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Understanding Cisco's Internet Of Things (IOT) Solutions

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Barcelona | January 27-31, 2020

Agenda

- Introduction
- IoT Building Blocks
  - Connectivity
  - Edge Computing
  - Device Management
- IoT Solutions
  - Cities
  - Power and Utilities
  - Manufacturing and OT
  - Fleet and beyond
- Conclusion + Q&A

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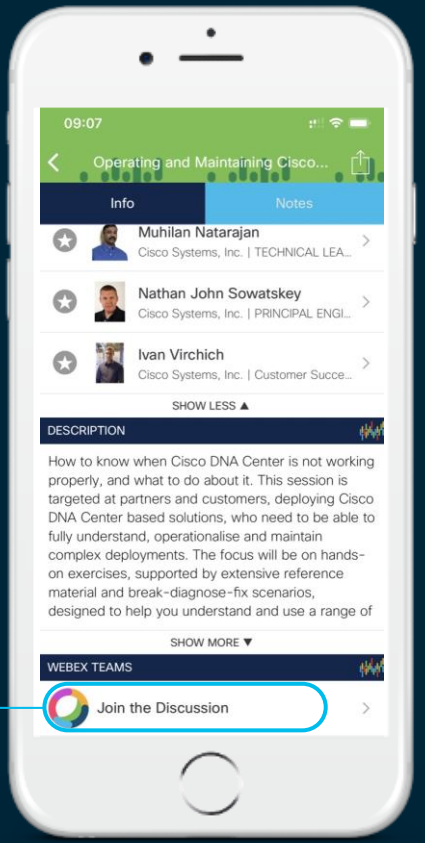
How

1. Find this session in the Cisco Events Mobile App
2. Click “Join the Discussion”
3. Install Webex Teams or go directly to the team space
4. Enter messages/questions in the team space



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Introduction

Conversation starters

"What's the digital roadmap for your city?"

"Do you have a plan for Micro-Grids or for renewables?"

"How much downtime do you experience? What's the cost you?"

"What Industry 4.0 projects are you working on?"

"How much of your factory is connected today?"

"How many networks are you managing ?"

"Where do you see your factory in 5 years?"

Have you looked into 5G or Wifi6?

"What predictive maintenance programs to you have in place?"

"What are you doing in IoT?"

"How are you working with IT today to help transform your factory?"

"How do you address cyber security today?

"Do you have a Grid Modernization initiative?"

"What industrial partners do you work with today?

"What keeps you up at night?"

"Are OT and IT talking with each other?"

"How are you addressing Fleet Optimization"

"How are you doing with Safety, Security and Compliance?"

"What are your most pressing needs from an infrastructure management perspective?"

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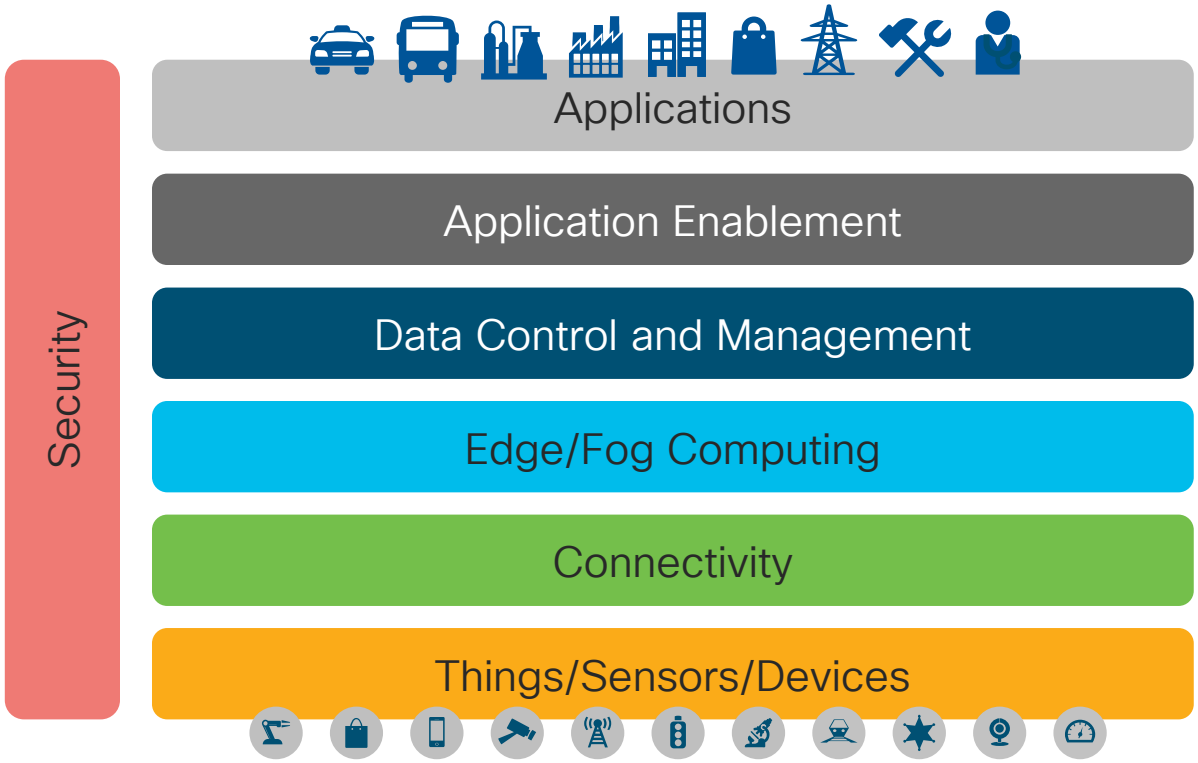
IoT goes beyond traditional networking and DC

- New challenges
- Different requirements
- Different people
- Different priorities
- Different environment
- …



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IoT portfolio overview – building blocks

Industrial Switching

IE 1K,2K,3K,4K,5K, CGS

IoT Gateways

IR500, IR800, IR1100

Industrial Routing

ASR 902/903,
CGR 1000, CGR 2000

Industrial Wireless and Resilient Mesh

AP1552, IW3702, IW6300
WPAN, FAN, IR500

Low Power Wide Area Wireless

LoRaWAN
IXM Gateway

Embedded IoT

ESS, ESR, ESW

Industrial Security

ISA 3000
Cyber Vision

IoT Solutions

CKC, CVD, Extended Enterprise,
RaMa,...

Edge Computing

IOx, IC3000, Edge Intelligence

Management & Automation

Field Network Director,
Kinetic GMM

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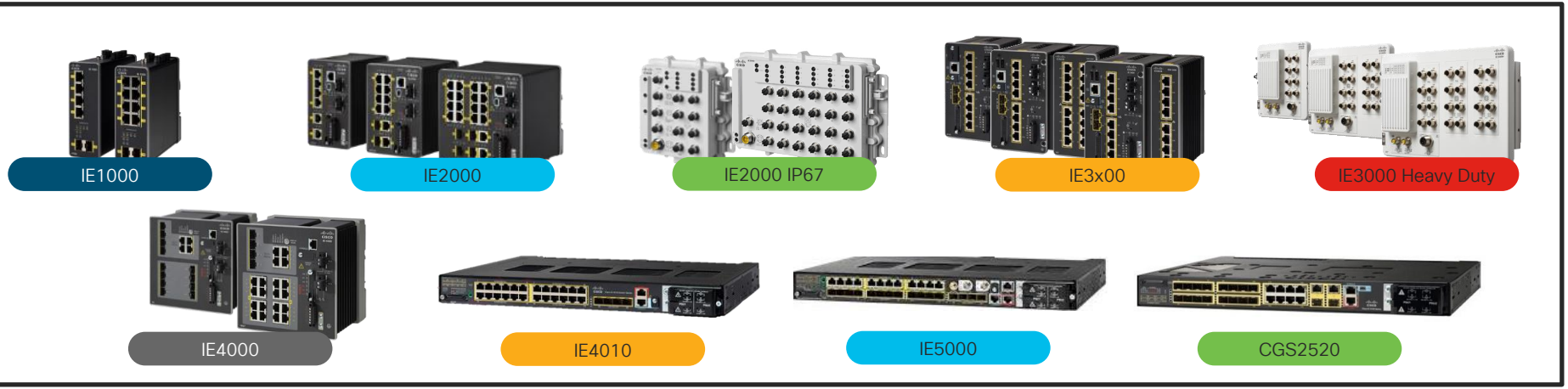
Connectivity

IoT Connectivity – Industrial Ethernet Switches



- Ruggedized, for harsh environments, vibration, shock and extreme temperatures (-40C to 70C)
- Industrial design, compliance and certifications
- Flexible (dual) power input (AC/DC) and PoE+ support*
- Built for Manufacturing, Transportation, Utilities, Oil & Gas, Mining and other ruggedized applications

- Different form factors for different needs: DIN-Rail, rack mount, fixed, modular, copper, fiber, M12
- Industrial protocols support (REP, PTP, MRP, CIP, Profinet, etc.)
- Network security based on open standards and SD-access support
- IOx application hosting

* Feature set is model-specific

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IoT Connectivity – Connected Grid Routers

CGR1240

CGR1120

CGR2010

- Ruggedized modular services routers
- WPAN/Mesh (802.15.4g/e)
- 2G/3G/4G/LTE cellular
- Wi-Fi (management) and GPS-embedded
- Serial ports
- Ethernet Switch
- T1/E1

- Segmentation and prioritization of control and Distribution Automation traffic
- SCADA protocol translation T101/T104
- Raw socket support
- Automatic power failover with BBU or dual power
- Edge computing (IOx) ready
- Industry compliance for utility substations

* Feature set is model-specific

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IoT Connectivity – IoT Gateways

IR807

IR809

IR829

IR1101

- Ruggedized and built for harsh environment – shock, vibration, humidity, temperature and dust
- Industrial certifications and compliance
- Enhanced Security with ACL, VPN, Firewall, Intrusion Prevention, 802.1x
- Seamless integration to SCADA with Raw socket and DNP3 Serial/IP and IEC 60870 T101/T104 protocol translation

- WiFi and PoE (IR 829)
- Serial ports (RS232/RS485)
- GPS, Accelerometer and Gyroscope
- Cellular: 3G/4G/LTE connectivity (dual/single)
- Easy Manageability with Zero Touch Provisioning using Field Network Director, GMM or DNA-C
- Edge Computing (IOx) Capable

* Feature set is model-specific

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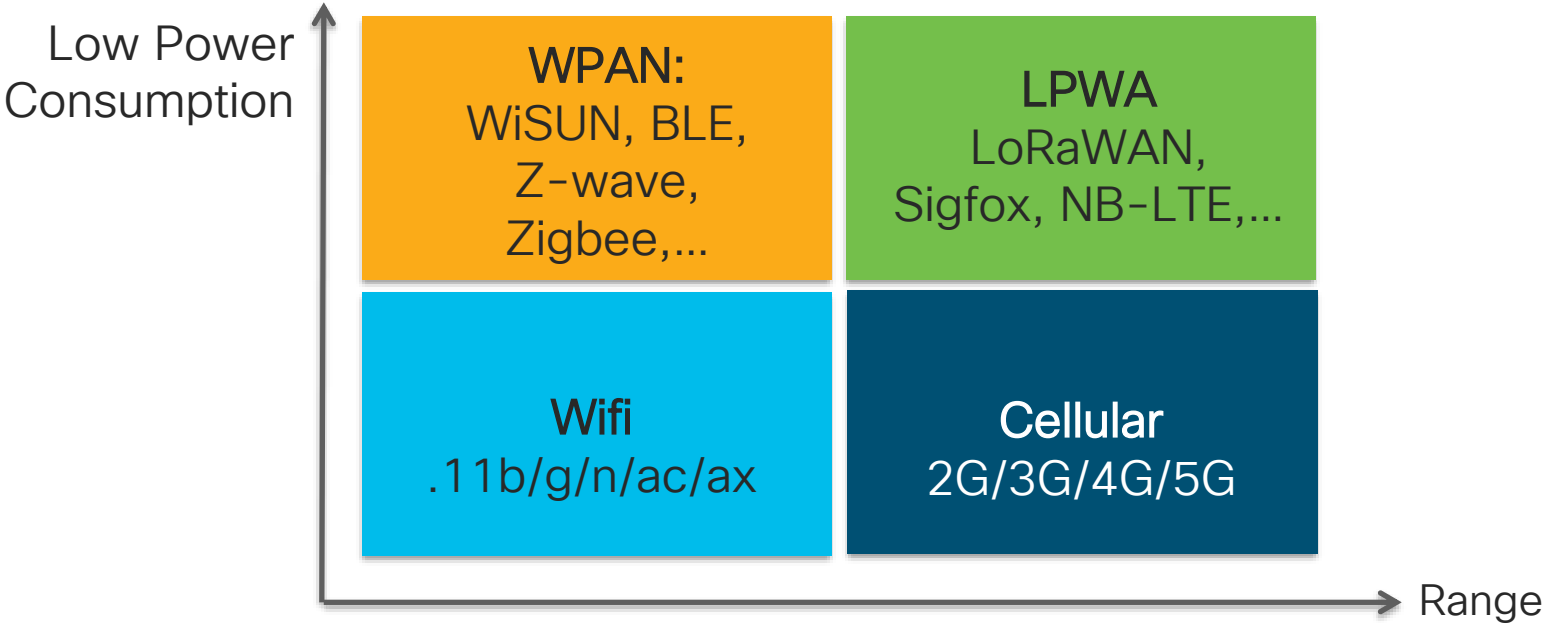
IoT Connectivity - Wireless



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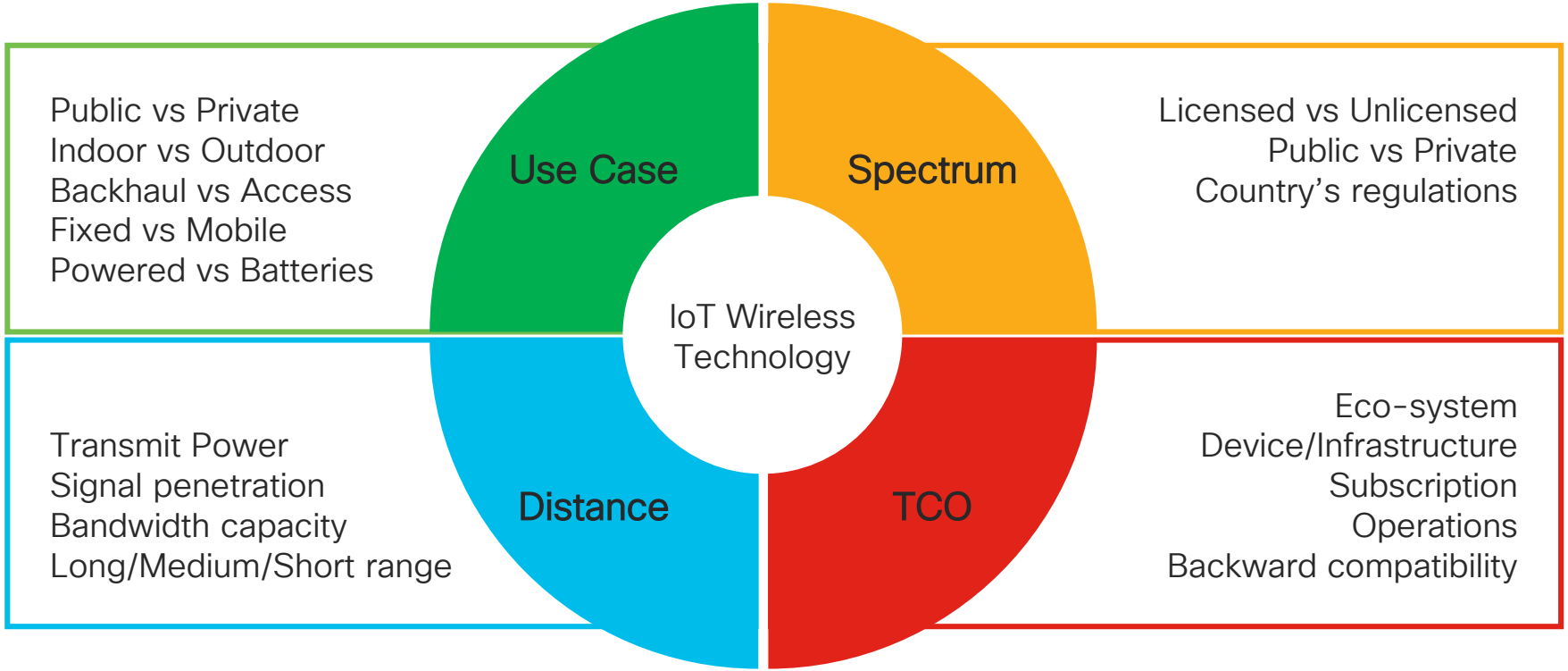
IoT connectivity – Wireless Selection Criteria



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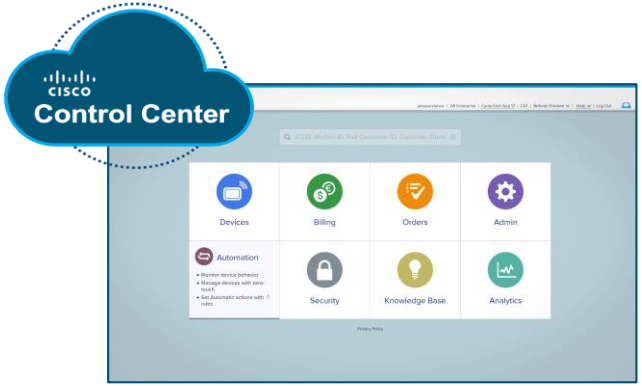
IoT Connectivity – Cellular



GSM/2G/3G/4G/LTE/5G cellular network

- Range: km's Power: high Speed: (Mb/s)
- Operates in licensed spectrum
- Infrastructure: Public (SP)*

5G

Massive IoT (mIoT)
- Device density – up to 1M/km2
- Low power endpoints
- 5G Rel 15/16 – no change to NB-IoT & LTE Cat. M radio technologies

Enhanced Mobile Broadband (eMBB)
- High data rate: > +1Gbs –
- spectrum allocation: sub-GHz, 1-6GHz, and mmWave: countries/SP dependent
- Area traffic capacity – n x Mbs per user/Km2

Ultra-Reliable Low-Latency Communication (uRLLC)
- Low latency – 1-10 ms
- Determinism access
- Multi-Access Edge Computing (MEC)
- Network Slicing

Low power / Density Bandwidth / Capacity Time Sensitive Network / Edge Computing

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IoT Connectivity – 6LoWPAN and Wi-SUN

IEEE 802.15.4g/e Mesh networking with IPv6

- Range: ~1,5 km Power: moderate Speed: kbit/s
- Operates in unlicensed spectrum (*currently no EU868)
- Infrastructure: Private
- Typical use cases: AMI, DA, lighting, oil wells

Connected Grid Field Area Network – Resilient Mesh

IR509

CGM-WPAN-OFDM

IR510

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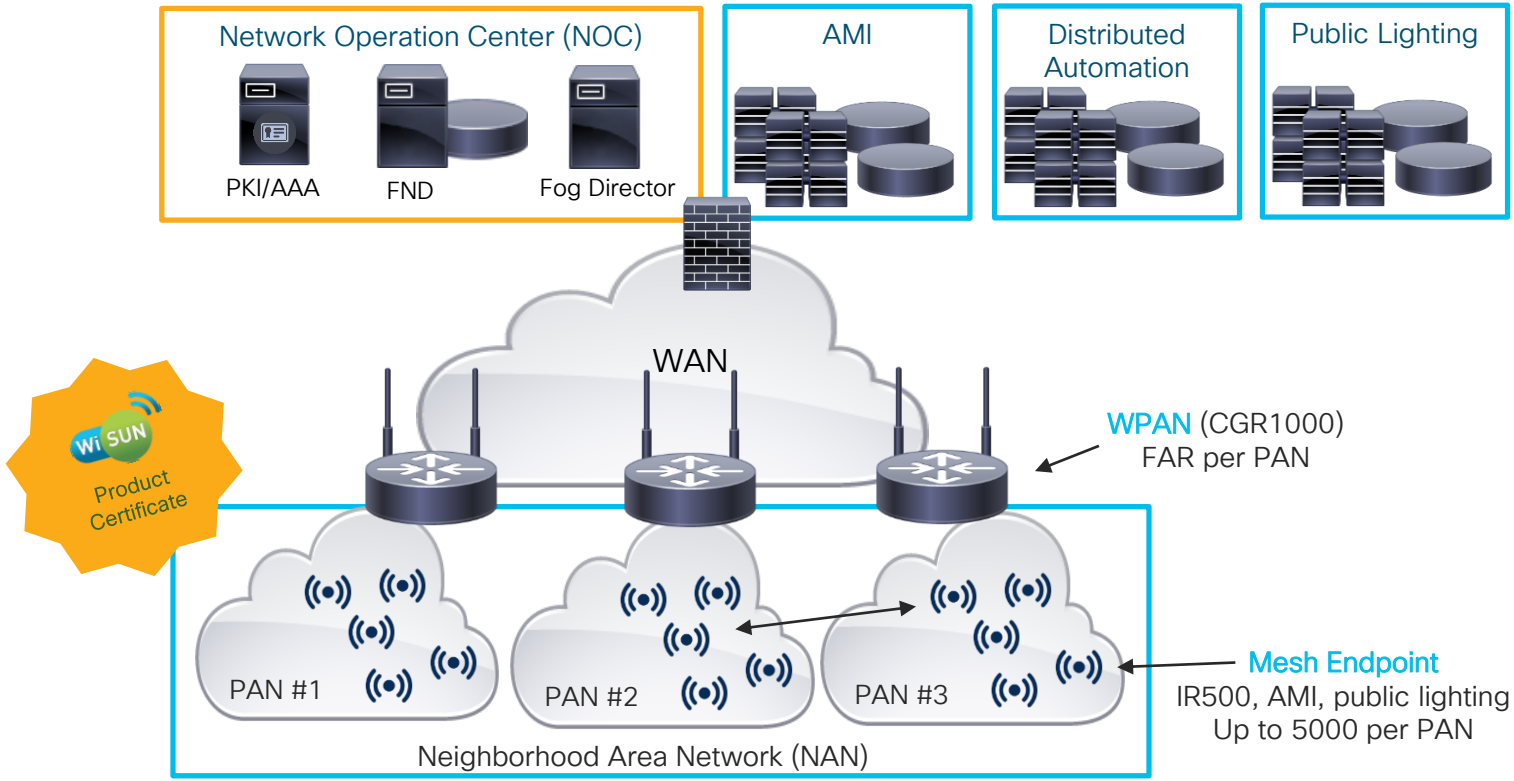
IoT Connectivity – Resilient Mesh



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IoT Connectivity – WiFi

- IEEE 802.11 wireless networking
- Range: km's* Power: high Speed: Mb/s
- Operates in unlicensed spectrum
- Infrastructure: Private
- Wireless Connectivity In Extreme Environments

802.11ax (Wifi6)

- Higher speeds 1024 QAM)
- OFDMA Media Access:
  - Reduced Latency
  - Deterministic capacity
  - Higher Density
- Power efficient: Target Wake Time (TWT)

Wi Fi 6 CERTIFIED™

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IoT Connectivity – LoRaWAN

Long Range, Low power Wide Area Network

- Range: km's Power: very low Speed: b/s (messages/day)
- Operates in unlicensed spectrum
- Infrastructure: public and private
- Localization support

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Cisco Industrial IOT Wireless Summary

	LoRaWAN	Resilient Mesh	WiFi	4G/LTE – 5G
Topology	Point to multipoint	Mesh	Mesh point to multipoint	Point to multipoint
Coverage Range	2k-10km	1.5km per hop up to 8 hops	~50km	10's km
Data Rate	250bs-21kbs	50kbps -1.2Mbps	11Mbs (.b) 1.7 Gbs (.ac W2) 9.6 Gbs (.ax)	27kbs(DL)/65kbs(UL) NB-IOT HDx 300 Mbps (DL)/50Mbs (UL) LTE Cat.6 to 5G (500Mbs UL/5Gbs DL) on today's modem
Public SP vs Private Networks	Private/Public SP	Private	Private/Public SP	Public SP/Private
Battery powered devices	Optimized lifetime (+10 years)	NA	Limited lifetime (months)	NB-IOT provides good lifetime
TCO	Low	Low-Medium	Medium-High	Medium-High

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Why Low Power WAN

Power

Designed for low power, long range, and lightweight data collection IoT use cases

Range

Fills the gap between short-range wireless and cellular communication technologies

ISM or Licensed Band

Licensed band: NB-IoT
Unlicensed ISM (Industrial, Scientific, Medical) band: LoRa, SigFox

End Devices

Battery life of over 10 years,
Outdoor coverage of up to multiple kilimeters,
Low service cost and endpoint complexity

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IoT connectivity – LoRaWAN – use cases

Energy metering
(gas, power, water)

Street lighting

Parking

Tracking
(goods, vehicles, animals)

Traffic Management

Environment monitoring
(sound, temperature, pollution, radiation, humidity)

Smoke detectors

Waste Management

Buildings
(physical security, facility management)

Healthcare
(fall detection, surveillance)

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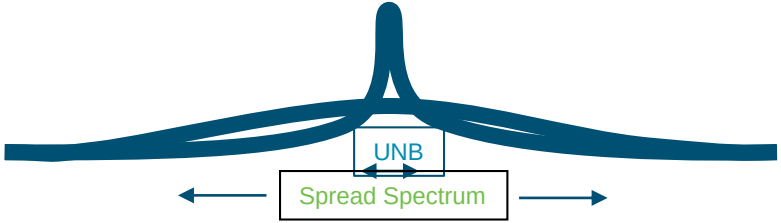
What is LoRa ?

- LoRa is the physical layer or the wireless modulation
- LoRa stands for Long Range
- Cell range can go up to multiple kilometers
- Chirp spread spectrum modulation
- High resistance to natural interference, noise and jamming
- Information is recovered with negative SNR (up to -22dB)
- Developed by Semtech



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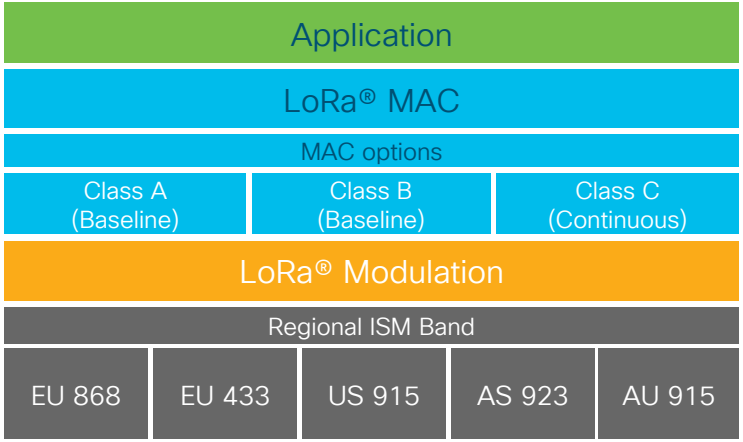
What is LoRaWAN?

- LoRaWAN defines the communication protocol and system architecture
- Optimized for low data rate communications
- Defines the MAC layer:
  - Channel management and
  - Adaptive Data Rate (ADR)
  - Device enrolment, security and encryption
  - Network based localization
  - …
- Defines classes of devices to adapt to different use cases
- Leverages regional ISM bands: suitable for private network deployment



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LoRaWAN™ characteristics

LoRaWAN™	
Sponsoring Entity	LoRa Alliance
Spectrum	ISM Band (868/915 MHz and subsets)
Radio Technology	CSS (Chirp Spread Spectrum)
Standard	LoRaWAN™ Specification
Commercial Availbility	Now
Business Strategy	Create strongest ecosystem for higher-tier unlicensed LPWA through open IoT alliance
Marekt Positioning	SPs (Cellular and Cable) Private Networks (Enterprise)

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ADR, Spreading Factor and Payload

Spreading Factor	Data rate (bit/s)	Time on Air (ms)	Maximum Payload Size	End-device sensivity (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

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LoRaWAN™ End Device Classes

Device Class	Intended usage
A « all »	Very suitable for lowest powered devices with no latency constraint Most energy efficient communication class. Must be supported by all devices Class A must initiate a TX before listening on RX windows
B « beacon »	Suitable for battery operated devices Energy efficient communication class for latency controlled downlink. Based on slotted communication synchronized with a network beacon (from gateways). Class B Bi-directional with scheduled receive slots (Beacons) Implements Class A plus… Open extra receive windows at scheduled times
C « continuous »	Powered devices which can afford to listen continuously. No latency for downlink communication. Implements Class A RX1 window plus… Continually listens on RX2 channel, only closed when TX

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LoRaWAN™ Security

Mutual Authentication between Network Server and end-device

End-to-End encryption between Application Servers and end-devices

AppNKey is used to encrypt network management traffic

AppSKey is used to encrypt data

Each LoRaWAN device is personalized with unique 128 bit AES key (AppKey)

Both AppNKey and AppSKey are generated using AppKey

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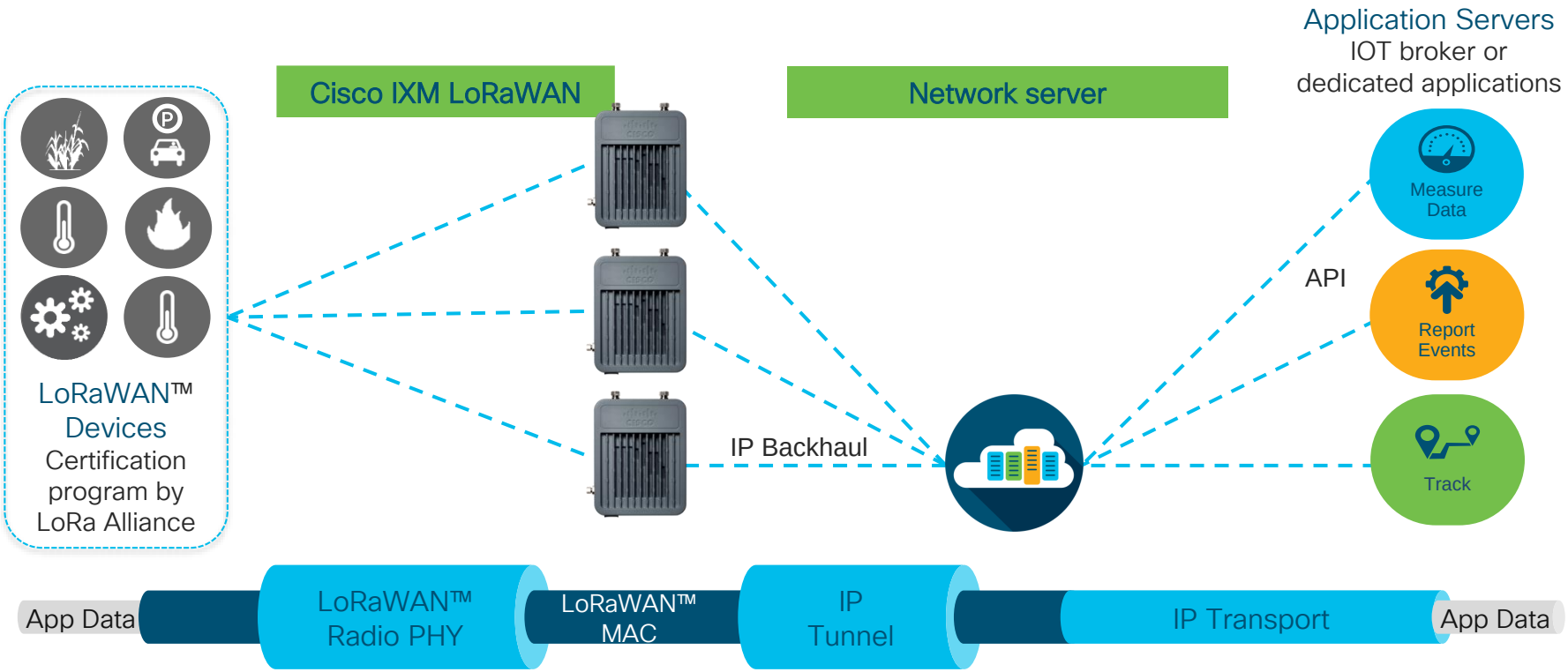
LoRaWAN Network Architecture



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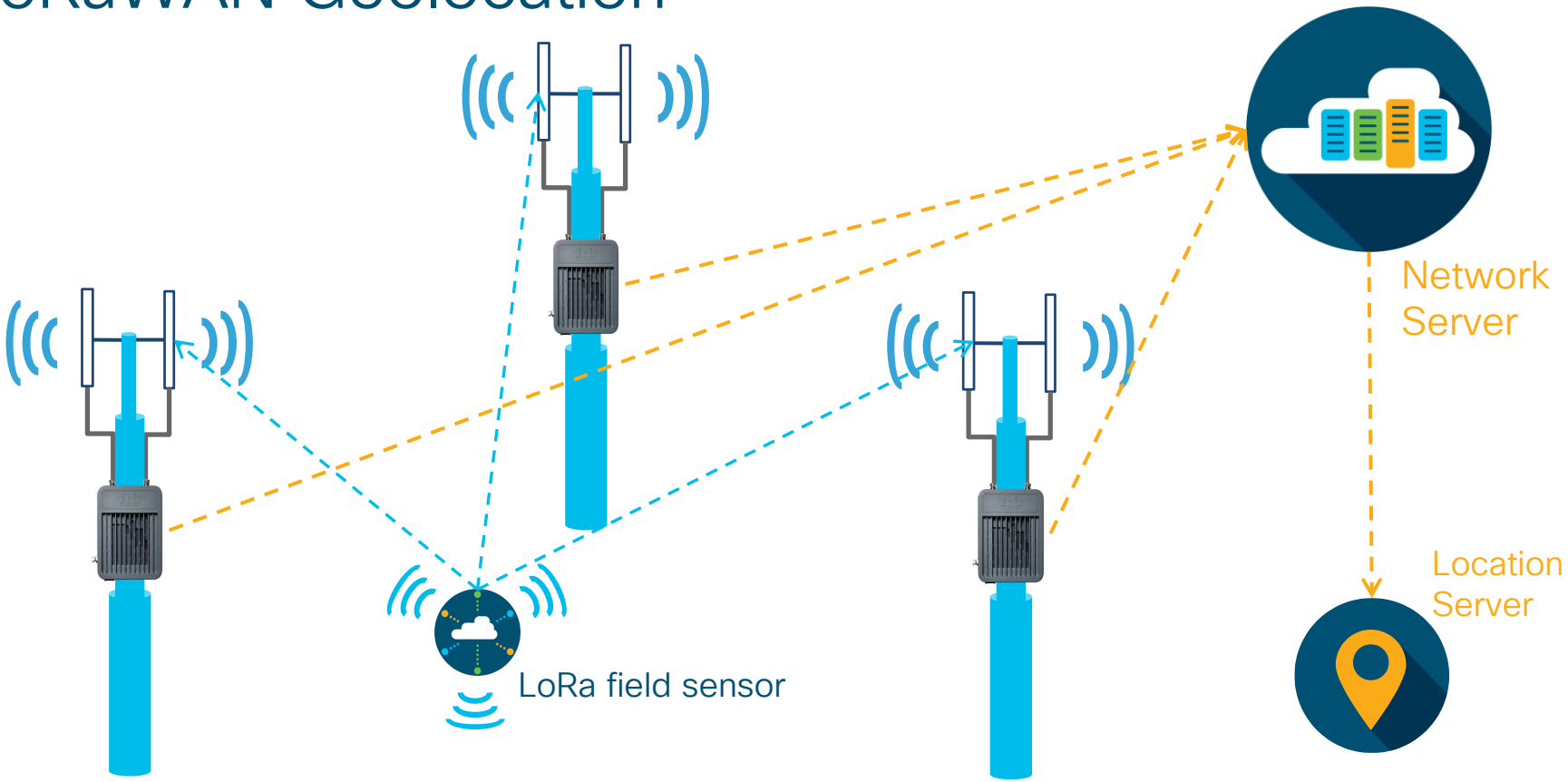
LoRaWAN Geolocation



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Cisco LoRaWAN Gateway: IXM

- Carrier-grade, designed for high reliability, IP67 rated, PoE+ or DC power input, GPS, Main and diversity antennas
- Supports up to 16 uplink channels
- Geolocation capability using TDoA and RSSI
- Can be managed by Cisco Field Network Director (FND)
- Flexible deployment:
  - Ethernet backhaul: Standalone mode
  - LTE/Wifi/Ethernet backhaul: Virtual mode: connected/controlled from IR800/ CGR1000

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Cisco LoRaWAN Packet Forwarders

Actility Packet Forwarder

- Developed by Actlity
- Works only with Actlity Network Servers
- Supported by Cisco

Common Packet Forwarder (CPF)

- Based on Semtech latest Basic Station LNS protocol
- CPF is a licensed feature in IXM
- Available starting from release 2.0.35
- Supported by Cisco

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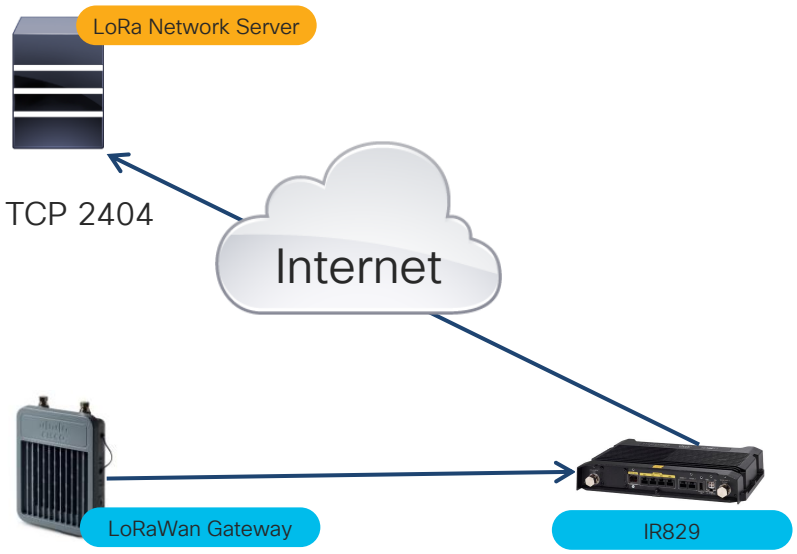
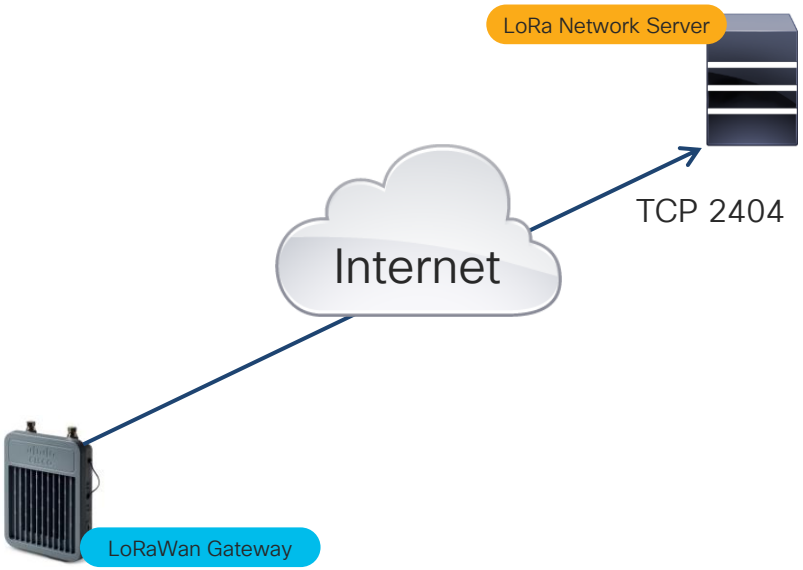
Cisco IXM single unit deployment modes

Virtual Interface Mode



Standalone Mode



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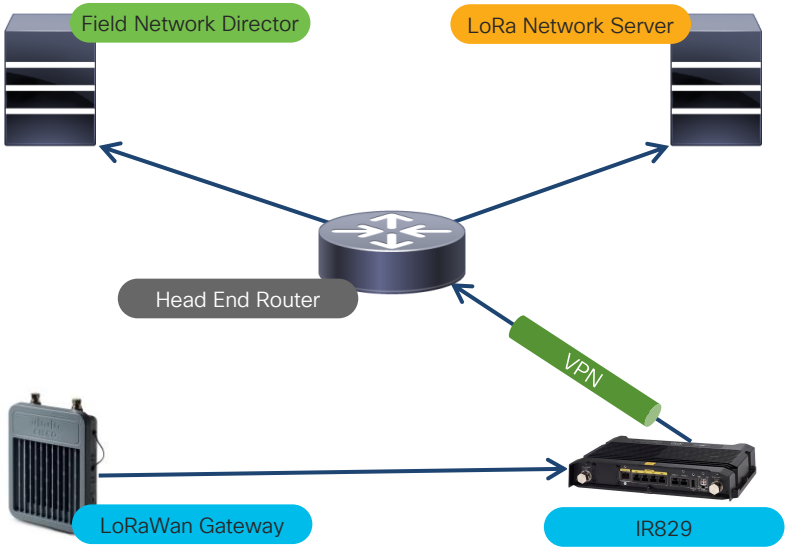
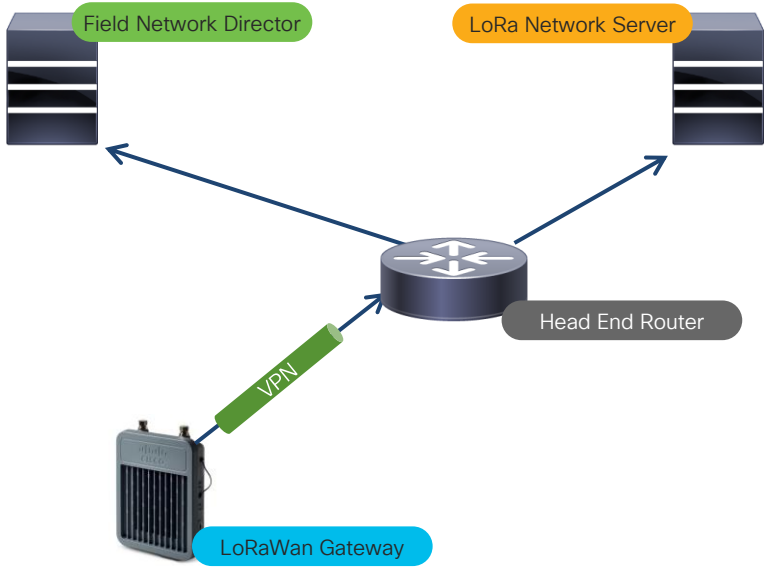
Cisco IXM mass deployment modes

Virtual Interface Mode



Standalone Mode



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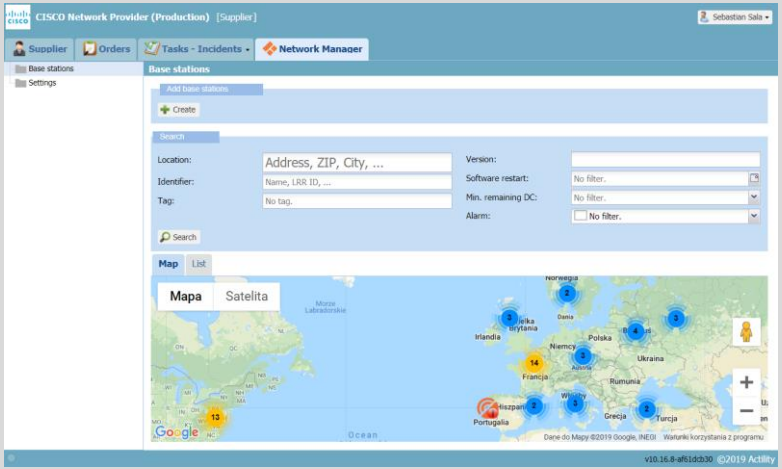
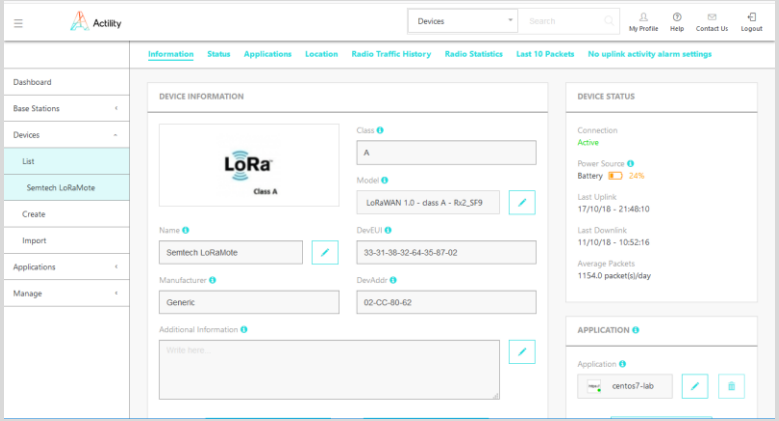
Actility Network Servers

ThingPark Wireless



ThingPark Enterprise



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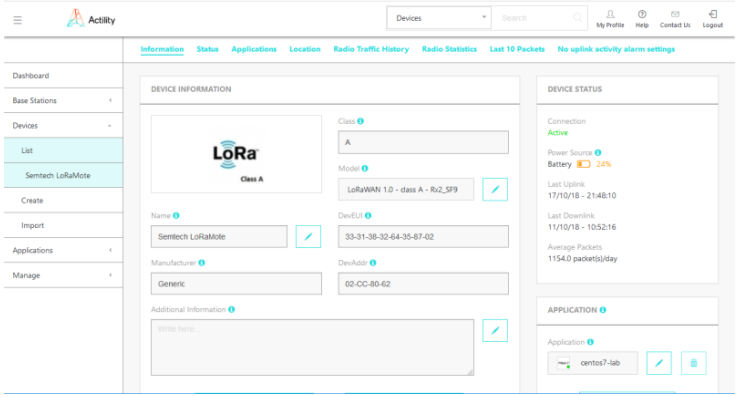
LoRaWAN - Summary

- Use case
  - Gathering data from network of battery powerred devices
  - Geolocation of assets
- Outcomes
  - Simple deployment (Cloud Network Server or VMWare OVA)
  - Low cost (uses free ISM band, end devices are cheap)
  - Low power use
  - Long end node battery life (years)
  - Long range



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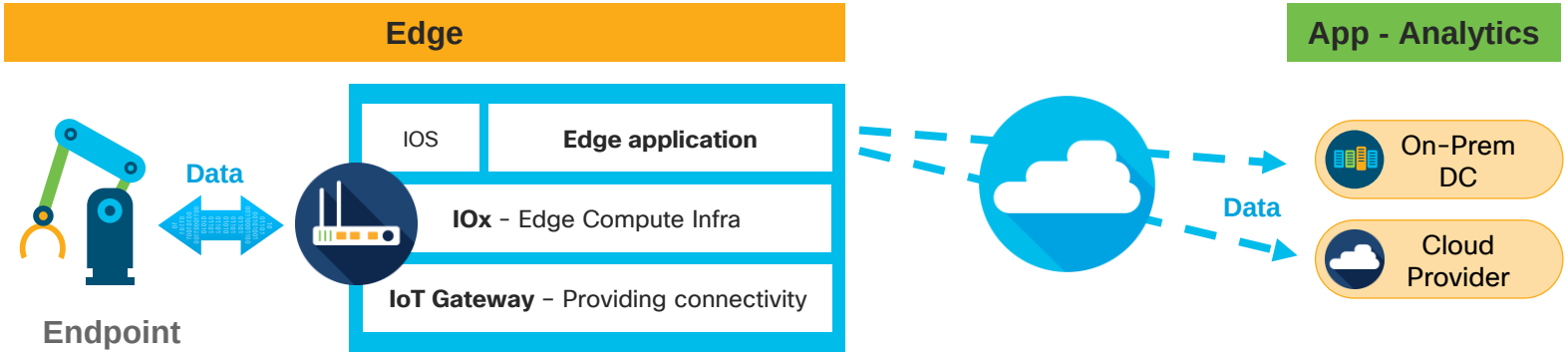
DEMO - LoRaWAN

Edge Computing

Edge Computing

Near-edge, decentralized processing of data



Take processing to the data to improve latency and reduce bandwidth requirement

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Why compute at the edge?

There may not be enough network bandwidth	Data reduction
Most of the data is not interesting	Filtering
The use of data may be at the edge	Latency optimization
Computation can be optimized for some purposes	Partitioning
Data normalization	Application simplification
Data redirection based on the content of the data	Dynamic changes

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Edge computing - use case examples

Traffic control and driver safety

Collect data from vehicle and weather sensors to control traffic lights and display warning dashboard

IC3000

Reduce machine downtime

Collect machine data and perform analytics to eliminate machine down time

IR829

Fleet management

Real-time Telemetry for operational efficiency and driver analysis

IR829

Secondary substation automation

Remotely configure and operate Virtual SCADA for telemetry and automation

IR1101

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Cisco IOx

Edge Computing

Cisco IOx

- Enables hosting applications and services at network edge
- Available on different Cisco hardware platforms
- Full application life cycle:
  - Development
  - Distribution and Deployment
  - Hosting
  - Monitoring and Management
- Leverage secure connectivity of Cisco IOS
- On-prem or cloud-based management

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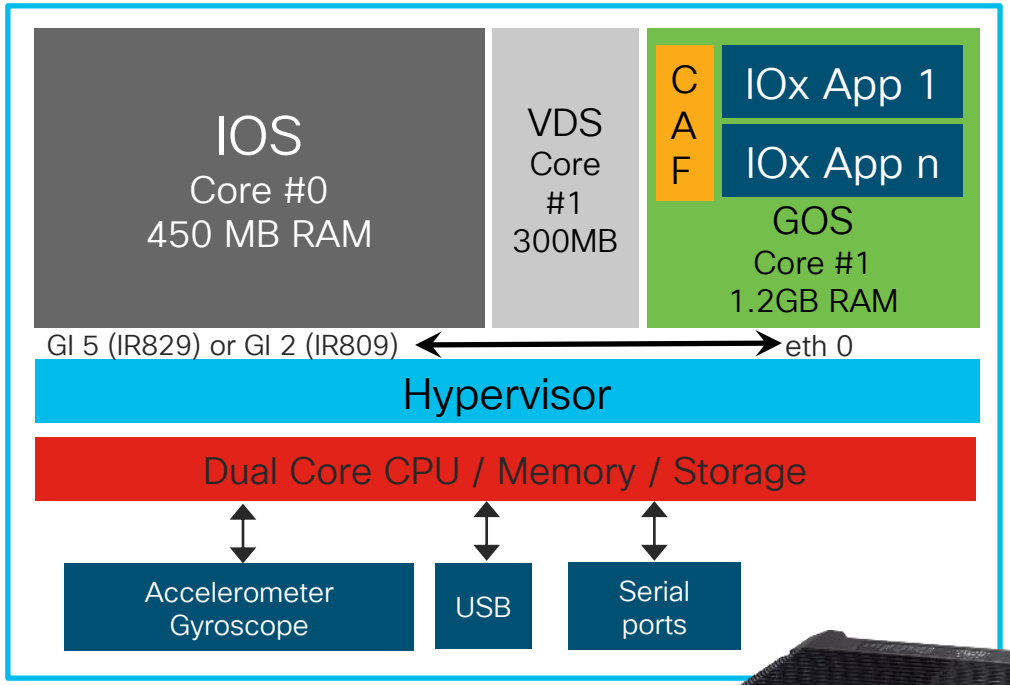
Cisco IOx – Architecture example (IR829)



- Type 1 Hypervisor running directly on the IR800 hardware
- Virtual Device Server (VDS) – handles device's sharing, eg. Console, USB,…
- Guest-OS (GOS) hosts IOx applications
- Full isolation between IOS and GOS
- Communication through internal virtual Ethernet connection

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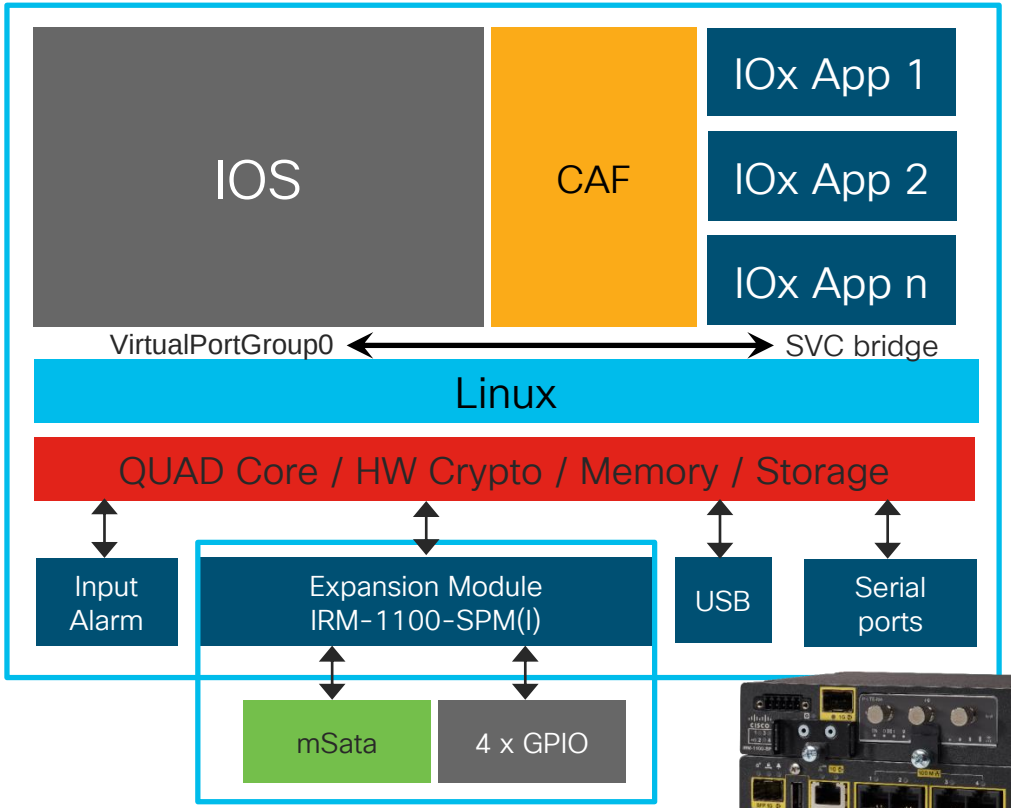
Cisco IOx – Architecture example (IR1101)



- IOS running on Linux
- CAF (Cisco Application Framework) running as a process
- CAF controls IOx applications and resources
- L3 IOS communication through internal VirtualPortGroup
- vNIC per application/container
- CPU Architecture: ARM 64v8

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Cisco IOx – Portfolio

Compute Gateway

Dedicated compute gateway designed to be fully secure and remotely managed

IC3000

Network with Edge compute

Lower TCO with integrated network and edge-compute functionalities. Extensive coverage of connectivity options (cellular, WiFi, Ethernet, Low power Mesh etc.)

IR809

IR1101

IR829

Catalyst IE3x00

CGR 1120, 1240 & compute module

Purpose-build for Industrial environments

Ruggedized | Built for IoT | Industries Certified

Proven Cisco Technology

Intent-based Networking to the IoT Edge

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Cisco IOx – IoT platform hardware overview






	IE4000	IR8x9	IR1100	CGR 1000	IE3400	IC3000
Ruggedized HW	IP30 -40° C to +70° C	IR809: IP30 IR829: IP40 -40° C to +60° C	IP30 -40° C to +60° C	CGR1120: IP30 CGR1240: IP67 -40° C to +70° C	IP30 -40° C to +75° C	IP30 -40° C to +60° C
Architecture	PPC32	X86_64	ARMv8	X86_64	ARMv8	X86_64
CPU	PowerPC ~600 MHz 1 dedicated core for IOx	Intel Rangeley 1.25GHz 2-core with 50% of one core to IOX	Marvell 4-core ARMv8 Cortex-A72 CPU, 1.2GHz	4-Core 800Mhz AMD Gx-410VC on Compute module	4-core Zynq UltraScale+ ARMv8 Cortex-A53 - 1.2GHz	Intel Rangeley 1.25GHz 4-core
Memory	512 MB	2GB with 760MB for IOX	4GB with 2GB for IOX	4GB	4GB with 2GB for IOX	8GB
Storage mSATA for R/W longevity	256 MB flash storage	512MB-1.5GB storage, 50-100GB (mSATA SKU)	4 GB with 2 GB reserved for IOx	64 (50)- 128 (100) GB mSATA	2 GB + SD	64 -128 GB mSATA

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IOx Application Packages

- Compressed packages of code or binaries that can be deployed to the Cisco Application Hosting Framework (CAF)
- Different types of applications depending on your needs
  - Docker container based
  - Platform as a Service (PaaS)
  - Linux Container (LXC)
  - Kernel Virtual Machine (KVM)
- IOx application package :
  - Package Descriptor
  - Package Configuration
  - Binaries, code, libs, virtual disks, root FS, images
- Different architectures: x86, ARM, PowerPC

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IOx Application Packages

- Lifecycle: Deployed – Activated – Running
- Package descriptor: package.yaml
  - Required resources
  - Required devices
  - Network configuration
  - Command to run
  - …
- config.ini: Configuration bootstrapping
- activate.json: Set activation options

Example package.yaml

```
descriptor-schema-version: "2.2"

info:
  name: "iox_docker_pythonweb"
  description: "simple Python Webserver"
  version: "1.0"
  author-link: "http://www.cisco.com"
  author-name: "Jens Depuydt"

app:
  cpuarch: "x86_64"
  type: docker
  resources:
    profile: c1.small
    network:
      -
        interface-name: eth0
        ports:
            tcp: [9000]

  startup:
    rootfs: rootfs.tar
    target: ["python","/webserv.py","9000"]
```


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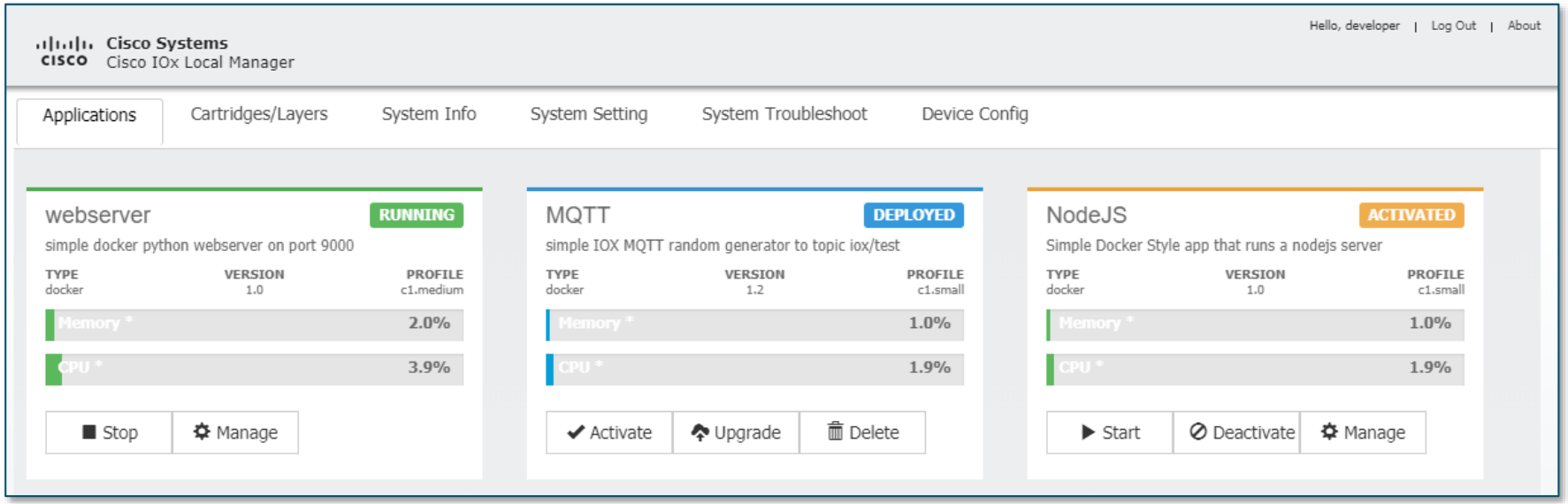
IOx Application Packages – Local Manager

Local IOx application management with GUI

Deploy, activate, start and troubleshoot IOx application packages for a single device



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IOx Application Packages – ioxclient

- CLI tool to manage IOx on devices
- Can be used to package apps
- OS X, Windows, Linux

```
[jedepuyd@cen7 ~]$ ioxclient app list
Currently active profile :  lab
Command Name:  application-list
Saving current configuration
List of installed App :
 1. webserver  --->    RUNNING
 2. MQTT       --->   DEPLOYED
 3. NodeJS     --->  ACTIVATED
[jedepuyd@cen7 ~]$ ioxclient app stop webserver
Currently active profile :  lab
Command Name:  application-stop
App webserver is Stopped
```


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Docker on IOx

Deploying a Docker container to IOx:

Before IOx AC9:

Docker -> IOx package (ioxclient) -> LXC container with libvirt lxc driver

After IOx AC9:

Docker -> IOx package (ioxclient) -> Docker container on Docker daemon

After IOx AC10:

Docker -> Docker container on Docker daemon

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Docker on IOx

App packaged in docker, then packaged again in LXC	Natively packaged in Docker
Needs cisco-specific toolchain (ioxclient)	Uses Docker client, ioxclient not needed
Very difficult to test (package, deploy, activate, start)	Can instantly run containers at the edge with single command and debug real-time

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DEMO – IOx

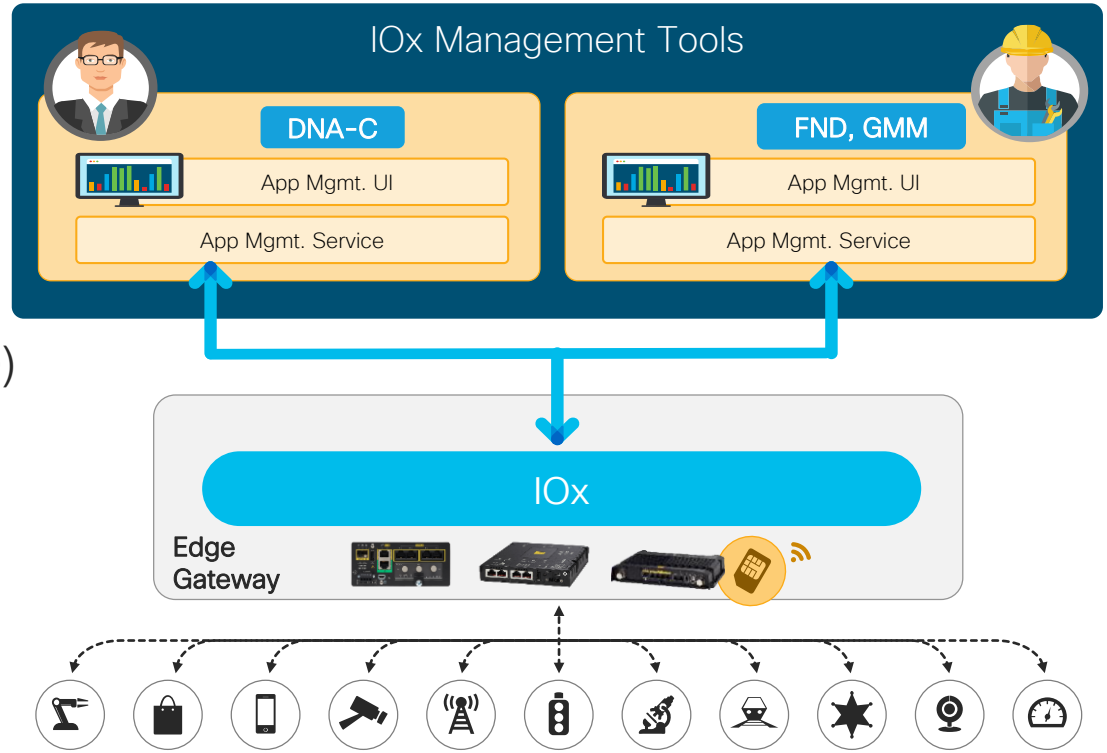
Cisco IOx – Mass Deployment

Single GW:

- Local Manager
- ioxclient

Mass:

- Field Network Director (FND)
- Kinetic GMM
- DNA-C



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Edge Intelligence

Edge Computing

Edge computing – Access and scale IoT data

Remote Site Locations

75% of data processed at edge

Heterogenous Environments

Thousands of protocols

Many Application Locations

Multiple applications need the same data

Multi-vendor Integration

Up to six vendors (and multiple boxes)

Labor intensive, expensive, long lead times

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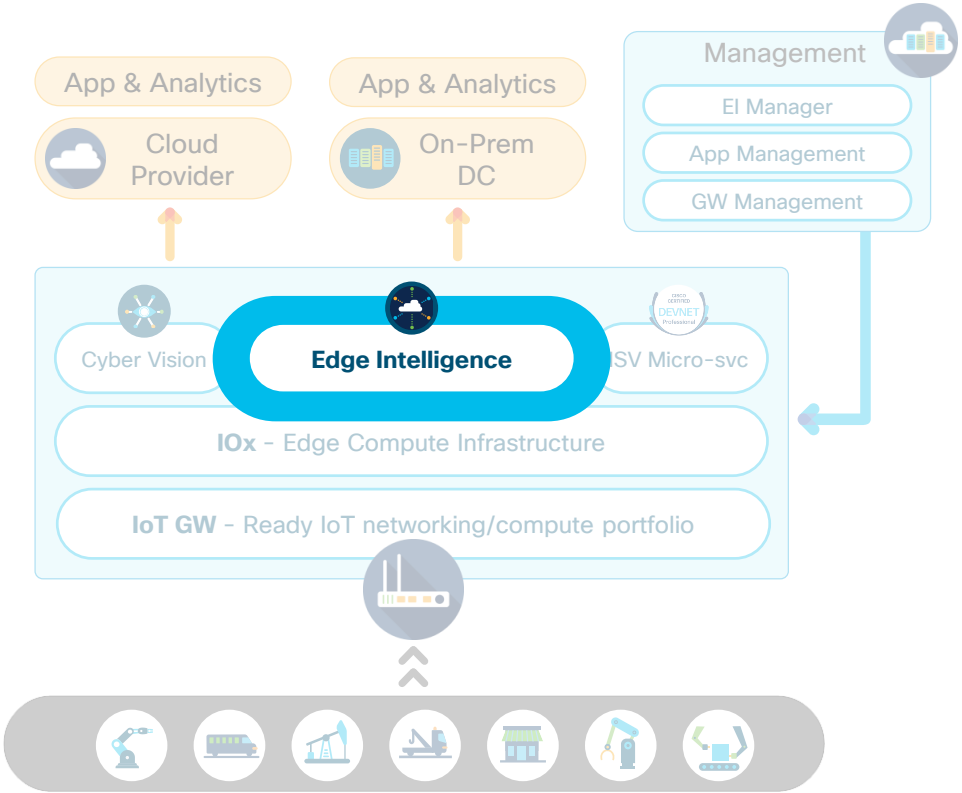
Cisco Edge Intelligence



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Unlocks business intelligence
by simplifying the edge to multi-cloud data flow

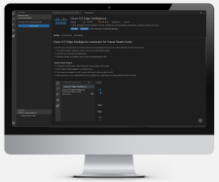
Extract
Pre-Integrated with Solution

Transform
Converting raw data to intelligence

Govern
Control flow of raw and transformed data

Deliver
Pre-integrated for secure delivery

Modbus
OPC UA
MQTT
...



Built on industry's well accepted & developer-friendly tools

Policy control at device or attribute level on raw or transformed data

Microsoft Azure
software AG Freedom as a Service
Quantela
MQTT
... more to come

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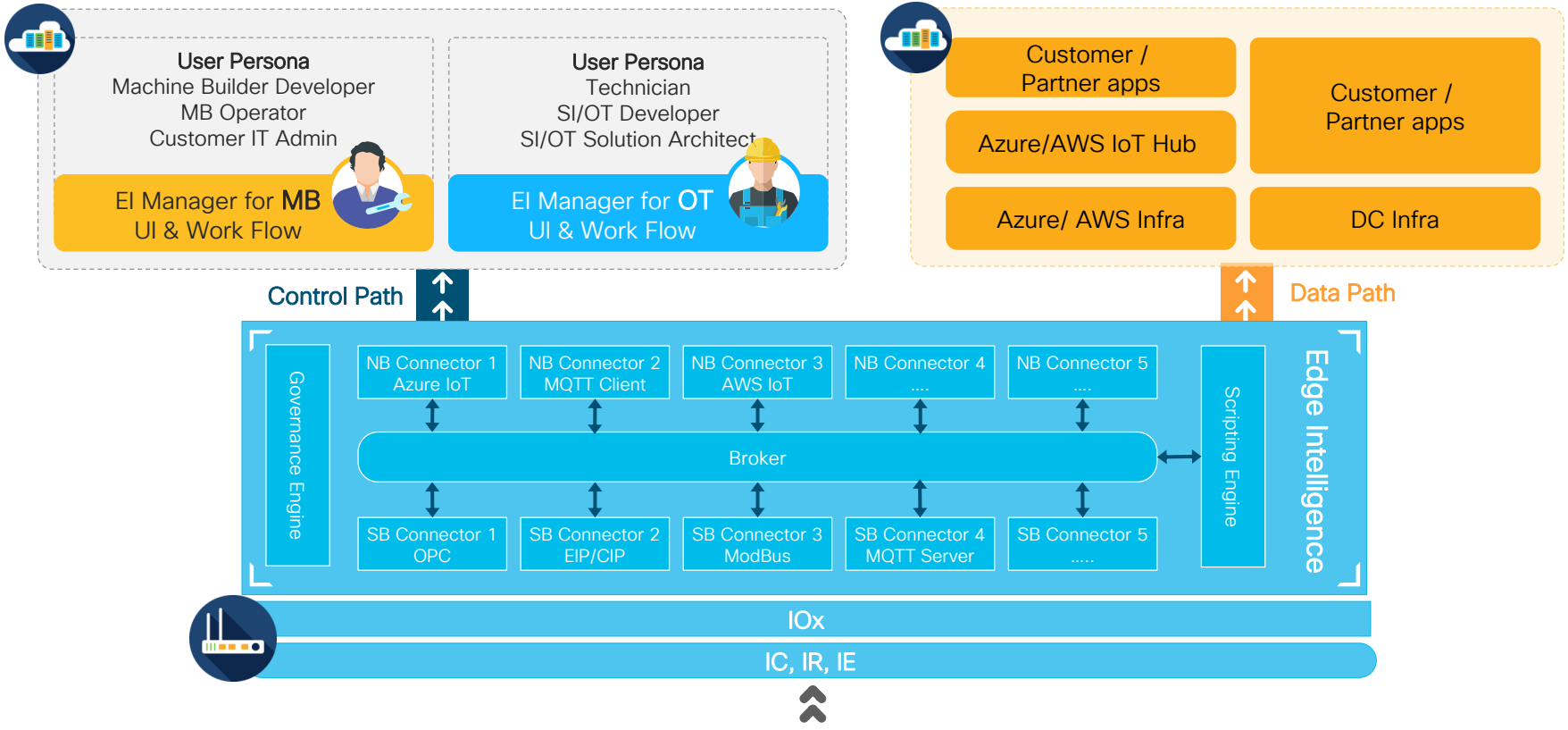
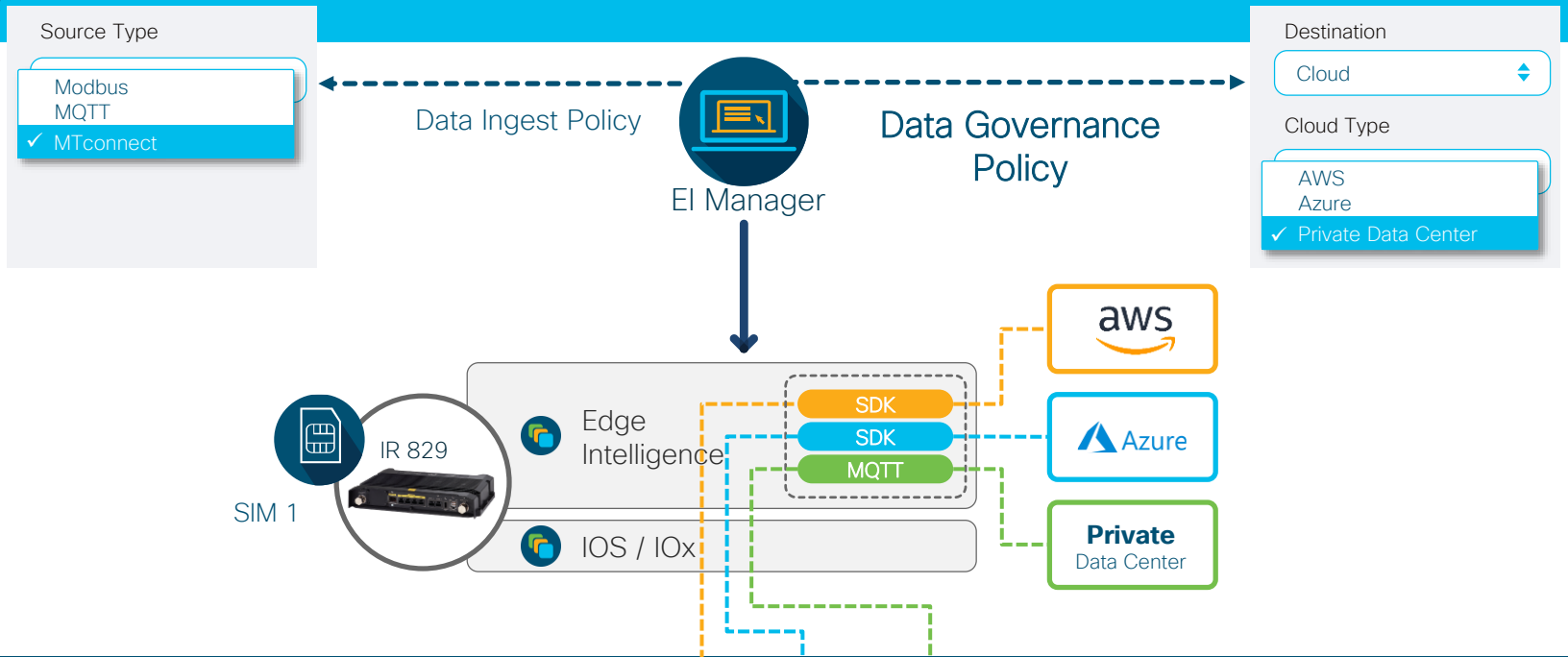
Cisco Edge Intelligence



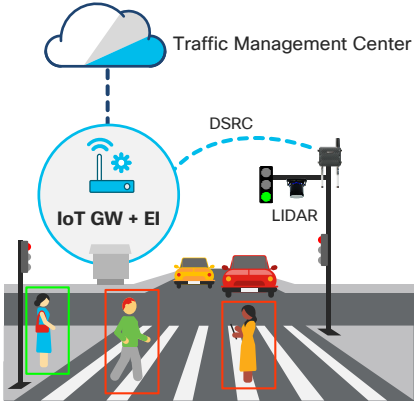
Cisco Edge Intelligence – Data Governance

Neutral Data Governance in a multi-destination, multi-app, multi-user world



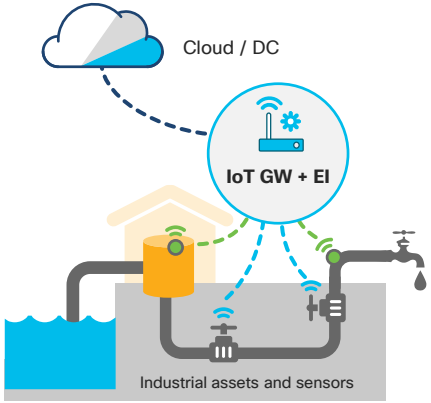
Cisco Edge Intelligence – Use case examples

Roadway Intersection



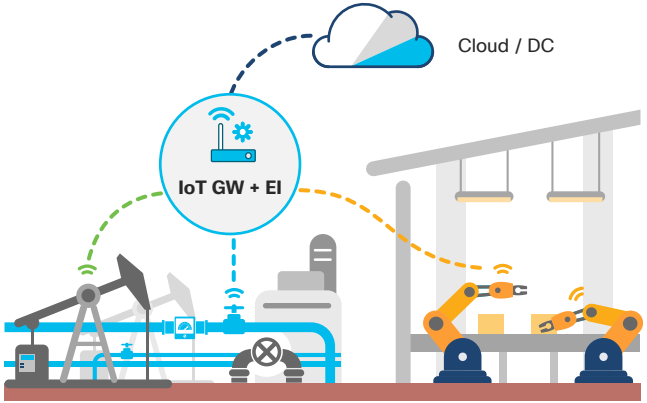
- Pedestrian Safety
- Smooth Traffic Operations

Water Distribution



- Enabling drinking water to world population
- Operational Cost Savings

Distributed Industrial Asset Monitoring



- Operational Efficiency in O&G (pipeline, oil field assets)
- Operational predictability in job shops (connected machines)
- …

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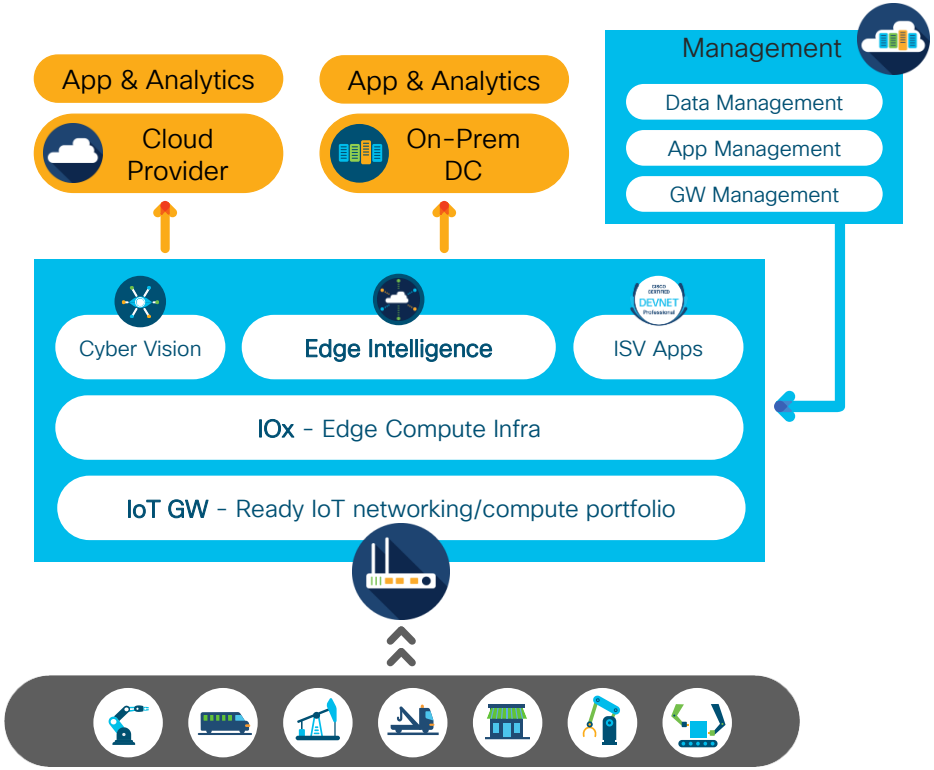
Cisco Edge Intelligence

SIMPLE: Out-of-the-box, scalable deployment with security

FLEXIBLE: Tools for multitude of edge compute options

SCALABLE : Partner ecosystems cloud/platform/apps partners



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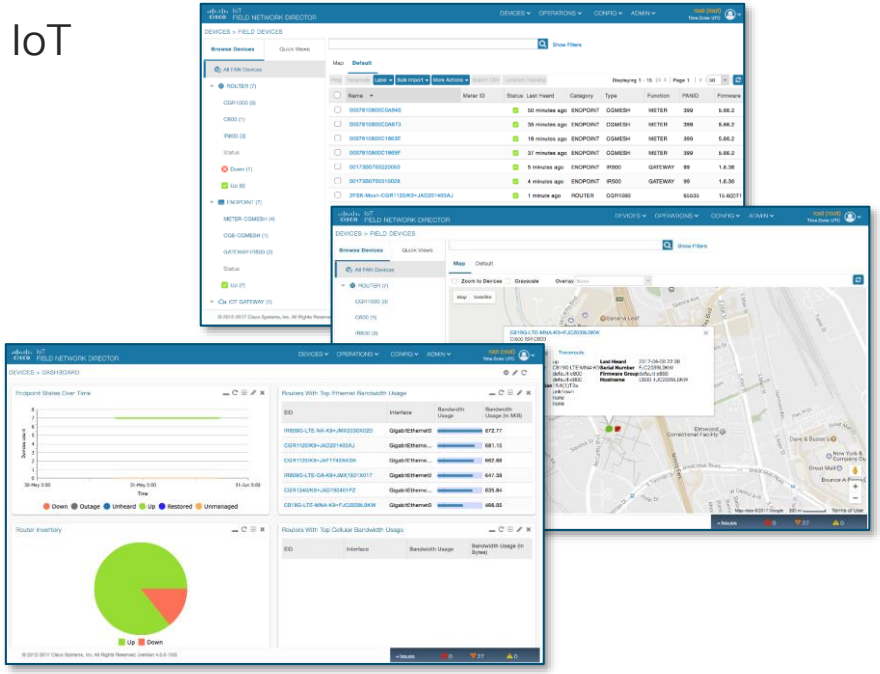
IoT Device Management

Field Network Director

IoT Device Management

What is Field Network Director (FND)?

- Network Management System for FAN and IoT
- Secure zero touch deployment (ZTD)
- Real-time device and endpoint monitoring
- Geographical visualization of assets
- Field device lifecycle management
- API for 3rd party integration
- Scales up to millions of devices
- On-premise



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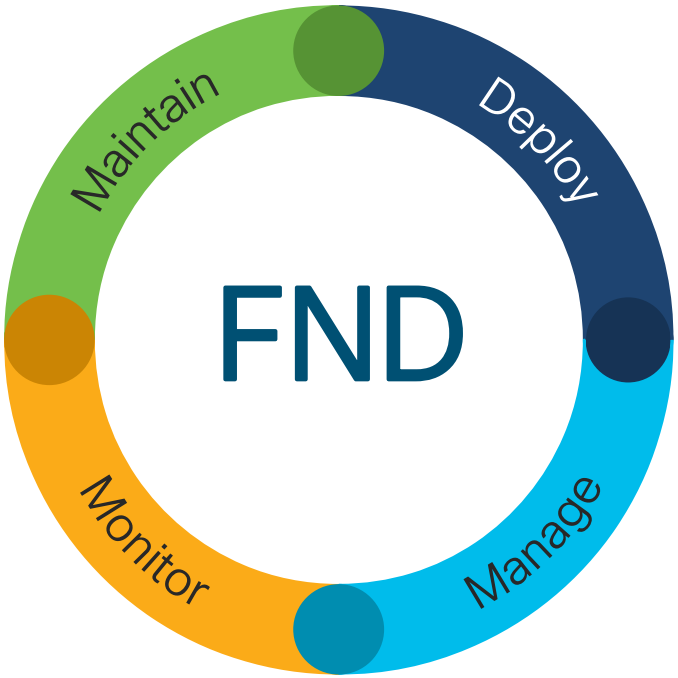
FND Full Lifecycle Management



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FND Functionality

Deploy

- Automatic enrollment and provisioning
- Secure tunnel provisioning
- Zero-touch deployment

Manage

- Configuration and network management
- Troubleshooting
- API for 3rd party integration

Monitor

- Realtime monitoring & alerts for critical events
- Location tracking & geo fencing
- Customizable dashboard

Maintain

- Over-the-air configuration and firmware management
- Reconfiguration and Field engineer support

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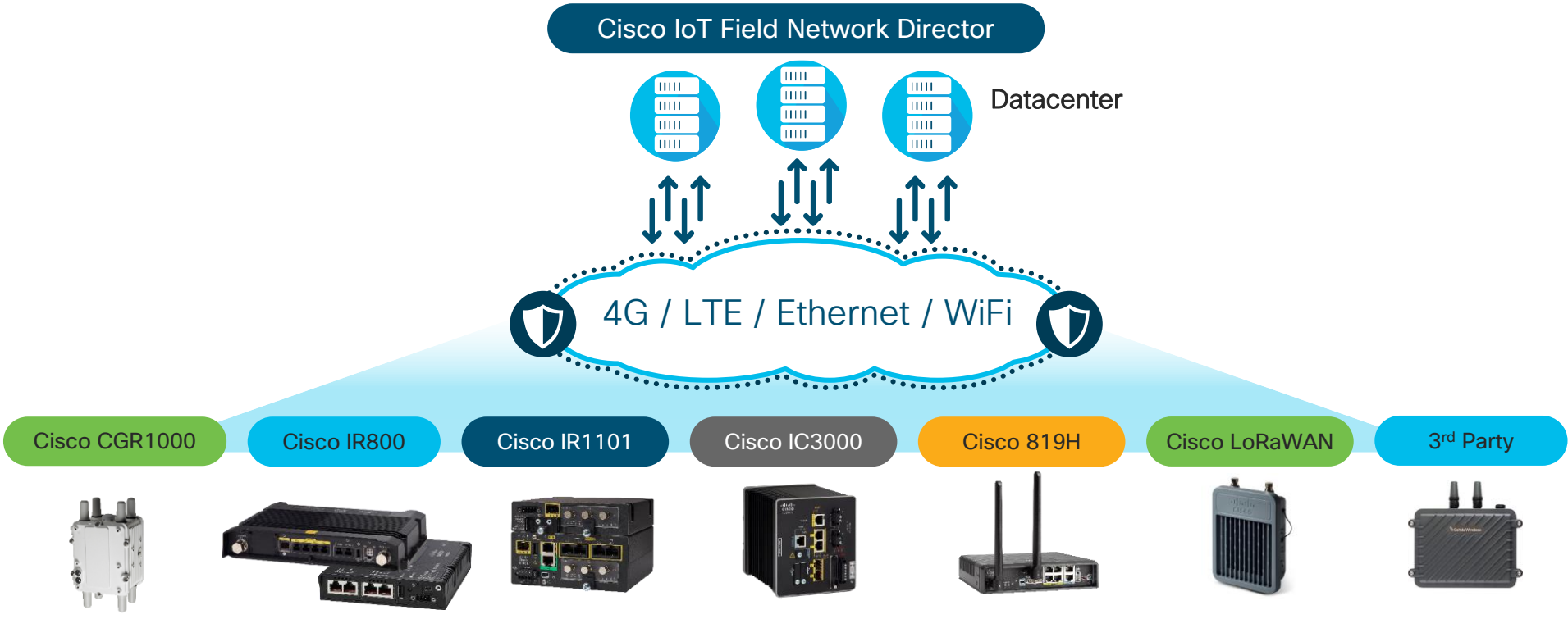
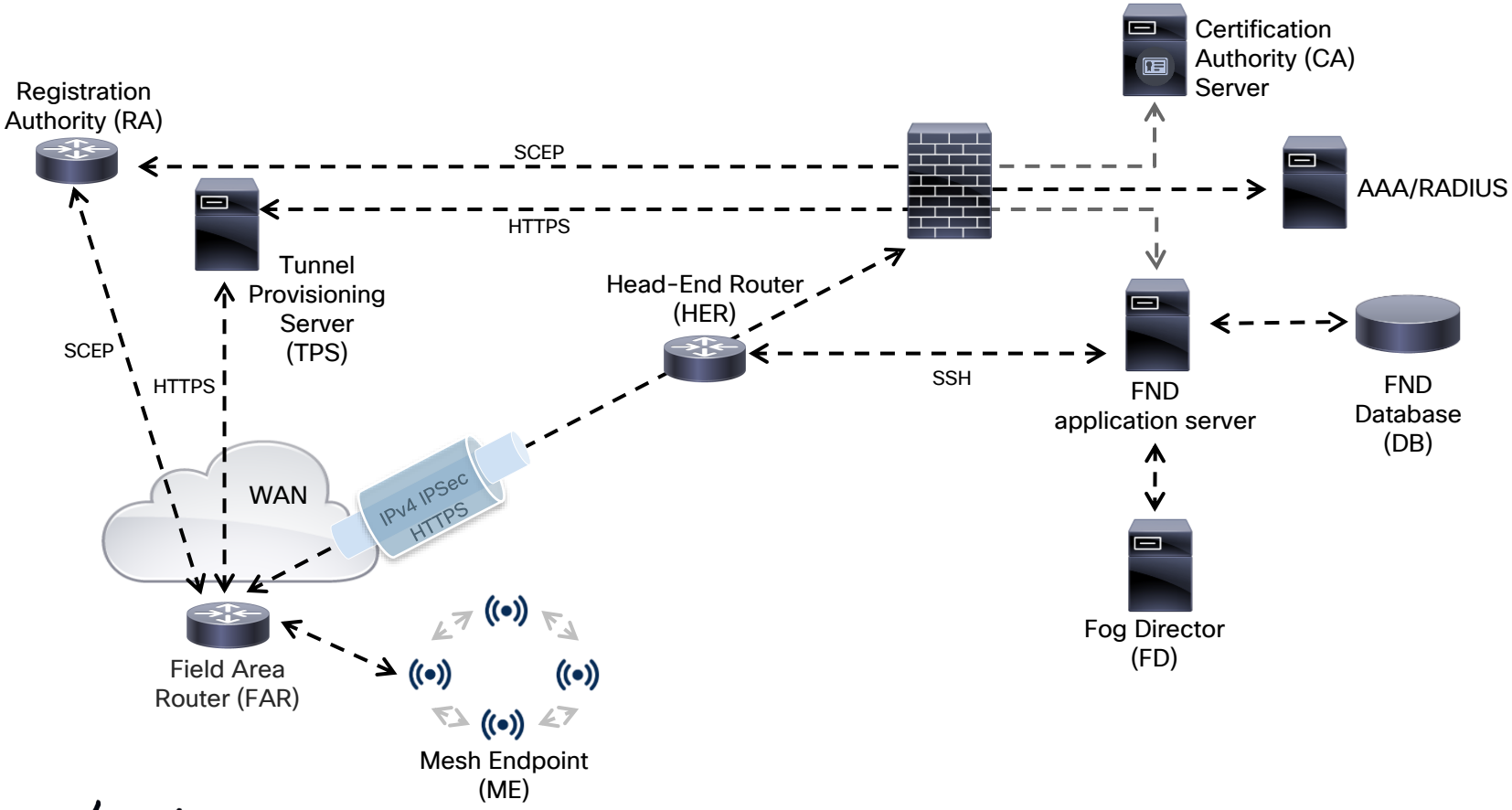
High Level


Cisco IoT Field Network Director
Datacenter
4G / LTE / Ethernet / WiFi
Cisco CGR1000
Cisco IR800
Cisco IR1101
Cisco IC3000
Cisco 819H
Cisco LoRaWAN
3rd Party

Components



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Components and terminology

Core:

- FND application server
- FND database (DB)

Security:

- Public Key Infrastructure (PKI)
- Registration Authority (RA)
- Head-End Router (HER)
- Tunnel Provisioning Server (TPS)

Field Devices

- Field Area Router (FAR)
- Mesh Endpoint (ME)

IOx application management:

- Fog Director (FD)

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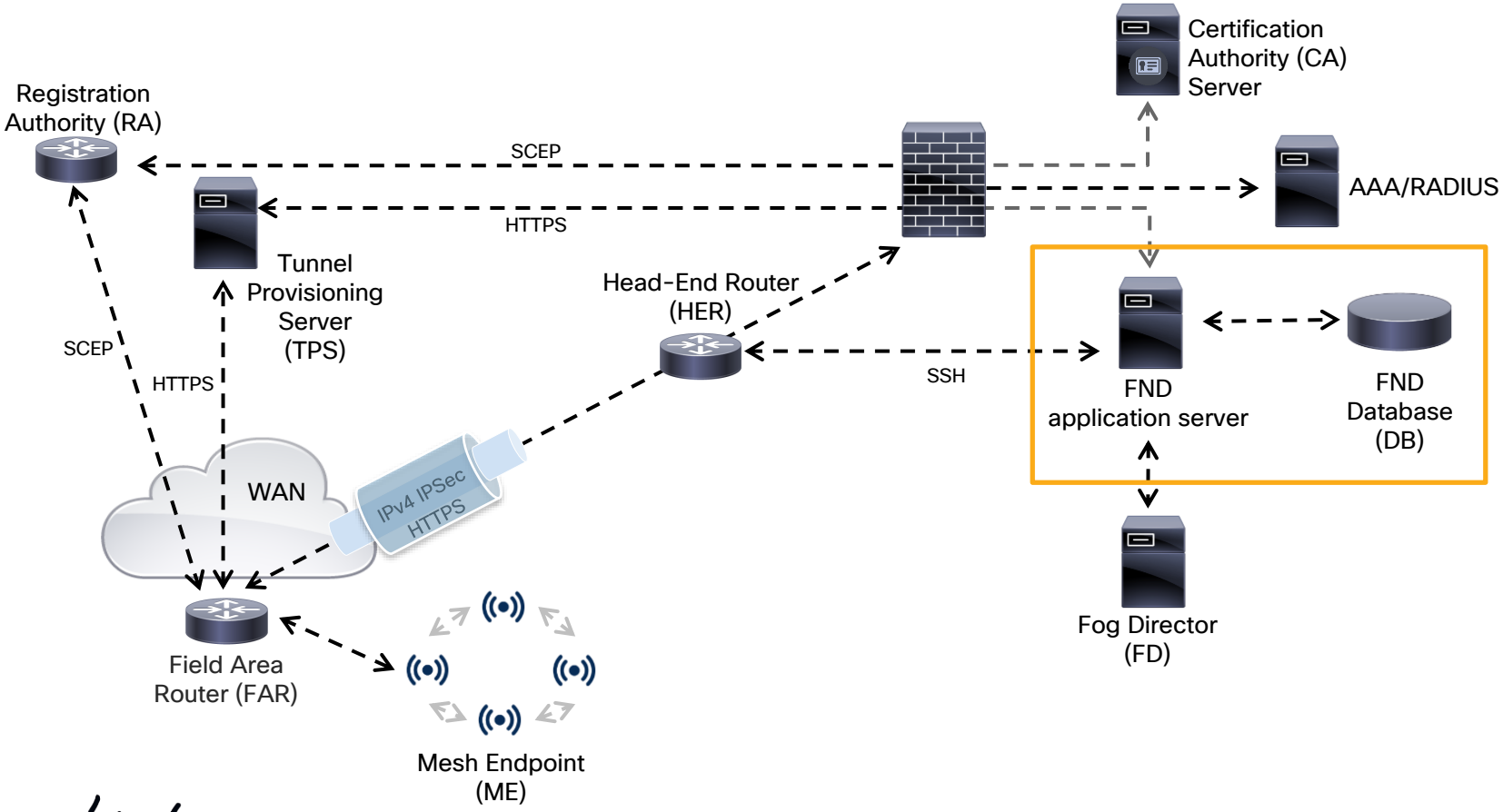
Components



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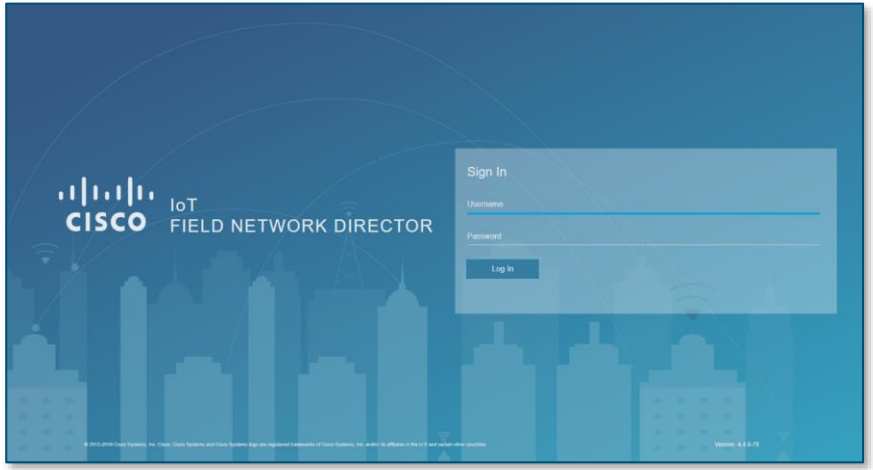
Components – FND application server

Core of FND

- Manages, configures and monitors assets
- GUI access for control and configuration
- NB API for integration with 3rd party
- On Linux (V)M or in Docker container



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Components – FND database (DB)

Stores data and metrics required for FND operation

Two flavors:

- Oracle

or

- PostgreSQL (configuration)
- InfluxDB + Kapacitor (time series data)

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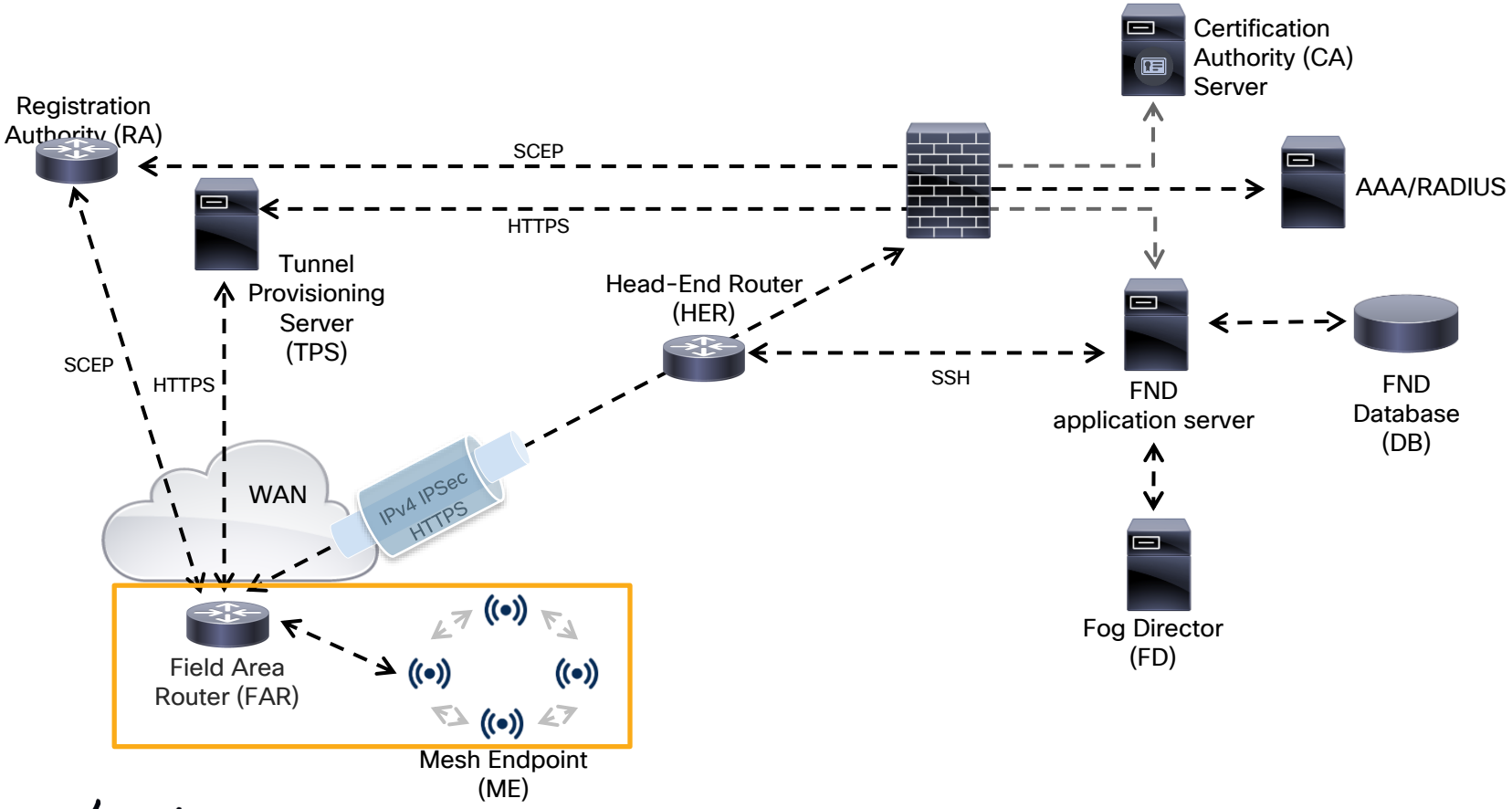
Components



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Components – Field Area Router (FAR)

Network device managed by FND

Supported devices:

- IXM LoRaWAN Gateway (standalone and virtual mode)
- 800-series (IR807/IR809/IR829/C819)
- CGR1000-series (CGR1120/CGR1240)
- IR1101
- IC3000
- ESR5921
- 3Rd Party (IDA agent)

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Components- Mesh Endpoints (ME)

Mesh endpoints or extenders connected to the Field Area Routers

Supported devices

- Cisco Resilient Mesh Wi-SUN meters
- CGR WPAN Module (IEEE 802.15.4e/g)
- iTron OpenWay ACT (IEEE 802.15.4e/g)
- IR500-series

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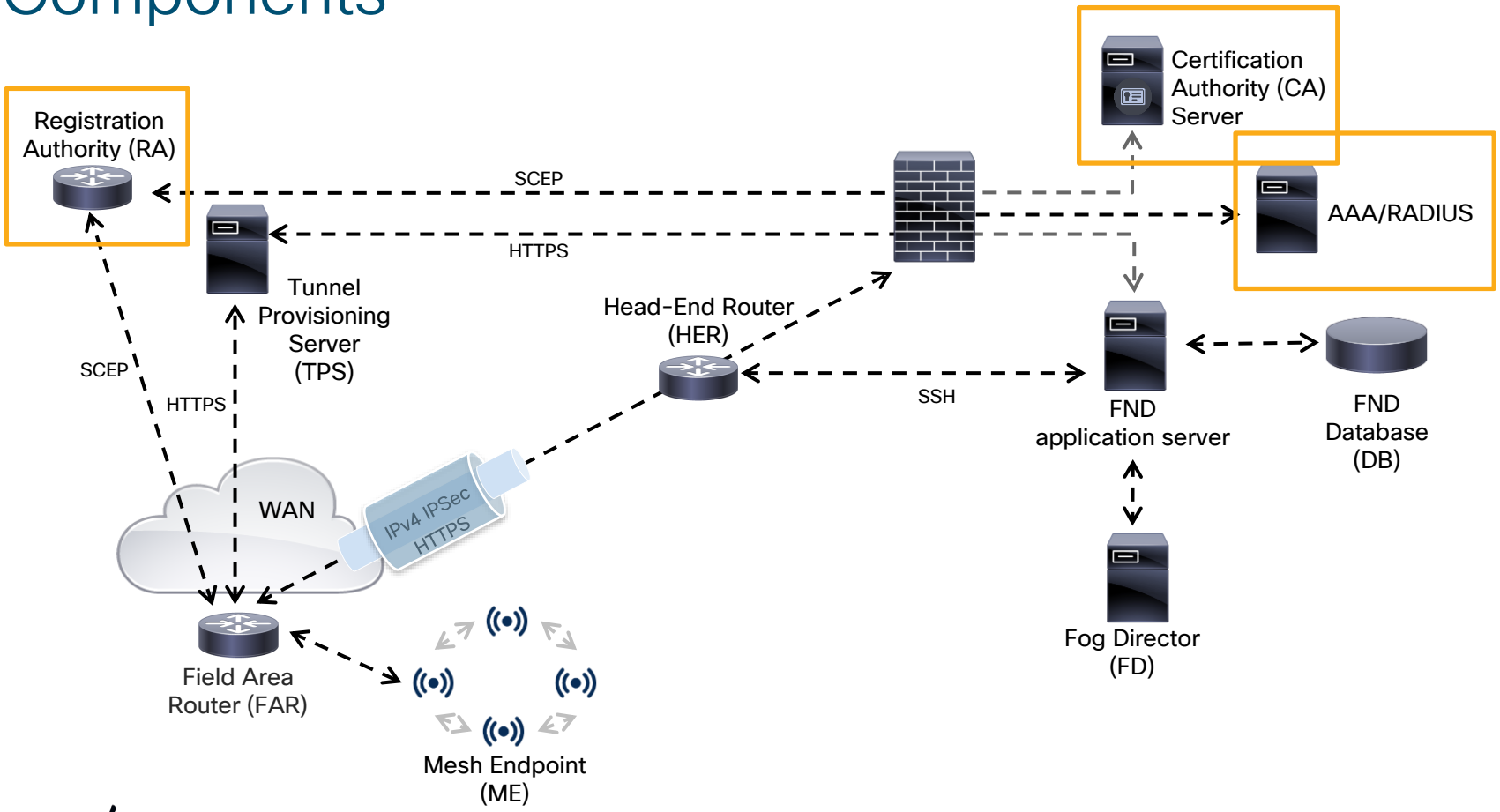
Components



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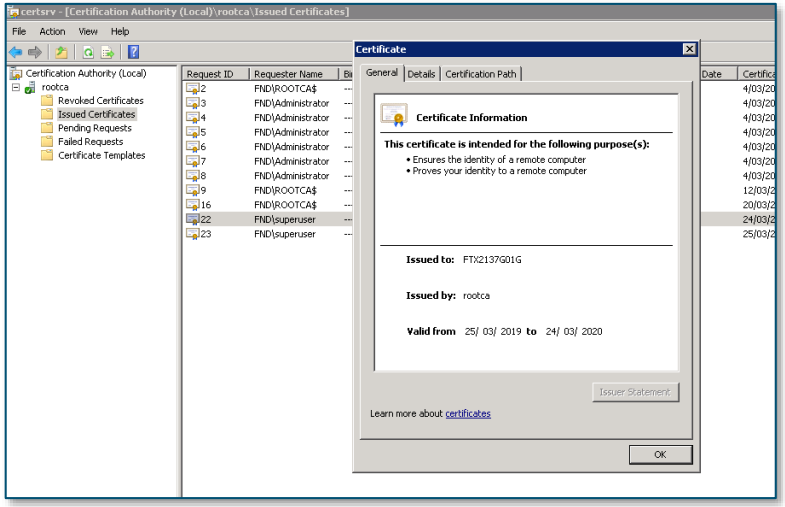
Components – Public Key Infrastructure (PKI)

Issues certificates to Field Area Routers and Mesh Endpoints

- Secure authentication and communication
- Uses SCEP for certificate enrollment
- Typically used with Windows PKI
- RSA certificates for Field Area Router
- ECC certificates for Mesh Endpoints



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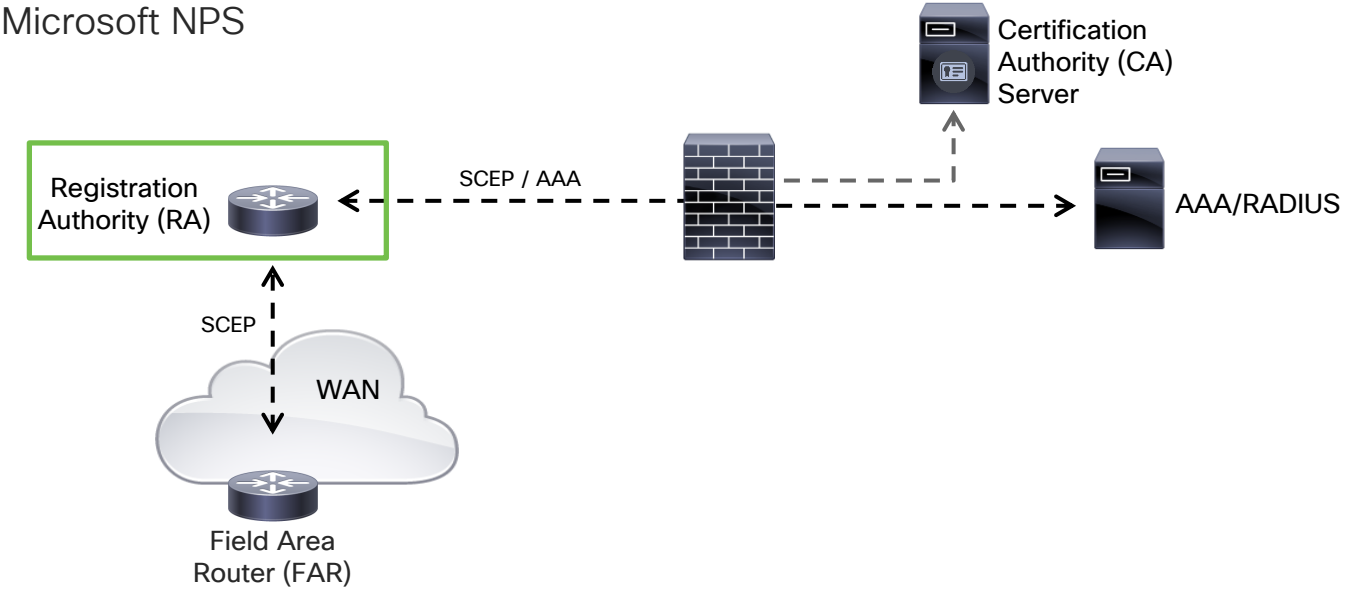
Components – Registration Authority (RA)

Proxies certificate enrollment using SCEP to PKI/CA-server

- Optionally performs AAA for additional security with SCEP
- Prevents PKI server being exposed externally
- Cisco ACS/ISE or Microsoft NPS
- In DMZ



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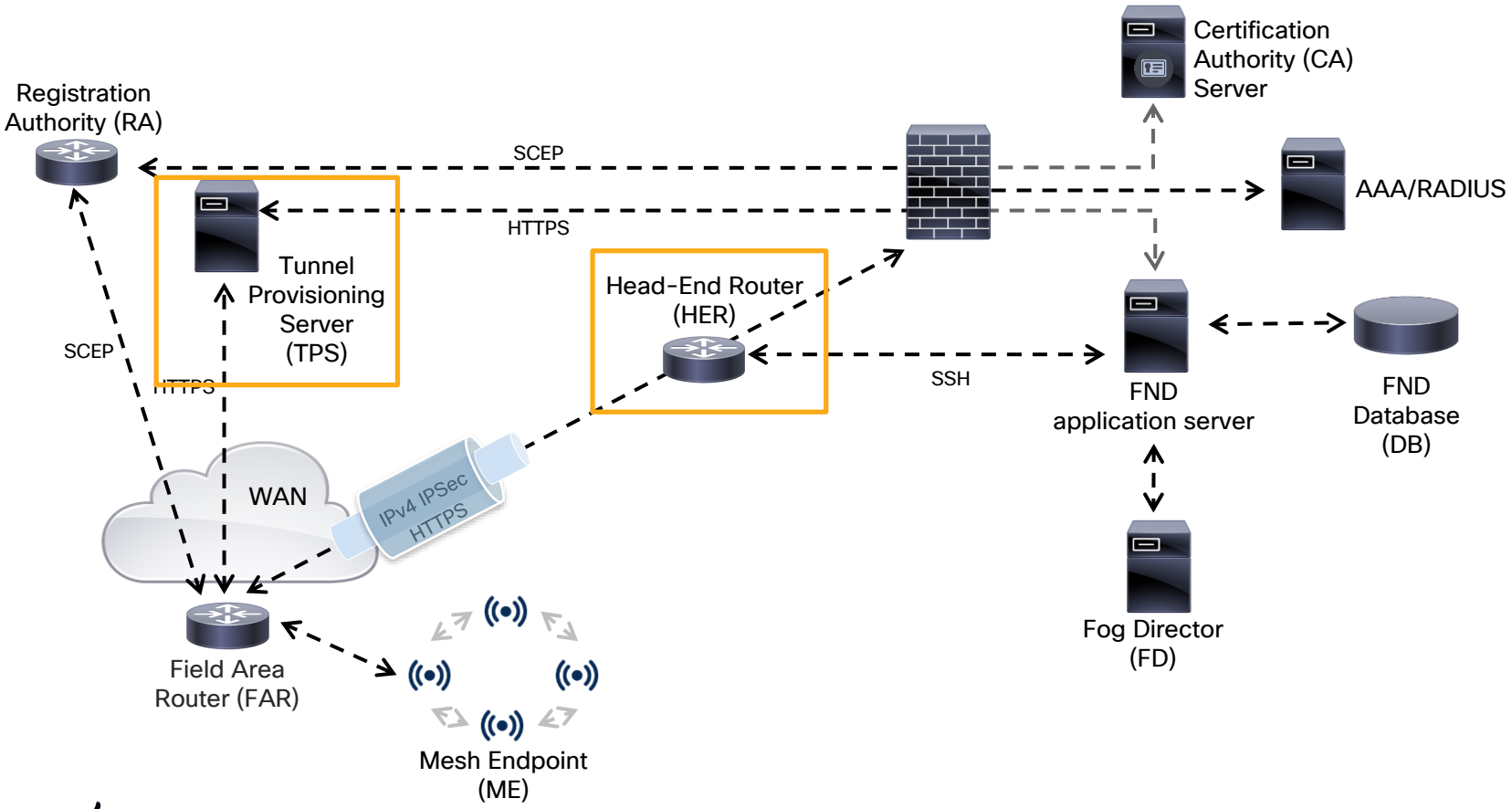
Components



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Components – Head-End Router (HER)

Terminates tunnels between Field Area Router and FND

- IOS: FlexVPN
- CG-OS: Spoke (FAR) and Hub (HER)

Supported devices:

- ISR4300/4400
- ASR1001/ASR1002
- ISR3945
- CSR1000v

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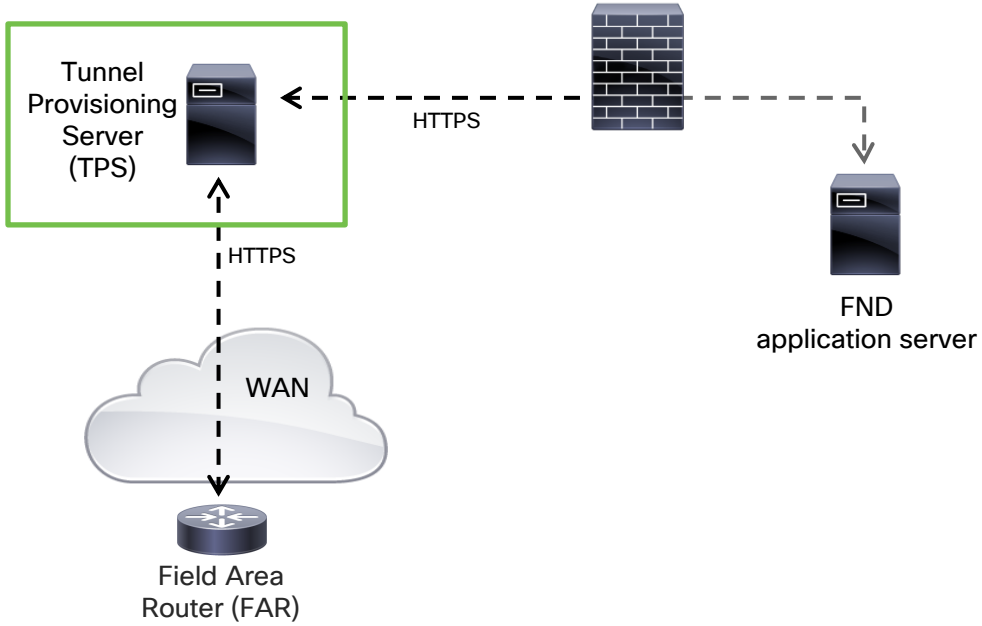
Components – Tunnel Provisioning Server (TPS)

Proxies requests to FND application server for tunnel provisioning

- Prevents FND server being exposed externally
- In DMZ



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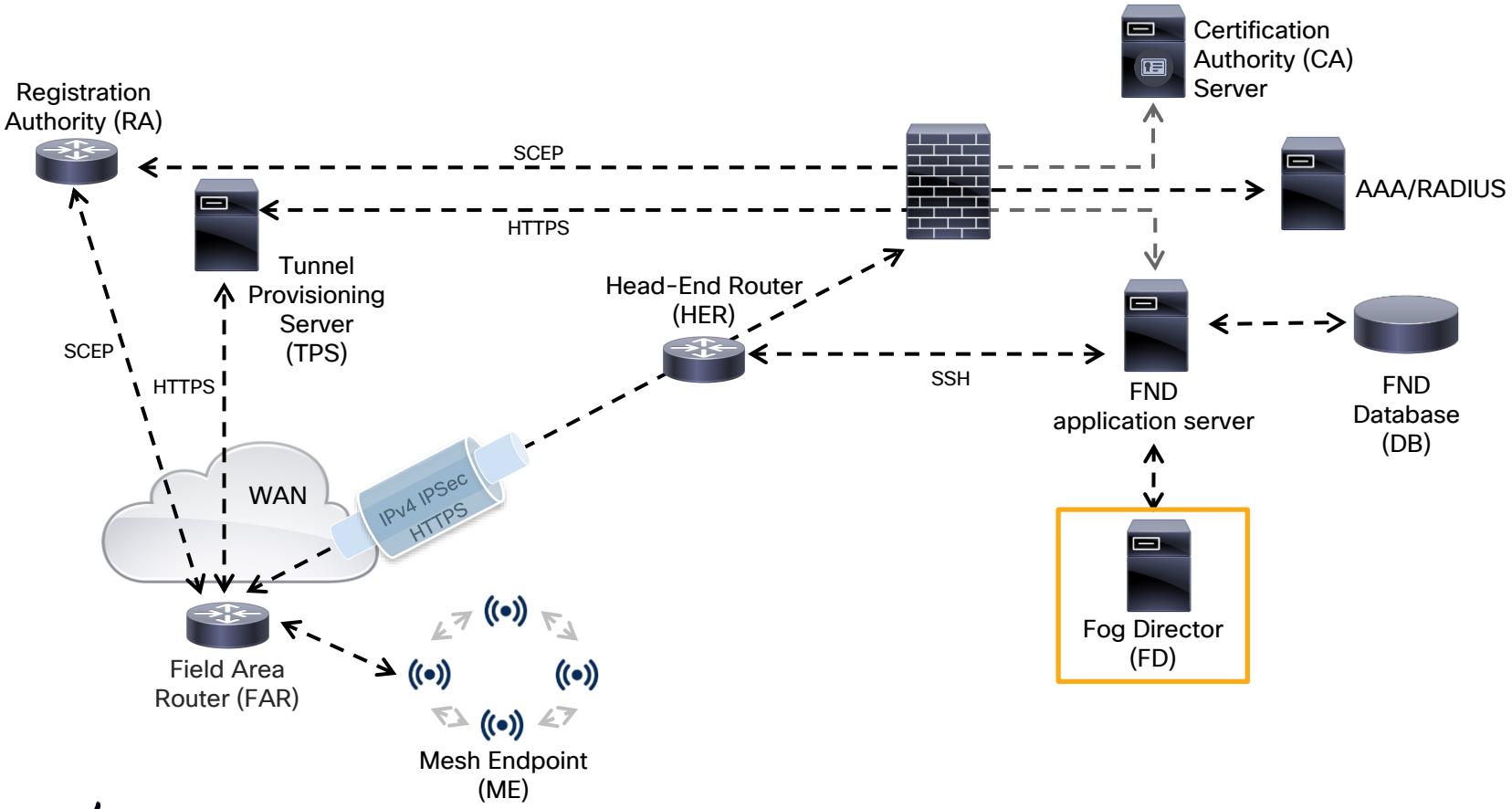
Components



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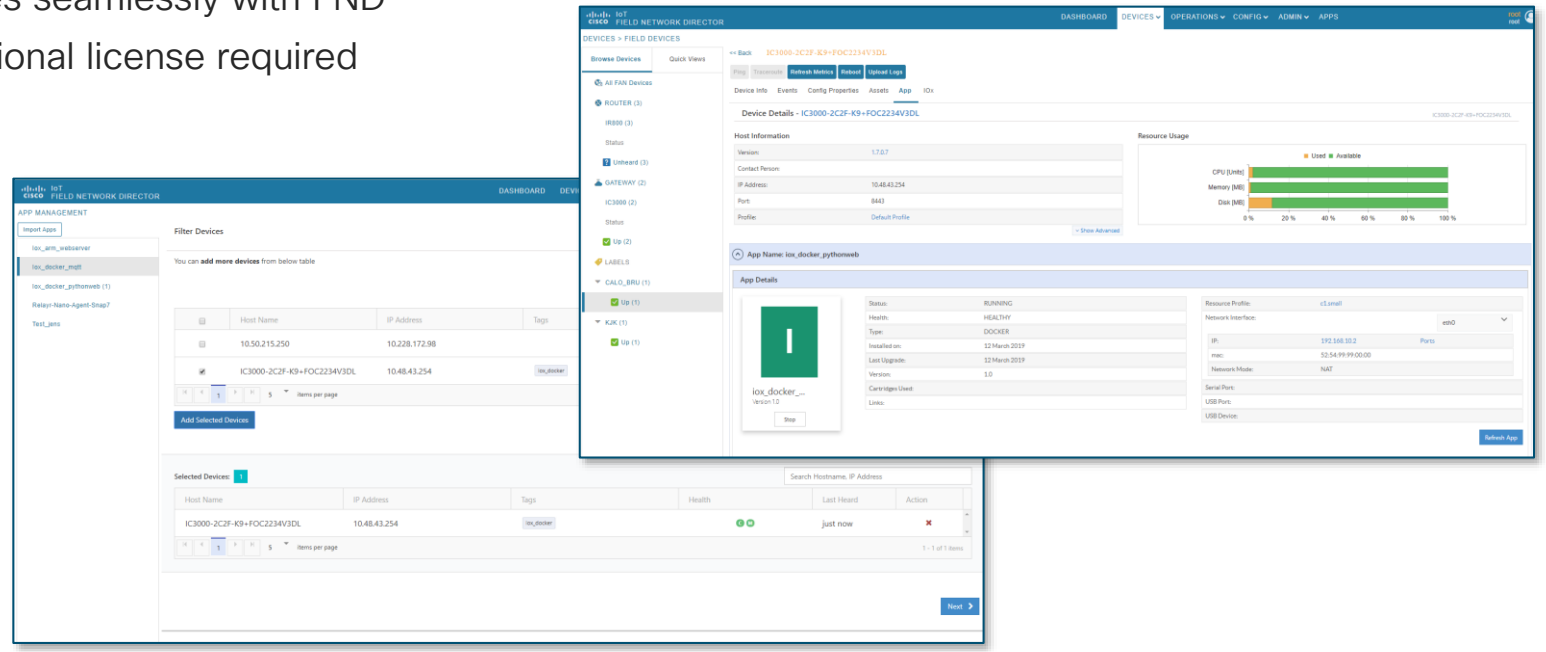
Components – Application Management

Provides IOx application management on supported Field Area Routers

- Integrates seamlessly with FND
- No additional license required



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FND network architecture

- Not all components are mandatory
- Recommended to start small and add components
- Depends on use case and security requirements
  - Private network vs. public network
  - Public CA vs. Enterprise CA
  - Mesh Endpoints vs. only Field Area Router management
- Fog Director is optional in all modes

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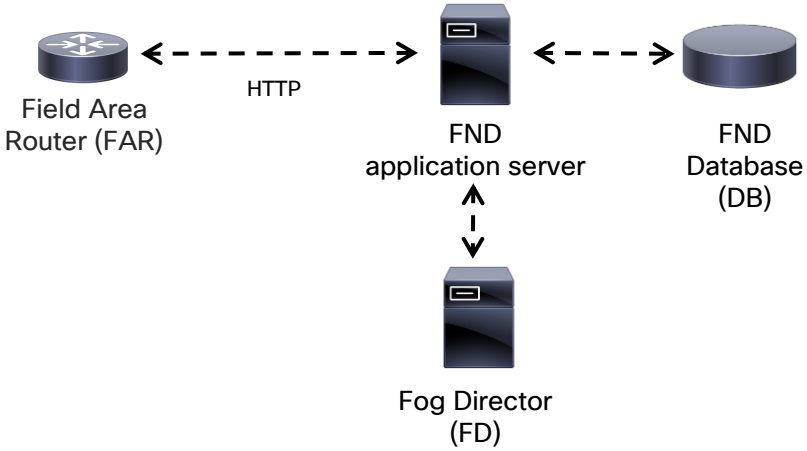
FND architecture – Easy mode

- Ideal starting point
- No need for:
  - Head End Router or tunnel to FND
  - PKI and SCEP
  - Router certificates, trustpoints and SSL certificates
  - All communication over HTTP instead of HTTPS



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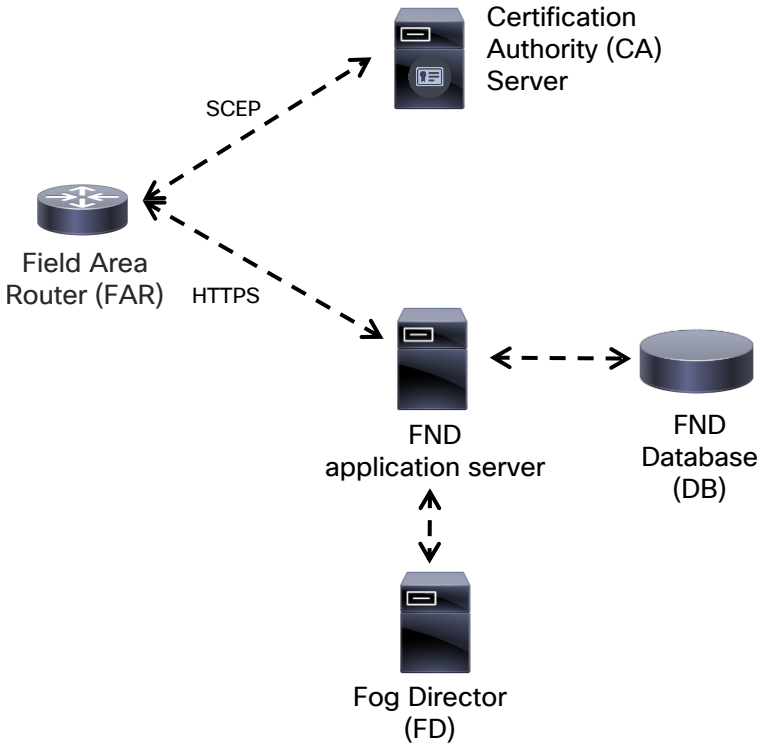
FND architecture – Production without tunnels

- HTTPS communication
- Mutual certificate validation
- Can use private CA or public CA
- Ideal when working over private network (for example private APN)



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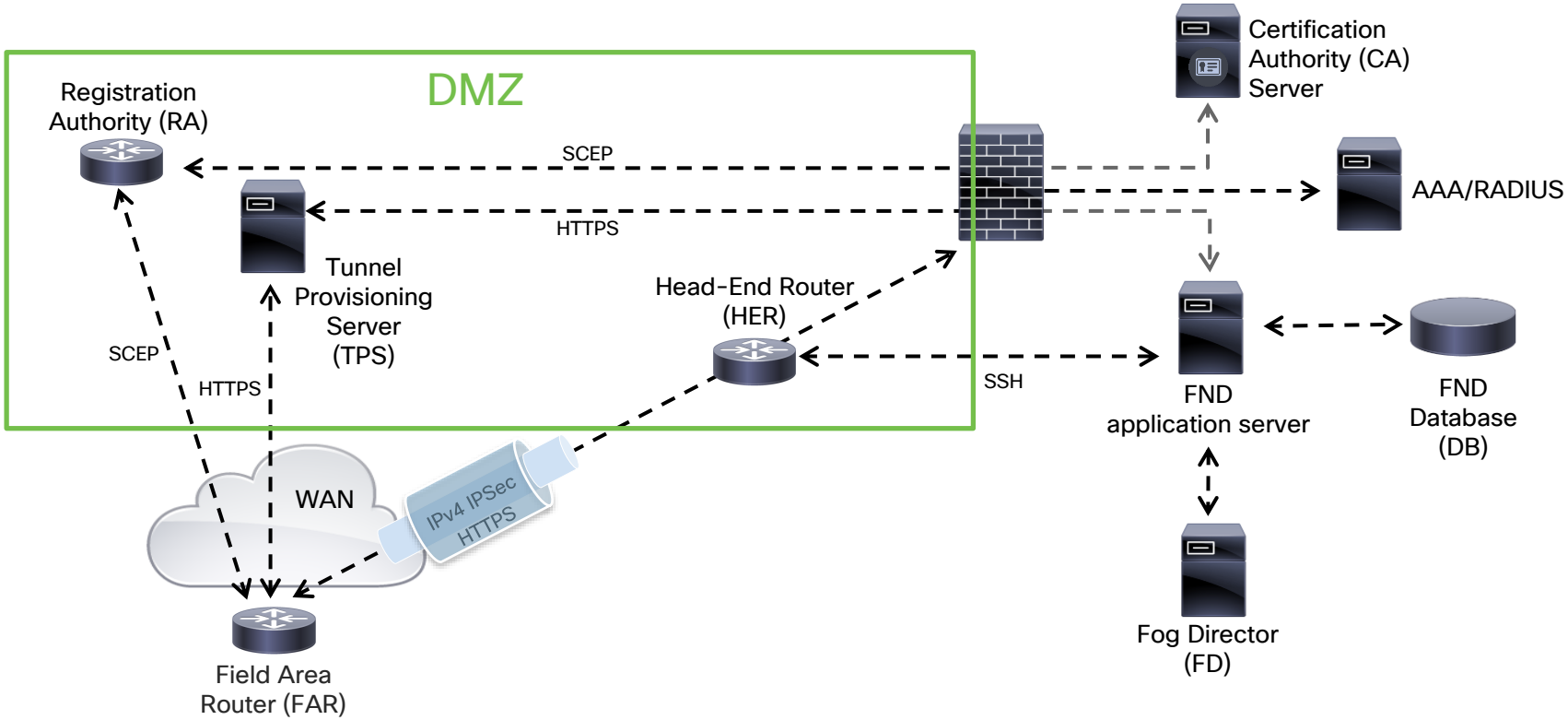
FND architecture – Production with tunnels/DMZ



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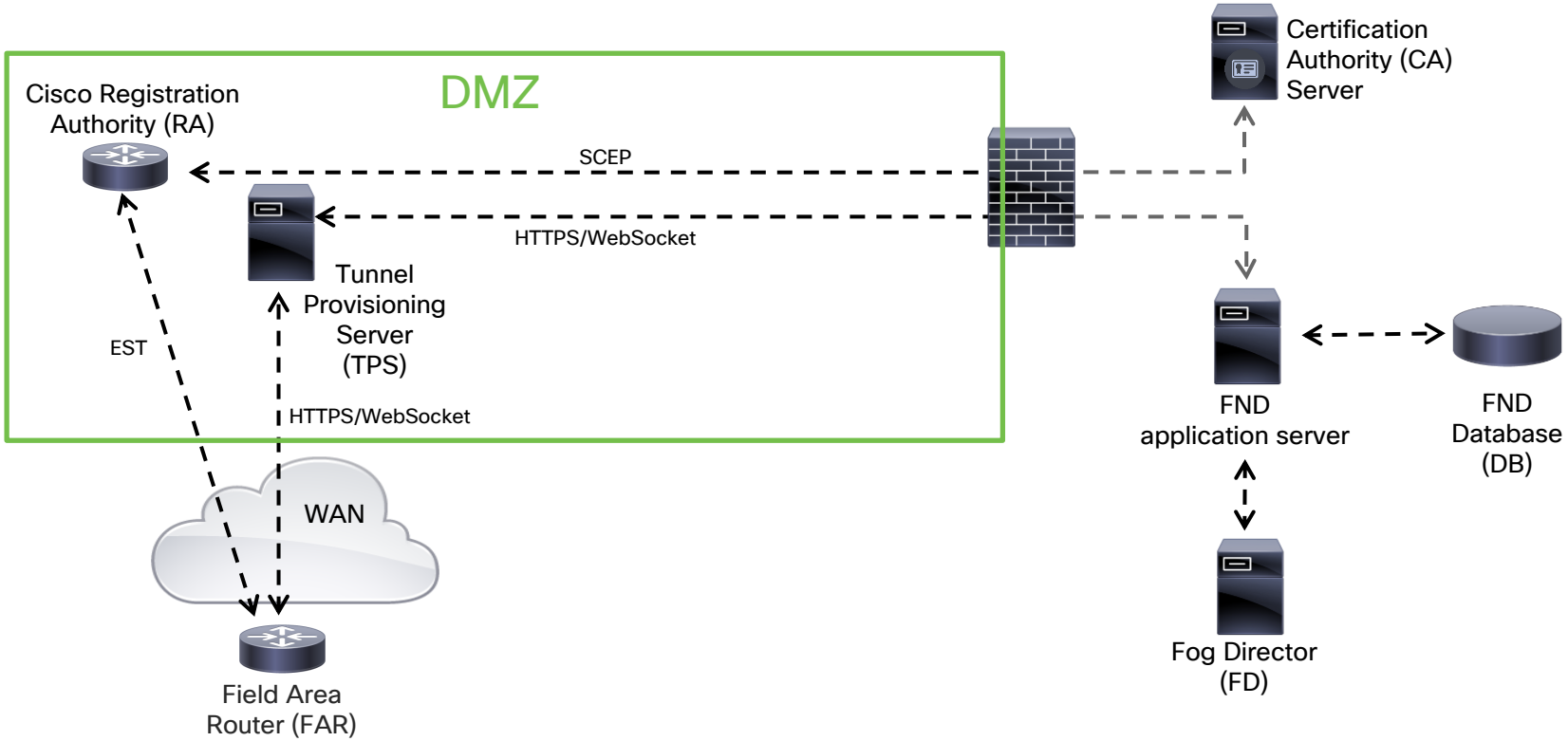
Enrollment over Secure Transport / WebSocket



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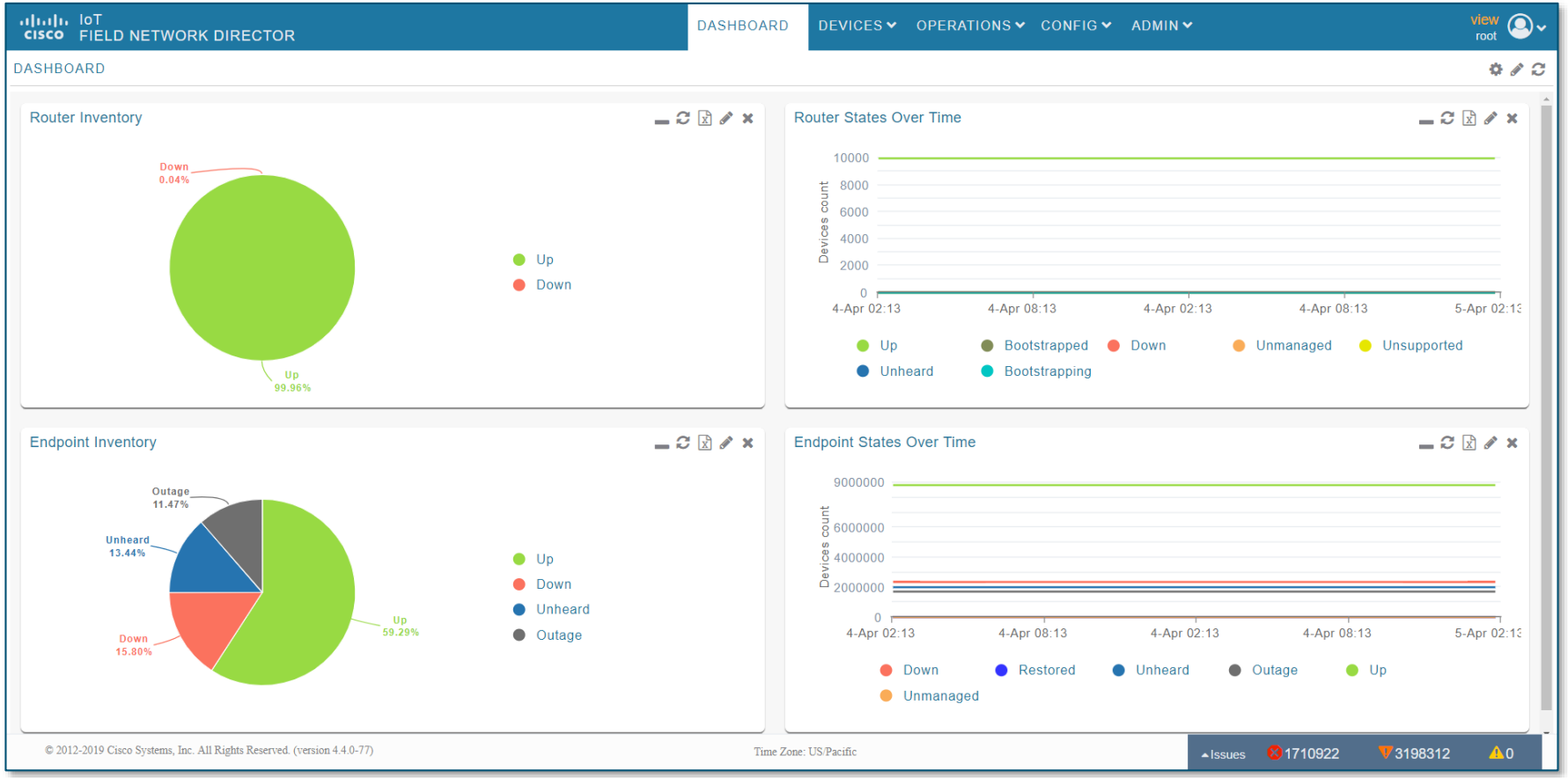
GUI overview – Dashboard



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GUI overview – Map

IoT FIELD NETWORK DIRECTOR

DASHBOARD | DEVICES | OPERATIONS | CONFIG | ADMIN

view root

DEVICES > FIELD DEVICES

Browse Devices | Quick Views

Show Filters

All FAN Devices

ROUTER (9,994)

CGR1000 (9,994)

Status

Down (4)

Up (9,990)

ENDPOINT (14,907,770)

METER-CGMESH (14,907,770)

Status

Down (2,354,949)

Outage (1,710,768)

Unheard (2,003,625)

Up (8,838,428)

LABELS

CELLRSSI (9,994)

Map | Inventory

Zoom to Devices | Grayscale | Overlay None

Map | Satellite

CGR1120/K9+JSJ30035251
Cisco Connected Grid Router 1000-Series
192.167.34.225

Details | Ping | Traceroute | Create Work Order

Status	up	**Last Heard**	2019-04-05 01:33
Model Number	CGR1120/K9	**Serial Number**	JSJ30035251
Config Group	default-cgr1000	**Firmware Group**	default-cgr1000
Tunnel Group	default-cgr1000	**Hostname**	simulatedfar-hname-87
Firmware Version	15.4(20130724:220328) [awang-cgna4 113]		
PANID	1		
Issues	Certificate Expiration		
Labels	txrx, cellrssi		

Map data ©2019 Google 2 km Terms of Use

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Time Zone: US/Pacific

Issues 1710922 3198312 0

GUI overview – Device details

IoT FIELD NETWORK DIRECTOR

DASHBOARD | DEVICES | OPERATIONS | CONFIG | ADMIN | view root

DEVICES > FIELD DEVICES

Browse Devices | Quick Views

- All FAN Devices
- ROUTER (9,994)
  - CGR1000 (9,994)
    - Status
      - Down (4)
      - Up (9,990)
- ENDPOINT (14,907,770)
  - METER-CGMESH (14,907,770)
    - Status
      - Down (2,354,949)
      - Outage (1,710,768)
      - Unheard (2,003,625)
      - Up (8,838,428)
- LABELS
  - CELLRSSI (9,994)

<< Back CGR1120/K9+JSJ30034831

Show on Map | Ping | Traceroute | Refresh Metrics | Reboot | Refresh Router Mesh Key | Create Work Order

Device Info | Events | Config Properties | Running Config | Mesh Routing Tree | Mesh Link Traffic | Router Files | Raw Sockets | Work Order | Assets

RPL DIO Min	20
RPL DIO Double	0
RPL DODAG Lifetime	120
RPL Version Incr. Time	240

Mesh Link Metrics

Transmit Speed	0 bits/sec
Receive Speed	0 bits/sec
Mesh Endpoint Count	1221 devices

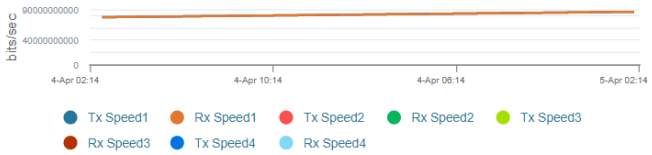
Mesh Link Keys

Key Refresh Time	Sat Jan 25 16:43:20 2020
Key Expiration Time	Thu Jun 25 21:31:20 2020

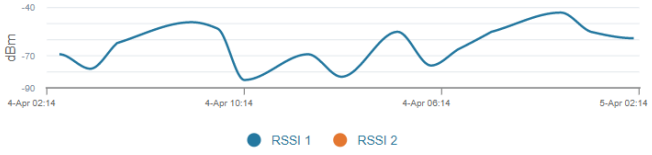
Cellular Link Settings

	Modem1
Network Type	LTE
Network Name	054-154
IMSI	310410935941036
Roaming Status	Home
Serial Number	N/A
Firmware Version	SWI9X15C_05.05.58.00
Connection Type	LTE
Cellular Modem Active	true
Cellular Module Temperature	39.0 Celsius

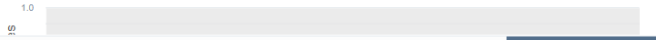
Cellular Link Traffic



Cellular RSSI



Endpoint Hop Count



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Time Zone: US/Pacific

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GUI overview – App management

IoT FIELD NETWORK DIRECTOR

DASHBOARD | DEVICES | OPERATIONS | CONFIG | ADMIN | APPS

root root

DEVICES > FIELD DEVICES

Browse Devices | Quick Views

- All FAN Devices
- ROUTER (3)
  - IR800 (3)
  - Status
  - Unheard (3)
- GATEWAY (2)
  - IC3000 (2)
  - Status
  - Up (2)
- LABELS
  - CALO_BRU (1)
    - Up (1)
  - KJK (1)
    - Up (1)

<< Back IC3000-2C2F-K9+FOC2234V3DL

Ping | Traceroute | Refresh Metrics | Reboot | Upload Logs

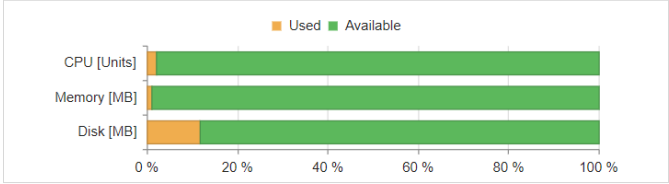
Device Info | Events | Config Properties | Assets | App | IOx

Host Information

Version:	1.7.0.7
Contact Person:	
IP Address:	10.48.43.254
Port:	8443
Profile:	Default Profile

Show Advanced

Resource Usage



App Name: iox_docker_pythonweb

App Details

Status:	RUNNING
Health:	HEALTHY
Type:	DOCKER
Installed on:	12 March 2019
Last Upgrade:	12 March 2019
Version:	1.0

Resource Profile:	c1.small	
Network Interface:	eth0	
IP:	192.168.10.2	Ports
mac:	52:54:99:99:00:00	
Network Mode:	NAT	

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Time Zone: UTC

Issues 0 1 0

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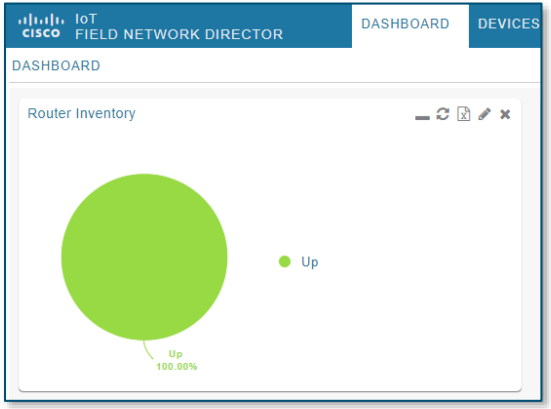
Zero Touch Deployment (ZTD)

1. Add device in FND
2. Boot/connect FAR to (WAN) network
3. Get bootstrap configuration (if not preconfigured) using PNP
4. Request LDevID certificate from PKI or RA
5. Contact TPS for tunnel provisioning
6. Build FlexVPN tunnel to HER
7. Contact FND for registration
8. FND pushes configuration to FAR
9. FAR is up in FND



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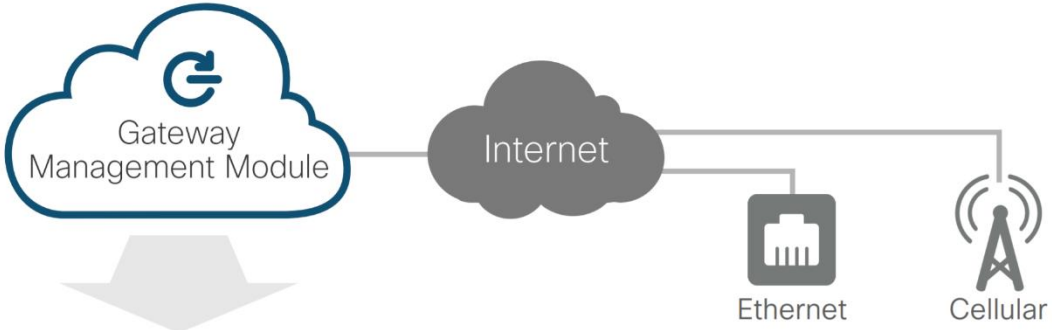
DEMO – Field Network Director

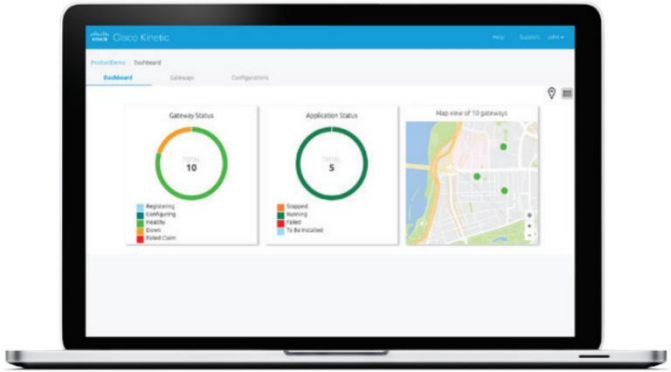
Kinetic Gateway Management Module

IoT Device Management

cisco Live!

Cisco Kinetic Gateway Management Module





View and control gateways remotely.

Connect remote and/or mobile
Cisco IR 8x9,IR 807 and IR 1101 quickly and securely.

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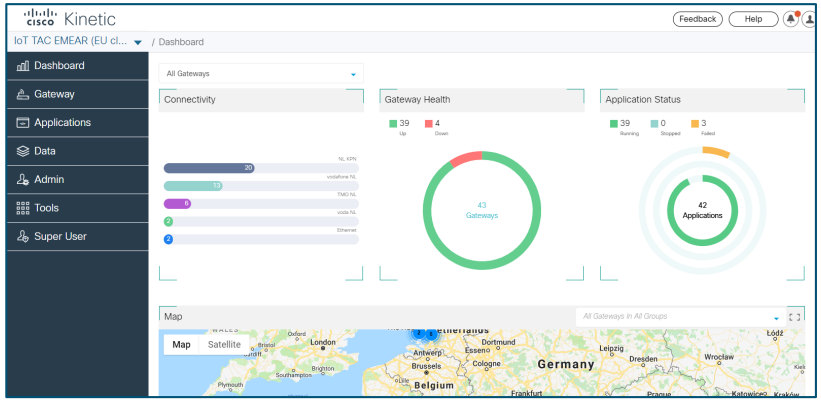
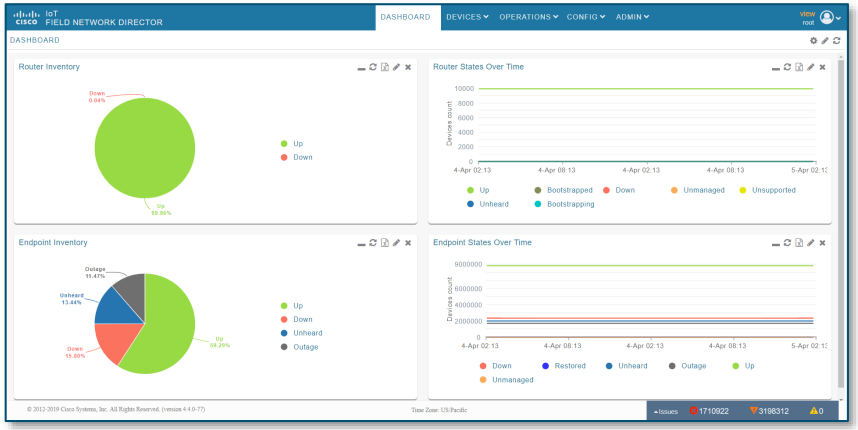
Cisco Kinetic GMM vs. FND

- Kinetic Gateway management module
- Cisco cloud-hosted IoT device management
- Two clusters (US and EU)
- Built on top of Field Network Director
- Available in SaaS model
- Ease of use vs. flexibility





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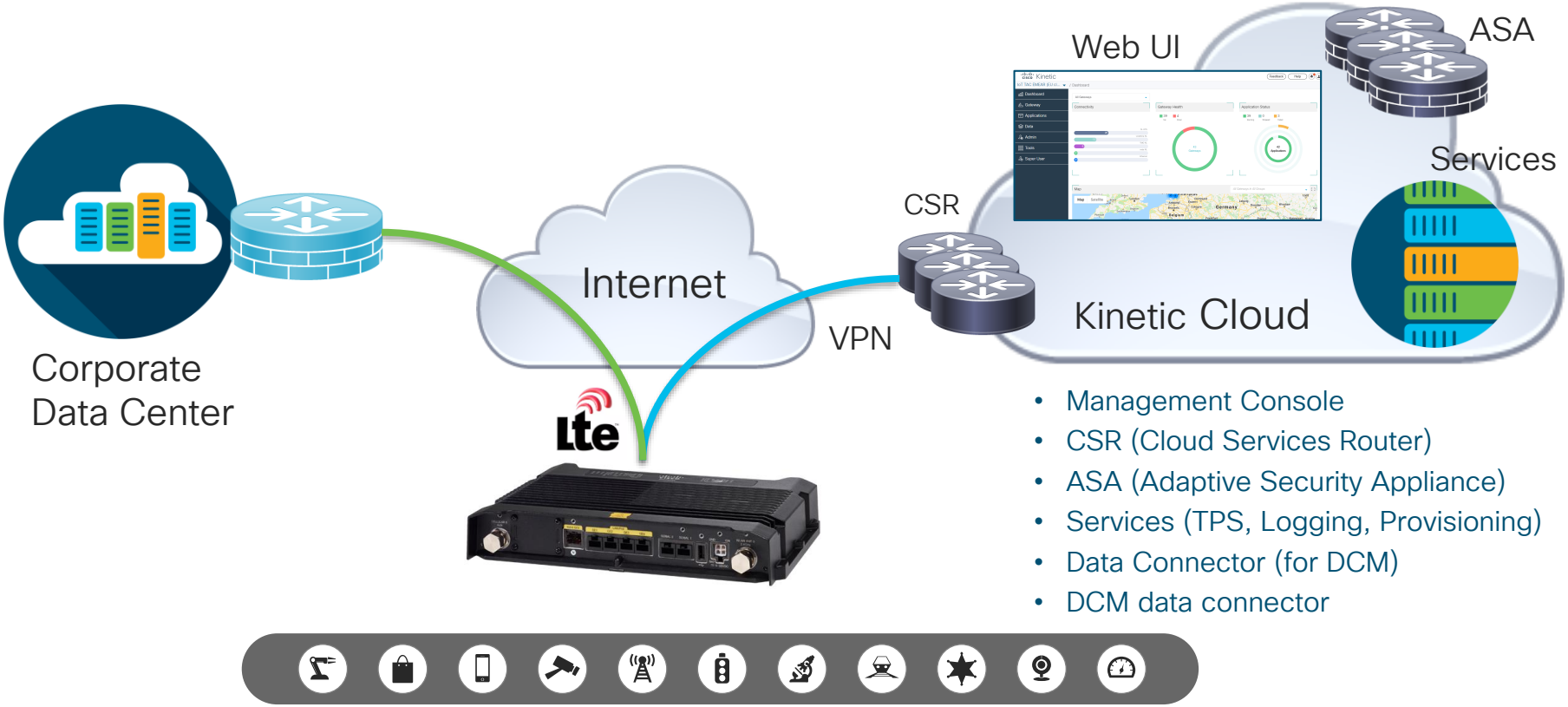
GMM Architecture



- Management Console
- CSR (Cloud Services Router)
- ASA (Adaptive Security Appliance)
- Services (TPS, Logging, Provisioning)
- Data Connector (for DCM)
- DCM data connector

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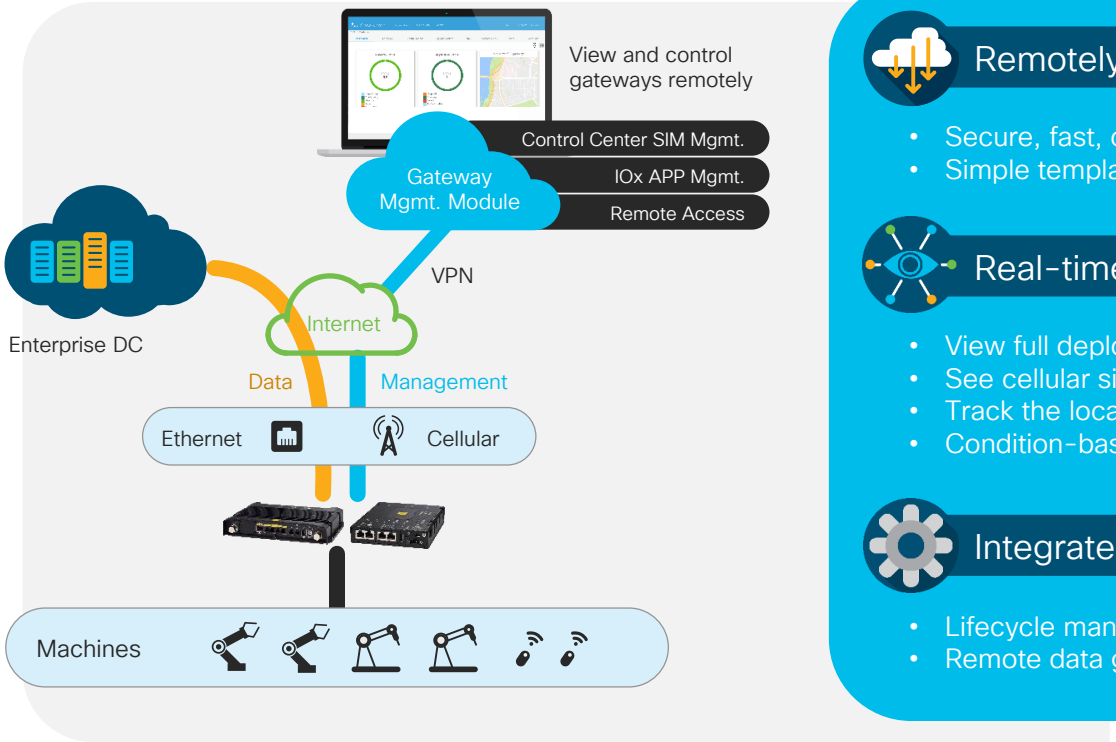
Gateway Management Module (GMM)



Remotely provision IoT gateways in minutes

- Secure, fast, cloud based IoT gateway and SIM on-boarding
- Simple template-based IOS configuration

Real-time operation visibility

- View full deployment of gateways and connected assets
- See cellular signal strength, plus data usage for past 24 hours
- Track the location of assets with integrated GPS, geo-fencing
- Condition-based alerts

Integrated edge compute

- Lifecycle management of applications for edge data processing
- Remote data gathering

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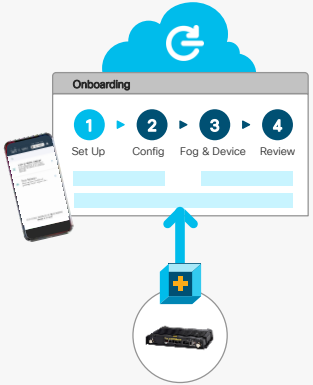
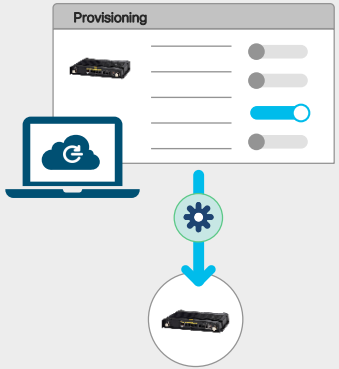
Simplified IT deployment & OT operations





Simplified Install

Network

- Simple GW onboarding
- IT-friendly diagnostics

IOx APP

- Simple App upload
- Template driven install

Easy and Rich Service Enablement

- Simplified provisioning without sacrificing the rich IR8x9 features
- Template-based configuration

- App integration w/IR829 HW (GPS, gyro)
- Scalable per-GW parameter passing

OT Operation Assist

- GPS tracking & history
- Cellular usage report
- Event-based altering
- Remote device access
- App health monitoring
- App resiliency/restart

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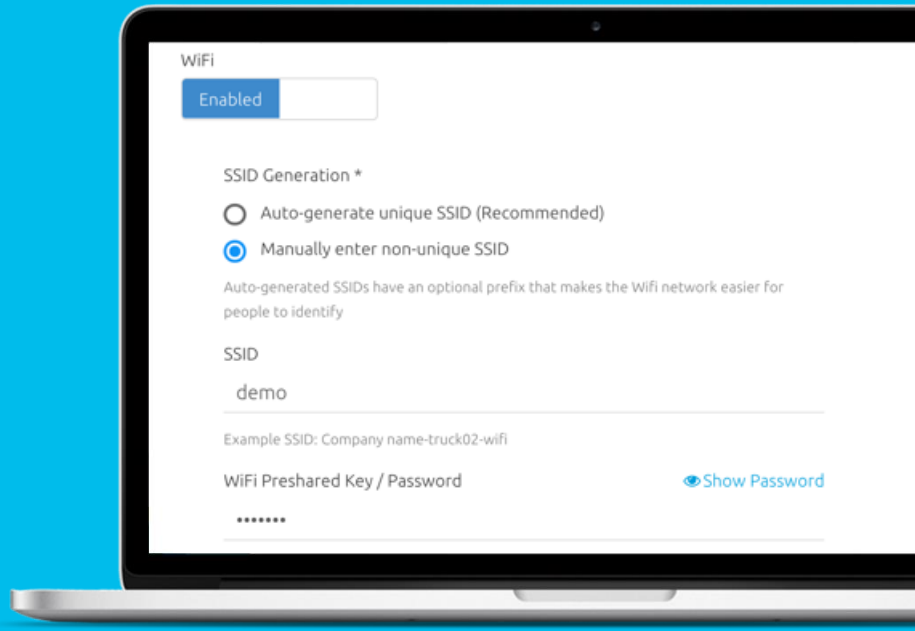
I want to ...
enable WiFi

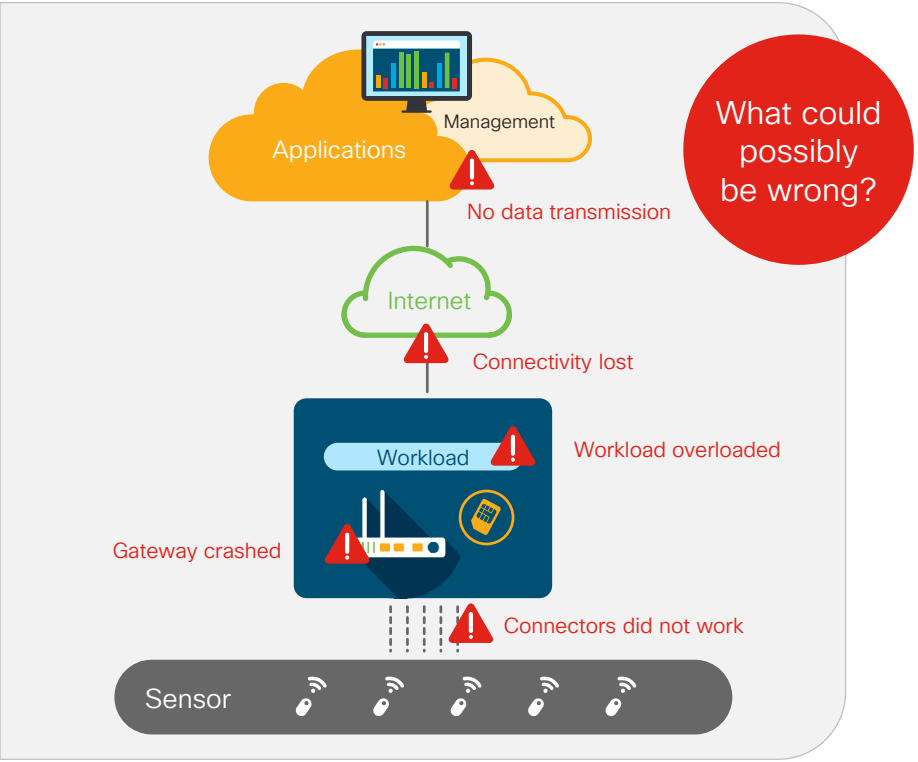
```
AP Config
dot11 ssid demo
  vlan 1
  authentication open
  authentication key-management wpa version 2
  mbssid guest-mode

interface Dot11Radio0
 no shutdown
 no ip address
 !
 encryption vlan 1 mode ciphers aes-ccm
 !
 ssid demo
 !
 antenna gain 0
 mbssid
 station-role root
!
interface Dot11Radio0.1
 encapsulation dot1Q 1 native
 bridge-group 1
 bridge-group 1 subscriber-loop-control
 bridge-group 1 spanning-disabled
 bridge-group 1 block-unknown-source
 no bridge-group 1 source-learning
 no bridge-group 1 unicast-flooding
```

```
interface Dot11Radio1
 no shutdown
 no ip address
 !
 encryption vlan 1 mode ciphers aes-ccm
 !
 ssid demo
 !
 antenna gain 0
 peakdetect
 dfs band 3 block
 mbssid
 channel dfs
 station-role root
!
interface Dot11Radio1.1
 encapsulation dot1Q 1 native
 bridge-group 1
 bridge-group 1 subscriber-loop-control
 bridge-group 1 spanning-disabled
 bridge-group 1 block-unknown-source
 no bridge-group 1 source-learning
 no bridge-group 1 unicast-flooding
```



Simple Template-based Configuration

Operation:
Monitoring and troubleshooting



End to end visibility

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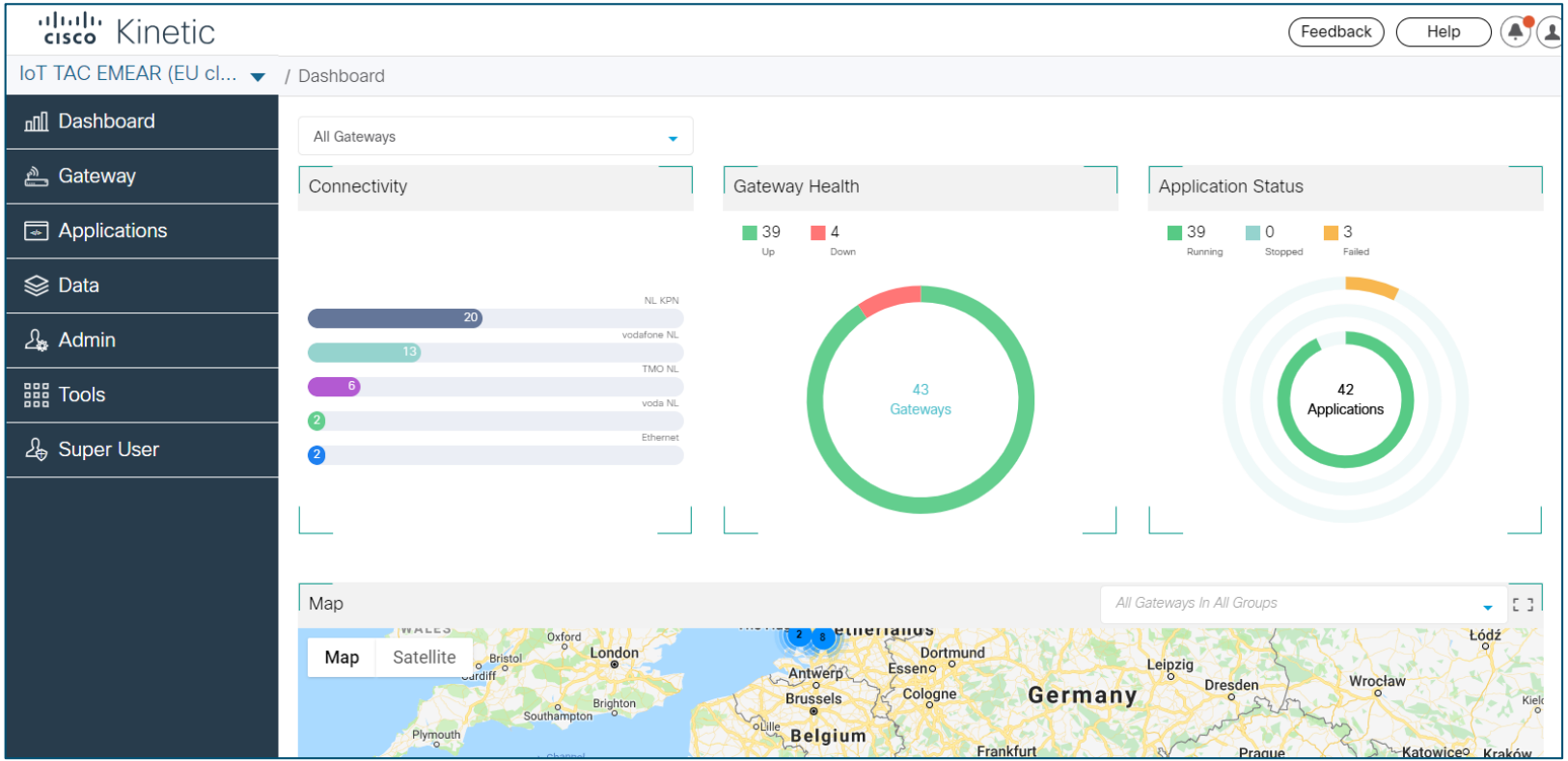
GMM – Dashboard



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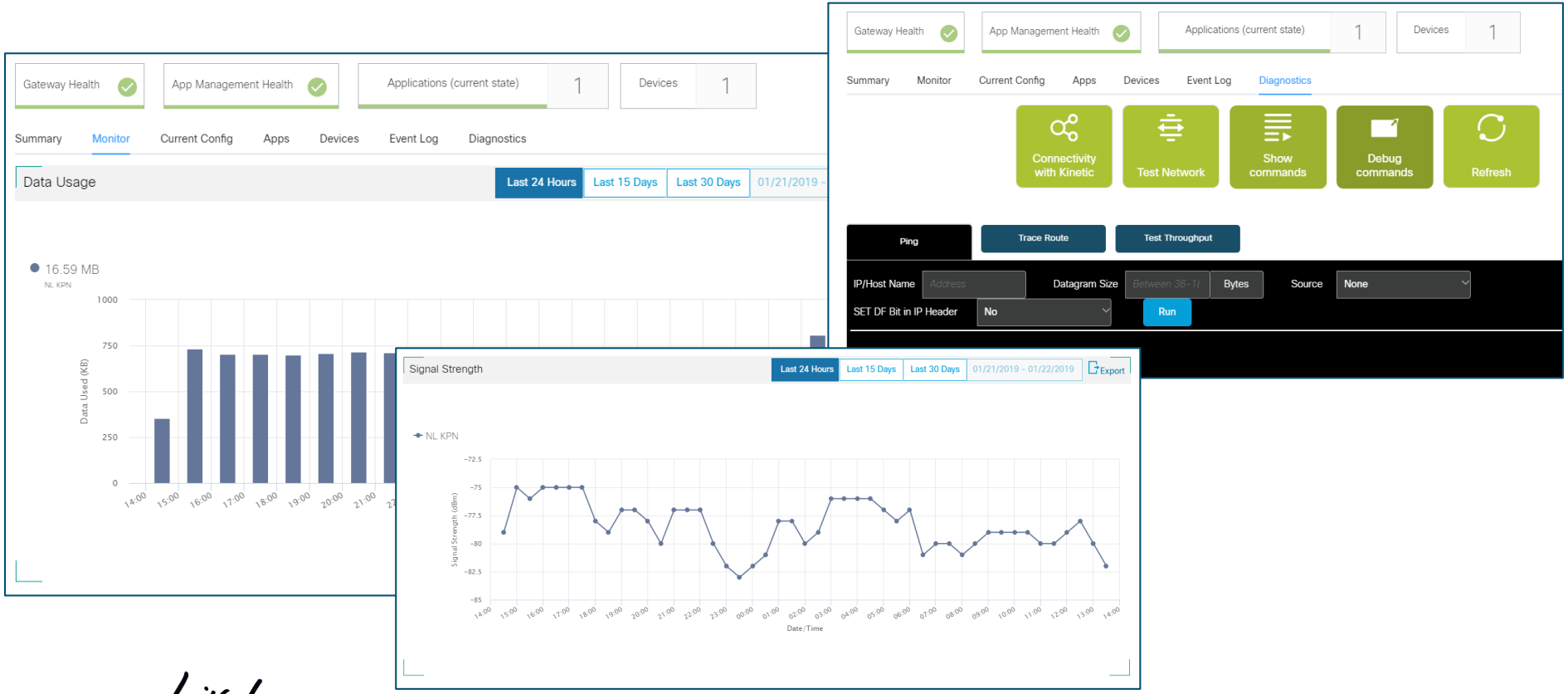
GMM – Monitoring and diagnostics



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GMM – Deploy apps

Kinetic

Feedback

IoT TAC EMEAR (EU cl... / Applications / efm_ir8x9 / Summary

- Dashboard
- Gateway
- Applications
- Data
- Admin
- Tools
- Super User

Summary | Instances

Install

efm_ir8x9

Resources Needed	RAM	767 MB	CPU	732 Units

Description

EFM with JVM (ir8x9)

App Type: lxc

Version: RLS-EFM-1.5.0 — Upgrade

Author: femasche

Author Link: mailto://femasche@cisco.com — Link

Default Application Configurations

Section	Name	Version
No Data		

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GMM – Data Control Module (DCM)

Kinetic

IoT TAC EMEAR (EU cl... / Destinations

- Dashboard
- Gateway
- Applications
- Data
- Admin
- Tools
- Super User

+ Add Data Destination

Azure TAC EMEAR

Summary | Event Log

Test Broker Connection

Destination: Microsoft Azure IoT H

Name: Azure TAC EMEAR

Host Name: ciscotacemear

Server : ciscotacemear.azure-devices.net

Edit Rule Set

Name: Temperature

Description (Optional): Change topic depending on type of mesurement

Rule

```
1  when brakes.temp in-msg THEN  {
2          when msg(brakes.temp) > 5 the
3                  SEND TO "DefaultProfi
4          }
5  }
6  else when engine.temp in-msg then {
7          when msg(engine.temp) > 5 the
8                  SEND TO "DefaultProfi
9          }
10 }
```

Edit Data Policy

Policy Detail

Policy Name: to_azure_iot

Description (Optional): send to Azure IoT

Default: Yes / No

Data Destination: Azure TAC EMEAR

Data Rule: Temperature

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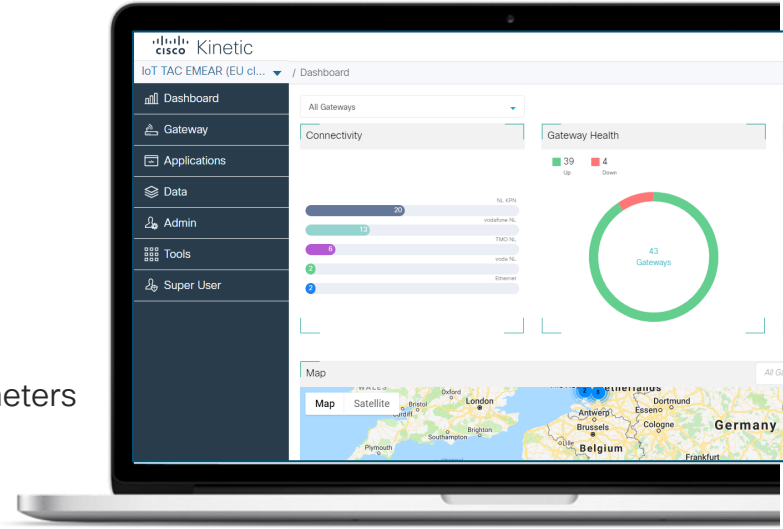
Gateway Management Module – Summary

- Use case
  - Management and monitoring of IoT gateways
  - Deployment of applications at the edge
  - Cloud based web user interface
- Outcomes
  - No need to have own infrastructure as this is Cloud service
  - Fast start and deployment
  - Integrated security
  - Centralized network management
  - Historical statistics of performance and cellular connection parameters
  - Deployment and management of IOx applications



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DEMO – Gateway Management Module

BREAK

IoT solutions

Cisco IoT solutions – Use the building blocks

Cities

- Cisco Kinetic for Cities
- Connected Communities Infrastructure

Manufacturing and OT

- Industrial Automation
- Cyber Vision

Power and utilities

- Connected Substation
- Distribution Automation
- Grid Security

Fleet and beyond

- Extended Enterprise
- Remote and Mobile Assets

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Cisco Validated Design (CVD)

- Prescriptive set of recommended design options and golden configurations
- Option variations are minimized to make it easy for organizations and partners
- End-to-End Solution – not a replacement for product documentation
- Modular documentation:
  - One design guide (what/why)
  - One/multiple related deployment guides (how)
  - Can include additional configuration guides or other collateral
- CVD delivery dependencies:
  - Solution Test (scale and performance) completion and results
  - FCS of software for included components
  - Successful integration into IoT Solutions CVD labs (including new hardware components)

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Cisco Validated Design (CVD)

cisco.com/go/iotcvd

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Solution Support (SSPT)

IoT Cisco Validated Designs and SSPT:

- Conn. Communities Infra
- Distribution Automation
- Grid Security
- Connected Machines
- Industrial Automation
- Extended Enterprise
- Remote & Mobile Assets

Service feature	Smart Net Total Care	Software Support Service (Basic/SWSS)	Solution Support
Cisco® 24x7 product-level technical support	●	●	●
24-hour access to Cisco online resources	●	●	●
Network management / software update and upgrades	● [1]	● [2]	●
Hardware replacement (2- and 4-hour, next business day)	●		●
Primary point of contact delivering centralized support across solution deploy.			●
Solution expertise			●
Coordination of Cisco TAC & Solution Support Partner product support teams			●
Case management from first call to resolution			●
Proactive support to identify and mitigate potential issues or resolve			●
Prioritized case handling			●
30-minute service level response time for high priority issues			●
Ability to open a case without isolating a specific product			●

[1] OS only
[2] Apps only

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Kinetic for Cities

IoT solutions - Cities

Why Smart Cities?

Lighting

Up to **38%**

of overall municipal utility bill

Parking

30%

of traffic congestion is caused by drivers circling to find a space

Environment

$1.7T

economic impact due to air pollution

Urban Mobility

$300B

Annual cost of congestion for US drivers.
$1400 per driver

Safety and Security

$3.2T

annual cost of crime in the US, including both direct and indirect costs

Waste Management

60%

inefficiency in waste bin collection

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City data is often there but typically in silos

Safety and Security

Urban Mobility

Lighting

Environment

Parking

Waste Management

- Limited Sharing of Operational Insights
- Limited Sharing of Infrastructure Costs and IT Resources
- Lack of Cross Domain Data and Information Sharing
- Missed Opportunities for Synergies and Cost Efficiencies

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Network as the foundation for managed city

Cisco Kinetic for Cities- What does it do

Application Layer

Cisco Kinetic for Cities

Infrastructure Layer

Cisco Connected Communities Infrastructure for Cities

Data From Any Device

- Connect with any technology
- Aggregate and normalize data across multiple sensors
- Provide a digital model for the city

Cross-Domain Information

- Enable cross-domain contextual control (i.e., With outdoor lighting & crime)
- Process automation through policies

Open Ecosystem

- Expose APIs for local and global ISVs applications
- Secure key management and Role-Based Access Control

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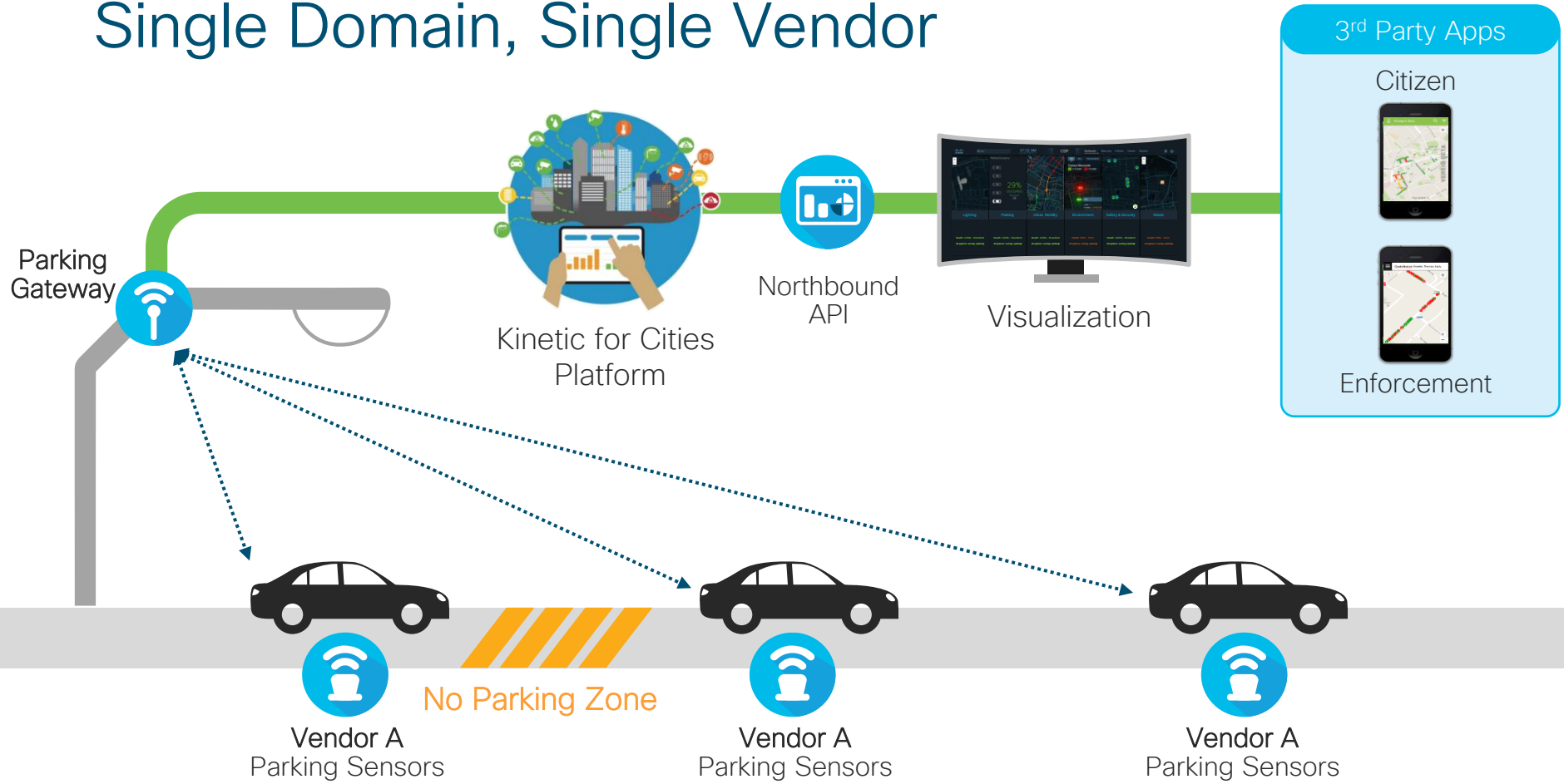
Single Domain, Single Vendor



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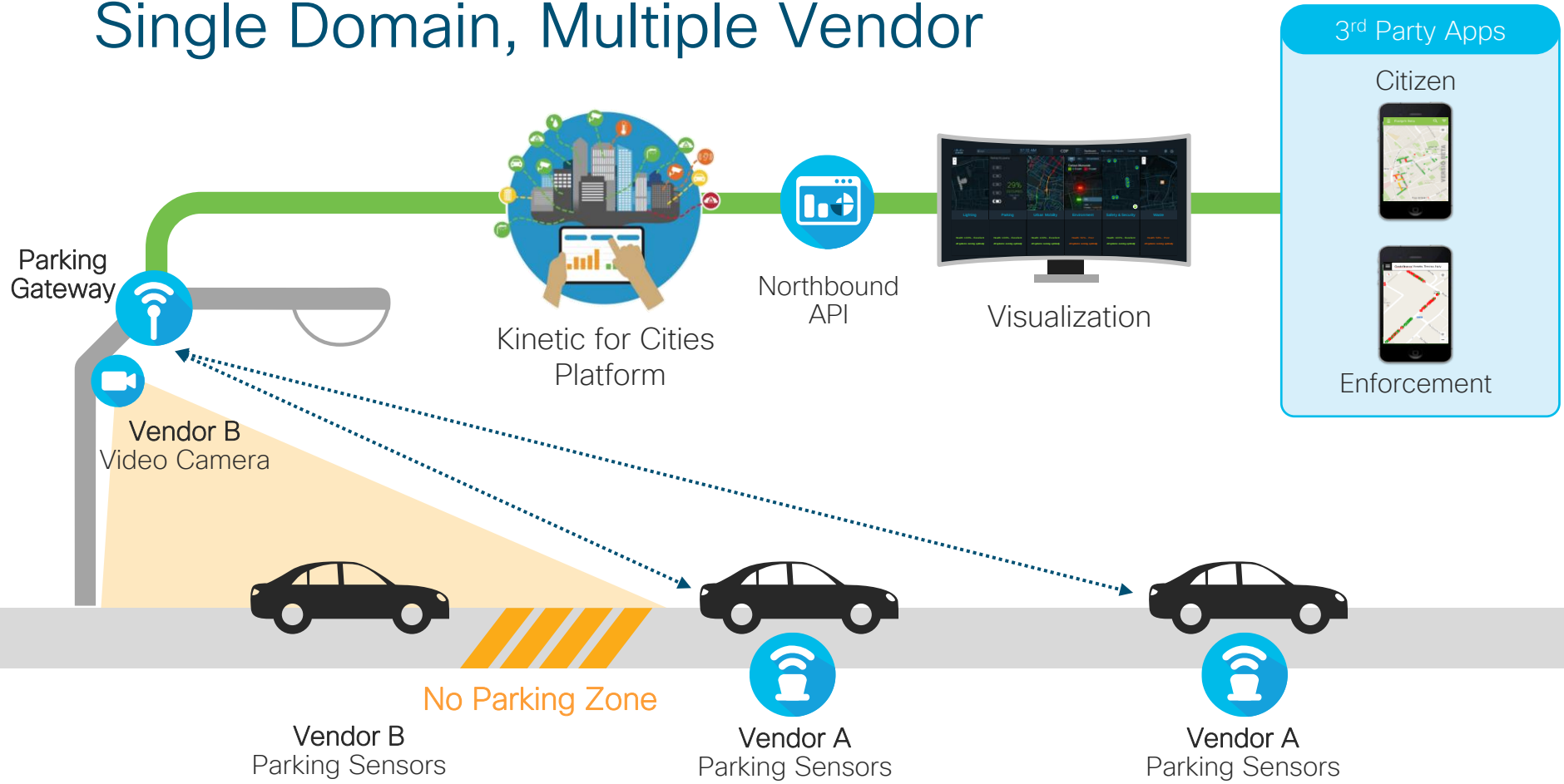
Single Domain, Multiple Vendor



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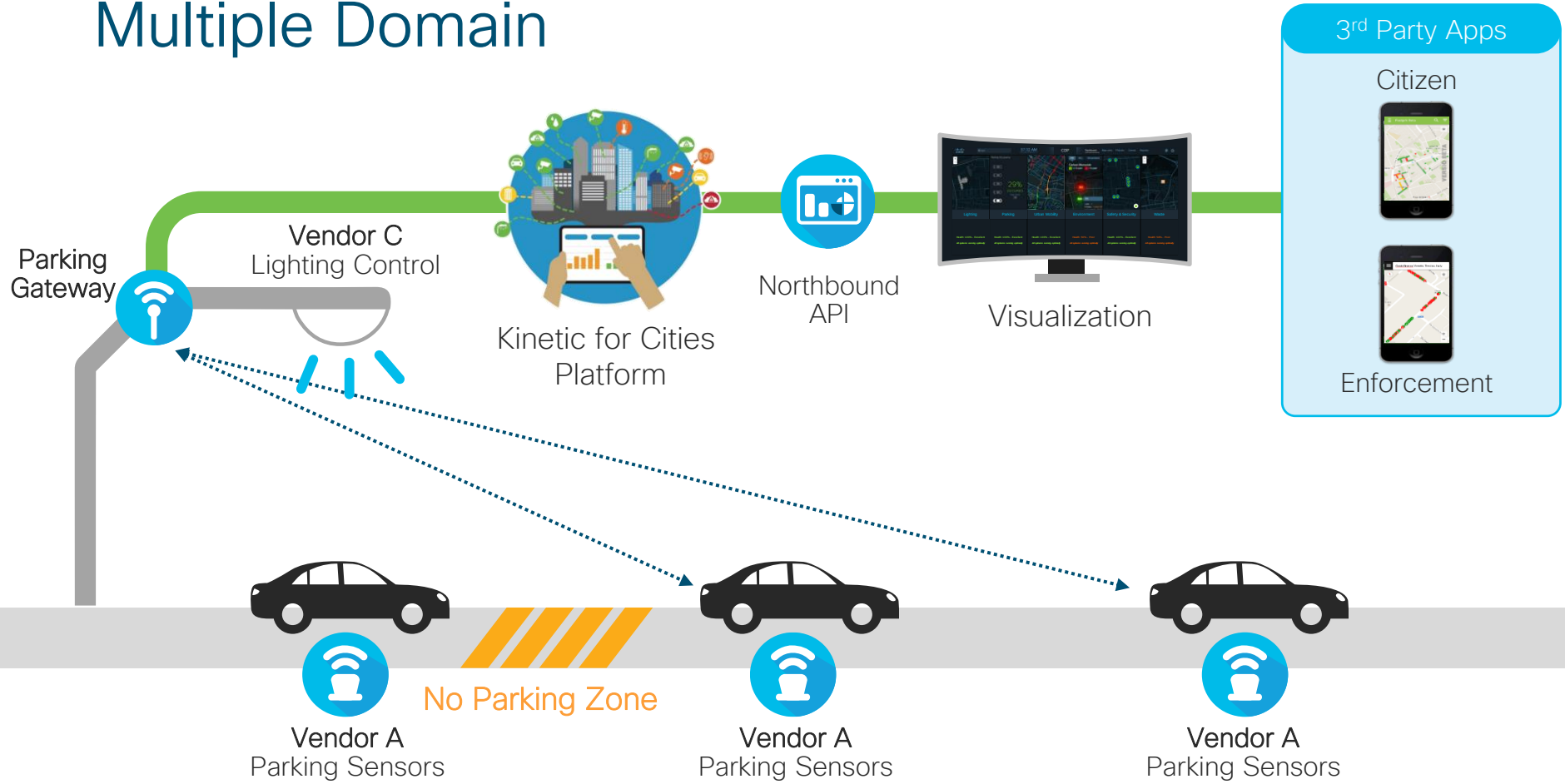
Multiple Domain



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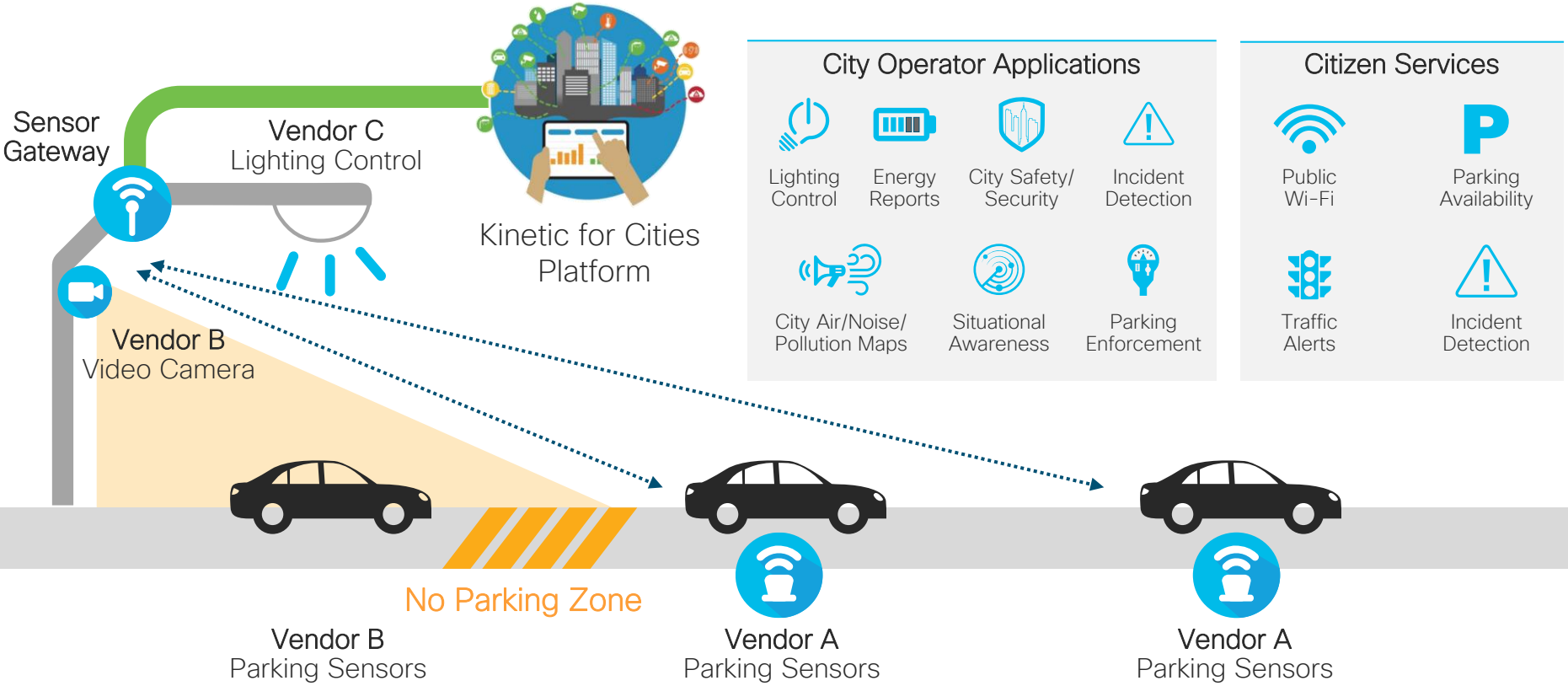
Correlations Between Domains



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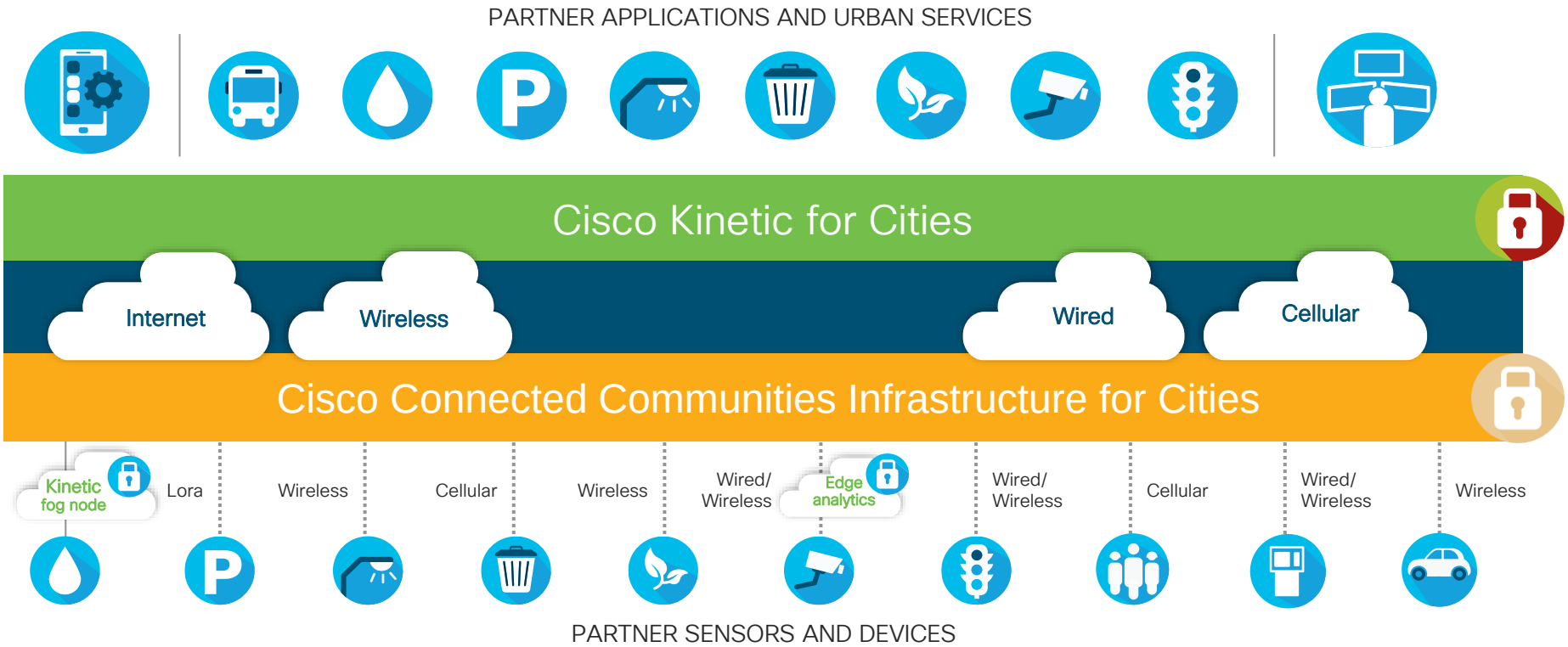
CKC High Level Architecture



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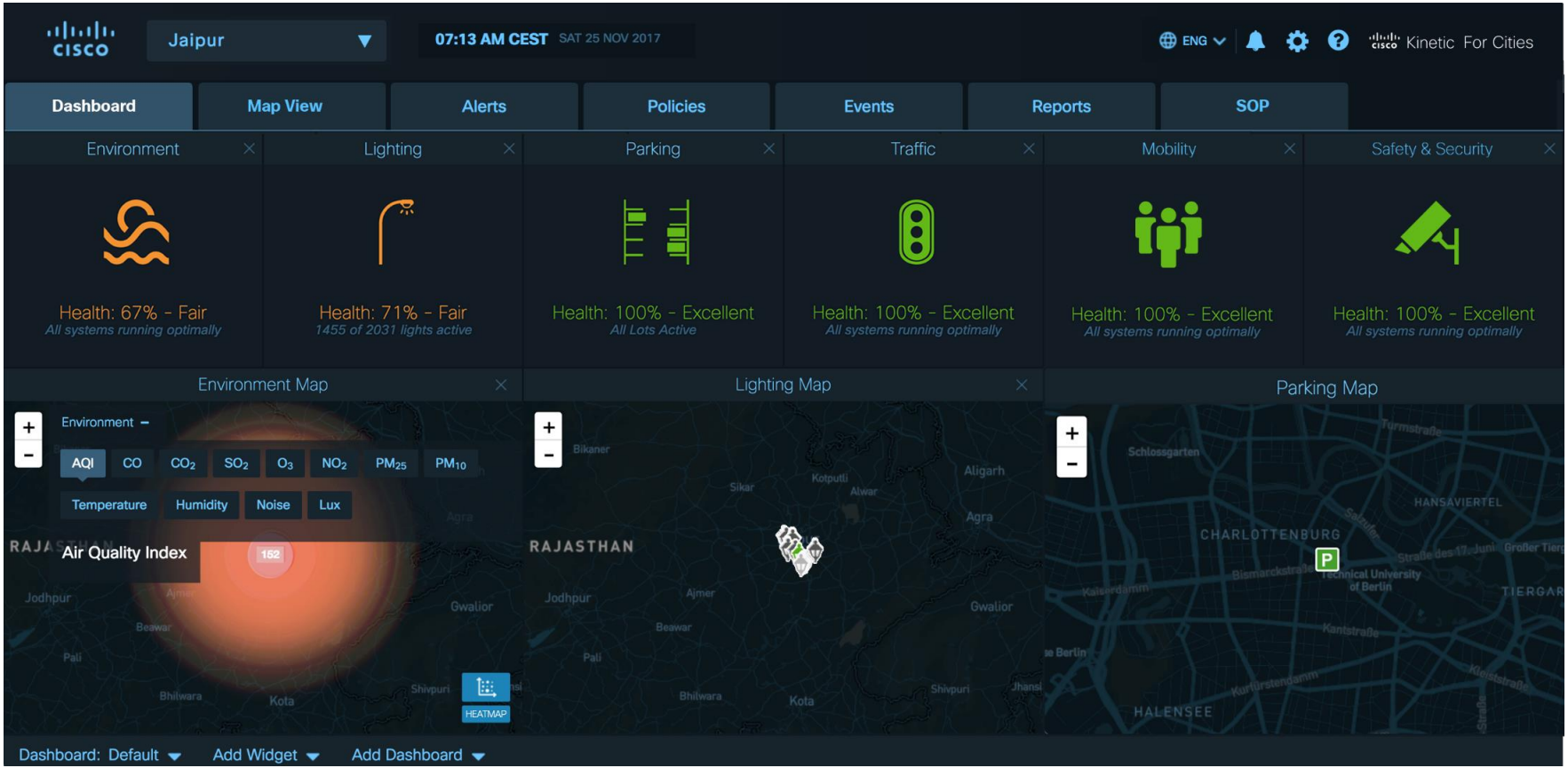
CKC Dashboard: Single pane for city data



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Cisco Kinetic for Cities (CKC) - Summary

- Use case
  - Monitoring of multiple systems within the city
  - Aggregating data from multiple vendors (data providers)
  - Data visualisation

- Outcomes
  - Single dashboard for all domains
  - Automated alerting in case of an issue
  - API to build custom applications

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DEMO – Cisco Kinetic for Cities

Connected Communities Infrastructure

IoT solutions - Cities

What is Connected Communities Infrastructure?

- Cisco Validated Design (CVD)
- Guides a customer to design and deploy a multi-service, multiple access technologies network
- Can be deployed in City / Metropolitan area / Campus / Geographic region / or along Roadways
- Delivers Intent-based Networking by leveraging Cisco's Software-defined Access (SDA) with Cisco DNA-Center management and Identity Services Engine (ISE)
- Uses industrial ruggedized edge hardware
- Enables scalable, segmented and secure network

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Framework for Cities, communities, & roadways

Many varied applications and use cases for

- Efficiencies and cost savings
- Improved citizen and road safety
- New services and citizen engagement
- Data and metrics for planning

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Connectivity technology and options

External < Control > Internal

OpEx < Costs > CapEx

Cellular 3G, 4G, 5G
- Variable to high bandwidth, easy to deploy
- Variable monthly cost, dependent on mobile SP

NB-IoT, public LoRa
- Long range, low power, low bandwidth
- Variable coverage and monthly cost, dependent on mobile SP

LoRaWAN, mesh
- Long range, low power, low bandwidth
- Great for sensors with small data payload

802.11 Wi-Fi
- High bandwidth, broadly supported
- Public spectrum, prone to interference

Fiber or wired Ethernet
- Highly versatile, high bandwidth, long range
- Costly to deploy unless fiber already available

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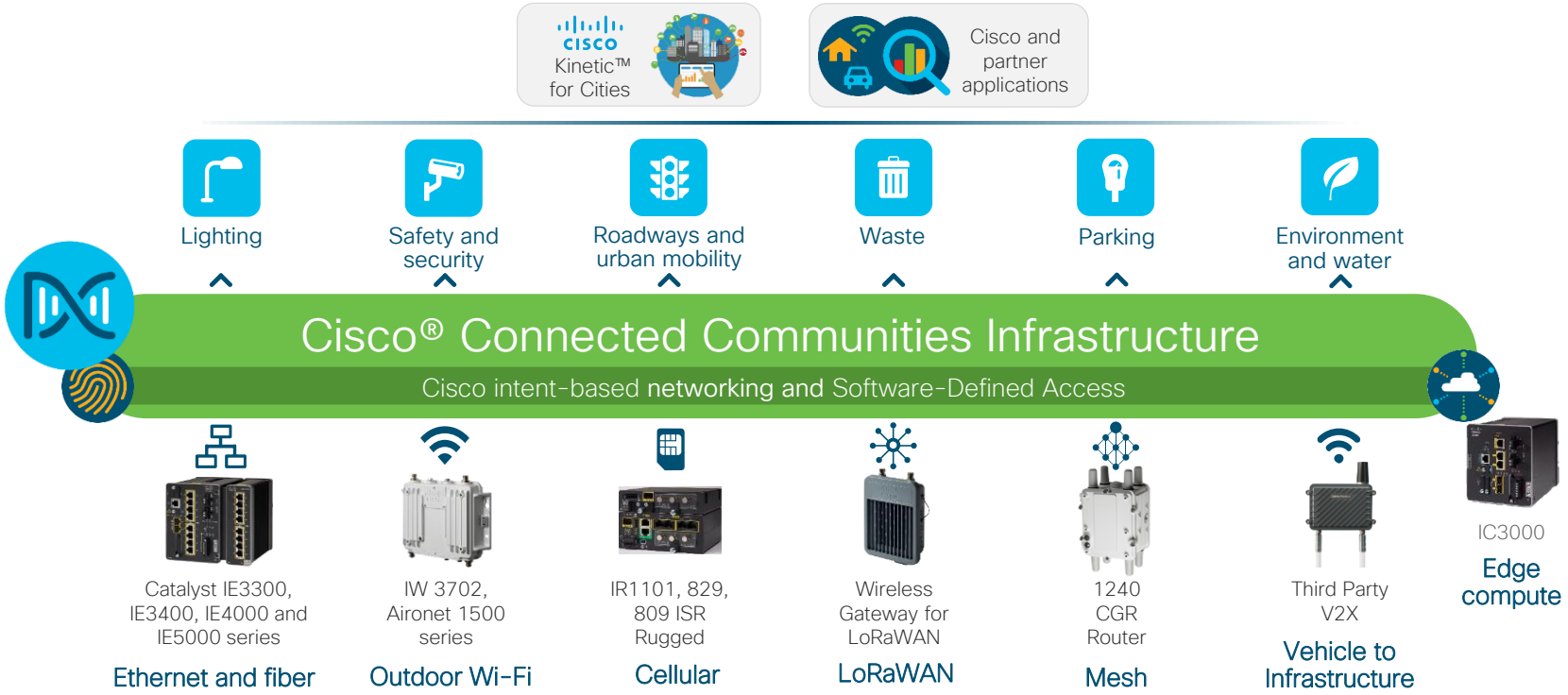
Cisco Connected Communities Infrastructure

A Cisco Intent-Based Network for Smart Cities and Connected Roadways



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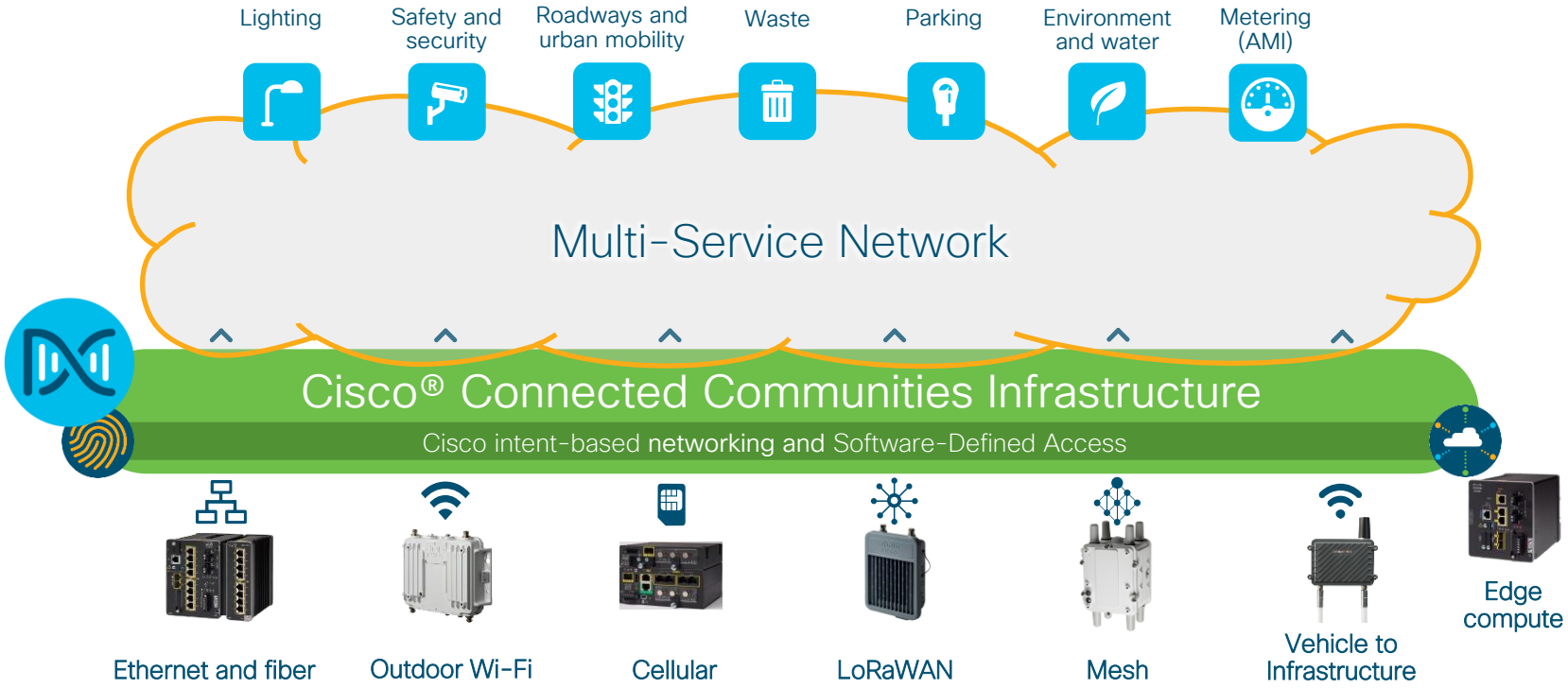
Virtual Networks and Segmentation
with Cisco Software-Defined Access



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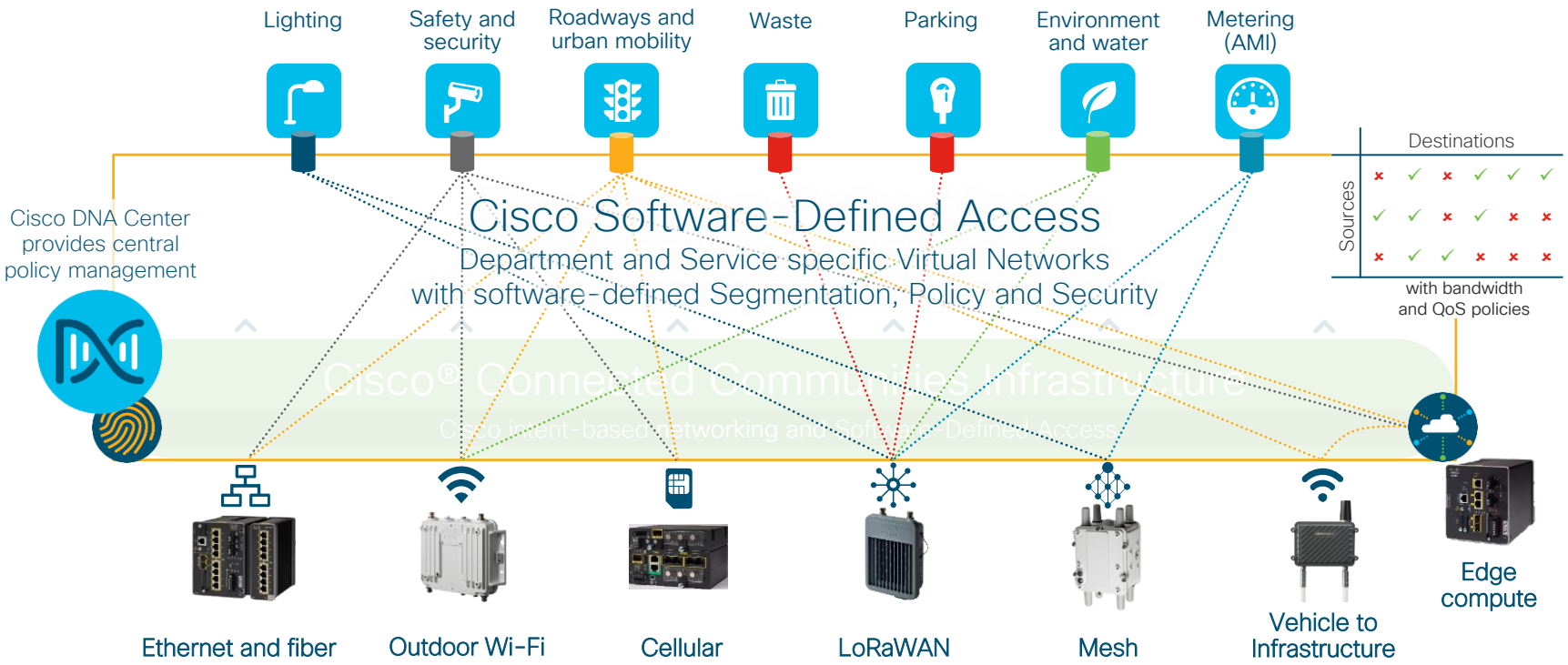
Virtual Networks and Segmentation

with Cisco Software-Defined Access



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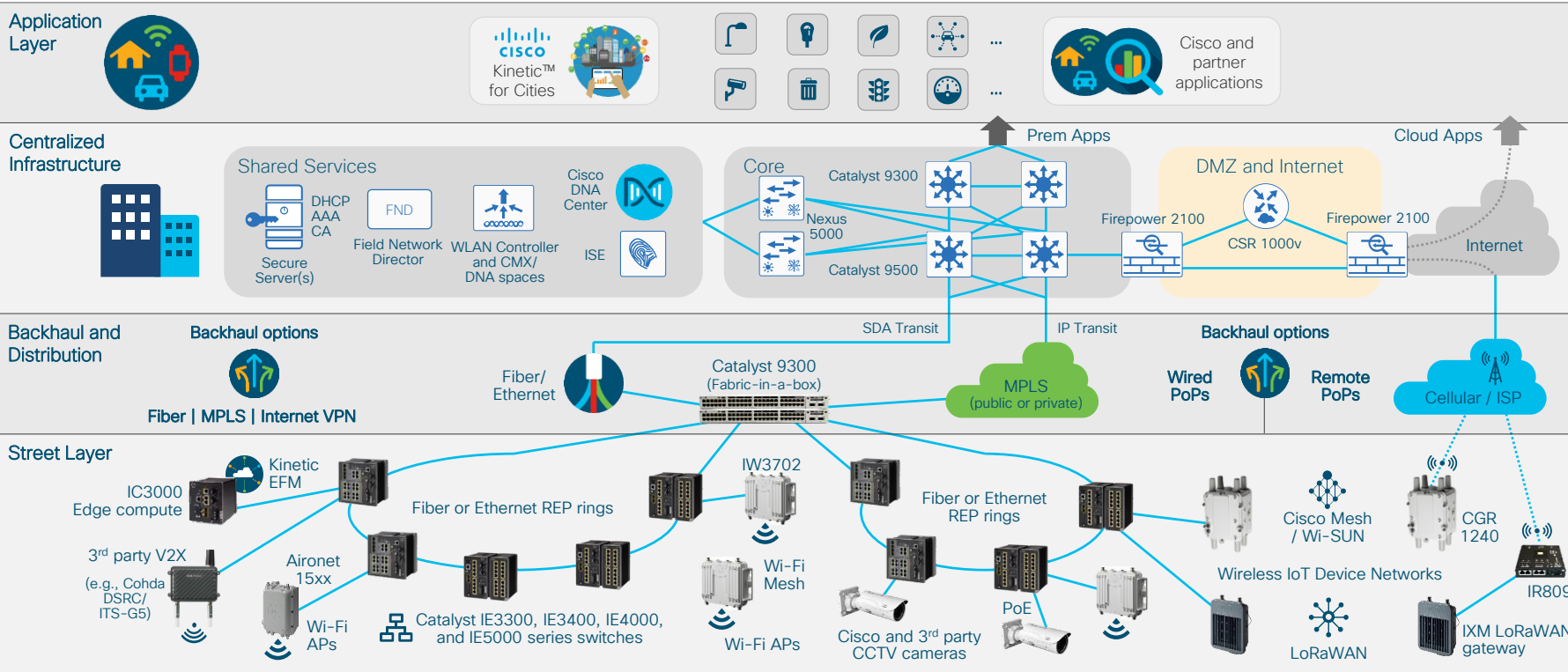
Connected Communities Infrastructure 1.0

High-Level Overall Architecture



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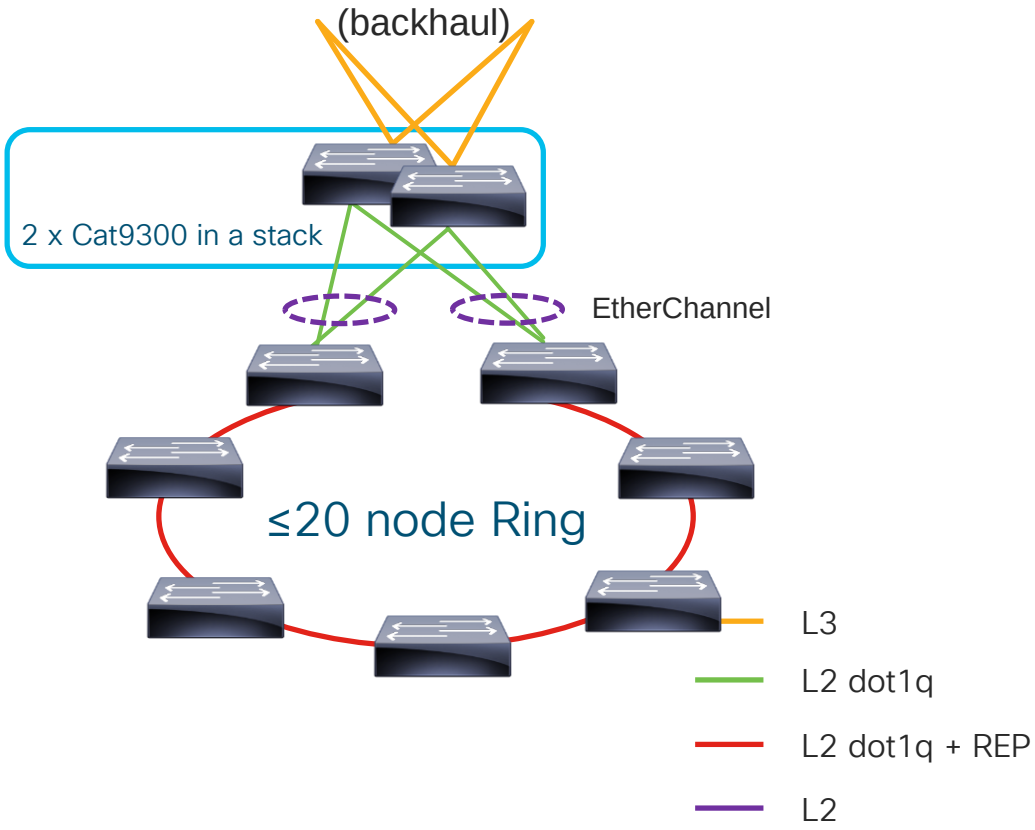
Connected Communities Infrastructure 1.0

Point of Presence (PoP): Network Topology

- CVD tested Cat9300 as collapsed core-distribution (and to some degree, WAN router).
- CVD tested IE-3300, 3400, 4000 and 5000 as access switches.



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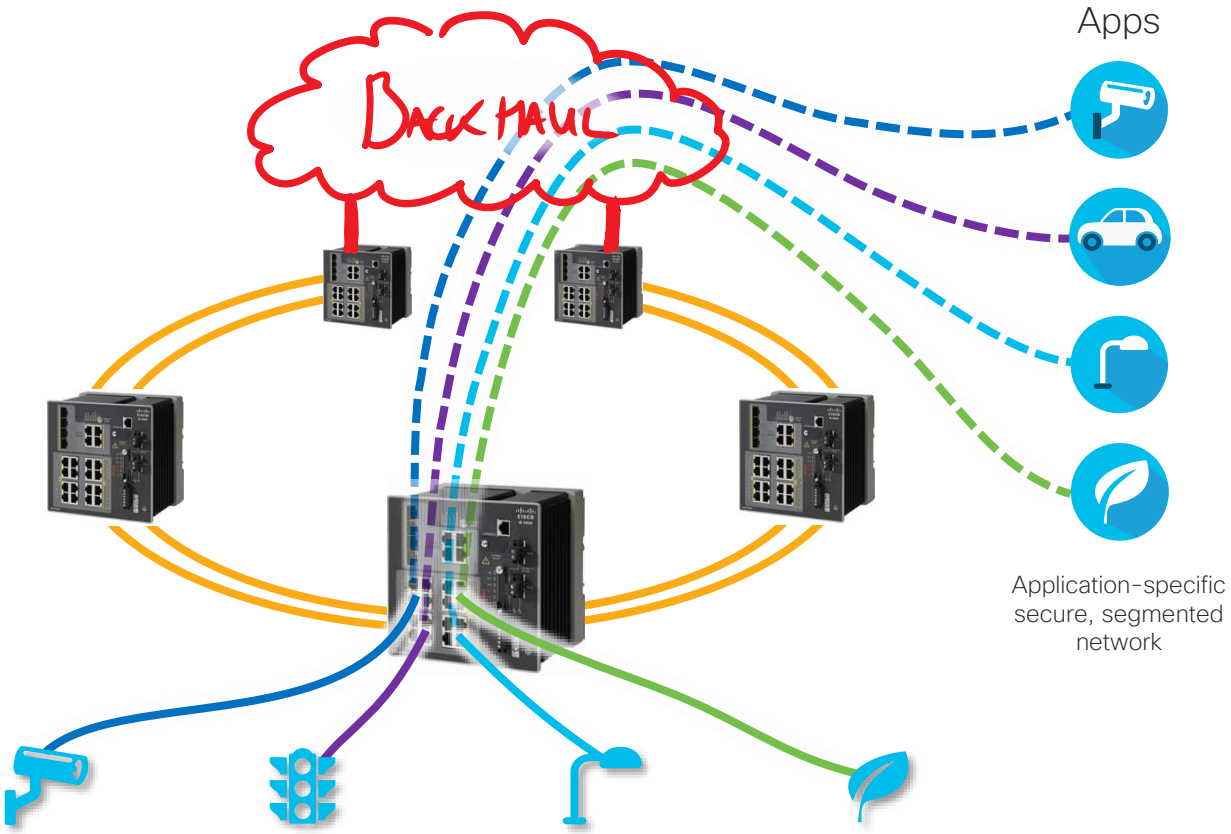
Connected Communities Infrastructure 1.0
Multiservice + Segmented + Intent-based

- **Fully Secured**
  - Port-level segmentation
  - End-to-end Security - Sensor/Device to App
- **Simplified Management**
  - No per-Port/Service ACLs
  - Powerful end-to-end Management tools (DNA-Center, FND)



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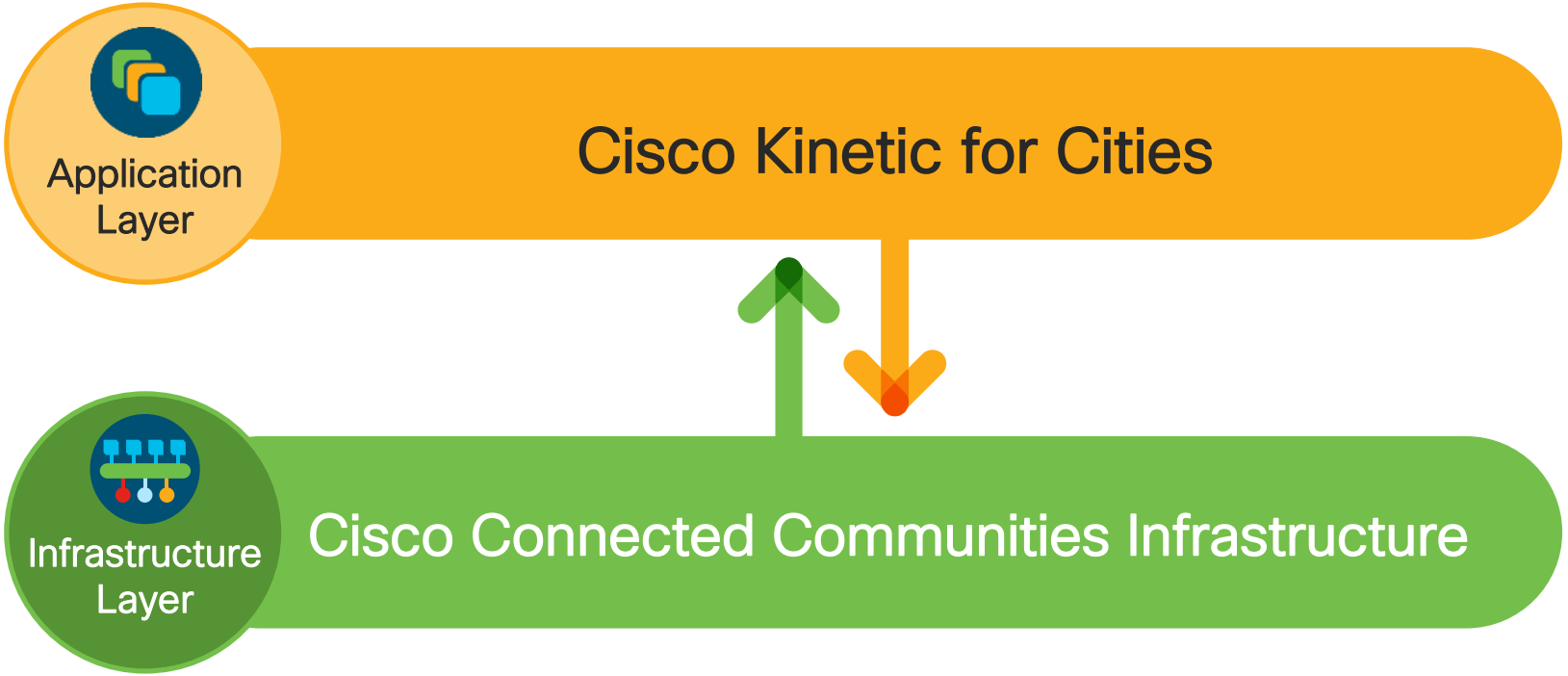
Cisco's Approach for Smart Cities



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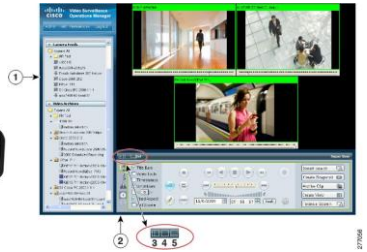
Connected Communities Infrastructure 1.0

Applications: Examples



ThingPark by actility

cisco
Kinetic™
for Cities

- Video Management System (e.g. Cisco VSOM) for CCTV
- Street Lighting control system (e.g. Cimcon LightingGale) for Smart Lighting
- Camera-based vehicle detection (e.g. Iteris Vantage Next) for Connected Intersections
- LoRaWAN Network Server (e.g. Actility ThingPark) for LoRaWAN services
- Overall smart city platform (e.g. Cisco Kinetic for Cities)

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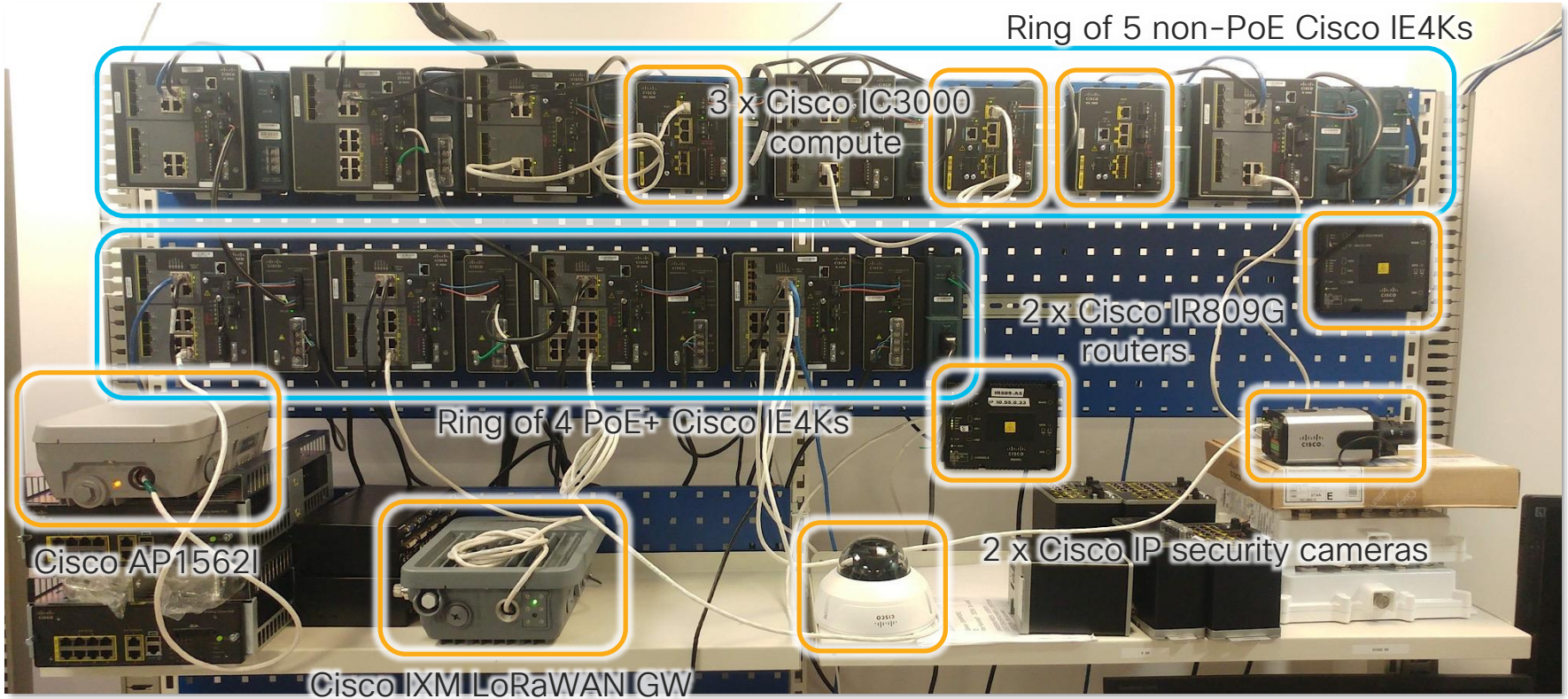
Use Case - CCI 1.0 on the bench
Literally



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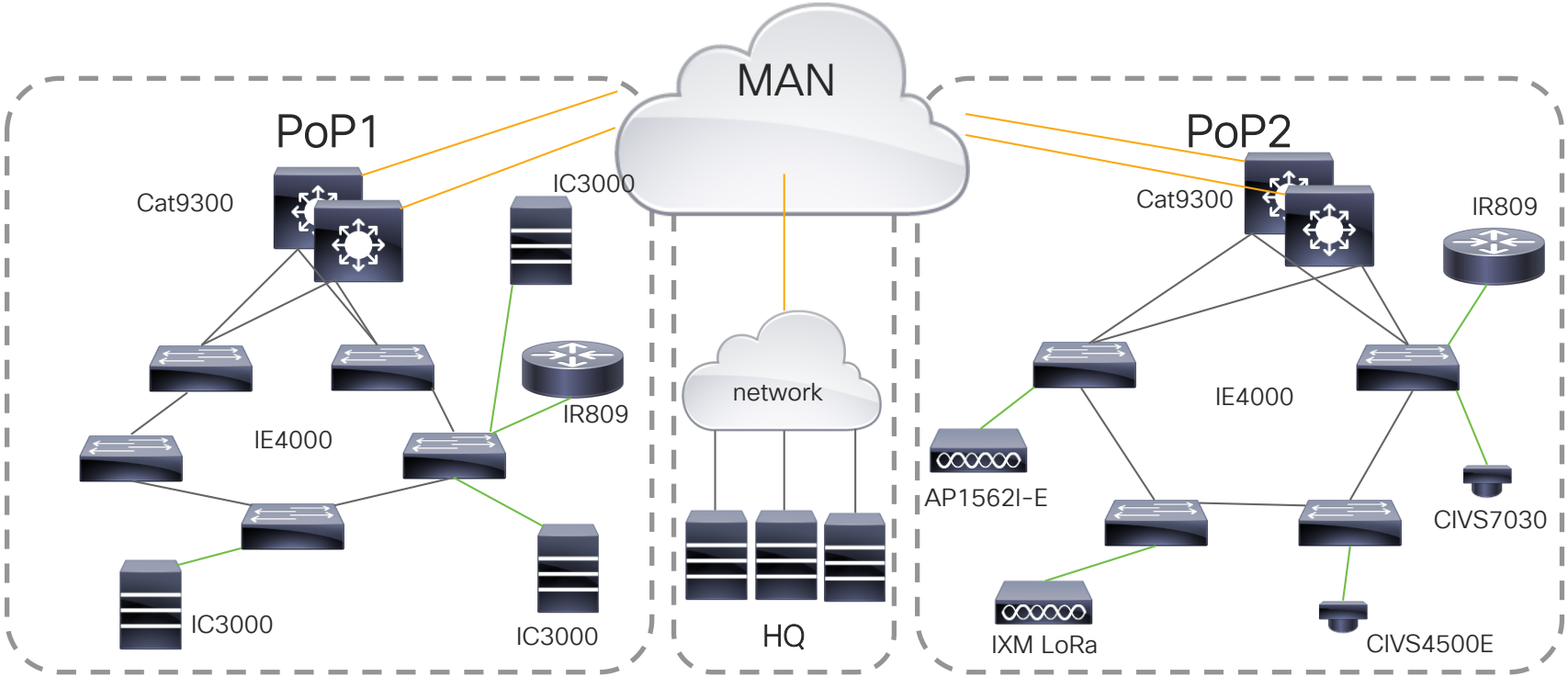
CCI on the bench
Network Topology



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Connected Communities Infrastructure

- Use Case
  - World's first multi-service Intent-based network blueprint for connected communities
- Outcomes
  - Reduce City Costs
  - Safer Roads and Intersections
- Solution
  - Modular expandability
  - End-to-end Segmentation
  - Access Policy automation
  - Holistic security

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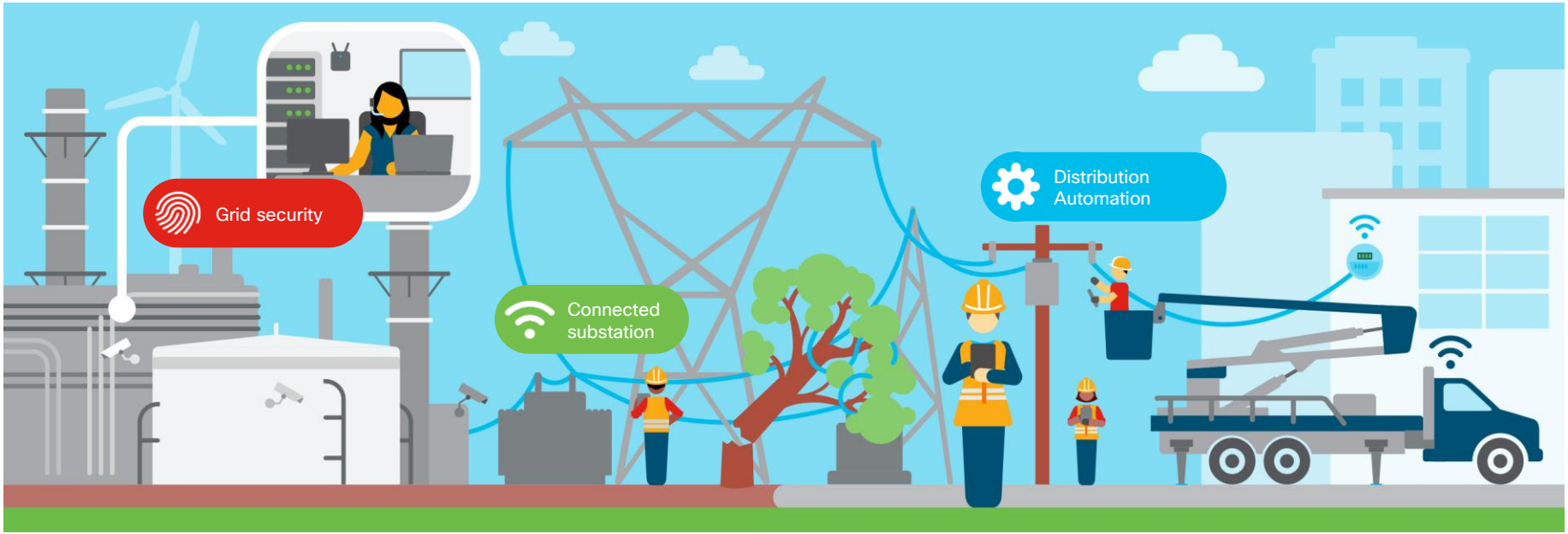
Power and Utilities

IoT solutions

Power and Utilities



- Grid security
  - Cybersecurity
  - Physical security
- Connected substation
  - Substation automation
  - OT WAN
- Distribution Automation
  - Volt/ VAR optimization (VVO)
  - Fault location, isolation (FLISR)
  - Advanced metering infrastructure (AMI)

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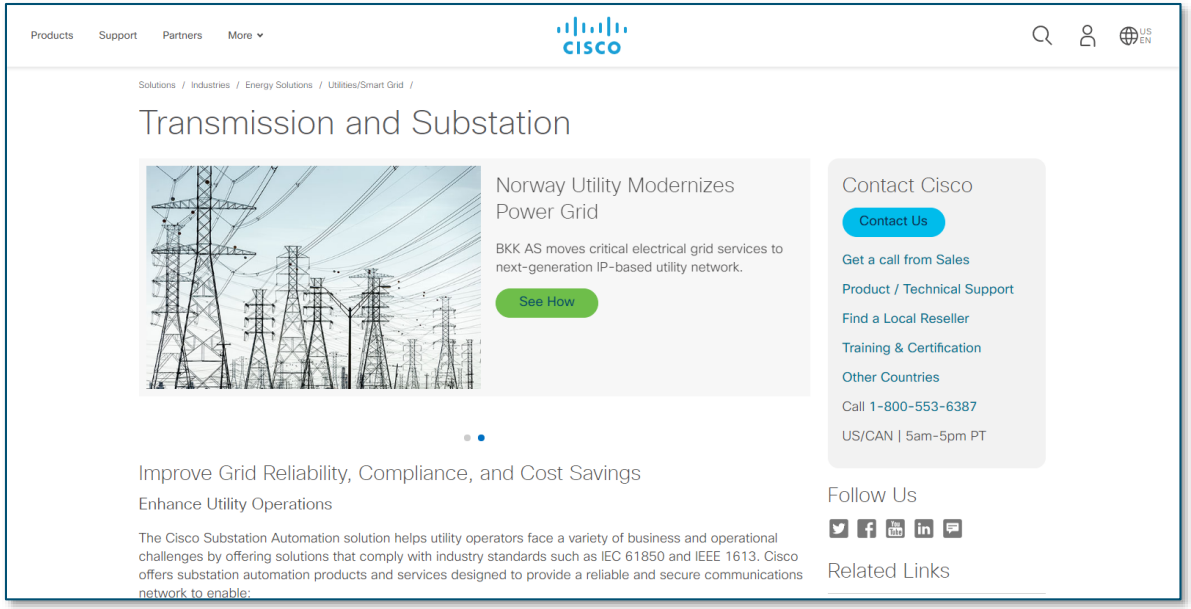
Connected Substation

IoT solutions – Power and Utilities

cisco Live!

Connected Substation CVD

- Substation Automation:
  - Reliable and secure communications network
  - Protection and control
  - Remote diagnostics
  - Predictive maintenance solutions
- OT WAN / Utility WAN
  - TDM/SDH to IP/MPLS
  - Substation connectivity



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Substation automation

Provide protection, control, automation and monitoring via communication capabilities as a part of a comprehensive substation automation solution.

Industry drivers	Business needs	Capabilities	Business outcomes	Stakeholders
• Incorporation of distributed alternative energy sources • Replacement of aging infrastructure • Modernization of grid • Installation of smart grids to improve reliability and efficiency of the electric grid	• Comply with Industry standards and regulation – NERC/CIP v5 and others • Improve operations and maintenance • Increase system and staff efficiencies • Leverage and defer major capital investments	• Enable remote control diagnostics & predictive maintenance • Enable physical monitoring of substations • Maintain strong regulatory compliance • Provide secure communication to substations • Substation ruggedized hardware to meet reliability standards	• Avoid unplanned downtime and corresponding power delivery interruption • Improve grid reliability • Reduce OpEx and Improved revenues • Prolong the useful life of costly capital assets such as transformers	• Substation Eng. • OT Telecom • Telecom Engineering • Protection Engineering • Distribution Eng. • Control Systems Eng. • CISO • Security Department • Grid Planning Personnel • Corporate Risk

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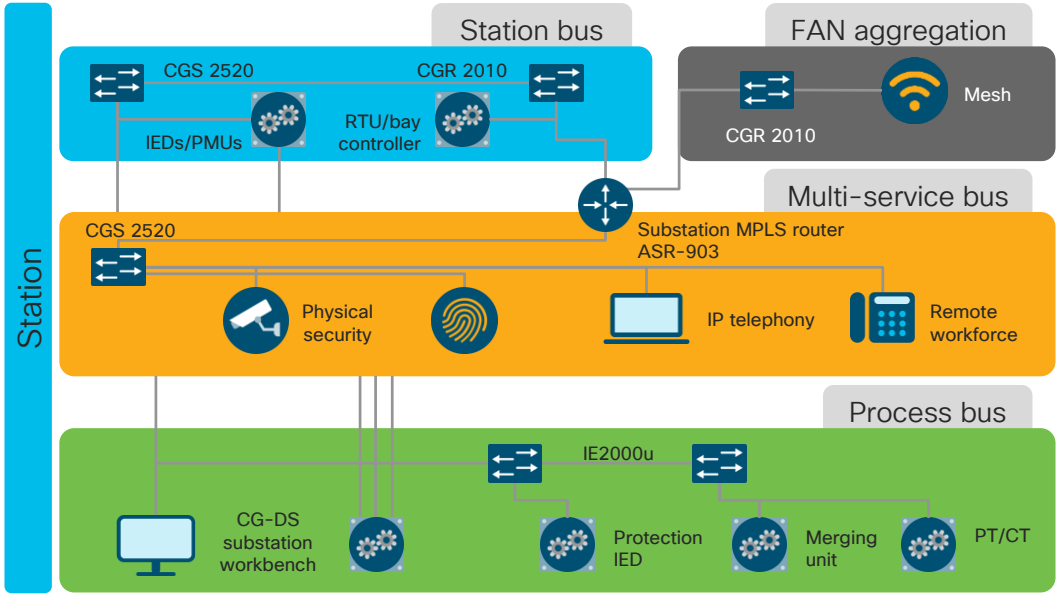
Substation automation



Cisco products

Component	
Routing	Connected Grid Router (CGR) 2010 Industrial Router (IR) 800
Switching	Industrial Ethernet (IE) Switches Portfolio
Wireless	Aironet 1552 Outdoor Access Point and Industrial Wireless portfolio Wireless LAN Controller (WLC)
Network management	IoT Field Network Director (FND)
Security	Industrial Security Appliance (ISA) 55xx Industrial Security Appliance (ISA) 3000

Solution partners

RTU (remote terminal unit) partner
SCADA system partner
Substation gateway partner

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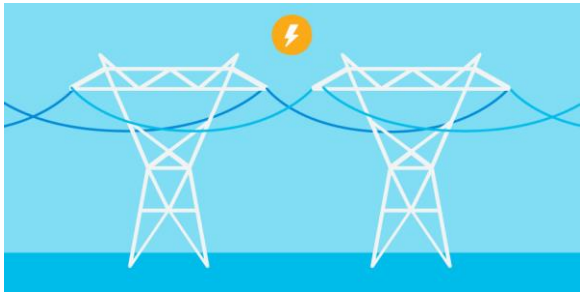
OT WAN/transmission networks



Enable highly reliable and secure substation IP connectivity via both private WAN and public carrier circuits.

Industry drivers	Business needs	Capabilities	Business outcomes	Stakeholders
• Safe, reliable, and efficient power delivery • Maximize power generation and delivery • Avoid worker injury and minimize property damage • SONET and TDM Discontinuance	• Improve Teleprotection • Technology modernization • Growing Distribution Grid Administration • System reliability • Improve real-time monitoring, analytics and automation	• Packet Network with advanced virtualization • Hardened equipment for electric grid environment • NERC/EPCIP CIP Compliance • Agility - Enable new Distribution Grid applications	• Lower cost of OT/WAN • Improved business function reliability • Regulatory Compliance • Minimize Cyber risk	• Telecomm Engineering • Protection Engineering • Control Systems Engineering • Metering • Security Department

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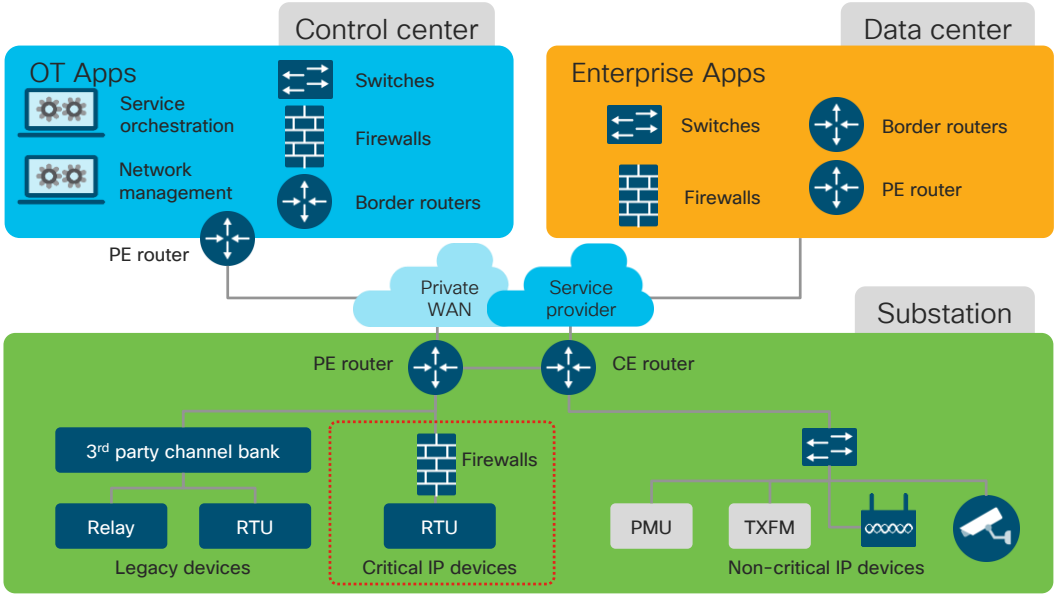
OT WAN/transmission networks



Cisco products

Component	
Routing	Connected Grid Router (CGR) 2010 Aggregation Services Router (ASR) 900 Industrial Router (IR) 800
Switching	Industrial Ethernet (IE) 5000 Series Switches Industrial Ethernet (IE) 4000 Series Switches Connected Grid Switch (CGS) 2520
Wireless	Industrial Wireless 3700 Series Access Points Aironet 1500 Series Access Points
Security	Industrial Security Appliance (ISA) 3000
Key enabling technologies	Multiprotocol Label Switching (MPLS) and segment routing
WAN modeling	WAN Automation Engine

Solution partners

Teleprotection hardware partner

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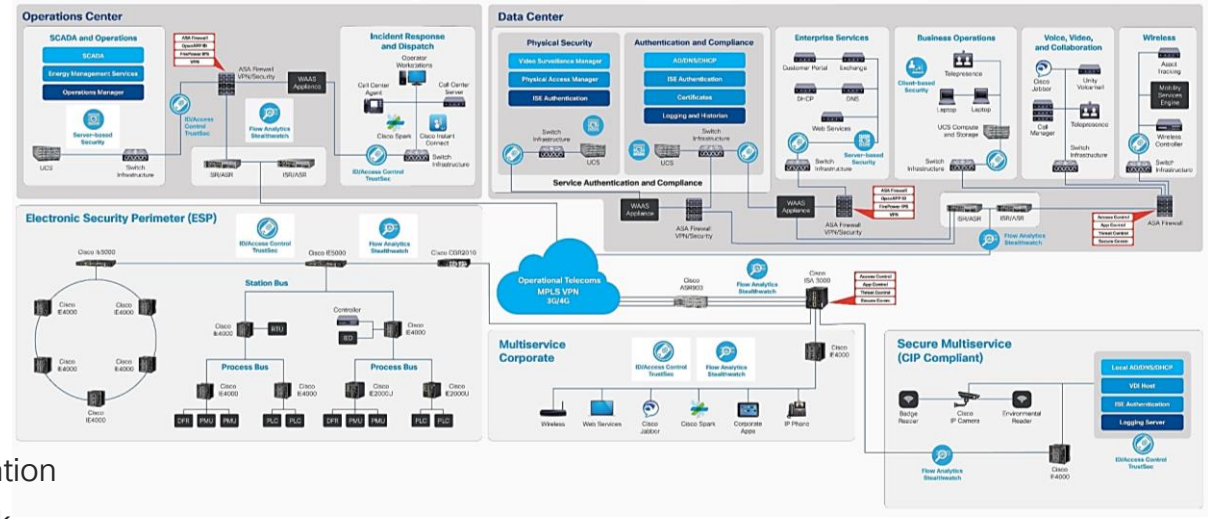
Connected Substation- Summary

- Use Case:
  - Substation Automation
  - Utility WAN
- Outcomes:
  - Lower cost of OT/WAN
  - Improved reliability
  - Regulatory Compliance
  - Prolong life of costly capital assets
- Solution:
  - Provide connectivity and segmentation
  - MPLS/TE/TP based packet network



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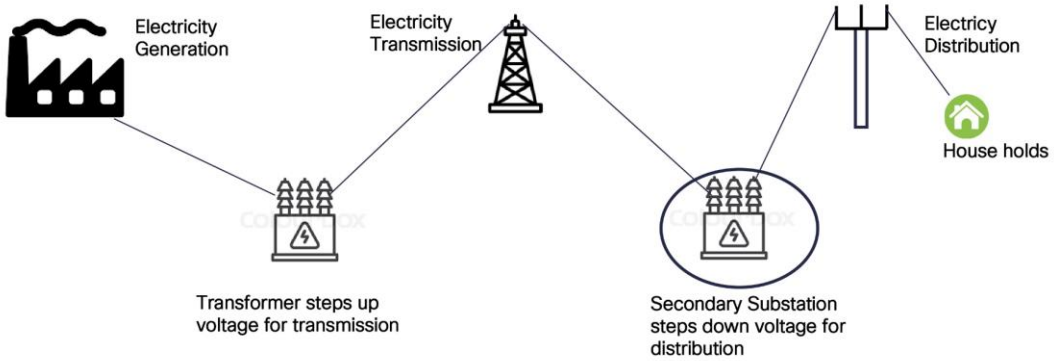
Distribution Automation

IoT solutions - Power and Utilities

Distribution Automation CVD

Distribution Automation architecture addresses substation automation and the utility requirements for Volt/VAR, FLISR and AMI

- In North America, portions of South America, and along the Pacific Rim, distribution is based on a decentralized transformer model: Feeder Network
- In Europe, portions of South America, and Asia, distribution is based on a more centralized transformer design: Secondary Substation



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Why?

Addressing large scale deployments systematically

Improve Reliability
- Fault notifications & remediation
- Edge intelligence
- Real time data
- Real time decisions & actions

Improve Safety & Security
- Remove humans from hazardous environments
- Advanced failure warnings

Reduce Operational Costs
- Reduced truck rolls
- Simplified Deployments
- Single Management platform

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Distribution automation: challenges and drivers

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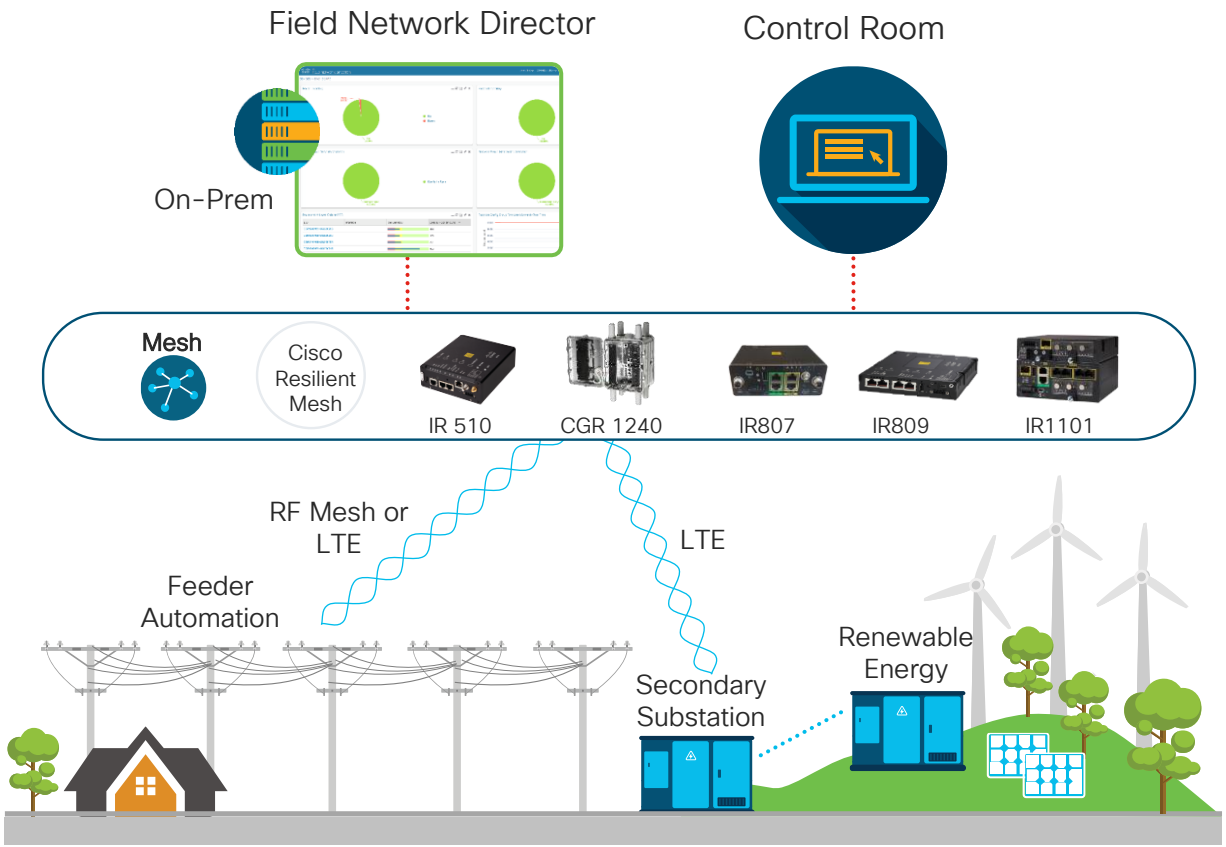
Distribution Automation – High Level



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Volt/VAR optimization (VVO)

Voltage optimization enables the electric utility to reduce costs via the large scale deployment of sensors, which require secure, reliable connectivity.

Industry drivers	Business needs	Capabilities	Business outcomes	Stakeholders
• Incorporation of Distributed Energy Renewable systems • Reduce technical losses • Improve reliability of distribution grid	• Asset monitoring • Measure, comply and report on industry standards • Avoid regulatory compliance fines • Improve margin and reduce OPEX • Improve customer experience	• TDM capabilities • Zero Touch Deployment • Incorporation of third party Volt-VAR devices • More frequent VVO measurement and control • Secure connections	• Improved safety for Grid infrastructure • Integrated Grid Planning • Real-time monitoring and analytics • Regulatory Compliance • Higher margins in reduced OPEX	• Telecomm Eng. • Distribution Eng. • Grid planning personnel • Third party enhanced Service providers • Independent power producers • Aggregators

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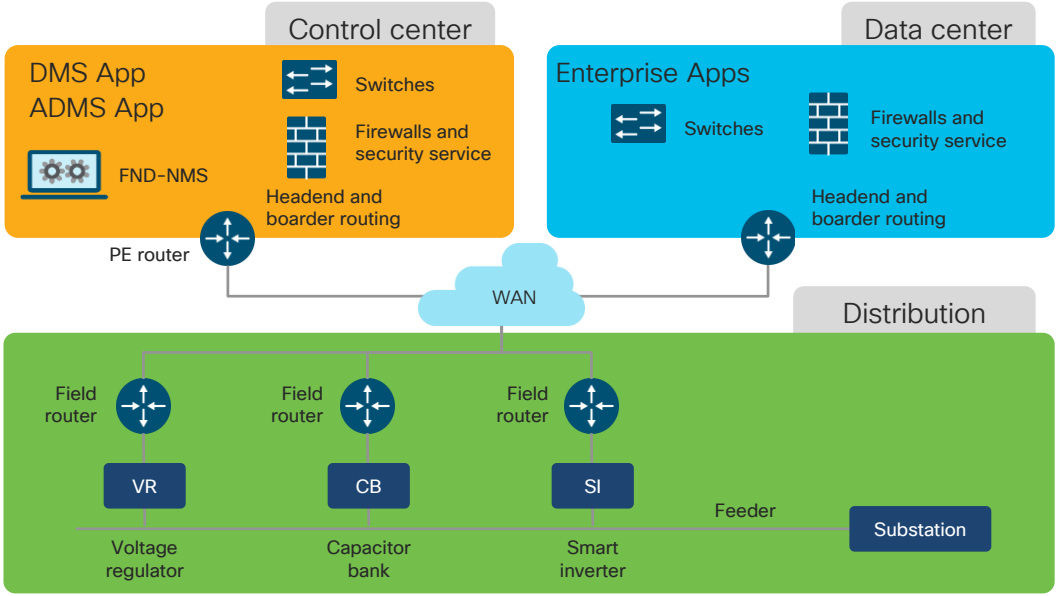
Volt/VAR optimization (VVO)



Cisco products

Component	
Routing	Industrial Router (IR) 1101, 800, 500
Wireless	LTE and Wi-SUN mesh backhaul
Network management	Field Network Director (FND)
Traffic segregation	Dynamic Multipoint VPN
Firewall	Adaptive Security Appliance (ASA) and iOS
Encryption	IPsec and Advanced Encryption Standard (AES) 256
User and device authentication and profiling	Identity Services Engine (ISE)
Security	FireSIGHT Management Center Umbrella
Visibility and analysis	Netflow Stealthwatch
Real-time threat identification	Talos Threat Intelligence

Solution partners

DMS system partner, Control system partners, Virtual RTU partners

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Fault location, isolation (FLISR)

Improving grid resiliency and mean time to repair through automated fault location, isolation and the subsequent restoration.

Industry drivers	Business needs	Capabilities	Business outcomes	Stakeholders
• Improved reliability from fewer and shorter interruptions • Improve efficiency by reducing technical and nontechnical losses due natural disasters and other events • Maintain acceptable voltage levels along the distribution feeder	• Restore power to disabled circuit / customers quickly • Avoid regulator fines for prolonged outages • Minimize interruptions of power to customers	• Improve the reliability by “localizing” outages • Locate, isolate, reconfigure, and restore power to healthy sections of a circuit • Create secure highly reliable communications to FLISR infrastructure to insure FLISR application uptime is maximized	• Improve outage restoration times • Improve revenue via customer uptime • Optimize SAIFI scores to avoid financial penalties and assure rate relief return	• Distribution Eng. • OT Telecom • Telecom Eng. • Protection Eng. • Control Systems Engineering • CISO • Security Department • Grid planning personnel • Corporate Risk

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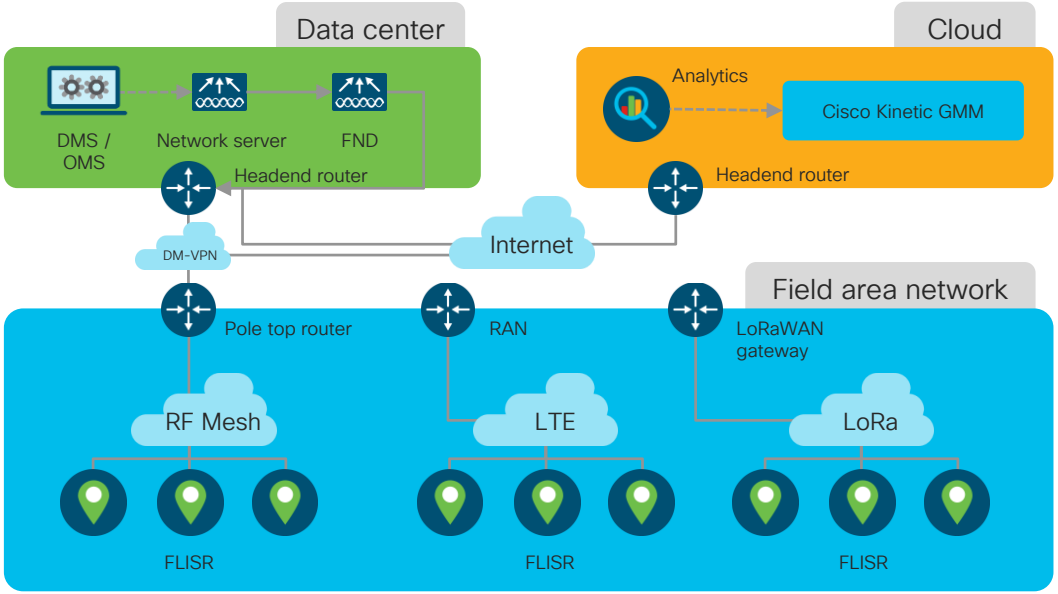
Fault location, isolation (FLISR)



Cisco products

Component	Cisco Mesh	LTE
Routing/wireless	Connected Grid Router (CGR) 1240 Connected Grid Router (CGR) 1120 Industrial Router (IR) 5xx	Industrial Router (IR) 8x9
WAN	Dynamic Multipoint VPN (DMVPN)	
Switching	✓	
Network performance	Field Network Director (FND)	Field Network Director (FND) / Gateway Management Module (GMM)
Application performance		

Solution partners

Distribution protection system vendors

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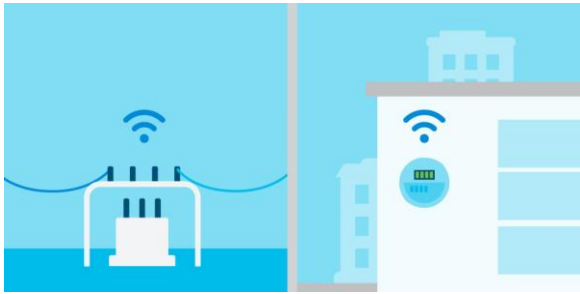
Advanced metering infrastructure



Enabling meter reads, power quality sensing and customer load profiles through automated two way communication.

Industry drivers	Business needs	Capabilities	Business outcomes	Stakeholders
• Reduce OpEx • Enable distributed energy resources • Determine consumer behavior to gain insight into planning • National metering standards can requires utility companies to provide time-based rates	• Provide better customer service as a competitive advantage • Insight into customer usage to determine demand • Time of day billing to drive peak load shedding	• Automate manual processes • Reduce costs • Improve data quality • Accurately size new substations and circuits to match peak load conditions • Detect outages more quickly • Prevent 'theft' by identifying strange usage patterns	• Improved customer service • Regulatory compliance • Peak load shedding • Outage detection and prevention to improve grid reliability • Shortens billing process	• Metering • Distribution Eng. • Telecom Eng. • Control Systems Eng. • Security Department • Grid planning personnel • Independent power producers • CISO • Corporate Risk

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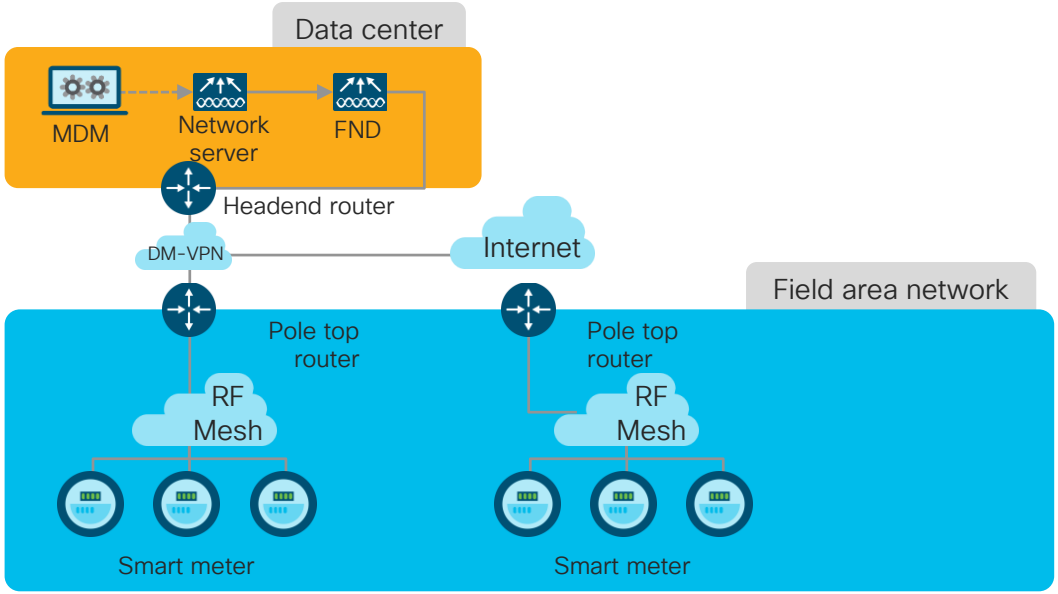
Advanced metering infrastructure (AMI)



Cisco products

Component	
Routing	✓
Switching	✓
Wireless	Connected Grid Router (CGR) 1240 Connected Grid Router (CGR) 1120 Industrial Router (IR) 5xx
WAN	Dynamic Multipoint VPN (DMVPN)
Network performance	Field Network Director (FND)
Application performance	
Meter data management	Electric and gas metering partners

Solution partners

Electric metering partners
Gas metering partners
Streetlight partners

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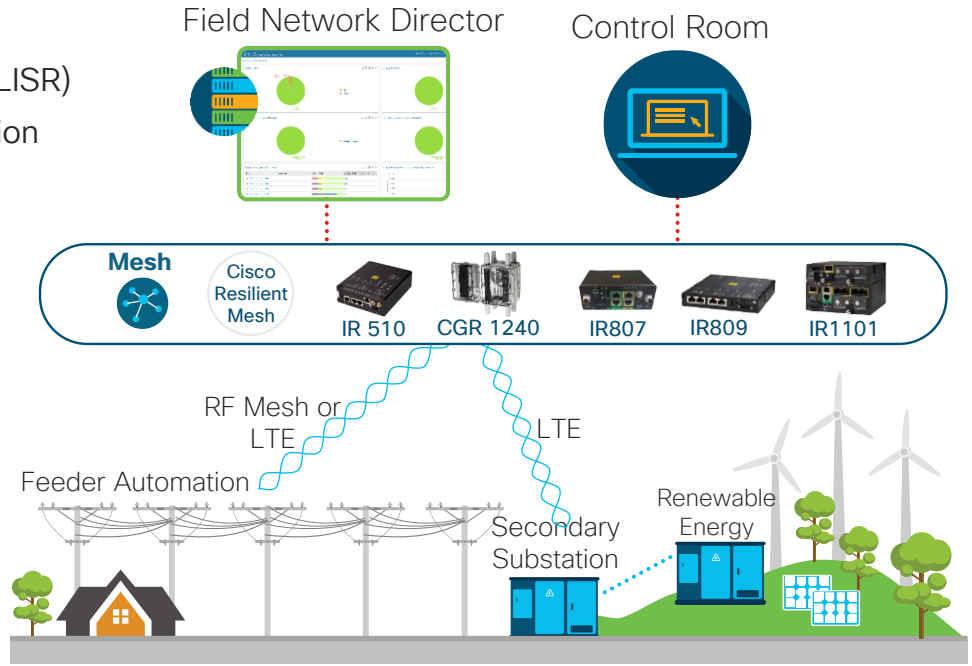
Distribution Automation – Summary

- Use Case:
  - Improved Grid Monitoring and control
  - Volt-VAR (reactive power) control
  - Fault isolation, location, and service restoration (FLISR)
  - Demand response and renewable energy integration
- Outcomes:
  - Reduce OpEx by optimizing power distribution
  - Reduce outage incidents and duration
  - Smooth integration with renewable energy
- Solution:
  - High performance mesh and cellular IoT networks
  - Industry-leading security
  - Easy deployment and management



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Grid Security

IoT solutions - Power and Utilities

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Grid Security CVD

Reduce risk and protect intellectual and physical property, grid integrity and people with industrial security technologies for OT

- Cybersecurity
  - Reduce risk
  - Mitigate the impact of advanced OT-threats
- Physical security
  - Safety and security of employees and assets

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Grid Security – Why?

Top 4 cybercrime consequences in order:

1. Information loss
2. Business disruption
3. Revenue loss
4. Equipment damages

Accenture

Combined cost of cyber attack on four industrial companies (Maerks, Mondalez, FedEx, Merck) in one quarter:

>$1 billion

Accenture

Threat groups such as Thrip and Triton have created a cyber warfare battleground and are vested in compromising operational and industrial control systems.

Symantec

Legislation and Industry compliance are driving increased spending in Cyber Security Solutions for Utilities

Cisco

Physical Security Market Worth By 2025:

$290.7 billion

Grandview Research

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Grid Security – High Level

	IT / OT Interconnect	Control Center	Generation	Primary Substations	Secondary Substations	Distribution and Field
Security Capabilities						

FirePOWER Threat Defense (Segmentation)	ISE (Segmentation)	IOS firewall (Segmentation)	ASA/ISR/CGR/IE/ISA hardware
AMP (Visibility / Analysis)	Tetration (Visibility / Analysis)	Netflow + Stealthwatch (Visibility / Analysis)	Cyber Vision (Visibility / Analysis)

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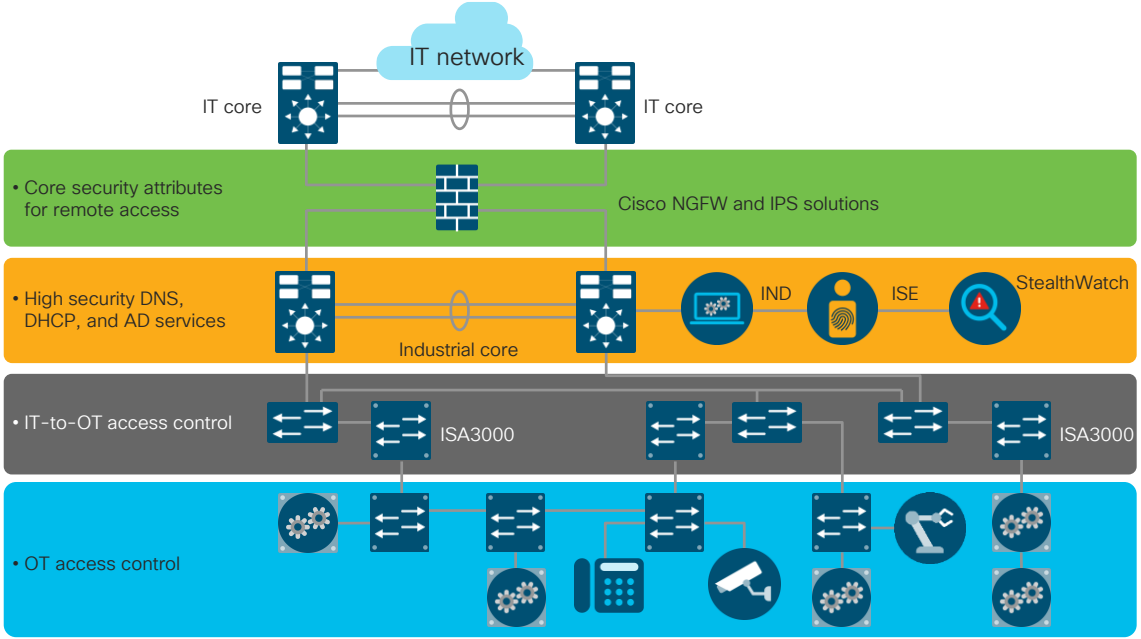
Cybersecurity



Cisco products

Component	
Industrial DMZ	Access control lists (ACLs) Intrusion detection systems (IDS) and intrusion prevention systems (IPS) VPN services Portal and remote desktop services
Industrial zone	Authentication, authorization, and accounting (AAA) identity services Network management Anomaly detection Plant-wide services Traffic enforcement (plant to IDMZ, north/south)
Inter-cell zone	Industrial Security Appliance (ISA) 3000 Industrial deep packet inspection (DPI) Stateful firewall and intrusion prevention system (IPS) Cyber Vision
Cell zone	Layer 2 Network Address Translation (NAT) 802.1X MAC Authentication Bypass (MAB) Quality of Service marking Netflow (Industrial Ethernet 4K only) TrustSec tagging (Industrial Ethernet 4K only) Edge compute (IE3400, IE4K or IR-series) Cyber Vision

Solution partners

Industrial cybersecurity software partners

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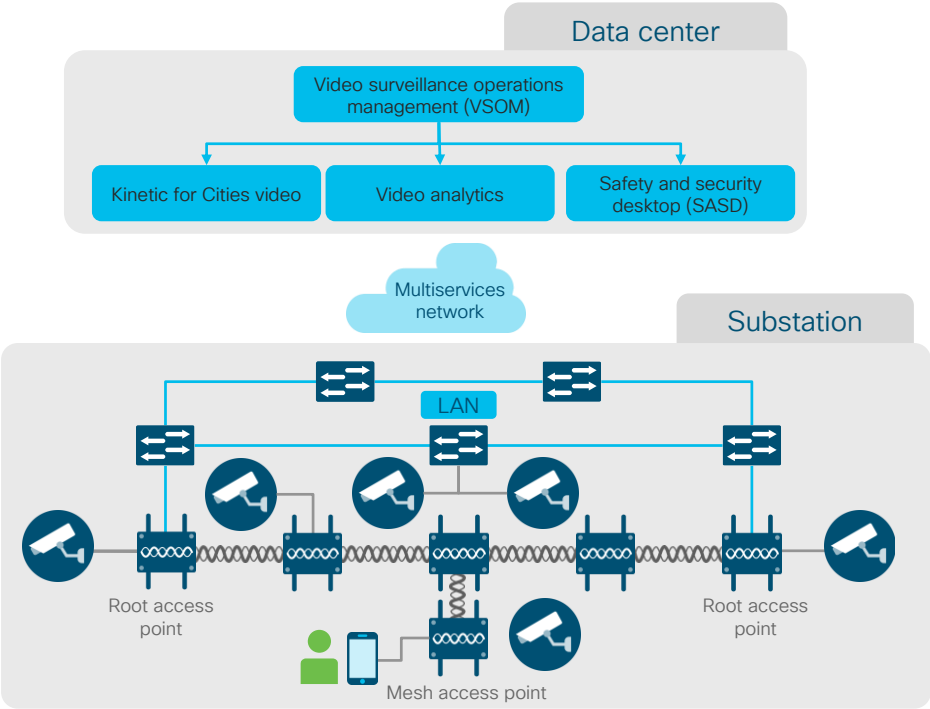
Physical security



Cisco products

Component	
Routing	Connected Grid Router (CGR) Aggregation Services Router (ASR) 920
Switching	Industrial Ethernet (IE) 5000 Series Switches Industrial Ethernet (IE) 4000 Series Switches Industrial Ethernet (IE) 3000 Series Switches Industrial Ethernet (IE) 2000 Series Switches Connected Grid Switch (CGS) 2520
Wireless	Industrial Wireless 3700 Series Access Points Aironet 1572 Access Point
Cameras	Video Surveillance IP cameras
Video management	Video Surveillance Manager (VSM)

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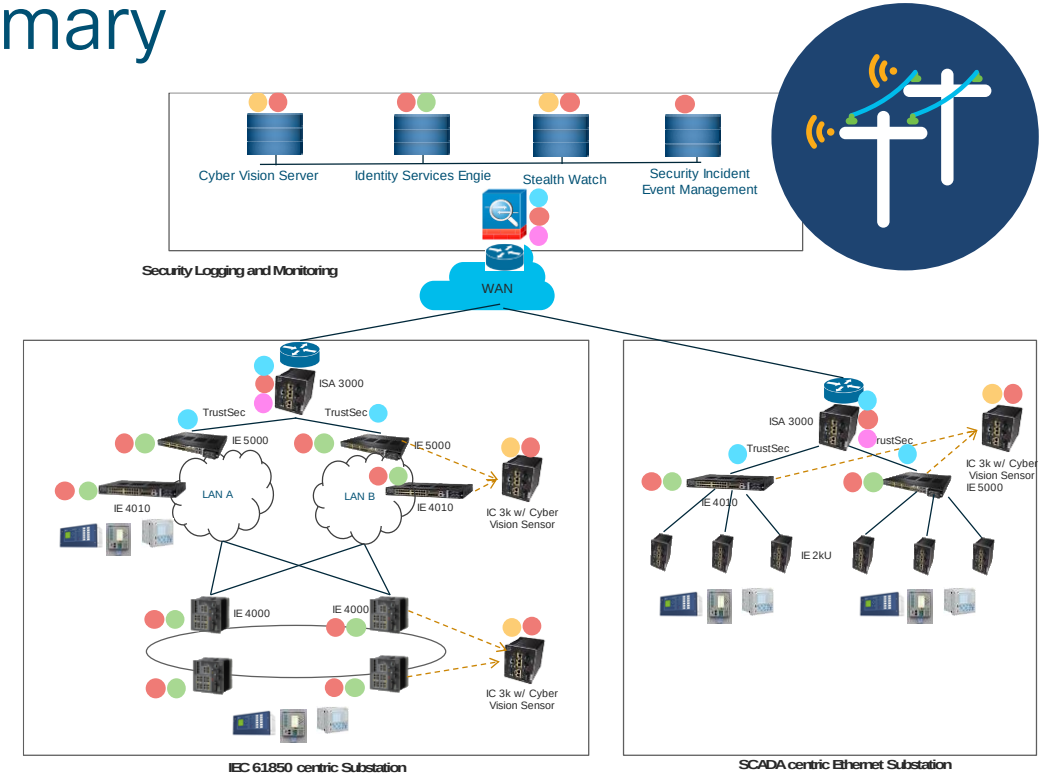
Grid Security – Summary

- Outcomes
  - Increase Grid reliability
  - Ensure network health and security
  - Achieve OT asset visibility
- Use Cases
  - Asset visibility and OT operational insight
  - Network segmentation
  - Threat detection and protection
  - Encryption
  - User authentication and access control
- Solution
  - Substation security architecture with Cyber Vision for OT asset, visibility, and insight
  - IoT products: Cyber Vision, IC 3000, ISA 3000, IE 4010/5000 switch
  - Integration with Cisco security portfolio: Cyber Vision, ISE, StealthWatch, and NGFW



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Manufacturing and OT

Industrial Automation

IoT solutions – Manufacturing and OT

How is IoT enabling digital transformation?

Preventative maintenance

Workforce Enablement

Safety

Remote monitoring

Asset tracking and management

OEE (Overall Equipment Efficiency)

Real-time quality detection

Condition-based maintenance

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Why Industrial Automation Solution?

Deliver digital transformation with a proven architecture

Barriers	Requirements
Legacy networks	Converged sensor to cloud connectivity
Security concerns	End-to-end security architecture
Lack of IT resources	Centralized automation and scale
Reliability and performance	Available and support for real-time
Multiple Vendors – Multiple solutions	Support for broad set of vendors/protocols
Lack of compute and open OS at edge	Flexibility to deploy applications at edge

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Industrial Plant Environment Objectives & Challenges

Customer objectives

- Reduce risk
- Employee productivity
- Asset utilization and OEE
- Compliance and regulatory goals
- Innovation and differentiate

Customer challenges

- IT vs. OT and an aging workforce
- Security concerns
- Data accessibility and control
- Lack of standardization

Manufacturing	Power Utilities	Oil and Gas	Mining	Water Treatment

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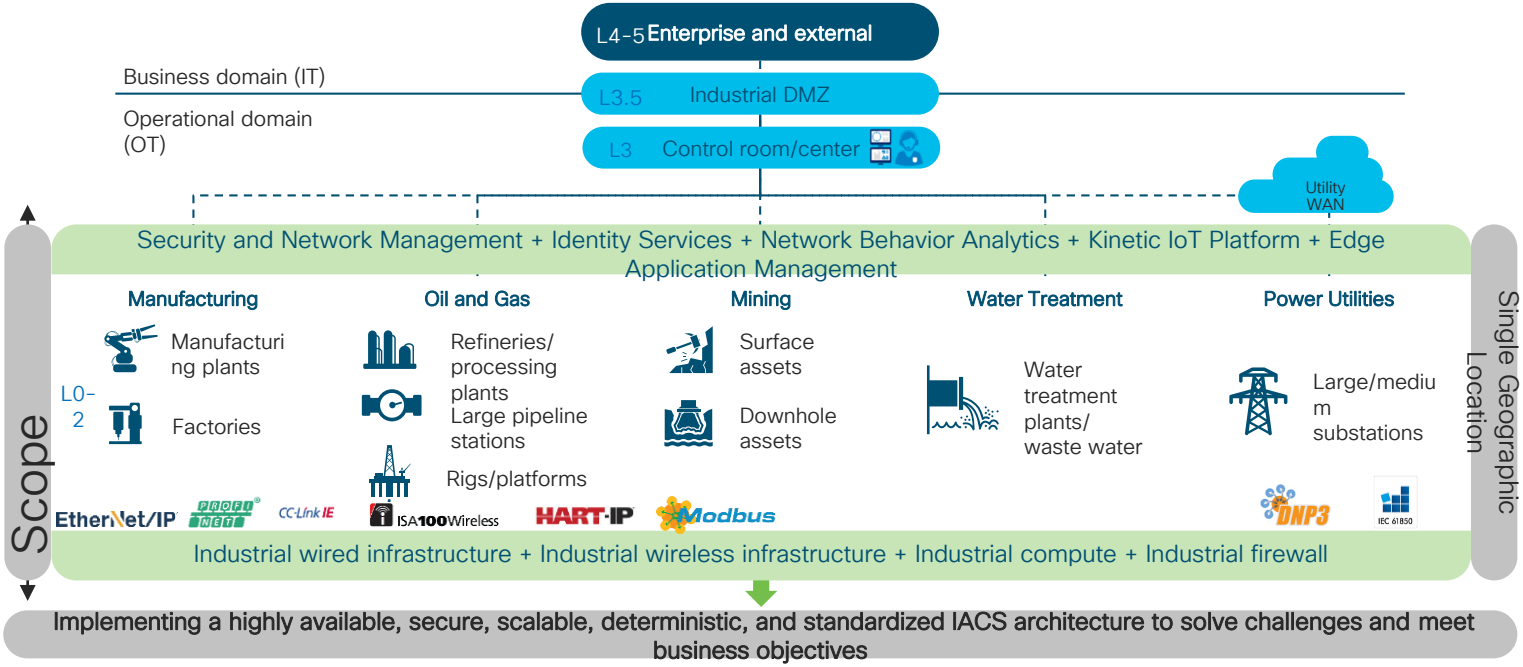
Industrial Automation

Cisco Validated Design

- IT security/resilience to Cell/Area Zone: Device and traffic visibility, segmentation, and anomaly detection.



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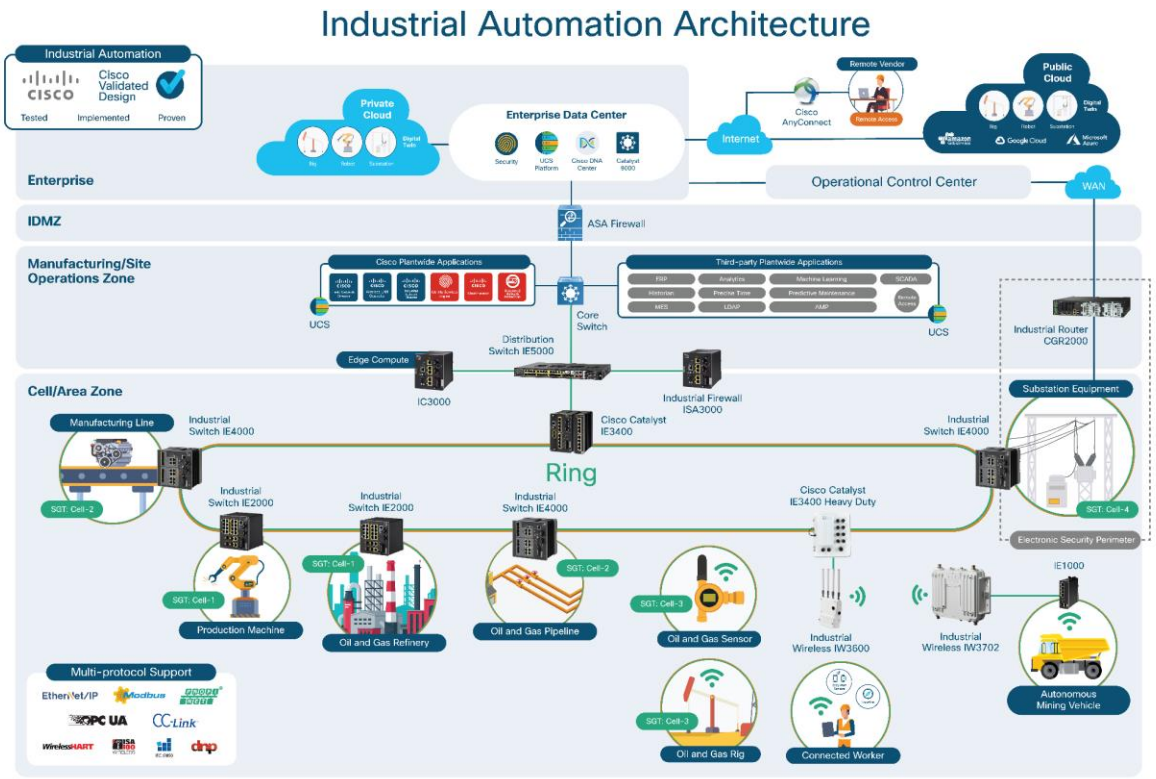
Industrial Automation Solution architecture



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Industrial Automation

- Outcomes:
  - Tested, implemented and proven solution
  - Improve OEE
  - Reduce Security Risks
  - Industry 4.0 data availability
- Solution:
  - Multiple Protocol support
  - Redundancy
  - ICS Visibility
  - Easy Management

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Cisco Cyber Vision

IoT solutions – Manufacturing and OT

Cisco Cyber Vision

Asset Inventory & Security Platform for the Industrial IoT

ICS Visibility

Asset Inventory
Communication Patterns
Device Vulnerability

Operational Insights

Identify configuration changes
Record control system events
relevant to the integrity of the system

Threat Detection

Behavioral Anomaly Detection
Signature based IDS
Real-time alerting

Cisco Cyber Vision helps companies protect
their industrial control systems against cyber risks

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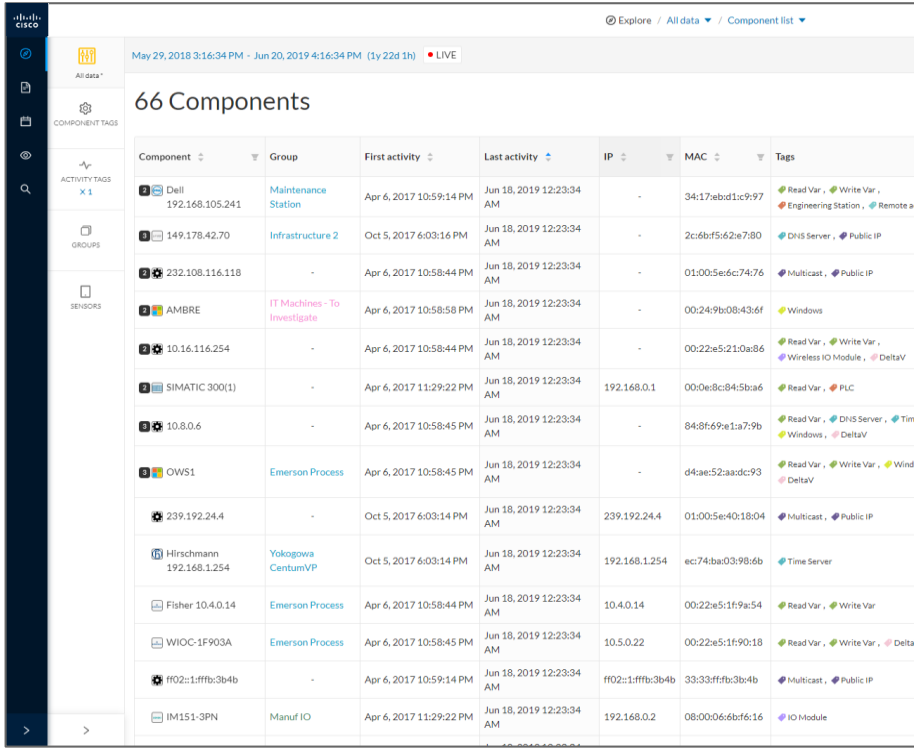
Visibility: Comprehensive **Asset Inventory**

- Automatically maintain a detailed list of all OT & IT equipment
- Immediate access to software & hardware characteristics
- Track rack-slot components
- Tags make it easily to understand asset functions and properties

Track the industrial assets to protect throughout their life cycles



Component	Group	First activity	Last activity	IP	MAC	Tags
Dell 192.168.105.241	Maintenance Station	Apr 6, 2017 10:59:14 PM	Jun 18, 2019 12:23:34 AM	-	34:17:eb:d1:c9:97	Read Var , Write Var , Engineering Station , Remote a
149.178.42.70	Infrastructure 2	Oct 5, 2017 6:03:16 PM	Jun 18, 2019 12:23:34 AM	-	2c:6b:f5:62:e7:80	DNS Server , Public IP
232.108.116.118	-	Apr 6, 2017 10:58:44 PM	Jun 18, 2019 12:23:34 AM	-	01:00:5e:6c:74:76	Multicast , Public IP
AMBRE	IT Machines - To Investigate	Apr 6, 2017 10:58:58 PM	Jun 18, 2019 12:23:34 AM	-	00:24:9b:08:43:6f	Windows
10.16.116.254	-	Apr 6, 2017 10:58:44 PM	Jun 18, 2019 12:23:34 AM	-	00:22:e5:21:0a:86	Read Var , Write Var , Wireless IO Module , DeltaV
SIMATIC 300(1)	-	Apr 6, 2017 11:29:22 PM	Jun 18, 2019 12:23:34 AM	192.168.0.1	00:0e:8c:84:5b:a6	Read Var , PLC
10.8.0.6	-	Apr 6, 2017 10:58:45 PM	Jun 18, 2019 12:23:34 AM	-	84:8f:69:e1:a7:9b	Read Var , DNS Server , Tim Windows , DeltaV
OWS1	Emerson Process	Apr 6, 2017 10:58:45 PM	Jun 18, 2019 12:23:34 AM	-	d4:ae:52:aa:dc:93	Read Var , Write Var , Wind DeltaV
239.192.24.4	-	Oct 5, 2017 6:03:14 PM	Jun 18, 2019 12:23:34 AM	239.192.24.4	01:00:5e:40:18:04	Multicast , Public IP
Hirschmann 192.168.1.254	Yokogowa CentumVP	Oct 5, 2017 6:03:14 PM	Jun 18, 2019 12:23:34 AM	192.168.1.254	ec:74:ba:03:9B:6b	Time Server
Fisher 10.4.0.14	Emerson Process	Apr 6, 2017 10:58:44 PM	Jun 18, 2019 12:23:34 AM	10.4.0.14	00:22:e5:1f:9a:54	Read Var , Write Var
WIOC-1F903A	Emerson Process	Apr 6, 2017 10:58:45 PM	Jun 18, 2019 12:23:34 AM	10.5.0.22	00:22:e5:1f:90:18	Read Var , Write Var , Delta
ff02::1:fffb:3b4b	-	Apr 6, 2017 10:59:14 PM	Jun 18, 2019 12:23:34 AM	ff02::1:fffb:3b4b	33:33:ff:fb:3b:4b	Multicast , Public IP
IM151-3PN	Manuf IO	Apr 6, 2017 11:29:22 PM	Jun 18, 2019 12:23:34 AM	192.168.0.2	08:00:06:6b:f6:16	IO Module

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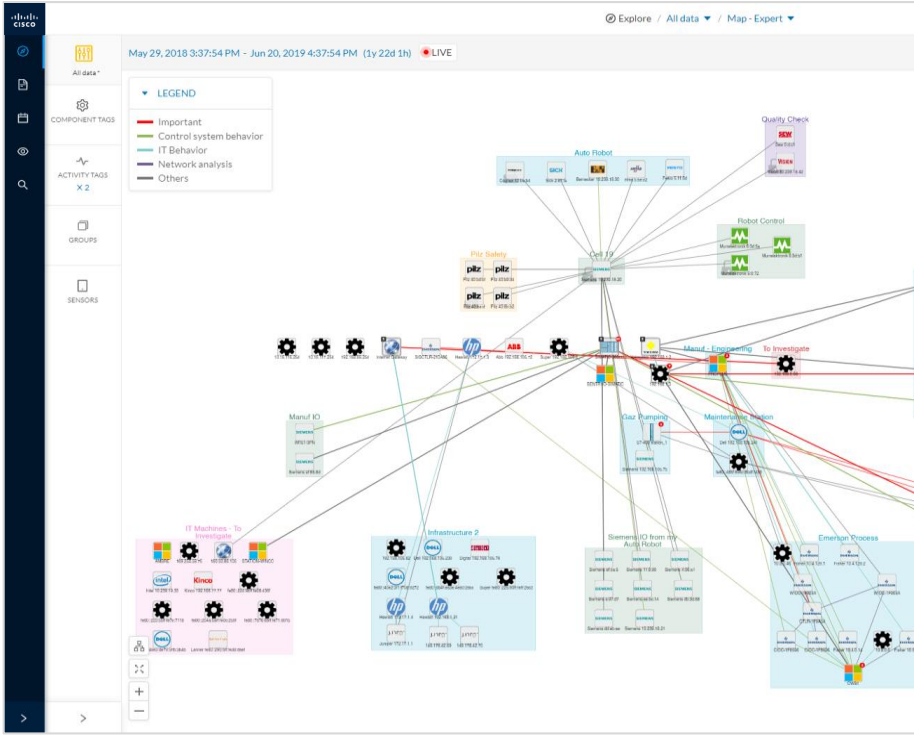
Visibility: Track **Application Flows**

- Identify all relations between assets including application flows
- Spot unwanted communications & noisy assets
- Tags make it easily to understand the content of each communication flow
- View live information or go back in time

Drive network segmentation and fine-tune configurations



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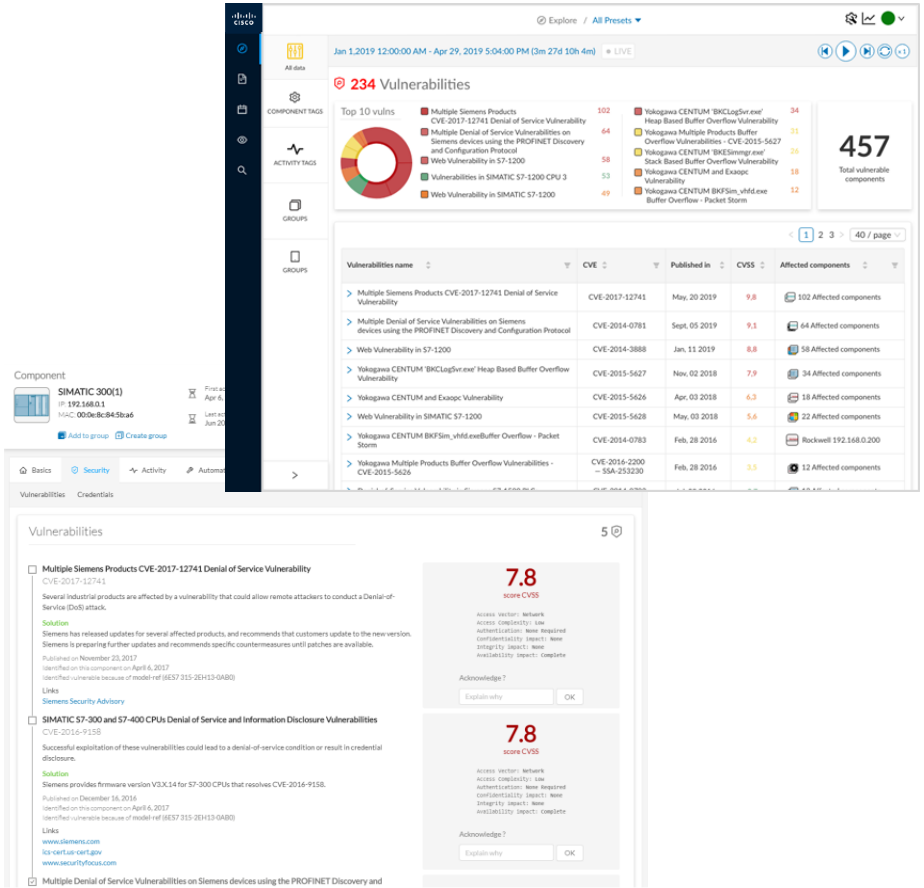
Visibility: Instantaneous **Vulnerability** Identification

- Automatically spot software vulnerabilities across all your industrial assets
- Access comprehensive information on vulnerability severities and solutions
- Built-in vulnerability database always up to date

Enforce Cyber-Hygiene best practices

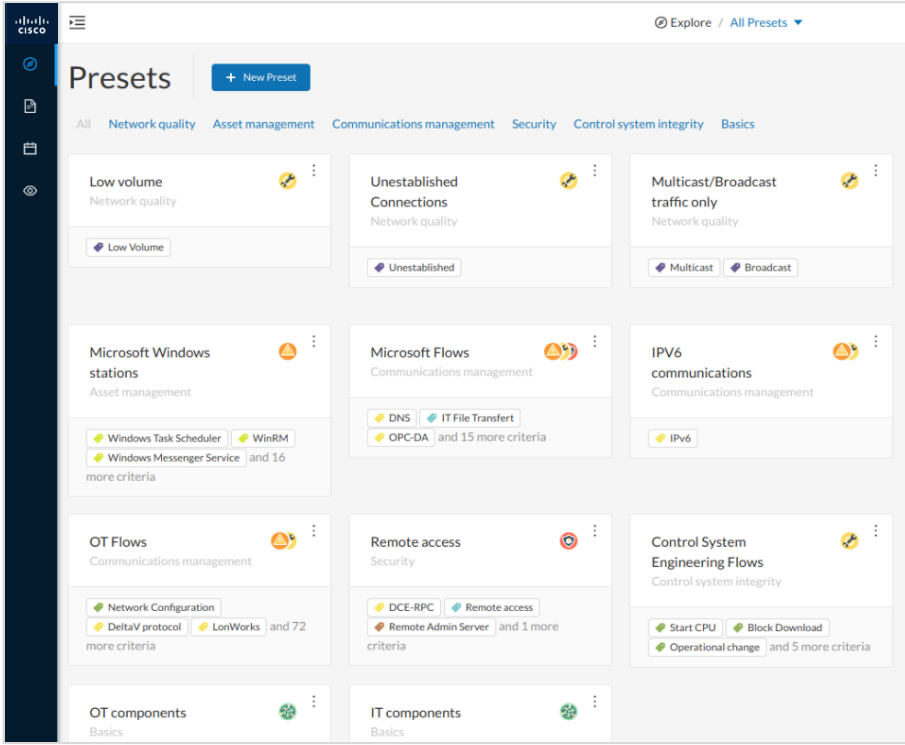


cisco Live!

Visibility: **Guided Data Discovery**

- Filtered views based on Tags you want to track
- Deep-dive into very large datasets with ease
- Share presets with other users to show your discoveries & enable collaboration

Focus on what is most important to you



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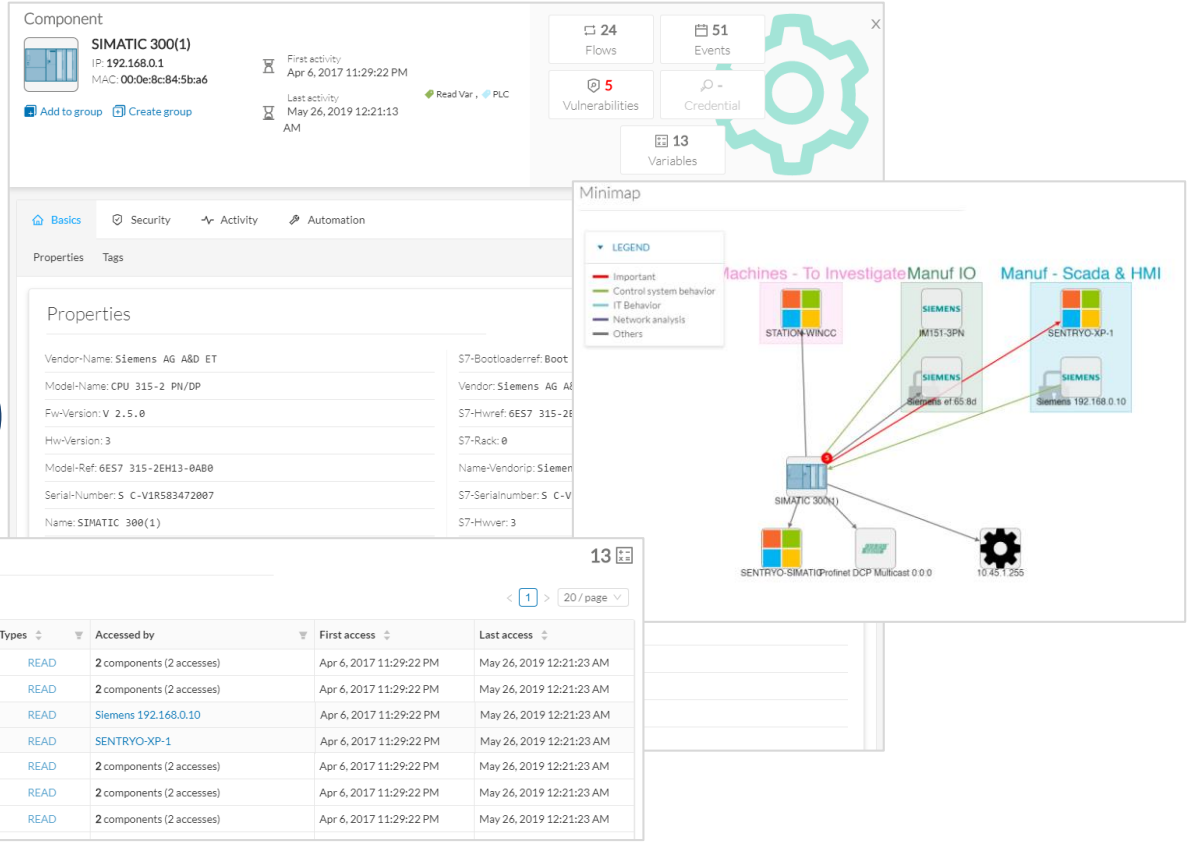
Operational Insights: **Views for OT** Teams

- Asset details
- Communication maps
- Variable accesses

Monitor the integrity of your industrial process



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Operational Insights: **Views for Security Leaders**

- Access the full history of all communication flows
- View detailed properties and content statistics for each flow
- View live information or go back in time for forensic search

Your ICS Flight Recorder

Flows

1 40 / page

From	Source Port	To	Destination Port	First activity	Last activity	Tags	Packets	Bytes
Siemens 192.168.105.120	102	PLC_1	49158	Aug 20, 2018 6:34:42 PM	May 26, 2019 12:21:13 AM	No tags	0	0 B
PLC_1	102	Dell 192.168.105.241	1613	Apr 6, 2017 10:59:13 PM	May 26, 2019 12:21:13 AM	Program Upload , Start CPU , Stop CPU , Read Var , Write Var ...1+	0	0 B
PLC_3	102	PLC_1	49159	Aug 20, 2018 6:34:42 PM	May 26, 2019 12:21:13 AM	No tags	0	0 B
Siemens 192.168.105.120	102	PLC_1	49158	Apr 6, 2017 10:59:13 PM	May 26, 2019 12:21:13 AM	No tags	0	0 B
Siemens 192.168.105.120	0	PLC_1	0	Aug 20, 2018 6:34:42 PM	May 26, 2019 12:21:13 AM	ARP	0	0 B
PLC_3	0	PLC_1	0	Aug 20, 2018 6:34:42 PM	May 26, 2019 12:21:13 AM	ARP	0	0 B
PLC_1	102	Dell 192.168.105.241	1611	Aug 20, 2018 6:34:42 PM	May 26, 2019 12:21:13 AM	Program Upload , Read Var , Write Var , S7Plus	0	0 B
PLC_1	102	Dell 19						
PLC_1	102	Dell 19						
PLC_1	102	Dell 19						
Siemens 192.168.105.150	49162	PLC_1						
Siemens 192.168.105.150	49163	PLC_1						
PLC_1	102	Dell 19						
Siemens 192.168.105.150	0	PLC_1						
PLC_1	0							

Content Statistics

1 40 / page

Property	Value	Occurences
emerson-udp-event	setvar	7
emerson-udp-function	KeepAlive	1
emerson-udp-function	Message	7
emerson-udp-var-name	PID1/MODE	1
emerson-udp-var-name	PID1/SP	6
emerson-udp-var-scope	CV	6
emerson-udp-var-scope	TARGET	1
emerson-udp-var-value	49.52	1
emerson-udp-var-value	49.97	1
emerson-udp-var-value	69.97	1
emerson-udp-var-value	70	1
emerson-udp-var-value	70.41	1
emerson-udp-var-value	72	1
emerson-udp-var-value	AUTO	1
ipv4-ttl	128	1
ipv4-ttl	64	1

1 40 / page

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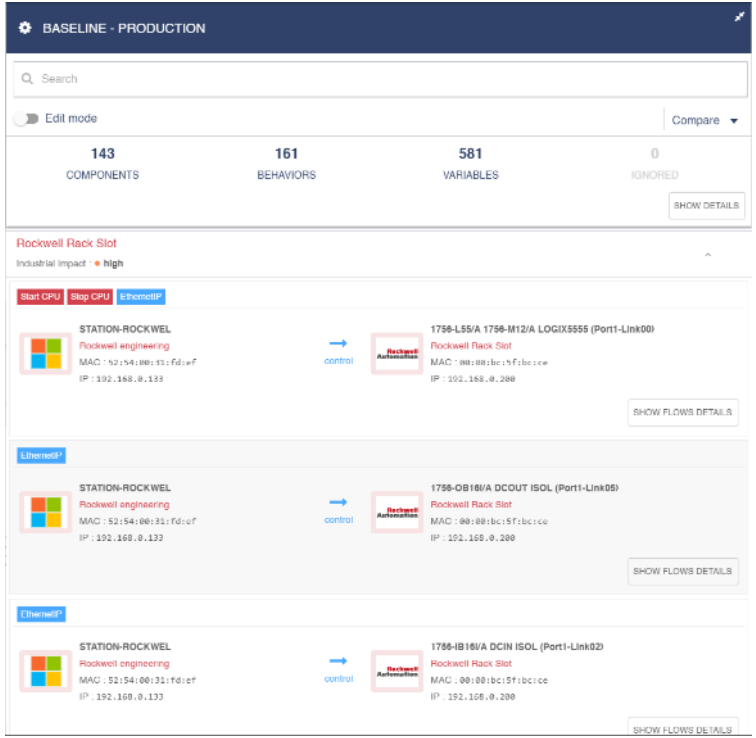
Threat Detection: **Behavioral Analytics**

- Create Baselines to define normal behaviors and configurations
- Behavior modeling automatically triggers alerts on deviations to the baselines
- Import IoC to detect known malicious behaviors
- Continuously improve detection with classification of new events

Detect unknown attacks and malfunctions



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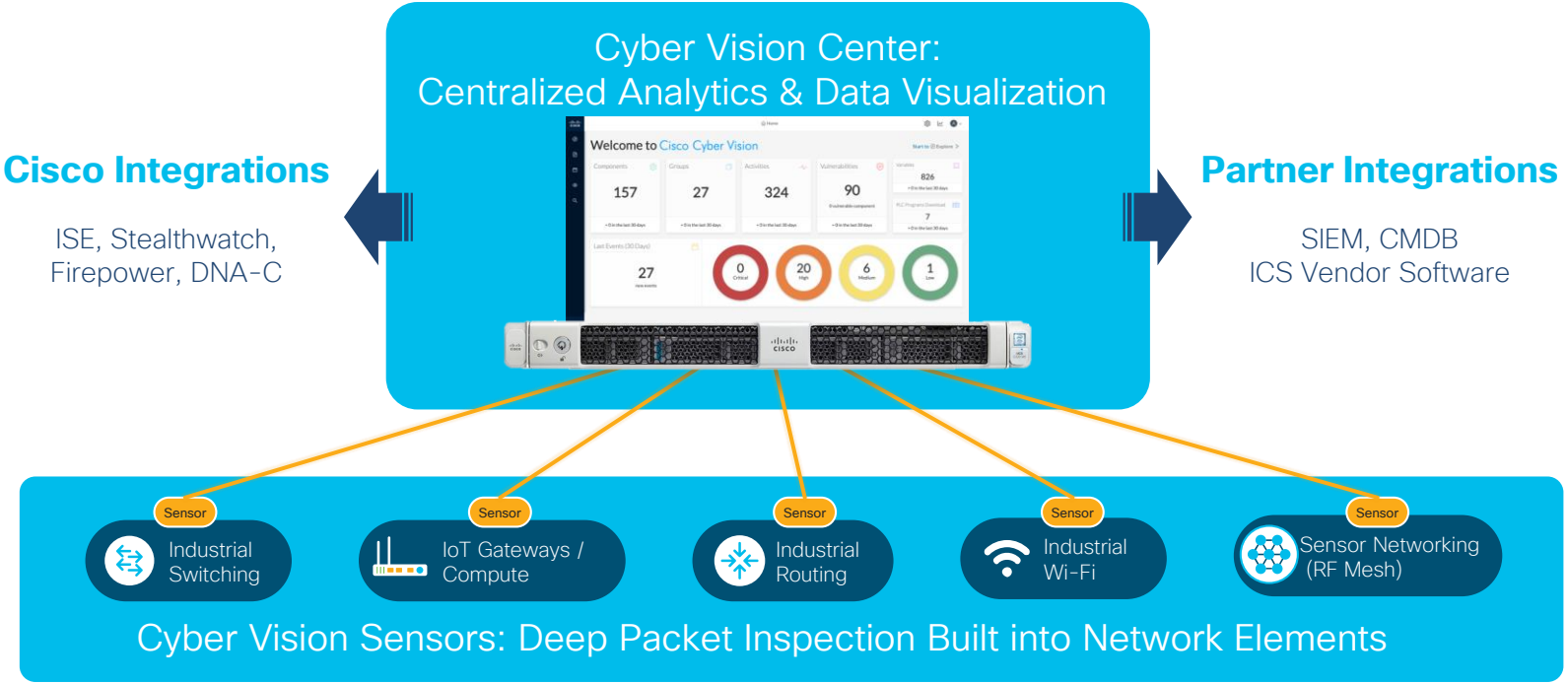
Cisco Cyber Vision Architecture



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Cisco Cyber Vision Portfolio

Hardware appliance

- PID: CV-CNTR-S5
- Intel 2.3GHz (16 Core) CPU
- 32GB RAM
- 2x 800GB SSD RAID-1
- or 4x 800GB SSD RAID-10

Software appliance

- PID: CV-CNTR-ESXI

System Requirements
CPU: Intel Xeon, 2 cores minimum (4 cores recommended).
RAM: 4GB minimum (8GB recommended).
Storage: 20GB minimum (50GB recommended).
Hard drive: SSD hard drives highly recommended to ensure short response time for database access.
Network: 2 Network interfaces

Hardware sensor

- IC3000 Industrial Compute
- Dedicated hardware sensor

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Why is a network-sensor important?

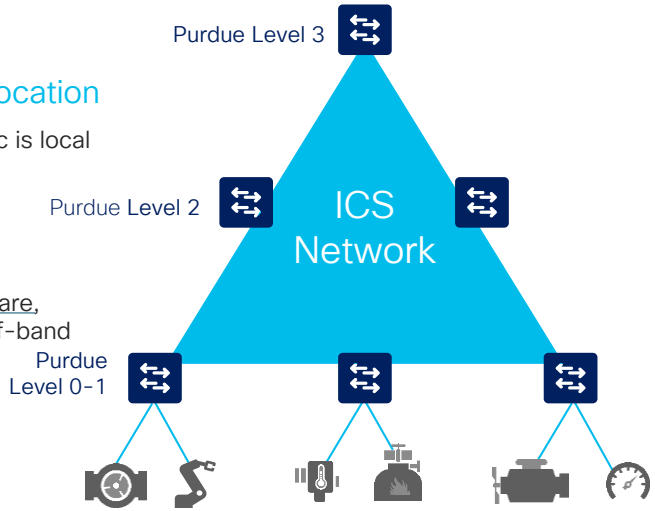
SPAN can be expensive and detrimental to your control system performance

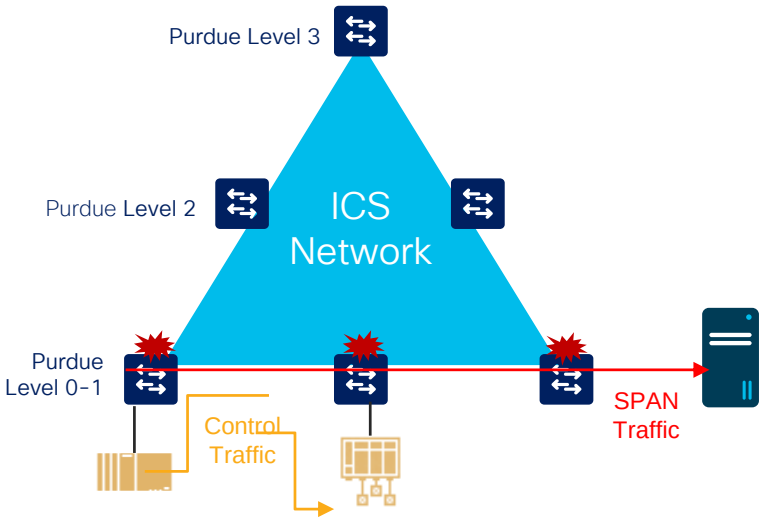
Suboptimal Location

Most control traffic is local to the cell

Expensive

- Additional Hardware, cabling for out-of-band SPAN network





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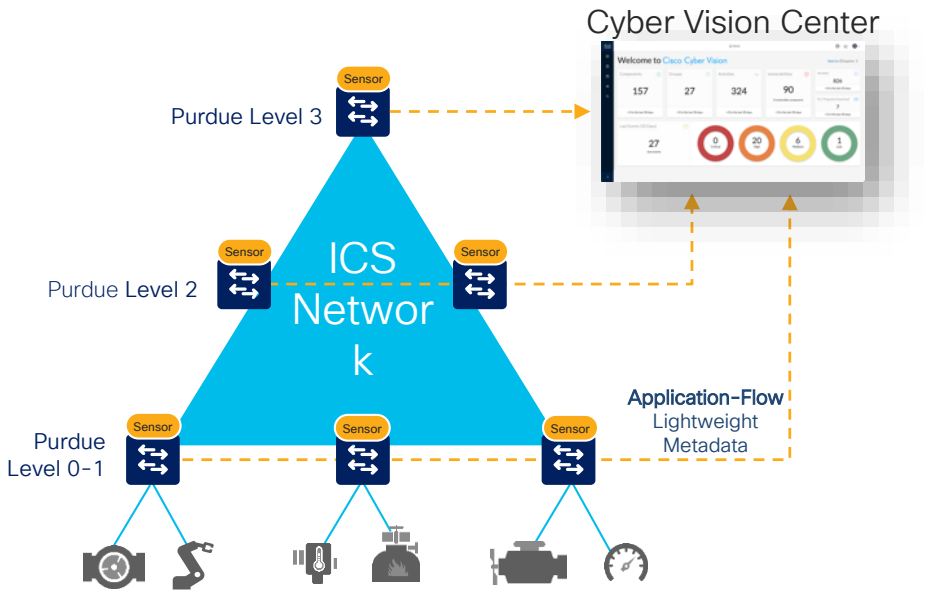
Visibility Using your Network Infrastructure

The Cisco industrial network lets you see everything that connects to it



Monitoring at the Edge

- Cyber Vision Sensors embedded into industrial network equipment
- No additional hardware needed
- No need for an out-of-band monitoring network

Easy deployment
Low TCO

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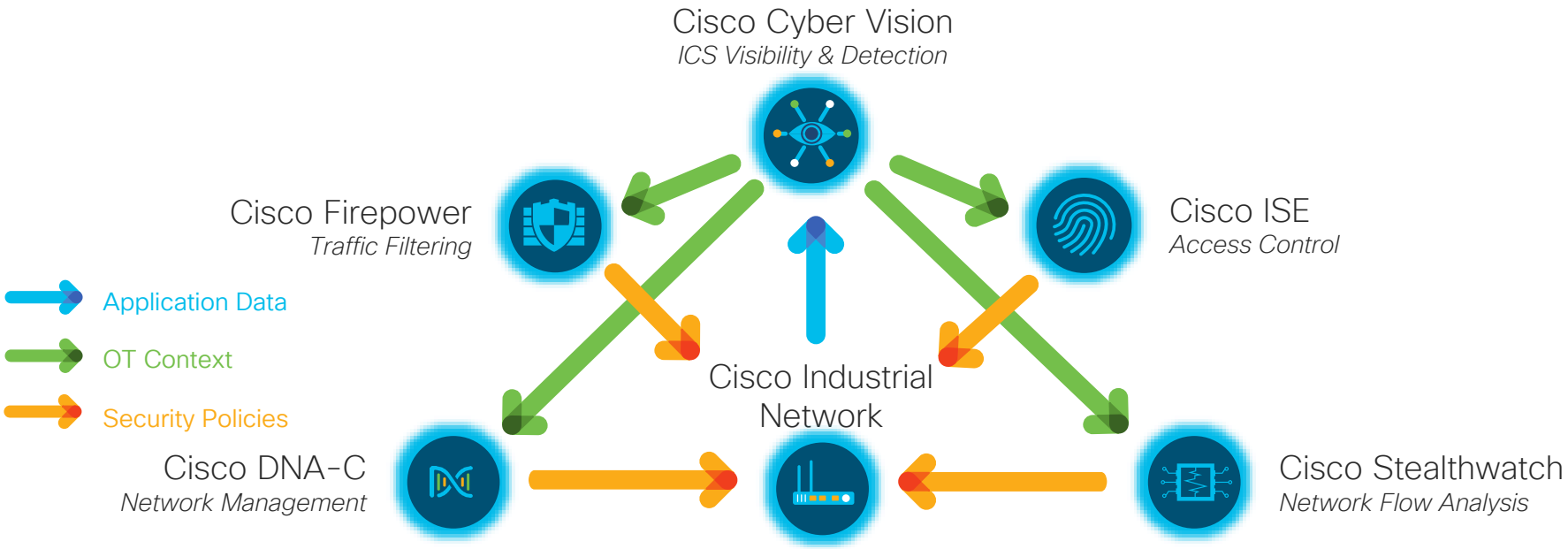
Working together to define & apply IoT security policies



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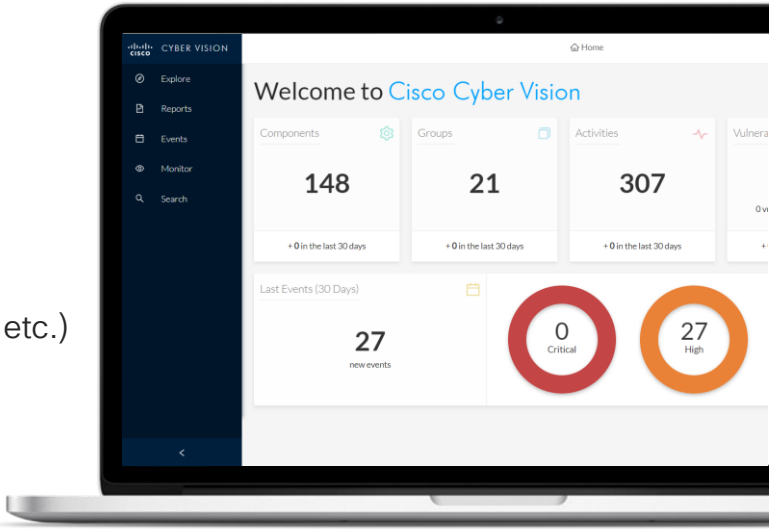
Cisco Cyber Vision (CCV) - Summary

- Use case
  - Monitoring of OT network traffic
  - Detection of all communication between network nodes
  - Anomaly detection
- Outcomes
  - Automated asset inventory of OT network
  - Visability of application flows
  - Automated vulnerability detection
  - Guided data discovery
  - Customized views for different teams (OT teams, security leaders etc.)
  - Fully passive analisys which will not interupt OT network
  - Integration with Cisco ISE, Firepower, Stealthwatch and DNA-C



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DEMO – Cyber Vision

Fleet and Beyond

Extended Enterprise

IoT solutions – Fleet and Beyond

Extended Enterprise

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Extended Enterprise

Enterprise

Extended Enterprise

Industry Plays

Office Space

Warehouse

Distribution Center

Parking Lot

Kiosks

Delivery Truck

Manufacturing

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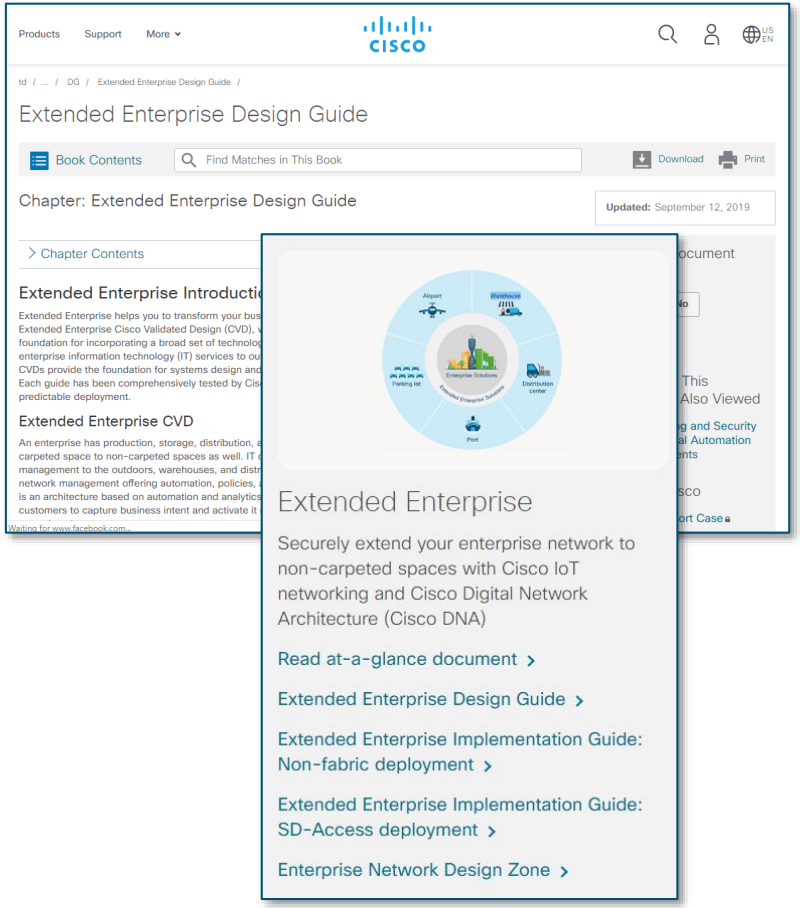
Extended Enterprise CVD

- Deployment Scenarios:
  - Extended enterprise non-fabric deployment
  - Extended enterprise SD-Access deployment
- Use cases:
  - Warehouse connectivity
  - Distribution center connectivity
  - Roadway connectivity
  - Port connectivity
  - Airport connectivity
  - Parking lot connectivity



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Extended Enterprise – Requirements

Simplicity

- Simple, centralized network management across the carpeted spaces and non-carpeted
- Plug and Play deployment of industrial networking in the non-carpeted spaces
- Simplify deployment of QoS for IE

Security

- Capture and translate business intent into network policies and enforce the policies across entire network
- Security compliance of industrial networking
- Extend secure connectivity to outdoor environments

Scale

- High availability, reliability and scale of extended networks to meet the needs of operations
- Extend shared services to non-carpeted spaces
- Flexible industrial ethernet network for rugged environments

Consistent Experience

- Network Assurance – visibility and analytics on the health of industrial network devices
- Guided remediation and trouble-shooting of issues for the network devices
- Same user experience from Enterprise to IoT edge

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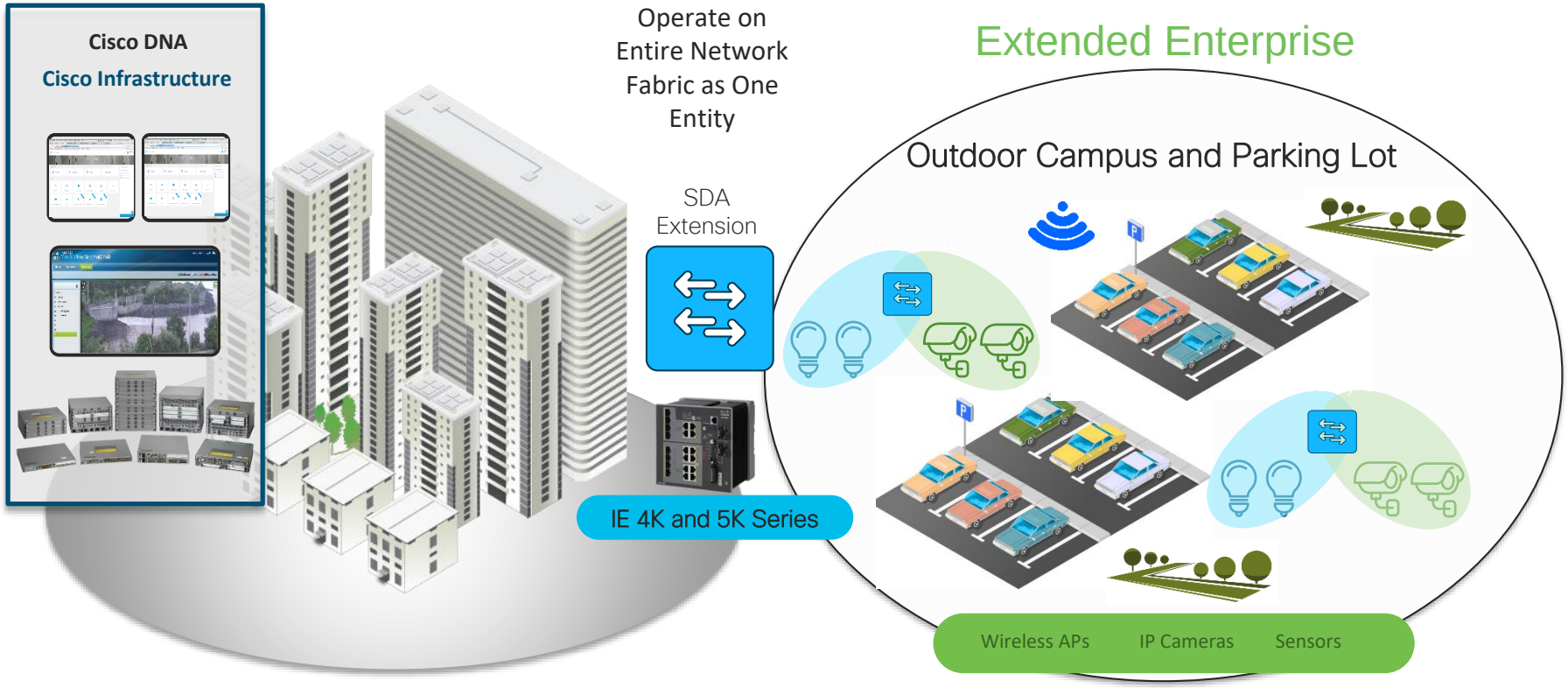
Extended Enterprise – Use case example



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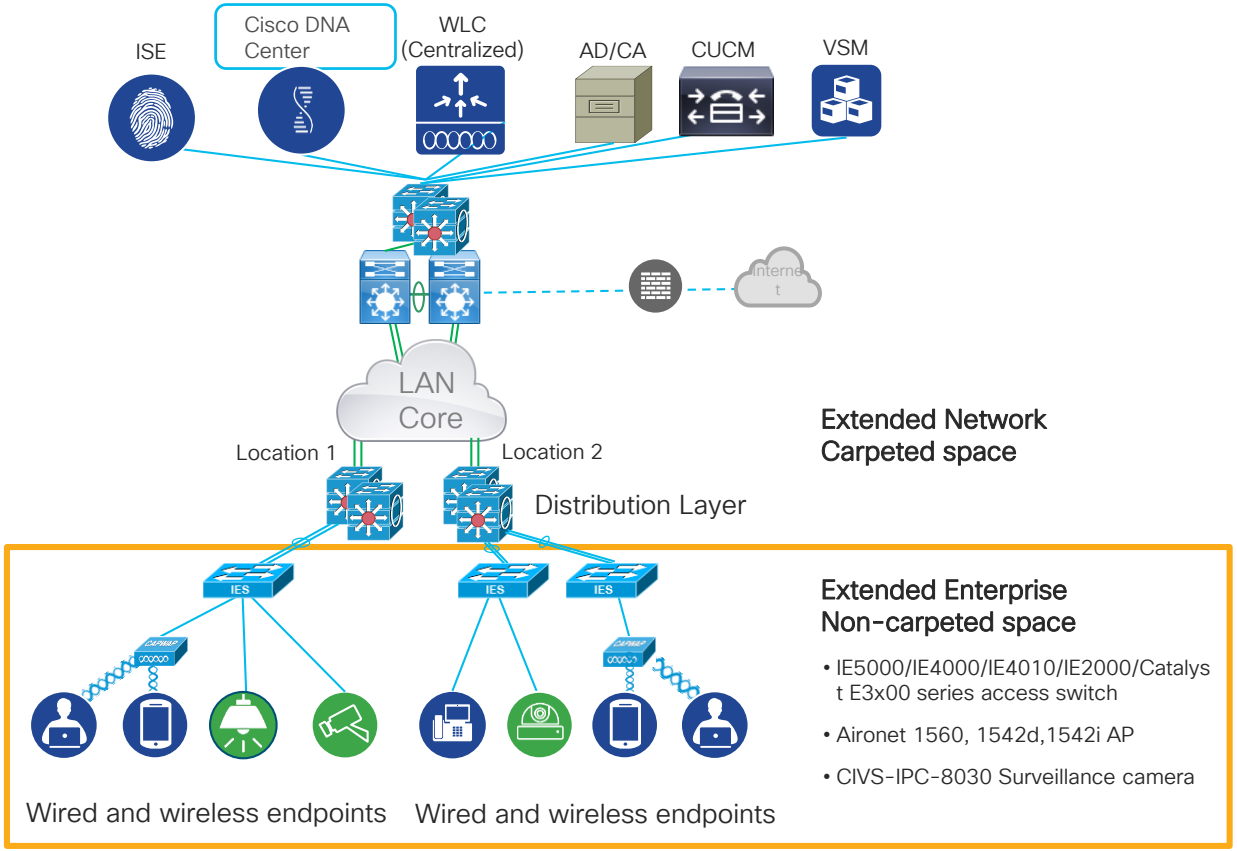
Extended Enterprise Non-Fabric Deployment



- Applicable to customers using Cisco DNA Center to manage devices without SD-Access
- Reference design: Campus Wired and Wireless LAN
- Reference design doesn't use DNA Center

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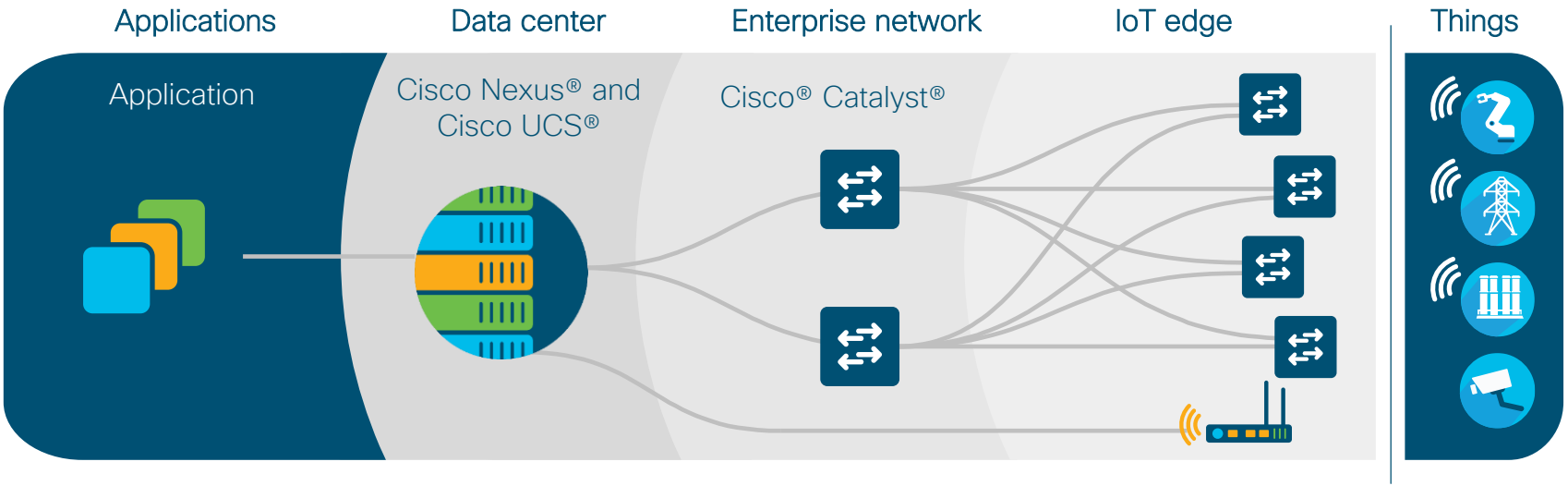
Extended Enterprise SD-Access Deployment



Consistent experience from end to end |
One intent-based network architecture | One set of security policies

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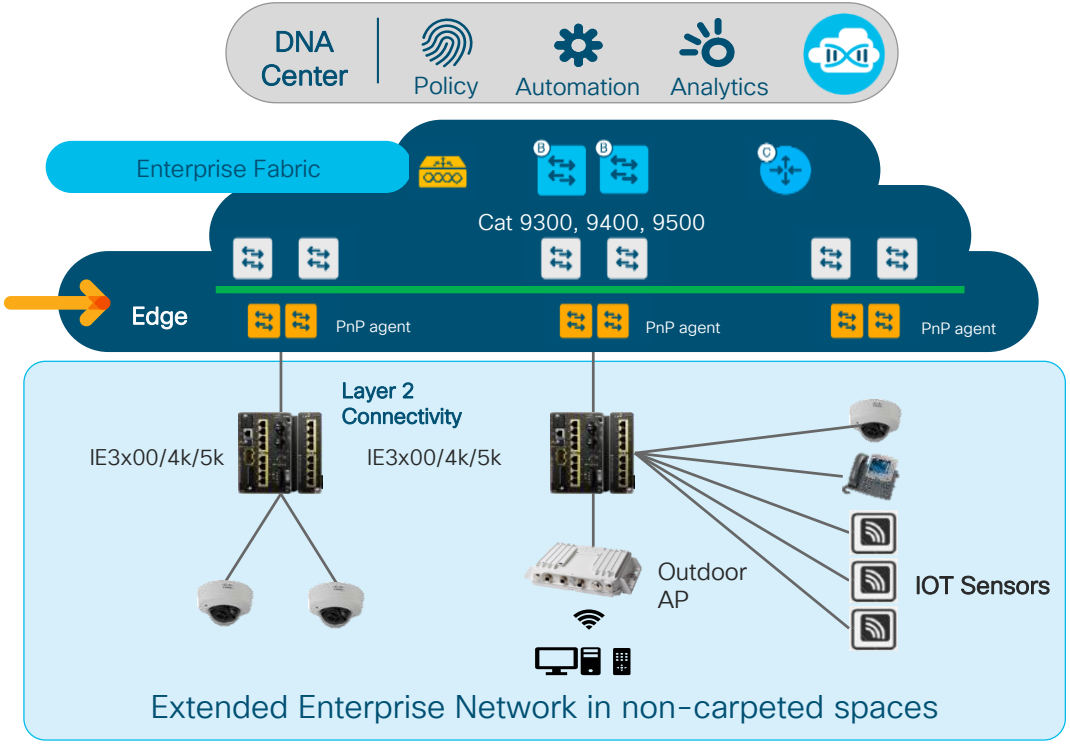
Extended Enterprise SD-Access Deployment



- Applicable to customers with SD-Access deployments
- Reference design: *Software-Defined Access Deployment Guide*

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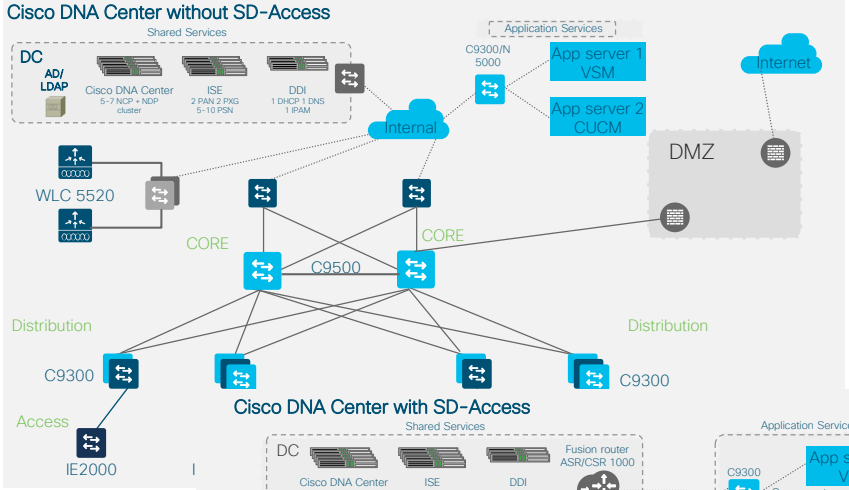
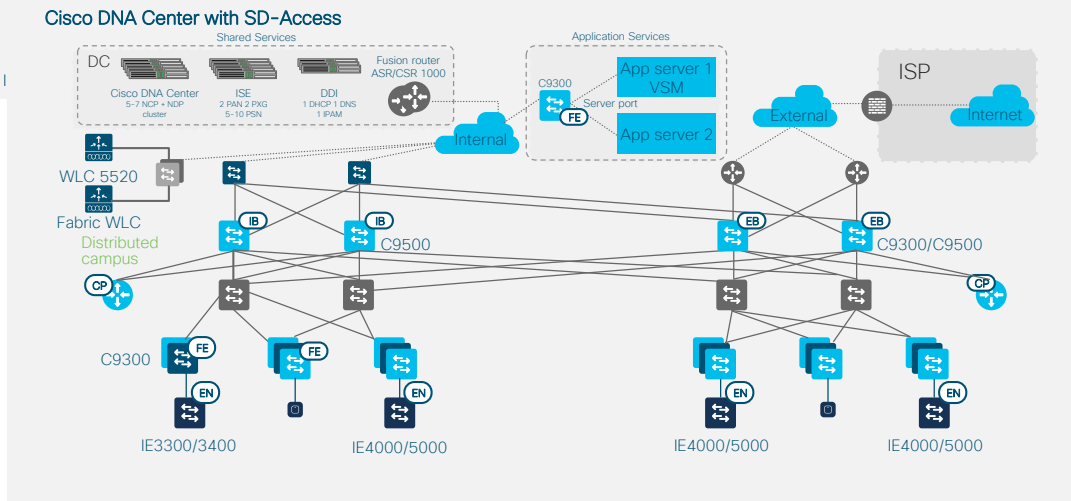
Extended Enterprise – Summary

- Use Case
  - Parking Lots
  - Warehouses
  - Outdoor Spaces
  - Ports, etc…
- Outcomes
  - Reduce operating resources
  - Extend security policy
  - Faster deployment
- Solution:
  - Industrial Connectivity Portfolio
  - DNA Center
  - SD-Access





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Remote and Mobile Assets

IoT solutions – Fleet and Beyond

Asset Visibility is No. 1 use case

Many types of remote and mobile assets to connect

Point of Service Kiosks

Handle transactions from anywhere

Remote Equipment

Gain remote access to equipment to monitor and update

Public Safety Fleets

See location, improve safety, productivity. Maintenance monitoring.

Service Vehicle Fleets

Monitor driving behavior for safety, liability & maintenance

Transit Fleet

Connect cameras, passenger Wi-Fi, more. Maintenance monitoring.

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Common networking and operational concerns

Cannot connect to enterprise network by cable

Assets are remote or in motion

Hard to access to update, troubleshoot, fix

Truck rolls and site visits are costly

Need to manage operations at scale

Support growing number of distributed assets

Limited/no IT staff to onboard, manage devices.

OT/LoB teams need ability to manage

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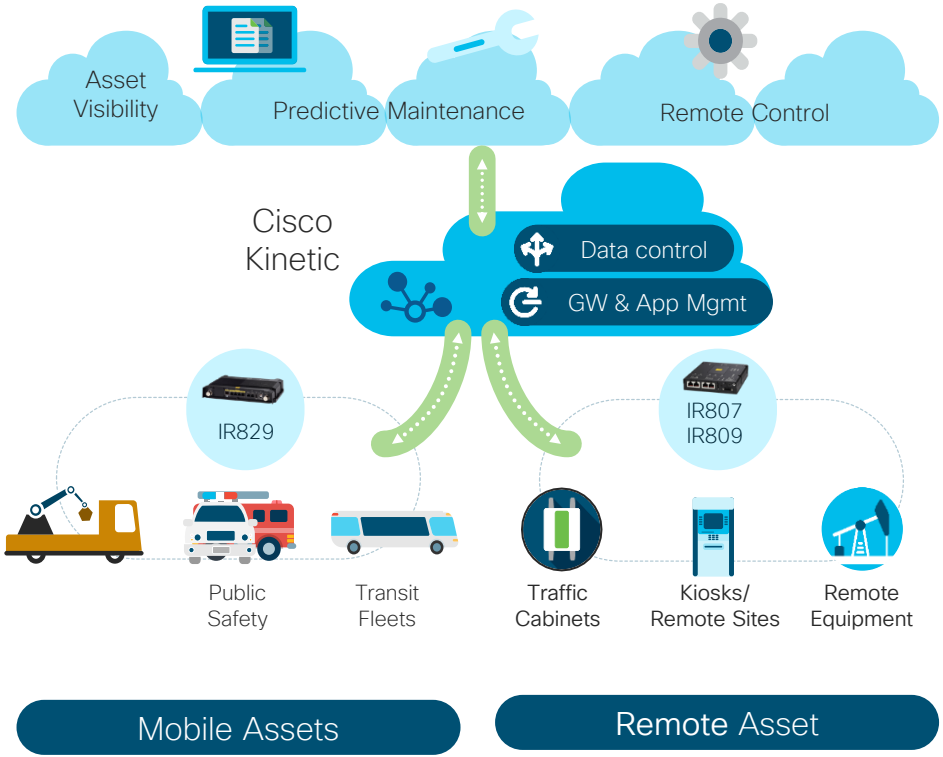
Remote and Mobile Assets

Ruggedized IoT and edge-ready Dual 4G/LTE option

Provision, view, remotely control gateways and edge applications from the cloud.



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Cisco solution addresses key challenges

Cannot connect to enterprise network by cable

LTE connectivity with dual LTE option. Plus automated Wi-Fi offload for mobile assets

Hard to access to update, troubleshoot, fix

Secure remote access to gateways and connected IP devices

Need to manage operations at scale

Remote gateway onboarding and management are streamlined with UI templates and bulk operations

Limited/no IT staff to onboard, manage devices.

OT/LoB friendly UI to add, monitor & manage assets, update edge apps from a cloud-based dashboard

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Remote and Mobile Assets CVD

- Mobile assets:
  - Service Fleet
  - Public transportation: buses & taxis
  - Public Safety
- Remote assets:
  - Outdoor Equipment
  - Remote Sites
  - Retail kiosks

Remote and Mobile Assets

Get your remote and mobile assets securely connected to your network with Cisco Industrial Routers and Kinetic.

Read at-a-glance document ›

View RaMA CVD ›

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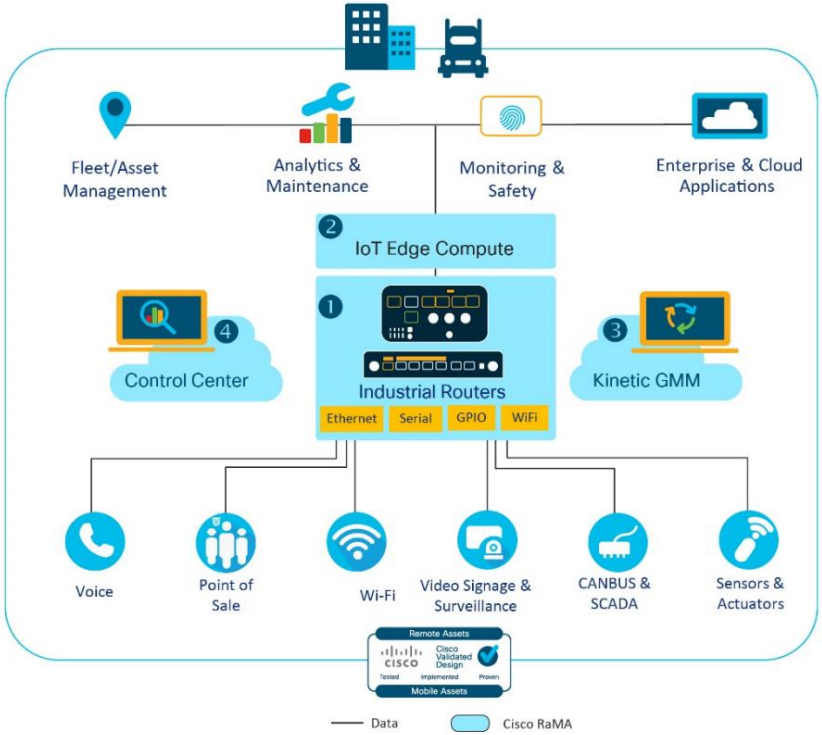
Remote and Mobile Assets – High Level



Four products, seamlessly integrated

- Cisco's industry leading secure gateway portfolio: IR800, IR1100
- Integrated IoT edge compute
- Management with Kinetic Gateway Management Module (GMM)
- Cellular connectivity management with Control Center.

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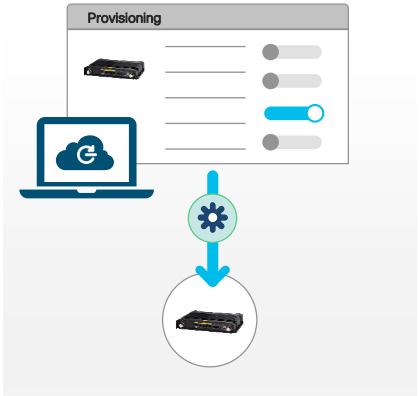
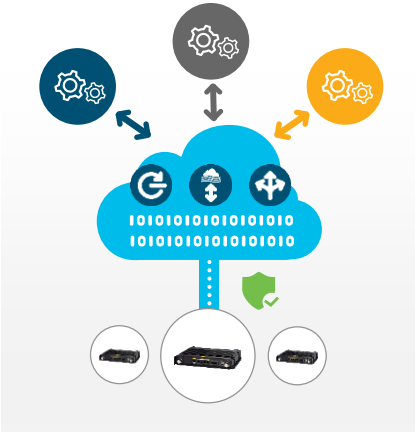
Simplified IT deployment & OT operations





Simplified Deployment	Rich IR Feature Set	OT Operation Assist	OT applications
Simple GW onboarding Template-based configuration IT-friendly diagnostics	Simplified provisioning without sacrificing the rich IR8x9 features	GPS tracking & history Cellular usage report Event-based altering Remote device access	Seamless app provisioning for edge compute Remote data gathering

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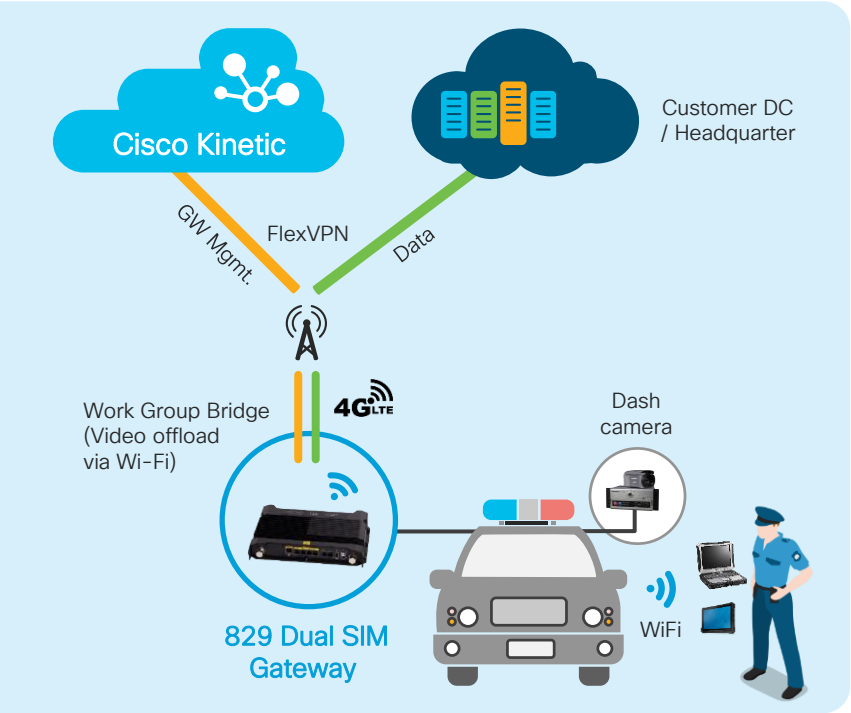
Mobile Asset Use Case: Public Safety Fleet

Law Enforcement Vehicles, Fire trucks, Ambulance, Emergency Response Vehicles, etc.



Needs

- Improved Operation
- Improved Safety
- Mission-critical Connectivity

Solution Capabilities

- Secure, always-on connectivity with dual LTE
- High performance in-vehicle WiFi hotspot
- Simple cloud GW mgmt with op visibility
- Edge compute (e. g vehicle telemetry)

Solution Benefits

- Comprehensive security
- Simple to deploy and manage
- High reliability for mission-critical ops
- Operation visibility

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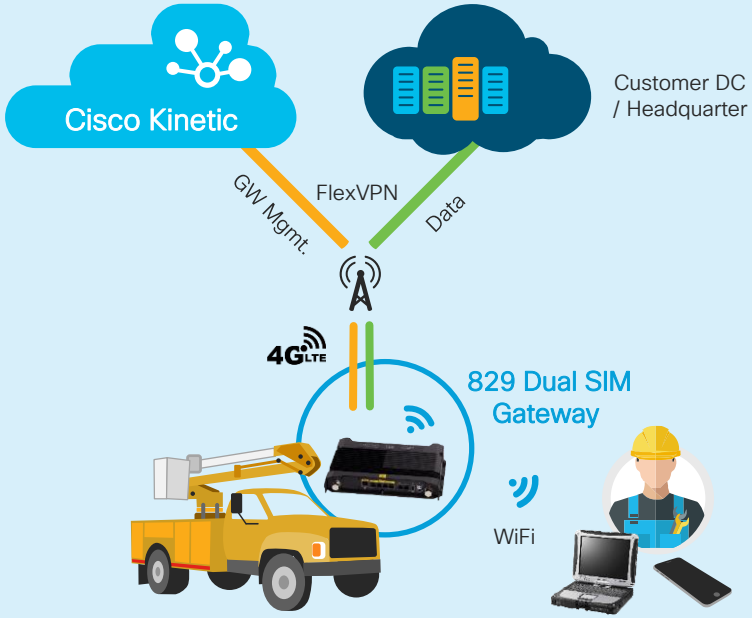
Mobile Asset Use Case: Service Fleet

Utility Trucks, Dump Trucks, Street Sweepers, Flat Bed Trucks, Telecom Service Vehicles, Postal Service Vehicles, etc.



Needs

- Simplified Management
- Cost Reduction
- Increased Visibility and Safety

Solution Capabilities

- Reliable, broad cellular coverage in all types of weather conditions
- High perf in-vehicle WiFi hotspot
- Visibility of vehicle location, dispatch and time of arrival
- Vehicle telemetry, performance tracking and driver safety

Solution Benefits

- Comprehensive security
- Simple to deploy and manage
- Operational cost savings

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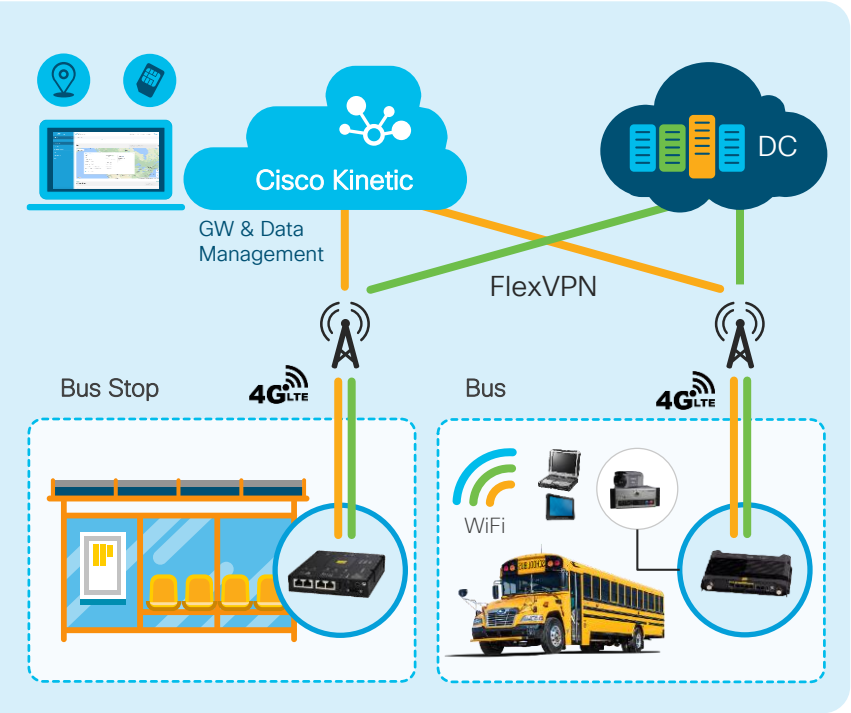
Mobile Asset Use Case: Transit Fleet

School Bus, Public Transit Fleet, etc.



Needs

- Improved Service
- Improved Operations
- Improved Passenger Experience

Solution Capabilities

- Delivery of improved in-vehicle services (WiFi, VOD, announcements, cameras)
- Visibility of vehicle location, dispatch and time of arrival
- Vehicle telemetry, performance tracking and driver safety

Solution Benefits

- Comprehensive security
- Simple to deploy and manage
- Operational cost savings
- One solution for multiple services

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Remote Asset Use Case: Equipment Monitoring

Manufacturing Robots, CNC Machines, Pumping and Pipelines, Field Machines, etc.

Needs

- Simplified Onboarding and Management
- Cost Reduction
- Increased Visibility

Solution Capabilities

- Remote, secure access to control and troubleshoot devices without a truck-roll
- Real-time visibility into status of gateways and connected IP devices
- Secure data delivery with customer-defined policy

Solution Benefits

- Comprehensive security
- Simple to deploy and manage
- Operational cost savings

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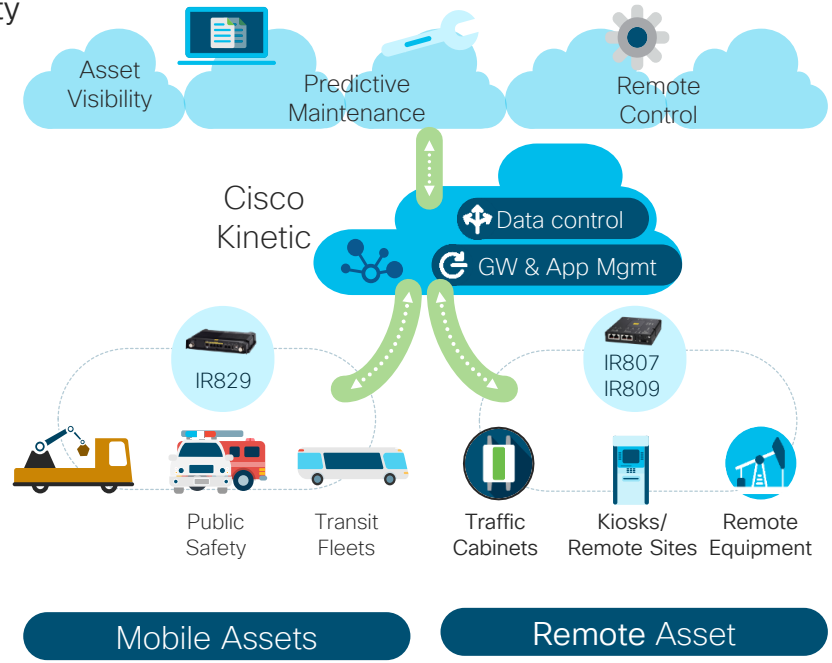
Remote and Mobile Assets – Summary

- Use Case
  - Mobile assets: Service Fleet, Buses & Taxis, Public Safety
  - Remote assets: Outdoor Equipment, Remote Sites
- Outcomes
  - Lower deployment and operating expense
  - Reduce security threats
  - Secure remote access
  - Scalability
- Solution:
  - IR800, IR1100
  - Kinetic GMM
  - Control Center



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Conclusion

End-to-end IoT portfolio

Network connectivity

Connectivity management

Data control and exchange

Edge computing

Security

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