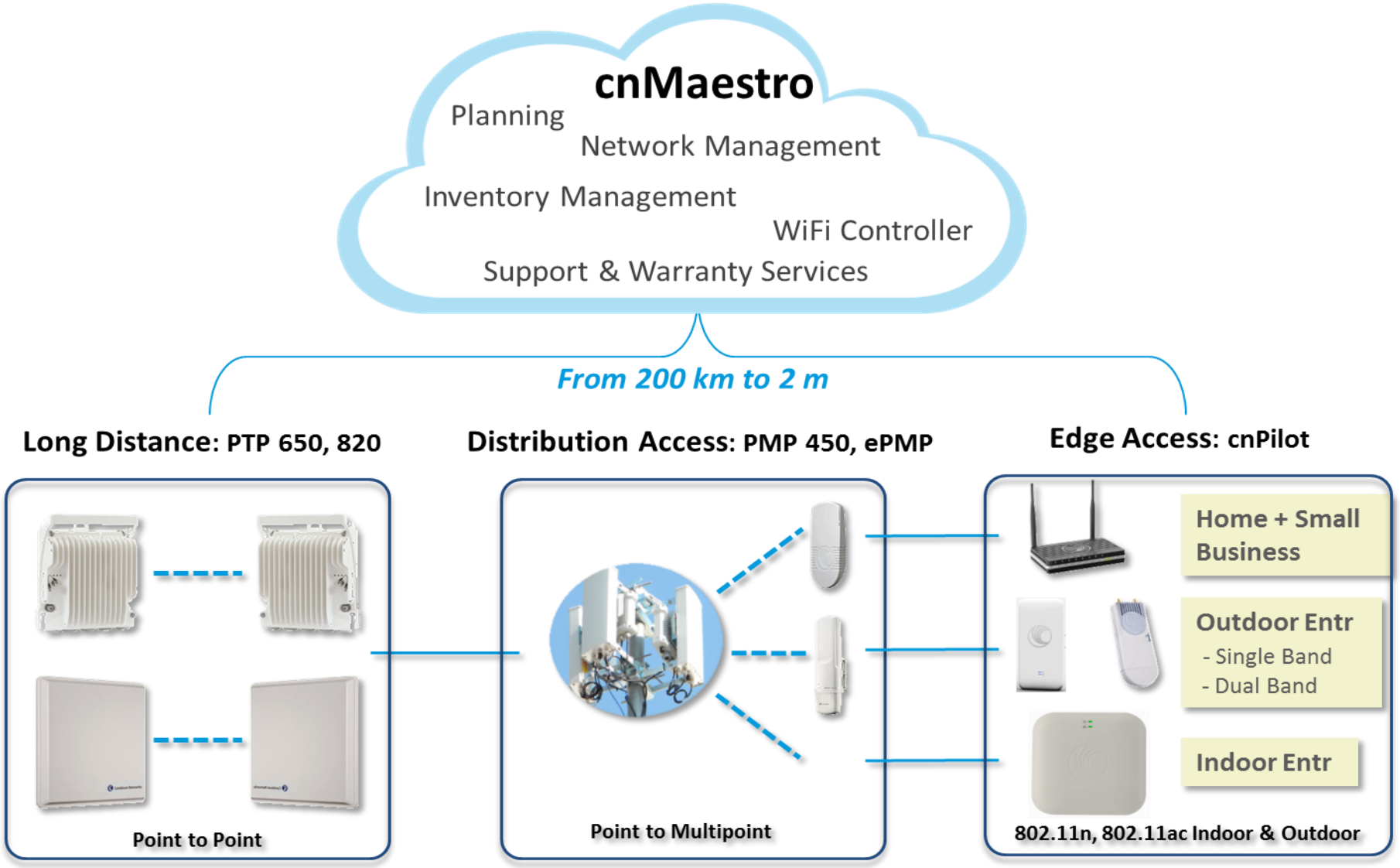
Cambium Networks™

Smart Cities

Bruce Collins
Director, Product Management

Vision: Complete Network Lifecycle Management



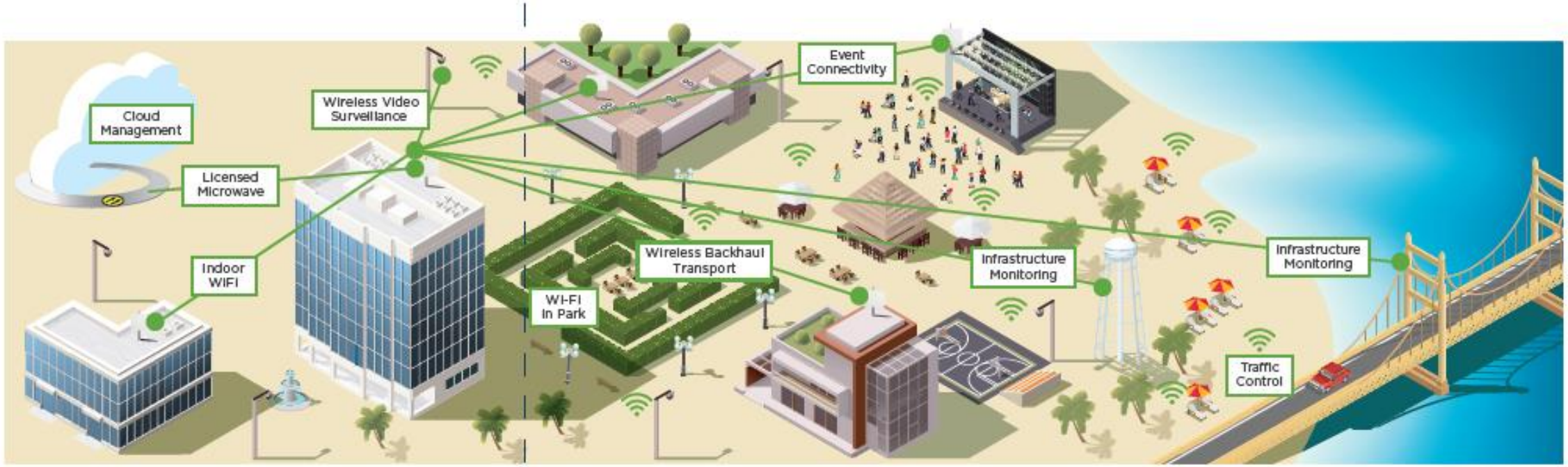
Market Drivers

- High standards for quality
- Efficiency and economics of automation
  - Reduce loss and waste
  - Reduce service outage and repair times
  - Reduce communication costs
  - Operation continuity / disaster recovery
- Improve operation security
  - Personnel safety
  - Asset protection
  - Cyber threat avoidance

Critical Infrastructure

- Security
  - Reducing the risk to critical infrastructure by physical means or defense cyber measures to intrusions, attacks, or the effects of natural or man-made disasters
- Resilience
  - Prepare for and adapt to changing conditions, withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents

Smart Cities



- High capacity connectivity
- Secure communications
- Affordable and rapidly deployed
- Reliable to perform in harsh conditions

Benefits

- Video surveillance
- Connectivity at special events
- Infrastructure monitoring and control
- Automatic metering infrastructure
- Public WiFi connectivity
- Traffic control and digital signage
- Street light controls
- Parking lot automation

Case Study: HCSO

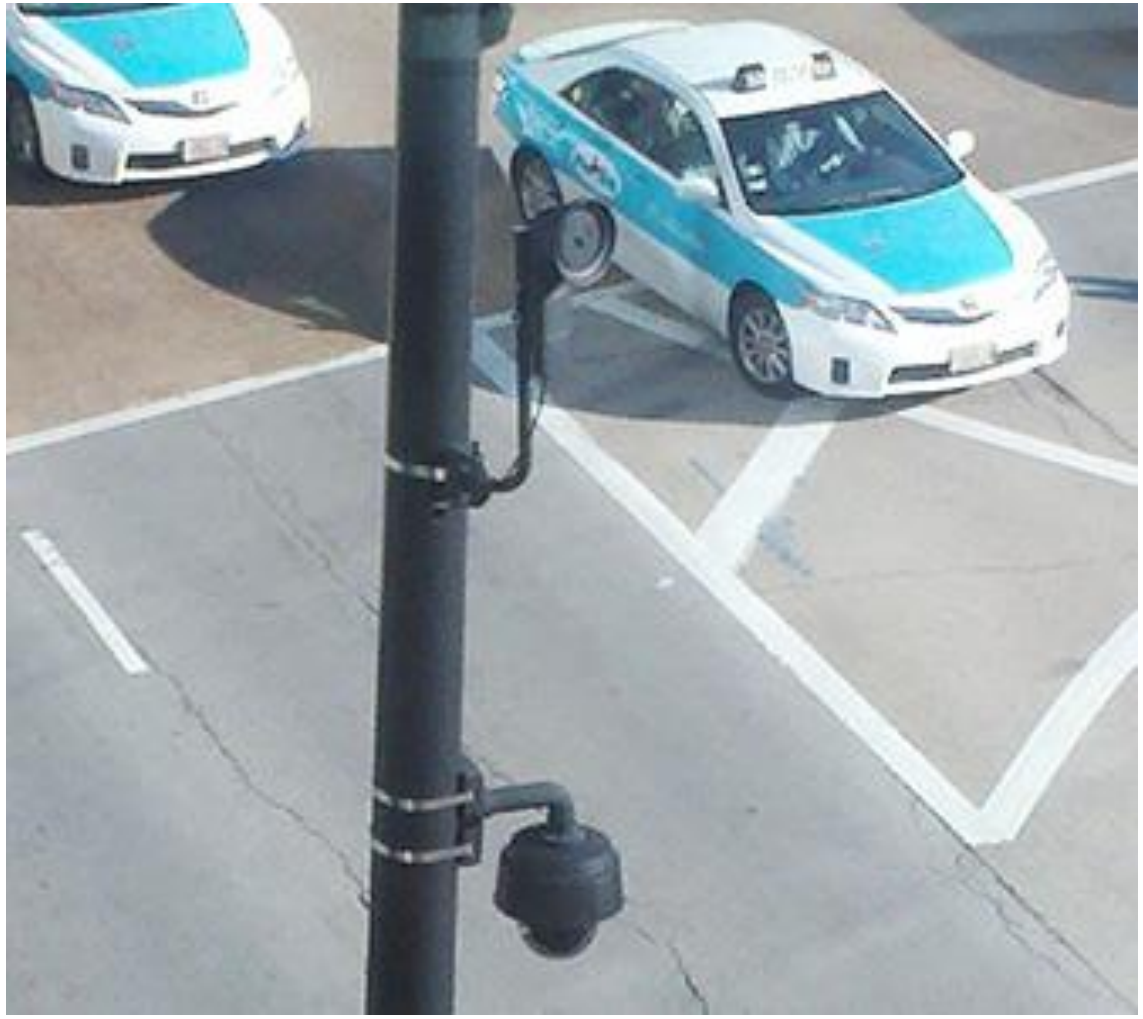
- City-wide video surveillance of traffic intersections
- Integrated with Automatic License Plate Recognition (ALPR)
- Surveillance of key meeting areas
- Solution
  - PMP 450 unlicensed distribution network

Case Study: Budapest Video Surveillance

- City-wide video surveillance
- Leverages streets as radio transmission conduit
- Installed in a matter of weeks at a fraction of the cost of wired solutions
- Expanding network to add new coverage areas
- Solution
  - ePMP unlicensed distribution network

Case Study: City of Chicago, USA

- Office of Emergency Management Communications (OEMC) deployed city-wide video surveillance
- Wireless connectivity enabled the system to be installed rapidly at a reasonable cost
- Network has performed for years in harsh weather
- Solution
  - PMP 450 distribution network



Case Study: Ramos Arizpe

- City-wide connectivity for 20,000 users
- Connectivity at hospitals, schools, parks, and businesses in a 15 square km area
- Rapidly deployed
- Solution
  - ePMP unlicensed distribution network
  - cnPilot E500 enterprise outdoor WiFi

Case Study: Lorain County Fair

- High-speed connectivity for guests
- Indoor and outdoor WiFi coverage
- PCI wireless security for event vendors
- Leverage for video surveillance
- Solution
  - PTP 650 unlicensed wireless backhaul
  - ePMP unlicensed distribution network
  - cnPilot E400 indoor enterprise WiFi
  - cnPilot E500 outdoor enterprise WiFi

Case Study: South Asia Games

- 4,500 athletes from eight nations
- Indoor and outdoor coverage for dormitories and venues
- High capacity for spectators and media
- Solution
  - PTP 650 unlicensed backhaul
  - PTP 450 unlicensed backhaul
  - PMP 450 unlicensed distribution
  - cnPilot E400 enterprise indoor WiFi
  - cnPilot E500 enterprise outdoor WiFi

Technology

Cambium Networks™

The Cambium Networks Difference

- Spectral Efficiency
- Scalability
- Security
- Reliability
- Total Cost of Ownership
- Sustainability

PTP Portfolio Overview

Unlicensed Sub 6GHz | Licensed 6-38 GHz

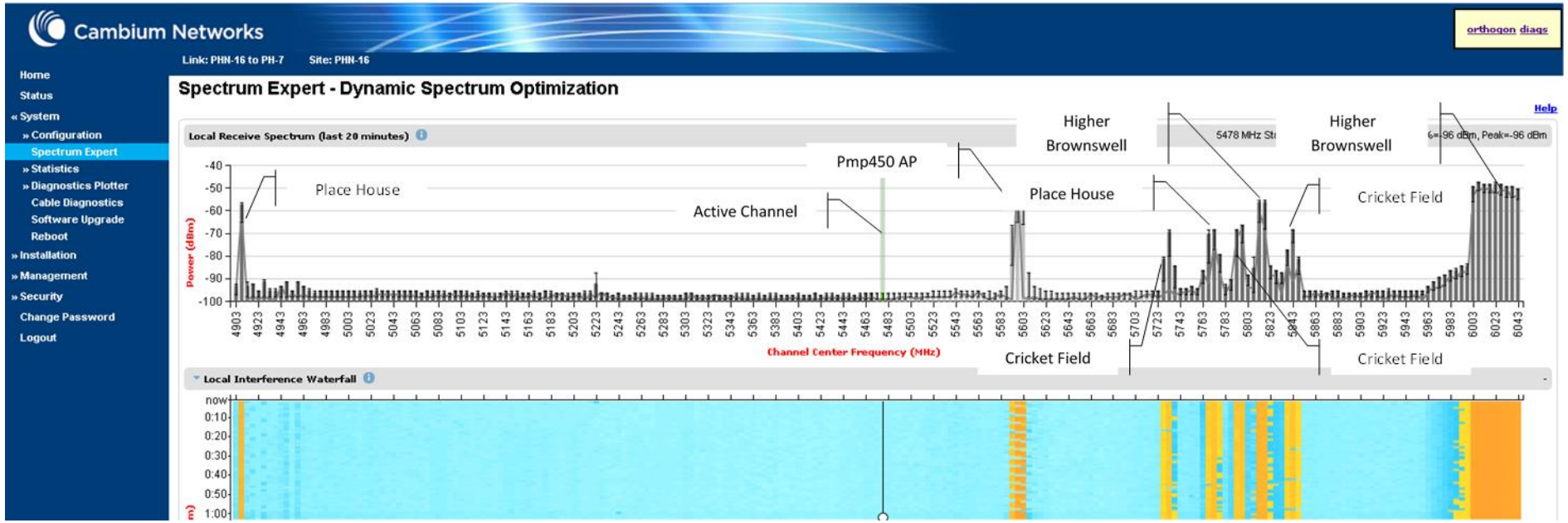
FEATURE	PTP 450i	PTP 650	PTP 820
			
RF Bands (GHz)	4.9-5.925 GHz 3.5 GHz	4.9 – 6.05	6-42
Technology	TDD	TDD	FDD
Max. Throughput	125 agg.	450 agg.	**1 Gbps+** **Full duplex**

- Immediate roll-out
- No fee
- LOS/NLOS
- Low Cost

- Licensed spectrum
- license fee
- LOS
- Highest capacity

Dynamic Spectrum Optimization

- Always-on, wide-band spectrum analyzer
- Real-time and historical analytics
- Find available channels; identify sources of interference
- Scans all bands and channels from 4.9 GHz to 6.05 GHz

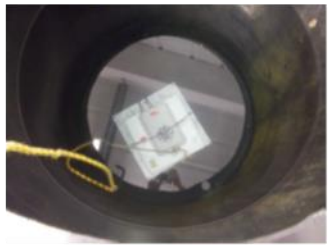


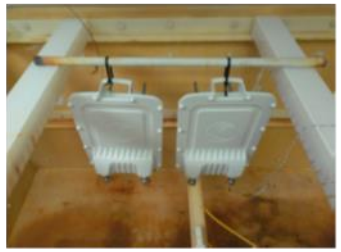
Security

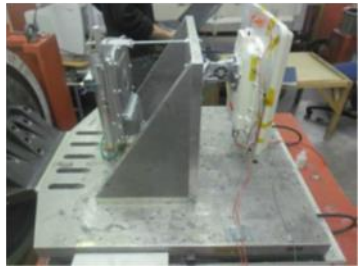
- Physical Security
  - Detect physical tampering
  - Prevent unauthorized software
  - Encrypt sensitive configuration data
  - Defend against network attacks
- Management Security
  - Prevent unauthorized access
  - Audit trail of changes
- Data Security
  - Encryption of over-the-air data
  - Prevent decoding of network transmissions
- Process Security
  - Gain validation from third parties

Designed for Harsh Environments

- Wind Survival
  - 200 mph survivability
- Dust / Water Intrusion (IP66/67)
  - Water jets from any direction
  - Immersion in 1 m water
  - Dust tight
- Salt Fog Environment (MIL-STD-810G)
  - Tests resistance to corrosion if face of extended exposure to salt spray
- Shock / Vibration (MIL-STD-810G)
  - Handling, transportation, long-term deployment





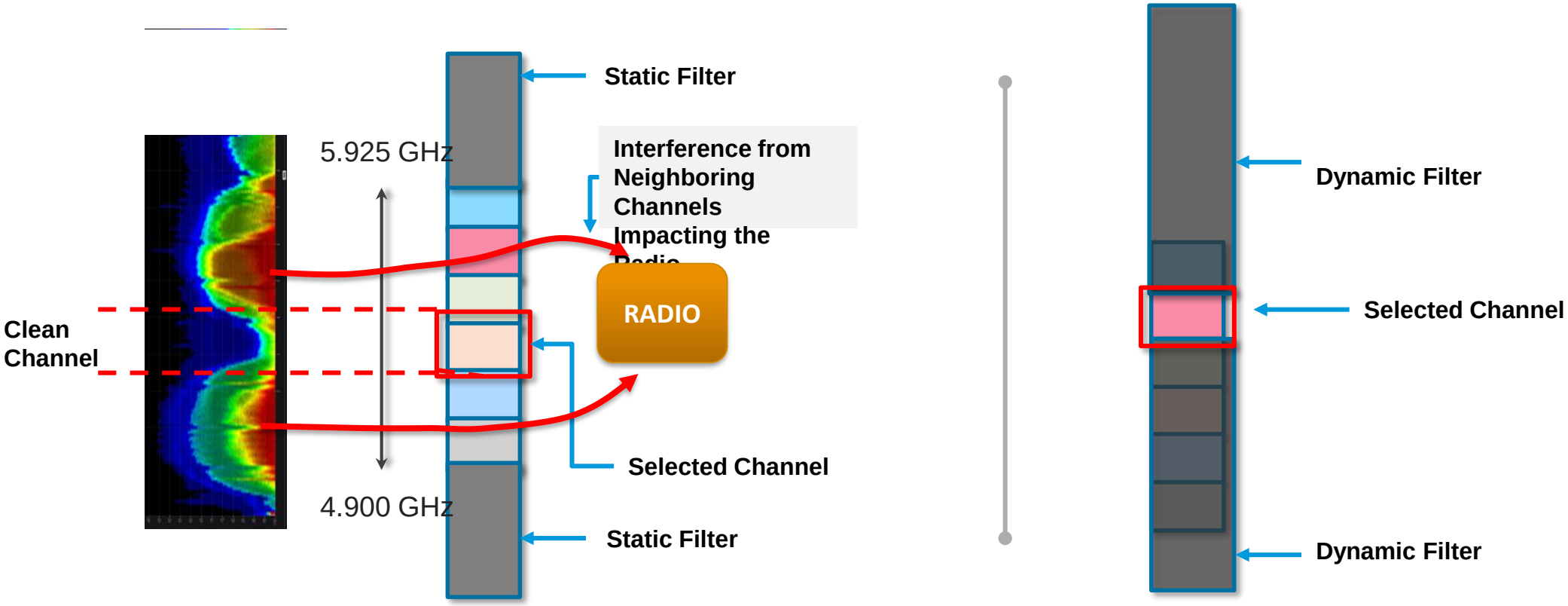


Quick Deploy Positioner

- Applications
  - First responders (public safety / national guard / CIVLEA)
  - Rapid tactical deployment (DoD)
  - Oil/Gas re-alignment after re-location of mast head
  - Cell on wheels / temporary deployments
- Eliminates need for on-site techs
- Tightly integrated all-outdoor solution
- Goes live in <3 minutes
- Compatible with PTP 650, 700, 450i, and PMP 450i

Multipoint Distribution – PMP 450

Dynamic Interference Filtering Technology



Spectrum

Traditional Fixed Filter

Makes radio susceptible to neighboring channel interference

Cambium's Dynamic Filtering

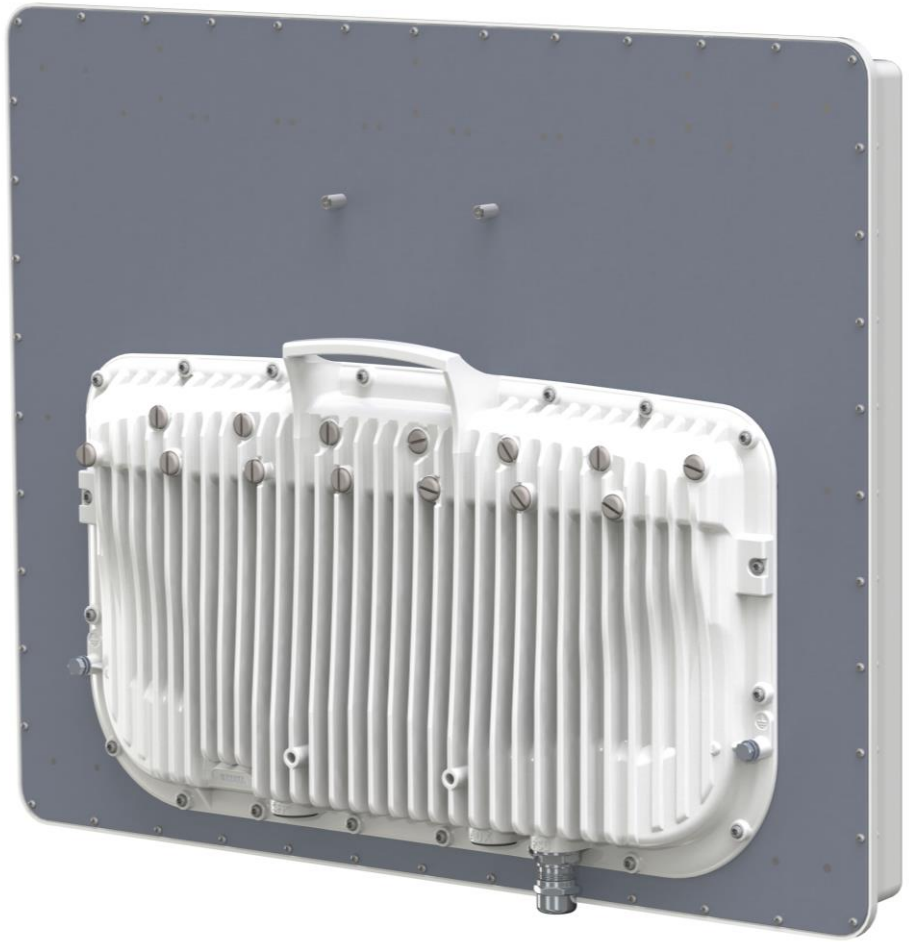
Wraps around selected channel, filtering out interference from neighboring channels

PMP 450i

- Ultra Wide-band 4900-5925 MHz
  - Supports Supports 4.9, 5.1, and 5.2 MHz
- Enhanced Performance
  - Dynamic interference filtering
  - Increased transmit power
  - Better receive sensitivity
- Rugged IP66/67 Enclosure
- Agile
  - 802.3at PoE compatible
  - Auxiliary port with PoE output
  - 5, 10, 15, 20, 30 and 40 MHz channel

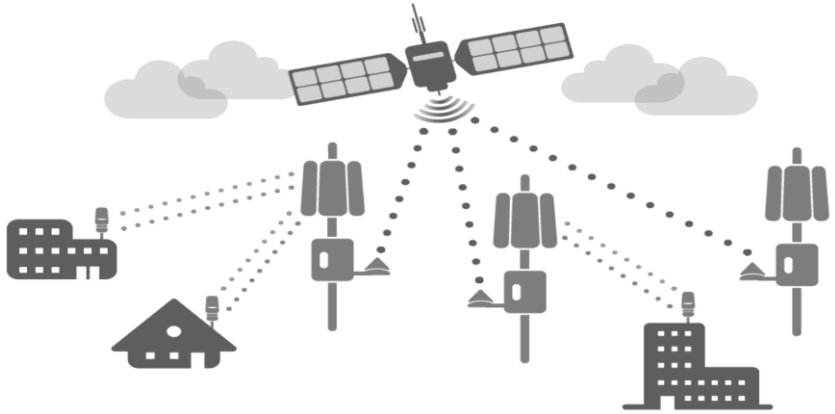
PMP 450m

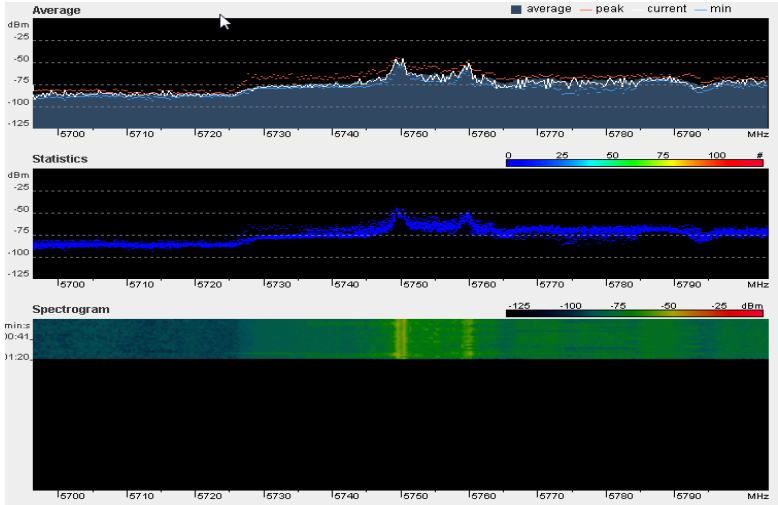
- Massive MU-MIMO technology
- Industry leading spectral efficiency
  - Delivers 500 Mbps throughput in a 20 MHz channel
- Links with up to 7 SMs simultaneously
- Increases sector capacity by 3 – 4X
- Improved performance in high interference
- Uses current PMP 450 SMs



Superior Performance in Real World Conditions

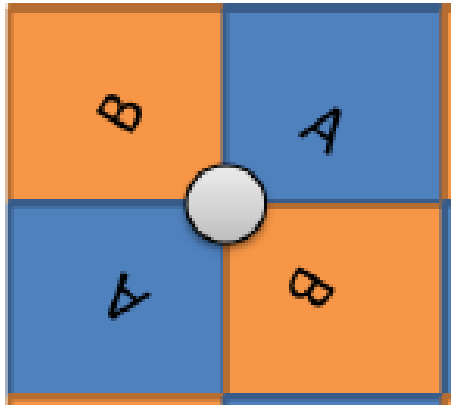
- Unlicensed spectrum is congested!
- eFortify technology increases interference tolerance to provide higher performance and consistent latency under external interference
- GPS Synchronization provides a solid foundation for your network's deployment and growth
- Rate adapt algorithms adjust radio operation automatically to boost performance and resiliency





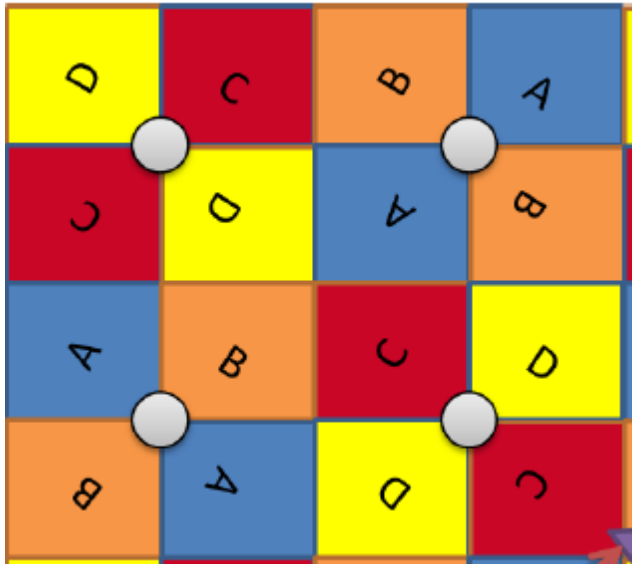
GPS Synchronization Allows for Frequency Re-use

Within Sectorized Site



One Site with 2 Channels

Across Contiguous Network



The Entire Network with 4 Channels

ePMP 2000 Access Point with Intelligent Filtering

- Next Generation ePMP Access Point
- Frequency reuse via GPS synchronization
- Supports up to 120 SMs
- Available in Lite (10 SM) or Full models
  - License Key to upgrade Lite to Full
- 802.3at compliant gigabit Ethernet port
- Wide Frequency range: 5150 – 5970 MHz
- Intelligent Filtering to reduce impact of off-channel interferers
- Interface to optional Smart Antenna

WiFi Access - cnPilot™

Intelligently managed, Affordable, Quick to deploy & Easy to Operate

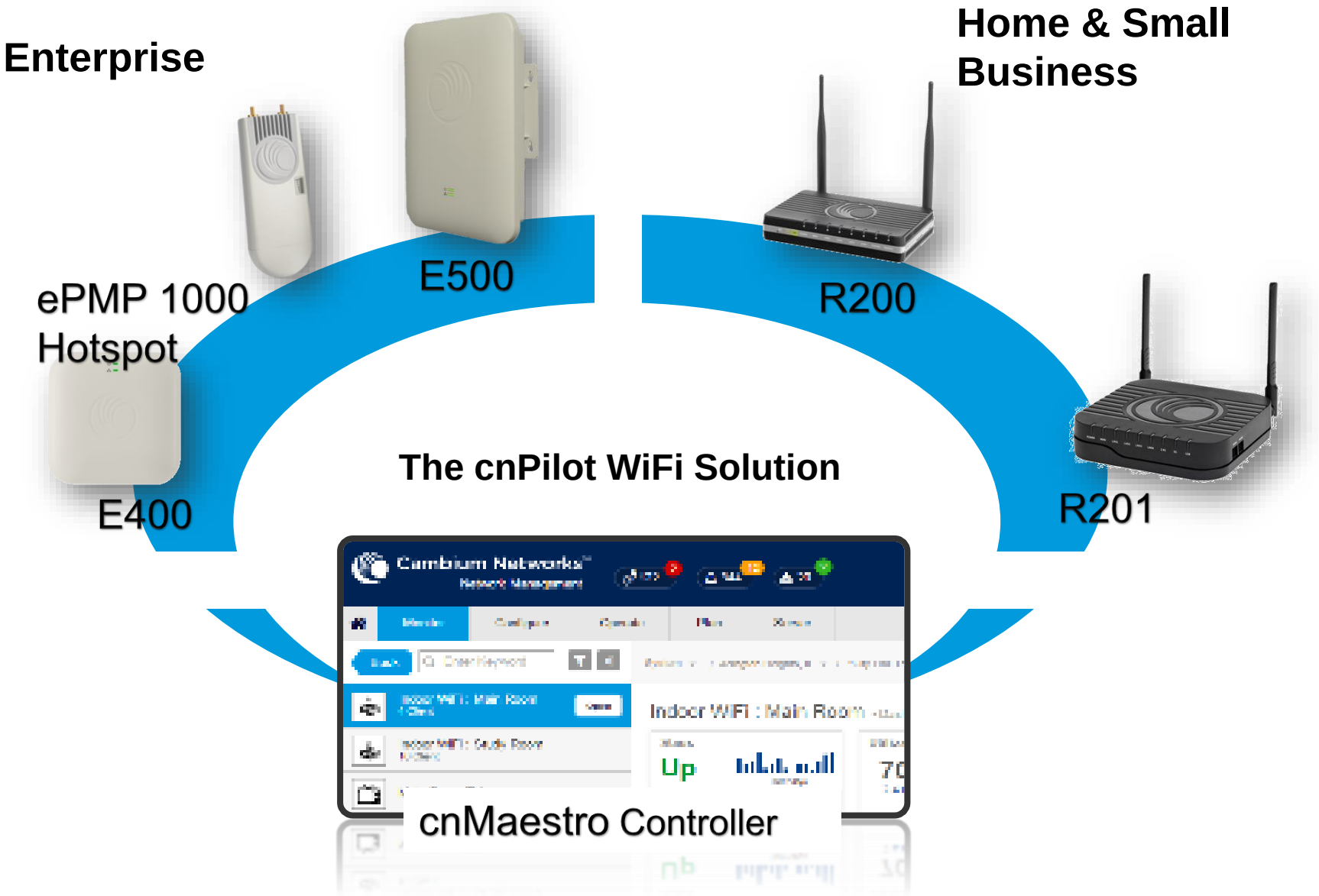
Wi-Fi for

Enterprise
Indoor, Outdoor

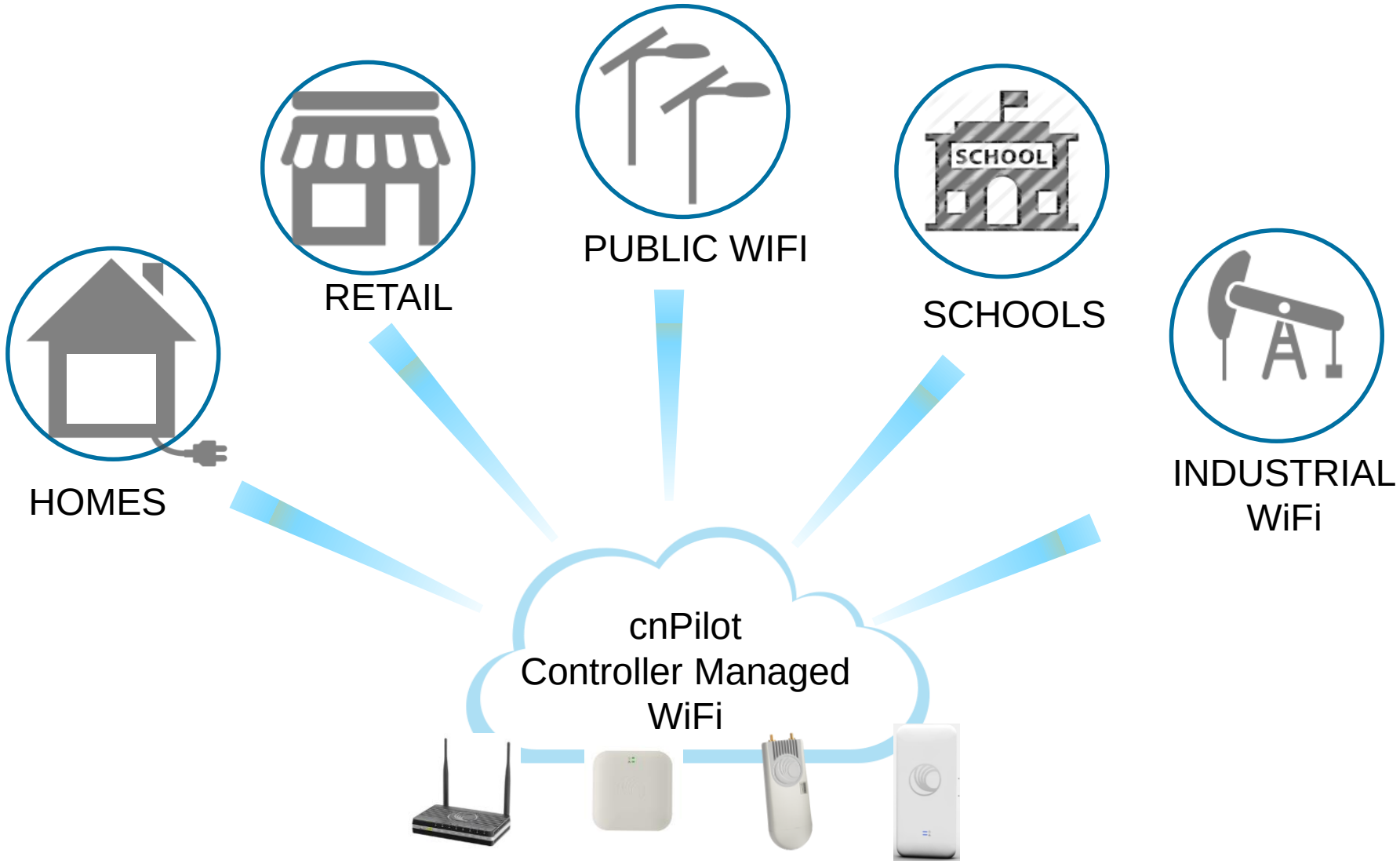
Service Providers
Indoor

Industrial
Indoor, Outdoor

WiFi Access Portfolio



cnPilot Applications



cnPilot E400 Enterprise Indoor AP

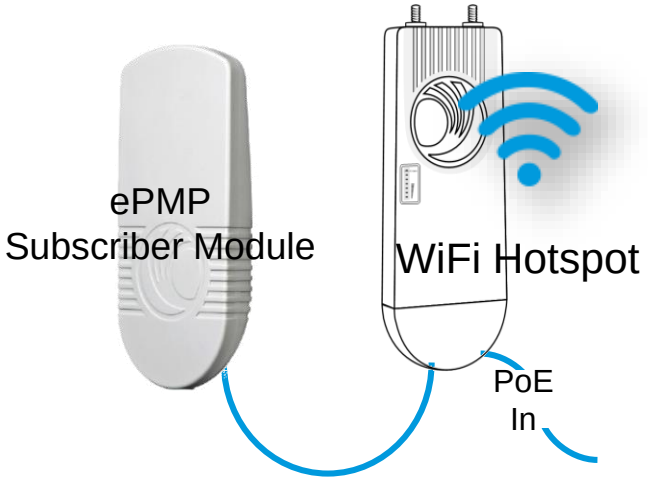
- RF
  - 802.11a/b/g/n/ac
  - 2x2 MIMO
  - 2.4/5 GHz
  - Max TX power = 24/25 dB
- Physical
  - Dimensions: 180x180x26-31mm
  - Software controlled LED
  - Operating temp 0-45º C
- Installation
  - Installable shoes for table mount
  - Detached back-plate for easy ceiling mount
- Port – 802.3af PoE gigabit

cnPilot E500 Enterprise Outdoor AP

- RF
  - 802.11a/b/g/n/ac
  - 2x2 MIMO
  - 2.4/5 GHz
  - Max TX power
    - 28 dBm @ 2.4 GHz
    - 29 dBm @ 5 GHz
  - LTE co-existence filter
  - Ruggedized circuitry
- Physical
  - 200x162x40mm
  - 881g

cnPilot ePMP Hotspot

- Hardware
  - Proven in the field – as ePMP and hotspot Access Point
  - Single band 802.11n – 2.4 & 5 GHz models
  - Can be converted to a Backhaul AP or SM or vice versa
  - Versatile – Ethernet or wireless backhaul
- Specifications
  - 2 10/100 Ethernet ports
  - Power consumption: 5W (typical)/7W (max)
  - Weight < 0.5 Kg
  - Dimensions: 30x15x9
  - Certification: IP55
  - Canopy PoE out PMP 450/ePMP
  - Temperature rating: -30° C ~ + 60° C
  - Single Band 802.11n [2.4, or 5 GHz]



IIoT Connectivity - cnReach™

cnReach Narrow-Band Platform

Deployment Flexibility	• PTP/PMP/Store-and-Forward Relay • Optional digital / analog I/O • Dual-band 900 MHz (MAS / ISM) • Dual-radio options
Reliability	• 100% factory testing over temperature • ATEX/HAZLOC • Made in the USA
Low Power Consumption	Simple integration with existing power (including solar)
Scalable	Access Point synchronization Adaptive modulation
Secure	128/256-bit AES encryption
Manageable	• Cloud or NOC-based cnMaestro • LINKPlanner planning and BOMs

cnReach 900 MHz Narrow-Band Radio

	MAS Licensed	ISM Unlicensed
Frequency	928 – 960 MHz	902 - 928 MHz
Power	10 mW to 3W	10 mW to 1W
Channel Sizes	12.5 / 25 / 50 kHz	76 / 154 / 207 / 310 / 600 / 900 / 1200 kHz
Capacity	10 kbps – 210 kbps	57 kbps – 4.4 Mbps
Modulations	Up to 32QAM	Up to 64QAM
Range	Up to 70 miles	
Encryption	128/256-bit AES	
I/O	2 x 10/100 Ethernet 2 x Serial Port Optional Digital/Analog I/O	

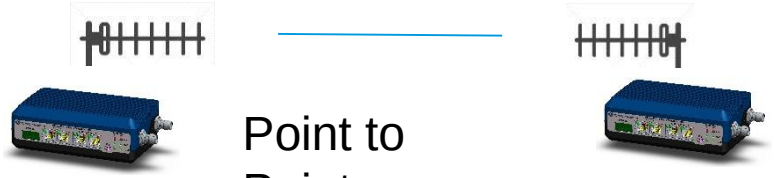
cnReach 700 MHz Narrow-Band Radio

	Licensed
Frequency	757-758 MHz & 787-788 MHz
Power	100 mW to 5 W (20 dBm to 37 dBm)
Channel Sizes	12.5 / 25 / 50 / 100 / 200 / 250 kHz
Capacity	9.6 kbps to 1.0 Mbps
Modulations	Up to 32QAM
Range	Up to 70 miles
Encryption	128/256-bit AES
I/O	2 x 10/100 Ethernet 2 x serial port Optional digital/analog I/O

cnReach 450 MHz Narrow-Band Radio

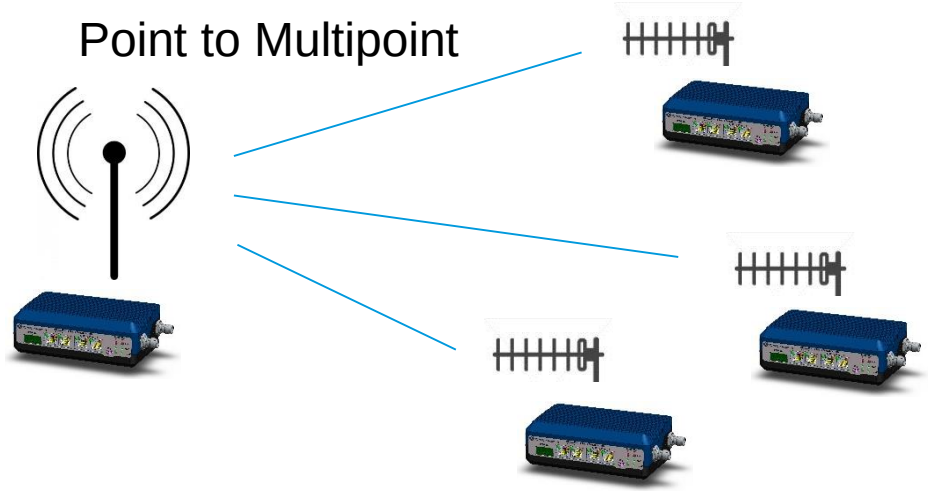
	Licensed
Frequency	757-758 MHz & 787-788 MHz
Power	100 mW to 5 W (20 dBm to 37 dBm)
Channel Sizes	12.5 / 25 / 50 / 100 / 200 / 250 kHz
Capacity	9.6 kbps to 1.0 Mbps
Modulations	Up to 32QAM
Range	Up to 70 miles
Encryption	128/256-bit AES
I/O	2 x 10/100 Ethernet 2 x serial port Optional digital/analog I/O

cnReach Deployment Topologies – Single/Dual Radios

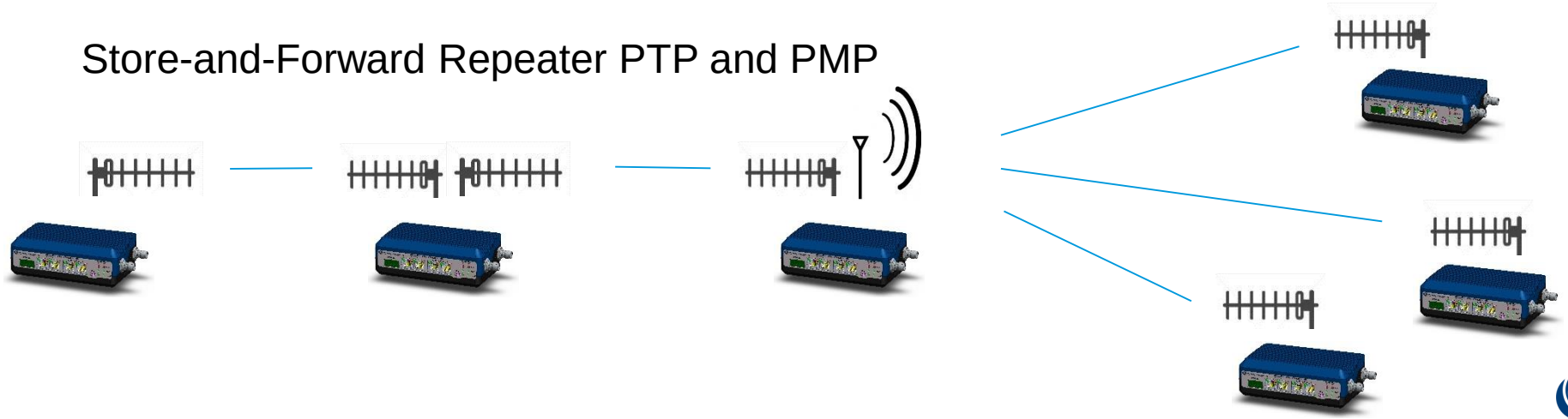


Point to Point

Point to Multipoint



Store-and-Forward Repeater PTP and PMP



cnReach Connectivity

- RS-232 serial ports with command line interfaces
- RS-422/485 serial bus sensors
- SCADA control systems (DNP3, MODBUS RTU, MODBUS TCP protocols)
- Terminal server/client interfaces
- Ethernet ports for TCP/IP communications
- Analog input signals
- Digital I/O signals

cnReach Data Capabilities

- Switching Fabric
  - Integrated Ethernet switch
  - Static layer 3 routing
- OR
  - Layer 2 flat network
  - VLAN tagging support

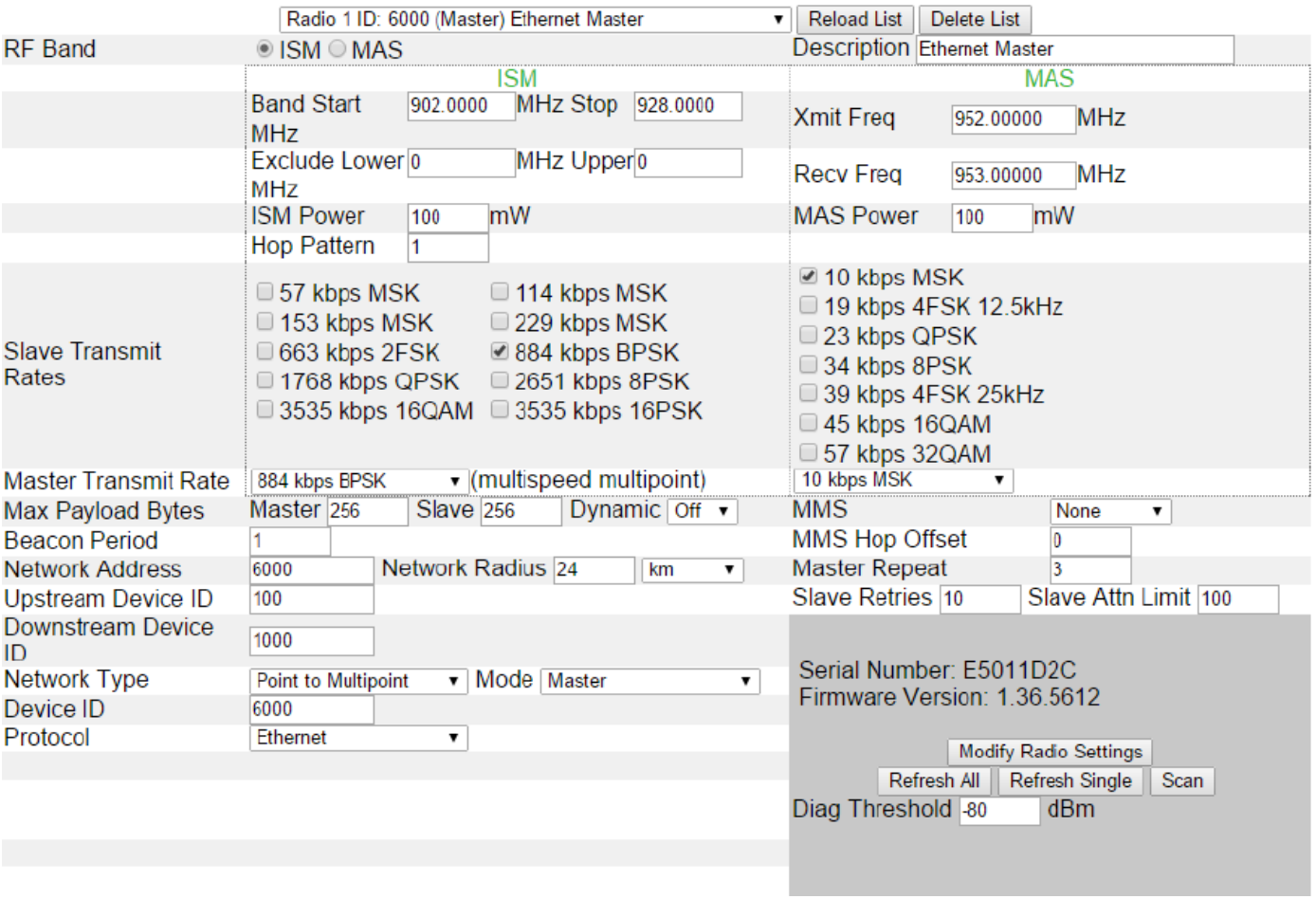
- Benefits
  - Keep licensed and unlicensed traffic separate
  - Prevent broadcast data from using narrow-band channels
  - Store-and-forward
  - Shared Serial / IP network
    - Terminal server
    - Terminal client
    - MODBUS RTU server
    - MODBUS TCP
    - DNP3

cnReach Physical Interfaces

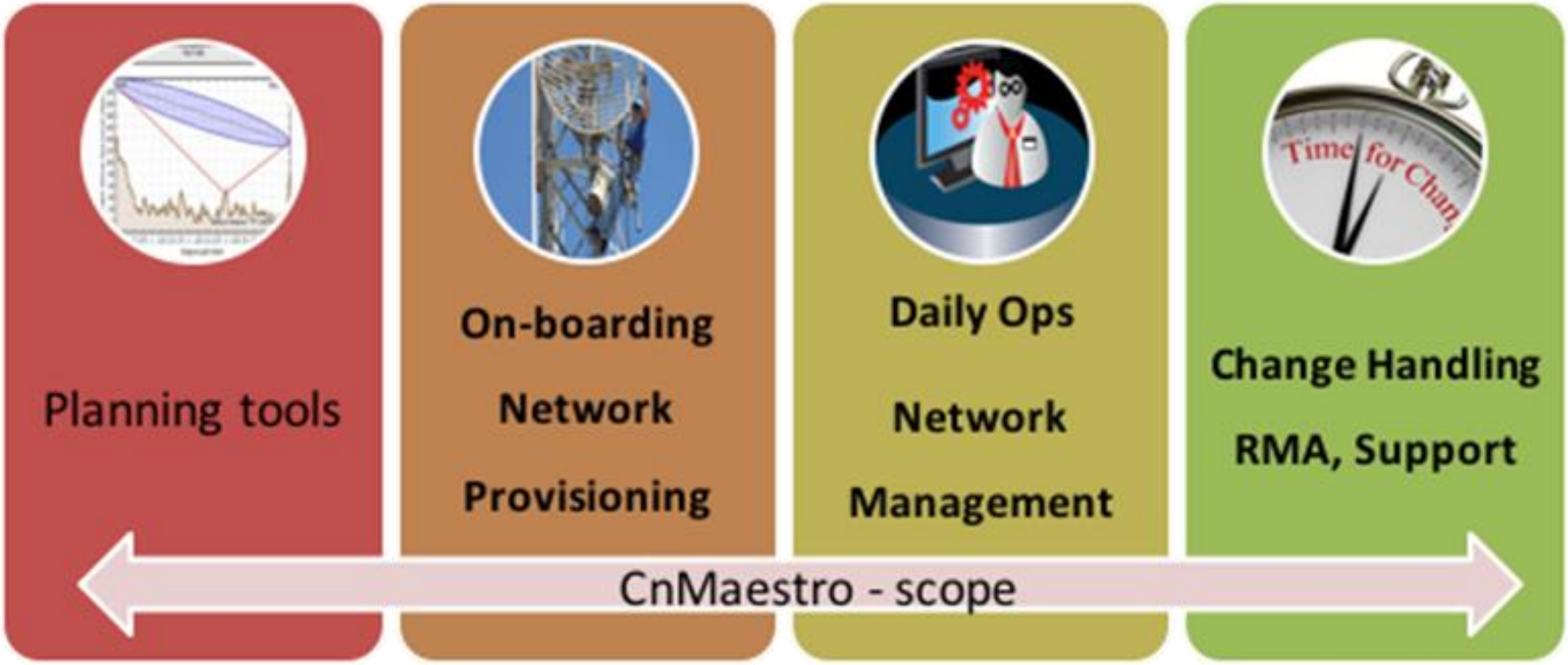
- 2 x 10/100 Ethernet
- 2 x serial interfaces
  - RS-232/-422/-485
- 1 or 2 radios
- Optional 8-ports analog/digital I/O

Web-based Management Interface

- Secure web management
- Distributed firmware updates
- File-based configuration backup/restore

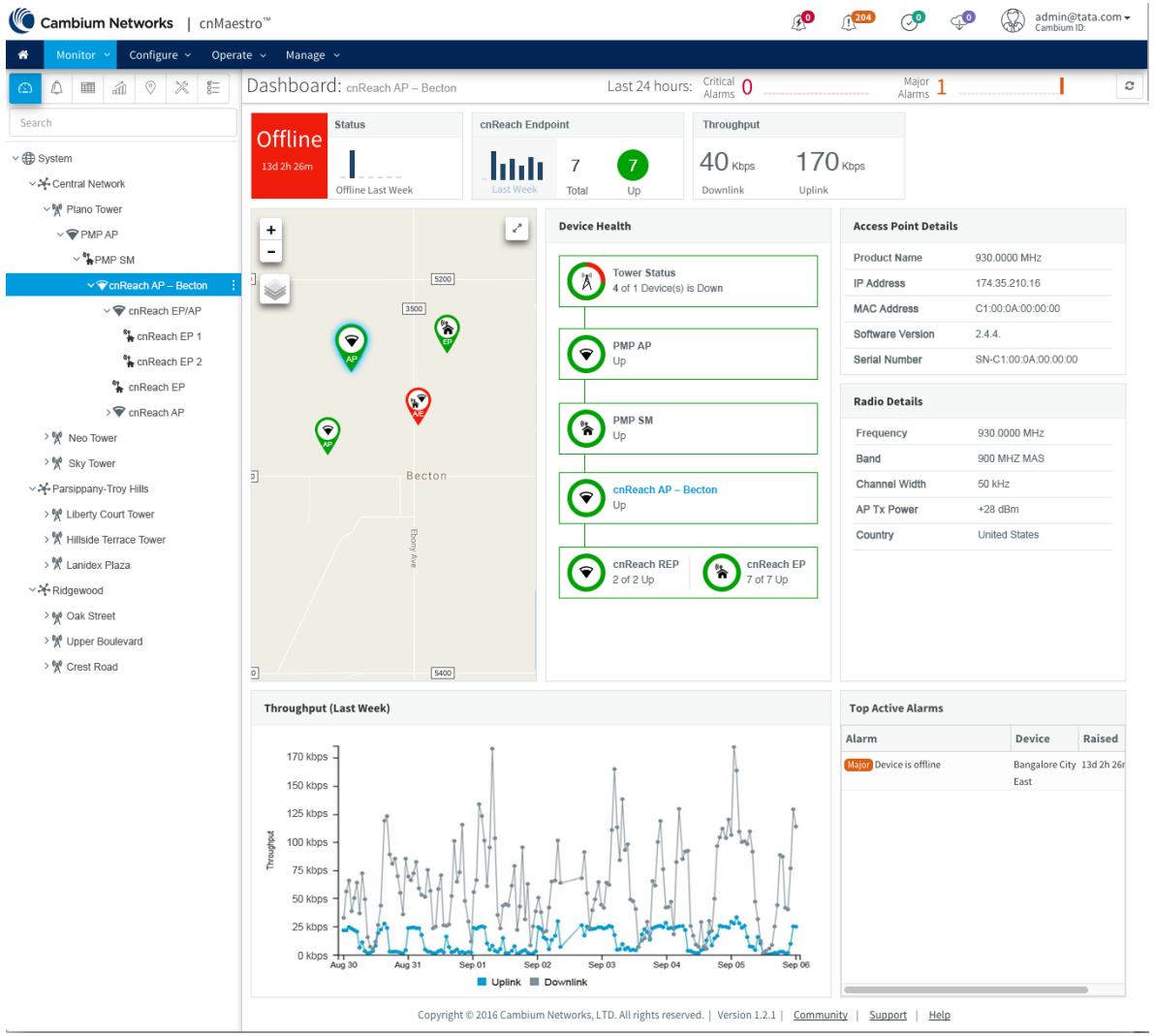


End-to-End Network Management - cnMaestro™



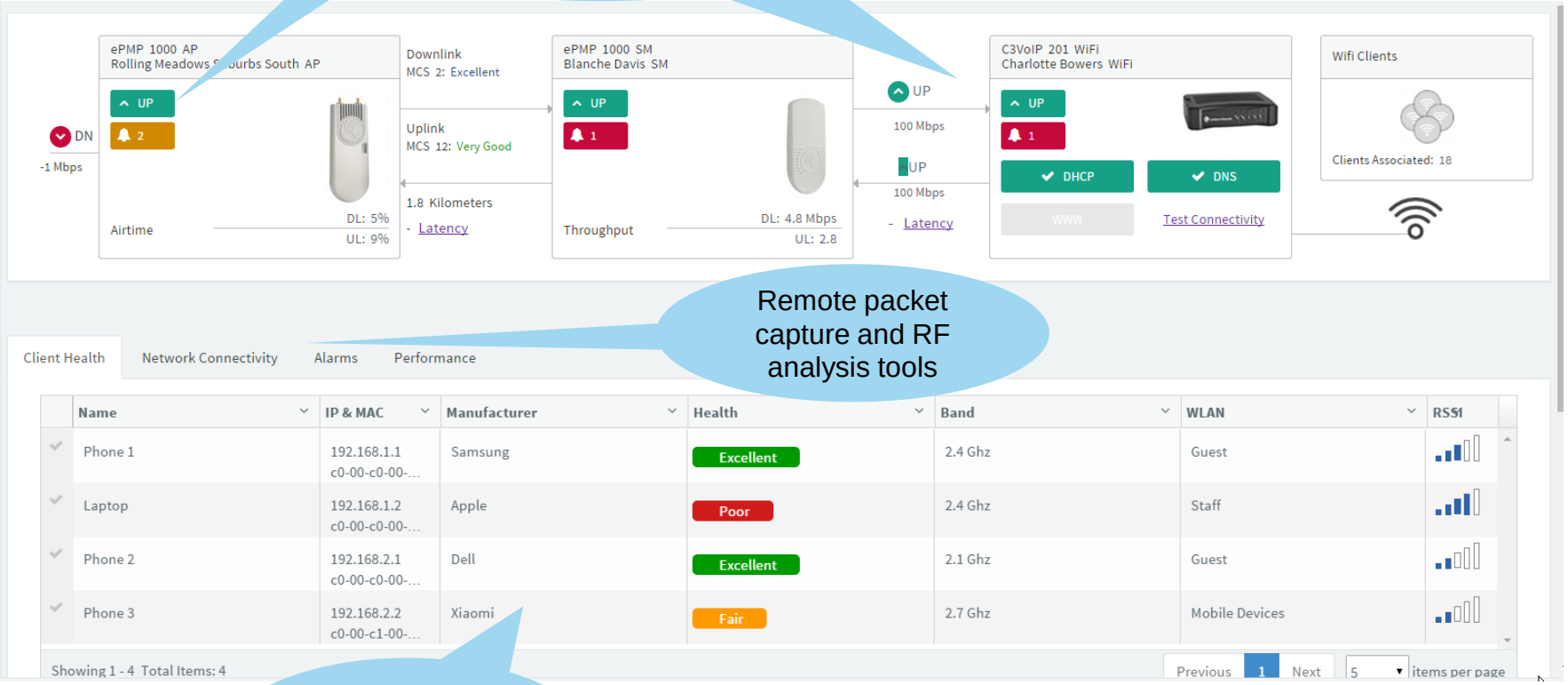
cnMaestro End-to-End Management

- Single pane of glass
- Map location of devices
- Hierarchical device organization
- Summary view of UP & DOWN devices
- Sticky alarms – critical, major & minor



cnMaestro Network Troubleshooting

Preloaded status of all the component of end to end network - from mobile device having problem to the backhaul

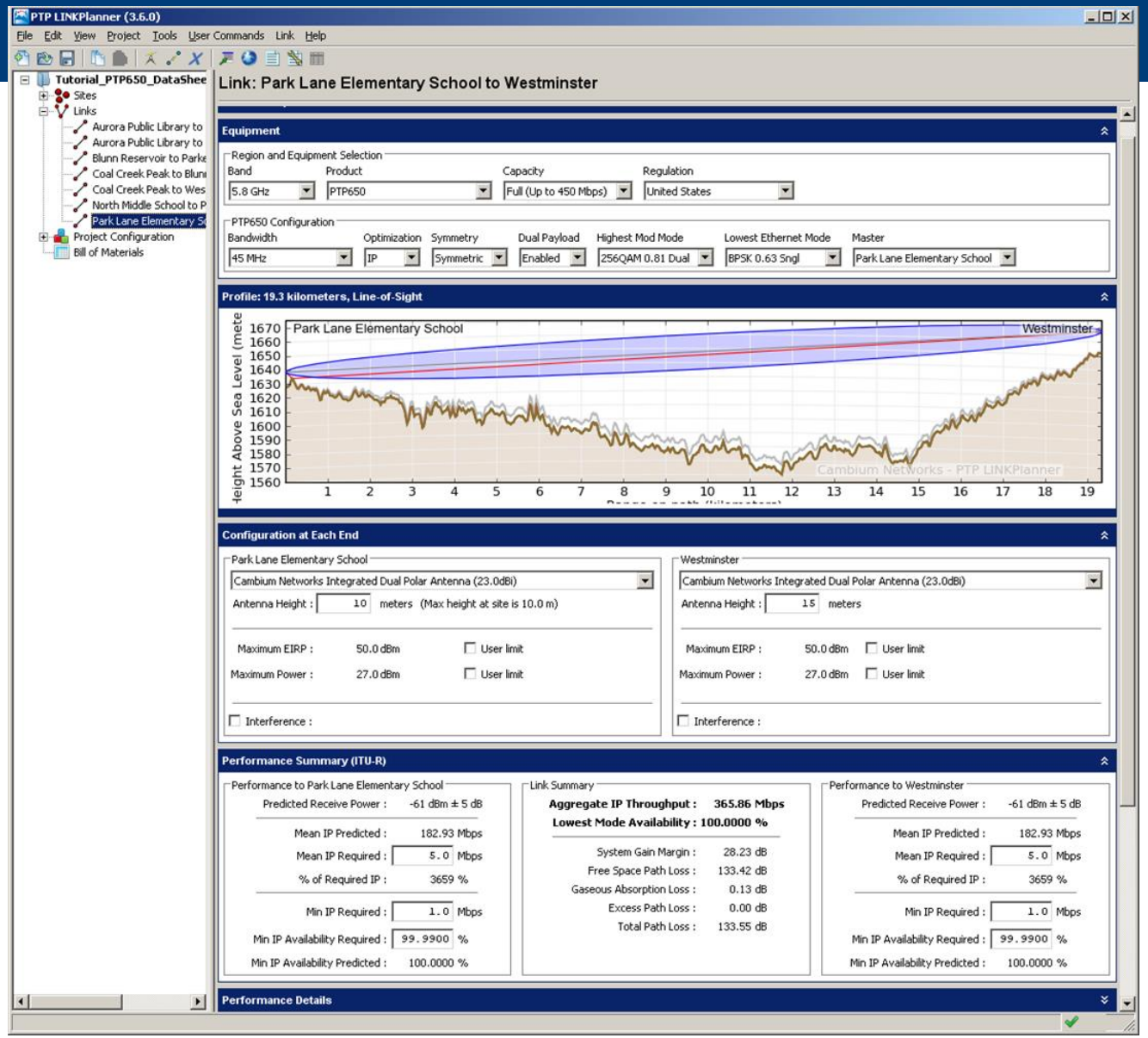


Remote packet capture and RF analysis tools

Easily identify the mobile device through their names and manufacturer

LINKPlanner

- Free network planning software improves success rate of first installation
- Path profile
- Configuration details
  - Bill of materials tailored for each link
- Performance summary



References

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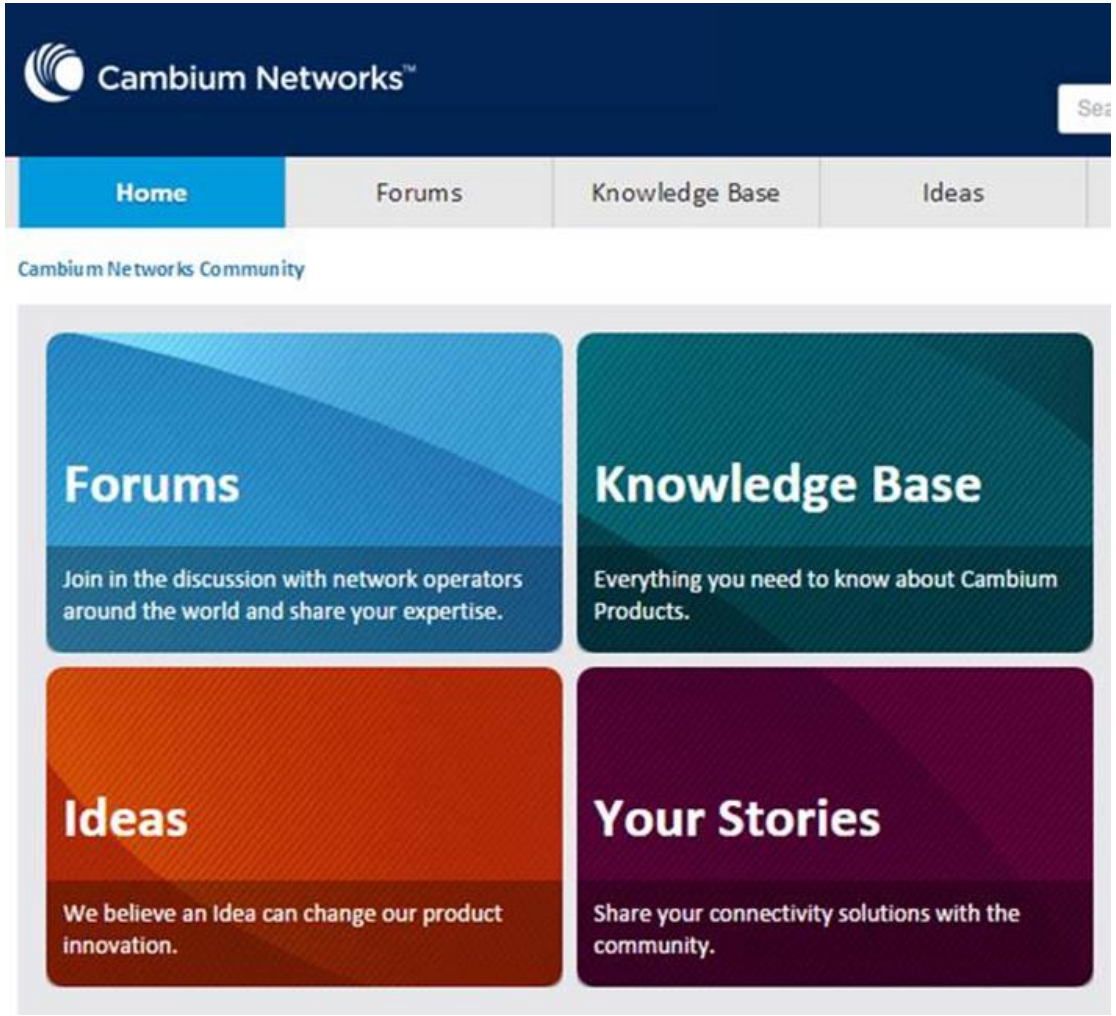
Cambium Community

- Learn from network operators around the world
- Community Forum
  - Products
  - Network planning
  - Languages
  - Business issues
- Knowledge Base with technical detail documents
- Submit development ideas
- Real-world connectivity stories



Technical Certification Training

- Certification on all products
- 2-Day classes
  - Certified instructors
  - Live hands-on training
  - Proficiency test
- 8 classes per month
- Courses offered around the world in multiple languages
- Option to take test online to achieve certification

Social Media

- Follow Cambium Networks to get the latest information
- Facebook
- Google+
- Instagram
- LinkedIn
- Twitter
- Weibo
- YouTube

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