



# Cisco Connected Rail: Meeting New Transportation Demands Solution Overview

This document describes the Cisco® Connected Rail Solution for railways and other mobile transit environments.

## What You Will Learn

This document explains how Connected Rail helps rail operators and transit authorities do the following:

- Keep passengers and employees safe
- Deliver high-speed voice, video, and data services to passengers and crew
- Integrate multiple single-purpose networks for greater interoperability, improved communications, and lower costs
- Meet legislative safety compliance requirements
- Provide onboard passenger Wi-Fi and other services

This Solution Overview provides detail about the three component solutions of Cisco Connected Rail:

1. Cisco Connected Train for onboard and off board IP-based communications, including Wi-Fi services, video surveillance, passenger information and entertainment, and automated operations such as Automatic Train Control (ATC) and Communication-Based Train Control (CBTC).
2. Cisco Connected Trackside, a ruggedized IP infrastructure that connects trackside equipment to a unified mobile-to-Multiprotocol Label Switching (mobile-to-MPLS) backhaul network and, ultimately, the data center
3. Cisco Connected Station, which integrates multiple in-station networks and retail communication systems into a standards-based IP network

The solutions can be combined in various ways to create applications that extend from onboard trains to trackside-to-train stations to your data and control centers.

## Safety, Mobility, and Efficiency Challenges in the Rail Industry

Goals for safety, mobility, and efficiency inform most decisions made in transportation today. New safety capabilities such as ATC and CBTC can automate train operations to improve safety. Meanwhile, passengers expect to have mobile Internet access onboard trains, within stations, and everywhere in between. On-demand entertainment for passengers, first implemented on commercial aircraft, is becoming an expected offering in other areas of the Transportation space. Operations teams also need mobility to increase responsiveness and productivity.

## Safety, Mobility, and Efficiency Challenges in the Rail Industry

For end users, to stay within the limits of their mobile data plans, selecting Wi-Fi over cellular for most of their data consumption is an important consideration. Service providers and rail operators should recognize that the resulting growth in Wi-Fi traffic has strong implications for planning their future networks to accommodate onboard and in-station Wi-Fi. For example, according to the *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2015-2020* (February, 2016), by 2020:

- There will be 5.5 billion global mobile users, up from 4.8 billion in 2015.
- There will be 11.6 billion mobile-ready devices and connections, nearly 4 billion more than in 2015.
- The average mobile connection speed will more than triple, from 2.0 Mbps in 2015 to 6.5 Mbps by 2020.
- Global mobile IP traffic will reach an annual run rate of 367 exabytes, up from 44 exabytes in 2015.

Amid all this growth, railways face the following:

- **Aging Systems**—Communications networks in the transportation industry have changed little over many years. It has grown complicated and costly to maintain and manage multiple, aging proprietary networks, each supporting a specialized application with its own unique telecom requirements. Each network may also have its own upgrade, maintenance, and operational processes. Without open standards across an infrastructure, solution choices are limited and inflexible. Network rigidity also prevents new technologies from being added and new services from being delivered. The Connected Rail System provides the way to move forward while bridging the old with the new.
- **Challenging Environmental Conditions**—Rail transportation and public safety environments demand rugged solutions. High-speed networks on a train and trackside must withstand wide temperature swings, extreme weather, vandalism, shock, and vibration, for example. In addition:
  - Power is not as readily available on a train as it is in a building, and the onboard voltage range on a train is not typical of other industry verticals.
  - Train cars aren't designed for large network deployments. Networking equipment must use minimal space.
  - It can be difficult—or impossible—to implement high-speed wireless coverage of the entire rail infrastructure. Geographic factors, right-of-way concerns, and interference often prevent consistent cellular and Wi-Fi coverage.
  - Rail cars move around. Sometimes they are pulled for maintenance or inserted into a different train. Some rail operators prefer to off-board wireless traffic from every car; others only off-board from front and back cars.

Cisco Connected Rail Solutions help to meet all these challenges while augmenting or extending the life of existing single-purpose networks. The solution includes proven and tested reference architectures and validated communications network designs for the train, track, backhaul network, and data center to offer immediate benefits.

Table 1 lists several of the features and benefits of Cisco Connected Rail.

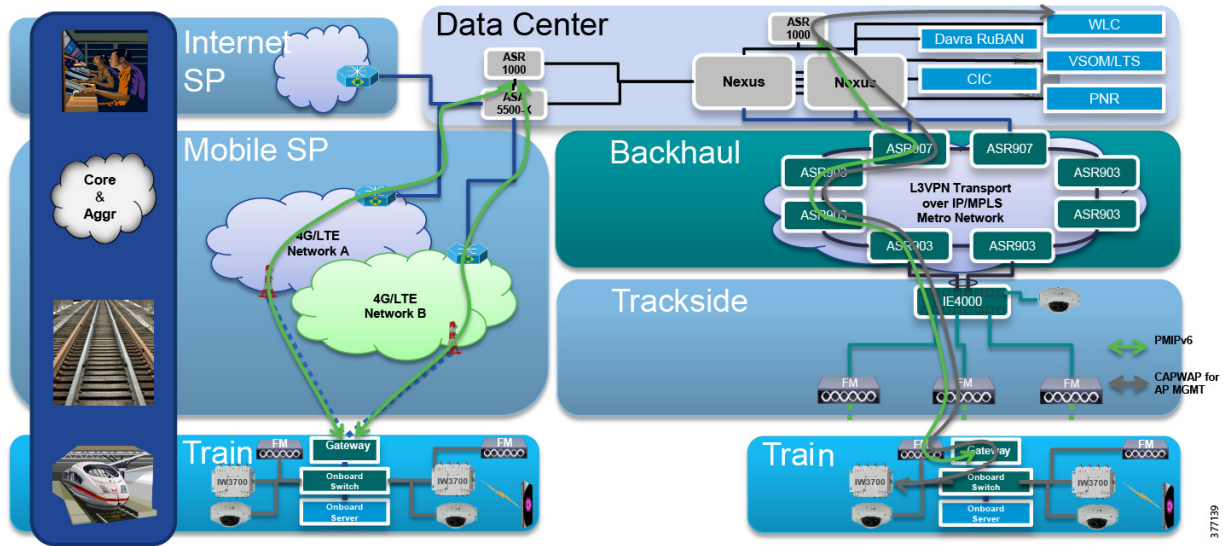
**Table 1 Cisco Connected Rail Features and Benefits**

Use Case	Application/Feature/Service	Benefit(s)
Safety	Video surveillance, Computer-based Train Control (CBTC), Automatic Train Control (ATC), Positive Train Control (PTC)	Reduced human error and related mishaps, improved situational awareness
Compliance	Support for PTC; automation that overrides human error	Increases ability to meet U.S. Rail Safety Improvement Act legislative PTC mandate in the U.S. by December 31, 2018 deadline
Passenger Mobility and Services	<ul style="list-style-type: none"> <li>■ Onboard Wi-Fi and other mobile Internet access services</li> <li>■ Bundled Internet access service with monthly ticket fee</li> <li>■ Onboard screens display location and weather information; travel tips; advertisements</li> <li>■ On-demand entertainment services to passenger devices</li> </ul>	<ul style="list-style-type: none"> <li>■ Passenger retention</li> <li>■ Increased ridership</li> <li>■ Revenue generation and new business models</li> </ul>
Operations	<ul style="list-style-type: none"> <li>■ High-speed train-to-trackside wireless infrastructure supports service delivery</li> <li>■ Train operators communicate with passengers or crew over IP-based intercom</li> <li>■ High-Definition IP video cameras for live monitoring of activity on trains, in stations, and at trackside</li> <li>■ Automated systems for correlating data instead of manually viewing multiple screens</li> <li>■ Predictive maintenance enabled through sensor data collection and correlation</li> <li>■ Consolidate multiple single purpose applications onto one converged IP network</li> </ul>	<ul style="list-style-type: none"> <li>■ Improved passenger safety</li> <li>■ New service enablement</li> <li>■ More efficient operations</li> <li>■ Lower operating expenses (OpEx)</li> <li>■ Reduced capital expense</li> <li>■ Simplified maintenance</li> <li>■ Greater network security</li> <li>■ Move from proprietary to open standards</li> </ul>

# The Solution under the Hood: Architectures and Designs

Rail operations encompass a multitude of areas, as illustrated in Figure 1.

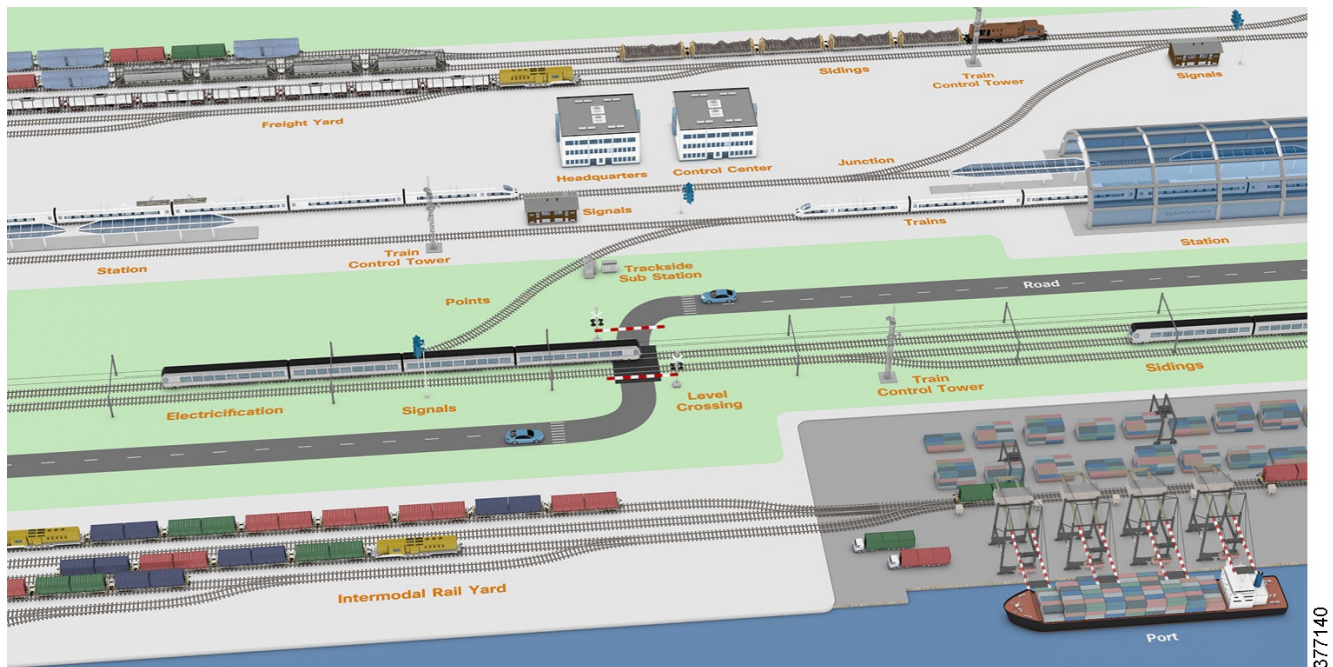
**Figure 1 Rail Operations Overview**



The Cisco Connected Rail reference architecture provides a standards-compliant design that combines best-of-breed products with key ecosystem partner integration, and focuses on the following operational areas: Connected Train, Trackside, and Station.

## Cisco Connected Train

Cisco Connected Train integrates capabilities from multiple proprietary networks in train cars onto a new converged IP network infrastructure. The solution provides a resilient infrastructure to deliver numerous services, like onboard safety and security (including video surveillance), passenger Wi-Fi and entertainment services, passenger information displays, and collaboration capabilities. Cisco Connected Train also provides a link to operations and control center teams for CBTC, Positive Train Control (PTC) and fleet dispatch features. The Connected Train architecture is shown in Figure 2.

**Figure 2 Cisco Connected Train Reference Architecture**

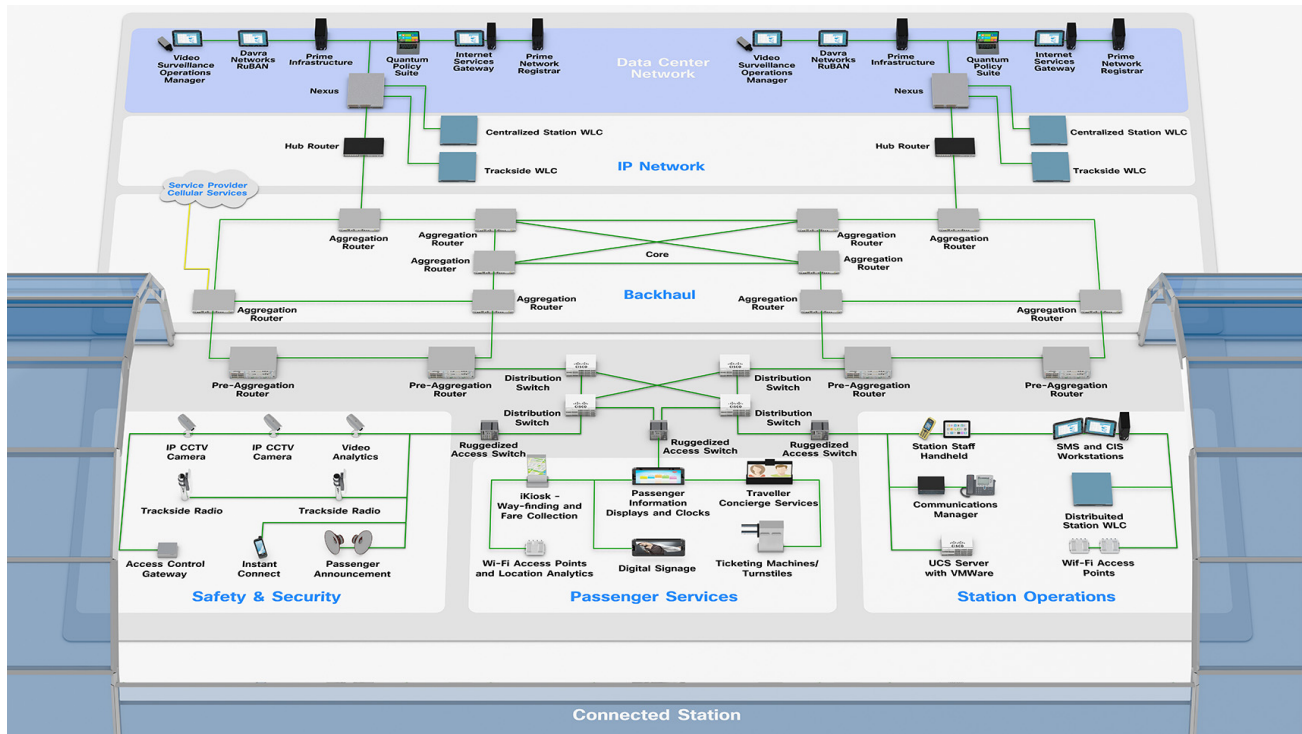
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The high-speed Cisco Connected Train network is built on hardened, small form factor (SFF) switches and gateways that support consumer and business mobility features. The onboard gateway manages seamless service transport simultaneously over multiple Wide Area Network (WAN) connections, including both Ethernet-connected train-to-trackside radios and multiple Long Term Evolution (LTE) cellular links. Wireless access points provide Wi-Fi connectivity to rail personnel and passengers. The network also supports comprehensive video surveillance, with a dedicated Video Surveillance Media Server on each car to store video archives from the onboard IP cameras. This same server platform is used for hosting on demand content for passenger entertainment services.

## Cisco Connected Trackside

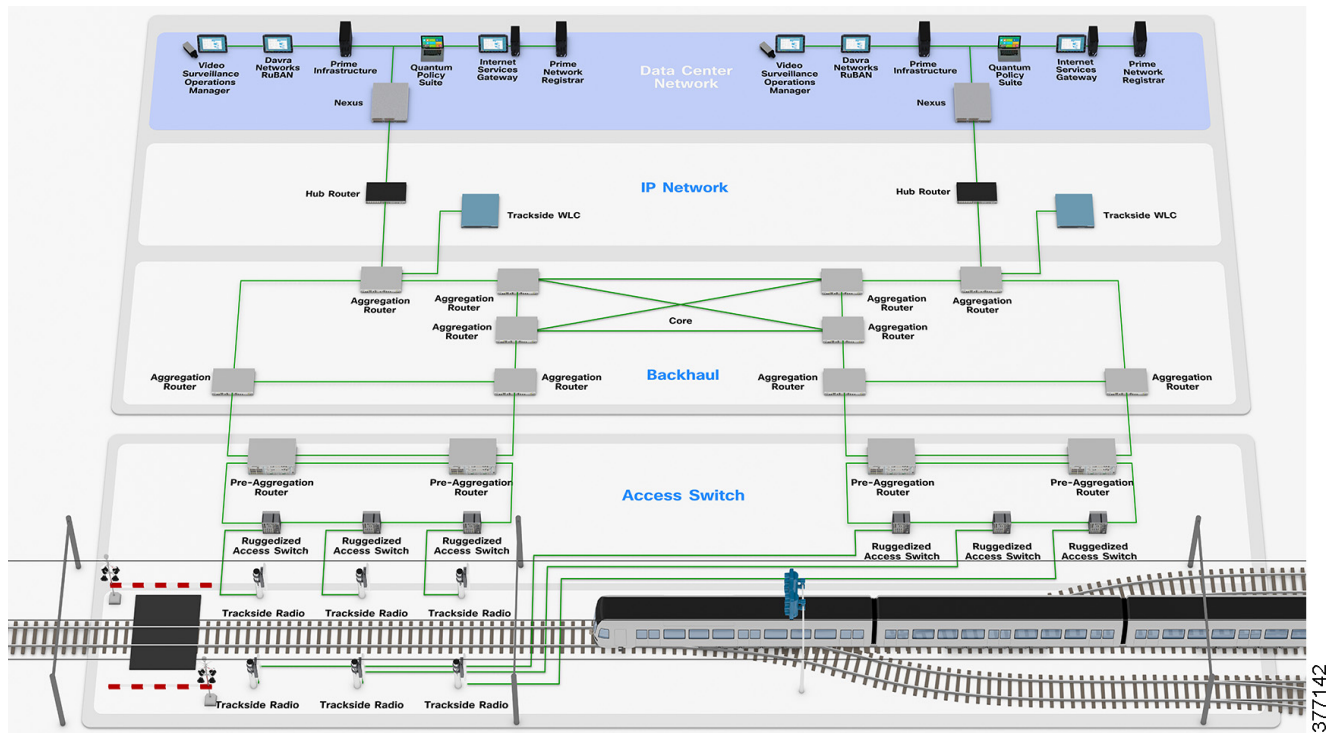
Trackside radios, which are ruggedized for almost any environment, provide broadband wireless connectivity between the trackside backhaul infrastructure and high-speed trains. Trackside radios connect to the transport network using fiber or copper connections to ruggedized Ethernet access switches, which are able to supply power via Power over Ethernet (PoE) to the radios and other trackside devices, like video surveillance cameras. These ruggedized switches are connected in either ring or hub-and-spoke topologies via fiber connections to Pre-Aggregation Nodes, which form the edge of the Unified MPLS-based highly-scalable converged backhaul network. The Cisco Connected Trackside architecture is shown in [Figure 3](#).

Figure 3 Cisco Connected Trackside Reference Architecture



Cisco also provides a validated design for a highly-scalable and resilient converged service transport network that connects the trackside network with operations and data centers. The transport network consists of access, aggregation, and core networks. It provides a resilient communication path between Connected Train, Connected Trackside, Connected Stations, and the data center. This network includes ruggedized Ethernet switching at the edge and a multipath, IP-based MPLS transport network with sub-second reconvergence for communications between trains and the data center. The architecture for train-to-data center backhaul is shown in [Figure 4](#).

**Figure 4** Connectivity from Train, Trackside, and Station to Data Center



A Virtualized Multiservice Data Center (VMDC) validated design, shown at the top of [Figure 5](#), creates a data center infrastructure to support high-speed mobile networking for rail applications. The data center houses a highly-scalable and virtualized server infrastructure on which are hosted all applications for the Cisco Connected Rail Solution. These application servers may run directly on physical servers or be virtualized through the use of a hypervisor. They include the following:

- The Local Mobility Anchor (LMA) hub router for Connected Train traffic aggregation.
- Wireless LAN Controllers (WLCs) for managing the Wi-Fi infrastructure in the Connected Station and onboard the Connected Train.
- Network Management Systems (NMS) for managing the network infrastructure and passenger services.
- Cisco Video Surveillance Manager (VSM) application servers including the Cisco Operations Manager and Long Term Storage to manage Video Surveillance on the Train, along the Trackside, and in the Station
- Other servers, such as the Cisco Instant Connect system, formerly known as the IP Interoperability and Collaboration System (IPICS). This system dissolves communication barriers between land mobile radio (LMR) systems and devices such as mobile phones, landline phones, IP phones, and PCs. Instant Connect is a scalable, cost-effective way for all rail and security personnel to communicate quickly using any desktop or mobile device wherever they are located. It simplifies radio dispatch operations and accelerates incident and emergency response times. It also adds new capabilities to your existing communications equipment.

## Cisco Connected Station

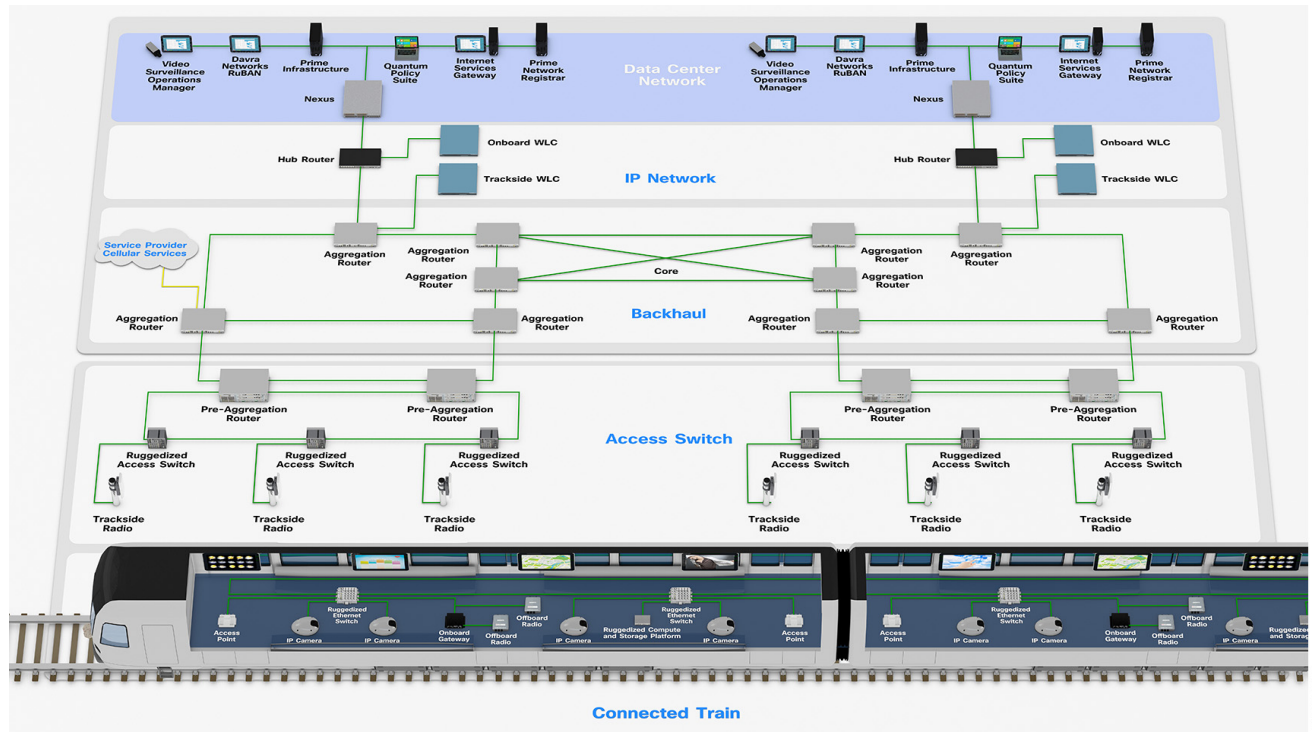
Cisco Connected Station delivers innovative services to passengers, help stations enhance safety and security, simplify operations, and provides station staff with more efficient communications. With Cisco Connected Station, multiple proprietary station networks evolve into a unified multiservice network and displays, ticketing systems, voice communications, and fire and safety alarm systems, and passenger services and applications are unified into one

Ecosystem Partners

manageable infrastructure. In addition, the network infrastructure supports deployment of physical safety and security capabilities such as emergency help points and video surveillance cameras to enhance station safety and monitoring systems.

The architecture for Cisco Connected Station is shown in Figure 5.

Figure 5 Cisco Connected Station Reference Architecture



## Ecosystem Partners

A key advantage of the Cisco Connected Rail solution is that it brings best-of-breed Cisco products together with offerings from key ecosystem partners into a cohesive, end-to-end, validated design that fulfills the business needs of rail operators. Some ecosystem partner products that have been validated with the Cisco solution are even available on the Cisco Global Price List (GPL) to simplify your procurement process. Ecosystem partners whose products have been validated with the Cisco Connected Rail Solution include:

**Fluidmesh Networks**

Provides train-to-trackside radio systems for near seamless connectivity of high-speed trains. <https://www.fluidmesh.com/>

**Klas Telecom**

Provides fully rail-certified, ruggedized onboard gateways and Ethernet switches. <http://klastelecom.com/>

**Lilee Systems**

Provides fully rail-certified, ruggedized onboard gateways. <http://www.lileesystems.com/>

**Davra Networks**

Provides the RuBAN Application Enablement Platform for infrastructure and service management. <http://www.davranetworks.com/>

## Quick Look: Validated Cisco Connected Rail Components

Onboard Gateways	A ruggedized multiservice gateway from Klas Telecom, integrating the Cisco ESR 5921 router, offers flexible off-boarding via both train-to-trackside radio and multiple LTE interfaces, and Layer 3 routing and security. Onboard devices use the ESR 5921 as their default Mobile Access Gateway (MAG). The data center uses the Cisco ASR 1000 Series Aggregation Services Router as a Local Mobility Anchor (LMA) hub router for terminating tunneled connections from the onboard gateways.
Industrial Ethernet Switching	The Cisco IE 2000, Cisco IE 3000, and Cisco IE 4000 Series of Industrial Ethernet switches provide a variety ruggedized switching options. Onboard the train, a ruggedized rail-certified Layer 2 switch from Klas Telecom, integrating Cisco technology, provides Ethernet connectivity, PoE, and mechanical bypass to avoid cars becoming isolated islands during a power failure. Off-board, standard Cisco Industrial Ethernet switches support Layer 2/3 connectivity with flexible configuration options.
Train-to-Trackside Radio	Ecosystem partner Fluidmesh Networks provides an IEEE 802.11-based Ethernet-connected radio system to provide train-to-trackside wireless communications. Integrating their FLUIDITY technology provides high bandwidth connectivity to high-speed trains with near-seamless roaming.
Wi-Fi Access Points	Cisco offers the IW3700 series industrial wireless LAN access points designed for onboard and station deployment. Another option for station deployment, the Cisco Aironet® 3700 Series wireless LAN APs may be used in air conditioned spaces where hardened devices are not required.
Wireless LAN Controller (WLC)	The Cisco 5500 Series Wireless Controller provides high-performance, scalable, and reliable services for wireless networking. It can support up to 500 access points. For larger deployments, the Cisco 8500 Series Wireless Controllers offer the same functions with higher scale.
Subscriber Policy Control	For service providers who offer mobile services to rail passengers and operations teams, the Cisco Service Provider Wi-Fi solution offers subscriber policy control to create revenue-generating opportunities. Cisco Quantum Policy Suite (QPS) for Wi-Fi is a carrier-grade policy and subscriber data management software solution for controlling, monetizing, and personalizing Wi-Fi offerings.
IP Video Surveillance	Cisco provides video surveillance cameras including the rugged, high-definition, IP67-rated 3050 and 7070, and media servers. The Cisco Video Surveillance Manager (VSM) management suite lets you view and archive video and manage the video surveillance infrastructure.
Cisco Unified MPLS for Transportation	Cisco Unified MPLS design is a scalable and resilient backhaul network for mobile voice, video, and data traffic between the train, trackside, station, and the data center. It complements existing backhaul networks to enhance their capacity and resiliency.

## Summary

Use Cisco Connected Rail to integrate the capabilities of multiple standalone networks with an open-standards IP infrastructure. The newer, more reliable network enables rich capabilities to achieve safety, mobility, and efficiency goals. You can implement video surveillance to protect assets and monitor passenger safety. Give station and trackside employees mobile communication capabilities to maintain situational awareness. And more easily meet industry regulations and compliance requirements using the same physical infrastructure. This is all thanks to the converged Cisco Next-Generation IP Network.

For More Information

## Why Turn to Cisco?

Cisco architecture and validated network designs, built on open standards, let you take advantage of commercially available products and services to lower costs while improving performance. Whether you are a railroad operator, transit authority, or first responder, you gain the benefits of IP networking capabilities that have been proven in every other industry around the world. Get the high capacity needed to support today's rail applications and services with the flexibility you need to easily adapt over time. Cisco Services help you plan, build, and manage the new capabilities cost-effectively. With Cisco, you can support new and future requirements, lower your total cost of ownership, reduce deployment costs, manage risk, and deliver high performance of your Connected Rail solution.

## Cisco Services

From strategy to execution, we help you plan, build, manage, and support your Cisco Transportation Smart Solution. We apply our industry leading experience to help you improve system operational efficiency, scalability, security, and profitability. With an end-to-end approach that aligns outcomes to your business goals.

## For More Information

For more information about Cisco Connected Transportation solutions, including Connected Rail, visit <http://www.cisco.com/go/transportation>.