

# On Futures of Research Networking on UIUCnet

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# Current Picture

What's in place right now

What we're positioning for in the very near future

What services those infrastructures can provide

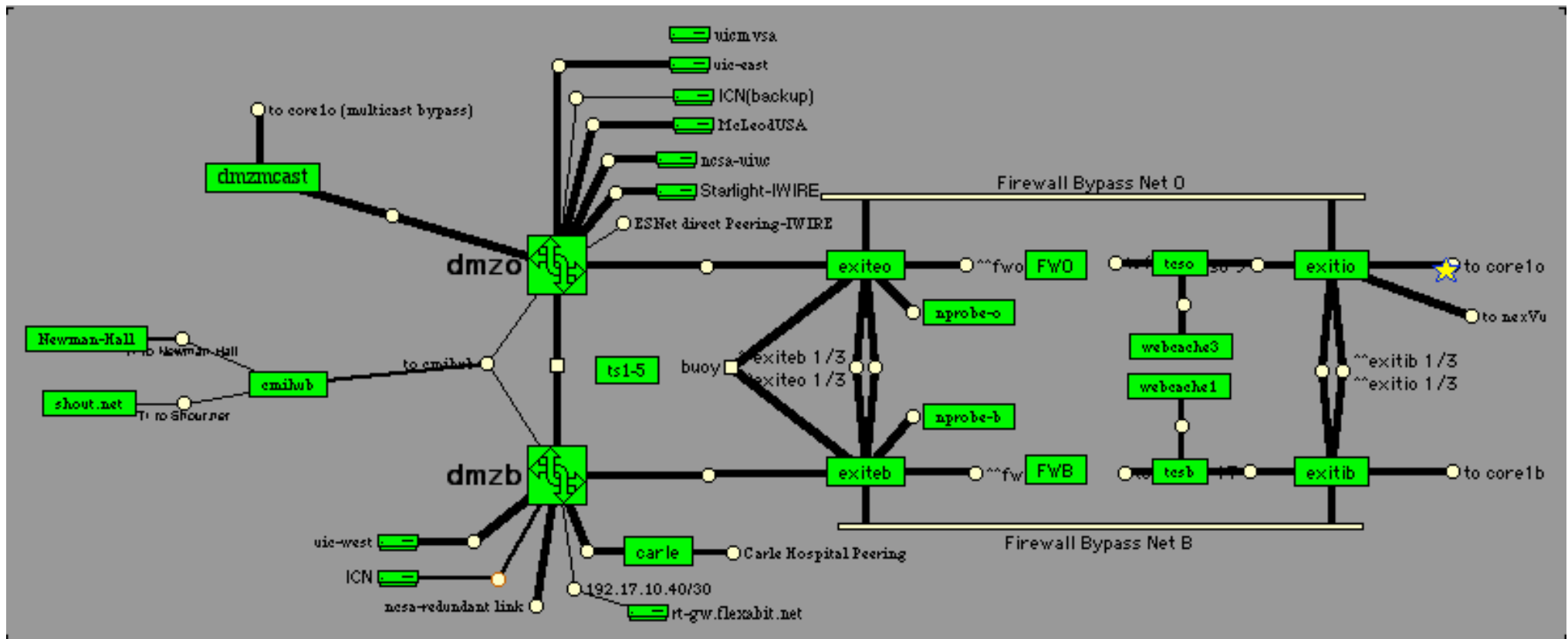
# UIUCnet Service Now

- Core/Distribution network is one Gb/s
- Most buildings served with 100 Mb/s or one Gb/s
- Some buildings provide 100 Mb/s to each station, but many are still on substandard wiring limiting connectivity to 10 Mb/s

# UIUC External Connections

- Campus exit is 2x one Gb/s (includes web caches, firewalls, intrusion detection devices, traffic accounting)
- 2x ~125 Mb/s “Commodity” Internet access
- One Gb/s to Starlight (Internet2, ESnet, others)
- Campus firewall bypass option to improve latency and protect general campus Internet

# UIUC External Connections



# UIUC Network Upgrade

- Campus-funded plan to bring all buildings and network connections to a “minimum standard”
- One Gb/s from backbone to each building
- 100 Mb/s to each station jack
- Core/Distribution at 10 Gb/s non-blocking
- All Ethernet technology

# Performance Edges

- The network upgrade positions UIUCnet for “easy” (financial expenditure only) increases in network performance:
- One Gb/s non-blocking to station jacks
- 10 Gb/s in-building LANs
- 10 Gb/s from backbone to building

# Performance Edges

- “Easy” performance increases at the campus exit:
- One Gb/s  $\rightarrow$  10 Gb/s
- Improved firewall bypass
- However, still no way off-campus at faster than 1 Gb/s (I-WIRE to Starlight)

# Research Network Service Requirements

# Research Needs

- Very high bandwidth ( $> 500$  Mb/s)
  - Clustering (also requires low latency)
  - Visualization (also requires low loss)
- Some current experiments exceed 2 Gb/s
- Latency/Loss requirements may necessitate “clear channel” services that aren’t interfered with by “normal” campus traffic
  - Dedicated on-campus paths (physical or virtual)
  - Dedicated off-campus wavelengths on ICCN

# Research Needs

- Point-to-Point non-IP channels for testing network protocols
- Most networking research is interesting when the Delay\*BW product is high
- Ethernet transport vs. fiber wavelength

# Research Needs

- Raw physical connectivity
- Dark fiber or wavelengths on existing DWDM system
- Needed for fundamental network research such as all-optical routing, GMPLS, etc.
- Essentially must run completely separately from all existing production services

# Possible Solutions

Exploring ways existing network can be exploited to serve research needs, or how the existing network can be re-engineered to provide solutions that meet these needs.

# Possible Solutions

- “Pure Bandwidth” (on-campus)
  - Can easily scale up in-building networks to gigabit or better speeds
  - If interference from non-research traffic is undesirable, can arrange for separate fiber feed into building
  - Core network is non-blocking—no special needs there
  - Service can be either “public” (visible to/ combined with other UIUCnet traffic) or “private” (virtual point-to-point link)

# Possible Solutions

- “Pure Bandwidth” (off-campus)
  - Current “best speed” off campus is one Gb/s (via I-WIRE to Starlight)
  - There *may* be room on I-WIRE fiber for additional 10 Gb/s wavelengths, at campus expense
  - Firewall bypasses can streamline research traffic flows and can be upgraded from one Gb/s to 10 Gb/s if needed
  - ICCN (currently in engineering) will vastly improve access to advanced networking resources in Chicago such as NLR and Starlight

# Possible Solutions

- Non-IP connectivity
  - If it's still Ethernet, fairly easy given our VLAN architecture
  - Future network technologies such as MPLS will make this easier yet including access to Chicago
  - Non-Ethernet transports such as Fiberchannel will require dedicated fiber resources; enough demand for this will make an on-campus fiber wavelength switching system look attractive

# Possible Solutions

- Dark fiber on campus
  - Depends critically on available fiber resources in buildings and to nodes
- Dark fiber off-campus
  - Depends critically on I-WIRE resources or ICCN
  - Much easier to implement a “standard transport” (Ethernet, SONET, Fiberchannel, etc) than “alien wavelengths”
  - Circuit switching at Starlight can be engineered if needed but nothing is in place now

# Glossary

**Dark Fiber** - Fiber-optic strands with no pre-existing service running on them. Can be used to provide any arbitrary service or set of services. UIUCnet itself runs on campus-owned dark fiber.

**DWDM** - Dense Wavelength-Division Multiplexing. A technology for packing many services onto one fiber-optic strand by separating each service into a separate wavelength of light. Wavelengths are sometimes referred to as “colors” or “lambdas” (after the symbol  $\lambda$  used in physics to represent wavelength).

**Gb/s** - gigabit per second. A measure of *bandwidth* or data transfer capacity 1,000 times greater than one megabit per second.

**GMPLS** - Generalized MPLS. A very new framework which extends the virtual circuit provisions of MPLS (*q.v.*) to include setting up end-to-end paths across an all-optical network including wavelength reservation and resource allocation.

**I-WIRE** - a dark fiber communications infrastructure interconnecting UIUC (NCSA), UIC, Argonne National Lab, Starlight, IIT, the University of Chicago, and Northwestern University. UIUCnet makes use of one I-WIRE wavelength to establish gigabit connectivity to Starlight.

**ICCN** - Intercampus Communication Network. A dark fiber infrastructure which will connect the three University of Illinois campuses and provide reliable, very high speed communication via DWDM to all University users. Currently in the procurement and engineering phase; due to come online Summer 2006.

**Mb/s** - megabit per second. A measure of *bandwidth* or data transfer capacity roughly equal to that provided by a home cable modem or T1 line.

**MPLS** - Multiprotocol Label Switching. A relatively new network switching technology which provides virtual circuits or dedicated pathways across existing IP switching networks. Includes very powerful traffic engineering features which allow for certain users of the network to use link resources allocated solely to them. The UIUCnet core upgrade currently being designed will not include central MPLS features, but its follow-on will.

**Non-blocking** - A feature of network switching equipment whereby all physical connections can operate at full rated speed without overtaxing any internal resource in the device. The UIUCnet core is built entirely of non-blocking switches, meaning that they will perform well no matter what speed links are connected to them or how heavily they are utilized.

**Starlight** - A 1 Gb/s and 10 Gb/s Ethernet switching and routing facility located in Chicago. I-WIRE, NLR, and the ICCN can or will connect into Starlight in order to provide connectivity among these networks and other high-speed international research networks such as Abilene, ESnet, MREN, and CA\*net.

**VLAN** - Virtual LAN. A mature network technology which allows local area networks (LANs) to be overlapped on a single backbone architecture in a way that each maintains its identity. VLANs have been used on UIUCnet since 1995 to separate one department's traffic from another even when they co-exist in a single building or when one must exist in multiple buildings. VLAN technology is very versatile and can be used to similarly separate different applications on long-distance connections sharing the same bandwidth.