Geo-Information Science for Disaster Management

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Santa Barbara

Space and time are critical

- "Everything that happens, happens somewhere in space and time" (Michael Wegener)
- Geoinformation
  - links properties/attributes/characteristics to locations in space-time
  - decomposable into atomic tuples <**x**,**z**>

Six arguments for location

- Integration of disparate data and processes
  - the GIS layer cake
  - linking through common site
- The importance of context
  - situation
  - nearby facilities, events

More arguments for location

- Spatial processes
  - modeling diffusion, spread through time
  - atmospheric plumes
  - tsunamis
- Space and time appear explicitly in the process model

North Korea's missile threat

Type	Maximum range	Payload	Status
Nodong	1,300 km (810 miles)	700 kg (1,550 pounds)	Currently deployed
Taepodong-1	Up to 10,000 km	Several hundred kg	Test failed 1998, not yet operational
Taepodong-2	10,000–15,000 km	Several hundred kg	Not yet tested

Source: Task Force for US Korea Policy, Centre for International Policy

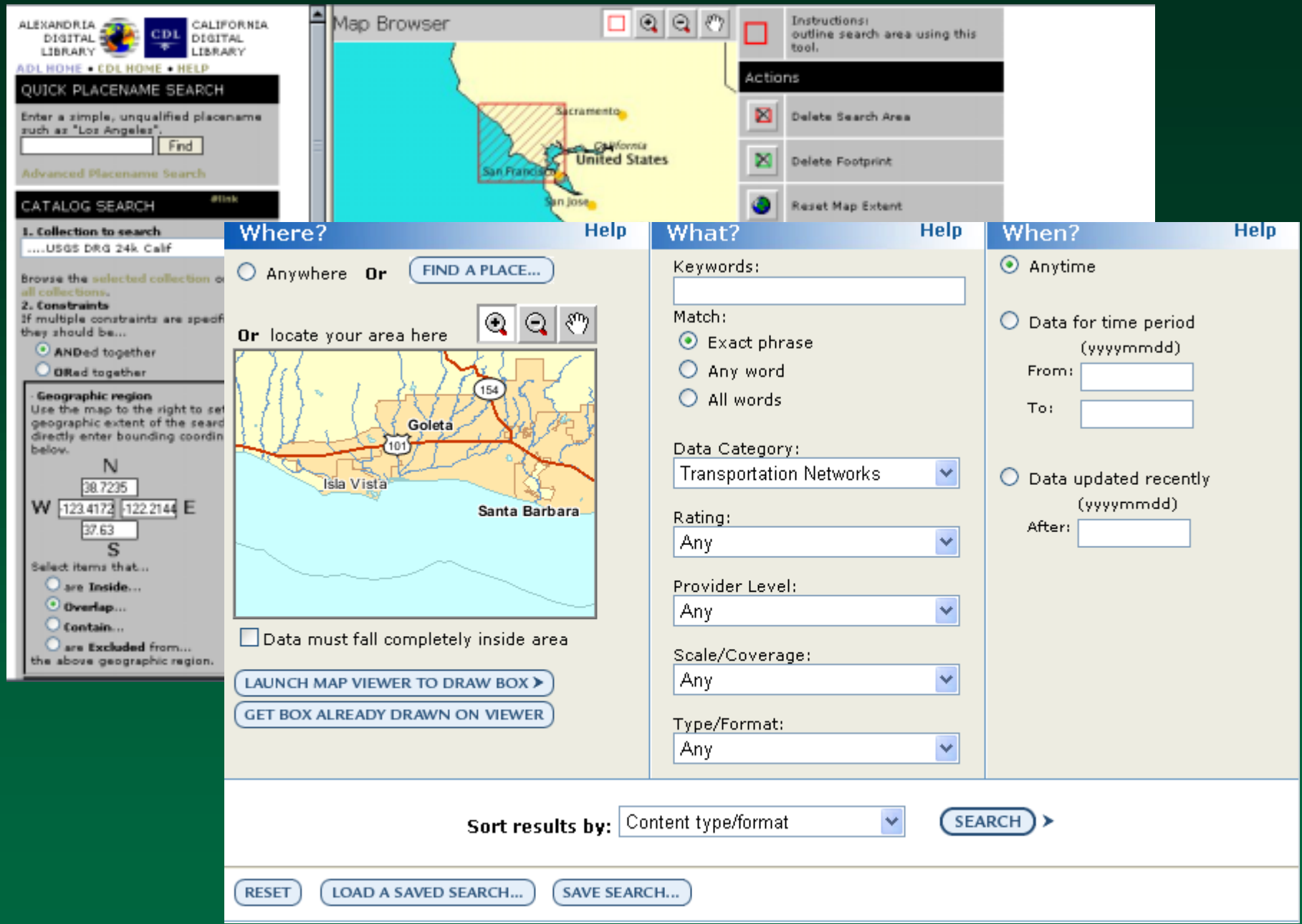
The Economist, May 3rd 2003

More arguments for location

- Design and optimization of systems
  - location, distance appear in objective function
  - location to minimize distance traveled
    - location-allocation problems
  - location to minimize visibility
  - location to minimize vulnerability

More arguments for location

- Space and time as dimensions for organizing information
  - and retrieving information from archives/warehouses/digital libraries
  - the geolibrary
    - a library whose contents can be searched by location
  - the geoportal
    - a single point of access to geoinformation and geoservices


ALEXANDRIA DIGITAL LIBRARY
CDL
CALIFORNIA DIGITAL LIBRARY
ADL HOME • CDL HOME • HELP
QUICK PLACENAME SEARCH
Enter a simple, unqualified placename such as "Los Angeles".
Find
Advanced Placename Search
CATALOG SEARCH
1. Collection to search
....USGS DRG 24k Calif
Browse the selected collection or all collections.
2. Constraints
If multiple constraints are specified they should be...
ANDed together
ORed together
Geographic region
Use the map to the right to set geographic extent of the search or directly enter bounding coordinates below.
N
38.7235
W
-123.4172
-122.2144
E
37.63
S
Select items that...
are Inside...
Overlap...
Contain...
are Excluded from...
the above geographic region.
Map Browser
Sacramento
California
United States
San Francisco
San Jose
Instructions:
outline search area using this tool.
Actions
Delete Search Area
Delete Footprint
Reset Map Extent
Where?
Help
Anywhere
Or
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Or locate your area here
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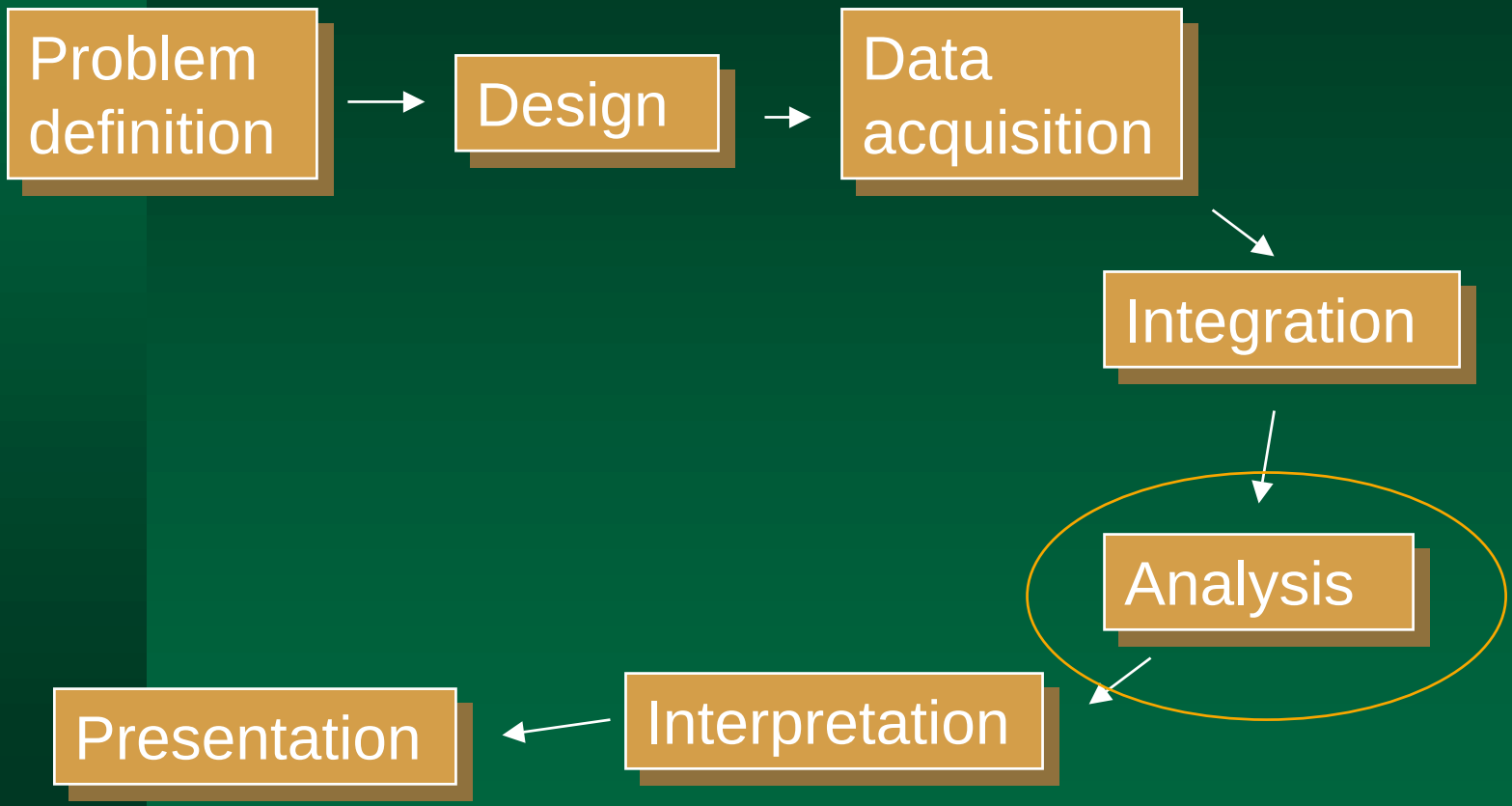
Santa Barbara
Data must fall completely inside area
LAUNCH MAP VIEWER TO DRAW BOX
GET BOX ALREADY DRAWN ON VIEWER
What?
Help
Keywords:
Match:
Exact phrase
Any word
All words
Data Category:
Transportation Networks
Rating:
Any
Provider Level:
Any
Scale/Coverage:
Any
Type/Format:
Any
When?
Help
Anytime
Data for time period
(yyyymmdd)
From:
To:
Data updated recently
(yyyymmdd)
After:
Sort results by:
Content type/format
SEARCH
RESET
LOAD A SAVED SEARCH...
SAVE SEARCH...

The final argument: the locations of computing

- User location *U*
  - perhaps U_1 through U_n
- Subject location *S*
  - traditionally independent of *U*
- Data location *D*
- Processing location *P*

Stages of problem solving



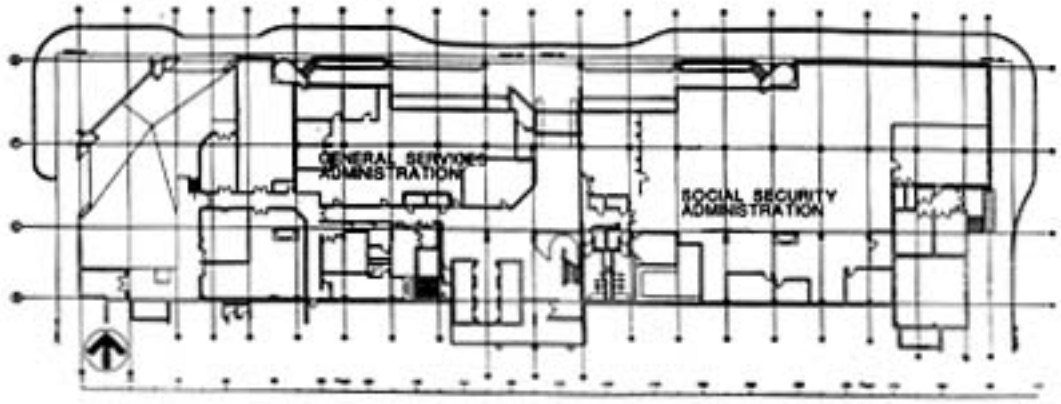
Why does it take so long?

- Analysis at the speed of light
- Why can't we solve problems in real time?
- How can we make it faster?
- Disaster management requires rapid response

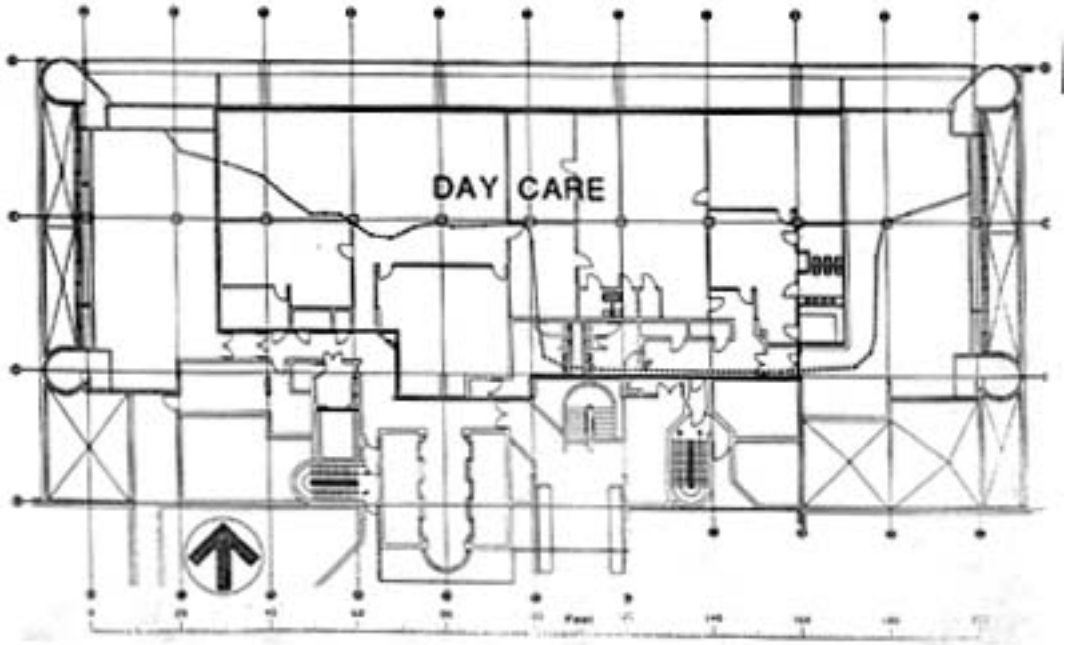
EXHIBIT A

ALFRED P. MURRAH BUILDING FLOOR PLAN

FIRST FLOOR



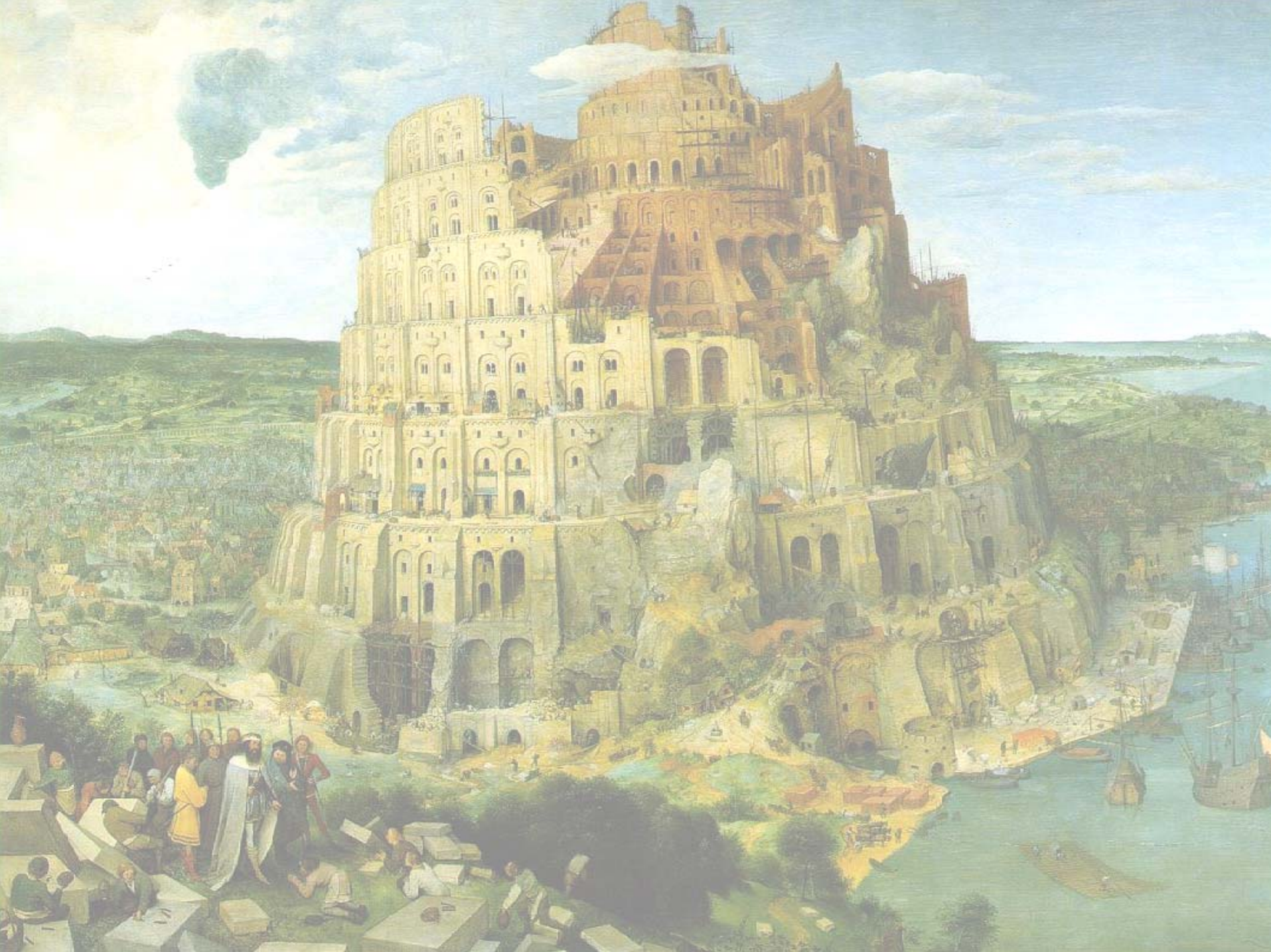
SECOND FLOOR

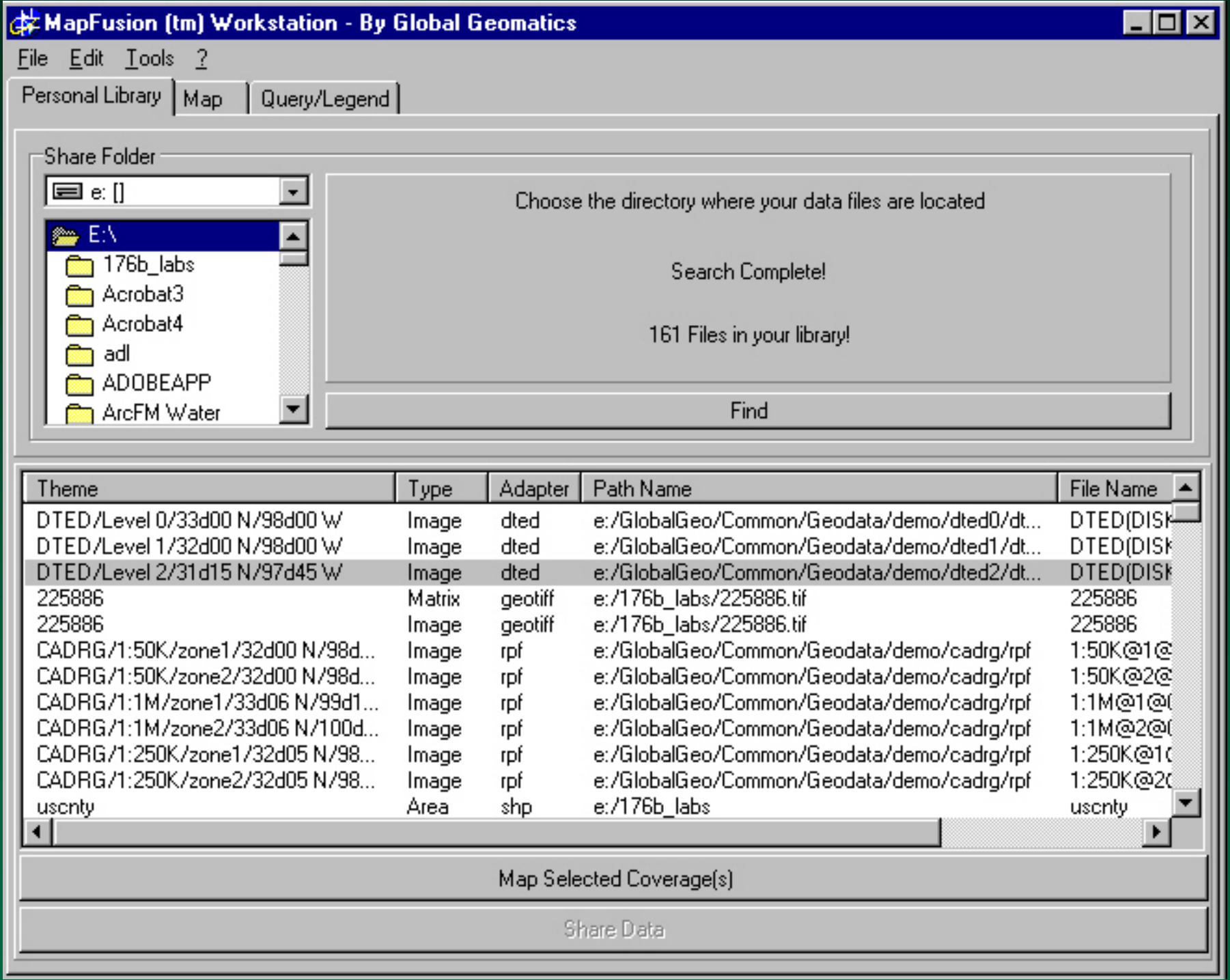



Original
OEM in
WTC
Complex
Bldg 7

A 5-stage model

1. Specify
2. Search
3. Assess
4. Retrieve
5. Open




MapFusion (tm) Workstation - By Global Geomatics
File Edit Tools ?
Personal Library Map Query/Legend
Share Folder
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Acrobat4
adl
ADOBEAPP
ArcFM Water
Choose the directory where your data files are located
Search Complete!
161 Files in your library!
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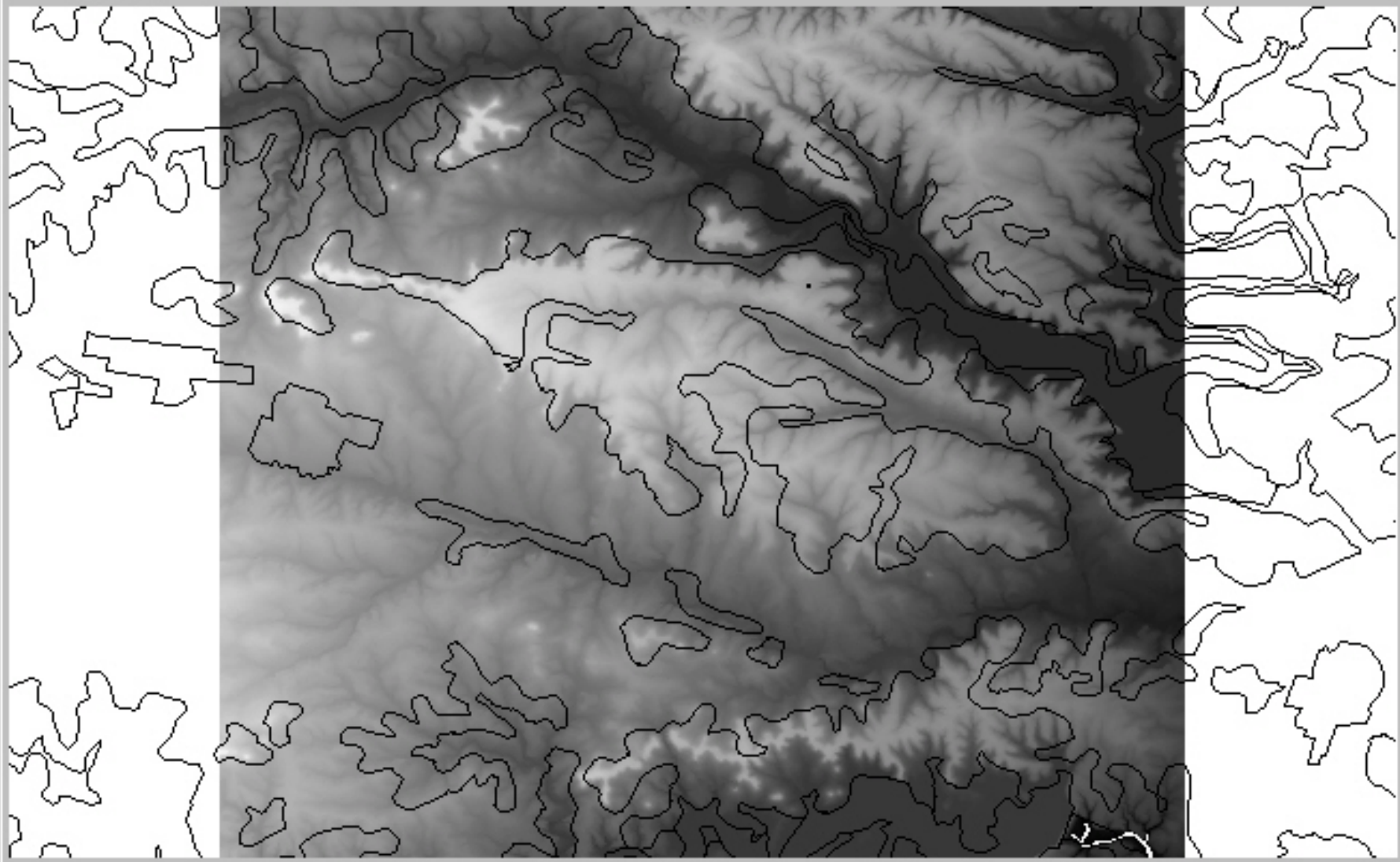
Map Selected Coverage(s)
Share Data

MapFusion (tm) Workstation - By Global Geomatics

File Edit Tools ?

Personal Library | Map | Query/Legend



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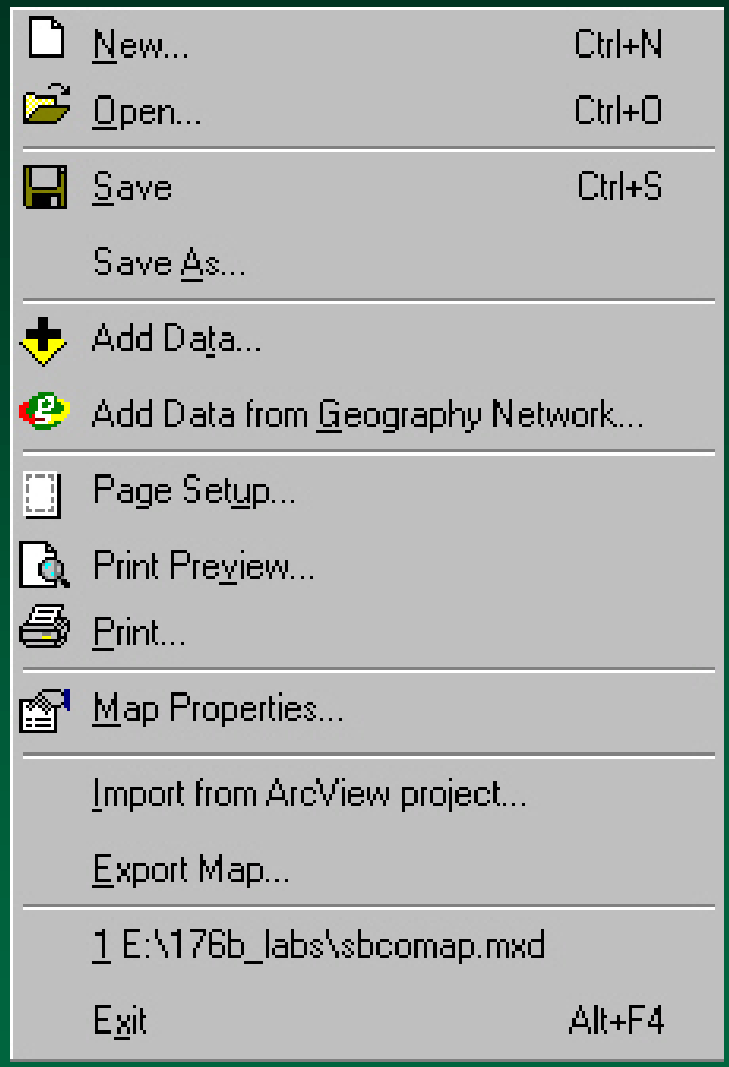
Scale: 1:201000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Add Data...
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Import from ArcView project...
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Exit Alt+F4

geography network

ACCESS A WORLD OF INFORMATION

ABOUT

MAPS

DATA

GEOSERVICES

SOLUTIONS

COMMUNITY

Geography Network Explorer

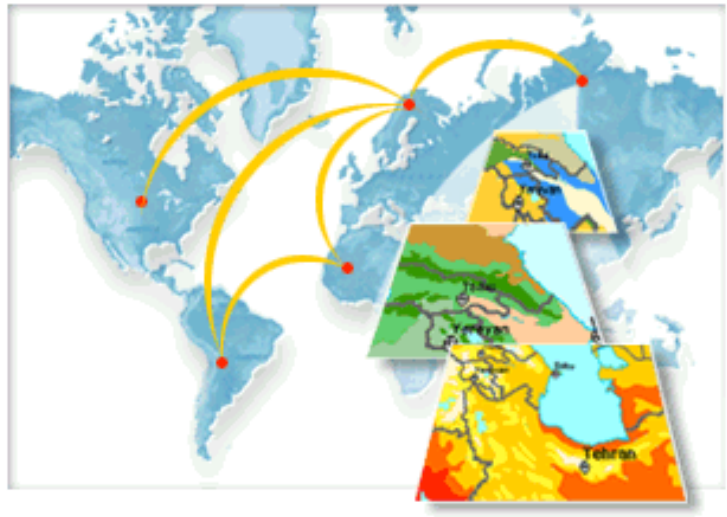
Free Resources

Be a Publisher

SEARCH & VIEW

use the **Geography Network Explorer** to search and view maps and other geographic content over the Internet

The Geography Network is a global community of data providers who are committed to making geographic content available. This content is published from many sites around the world, providing you immediate access to the latest maps, data, and related services. This portal to the Geography Network enables you to discover this content and share your own.



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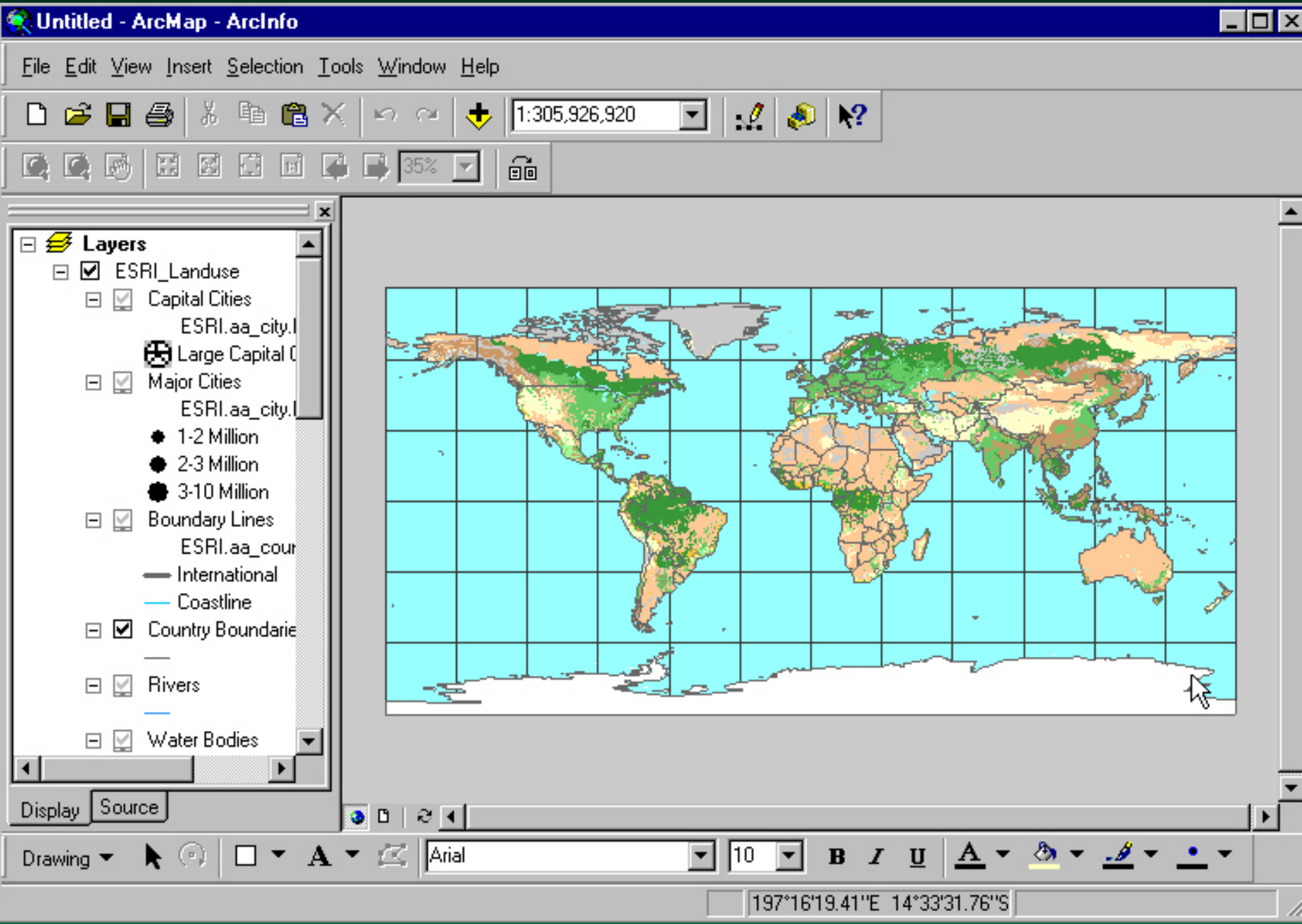
U.S. Census TIGER 2000

- View Live Maps
- Download Data Sets
- Build Custom Apps
- Publish Your Content
- Find Useful Tools
- Share Your Ideas

GEOGRAPHYNETWORK.COM Challenge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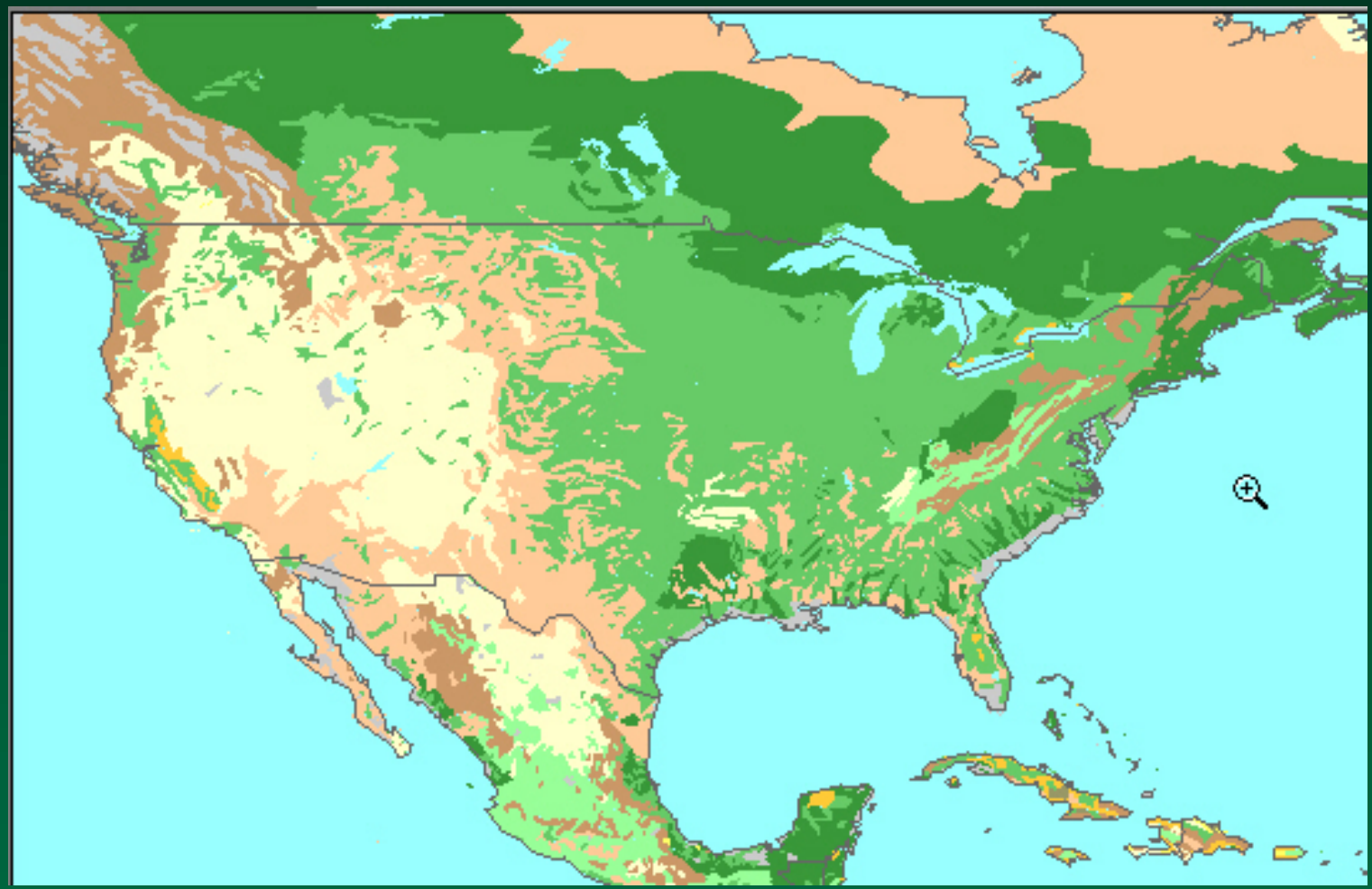

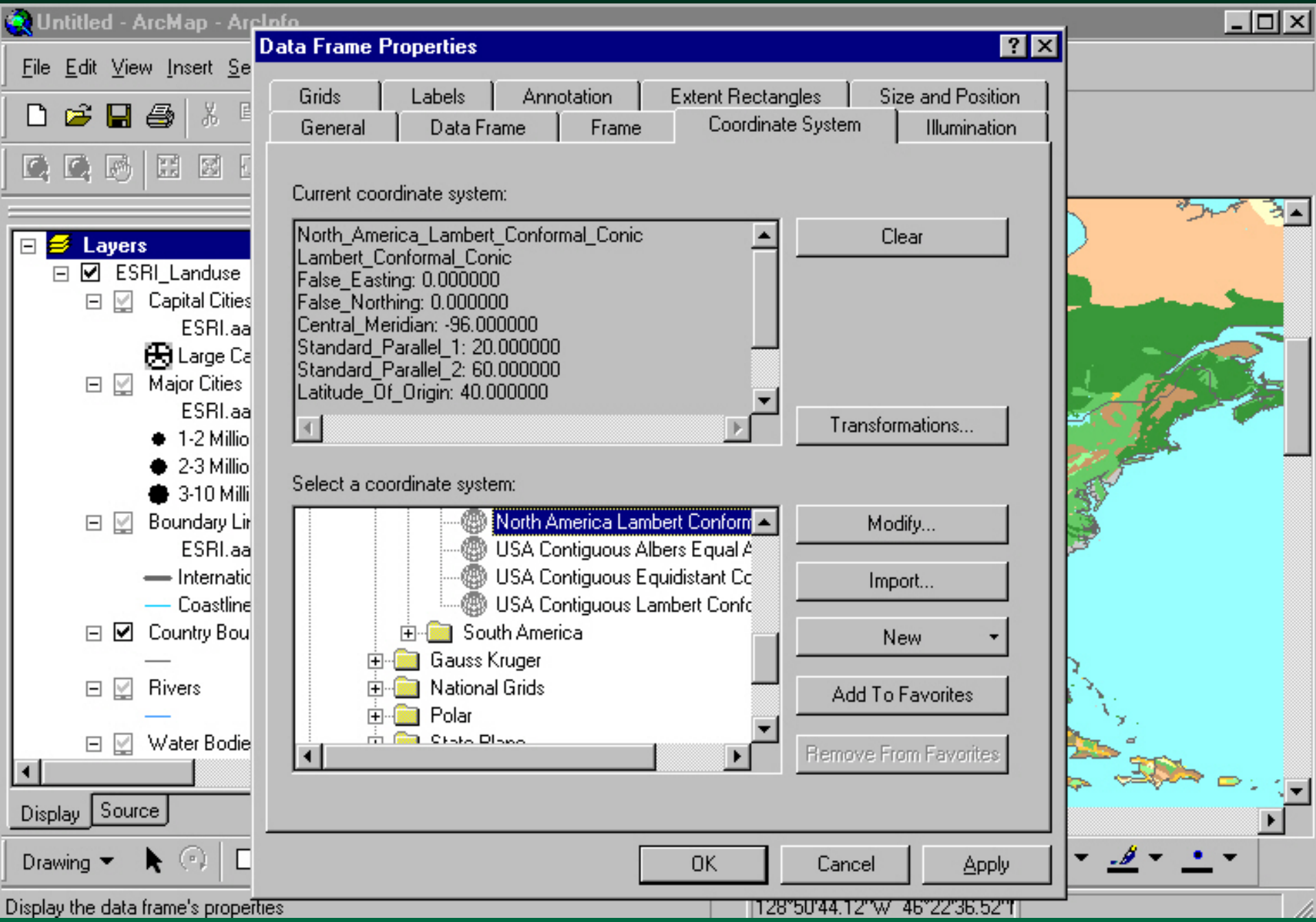
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False_Northing: 0.000000
Central_Meridian: -96.000000
Standard_Parallel_1: 20.000000
Standard_Parallel_2: 60.000000
Latitude_Of_Origin: 40.000000
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Cancel
Apply
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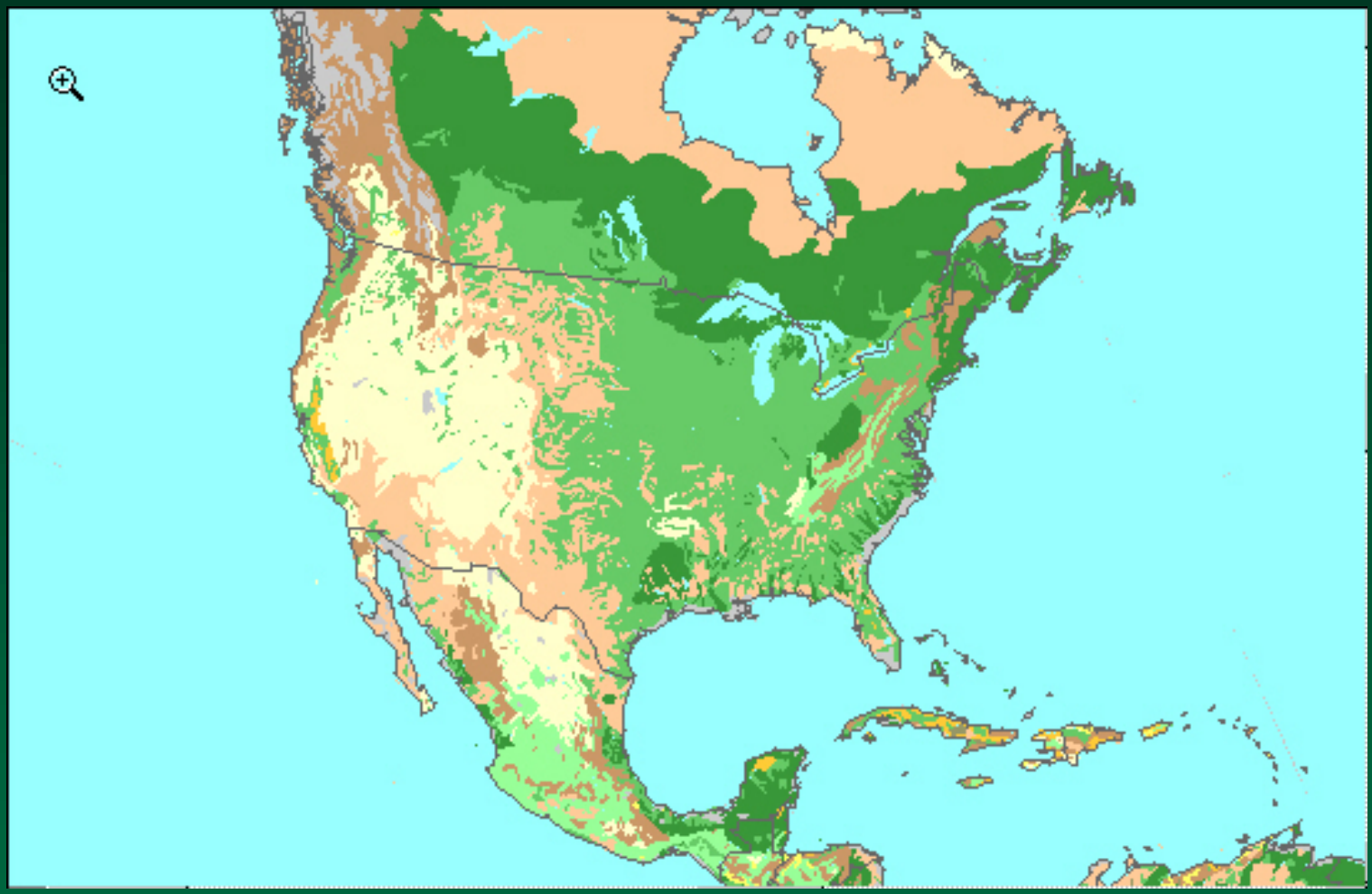

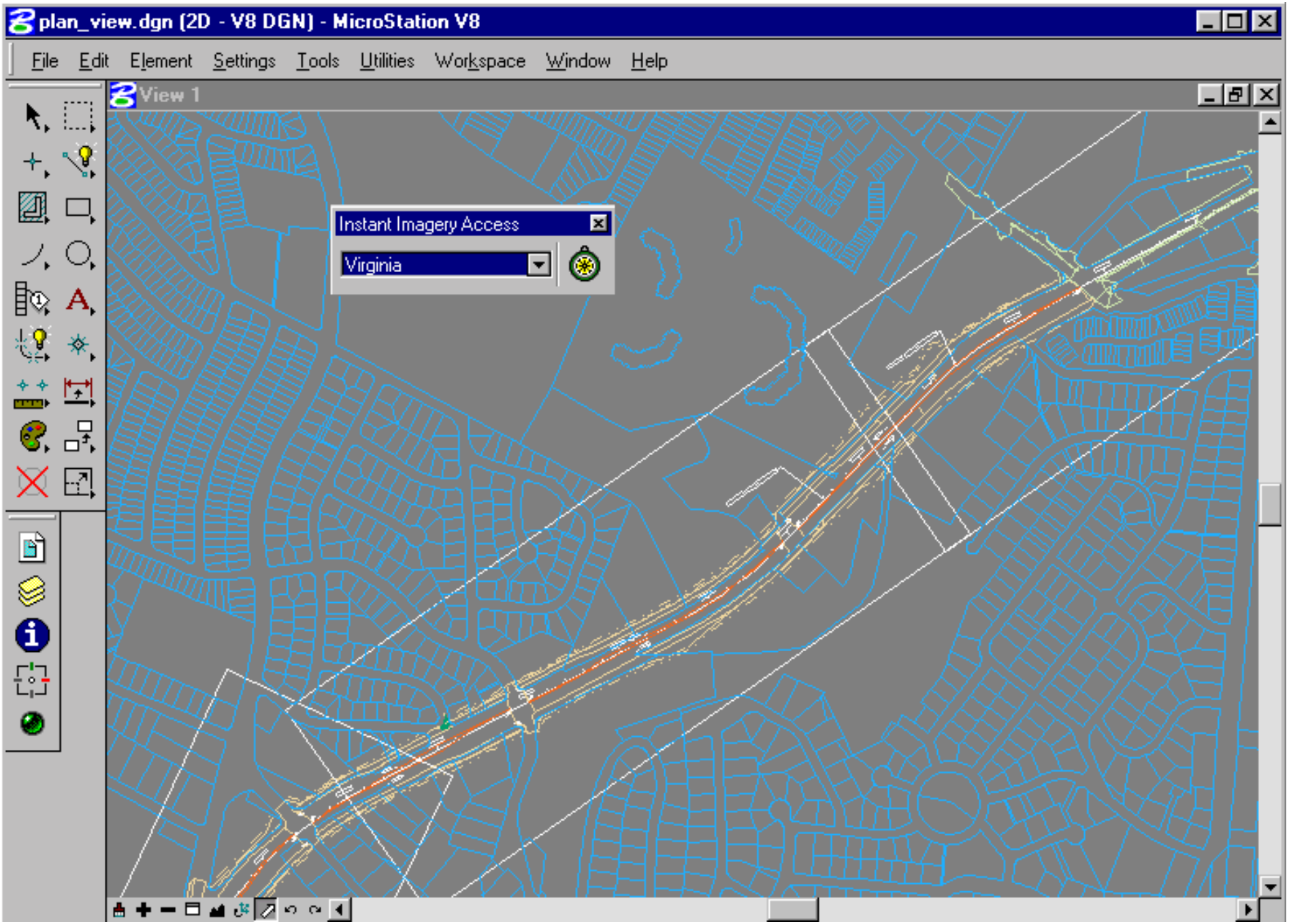
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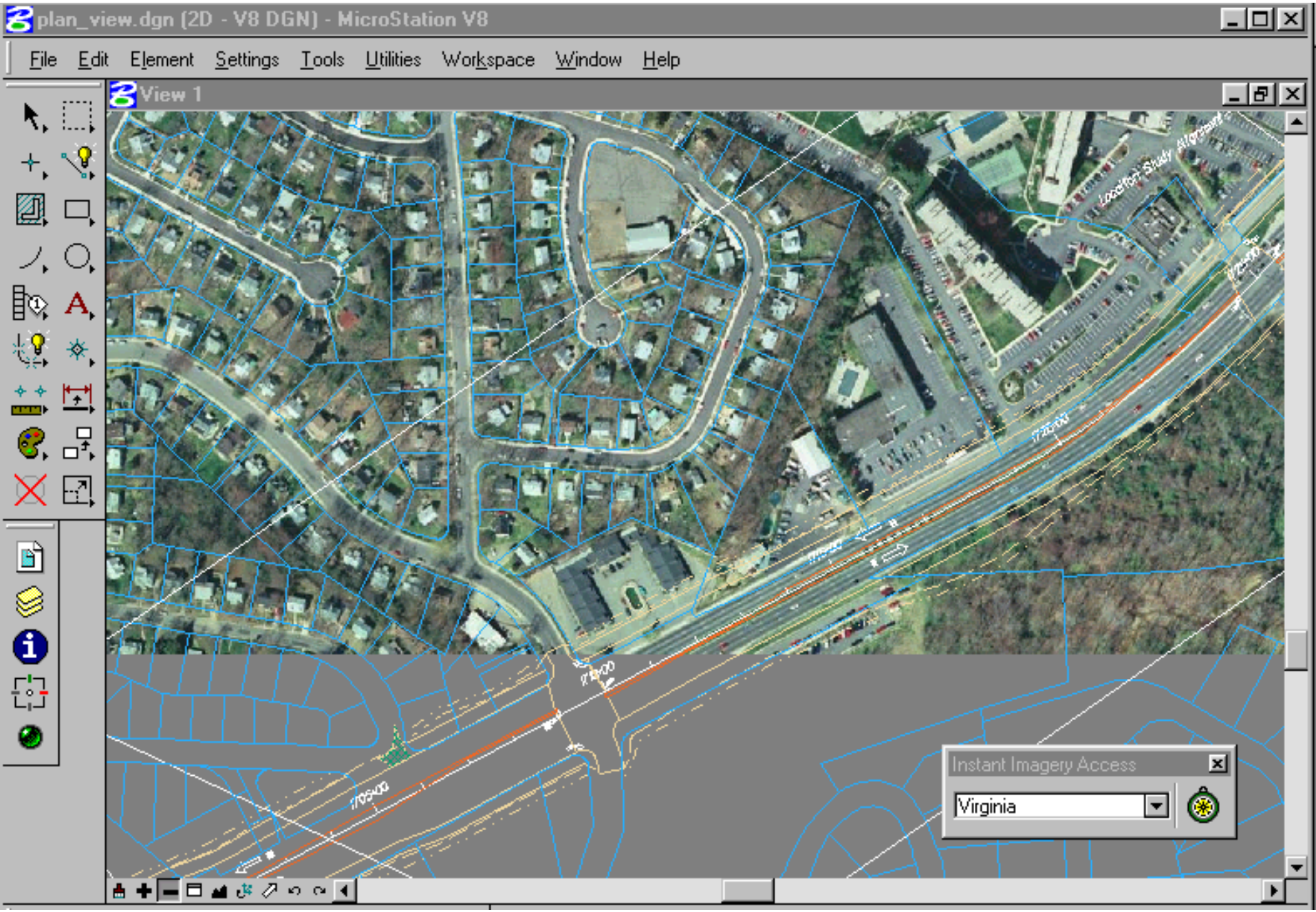
File Edit Element Settings Tools Utilities Workspace Window Help
View 1
Instant Imagery Access
Virginia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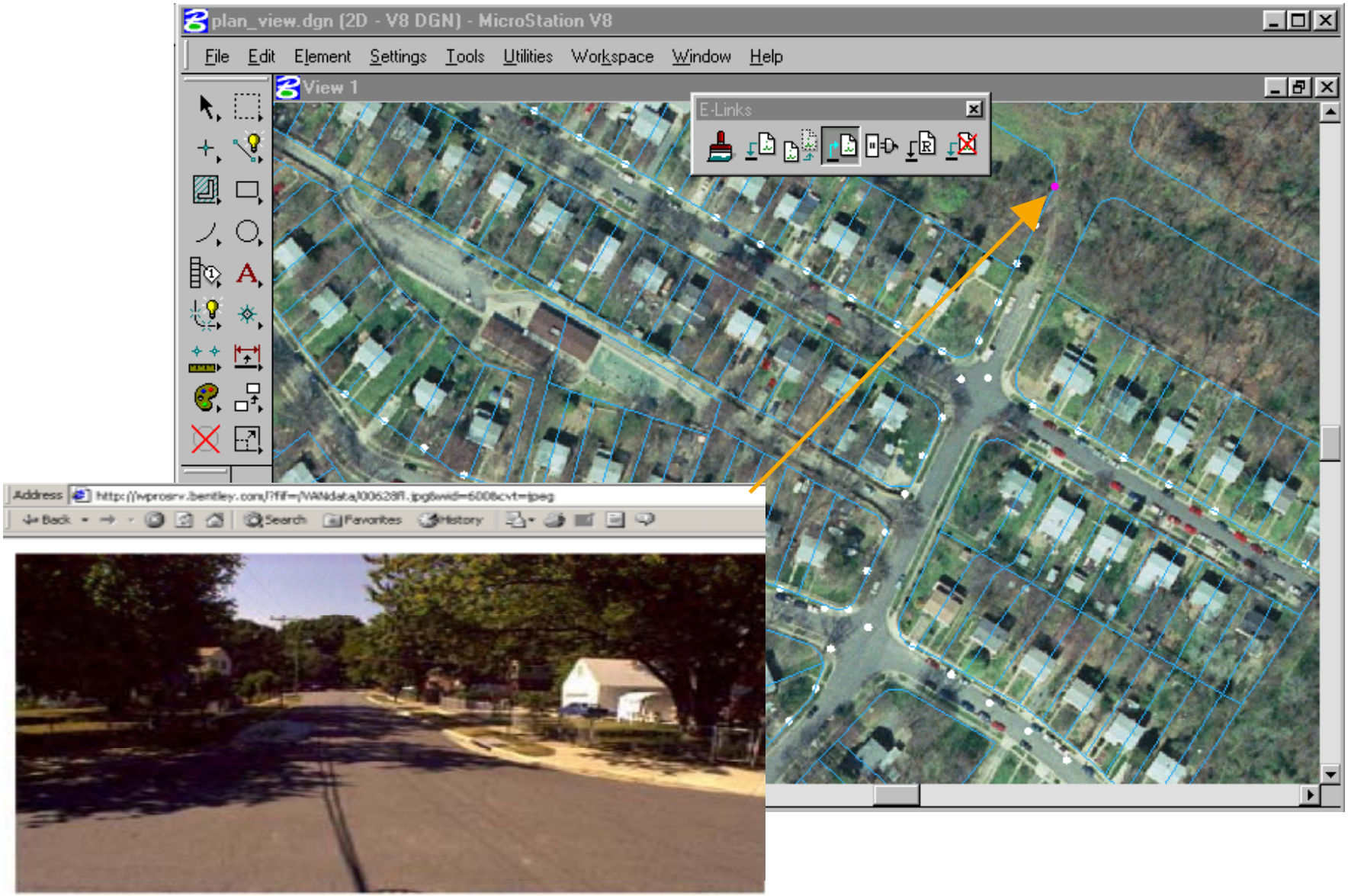
View 1
Instant Imagery Access
Virginia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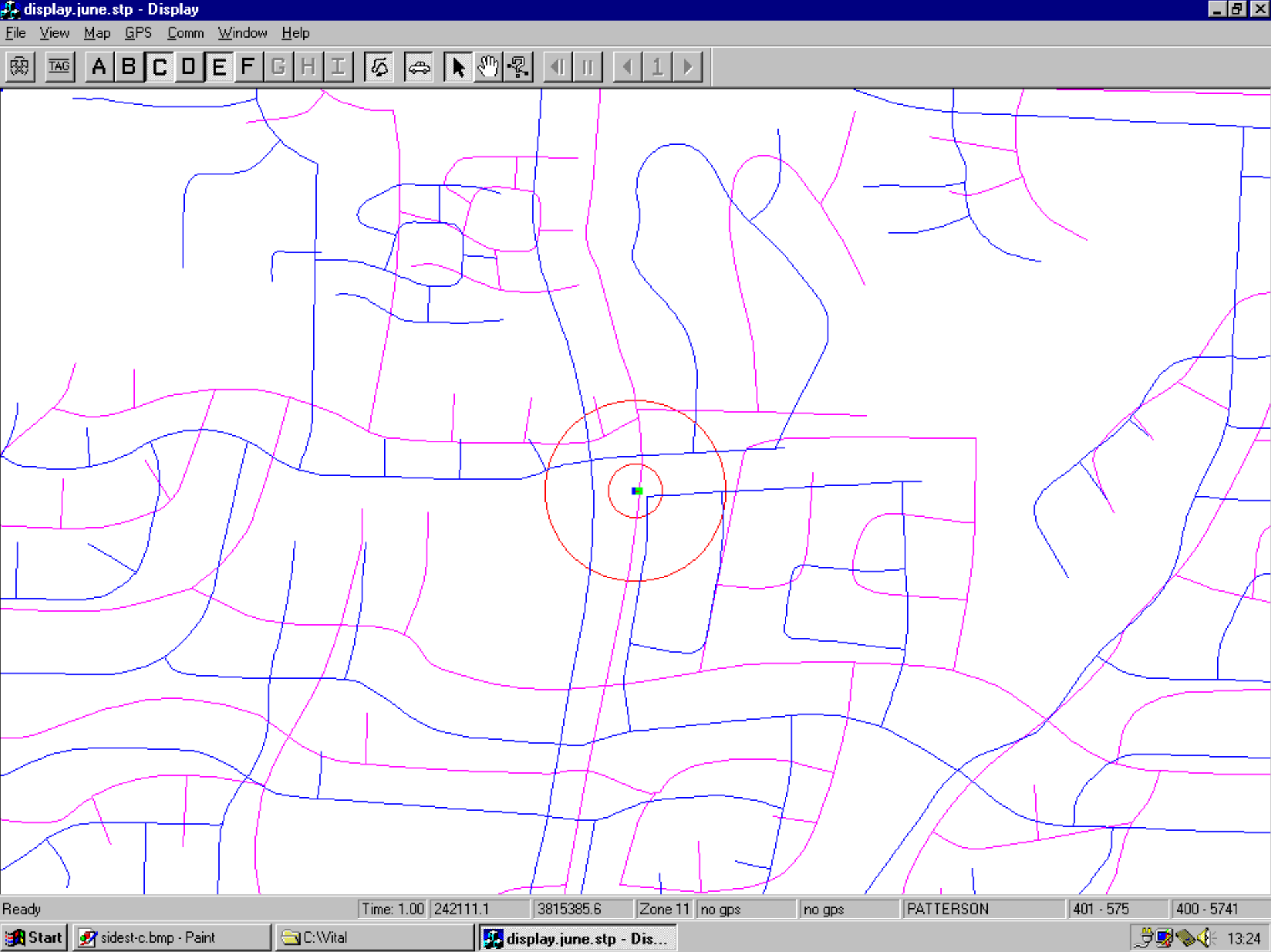
File Edit Element Settings Tools Utilities Workspace Window Help
View 1
E-Links
Address
Back
Search
Favorites
History

Objectives of interoperability

- Using technology to overcome differences
  - rather than imposing uniformity
  - enabling rather than intrusive
  - specifications not standards
- Bridging information communities
- Speeding and easing access to data

Major forces in spatial data interoperability

- U.S. National Spatial Data Infrastructure
  - Federal Geographic Data Committee
- Open GIS Consortium
  - industry, government, academic
- National, regional, and international standards organizations


display.june.stp - Display
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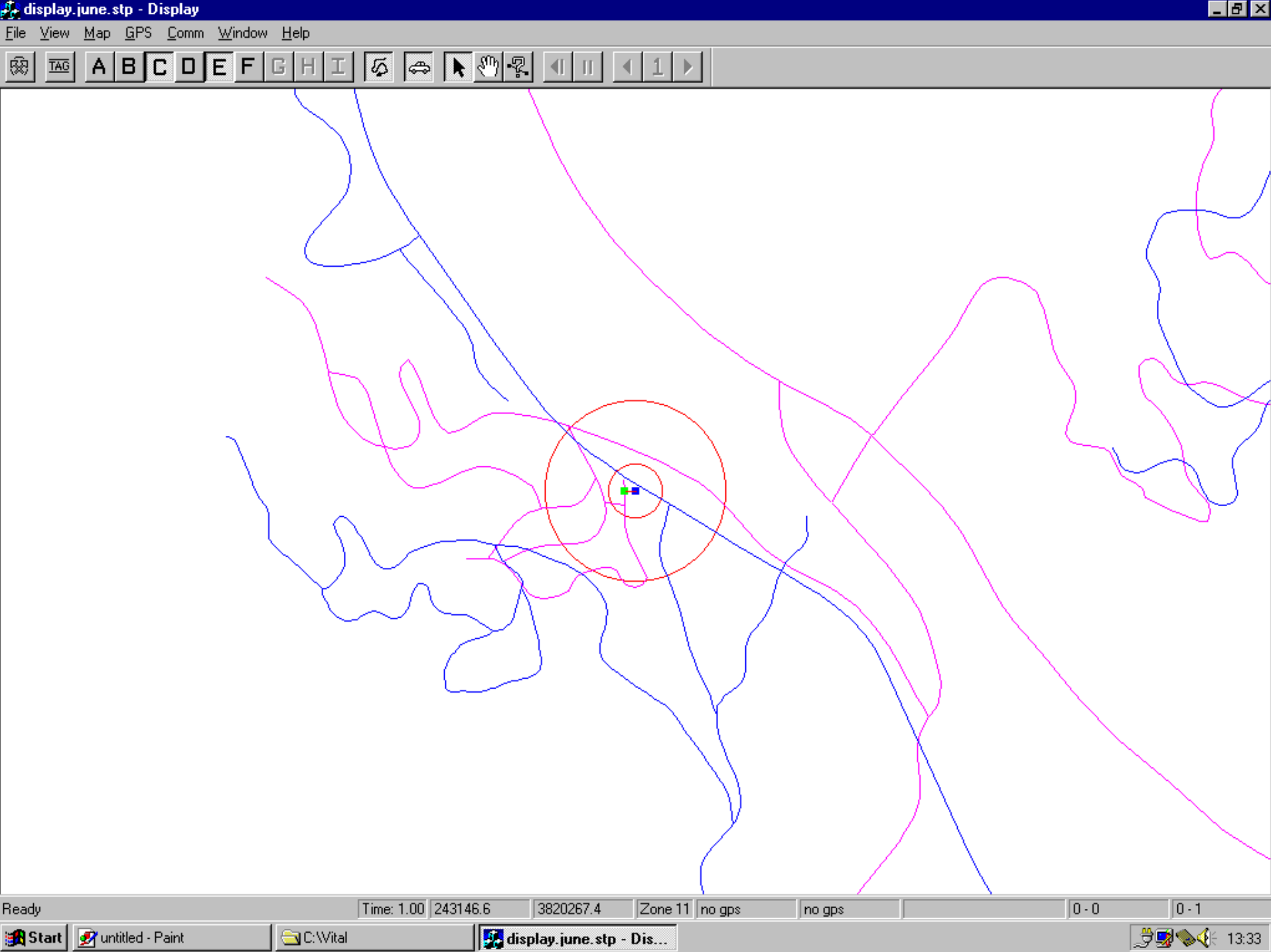
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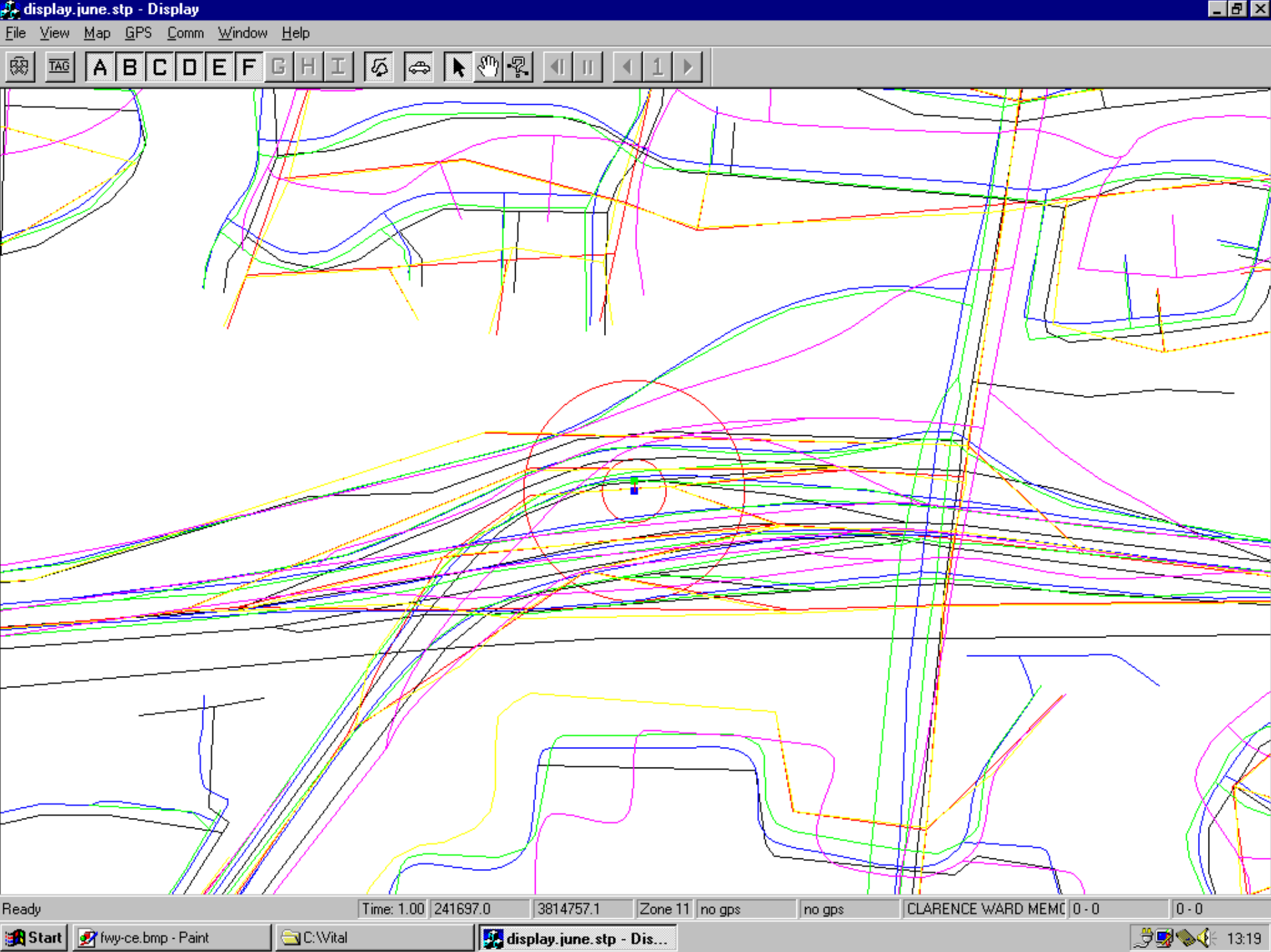
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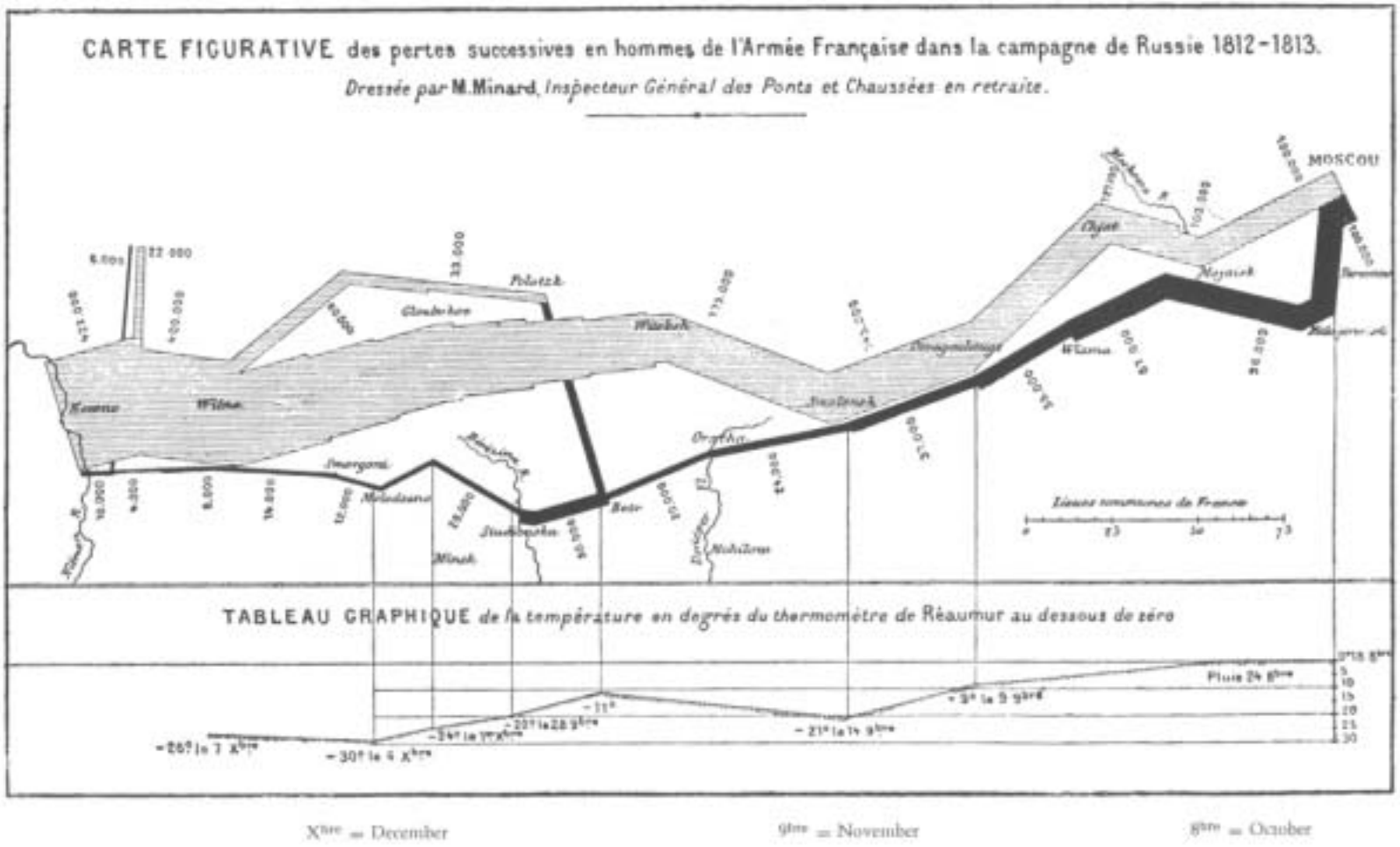
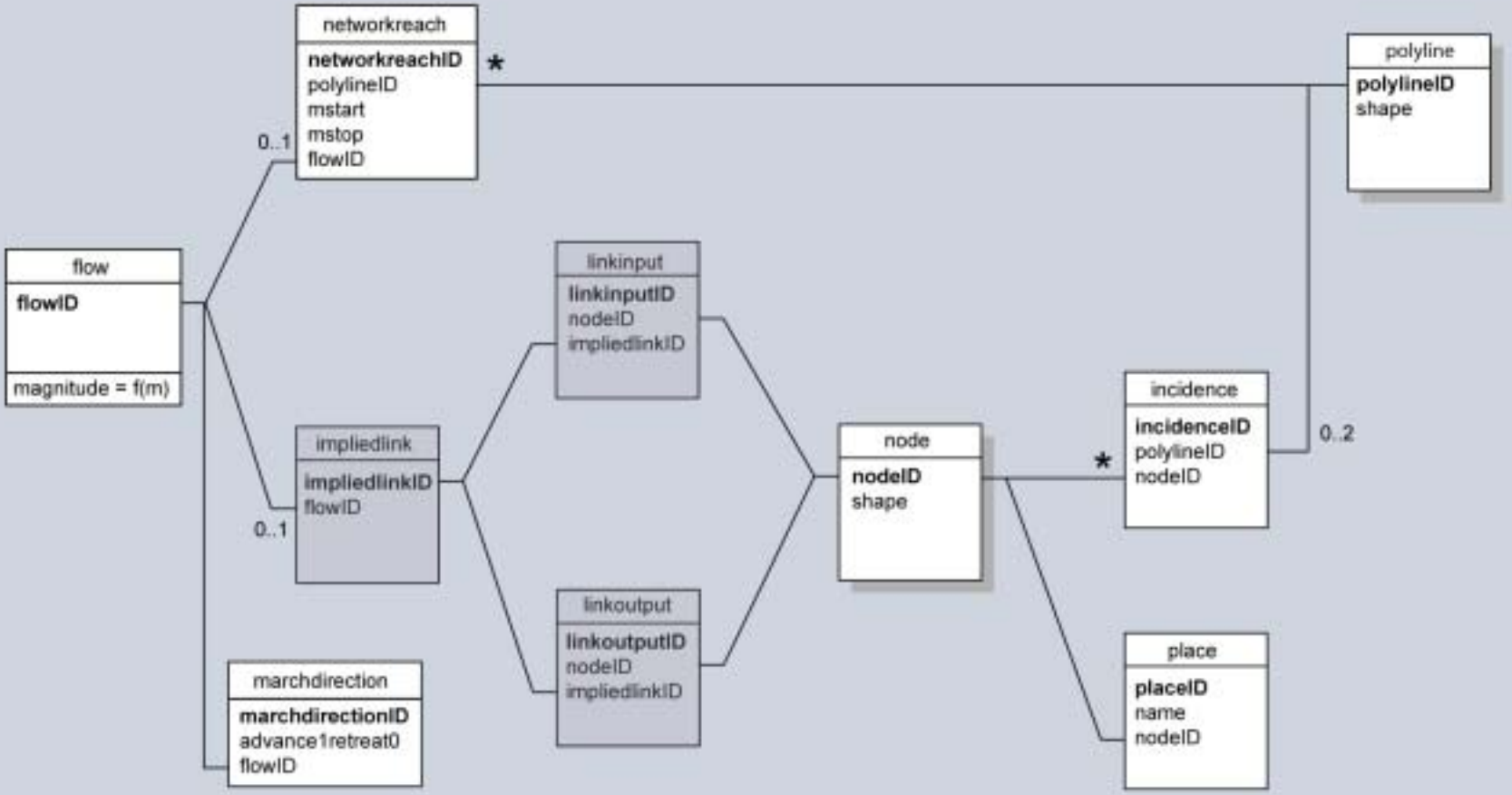
Data models as templates

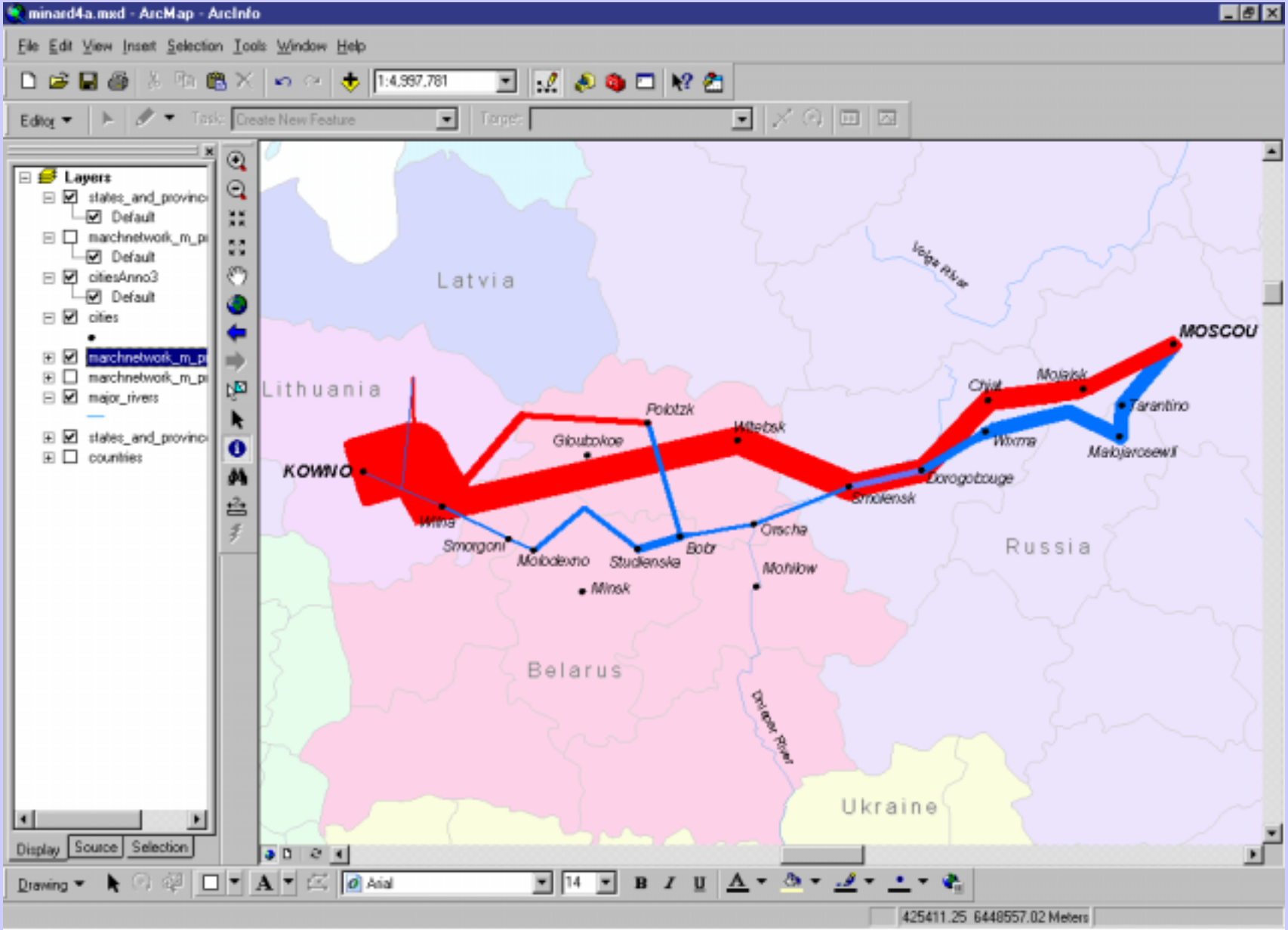
- Traditional GIS data models
  - templates for representing the contents of maps
    - coverage
    - shapefile
- Object-oriented data modeling
  - representing the classes of objects of importance to the application



Source: Tufte, 2001



Use Case: Minard Map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states_and_provinc
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Latvia
Lithuania
Belarus
Russia
Ukraine
Volga River
KOWNO
Wilna
Smorgoni
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Polotzk
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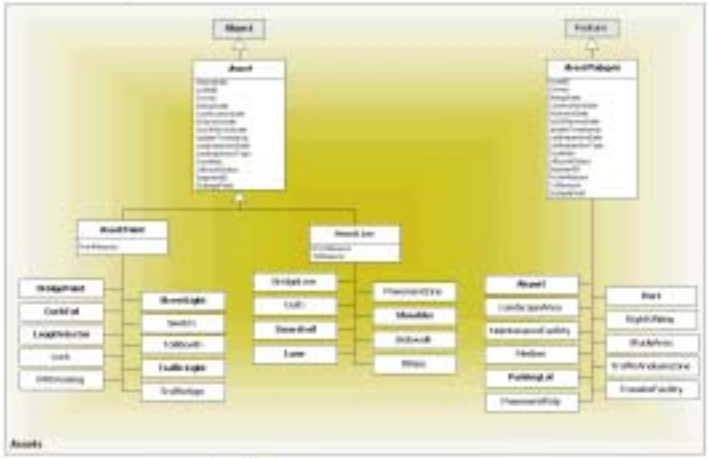
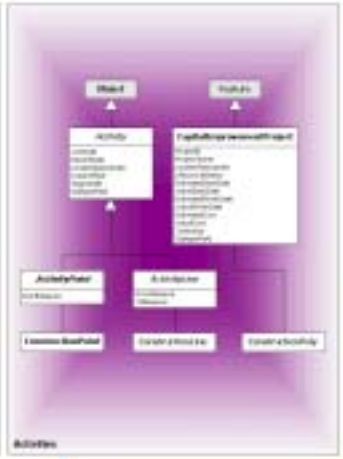
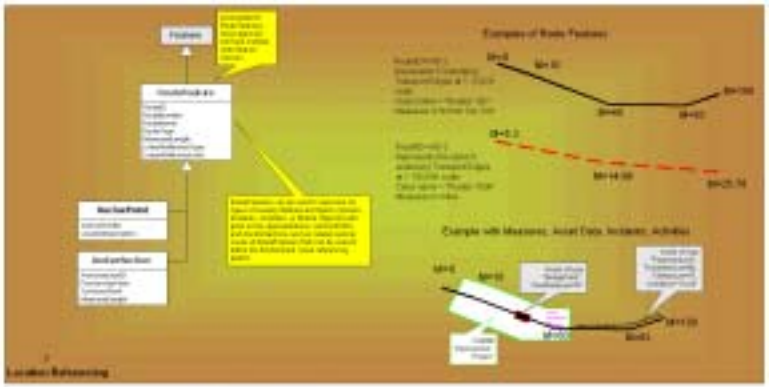
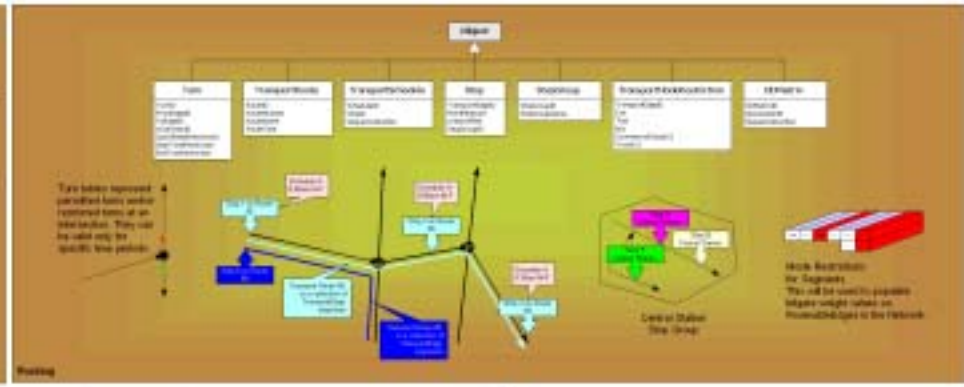
ArcGIS™ Transportation Data Model (Draft)

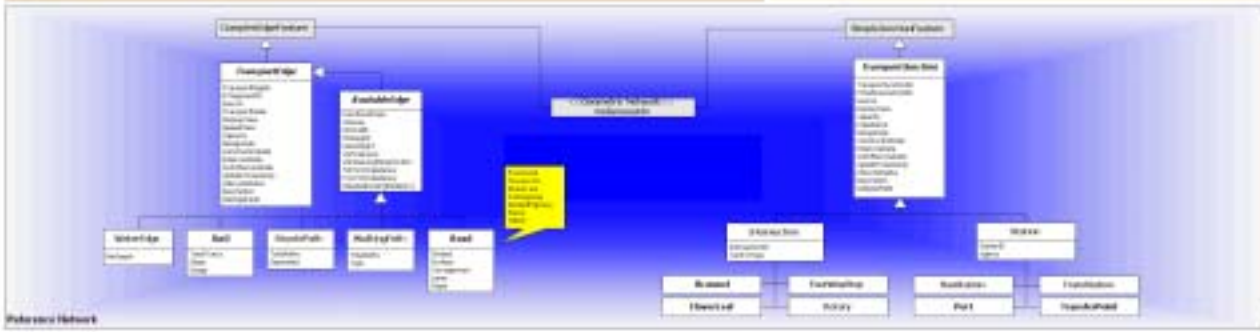
May 11, 2001

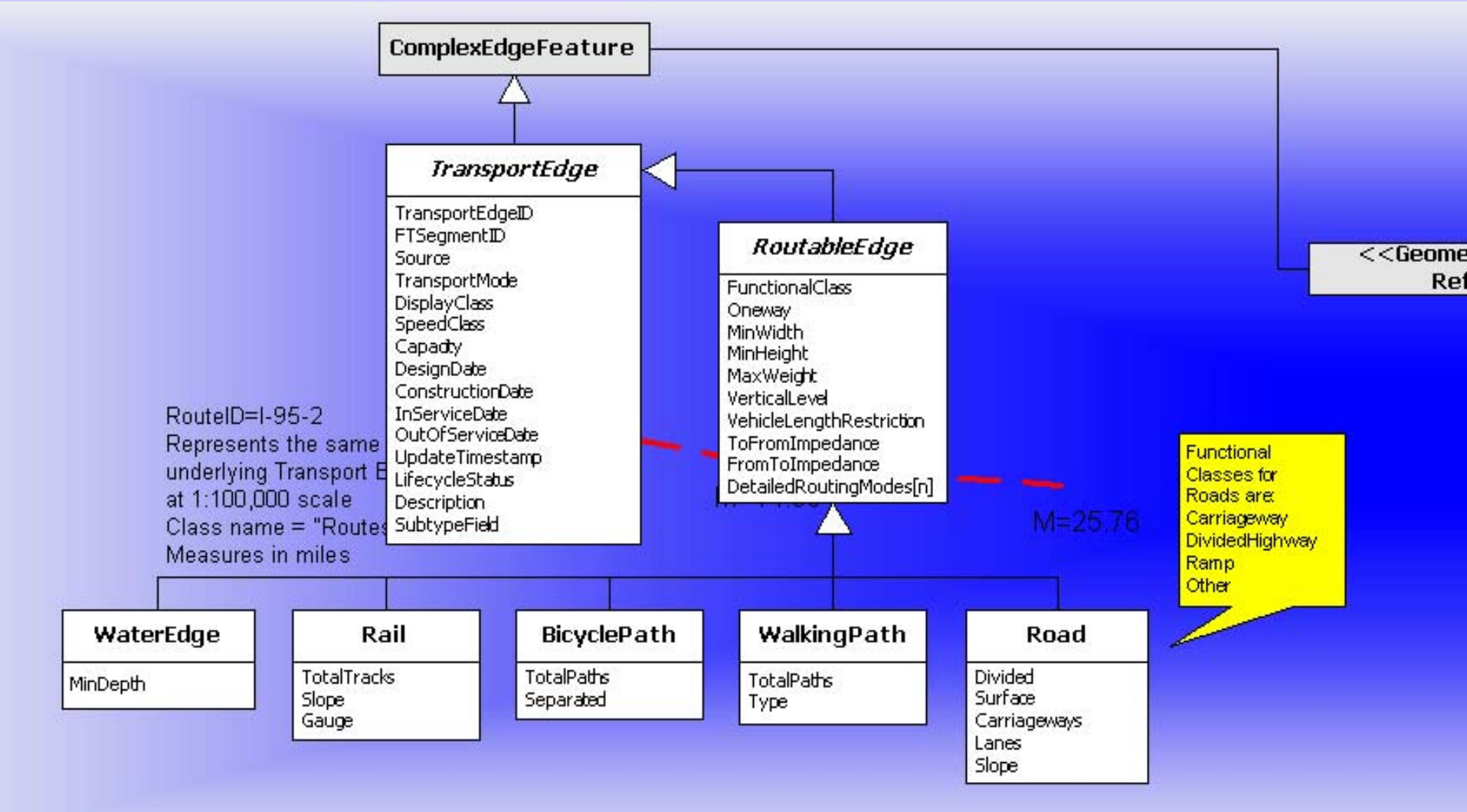











ComplexEdgeFeature
TransportEdge
TransportEdgeID
FTSegmentID
Source
TransportMode
DisplayClass
SpeedClass
Capacity
DesignDate
ConstructionDate
InServiceDate
OutOfServiceDate
UpdateTimestamp
LifecycleStatus
Description
SubtypeField
RoutableEdge
FunctionalClass
Oneway
MinWidth
MinHeight
MaxWeight
VerticalLevel
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underlying Transport E
at 1:100,000 scale
Class name = "Routes
Measures in miles
M=25.76
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Classes for
Roads are:
Carriageway
DividedHighway
Ramp
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WaterEdge
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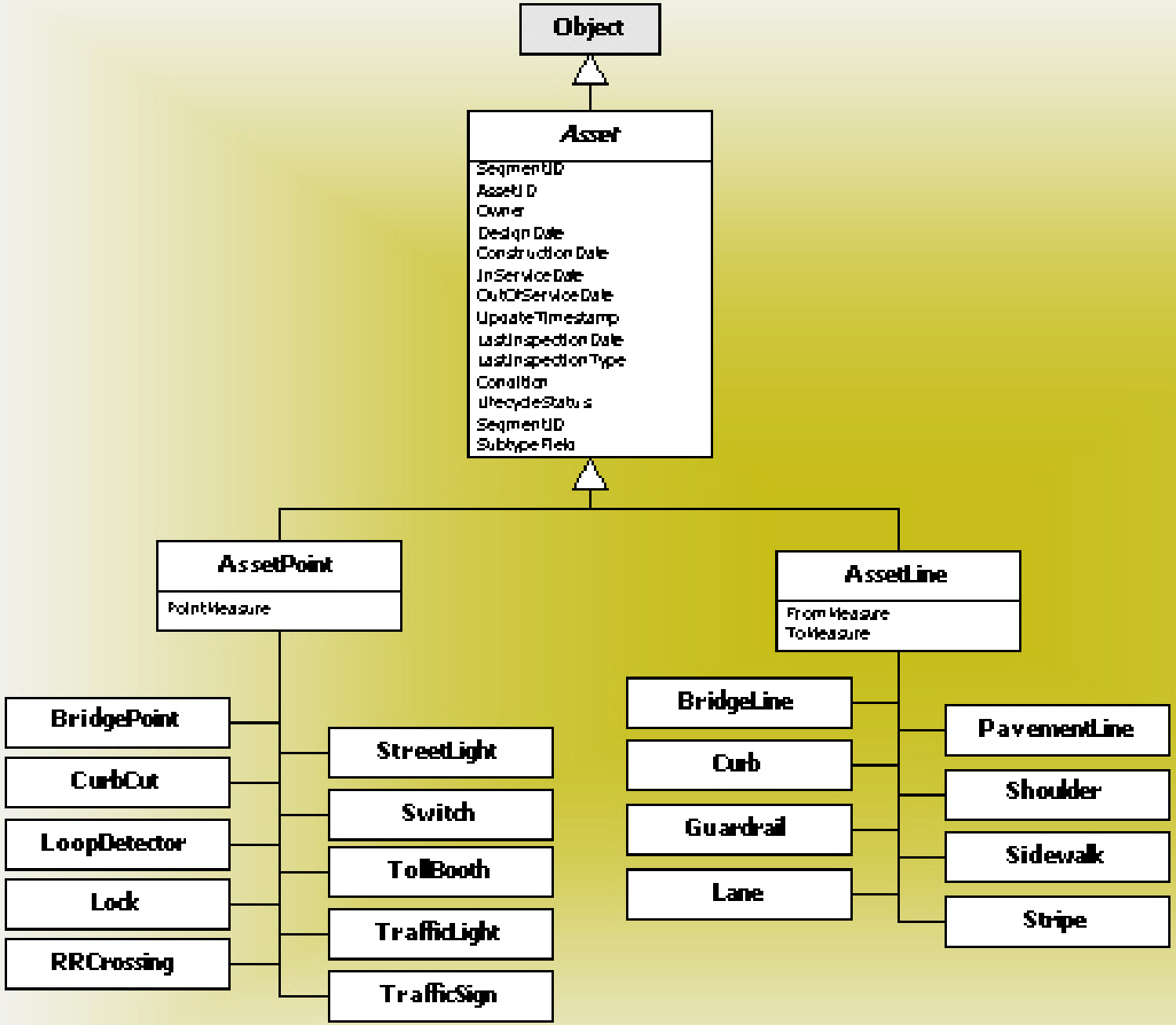
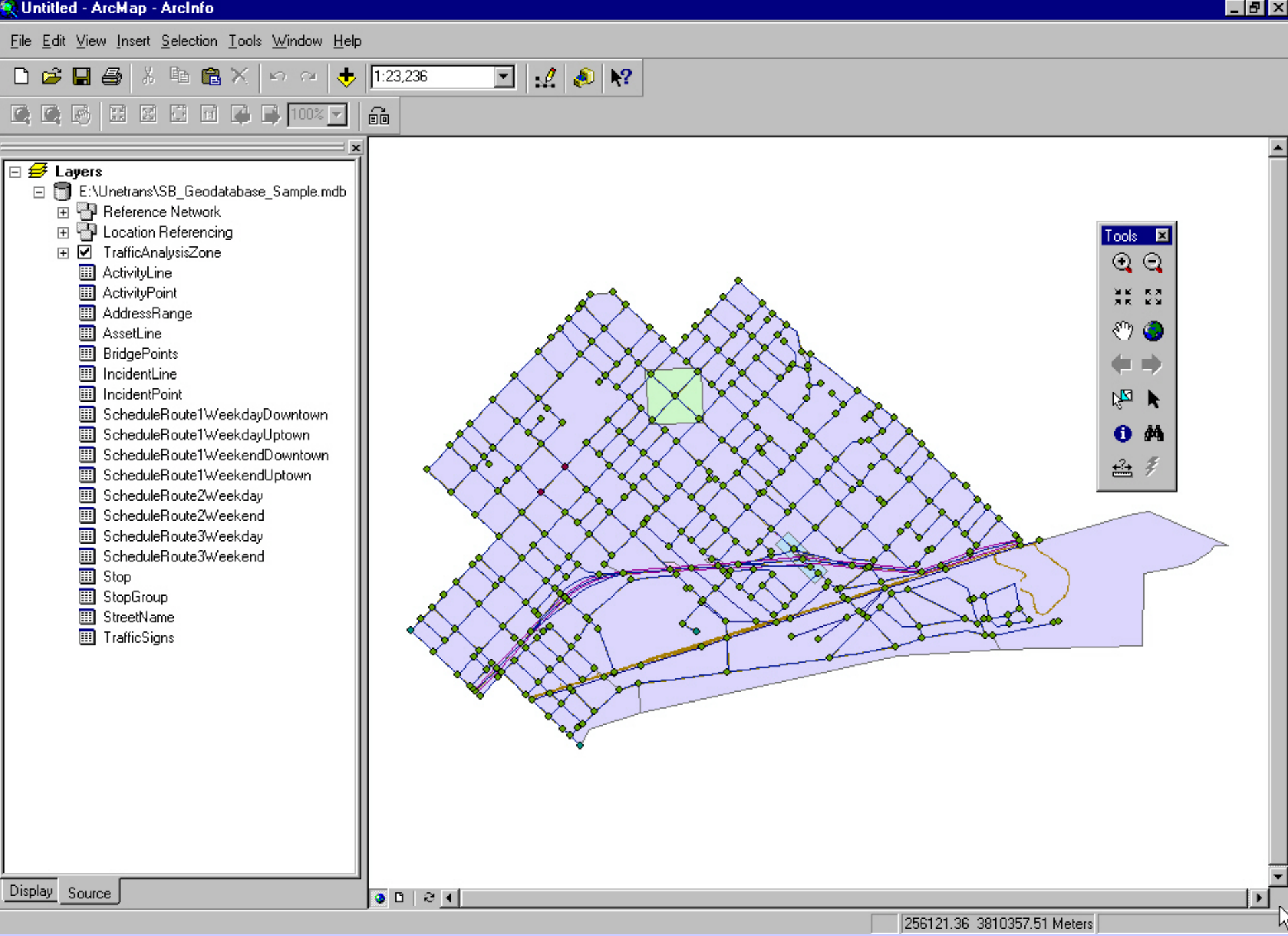

Object
Asset
SegmentUID
AssetID
Owner
DesignDate
ConstructionDate
InServiceDate
OutOfServiceDate
UpdateTimestamp
LastInspectionDate
LastInspectionType
Condition
LifecycleStatus
SegmentUID
SubtypeFields
AssetPoint
PointMeasure
AssetLine
FromMeasure
ToMeasure
BridgePoint
CurbCut
LoopDetector
Lock
RRCrossing
StreetLight
Switch
TollBooth
TraffidLight
TrafficSign
BridgeLine
Curb
Guardrail
Lane
PavementLine
Shoulder
Sidewalk
Stripe


Untitled - ArcMap - ArcInfo
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1:23,236
100%
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ActivityPoint
AddressRange
AssetLine
BridgePoints
IncidentLine
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ScheduleRoute1WeekdayDowntown
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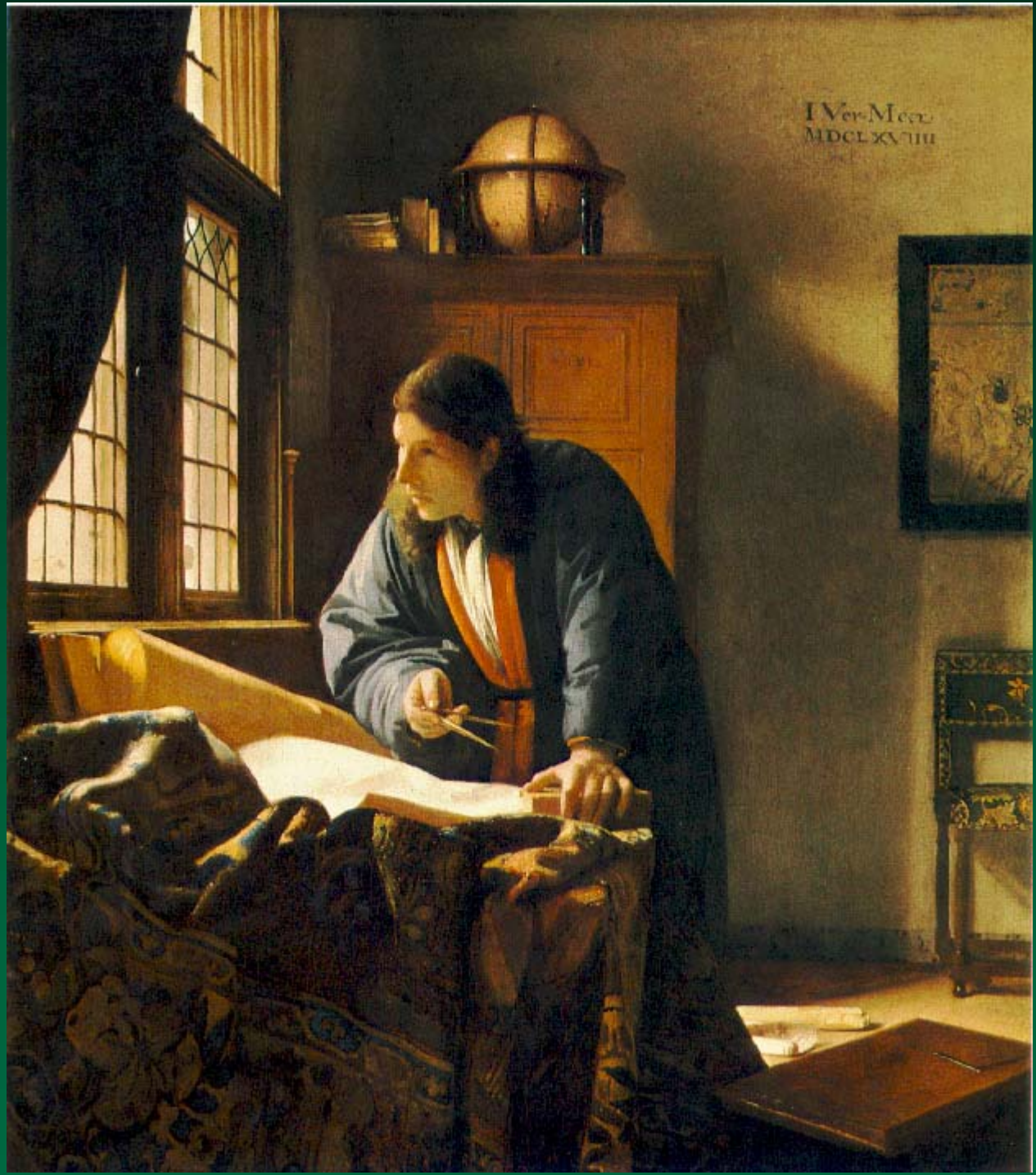
ScheduleRoute1WeekendUptown
ScheduleRoute2Weekday
ScheduleRoute2Weekend
ScheduleRoute3Weekday
ScheduleRoute3Weekend
Stop
StopGroup
StreetName
TrafficSigns
Tools
Display
Source
256121.36 3810357.51 Meters

A data model for disaster management

- A prepared template
- Rapidly populated
  - using prepared routines
- Prepared analysis functions
- Up and running within minutes

Computing in the presence of the subject matter

- $U = S$
  - or $S = U_1$ through U_n
- Managing the disaster on the spot
- Collaborative technologies
- Augmented not virtual reality
- Mobile, ubiquitous GIS
  - location-based services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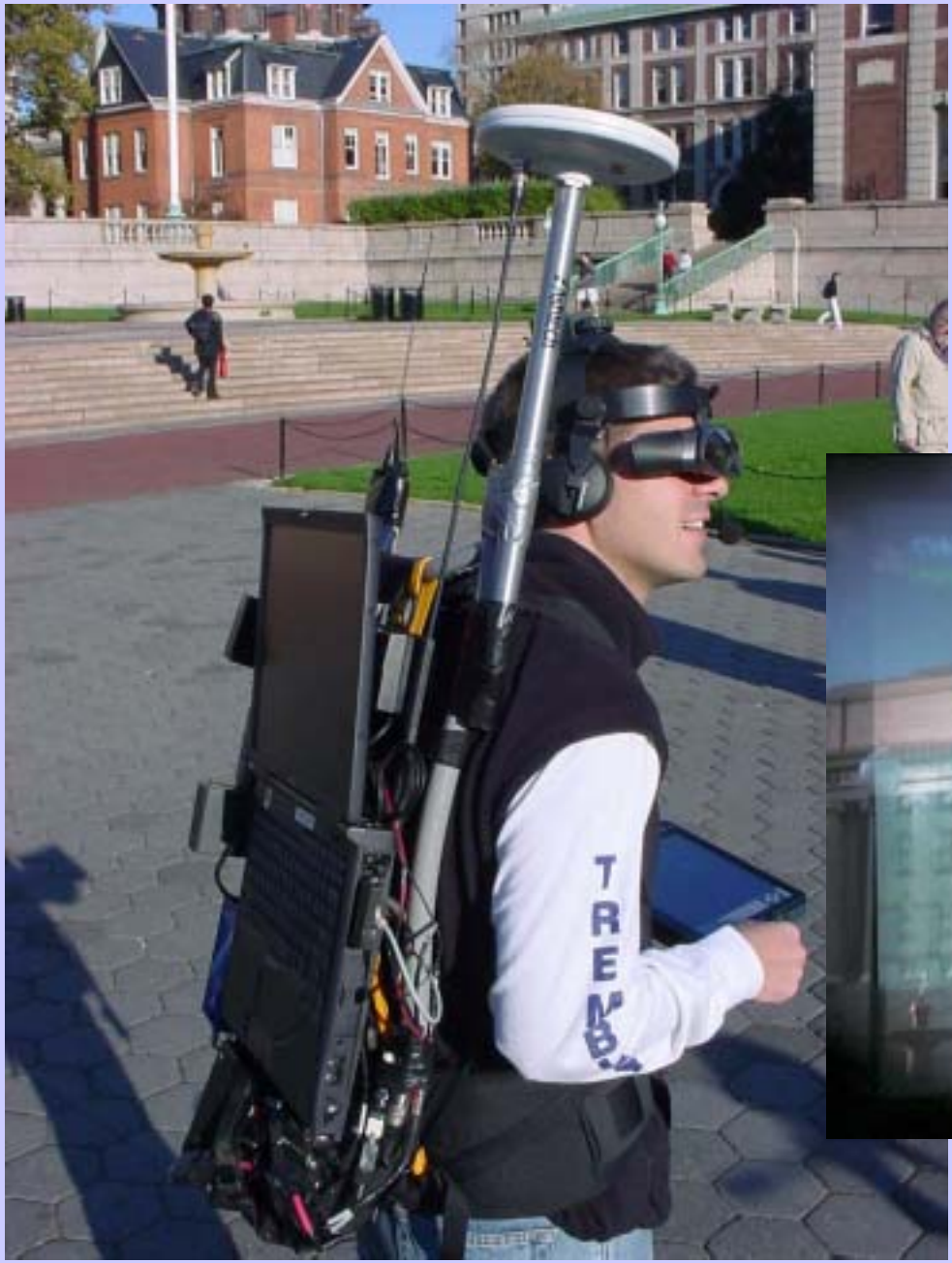
The technologies of $U = S$

- Portable, wearable devices
  - user interfaces
- Positioning
  - the device knows where it is
- Wireless communication



How does a system know where it is?

- GPS onboard
  - cellphone
- Triangulation from towers
- Determined at system build time
- IP address

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SPACEDAILY
TERRADAILY
SPACEWAR
MARSDAILY
SPACE DATABASE
Paid Links
RAST 2003
NANODATA
Space
Find a The
RENT THIS
SERVIC
SITE BEAR
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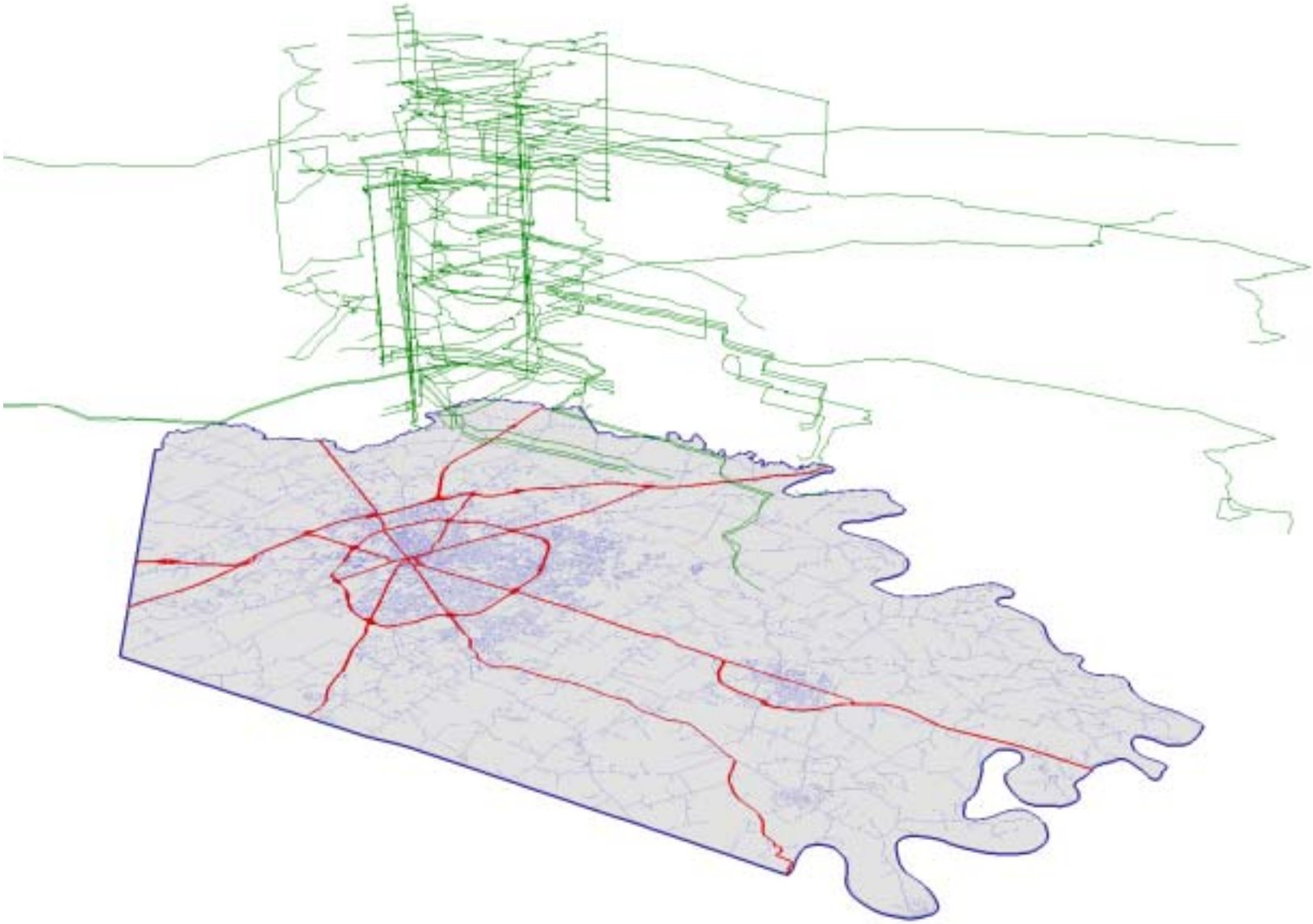
GPS NEWS

More Than 10 Million Subscr
Served by gpsOne

San Diego - Feb 13, 2003
Qualcomm has announced that more than 10 million gpsOne-enabled devices are now in commercial use in Japan, South Korea and the United States. Sales of phones



Date Posted: January 18, 2003

False Alarm

Suspected car bomb turns out to be tracking device

By BRADEN BUNCH
Item Staff Writer

A device that appeared to be a bomb on a vehicle parked outside Simpson's Hardware and Sports on Wesmark Boulevard kept local and state authorities busy for nearly four hours Friday before the object was found to be a tracking system placed on the car by the driver's wife.

Sumter Police Chief Patty Patterson said police were called at 3:23 p.m. when a sales representative for Simpson's Sales Co., who was delivering an order of Browning firearms, spotted a suspicious package on the undercarriage of his Chevrolet Suburban as he came out of the store.

After a preliminary inspection indicated to authorities that the device could be an explosive, surrounding businesses were ordered closed and authorities evacuated the area within a mile of the vehicle.

Described as a "very professional-looking device," the object was thought to be several sticks of dynamite with a remote detonation transmitter attached. The entire device, authorities said, was attached to the vehicle with duct tape.

Hours later, Patterson said, authorities learned from a call by the Florence man's wife that she had placed the tracking device on the car so she could keep tabs on her husband.

Soon after the initial 911 call, local police were joined by several dozen safety workers from Shaw Air Force Base, the State Law Enforcement Division, Sumter Fire Department, Sumter County Emergency Medical Services and the Sumter County Department of Public Safety.

Chris Moore / The Item

A robot from the Shaw Air Force Base bomb squad approaches a Chevrolet Suburban in order to get a closer look at the truck Friday afternoon. The wire hanging below the Suburban was connected to a tracking device believed to be a bomb.

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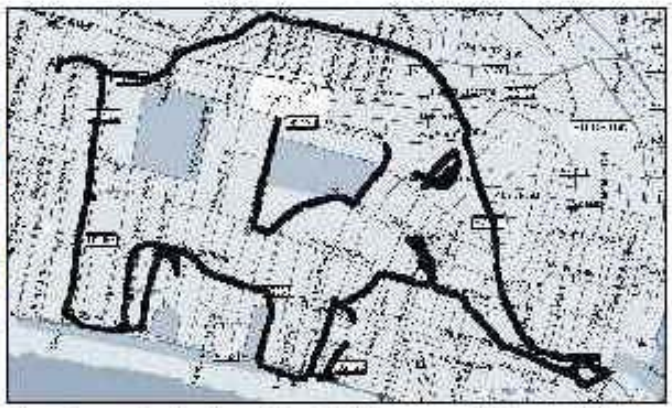
Monday, 15 October, 2001, 12:20 GMT 13:20 UK

Safari by satellite



The biggest elephant in Brighton - and the world

Satellite tracking is commonly used to avoid traffic jams. But it is now being used to find elephants in Brighton, writes BBC News Online's technology correspondent Mark Ward

The evidence of our effect on the land is all around us.

Roads divide landscapes, hills are shorn of their trees, tunnels are punched through mountains and cities pockmark the countryside with pavements and homes.

dot.life

Every Monday, the guide to getting buttoned up

- Phones, tones and music
- Write here, right now
- Fax machine rebellion
- Ads we can't avoid
- What if ET called us?
- Forgetful? Don't stress

See also:

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Limitations

- Two-dimensional
- Outdoors
  - tree canopy
  - urban canyons
- A true LBS would know where it was at any time
  - in three dimensions
  - within structures
  - to limits of geographic resolution
  - sub-meter

Summary

- Disaster management is an inherently spatial problem
- Technologies are needed for rapid acquisition of data from networks
- A major effort is needed to develop an appropriate data model
  - and associated methods
- New location-measurement technologies are needed that perform in all environments