivity?
- Collect information, and plot location on Google Earth (.kmz/.kml files preferred).

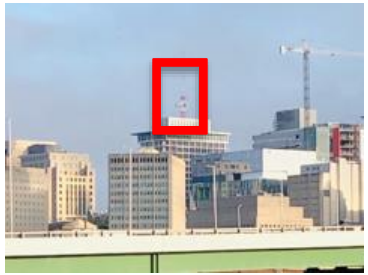
Network Asset Survey

- Understand the full wired framework that's in place.
- Is it customer owned, leased from a Service Provider, are there dark-fibers that can easily network to existing LANs?
- Where are the head-end location(s) connected to the ISP, as well as well-known network Point-of-Presence (PoPs) outside the carpeted spaces.
- Understand any network bottlenecks, that may throttle the overall network performance.
- How are we interfacing to the radios on the vertical assets? Direct fiber with DC input, PoE from an IE SW, combination of both?



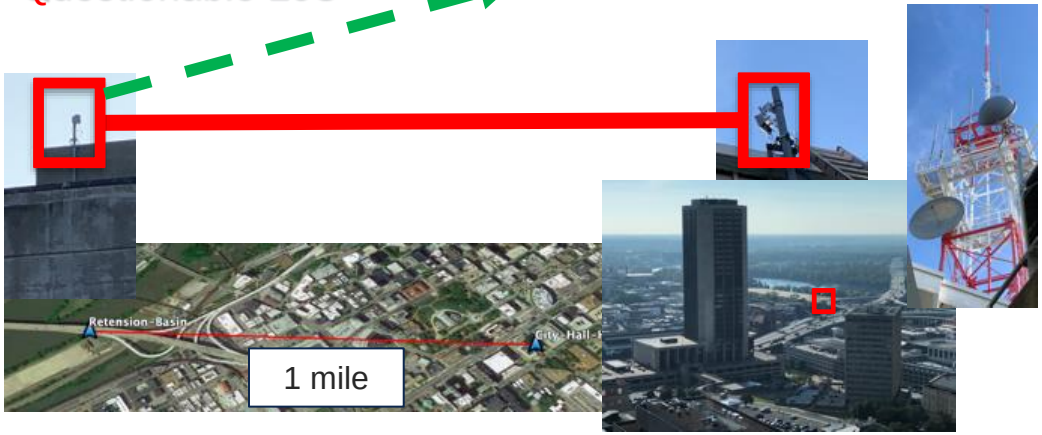


Rooftop PtPs (1-5 miles)



Ground Level:
Questionable LoS

Roof Level:
Clear LoS



WiFi Bridge
to CURWB

BRIDGE FMQuadro™

Bridge Topology (Frequency: 5180 MHz, Width: 40 MHz)

Wireless Statistics	
Signal Strength	-59 dBm
Link Error Rate	9.84 %
Packet Error Rate	0 %
Current TX Rate	216 Mb/s
TX Throughput	0 Mb/s
RX Throughput	0 Mb/s
Total Throughput (RX + TX)	0 Mb/s

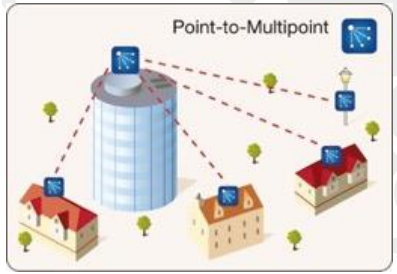
Ethernet Statistics	
TX Throughput	0 Mb/s
RX Throughput	0 Mb/s
Total Throughput (RX + TX)	0 Mb/s

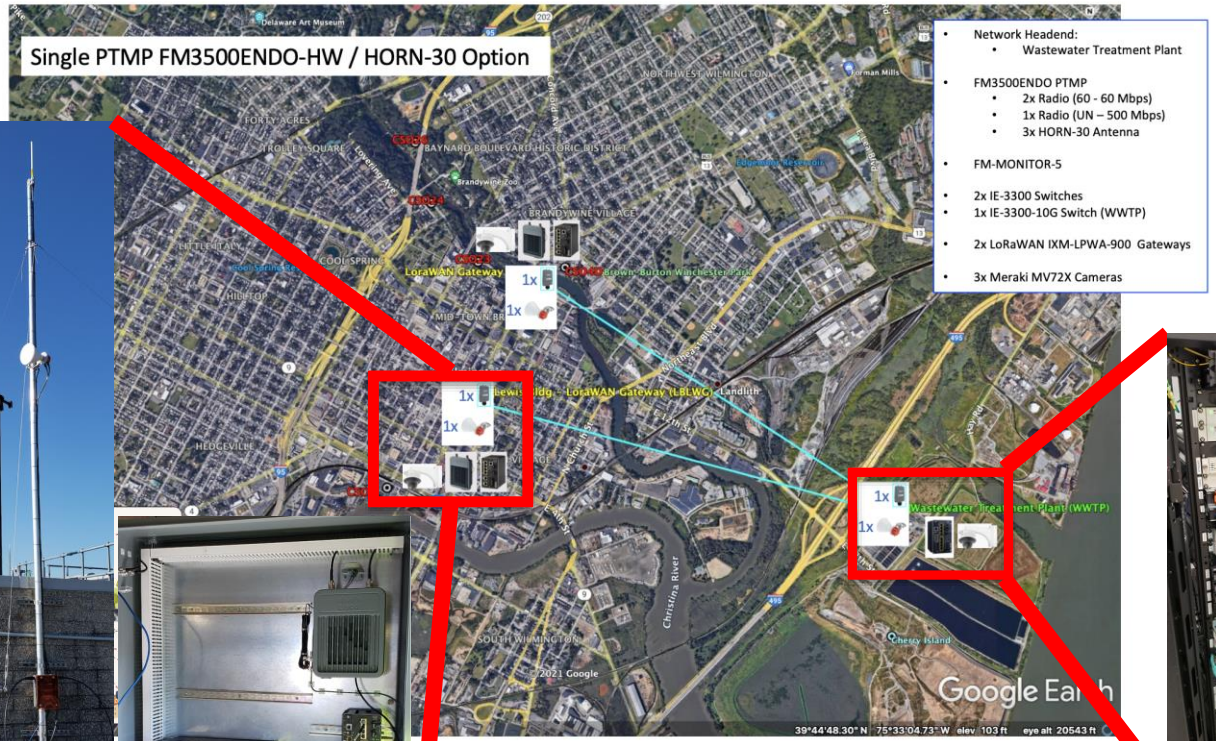
Link Utilization

Legend:
Free
10.15.8.2 (5.1.89.207 - Local)
10.15.8.6 (5.1.90.51 - Remote)

3500-ENDO

Water and Wastewater Utility Connections Extending LoRaWAN and CCTV Coverage





3500-ENDO + HORN

IXM + OMNI

Hybrid Wireless Approach in connecting ”main streets”

4G-CBRS BaseStation

3500-ENDO

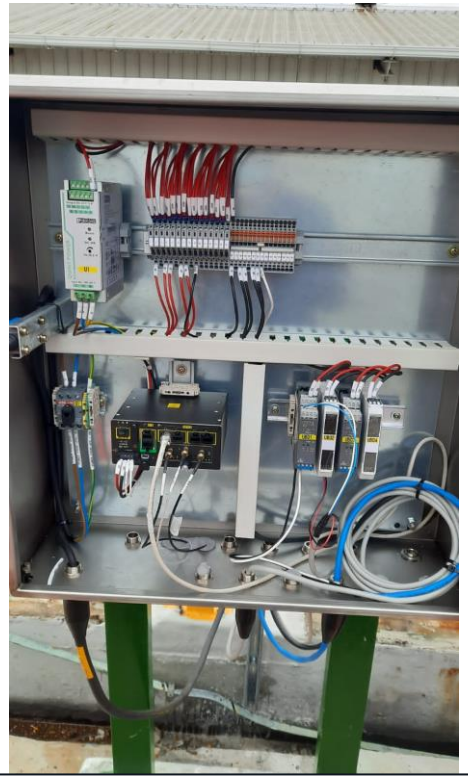
4G-CBRS UE

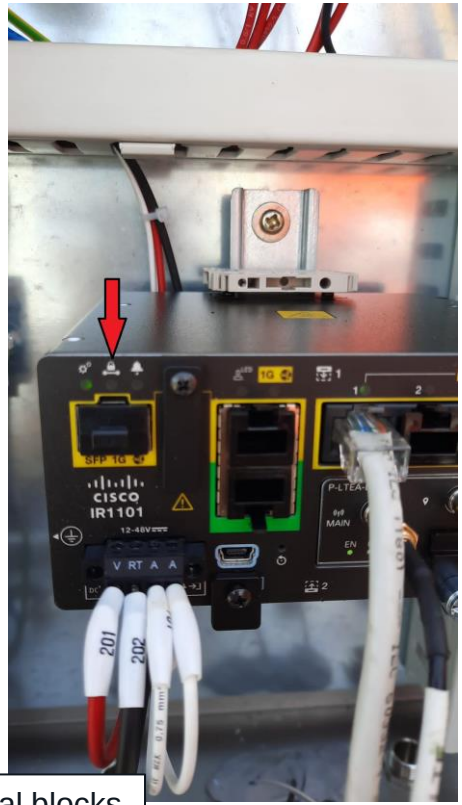
Meraki MV

Meraki MR

IR-1101

Cellular Connectivity to I/O and SCADA





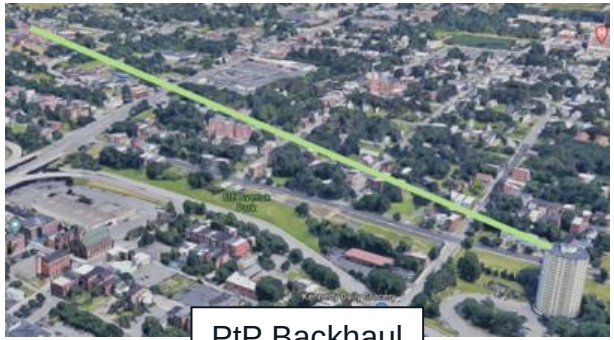
NEMA-4X Enclosure with IR, and I/O terminal blocks

IR-1101

Smartcity Urban Mixed (1-5 miles)

Street-Level Connectivity

Vertical or Horizonal Separation (>3ft)



PtP Backhaul

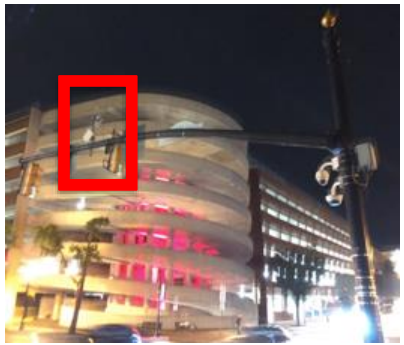
Street-Level Intersection Aggregation

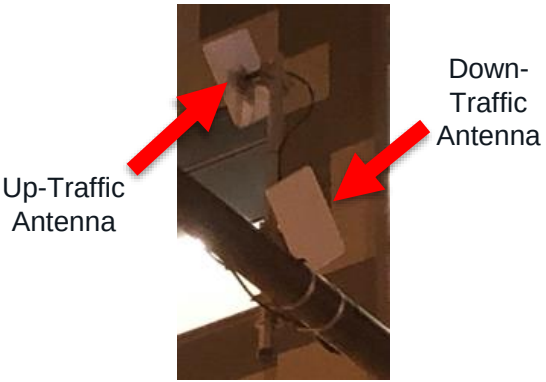
1200-VOLO

Smart city Urban Mixed (1-5 miles)

- Install radio + antenna on mid-point of cantilevered traffic poles (if possible)
- Mid-Point provides clearance from ”RF Clutter and Obstructions” on roadway sides, including:
  - Trees
  - Buildings
  - Adjacent utility and traffic poles
- Provide additional height using extension pipes and proper mounting off of traffic poles
- Linear RF Relay installations, align a Up-Traffic and Down-Traffic installations
  - RF Relays should be used where there is no good LoS between two end-points
  - Relay location should be within LoS of two end-points

3500-ENDO





Meraki MV

Smartcity Urban Mixed (1-5 miles)

- Likewise, RF Relays can be aligned perpendicularly (+/-90 degrees)
- Install radio + antenna at good physical vantage points on structure
- Can extend relay radio placement within 300ft CAT5/6 constraint from network switch

3500-ENDO

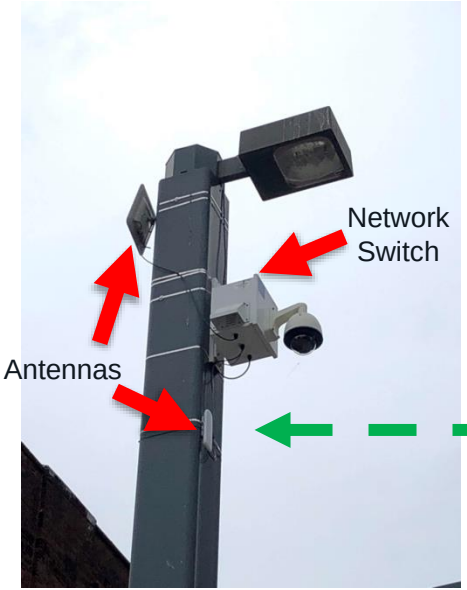
Meraki MV

Smartcity Urban Mixed (1-5 miles)

- RF Relays can be aligned back-to-back (i.e. 180 degrees)
- Install radio + antenna at good physical vantage points on structure

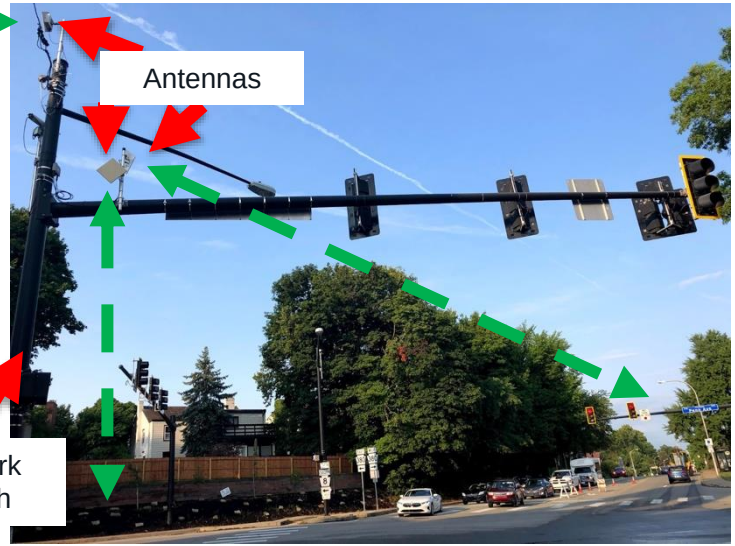
Antennas

Smartcity Urban Mixed (1-5 miles)



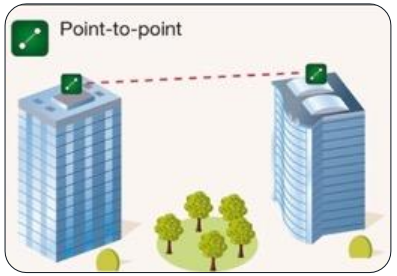
Wireless Backhaul

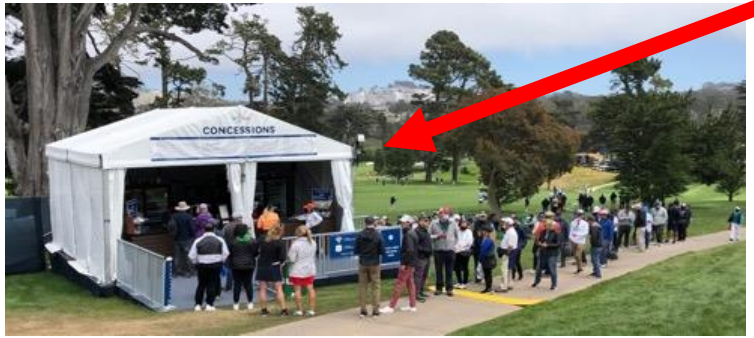
Smartcity Urban Mixed (1-5 miles)



Multi-Day Event Connections

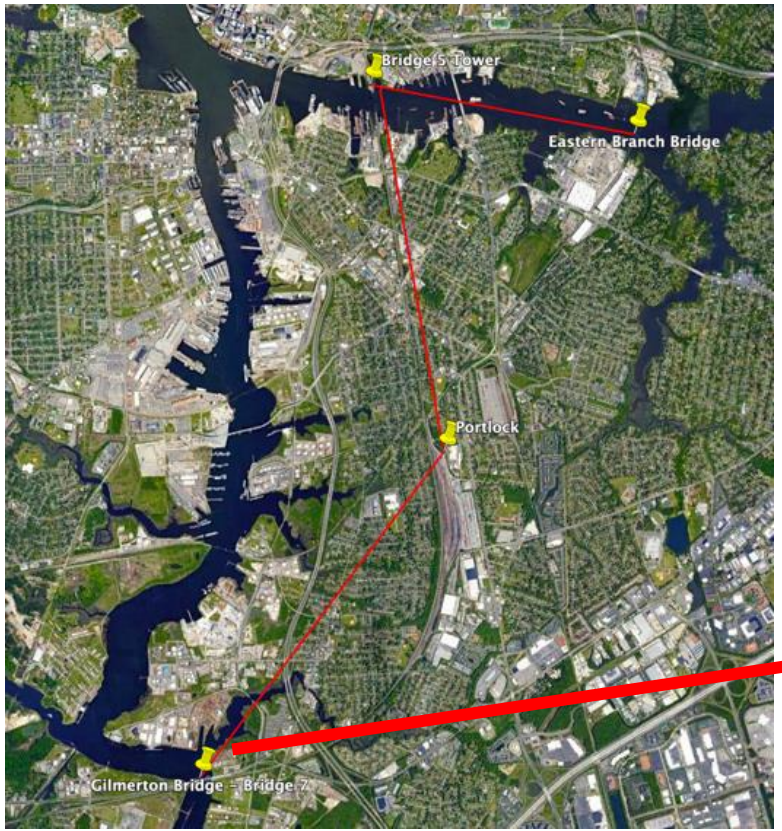
Extending WiFi, IPTV, CCTV, PoS, and E-TEL





“ULTRA-RELIABLE”…Wireless Backhaul

15+ Years in Operation (FM-3100 w/DISH)



Double-Up for Redundancy

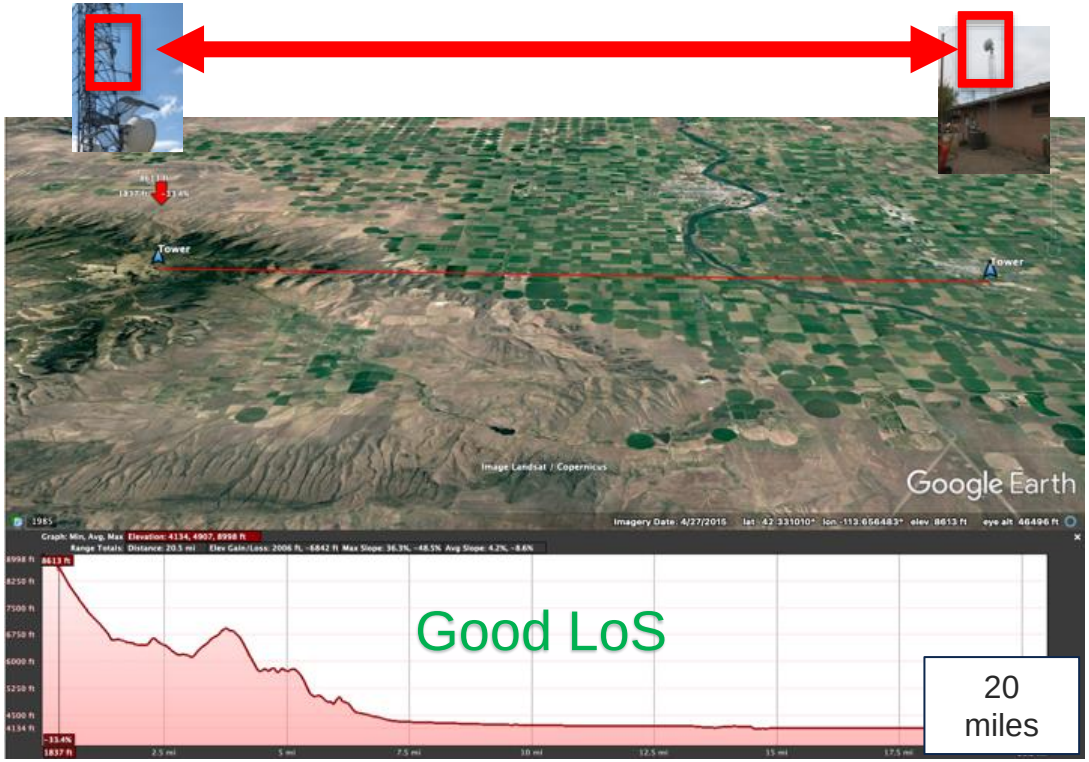
FM-DISH-29

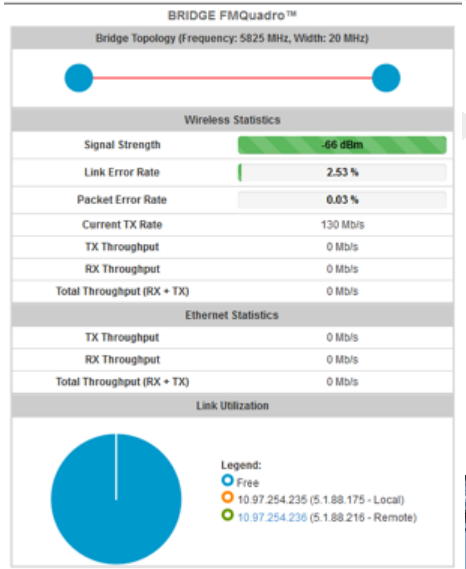
FM-3500-ENDO

Great LoS Vantage Points

Long Distance PtP (20+ miles)

Tall Vertical Assets (150-200ft AGL)

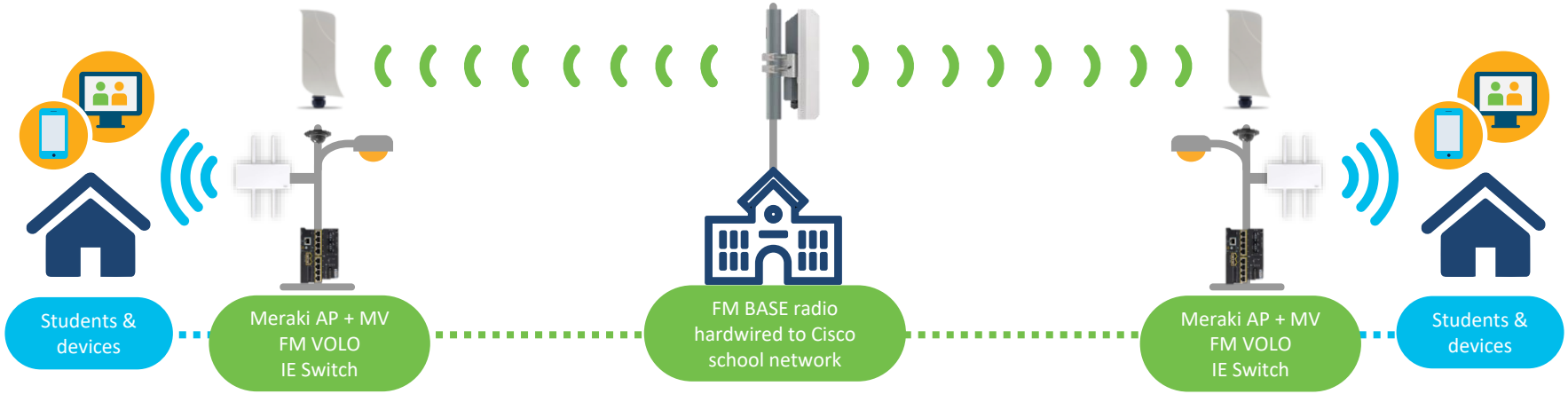




FM-DISH-29

FM-3500-ENDO

Bridging the Digital Divide



Outcomes & benefits for our customers

- Extend the private, secure school network to students' homes
- Fiber-free backhaul across the district with directional RF coverage for maximum distance
- Allows students the flexibility to use any Wi-Fi device to connect and learn
- Increased bandwidth parity across the student body
- Enables safe, secure distance learning for all
- Gateway to additional opportunities for campuses, hospitals, and businesses.

Extends the school network anywhere, securely

Wireless Backhaul

CURWB
Fiber-free backhaul across the district with directional RF coverage for max distance.

Cisco Fluidmesh
Ultra Reliable Wireless Backhaul

Industrial Switching

Cisco Catalyst IE Switches
Ruggedized switches to connect APs in outdoor spaces.

Cisco Catalyst
IE Switches

Access Points

Cisco and Meraki Access Points
Enable Wifi in outdoor spaces.

Meraki
Access Points

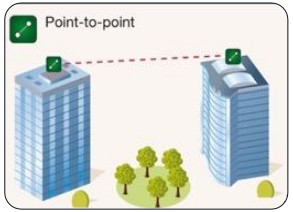
Cisco Aironet
Access Points

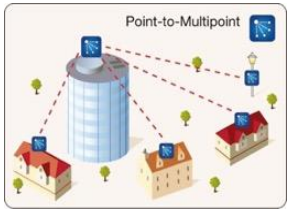
Security

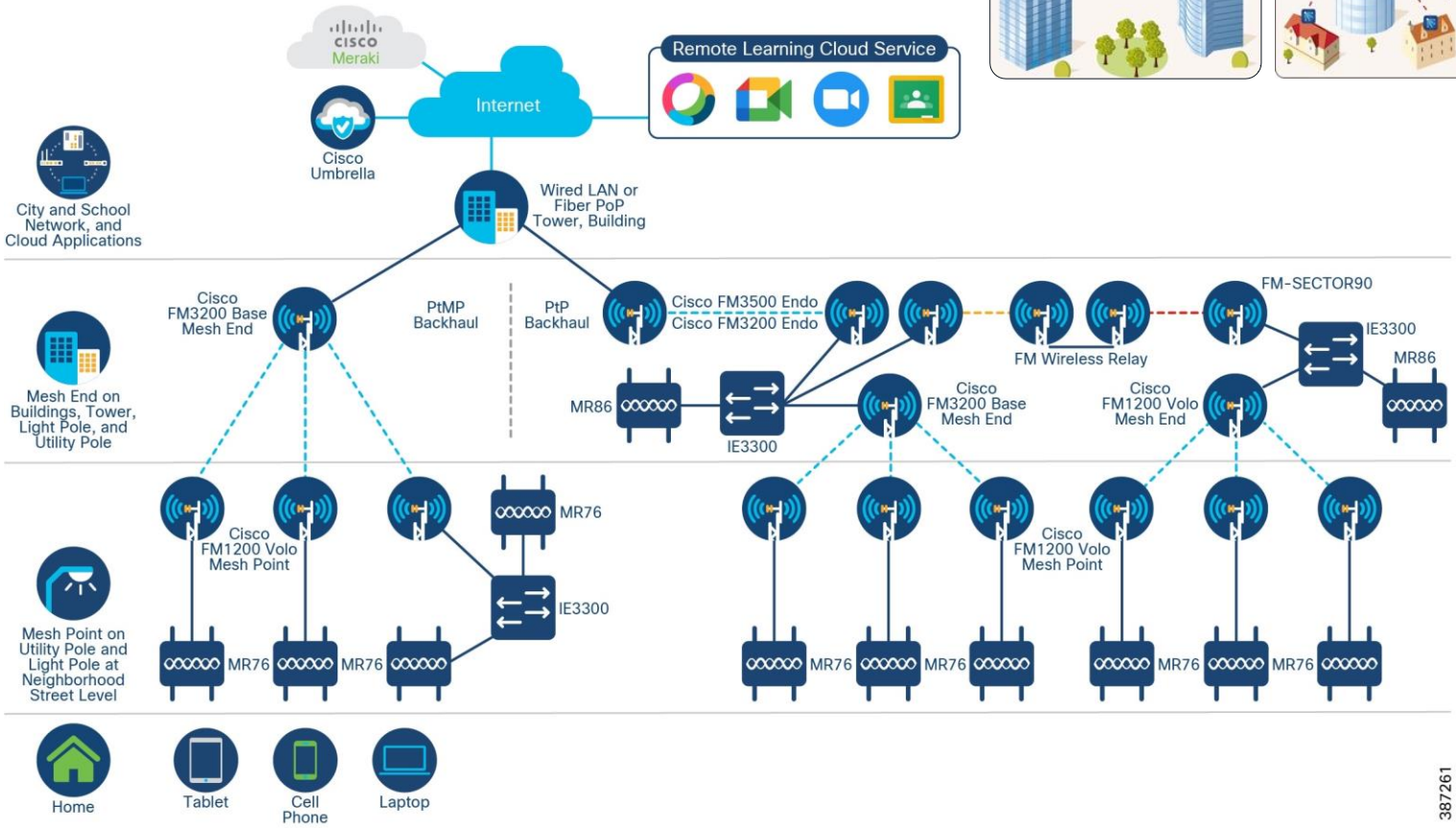
Cisco Umbrella

Digital Divide – Reference Architecture

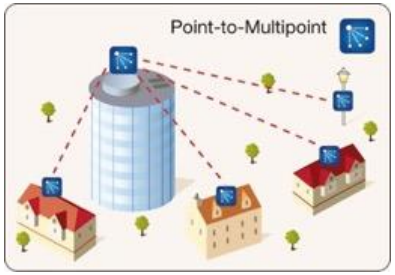
https://www.cisco.com/c/en/us/td/docs/solutions/Verticals/CCI/Digital_Divide/DD-DG1/DD-DG1.html

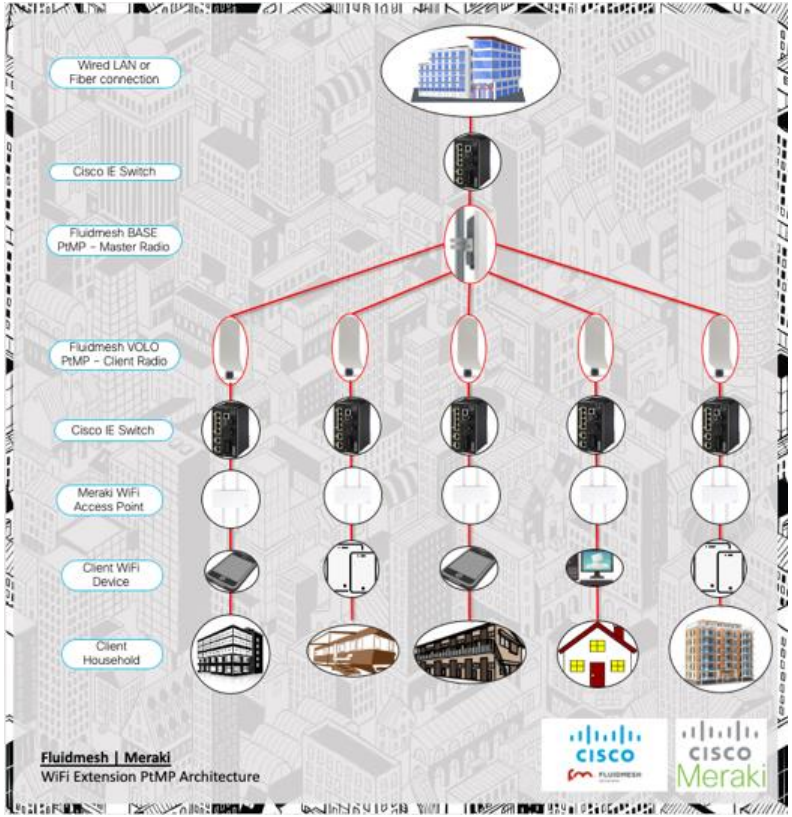




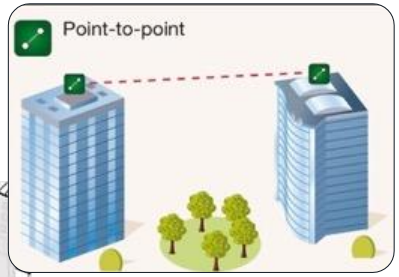


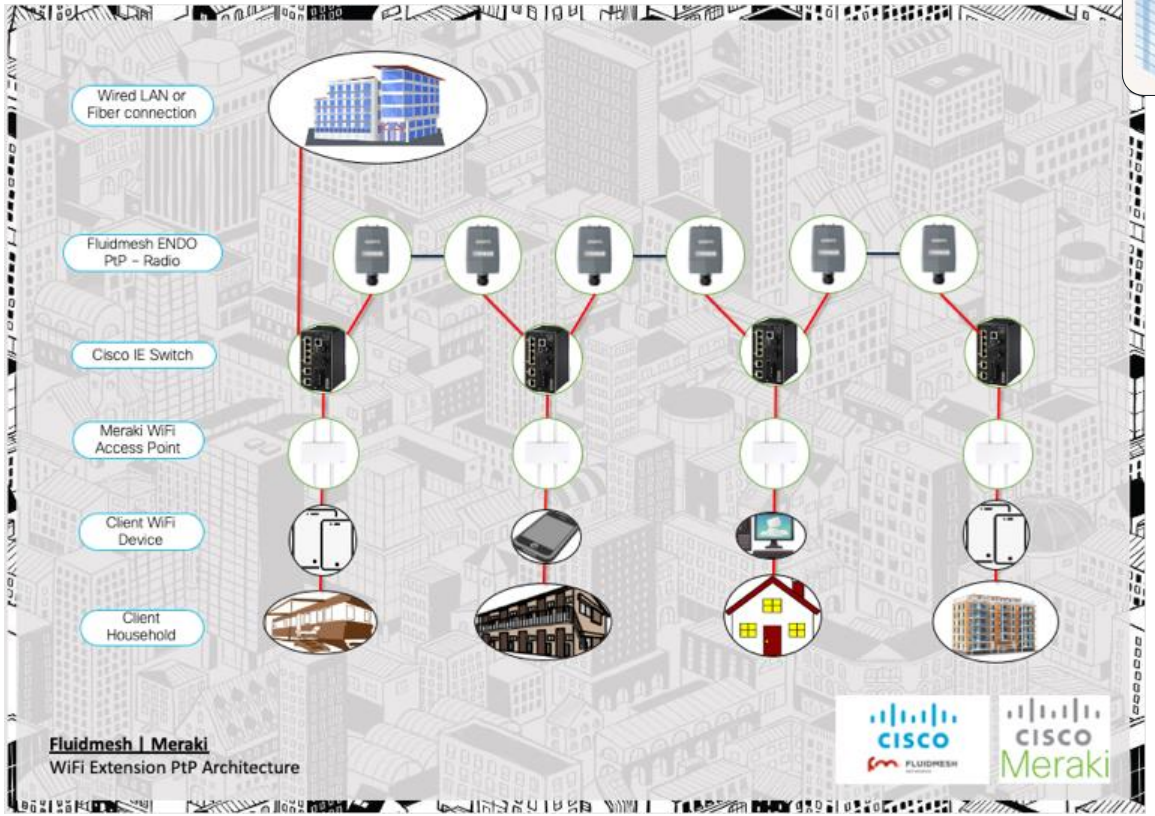
Digital Divide – Extending WiFi Reach PtMP, CURWB Backhaul (Meraki WiFi AP)



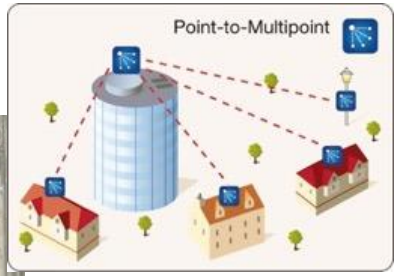


Digital Divide – Extending WiFi Reach PtP, CURWB Backhaul (Meraki WiFi AP)

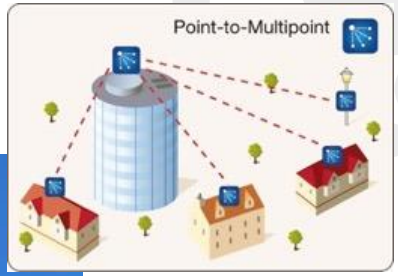




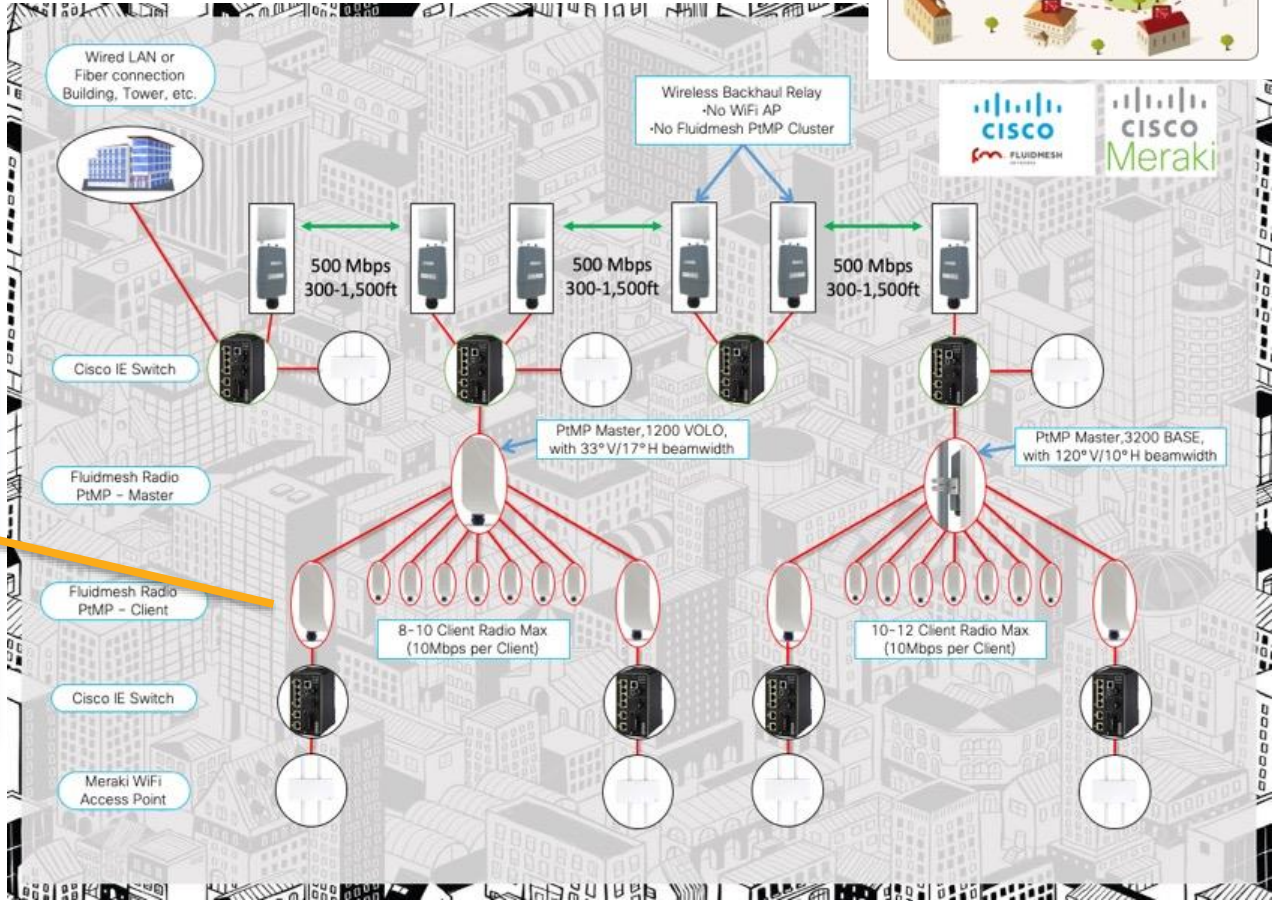
Digital Divide – Extending WiFi Reach
PtMP, CURWB Backhaul (Meraki WiFi AP)



Digital Divide – Extending WiFi Reach
PtMP, CURWB Backhaul (Meraki WiFi AP)



Digital Divide – Extending WiFi Reach
Mixed, CURWB Backhaul (Meraki WiFi AP)

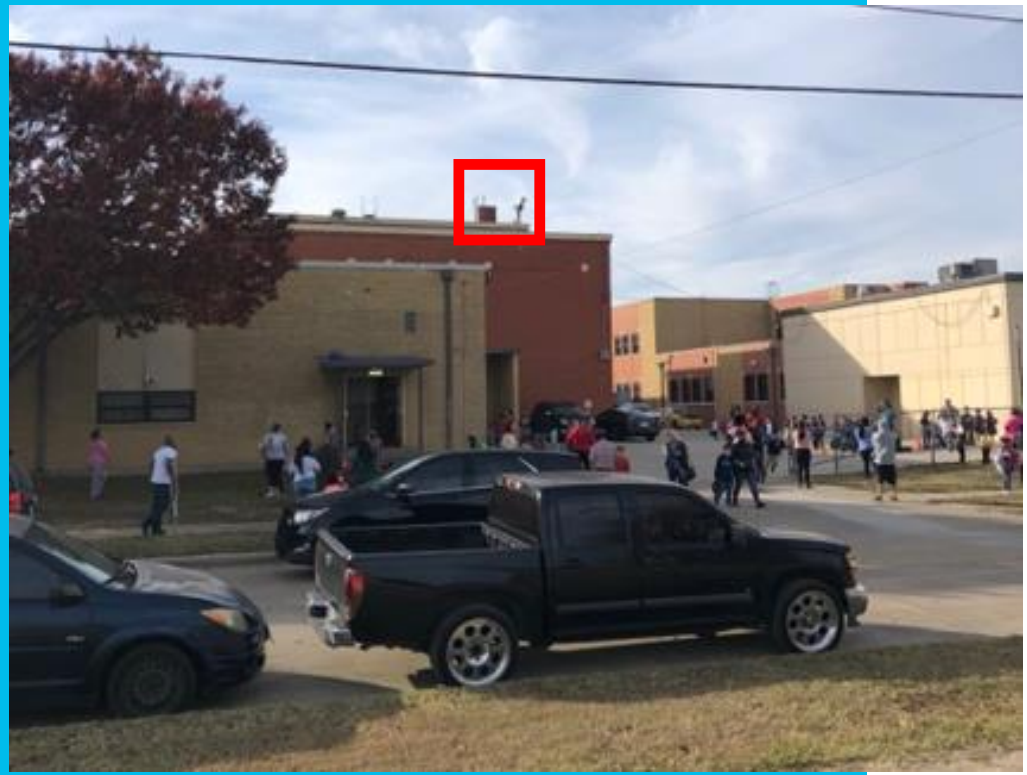


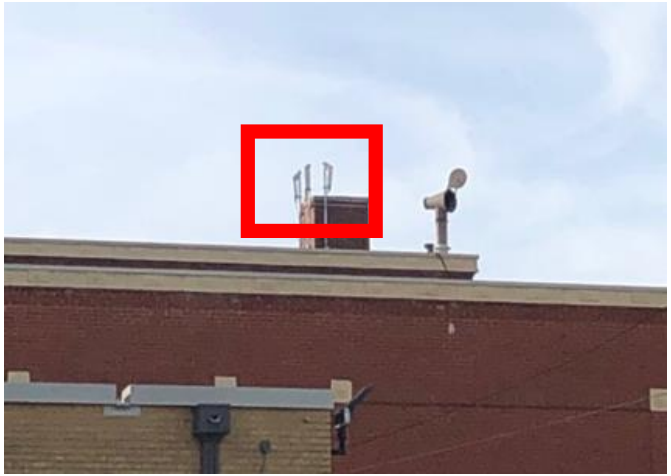
Vertical Assets Equipment

Street Level Asset Assembly

Vertical Assets Equipment

Fiber Point of Presence Assembly



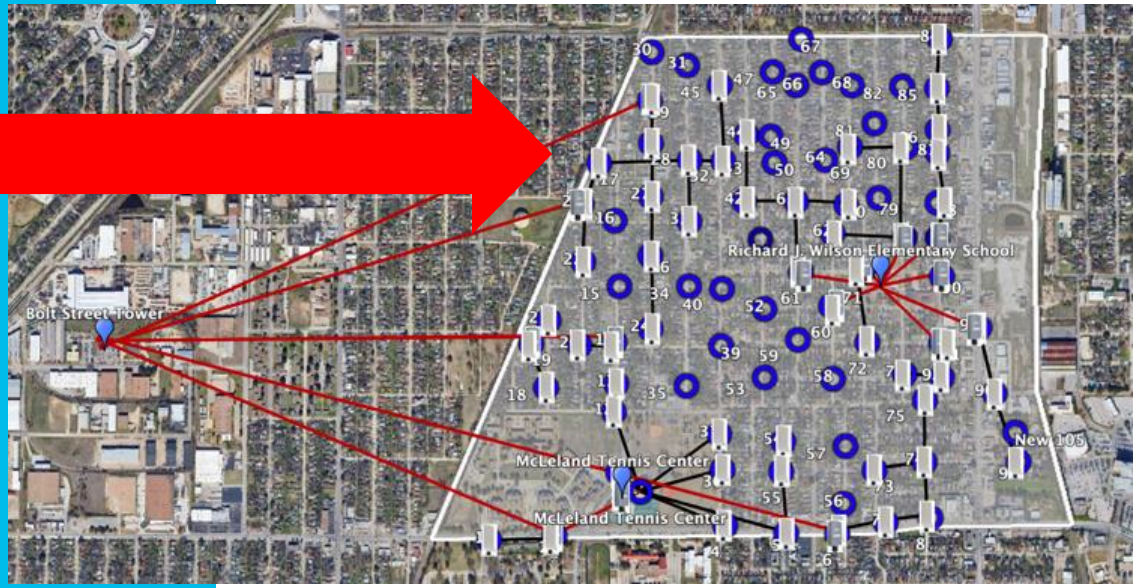


Vertical Assets Equipment

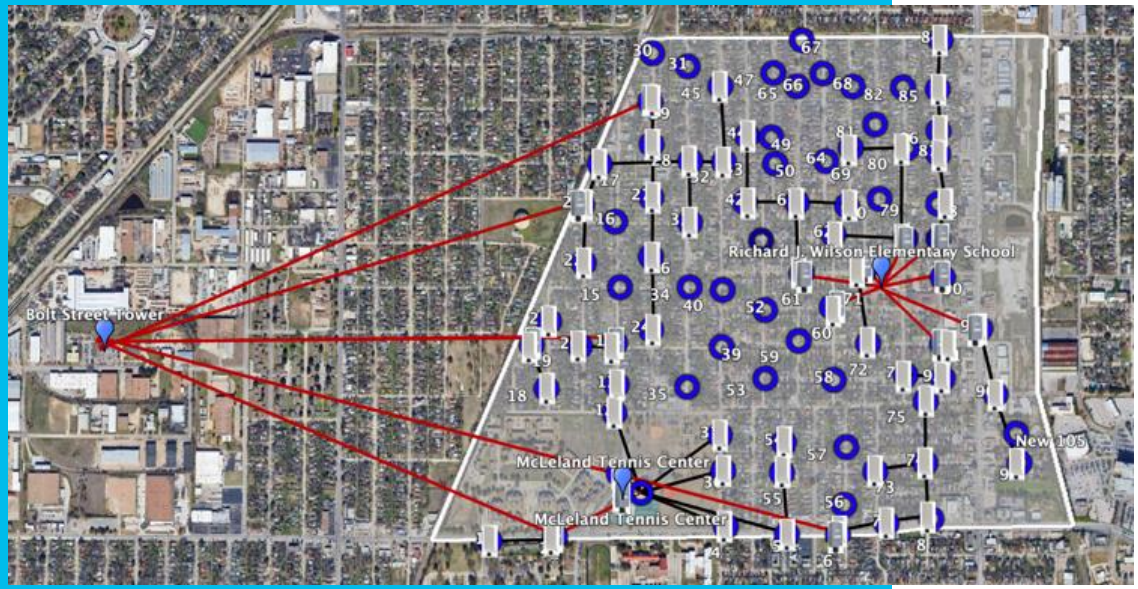
Street Level Asset Assembly

Design Outputs

Pulling it all together for a constructible design



Design Outputs
Hybrid Solution

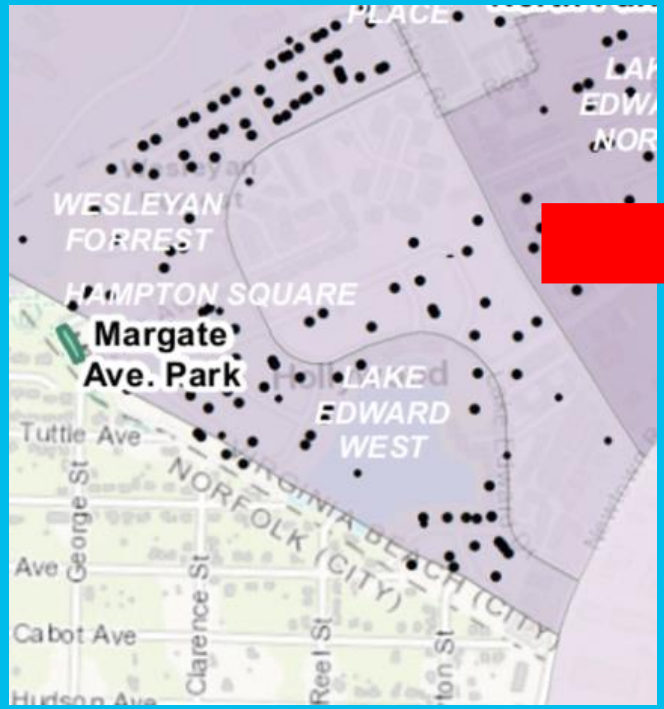


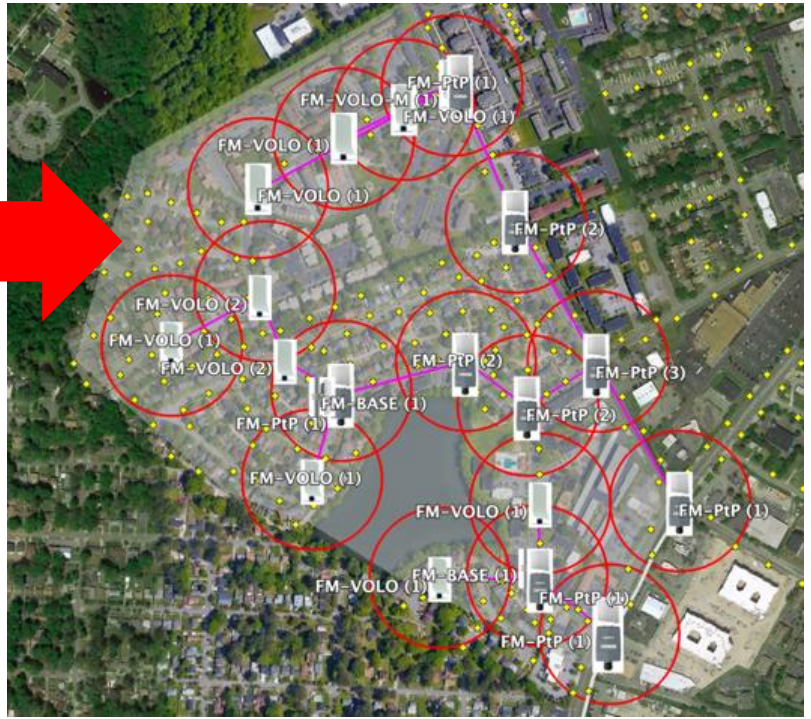
- Where we don't have CURWB backhaul LoS or Fiber, we put in Cellular Gateway with a WiFi AP

IR-1101

Key Design Elements

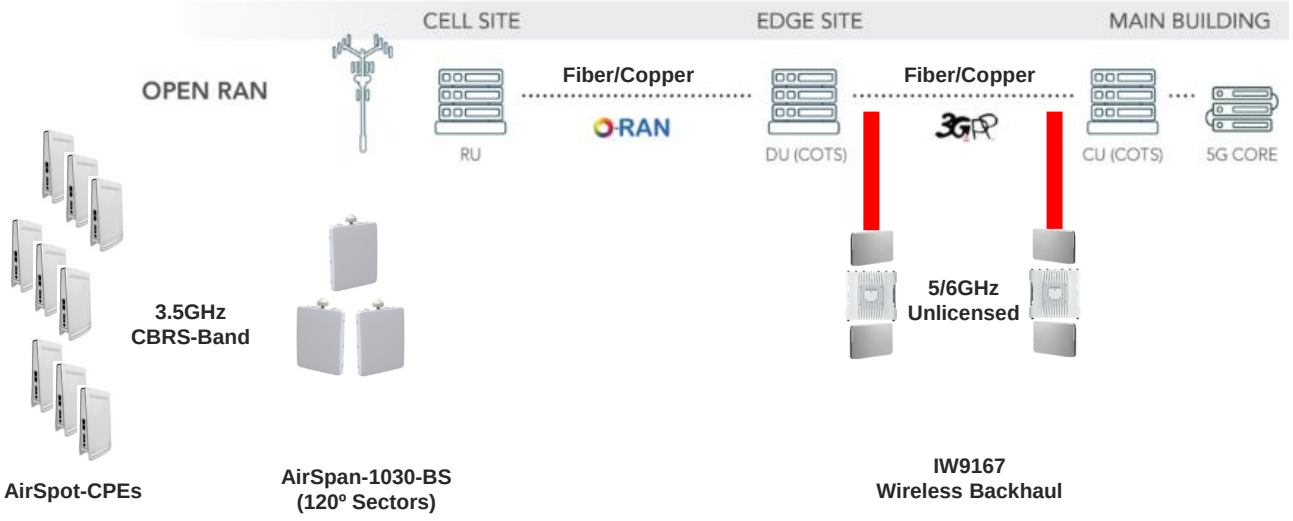
Pulling it all together for a constructible design

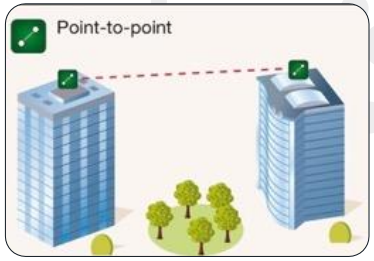




Extending Private 4G and 5G RANs

Connecting new cells with wireless backhaul

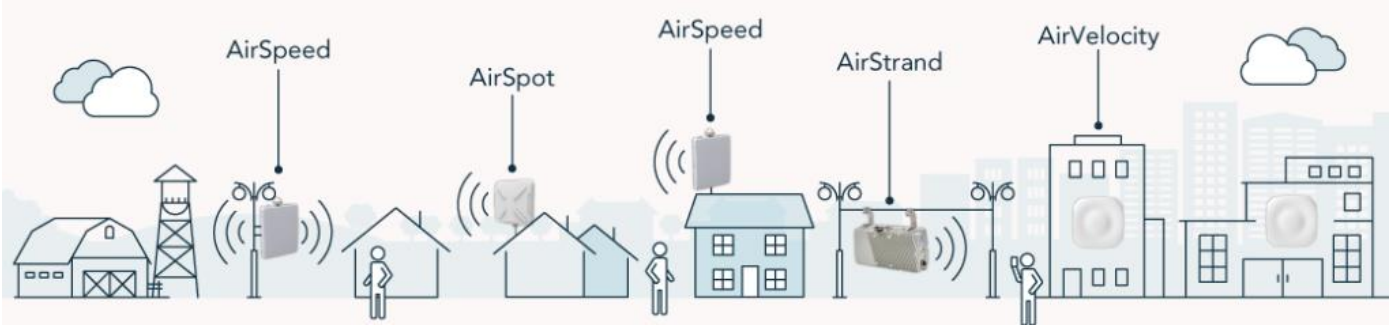




AirSpan-1030
4G-CBRS

IW9167-URWB

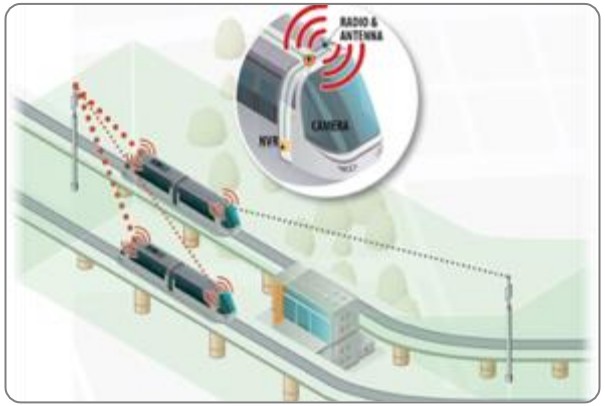
AirSpot-CPE
4G-CBRS

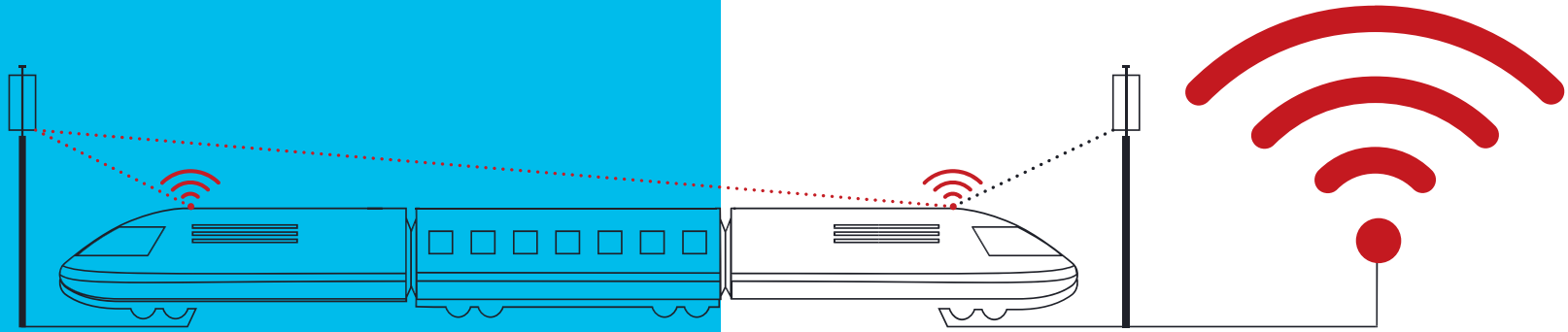


Deep Dive: Mobile Wireless Site Survey

Mobile Site Survey

Train-to-Ground Applications



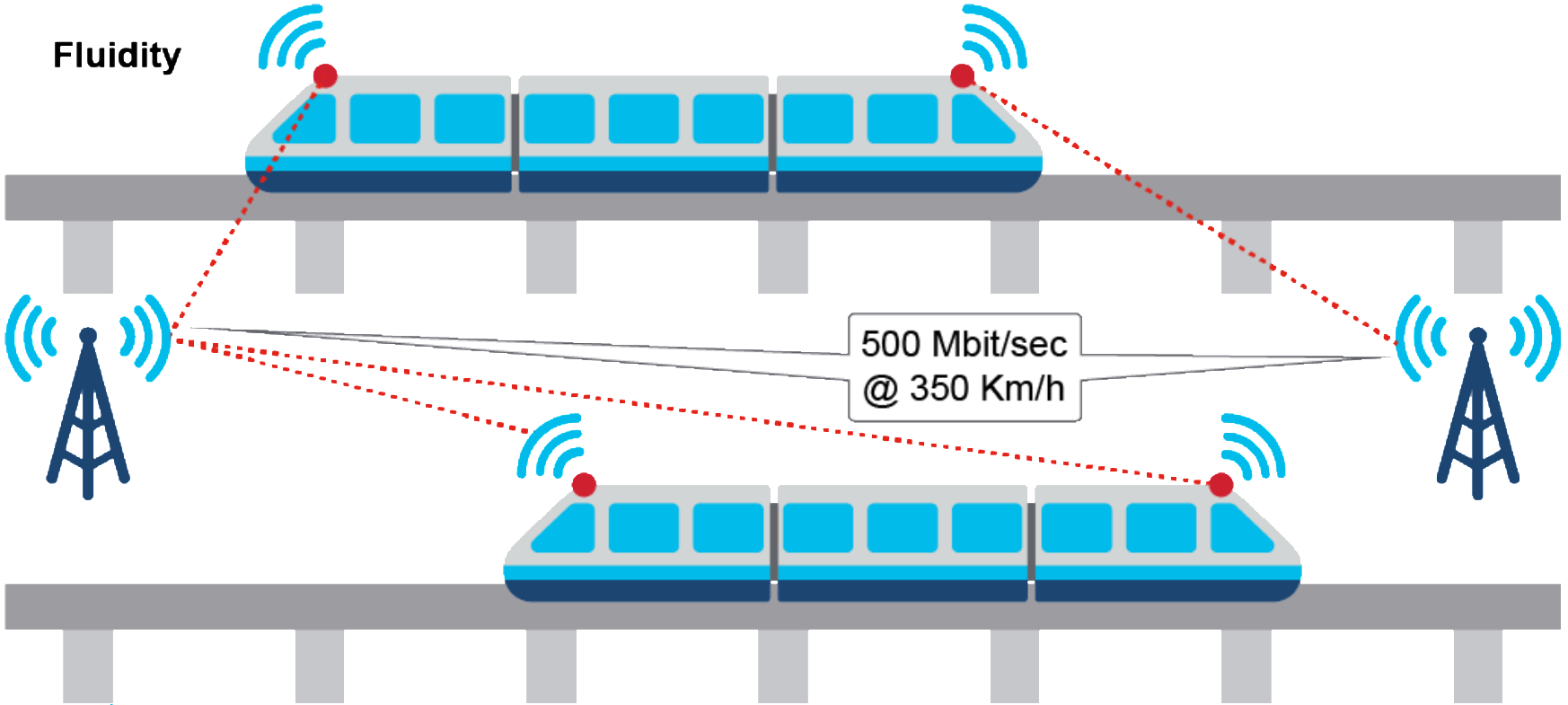


Rail Market – Why We Fit

ENVIRONMENT	CHARACTERISTICS	SERVICES		
		MANAGEMENT PLATFORM	DELIVERY SERVICES	FLUIDCARE & CUSTOMER SUCCESS
MAIN TRACK	• Fast Roaming • High Throughput • Make before Break handoff • Ultra High-Availability			
DEPOT	• Load Balancing • Prioritization • Multi Frequency • Auto-sensing			
INTER-CAR	• Intercar ad-hoc bridging • Loopback protection • Association threshold • Shuffling Algorithm			

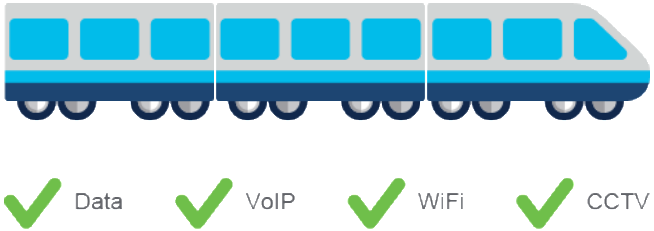
DESCRIPTION	NETWORK REQUIREMENTS
Vital Communications: Communications Based Train Control (CBTC) PLC and Safety Controls	450 Kbps to 5 Mbps Fast Failover < 500ms Fault tolerant (HA) and L3 support Mobility up to 225mph/360kmh 100% redundant RF coverage QoS ready, up to few ms of latency
Non-Vital Communications: CCTV, Wi-Fi backhaul, PA/PIS, VoIP, SCADA	5-500 Mbps Variable traffic Mobility up to 225mph/360kmh 100% RF coverage not guaranteed/needed QoS ready, up to few ms of latency
Depot Offloading: Onboard CCTV NVR offloads, PA/PIS content uploads, Advertising uploads, Onboard system upgrades	1 to 500 Mbps Variable traffic Mobility less than 20mph/40kmh 100% RF coverage not guaranteed/needed QoS ready, up to few ms of latency
Inter-Car Connectivity: CBTC car, Wi-Fi AP, CCTV camera, VoIP, femptocell connectivity and backhaul aggregation points for train-to-ground	150 Mbps to 500 Mbps Variable traffic Car shuffling algorithms Loopback prevention algorithms QoS ready, up to few ms of latency

Broadband wireless for high-speed train/light rail



Site Survey – Transportation - Qualifying

- Who owns the track?
- Size of the network
  - Determines whether Layer 2 or 3 Fluidity
- How are the trains being run (married pairs, 4-car consists, or other?
- Current onboard connectivity solution (if any)
  - Good opportunity for Inter-Car Bridging
- Application(s) and technical requirements
  - Determine criticality of the network
  - Latency, throughput, available frequency, encryption

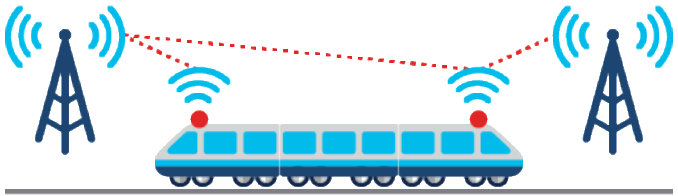


Fluidity™

Wireless Broadband for trains and vehicles moving up to 225MPH/360KMH.

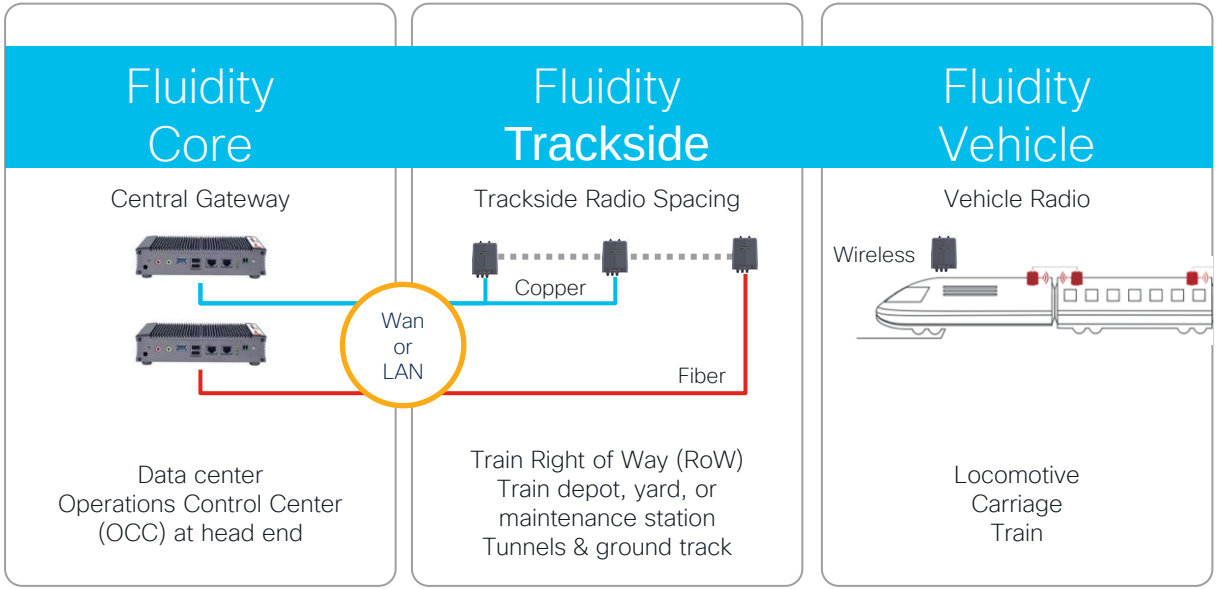
Site Survey – Transportation (Trackside)

- Main track coverage varies between projects.
- Radio coverage is dependent on track curvature.
- Typical radio interval spacing varies from 500 to 3,000 meters, based on performance requirements and railway LoS.
- Typically, train density is low per trackside area (in the region of one to two trains).
- Track distances can span between tens and hundreds of miles.
- Understand coverage requirements (related to the application, Vital or non-Vital):
  - Complete coverage
  - Redundant coverage



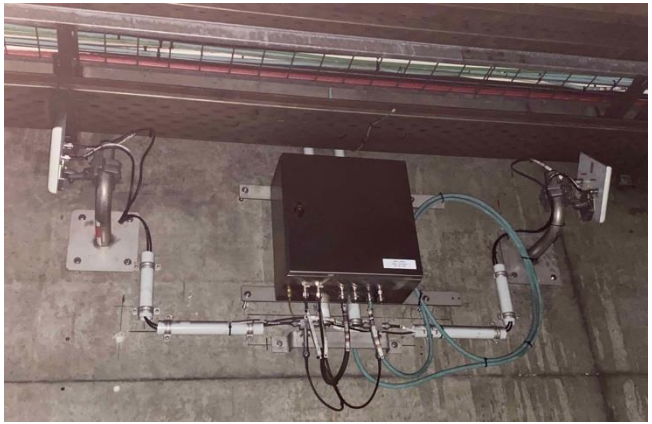
Site Survey – Transportation - Qualifying

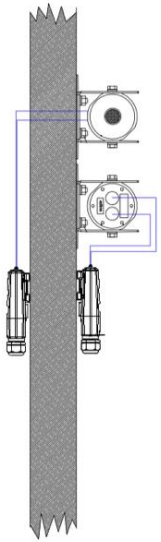
- Network design for T2G covers three CURWB network areas: Core, Trackside, and Vehicle.
- The Core network contains gateway devices acting as MPLS label edge routers.
- Trackside radios connect directly to a stable trackside wired network through copper or fiber and are networked or routed back to gateway devices.
- Vehicle radios wirelessly connect to the Trackside radios to enable train-to-ground communication.

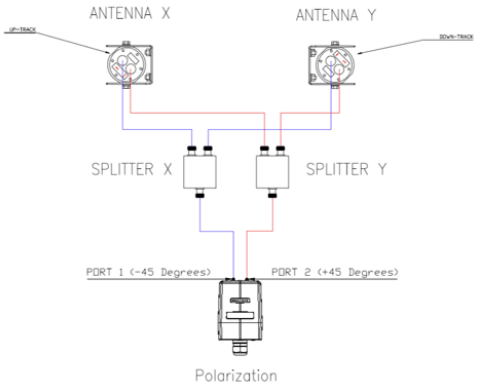


Site Survey – Transportation (Trackside)

- Installation of Wayside CURWB radios have a few unique considerations
- Understand constraints, such as mounting locations and vehicle clearance
  - Wall or ceiling mount
  - Fiber/CAT6 breakout points to NEMA enclosures
  - Antenna alignment with centerline of track







Site Survey – Transportation (Tracksi

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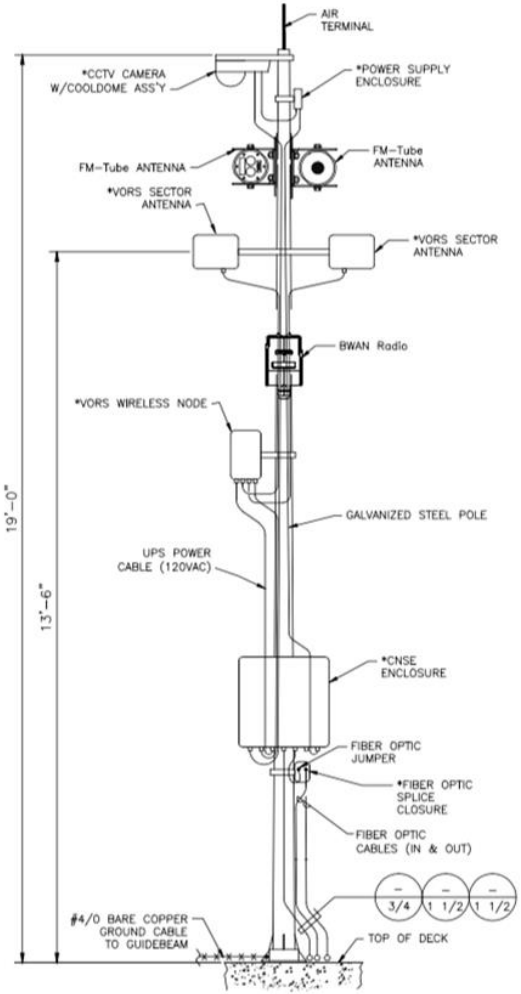
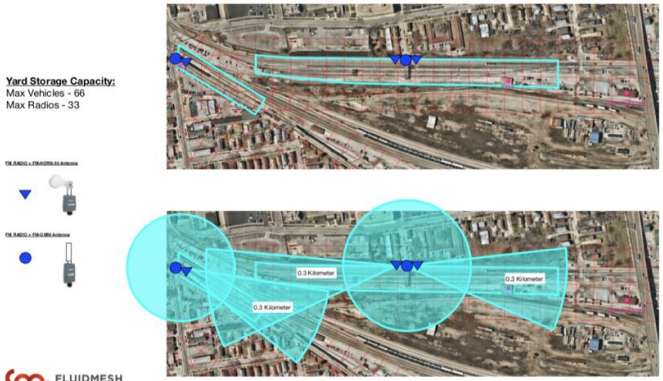
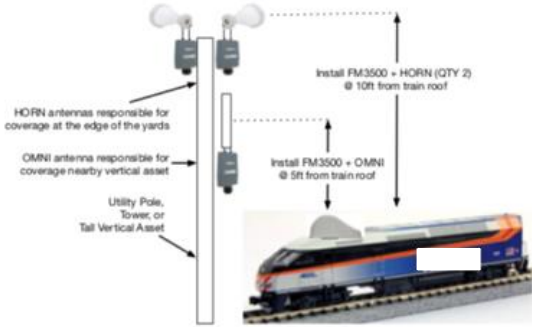


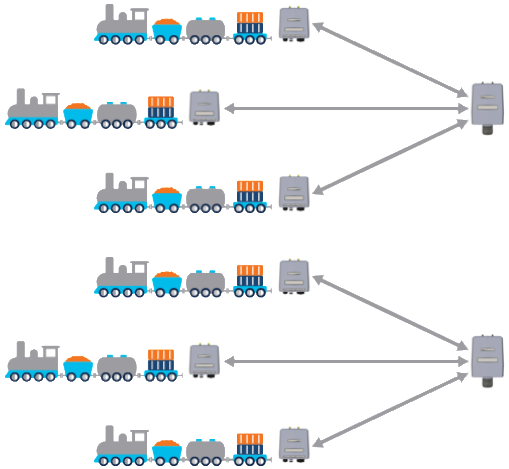
Site Survey – Transportation (Trackside)

Site Survey – Transportation (Depots And Yards)

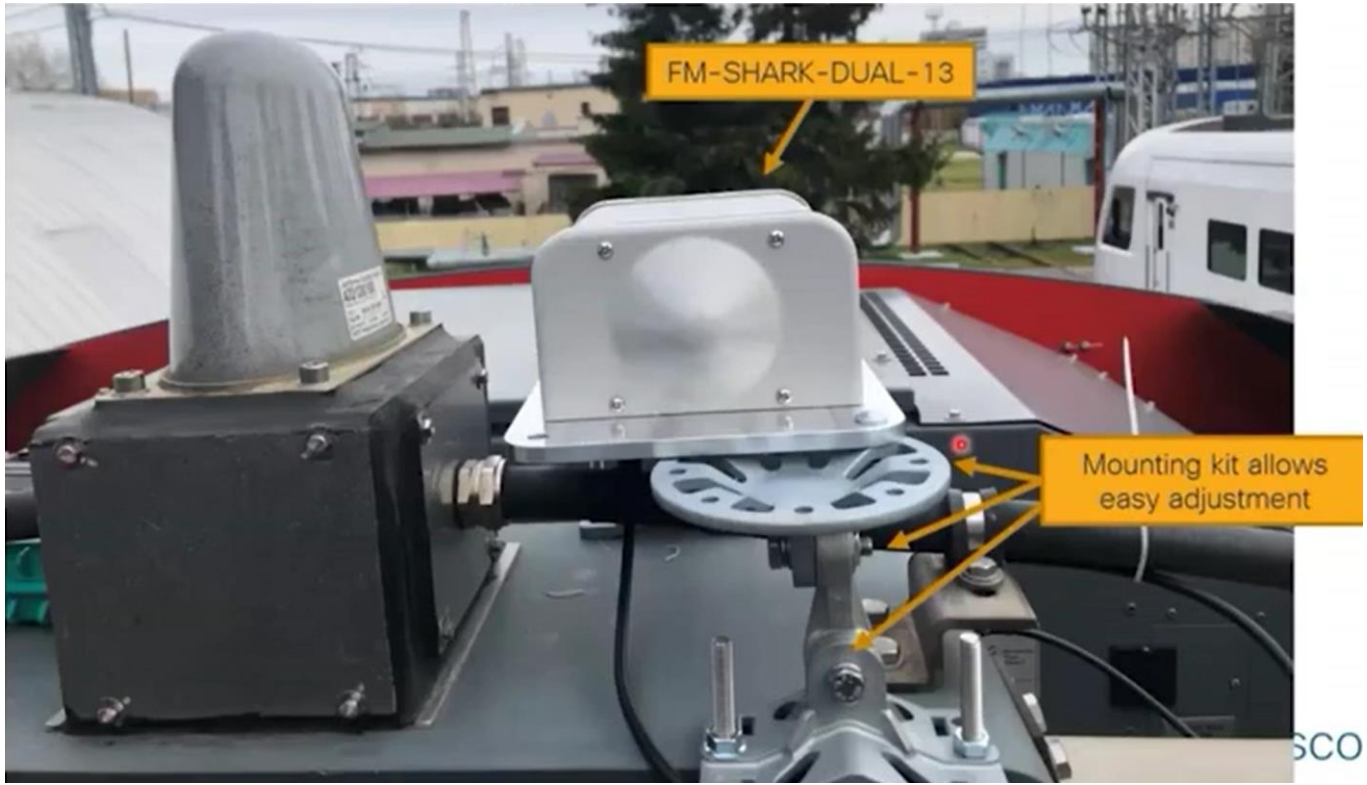
- Depots are characterized as areas with high train density.
- Train density and average throughput per train must be considered.
- Typically, trackside radios are installed to manage train density with load-balancing.
- Depots are typically no larger than 1 to 2 km long.
- Can range from 1 or 2 tracks wide to 15 or 20 tracks wide.
- Depot density can range from a few vehicles to hundreds.
- Train depots never stop moving and are highly dynamic environments.





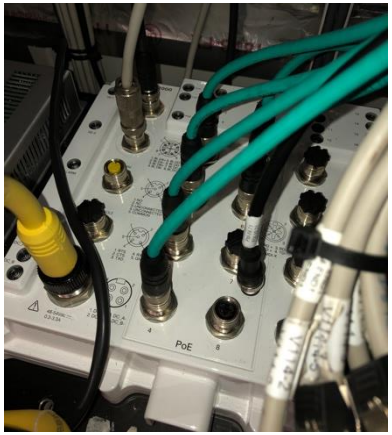


Site Survey – Transportation (Vehicle)



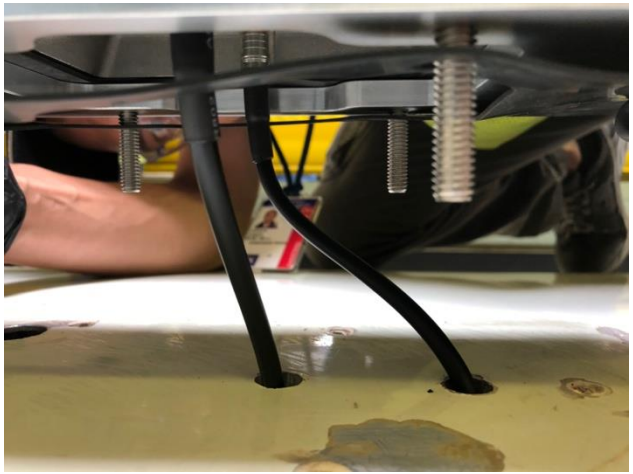
Site Survey – Transportation (Vehicle)

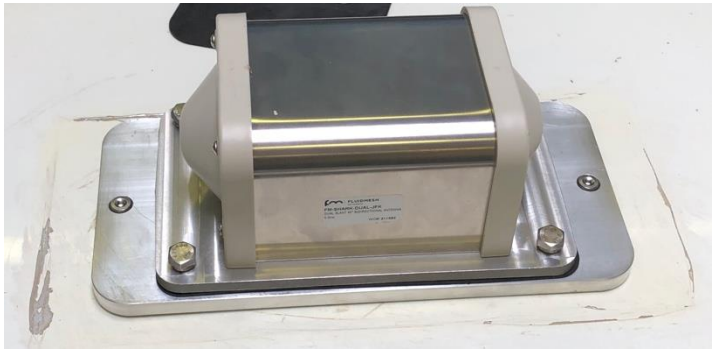
- Onboard the Vehicle CURWB radios have a few unique considerations
- Understand constraints, such as network switch and power locati
  - Radios installation and mounting brackets
  - CAT6 Ethernet and RF coax cable runs and lengths
  - RF cable egress points to exterior of Vehicle carbody



Site Survey – Transportation (Vehicles)

- Vehicle antenna mounting locations
- Drill-through patterns for proper mounting
- Weatherproofing and additional adapter plates (as needed)



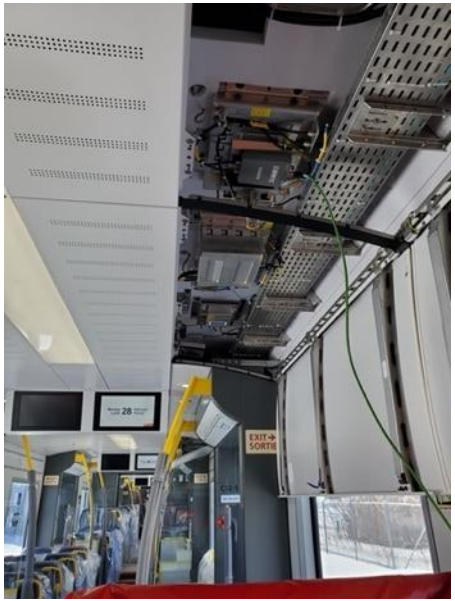


Site Survey – Transportation (Vehicles)

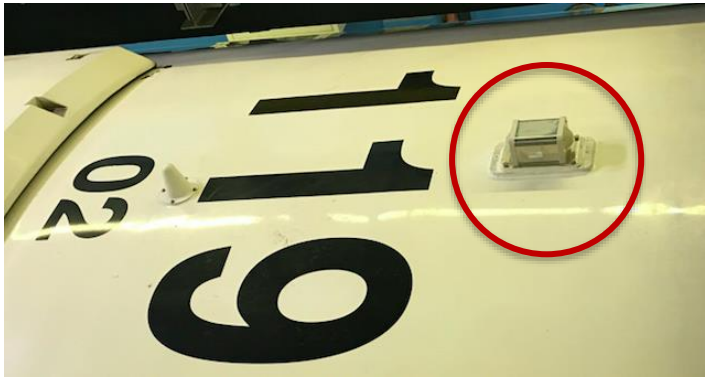
- Keep antennas away from rooftop obstructions

Site Survey – Transportation (Vehicles)

- Cables runs clean and properly labeled

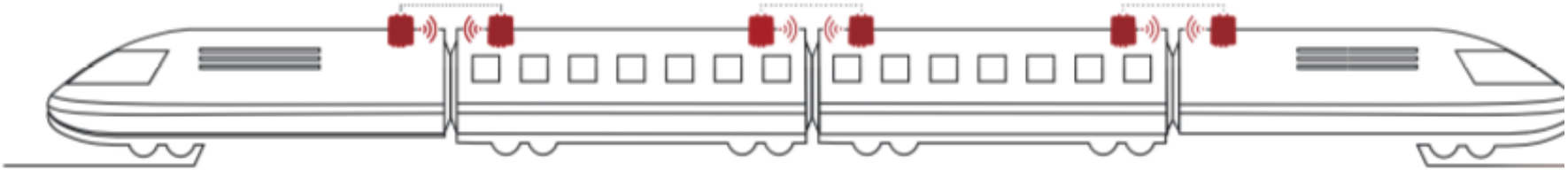


Site Survey – Transportation (Vehicles)

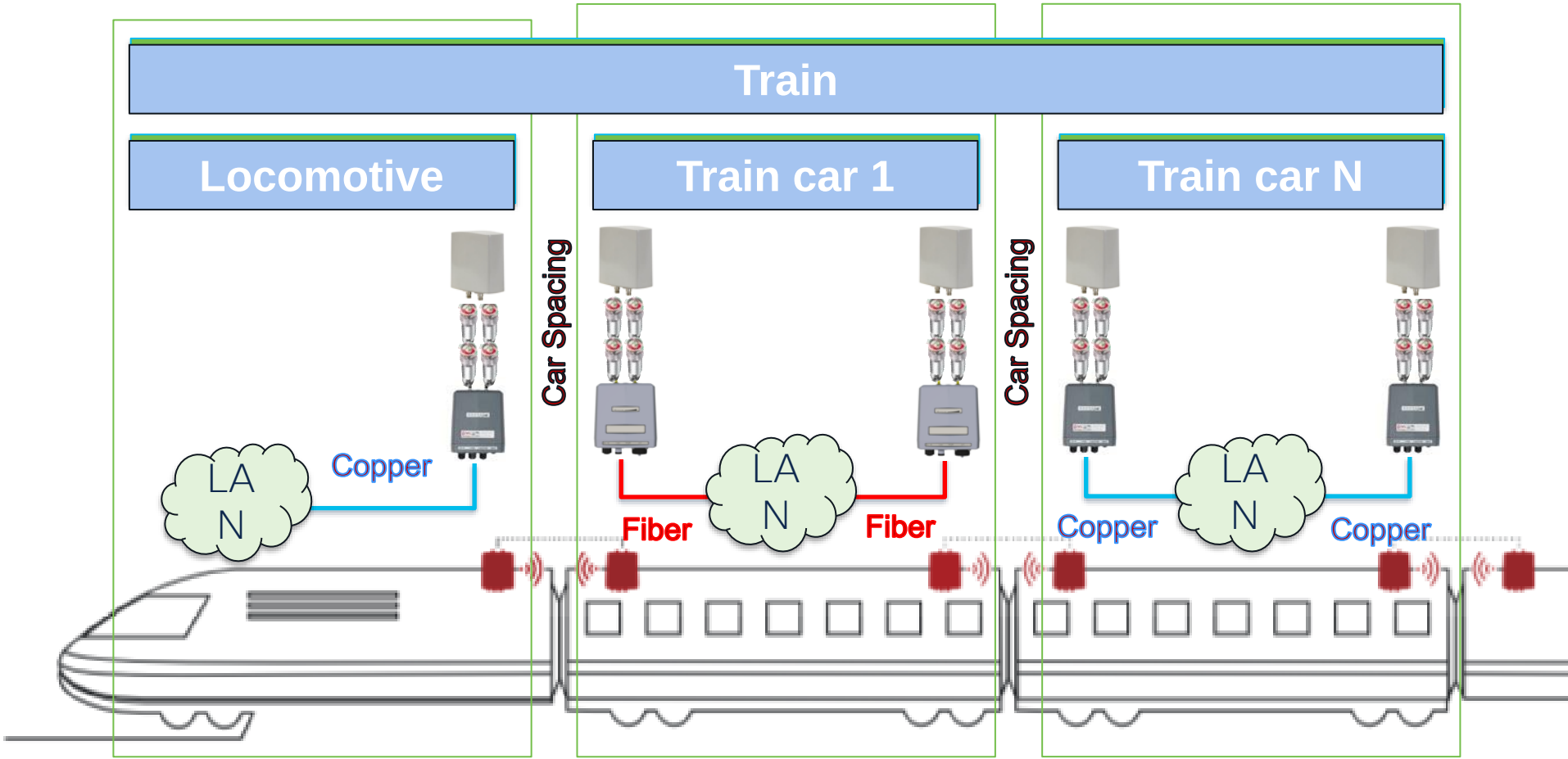


Site Survey – Inter-Car (Vehicle-to-Vehicle Bridge)

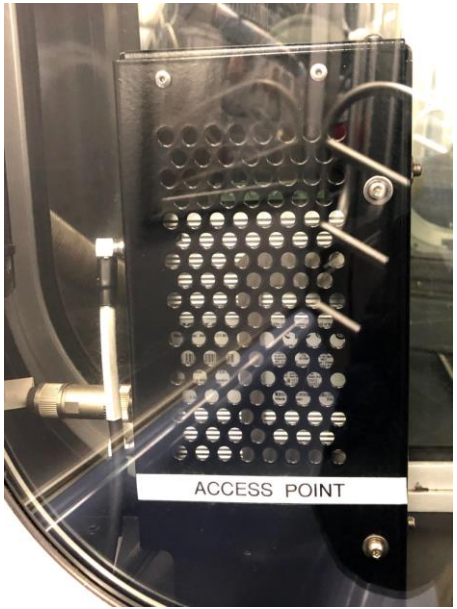
- Inter-car systems provide connectivity that connects two or more train cars together.
- Inter-car can also interconnect the train's vehicle network sub-systems. Sub-system traffic includes:
  - CBTC
  - CCTV
  - VoIP
  - Wi-Fi backhaul
  - Ethernet train data
  - Fluidity vehicle radios
- No wires between cars to enable communications.



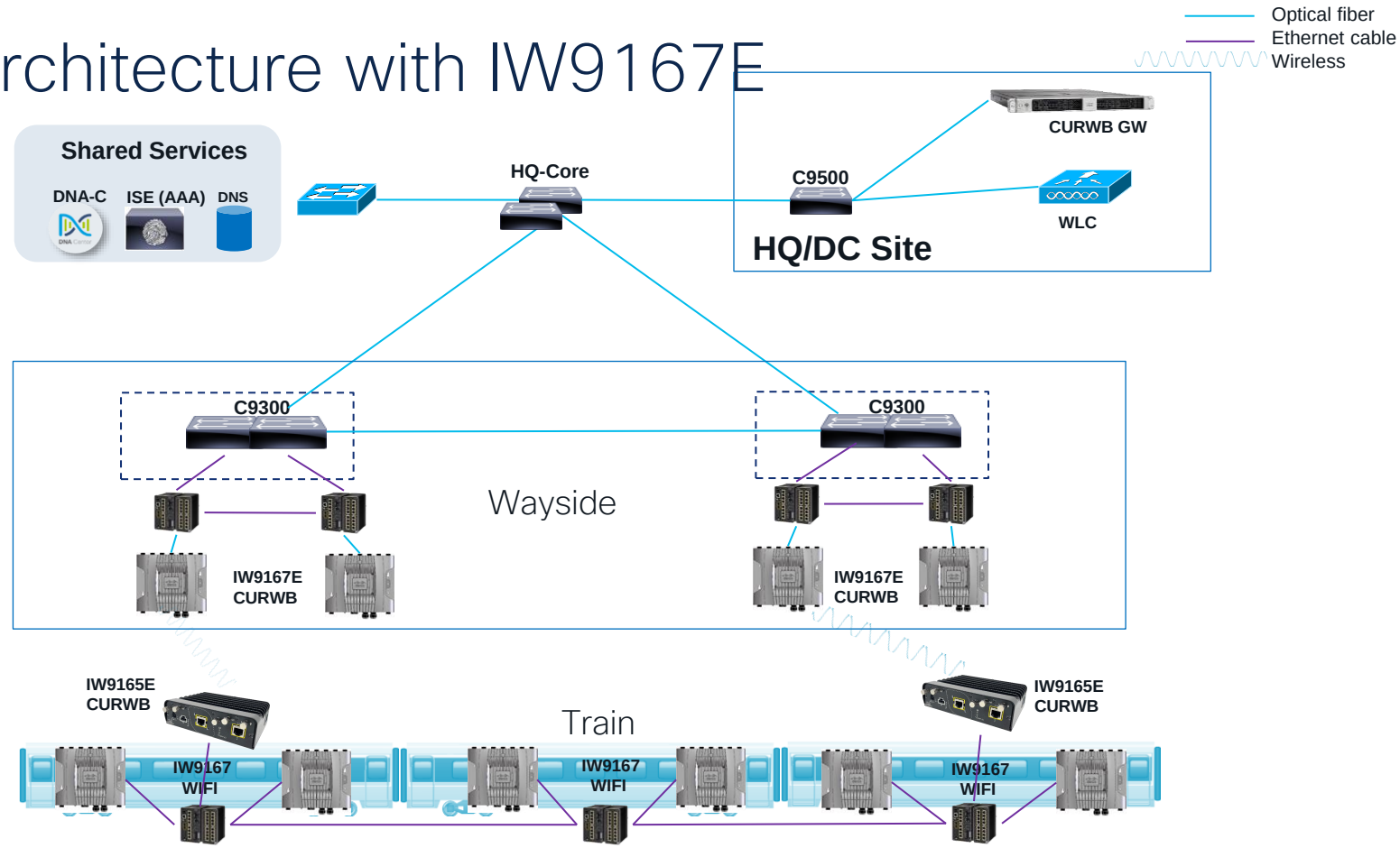
Site Survey – Inter-Car (Vehicle-to-Vehicle)



Site Survey – Inter-Car

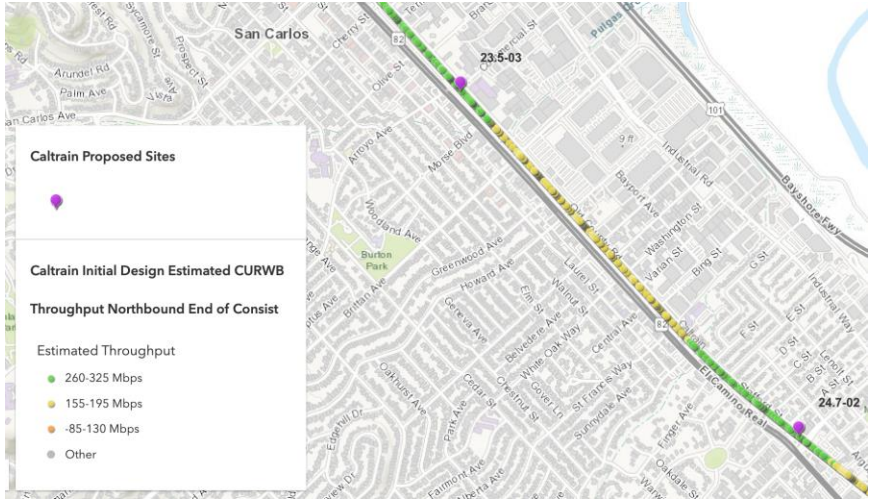


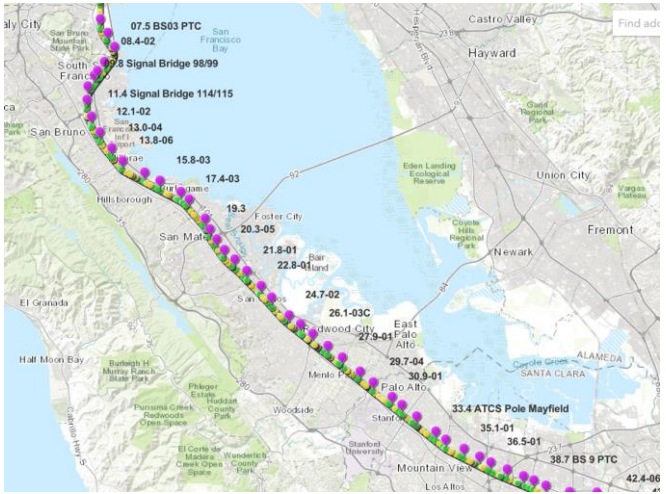
Rail Architecture with IW9167E



RF Route Studies

- The million dollar question:
  - ”How many Trackside radios do I need to cover my track?
- You can ROM BOM it with some assumptions and track spacing
- Ultimately, you need specialized help to determine where to place radios





Mobile Site Survey

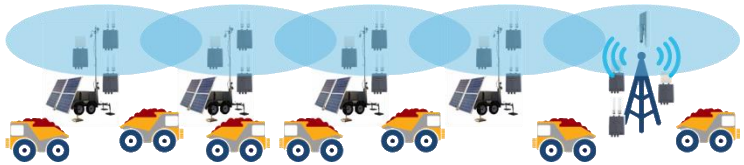
Mining – Open Pit

Site Survey – Mining

Site survey must be done by the Partner/System Integrator together with the End Customer to confirm the design, including:

- Physical placement of components at every fixed location.
- Physical placement of components on all trailers.
- Hardware installation procedure on all relevant vehicles.

- The project site may change between the design and implementation phases. The network design should be as flexible as possible to take this into account.
- A RF study is recommended before deploying the network.
- Application(s) and network technical requirements

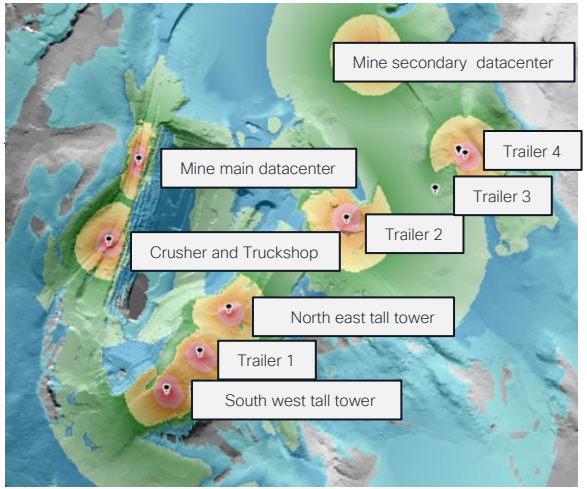


Site Survey – Mining - Qualifying

- Mine type
  - Target mineral: gold, iron ore, coal, etc.
  - Size and shape
  - Depth
  - Number of pits
  - A GIS map or 3-D drawing of the mine in the present and future, based on a production plan.√
- Infrastructure (Wayside)
  - Towers or poles
  - Buildings
  - Trailers
  - Fiber locations
- RF study
  - Existing wireless networks and spectrum analysis
  - RF models with computer software, based on production plan

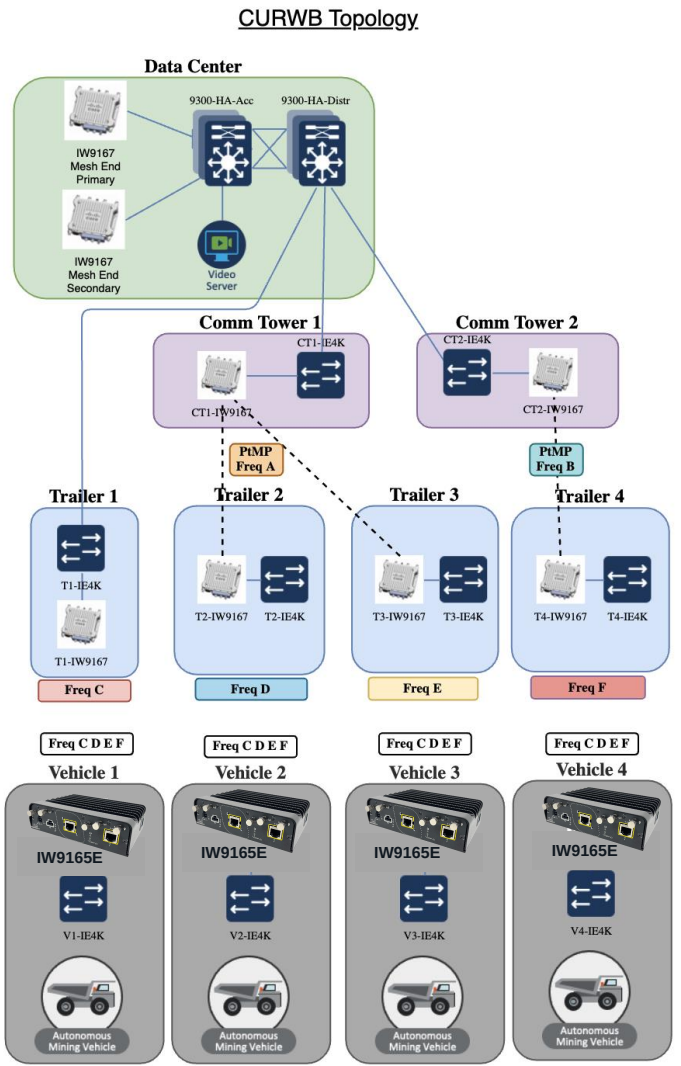
Site Survey – Mining

- This is a wireless network coverage map generated using computer simulation.
- The following information is required to run the simulation:
  - Locations of access-point radios (co-ordinates, elevation and height)
  - Antenna radiation patterns
  - Power output of the relevant radios (+ losses caused by cables, connectors, etc.)
  - *.DXF file or 3-D drawing of the mine layout



Mining AHS Architecture using IW9167E and IW 9165E

- CURWB L2 Fluidity for Autonomous Vehicle to Trailer connectivity
- CURWB Point-to-Point or Point-to-Multi-point wireless backhaul connectivity from Trailer(s) to Communications Tower
- Multi-Frequency deployment with Seamless 0 mSec Make-before-Break connectivity
- Single IW9167 radio can be used on trailers both for Access (Vehicle Connectivity) and wireless Backhaul (Trailer to Comm Tower) connectivity



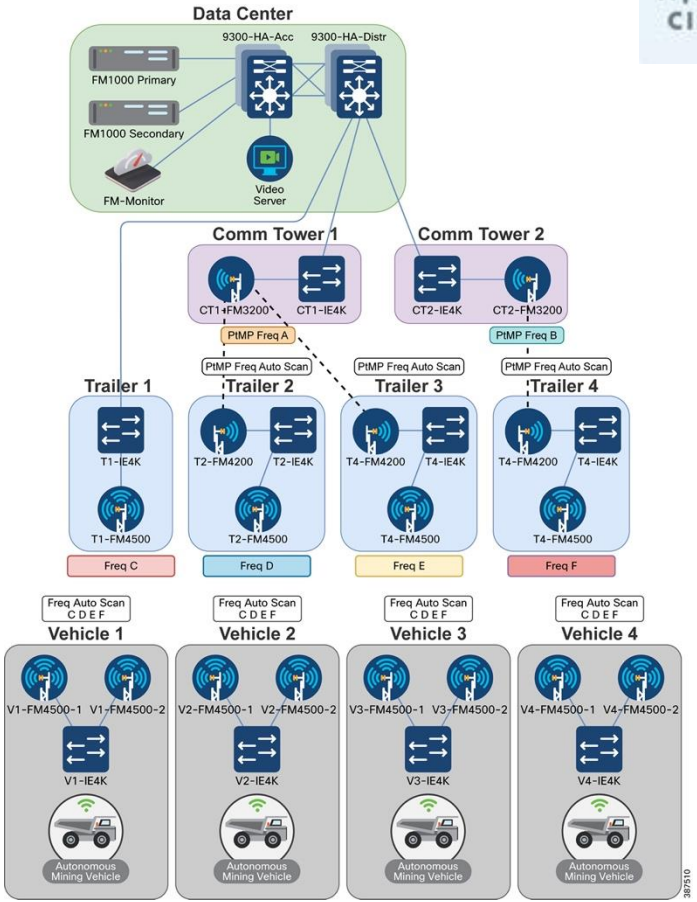
CURWB CVDs

CURWB Deployment for Autonomous Operations in Open-Pit Mining

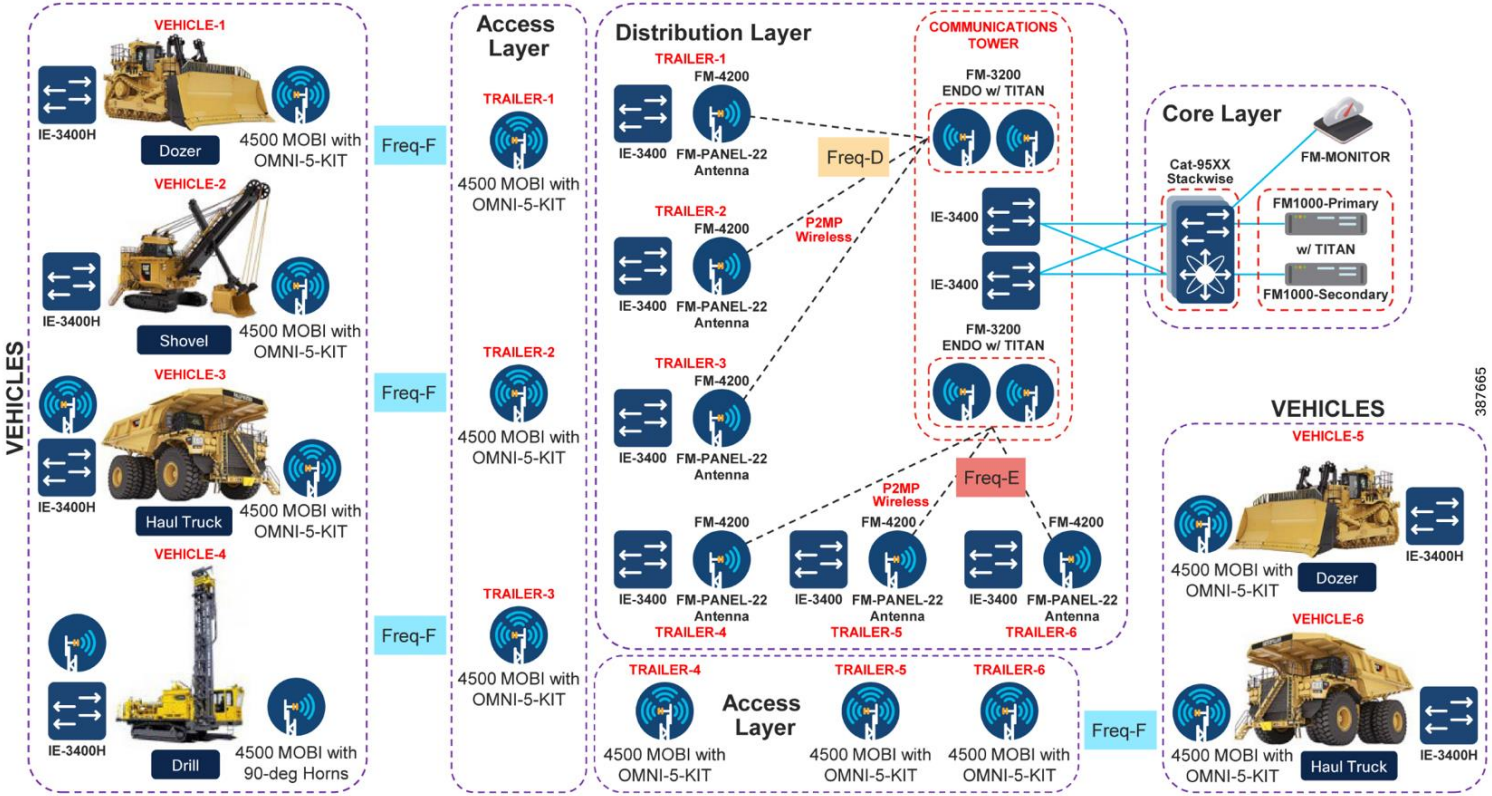
Solution highlights:

- Mining Use-Cases and Requirements
- CURWB Architecture to support Autonomous and Tele-Remote Operations within Open-Pit Mines
- Open-Pit Mine - RF Planning, Design, and Installation
- Solution Implementation Guide

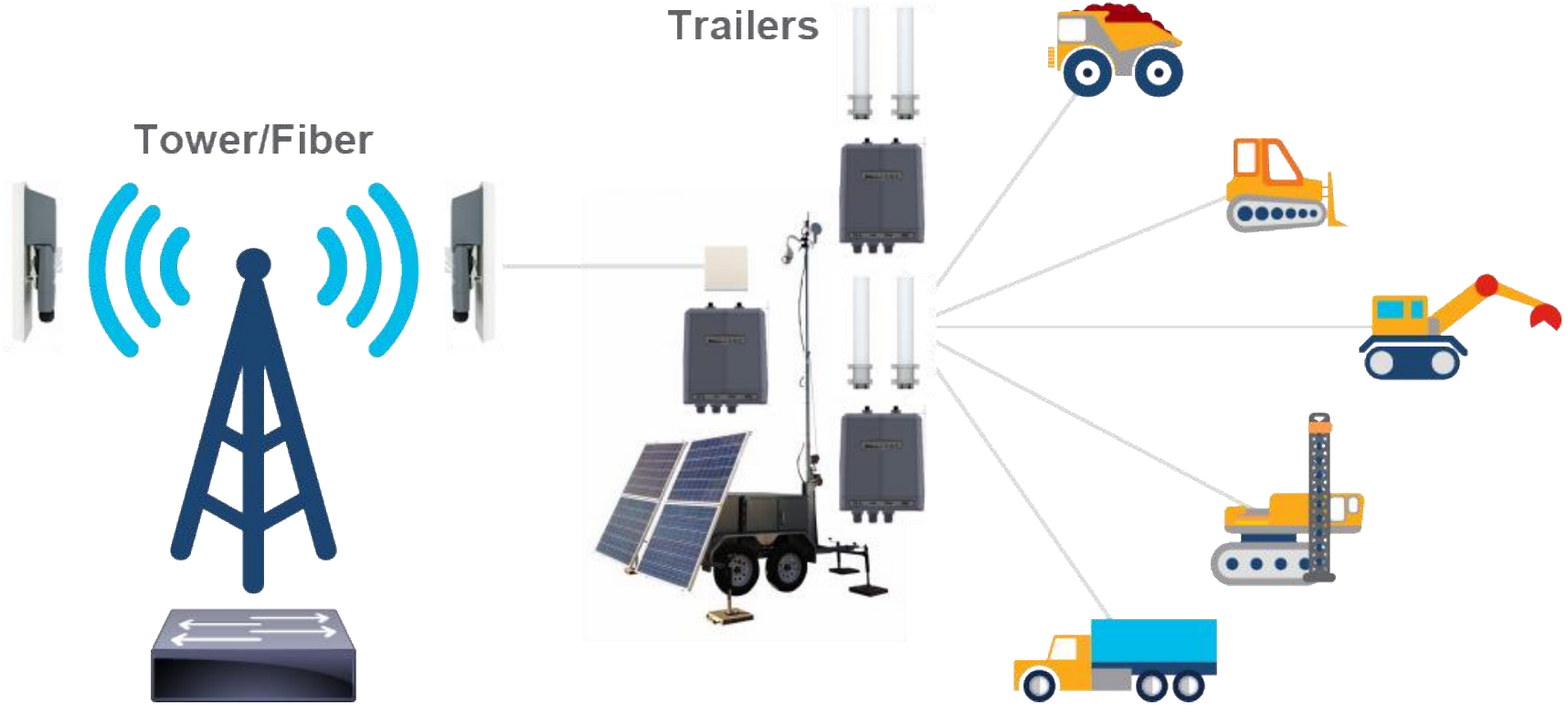
CVD Link:
https://www.cisco.com/c/en/us/td/docs/solutions/Verticals/Industrial_Automation/IA_Verticals/Mining/Mining2_0-CVD/IA-Mining-DG/IA-Mining-DG.html



Fluidity Overview – Mining



Distribution and Access Layer

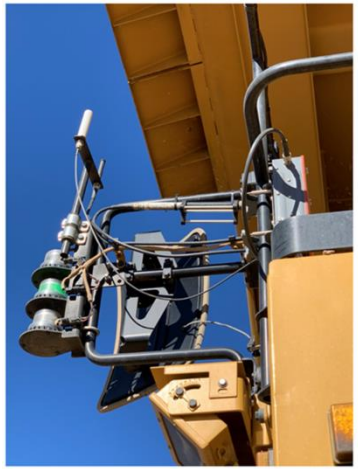


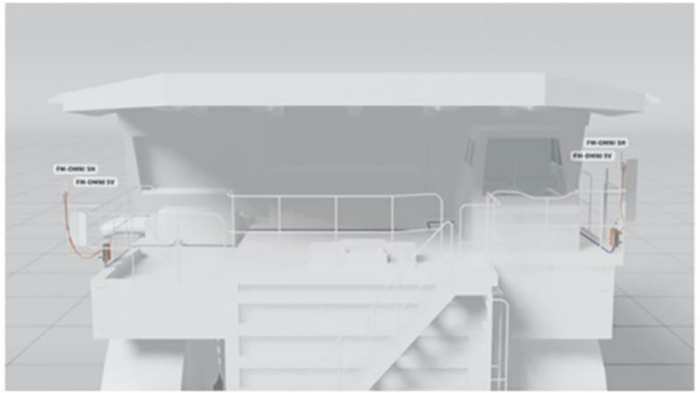
Trailers using CURWB Wireless MPLS Technology

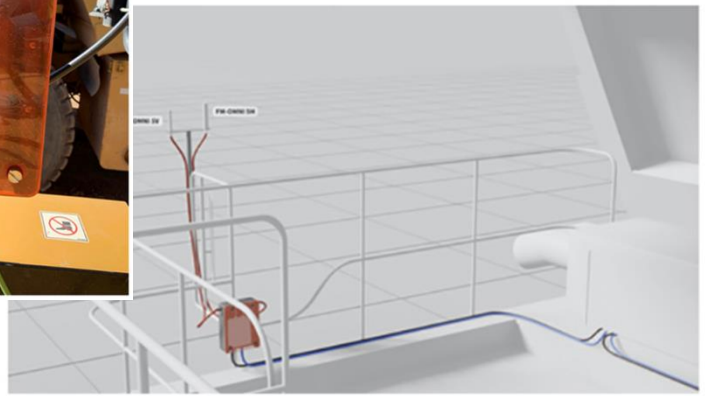
Trailers using CURWB Wireless MPLS Technology

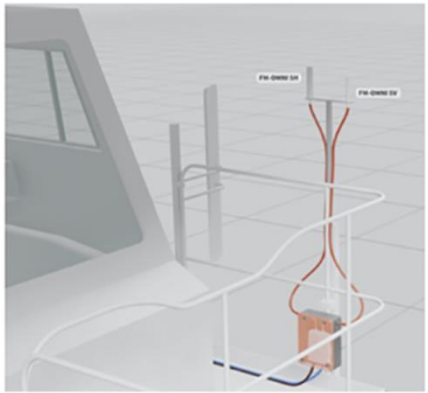
Roll-out – Mining

- Haul Truck Installation - Dual Radios with OMNI-5-KIT omni-directional antennas



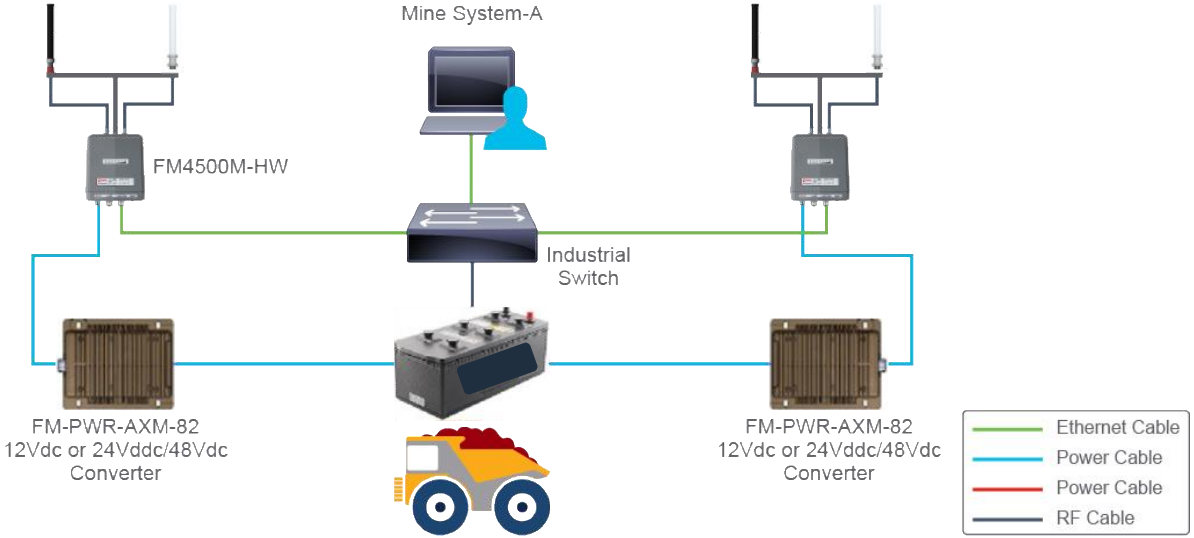






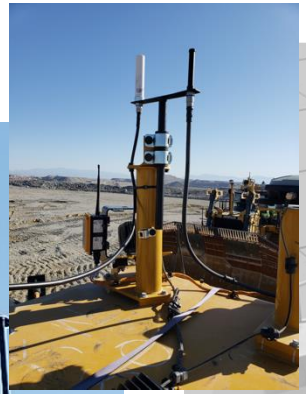
Roll-out – Mining

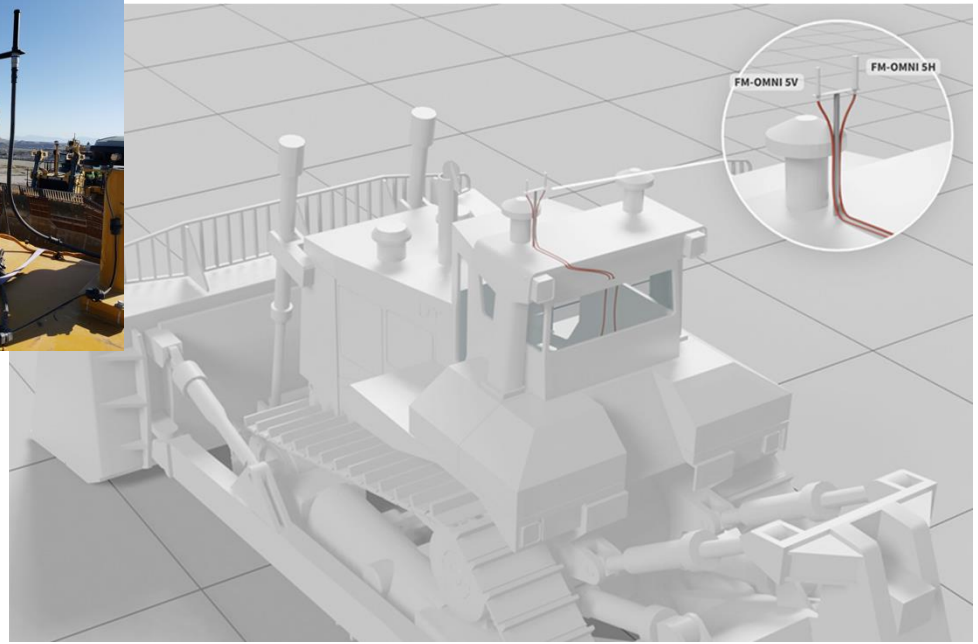
- Haul Truck Electrical Power And Ethernet Wiring



Roll-out – Mining

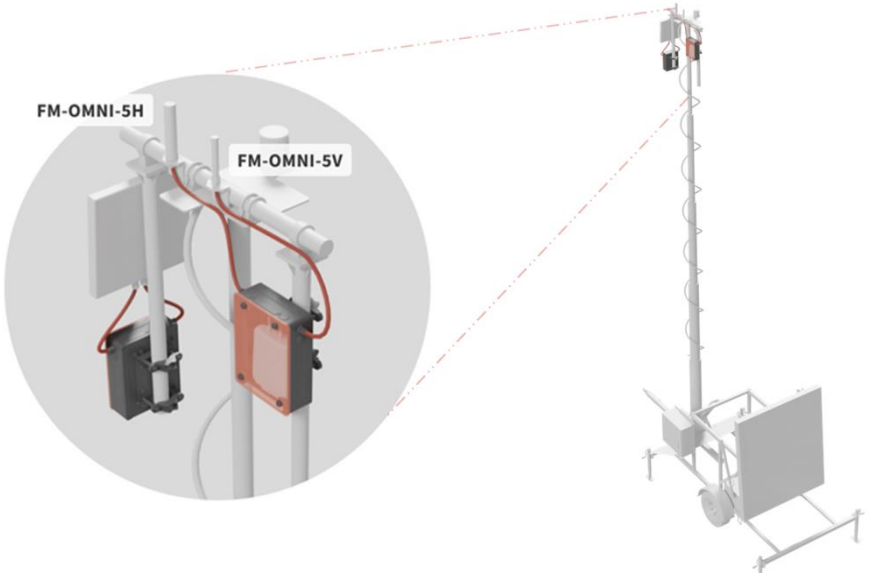
- Dozer installation with a single radio and omni-directional antenna





Roll-out – Mining

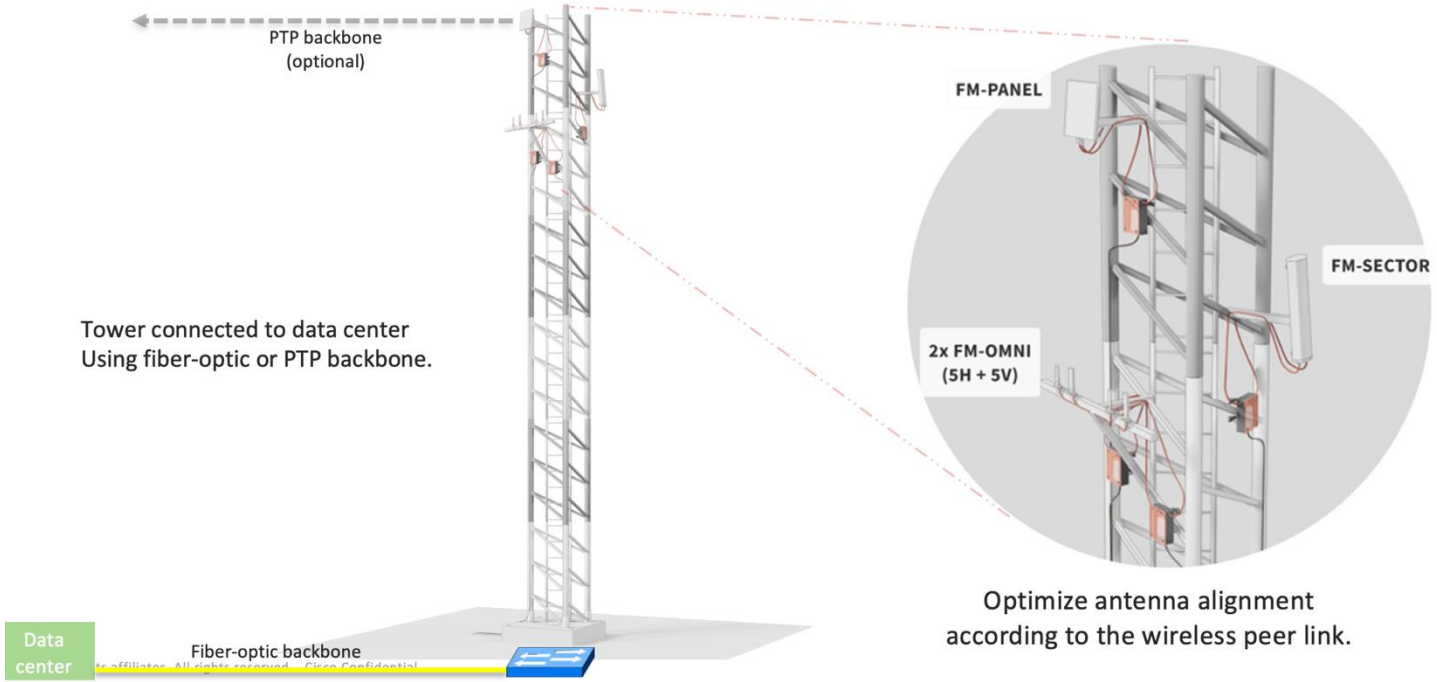
- Trailer | single omnidirectional radio



Set the mobile trailer to run on 12Vdc or 24Vdc.
Power the radio at 48V from an industrial DC-to-DC convertor

Roll-out – Mining

- Installation Of Radios On Towers

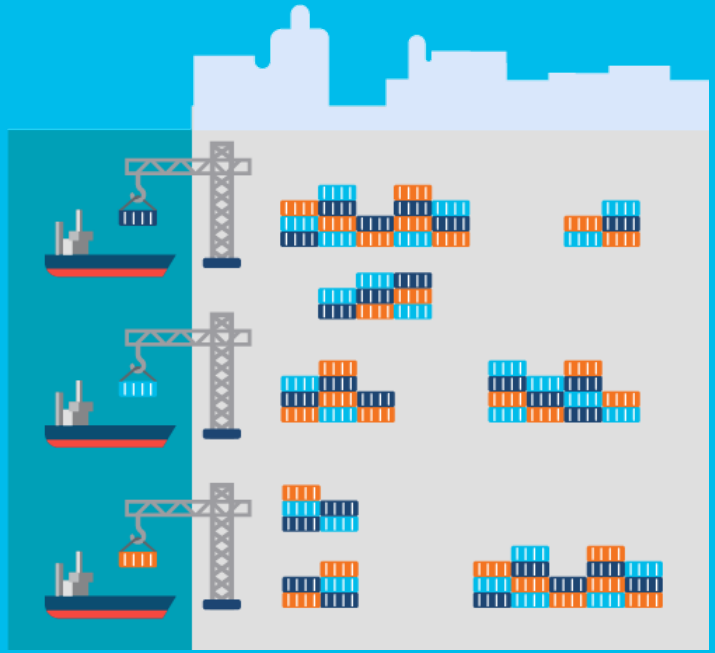


Anglo American Khwezela Open Cut Coal Mine

Anglo American Khwezela Open Cut Coal Mine

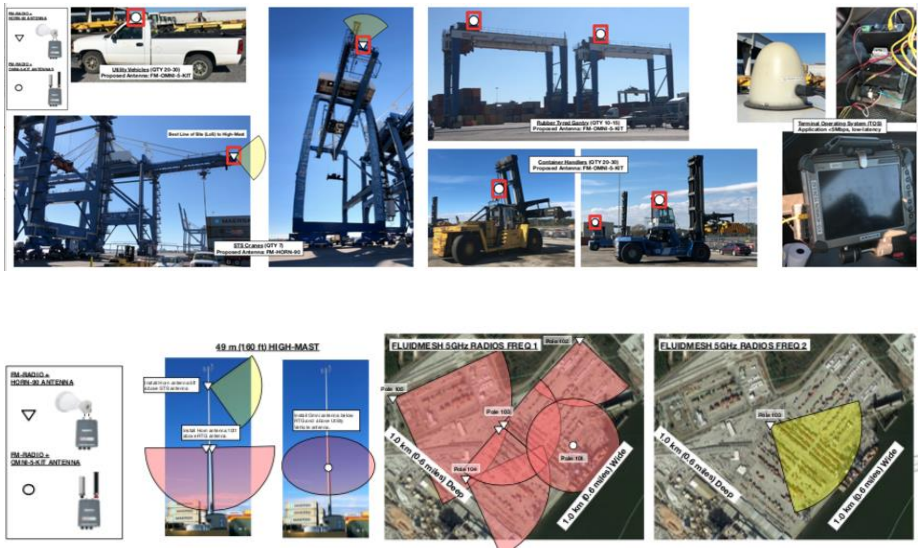
Mobile Site Survey

Ports and Terminals



Site Survey – Ports and Terminals

- Project details:
  - Site layout information, or a relevant Google Earth *.KMZ file
  - Proposed vehicle layout and construction drawings
  - Information detailing the network layout between the central control area and site coverage areas
  - Understanding application and coverage requirements



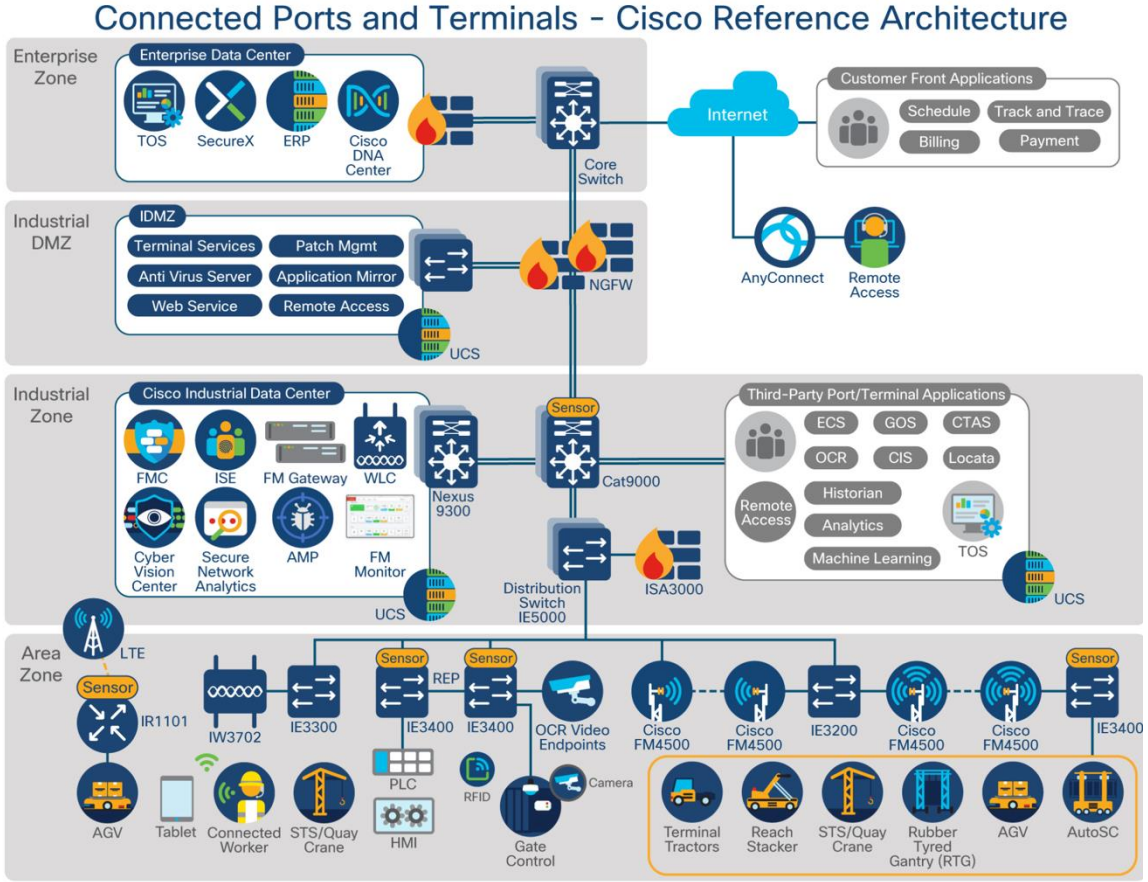
CURWB CRDs

Connected Ports and Terminals

Solution highlights:

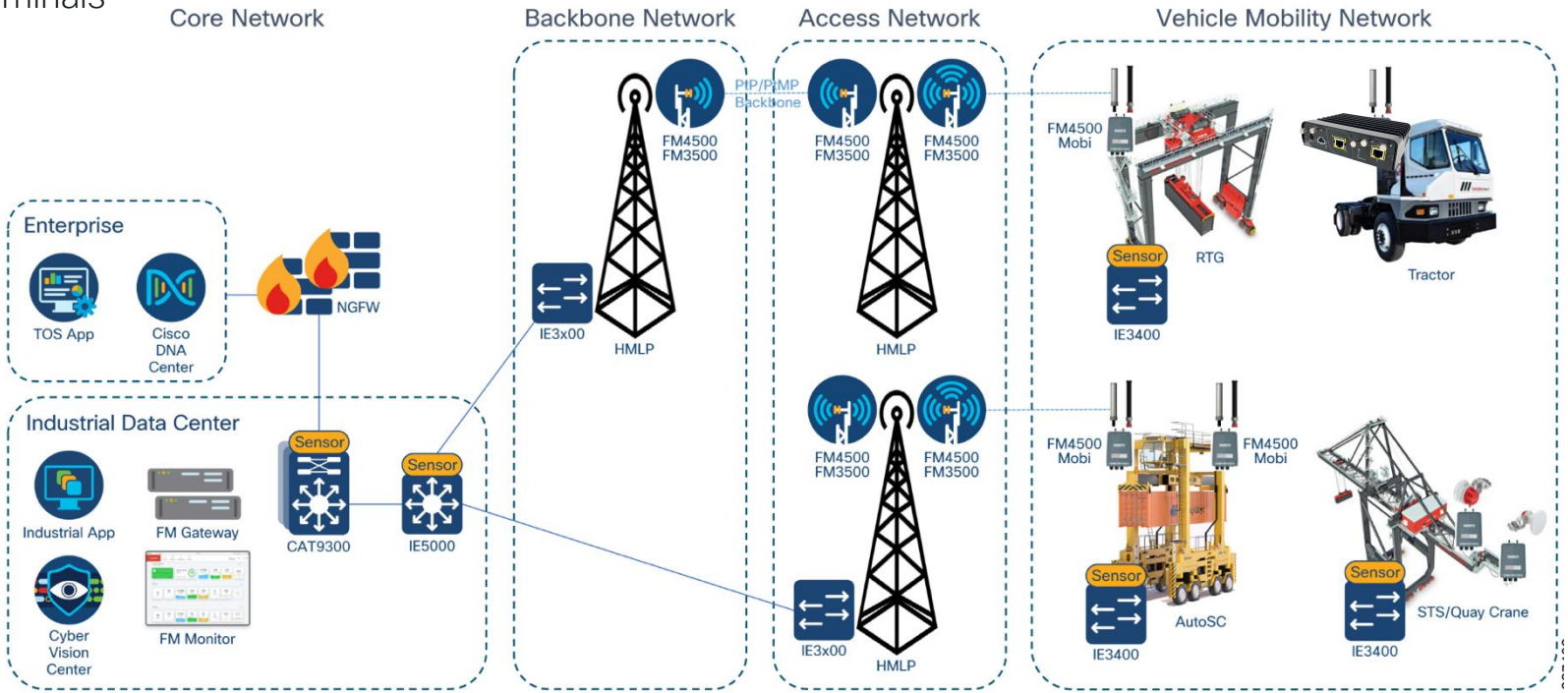
- Connected ports and terminal reference architecture
- CURWB technologies and best practice for terminal automation use cases (TOS)
- Cyber Security for ports and terminals operation best practice
- CURWB RF planning, design, and installation best practice

CRD Link:
https://www.cisco.com/c/en/us/td/docs/solutions/Verticals/CCI/Ports/DG/cci-ports-dg/cci-ports-dg.html



Fluidity Overview – Port and Terminals

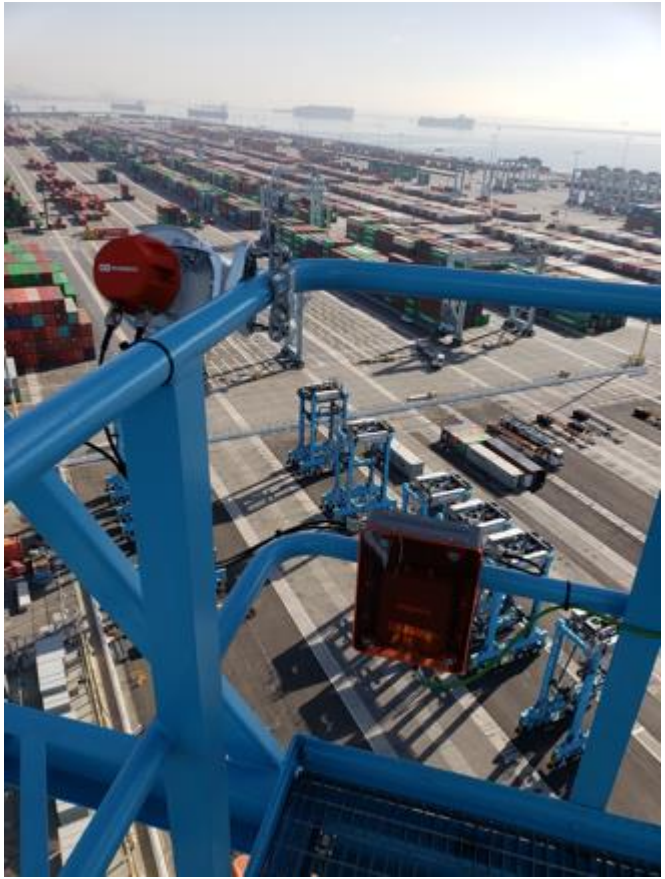
- CURWB L2 Fluidity deployment for Ports and Terminals



Site Survey – Ports and Terminals (Wayside)

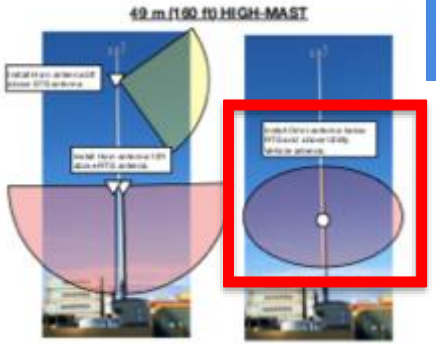
- Trackside spacing varies per deployment, and a rigorous physical site survey must be completed.
- The signal can be split to create aligned coverage up and down the area from a single radio location.
  - The link budget calculation must allow for an ~3dB RF power reduction.
  - This approach will require shorter trackside radio placement intervals.

Site Survey – Ports and Terminals (Wayside)



Site Survey – Ports and Terminals (Wayside)

- Single radio with single antenna setup

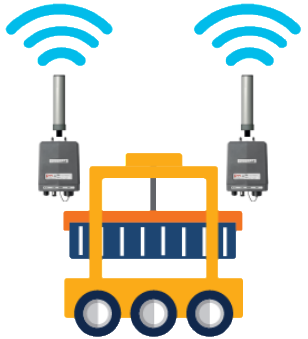


Site Survey – Port and Terminals (Wayside)

- Single radio with split antenna setup

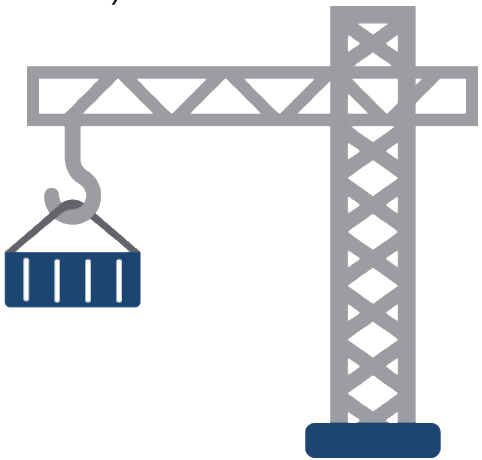
Site Survey – Port and Terminals (Vehicles)

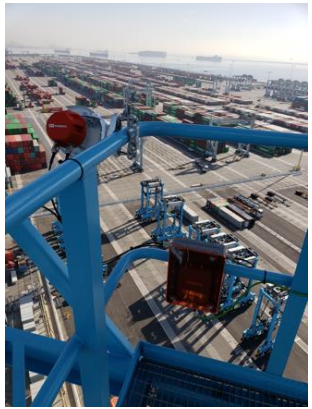
- Vehicle-mounted radio configurations are shown below (using FM-OMNI-5-KIT).
- A dual-radio solution can exploit TITAN for redundancy and ensure high signal strength between vehicle and wayside.

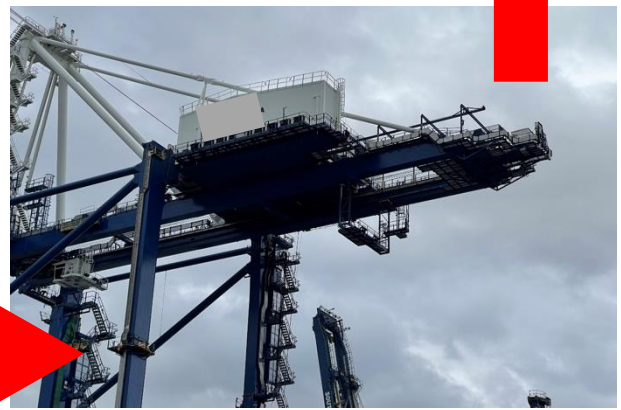


Site Survey – Port and Terminals (Vehicles)

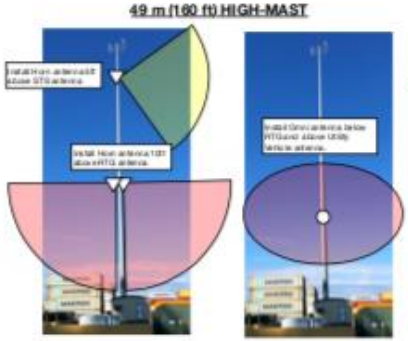
- Vehicle-mounted radio configurations are shown below (using FM-OMNI-5-KIT).

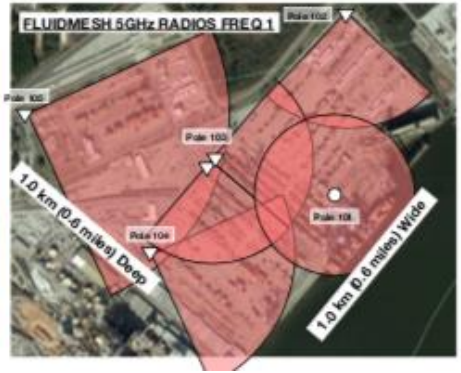




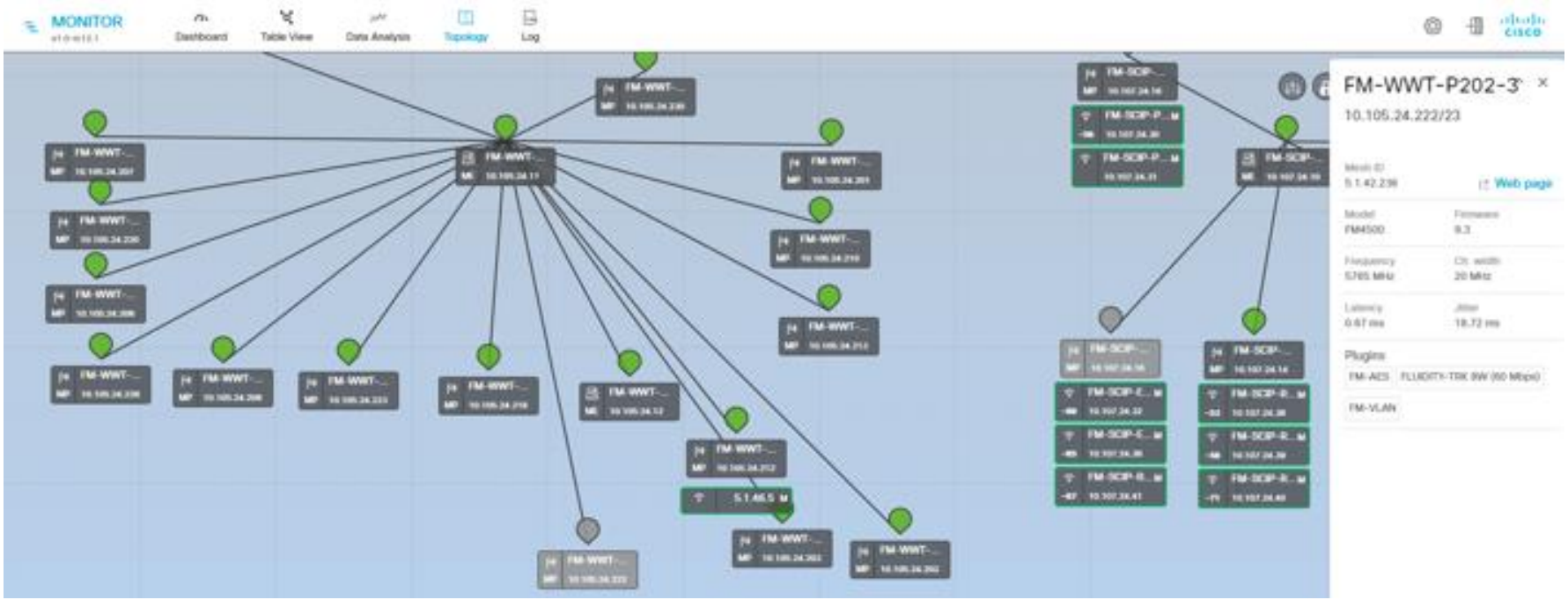


Site Survey – Port and Terminals



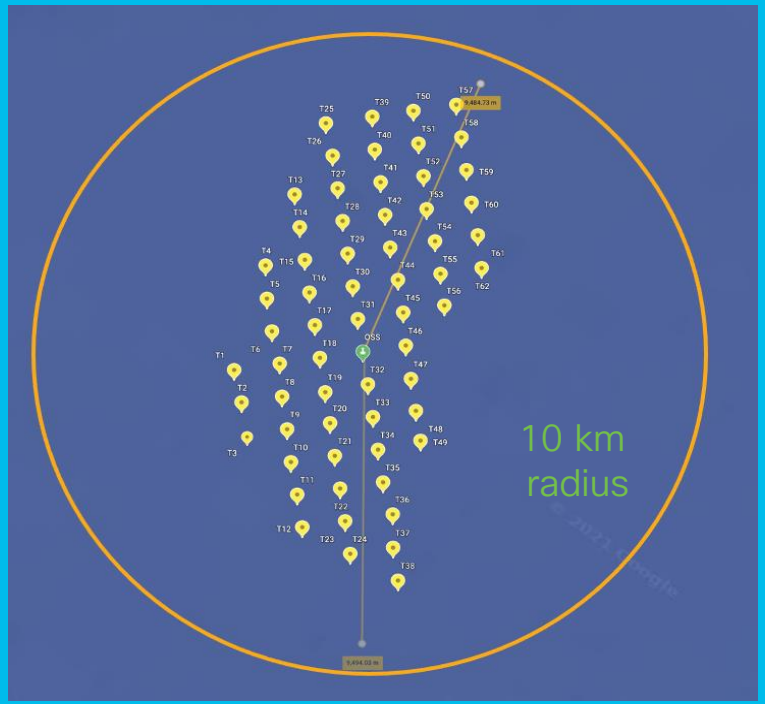


Port and Terminals
FM-Monitor (monitoring)

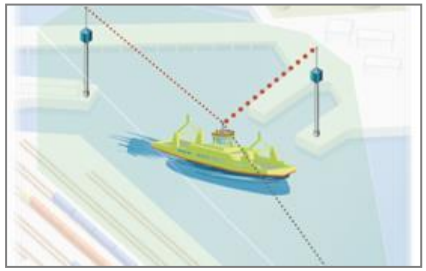


Mobile Site Survey

Transportation – Offshore Windfarms



Customer Challenge



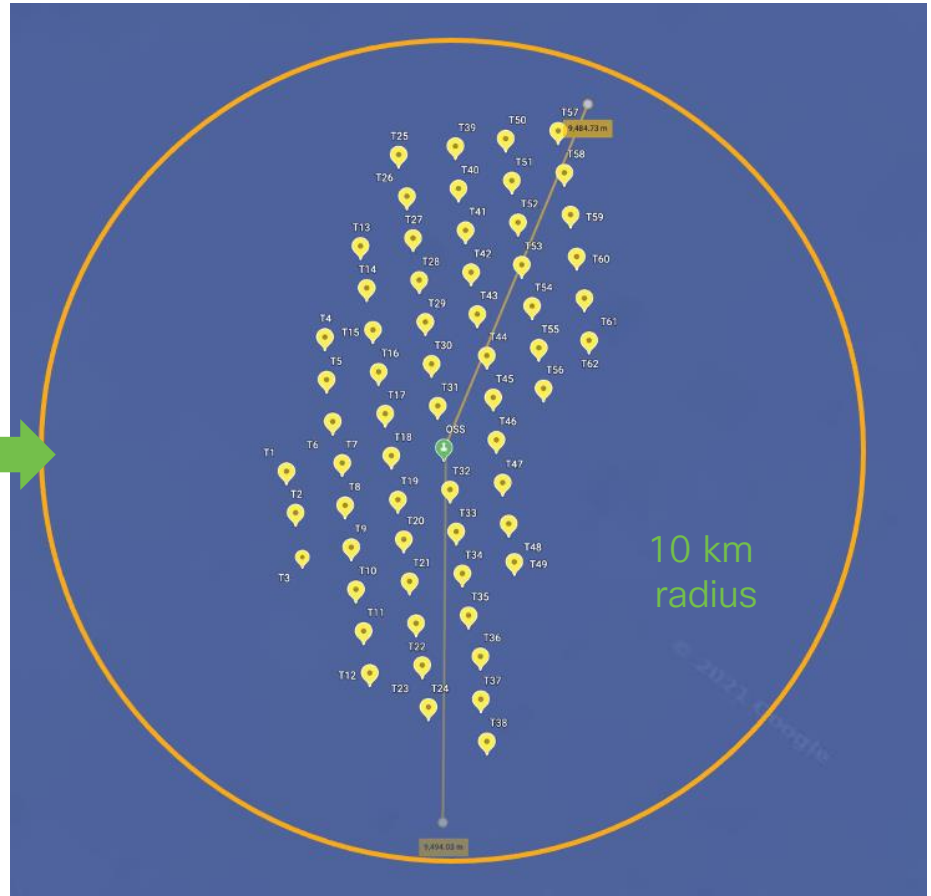
- Customer requires a solution to provide internet connectivity on vessels that is used for work and ‘welfare’ purposes
- Challenge: Initial investment and running costs for satellite communications and private LTE at offshore wind farm
- Looking for an alternative technology that’s reliable and less expensive to address these communication requirements (improved bandwidth would be a bonus!)

Example: Service Operation Vessel (SOV)

Example: Crew Transfer Vessel (CTV)

Example: Offshore Substation (OSS)

Offshore Wind Farm – Vessel communication requirements



10 Mbps on vessel at 10 km distance from OSS

Use public LTE when vessel close to shore

Target: 30 to 50 Mbps on vessel at 10 km distance from OSS

Overview of Solution (1)

Mesh Points: two antennas on vessel, each with its own radio.

Networking on vessel set up as a branch office with Wifi access points and physical Ethernet connections

Mesh End: Offshore Substation Platform (OSS)

- Four 90 degree panel antennas mounted on communications mast. each with radio
- Mesh End Radios connect to the ‘enterprise’ network, which is connected shore by undersea fibres

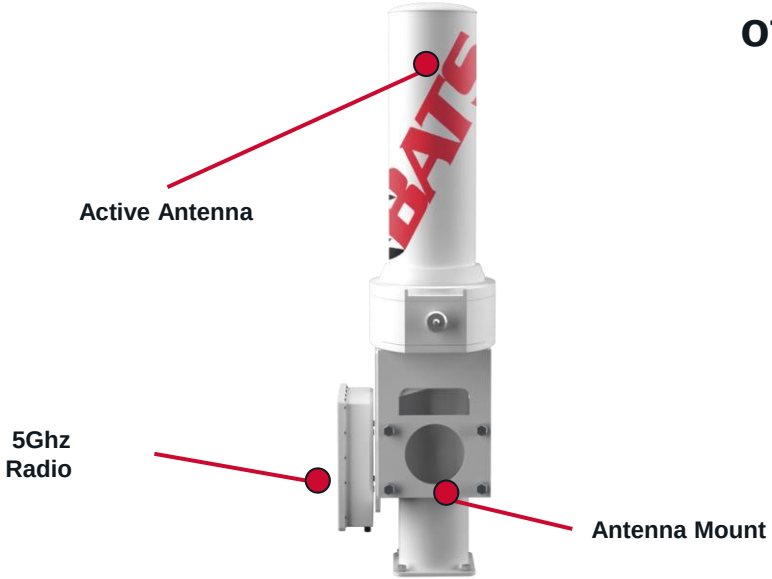
Overview of Solution (2)

BATS Wireless Antennas

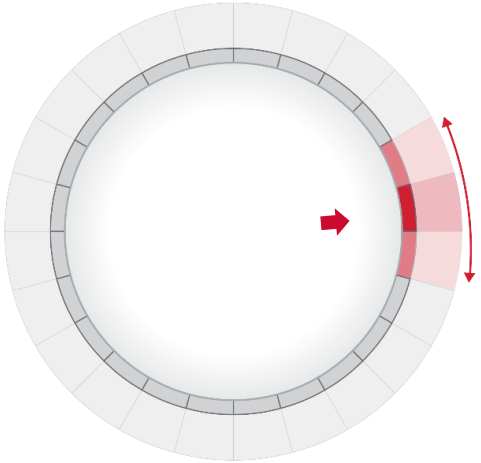
- Specialist antennas
- Software controlled antenna dynamically focuses radio beam on OSS antennas, as vessel moves

BATS Technology

FAST Antenna

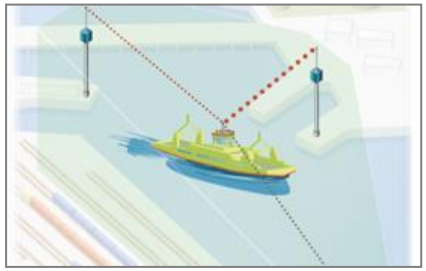


The FAST is an active antenna made up of 24 mini sectors, that send the signal to a specific point, when required.



BATS Wireless has qualified Cisco URWB radios for FAST antenna

Overview of Solution (3)



BATS Combination Antenna accommodates CURWB and LTE

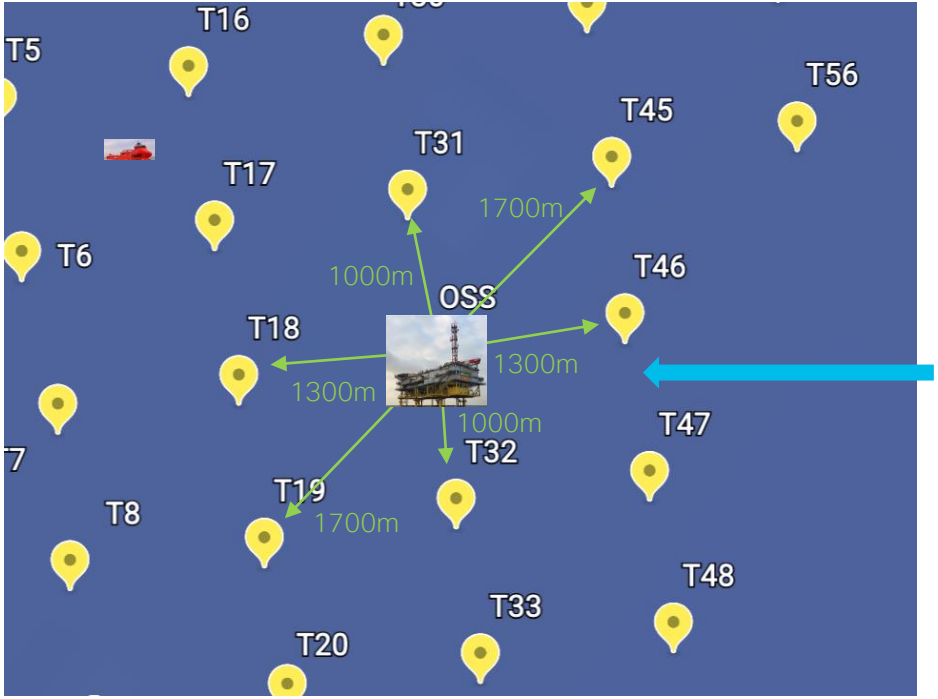
BATS Wireless has qualified their antennas with Cisco URWB radios and the IR1101 with LTE

When leaving or heading to shore, vessel will attach to public LTE several km offshore

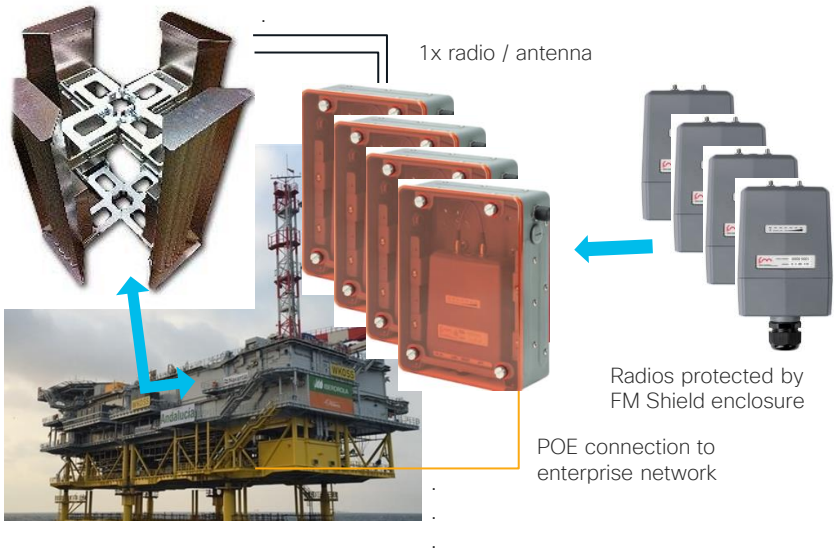
When the vessels are at the windfarm, they will switch to use CURWB.

BATS Antenna with equipment enclosure

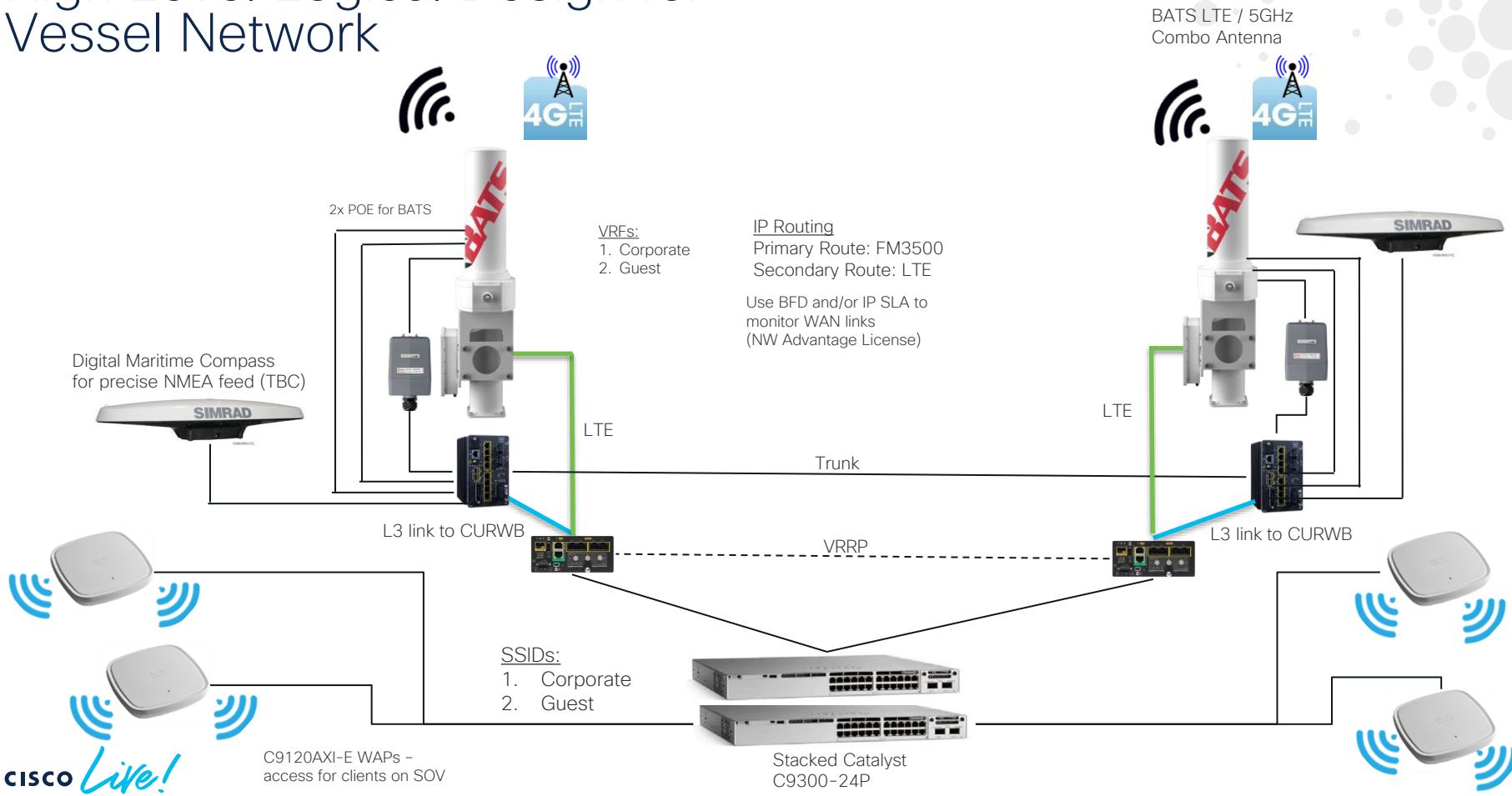
Saint Brieuc Windfarm



- Closest turbines to OSS are minimum 1000m away
- Vessels will usually be at least 500m away from OSS



High Level Logical Design for Vessel Network



Mobility Site Survey

Entertainment and Manufacturing

Main Applications

Live Shows

- Show Control
- Special Effects
- Lighting
- Performer Flying System
- Trolley/Float Control

Parades

- On-Board PLC for Float Control (Safety Protocol)
- Show Control (Audio /Visual Sync with Float Movement)
- On-Board Video Surveillance

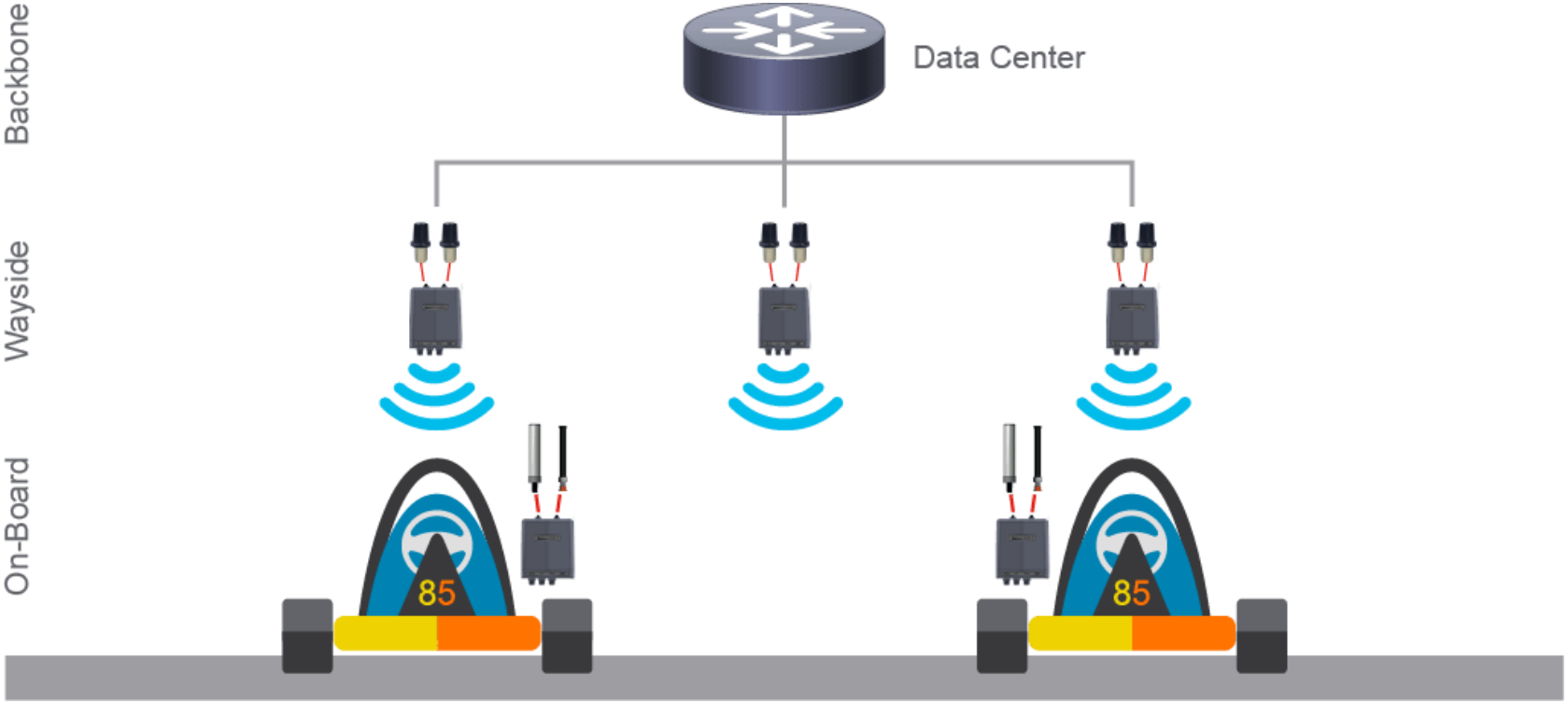
Dark Rides / Attractions

- On-board PLC for Vehicle Control (Safety Protocol)
- Ride Control Protocol
- Show Control (Audio /Visual Sync with Vehicle Movement)
- On-Board Video Surveillance

Security & Wifi

- Video Surveillance
- Access Control
- WiFi
- Temporary Data AP
- VoIP
- Audio Broadcasting

CURWB Fluidity: Typical Network Topology



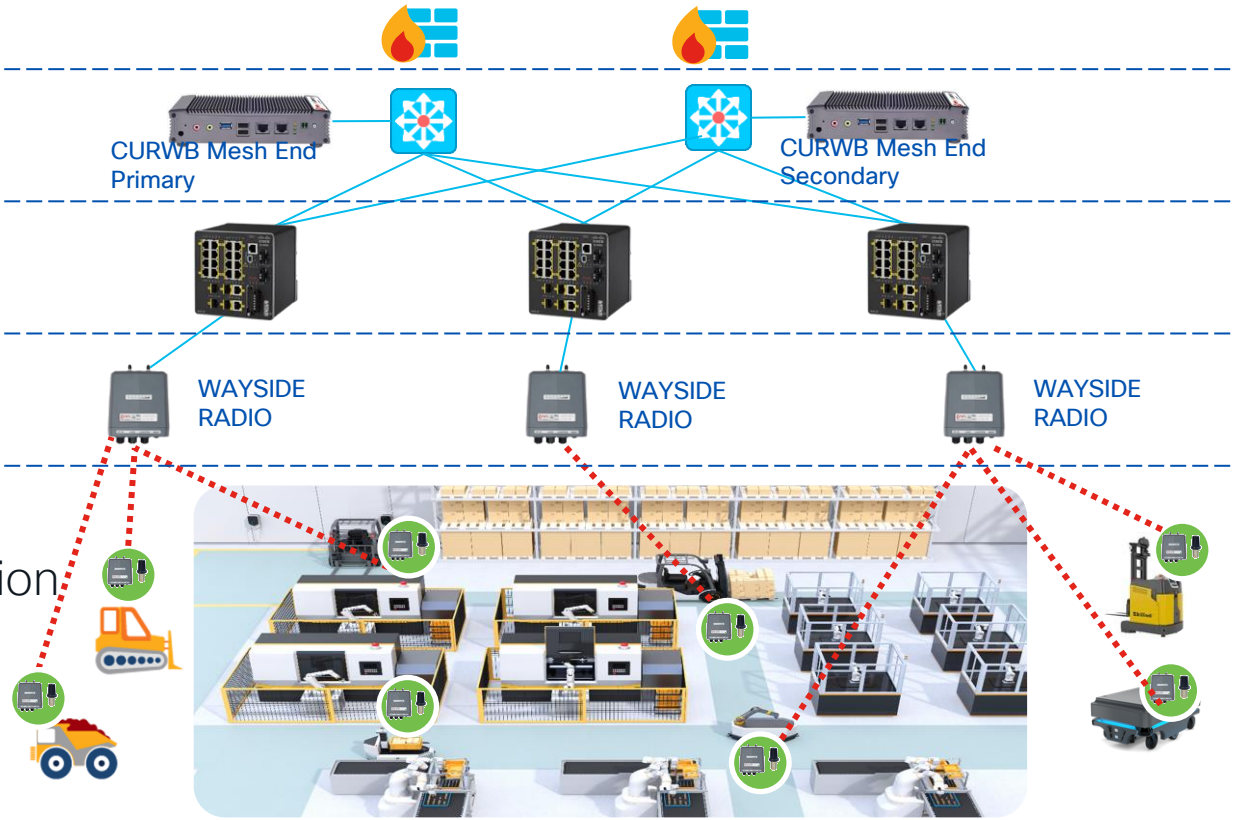
CURWB Fluidity Layer 2: typical network topology

DMZ/Firewall

Core Network

Access Network

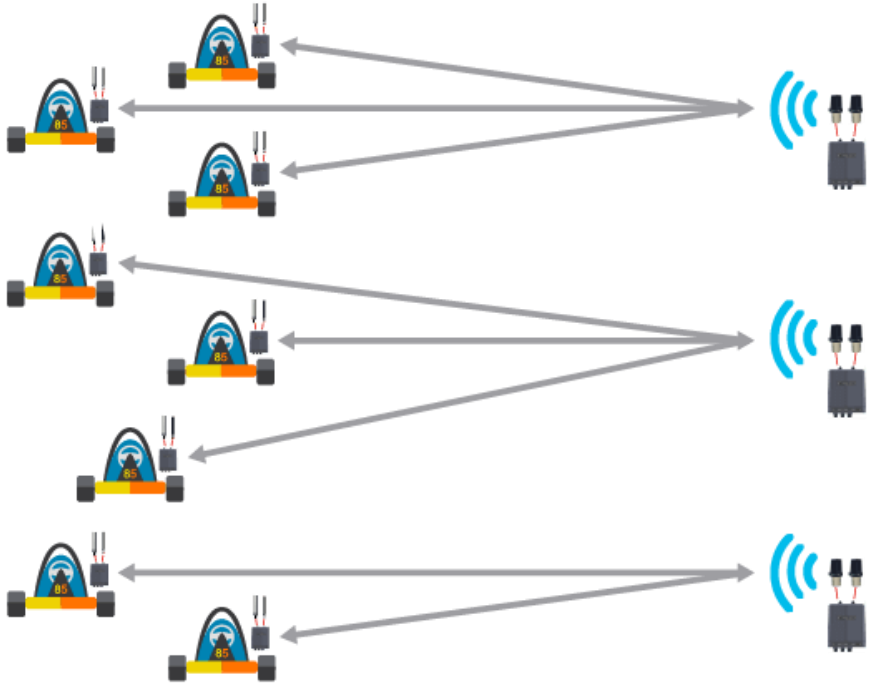
Access Layer Radios



- Connectivity in motion
- Low latency
- Zero loss

Broadband Wireless in the Maintenance Bay

FLUIDITY



Ride Control

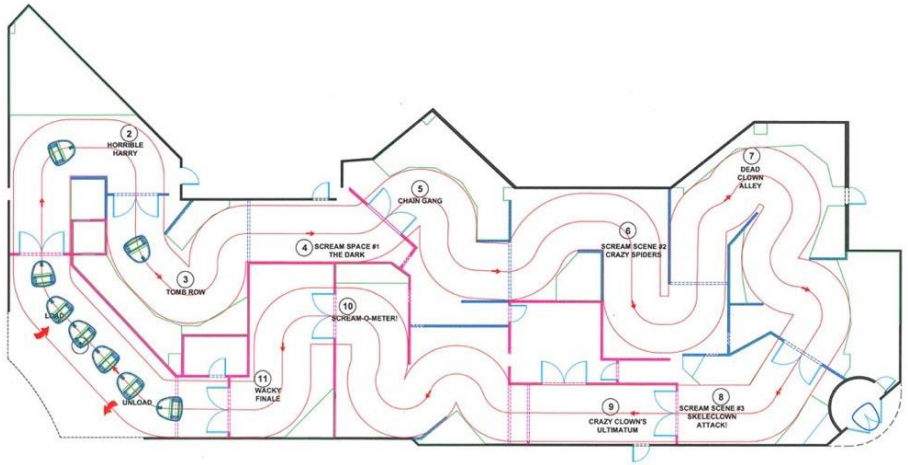
Show Files Dowload

Vehicle Diagnostic

Site Survey – Entertainment

- Site survey must be done by the Partner/System Integrator together with the End Customer to confirm the design, including:
  - Physical placement of components at every fixed Scene location.
  - Physical placement of components on all Vehicle locations.
- The project site may change between the design and implementation phases. The network design should be as flexible as possible to take this into account.
  - Typically these are multi-frequency designs and highly-redundant (i.e. TITAN)
  - Multiple-frequency configurations on the Scene-side and dual radio on the Vehicle-side
- Application(s) and network technical requirements
  - <1mbps
  - 0ms hand-off (i.e. no packet drops)
  - <50ms latency (otherwise system-wide shutdown)
  - safety-critical PLC

Typical Track and Frequency Configuration



Theming Concept vs. Actual

LOCATION 5.0.174.234
SCENE 13, OUTSIDE TRACK, TRACK LEFT

PROPOSED SOLUTION:

Mount Radio inside off a Large off the shelf Tool Box and mount Antenna Nodes at top of box lid.

Toolbox to be thoughtfully selected to fit into world of MarioKart.

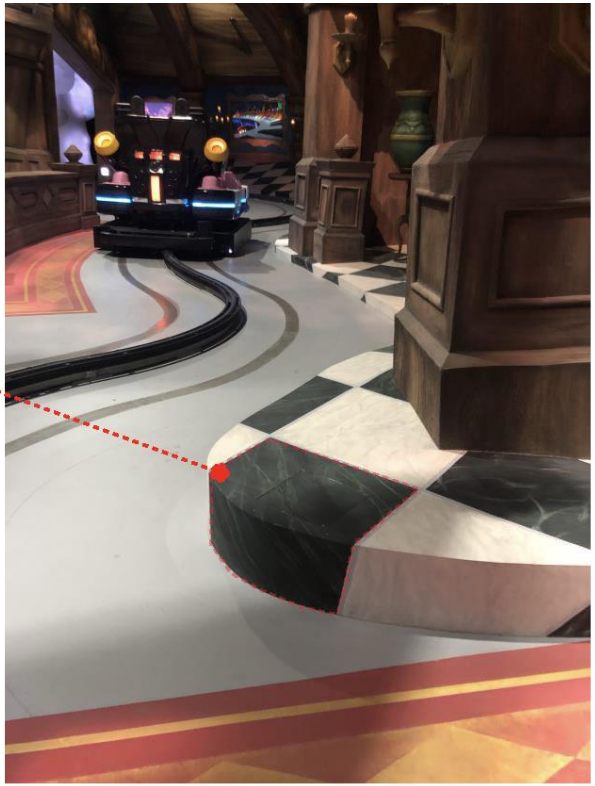
All cable to be concealed from guest view.

Show Set Integration

Track: Inside
Scene: 7

Radio Mesh 223
(underneath checkered show set – use removable panel to access)

radio transparent panel, painted to match Show Set - to be all non metallic materials



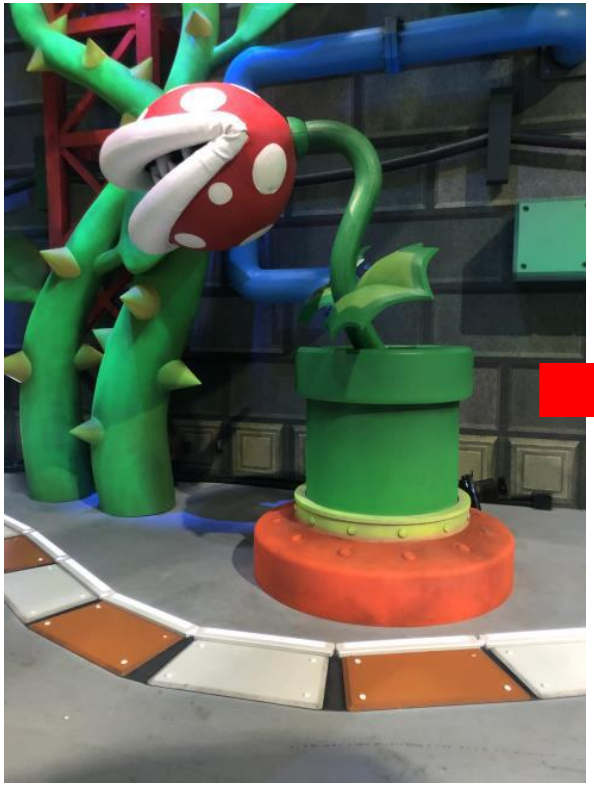
Show Set Integration

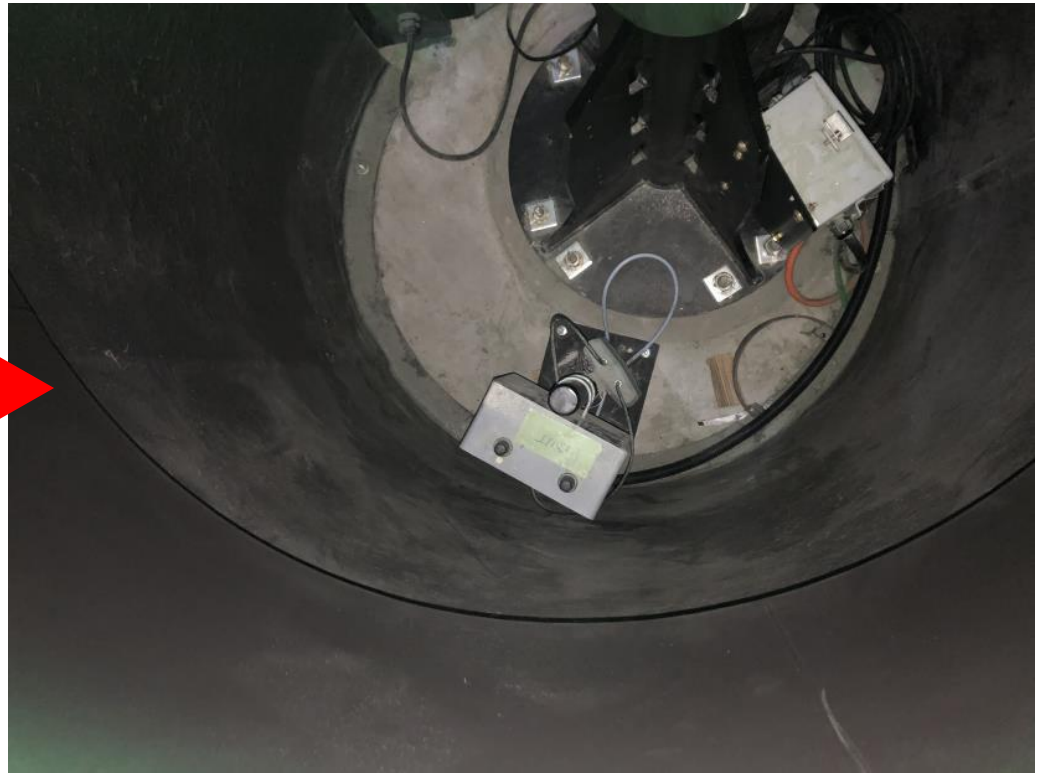
Track: Inside
Scene: 7

Radio Mesh 212
(inside short pillar, next to vase – access from rear)

radio transparent panel, painted to match Show Set - to be all non metallic materials

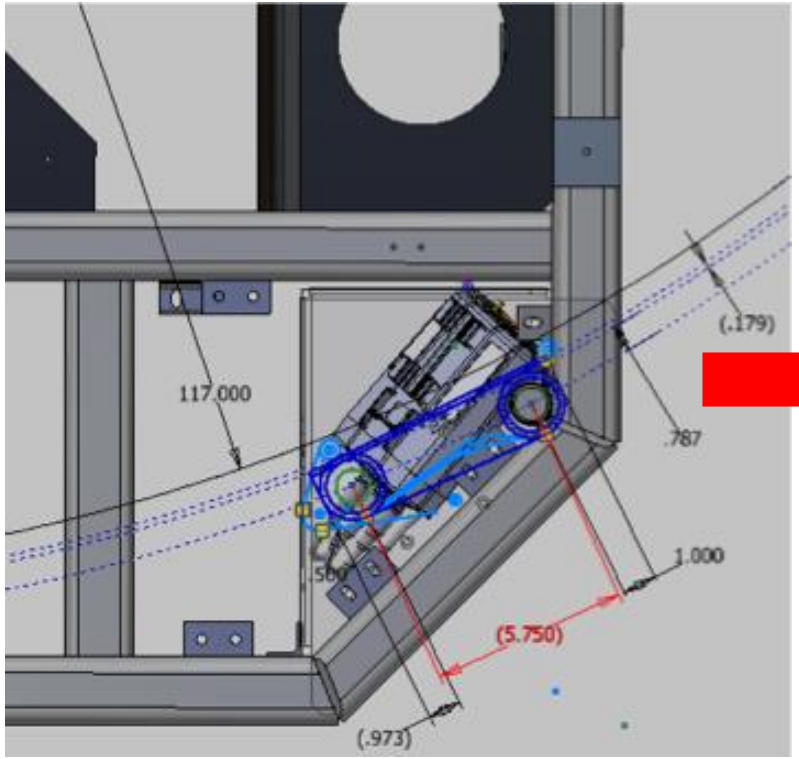
Show Set Integration



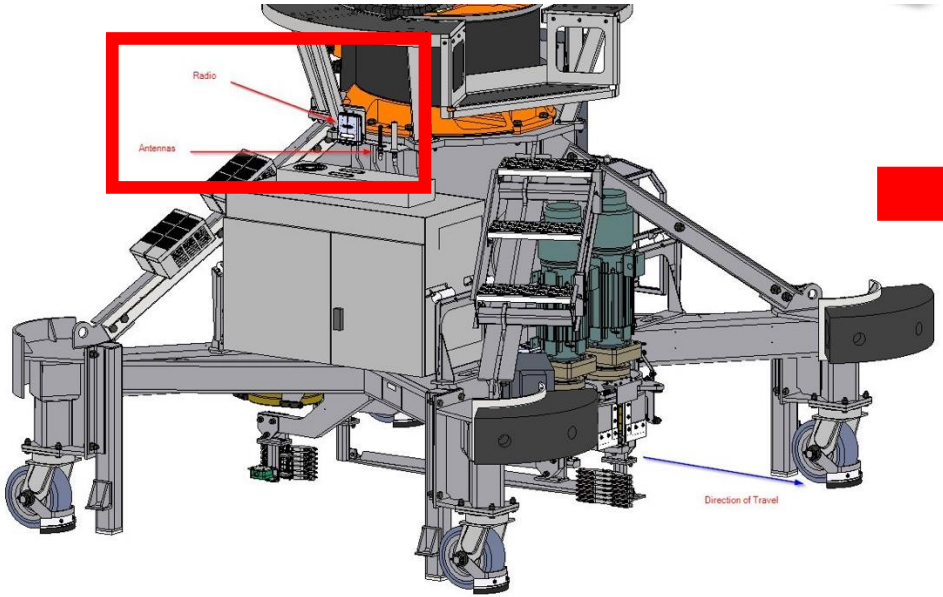


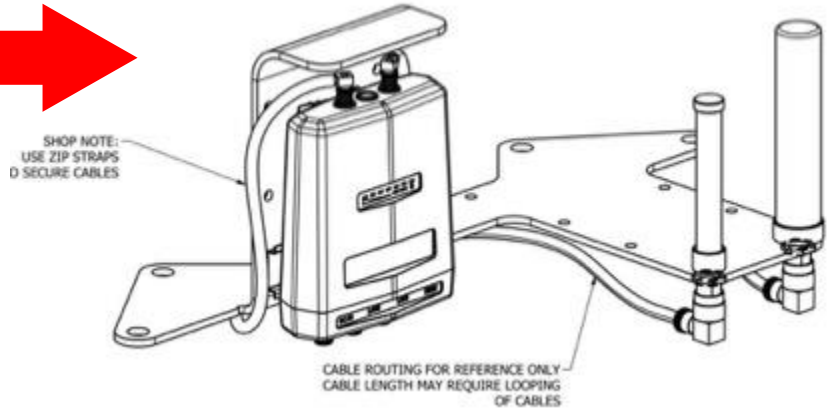
Test and Adjust Phase vs Production Placement

Vehicle Radio Integration (2x CURWB Radios)

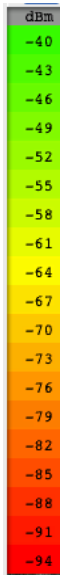


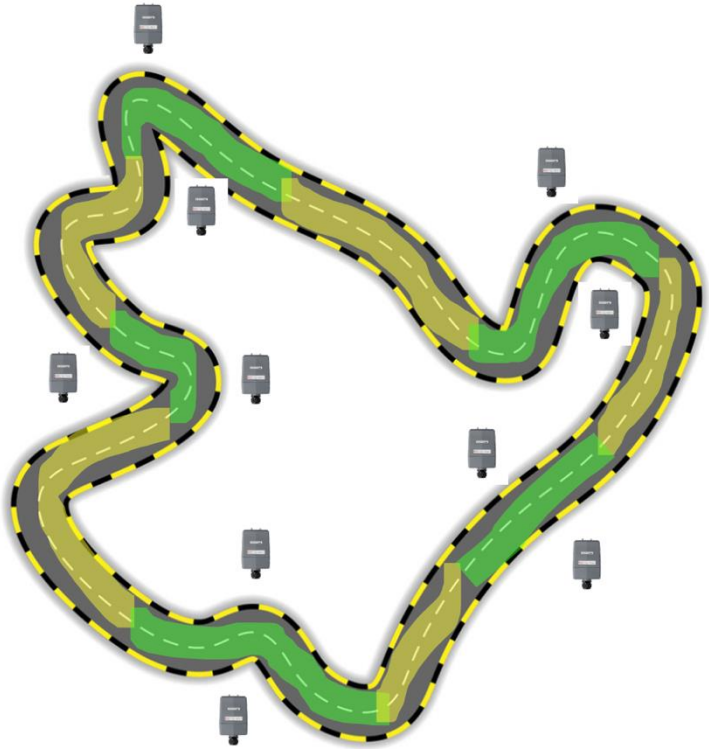
Vehicle Radio Integration (2x CURWB Radios)





Typical Track and Frequency Configuration





INSIDE TRACK

FRONT RADIO 4920

REAR RADIO 4960

OUTSIDE TRACK

FRONT RADIO 4940

REAR RADIO 5180

MAINTENANCE BAY

FRONT RADIO 4920

REAR RADIO 4960

FRONT RADIO 4940

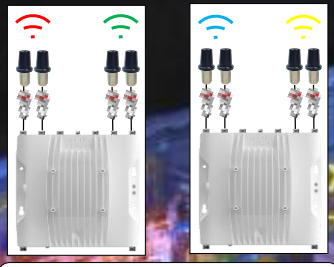
FRONT RADIO 5180

OTHER

DISABLED


Ride Attraction Network Core:
CURWB GWYs, IoT-OD, Monitor
Core Routing/Switching
Cisco Ultra-Reliable Wireless Backhaul Entertainment – Indoor Attractions
Vehicles Connectivity for Safety-Critical Comms
CISCO
Cisco Ultra- Reliable Wireless Backhaul
Wired Connections
Fluidity FREQ-A
Fluidity FREQ-B
Fluidity FREQ-C
Fluidity FREQ-D
CAT6 PoE/Fiber
Scene RF Coverage (Inside & Outside Tracks)
Scene RF Coverage (Inside & Outside Tracks)
1:N Scenes
Multi-Path Operations (MPO)
Multi-Path Operations (MPO)
1:52 Vehicles
Dark Ride: AGV (Inside Track)
Dark Ride: AGV (Outside Track)
Dark Ride: AGV (Inside Track)
Dark Ride: AGV (Outside Track)

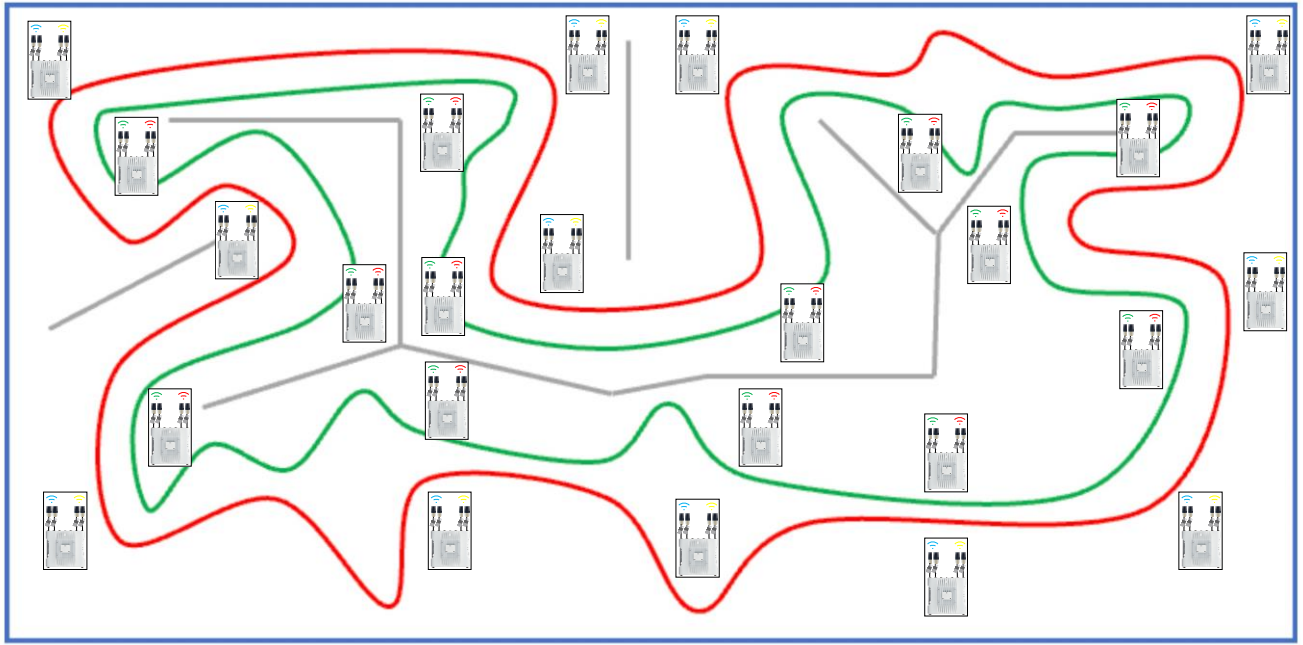
Cisco Ultra-Reliable Wireless Backhaul
Entertainment – Indoor Attractions
Vehicles Connectivity for Safety-Critical Comms



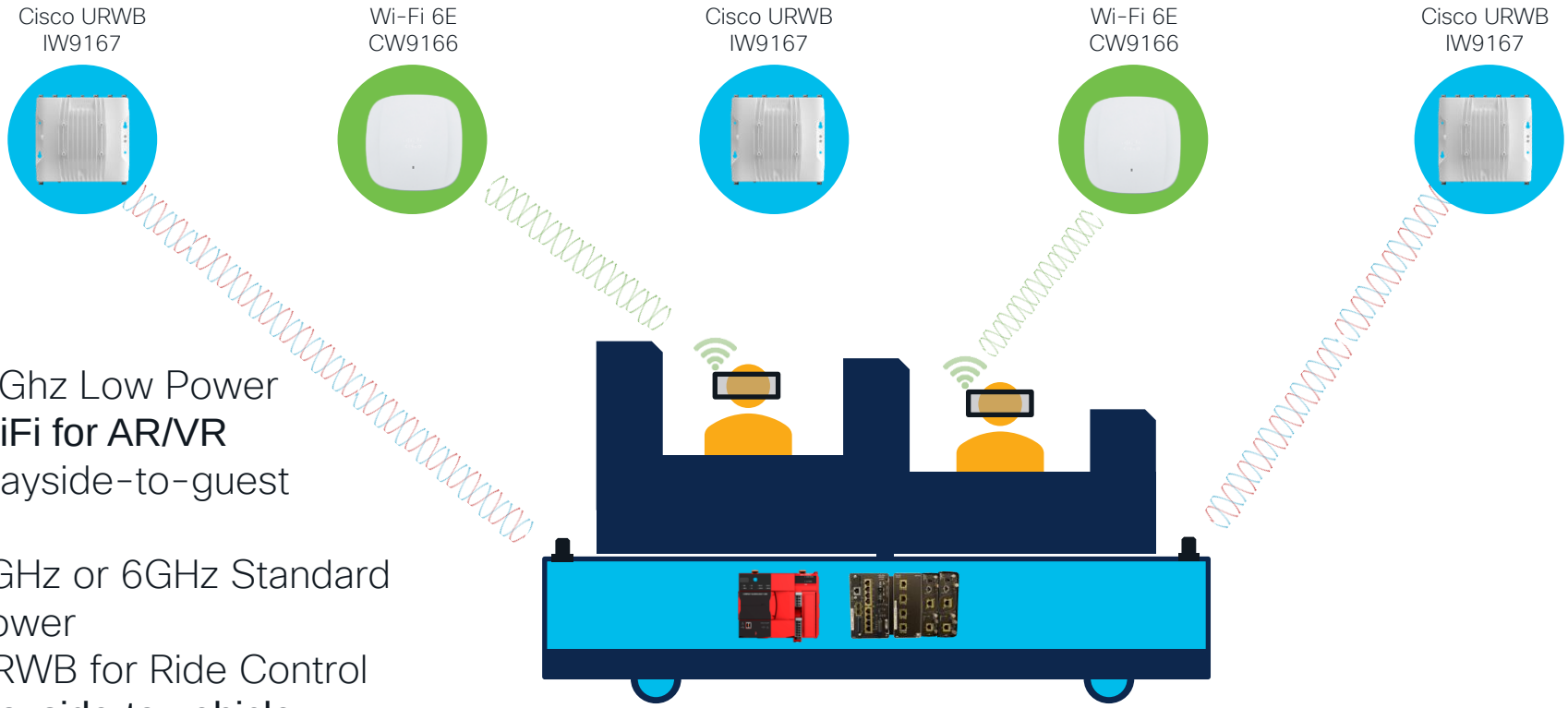
Scene Coverage Radios (Inside & Outside Tracks)

cisco
Cisco Ultra- Reliable
Wireless Backhaul

Wired Connections
Fluidity FREQ-A
Fluidity FREQ-B
Fluidity FREQ-C
Fluidity FREQ-D



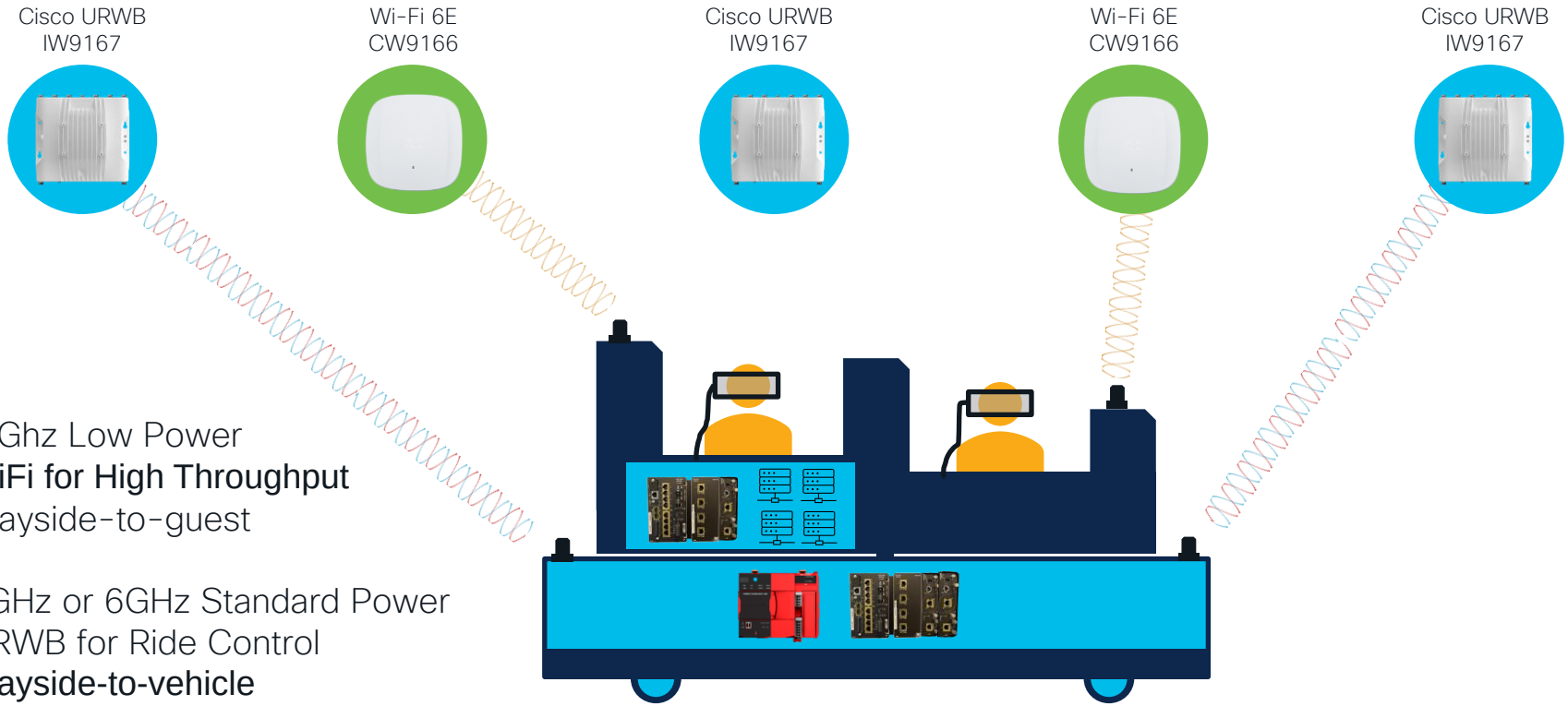
6GHz Positioning Example – CURWB & WiFi



6 Ghz Low Power
WiFi for AR/VR
Wayside-to-guest

5GHz or 6GHz Standard Power
URWB for Ride Control
Wayside-to-vehicle

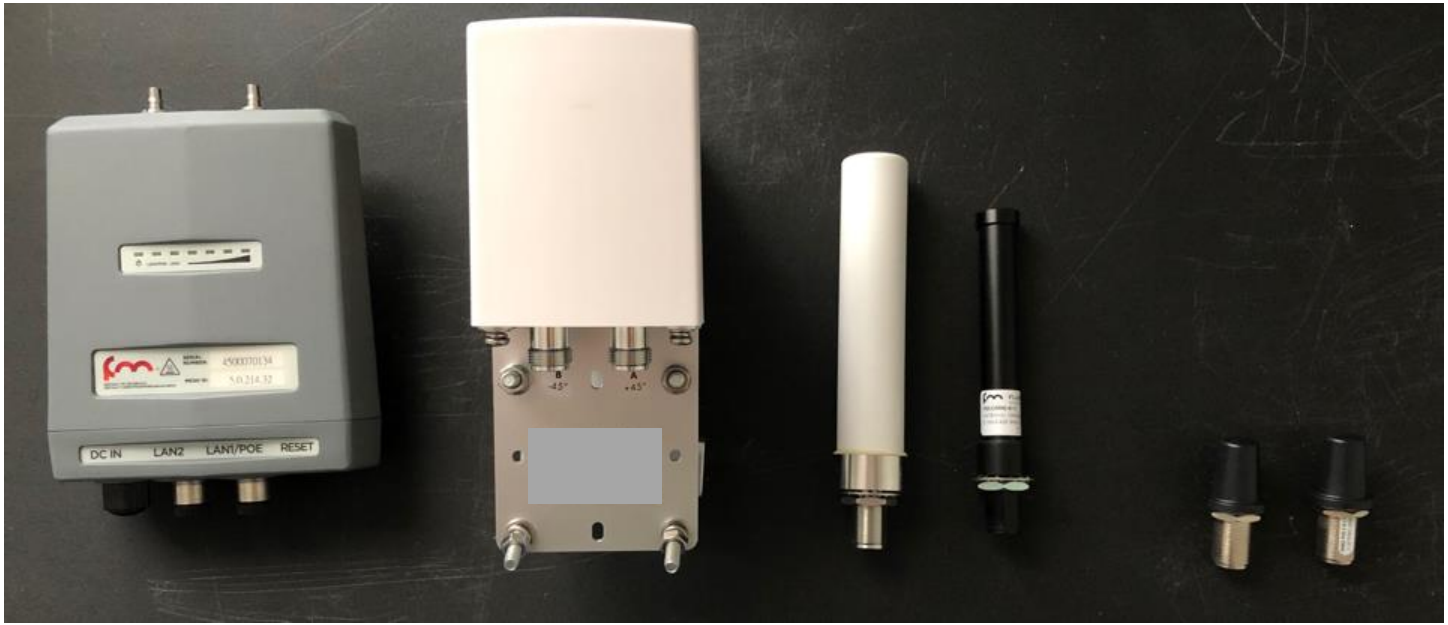
6GHz Positioning Example – CURWB & WiFi



6 Ghz Low Power
WiFi for High Throughput
Wayside-to-guest

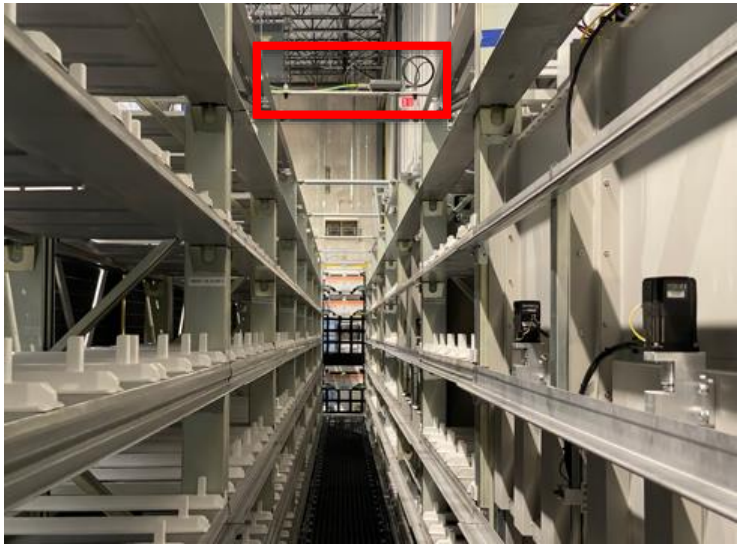
5GHz or 6GHz Standard Power
URWB for Ride Control
Wayside-to-vehicle

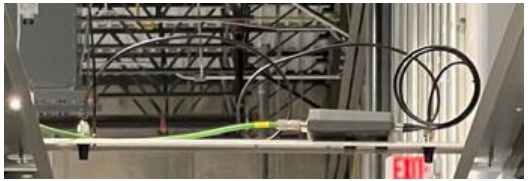
Indoor CURWB Designs
Fluidity, PtP and PtMP Extensions

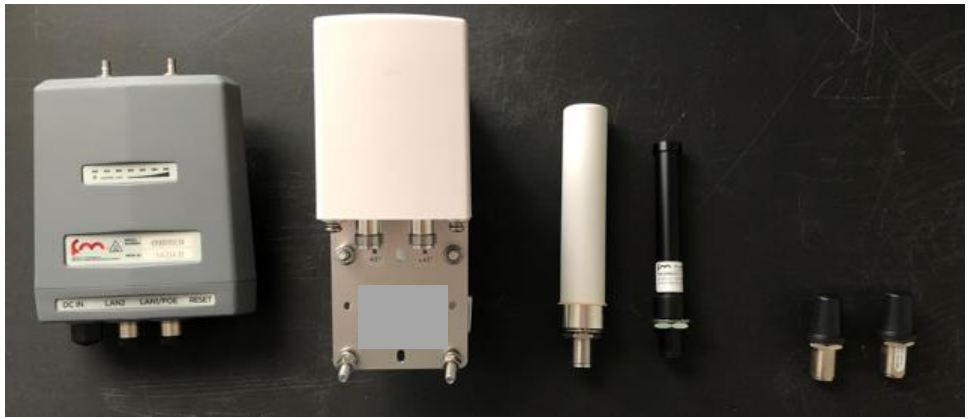


4500 MOBI PANEL-9 OMNI-5 OMNI-3

Indoor CURWB Designs
Fluidity, PtP and PtMP Extensions



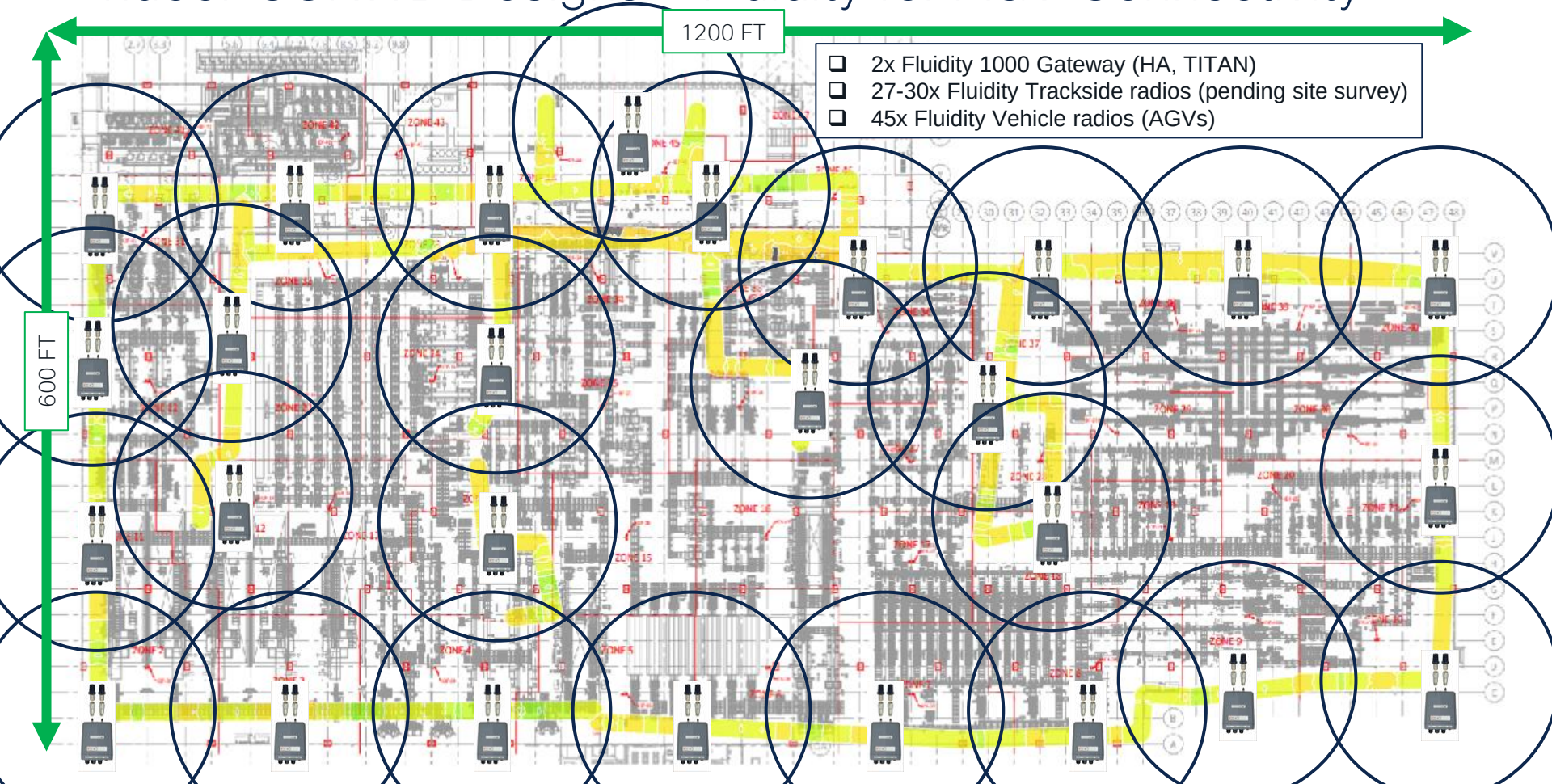




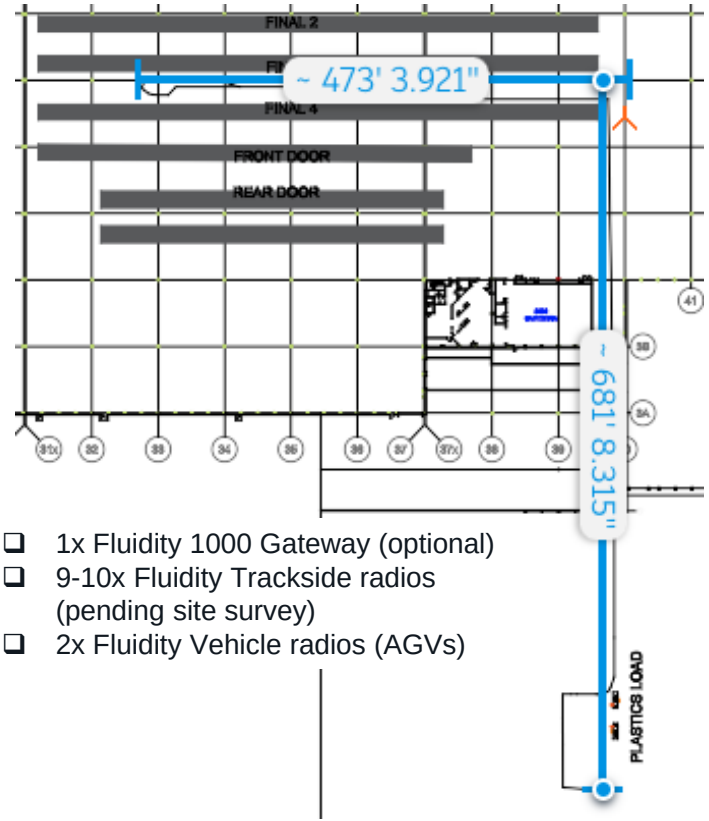
4500 MOBI PANEL-9 OMNI-5 OMNI-3

Indoor CURWB Designs Fluidity for AGV Connectivity

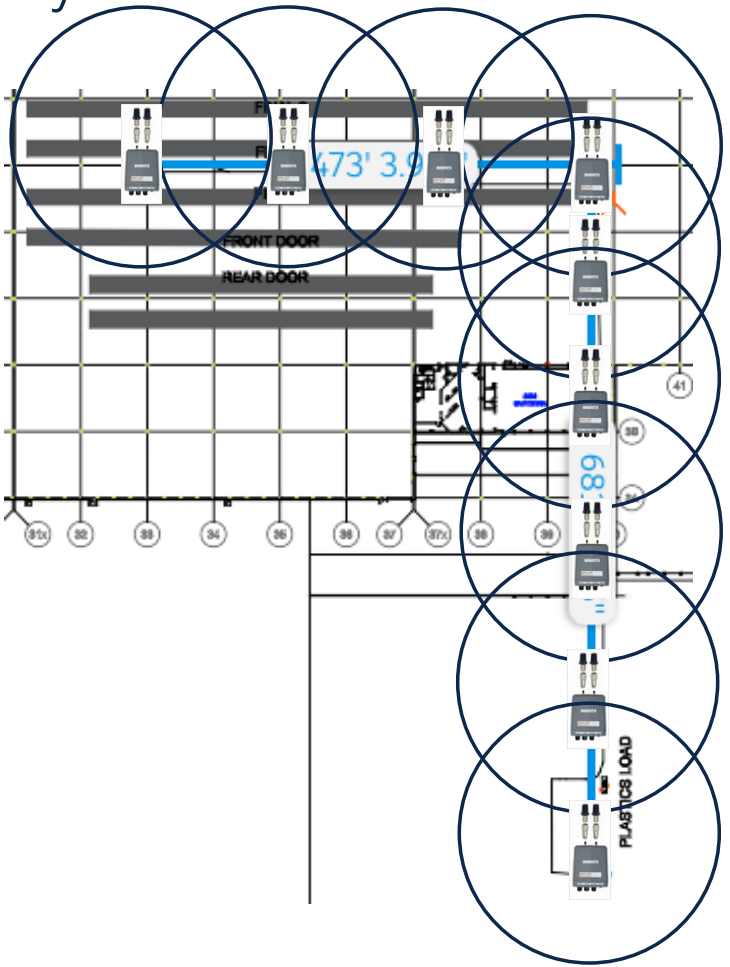
Indoor CURWB Designs – Fluidity for AGV Connectivity



CURWB Designs – Fluidity for AGV Connectivity



- ❑ 1x Fluidity 1000 Gateway (optional)
- ❑ 9-10x Fluidity Trackside radios (pending site survey)
- ❑ 2x Fluidity Vehicle radios (AGVs)



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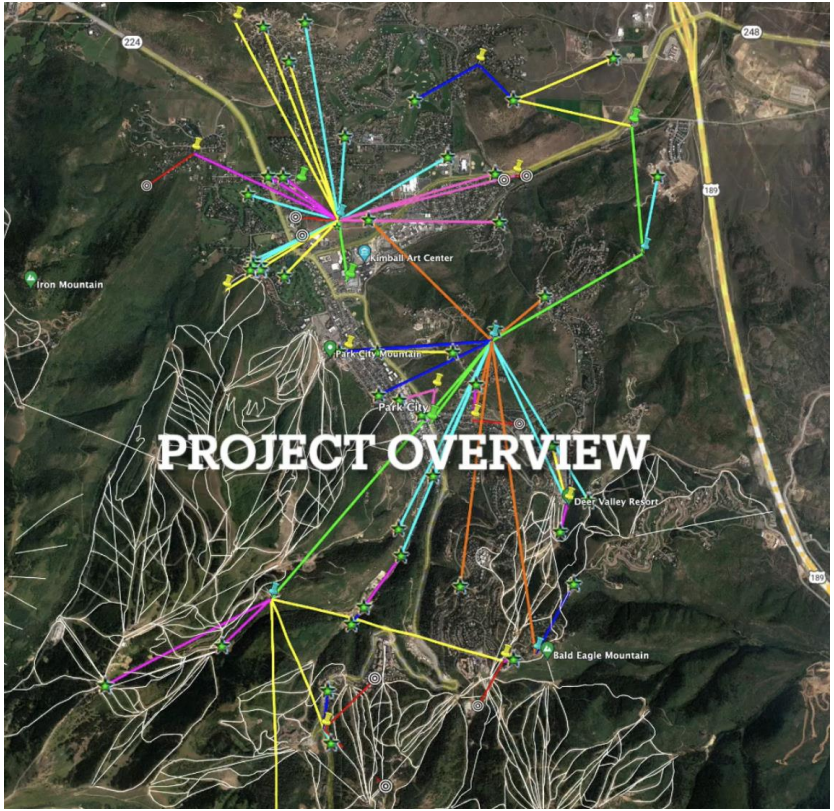
Site Survey: PtP/PtMP Video Demo

Field Site Surveys

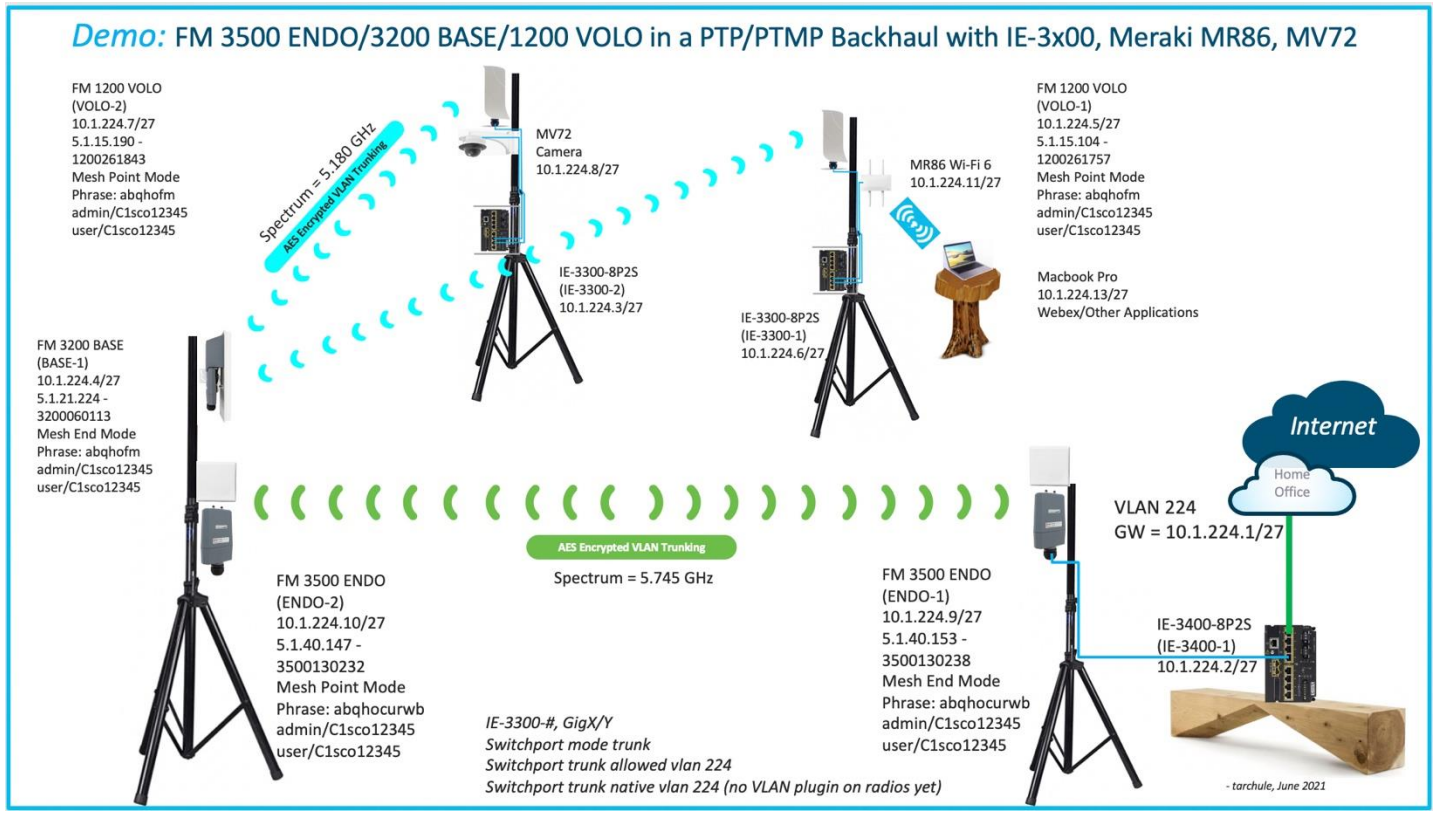
- Validate desktop survey, and red-line/modify as needed
- Testing Gear
  - Analyses real signal
  - Perform spectrum analysis
  - PoE Batteries
  - Radios
  - Temporary stands

Large PtP and PtMP Deployments

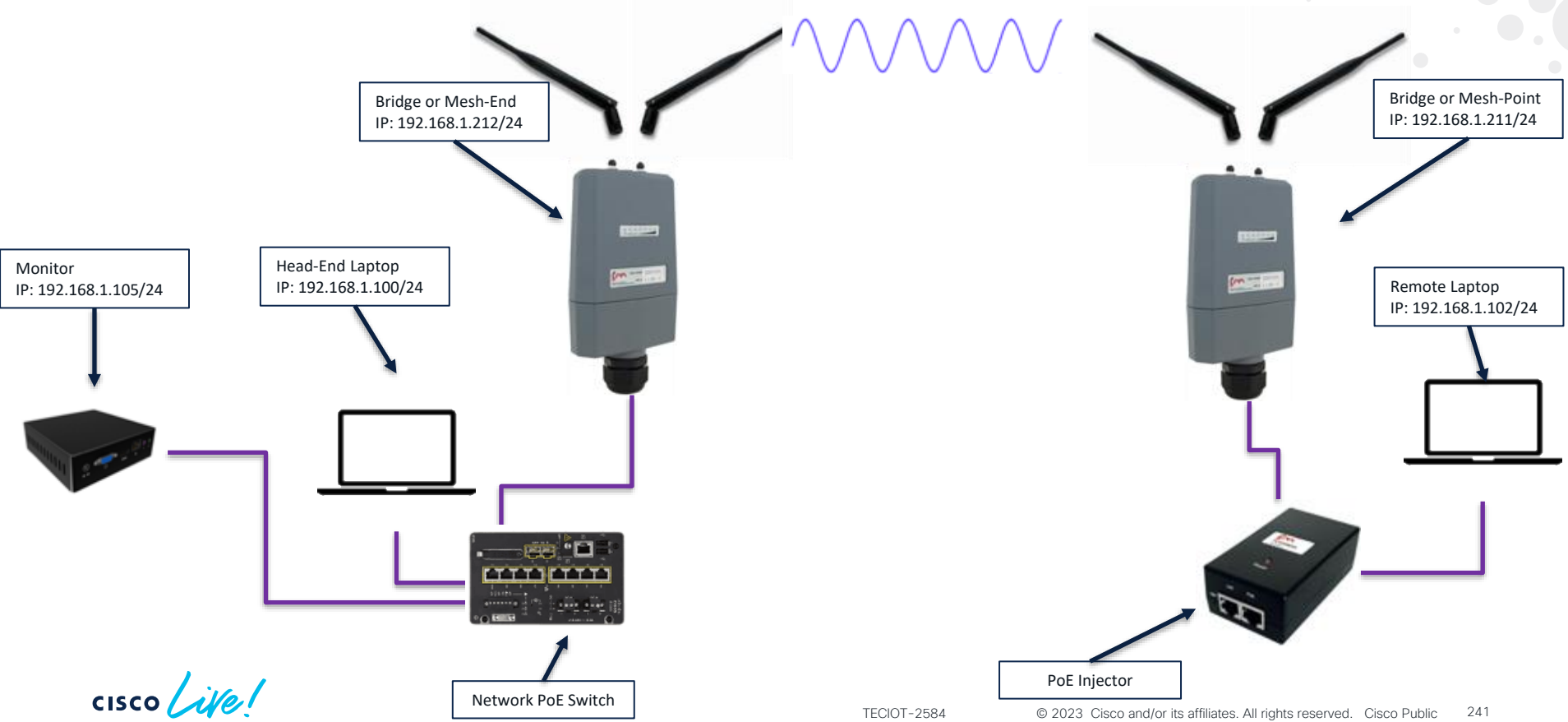


CURWB Lab:
Video Demo

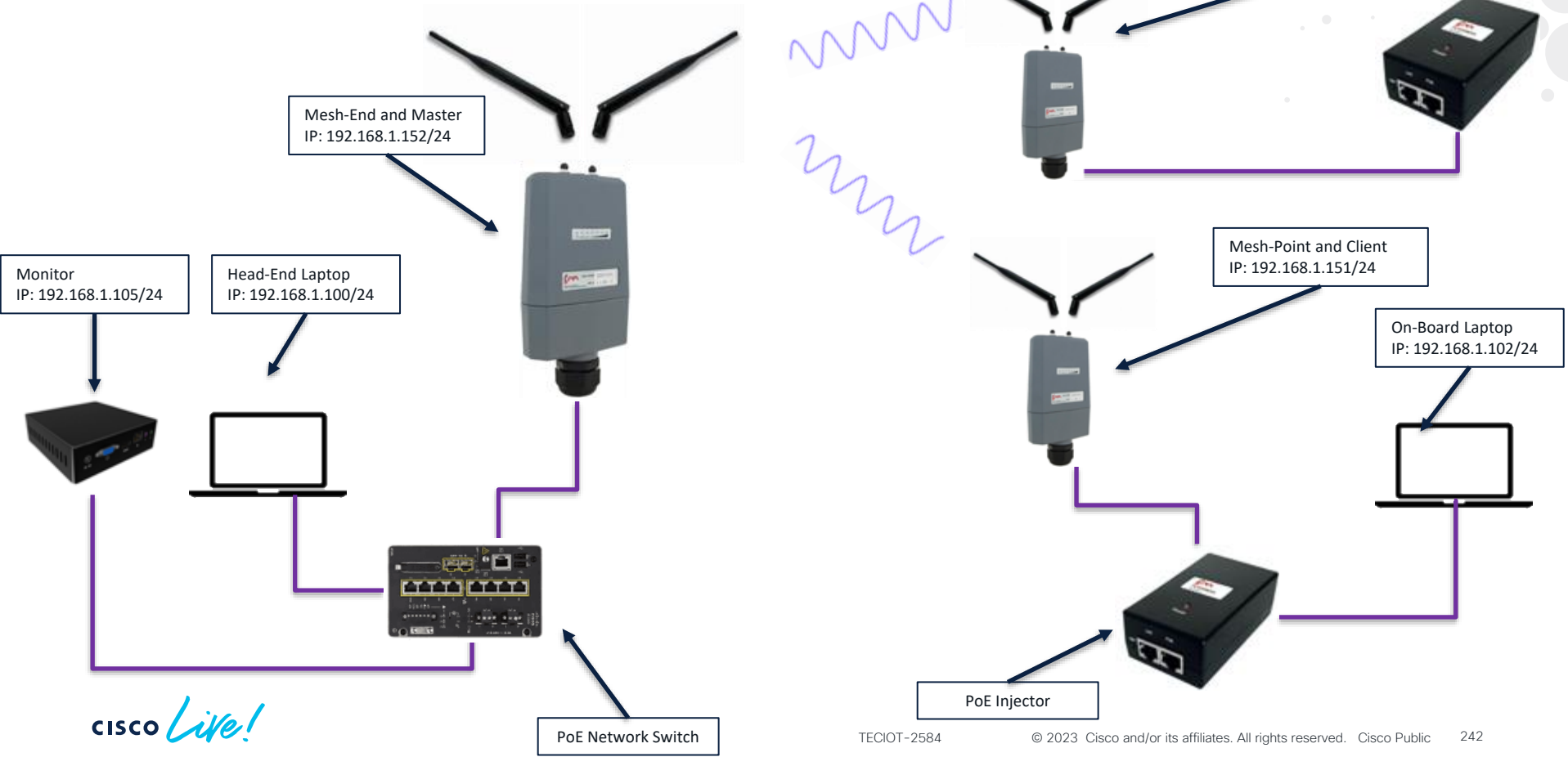
PtP/PtMP Demo



PtP Demo Configuration

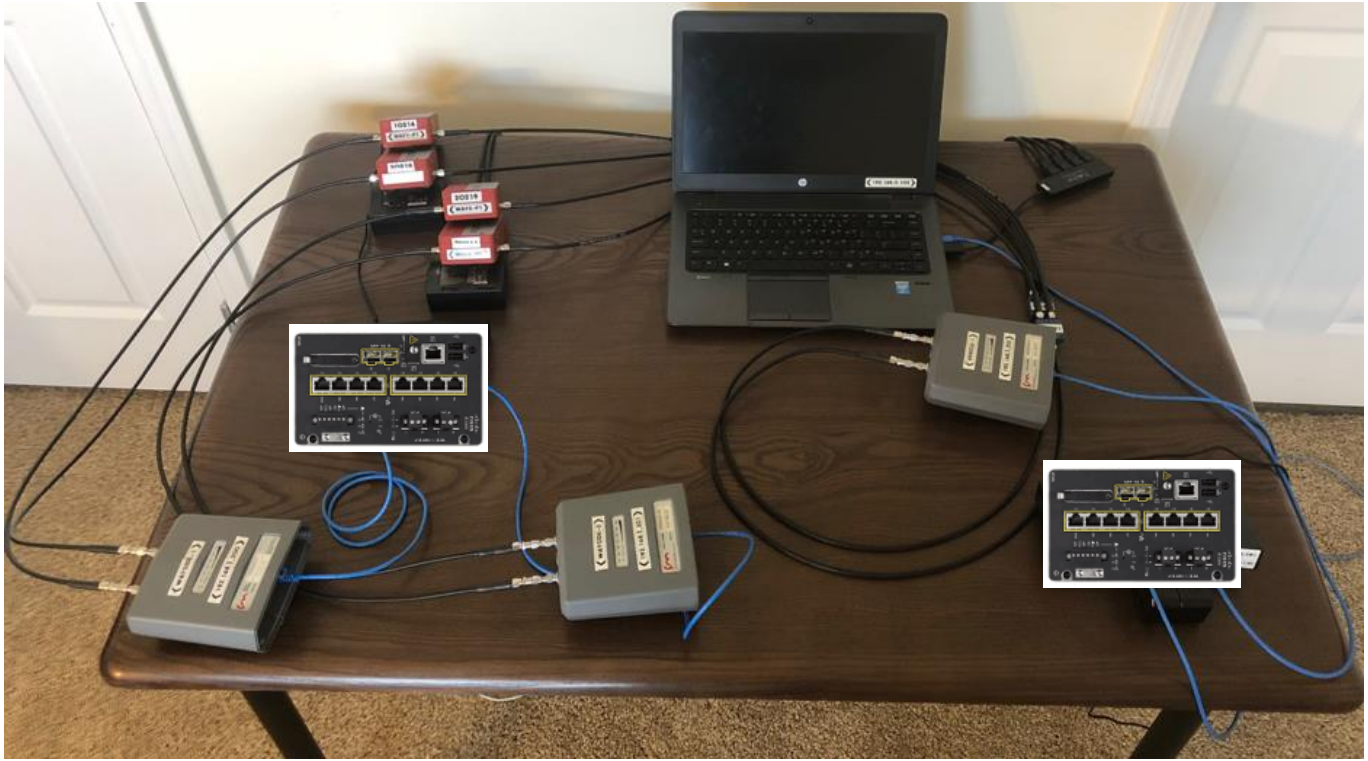


PtMP Demo Configuration



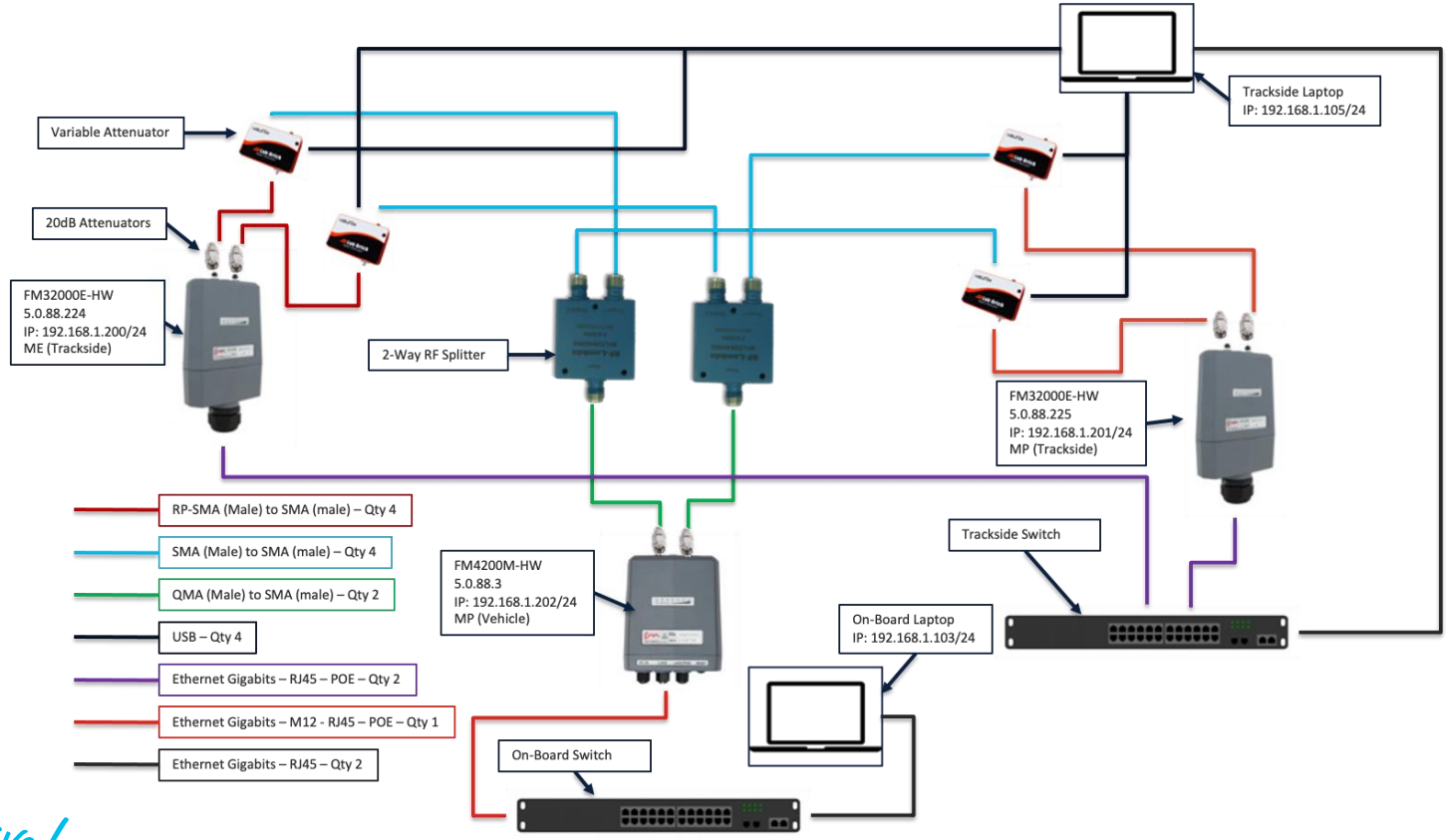
Desktop Fluidity

2x Trackside, 1x Vehicle Simulation



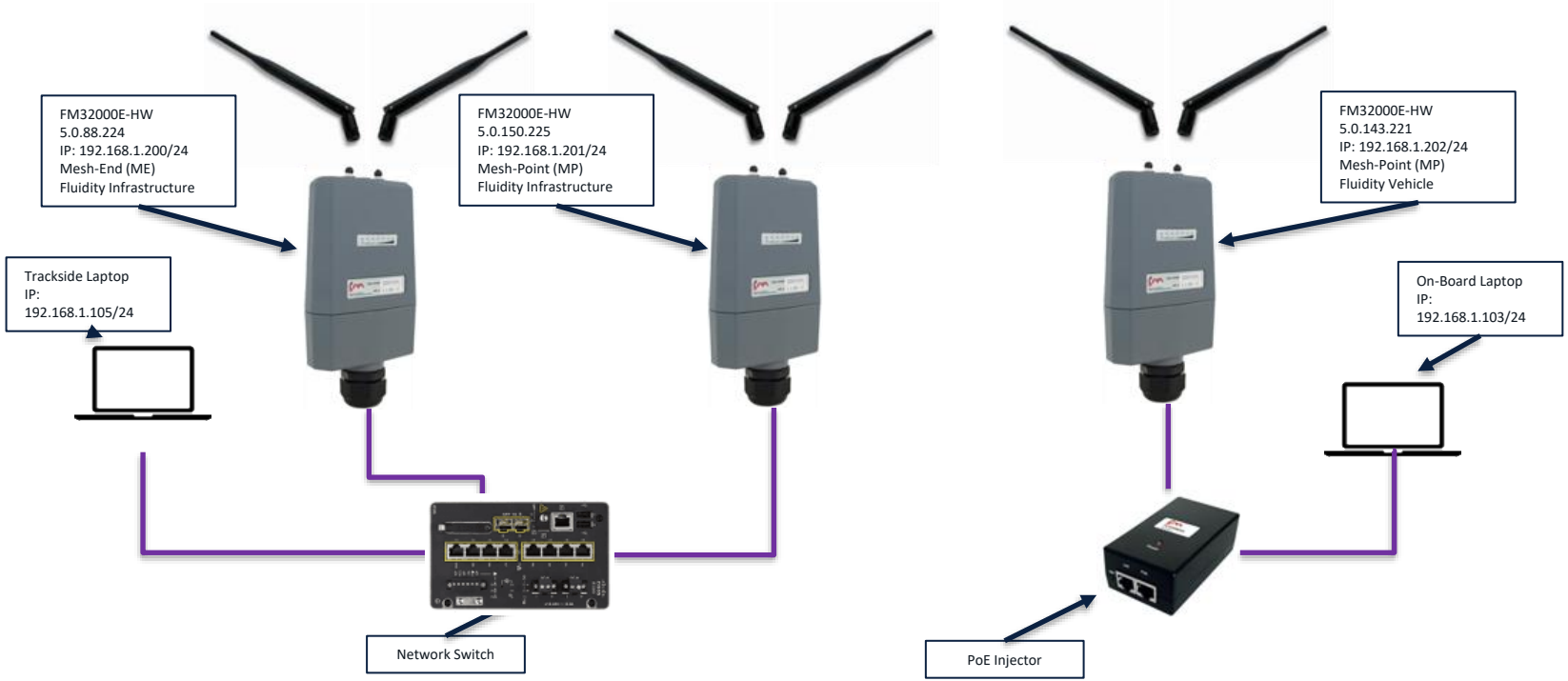
Desktop Fluidity

2x Trackside, 1x Vehicle Simulation



Desktop Fluidity – Configuration

2x Trackside, 1x Vehicle Simulation



Desktop Fluidity – Vehicle

2x Trackside, 1x Vehicle Simulation

The Vehicle lab network consists of the following

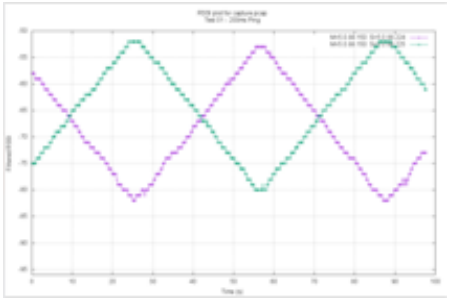
- Fluidmesh radio (QTY 1)
  - ✓ Fluidity Vehicle License
- Vehicle PoE Switch (QTY 1)
  - ✓ Powers radio and networks Vehicle Laptop
- Vehicle Laptop (QTY 1)
  - ✓ Windows machine
  - ✓ Run variable attenuator software
  - ✓ Used as iPerf Client/Server
  - ✓ Network end-point (good for system testing)
- USB Hub (QTY1) and Cables (QTY 5)
  - ✓ Powers and communicates to variable attenuators
- RF 2-Way Splitters (QTY 2)
  - ✓ Splits each Vehicle radio RF port into feeds
  - ✓ Directly connected to variable attenuators
- 20dB Attenuators and Gender-Bender (QTY 2)
  - ✓ Reduces radios noise floor
  - ✓ Reduces overall EIRP for bench-testing
  - ✓ Allows increasing radio Tx power without increasing EIRP
- RF Cables (QTY 2)

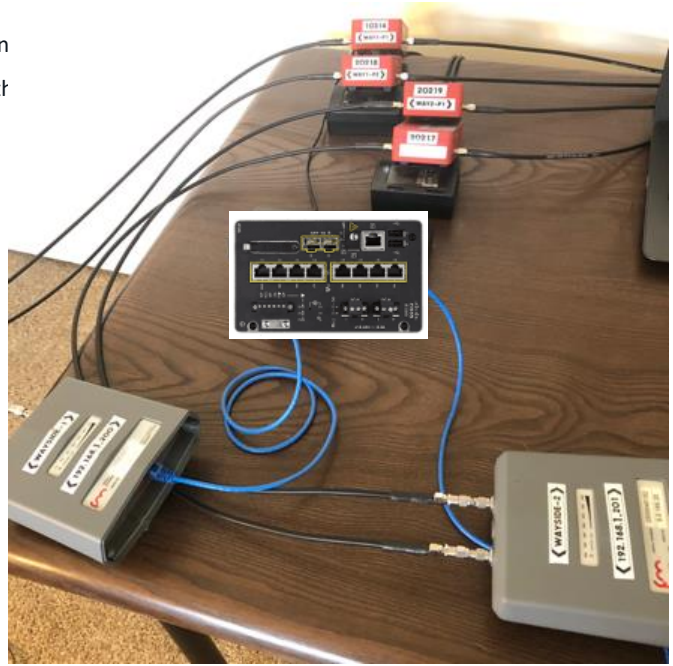
Desktop Fluidity – Trackside

2x Trackside, 1x Vehicle Simulation

The Trackside lab network consists of the following

- Fluidmesh radios (QTY 2)
  - ✓ Fluidity Trackside License
- Trackside PoE Switch (QTY 1)
  - ✓ Powers radio and networks Central Laptop
- Central Laptop (QTY 1) and Server
  - ✓ Central Mac machine
    - ✓ Used as iPerf Client/Server
    - ✓ Internet connection via WiFi
  - ✓ Central head-end (good for system testing)
    - ✓ MONITOR and SNMP Server (PRTG)
- Variable Attenuators (QTY 4)
  - ✓ Attenuates split Vehicle radio RF port feeds
  - ✓ Creates ”sawtooth” RRSI envelope for testing
- 20dB Attenuators and Gender-Bender (QTY 4)
  - ✓ Reduces radios noise floor
  - ✓ Reduces overall EIRP for bench-testin
  - ✓ Allows increasing radio Tx power with increasing EIRP
- RF Cables (QTY 8)





Desktop Fluidity – Trackside

2x Trackside, 1x Vehicle Simulation

The Central lab network consists of the following

- Central Laptop (QTY 1)
  - ✓ Central Mac machine
    - ✓ Used as iPerf Client/Server
    - ✓ Internet connection via WiFi
- Central Server (QTY 1)
  - ✓ Central head-end (good for system testing/monitoring)
    - ✓ MONITOR and SNMP Server (PRTG)
  - ✓ Mini-PC w/ 512GB SSD and and 16G RAM
- Networked directly to Trackside switch

Technical Session Surveys

- Attendees who fill out a minimum of four session surveys and the overall event survey will get Cisco Live branded socks!
- Attendees will also earn 100 points in the Cisco Live Game for every survey completed.
- These points help you get on the leaderboard and increase your chances of winning daily and grand prizes.

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IoT Wireless CRD, CVD, and dCloud

- Great documentation and architectures on the IoT CVD page:
  - https://www.cisco.com/c/en/us/solutions/design-zone/industries.html

- dCloud demos for IoT Wireless and CURWB
  - https://dcloud2-rtp.cisco.com/content/catalogue?search=urwb&screenCommand=openSearchScreen

IoT

Transform and Secure your IOT Infrastructure

In this new IoT world, the network is the nervous system that allows everything to work together. And while it's creating limitless possibilities, it also introduced more complexity. Today everything is a connected device, from a robot to a power transformer, from a vehicle to crane.

In these industrial IoT environments, the scale and associated attack surface increase exponentially. Also the extreme requirements for performance, availability and visibility raise the need to transform the way of thinking and designing these complex IoT networks, especially when agility and ease of use are a must. Secure network automation and orchestration lead the way and secure network transformation is the core platform for line of business innovation and resilience.

START

Feb 7 | 08:30
BRKIOT-2774
How Cisco addresses Reliability within Industrial Wireless Networks thanks to the Cisco's IoT Wireless Products

Feb 8 | 08:45
BRKIOT-2601
Deploying Indoor Wireless Mobility for Industry with Cisco Industrial Wireless

Feb 8 | 10:30
BRKIOT-2585
Deployment of Cisco Catalyst Industrial Routers in Public and Private Cellular infrastructures

Feb 9 | 10:30
BRKIOT-2356
Cisco Solutions for Mission-Critical Mobile Infrastructure in Industrial IOT Environments

Feb 9 | 13:45
BRKIOT-2875
Industrial Redundancy: PRP and HSR Best Practices

Feb 10 | 11:15
FINISH **BRKIOT-2882**
Implementing Segmentation in Industrial Networks

If you are unable to attend a live session, you can watch it On Demand after the event.

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IoT

Reimagine your IOT Applications and Use Cases

Applications are how services are delivered and consumed, including IoT network and security services. Also, the focus for line of business teams in Industrial companies is to achieve specific business outcomes and not to just acquire technology. We will demonstrate that Cisco IoT technology is that bridge between line of business needs/ requirements and the desired business outcomes for multiple Industries.

In these sessions we will learn how Cisco IoT technology and applications can impact operations and line of business inside industrial companies, improving business resilience, operational performance and efficiency, or introducing new services and revenue sources.

START

Feb 7 | 15:30
BRKIOT-1203
Connecting and Securing Renewable Energy - Enabling Green Technologies with Cisco IoT

Feb 7 | 16:45
BRKIOT-2720
Connected Factory Architecture

Feb 8 | 14:30
BRKIOT-2366
Simplified IT and Operations workflows for ruggedized outdoor industrial networks with IoT Operations Dashboard

Feb 8 | 16:30
BRKIOT-2015
The New Digital Substation - more efficient, more secure and ready for demanding modern Grid applications

Feb 9 | 08:30
BRKIOT-2544
Future-ready Shopfloor Architecture and How You Can Get to It – Step by Step

Feb 9 | 12:00
FINISH **BRKIOT-2354**
Managing and Accessing Remote IoT Equipment with Cloud Management

If you are unable to attend a live session, you can watch it On Demand after the event

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Thank you
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ALL IN