

# AASHTO Technology Implementation Group (TIG)

**FY 2007 AASHTO TIG Focus Technologies**

## **Linear Reference System (LRS)**

**Steve Kadolph – Iowa DOT**

**Jonathan (J.J.) DuChateau – Wisconsin DOT**

**Oscar Jarquin – California DOT**

**Eric Abrams – Iowa DOT**

# Technology Implementation Group

- AASHTO's TIG invests time and money to accelerate selected technology adoption by agencies nationwide.
- TIG's lead states team objective is to share information with AASHTO member agencies to improve the Nation's transportation system
- The LRS TIG objectives are
  - Knowledge and experience related to LRS implementation
  - Webinars to share experiences and educate others
  - Customized state visits
  - Iowa's LRS Maintenance Tool and system at no charge

# NCHRP 20-27 (2) LRS Model

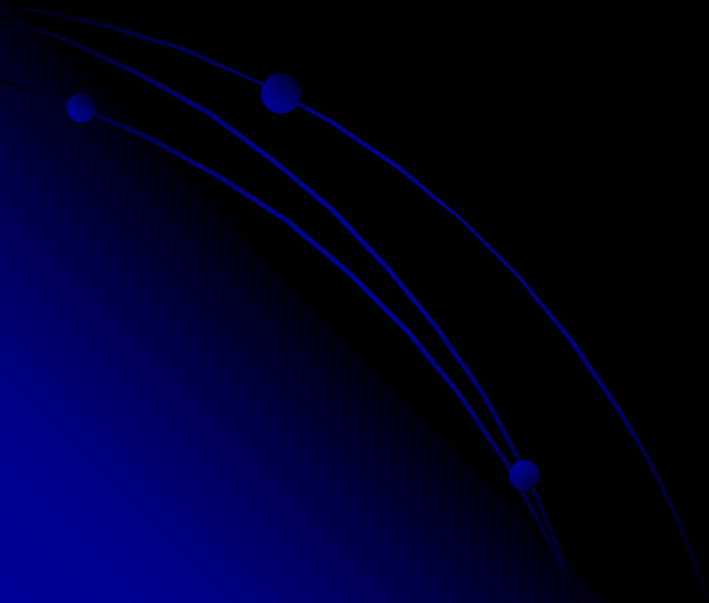
- Linear Referencing System Data Model
- Developed in response to the need to integrate linearly referenced data
- Includes
  - Multiple linear referencing methods (LRM)
  - Multiple cartographic representations
  - Multiple Network Representations
  - Multiple Route Names
- Business data integration is supported through transformations among methods, networks and cartographic representations by associating with a central linear datum

# What Does a 20-27 (2) System Contain

- Spatial representation of a transportation system
  - Accurate Centerline
  - Multiple Cartographic abstraction layers
- Datum most stable layer over time
- Network Layer
  - Links and Nodes that define the network
- LRM Location
  - Data required for those methods
  - Programs and interfaces to supply a LRS location to business data

# What Does a 20-27 (2) System Does Not Contain

Business data is separated from the 20-27 (2) model order to minimize the impact on existing business data



# Why Implement a 20-27 (2) Model

- Single source for transportation systems
- Navigable network
- As many LRMs, routes and cartographies as needed
- Minimizes changes to existing business data
- Can support needs of multiple business areas

# Marketing Plan for Linear Referencing System

- Assess LRS Needs and Contacts in Each State
- Develop PowerPoint Presentation, Brochure and Posters
- Develop Value Analysis Document (Contractor)
- Develop and Host Webinar(s)
- **Give Presentation and/or Workshop at TRB, GIST and AASHTO IS Conferences**
- Visit States Offering Invitation
- Assess LRS Level of Knowledge Transfer and Implementation Success
- Final Report

# TIG LRS Team Members

## ● Iowa Lead State

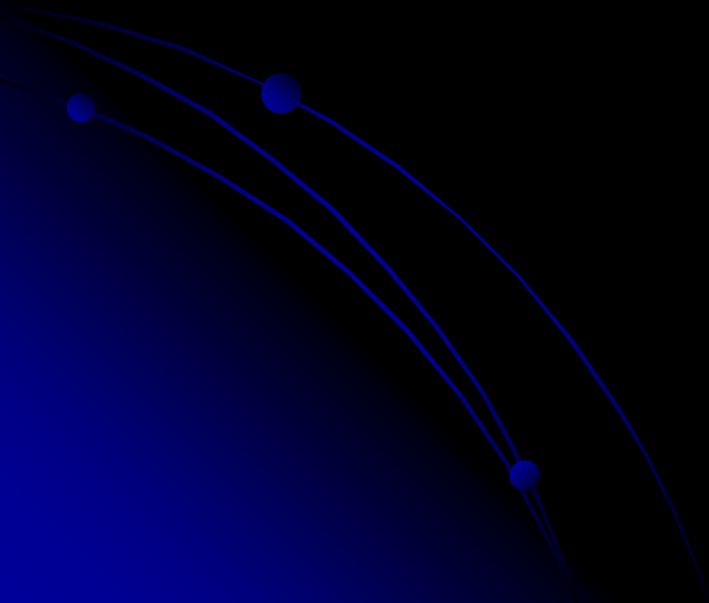
- Peggi Knight ( Team Leader)
- **Eric Abrams** (Gis Coordinator)
- Karen Carroll (LRS Manager)
- Mike Clement (QA LRS)
- **Steve Kadolph** (Technical Exp.)
- Ryan Wyllie (QA LRS)

## ● Other States

- David Blackstone (Ohio)
- **Jonathan (J.J.) DuChateau** (Wis)
- John Farley (N. Car.)
- **Oscar Jarquin** (Calif.)
- Thomas Martin (Minn.)

## ○ Non State

- Tim Bisch (Bentley Systems, Inc.)
- Dave Fletcher (Geographic Paradigm Computing, Inc. )
- Mark Sarmiento (FHWA)

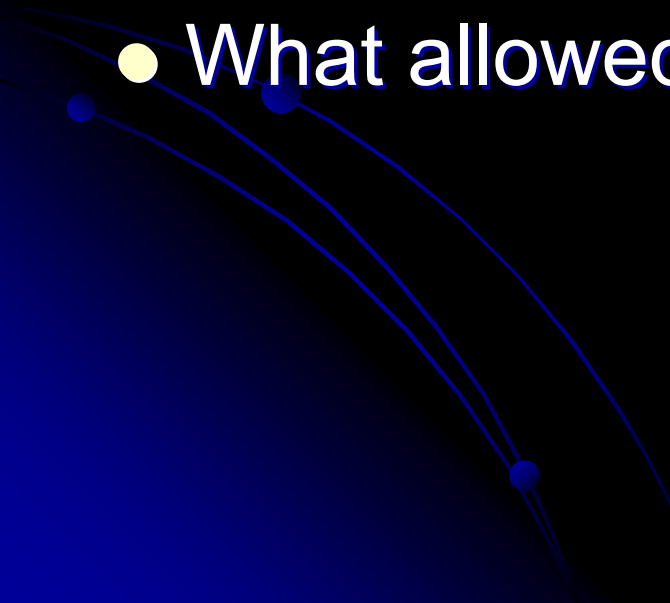






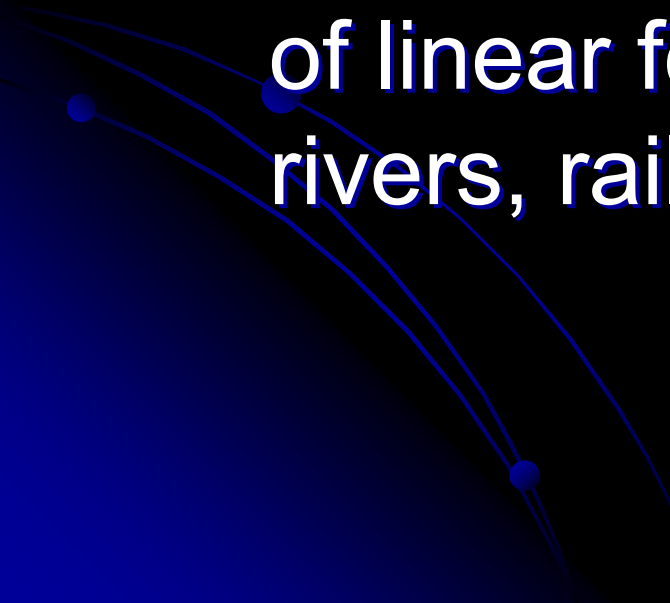
# Iowa's LRS Experience

# Agenda

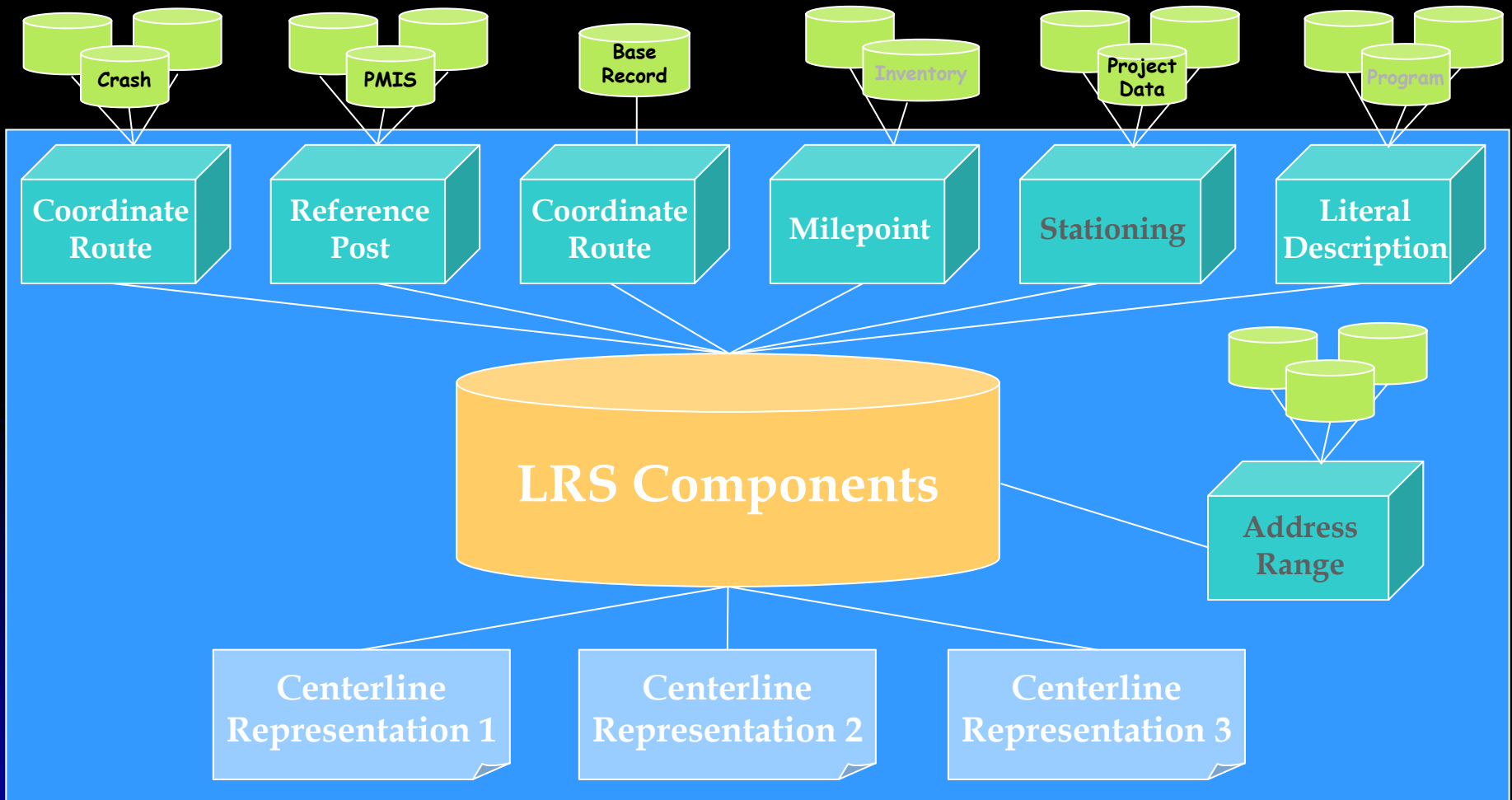
- What Iowa's LRS includes
  - What do the DOT's business units gain
  - What allowed Iowa to succeed
- 

# Iowa's LRS

Implementation of NCHRP 20-27 model. Which separates business data from the location components of linear features (roads, navigable rivers, railroads, pipelines, etc.).



# NCHRP 20-27 Model



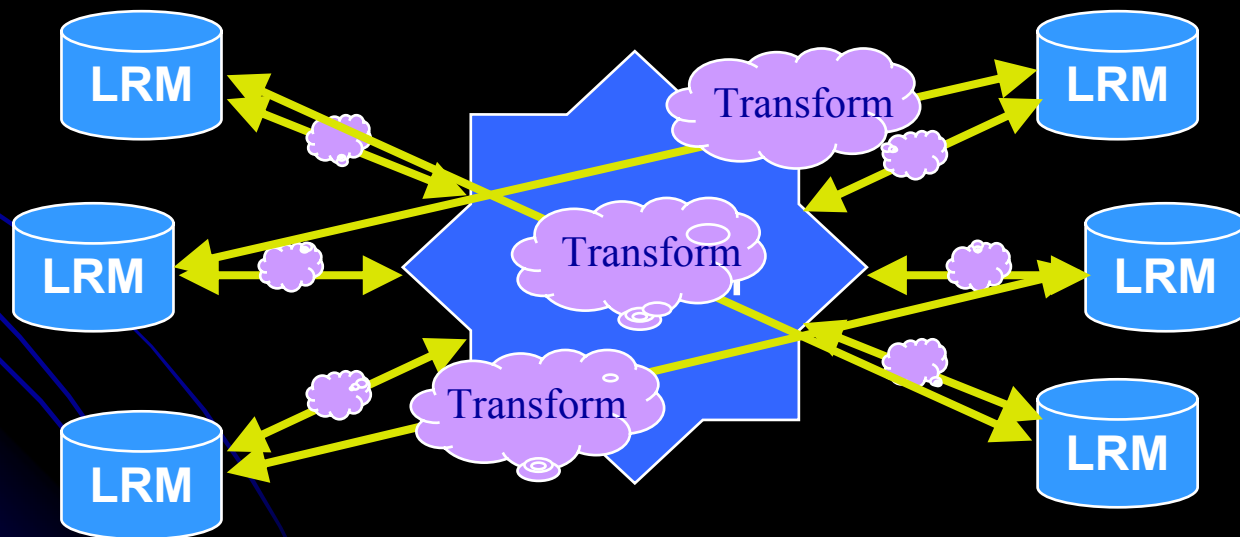
# LRS Components

(all public roads 114,000 miles)

- Cartography
  - Traveled Way Spatial
  - Roadway Spatial
- Datum (Anchor Sections & Points)
- Network (Transport Links & Nodes)
- Routes
  - Parsed Names
  - Paths
- LRM Components (i.e. Reference Post)

# Transformations between supported business location referencing methods (LRM)

A common linear description of the network that can relate all the methods.



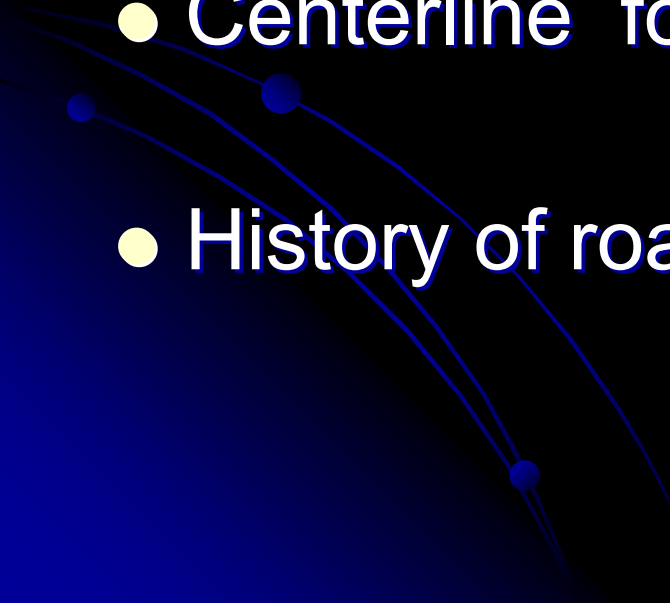
# How does LRS benefit the DOT

## Improved Accuracy

- Entire road system (all public roads) are created based upon same standard
- A separate abstraction layer call Roadway exist that provides a single representation of divided roadways
- The system is represented over time (from 1/1/2001)

# How does LRS benefit the DOT

## Central location of data

- Route names for all roadway systems
  - One navigable network
  - Centerline for all roads
  - History of road network
- 



# How does LRS benefit the DOT

## Clearly defined rules and practices

- LRM usage and results
  - Data staged has same location component
  - Processes and QC processes clearly defined
- Metadata for all LRS components
  - Source for centerlines identified and dated
  - Who owns LRS components known

# LRS how did Iowa succeed

- Business case for creation of LRS
  - Division Level Sponsors
  - Business data kept separate from location
  - Business unit ownership LRS
  - Active project management
- 

# Implementation Issues

- Time span (1998 2001-2009)
  - Digitize roads (2001-2005)
  - Develop maintenance tool (2003-2008)
  - Create LRS components (2004-2009)
- Cost to develop maintenance tool
  - Dollars
  - Multiple vendors

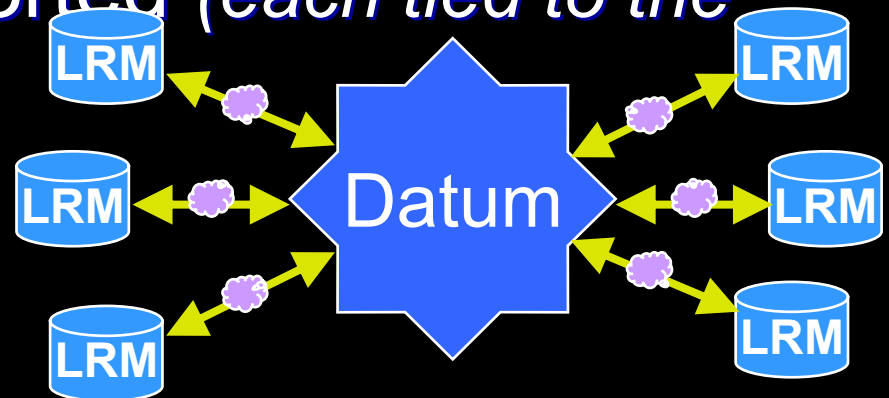


# Wisconsin's LRS Experience

# Wisconsin's LRS

## Similarities to Iowa

- Most concepts in Iowa's slides also apply to WI's implementation
- Separate business data components from LRS
- Linear Datum that serves as a LRS "hub"
- Multiple LRMs supported (*each tied to the Linear Datum*)



# Wisconsin's LRS

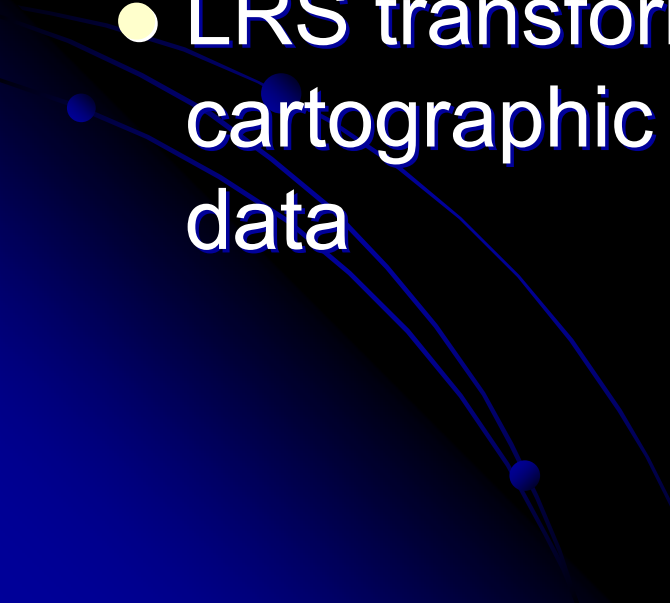
## Difference from Iowa

- WI's Linear Datum & Network are one and the same
- Built state roads (1993), then local roads later (2002)
- In-house solution (*mainly because commercial solutions didn't exist at this time*)
- Best practice to store Linear Datum location instead of LRM for business event data
- Iowa has put more emphasis on statistics for determining linear measurement accuracy

# Wisconsin's Experience

- 17 years production experience with these LRS concepts
- Design driven by Information Engineering principles
- LRS design was essentially a data modeling & normalization exercise
  - Results in many of the 20-27 concepts
- Allows management of one LRS component not to dictate management of another LRS component

# Wisconsin's Experience

- Designed so linear data processing can be done outside of GIS software
  - Only “GIS” layer required is a roadway centerline representation
  - LRS transformation processes to create cartographic representation of business data
- 



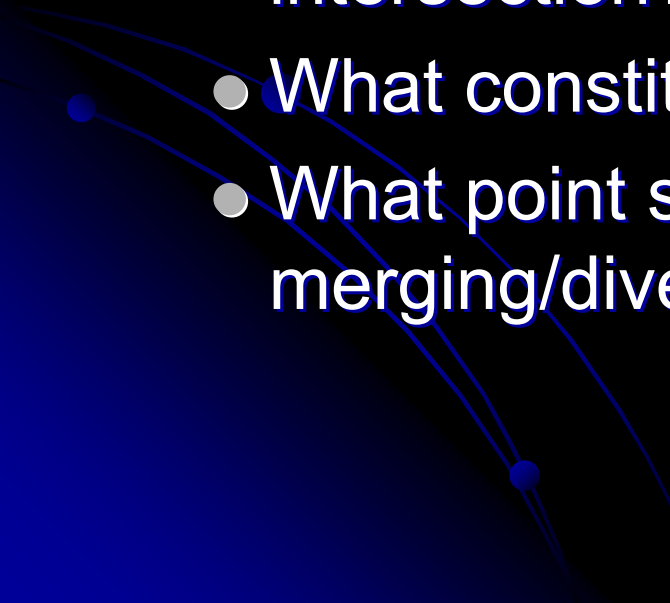
# Wisconsin's Experience

- Conceptual & design details are important to understand
  - Entity Definitions, Business Rules, Use Cases

Such as:

- What is a “road”?
- Where does a route start/end?
- What events cause birth/death of a LRS object?

# Wisconsin's Experience

- Implementation considerations for LRS entities need to be weighed
    - Is each linear location uniquely described?
    - How many nodes should represent an intersection?
    - What constitutes a divided roadway?
    - What point should be used for merging/diverging roadways?
- 

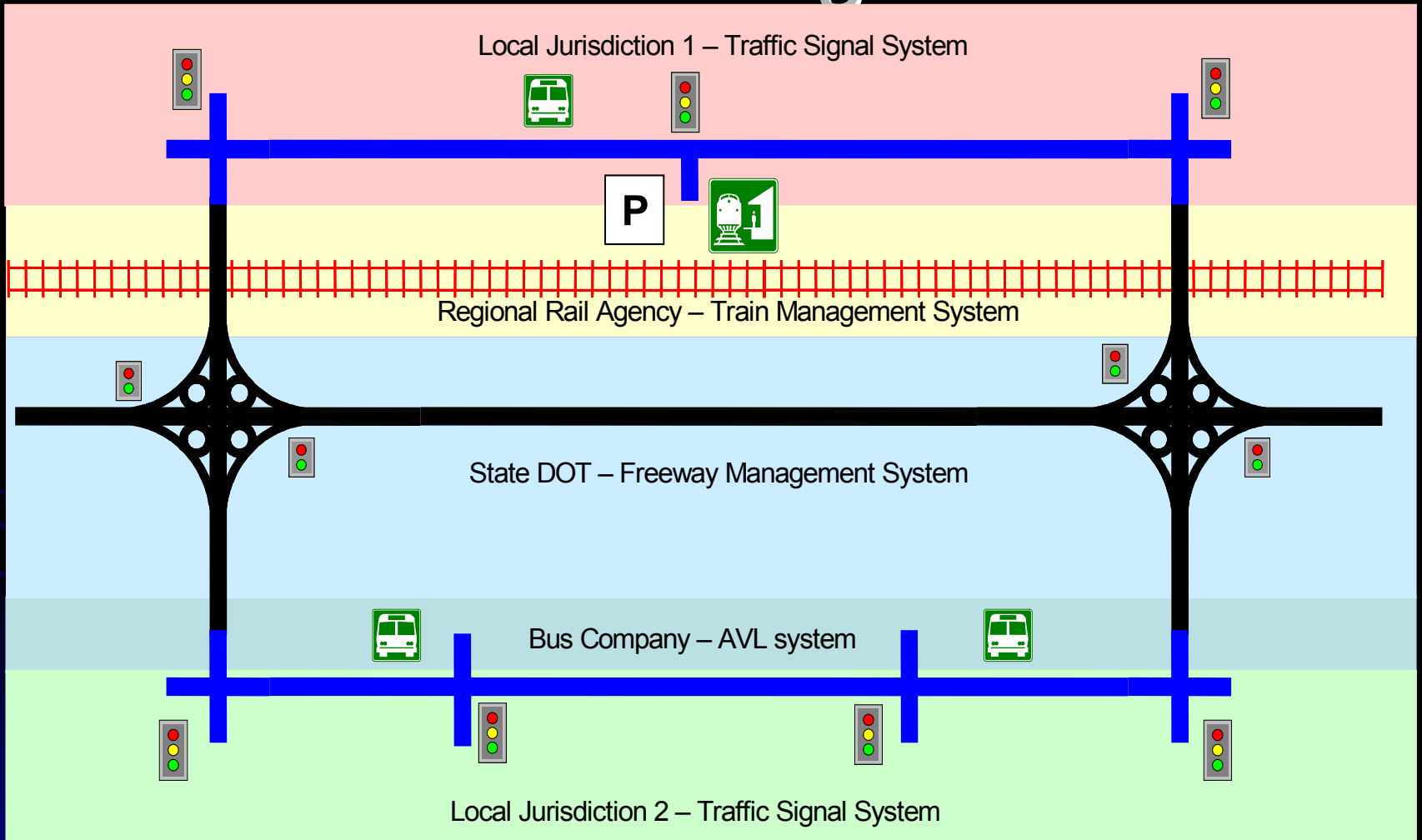
# Wisconsin's Experience

- Additional LRS functionality considerations  
*(Some things not explicitly mentioned in 20-27)*
  - Ability to associate still valid portions of old Anchor Sections to its replacement(s)
  - Ability to associate opposite direction Anchor Sections
- The temporal aspect of this data is much harder than it seems

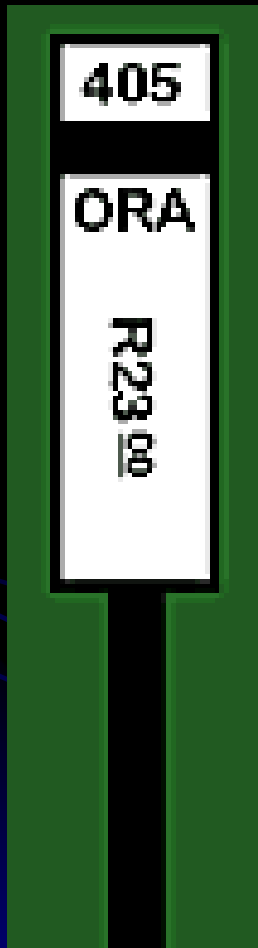
A 3D map of California in a vibrant orange-red color, set against a black background. The map is rendered with a slight perspective, giving it a three-dimensional appearance. Overlaid on the map is the text "California's LRS Experience" in a clean, white, sans-serif font. In the bottom-left corner, there are decorative blue curved lines and small circular nodes, suggesting a digital or technological theme.

# California's LRS Experience

# California Business Driver... Corridor Management



# Multiple LRM's



County	Route	Postmile
ORA	405	R 23.000

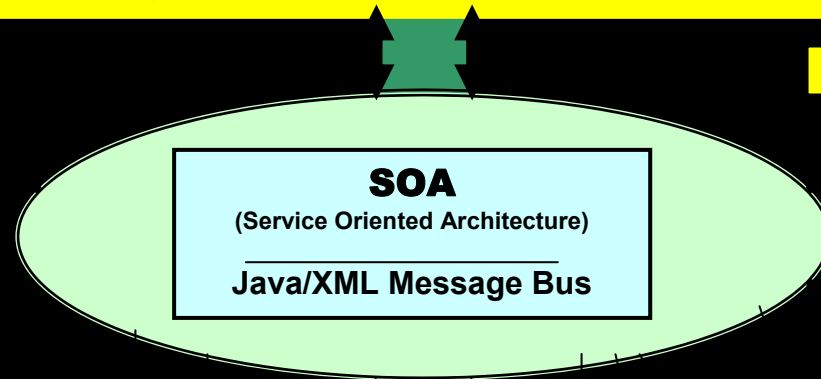
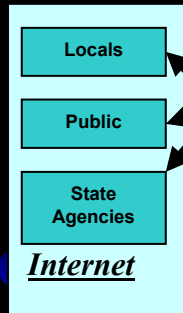
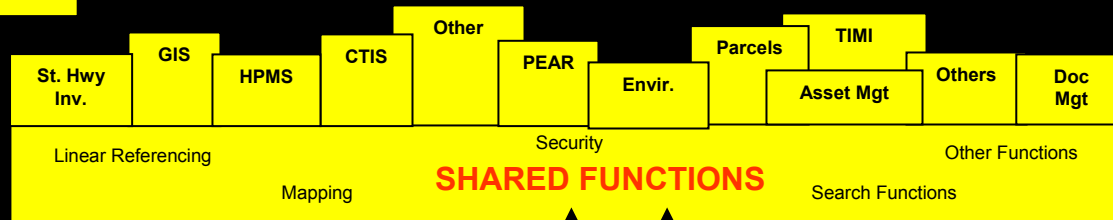
County	Route	KiloPost
ORA	405	R 33.877

●	Ventura BI OH	
●	Bridge 00-0000	
●	405 LA	32 <u>48</u>



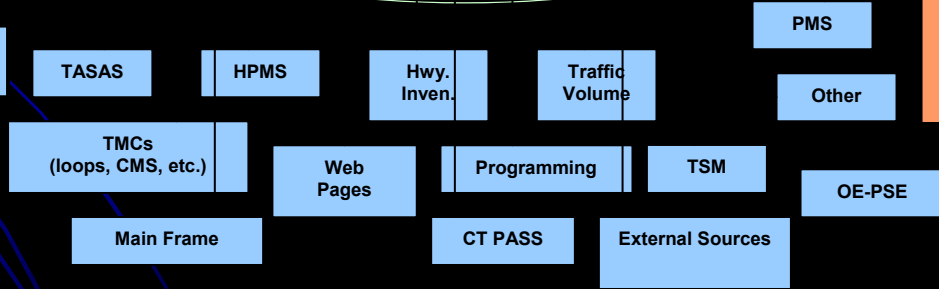
# Service Oriented Architecture (SOA)

## Applications

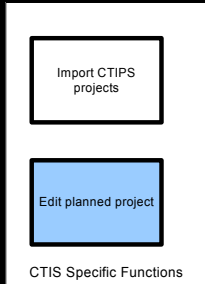


**SOA output via GIS =** Planning, PID, Design, Proj. Mgt., Constr., Operations, etc. for system performance, geometrics, etc.

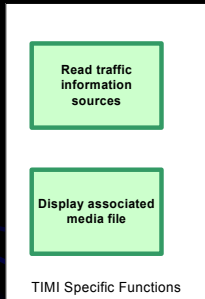
## Data Files



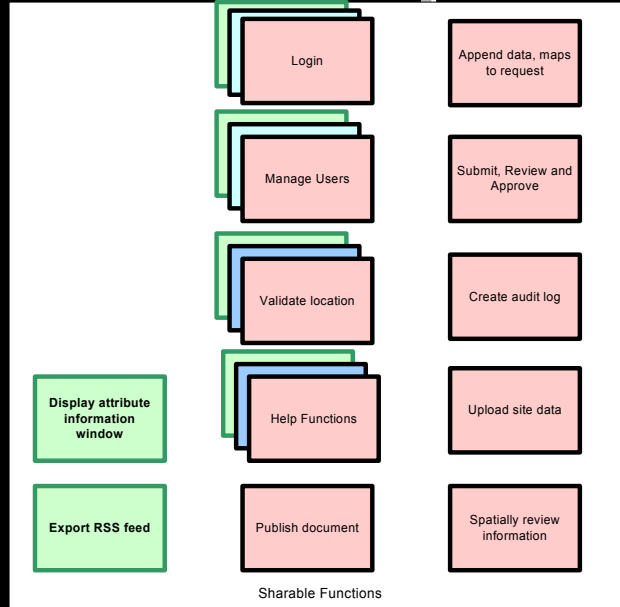
# Identifying Common SOA Components



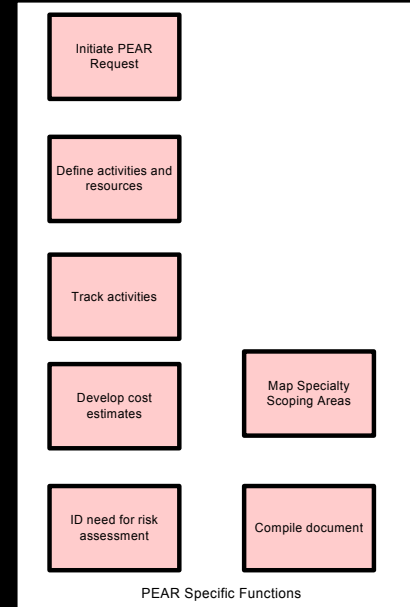
CTIS Specific Functions



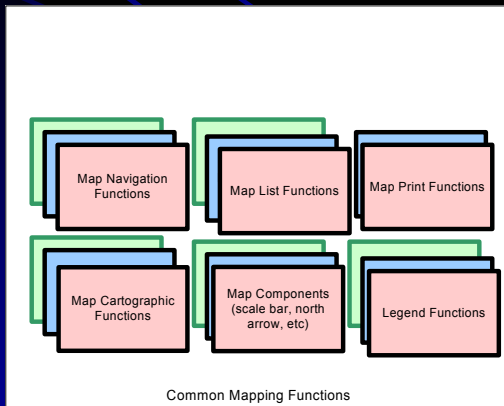
TIMI Specific Functions



Sharable Functions



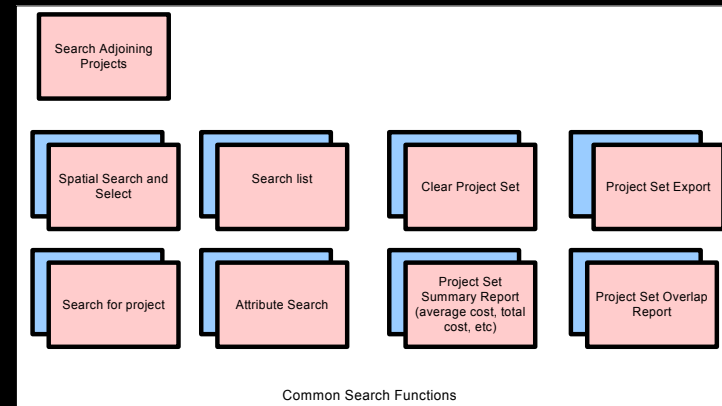
PEAR Specific Functions



Common Mapping Functions



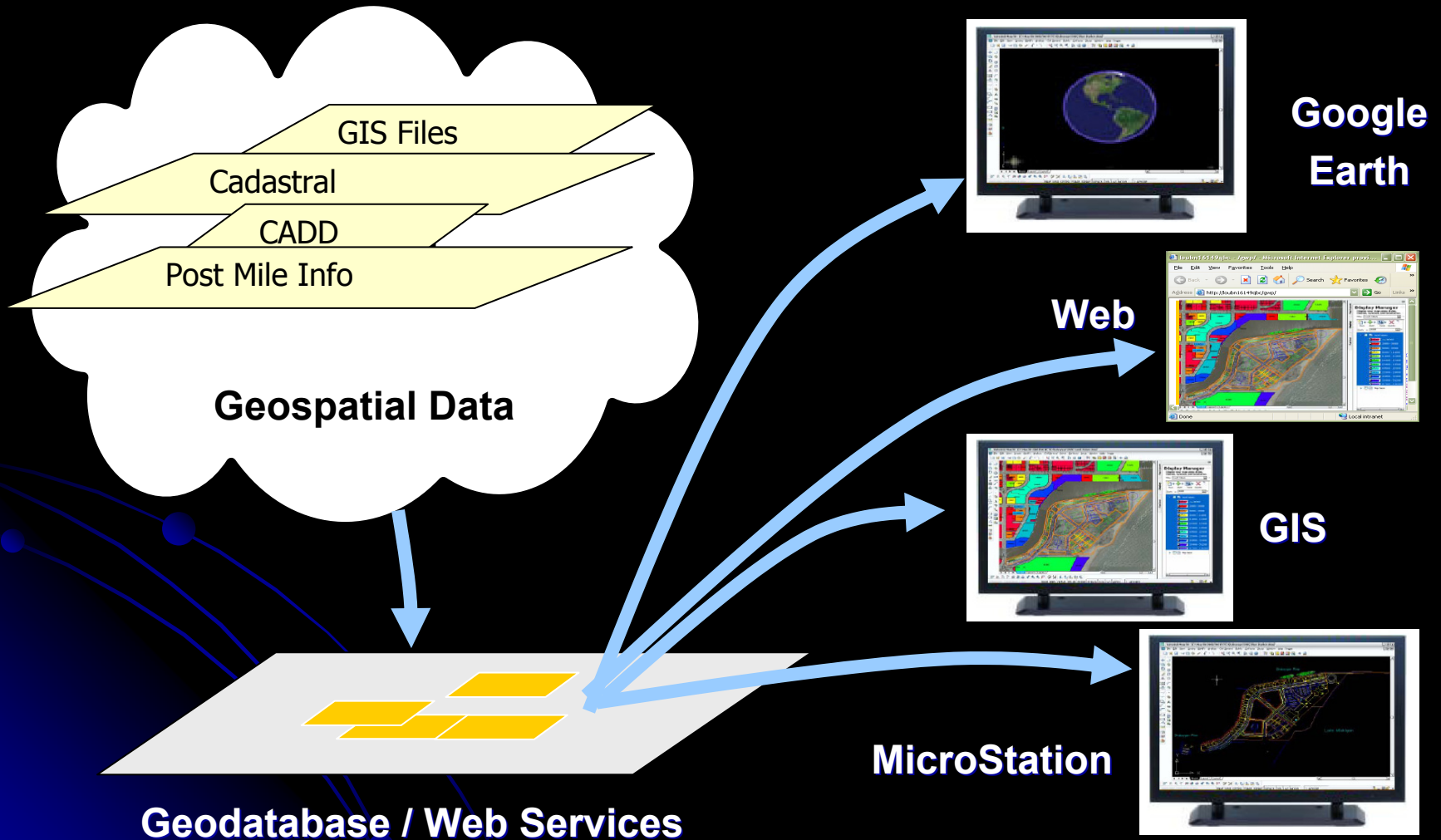
Common Metadata Functions



Common Search Functions



# Geospatial Data Management



# Postmile Lookup Tool

Office of **GIS** Postmile Services [Back to Tools](#) [OGIS Home](#)

**Validate PM Point** **Validate PM Line** **Find PM** **Convert Lat/Long to PM**

County1  Route  Postmile1   
County2  Postmile2

**Route 80**  
County Postmile:  
**YOL 7.863/YOL 9**  
Statewide Postmile:  
**80.05/81.187**

Map Satellite Hybrid

Map data ©2009 Maponics, Tele Atlas - [Terms of Use](#)

# ArcGIS Tool Bar

Untitled - ArcMap - ArcInfo

File Edit View Insert Selection Tools Window Help

1:380,937

Options

Layers

- State Highway Geodatabase

Postmile Validation Wizard

FID	Shape	Id	DYNSEGPM	PMSTATUS	RT	SEG	CO	PM	SPE
0	-	0	MAD 49 0 / MAD 49 8.921	Valid	049	40	MAD	000.000/008.921	40
1	-	0	MAD 49 8.921 / MAD 49 9.275	Valid	049	40	MAD	008.921/009.275	60
2	-	0	MPA 49 0.332 / MPA 49 2.868	Valid	049	480	MPA	000.332/002.868	65
3	-	0	MPA 49 2.868 / MPA 49 3.681	Valid	049	600	MPA	002.868/003.681	65
4	-	0	MPA 49 3.681 / MPA 49 8.795	Valid	049	699	MPA	003.681/008.795	65
5	-	0	MPA 49 8.795 / MPA 49 13.852	Valid	049	1799	MPA	008.795/013.852	65
6	-	0	MPA 49 13.852 / MPA 49 15.576	Valid	049	1799	MPA	013.852/015.576	45
7	-	0	MPA 49 16.616 / MPA 49 18.5	Valid	049	3470	MPA	016.616/018.500	60
8	-	0	MPA 49 18.51 / MPA 49 19.611	Valid	049	3905	MPA	018.510/019.611	40
9	-	0	MPA 49 19.611 / MPA 49 29.12	Valid	049	3905	MPA	019.611/029.120	65
10	-	0	MPA 49 29.12 / MPA 49 29.42	Valid	049	3905	MPA	029.120/029.420	30
11	-	0	MPA 49 29.42 / MPA 49 29.57	Valid	049	3905	MPA	029.420/029.570	65
12	-	0	MPA 49 29.57 / MPA 49 34.203	Valid	049	3905	MPA	029.570/034.203	35
21	-	0	TUO 49 6.382 / TUO 49 6.468	Error - Validation	049	7920	TUO	006.382/006.468	55
22	-	0	TUO 49 8.779 / TUO 49 12.279	Error - Validation	049	8500	TUO	008.779/012.279	60
23	-	0	TUO 49 11.587 / TUO 49 13.519	Valid	049	8800	TUO	011.587/013.519	60
24	-	0	TUO 49 13.519 / TUO 49 13.82	Valid	049	8800	TUO	013.519/013.820	55
25	-	0	TUO 49 13.82 / TUO 49 15.2	Valid	049	8800	TUO	013.820/015.200	45

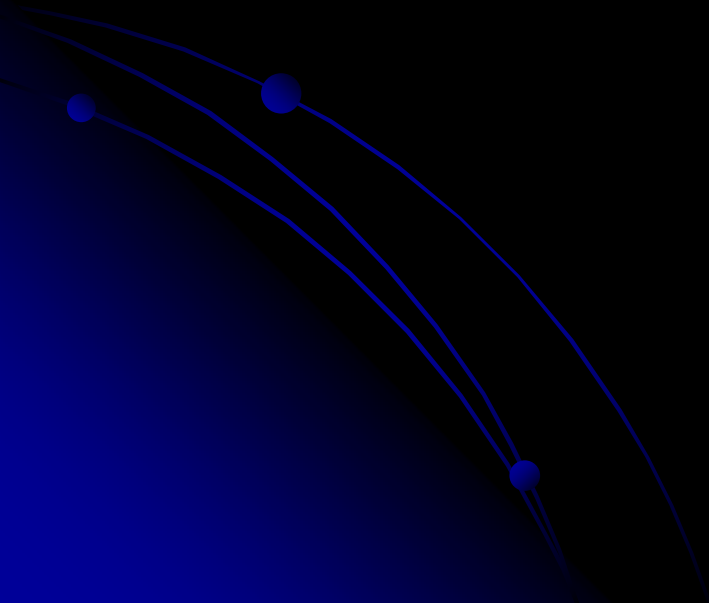
Create Geometry ReValidate Help

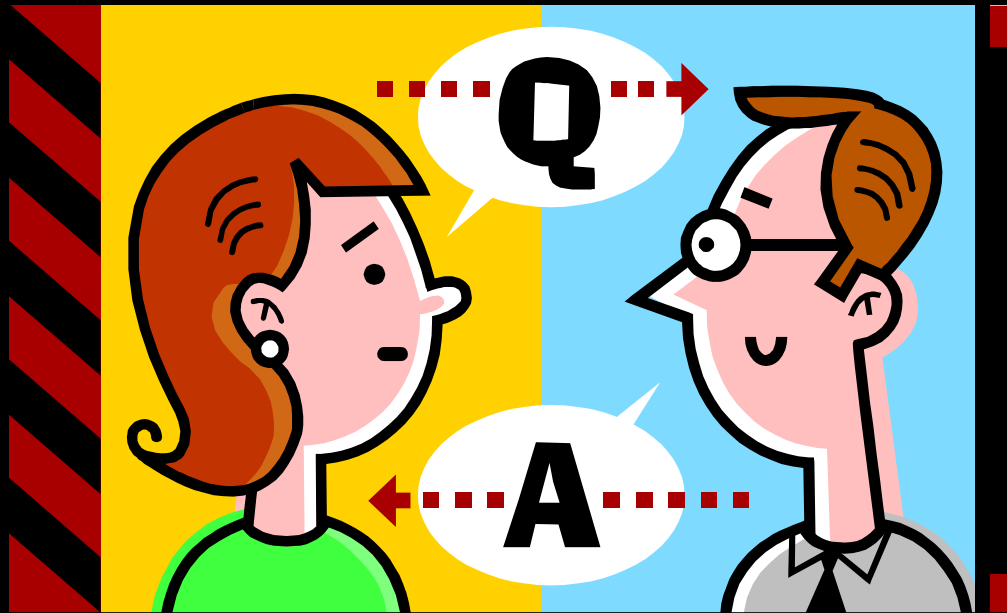
Warnings and Errors: Candidates: Replace Replace All

C:\Wy Example Project\output files\speed\_limits\_049\_Events.shp 27 Errors 0 Warnings 149 Records

# Questions

- State Name and who you represent
- Ask question to the panel





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- Knowledge and experience related to LRS implementation
- Webinars to share experiences and educate others
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