Solutions to Infrastructure Asset Location Cross Referencing

Presentation to:
URISA

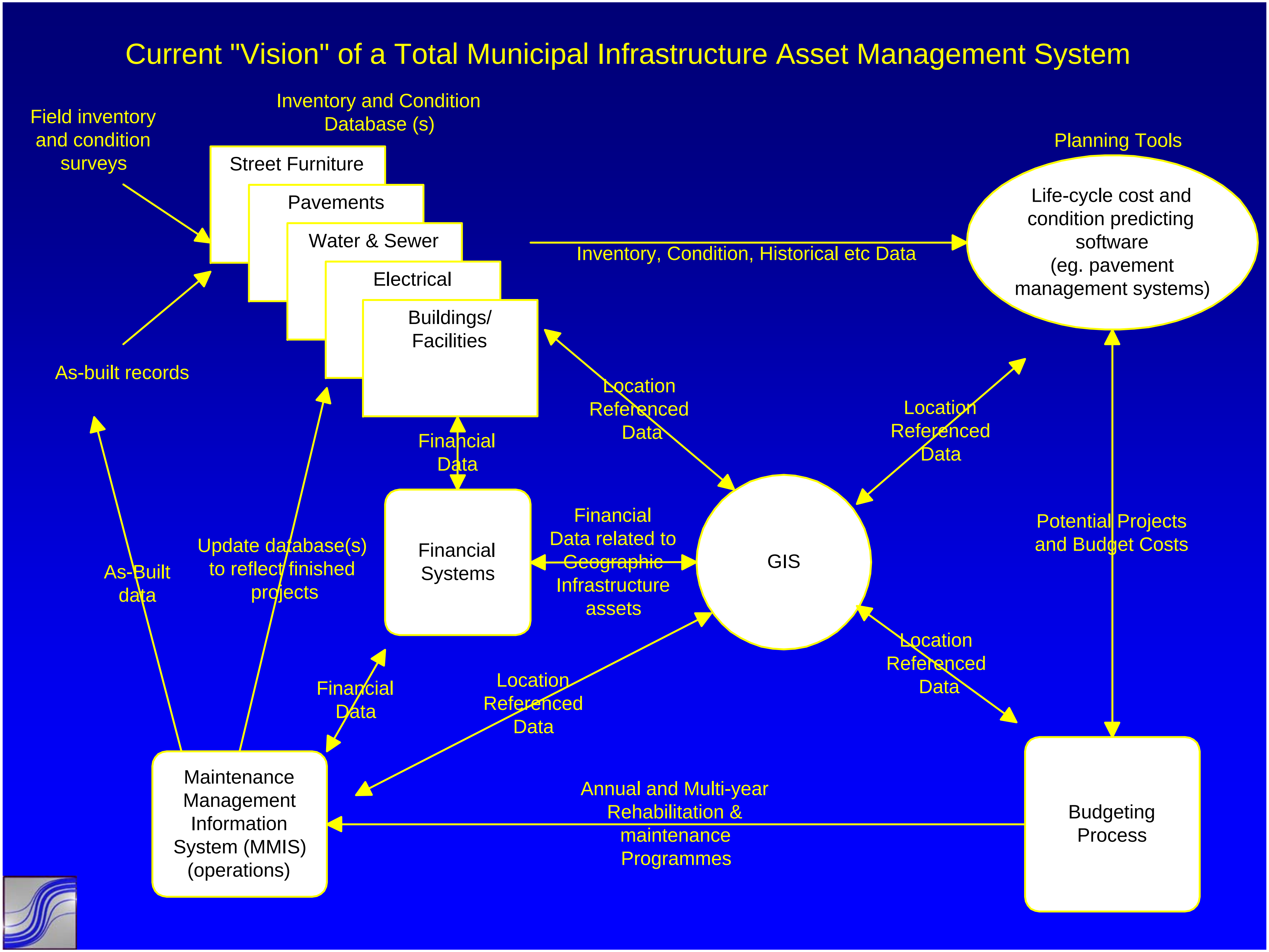
Presentation by:

Gary St. Michel, P. Eng.

Solutions to Infrastructure Asset Location Cross Referencing

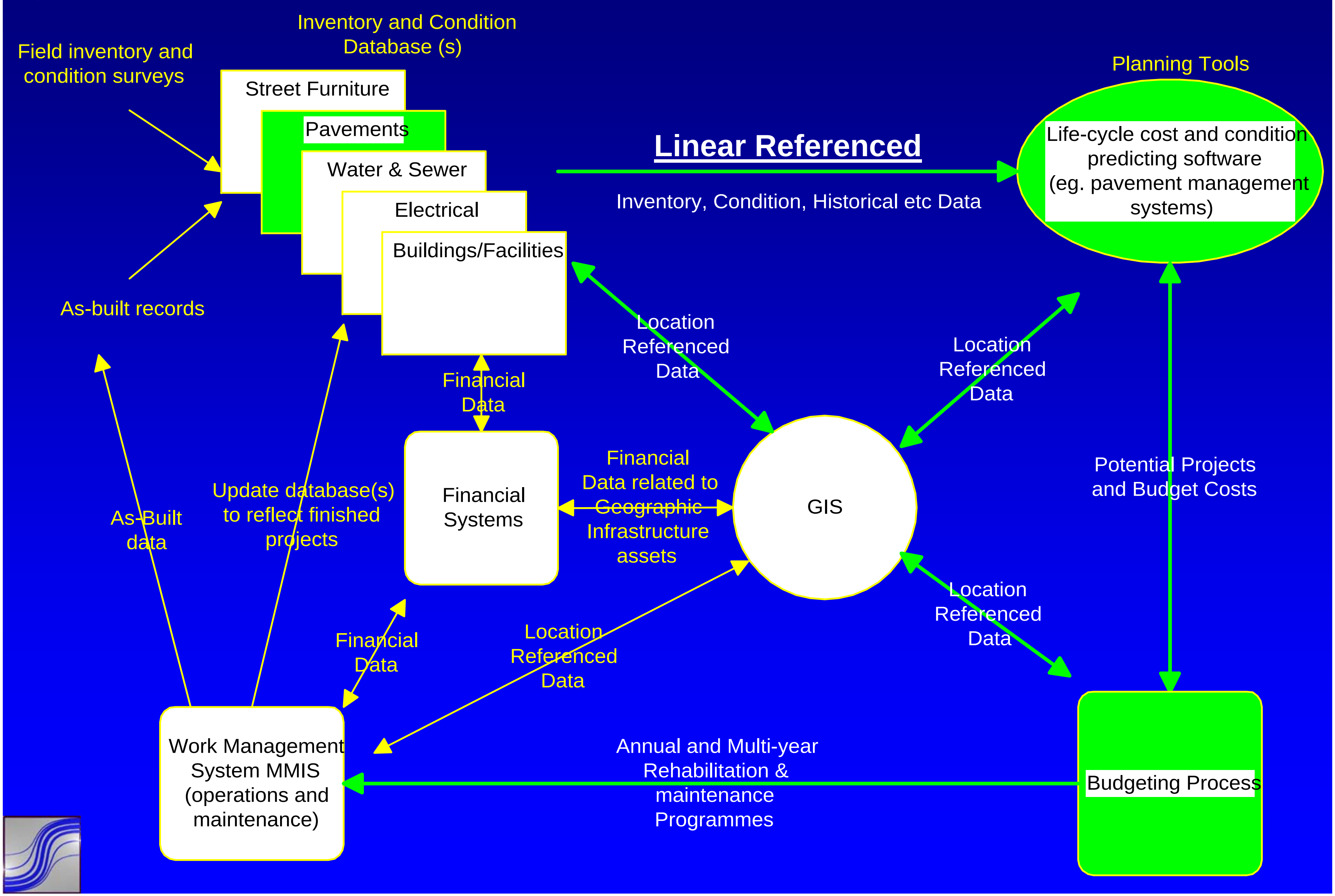
- Integrating road management with other management Systems through GIS
- Linear Referencing in GIS
- Managing data synchronization
- Using GIS as a data collection tool

Integrating road management with other management Systems through GIS

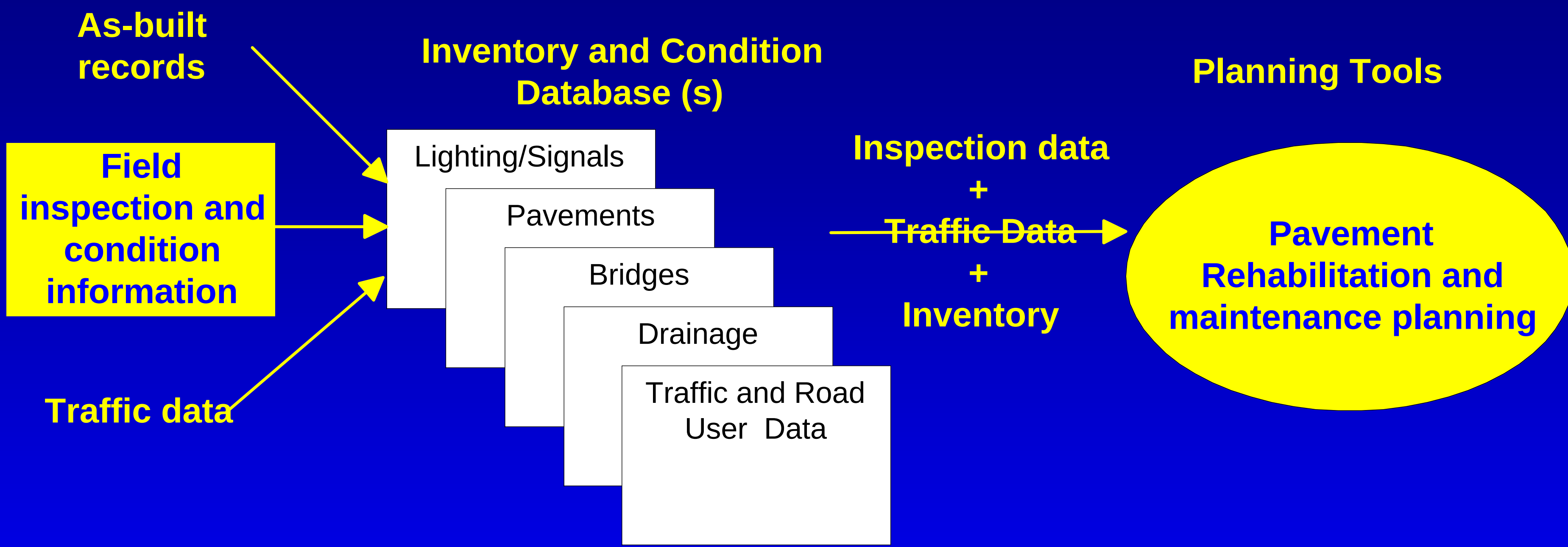


Current "Vision" of a Total Municipal Infrastructure Asset Management System
Field inventory and condition surveys
Inventory and Condition Database (s)
Street Furniture
Pavements
Water & Sewer
Electrical
Buildings/ Facilities
As-built records
Planning Tools
Life-cycle cost and condition predicting software (eg. pavement management systems)
Inventory, Condition, Historical etc Data
Location Referenced Data
Financial Data
Location Referenced Data
Financial Systems
Financial Data related to Geographic Infrastructure assets
GIS
Potential Projects and Budget Costs
As-Built data
Update database(s) to reflect finished projects
Financial Data
Location Referenced Data
Location Referenced Data
Maintenance Management Information System (MMIS) (operations)
Annual and Multi-year Rehabilitation & maintenance Programmes
Budgeting Process

Pavement Management System Components



Several data types must be combined to be used for planning and asset managment

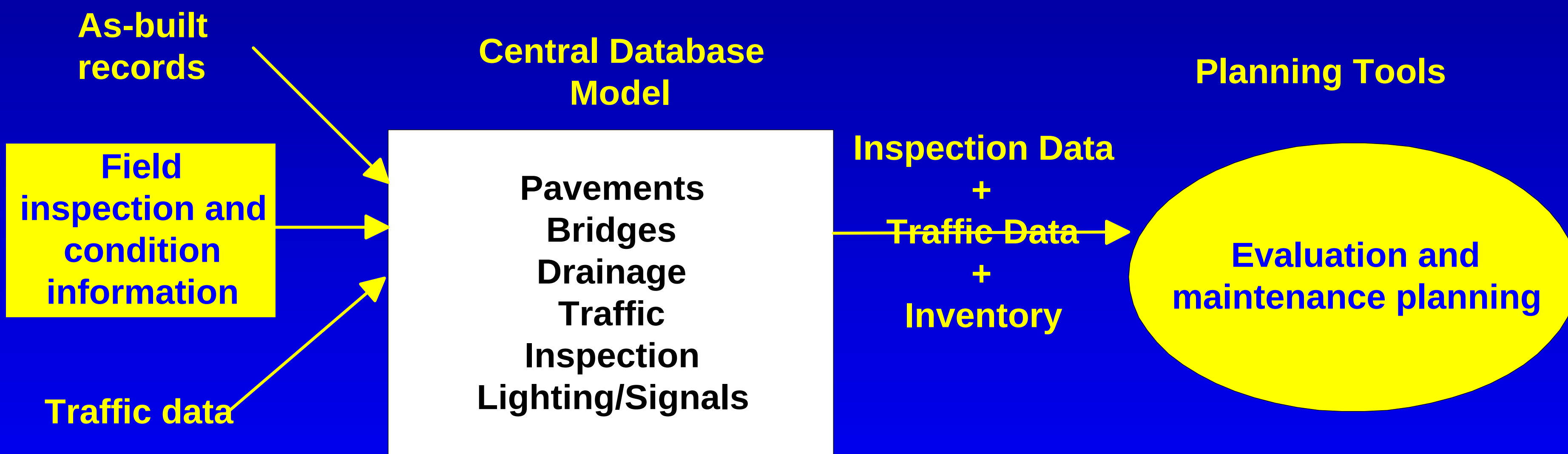


<u>Need good locational cross-referencing !!</u>

The Key to Linking Data sets is Managing Location Referencing

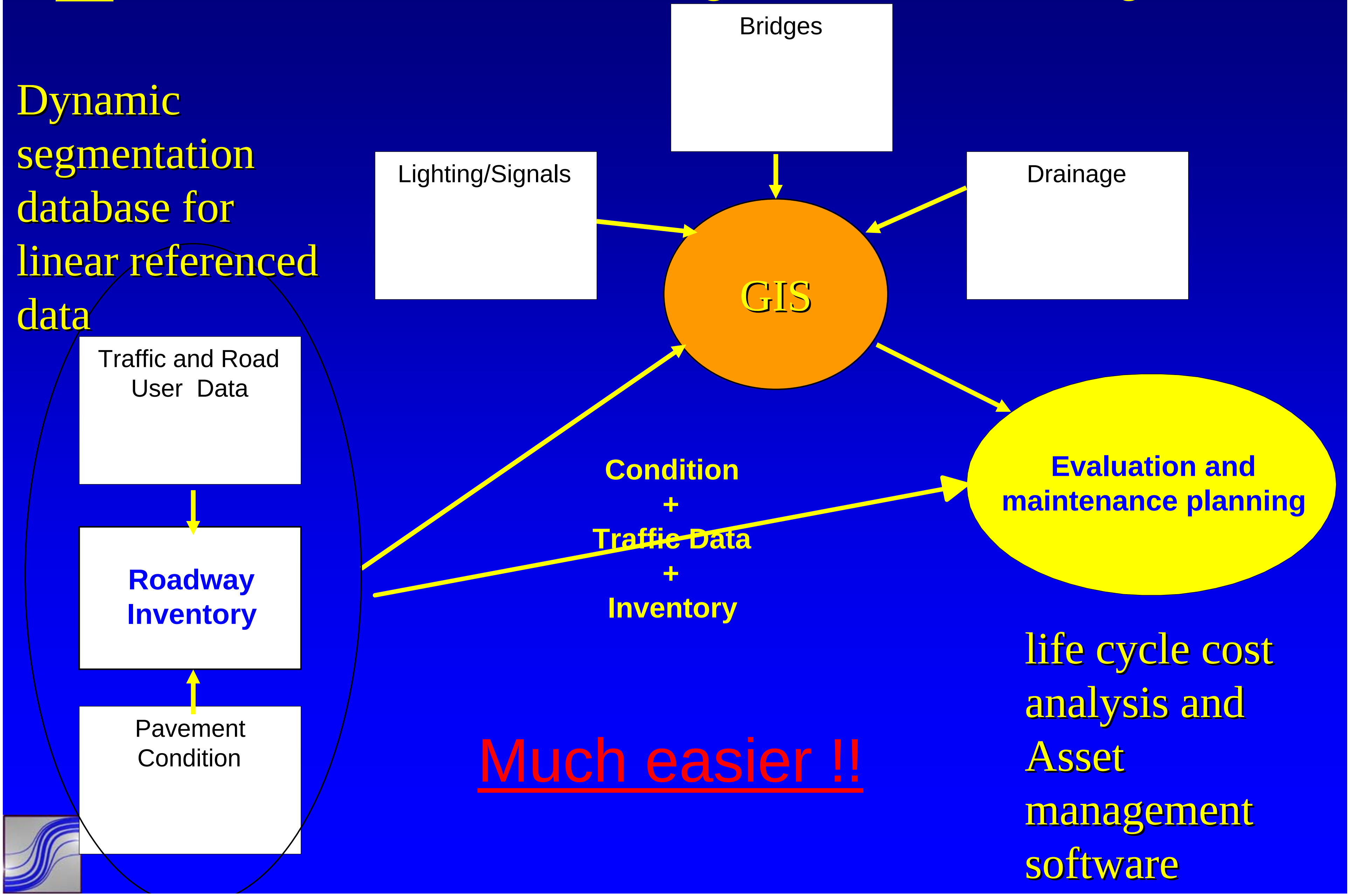
- A Typical Agency uses Several Different Location Referencing Methods
  - Fixed link segments used for Capital/Capacity Planning
  - Different Fixed Link Segments Used for Maintenance Management;
  - Reference point descriptions, (such as Intersection names), used by police for accidents;
  - Linear referencing used for Road Inventory/condition;
  - Spatial Referencing, (longitude/latitude or x,y coordinates), GPS locations – traffic signs.
  - Geo-referencing (street addresses)

Cross -location Referencing can be done by forcing all data types to use the same method - all data types use the same fixed links



<u>This is difficult and does not work well</u>

Or locational cross-referencing can be done using GIS



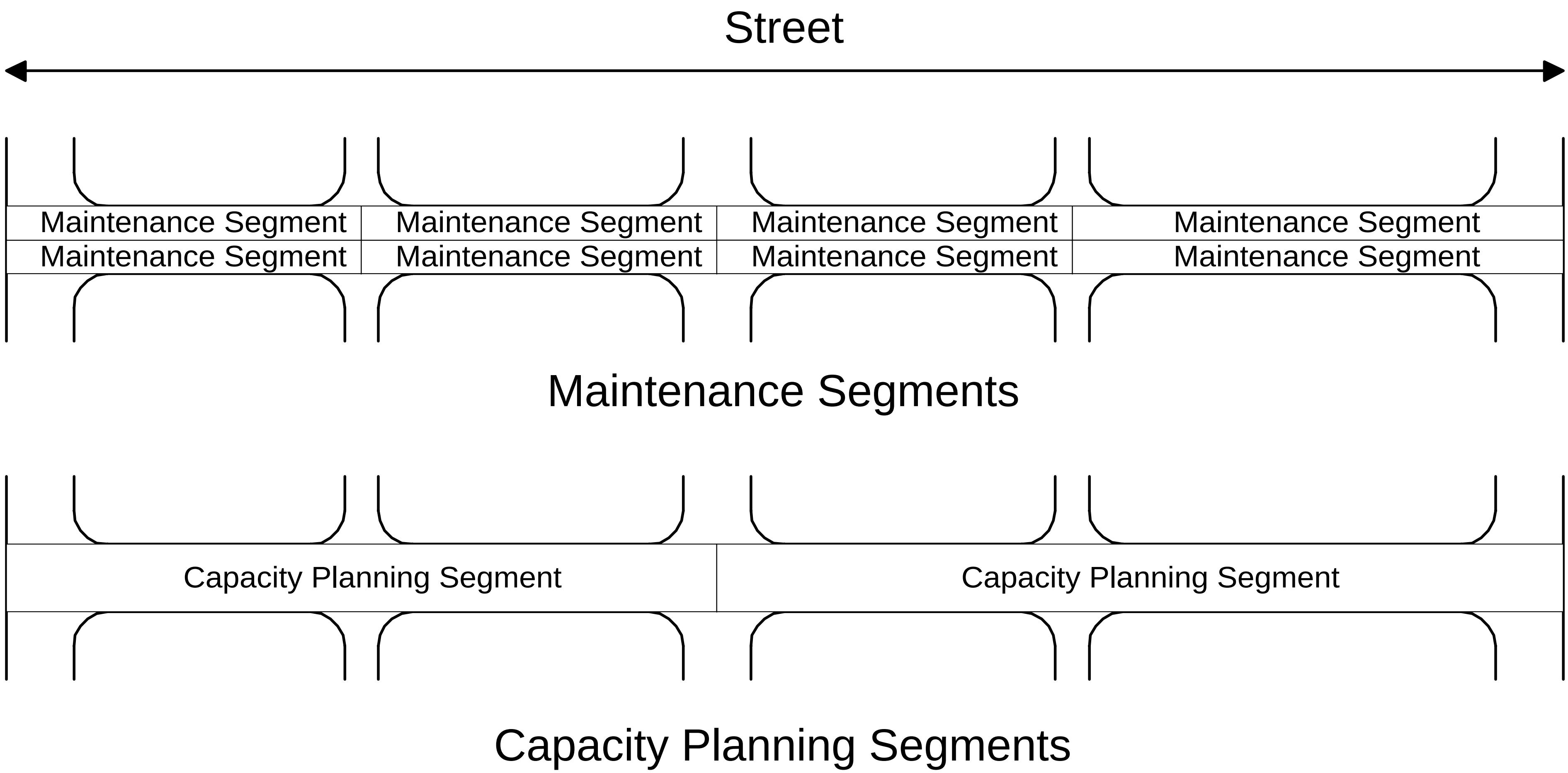
Data from any other application can be linked to the road management System through GIS

- Bridges (linear referencing)
- Traffic Accidents (reference points)
- Maintenance Costs (fixed links)
- Roadside furniture (x,y coordinates)
- Water/Sewer
- Sidewalks
- Street Lights etc.

Traditional Method of Referencing Data to Maps

- Map Objects
    - data points
    - Nodes
    - PolyLines
    - Polyshapes

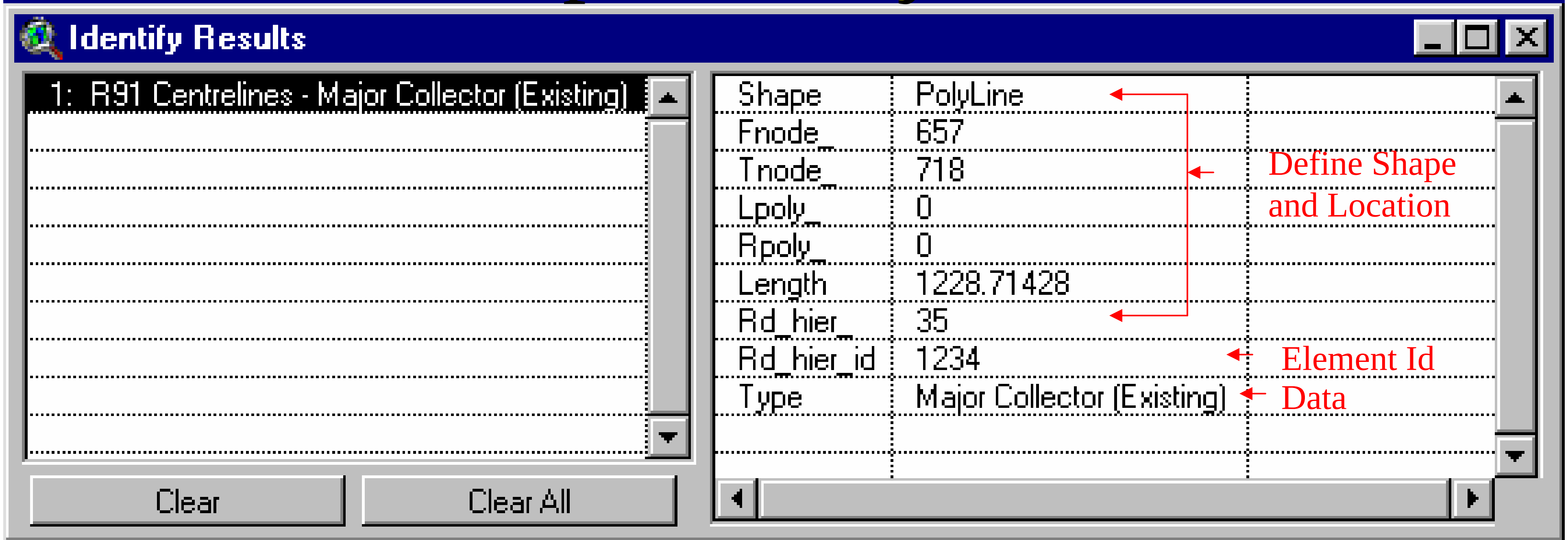
  – Data tables are linked/attached to these objects through the use of related object identification numbers



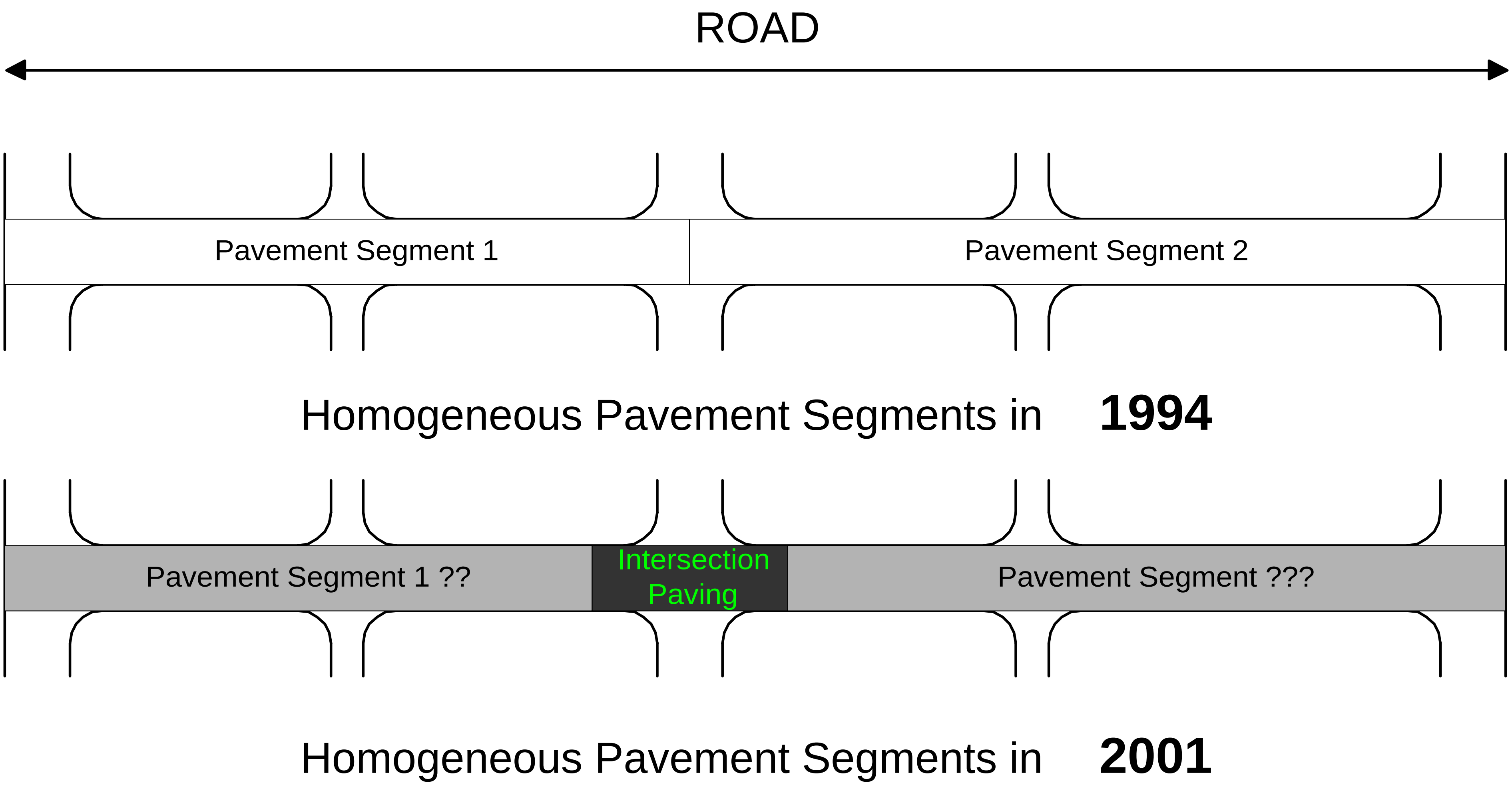
Typical Fixed Link Objects

Collector
Collector
Collector
Collector
Arterial
Fixed Length PolyLines

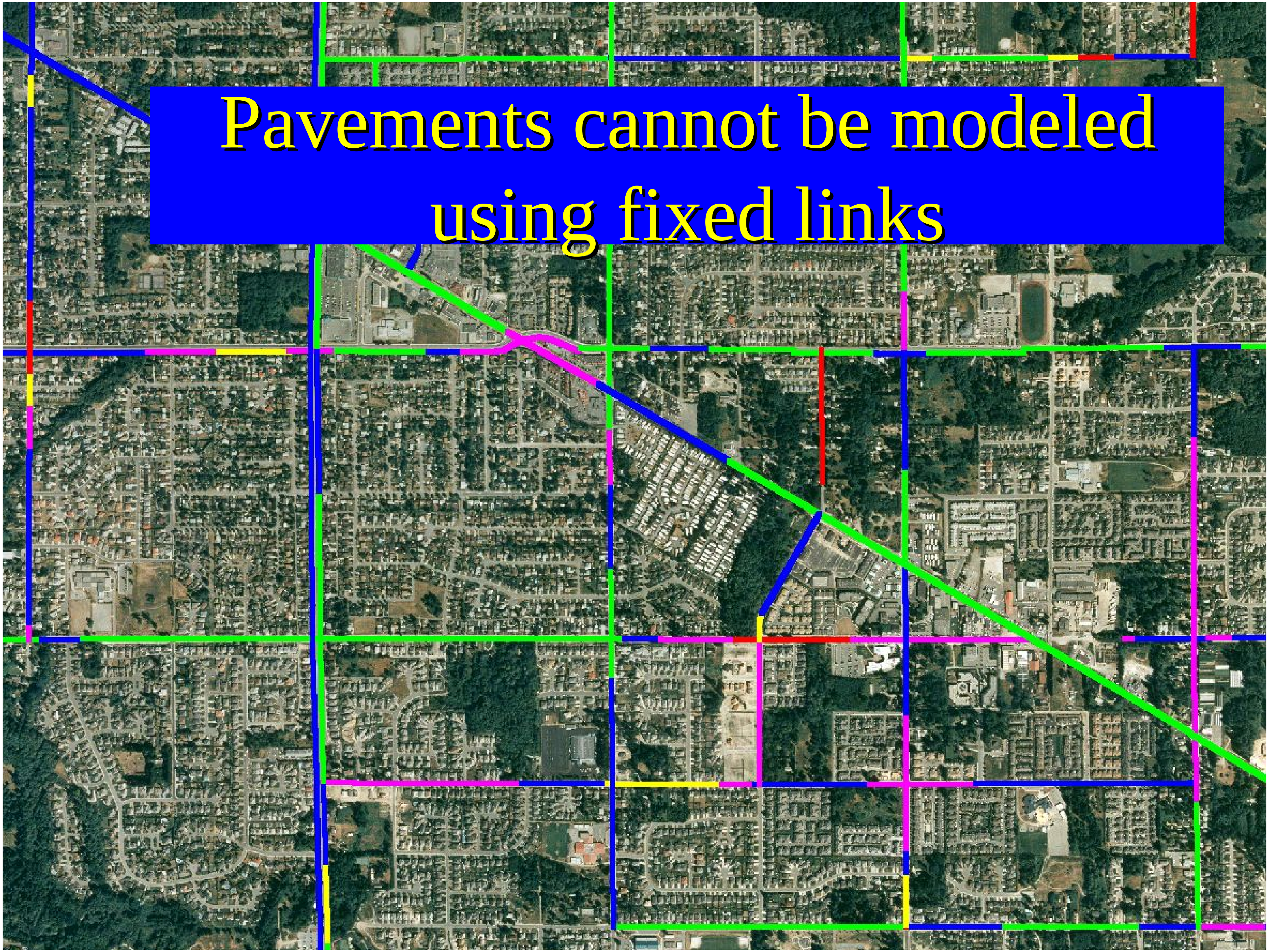
Shapes - PolyLines

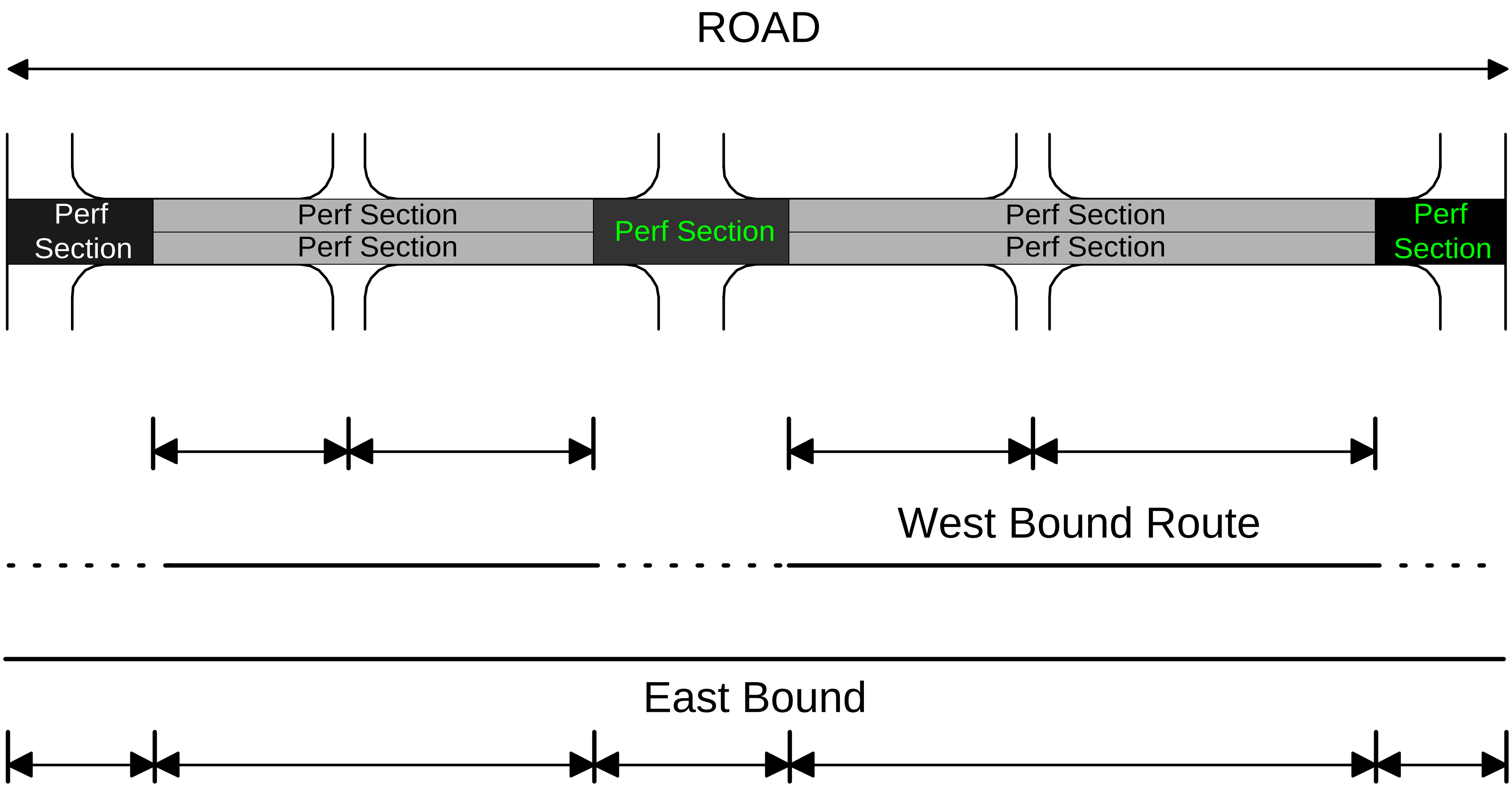


- Problem with Fixed Length PolyLines
  - Data is applied to the entire polyline
  - Length and Location of each line must be synchronized with the database each time the database changes - not practical for pavements!!!

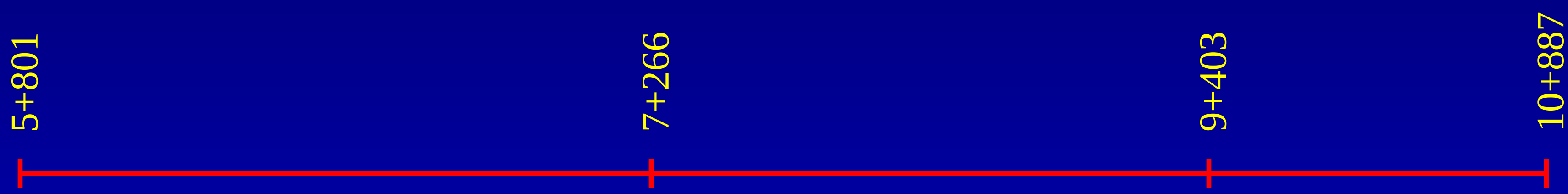


Homogeneous Pavement Segments Are Not Static !!!

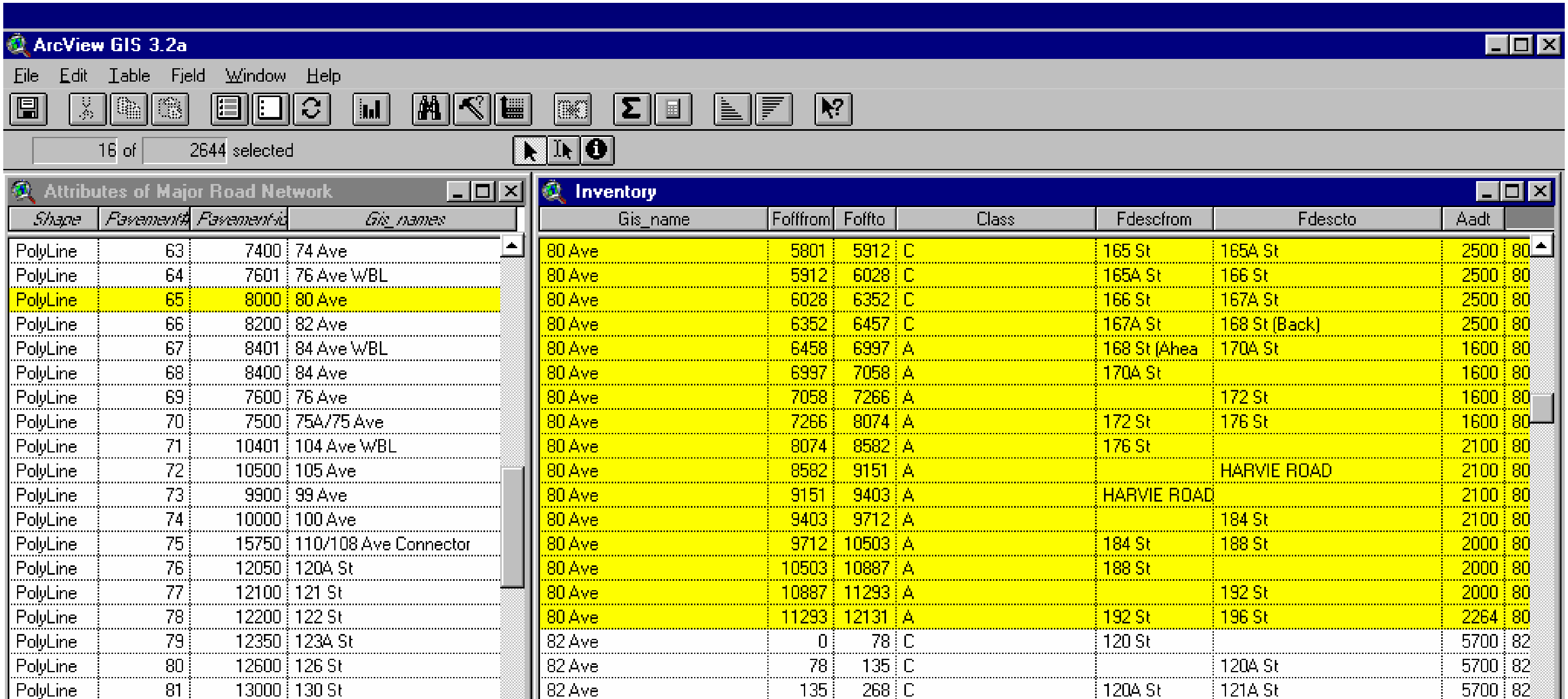

Pavements cannot be modeled using fixed links



The simplest way to model complex and continuously changing segments is by using linear referencing and dynamic segmentation

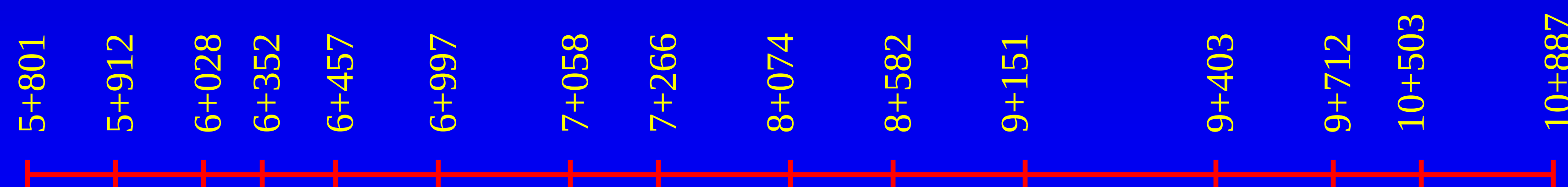


Linear Referencing



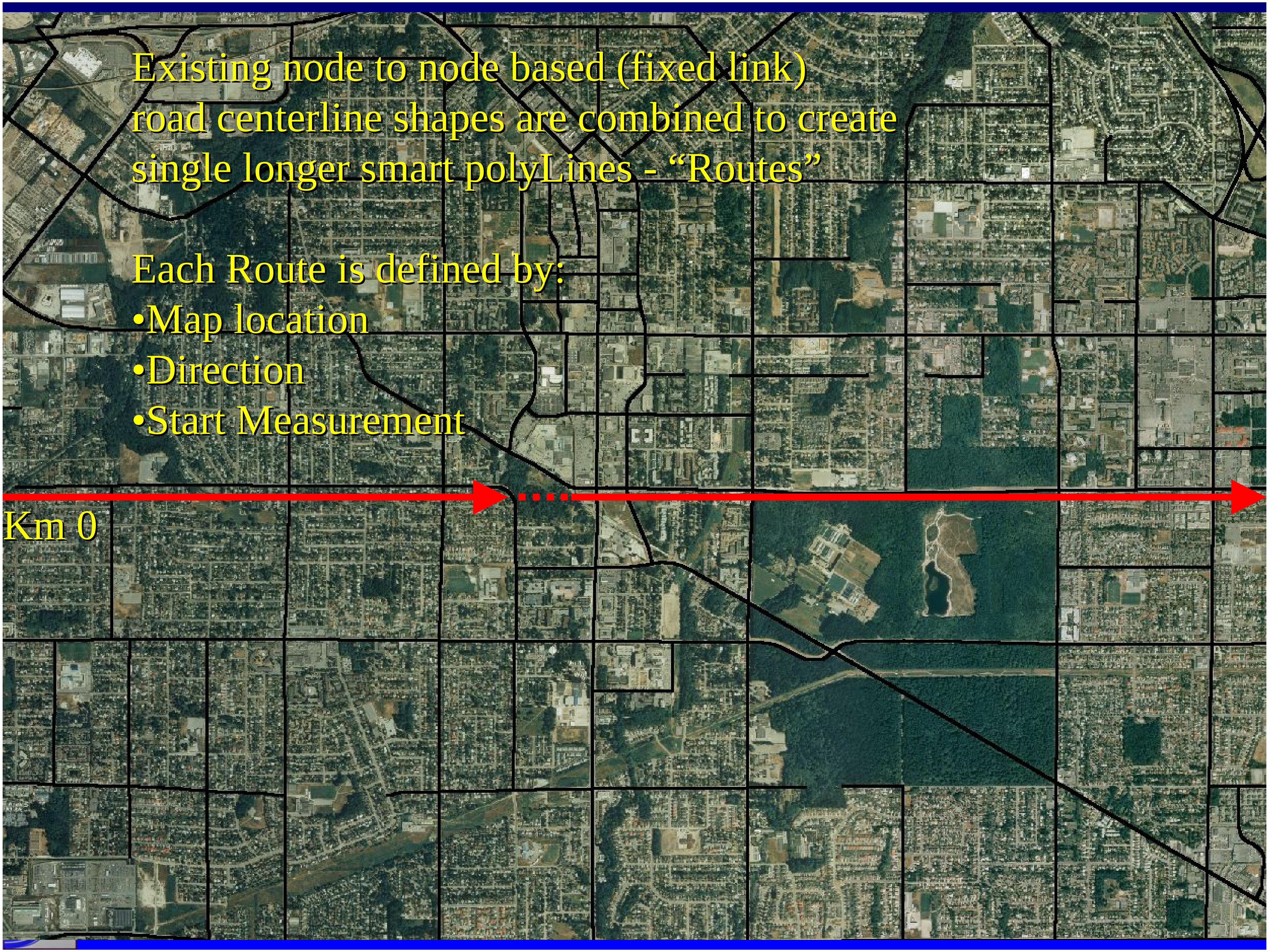
Shape	Pavement#	Pavement-id	Gis_names
PolyLine	63	7400	74 Ave
PolyLine	64	7601	76 Ave WBL
PolyLine	65	8000	80 Ave
PolyLine	66	8200	82 Ave
PolyLine	67	8401	84 Ave WBL
PolyLine	68	8400	84 Ave
PolyLine	69	7600	76 Ave
PolyLine	70	7500	75A/75 Ave
PolyLine	71	10401	104 Ave WBL
PolyLine	72	10500	105 Ave
PolyLine	73	9900	99 Ave
PolyLine	74	10000	100 Ave
PolyLine	75	15750	110/108 Ave Connector
PolyLine	76	12050	120A St
PolyLine	77	12100	121 St
PolyLine	78	12200	122 St
PolyLine	79	12350	123A St
PolyLine	80	12600	126 St
PolyLine	81	13000	130 St

Gis_name	Fofffrom	Fofto	Class	Fdescfrom	Fdescto	Aadt	
80 Ave	5801	5912	C	165 St	165A St	2500	80
80 Ave	5912	6028	C	165A St	166 St	2500	80
80 Ave	6028	6352	C	166 St	167A St	2500	80
80 Ave	6352	6457	C	167A St	168 St (Back)	2500	80
80 Ave	6458	6997	A	168 St (Ahea	170A St	1600	80
80 Ave	6997	7058	A	170A St		1600	80
80 Ave	7058	7266	A		172 St	1600	80
80 Ave	7266	8074	A	172 St	176 St	1600	80
80 Ave	8074	8582	A	176 St		2100	80
80 Ave	8582	9151	A		HARVIE ROAD	2100	80
80 Ave	9151	9403	A	HARVIE ROAD		2100	80
80 Ave	9403	9712	A		184 St	2100	80
80 Ave	9712	10503	A	184 St	188 St	2000	80
80 Ave	10503	10887	A	188 St		2000	80
80 Ave	10887	11293	A		192 St	2000	80
80 Ave	11293	12131	A	192 St	196 St	2264	80
82 Ave	0	78	C	120 St		5700	82
82 Ave	78	135	C		120A St	5700	82
82 Ave	135	268	C	120A St	121A St	5700	82

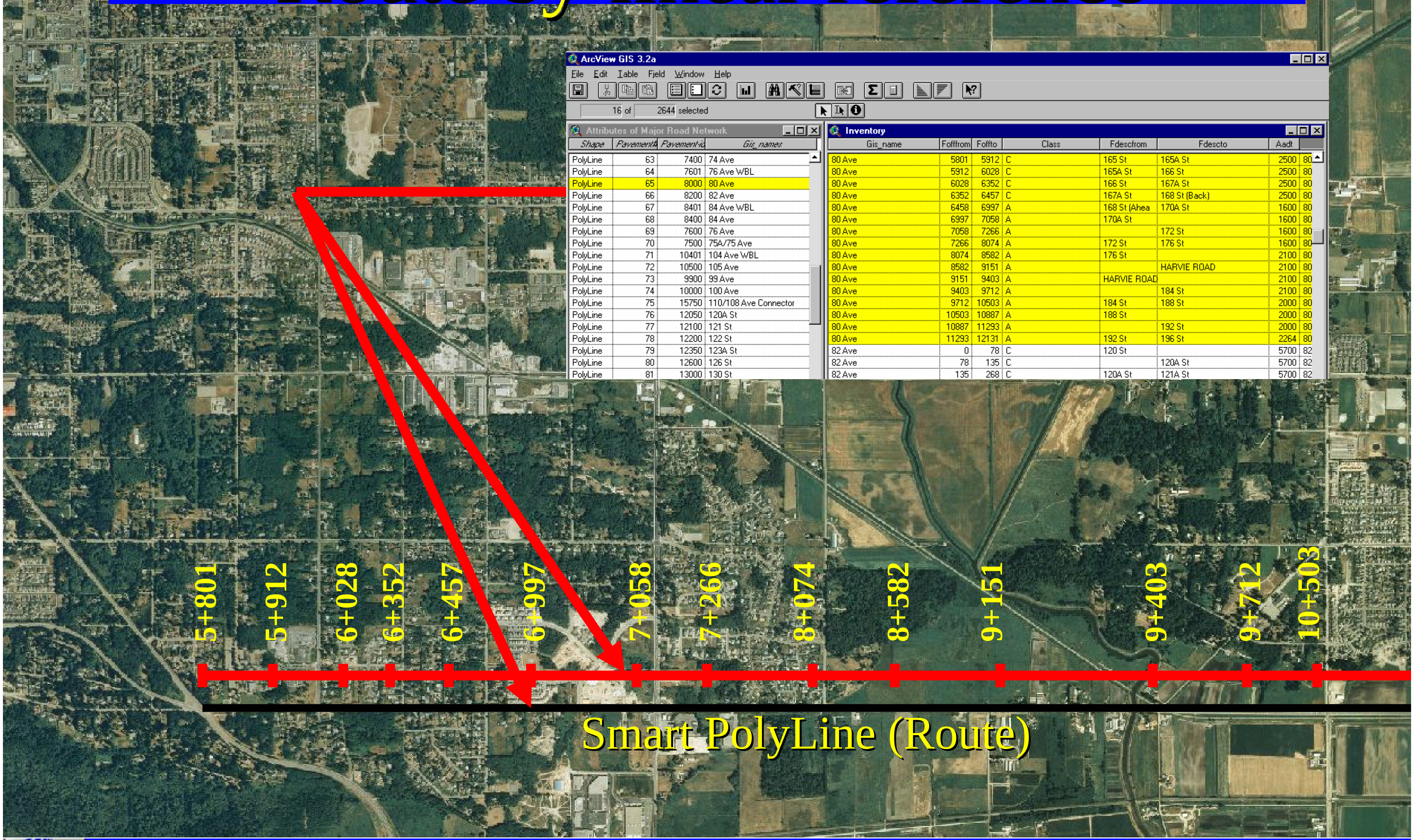


Linear references are stored in a database table


Collector
Collector
Collector
Collector
Arterial
Fixed Link PolyLines
Collector
Arterial
Advanced type of Polyline - PolyLineM (Route)


Existing node to node based (fixed link)
road centerline shapes are combined to create
single longer smart polyLines - “Routes”
Each Route is defined by:
•Map location
•Direction
•Start Measurement
Km 0

The data table is linked to the Route by linear reference



Attributes of Major Road Network

Shape	Pavement#	Pavement-id	Gis_names
PolyLine	63	7400	74 Ave
PolyLine	64	7601	76 Ave WBL
PolyLine	65	8000	80 Ave
PolyLine	66	8200	82 Ave
PolyLine	67	8401	84 Ave WBL
PolyLine	68	8400	84 Ave
PolyLine	69	7600	76 Ave
PolyLine	70	7500	75A/75 Ave
PolyLine	71	10401	104 Ave WBL
PolyLine	72	10500	105 Ave
PolyLine	73	9900	99 Ave
PolyLine	74	10000	100 Ave
PolyLine	75	15750	110/108 Ave Connector
PolyLine	76	12050	120A St
PolyLine	77	12100	121 St
PolyLine	78	12200	122 St
PolyLine	79	12350	123A St
PolyLine	80	12600	126 St
PolyLine	81	13000	130 St

Inventory

Gis_name	Fofffrom	Foffto	Class	Fdescfrom	Fdescto	Aadt	
80 Ave	5801	5912	C	165 St	165A St	2500	80
80 Ave	5912	6028	C	165A St	166 St	2500	80
80 Ave	6028	6352	C	166 St	167A St	2500	80
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80 Ave	8582	9151	A		HARVIE ROAD	2100	80
80 Ave	9151	9403	A	HARVIE ROAD		2100	80
80 Ave	9403	9712	A		184 St	2100	80
80 Ave	9712	10503	A	184 St	188 St	2000	80
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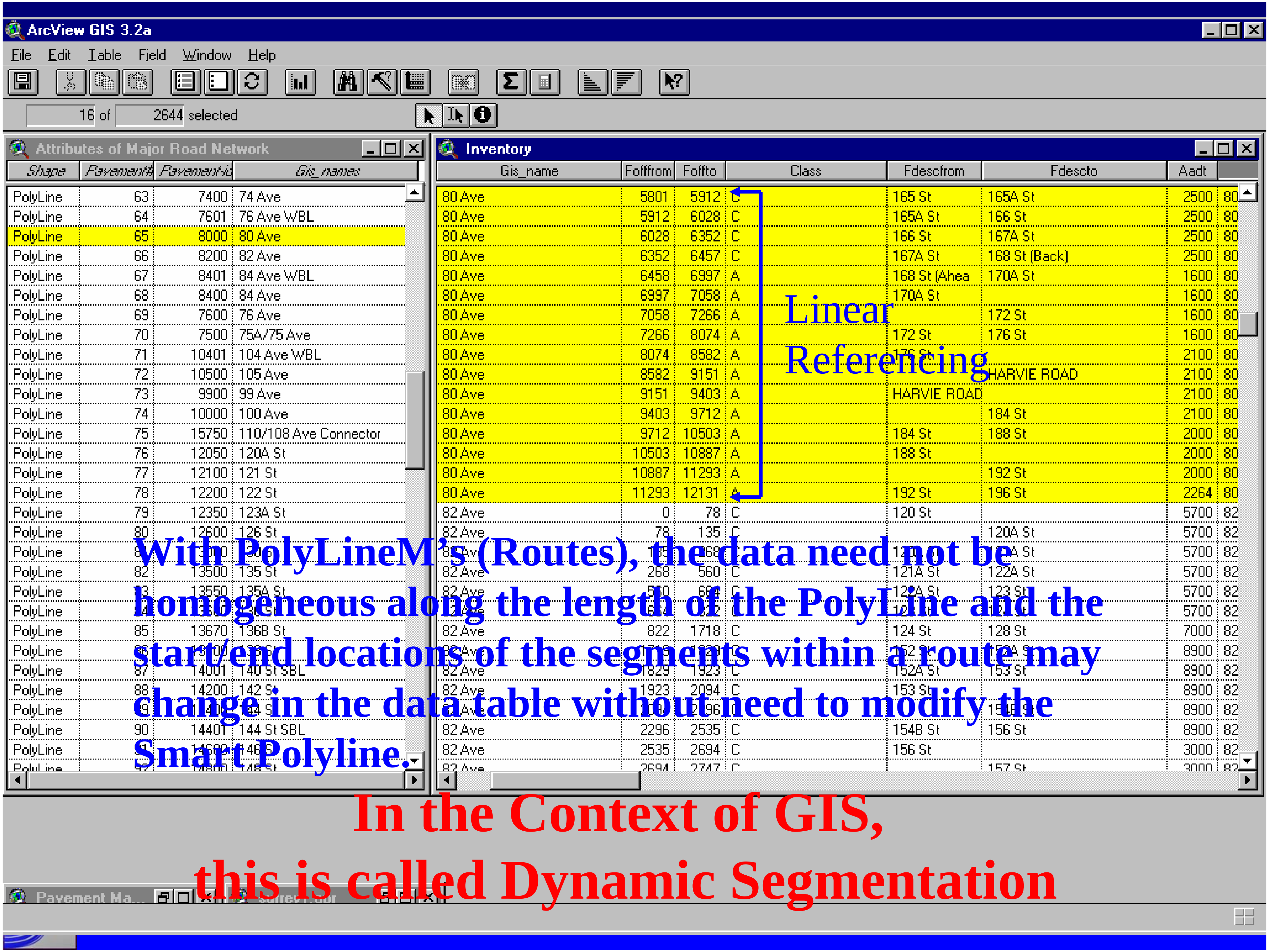
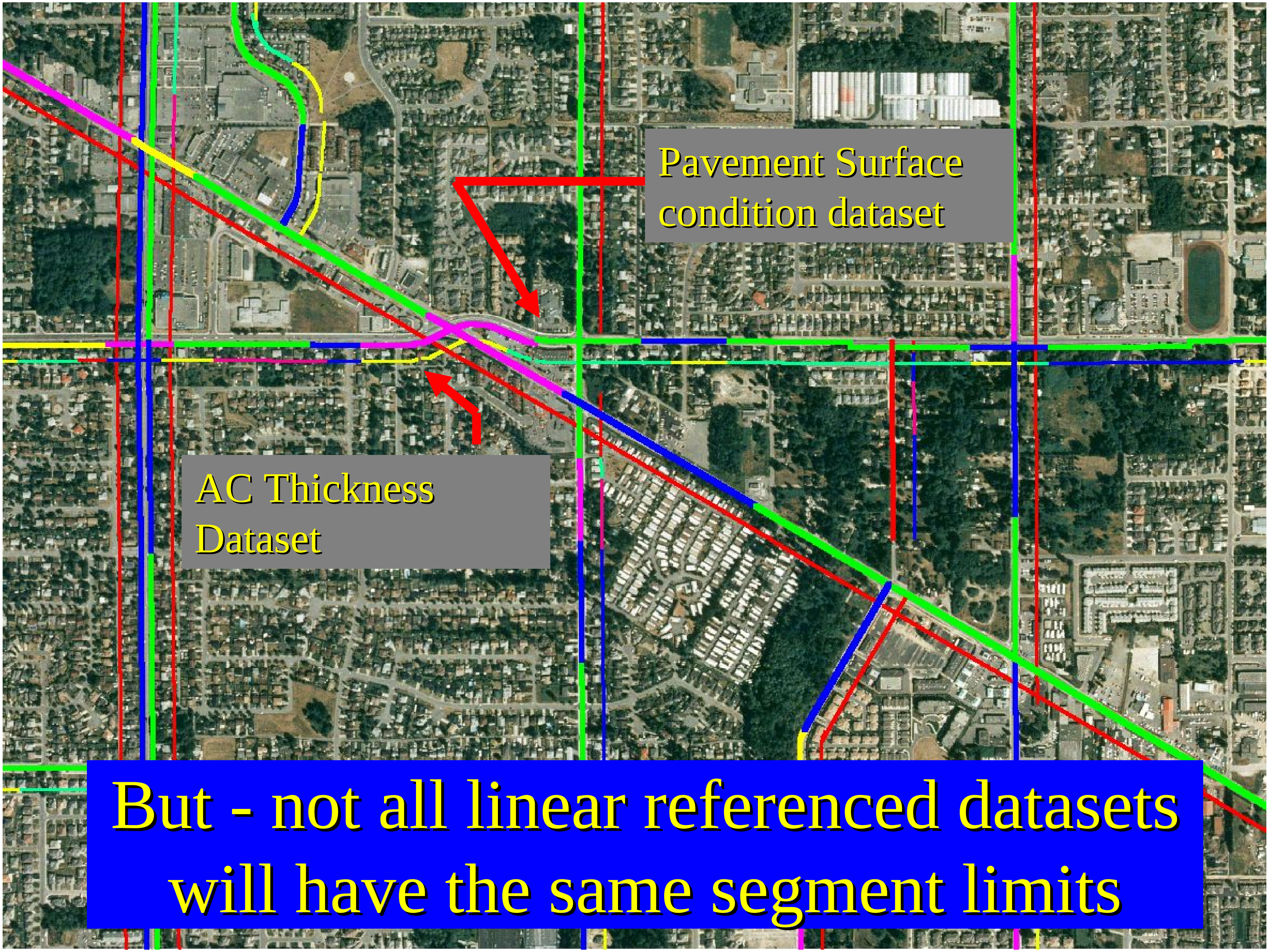
80 Ave	10887	11293	A		192 St	2000	80
80 Ave	11293	12131	A	192 St	196 St	2264	80
82 Ave	0	78	C	120 St		5700	82
82 Ave	78	135	C		120A St	5700	82
82 Ave	135	268	C	120A St	121A St	5700	82



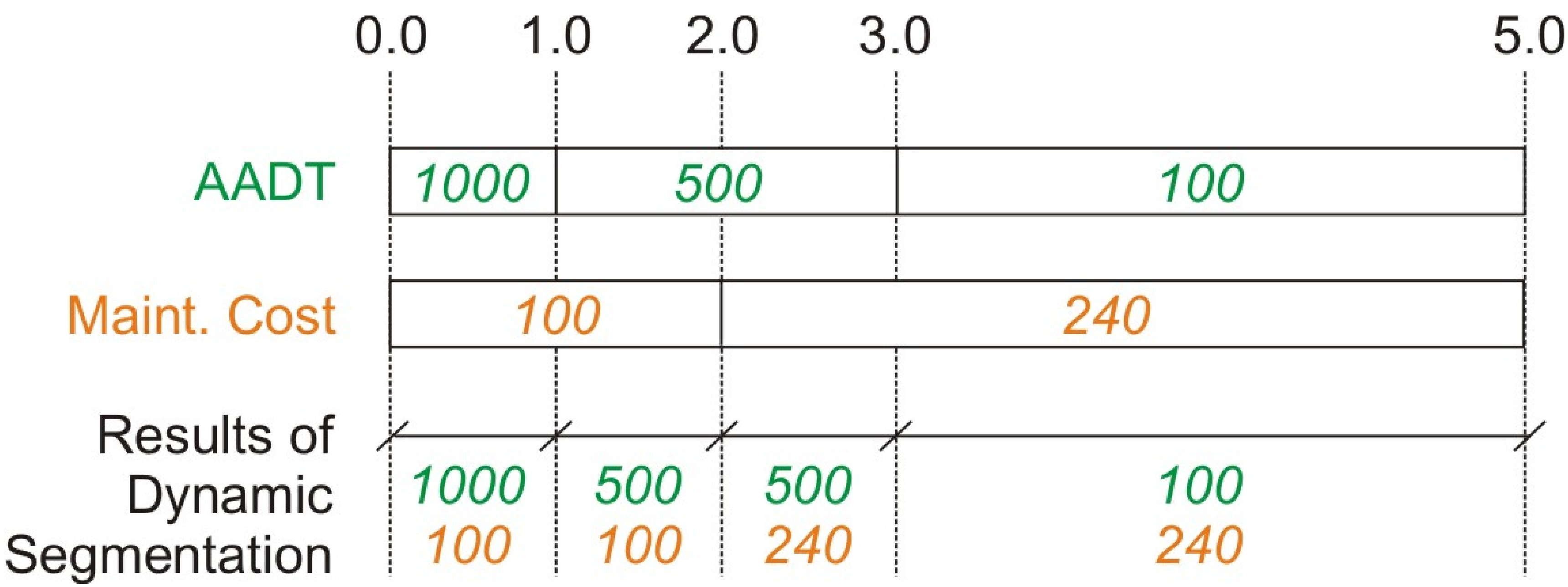
With PolyLineM's (Routes), the data need not be homogeneous along the length of the PolyLine and the start/end locations of the segments within a route may change in the data table without need to modify the Smart Polyline.

In the Context of GIS, this is called Dynamic Segmentation



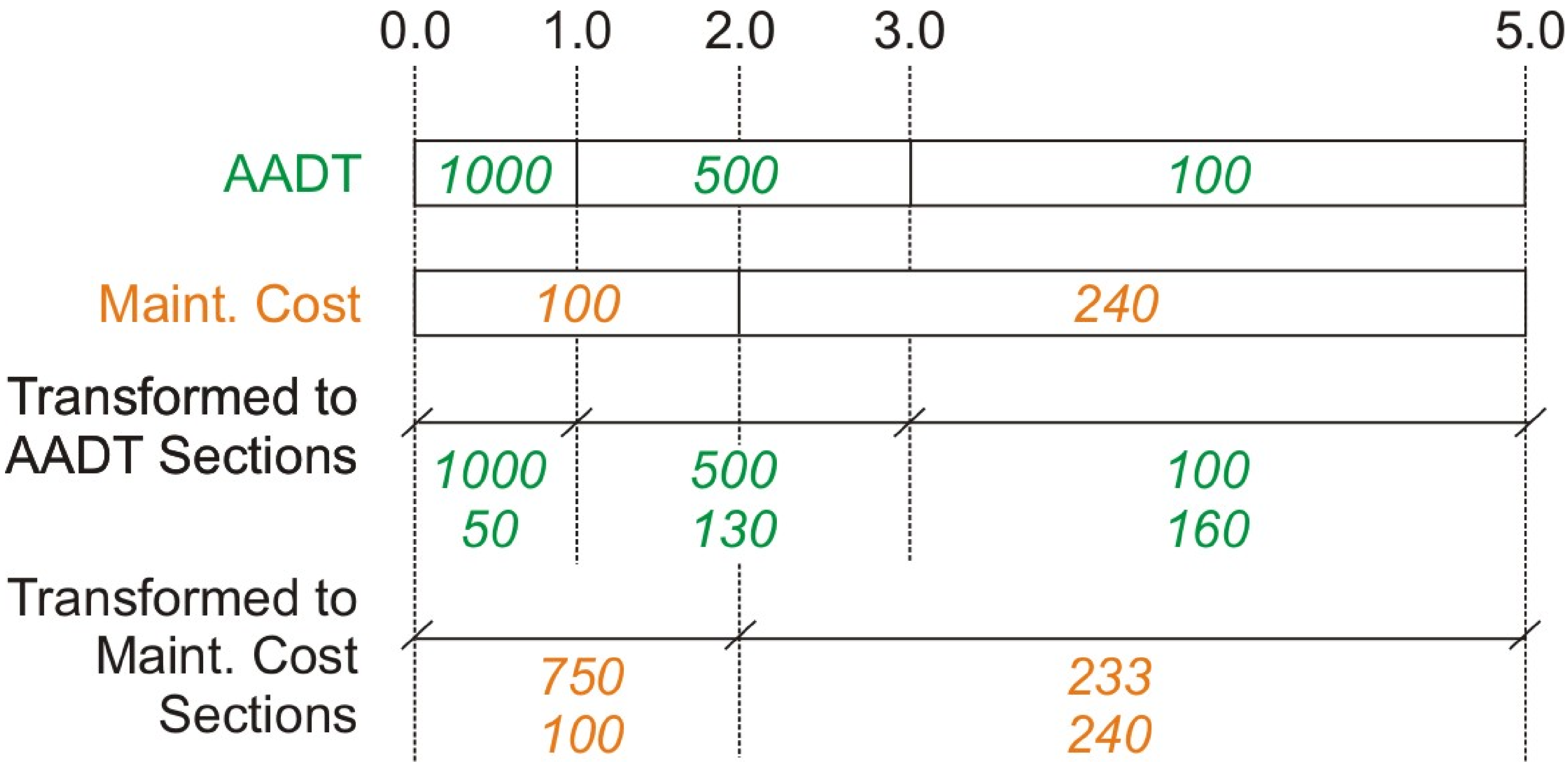
But - not all linear referenced datasets will have the same segment limits

Therefore we need a higher level of Dynamic Segmentation



New segments resulting from higher level dynamic segmentation

and intelligent transfer of data between segments (dynamically)

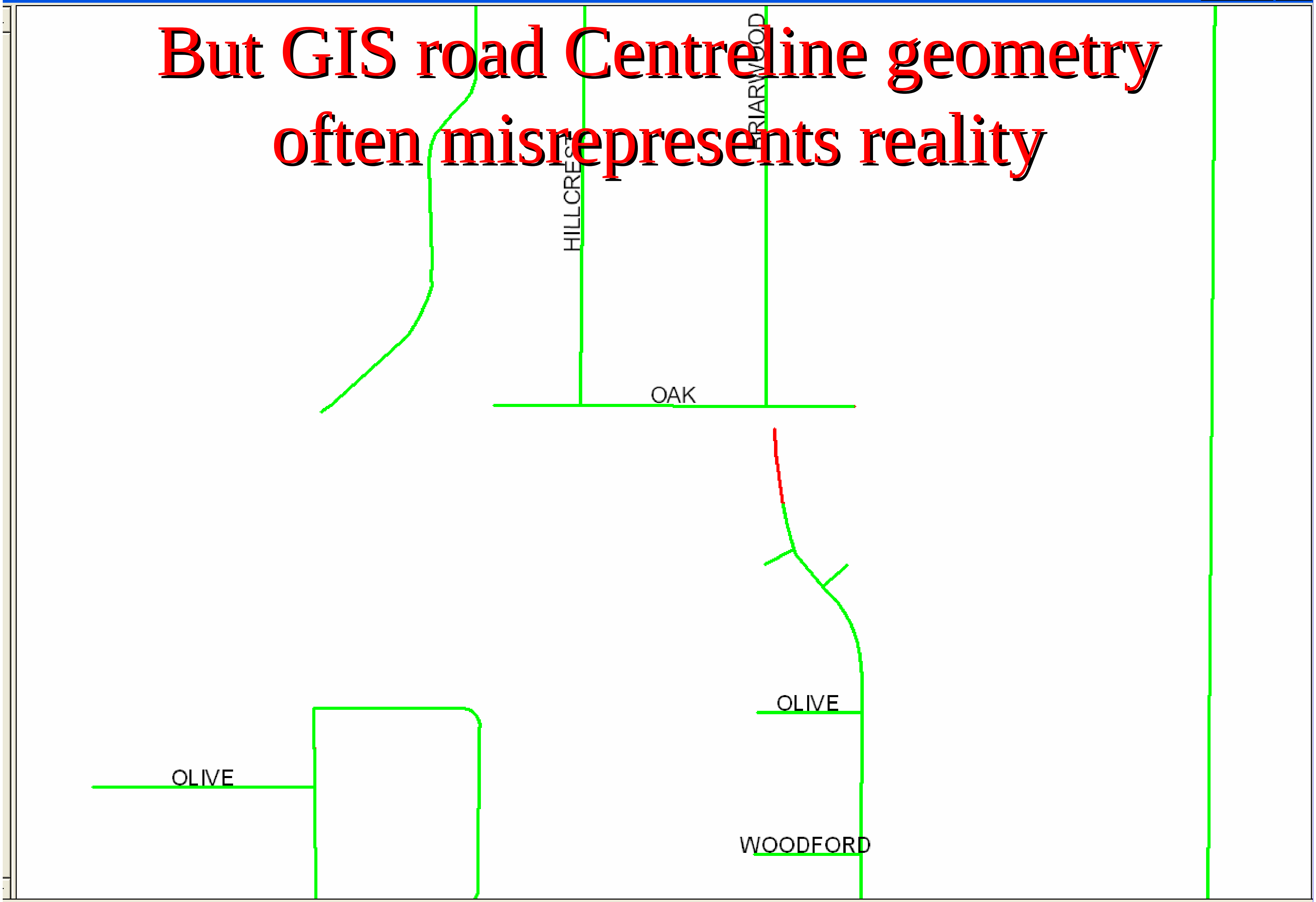


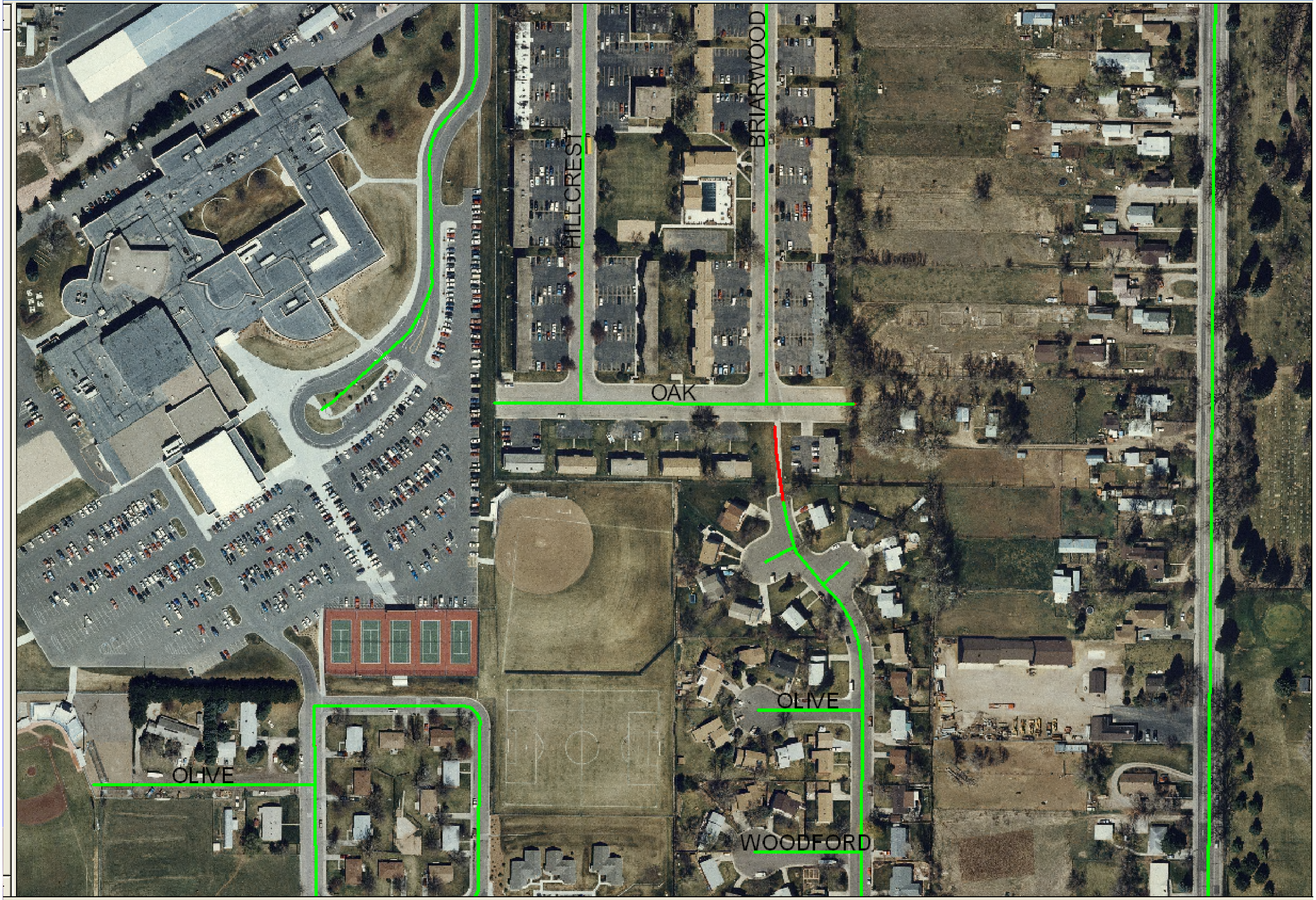
New values resulting from dynamic data transformation

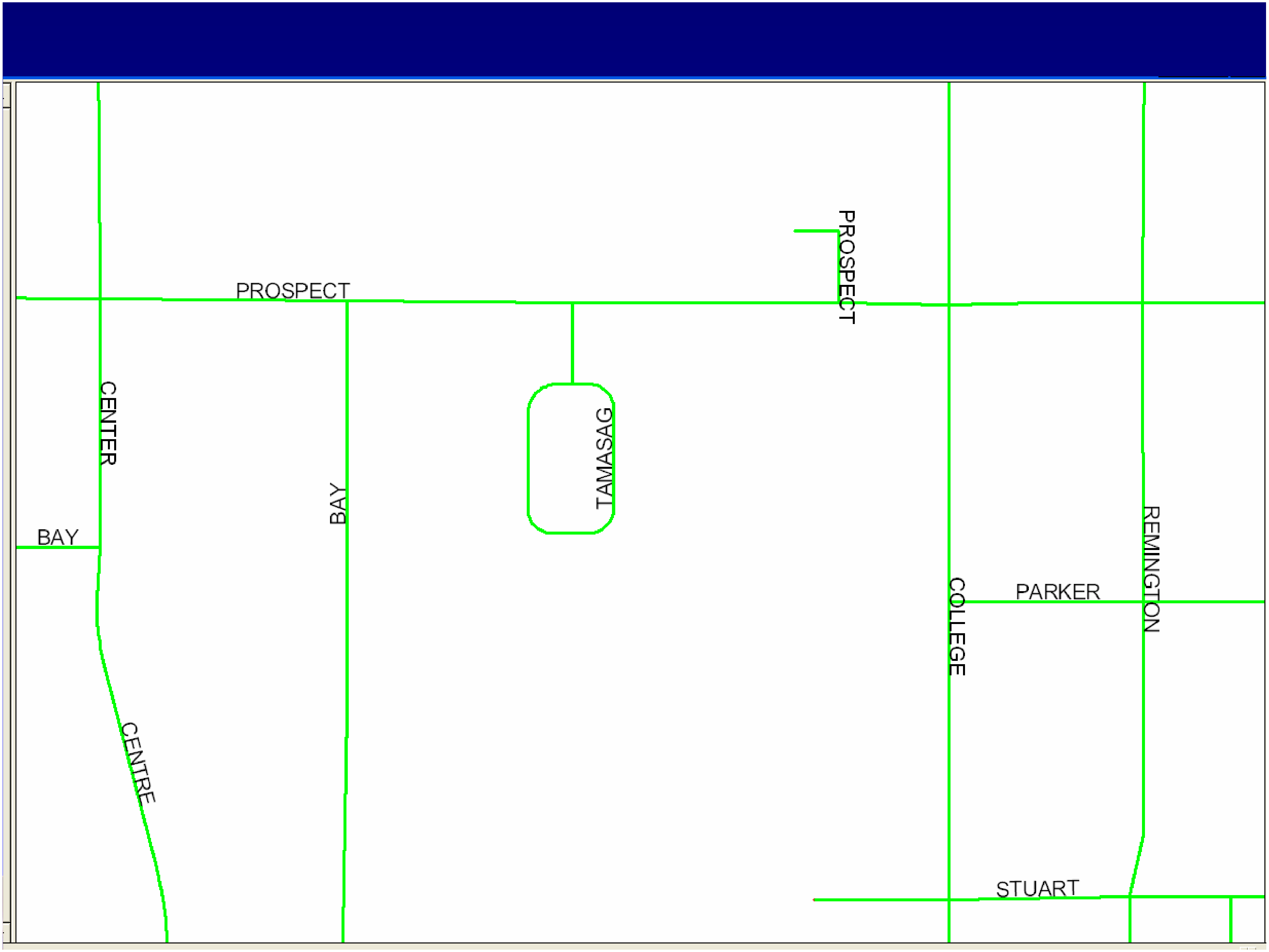
Performing Higher Level Dynamic Segmentation and/or Dynamic Data Transformation within a GIS environment is cumbersome if not impossible…..

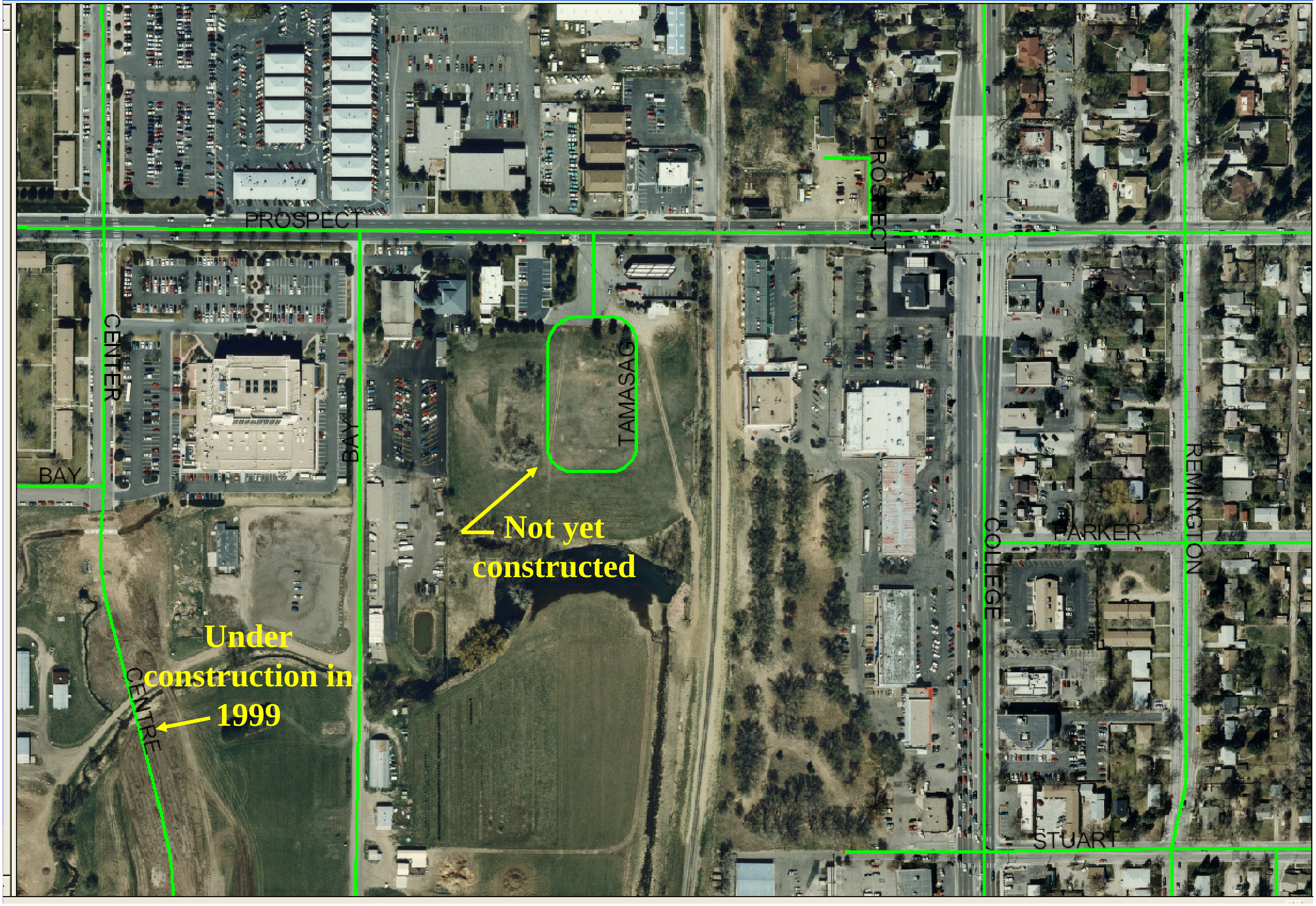
….although it is readily accomplished within some linear based Asset management software

But GIS road Centreline geometry often misrepresents reality

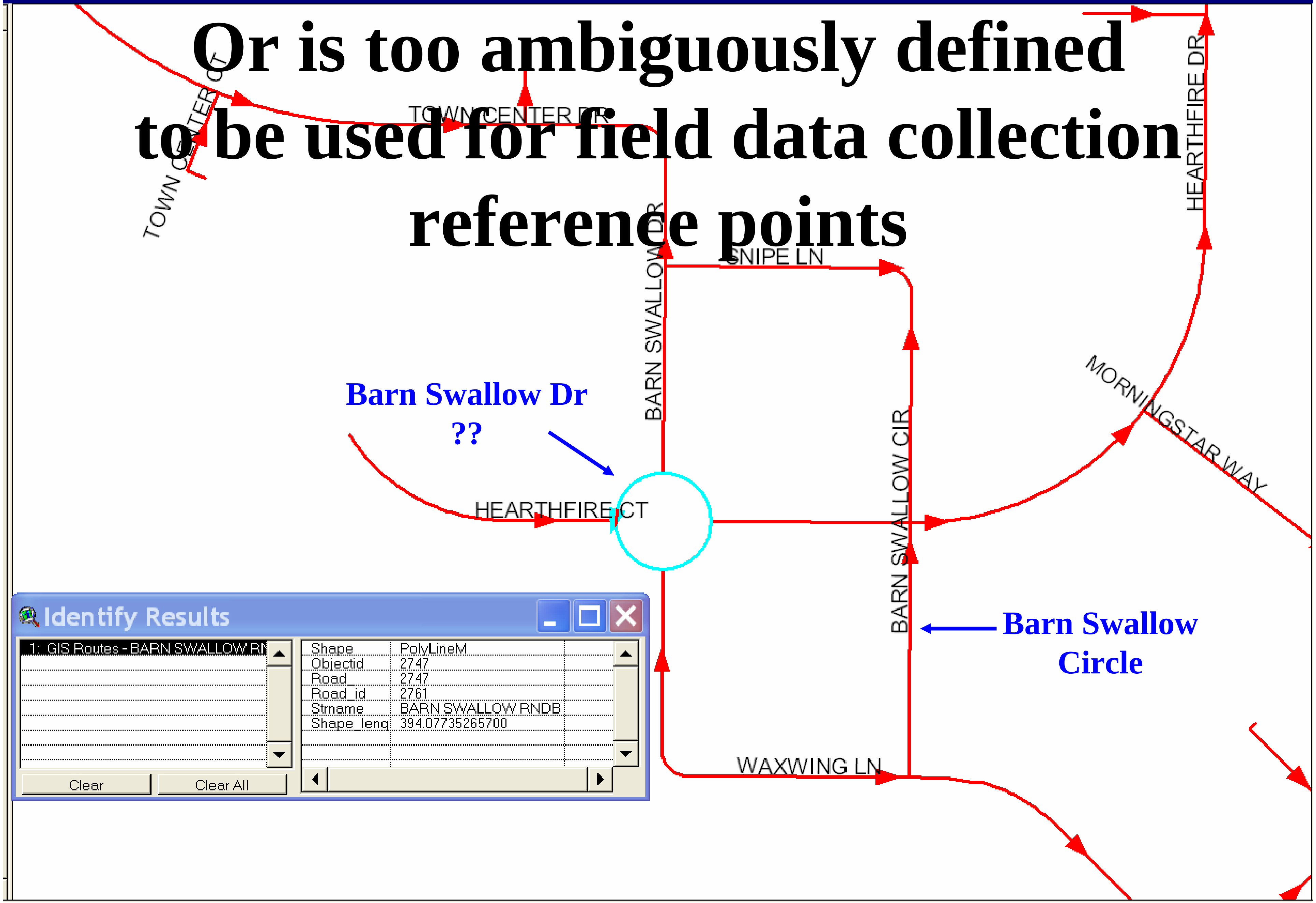



HILLCREST
BRIARWOOD
OAK
OLIVE
OLIVE
WOODFORD

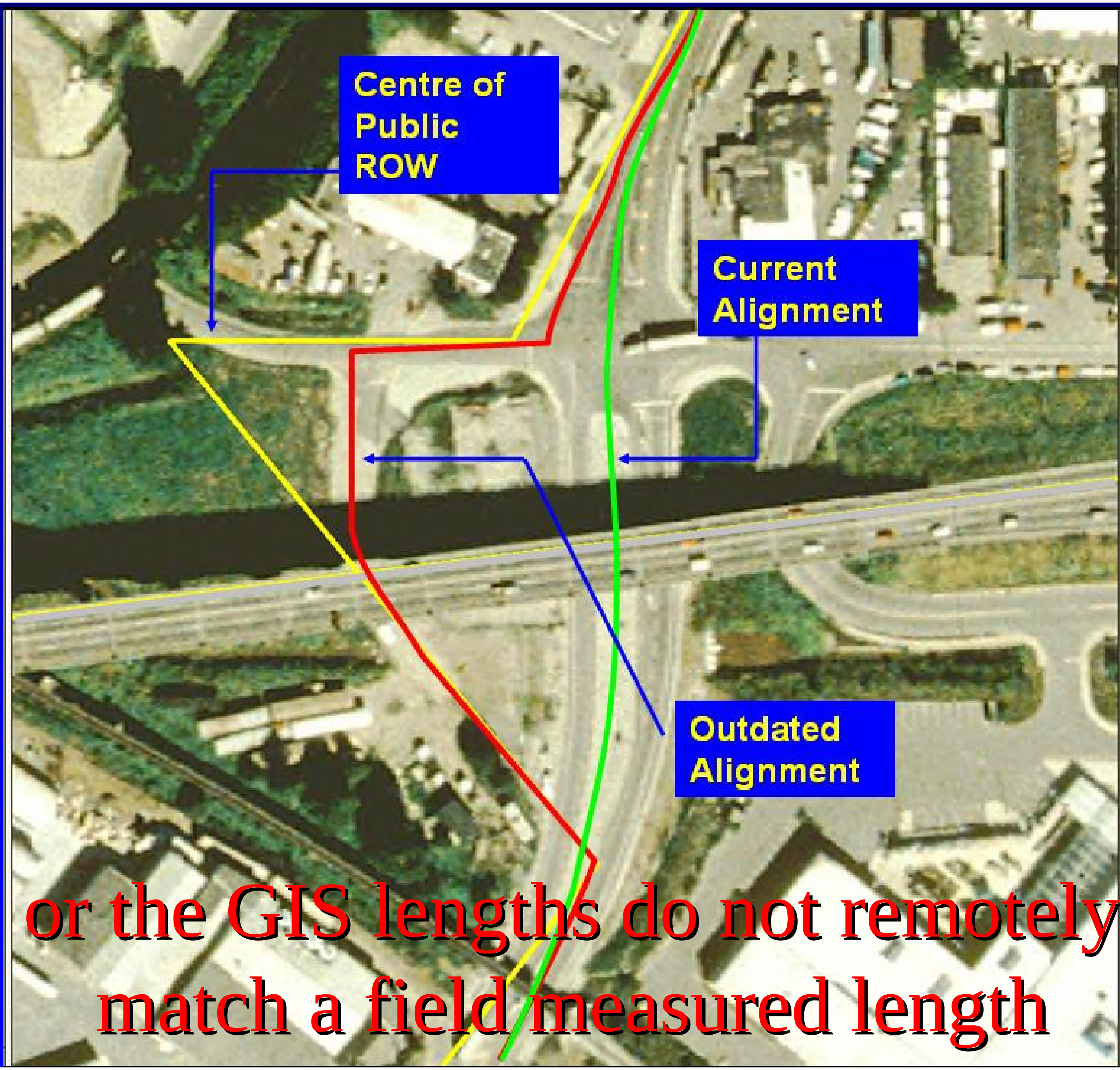

PROSPECT
PROSPECT
CENTER
BAY
TAMASAG
BAY
PARKER
COLLEGE
REMINGTON
CENTRE
STUART


PROSPECT
PROSPECT
CENTER
BAY
BAY
TAMASAG
Not yet constructed
Under construction in 1999
CENTRE
COLLEGE
PARKER
REMINGTON
STUART

Or is too ambiguously defined to be used for field data collection reference points

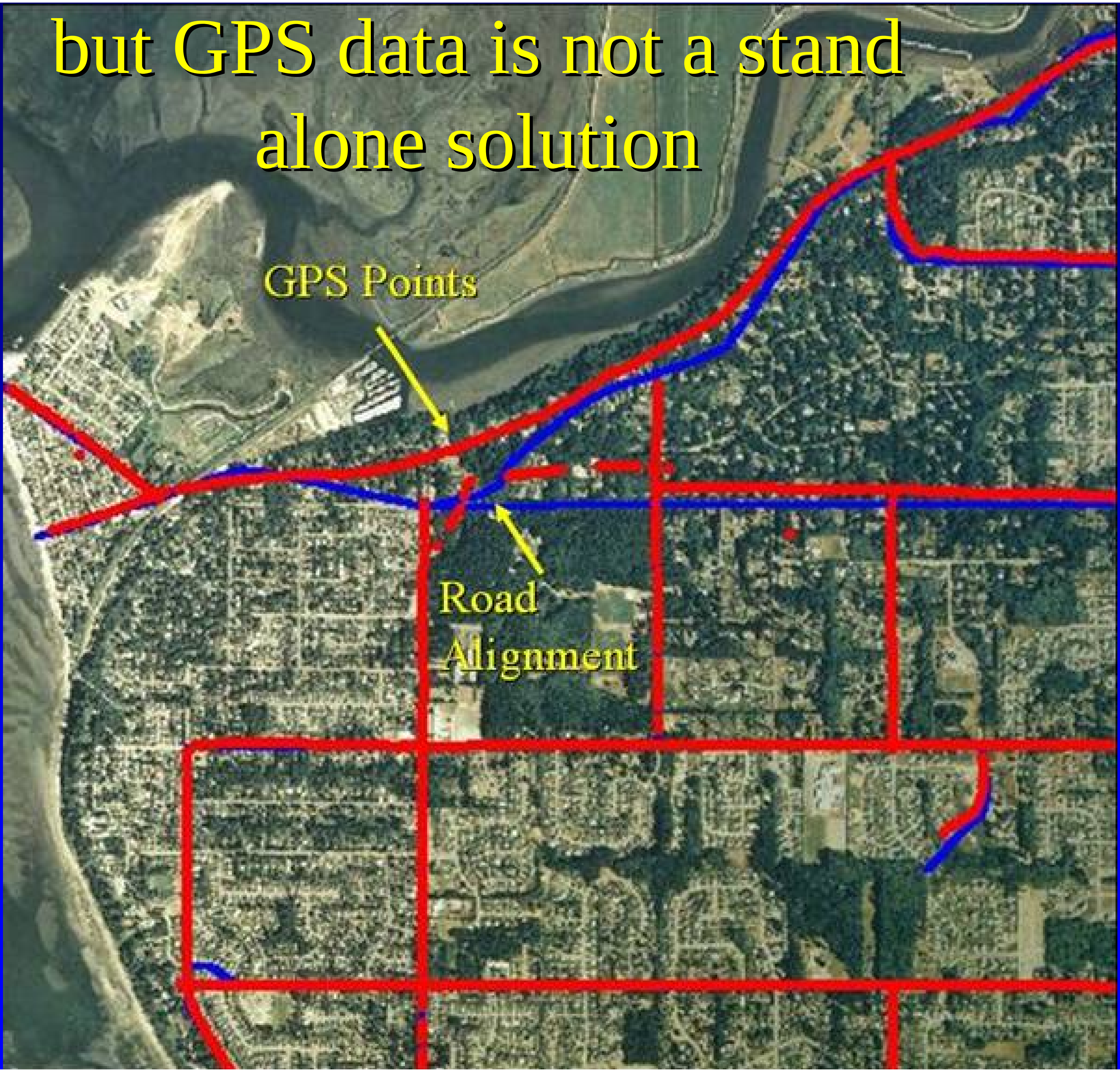



Highway 2
Highway 1
Highway 1



or the GIS lengths do not remotely match a field measured length

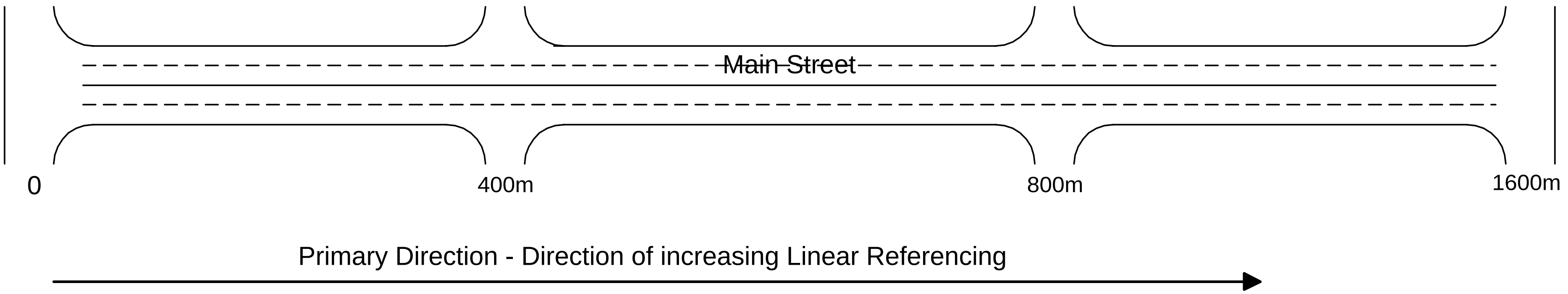
but GPS data is not a stand alone solution



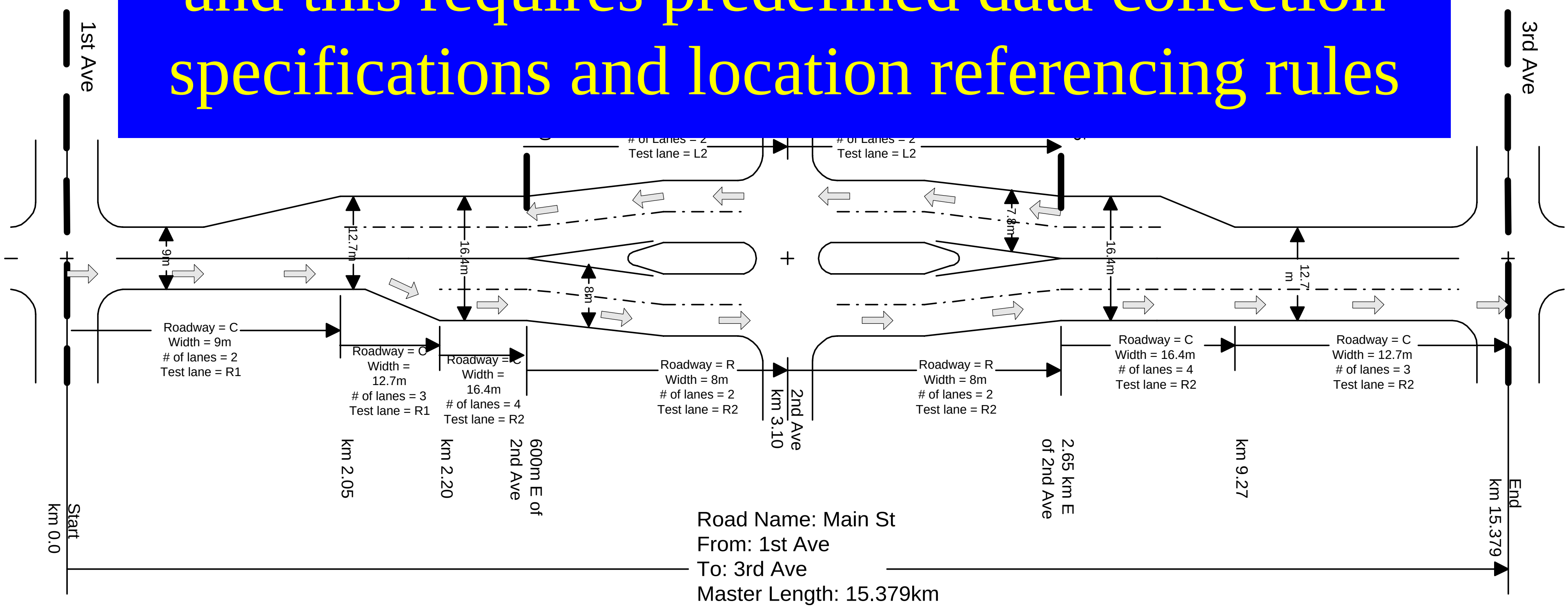
The solution requires maintaining the synchronization between:

- GIS Routes
- Data base Routes
- Field the data Collect File

Linear Location Referencing Method



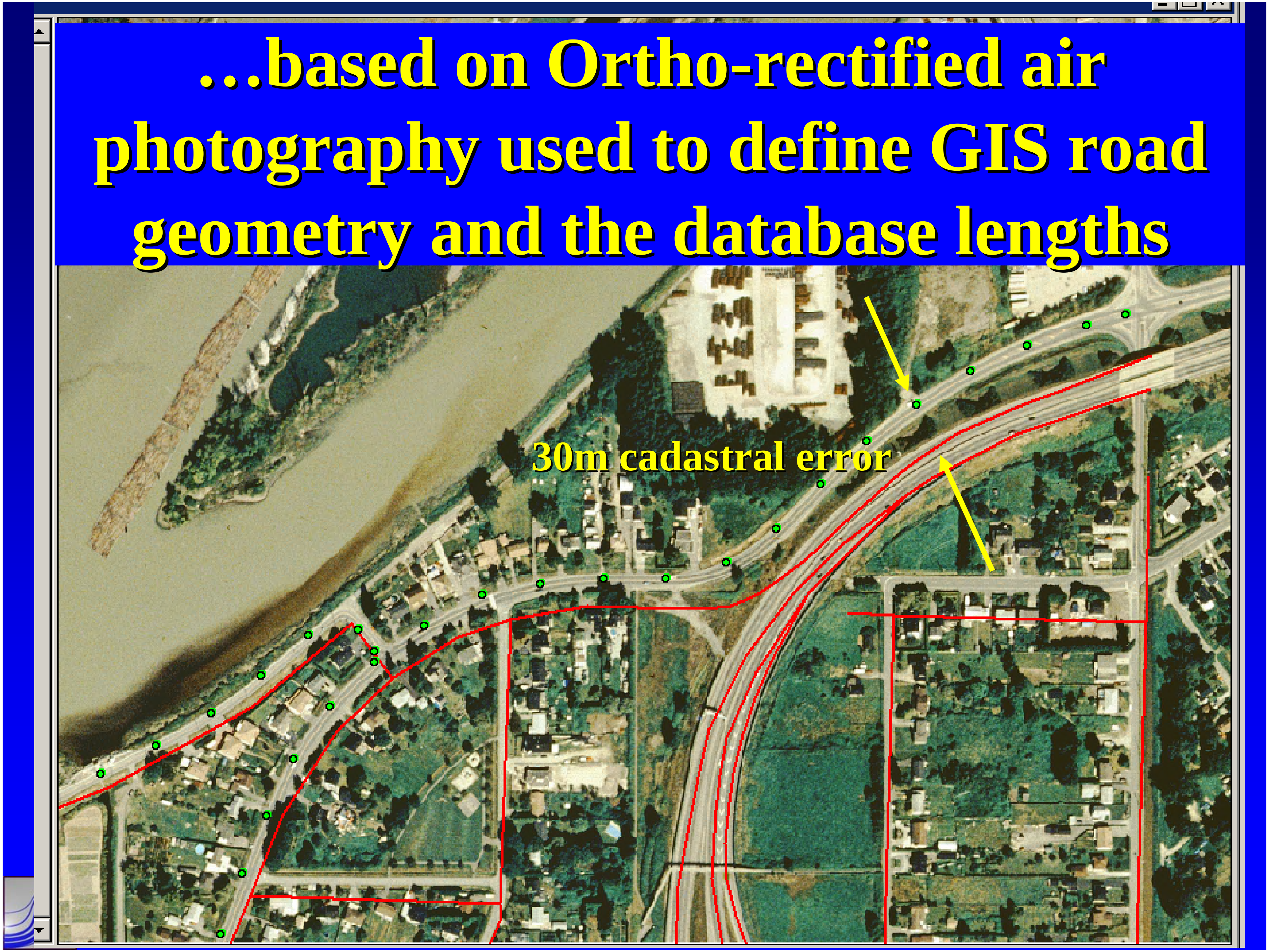
and this requires predefined data collection specifications and location referencing rules



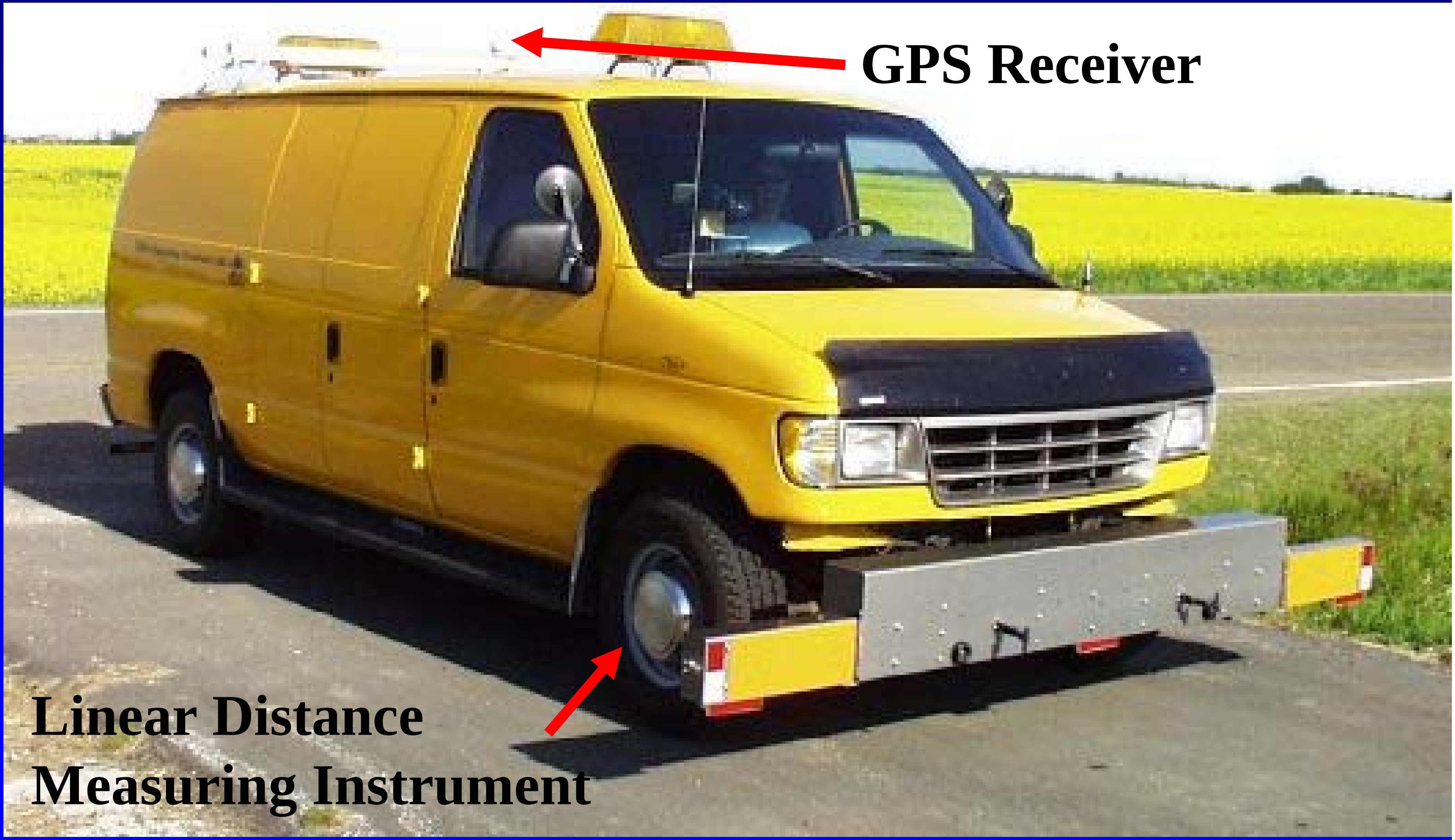
		DMI Lineal Referencing				GPS Spatial Referencing						
		Offset		Description		From Coordinates		To Coordinates		Attributes		
Road	Roadway	From	To	From	To	North	East	North	East	# of Lanes	Width	Test Lane
Main St	C	0	2050	1st Ave						2	9.00	R1
Main St	C	2050	2200							3	12.70	R1
Main St	C	2200	2500		600m W of 2nd Ave					4	16.40	R2
Main St	R	2500	3100	600m W of 2nd	2nd Ave					2	8.00	R2
Main St	R	3100	5750	2nd Ave	2.65km E of 2nd Ave					2	8.00	R2
Main St	C	5750	9250	2.65km E of 2nd Ave						4	16.40	R2
Main St	C	9270	15379		3rd Ave					3	12.70	R2
Main St	L	2500	3100	600m W of 2nd	2nd Ave					2	7.80	L2
Main St	L	3100	5750	2nd Ave	2.65km E of 2nd Ave					2	7.80	L2

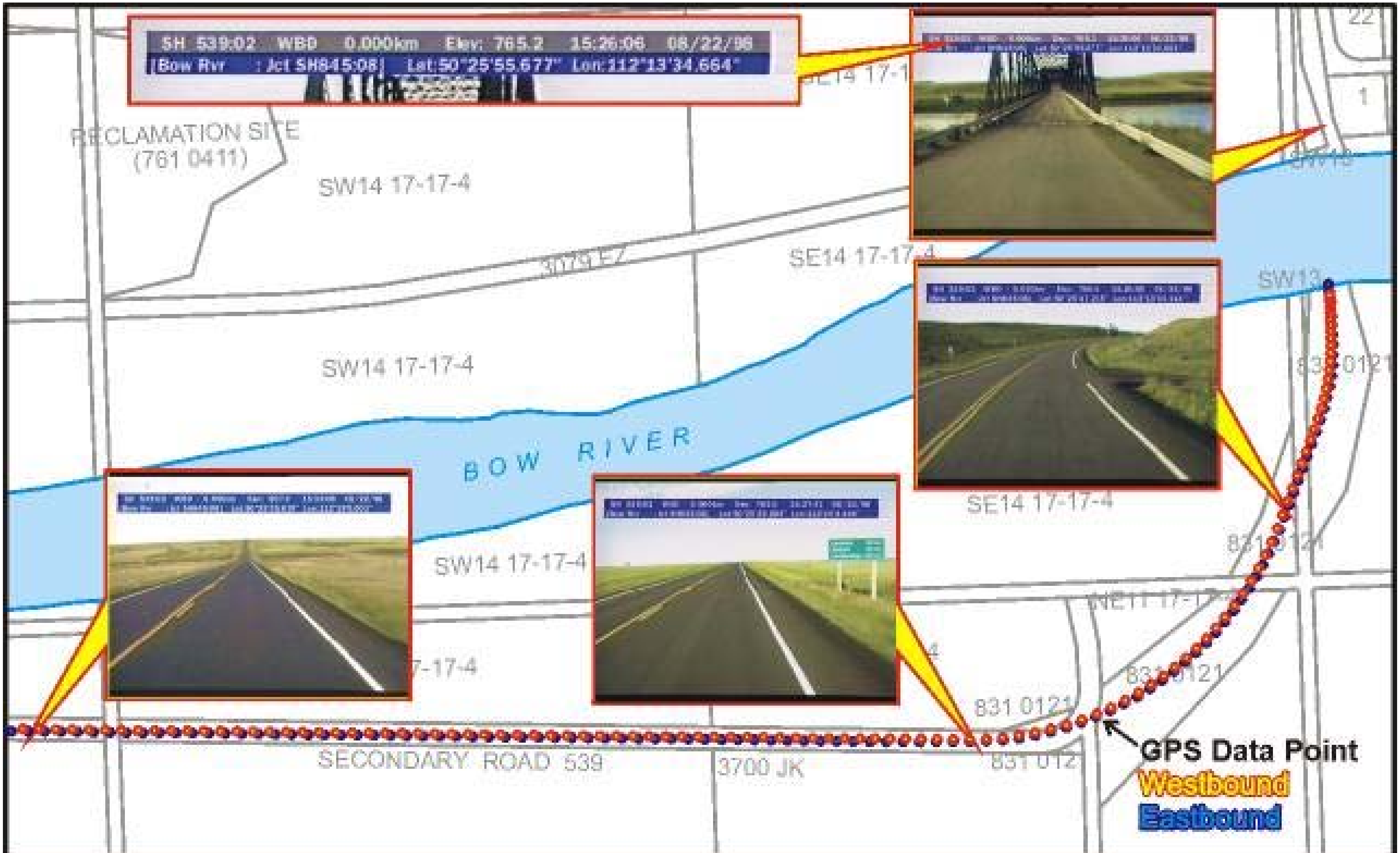
= CCR road - data collection lane(s)

…based on Ortho-rectified air photography used to define GIS road geometry and the database lengths



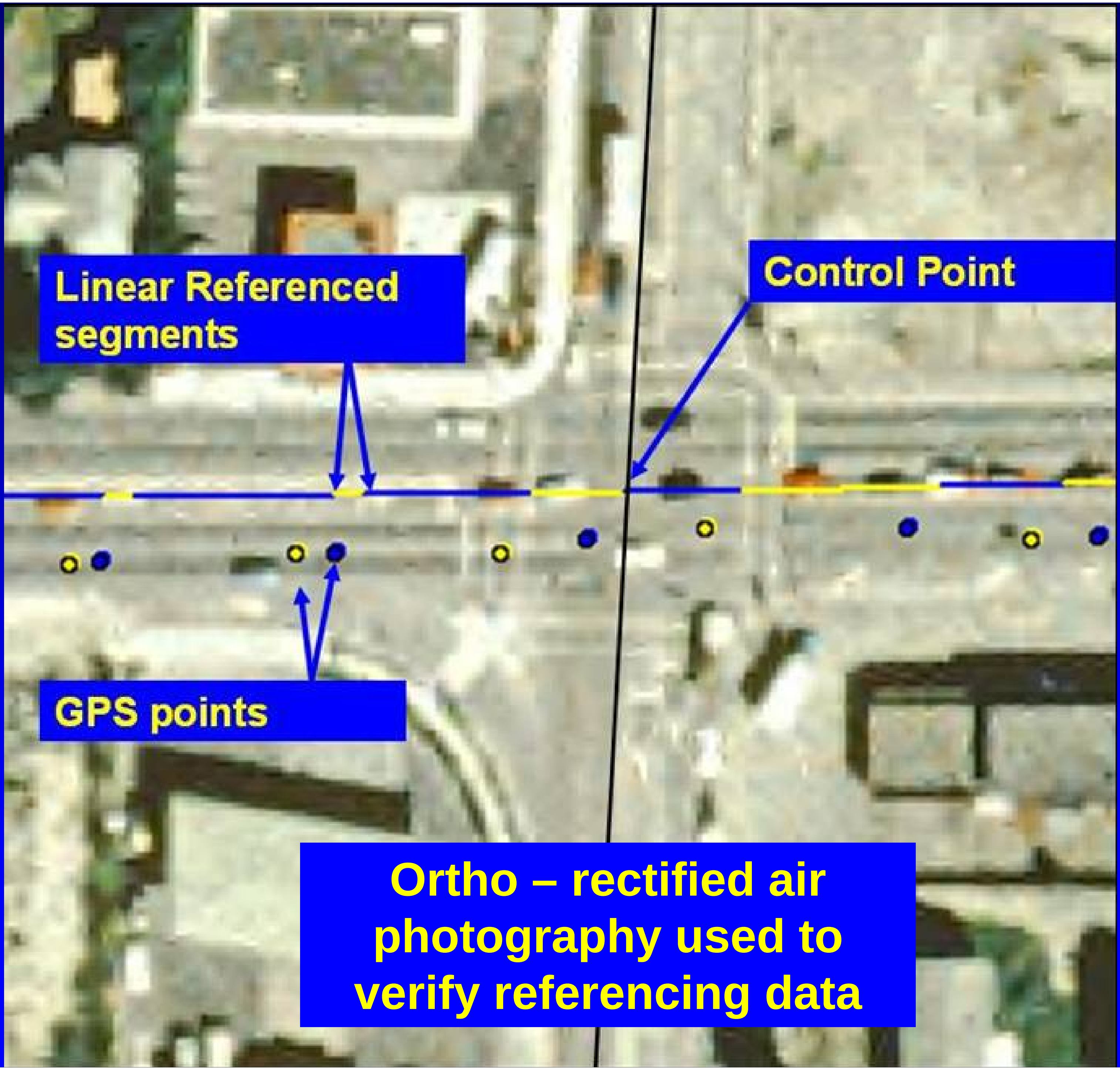
and specialized location referencing equipment on inspection vehicles …





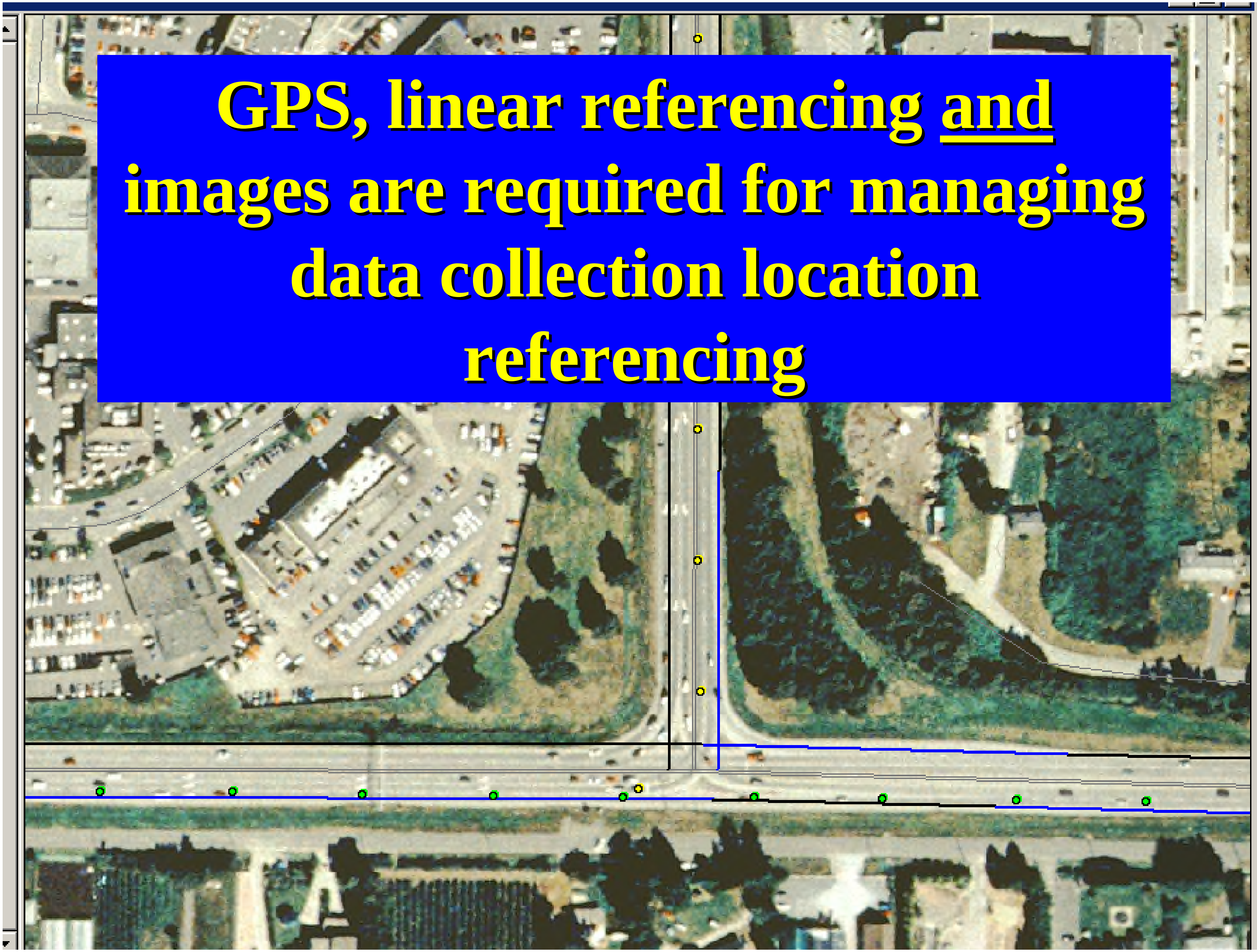
that incorporate visual, linear and spatial referencing

Because GPS alone is not enough !!



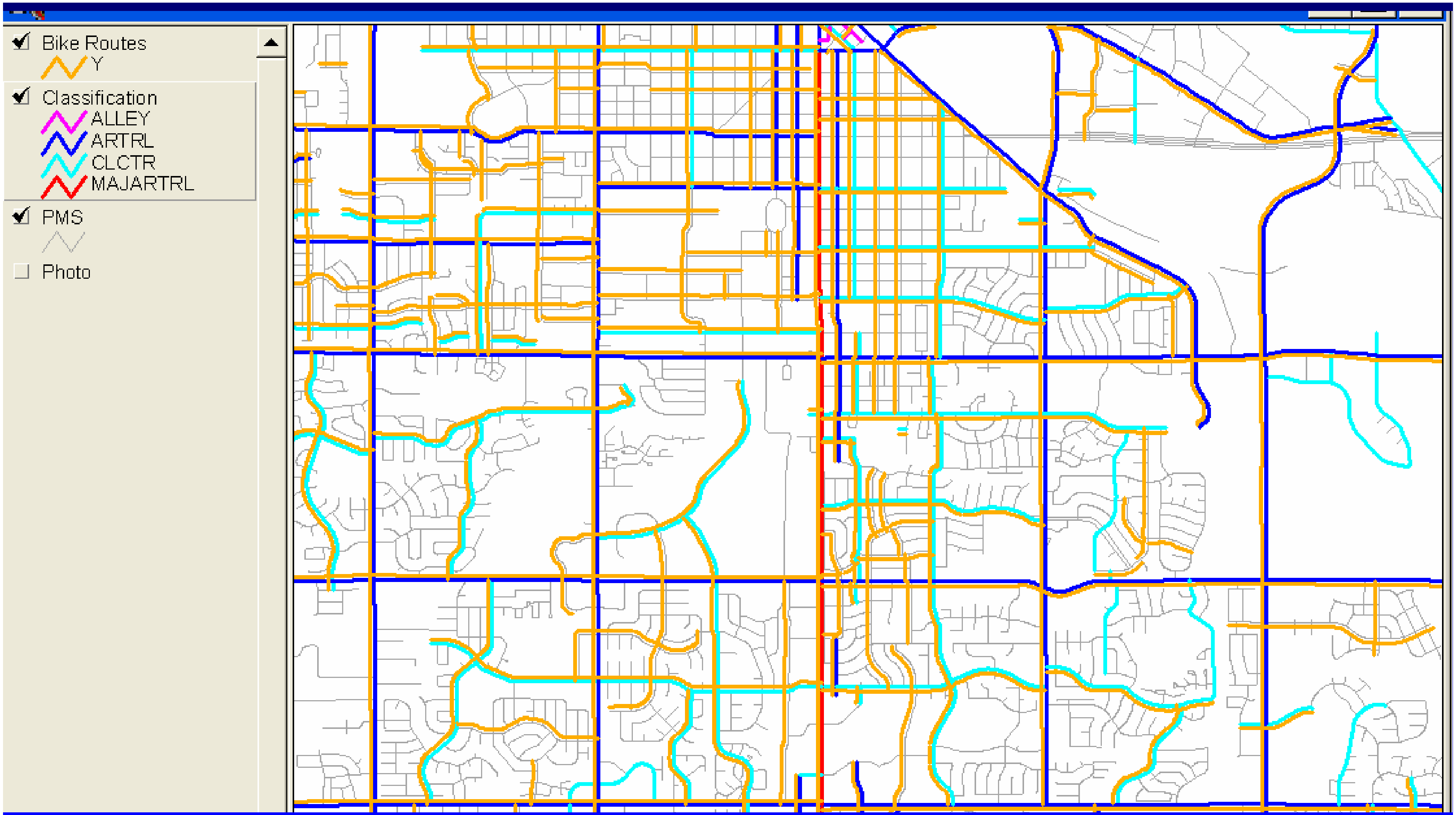
Ortho – rectified air photography used to verify referencing data

GPS, linear referencing <u>and</u> images are required for managing data collection location referencing



but there is a practical limit to the accuracy of field location referencing

but within these limits, pavement management information….



and other management system data can now be accurately integrated with roadway management data through GIS

and it is now possible to transfer linear referenced data from archived CAD as-built drawings to Asset Management Databases using a “virtual” data collection vehicle in a GIS environment.

Conclusions

- Positional accuracy of roadway related data used in most GIS and IMS is of insufficient accuracy to produce meaningful cross-location referencing queries
- The above problem can be minimized by careful attention to GIS network definition and a much more rigorous approach to data collection management

Conclusions

- Complex data analysis and life cycle cost analysis are features not readily supported within the GIS environment
- IMS applications exist that are capable of performing these complex data analyses as required for asset management
- GIS environment is well suited to maintaining the location cross-referencing between different asset classes and now as an inventory data collection tool.