Transit ITS: Evolution, Developments, Challenges, and Future Directions

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Agenda

- Transit ITS: Functionalities and Evolution
- Benefits and Challenges
- Strategic Approach
- Latest Developments in Transit ITS
- The Future: Connected Vehicle Environment
Intelligent Transportation Systems for Transit
(Transit ITS)
Back to the Future....
Design of the automated dual mode bus would give particular attention to passenger comfort on the longer excursions trips.
A satellite city fast intracity transit link station.
A personal rapid transit dual mode vehicle station showing a small car entering the network through an inspection point, a destination encoder, and an automatic fare collector.
A suburban personal rapid transit station showing terraces for vehicles stopped to pick up or discharge passengers.
A Dial-a-Bus, with its position established by automatic vehicle monitoring, can be routed by computer and a communication link to collect passengers who have called for service.
Customers desiring Dial-a-Bus service could telephone the controller from home and indicate their desired starting time, origin and destination. A signal on the panel might announce the approach of the Dial-a-Bus.
Dial-a-Bus call stations could be located at convenient intervals throughout a suburban area.
Basic Components - Transit ITS

1. Intelligent / Smart Vehicles
   with on-board computers / data storage

2. Location
   (typically using GPS)

3. Mobile Communications
   (Centres, Wayside, Other Vehicles)
   - Back-End Systems (CAD/AVL, APC Database)
   - Control Centre
   - Web / Mobile Applications (Trip Planning, RTPI, etc.)
   - IVR
   - Connected Services (Call Centres, Garages, Archived Data, TMC)
Transit ITS Functionalities

- Communications (voice and data)
- Computer Assisted Dispatch (CAD)
- Automatic Vehicle Location (AVL)
- Security Alarms
- Schedule Adherence Monitoring
- Passenger Counting (APC)
- Transit Signal Priority (TSP)
- Customer Information (Pre-Trip, At Stop, On-Board)
- Analysis using Archived Data
- Vehicle Health Monitoring
- Advanced Fare Collection (AFC)
Typical Transit ITS Architecture

- Purchased as capital project
- Integrated voice and data communications
  - Flexibility in radio comm: individual, by route, entire fleet
  - Data: canned messages
  - Location position reported by exception
  - Most logged data downloaded at end of day in garage
- Private radio infrastructure for voice on own channels
  - Ensures reliability in emergency operations
- Data communications: increasingly by cellular

- Alternative business models exist (e.g. software as a service)
Transit ITS - Evolution

- **1980s:**
  - European cities, and a few pioneers in Canada
  - CAD/AVL using data radio, signposts, etc.
  - Stand-alone APC, TSP systems

- **1990s:**
  - Federal involvement in APTS (funding, demos, studies)
  - First major AVL-based deployments using GPS
  - A few big failures of AVL system deployments
  - Initiation of regional smart card projects

- **2000-Present**
  - Widespread deployment
  - Integration of modules
  - Increasingly mature technology
ITS as Part of BRT Corridors

- Greater stop spacing
- Reserved right of way
- Stations and Vehicles
- Branding

ITS
- CAD/AVL
- Real-time information
- Transit signal priority
- Advanced fare collection
Why ITS Technology?

- Sometimes reduces costs
  - Computerization of data logging (e.g. incidents)
- **But more importantly, enhances service to customers**
  - Improved reliability of service
  - Improved security and safety
  - Better design of service
  - Enhanced information to customers (before and during trip, through multiple media)
  - Customer relations (investigation of complaints)
- **Public Expectations / Image**
Key Dilemma for Transit Technology

- High (and growing) public expectations
- Rapid rate of technological change
- Short-term horizon of politicians
  versus
- Risk-adverse *fishbowl* of public sector
- Long time required to line up funding
- Long technology procurement and deployment times
Organizational and Other Challenges (other than funding)

- Implications for organization
  - Expertise and staffing
  - Management of technology
  - Effective use of technology

- Changes to business practices

- Customer implications

- Labor implications (diminishing)

- Coordination with other departments, agencies
Requires a Strategic Approach

- Technology should be viewed as strategic resource
  - Service design
  - Operational control and security
  - Quality and performance monitoring
  - Corporate management
  - Revenue management
  - Customer relationship management
  - And eventually...Integrated Mobility Systems

- Goals / Strategy / Business Cases
- Changes to business processes
- Information for decision-making: Business Intelligence
Transit ITS Latest Developments

- Transit Traveler Information Systems (TTIS):
  - Explosion of delivery mechanisms
  - Open Data, Open Source software

- TSP: slow growing acceptance in traffic control

- Effective use of AVL / APC data – Business Intelligence
- Deployment of ITS Standards
- Video images (snapshots on demand)
- Specialized Transit-Reservation / IVR / AVL / CAD
  - Reservation / Scheduling / Control / (Coordination / Brokerage)
Data Explosion

- CAD / AVL (not just GPS location)
  - Provides location and time-stamped information that is comparable to schedule
- Automatic Passenger Counting (APC)
- Automatic Fare Collection (AFC)
  - Farebox data structure typically of limited value (except total boardings by fare category)
  - Smart card data can (should) be geocoded
- General Transit Feed Specification (GTFS)
  - Standardized geocoded inventory of stops, routes, and schedules
  - Provides network model
- GTFS-RT (Real-time)
- Maintenance (Asset Management) Records
Data, Information, and Business Intelligence

- **Service Planning and Customer Behavior**
  - Running Times for schedule enhancement
  - On-Time Performance / reliability
  - Origin-Destination matrices (from smart card data)
  - Fare elasticities (from smart card data)

- **Operations Management**
  - Operational performance
  - Targeted street supervision

- **Executive Information**
  - Warning signs
  - Reporting
  - Contractor performance
Challenges to Use Transit ITS Data

- Ownership of Data! (No ask / no get!)
- Limited availability of analytic expertise
- Lack of standardized approaches and methodologies
- Lack of IT resources
- Data storage (volume and lack of integrated warehouse)
- Multiple, conflicting databases
  - AFC vs. APC data
- Manual special-purpose databases (Joe’s spreadsheet)
Transit ITS Future Directions

- New approaches to AFC
  - Mobile Payment (by cell phone, NFC)
  - Open systems (Contactless credit card)
  - Account-based systems
- Real-time video on demand
- New Transit ITS applications
  - Real-time control decision support (predictive analytics)
  - General public demand-responsive systems (FlexBus)
- Vehicle Assist and Automation (VAA) – Guided Bus
- Integrated Corridor Management
- Connected Vehicle Environment (V2V, V2I)
Integrated Corridor Management (ICM)
King County RapidRide ITS Architecture

Roadside Network Operation and Maintenance

- Off the shelf TCP/IP and 802.11a technologies

- WiFi-Corridor Concept
  - From DSRC / IntelliDrive(sm)

- Passenger Info Sign
- SAFTP
- Tech Pylon
- RapidRide Coach
- Wi-fi transceiver
- Wi-fi Antenna
- Wi-fi Access Pt/Bridge
- RF Tag

- TCIP Dialog
  - “Notify Onboard PRG Input”

- TCIP Gateway

- RR crosses multiple jurisdictions -- Migrating to ATC Standard Controllers
Connected Vehicle Technology
# US DOT Connected Vehicle Research Program

## Applications

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## Technology

- Harmonization of International Standards & Architecture
- Human Factors
- Systems Engineering
- Certification
- Test Environments

## Policy

- Deployment Scenarios
- Financing & Investment Models
- Operations & Governance
- Institutional Issues
US DOT Safety Pilot: Applications

- Forward Collision Warning (FCW)*
- Emergency Electronic Brake Light (EEBL)*
- Intersection Movement Assist (IMA)
- Blind Spot Warning (BSW)
- Do Not Pass Warning (DNPW)
- Left Turn Across Path (LTAP)
- Curve Speed Warning (CSW)*

Transit Applications
- Right Turn in Front Warning*
- Pedestrian Detection*
IDTO
(Integrated Dynamic Transit Operations)

- **T-CONNECT (Connection Protection)**
  - Individualized requests for connection protection
  - To increase the likelihood of making successful transfers
  - Especially for transfers multi-modal or multi-agency transfers

- **T-DISP (Dynamic Transit Operations)**
  - For the traveler: access to real-time information about all available travel options across multiple modes / agencies.
  - For agencies: extends demand / response services to support dynamic routing and scheduling,
    - based on much more real-time information: traffic conditions, vehicle capacity, ridership and origin-destination, among other factors.

- **D-RIDE (Dynamic Ridesharing)**
  - Use smartphones for real-time rideshare matching (“slugging”).
  - Lets drivers and travelers, in real-time, exchange information about needs and available space.
Connected Vehicle Research for Mobility

Real-time Data Capture and Management (DCM)

- Vehicle Status Data
- Infrastructure Status Data
- Weather Data
- Truck Data
- Transit Data

Dynamic Mobility Applications (DMA)

- Reduce Speed 35 MPH
- Weather Application
- Transit Connection Protection
- Real-Time Travel Info
- Fleet Management/Dynamic Route Guidance
- Signal Phase & Timing Adjusts Real-Time Conditions
- Safety Alerts and Warnings

Data Environment
Some Challenges for Transit

- Adapting well established Transit ITS architecture
- Managing integration of voice and data communications
  - Voice typically through private radio
  - Data through cellular communications
- Ensuring reliability of system and ability to function under emergency conditions
- Developing business and governance models that create synergy
- Autonomous Vehicles???
  - What will happen?
  - What are implications for transit?
Transit ITS: An exciting future, with many opportunities, but with many challenges as well!

Thank You!