

Free LRS from GIS with LRS Data Framework: Some random thoughts

presented by

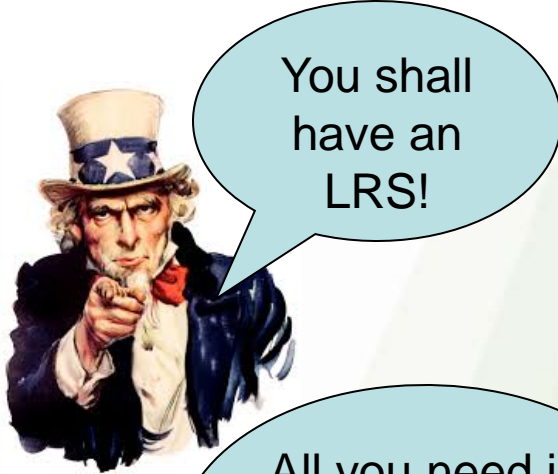
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Topic

- Arguments for simplified LRS data model
- Is GIS essential to an LRS Implementation?
- An attempt to define LRS data framework
- Demo of some LRS analysis functions

LRS Dialogue I

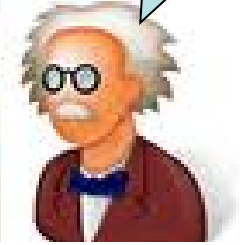


You shall have an LRS!



All you need is GIS!

My model fits all!



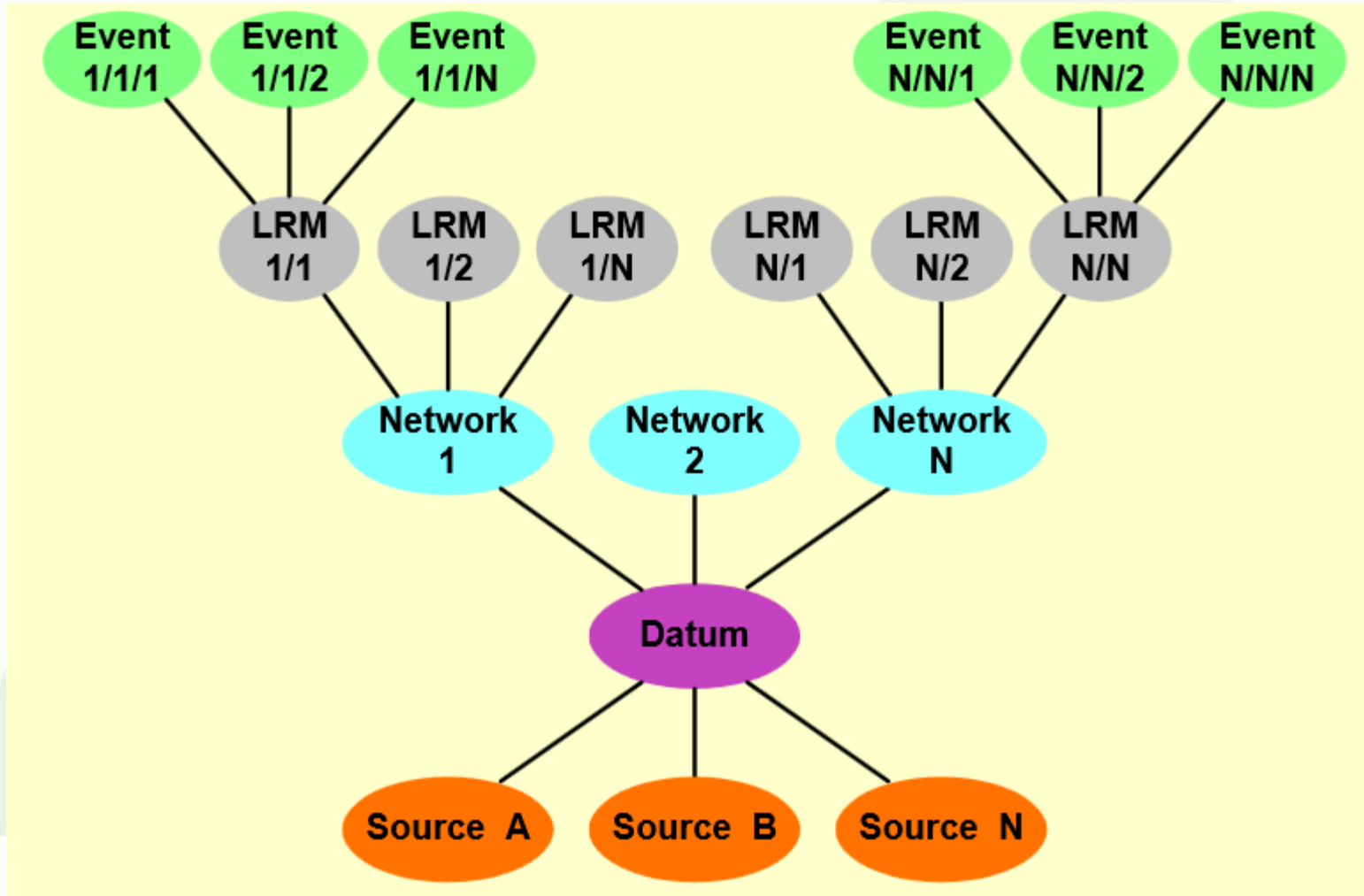
All you need is RDBMS!
BTW, how is LRS spelt?



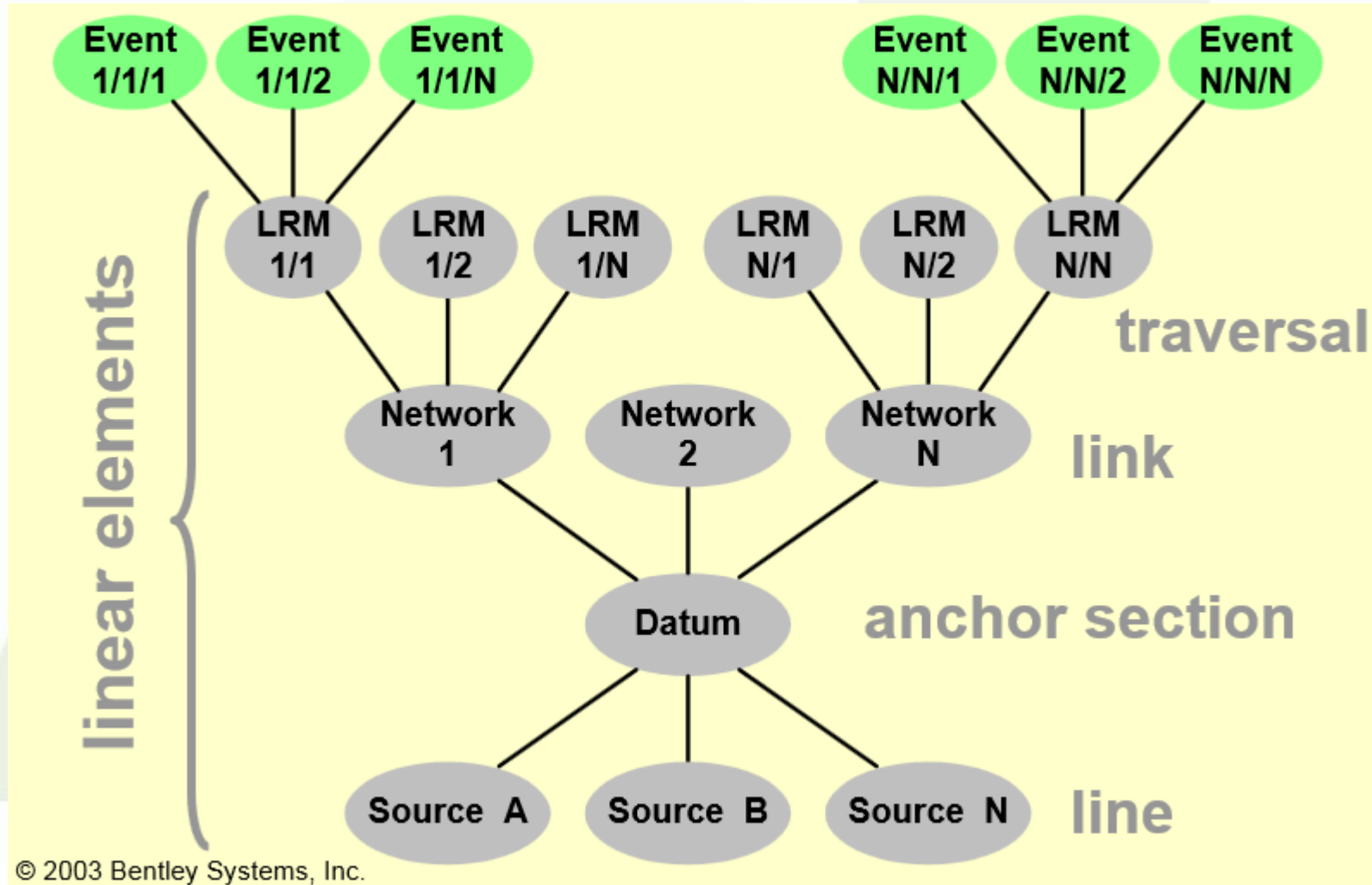
System Users

Practitioners

NCHRP Model



The Generalized Model

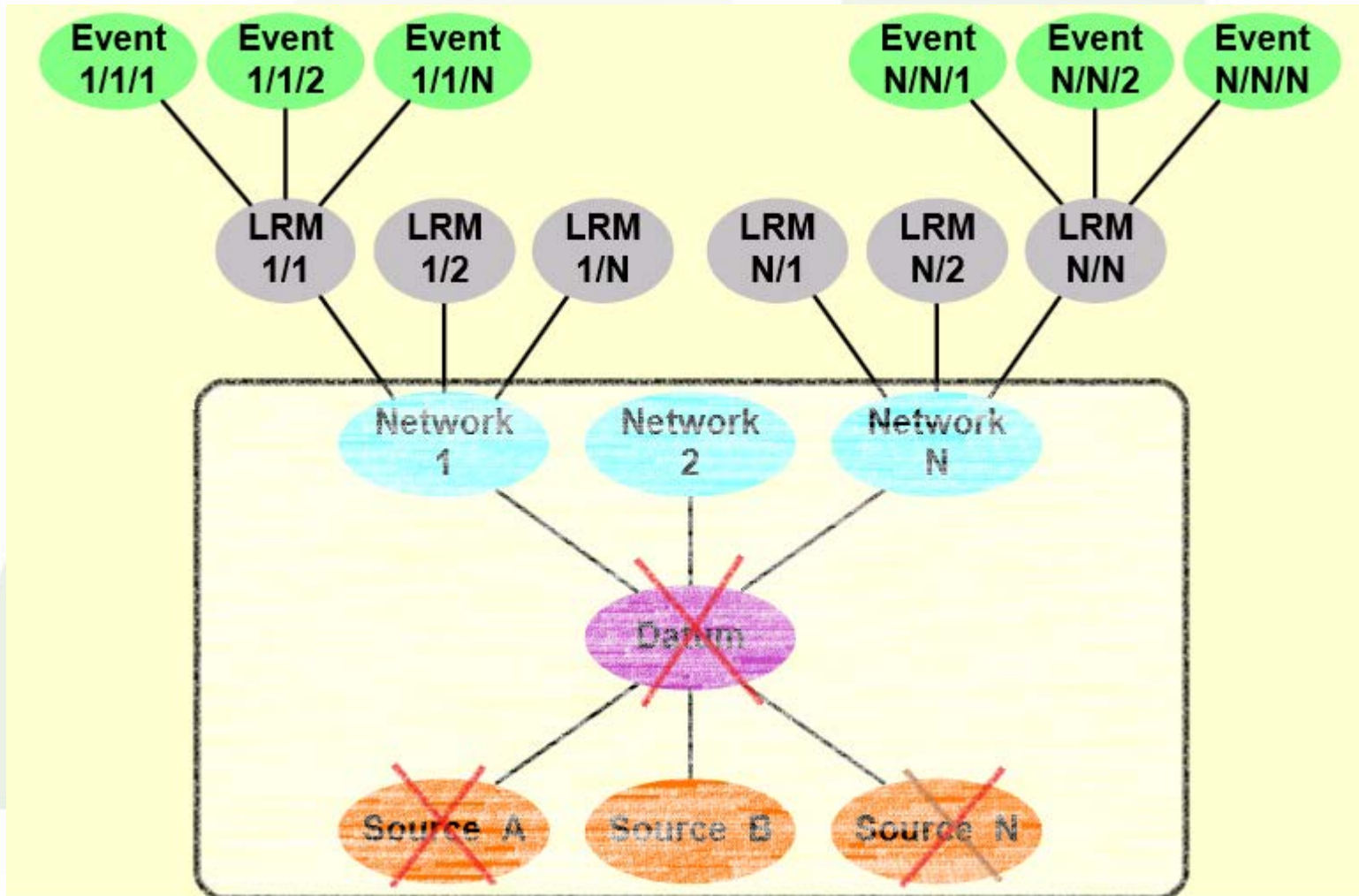


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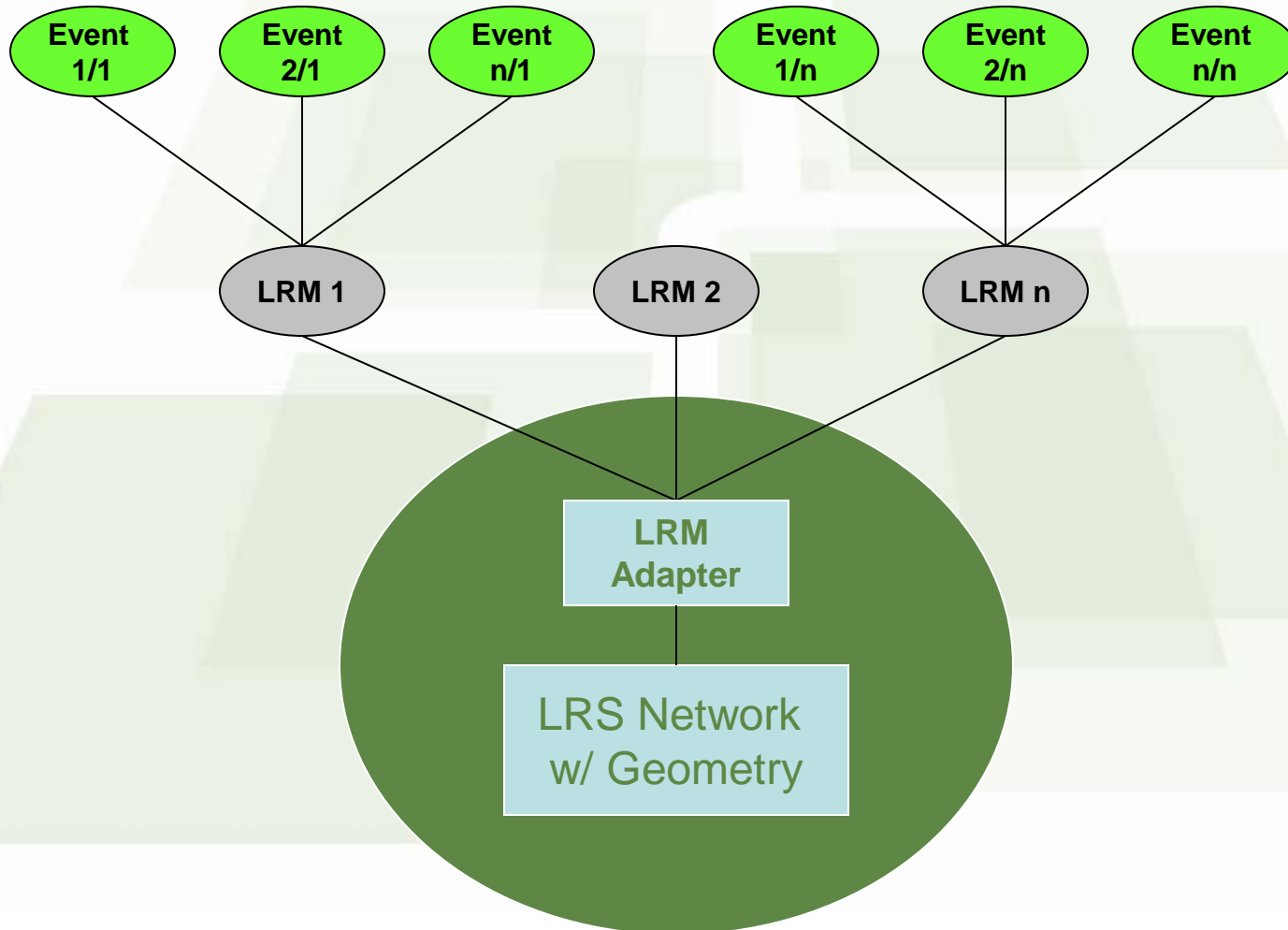
Model Implementation Challenges

- The NCHRP model and the Generalized model have been proven to work for agencies adopted.
- The cost of building and maintaining the datum layer (anchor-point/section-based network) and multiple representations is very high.
- There are agencies who would settle for ONE geographic network
 - that is accurate enough,
 - that is in sync with the LRS system, and
 - that can support most if not all LRMs.

Another Attempt to Reduce Complexity



The BaseNet Model

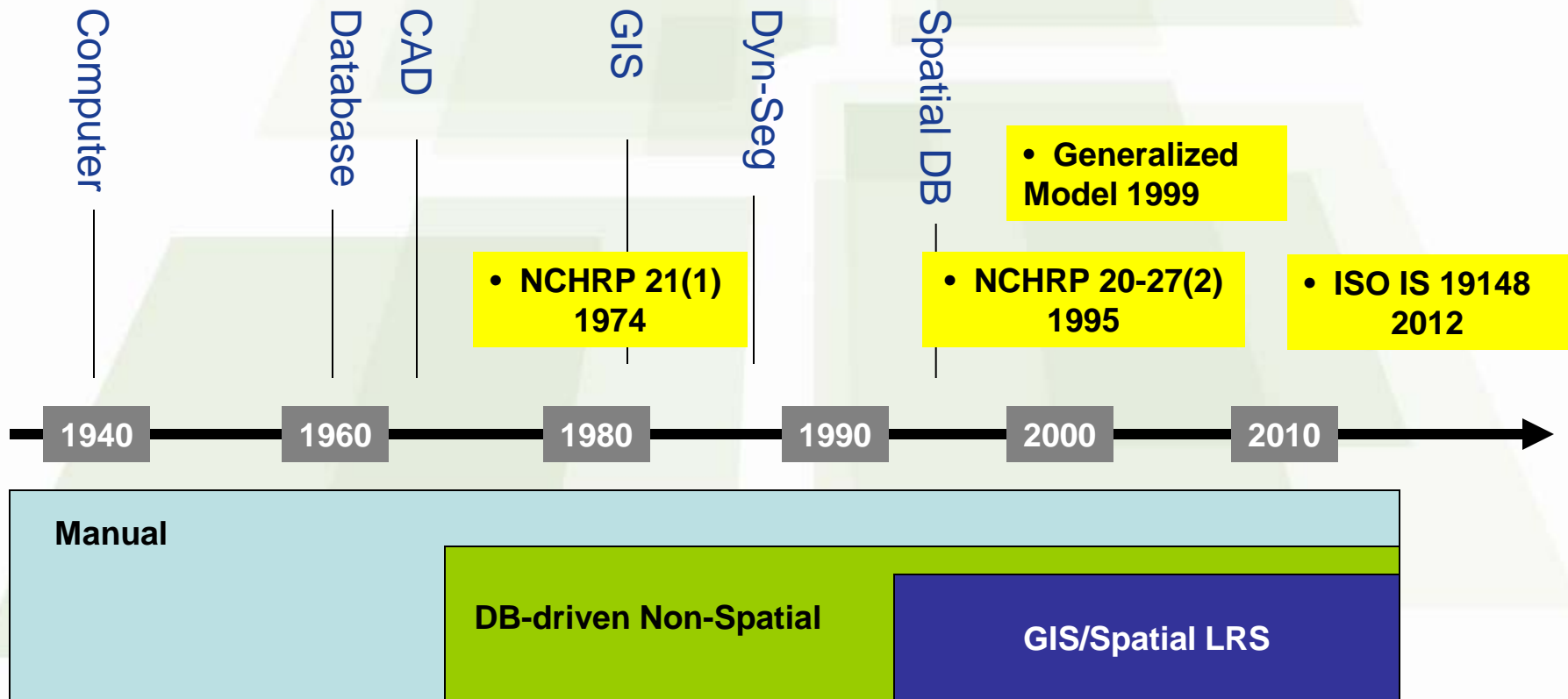


BaseNet Under the Hood

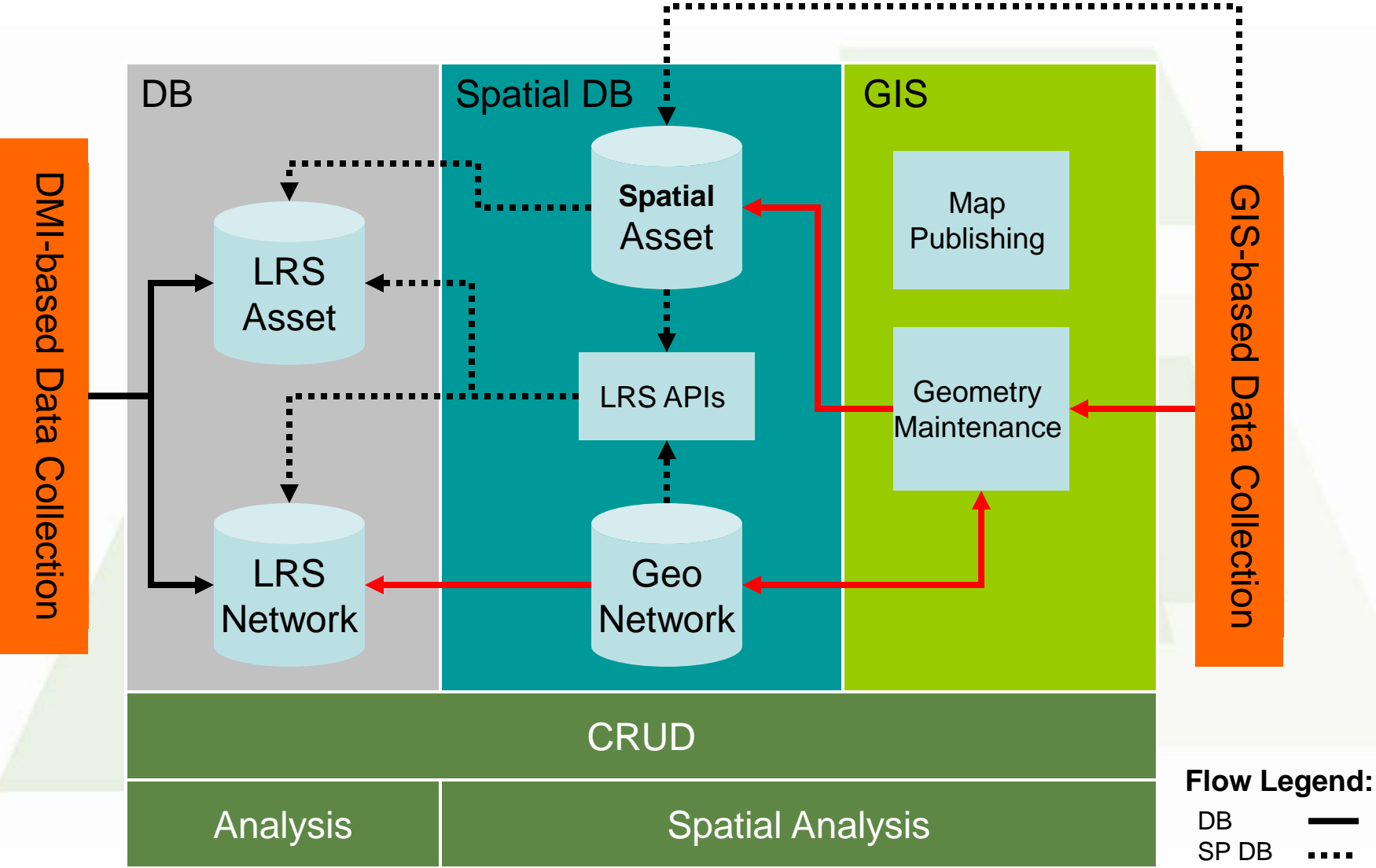
- Geographic Network with routes with or without measure calibration.
- LRM Adapter - Conversion functions support LRMs such as
 - Literal description,
 - Reference post with offset
 - Reference point with offset
 - Street address,
 - Coordinate Route
 - ...

Evolution of LRS Implementations

It is conceivable that the basic human cognition led to the invention of LRMs.



Key LRS Tasks by Tool



Flow Legend:
 DB ———
 SP DB
 GIS ———

Roles for GIS in LRS

Visual
presentation



Network
maintenance
through mapping
UI.



- Leave the rest to RDBMS if possible!
 - database modeling
 - transactional processes
 - ETL processes
 - reporting and analysis, etc.

LRS Dialogue II



Yes, Sir!



Yes, Prof. But could you make your model simpler for us?



Please support LRS which is spelled "L-R-S."



Please stay away from things that RDBMS do better!

No worries, the good days are coming!



System Users

Are better days coming?

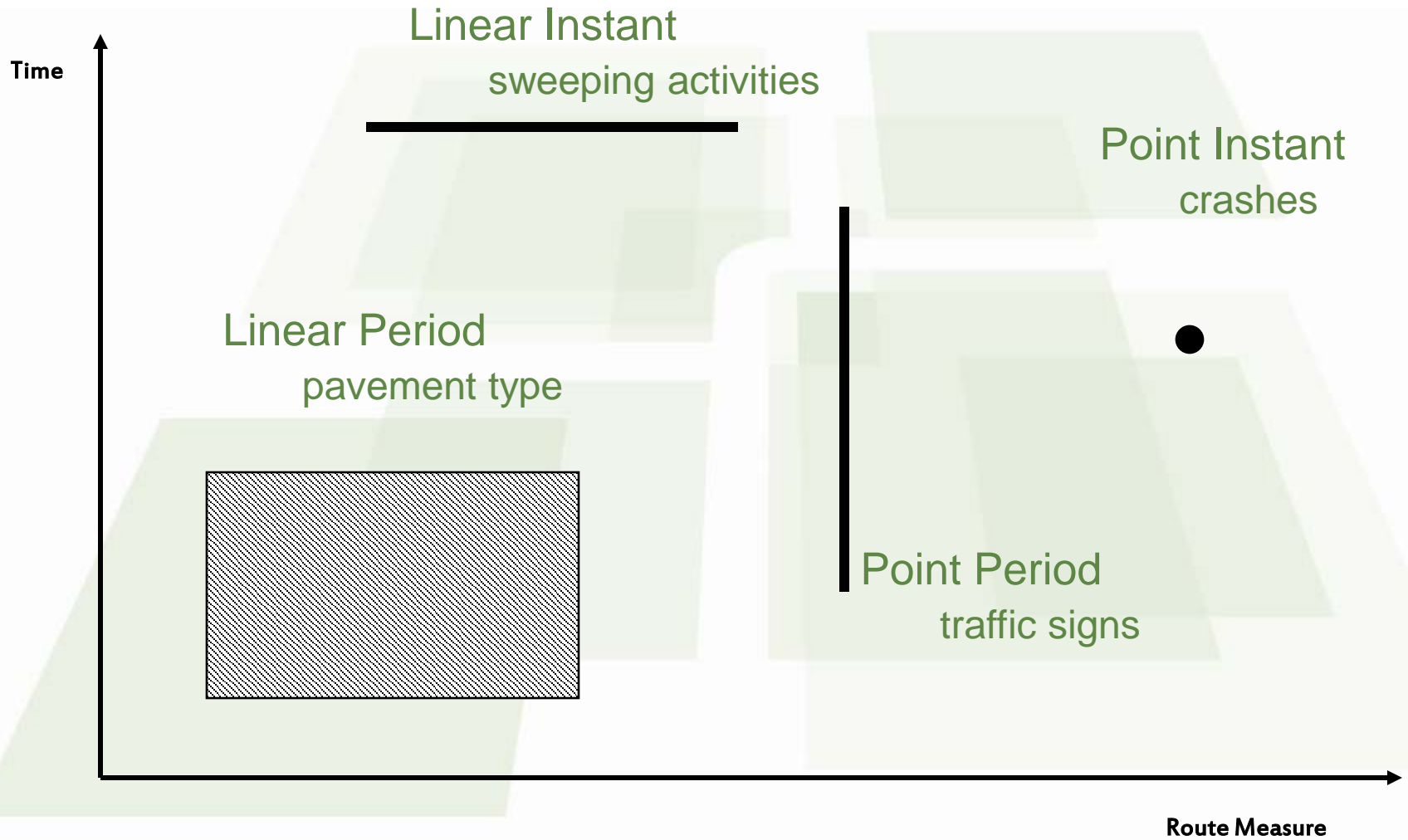
- Yes!
- But an LRS Data Framework will get us there sooner!
 - Primitive LRS – Segment
 - Segment set constraints
 - Segment relational operators
 - Segment topological relations
 - CRUD operations (storage)
 - Segment-geometry functions
 - Segment analysis functions
 - Network maintenance functions



LRS Primitive – Segment

- Assets/Events are represented by segments
 - 1-D Segment:
(route, fmeas, tmeas)
where $fmeas \leq tmeas$
 - 2-D Segment:
(route, fmeas, tmeas, beg_time, end_time)
where $fmeas \leq tmeas, beg_time \leq end_time$
- Segments have no geometry
- Segment set has closure property

2-D Segment Types



Segment Set Constraints

- Homogeneity Constraint
 - Allows one type of segment in a segment set
- Topological Constraint - examples
 - Set of segments representing IRI should not have gaps or overlaps, but
 - Topological Constraint should be relaxed for set of segments representing construction projects

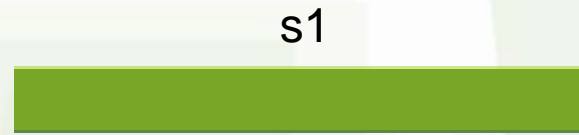
Segment Topological Relations

2-D Segment Relationships

Spatial Temporal	Disjoint	Meet	Overlap	Cover	Equal	Contain
Disjoint	Disjoint 	Disjoint 	Disjoint 	Disjoint 	Disjoint 	Disjoint
Meet	Disjoint 	Meet 	Meet 	Meet 	Meet 	Meet
Overlap	Disjoint 	Meet 	Overlap 	Overlap 	Overlap 	Overlap
Cover	Disjoint 	Meet 	Overlap 	Cover 	Cover 	Cover
Equal	Disjoint 	Meet 	Overlap 	Cover 	Cover/Equal 	Cover
Contain	Disjoint 	Meet 	Overlap 	Cover 	Cover 	Contain

Segment Relational Operators

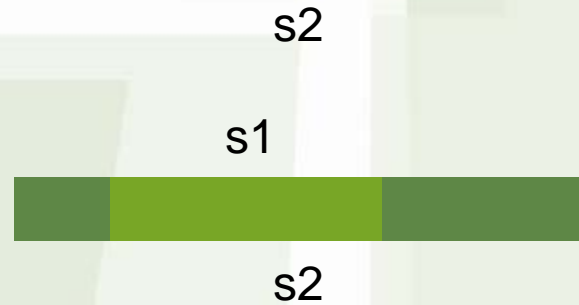
- Equals



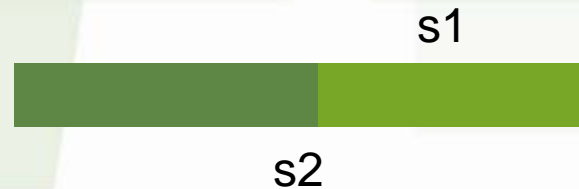
- Leads



- Lags

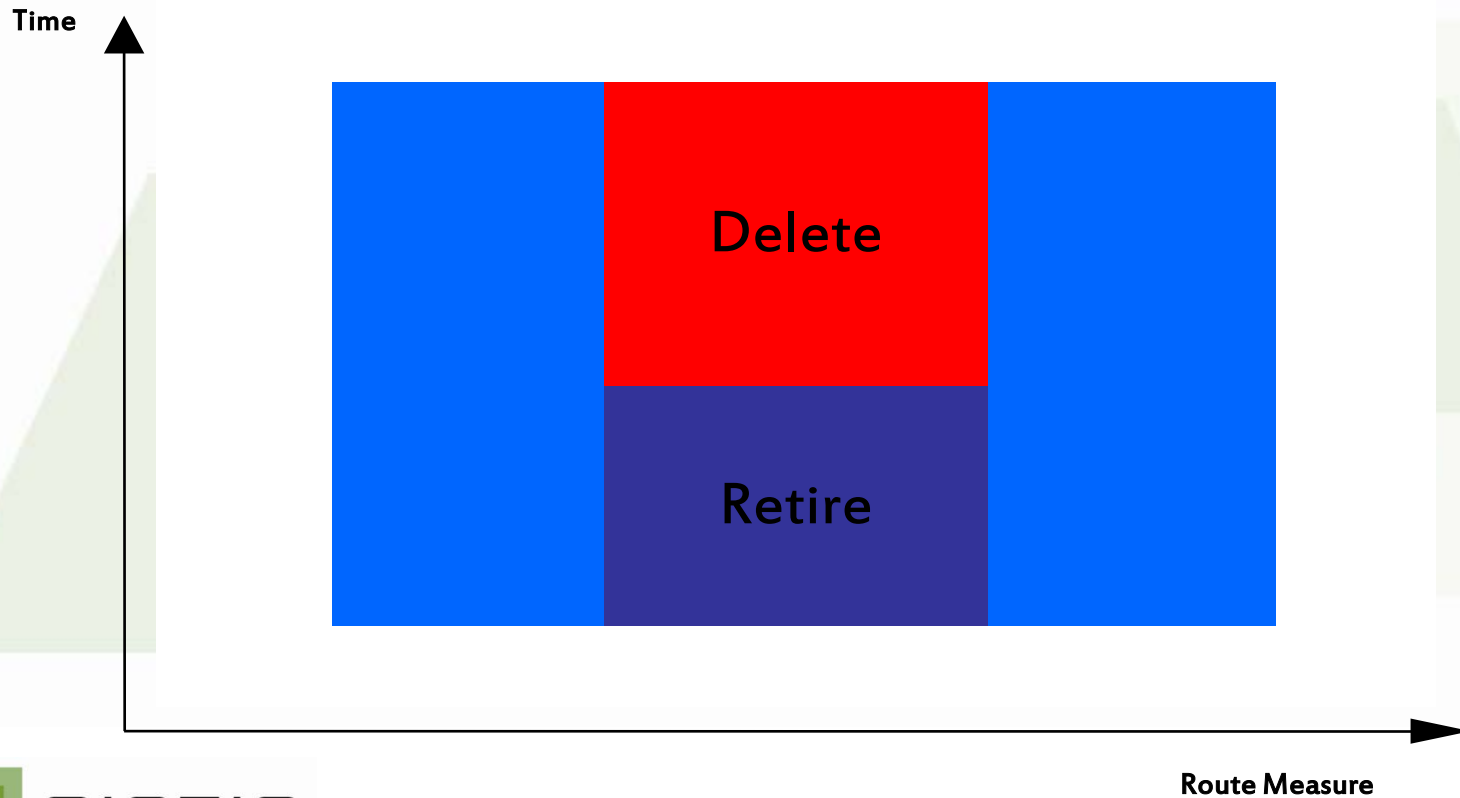


- Ties



Segment CRUD Operations

Insert, Update and Delete on 2-D Segment



Segment-Geometry Operations

- From segment to geometry
 - Dynamic Segmentation

("US 89", 275.3, 276.5)



- From geometry to segment
 - Segment Projection



("I 17", 275.3, 276.5)

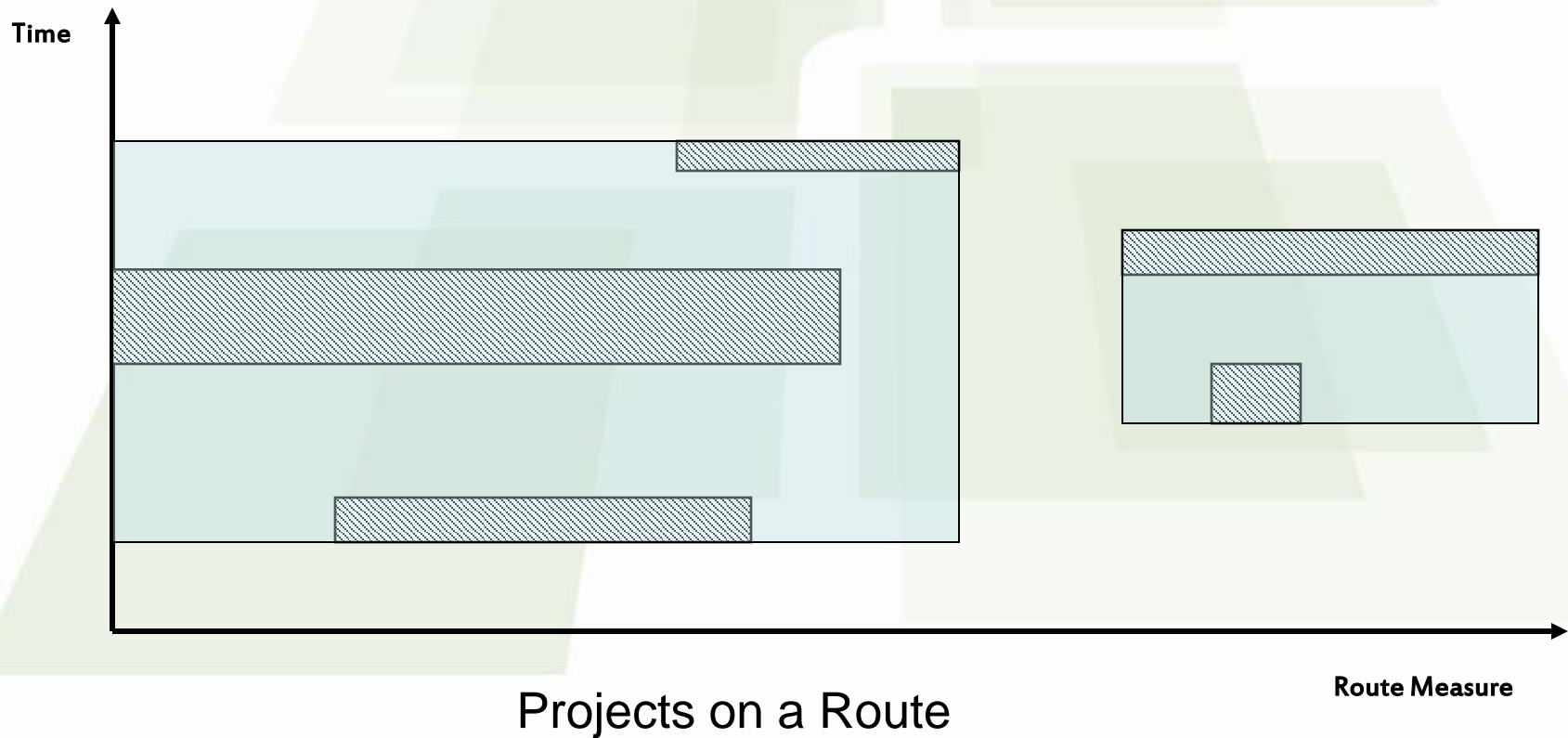
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Network Maintenance Operations

- Building LRS network with geometry
 - Interactive mapping UI is needed
 - Route calibration is required
- QC LRS network
 - Positional/representational accuracy
 - Attribute accuracy
 - Logical consistency
- LRS network change management
 - Triggering asset/event segment updates
 - Network temporal maintenance

Segment Analysis Operation Examples

- Segment Aggregation Function



Segment Analysis Function Examples

■ Basic Segment Overlay Function

Road	From-mp	To-mp	PCR
Main St	0.0	1.0	80
Main St	1.0	2.0	93
Main St	2.0	2.8	76

Overlays

Road	From-mp	To-mp	Pavement type
Main St	0.0	1.5	Asphalt
Main St	1.5	2.8	PCC

Results in

Road	From-mp	To-mp	PCR	Pave. type
Main St	0.0	1.0	80	Asp
Main St	1.0	1.5	93	Asp
Main St	1.5	2.0	93	Con
Main St	2.0	2.8	76	Con

- Iowa DOT has defined
 - Difference Overlay Function
 - Intersection Overlay Function
 - Union Overlay Function

Segment Analysis Function Examples

- Segment Density Function
 - calculates the basic statistics of selected asset attributes on a given route section subdivided by a user-defined equal length
- Segment Cluster Function
 - groups LRS points on a given route based on their spatial proximity using a K-means clustering algorithm
- Demo - LinearBench Analyze

Conclusion

- The BaseNet model attempts to simplify LRS implementations.
- Most of the LRS challenges can be addressed by RDBMS.
- LRS data framework defines the LRS building blocks and functional requirements, a majority of which can be implemented efficiently in SQL.





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