Managing Multi Modal Travel Corridors – Is All in the Cloud

Toronto, 1959

Pilot Project Evaluation - Closed Circuit Television (circa 1959)

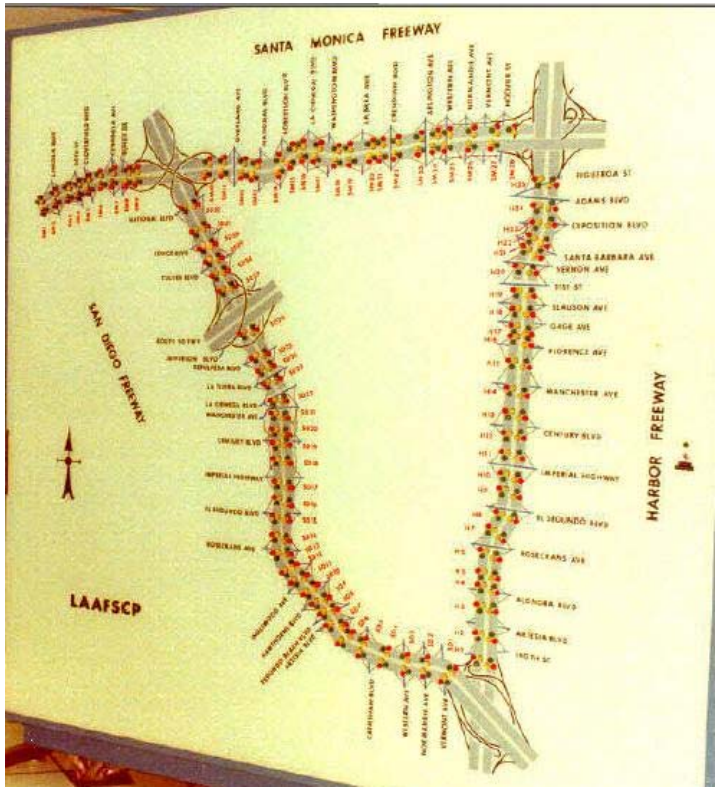
Los Angeles, 2009

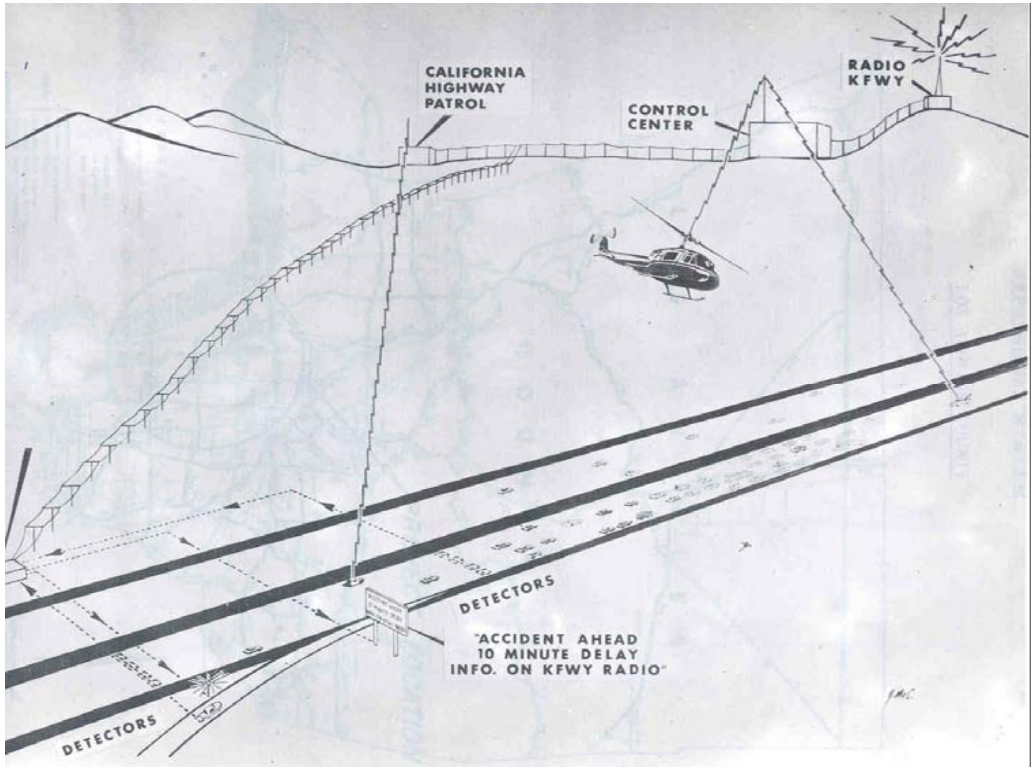
Alex Skabardonis
With Brian Peterson & Joe Butler
University of California, Berkeley

96th TRB Annual Meeting
January 10, 2017
Washington, DC

Early Flying in the "Cloud"

1971 Los Angeles – 42 mile loop





Integrated Corridor Management (ICM)

Corridor Traffic Management & Information Vision

The I-10 Smart Corridor (1)

Twelve mile corridor composed of the Santa Monica Freeway carrying up to 315000 vpd and five parallel arterial streets.

Goal: improve the efficiency and reliability of traffic through the coordinated use of management measures utilizing advanced technology.

Link five different TMCs currently operating independently: Caltrans (freeway), Los Angeles (ATSAC - traffic signals), Los Angeles (city street traffic officers), Highway Patrol (freeway), and SCRTD (buses).

Full detection on freeway and city streets within the corridor.

The I-10 Smart Corridor (2)

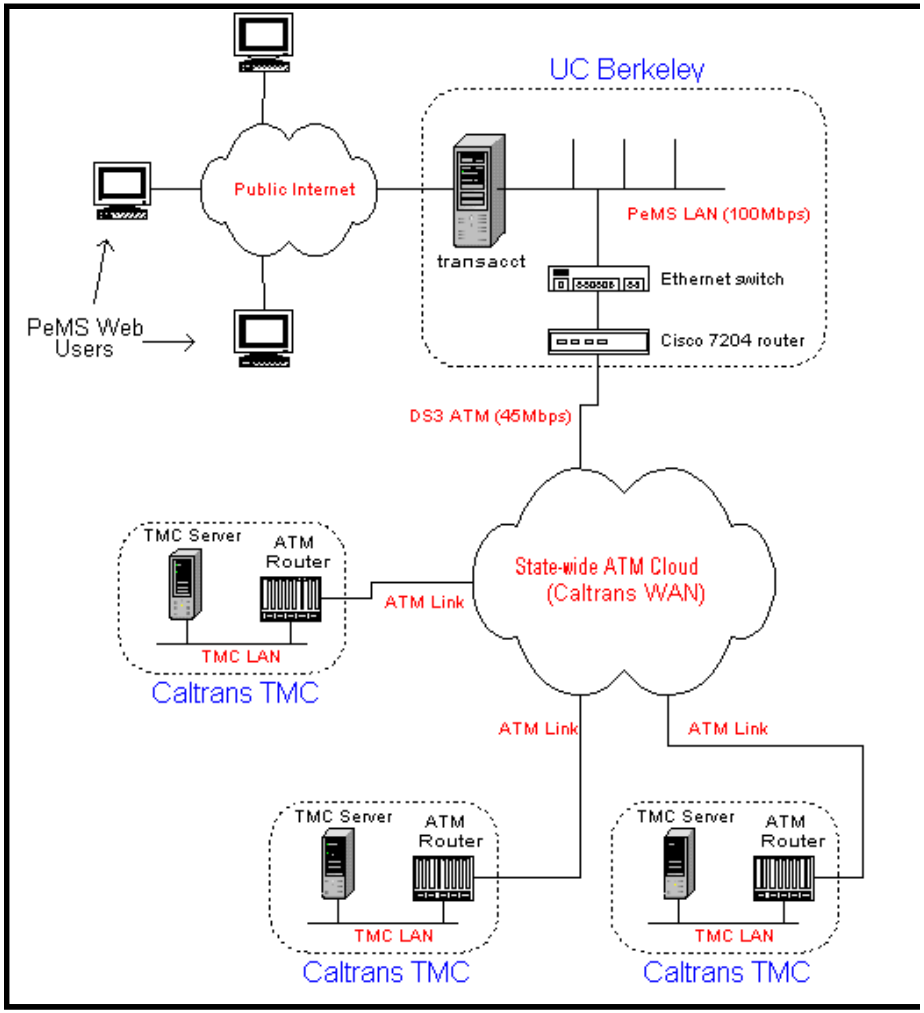
Information systems: CMS, HAR, automated telephone response, cable TV, in-vehicle navigation system, and computer bulletin boards.

New traffic management strategies will provide drivers with suggested alternate routes to avoid congestion and traffic incidents.

Expert system technology will assist TMC operators in the identification of incidents and the selection of appropriate countermeasures.

1998: PeMS System

- PeMS collects and stores data from loop detectors in the State's freeways in a central database at UC Berkeley. (33,000 Detectors)
- PeMS also obtains and stores CHP-published incident data
- PeMS is accessed from anywhere via a standard Internet browser
- PeMS supports freeway operations, planning, travelers and researchers



Why Cloud

Variety of inputs
Scalability
Multiple Storage/Processing Technologies Allowed
Choice of the Best Technology for the Task

CALTRANS IT Management
"Cloud based computing is an excellent venue for private, public and academia partnership to collaborate in leveraging IT to transform transportation in California."

FUTURE OF HIGHWAY CAPACITY MANUAL Task Force
"To facilitate maintenance of the HCM and to improve dissemination, HCM absolutely must go 100% cloud based"

I-210 ICM Corridor – Los Angeles

14 fwy miles-62 metered ramps

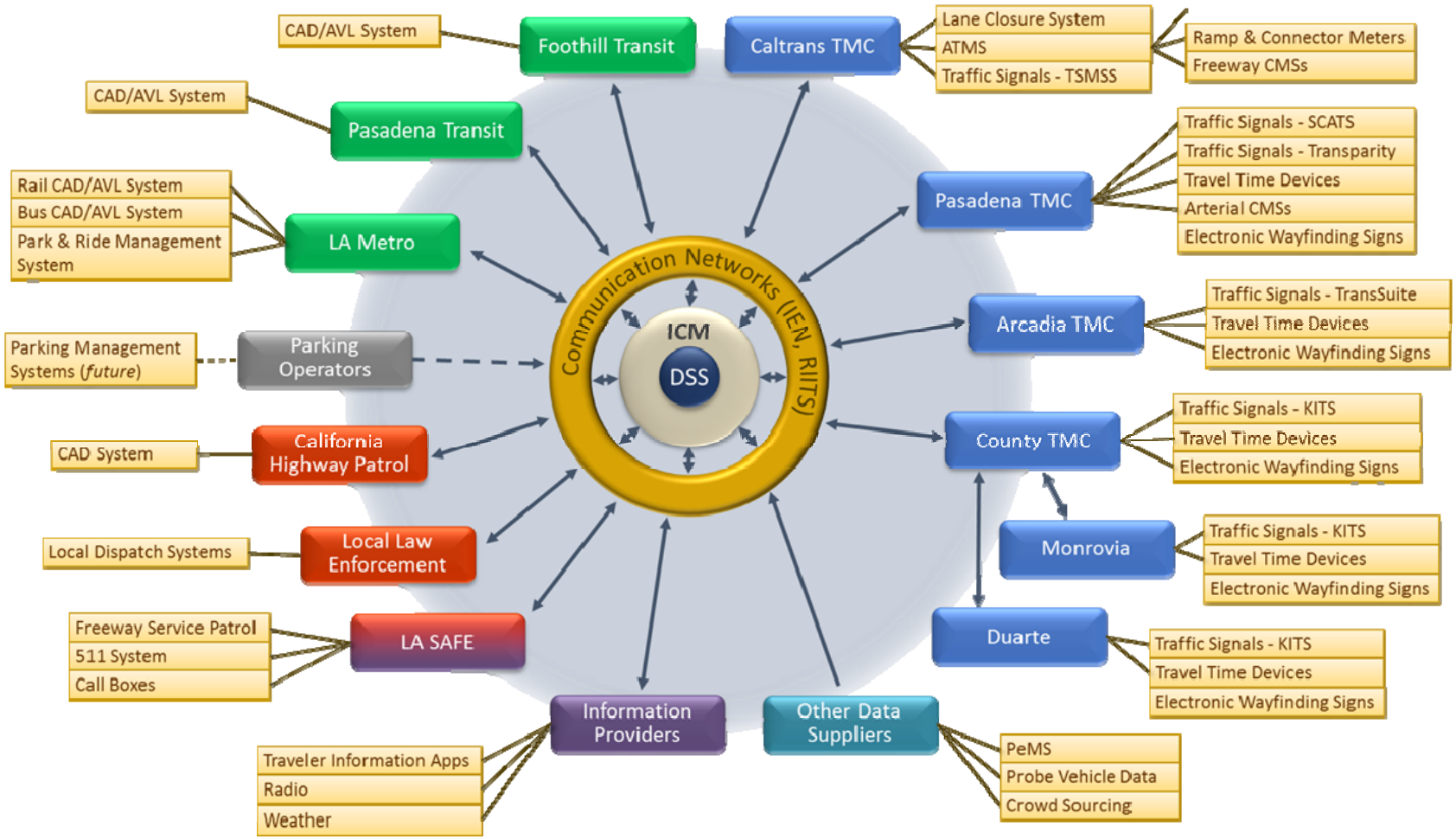
450 signals

Multimodal: Light rail line + 35 bus lines

I-210 Program Goals

- Improve operational situational awareness
- Promote collaboration among corridor stakeholders
- Improve response to incidents and events
- Improve travel reliability
- Improve overall corridor mobility
- Empower travelers to make informed travel decisions
- Facilitate multi-modal movements across the region
- Promote transportation sustainability by reducing impacts on the environment
- Improve corridor safety

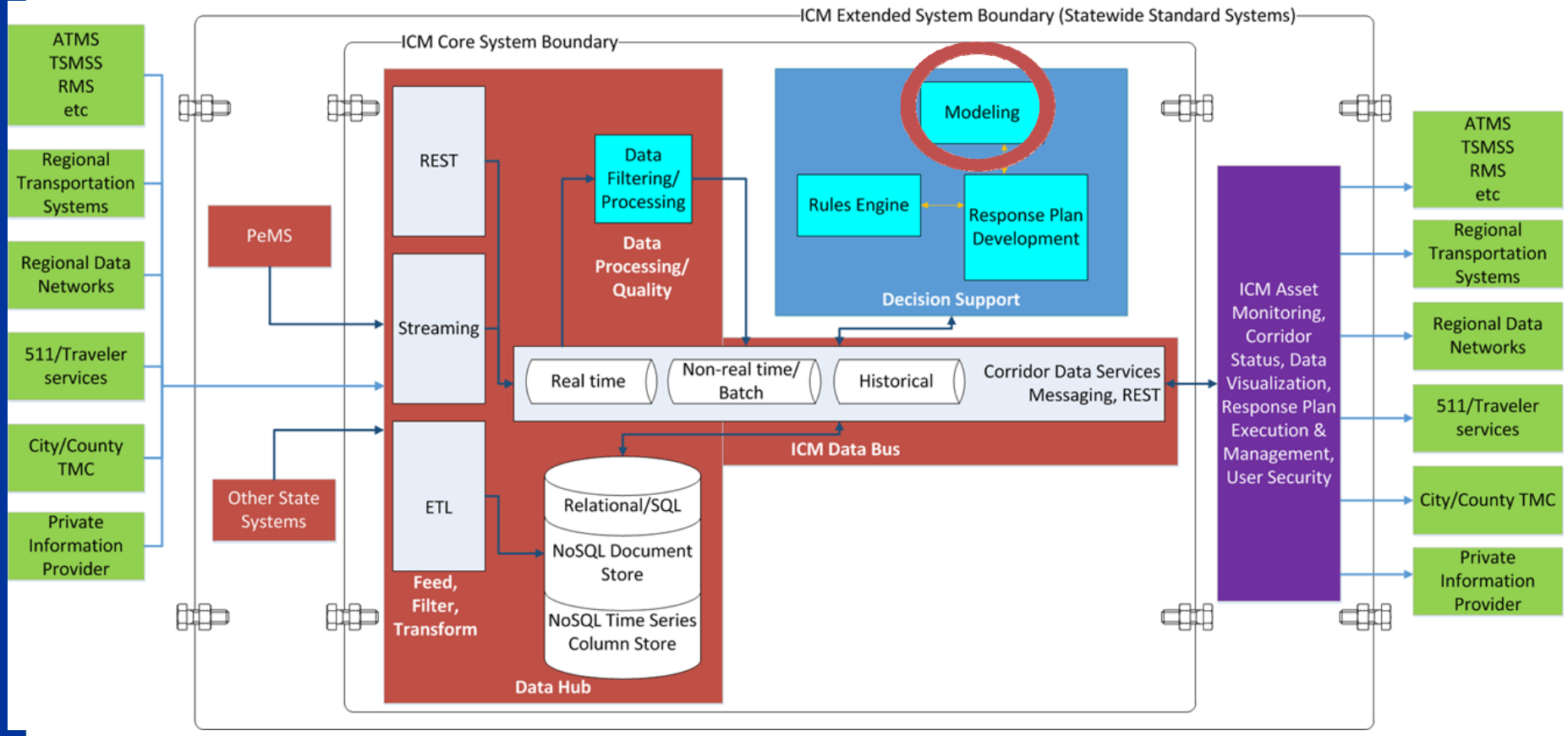
I-210 ICM: Data Sources



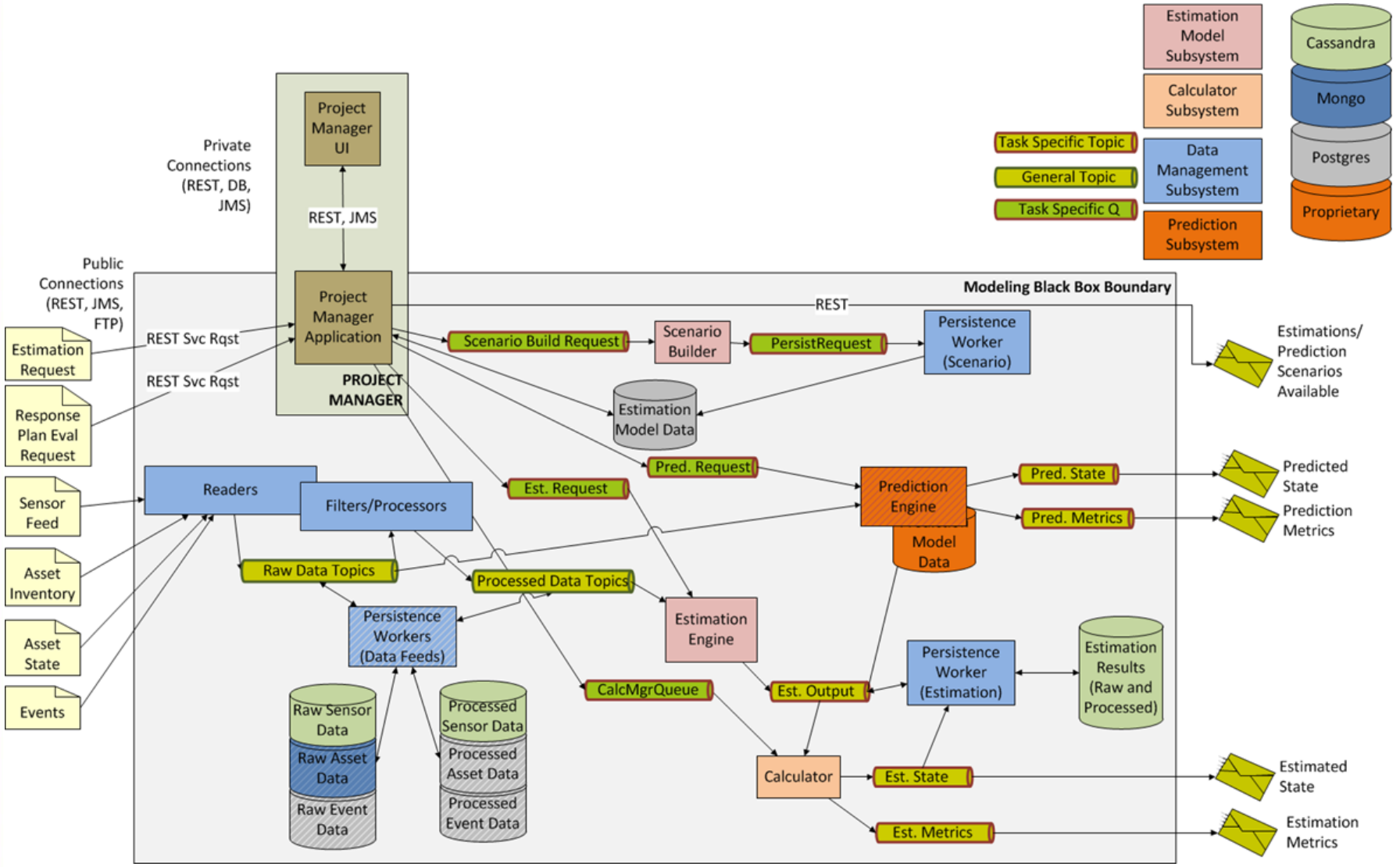
I-210 ICM: Primary Design Objectives

- Secure
- Optimize incident response/evaluation time
- High data volume, high throughput, low latency data handling
- Scalable – Local (time), regional (corridors), state
- Replicable/repeatable
- Fit to budget, minimal time to delivery
- Incremental delivery/ease of adding functionality

I-210 ICM Proposed Architecture



I-210: Modeling Component Architecture



Available Data Processing Tools (1)

Technology	Purpose	(+)	(-)
Java	Primary server-side programming language/ framework	Broadly understood, easy to find resources, lots of experience/tools	Can be complex
Cassandra (OS/Commercial)	High volume, real time time-series data (sensing/probe)	Very fast with large data volumes, highly scalable, fault tolerant	No ad-hoc querying, limited talent/resources
MongoDB (OS/Commercial)	Transformation of complex relational structures	Document storage (schema-less), very fast querying	Limited talent/resources

Available Data Processing Tools (2)

Technology	Purpose	(+)	(-)
Postgres	Relational data store	Large installed base, used within Caltrans already, easy to find resources, PostGIS for geospatial, AWS hosted service	Not as scalable for extremely large data sets
Spark	High speed analytics and stream processing (sensor/probe), machine learning platform	Exceptionally fast and scalable processing, AWS hosted service	Limited talent/resources

Available Data Processing Tools (3)

Technology	Purpose	(+)	(-)
ActiveMQ	Decoupling mechanism, control messaging, status messaging, large structure data messaging	Significant installed base, broadly understood, capable of large messages	Not the fastest gun in town, not as easily scalable
Kafka	High speed, high volume data messaging	Built for speed, message persistence, scalable, fault tolerant	Reputation for being temperamental, limited to smaller message sizes, limited talent/resources

Available Data Processing Tools (4)

Technology	Purpose	Key uses
EC2	Server processing on demand	Estimation, Prediction, data processing, Persistence workers, Cassandra, MongoDB, other custom workers, messaging, logging
RDS	Postgres w/PostGIS	Modeling data store (models, corridor asset model element information) Data hub relational store (corridor asset post transformation)
S3	Storage	Stateful processing
Security Groups/ VPC/IAM	Cloud/network isolation/identity & access management	Networking/Security/Cloud access
EMR (future)	Hosted Spark	Analytics, data quality, machine learning

CA CC I-210: Decision Support