CLOUD DEPLOYMENT OF CORRIDOR MANAGEMENT SYSTEMS

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Connected Corridors State-Wide Program

- **A state wide program focused on:**
  - Bringing ICM to major corridors in California
  - Growing Caltrans leadership in corridor based transportation management
  - Showcasing new technologies and processes
  - Delivering an ICM implementation on the I-210 in LA
  - A solution that is affordable, replicable and scalable

- **We must lower the barriers to ICM implementation:**
  - Funding and Costs
  - Work force skills
  - Technical Complexity and Risk
I-210 Pilot
Integrated Corridor Management

To us, ICM is...

<table>
<thead>
<tr>
<th>People</th>
<th>Organizations</th>
<th>Hardware</th>
<th>Software</th>
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</thead>
<tbody>
<tr>
<td>Corridor Manager</td>
<td>Caltrans</td>
<td>Signals</td>
<td>Data Hub</td>
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<tr>
<td>Roadway Operators</td>
<td>Metro</td>
<td>Ramp Meters</td>
<td>Models / Decision</td>
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<td>TMC Operators</td>
<td>LA County</td>
<td>Sensors</td>
<td>Support</td>
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<td>First Responders</td>
<td>Cities</td>
<td>Probe Vehicles</td>
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<td>Travelers</td>
<td>Transit Agencies</td>
<td>Bluetooth</td>
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<td>CCTV Cameras</td>
<td>Corridor Management</td>
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<td>System</td>
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To us, ICM is…

Integrated Corridor Management

**People**
- Corridor Manager
- Roadway Operators
- TMC Operators
- First Responders
- Travelers

**Organizations**
- Caltrans
- Metro
- LA County
- Cities
- Transit Agencies

**Hardware**
- Signals
- Ramp Meters
- Sensors
- Probe Vehicles
- Bluetooth
- CCTV Cameras

**Software**
- Data Hub
- Models / Decision Support
- Corridor Management System
- TCS & ATMS

**Connected Corridors**

Wed, 9am: ICM Progress in CA
I-210 Pilot ICM Software/Data System

Data Sources/TMCs → Data Hub → Decision Support System (DSS) → Corridor Management System → Control Targets/TMCs
I-210 Pilot ICM Software/Data System

ICM Regional System Boundary

ICM Extended System Boundary (Statewide Standard Systems)

ICM Local System Boundary

Corridor Management System

TMDD

State Transportation Systems
Regional Transportation Systems
Regional Data Networks
511/Traveler services
City/County TMC
Private Information Provider
Corridor Asset Cloud
Trailblazer Management
lane Closure

PeMS
EDW

Decision Support

Historical

Corridor Data Services Messaging, REST

Machine Learning/Demand Prediction

ICM Data Bus

Data Hub

Relational/SQL Postgres+PostGIS
NoSQL Document Store
MongoDB
NoSQL Time Series Column Store
Cassandra

Screaming

Transform
Data Quality
Data Processing

Real time

Non-real time/Batch

BI

PeMS

Archive

Feed, Filter, Transform

ETL
I-210 Pilot ICM Software/Data System

Data Sources/TMCs

Data Hub

Decision Support System (DSS)

Corridor Management System

Control Targets/TMCs
I-210 Pilot ICM Software/Data System

Data Hub

Decision Support System (DSS)

Corridor Management System

Control Targets/TMCs

Data Sources/TMCs

amazon web services
Cloud Computing: Information Technology Services

“Cloud Computing” is an umbrella term for a huge range of IT services

- Pay only for what you use / when you use it
- Low cost (when used correctly!)
- Extraordinarily reliable, very secure
- Astronomical scale
- Offered by multiple companies
Amazon Data Centers
Example AWS Data Center

Each Data Center has over 50,000 servers
Examples of AWS Cloud Customers

- Netflix, AirBnB, Uber, Lyft, Nike, US Navy, CDC, CIA
- Yelp, Reddit, Twilio, ESRI, Cisco, Juniper, Capital One
- FINRA, SEC, SalesForce, Spotify, Nextdoor, Pinterest…
- …MTC (511.org)…
- …and one million others (literally!)
Connected Corridors in the Cloud
Why did we have this?
“IT functionality available as a service”

<table>
<thead>
<tr>
<th>Traditional IT</th>
<th>Infrastructure as a Service</th>
<th>Platform as a Service</th>
<th>Software as a Service</th>
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<tr>
<td>Applications</td>
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Why is cloud better for Connected Corridors?

- Better for corridor management
- Better for software development
Corridor Management

- What do we expect from modern applications?
  - High Availability
  - Scalability
  - Fault Tolerance
  - Cost-Effectiveness
  - Security
Corridor Management

- **Quickly deploy a new corridor with minimal effort**
  - Work (and funding) can go toward corridor infrastructure, response planning, and integration instead of the technology solution

- **Quickly add new capabilities to the ICM**
  - Provides “future-proofing” of the system, with new capabilities and increased data volumes without design modifications or significant development effort

- **Possible to automate deployment, operations, and security**
  - Faster, less expensive
Software Development

- We can focus our efforts on our areas of expertise
- We can try, change, adopt or abandon various solutions quickly and inexpensively
- Fast concept-to-operations
- No up-front hardware cost
- Made a small development team far more capable and nimble
- Development speed increased with cloud approach
- Infrastructure as code
Transitioning

- Easy to get started; learning curve to get right
- Capabilities always changing, improving; always learning
- Must modify your approach to IT functions, including:
  - Operations
  - Deployment
  - Maintenance
  - Security
Take-home Message

- **Cloud computing improves our ability to do…**
  - **Corridor Management**
    - Build more transparently-secure solutions
    - Spend more cost-effectively
    - Scale capacity – up AND down – to match demand
  - **Software Development**
    - Focus on our strengths
    - Develop more quickly

- **Working in the cloud requires…**
  - Climbing a learning curve
  - Training (initial and ongoing)
  - Working differently
IoT ↔ Cloud