New York City DOT

Advanced Intersection Signal Control Systems

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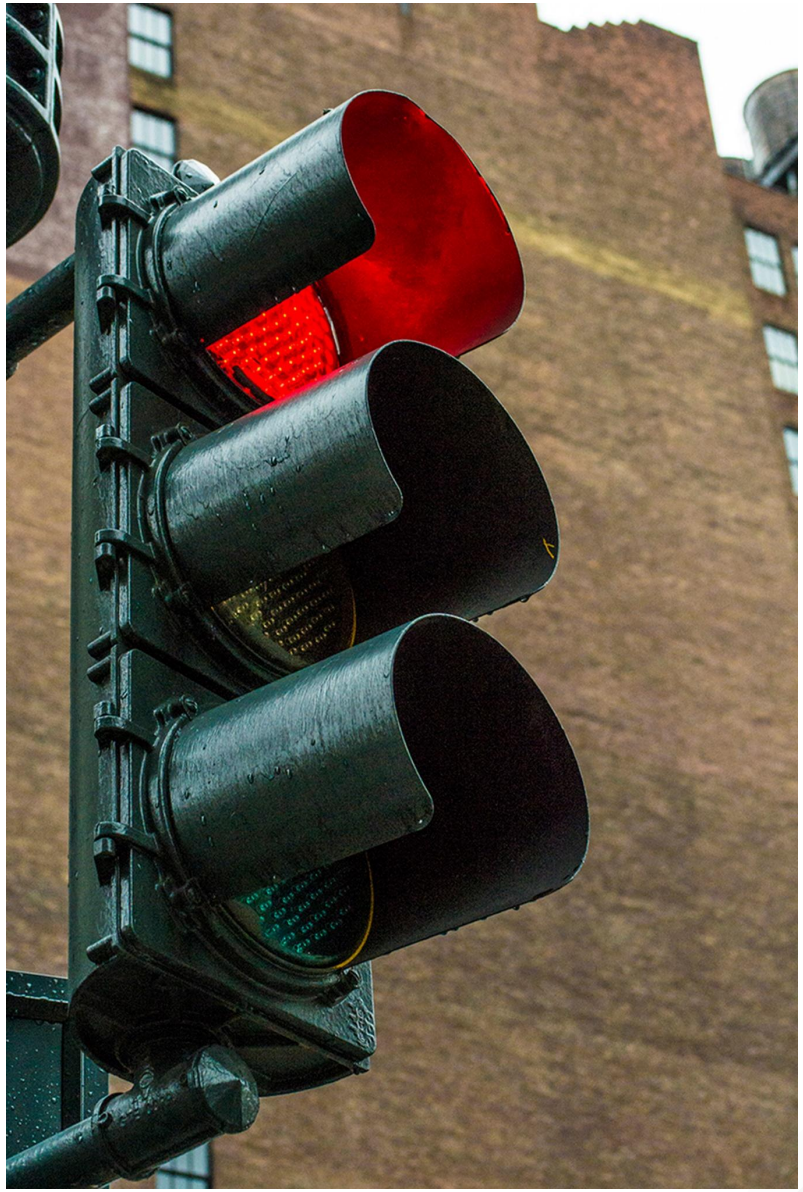
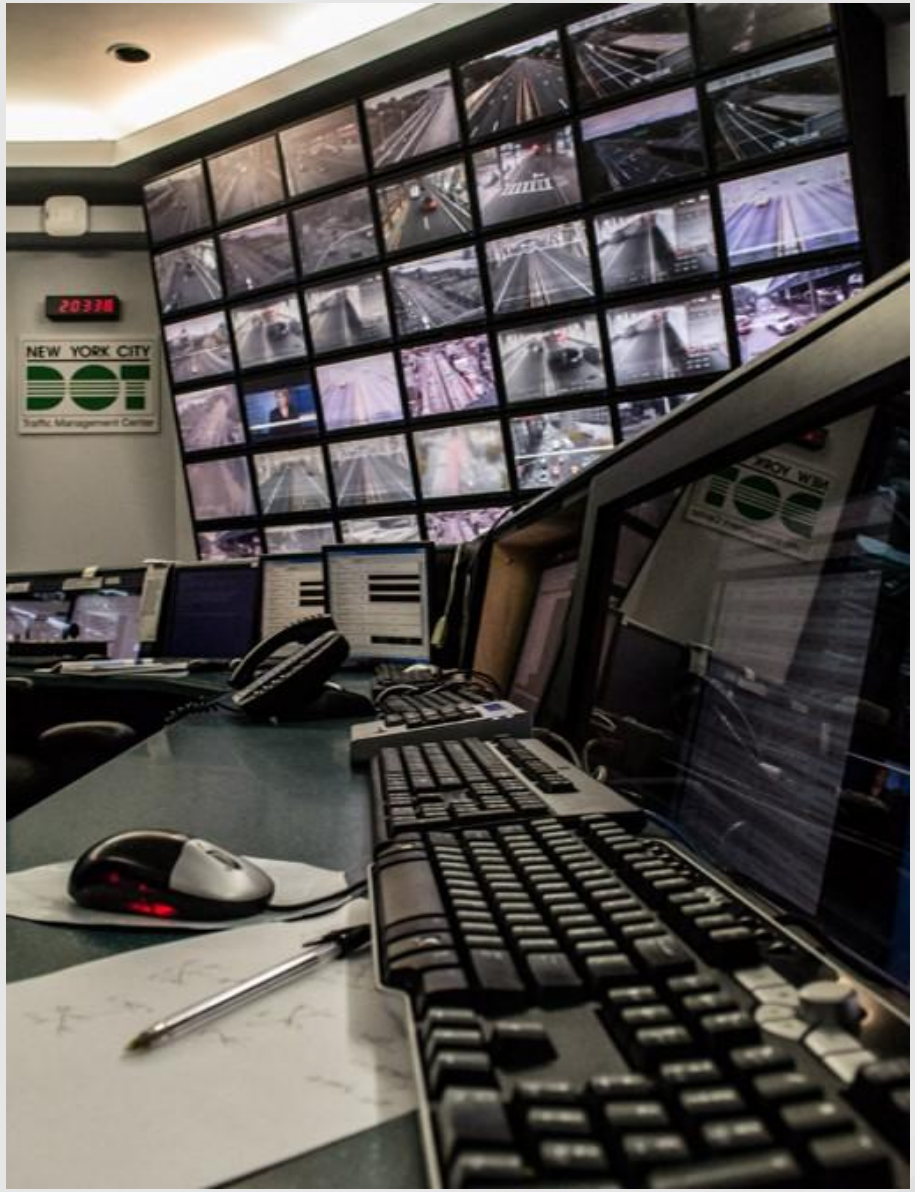
Agenda

- 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

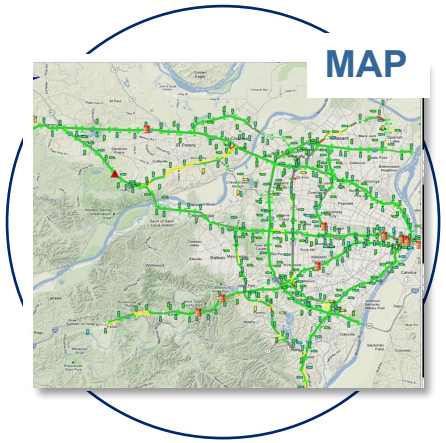


TransSuite®

Traffic Control System

TransSuite

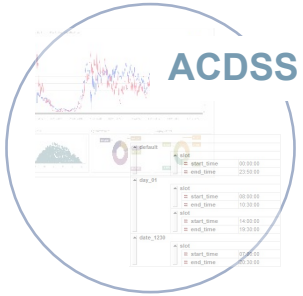
NYCDOT TransSuite Modules



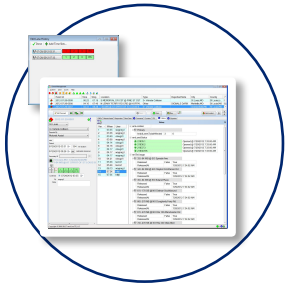
ATMS MAP

Traffic Control System

ATMS Explorer

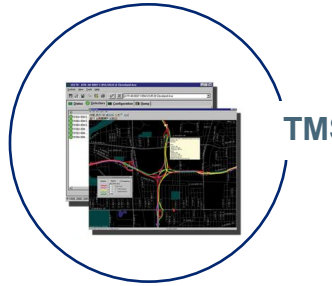


Adaptive Control



Event Manager

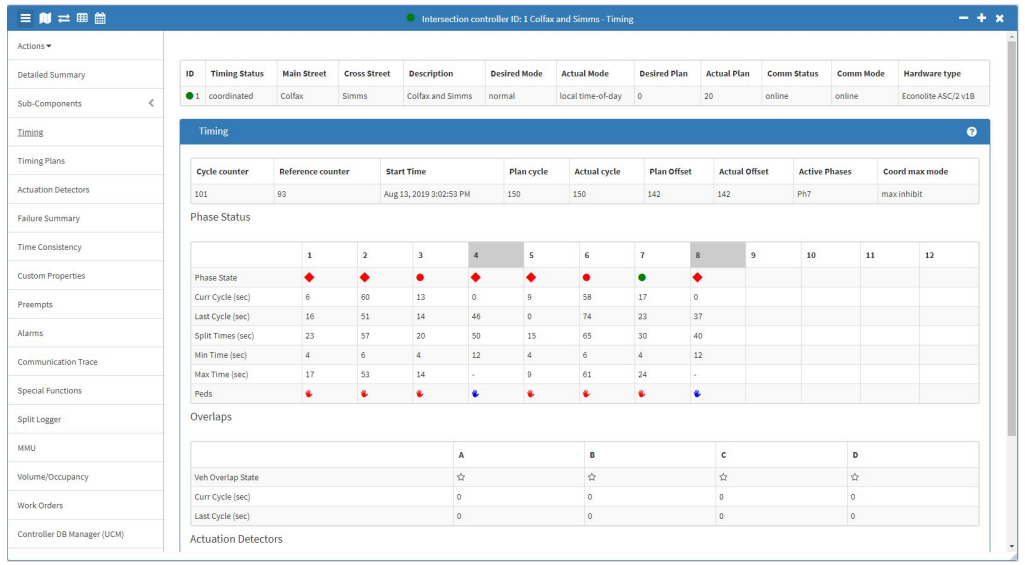
Traveler Inform. System

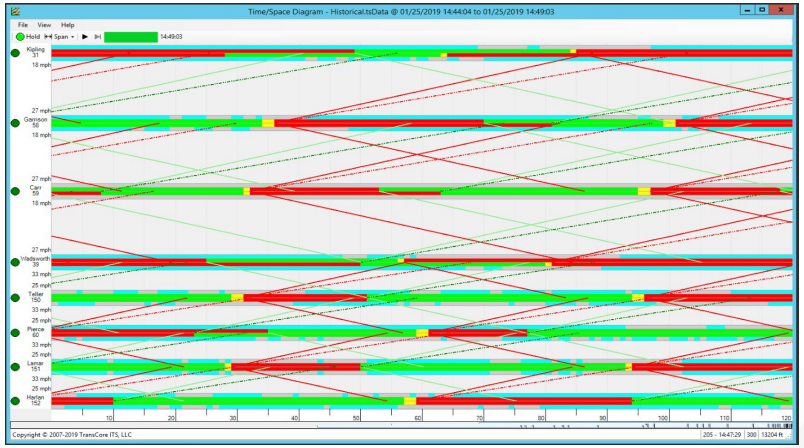


Traffic Management System

TransSuite Traffic Control System

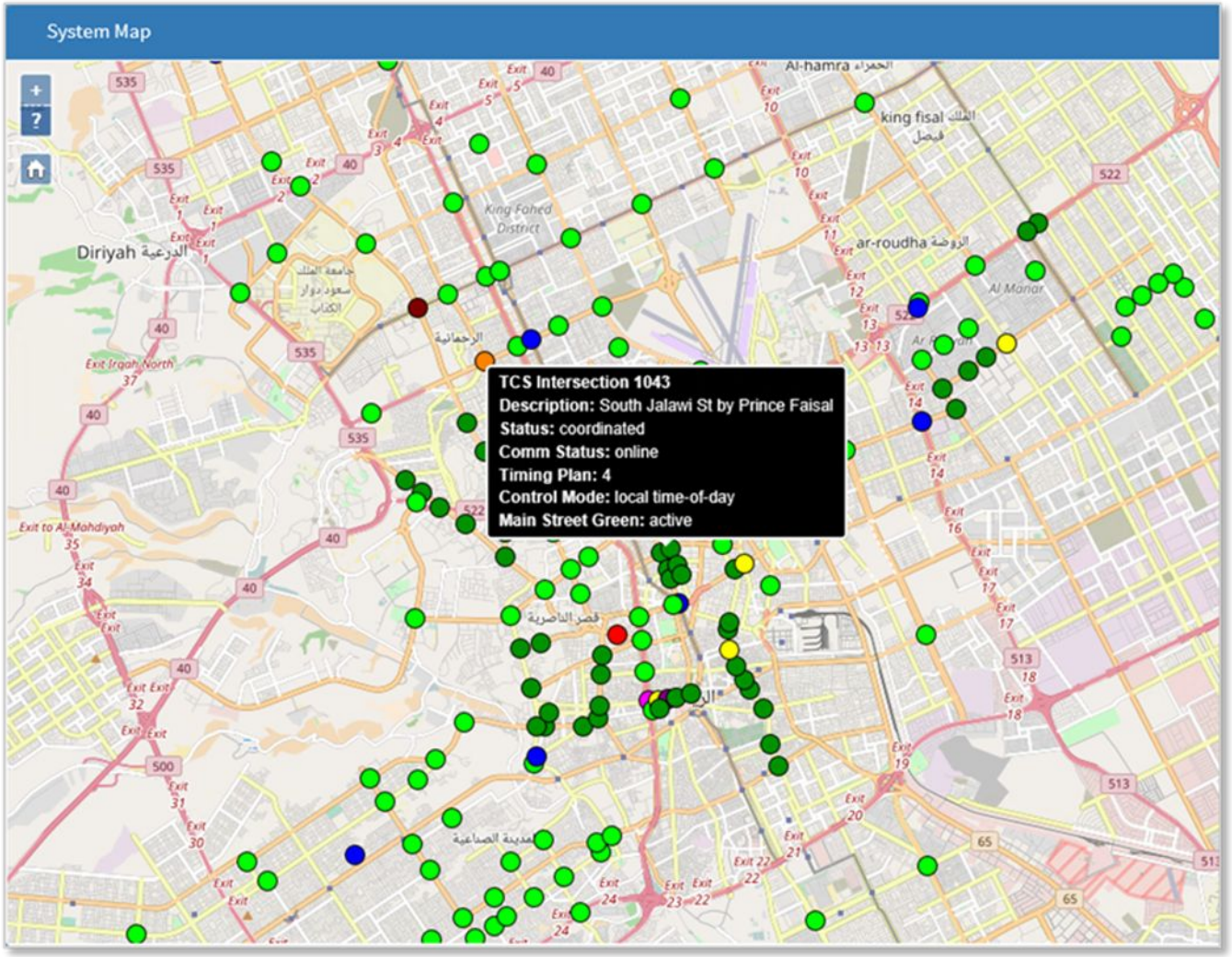
- Reliable signal control to 13,600+ NYC intersections
  - Fully supports NYCDOT standard-based traffic controllers (ASTC)
  - Multiple traffic control modes
  - Controller database management
  - Real-time split monitor
  - Real-time time-space diagram
- Transit Signal Priority
- Traffic Responsive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

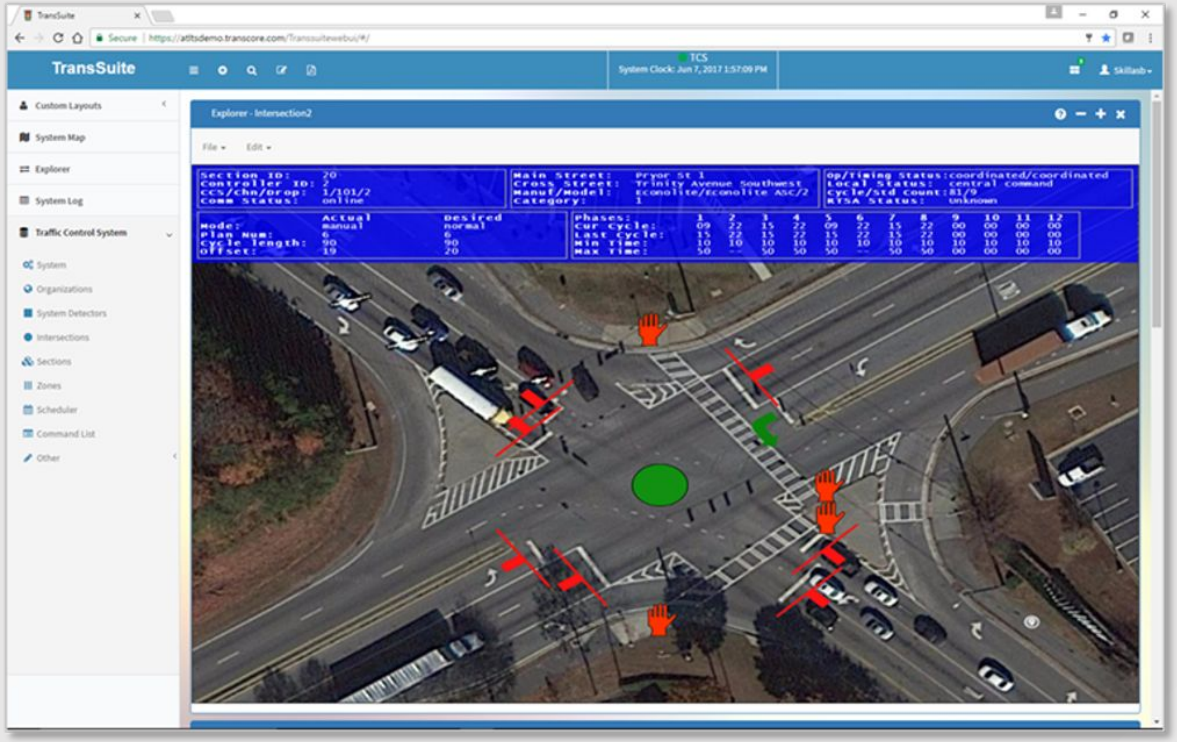


ATMS Explorer Diagrams

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

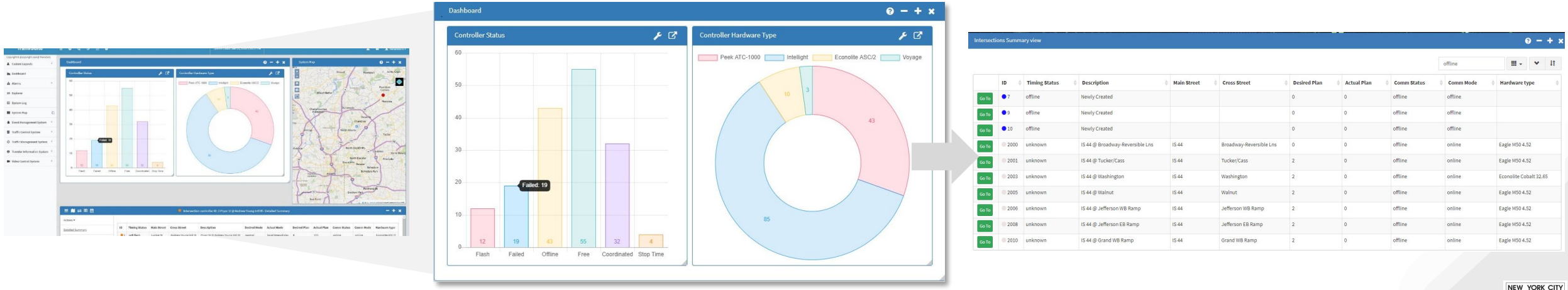
Diagram Elements

- Intersection(s)
- Detectors (system and actuated)
- Pedestrian Control
- Section Control
- Signs, Cameras, File Access, and Hyperlinks



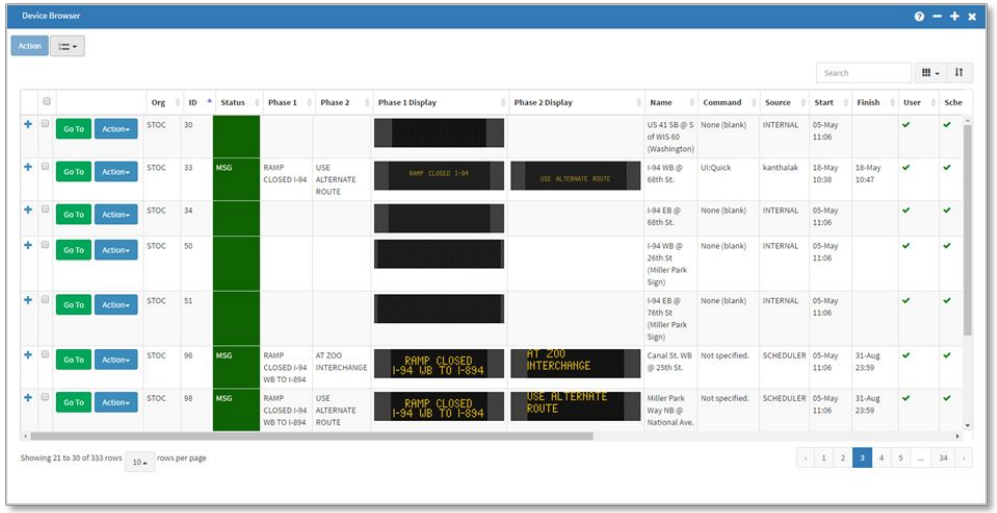
System Status & Performance Measures (Reporting & Dashboards)

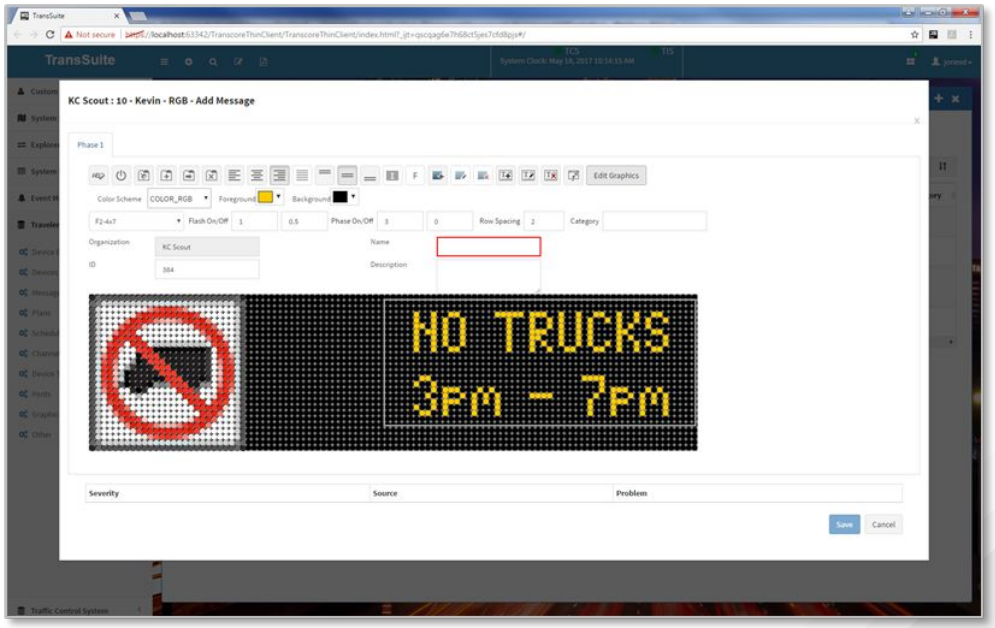
- Ongoing operational status and performance reported by customizable dashboard
- Build your dashboard with widgets of interest
- See operational conditions at a glance, or click on links to dive in and take action
  - some dashboard widgets bring up lists of relevant intersections for details/troubleshooting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



TransSuite Travel Information System

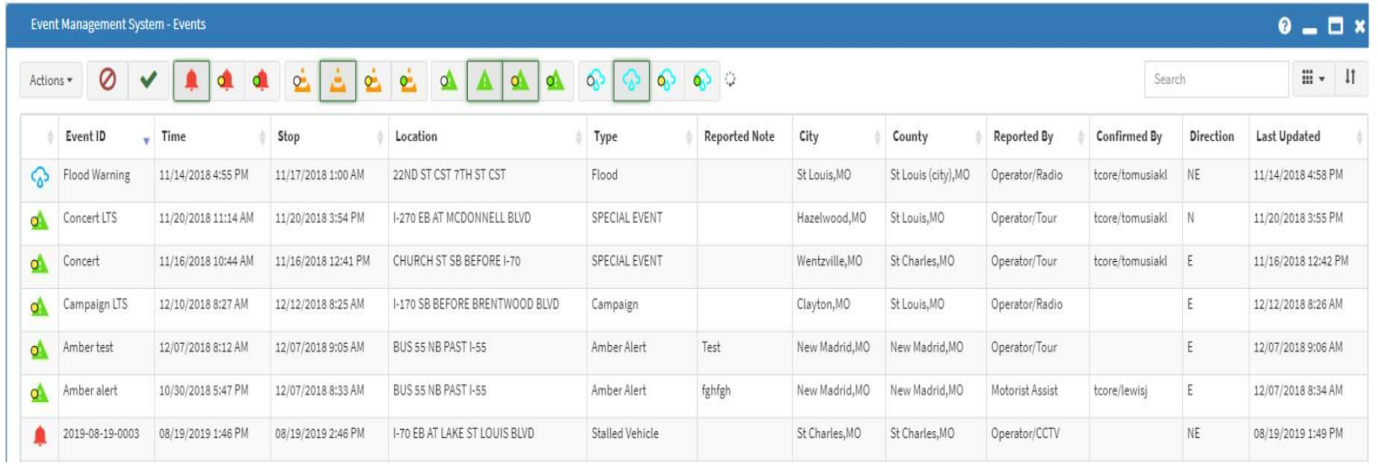
- Variable Message Sign (VMS) management
  - Create and edit messages
- WYSIWYG viewing
- NTCIP supported
  - full color & graphics, including display of Arabic text
- Word dictionary
- Automated scheduling
- Sign plans
- Hierarchical control
- Integration with Automated Message Display

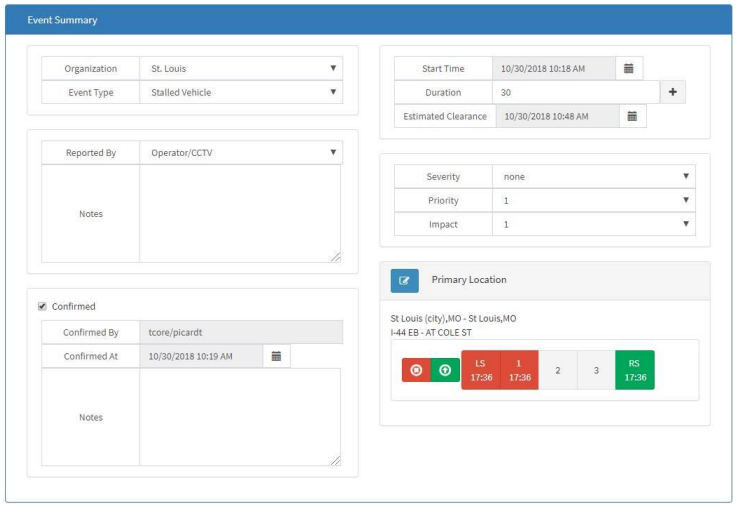




TransSuite Event Management System (EMS)

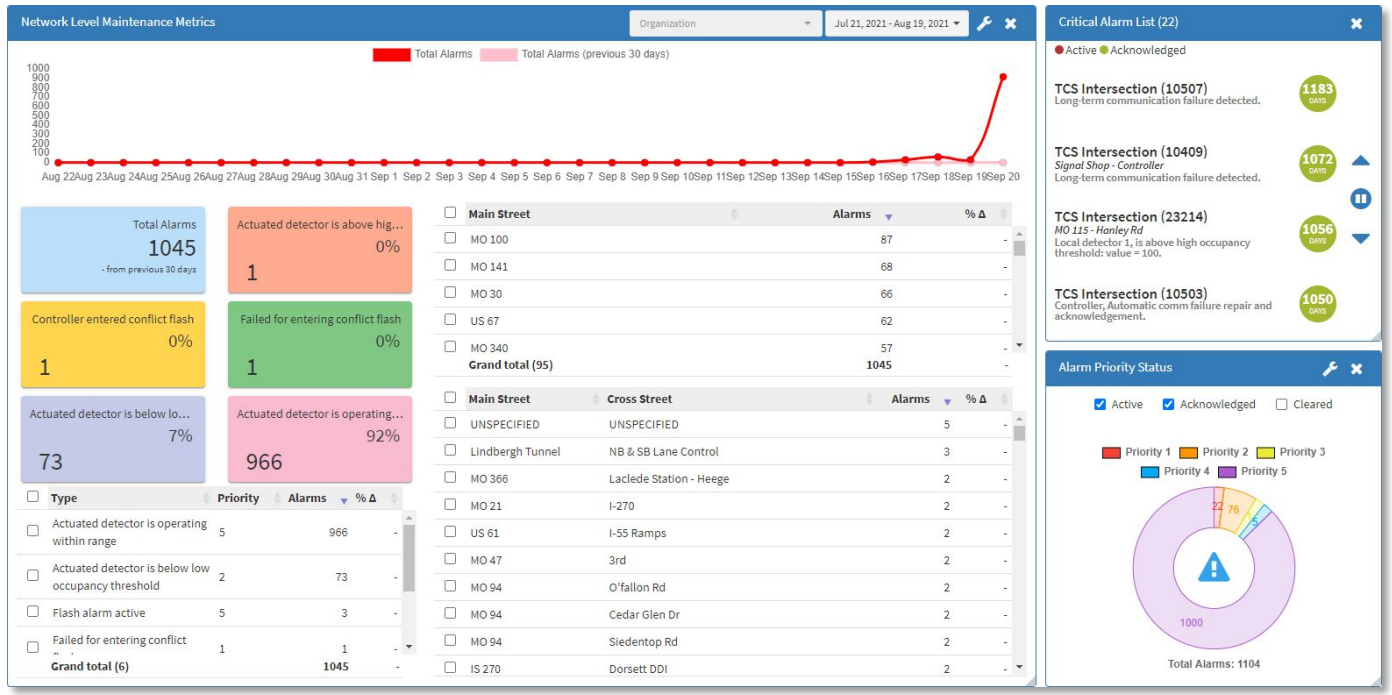
- Monitors incidents automatically detected by the Traffic Management System or manually entered by system users
- Used for:
  - Construction events
  - Planned special events
  - Incidents (manual, automated, external)
  - External incidents from 3rd Party
- CAD / 911
- Logs and displays all operator and system actions
- Standard reports for incident data





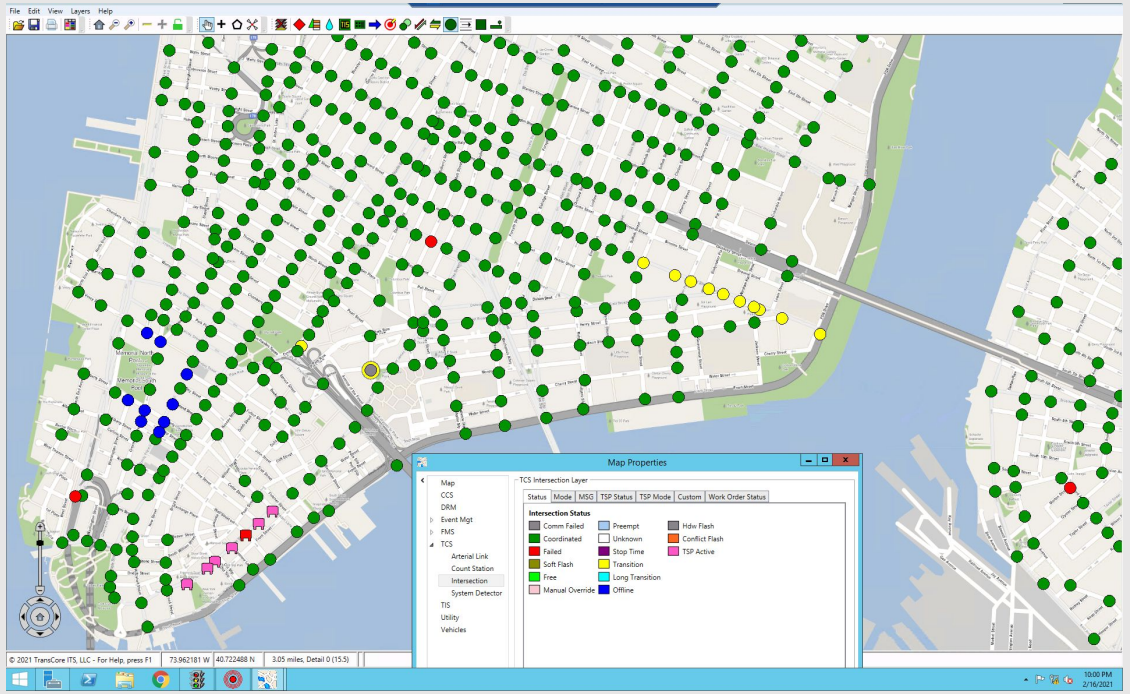
Alarm System

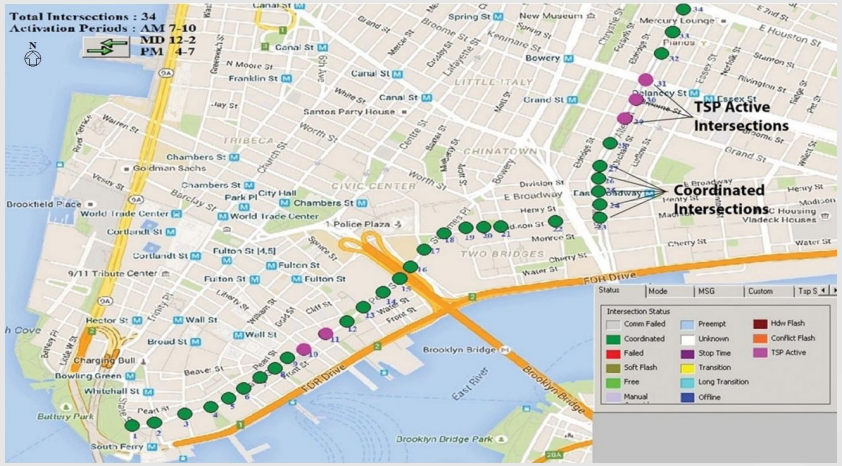
- Manage error messages and alerts for users
  - System hardware
  - Field hardware
  - Communication
  - User access
- Send email/text messages to designated staff
- Use Alarm Codes and Types to filter emails to recipients



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

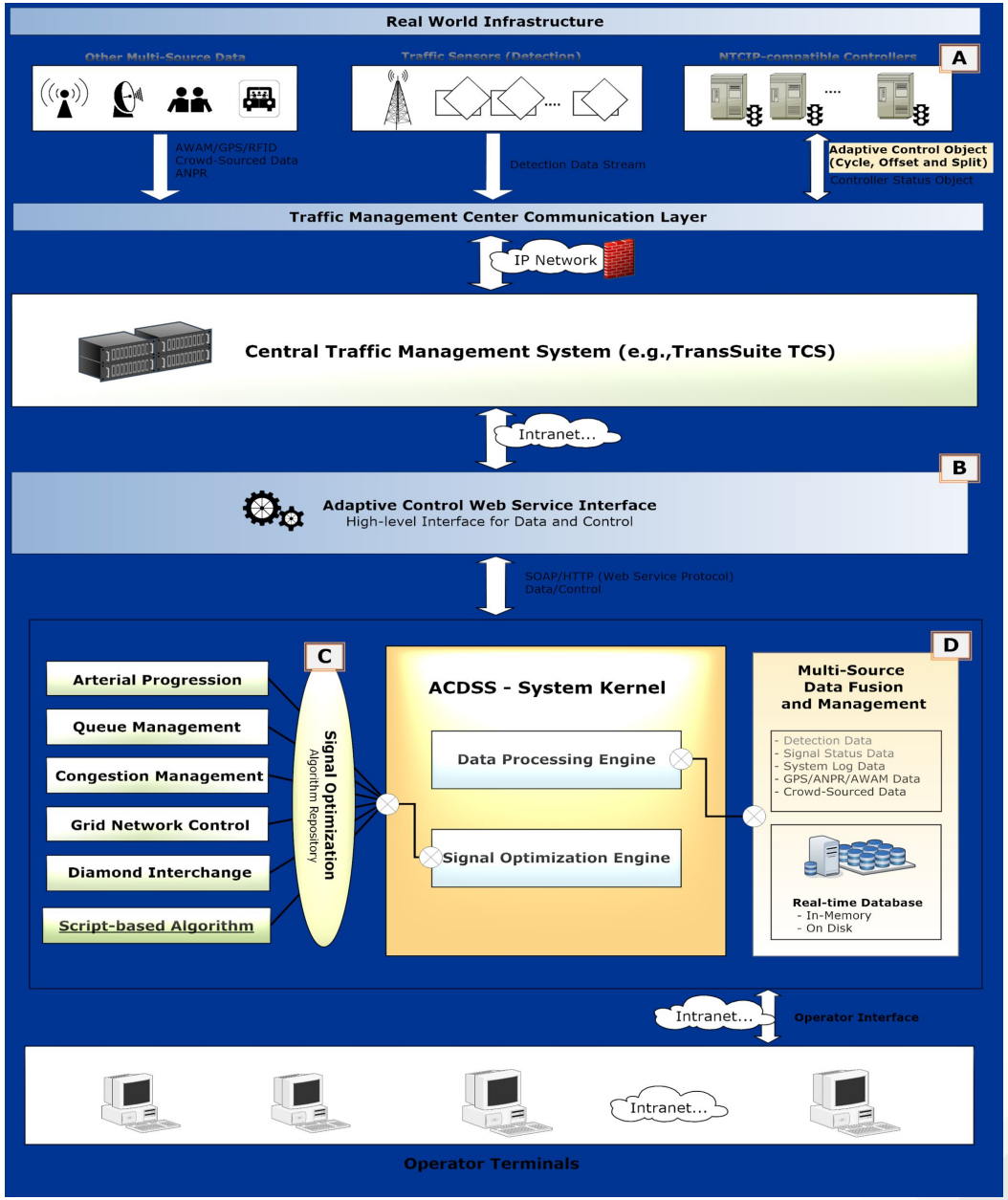
Design Constraints:

- 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



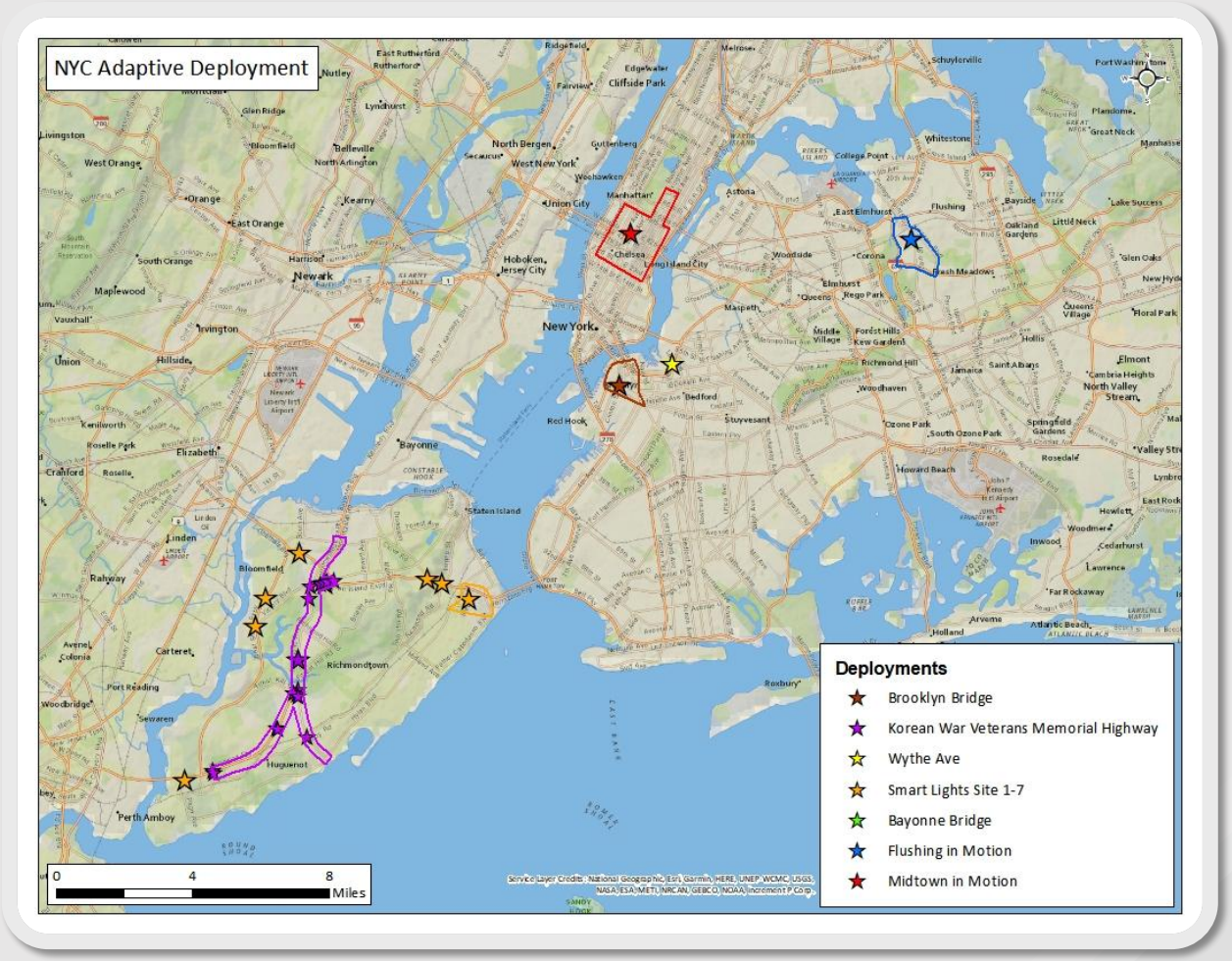
Centralized Adaptive Control

Active Traffic Management (ATM)

- Midtown-In-Motion (MIM)
  - With operator override

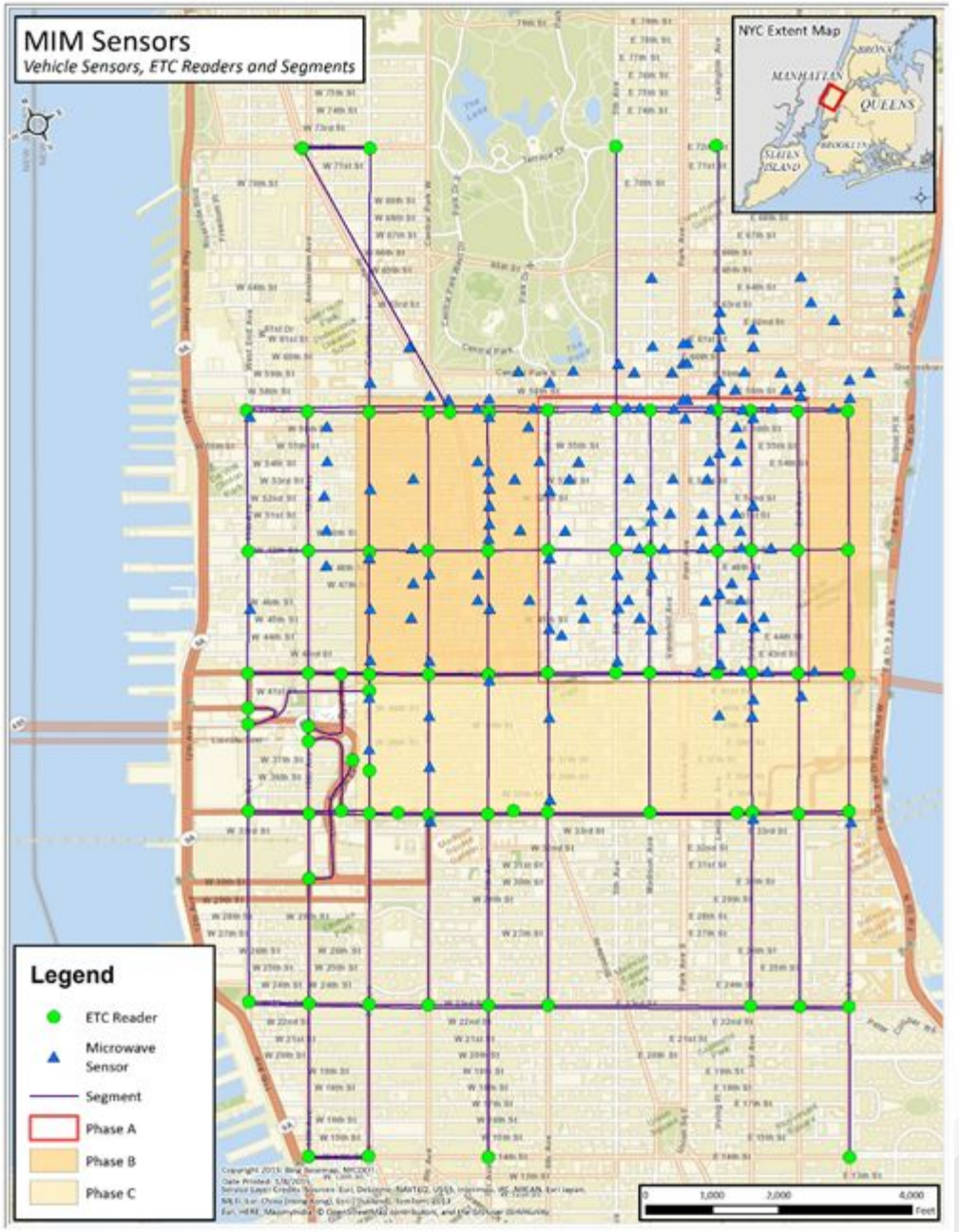
Smart Lights

- Diamond Interchange
- Arterial
- Intersection Clusters



Midtown-in-Motion

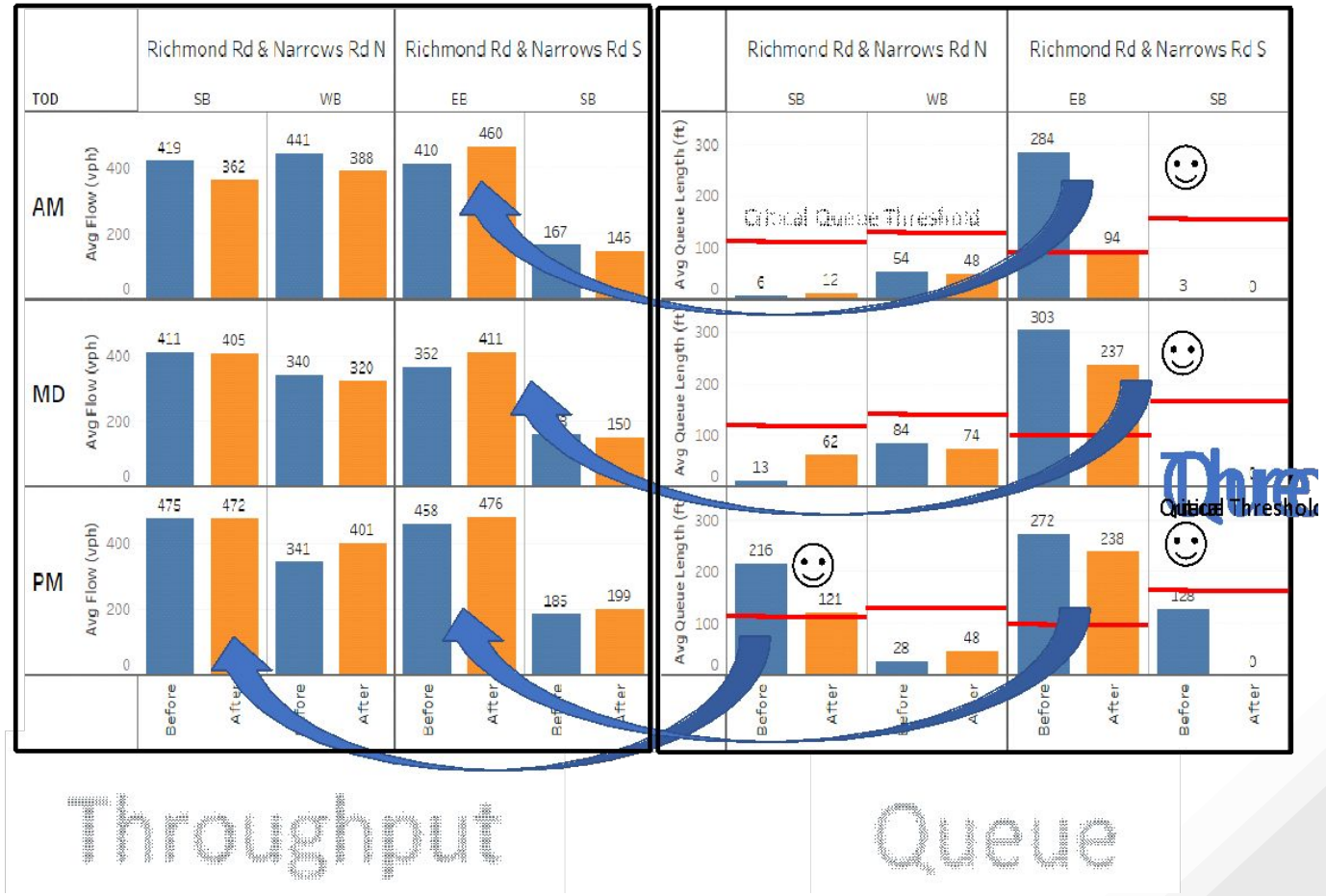
- Developed following approach to accommodate extremely complex grid network
- Hierarchical Control
  - Level 1 – Strategic area-wide control
    - Implemented by Avenue, rebalanced traffic being delivered to the zone, used library of carefully developed plans
  - Level 2 – Tactical control
    - Implemented 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

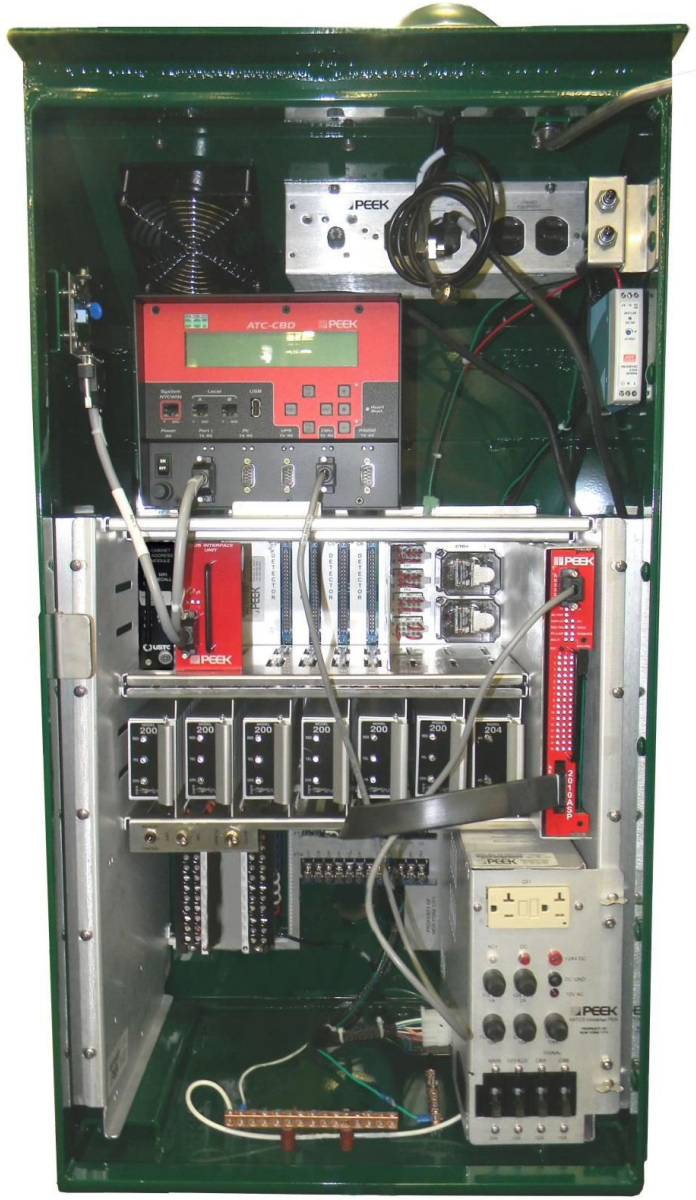
Field Performance



Green Cabinet

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



Typical ASTC-6 Cabinet

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

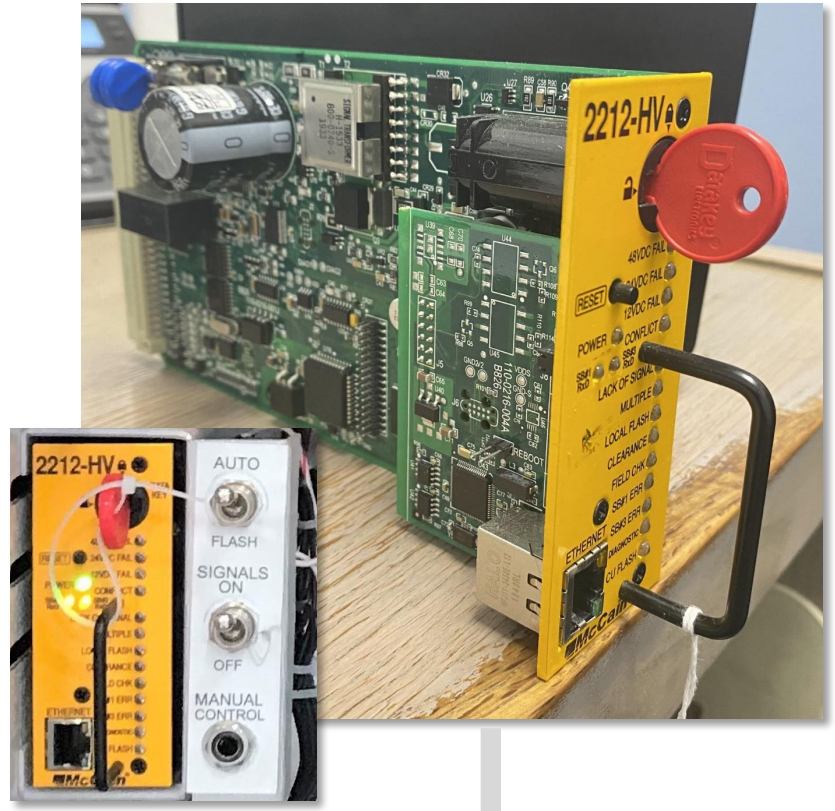
Examples of ATC 5301 Efficiencies/Density

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
  - One-Way/Two-Way intersection – 6 Signal heads, 4 Walk/Don't Ped. heads, 4 count-down Ped. heads.
- 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)
- USDOT - funding ATC 5301 updates and supporting development of a National Standard for LED signals for Low Voltage Op.
- 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
  - 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
  - Traffic Operations (real-time information)
  - Traffic Safety (incident/crash/near-miss)
  - 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