UNITED STATES
DEPARTMENT OF TRANSPORTATION

ITS ePrimer
Module 7: Public Transportation

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ITS Professional Capacity Building Program
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Instructor

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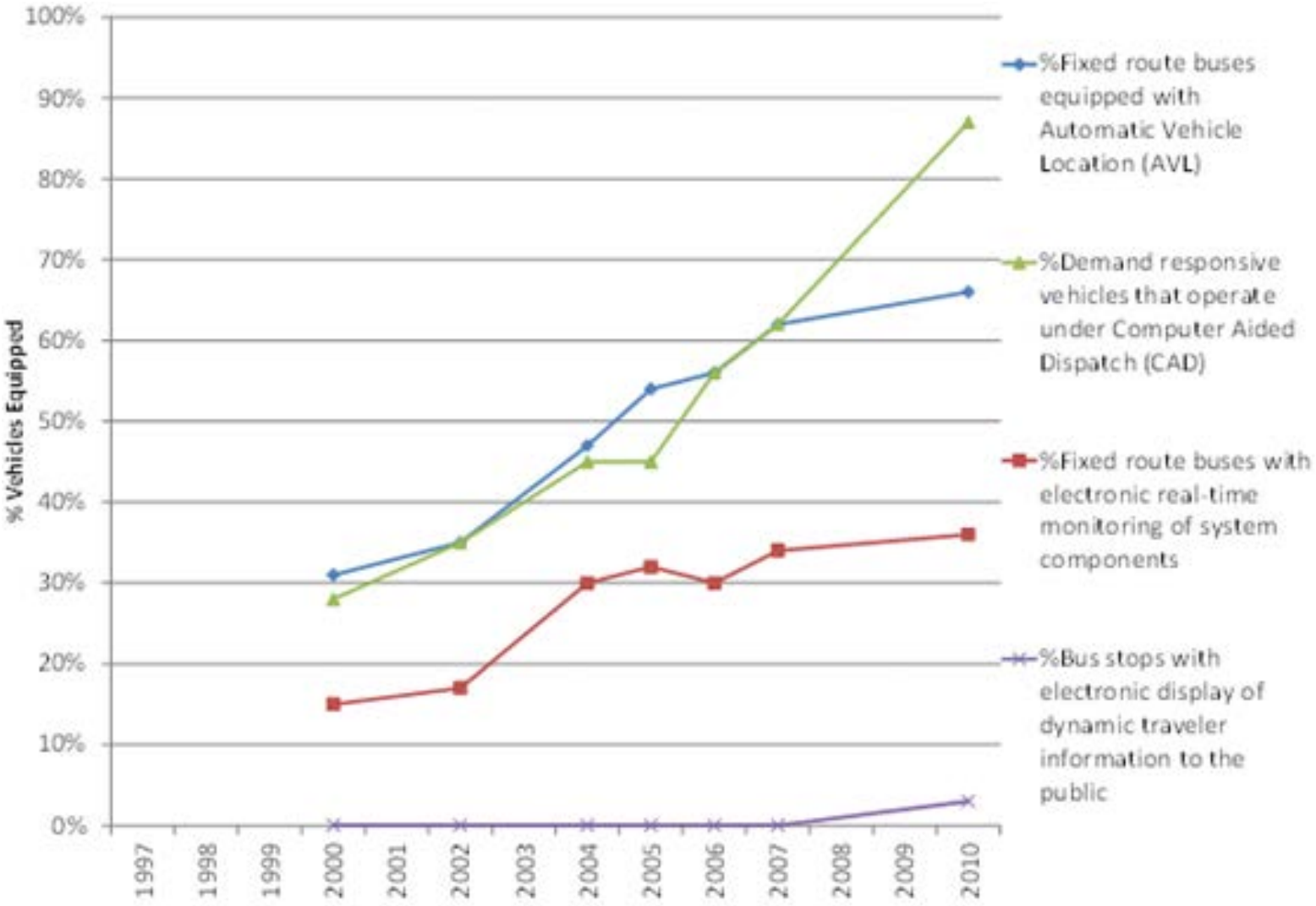
Learning Objectives

1. Understand public transportation technologies, how they function, and how they can be applied to facilitate or improve operations, customer service, and management
2. Recognize the dependencies among specific technologies
3. Understand the relationship between non-transit (e.g., highway-related) and transit technologies
4. Realize the potential of transit ITS technologies to facilitate multimodal travel

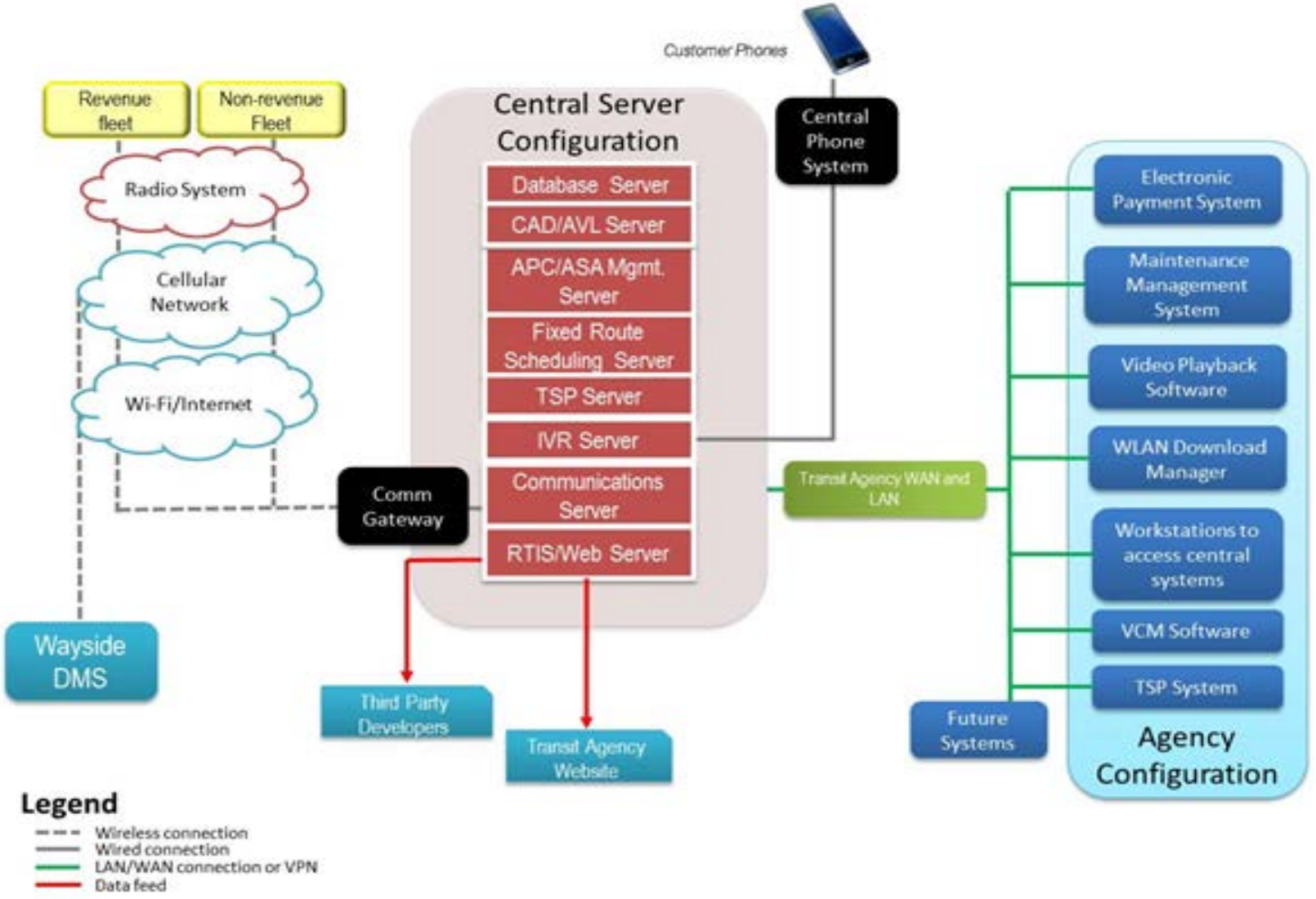
Module Organization

- Fleet Operations and Management – implemented to facilitate transit operations and provide input to senior management
- Traveler Information – customer-facing technologies that provide trip planning and real-time operational information
- Safety and Security – improve safety and security of transit staff and passengers
- Automated Fare Payment – fare collection and payment technologies
- Maintenance – facilitate maintenance activities
- Other – other technologies and systems, such as data management and the use of open data

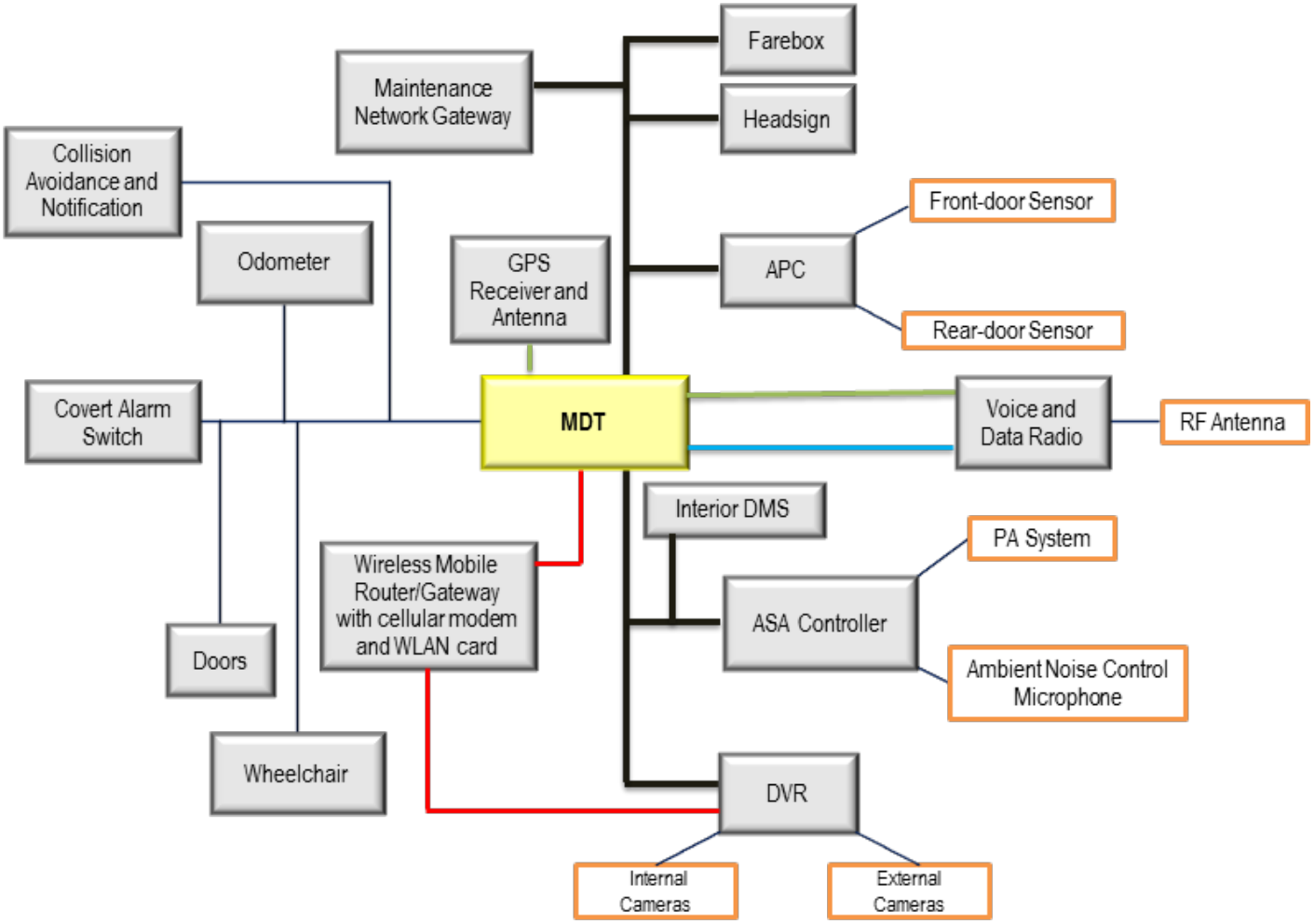
Transit ITS Deployment (1997–2010)



Example of Central System Technology Relationships



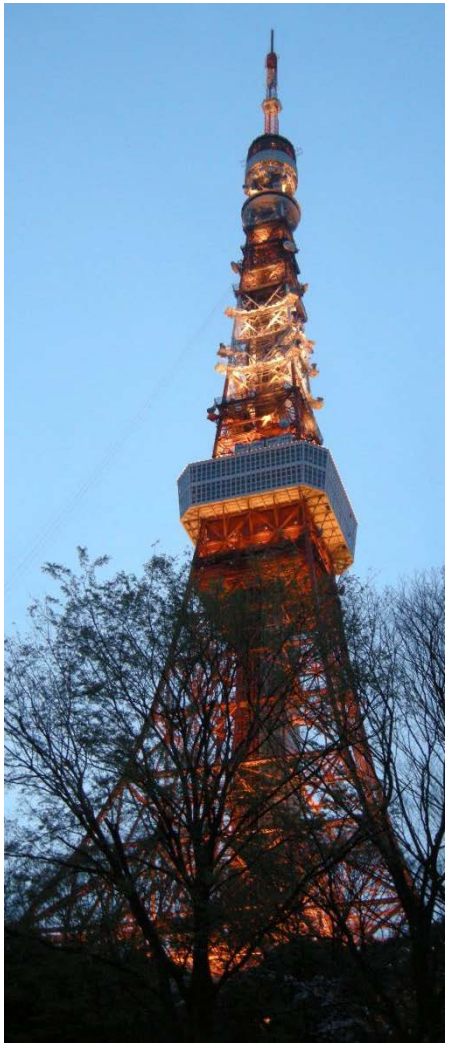
Example of Onboard Technology Relationships



Fleet Operations and Management

Communications Technologies

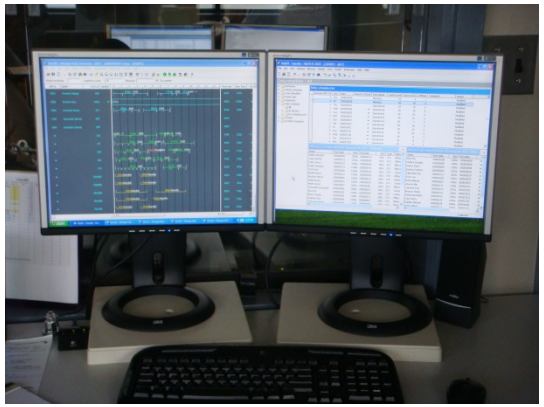
- Depend on infrastructure and devices used to transmit voice and data
- Can transmit voice, text, data, and video over radio, cellular, or other wireless networks
- Types of wireless networks:
  - Wide area wireless (WAW)
  - Wireless local area network (WLAN)
  - Dedicated short-range communications (DSRC)
  - Land line and cellular telephone networks
  - Internet and intranet



Fleet Operations and Management

Automatic Vehicle Location (AVL) and Computer-aided Dispatch (CAD)

- For operations management-periodically receives real-time updates on vehicle locations and schedule/route status
- Onboard computer with Global Positioning System and mobile data communications
- Provides decisions support tools used by dispatchers and supervisors, allowing proactive management of operations
- Allows for "single point" logon for all onboard systems



Fleet Operations and Management

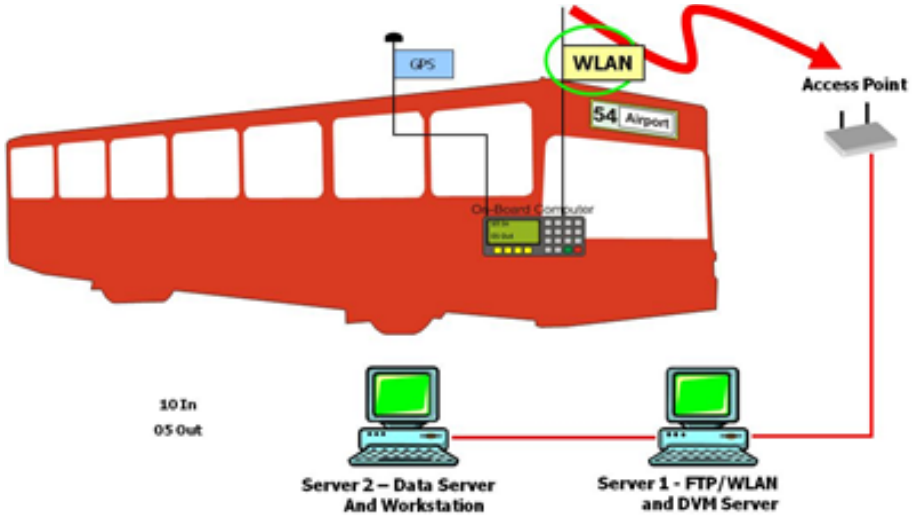
Automatic Passenger Counters (APCs)

- Monitors passenger activity and uses algorithm to count number of boarding and alighting passengers
- Data can either be stored for downloading/uploading or transmitted in real-time
- Most common types are treadle mats and infrared technology
- Ability to "stamp" data with exact bus stop location and time of day through integration with AVL

Fleet Operations and Management

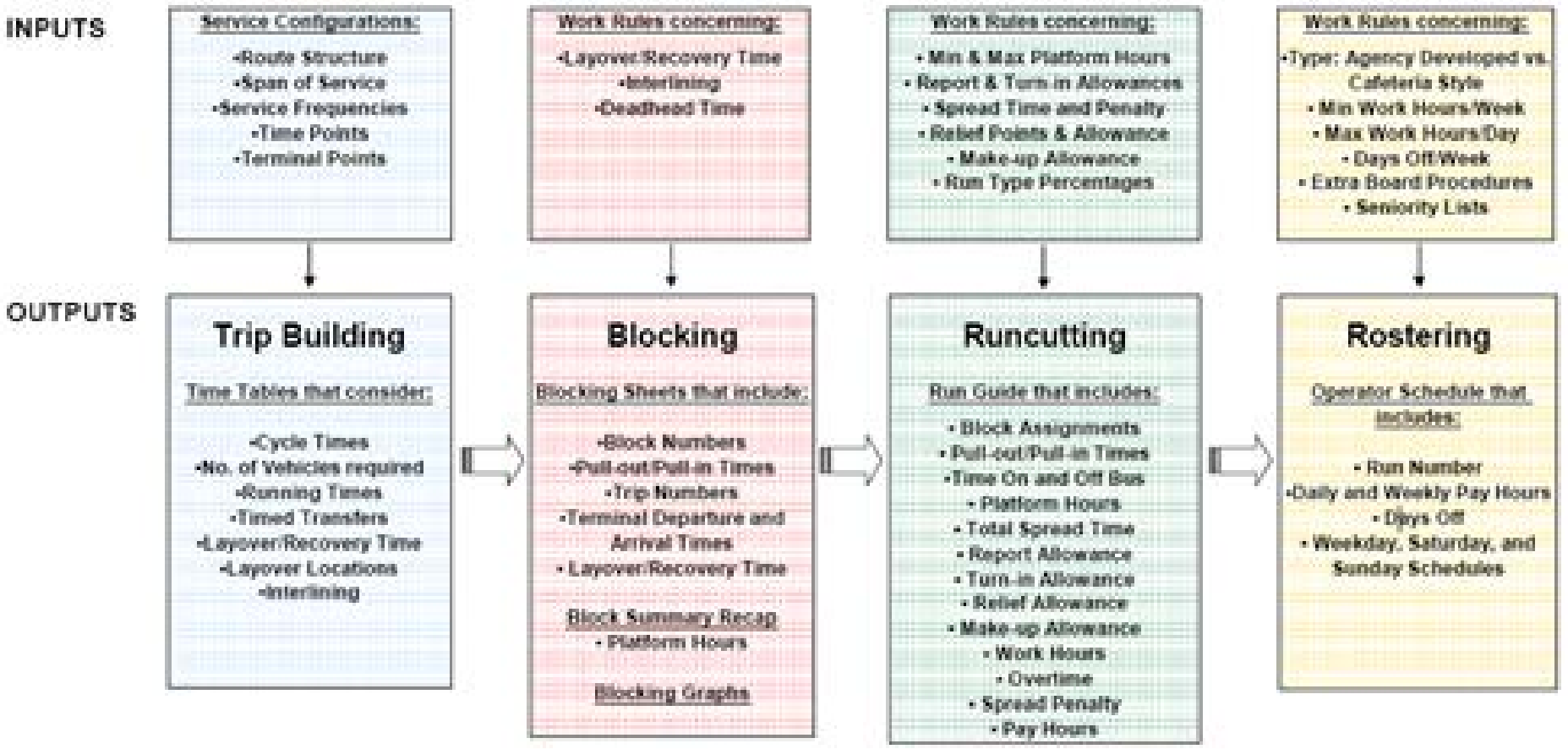
APCs (continued)

- Real-time information used for conditional TSP
- Can reduce cost of manual data collection and National Transit Database reporting requirements
- Transit operators typically deploy APC equipment on 12–25% of their vehicles and then rotate the vehicles on different routes as needed



Fleet Operations and Management

Scheduling Software



Fleet Operations and Management

Transfer Connection Protection (TCP)

- Triggered when vehicle operator of incoming vehicle makes a transfer request using a mobile data terminal (MDT) to enter outgoing route
- Central system determines whether outgoing vehicle can and should be held based on estimated arrival time of incoming vehicle
- Central system will notify:
  - Incoming vehicle's operator whether outgoing vehicle will be held
  - Outgoing vehicle's operator if it is to hold, until what time, and for what route
- Dispatcher reviews current pending transfers

Fleet Operations and Management

Transit Signal Priority (TSP)

- Give authorized transit vehicles ability to automatically change the timing of traffic signals
- Can be limited to extending green cycle, but can result in red cycle truncation and phase insertion
- May be done “conditionally” based on passenger load, type of service (Bus Rapid Transit (BRT) vs. local), and schedule adherence

Fleet Operations and Management

Transit Signal Priority (continued)

- Interaction of four major elements:
  - Transit vehicle
  - Transit fleet management
  - Traffic control
  - Traffic control management
- Enhanced with four functional applications of vehicle detection, priority request generation (PRG), priority request server (PRS), and TSP control

Fleet Operations and Management

Yard Management

- Automatically locates vehicles within certain distance accuracy inside yard
- Allows yard attendants to adjust vehicle locations manually on a yard map
- Provides interface with CAD/AVL system to record pull-in and pull-out time, and assigned vehicle operators
- Can be interfaced with fixed-route scheduling software to access vehicle operator information in real-time

Fleet Operations and Management

Intelligent Vehicle Technologies

- Rear Impact Collision Warning System
- Side Collision Warning/Object Detection System (aka Lane Change and Merge Collision Avoidance)
- Frontal Collision Warning System
- Intersection Conflict Warning System
- Lane Change/Merge Warning System
- Pedestrian Collision Warning

Fleet Operations and Management

Intelligent Vehicle Technologies (continued)

- Vehicle Assist and Automation (VAA):
  - Lateral Guidance (aka lane keeping for operating on narrow rights-of-way, such as freeway shoulders)
  - Vehicle Platooning
  - Precision Docking
  - Automated Operations

Fleet Operations and Management

Lane Control Technologies

- Bus shoulder riding
- Intermittent bus lane (IBL)/moving bus lane (MBL)
  - Restricted lane for short time intended to be activated only when flow of general traffic is operating below speed that inhibits bus transit speeds
  - When traffic conditions not expected to cause delays to bus, intermittent bus lanes not activated
  - AVL required to establish bus location, ties into variable message signs (VMS) to inform drivers of lane restriction, and integration into real-time ITS traffic monitoring systems

Traveler Information

Automatic Voice Announcements (AVA)

- Audio and visual announcements to onboard riders and those waiting to board
- As fixed-route vehicle approaches a stop or other designated location:
  - Digitally recorded announcement automatically made over onboard public address system speakers
  - Displayed on dynamic message signs inside vehicle to inform passengers about upcoming stops, major intersections
  - Can make time-based, location-based, and vehicle operator-initiated announcements/displays

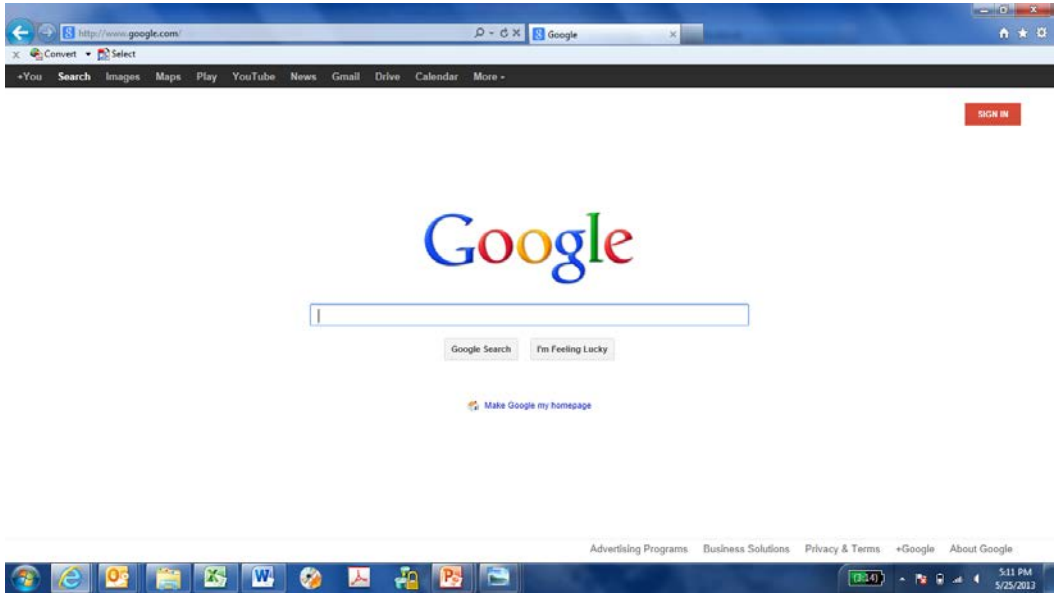
Traveler Information

En-route/Wayside Traveler Information

Traveler Information

Onboard Internet Access

- Being provided particularly on vehicles that service lengthy routes
- Some agencies leveraged onboard communications hardware that provides both data communication for the agency and Wi-Fi for passengers



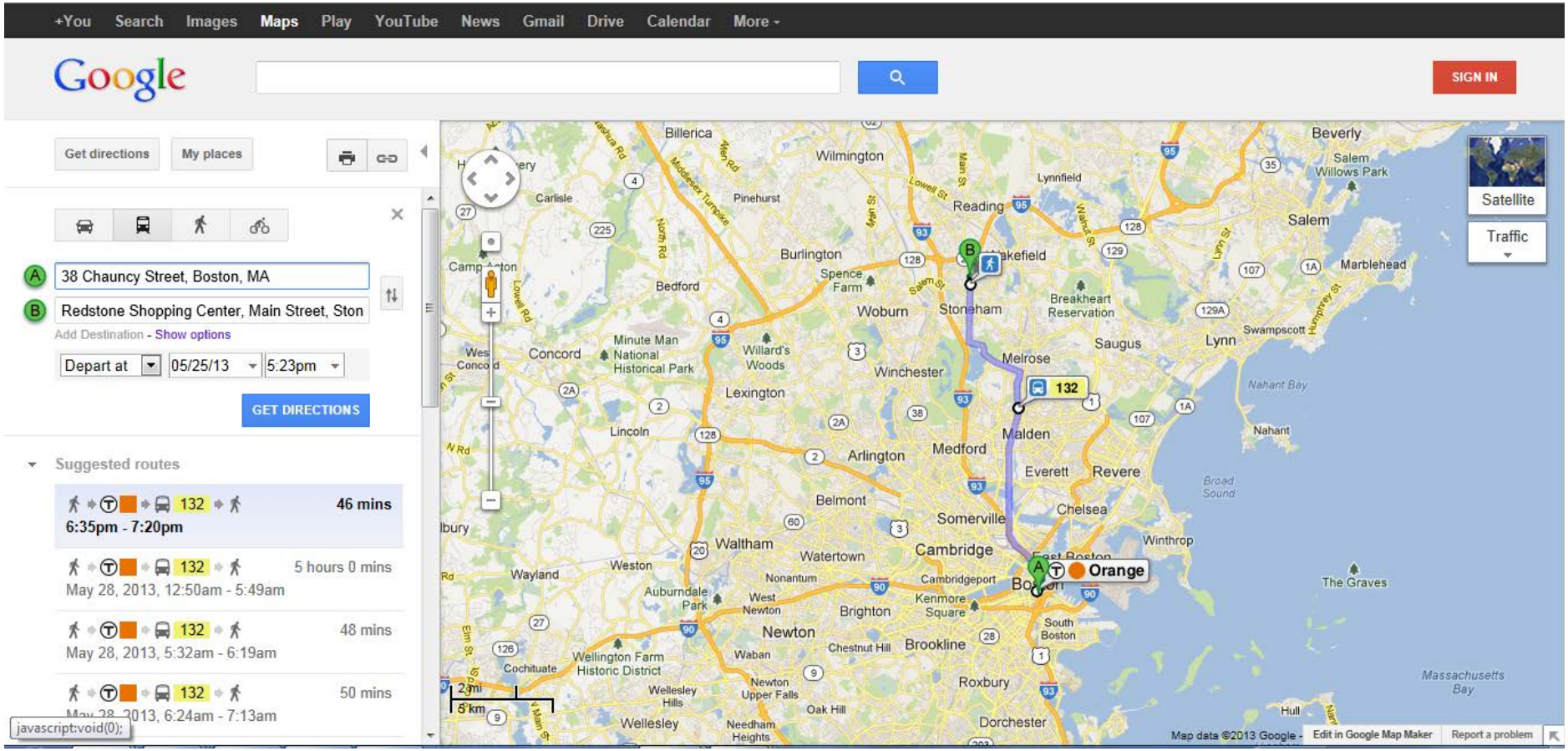
Traveler Information

511, 311, and 211 Systems

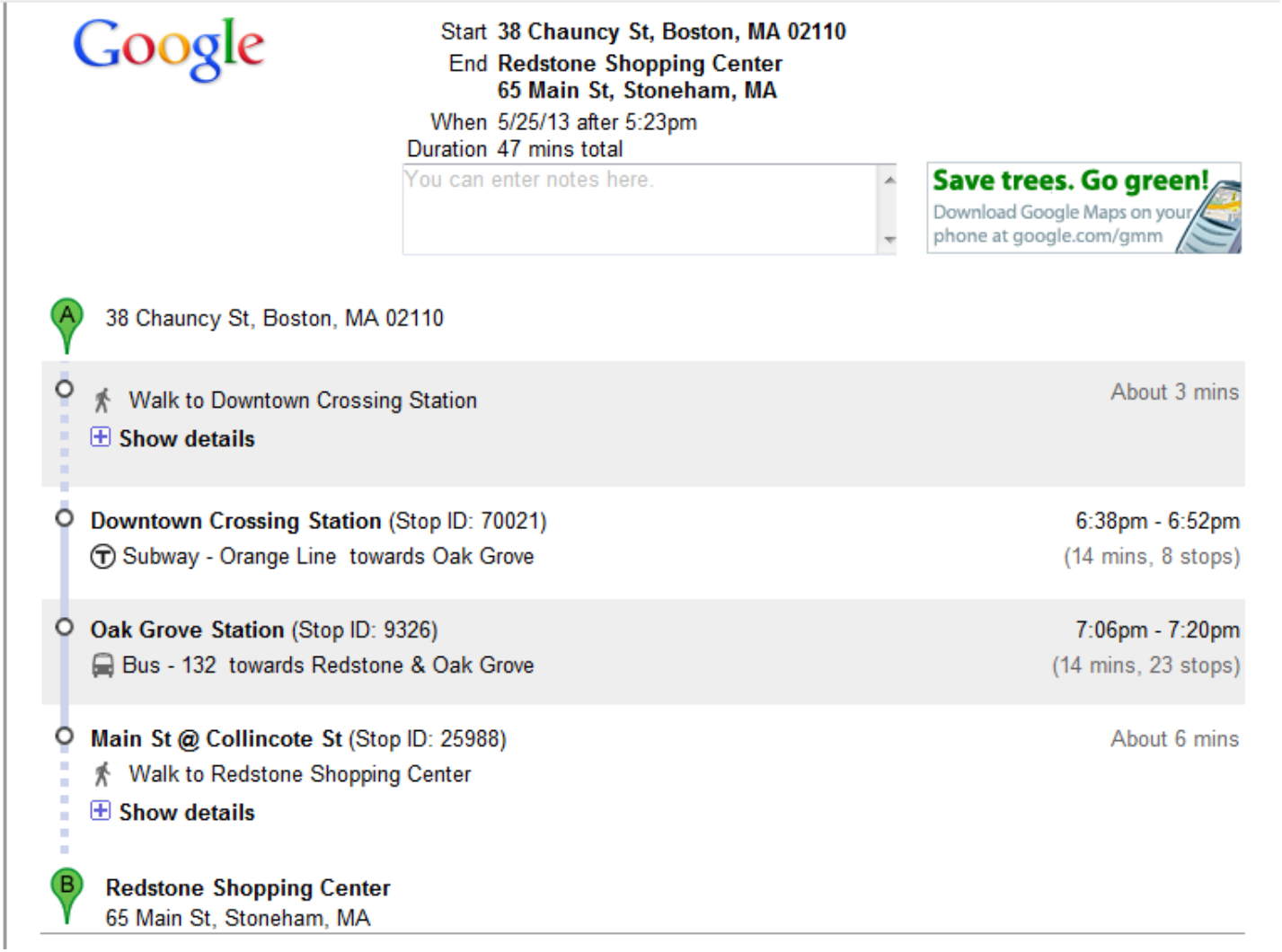
- On July 21, 2000, Federal Communications Commission (FCC) assigned 511 as nationwide telephone number for traveler information - provided statewide and/or regionally
- FCC designated 211 to be used for locally/regionally operated "community information and referral services" phone systems
- FCC designated 311 to be used for locally/regionally operated, staffed (live operator) phone systems for “non-emergency policy and other government services” information

Traveler Information

Google Transit

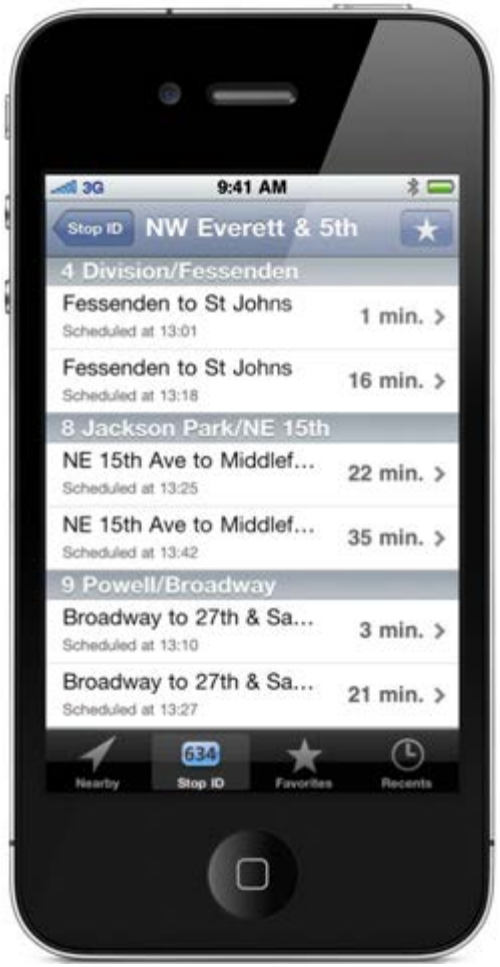


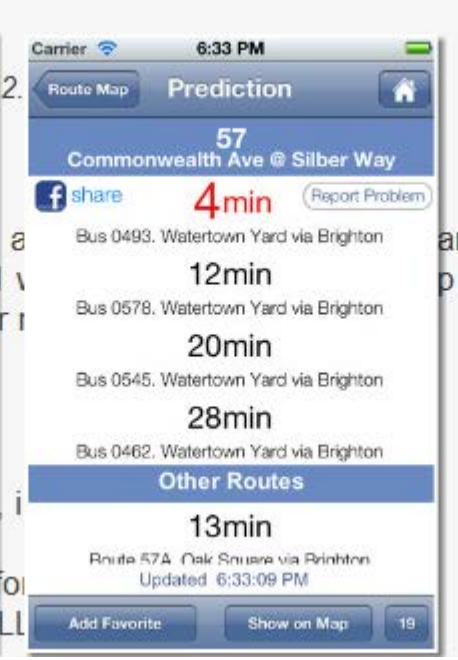
Traveler Information

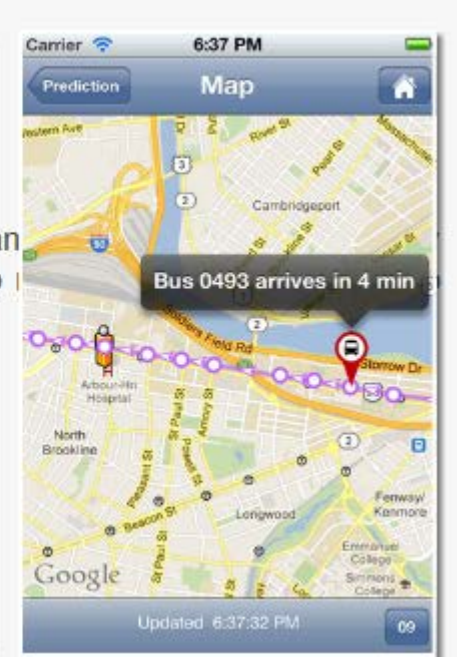


Traveler Information

Third-Party Smartphone Applications







Safety and Security

Mobile (onboard and exterior) and Fixed Video Surveillance

- Review recorded images
- Potential crime prevention
- Identify criminal activity and perpetrator(s)
- Identify improper passenger and driver behavior
- Incident/ insurance investigation

Safety and Security

Covert Emergency Alarm and Covert Live Audio Monitoring

- Allows dispatchers to listen in on what is happening inside vehicle while an incident is taking place
- Covert microphones are one-way communications in order not to alert person responsible for incident that dispatcher/police are listening in
- Driver in distress presses a covert switch that activates the covert microphone and monitor in dispatcher's office automatically displays the information for that vehicle and map display zooms in on that vehicle

Safety and Security

Onboard Digital Video Recorders (DVRs)

- Connected to onboard cameras to record images from cameras
- Equipped with removable recording drive to allow playback of recorded video on centrally located playback system
- Able to store specific number of days of video, beyond which, previously recorded video will be overwritten
- May have capability to use Wi-Fi to upload video once vehicle enters yard or garage

Safety and Security

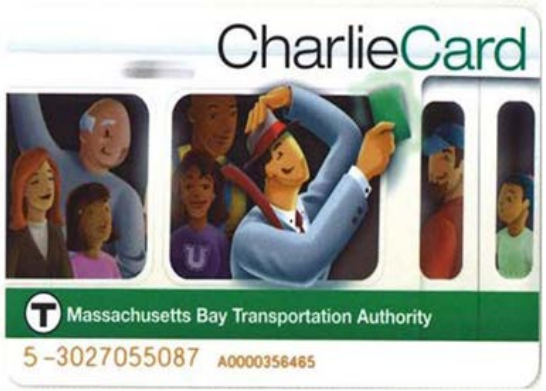
G-Force Monitoring

- System includes g-force sensor and electronic data logger to capture and provide information about unusual movement of transit vehicles and capture events such as vehicle turns, hard braking, and fast acceleration or deceleration
- G-force data can:
  - Assist in accident reconstruction and analysis
  - Protect transit agencies from litigation
  - Reduce cost of insurance
  - Analyze operator actions
  - Identify maintenance issues

Automated Fare Payment

Automated fare media

- Magnetic stripe cards http://youtu.be/C1l5MxnHR3c - MBTA mTicket
- Smart cards - integrated circuit (or chip) card that has microprocessor and built-in logic: contact, contactless, and combi-card
- Mobile payment - mobile ticketing apps using visual, QR code validation or Near Field Communication (NFC)
- Accommodate options such as stored value, stored trip, various lengths of passes, and capped-trip passes
- Facilitates transfers



Automated Fare Payment

Automated Fareboxes and Faregates

Automated Fare Payment: Ticket Vending Machines

- Types of transactions:
  - Accept coins only
  - Accept bills and coins
  - Accept credit cards
  - Accept debit cards
  - Make bill change
  - Accept tokens
  - Accept paper coupons
  - Validate vouchers
  - Reload smart cards
- Types of fare media issued:
  - Single ride
  - Round trip
  - Day pass
  - Monthly pass
  - Multiple-day pass
  - Multiple-ride pass
  - Stored-value fare card
  - Reload stored-value fare card

Maintenance

Engine and Drivetrain Systems Monitoring (a.k.a. vehicle component monitoring)

- Sensors that monitor various components of vehicle and report back on components performance
- Maintenance supervisors can use this information to perform preventive maintenance intervention before a minor problem becomes major and costly one
- Monitoring performed in real-time and problems are reported instantly

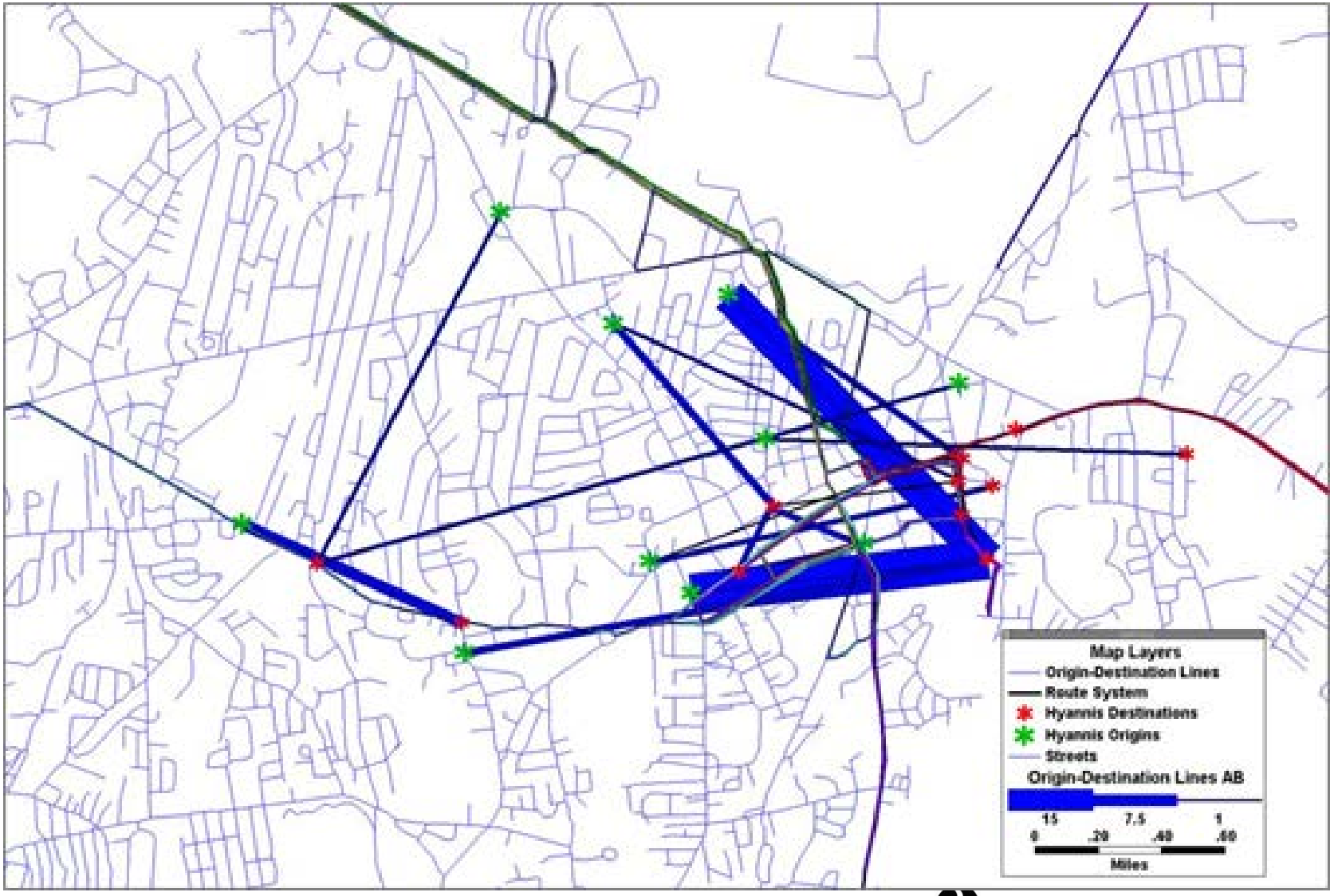
Data Management and Reporting

- Data generated by public transit ITS components installed in vehicles, at central locations, or at other locations
- Data typically collected and archived in individual databases
- Once data archived, used for “after-the-fact” analyses and reporting by different business units within a public transport organization (e.g., planning, operations, customer service)
- Utilize true potential of data by consolidating in central repository to make process of data management, analysis, and reporting more efficient

Technology Integration

- Opportunities for technologies to be integrated with systems that are external to transit agency, such as a regional traffic management center or an information services provider
- Integration, when implemented from enterprise-wide perspective and regional perspective when appropriate, improves overall usability of technology environment made up of products from different vendors on multiple platforms and data from different systems
- Facilitates “system” of interconnected ITS applications that collectively produce services and advantages far greater than ITS applications could achieve individually and independently

Geographic Information System (GIS) Application



Service Coordination Facilitated by Technology: Example

- The Lower Savannah Aging, Disability & Transportation Resource Center in Aiken, SC deployed a regional Travel Management and Coordination Center (TMCC) in August 2010
- Established TMCC to handle requests for service from consumers and agencies needing human services information or referral, and regional transportation
- TMCC has visibility and access to all transportation resources to refer, schedule and assign consumers to transportation providers
- Technologies increased coordination among agencies that transport clients and provided more passenger trips in the Lower Savannah region

Service Coordination Facilitated by Technology (continued)

- The foundations of the MSAA program is best described in the following videos:
  - https://www.youtube.com/watch?v=PR706w5Jalw - Transportation Coordination and the Customer Experience (Part 1)
  - https://www.youtube.com/watch?v=rohX65Dnwxg - Transportation Coordination and the Customer Experience (Part 2)

Open Data for Third-party Application Development

- Definition:
  - Accessible at no more than cost of reproduction, without limitations based on user identity or intent
  - In a digital, machine readable format for interoperation with other data
  - Free of restriction on use or redistribution in its licensing conditions
- As of 2014, of 864 U.S. transit agencies, 248 have open data

Summary

- Transit ITS continues to improve in terms of systems integration and new technologies:
  - Mobile payment systems
  - Potential to connect travelers, infrastructure, and vehicles to provide the best possible public transportation options was demonstrated as part of Integrated Dynamic Transit Operations (IDTO) portion of the USDOT Connected Vehicle Program
- Various aspects of vendor products have become open and more open systems are being developed
- Many transit agencies are facing technology retirement and replacement

References

- A Case Study on Applying the Systems Engineering Approach: Best Practices and Lessons Learned from the Chattanooga SmartBus Project
- TCRP Synthesis 115 - Open Data: Challenges and Opportunities for Transit Agencies
- TCRP Synthesis 73 - AVL Systems for Bus Transit
- Monterey Salinas Transit ITS Augmentation Project - Phase III Evaluation Report
- TCRP Synthesis 77 - Passenger Counting Systems
- Report on Assessment of Relevant Prior and Ongoing Research for the Concept Development and Needs Identification for Integrated Dynamic Transit Operations
- Transit Signal Priority (TSP): A Planning and Implementation Handbook
- TCRP Synthesis 91 - Use and Deployment of Mobile Device Technology for Real-Time Transit Information

Questions?

1. What technologies are dependent upon AVL?
2. What is the primary function of an APC system?
3. What dissemination media can be used to provide real-time transit information?
4. What technologies increase the safety and security of passengers?
5. What are the benefits of open transit data?