



Distinct Road Layer Correlation Using Linear Referencing

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The Situation in Formal Terms



Police reports
Operator reports

Data entry pick lists



HPMS
Planning



Emergency dispatch
Public geocoding



The Situation in Formal Terms (Cont'd.)



Police reports
Operator reports

Data entry pick lists



HPMS
Planning



Road names
Addresses

Centerlines
Ramp, service road names



Emergency dispatch
Public geocoding



The Situation in a Nutshell

- Two line layers represent the same real world objects
 - Attributes from one could enrich or correct attributes in the other
 - The layers will be separately maintained and updated
- Asset management roads
vs.
Address geocoding roads
- Street names,
address ranges
- Different purposes,
agencies, providers

Problem

The ~~Situation~~ in a Nutshell

- Two line layers represent the same real world objects
 - Attributes from one could enrich or correct attributes in the other
 - The layers will be separately maintained and updated
- Different geographic accuracy, network topology
- Street names, address ranges
- Edits will break or invalidate established relationships

Data Sets Illustration



Simple Relation

Add the key value to each row in one data set uniquely identifying the corresponding row in the other data set

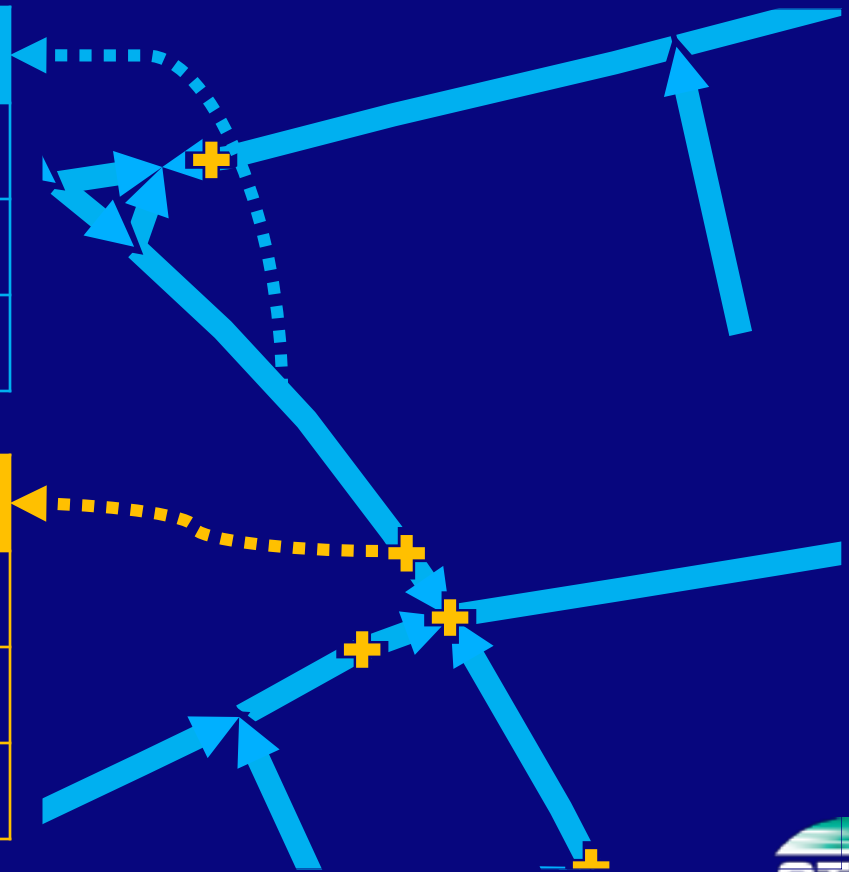
Optimal Conditions:

- Key values are reasonably stable
- Relationship is one-to-one
- Attribute values independent of shape

Simple Relation Illustration

Road Record	
Road_ID	23391
Road_Class	Arterial
Speed_Limit	30

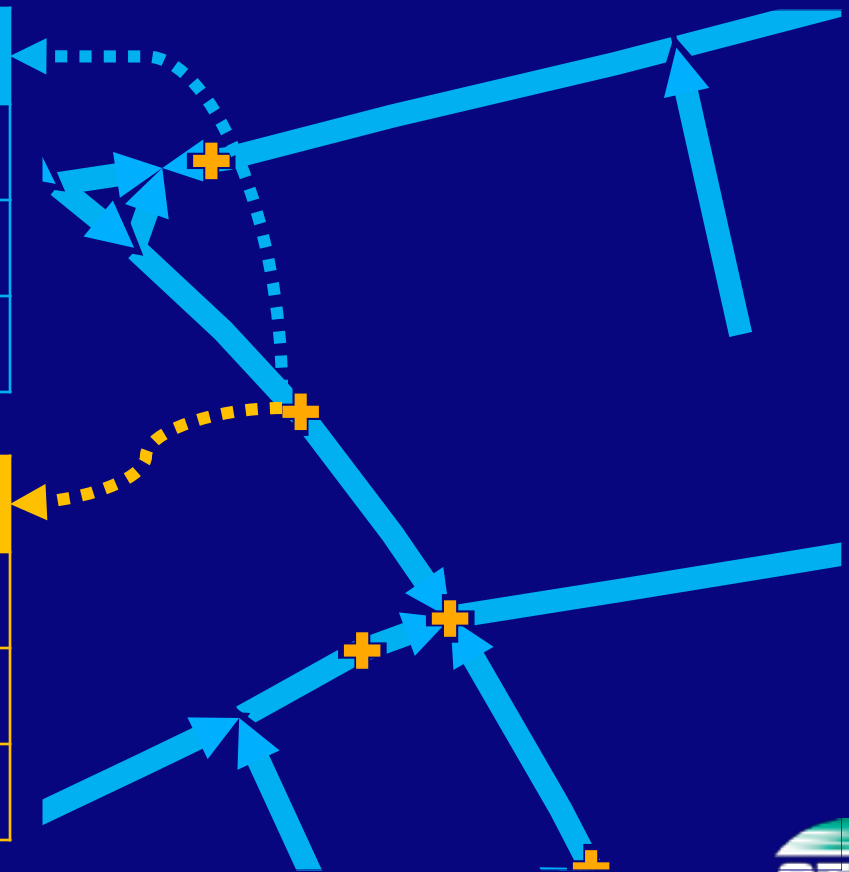
Crash Record	
Crash_ID	102234
Fatalities	2
Road_ID_FK	23391



Simple Relation Illustration (Cont'd.)

Road Record	
Road_ID	23391
Road_Class	Arterial
Speed_Limit	30

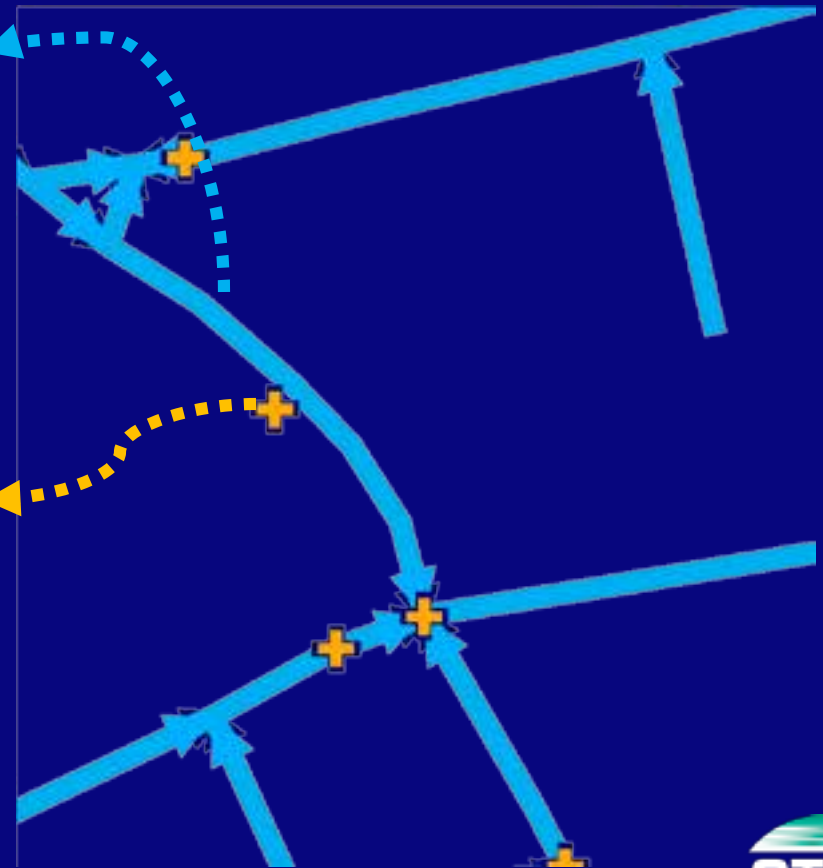
Crash Record	
Crash_ID	102234
Fatalities	2
Road_ID_FK	23391



Simple Relation Illustration (Cont'd.)

Road Record	
Road_ID	23391
Road_Class	Arterial
Speed_Limit	30

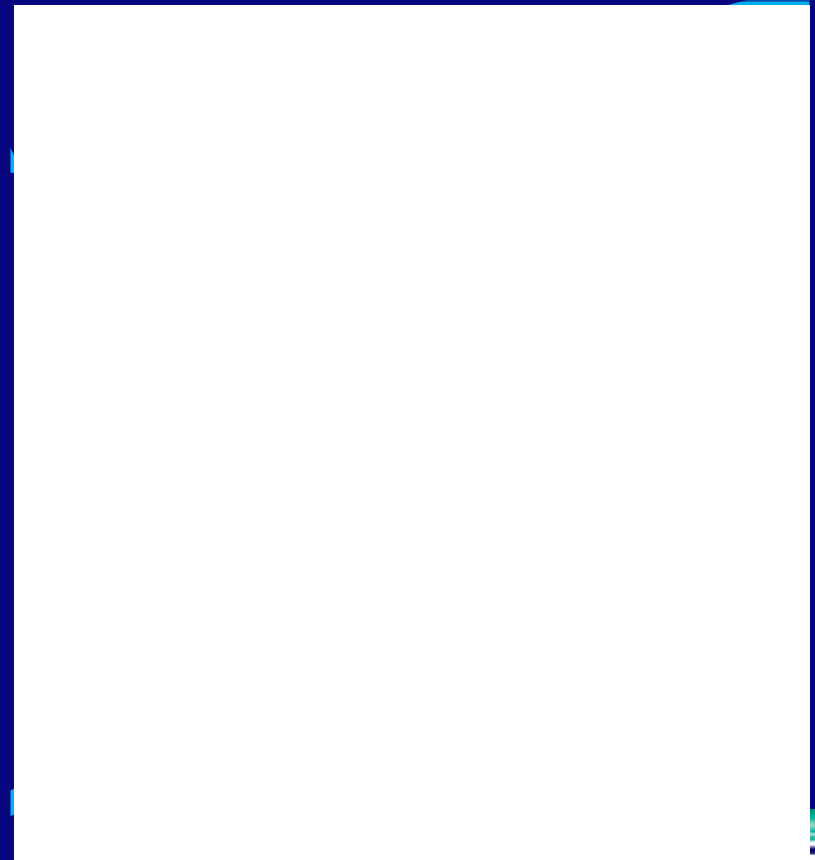
Crash Record	
Crash_ID	102234
Fatalities	2
Road_ID_FK	23391



Simple Relation Shortfall

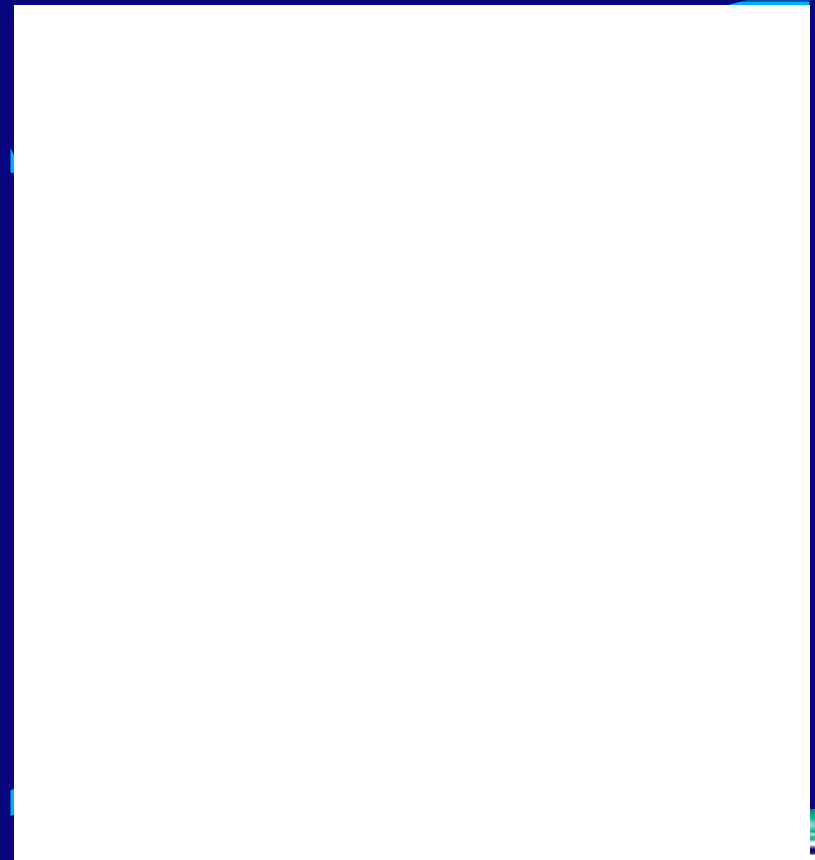
Road Record	
Road_ID	23391
Road_Class	Arterial
Speed_Limit	30

Address Record	
Address_ID	102234
R_Addr_From	2
Road_ID_FK	23391



Simple Relation Shortfall (Cont'd.)

Road Record	
Road_ID	23391
Road_Class	Arterial
Addr_ID_FK	102234



Simple Relation Shortfall (Cont'd.)

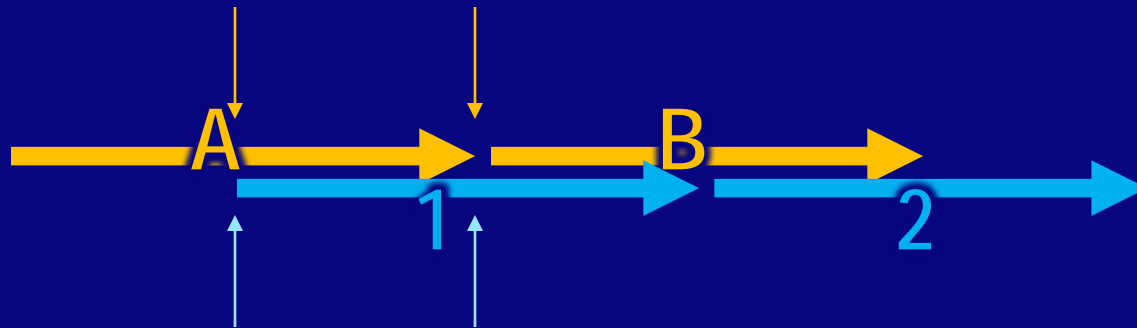
Entire feature in one set corresponds to *entire* feature in other set



Complex Relation


Section of feature in one data set corresponds to *section* of feature in other data set

Linear referencing events can specify sections of features



Complex Relation (Cont'd.)

Linear referencing events usually store simple attributes like surface width, speed limit, etc. for sections of features in one layer

Event Record	
Event fields	Route ID
	From measure
	To measure
Attribute fields	24 feet wide, 

Complex Relation (Cont'd.)

Instead of simple attributes, we can store events for another layer

Now there is a relationship between a section of one feature and a section of another

Event Record	
Event fields	Route ID
	From measure
	To measure
Attribute fields	Other-layer event

Complex Relation (Cont'd.)

To ensure correct relationship of attributes with a lateral component (left-hand, right-hand), we can store *two* events—one for each side.

Event Record	
Event fields	Route ID
	From measure
	To measure
Attribute fields	Other-layer event for left-hand attributes
	Other-layer event for right-hand attributes

Complex Relation Illustration

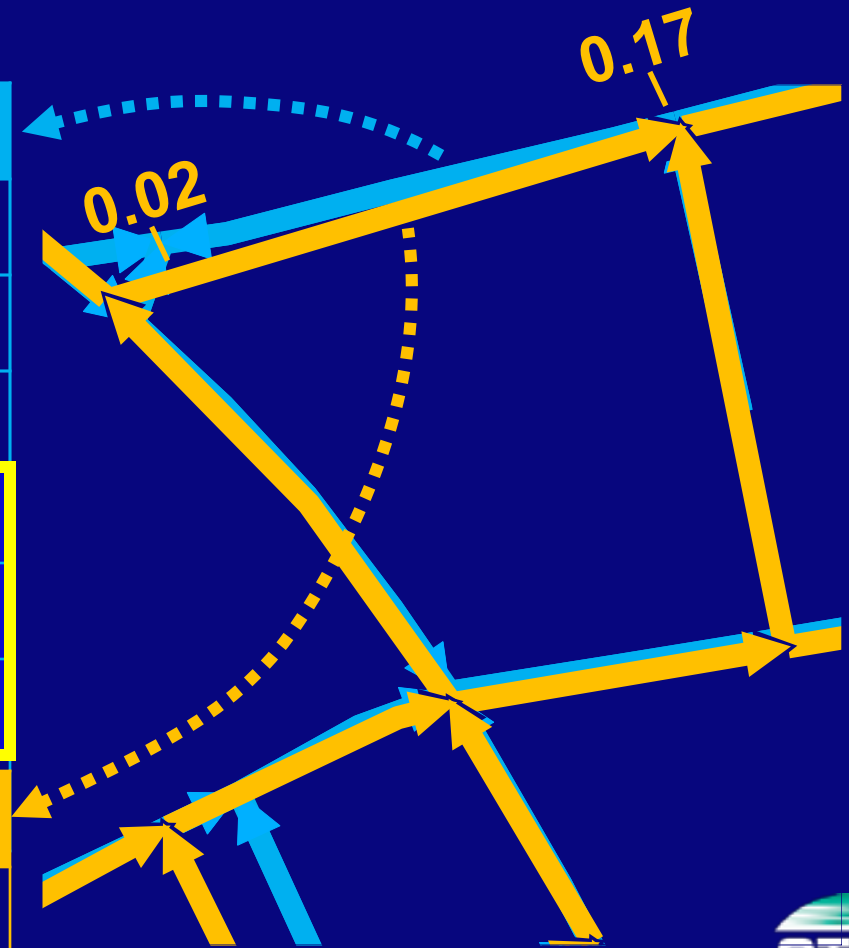
Road Event Record	
Road_ID	23391
From_Meas	0
To_Meas	0.16
R_Addr_ID	
R_Addr_From	
R_Addr_To	
Address Record	
Addr_ID	102234



Complex Relation Illustration (Cont'd.)

Road Event Record	
Road_ID	23391
From_Meas	0
To_Meas	0.16
R_Addr_ID	102234
R_Addr_From	0.17
R_Addr_To	0.02

Address Record	
Addr_ID	102234



Complex Relation Illustration (Cont'd.)

Road Event Record	
Road_ID	23391
From_Meas	0
To_Meas	0.16
R_Addr_ID	102234
R_Addr_From	0.17
R_Addr_To	0.02

Address Record	
Addr_ID	102234

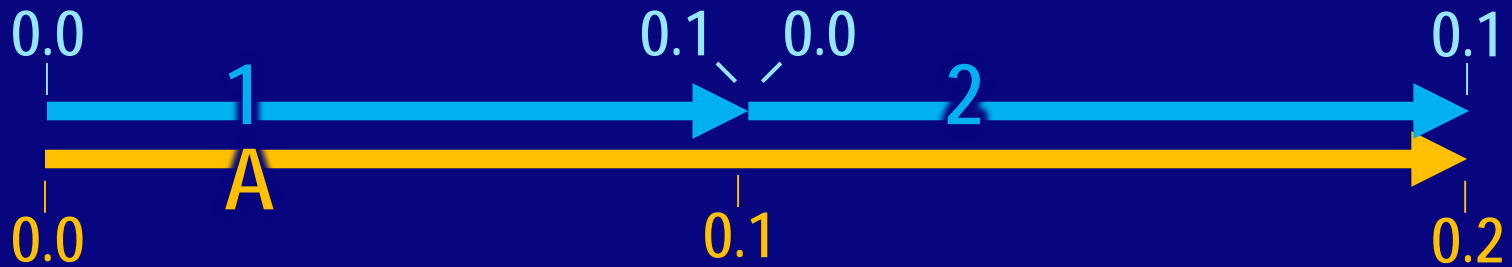


Relation: One-to-One



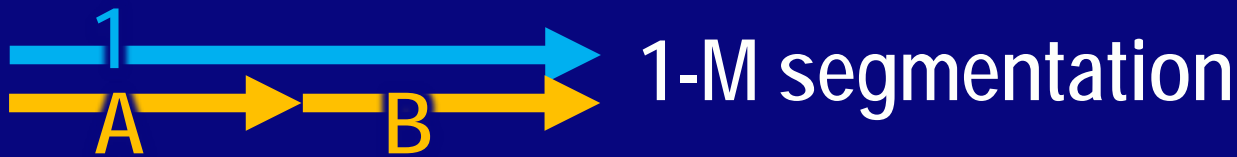
Road ID	From Meas.	To Meas.	R. Addr. ID	R. Addr. From	R. Addr. To	L. Addr. ID	L. Addr. From	L. Addr. To
1	0.0	0.2	A	0.0	0.2	A	0.0	0.2

Relation: M-1 Segmentation



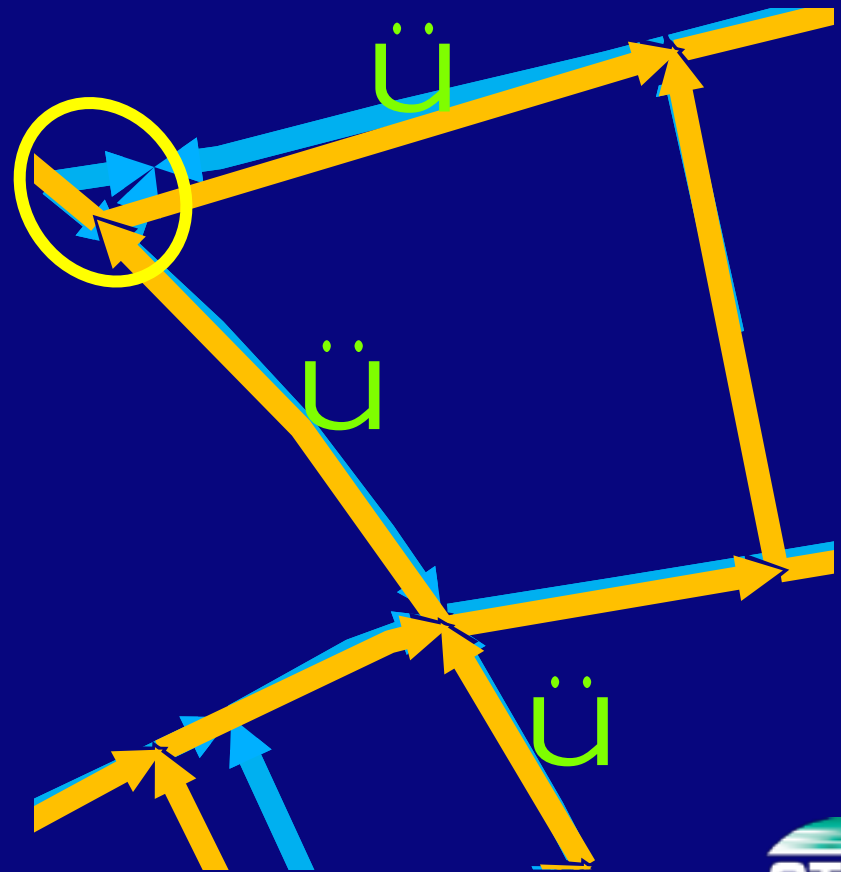
Road ID	From Meas.	To Meas.	R. Addr. ID	R. Addr. From	R. Addr. To	L. Addr. ID	L. Addr. From	L. Addr. To
1	0.0	0.1	A	0.0	0.1	A	0.0	0.1
2	0.0	0.1	A	0.1	0.2	A	0.1	0.2

Other Relations



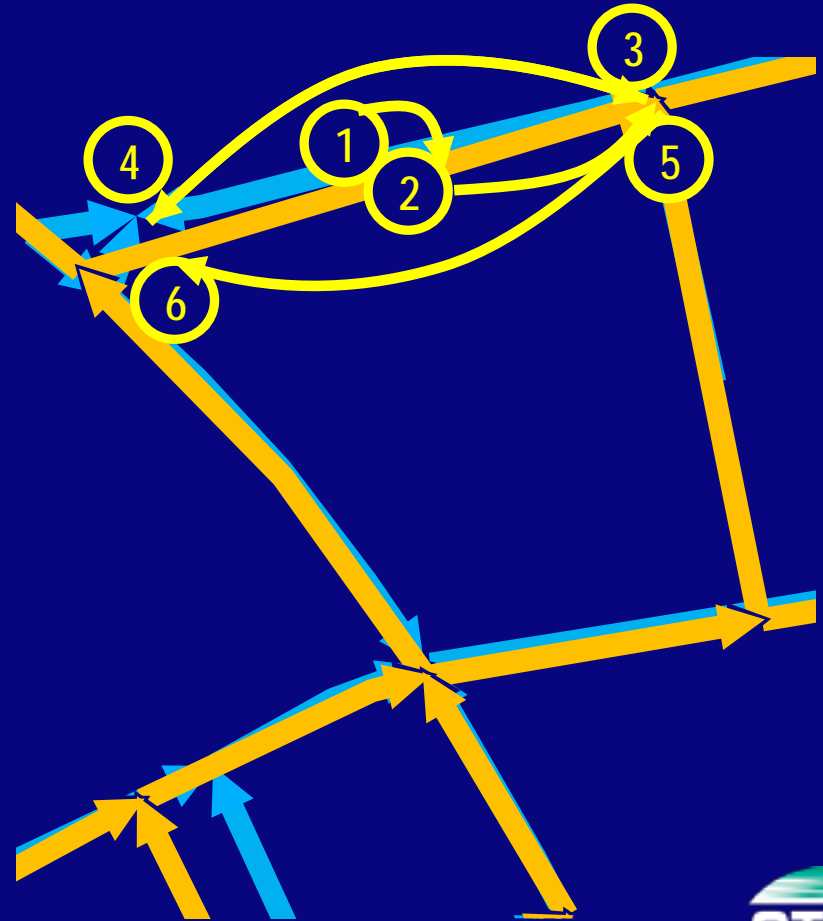
Creating Relations Automatically

- Use spatial join ("is identical to")
- Creates only relations between full lengths
- Adjust tolerance to suit
- Fix overly tolerant matches when reviewing adjacent, unmatched features



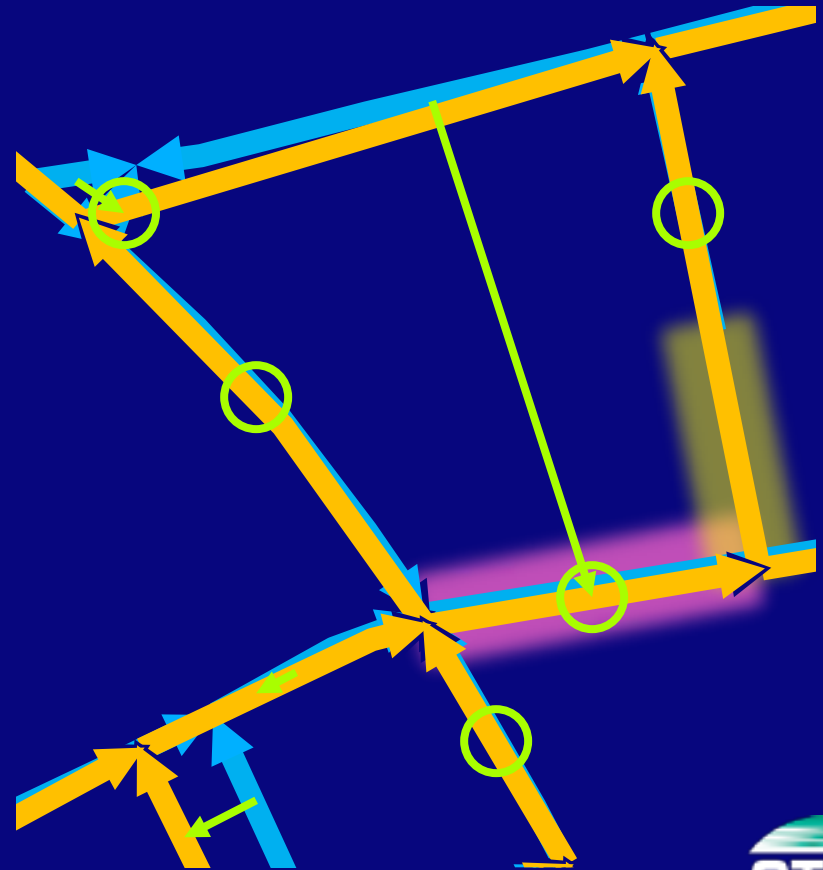
Creating Relations Manually

- Use utility tool (add-in created using VB.NET)
- Click to pick features being related
- Click to define start and end of events being related on those features



Finding Errors in Relations

- Error types
 - Unused key values
 - Event gaps/overlaps
 - Incorrect references
- Batch data checking
- Visual indicators
 - Gap/overlap highlights
 - Arrows between event midpoints



Maintaining the Relations

- Identify stale relations by comparing edit dates (when available)
- Identify missing, obsolete, and stale relations by finding differences (added, deleted, or changed features) between subsequent versions of one data set

Statistics

Road features (each data set)	~half million
Features in one-to-one relations	58%
Features in part-to-part relations	4%
Features in single-centerline-pair relations	3%
Features with no corresponding feature	15%
Automatable (prior simple relation)	~66%
Staff time (approximate person-years)	2

Esri's Roads and Highways (R&H)

- Relations transferred directly to new R&H advanced linear referencing system
- Utility tool for manual matching recreated for Roadway Characteristics Editor
- Upon acceptance of correlation, R&H could support joint maintenance of formerly separate data

Questions and Comments

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Appendix: Complex Relation Cases

Relation: One-to-One Reversed



Road ID	From Meas.	To Meas.	R. Addr. ID	R. Addr. From	R. Addr. To	L. Addr. ID	L. Addr. From	L. Addr. To
1	0.0	0.2	A	0.2	0.0	A	0.2	0.0

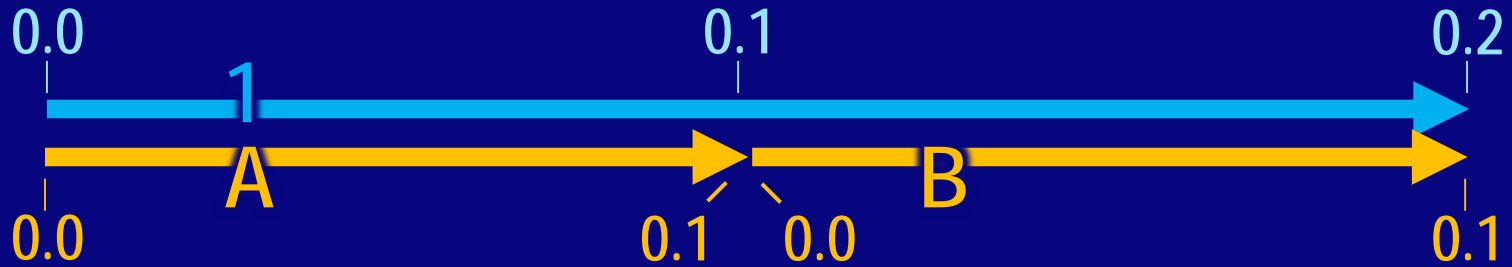
Relation: One-to-One Reversed



Last left-hand address
becomes
first right-hand address

First left-hand address
becomes
last right-hand address

Relation: 1-M Segmentation



Road ID	From Meas.	To Meas.	R. Addr. ID	R. Addr. From	R. Addr. To	L. Addr. ID	L. Addr. From	L. Addr. To
1	0.0	0.1	A	0.0	0.1	A	0.0	0.1
1	0.1	0.2	B	0.0	0.1	B	0.0	0.1

Relation: One Centerline to a Pair



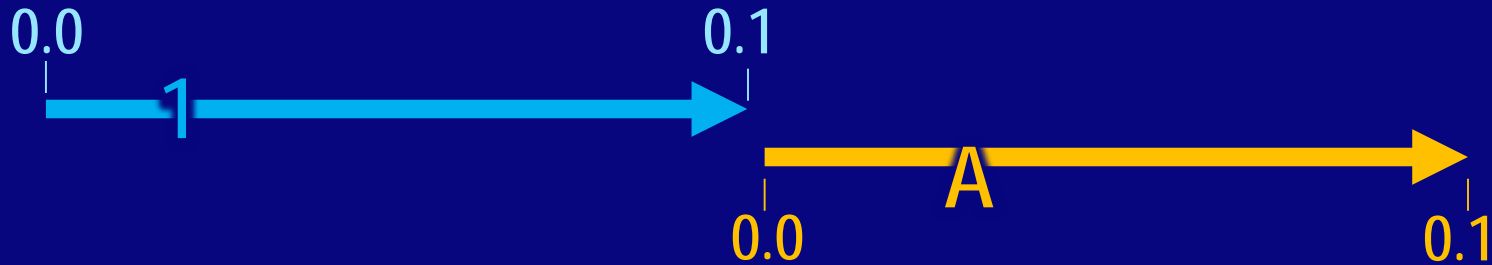
Road ID	From Meas.	To Meas.	R. Addr. ID	R. Addr. From	R. Addr. To	L. Addr. ID	L. Addr. From	L. Addr. To
1	0.0	0.2	A	0.0	0.2	B	0.2	0.0

Relation: A Pair to One Centerline



Road ID	From Meas.	To Meas.	R. Addr. ID	R. Addr. From	R. Addr. To	L. Addr. ID	L. Addr. From	L. Addr. To
1	0.0	0.2	A	0.0	0.2			
2	0.0	0.2	A	0.2	0.0			

Relation: None-to-One and *vice versa*



Road ID	From Meas.	To Meas.	R. Addr. ID	R. Addr. From	R. Addr. To	L. Addr. ID	L. Addr. From	L. Addr. To
1	0.0	0.1						
			A	0.0	0.1	A	0.0	0.1