New York City DOT
Advanced Intersection Signal Control Systems

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Agenda

• Introduction
• NYCDOT Traffic Control System – TransSuite®
• Centralized Adaptive Control
• Green Cabinet
• Video Analytics
Introduction

• Largest metro area in the U.S.
• Over 13,600 signalized intersections
• State of the art Traffic Control Center
• Large ITS systems and subsystems: DMS, CCTV, RFID (Travel Time), Transit Signal Priority, Connected Vehicles
• Sophisticated intersection control systems
• Centralized Adaptive Control
• Green Cabinet
• Video Analytics
Traffic Control System
TransSuite
NYCDOT TransSuite Modules

ATMS MAP

Traffic Control System

Event Manager

Traveler Inform. System

Traffic Management System

ATMS Explorer

ACDSS

TCS

XPL

TIS

TMS
TransSuite Traffic Control System

- Reliable signal control to 13,600+ NYC intersections
  - Fully supports NYCDOT standard-based traffic controllers (ASTC)
  - Multiple traffic control modes
  - Controller database management
  - Real-time split monitor
  - Real-time time-space diagram

- Transit Signal Priority

- Traffic Responsive (part of base system)

- Traffic Adaptive (module available)

- Alerts and Notifications - detailed event log and notifications

- Full NTCIP support for controllers and legacy controller support
ATMS Map

- Supports ITS device layers
- Regional and local views
- Overview of system performance
- Centralized access to field devices
- Center-to-Center support
- Unlimited device display
- Support for OpenStreetMap, Bing or partner GIS
ATMS Explorer Diagrams

- User-designed system views
- Dynamic information in real time
- Direct control of devices
- Windows graphic formats supported
- Intersection, section, or network views

Diagram Elements

- Intersection(s)
- Detectors (system and actuated)
- Pedestrian Control
- Section Control
- Signs, Cameras, File Access, and Hyperlinks
System Status & Performance Measures (Reporting & Dashboards)

• Ongoing operational status and performance reported by customizable dashboard
• Build your dashboard with widgets of interest
• See operational conditions at a glance, or click on links to dive in and take action
  • some dashboard widgets bring up lists of relevant intersections for details/troubleshooting
• Set alarms/alerts on certain operational conditions
• Save to your custom view
TransSuite Travel Information System

- Variable Message Sign (VMS) management
  - Create and edit messages
- WYSIWYG viewing
- NTCIP supported
  - full color & graphics, including display of Arabic text
- Word dictionary
- Automated scheduling
- Sign plans
- Hierarchical control
- Integration with Automated Message Display
TransSuite Event Management System (EMS)

• Monitors incidents automatically detected by the Traffic Management System or manually entered by system users

• Used for:
  • Construction events
  • Planned special events
  • Incidents (manual, automated, external)
  • External incidents from 3rd Party

• CAD / 911

• Logs and displays all operator and system actions

• Standard reports for incident data
Alarm System

- Manage error messages and alerts for users
  - System hardware
  - Field hardware
  - Communication
  - User access
- Send email/text messages to designated staff
- Use Alarm Codes and Types to filter emails to recipients
TransSuite Centralized Transit Priority (TSP)

• Central TSP services and communication to the controllers are provided by NYCDOT Traffic Control System – TransSuite

• 2,300+ intersections across all 5 boroughs are TSP-enabled

• Plans to expand and study up to 8,000 intersections for TSP, enable TSP at up to 6,000 Intersections
TransSuite Connected Vehicle

• Implemented for NYCDOT Connected Vehicle Pilot Program

• TransSuite has a key role in the CV environment:
  • RSU Management
  • Onboard Unit Data Collection
  • MAP and TIM Management
  • SPaT Message Generation
Centralized Adaptive Control
Centralized Adaptive Control

NYC Challenges:
- Oversaturated traffic, heavy pedestrian volume, grid/arterial/diamond interchanges/CBD, and 12,000+ intersections

Design Constraints:
- Centralized control
- Support for Transit Signal Priority
- Support NEMA and interval-based timing
- Prioritize pedestrian phasing (LPI, minimum crossing time)
- Non-intrusive detection
- Build upon existing ITS infrastructure
  - NYC TCS, Wireless Network, and ASTC
Centralized Adaptive Control

- NYC TCS Plug-in
- Centralized
  - NTCIP Based
- Cyclic
  - Cycle/offset/split
- Multi-Regime
  - Undersaturated
  - Oversaturated
- Variable Objective
  - Delay Minimization
  - Queue Management
  - Progression
  - Interchange Control
Centralized Adaptive Control

Active Traffic Management (ATM)
- Midtown-In-Motion (MIM)
  - With operator override

Smart Lights
- Diamond Interchange
- Arterial
- Intersection Clusters
Midtown-in-Motion

- Developed following approach to accommodate extremely complex grid network

- Hierarchical Control
  - Level 1 – Strategic area-wide control
    - Implemented by Avenue, rebalanced traffic being delivered to the zone, used library of carefully developed plans
  - Level 2 – Tactical control
    - Implemented at intersection level, complimentary to level 1, balanced queueing and minimized gridlock condition
  - With Operator-in-Loop option

- Performance since 2011
  - ~60% of the time - system prevented travel time deterioration
  - ~15% - average travel time savings
Smart Lights

- **Challenge:**
  - Queueing and spillbacks
  - Varying traffic pattern
  - Signal phasing constraints

- **Treatment:**
  - Splits optimization for varying traffic
  - Utilize available capacity
  - Metering inflow when warranted

- **Important Metrics/Measures:**
  - Measure of Congestion by Occupancy
  - Flow/Occupancy Regimes
Program Goals

• Reduce power consumption for intersection operation
  • Energy efficiency of Low Voltage LED signal heads
  • Reduced operating costs

• Improve the safety of field wiring
  • Low Voltage Controller cabinet to signal heads
  • Improve cabinet safety for maintenance personnel
    • Limited exposure to high voltages

• Evaluate the application of the Advanced Transportation Controller Cabinet (ATC 5301) standards
  • Development of the procurement specifications for the next generation of controllers for New York City
Background

- The current traffic controller (initial procurement ~2002)
  - Replaced the electromechanical controllers
  - Compact, cost-efficient design
  - Increased reliability and ease of maintenance
- Requirements & Design based on:
  - *Evolving* National Advanced Transportation Controller (ATC) standards
  - NY State cabinet specifications
  - Incorporate NEMA TS2 Type 1 Serial Cabinet standards
  - Use CALTRANS/NYS cost effective, simple plug-in monitoring unit
  - Low cost NEMA/NYS Load Switches/Flashers (10 AMP 120 VAC)
  - Optimized for use of 6 Load Switch and 12 Load Switch configurations
- Designed for wireless connectivity
  - NYCWiN (~circ 2008) and now using AT&T FirstNet/Sprint backup
  - NTCIP support for efficient wireless communications
- Adapted for *Connected Vehicle Operations* (SPaT)
- Support TSP/EVP and Adaptive Control (Midtown-in-Motion)
- ~14,000 currently installed and online
- Multiple vendors approved for deployment
Green Cabinet Adaptations

- Operation using 48 Volts DC Operation
  - LED signal heads – 8 watts
- Compact Cabinet design – Based on ATC 5301
  - **High Density Switch Packs** – 6 circuits, 1” of rack space
  - **Serial Interface Unit** (SIU) – serial cabinet design
  - Improved **cabinet monitoring system** (CMU)
    - Current & voltage monitoring → proactive maintenance
  - Redundant 48 VDC Power Supplies
    - Limited operation during main supply failure
- Partial Adaptation
  - Controller remained unchanged
    - Plugs into the cabinet outlet (120 VAC)
  - Modified controller firmware (Oriux)
    - Supports the ATC standard CMU and SIU

Typical LP/LV8 Cabinet
Examples of ATC 5301 Efficiencies/Density

Typical HDSP equivalent to 2 traditional load switches

SIU Serial Interface Unit

4-HDSP 24 Circuits

Flasher

Typical Cabinet Monitoring Unit (CMS) communicates with the HDSP, looks for sequence errors, conflicts, monitors currents and voltages
Project Approach

• Outfitted 10 cabinets with power monitors
• Collected Cabinet Power consumption before

• Install Low Voltage/Low Power cabinets at sample locations
• Collect Cabinet Power consumption after

• Did not go according to plan - -
  • Discovered many issues/challenges with the standards and signal head design
Some Complications and Challenges

- ATC5301 standards were a moving target – Finalized 2021/2022
  - Changes affected cabinet design
- Major issues with the 48 VDC signal displays (Pedestrian and Vehicle)
  - Signal Head Failure mode
    - Was ok for 10-amp 120 VAC circuits but not for 48 VDC 2-amp operation
    - Vendor had to modify their circuitry
    - Need an updated signal standard for LED signal heads *Existing Standards insufficient*
  - Inrush current for pedestrian signals with down counters
    - Current required during the “on” time was 3x to 4x the specified power consumption
    - Needed significantly larger 48-volt supply (12 amps) than calculated (3 amps)
    - Fuses required for each circuit to support failsafe flash on signal head failure
- Need for backup 48 VDC supplies; no 48 volts = dark signals
  - Needed a power monitoring and transfer module
Where Are We Now?

- Vendors’ device modifications are ongoing
- We have alternative power supplies that run reliably with higher current power supply
- Power savings are real, but not as large as expected
  - ~10% average power reduction across 4 sample intersections
- Evaluating final cabinet subassemblies (fuse panels etc.)
- Participating in the modifications to the standards – lower wattage signal heads (ITE), backup (flashing) operation – backup 48-volt supply (ATC)
- City is evaluating the impact of changing to 48 VDC operation,
- Additional Field Trials to evaluate vendor device improvements
Next Steps

• Development of procurement specifications
  • Incorporating changes to standards and lessons learned
  • Upgrade the specifications for the various plug-in devices based on lessons learned
  • Evaluate additional LED signal heads and pedestrian signals

• Upgrade TCS to retrieve advanced diagnostic data - proactive maintenance
  • Signal Head Current monitoring
  • Dispatch for repairs for signal outage before it causes flashing operation

• Upgrade Controller diagnostic display capabilities to eliminate the need for the costly Auxiliary Display Unit

• Add enhancements to the controller operation, including:
  • Over-the-air Software updates
  • Upgrade communications security (SNMPv3 with TLS 1.3)
  • Addition of a hardware security module for the Controller unit
  • Enhancements to firmware support for adaptive (MIM) and TSP operation for all modes
  • Support for Connected Vehicle applications (SPaT and RSU interface)
Summary

• We have been able to deploy a low voltage, lower power cabinet
  • There are savings – expect more as heads become more efficient

• Switching to 48 VDC field operation still has challenges
  • Cabinet standard needs modification
  • Signal Heads need revised standards

• Switching to the ATC 5301 provides more capabilities
  • Proactive cabinet monitoring and repairs – improves safety
  • Greater density means more circuits/capabilities in smaller cabinets

• The Low Voltage wiring offers a safer field environment and potentially lower maintenance costs
Video Analytics
Video Analytics

• Objective
  o NYCDOT is evaluating ground-breaking roadway user detection & analytics (RUDA) systems to meet the Safety and Mobility goals from the OneNYC 2050 Plan and Vision Zero Action Plan

• Focus Areas
  o Traffic Operations (real-time information)
  o Traffic Safety (incident/crash/near-miss)
  o Traffic Planning (data/historical/parking)
Use Cases

- Real-time monitoring for traffic operations
- Intersection turning movement counts
- Pedestrian data collection
- Near misses detection
- Roadway incident detection
- Parking
Video Analytics

- Completed industry scan in September 2022
- Responses from 20 domestic and international vendors
- Varied edge and central computing systems
- Developed technical specifications for Video Analytics System with industry scan knowledge
Technical Requirements

- Camera Hardware & Software
- Video Analytics Software
- Edge Computing Device Hardware & Software
- Power and Grounding
- Environmental Specification
- Network and Security
- Maintenance
- Central Management
- Cost
Potential Use of Technology

- Procurement
- Deployment
Look Ahead / Next Steps

- Publish Request for Expression of Interest (RFEI)
- Pilot testing of RUDA systems
- Demonstration across 500+ signalized intersections within New York City