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WELCOME

U.S. Department of Transportation

Office of the Assistant Secretary for Research and Technology

Welcome

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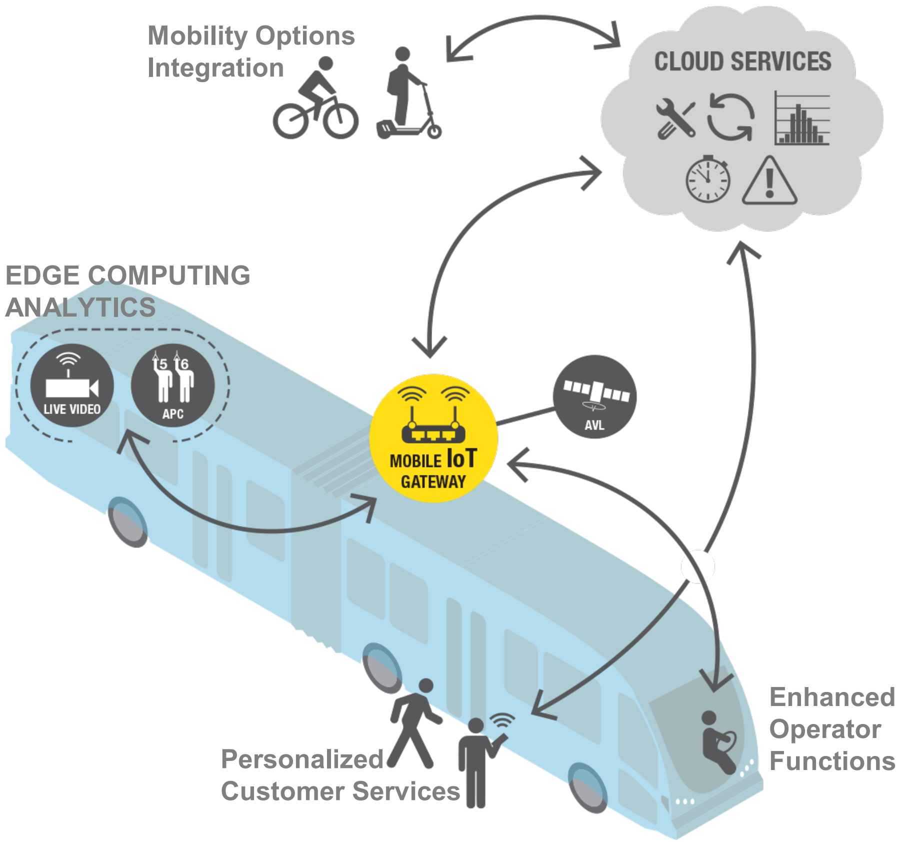
Module 23:

Leveraging Communications Technologies for Transit On-board Integration



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Instructor

Carol Schweiger

President

Schweiger Consulting

Learning Objectives

Review key concepts from Module 19: On-board Transit Management Systems for Buses

Describe how to use current communication technology for on-board systems integration for buses

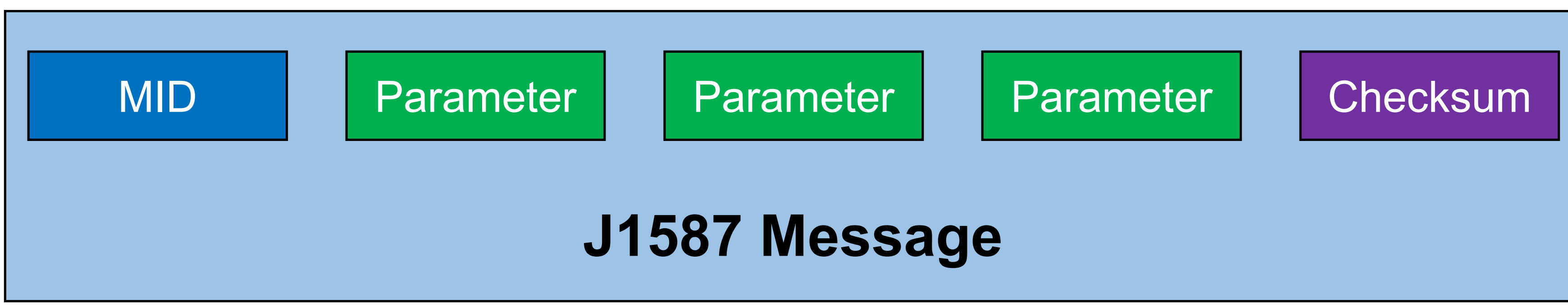
Illustrate how to procure systems that use current communication technology for on-board systems

Learning Objective 1

Review Key Concepts from Module 19 On-board Transit Management Systems for Buses

Summary of Contents and Use of SAE J1587

- Defines messages transmitted on SAE J1708 network
- Specifies transport, network and application layers
- Outdated and being replaced by J1939
- Defines format of messages and data being communicated between on-board microprocessors
- Format:
  - Message identifier (MID) – source address of transmitting node
  - One or More Parameters
  - Checksum



Summary of Contents and Use of SAE J1587 (continued)

- J1587 is outdated, but is often **found in legacy systems**
  - **Vehicle and component information**
  - **Routing and scheduling information**
  - **Driver information** relating to driver activity
- **SAE J1708, defining basic hardware and conditions** required for on-board data exchange
- With J1708 backbone in place, **J1587** added for **general on-board information sharing and diagnostic functions**
- Use of **J1587 and J1708 described together**

Summary of Contents and Use of SAE J1708

- Addresses **transmission of information** among bus components
- Identifies **minimum hardware and procedural requirements** for routing messages over network
- Establishes method for determining:
    - Which device is communicating (i.e., engine, farebox, etc.)
    - Length of time that each device is allowed to communicate
    - Which device has priority in accessing network when two try to gain access simultaneously
    - That message was received correctly should there be problems in transmission
- Describes **physical and data link layer**
- Transmission rate **9600 bps** and message up to **21 bytes** long

Summary of Contents and Use of SAE J1708 (continued)

- Exchange information between **vehicle logic unit (VLU)** and automatic vehicle location (AVL), fare collection, radio, passenger information and other systems
- Integration examples:
  - Passenger information systems with AVL provides **automatic next-stop audio and visual announcements**
  - Fare collection with passenger counters, passenger information systems and AVL **identifies passenger trends**
  - On-board cameras and AVL to store **video images** on-board **for review** or send **emergency-related images** in real time
- Combine **health-monitoring** capabilities of vital on-board components with **AVL** to send fault alarms in real time

Summary of Contents and Use of SAE J1939

- Defines **how information transferred across network** to communicate information such as vehicle speed
- Capable of handling requirements satisfied by **J1708/ J1587/ J1922**
- Spans all **7 Open Systems Interconnection (OSI) layers**
- Data rate of **250,000 bits per second** - faster than J1708
- Permits connection **up to 30 units** compared to maximum of 20 for J1708
- Most messages defined by J1939 **intended to be broadcast**
  - Data transmitted on network without specific destination
  - Permits any device to use data without requiring additional request messages
  - Allows future software revisions to easily accommodate new devices
- Uses **29-bit identifier defined within CAN 2.0B protocol**

Summary of Contents and Use of SAE J1939 (continued)

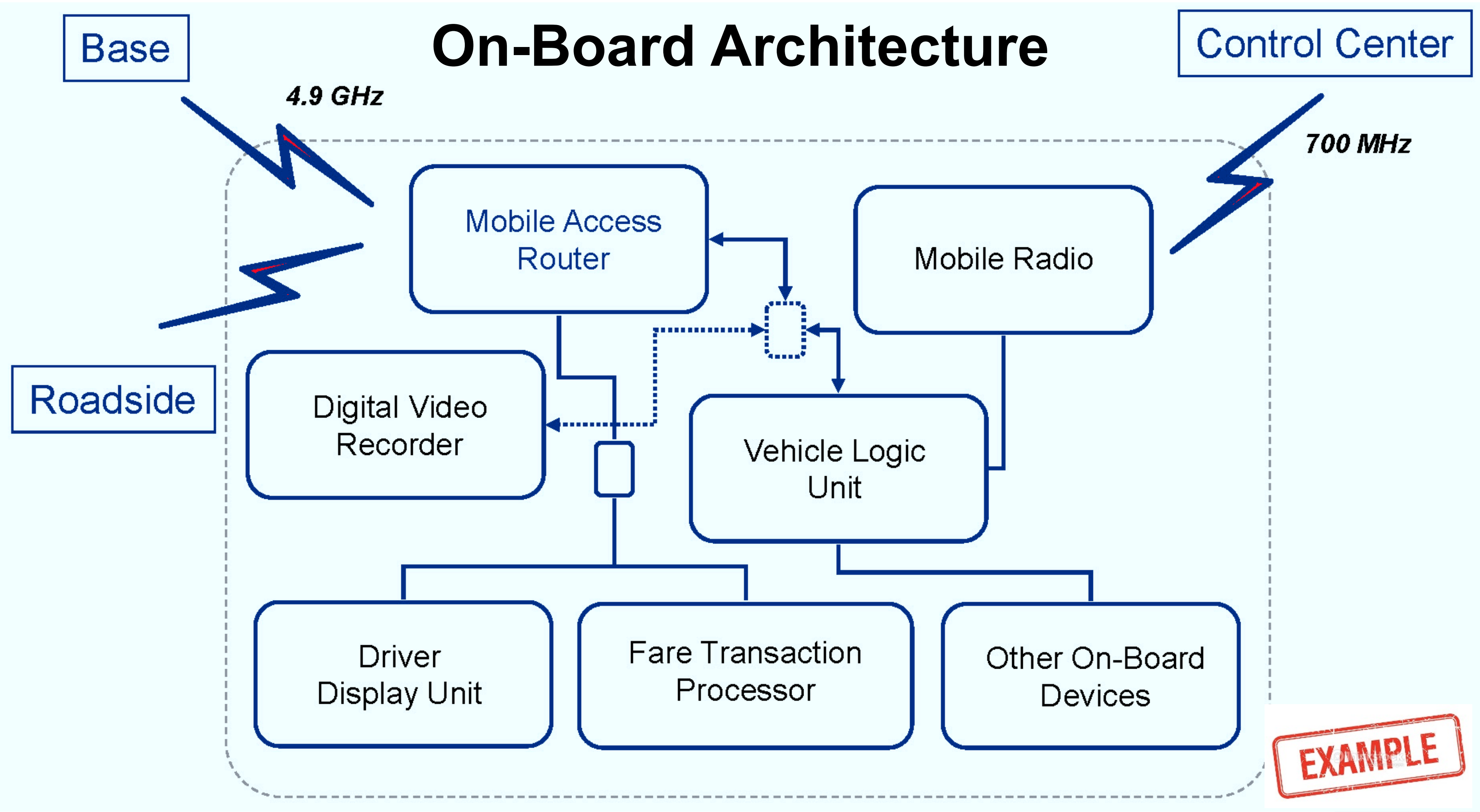
- Defines message timeouts, how large messages are fragmented and reassembled, network speed, physical layer and how applications acquire network addresses
- Defined using individual SAE J1939 documents based on OSI model layers
- Uses Controller Area Network (CAN) protocol permitting any ECU to transmit message on network
- Every message uses an identifier that defines:
  - Message priority
  - From whom it was sent
  - Data that is contained within it
- Collisions are resolved non-destructively as result of arbitration process that occurs while identifier transmitted
- J1939 messages built on top of CAN 2.0b - make use of extended frames

Summary of Use of Wireless Access Points and On-board Internet

- Use of IEEE 802.11x
  - Agencies use wireless access points (WAPs) to upload/ download data and perform software updates for vehicles
  - Current WAPs use IEEE 802.11ac
  - On-board Wi-Fi for passengers uses 802.11x
- What is Single-point Logon?
  - Computer-aided Dispatch (CAD) allows for single point logon for all on-board systems
  - Driver can initiate systems connected to CAD (e.g., AVL, farebox)
  - Reduces potential for error
  - Where more than one GPS unit on board provides one GPS location and time/date stamp for all systems
  - Keeps operational information being used and generated by on-board systems synchronized

Use of On-board Standards to Provide a Single-point Logon

Single-point Logon at King County Metro



CASE STUDY


SHERIFF DISPATCH
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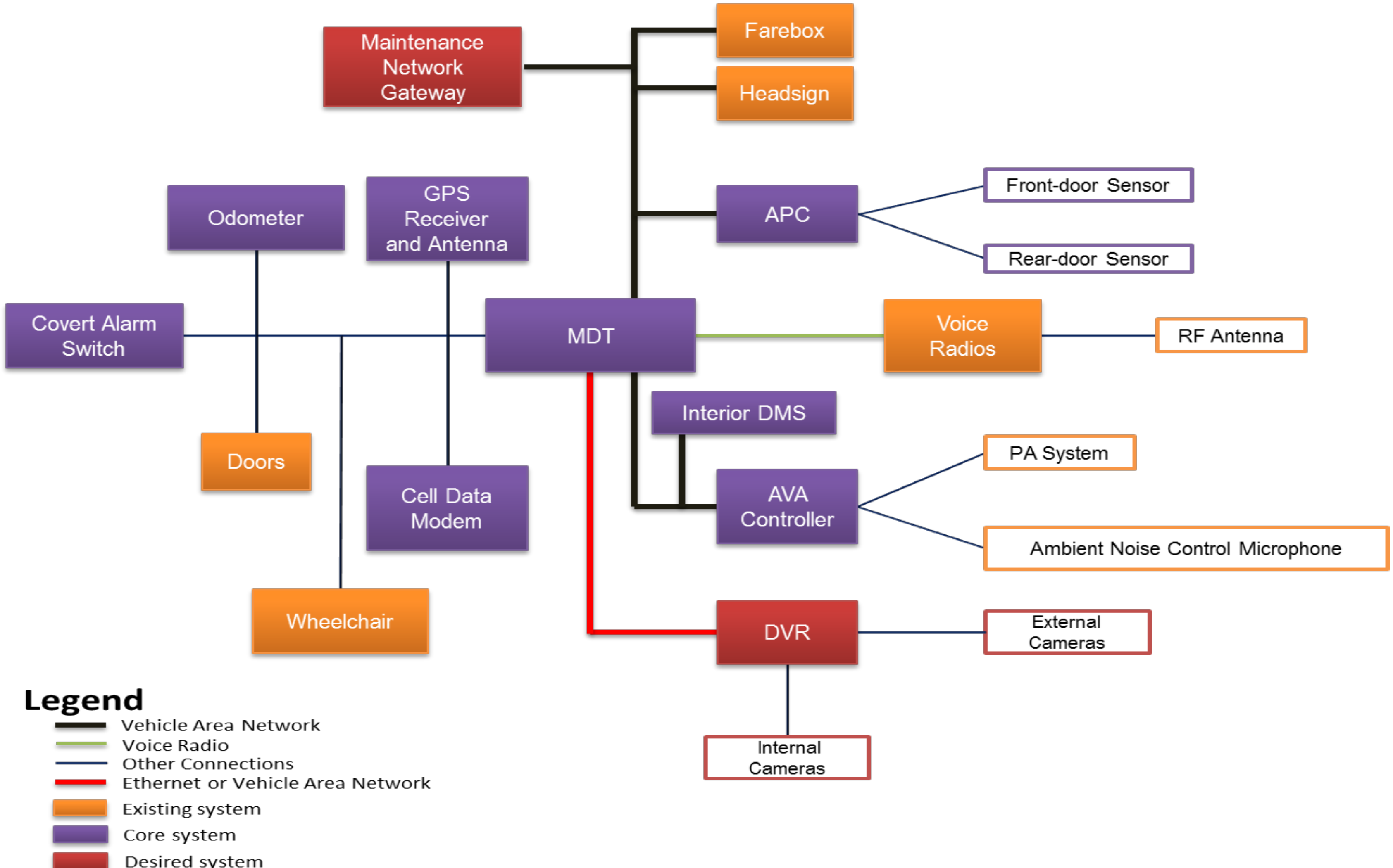
Illustrate How to Procure Systems Using Transit On-board Management Standards

Summary of How to Procure Systems Using Transit On-Board Standards

- Case Study of Procuring System(s) Using SAE J1708/1587
  - Norwalk Transit District (NTD) CAD/AVL System
  - Capital District Transportation Authority (CDTA) Intelligent Transportation Management System (ITMS)
  - Ann Arbor Area Transportation Authority (AAATA) CAD/AVL Hardware and Software

Illustrate How to Procure Systems Using Transit On-board Management Standards

NTD CAD/AVL On-board Systems



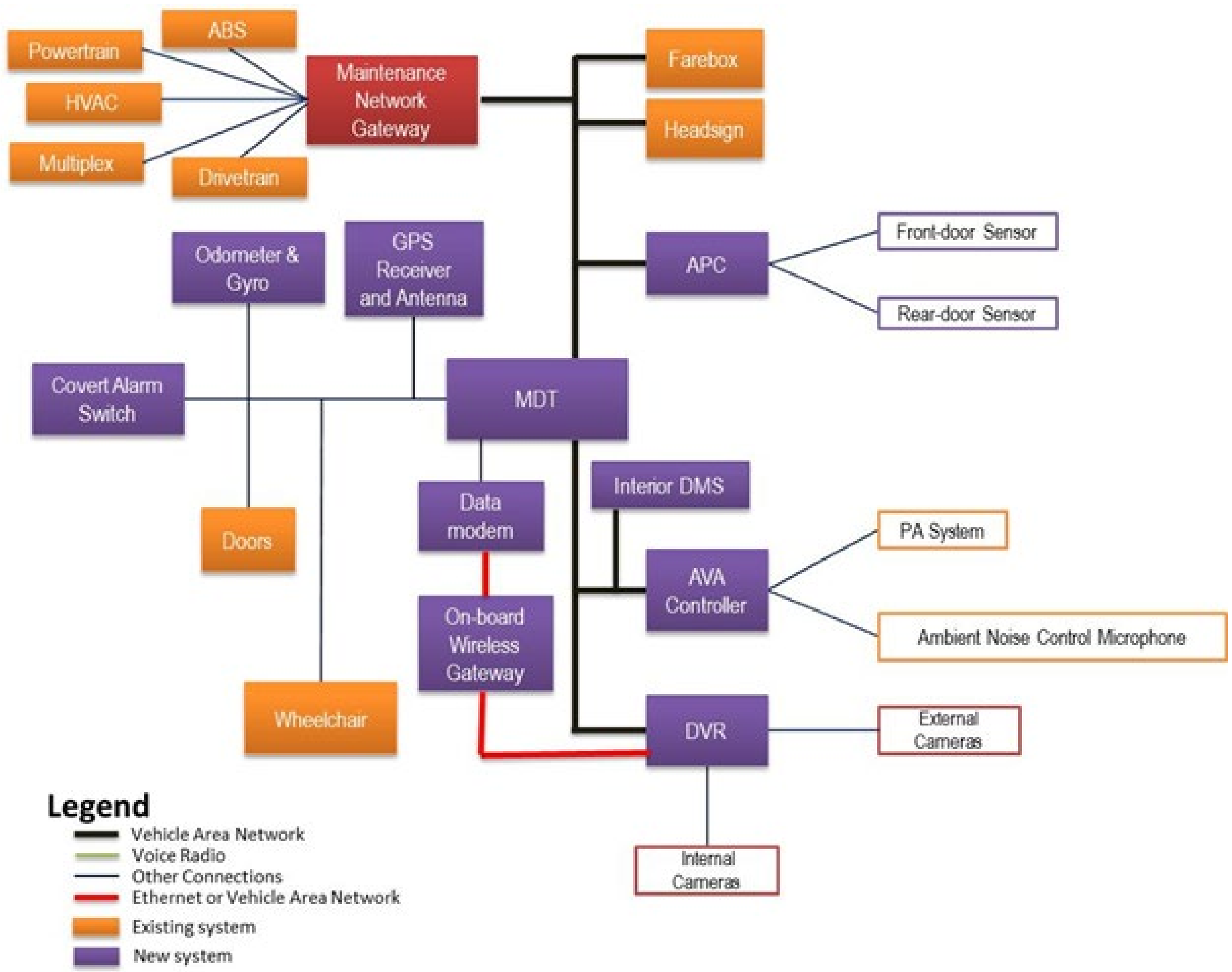
Illustrate How to Procure Systems Using Transit On-board Management Standards

CDTA ITMS – System Procurement

- Single-point login
- SAE J1708/1587 to connect ITMS Vehicle Logic Unit (VLU) with multiple technologies
- Interface Control Document (ICD) for SPX-Genfare FastFare™ Fareboxes integration with ITMS
- Additional Testing for Integration

Illustrate How to Procure Systems Using Transit On-board Management Standards

AAATA CAD/AVL On-board System – System Procurement



ACTIVITY

Question

Which one of these differences between SAE J1939 and J1708 is NOT true?

Answer Choices

a) J1939 is much faster than J1708

b) J1939 permits a connection of more devices than J1708

c) J1939 is based on the Controller Area Network (CAN)

d) J1939 covers the same number of OSI layers as J1708

Review of Answers

a) J1939 is much faster than J1708

Incorrect. SAE J1939 has a data rate of 250,000 bits per second, making it much faster than J1708.

b) J1939 permits a connection of more devices than J1708

Incorrect. SAE J1939 also permits a connection of up to 30 units compared to a maximum of 20 for a J1708 network.

c) J1939 is based on the Controller Area Network (CAN)

Incorrect. J1708 is not based on the CAN.

d) J1939 covers the same number of OSI layers as J1708

Correct! J1939 covers all 7 layers while J1708 only covers 2.

Learning Objective 2

Describe how to use current communication technology for on-board systems integration for buses

Use of Mobile Gateway Routers (MGRs)

Introduction to Module

- Communication technologies to **manage/integrate on-board devices rather than applications** using these technologies
- Impact:
  - Data **communicated outside vehicle** might be communicated faster, but **data no different**
  - Mobile gateway routers (MGRs) **prioritize which communication technology** used to communicate which data, but **data no different**
- Example:
  - Real-time communication of fare information from on-board to web is **data intensive**
  - However, fare collection devices and applications **no different than they were before new communication technologies were deployed**

Use of MGRs

Definitions

- Wireless gateway: connects **local private device** or local private network **to carrier's public network** and internet
- **Mobile gateway router (MGR):**
  - Performs all functions of **wireless gateway**
  - Adds **sophisticated routing capabilities** and multiple Ethernet and/or WLAN connections
  - Single public IP assigned from carrier mapped in MGR so that one port is mapped to **camera**, another to **sensor**, and another to **manage MGR**, and another to locally connected network for **web access**
- Sometimes referred to as **On-board Mobile Gateway Router (OMGR)**
- Current transit communications technology is:
  - Moving functionality to the **cloud**
  - **Integrating functions** with customer experience and new mobility options
  - **Improved situational awareness** and performance metrics
  - Evolution of on-board IoT **edge logic**

Use of MGRs

Chronology of On-board Communications Technology

1990

- **1st Gen – Reliance on Land Mobile Radio (LMR)**
- Relies heavily on on-bus processing and data

2005

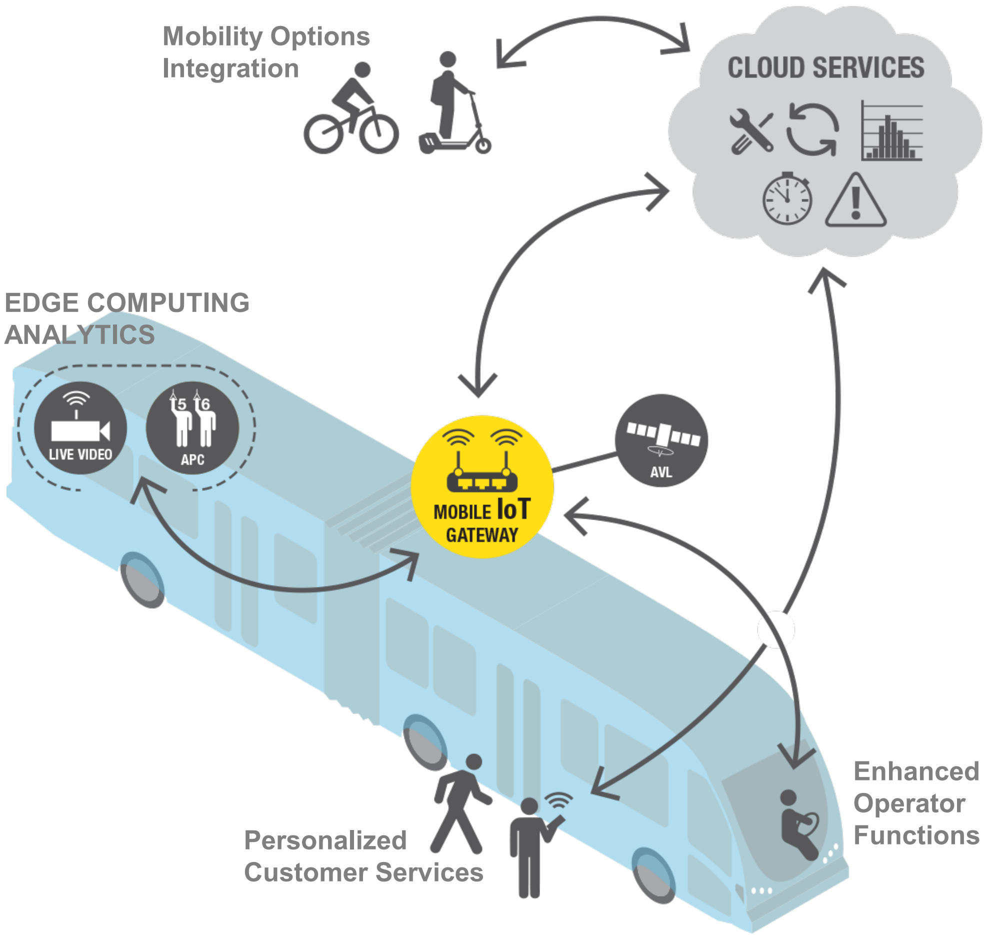
- **1.5 Gen – Emergence of Mobile Gateway Router (MGR)**
- More flexible communications and improved central system interaction

Today

- **2nd Gen –Appearance of Internet of Things (IoT) Gateways**
- Core functions remain on-bus with on-board analytics and "smarts" move into the cloud

Use of MGRs

Vision of Communications Technologies in Future



- MGR **facilitates integration of on-board devices** as well as **communication with cloud, Internet, dispatch center**, etc.
- MGR can **provide Internet access to passengers**
- On-board **edge computing** allows **data produced by IoT devices** to be **processed closer to where it is created**
- **Other mobility services can utilize the cloud** being used by transit to facilitate integrated payment

Use of MGRs

Applications that use On-board Communications Technologies

- Automated and mobile fare payment and validation
- Automated and mobile fare payment backhaul
- Computer-aided dispatch/ automatic vehicle location(CAD/AVL)
- Passenger Internet access
- Automatic passenger counters (APCs)

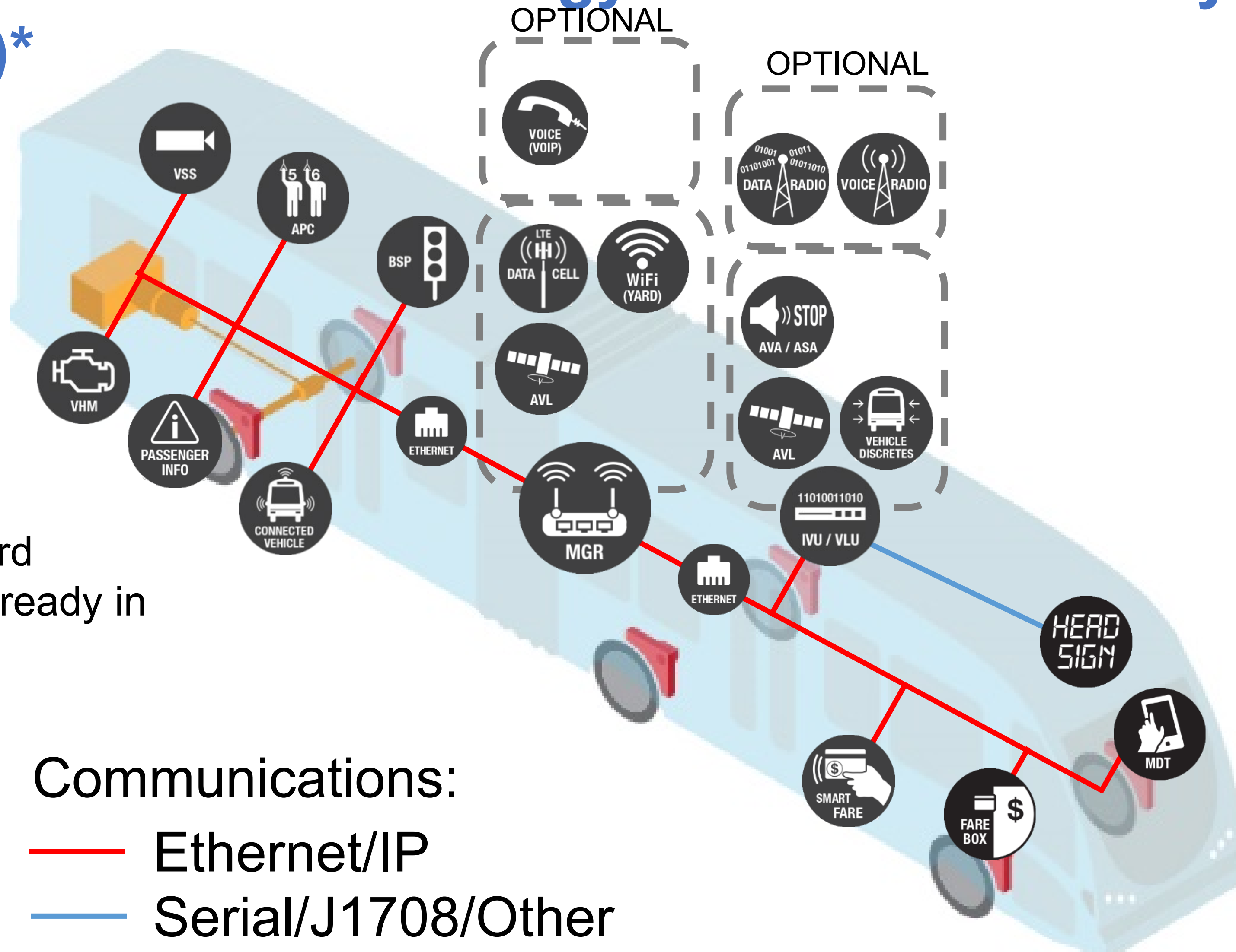
Use of MGRs

Applications that use On-board Communications Technologies

- On-board security cameras
- Remote engine (and other bus component) diagnostics and fuel consumption
- Driver performance, including speed, idle time and braking
- Digital maps, signage and advertising

Use of MGRs

Communications Technology Architecture Today (Gen 1.5)*



*Not all on-board devices are IP-ready in Generation 1.5

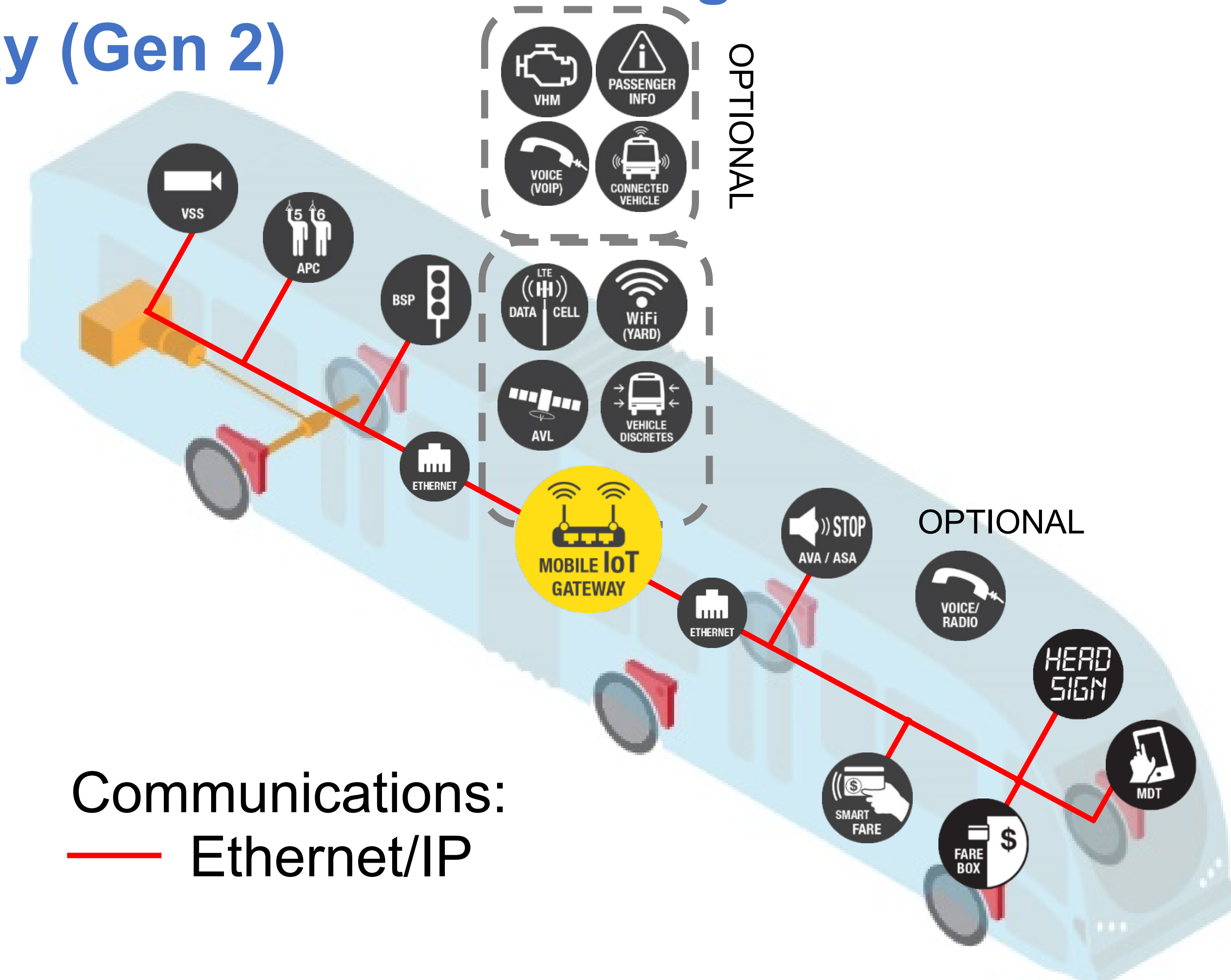
Communications:

Ethernet/IP

Serial/J1708/Other

Use of MGRs

Communications Technologies Architecture Today (Gen 2)

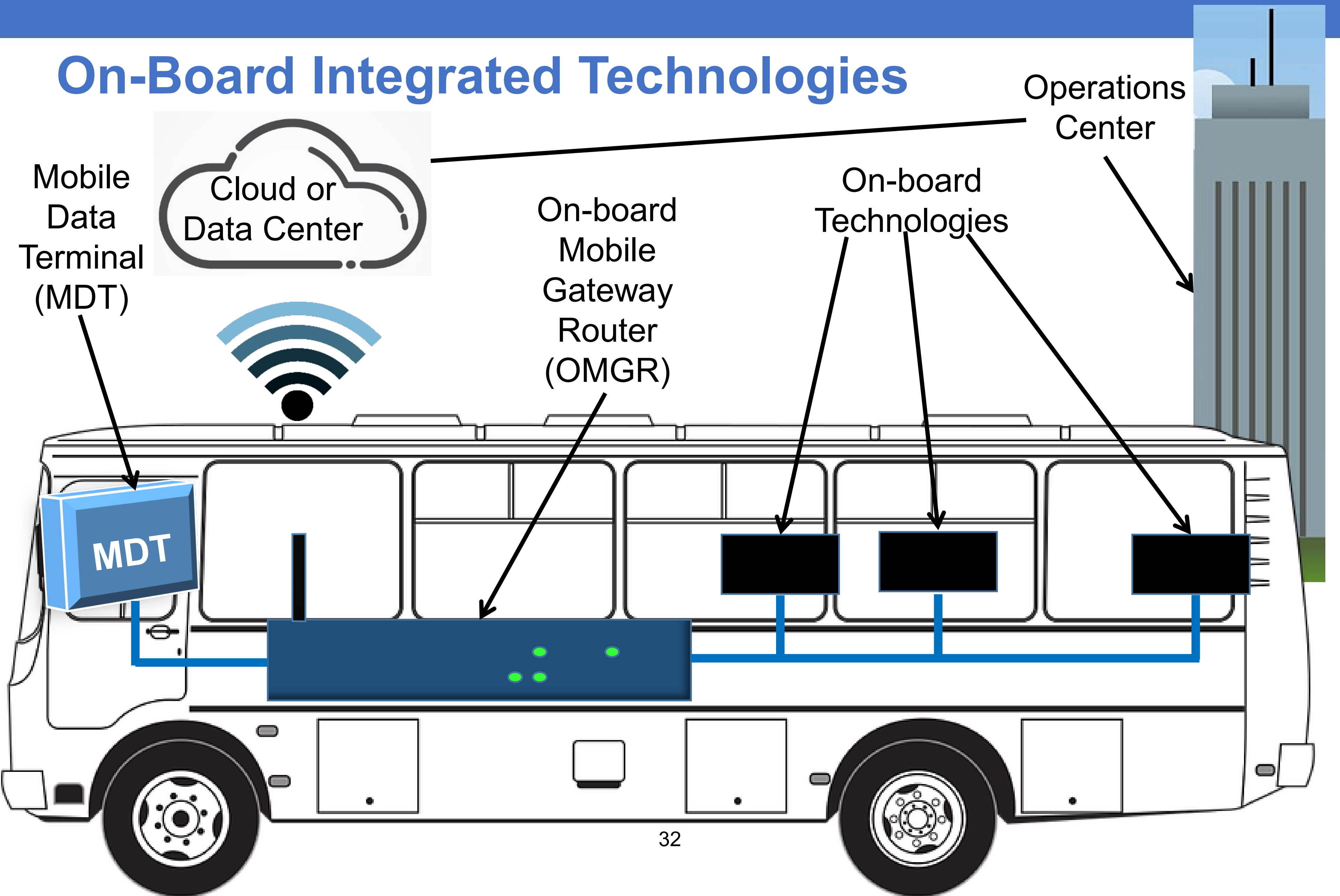


Communications:

Ethernet/IP

Use of MGRs

On-Board Integrated Technologies



Determine and Select the Best Available Network

Determining the best network for each data stream

- Prior to use of MGRs, **separate, dedicated router** deployed for each on-board application
- Current technology includes **single MGR** that provides encryption, authentication and message integrity
- **Not all data** generated on-board and being communicated from dispatch to vehicle **has same value**
- Subsystems such as **fare payment or bus engine data must take priority**, while passenger Wi-Fi and digital signage are less important

Determine and Select the Best Available Network

Mechanics of data traffic prioritization

- Goal of MGR: Ensure that **high-priority traffic has lowest latency**
- Accomplished using **Internet Engineering Task Force (IETF) standard** for Differentiated Services (DiffServ) - enhancement to IP
- Using quality of service (QoS)* settings at MGR, can **specify importance of data** in that packet
- IP packet receives priority throughout its journey to back office or data center. This ensures that connectivity **prioritizes data traffic that matters most**

*QoS is a family of evolving Internet standards that provides ways to give preferential treatment to certain types of IP traffic.

Determine and Select the Best Available Network

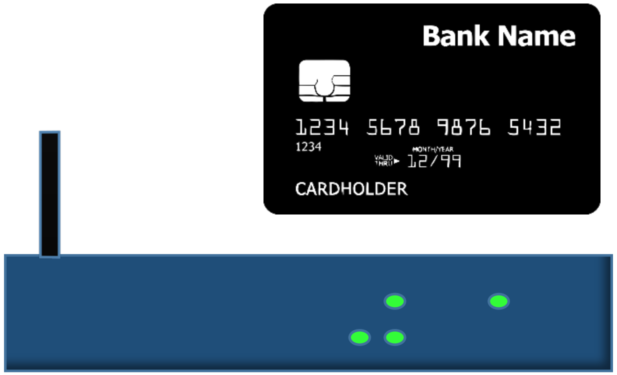
Connect to multiple communication systems

- MGRs can connect to **2 different wireless/mobile carriers**
  - For **redundancy** - If one carrier goes down, some MGRs can automatically switch to the other carrier
  - For **different roles or messaging**
- Typical functionality:
  - Private and public data communication
  - Video and vehicle data offload over Wi-Fi backhaul
  - Passenger Wi-Fi
  - Wired Ethernet for onboard systems
  - Secure key generation and storage

Determine and Select the Best Available Network

Complicated Data Transaction Example

- Fare payment via **debit or credit cards** through MGR:
  - Account for **payment card industry** (PCI) standard for security
  - **PCI compliance required** for processing card-based payments
- MGRs can provide **security that meets PCI** specifications because requirements can be incorporated into MGR:
  - Stateful firewall*
  - Encryption
  - Network segmentation
  - Event logging
  - User Authentication



*Stateful firewalls can watch traffic streams from end to end. They are aware of communication paths and can implement various IP Security (IPsec) functions.

Use of Cloud Platforms and Web Services

Types of cloud platforms and web services

- Cloud computing: **on-demand resource** to run applications, databases, virtual machines & servers
- 3 primary types of cloud environment:
  - **Public cloud services** are:
    - Hosted by third-party cloud service providers
    - Accessible through web browsers

    Examples: Amazon Web Services (AWS), Microsoft Azure & Google Cloud
  - **Private clouds**:
    - Dedicated and accessible to single organization
    - Examples: HP Enterprise, VMWare & IBM
  - **Hybrid clouds** combine various aspects of public and private clouds:
    - More control over data and resources than in public cloud
    - Still be able to scale like in public cloud when needed

Use of Cloud Platforms and Web Services

Cloud service model categories

- Infrastructure as a Service (IaaS):
  - Cloud layer enabling **self-service model** for managing virtualized data center infrastructure
  - Customers pay for **on-demand access** to pre-configured computing resources
- Platform as a Service (PaaS):
  - Cloud layer providing tools for organizations to focus on **building and running web applications & services**
  - PaaS environments **support developers, operations & hybrid teams**
- Software as a Service (SaaS): applications **hosted by third party & delivered over web browser**

Using Current Communication Technology to Conduct On-board Functions

Introduction to Example One

- **Valley Regional Transit (VRT)** in Boise, ID area
- Long Term Evolution (LTE) **MGRs deployed** in buses including:
  - Wi-Fi access point
  - Content filtering
  - Global Positioning System (GPS) and telematics integration
  - Cloud access
  - Troubleshooting
- Hybrid cloud platform

Using Current Communication Technology to Conduct On-board Functions

Introduction to Example Two

- **Los Angeles Metro Cloud-based Transit Signal Priority** (TSP):
  - Uses **IP-based devices** and **cellular networks**
  - 7 core elements:
    - Cloud-based platform for standardized signal system interfaces
    - Cloud-based **analytics platform**
    - Maintain support for legacy equipment and communications infrastructure
    - Support for **multiple signal system designs**
    - **Commercial cellular networks** for next-generation bus communication
    - Adopt **NTCIP 1211** messaging standards
    - Implementation of **MGR**

Using Current Communication Technology to Conduct On-board Functions

Valley Regional Transit

- Valley Regional Transit (VRT) - regional public transportation authority for Ada and Canyon counties in southwest Idaho
- 1.3 million fixed-route and paratransit trips per year using 60 buses
- Prior situation: 2G/3G modems in fixed-route buses had problems:
  - Connectivity was routinely lost
  - Modem and vehicle logic unit (VLU) could be ruined by accidentally plugging modem into wrong port of VLU
  - Inconsistent connectivity causing VLUs to send outdated information causing TSP errors and inaccurate real-time information

EXAMPLE

Using Current Communication Technology to Conduct On-board Functions

Valley Regional Transit (continued)

- Needed to **ensure connectivity**, especially in underground facility
- Desire to offer **free rider Wi-Fi**
- Installed **in-vehicle routing platform** in each bus, along with remote troubleshooting through the cloud and instant firmware upgrades
- Ability to add **automated vehicle announcements** (AVA) and **automated passenger counters** (APCs) in future

EXAMPLE

Using Current Communication Technology to Conduct On-board Functions

Valley Regional Transit (concluded)

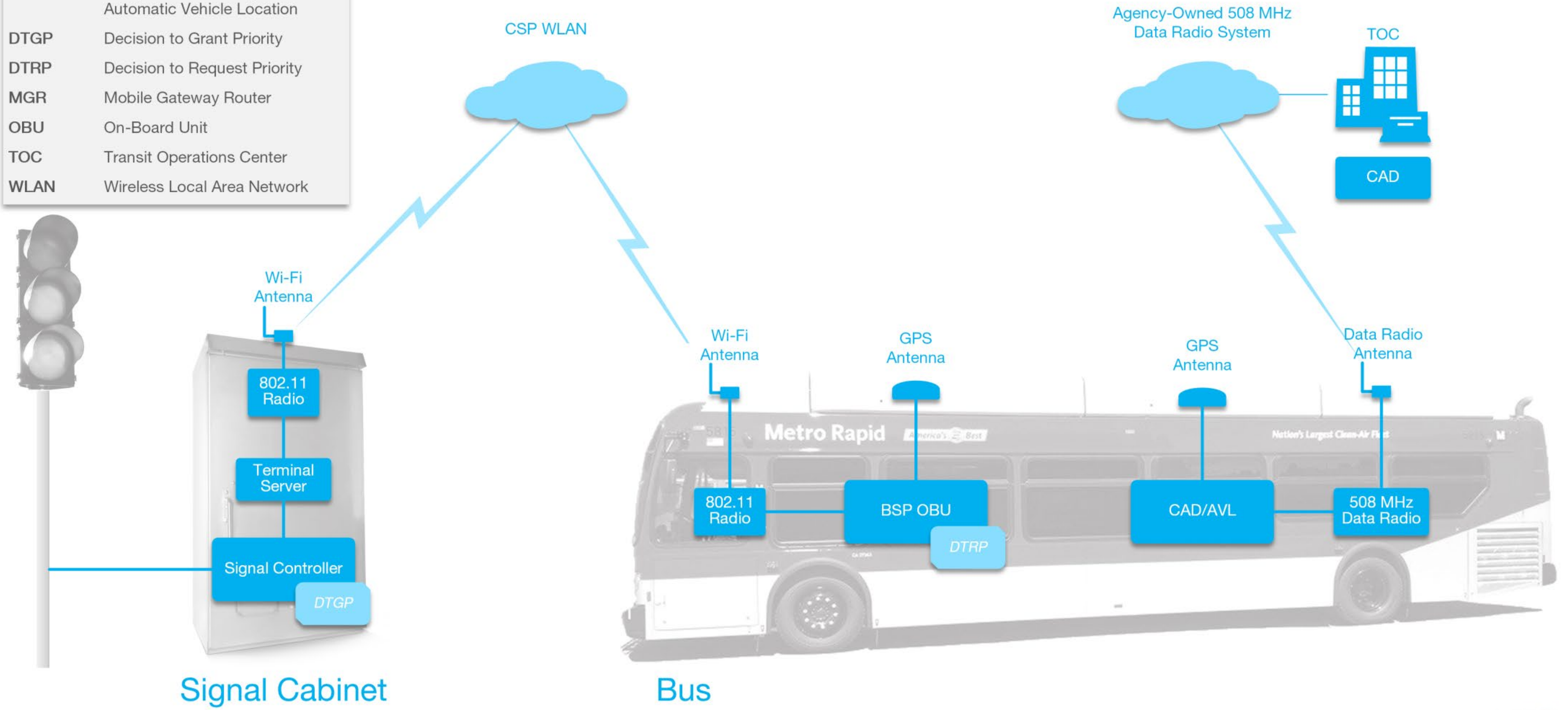
- MGR uses **multi-zone GPS repeater** to ensure uninterrupted vehicle tracking
- Constant wide area network (WAN) connectivity and GPS access **improve accuracy of real-time information**, resulting in fewer phone calls to VRT’s customer service team
- More than **350 passengers per day** are utilizing guest Wi-Fi
- Can **track Wi-Fi usage**, customize splash page, and **survey riders**
- Can troubleshoot and deploy **firmware updates remotely**
- Considering **new fare payment system** and **real-time CCTV monitoring**

EXAMPLE

Using Current Communication Technology to Conduct On-board Functions

LA Metro Existing TSP Architecture

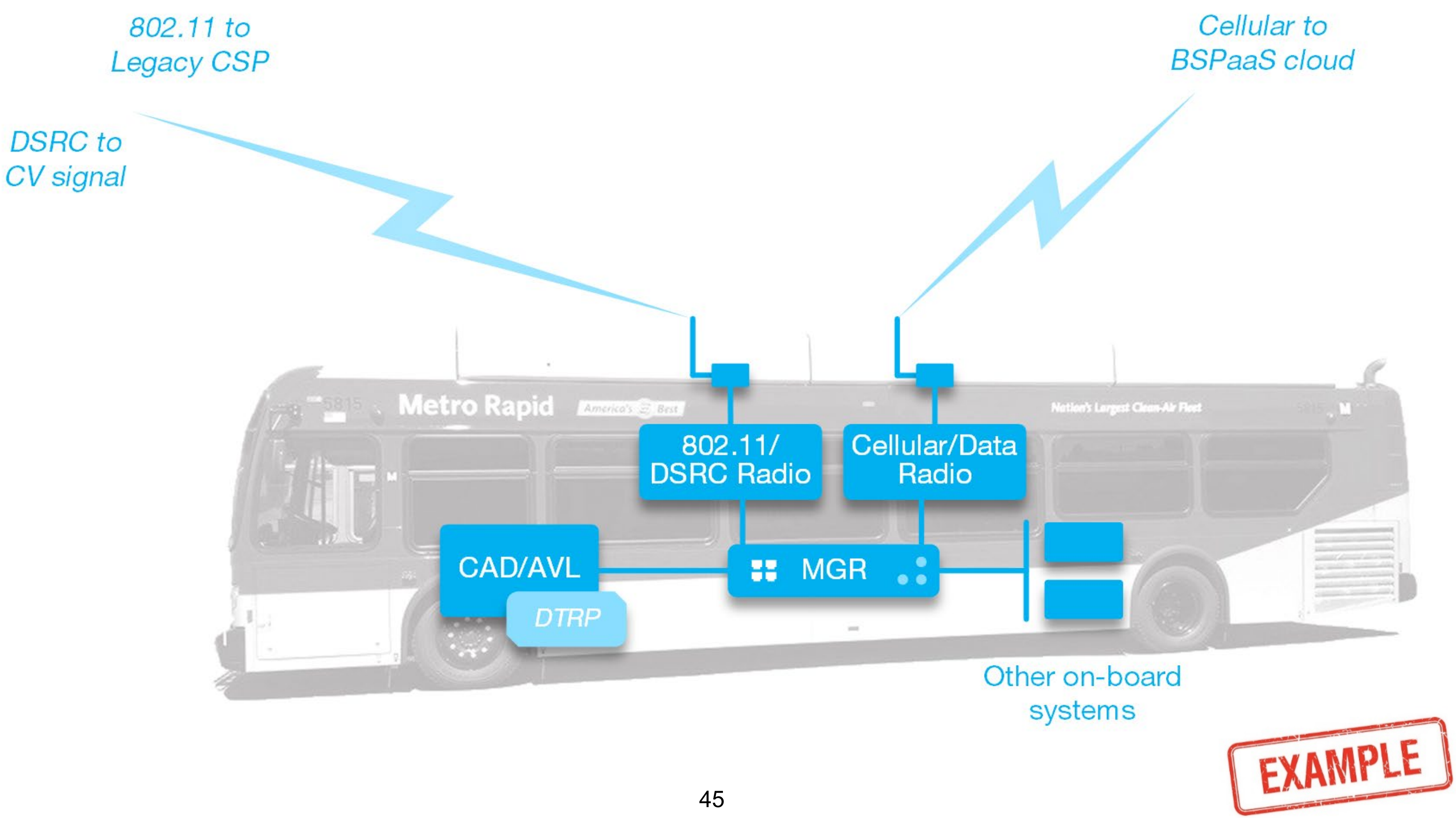
Legend	
CAD/AVL	Computer-Aided Dispatch/ Automatic Vehicle Location
DTGP	Decision to Grant Priority
DTRP	Decision to Request Priority
MGR	Mobile Gateway Router
OBU	On-Board Unit
TOC	Transit Operations Center
WLAN	Wireless Local Area Network



EXAMPLE

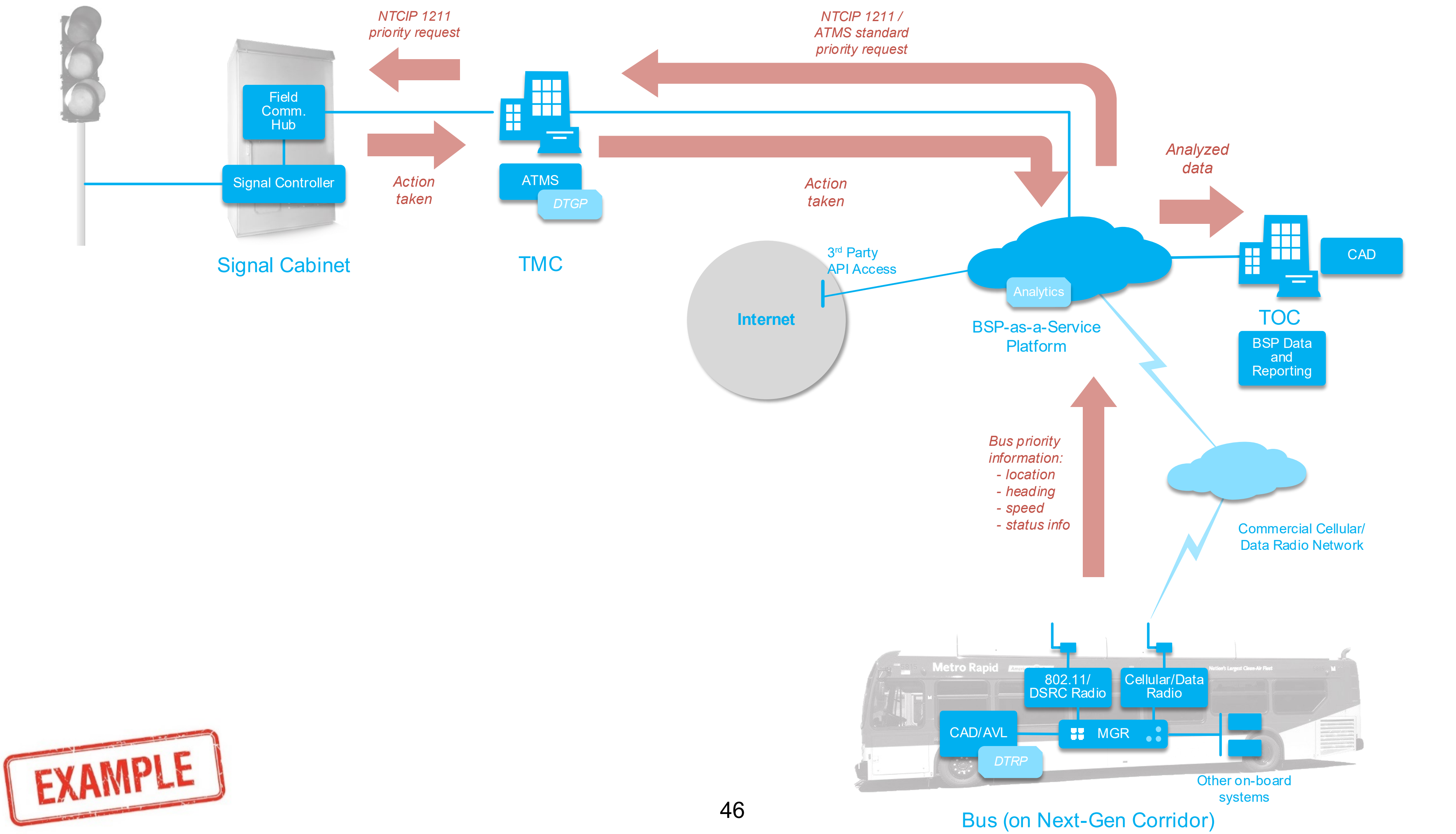
Using Current Communication Technology to Conduct On-board Functions

LA Metro Next Generation Cloud-based TSP



Using Current Communication Technology to Conduct On-board Functions

LA Metro Cloud-based TSP Information Flow



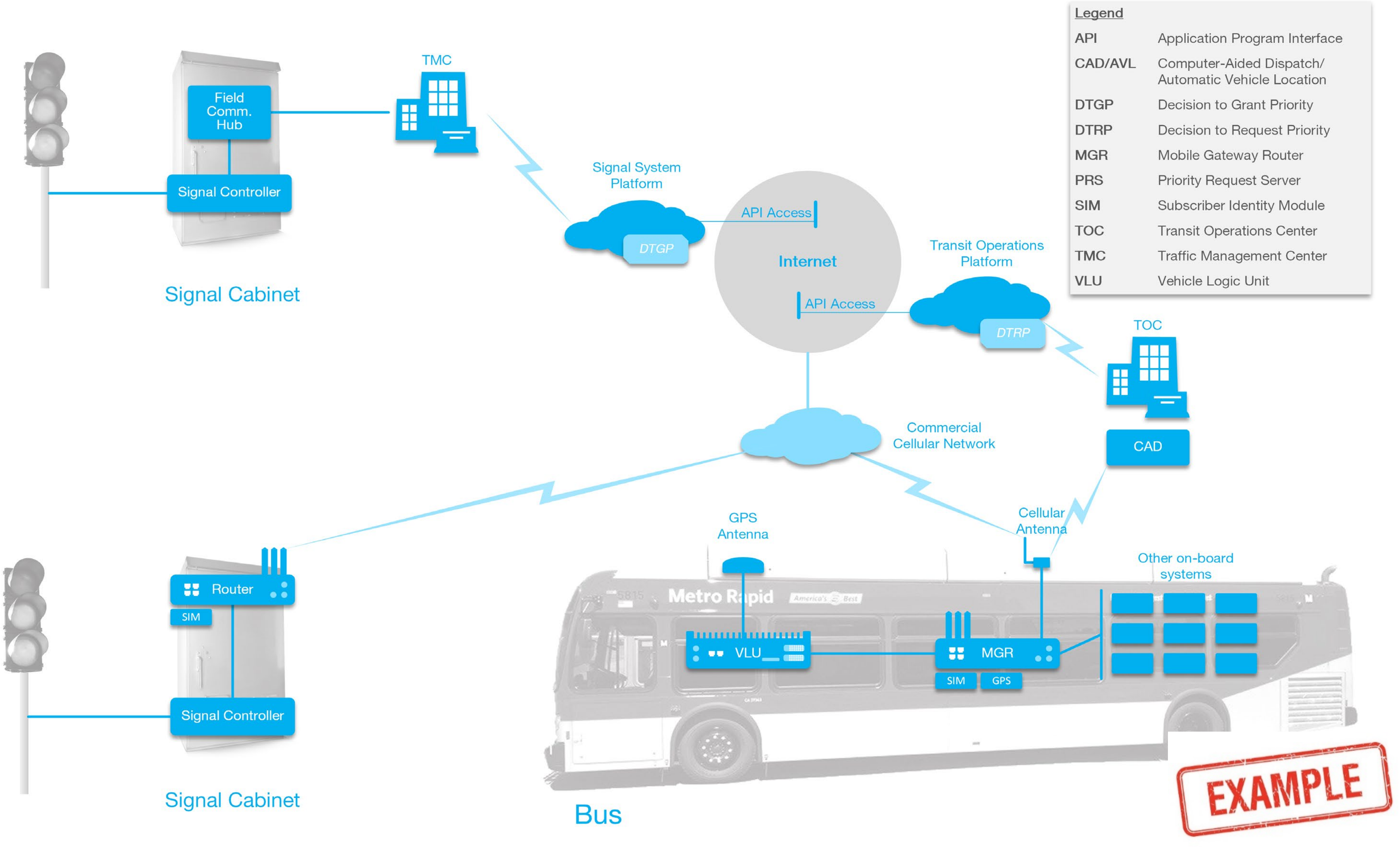
Using Current Communication Technology to Conduct On-board Functions

LA Metro TSP Concept Exploration

- Vehicle-to-Infrastructure (V2I) Connected Vehicle
- V2I Cellular to Isolated Signal
- Vehicle-to-Center (V2C) Cellular to Centralized TMC
- Center-to-Center (C2C) Fully Centralized TOC and TMC
- BSP (Bus Signal Priority)-as-a-Service (BSPaaS) Cloud Application
- As of October 2019, integrated new ATMS with BSP infrastructure, and other municipalities deploying current architecture for their BSP system.
- City of Arcadia deployed using BSPaaS

Using Current Communication Technology to Conduct On-board Functions

LA Metro BSPaaS Concept



ACTIVITY

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Question

What is the difference between Generation 1.5 and 2.0 of on-board architectures?

Answer Choices

a) The mobile gateway router (MGR) was introduced in Generation 2
b) Not all on-board devices are IP-ready in Generation 1.5
c) On-board analytics and “smarts” stay on-board in Generation 2
d) Ethernet is no longer used in Generation 2

Review of Answers

a) The mobile gateway router (MGR) was introduced in Generation 2

Incorrect. The MGR was introduced in Generation 1.5

b) Not all on-board devices are IP-ready in Generation 1.5

Correct! Not all devices are IP-ready currently

c) On-board analytics & “smarts” stay on-board in Generation 2

Incorrect. Core functions remain on-bus with on-board analytics & “smarts” move into the cloud

d) Ethernet is no longer used in Generation 2

Incorrect. Ethernet continues to be used in Generation 2

Learning Objective 3

Illustrate how to procure systems that use current communication technology for on-board systems

CASE STUDY

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Procuring and implementing CAD/AVL system using an MGR

Capital District Transportation Authority (CDTA) Intelligent Transportation Management System (ITMS)

- CDTA in Albany, NY replacing their aging CAD/AVL system
- ITMS procurement included requirement for OMGRs
- In Section 5 of RFP: Wireless Data Communication Requirements, Section 5.2 Wireless Data Communications includes Section 5.2.3 **On-Board Mobile Router/Wireless Gateway**

SUPPLEMENT

Procuring and Implementing CAD/AVL System Using an MGR

CDTA ITMS MGRs

- Open Payment System Infrastructure
- Transmit vehicle location data to vendor's central real-time prediction system
- Central Data System (CDS) wireless communications with on-board ITMS equipment, components, and devices via, in part, wireless MGRs on-board vehicles
- On-board Wi-Fi enabled Internet access to customers on all CDTA vehicles

SUPPLEMENT

Procuring and Implementing CAD/AVL System Using an MGR

CDTA ITMS MGRs

- 4 port, multi card, redundant configuration (multiple cellular cards) MGR
- Has 2 subscriber identity modules (SIMs): one for private connectivity and one for public Wi-Fi
- Private link will transfer:
  - Real-time location information
  - Alarms
  - Vehicle health
  - Canned messaging
  - Passenger loads
  - Potentially camera footage
  - In the future, farebox transaction data
- Wirelessly transfer data to bus at garage, including CAD/AVL, infotainment and TSP
- Use same Wi-Fi communication for farebox and camera data

Procuring and Implementing CAD/AVL System Using an MGR

CDTA ITMS MGRs

- **Proven Solution** - hardware needed to be already deployed and proven to be reliable
- **Management Software** - tools for maintaining equipment as well as configuring and monitoring equipment is critical. Several criteria:
  - Automatic alerts
  - Easy to use reporting writing
  - Certain amount of customization using existing and custom fields, and features
- **Hardware** - flexibility to handle multiple inputs (4-8 Ethernet ports), antennae and multiple SIM cards for redundancy
- **Private and Public Networks** - need to operate both private and public networks for internal data transfer and public Wi-Fi

CASE STUDY

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U.S. Department of Transportation
ITS Joint Program Office
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Procuring System Requiring On-board Integration and Transaction Processing

TriMet's Hop Fastpass

- Tri-County Metropolitan Transportation District of Oregon (TriMet) deployed **Hop Fastpass** - fare payment system that first launched in 2017
- Open architecture design:
  - Provides **flexibility to adjust** individual software and hardware components
  - Allows TriMet to **capitalize on changing technologies** or falling costs
  - **Avoided negotiations** with systems integrator that could minimize (or profit from) changes to fare payment system over time
- Issued RFP in 2013, including requirements for:
  - Onboard validators with Ethernet port that enables **connection to existing MGRs** installed on TriMet and C-TRAN buses
  - Where available, MGRs will serve as **primary means of off-board communication** with the eFare back

SUPPLEMENT

Procuring System Requiring On-board Integration and Transaction Processing

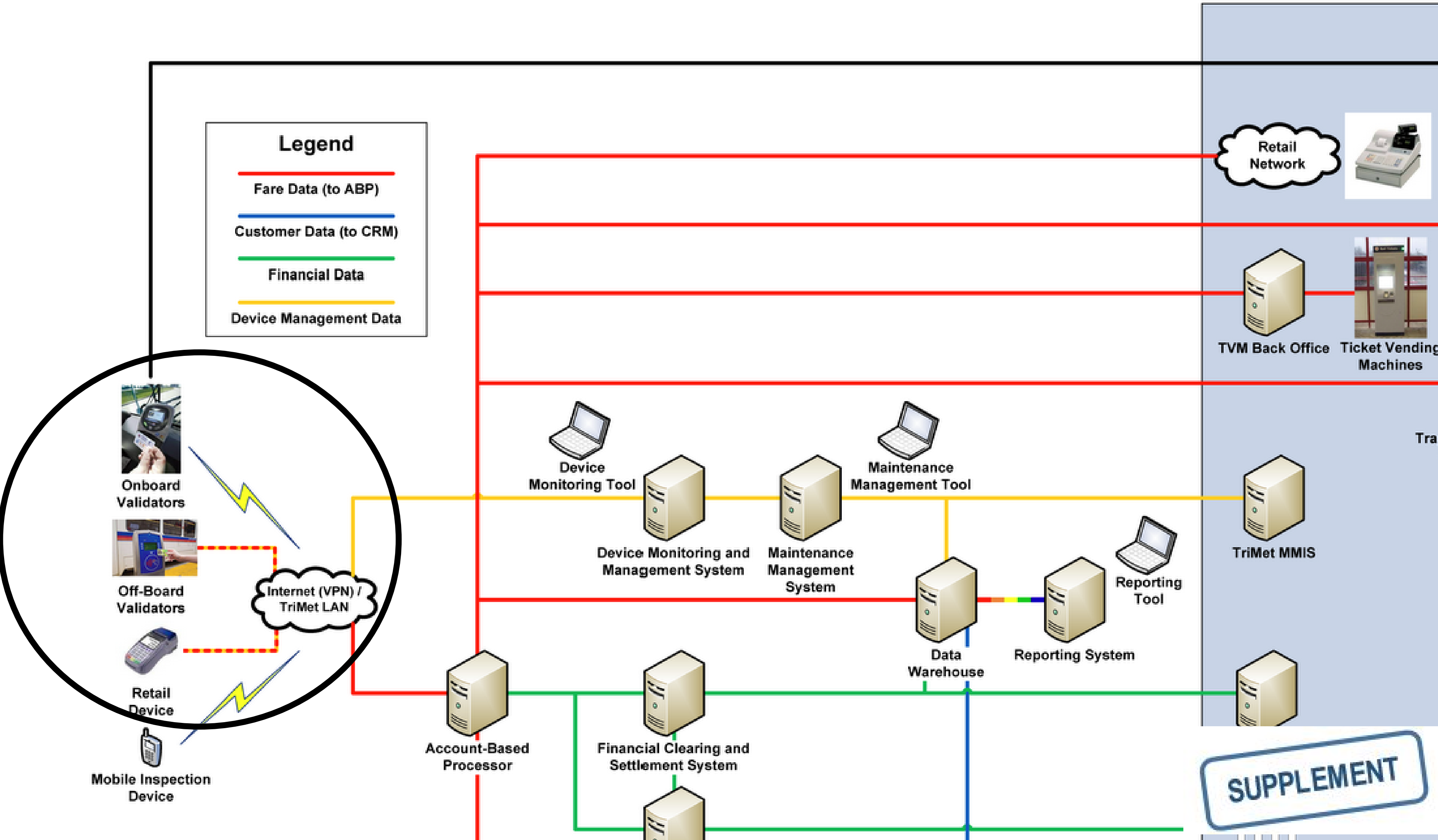
TriMet's Hop Fastpass (continued)

- **Went live in July 2017**, with physical card that worked on TriMet, C-TRAN (Clark County, WA) and Portland Streetcar
- **Fall 2017, open payments deployed**:
  - Payment card with embedded contactless chip
  - Apple Pay, Android Pay (now Google Pay) or Samsung Pay
- Spring 2018, Android Pay or Samsung Pay users **create "virtual Hop card"** - provides all benefits of physical Hop card
- In May 2019, Apple Pay users could use a virtual card
- **Hop benefits** no matter which payment media used:
  - Fare capping
  - Autoloading
  - Monthly passes
  - Concession
  - Add value online, by visiting regional transit ticket offices, making phone call, via mobile app or at more than 500 stores that are part of Hop retail network

SUPPLEMENT

Procuring System Requiring On-board Integration and Transaction Processing

TriMet's Hop Fastpass (continued)



Procuring System Requiring On-board Integration and Transaction Processing

TriMet's Hop Fastpass – Complex Transaction Processing

- Onboard validators with Ethernet port enabling connection to existing MGRs installed on TriMet and C-TRAN buses. **MGRs serve as primary means of off-board communication with eFare back office**
- All validators include Wi-Fi (802.11a/b/g/n/ac) to **enable integration with other systems via MGR**, exchange of non-critical data at designated locations, and sharing data connections on vehicles & at rail platforms
- eFare validators equipped with **real-time communication** to Account Management and Processing System (AMPS) for processing fare payments
- Validators will provide payment result **within 500 milliseconds** of valid fare media for all fare payment types

SUPPLEMENT

CASE STUDY

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Migrating to Using Current Communication Technology

Alameda-Contra Costa Transit District (AC Transit)

- Separate on-board components - not integrated
- CAD/AVL and land mobile radio (LMR) systems in place since 2003
- Needed scalable, open architecture and integrated platform:
  - More predictable for riders
  - Adapt to high-frequency service changes and dynamic route management
  - Improve operator safety
  - Leverage GIS mapping
  - Provide robust data management and visualization

- Decades old technology for Voice and Data
- Aging LMR System; costly to replace
- Considered joining the Regional Communications System (RCS)

- User Experience and reliability - critical considerations when weighing all options

Migrating to Using Current Communication Technology

AC Transit - Public Broadband: A viable option

Quick Deployment
With no expensive infrastructure to build out, a network can be quickly deployed with limited disruption to daily operating procedures

Reliability
Broadband networks backed by 24/7 – 365-day support personnel to ensure uptime and reliability

Reduced Costs
No expensive network to procure, deploy and maintain

No dedicated resources needed for maintenance or enhancements

No Fears of Obsolescence
Unlike closed private networks, the mobile broadband networks are continuously being enhanced and they will not become obsolete

Migrating to Using Current Communication Technology

AC Transit - Solution

- State-of-the-art technology to enable:
  - Flexible and efficient dispatching
  - Vehicle management
  - Disruption management
  - Vehicle maintenance
  - Real-time passenger information
  - Voice communication
  - Pro-active monitoring and predictive maintenance
- Open architecture and support for APIs, integrated CAD/AVL with data systems and Voice over IP (VoIP)

EXAMPLE

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AC Transit - Benefits of Multiple Communications Technology

- Reduce mobile workforce communication outages
- Extend service area coverage
- Leverage capitalized LMR assets longer
- Move from low data rate private radio system to high-speed network of 4G and 5G technology & mobile edge computing
- Utilize lower cost technologies while enhancing overall reliability

- LMR features using VoIP technology
  - Half or full duplex conversations
  - Private Calls
  - Scan
  - Priority Scan
  - Emergency Alarm and Covert Monitoring
  - Fleet calls
  - Individual and group text messaging
- Improve mobile workforce efficiency
- Provide path for technology evolution
- Maintain FCC licenses through active use of channels

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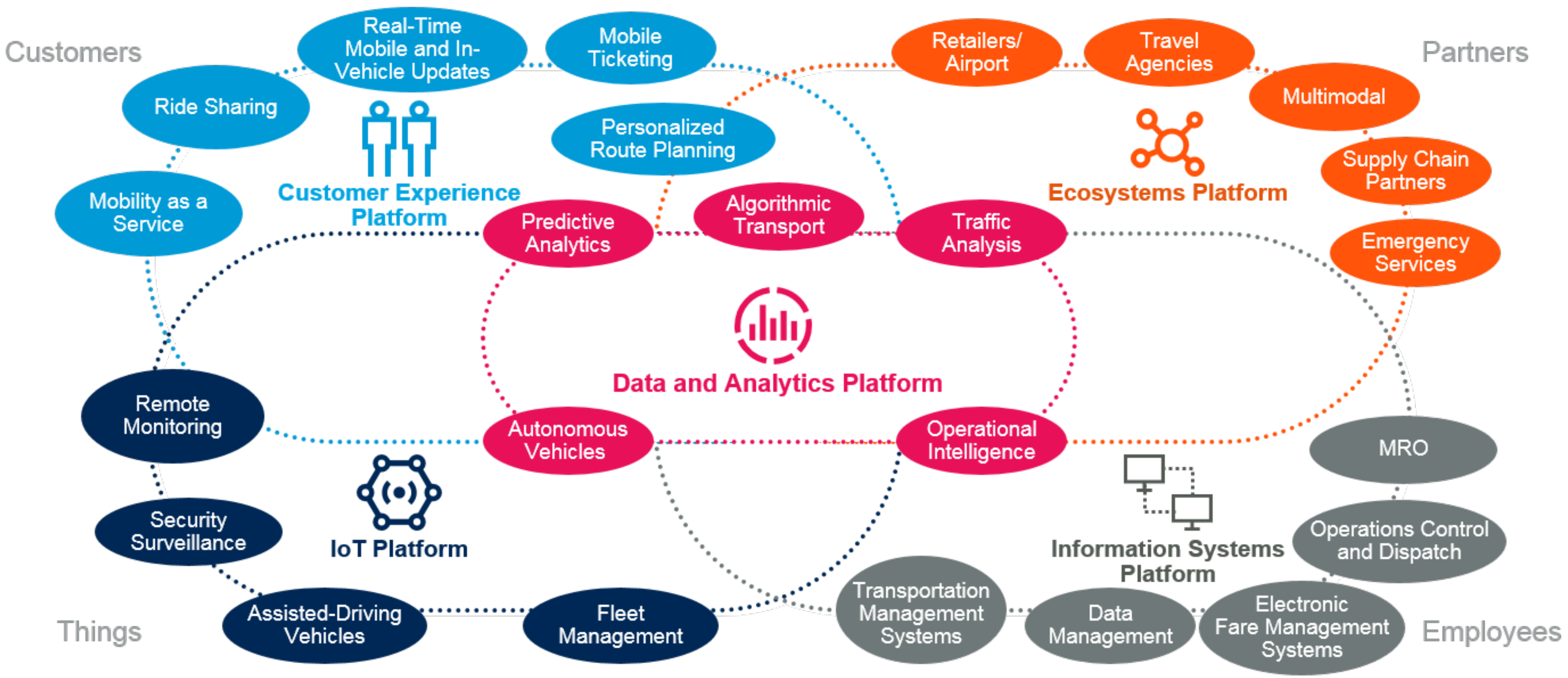
AC Transit – Digital Framework



ACTIVITY

STANDARDS ITS TRAINING TRANSIT

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

Question

CDTA’s selection of an OMGR included which considerations?

Answer Choices

a) Need to operate both private and public networks for internal data transfer and public Wi-Fi

b) Flexibility to handle multiple inputs, antennae and multiple SIM cards for redundancy

c) Hardware needed to be already deployed and proven to be reliable

d) All of the above

Review of Answers

a) Need to operate both private and public networks for internal data transfer and public Wi-Fi

Incorrect. This answer is correct along with b and c

b) Flexibility to handle multiple inputs, antennae and multiple SIM cards for redundancy

Incorrect. This answer is correct along with a and c

c) Hardware needed to be already deployed and proven to be reliable

Incorrect. This answer is correct along with a and b

d) All of the above

Correct! All statements are correct

Question

Which one of these benefits has been experienced by AC Transit due to their implementation of multiple technology communications?

Answer Choices

a) Limit service area coverage

b) Provide a path for technology evolution

c) Eliminate LMR assets

d) Reduce the number of FCC licenses

Review of Answers

a) Limit service area coverage

Incorrect. One of the benefits was to extend service area coverage

b) Provide a path for technology evolution

Correct! This was one of the benefits resulting from the deployment of multiple communication technologies.

c) Eliminate LMR assets

Incorrect. One of the benefits was to leverage capitalized LMR assets longer.

d) Reduce the number of FCC licenses

Incorrect. One of the benefits was to maintain FCC licenses through active use of channels.

Module Summary

Review key concepts from Module 19: On-board Transit Management Systems for Buses

Describe how to use current communication technology for on-board systems integration for buses

Illustrate how to procure systems that use current communication technology for on-board systems

Thank you for completing this module.

Feedback

Please use the Feedback link below to provide us with your thoughts and comments about the value of the training.

Thank you!