Adaptive Traffic Control System

Smart Solution – Smart City
Overview

- **CDAC** is a premier R&D Institution under the Department of Electronics & Information Technology (DeitY), Ministry of Communications & IT, Govt. of India

- **Metro InfraSys** Market Leader in Intelligent Transport System

- C-DAC created world class Traffic solution for Indian Cities

- Metro Acquired ATCS and WI-TRAC Technology from C-DAC

- C-DAC will continue to support Technology
Adaptive Traffic Control System (ATCS)

- ATCS - Traffic Responsive Systems, use real time data from vehicle detectors, optimizes traffic signal timing
- Improves Traffic Flow and reduces congestion
- The system operates in a closed loop, evaluating the real time demand and properly updating network signal timings
- Solution developed and implemented ATCS for road traffic having poor lane discipline and high heterogeneity in various Indian cities
WiTraC – Wi-Fi Enabled Signal Controller

- **State-of-the-art Traffic Signal Controller**
  - Signal Switching done on Wireless
    - No armored cable required for signal lamps
    - No road cutting required for Hume pipes / signal cables
    - Use unlicensed ISM band
  - Operates on Solar Power
    - Optimized for 12VDC Operation
  - Power Saving
    - Power efficient LED signal aspects
    - Brightness control for signal lamps
    - Selective switching of night flash
  - Miniature design
    - Pole mounting
Adaptive Signal Control

Adaptive traffic logics & strategies
- Distribution
- Cycle time
- Coordination
- Zones

Traffic data
- Flow
- Count
- Occupation
- ...

Traffic situation ➔ Adaptive control ➔ Active signal state
Building Blocks of ATCS

- Traffic Signal Controller
- Vehicle Detectors
- Application Software
- Central Control Station
- Communication Network
Different Flavors of ATCS

- **Popular operational models**
  - **SCOOT** – Split Cycle and Offset Optimization Technique
  - **SCATS** – Sydney Coordinated Adaptive Traffic System
  - **OPAC** – Optimization Policies for Adaptive Control
  - **RHODES** – Real-Time Hierarchical Optimized Distributed and Effective System
  - **CoSiCoSt** (Composite Signal Control Strategy)

- **Other systems**
  - **ACS-Lite** (Adaptive Control Software Lite)
  - **SPOT / UTOPIA** (Urban Traffic Optimization by Integrated Automation)
  - **MOTION** (Method for the Optimization of Traffic Signals in On-line controlled Networks)
  - **ITACA** (Intelligent Adaptive Control Area)
  - **RTACL** (Real-time Traffic Adaptive Control Logic)
Traffic Scenario in India

Traffic in developed countries

Traffic in developing countries
ATCS – Popular Models

The SCOOT Model

- Flow
- Stages or Phases
- Demand
- Queues
- Optimizers Split & Offset
- Current SCOOT Timings
- Translation Plan
- Preferences & Observations
- Traffic Engineers
- Weights & Bias
- Cycle Optimizers
- Close possible settings All possible settings
ATCS – Popular Models

Composite Signal Control Strategy (CoSiCoSt)
(Distributed System developed by CDAC)

FIGURE 15 Proposed Distributed System
## CDAC ATCS (CoSiCoSt) Implementations

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of Junctions</th>
<th>Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pune Phase I</td>
<td>38</td>
<td>CDAC</td>
</tr>
<tr>
<td>Jaipur Phase I, II, III</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Pune Phase II</td>
<td>30</td>
<td>KELTRON</td>
</tr>
<tr>
<td>Kolkata</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Ahmedabad</td>
<td>93</td>
<td>Webel</td>
</tr>
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</table>
Benefits of Proposed Solution

- **Increased**
  - lane carrying capacity
  - travel speeds

- **Reduction**
  - delay, stops, queue
  - fuel consumption and emissions
  - drop in accident rate

- **Traffic Management**
  - Green Wave Routes

- **Special events**
  - Diversions
  - Incidents Detection
Result of impact analysis (Pune Phase I)
Conducted by M/s. Consulting Engineering Services India P Ltd., Mumbai

- Average travel speed increase in the range of 2% to 12%
- Reduction in average delay in the range of 11% to 30%
- Estimated annual fuel savings in the year 2006 due to implementation of ATCS is about Rs. 4.77 Crores
- Estimated annual time saving benefits in the year 2006 due to implementation of ATCS is about Rs. 0.83 Crores
- Total annual saving in the year 2006 due to implementation of ATCS on the 6 project corridors is about Rs. 5.60 Crores

Over all Increase in the Traffic Volume is 9.06%
### Comparison with other systems

<table>
<thead>
<tr>
<th>Models</th>
<th>Traffic characteristics in Developing Countries</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCOOT, SCATS, ITACA . . .</td>
<td>High heterogeneity and limited lane discipline</td>
<td>Results in wrong vehicle counts and volume estimation</td>
</tr>
<tr>
<td>Assume limited heterogeneity and lane following</td>
<td>Lane change happens within and after detection zone</td>
<td>Detectors fail to report turning proportions</td>
</tr>
<tr>
<td>Assume no lane change within the detection zone</td>
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</tbody>
</table>

Obtaining reliable data in real-time for computing signal timings in highly heterogeneous traffic having limited lane discipline is a complex task. The mathematical models suffer from calibration issues due to the dynamic nature of PCU and high heterogeneity.
CoSiCoSt has special filters to address issues related to poor lane discipline, side roads, on-street parking and high heterogeneity. The system is self-calibrating and methods to address network failures are inbuilt.
# Comparison – SCOOT, SCATS & CoSiCoSt

<table>
<thead>
<tr>
<th>ATCS</th>
<th>SCOOT</th>
<th>SCATS</th>
<th>CoSiCoSt</th>
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</thead>
<tbody>
<tr>
<td><strong>SCOOT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centralized System</td>
<td>Hierarchical system</td>
<td>Distributed system</td>
<td></td>
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<tr>
<td>Communication overheads</td>
<td>Limited Scalability</td>
<td></td>
<td></td>
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<tr>
<td>Limited Scalability</td>
<td>Stop line detection</td>
<td>High Scalability</td>
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</tr>
<tr>
<td>Upstream detection</td>
<td>For Critical Junction only</td>
<td></td>
<td></td>
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<tr>
<td>At every lane</td>
<td>Good in ideal condition</td>
<td></td>
<td></td>
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<tr>
<td>Poor progression prediction</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fallback - fixed</td>
<td>Fallback - fixed</td>
<td></td>
<td></td>
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<tr>
<td>Model based</td>
<td>Algorithmic</td>
<td></td>
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<tr>
<td>Time generated</td>
<td>Plan selection</td>
<td></td>
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<tr>
<td>Signal time computation</td>
<td>Signal time computation</td>
<td></td>
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<tr>
<td>Classical Method</td>
<td>Classical Method</td>
<td>QAP Method-2</td>
<td></td>
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<tr>
<td>Calibration issues</td>
<td>Calibration issues</td>
<td>Self calibrating</td>
<td></td>
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</table>
Typical Operation of ATCS

- An area sub-divided into zones or corridors
- Corridors operate on common background cycle
- Signal timings and Cycle lengths updated dynamically based on real-time demand
- Signals synchronized for green-wave
- Offset deviation corrected at plan transition
CoSiCoSt Architecture
Wi-Trac – A Typical Intersection

RF Transceiver
Solar Panel

Master
Slave #1
Slave #2
Slave #3

2.4GHz / 868MHz
Wi-Trac Salient Features

- **Vehicle Actuated**
  - Inductive loop detector and above ground detector compatible

- **ATCS Compatible**
  - Compatible to CDAC Composite Signal Control Strategy, CoSiCoSt
    - Developed and tuned to Indian traffic condition of high heterogeneity and poor lane discipline
    - Indian Patent 239258

- **GPS Enabled**
Wi-Trac Other Features

- **Cable-less Synchronization**
  - Pre-timed
  - Vehicle Actuated

- **Remote Administration**
  - Hurry Call
  - Forced Flash
  - Junction Off
  - Plan Download

- **Wireless Police Panel**
Wi-Trac Safety Features

- Self diagnosis on Power up and runtime
- Green-Green Conflict Monitoring
- Lamp failure / Short Circuit / Open load Monitoring
- Battery Voltage Monitoring (Solar Power)
- Fallback on secondary frequency in case of wireless signal jam
- Automatic selection of Flashing program on error conditions
- Error logs sent to traffic monitoring centre, when networked
Strengths of Proposed Solution

- Designed to cater highly heterogeneous
- Built on Vehicle Actuated Platform
- Self Calibrating
- High Scalability
- Availability of Local Expertise
- Possible to network on different media, including 3G
- IPR belongs to Govt. of India
Q & A

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