Applications of Enterprise GIS in Transportation (AEGIST)
California Road Sharing (CaRS)

Road to Governed California Centerlines

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Agenda

- **Overview of Current Road Centerline Data & Application Architecture** at Caltrans, CalOES and Local Agencies (Pilot: Merced County)

- **Motivation for California Roads Data Sharing (CaRS) Initiative**
  - **California Road Centerlines Modeling & Impact on Business:** PeMS, MAP21, ARNOLD, Emergency Response
  - **NG911 & ARNOLD Roads Data Modeling Best Practices:** Kansas, Pennsylvania, Virginia, Ohio
  - **One Centerline Initiatives:** Transportation for the Nation (TFTN), Maryland One Centerline Program
  - **AEGIST:** FHWA-led National Pooled Fund Study (PFS) with Pilots at 18 States
  - **Business Users Data Integration**: Project Planning, Emergency Response, Safety, Traffic, Asset Management

- **CaRS Program Charter (Draft) – Road to Governed California Centerlines**

- **Next Steps:** GIS Working Group formation for Prioritizing and Implementing CaRS
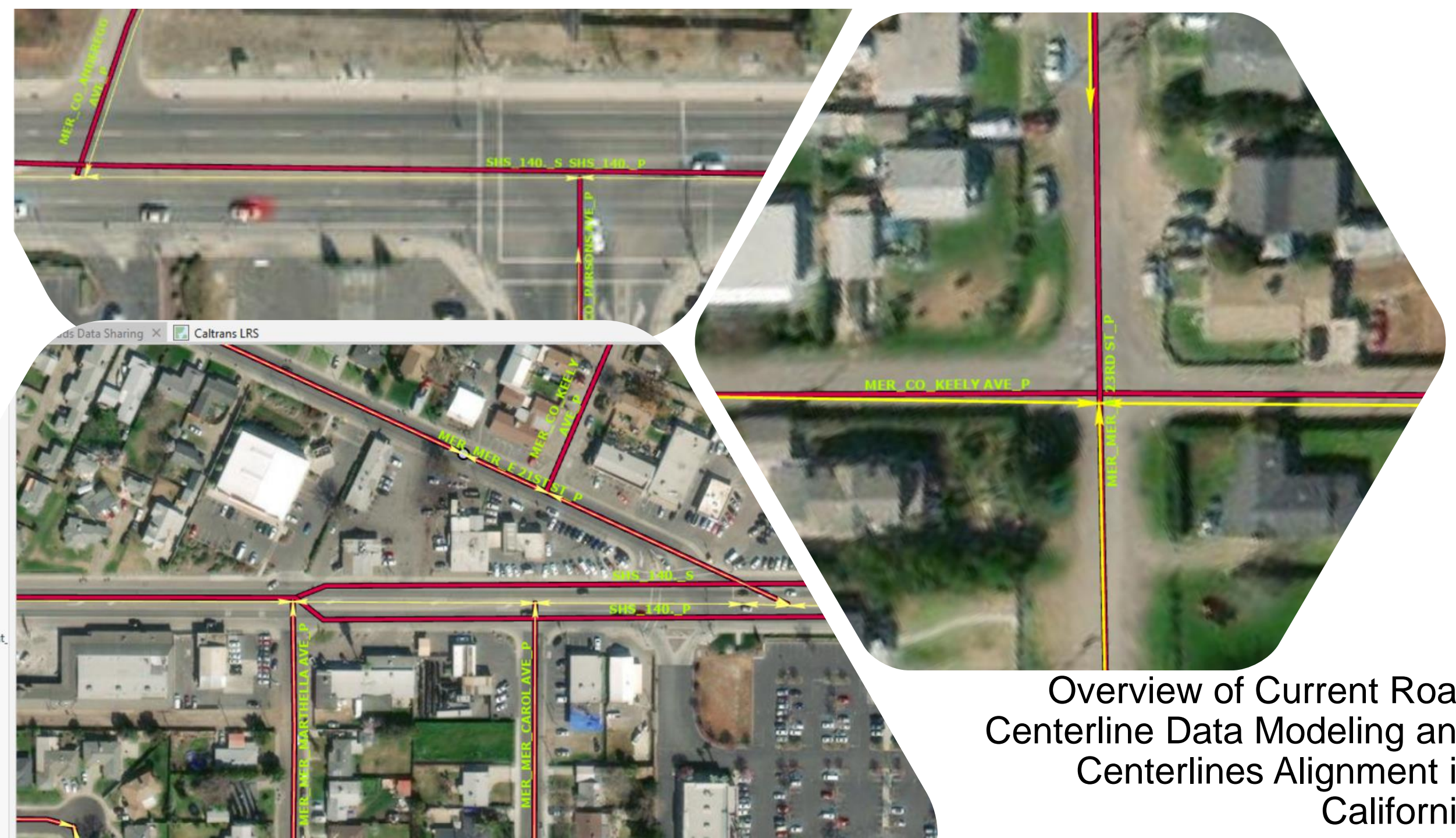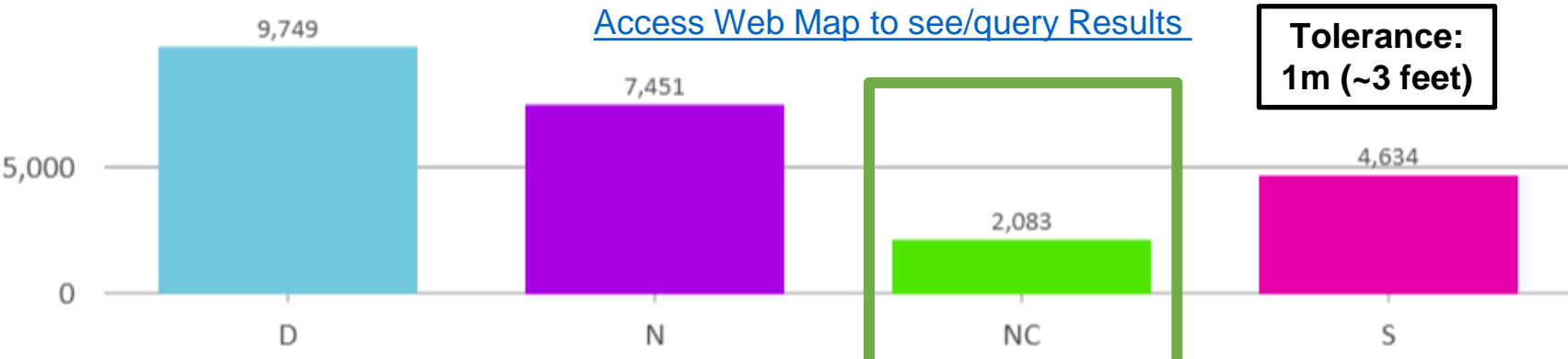
Overview of Current Road Centerline Data Modeling and Centerlines Alignment in California

Overview of Road Centerline Alignment:
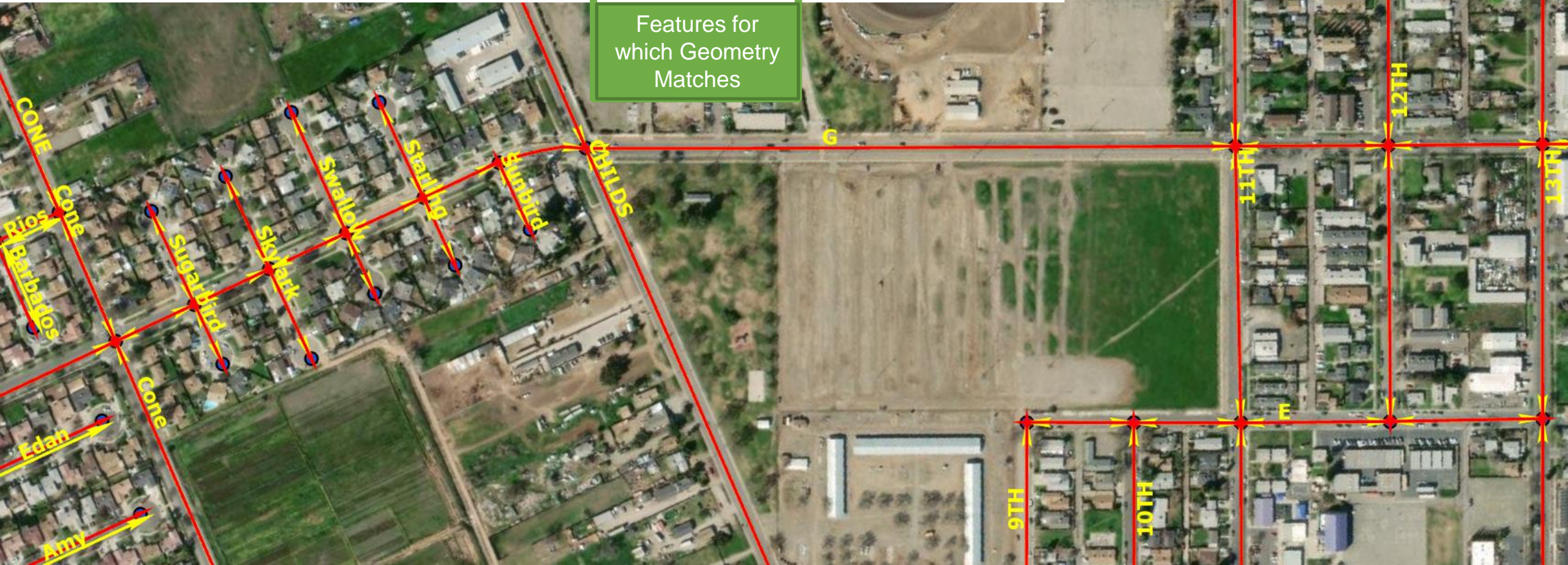## Caltrans and Merced Geometry Comparison

- **Road Centerlines in Merced County NG911 Database**   **: 14,159**
- **Merced County Road Centerlines in Caltrans All Roads LRS Database**
  - **Before Segmentation at Intersection Junctions**   **: 5,976**
  - **After Segmentation at Intersection Junctions**   **: 16,609**
- **Preliminary Results of Road Centerline Geometry Alignment Comparison**
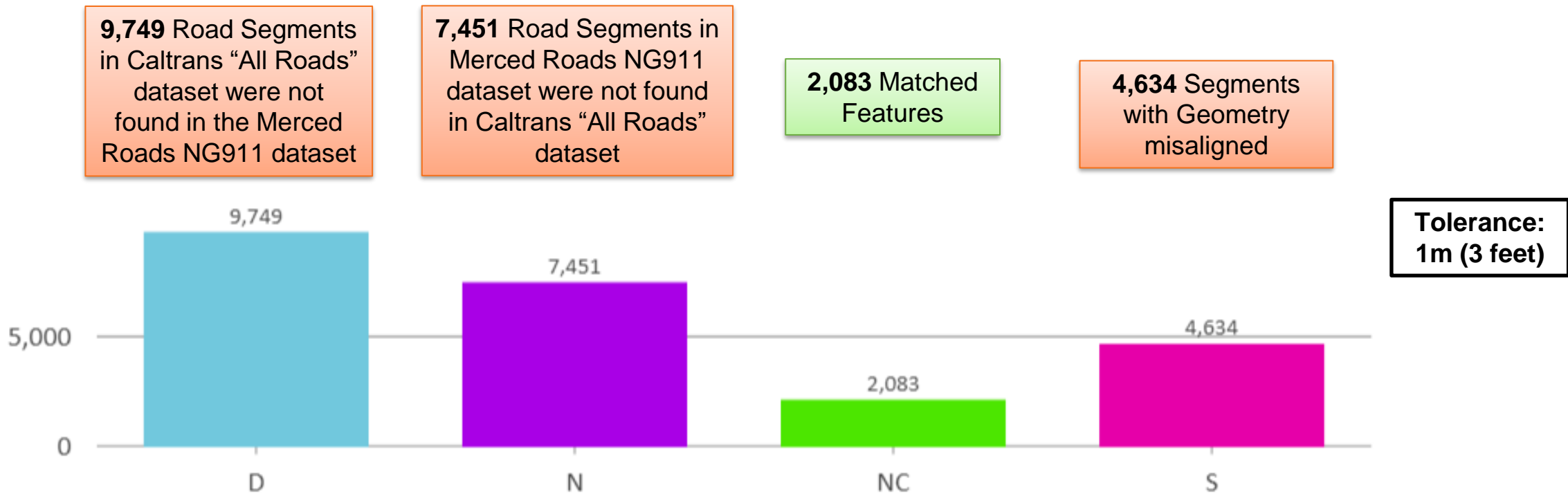
9,749 Road Segments in Caltrans "All Roads" dataset were not found in the Merced Roads NG911 dataset

7,451 Road Segments in Merced Roads NG911 dataset were not found in Caltrans "All Roads" dataset

2,083 Matched Features

4,634 Segments with Geometry misaligned

Tolerance: 1m (3 feet)

Overview of Road Centerline Alignment: Caltrans and Merced Geometry Comparison

Overview of Road Centerline Alignment:
Caltrans and Merced Geometry Comparison

Road Segments in Caltrans "All Roads" dataset that were not found in the Merced Roads NG911 dataset

Road Segments in Merced Roads NG911 dataset that were not found in Caltrans "All Roads" dataset

Features for which Geometry Matches

Segments with Geometry not aligned

Tolerance: 3m (~10 feet)
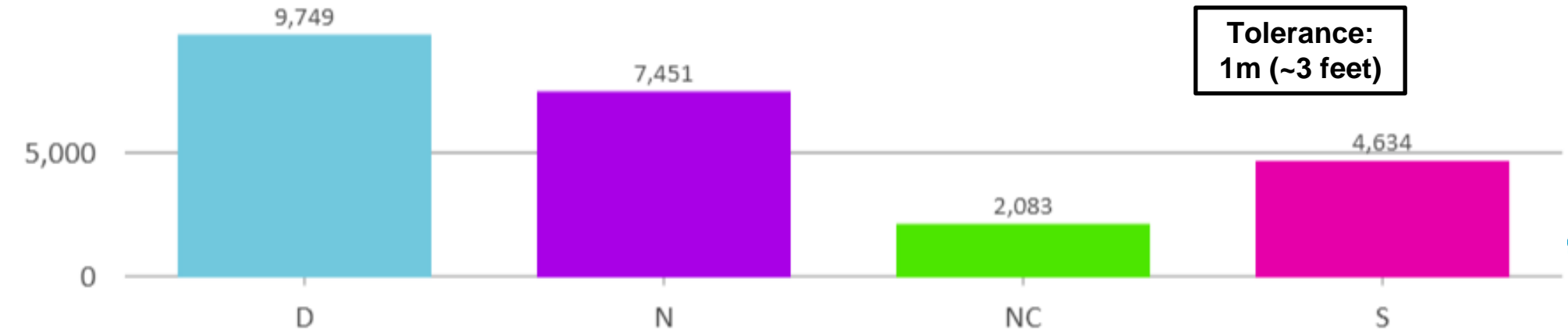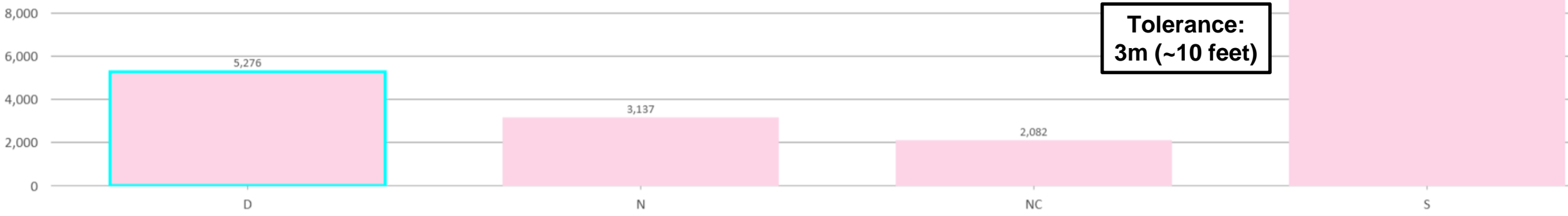
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Overview of Road Centerline Alignment:
Caltrans and Merced Geometry Comparison

Road Segments in Caltrans "All Roads" dataset that were not found in the Merced Roads NG911 dataset
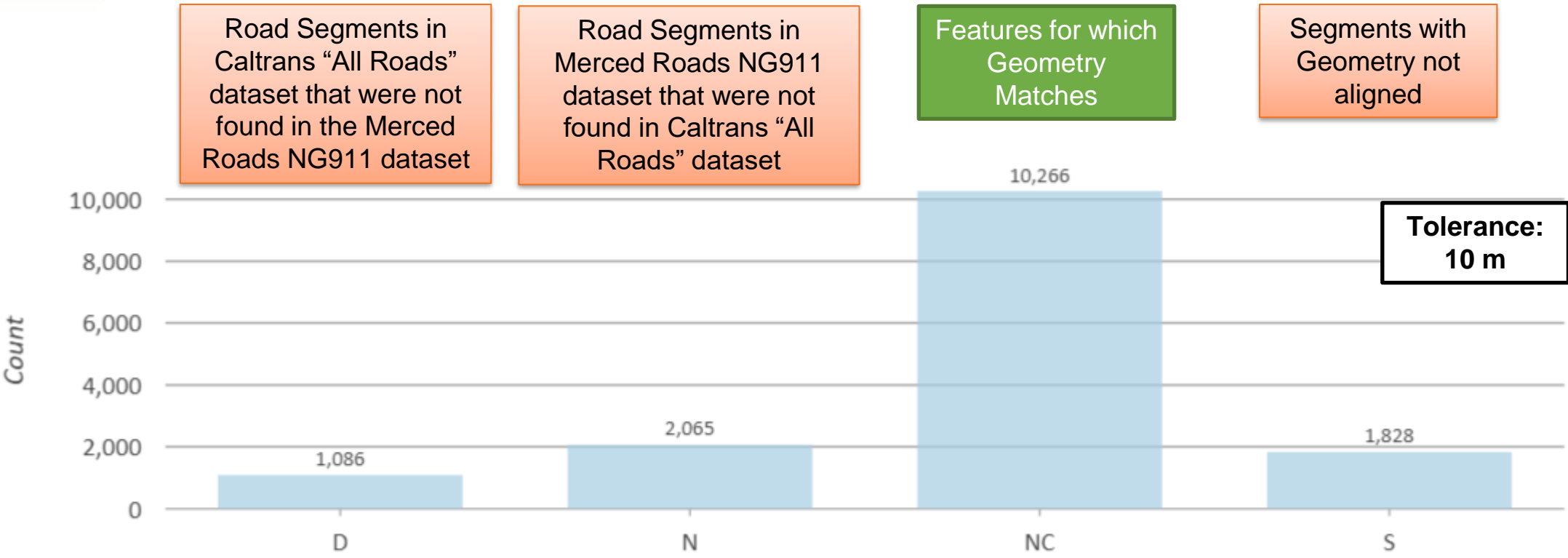
Road Segments in Merced Roads NG911 dataset that were not found in Caltrans "All Roads" dataset

Features for which Geometry Matches

Segments with Geometry not aligned

Tolerance: 10 m

Increasing Tolerance and filtering to Local Roads (eliminating State Highway System from the comparison)
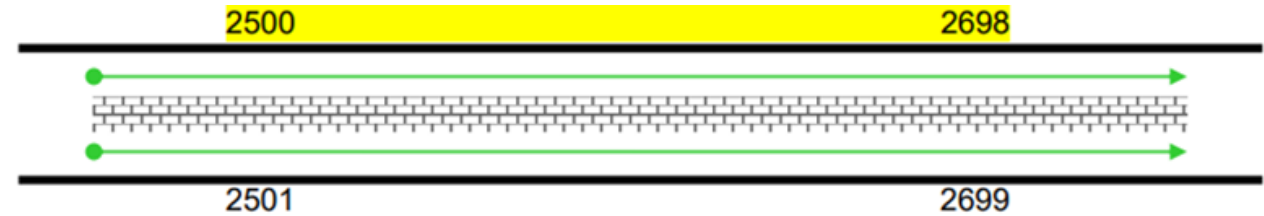
Motivation: State-of-Art Road Centerline and associated Data Management Initiatives in States

Kansas N-911: Single/Dual Carriageway (Divided-Undivided Highways)

- For the highlighted segment[1]
  - » R_F_ADD and R_T_ADD fields would be zero
  - » L_F_ADD would be 2500 and L_T_AD fields would be 2698

- NG911 strongly recommends that road is represented as dual-carriageway if median meets following specifications[1]:
  - » Median Type: Any physical barrier and any painted barrier greater than 4' wide.
  - » Median Length: Divides the road for 1/10th of one mile or more in urban areas and 3/10th of one mile or more in rural areas.

- FHWA ARNOLD-HPMS Specifications[2]: If Median Type: Physical Barrier – Always Divide. For all others:
  - » Median Width: 5 feet or more
  - » Median Length: 500 feet or more

Motivation for California Roads Sharing (CaRS) Initiative

- **Current State of California Road Centerlines Modeling & Impact on Business:** PeMS, MAP21, ARNOLD, Emergency Response

- **NG911 & ARNOLD Roads Data Modeling Best Practices:** Kansas, Pennsylvania, Virginia, Ohio, Arizona
  - [PEMA PA NG911](#)
  - [Kansas NG911 Specifications for Road Centerlines Modeling](#)
  - [Ohio DOT Local Roads Sharing (LBRS) Specifications](#)
  - [Virginia DOT Road Centerline Geometry Recommendations](#)
  - [Arizona 911 – Modeling Dual Centerlines](#)

- **One Centerline Initiatives:**
  - Transportation for the Nation (TFTN)
  - One Maryland One Centerline (OMOC) Program

one MARYLAND one CENTERLINE
collaborative. authoritative. seamless.

MARYLAND'S CENTERLINE

Maryland's public roadway system is jointly owned, operated and maintained by the Maryland State Highway Administration (SHA), the Maryland Transportation Authority (MDTA), Baltimore City, and Maryland's 23 counties and 159 incorporated municipalities. The One Maryland One Centerline Program aims to create a sustainable, current, authoritative, and multi-use centerline dataset through collaborative partnerships between these entities.

STATE
COUNTY
MUNICIPALITY

DELAWARE
MARYLAND

CENTERLINE ATTRIBUTES	
Road Name	Main St
Route Number	543
Owner	State
Address Right	100-140
Address Left	101-141
Speed Limit	45
Pavement	asphalt
# Lanes	2

Focus on the end points where linear features meet. These points help with edge-matching and the development a seamless roadway network.

USES

✓ Mapping and visual representation

✓ Routing and driving directions

✓ Geo-locating address information, also known as geocoding

✓ Transportation planning, traffic studies and safety assessments

✓ Asset and maintenance management

✓ Analysis of driving times and distances

✓ Emergency planning, preparedness and response

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The One Maryland One Centerline (OMOC) Program is a collaborative effort between federal, state, and local entities to create an authoritative, statewide roadway dataset that meets the needs of a diverse community.

PROGRAM GOALS

✓ Create a collaborative, state-wide, seamless centerline based on authoritative data.

✓ Meet MAP-21 requirements and enhance the HPMS reporting process.

✓ Coordinate roadway cartographic and data model recommendations.

✓ Provide mutual benefits to State and Local jurisdictions

✓ Support Transportation for the Nation (TFTN), which promotes a publically available, high quality road centerline that is coordinated across all levels of government.

AN INTEGRATED ROAD DATASET WILL...

✓ Be authoritative/accurately represented
✓ Be seamless across jurisdictions
✓ Meet multiple business needs
✓ Be efficiently maintained
✓ Reduce data duplication
✓ Support public safety and asset management systems
✓ Display updates in near real-time
✓ Benefit State and Local applications

MARYLAND STATE IMPLEMENTATION

The Maryland State Highway Administration will use the Roads and Highways desktop component to efficiently maintain the statewide linear referencing system and centerline. The Roads and Highways server component, the Roadway Characteristics Editor, will be available for local jurisdictions to directly interact with their authoritative roadway linework and information about their roadways, such as addressing information, assets, traffic, and pavement.

LOCAL JURISDICTIONS WILL NOT NEED TO PURCHASE LICENSES TO SOFTWARE.

Motivation: AEGIST, Ongoing National Effort for Professional, Governed and Standards-Based GIS Data & Applications

- ❏ FHWA-led National Initiative

- ❏ 18 Pooled Fund Study (PFS) States

- ❏ 4 Engaged (Friend) States

- ❏ Enterprise GIS Applications

- ❏ Spatial Data Modeling Standards

- ❏ Data Governance

- ❏ Building Information Modeling (BIM)

- ❏ Strategic Data Integration Pilots

- ❏ Professional Approach to GIS

- ❏ Spatial Data Engineering & Data Science
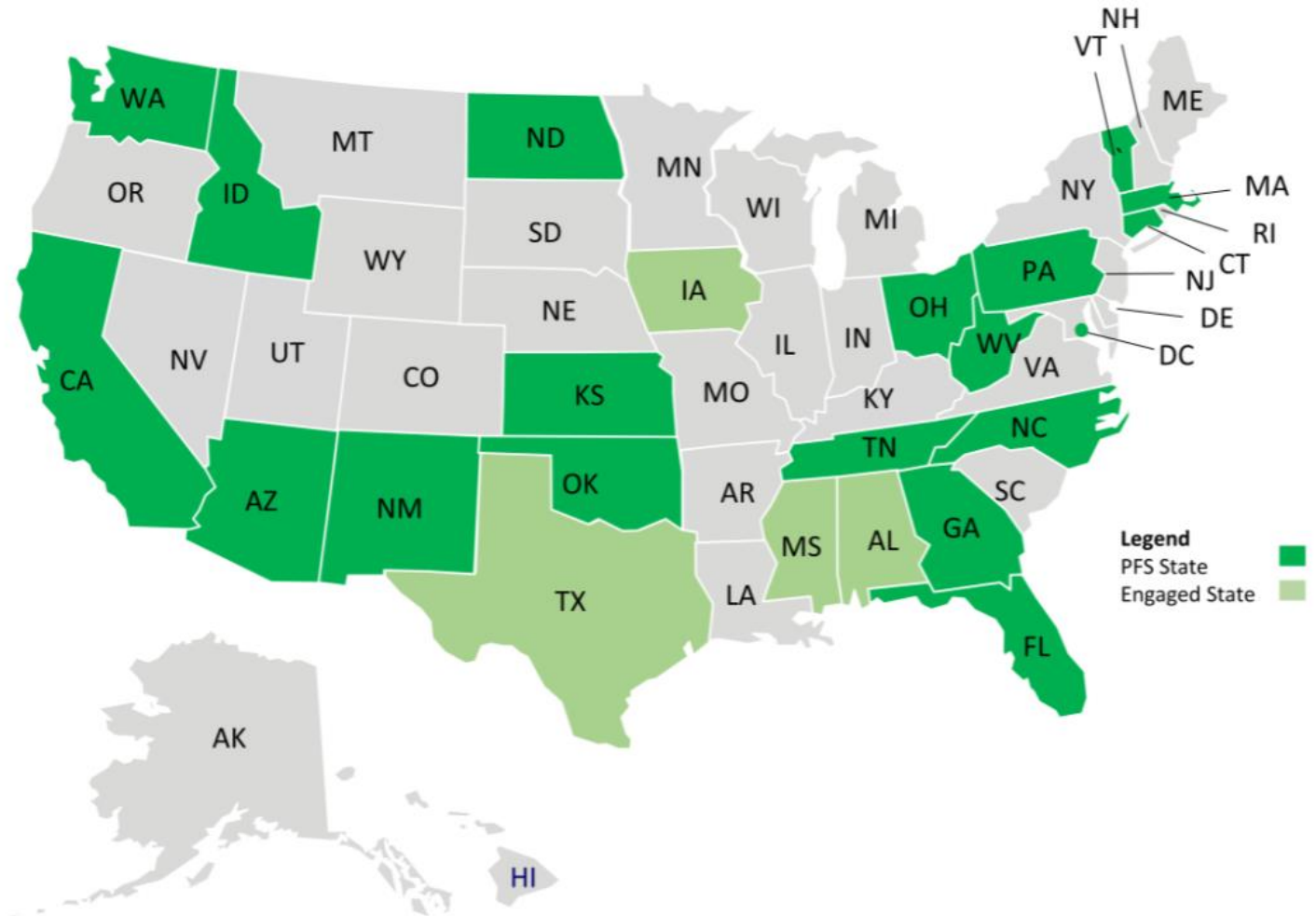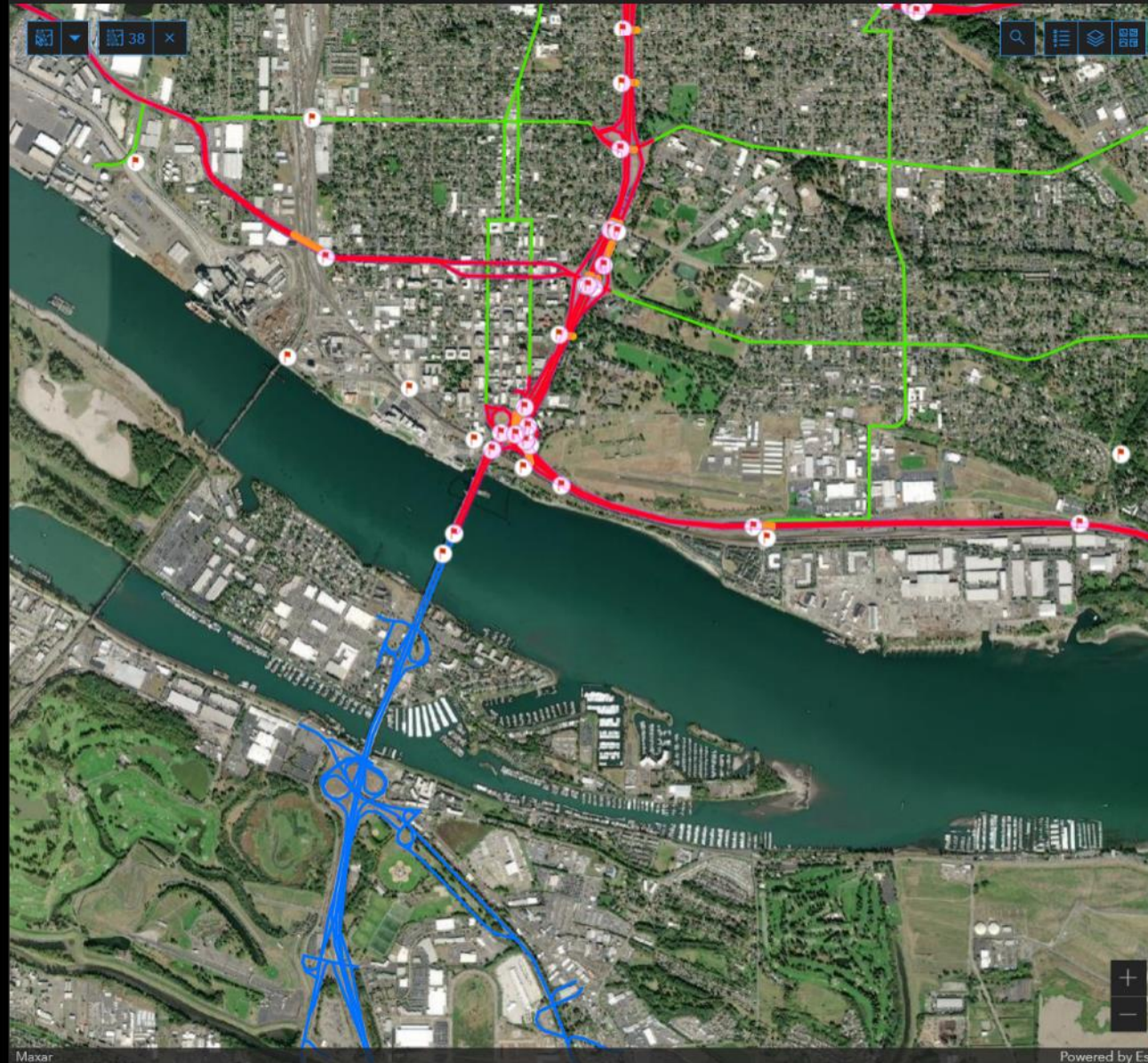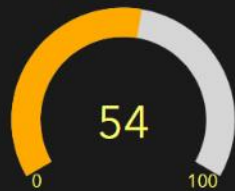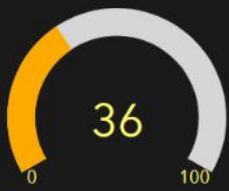
Legend
PFS State
Engaged State
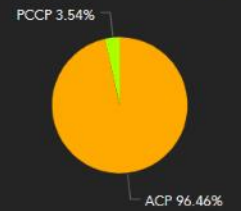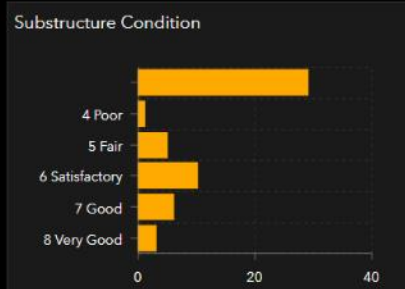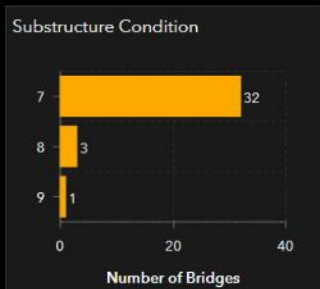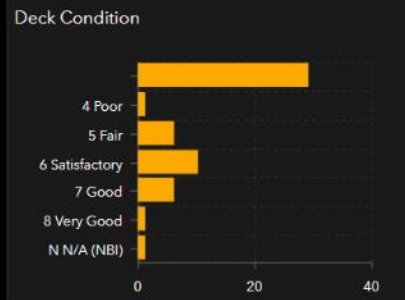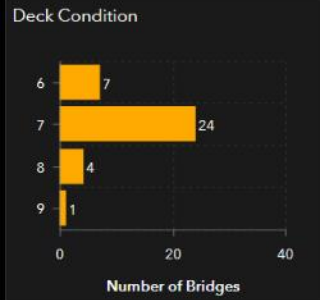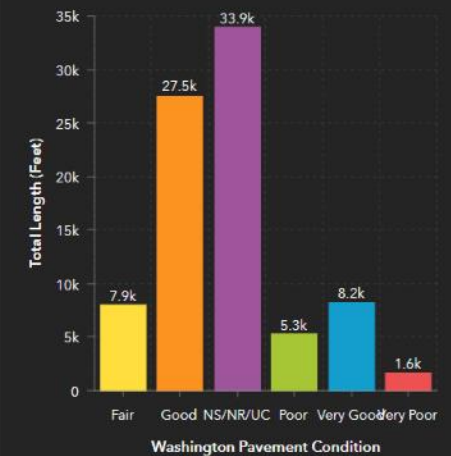
Motivation: Business Data Integration
Road Centerlines are used to Linearly Reference Business Data from Project Planning, Survey, Design, Construction, Asset Management, Highway Traffic & Safety Operations, Emergency Response;
Linearly & Spatially Referenced Business Data Analysis, Digital Twin Creation depends on Integrating Road Network Data across Government Agencies

CURRENT ROADS DATA MODELING, SHARING AND QA/QC WORKFLOW

GIS Data
(e.g.: Tiger Lines, Local Agency Roads)

Other GIS Data

CSU Data Integration & Data Checks
Tiger Lines, Imagery, Local Agency Files

Caltrans System

Roads Data Integration & Checks
4. Data Modeling & QA/QC Rules
App: 1Integrate

Roads, Intersections Data Modeling
App: Roads & Highways

ARNOLD-HPMS, Statewide All Roads Data

Cal OES System

NG911 GIS Data Sharing

GIS Data Integration & Checks
2. Data Modeling & QA/QC Rules
App: GeoComm

GIS Data Checks
3. Data Modeling & QA/QC Rules
App: 1Integrate

Valid Data

Data that Needs Validation

Validated Data

GIS Authority

Roads, Assets & Other GIS Data Modeling
1. Data Modeling & QA/QC Rules
Apps: Multiple (E.g.: Datamark)

FIRE/EMS 911 POLICE DISPATCH

PSAP & County Coordination

Local Agency GIS Data

Updated Local GIS Data

Some Local Agencies data used by CSU, Caltrans

Local Agency Systems

Source: Caltrans, CalOES & Merced County

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ENVISIONED ROADS DATA & APPLICATIONS ARCHITECTURE FOR ROADS DATA MODELING, DATA QA/QC & EXCHANGE

Caltrans System

Other Roads & GIS Data Sources
(e.g.: Tiger Lines, NPMRDS, FLMA, Open Street Maps etc.)

Data that Needs Validation

Data that Needs Validation

Roads Data Integration & Checks
4. Data Modeling & QA/QC Rules
App: 1Integrate

Roads, Intersections Data Modeling
App: Roads & Highways

ARNOLD-HPMS, MIRE, NRN & National Standards Compliant Statewide Data

NG911 GIS Data Sharing

Valid Data

GIS Data Integration & Checks
2. Data Modeling & QA/QC Rules
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FIRE/EMS 911 POLICE DISPATCH
PSAP & County Coordination

Updated Statewide GIS Data

Local Agency GIS Data: Roads, Assets, etc.

Updated Local GIS Data

Local Agency Systems

California Road Sharing (CaRS)

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Road to Governed California Centerlines

California's road system is managed by various authoritative roads data management government agencies. These include the Caltrans State Department of Transportation (DOT), 58 counties and 482 municipalities using multiple data systems.

Vision: The **California Road Sharing (CaRS) Program** will establish the **Road to Governed California Centerlines**. Road data modeling, management and exchange practices will be coordinated across Caltrans, Cal OES and Local agencies. A Statewide Roads Data, Applications and Technology Architecture will be created for management of road centerline geometry and road information. Pilot projects will be done with stakeholders in California and workshops will be held as part of the ongoing FHWA-led AEGIST program involving 18 States, in the U.S. to gather information for successful deployment of an integrated and federated data management system with data modeling, governance, sharing and QA/QC rules..

Benefits to Stakeholders

- Public safety enhancement through data-driven emergency management, preparedness and incident response
- Transportation planning, traffic studies, safety assessments and geo-locating address information (geocoding)
- Linear referencing of infrastructure asset inventory and condition assessment data in Asset Management Systems
- Capital and Maintenance project work data management (linear/spatial referencing)
- Topologically connected routable network development for map-based vehicle routing and analysis of driving directions, distances, roadway mileage.
- Deployment of Statewide Roads Data Governance Framework through establishment of National standards-based roads data modeling and QA/QC rules across government agencies
- Development of Digital Twin and AI/ML Applications for Infrastructure Management, CV/AV & Unmanned Aerial Systems

Roads Data Modeling & QA/QC Rules

- Null and Multi-Part Geometry
- Duplicate Vertices
- Centerline Alignment
- Digitization Direction
- Centerline Accuracy, Source
- Self-Intersecting Geometry
- Start/End Nodes Alignment
- Overshoots/Undershoots
- Kickbacks
- Bifurcations
- Turn Lanes & Ramps Centerlines
- Emergency Crossovers
- Railroad Crossings
- Administrative Boundary Junctions
- Overlap/Concurrent Roads
- Dual-Geometry (Divided/Undivided)
- Roundabouts & Traffic Circles
- Road Identification Information (ID, Name, Class etc.)

PROGRAM GOALS

- ✓ Create a governed state-wide road centerline dataset to meet ARNOLD and NG911 roads data requirements
- ✓ Provide mutual benefits to State and Local jurisdictions, especially the business users involved in highway project planning, survey, design, construction, safety, traffic and asset management operations
- ✓ Coordinate roadway cartographic and data model recommendations
- ✓ Support Transportation for the Nation (TFTN), which promotes a publically available, high quality road centerline that is coordinated across all levels of government
- ✓ Building Information Modeling (BIM) for Roads and Assets using Standards for supporting AI/ML Applications, CV/AV and UAS.

Envisioned Data Flow

Caltrans System

- Roads Data Integration & Checks — 4. Data Modeling and QA/QC Rules — App: 1Integrate
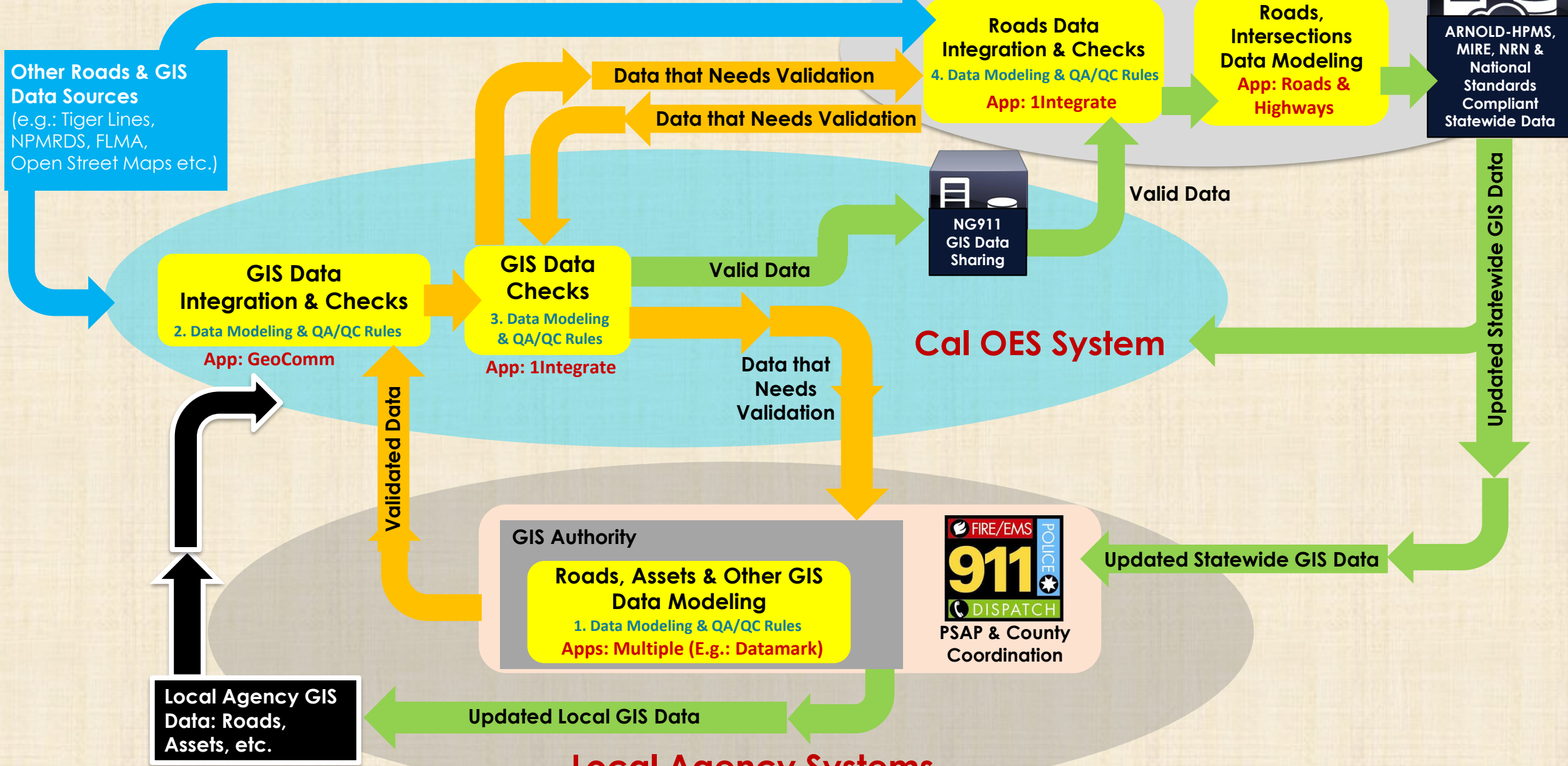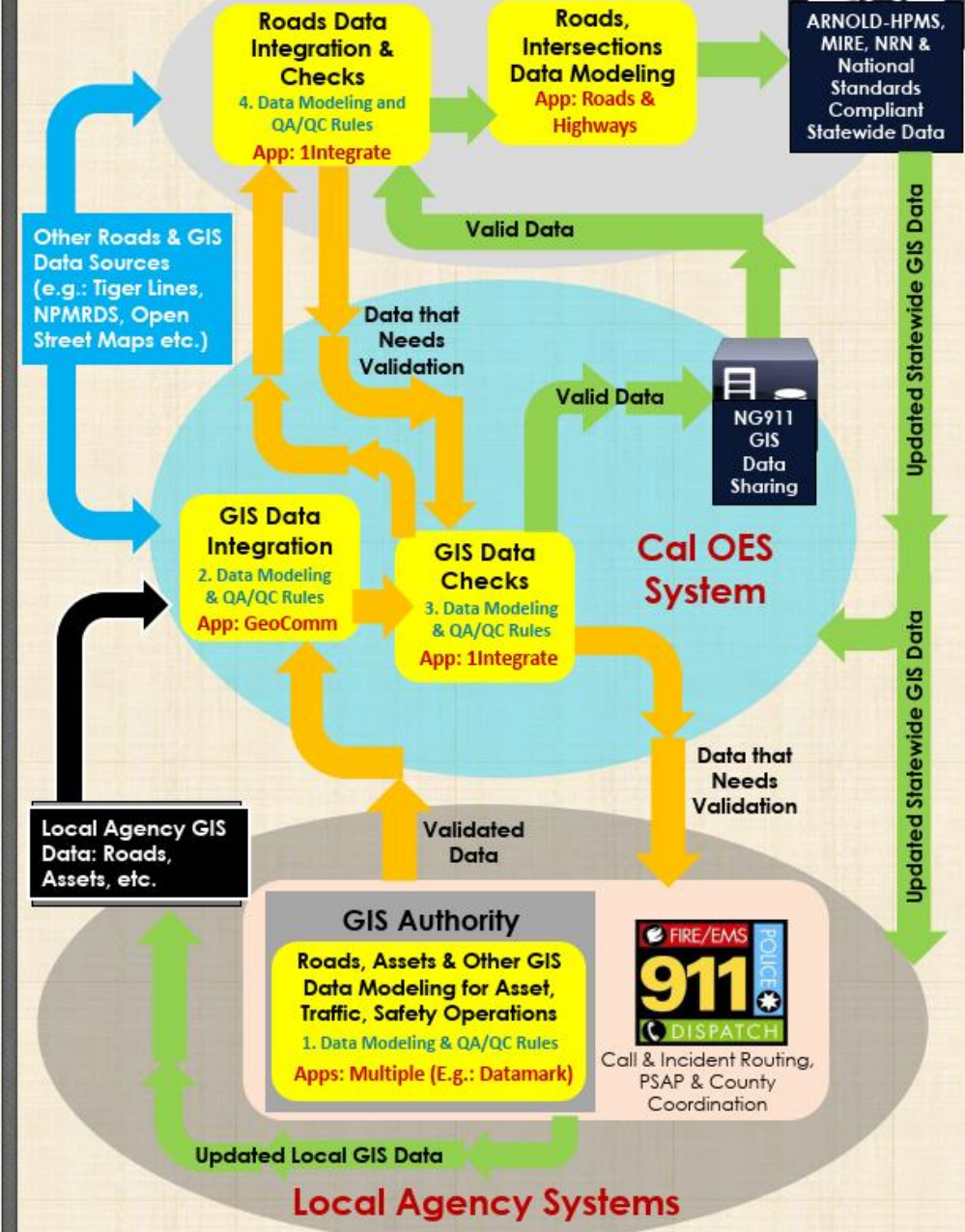- Roads, Intersections Data Modeling — App: Roads & Highways
- ARNOLD-HPMS, MIRE, NRN & National Standards Compliant Statewide Data

Other Roads & GIS Data Sources (e.g.: Tiger Lines, NPMRDS, Open Street Maps etc.)

Data that Needs Validation

Valid Data

Cal OES System

- GIS Data Integration — 2. Data Modeling & QA/QC Rules — App: GeoComm
- GIS Data Checks — 3. Data Modeling & QA/QC Rules — App: 1Integrate
- NG911 GIS Data Sharing

Updated Statewide GIS Data

Local Agency GIS Data: Roads, Assets, etc.

Validated Data

Data that Needs Validation

Local Agency Systems

- GIS Authority — Roads, Assets & Other GIS Data Modeling for Asset, Traffic, Safety Operations — 1. Data Modeling & QA/QC Rules — Apps: Multiple (E.g.: Datamark)
- FIRE/EMS 911 DISPATCH POLICE — Call & Incident Routing, PSAP & County Coordination

Updated Local GIS Data

Source: Abhishek Bhargava. Data Engineering and Architectures for Building Information Modeling in GIS (BIM-GIS).

Next Steps

- Form GIS Working Group for: California Road Sharing (CaRS)

- Review/Update CaRS Program Charter based on Stakeholder Inputs

- **Prioritize and Prepare Implementation Scope and Schedule**

- Conduct Pilots with Stakeholders to Finalize GIS Data & Applications Architecture

- Organize Workshops as part of FHWA-led AEGIST Pooled Fund Study (PFS)

- Deploy Envisioned Data and Applications Architecture

- Prepare Concept of Operations in terms of support to local agencies, data governance and data modeling