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
- Road Works
- Urban Traffic
- Freeways/highways/Tolls
- Ring Roads
- Events
- Parking
- Public Transportation
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
  – Lidars
  – 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 through 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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<td>Increase utilization and effectiveness of DMS</td>
<td>• Number of non-default messages displayed per sign per day</td>
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<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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<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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<th>Description</th>
<th>Requirement</th>
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| Incident Management    | Early detection and response to unscheduled events                          | • Incident detection/confirmation  
                          |                                                                      | • Emergency response/motorist assistance  
                          |                                                                      | • Pre-trip and en-route advisory |
| Congestion Management  | Mitigating the impacts of recurring and non-recurring congestion            | • Congestion monitoring  
                          |                                                                      | • Pre-trip and en-route advisory  
                          |                                                                      | • Lane metering  
                          |                                                                      | • Ramp metering |
| Corridor Management    | Balancing level of service among alternate parallel routes within a corridor | • Event and travel time monitoring  
                          |                                                                      | • Pre-trip and en-route advisory |
| Network Management     | Balancing level of service within the network as a function of current conditions | • Event and travel time monitoring  
                          |                                                                      | • Pre-trip and en-route advisory |
| Travel Demand Management | Improving traffic flow by managing travel demand                             | • Congestion pricing  
                          |                                                                      | • Ramp metering |


Example: Traffic Status
Example: Map-Matching
Example: Map-Matching
Traffic management capability
Traffic information capability
Results of merging (single platform)
Integrated Traffic Management & Traffic Information Services

Data Collection from different sources
- Floating Car Data
- Loops

Data Preprocessing
- Intelligent processing of traffic data
- Real time traffic status

Traffic Forecast
- Generating services: Broadcasting information to various receivers
- Customer relation management

Data fusion

Traffic Management System
(e.g. Siemens CONCERT)

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

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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
VANET
A modern vehicle is a computer on wheels

- 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
Self-Driving Cars

Sensors (Camera, Lidar, Radar, GPS, IMU, etc)

Self Localisation

Motion Control

Perception

Route Position Decision

Global Planner

Obstacle Detection

Local Planner

Collision Avoidance
Safety applications

SVA (Stopped or Slow Vehicle Advisor)
Safety Applications

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