GIS at JLAB

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Jefferson Lab has a Large and Complex Infrastructure

- **CEBAF (*24/7 electron utility*)**
  - **7 km of beamline**
  - **2000+ magnets & power supplies**
  - **338 5kW klystrons**
  - **42 Cryomodules each with 8 RF cavities**
  - **400,000L Low Conductivity Water system**
  - **A 2K helium refrigeration plant**
  - **65,000 I/O Control Points**
  - **250,000 EPICS records, 140 IOCs, 80 Unix hosts**

So does Salt Lake City, Utah…

- **Water Utility District**
  - 29 pump stations with 104 pumps
  - 1,400 miles of pipeline
  - 15,000 valves
  - 8500 Hydrants
  - 48,000 wastewater connections
  - 181,000 customers

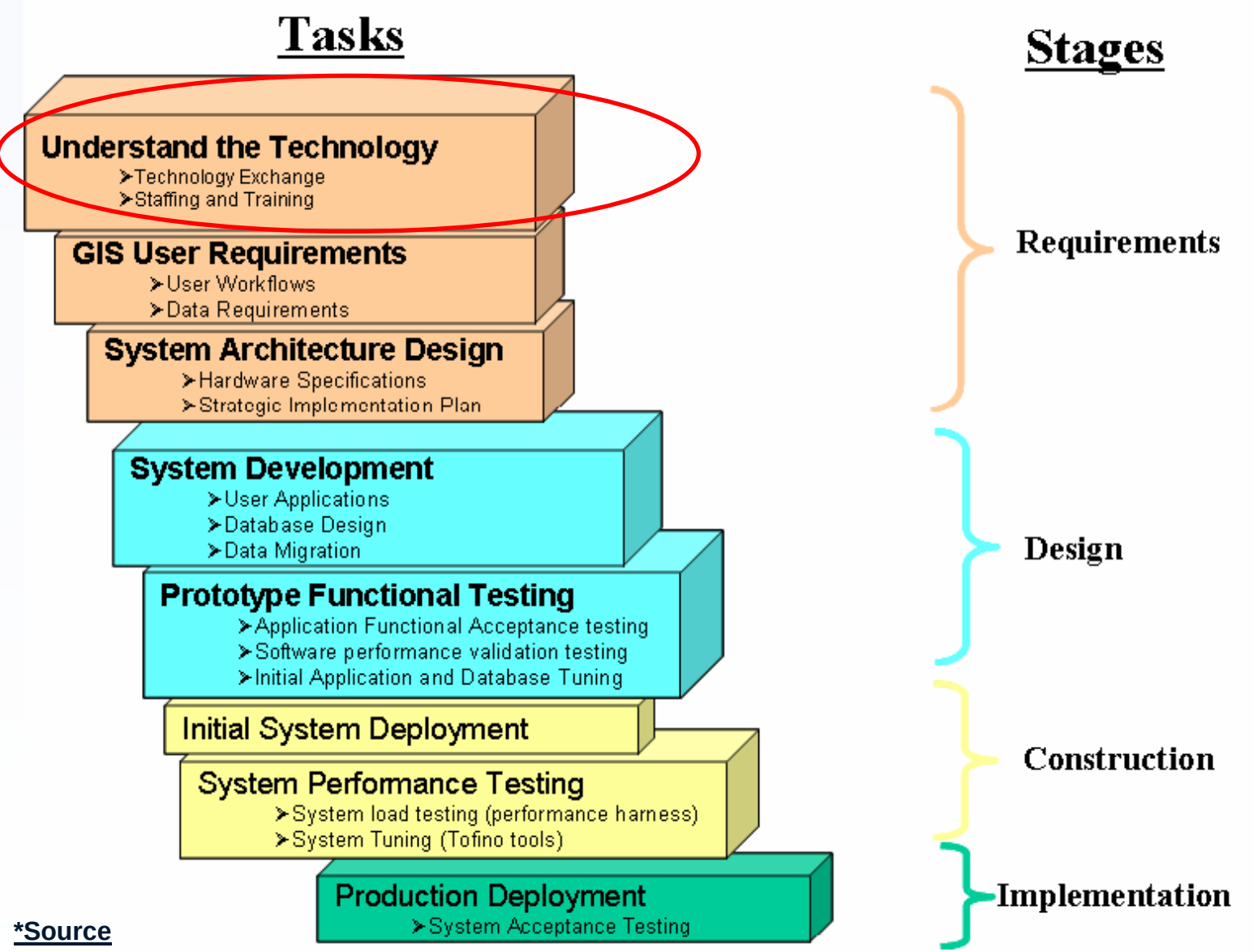
Or Sacramento, California…

- **Municipal Electrical Utility District**
  - 900 square miles service area
  - 553,337 customers
  - 10 Transmission bulk substations
  - 500 circuit miles of Transmission lines
  - 9,885 circuit miles of Distribution lines

The Premise

Most Utility Companies use Geographic Information Systems (GIS) to operate and manage their large and complex infrastructure networks.

According to American Waterworks Association 90% of water agencies now use GIS at least partially in their daily operation



***Source**

D. Peters. *System Design Strategies*.
Environmental Systems Research Institute, Inc.

What is GIS?

A GIS is a computer system capable of capturing, storing, analyzing, and displaying geographically referenced information; that is, data identified according to location. Practitioners also define a GIS as including the procedures, operating personnel, and spatial data that go into the system.

***Source**

USGS Geographic Information Systems Poster

http://erg.usgs.gov/isb/pubs/gis_poster/

GIS Software (ArcGIS)

- **Data Management Tools**
  - **(Geo)Database**
  - **Data Files (CAD, Raster, XLS, etc.)**
- **UI Tools**
  - **View/Query**
  - **Add/Edit data**
- **Extras**
  - **SDK**
  - **Tracking Server/Analyst**
  - **Schematics**

Commercial GIS vendors

ESRI	Intergraph	AutoDesk	MapInfo
34%	13%	7%	6%
Government, Utilities, Earth Science	Government, Transport, Utilities	Drafting, Architecture	Business

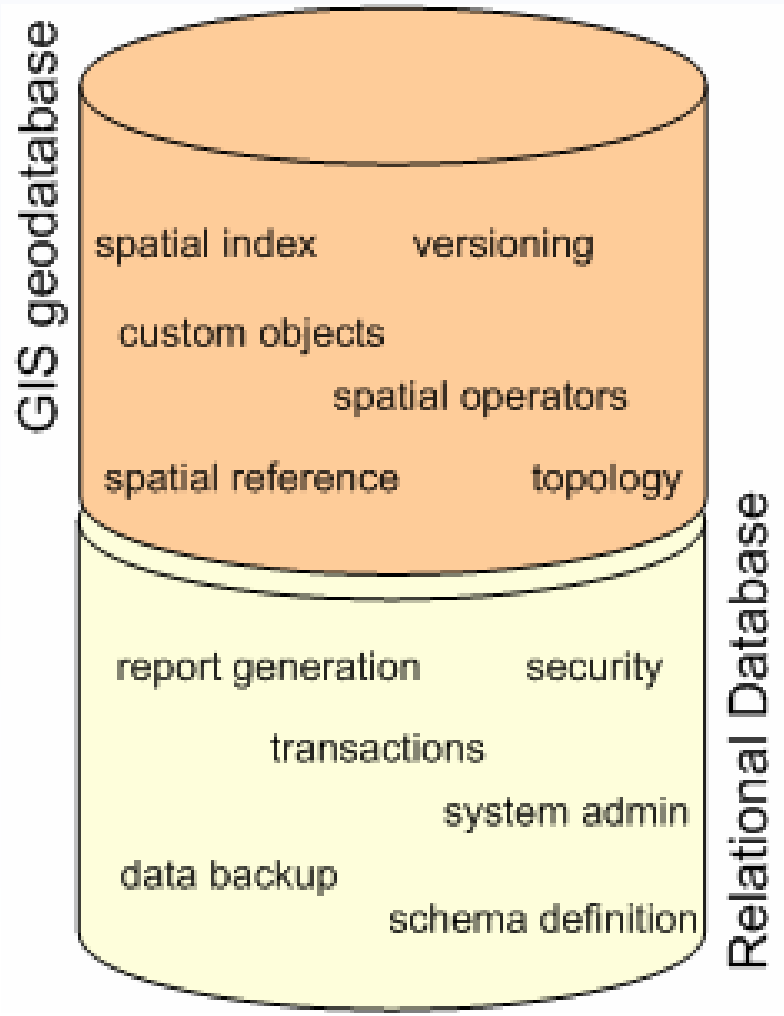
***Source**

GISmonitor, November 7, 2002,
http://www.gismonitor.com/articles/comment/110702_Daratech.php

Open Source

GRASS	MapServer
U.S. Army Corp of Engineers, now Sourceforge.	University of Minnesota.
CLI w/Some TK GUI	Environment for building spatially-enabled internet applications.
Good support for PostgreSQL. Oracle still a work in progress	Excels at rendering spatial data (maps, images, and vector) for the web.

Geodatabase Extends RDBMS

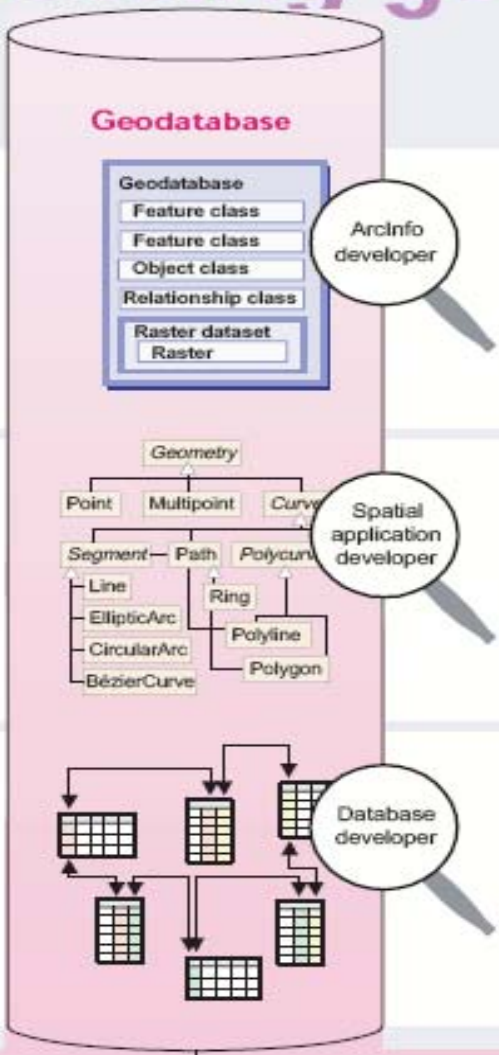


***Source**

M. Zeiler, “Modeling our World”

ESRI Press, Redlands, CA 1999

Accessing geodatabases



Via ArcObjects (Microsoft COM)

- Available in the Unix SDK via MainWin

As Simple Features (ArcSDE)

- Java & C APIs

Via SQL

- Provided by RDBMS vendor

***Source**

M. Zeiler, "Modeling our World." 199pp., Environmental Systems Research Institute, Redlands, CA, 1999.

Geodatabase Versioning

- **Conceptually similar to CVS**
  - **Version is named state of geodatabase**
  - **Multiple versions can coexist**
  - **A user can connect to any version**
  - **Differences between versions can be merged/reconciled**

Versioning Benefits

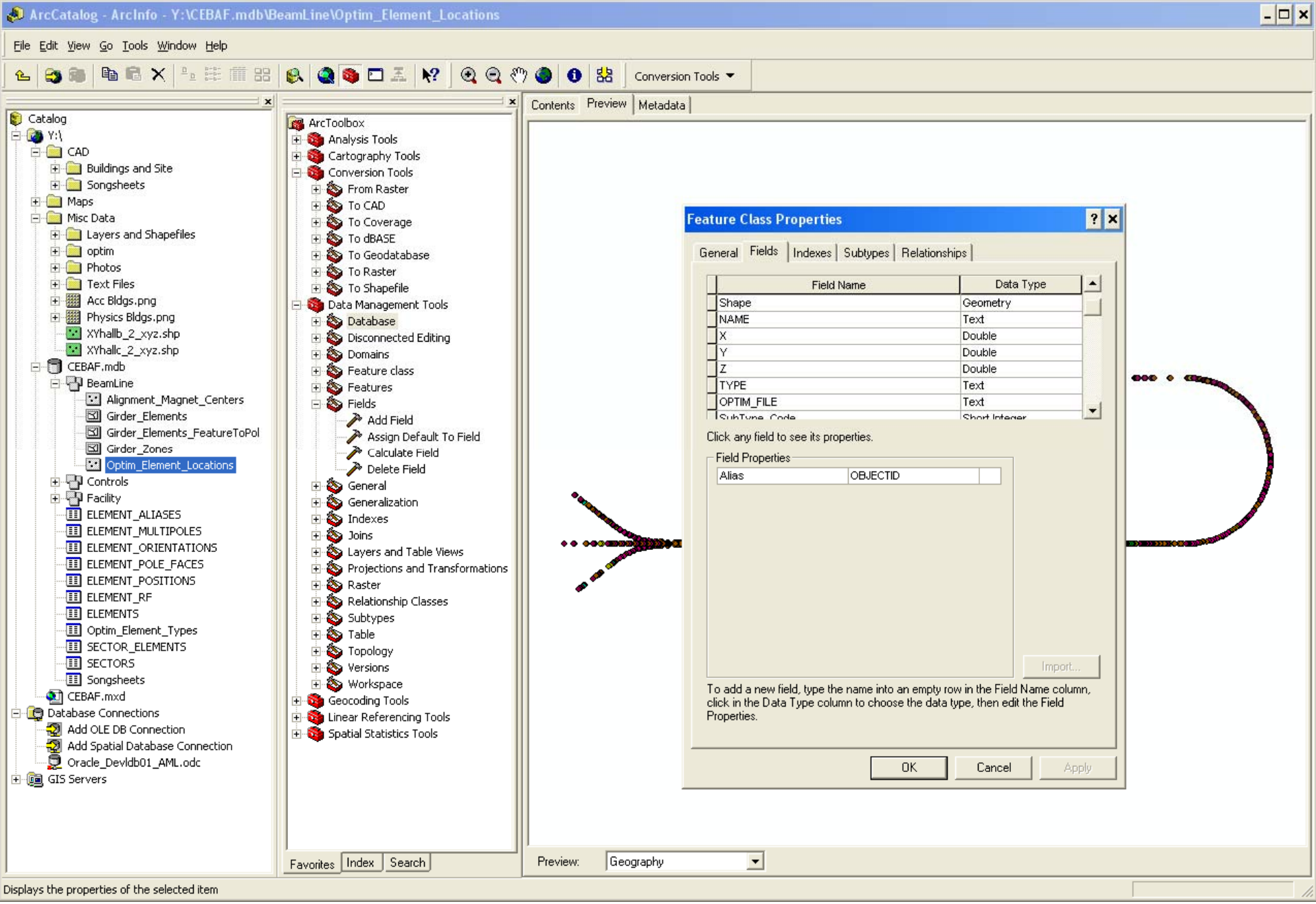
- Create named versions at useful save points such as completion of an experiment, or prior to or following a maintenance period.
- Tables containing CAD-derived objects, software configuration, Optics all versioned consistently.

Spatial Indexes & Operators

- **Allow efficient queries based on geometric relationships such as proximity, adjacency, and overlay.**
- **Select Objects that:**
  - **intersect**
  - **are within a distance of**
  - **contain**
  - **are contained by**
  - **share a line Segment with**
  - **crossed by outline of**
  - **have their center in**

User Interfaces

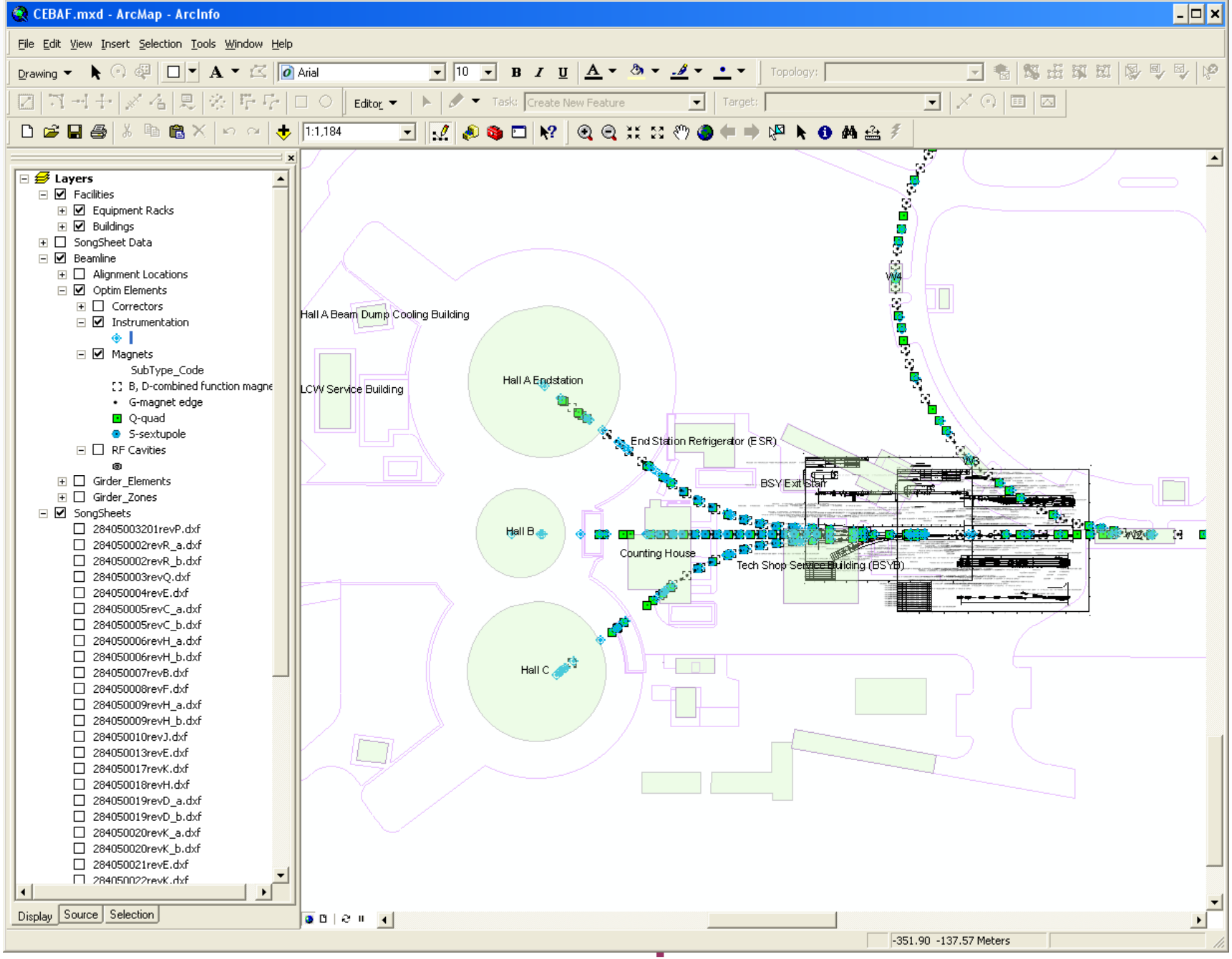
- **Data Source Management (ArcCatalog)**
  - Usable by non-programmers
  - Wizard-like toolboxes Import/Export/Convert etc.
- **Graphical Display (ArcMap)**
  - View/Display Data Layers
  - Search/Query Data
  - Add/Edit Data



Data Management

Jefferson Lab

Controls Group


CEBAF.mxd - ArcMap - ArcInfo
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Arial
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Topology:
Editor
Task: Create New Feature
Target:
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Layers
Facilities
Equipment Racks
Buildings
SongSheet Data
Beamline
Alignment Locations
Optim Elements
Correctors
Instrumentation
Magnets
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B, D-combined function magne
G-magnet edge
Q-quad
S-sextupole
RF Cavities
Girder_Elements
Girder_Zones
SongSheets
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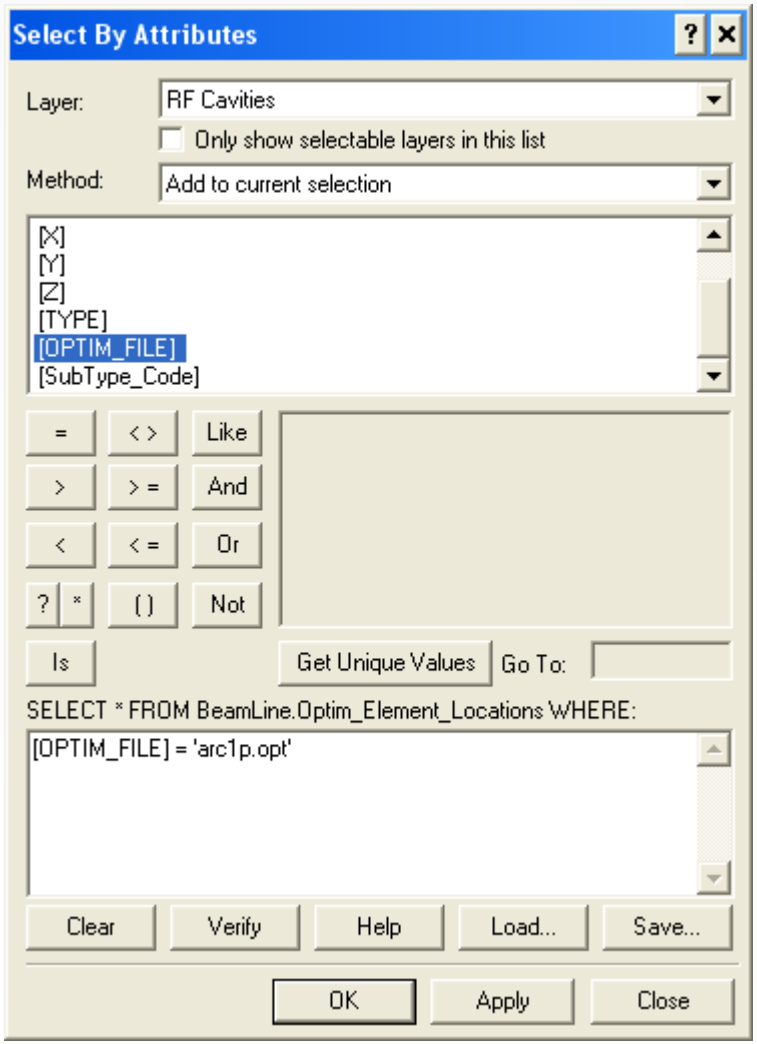
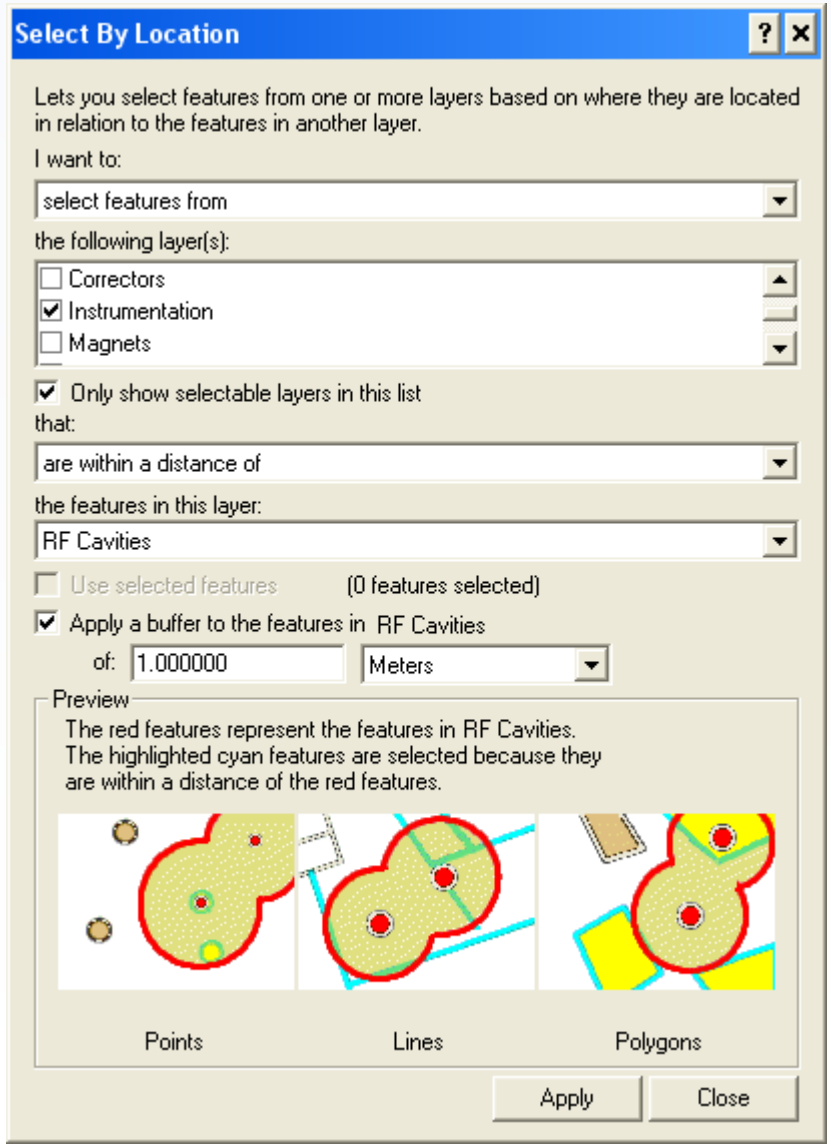
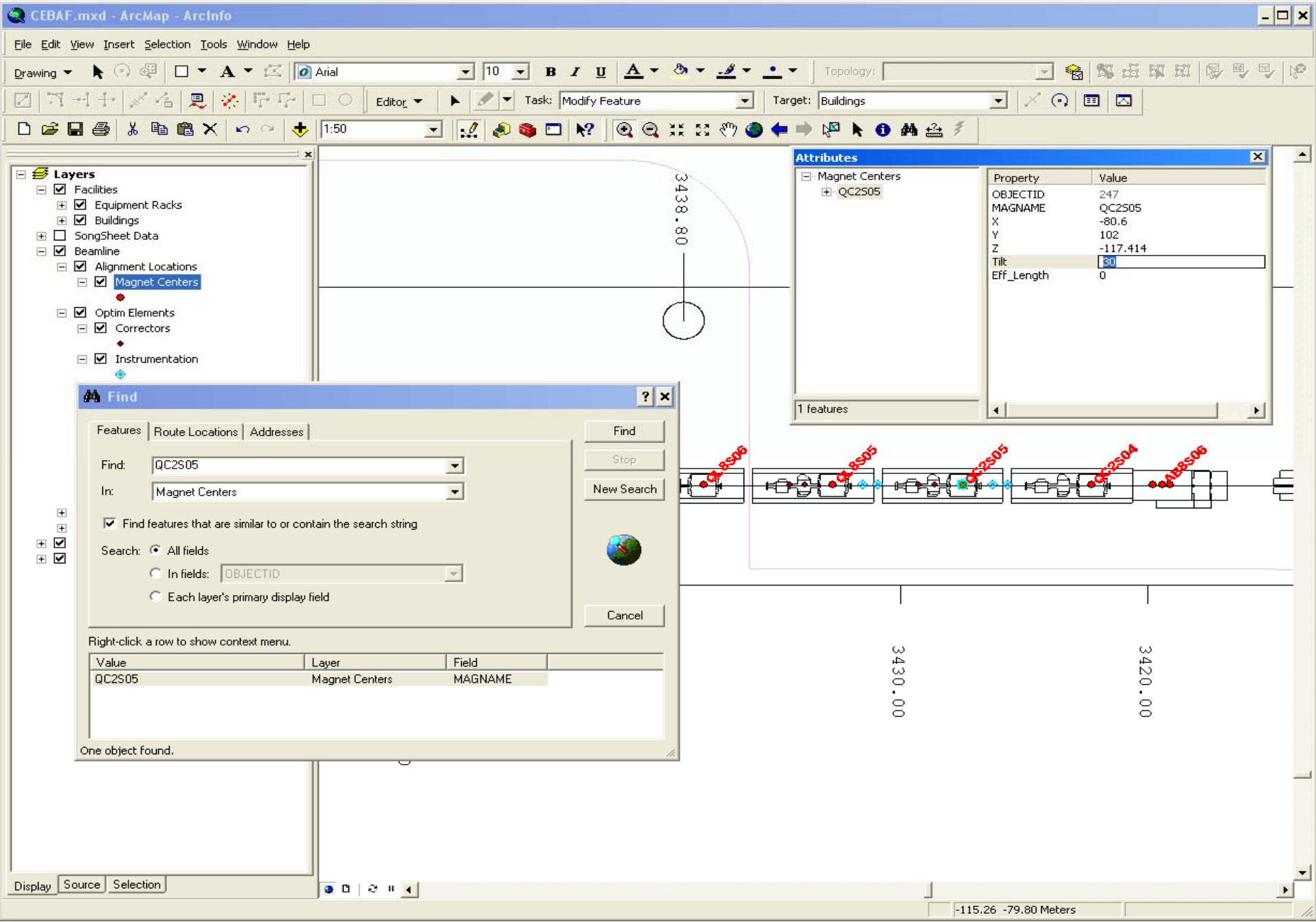
284050017revK.dxf
284050018revH.dxf
284050019revD_a.dxf
284050019revD_b.dxf
284050020revK_a.dxf
284050020revK_b.dxf
284050021revE.dxf
Display
Source
Selection
Hall A Beam Dump Cooling Building
LCW Service Building
Hall A Endstation
End Station Refrigerator (ESR)
BSY Exit Stair
Hall B
Counting House
Tech Shop Service Building (BSYB)
Hall C
-351.90 -137.57 Meters

Attribute or Spatial Query





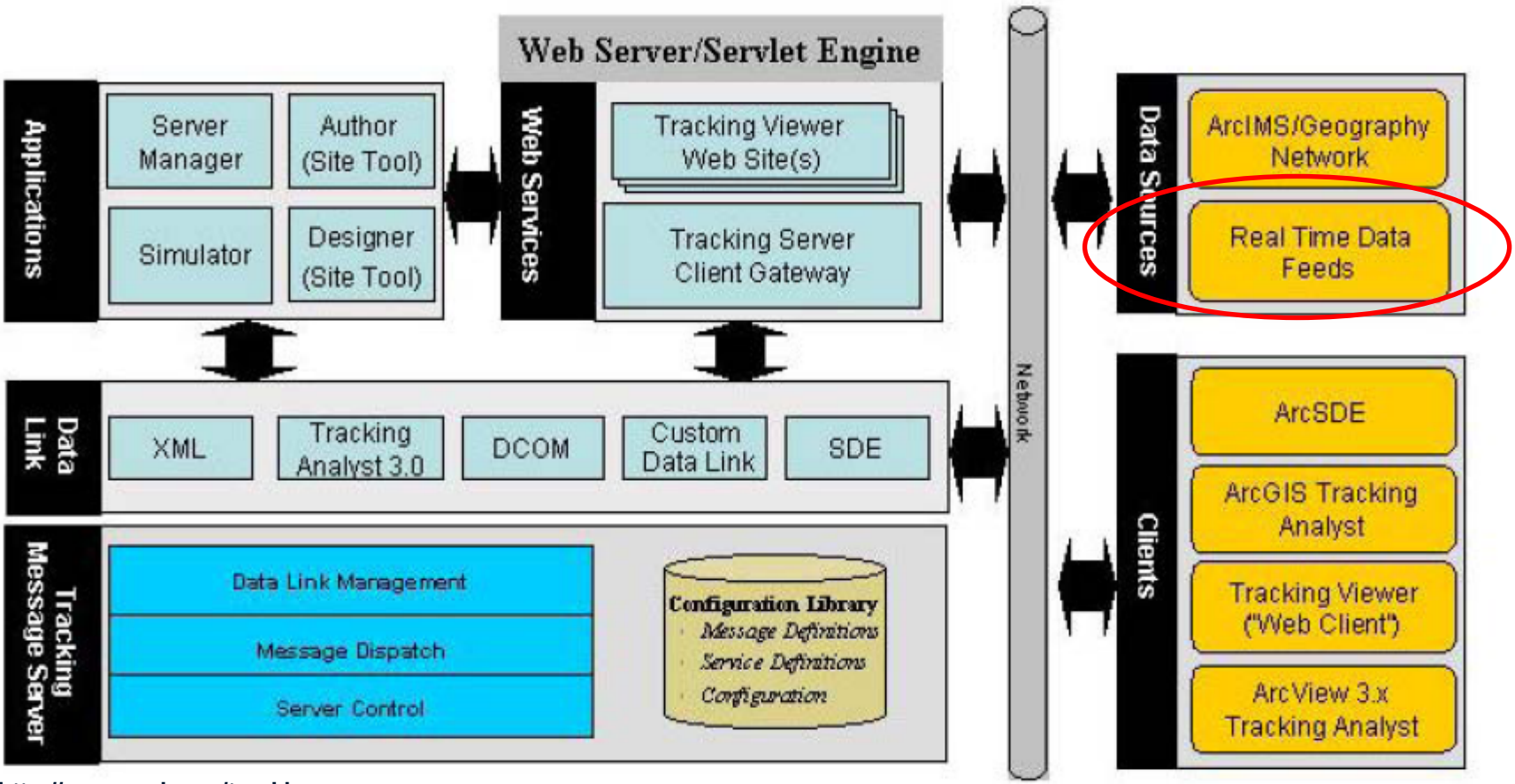
Data Editing w/ArcMap



Tracking Server

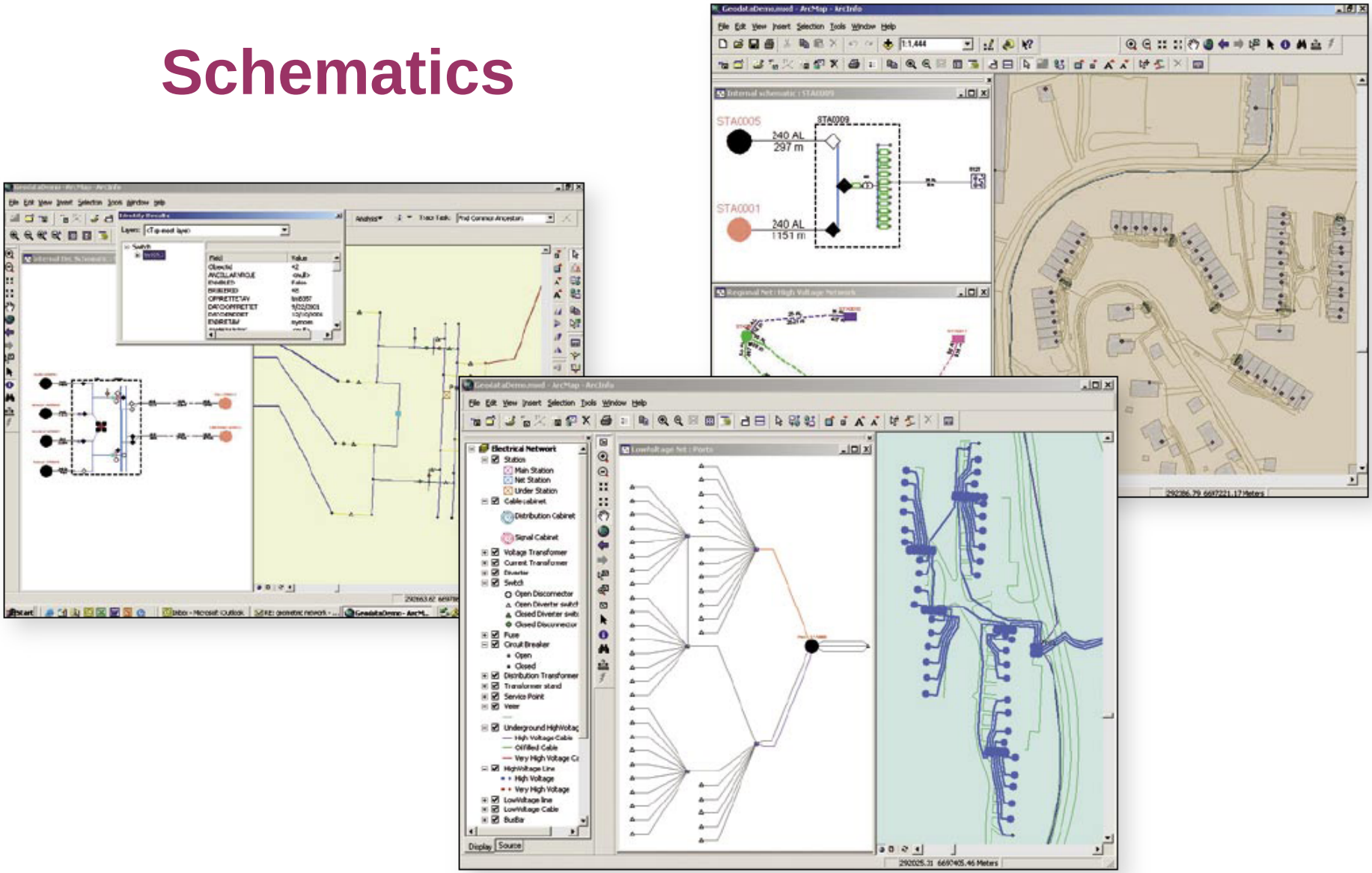
Architecture

Tracking Server uses an extensible architecture that allows it to receive data from new sources and to transmit that data to new clients such as a custom-built ArcObjects™ client.

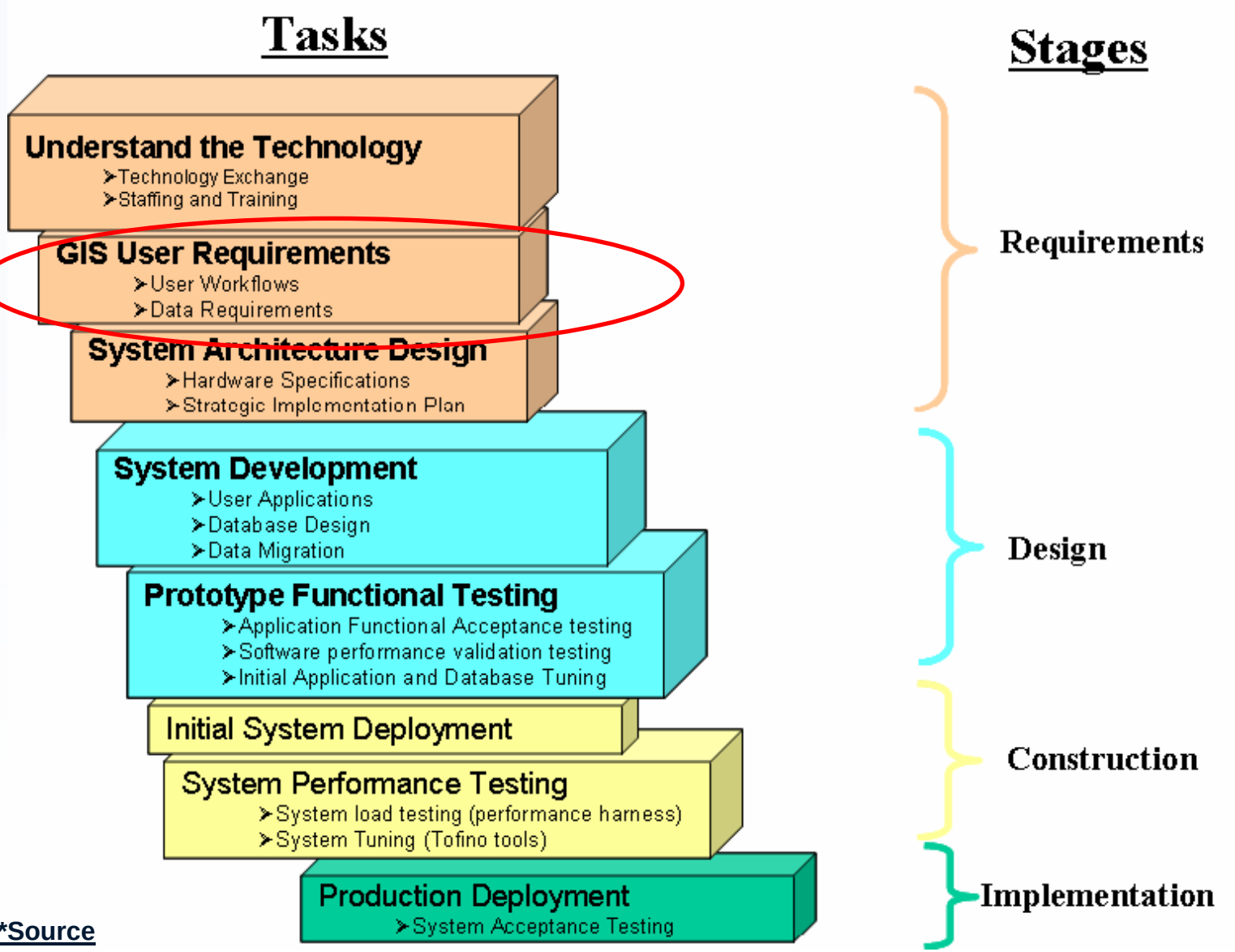


http://www.esri.com/trackingserver

Schematics



http://www.esri.com/schematics



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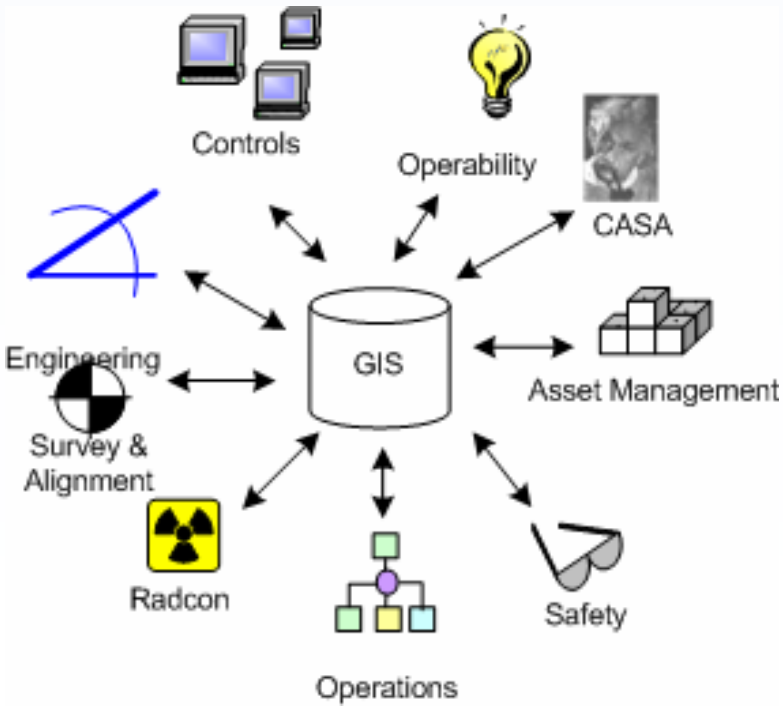
Potential Uses/Stakeholders

- Inventory (iocs, camac crates, power supplies, etc.)
- Configuring online model server
- Hazardous materials tracking
- Radcon tracking/mapping
- Environmental Regulatory Compliance
- Fault analysis
- Spatial selection & display of PVs and alarms



Control system questions for a GIS to answer

- Where does the other end of this cable terminate?
- What components are inline with this non-functioning device?
- When was hardware added, changed, or removed…?
- Which module type in this system has the worst reliability history?
- How many devices of a particular model number are installed?
- Where are all the devices of a particular model number installed?
- What application software will be affected if this device is removed?
- What equipment will be affected when this breaker is locked-out?

Data Requirements – Spatial

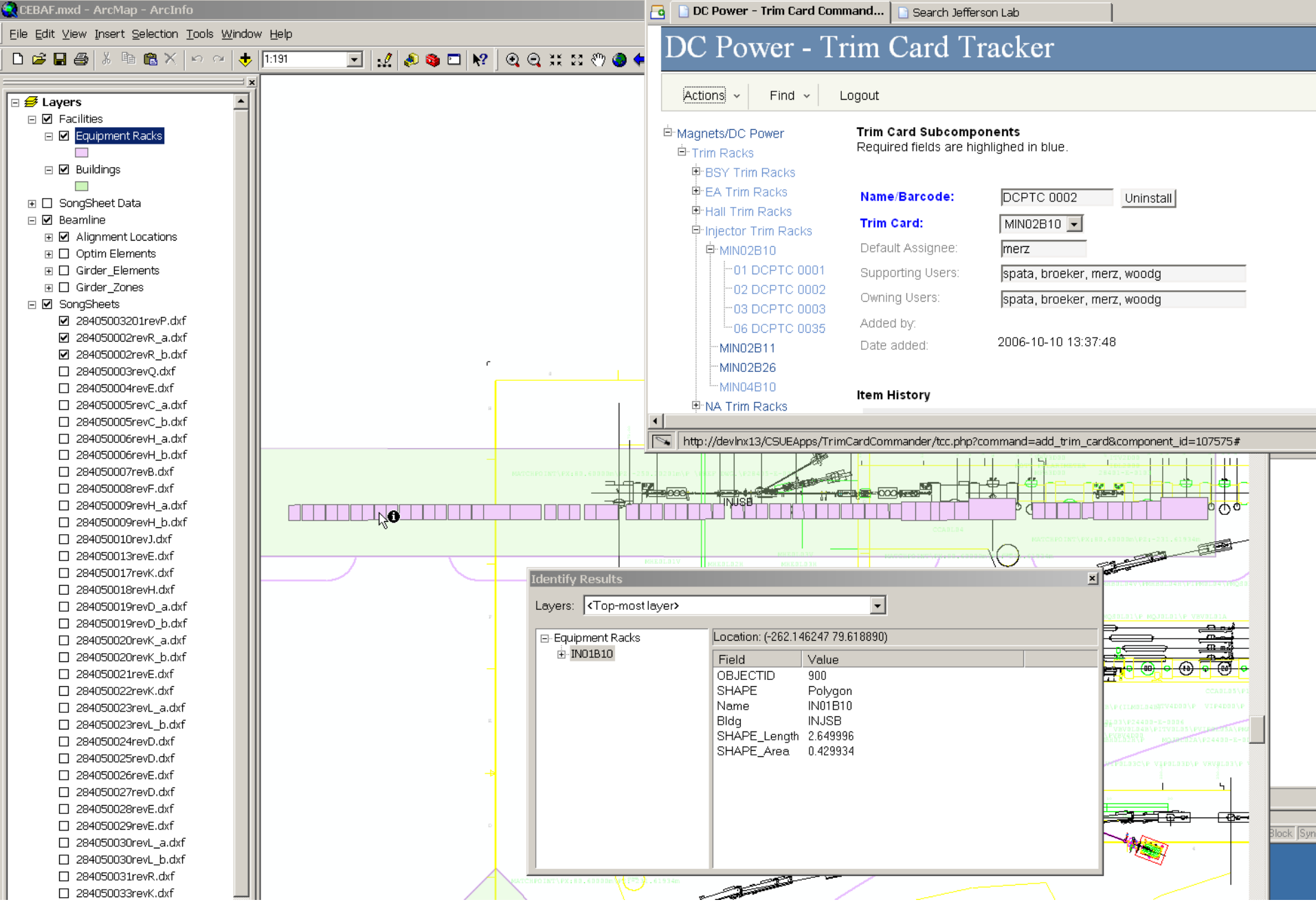
- Buildings
- Rooms
- Racks
- Breaker boxes
- Power supplies
- Cable-runs
- Beamline elements

Data Requirements - Attributes

- Name, Serial Number
- Hardware Model, Type
- Associated PV names, software applications, device support modules, etc.
- Power, Network, Other connections
- Subcomponent relationships

Data Gathering Challenges

- Sheer volume/scale is daunting.
- Much hardware never before barcoded/tracked.
- Much spatial information not in electronic format (hand-drafted service building floorplans ca. 1987-1990).
- More difficult than anticipated to parse CAD files when we do have them.
- Different system owners currently hold subsets of data .
- Overlapping data sets require manual reconciliation.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Layers
Facilities
Equipment Racks
Buildings
SongSheet Data
Beamline
Alignment Locations
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284050031revR.dxf
284050033revK.dxf
DC Power - Trim Card Command...
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DC Power - Trim Card Tracker
Actions
Find
Logout
Magnets/DC Power
Trim Racks
BSY Trim Racks
EA Trim Racks
Hall Trim Racks
Injector Trim Racks
MIN02B10
01 DCPTC 0001
02 DCPTC 0002
03 DCPTC 0003
06 DCPTC 0035
MIN02B11
MIN02B26
MIN04B10
NA Trim Racks
Trim Card Subcomponents
Required fields are highlighted in blue.
Name/Barcode:
DCPTC 0002
Uninstall
Trim Card:
MIN02B10
Default Assignee:
merz
Supporting Users:
spata, broeker, merz, woodg
Owning Users:
spata, broeker, merz, woodg
Added by:
Date added:
2006-10-10 13:37:48
Item History
http://devlnx13/CSUEApps/TrimCardCommander/tcc.php?command=add_trim_card&component_id=107575#
INJSB
Identify Results
Layers:
<Top-most layer>
Equipment Racks
IN01B10
Location: (-262.146247 79.618890)
Field
Value
OBJECTID
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Polygon
Name
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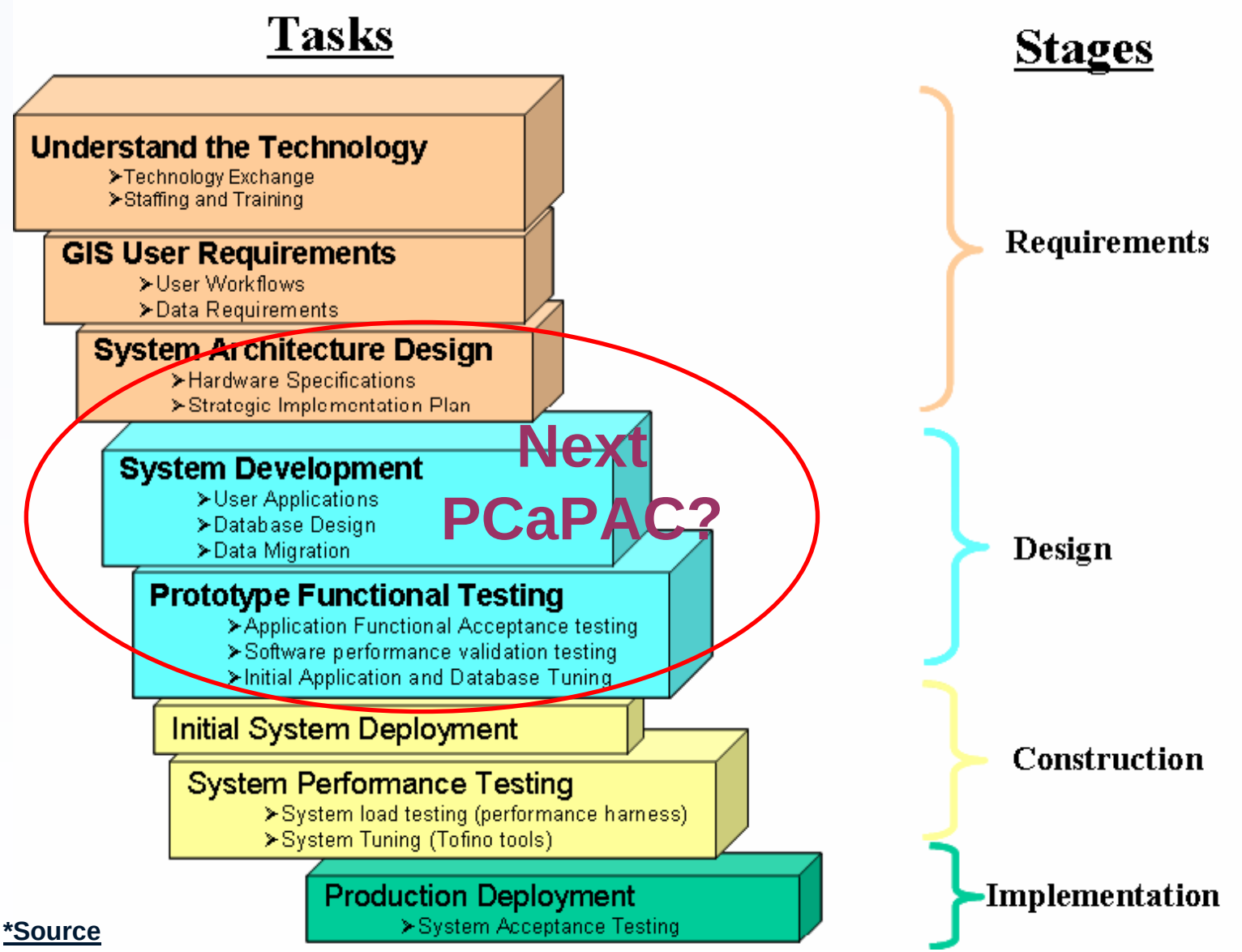

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“The application of GIS is limited only by the imagination of those who use it”.

Jack Dangermond, founder of ESRI