Connected Corridors

ICM Systems Architecture and Operations Workshop

March, 2014

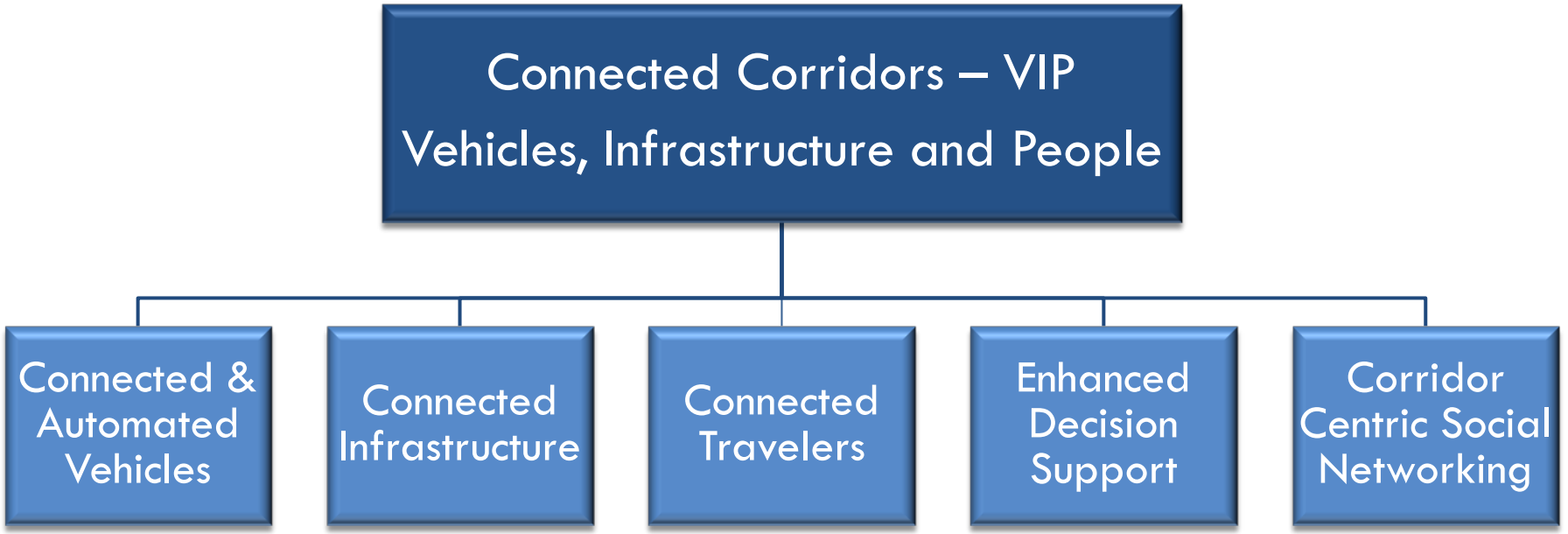
Agenda and Introductions

- 8:00-9:00 - Coffee and Pastries
- 9:00-9:15 - Introductions
- 9:15-9:30 - Remarks by Kris Kuhl, Roberto Horowitz, Alex Bayen
- 9:30-10:15 - Planning, Implementation and Operation - User needs for ICM
- 10:15-10:30 - Break
- 10:30-11:45 - Discussion of integrated corridor management architecture requirements
- 11:45-12:45 - Lunch
- 12:45-2:15 - Review of SANDAG, D4, D7 and DART architectures, Lessons learned
- 2:15-2:30 - Break
- 2:30-3:15 - Connected Corridors/ICM operation and maintenance discussion
- 3:15-3:30 - Closing and next steps
- 3:30-?? - Wine and cheese reception with faculty, students and staff

Goals – This is a conversation

- **Basic Goals**
  - Get to know each other
  - Discuss the system architecture needed for Integrated Corridor Management
  - Discuss the operational support needed for these systems
- **However there are deeper goals:**
  - Develop common understandings
  - Expand our sense of community
  - Grow our ability to collaborate
  - Commit, as a team, to the success of ICM in California
  - Know that Caltrans is committed to leading and enabling this team

The Connected Corridors Vision



Integrated Corridor Management

- **ICM – Managing a multi model, multi-jurisdictional transportation corridor so that corridor wide metrics such as efficiency, sustainability, safety and quality of life are maximized**

- **History –**
  - 2005 – USDOT begins ICM efforts
  - 2006 – USDOT selects 8 Pioneer Sites for ConOps Development
  - 2009 – SANDAG and DART selected for field demonstrations
  - 2009 – Approval of Alameda County Transportation Commission I-80 ICM
  - 2011 – Connected Corridors Program is started in California
  - 2013 – SANDAG and DART go live
  - 2015 – Expected launch of I-80 ICM
  - *2016 – I-210 ICM goes live*

Caltrans and ICM - Connected Corridors

- ***Goal:*** ***Caltrans*** **will lead the planning, implementation and ongoing operational support for 50 corridor segments in California –** ***"ICM California"***
- ***"I-210 Pilot"*** **– The first** ***Caltrans-lead*** **ICM effort in California and the first corridor site in the "ICM California" plan.**
- ***"Connected Corridors"*** **– The multi organizational program tasked with delivering all reusable components of "ICM California."**
- ***"Connected Corridors: VIP (Vehicles, Infrastructure and People)"*** **– The longer term vision of coordinating all major actors in a transportation corridor.**

The Connected Corridors Program

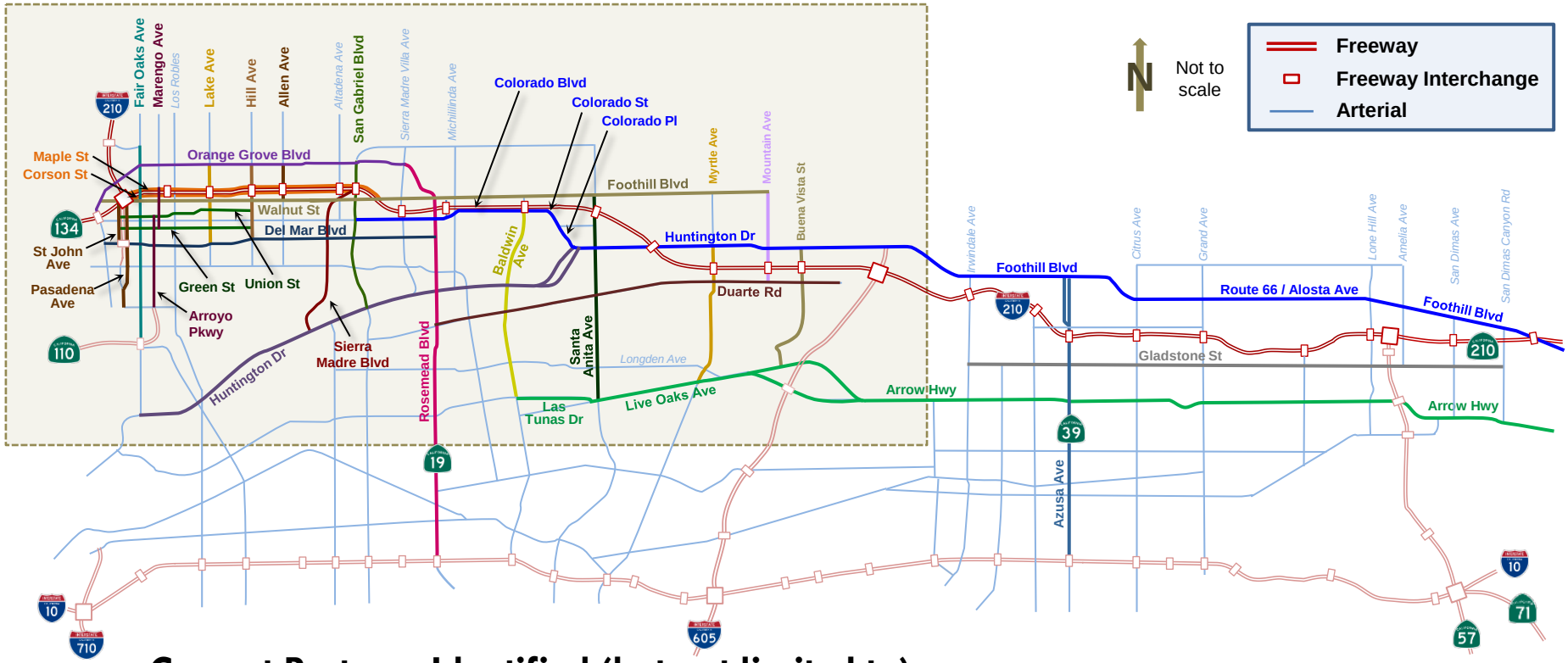
- **Caltrans**
  - Leadership of corridor management efforts
  - Organizational and cultural changes (HQ and districts)
  - Corridor focused and prioritized funding
  - Commitment to proper sensing and control elements
  - Integration with CMM (Capability Maturity Matrix) processes
  - Development of Corridor Wide operational scenarios, systems and awareness
  - I-210 PIlot
- **PATH**
  - Working with industry, government and academia to provide recommendations for "ICM California" components and methods
  - Enhancing decision support tools using new data sources, simulation methods and highway/arterial/multi-modal management strategies
  - Supporting the day to day needs of the I-210 Pilot planning and implementation
  - Documenting the I-210 pilot so that its tools and processes may be more easily reused in other corridors

Stages in ICM – Focus on Planning

- **Planning – *We are here!***
  - Assemble Sponsors and Stakeholders
  - Concept of Operations
  - Corridor Analysis
  - High level Architecture
  - High Level Deployment Planning
  - Funding and Organizational Structures
  - Initial Requirements
- **Implementation**
  - Agree on MOUs, Playbooks, Deployment
  - Integrate/build supporting systems
  - Refine corridor sensing and control capabilities
  - Deployment (System and MOUs)
- **Operations and Maintenance**
  - Operate the system
  - Evaluate the system
  - Maintain the system
  - Upgrade the system

I-210 Project Corridor & Caltrans Partners

Phase 1 Area of Interest



Current Partners Identified (but not limited to):

- **Caltrans, Metro, UC Berkeley PATH, LA County, Pasadena, Arcadia, Monrovia, Duarte** (Phase 2 - Irwindale, Azusa, Glendora, San Dimas, and La Verne)

Concepts and Metrics: I-210 Stakeholders

- **Initial concepts defined by I-210 Stakeholders**
  - Focus on incidents where ramp metering rates, signal timings, alternate routes and transit services are modified to ameliorate the situation
  - Pre-agreed playbook scenarios
  - Enable turn key operations when traffic managers are not available and coordinated system actions are needed
- **Metrics recommended by I-210 Stakeholders**
  - Citizen and traveler satisfaction
  - Mobility, Reliability and Productivity
  - Safety and Incident Management
  - Air Quality

Vendor Involvement – A few Examples

Delcan

McCain

here

TSS TRANSPORT SIMULATION SYSTEMS

Kimley-Horn and Associates, Inc.

SIEMENS

INRIX TRAFFIC

PTV GROUP

ITERIS

TRANSCORE

at&t

Mygistics

ECONOLITE

CAMBRIDGE SYSTEMATICS

System Metrics Group

Vendors Interactions – A few Examples

Caltrans D7

System Integrator

Delcan

Statewide Signal Control

TRANSCORE — TransSuite

Simulation

CAMBRIDGE SYSTEMATICS

System Metrics Group

LA County

Traffic Signal Control

Kimley-Horn and Associates, Inc.

Traveler Information

ITERIS — Blue Commute

Data Communication

TRANSCORE — IEN

Pasadena

Traffic Signal Control / Detection

SIEMENS — i2tms

McCain — QuickNet Pro

TRANSCORE — TransSuite, SCATS

ECONOLITE — Controllers, Video Detection

ITERIS — Video Detection

Simulation

PTV GROUP — VISSIM

Mygistics — Dynamic Traffic Assignment Model

Arcadia

Traffic Signal Control

TRANSCORE — TransSuite

Traffic Detection

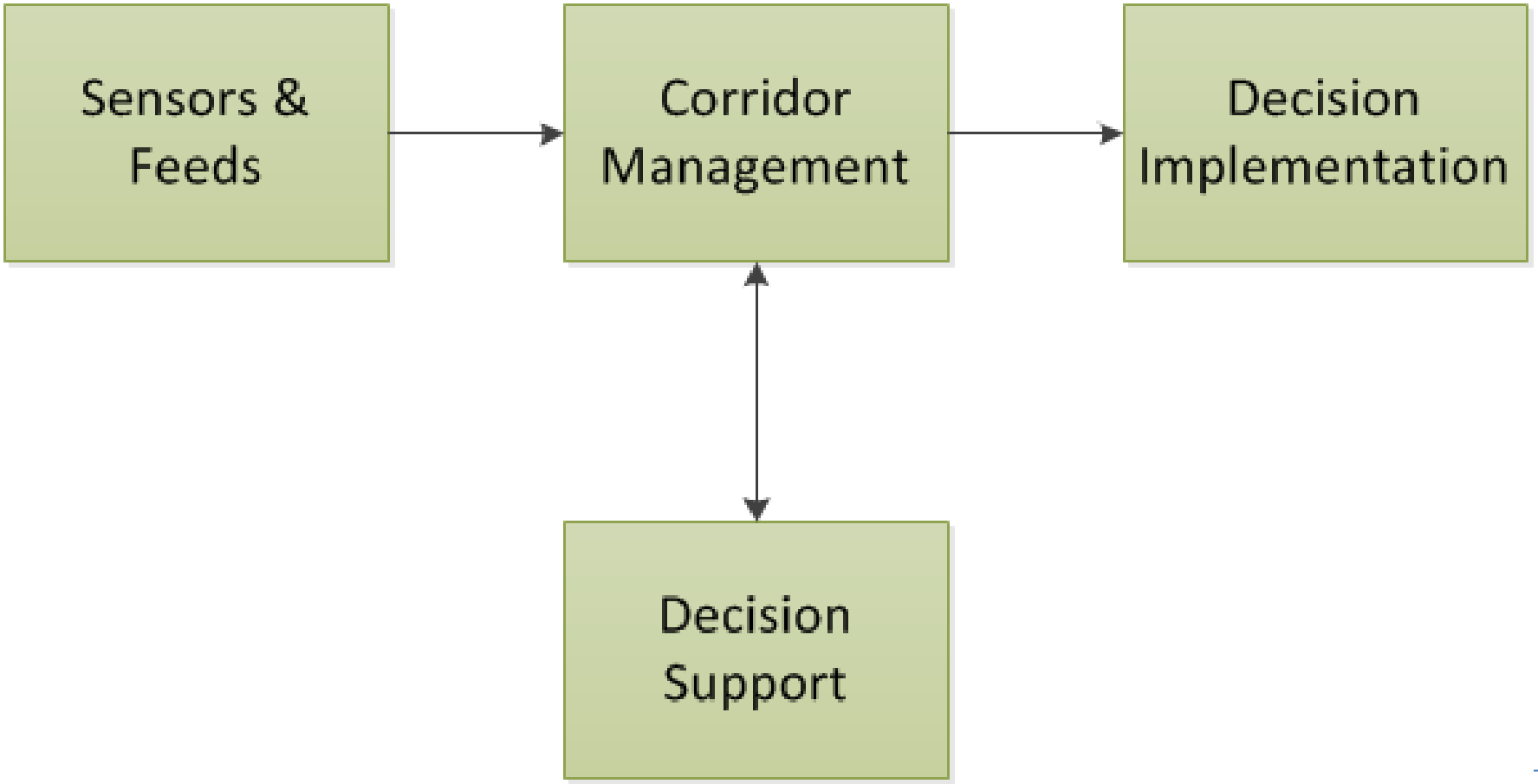
ITERIS — Video Detection

PELCO by Schneider Electric — CCTV Cameras

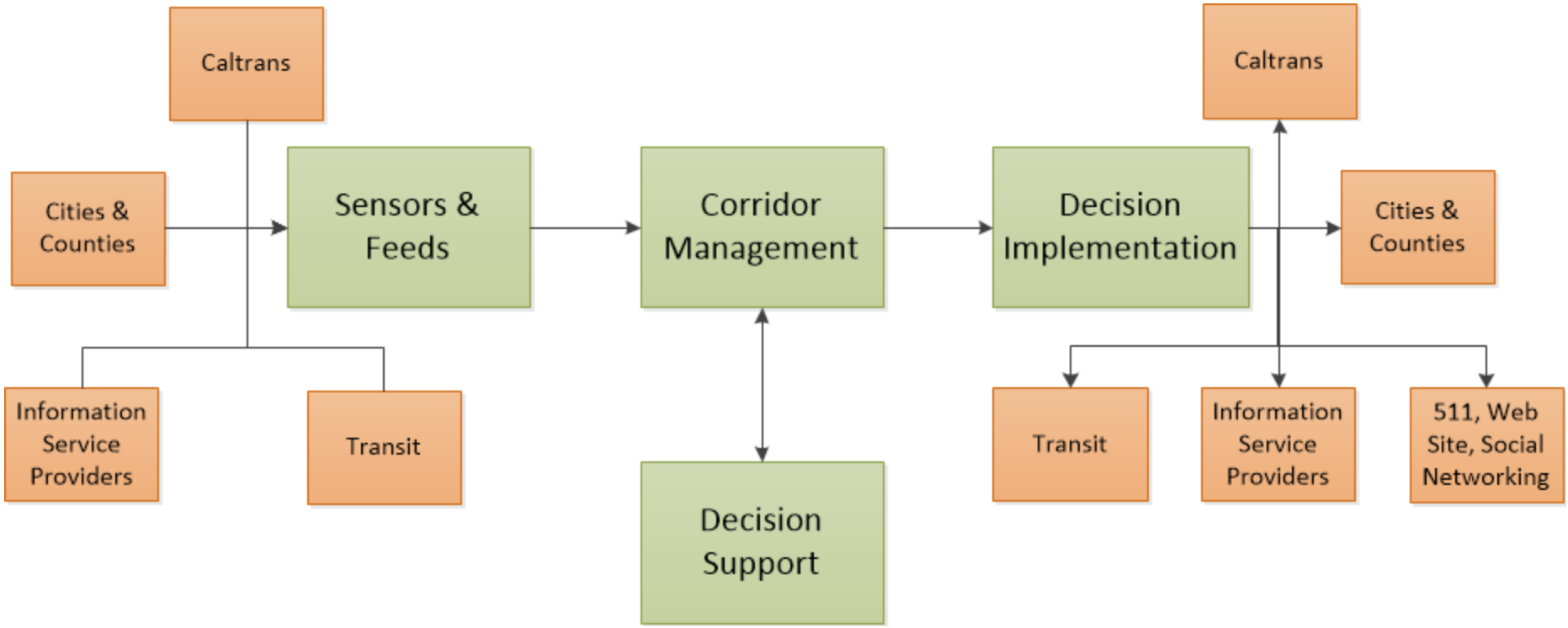
ICM Architecture

- **First - Understand and agree upon the overall generic components of an ICM Architecture**
  - Data Sources from numerous jurisdictions
  - Signals and Signs in numerous jurisdictions
  - Real time data communication requirements
  - Real time decision support and decision agreement
- **Next – Review implementations**
  - SANDAG
  - DART
  - Bay Area
- **Review current architecture of D7 as discussion point for future plans**

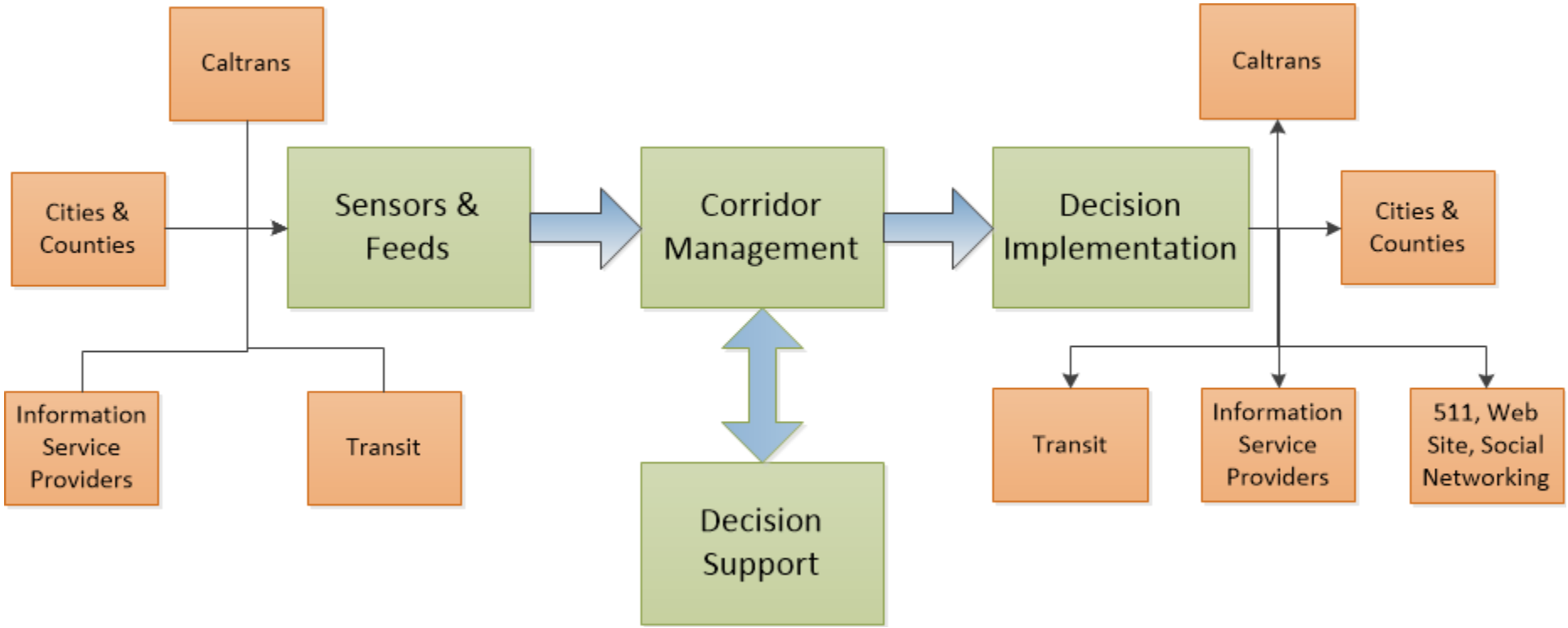
Architecture – At its most basic



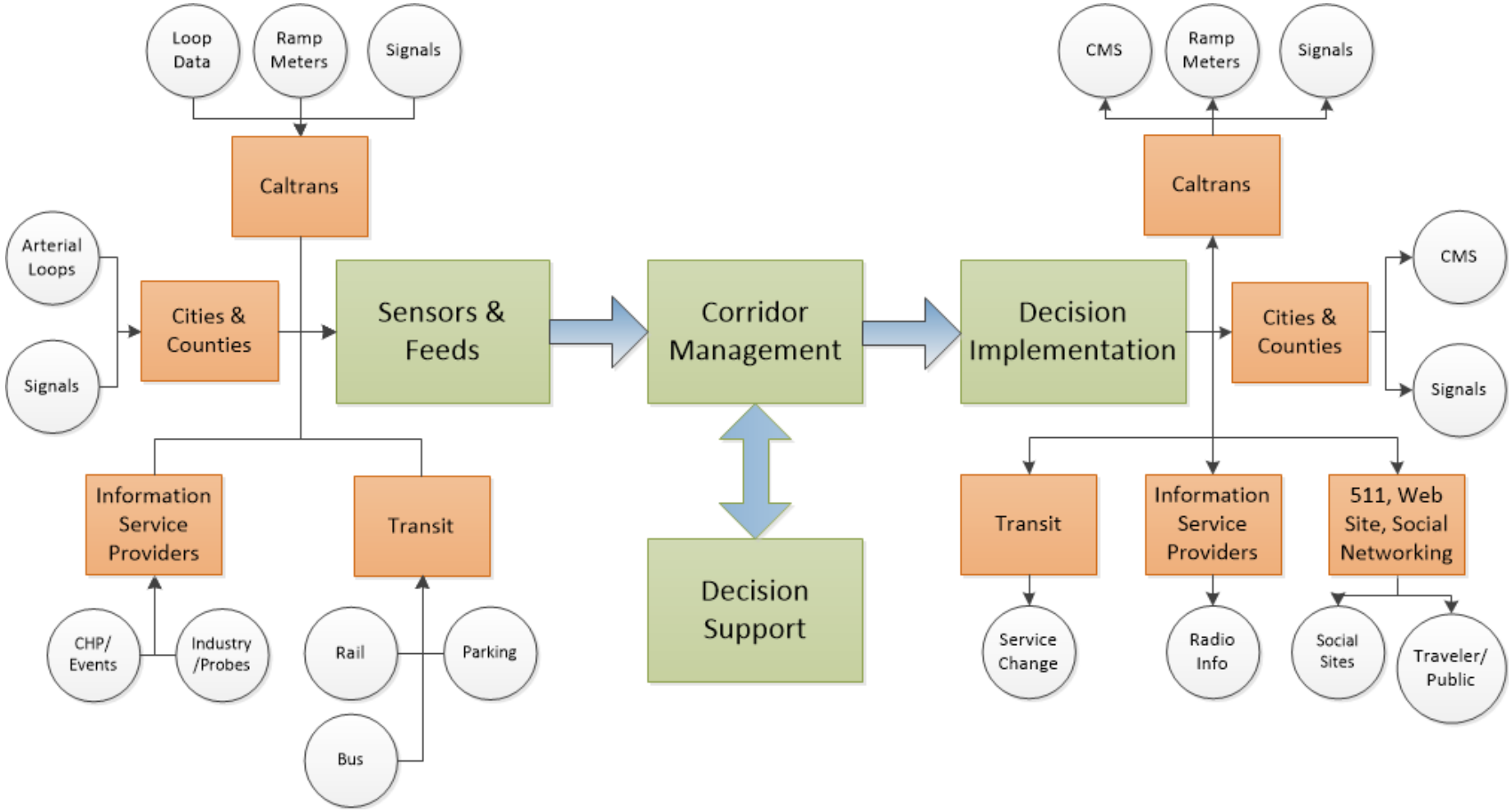
Adding the stakeholders



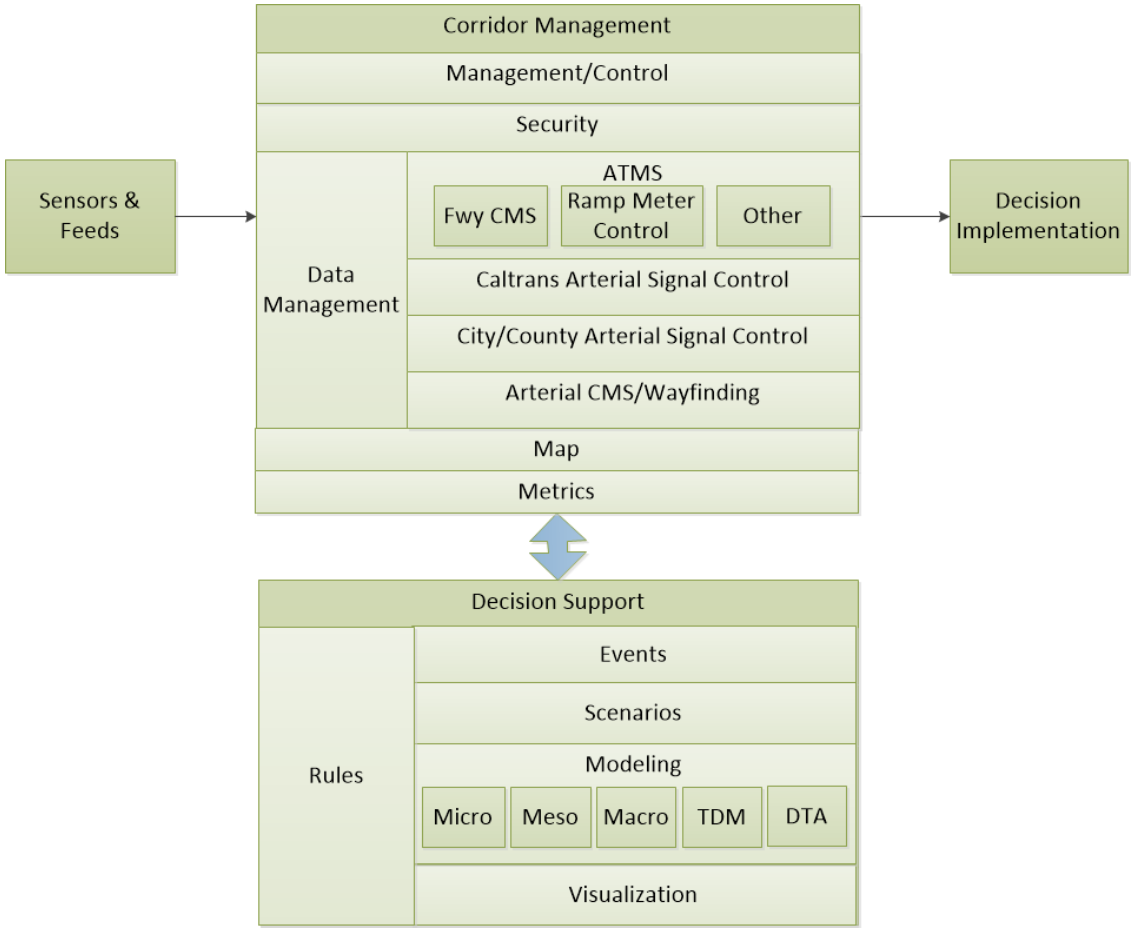
Communication and Data Standardization



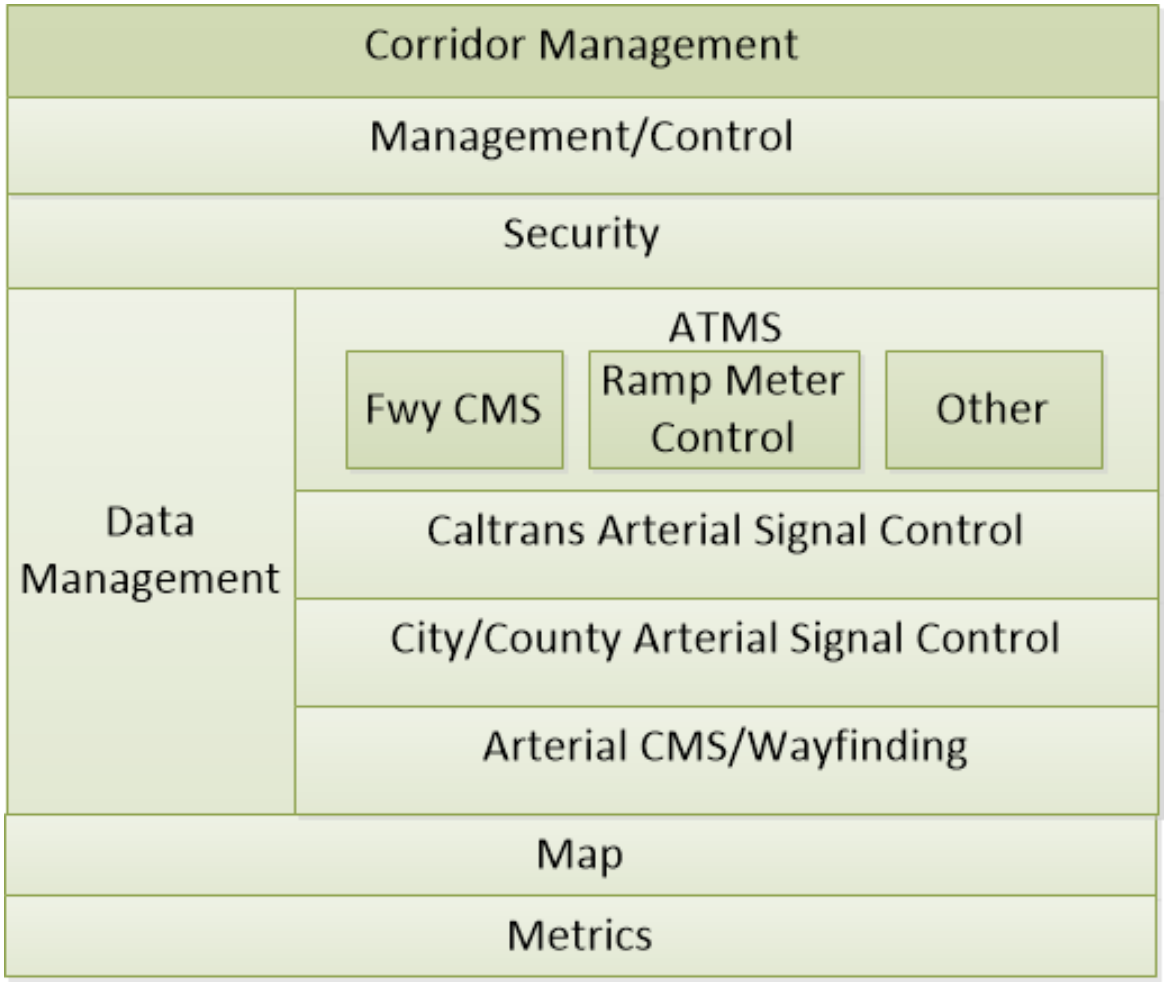
Stakeholder Data and Controllers

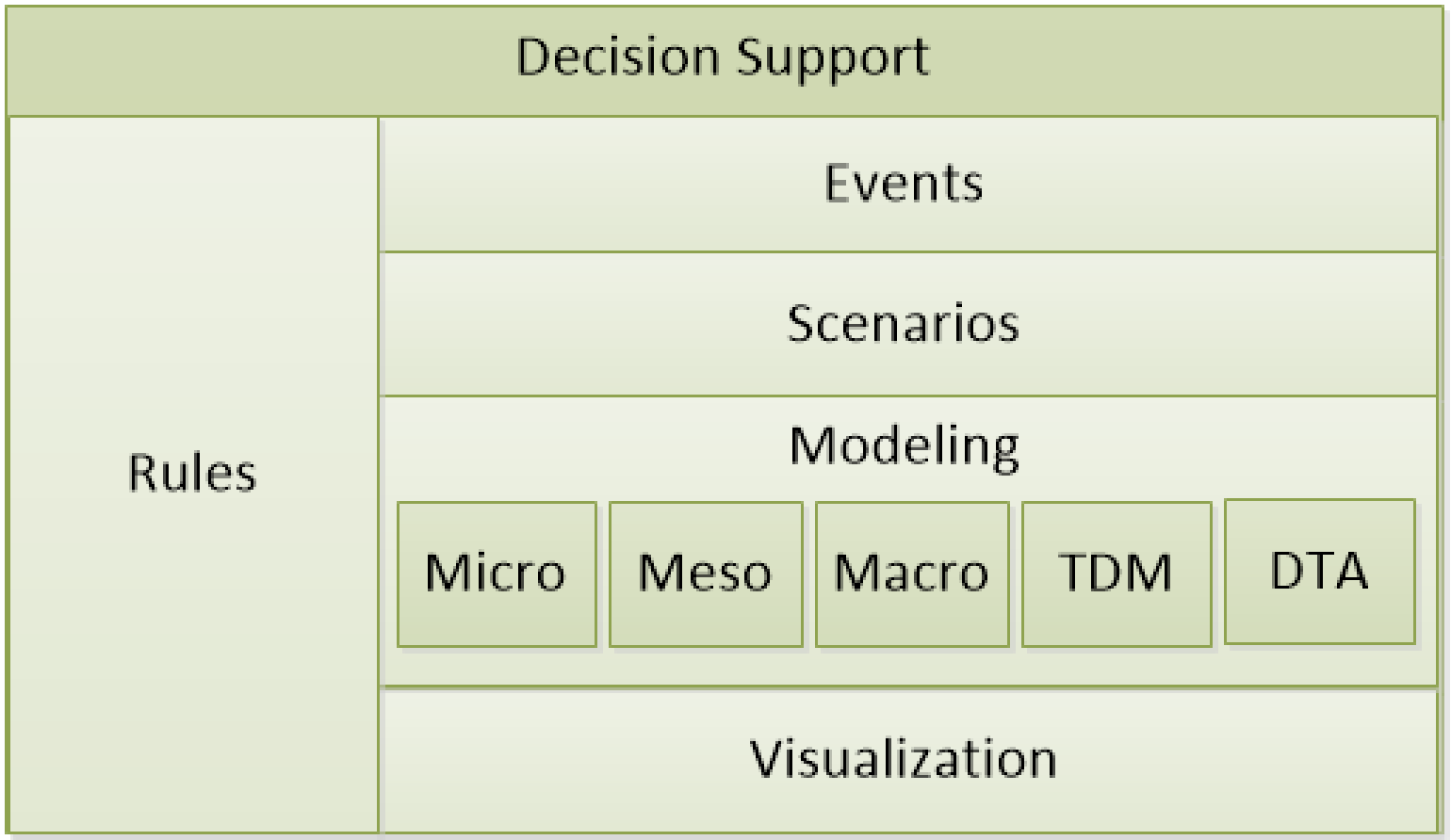


System Components



Corridor Management Subsystems

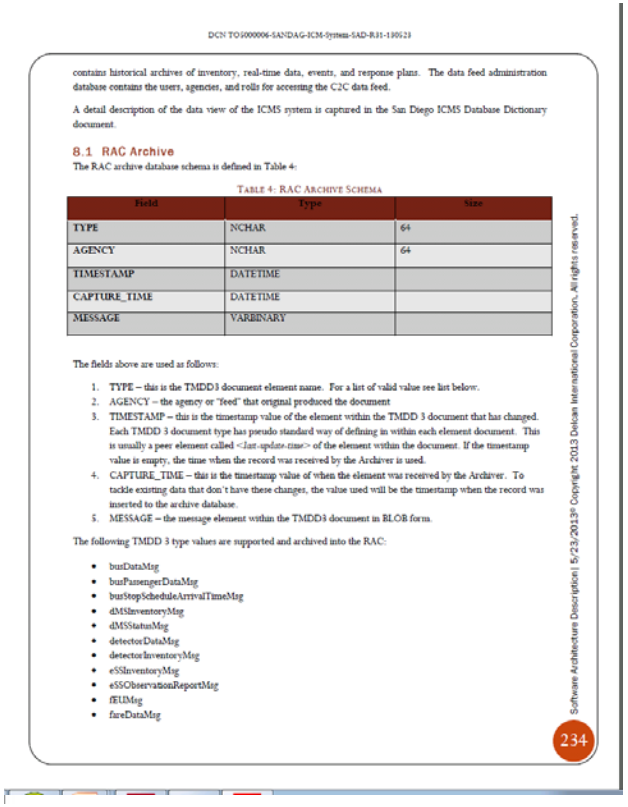



Decision Support
Rules
Events
Scenarios
Modeling
Micro
Meso
Macro
TDM
DTA
Visualization

Existing ICM Efforts (United States)

Corridor	Corridor Type	Lead Agencies	Activities
I-15 Diego	Suburban	SANDAG	• ConOps and System Requirements developed in 2008 • Simulation evaluation in 2009-2010 • System launched October 2013 • Currently in evaluation phase
US-75 Dallas	Suburban & urban	DART	• ConOps and System Requirements developed in 2008 • Simulation evaluation in 2009-2010 • System launched in April 2013 • Currently in evaluation phase
I-80 Bay Area	Suburban & urban	MTC / Caltrans	• ConOps developed in 2010 • Groundbreaking in October 2012 • Expected to be completed Summer 2015
I-95 / I-395 Virginia	Rural, Suburban & Urban	Virginia DOT	• ConOps development initiated in 2012 • Currently developing deployment plan & partnerships

SANDAG – Peter Thompson



DCN TO1000006-SANDAG-ICM-System-SAD-R31-130523

contains historical archives of inventory, real-time data, events, and response plans. The data feed administration database contains the users, agencies, and rolls for accessing the C2C data feed.

A detail description of the data view of the ICMS system is captured in the San Diego ICMS Database Dictionary document.

8.1 RAC Archive

The RAC archive database schema is defined in Table 4:

TABLE 4: RAC ARCHIVE SCHEMA

Field	Type	Size
TYPE	NCHAR	64
AGENCY	NCHAR	64
TIMESTAMP	DATETIME	
CAPTURE_TIME	DATETIME	
MESSAGE	VARBINARY	

The fields above are used as follows:

1. TYPE – this is the TMDD3 document element name. For a list of valid value see list below.
2. AGENCY – the agency or "feed" that original produced the document
3. TIMESTAMP – this is the timestamp value of the element within the TMDD 3 document that has changed. Each TMDD 3 document type has pseudo standard way of defining in within each element document. This is usually a peer element called <last-update-time> of the element within the document. If the timestamp value is empty, the time when the record was received by the Archiver is used.
4. CAPTURE_TIME – this is the timestamp value of when the element was received by the Archiver. To tackle existing data that don't have these changes, the value used will be the timestamp when the record was inserted to the archive database.
5. MESSAGE – the message element within the TMDD3 document in BLOB form.

The following TMDD 3 type values are supported and archived into the RAC:

- busDataMsg
- busPassengerDataMsg
- busStopScheduleArrivalTimeMsg
- dMSInventoryMsg
- dMSStatusMsg
- detectorDataMsg
- detectorInventoryMsg
- eSSInventoryMsg
- eSSObservationReportMsg
- fEUMsg
- fireDataMsg

Software Architecture Description | 5/23/2013© Copyright 2013 Delcan International Corporation, All rights reserved.

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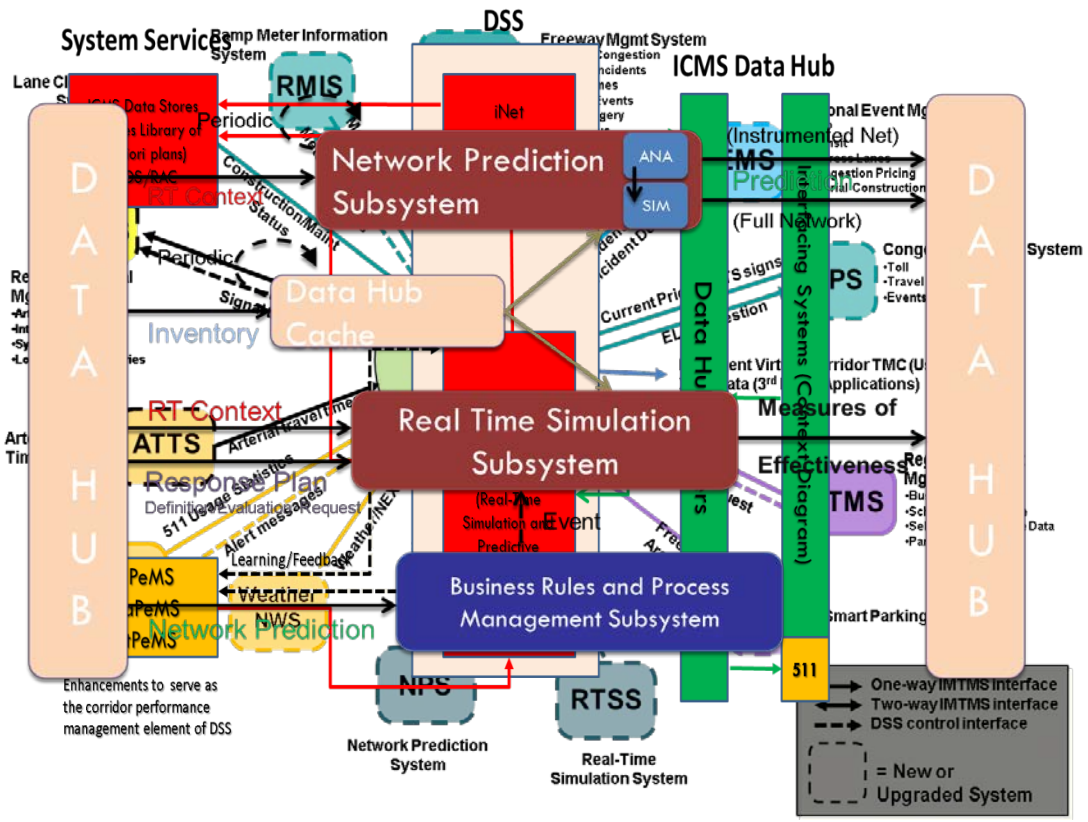
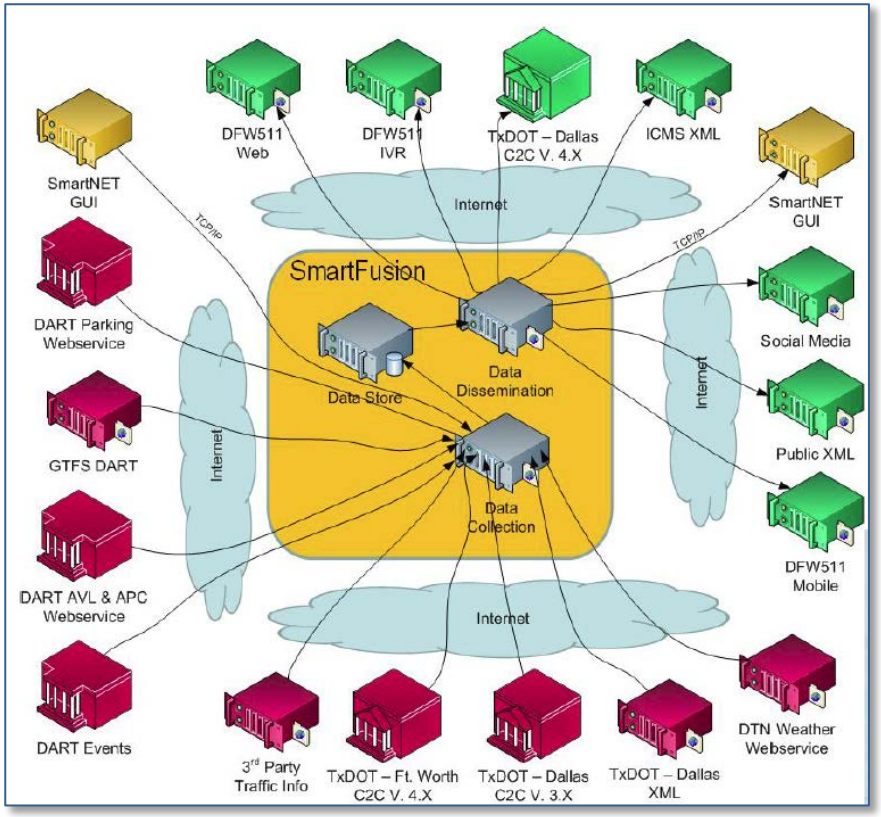


Concept → Use → Logical → Process → Deploy → Implement → Data

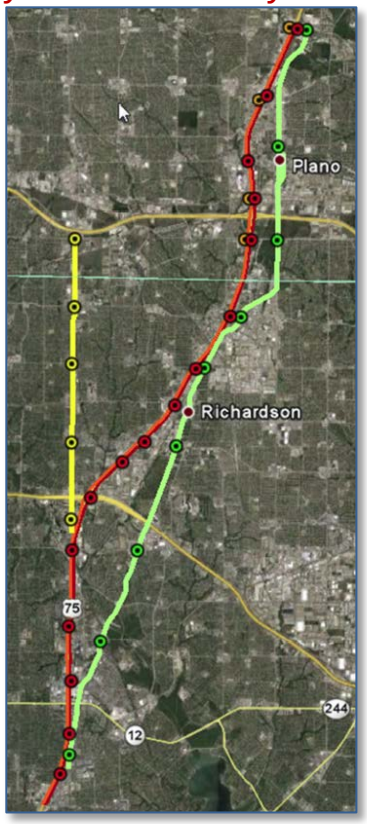
Caltrans Delcan ITERIS TSS TRANSPORT SIMULATION SYSTEMS here SANDAG System Metrics Group CALIFORNIA PATH

DART – Dallas Area Rapid Transit

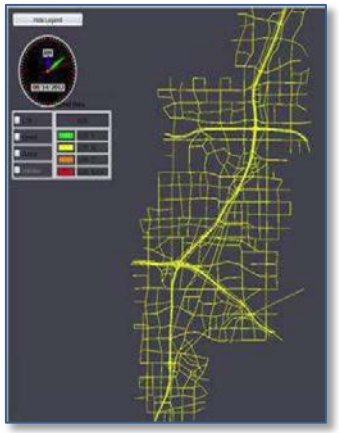
SmartNET System



Bluetooth arterial monitoring system + 3rd Party data



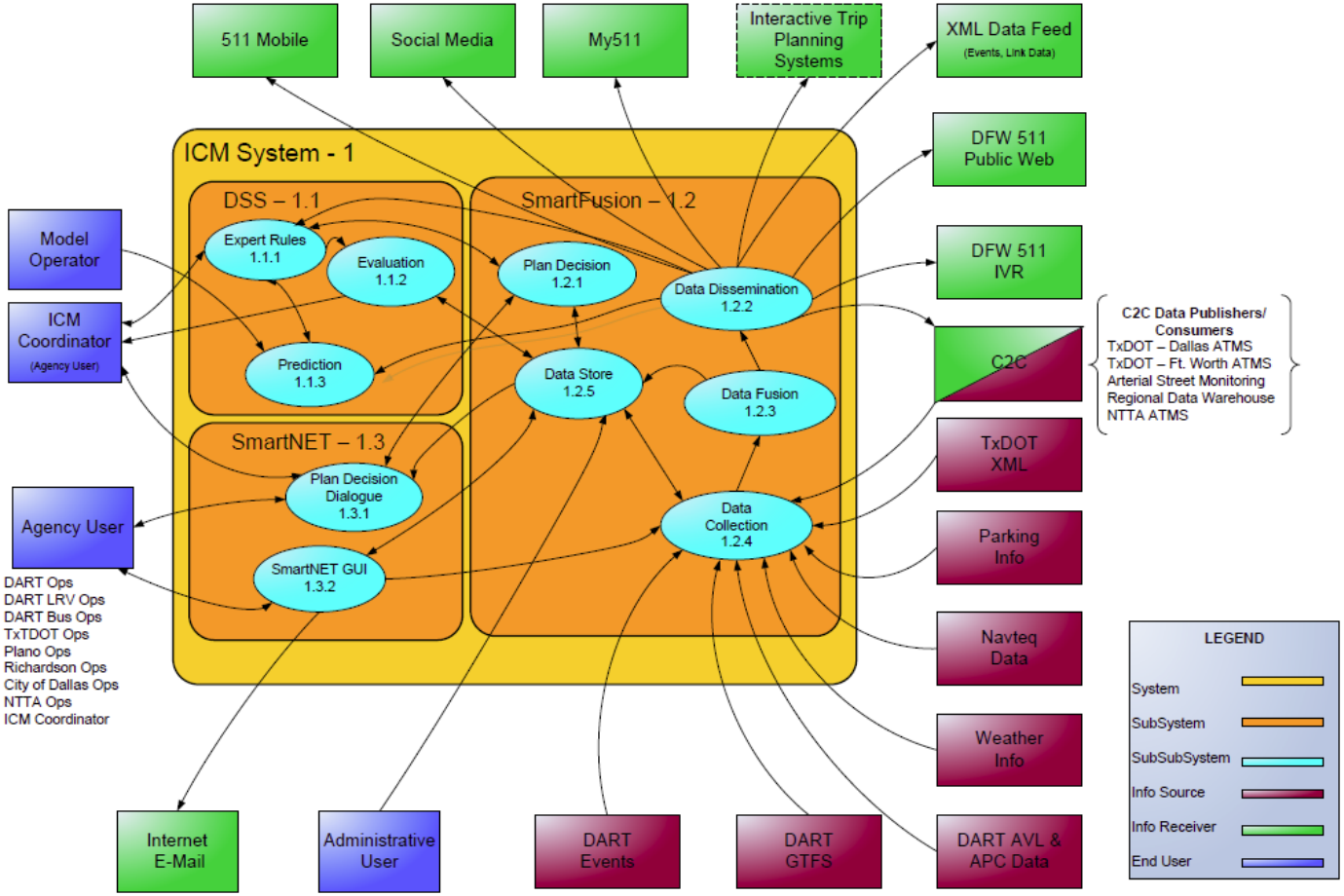
Simulation Model



Multimodal 511 system

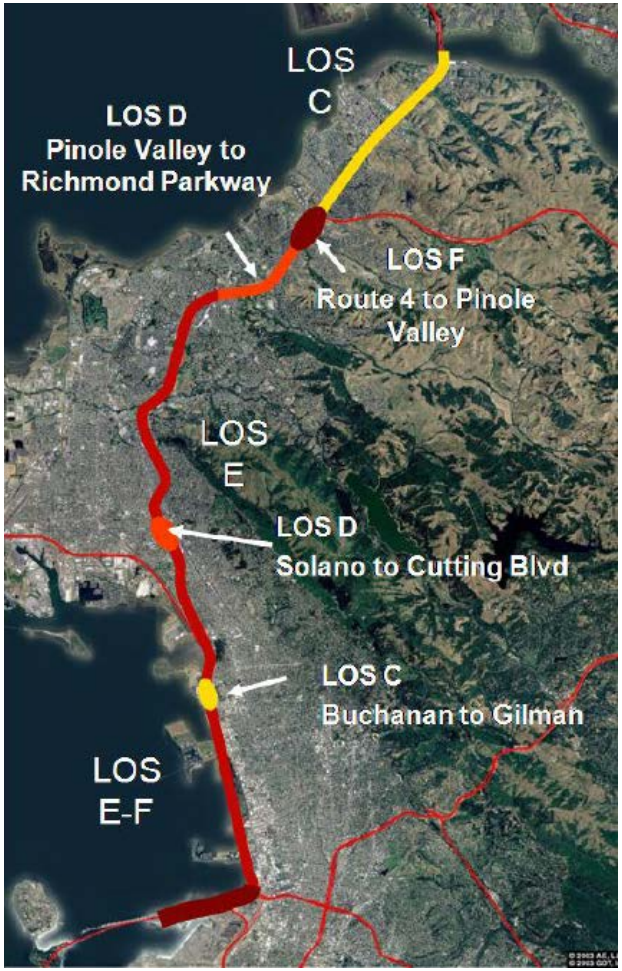
511 DFW BEGIN YOUR TRIP HERE.

DART – Decision Support System



I-80 Corridor – Dan Lukasik

- Over 20,000 vehicle-hours of delay per day
- Inconsistent level of service (C to F)
- Variable speeds (stop & go to 65 mph)
- High incident rates: over 2,000 incidents annually
- Un-reliability of travel (20 to>60 min)

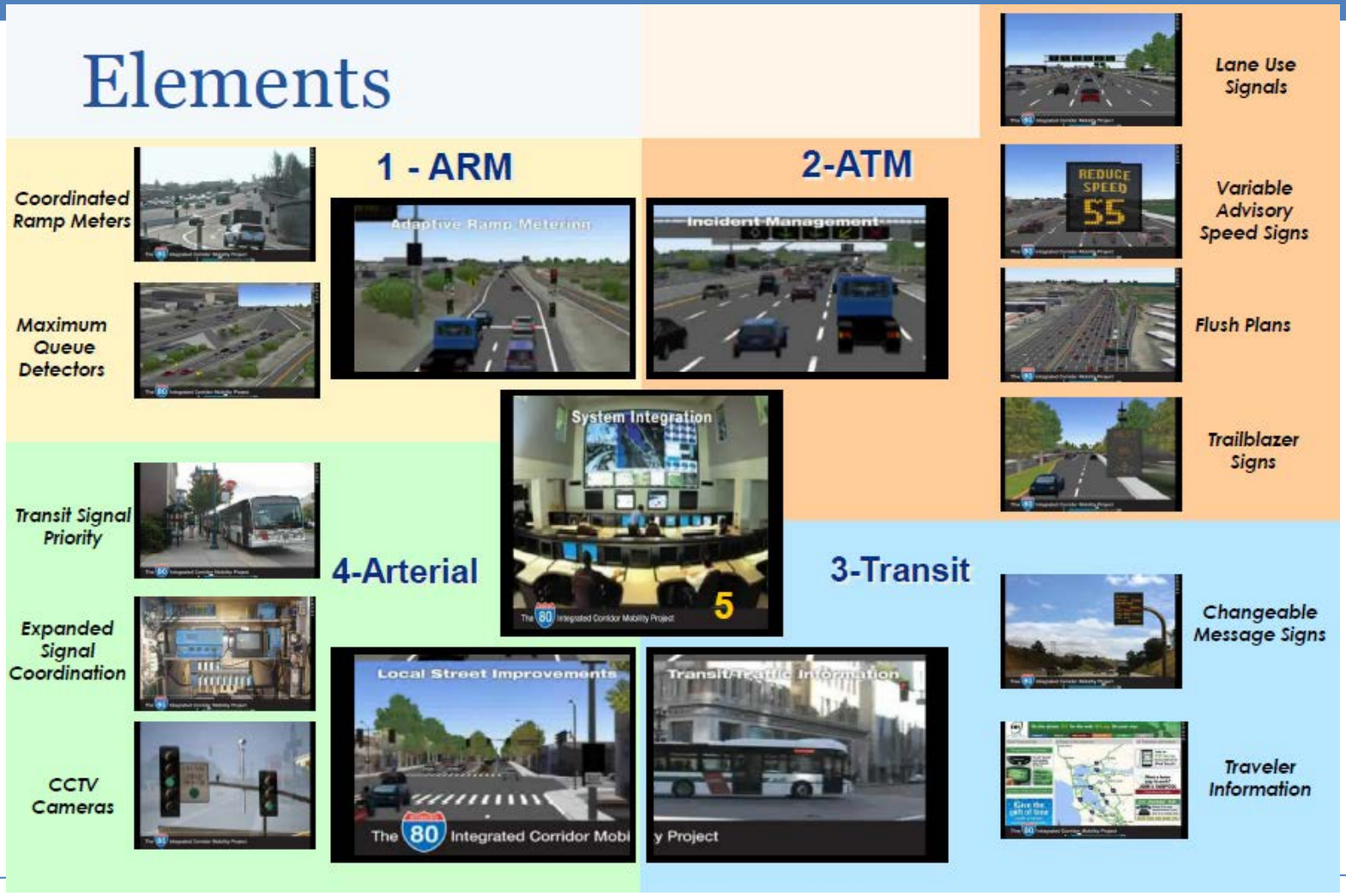


I-80 ICM Solution

I-80 ICM deploys ATM and ICM strategies that will:

- Create a Well Balance System
- Maintain Optimal Operational Viability
- Proactively Avoid Flow Breakdown
- Detect and Respond to Congestion Events Faster
- Improve Safety
- Manage Congested Flow When it Does Occur
- Promote Transit Ridership and Mode Shifts
- Clear Local Arterials from Diversion

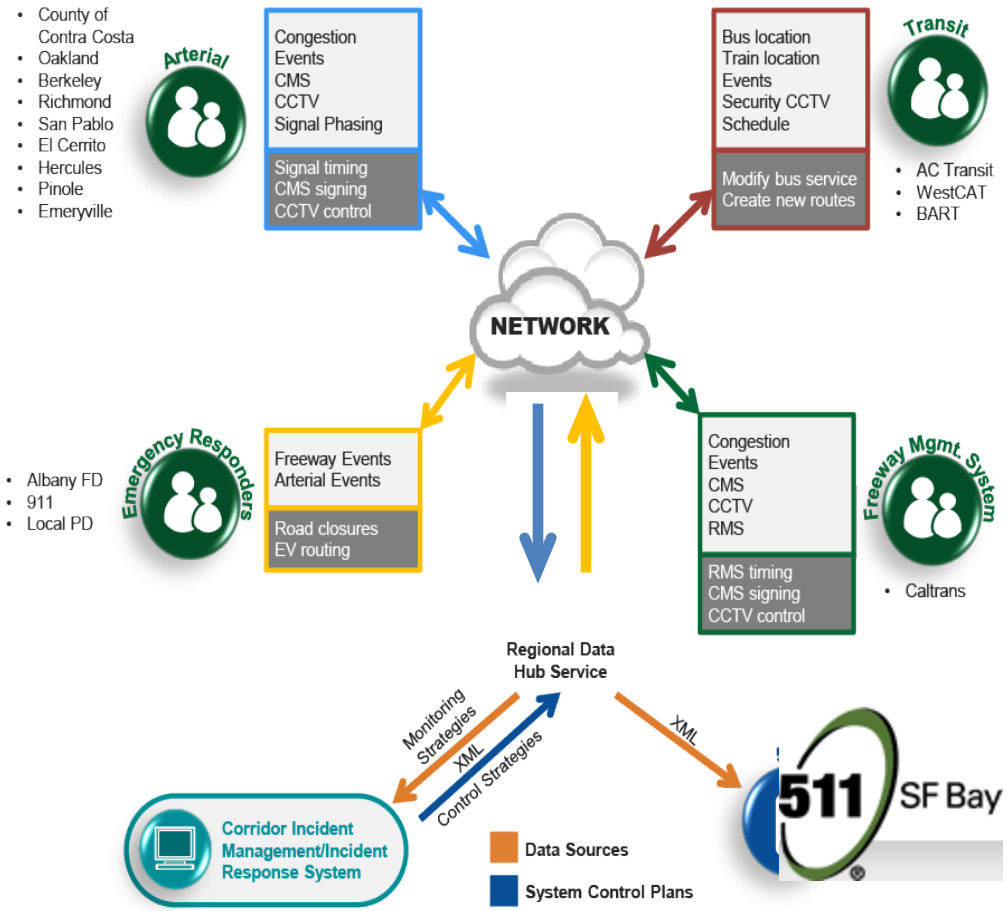
I-80 ICM Elements



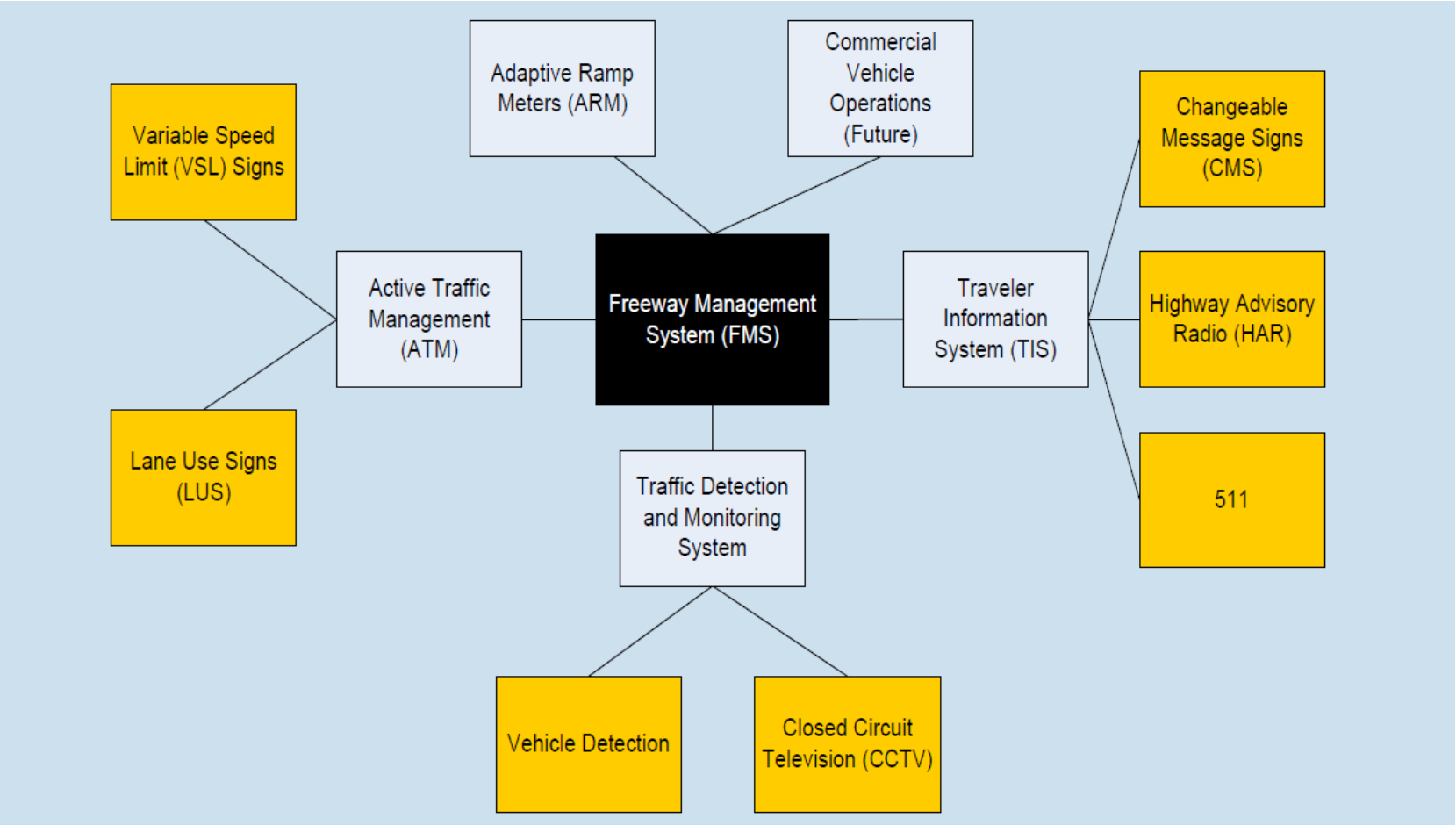
Caltrans Delcan ITERIS TSS TRANSPORT SIMULATION SYSTEMS here SANDAG System Metrics Group CALIFORNIA PATH

I-80 ICM High Level View

- Integration of various agency subsystems working together
  1. Arterial
  2. Freeway
  3. Transit
  4. Emergency Responders
- Key Component is the Incident Response System



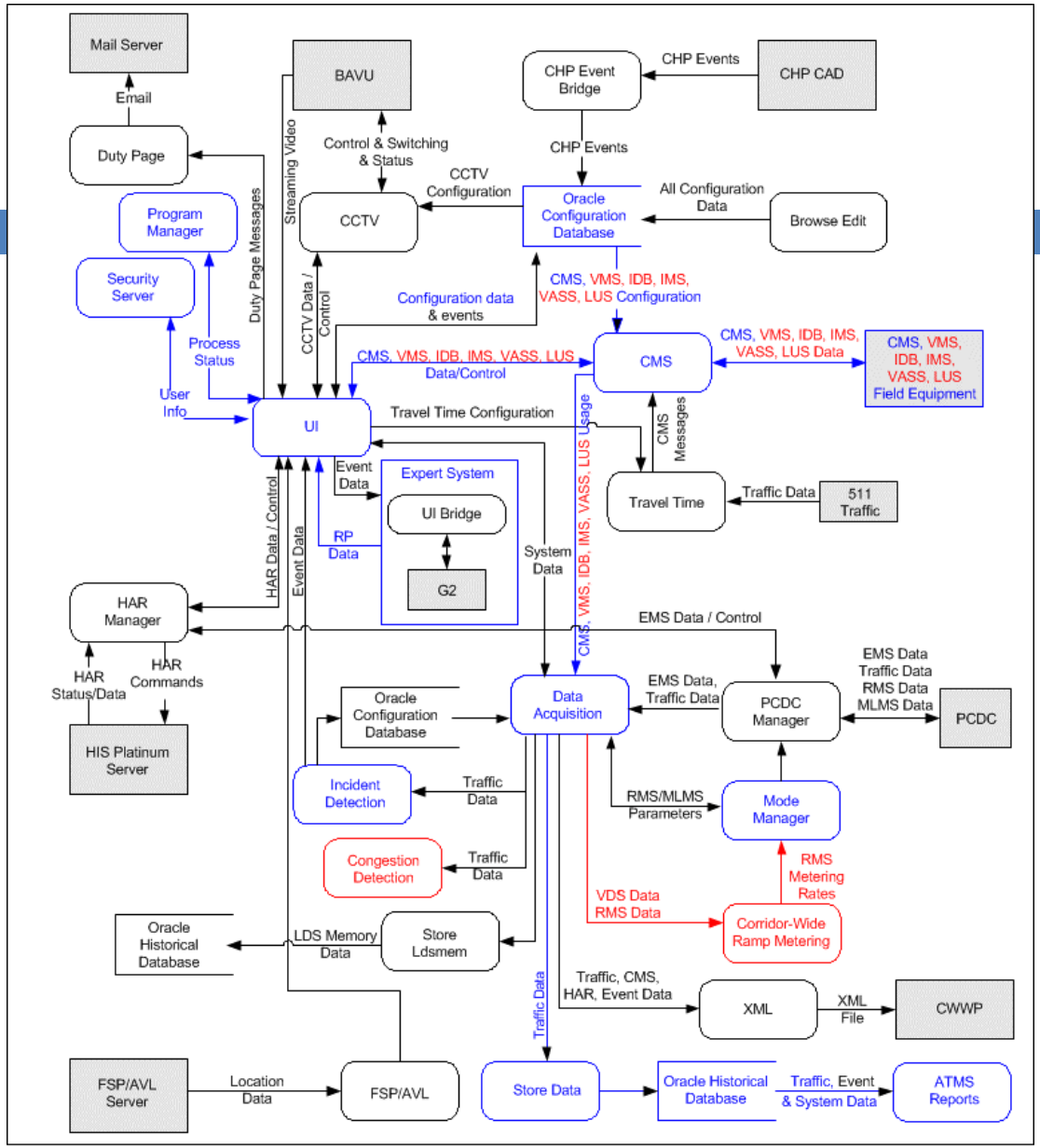
I-80 ICM Project Architecture



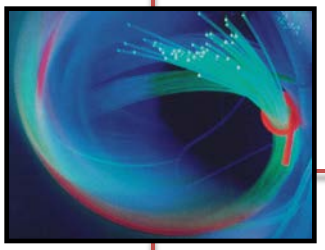
D4 ATMS Architecture

Red Items – New Components

Blue Items – Modified Components



D7 ATMS



TSMSS

Traffic Signal Management & Surveillance System

400+ miles Fiber optic Communication

(SONET* Ethernet)

*All analog communications are connected through Sonet

Detectors

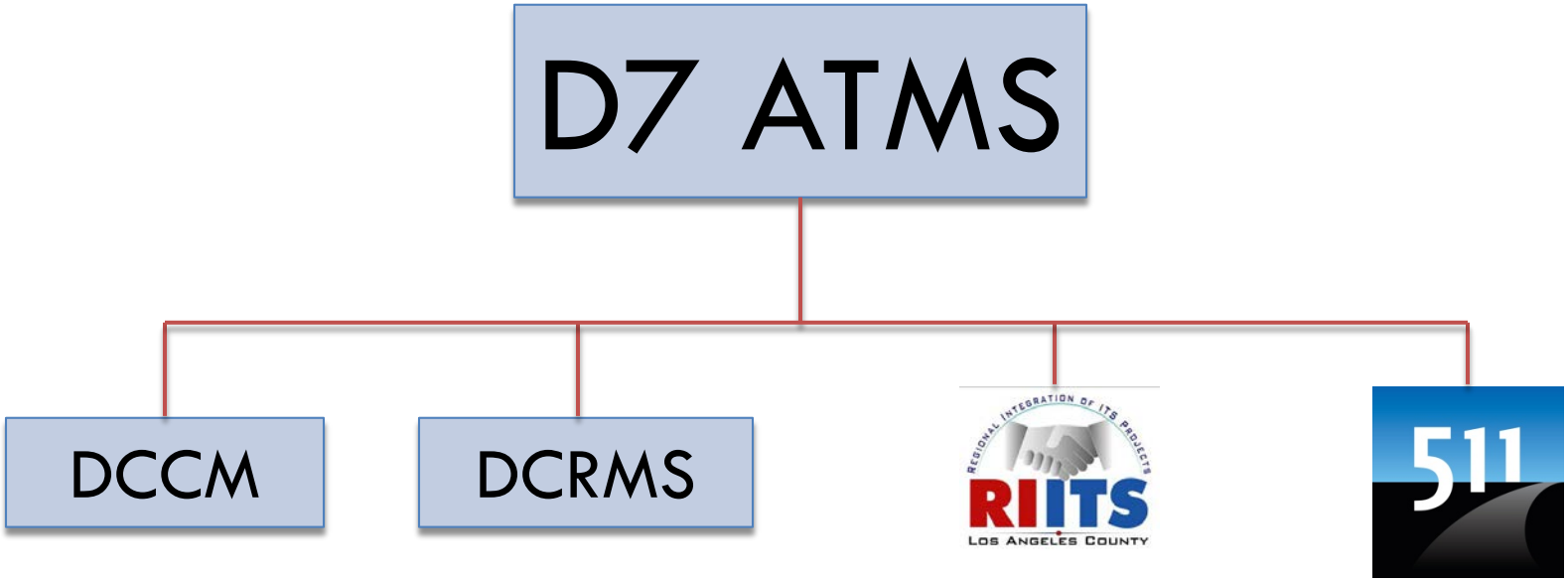
1,400 RMS

490 CCTV

130 CMS

22 HAR

1300 Traffic Signals



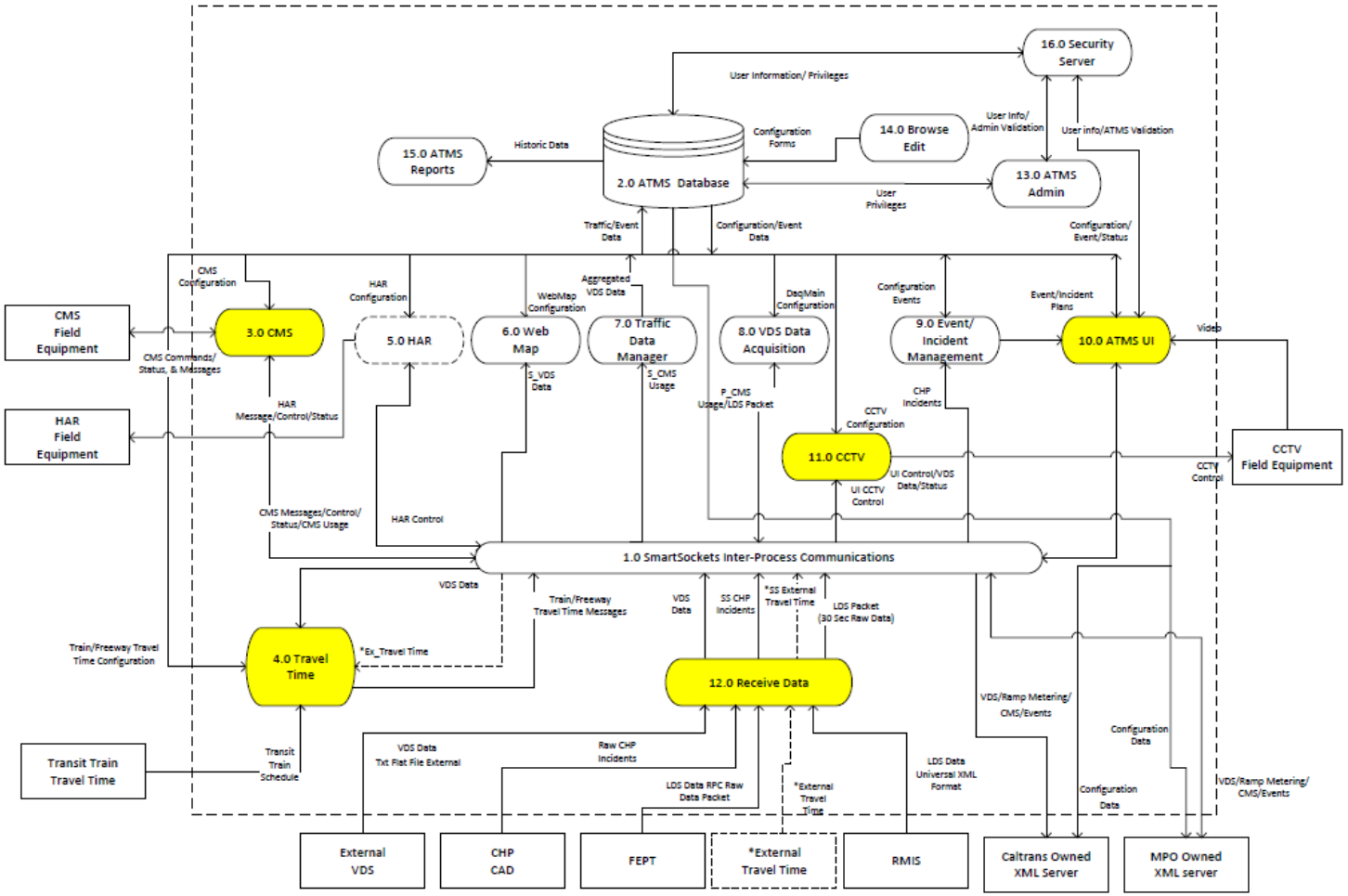
DCCM: (Dynamic Corridor Congestion Management) Coordinate Freeway Ramp Operation with Arterial Traffic Signal System Operation for regional corridor congestion relief

DCRMS: (Dynamic Corridor Ramp Metering System) An upgraded Adaptive Corridor wide Ramp Metering System which will support DCCM operations

RIITS: Operated by Metro in support of inter-agency information exchange (In addition to travel information to 511, also include Ramp Meter Operation Status/Meter Rate, CCTV Streaming Video).

511: Real time travel information (Congestion, CMS Message, Confirmed Event, Travel Time, CCTV Video).

ATMS 5.0


16.0 Security Server
User Information/ Privileges
15.0 ATMS Reports
Historic Data
2.0 ATMS Database
Configuration Forms
14.0 Browse Edit
User Info/ Admin Validation
User info/ATMS Validation
13.0 ATMS Admin
User Privileges
Traffic/Event Data
Configuration/Event Data
Configuration/ Event/Status
CMS Configuration
HAR Configuration
WebMap Configuration
Aggregated VDS Data
DaqMain Configuration
Configuration Events
Event/Incident Plans
Video
CMS Field Equipment
3.0 CMS
5.0 HAR
6.0 Web Map
7.0 Traffic Data Manager
8.0 VDS Data Acquisition
9.0 Event/ Incident Management
10.0 ATMS UI
CMS Commands/ Status, & Messages
HAR Message/Control/Status
S_VDS Data
S_CMS Usage
P_CMS Usage/LDS Packet
CHP Incidents
CCTV Configuration
HAR Field Equipment
11.0 CCTV
CCTV Field Equipment
UI Control/VDS Data/Status
UI CCTV Control
CCTV Control
CMS Messages/Control/ Status/CMS Usage
HAR Control
1.0 SmartSockets Inter-Process Communications
VDS Data
Train/Freeway Travel Time Messages
VDS Data
SS CHP Incidents
*SS External Travel Time
LDS Packet (30 Sec Raw Data)
Train/Freeway Travel Time Configuration
4.0 Travel Time
*Ex_Travel Time
12.0 Receive Data
VDS/Ramp Metering/ CMS/Events
Configuration Data
Transit Train Travel Time
Transit Train Schedule
VDS Data Txt Flat File External
Raw CHP Incidents
LDS Data RPC Raw Data Packet
*External Travel Time
LDS Data Universal XML Format
Configuration Data
VDS/Ramp Metering/ CMS/Events
External VDS
CHP CAD
FEPT
*External Travel Time
RMIS
Caltrans Owned XML Server
MPO Owned XML server

Operations and Maintenance

- **Operations Requirements**
- **Maintenance Requirements**
- **Liability Issues**
- **Staffing and Training**

Conclusions and Action Items

Thank You

- Wine and Cheese
- Faculty
- Students
- Staff

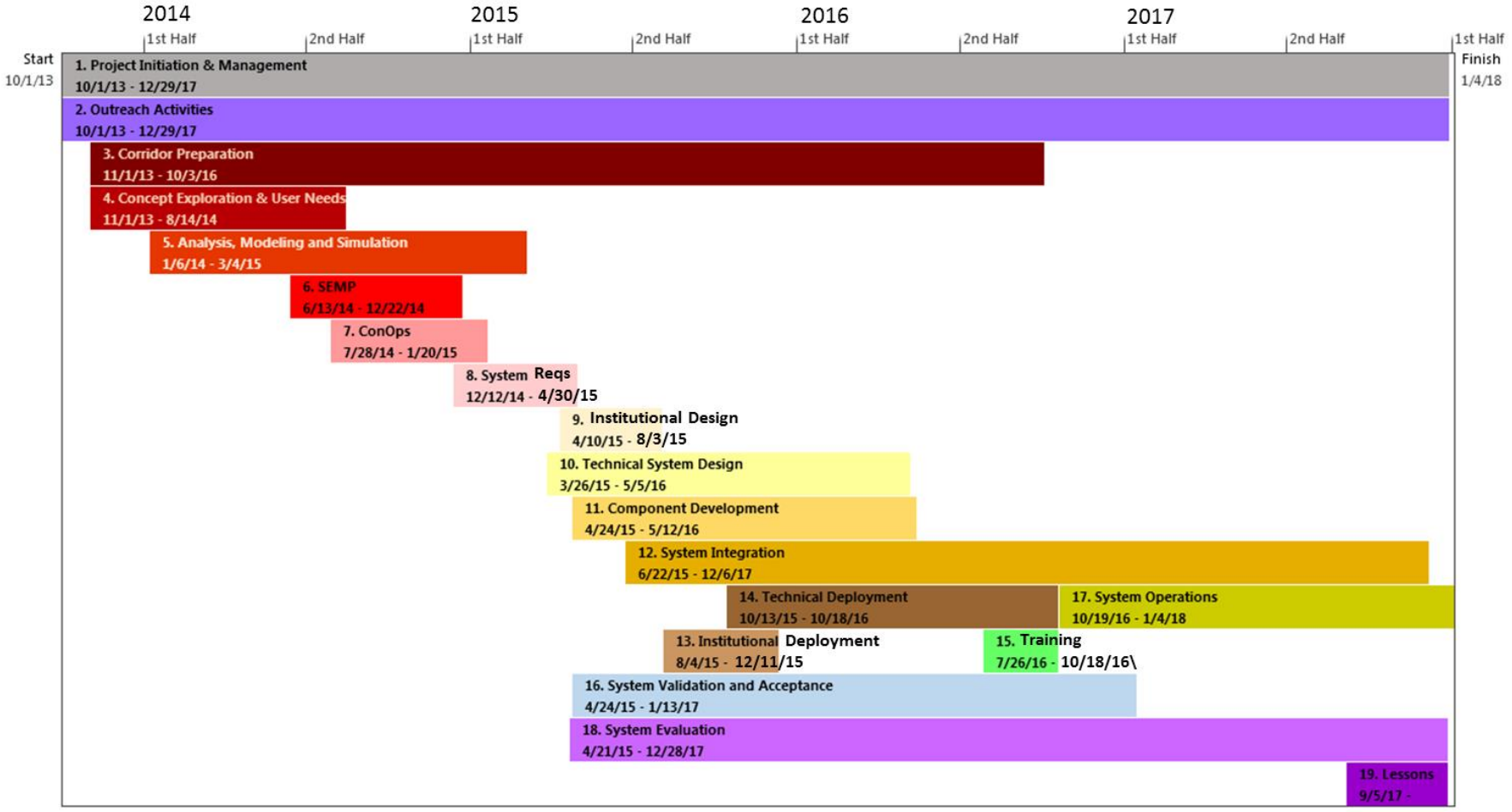
I-210 Pilot Project Goals

- **Bring together corridor stakeholders** to create an environment for mutual cooperation, including sharing knowledge, developing working pilots, and researching and resolving key issues
- **Formulate a roadmap** for the cost-effective implementation of future innovations
- Develop and deploy an integrated, **advanced decision support system** for use by the stakeholders as they actively manage the corridor
- Develop a **set of performance measures** to quantify the successes of the Connected Corridors pilot project
- **Demonstrate project effectiveness** that can lead to additional phases and funding for more advanced tools and capabilities
- Develop a pilot system that **can be replicated** on other corridors and be a model for other corridors in the state and country

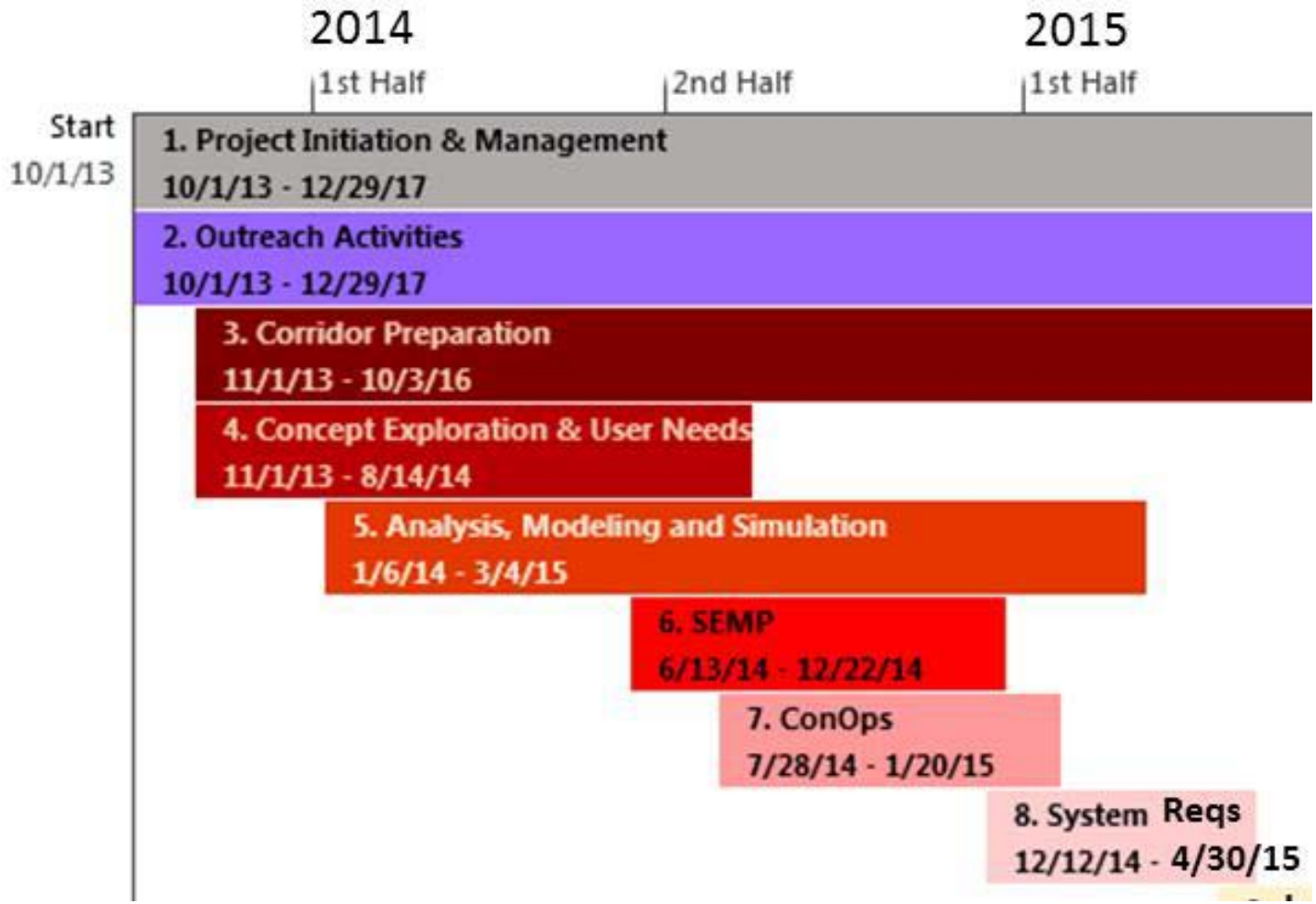
The Connected Corridors Program

- Organizational and cultural changes
- Funding and strategic planning
- System Engineering
- Relationship management with gov agencies, industry, legislature
- Decision Support Tools
- Applied research
- 210 Pilot
- Evaluations
- 50 corridors in Ca

I-210 Pilot – Overall Schedule



I-210 Pilot – Overall Schedule



Vendors Interactions

Caltrans D7

System Integrator

Delcan

Statewide Signal Control

TRANSCORE — *TransSuite*

Simulation

CAMBRIDGE SYSTEMATICS

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LA County

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Arcadia

Traffic Signal Control

TRANSCORE — *TransSuite*

Video Traffic Detection

ITERIS

CCTV Cameras

PELCO by Schneider Electric

Vendors Interactions

Monrovia

Traffic Signal Control

Kimley-Horn and Associates, Inc.

Duarte

Traffic Signal Control

Kimley-Horn and Associates, Inc.

Irwindale

Traffic Signal Control

TRANSCORE

LA Metro

Bus Tracking / Traveler Information

nextbus

Common Equipment Vendors

ECONOLITE

ITERIS

McCain

SIEMENS

Schneider Electric

SENSYS networks

Vendors Interactions

Simulation/Analytical Tool Providers

- TSS Transport Simulation Systems — *Aimsun*
- PTV Group — *Vissim*
- Caliper — *TransModeler, TransCAD*
- Trafficware (Engineered by Naztec) — *Synchro, SimTraffic*
- Pitney Bowes Software / QuadstoneParamics — *Paramics*

Potential Engineering Consultants

- SAIC From Science to Solutions™ Science Applications International Corporation
- Fehr & Peers
- URS
- Kittelson & Associates, Inc. Transportation Engineering/Planning
- AECOM
- HNTB
- Stantec
- Parsons Brinckerhoff
- CH2MHill
- Parsons
- ~~TELVENT~~ Schneider Electric

Caltrans · Delcan · ITERIS · TSS Transport Simulation Systems · here · SANDAG · System Metrics Group · California PATH

Applied Research

- Real Time Origin Destinations from Cell Tower Data (AT&T)
- Full integration of probes as data source (Here/Nokia and Inrix)
- Macro modeling capabilities based on measured traffic data and not driver behavior estimates
- Highway, arterial and transit coordination in real time
- Improvements in reroute response and estimation
- Determination of modeling accuracy
- Human Factors – outward looking
- Institutional issues

Additional Details