City of Surrey

Adaptive Signal Control Pilot Project

ITS Canada
Annual Conference and General Meeting
May 29th, 2013

ASCT Pilot Project Background

CITY OF SURREY
the future lives here.

Delcan

ASCT Pilot Project Background

- 25 Major Traffic Corridors across City
- Program to Update 4 - 8 Corridors each Year
  - Timing Plans therefore Typically Updated only Once every Five Years
- With the Continued Rapid Growth of City, Pre-determined Timing Plans expected to Age Very Quickly
  - Looking for new Safe and Cost-effective Approaches that will enable Staff to keep up with Rapid Traffic Growth in City and more Efficiently Manage Traffic Demand

Delcan

ASCT Pilot Project Background

- Transport Canada Supports ITS Deployment
  - Strategic Highway Infrastructure Program (SHIP)
  - Projects comply with ITS Plan for Canada: En Route to Intelligent Mobility
- City of Surrey applied for, and successfully secured, funding for ASCT Pilot Project
- Surrey and Delcan agreed to Implement and Evaluate ASCT Pilot Project
  - Delcan's "Multi-criteria Adaptive Control" System

Delcan

ASCT Pilot Project Network

- 72nd Avenue
  - 7 Intersections
  - Between 120th St and King George Highway

Delcan

ASCT Pilot Project Partners

CITY OF SURREY
the future lives here.

Delcan
TRANSPORTATION • INFORMATION TECHNOLOGY • WATER

ICBC

Transports Canada

Transport Canada

Delcan

Current Traffic Signal Infrastructure

- McCain's "QuicNet" Traffic Signal Management System
- Type 170 Traffic Signal Controllers
  - With "BiTrans" 233 Firmware
- Tree Topology Communications Network
  - Leased Line from Control Centre to "Master" Intersection in Field
  - Both Point-to-point and Multi-point Spread Spectrum Radio Links from "Master" to Local Controllers

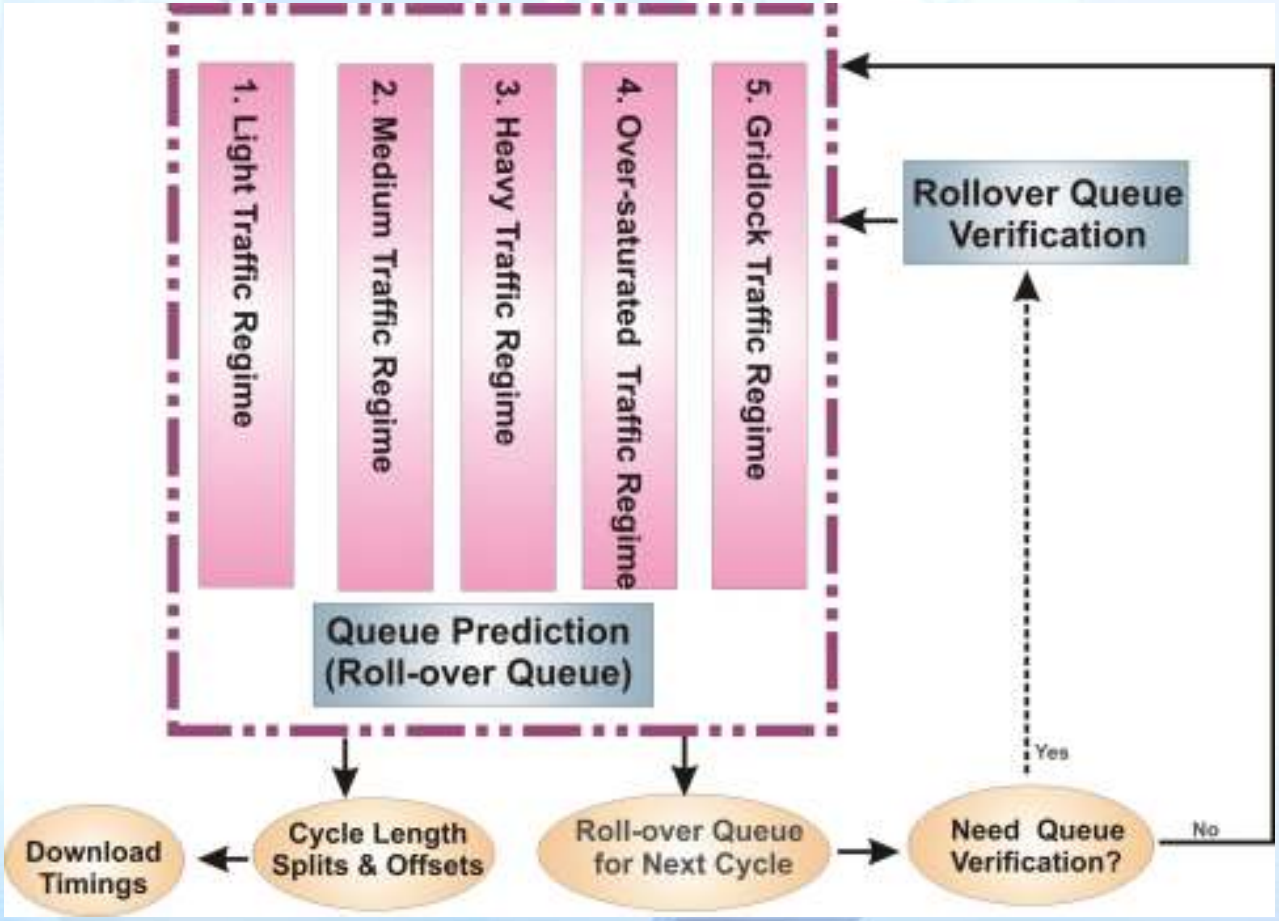
Delcan

ASCT Pilot Project Objectives

- Integrate with City's Existing Traffic Signal Management Infrastructure including:
  - "QuicNet" Traffic Signal Management System;
  - Type 170 Traffic Signal Controllers
  - Wireless Communications Network
- ASCT to Appropriately Respond SAFELY to Random Fluctuations in Traffic Patterns as well as to Unplanned Incidents and Events
- ASCT to Perform as well as Best Optimized Pre-determined Timing Plans

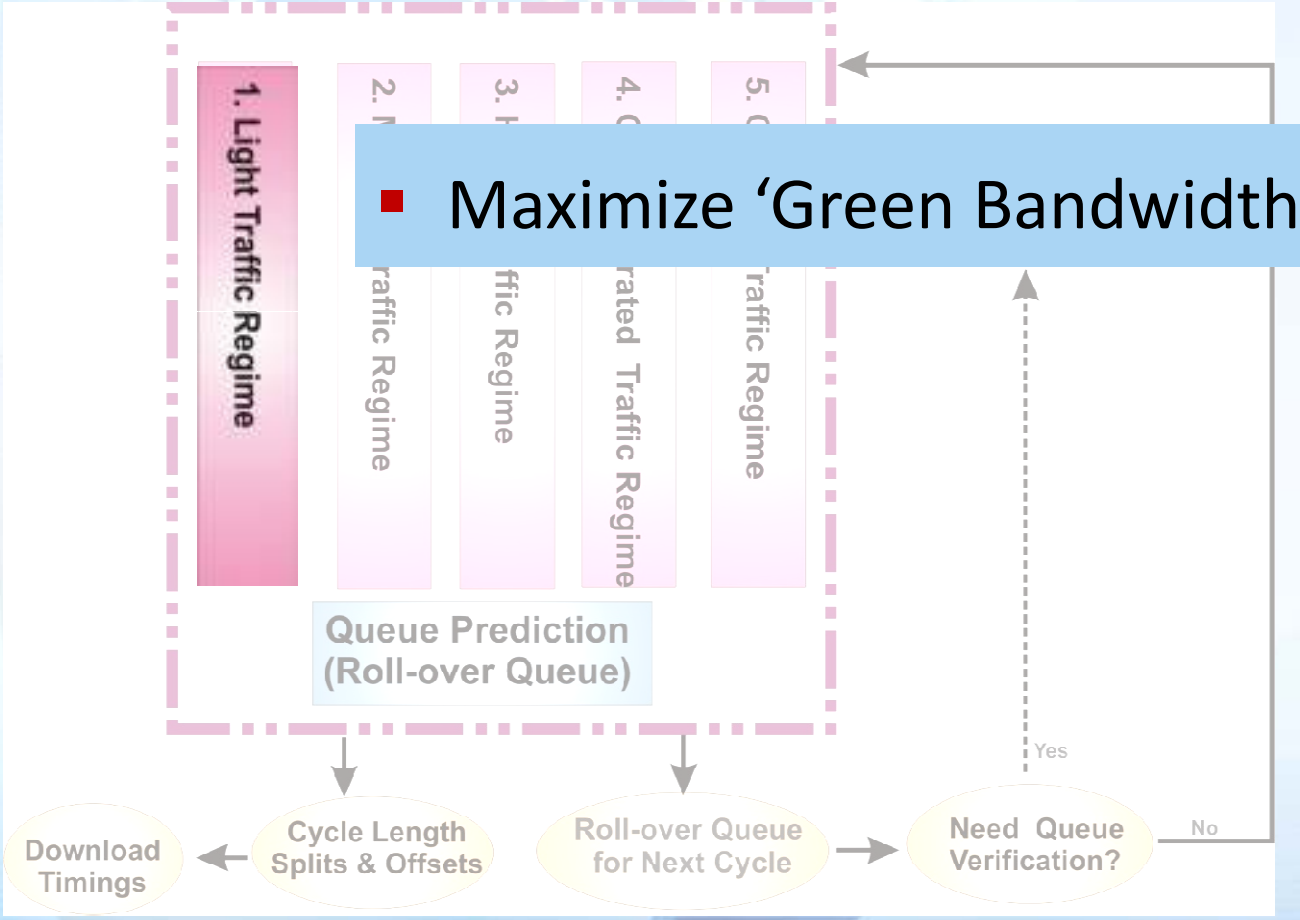
Delcan

Delcan Multi-Criteria Adaptive Control Algorithms



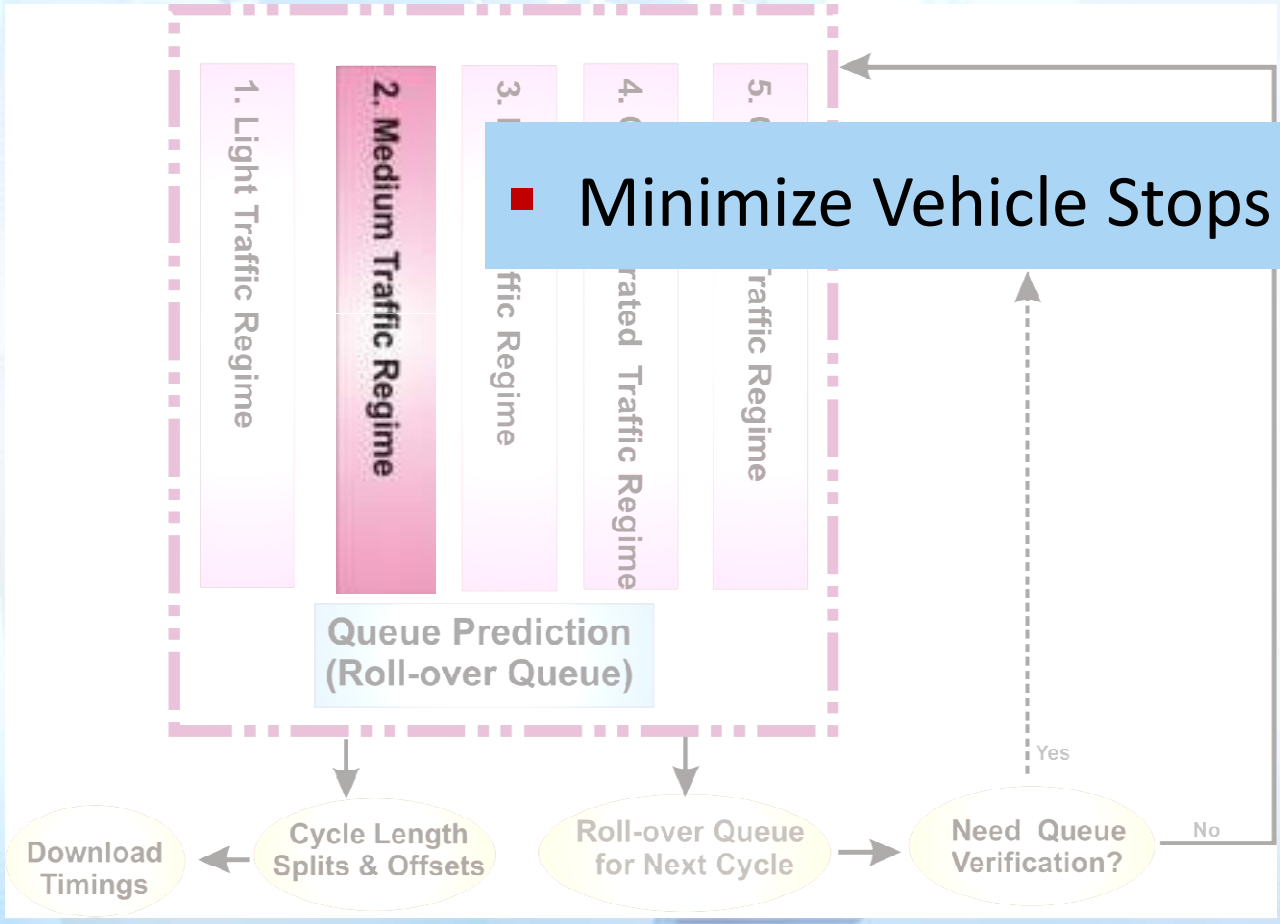
Delcan Multi-Criteria Adaptive Control Algorithms

- Maximize ‘Green Bandwidth’

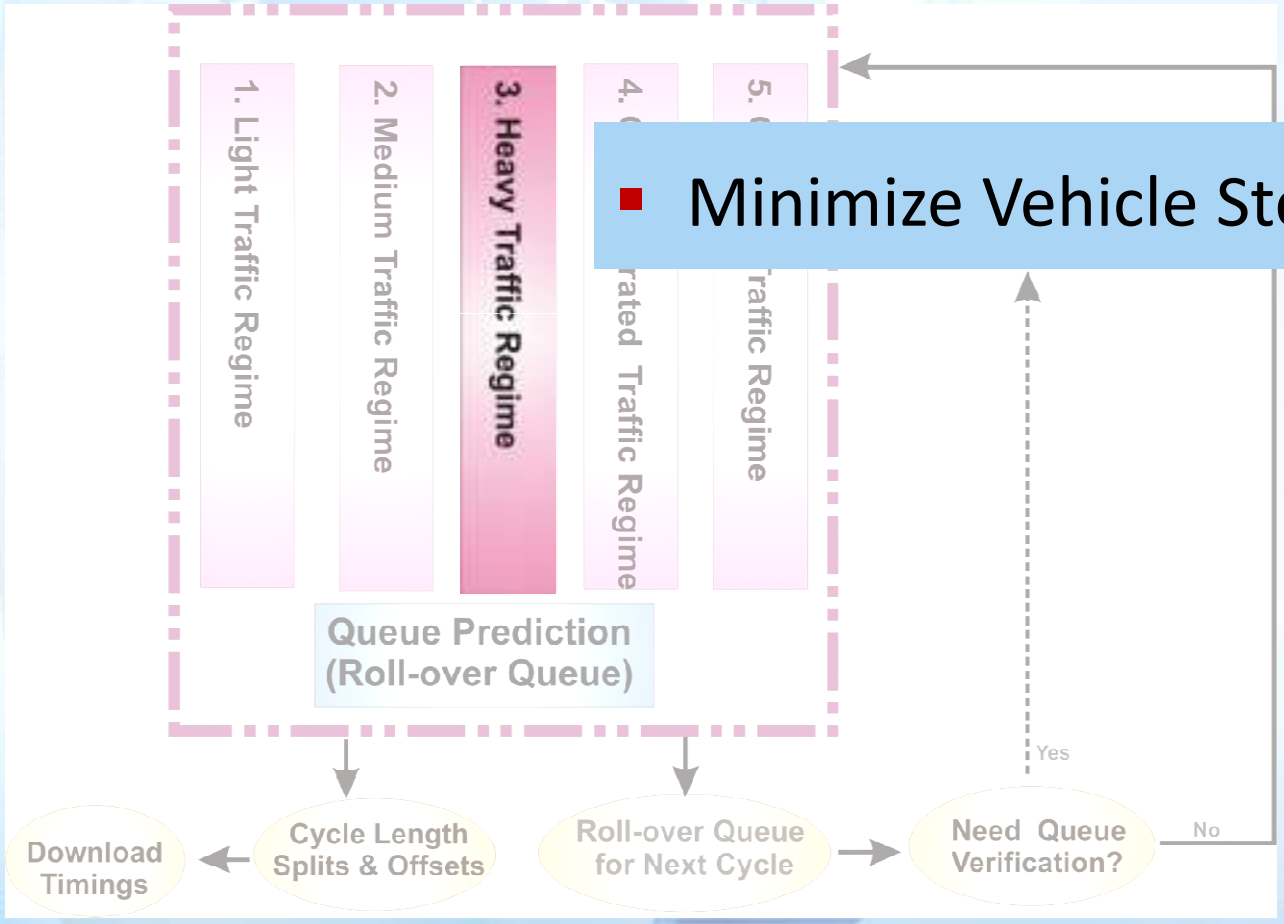


Delcan Multi-Criteria Adaptive Control Algorithms

- Minimize Vehicle Stops

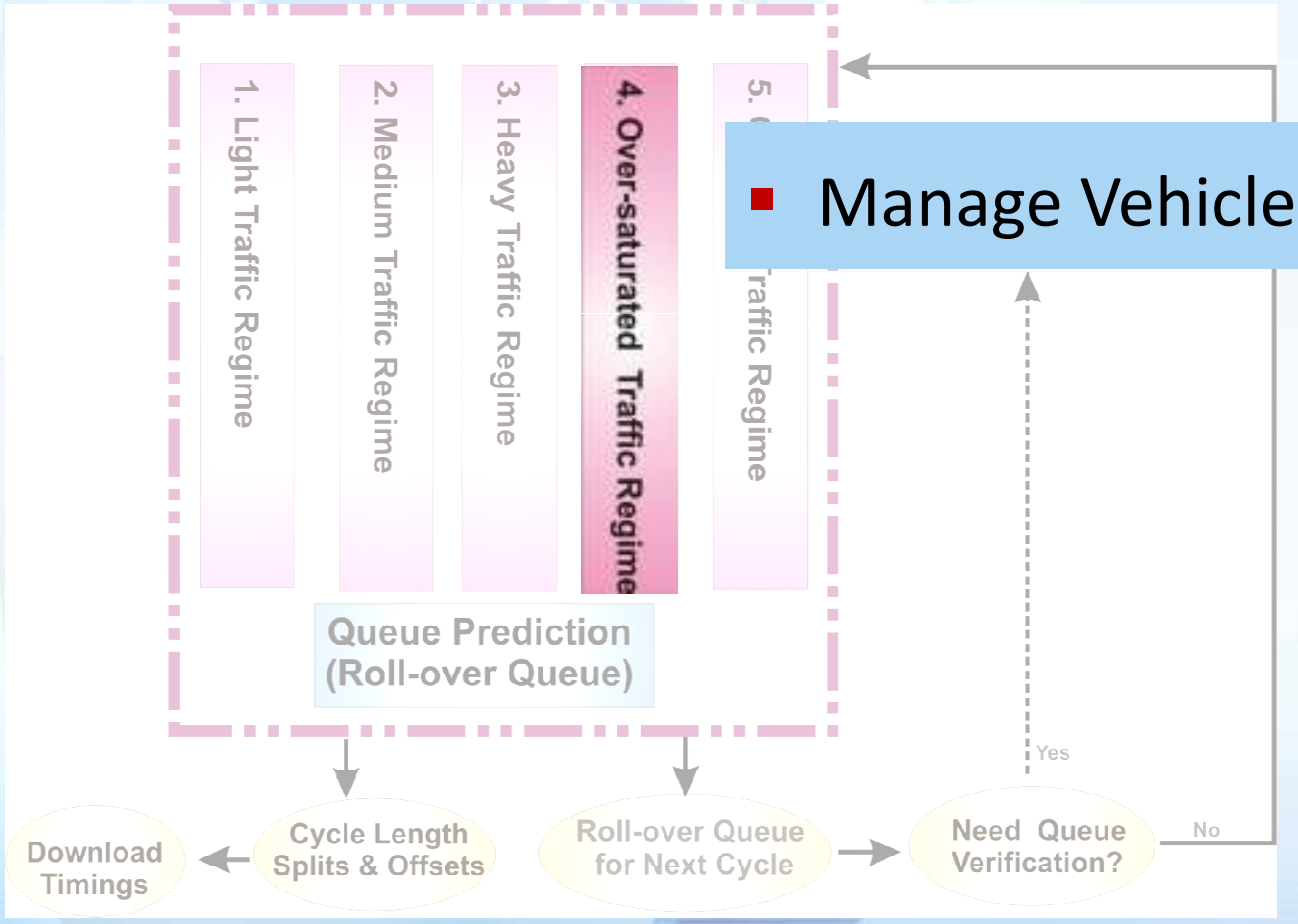


Delcan Multi-Criteria Adaptive Control Algorithms



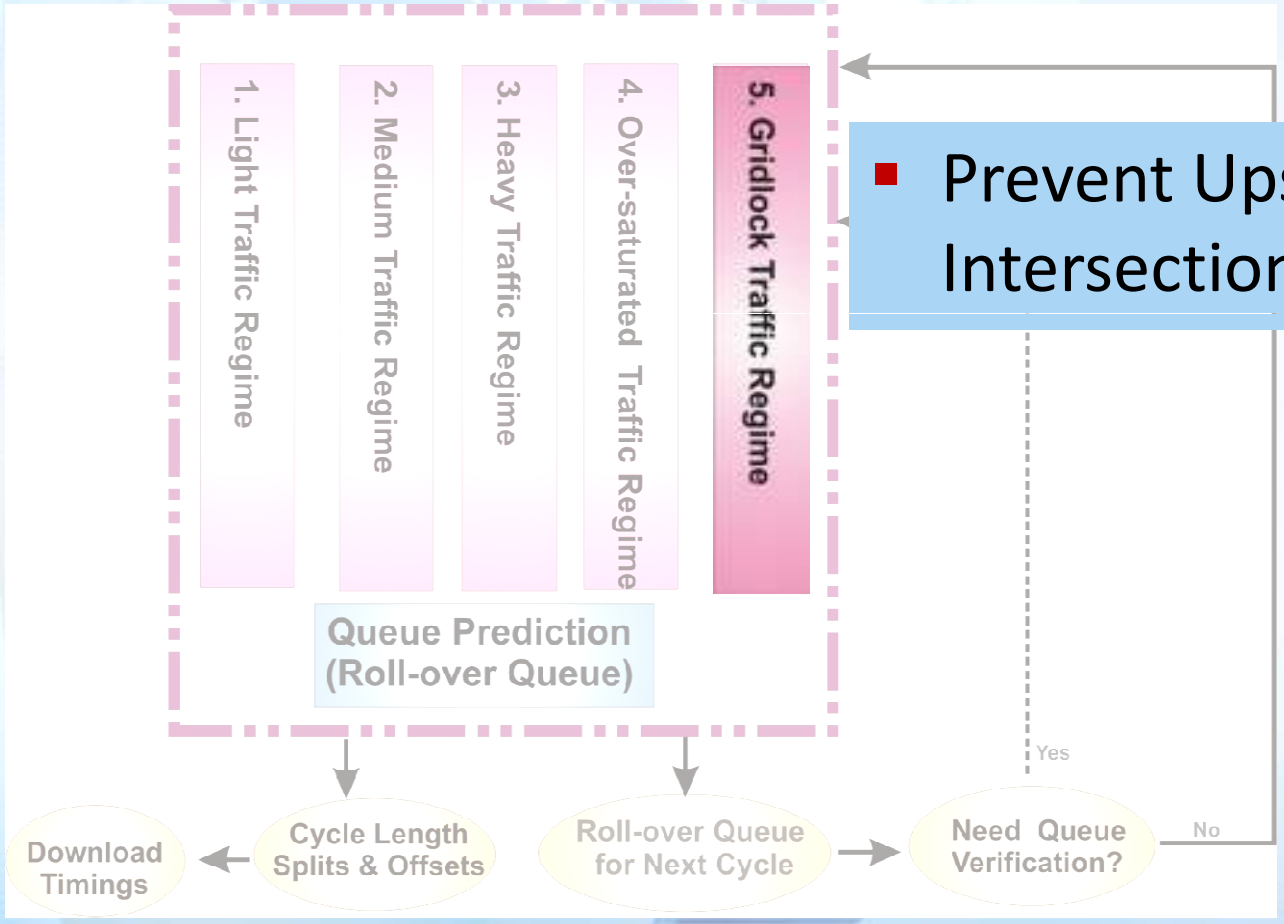
- Minimize Vehicle Stops & Delays

Delcan Multi-Criteria Adaptive Control Algorithms



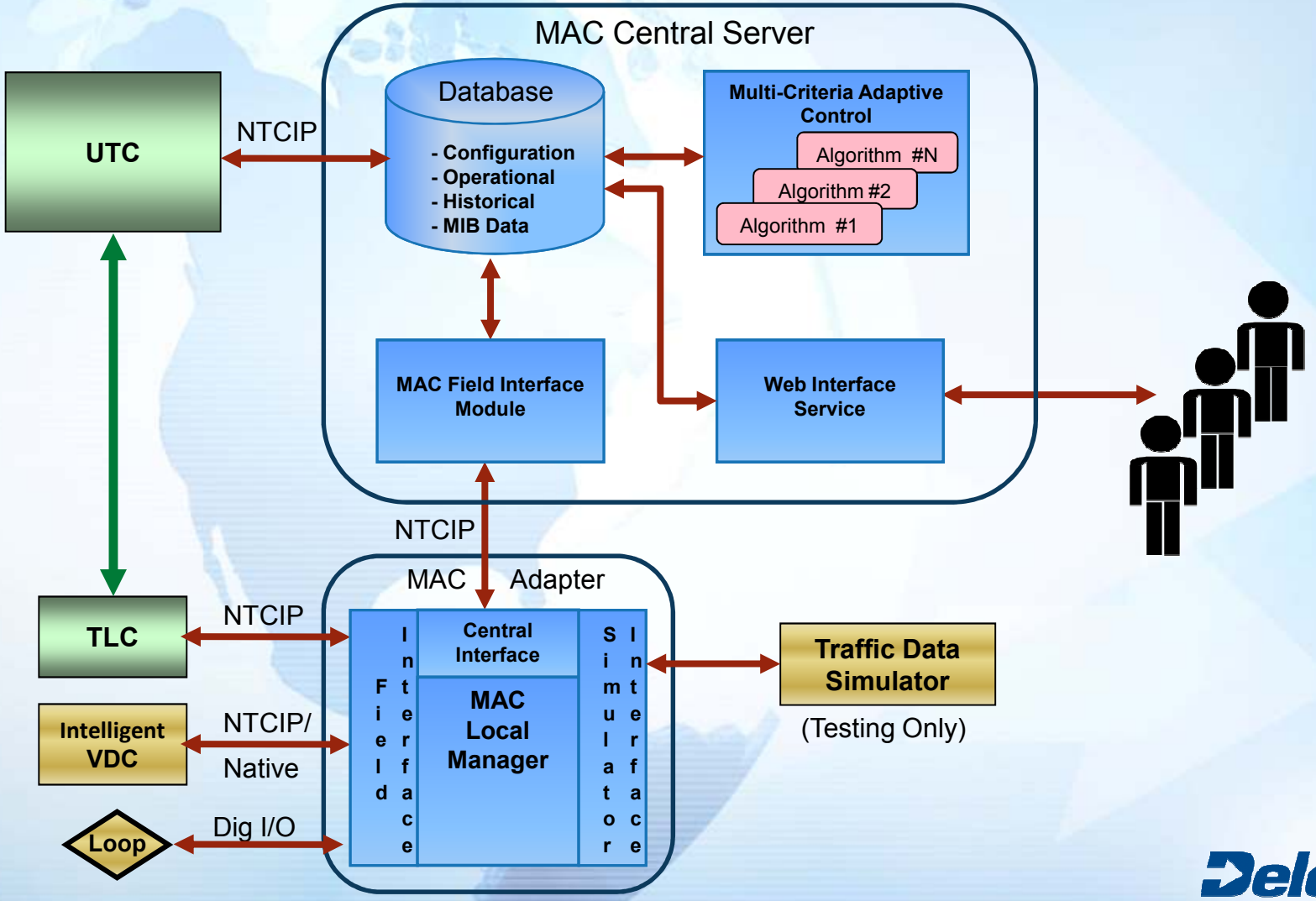
- Manage Vehicle Queues

Delcan Multi-Criteria Adaptive Control Algorithms

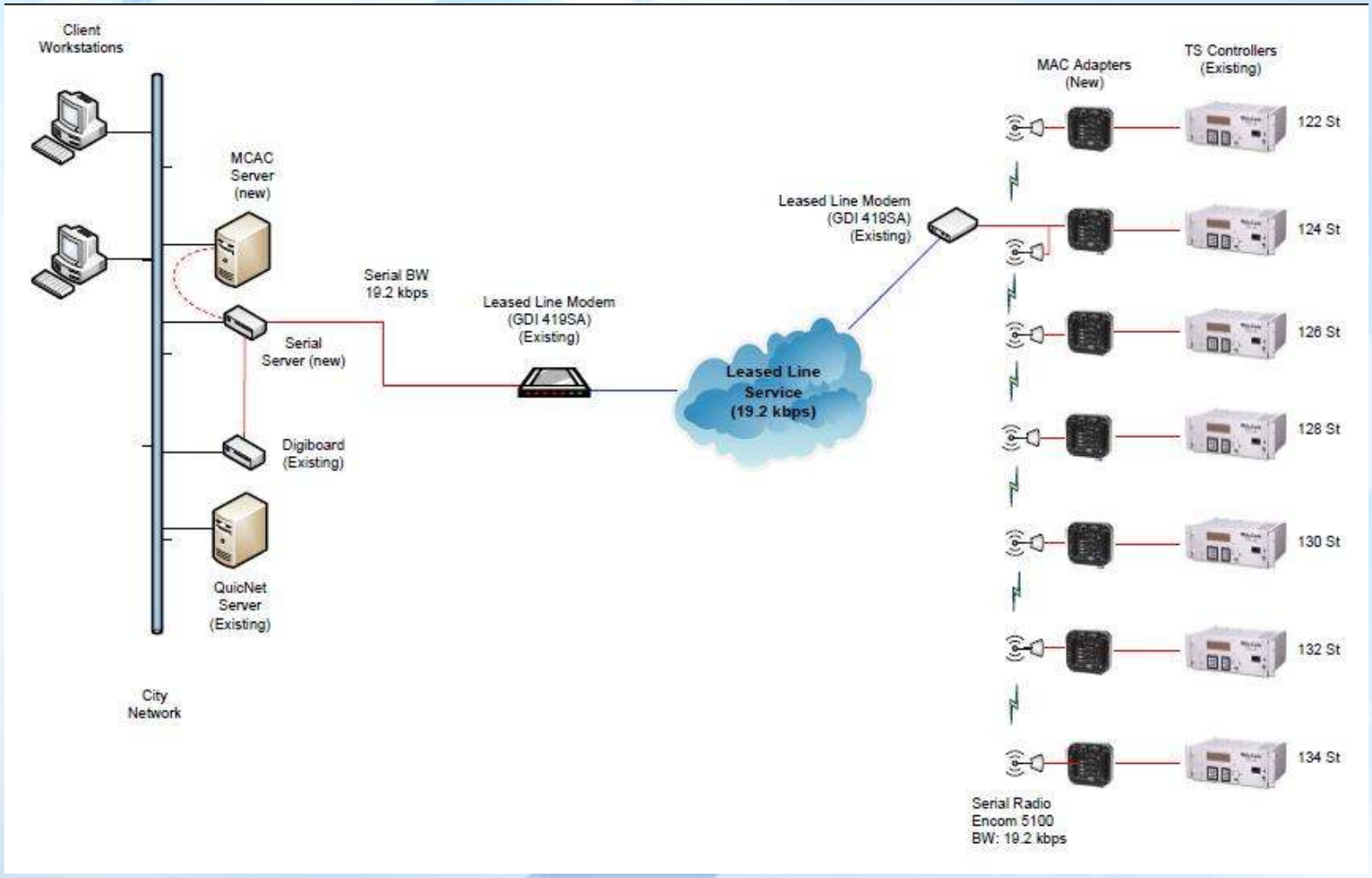


- Prevent Upstream Intersection Blocking

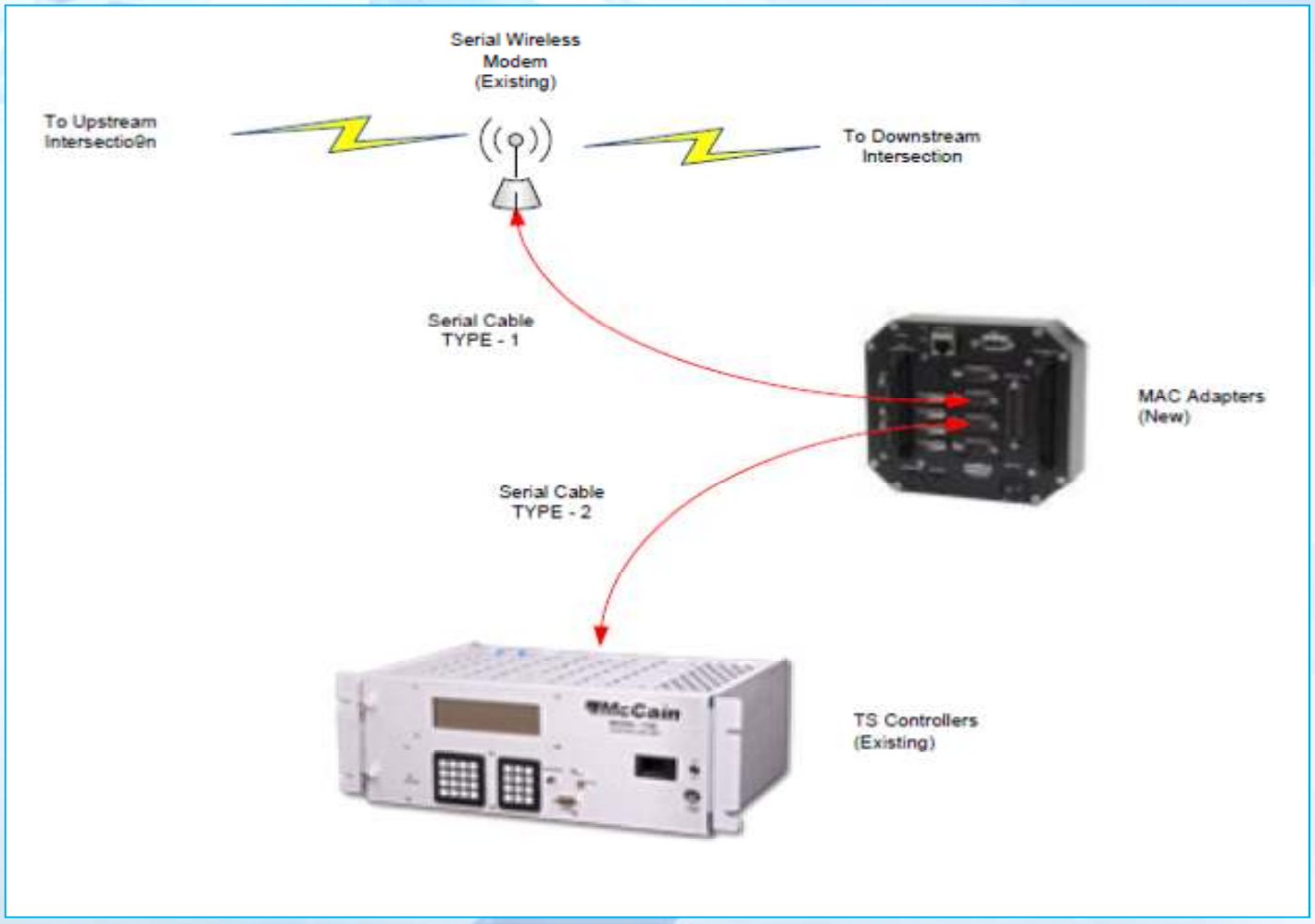
Delcan ASCT Software Architecture



Surrey Pilot Project System Layout

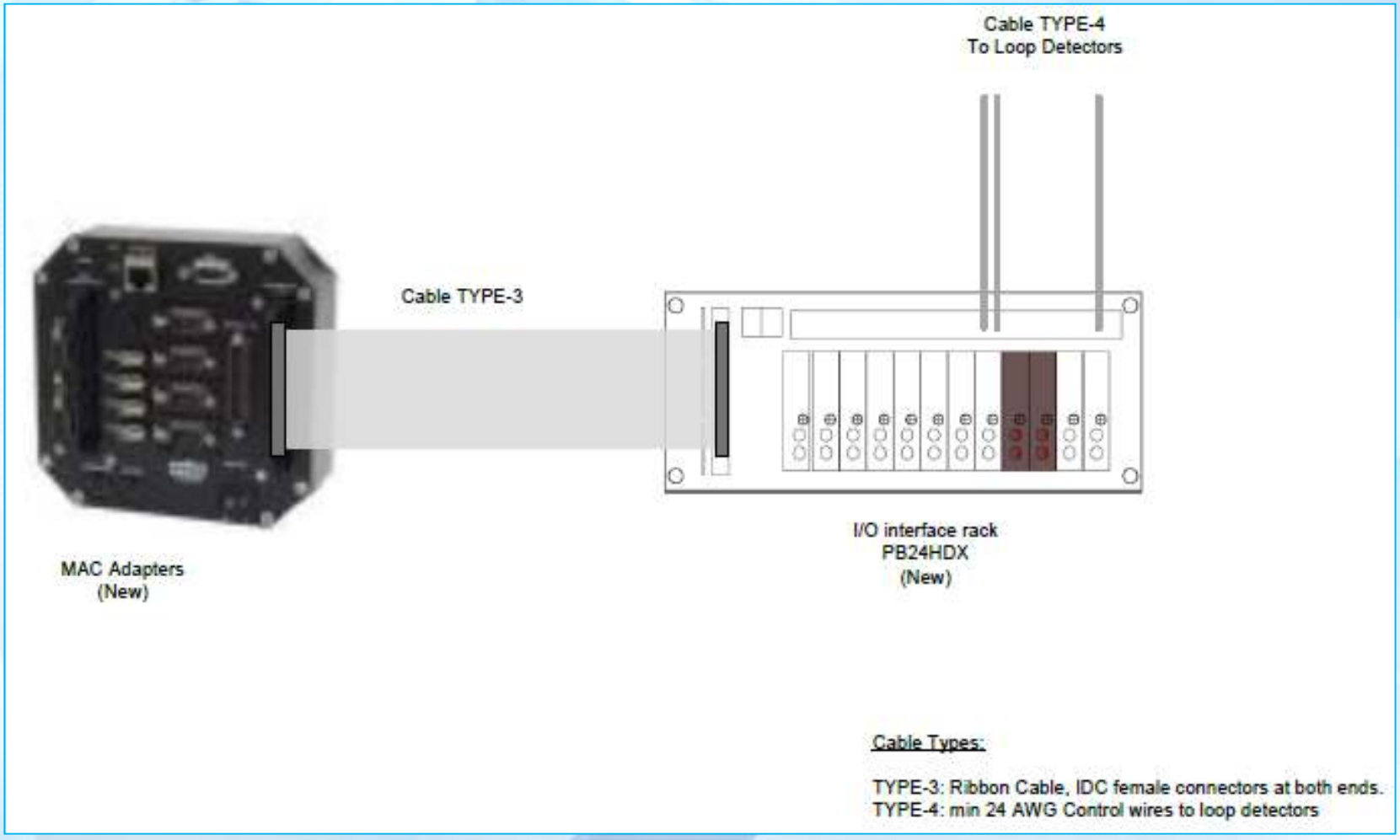


Surrey Pilot Project System Layout



Delcan

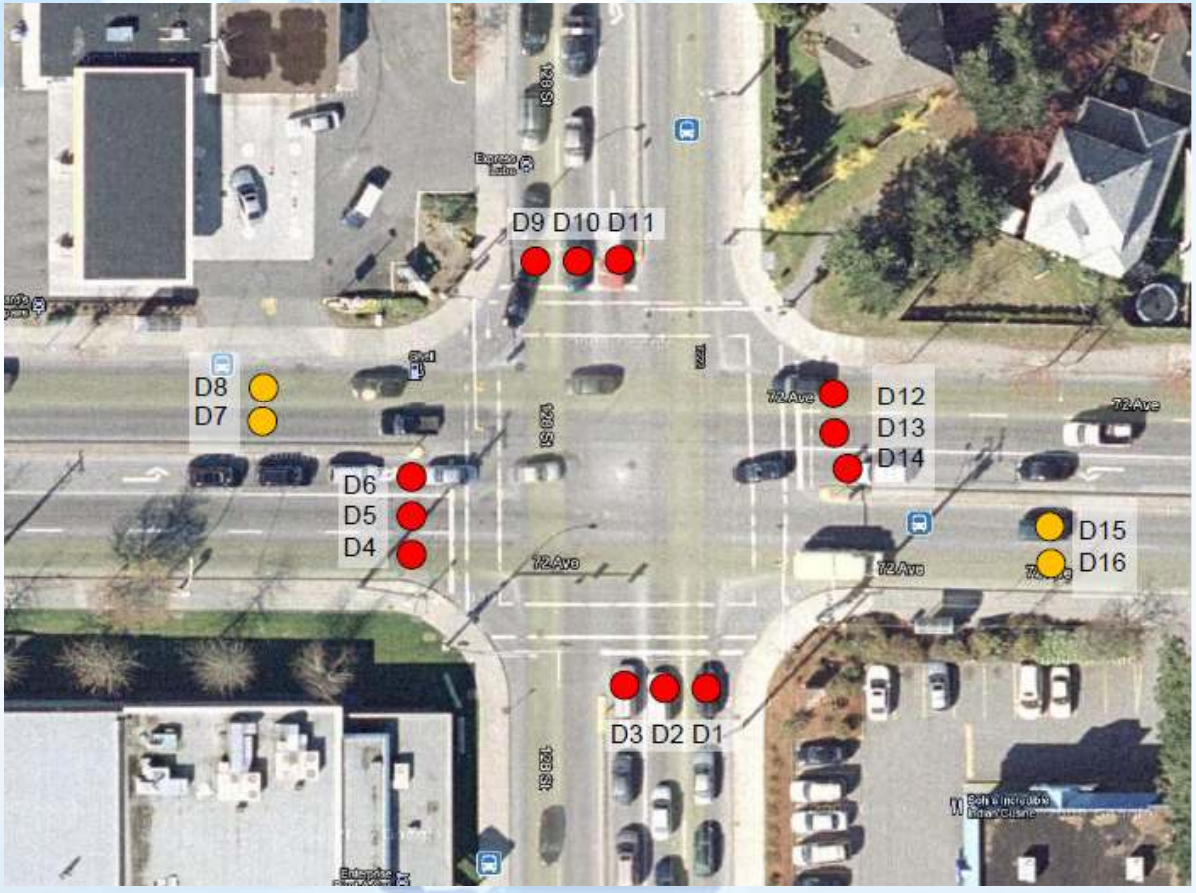
Surrey Pilot Project System Layout



Cable Types:

TYPE-3: Ribbon Cable, IDC female connectors at both ends.
TYPE-4: min 24 AWG Control wires to loop detectors

Surrey Pilot Project Detector Layout



Intersection at 128 Street

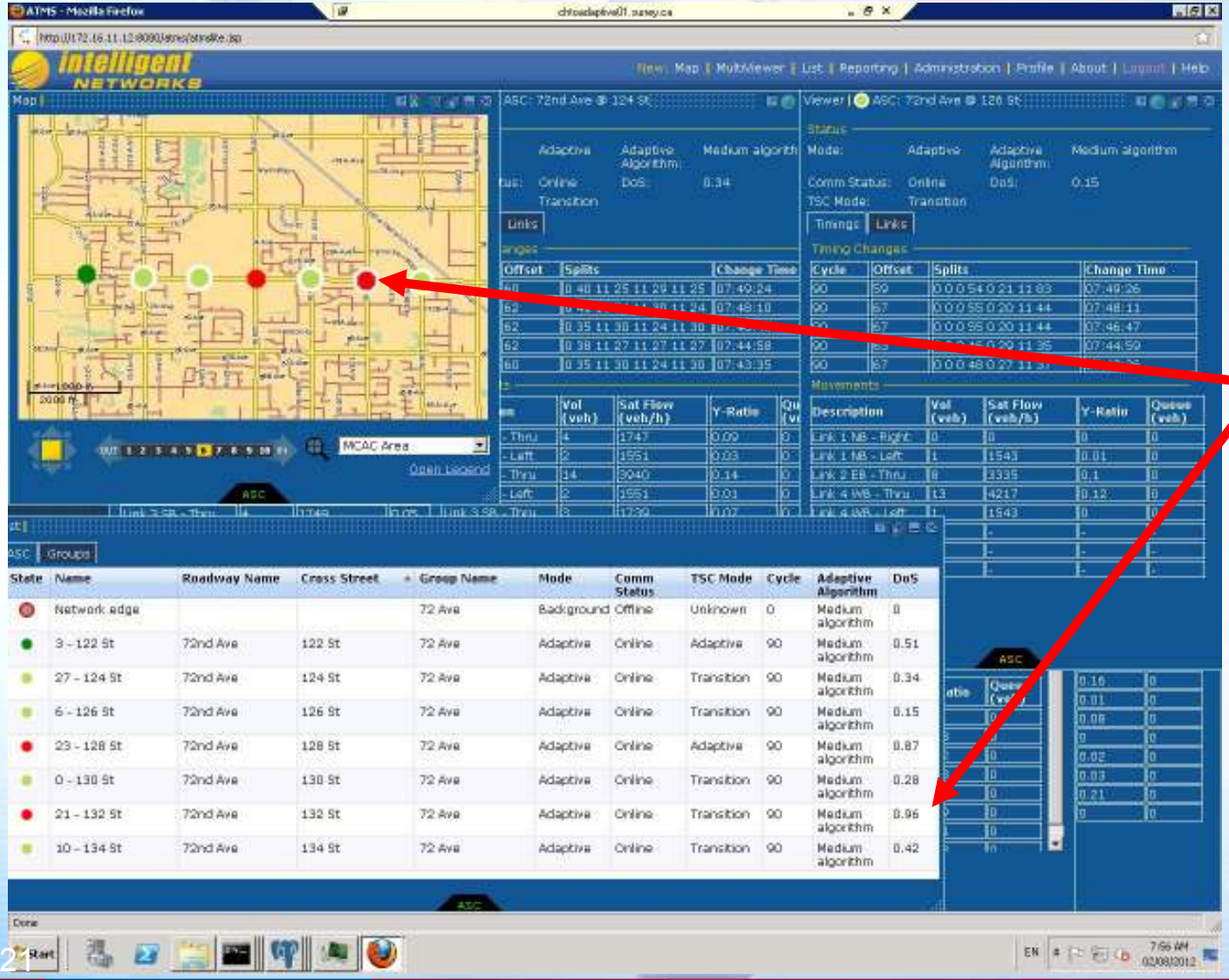
Delcan

Adaptive Control in AM Peak Period

- Initial Cycle Parameter Set Implemented:
  - Algorithm: Medium Traffic
  - Cycle Length: 90 s
  - Phase Splits: 25 s EW / 40 s NS
- Peak Cycle Parameter Set Implemented at 8:35 am
  - Algorithm: Heavy Traffic
  - Cycle Length: 102 s
  - Phase Splits: 35 s EW / 42 s NS
- Cycle Length Variation Step: +/- 6 s

Delcan

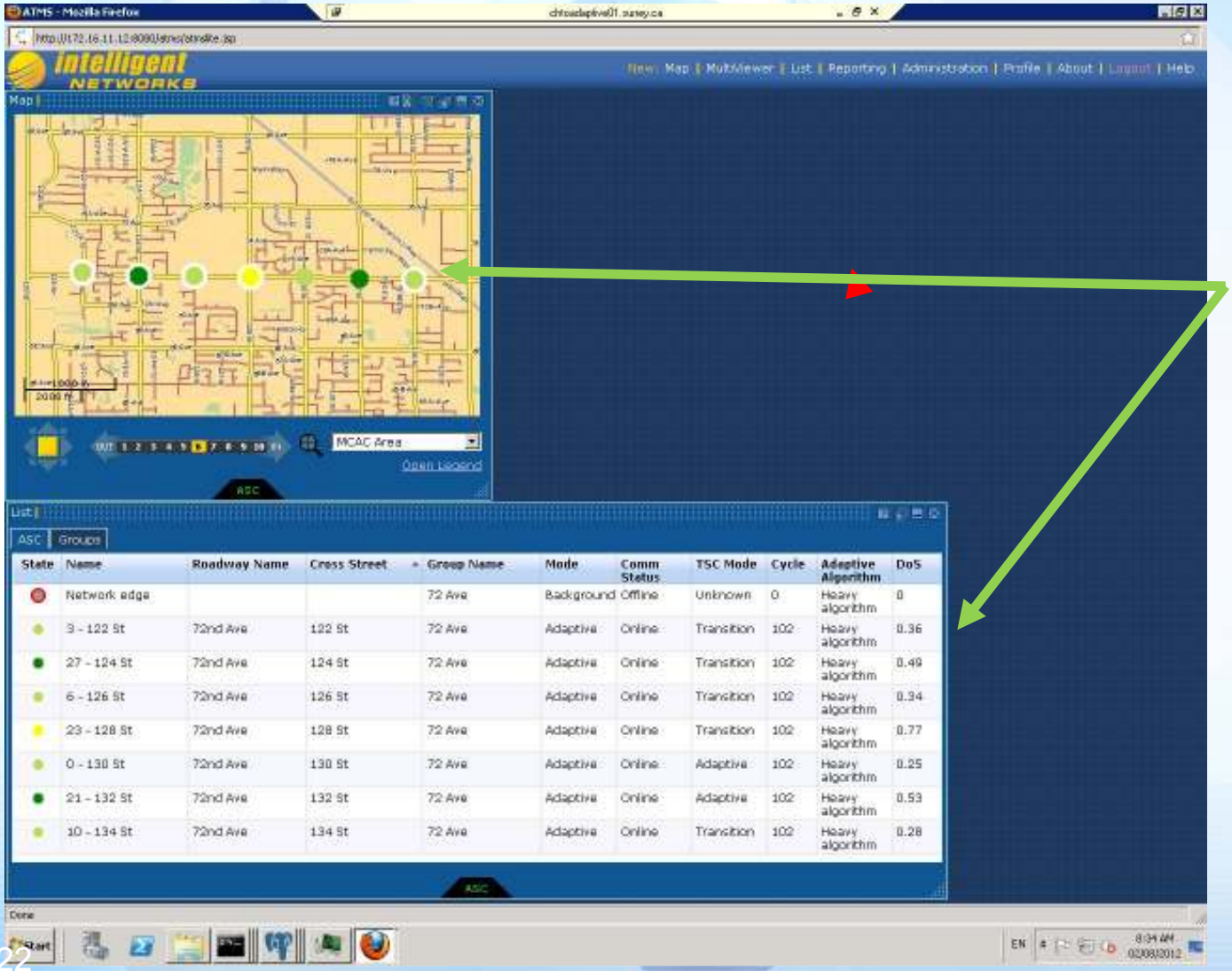
Pilot System Screen Capture
AM Peak – 90 Second Cycle



Red Coloured Symbols Represent High Degree of Saturation Values

Delcan

Pilot System Screen Capture
AM Peak – 102 Second Cycle



Light Colours Symbolize Low Degree of Saturation Values Reflecting Adaptive Algorithm Efficiency

Adaptive Control in PM Peak Period

- Illustrative Example of Efficient Management of Heavy Traffic during Special Events using ASCT
- Test Case: 2 August, 2012
  - PM Peak extended by Ramadan Celebration
  - Mosque Located Close to one of Test Intersections
- Traffic Detected: from 35 veh / cycle (at 90 s)
  to 110 veh / cycle (at 120 s)

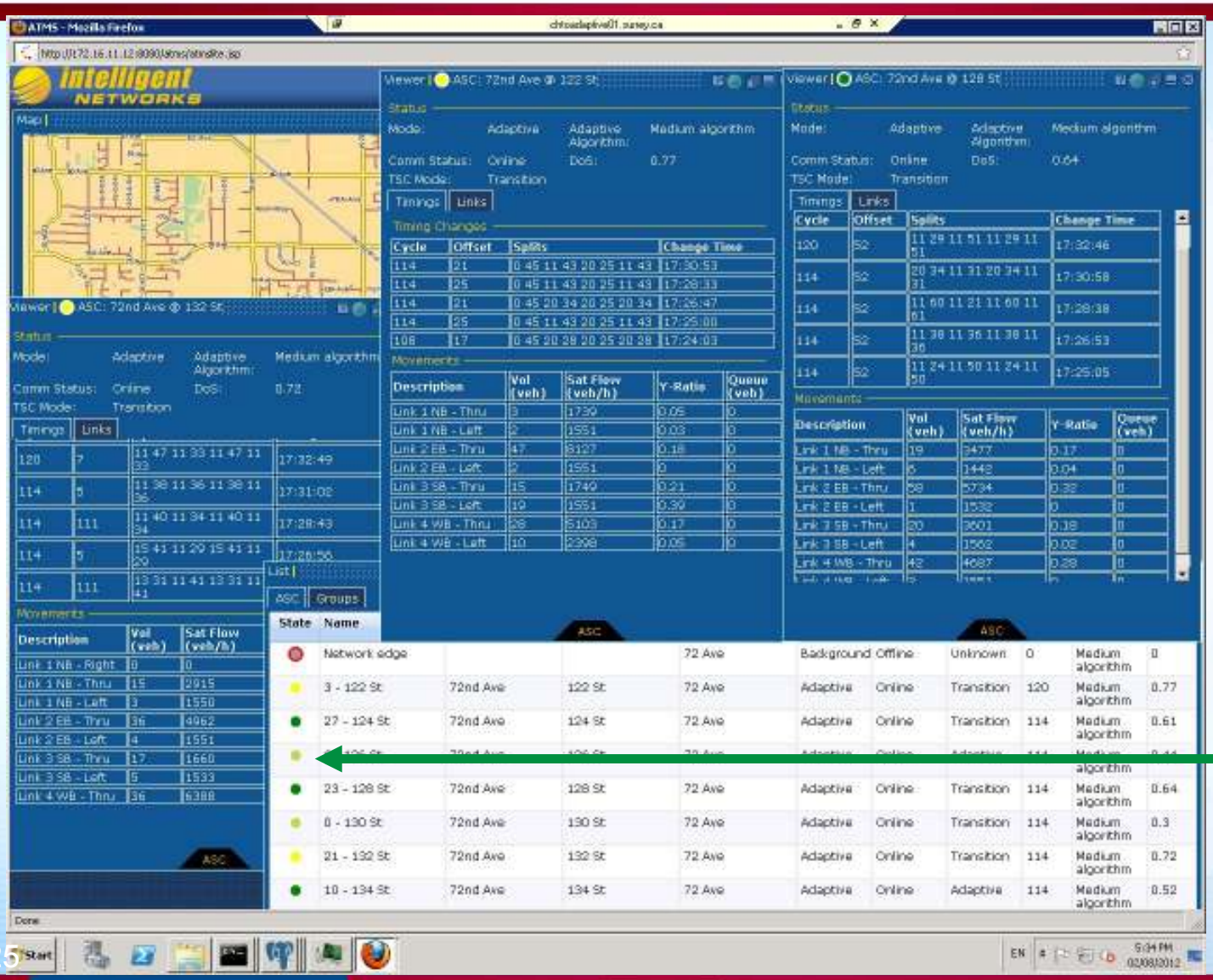
Delcan

Adaptive Control in PM Peak Period

- Test Conducted between 3:00 pm and 8:30 pm
- Initial Cycle Parameter Set Implemented:
  - Algorithm: Medium Traffic
  - Cycle Length: 90 s
  - Phase Splits: 20 s EW / 45 s NS
- Peak Cycle Parameter Set Implemented at 5:35 pm
  - Algorithm: Heavy Traffic
  - Cycle Length: 120 s
  - Phase Splits: 45 s EW / 43 s NS
- Cycle Length Variation Step: +/- 6 s

Delcan

Pilot System Screen Capture
PM Peak – 120 Seconds Cycle

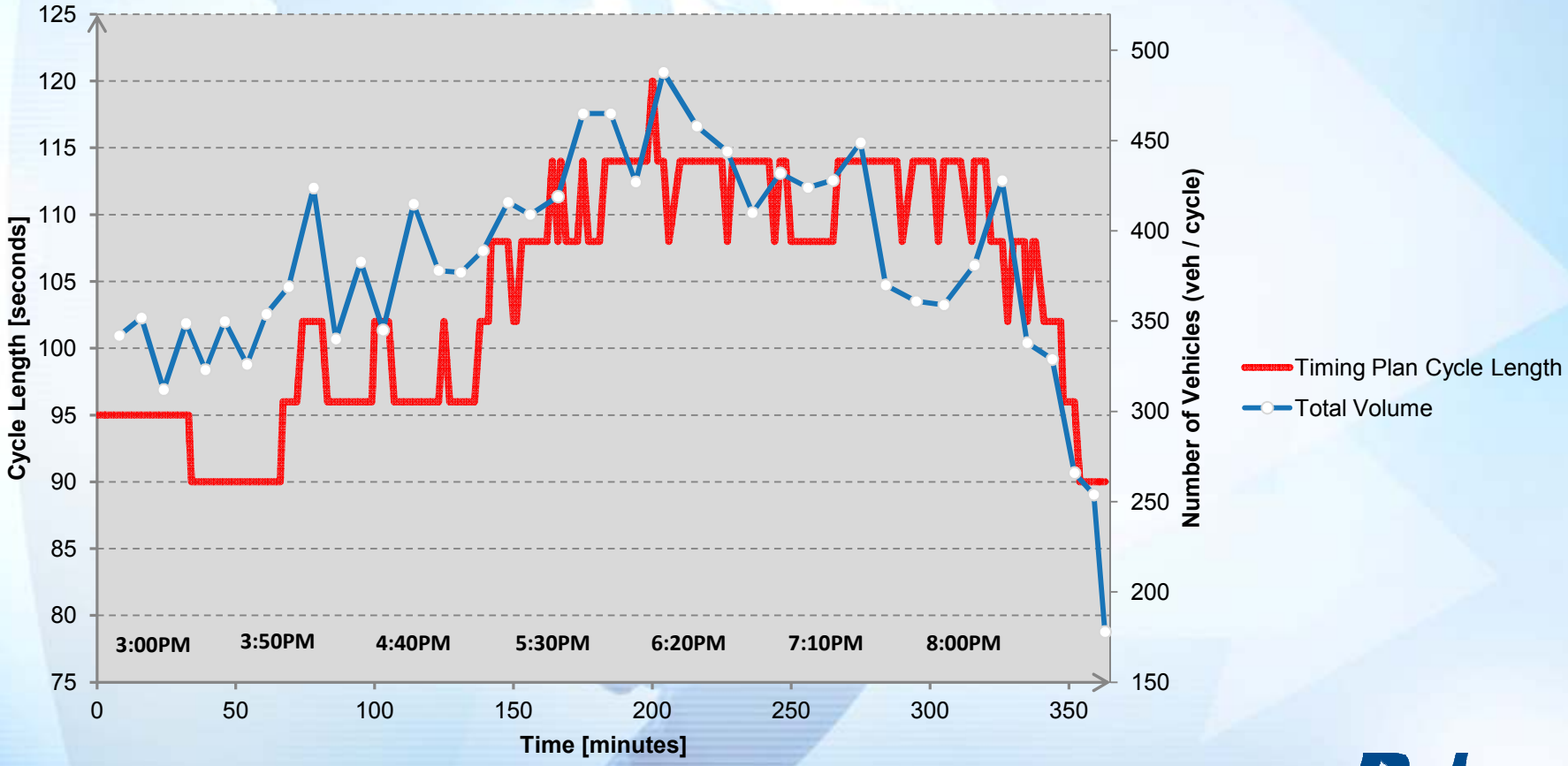


Light Colours Symbolize Low Degree of Saturation Values Reflecting Adaptive Algorithm Efficiency

Delcan

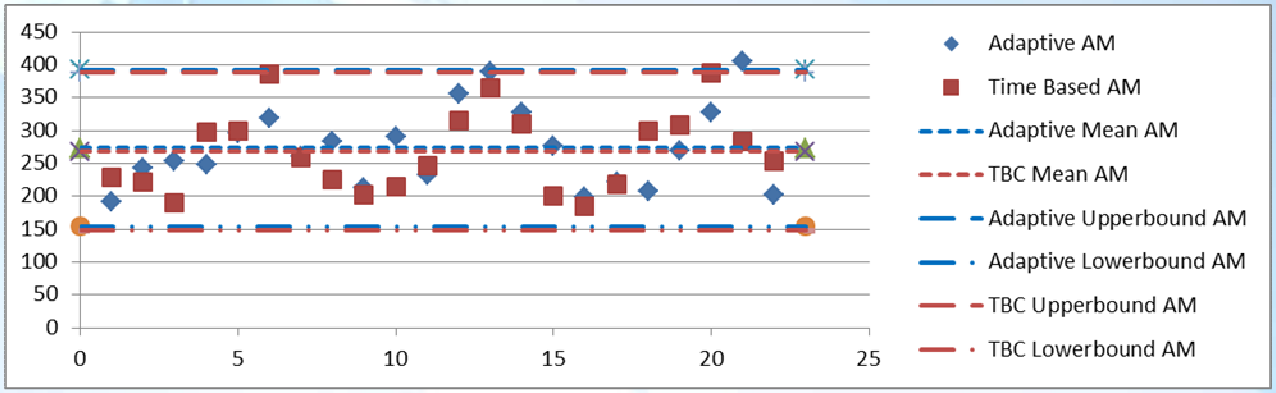
Adaptive Control in PM Peak

Total Volumes vs. Cycle Length at 72 Ave. & 122 St. in Surrey BC, on August 2, 2012

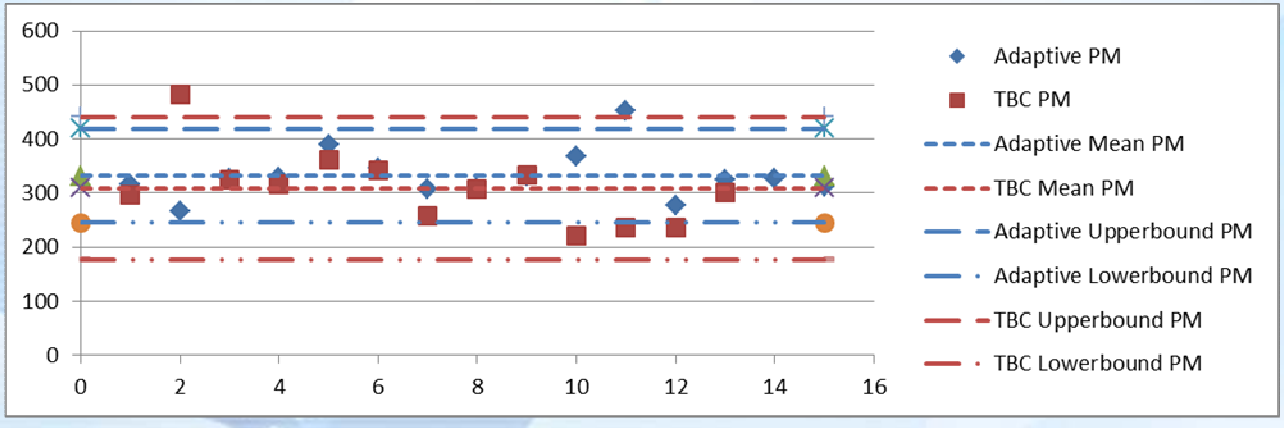


Travel Time Surveys

- Eastbound AM Peak



- Eastbound PM Peak



Measured Results are Statistically Similar

Queue Length Surveys

- At 124th Street (Through Lanes)

Northbound Through Lane	Ave Maximum Queue			Ave Remaining Queue		
	TBC	ASCT	Difference	TBC	ASCT	Difference
AM Peak	4.0	5.3	1.3	0.7	1.0	0.3
Off Peak	6.2	6.8	0.6	4.1	2.6	-1.5
PM Peak	5.2	5.9	0.7	1.3	1.1	-0.2

Southbound Through Lane	Ave Maximum Queue			Ave Remaining Queue		
	TBC	ASCT	Difference	TBC	ASCT	Difference
AM Peak	3.7	3.2	-0.5	0.7	0.2	-0.5
Off Peak	5.4	4.3	-1.1	0.8	0.3	-0.5
PM Peak	5.9	6.2	0.3	1.1	0.9	-0.2

Conclusions re On-street Operations

Adaptive Signal Control:

- Performed Safely as well as Best Optimized Pre-determined Timing Plans
- Efficiently Managed Traffic in:
  - Normal Conditions (AM Peak)
  - Exceptional Conditions (PM Peak + Ramadan Event)
- Extended Cycle Lengths and Phase Splits Ensuring:
  - Smooth Traffic Flow
  - No Residual Queues at End of Cycles under Heavy Traffic Conditions

Delcan

Conclusions from Pilot Project

Adaptive Signal Control Technology met Objectives for City's ASCT Pilot Project:

- MAC Open System Architecture Design provided for Seamless Integration with City's Existing Traffic Signal Control Infrastructure:
  - Type 170 (BiTrans) Traffic Signal Controllers
  - Wireless Tree Topology Communications Network
  - Vehicle Detectors

Delcan

Conclusions from Pilot Project

- ASCT Performed Equal to Best Optimized TBC Timing Plans
  - Because TBC Plans are Typically Updated every few Years, and ASCT will Continuously Adjust to Changes in Traffic Demands, this should result in a Continuously Widening Gap between Performance of ASCT and TBC
- ASCT System Correctly and Safely Reacted to Traffic Demands to Optimize Cycle Lengths, Phase Splits and Offsets without Unsafe Interruptions
  - ASCT System Observed to Appropriately Respond to Special Events that Resulted in Unexpectedly Heavier Traffic Volumes

Delcan

Lessons Learned from Pilot Project

- Maximize ASCT Benefits on Corridors with more Highly Variable and/or Unpredictable Traffic Volumes
- ASCT System Successfully Optimized Signal Timing Plans with Minimal Additional Vehicle Detectors
  - System Maximized Use of Existing Stop Line Detectors
  - Additional Link Entry Detectors at only Key Intersections
- To best Optimize Controller Offsets, Recommended Future System Enhancement would be for System to Predict Average Link Travel Speeds based on Real-time Field Measurements

Delcan

Lessons Learned from Pilot Project

- In Configuring ASCT System, Maximum Cycle Length was Restricted
  - As ASCT has ability to Continuously Adjust Cycle Length in response to the Current Traffic Demands, Higher Maximum Cycle Length should be enabled
- Length of Arterial Corridor (at approx. 3.2 km) was too Short for Definitive 'Before' and 'After' Vehicle Travel Time Comparisons
- Techniques to further Fine-tune Configuration Data and/or Enhance ASCT Algorithms to Improve Duration of Transition Periods should be Investigated

Delcan

Lessons Learned from Pilot Project

- Robust and Reliable Communications between Central Server and all MAC Adaptors in the Field is a Key Consideration in ASCT Deployment

- Micro-simulation Test Environment produced “Bird’s Eye View” of Whole Network; Excellent for Reviewing Network Traffic Flows, Intersection Offsets, Vehicle Queues, etc.
  - Output from Model was Effective in Off-line Configuration and Fine-tuning of ASCT Algorithms
  - Process of Confirmed Quality of ASCT System Configuration prior to Commencement of Operations in the Field

Delcan

Key Benefits of Delcan ASCT System

- Smooth Integration with Existing Legacy Systems
- Management of Oversaturated and Gridlocked Traffic (as well as Heavy Traffic)
- Multi-protocol Interface and Ability to Work with Multiple Controller Manufacturers / Types
- Flexible (and Minimal) Detector Requirements
- Low Data Transmission Requirements (and hence Low Communications Costs ~ 70% reduction)
- Robust and Highly Efficient Communications Scheme – Supports Variety of Wireless Technologies

Delcan

Questions?

- For Further Information:

Sinisa Petrovic, P.Eng.

Traffic Operations Manager, City of Surrey

Tel: 604-598-7954

Email: smpetrovic@surrey.ca

Perry Craig, P.Eng.

Senior Principal, Delcan Corporation

Tel: 905-943-0508

Email: p.craig@delcan.com

Delcan