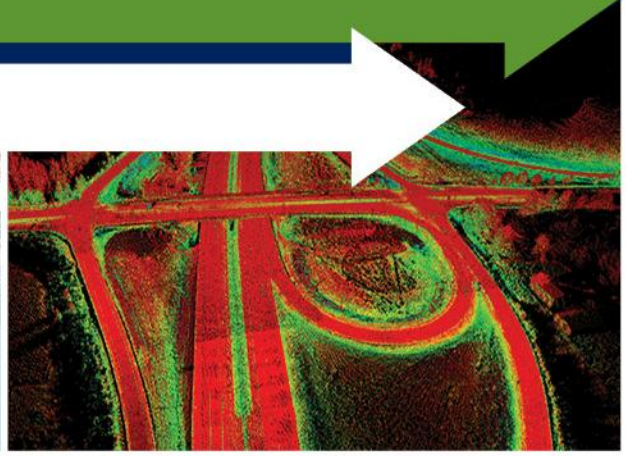
Introduction to 3D, 4D, 5D, Schedule, Cost and Post-Construction

September 1, 2015

1:30 pm – 3:00 pm EST



U.S. Department of Transportation
Federal Highway Administration

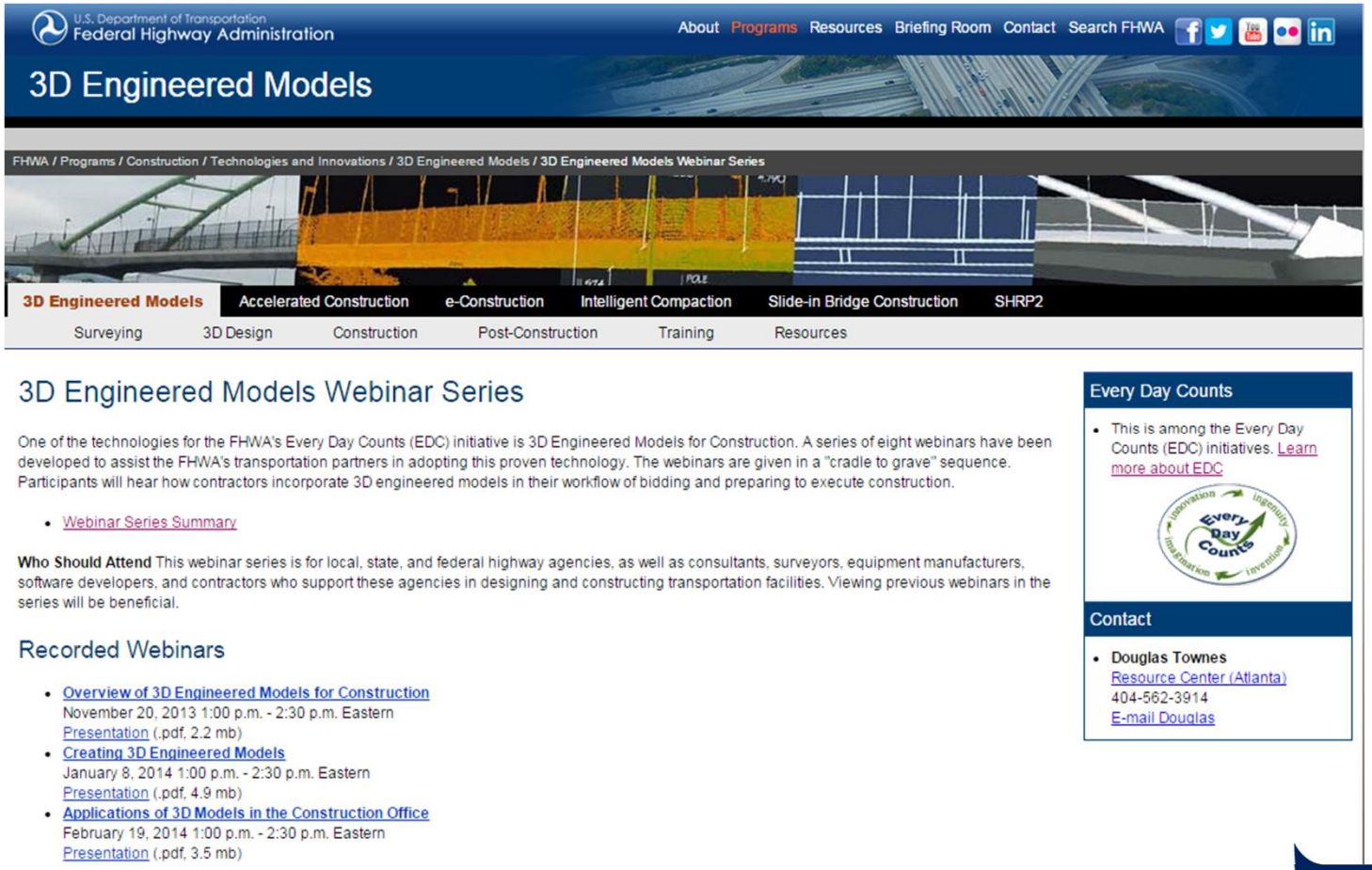
EDC-3 3D Engineered Models:
Schedule, Cost and Post-Construction

Why has FHWA selected 3D Modeling again for EDC3?

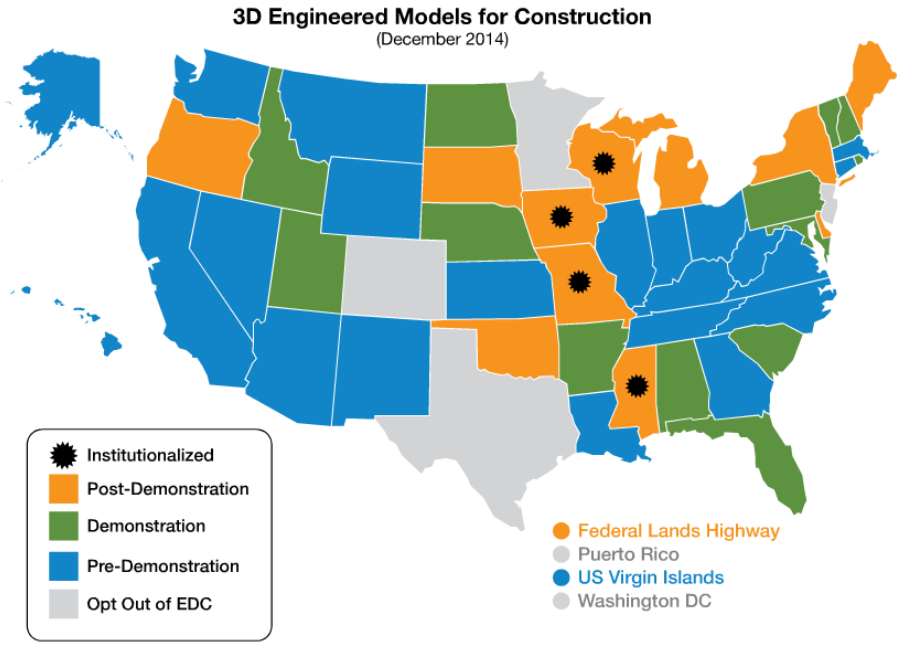
- FHWA launched Every Day Counts with its partner AASHTO in 2009
- Second series of ECD technologies launched in 2012.
- 3D Modeling was included
  - 8 webinars
  - 12 workshops
  - 4 on-line training courses
  - Website https://www.fhwa.dot.gov/construction/3d/
  - Field demonstrations

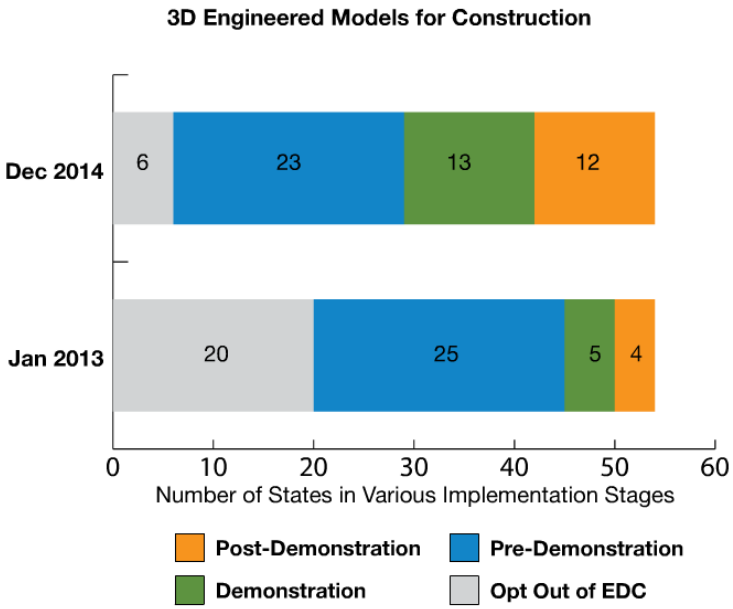
Recordings of Previous Webinars

http://www.fhwa.dot.gov/construction/3d/webinars.cfm

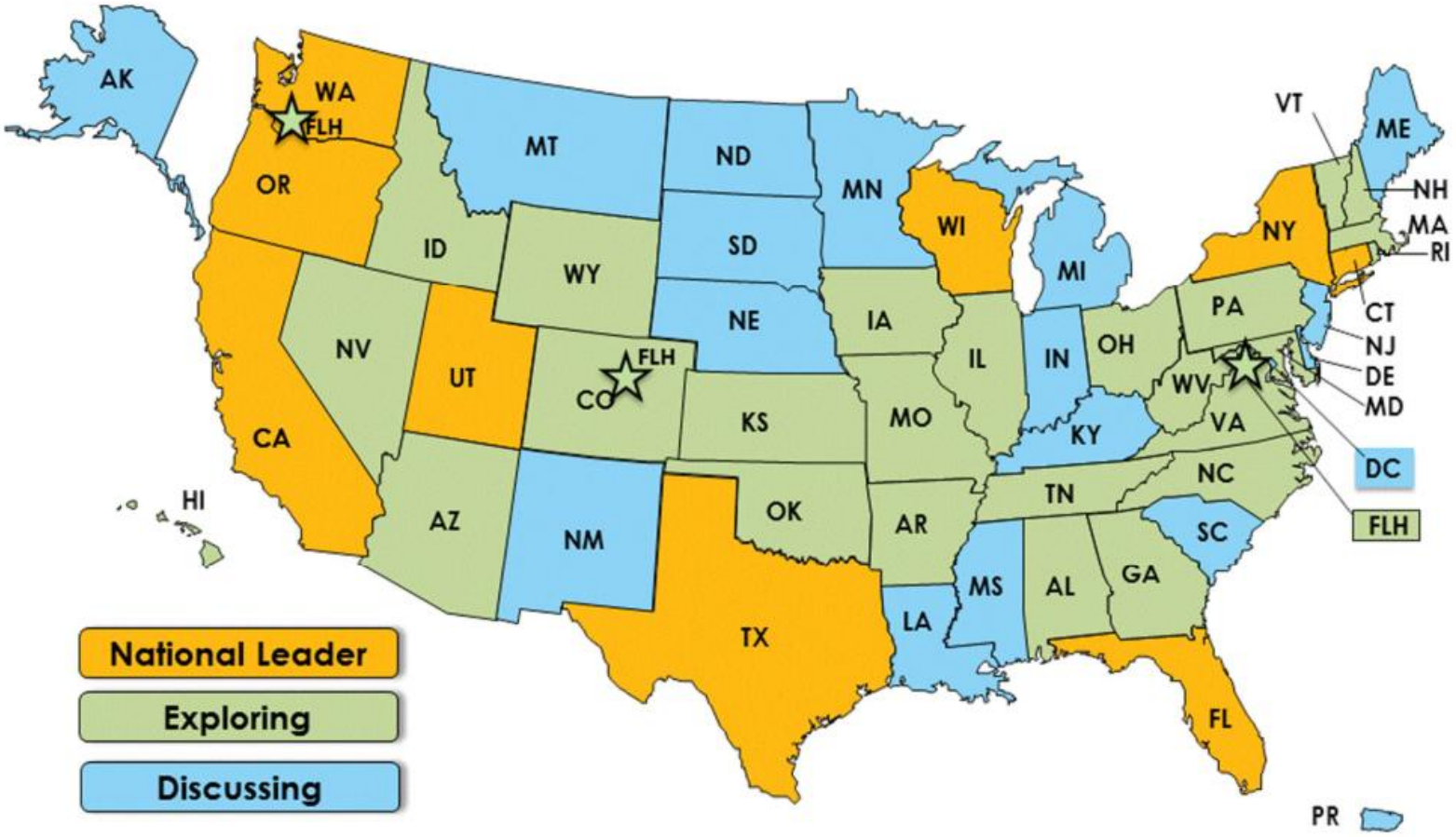


State Implementation During EDC2





EDC3 Baseline Implementation



National State of the Practice March 2015 based on States' self-reporting

3D Modeling is Dynamic

New innovations are coming on the market every day

- More accurate LiDAR
- Software advances accommodating collaboration between partners
- New specifications for owner quality control
- More uses of initial survey data
- Better utility location data management

3D Engineered Models Webinar Series

Today	Introduction to 3D, 4D, 5D Schedule, Cost and Post-Construction
Oct 2015	Using 3D Digital Data for Construction Engineering & Inspection
Nov 2015	Creating and Using 3D Models of Highway Structures
Jan 2016	Uses of 4D and 5D Models in Highways
Feb 2016	Getting Started with 4D and 5D Modeling
Mar 2016	Collection and Use of 3D Digital As-built Records
Apr 2016	Use of 3D Digital Data for Asset Management

Audience Demographics Polls

Please respond to the polls on screen.

Douglas Townes, PE (FHWA Resource Center)

Welcome and Introductions

Today's Speakers

Speaker	Topic
Douglas Townes, PE *FHWA-Resource Center*	Welcome, Introductions & Webinar Series Information
Francesca Maier, PE *Parsons Brinckerhoff*	New Technology Focus Areas
Evan Rothblatt, EIT *AASHTO*	AASHTO Support for EDC and Innovation
Nelson Aguilar, PLS *Caltrans District 4*	Lessons Learned with the Technologies
Francesca Maier, PE *Parsons Brinckerhoff*	Moderated Question & Answer Session
Douglas Townes, PE *FHWA-Resource Center*	Next Webinar Information & Close

Francesca Maier, PE (Parsons Brinckerhoff)

Technology Focus Areas

Learning Objectives

- Introduce and use terminology that describes 3D, 4D, and 5D Engineered Models
- Distinguish between the three main focus areas for EDC-3 and identify the link to EDC-2 focus areas
- Describe the purpose, need and benefits for the three new focus areas

Terminology

RTK GNSS Rover

4D Model

3D Geospatial Data

Post-Construction Surveying

Roadway Inventory

Subsurface Utility Engineering

Asset Management

Mobile LiDAR

Terrestrial LiDAR

Point Cloud

Acceptance

5D Model

Remote Sensing

GIS

Real-time Verification

Applications of 3D Data

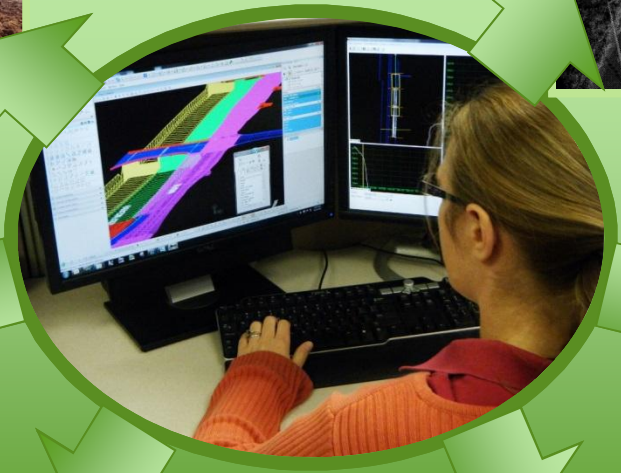


Image credits: Caltrans, Cold Spring Construction, Parsons Brinckerhoff

Construction Engineering & Inspection

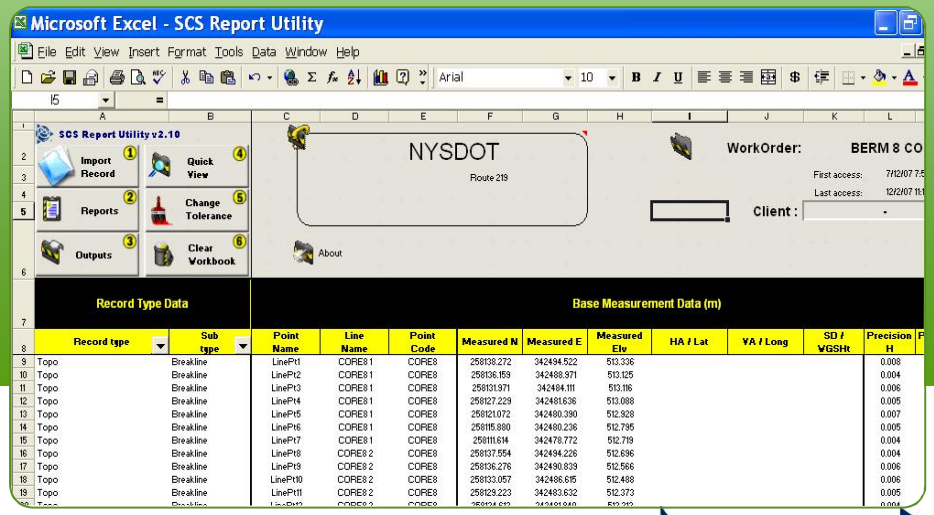
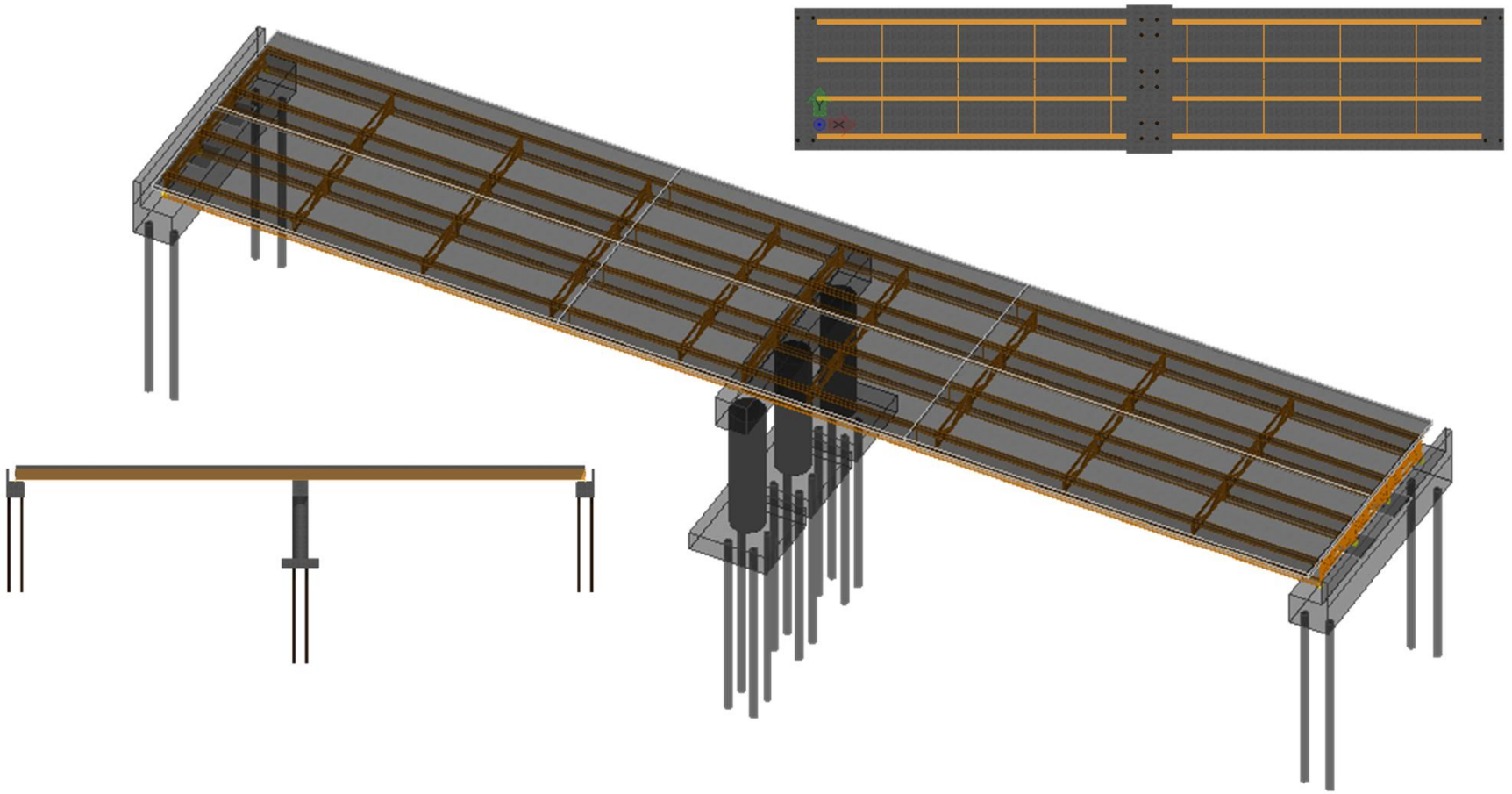


Image credits: Parsons Brinckerhoff

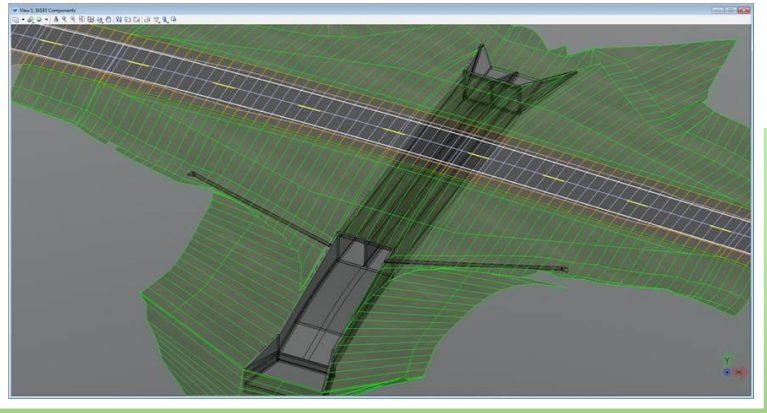
Structure Models: Design Coordination

Image credits: Parsons Brinckerhoff/Port Authority of New York & New Jersey

Structure Models: Analysis & Plans



4D and 5D Modeling



Task Name	Duration	Start
Project	19.47 days	5/6/2011
Start	0 day	5/6/2011
Task A	4 days	5/6/2011
Task B	5.3 days	5/6/2011
Task C	5.15 days	5/12/2011
Task D	6.32 days	5/12/2011
Task E	5.15 days	5/19/2011
Task F	4.5 days	5/20/2011
Task G	5.15 days	5/26/2011
Finish	0 day	6/2/2011

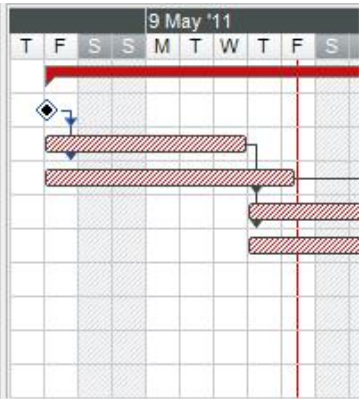


Image Sources: Iowa DOT, Wikimedia Commons, Caltrans

Convergence of Geospatial Data Systems

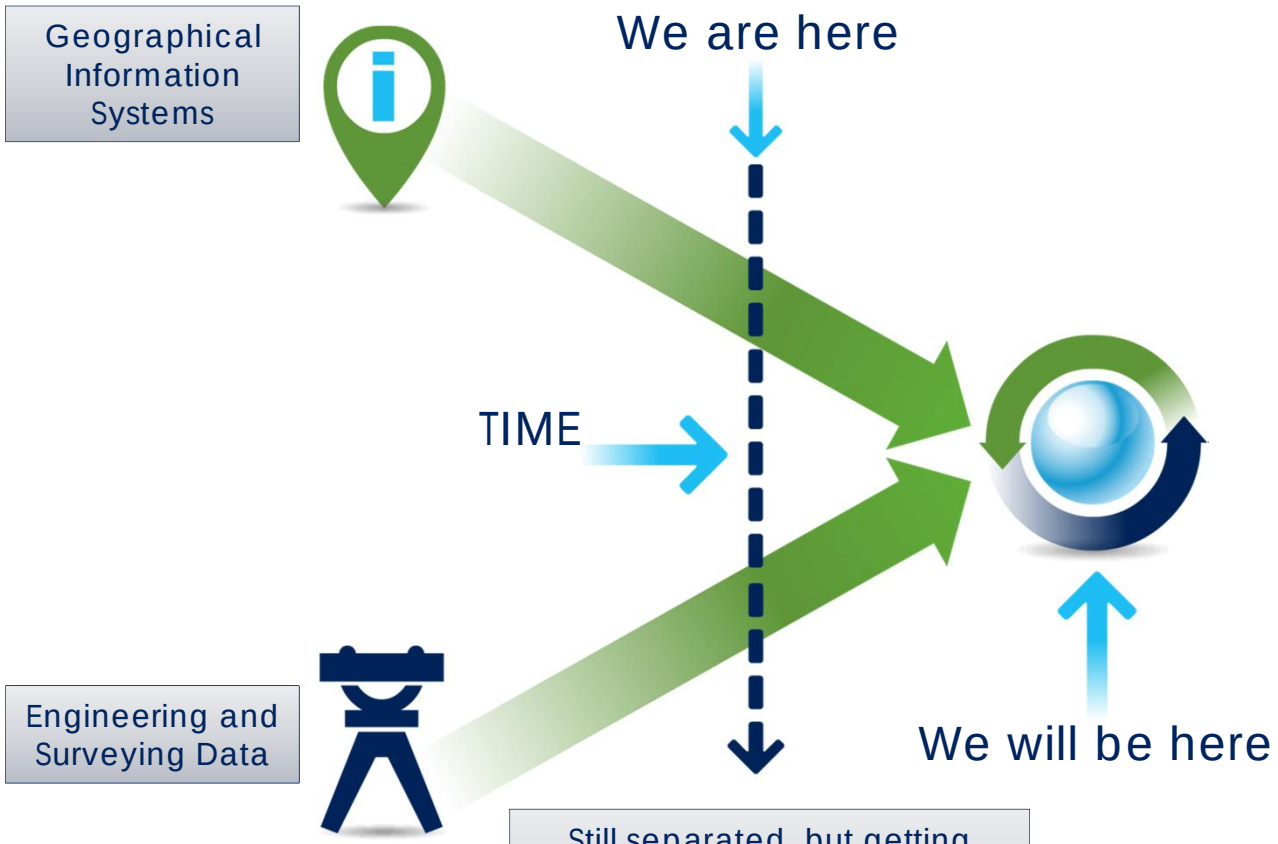


Image Source: Oregon DOT

Subsurface Utility Locating

Image Source: Cardno

Creating Digital As-Built Records

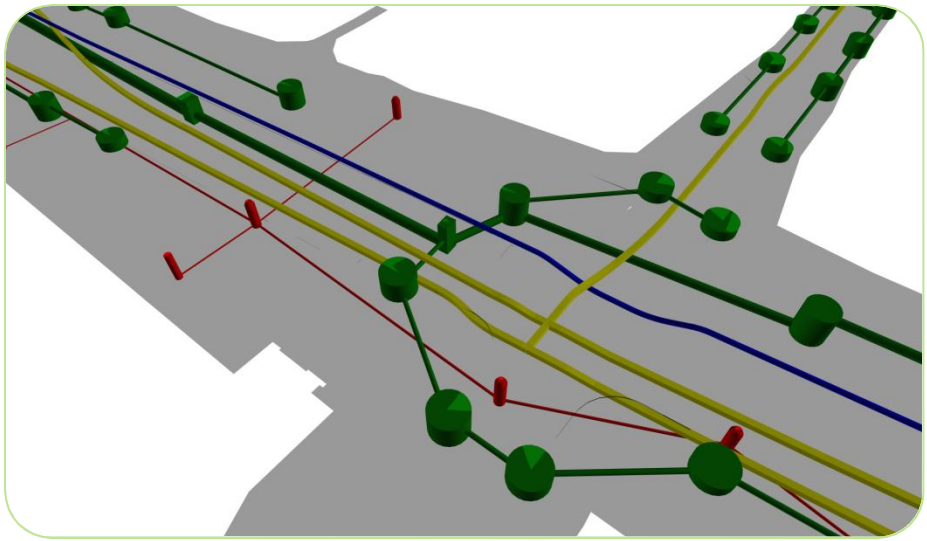
Construction is the safest, most cost-effective time to capture position information

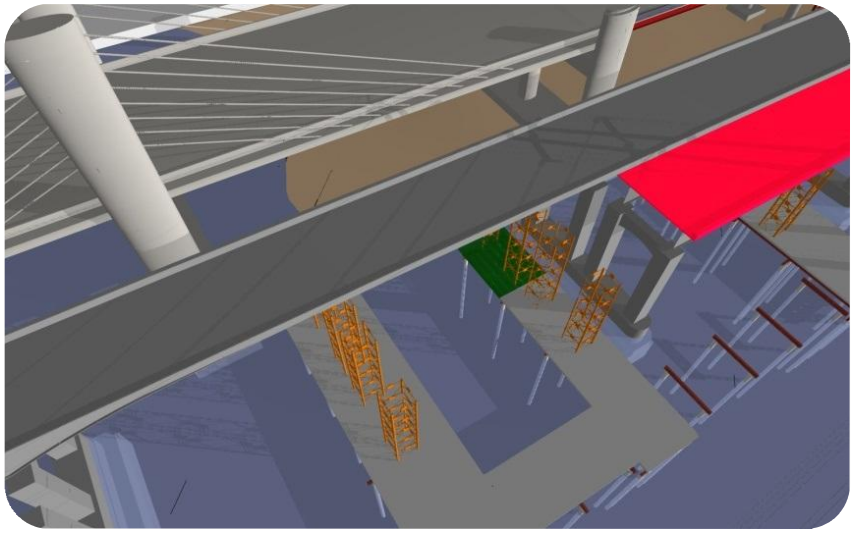
3D Data for Asset Inventory and Condition

- Multi-disciplinary collaboration
- Preconstruction uses still being explored
- 12 roadway assets inventoried
- 6,000+ center lane miles mapped in 1 year

Image Source: Utah DOT

Summary of EDC-3 Technologies





- CE&I workflows
- Structural models
- 4D/5D Modeling
- Post-construction survey data
- As-found survey data

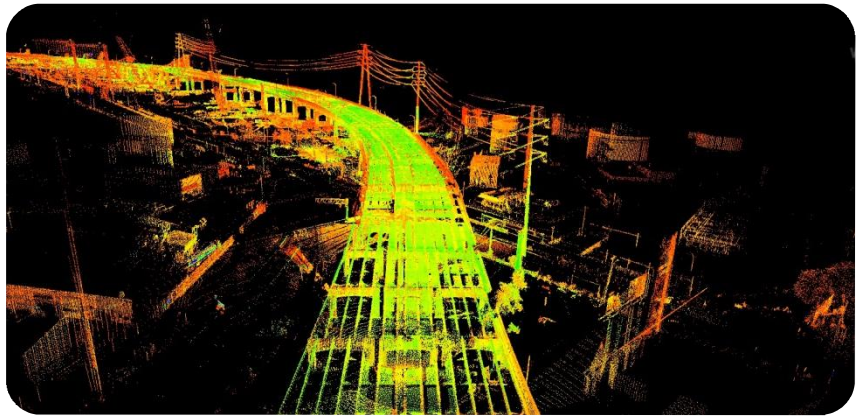


Image Sources: Parsons Brinckerhoff, Connecticut DOT, Walsh

Poll Group 1

Please respond to the polls on screen.

Evan Rothblatt, EIT (AASHTO)

AASHTO Support for EDC and Innovation

Current AASHTO Innovation Initiatives

Active Lead States Teams Focus Technologies

- Carbon Fiber Reinforced Polymer Strands
- e-Construction
- Plans on Demand
- Automated Traffic Signal Performance Measures
- Intelligent Roadway Information System
- UPlan Phase II
- Watershed Resources Registry
- Embedded Data Collector
- Sequential Flashing Warning Lights for Work Zones
- Towing and Recovery Service Partnership

Access earlier Lead States Team Focus Technologies

Additionally Selected Technologies (ASTs)

- Bridge Expansion Joint System
- Prep-ME Software
- Sandwich Plate System Bridge Decks
- Double Crossover Diamond Interchange

AASHTO Innovation Initiative

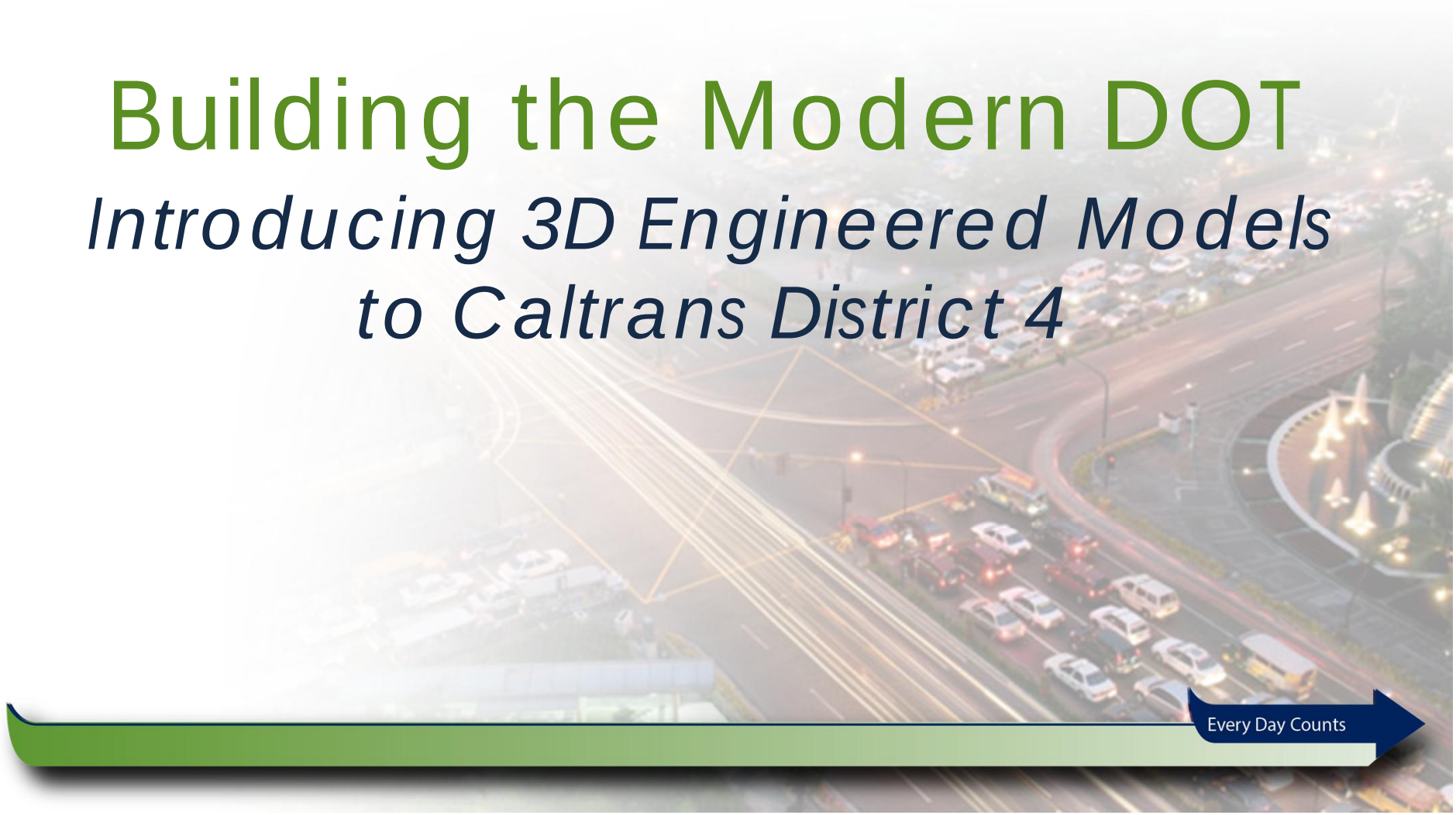
Poll Group 2

Please respond to the polls on screen.

Nelson Aguilar, PLS (Caltrans District 4)

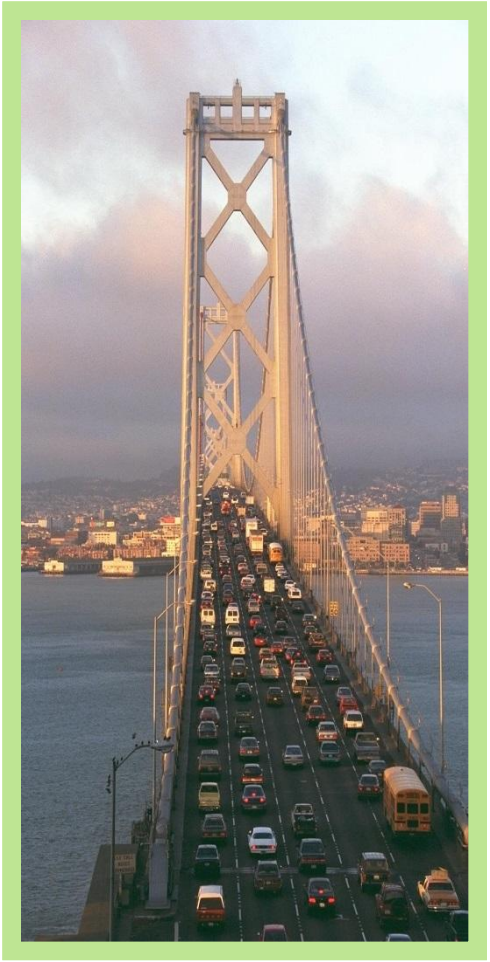
Building the Modern DOT

Introducing 3D Engineered Models to Caltrans District 4



Caltrans Mission Statement

Provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability.



About Caltrans - District 4

- Encompasses the 9 counties of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Solano, Sonoma, and Santa Clara
- Over 3,300 positions with an annual operating budget of over $500 million
- Manages over 6,500 lane miles on over 770 centerline miles of conventional highways and 690 centerline miles of freeways, including 459 miles of carpool lanes
- Over $3.4 billion and 119 capital outlay projects currently under construction
- Operates seven toll bridges: Antioch, Benicia, Carquinez, Richmond-San Rafael, San Mateo-Hayward, San Francisco-Oakland and Dumbarton

3D Engineered Models: Caltrans Progress Report January – June 2015

For 3D Engineered Models for As-found Survey Data for Inventory and Asset Management:

– *Demonstration Stage- Demonstration Stage*- By using LiDAR to map six hundred miles of freeway assets in the San Francisco Bay Area, Caltrans was able to significantly improve sign data. This data will not only be used for sign data asset inventory, but for original ground data, DTM's, for projects that are in the pipeline for roadway improvements.

For 3D Engineered Models for project Schedule and Cost (4D/5D):

– *Development Stage*- Collecting guidance and best practices, building support with partners and stakeholders, attending meetings with FHWA. The State is interested in pursuing 4D schedule and/or 5D cost estimating applications for improved project management or seeking additional information on how to implement them.

For 3D Engineered Models for Post-Construction:

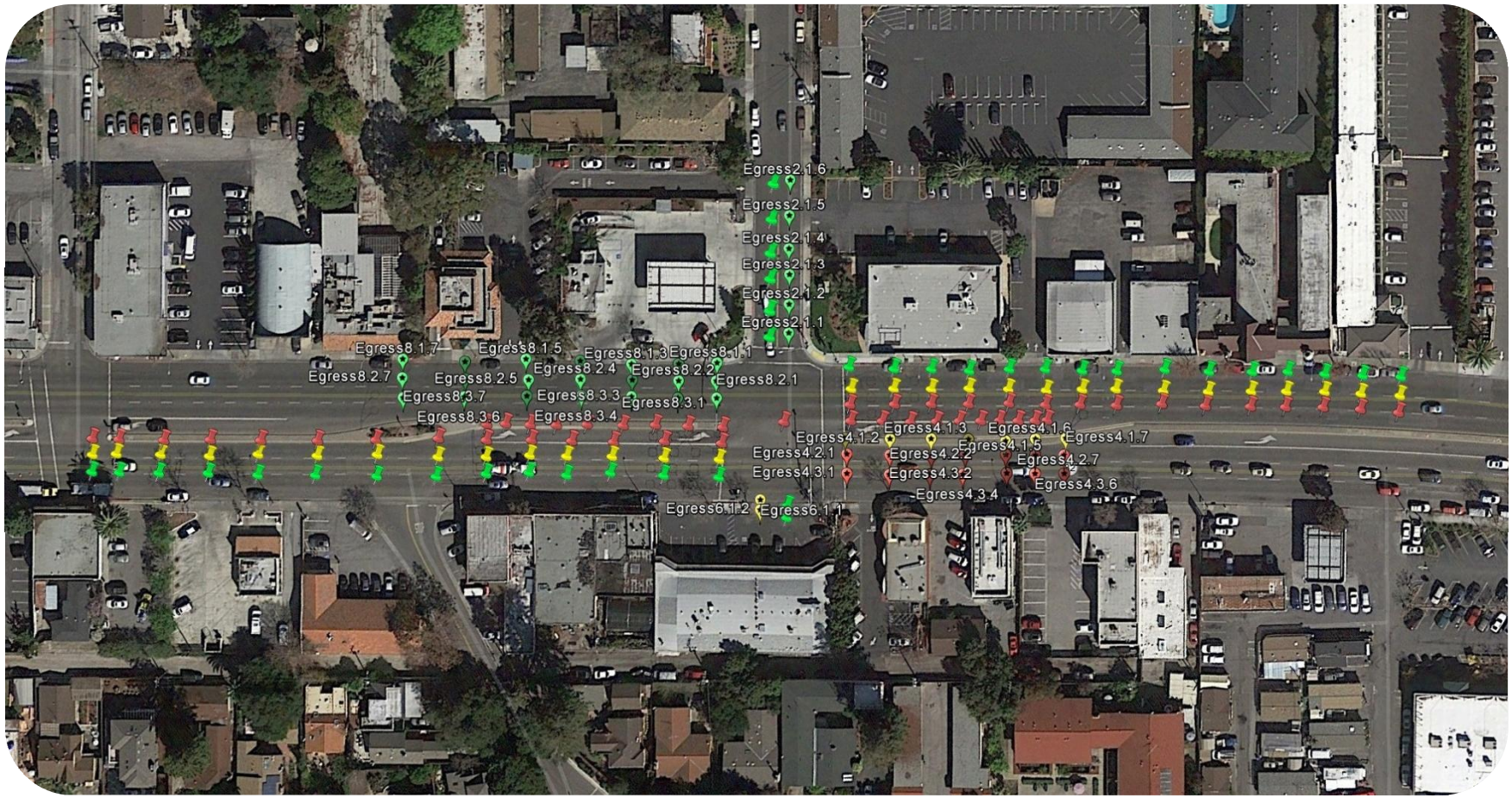
– *Development Stage*- For the practice of creating accurate as-built record drawings, the State is interested in pursuing 3D post-construction applications for continuing maintenance, management and future planning of highway facilities. Need to establish 3D engineered model for Design projects first.

As-found Survey Data for Inventory & Asset Management

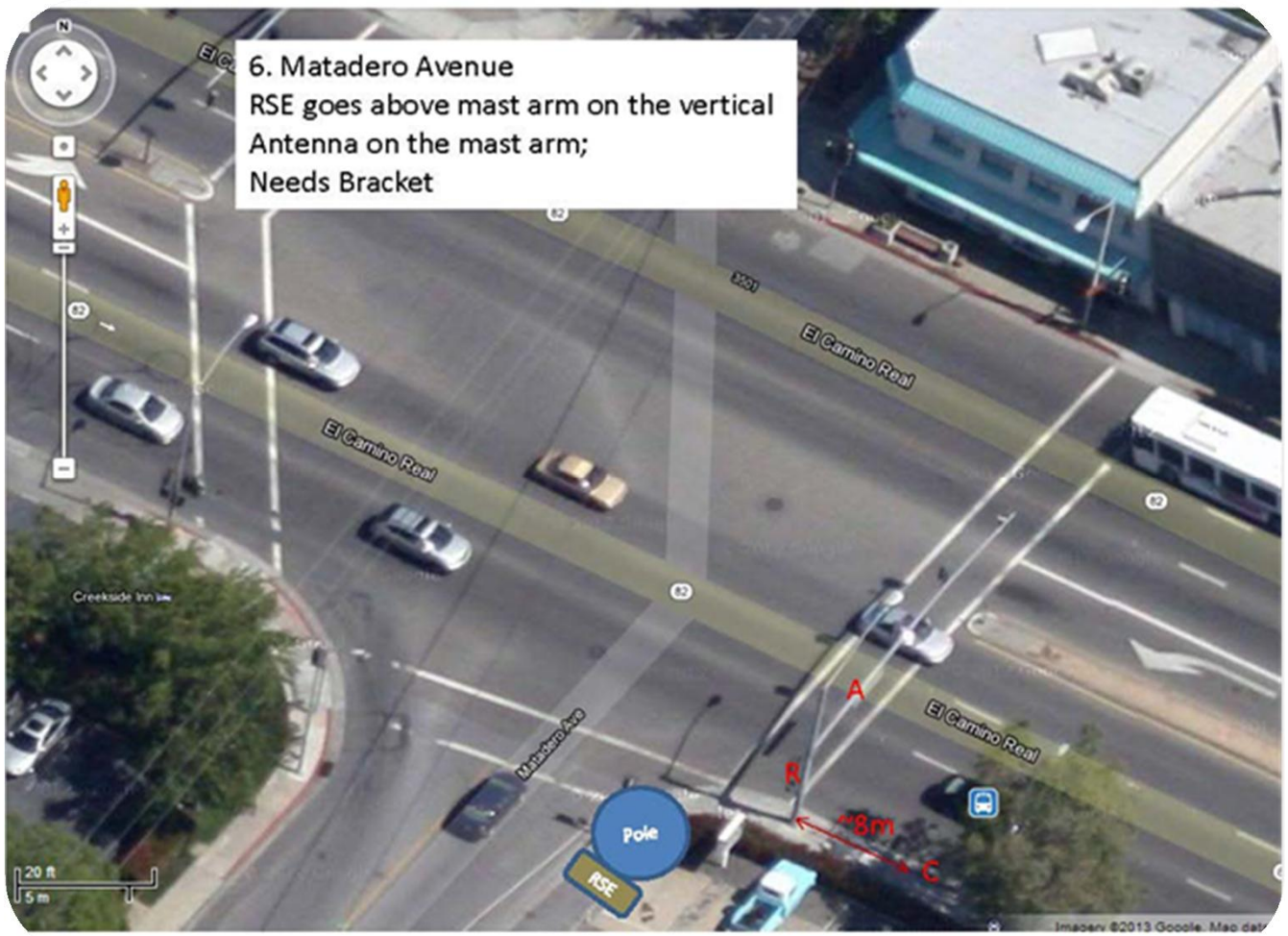
- California's Connected Vehicle Test Bed
- Mobile Scanning Freeways for Roadway Sign Project

California Connected Vehicle Test Bed

Project Requirements

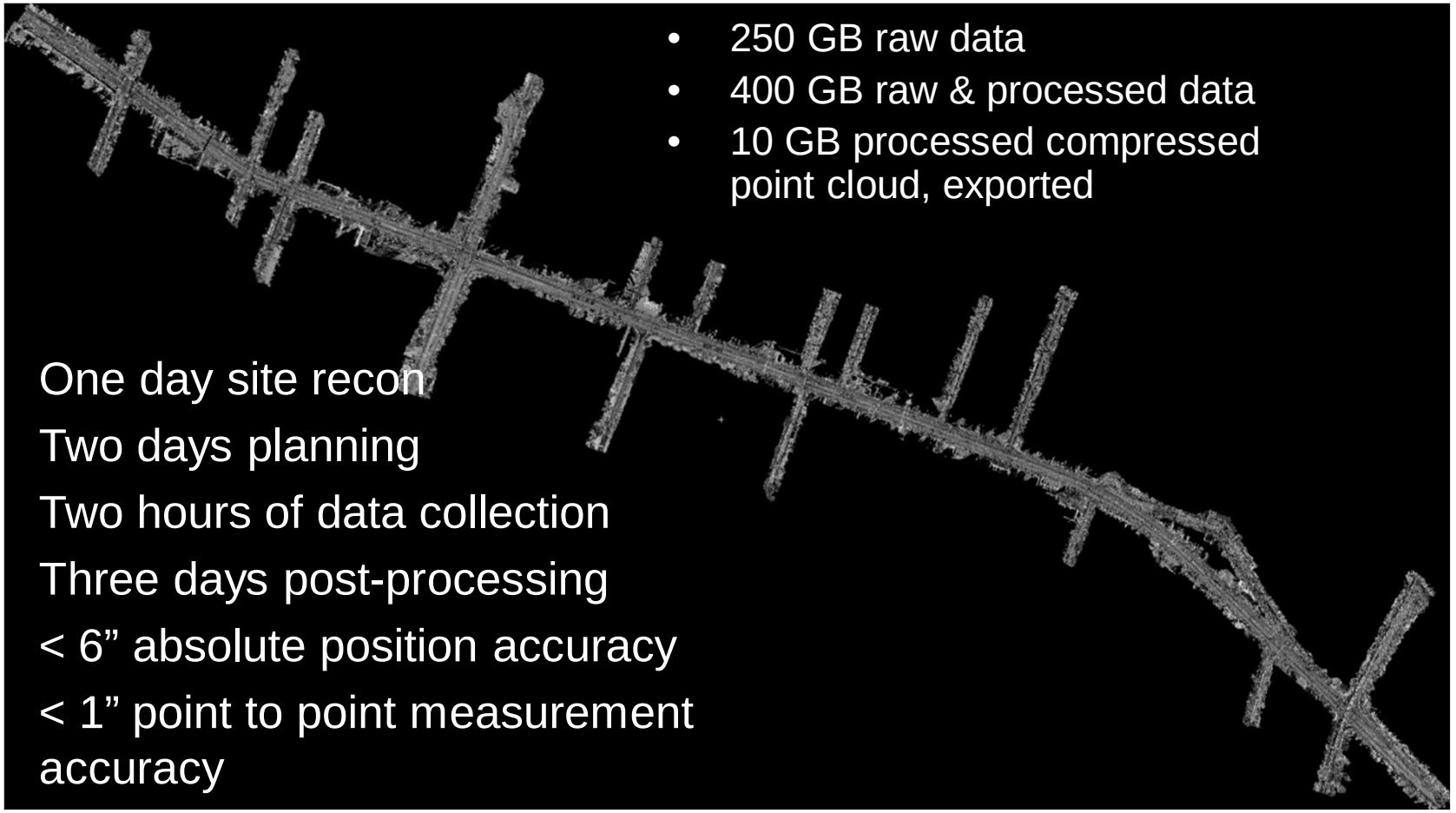


Example Installation



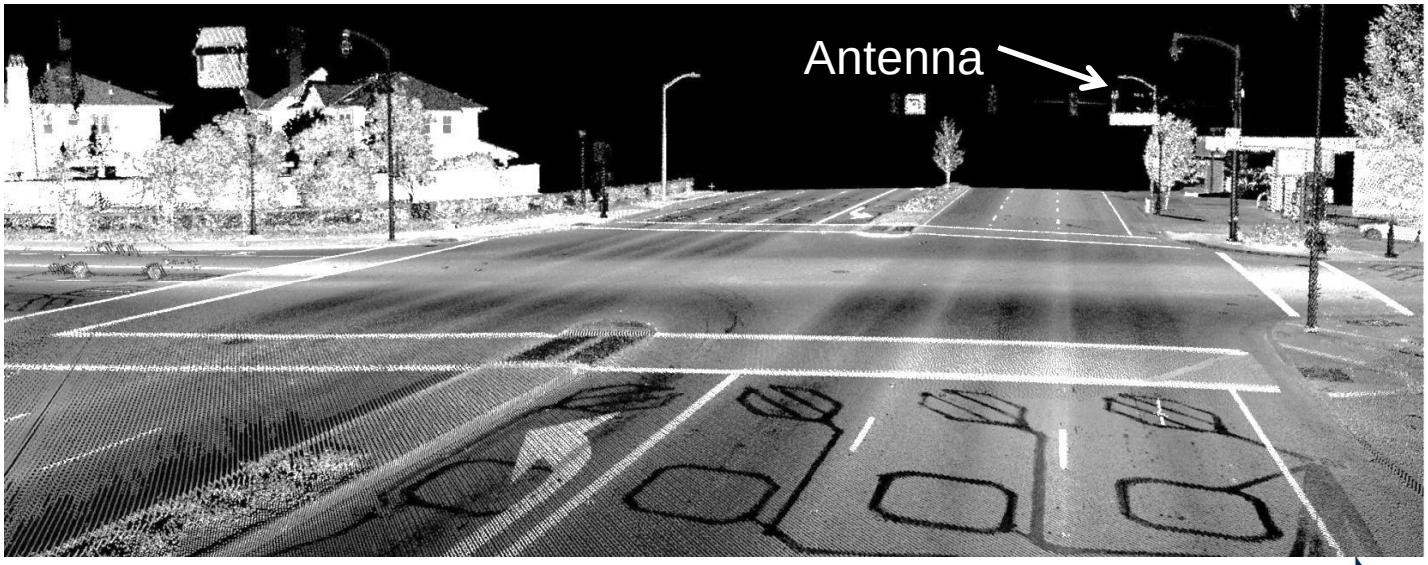
Actual Installation (Page Mill Road and El Camino Real)

MTLS Results



El Camino Real / Page Mill Rd.

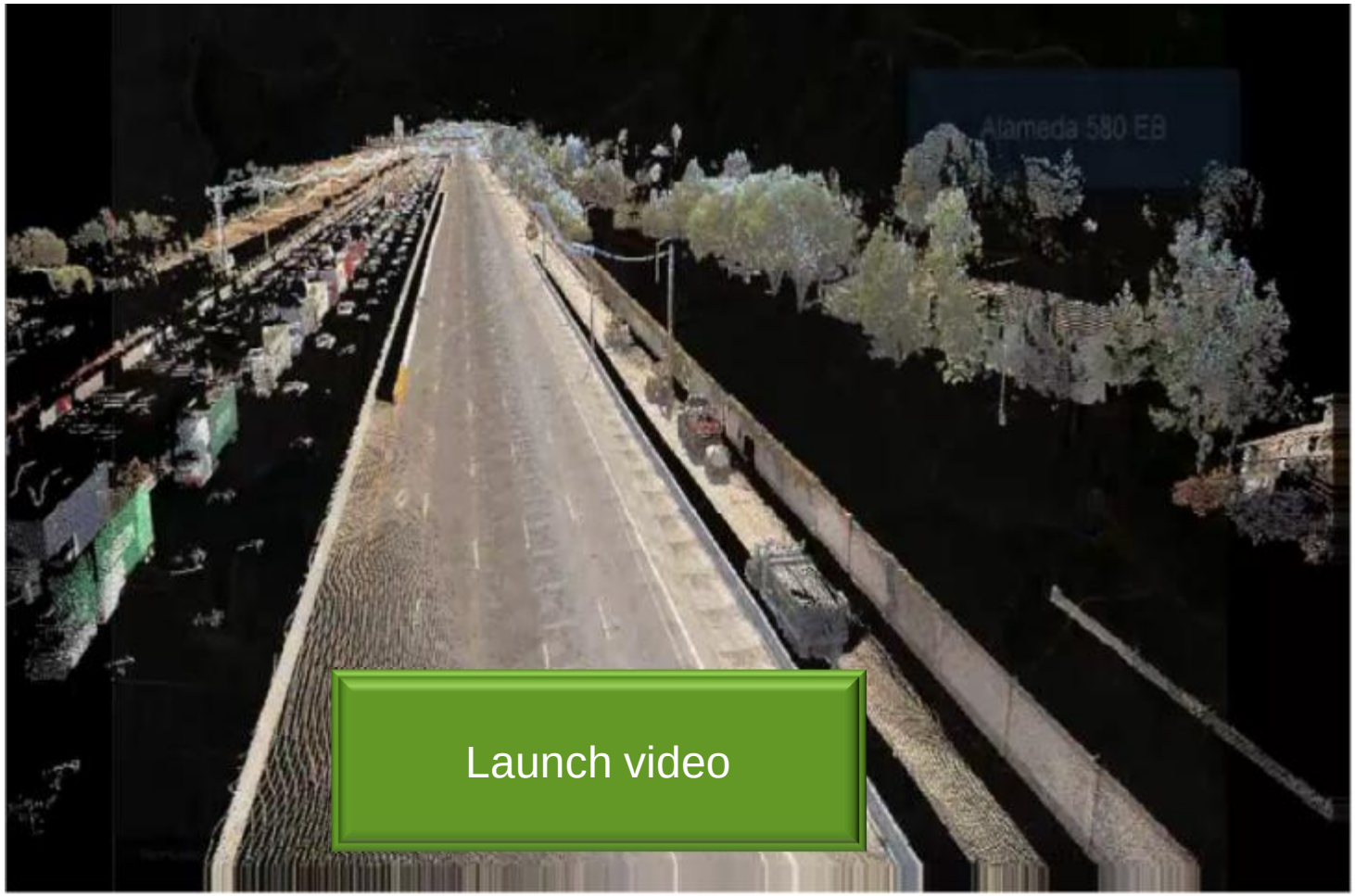
El Camino Real / Stanford.



Mobile Scanning Freeways for Roadway Sign Project

- Overhead sign project
- ~ 550 centerline miles
- Dimensioned over 1000 signs
- Delivery in GIS interface
- 18 TB of data collected, processed & stored

Overhead Sign Project Demo



The Added Benefits from the Overhead Sign Project

- The collected data is being mined for three capital projects
- However, decision was made not to target the scans due to the Sign Projects timetable. This decision had added costs and time to the capital projects.

Integrating Schedule (4D) & Cost (5D) Modeling

- San Francisco-101 Presidio Parkway
- San Francisco Oakland Bay Bridge (SFOBB)

SF-101 Presidio Parkway

San Francisco-Oakland Bay Bridge

4D/5D models support construction planning and logistics

Post-Construction Surveying for 3D As-Built Records

- Laser Scanning the San Francisco Oakland Bay Bridge

- Laser Scanning the San Francisco Route 101/280 Interchange

Laser Scan of the SFOBB

San Francisco-Oakland Bay Bridge

- System is well over 4 miles long
- West Span 9,620 feet long
- East Span 10,304 feet long
- West Approach Viaduct 3,707 feet long
- YBI Tunnel & West Transition 862 feet long
- East Span Transition Structures

SFOBB Project Scope

Original Concept	New Concept
STLS Scan of the SAS Tower and Deck	Complete Digital As-Built of the SFOBB
• Post-load transfer condition • Deck deformation analysis • Whatever else the engineers wanted	• Stationary scanning from pier caps, decks, and towers • Mobile scanning from decks • Airborne lidar and digital orthophotos

Main Cable


Saddle
SAS Bridge = Self-Anchored Suspension
Main Cable
Suspender Ropes
Decks
Pier Caps
Piers
TOWER
Photo by Caltrans

Inside the SAS

Image credit: Randy Wigton

Checking the data

Image credit: Randy Wigton

NCHRP Report 748: Guidelines for the Use of Mobile LiDAR in Transportation Applications

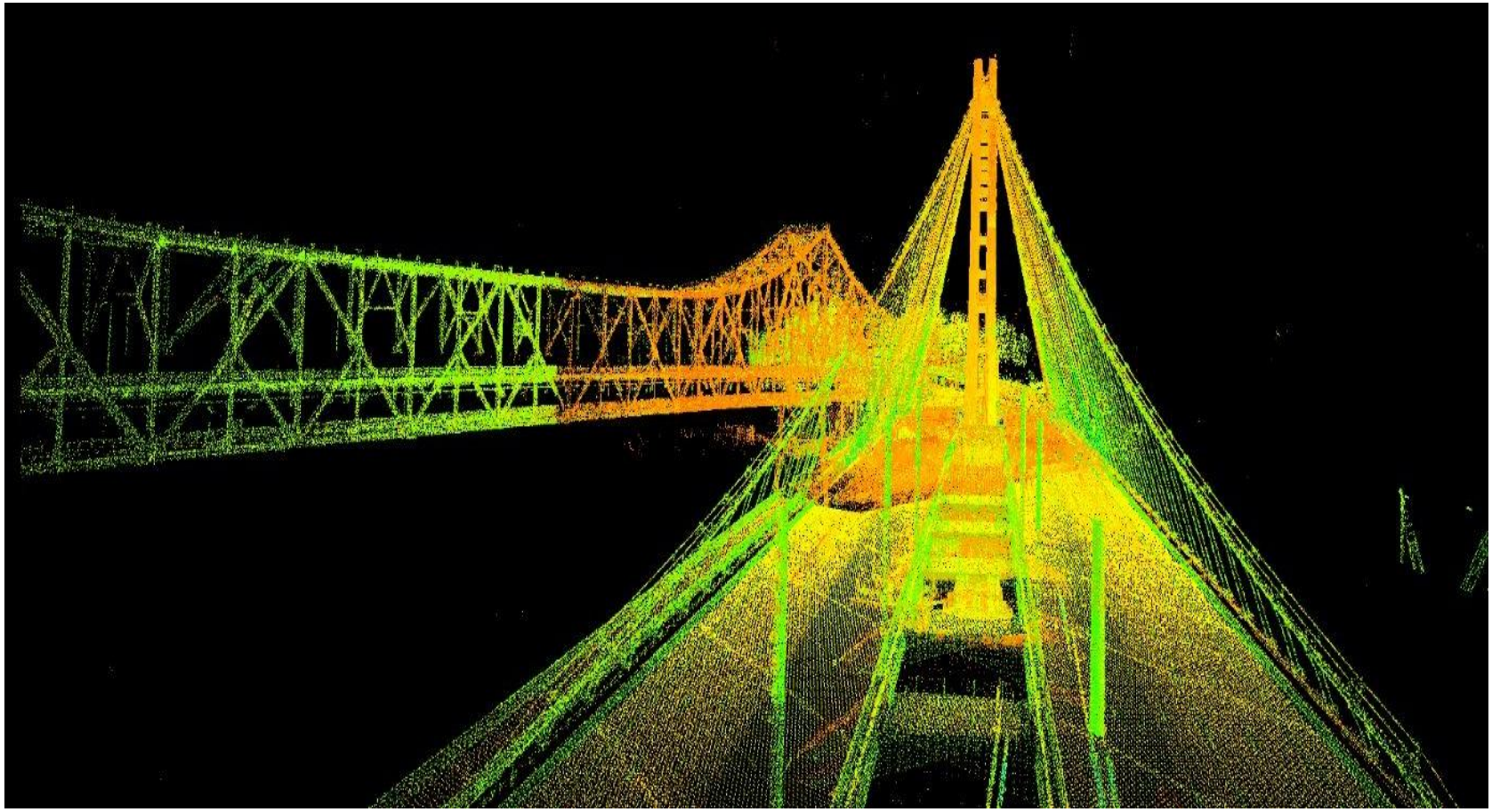
Surveyor at Work

Image credit: Randy Wigton

Staff Accessing a Pier Cap

Image credit: Randy Wigton

What does the Data Look Like?



Mobile LiDAR Point Cloud

LiDAR Data Collected

Data Volume, Storage, and Backup

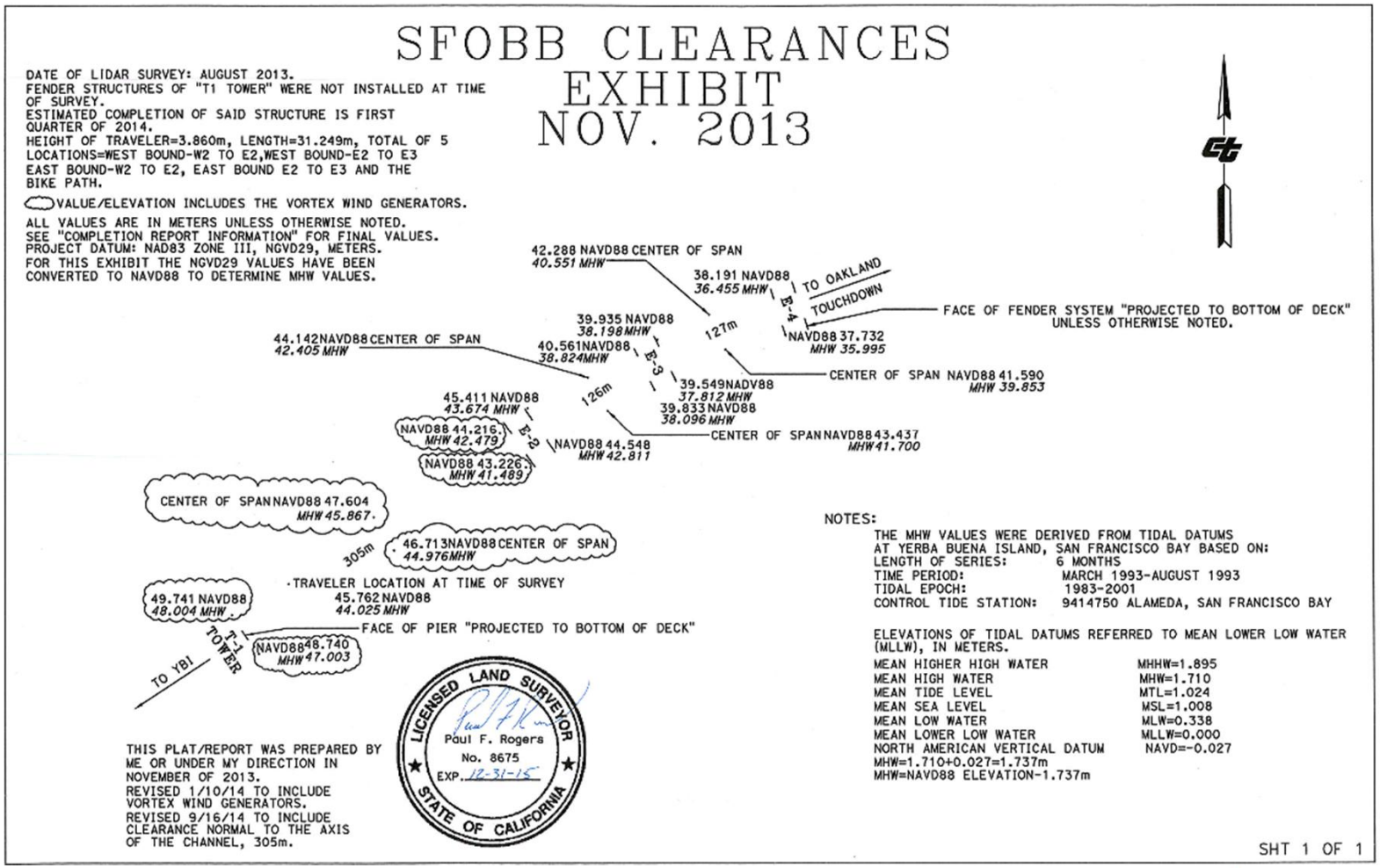
- 340 STLS Scans
  - 400 GB of data
- 3 Days of MTLS Scans
  - 1.1 TB of data
- Airborne LiDAR
  - 3 Longitudinal & 2 Cross Passes
  - 200 GB of data

Initial Use of the SFOBB Data

- East Span Shipping Clearances - USCG
- SAS Tower deformation Diagrams
- Vehicle Clearance Envelope Analysis
- Suspender Cable Verticality
- Main Cable Location vs. Plan
- West Span Tower Locations – USCG
- West Span Mid-Span Anchorage data for another project

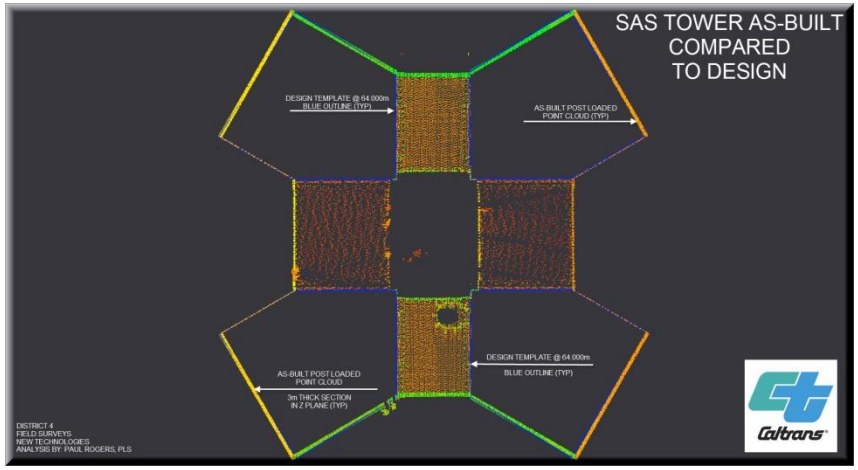
SFOBB East Span Profile

Final SFOBB East Span Clearance Report

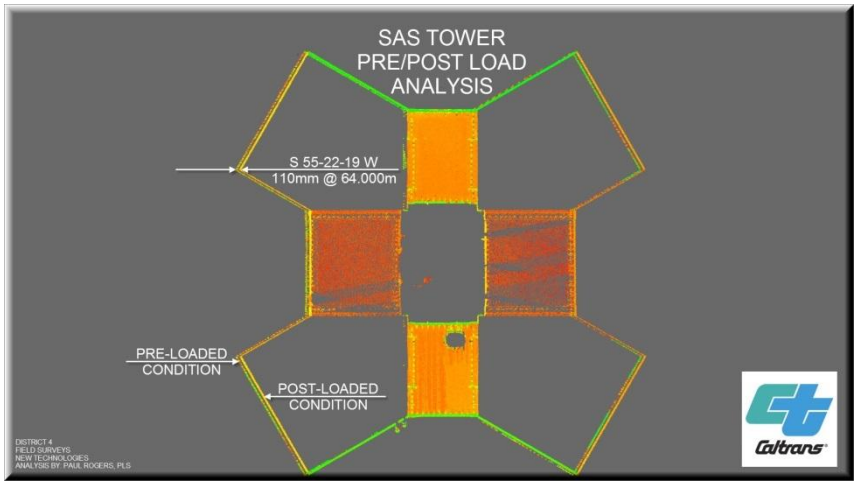


SFOBB East Span Tower Cross Section Comparisons

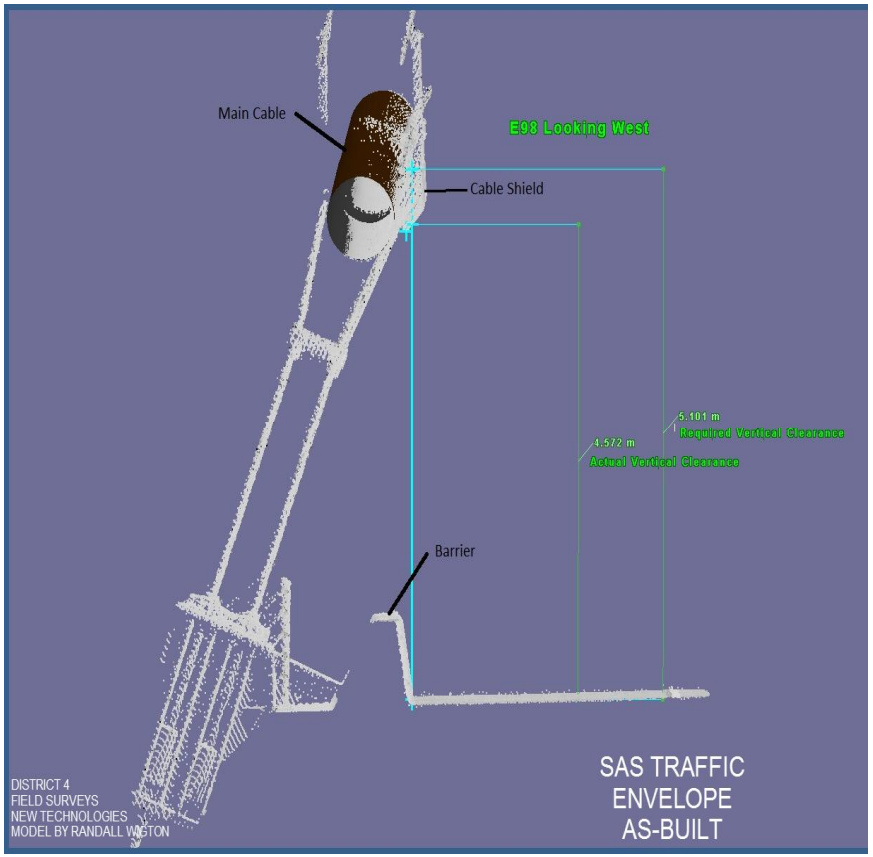
As-built to Design Comparison

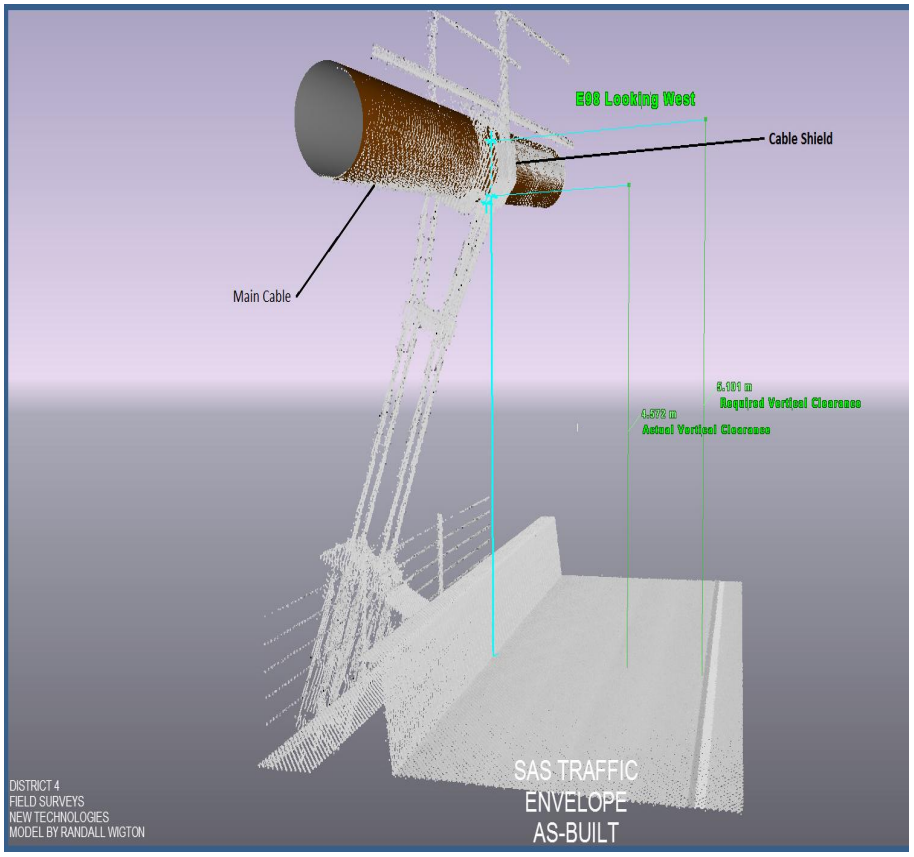


Pre to Post Load Analysis



SFOBB As-Built Traffic Envelope

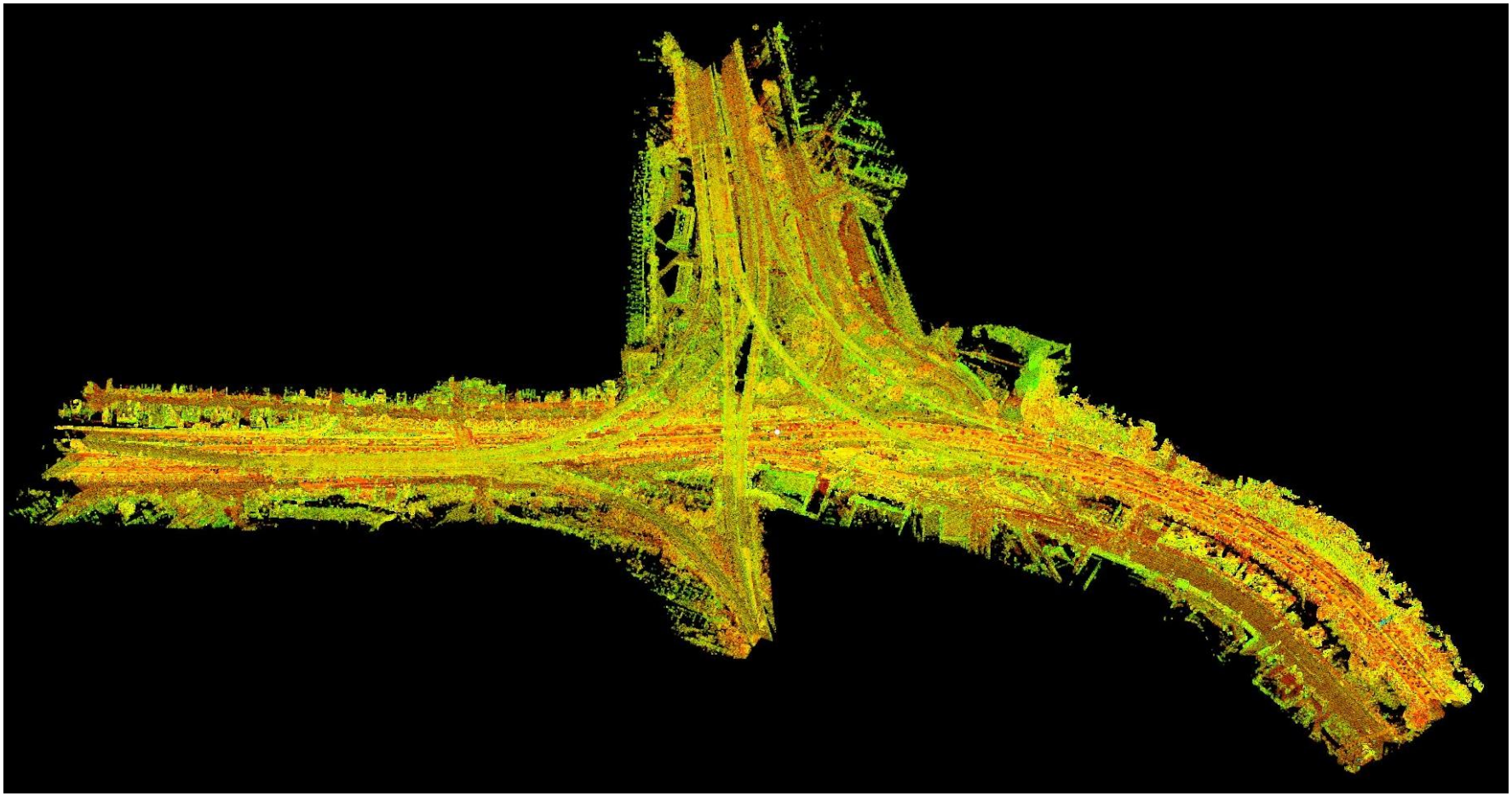




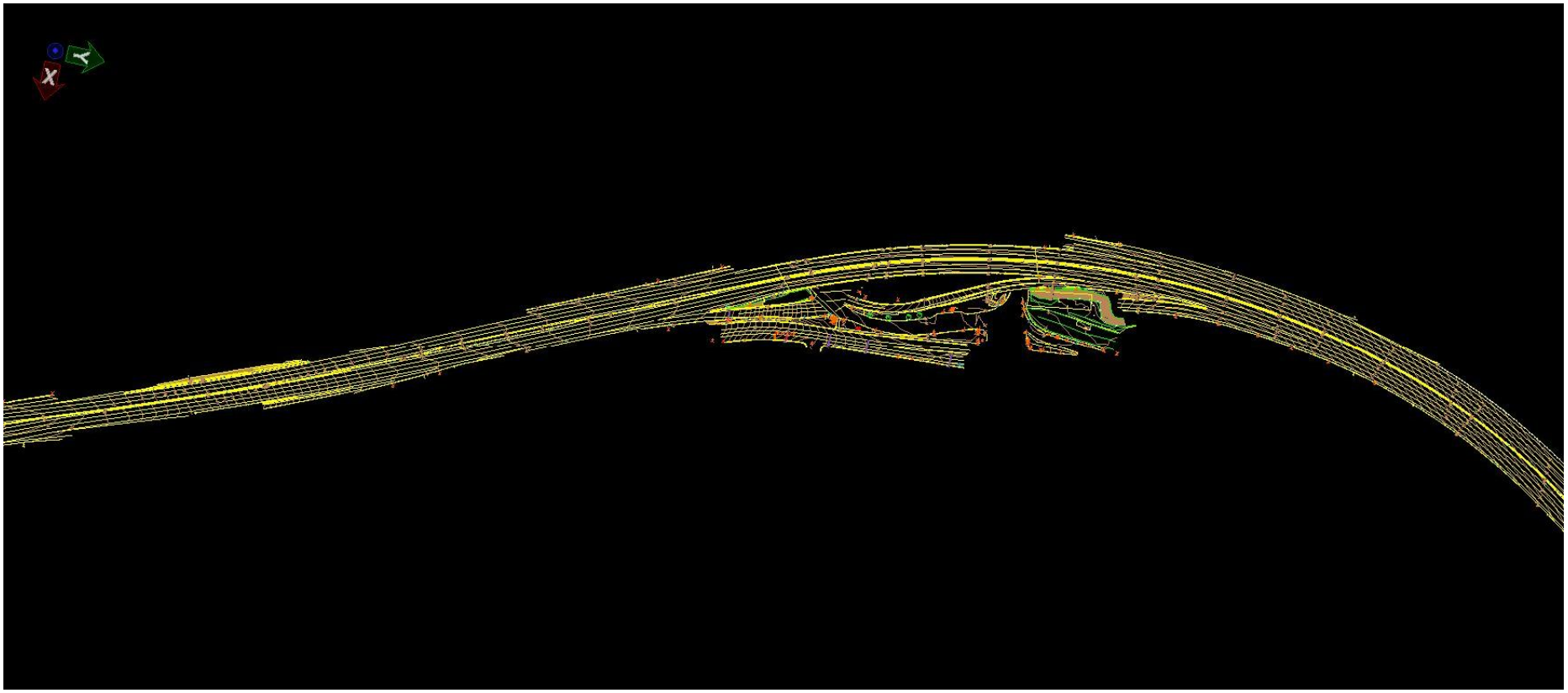
What are the possibilities?

- Mining Additional Data per Requests?
- Planning for New Improvements?
- Public Outreach?
- Emergency Response?
- Bridge Management Information System?

Laser Scan of the SF-101/280 IC



Partial DTM, SF-101



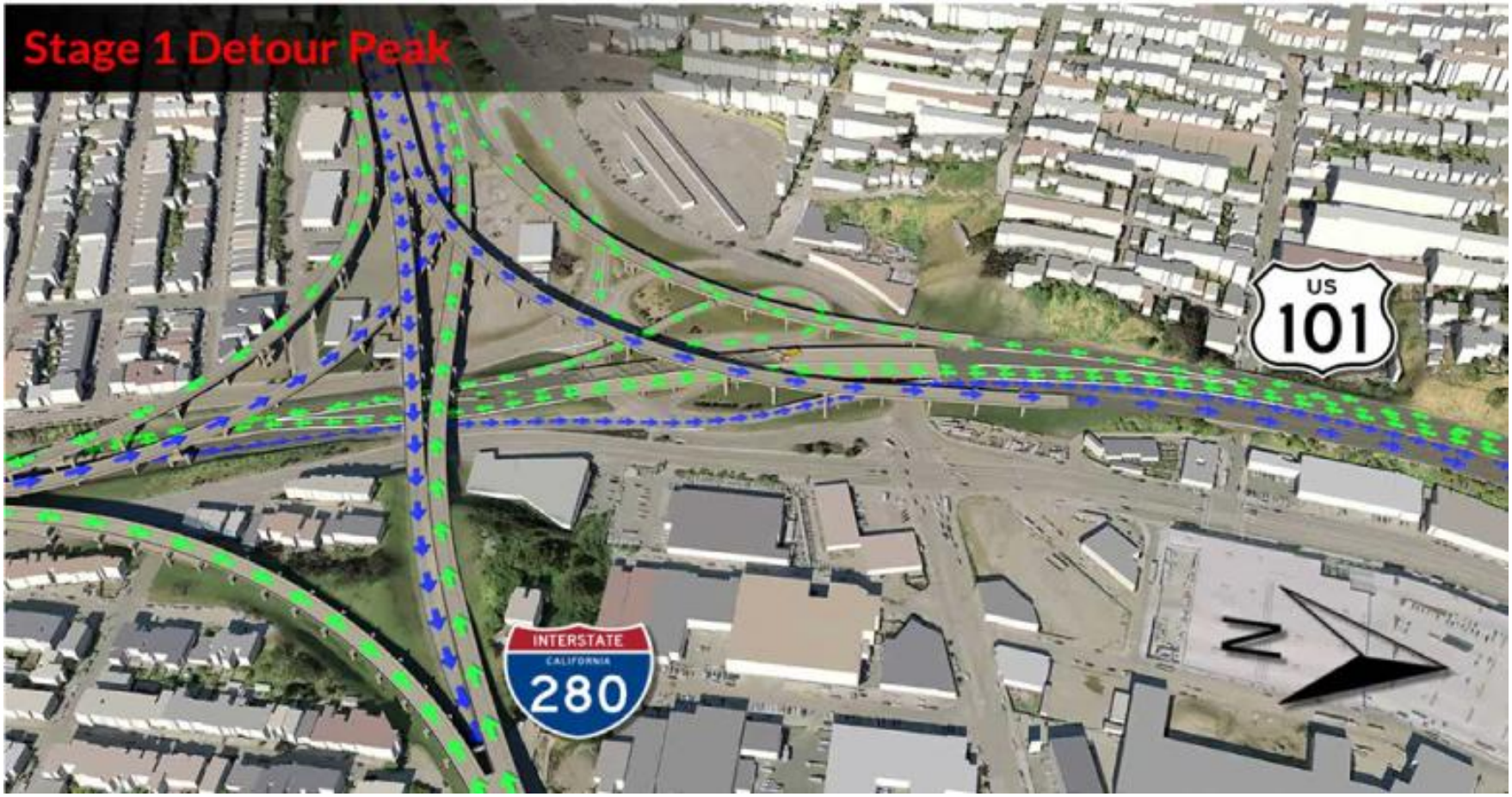
Rendered Visualization Model

Visualization Model with Rendered Traffic

Visualization Model with Rendered Traffic – Alternative Study

Temporary Bridge Study

Arrows Instead of Vehicles

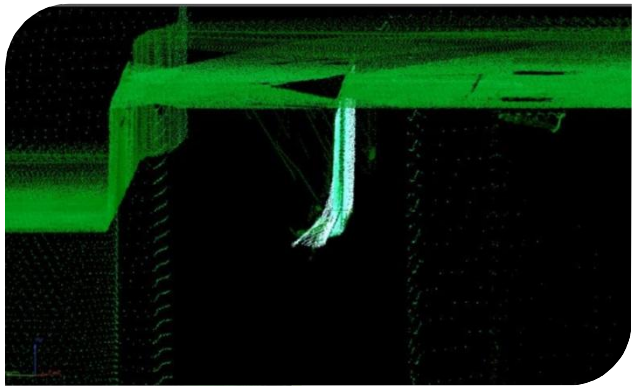


Final Visualizations Animation

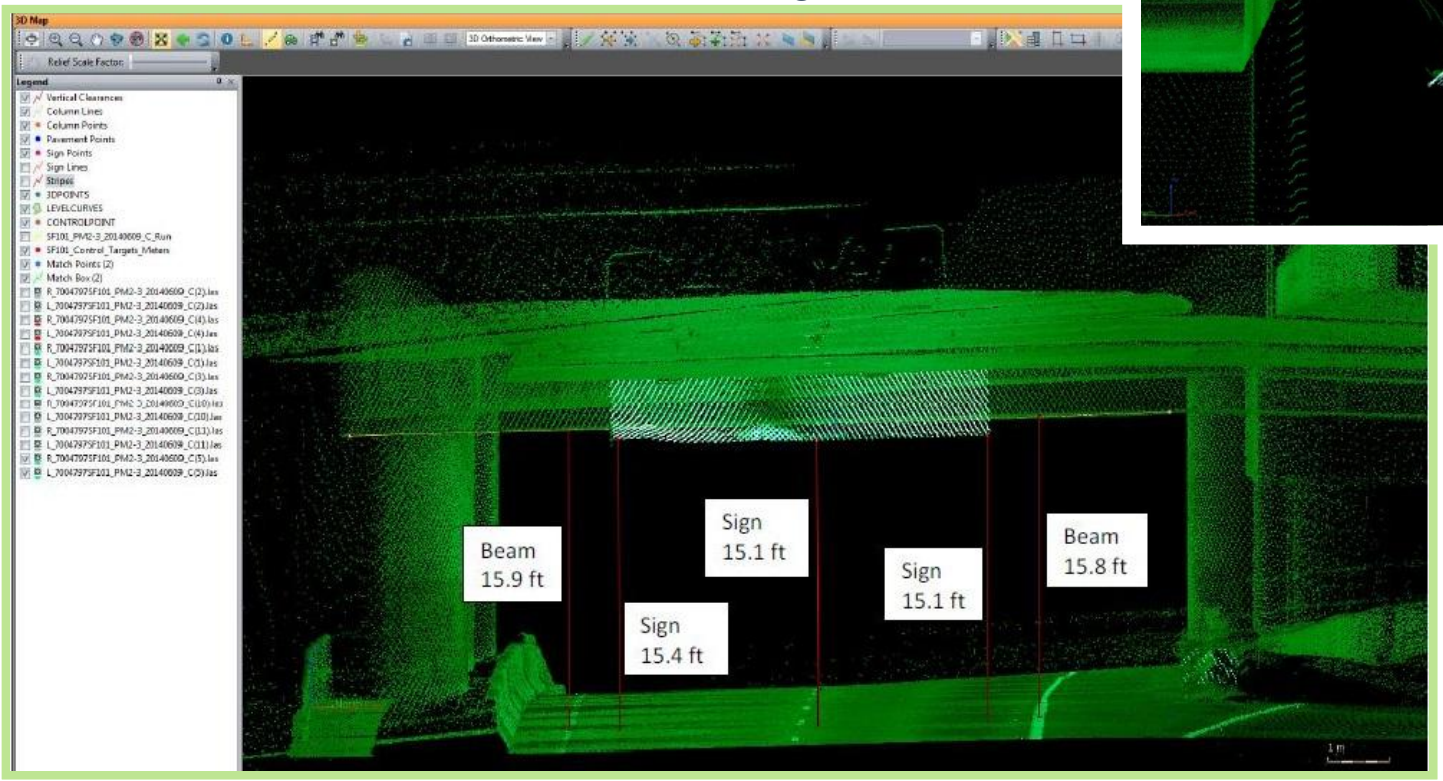
Final Visualization Animations

Mining Data for a Claim

Damaged Sign



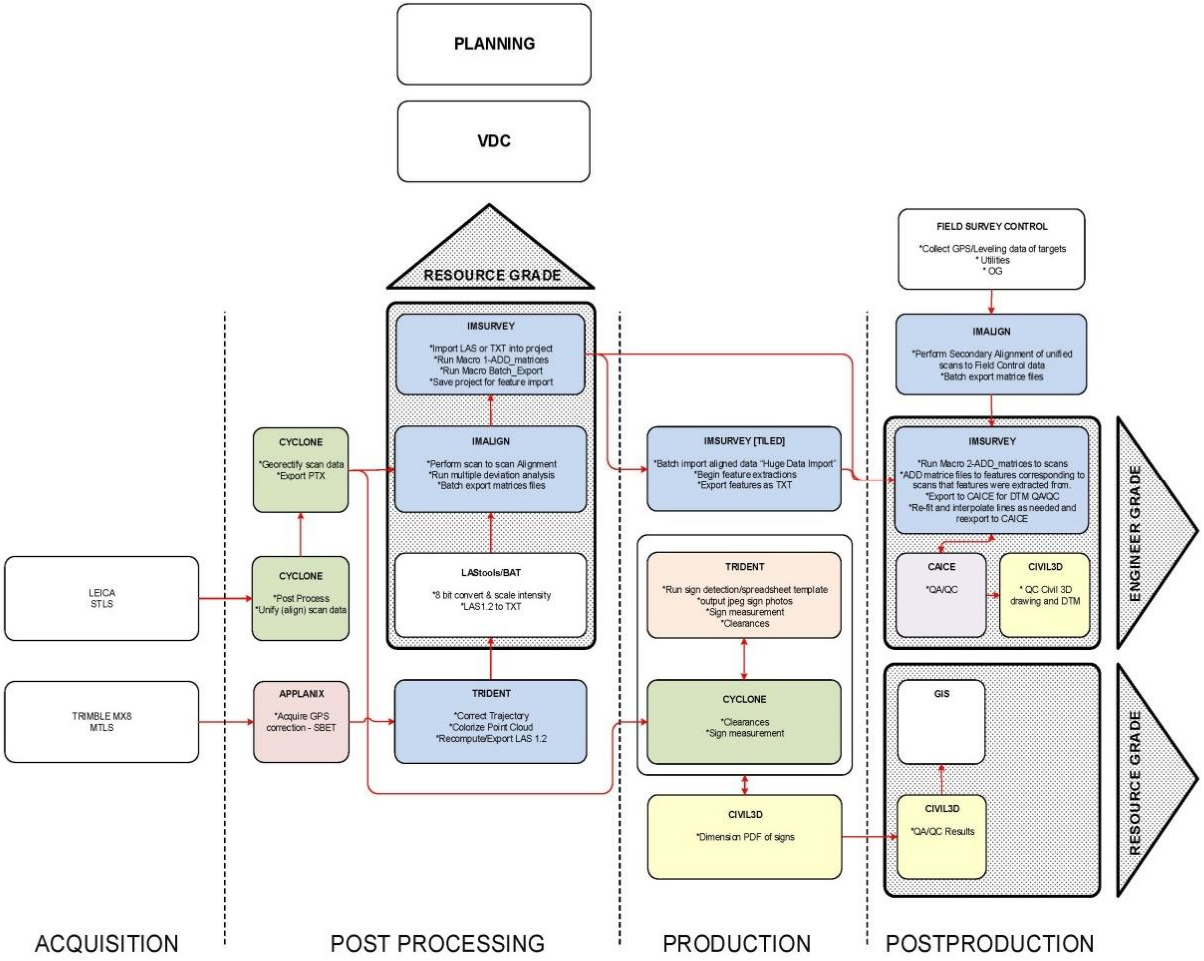
Vertical Clearances for Overhead Sign



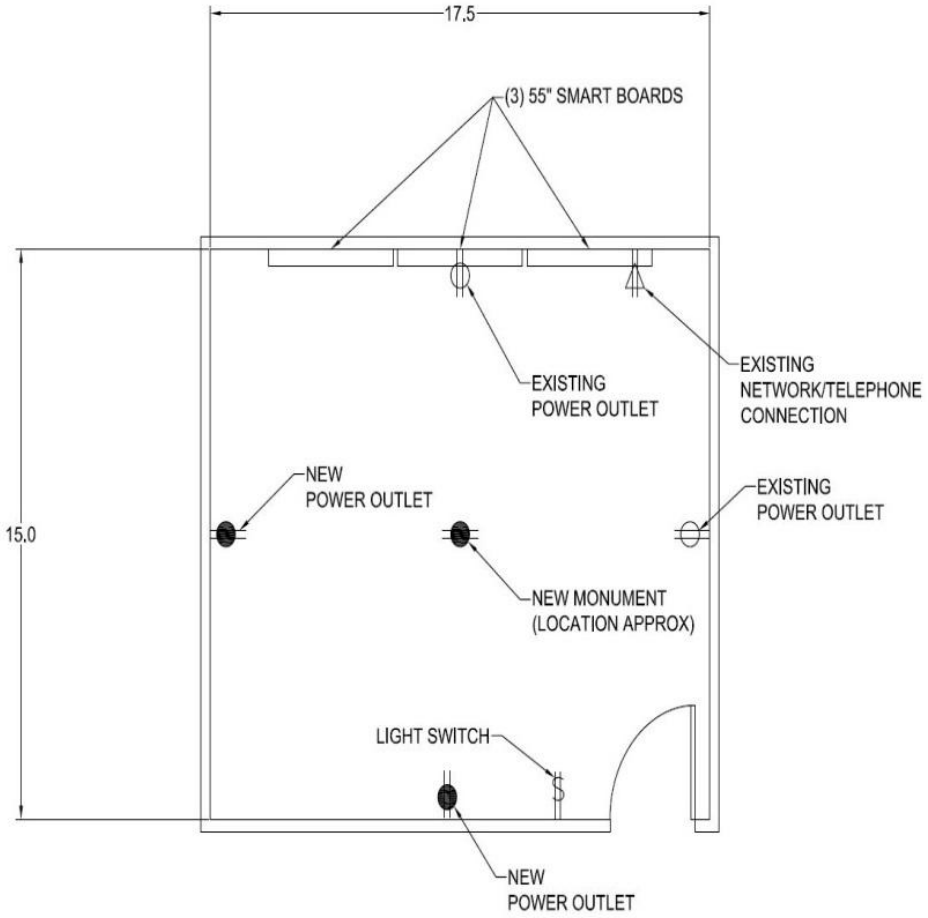
Where are we going from here?

- Evolution of technology for transportation projects
- Moving into the future – Integrated corridor management, Connected or Autonomous vehicles, …

New Workflows

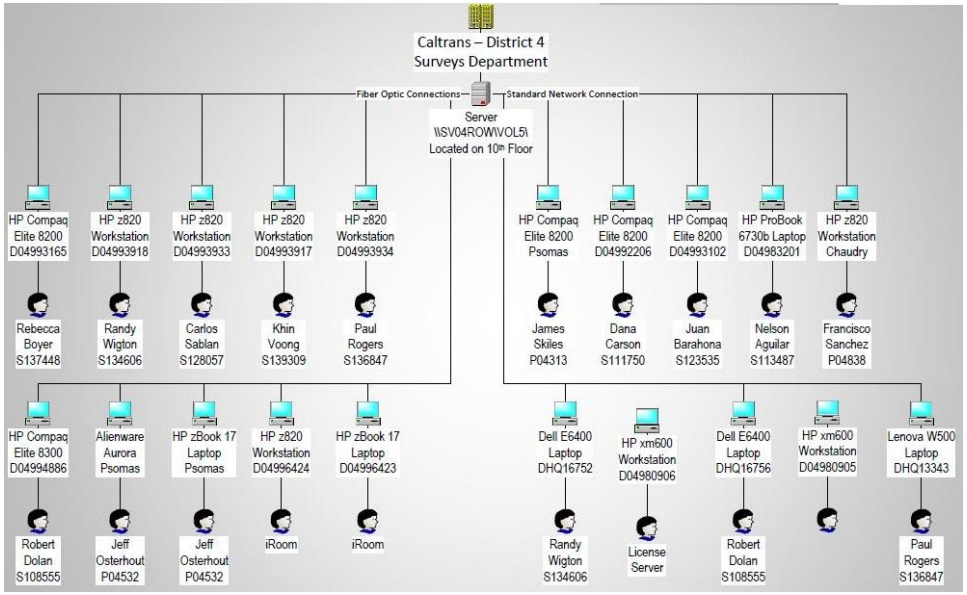


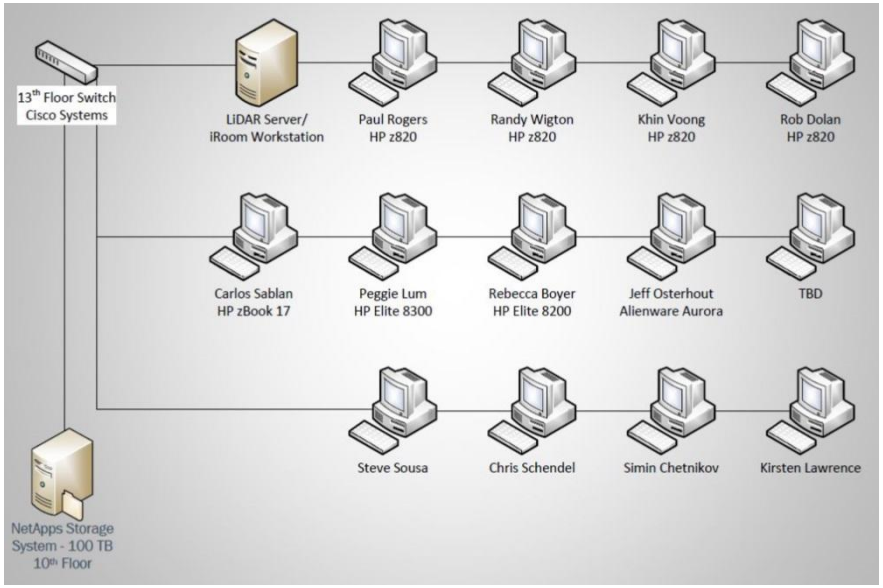
Data Management



I Room Simulation

Upgrade IT Infrastructure





NCHRP Legal Research Digest 58 March 2013: The Legal Aspects of Digital Data

- Copyright Laws
- Ownership of Models
- Protection of Models and Collaborators
- Liability
- Securing Classified Data
- Sharing Digital Data
- 3D Model Issues that may Limit Copyright Protection

THANK YOU!

Poll Group 2

Please respond to the polls on screen.

Learning Outcomes

- Introduce and use terminology that describes 3D, 4D, and 5D Engineered Models
- Distinguish between the three main focus areas for EDC-3 and identify the link to EDC-2 focus areas
- Describe the purpose, need and benefits for the three new focus areas

Learning Outcomes Polls

Please respond to the polls on screen.

Moderated Q&A

Next Webinar

Registration opens next week

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Oct 6, 2015	Using 3D Digital Data for Construction Engineering & Inspection
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