

# Network Services

Network Services

UVicNet

BCNet / CA\*Net



# Who am I ?

- UVic BSc, CSC (1987)
- Worked in IT/Telecom since
  - Industrial process control
  - Desktop support
  - Unix systems support
  - Network management systems (large)
  - UVic Network Services (2004)
  - Mgr of NETS (2006)

# Network Services Team

- 20 people
- 3 teams
  - Development & Network Security
  - Implementation
  - Operations
- We manage UVicNet from the ground up  
<https://nets.uvic.ca/staff.html>

# BCNet

- Our connection to the world:
  - Universities & Research (ORAN)
    - high-speed optical network
  - Commercial Internet (“buying club”)
- Partners:
  - UBC, SFU, UVic
  - BCIT, UNBC, TRU, RRU

<http://www.bc.net>

# BCNet - History

- 1988
  - UBC  $\leftrightarrow$  U of Washington: 9600 bps
- 2003
  - Vic  $\leftrightarrow$  Van: 1Gbps
  - User-controlled light-paths
- 2007
  - Vic  $\leftrightarrow$  Van: 10Gbps
  - (more) User-controlled light-paths

# BCNet & CA\*Net4



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# Ca\*Net4

- Industry Canada: CANARIE (1993)
- Links regional ORANs:
  - BCNet, Netera, SRNet, MBNet, ORION, RISQ, ...
- Links to international R & E networks

<http://www.canarie.ca/canet4>

<http://www.startap.net/starlight/NETWORK>

# BCNet - History

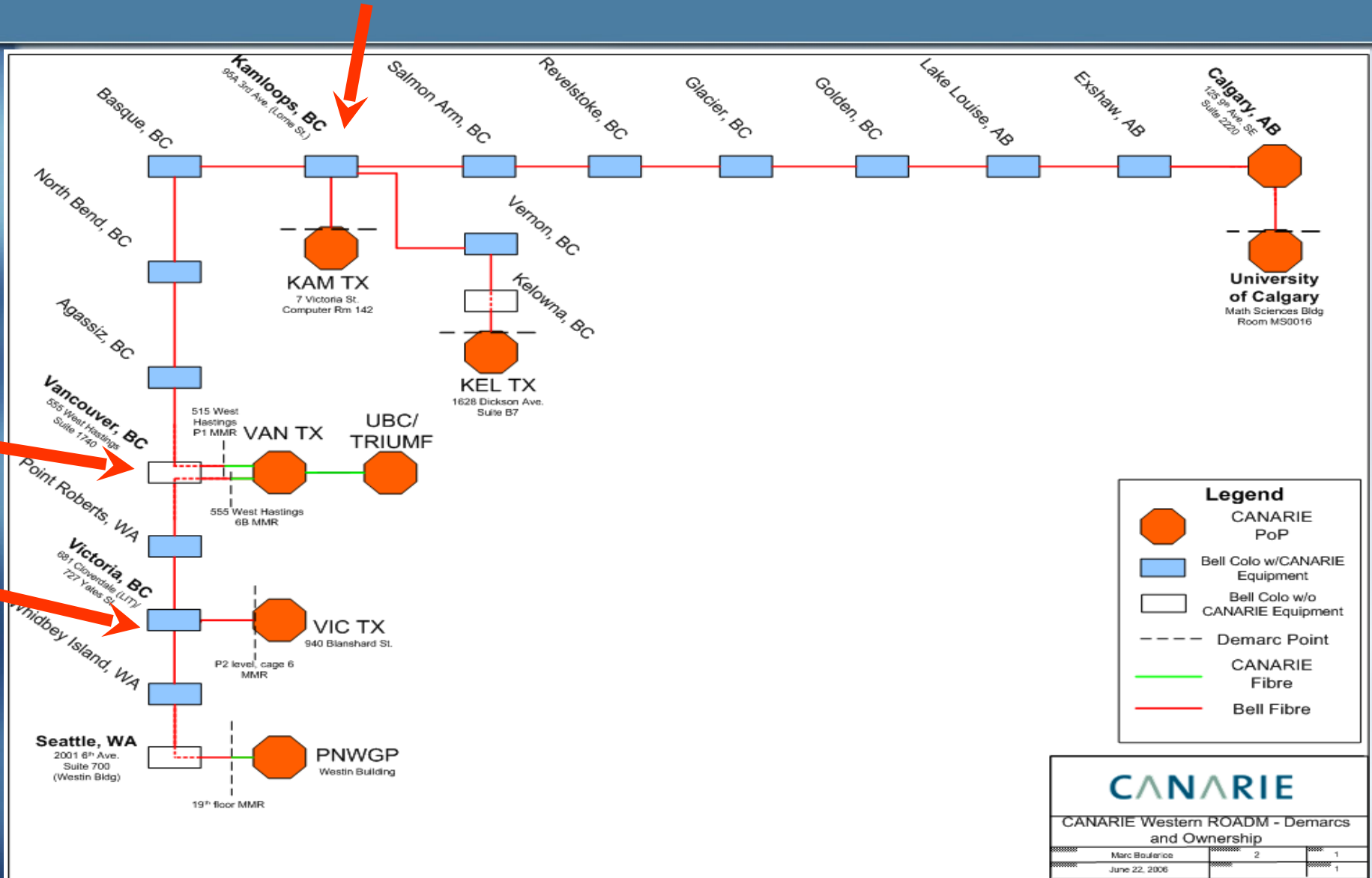
- 2007
  - Vic  $\leftrightarrow$  Van: 10Gbps
  - (more) User-controlled light-paths



# ROADM

- CANARIE, BCNet, Netera
- DWDM Calgary → Seattle, via southern BC
- 72 channels @10G
- Multiple add/drop locations
- Initial deployment:
  - 4 for CANARIE
  - 1 for BCNet
  - Upgrade switching to 10G-capable

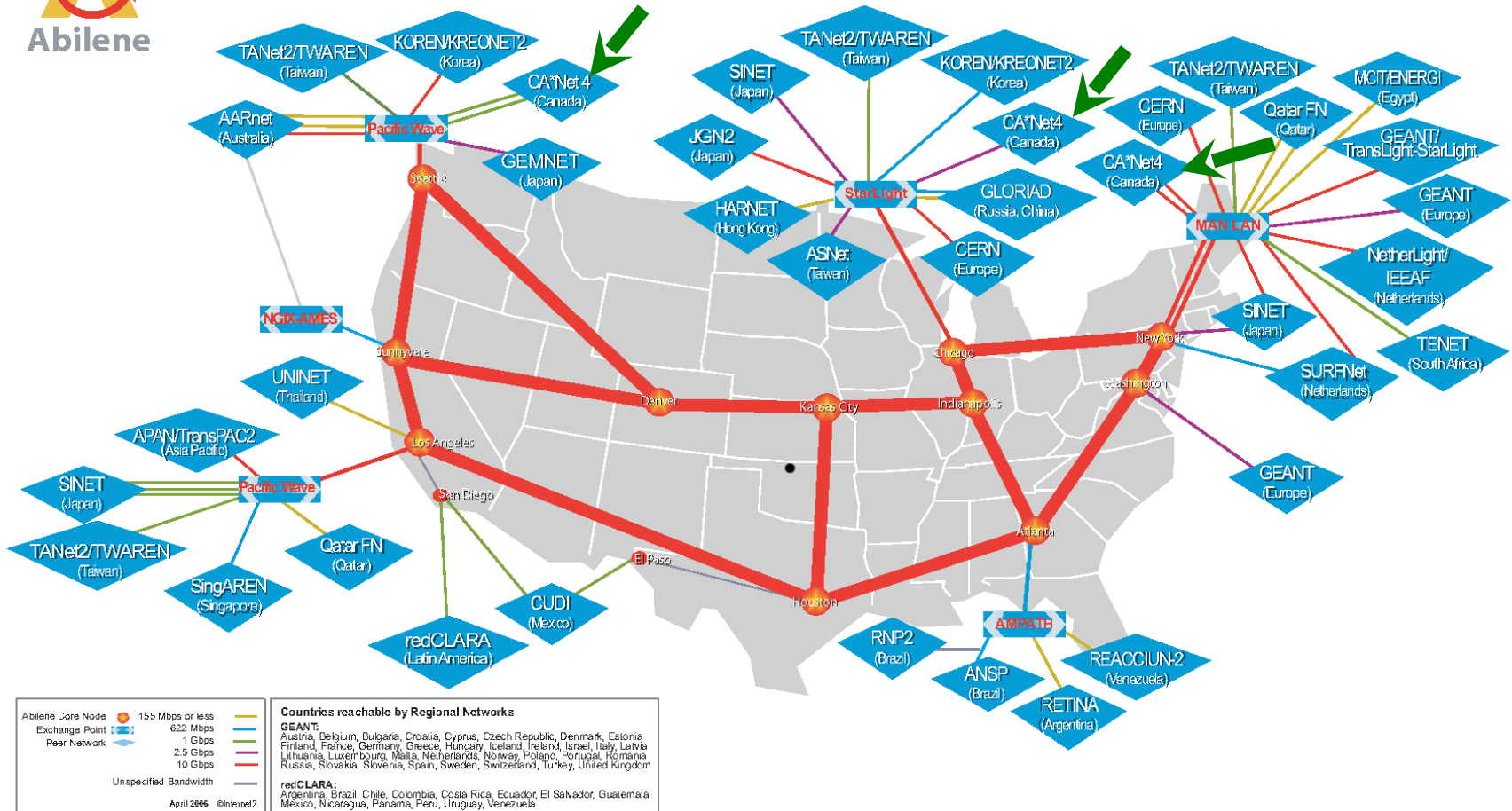
# ROADM



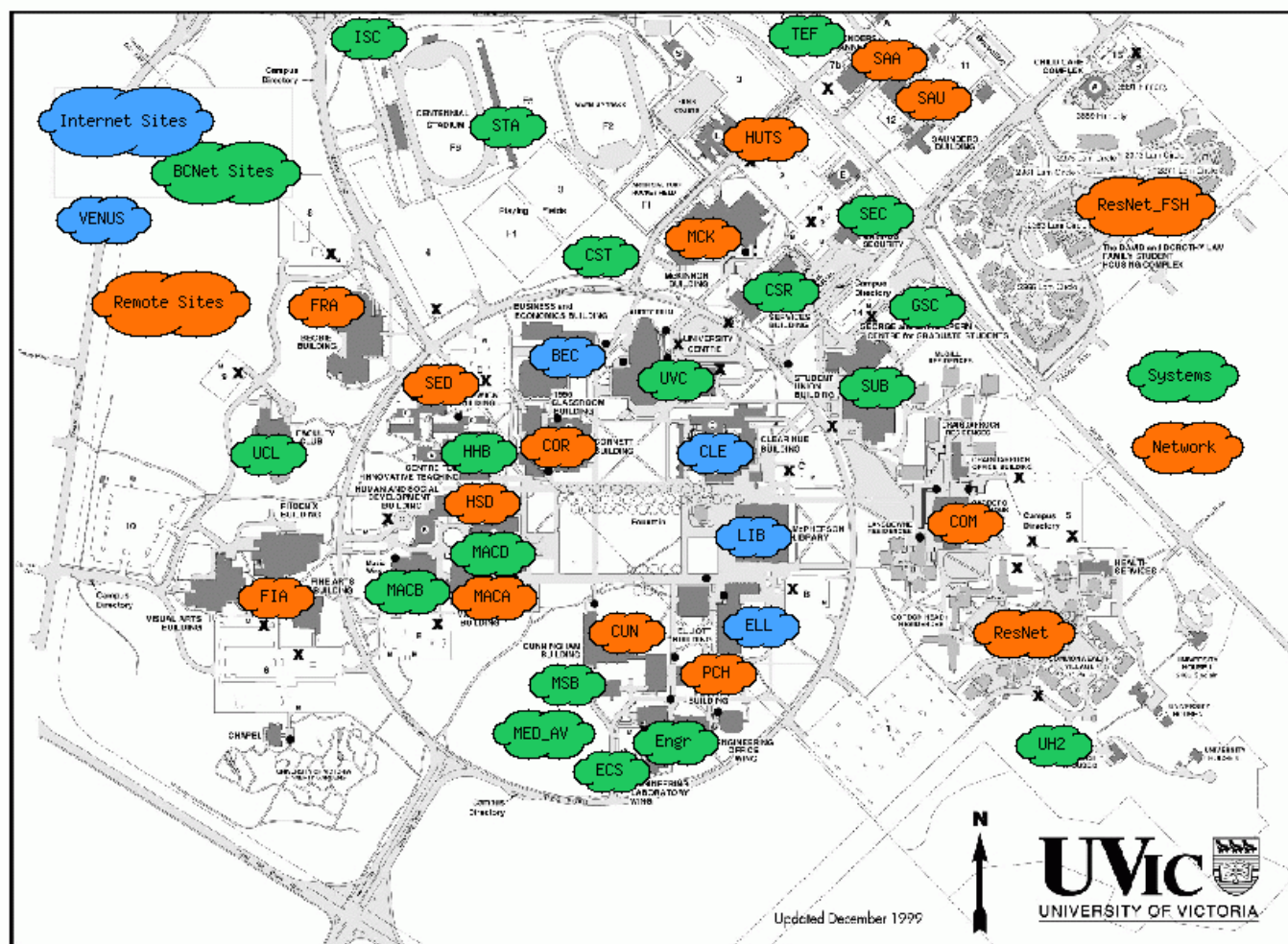
# International Connections



## Abilene International Peering



# UVicNet – 50,000' View



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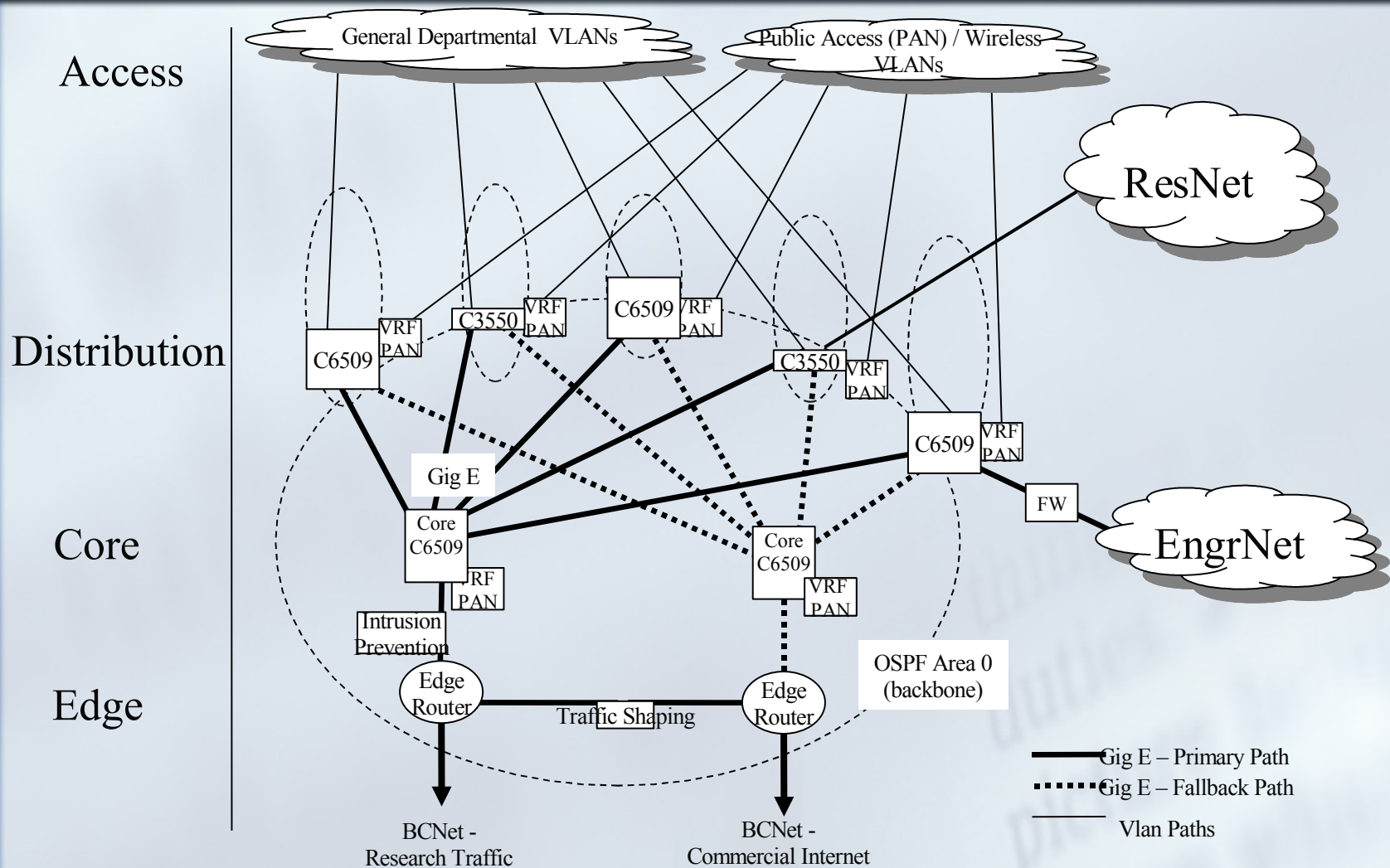
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# UVicNet Facts & Figures

- (main campus only)
  - 5,000 telephone lines (excl. Res)
    - Medium sized Nortel PBX (old technology)
    - Project to evaluate Voice/IP underway
  - 15,000 data ports (excl. Engr/CSC)
  - 700km of fibre optics (350 laps of Ring Road)

<https://nets.uvic.ca>

# UVicNet Structure



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# Hardware

- 99.9% Cisco
- switch/routers (~600)
- wireless access points (~300)
- Other vendors for “point” solutions:
  - PacketTeer for traffic shaping (Internet)
  - McAfee Intrusion Prevention
  - F5 Load Balancer
  - Intel servers (DNS, DHCP, Management apps, ...)

# Software

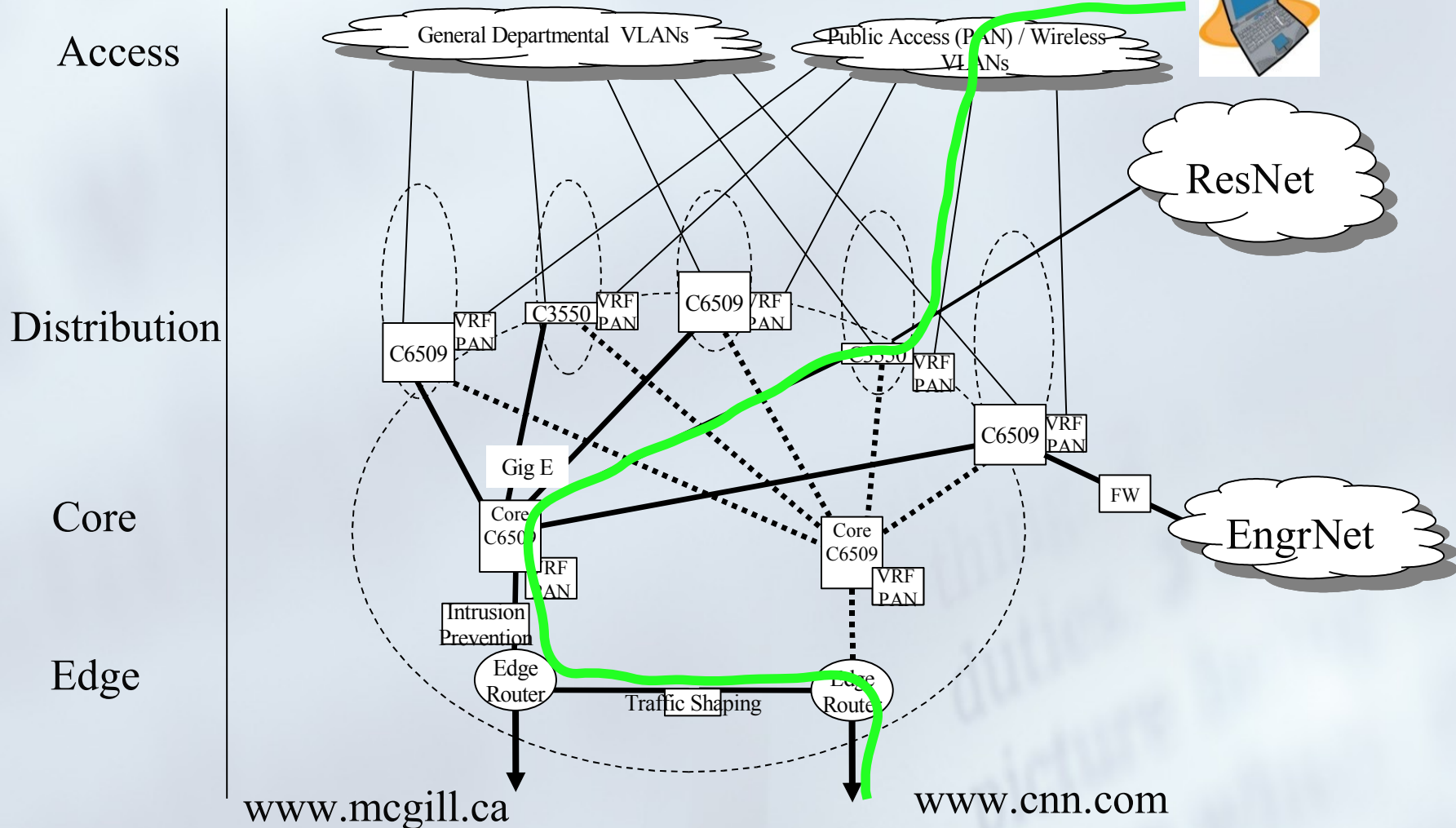
- Cisco
  - IOS (Internetwork Operating System)
- Intel servers
  - Mostly linux
  - Some Windows
- Others
  - Proprietary, based on Windows or \*nix variant



# Making Connections

- Access methods
  - 10/100 wired ethernet → 10/100/1000
  - 802.11b/g wireless
- Backbone
  - 1 GigE → 10 GigE
- Light-paths
  - <http://www.canarie.ca/canet4/uclp>

# Surfing 101



# Traceroute -ORAN

```
tcptraceroute www.mcgill.ca 80
Selected device eth0, address 142.104.22.13, port 49259 for outgoing packets
Tracing the path to www.mcgill.ca (132.216.177.140) on TCP port 80 (www), 30 hops max
 1 dmc2cled050.bb.uvic.ca (142.104.22.254)  0.319 ms  0.521 ms  0.229 ms
 2 csc1cled050.bb.uvic.ca (142.104.252.17)  0.249 ms  0.206 ms  0.192 ms
 3 emc1cled050.bb.uvic.ca (142.104.252.246)  0.428 ms  0.331 ms  0.353 ms
-----
 4 gigapop-ORAN.hc.BC.net (207.23.240.177)  2.408 ms  2.419 ms  2.549 ms
-----
 5 205.189.32.194  30.281 ms  23.078 ms  23.113 ms
 6 205.189.32.6  76.705 ms  67.595 ms  67.865 ms
 7 205.189.32.18  91.243 ms  91.090 ms  91.467 ms
 8 205.189.32.225  91.141 ms  91.191 ms  91.168 ms
-----
 9 C4-TIER-A.dntrl-rq.risq.net (132.202.80.45)  91.371 ms  91.397 ms  90.968 ms
10 mcgill-gw.risq.net (132.202.32.90)  91.609 ms  91.686 ms  91.257 ms
11 mcgill-canet-membrel.risq.net (206.167.128.50)  91.423 ms  91.398 ms  91.601 ms
-----
12 132.216.255.2  91.346 ms  91.738 ms  91.605 ms
13 datacentre1-vlan414.GW.McGill.CA (132.216.216.5)  91.390 ms  91.515 ms  91.686 ms
14 132.216.177.133  93.595 ms  92.231 ms  92.336 ms
15 132.216.177.131  92.230 ms  92.722 ms  92.466 ms
16 www.McGill.CA (132.216.177.140) [open]  92.243 ms * *
```

UVic

BCNet

Ca\*NET4

RISQ

McGill

# Traceroute - Internet

```
tcptraceroute www.cnn.com. 80
Selected device eth0, address 142.104.22.13, port 34717 for outgoing packets
Tracing the path to www.cnn.com. (64.236.91.24) on TCP port 80 (www), 30 hops max
 1 dmc2cled050.bb.uvic.ca (142.104.22.254) 0.276 ms 0.187 ms 0.181 ms
 2 csc1cled050.bb.uvic.ca (142.104.252.17) 0.238 ms 0.208 ms 0.211 ms
 3 emc1cled050.bb.uvic.ca (142.104.252.246) 0.441 ms 0.405 ms 0.325 ms
 4 emc1corb115.bb.uvic.ca (142.104.250.37) 0.827 ms 0.550 ms 0.480 ms
 5 UVicB-Policy1.VICTX.BC.net (207.23.241.221) 1.118 ms 0.952 ms 0.967 ms
 6 ralcv-ge3-2-11.gv.bigpipeinc.com (64.251.72.41) 1.061 ms 1.024 ms 1.125 ms
 7 rd1cv-ge3-2.gv.shawcable.net (66.163.72.9) 1.049 ms 1.510 ms 0.797 ms
 8 rd2cv-ge1-0-0.gv.shawcable.net (66.163.72.6) 1.100 ms 0.940 ms 0.797 ms
 9 rclwt-pos3-0-0.wa.shawcable.net (66.163.77.182) 3.169 ms 3.195 ms 3.745 ms
10 rc2wt-ge3-0-0.wa.shawcable.net (66.163.68.5) 3.583 ms 3.458 ms 3.423 ms
11 rclsj-pos0-0.cl.shawcable.net (66.163.77.70) 24.315 ms 24.600 ms 24.165 ms
12 rc2sj-ge1-0-0.cl.shawcable.net (66.163.67.102) 24.740 ms 24.773 ms 24.237 ms
13 pop2-sjg-P3-2.atdn.net (66.185.150.109) 24.282 ms 24.008 ms 24.203 ms
14 bb1-sjg-P1-0.atdn.net (66.185.150.96) 24.916 ms 24.635 ms 24.410 ms
15 * * *
16 * pop1-ash-S0-1-0.atdn.net (66.185.144.33) 82.904 ms 83.100 ms
17 dar1-mtc-S1-0-0.atdn.net (66.185.151.102) 83.763 ms 83.751 ms 84.080 ms
18 * * *
19 www.cnn.com (64.236.91.24) [open] 84.612 ms 83.125 ms *
```

# Traceroute vs TCPtraceroute

```
traceroute www.cnn.com.
```

```
traceroute: Warning: www.cnn.com. has multiple addresses; using 64.236.16.20
```

```
traceroute to www.cnn.com (64.236.16.20), 30 hops max, 40 byte packets
```

```
 1 dmc2cled050.bb.uvic.ca (142.104.22.254)  0.242 ms  0.215 ms  0.187 ms
 2 csc1cled050.bb.uvic.ca (142.104.252.17)  0.264 ms  0.216 ms  0.199 ms
 3 emc1cled050.bb.uvic.ca (142.104.252.246)  0.631 ms  0.564 ms  0.604 ms
 4 emc1corbl15.bb.uvic.ca (142.104.250.37)  0.903 ms  1.165 ms  0.899 ms
 5 UVicB-Policy1.VICTX.BC.net (207.23.241.221)  1.193 ms  1.172 ms  0.902 ms
 6 ralcv-ge3-2-11.gv.bigpipeinc.com (64.251.72.41)  1.253 ms  1.277 ms  3.350 ms
 7 rd1cv-ge3-2.gv.shawcable.net (66.163.72.9)  1.461 ms  1.585 ms  1.263 ms
 8 rclbb-pos4-0-0.vc.shawcable.net (66.163.77.185)  3.154 ms  3.194 ms  3.272 ms
 9 rclar-pos14-0.ed.shawcable.net (66.163.76.162)  18.222 ms  18.103 ms  18.316 ms
10 rc1sc-pos11-0-0.wp.shawcable.net (66.163.77.189)  35.442 ms  38.006 ms  35.800 ms
11 rc2nr-ge12-0-0.wp.shawcable.net (66.163.73.169)  35.012 ms  34.938 ms  35.194 ms
12 rc2ch-pos1-0-0.il.shawcable.net (66.163.77.94)  53.579 ms  52.991 ms  53.228 ms
13 rc2as-pos0-0.vx.shawcable.net (66.163.77.66)  71.037 ms  70.534 ms  70.736 ms
14 pop1-ash-S3-0-2.atdn.net (66.185.139.221)  70.150 ms  70.393 ms  70.596 ms
15 bb1-ash-P0-0.atdn.net (66.185.144.192)  72.024 ms  71.733 ms  71.918 ms
16 bb1-vie-P10-0.atdn.net (66.185.152.67)  70.953 ms  71.049 ms  70.687 ms
17 bb1-rdu-P4-0.atdn.net (66.185.152.14)  75.964 ms  76.041 ms  75.792 ms
18 bb2-rdu-P2-0.atdn.net (66.185.152.3)  76.323 ms  75.812 ms  75.888 ms
19 bb2-atm-P6-0.atdn.net (66.185.152.30)  83.666 ms  83.553 ms  83.709 ms
20 * * *
21 * * *
22 * * *
23 * * *
24 * * *
25 * * *
26 * * * ^C
```

# DNS Entries

```
$ dig www.cnn.com. A
```

```
;; QUESTION SECTION:
```

```
;www.cnn.com.                IN      A
```

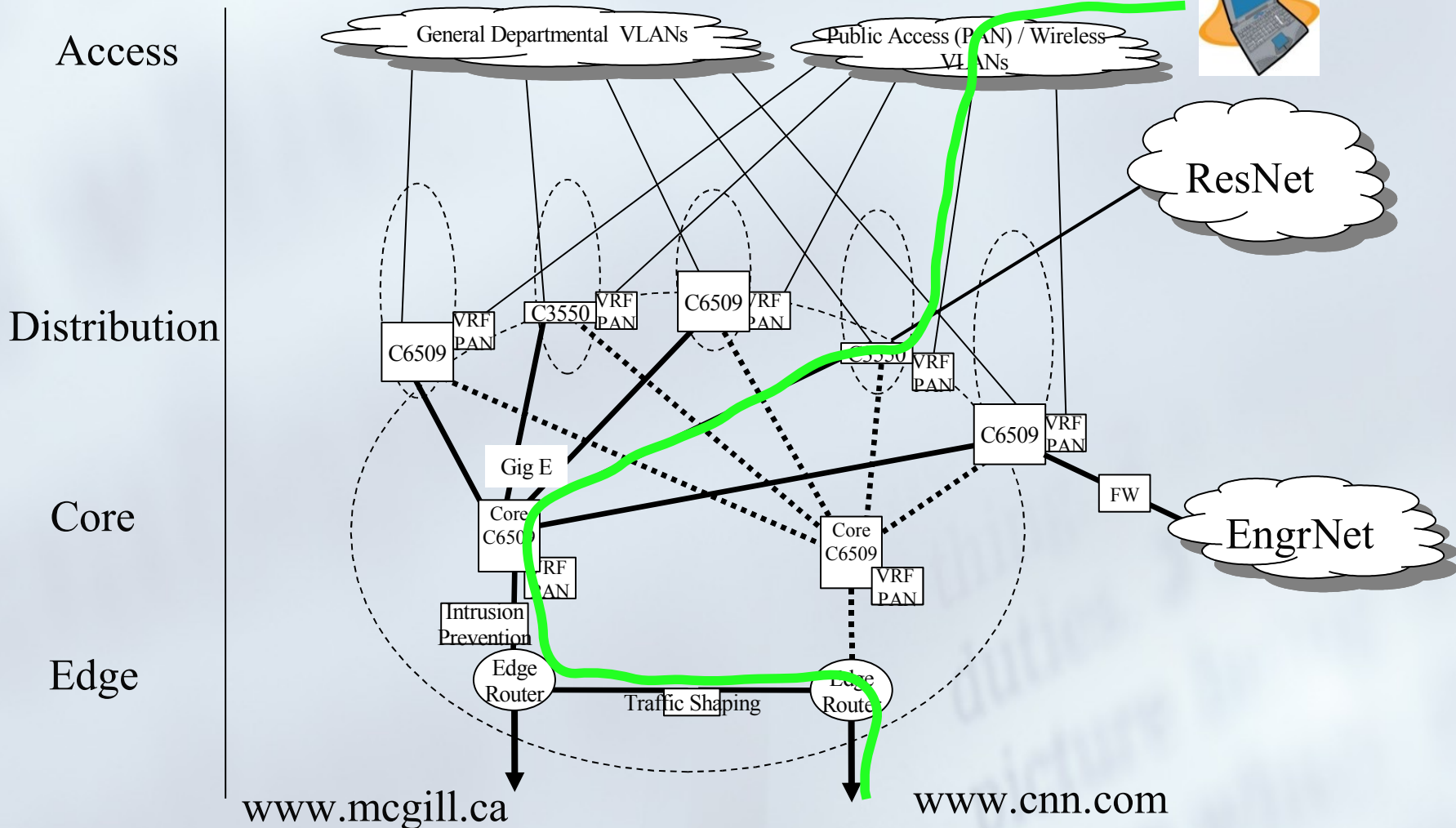
```
;; ANSWER SECTION:
```

```
www.cnn.com.                600     IN      A      64.236.16.20
www.cnn.com.                600     IN      A      64.236.16.52
www.cnn.com.                600     IN      A      64.236.24.12
www.cnn.com.                600     IN      A      64.236.29.120
www.cnn.com.                600     IN      A      64.236.91.21
www.cnn.com.                600     IN      A      64.236.91.22
www.cnn.com.                600     IN      A      64.236.91.23
www.cnn.com.                600     IN      A      64.236.91.24
```

# Know where you are going

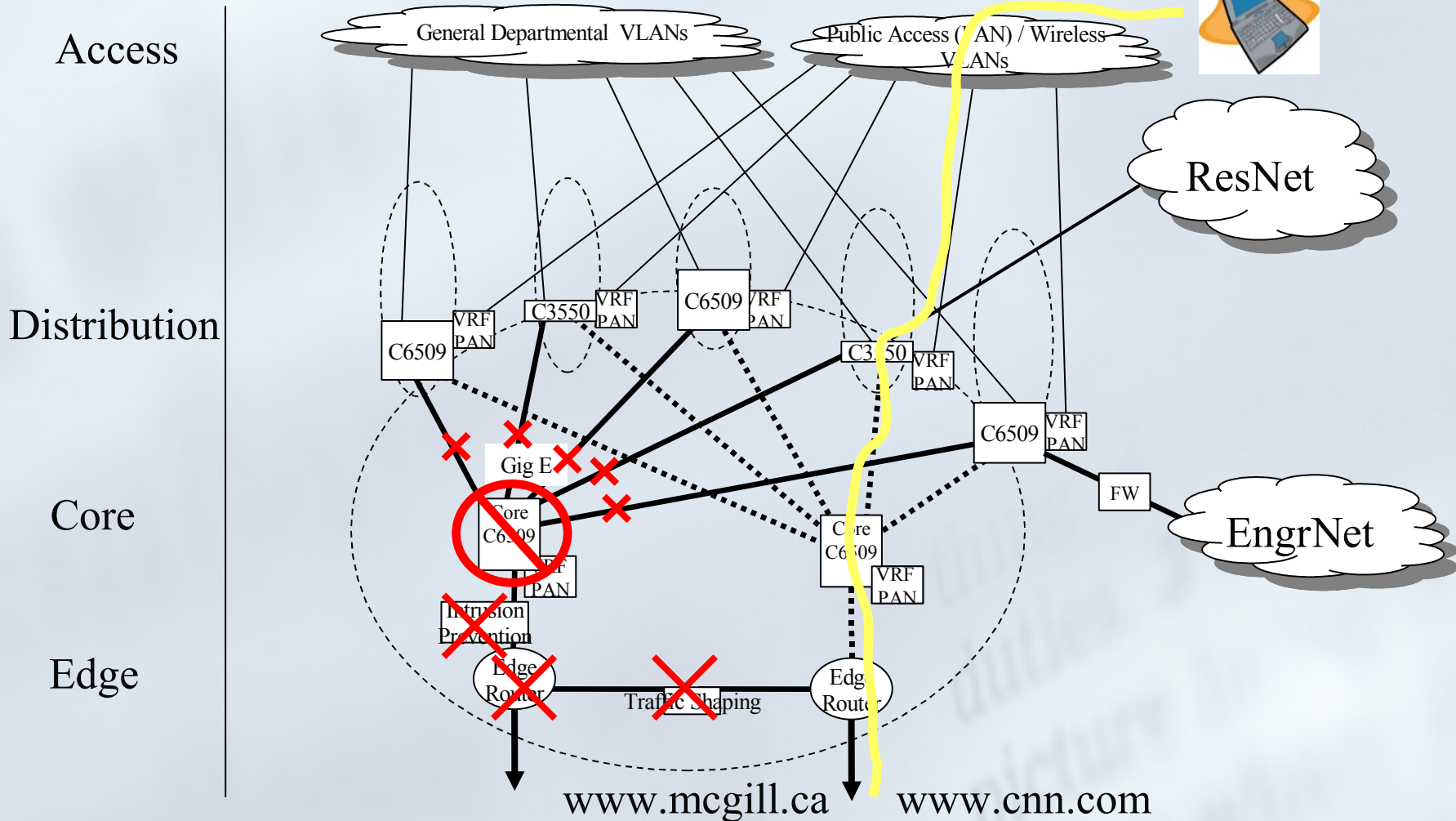
```
tcptraceroute www.ubc.ca. 80
Selected device eth0, address 142.104.22.13, port 49299 for outgoing packets
Tracing the path to www.ubc.ca. (64.40.111.228) on TCP port 80 (www), 30 hops max
 1 dmc2cled050.bb.uvic.ca (142.104.22.254)  0.379 ms  10.718 ms  1.071 ms
 2 csc1cled050.bb.uvic.ca (142.104.252.17)  0.259 ms  0.201 ms  0.200 ms
 3 emc1cled050.bb.uvic.ca (142.104.252.246)  0.411 ms  0.341 ms  0.361 ms
 4 emc1corb115.bb.uvic.ca (142.104.250.37)  0.920 ms  0.634 ms  0.635 ms
 5 UVicB-Policy1.VICTX.BC.net (207.23.241.221)  0.982 ms  0.782 ms  1.069 ms
 6 ralcv-ge3-2-11.gv.bigpipeinc.com (64.251.72.41)  1.175 ms  0.800 ms  1.132 ms
 7 rd1cv-ge3-2.gv.shawcable.net (66.163.72.9)  1.078 ms  0.837 ms  0.972 ms
 8 rclbb-pos4-0-0.vc.shawcable.net (66.163.77.185)  3.102 ms  3.300 ms  3.164 ms
 9 ralwh-ge3-1.vc.shawcable.net (66.163.69.42)  3.633 ms  3.801 ms  3.561 ms
10 rx0wh-net-nation.vc.bigpipeinc.com (64.251.87.222)  4.101 ms  3.902 ms  3.551 ms
11 itservices.ubc.ca (64.40.111.228) [open]  4.411 ms  4.200 ms  4.212 ms
```

# Surfing 102





# Failure of primary core



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# Challenges

- Troubleshooting
  - multiple vendors, operating systems, ...
  - “standards”
    - room for interpretation
    - can always define a new standard
  - mostly real-time
    - repairing a plane while it’s in the air
  - many external influences
  - often too complex to “duplicate in the lab”

# Tools

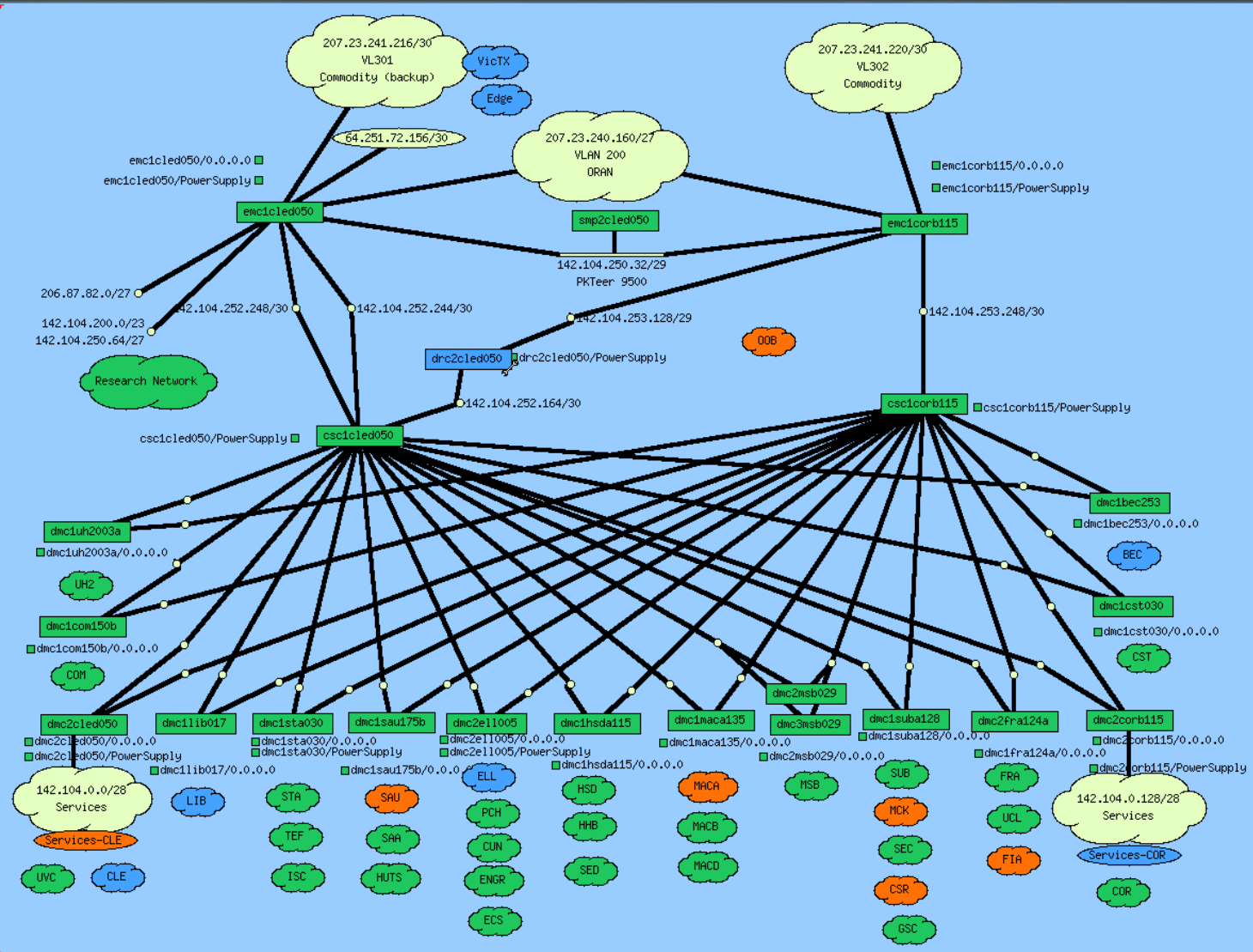
*Percussive Maintenance:*

*Hitting an electronic device repeatedly until it returns to normal operation.*

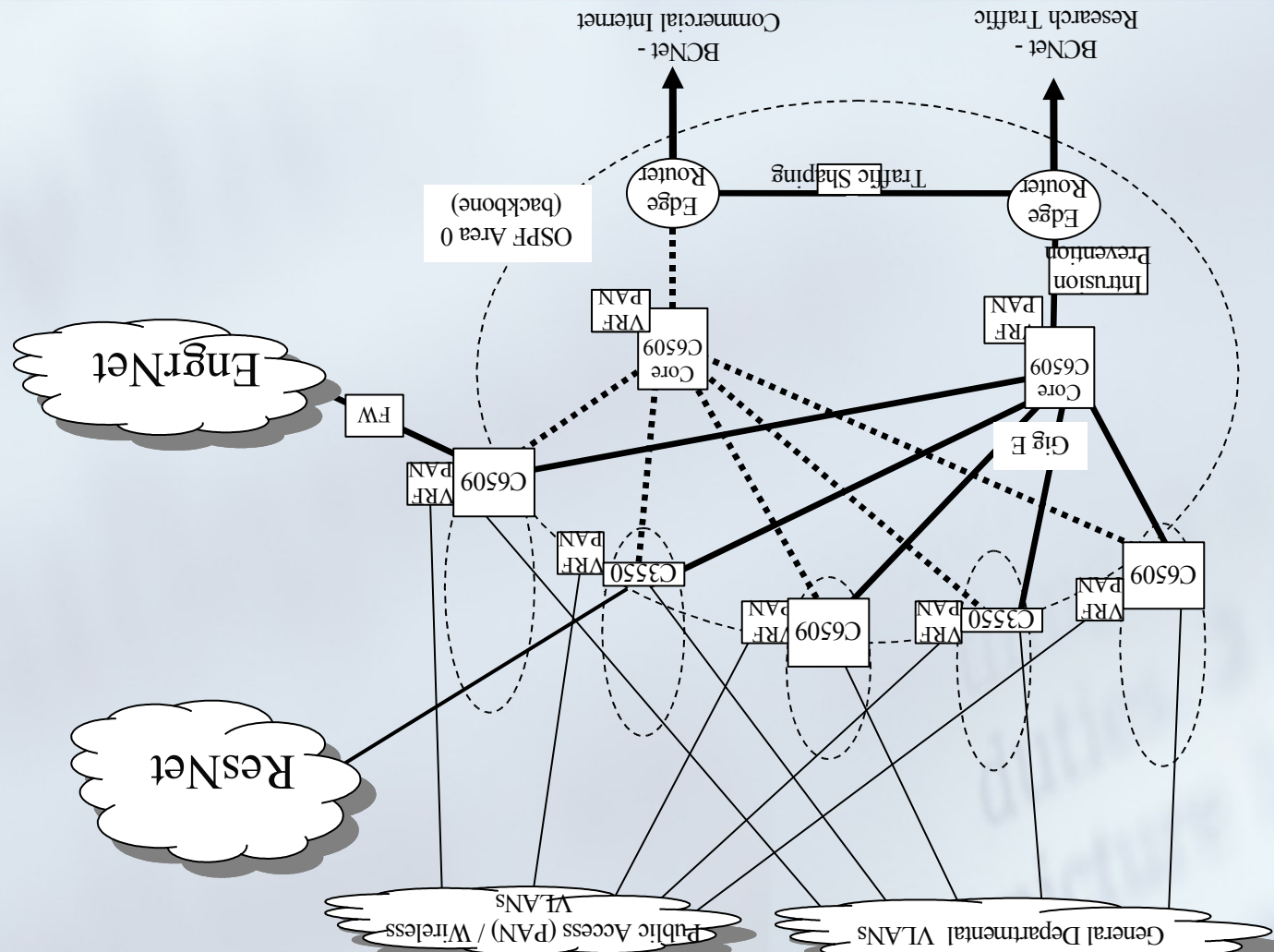
# Tools

- Fault Detection & Analysis
  - Intermapper, HP/Openview
  - Protocol analyzer (aka sniffer)
- Trend Monitoring
  - Cacti, MRTG, ...
- Configuration Mgt
  - CiscoWorks

# Intermapper



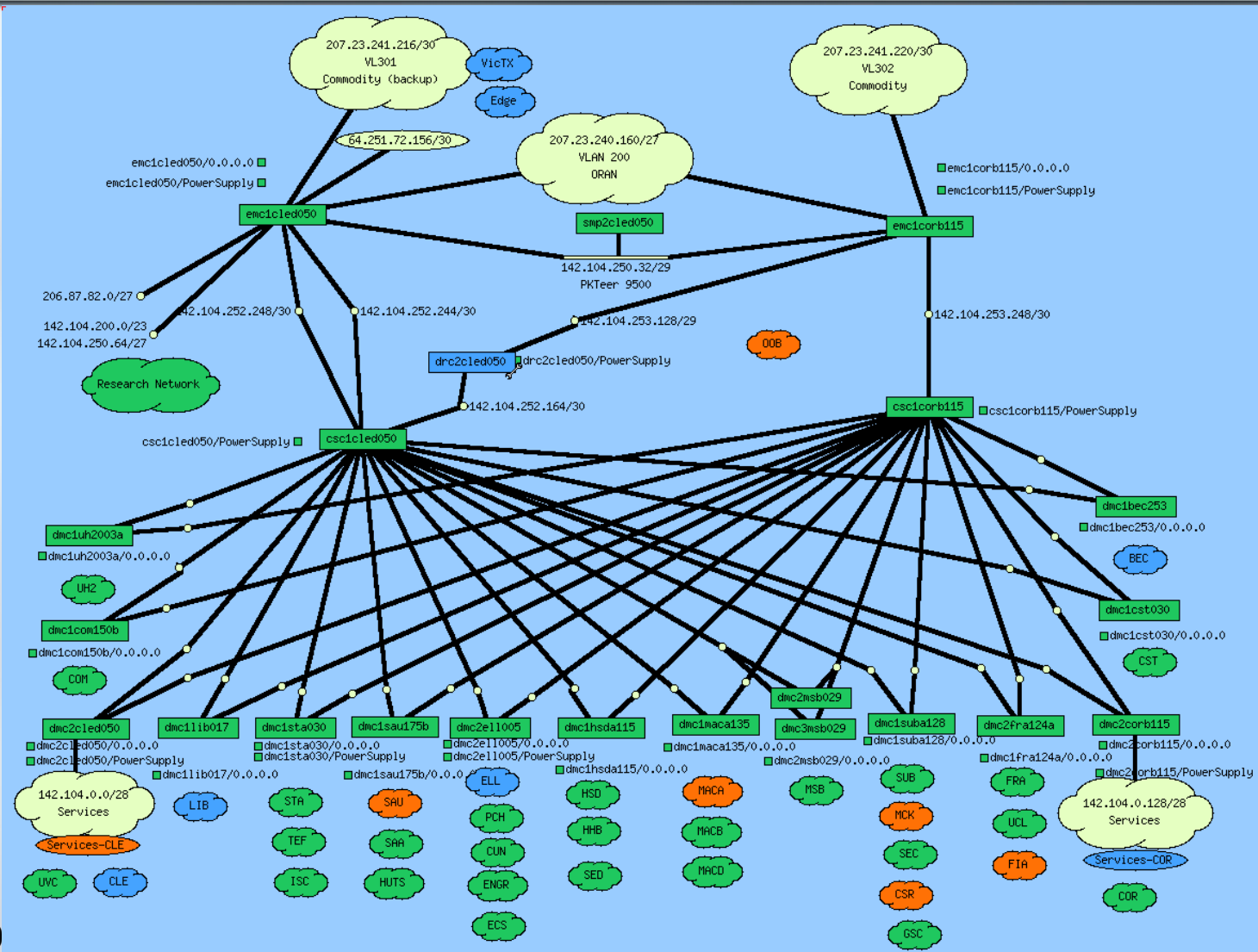
# UVicNet Structure



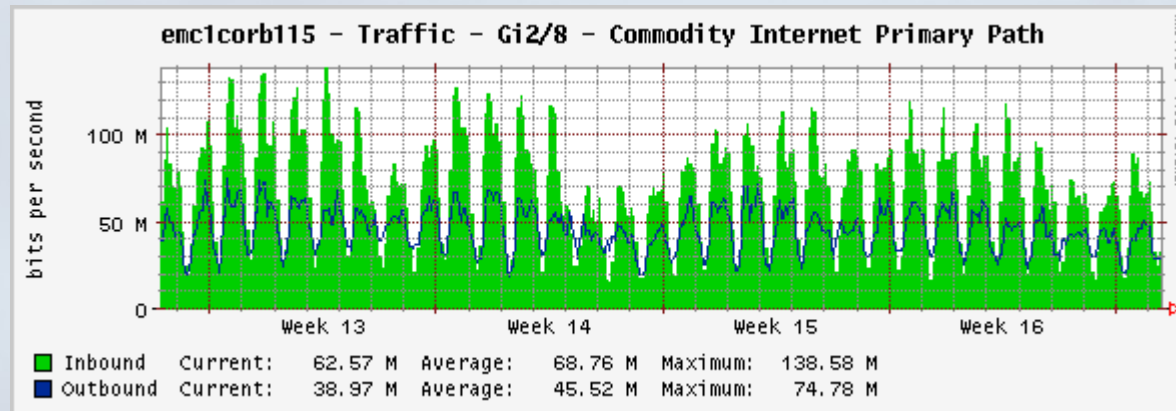
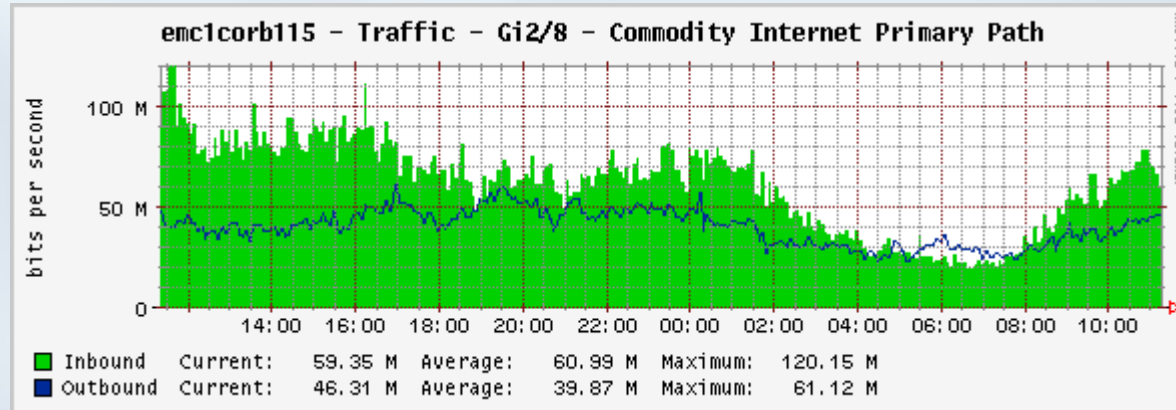
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# Intermapper

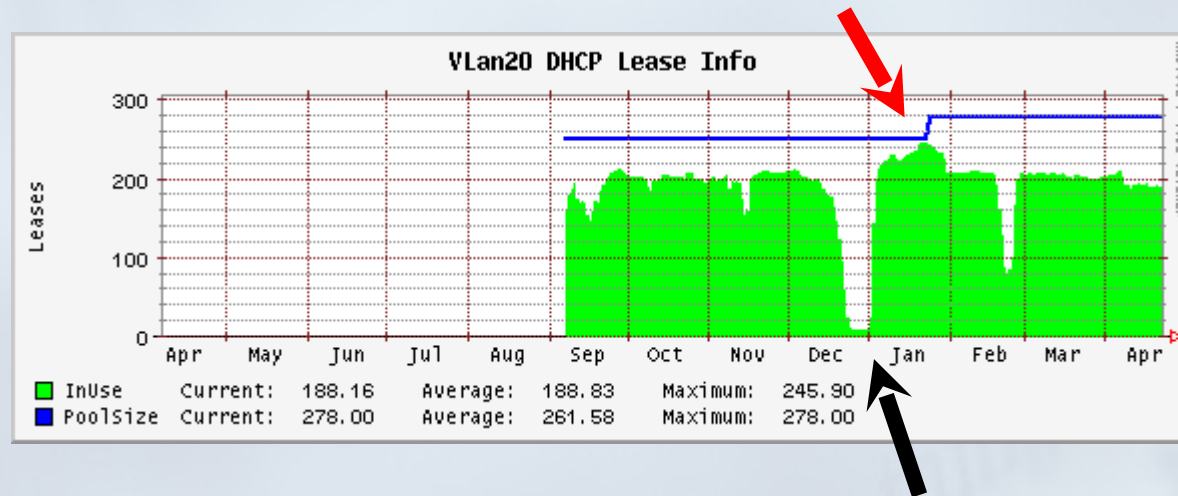


# Trend Monitoring - Bandwidth





# Trend Monitoring - DHCP



# Tools – in-house

- Use co-op students to
  - build web-enabled apps
  - admin & management tools
  - integration of heterogeneous environment
- Perl, java, apache, mysql, oracle
- Some customer “self-service” tools

# Tools – in-house-2

- IPAdmin
  - IP Addresses, DNS & DHCP
- ACL Manager
  - Customer management of router access-lists
- FibreMap
  - Document use of fibre strands on campus
- DuctMap
  - Document use of underground conduits

# Services

- Network Services:
  - DNS, DHCP, ...
- Other groups in Computing Services:
  - Web servers, email, Netlink, computer labs
  - Learning systems, research computing, ...
- Network brings all of this to our clients.

# Beneath the surface

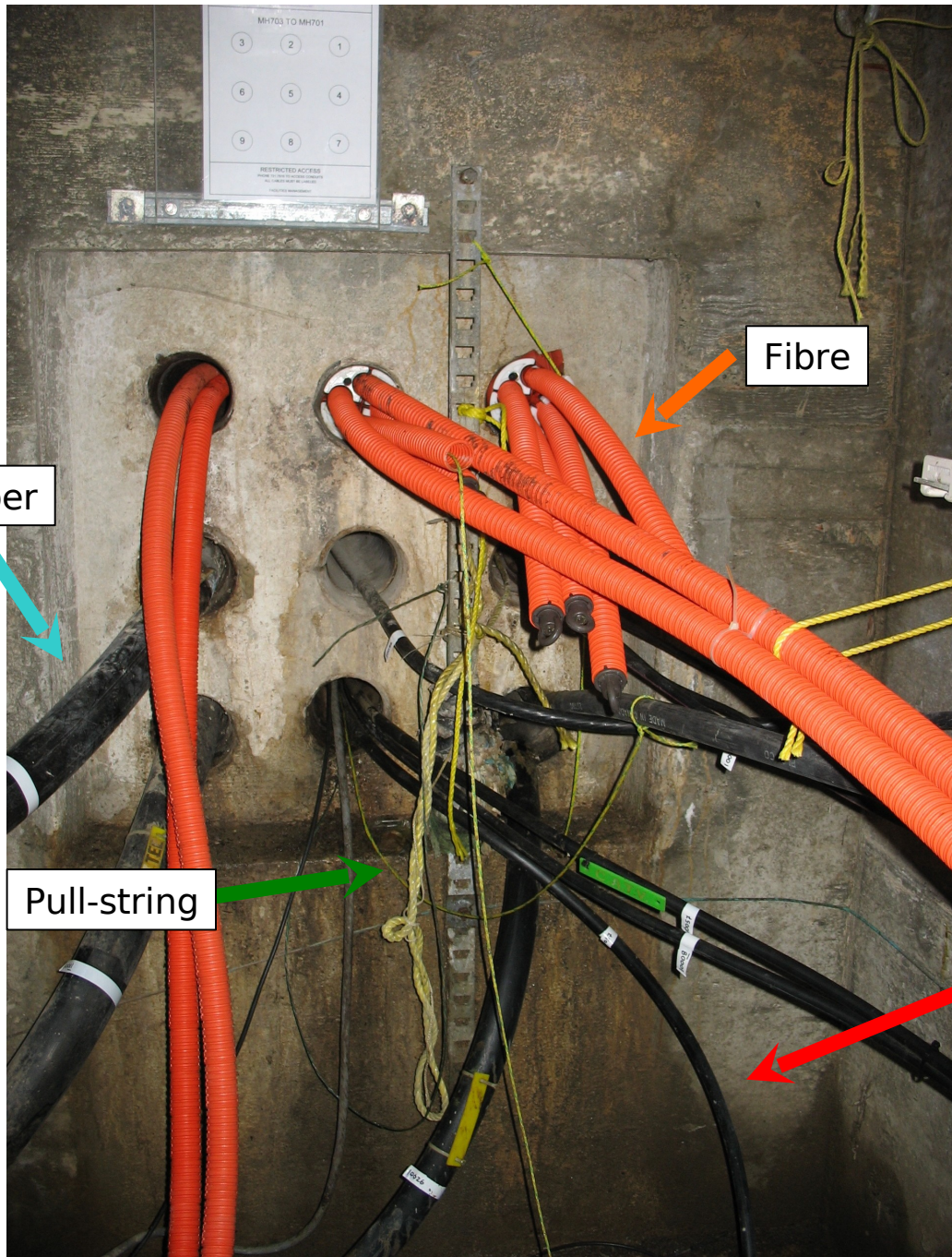


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Copper

Fibre

Pull-string

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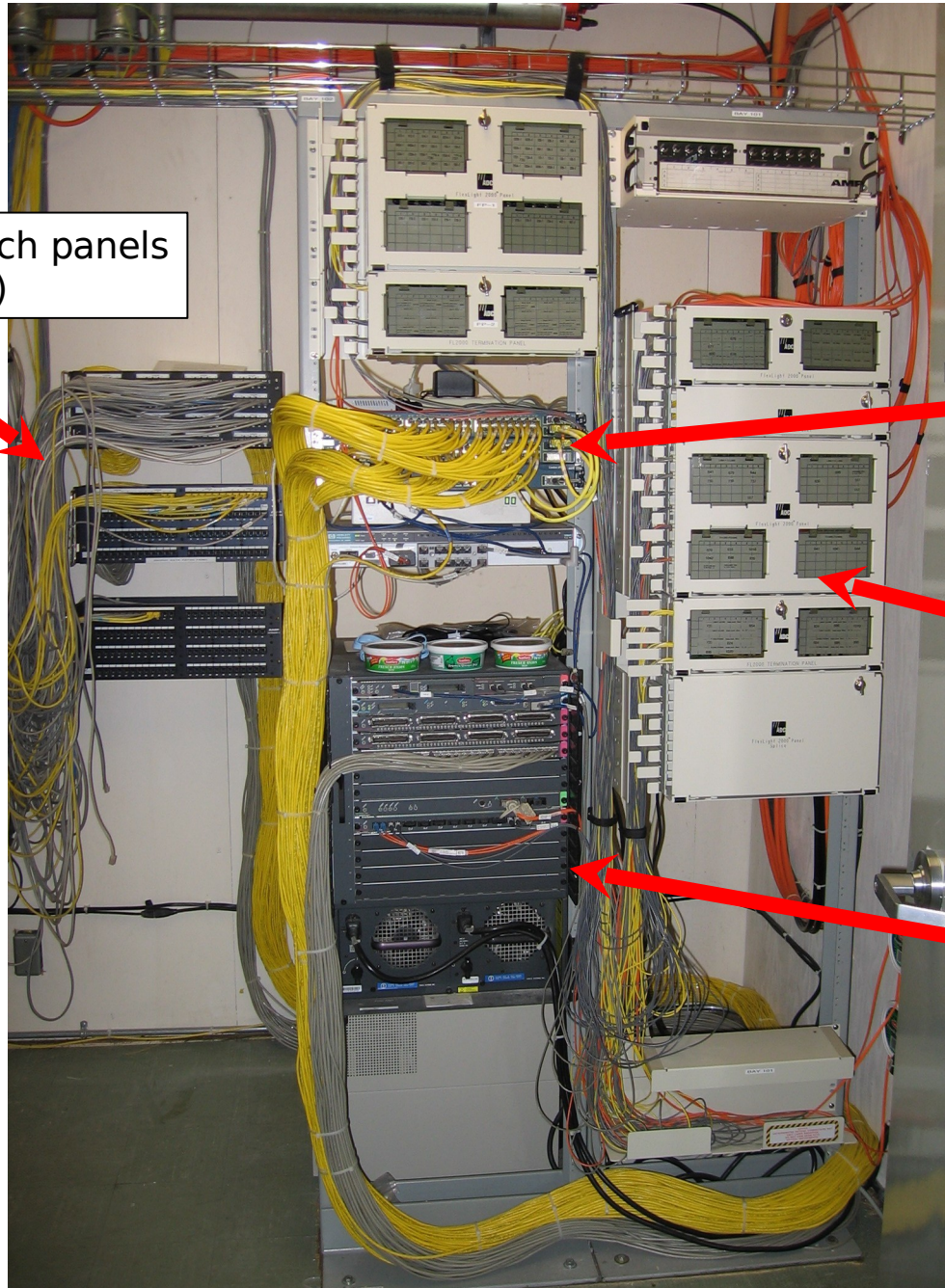
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copper patch panels  
(tel & data)

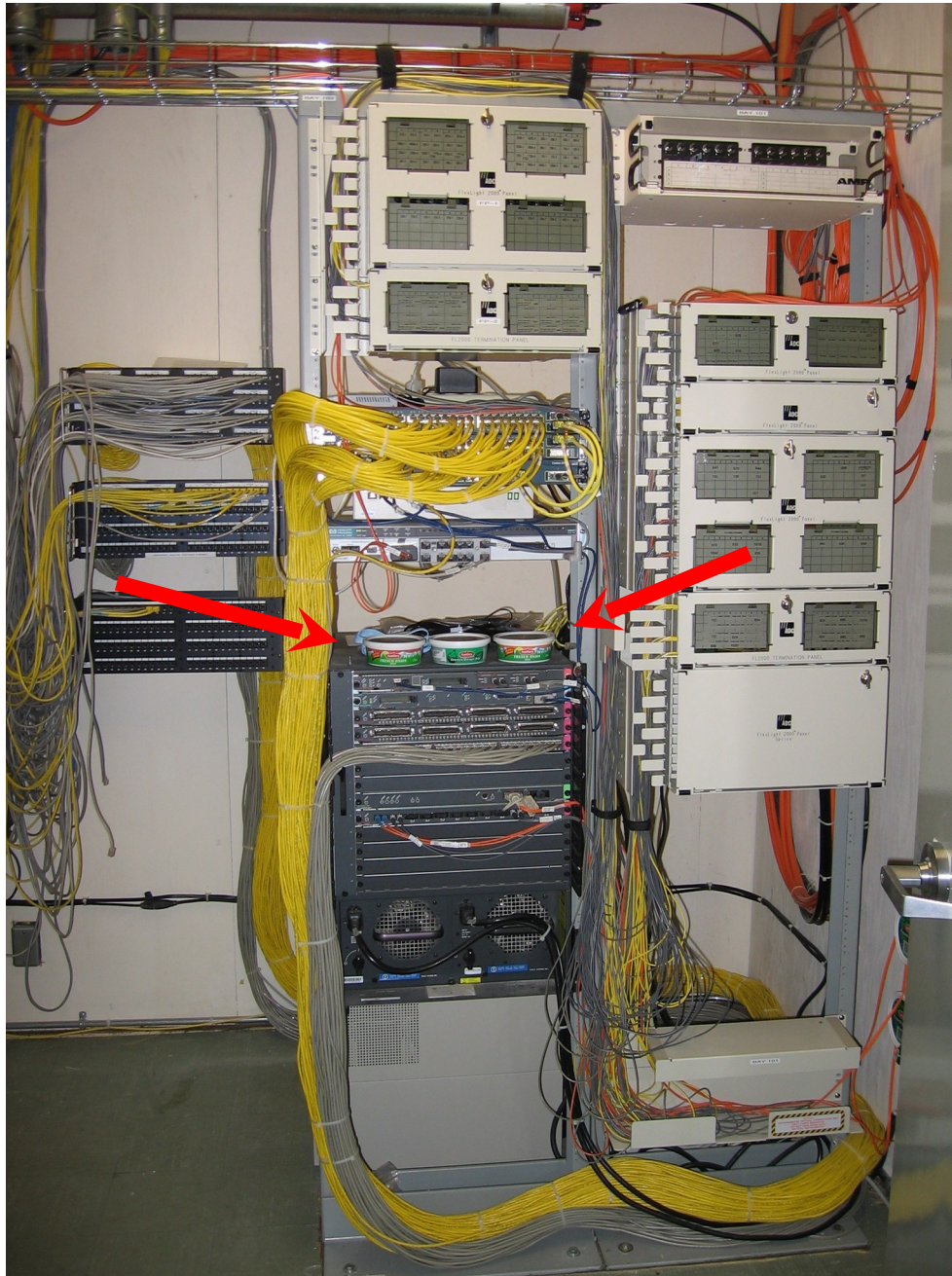
Cisco 2950  
(access layer)

fibre patch panels

Cisco 6509  
(distribution layer)



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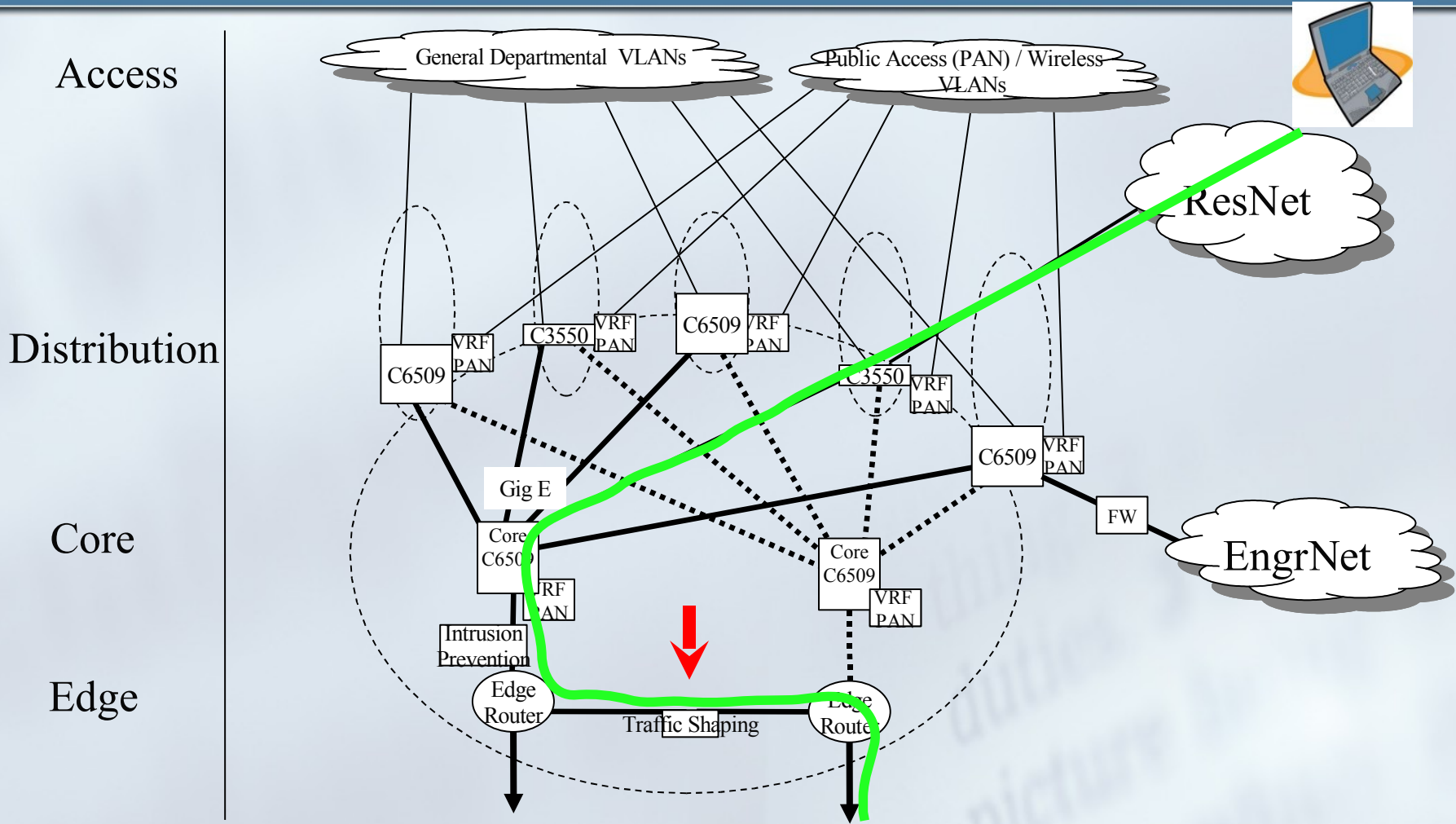
# Challenges - 2

- Constant evolution
  - new products, new protocols
  - “arms race”
    - Hackers
    - Peer-2-peer apps
- Bandwidth demands (commercial Internet)

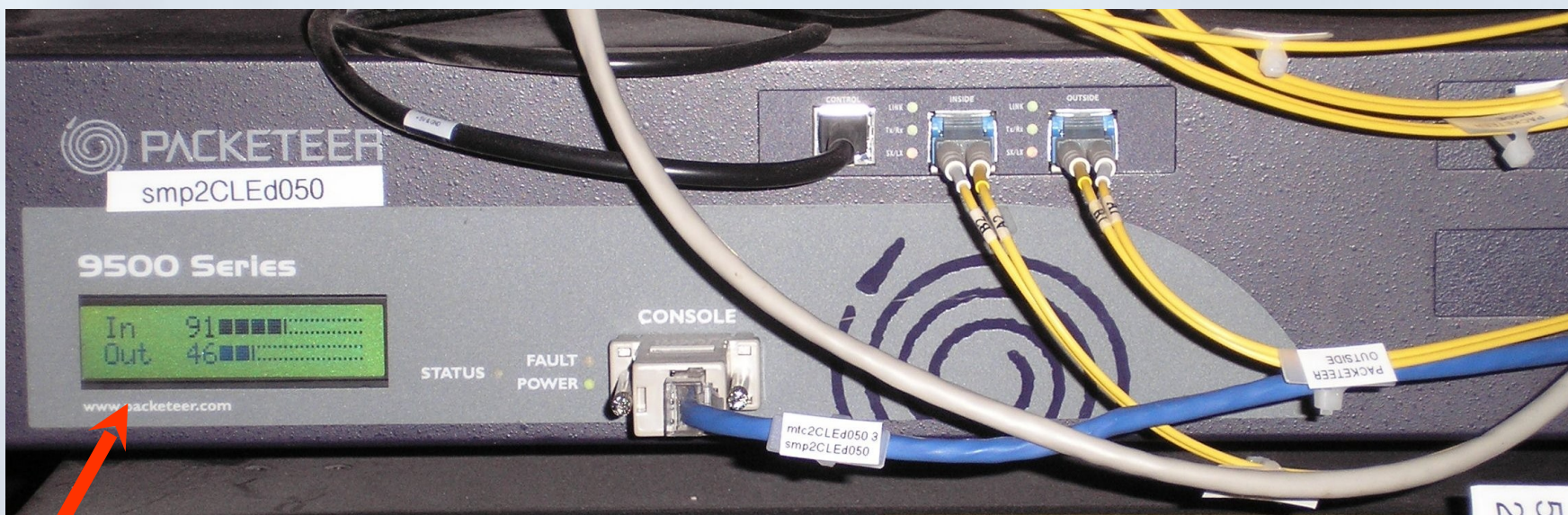
# Bandwidth Management

- Commercial Internet == \$\$\$
- ResNet: the #1 consumer
  - Limits
    - 1 Gbyte / day / user
    - 100mbps rate-limit for ResNet

# ResNet



# PacketTeer 9500



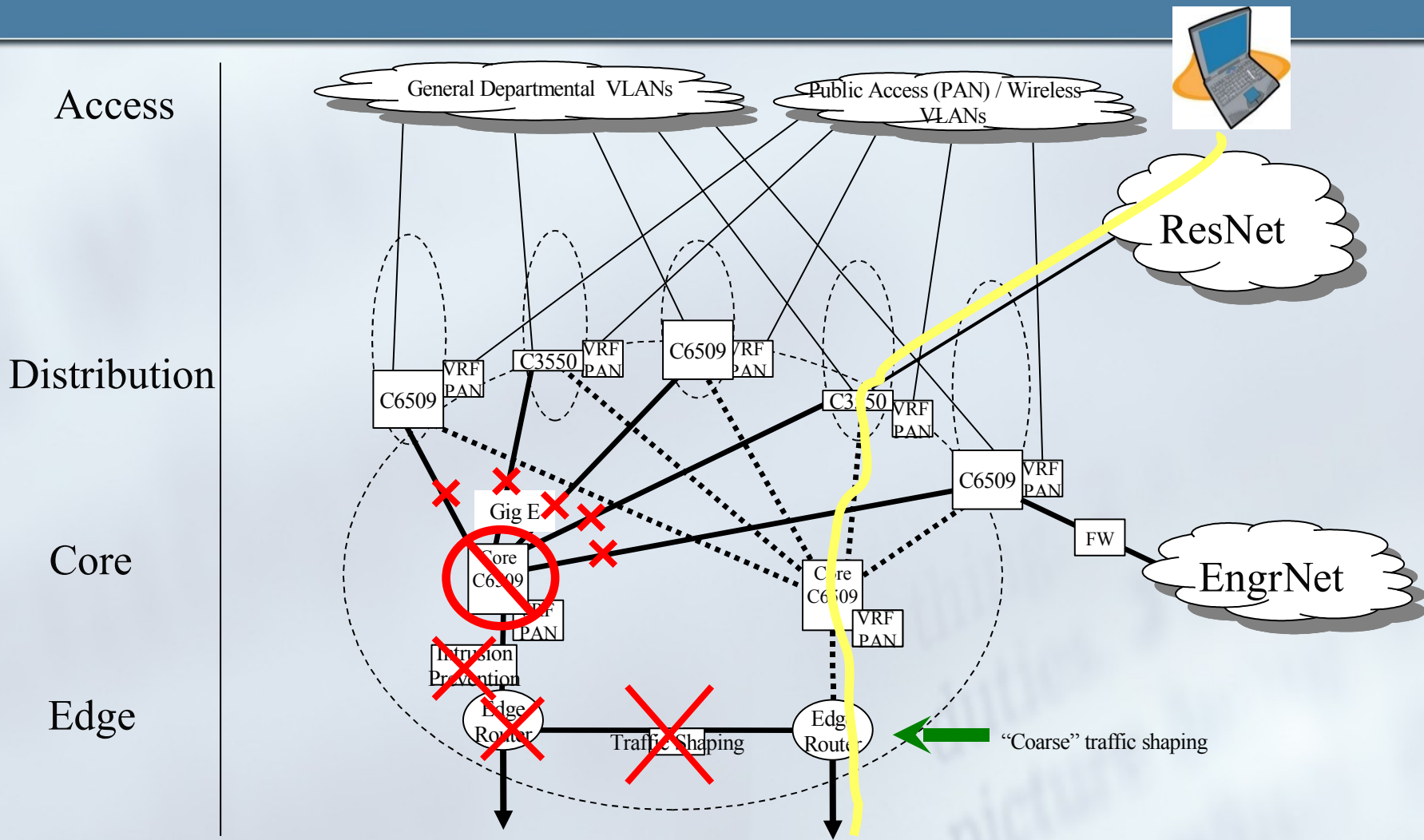
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# Traffic Shaping

- Define classes of traffic
  - By ip address/subnet
    - ResNet
      - Overall rate-limit (100mbps)
  - By protocol
    - X-win, RDP, telnet, SSH
      - incr. priority, guar. 6mbps
    - FTP, SMTP
      - decr. priority
  - By application
    - Peer-2-peer
      - decr. priority
      - rate-limit (12 mbps in, 5 mbps out)

# Traffic shaping -2



# Net-heads

vs

# Bell-heads



- adaptable
- innovative
- having fun



- highly-structured
- big & inflexible
- expensive
- boring

# Summary

- Challenging
- Never boring
- Fun



# Thank you

## Questions?

Feedback: [rkozsan@uvic.ca](mailto:rkozsan@uvic.ca)