Advanced Traffic Management Systems

ATMS
Outline

• The idea
• ATMS Requirements
• ATMS multilevel architecture
• Purpose of ATMS (objectives & strategies)
• Traffic management capability (TMC)
• Traffic information capability (TIC)
• Integration of TMC and TIC
• Applications
  – VANET
  – Embedded systems in cars
Traffic Management System - Idea

- Traffic Management
  - Urban Traffic
  - Parking
  - Public Transportation
  - Events
  - Freeways/highways/Tolls
  - Ring Roads
  - Road Works

Traffic Management System components include urban traffic management, parking, public transportation, events, freeways/highways/tolls, ring roads, and road works. The system aims to optimize traffic flow and manage various aspects of urban transport efficiently.
ATMS Requirements

- Control mechanism
- Sensors
- Communications
- Data collection and manipulation
- Algorithms
- Maintenance
ATMS Requirements

- Control mechanism
  - Traffic lights
  - Lane signal
  - Visual message system (VMS)
  - Traffic information
ATMS Requirements

• Sensors
  – Loops
  – Cameras
    • Data
    • Images
  – Lasers
  – Radar
  – Vehicle probe data
ATMS Requirements

• Communications
  – Vehicle to Vehicle (V2V)
    • WiFi
    • Bluetooth
  – Vehicle to infrastructure (V2I)
    • WiFi
    • GPRS
    • WiMax
ATMS Requirements

• Data collection and manipulation
  – Collecting though the communication means
  – Preprocessing data
    • Make it understandable
    • Decision support systems
  – Data fusion
    • This case when we have many source of data.
ATMS Requirements

• Algorithms
  – Old generation
    • Time of day
    • Fixed volumes
  – New generation
    • Adaptive
    • Real time volumes
    • Prediction in space and time
ATMS Requirements

• Maintenance
  – Higher level of maintenance than simple infrastructure
  – Question about data size
  – How sparse data should be
  – Insure the good functioning of all the requirements systems
ATMS Multi level Architecture

Strategic level

Traffic Management system

Tactical Level level

Parking guidance system/ Public transport system/ Urban traffic control system/ Freeway management system

Operative level

Cameras Signals Detectors Signs

Measured data, systems status, etc

Strategies, control settings, etc
The idea behind ATMS

• Now
  – Cities run various independent traffic systems
  – No interchange data between most systems

• ATMS can do
  – ATMS integrates these systems into a single application
  – Traffic Management thereby provides the basis for: (Cross-System Traffic Strategies & Distribution of Traffic Information)
What can Traffic Management change in your city?

• Achieve collaboration & central control of existing, independent traffic subsystems
• Comprehensively monitor & visualize traffic conditions in real time
• Provide value-added traffic information services to the public
• Improve road safety through incident detection & response management
• Prevent and actively fight congestion by intelligently influencing traffic on the road
• Demonstrate civil responsibility through a pro-active approach to traffic improvement
## ATMS Objectives

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Measures of Effectiveness (MOEs)</th>
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<tbody>
<tr>
<td>Increase corridor traffic throughout</td>
<td>• Monthly average daily traffic (veh/day)</td>
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<td>• Highest hourly volume per lane (veh/hr/lane)</td>
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<tr>
<td>Increase average travel speed</td>
<td>• Monthly average peak period speed (km/h) for 08:00 to 09:00 and for 17:00 to 18:00</td>
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<tr>
<td>Reduce vehicle delays</td>
<td>• Total monthly vehicle-hours of delay (veh-hours)</td>
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<td>• Time when travel speed is less than 70 km/h (minutes)</td>
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<tr>
<td>Decrease average travel time</td>
<td>• Average travel time at 08:00 and at 17:00 for a specific roadway section (minutes)</td>
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<tr>
<td>Increase utilization and effectiveness of DMS</td>
<td>• Number of non-default messages displayed per sign per day</td>
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<tr>
<td>Reduce number of collisions</td>
<td>• Total number of confirmed incidents</td>
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<tr>
<td>Improve incident detection system</td>
<td>• Percentage of incidents detected by system • Percentage of incidents detected manually • Percentage of false alarms</td>
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<tr>
<td>Reduce incident duration</td>
<td>• Total duration of incident (minutes)</td>
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<td>• Average duration of incident (minutes) • Incident detection time (minutes)</td>
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<td>• Response time to incident (minutes) • Incident clearance time (minutes)</td>
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<tr>
<td>Increase field equipment utilization</td>
<td>• Percentage of VDS controller-hour availability • Percentage of DMS controller-hour availability</td>
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<tr>
<td>Reduce secondary incidents</td>
<td>• Number of secondary incidents</td>
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<tr>
<td>Reduce vehicular delay due to incident reduction and delay reduction</td>
<td>• Average delay (veh-hr)</td>
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<tr>
<td>Improve quality of traffic flow</td>
<td>• Travel time index</td>
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<td>• Averaged speed (km/h)</td>
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<td>• Acceleration/deceleration ratio</td>
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<tr>
<td>Improve driver response (diversion) to DMS messages</td>
<td>• User perception to the sign</td>
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<td>• Message accuracy of the sign</td>
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# ATMS Strategies

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<tr>
<th>Strategy</th>
<th>Description</th>
<th>Requirement</th>
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<tr>
<td>Incident Management</td>
<td>Early detection and response to unscheduled events</td>
<td>• Incident detection/confirmation</td>
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<td></td>
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<td>• Emergency response/motorist assistance</td>
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<td>• Pre-trip and en-route advisory</td>
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<td>Congestion Management</td>
<td>Mitigating the impacts of recurring and non-recurring congestion</td>
<td>• Congestion monitoring</td>
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<td>• Ramp metering</td>
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<tr>
<td>Corridor Management</td>
<td>Balancing level of service among alternate parallel routes within a corridor</td>
<td>• Event and travel time monitoring</td>
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<td>• Pre-trip and en-route advisory</td>
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<tr>
<td>Network Management</td>
<td>Balancing level of service within the network as a function of current conditions</td>
<td>• Event and travel time monitoring</td>
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<td>• Pre-trip and en-route advisory</td>
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<td>Travel Demand Management</td>
<td>Improving traffic flow by managing travel demand</td>
<td>• Congestion pricing</td>
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Traffic management capability
Traffic information capability
Results of merging (single platform)
Integrated Traffic Management & Traffic Information Services

Data Collection from different sources
Data fusion

Data Preprocessing
Intelligent processing of traffic data
Real time traffic status
Traffic forecast

Generating services:
Broadcasting information to various receivers
Customer relation management
## Mapping subsystems to strategies

X- Primary role  
O-Secondary role

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Applications
What is a VANET?

- Vehicular Ad-hoc NETworks
- Individual nodes different from traditional wireless nodes
  - No power constraint
  - Nodes mostly mobile
- Extends existing infrastructure
A modern vehicle is a computer on wheels

- Event data recorder (EDR)
- Forward radar
- Positioning system (GPS)
- Rear radar
- Communication facility
- Display
- Computing platform

- Human-Machine Interface
- Navigation system

- Processing power: comparable with a Personal Computer + a few dozens of specialized processors
- Communication: typically over a dedicated channel:
  - Dedicated Short Range Communications (DSRC)
    - In the US, 75 MHz at 5.9 GHz;
    - In Europe, 20 MHz requested but not yet allocated
- Envisioned protocol: IEEE 802.11p
- Penetration will be progressive (over 2 decades or so)
Your car in the not so far distant future
Safety applications

SVA (Stopped or Slow Vehicle Advisor)
Safety Applications

- PCN: V2V Post Crash Notification
- EEBL: Emergency Electronic Brake Light
- RHCN: Road Hazard Condition Notification
- RFN: Road Feature Notification
- CCW: Cooperative Collision Warning
- CVW: Cooperative Violation Warning
Convenance Applications: CRN (Congested Road Notification)
Convenance Applications

- TP: Traffic Probe
- TOLL: Free Flow Tolling
- PAN: Parking Availability Notification
- PSL: Parking Spot Locator
Commercial Applications

- RVP/D: Remote Vehicle Personalization/Diagnostics
- SA: Service Announcements
- CMDD: Content, Map or Database Download
- RTVR: Real-Time Video Relay