Managing Multi Modal Travel Corridors – Is All in the Cloud

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Early Flying in the “Cloud”

1971 Los Angeles – 42 mile loop
Integrated Corridor Management (ICM)

Corridor Traffic Management & Information Vision

1988
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.
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: 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: Modeling Component Architecture
<table>
<thead>
<tr>
<th>Technology</th>
<th>Purpose</th>
<th>(+)</th>
<th>(-)</th>
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<tbody>
<tr>
<td>Java</td>
<td>Primary server-side programming language/ framework</td>
<td>Broadly understood, easy to find resources, lots of experience/tools</td>
<td>Can be complex</td>
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<tr>
<td>Cassandra (OS/Commercial)</td>
<td>High volume, real time time-series data (sensing/probe)</td>
<td>Very fast with large data volumes, highly scalable, fault tolerant</td>
<td>No ad-hoc querying, limited talent/resources</td>
</tr>
<tr>
<td>MongoDB (OS/Commercial)</td>
<td>Transformation of complex relational structures</td>
<td>Document storage (schema-less), very fast querying</td>
<td>Limited talent/resources</td>
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<tr>
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<td>Purpose</td>
<td>(+)</td>
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<td>Postgres</td>
<td>Relational data store</td>
<td>Large installed base, used within Caltrans already, easy to find resources, PostGIS for geospatial, AWS hosted service</td>
<td>Not as scalable for extremely large data sets</td>
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<tr>
<td>Spark</td>
<td>High speed analytics and stream processing (sensor/probe), machine learning platform</td>
<td>Exceptionally fast and scalable processing, AWS hosted service</td>
<td>Limited talent/resources</td>
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### Available Data Processing Tools (3)

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<tr>
<th>Technology</th>
<th>Purpose</th>
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<tbody>
<tr>
<td>ActiveMQ</td>
<td>Decoupling mechanism, control messaging, status messaging, large structure data messaging</td>
<td>Significant installed base, broadly understood, capable of large messages</td>
<td>Not the fastest gun in town, not as easily scalable</td>
</tr>
<tr>
<td>Kafka</td>
<td>High speed, high volume data messaging</td>
<td>Built for speed, message persistence, scalable, fault tolerant</td>
<td>Reputation for being temperamental, limited to smaller message sizes, limited talent/resources</td>
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## Available Data Processing Tools (4)

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