Innovation for better mobility

PRESENTATION FOR THE
Adaptive Traffic Control
OCTEC Meeting
June 21, 2012
Traditional Signal Timing

PEAK 15 Min
Variability Is Normal; And the Problem

PM Peak Period Demand

Demand (VPH)

Time

3:00-3:15, 3:15-3:30, 3:30-3:45, 3:45-4:00, 4:00-4:15, 4:15-4:30, 4:30-4:45, 4:45-5:00, 5:00-5:15, 6:15-5:30, 5:30-5:45, 5:45-6:00, 6:00-6:15, 6:15-6:30, 6:30-6:45, 6:45-7:00

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Benefits

Variability in Demand over time

Do Nothing

Periodic Retiming

Constant Monitoring & Fine Tuning (Adaptive)

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Source: City of Alpharetta
What Do Motorists Want?

- “Why do I have to wait when there’s nobody else moving”
  - Translation: Equitable distribution of green time

- “Can’t I just drive down the street without stopping?”
  - Translation: Progression—driving through successive greens
Adaptive Benefits

- Improves arterial performance
  - Maintains the effectiveness of traffic signal timing
  - Adapts to seasonal fluctuations in traffic
  - Accommodates changes in traffic patterns
- Delivers better service to road users
  - Provides Progression
  - Reduce Delay
- Traffic incident reaction
Incident Traffic Congestion
How Does Adaptive Work?

Adaptive Traffic Signal Control System

- Raw Data
- Measurements: Detectors
- Actuators: Signals

Feedback & Decisions
Will Adaptive Work Anywhere?

- Not recommended
  - CBD – Closely spaced blocks in a grid layout
  - During major detour
- Most corridors can benefit from adaptive
  - Excessive congestion on main arterial due to traffic surges
  - Excessive delay on crossings due to high cycle length
  - Near major traffic generators with unpredictable traffic
- Depends on the system
Before Selecting Adaptive

- Diagnose the traffic problem.
- Can signal timing enhancements fix the problem?
- Is there support for long-term operation & maintenance?
- Who will operate the system?
- Define functional requirements
  - Make sure verifiable
- Match traffic needs and goals with available traffic systems
- Don’t start selection process from the hardware or aesthetics
Model Systems Engineering Documents for Adaptive Signal Control Technology (ASCT) Systems

Draft Guidance Document

August 2011

U.S. Department of Transportation
Federal Highway Administration

FHWA-HOP-11-027
Adaptive Gone Wrong
Washington DC - Adaptive

- Corridor Selection
  - 6 corridors evaluated
  - Selected 3 for pilot project
- Identified corridor limits
- Evaluated 16 Adaptive Systems
- Identified 4 systems for detailed review
## Important Considerations

### Agency Resources
- Operational Objectives and Philosophy
- Operations and Maintenance
- **Staff skills and abilities**
- Funding Sources

### Site Suitability
- Arterial v. grid
- Emerging congestion
- Traditional objectives unattainable
- Traditional methods failed

### System Cost
- Capital Cost
- Operations
- Maintenance
- Staff Training

### Existing Infrastructure
- Closed loop vs Centrally managed
- Communications
- Sensor hardware
- Overall system reliability
# Selecting Adaptive Systems

<table>
<thead>
<tr>
<th>Categorization</th>
<th>Function/Capability/Software/Hardware</th>
<th>ACS-Lite</th>
<th>Naztec Streetwise (ATMS)</th>
<th>McCain QuicTrac™</th>
<th>SYNCHRO Green</th>
<th>BALANCE</th>
<th>INSYNC</th>
<th>LA ATCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector Type</td>
<td>Required</td>
<td>Stop-line (SL), Mid-block (MB) / Upstream (US)</td>
<td>Stop-line (SL), Upstream (US)</td>
<td>Mid-block (MB) &amp; Stop-line (SL)</td>
<td>Stop-line (SL) &amp; Advanced Detection (200-500 ft upstream of stop bar)</td>
<td>Near-stop-line (NSL)</td>
<td>Stop-line (SL), Near-stop-line (NLS)</td>
<td>Advanced Detection (200-400 ft upstream of stop bar)</td>
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<tr>
<td>Optional</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Adjustment</td>
<td></td>
<td>Time-constrained optimization</td>
<td>Rule-based adjustment</td>
<td>Domain-constrained optimization</td>
<td>Rule-based adjustment</td>
<td>Time-constrained optimization</td>
<td>Rule-based adjustment, Time-constrained optimization</td>
<td>Data-based adjustment, Domain-constrained optimization</td>
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<tr>
<td>Time-Frame</td>
<td></td>
<td>5-15 sec</td>
<td>Cycle</td>
<td>Cycle</td>
<td>Cycle</td>
<td>Cycle</td>
<td>Cycle</td>
<td></td>
</tr>
<tr>
<td>Level</td>
<td></td>
<td>Local &amp; Central</td>
<td>Local &amp; Central</td>
<td>Local &amp; Central</td>
<td>Local &amp; Central</td>
<td>Global &amp; Local</td>
<td>Local &amp; Central</td>
<td></td>
</tr>
<tr>
<td>Flex Region</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Vehicle Actuated</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Mode Support (ATS)</td>
<td></td>
<td>Not Available</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Interfaces</td>
<td></td>
<td>CORSIM</td>
<td>No</td>
<td>No</td>
<td>SimTraffic</td>
<td>NONSTDP Vissim</td>
<td>Vissim, Inspc Sim</td>
<td>CORSIM/Offline post-processing interface</td>
</tr>
<tr>
<td>Communication Architecture</td>
<td></td>
<td>Centralized &amp; Distributed</td>
<td>Centralized</td>
<td>Hierarchical</td>
<td>Centralized</td>
<td>Centralized</td>
<td>Fully Distributed - Decentralized</td>
<td>Centralized</td>
</tr>
<tr>
<td>No. of Installations</td>
<td></td>
<td>15</td>
<td>&lt;10</td>
<td>2</td>
<td>1</td>
<td>Not available</td>
<td>47</td>
<td>3</td>
</tr>
<tr>
<td>No. of Intersections operating with adaptive</td>
<td></td>
<td>100</td>
<td>Not Available</td>
<td>80</td>
<td>12</td>
<td>Not available</td>
<td>200</td>
<td>&gt;200</td>
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<tr>
<td>Vendor estimated Cost per Intersection</td>
<td></td>
<td>≤ $ 10,000</td>
<td>≤ $ 10,000</td>
<td>≤ $ 10,000</td>
<td>≤ $ 25,000</td>
<td>Not available</td>
<td>≤ $ 25,000</td>
<td>≤ $ 15,000</td>
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<tr>
<td>Minimum Cost (12 Intersections, including control &amp; Comm, up-front installation)</td>
<td></td>
<td>$168,000</td>
<td>Not Available</td>
<td>With existing QuicNet in DC, actual cost is ≤ $168,000</td>
<td>$168,000</td>
<td>Not available</td>
<td>$175,000</td>
<td>$115,000</td>
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**Innovation for better mobility**
Douglas Park – Adaptive Project
Douglas Park - SE Process

- Implement one single adaptive traffic control system
- Provide for data exchange amongst agencies/operators to enhance coordination
- Adapt to traffic signal operations & congestion by all jurisdictions
- Be able to relinquish control if so desired
- Enable multi-jurisdictional coordinated response to incidents & special events
- Compatible with Long Beach transit systems
  - Light Rail Train Operations
  - Transit Priority Systems
- Event Management
Adaptive Traffic Control System (ATCS)

- Developed by Traffic Operation Engineers for Traffic Operation Engineers - LADOT
- Windows based “Real-Time” traffic control
- Central system control
- Fully functional traffic system
- Flexible operation
  - Local controller operation
  - On-Line: Time-of-day
  - On-Line: Adaptive
  - Works with 170 and 2070 controllers
ATCS – System Operation

Adaptive Demand Algorithms

ATCS allows for various algorithms to be implemented by the user based upon traffic conditions:

1. Cyclical Volume and Occupancy Algorithm
   Used in typical urban and sub-urban areas

2. Free Flow Speed Algorithm
   Used in locations with under-saturated, free flowing traffic

3. Cyclic Volume and Occupancy with Occupancy Multiplier Algorithm
   Used in typical urban, congested conditions. Allows for more rapid changes to be made in calculations (e.g. airport, schools)

4. Cyclic Volume and Occupancy with Signal Data Algorithm
   Used in urban and suburban areas with good system detection and similar vehicle types (e.g. truck)

5. Free Flow Speed Algorithm with NCHRP 3-79 adjustment
   Used in locations with under-saturated, free-flowing traffic with high speeds
ATCS Data Distribution

ATCS and ITS Field Elements

Remote Communications Hub

Long Beach Workstation

Long Beach TMC

ATCS Central Elements

VPN link over Internet

LA County Workstation

Bellflower Workstation

Signal Hill Workstation

Lakewood Workstation

Caltrans District 7 Workstation

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Traffic System Map
Cycle Length History Display
ATCS – System Operation

- **Adaptive Feature**
  - New cycles are locked in for minimum 3 cycles, avoid excessive transitions
  - Past cyclical demands used to predict cycle length

PST 0 DMD = Projected Demand 0 (for current cycle)
PST 1 DMD = Past Demand 1 (for one cycle in past)
PST 3 DMD = Past Demand 3 (for three cycles in past)
SD = Slope Devisor
DMD SLP = Demand Slope
PRED = Predicted Cycle = PST0 + DMD_SLP
Critical Arterial Control (CAC)
- Adjusts offsets of all intersections within a defined section based on traffic demand and speed of a critical arterial by providing either one-way or two-way progression

Progression
1. Select highest combined demand of an arterial in the network
2. Adjust its offsets based on direction of traffic flow
3. Repeat Step 2 process for all crossing streets using intersections on critical arterial as an anchor

Note: Green arrows indicate system selected traffic flow direction
Adaptive Operation - Progression
ATCS – Adaptive Evaluation Studies

- **Century City ATCS Evaluation Report (2005):**
  - Floating Car Method, Comparing ATSAC(UTCS) timing with ATCS timing

<table>
<thead>
<tr>
<th>Category</th>
<th>AM Peak</th>
<th>PM Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intersection V/C Improvement</td>
<td>1.9%</td>
<td>3.3%</td>
</tr>
<tr>
<td>V/C Improvement (most congested approaches)</td>
<td>5.2%</td>
<td>8.8%</td>
</tr>
<tr>
<td>Net Travel Time Savings</td>
<td>2%</td>
<td>8%</td>
</tr>
<tr>
<td>Stop Delay Reduction</td>
<td>4%</td>
<td>18%</td>
</tr>
<tr>
<td>Net Vehicle Hours Saved</td>
<td></td>
<td>354 hrs/day</td>
</tr>
</tbody>
</table>

- **Sunset Boulevard (near the 405 Freeway) ATCS Evaluation Report**
  - Floating Car Method

  Average Travel Time Reduction: 21%

- **Arterial Travel Speed Performance Study – Sponsored by SCAG & Conducted By Dowling Associates, Inc. (2010)**
  - Study to compare the NCHRP 3-79, Measuring the Performance of Automobile Traffic on Urban Streets, with ATCS speed calculation and concluded:
    - ATCS accurate speed calculation;
    - Result: supplement signal delay input into ATCS Demand Algorithms
Transit Priority Integration
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Light Rail Train Operation Integration

METRO BLUE LINE PREDICTOR STATUS

12TH  PICO  VENICE  18TH  FLOWER  HOPE

GRAND  OLIVE  HILL  BROADWAY  MAIN  LOS ANGELES

MAPLE  TRINITY  SAN PEDRO  PED XINGS  GRANT

CENTRAL  NAOMI  HOOPER  LONG BEACH
Heavy Rail Crossing Integration
Results
Questions

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