Real-time Big-Data Management Architecture for Adaptive Traffic Signal Control

Presented by

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Agenda

- Background
- Big-Data Challenge
- System Development
- Implementation and Application

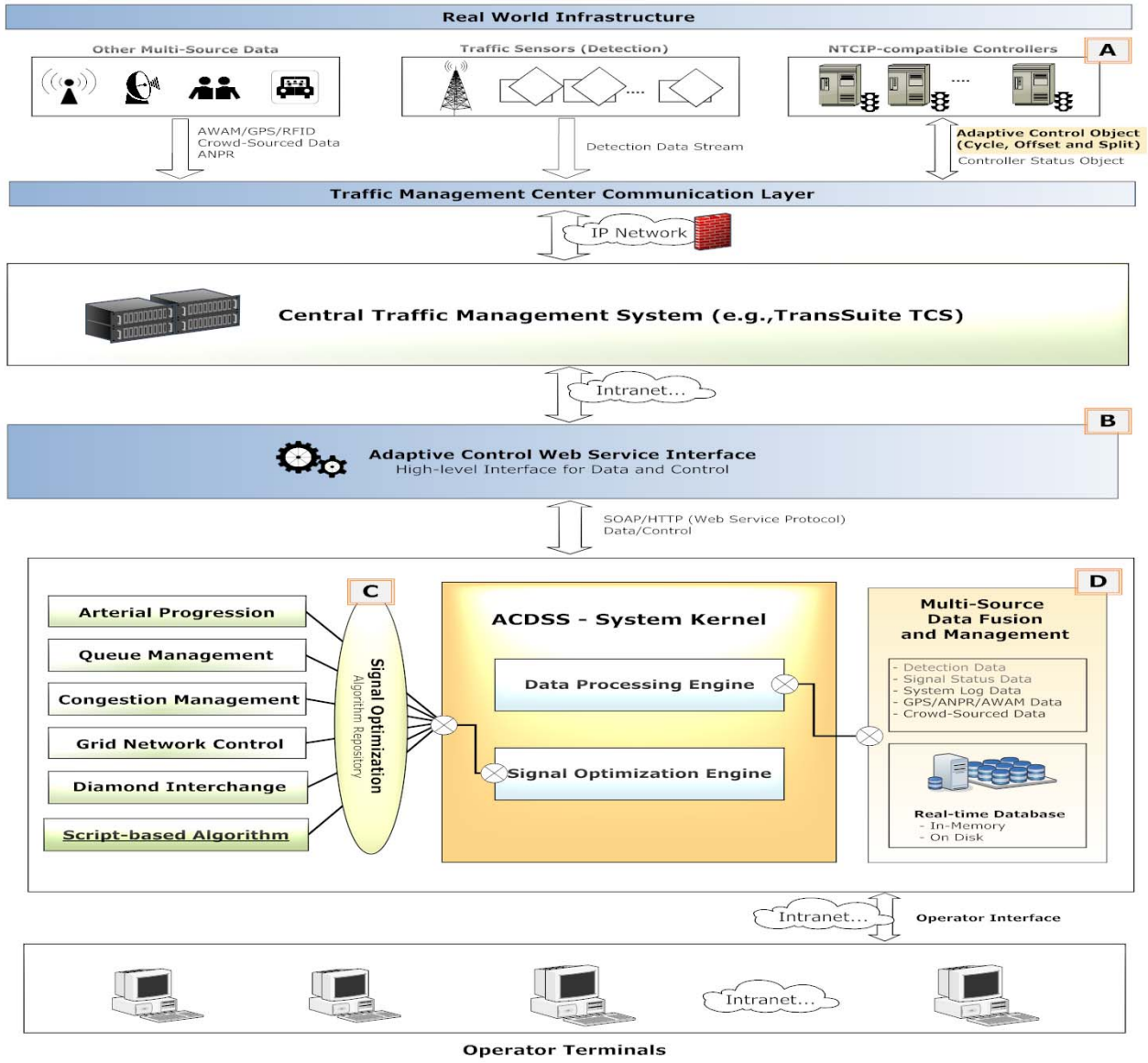
Background

- **Adaptive Control in a Nutshell**
  - The years of 1903, 1912, 1914, 1917, 1918
  - The 1920's-1930's witnessed introduction of fixed-time control and later actuated signal control
  - Major paradigm shift in the 1950's – 1960's
  - Adaptive signal control, concepts, systems, and implementation

Background cont'd

- **Sources of "big data" for real-time control**
  - Conventional data collected at higher resolution
  - Cost-effective technology enables previously prohibitive data
  - Data originally intended for other domain application
  - Controller status, and log data
  - High-resolution event-based data
  - Low-cost traffic sensor network, with high-bandwidth communication
  - Crowd-sourced data

System Context



Big Data Challenges

- ***Acquire*** - *Acquiring* multi-source data (AWAM, RFID, traffic sensor data, controller status data etc.) involves accessing various data sources and retrieving the data using appropriate protocols.

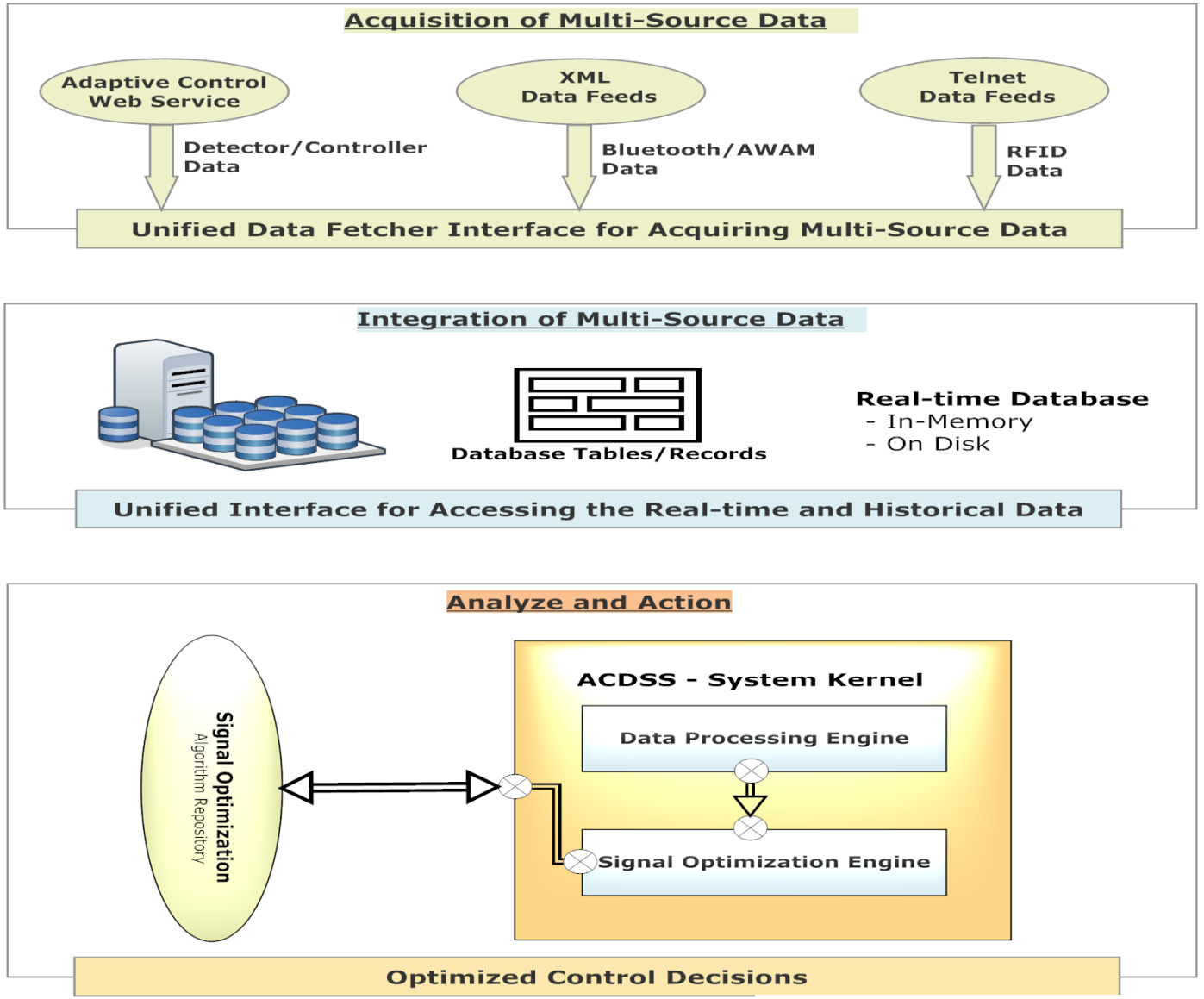
- ***Integrate and Organize*** - Heterogeneity in data formats, the different data transmission protocols, and the fact that new types of data keeps emerging

- ***Analyze and Action*** – Historical and real-time time series analysis and low-latency action

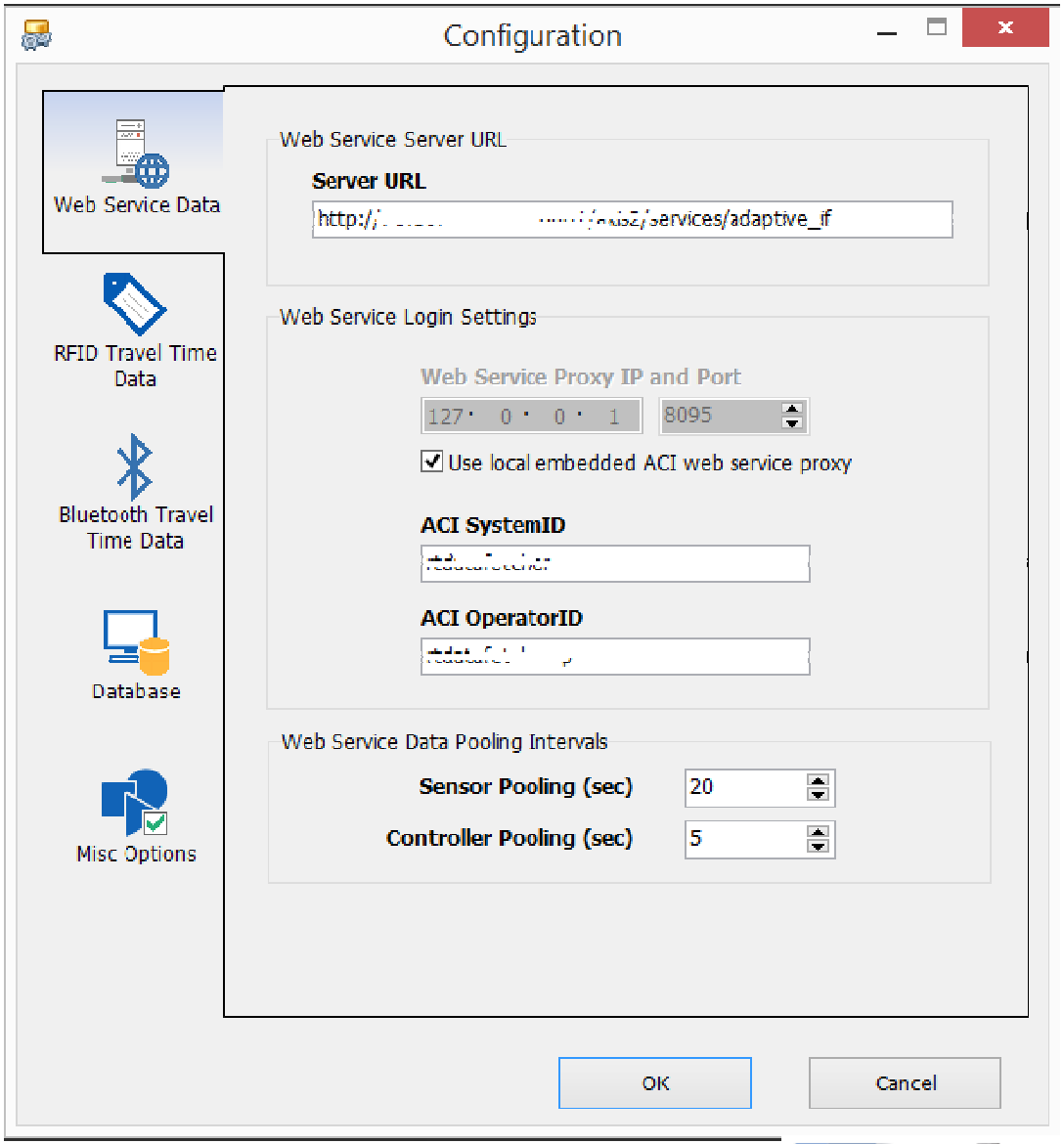
Acquisition of Data

- Data source that publishes data in XML format via a public accessible HTTP URL (AWAM data, and other XML-based data);
- Data source that publishes data using Telnet protocol (RFID data);
- Data source that publishes data using the ACDSS Adaptive Control Web Service Interface (detector data, controller status data);

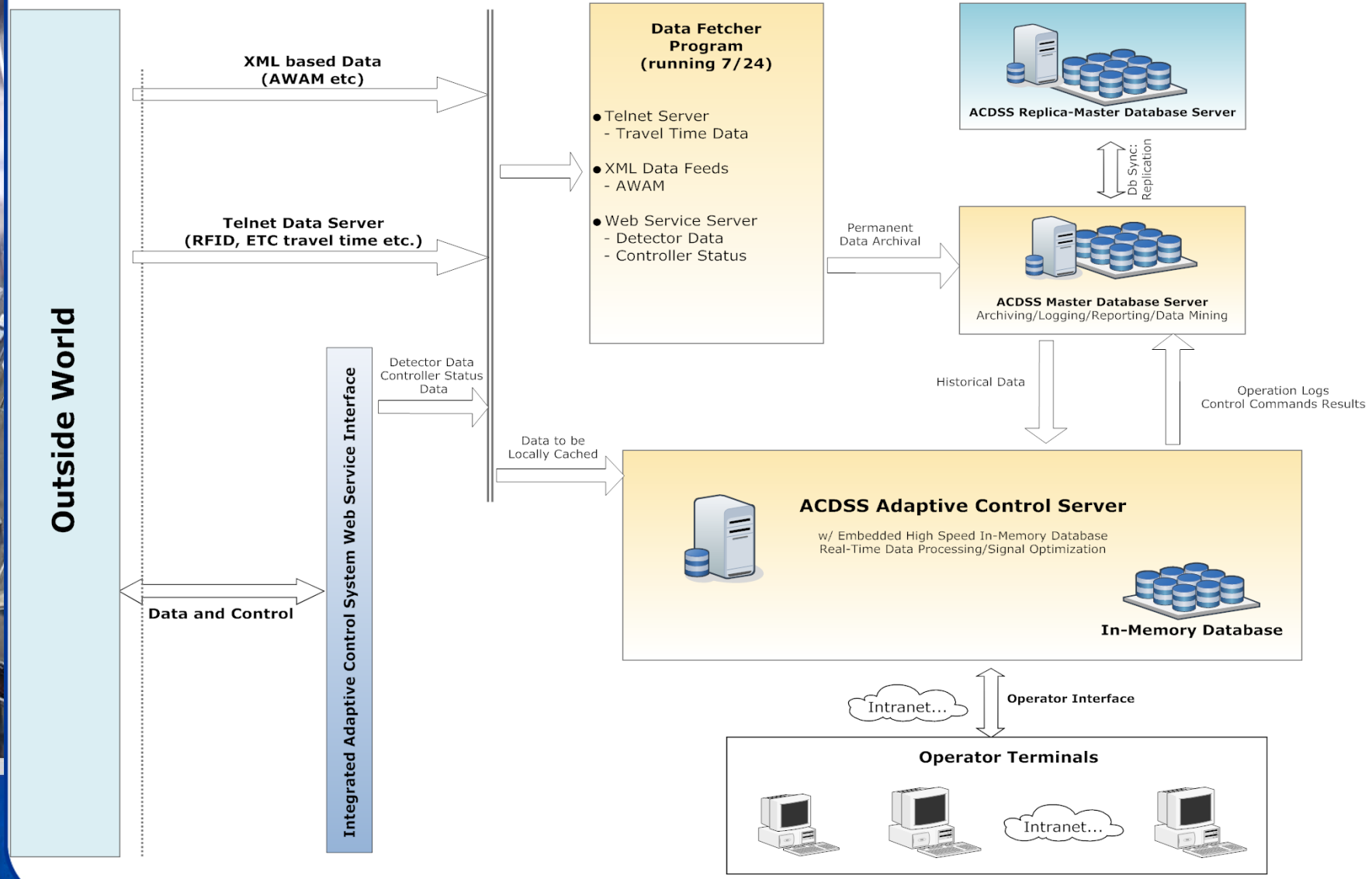
Integration, Analysis and Action



Data Fetcher Service



Complete Picture



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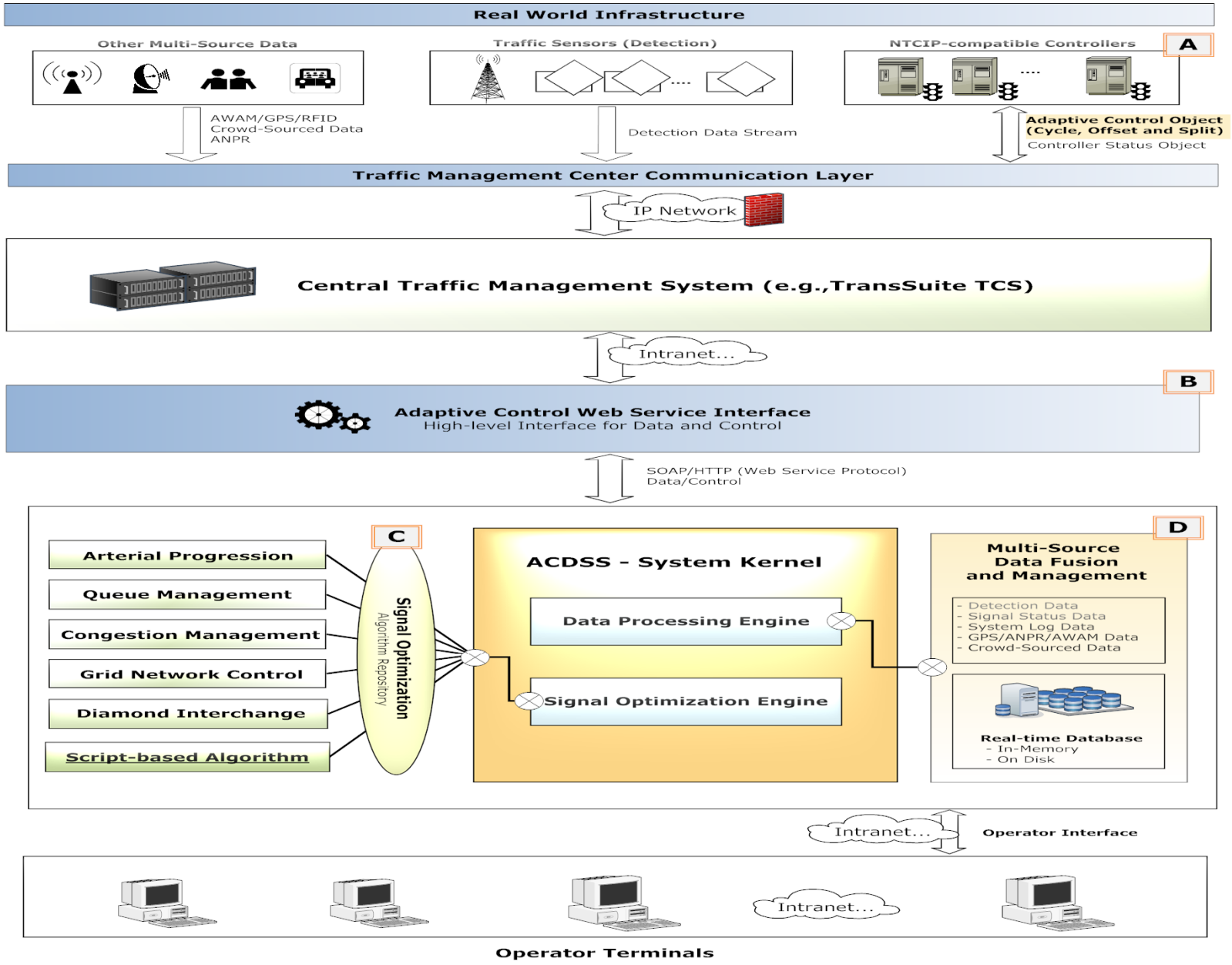
Implementation and Sample Applications



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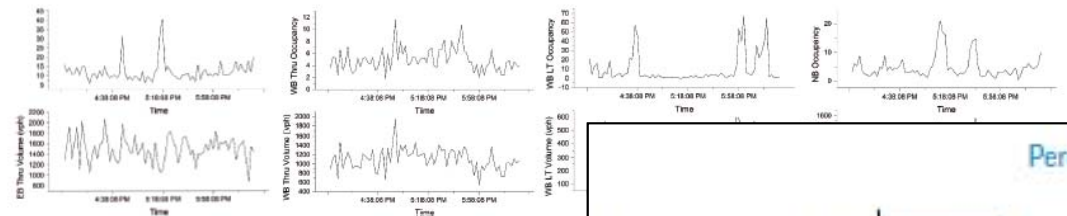
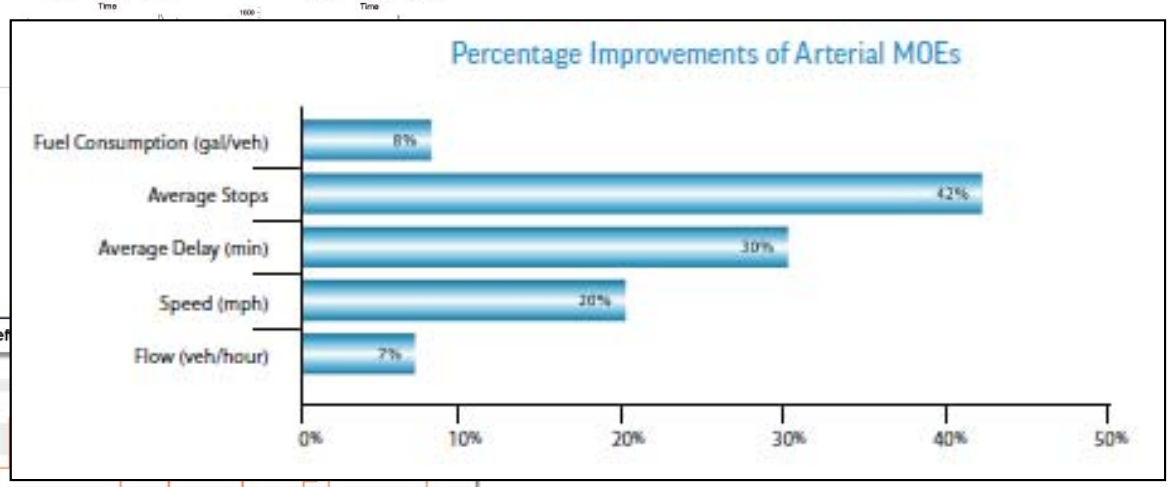
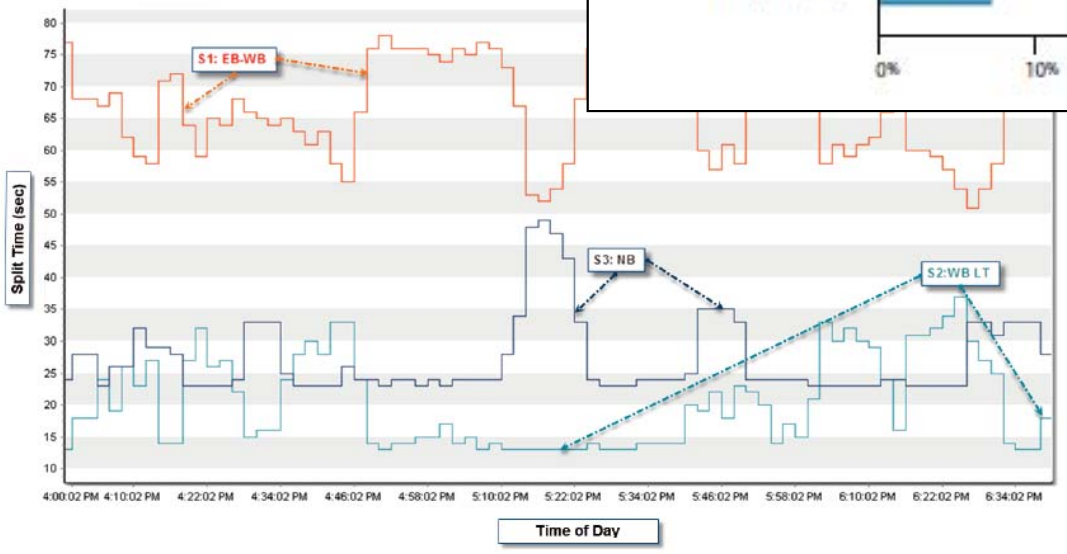
Victory Blvd. – Staten Island







New York City

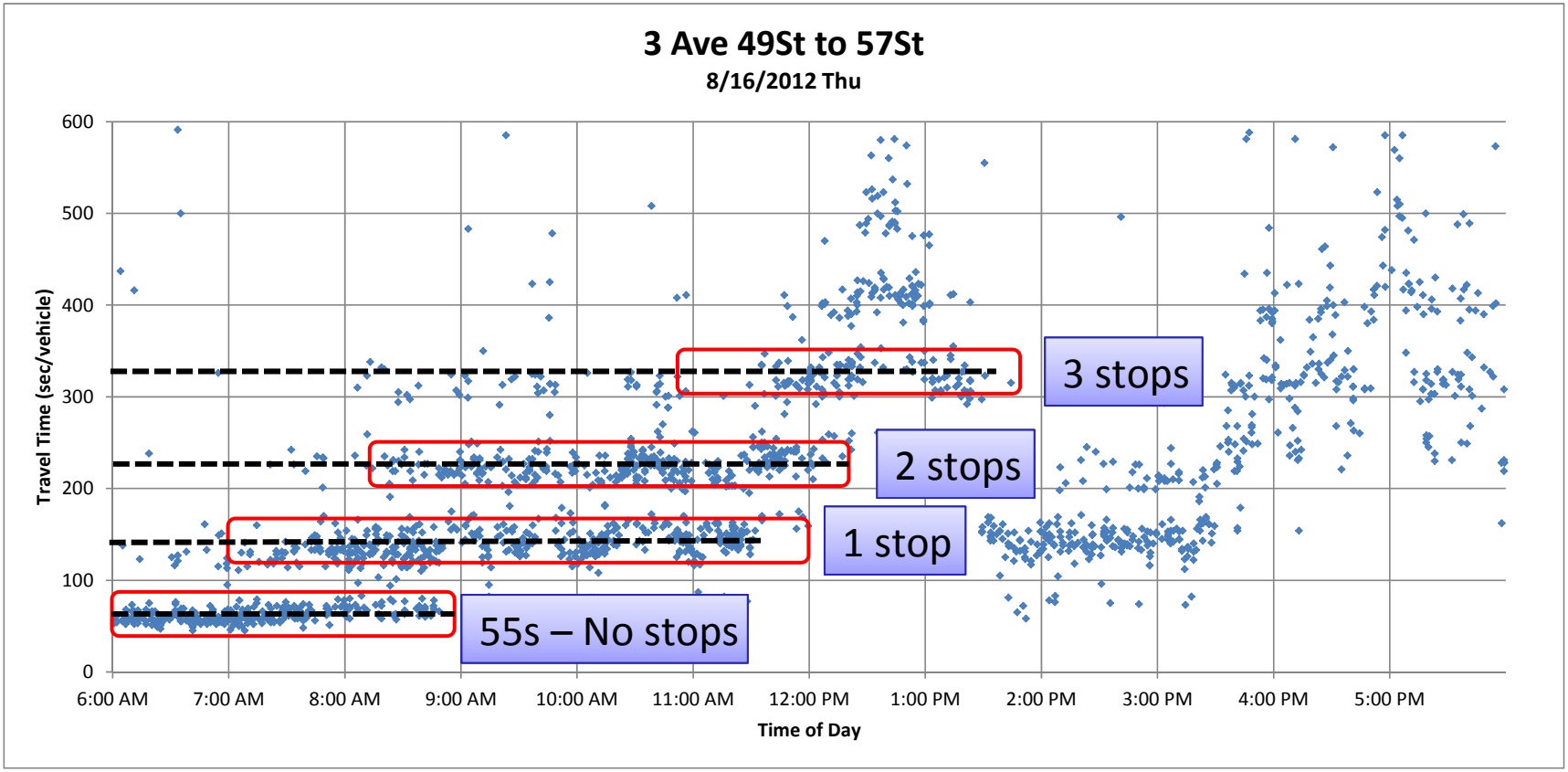
- Dense grid network
- >12000 intersections
- > 300 under real-time control
- Oversaturated
- > 500 RTMS sensors
- > 100 roadside EZ-Pass tag readers collecting large-scale per-trip travel time data (4.5 million records daily), from 8 million commuters

Big-Data for Real-time Control

- Level 1 – Strategic Area Wide Control
  - Implemented by avenues
  - Rebalance traffic being delivered to the target control area
  - Real-time selection from a library of pre-designed congestion management plans
- Level 2 – Tactical Control
  - Implemented at critical intersections
  - Complimentary to Level 1 with splits dynamically optimized
  - Balance queuing and minimize the gridlock potential

Travel Time

- Per-trip travel times are processed and analyzed, to derive measure of congestion levels



Level 1 Control

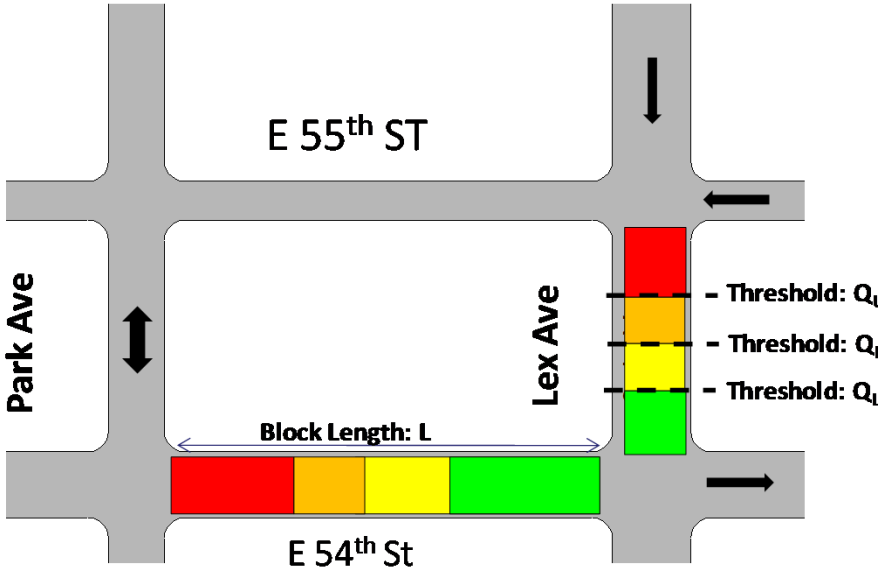
- Trigger conditions based on real-time travel time data

Travel Time	Area Wide Control Plan
2 Stops	Network Balancing Plan (NBP)
3 Stops	Access Control 1 (AC1)
3+ Stops	Access Control 2 (AC2)

- NBP – Simultaneous offset, minimal green tapering
- AC1 – Simultaneous offset, increased green tapering
- AC2 – Simultaneous offset, higher green tapering

Level 2 Control

- Robust queue control at critical intersections
  - A local congestion index called Severity Index (SI) is derived from flow/occupancy
  - Splits are dynamically optimized to minimize the grid lock potential



SI=1		Q < L/3
SI=2		L/3 < Q < 2L/3
SI=3		2L/3 < Q < 3L/4
SI=4		Q > 3L/4

Thank you