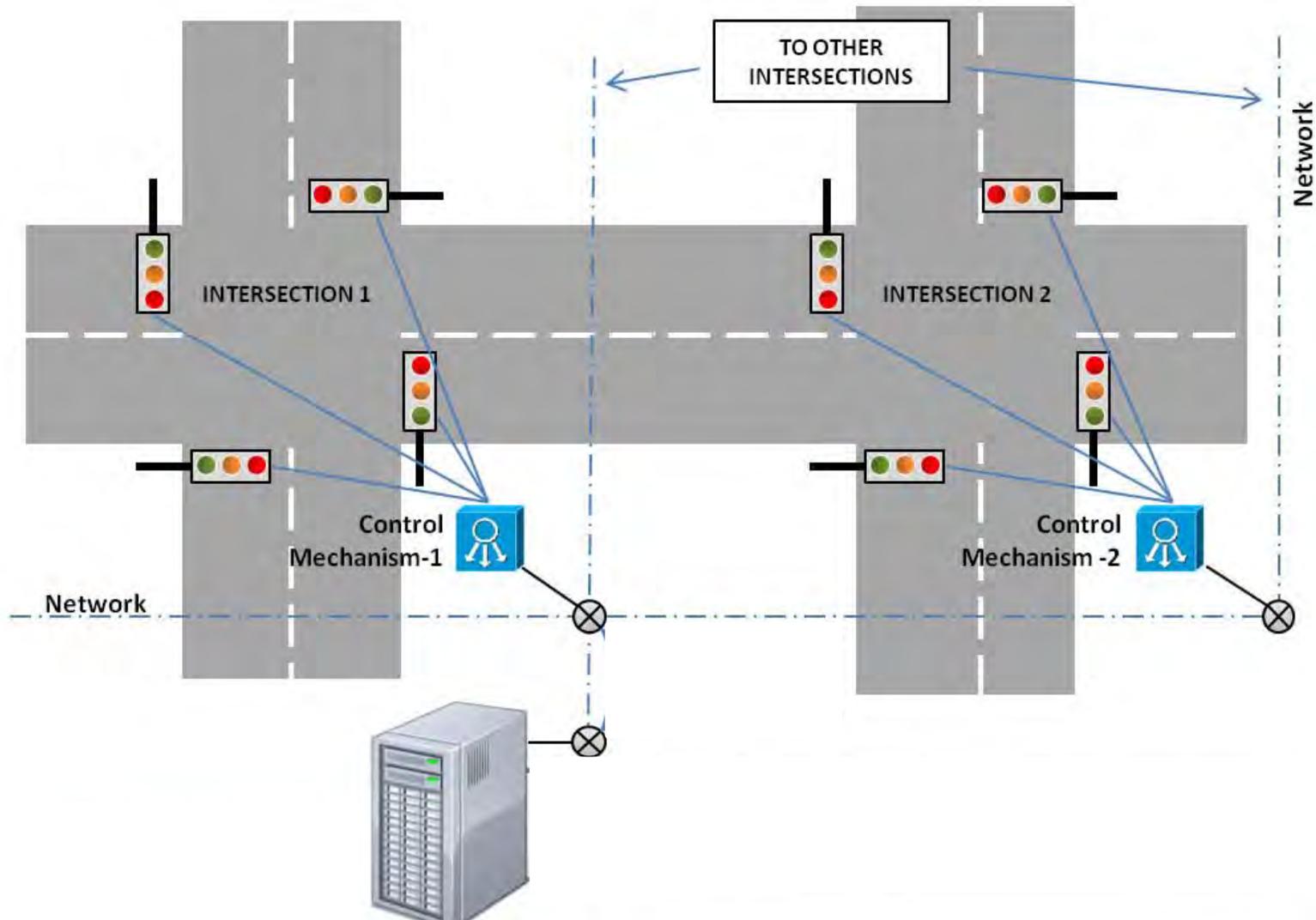


The logo for DKS, featuring the letters 'DKS' in white on a dark blue square background, followed by the tagline 'Experts Connecting Communities' in white text.

**DKS** Experts Connecting Communities

# Central Traffic Signal Systems Primer

# The Central Traffic Signal System

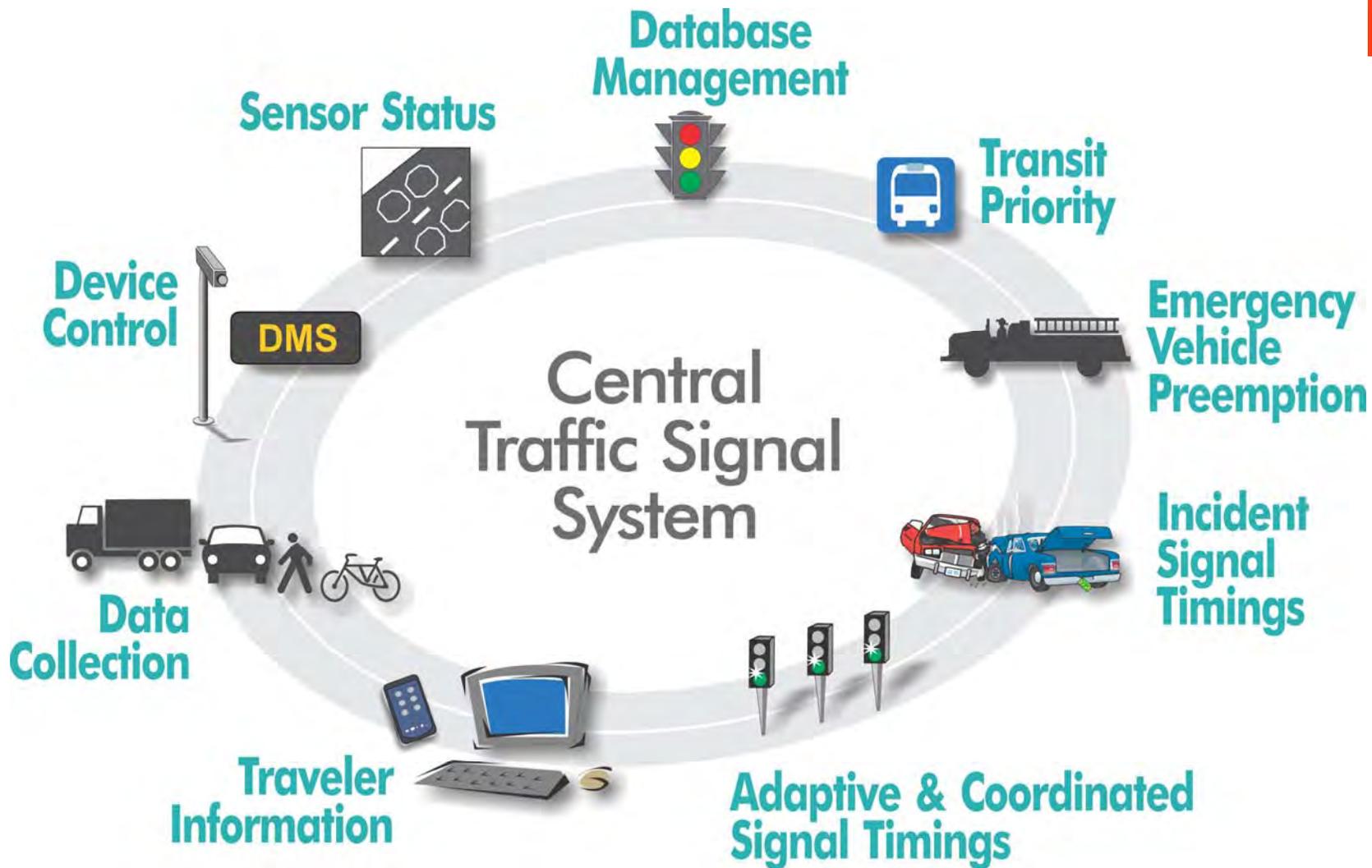
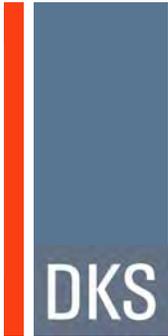


# The central traffic signal system enables remote management and control

DKS



# Current Signal System Capabilities



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# History of SW Washington ATMS

# SW Washington Signal System Timeline



**Way back up  
until 2003**

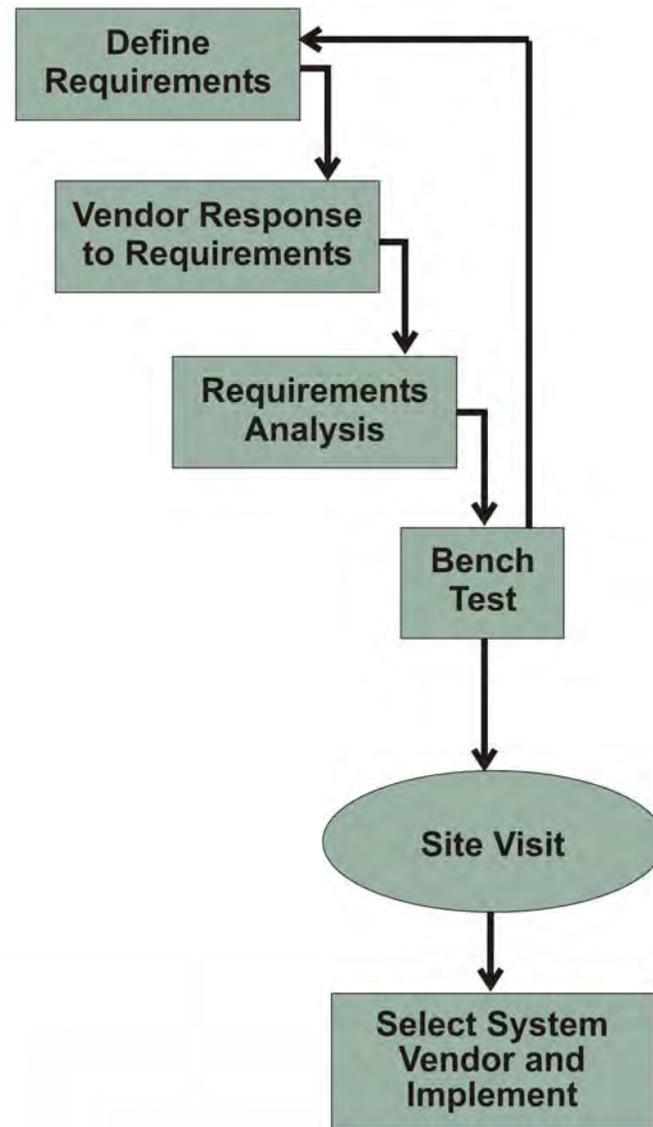
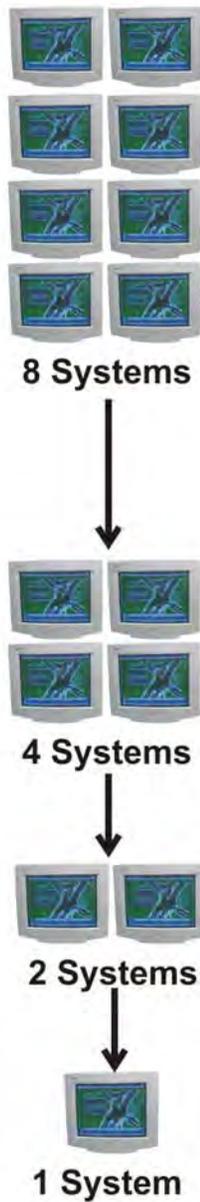
**2003 - 2004**

**2004 - Present**

MultiSonics VMS	Signal System Evaluation and Testing	Operating ATMS.now
-----------------	---	--------------------

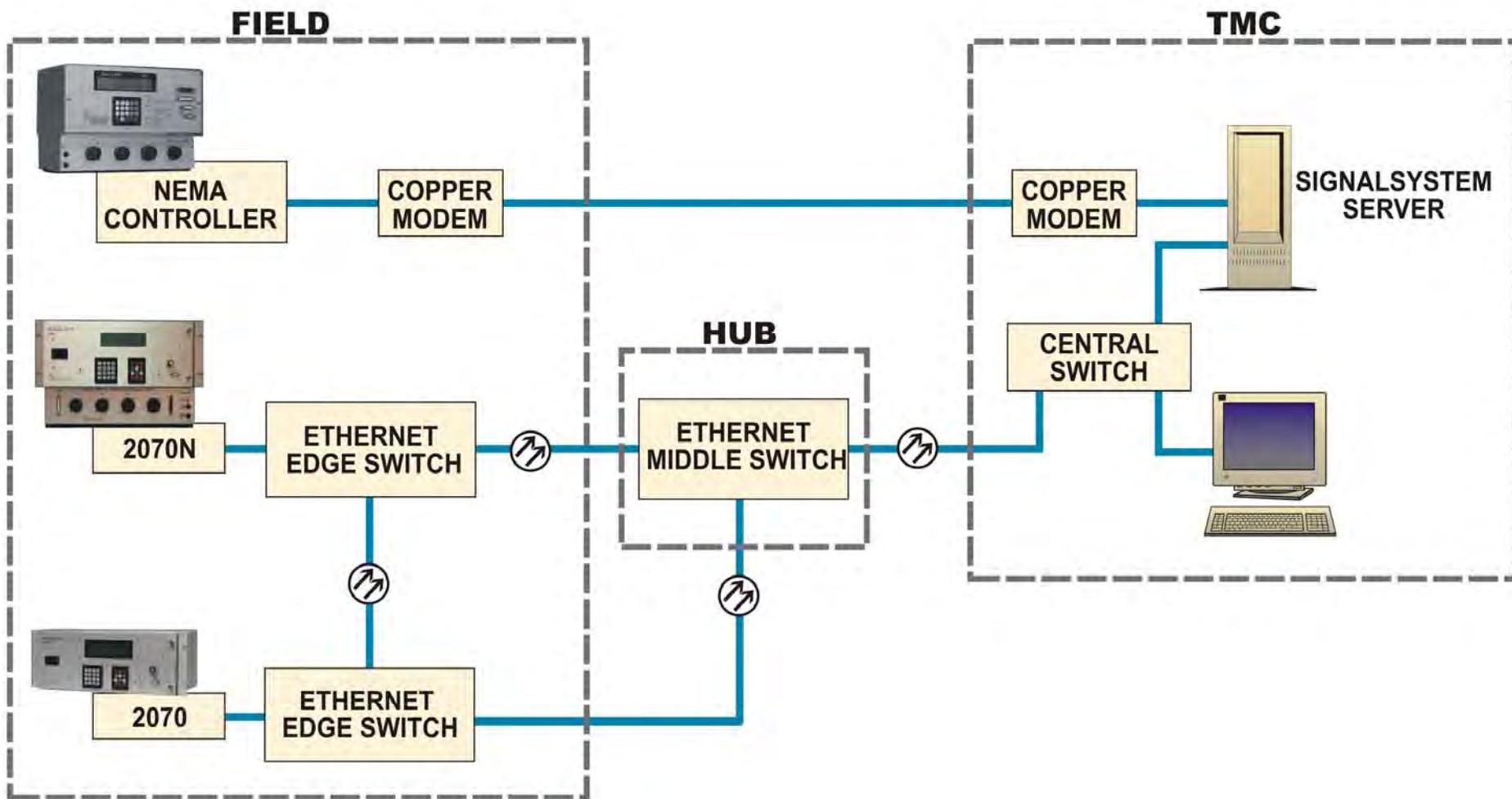
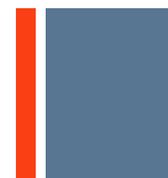
# Signal System Procurement Process

2003-2004



**Technical Advisory Committee**  
(WSDOT, Vancouver Maintenance, Vancouver Engineers, FHWA)

# System Diagram



 - Fiber Optic Cable

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# ATMS.now Capabilities



# Monitor intersection status and reporting

NKS

The screenshot displays the ATMS.now 2.2 software interface. The main window shows a map view of an intersection area, with a pop-up window displaying details for ID 23: NAME: Bench NTCIP TS2V61.x ENET - 23. The interface includes a menu bar (Home, Definitions, AVL, SynchroGreen, Assets, Reports) and a toolbar with various functions like Upload, Download, View, Compare, Copy, and Local Download. A secondary window titled 'CapS Camd - ArcMap - ArcEditor' is open, showing a detailed view of the intersection with various camera and sensor locations marked. The bottom status bar indicates 'Ready' and lists various system components like Recent Alarms, Alarm History, System Notes, Current Users, Incident Trigger, Daktronics, Adaptive, Selected Details, AVL Data, and Trip Logs.

# Monitor intersection status and reporting

**Map View**

Legend

- Controller**
  - Idle
  - OK
  - Offline
  - Flash
  - Coord. Failure
  - Preempted
  - ID
- Event**
  - Incident
  - Construction
- Congestion**
  - Low
  - Medium
  - High
  - Vol/Occ
- Vehicle**
  - Fire Truck
  - Ambulance
  - Rescue Support
  - Bus
  - Lite Rail

Map View

ID : 82      Date : 1/12/2007      Time : 12:53  
 Name : Pacific St \_DelMar Ave  
 Drop : 2      Rev : 65.0p      Ring    Min Max Ped  
 Free : COORD      Coord : SYNC      1  
 Cycle : 100      Source : TEST      2  
 Seq : 1      Offset : 25      3  
 Preempt:      Pattern : 1      4  
 Ok % : 99

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Phase	Red	Green	Red	Red	Red	Green	Red	Red								
Overlap																
Call		✓		✓												
Ped		Red		Red		Red		Red								
Ped Call																
Detector																✓
17 - 32																
33 - 48																
49 - 64																

X: 749689.770322186 Y: 848315.541450723 (feet) X: 231 Y: 87

List Map

# Adaptive signal timing

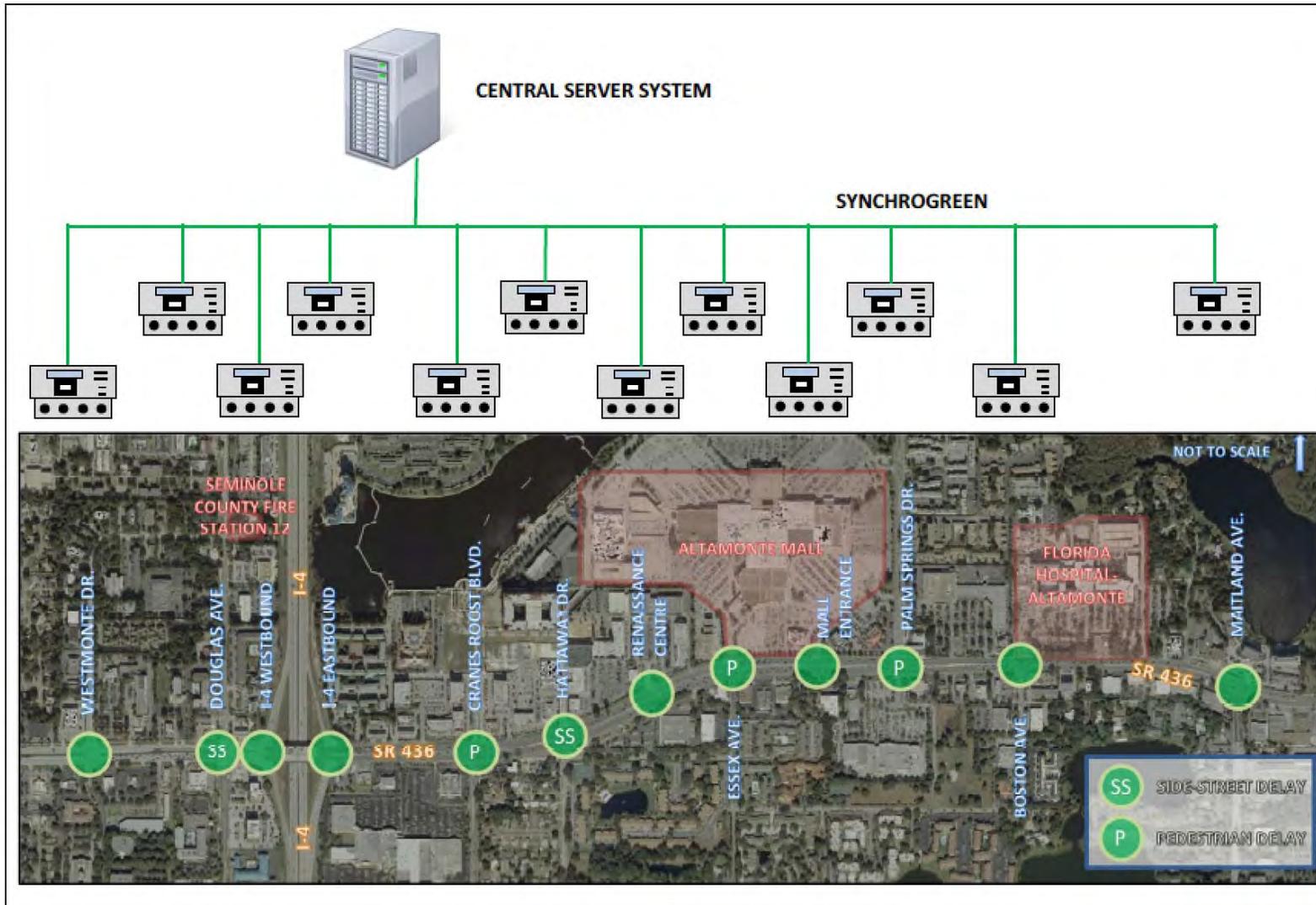
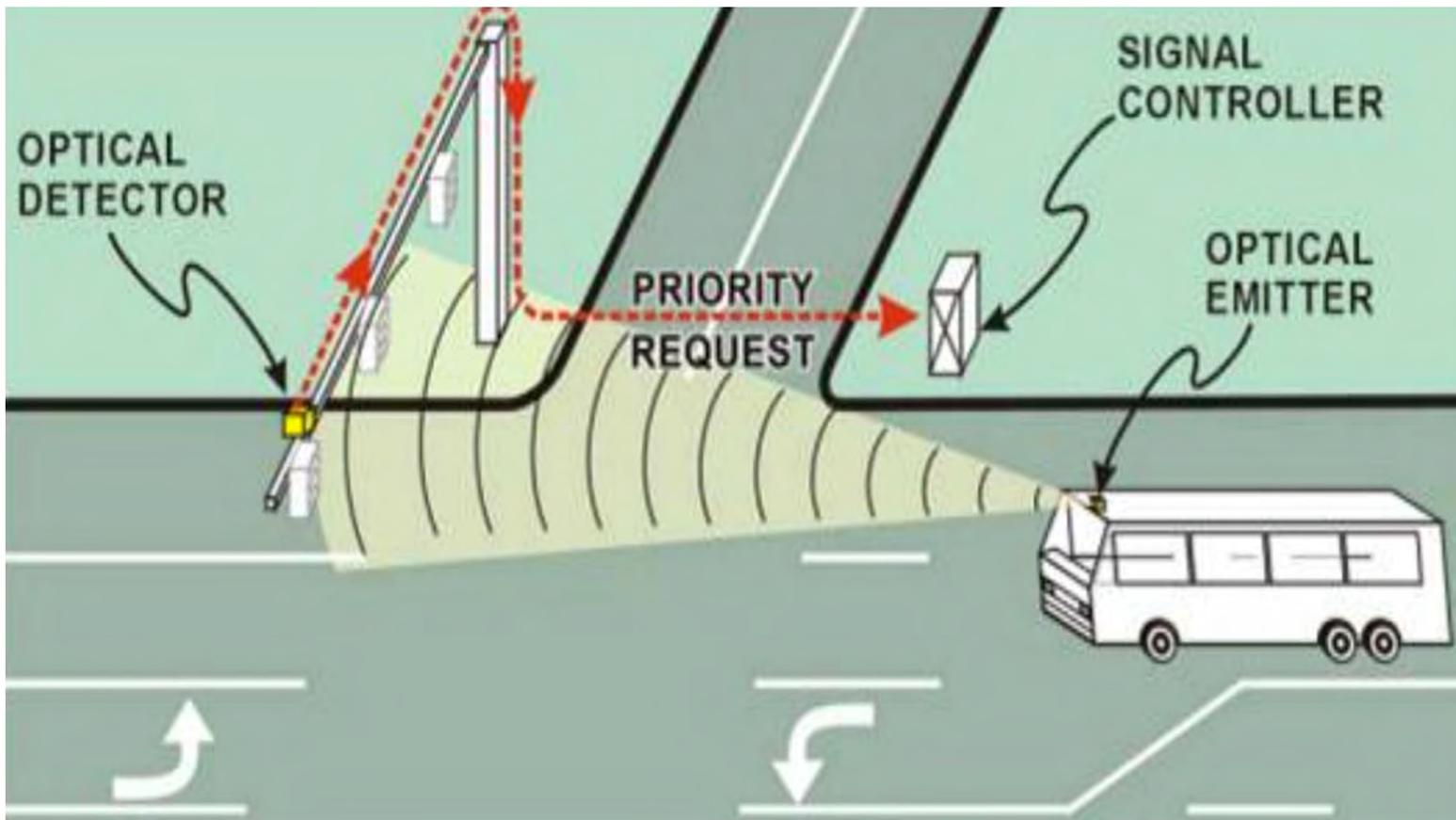
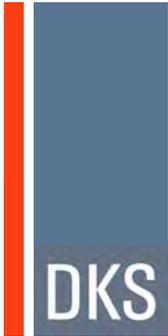


Figure 1 - SR 436 Deployment in Seminole County, Florida

# Transit signal priority



# Performance reports



## Purdue Coordination Diagram

Controller: 2356 Purdue Controller

Coord Phase/Overlap: PH2

Phases: 2,8

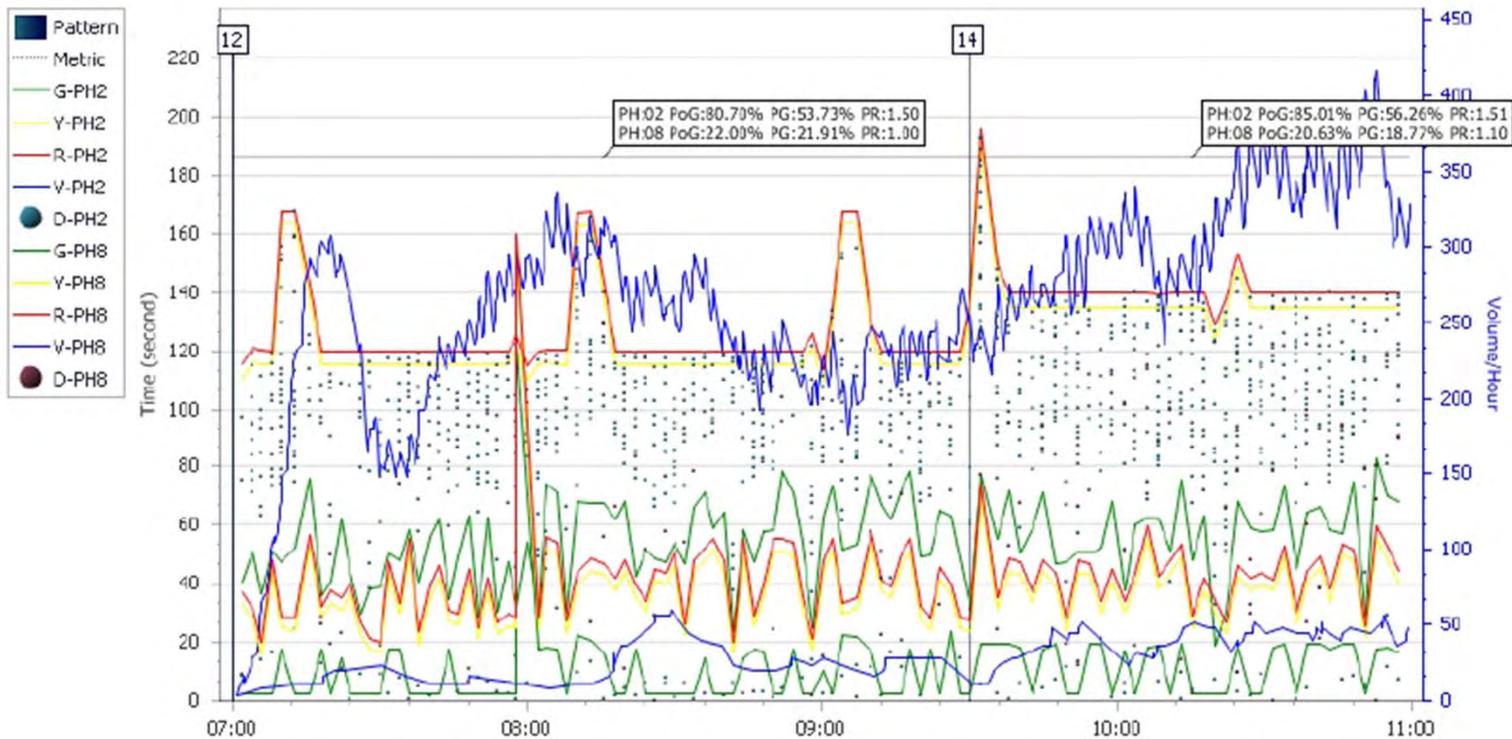
Overlaps:

Time: 12/01/2014 7:00:00

Start Color: Red

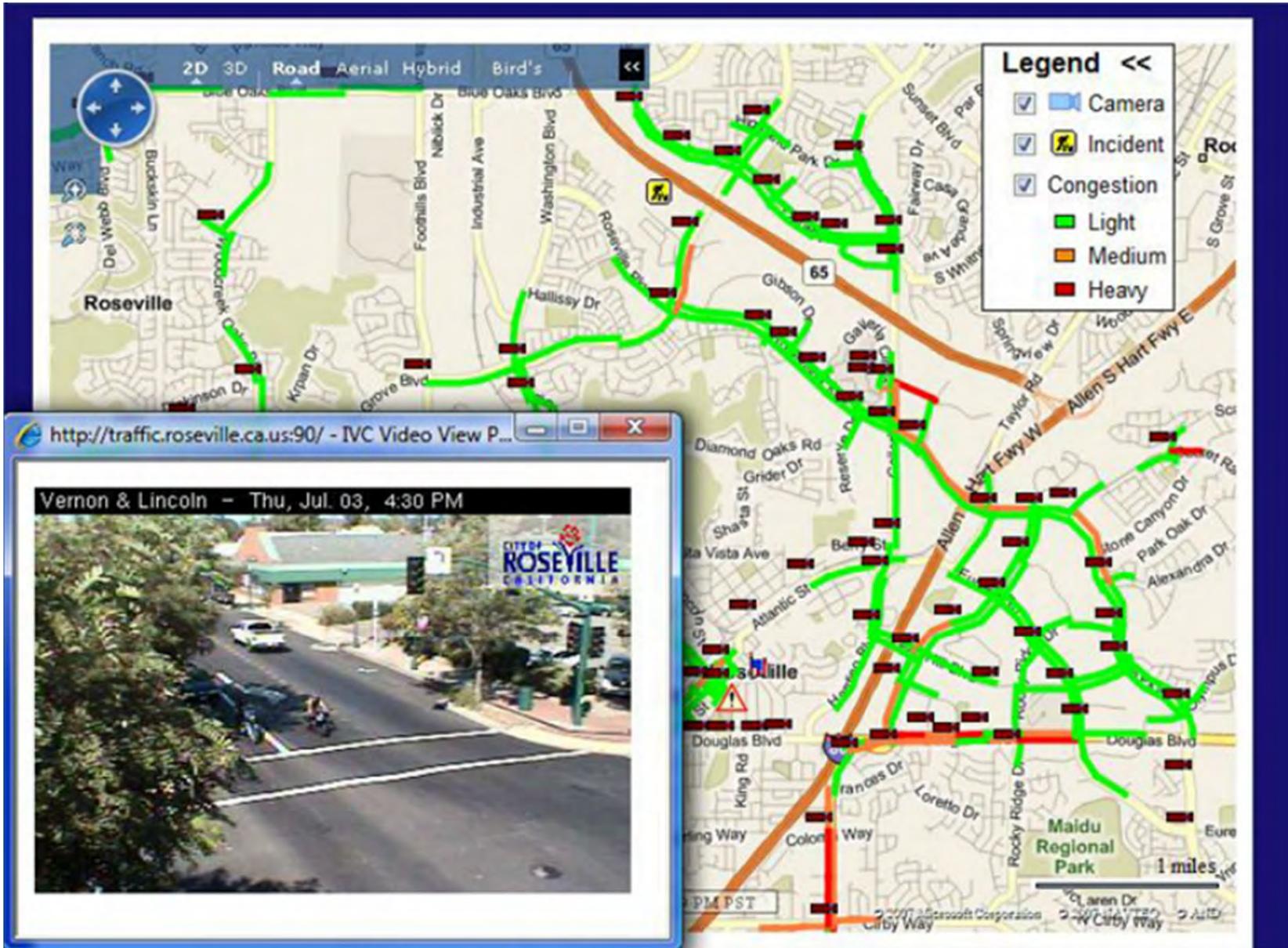
Detectors: 2;4

12/01/2014 10:59:59



# Camera control and monitoring

DKS



# Dynamic message sign control

The screenshot displays a software interface for dynamic message sign control. The main window shows a satellite map with several red location markers. A 'Device Properties' dialog box is open, showing fields for 'Type' (Deltronics), 'ID' (1), and 'Name' (Deltronics Board [2]). Below these are 'Parameters' for 'Name' and 'Value'. A 'New Message' dialog is also open, containing a 'CMS Message' section with three lines of text input:

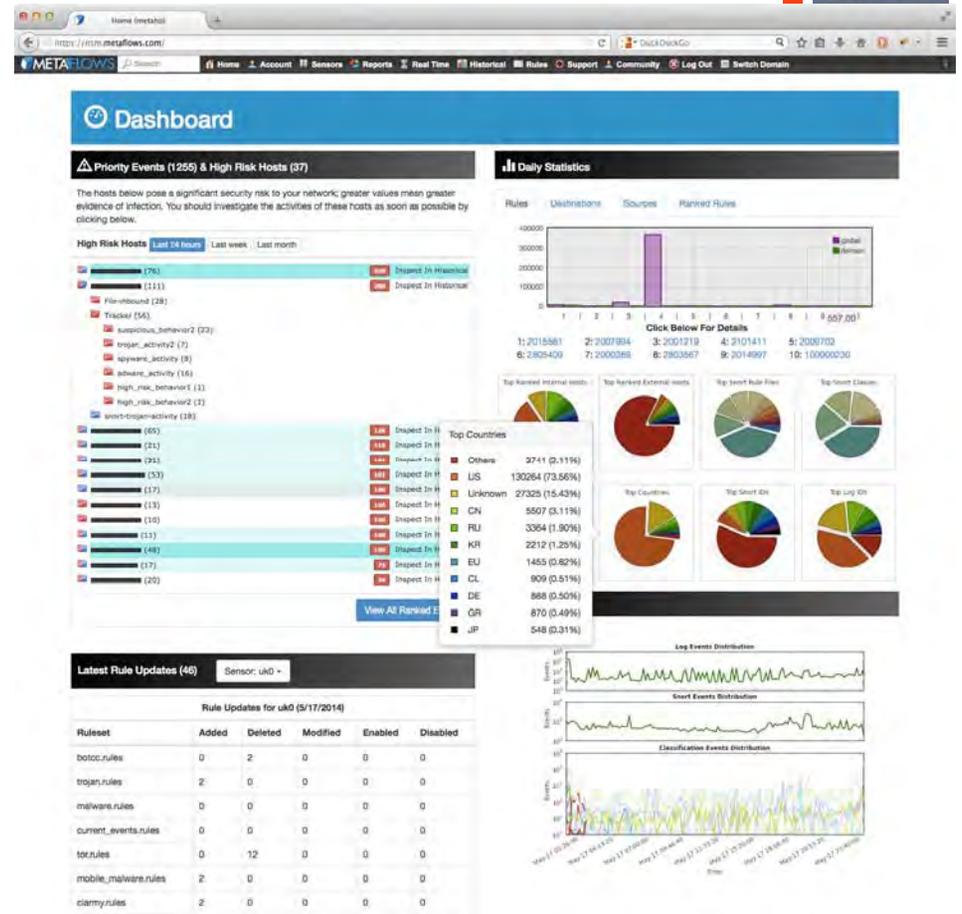
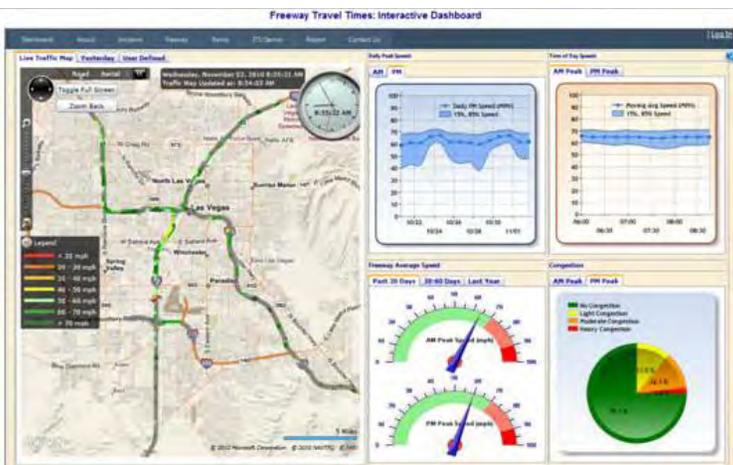
CMS Message	
Line 1	Missing Elderly Person
Line 2	Lic # 678901
Line 3	Tundra Van

The logo for DKS, featuring the letters 'DKS' in white on a dark blue square background, followed by the tagline 'Experts Connecting Communities' in white text.

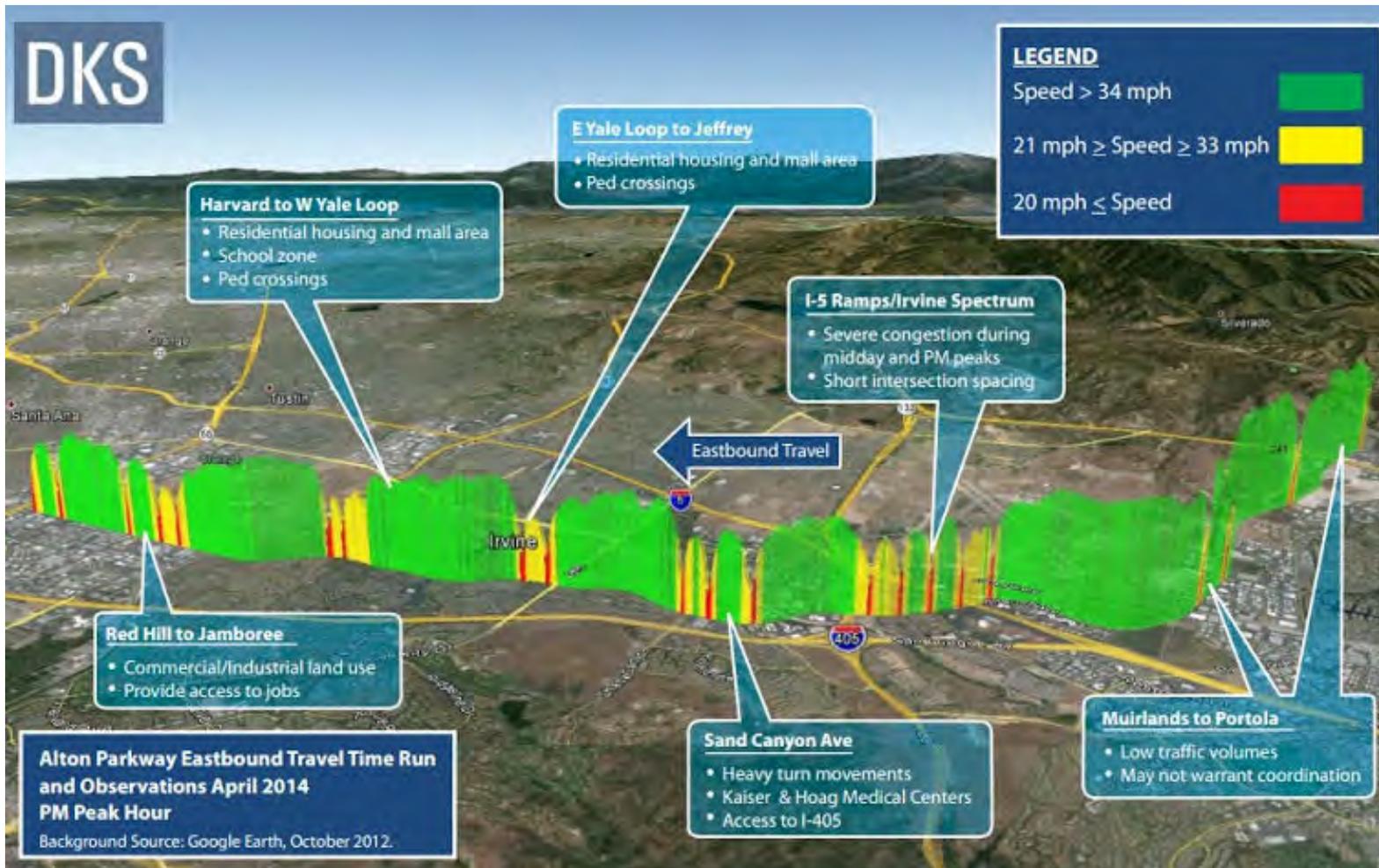
**DKS** Experts Connecting Communities

# Future of Central Signal Systems

# Real-time performance reporting



# Arterial corridor data used for operational planning



# Priority vehicle routing through central

DKS

glance

Preempt Test - Preempt Test

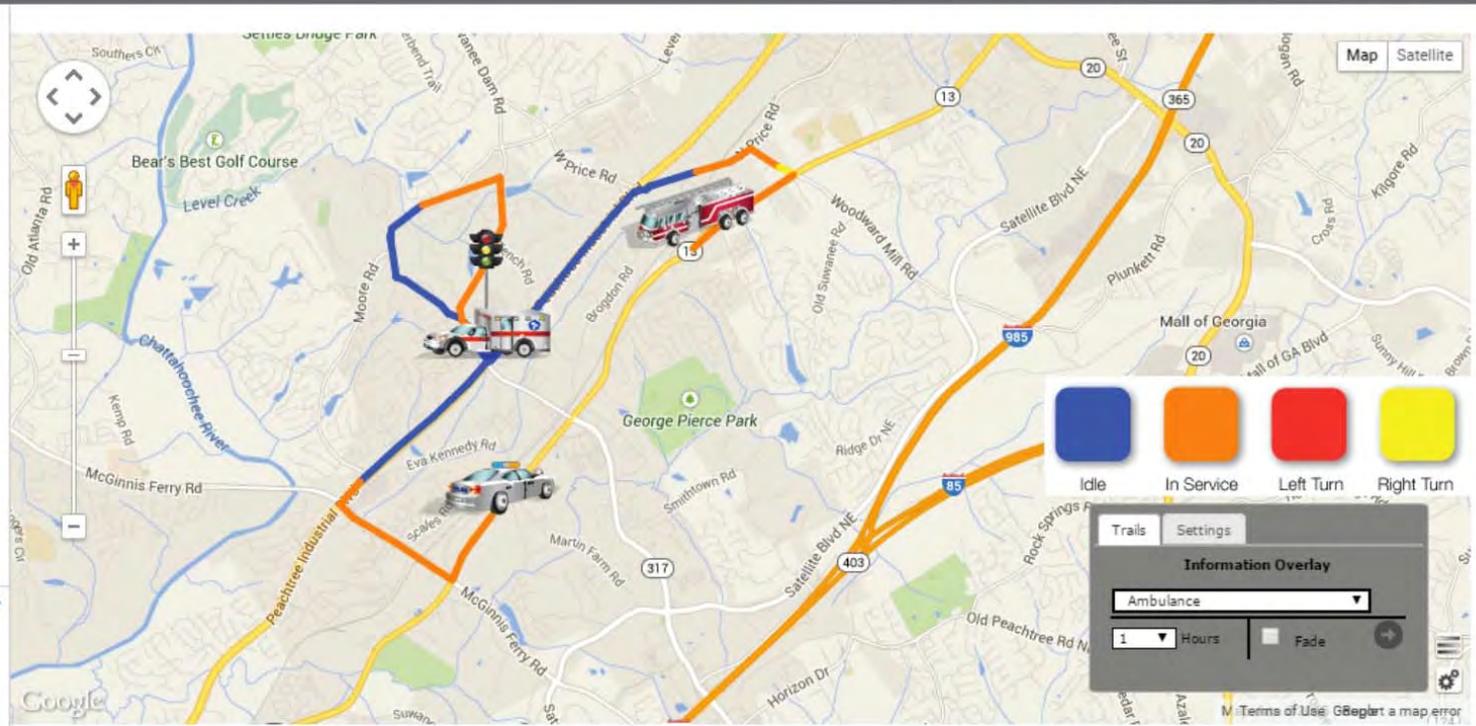
powered by Applied Information

[Playback](#) | [Home](#) | [Edit Profile](#) | [Report](#) | [Log-Off](#)

## Preempt Test

Name	Status	A
Test Intersection	Online	0
Ambulance 1	Online	0
Fire 1	Online	0
Police 1	Online	0

Alarm	Ack	Unack	Supp
Critical	0	0	0
High	0	0	0
Low	0	0	0





# Proactive and predictive maintenance

## Intersection status and health reports

DKS

The screenshot displays two windows from the MMU software. The top window, 'Current Status of MMU', shows real-time data for 16 inputs and various system parameters. The bottom window, 'History Logs', provides a detailed record of past faults, with a 'Prior Faults' section highlighting a 'CONFLICT' fault.

**Current Status of MMU**

MMU Inputs	R Volts	Y Volts	G Volts	W Volts
1	120v	6v	5v	0v
2	121v	5v	3v	0v
3	120v	6v	5v	0v
4	3v	5v	120v	0v
5	120v	5v	5v	0v
6	120v	5v	3v	0v
7	120v	6v	5v	0v
8	3v	5v	120v	0v
9	121v	8v	5v	0v
10	121v	9v	5v	0v
11	120v	9v	5v	0v
12	120v	8v	5v	0v
13	4v	5v	120v	0v
14	120v	0v	1v	0v
15	154v	6v	119v	0v
16	120v	8v	5v	0v

System Parameters:  
AC Power: 121v 60.0 Hz  
Red Enable: 121v ON  
AC Aux 1: 0v OFF  
AC Aux 2: 0v OFF  
Temperature: 91 F  
Port 1 Disable: OFF  
Ext. Reset: 21.6v HIGH

Fault Status:  
POWER (Green)  
TYPE 12 (White)  
24V-1 (White)  
24V-2 (White)  
CVM / WD (White)  
CONFLICT (White)

Current MMU Date/Time: 08/10/2012 06:53  
Fault Codes: Global = 0000h Dis

**History Logs**

Entry	Date & Time	Fault	Serial #	Agency ID	Unit ID	Location	Model
1	08/09/2012 10:15:32	Loc Flash	921658	CCPW		NE Ward	MMU1
2	08/09/2012 09:56:08	Loc Flash	921658	CCPW		NE Ward	MMU1
3	03/12/2012 11:52:37	Conflict	921658	CCPW		NE Ward	MMU1
4	03/12/2012 11:51:48	Conflict	921658	CCPW		NE Ward	MMU1
5	01/20/2012 15:30:49	Loc Flash	921658	CCPW		NE Ward	MMU1
6	01/20/2012 15:30:46	Loc Flash	921658	CCPW		NE Ward	MMU1
7	01/20/2012 15:30:46	Loc Flash	921658	CCPW		NE Ward	MMU1
8	01/20/2012 15:25:31	Port 1 Fail	921658	CCPW		NE Ward	MMU1
9	01/20/2012 15:25:05	Loc Flash	921658	CCPW		NE Ward	MMU1
10	01/20/2012 11:26:19	Port 1 Fail	921658	CCPW		NE Ward	MMU1
11	01/20/2012 11:11:14	Port 1 Fail	921658	CCPW		NE Ward	MMU1
12	01/20/2012 11:10:56	Port 1 Fail	921658	CCPW		NE Ward	MMU1
13	01/20/2012 10:44:45	Loc Flash	921658	CCPW		NE Ward	MMU1
14	01/20/2012 10:18:04	Port 1 Fail	921658	CCPW		NE Ward	MMU1
15	01/20/2012 10:17:26	Port 1 Fail	921658	CCPW		NE Ward	MMU1
16	01/20/2012 10:16:48	Port 1 Fail	921658	CCPW		NE Ward	MMU1
17	11/17/2011 05:02:43	Loc Flash	921658	CCPW		NE Ward	MMU1
18	11/16/2011 22:30:33	Conflict	921658	CCPW		NE Ward	MMU1
19	05/02/2011 18:43:34	Loc Flash	921658	CCPW		NE Ward	MMU1
20	05/02/2011 17:37:33	Port 1 Fail	921658	CCPW		NE Ward	MMU1

Prior Faults:  
Marker Display:  
R Y G W  
1 (Red) (White) (White) (White)  
2 (Red) (White) (White) (White)  
3 (Red) (White) (White) (White)  
4 (Red) (White) (White) (White)  
5 (Red) (White) (White) (White)  
6 (Red) (White) (White) (White)  
7 (Red) (White) (White) (White)  
8 (Red) (White) (White) (White)  
9 (Red) (White) (White) (White)  
10 (Red) (White) (White) (White)  
11 (Red) (White) (White) (White)  
12 (Red) (White) (White) (White)  
13 (Red) (White) (White) (White)  
14 (Red) (White) (White) (White)  
15 (Red) (White) (White) (White)  
16 (Red) (White) (White) (White)

Status of Inputs:  
Line Voltage: 120  
Red En Voltage: 120  
Temperature: 66 F  
Diagnostic Code: Nom  
Port 1 Disable: OFF  
Red Enable: ON  
AC Aux 1: OFF  
AC Aux 2: OFF  
Ext. Reset: HIGH  
Ext. Watchdog: LDW  
Local Flash: OFF  
24v Mon Inhib: OFF  
Type Select: LDW  
CVM: GOOD  
24v Mon -1: GOOD  
24v Mon -2: GOOD

Prior Faults Log Successfully Retrieved

# Signal phase and timing data will be delivered in vehicles

DKS



The logo for DKS, featuring the letters 'DKS' in white on a dark blue square background, followed by the tagline 'Experts Connecting Communities' in white text.

**DKS** Experts Connecting Communities

Three colored squares are arranged in a row. The leftmost square is dark grey and contains the DKS logo and tagline. The middle square is a medium blue. The rightmost square is a teal color. Above the teal square is a red square, which is partially overlapping it.

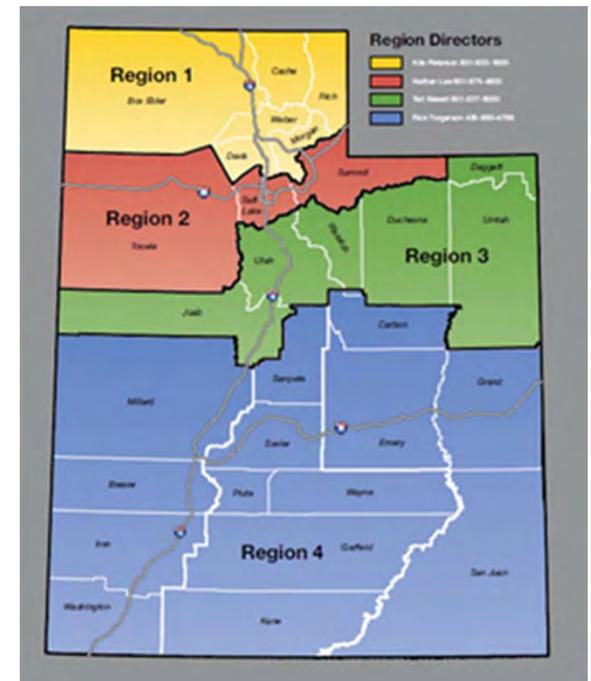
# Shared Signal System Experiences

# Utah DOT

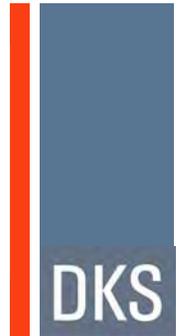


## Background

- Until mid-1990's – Salt Lake City had a central system and the rest of the state had a hodge-podge of closed loop systems.
- 2000 – ICONS was procured (funding from local and CMAQ). Encouraged all agencies to be integrated.
- 2015 – MaxView was procured. All agencies within the state are now on a single shared system.

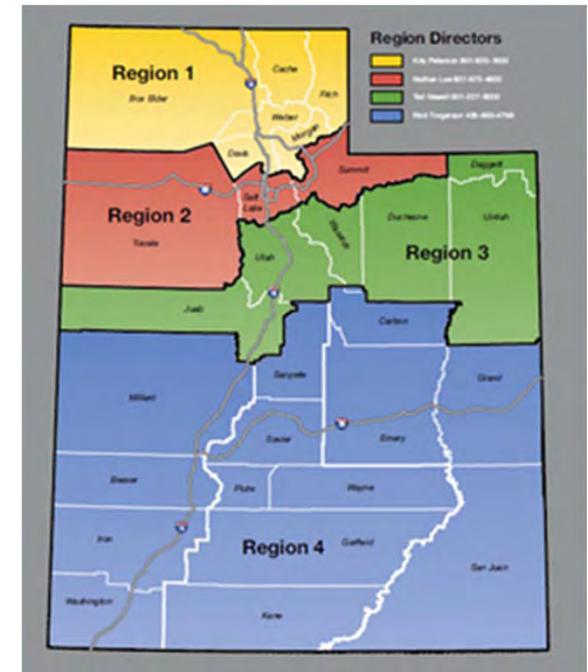


# Utah DOT

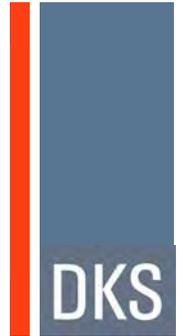


## Today

- UDOT and all local agencies share the same ATMS (single server statewide)
- 60% of signals owned and operated by UDOT
- 40% owned and operated by 20 different cities /counties
- UDOT maintains the ATMS and communications network
- Local agencies responsible for operating/maintaining their own signals



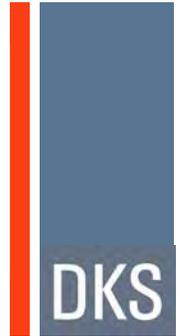
# Utah DOT



UDOT wants to provide **“world class traffic signal maintenance and operations”**

- Transition from “reactive” to “proactive” signal maintenance
- Implement real-time monitoring of system health and quality of operations

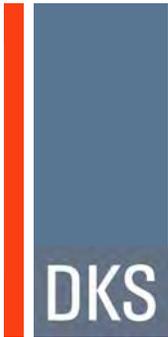
# Utah DOT



## Real-time System Monitoring

- Identify corridors in need of updated coordinated timing
- Identify intersections in need of updated local timing
- Identify detectors in need of maintenance
- Use high resolution data to monitor several types of performance measures:
  - Arrival on green
  - Volumes
  - Delay
  - Speed
  - Split monitor

# UDOT Performance Measures Website



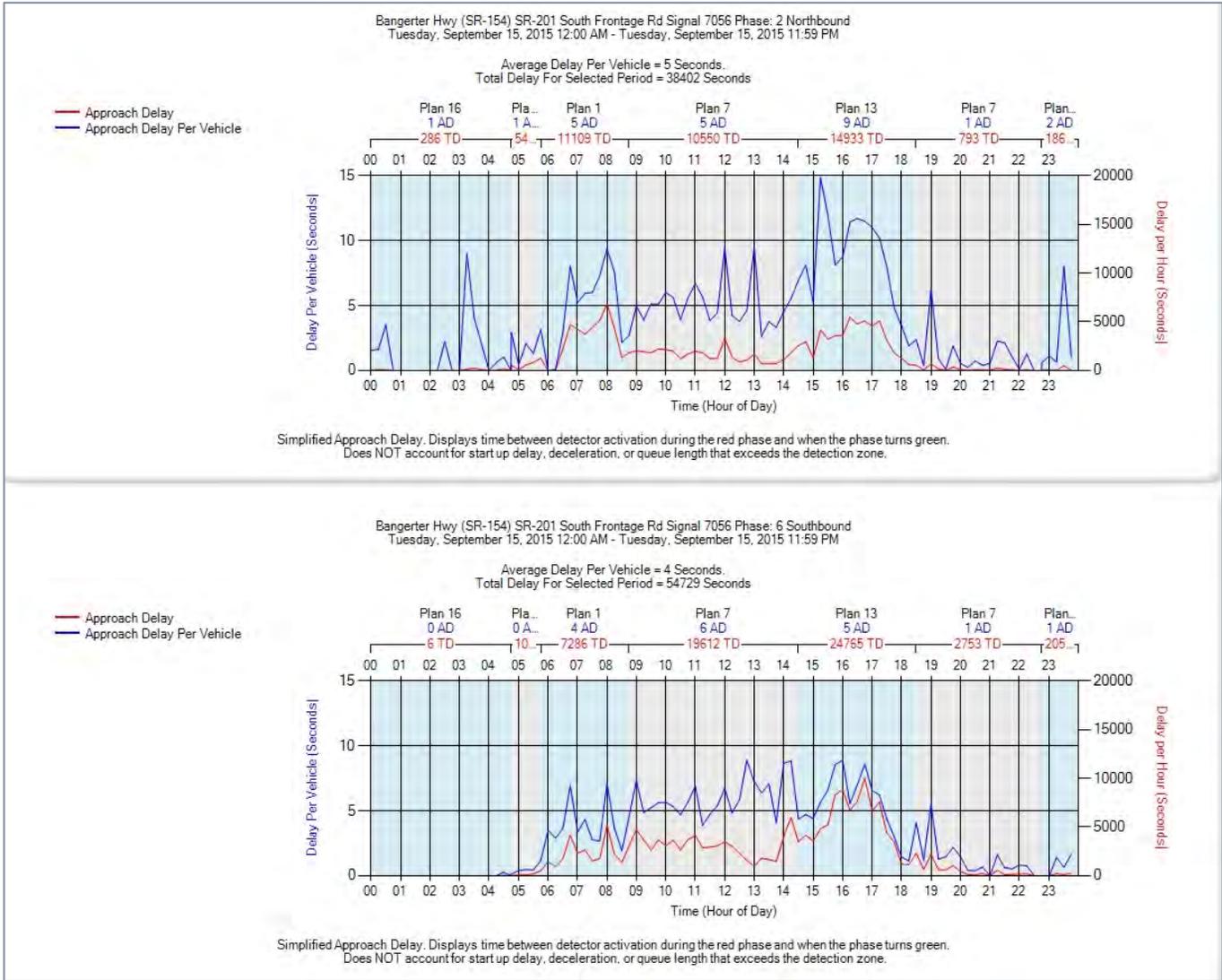
The screenshot shows the 'Signal Performance Metrics' web application. At the top left is the UDOT logo with the tagline 'Keeping Utah Moving'. The main title is 'Signal Performance Metrics'. On the top right is the AASHIO Innovation Initiative logo. Below the title is a navigation bar with links for 'Charts', 'Reports', 'Log Action Taken', 'Links', and 'FAQ'. The main content area is titled '->Signal Metrics' and contains several sections:

- Selected Signal:** A text box containing '7056 Bangerter Hwy (SR-154) SR-201 South Frontage Rd'.
- Signals:** A section with dropdown menus for 'Region' (set to 'All'), 'Metric Type' (set to 'All'), and 'Filter' (set to 'Signal Id'). There are 'Filter' and 'Clear Filter' buttons.
- Metric Settings:** A section with 'Metric Type' radio buttons: 'Approach Delay' (selected), 'Approach Volume', 'Arrivals On Red', 'Purdue Phase Termination', 'Speed', and 'Purdue Coordination Diagram'. Below are input fields for 'Delay Per Vehicle Y Axis Maximum' (15), 'Total Delay Per Hour Y Axis Maximum' (20000), and 'Volume Bin Size' (15). There are checkboxes for 'Show Plan Statistics', 'Show Delay Per Vehicle', and 'Show Total Delay Per Hour', and an 'Upload Current Data' checkbox.
- Dates:** A section with 'Start Date' (9/15/2015, 12:00 AM) and 'End Date' (9/15/2015, 11:59 PM) fields. A 'Reset Date' button and a calendar for 'September 2015' are also present.
- Map:** A map showing the location of the selected signal in the Salt Lake Valley area, with many orange circular markers representing other signals. Labels on the map include 'Magna', 'Tooele', 'Oquirrh Mountains', 'Wasatch National Forest', and 'Utah Lake'.
- Signal List:** A section with a 'Signal List' header and a 'Map' button.

At the bottom center of the interface is a 'Create Metrics' button.

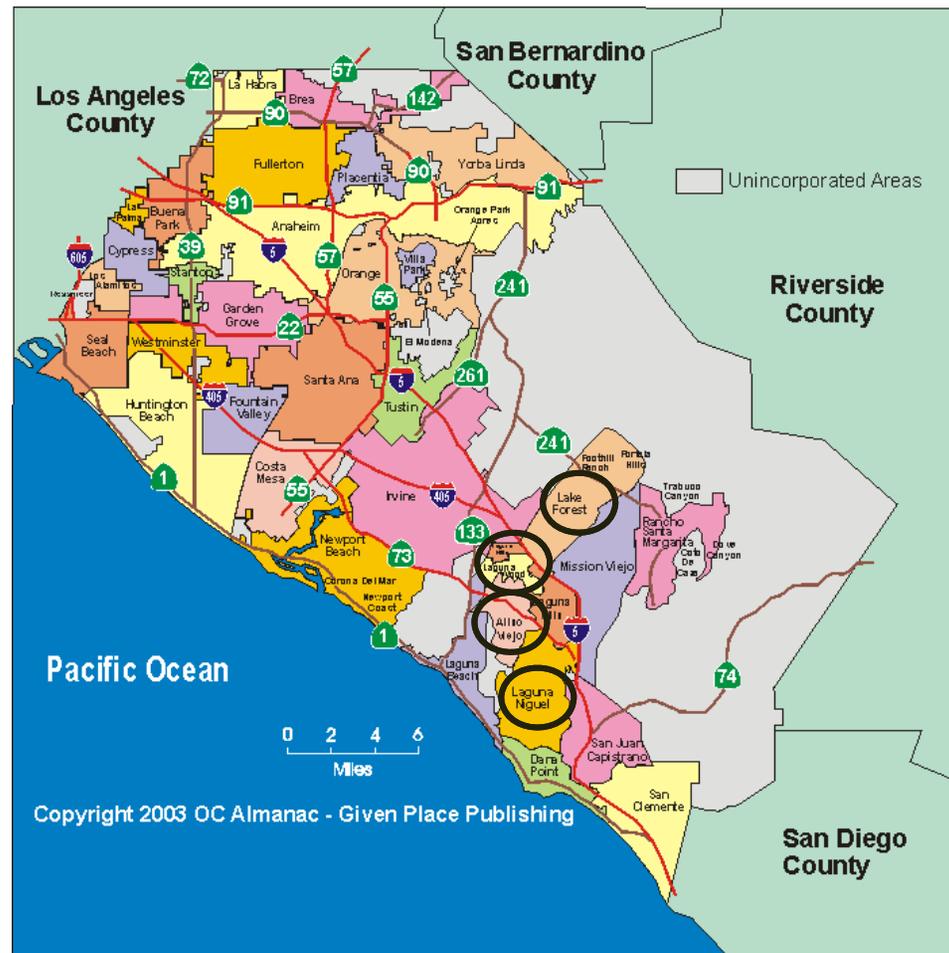
<http://udottraffic.utah.gov/signalperformancemetrics/>

# Approach Delay



# Orange County, CA

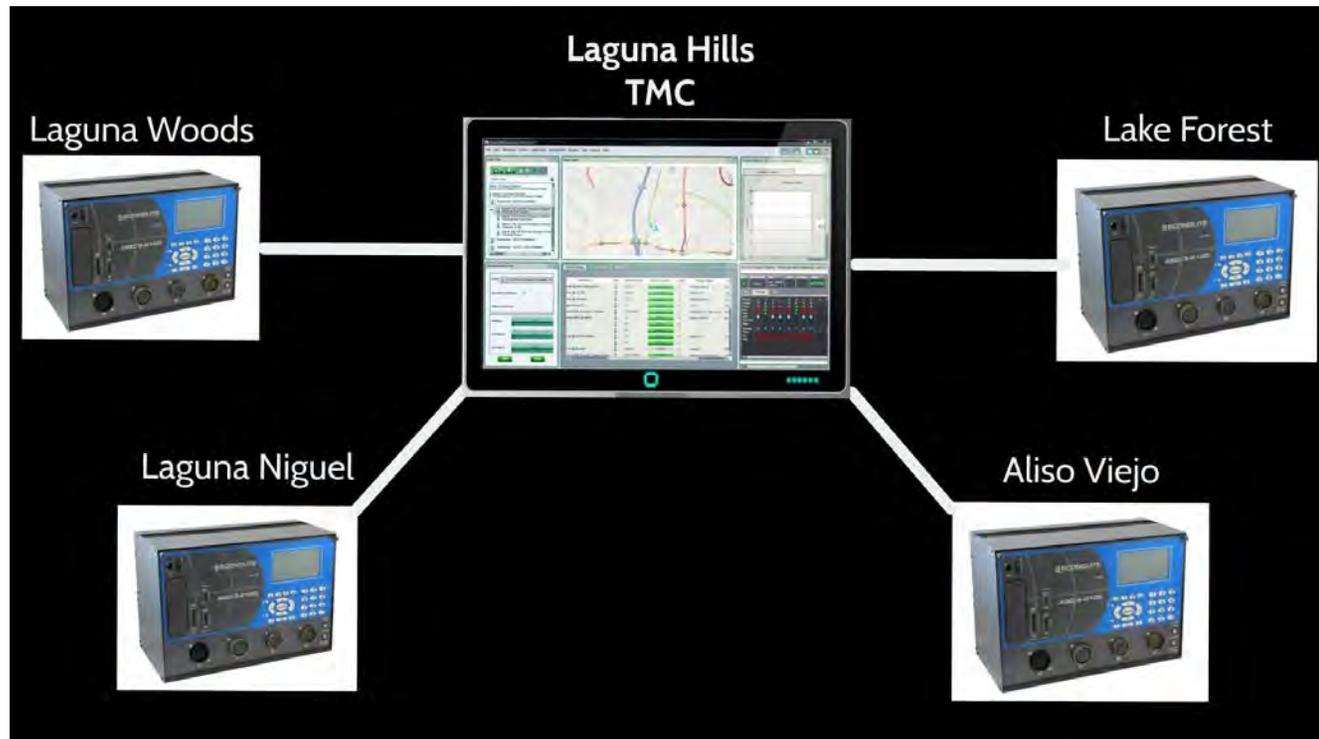
- 45 Cities
- Ranging in population from 13,000 to 340,000
- Capabilities and resources vary widely



# Orange County, CA

- These cities have decided to connect to a single central signal system.
- They are able to share the network and staffing resources.

DKS

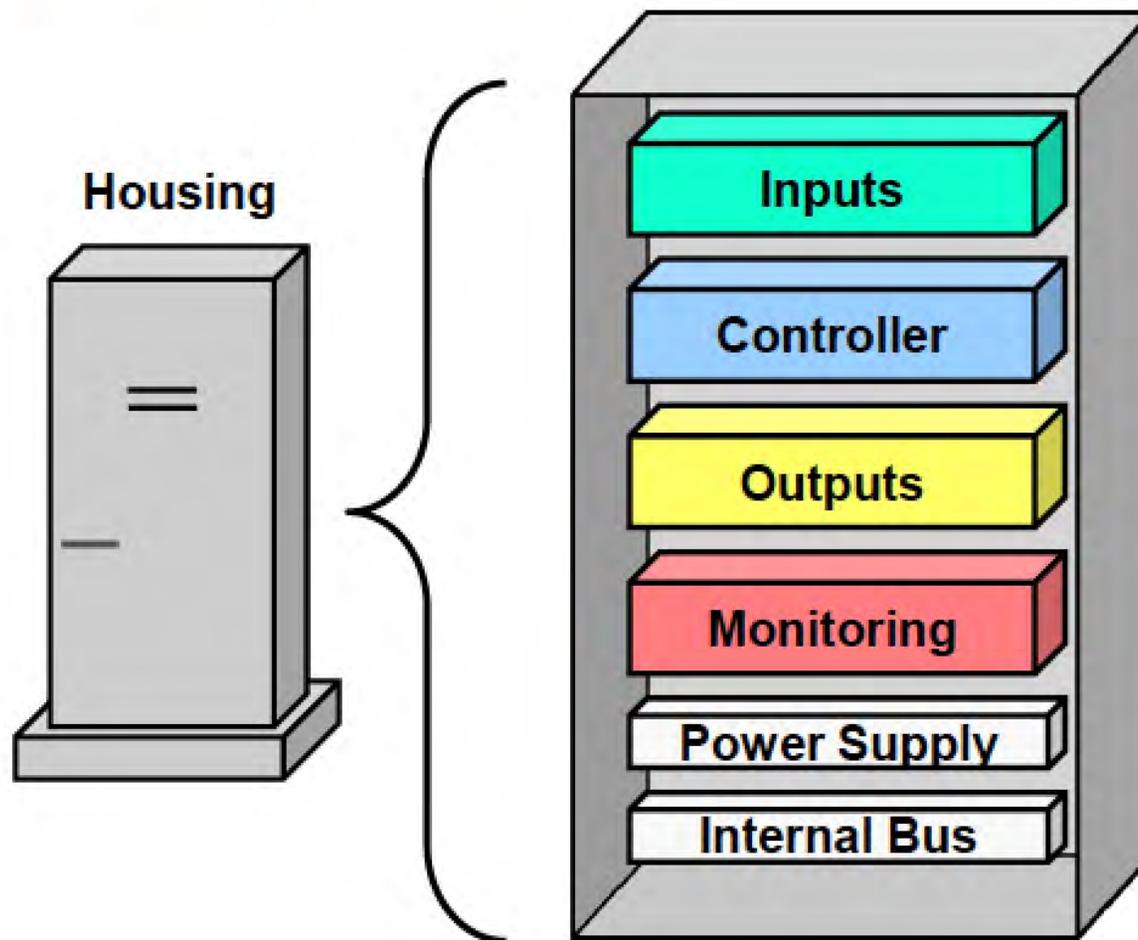


The logo for DKS, featuring the letters 'DKS' in white on a dark blue square background, followed by the tagline 'Experts Connecting Communities' in white text.

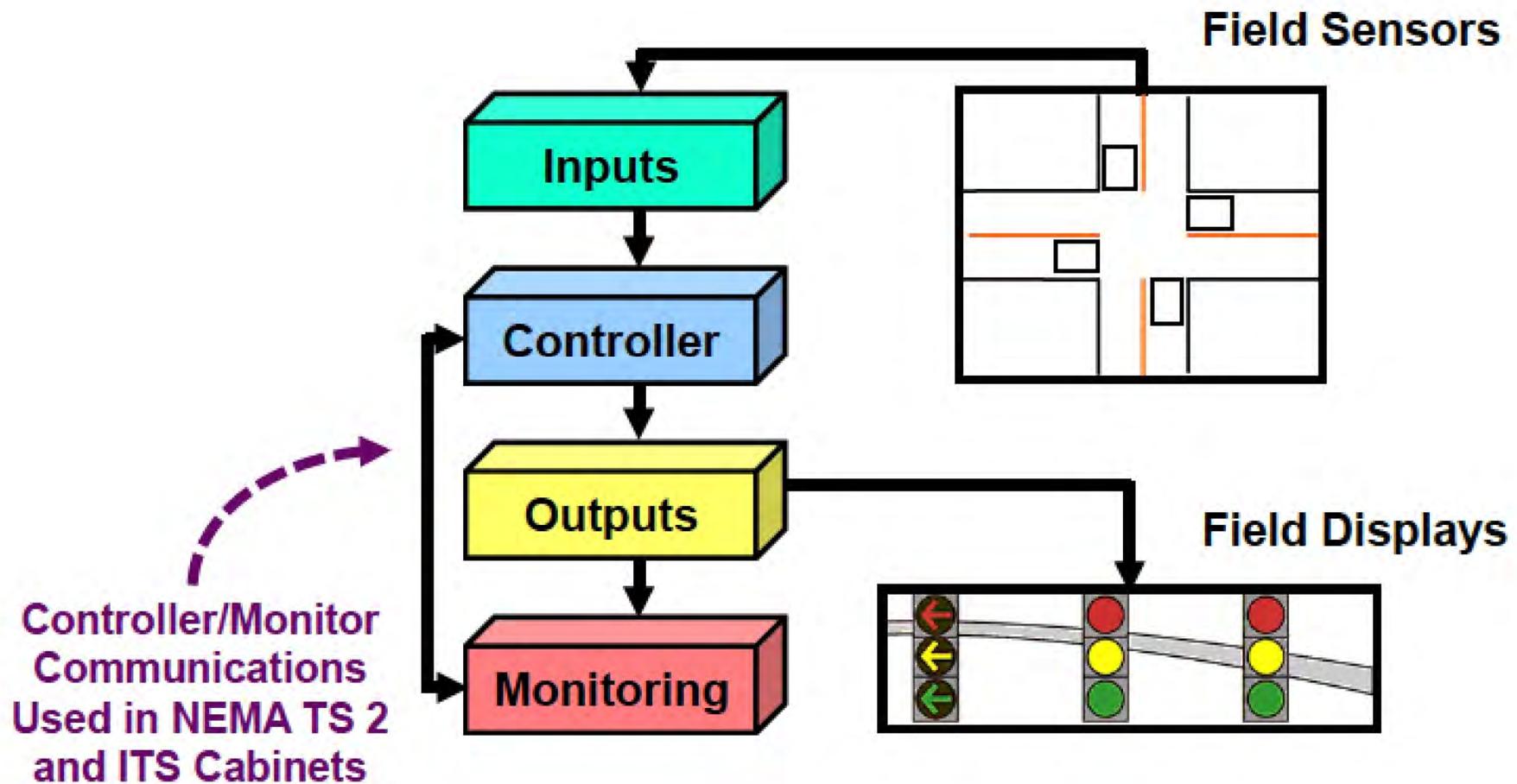
**DKS** Experts Connecting Communities

# Implementing Standards

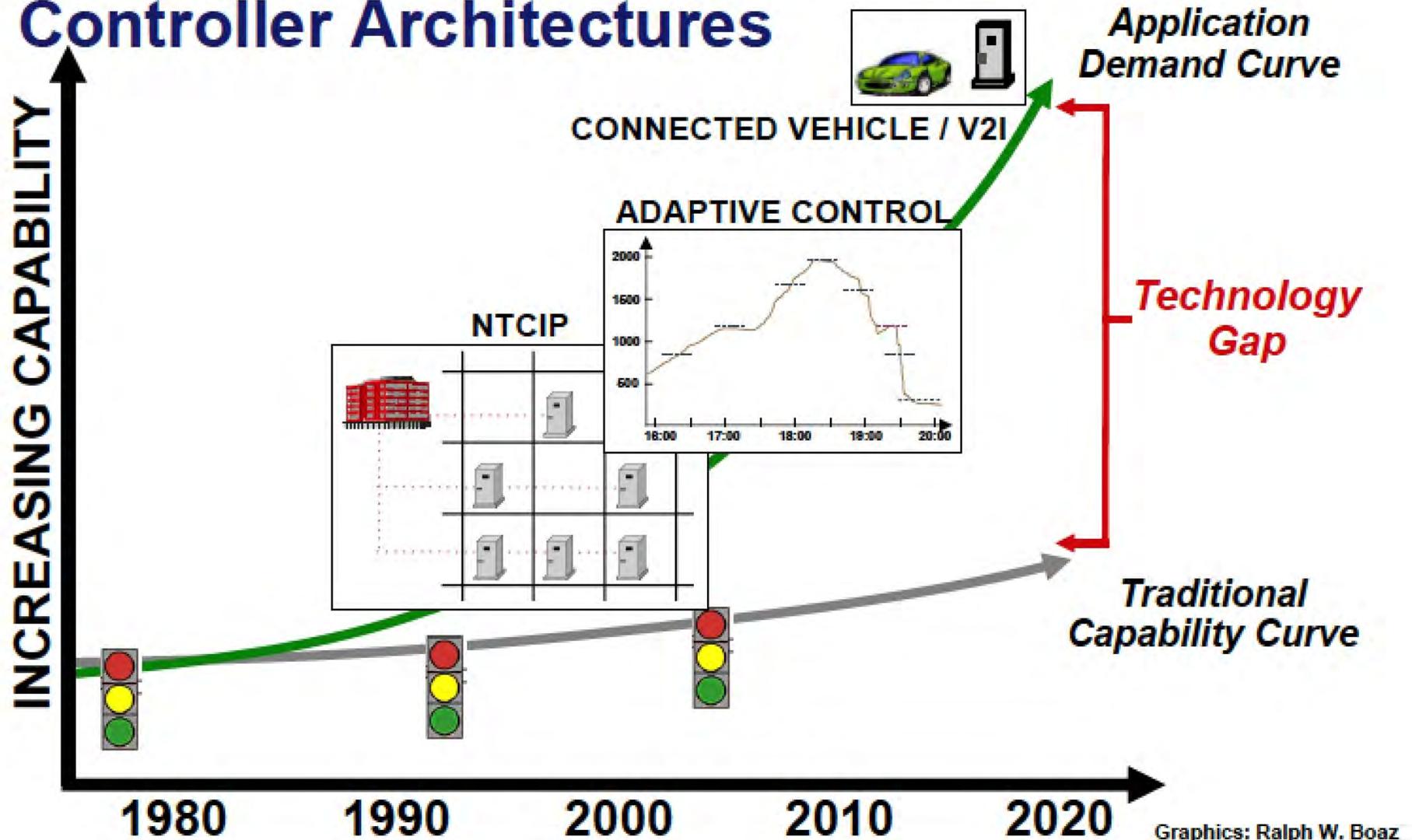
# Basic Transportation Field Cabinet System (TFCS) Components



# Basic TFCS Operation



# Problem with Traditional Transportation Controller Architectures

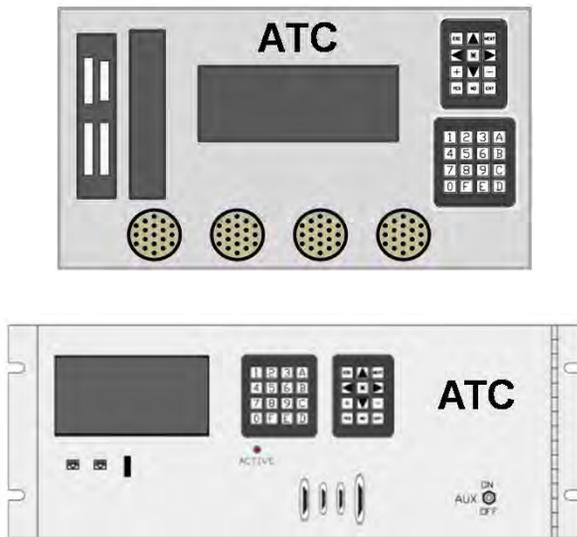




# Purpose of the ATC Family of Standards

- Provide a general purpose field computing platform for transportation applications that is:
  - Open architecture
  - Modular
  - Multi-tasking / Multi-application
  - Can grow with technology
  - Upgrade legacy TFCSSs

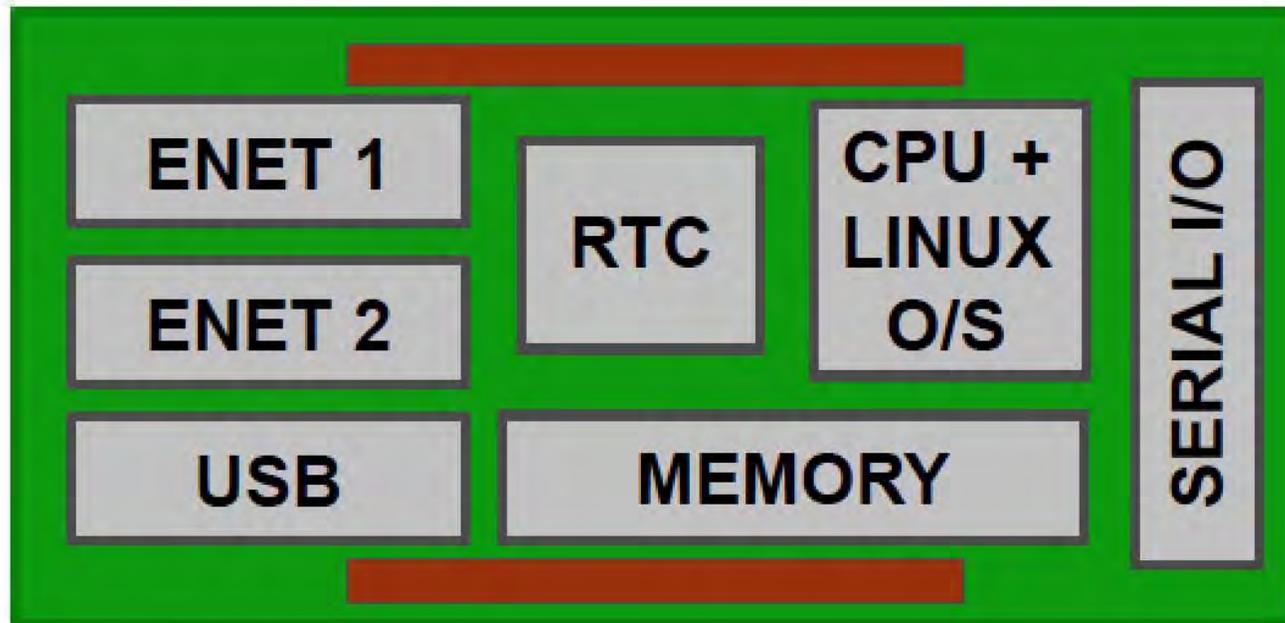
# Advanced Traffic Controllers can run multiple applications at the same time



- Traffic Signal Control/Traffic Management
- Transit/Light Rail Priority
- Emergency Management
- Lane Use
- Red Light Enforcement
- Speed Monitoring/Enforcement
- Access Control
- Advanced Traveler Information Systems (ATIS)
- Data Collection Systems
- Connected Vehicle (CV) Applications
- Others

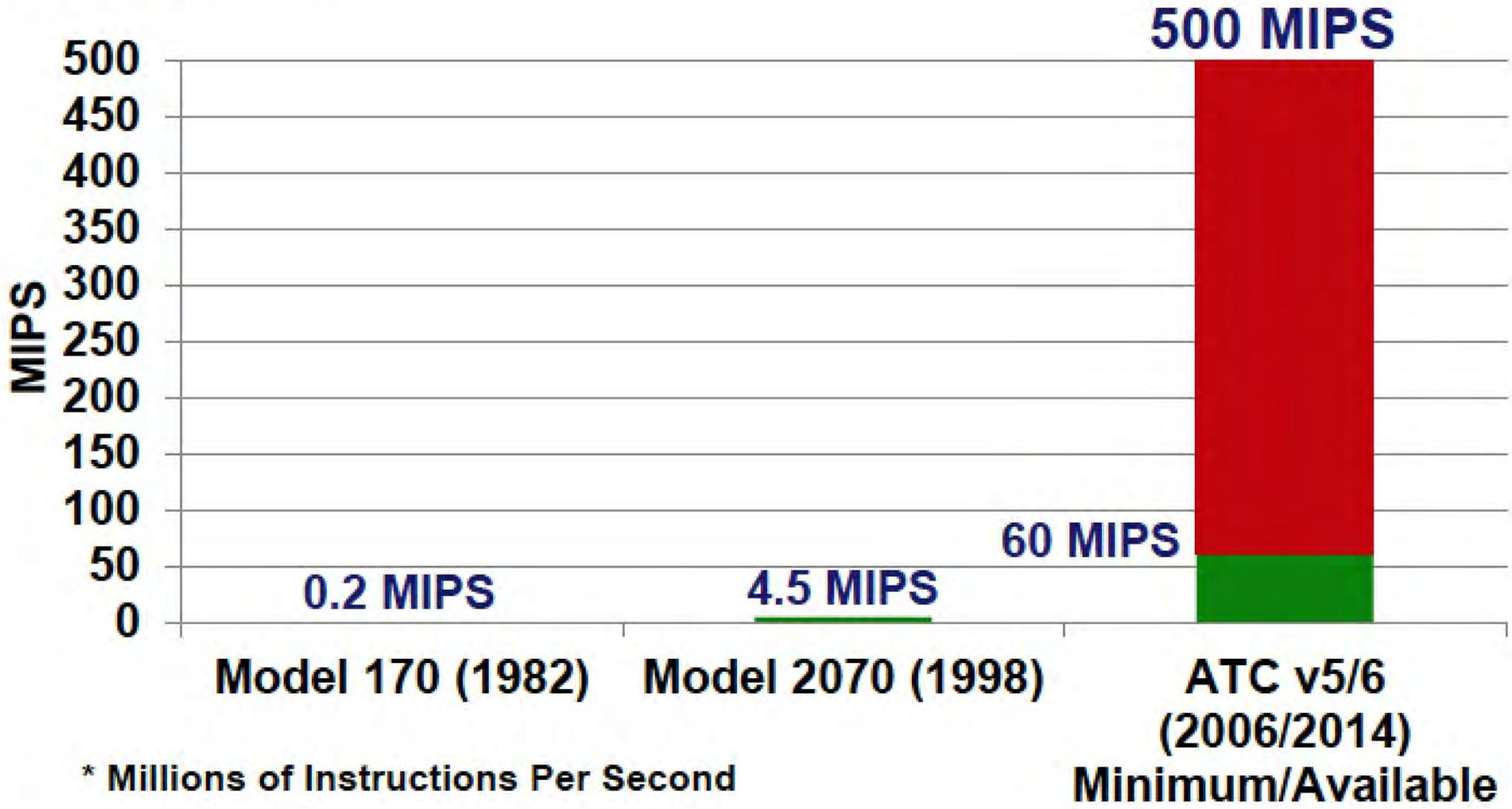


# ATC Engine Board Concept



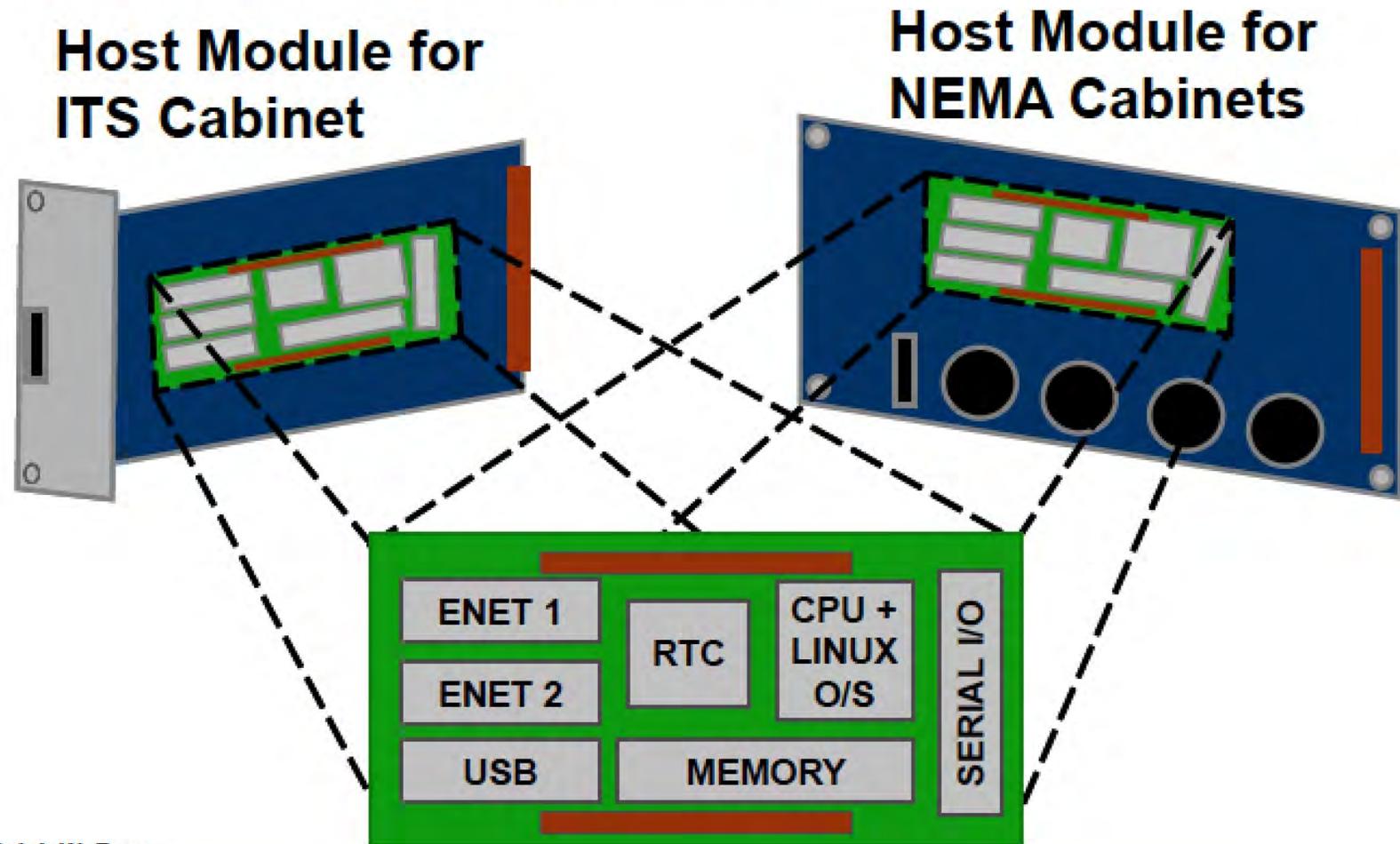


# Transportation Controller Comparative Performance



Graphics: Ralph W. Boaz

# Controllers Conform to Other Standards Using the Engine Board



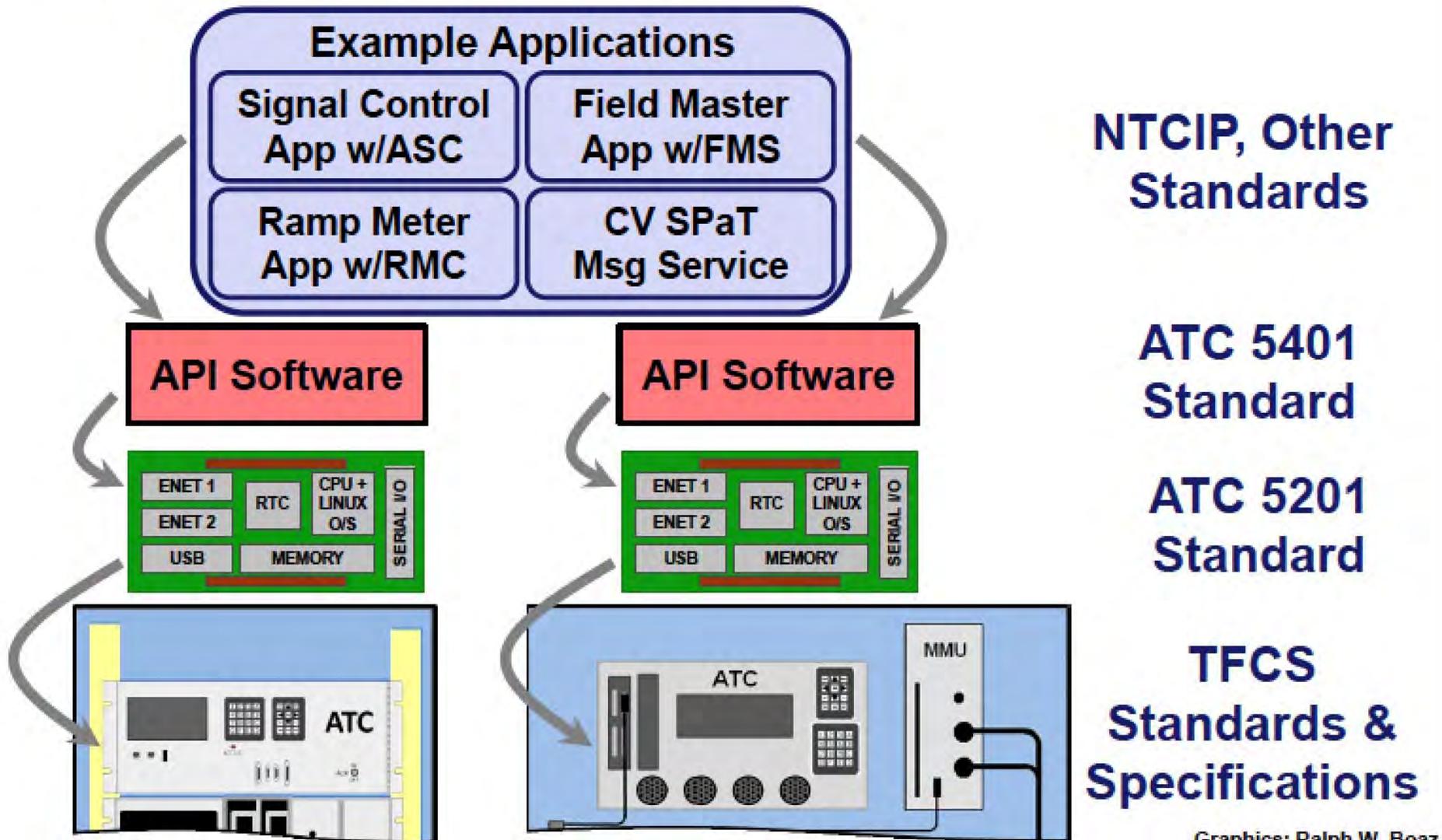


# Examples of ATC Units



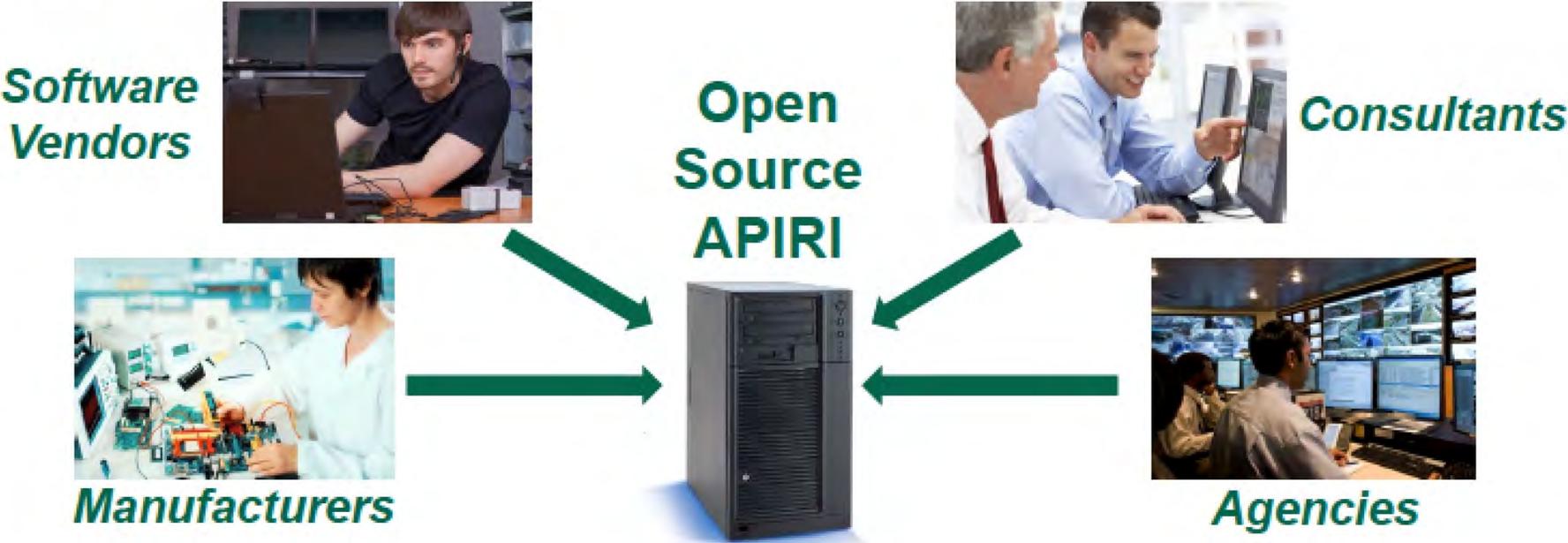
Photos: See Photo Credits

# Bringing It All Together





# Open Source API Reference Implementation (APIRI)

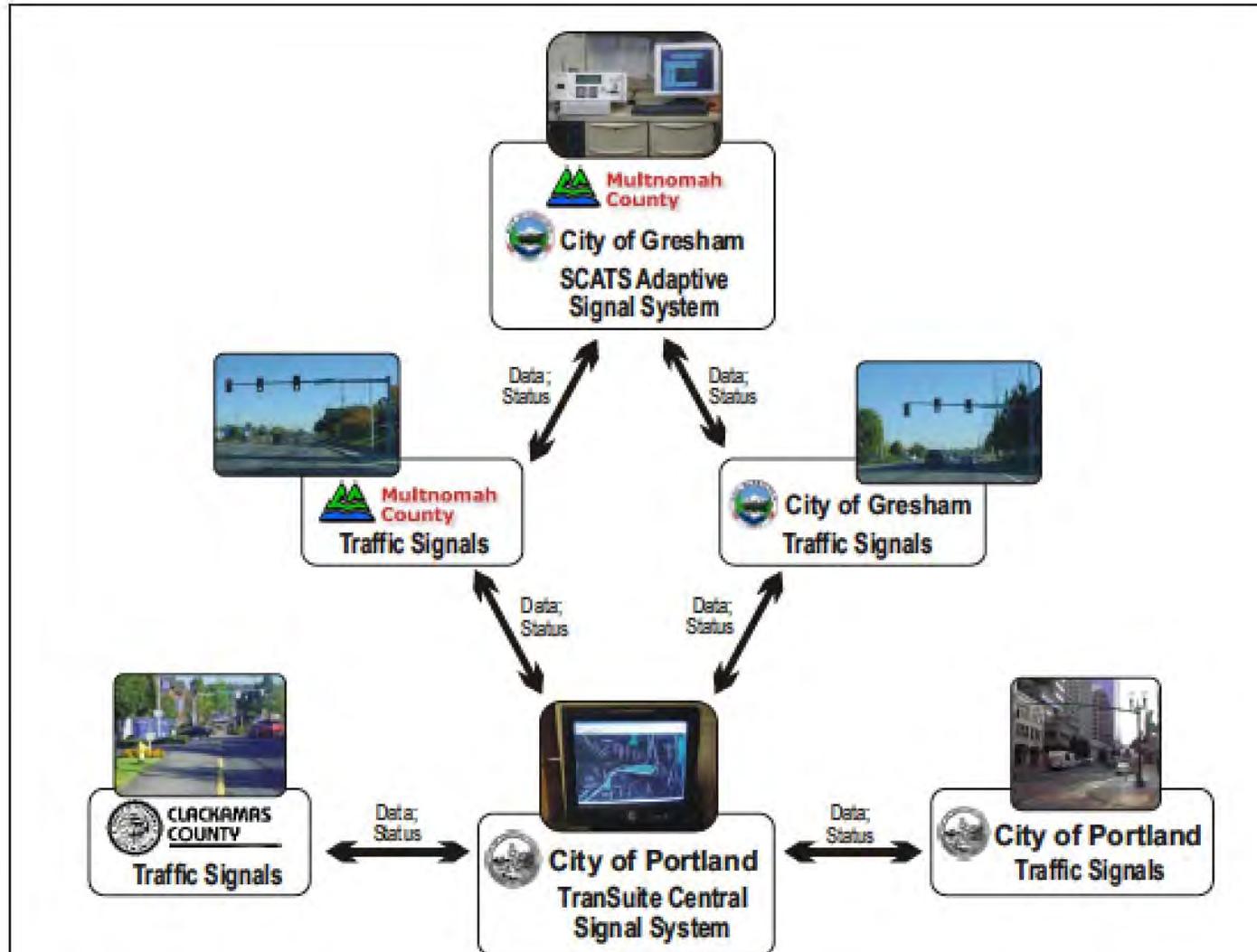


Photos: See Photo Credits      Graphics: Ralph W. Boaz

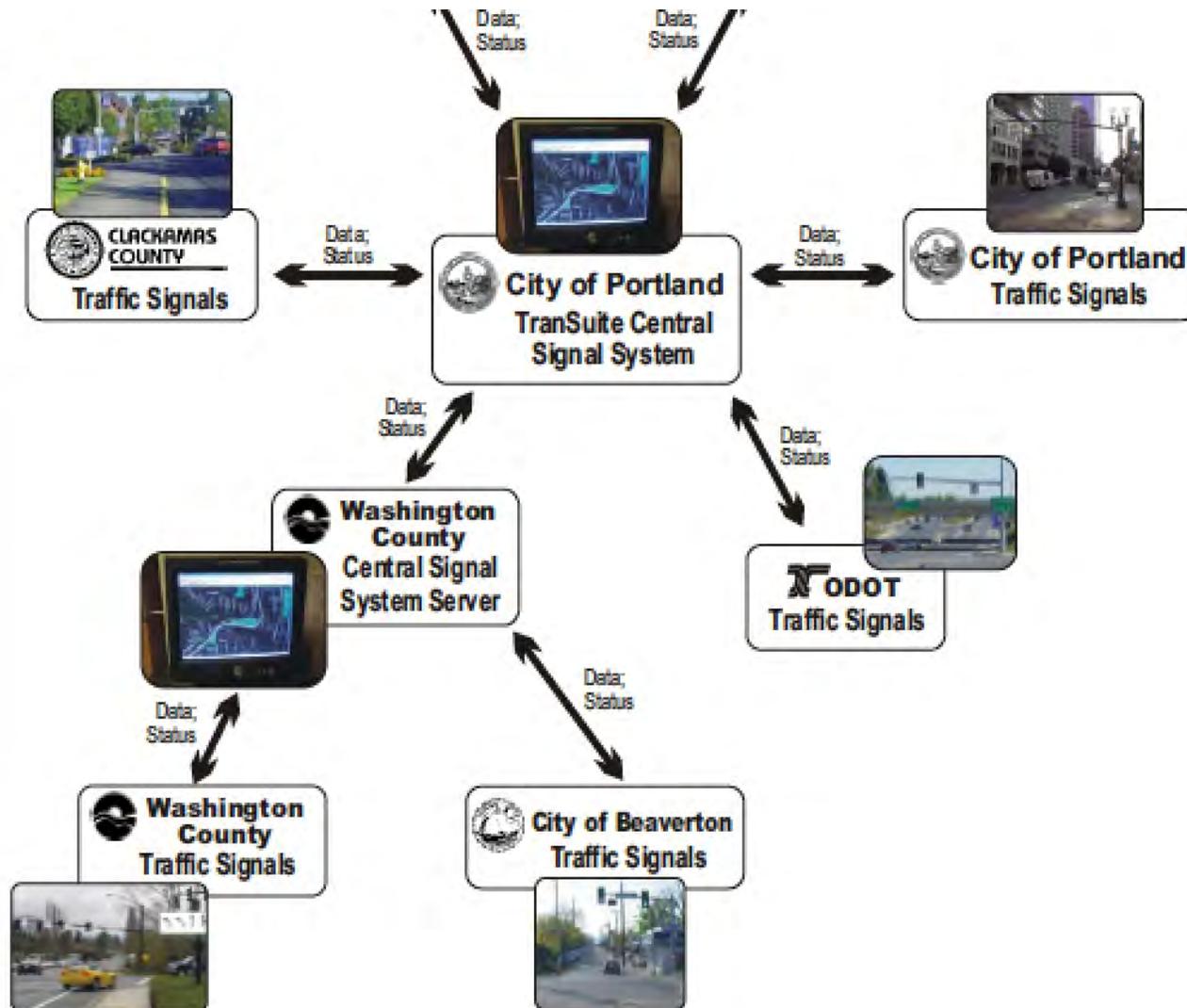
# Shared Signal System Issues

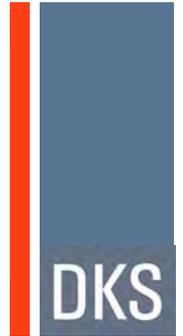
- System architecture
- License and upgrade structure

# Shared server architecture



# Separate server architecture





# Trade offs of a shared server

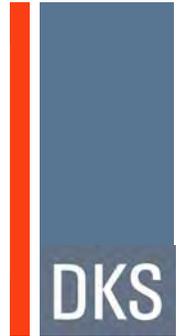
## Advantages:

- Shared maintenance of the server reduces costs
- A central location to back up databases
- Visibility into another agency signals
- Automation of emergency patterns. For example: Incident triggers could be configured to trigger an automatic response.
- Remote database management
- Positions everyone for connected vehicle information

## Disadvantages:

- Lead agency must configure user rights
- Lead agency has more responsibility for server up keep

# Trade offs of a separate server



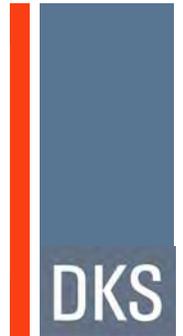
## Advantages:

- Distinct separation of resources and assets
- From an IT perspective the lines of separation are clear

## Disadvantages:

- The agencies must maintain the same version of software
- Agencies must keep separate device ID numbers

# Business issues and license structure



- Users pay a use license to the larger agency.
- Still have to pay for installation. It's a small fraction less.
- There is a server license for each server. The small agencies have a license fee for their intersections. Cost is proportional to the number of traffic signals.
- Maintenance cost would be based on the total number of intersections.
- They can lock down modules to certain modules so it can be locked down by agency. They pay for this by number of intersections.



# Discussion