NCFMTC- Modeling Your Campus

Basic GIS Modeling: Improving Campus Maintenance, Management, and Planning

August 8th, 2007

Matt Davis

mdavis@esri.com

Abstract

- **Basic GIS Modeling: Improving Campus Maintenance, Management, and Planning**
- ***Matt Davis***

  Regional Manager

  ESRI Boston
- Data models, workflow and geoprocessing models, 3D and time series models are all basic GIS building blocks. When combined these capabilities add new dimensions to how decisions are being made in day to day operations as well as planning for the future. This presentation will explore some of the many uses and benefits that can be realized by providing broad access to basic GIS capabilities in a campus environment.

Topics

- What is GIS
- How is GIS being used
- GIS models
  - Data models
  - 3D models
  - Geoprocessing models
  - Integration of Time
  - Making them work together
- ESRI's vision
- Q&A

What is GIS?

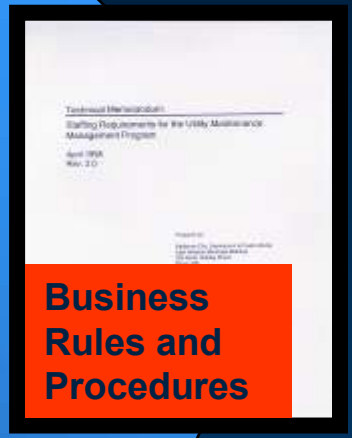
Geographic Information System

- An information system based on geographic location
- A complete system to
  - Visualize results via maps and reports distributed in softcopy or hardcopy form
  - Perform spatial and relational queries and analysis
  - Create, update, and maintain spatial data

…an integrating technology
…promotes sharing and coordination

Geographic Information Systems

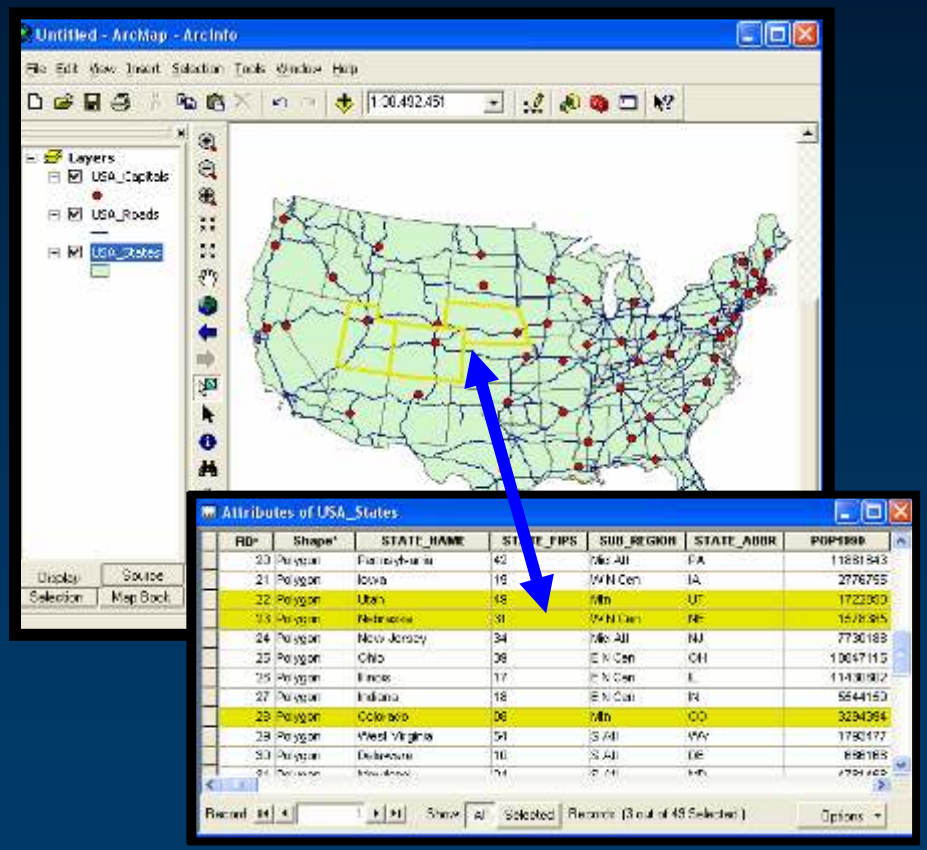
GIS



…5 parts of a GIS

What is a Geographic Information System?

A GIS links spatial data (geography) with tabular data (attribute data)



Features
(on map)

Attributes
(in table)

Managed As

Layers

GIS database
(set of layers for a geographic area)

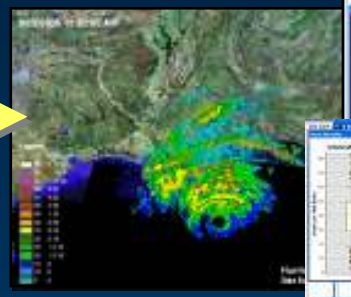
…all data is mapped to a location on the earth

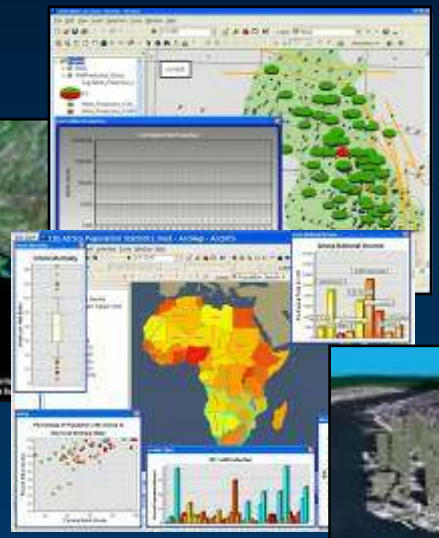
Visualization & Communication

ArcGIS Desktop

Visualization

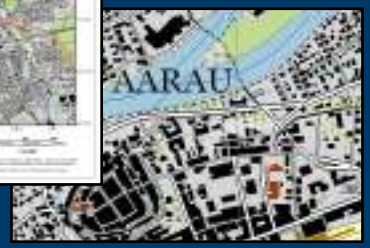
- Thematic analysis
- Authoring
- 2D/3D viewers





Iteration & Learning

- Visual interrogation
- Animation and graphing
- Spatial selection

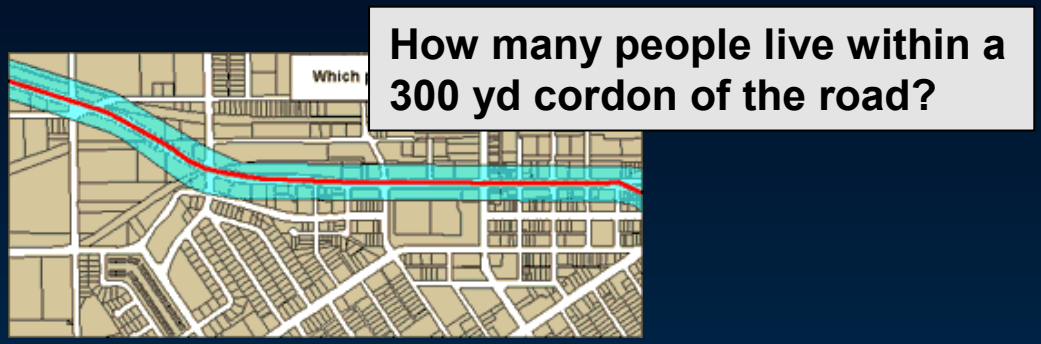


Mapping

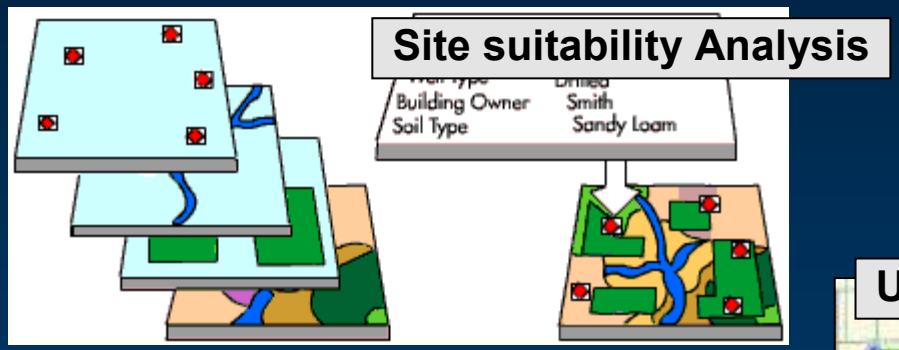
- Symbolization
- Labeling
- Publishing

Complex Spatial Analysis

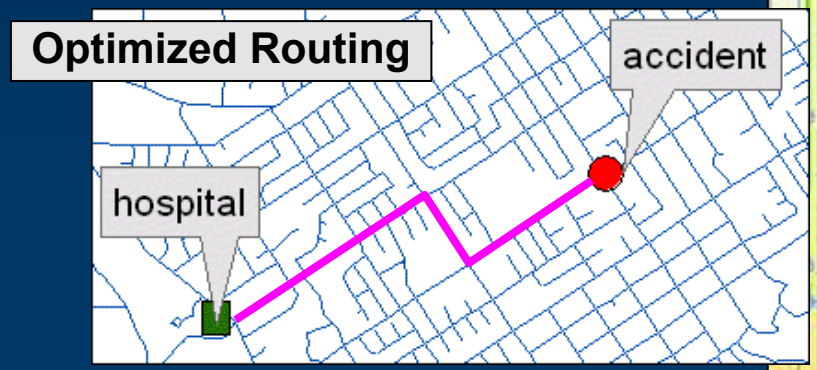
- Proximity

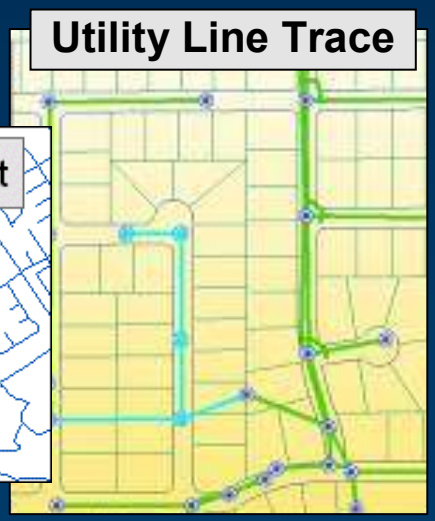


- Overlay



- Network

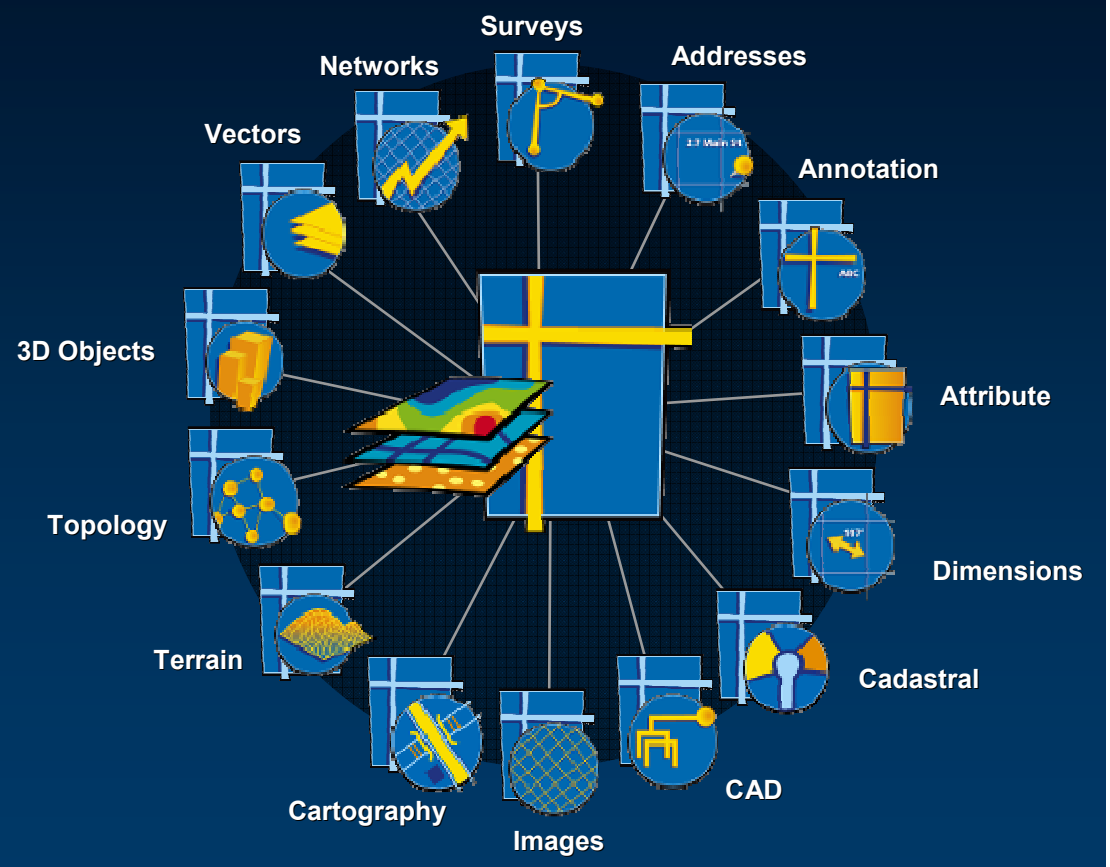




…all data is self aware…

Geodata Management

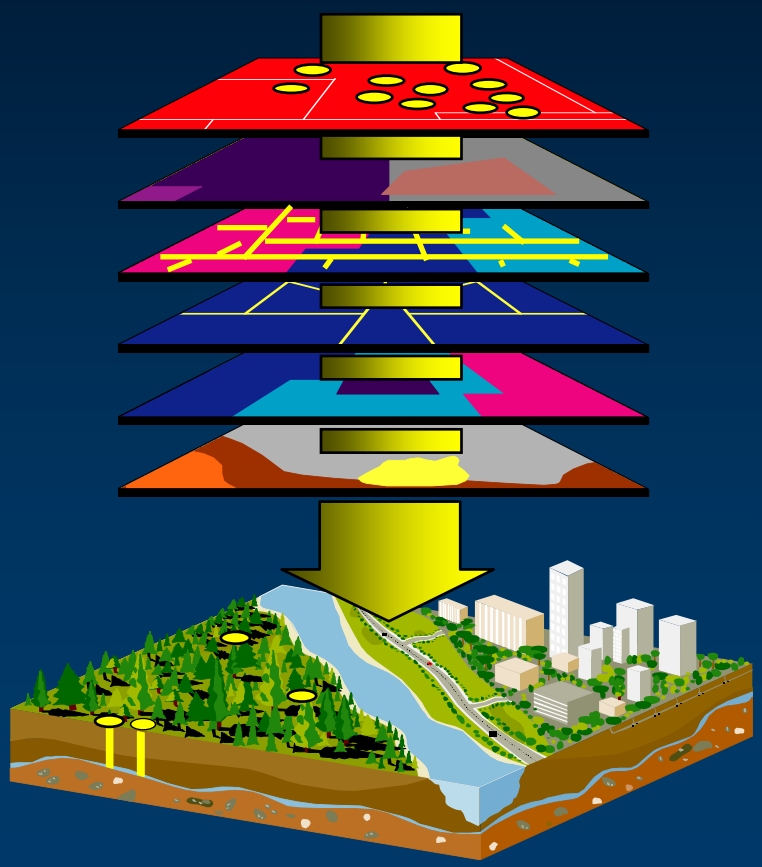
- Organization and management of spatial information
  - Persistence
  - Access
  - Replication
  - Versioning
  - Check in/out



Geodatabase: Object-relational information model responsible for managing all geographic data types and their associative rules and behaviors.

GIS Organizes & Integrates Data & Workflows

A GIS works with thematic layers of spatial data to model the natural and built environment providing a common picture



Transportation
- Roadways & Paths
- Railways
- Bus Routes
- Waterways

Utilities
- Electric
- Gas
- Water
- Phone
- Steam

Boundary Data
- Town
- Campus
- Police Precincts
- Land Parcels
- Buildings

…a framework for performing "what if" scenarios

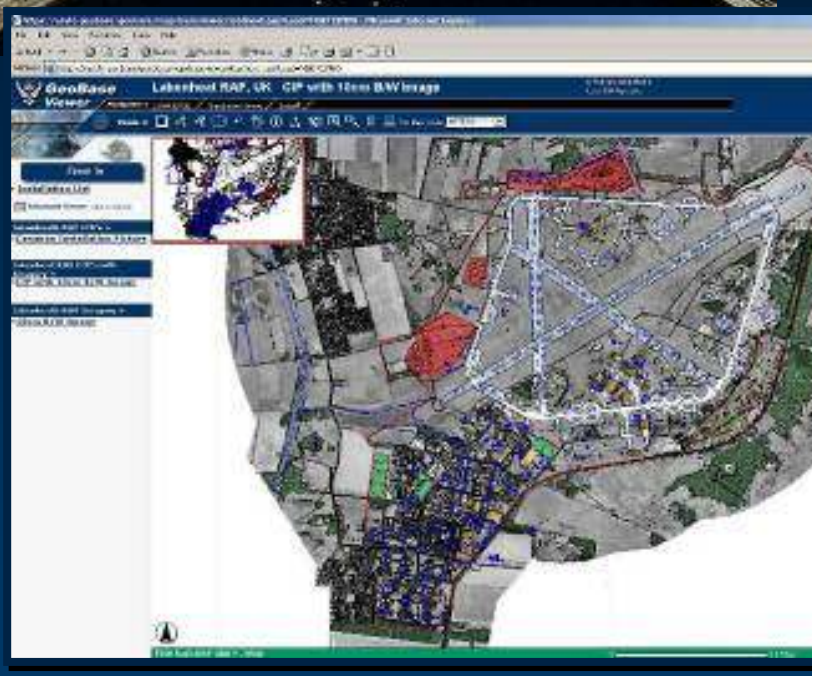
How is GIS Being Used in Facility/Campus Management

- GIS is being used for:
  - Planning
  - Space Management
  - Real-estate/portfolio management
  - Asset management
  - Safety/Security
  - Environmental health
  - Transportation planning
  - Emergency planning and response
  - Work order management
  - Way finding (routing across campus and thru buildings)
  - IT infrastructure management

…Just some of the business functions

Where is this happening?

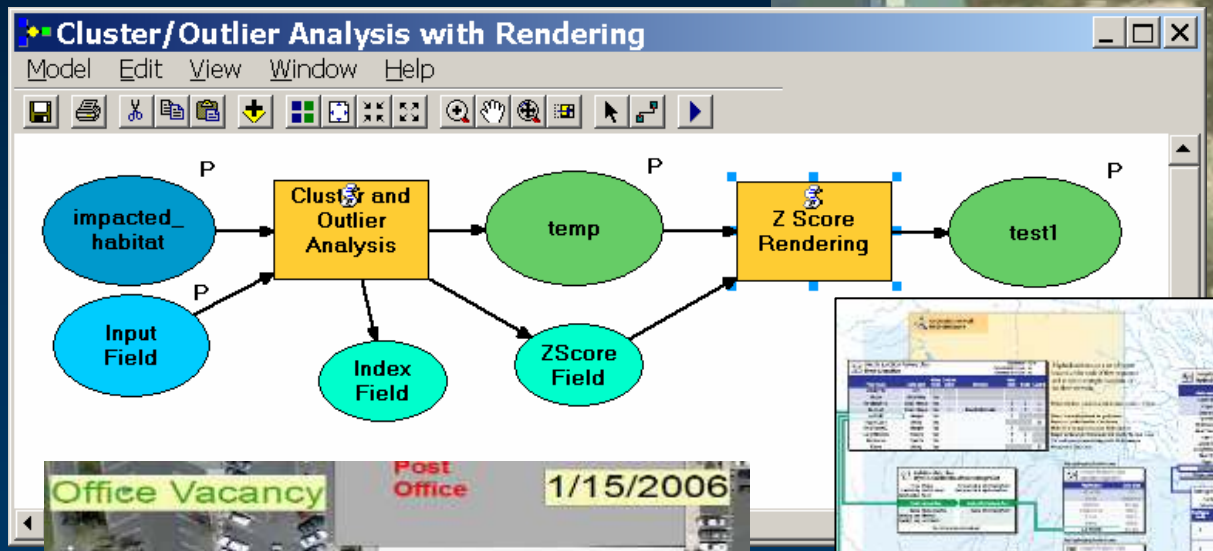
Who Are the Early Adopters?

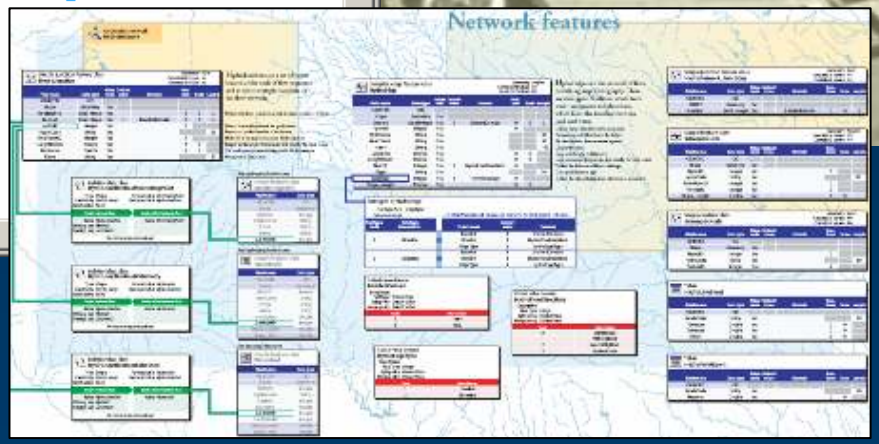


- Universities
- Federal Gov't
  - DoD all services
  - NASA, GSA, etc…
- Large private companies
- State, County & large City
- Airports

…Organizations managing large campus environments

GIS Models

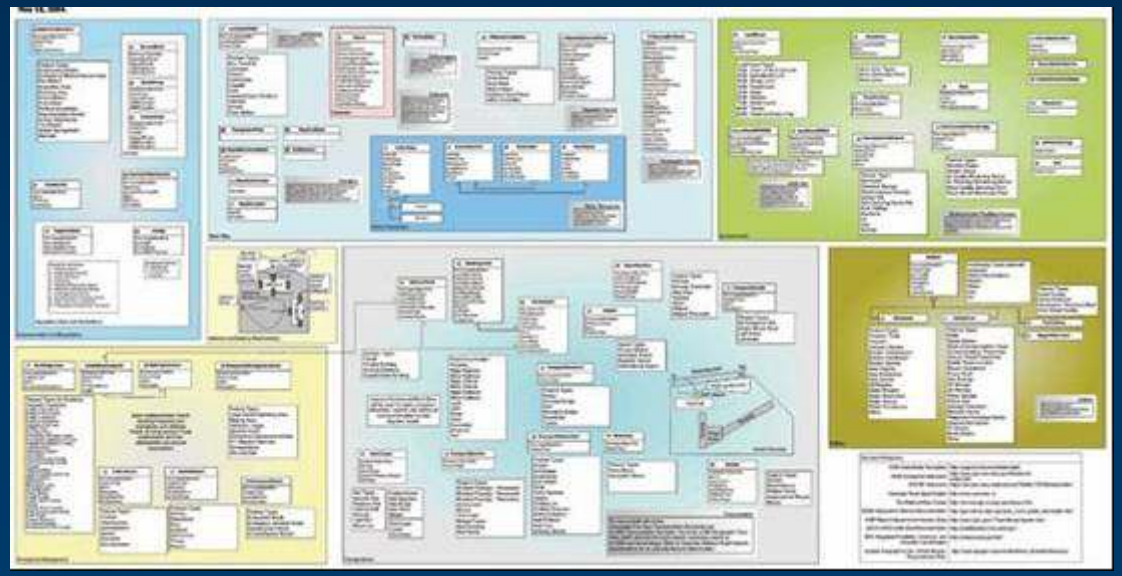




…GIS "Abstracts" Geography

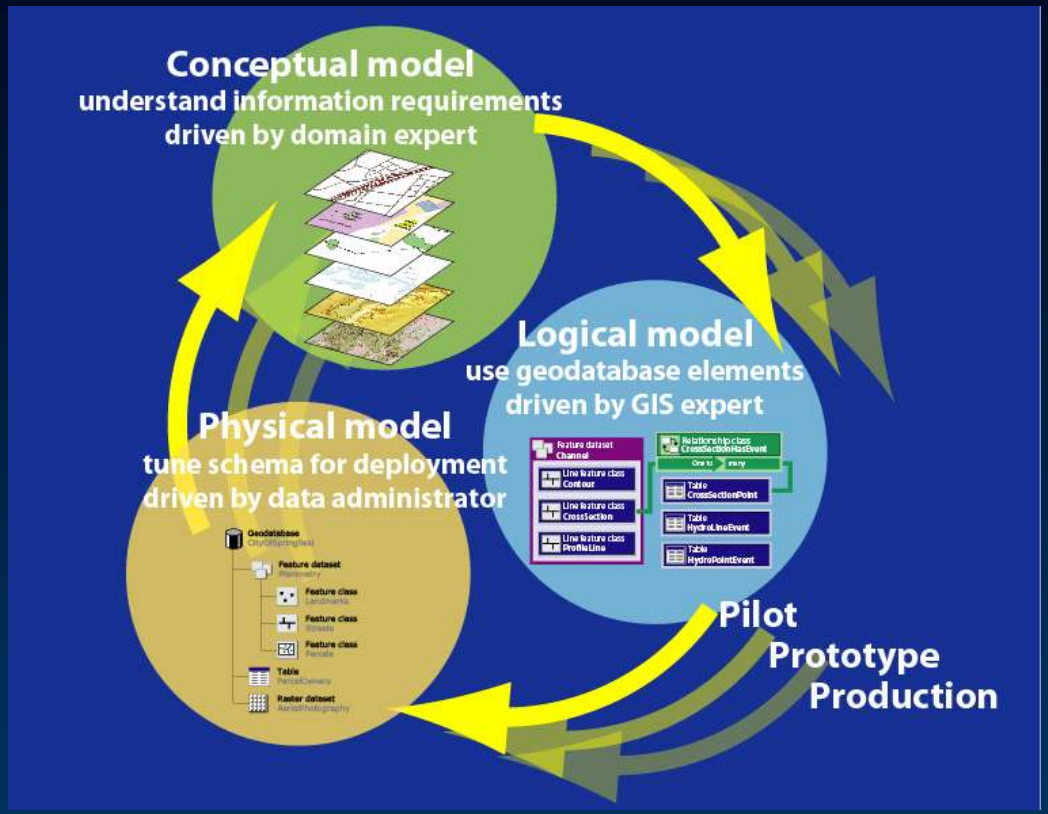
Data Models

- GIS data sets are more than database management system (DBMS) tables
  - They incorporate advanced behavior and integrity like other information systems.
  - The schema, behavior, and integrity rules of geographic data sets play a critical role in GIS.



…more closely represent real world objects

Data Modeling
Basics to get started



- GIS design involves organizing geographic information into data themes that can be integrated using geographic location.
- Design begins by identifying the data themes to be used, then specifying the contents and representations of each thematic layer.

…data modeling cycle

11 Steps to GIS database modeling

Basics to get started

1. Identify the information products that you will create and manage with your GIS
2. Identify the key data themes based on your information requirements
3. Specify the scale ranges and spatial representations of each data theme at each scale
4. Decompose each representation into one or more geographic datasets
5. Define the tabular database structure and behavior for descriptive attributes
6. Define the spatial behavior and integrity rules for your datasets

11 Steps to GIS database modeling cont.

7. Propose a geodatabase design
8. Design editing workflows and map display properties
9. Assign responsibilities for building and maintaining each data layer
10. Build a working prototype and review and refine your design
11. Document your geodatabase design

The Geodatabase
Contains Datasets

- Datasets represent integral collections of information with a meaningful real-world interpretation.
- Types of geographic dataset:
  - Tables
  - Object classes, feature classes, relationship classes
  - Feature datasets
  - Networks, Topologies, Raster and Survey datasets
- Datasets have associated information to help manage integrity, behavior, and interpretation
  - Domains
  - Relational integrity
  - Topology
  - Metadata

…the data model defines the schema of the Geodatabase

Validation Rules

- Store attribute, connectivity, and relationship rules on objects as part of the geodatabase.
- Predefined, parameter driven
  - Attribute range rule
  - Attribute set rule
  - Connectivity rule
- Perform custom validation by writing code.

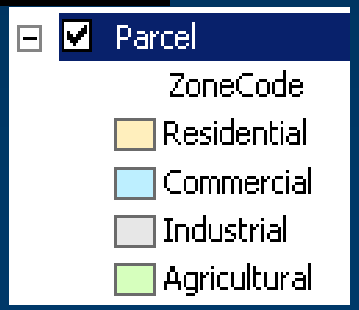
Domains

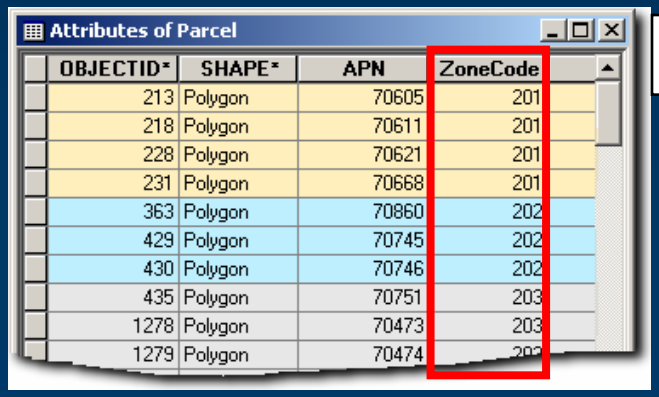
- Describe the legal values of a field type.
  - Used to ensure attribute integrity
- Can be shared among classes
- Transfer with the geodatabase
- Types of domains:
  - Range
    - A tree can have a height between 0 and 300 feet.
    - A road can have between one and eight lanes.
  - Coded value (e.g., a set)
    - A tree can be of type oak, redwood, or palm.
    - A road can be made of dirt, asphalt, or concrete.

Subtypes

- Partition the objects in a class into like groups.
- Defined by the value of a subtype field.
  - Have the same attribute schema
  - Have the same behavior schema
  - Can have different default values and domains for each field
  - Can define topology rules between subtypes

Descriptions





OBJECTID*	SHAPE*	APN	ZoneCode
213	Polygon	70605	201
218	Polygon	70611	201
228	Polygon	70621	201
231	Polygon	70668	201
363	Polygon	70860	202
429	Polygon	70745	202
430	Polygon	70746	202
435	Polygon	70751	203
1278	Polygon	70473	203
1279	Polygon	70474	203

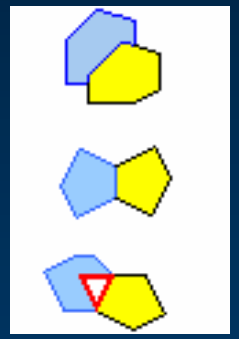
Codes

Topology

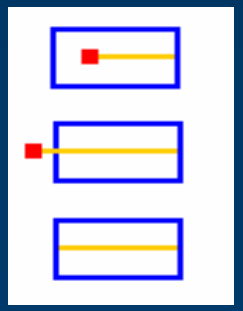
- A topology manages a set of simple feature classes that share geometry.
- Topology is used to
  - Integrate feature geometry
  - Validate features
  - Control editing tools
  - Define relationships between features
  - Ensure the quality of your data

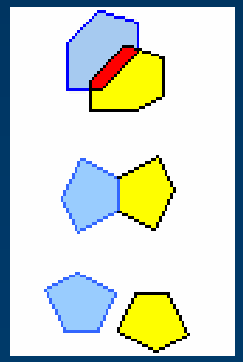
Topology Error Examples

No Gap



Dangling edge





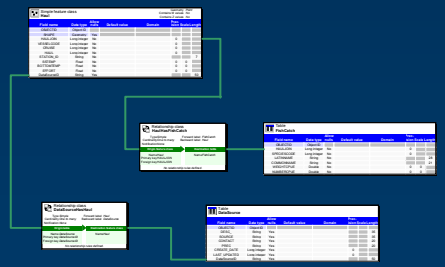
No Overlap

Geodatabase Data Models

Standardized Templates for Many Fields

ArcHydro

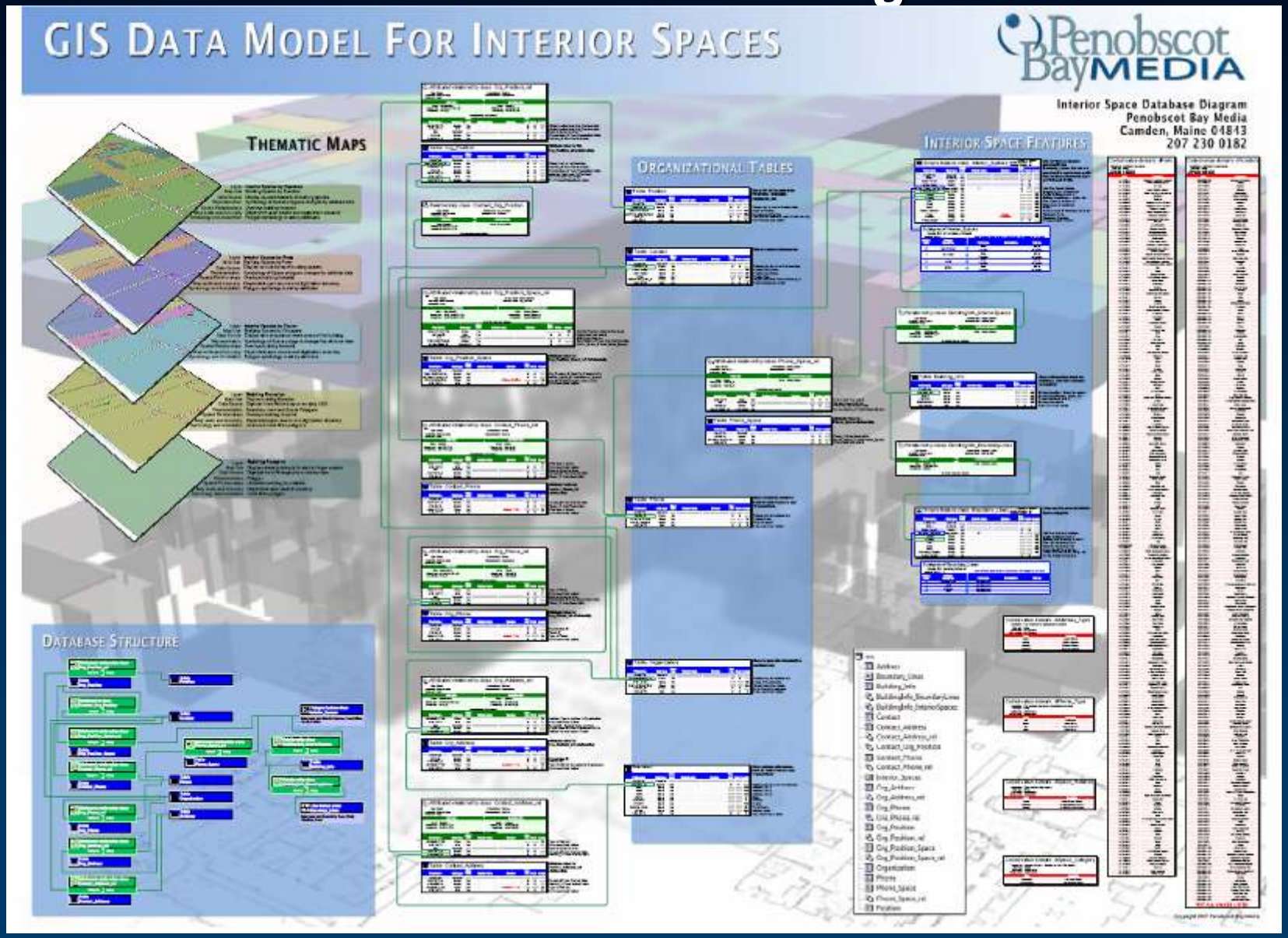
- Address
- Agricultural
- Atmospheric
- Base Map
- Biodiversity
- Census-Admin
- Boundaries
- Defense-Intel
- Energy Utilities
- Environmental
- Forestry
- Geology
- Groundwater
- Health
- Historic Preservation & Archaeology
- Homeland Security
- Hydro
- IHO
- Land Parcels
- Local Government
- Marine
- National Cadastre
- Petroleum
- Pipeline
- Telecommunications
- Transportation
- Water Utilities



. . . Help Users Get Started

. . . Provide Consistent Standards

Geodatabase Model for Building Interiors

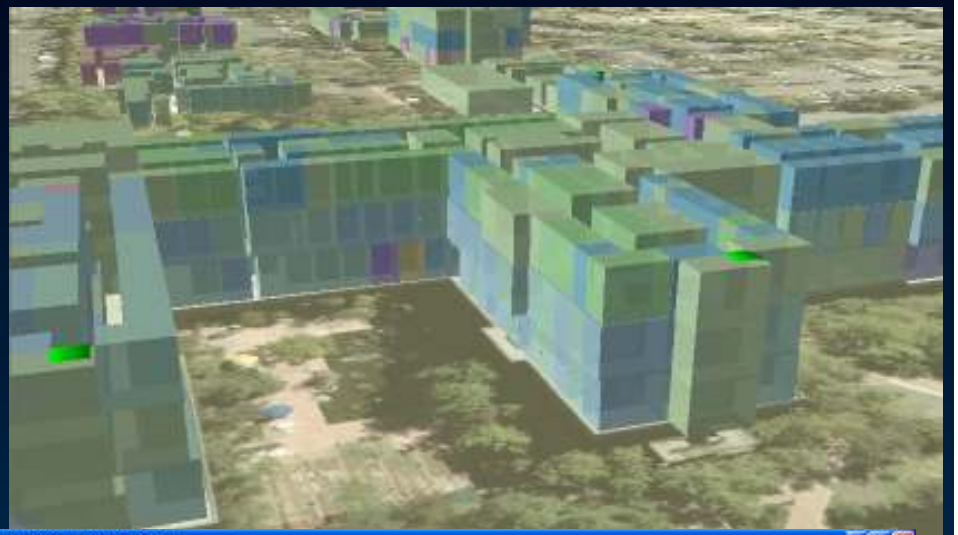


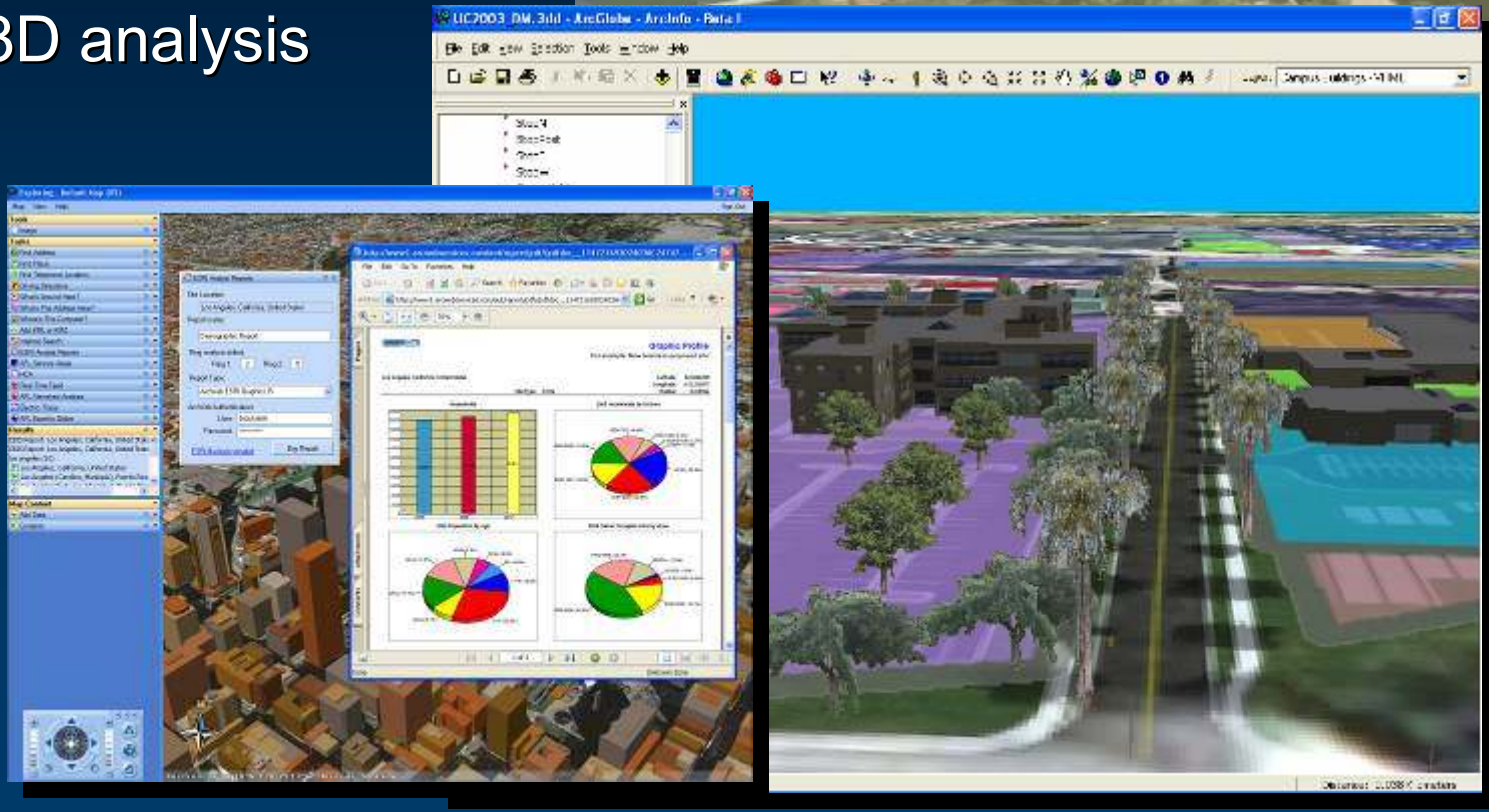
Penobscot Bay Media

3D Models

Providing new perspectives

- A means to visualize “reality”
- Another dimension for thematic mapping & reporting
- Basis for 3D analysis





…a powerful way to visualize your campus

City & Campus Planning

Economic Development

Green Mountain Geographics, Ltd.

City & Campus Planning

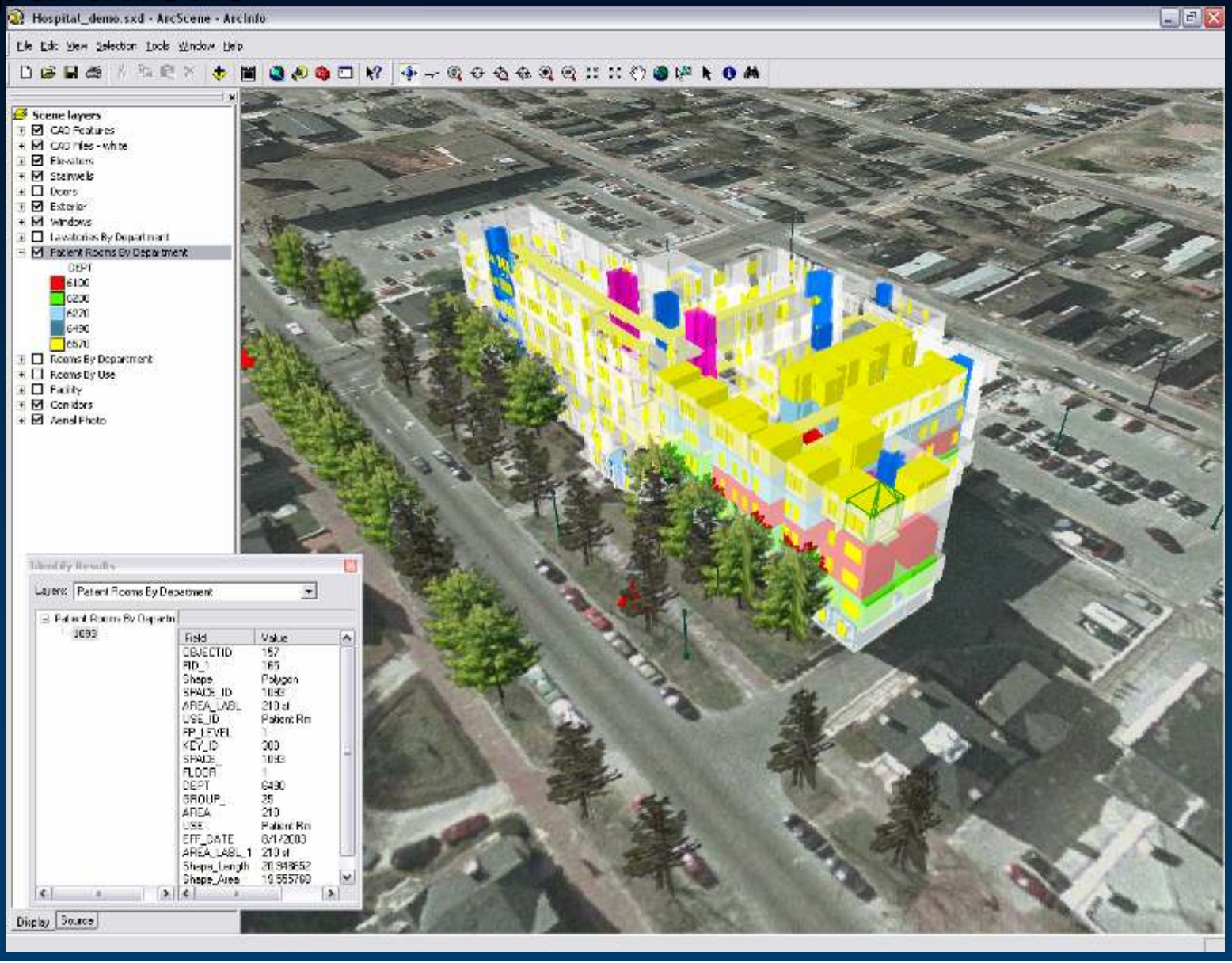
Economic Development

Green Mountain Geographics, Ltd.

Simple Campus Visualization

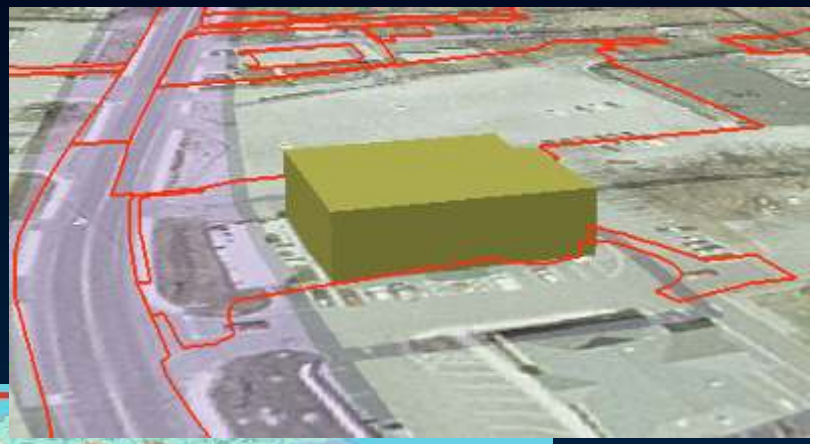
Class Room Use

Hospital Visualization – Patient Rooms by Department

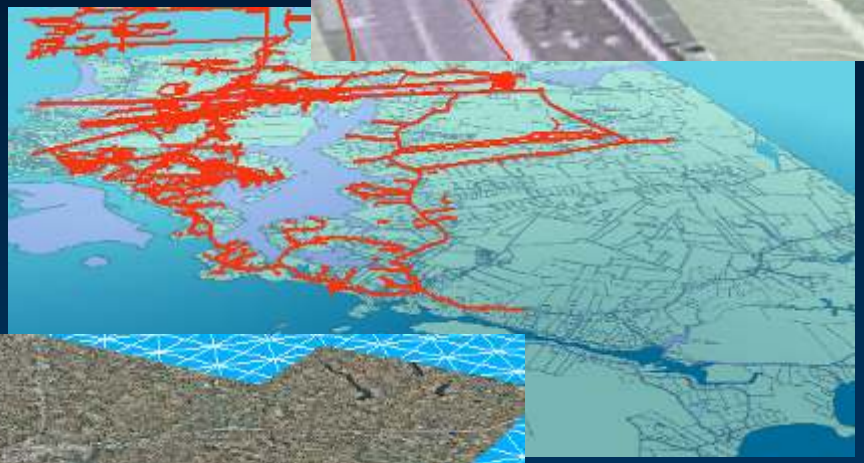


Developing a 3D Model
Demo

- Extruded Vectors

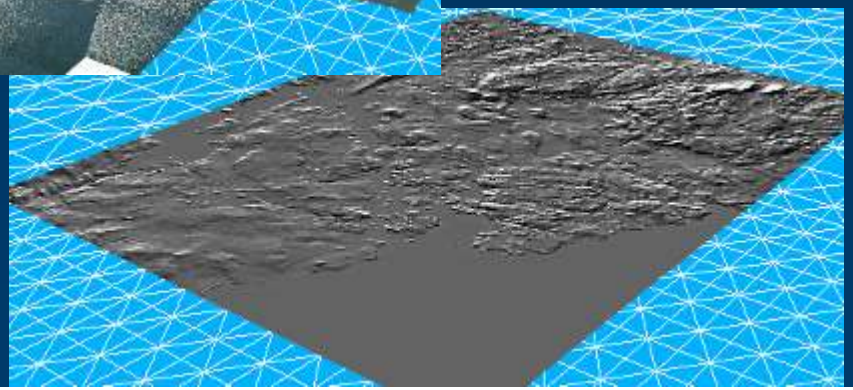


- Draped Vectors



- Imagery

- Elevation

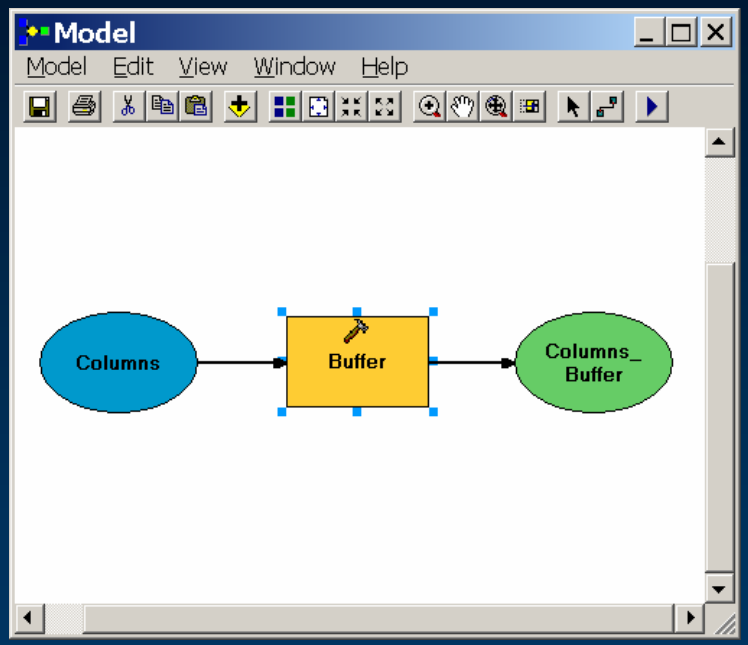


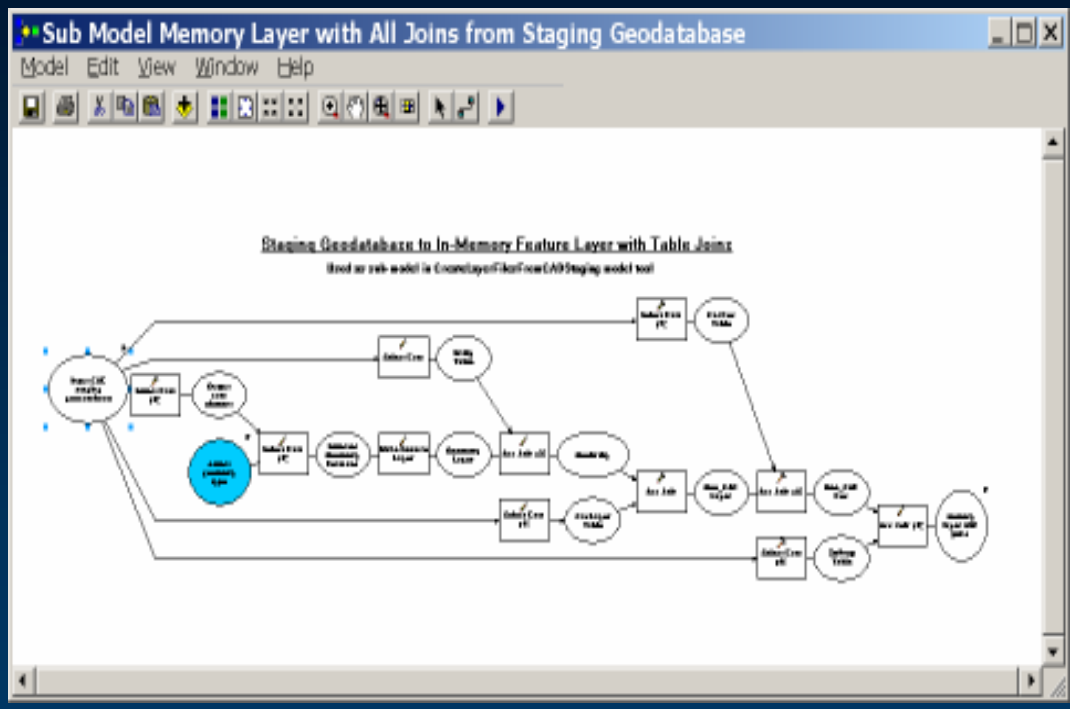
Geoprocessing Models

- Geoprocessing is a language consisting of operators, or tools, that operate on the data (tables, feature classes, rasters, TINs, and so on), and perform tasks that are necessary for manipulating and analyzing geographic information across a wide range of disciplines

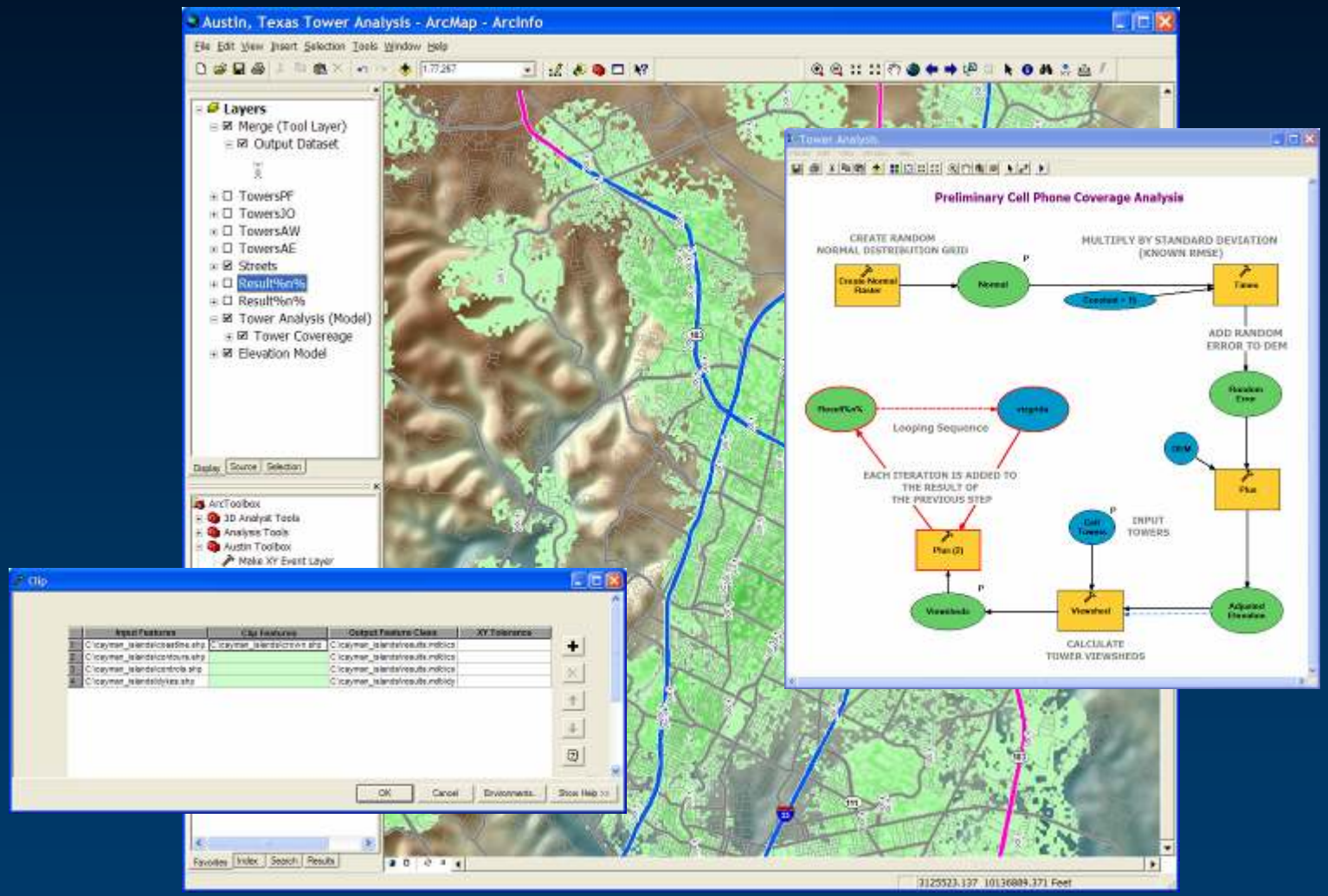
- Geoprocessing models are how you automate your work.
  - When you create a model, you are preserving a set of tasks, or a workflow, that you can execute multiple times.
  - There are an infinite number of workflows you can automate using models.
  - Models can range from very simple to as complex as you can imagine
  - Models are a way of documenting & sharing your knowledge about a workflow with others

A Simple and a Complex Model



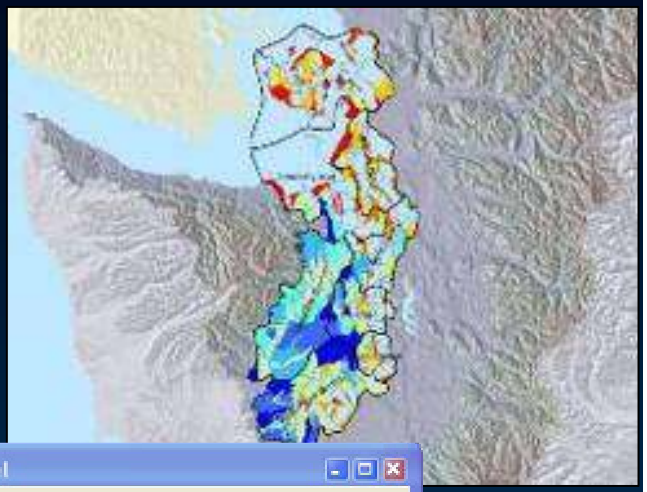


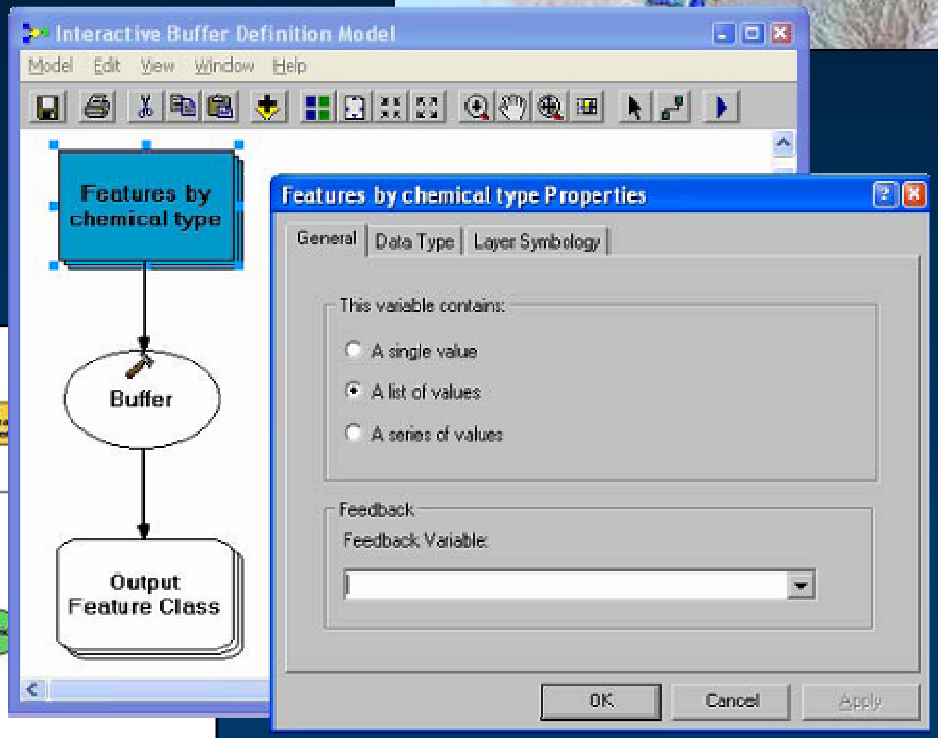
Geoprocessing Demonstration

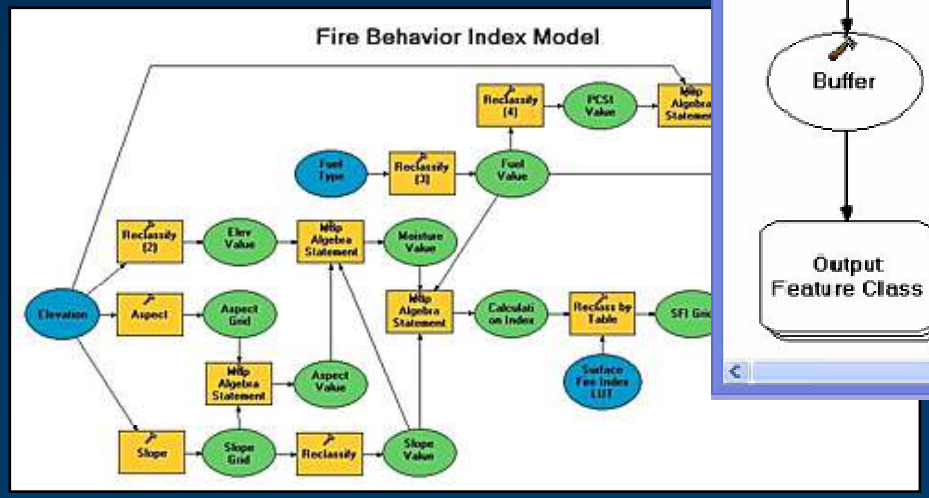


Iterative Modeling

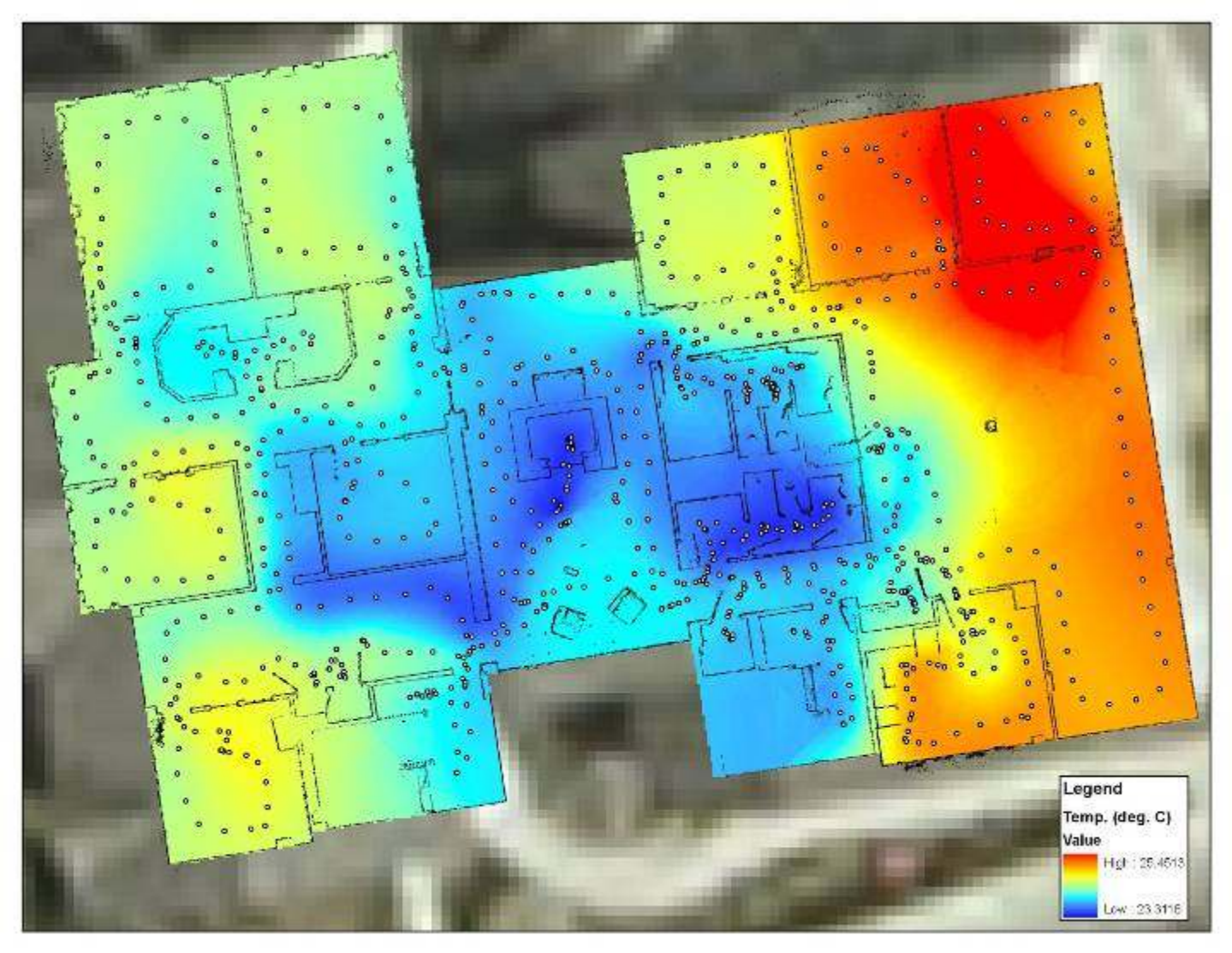
- ModelBuilder now supports looping
- Use…
  - Lists
  - Series
  - Boolean conditions
  - Count
  - Feedback







Monitoring the built environment

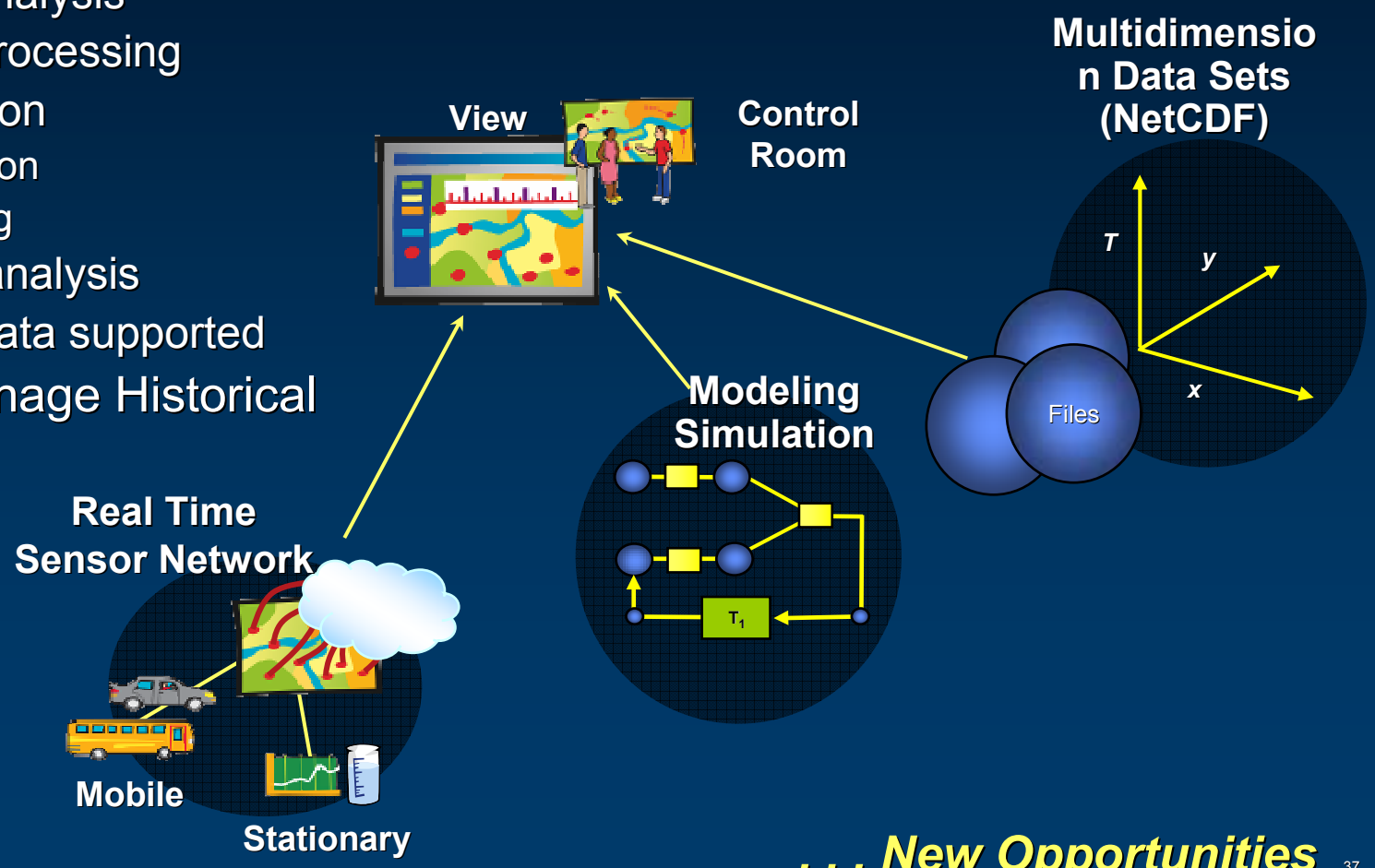


…interpolated surface from field readings

Integration of Time

New Ways to Manage, Analyze, & Visualize Geography

- Tools for Manipulation
  - Query
  - Change analysis
  - Iterative processing
  - Visualization
    - Animation
    - Charting
  - Tracking analysis
  - NetCDF data supported
- Tools to Manage Historical State

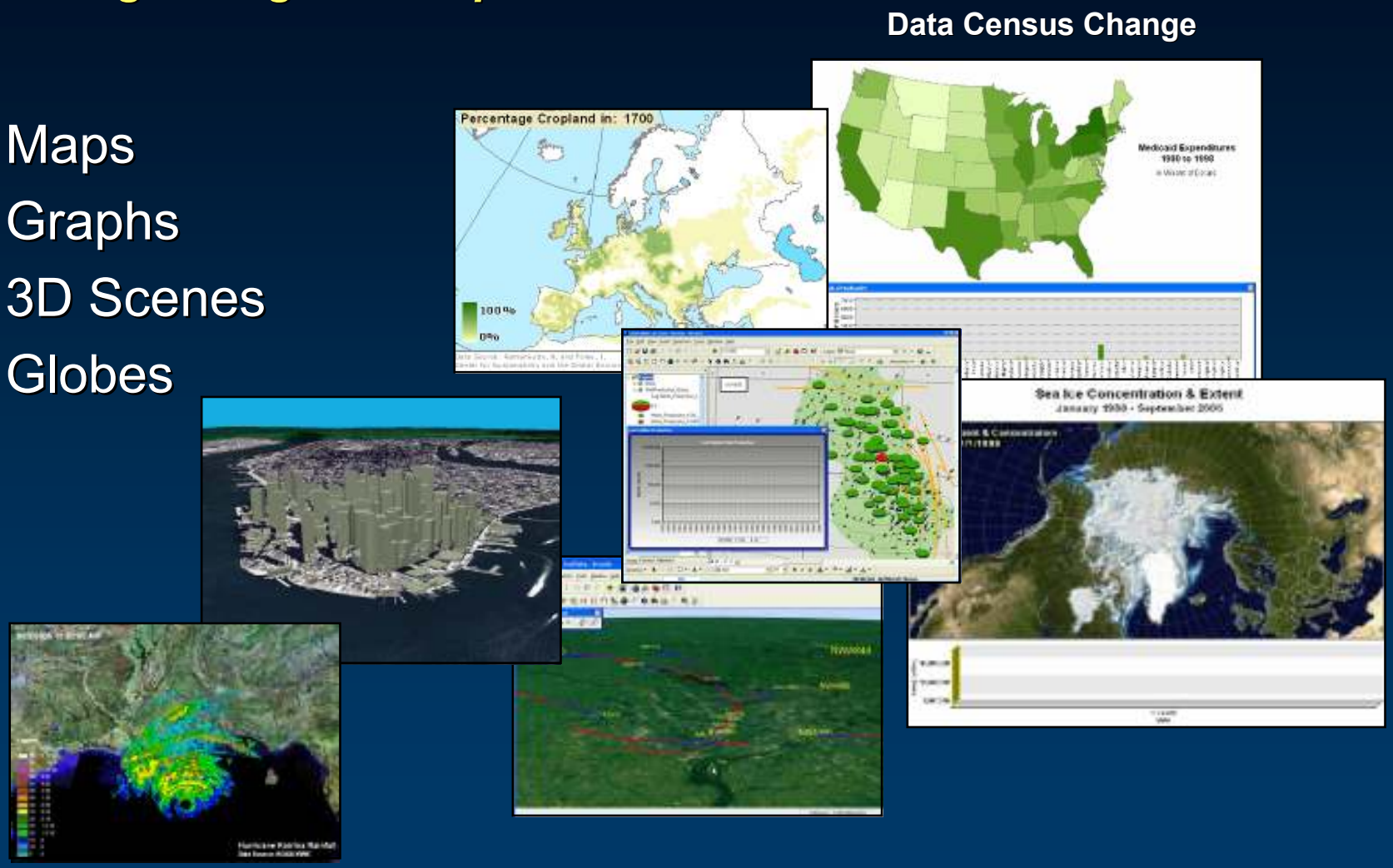


. . . New Opportunities

Animation in All Applications

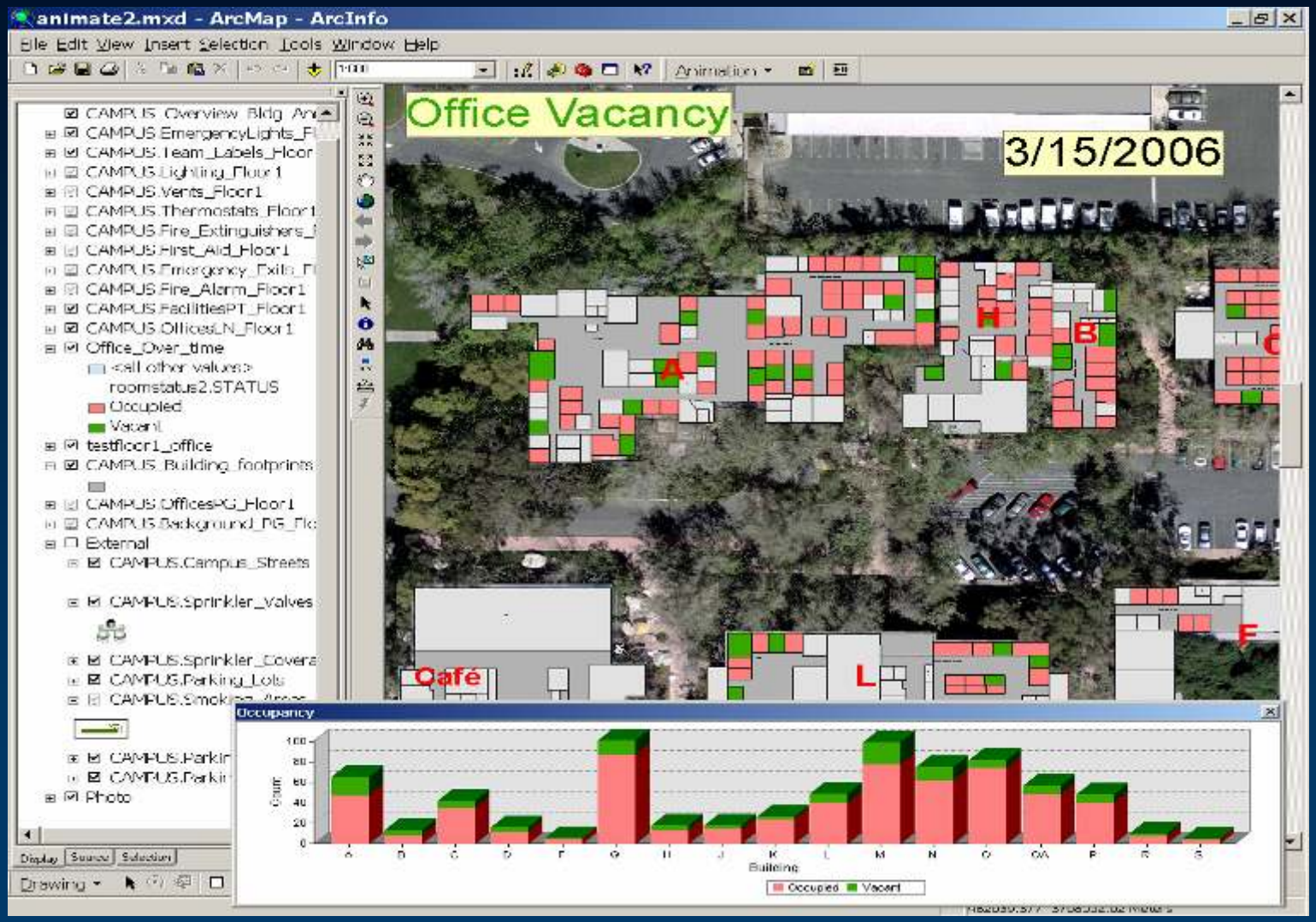
Visualizing Change Over Space & Time

- Maps
- Graphs
- 3D Scenes
- Globes



. . . Communicating Patterns, Relationships, & Processes

Example: Office Vacancy Animation

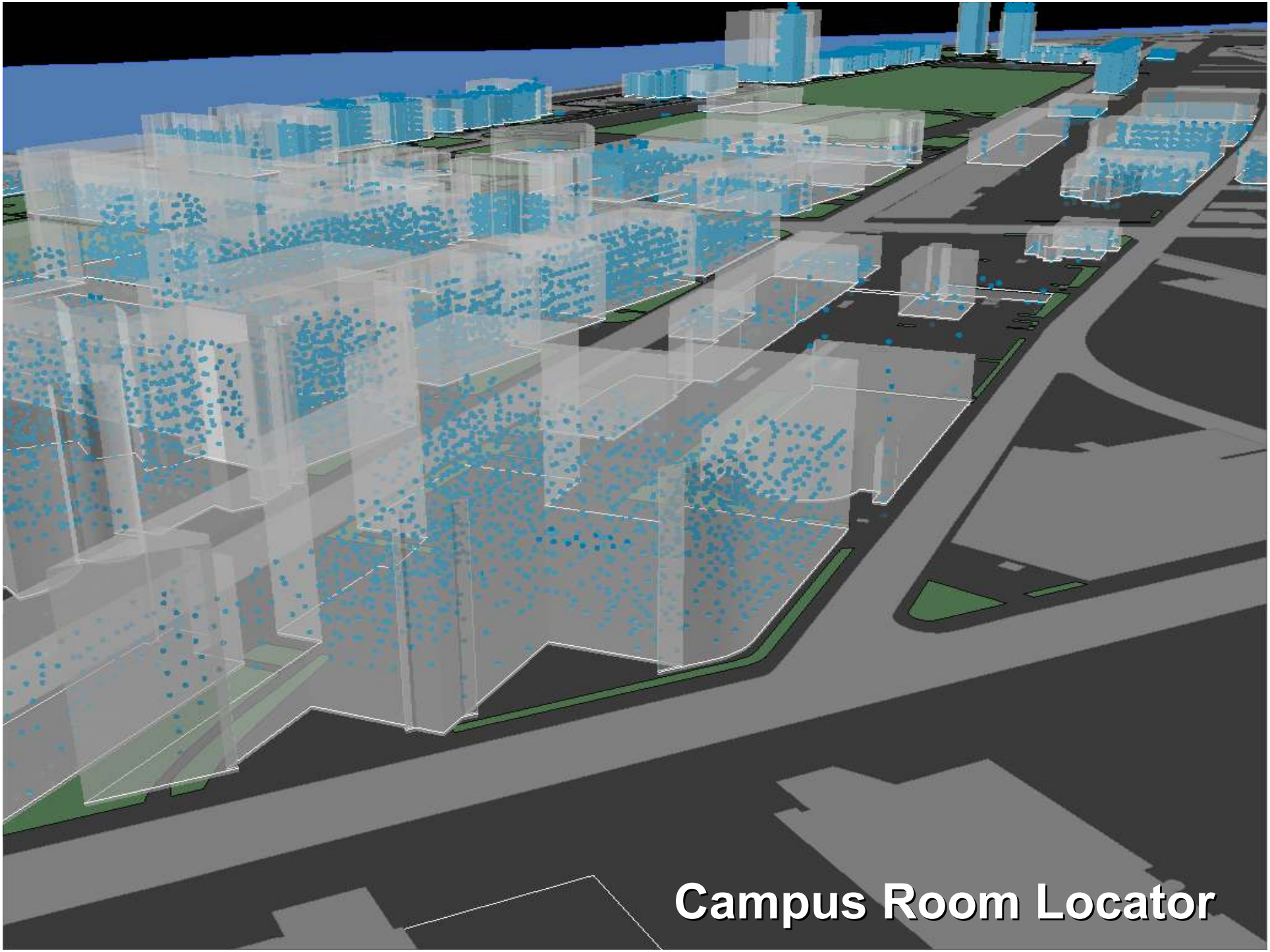


Making Them Work Together

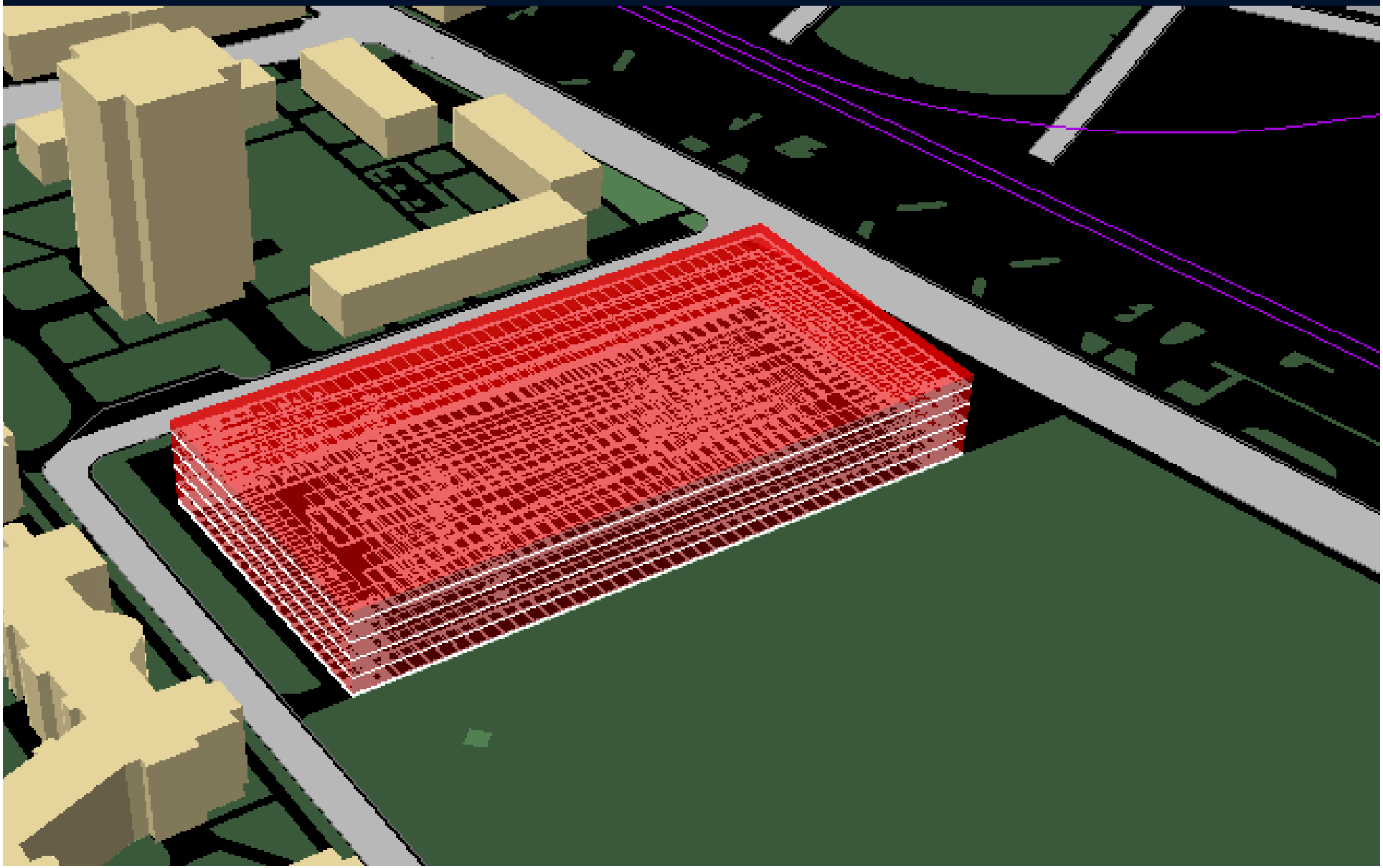
More complex scenarios can be modeled by combining basic capabilities from each area discussed

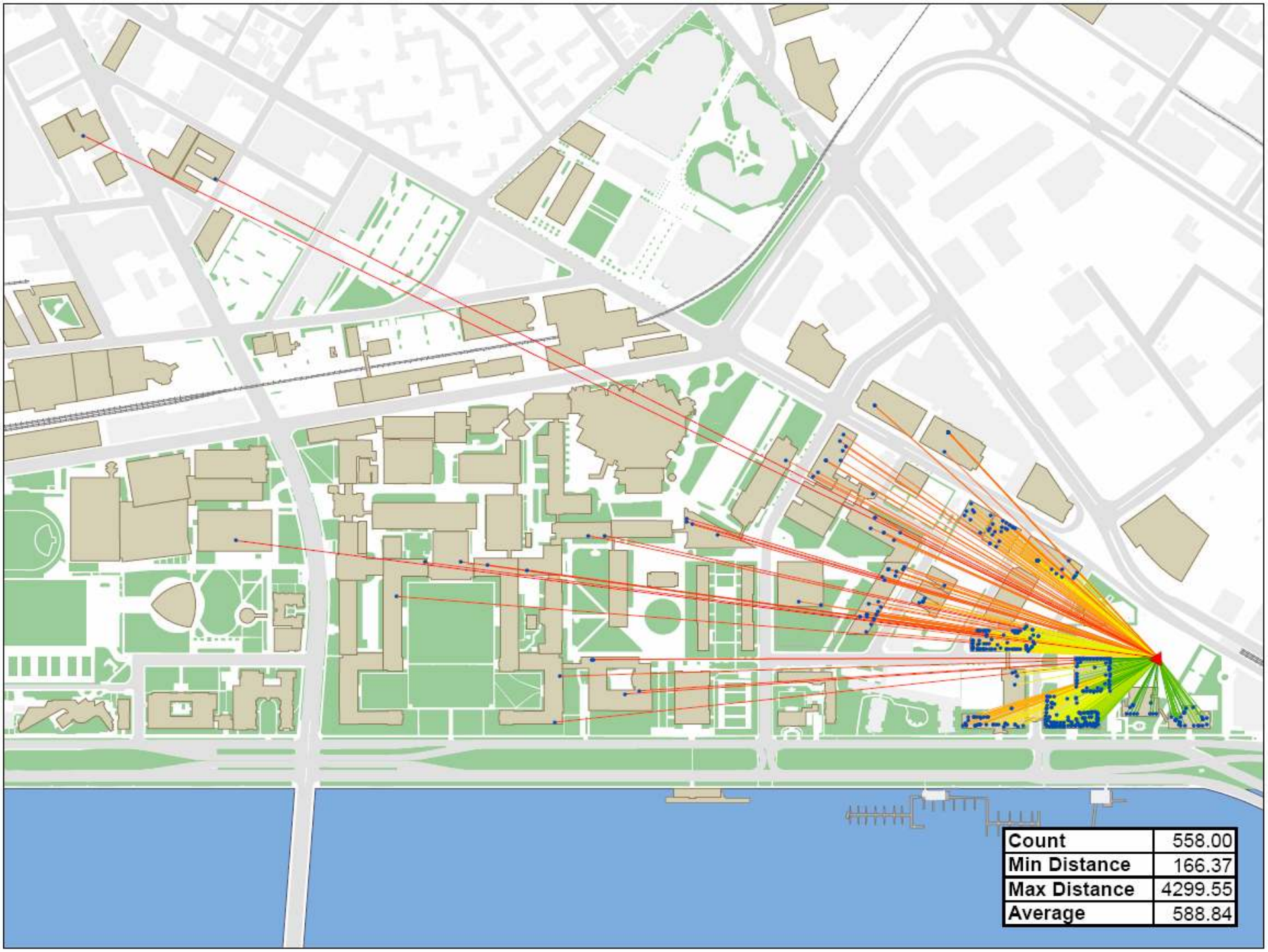
- Data Models
  - Representation and Behavior
- 2D & 3D Visualization
- Geoprocessing
- Time

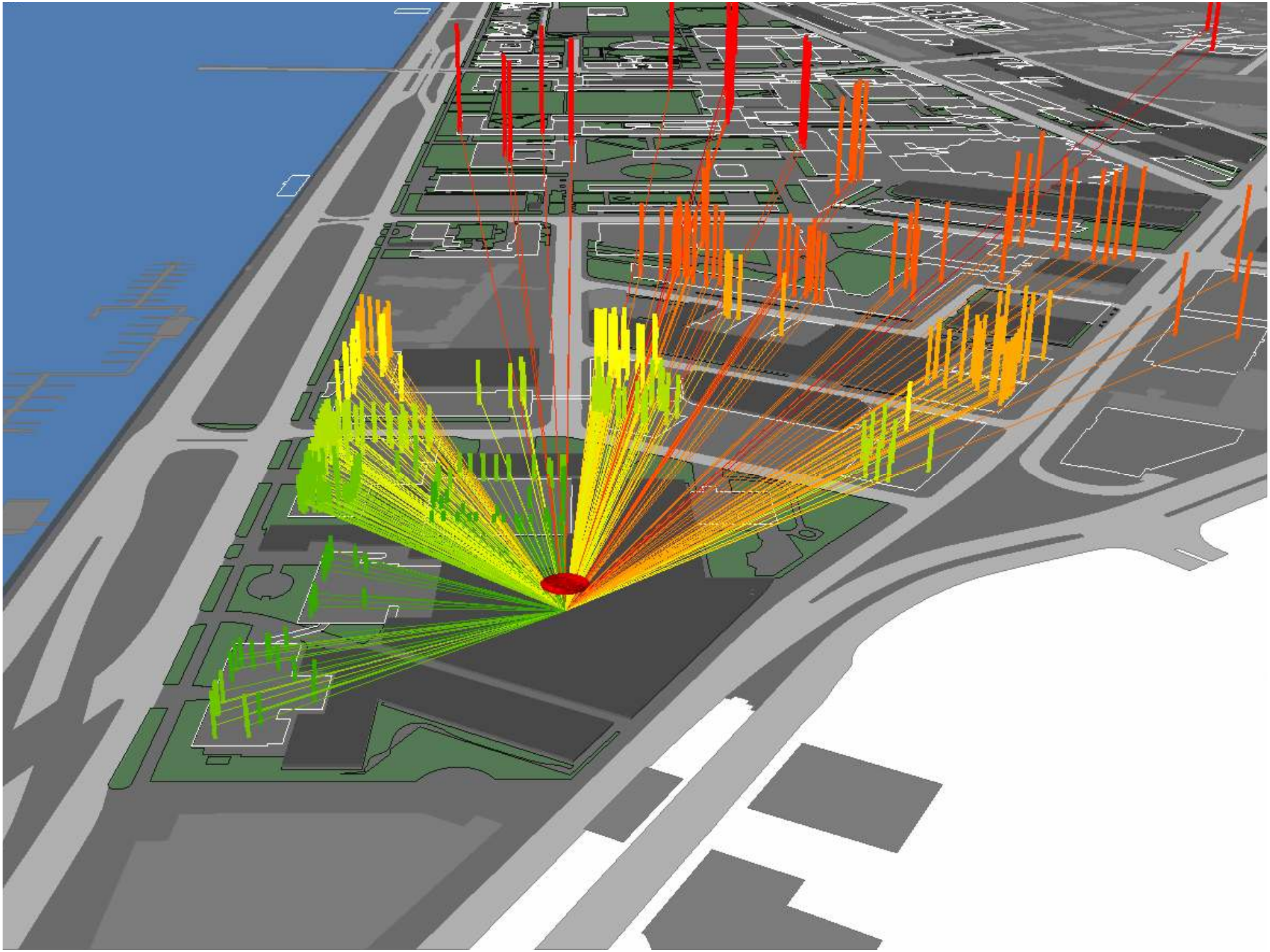
…The whole is more than the sum of the parts


Campus Room Locator

Planning & Analysis - Parking

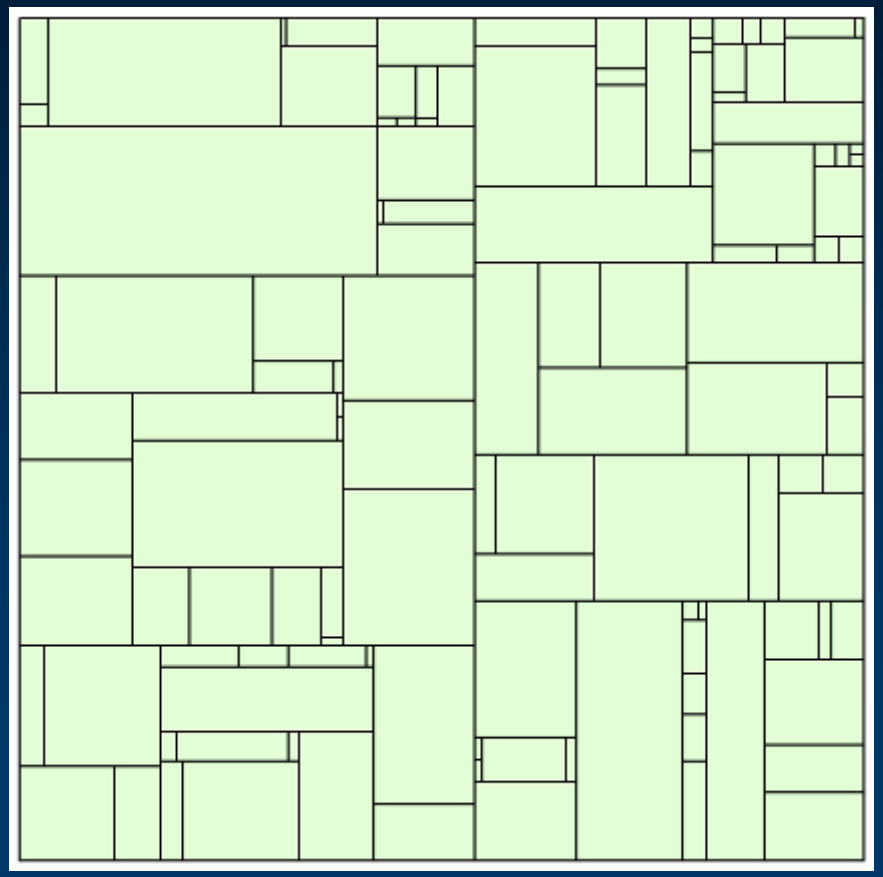



Count 558.00
Min Distance 166.37
Max Distance 4299.55
Average 588.84

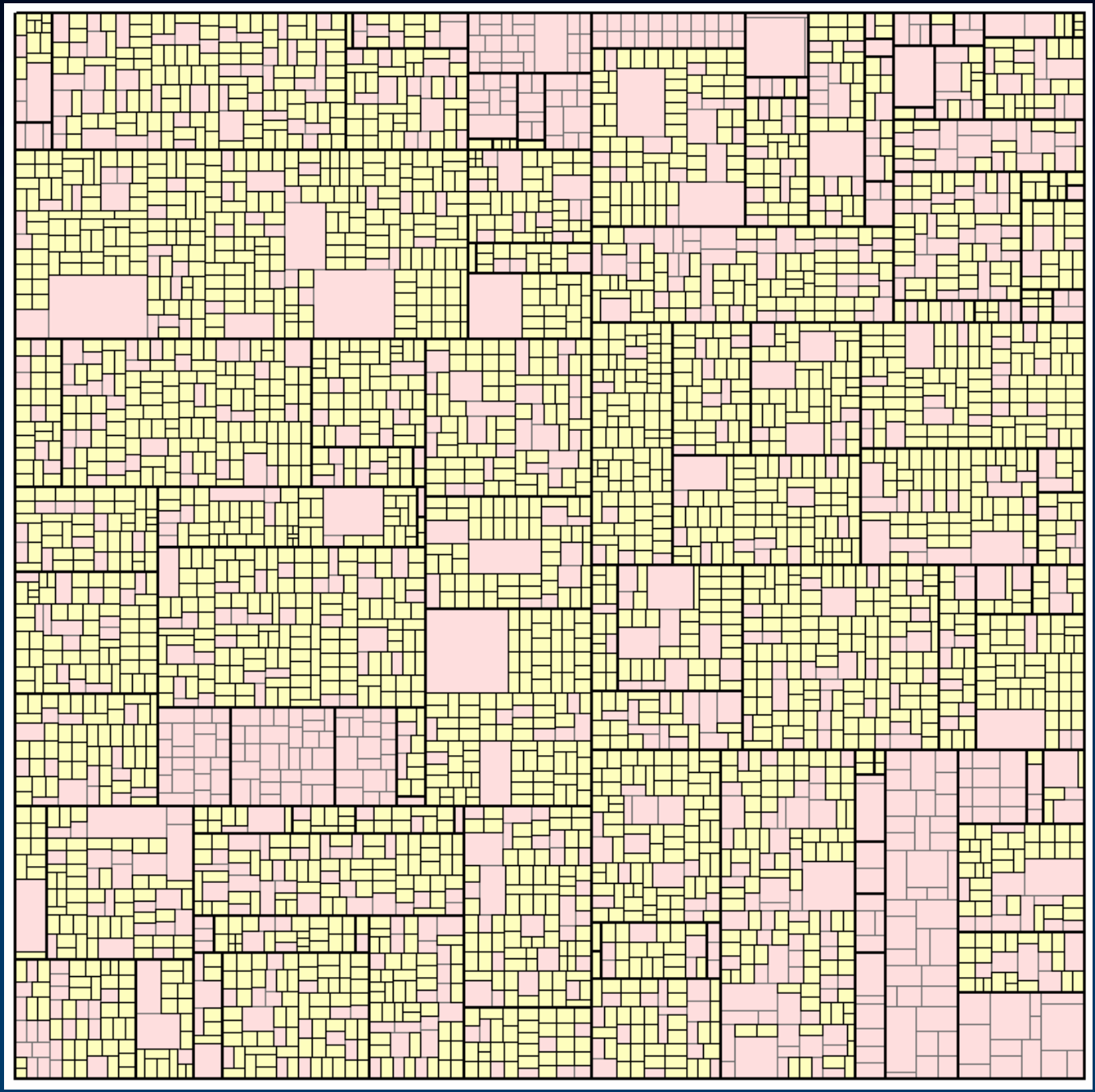


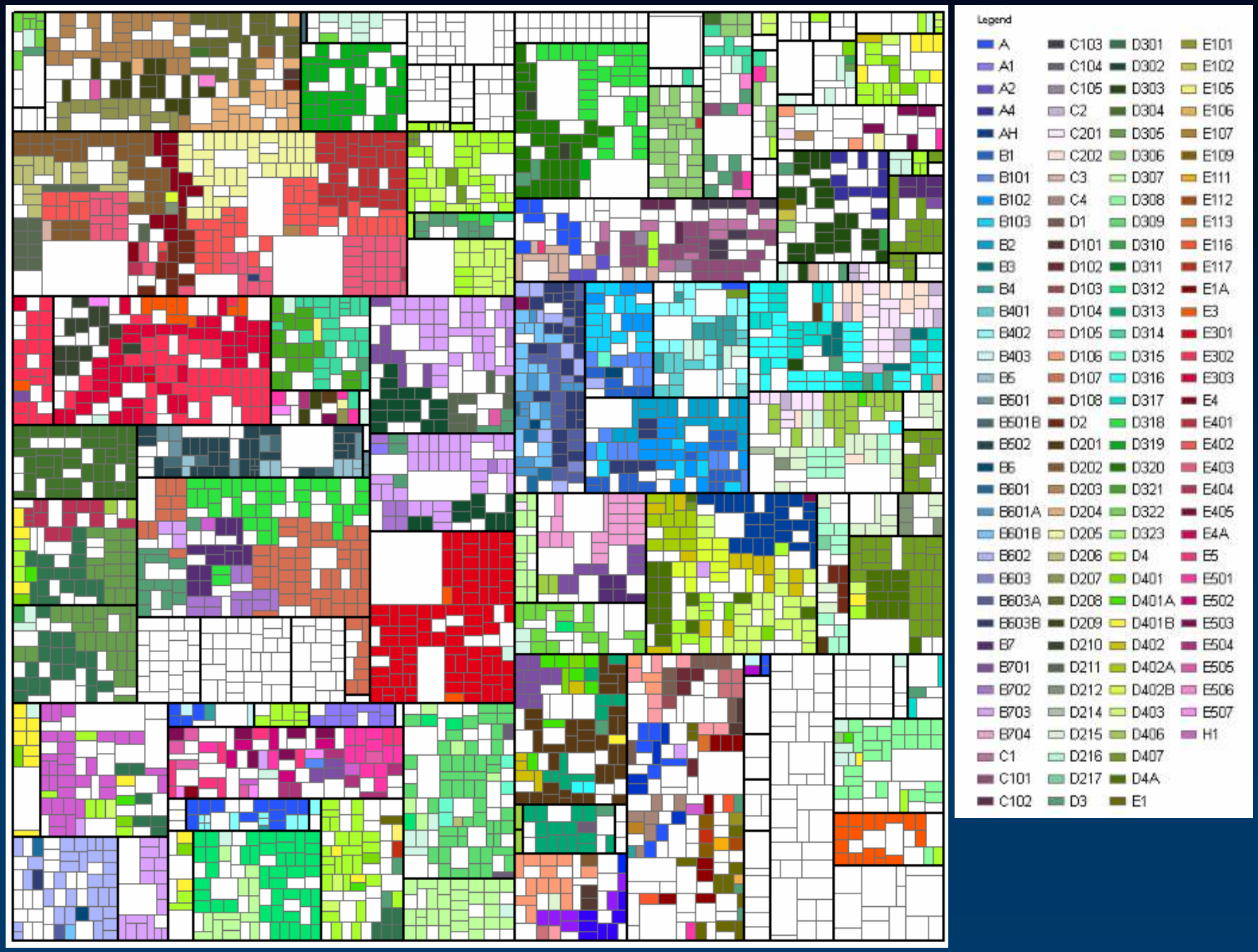
Optimization Visualization
Spatial Subdivision Diagram

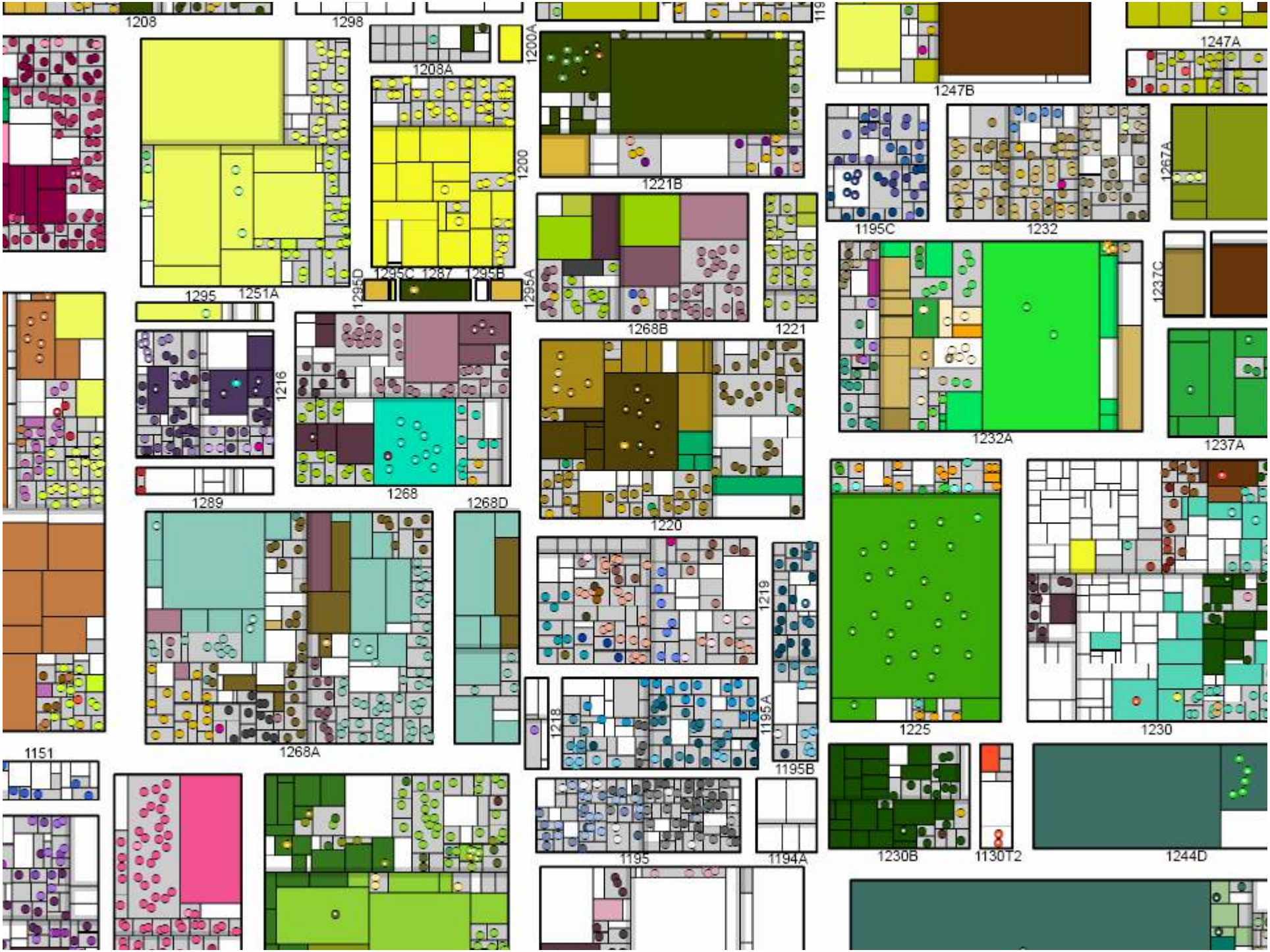
- Compact 2D display of large amounts of information
- Abstract representation for the real features
- Features scaled to represent any quantity
- All ESRI GIS tools applicable
- Modeled in ArcGIS ArcMap

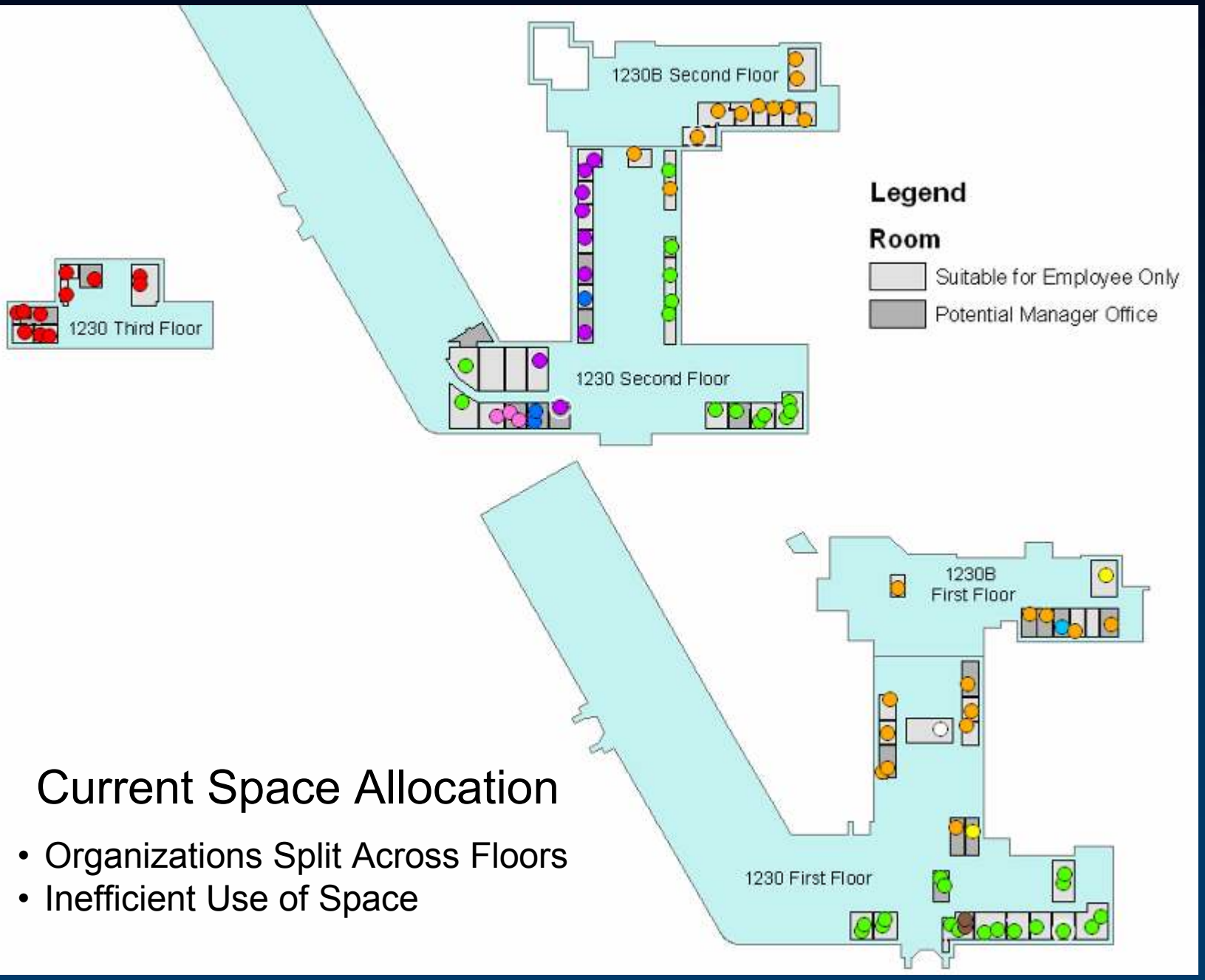



1297
1202
1297T1
1209
1250A
1250
1200
1251
1251A
1168
1192E
1192D
1268D
1192
1213
1215
1151
1218A
1212C
1212
1152
1146
1149
1153
1001
1201
1242
1148
1236
1205
1293A
1230
1228
1308
1230B
1190T2
1244C
1244
1231C
583A
583
562A
582
584
720
644
645A
648
647
643



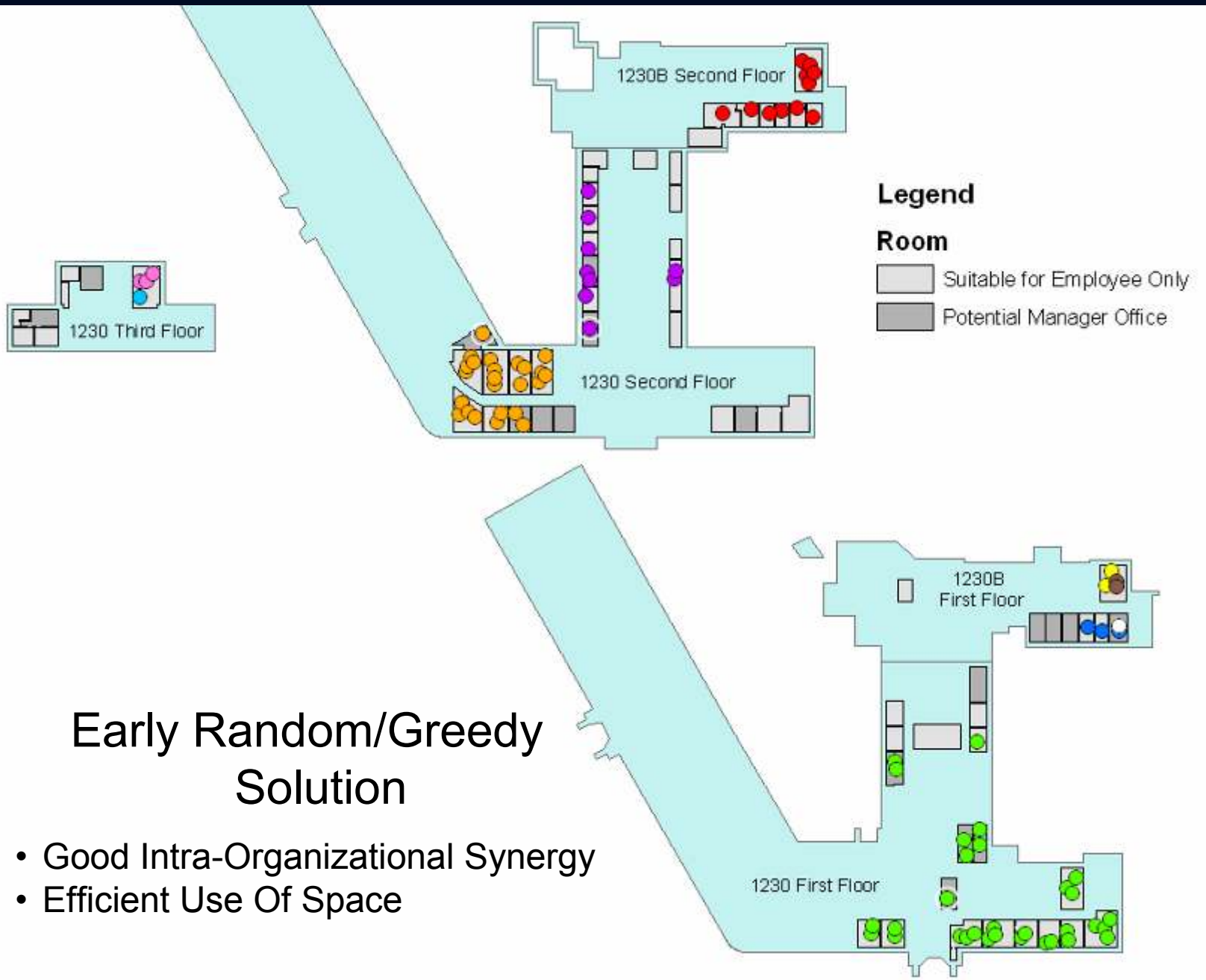

Legend
A
A1
A2
A4
AH
B1
B101
B102
B103
B2
B3
B4
B401
B402
B403
B5
B601
B601B
B602
B6
B601
B601A
B601B
B602
B603
B603A
B603B
B7
B701
B702
B703
B704
C1
C101
C102
C103
C104
C105
C2
C201
C202
C3
C4
D1
D101
D102
D103
D104
D105
D106
D107
D108
D2
D201
D202
D203
D204
D205
D206
D207
D208
D209
D210
D211
D212
D214
D215
D216
D217
D3
D301
D302
D303
D304
D305
D306
D307
D308
D309
D310
D311
D312
D313
D314
D315
D316
D317
D318
D319
D320
D321
D322
D323
D4
D401
D401A
D401B
D402
D402A
D402B
D403
D406
D407
D4A
E1
E101
E102
E105
E106
E107
E109
E111
E112
E113
E116
E117
E1A
E3
E301
E302
E303
E4
E401
E402
E403
E404
E405
E4A
E5
E501
E502
E503
E504
E505
E506
E507
H1


1208
1298
1208A
1200A
1200
1221B
1247B
1247A
1195C
1232
1267A
1295
1251A
1295D
1295C
1287
1295B
1295A
1268B
1221
1237C
1216
1268
1232A
1237A
1289
1268D
1220
1219
1225
1230
1151
1268A
1218
1195A
1195B
1195
1194A
1230B
1130T2
1244D



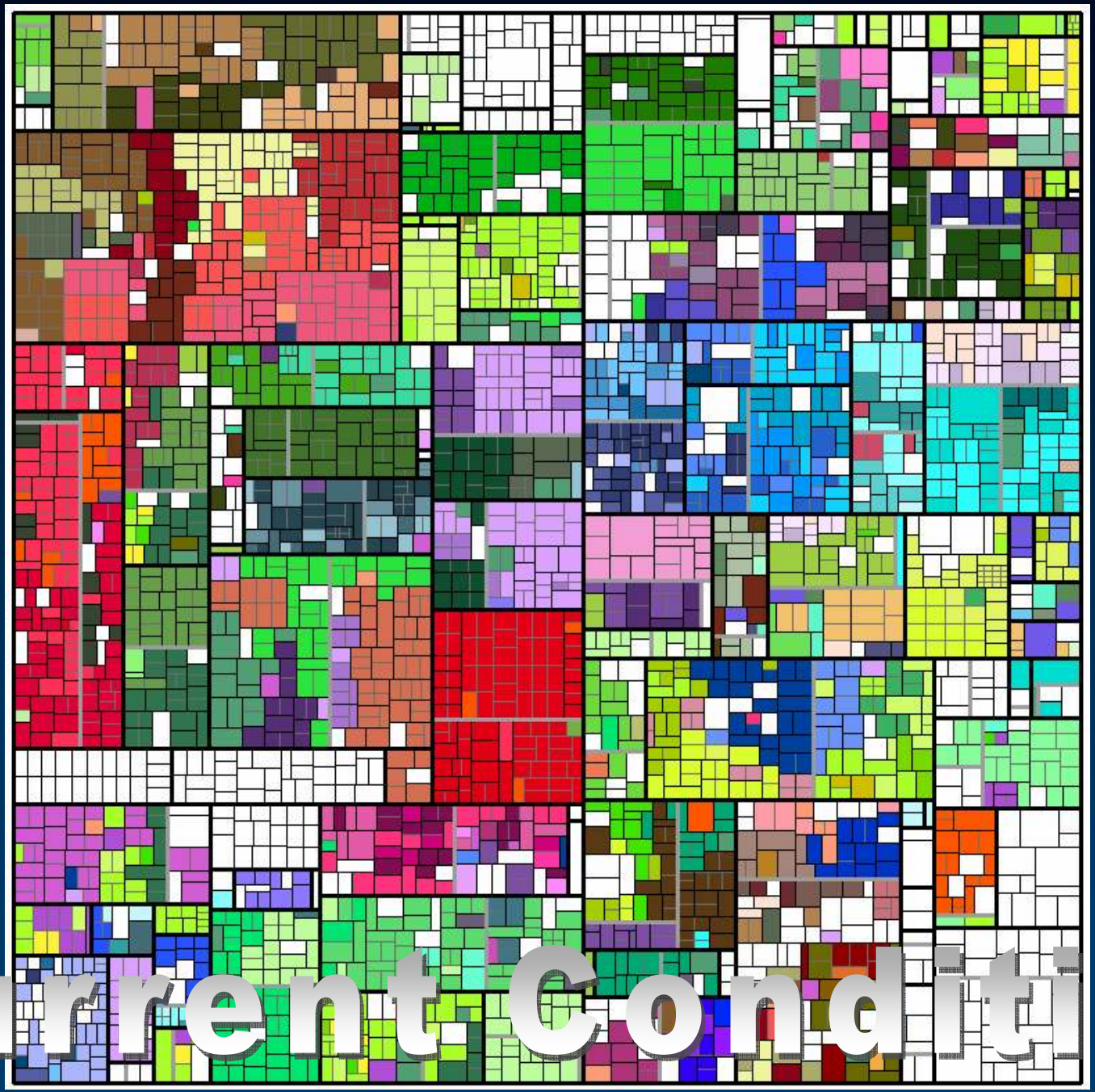
Current Space Allocation

- Organizations Split Across Floors
- Inefficient Use of Space

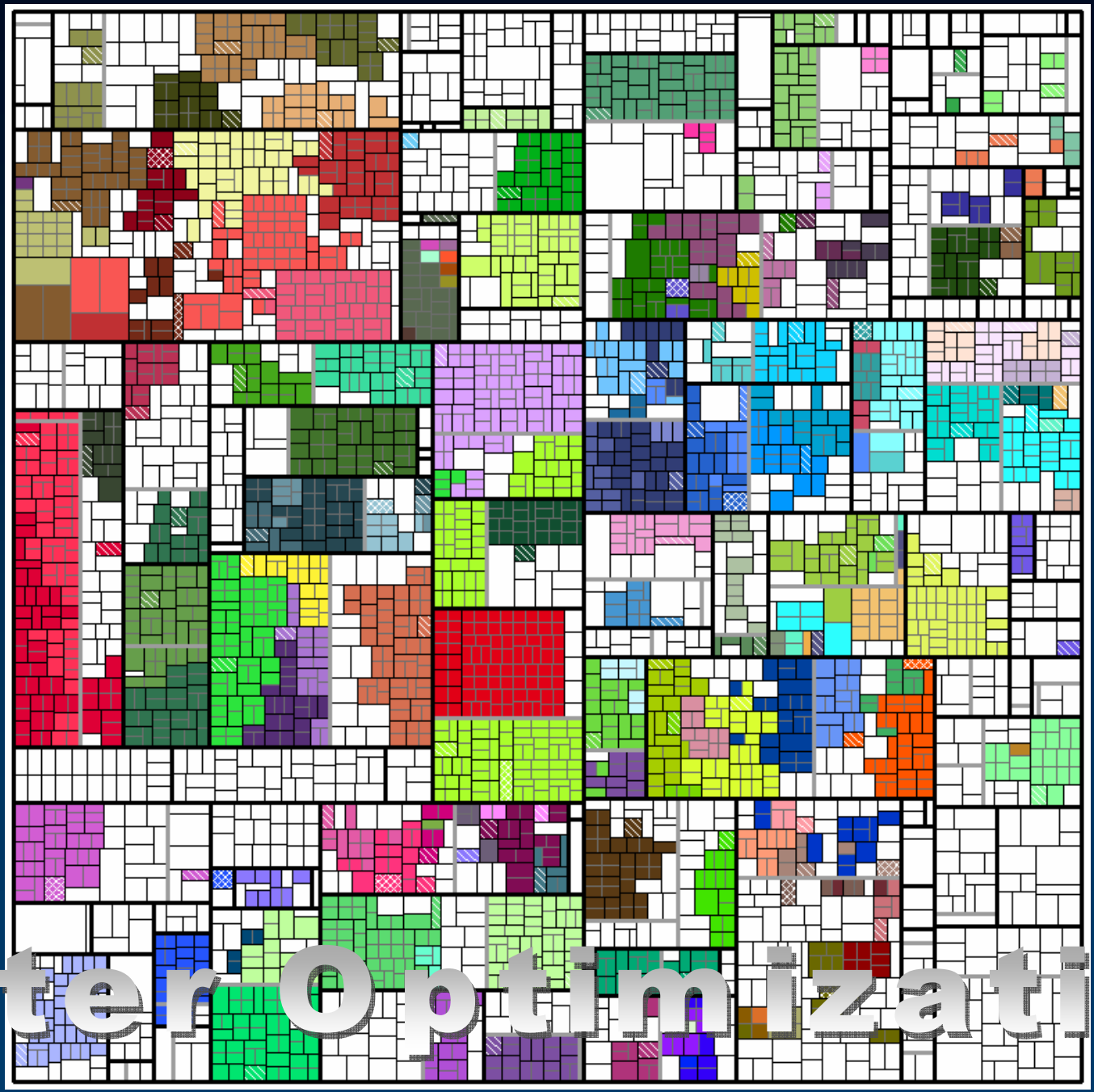


Early Random/Greedy Solution

- Good Intra-Organizational Synergy
- Efficient Use Of Space

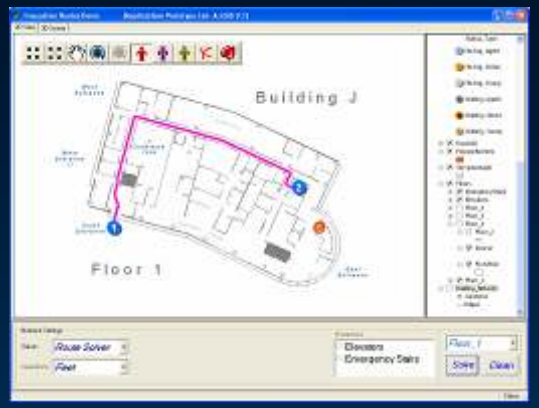


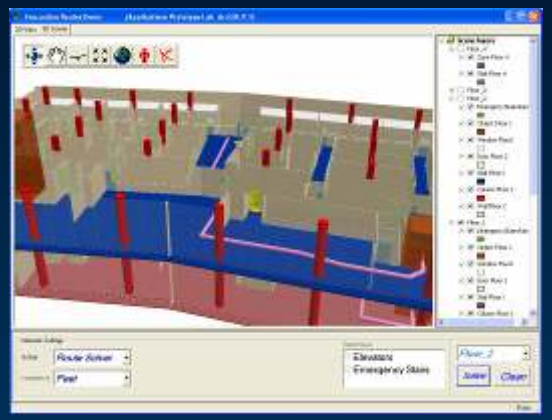
Current Condition

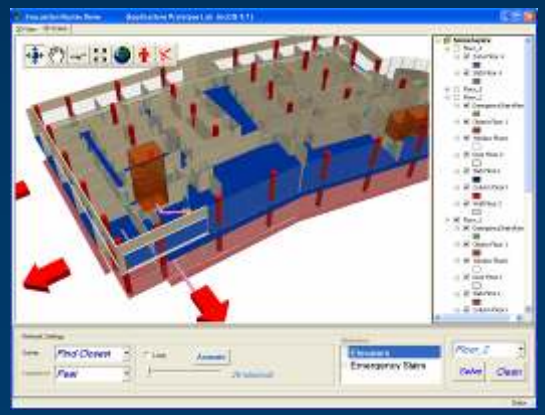


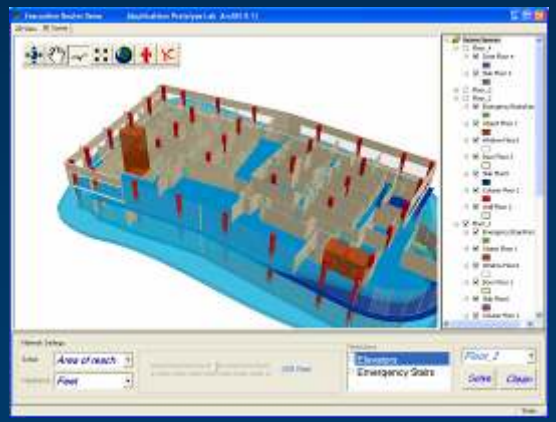
After Optimization

Emergency Preparedness and Response planning









ESRI’s Vision

Our Customers Use GIS as a Framework for Managing Their Business

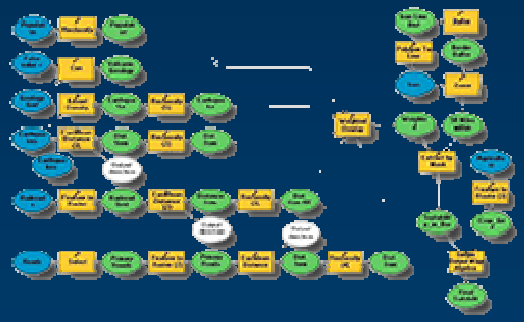
. . . Connects Disciplines, Departments, Organizations

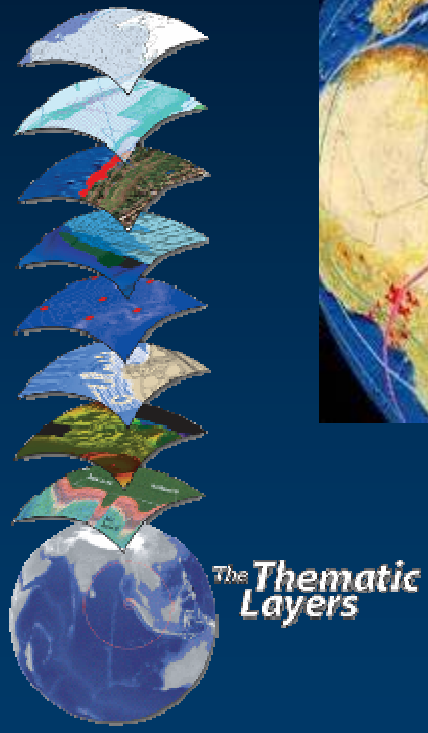
GIS is Providing a New Medium For Understanding

Modeling the Physical and Cultural Knowledge of our World
Breaking Down the Earth into Components and Systems . . .

Providing

- Systematic Knowledge
- An Integrative Framework
- Analytic Methods
- Intuitive Visualization





. . . Creating Order and Meaning
. . . Defining Interconnections and Interdependence
. . . Providing a Broad Understanding of Natural and Human Ecology

GIS Is Influencing How We See and Do Things

Building a Common Understanding

Creating a Sense of Engagement

Providing More

- Science
- Accuracy/Detail
- Realism
- Logic & Analysis
- *Immediacy*

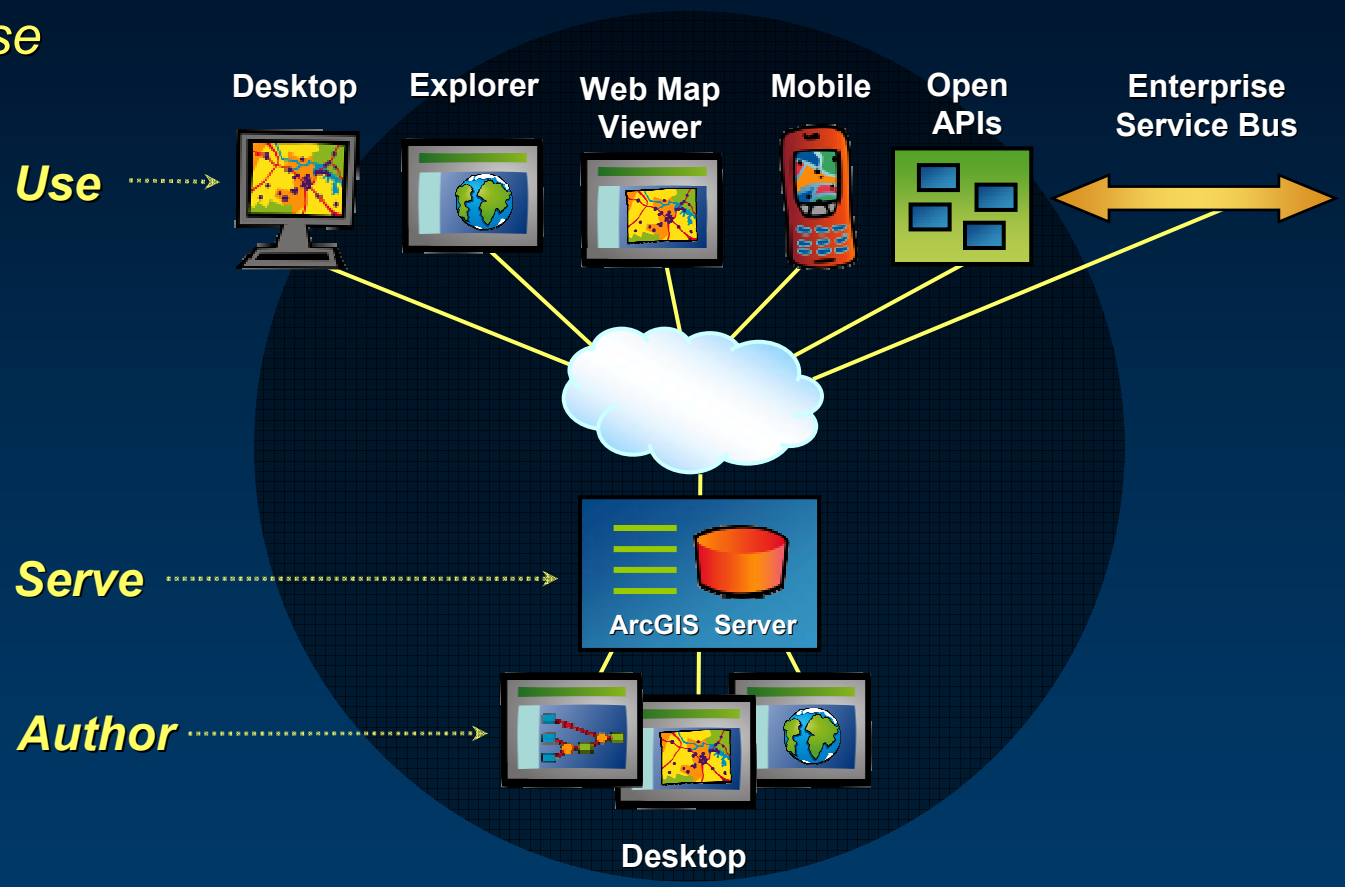
. . . Changing How We Communicate

GIS Should Work as a Complete System

A New Way to Manage and Disseminate Geographic Knowledge

Author/Serve/Use

- Maps
- Data
- Models
- Globes
- Metadata



Making GIS Knowledge Available To Anyone . . .

. . . Integrates With Other Systems Via Standards

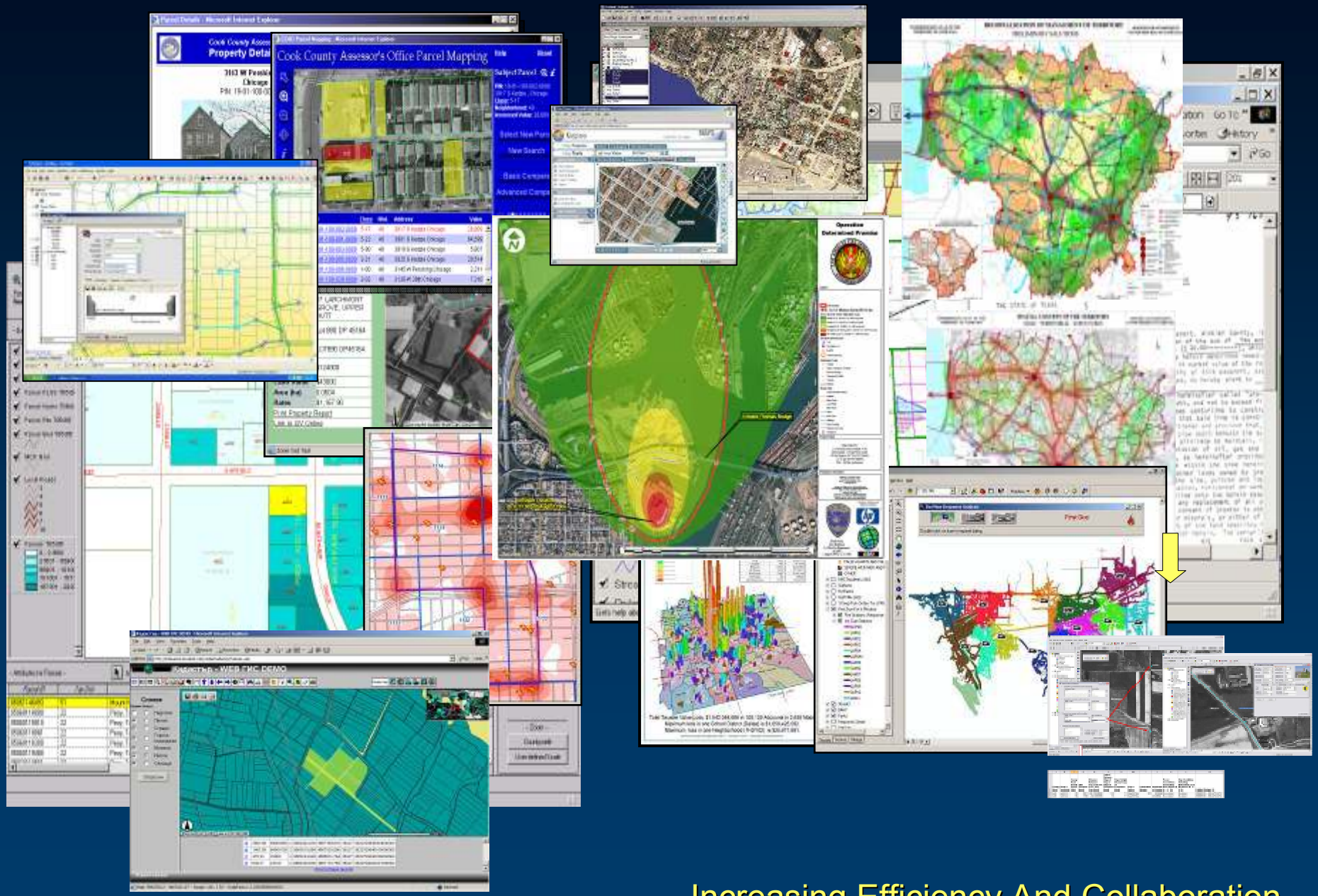
GIS is the Perfect Platform for Integration

To Author, Serve, and Use Geographic Knowledge

Managing Complexity . . .

. . . And Making It All Accessible

Managing *Governments, Businesses, & Campuses*

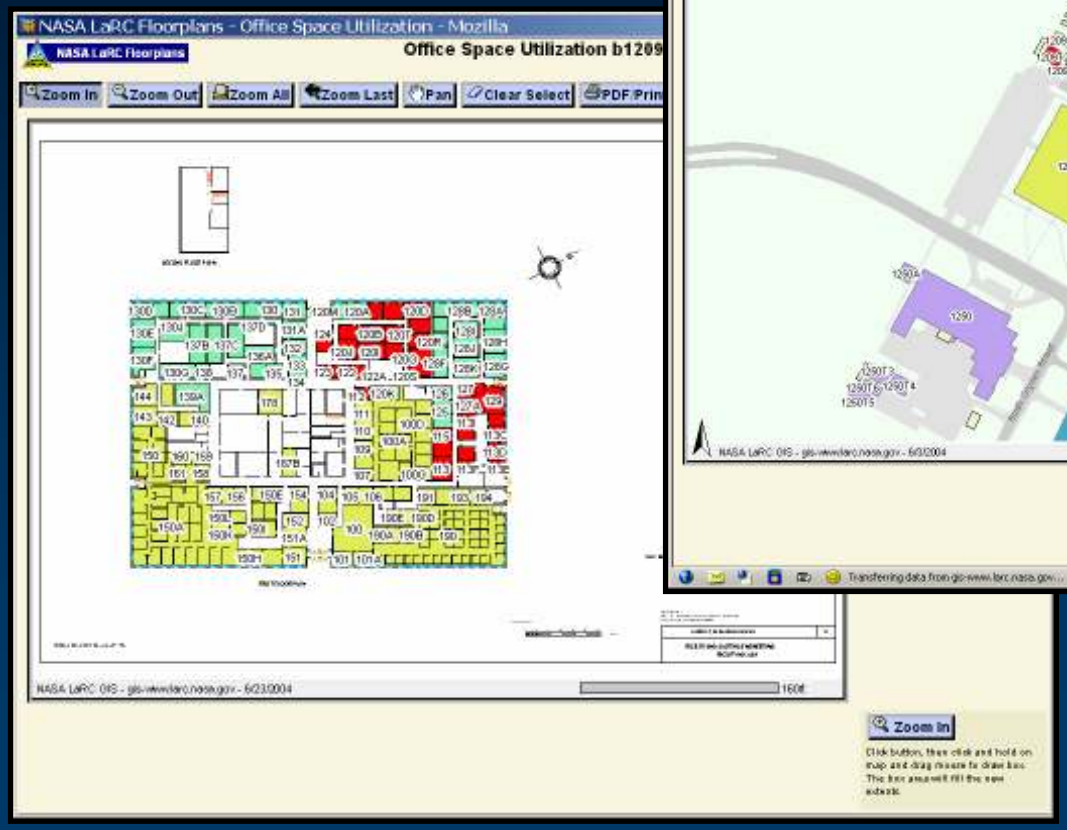


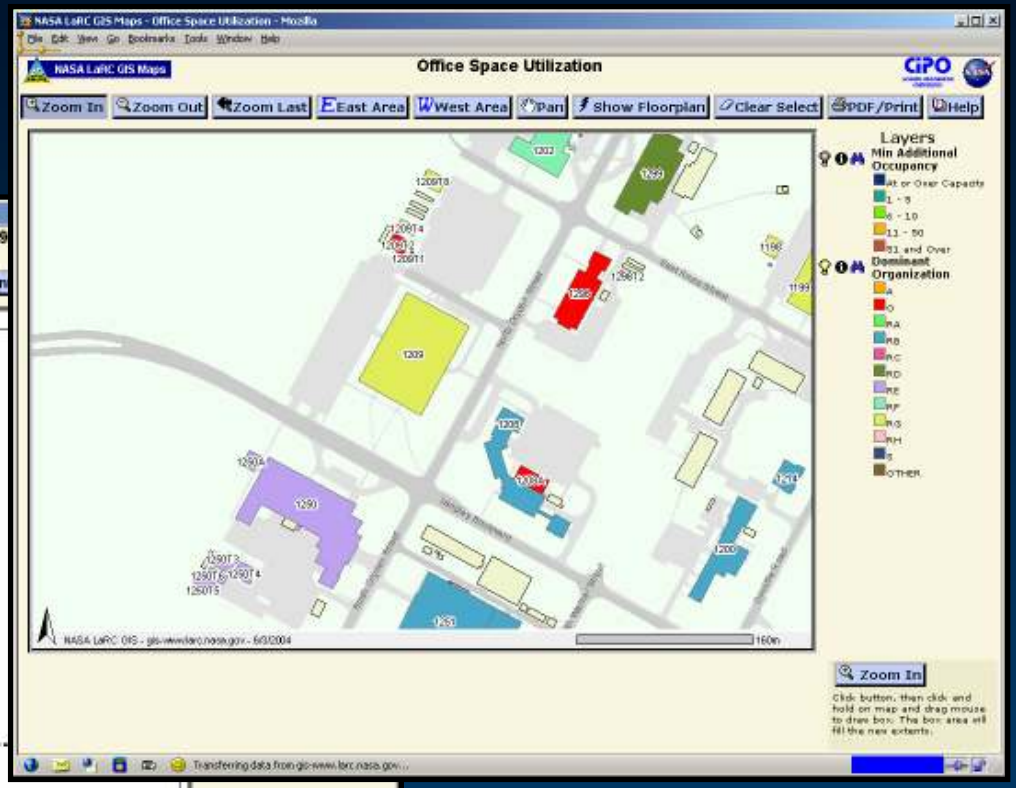
. . .Increasing Efficiency And Collaboration

Visualizing & Reporting Space Utilization

NASA LaRC

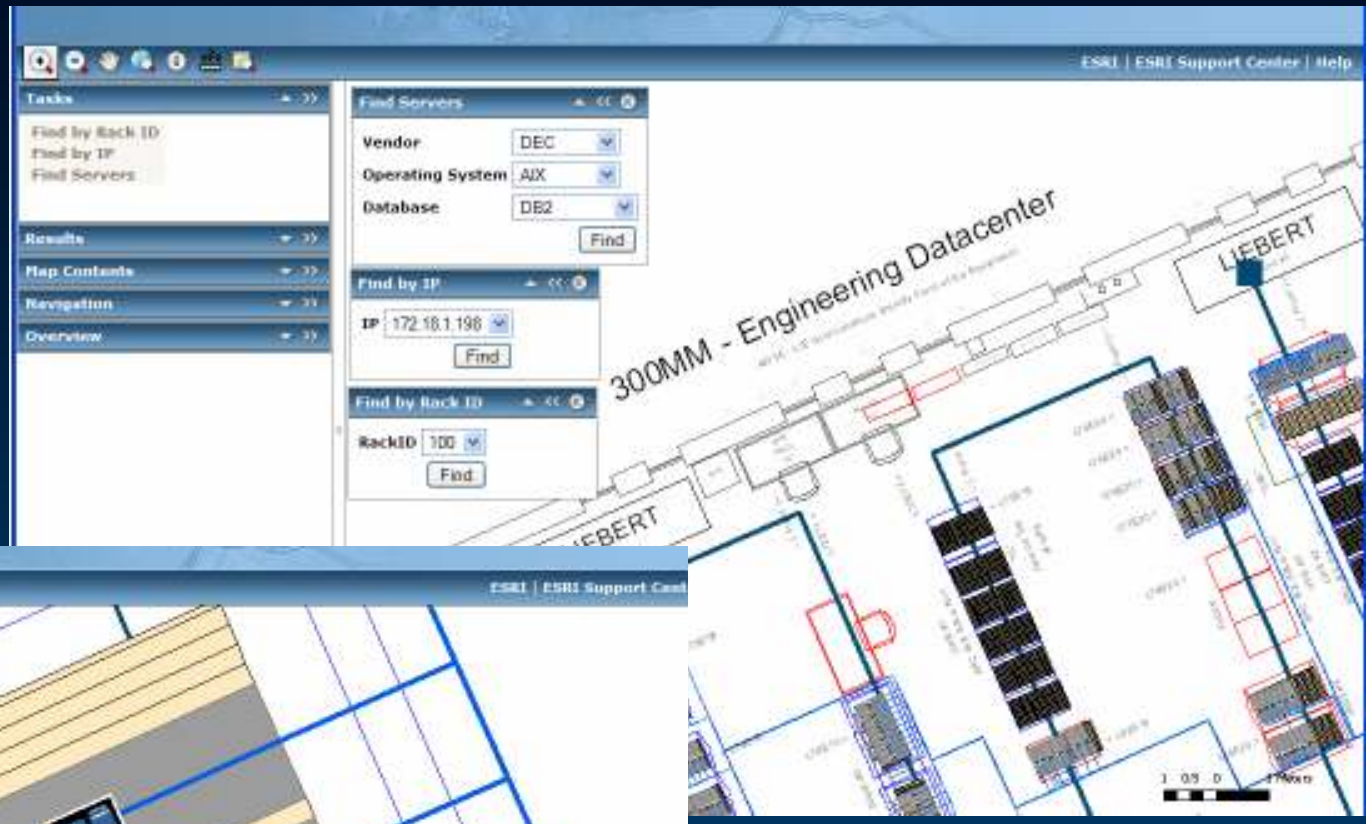
Inside Buildings

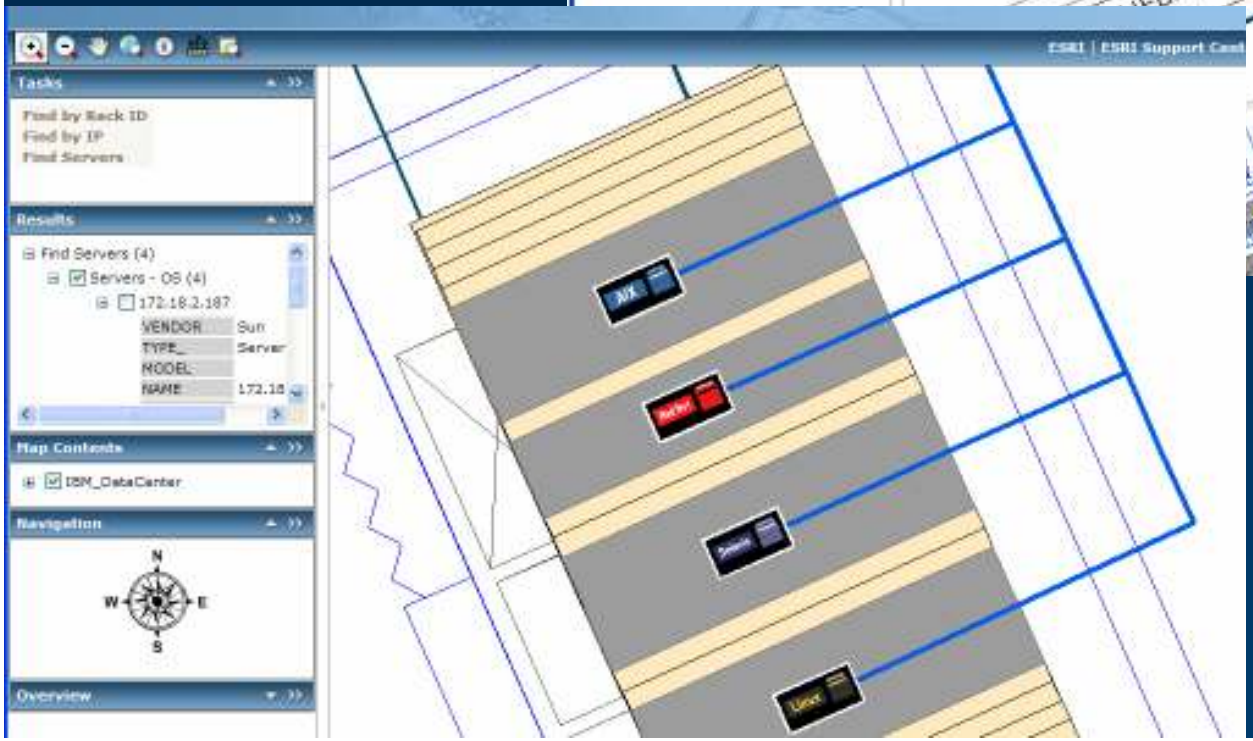




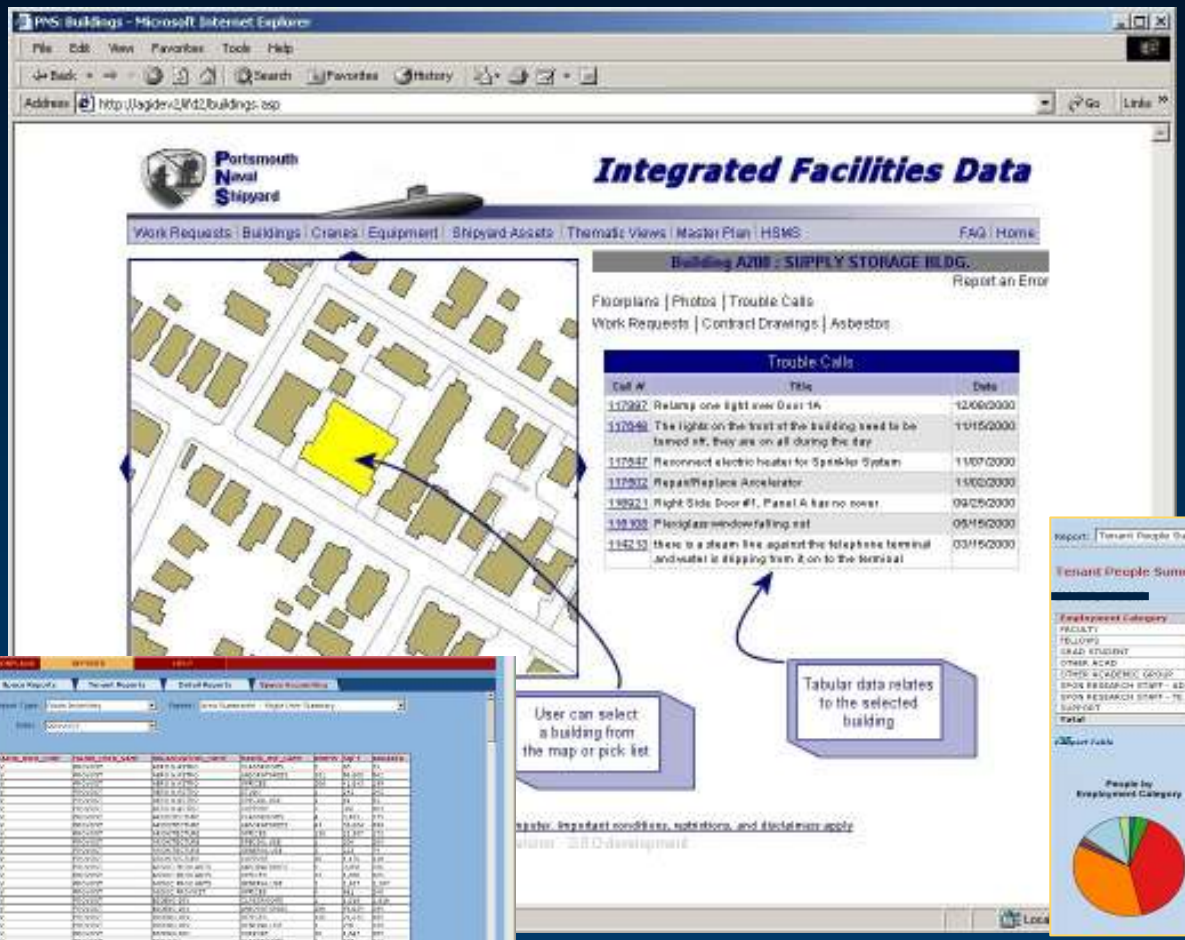
Across Facilities/ Real Property Portfolios

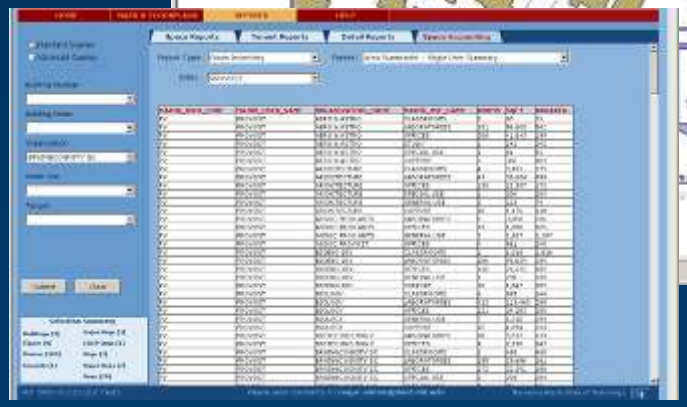
Managing IT Infrastructures

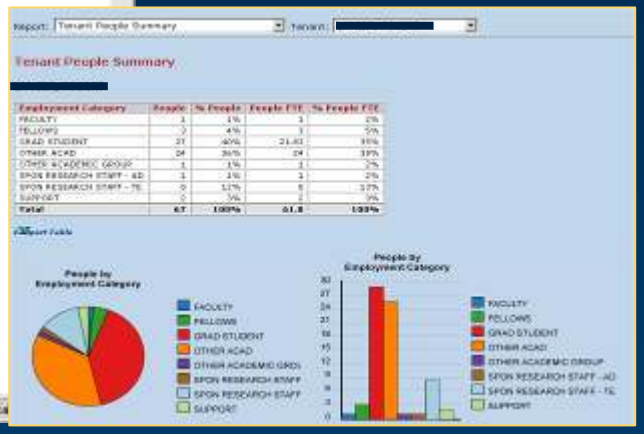




Web-based Facility Management Reporting



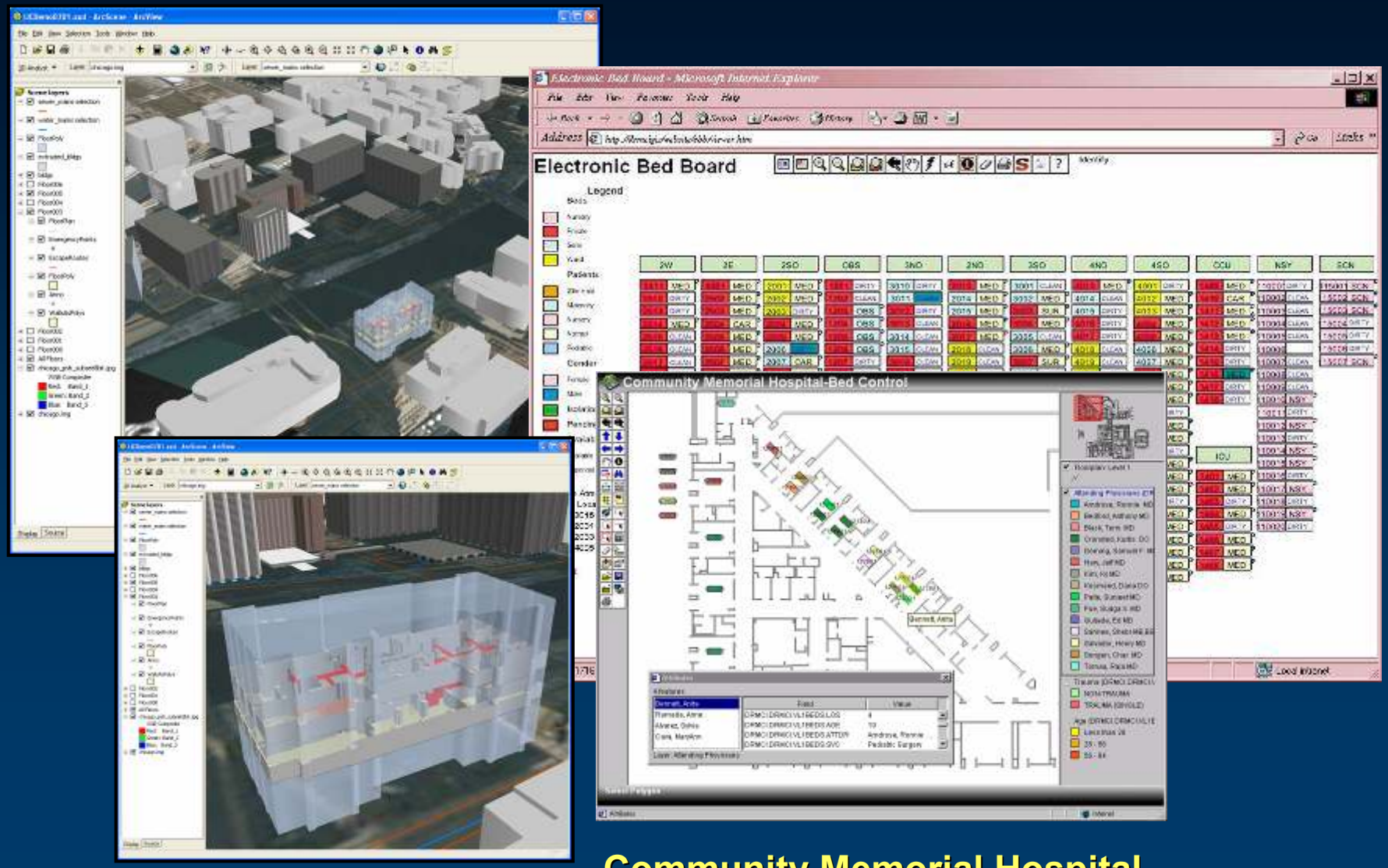




US Navy Atlantic Fleet Shore Installation Management Systems

Applied Geographics, Inc.
Empowering People with Spatial Solutions

Bed Capacity Management

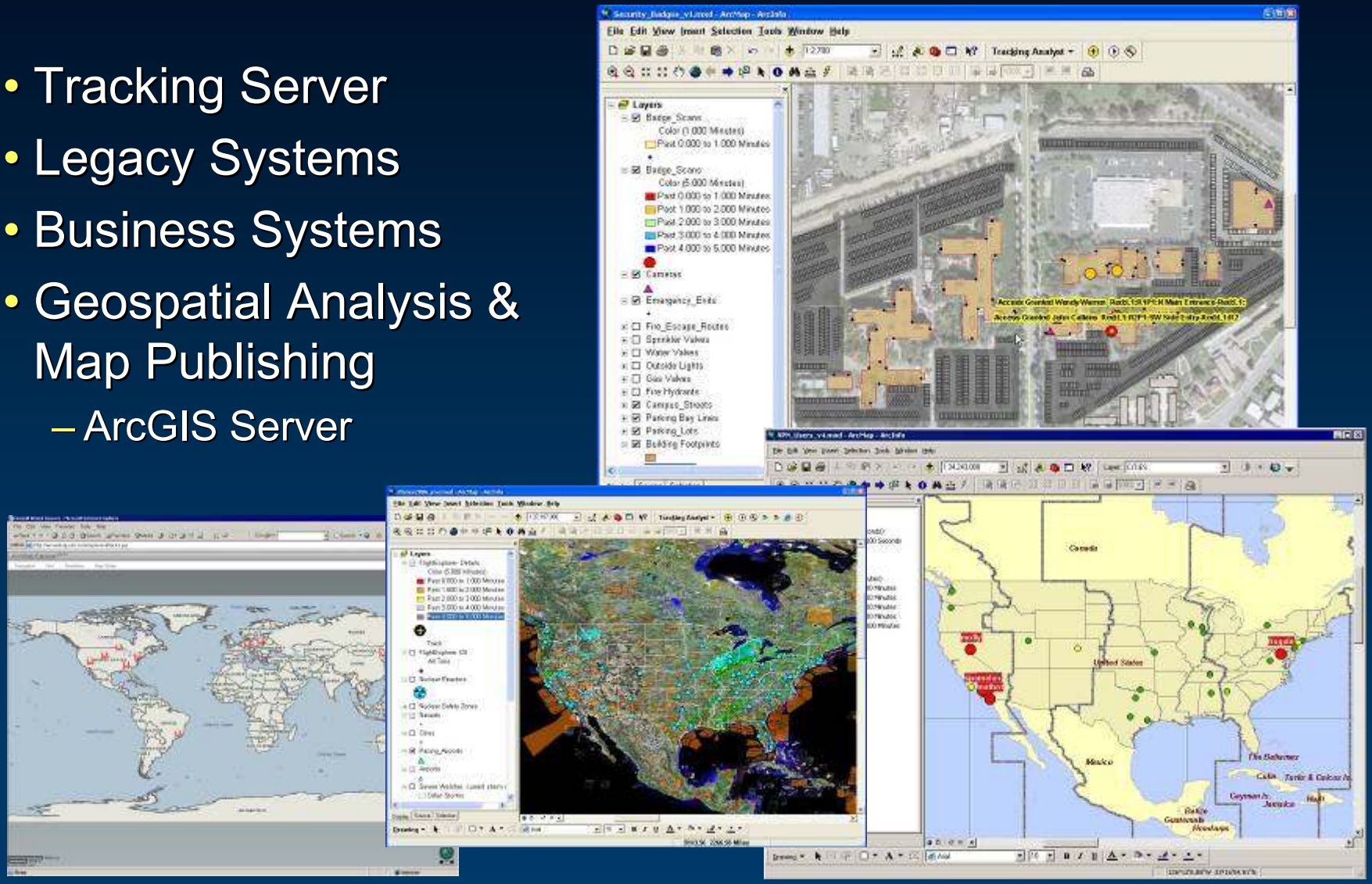


Community Memorial Hospital

Building an ESRI Common Operating Picture

Employee Locator

- Tracking Server
- Legacy Systems
- Business Systems
- Geospatial Analysis & Map Publishing
  - ArcGIS Server



Where To Go From Here?

Session to Attend to Learn More:

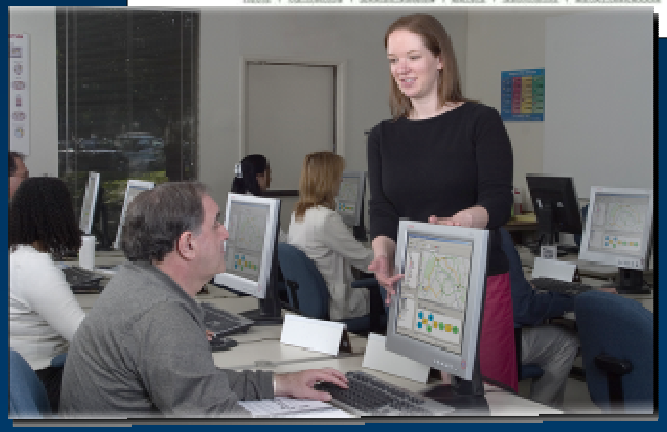
- W2A - Jim Nelson - Building a Campus Model from Scratch
- W4A – Mike Parkin – Inside Out: Performing GIS Analysis on interior spaces
- W4C – Katherine O'Brien – A Campus-Wide Geodatabase: bricks and Mortar of a University's GIS
- TG1 – Panel moderated by Jeannie Rice – Implementing GIS: How Do I Know If I Was Successful?
- T2A – Paul Cote – Integrating BIM and GIS: The Road Ahead
- T4B – Stuart Rich – Developing a GIS Data Model Standard for Interior Spaces
- F2A – Gary Smith – Using SketchUp and ArcGIS to Map and Manage Buildings
- F3A – Birds of a Feather Session - Assessment and Implementation Planning for GIS Systems

ESRI Training and Education

Helping You to Learn

- Instructor-led Training
- ESRI Virtual Campus
  - Online self-paced learning
  - Virtual classroom
  - Live training seminars
- Learning Pathways
- Instructional Series Podcasts
- Training and Education Web Site

NEW



http://training.esri.com

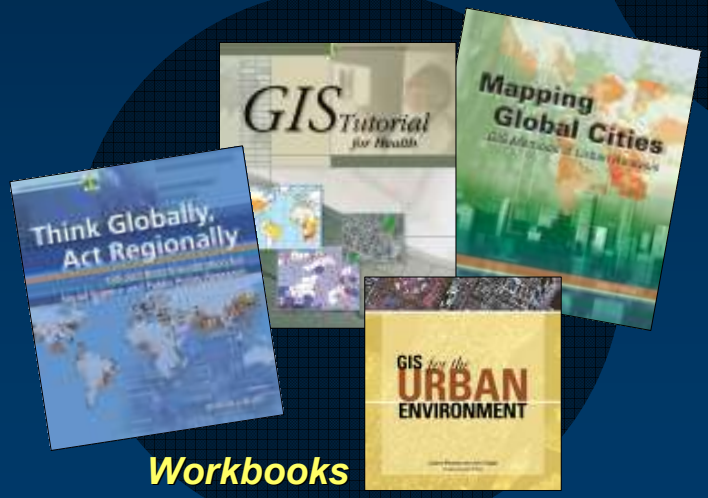
ESRI Press

Leader in Quality GIS Educational Materials

- **68 Titles in print**
- **Worldwide distribution**

History of GIS at Harvard

Real World Case Studies



Workbooks

Teacher Resources


Our World Needs Better Management
Questions?
Thank You
Please Come See Us at Our Booth
. . . More Rational Approach That Considers & Integrates All the Factors . . .
. . . A Geographic Science Approach