Outline

• ACS-Lite Overview
• Efficient NTCIP MIB Objects
• Measures of split performance
• Measures of progression performance
Goals for ACS-Lite

• Low cost design
• Leverage existing infrastructure
  • Standard actuated controllers
  • Standard (fully-)actuated detector layouts
  • Typical communications
• Integrate with major signal system vendors
• Use NTCIP standards
Project Team

ACS Lite
TRB SigSys Committee Performance Measures Workshop
Washington, DC  Jan 2006

U.S. Department of Transportation
Federal Highway Administration
FHWA Contract No.DTFH61-02-C-00047

Slide 4
System Architecture Options

• ACS Lite as the master
  – Eagle, PEEK

• ACS Lite to vendor master
  – McCain

• ACS Lite in parallel to master
  – Econolite
ACS-Lite Detection Layout

Need detectors at stop-bar of coordinated phases

Phase Utilization Detectors

Flow Profile Detectors
ACS-Lite NTCIP firmware upgrade

1. Phase Timing Status Object
2. Detector Status Object
3. Configuration objects

- Polled once per minute
  - With second-by-second accuracy
- “Stitched” together for cycle-by-cycle performance assessment
ACS-Lite performance measures philosophy

• Data-driven parameter tuning
• Limited/no traffic modeling
• Recent past predicts the near future

1. Splits
   – Phase Utilization

2. Offsets
   – Capture Efficiency
KEY: Cycle-by-cycle Data

Phase Timing

Occupancy (Volume)
ACSLite Performance measures

Phase Utilization

- Ø2: 26 ← 80 → 107, -54 ← Δ → +27 (85.0%)
- Ø1: 11 ← 12 → 92, -1 ← Δ → +80 (90.6%)
- Ø3: 11 ← 23 → 92, -12 ← Δ → +69 (84.3%)
- Ø4: 11 ← 25 → 92, -14 ← Δ → +67 (90.5%)
- Ø5: 11 ← 30 → 92, -19 ← Δ → +62 (85.6%)
- Ø6: 26 ← 62 → 107, -36 ← Δ → +45 (85.7%)

no phases
Occupancy per interval $\rightarrow$ split tuning

Phase 2

Unoccupied

Average Occupancy

29s

4s

57s
Green occupancy $\rightarrow$ Phase Utilization

- **Average Available Green (AAG)**
  - Green used + time to min \{force-off point, phase max\}

- **Average Used Green (AUG)**
  - Occupied green + “fill in the unusable gaps” time

- Phase Utilization = AUG/AAG

- Average Phase Utilization over last few cycles $\rightarrow$ tune split times
Green occupancy → Phase Utilization

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Cyclic occupancy → Progression Efficiency

move offset so green corresponds with traffic earlier in cycle

“Not Captured”

“Captured”
Statistical flow profiles → Progression Performance

- Performance measure for offsets → “capture efficiency”
- Inbound and outbound considered at each signal to tune the offset value

| Shifting the controller 2 offset by +T(-T) seconds shifts the start downstream green phases by T(-T) seconds |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 |
| Inbound | | | | | | | | | | | | | | |
| Outbound | | | | | | | | | | | | | | |

Shifting the controller 2 offset by +T(-T) seconds shifts the outbound platoon arrival to downstream green phases.
Further application of the measures

• Capture efficiency → link travel times
• Utilization + capture efficiency → Delay
• Delay → Level Of Service
Further application of the measures

- Near-real-time/off-line HCM delay estimation

\[ d = d_1(PF) + d_2 + d_3 \]

\[ d_1 = \frac{0.5C(1 - \frac{g}{C})^2}{1 - \left[ \min(t, X) \frac{g}{C} \right]} \]

\[ d_2 = 900T \left[ (X - 1) + \sqrt{(X - 1)^2 + \frac{8k1X}{cT}} \right] \]

- Progression Factor (PF)
- V/C ratio (X)
- Effective green time (g)
- Controller type factor (k)
- Filtering factor (I)
Summary

• ACS Lite works (!)
  – Houston, TX & Columbus, OH
  – Bradenton, FL & El Cajon, CA (coming soon)

• Surrogate measures for delay/stops based on occupancy
  – Overcomes the un-reliability of volume estimation

• Measures usable off-line for analysis

• Uses NTCIP and low cost of deployment