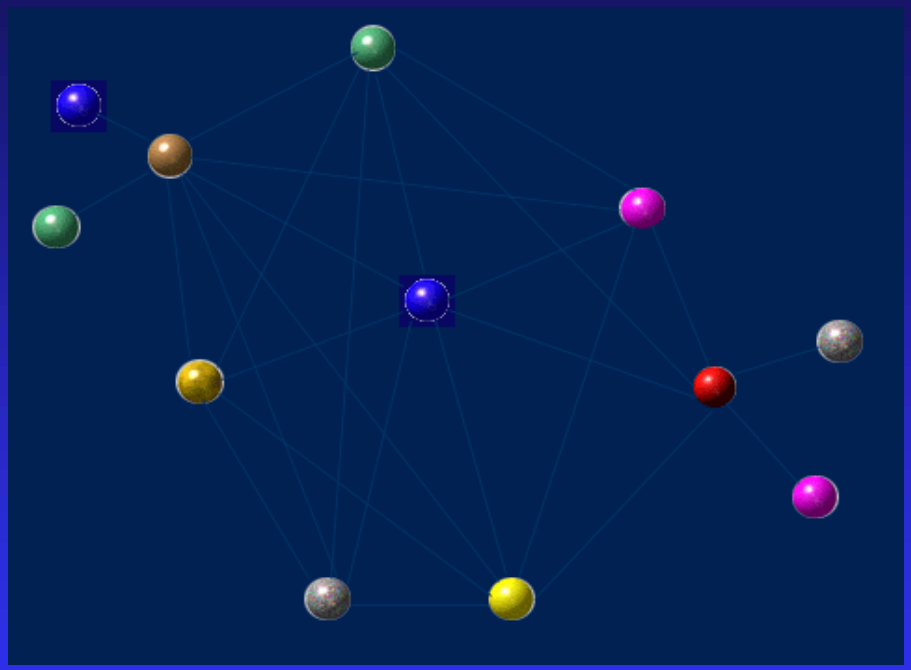
Coevolution of knowledge networks and 21st century cyberinfrastructure



Noshir Contractor
Professor, Departments of Speech Communication & Psychology
Co-Director, Age of Networks, Initiative, Center for Advanced Study
Director, Science of Networks in Communities - SONIC
National Center for Supercomputing Applications
University of Illinois at Urbana-Champaign
nosh@uiuc.edu

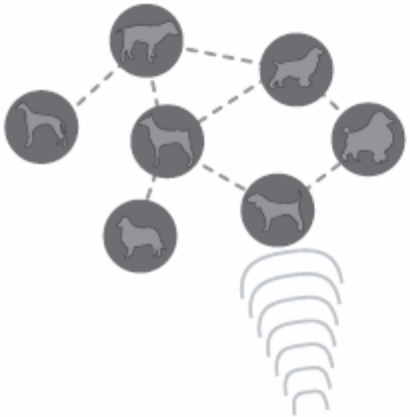
ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

NCSA

Lovegety

1. Turn on power & set MODE with MODE button. You can confirm the MODE you chose as the red indicator blinks.
2. Lamp blinks when (someone with) a Lovegety for the opposite sex set under the same MODE as yours comes near.
3. FIND lamp blinks when (someone with) a Lovegety for the opposite sex set under different mode from yours comes near. May try the other MODES to “GET” tuned with (him/her) if you like.

Social "Petworking" – Reported in Wired, April 11, 2005



SNIF: Social Networking in Fur

Group: Noah Fields, Jonathan Gips, Philip Liang, Arnaud Pilpré

What

We present a system that allows pet owners to interact through their pets' social networks. Inexpensive, unobtrusive hardware can be affixed to pet collars and paraphernalia in order to augment pet-to-pet, pet-to-owner, and owner-to-owner interactions. SNIF devices aggregate pertinent environmental, social, and individual information that can be broadcast or addressed to other participating community members.

Why

Pets already function as social devices. Walking a dog in the park can lead to conversations that one might not otherwise have. Pets function as active icebreakers that will go up to anyone without any notion of social inhibition. Furthermore, pet-owners love buying products for their pets: sweaters, leashes, collars, toys, dishes, and beds. These items provide a set of rich interactions that can be brought into the digital world.

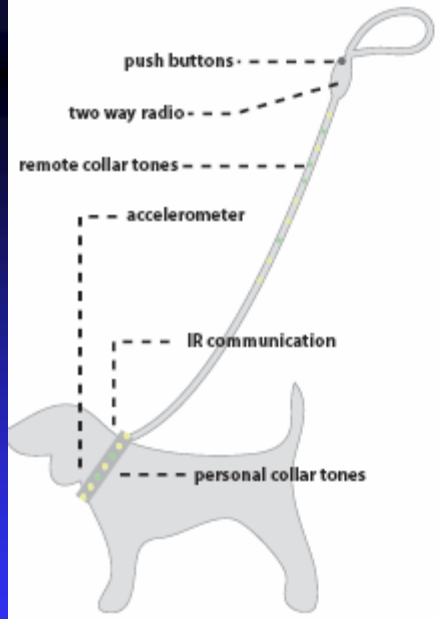
How

The SNIF starter kit includes a leash and collar as well as membership in the online community.

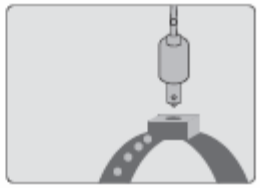
SNIF collars contain an LED display, an IR transceiver, and various sensors such as accelerometers and digital thermometers. They function as output devices that display personalized "collar tones" when the pet comes in proximity to another pet. They serve as input devices that sense activity levels, microclimate conditions, and other pets' presence.

The SNIF leash contains a two-way RF device, such as the Ambient Devices platform, and serves multiple purposes in the SNIF system. When attached to a pet's collar, it can upload information from the collar to the SNIF servers. When disconnected, the leash functions as an ambient device that displays real-time information, which is streamed from the SNIF servers, relevant to the pet and pet owner. For example, the leash displays the "collar tones" of frequently encountered pets that are going out for a walk. It may also give an indication of the general pet-walking index.

The online community portion of SNIF allows pet-owners to set privacy preferences, communicate with other pet owners, arrange pet outings, and customize the ambient information that their SNIF leashes display.

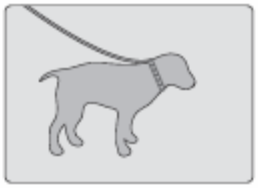


1. leash up



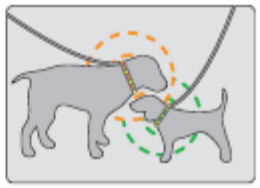
By connecting the leash to the collar, you signal the network that you are about to head out to play.

2. walk



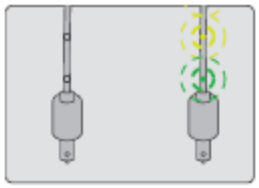
While you are on your walk, your collar keeps an eye out for your pals.

3. sniff



When you discover another dog, your collar displays a unique sequence of flashing lights, these are your collar tones. Your friend's collar tones flash on his collar.

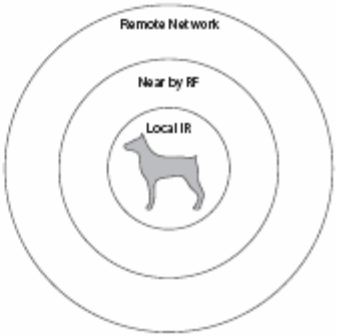
4. friend!



When you are back at your house, you can keep an eye on your companions. When one of your pals goes out to play, their collar tones are displayed on your leash!

Extensions

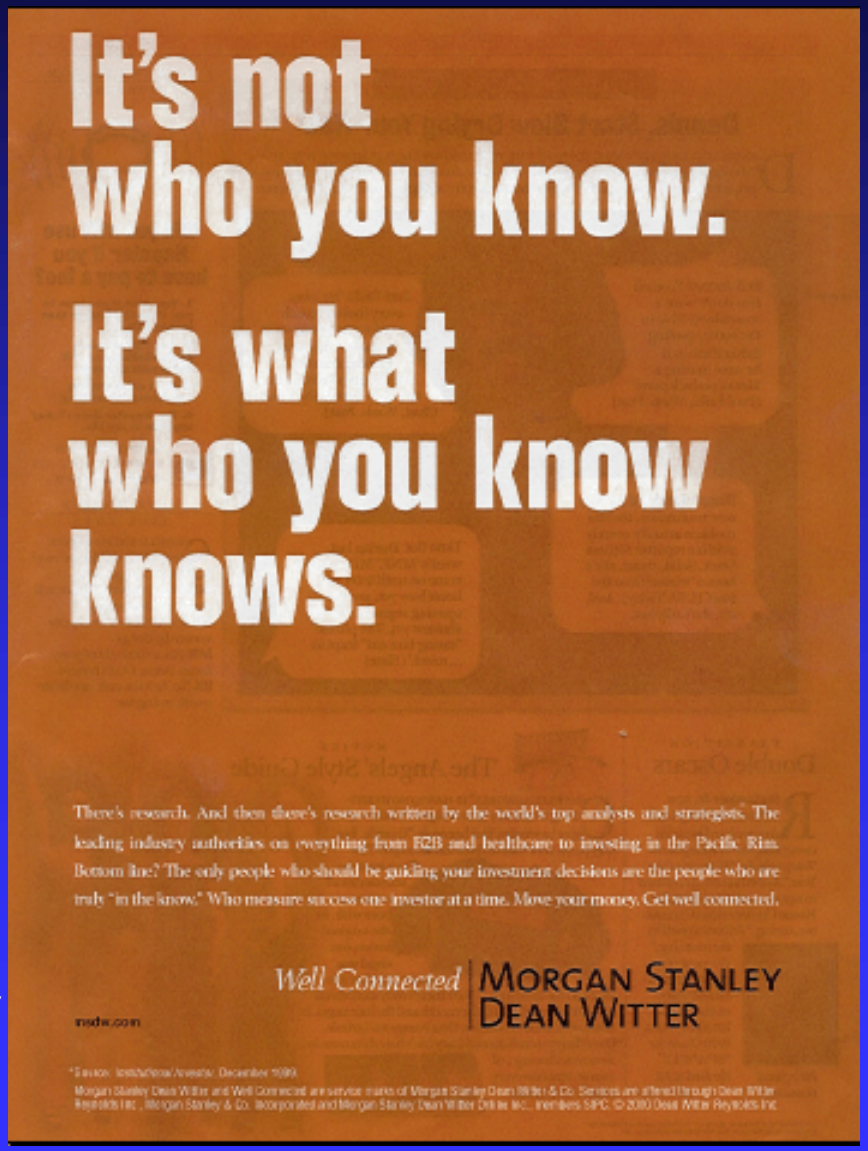
Pet toys that serve as tangible interfaces for the pet.
Degrees of separation between pets that changes as they interact.
Remote monitoring of pet's activity.
Local RF detection to display degrees of separation from the other pets in the vicinity.



Aphorisms about Networks

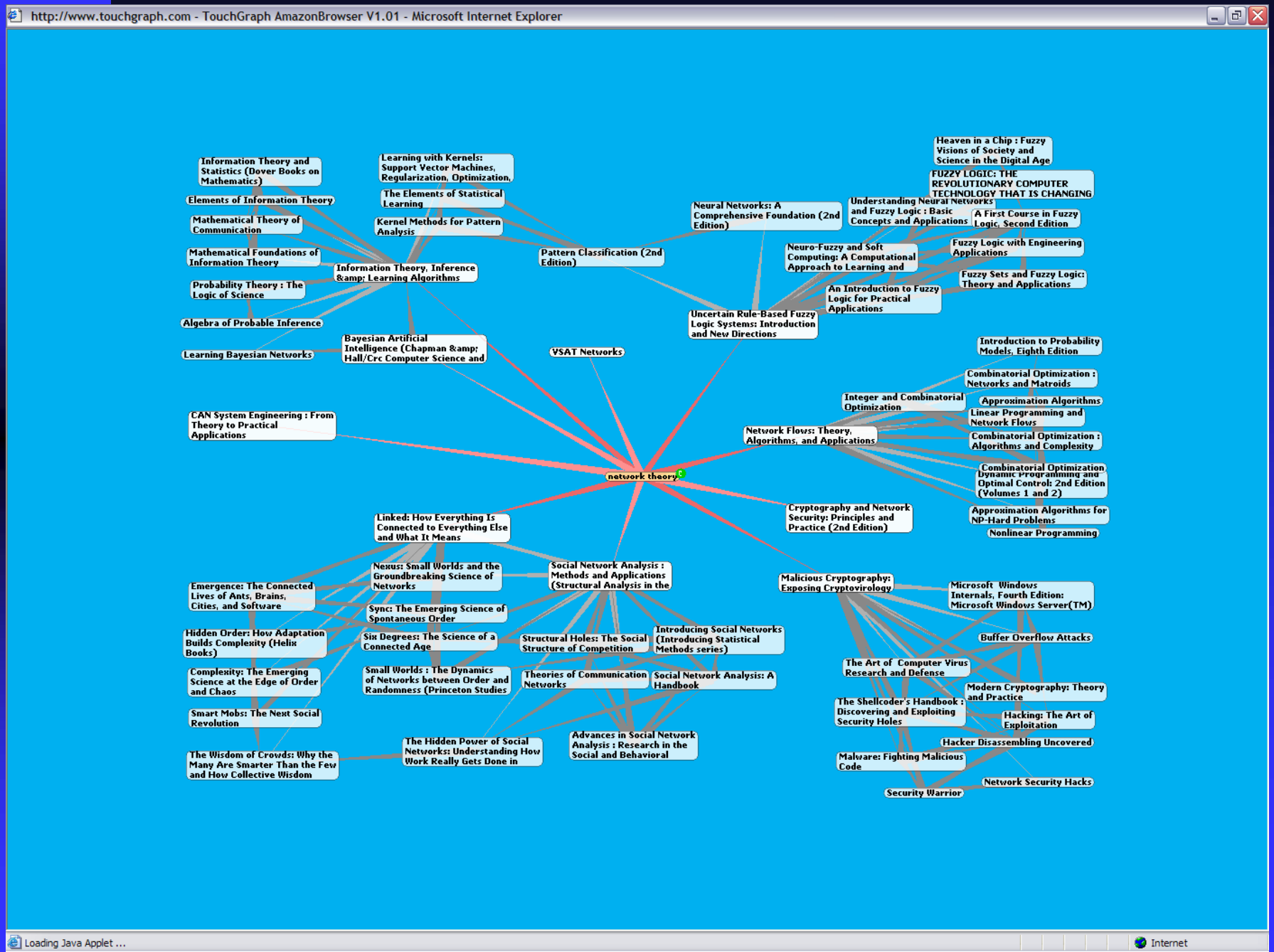
- Social Networks:
  - Its not what you know, its **who** you know.
- Cognitive Social Networks:
  - Its not who you know, its **who they think** you know.
- Knowledge Networks:
  - Its not who you know, its **what they think** you know.

Cognitive Knowledge Networks



Source: Newsweek, December 2000

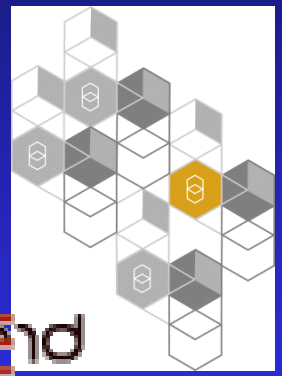
Amazon Purchase Network of Books on “Network Theory”

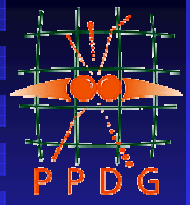


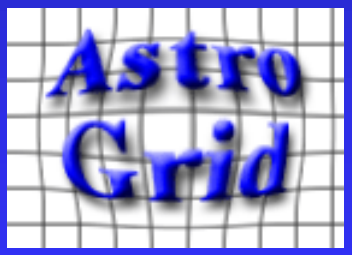
TECLab/SONIC Projects on Enabling Networks

- Networks to enable Cyberinfrastructure, NCSA/NSF
- Emergency Response Networks, NSF-ITR
- Transnational Immigrant Networks, *Rockefeller Foundation*
- Economic Justice Networks, *Rockefeller Foundation*
- Communities of Practice Networks, *Procter &Gamble*
- Food Safety Networks, UIUC Cross-Campus Initiative & *John Deere*
- Global Supply Chain Infrastructure, *Vodafone*

Science and Engineering Cyberinfrastructures







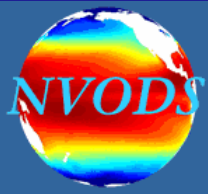
Geosciences Cyberinfrastructures

CUAHSI
Consortium of Universities for the Advancement of Hydrologic Science, Inc.

Meteorological Assimilation Data Ingest System (MADIS)

LINKED ENVIRONMENTS FOR ATMOSPHERIC DISCOVERY

THE EARTH SYSTEM GRID
ESG



The National Virtual Ocean Data System

Distributed Oceanographic Data System
Global Change Master Directory Portal

NOMADS
The NOAA Operational Model Archive and Distribution System

DLESE
A community-centered resource for anyone interested in learning more about the Earth.
Supported by the National Science Foundation

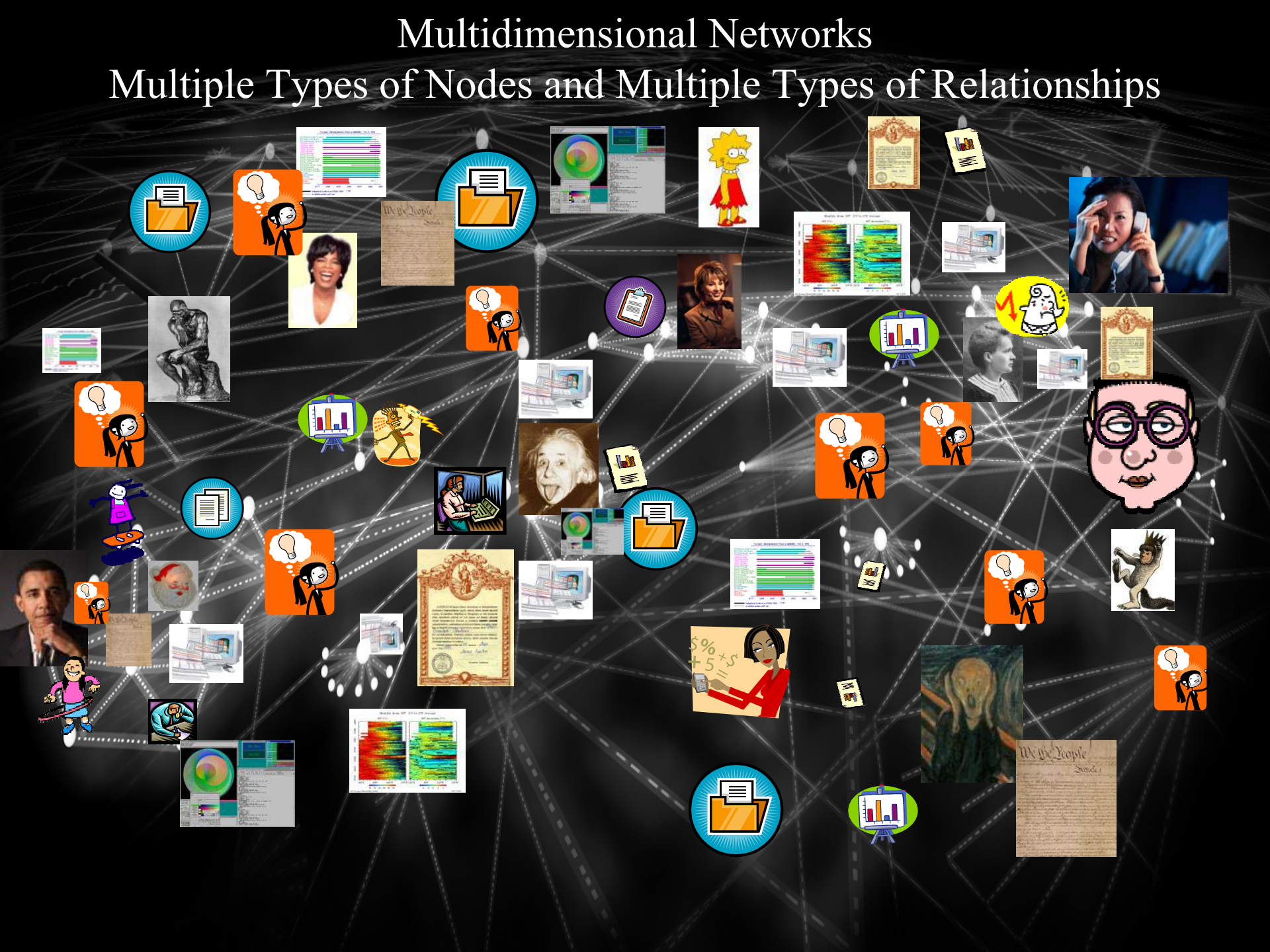
earth scope

GEON
CYBERINFRASTRUCTURE FOR THE GEOSCIENCES

Building the National Virtual Collaboratory for Earthquake Engineering Research
NEESgrid

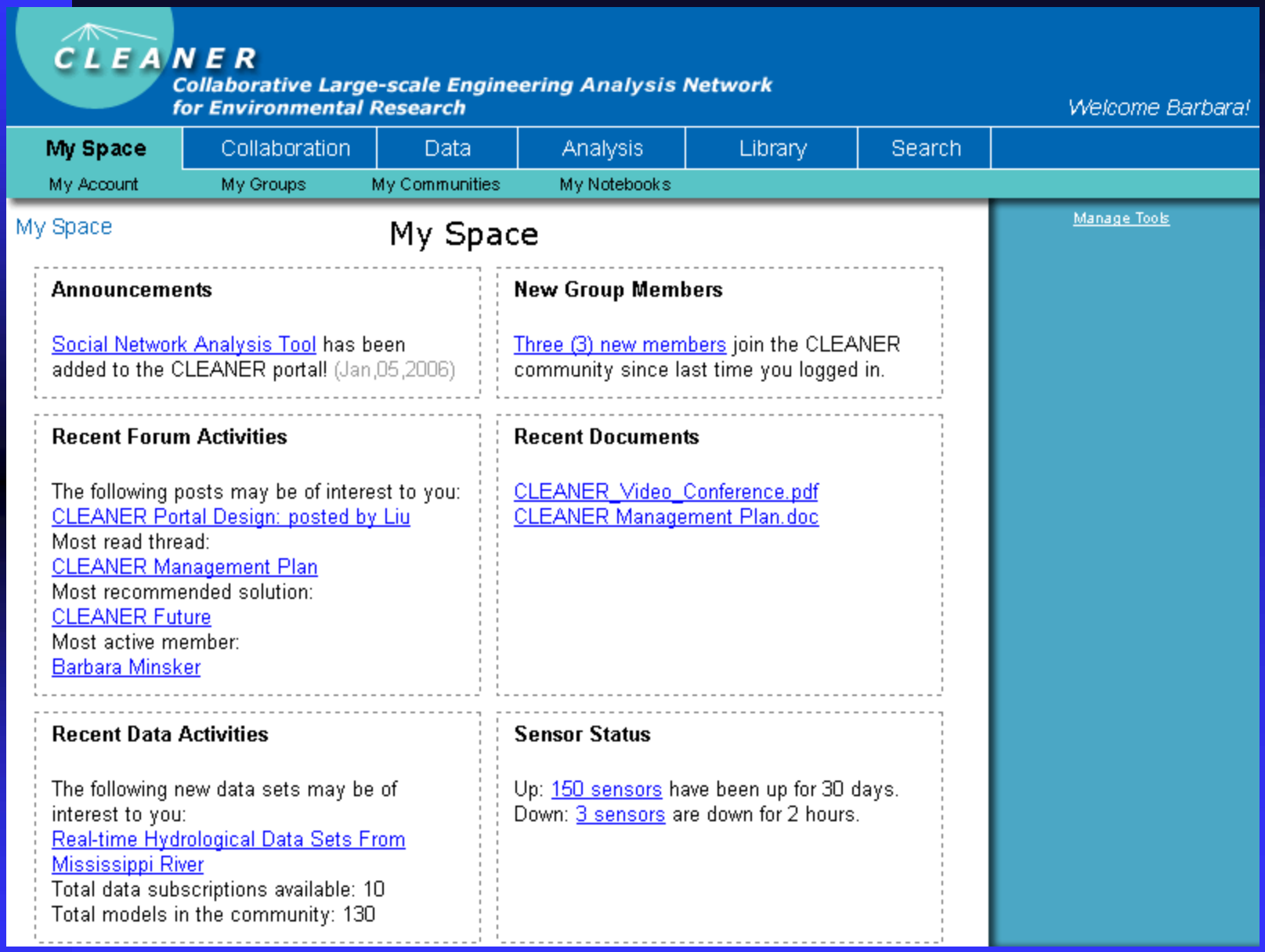
SEEK: The Science Environment for Ecological Knowledge

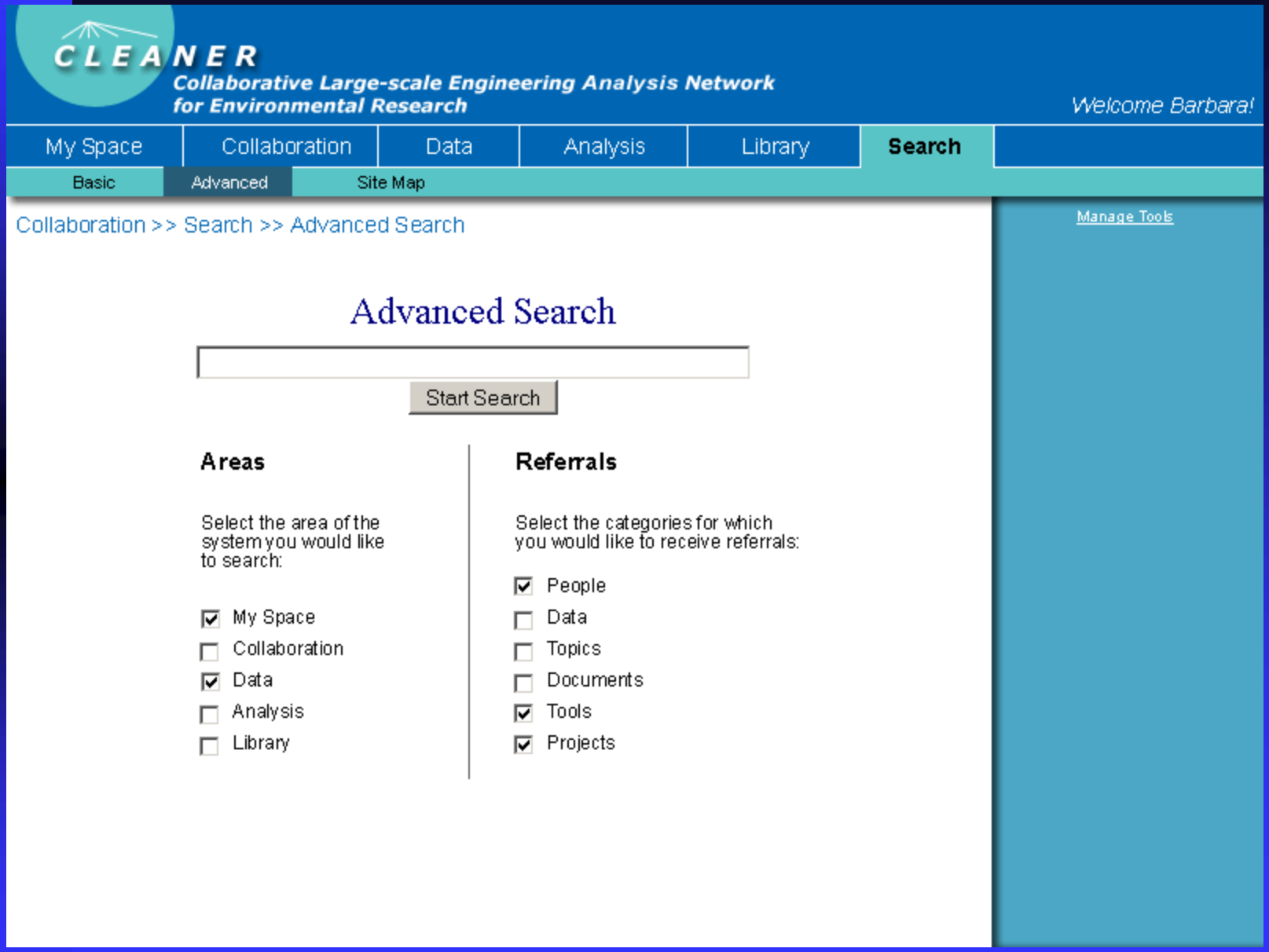
Multidimensional Networks
Multiple Types of Nodes and Multiple Types of Relationships



Testbed Communities: Partners

- Collaborative for Large-scale Engineering Analysis Network for Environmental Research (CLEANER)
- Tobacco Systems Integration Grid (Tobacco SIG)
- Social Network Analysis Cyberinfrastructure (SNAC)


CLEANER
Collaborative Large-scale Engineering Analysis Network for Environmental Research
Welcome Barbara!
My Space
Collaboration
Data
Analysis
Library
Search
My Account
My Groups
My Communities
My Notebooks
My Space
My Space
Manage Tools
Announcements
Social Network Analysis Tool has been added to the CLEANER portal! (Jan,05,2006)
New Group Members
Three (3) new members join the CLEANER community since last time you logged in.
Recent Forum Activities
The following posts may be of interest to you:
CLEANER Portal Design: posted by Liu
Most read thread:
CLEANER Management Plan
Most recommended solution:
CLEANER Future
Most active member:
Barbara Minsker
Recent Documents
CLEANER_Video_Conference.pdf
CLEANER Management Plan.doc
Recent Data Activities
The following new data sets may be of interest to you:
Real-time Hydrological Data Sets From Mississippi River
Total data subscriptions available: 10
Total models in the community: 130
Sensor Status
Up: 150 sensors have been up for 30 days.
Down: 3 sensors are down for 2 hours.


CLEANER
Collaborative Large-scale Engineering Analysis Network for Environmental Research
Welcome Barbara!
My Space
Collaboration
Data
Analysis
Library
Search
Basic
Advanced
Site Map
Collaboration >> Search >> Advanced Search
Manage Tools
Advanced Search
Start Search
Areas
Select the area of the system you would like to search:
My Space
Collaboration
Data
Analysis
Library
Referrals
Select the categories for which you would like to receive referrals:
People
Data
Topics
Documents
Tools
Projects

CLEANER
Collaborative Large-scale Engineering Analysis Network for Environmental Research

Welcome Barbara!

My Space | Collaboration | Data | Analysis | Library | **Search**

Basic | Advanced | Site Map

Collaboration >> Search >> Advanced Search

Advanced Search

watersheds

Start Search

Displaying Results 1 through 20 of approximately 286 [Next 20 Results]

Draft Action Plan for Reducing Mitigating and Controlling Hypoxia in the Northern Gulf of ...
HTML, Thursday September 04 2003 8:31 PM

Notice of Availability and Request for Comment on Draft Plan of Action for Reducing Mitigating< ...
HTML, Saturday October 14 2000 10:52 PM

ens
HTML, Monday September 29 2003 1:13 PM

Chesapeake Research Consortium Publications
HTML, Tuesday January 14 2003 6:28 PM

Stormwater | Nutrient Trading
HTML, Friday September 26 2003 10:22 PM

Manage Tools

Relevant People

Based on your search, you might be interested in the following people:

Scott Rayder

Paul L. Kelly

Robert Stickney

Robert Twilley

Social Network Map

CLEANER

Collaborative Large-scale Engineering Analysis Network for Environmental Research

Welcome Barbara!

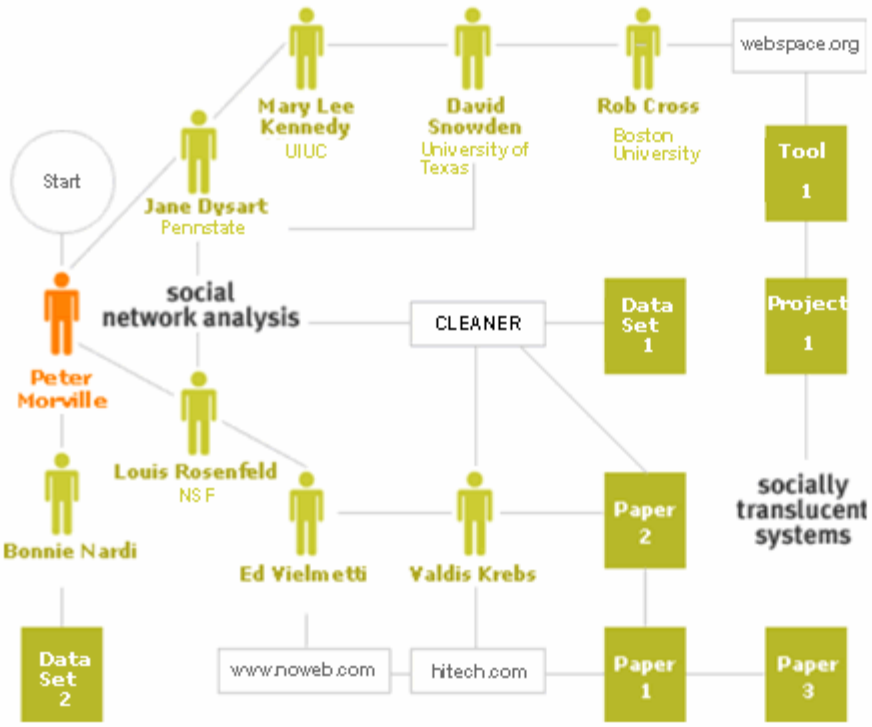
My Space | Collaboration | Data | Analysis | Library | **Search**

Basic | Advanced | Site Map

Search >> Advanced Search >> Social Network Analysis

Manage Tools

Social Network Map



Demo of multidimensional network

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- Food Safety Networks, UIUC Cross-Campus Initiative & *John Deere*
- Global Supply Chain Infrastructure, *Vodafone*

ICT Support in Emergency Management Networks

} Drawing Analogies from Natural Systems

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

NCSA

Natural System: Honey Bees

ENTOMOLOGY: Learning from natural robust societies.

Successful systems (evolution time)

Ant - based models have successfully been applied to solve optimization [Dorigo, 1996; Botee, 1999] and networking [Bonabeau, 2000] problems, among others.

Bees' setting and objectives in foraging [Seeley, et al. 1991] resembles disaster relief response scenario (collective decision-making).

Problem: Information Overload

- Hundreds or Thousands of first responders operate sharing couple of voice channels (radio, cell-phones) [Domel, 2001]

http://www.hollandsentinel.com/images/031503/Borculofire4.jpg

- If technology provides a mean to enhance delivery and media of information, we envision this problem would increase

Information Overload: Ants

Analogy (Ants' alarm propagation)

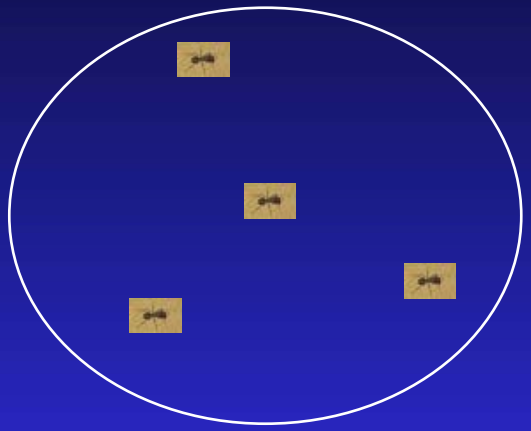
Division of Labor; each ant "has" a threshold for each stimulus (pheromone).

When stimulus is greater than threshold the ant will be on "alarm" mode.

Centels ants detects a hazard and release "alarm" pheromone (volatile).

Each pheromone release will last for a limited time; seconds or minutes.

The heterogeneous response to alarm pheromone avoids all ants react immediately (good or bad?).



H
O
W

Idea:

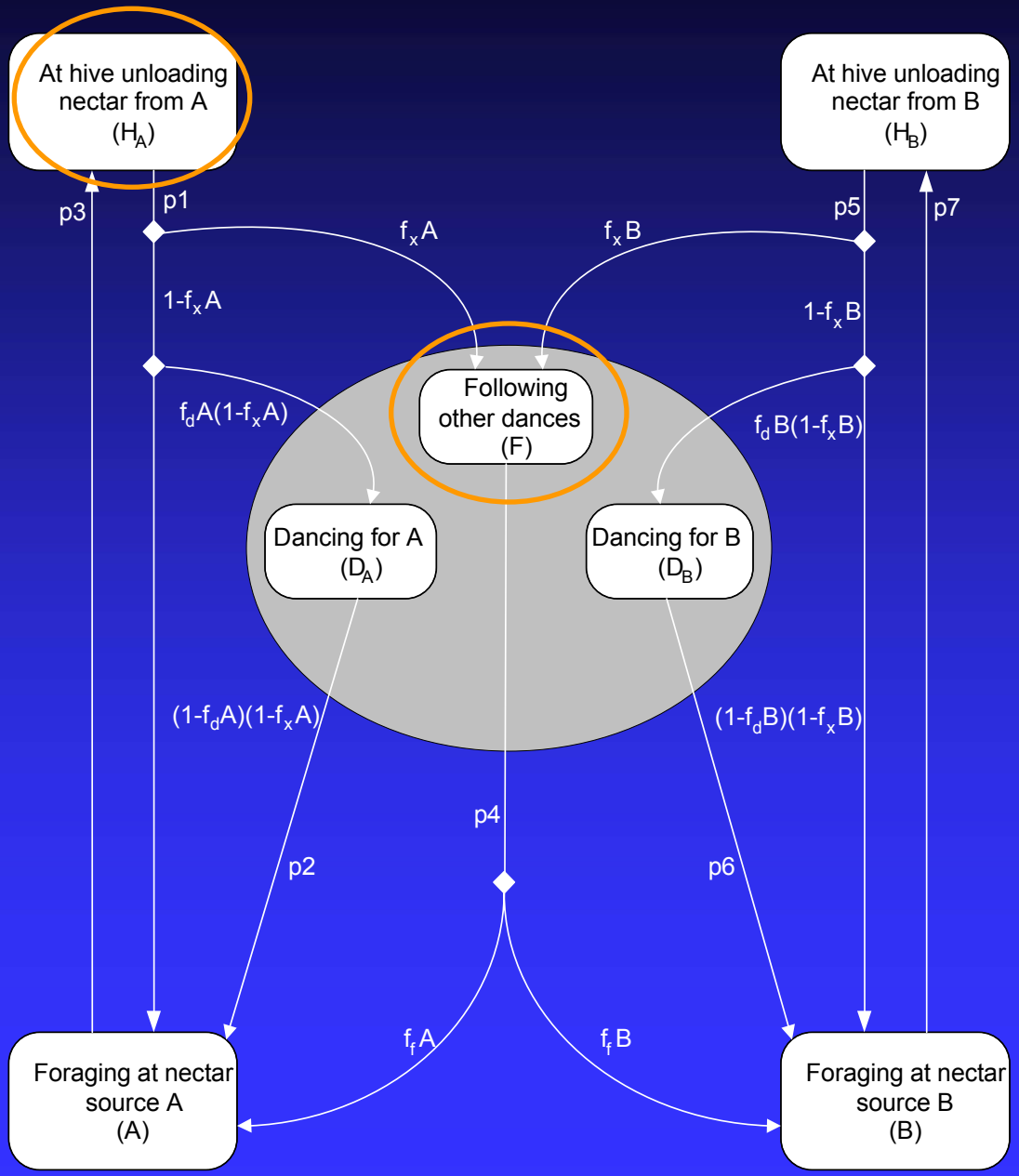
Actors will propagate information received only if the stimulus, i.e., "quality of information", is greater than his/her threshold for that type of information.

Avoiding cascading effect; controlling information overload.

Natural System: Honey Bees

Honey Bees (*Apis melifera*)
Foraging Model [Seeley, 1991]

The system evaluates ALL the information, though individuals evaluate only partial information



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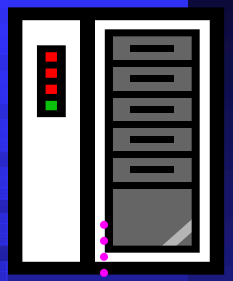
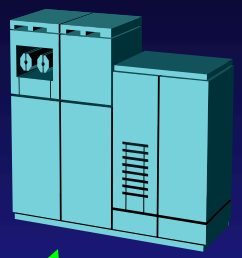
INTERACTION NETWORKS

Non Human Agent to
Non Human Agent
Communication





Non Human Agent
(webbots, avatars, databases,
"push" technologies)
To Human Agent

Publishing to
knowledge repository

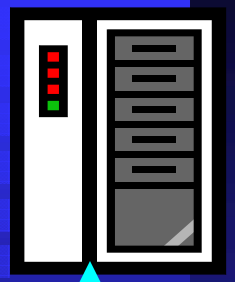
Retrieving from
knowledge repository

Human Agent to Human Agent
Communication

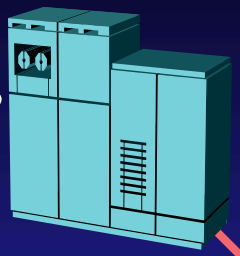
Source: Contractor, 2001

SONIC

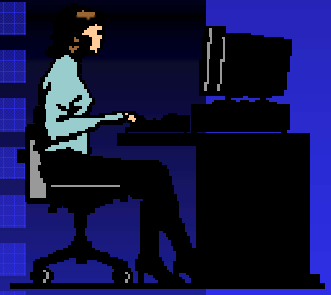
COGNITIVE KNOWLEDGE NETWORKS



Non Human Agent's Perception of Resources in a Non Human Agent



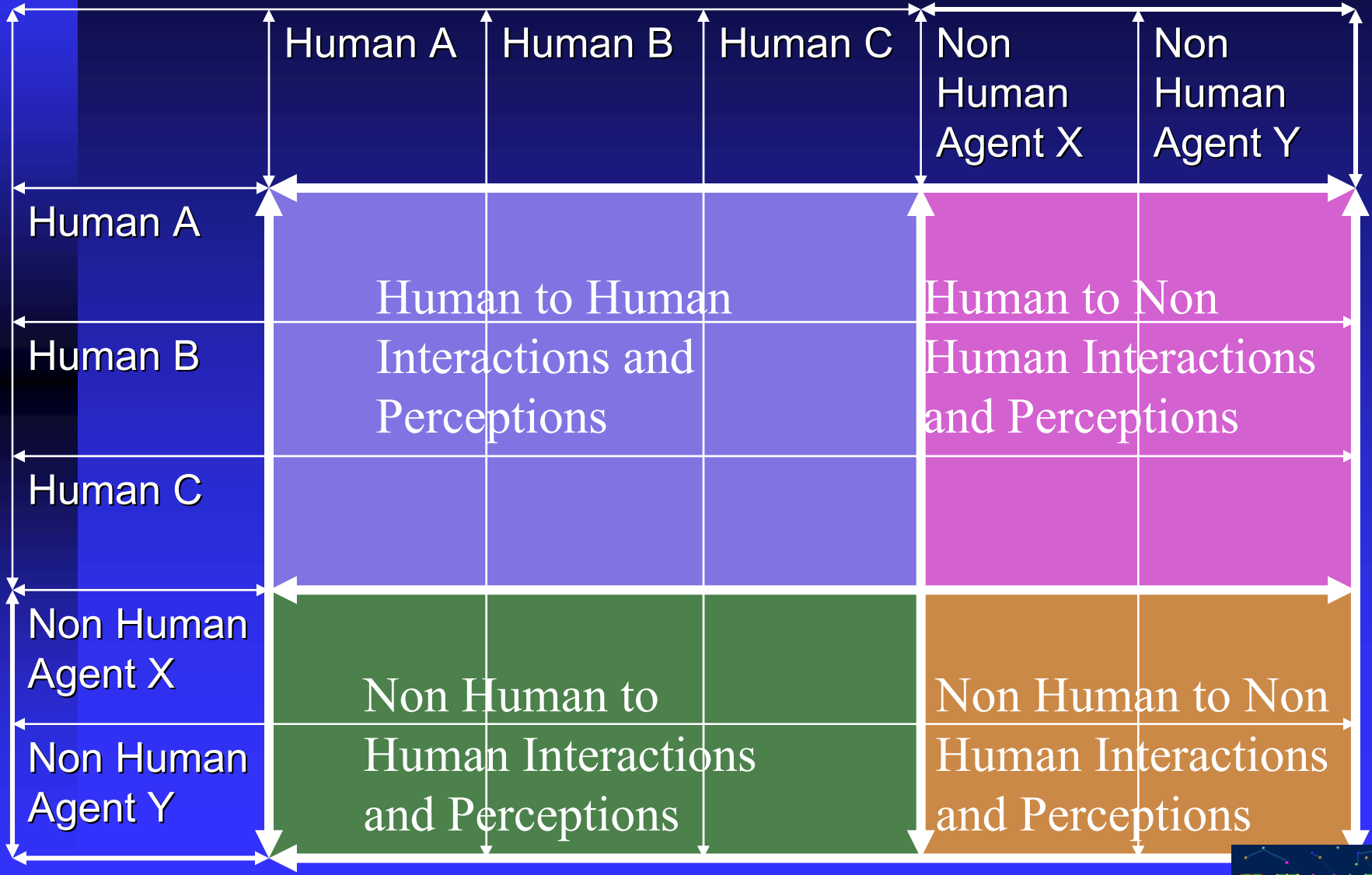
Human Agent's Perception of Provision of Resources in a Non Human Agent



Non Human Agent's Perception of what a Human Agent knows

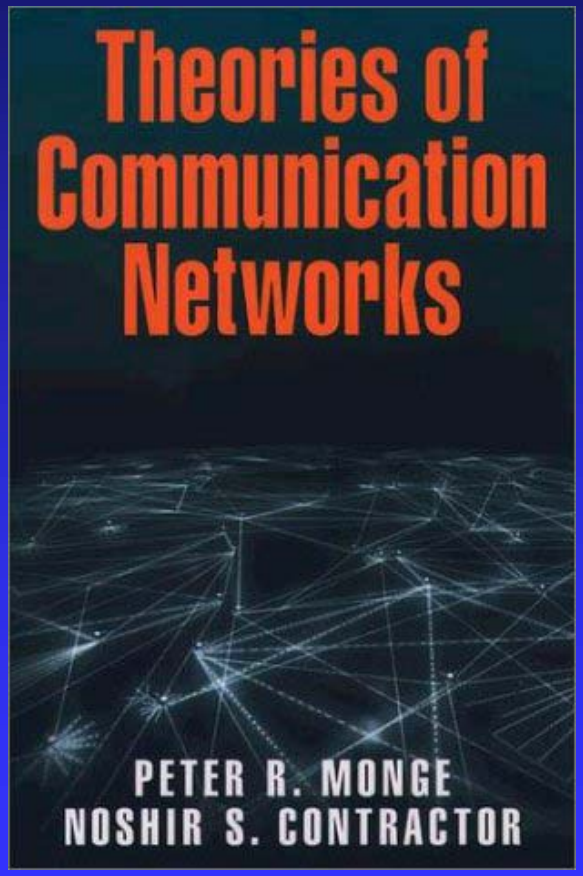
Human Agent's Perception of What Another Human Agent Knows

Source: Contractor, 2001


Human A
Human B
Human C
Non Human Agent X
Non Human Agent Y
Human A
Human B
Human C
Non Human Agent X
Non Human Agent Y
Human to Human Interactions and Perceptions
Human to Non Human Interactions and Perceptions
Non Human to Human Interactions and Perceptions
Non Human to Non Human Interactions and Perceptions

WHY DO WE CREATE, MAINTAIN, DISSOLVE, AND RECONSTITUTE OUR COMMUNICATION AND KNOWLEDGE NETWORKS?

Monge, P. R. & Contractor, N. S. (2003). Theories of Communication Networks. New York: Oxford University Press.



Why do actors create, maintain, dissolve, and reconstitute network links?

- Theories of self-interest
- Theories of social and resource exchange
- Theories of mutual interest and collective action
- Theories of contagion
- Theories of balance
- Theories of homophily
- Theories of proximity
- Theories of co-evolution

Sources:

Monge, P. R. & Contractor, N. S. (2003). Theories of Communication Networks. New York: Oxford University Press.

Contractor, N. S., Wasserman, S. & Faust, K. (in press). Testing multi-theoretical multilevel hypotheses about organizational networks: An analytic framework and empirical example. Academy of Management Review.

Co-evolution of knowledge networks and 21st century organizational forms

- NSF KDI Initiative 1999-04. PI: Noshir Contractor, University of Illinois.
- Co-P.I.s: Monge, Fulk, Bar (USC), Levitt, Kunz (Stanford), Carley (CMU), Wasserman (Indiana), Hollingshead (Illinois).
- Three dozen industry partners (global, profit, non-profit):
  - Boeing, 3M, NASA, Fiat, U.S. Army, American Bar Association, European Union Project Team, Pew Internet Project, etc.

Public Goods / Transactive Memory

–Allocation to the Intranet

–Retrieval from the Intranet

–Perceived Quality and Quantity of Contribution to the Intranet

Transactive Memory

- Perception of Other's Knowledge
- Communication to Allocate Information

Communication to Retrieve Information

Inertia Components

–Collaboration

–Co-authorship

–Communication

Social Exchange

- Retrieval by coworkers on other topics

Proximity

-Work in the same location

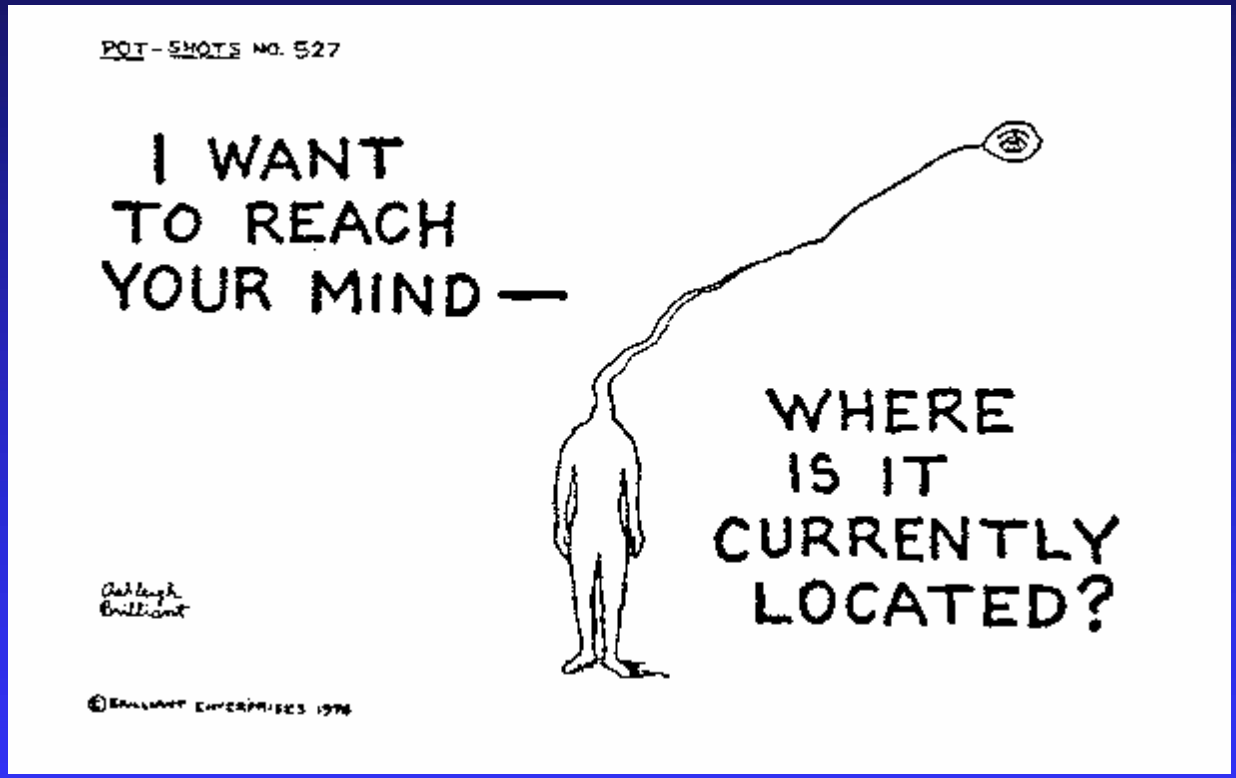
Motivation for Information Retrieval in Knowledge Networks

1. Social Communication	0.144
2. Perception of Knowledge & Communication to Allocate	0.995
3. Perception of Knowledge & Provision	0.972
4. Perception of Knowledge, Social Exchange, & Social Communication	0.851
5. Perception of Knowledge, Proximity, & Social Communication	0.882

3D Implications for Enhancing Networks

- Discovery: Effectively and efficiently foster network links from people to other people, knowledge, and artifacts (data sets/streams, analytic tools, visualization tools, documents, etc.). *"If only CECCR knew what CECCR knew."*
- Diagnosis: Assess the "health" of knowledge networks - in terms of scanning, absorptive capacity, diffusion, robustness, and vulnerability to external environment
- Design or re-wire networks using social and organizational incentives (based on social network research) and network referral systems to enhance evolving and mature communities.

Discovery - IKNOW Demo

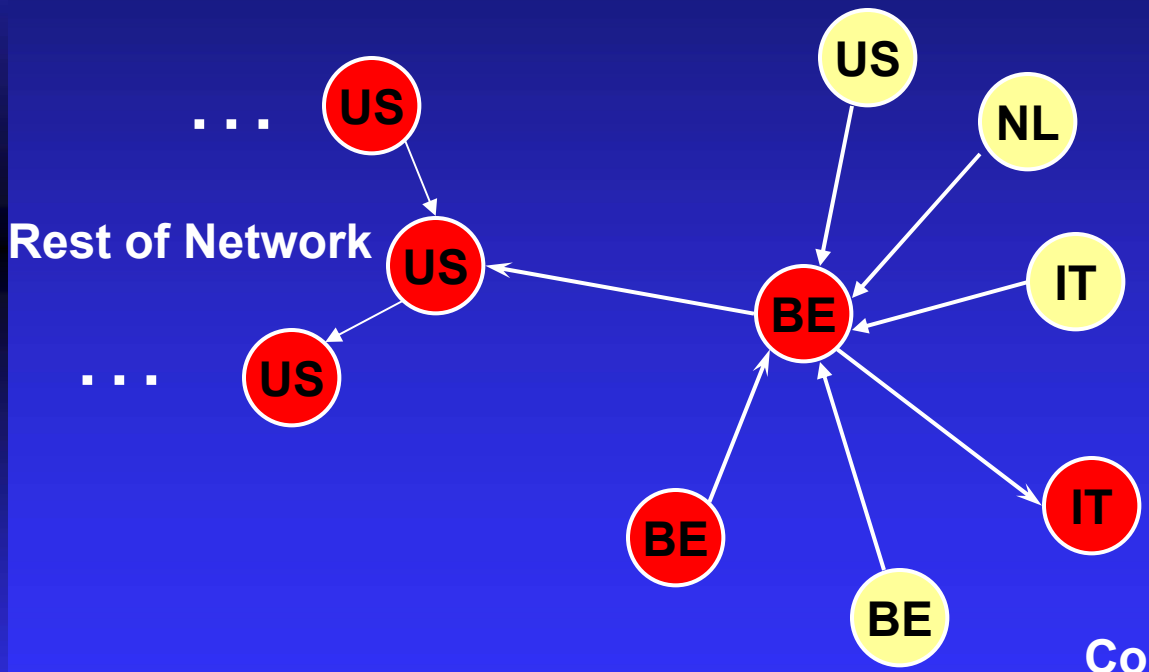


http://iknow.spcomm.uiuc.edu

Use courtesy logins and passwords provided on the website

Diagnosis - Scanning

Scanning from many sources (such as countries)



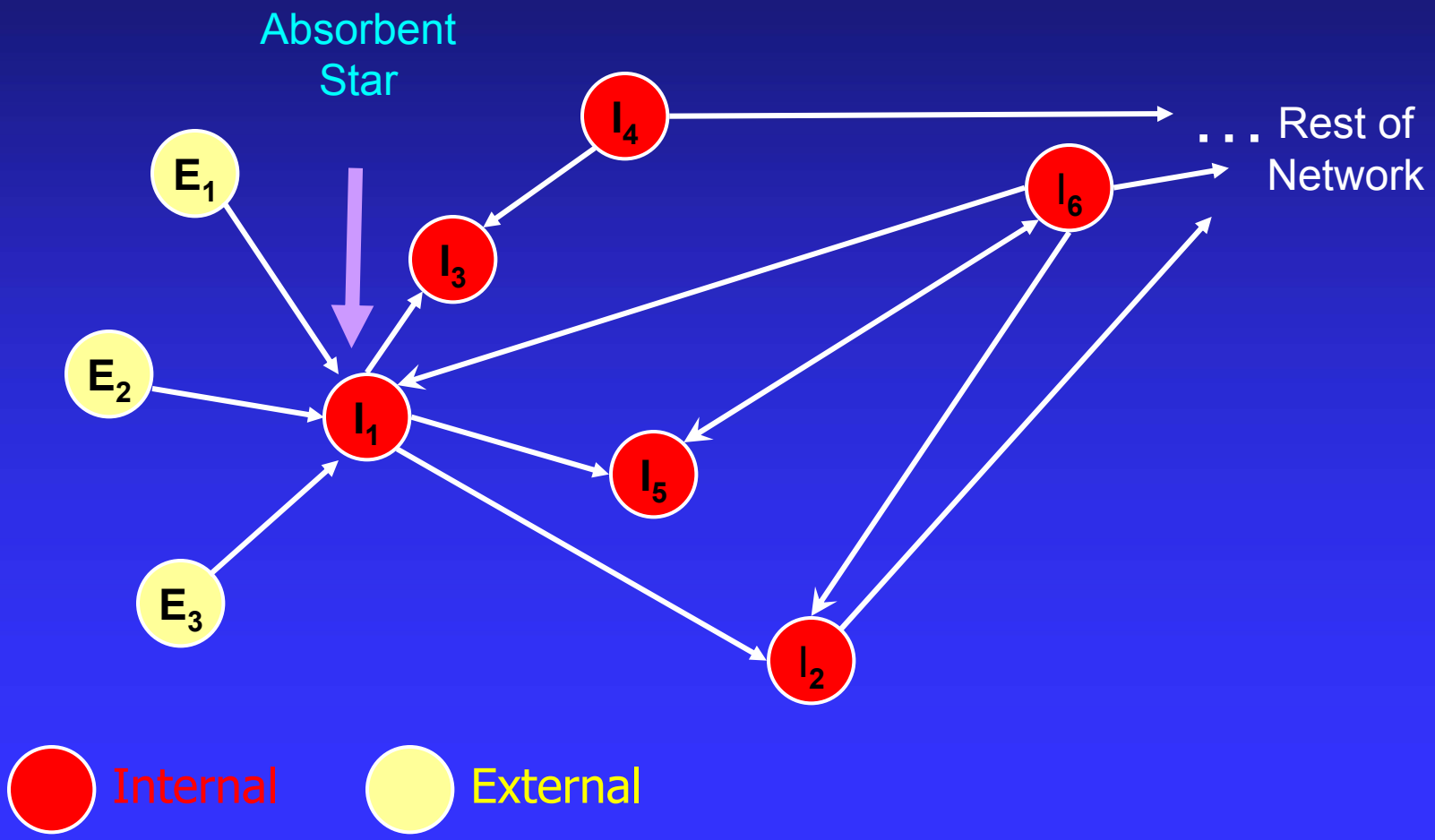
Country codes indicated in nodes

Internal

External

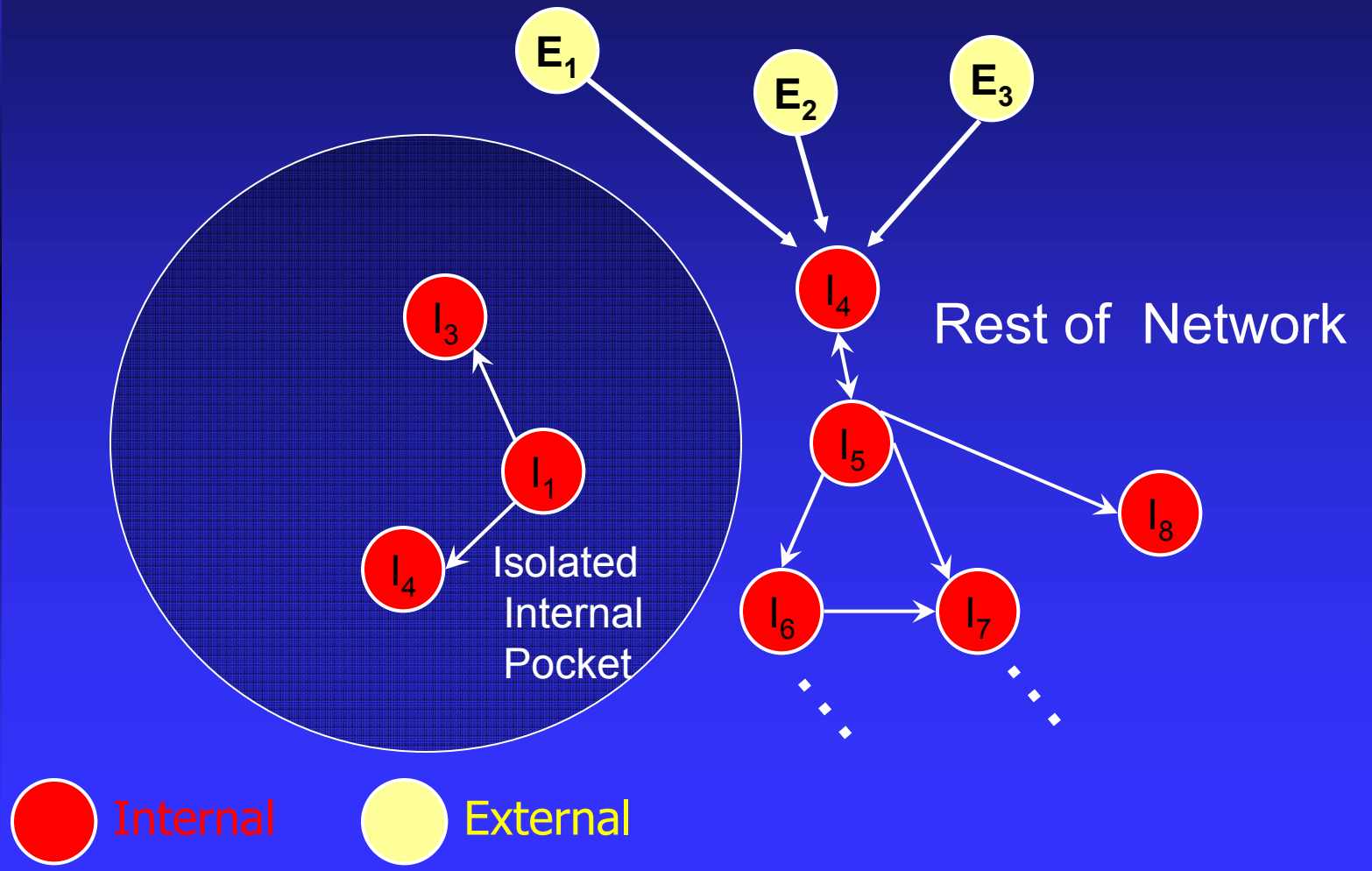
Diagnosis - Absorbent Star

Absorbent star links external experts to internal network



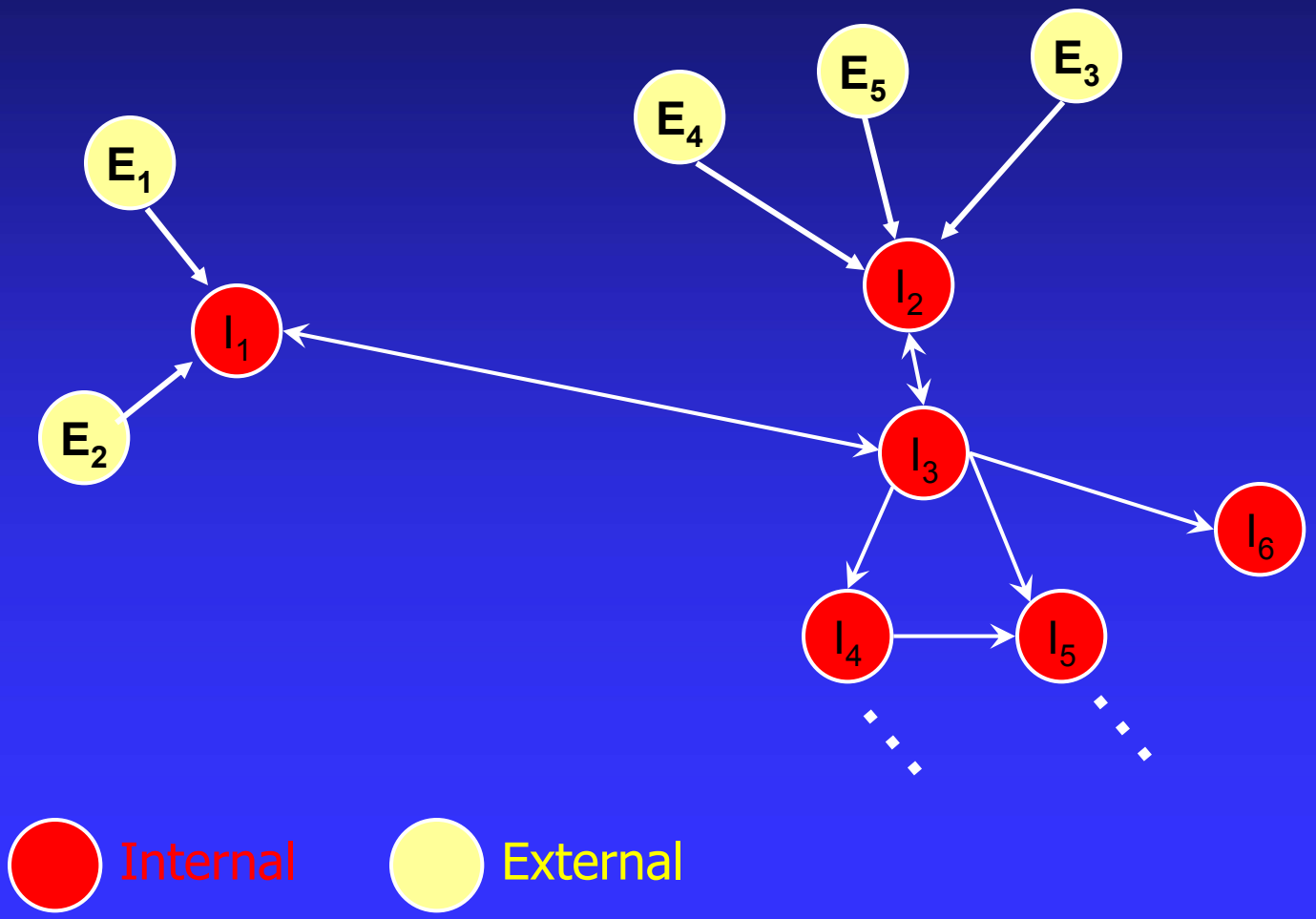
Diagnosis - Diffusion

Internal cluster not connected to the rest of the internal network



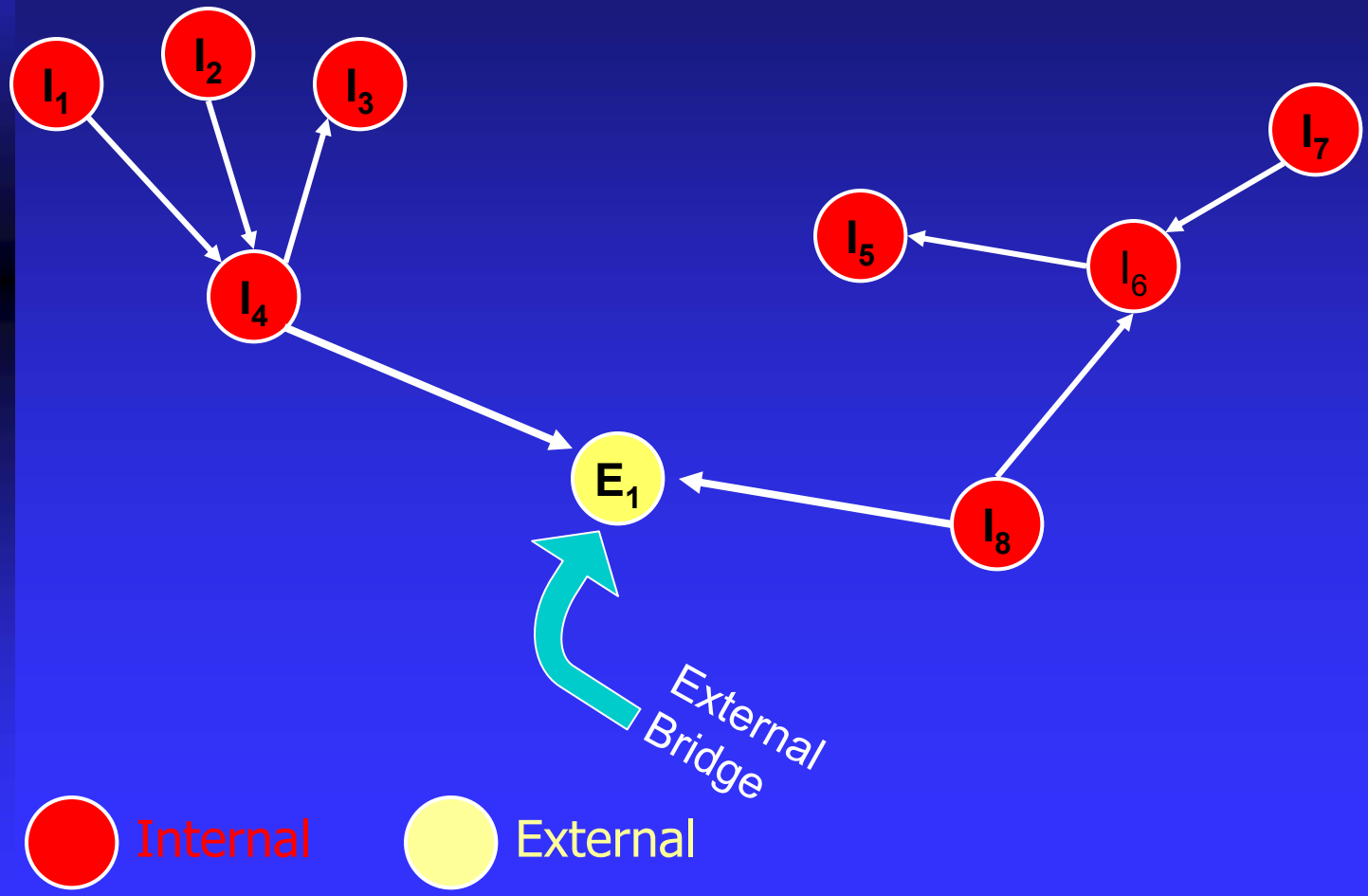
Diagnosis - Robustness

Internal network not robust to loss of I_3



Diagnosis - Vulnerability

Internal network vulnerable to external expert **E_1**



Design

- Design "**small world**" external networks for *exploration of disruptive technologies*
- Design "**dense**" external networks for *exploitation of existing technologies*
- Design "**star**" external networks for *mobilization of incremental, non-disruptive technologies*

Summary

- The Lovegety and SNIF underscore 21st century aspirations for more effective networking.
- Recent advances in cyberinfrastructure development provides the technological capability to more effectively leverage our networks.
- Recent advances in communication networks research provides important insights into the social and organizational motivations that explain how we leverage our networks.
- We are poised for the design, development, and deployment of large scale socio-technical network referral systems as part of the next generation public health cyberinfrastructures.

Science of Networks in Communities

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