INTELLIGENT TRANSPORTATION SYSTEMS:

LECTURE 2: ADVANCED TRAFFIC MANAGEMENT SYSTEMS

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ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)

DEFINITION 2.1:
Advanced Traffic Management Systems are responsible for streaming real-time transport data from the entire traffic infrastructures into one Transport Management Centre (TMC). The TMC is where all the data is processed in order to take intelligent measures for handling traffic jams, increasing mobility efficiency, maintaining and improving safety.

WHY:
ATMS helps in:
- Monitor
- Control
- Optimize
- Operate

ATMS are the eyes of Transport Management Centres which acts like a control room for mobility in smart cities.
## ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)

### FUNCTIONS 2.1: ATMS operational roles:
- Real-time traffic monitoring
- Video analytics
- Active traffic management

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<th>Real time traffic monitoring</th>
<th>Video analytics</th>
<th>Active traffic management</th>
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<td>Live public transport updates</td>
<td>Traffic congestions detection</td>
<td>Variable Message Sign</td>
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<td>Re-routing</td>
<td>Incident detection</td>
<td>Traffic lights</td>
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<td>Transparency</td>
<td>Counting vehicles and pedestrians</td>
<td>Road weather information</td>
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<td>Emergency responses</td>
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<td>Safety and control</td>
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DEFINITION 2.2: Traffic Information

Traffic information is information collected about road traffic or air traffic services unit that is used to have an understanding of traffic situation based on observation of the data. This known information is used to manage the traffic or avoid incidents.
ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)

- Automatic
  - Point Detector
  - Interval Detector
- Traffic Information
- Manual
  - Survey
  - Manual Counting
ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)

- Automatic
  - Point Detector
  - Interval Detector
- Manual
  - Survey
  - Manual Counting

Manual Counting:
- Tally Sheets
- Mechanical Counting Boards
- Electronic Counting Boards

Mechanical Counting Boards

Electronic Counting Boards

Tally Sheet
Survey:
- Household survey
  - Reliable
  - Not feasible in a large scale study
- OD-Matrix survey
- Roadside interviews
- Etc
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Point detector
- Fixed
- Costly maintenance
- Replaced by
  - Video CCTV

Source: Smartmicro
ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)

Interval detectors
- Inductive loops
- Floating cars or probe vehicles
  - GPS-based
  - Cellular-based
- Automated vehicle identification
ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)

- Automatic
  - Point Detector
  - Interval Detector
  - Automated Vehicle Identification
  - Floating Car Data
    - Cellular
    - GPS
- Manual
  - Survey
  - Manual Counting
DEFINITION 2.3: Traffic assignment

The traffic assignment problems is about determining the traffic flows per road segments or links go a given road network.

PROCEDURE:

The main procedures are as follows:

- Estimating the traffic volume in network links
- Estimating the cost of the trip between the zones
- Determining the trip pattern and detecting traffic jams
ADVANCED TRAFFIC MANAGEMENT SYSTEMS
(ATMS)

TECHNIQUES:

• Network loading model
  Network loading model or traffic flow component allows us to explain how the traffic is distributed within our road network. The performance is usually measured using travel time.

• Trip matrix (Origin-Destination Matrix)
  OD-matrix is about any movement for performing a task that started from a specific origin to a specific destination.
  - Static ODM
  - Dynamic ODM

• Travel choice principle
  Travel choice principle is about pointing out how the travellers choose their routes, departure time, mode of transportation and destination.
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EXAMPLES & APPLICATIONS

Source: housys
INFO:

ATMS are based on real time systems therefore the most common architecture pattern used in designing distributed aspect of ATMS is based on Master-slave architecture for guaranteeing interaction response times and in some cases you will find also Multi-tier client server architecture is adopted due to high volume of transactions to be processed by the server.
DEFINITION 2.4: Master-slave architecture

Master-slave architecture is a model usually used for real time systems of asymmetric communication or control. This means that the system might have a separate processors associated with data collections, data processing and computation, and actuator management.

- "Master" is in charge of computation, coordination, communication and slave processes.
- "Slave" processes are focused on special actions like data acquisition from multiple sensors.
EXAMPLE 2.1: IRIS
Intelligent Roadway Information System (IRIS) is an open source ATMS developed by Minnesota Department of Transportation. It is an integrated platform designated for transport agencies to perform traffic management, control and monitoring.

REMARK 2.1:
The IRIS software is developed in java and it has an intuitive map based interface for operation management.

Source: https://mnit-rtmc.github.io/iris/installation.html
EXAMPLE 2.1: IRIS- Architecture

- **IRIS Clients**
- **Apache Server**
- **IRIS Server**
- **Database** (PostgreSQL)
- **Honeybee**
- **Authentication Server** (Optional)
- **Traffic Monitoring and Control Devices**
- **LDAP**
- **Client Jar Map Tiles**
- **JSON Files**
EXAMPLE 2.2: Traffic light Control Systems
Traffic light control systems are used to monitor and control the flow of traffic in intersection or junctions. Nowadays, the systems are even capable of estimating the traffic density and reporting incidents.

BRIEF HISTORY:
1722 London Bridge - traffic police
1868 First non-electric gas-lit traffic light
1912 Electric traffic light was developed
1914 Electric traffic was in use

Source: http://www.kbrhorse.net/signals/history01.html
TERMINOLOGY 2.1: **Green time**
The green time is the time period in which the traffic signal has the green indication.

TERMINOLOGY 2.2: **Cycle or cycle length**
The cycle is the total time for the signal to complete one sequence of signal indicator.

TERMINOLOGY 2.3: **Phase**
Phase or signal phase is a set of intervals in which a designated movement is allowed to flow and to halt safety. There are three intervals in each phase: green, yellow, red.
EXAMPLE 2.2: Traffic light Control Systems

Adopted network:
Junction of two roads with four lines each. Each line has two sensors that help in having more accuracy in handling the junctions by the controller.
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DEFINITION 2.5: Hierarchical TLC Architecture [*]

Sensors are structured in following two groups or layers:
- Before light (BL)
- After light (AL)

Master node is in charge of decision-making and data aggregation.

WHY:

Advantages:
- Easing data aggregation
- Saving energy and bandwidth

ADVANCED TRAFFIC MANAGEMENT SYSTEMS (TLCS)

CONFLICT MATRIX

Matrix I

Matrix II
ADVANCED TRAFFIC MANAGEMENT SYSTEMS
(TLCS)

- **CONFlict MATRIX**
- **Vehicle Counts**
- **Aggregation Process**
- **Evaluation**
- **Listing**
- **Selection**
- **Strategy Execution**
- **Info propagation**

**Process Stages:**
- **Before Light**
- **After Light**

**Components:**
- **Controller**
- **Sensors**
- **External Network**

**Layers:**
- Master node - decision and final computation (Layer 4)
- Intermediate computation (Layer 3)
- Departure detection (Layer 2)
- Arrivals detection (Layer 1)
THANK YOU FOR YOUR ATTENTION

— Intelligent Transportation Systems - MTAT.08.040 - Lecture 1