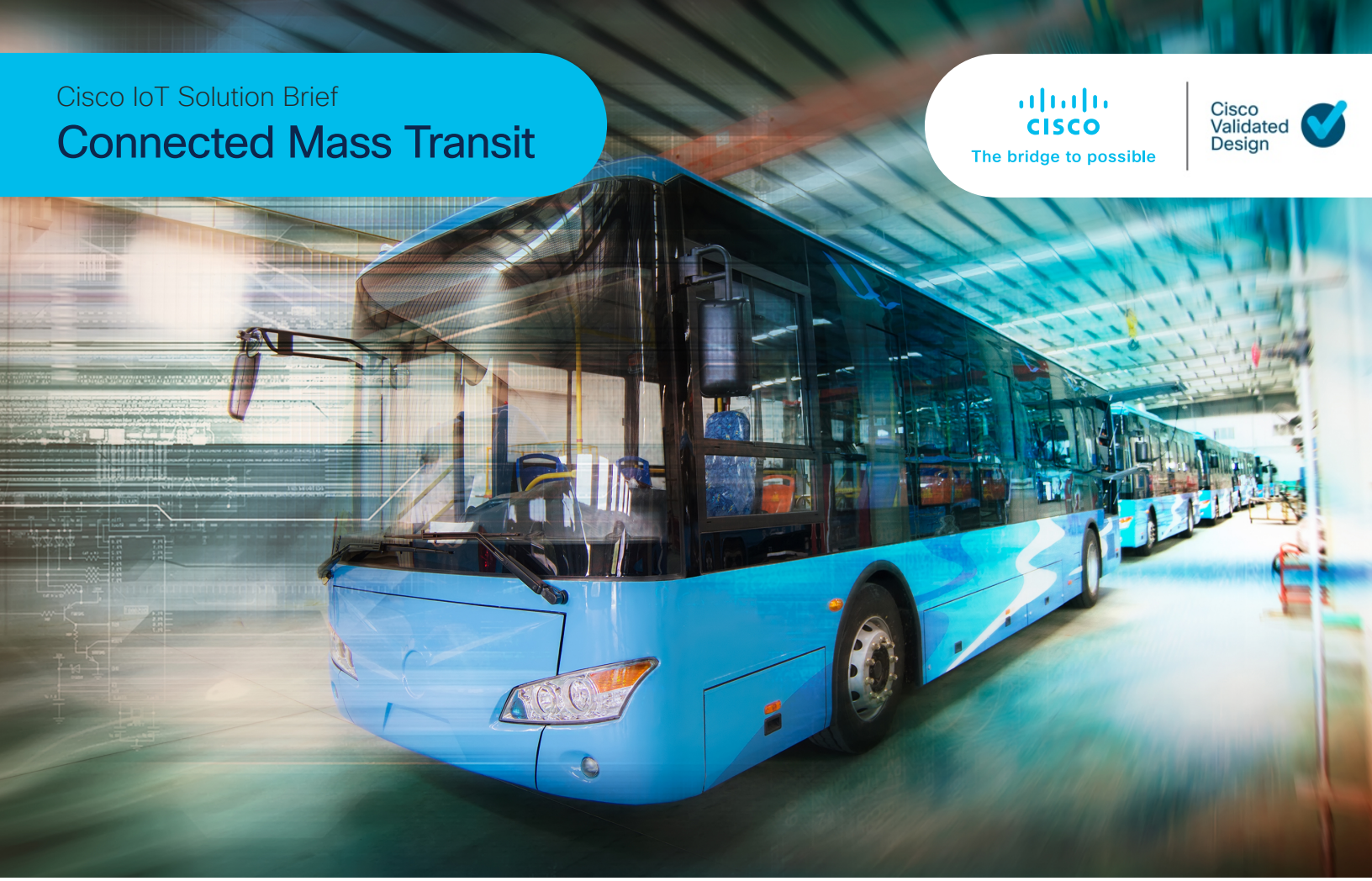
Cisco IoT Solution Brief

Connected Mass Transit

The bridge to possible

Cisco Validated Design



Benefits

Manage and optimize your mass transit fleet operations via:

- **Simple** solutions geared towards OT staff and easily integrated into existing asset operations
- **Secure** solutions that ensure asset availability and operational integrity
- **Scalable s**olutions that allow thousands of assets to operate simultaneously, positioning the customer to meet future requirements

Connecting and optimizing Mass Transit fleets:

Introduction to Cisco Managed Gateways for Mass Transit

Cisco is a global leader in data and networking and provides a wide range of products to address connected mass transit solutions. By applying our networking and IoT expertise to mass transit systems we have created innovative technology solutions which optimize system operations for mass transit. Our goal is to future-proof your investment by providing an evolution path from today's bus-centric connected bus and rail systems to cloud-based solutions and interaction with the smart cities of tomorrow.

Cisco Validated Designs

Since the inception of IP networking, Cisco Validated Designs™ (CVDs) have been used to validate, architect, and configure next-generation technologies. CVDs start with the vertical use cases and architect the flow from the edge device to the application, validating the key Cisco and 3rd party components

© 2020 Cisco and/or its affiliates. All rights reserved.

along the way. Each aspect of the architecture is thoroughly tested and documented with sample configurations, helping to simplify integration through proven solutions.

The goal is to ensure a deployment that's simple, faster, reliable and cost effective.

Mass transit challenges

Currently, mass transit faces a host of problems and inefficiencies in the way it is operated:

- Multiple, disjointed on-board systems resulting in the presence of multiple LTE gateways/SIM cards
- Lack of unified connected fleet operations insights
- High costs, especially with antenna installation and recurring cellular charges. Also, leads to difficult scaling, as thousands of vehicles each require multiple gateways and vendors
- Minimal to no security
- Legacy Vehicle Logic Unit (VLU)-centric architecture that limits future technologies and passenger services
- Serviced mainly by IT professionals and the IT department
- Systems are often on-premise-based and require staff to be on site at the Operations Control Center for access and visibility into the network
- Access to high quality and high-fidelity data is often difficult due to outdated legacy technology

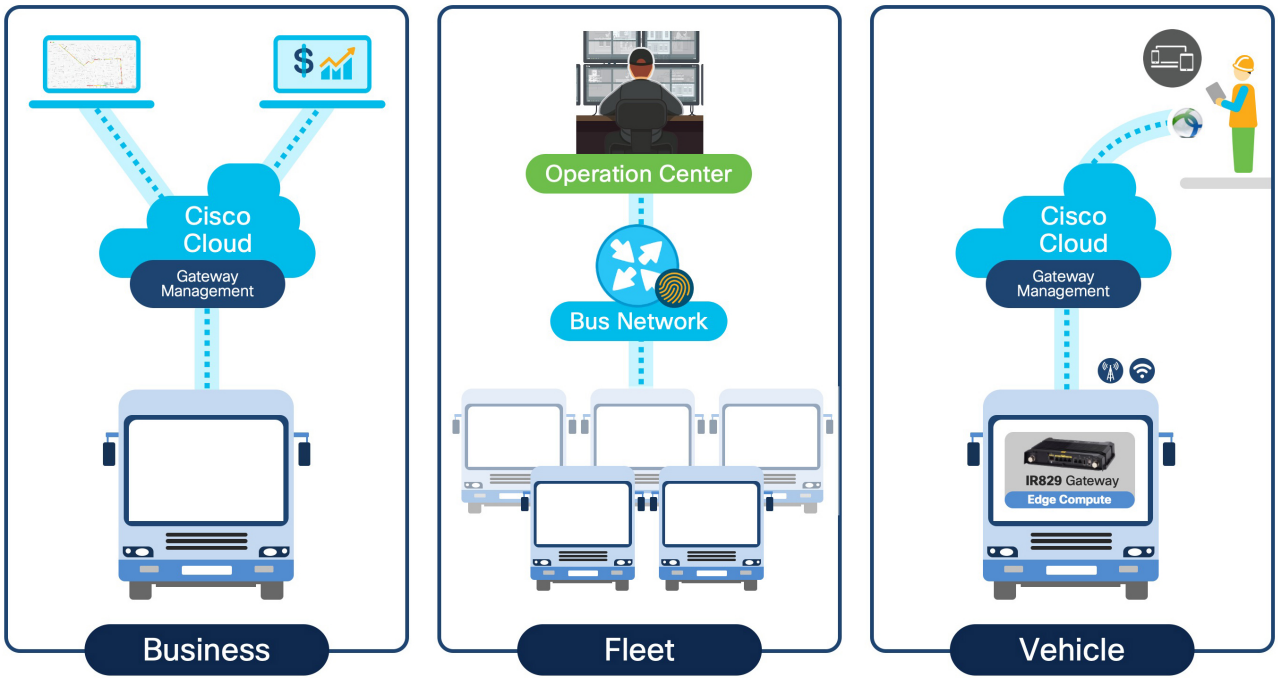
Target audience

Although all stakeholders can benefit from this document, we have focused on:

- **Technology buyers** responsible for selecting asset connectivity platforms
- **Mass Transit Operators** responsible for operating the bus or rail system

Transit operational processes and use cases

Transit solutions must consider three key aspects of a transit operations: business, fleet and vehicle operations.



© 2020 Cisco and/or its affiliates. All rights reserved.

Business operations support the planning, commercial, ridership and financial performance. Fleet operations focus on the day-to-day real-time operation of the transit service including vehicle location, on-time performance, route compliance and route adjustments, as necessary. Lastly, vehicle operations focus on the fleet vehicle performance, maintenance, refreshes of hardware and software systems for optimal fleet performance.

Note: This presentation focuses on busses, but concepts also apply to ligh trail and part apply to transit service vehicles.

Operational processes	Types of use cases supported	Device and applications
Business operations	**Route planning and optimization** • Scheduling	• AVL • Dashboard
	Passenger information and management • Passenger WiFi, advertisement • Automatic voice annunciation • Fare collection • Security cameras	• Displays and head signs • Text to speech engine • Speaker • Fare collection equipment • Safety and enforcement
	Asset utilization • Automatic passenger counting, driver management • Scheduled maintenance	• 3D sensors • APC
Fleet and operational management	**Fleet tracking** • Dispatch, location, schedule adherence, safety, route compliance, vehicle predictions, vehicle headway adherence, service adjustments, rider alerts	• AVL • Dashboard • Communications equipment
	Connectivity statistics • Cellular, GPS, WiFi	• Cellular gateway • Cloud management
Vehicle operations	**Telematics** • Fuel monitoring, engine diagnostics, predictive maintenance	• OBD-II device • CANBUS
	Upgrades and refreshers • Vehicle ID/gateway ID alignment • Hardware/firmware updates	• Cloud management • ISE
	Security • VPN, access control, secure boot	• Firewall • iOS configurations

© 2020 Cisco and/or its affiliates. All rights reserved.

The bridge to possible

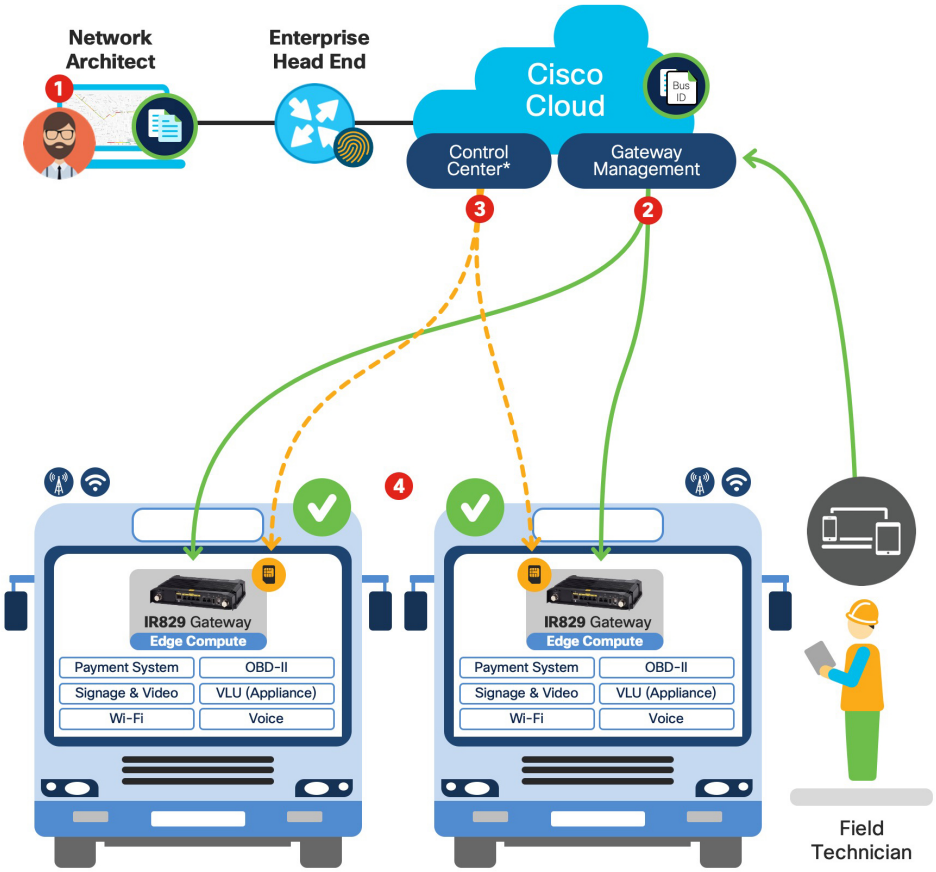
Simple provisioning and operations

To ensure our architecture is Simple, Scalable and Flexible, we have developed field-friendly gateway management with strong asset operation capabilities. Deep integration with asset systems and operations ensures that field crew can easily deploy and manage these gateways without the need for IT support. Simple provisioning

Simple provisioning

Challenge

Make it easy for the technician and non-IT staff to provision and manage connectivity at scale.



Solution

True zero touch deployment of the gateways

1. Configure templates using our point and click simplicity. Associate gateways with bus ID
2. Technician deploys the gateways using either a mobile or web application
3. A single pane-of-glass to activate/deactivate your SIM card and manage your rate plan with Cisco Control Center (offered by select Service Providers)

Your busses are now in service.

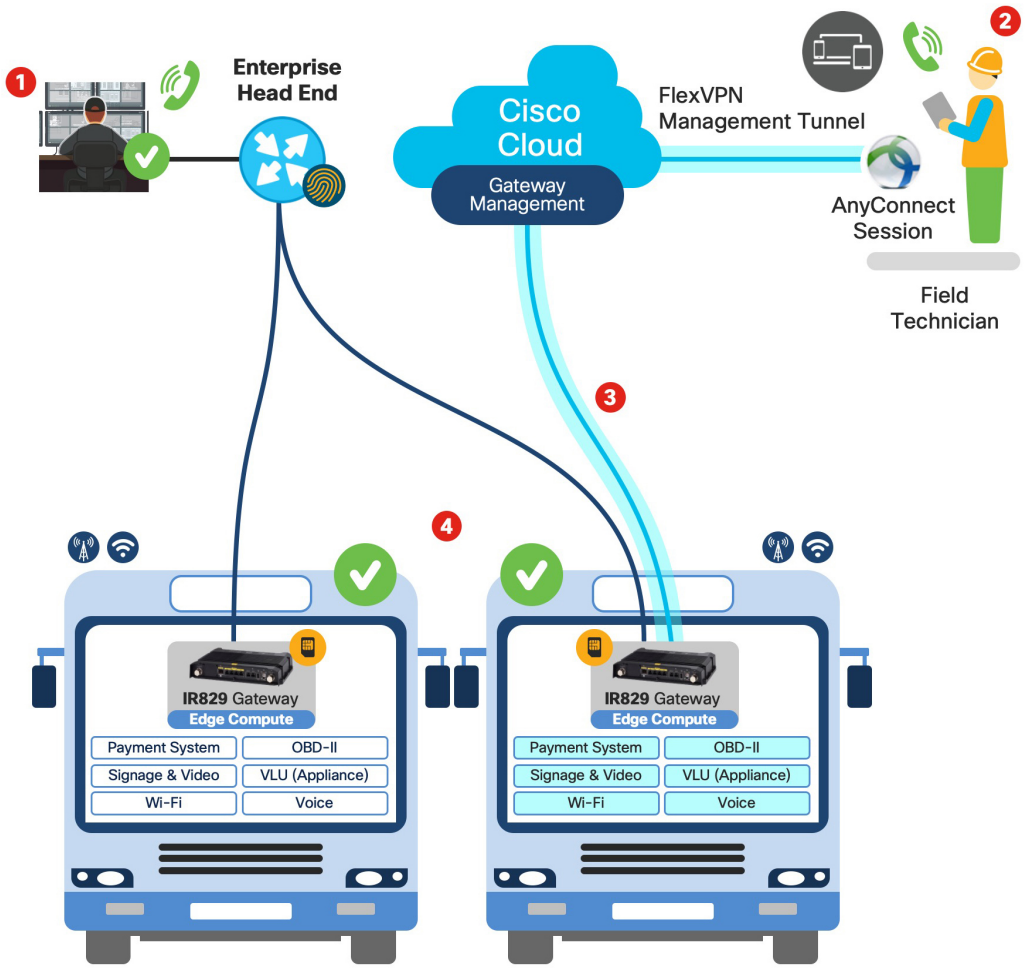
© 2020 Cisco and/or its affiliates. All rights reserved.

The bridge to possible

Simple operation

Challenge

Minimize service outages and support faster troubleshooting/updates.



Solution

Minimize downtime through remote troubleshooting using the bus ID.

1. **10 pm:** Alert at Operations Center indicating faulty CAD/AVL system.
2. **10 pm:** Transit Center supervisor asks maintenance to remotely troubleshoot and fix.
3. **10:05 pm:** Mechanic securely logs into the gateway using the asset ID and applies VLU updates.
4. **10:15 pm:** Bus back in service with functioning VLU.

© 2020 Cisco and/or its affiliates. All rights reserved.

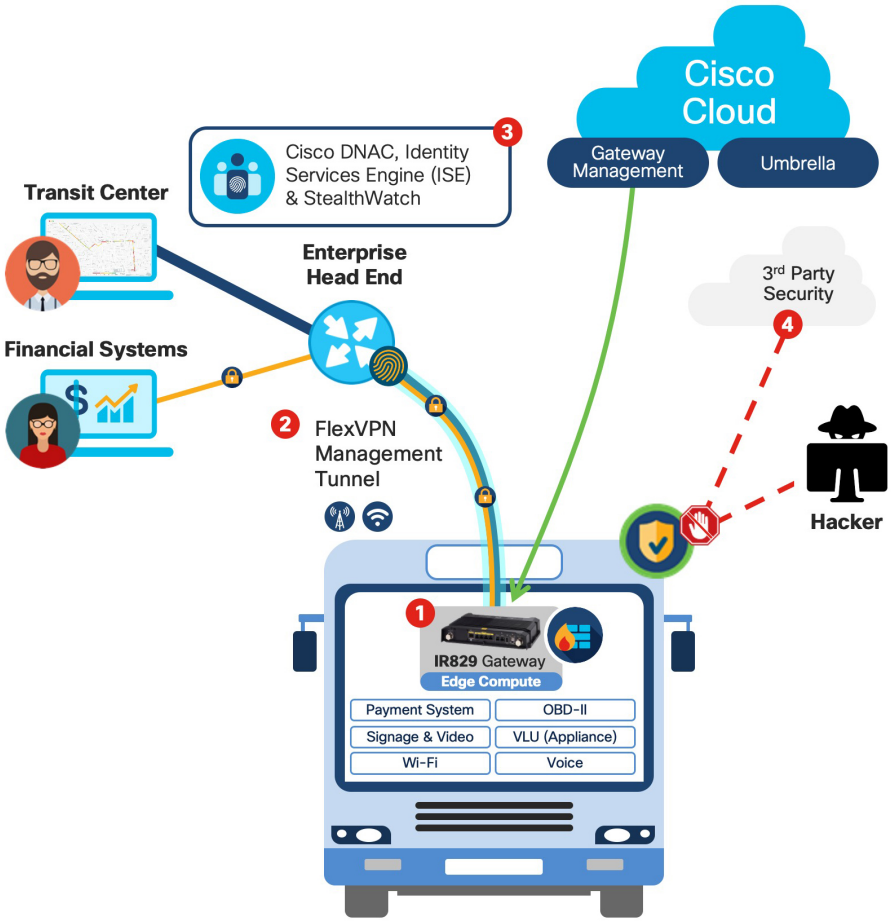
Scalable security and flexible Edge Compute

We also ensure a secure architecture designed for environments that are constantly under attack. Application flexibility is provided through a full-featured, secure Edge Compute layer that supports next generation applications along with a large partner ecosystem that can help drive innovation.

Scalable security

Challenge

Real-time cyber security protection from external and internal threats for thousands of buses.



Solution

Multi-layered security enforced through a single control point; ensure data confidentiality and end-end encryption. Standard IPSEC VPN to the operations network. Enforce network segmentations and policies:

1. Keep high-priority data separate and protected
2. High availability and connectivity of CAD/AVL data
3. Full integration with existing security services like Umbrella, Cisco's Cloud based security that secures users and devices, Stealthwatch, Cisco's machine learning network security traffic analysis, no need for 3rd party security

Your buses are now equipped with internet-ready cybersecurity.

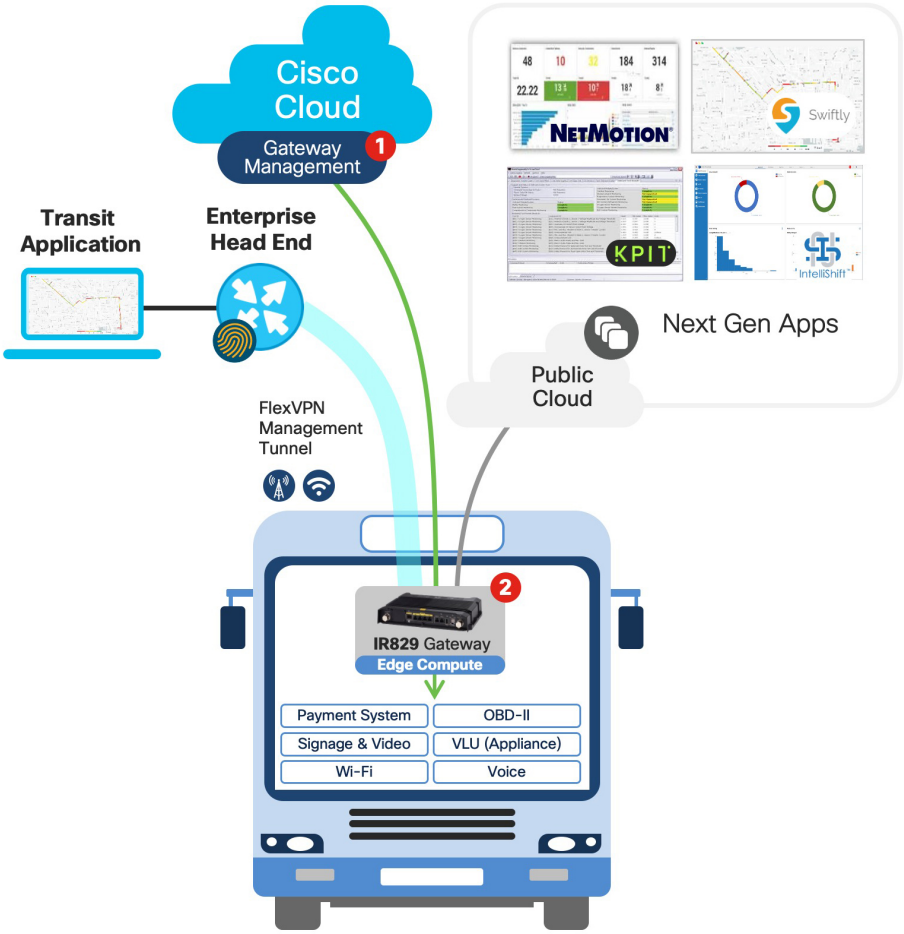
© 2020 Cisco and/or its affiliates. All rights reserved.

The bridge to possible

Flexible Edge Compute

Challenge

Support a variety of NextGen Transit apps like smart mobility, traffic signal prioritization and monitoring of operational sensors.



Solution

Edge Compute that support standards-based microservices through an open ecosystem.

1. Deploy Linux-based microservices onto the IR829 gateway
2. The necessary gateway/sensor data is pulled by applications located anywhere; on-site, at the data center, or in the cloud

Flexible and versatile operations are available.

© 2020 Cisco and/or its affiliates. All rights reserved.

The bridge to possible

Simple mass transit architecture

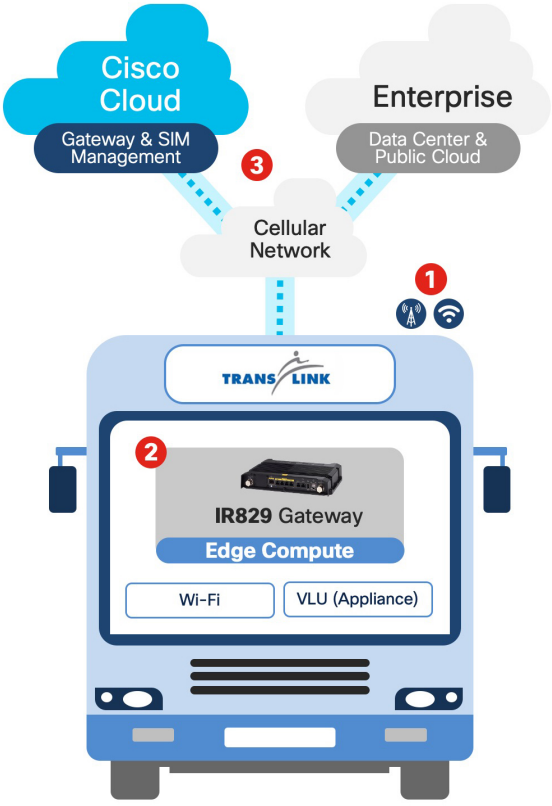
This architecture covers a typical basic deployment scenario for managed gateways considering use case requirements and available connectivity options and management.

Requirements

- A VLU or other on-vehicle equipment that requires a secure connection over cellular
- Simple to deploy and operate by field technicians
- Visibility to VLU and connected devices with secure remote access
- On-board devices can report events and logs to the operations center
- Able to troubleshoot and perform remote updates
- Real-time information delivered to operations center for fleet management
- Provides a passenger WiFi service

Proposed network architecture

- Integrated gateways and cloud management
- WiFi AP for passenger internet access



Benefits

- The Remote and Mobile Assets solution ensures ease of deployment across an entire fleet
- Cisco's Validated Design process guarantees reliable connectivity
- Integration with Cisco security applications results in robust end-to-end security

Key design elements

1. Reliable LTE connectivity/expansive coverage with low interference
2. Predefined configuration templates for fleet management and on-board devices
3. Robust end-to-end security for business, vehicle, and fleet data and management

© 2020 Cisco and/or its affiliates. All rights reserved.

The bridge to possible

Next generation mass transit site

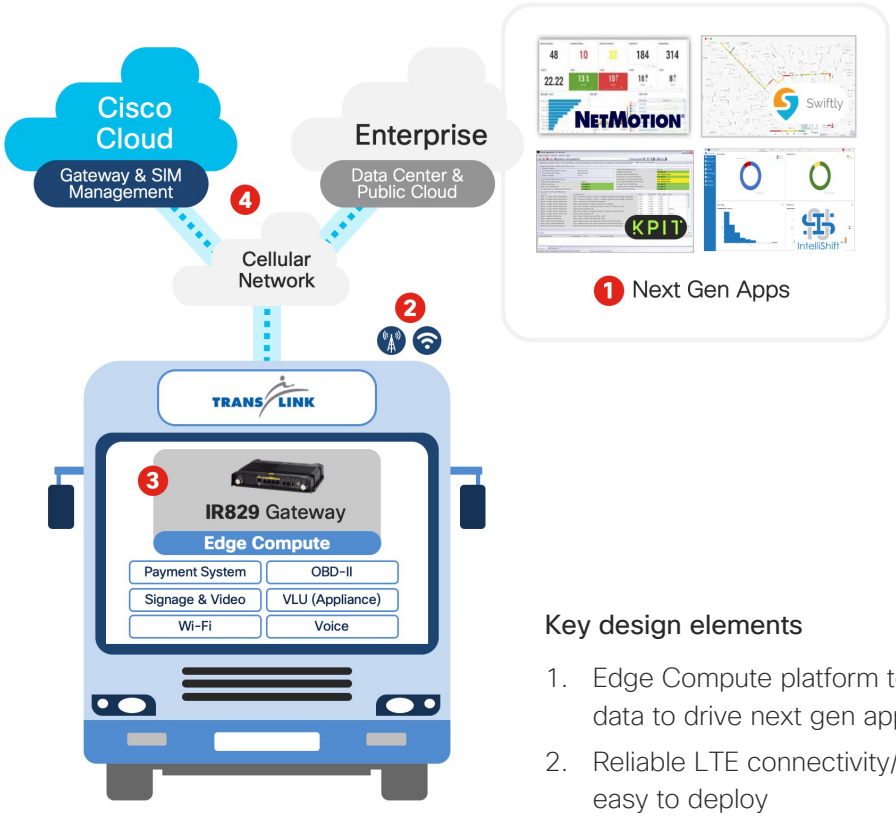
This architecture covers deployment scenarios with multiple services on the fleet vehicle using managed gateways and cloud management with Edge Compute available for local processing, as needed. Multi-agency use of vehicle device data is supported through segmentation and security.

Requirements

- Consolidated communications into one dual WiFi/LTE gateway
- Integration with next gen apps to perform advanced functions such as fleet management, vehicle diagnostics and rider alerts
- Simple to deploy (gateway, devices and Edge Compute applications) and operate by field technicians
- Support for multiple agency access to data from their specific devices and services located on the vehicle
- Establishment of controls to limit agency access to their vehicle devices and services
- Edge computing to enable local interaction between systems for vehicle location, fleet management, operations and diagnostics

Proposed network architecture

- On-site network with cloud management
- Unified deployment and management of on-site gateways, switches and compute



Note: Edge Compute capacity can be expanded by including the Cisco IC3000 Industrial Compute product (not shown)

Benefits

- All networking capabilities of on-board devices are consolidated into one, easy to use gateway
- Segmentation of data streams ensures robust end-to-end security
- Edge Compute allows 3rd party applications to bring benefit to the customer

Key design elements

1. Edge Compute platform to enable local processing of sensors/device data to drive next gen applications such as Swiftly or KPIT
2. Reliable LTE connectivity/expansive coverage with low interference, easy to deploy
3. Easy to deploy configuration templates for systems/devices at the vehicle
4. Robust security for vehicle and fleet device data and management
5. Network segmentation to enforce secure device data access to authorized agencies

© 2020 Cisco and/or its affiliates. All rights reserved.

The bridge to possible

Next generation mass transit–partners ecosystem

One foundational aspect of our next generation mass transit architecture is our robust partner ecosystem. Our partners seek to build an ecosystem which enables next generation functions that provide value to our customers. Utilizing Edge Compute, our partner's Linux based microservices can be pushed down to the IR829 Gateway. The necessary gateway/sensor data can be accessed via the cloud, at the data center, or on-site.

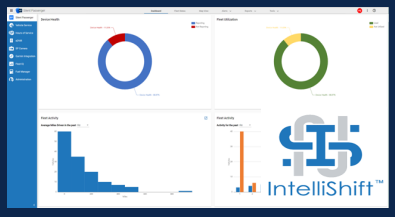
Swiftly

- View vehicle schedule adherence and on-time performance metrics and reports including real-time transit vehicle location with passenger predictions
- Tools for operators to view vehicles in real-time and make adjustments to the transit service
- Vehicle movement replay and analysis of run-times with suggested schedule improvements
- Provide updates to passengers about service changes, stop adjustments, and detours/delays and to field operators and drivers via onboard tablets



IntelliShift

- Delivers single pane-of-glass cloud-based platform for all connected vehicle and asset types coupled with field service mobility applications
- Connects fleet and operational data for optimal fleet visibility, utilization, and monetization
- Real-time visibility into location, productivity, fuel spend and fleet run time costs
- Captures drive time; route effectiveness and delivers ETA's using current and historical traffic data
- Vehicle/asset diagnostics to drive preventative maintenance and driver/passenger safety



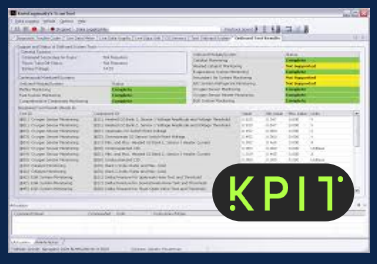
NetMotion

- Display diagnostics data to show signal strength and connectivity information
- LTE data consumption, application performance, network speed/performance, and mobile data usage
- Provides information on the networking capabilities on-board the vehicle



KPIT

- Enables the implementation of remote vehicle diagnostics and service-oriented vehicle telemetry for predictive maintenance
- Provides vehicle state event management, KPI dashboarding, and repair instructional information
- Reduces vehicle down-time and increases FFV (Fixed-First-Visit) rates



© 2020 Cisco and/or its affiliates. All rights reserved.

The bridge to possible

Smart city integration

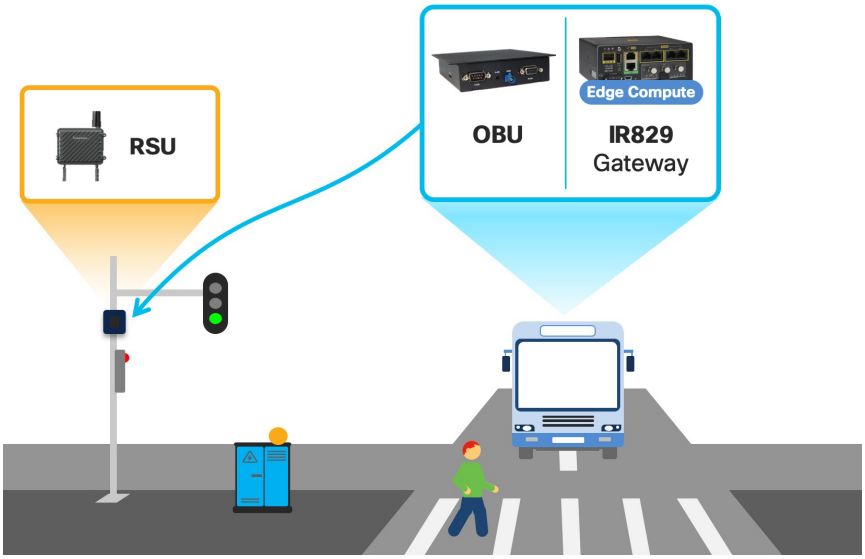
This architecture covers more advanced or next generation deployment scenarios requiring high bandwidth, low latency links to smart city fiber-connected intersections and coordination between other connected autonomous vehicles.

Requirements

- Real-time communication with the intersection supporting traffic signal prioritization (TSP) decisions for bus and emergency vehicles
- C-V2X On-board Unit (OBU) for high-speed bi-directional communication with an intersection RSU (roadside unit) or other vehicles to share speed, location, trajectory, and telemetry data
- Via the OBU, receive C-V2X data from the intersection or other vehicles for driver alerting, safety messages, etc.
- OBU vehicular data upload to fleet management systems
- Unified deployment and management of on-site gateways, switches and compute

Proposed Network Architecture

- On-board network with cloud management
- C-V2X connectivity to support advanced ITS applications and improve passenger safety



Benefits

- Increases efficiencies in transportation by leveraging both the roadways and the vehicles
- Builds out the foundations of a future-proof connected cities infrastructure
- Minimizes traffic jams while ensuring pedestrian and driver safety

Key Design Elements

1. On-board unit (OBU) supporting C-V2X communication between the mass transit vehicle, intersection RSU and other connected vehicles
2. Direct wireless connection between the OBU and the RSU to enable C-V2X operations
3. C-V2X capabilities for urban location, platooning, traffic efficiency, vehicle operations management, etc.
4. Easy to deploy configuration templates for systems/devices at the intersection
5. Robust security for intersection device data and management
    a. Network segmentation to enforce secure device data access to authorized agencies
6. Edge Compute platform enables local processing of RSU device data to drive intelligent traffic control and analytics

© 2020 Cisco and/or its affiliates. All rights reserved.

The bridge to possible

Deploying connected mass transit

Deployment of connected mass transit solutions requires careful planning and execution to guarantee success and support later expansion and evolution. Below are steps and actions as well as deployment challenges and how they can be overcome.

Deployment steps

01 Use case capture and definition

02 Identification of future needs

03 Identification of Edge Compute needs

04 Planning and designing

05 Local site network design

06 Antenna selection and placement

07 Deployment and factory acceptance

Actions

1. Identify initial required services (e.g. secure backhaul for VLU, video security, APC systems, passenger WiFi services, etc.)
2. Capture and assess plans for future service expansion and connectivity such as vehicle telematics collection/assessment, interior and exterior signage, emergency alerting and cloud services
3. Assess current and future services—will local processing be required for telematics, intelligent linking of vehicle on-board systems, integration with cloud services?
4. Create engineering design considering available power/space, on-board subsystem connectivity and data center interfaces. Plan your deployment phases for easy rollout of services in the future
5. Define on-board device addressing, port mapping/forwarding, device and network security options. Leverage Cisco Validated Designs for guidance
6. Assess antenna mounting options and location via a study of other RF systems and antennas in use. Select optimal MIMO antenna solution given RSSI in service area
7. Execute the plan—install/configure equipment, provision the vehicle and perform an acceptance test

Cisco help in addressing key intersection deployment challenges

Integration

- Zero-touch deployment to automate the process and remove human error
- Secure remote access and visibility to on-board devices behind the gateway
- Effective link debugging with cellular performance metrics and history dashboard

Security

- Multiple/flexible VPN options to control access and protect your data
- Port security (802.1x, MAB) to limit and authenticate access to switching ports
- Network segmentation to enforce secure device data access to authorized agencies
- Physical security via alarm inputs triggering SNMP alarms
- Stealthwatch for protocol inspections to detect intruders

© 2020 Cisco and/or its affiliates. All rights reserved.

The bridge to possible

Mass transit technology selection guide

Cisco products are designed for harsh outdoor environments such as would be experienced in mass transit or intersection cabinets. With the support Cisco's advanced management and security products as well as Edge Compute capability, they provide a rich set of capabilities and possibilities for meeting current and future intersection and roadway needs.



Pictured: Cisco IR829 Industrial Router

See also: Cisco IR800 Series Industrial Routers

Production options

Mounting	Panel
WAN options	LTE x 2
Switch ports (RJ45)	4 GigE
WiFi	802.11
RS232/RS485	2 DTE/DCE
GPS	Yes + gyroscope + accelerometer
GPIO	Alarm input
Dimensions and availability	1.15 X 5.05 X 6.27(globally)

Edge Compute options

CPU architecture	Intel 64 bit (x86_64)
CPU (units) available	732
Memory available	767MB
Storage available	512 - 1800MB (40GB-80GB with SSD)
CPU architecture	PaaS, LXC, Docker

Resources

IoT Operations Center

- Overview

Cisco Validated Designs
Remote and Mobile Assets

- Industry solutions

Cisco DevNet

- Home page

Cisco IOx

- Platform support matrix
- Documentation

For more information, please refer to the links above or contact your local Cisco Account Manager.

Americas Headquarters
Cisco Systems, Inc.
San Jose, CA

Asia Pacific Headquarters
Cisco Systems (USA) Pte. Ltd.
Singapore

Europe Headquarters
Cisco Systems International BV Amsterdam,
The Netherlands

Cisco has more than 200 offices worldwide. Addresses, phone numbers, and fax numbers are listed on the Cisco Website at **https://www.cisco.com/go/offices**.

Cisco and the Cisco logo are trademarks or registered trademarks of Cisco and/or its affiliates in the U.S. and other countries. To view a list of Cisco trademarks, go to this URL: https://www.cisco.com/go/trademarks. Third-party trademarks mentioned are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (1110R)

