DePaul University
Network Overview

(from 50,000 ft)

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About me

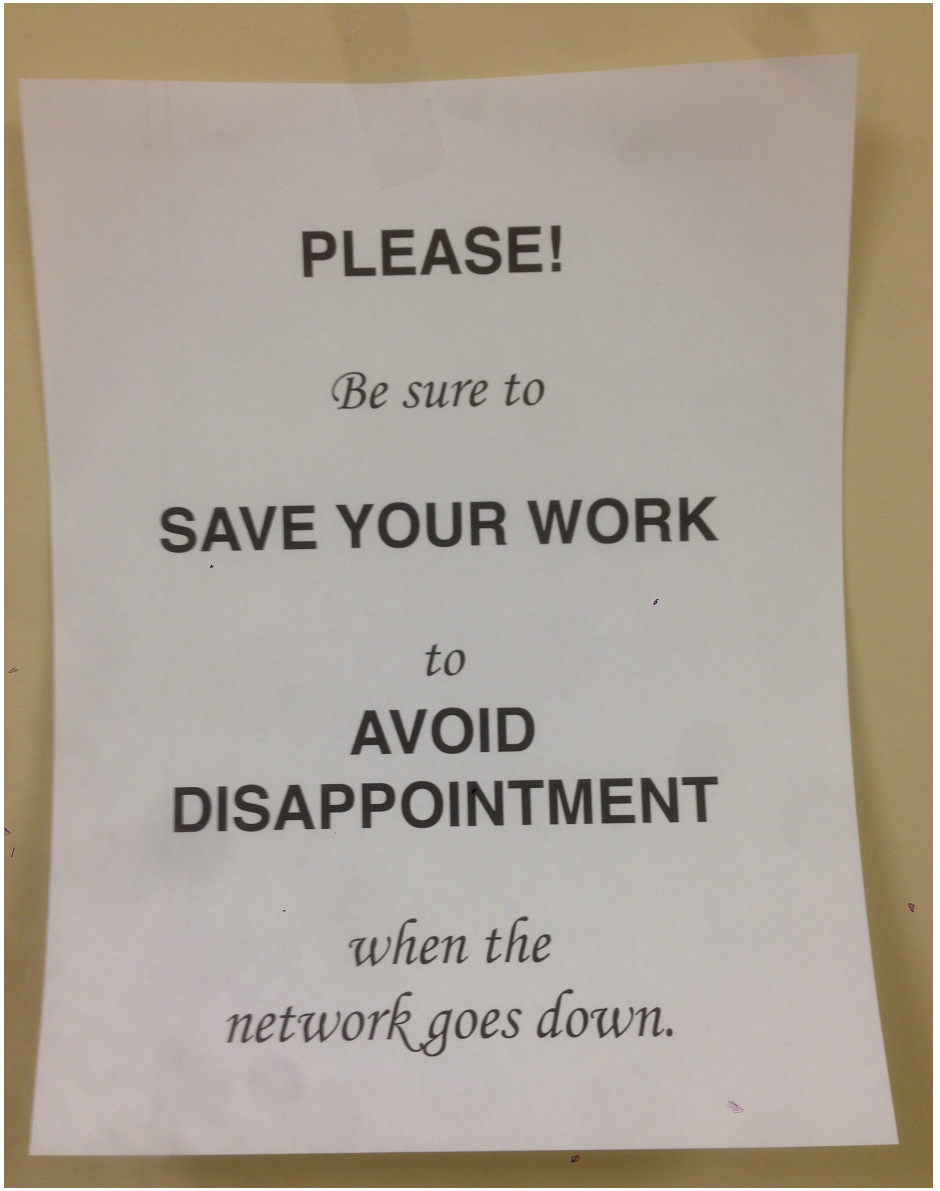
I work for the Infrastructure Division of Information Services

Held positions as a Lab Assistant (1995), Help Desk Tech/Field Tech (1996), ResNET Engineer (1999), Network Engineer (2001), Network Manager (2003), Infrastructure Architect (2006 – Present)

(worn a lot of hats; know where a lot of bodies are buried)

-Have an MS from DPU in N.E.a.M.
-Belong to a number of impressive sounding “secret handshake” clubs and orgs. (NANOG, REN-ISAC, ACUTA, and so on)

The olden days…



What we do

Team of five full-time engineers + student workers
(ask me about this later)

Manage the end-to-end operations of all N&T infrastructure

- Physical/logical design and engineering
- Procurement (vendor relationships, budgeting)
- Implementation (installation/setup)
- Ongoing maintenance (break/fix support)
- …and lifecycle management (long-term planning)

What we do

This is across:
800+ Switching and routing devices (Cisco, Juniper)
There's other stuff too (F5, InfoBlox, Serial management)

1,427 wireless access points and AP controllers (Aruba)
(2010: 560, 2012: 930, 2013: 1222)

5,500+ telephones across both traditional PBX and VoIP domains

Lots of private and vended circuits, supporting equipment

Auxiliary services as well:
(DNS, DHCP, NTP, Multicast, Video over IP, log centralization and management, security services*, ID Card network, RF space management… and "other duties as assigned")

DePaul's IP Space

We manage our own IPv4 space:

140.192.0.0/16 – Assigned May 1995 – 65534 Addresses
75.102.192.0/18 – June 2009 – 16382 Addresses
216.220.176.0/20 – June 2012 – 4094 Addresses

We have a little bit of IPv6 space, too...
2001:468:1202::/48 – Assigned 2002 – 65536*2^64) Addresses
2620:0:2250::/48 – Assigned May 2009 – 65536*(2^64) Addresses

(That's 1,208,925,819,614,629,174,706,176 Addresses per /48)

And we perform traffic engineering, routing with OSPF and BGP

Autonomous System (AS) numbers: 20130, 54728

And that's just the "User" Network…

We also support two data centers

- Primary in Elk Grove Village, secondary in CDM
- HA apps where possible, failover, backups to third site

800+ Virtual machines

~60 Physical servers and supporting devices

Multiple classes of storage replicated between campuses

But this is a completely separate presentation…

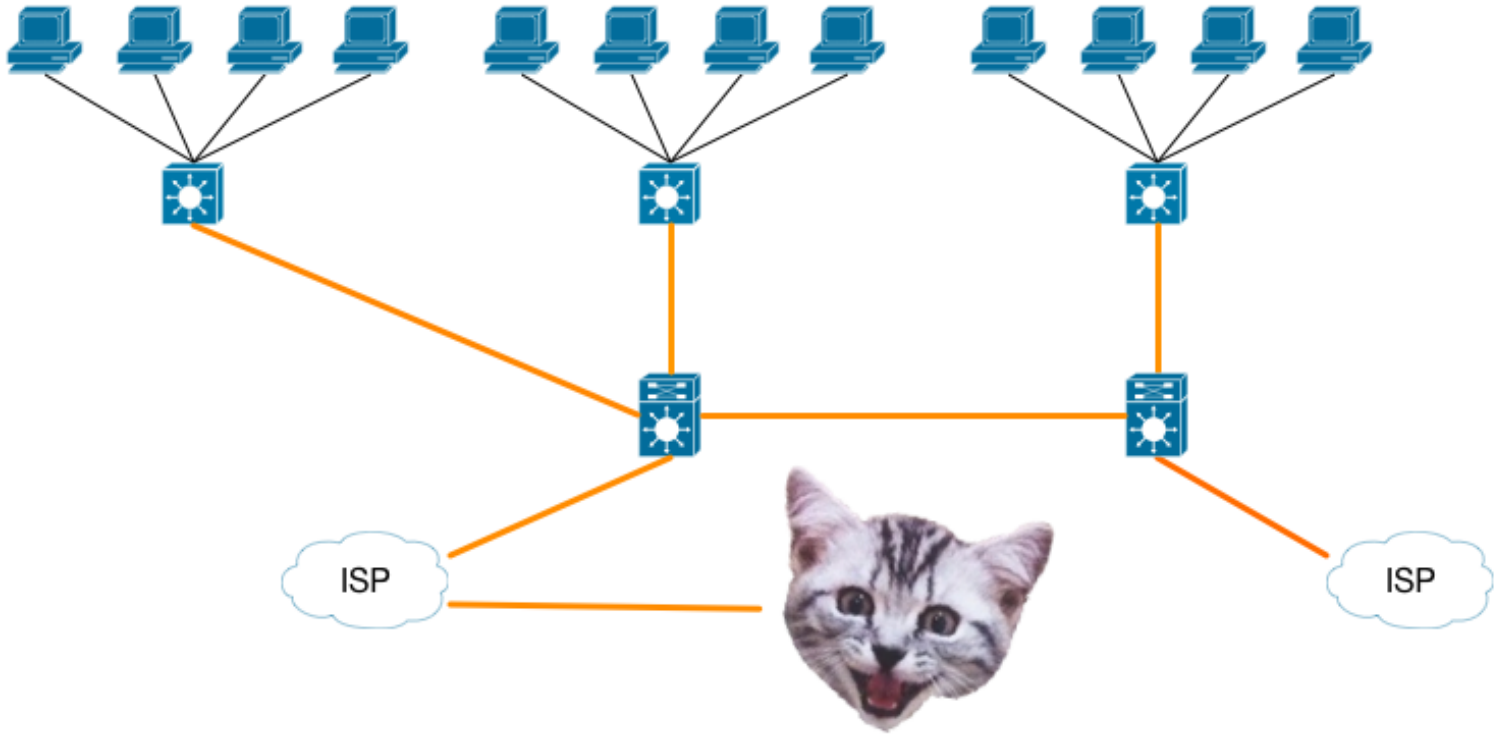
Overall Layout of the Network

"Concentric Rings", designed for multiple layers of redundancy

Two main, three (point five) minor campuses

"Edge", "Distribution", and "Core" architecture

Workstation to IDF, IDF to MDF, MDF to core, core to Internet, Internet to reddit.



Internet connectivity points

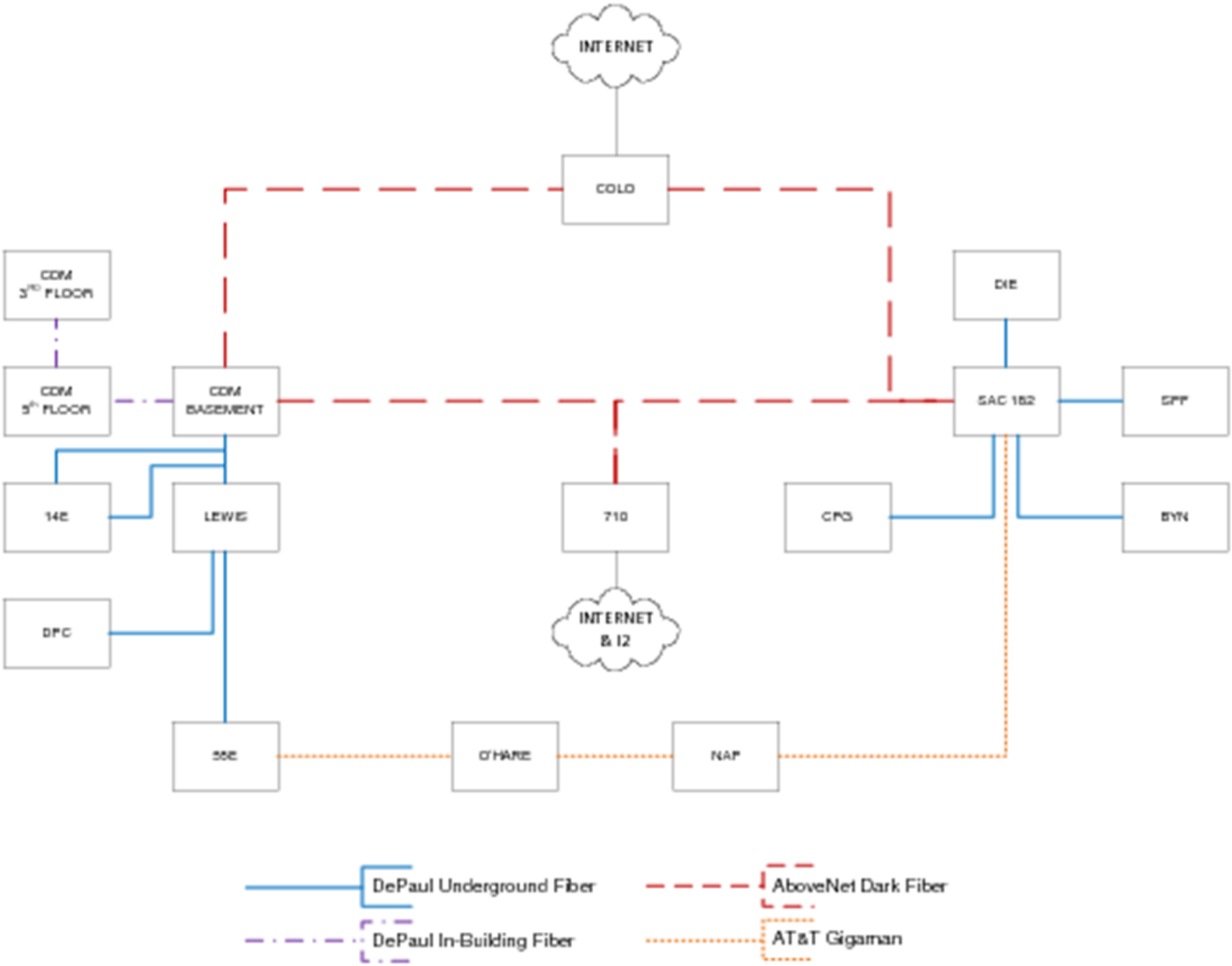
Cogent (2 Gb/sec)

HE (1Gb/sec)

ServerCentral (500Mb/sec (1G burst))

Internet2 (10Gb/sec)

+several BGP peers (NASA, ICN)
This is at several physical locations (710, 350, and DFT)


INTERNET
COLO
CDM 3RD FLOOR
CDM 5TH FLOOR
CDM BASEMENT
DIE
SAC 182
SFP
14E
LEWIS
710
CPS
BYN
DFC
INTERNET & I2
55E
O'HARE
NAP
DePaul Underground Fiber
DePaul In-Building Fiber
AboveNet Dark Fiber
AT&T Gigaman

Fiber, DWDM, and you

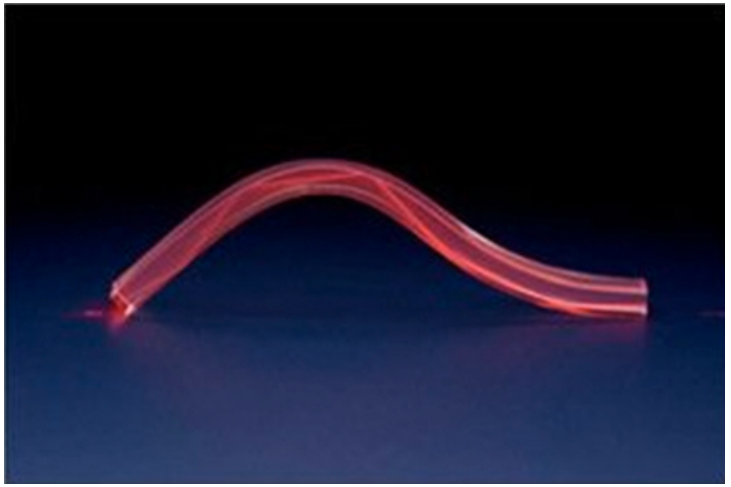
Let’s take a moment to talk about fiber:

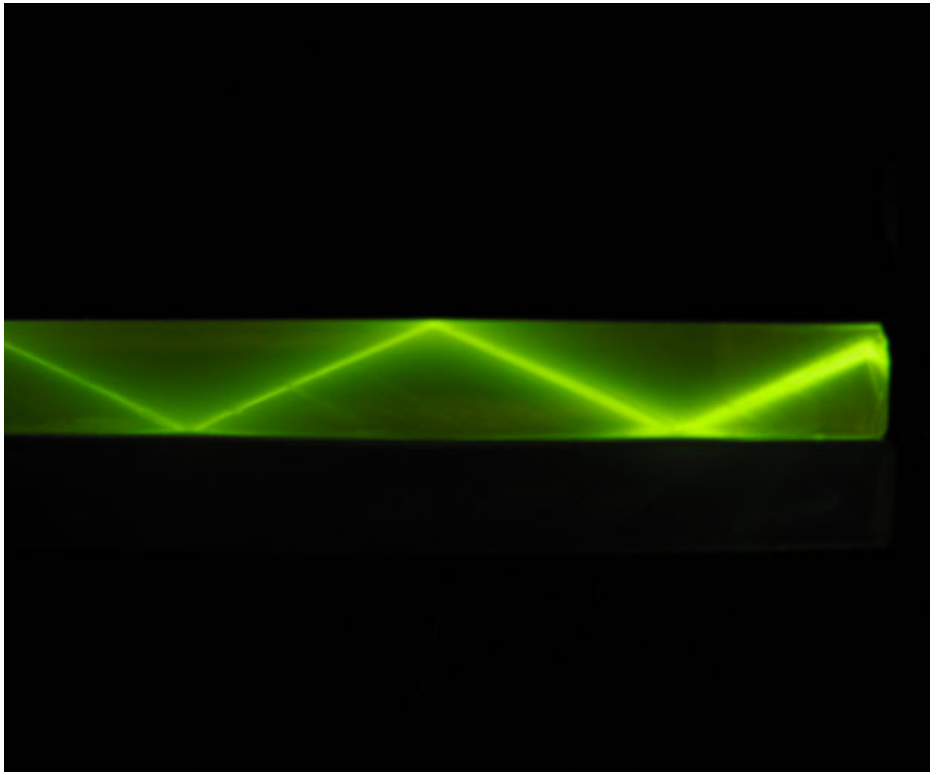
Literally a “glass” cable (element) that carries light
Multiple types and purposes (MM/SM), measured in microns
Installed for distance, throughput
Use different “optic types” (LEDs/lasers)

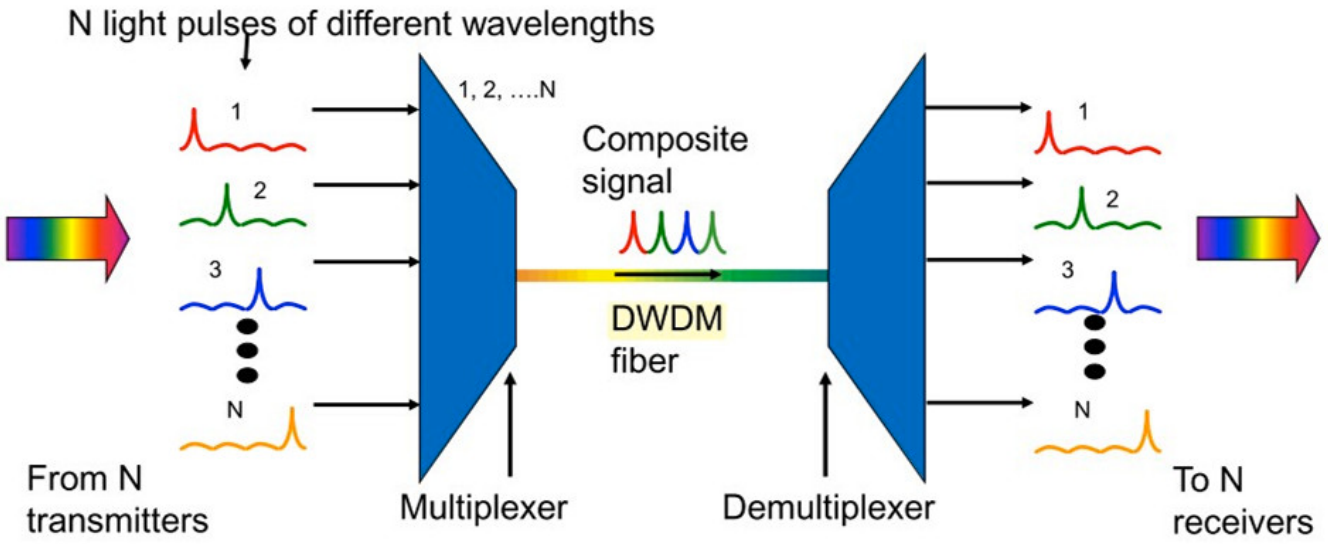
“Outside physical plant:”
Lit fiber services vs. leased “dark” fiber, vs. private

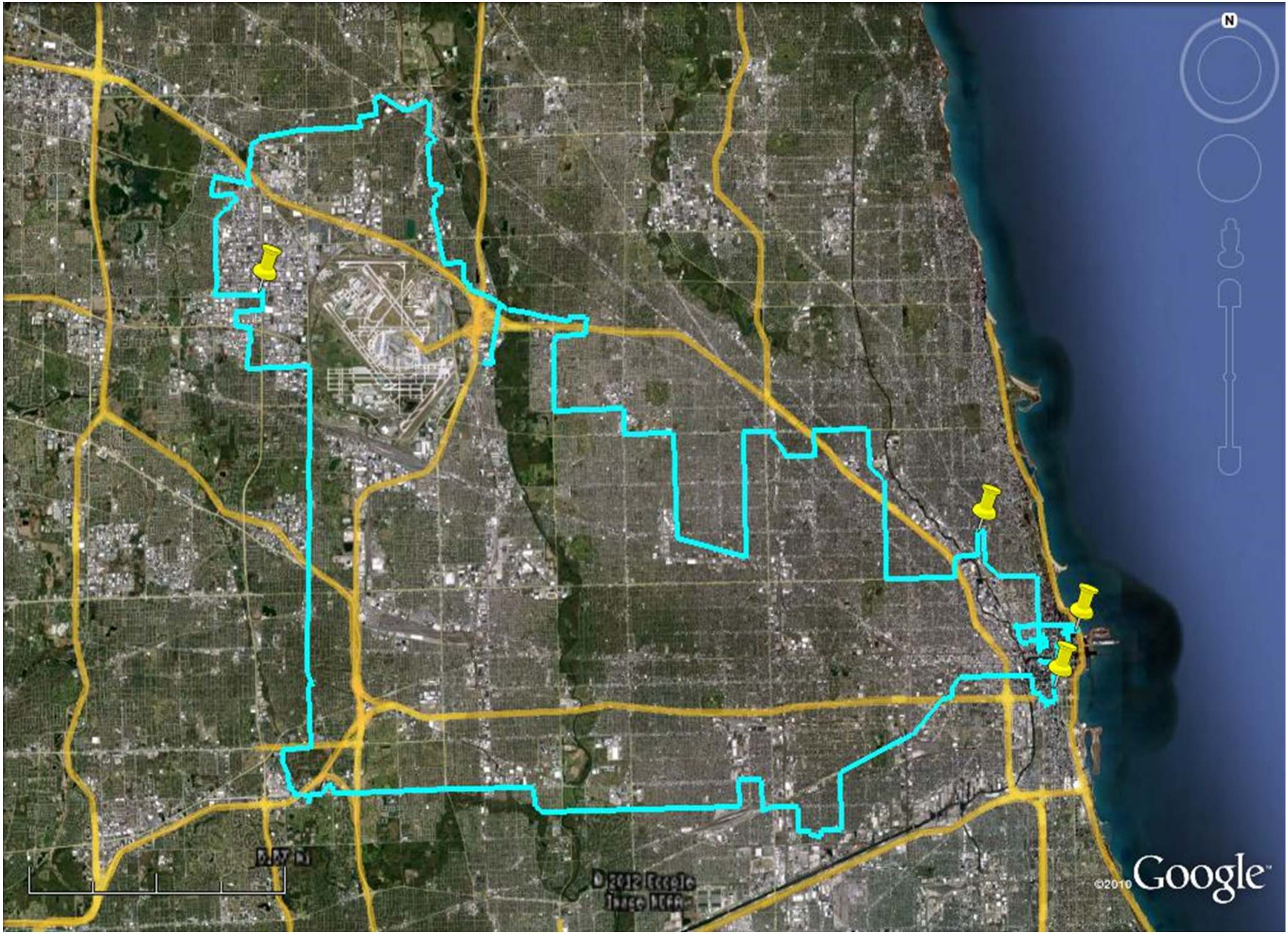
Dense Wavelength Division Multiplexing (DWDM)

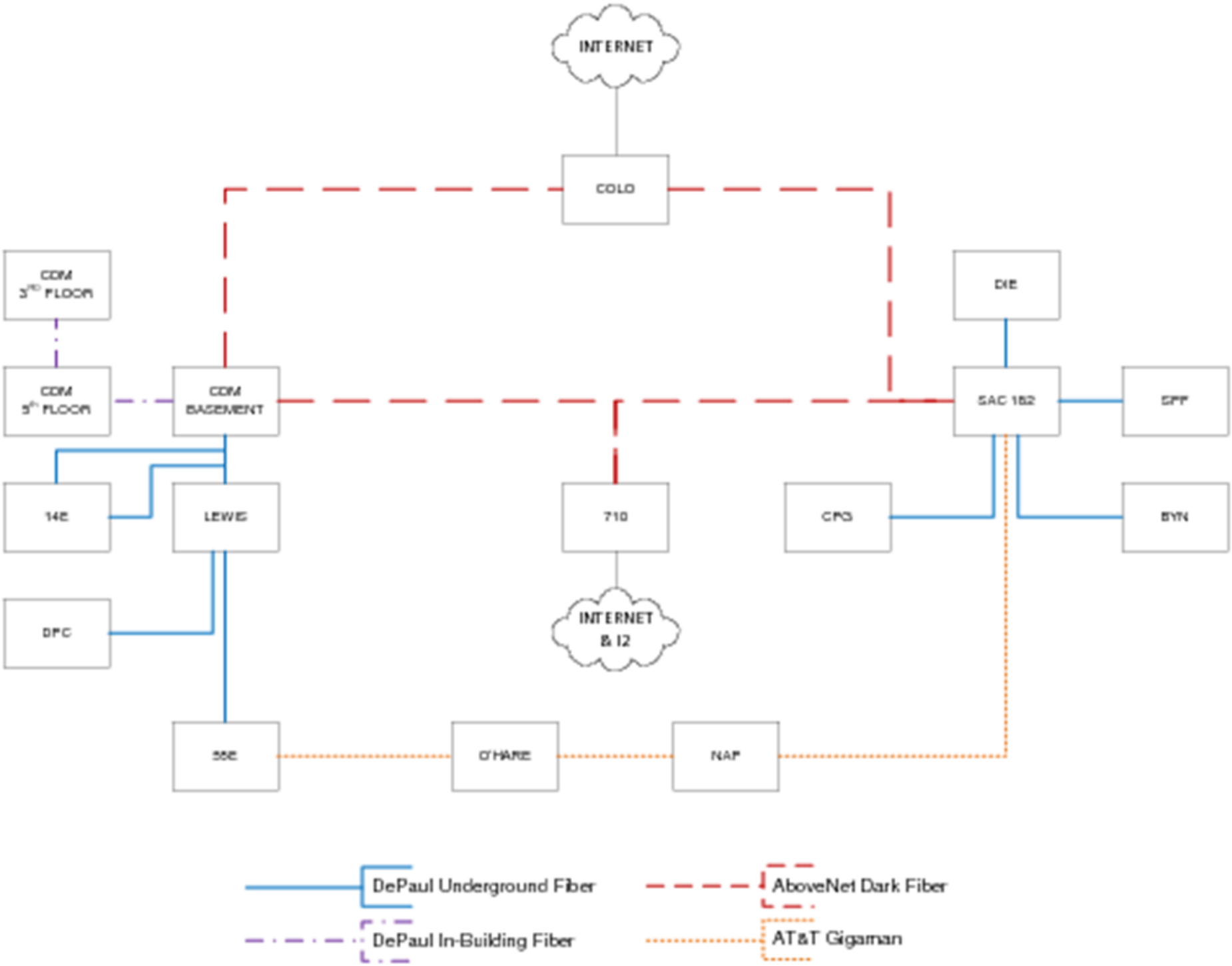
So colors, much pretty






N light pulses of different wavelengths
1
2
3
N
1, 2, ...N
Composite signal
DWDM fiber
1
2
3
N
From N transmitters
Multiplexer
Demultiplexer
To N receivers


N
©2010 Google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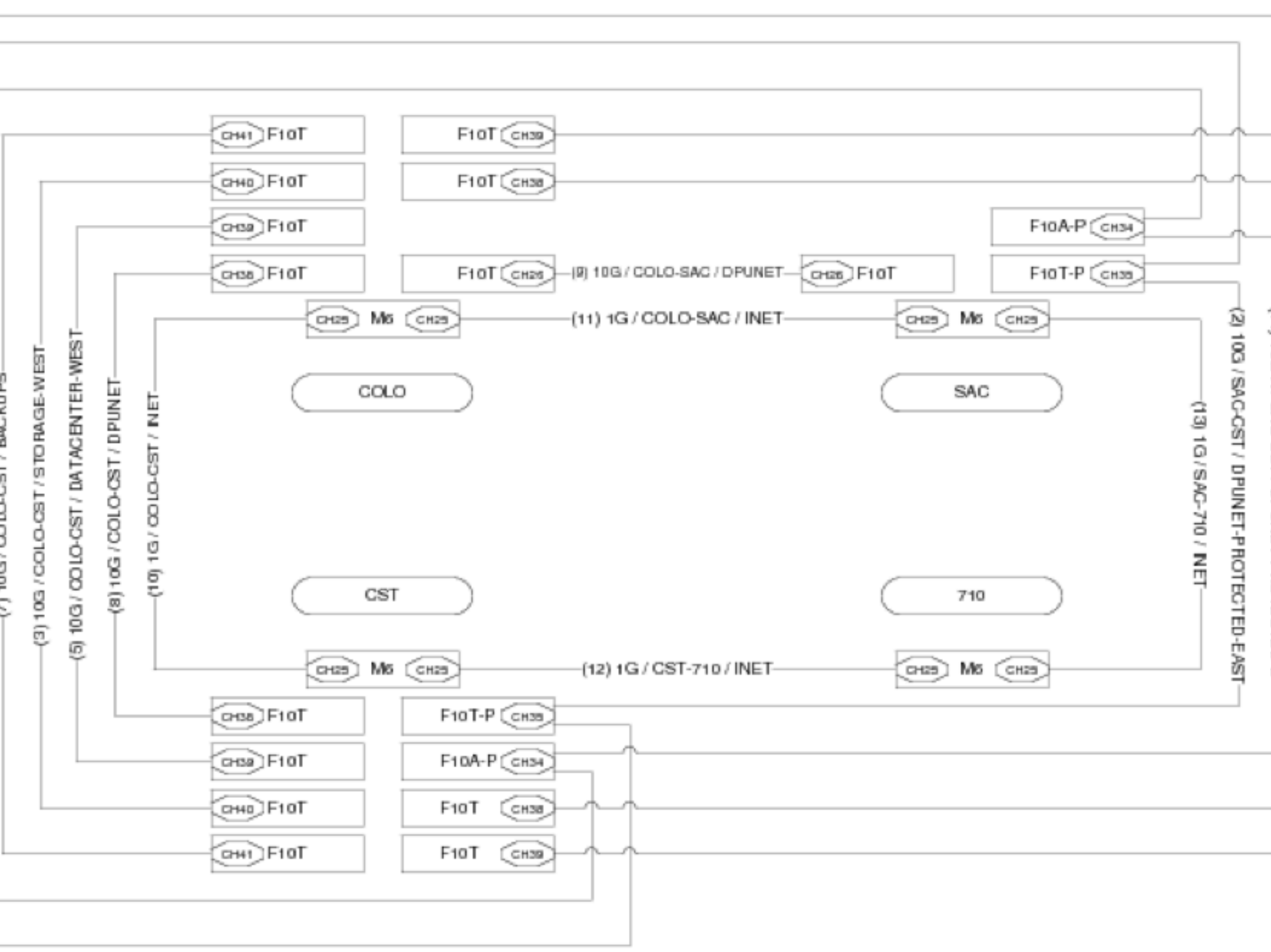

CH41 F10T
F10T CH39
CH40 F10T
F10T CH38
CH39 F10T
F10A-P CH34
CH38 F10T
F10T CH26
(9) 10G / COLO-SAC / DPUNET
CH26 F10T
F10T-P CH35
CH25 M6 CH25
(11) 1G / COLO-SAC / INET
CH25 M6 CH25
(2) 10G / SAC-CST / DPUNET-PROTECTED-EAST
COLO
SAC
(13) 1G / SAC-710 / INET
(7) 10G / COLO-CST / BACKUPS
(3) 10G / COLO-CST / STORAGE-WEST
(5) 10G / COLO-CST / DATACENTER-WEST
(8) 10G / COLO-CST / DPUNET
(10) 1G / COLO-CST / INET
CST
710
CH25 M6 CH25
(12) 1G / CST-710 / INET
CH25 M6 CH25
CH38 F10T
F10T-P CH35
CH39 F10T
F10A-P CH34
CH40 F10T
F10T CH38
CH41 F10T
F10T CH39


DePaul University
3909

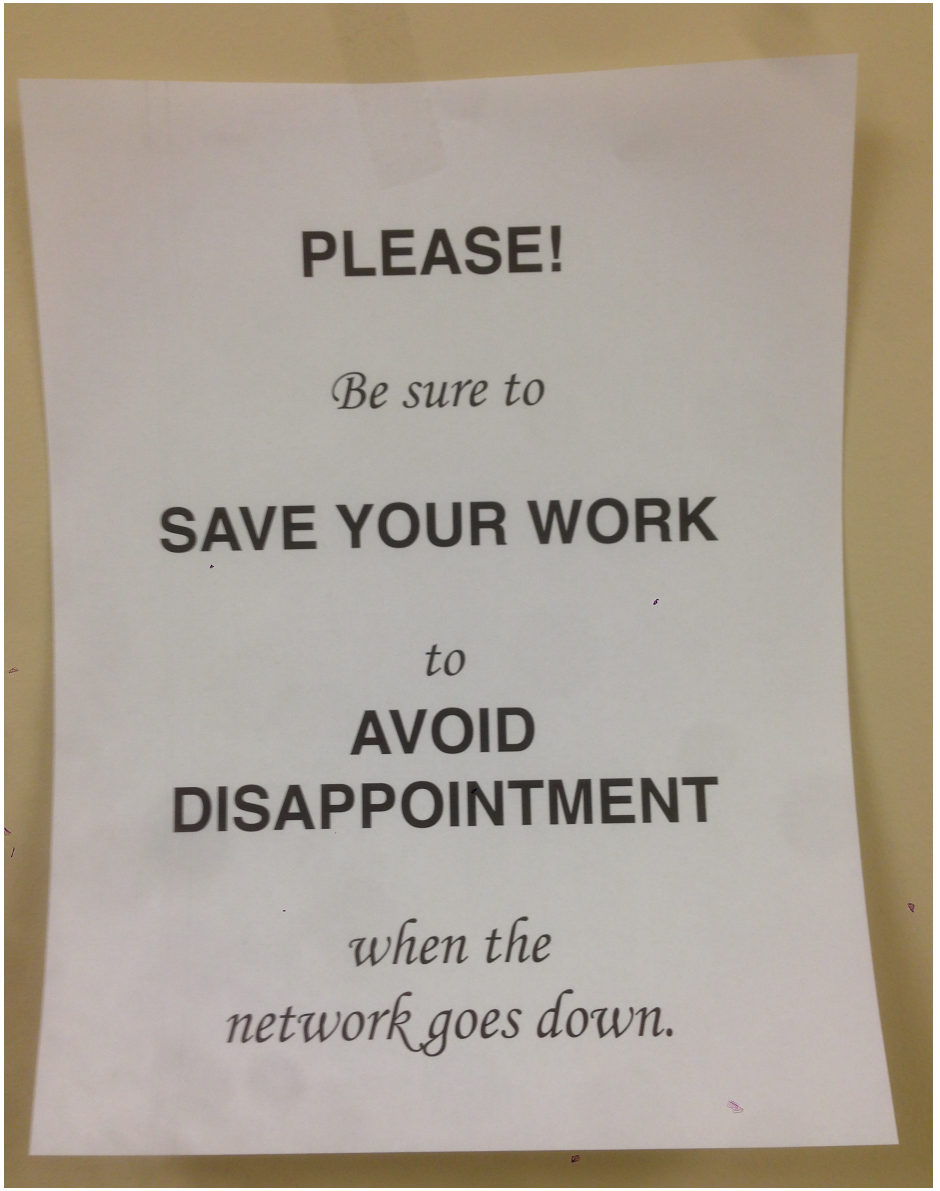
Wireless

By far, the most popular student access medium

Deployed to common areas and classrooms

There are lots of problems in today's IOT (maybe it should be the IOCT?) world which are only going to get worse…

So we've gone from this…



Nicole Ratcliffe @NicoledoubleR · 11 May 2014
LITERALLY **depaulwireless** you're being SO RUDE I'm just trying to play INTERNET GAMES

LIKES
8

1:01 AM - 11 May 2014 · Details

Annie Zidek @atozandback · Sep 28
@ **depaulsecure** wifi: u flakey af

LIKES
4

11:21 PM - 28 Sep 2015 · Details

Daphne Barin @daphadils · 10 Sep 2014
depaulwireless got even more confusing this year...everyone just use depaulsecure

10:38 AM - 10 Sep 2014 · Details

Natalia @Nataliacm2014 · May 28
Depaulsecure is the least secure thing in my life honestly

LIKES
2

kudathekid @amccuda · 9 Jun 2014
If i get disconnected from **depaulsecure** one more time....

2:33 PM - 9 Jun 2014 · Details

melissa stop @melissaweirick · 3 Oct 2014
depaulsecure is the shadiest most crap wifi ever

12:14 AM - 3 Oct 2014 · Details

Tyler Stone @manicpixietyler · 10 Feb 2014
I simultaneously do and do not have Internet thanks to **depaulsecure**. Thanks?

11:55 AM - 10 Feb 2014 · Details

1

James Schaefer @james_schaefer_ · 3s
My goodness @james_schaefer_, you are very, very handsome.

Ayesha Ali @ayeshaali · 25 Feb 2014
I hate you **depaul wireless**

11:34 AM - 25 Feb 2014 · Details

S-Pizzle @ninjabby36 · 28 May 2013
This **DePaul wireless** is worse than Barry

4:27 PM - 28 May 2013 · Details

The trouble with Wireless

Broadcast (shared) technology

High density of devices per AP

High density of networks in populated areas

Constant movement of devices in and out of range

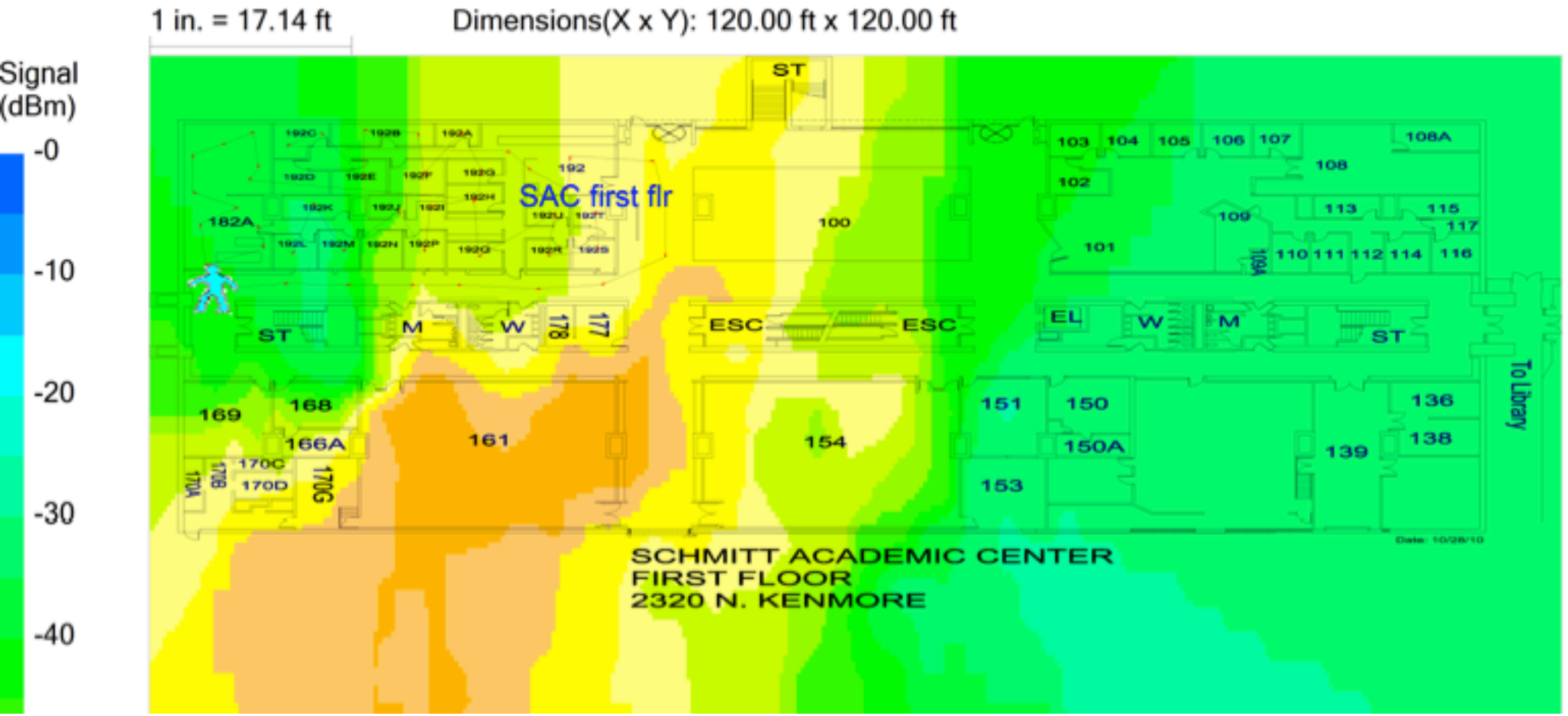
Limited frequency (RF) availability (and limited channels)

Building materials, (concrete, steel, high efficiency glass)

Interference (microwaves, other wireless devices)

Low power nature or wireless devices

“Chatty” protocols…

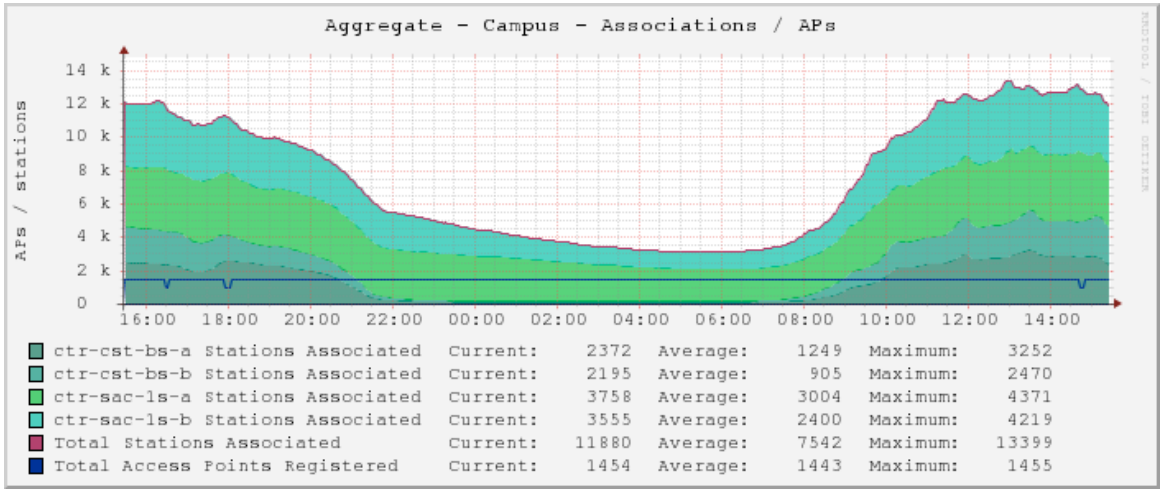

1 in. = 17.14 ft
Dimensions(X x Y): 120.00 ft x 120.00 ft
Signal (dBm)
-0
-10
-20
-30
-40
SAC first flr
SCHMITT ACADEMIC CENTER
FIRST FLOOR
2320 N. KENMORE
To Library
ST
M
W
ESC
EL
182A
192
100
101
102
103
104
105
106
107
108
108A
109
109A
110
111
112
113
114
115
116
117
151
150
150A
153
154
136
138
139
169
168
166A
161
170A
170B
170C
170D
170G
177
178

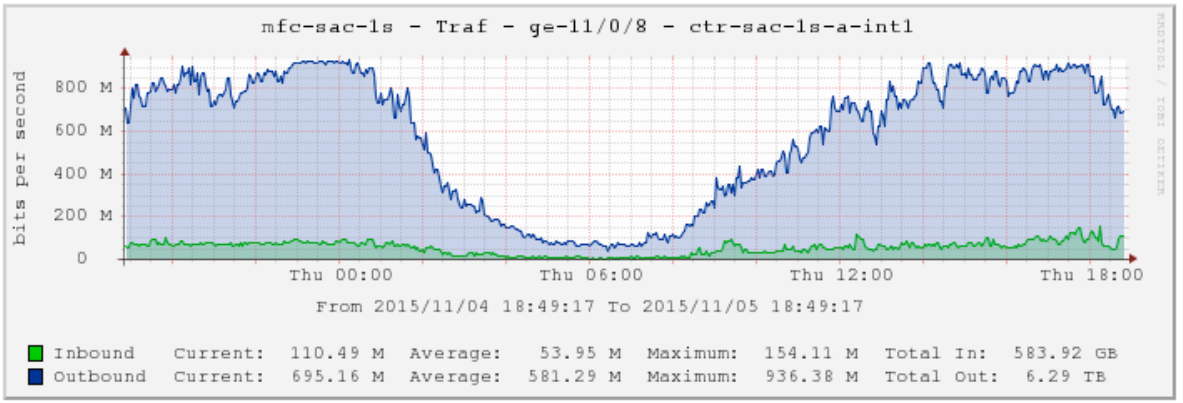
What we're doing about it

1.) Identify and triage trouble spots
(we'll need some help with this)

2.) Augment existing locations where problems exist

3.) Re-survey wireless trouble spots at high utilization times





How we monitor our systems

Up/down monitoring, with service thresholds (nagios):
https://whatsup.depaul.edu/

Traffic/throughput monitoring (and other cool stats) (Cacti):
https://netstat.depaul.edu/

Network Flows (traffic types/destinations) (flowscan):
https://flows.is-net.depaul.edu/

RTT (Round Trip Time) and network latency (smokeping):
http://smokeping.is-net.depaul.edu/

Other tools:
MAC address tracking (network wide), inventory: netdisco (http://www.netdisco.org/); Change management: RANCID (http://www.opennms.org/wiki/RANCID_RWS); IP Address space planning: Ipplan (http://iptrack.sourceforge.net/) ; ticket and workflow queues: Request Tracker (https://www.bestpractical.com/rt/), we have a number of others.
BTW – they're all free.

If I were you, I'd...

Become indispensable:

Add to your skill set (ask questions, and take power where it is offered).
Take on new challenges, you never known where they will lead.
No one knows it all, but the most valuable want to find out.

Take ownership and responsibility:

If you mess up, you have to “fess up”, and then make it right.
Always look to fix the problem, not fix the blame.
A reboot to fix an issue is okay once or twice, but not a third time.

Make sure you cover the basics:

Sometimes there's a BGP route reflector bug....
Attitude can't be taught, but it can be 'learned'.

Remember that accidents will happen (floods, fires, and backhoes).

“chance favors the prepared mind”

The cost of pulling cable isn't the cable, and it will always take longer & cost more

Questions?

James, show them some pictures of the tunnels and stuff
(and ask for smokeping ~~victims~~ volunteers)

Cool! Thank you!

James Schaefer
jschaefe@depaul.edu
https://condor.depaul.edu/jschaefe

(join us)