

27 May 2004

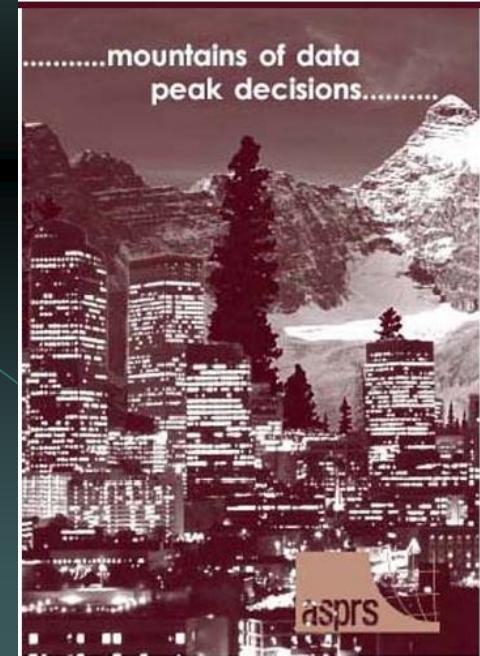
INTEGRATION OF THE NATIONAL MAP: DATA LAYERS AND FEATURES



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U.S. Geological Survey



Outline

- Goals and Objectives
- Approach
- Data
- Test Sites
- Methods
- Conclusions

Goals and Objectives

- *The National Map* will consist of integrated datasets
- Current USGS digital products are single layer and not vertically-integrated
- The goal is to develop procedures for automated integration based on metadata
- Framework for layer integration based on metadata
- Framework for feature integration
- Example results for Atlanta and St. Louis

SALES ARE
DROPPING
LIKE A ROCK.



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Integrating Disparate Networks

Conceptual Data Flow:

Federated Database design – Local schemas mapped to a global schema for attribute conflation and maintenance.

Physical Integration Processes:

Vertical Integration = Cross-thematic topological integrity

Horizontal Integration = Same-theme edge-matching

Approach

- Layer-based

- Use existing seamless datasets
- Determine integration feasibility based on resolution and accuracy

- Feature-based

- Implement integration on feature by feature basis
- Use developed feature library

Data

- Orthoimages from Nunn-Lugar-Domenici 133 priority cities of the Homeland Security Infrastructure Program
- National Hydrography Dataset (NHD)
- National Elevation Dataset (NED)
- Transportation (DLG, TIGER, State DOT, others)
- National Land Cover Dataset (NLCD, others)

Test Sites

- St. Louis, Missouri

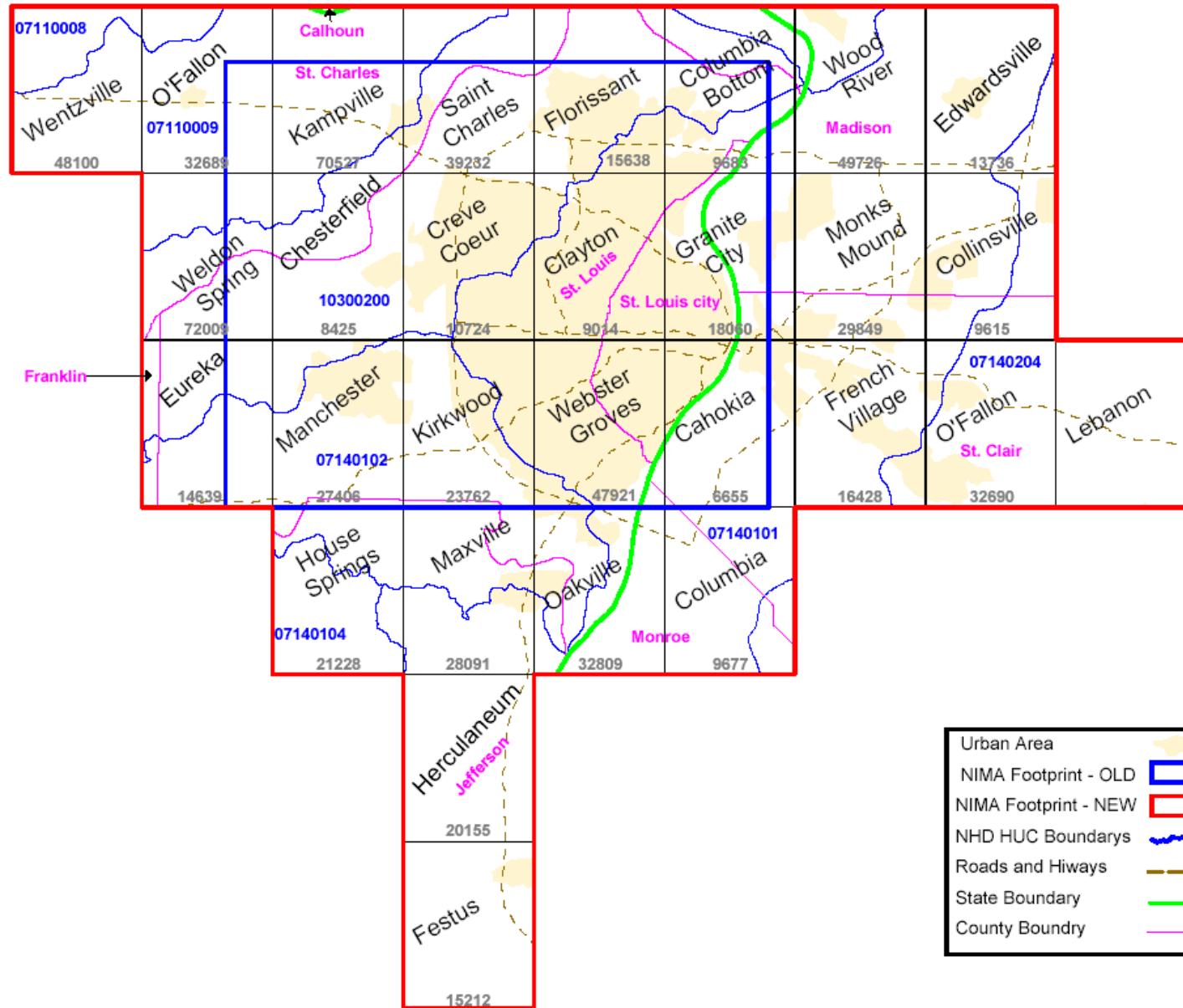
- Initially the Manchester and Kirkwood quadrangles

- Atlanta

- Initially the Chamblee and Norcross quadrangles

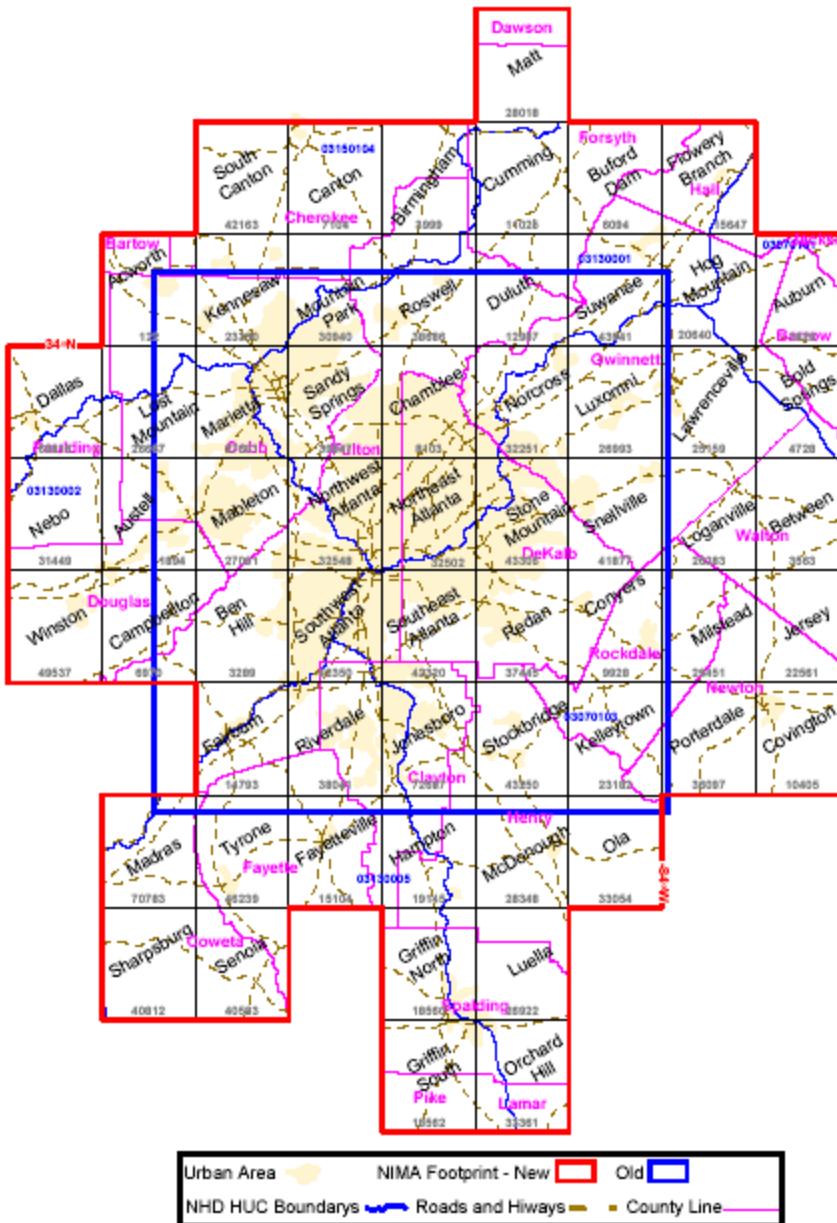
St. Louis, MO

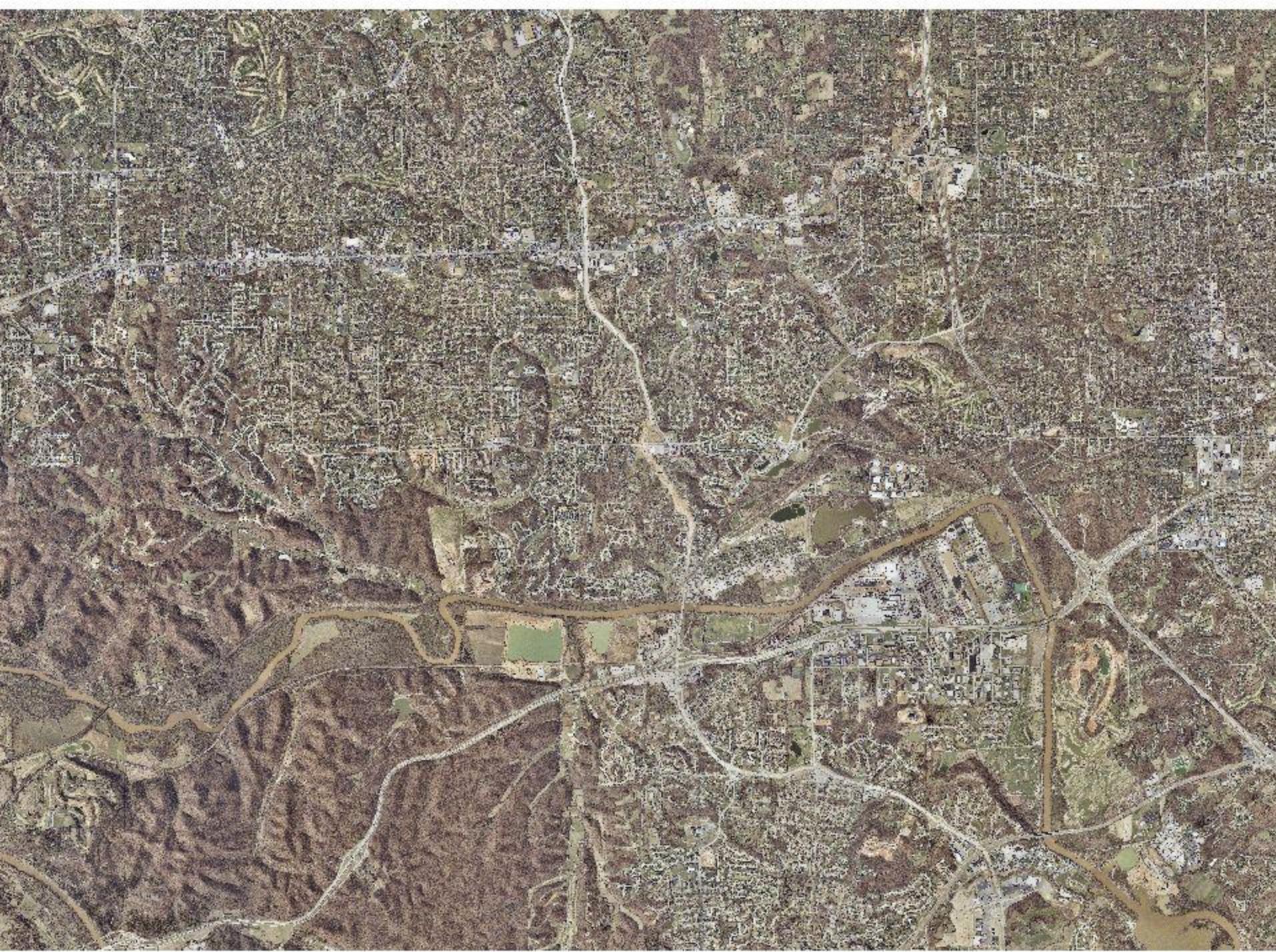
(NIMA 133 Urban Areas for Domestic Preparedness)

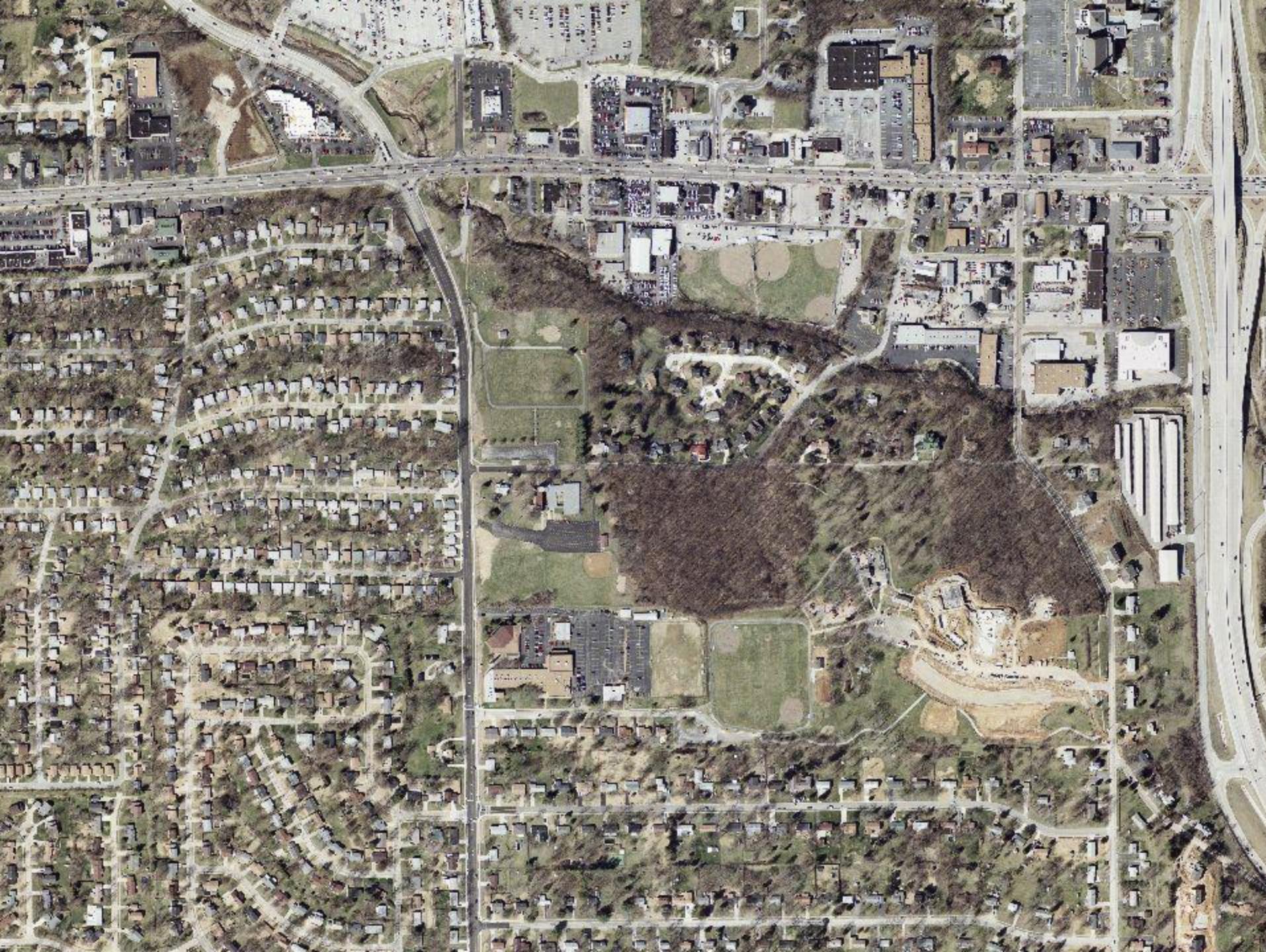


Atlanta, GA

(NIMA 133 Urban Areas for Domestic Preparedness)









Challenges Facing TNM: Institutional

Masser and Campbell (1995)

- Variation in participant priorities
- Variation in GIS experience among participants
- Differences in spatial data handling

The more participants in a data sharing program, the greater organizational complexity (Meredith, 1995; Fountain, 2001).

Azad et al. (1995) found an inverse relationship between the interdependency of participants and the likelihood of program success.

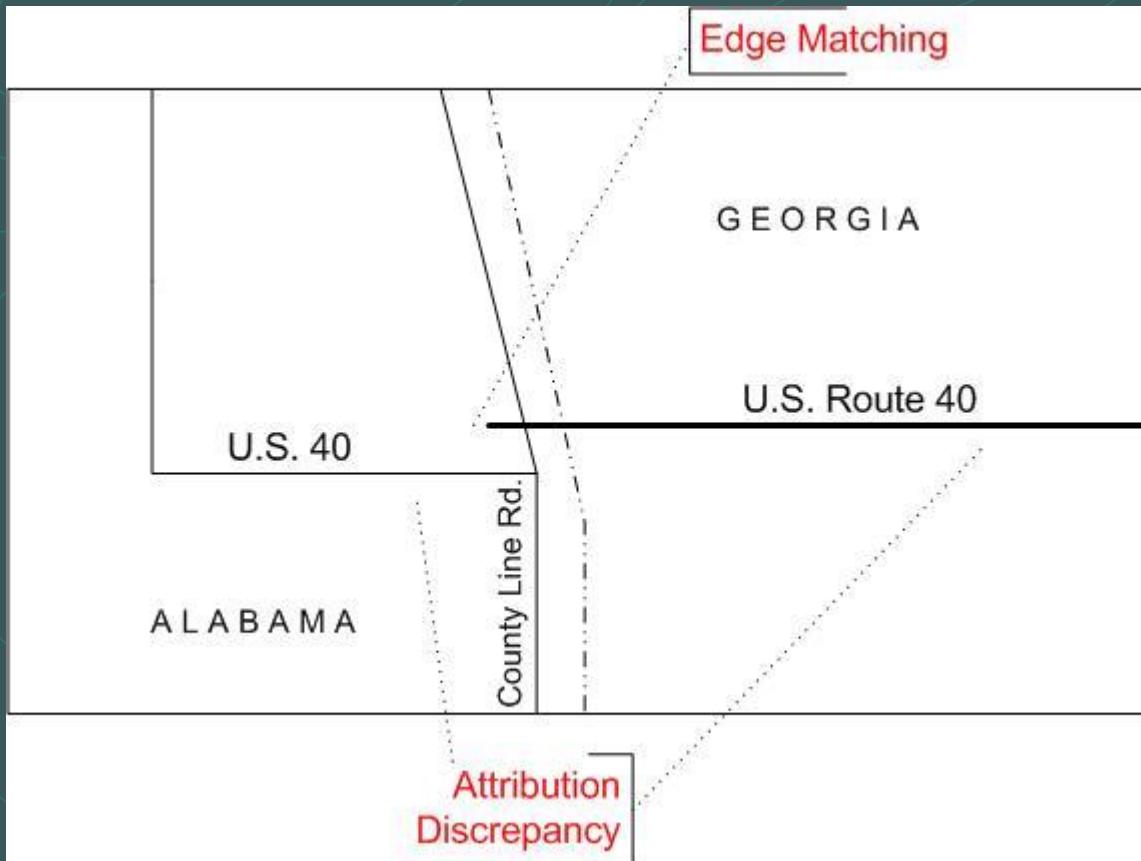
Challenges Facing TNM: Technical

Most datasets are outdated and inaccurate:



Challenges Facing TNM: Technical

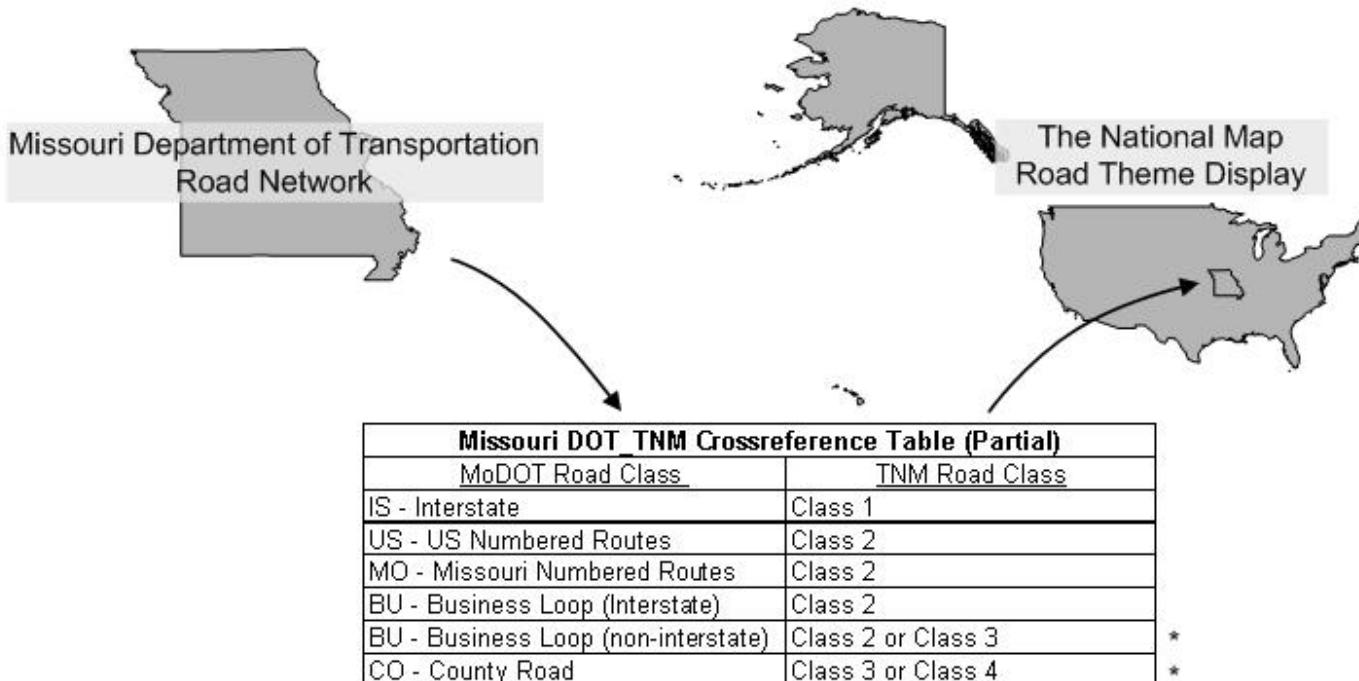
Horizontal data integration:



Attribute Translation from Local to Global

Local to Global Schematic Federation

An example the translation challenge



* Additional MoDOT attributes are needed to determine which TNM road class value should be assigned to road segment objects within these MoDOT road classes.

Source: USGS, 2003

Technical Factors Complicating Integration:

- Total length of coincident participant boundaries
- Road network feature density at the participant boundaries
- Complexity (attribute precision) of the global schema

Methods

• Layer integration

- Determine compatible resolutions and accuracies and use metadata to automatically combine appropriate datasets
- Determine transformations possible that integrate datasets of incompatible resolutions and accuracies
- Determine limits of integration based on resolution and accuracy

Cartographic Transformations from Keates

- Sphere to plane coordinates – projection
 - Mathematical, deterministic, correctable
- Three-dimensional to two-dimensional surface
 - Mathematical, deterministic, correctable
- Generalization
 - Non-mathematical, scale dependent,
humanistic, not correctable

Scale and Resolution Matching (Mathematical Transformations)

- Working postulate: If data meet NMAS (NSSDA), then integration can be automated based on the scale ratios
 - If linear ratios of scale denominators are $\geq \frac{1}{2}$, then integration is possible through mathematical transformations ($12 - 24 K = 0.5$)
 - For ratios $< \frac{1}{2}$, generalization results in incompatible differences ($12 - 48 K = 0.25$)

Generalization Issues

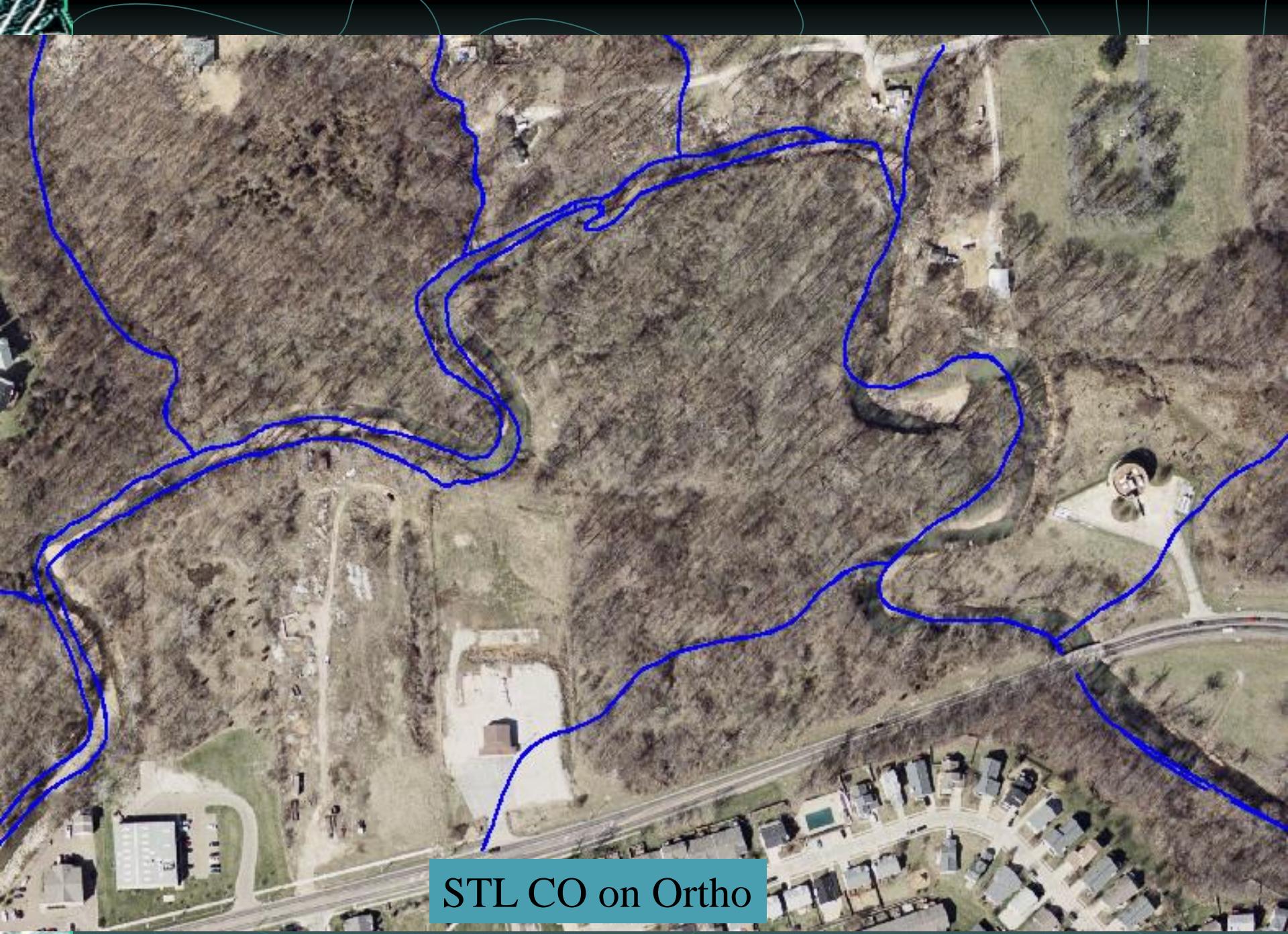
- **Selection** – common features may not appear on data layers to be integrated (Topfer's Radical Law)
- **Simplification** – lines may contain reduced numbers of points and have different shapes
- **Symbolization** – for map sources, symbolization may result in areas shown as lines or points
- **Induction** – features may have been interpolated and appear differently on different sources



NHD on Ortho



NHD on Ortho



STL CO on Ortho



STL CO on Ortho

Data Integration Project

Visual Assessment

Evaluator ID: _____

Map Sheet Name: _____ Map Scale: _____

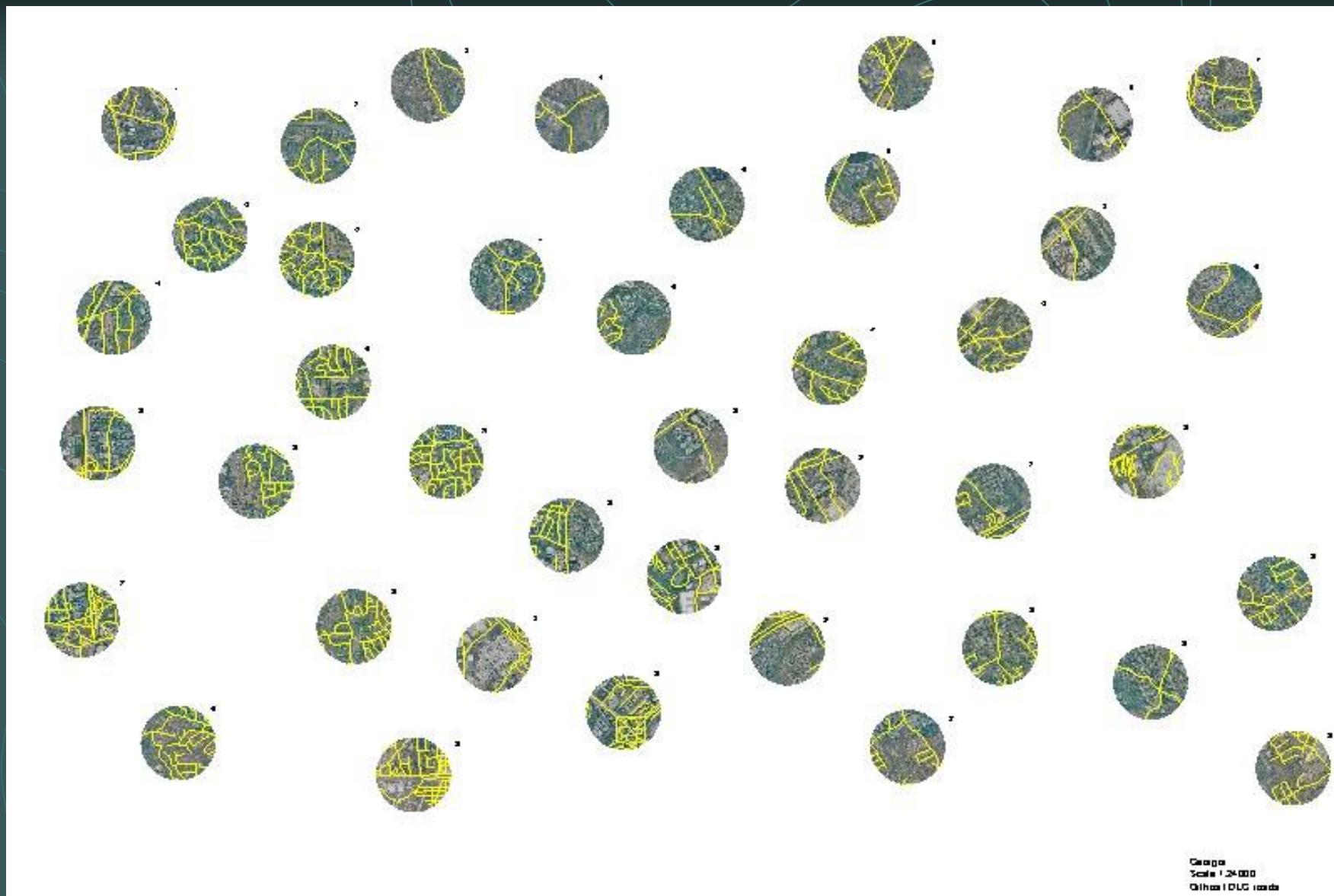
Evaluation Region #:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Shape Rating:																				
Geometry (position) Rating:																				
Temporal Rating:																				

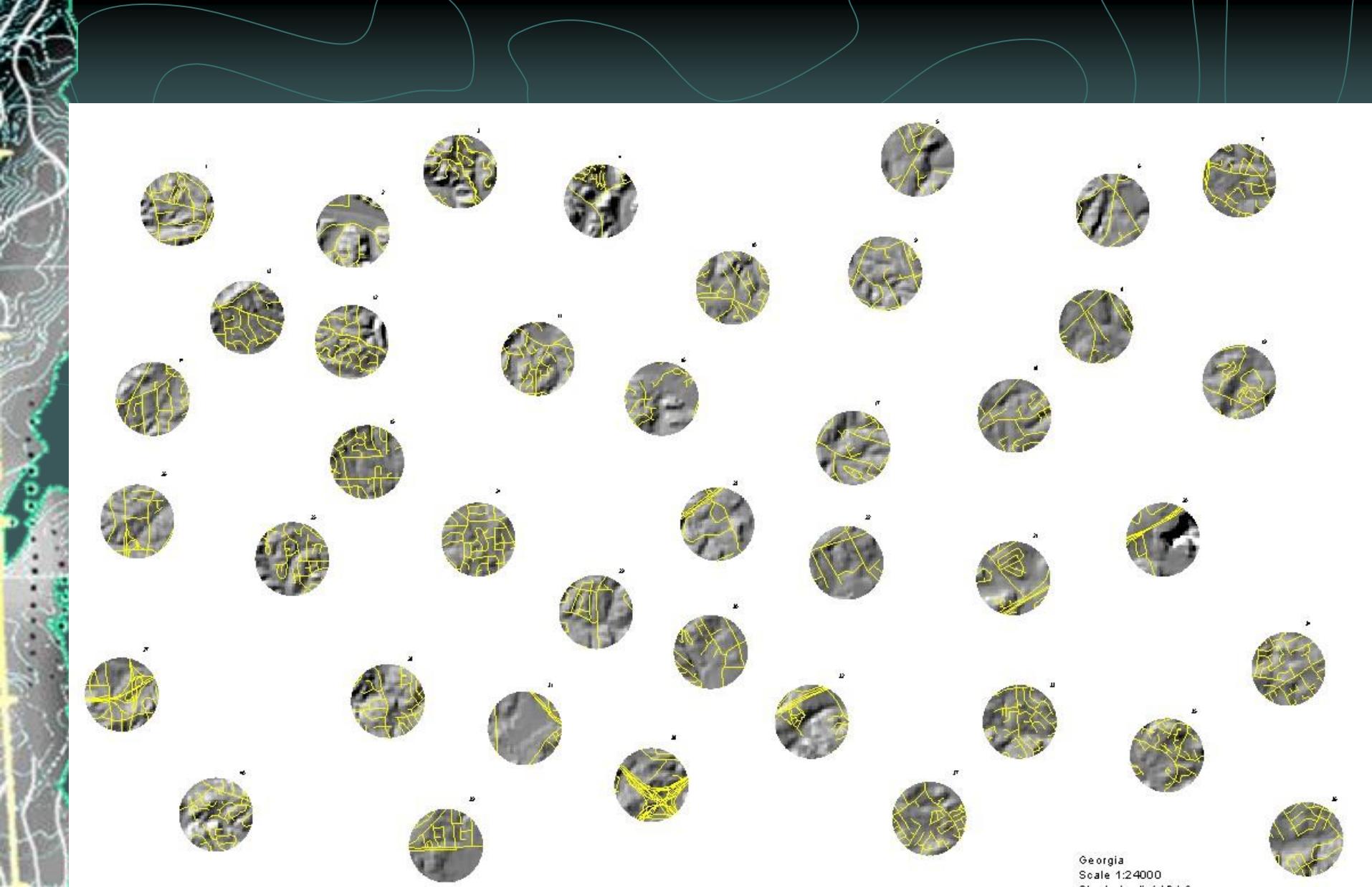
Rating Scale:

- 5 Good
- 4
- 3 Mediocre
- 2
- 1 Poor

X Not evaluated

Evaluation Region #:	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Shape Rating:																				
Geometry (position) Rating:																				
Temporal Rating:																				





Georgia
Scale 1:24000
Shaded relief / D.LG



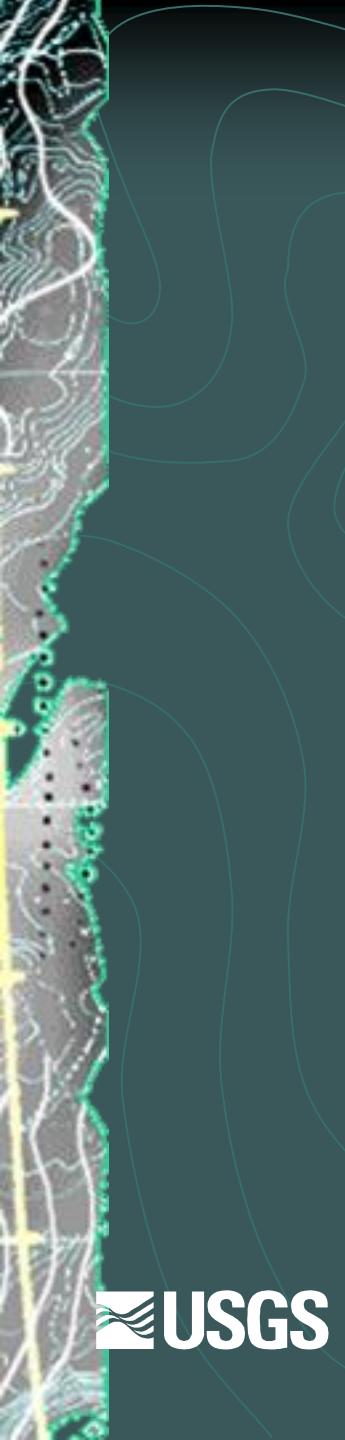
GA DOT on Ortho (12K)



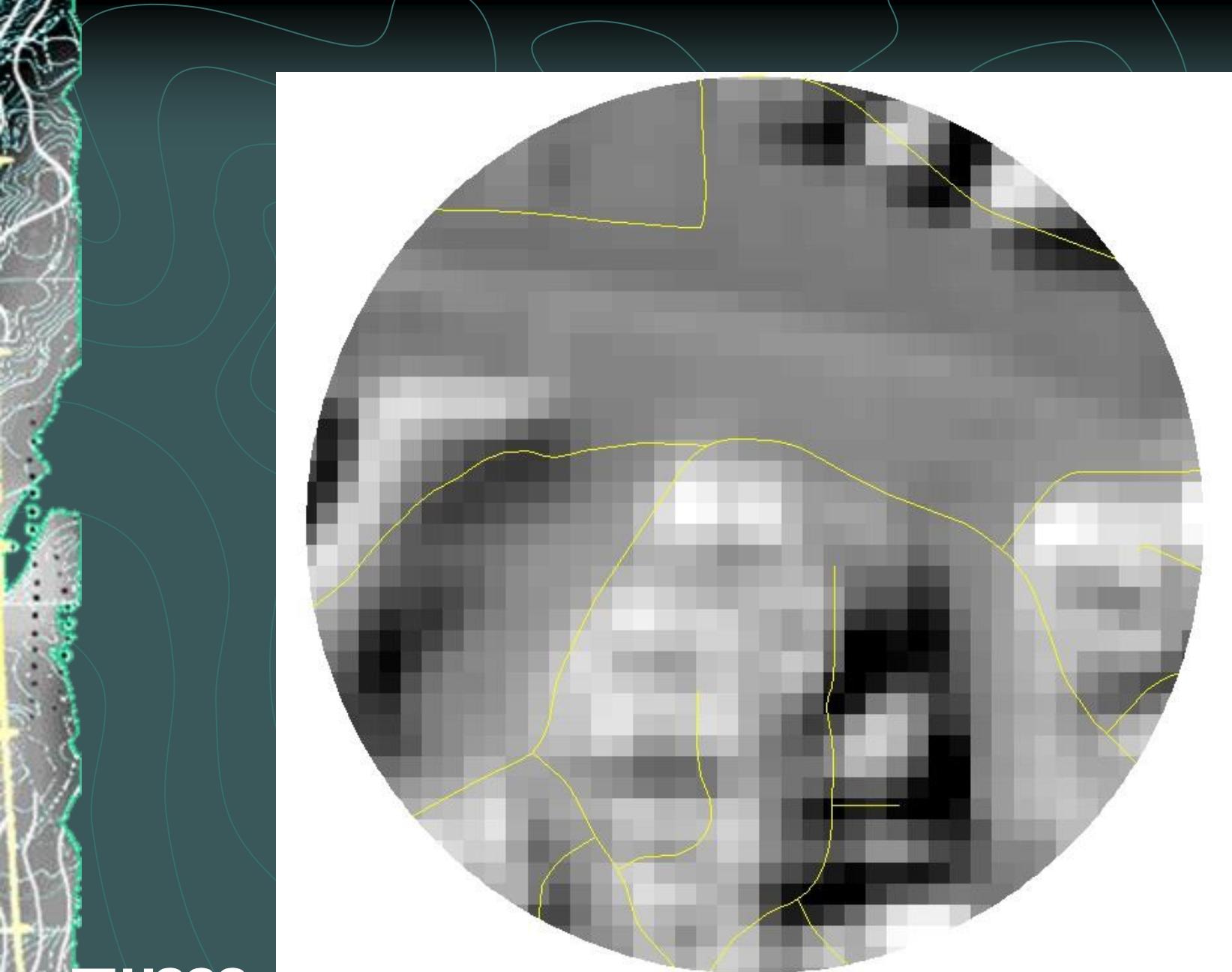
USGS DLG on Ortho (12K)



Census TIGER on Ortho (12K)



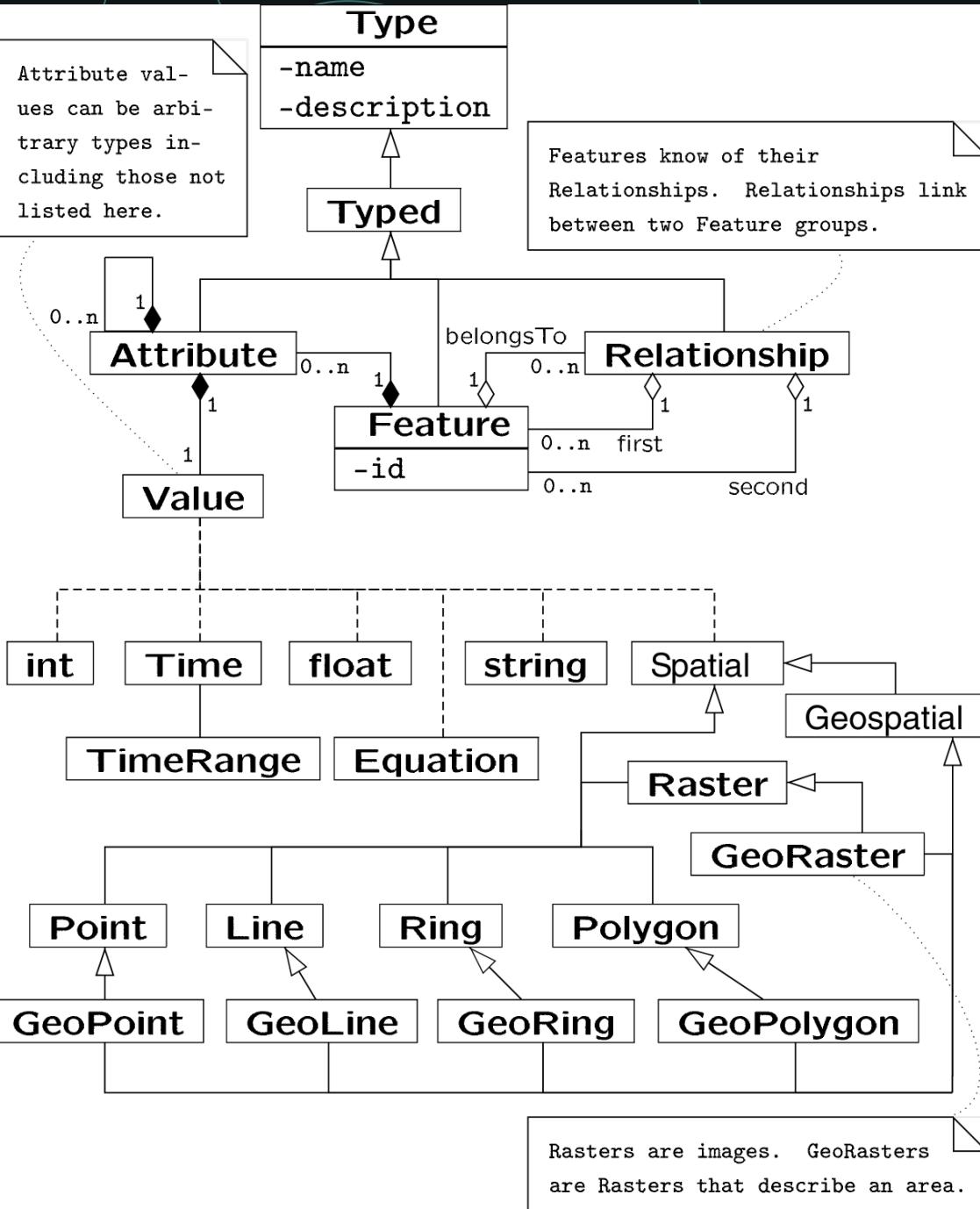
MO DOT on Ortho (12K)



Transportation on Shaded Relief

Feature Integration

- **Metadata exists on a feature basis**
 - Accuracy, resolution, source are documented by feature
 - Use Feature Library with an integration application



Conclusions

- Data integration of layers for *The National Map* can only be accomplished with datasets that are compatible in resolution and accuracy
- Mathematical transformation can automate integration with limited ranges of scales, but cannot correct generalization differences
- *The National Map* road data will leverage the U.S. Census Bureau's TIGER Enhancement Program and local data providers
- Technical integration (horizontal and vertical) and institutional integration present many challenges to partnering

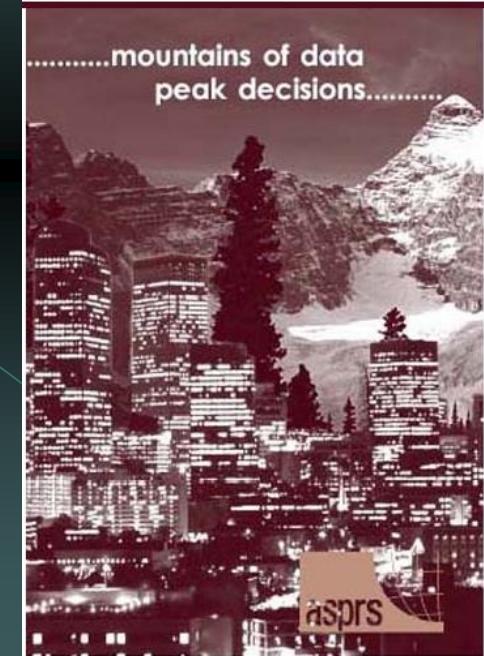
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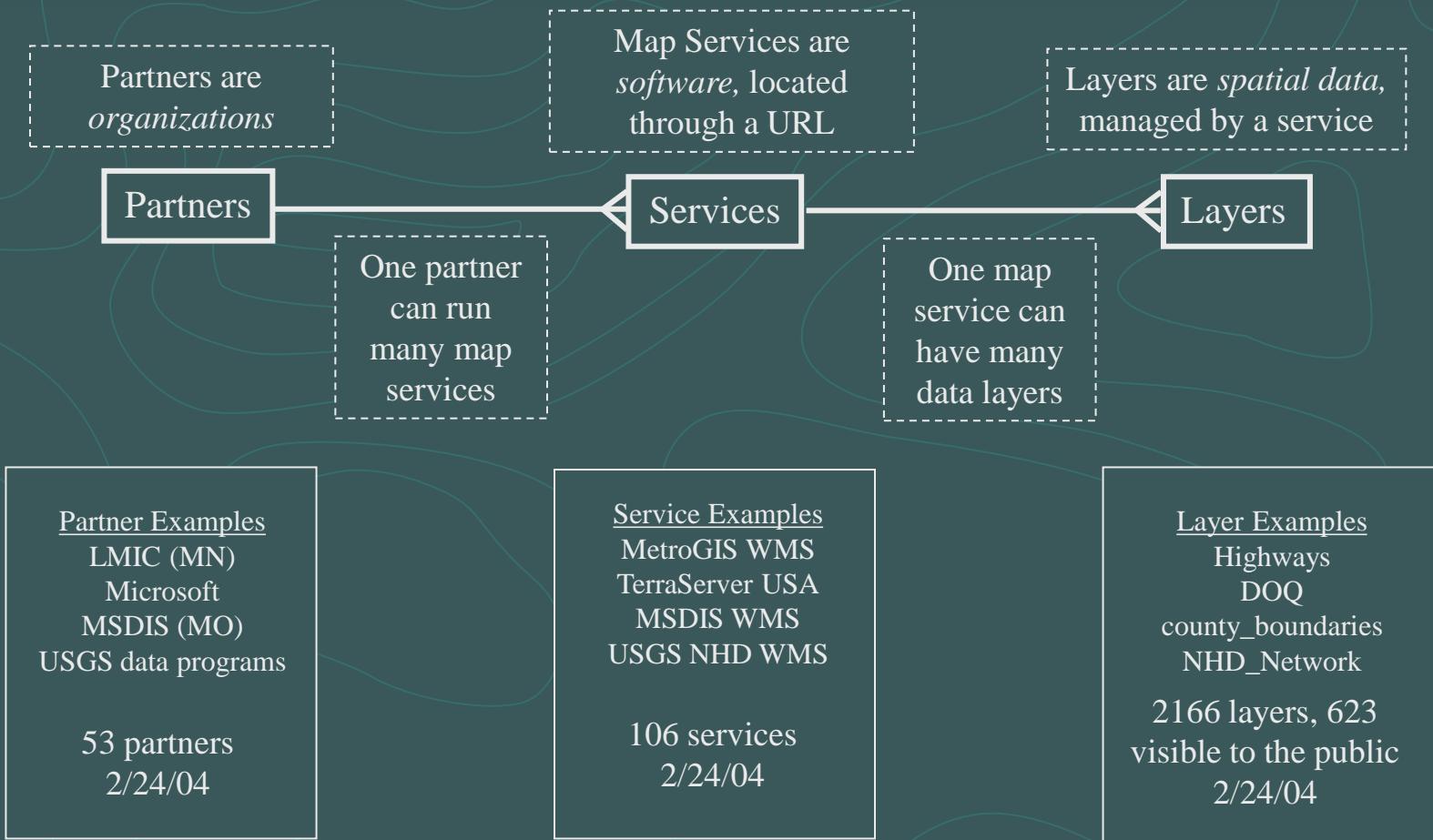
http://mcmcweb.er.usgs.gov/carto_research/



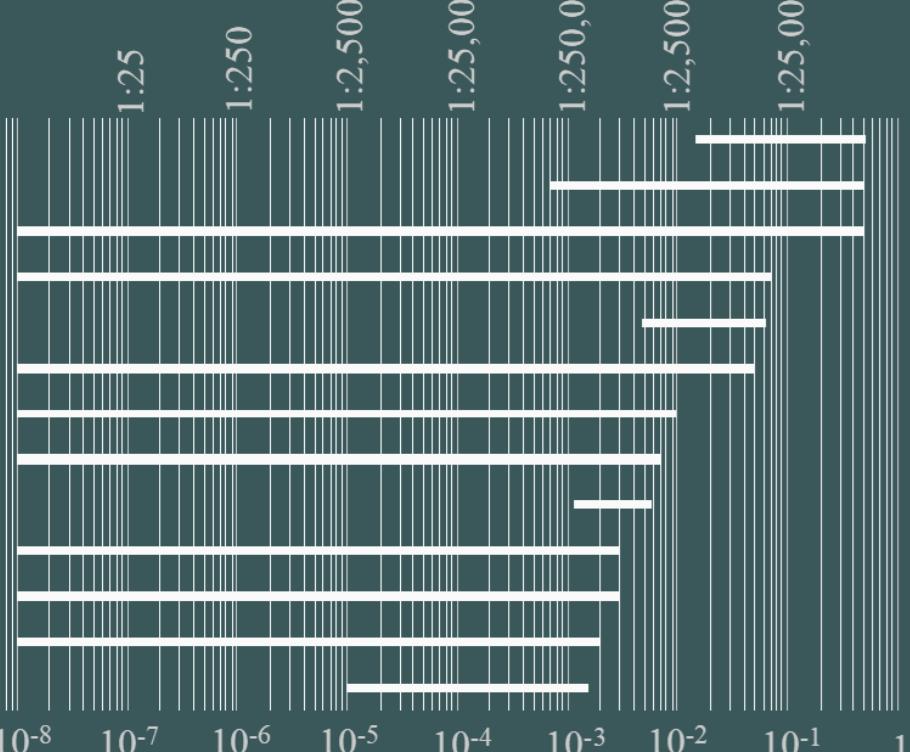


 USGS

Catalog Data Model, v1



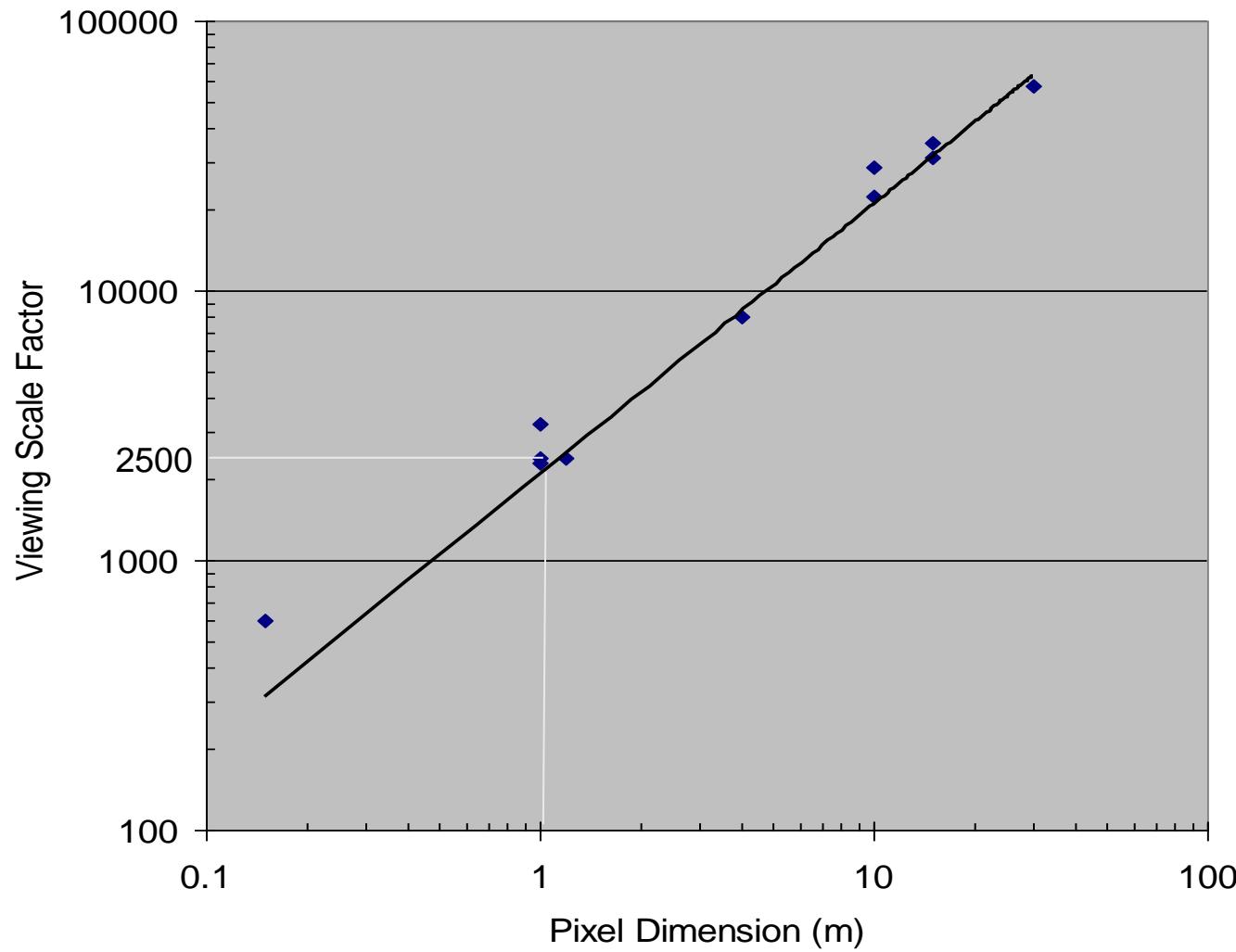
Approximate map scale



GTOPO60 Color Shaded Relief <1692>
State and Province Boundaries (USGS) <838>
USGS National Land Cover Database 2001 (TEST) <1974>
 US NED Shaded Relief <873>
 Interstates (USGS) <829>
 LANDSAT7 Index <198>
 NHD Waterbodies (100K) <978>
All Urban Area High-Res DOQ layers
 Major Roads (USGS) <832>
 GNIS Civil <1372>
 GNIS Populated Places <1375>
 NHD Network (100K) <981>
DOQ (TerraServer USA) <1652>

Viewer display scale, degees/pixel

Optimal Viewing Scale vs Resolution



Overlay_Chart.xls

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Done (view)	Zoom (plot)		Visual Accuracy Assessment(12K)			Visual Accuracy Assessment(24K)			Data Type	Resolution (Horizontal) (meter)	Accuracy		Dataset
2		12k	24k	Shape	Position	Temporal	Shape	Position	Temporal					
4	1	yes	yes	yes						Orthoimage / MoDOT	.30 / n/a	0.6500 / 57.9425		Orthoimage
5	2	yes	yes	yes						Orthoimage / NHD	.30 / n/a	0.6500 / 57.9425		NED
6	3	yes								NED / MoDOT	.30 / n/a	/ 57.9425		NED(shade)
7	4	yes	yes	yes						NED / NHD	.30 / n/a	/ 57.9425		NLCD
8	5	yes	yes	yes						NED(shade) / MoDOT	.30 / n/a	/ 57.9425		Stier STL LC
9	6	yes	yes	yes						NED(shade) / NHD	.30 / n/a	/ 57.9425		MoDOT
10	7	yes	yes	yes						NLCD / MoDOT	.30 / n/a	30.0000 / 57.9425		NHD
11	8	yes	yes	yes						NLCD / HND	.30 / n/a	30.0000 / 57.9425		
12	9	yes	yes	yes						Stier STL LC / MoDOT	.5 / n/a	/ 57.9425		
13	10	yes	yes	yes						Stier STL LC / NHD	.5 / n/a	/ 57.9425		
14	11													
15	12	yes								Orthoimage / NED	.30 / 30	0.6500 /		
16	13	yes								Orthoimage / NLCD	.30 / 30	0.6500 / 30.0000		
17	14	yes								Orthoimage / Stier STL LC	.30 / 5	0.6500 /		
18	15	yes								NED / NLCD	.30 / 30	/ 30.0000		
19	16	yes								NED / Stier STL LC	.30 / 5	/		
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