The Next Disruptive Networking Technology
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• Proposal Rather than Results - Heilmeier Questions

H1: What are you trying to do?
A1: Determine the network that will replace the Internet.

• Premise:

Next generation communications networks evolve incrementally.
However there are disruptive technologies that start a new progression and eventually replace the earlier technology.

Examples of Disruptive Technologies

1) The Telephone Network Replaced the Telegraph Network

• Technologies:
  Circuit Switching -- Universal connectivity
  Voice communications -- Eliminated specialized training
• Generations:
  Operator patch panels, Electromechanical switches (hat box), reed relay switches, electronic switches (ESS series), ATM (Internet type data)

2) The Internet is Replacing the Telephone Network

• Technologies:
  decentralized routing and control/packet switching -- rapid change in connections, unplanned growth and changes in topology as needed
  personal computers -- universal, instantaneous access to information
• Generations:
  Arpanet (IMPS- special hardware), Commercial/Software routers, Internet layer (stabilized the services platform, enabled commercialization), NGI

The services of the Internet can also be provided on the telephone network:
  Email - UUCP-Net, The Web - ATM switches
H2) What is the problem with the Internet?

- The Internet layer stabilized the services layer by freezing the network interface
  - New capabilities of networking technologies cannot be used, creating a pent-up demand from unused or under used networking technologies
  - Some new services are not handled well by the Internet network layer

- Examples of under utilized networking technologies:
  - DWDM and optical switching - reconfigure logical network topology
  - Broadcast/Multicast,
  - MANET's and Ad Hoc networks,
  - Intermittently connected networks,
  - Network Coding

Which new services were not handled well by the Internet?  
H3: How is it done today?

- Wireless connections
  - higher error rates require changes in TCP

- Highly mobile services
  - Cell phone hand-offs are managed by the cellular network
  - Smart phones are increasing mobile data and are also reducing the cell size

- Large data transfers, for instance data collected by satellites
  - change in TCP to prevent restart
  - net flix: - replacing CATV and increasing the demand for real time transmission of movies
  - Smart phones increasing demand for mobile video

Smart Phones will have as big an effect on communications in the 2010's as personal computers had in the 1990's
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Variable Topology Networks

• H4: What's new in your approach and why do you think it will be successful?

  – DWDM and optical switching can reconfigure networks to provide dedicated bandwidth where and when it is needed to better support large file transfers and real time video requirements
  – Ad hoc techniques, multicast/broadcast, and network coding are intended to deal with mobility, especially on small cells, and changing topologies
  – There are new services that are needed that will be better supported on networks that respond well to changing topologies

Applications of Variable Topology Networks
H5: If you're successful, what difference will it make?

• Optimal Logical Topologies on Reliable Physical Topologies:
  DWDM and optical switching
  – Network Restoration – Japan
  – High bandwidth point-to-point data transfers – NASA, NetFlix
  – Real-time movie multicast, distance learning

• Uninterruptable Networks
  Ad hoc networking techniques
  – Social Networks - Egypt, Wisconsin

• Green Cellular Networks
  Multicast/Network Coding
  – An Alternative to Hand-offs on Micro cells
Unanswered Heilmeier Questions

- How will success be measured?
- What are the risks and the payoffs?
- How much will it cost?
- How long will it take?
- What are the midterm and final "exams" to check for success?

In order to answer the final set of questions we need to select specific pent-up technologies for changing the topology of the network and specific protocols for using the network as the topology changes.

The DARPA Fresh Start Program