In U.S., **Automatic Vehicle Location (AVL)** currently is synonymous with use of **Global Positioning System**

- Pre-1980’s – Radio voice communication
- Up to early 1990’s – Odometer & Signpost systems
- 1990’s – GPS dominant AVL technology
- May 1, 2000 – U.S. Government stopped intentional degradation of GPS signals
- 2008 - GPS technology represents 80+% of all transit AVL systems deployed
GPS Applications in United States Transit

Transit seeks improvements to:

- Operations
- Communications
- Passenger Information

- Scheduling & Planning
- Safety & Security

BENEFITS from GPS Deployments

Operations
- Productivity gains (increased passenger trips / capital savings – reduced fleet demands)
- Improved schedule adherence
- Labor savings (fewer road supervisors, less manual data entry)
GPS Applications in United States Transit

BENEFITS from GPS Deployments (continued)

Communications
- Improved communications between transit operations staff
- Reduced voice radio traffic

Passenger Information
- Predict bus arrival times
- Reduces complaints about late vehicles

Scheduling & Planning
- More complete & accurate data
- Aids in effective bus stop placement

Safety & Security
- Enhances driver & traveler safety & security
- Better response to route detours
GPS Applications in United States Transit

AVL-GPS System Costs dependent on:
- System size
- Level of sophistication
- Components to be included/integrated

**COSTS**
- $500-$2000 per vehicle
- O&M cost = 2% capital

**TOTAL Project Cost:**
- $15,000 maximum per vehicle
- $8000 median per vehicle

**LEVEL OF SOPHISTICATION & INTEGRATION**

**Standard:**
- Computer Aided Dispatch
- Mobile Data Terminal
- Emergency Alarms
- Digital Communications

**Sophisticated:**
- Real-time Passenger Information
- Automatic Passenger Counters
- Automated Fare Payment Systems
- Automatic Stop Annunciation
- Automated Destination Signs
- Vehicle Component Monitoring
- Traffic Signal Priority
GPS Applications in United States Transit

U.S. TRANSIT MODES

- **Fixed Route Bus**: 2,000 Agencies
- **Rail Transit**: 65 Rail Systems, 5,400 Agencies
- **Demand Response Service**: 1,260 Agencies
- **Ferry Boat**: 46 Agencies
- **Human Services Transit**: 3,600 Agencies
- **Rural Transit**: 1,260 Agencies
GPS Applications in United States Transit

% of U.S. TRANSIT MODES that use GPS*

- Fixed Route Bus: 15% (2,000 Agencies)
- Rail Transit: 40% (65 Rail Systems)
- Rural Transit: 25% (1,260 Agencies)
- Demand Response Service: 10% (3,600 Agencies)
- Human Services Transit: 20% (1,260 Agencies)
- Ferry Boat: >75% (46 Agencies)

*2004 ITS Deployment Survey
GPS Applications in United States Transit

Number of Public Transit Agencies Using GPS Technology:

- Between 1,200 and 2,000

Primary GPS Transit Applications:

1. Automatic Vehicle Location (AVL)
2. Geographic Information System (GIS)
3. Traveler Information System
4. Transit Signal Priority
5. Automatic Passenger Counters (APC)
6. Electronic Fare Payment System
GPS Applications in United States Transit

Automatic Vehicle Location

GPS

GPS Antenna

Transit Vehicle

MDT

Mobile Data Terminal (MDT)

Dispatch Center
GPS Applications in United States Transit

Data Management & GIS

- Clients
- Routes
- Stops
- Vehicles
- Data Management & GIS
- Origin/Destination Points
- GPS-tagged locations

Map Layers
- Origin-Destination Lines
- Route System
- Hyannis Destinations
- Hyannis Origins
- Swales
- Origin-Destination Lines All
GPS Applications in United States Transit

Top GPS Purposes for Geographic Information Systems

1. Bus Stops
2. Automatic Vehicle Location (AVL)
3. Bus Stop Amenities
4. Rail Stops
5. Rail Right-Of-Way
6. Transit Yards and other facilities
7. Transit Real Estate
GPS Applications in United States Transit

Traveler Information

Transit Information Center

Customer Service

Work / Home Transit Trip Planning

Transit Schedule enabled by GPS

En-Route Real-time Transit and Multimodal Information

In-Station Travel Information

Kiosk

In-Station Information
GPS Applications in United States Transit

Traffic Signal Priority

Traffic Signal Priority Emitter with Switch: Emitter initiates request for signal priority to be checked by Traffic Signal Controller against pre-determined desired conditions.

Automated ID via GPS signal

Detection System: Optical Strobe Light or Radio Frequency-Infrared Tags

Optical Detector

Wayside RF-IR Tag Reader
GPS Applications in United States Transit

Automatic Passenger Counter

GPS-location stamped information

APC System Components

Source: PerMetrics Technologies, Inc.

Infrared (IR) Sensors
GPS Applications in United States Transit

Electronic Fare Payment

GPS systems can enable simplified collection of zonal fares
## GPS Applications in United States Transit

### Public Transit Agencies Using GPS Technology

<table>
<thead>
<tr>
<th>Agency</th>
<th>Number of Vehicles</th>
<th>Context / Success of Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles County Metropolitan Transportation Authority (LAC MTA) Los Angeles, California</td>
<td>2,450 buses 127 light rail 104 heavy rail; 30 BRT</td>
<td>Integrated AVL-GPS system archives and automatically feeds run-time data to scheduling department.</td>
</tr>
<tr>
<td>Denver Regional Transportation District (RTD) Denver, Colorado</td>
<td>1,335 buses 70 light rail</td>
<td>Use of AVL-GPS, combined with an upgrade in the radio communications system and MDTs, improved on-time performance and increased ridership.</td>
</tr>
<tr>
<td>Metro Transit Minneapolis &amp; St. Paul, Minnesota</td>
<td>922 buses 24 light rail</td>
<td>Integrated AVL &amp; CAD along with APC and a new regional digital 800MHz radio system.</td>
</tr>
<tr>
<td>Metropolitan Atlanta Rapid Transit Authority (MARTA) Atlanta, Georgia</td>
<td>556 buses 336 heavy rail</td>
<td>Use of AVL &amp; CAD resulted in operating savings and improved data collection, but also had high implementation costs.</td>
</tr>
</tbody>
</table>
## Public Transit Agencies Using GPS Technology

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<tr>
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</table>
| Milwaukee Country Transit System (MCTS)  
Milwaukee, Wisconsin | 484 buses | Use of an integrated AVL-GPS system improved on-time performance and adherence to schedules. |
| Ann Arbor Transportation Authority (AATA)  
Ann Arbor, Michigan | 82 buses | Deployed integrated AVL-CAD, MDT, remote diagnostics, and silent alarms on fleet in stages. Improved on-time departures, but not arrivals. Initially, major errors in vehicle location data. |
| County of Lackawanna Transit  
Scranton, Pennsylvania | 32 buses | Deployed basic AVL-GPS system in about 9 months |
| Montachusett Area Regional Transit Authority (MART)  
Fitchburg, Massachusetts | 23 buses | Employs AVL-GPS and MDT for its fixed and demand-response buses. |
GPS Applications in United States Transit

IMPLEMENTATION & OPERATIONAL CHALLENGES

Costs
- Capital funding sources
- Sustaining O&M funding

Implementation
- Lengthy procurement and installation process
- Institutional relationships
- Software or extensive customization
- Accurate GIS database
- National ITS Architecture consistency

Operations
- New technical expertise
- Reluctance of existing staff
- Schedule adherence design difficult
- GPS signal reception problems
GPS Applications in United States Transit

Other GPS Transit Applications:

- Computer Aided Dispatch & Scheduling (CADS)
- Maintenance Management
- Transit Communications
- Security Cameras & Systems
- Weather Information Systems
Computer Aided Dispatch & Scheduling

MDT Text Communications

AVL-GIS Vehicle Tracking

Computer Aided Dispatch Screen
GPS Applications in United States Transit

Maintenance Management

Vehicle Scheduled Maintenance

Maintenance Management System Processor

Maintenance Monitoring Equipment
GPS Applications in United States Transit

Security Cameras and Systems

- Video Cameras
- Video Recorder
- Local Area Network
- Video Monitor
- PC (for viewing and archiving)
- Digital Camera
- Installing a Fixed Route Bus Security Camera

Transit Security Center
GPS Applications in United States Transit

Weather Information Systems

Environmental Sensor Station
GPS Applications in United States Transit

SUMMARY

GPS Transit Applications:
• Automatic Vehicle Location (AVL)
• Geographic Information System (GIS)
• Traveler Information System
• Transit Signal Priority
• Automatic Passenger Counters (APC)
• Electronic Fare Payment System
• Computer Aided Dispatch & Scheduling (CADS)
• Maintenance Management
• Transit Communications
• Security Cameras & Systems
• Weather Information Systems

Promote Increased Use

Address Implementation and Operational Challenges