

Transportation GIS

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GeoDecisions

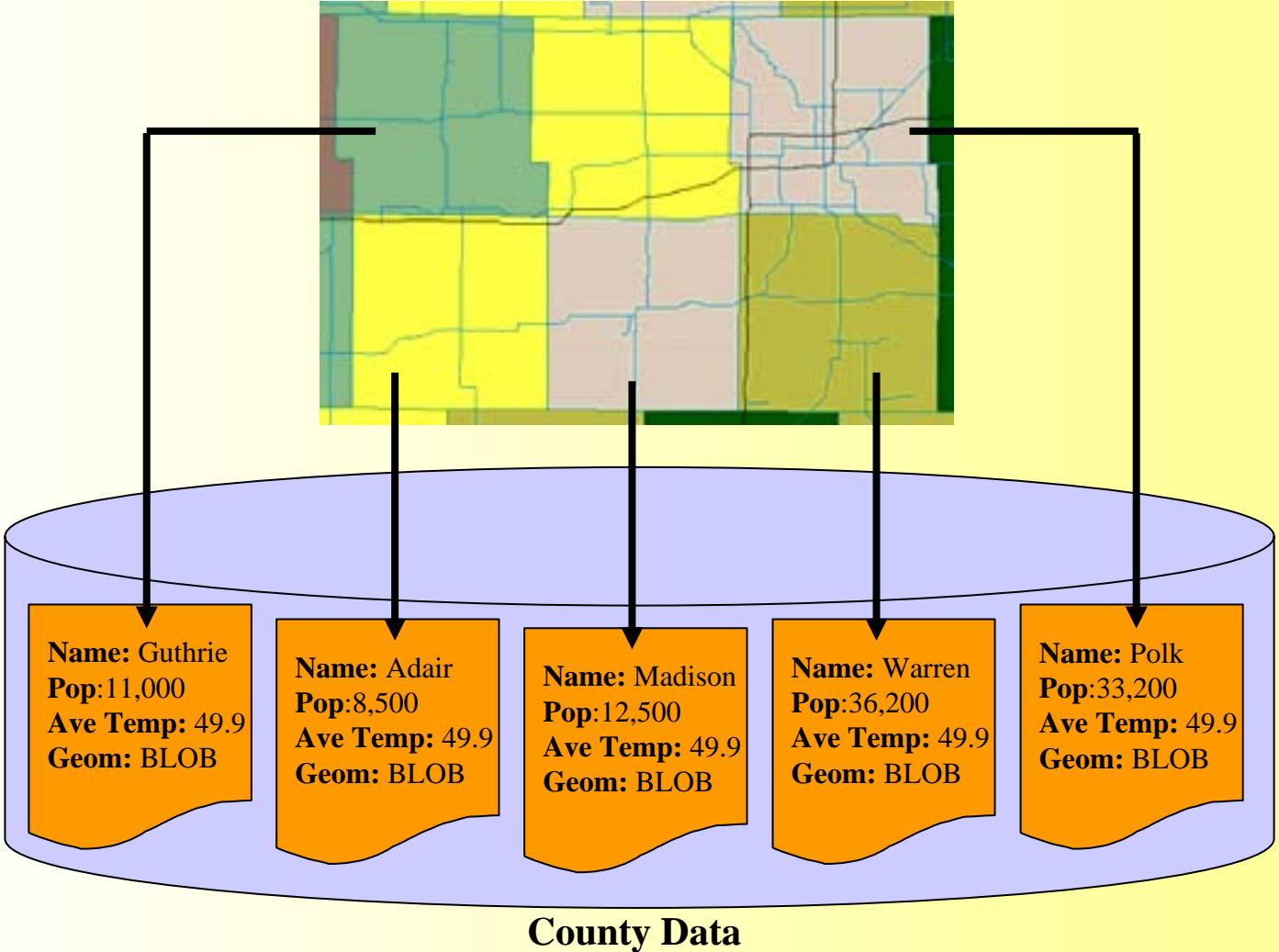


Session Agenda

- Transportation GIS
 - GIS Fundamentals (just to set the stage)
 - How is Transportation GIS different
 - Linear Modeling
 - Linear Analysis
- Practical uses of linear GIS
 - Decision Support
 - Transportation Logistics

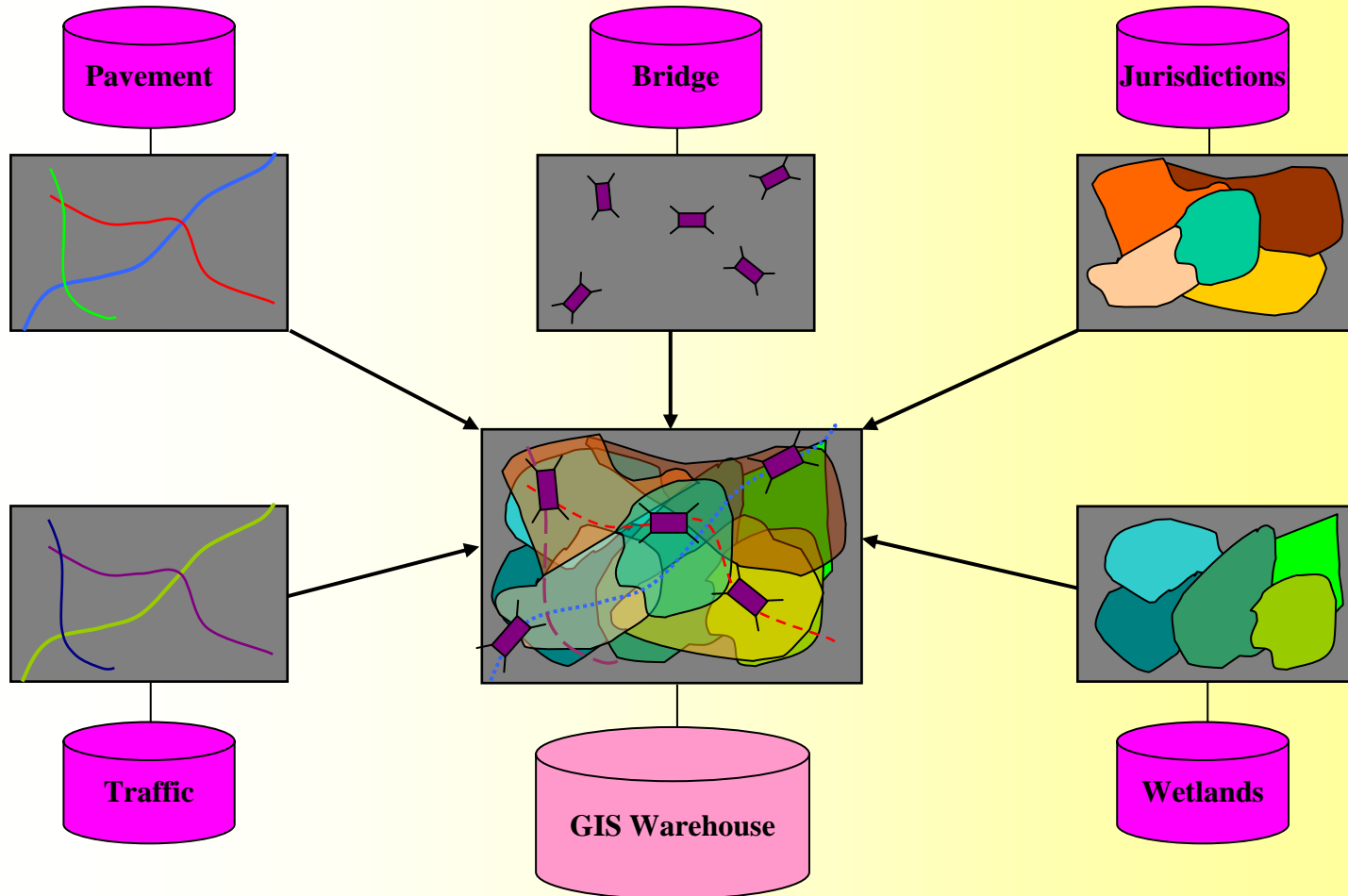
GIS Fundamentals

Data Relationship with Map



GIS Fundamentals

Using Location as an Integrating Attribute



GIS Fundamentals

Using Location as an Integrating Attribute

- Polygonal analysis is standard in GIS
 - Transform between coordinate systems
 - Polygonal overlay (contains, overlap)
 - Within distance (all wells within 25ft of contaminant)
 - Display in a map (2-D analysis and display)
- Linear analysis is custom/add-on in GIS
 - Transform between linear location methods
 - Linear overlay (intersect, union, difference)
 - Display in a map (1-D analysis, 2-D display)
 - Network analysis (link-node analysis of paths)

Linear Modeling

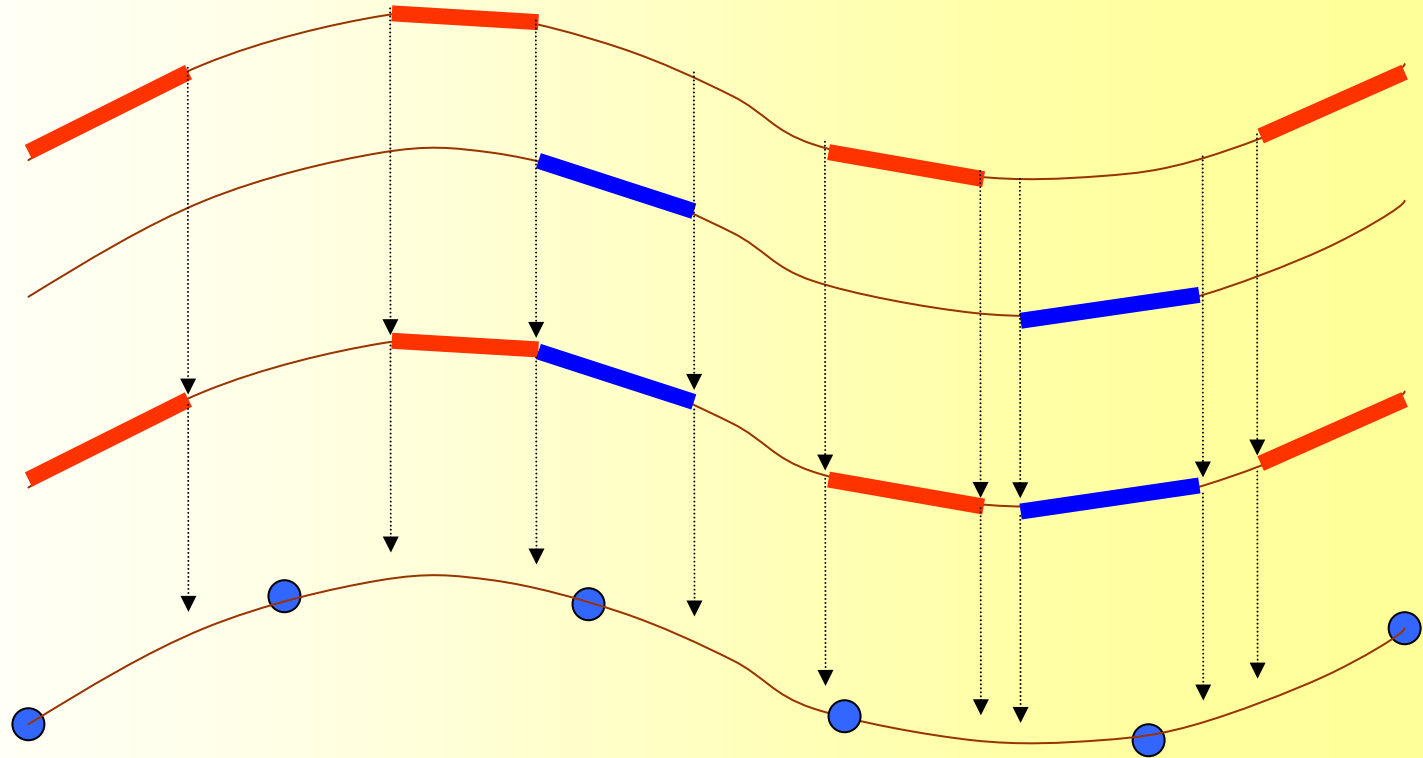
Special Problems in Linear GIS

Business Data A

Business Data B

Integrated
Business Data

Cartographic
Representation



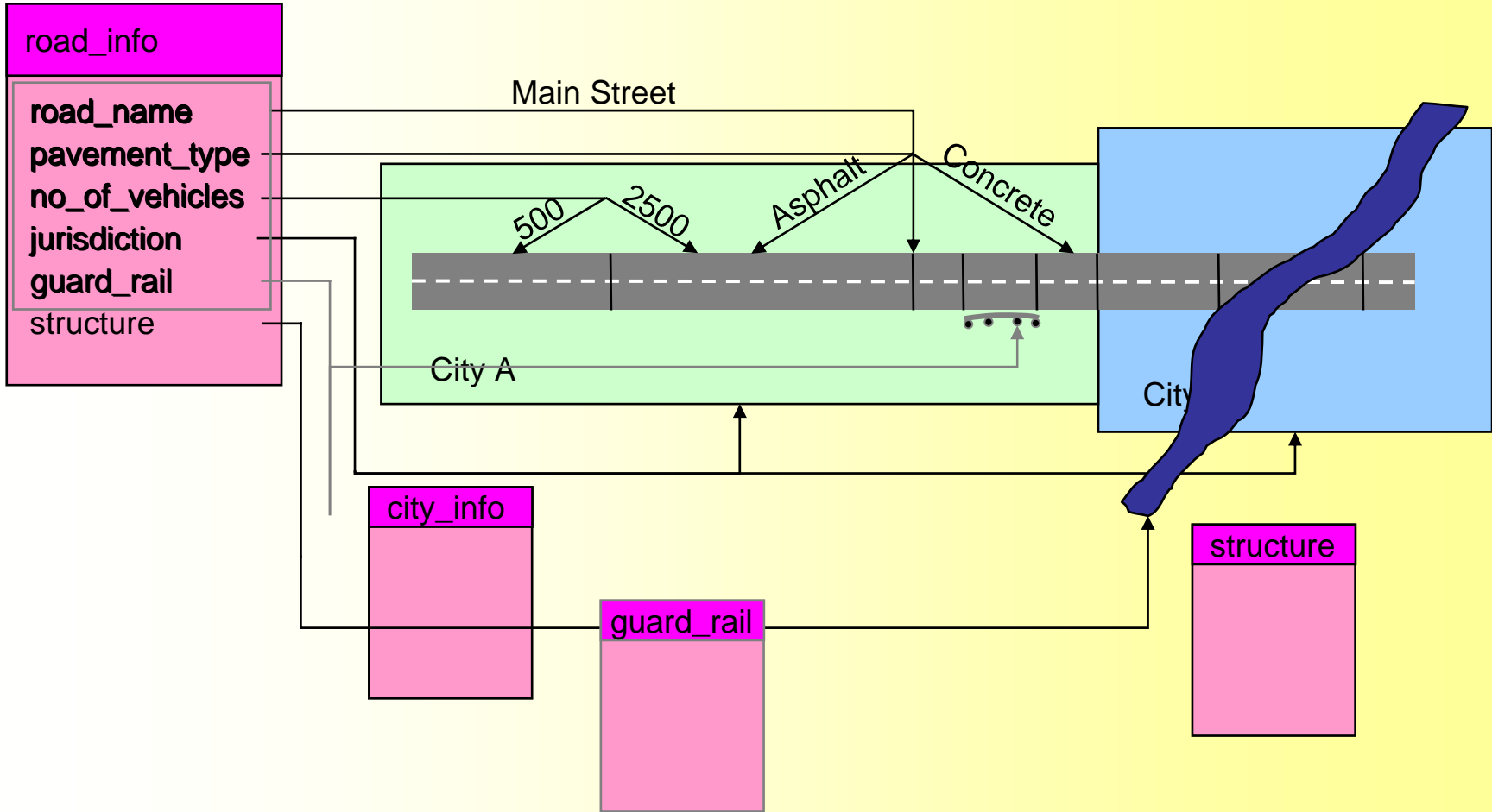
Linear Modeling

Different Approaches

- Fixed length segments
 - All segments the same length
 - Must summarize data & very redundant
- Variable length segments
 - Segment determined by unique sections
 - Some summarization & redundancy
- No segments / dynamic segmentation
 - Minimizes redundancy
 - More database tables

Linear Modeling

Variable Segment Length



Linear Modeling

Variable Length Segments - Iowa DOT Example

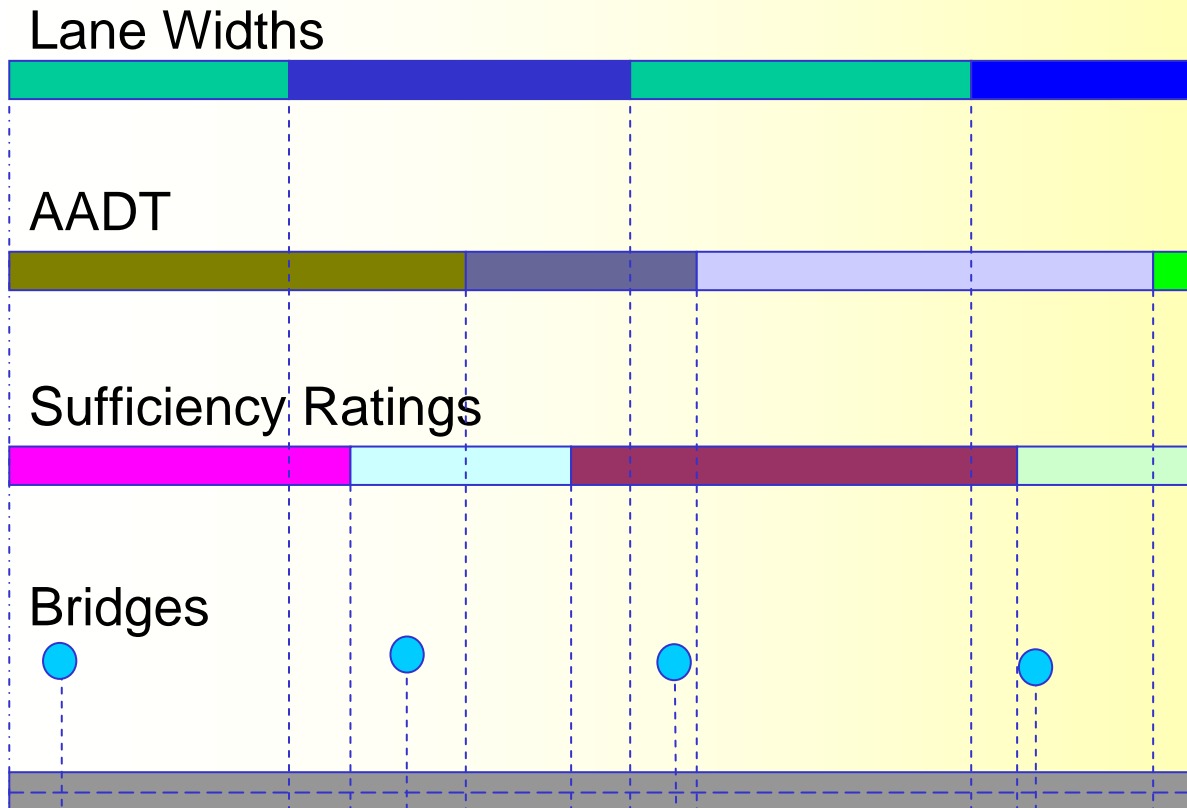
The screenshot displays the MicroStation software interface for a project named 'b1218069.dgn (2D)'. The main window shows a road network with a cyan centerline and magenta vertices. A dialog box titled 'b1218069 - Create & Update Centerline' is open, showing the following attributes:

Attribute	Value
County Number	25
Jurisdiction	1
System	2
Status	0
State Route Prefix	0
Route	0169
Seg Sequence	0520
911 Address	
Township	81
Range	27
Section	29
Road Number	0

The dialog box also includes a 'Review Attribute' dropdown menu and buttons for 'Line Work', 'Change', 'Vertex', and 'Search'. The status bar at the bottom indicates 'Level = 1' and 'Get Attributes > Data point on Element to Get Attribu'.

Linear Modeling

Dynamic Segmentation Approach



- Data are maintained in individual tables, limiting data redundancy
- Attributes describe varying extents along a section of roadway
- Graphic representations of attribute data are generated “on the fly”

Definitions

Fundamental Definitions

- **LRS - Linear Referencing System**
 - A set of procedures and methods for specifying a location as a distance, or offset, along a linear feature, from a point with known location.
 - A LRS can relate a linear location (1D) to a spatial (2D) location through a centerline representation of the roadway.
- **LRM - Linear Referencing Method**
 - Different methods of measuring locations (i.e. milepost, literal descriptions, stations, address ranges, etc.).
 - A LRM is part of the LRS.

Linear Referencing Methods

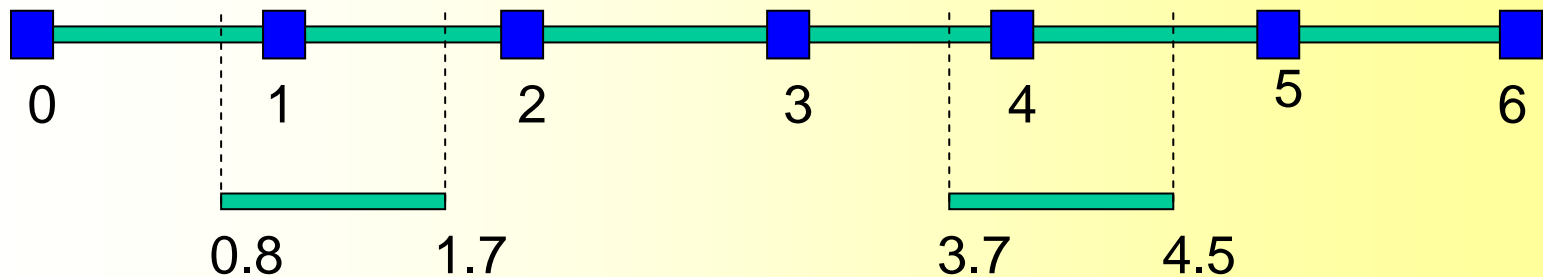
Various LRMs Used

- Distance Measure
 - Milepoint
 - Log mile
- Reference Marker
 - Mile post
 - Node/offset
- Control Segment
 - Project stationing
 - City block
 - Pavement section

Linear Referencing Methods

Basic Distance Measure

Route 0023

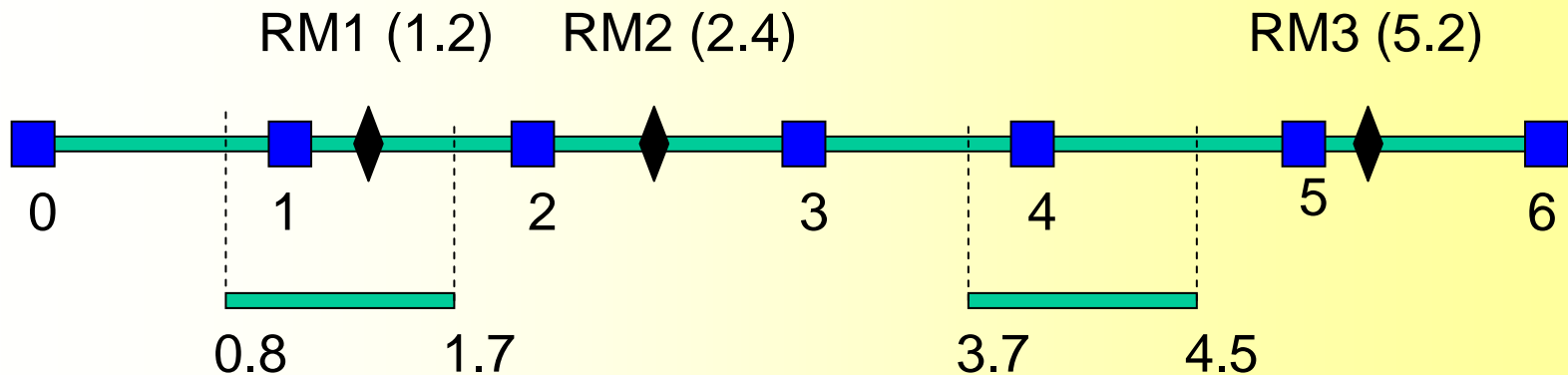


ROUTE_ID	BEGIN_DISTANCE	BEGIN_SECID	END_DISTANCE	END_SECID	ATTRIBUTES
0023	0.8		1.7		...
0023	3.7		4.5		...

Linear Referencing Methods

Example LRM - Reference Marker Offsets

Route 0023



ROUTE_ID	BEGIN_MARKER	BEGIN_OFFSET	BEGIN_SECID	END_MARKER	END_OFFSET	END_SECID	ATTRIBUTES
0023	RM1	-0.4		RM1	0.5		...
0023	RM2	1.3		RM3	-0.7		...

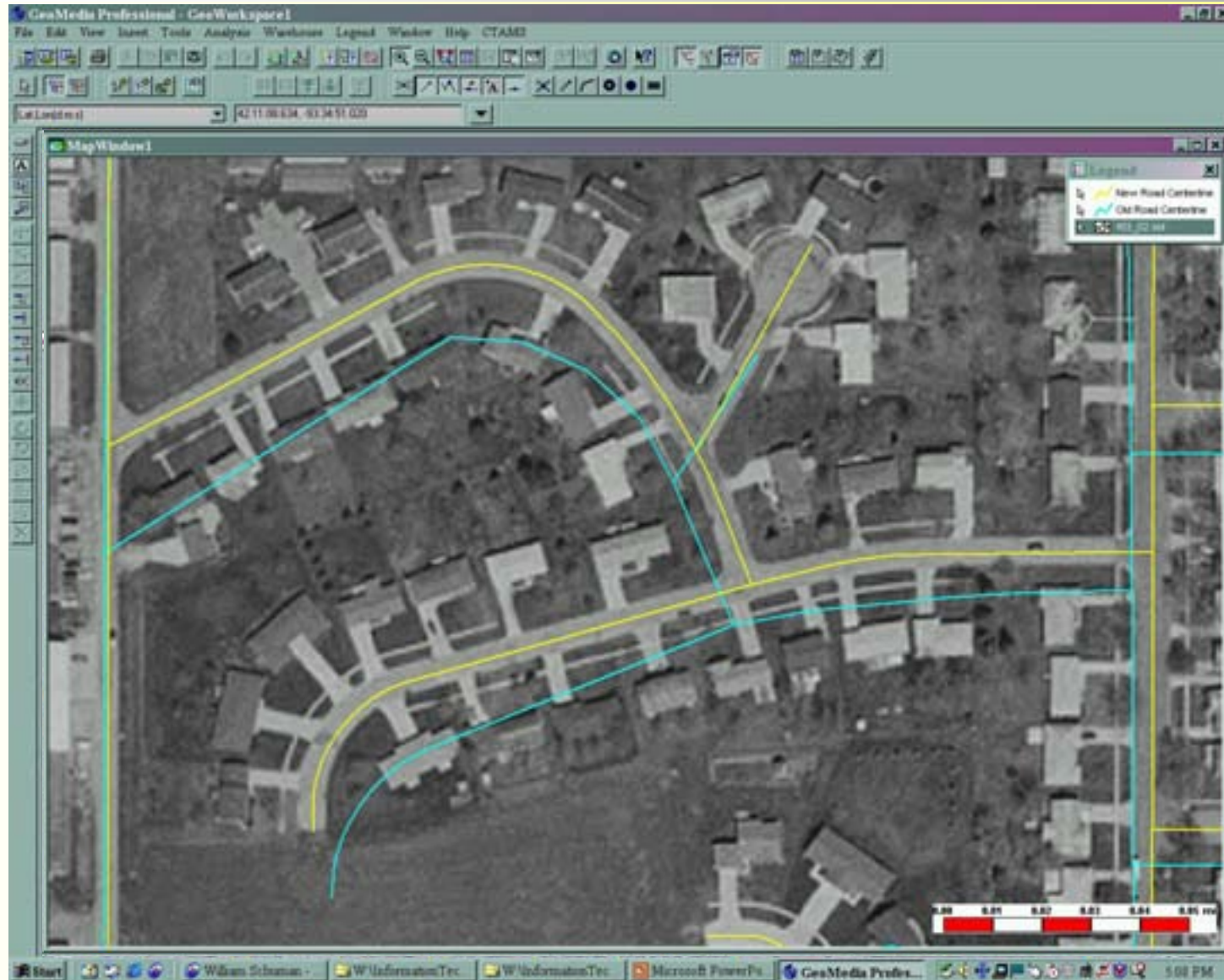
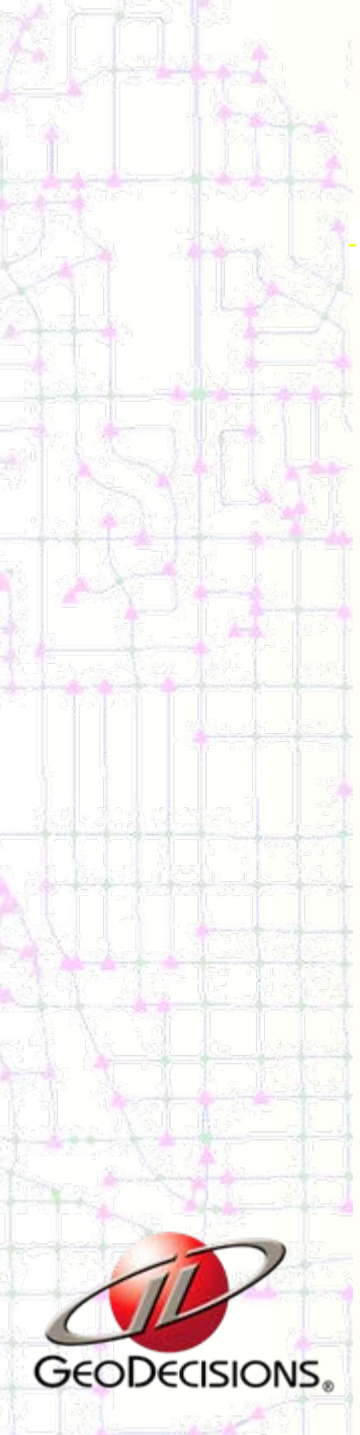
Linear Referencing Methods

LRMs with a 2D component

- Coordinate only
 - Cannot ensure event links to correct road centerline
 - Variable accuracies between road centerline and point measurement problematic
- Route and coordinates
 - Allows a coordinate to identify a viable road centerline
 - Reduces mismatches at complex intersections or interchanges

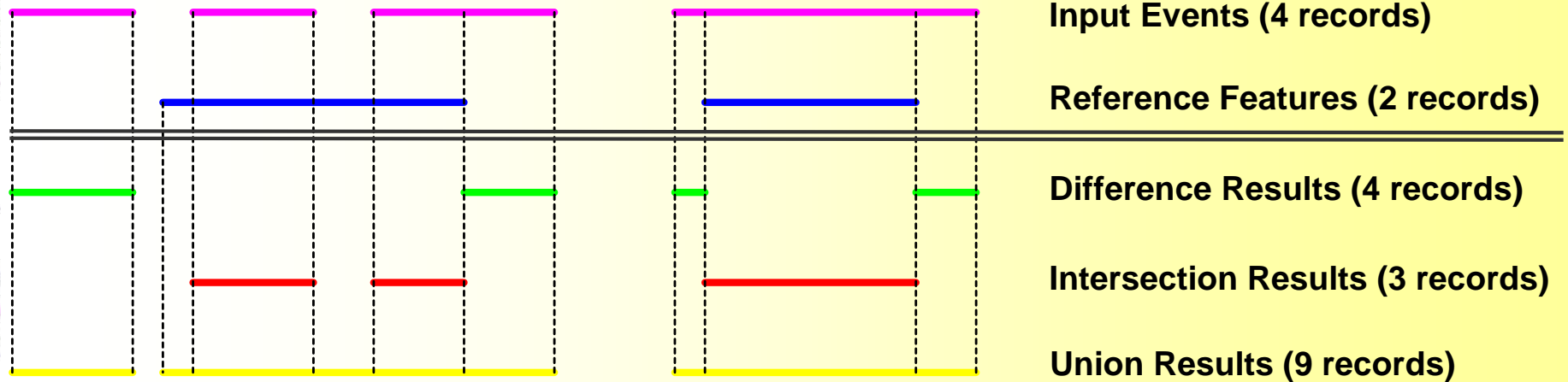
Positional Accuracy

Importance of Accuracy Improvement



Linear Analysis

Linear Integration (Overlay) Requirements



Linear Analysis

Dynamic Segmentation Analysis

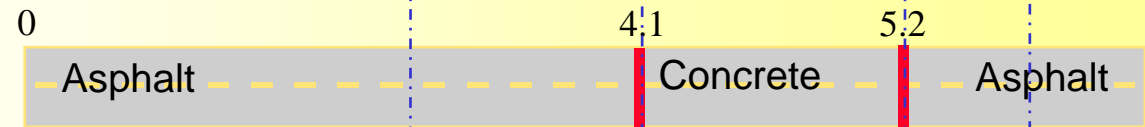
Speed Limit



AADT Values



Pavement Type



Friction



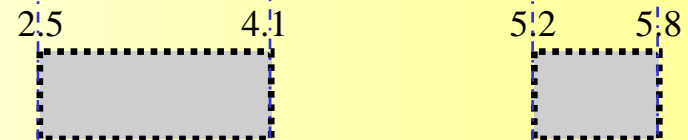
Linear Query Results

where: Speed => 45

AADT < 25000

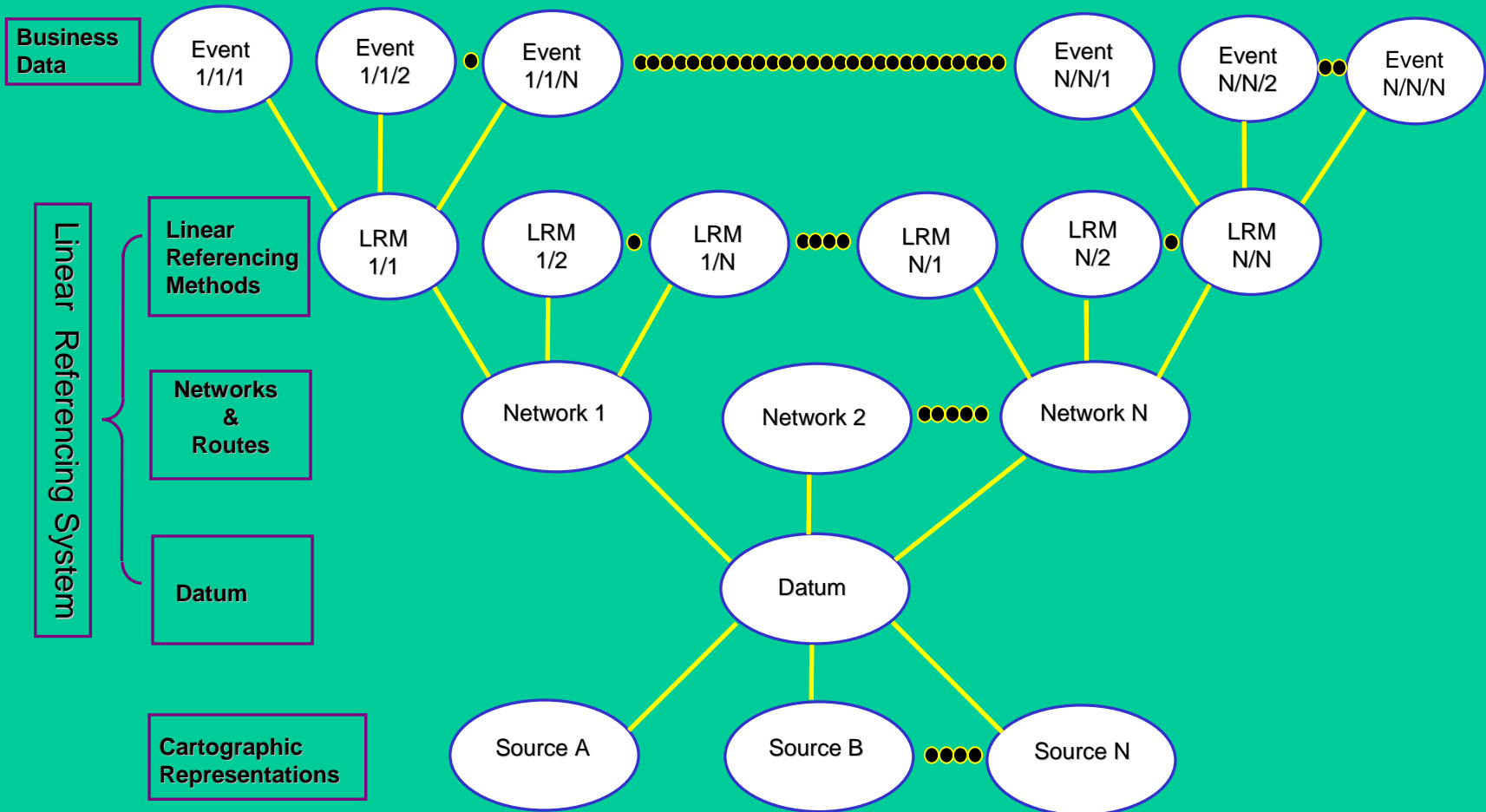
Pavement = Asphalt

Friction =< 30

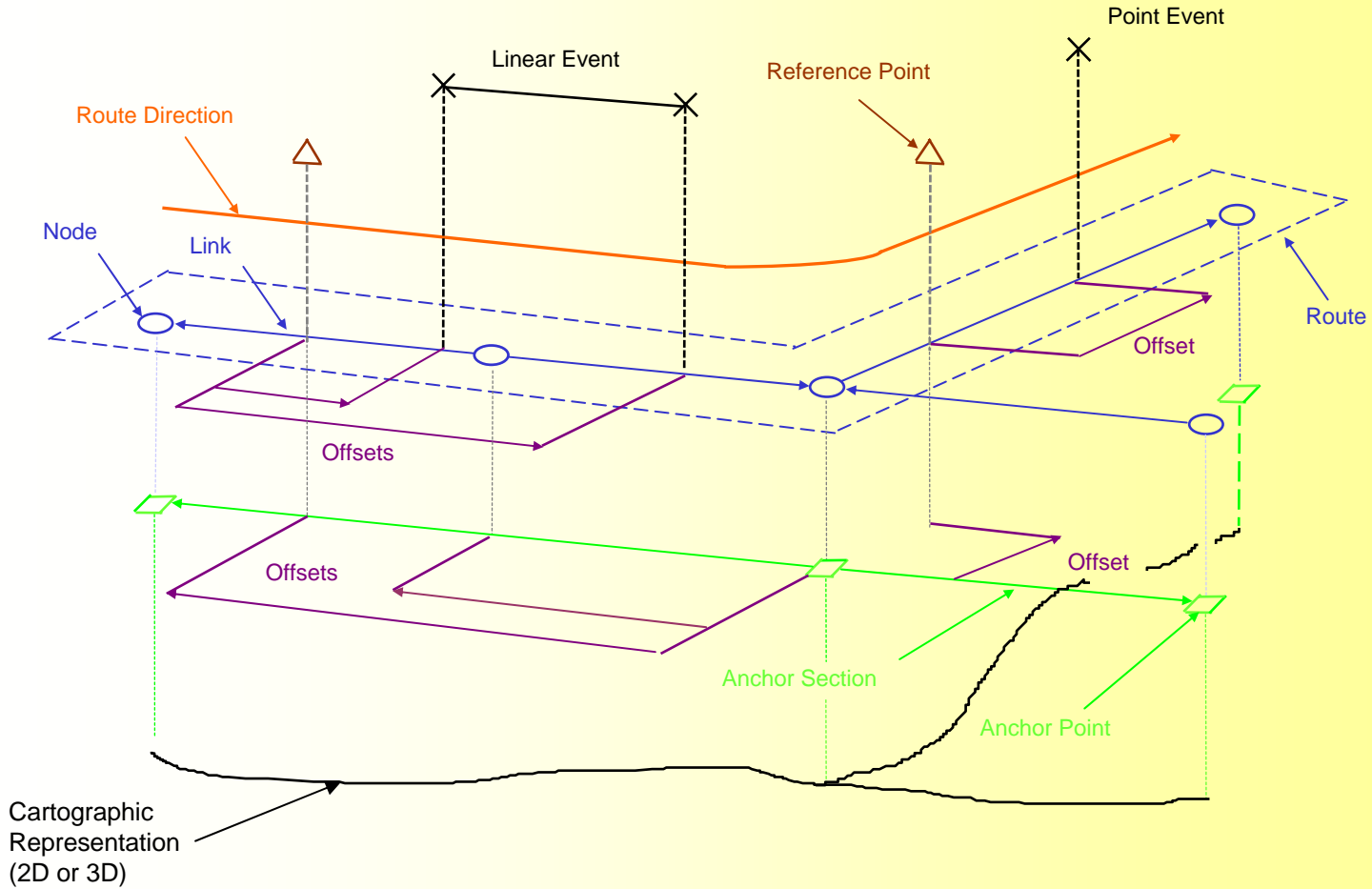


NCHRP 20-27 Design

Conceptual Model



NCHRP 20-27 Design LRS Conceptual Data Model



Linear Modeling

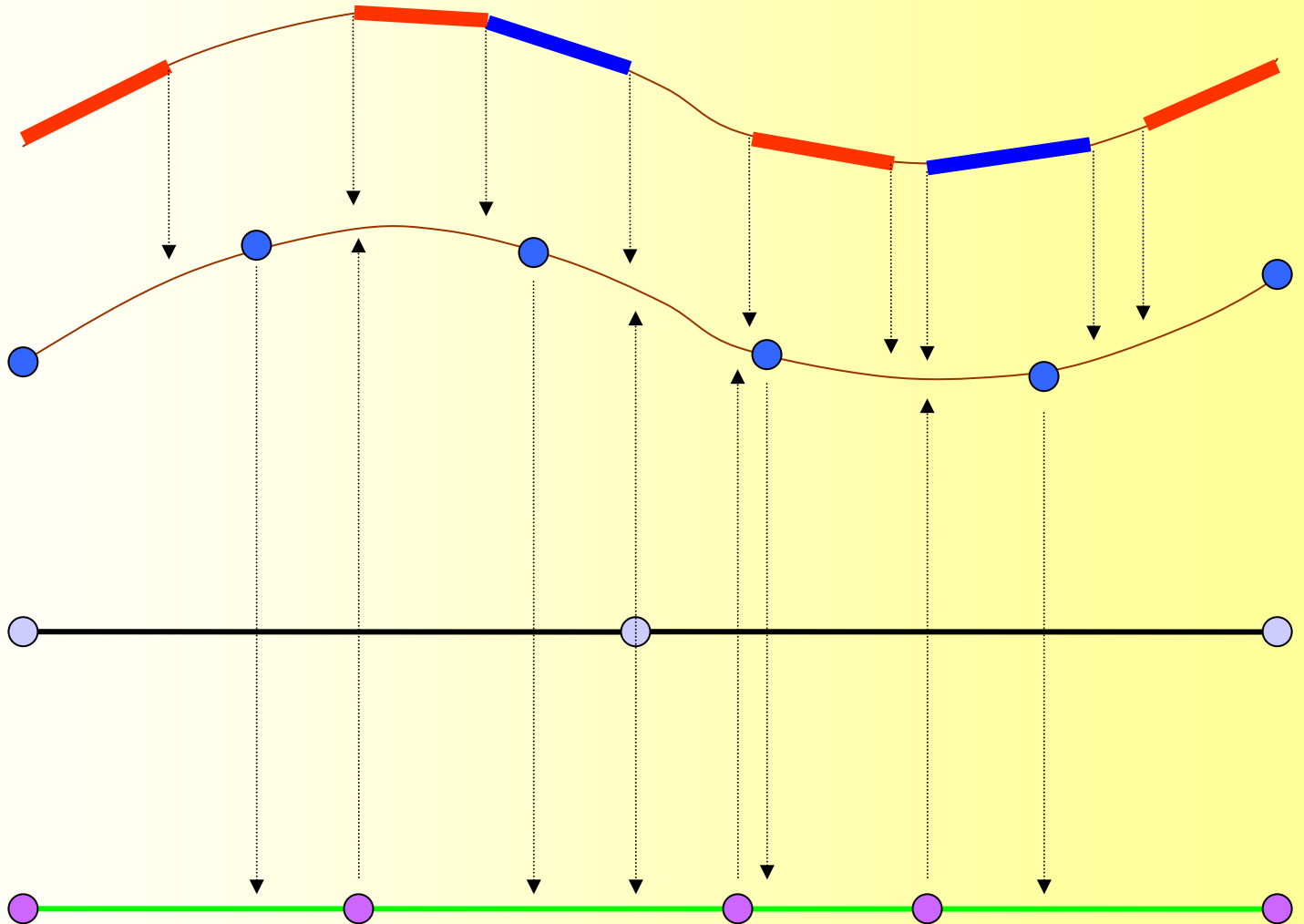
The problem compounded...

Business Data

Cartographic
Representation

Datum

Network

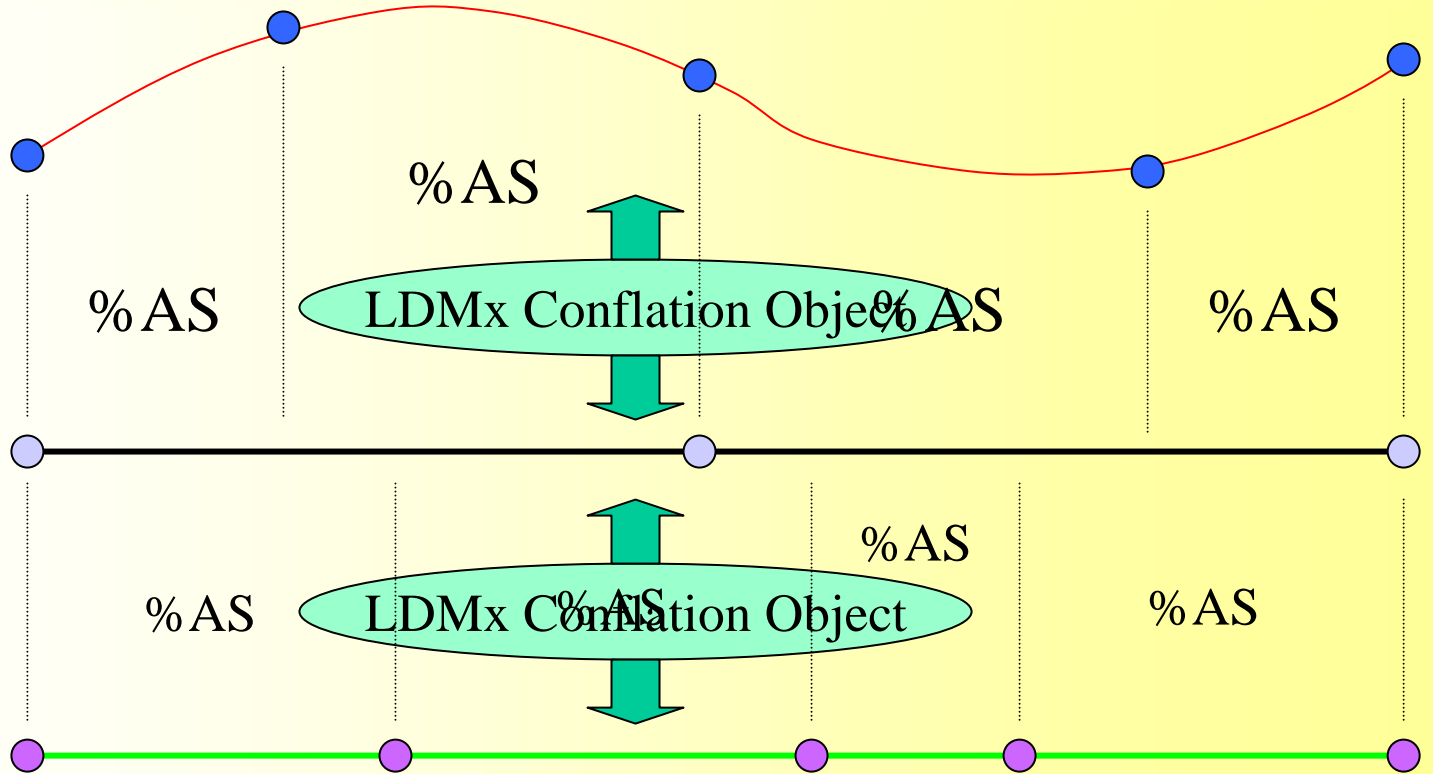


NCHRP 20-27 Design Technical Solution

Cartographic
Representation

Datum

Network



NCHRP 20-27 Design Physical Database

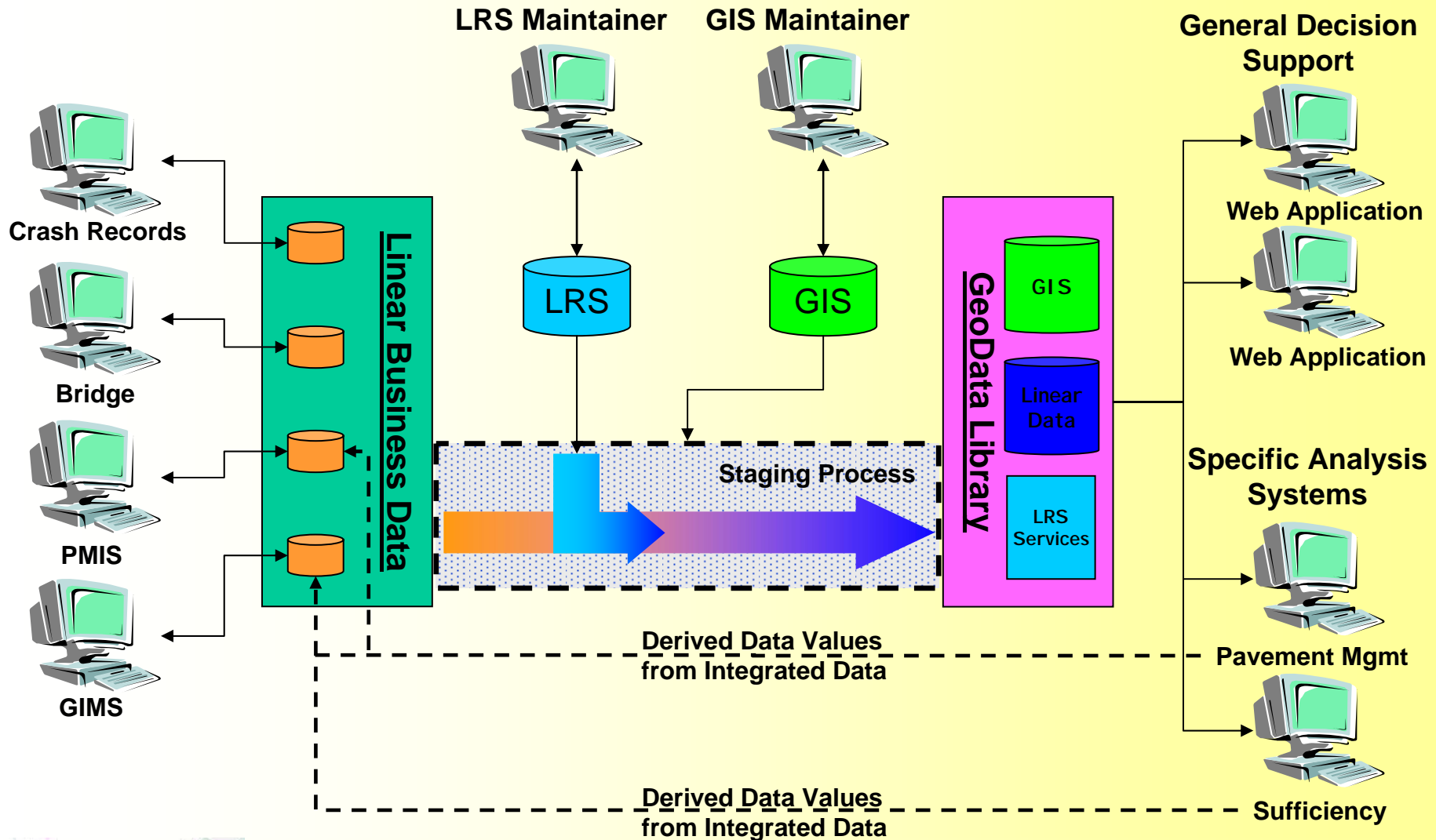
Anchor_Section	
Anchor_Section_ID	LONG
Anchor_Point_ID_From (FK)	LONG
Anchor_Point_ID_To (FK)	LONG
Datum_Version_ID (FK)	LONG
Measurement_Methods_ID (FK)	LONG
Measurement_File_Name	TEXT(255)
Datum_Distance	LONG
LRS_Change_Event_ID	LONG
Improvement_Proj_Phase_ID	LONG
General_Stage_ID	LONG
Sub_Alternative	LONG
EffectiveStartDate	DATETIME
EffectiveEndDate	DATETIME
EffectiveStatus	CHAR(10)
MaintenanceState	CHAR(10)
ChangesPending	CHAR(10)
LineageID	CHAR(10)
Geometry_Datum (SDO_Geom - derived)	
Geometry_GA_TW (SDO_Geom - derived)	
Conf_GA_TW (LRSX_Conf - derived)	
Geometry_GA_RW (SDO_Geom - derived)	
Conf_GA_RW (LRSX_Conf - derived)	

Road Centerline Databases

Important Uses

- Asset management systems
 - Tracking events and objects that exist along the road
 - Traffic and crash events
 - Pavement, bridge and safety feature inventories
- Navigation and Intelligent Transportation Systems (ITS)
 - Emergency response systems (Des Moines)
 - Traffic, construction and road condition maps
 - Consumer use electronic maps
 - MapQuest type applications
 - In-car navigation systems

Using Linear Referencing System Architecture for Integrating Data



Decision Support Environment Iowa DOT CTAMS Project

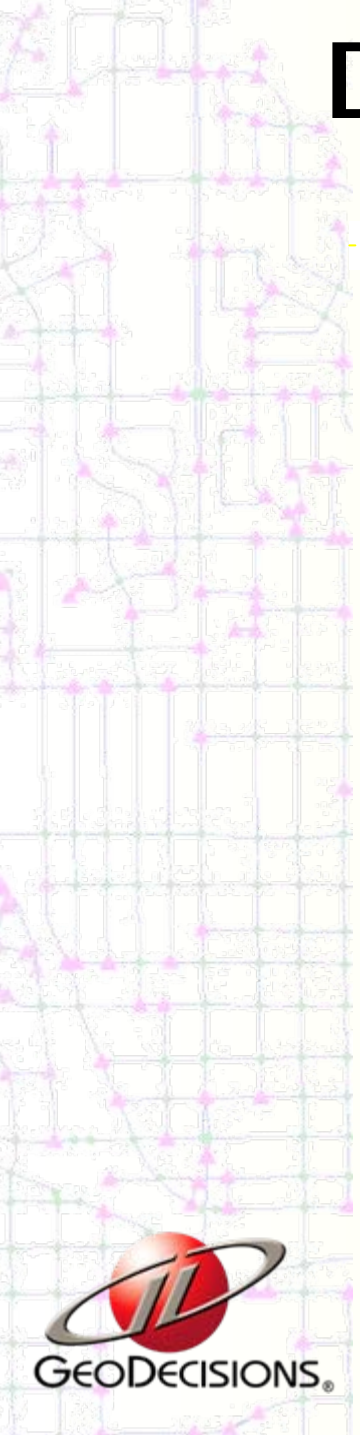
The screenshot displays the Iowa DOT CTAMS web application interface. The main window shows a data table with 1 record returned for a bridge structure. The table includes fields such as BRMS Doc#, FHWA Number, Bridge Maintenance Number, County, Facility Carried, Location Description, Mile Post, Feature Crossed, Bridge Length, Bridge Roadway Width, SIA Sufficiency Rating, Inventory Rating, Operating Rating, Vertical Underclearance, and Month. A technical drawing of a bridge structure is shown in the center, and an aerial view of the bridge location is shown below it. A street view image is also visible on the right side of the interface.

Attribute 1	Query
1 Record Returned	
BRMS Doc#	View
FHWA Number	40603
Bridge Maintenance Number	8546.9L030
County	Story (85)
Facility Carried	VB US 30
Location Description	1.5 MI W OF JCT 69
Mile Post	148.9
Feature Crossed	COVER ELWOOD DR
Bridge Length	191
Bridge Roadway Width	40
SIA Sufficiency Rating	98
Inventory Rating	49.5
Operating Rating	58.5
Vertical Underclearance	1610
Month	7

Iowa Department of Transportation

3 In... DSE 1... Micro... Links ** 8:24 AM

Decision Support Environment Iowa DOT CTAMS Project



Legend

- Severity of Crash**
 - Fatal Injury (1)
 - Injury (2)
 - Property Damage Only (3)
- AADT**
 - 40,000 - 89,999
 - 34,500 - 39,999
 - 13,000 - 34,499
 - 7,500 - 12,999
 - 2,000 - 7,199
 - 0 - 1,999
- Highways**
 - Interstates
- County Collectors**
 - Major Collectors Rural
- Urban Layers**
 - Minor Arterials
 - Collector Streets
- Base Layers**
 - Counties
 - Rail Lines
 - Local Roads
 - Hydrology
 - City Limits
 - Urban Areas
 - Oklahoma
 - Outside States

Map | **Attributes** | **Report**

Map Status: Complete

Crash Details:

Location	CR 1 CR
County	Oklahoma
Control Number	68
Subsection	0
Total Vehicles	03
Severity of Crash	Fatal (1)
Cause	UNLAW SPD (20)
Collision Date	05/04/2003
Crash Type	S-CLSAE-DR (3)

Decision Support Environment

New Hampshire DOT SLD Project

The screenshot displays the 'New Hampshire Route Log' web application in a Microsoft Internet Explorer browser. The address bar shows the URL: <http://207.140.67.82/NHRouteLog/private/lanhdot.aspx?rteSelMeth=sRoute>. The page header includes 'NH DOT home' and 'NEW HAMPSHIRE'. Navigation buttons include 'Stick Elements', 'Data Elements', 'Map', 'New Route', 'Save Template', 'Report', and 'Print'. The main content area features a map of a road segment with a yellow vertical line indicating a specific location. A label 'HOPKIN TON TOWN HALL' is positioned above the road. Below the map, a scale bar shows 'Mileage: 4.773' and 'Station(ft): 25204' on the left, and 'Mileage: 5.142' and 'Station(ft): 27154' on the right. A 'Guide: 4.962' and 'Distance: 48.676' are also displayed. Below the scale bar, there are several data rows with colored bars: 'Facilities' (green), 'Lane Counts' (yellow), 'Lane Widths' (blue), 'Pavement Type' (purple), 'Speed Zones' (blue), and 'Guide Rail Type - Right' (green). The bottom of the screen shows the Windows taskbar with the 'start' button and several open applications: 'Inbox - Micro...', 'D:\45407_NH...', 'CoreDRAW 9...', and 'New Hampshire...'. The system clock shows '1:46 PM'.

Decision Support Environment

North Dakota DOT OnRAMP Project

My NDDOT
North Dakota
Department of Transportation

NDDOT OnRAMP
Online Roadway Analysis & Mapping Portal

Home Site Map ? FAQ

Query Tools
Legend
Identify
Advanced Query

Video Log Data

Date Driven	11/7/2005 4:20:00 PM
District	5
Road Name	0094
Direction	E
IRI_Avg_e	130.50000
RUT_Avg_e	107.50000
FAI_Avg_e	195.00000
Route Id	15
Measure (mi)	50.60031
Route Set Id	315
Measure Change	1
Heading (deg)	92.796
Latitude	N 46.89029
Longitude	W -102.84954

Lat: 46.97377 Lon: -102.77749

Start Windows Live Messenger Inbox - Microsoft Outlook RE: NDDOT - Message NDDOT OnRAMP - Onli... 11:28 AM

Decision Support Environment Military IRRIS Application

IRRIS - Microsoft Internet Explorer

File Edit View Favorites Tools Help

IRRIS Thu, 21 Apr 2005 18:57:56 Zulu 1457:56 EDT Quick Search Go

My IRRIS World Map Mapping Reporting Tracking Testing

Criteria Map Layer List Report Analysis Print

Overview Map Map Utilities Legend Refresh Map

- Base Layers
- World Airports
- Counties
- Road
- Urban Areas
- Water
- Gato
- MRE
- Rail Yard
- Rail Network
- Anchorage
- Berth
- Buildings
- Call Forward Area
- Cheesin Storage
- Container Storage
- Crane
- Installation

Done Internet 2:57 PM

Decision Support Environment

Military IRRIS Application

The screenshot displays the IRRIS web application interface. The browser address bar shows <https://www.iris.tea.army.mil>. The page header includes the IRRIS logo, navigation tabs (My IRRIS, World Map, Mapping, Reporting, Tracking, Routing, Querying, Rail Admin), and a search bar. The main content area features a map of a region with a purple highlighted route. A callout box on the map states: "The purple highlighted road is the mapped route." The interface includes a "Map Tools" panel on the left with various icons for map manipulation, an "Overview Map" section, and a "Map Legend" section. The legend is organized into several categories:

- Default Layers**
 - ABC Road Labels
 - Urban Areas
- Emergency Response**
 - Fire Department
 - Police Department
 - IRRIS Mobility Map
- Road Features**
 - ABC IRRIS Road Names
 - Highways
 - Major Roads
 - Water Roads
 - Local Roads
- Weather

The bottom of the browser window shows the Windows taskbar with the Internet Explorer icon and the text "Internet".

Decision Support Environment Military IRRIS Application

The screenshot displays the IRRIS web application interface. At the top, the title "IRRIS" is visible along with the date and time: "Thu, 25 Aug 2006 19:34:58 Zulu 15:34:58 EDT". A "Quick Search" field is present. The main navigation bar includes tabs for "My IRRIS", "World Map", "Mapping", "Reporting", "Tracking", "Rail Admin", "Routing", "Querying", and "Testing". Below this, a secondary navigation bar shows "Criteria", "Map", "Map Layers", "Report", "Analysis", "Print", and "Presentation".

The central map area is titled "EAST HOUSTON, HARRIS County, TX" and shows a satellite view with a plume model overlay. The plume is represented by concentric, semi-transparent regions in shades of purple and red, indicating different levels of concentration or impact. Major roads like I-610 and I-25 are visible. The map includes standard navigation controls such as "Original Map", "Leaf Map", "Zoom Box", "Zoom In/Out", and "Pan".

On the left side, there are three utility panels:

- Overview Map:** A small thumbnail map showing the current location within a larger regional context.
- Map Utilities:** A set of icons for various map functions like pan, zoom, and layer management.
- Legend:** A list of map layers with checkboxes. The "Plume Model" layer is checked and highlighted with a red box. The legend also includes "Base Layers" (World Airports, Counties, Road, Urban Areas, Water, U.S. Roads) and "Dynamic Layers" (COMUS Aerial Photo, EAST HOUSTON, HARRIS COUNTY, TX, Plume Model).

At the bottom of the map, there is a scale bar and a north arrow. The text "© Limited Distribution © Space Imaging Inc. Licensed for DOD Title 50 © Digital Globe Inc. Licensed for DOD Title 50" is visible at the bottom of the map area.

Decision Support Environment

Mississippi DOT Crash Analysis Mgmt System

MDOT Safety Analysis Management System (SAMS) - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address: http://10.1.20.26/sams_beta/MainFrames.aspx?au

Links: MDOT DEV SAMS Beta MDOT TEST SAMS Beta

MDOT

Contacts
What's New
User Feedback
Help

Queries Reports Analysis Administration

Data Summary:

- Total Crashes: 211
- Total Fatalities: 1
- Fatal Crashes: 1
- Total Injuries: 77
- Injury Crashes: 49
- Daylight Crashes: 135
- DUI Crashes: 7
- Wet Conditions Crashes: 38
- Unmapped Crashes: 1

Query Summary

County: Forrest [18]

City: Hattiesburg

Start Date: 01/01/2006

End Date: 01/31/2006

County Name	Intersection Dist	Intersection
Forrest [10]		
Forrest [10]		
Forrest [18]	200	F
Forrest [18]	1	M
Forrest [18]	40	F
Forrest [18]		
Forrest [18]	200	F
Forrest [18]	150	F
Forrest [18]	40	F
Forrest [18]	75	F
Forrest [18]	10	F
Forrest [18]		
Forrest [18]	500	F
Forrest [18]	5	F
Forrest [10]	20	F
Forrest [18]	75	F
Forrest [18]		
Forrest [18]	45	F
Forrest [18]	50	F
Forrest [18]	100	F

Column Selector Selected Rows: 1

Decision Support Environment

PennDOT Road Closure Reporting System

The screenshot displays the RCRS web application in a Microsoft Internet Explorer browser. The address bar shows <http://164.156.155.64/RCRS/>. The page features a navigation bar with the RCRS logo, "About RCRS", "Administrative Login", and "Back to Bulletin Board". Below this, there are filters for "Active County: <Entire State>" and "Active State Route: <All Routes>", along with a "Generate Map" button. A "Map Legend" is visible on the left, listing various map features such as "Active Counties", "Roads Closed", "Active Routes", "No Data Available", "State Routes", "Water", "Cities / Boroughs", "Active Counties with Closures / Restrictions", "Route Shields", and "Text Labels". The main map area shows a network of roads in Pennsylvania, with a specific road highlighted in red. A popup window identifies this road as "State Route 0083 (I - 083) VFW OF US MEM HW (Active)". The map includes a scale bar (0 to 3.5 miles) and a north arrow. At the bottom, a status bar indicates "1 closure(s) loaded in the map." The GEODECISIONS logo is visible in the bottom left corner.

Session Wrap-up

- Transportation GIS
 - How is Transportation GIS different
 - Linear Modeling
 - Linear Analysis
- Practical uses of linear GIS
 - Decision Support
 - Transportation Logistics

Questions

