Networking Grand Challenges

NSF Future Directions
Workshop
April 2003

Our panelists:

- Ravi Mazumdar, Purdue
- Larry Peterson, Princeton
- Lixia Zhang, UCLA
- Jean Walrand, Berkeley

Moderator: Don Towsley, UMass
Is networking in doldrums?

- stagnant economy
- uncertain funding picture
- world affairs
- SARS
- university budget cuts

These are exciting times!

- sensornet
- wireless
- mobile
- Internet
- layered networks
- high performance
- interplanetary

10 years
Charter of panel

- What constitutes a grand challenge?
  - *intra area?* e.g., one petabyte transfer in < one second
  - *inter-area?* how to design robust networks independent of technology/application
- What are some of the grand challenges?

What *are* the important research challenges?

- *timeless* (still unsolved) problems?
  
  *how to build robust networks that scale with technology to handle diverse apps* (1965)

- What are the *new drivers*:
  - technological?
  - applications?
  - social?

- Short-term versus long term challenges?
Observation: diversification of community

- 1994 - INFOCOM, SIGCOMM
  portions of Globecom, ICC
- 2003 - INFOCOM, SIGCOMM, ICNP, IMC, MOBICOM, MOBIHOC, MOBISYS, WCNC, web/P2P/CDN
  conferences, ...
  portions of many other conferences

Are we splintering?

Observation: diversification of community

- 1994 - INFOCOM, SIGCOMM
  portions of Globecom, ICC
- 2003 - INFOCOM, SIGCOMM, ICNP, IMC, MOBICOM, MOBIHOC, MOBISYS, WCNC, web/P2P/CDN
  conferences, ...
  portions of many other conferences

Challenge: how to maintain communication / interactions? NSF role?
Panel Format:

- panelists (short) presentations (8 min each)
- panelist observations/questions
- open discussion

Ravi Mazumdar
Larry Peterson
Lixia Zhang
Jean Walrand
Don Towsley

A network science?

Goal: to answer questions like

- why do topologies look as they do?
- why do disruptive apps appear? what are their effects?
- a single bottleneck link? multiple bottleneck links? on end2end paths

Components:

- physical laws, mathematics, algorithms, markets
- components change over time (how?)
- parallel networks (universes)
A network science?

- multidisciplinary - stat/probability, computer science, nonlinear systems, market economics, communication theory, complex systems, ...
- experimental methods, need for data
- translation into engineering

As challenging/important as physics, biology, ...

Evolution of the Internet
What have we heard?

- mathematical theories to:
  - understand performance limits
    - compute/communication/sensing tradeoffs with power constraints
  - understand as a complex system
- how to design evolvable networks
- how to design resilient (tolerate any fault) networks
- how to design markets and network mechanisms to support future heterogeneous apps