



Cisco LoRaWAN Solution

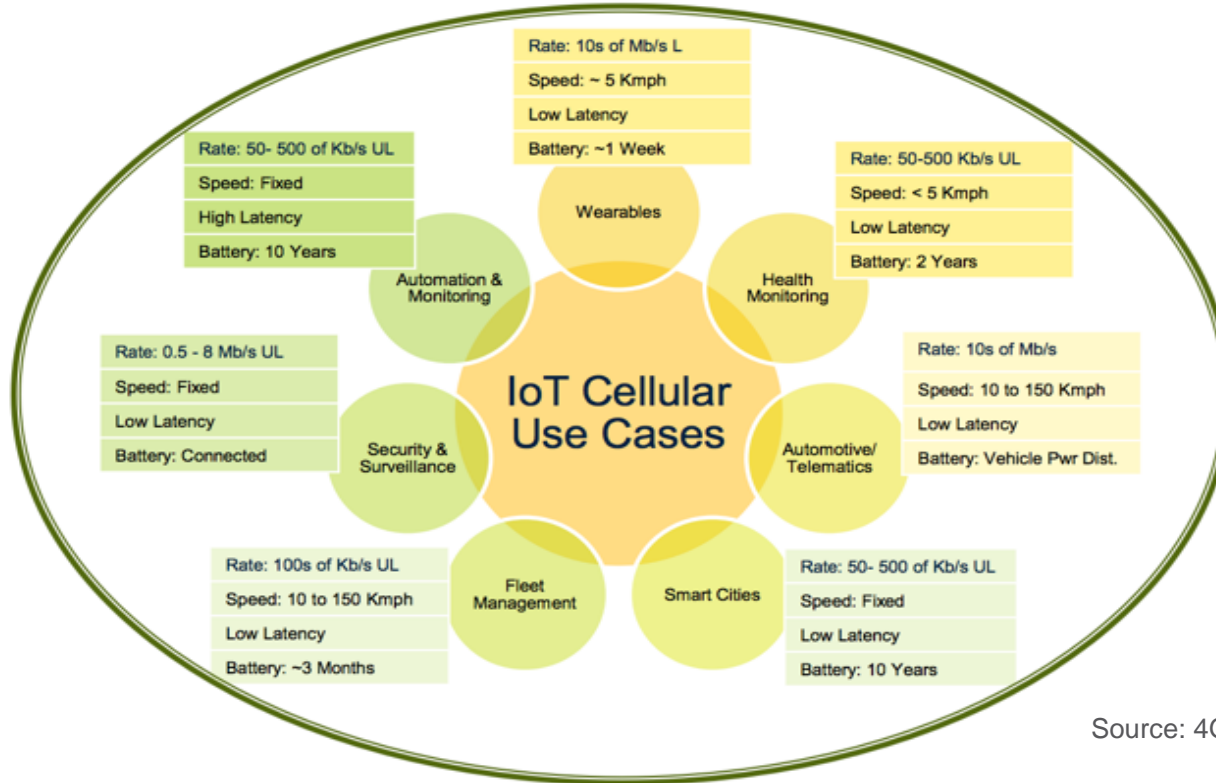
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Consulting Systems Engineer, CCIE Emeritus

May 16th 2017

Technology Overview

IOT Use Cases Bring Various Traffic Patterns



Source: 4G Americas Use Cases

Current Wireless IoT Connectivity Options

Current SP Offering

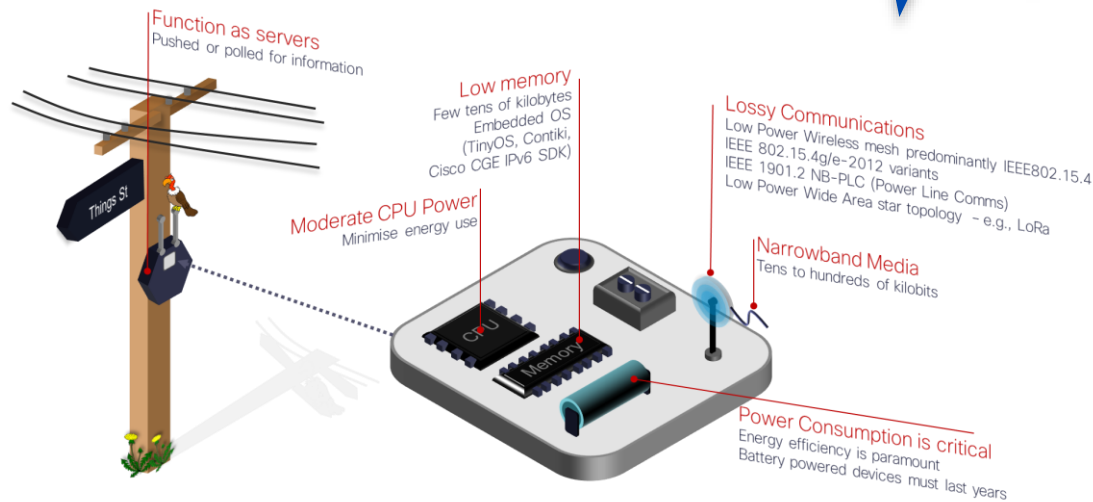
Private Network

Technology	2G	3G	LTE	LTE-M (Cat M)	WiFi	Zigbee	Wireless Hart	802.15.4g
Range	Long	Long	Long	Long	Limited (<200m in EU)	Short	Limited (<250m)	Limited (<1 km)
Topology	P2P	P2P	P2P	P2P	P2P/ Mesh	Mesh	Mesh	Mesh
Energy Harvesting	No	No	No	No	No	Possible	Possible	Possible
Operating Life on battery (2000mAh) A=active; I=idle	4-8h (A) 36d (I)	2-4h (A) 20d (I)	2-3h (A) 12d (I)	Days	4-8h (A) 50h (I)	60h (A)	8-10 years	Variable
Licensed/Unlicensed	L	L	L	L	U	U	U	U
Link Budget			130dB+	145dB+				
Throughput	384kbps	40Mbps	100Mbps +	10Mbps	300Mbps			
Mobility	Yes	Yes	Yes	Yes	Yes	Limited	Limited	Limited
Module Cost (est.)	\$8-10	\$35-\$50	\$40-\$80	NC	\$5-\$8	\$6-\$12	NC	\$3

Cellular & WiFi not Suitable for Constrained Devices

- Many sensors are low cost, low power, constrained devices
 - Battery/solar/scavenger energy
 - Wireless
 - Low CPU
 - Autonomous
 - Huge scale

New type of network is required



LPWA: An Emerging Wireless Infrastructure

Designed for Low Power Consumption, Low Data Rate and Long Distance IoT Use Case

- Fill the gap between local wireless and cellular wireless technologies
- End-device with battery life lasting over 10 years
- Optimized for small and intermittent data burst
- Over-the-air distance over 15 km
- Outdoor coverage and sufficient indoor penetration
- Low cost module at sub-\$5
- Technology branches from utilized spectrum
 - Licensed band - 3GPP NB-IOT on LTE – Public Mobile SP
 - Unlicensed band - LoRaWAN and SigFox on ISM radio – SP and Enterprises and Open Communities



Wireless IoT Connectivity Options + LPWA

	Current SP Offering					Private Network			LPWA	
Technology	2G	3G	LTE	LTE-M (Cat M)	WiFi	Zigbee	Wireless Hart	802.15.4g	LoRa	NB-IOT (Cat M2)
Range	Long	Long	Long	Long	Limited (<200m in EU)	Short	Limited (<250m)	Limited (<1 km)	Long >10 km (rural) >1 km (urban)	
Topology	P2P	P2P	P2P	P2P	P2P/ Mesh	Mesh	Mesh	Mesh	P2P	P2P
Energy Harvesting	No	No	No	No	No	Possible	Possible	Possible	Possible	Possible
Operating Life on battery (2000mAh) A=active; I=Idle	4-8h (A) 36d (I)	2-4h (A) 20d (I)	2-3h (A) 12d (I)	Days	4-8h (A) 50h (I)	60h (A)	8-10 years	Variable	Up to years	Up to years
Licensed/Unlicensed	L	L	L	L	U	U	U	U	U	L
Link Budget			130dB+	145dB+					155dB+	155dB+
Throughput	384kbps	40Mbps	100Mbps +	10Mbps	300Mbps				300-50kbps	< 170kbps
Mobility	Yes	Yes	Yes	Yes	Yes	Limited	Limited	Limited	Yes	No
Module Cost (est.)	\$8-10	\$35-\$50	\$40-\$80	NC	\$5-\$8	\$6-\$12	NC	\$3	<\$5	NC

LPWA Use Cases

Smart water/
gas metering



Public lighting



Smart building



Smart parking



Assets Tracking



Smart Agriculture, i.e. leak
detection and irrigation



Water level and
flood management



Fault management



Security services, i.e.
Smoke detectors



Smart energy and fast
demand response



Waste management



Traffic management



Which PHY RF Layer for LPWA

- To achieve Long Range and Low Power there are two main approaches:
 - Ultra Narrow Band: slowly transmitting small amount of data in narrowband channels (few khz) using various SK modulation (GFSK, BPSK, etc.)
 - Spread Spectrum: spreading the data across a larger radio spectrum allowing to recover data from noise at the receiver
 - Direct-Sequence SS (DSSS) and Frequency-Hopping SS (FHSS) use pseudo-random elements
 - Chirp Spread Spectrum (CSS as used in 802.15.4a) uses wideband linear frequency modulated [chirp](#) pulses to [encode](#) information
- LPWA technologies includes:
 - LoRa, Sigfox, OnRamp (unlicensed)
 - LTE-M/NB-IOT (licensed)

LoRa (Long Range) PHY

- Developed by Semtech:
 - Leading supplier of high-quality analog and mixed-signal semiconductor products
- Handed-out to LoRa Alliance:
 - Multiple LoRa chipset vendors today: Semtech, ST Micro, Microchip
- Spread spectrum based modulation
- Data rates:
 - 0.3 kbps (SF12) 125kHz to 5.5 kbps (SF7)@125kHz
- Packet size up to 250 Bytes (dependent of the SF and frequency)
- Dynamically trades data rate against range
 - up to +20dBm TX power, 157 dB link budget

LoRaWAN™ Layered Architecture



LoRaWAN Specification



LoRaWAN™ Specification

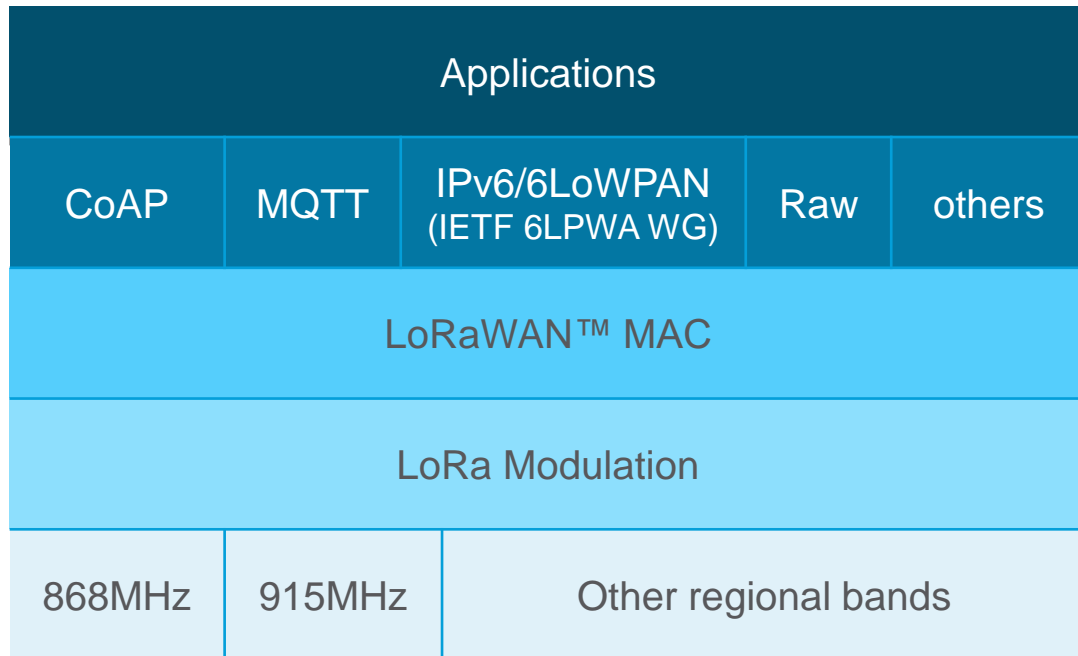
Authors:

N. Sornin (Semtech), M. Luis (Semtech), T. Eirich (IBM), T. Kramp (IBM), O. Hersent (Actility)

Version: V1.0.1

Date: 2016 Feb

Status: Final



LoRa Alliance Specifications

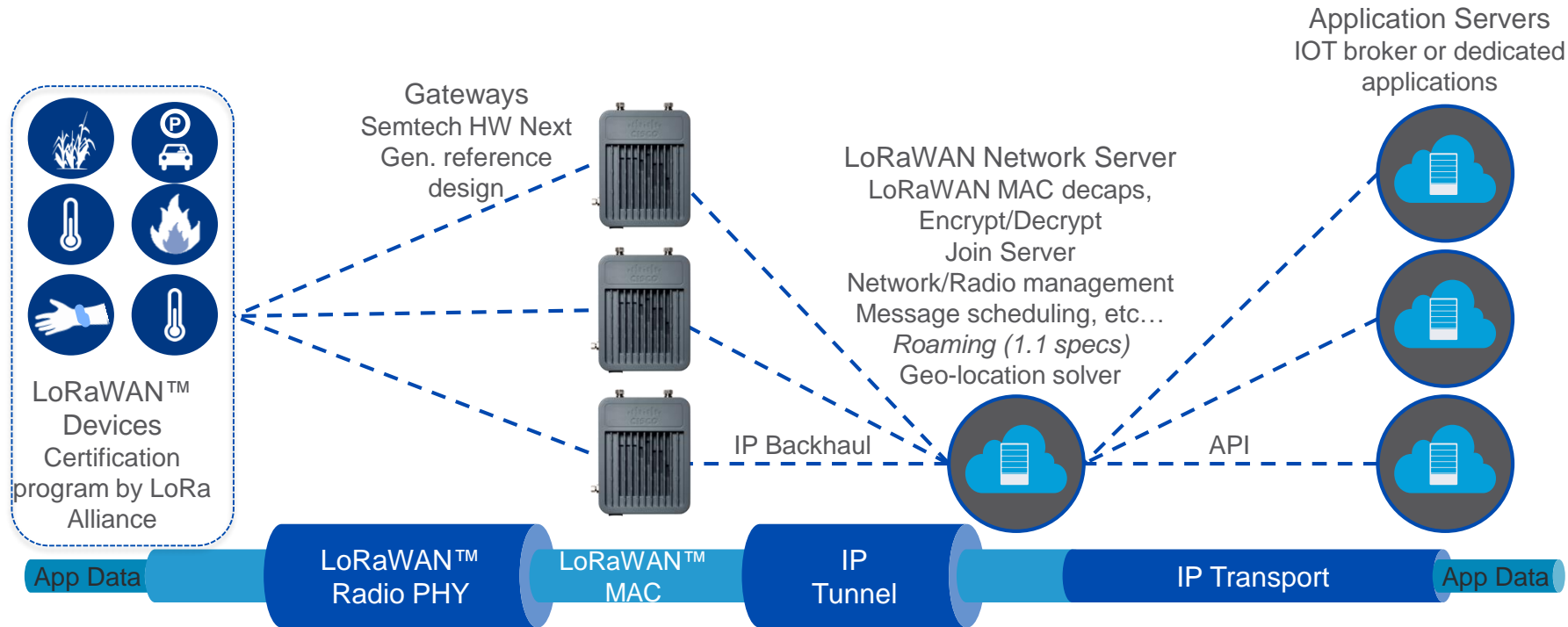
Semtech modulation

LoRa Alliance Regional Profiles

LoRaWAN Principles

- Gateways act as transparent bridge relaying messages between devices and a network server (NS)
- Sensors use single-hop wireless communication to one (or many) gateway(s)
- Communication between sensors and Gateway is spread using different channels and rates
- Network Server manages the data rate and RF output for each sensor using ADR scheme
- Any device can transmit to any channel at any time
- No synchronization between devices required
- Node changes channel randomly for each transmission
 - Robust to interferers and collisions
- Piggy-backing for gateway to node communication
 - Predictable battery-life

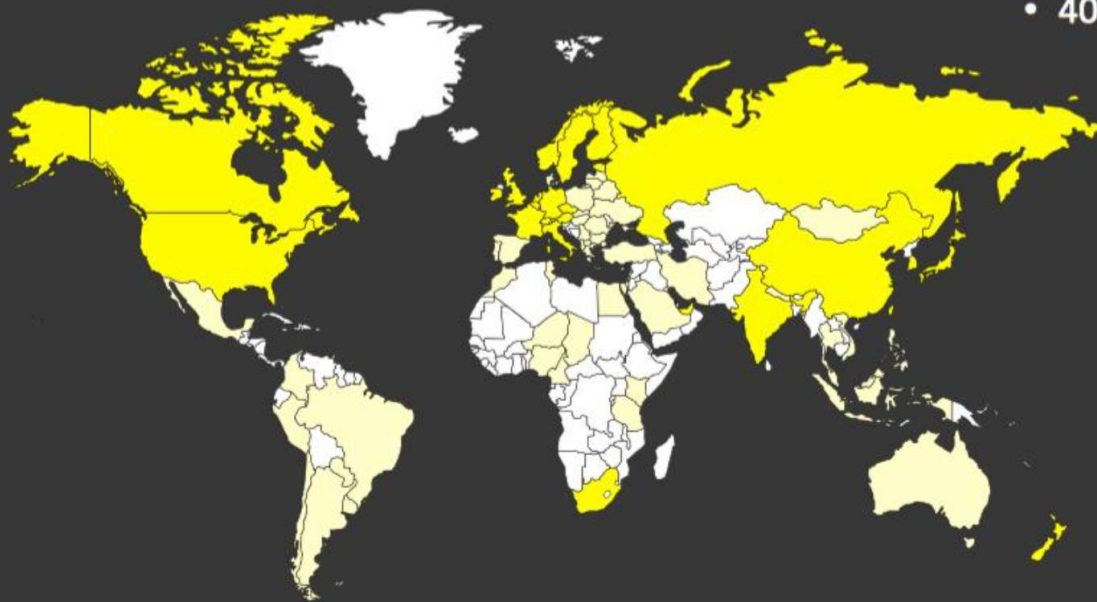
LoRaWAN™ End-to-End Architecture



LoRaWAN Deployments

Countries – LoRaWAN Networks

- 34 Publicly Announced Operators
- 150+ on-going trials & city deployments
- 400+ members in the Alliance

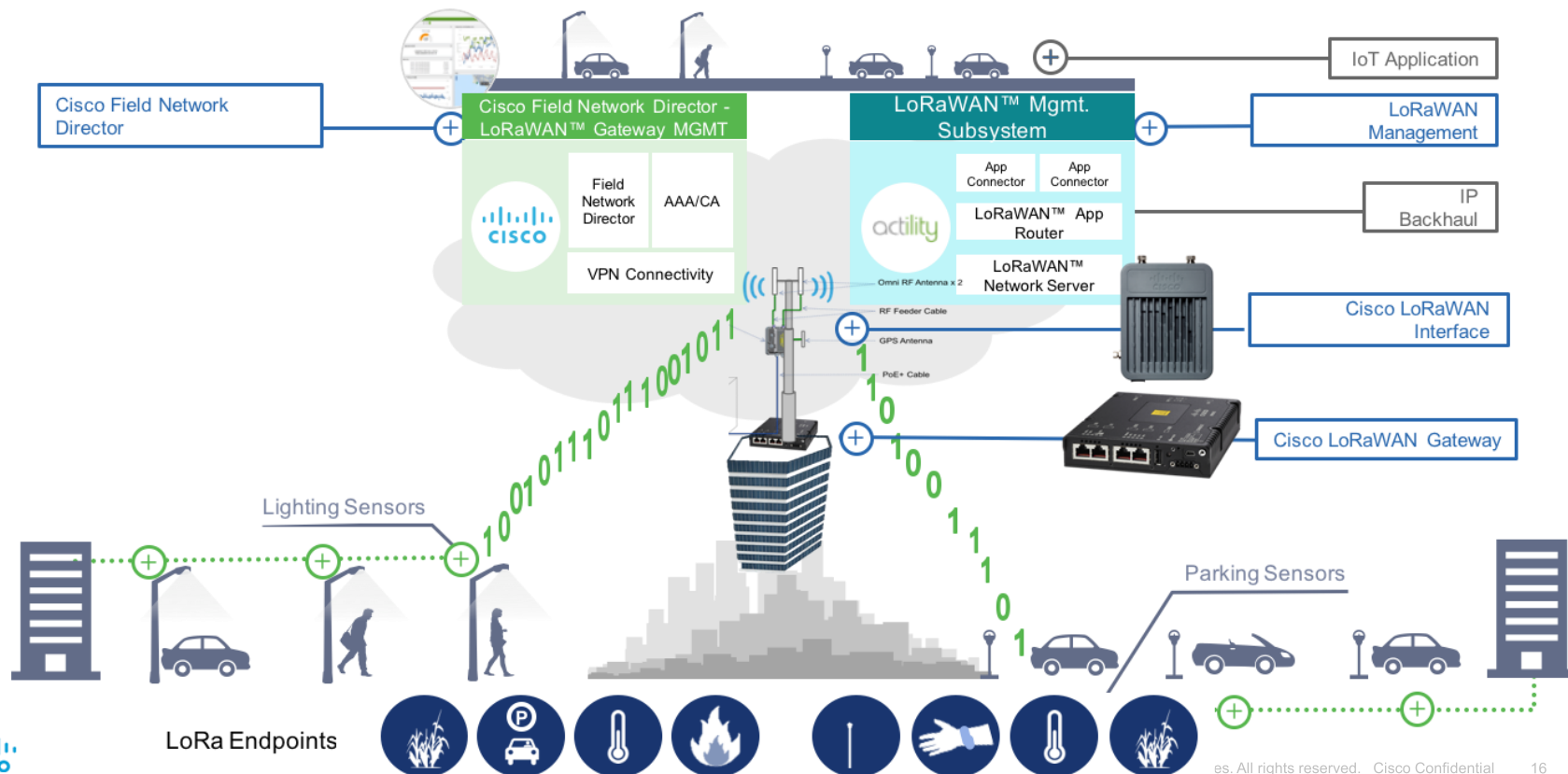


Legend:

- Publicly Announced
- Other deployments

Cisco Solution Overview

Cisco Solution for LoRaWAN™



Cisco interface module for LoRaWAN

Part of the IoT eXtension Modules (IXM) series

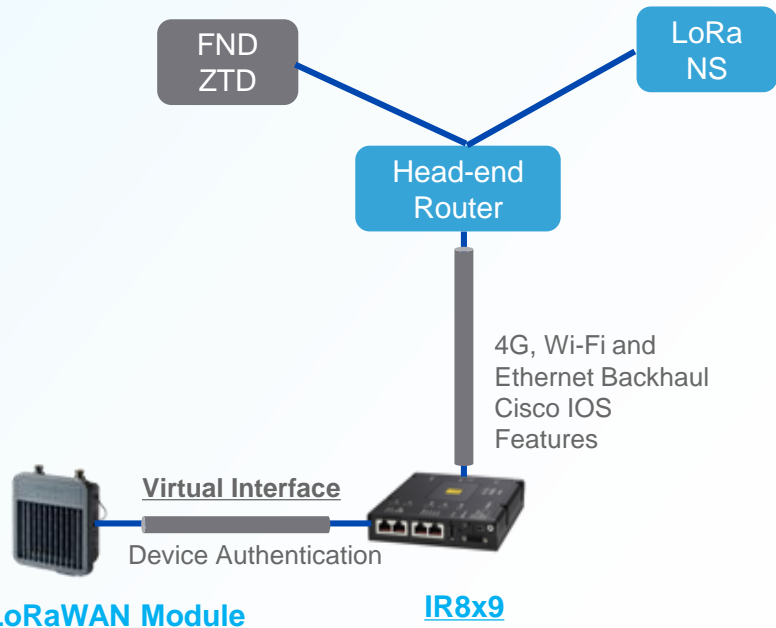
- Cisco LoRaWAN Interface adds LoRaWAN Gateway services to Cisco® IoT portfolio
 - LoRaWAN as standalone GW (Ethernet backhaul) or IOS interface on IR809, IR829, CGR 1000 (future)
 - Based on Semtech Next Gen GW reference design (known as v2 GW)
 - Carrier and industrial grade: IP67 rating, PoE+ power, GPS, main and diversity antennas,...
- Cisco LoRaWAN Interface fully complies with LoRaWAN specifications
 - 868 MHz and 915 MHz hardware SKUs,
 - LoRaWAN regional RF parameters profiles through LoRaWAN Network Server solution
 - LoRaWAN devices class A, B and C support
 - Geo-location support
- Enables flexible topologies – standalone for Ethernet backhaul, one to multiple Cisco LoRaWAN Interface modules on IR8x9...
- Scalable operations management with Cisco IoT Field Network Director



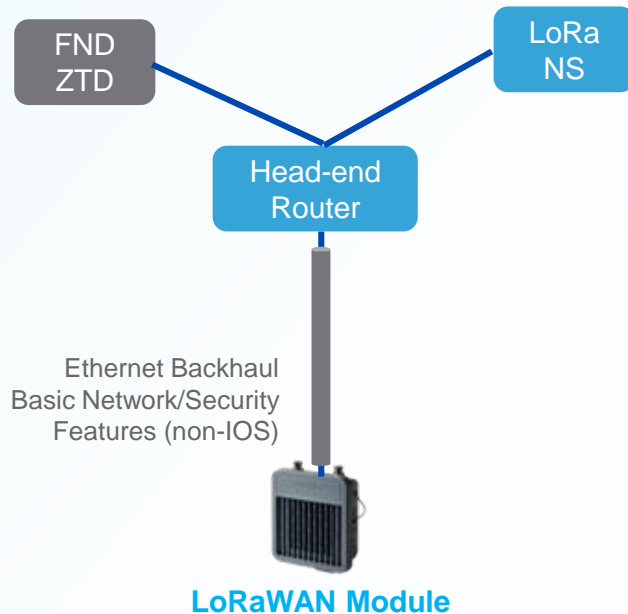
Cisco interface module for LoRaWAN

Modes of Deployment

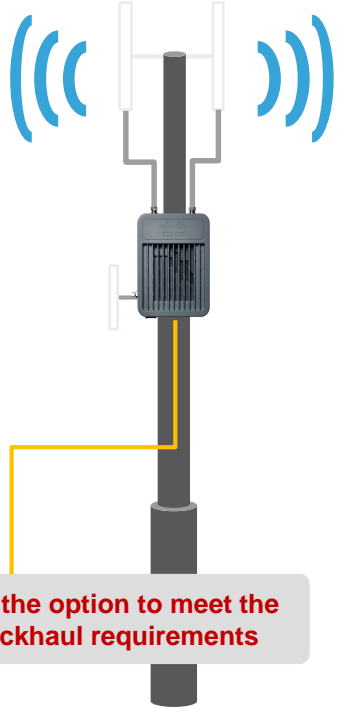
Solution 1 – IXM + IR8x9



Solution 2 – Standalone IXM



IXM LoRaWAN Backhaul Options



Ethernet RJ45

- Standalone mode
- IOS interface mode on IR8x9

Ethernet Fiber

- Standalone mode with 3rd party media adapter
- IOS interface mode on IR829 with fiber SFP

3G/4G Cellular

- IOS interface mode on IR8x9

Wi-Fi

- IOS interface mode on IR829
- Standalone or IOS mode (VLAN) through AP with Ethernet PoE+ port

Cisco IR800 Series for LoRaWAN™ Interface Module

Compact

Small form-factor hardened Gateway

Utilities, Oil&Gas,
Transportation,
PMB, SP IOT/M2M

Future proofing
IPv6-ready, FOG,
BYOI,...

Hardened

Built for challenging environment –
shock/vibe, humidity, temperature,
dust,...

Services-Rich

IOS 15.6M/T SW release
IPv4/IPv6, Routing, Security, QoS,
Segmentation (VLAN, VRF), VPN, ...



IR 809



IR 829



Connectivity & Sensors

Ethernet,
Cellular 3G/4G
Serial (RS232/RS485)
Wi-Fi a/b/g/n (IR829),
GPS, Accelerometer,
Gyroscope,...

Pervasive Security

HW ID, HW crypto, IPsec VPN,
Certificate based identity, 802.1x,
Cisco Firewall,...

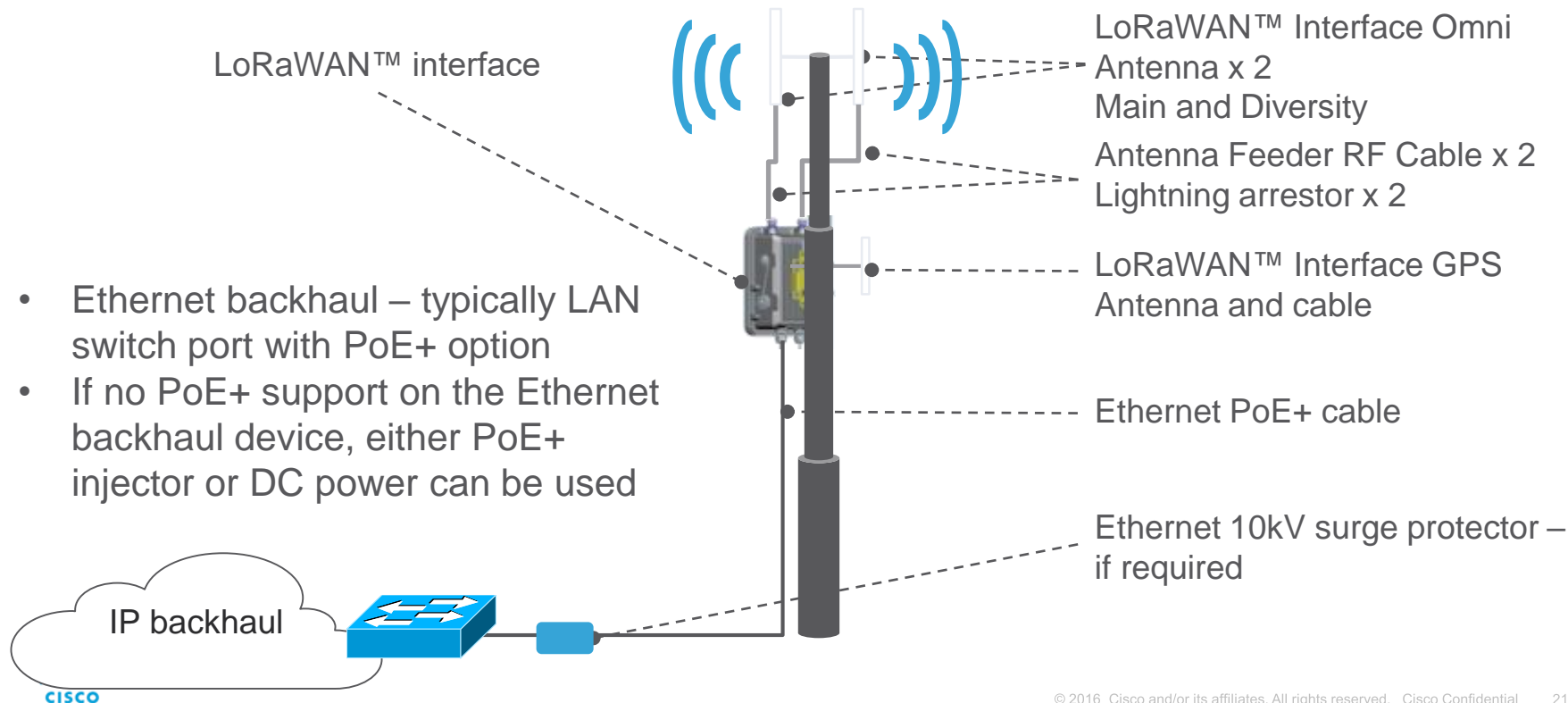
Fog Computing

Linux Guest OS, SCADA protocol
translation, LoRa GW,...

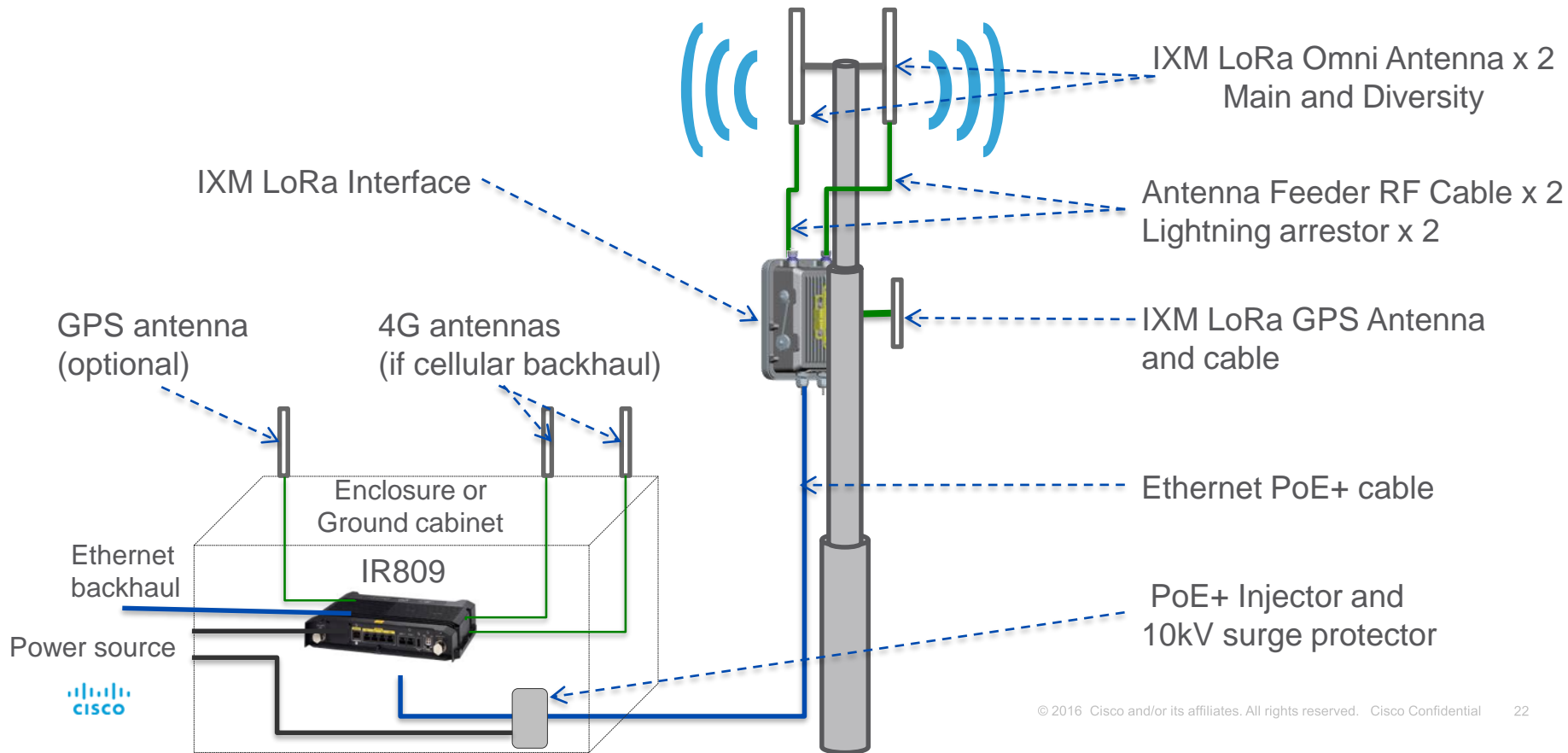
Manageability

IOS comprehensive Network & Security
Management, Zero Touch Provisioning, IOT
Field Network Director/IOT,...

Standalone IXM LoRaWAN™ Site Installation



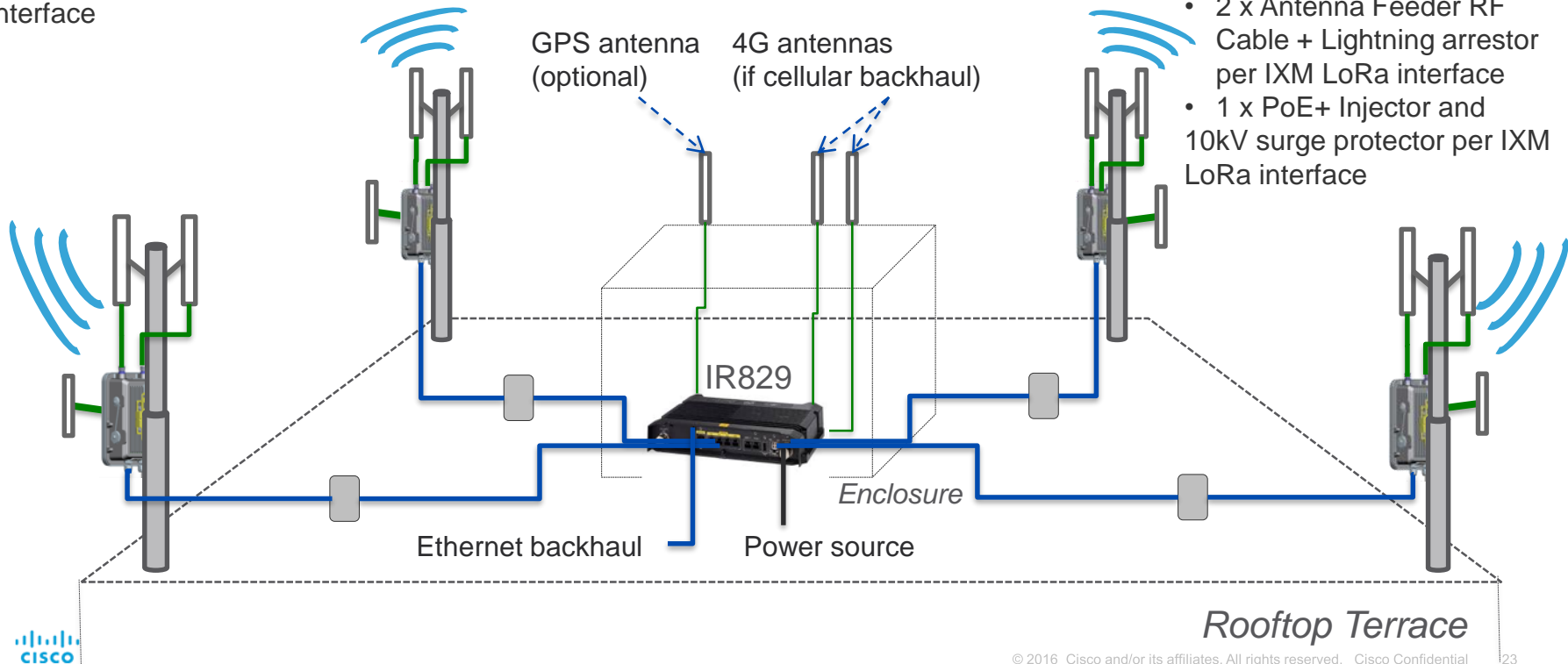
Typical Single IXM+IR809 IXM LoRa Site



Typical Multiple IXM+IR809 IXM LoRa Site

2 x non-Cisco sectorized Antennas
(Main and Diversity) per IXM LoRa
interface

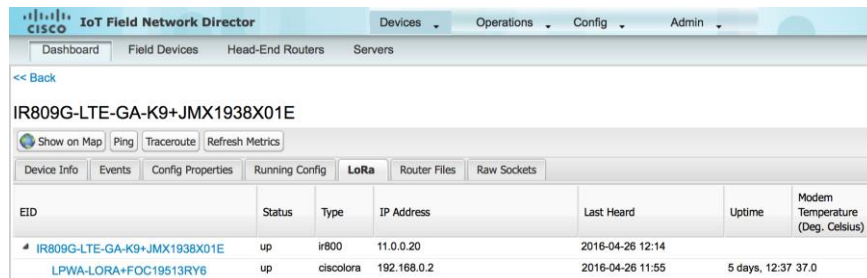
- 1 x GPS Antenna and cable
per IXM LoRa interface
- 2 x Antenna Feeder RF
Cable + Lightning arrestor
per IXM LoRa interface
- 1 x PoE+ Injector and
10kV surge protector per IXM
LoRa interface



Cisco IoT Field Network Director (FND)

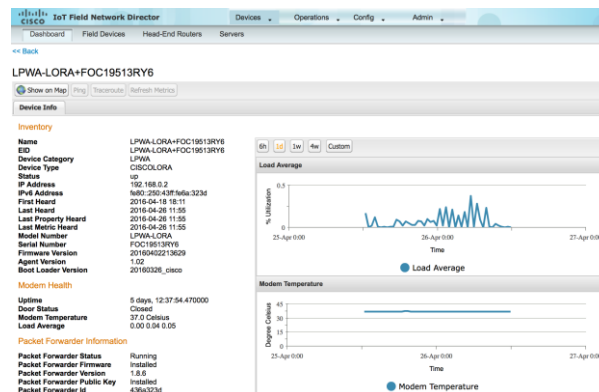
Network Management Solution for IR8x9 and LoRaWAN IXM

- Scalable operations and management
- Monitoring and lifecycle management
- Geographical Information System (GIS) based visualization of all network assets
- Secure network zero-touch commissioning
- Update firmware on groups of IR8x9 and the LoRaWAN interface
- Alarm processing and event generation
- Integrates with applications in enterprise



The screenshot shows the Cisco IoT Field Network Director interface. The top navigation bar includes 'Dashboard', 'Field Devices', 'Head-End Routers', and 'Servers'. The main content area displays details for device 'IR809G-LTE-GA-K9+JMX1938X01E'. Below the device name are buttons for 'Show on Map', 'Ping', 'Traceroute', and 'Refresh Metrics'. A tabbed interface shows 'Device Info', 'Events', 'Config Properties', 'Running Config', 'LoRa', 'Router Files', and 'Raw Sockets'. The 'Device Info' tab is active, showing a table with columns: EID, Status, Type, IP Address, Last Heard, Uptime, and Modem Temperature (Deg. Celsius). The table lists two entries: 'IR809G-LTE-GA-K9+JMX1938X01E' (Status: up, Type: ir800, IP Address: 11.0.0.20, Last Heard: 2016-04-26 12:14) and 'LPWA-LORA+FOC19513RY6' (Status: up, Type: ciscolora, IP Address: 192.168.0.2, Last Heard: 2016-04-26 11:55, Uptime: 5 days, 12:37 37.0).

EID	Status	Type	IP Address	Last Heard	Uptime	Modem Temperature (Deg. Celsius)
IR809G-LTE-GA-K9+JMX1938X01E	up	ir800	11.0.0.20	2016-04-26 12:14		
LPWA-LORA+FOC19513RY6	up	ciscolora	192.168.0.2	2016-04-26 11:55	5 days, 12:37 37.0	



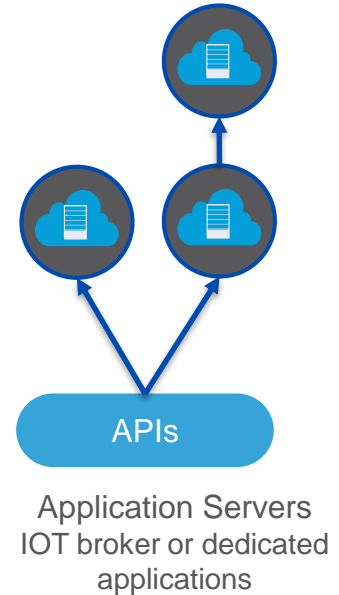
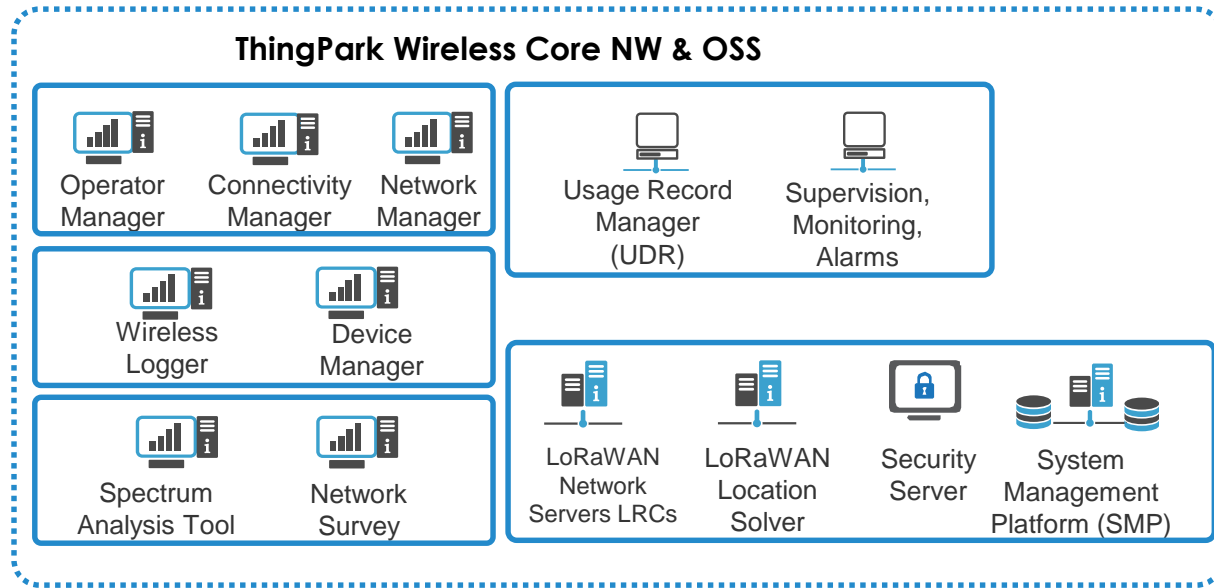
Cisco LoRaWAN Partners



Rapidly Growing Technology Partner Community



Cisco Solution +: ThingPark Components Overview



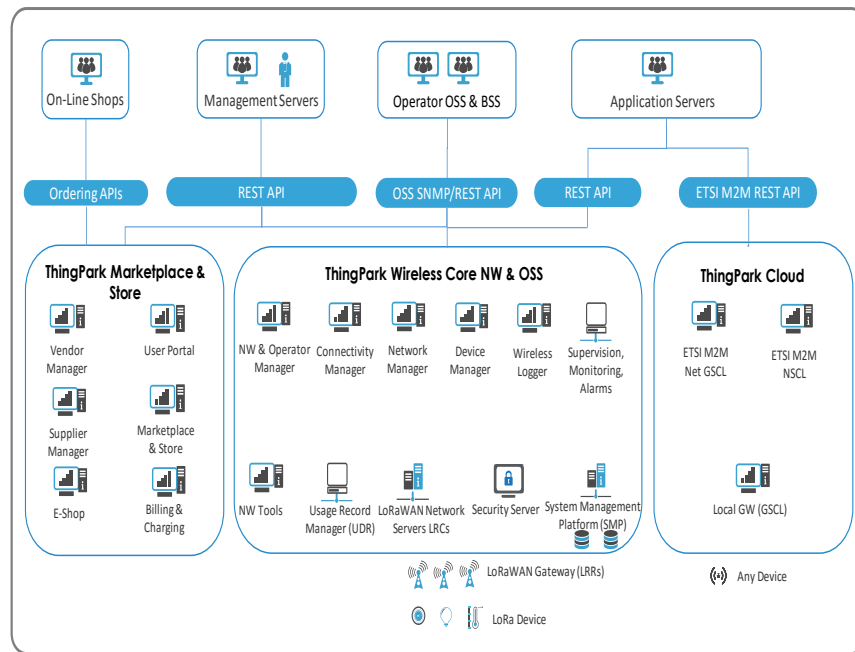
Actility ThingPark – LoRaWAN™ Back-end Platform

LoRaWAN™ End-device Management, Application Enabler and User Portal

- Full-functional turnkey platform
 - Network Server, Application Routing Server
 - Offer OSS/BSS interface through API
 - Support both Cloud and On-premise mode
 - Scalable to SP, multi-tenant and private network
- High usability
 - Multiple portals for network partner, connectivity supplier and device management
 - Market place, eShop
- Powerful engineering and maintenance tools
 - RF planning, Online radio noise scanning

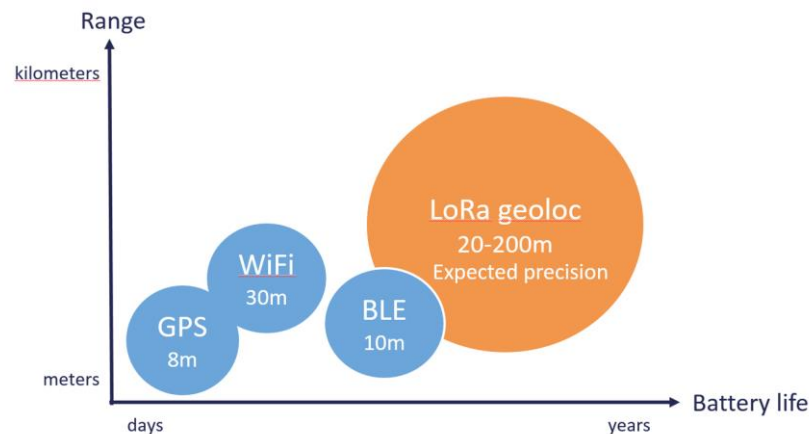


Wireless logger, monitoring, alarms



LoRaWAN™ Geo-Location Overview

- Any uplink demodulated by a gateway is time-stamped with an accuracy better than 30nsec
- When an uplink is received by at least 3 gateways, the position of the transmitter can be estimated by TDOA (Time Difference of Arrival).



LoRaWAN™ Geo-localization Scenario

