ADVANCED TRAFFIC SIGNAL CONTROL SYSTEM IN INDIAN CITIES

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Traffic Signal Controllers in India

• **Most of them are Pre-timed**
  – Simple and inexpensive
  – Signal timings derived from the statistical data
  – Duration and order of all green phases are fixed
  – Cannot respond to real-time demand

• **Few Vehicle Actuated Signal Controllers**
  – Signal timings based on real-time traffic demand

• **Very few Adaptive Traffic Control Systems**
  – Real-time signal control applied to a network of traffic junctions
Pre-timed Traffic Signal Controller
(Isolated / Coordinated)

No real-life Interaction

Traffic Situation
Pre-timed Control
Active Signal State

Thursday 10

Sign Program 1
Sign Program 2
Sign Program 3
Sign Program n
Coordinated Signal Control

- A technique to reduce stopped delay and improve travel time
- Provides progressive green signal at consecutive intersections when travelled at specified speed
Myth about Signal Coordination

• Any type of junctions can be coordinated ....
  – Junctions of similar characteristics only can be coordinated (e.g. junctions requiring more or less same cycle lengths)

• All vehicles in the platoon get green signal at all consecutive junctions ....
  – Signal coordination can be assumed for 70-80% vehicles in the platoon

• The signals can be coordinated in all direction ....
  – Generally the direction of maximum flow only is coordinated
Vehicle Actuated Traffic Signal Controller
(Isolated / Coordinated)

Traffic Situation → VA Control → Active Signal State

Traffic Data
- Volume Count
- Average Detector Occupancy
- Speed
- Average Vehicle length
- etc.

VA Strategy
- Analytical
- or
- Heuristics

Traffic Signal System
Vehicle Detection

• Inductive Loop
• Camera
• Microwave Radar
• Thermal Camera
• Piezoelectric
• Magnetic
• ----
Advanced Traffic Signal Control System

• Provides real-time signal coordination for a group of traffic signals based on real-time traffic demand
  – Phase timings, Cycle lengths
  – Signal coordination route

• Operates in two levels
  – Local level: Traffic Signal Controller and other field equipment
  – Central level: ATCS application software running on a computer
  – Both levels are networked on a robust communication backbone

• Generates decision support reports and logs

• Supports remote Monitoring and Administration
Traffic Responsive Signal Controller
(Traffic Network – Real time signal coordination)

- Appropriate signal plan selected from a library of coordinated signal plans based on the real-time traffic demand
Adaptive Signal Controller
(Traffic Network – Real time signal coordination)

- Appropriate signal plan generated based on the real-time traffic demand
## Operational Categorization of ATCS

<table>
<thead>
<tr>
<th>ATCS</th>
<th>Detection</th>
<th>Action</th>
<th>Time Frame</th>
<th>Model</th>
<th>Timings</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS Lite</td>
<td>SL, MB, US</td>
<td>P &amp; R</td>
<td>5-10 Mins</td>
<td>No</td>
<td>S.O</td>
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<tr>
<td>Balance</td>
<td>NSL</td>
<td>P &amp; R</td>
<td>5 Mins</td>
<td>Yes</td>
<td>S.Cl.O.PS</td>
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<tr>
<td>InSync</td>
<td>NSL</td>
<td>P &amp; R</td>
<td>Phase / Cycle / 15 Mins</td>
<td>Yes</td>
<td>S.Cl.O.PS</td>
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<tr>
<td>LA ATCS</td>
<td>SL, US</td>
<td>P &amp; R</td>
<td>Cycle</td>
<td>Yes</td>
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<tr>
<td>MOTION</td>
<td>NSL</td>
<td>P &amp; R</td>
<td>5-15 Mins</td>
<td>Yes</td>
<td>S.Cl.O.PS</td>
</tr>
<tr>
<td>OPAC</td>
<td>MB, SL</td>
<td>P</td>
<td>Phase / Cycle / 5 Mins</td>
<td>Yes</td>
<td>S.Cl.O</td>
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<tr>
<td>RHODES</td>
<td>MB, SL</td>
<td>P</td>
<td>Sec-by-Sec</td>
<td>Yes</td>
<td>S</td>
</tr>
<tr>
<td>SCATS</td>
<td>SL, NSL, MB</td>
<td>R</td>
<td>Cycle</td>
<td>No</td>
<td>S.Cl.O</td>
</tr>
<tr>
<td>SCOOT</td>
<td>US, SL</td>
<td>P &amp; R</td>
<td>Cycle / 5 Mins</td>
<td>Yes</td>
<td>S.Cl.O.PS</td>
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<tr>
<td>UTOPIA</td>
<td>US, SL</td>
<td>P</td>
<td>3Sec / 5 Mins</td>
<td>Yes</td>
<td>S.PS</td>
</tr>
<tr>
<td>CoSiCoSt</td>
<td>SL, NSL</td>
<td>R</td>
<td>Cycle</td>
<td>No</td>
<td>S.Cl.O</td>
</tr>
</tbody>
</table>
• **Model based**
  - Use macroscopic, mesoscopic, or microscopic models to estimate the current state of traffic
  - The estimated value is further used as an input to adjust signal timings
  - Most of the currently operational ATCS are Model based

• **Non-model based**
  - Based on functional relationship between parameters that describe change of traffic conditions
  - Use feedback of the traffic measured during the previous interval
Myth about ATCS

• ATCS Solves all urban traffic problems......
  – In reality it helps in improving the traffic conditions
  • Increased lane carrying capacity and travel speeds
  • Reduction in delay, stops, queue, fuel consumption, emissions and drop in accident rate
  • Better Traffic Management - Green Wave Routes, Diversions, Incidents Detection
Myth about ATCS

• **All ATCS Optimizes all timing parameters**……
  
  – The reality is that some of them perform some kind of optimization, which is usually constrained by its domain or time allowed to conduct the optimization process
  
  – Some of these optimizations use heuristic techniques, whereas others use extensive search techniques, to find solutions
  
  – Others do not formally optimize (no search process and no objective function); instead, they adjust signal timings by using some heuristic methods and common traffic engineering concepts.
ATCS Philosophy

• An area is divided into corridors of closely spaced traffic junctions having similar flow characteristics and, synchronize them independently based on real-time demand

• Signal Coordination is achieved by
  – **Phase Sequencing:** Not used widely because of the negative impacts due to frequent transitions. Not permitted in many countries
  – **Common Cycle time method:** Consider Cycle length, Phase length and Offset as the fundamental parameters for signal synchronization
Advanced Traffic Signal Control Systems in India

- Delhi – SCOOT
- Mumbai – ITACA
- Jaipur – CoSiCoSt

- Model based
- Proactive and Reactive
- Non-model based
- Reactive
How Adaptive are the Adaptive Traffic Control Systems on our Road...

• The analytical models are constrained by inadequate input data
  – Low level of lane discipline
  – High mix of traffic
  – Higher percentage of two wheeler population
  – Poor junction geometry

• And we are constrained by
  – Lack of expertise
  – Power and Network connectivity interruptions
Non-lane based driving

• Deriving the critical parameters in real-time for vehicle actuated signal control is highly complex
  – volume counts, turning proportion, headways and gaps
Mixed Traffic Flow Conditions

- Data collection is more complex in mixed traffic flow conditions
Calibration is much more complex
What is required...

- Handle non-lane based mixed traffic flow conditions
- Implementation of Complex Phasing Schemes
- Self-calibrating for Phase lengths and Cycle lengths
- Dynamic Route Selection
- Real-time Signal Coordination
- Fallback operation in Vehicle Actuated mode
- Remote Monitoring and Administration
- Scalable
- Decision Support Reports
- Local Expertise
- Simulator interface
Relevance of the topic

• Adaptive Traffic Signal Control (ATCS) is one of the major components of all Smart City Mission Projects
END OF PRESENTATION

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