Table
Route

Field name	Data type	Allow nulls	Default value	Domain	Pre-cision	Scale	Length
OBJECTID	Object ID						
RouteID	Long Integer	No			0		
RecordDate	Date	Yes					
RecordStatus	Short Integer	Yes	1	RecordCodes	0		
EntityStatus	Short Integer	Yes	7	EntityCodes	0		
FromDate	Date	Yes					
ToDate	Date	Yes					
Name	String	Yes					12
Abbreviation	String	Yes					12
RouteType	String	Yes		RtTypes			2
RouteDesignator	Short Integer	Yes		RtDesignators	0		1
MileLength	Double	Yes			7	3	

Portion of data model design template appearing in Butler's *Designing Geodatabases for Transportation.*

GEOG 482 / 582 : GIS Data Management

Lesson 6: Transportation Data Models

Overview

Learning Objective Questions:

1. What transportation data models are suitable for use in urban-regional applications of GIS?
2. What are some conceptual database design challenges with regard to transportation databases?
3. What are some of the different application contexts for transportation databases?
4. How might we compare and contrast transportation data models?
5. What are some of the Esri approaches to transportation data models?

Lesson Preview

Learning objective questions act as the lesson outline.

Questions beg answers.

Urban/Regional Transport Data Models

1. What transportation data models are suitable for use in urban-regional applications of GIS?

Urban-regional transportation concerns for data models are reflected in a variety of perspectives such as:

- planning,
- improvement programming, and
- project-level implementation

These three decision contexts are used for developing the transportation infrastructure for urban-regional communities, but are also more broadly used in growth (sustainability) management contexts

Key terms
Planning
Improvement program
Project Implementation

Contexts for database design and management

Plan, Program, Project Implementation have different needs for database design and management

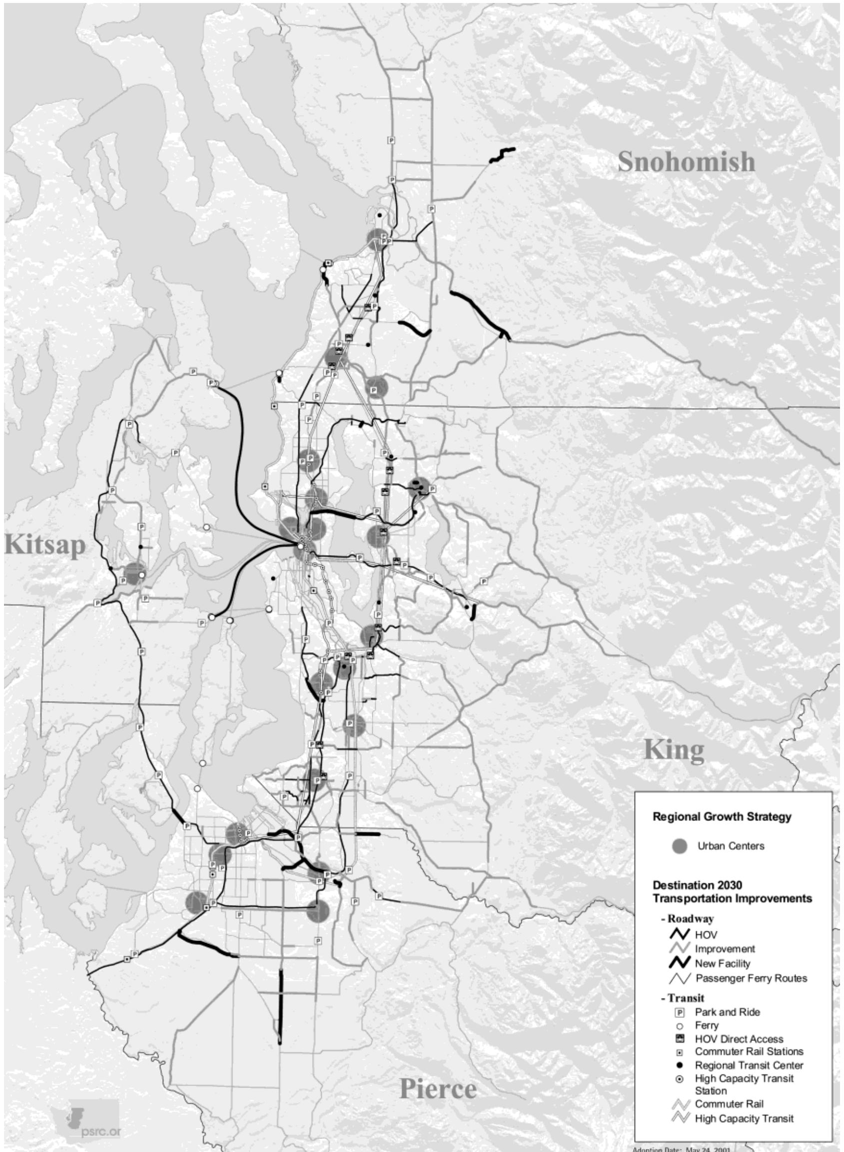
Plans establish a long-term plan,
e.g. Puget Sound Regional Council's Transportation Plan called Transportation 2040

Improvement programming involves development of budgets (revenue and cost) activities assembled for a plan, e.g. six year budgeting on rotation: plan, design, build

Implementation activities carry out the actual development of programs, e.g. take action to build specific transportation projects

Generally, a "capital" improvement process

Puget Sound Regional Council – Vision 2040 Plan



Plan contains transportation network of regional significance, i.e., regionally significant flows

This plan is the basis for identifying projects (approx. 2200) of regional significance, which when funded on a rolling six-year basis constitute a transportation improvement program.

Plan created by Puget Sound Regional Council (PSRC) – counties and cities are the members of the PSRC

Different data models

Different units within organizations are responsible for planning, improvement programming, and project implementation.

The data models can be expected to be different.

Current situation with most public facilities.

Big opportunity for integration activities supported by GIS databases, the enterprise GIS database.

But not easy, because many people are involved.

PSRC makes use of GIS for Transit-oriented Development as a general approach to corridor action strategies for implementing Vision 2040.

Key terms
Sustainable communities

2. What are some significant conceptual database design challenges with regard to transportation databases?

Planning and programming treat the concept of a "transportation project" differently, due to contextual use of information.

Not only is this a problem within each jurisdictional scale,
but it is even more significant across jurisdictional scales as depicted on the next slide.

Different organizations conceptualize the planning process within different geographic domains, even though the domains are overlapping.

Transportation projects can be spatially represented as points, lines, polygons, or surfaces depending on how an organization interprets the character of the project.

Institutional scales motivate differences for databases

Importance of transportation planning topics in relation to geographic and administrative foci
Size of lettering in the figure below indicates importance level.

Administrative Focus

Geographic Focus	Urban Emphasis MPO Tradition (some rural concerns)	Rural Emphasis New RTPOs (some urban concerns)
Urban	Region-Wide Urban-wide Sub-Area Corridor	Region-Wide
Urban-Rural Transition	Sub-Area Corridor	Sub-Area Corridor
Rural	Corridor Link Intersection	Corridor Link Intersection

Database design can be a matter of ‘project abstraction’

‘Project Abstraction’ refers to the level of detail specified for a particular transportation project.

Long-range plans contain the general project concept, general impacts.

Programming requires more specifics to fund an improvement project as part of an improvement package, all of these projects being in the plan

Implementation requires more detail yet…
social, economic, ecological, and physical impacts are needed to understand the character of projects

Transportation planning databases

Transportation projects are conceptual in character

- Projects appear as symbols on a planning map
- Sketch character of the project is defined
- Full character of the projects not defined

Transportation modeling software estimates changes in vehicle flow

Physical details of the projects are not necessary to estimate logical flows.

Link and node network

Abstraction of the real network

Transportation improvement programming databases

Transportation improvement programs require a bit more detail because funds involved (e.g., $6.4 billion for PSRC 2019-2022 TIP)

Main consideration is funding a package of projects (packaging of projects, while raising the funds to pay for them, is the idea of "programming") NOTE: it is not computer programming

Funding requires specifying more of the details than in plan, from what start reference marker and ending reference marker on a highway.

Improvement programming process identifies funds for scoping, designing and building projects.

Funding is the main concern, but impacts of the implementation are still important in scoping and designing phases. How will the projects being funded perform as a "collection"?

Transportation project implementation databases

Implementation phase of a transportation project

- social, economic, ecological, and physical impacts on the ground;
- identified in detail, i.e., commonly in the scoping phase of a project as funded within a transportation improvement program;
- impacts of a project are compared against the current conditions of the system;
- often impacts computed on a one-by-one basis; and
- cumulative effects are seldom addressed because it is difficult and costly, but is now being done for various characteristics, e.g. air emissions (PM, Nox, CO2 etc.).

3. What are some of the different application contexts for transportation databases?

Planning, programming, and implementation situations are different because the information they treat is different.

Different mandates for activity encourage different perspectives, and thus different groups of people (i.e., organizations and units within organizations) could be involved.

This leads to different kinds of databases for transportation.

Let us look at some examples of transportation data models.

Metropolitan Planning Organization (MPO) data model

Planning-level data models support the four-step planning cycle to develop a plan like PSRC Transportation 2040 (previously shown).

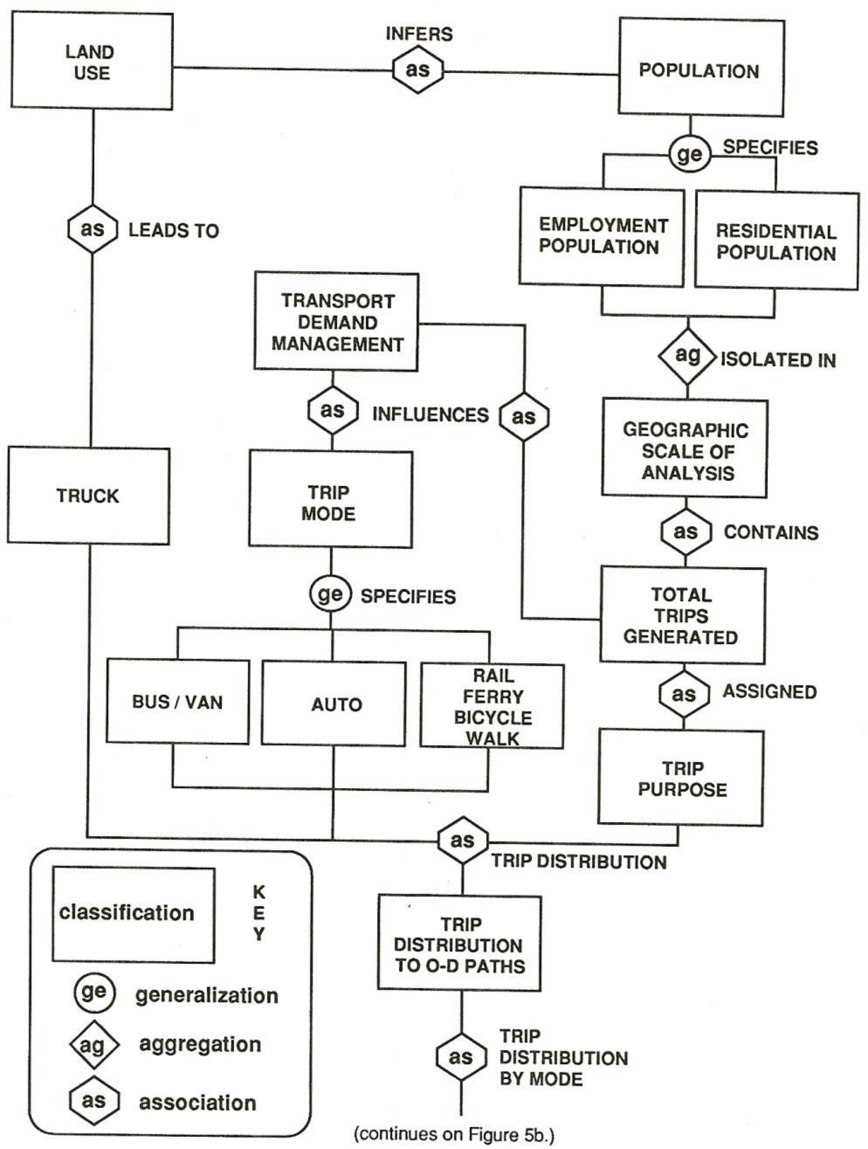
Data model for regional growth management & transportation planning – (next two slides graphic 1 and 2).

Graphic 1 addresses trip mode distribution.

- Data are input to transportation demand forecasting model.
- Multimodal character of transportation systems.
- Six modes of transportation in that data model.
- Each mode can be modeled as a network.
- Important to understand how they work together

Graphic 2 addresses trip mode assignment on a network.

MPO planning data model addresses trip mode distribution

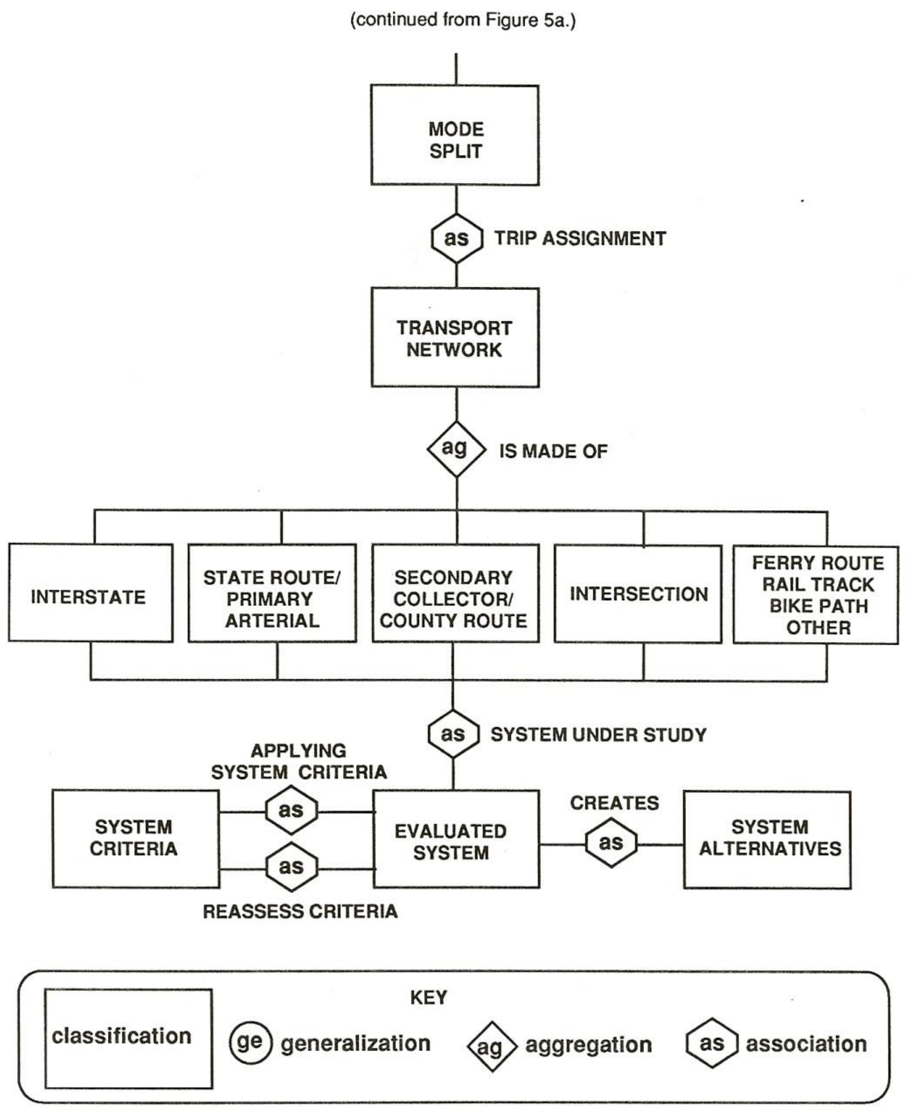


Key terms
Mode
Trip distribution

MPO graphic 1
(originally Figure 5a)

Data model for four-step transportation modeling process

MPO planning data model for trip mode assignment



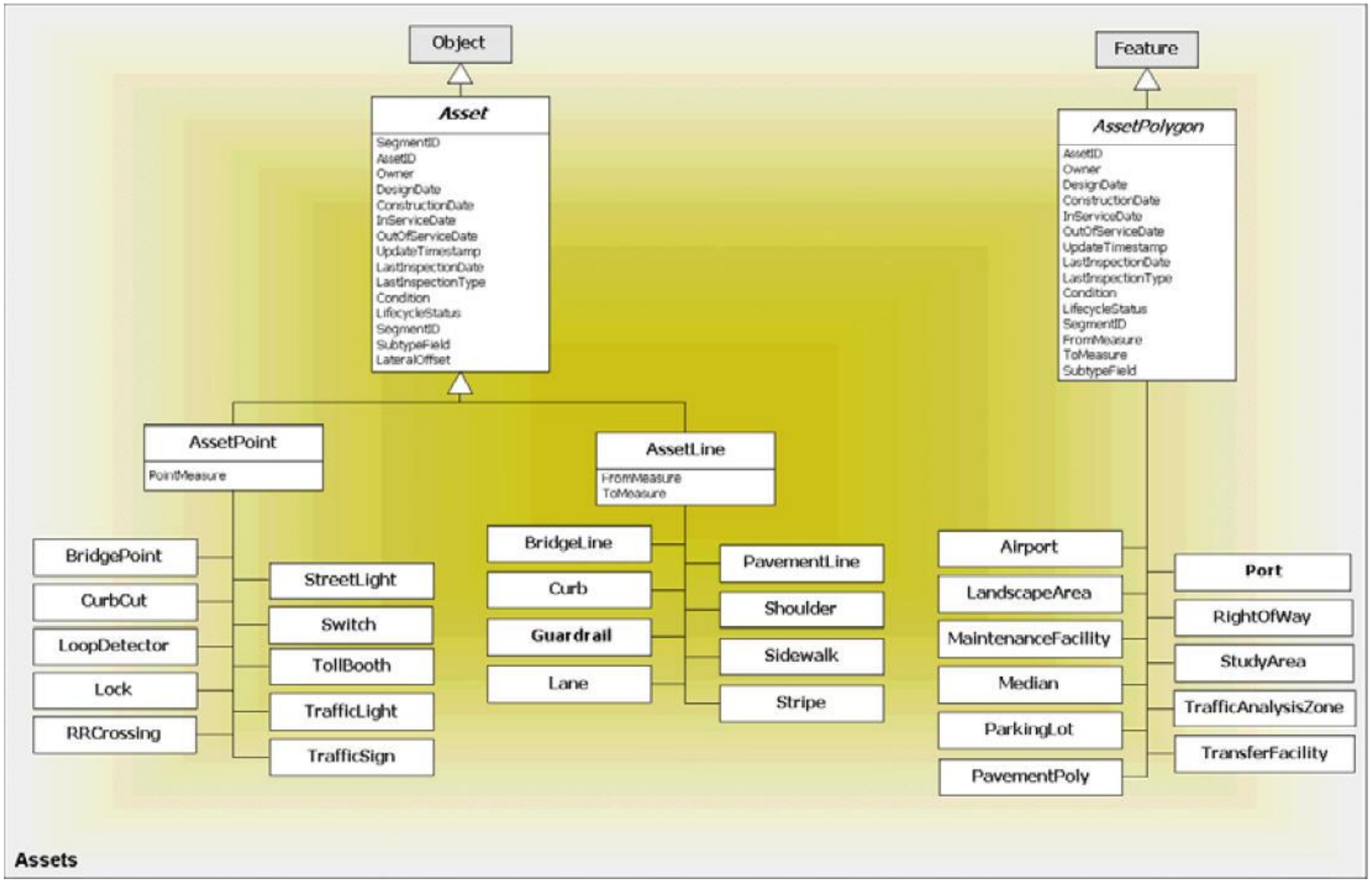
MPO graphic 2
(originally Figure 5b)

Local Government - Urban street data model

An urban street data model provides a skeletal street network.

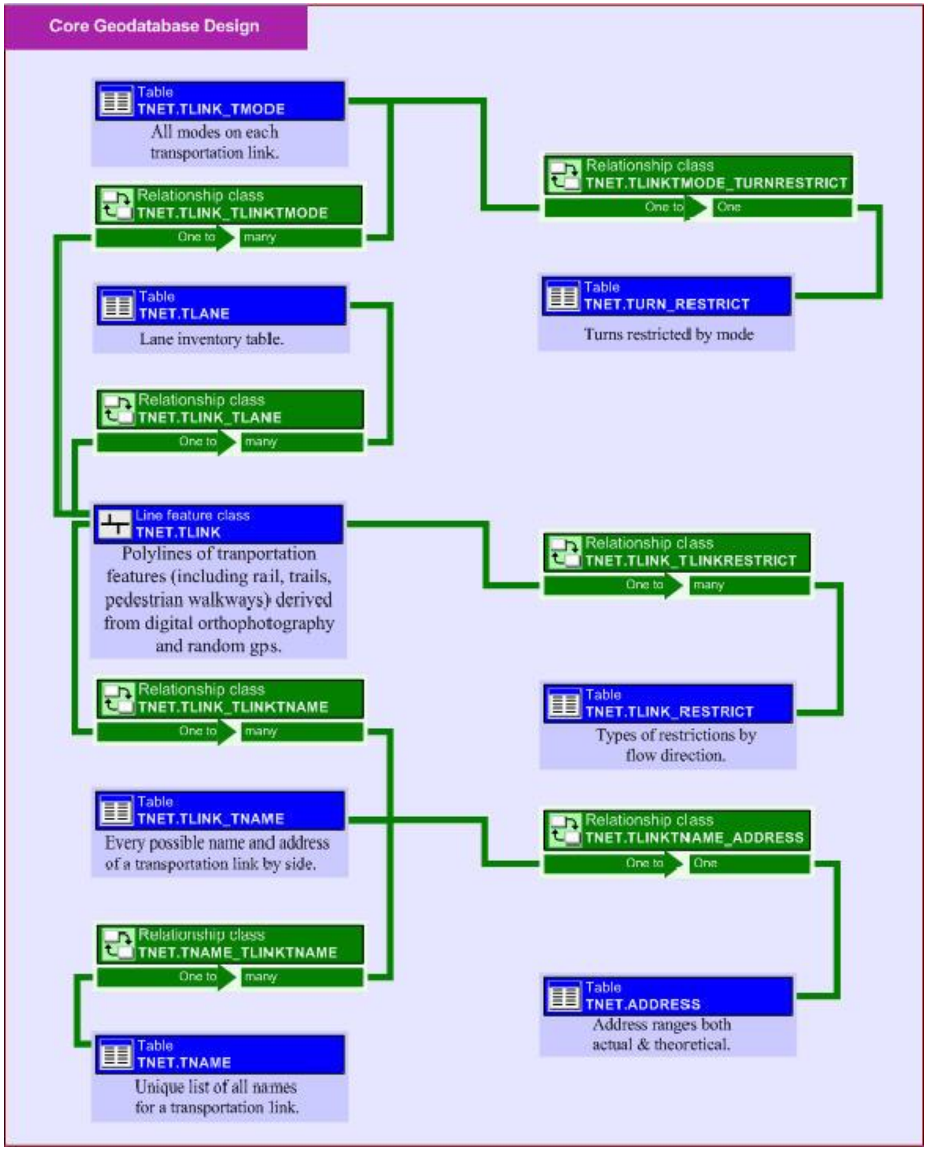
Data model could be used for street maintenance operations.

UNETRANS assets data model – state highway inventory
This is a state highway projects-oriented data model.



Urban base map database
Could be used for capital improvement programming (CIP)

King County Metro Public Transit Network (T-NET)



4. How might we compare and contrast transportation data models?

1) Requirements for planning-level data model

A "link and node" network is essential.

Schematic representation because we need to know about "breadth" of the system, rather than "depth" of each project

2) Requirements for improvement programming data model

Individual projects with budgetary concerns for financial (fiscal) considerations.

3) Requirements for project implementation data model

Details for engineering, social, economic, ecological impacts.

4) Requirements for a highway inventory database.

Reporting requirements to federal government can dictate what is to be included.

5. What are some of the Esri approaches to transportation data models?

Due to the vast number of GIS applications that can draw upon transportation data, there are many transportation data models from which to choose.

- **State Roads and Highways with Linear Referencing Events**
- **Traffic Monitoring Systems**
- **Transit Systems**

Esri website provides lots of information associated with transportation data models available at.... http://downloads2.esri.com/support/TechArticles/Transportation_Data_Model.pdf

Transportation Data Model User Group

Defines an 'essential data model' for ArcGIS user organizations within the transportation industry, and in particular for roadway management organizations (e.g., DOTs), as well as for Railroads, Transit, and Waterway Authorities.

Significant data design patterns of interest include road and rail network topology, linear referencing systems, dynamic event representation and asset location and management.

Logical Model in Visio .vsd is available here. The graphic is rather large, so you will have to pan across graphic to see everything. Let's look at a few excerpts from the data model on the next few slides.

Note: full data model can be accessed through data model page at… http://downloads2.esri.com/support/TechArticles/Transportation_Data_Model.pdf

Portion of the geodatabase conceptual-logical model

Simple feature class
Bridge

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Pre-cision	Scale	Length
OBJECTID	Object ID						
BridgeID	Long Integer	No			0		
OverRouteID	Long Integer	No			0		
OverMaxWidth	Short Integer	Yes			0		
OverMaxHeight	Short Integer	Yes			0		
OverMaxWeight	Short Integer	Yes			0		
UnderRouteID	Long Integer	No			0		
UnderMaxWidth	Short Integer	Yes			0		
UnderMaxHeight	Short Integer	Yes			0		
UnderMaxWeight	Short Integer	Yes			0		
NBINumber	String	Yes					12
BridgeType	Short Integer	Yes		BridgeTypes	0		
Shape	Geometry	Yes					
Shape_Length	Double	Yes			0	0	
Shape_Area	Double	Yes			0	0	

Table
Route

Field name	Data type	Allow nulls	Default value	Domain	Pre-cision	Scale	Length
OBJECTID	Object ID						
RouteID	Long Integer	No			0		
RecordDate	Date	Yes					
RecordStatus	Short Integer	Yes	1	RecordCodes	0		
EntityStatus	Short Integer	Yes	7	EntityCodes	0		
FromDate	Date	Yes					
ToDate	Date	Yes					
Name	String	Yes					12
Abbreviation	String	Yes					12
RouteType	String	Yes		RtTypes			2
RouteDesignator	Short Integer	Yes		RtDesignators	0		1
MileLength	Double	Yes			7	3	

Simple feature class
Centerline

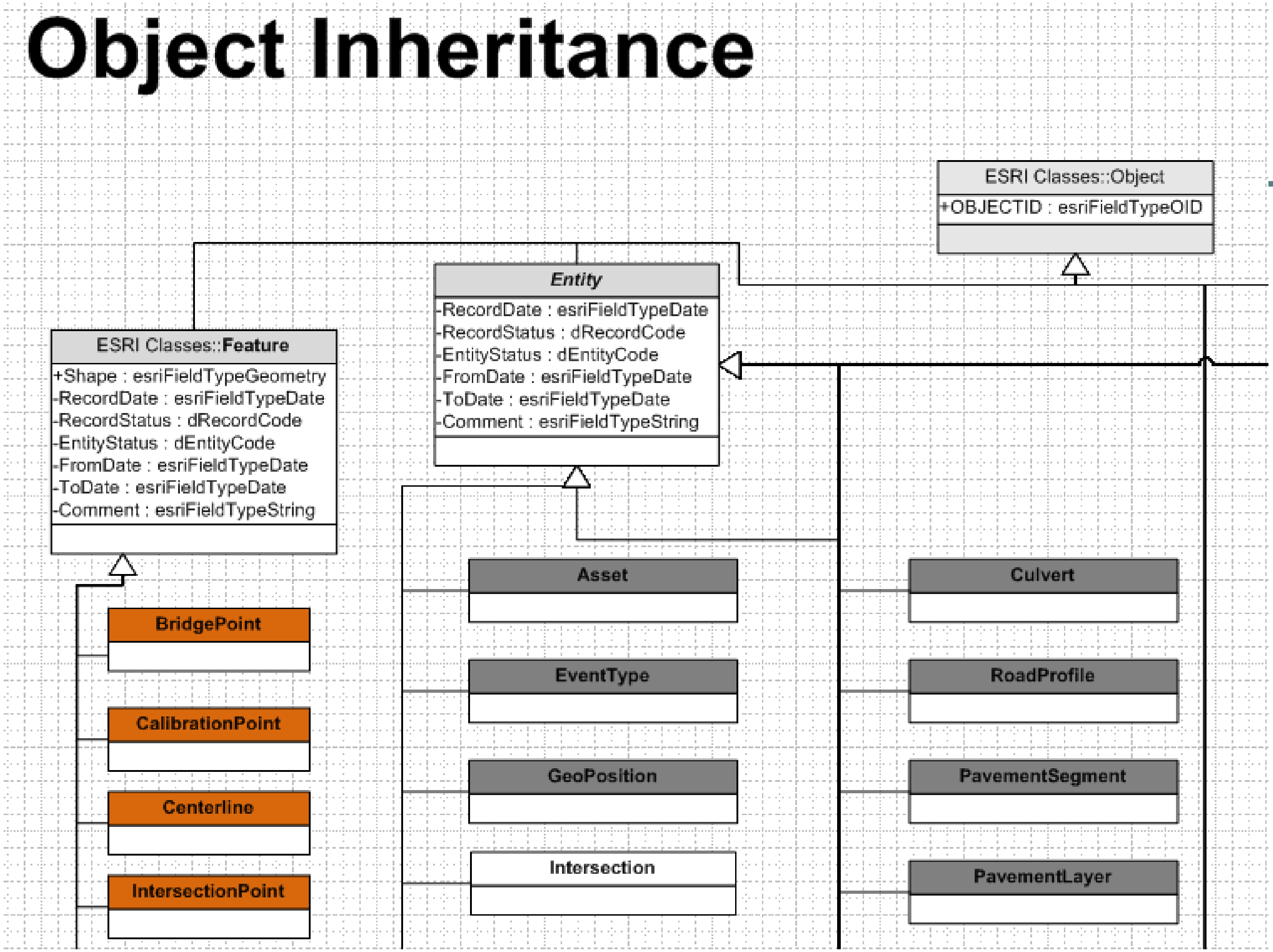
Geometry *Polyline*
Contains M values *Yes*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Pre-cision	Scale	Length
OBJECTID	Object ID						
Shape	Geometry	Yes					
RoadwayID	String	Yes					10
RecordDate	Date	Yes					
RecordStatus	Short Integer	Yes	1	RecordCodes	0		
EntityStatus	Short Integer	Yes	7	EntityCodes	0		
FromDate	Date	Yes					
ToDate	Date	Yes					
ToDate	Date	Yes					
Shape_Length	Double	Yes			0	0	

Table
Segment

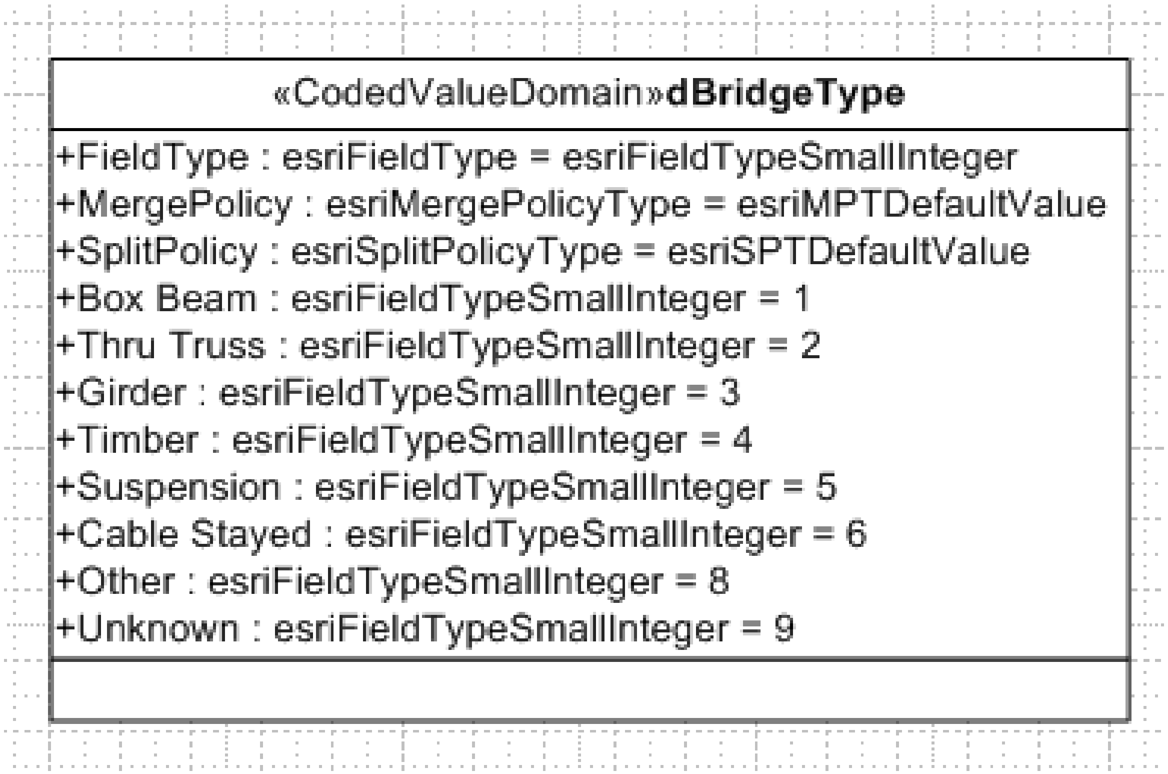
Field name	Data type	Allow nulls	Default value	Domain	Pre-cision	Scale	Length
OBJECTID	Object ID						
RouteID	Long Integer	Yes			0		
CountyID	Long Integer	Yes			0		
SegmentID	Long Integer	No			0		
RoadwayID	String	Yes					10
RCLink	String	Yes					10
RecordDate	Date	Yes					
RecordStatus	Short Integer	Yes	1	RecordCodes	0		
EntityStatus	Short Integer	Yes	7	EntityCodes	0		
FromDate	Date	Yes					
ToDate	Date	Yes					
LRMType	Short Integer	Yes		LRMTypes	0		
BeginMeasure	Double	Yes			7	3	
EndMeasure	Double	Yes			7	3	
MileLength	Double	Yes			7	3	

Logical model



Key terms
Object inheritance

Coded value domains for junction



Merge Policy Type - a rule for combining a bridge type features
Split Policy Type - a rule for separating bridge type features

Key terms
CodedValueDomain
Merge Policy Type
Split Policy Type

Summary

In this lesson, you learned about…

1. Transportation data model suitability for use in urban-regional applications of GIS.
2. Conceptual database design challenges in transportation databases.
3. Different application contexts for transportation databases.
4. Comparing and contrasting transportation data models.
5. Examples of Esri approaches to transportation data models.

Contact me at nyerges@uw.edu if you have questions or comments about this lesson.

GEOG 482/582: GIS Data Management

END Lesson 6: Transportation Data Models