Network Visualization

Presented by

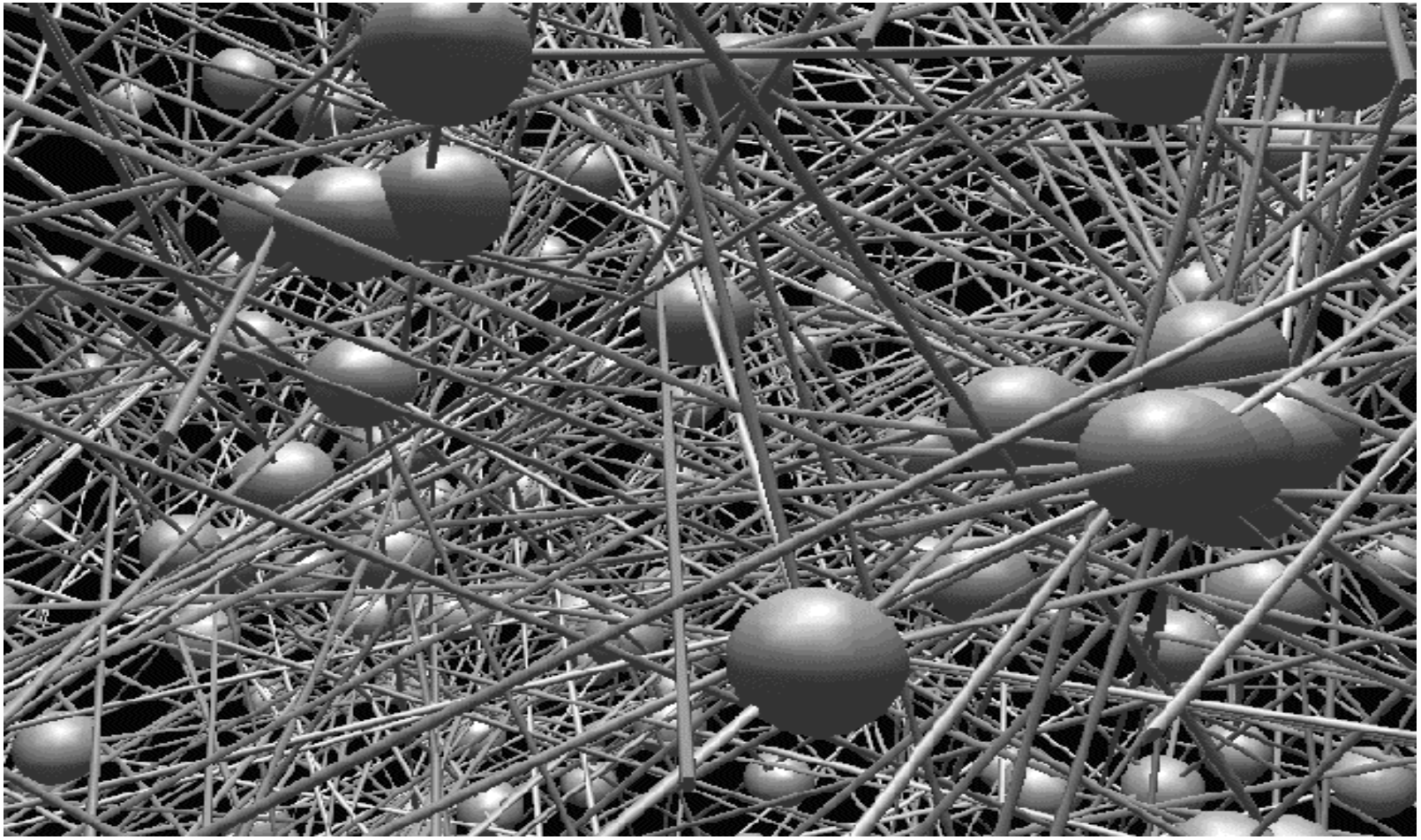
Shahed

Introduction

Introduction

- Basic building blocks
  - Node
  - Links (relationship between nodes)
  - Spatial information
  - Network data

Introduction



http://zeeb.library.cmu.edu:7850/JoSS/article.html

Paper List

- **Visualizing Network Data**
  - Richard A. Becker, Stephen G. Eick, Allan R. Wilks.
- **3D Geographic Network Displays**
  - Kenneth C. Cox, Stephen G. Eick, Taosong He.
- **CyberNet: A framework for managing networks using 3D metaphoric worlds**
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Goal

- **Visualize the data associated with a network**
  - Understand data, not network themselves
- **Coping with large data volumes**
  - Hundreds of nodes
  - Thousands of links
  - Data from time periods
- **Overcome the map clutter problem**

Traditional Approach

- To reduce cluttering of data (traditional)
  - *Aggregation*: for large numbers of links or nodes
  - *Averaging*: for large numbers of time periods
  - *Thresholding*: for detecting changes

Solution

- **SeeNet**
  - ***Static Displays***
    - Link Map
    - Node Map
    - Matrix
  - ***Interactive Controls***
    - Parameter focusing
    - Data filtering
  - ***Animation***
    - Smooth zoom

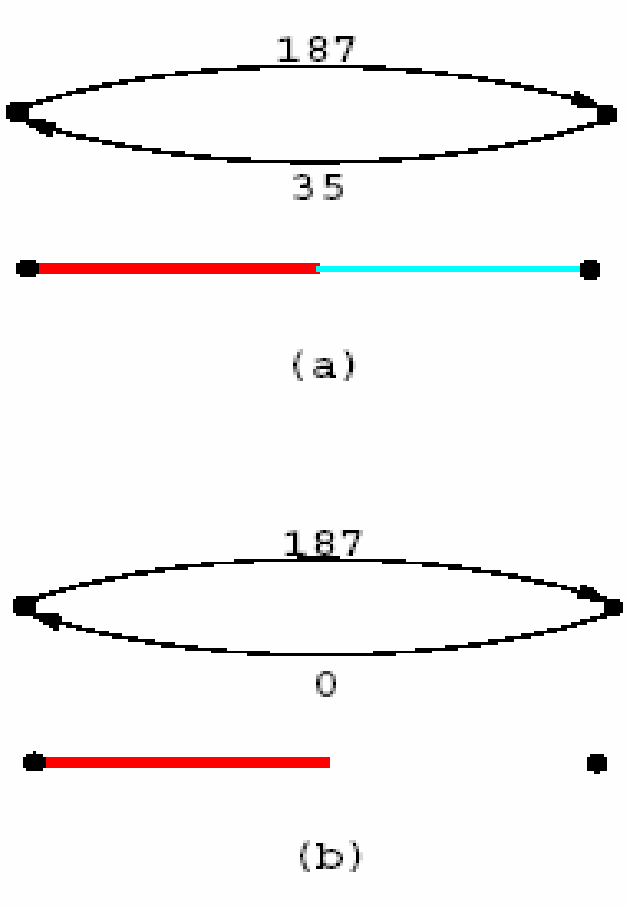
Dataset

- Telecommunication traffic
- 110 switches in the AT&T network
- 12,000 links
- Oct. 17, 1989, (San Francisco earthquake)
- **FOCUS:**
  - Traffic flow between switches (nodes)

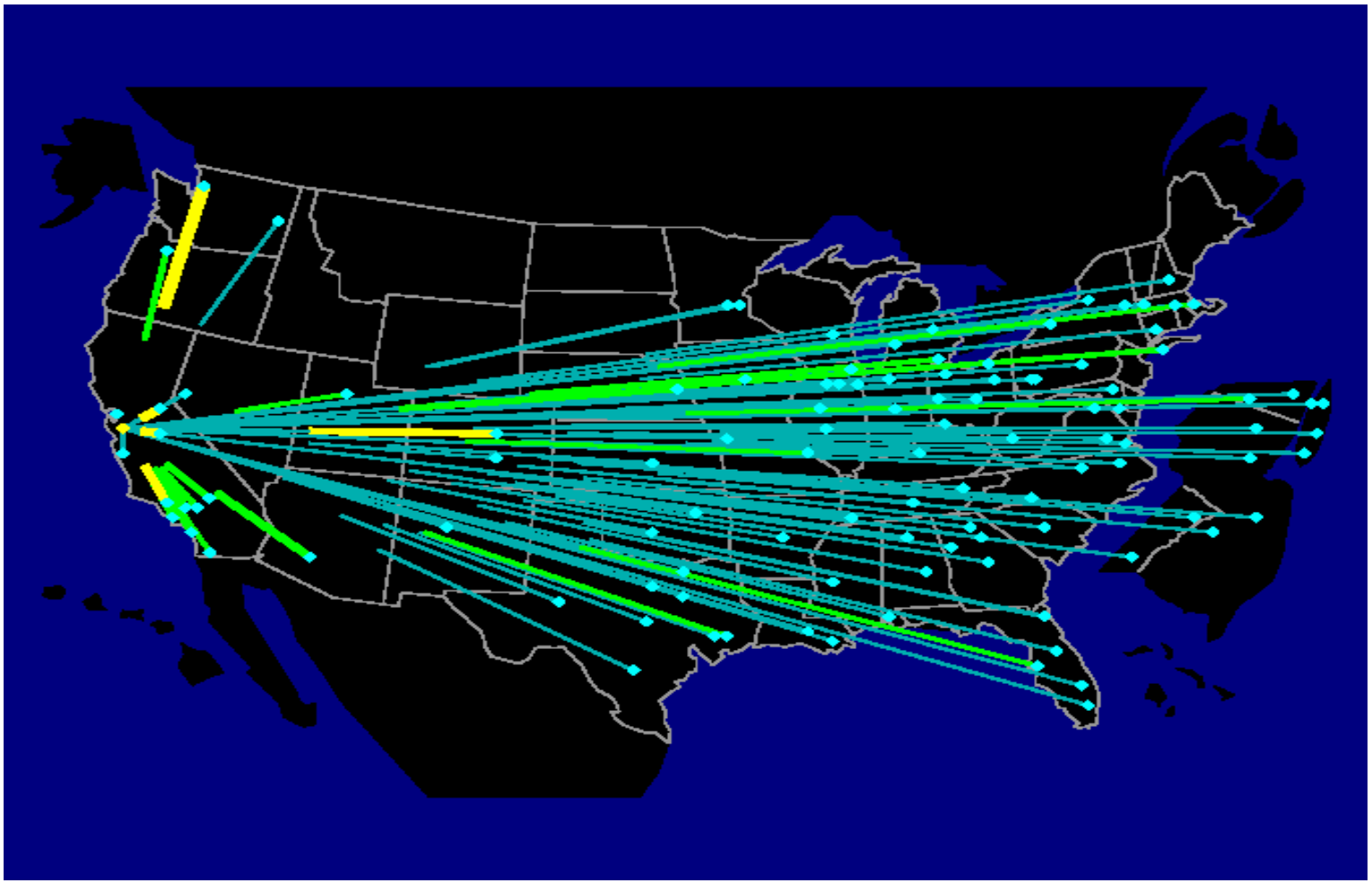
Static Displays

Static Displays (1/3)

- LINK MAP
  - Draw lines connecting nodes
  - Show values using colors or thickness of line

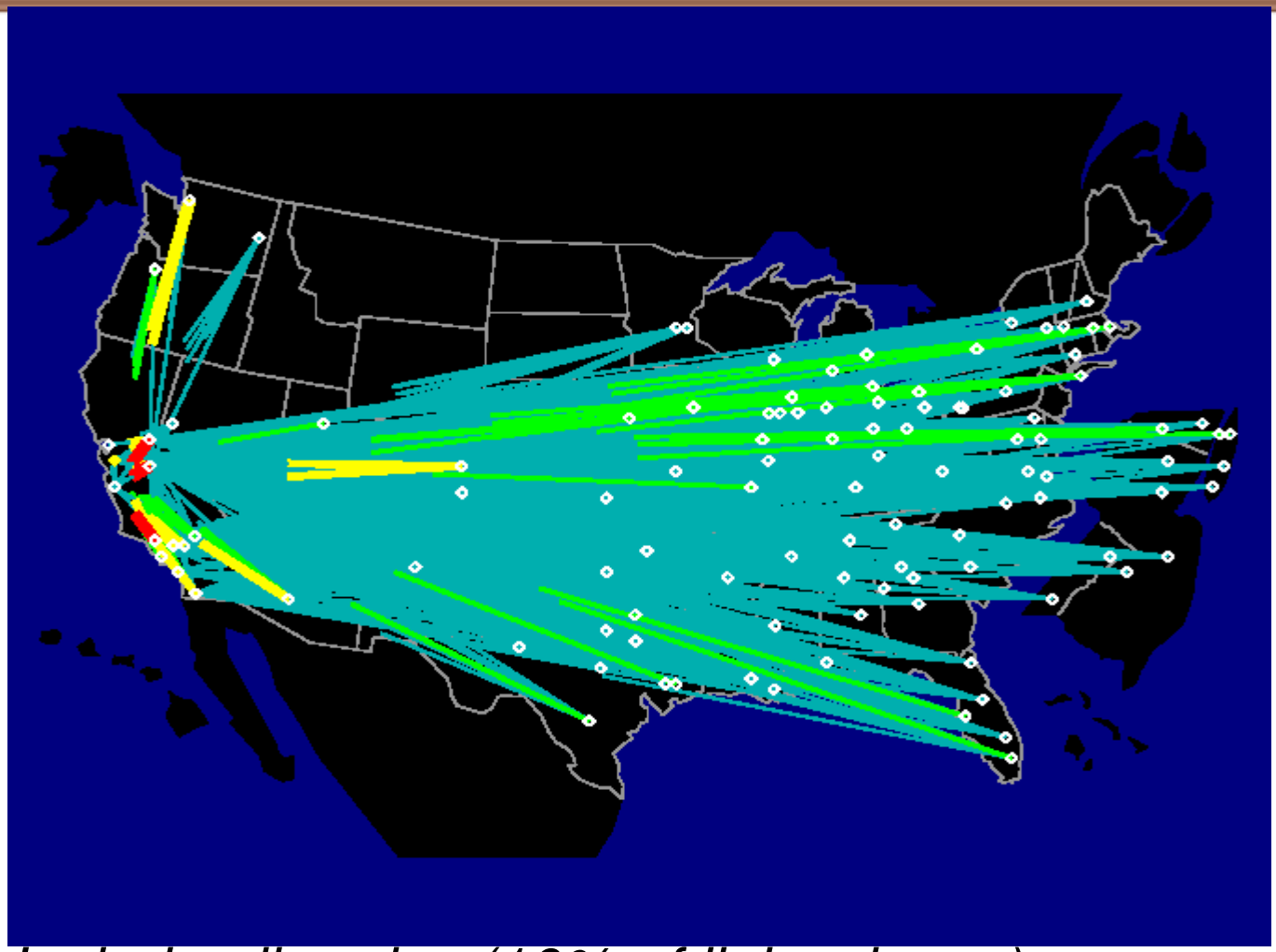


Static Displays (LinkMap)



Focus on one Node (Oakland)

Static Displays (LinkMap)



Include all nodes (10% of links shown)

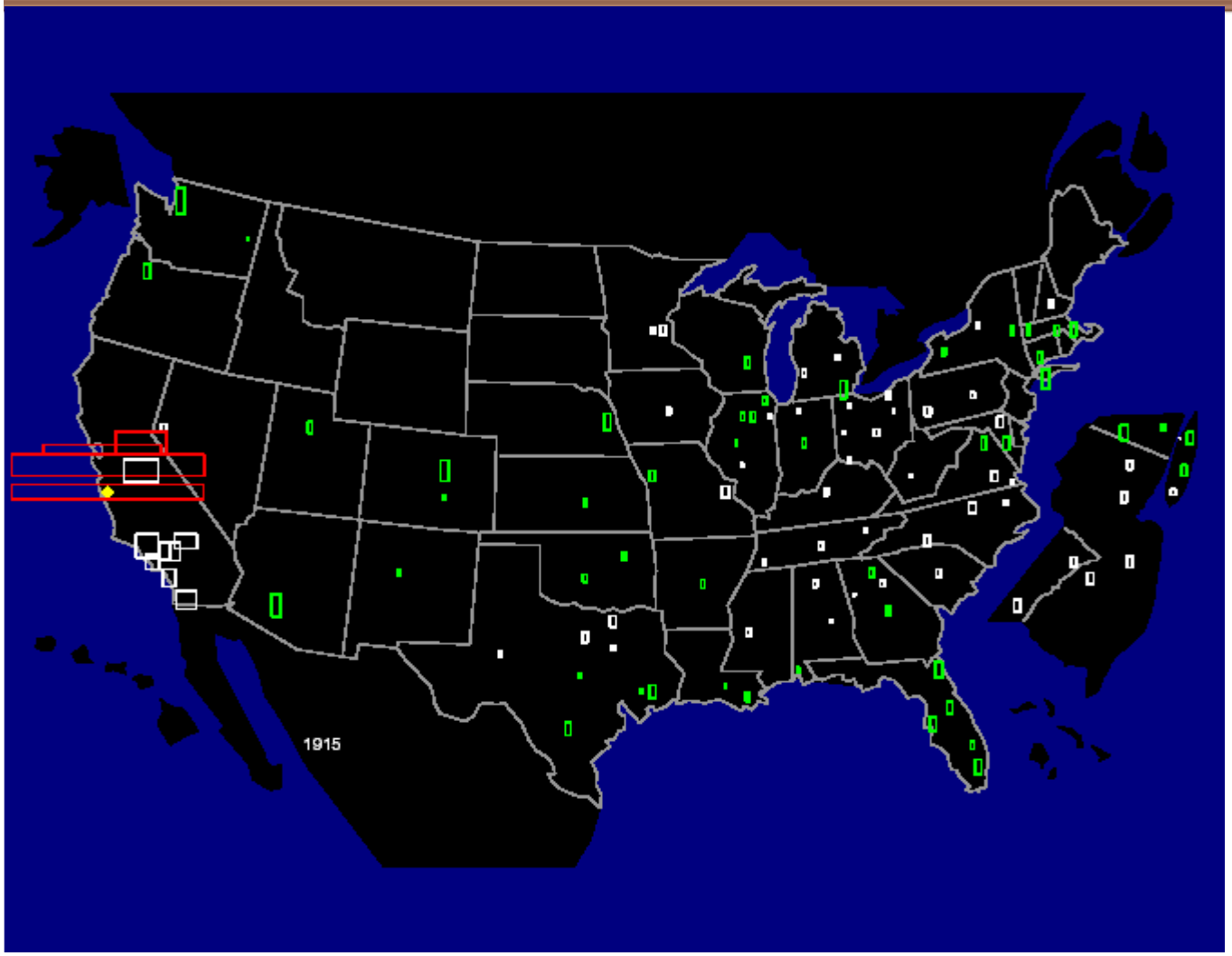
Disadvantage

- Disadvantage of Link Map
  - Too many links cause map cluttering
  - Use Node Maps !!!

Static Displays (2/3)

- NODE MAP
  - Aggregation of information at each node
  - Use Glyphs
    - Vary *Size, shape, color* for statistics

Static Displays (NodeMap)



1) Tall & Thin: Outbound overload (green)

2) Short & Fat: Inbound Overload (red)

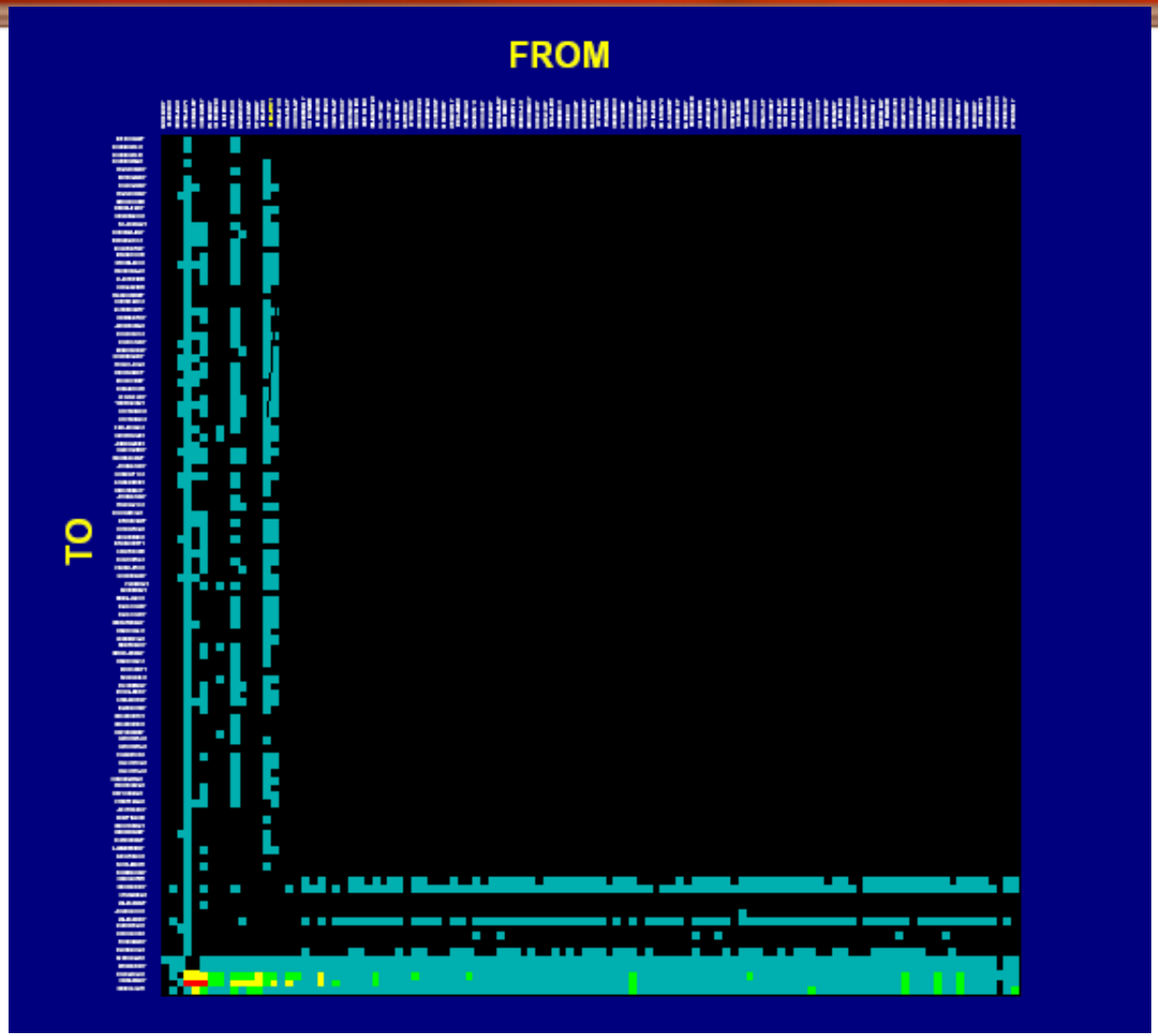
3) Square: Equal load (white)

Disadvantage

- Disadvantage of Node Maps
  - Detailed Information about particular links lost
  - Solution:
    - Do away with geography
    - Try **Matrix display**

http://funwavs.com/movie/pictures/the-matrix/

Matrix Display



Static Displays (3/3)

- MATRIX
  - Concentrates on links of a network (like Linkmap)
  - Color of square designates traffic
  - Does not have problems of geographic displays:
    - Visual prominence of long lines
    - Long lines (transcontinental) over plots others

Disadvantage

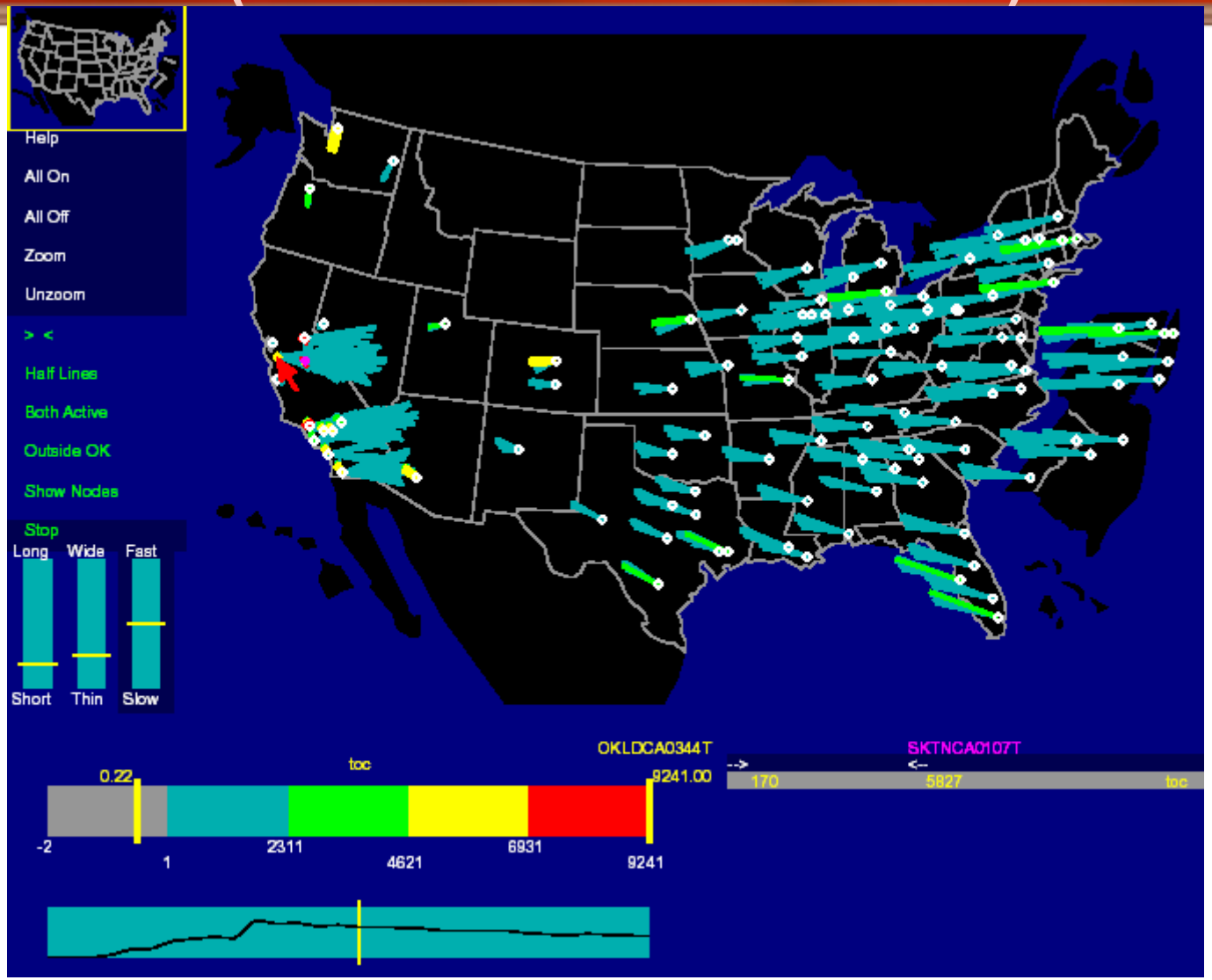
- Disadvantage of Matrix Display
  - Information about geography lost
    - Tries to fix problem with nodes ordered from west coast to east coast along axis

Parameter Focusing

Parameter Focusing

- Parameters determine network display
- Parameter values (range) control what is displayed
  - Example:
  - Glyph size in node maps
  - Coloring of nodes & links
- Dynamic parameter adjustments helpful

Parameter Focusing Example (Shortened Links)



Parameter classes

- Statistics
- Levels
- Geography / topology
- Time
- Aggregation
- Size
- Color

Issues with parameter focusing

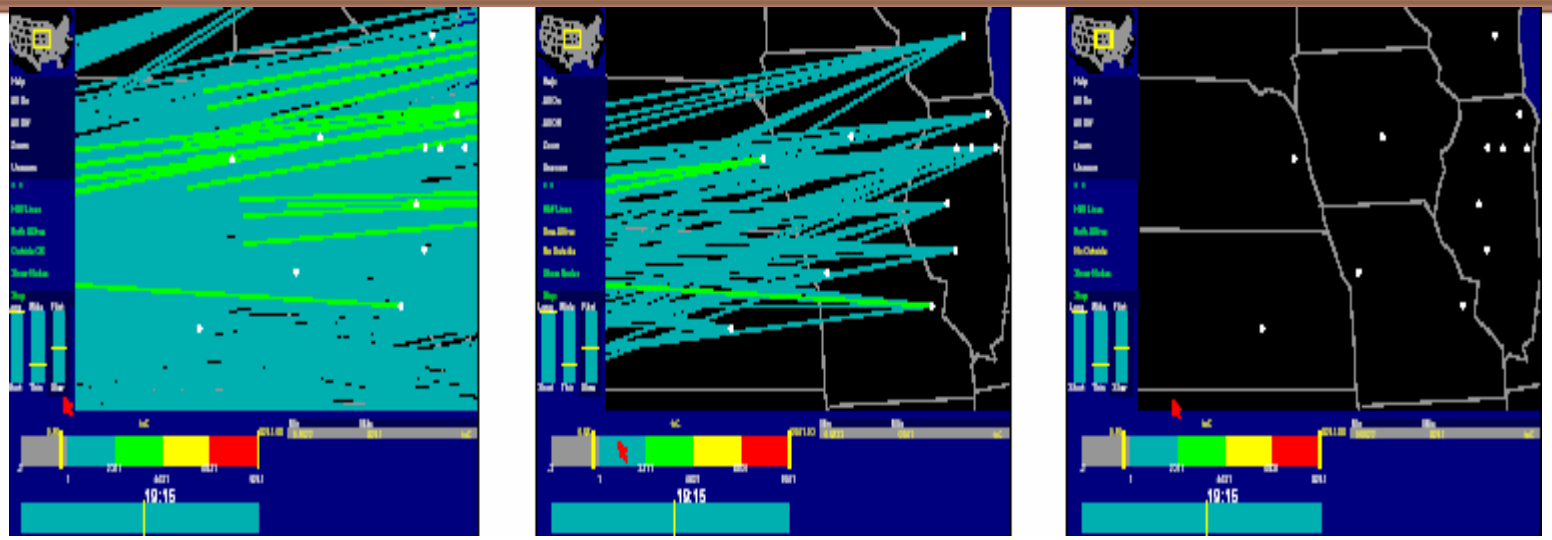
- Space of parameters large
- Combination of parameters to chose
- Displays sensitive to particular parameter values

- SOLUTION
  - Allow Direct manipulation of parameters

Direct Manipulation

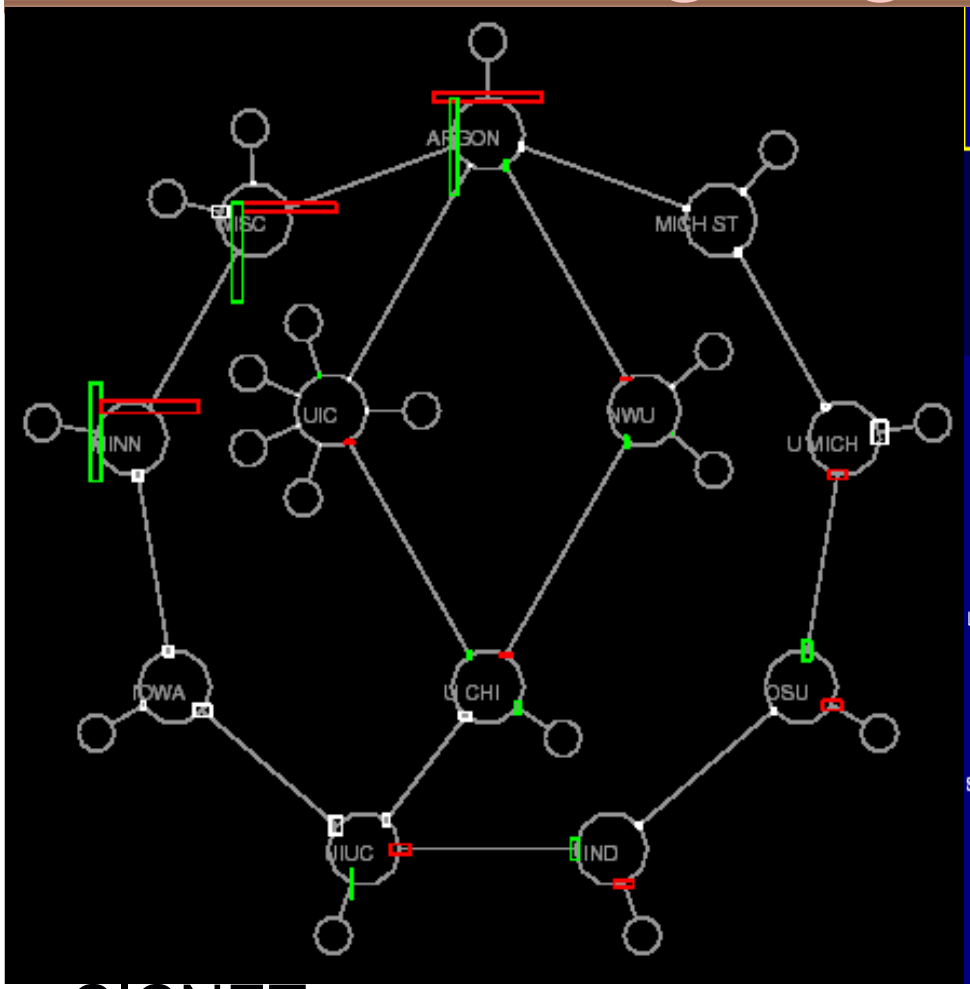
- Automatic animation
- Manual animation
- Sound
- Conditioning (‘and’ operation on parameters)
- Identification (display tool tip of node)
- Zoom
- Birds-eye view

Example (zoom in Link Map)

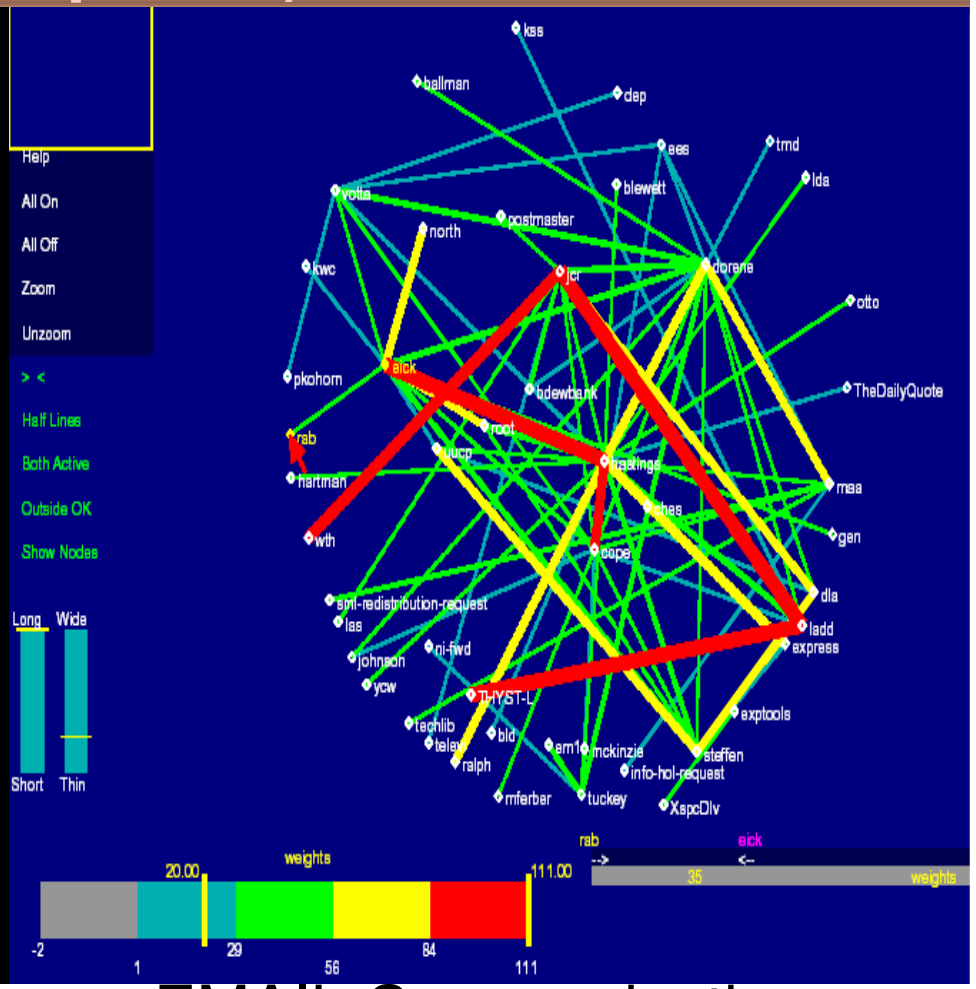


- Left: All line segments intersecting the display
- Middle: any line segments with at least one endpoint in the display
- Right: only lines that both begin and end inside the display

Other applications (non geographic)



CICNET



EMAIL Communication

Critique

- **The Good**
  - Clear graphs with interpretation
  - Presented motivation and challenge papers
  - Tested on different data sets
  - Provides implementation details (C++ & Vz)
- **The Evil**
  - Self evaluation (no user studies)
  - Redundant information (parameters and direct manipulation)

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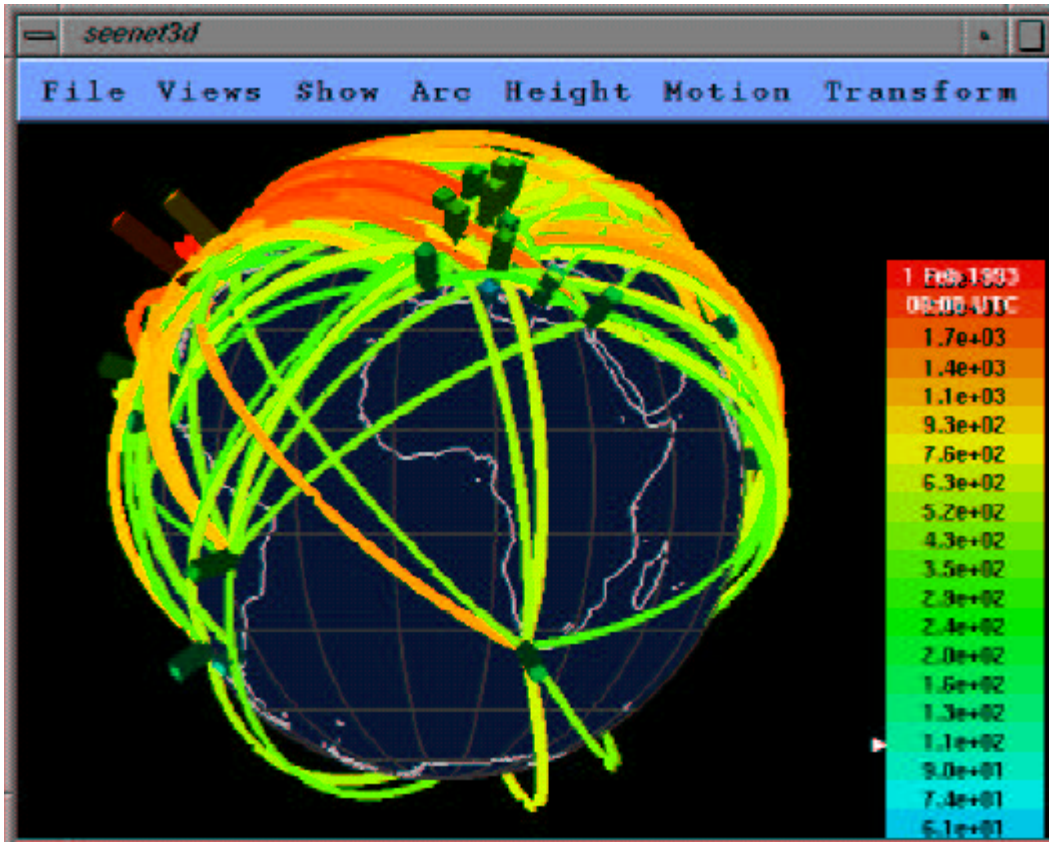
Introduction

- Presents “ SeeNet 3D”
  - 5 network views
    - 2 views are geography related
    - 3 views concentrate on portion of a large network
- SeeNet3D follow-up of
  - SeeNet
  - NicheWorks

Global Network 1/2



Global packet count in 2 hour period
Tall red glyphs have more traffic

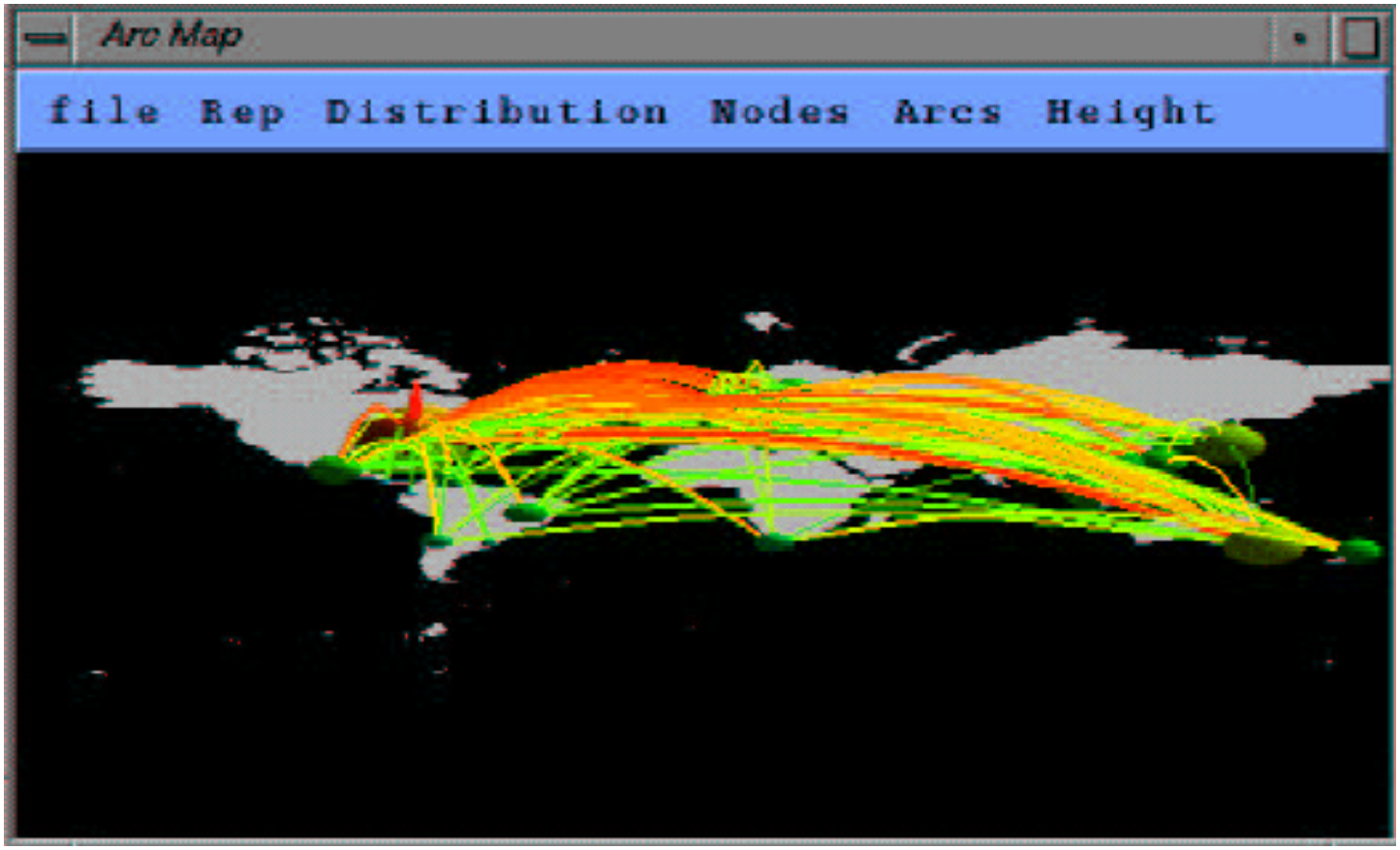
Disadvantage

- Only Front side of map viewable
  - Occludes arc ends
- Solution
  - Make globe partially translucent (does not work with too many arcs)
  - Allow user to route arcs (through globe if needed)
  - Filtering

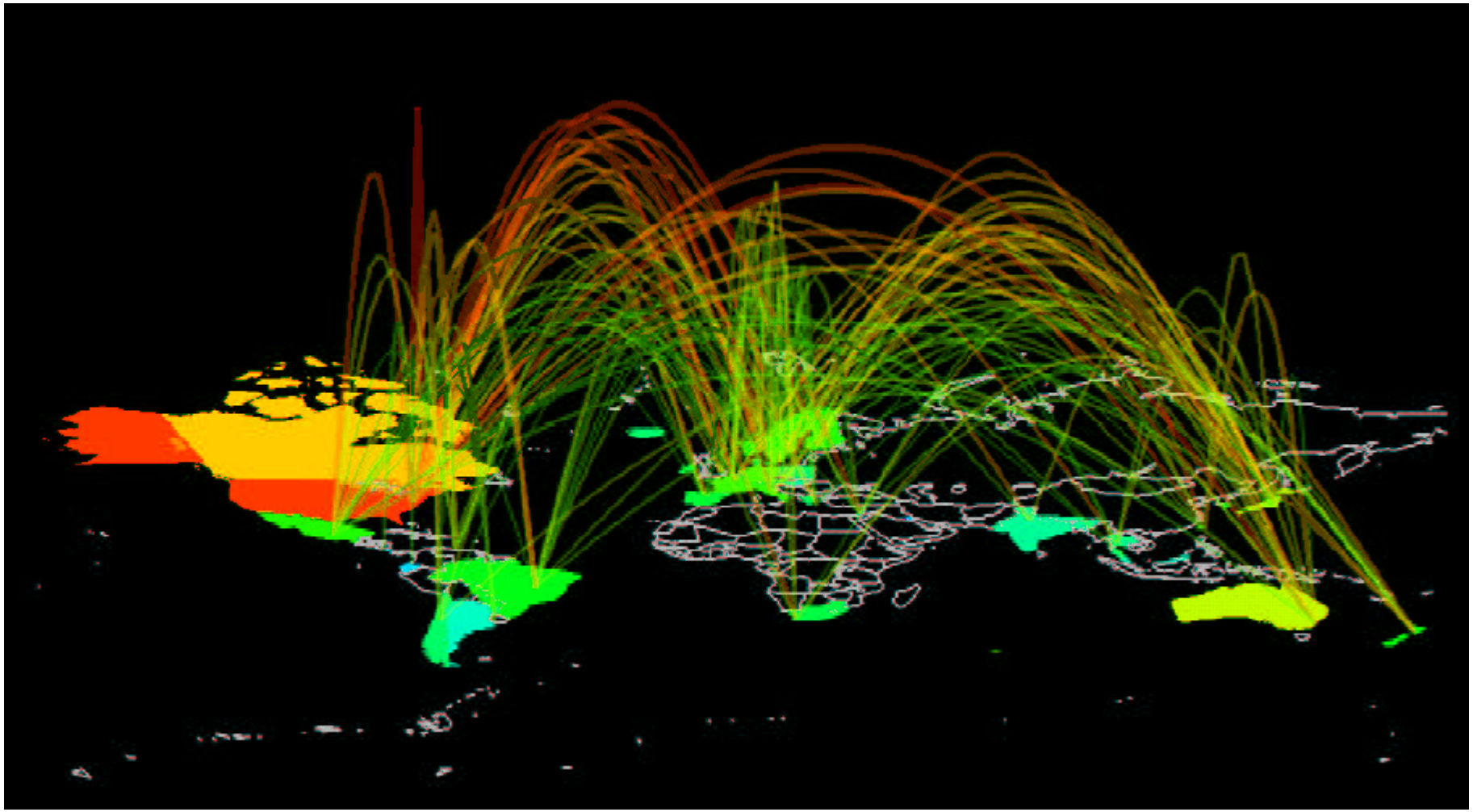
Global Network (2/2) - Arc Maps

- Draw arcs on flat 2D map in 3D space
  - 2D map can be oriented as desired
  - Eliminates line crossing to a certain extent (vary arc height)

Arc Map without parameterization of height



Arc Map with parameterization of arc height

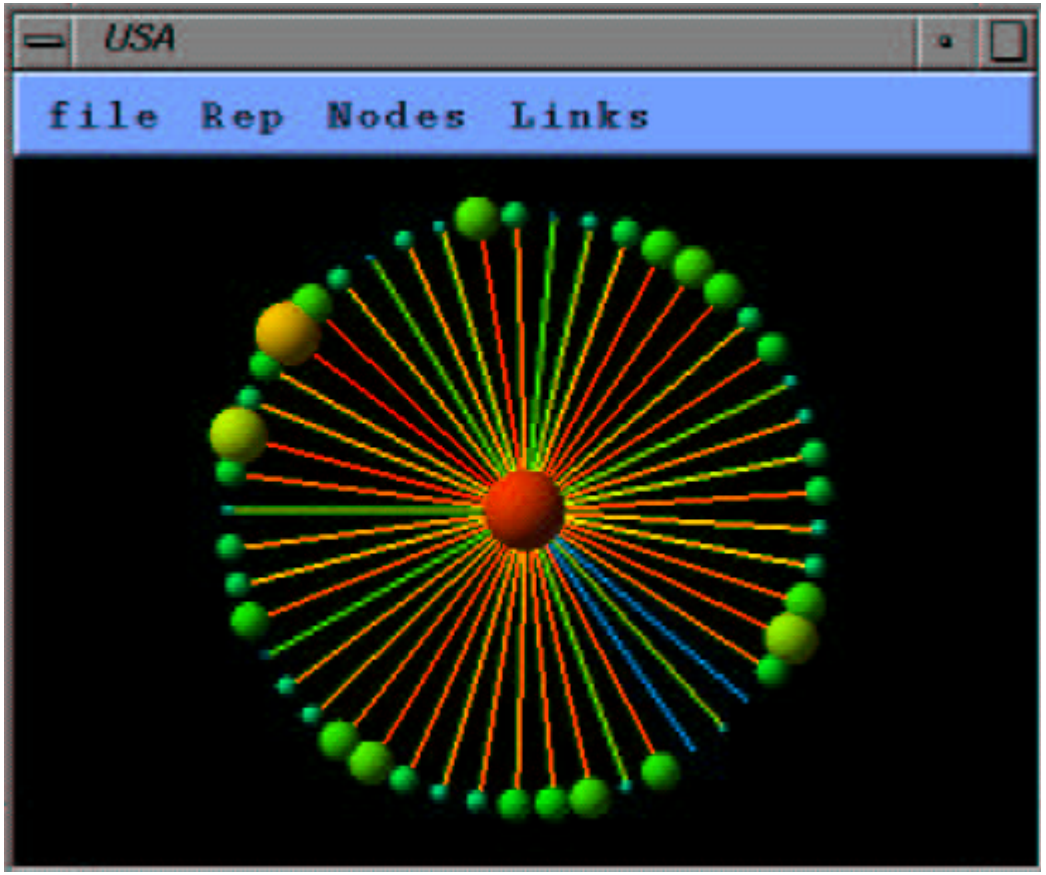


Add translucency of arc &, coloring and size glyphs of countries

Drill Down network views

- Three types of views:
  - Spokes on a wheel
  - Helix
  - Pin Cushion

Spokes on a wheel



Traffic to/from US to other countries

-Works for 50 to 100 nodes

-Does not make efficient use of screen space : All spokes of equal length

-Better approach (Helix)

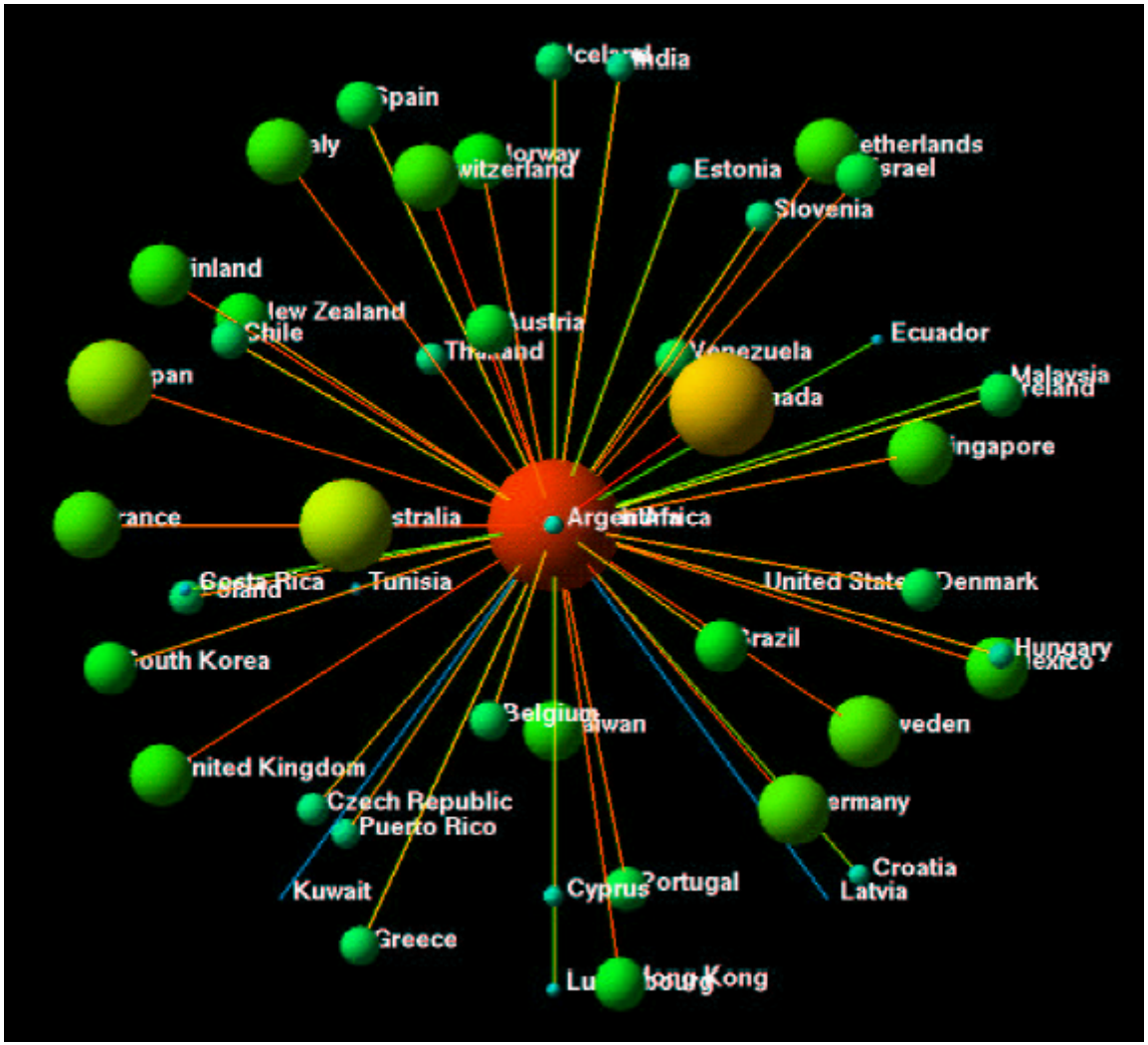
Helix

-When Viewed from above, Helix view becomes spoke view

-Use rotation of helix to bring occluded nodes into view

-Preferred approach by authors over others (more ordered)

Pin Cushion



-Motivated by helix display

-Position uniformly around sphere (anchor node)

- Number of circles and number of nodes per circle chosen such that angle between circles and between nodes in a circle same

Critique

- **The Good**
  - Shows more in less space (5 vs 3)
  - Provides implementation details
- **The Evil**
  - No user studies (as usual)
  - Some displays have limited information
  - Does not give scalability constraints for most

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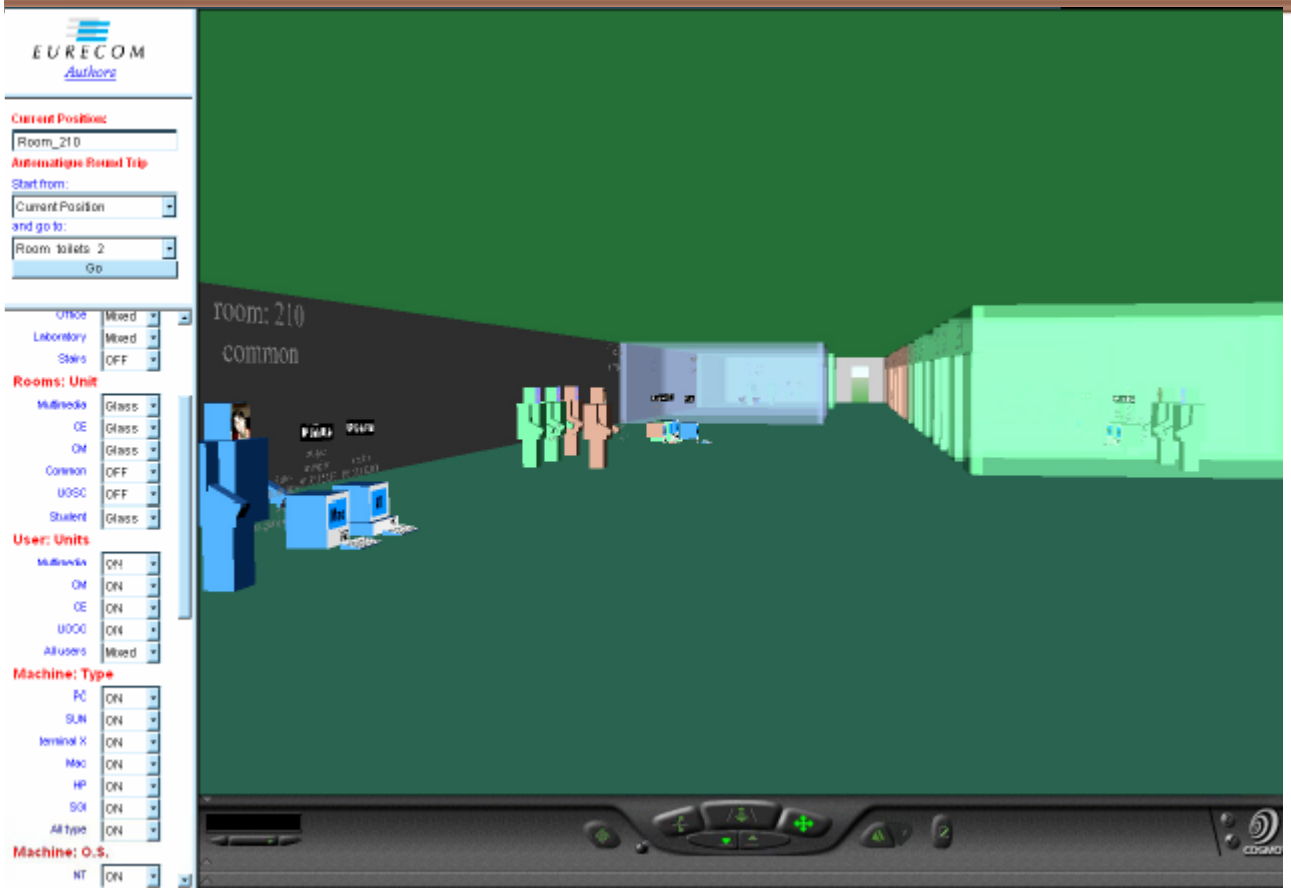
Introduction

- Network administration in 3D
- **Provides 5 metaphors**
- Dynamically builds & updates 3D world
- Captures information
  - Topology, Connectivity, Routing, Mailing, NFS
- Each 3D tool solves specific problems – chose metaphor that best suites a task

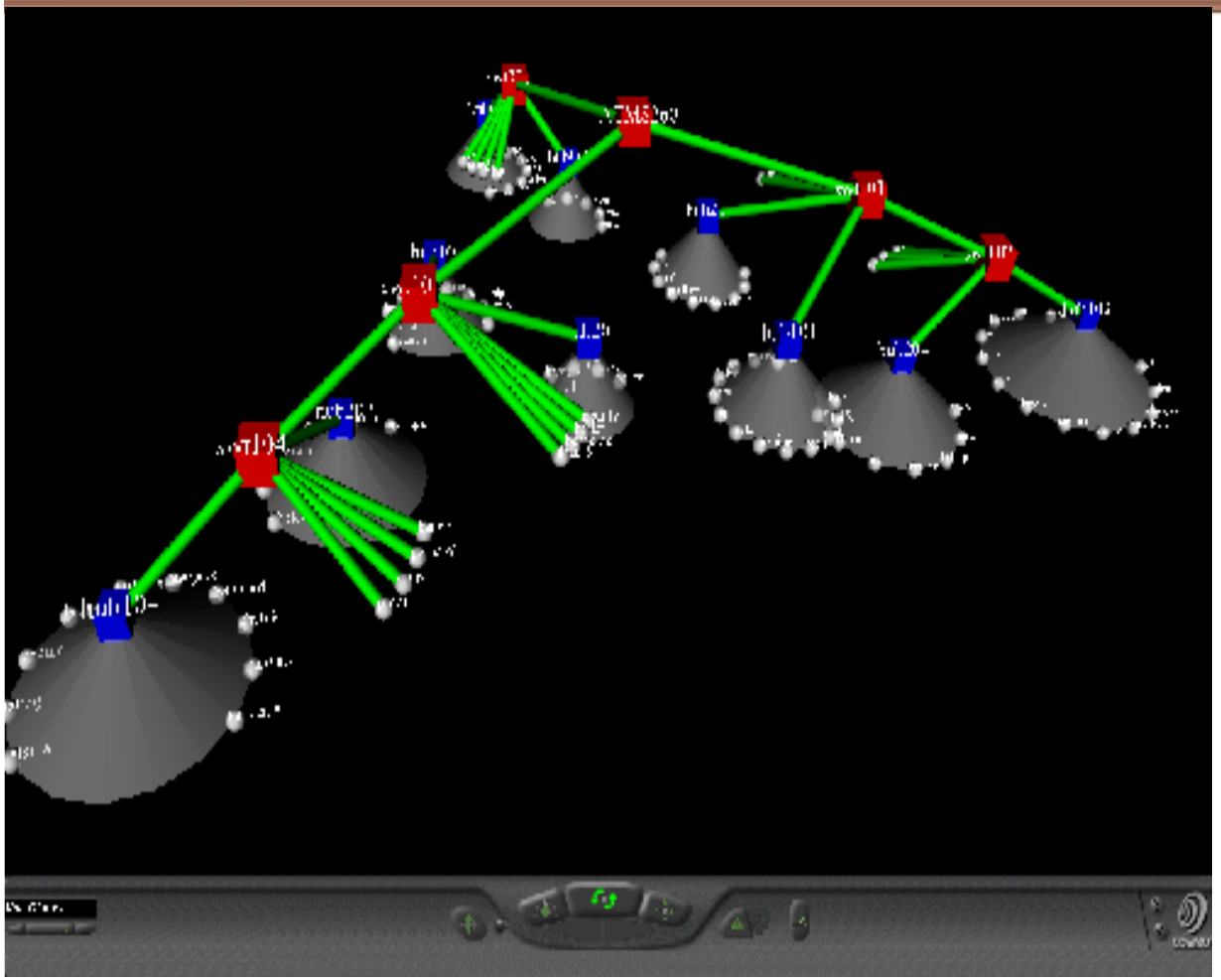
Geographic administration building metaphor



-For physical link problem detection

-Building (a container for network devices)
-Object location is relative to position in actual world
-User allowed to chose destination (automated paths)
-Filtering

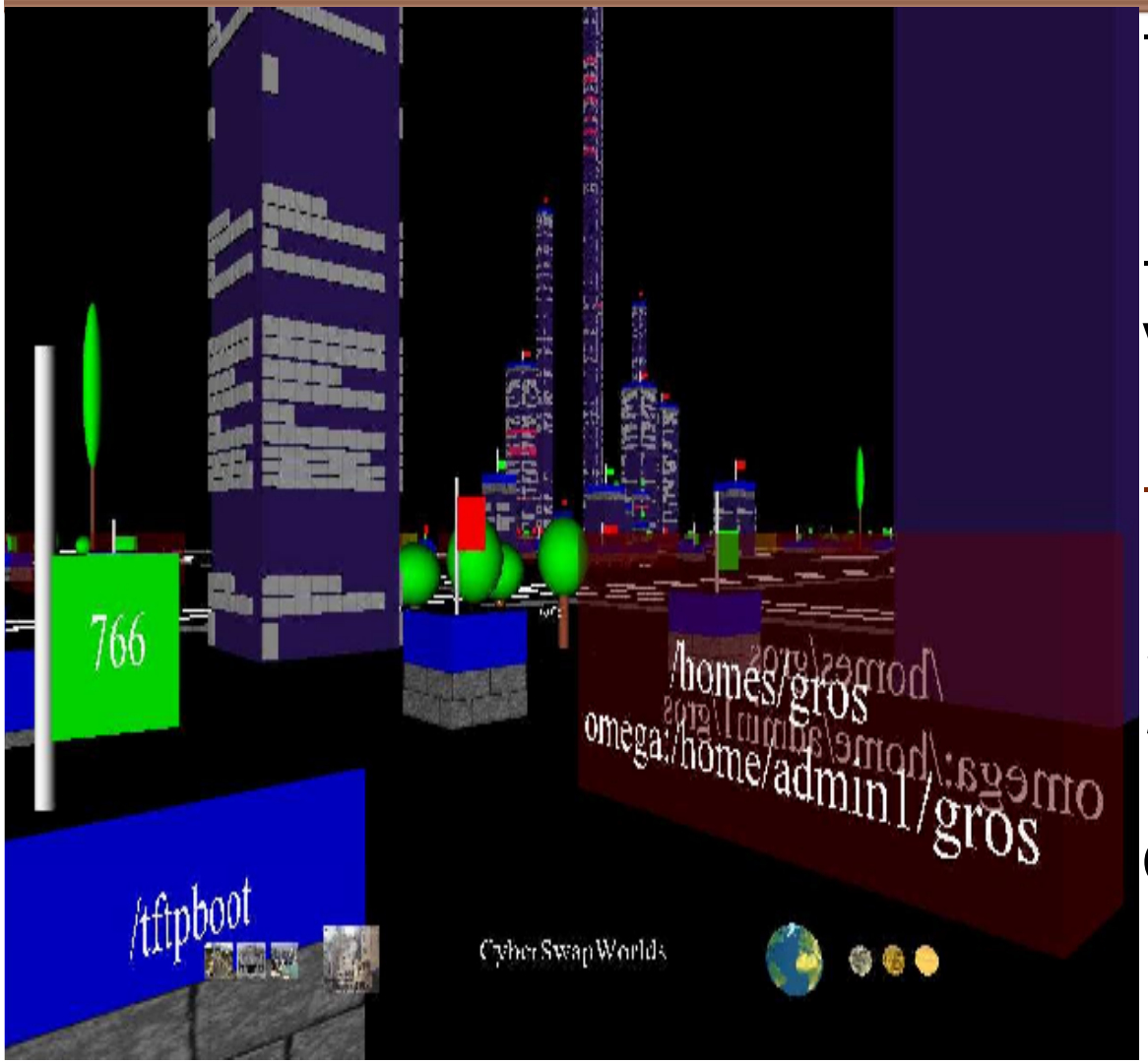
Topology administration
cone-tree metaphor



Red: switches
Blue: Hubs
Leaves: Computers

Size of cone depends on bandwidth flow in hub

Distributed system admin city metaphor



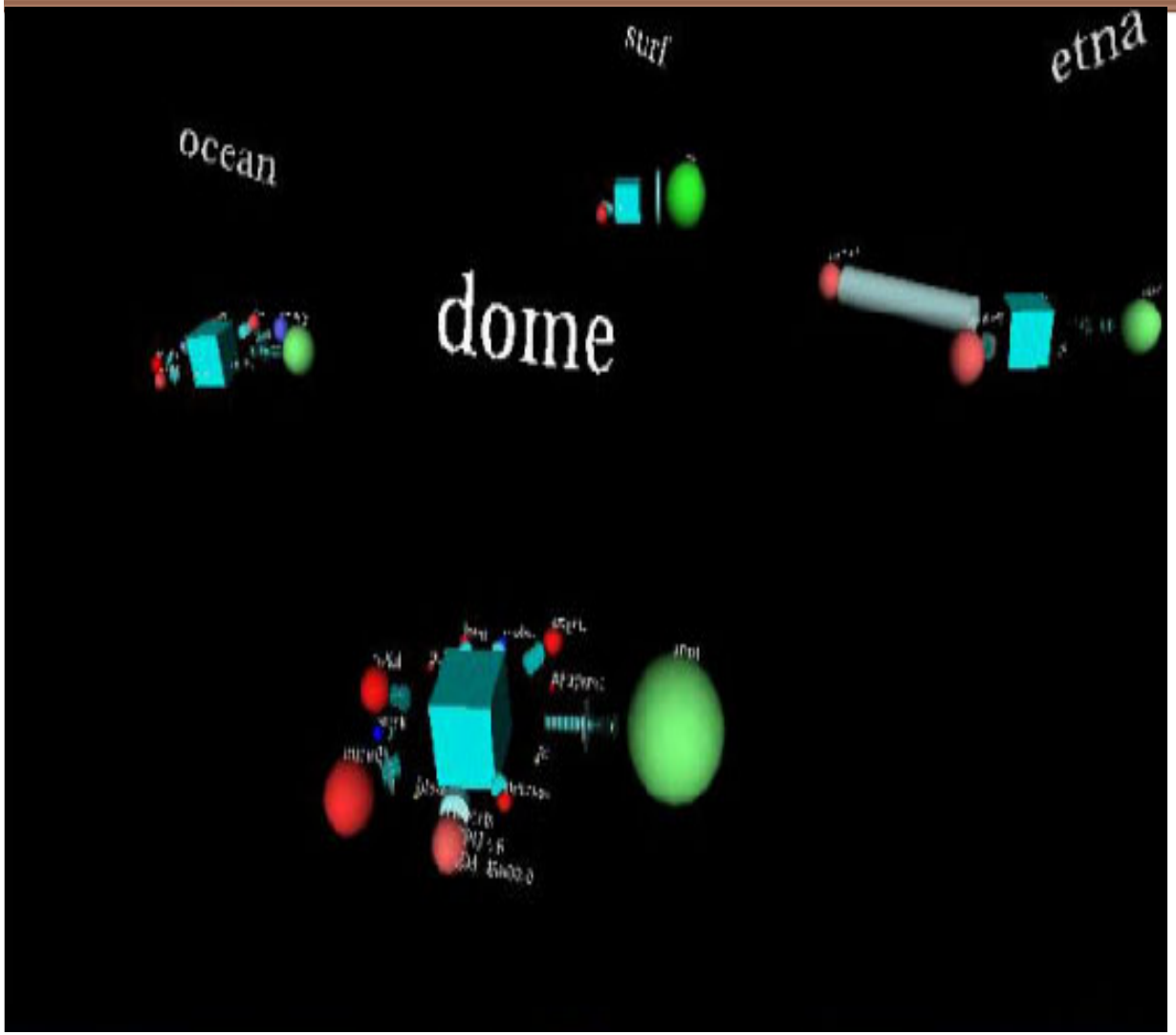
- Maps Client/server (Mail, DBMS, NFS)

-Separate Client & server view

-Metaphors:
Town : sub network
District: Computer
Building: Disk resource

On server:
-Each client a floor
-Each window a File Handle

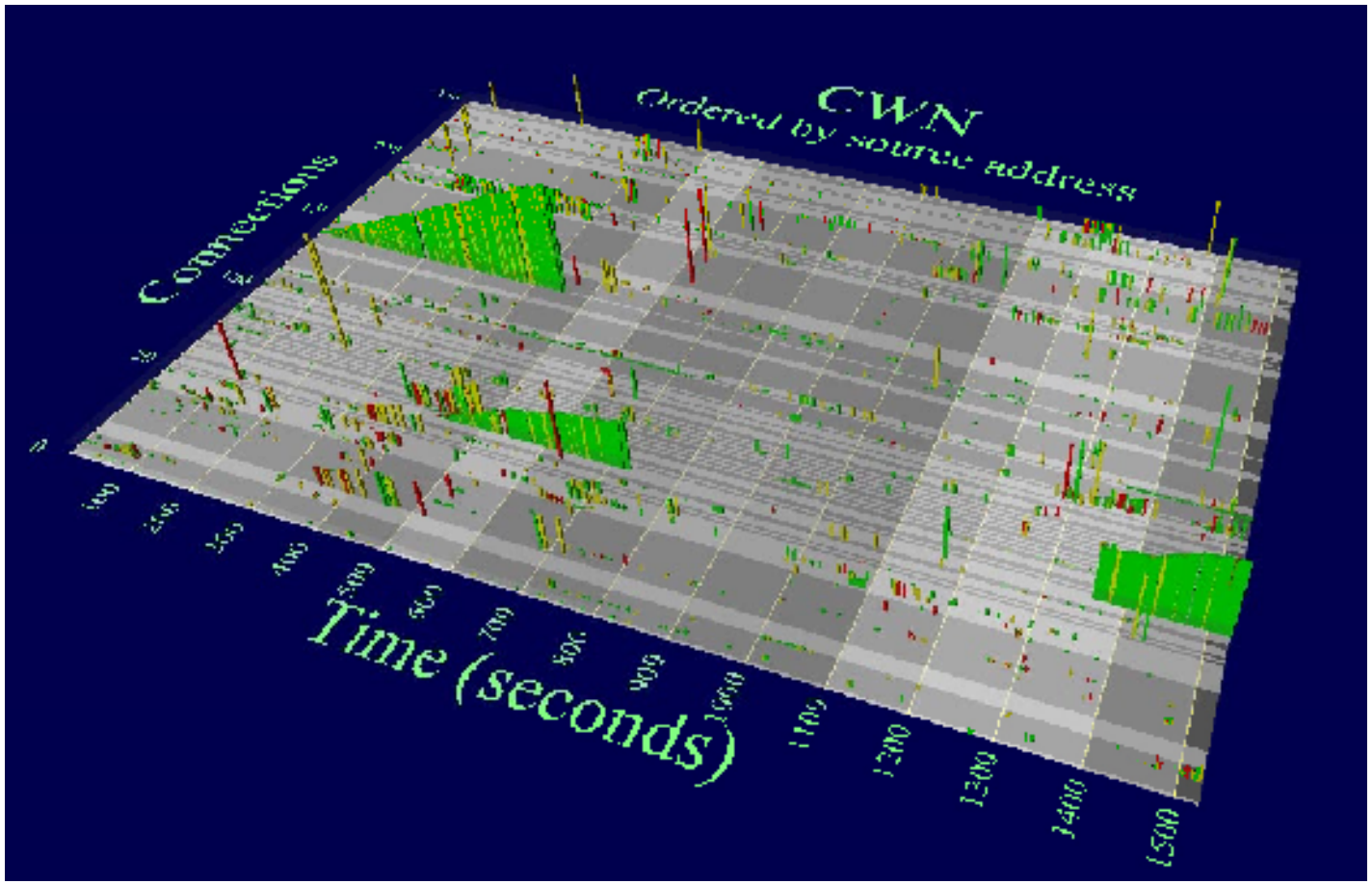
Computer admin tool
solar system metaphor



Metaphors:
Stars
Planets
satellites

To:
Computers
Users
Processes

Network traffic characterization landscape metaphor

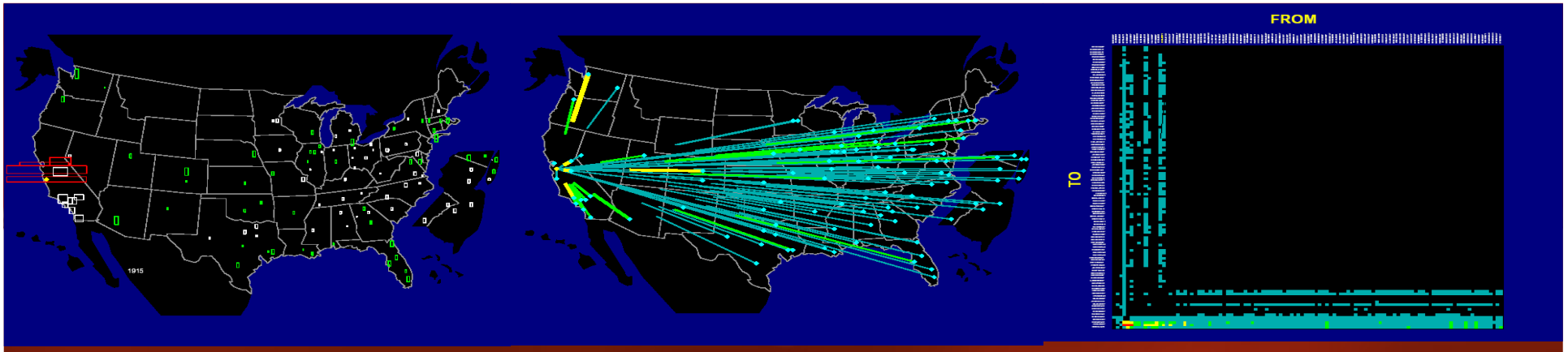


More on CyberNet

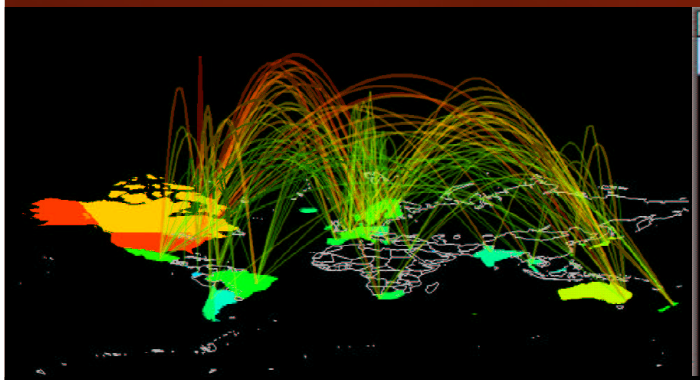
- Users can toggle between various 3D structures
- Technical Stages
  - Collecting Layer (subscribe/notify, agents)
  - Structuring Layer (build service model tree)
  - Visualization Layer (generate 3D form)

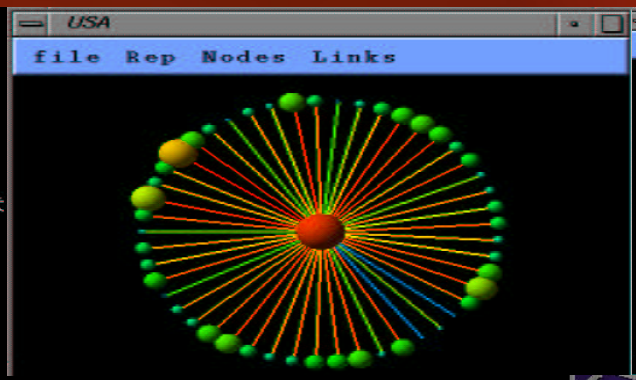
Critique

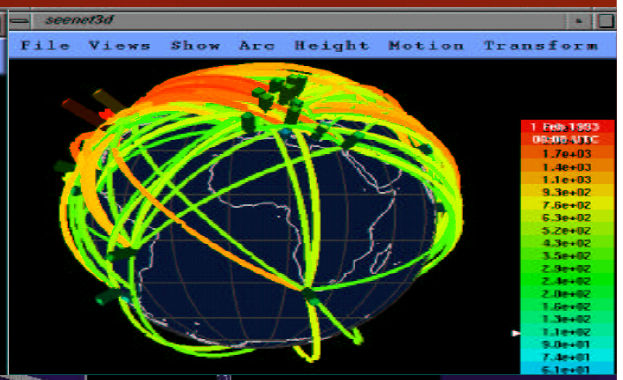
- **The Good**
  - design architecture explained
  - Implementation language for each stage (VRML, corba, Java, perl)
  - Screen Shots helpful
- **The Evil**
  - Some concepts unclear (city metaphor)
  - No user studies
    - Mentions users found metaphors helpful
  - No scalability discussion
  - Dead Site !!

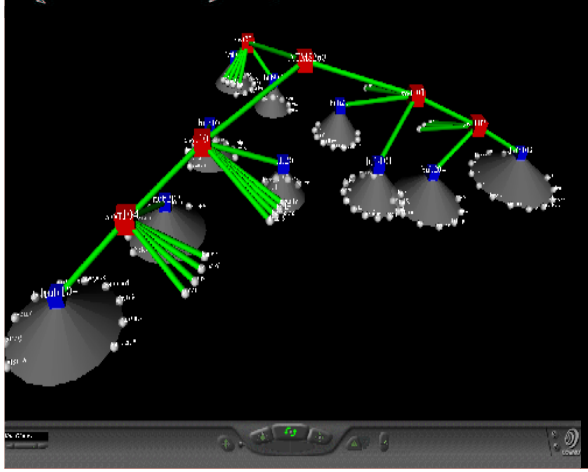

FROM
TO

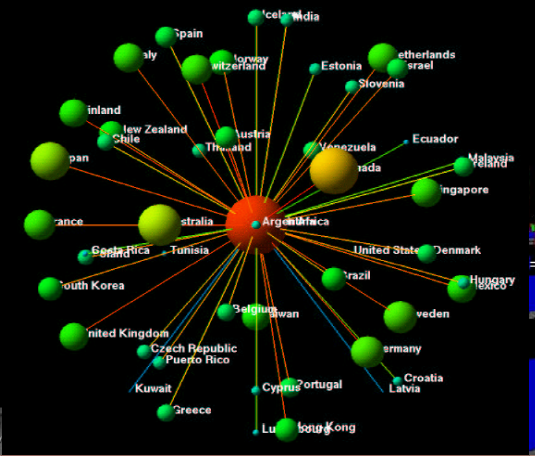
? QUESTIONS ?




USA
file Rep Nodes Links


seenet3d
File Views Show Arc Height Motion Transform

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766
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CyberSwarmWorlds