Kinetic Visualizations

A New Way to Look at and Understand
Complex Networks,
Geo-spatial Events and High Dimensional Data

Rusty (Robert J.) Bobrow – *BBN Technologies*

BBN TECHNOLOGIES

rusty@bbn.com (617) 873-3601

What is Kinetic Visualization?

A family of visualization techniques based on the human visual ability to interpret patterns of motion

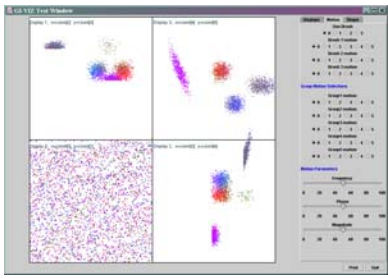
We have evolved to use motion to understand critical patterns in the world

- ***The ability to perceive motion is an untapped resource for increasing the information content and usability of visualizations over what can be portrayed by static graphical properties alone.***

- Don't have to search for movement in order to see it.
- Many patterns of movement can be easily seen
- Motion can be seen out to the periphery (unlike color)

Kinetic Objects

- We automatically interpret ***elements with common motion*** as p***arts of a single object***,
  - even if they are otherwise dissimilar, widely separated in the field of view,
    or surrounded by clutter or camouflage.
  - We can see patterns in such ***kinetic objects*** beyond the characteristics of the individual elements.
  - Such objects stand out from the background, but can be readily seen in relation to other objects, both moving and stationary.

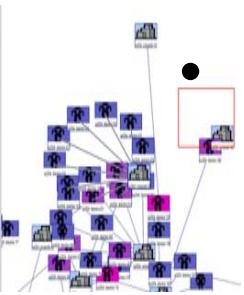


- Representing critical information as motion allows warfighters and analysts to:
  - Detect patterns quickly and accurately
  - Understand patterns in relation to complex contexts
  - Interpret fused data in multiple displays

KineViz Evolution

- Basic research funded by ARDA/DTO (2002-2007)
  - GI2Vis / ARIVA / A-SpaceX programs
  - See the KineViz page on **IntelLINK**
  - Multiple published papers

- BBN Implements COTS KineViz Toolkit (2005-2007)
  - NSA licenses KineViz as plugin to Renoir
  - DoD agency funds KineViz prototype integration with ANB



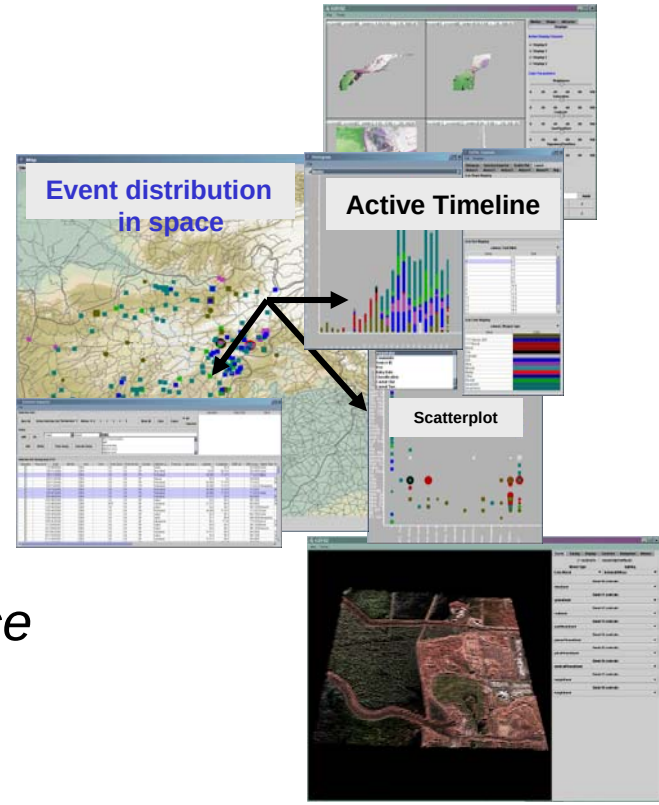
- Patent # 7,069,520 (6/27/06) describes the basic network motion ideas; 7,280,122 and 7,315,306 (2007), other patents in process

Specific Application Areas

Understanding Complex Networks – *social network analysis, financial links, communications networks*

Information Fusion In Multiple Displays –

geo-temporal event analysis, imagery analysis, imagery derived MASINT



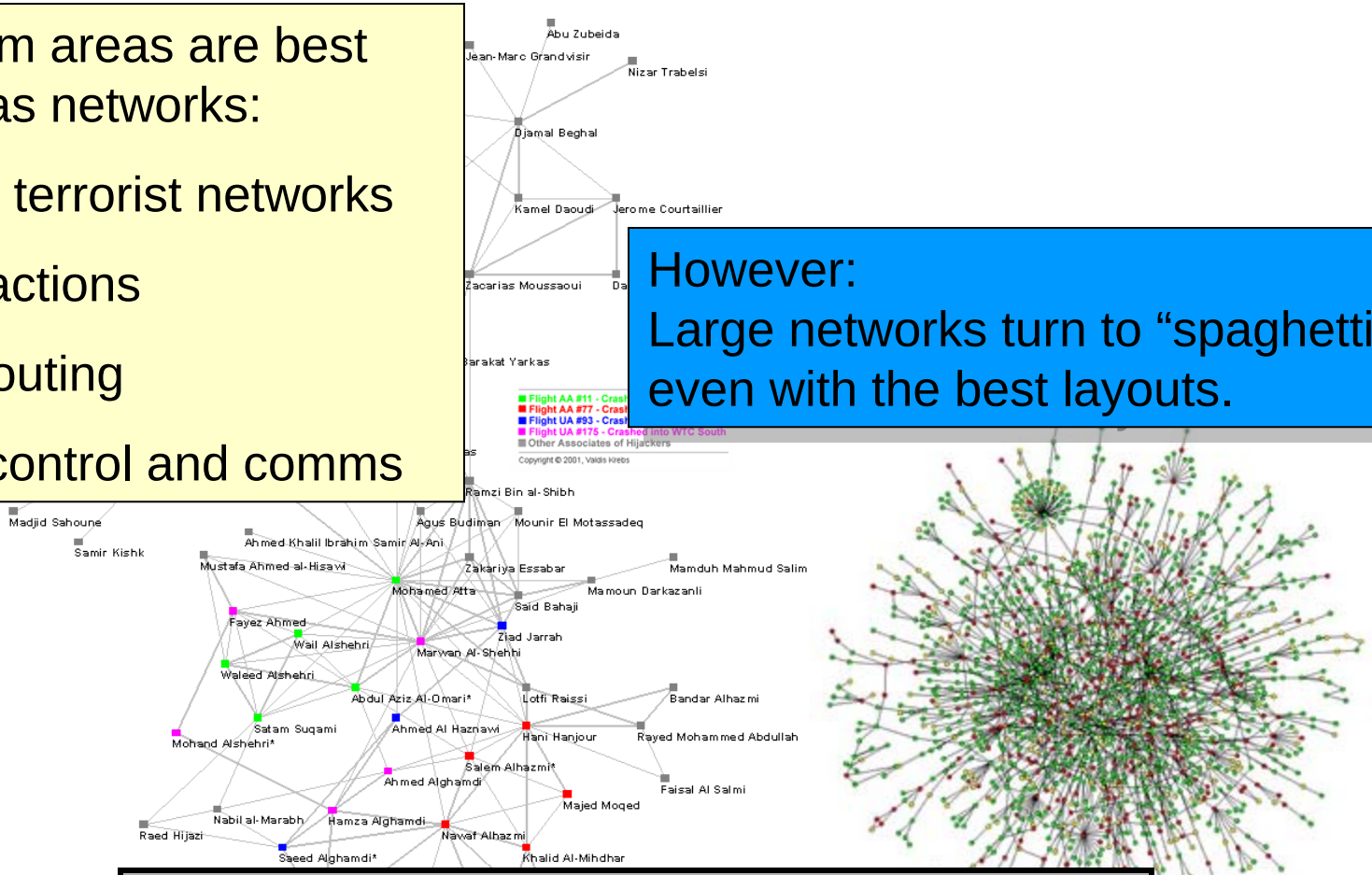
Detecting patterns in dense two-dimensional arrays of high-dimensional data –

image analysis, MASINT, information assurance

Link Analysis of Large Networks

Many problem areas are best understood as networks:

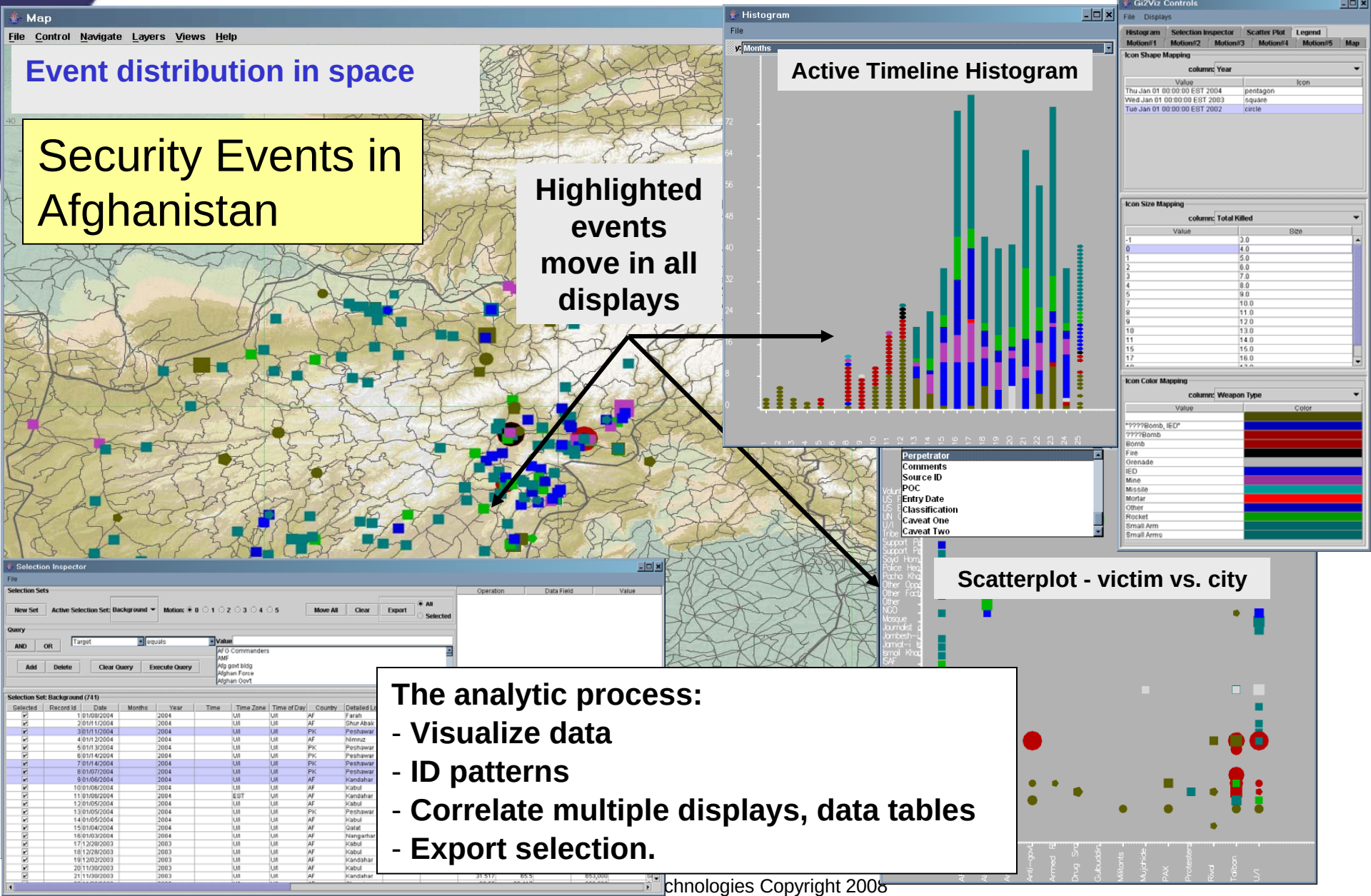
- structure of terrorist networks
- bank transactions
- computer routing
-command, control and comms



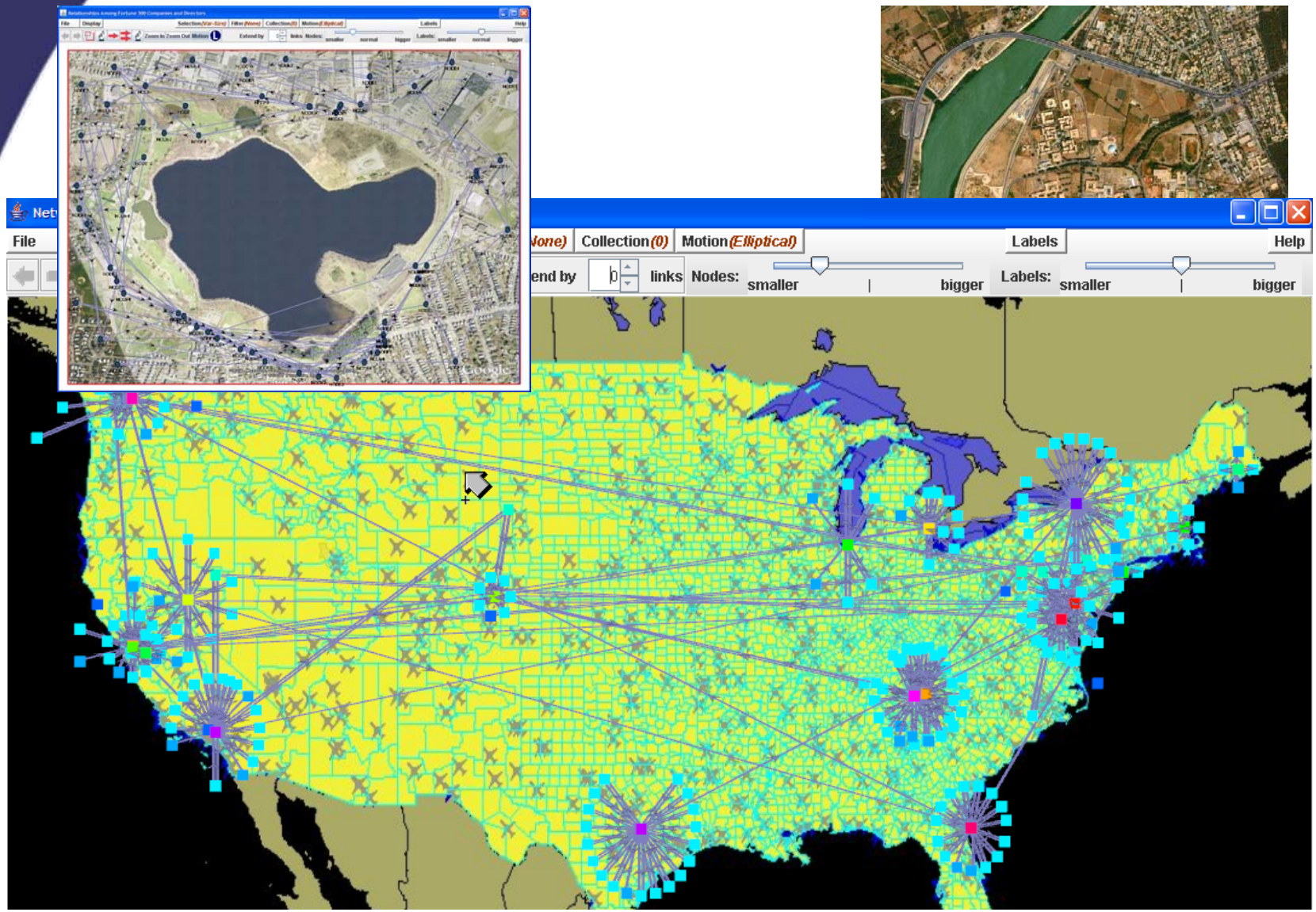
However:
Large networks turn to “spaghetti” even with the best layouts.

Motion can be effectively used to highlight sub-sets of the network.

Event Analysis



Networks on Maps and Imagery



Simultaneous Visualization of Many Dimensions

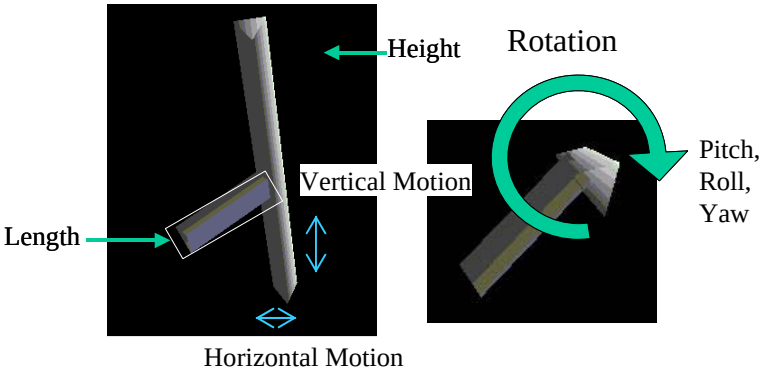
Goal: Support human detection of patterns in large, dense two-dimensional distributions of high dimensional data.

You can see more patterns when all the data is visible in one display

Example Applications:

- **"Image" analysis**
  - ***Hyperspectral***
  - ***Polarimetric***
  - ***SAR***
  - ***Medical imagery (MRI/CT)***
- **Signal processing analysis:**
  - ***UGF detection, geo-acoustic tracking of vehicles***
  - ***Undersea monitoring***

Key Idea: $<x_1, x_2, \ldots, x_n>$
→
motions of 3D ***moxel***



Encoding data in the **motion of 3D icons** adds 5-10 independently perceivable dimensions to color
– total of **8-13 data dimensions visualized simultaneously**.

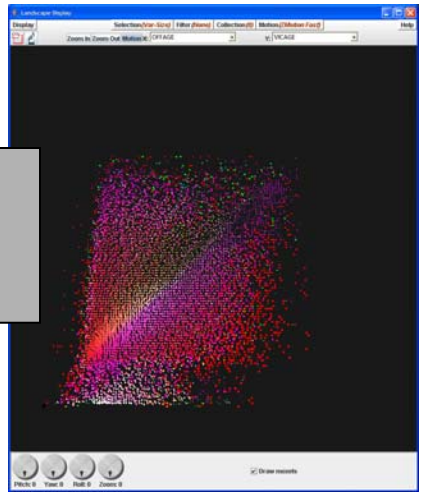
What Does a Dimension Represent?

- Many different types of information can be encoded as separate layers
  - Bands of raw spectral information
  - Alternative sensor data (SAR, polarimetric, …)
  - Match to known signatures
  - Clustering values (K-means, SOM, …)
  - Geospatial reference data (geological, land use,…)

- Non-geospatial data can be readily represented
  - IP communications patterns
  - Demographic data

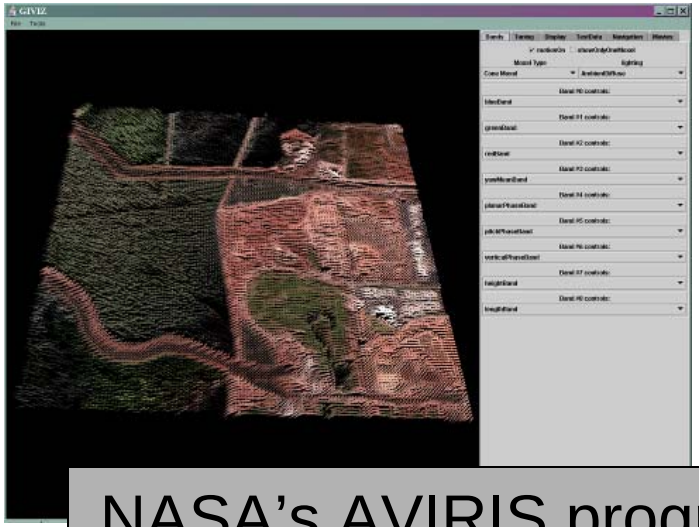
Moxel Displays

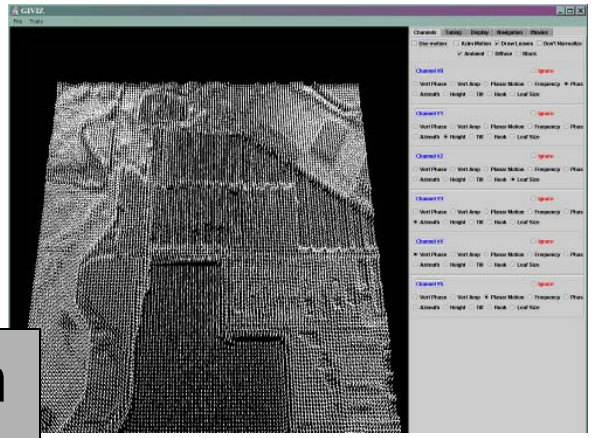
FBI Crime Statistics



Data values control motion of image elements–>

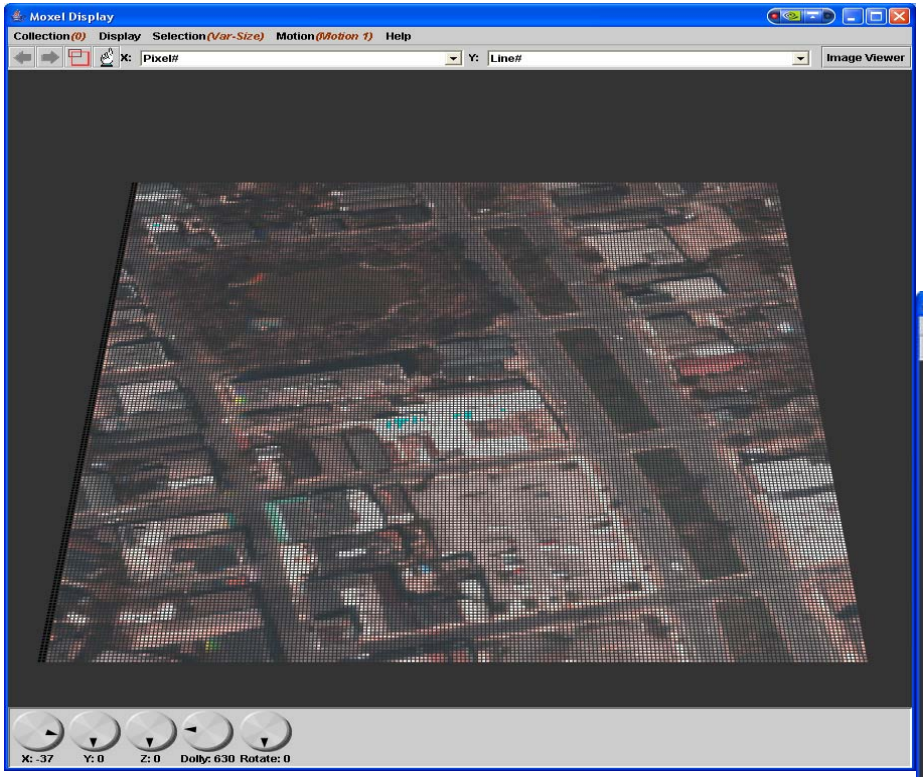
More complex and higher dimensional patterns can be readily detected.

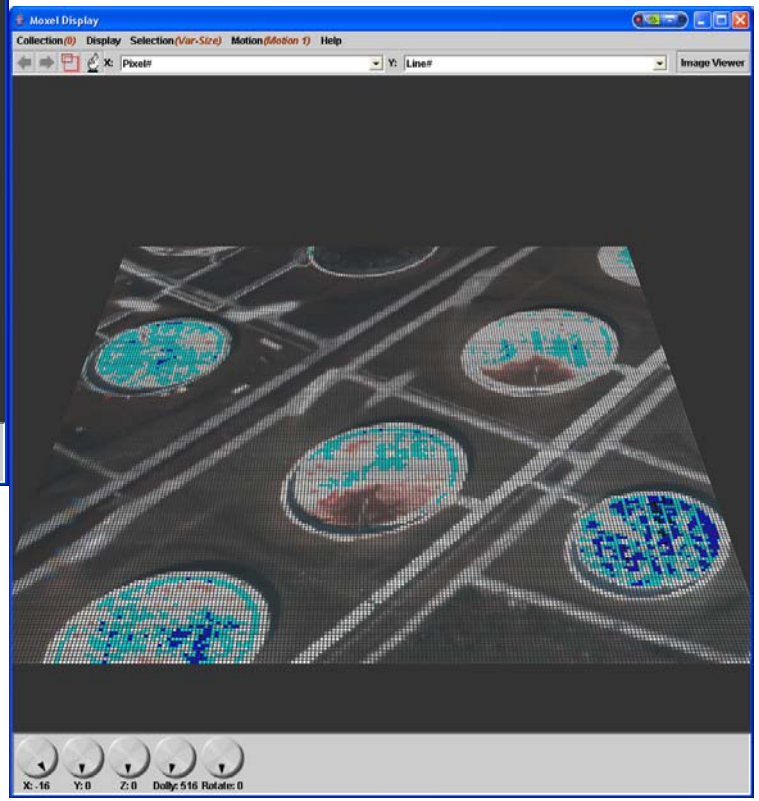




NASA's AVIRIS program Moffett Field Data

Signatures/Plume Characterization

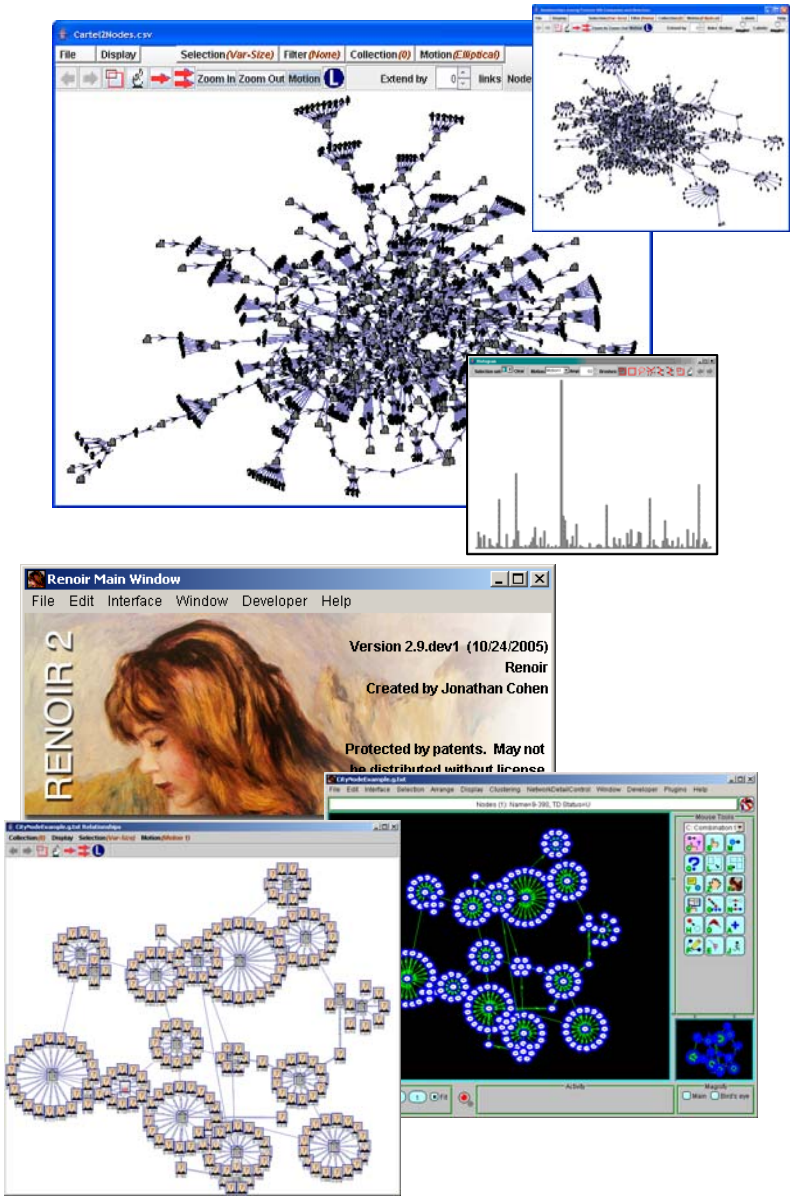




Exploring and Understanding Signatures in Context

KineViz API and Toolkit

- BBN's commercial API and Toolkit incorporates Kinetic Network Displays and Motion Brushing.
- Basis for integration of KV and Renoir
- Licensed to DoD agency for prototype integrating KV with Analyst's Notebook and internal network tools



Summary

- Kinetic Visualization techniques leverage the users' innate powers of motion detection to query and exploit complex data, and visualize the answers while retaining the full context of the underlying data environment.
  - Relational -- Temporal
  - Spectral -- Geospatial

- BBN's KineViz™ provides the tools to create domain specific kinetic visualization applications
- BBN builds custom applications to suit your operational requirements and integrate them into your analytical environment

- Talk to us about licensing the KineViz™ toolkit, or the patents.