

# Sensor Networks: Decision & the Role of Connectivity

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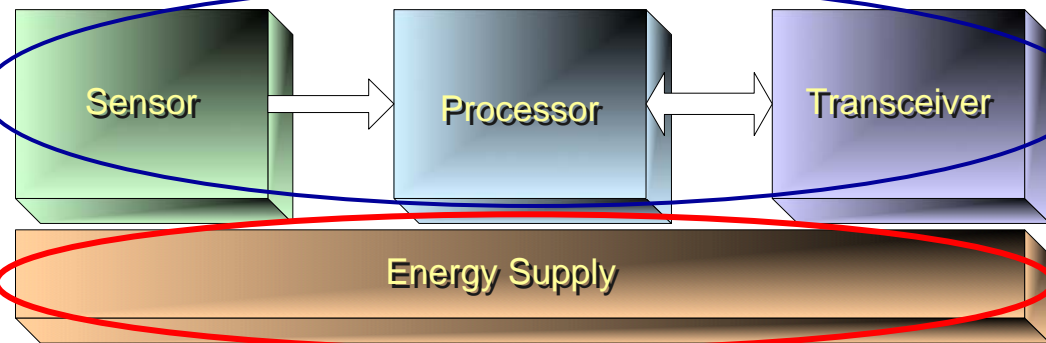
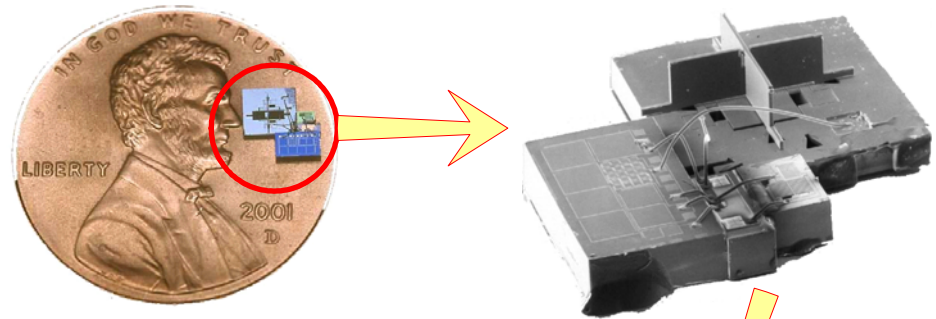
**CenSCIR Center Sensed Critical Infrastructure Research**

**Forum Para a Sociedade da Informação  
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# A Story of Two Tales

- Sensor networks:
  - Tiny devices, product of very large scale integration, RF and CMOS
  - Inexpensive, deployable, autonomous
  - Sense, communicate, process
- Critical infrastructures:
  - Large scale
  - Complex, interconnected

# Sensors



**MEMS: Sensing & RF**  
**Moore's Law: 1.6/year DSP**

**No Moore's Law: Battery tech 5%/year**  
**Limit on ADC speed\*resolution/power**

# Critical Infrastructures: Large Scale

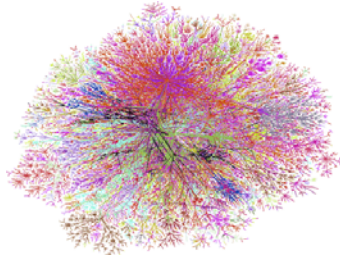
*Telecom network*



*Power, gas, energy*



*Internet*



*Water distribution*



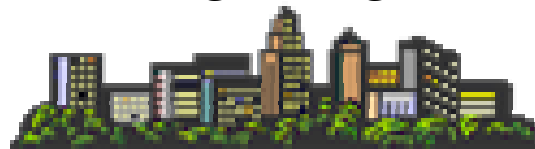
*Industrial Infrastructure*



*Cities, Buildings, Bridges*

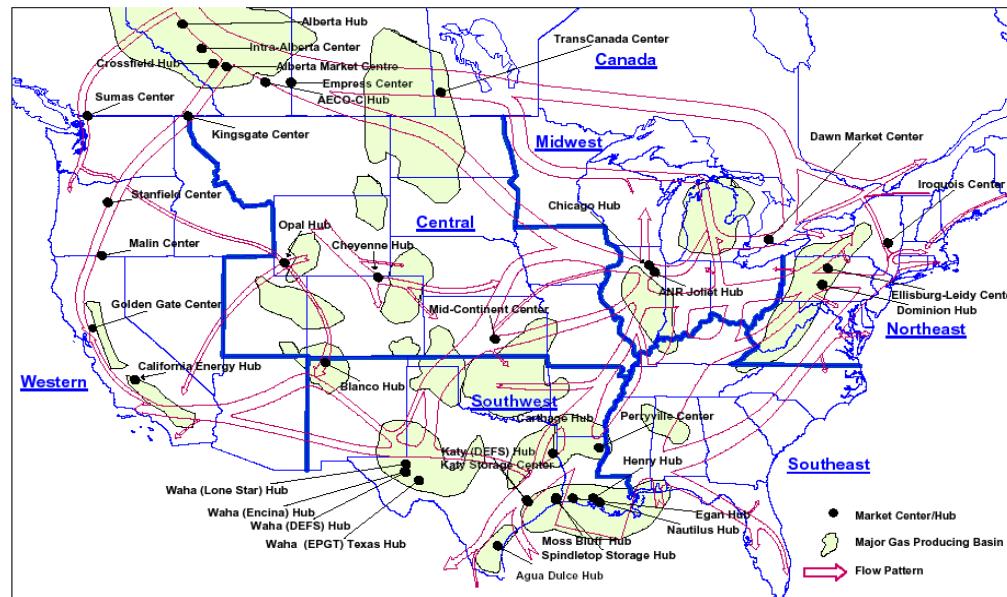


*Transportation*



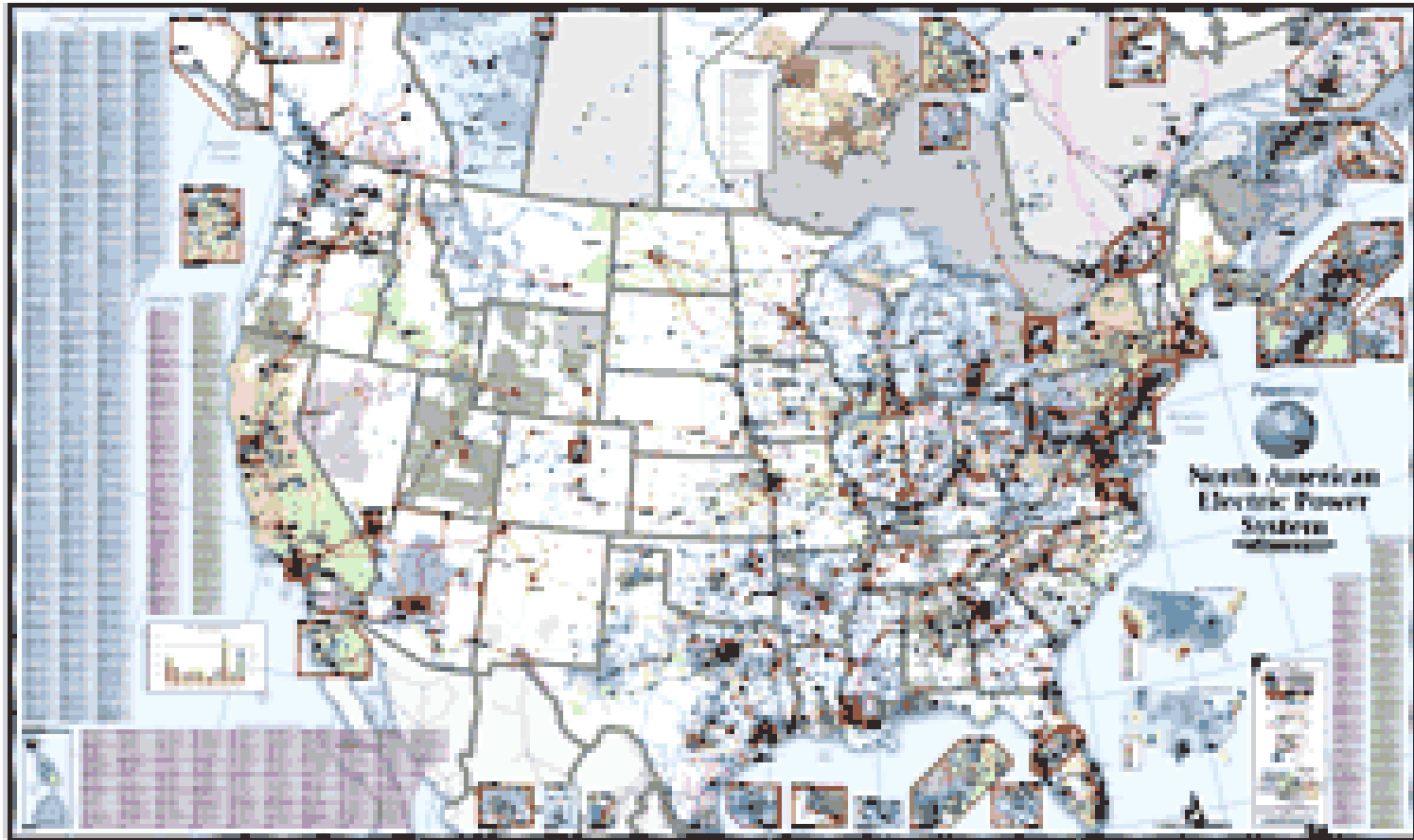
# Issues Facing Pipeline Transport

Vast natural gas infrastructure in need of monitoring and protection against failures and sabotage

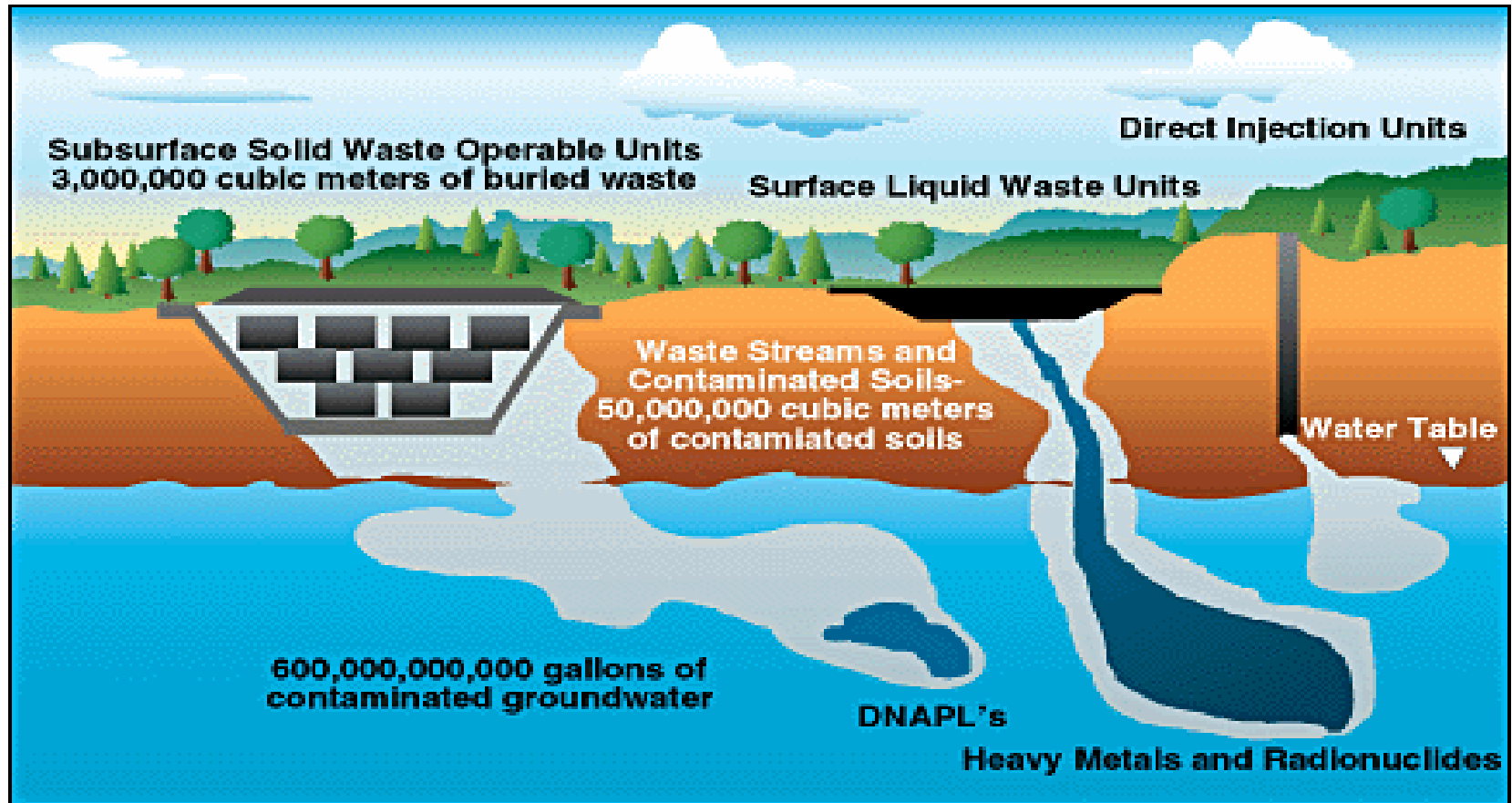


- > 250,000 miles of transmission pipelines;
- > 1 million miles of distribution pipelines in the U.S.

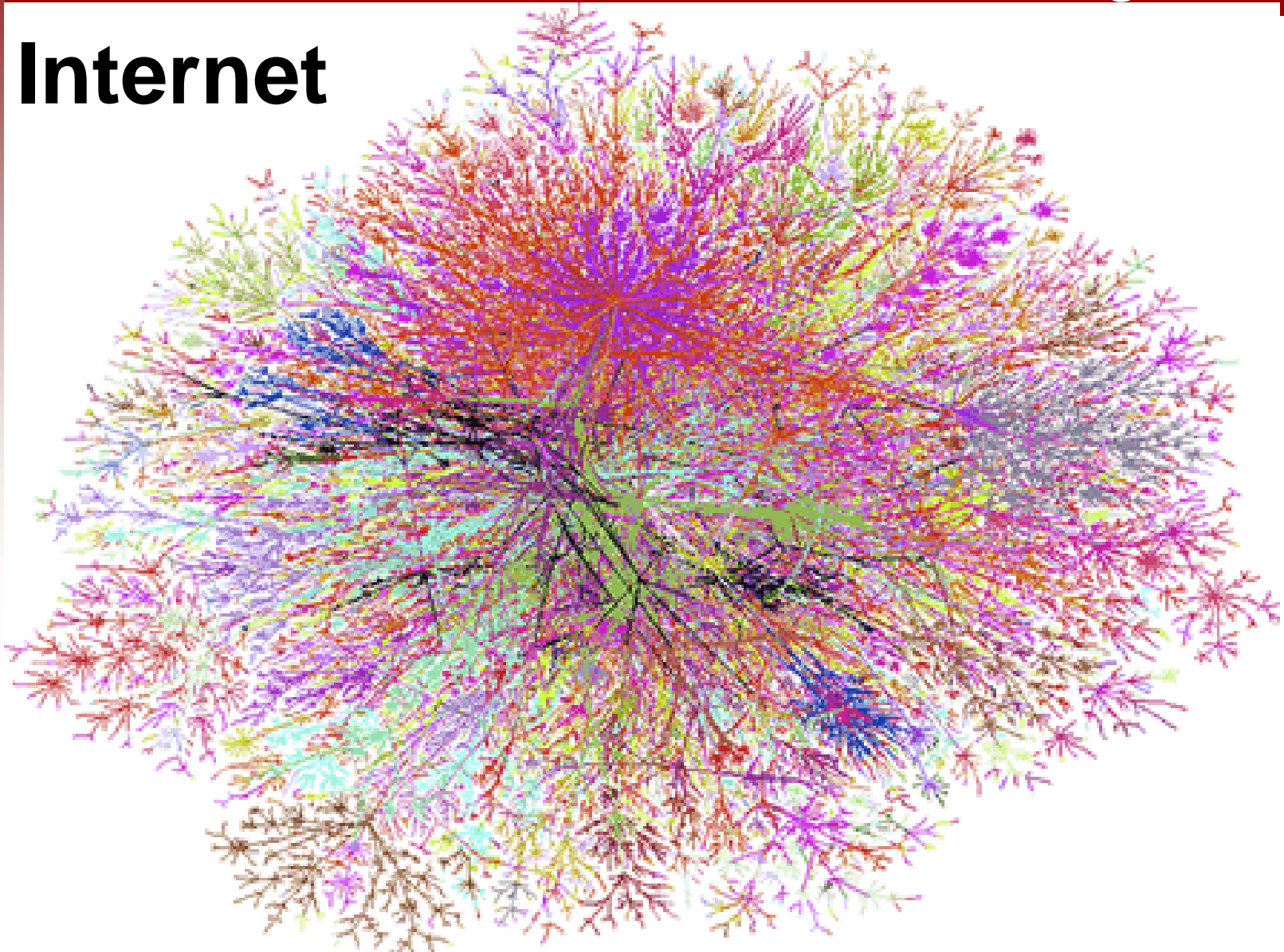
# Power, Gas, Energy Grid



# Long-Term Environmental Monitoring



# Internet



<http://research.lumeta.com/ches/map/gallery/wired.gif>

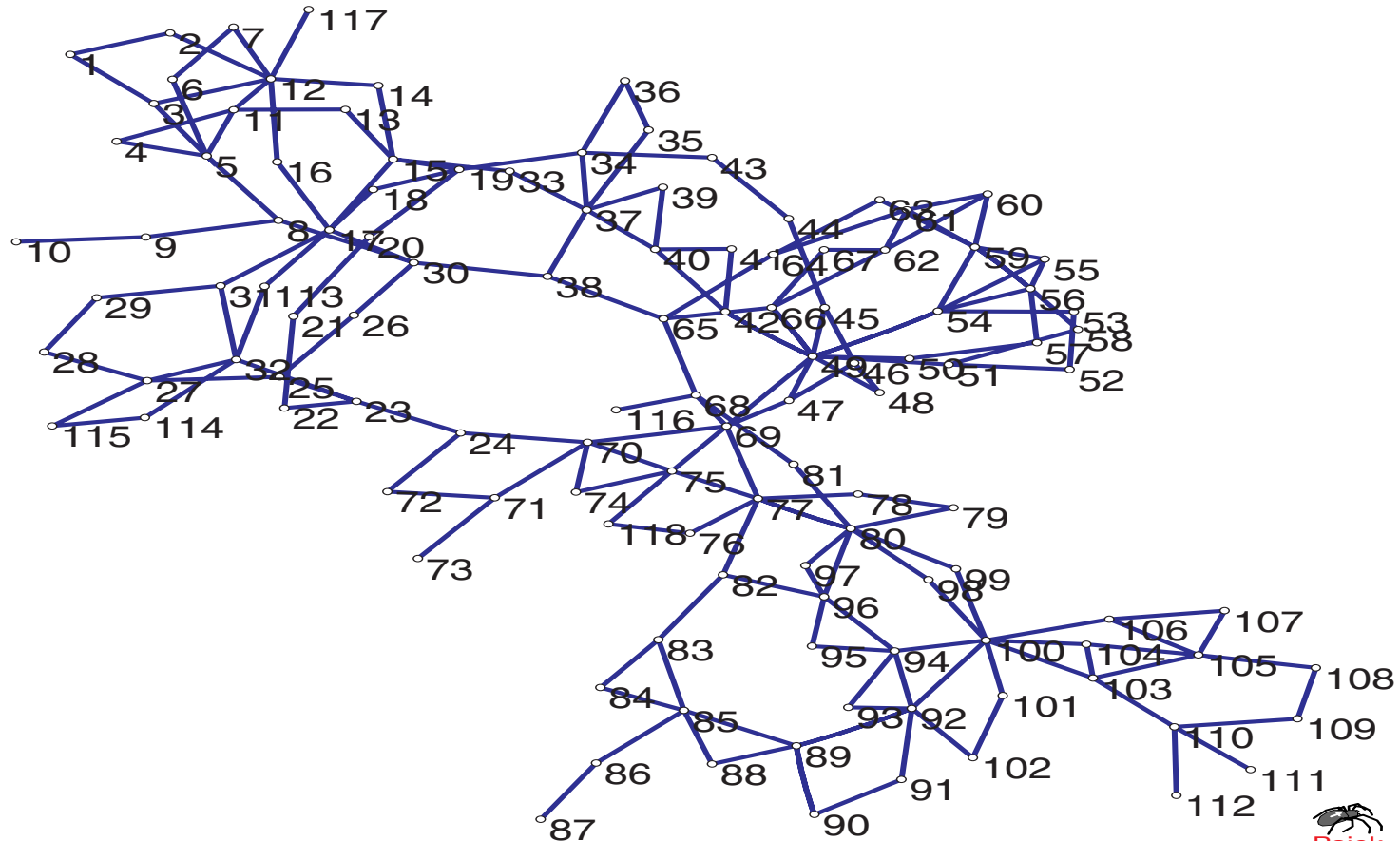


# Abnormalities

- U.S. infrastructure: trillion dollar (roads, bridges, water distribution, water treatment plants, power distribution, telecom nets, commercial/ industrial facilities, etc.
- Grades (by ASCE 05): D
- Blackout: 8/14,/03,  $\leq 8$  min, blackout, twice as large as any in the US history,  $\geq 250$  power plants, 62 Gw generating capacity,  $\geq 50$  million people in NE and Canada without electrical power (*Conservation Update*, Sep-Oct 2004).
- MyDoom internet virus: 1 in 12 e-mails; viruses cost businesses 55 Billion \$/year in 2003, up from 20 and 13 billion in 2002 and 2001 (*Computer World*, January 2004).
- Heightened security concerns of critical infrastructures: airports, harbors, water systems, public transportation.
- Everyday concerns: securing and monitoring buildings (offices, labs) or campus size facilities.

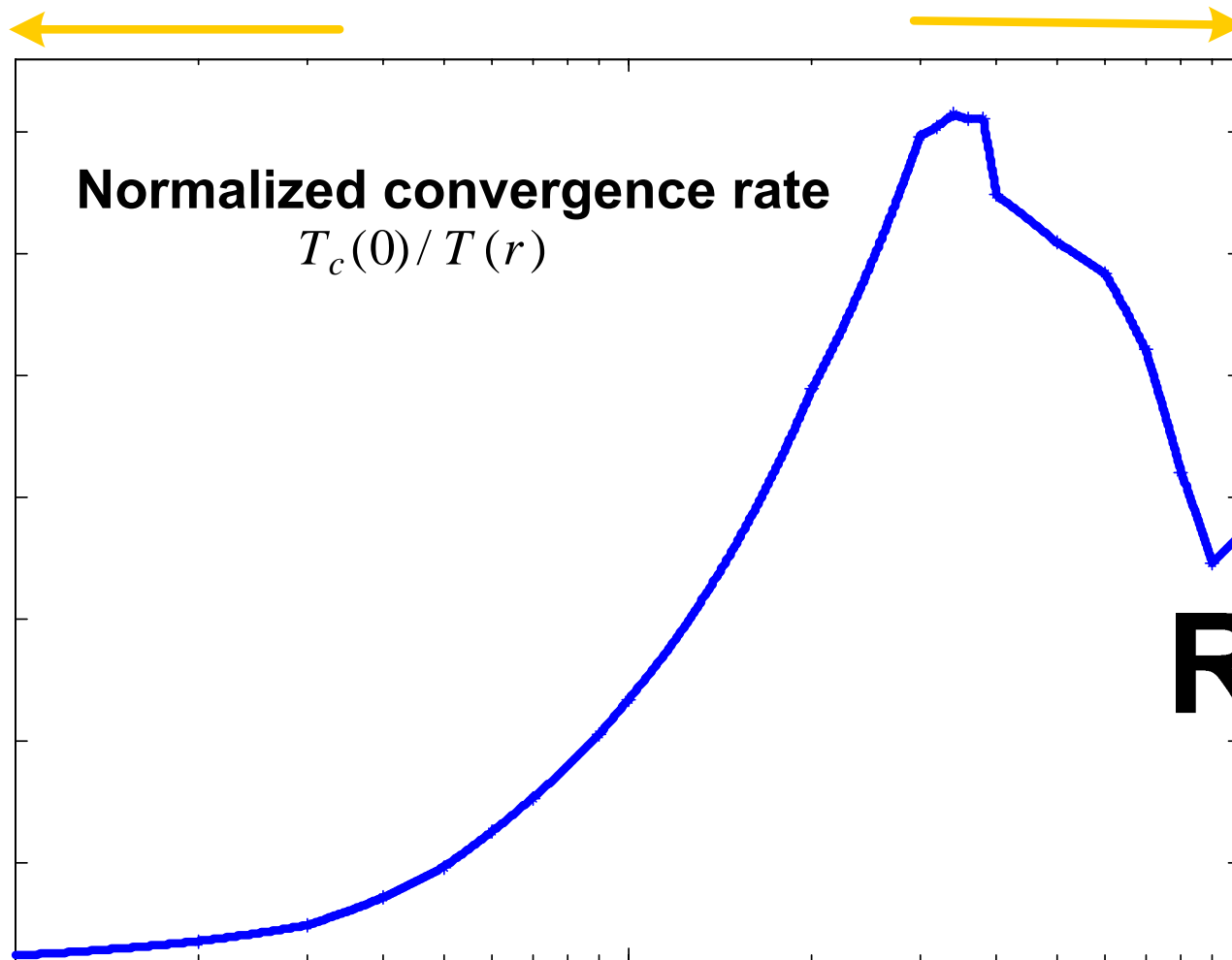
# Distributed Decision: Network Topology

Does it matter to whom we talk? Topology

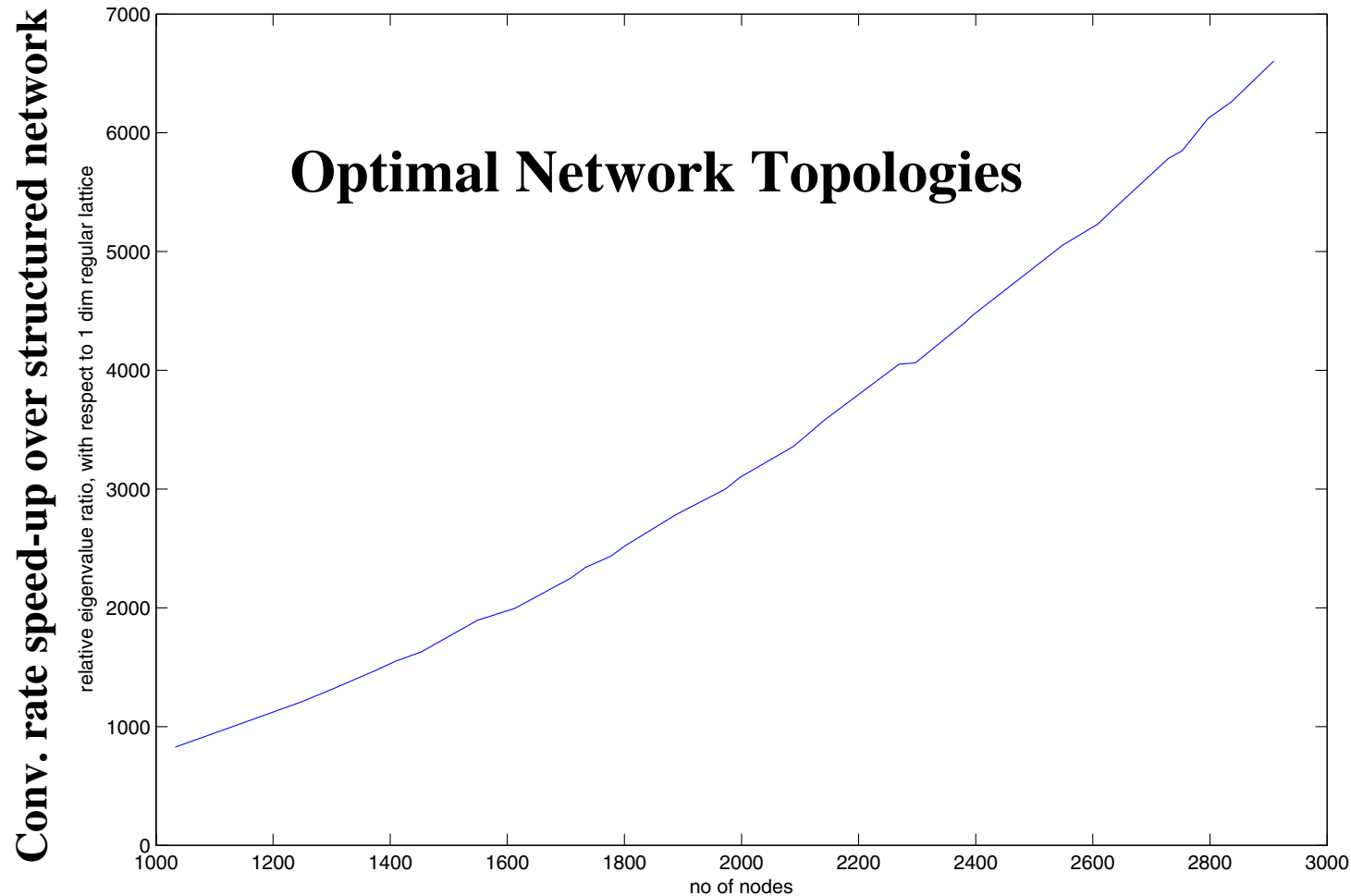


Pajek

## Results – Convergence rate (Small World Networks)

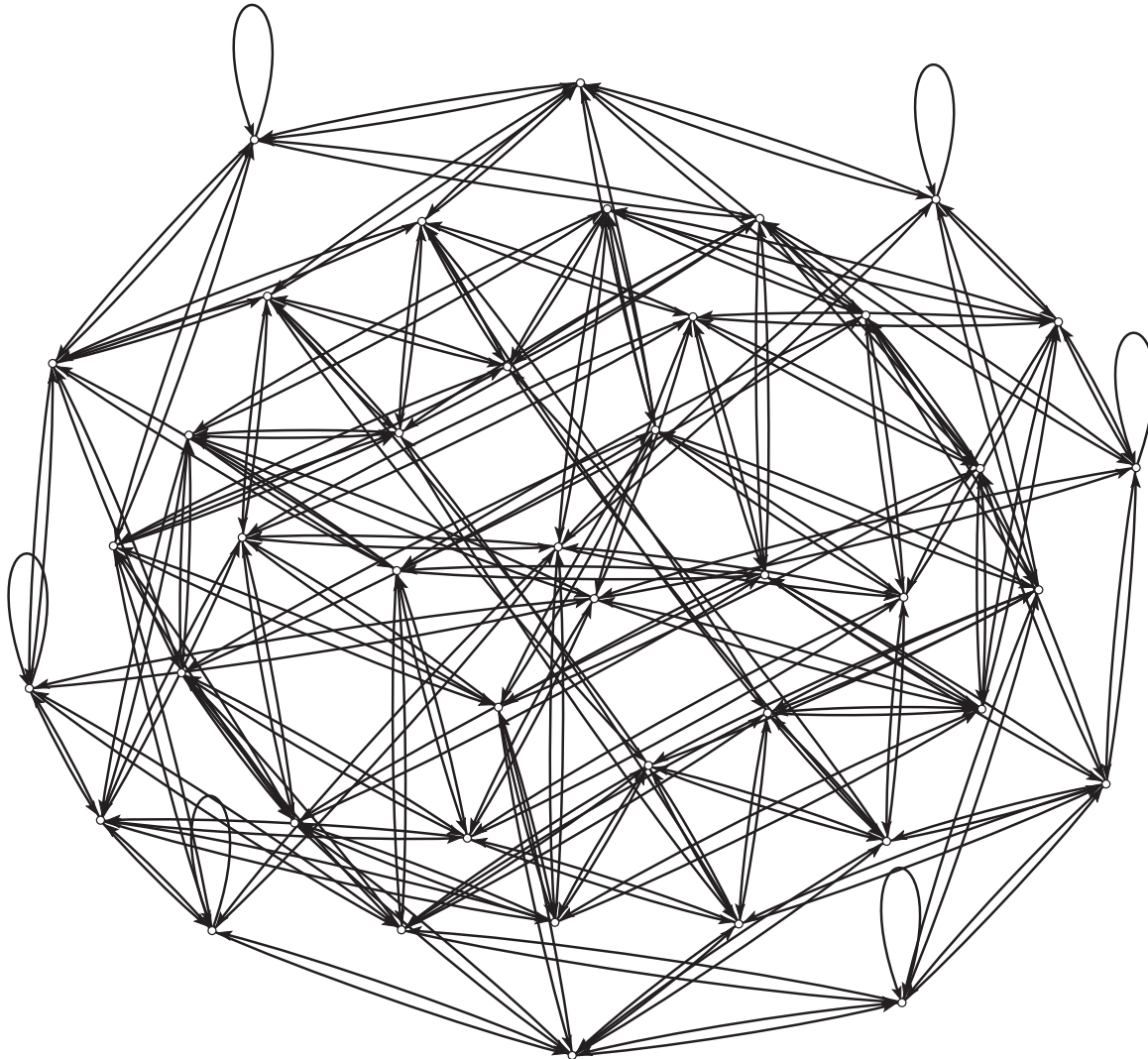


# Convergence Rate Results



Number of nodes in network

# Efficient Network



# Conclusions

- ❖ Sensing technology:
  - New opportunities
- ❖ Critical infrastructures:
  - Networked
  - Complex
- ❖ Distributed decision:
  - ❖ Topology
  - ❖ Reduce energy consumption, by reducing time it takes to reach decision, less communication