Beyond Social Networks: The Dynamics of Networks and Trails

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Every Day Life Leaves Trails

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Network Science - Connecting the Dots and Trails to Predict and Explain Behavior

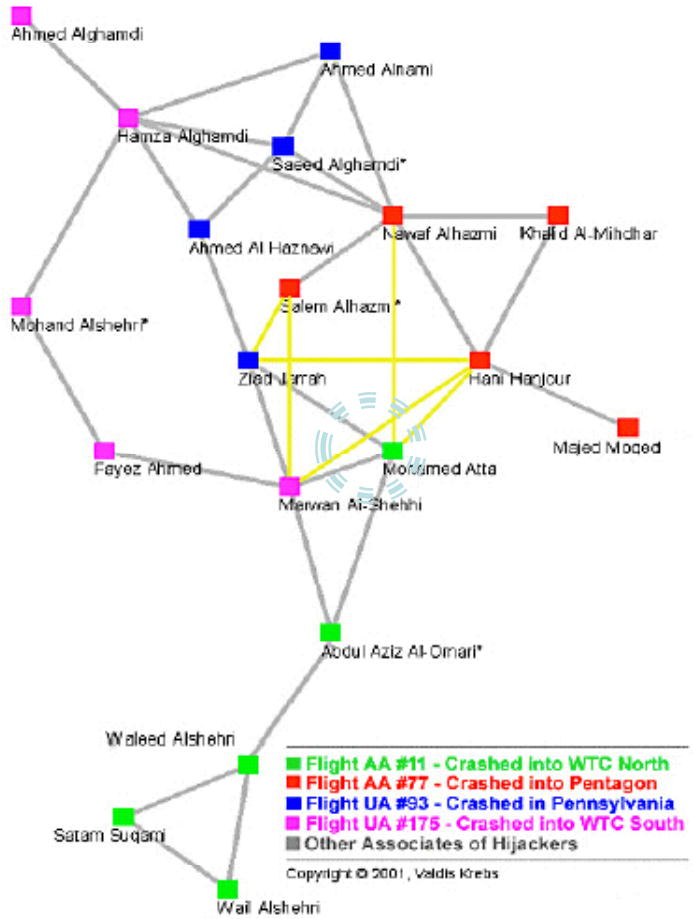
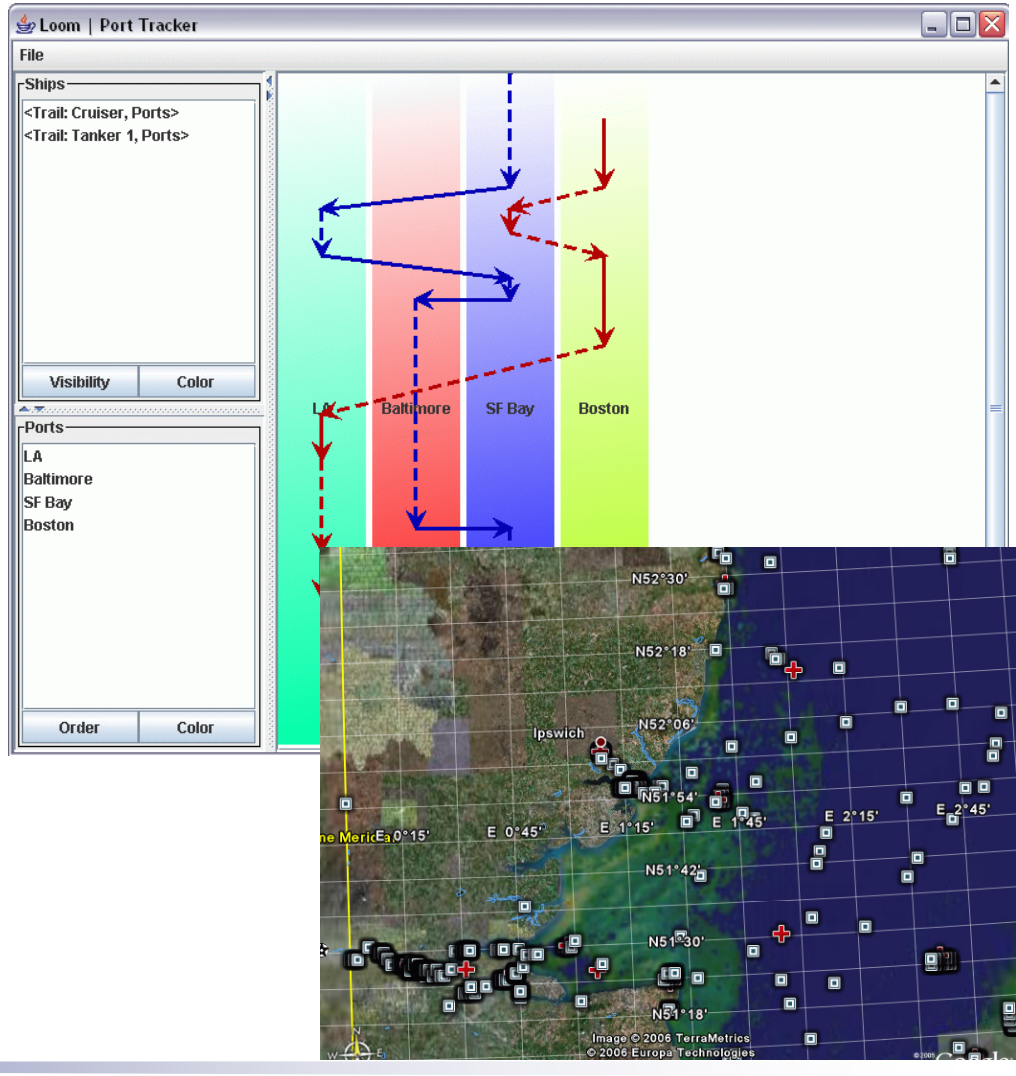


Figure 3 Trusted Prior Contacts + Meeting Ties [shortcuts]



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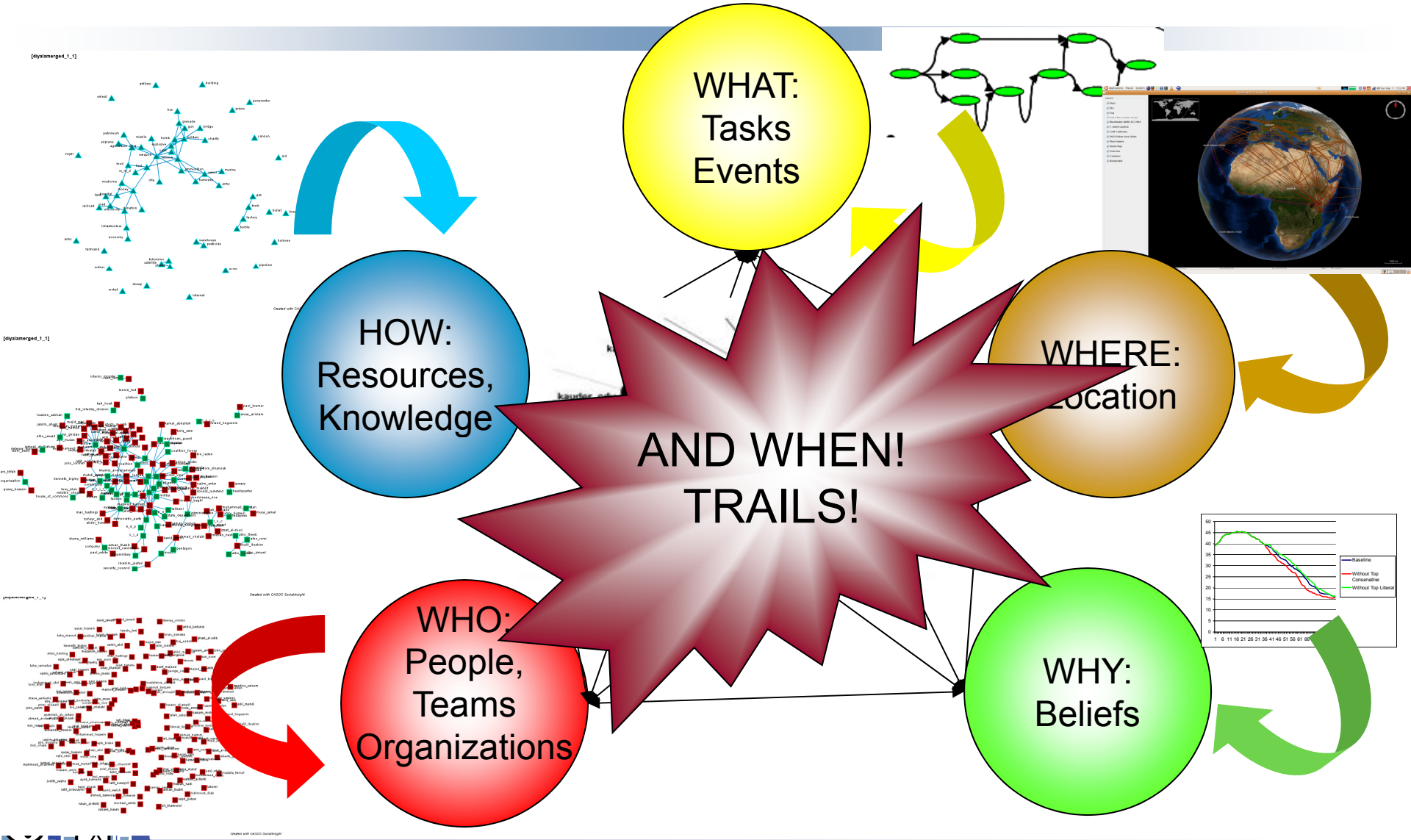
We pull out – the Meta-Network



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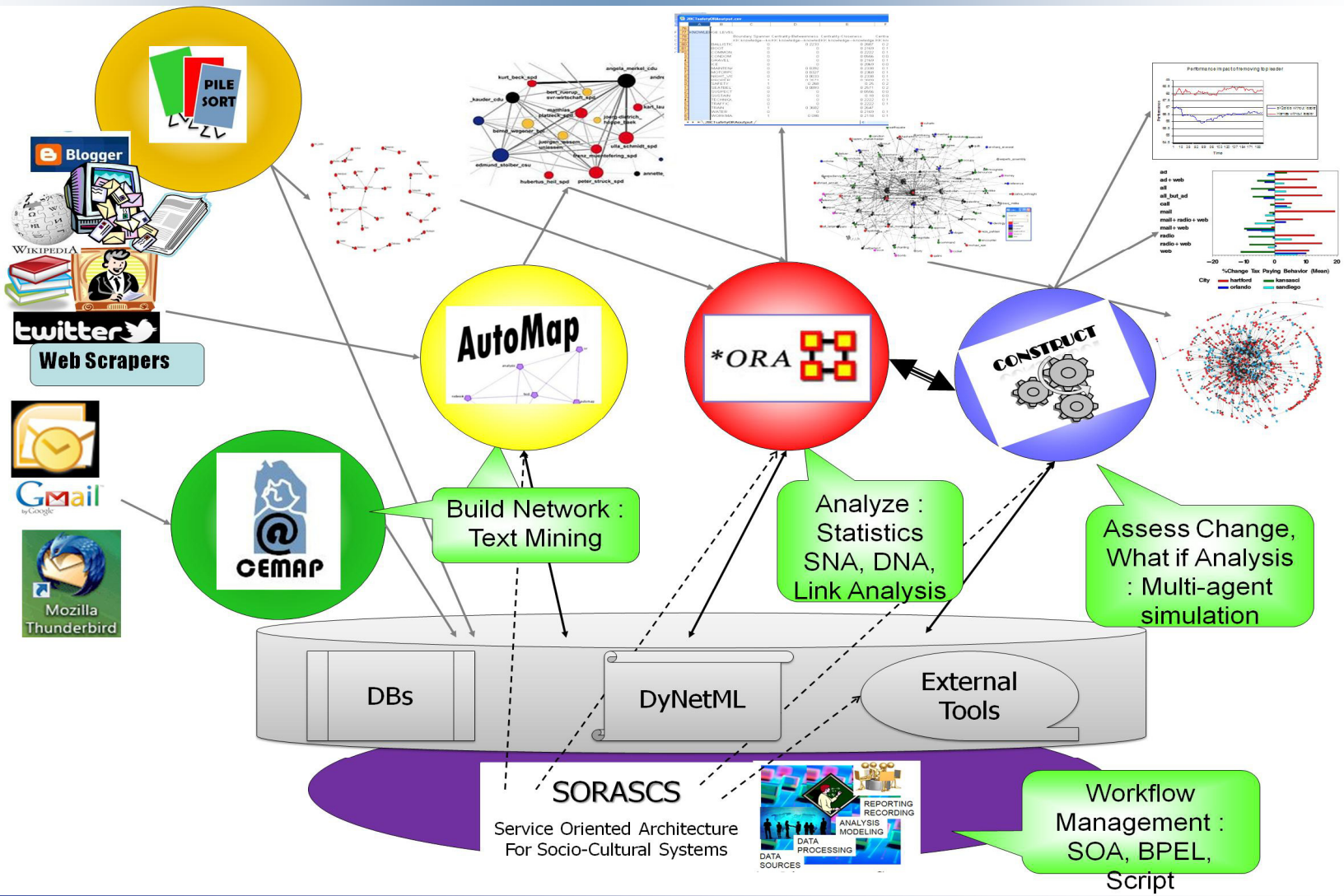
Data to Model Process is Complex



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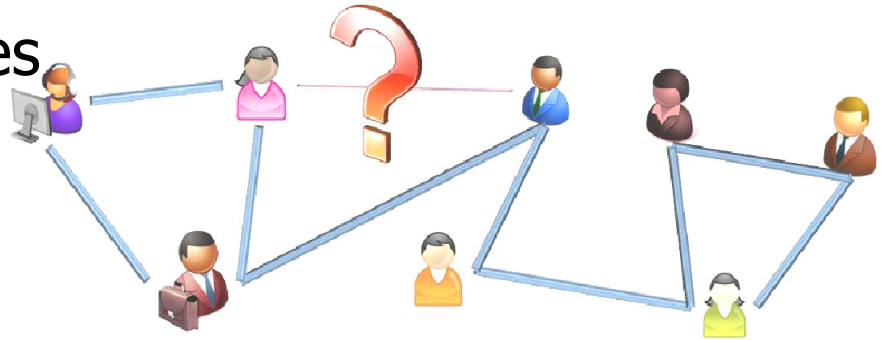
Social Networks are Continuously Emerging Structures

- Networks emerge from intersecting trails
- Networks reinforce some trails
- Slices across trails are the "observed" social network
- Level of aggregation determines the "width" of the slice
  - The great the width – the higher the density
- THEREFORE
- Observed networks are samples
- They are missing information
  - Missing link
  - Missing node
- Infer missing links using information about the trails



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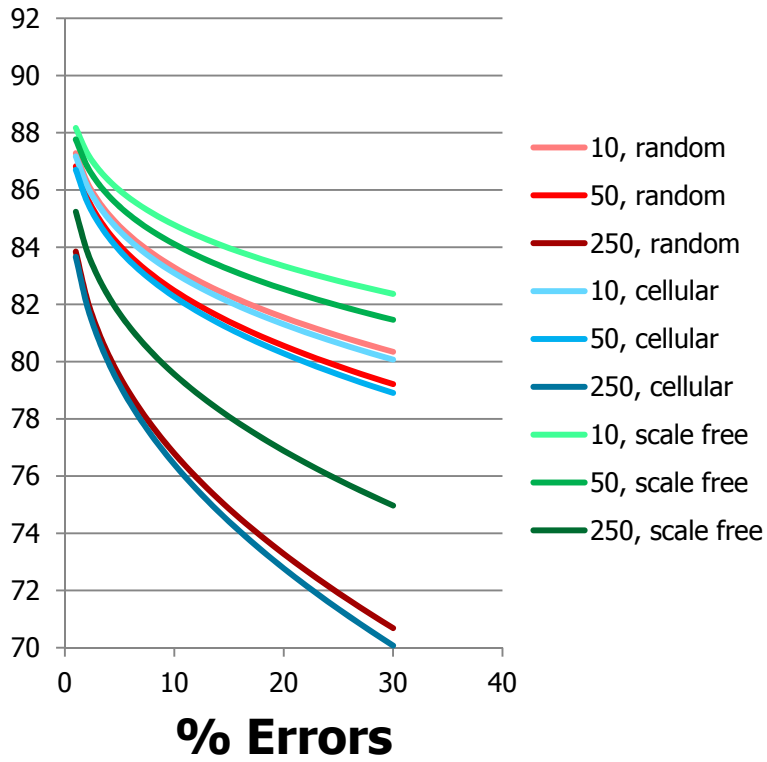
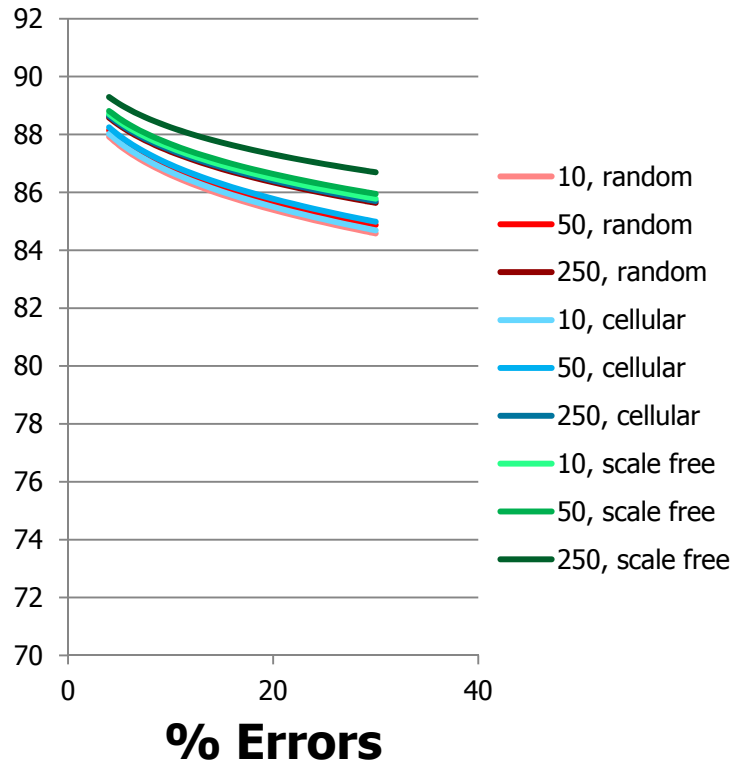
Inferring Missing Links is Important

% Accuracy in Predicting Top Node in Betweenness



% Accuracy in Predicting a Node is in the top 10% of Betweenness



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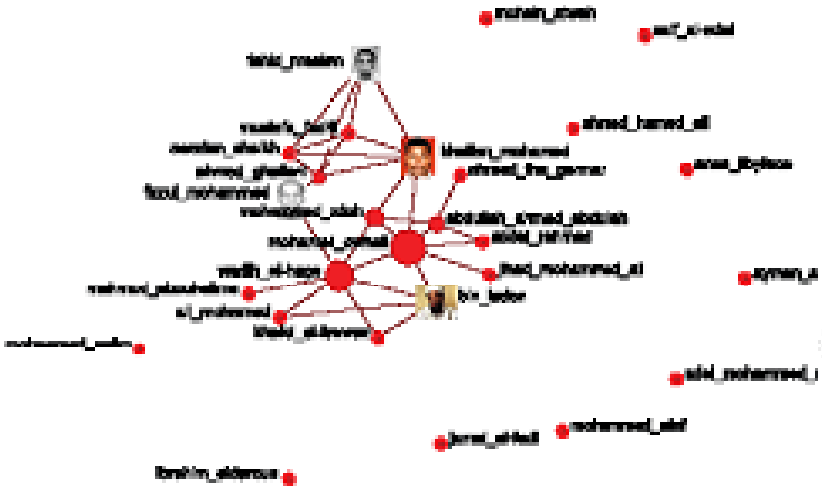
Inferring Missing Links has Practical Consequences



Metric	Base Data
Probable Leader	Bin Laden
Leader of Sub-group	Khalfan Mohamed
Links disconnected groups	Mohamed Owahali
Density	.07
Fragmentation	.61
Generic Performance	.23

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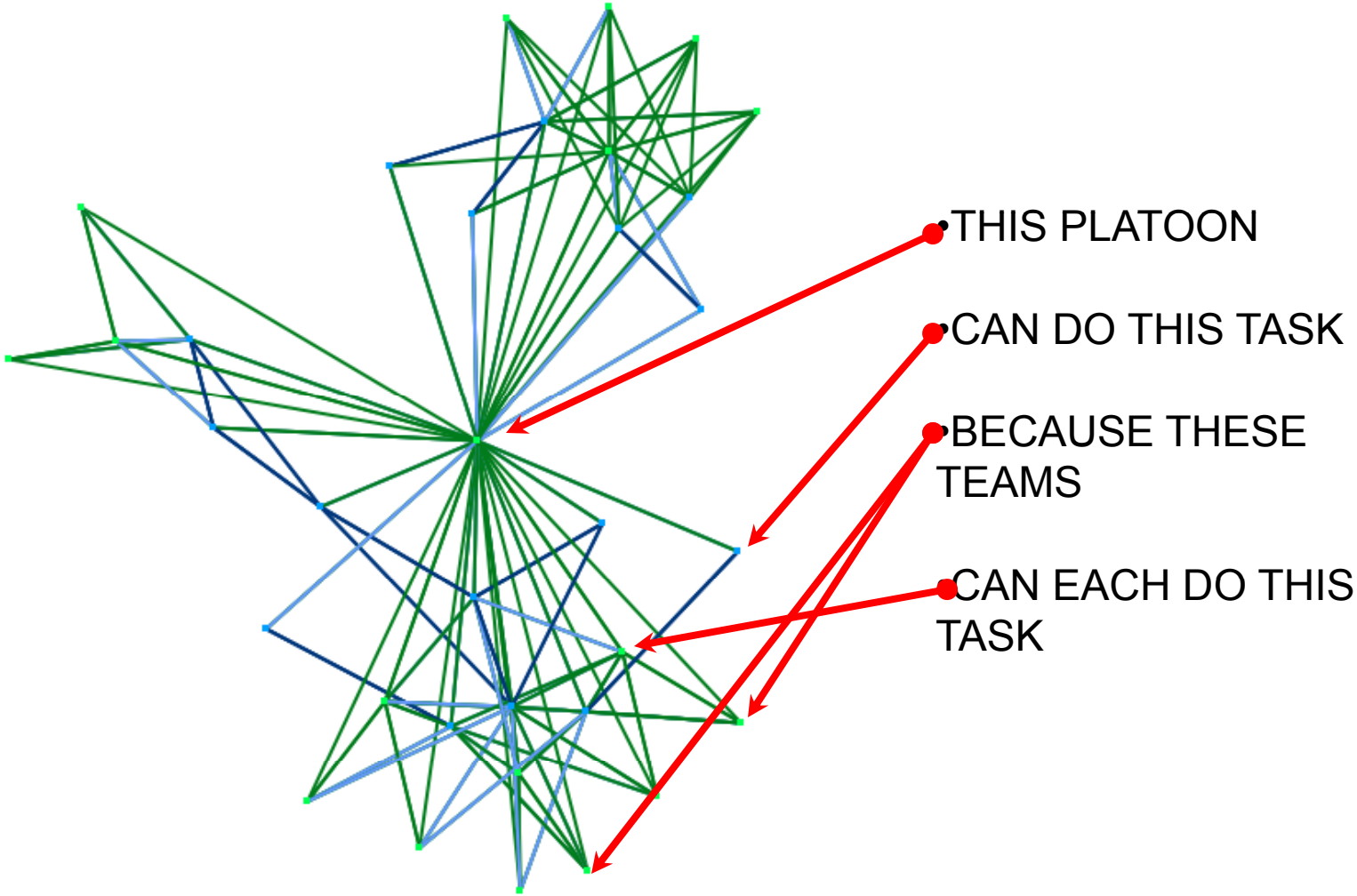
Meta-Networks Support Assessment & Prediction



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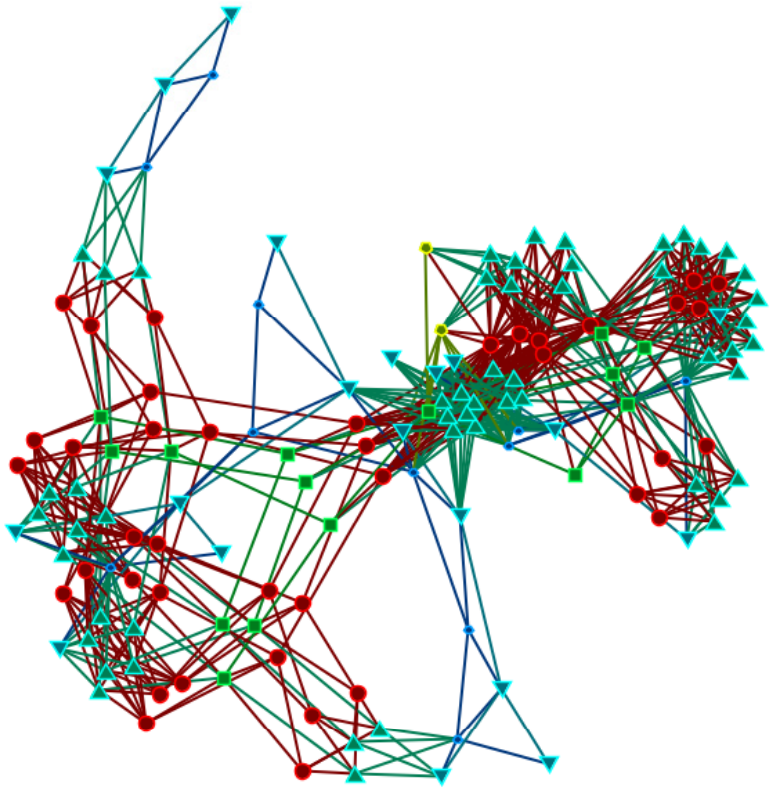
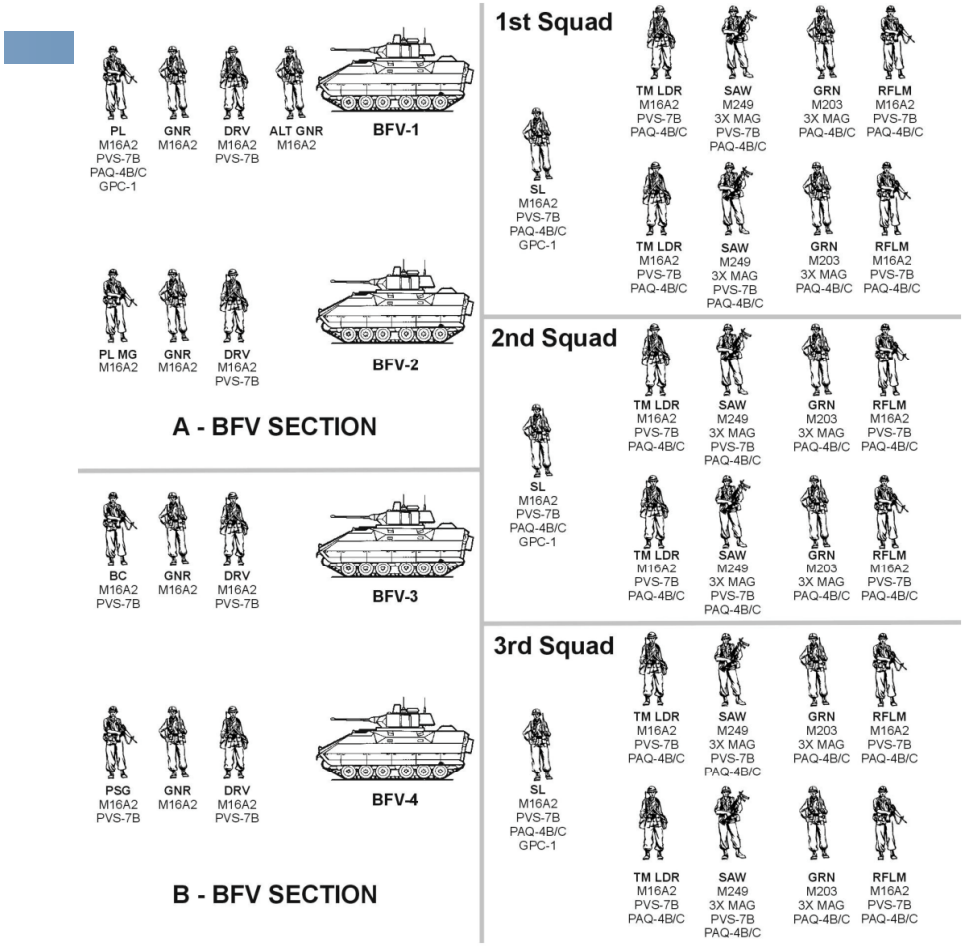
CAB Mechanized Infantry Platoon





Agent
Knowledge
Organization
Resource
Role
Task

Access
Assignment
Command
Communication
Composition

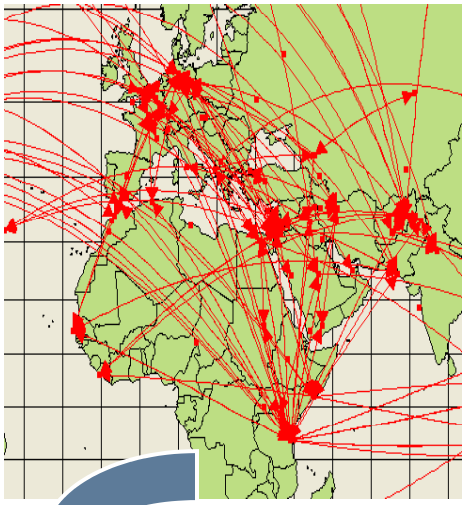
Contribution
Control
Decomposition
Membership
Personnel

Relevance
Requirement
Responsibility
Skill
Storage

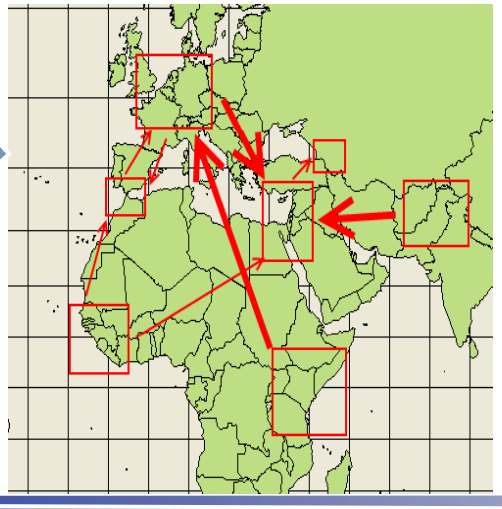
Update
Utilization

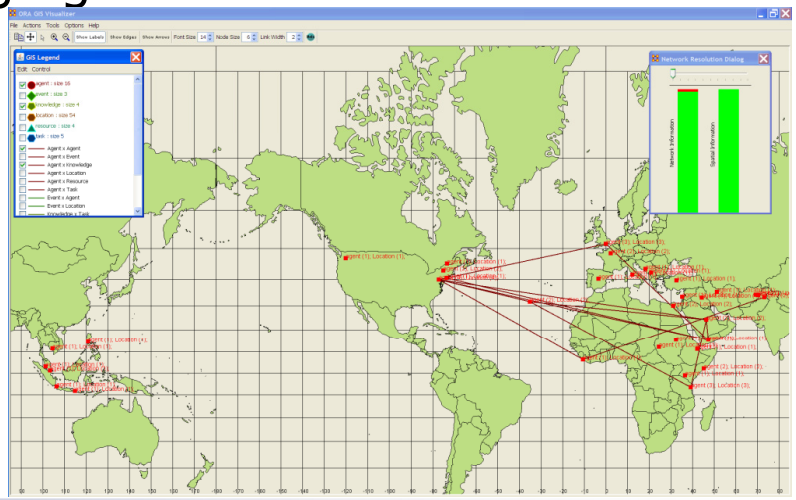
CASOS

Information Gain/Loss Summarized in ORA



- Geospatial network resolution changes
  - Choose appropriate level of granularity/summarization
  - Balance with information loss
- Utilizes Shannon's notion of Entropy
  - Amount of uncertainty in the network caused by the aggregation
- Provide information about what is hidden by the current level of aggregation





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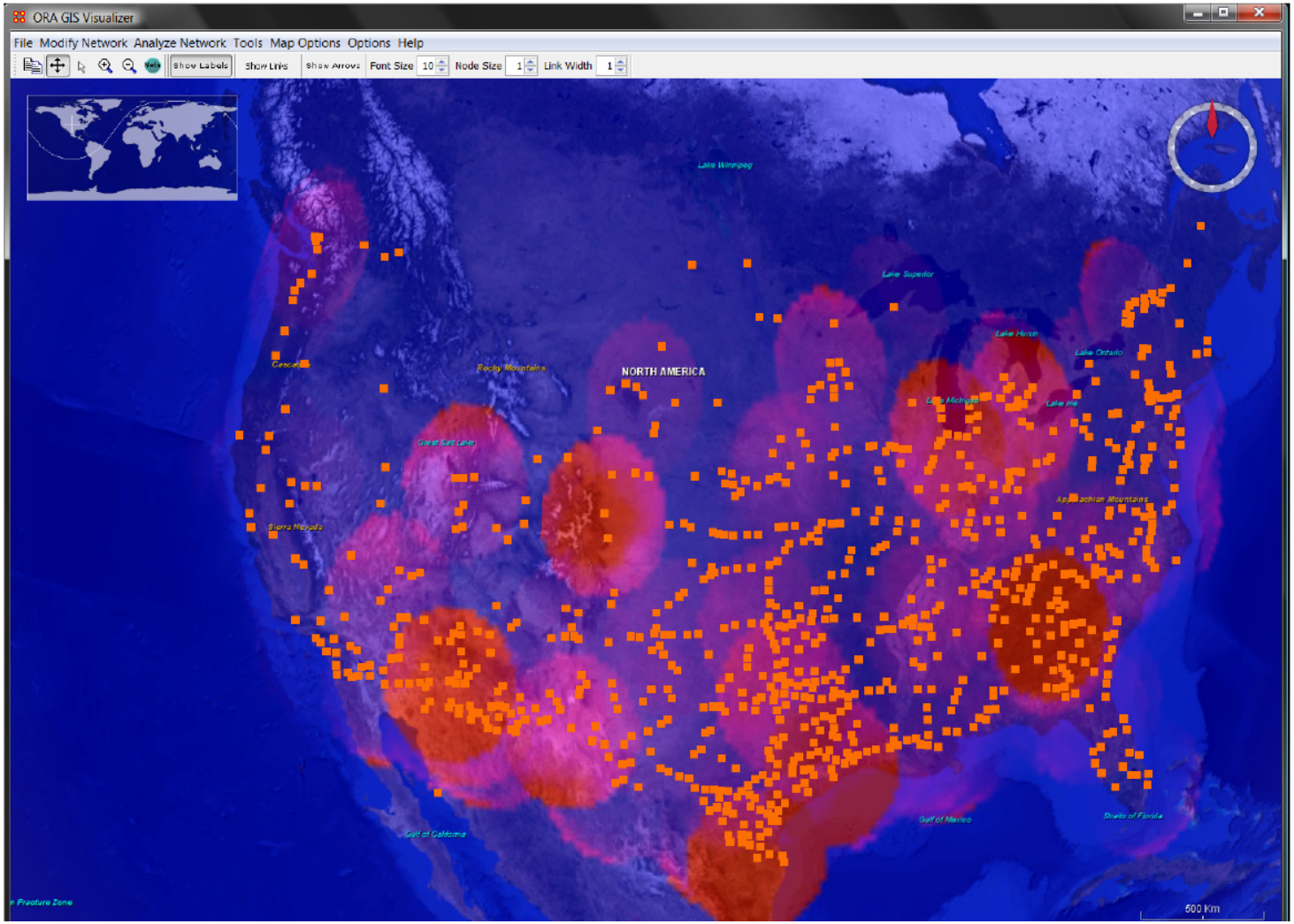
Spatial Density of Betweenness



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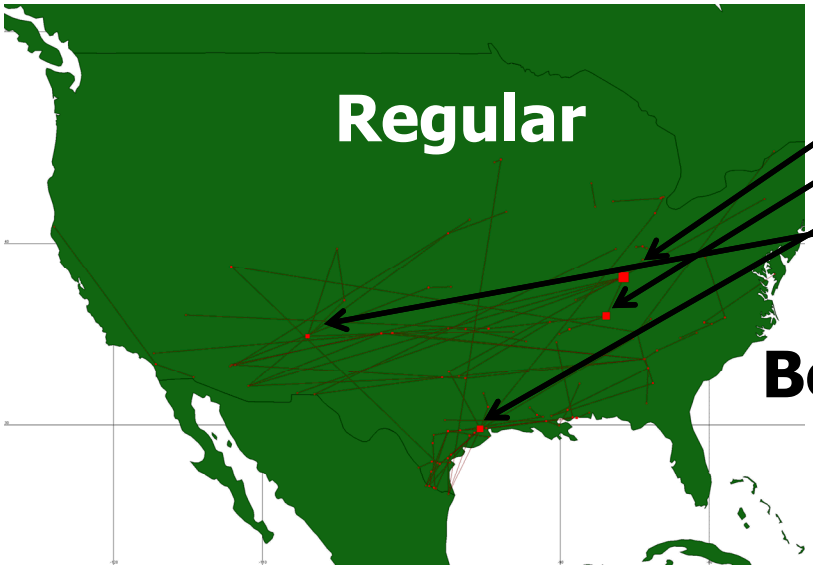
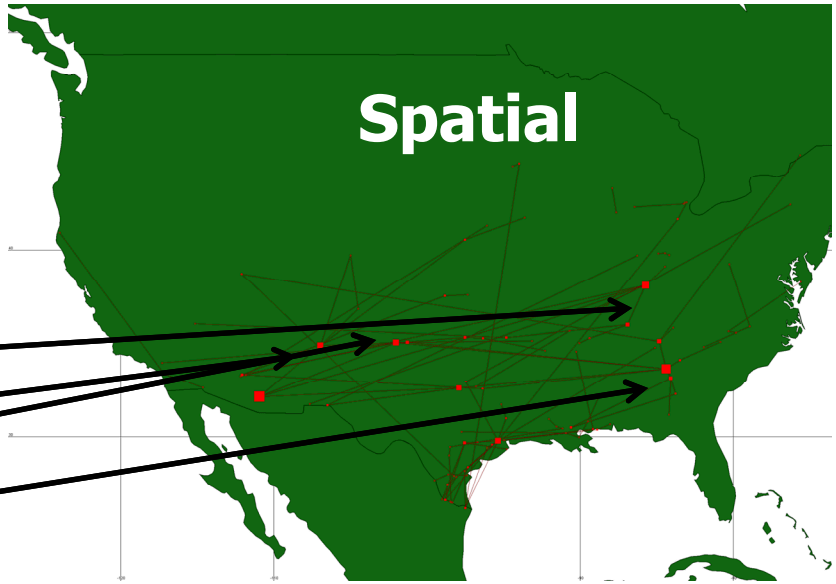
Using Constraints to Set Strength of Links has Practical Consequences



- Louisville
- Nashville
- Houston
- Albuquerque

Betweenness



- Louisville
- Albuquerque
- Tucson
- Atlanta

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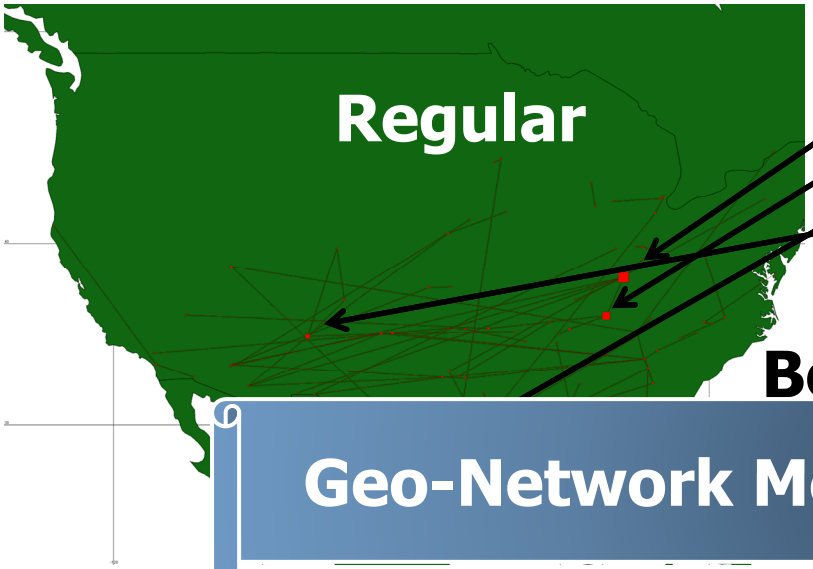
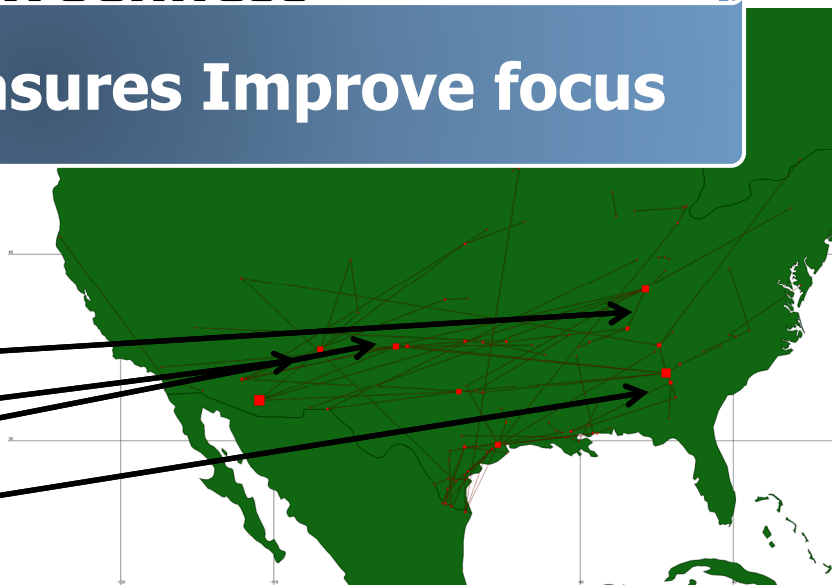


- Louisville
- Nashville
- Houston
- Albuquerque

Betweenness

Geo-Network Measures Improve focus



- Louisville
- Albuquerque
- Tucson
- Atlanta

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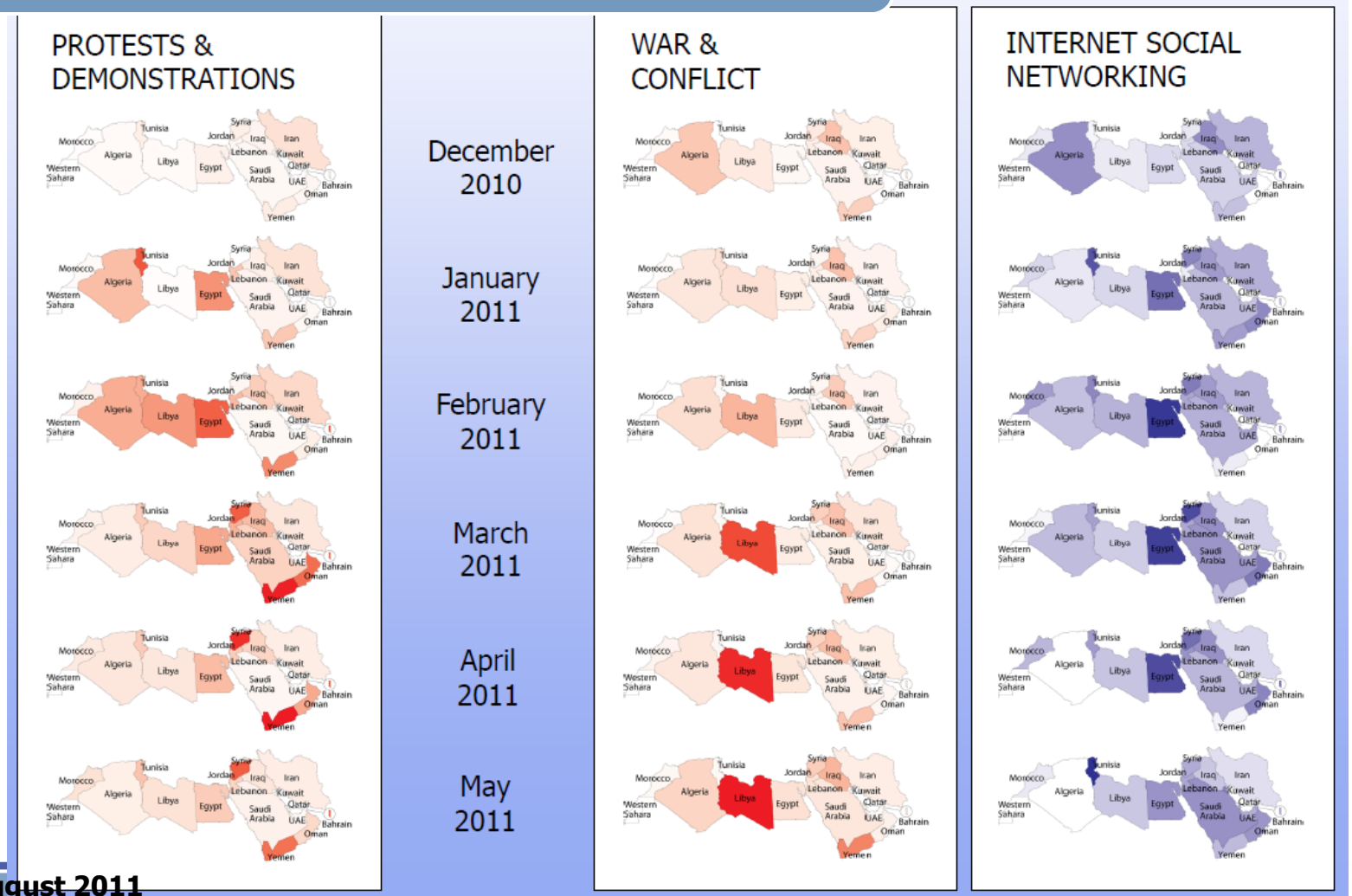
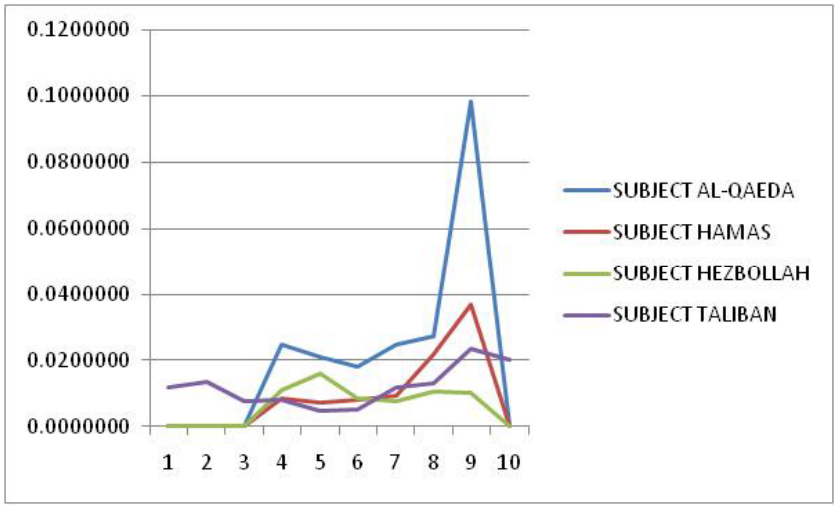
Arab Spring

Data Collection Period: Dec. 2010-June 2011
Articles Processed: 129,712 articles.
People, Organisations, Topics, Locations



Arab Spring and Interest in Terrorism



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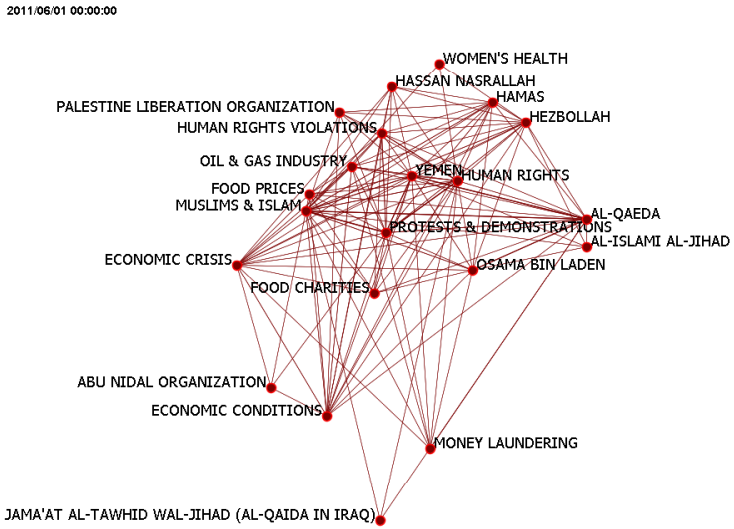

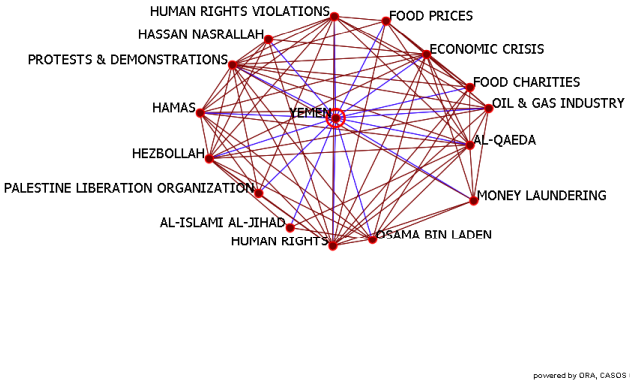

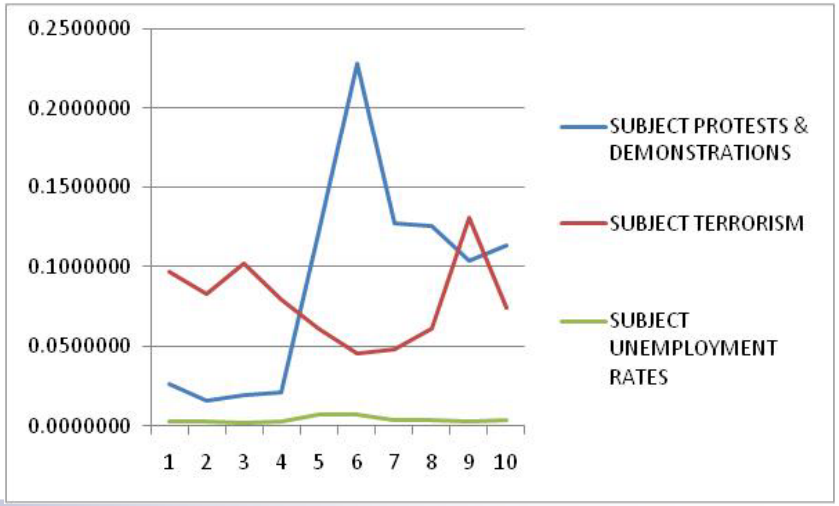

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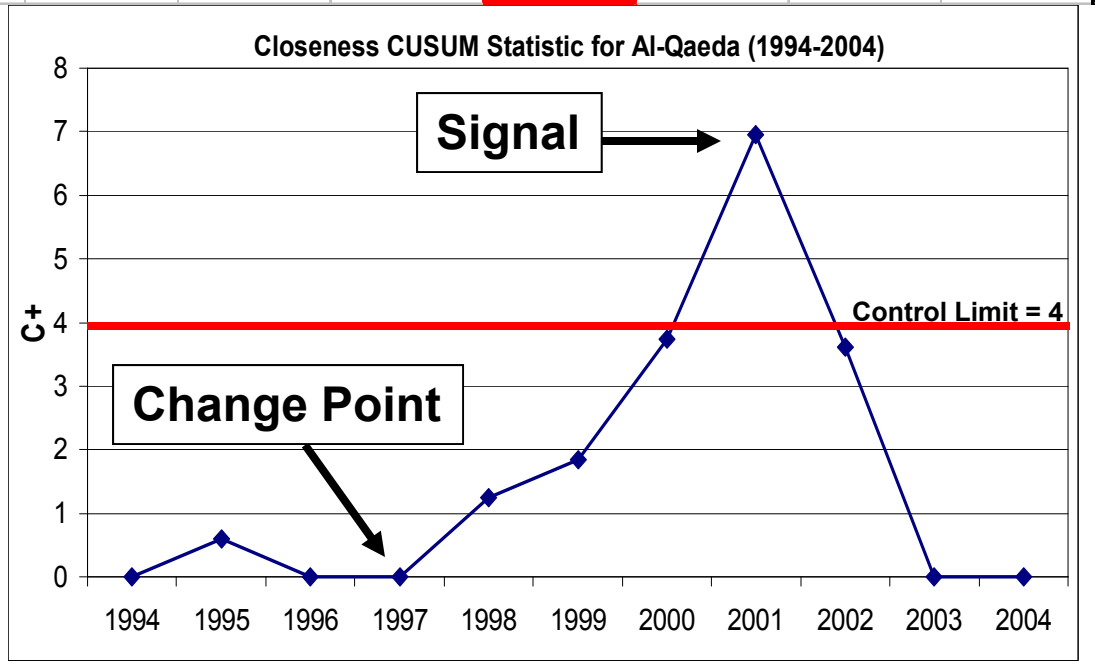
Al-Qaeda Application

The control chart signals a change in the network in 2001.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Closeness	0.0027	0.003	0.0028	0.0028	0.0031	0.003	0.0032	0.0034	0.0024	0.0015	0.0004
Z	-0.8729	1.0911	-0.2182	-0.2182	1.7457	1.0911	2.4004	3.7097	-2.8368	-8.7287	-15.9299
C+	0	0.5911	0	0	1.2457	1.8368	3.7372	6.9469	3.6101	0	0
C-	0.3729	0	0	0	0	0	0	0	2.3368	10.5655	25.9955
Signal	0	0	0	0	0	0	0	1			

Most Likely Estimate of the change point is 1997:
- Re-establish base in Afghanistan
- Bright Star ’97 cut short
- Feb ’98 Islamic Front
- Embassy bombings in ’98

1997 was a critical planning year for Al-Qaeda



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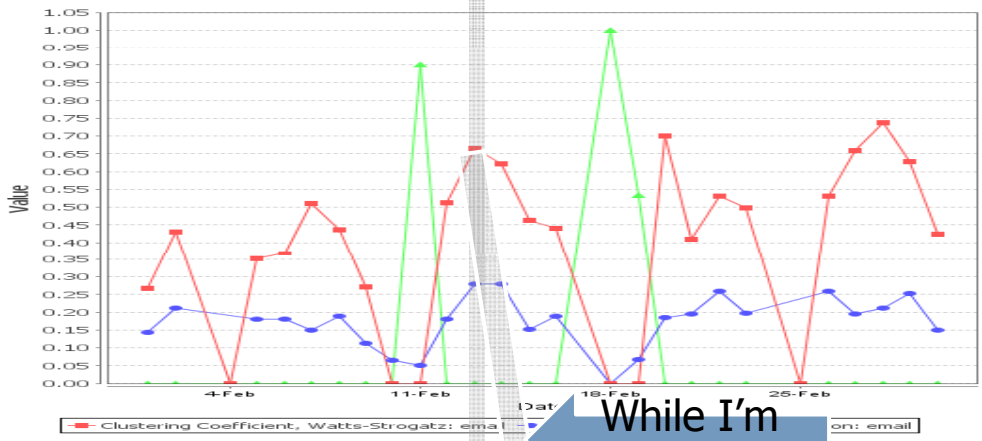
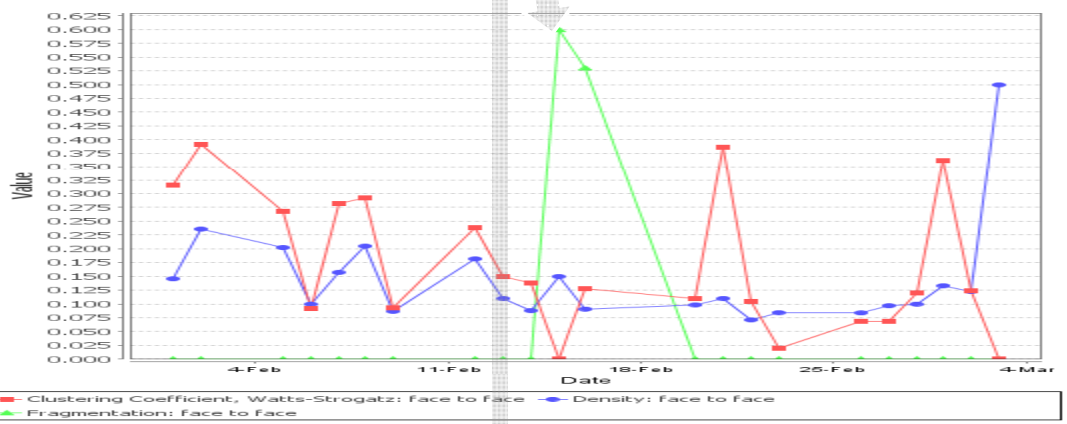
Trail Differences Due to Mode of Interaction

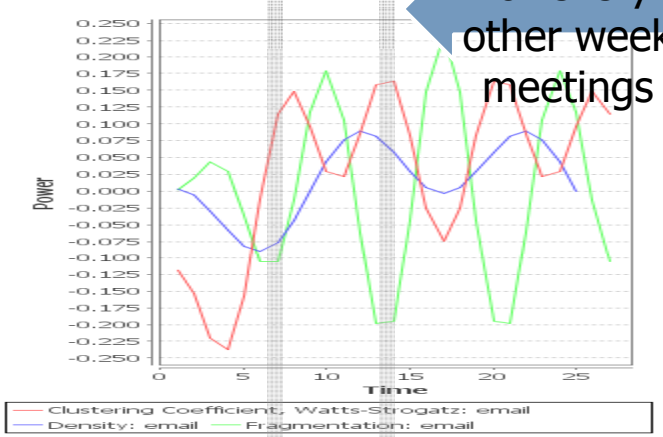
EMail



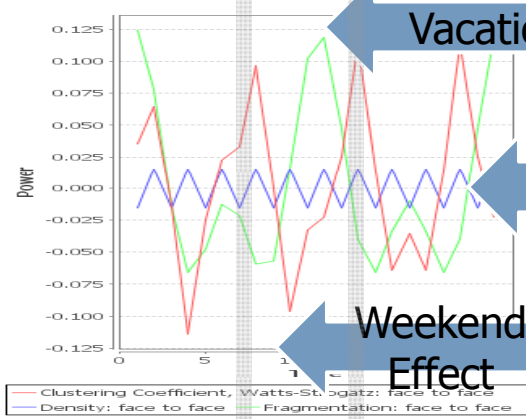
While I'm Away

Face-to-Face





Coordination for every other week meetings



Vacation

# of interactions is random

Weekend Effect

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Rates of Adaptation

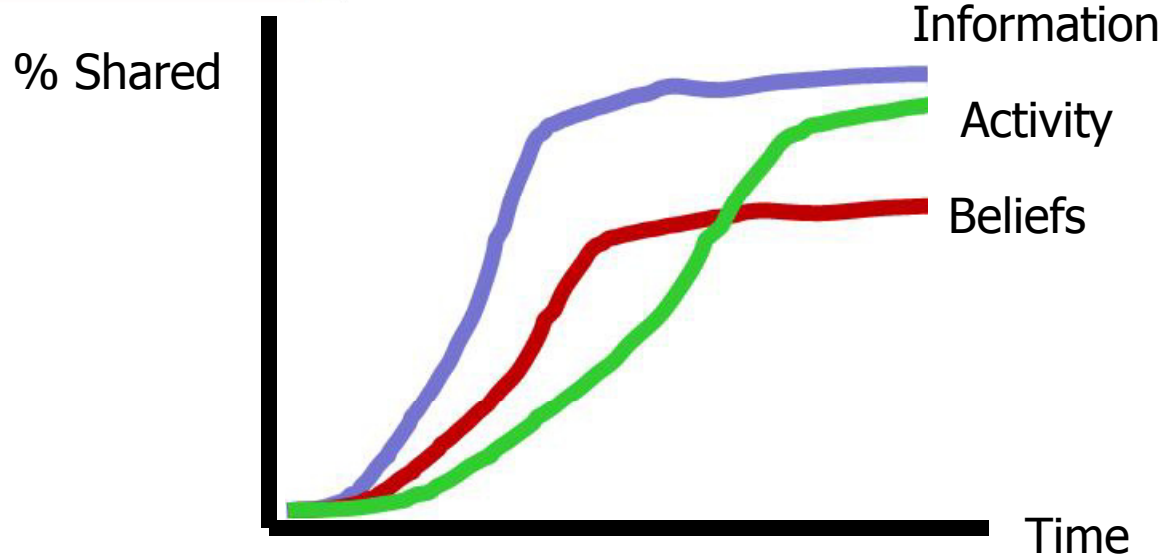
	People	Expertise	Activities	Locations
People				
Expertise				
Activities				
Locations				

Learning Based

Social-Technological Based

Fast

Slow



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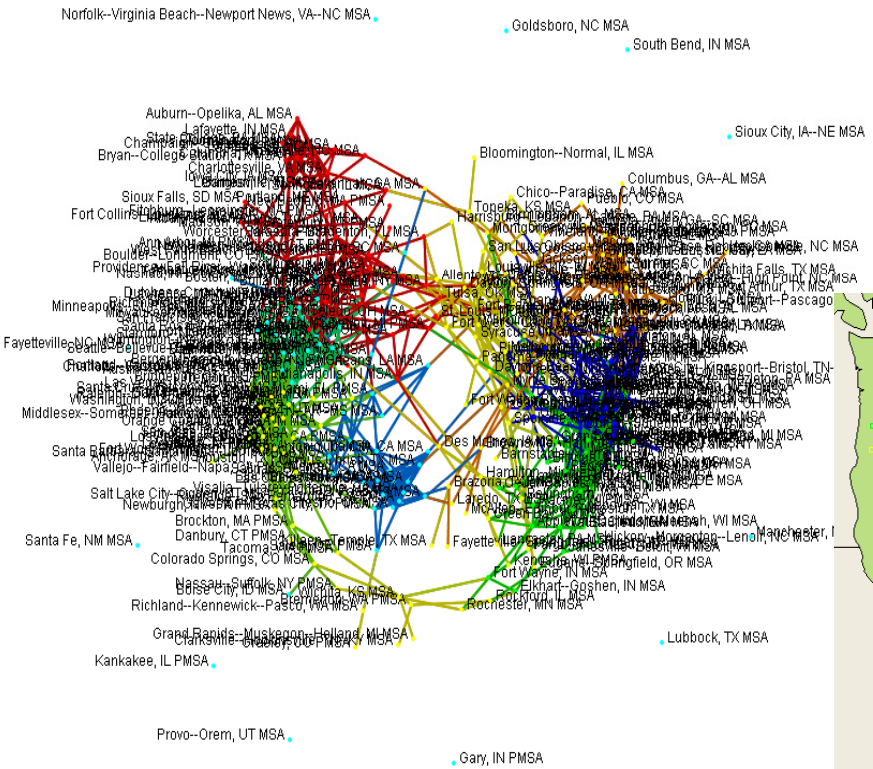
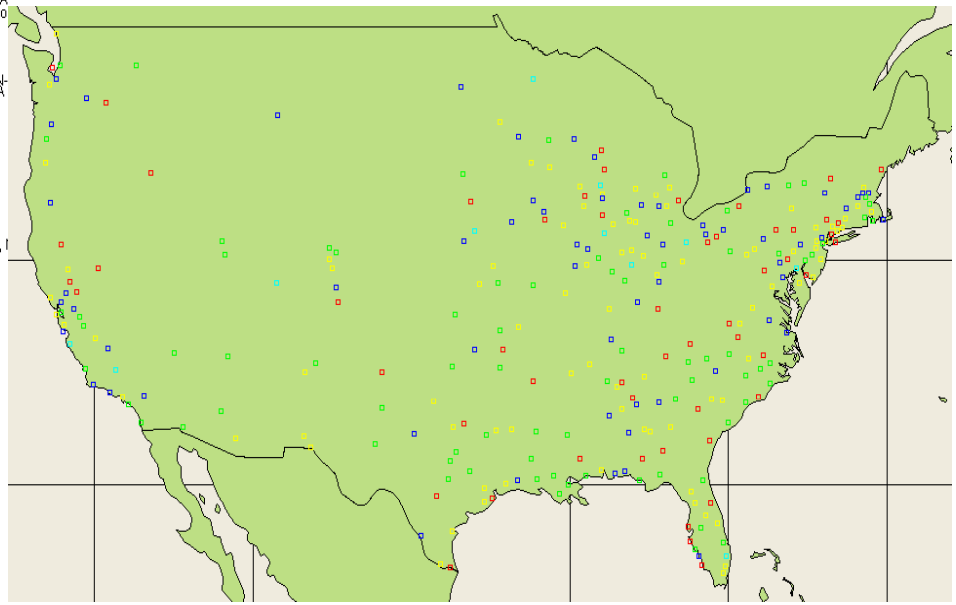
Human Terrain Mapping
Exploring Similarities





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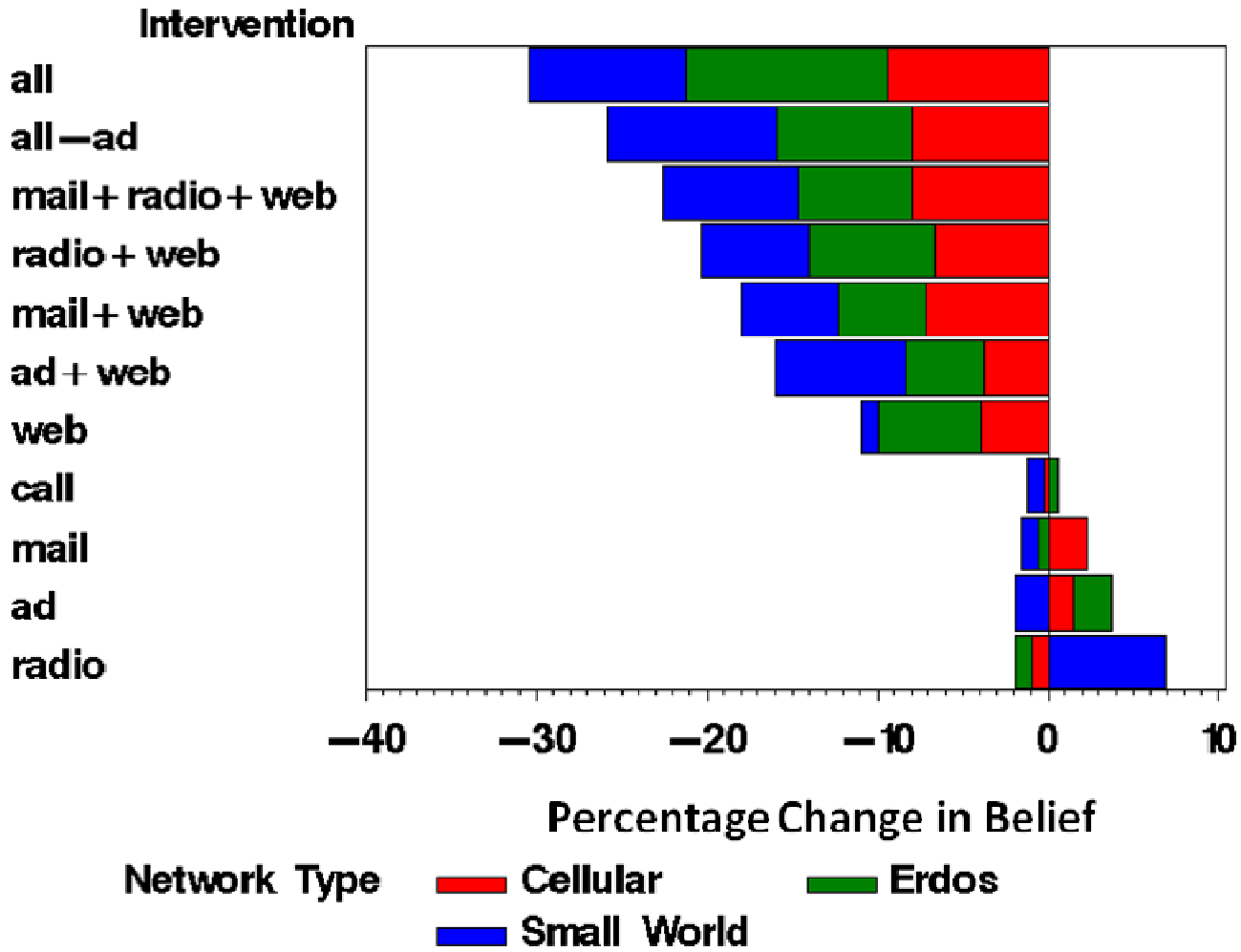
Impact of Media, by Topology



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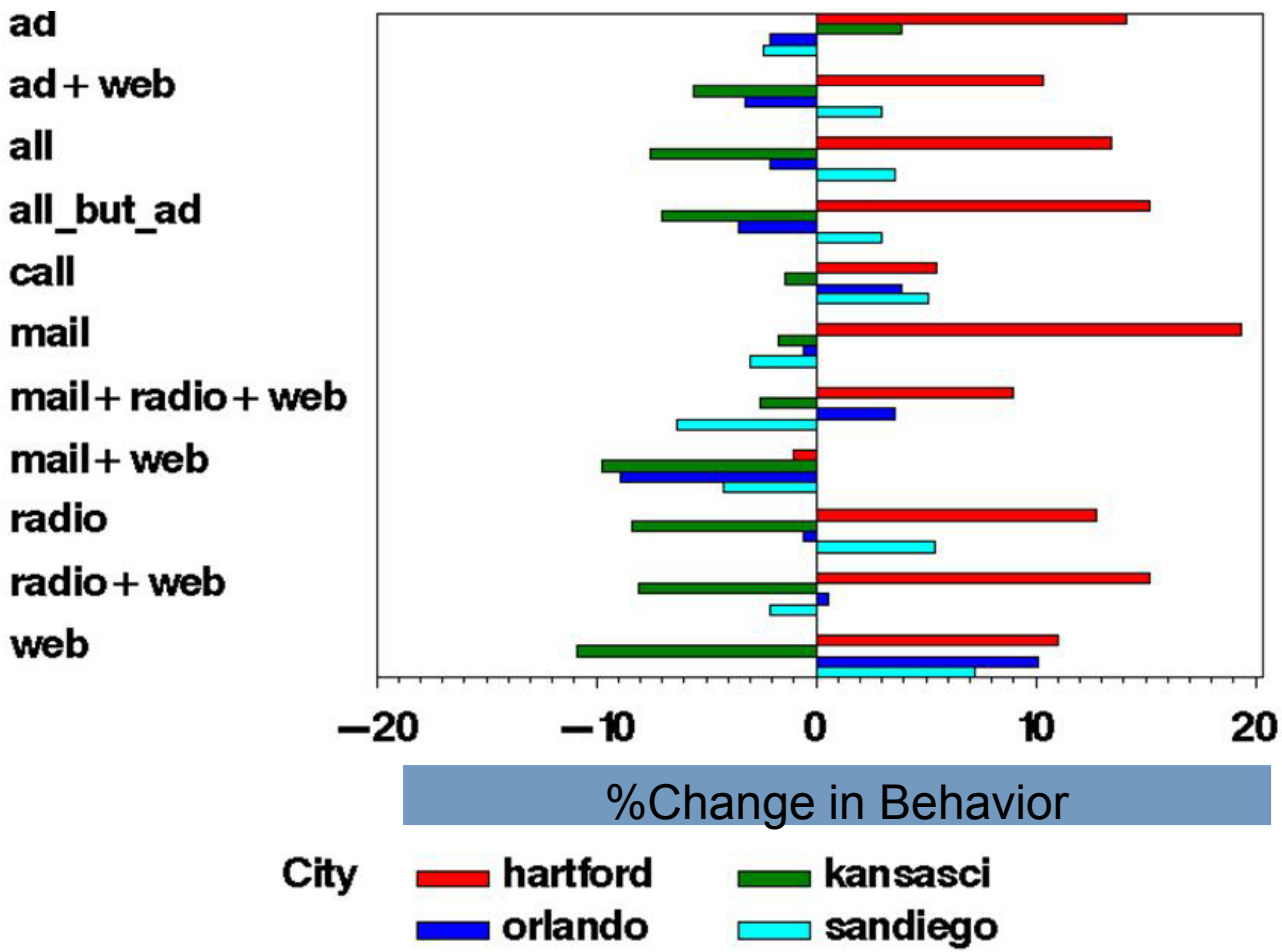
Media Differences by U.S. cities



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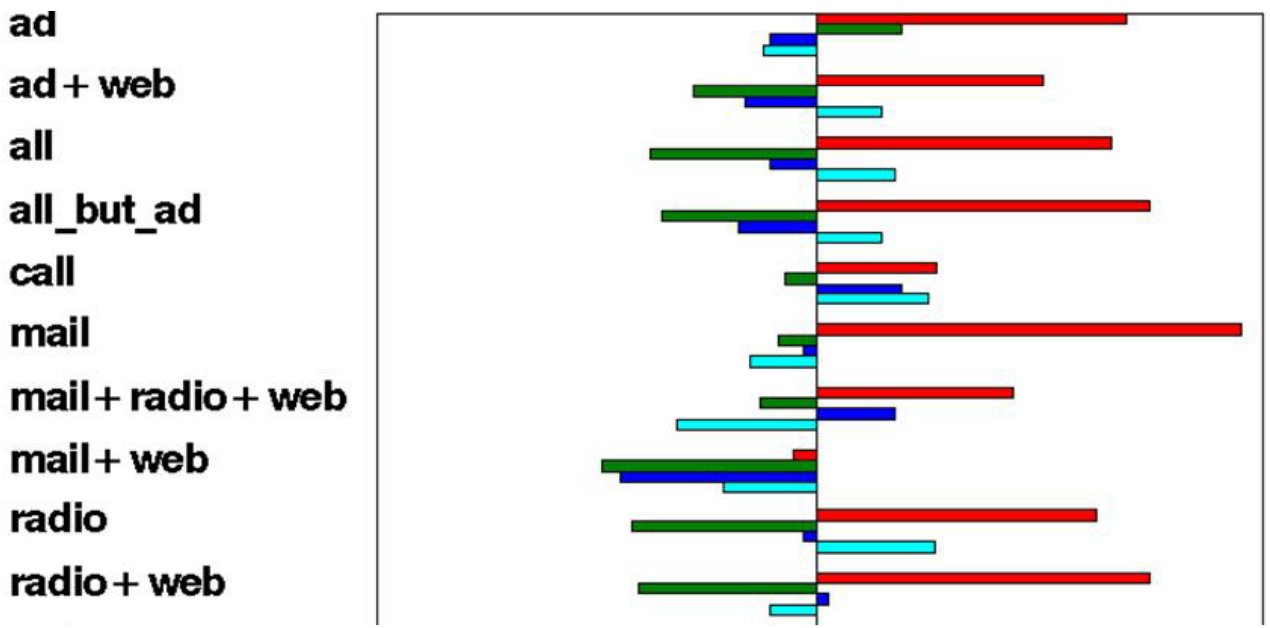
Media Differences by U.S. cities



Different Cities have different networks leading to different diffusion patterns and so distribution of results

City hartford kansascl orlando sandiego

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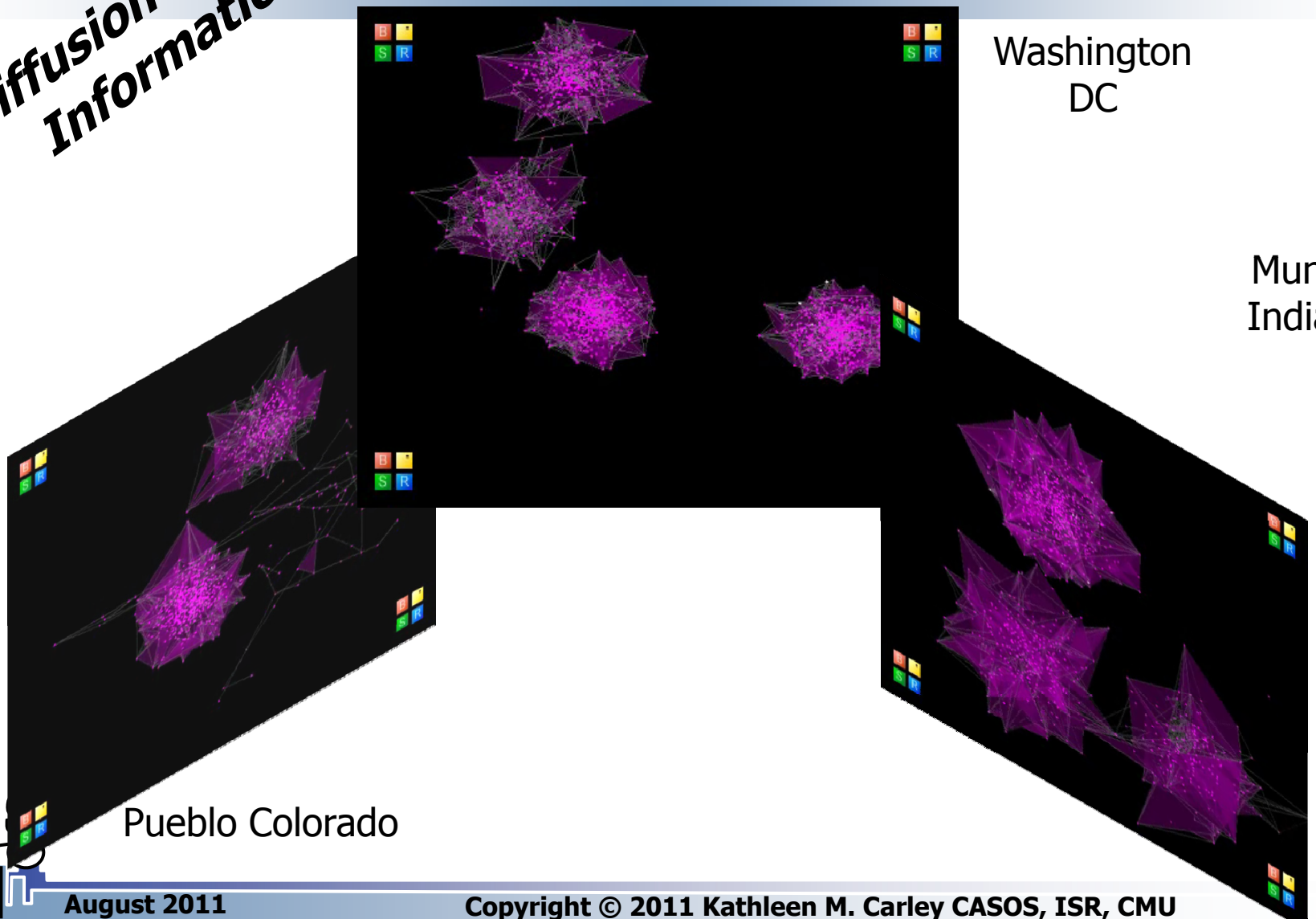
Social Results Vary Due to These Differences

Diffusion of Information



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Summary

Meta-Network

Implicit & Explicit Networks

Dimensions of Aggregation
Time
Space
Groups

Fusing Networks Supports Prediction Link Inference

Trails
Track of Every Day Life
Slices are Networks

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