



2006 GIS-T Symposium Columbus Ohio

Roadway Geodatabase Implementation at the Colorado Department of Transportation: Core Roadway Classes and Data Transformations.

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Project Goals

- @ Principles and business rules
- @ Data model for the editing environment
- @ Editing vs. Publication
- @ Move all TranSys data, now in Sybase, to Oracle
- @ Integrate geographic and tabular data for roadways and jurisdictions into one database
- @ Position the geodatabase that we build using ArcSDE/Oracle to become an enterprise database
- @ Minimize impacts on work activities outside migration project
- @ Enable on-going work to continue while migration data model and procedures are developed



Project History

- ④ Geodatabase Logical Data Model – Editing Environment – July '03
- ④ Linked Major Roads Tabular and Centerline Data – Oct. '03
- ④ Application Requirements & Geodatabase Physical Data Model – Nov. '03
- ④ Pilot Migration Project Plan – Dec '03
- ④ Editing Web Application Design – Jan '04
- ④ Pilot Data Migration – Completed and Validated – May '04
- ④ Data Migration Project – June '05 (Consultant Finished)



TranSys Database

- ④ TranSys database contains route and roadway inventory data
 - Linearly referenced State highway routes
 - E.G. XSecOn table
 - Roadway segments for roads under other jurisdictions
- ④ Geometric datasets represent
 - Roadway centerlines
 - Jurisdiction boundaries
 - Topologies

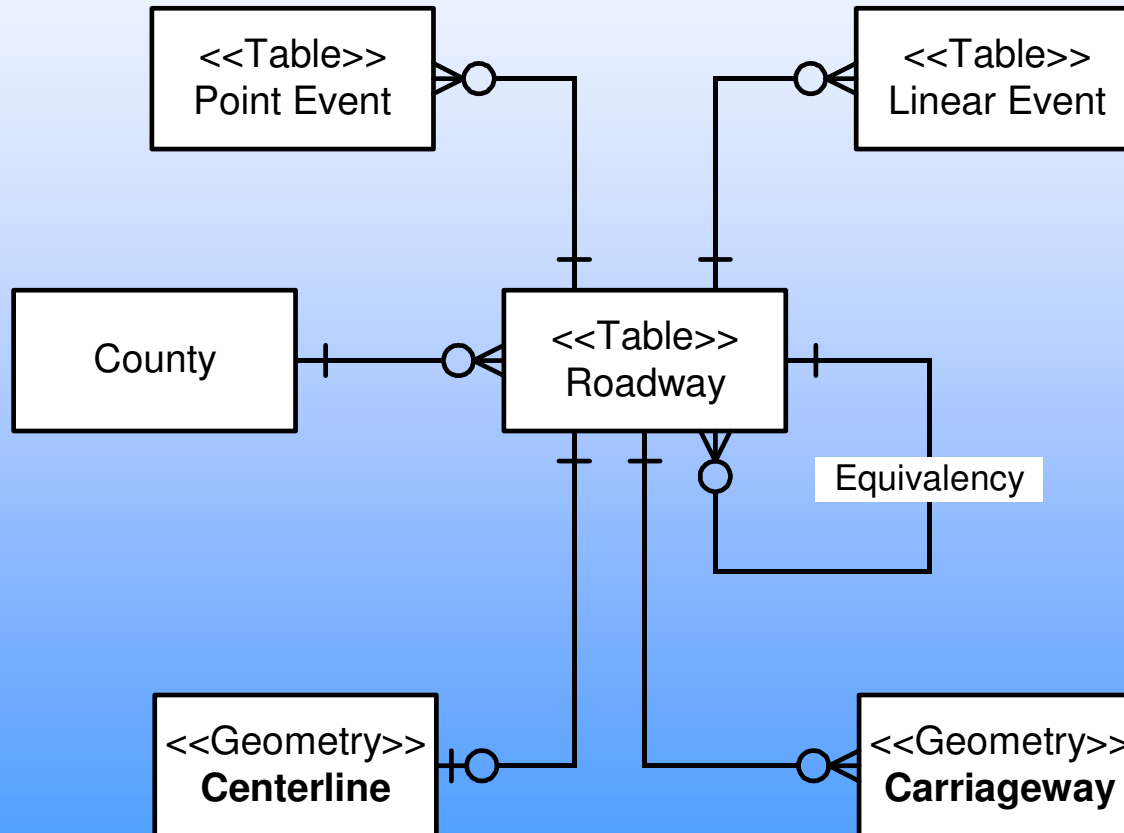


Roadway Geodatabase

- Ⓢ Roadway is a facility in the real world
- Ⓢ Roadways in the geodatabase own their abstractions, attributes, and geometric representations
- Ⓢ Fully normalized (except Local Segments)
 - No redundancies
 - No derived elements
- Ⓢ Continuous versioning through date stamps
- Ⓢ Be able to reconstruct state of database at any point in time
- Ⓢ Record-level metadata
- Ⓢ Single format (geodatabase)
- Ⓢ Server located in editing staff's office



Basic Roadway Geodatabase Logical Data Model





Publication Databases

- Ⓢ Used by read-only applications
- Ⓢ Denormalized subsets of editing database
- Ⓢ Multiple data formats
- Ⓢ Derived and calculated fields
- Ⓢ Periodic update with certified data (discrete versioning)
- Ⓢ Server(s) located in central IT shop



Routes & Roadways

- ④ Route – Numbered and signed traversal along a continuous linear sequence of roadways. Has a linear reference system containing reference values assigned along the route. Reference values increase in one travel direction.
- ④ Roadway – Physical feature supporting automotive conveyance. Uses a unique public key as its identifier. Routes utilize sequences of roadways to define their path through the state.



Varieties of Measures

- ④ Reference Points
- ④ Segment (Sacred) Lengths
- ④ Arc Measures (“M” values)
- ④ Arc Feature Lengths
- ④ Anchors, Anchor Points, Anchor Segments

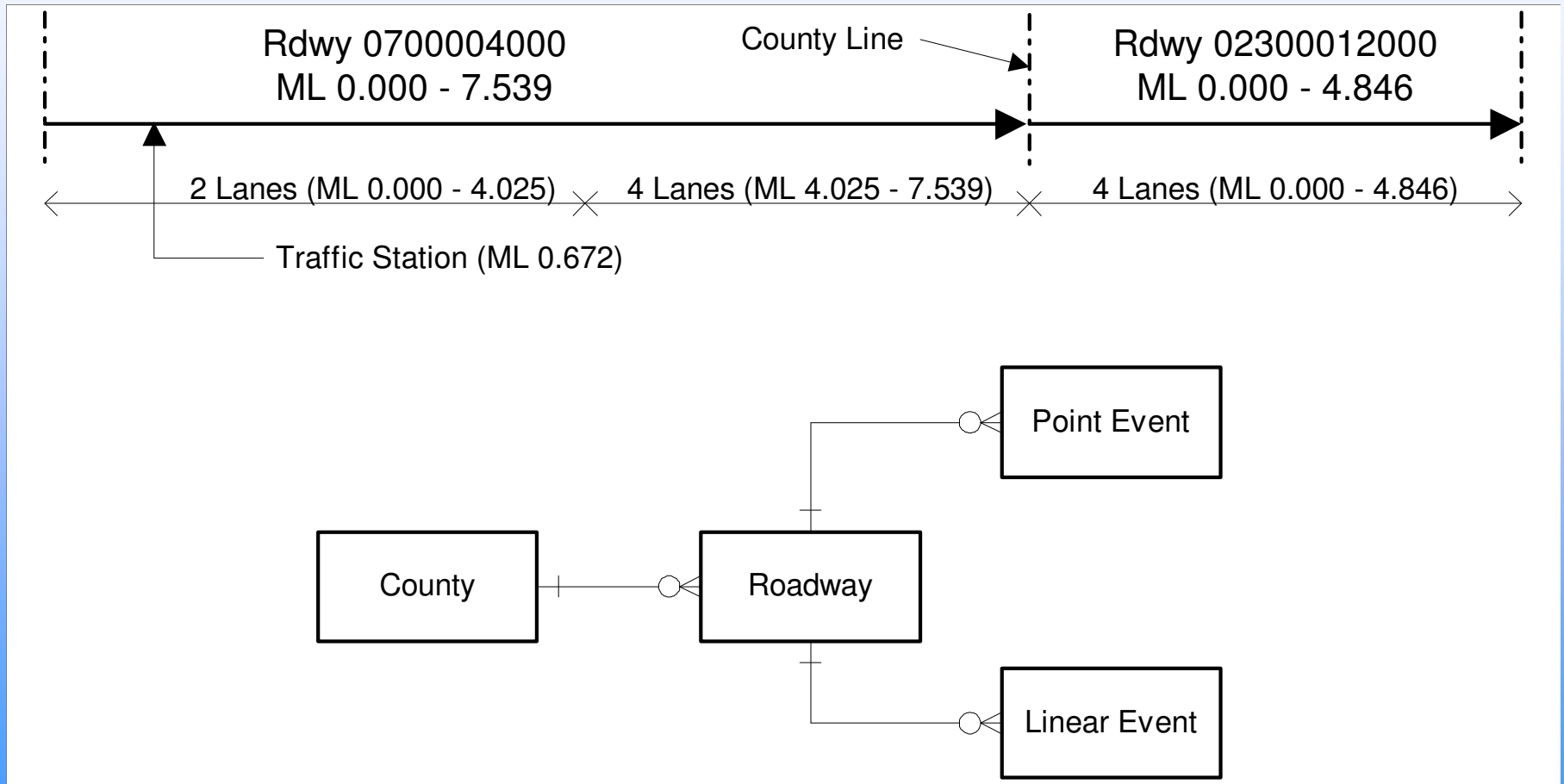


Transformation: Transys Database to Roadway Geodatabase

- ④ Build Routes from Arcs
- ④ Use Routes to Make Roadways and Centerlines Partitioned at County Boundaries
- ④ Derive Roadway Public Keys
- ④ Populate Roadway Table & Centerline Feature Class
- ④ Set Roadway Measures
- ④ Cut Linear Events into County Pieces
- ④ Relate County Linear Events to Roadways, Transforming Beginning and Ending Reference Points
- ④ Assign Point Events to Counties
- ④ Relate County Point Events to Roadways, Transforming Reference Points



Roadway Segmentation Schema





Transformation: Roadway Geodatabase to Publication Database

- ④ Use Route to Extract Ordered Linear Events
- ④ Extract Roadway and Centerline for Each Linear Event
- ④ Transform Reference Point Measures from Roadway to Route
- ④ Build Routes from Transformed Centerline Arcs
- ④ Extract Desired Linear Events for Routes Using Traversal Linear Events
- ④ Use Transformed Route Reference Points
- ④ Use Dynamic Segmentation on Routes to Build Highway Segments



Validation: Input from Transys Database Identical to Publication Database

ⓐ For Event Tables

One-To-One Match on every Row

Data Values Match for every Row

ⓐ For Route Features

One-To-One Match on every Feature

Attribute Values Match for every Feature

Vertices with Measures (M-Values) Match for every
Vertex for every Feature



Roadway Geodatabase Editing Workflows

Ⓢ New Roadway

Create Roadway Record with Public Key

Populate Roadway Attributes

Create Roadway Centerline with Public Key

Create Linear and Point Events

Ⓢ Existing Roadway

Revise Roadway Attributes

Revise Roadway Centerline

Add, Change, or Delete Linear and Point Events

Ⓢ Review

Editor Commits Changes

Reviewer Inspects Changes

Reviewer Validates Correctness and Consistency



Lesson: Documentation is Essential

- ④ “Mom and Apple Pie” Issue
- ④ Needed because:
 - Developers need to know what the project expects, in some detail
 - Managers need to have ways to measure success, and to detect when the project is off track
 - Staff can change during the life of the project
- ④ Resisted because:
 - Developers like to design, write, and run software, and don't like to document
 - Time or money runs out
- ④ A Solution: document first! Use spiral approach.



Lesson: Controlling Terminology

- ④ What are we talking about?
- ④ “Route” vs. “Roadway”
- ④ “Project” vs. “Product”
- ④ “Model” – Database or Geoprocessing
- ④ TranSys or DATALOAD – Instance or Schema?



Lesson: Controlling Changes to Databases

- ④ Migration Process Requires Consistent, Validated Data
- ④ Ongoing Data Editing Continues
- ④ Both Efforts Used Tables in the DATALOAD Schema in the TranSys Database
- ④ Confusion Resulted in Data in an Intermediate State
- ④ Migration Process Testing Became Unreliable Because of Lack of Change Control



Lesson: Geoprocessing Models

- ④ Geoprocessing models are not easy to re-use
- ④ Business processing is relying on technology that looks easy to use, but is hard to maintain
- ④ Building geoprocessing models using Python would be more effective and usable



Summary

- ④ Migration to a Radically Different Data Structure for Roadway Data is a Long and Difficult Process
- ④ Process Made Longer when Staff Have Other Priorities
- ④ Conceptually Difficult Data Structures and Migration Process Require More of Staff
- ④ It's Happening at CDOT!