Transit Management Centers:

Human Factors Issues

TRB Human Factors Workshop

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Transportation Management Center

- A facility housing the operations management centers for at least two transportation modes.
  - It includes advanced technologies for various functions including highway congestion mitigation (e.g., assist in incident management), transportation information, and transit dispatching.
  - Centers are also known as Traffic Control Centers, Central Control Centers, Traffic Information Centers, Transit Information Centers, Transit Control Centers and Transit Management Centers.

**NTI/FTA sponsored course, "TRANSIT ITS AWARENESS SEMINAR"*

TMC vs. TMC

Traffic Management Center

- Acquires and analyzes traffic data
- Provides guidance and coordination directly to the public as well as public and private agencies to maximize traffic throughput

Transit Management Centers

- Monitors transit system operations and traffic conditions
- Controls transit operations
- Coordinates with emergency service providers and other public and private agencies

Traffic Management Centers

Focus is on traffic management, a broad range of vehicle types, no direct control of individual vehicles

- Proactive responses based on analysis of a broad range of incoming data that is compared to "historical" patterns
- Communication with drivers mostly one way through broadcast (auditory or visual)
- Communication with traffic personnel only in emergency or other unusual condition
- Problem response usually accomplished through a limited choice of available solutions
- Information provided by sensors, sampling through instrumented vehicles (traffic probes), and volunteers

Transit Management Centers

Focus is on maintaining scheduled service for a limited range of vehicles with direct supervision of vehicles

- Two way and targeted communications with bus drivers and street supervisors
- Information shared within TMC and conducted interactively with drivers and street supervisors to accomplish *problem-solving*
- Information gathered through verbal interactions and sensors on vehicles and roadway sensors or cameras
- Requirements for communications with police and traffic personnel as needed rather than routine
- Most transit systems have existing TMC that have to be retrofitted or replaced rather than designed from scratch

Transit Management Center Requirements

TMC staff must

- Support intermittent and scheduled services
- Understand the capabilities of a variety of equipment (buses, light rail)
- Guide drivers who are often new to the route and equipment
- Remotely diagnose complex systems (lifts, fare boxes, air conditioning)
- Interact with
  - supervisors, bus drivers, support personnel, public safety personnel, members of unions, contractor employees, and sometimes customers
  - a variety of service providers

Other Transit Considerations

Because transit provides a "linking" service, it is a creature of its environment

- Constraints include schedules, stops, and interfaces with other modes, and weather
- Enabling services include parking management, fare collection procedures, accessibility, terminal surveillance, real time schedule access

Denver RTD

an Illustrative Example

Initial Goals:

- Better (more efficient) fleet management
- Improved security
- Better emergency management
- Better passenger service

Denver RTD

System Description

- Real time vehicle location displayed on Automatic Vehicle Location (AVL) Computer using differential GPS
- TMC incoming data
  - AVL Screen for bus location, Computer Aided Dispatch (CAD) screen for driver initiated voice communication
- TMC outgoing data
  - CAD or directly initiated voice and canned text
  - Targeted, narrow cast, or broad cast

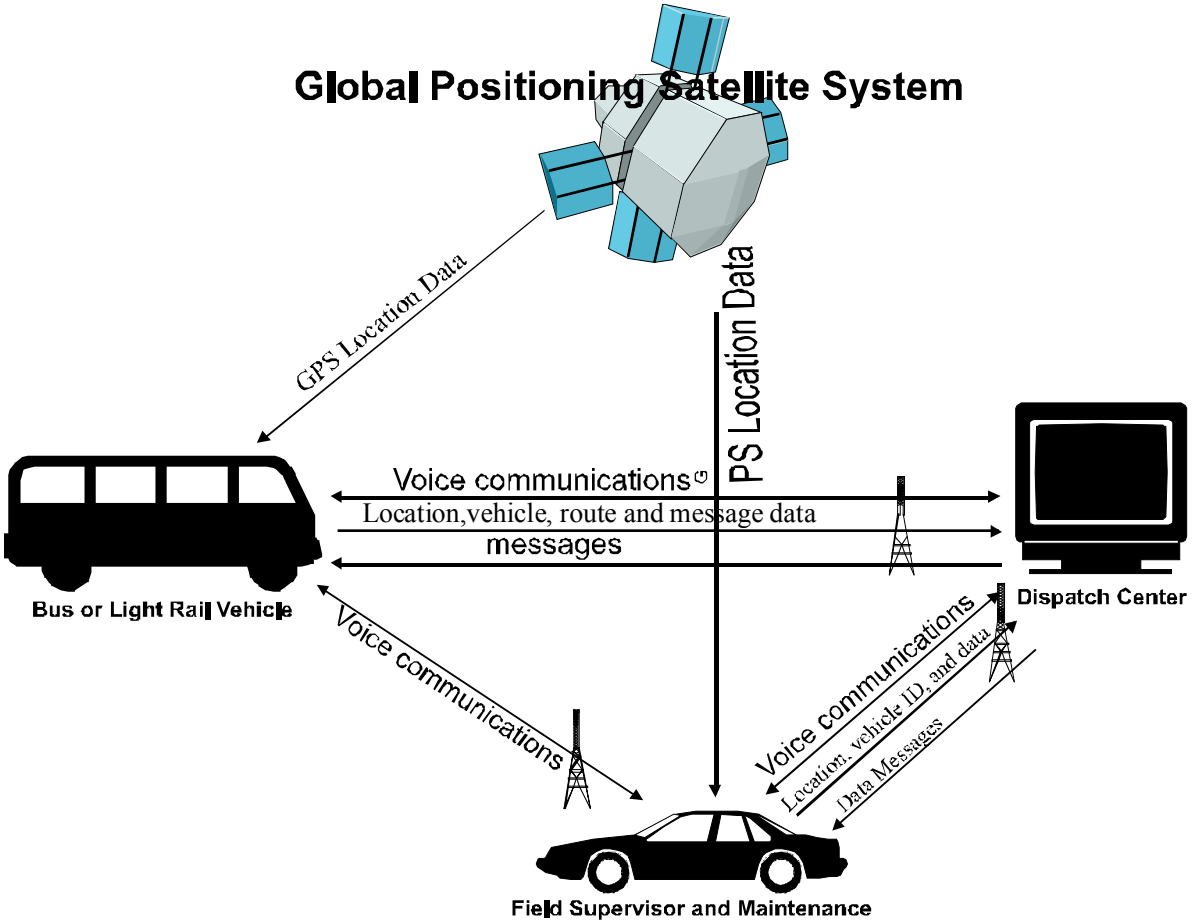
Denver RTD

System Description

- Street supervisors equipped with voice and laptop based real time information
- Communication using 9 microwave channels (2 data, 7 voice) with pre-coded text message capability
- Security based on "silent alarm"
- Automatic archiving of operations information

Denver RTD

Data/Information Flow



Lead Dispatcher
Denver RTD Dispatch Center

I-25 CC TV
Denver RTD Dispatch Center

CAD / AVL Dispatch Console Denver RTD Dispatch Center

Lessons Learned

Fleet Efficiency *

- Accurate accessible real-time vehicle location information resulted in improved
  - Fleet distribution
  - Deployment of support vehicles
  - Management of connecting service, "connection protection"
- Transit management data collection
  - Collected in real time and automatically archived supports administrative as well as traffic needs
- Message storage capabilities
  - Reduced driver distraction in high workload environments e.g. heavy traffic

**This project was the subject of two multiyear evaluations sponsored by the FTA the results are summarized in the following slides*

Lessons Learned

Security

- Improved coordination with police through the use of accurate real time location data
- There was an initial reduction in perceived security due to use of "silent alarm" and pre-programmed communication lockout
- During the period of the project Passenger assaults decreased 33%

Lessons Learned

Passenger Service

AVL allowed the system to respond quickly to unusual service demands

- Operated "load and go" shuttles by real time location monitoring
- Handled increased (doubled) call volume in snow emergencies
- Accomplished rapid reassignments during incidents and accidents

AVL provided passengers with information that was authoritative, uniform and shared.

- E.g. GPS based system time

Lessons Learned

Emergency Management

Distributed information- resulting in a better informed field staff, that can marshal more internal resources to deal with emergencies

Better coordination with rescue, law enforcement, and fire services resulting in quicker, more effective rescue services

Lessons Learned

System Effectiveness

Over the five years of the project

- Early bus arrivals deceased 12%
- Late arrivals decreased 21%
- Customer complaints deceased 26%

To Successfully Manage the Introduction of New Technology,

- Define critical prior elements / functional requirements.
- Establish a concept of operations
- Use cognitive task analysis to identify critical tasks.
- Identify the organizational elements and their internal formal and informal communication processes.
- Develop operational scenarios and talk them through with staff.
- Balance designer inputs with staff inputs
- Prototype the system for evaluation before committing to a full build.

Learn from the experience of other systems

All Management Centers
Issues:

Upgrades are often technology driven

- Design to employees' / maintainers' needs and qualifications
- "Technology push, feature creep"
  - Balance integration and modularity
  - Avoid outdated technology but stay away from the"bleeding edge"
  - Technology will continue to develop
- "Keep the best replace the rest"
  - What is the value added?
- Anticipate unanticipated "local" application problems
  - Buy the source code
  - Beware COTS

Coordination Issues

Transit and Traffic Management centers

Map conventions differ

- Highway maps isomorphic
- Transit maps symbolic, nodes

- Message propagation
  - broadcast vs. narrowcast v.s. one to one
- Inter-vehicle communication
- Inter-system communication

Both must deal with different frequencies patchy coverage, dead zones

Transit and Traffic Management Centers

Employee Issues

- Recognize the need to train, expect to find
  - heterogeneous skills
  - varying educations
  - multiple employers
- Assess how long it will take to learn, and what assistance will be required, to use new feature
- You will need to "train more than you think"

HF Considerations in All TMCs
Work Environments

TMC staff works as a team,

- They should be able to scan the other work stations and communicate verbally with each other

Lighting / Sound

- "There will always be paperwork"
  - Avoid "subdued" lighting
  - Allow for personal preference for lighting
  - Sound levels should be user adjustable

Consider worker schedules

- Long shifts are common
  - Conveniences must be near at hand

Allow space for retention of some legacy systems

HF Considerations in All TMCs
Interfaces

No display is too big

- AVL screens must display high levels of detail
- Pull down menus should not block important information
- System should have de-cluttering modes
- Color sets should be established through research rather than operator choice
- Field personnel want same picture as Management Center even though their displays will have lesser capabilities

No system is too fast

- The lag in displaying new information is very disruptive
- Limit the number of input devices

Specific HF Issues in Transit Management Systems

System integration

- Provide redundant auditory cues for critical signals
- Displayed information (particularly calls) should be transferable between consoles
- End-to-end confirmation of message receipt is required
- Provide a convenient way of correcting data entries

Specific HF Issues in Transit Management Systems

Training

- Assume workers will have a wide range of skills, particularly computer skills
- Assume that critical learning will take place through formal or informal apprenticeship and OJT

Integration questions

- Given multiple types of management centers
  - Traffic Control Centers, Central Control Centers, Traffic Information Centers, Transit Information Centers, Transit Control Centers and Transit Management Centers, and Emergency Response Centers, how should they be integrated?
- How do we focus on the trip as opposed to the transit segment?
  - How do we integrate traffic management, lane priority, parking lots, airports, sports events?
  - What should the model be?
    - Is there a model?
- How do we introduce a new technology?
- How do we incorporate the benefits of new technology and retain equipage flexibility?