SHARKFEST '14

WIRESHARK DEVELOPER AND USER CONFERENCE

JUNE 16-20 2014 · DOMINICAN UNIVERSITY

Diagramming IT Environments

http://www.skendric.com/seminar/

Stuart Kendrick

Sustaining Engineer

EMC Isilon

The Concept

Diagramming IT Environments

I developed this seminar as a day-long Hands-On Lab, in which we alternate between working together as a class and working individually.

:START

1. Review a species of diagram, focus on specific techniques
2. Work individually to sketch a first draft of a diagram applicable to your environment
3. Print our drafts
4. Come back together as a class to review our drafts and what we have learned

goto START

Today, we have 75 minutes. Hmm. So, we'll skip the 'work individually' part, go faster, and skip many of the diagrams.

I promote interactivity: please interrupt, contribute, heckle as you see fit. Then again, if you prefer to sit back, watch, and listen, you are welcome to do that also.

Each table should have a print-out of most of the diagrams. Feel free to get up, walk around the room, peer closely at the diagrams hung on the walls.

Philosophy

- *If I can't draw it, I don't understand it*
- Without understanding, I'm trouble-shooting by guessing
- I prefer nudging my future rather than throwing myself to the winds

> In this session, I provide you with electronic templates, practical techniques, and real-world examples of diagrams which support an operational IT shop's needs for trouble-shooting: cabling, power, networks, storage systems, applications. We'll see examples of what has worked and examples of what hasn't worked. From this review, I propose deeper lessons around how sustainability and supportability interact with design and architecture and how to use diagramming to inform your trouble-shooting strategies horizontally as well as to communicate the cost of business decisions upward.

Success

- You grab your diagram at 2am to help trouble-shoot a problem
- Your colleagues ask *Would you print me a copy of that diagram?*
- Your manager asks *Would you print me a copy? I want to show it to my boss*

I am a fan of Edward Tufte and recommend his course:
http://www.edwardtufte.com/tufte/courses

Tufte teaches critical thinking … but in doing so, he demos a ton of ways to reason visually

Mechanics

Talk

- I encourage interactivity
- If you want to contribute, feel free to interrupt me
- Or raise your hand, and I'll call on you
- I'm good with either approach

Move

- You have copies of the small diagrams at your tables (ideally, one copy per table)
- The big ones are posted on the walls
- Get up and walk around the room while I'm talking – get close to these diagrams

URLs

- See http://www.skendric.com/map for examples and templates
- Want the .cvx or .vsd version? If the URL on the Web site says:

  http://www.skendric.com/map/Host-Ethernet-IP.pdf

  Then try typing http://www.skendric.com/map/Host-Ethernet-IP.vsd or http://www.skendric.com/map/Host-Ethernet-IP.cvx into your browser, and see what you get ☺ … Doesn't always work ☹
- This deck available at http://www.skendric.com/seminar/

Me

Multi-disciplinary IT trouble-shooter / Root Cause Analysis
http://www.skendric.com

sbk@cornella	*student*	*1981*
stuart@cpvax5 (Science Applications Inc)	*programmer*	*1984*
sbk@cornellc.cit.cornell.edu	*desktop / server*	*1985*
stuart.kendrick@med.cornell.edu	*server / network*	*1991*
skendric@fhcrc.org	*multidisciplinary*	*1993*
stuart.kendrick@ isi lon dot com	*sustaining engineer*	*2013*

IT Architect | ITIL Problem Manager | Problem Analyst | Device Monitoring | Transport

Geeky Highlights

PL/1 on IBM mainframes	*Cornell University*	*Ithaca*	*1981*
FORTRAN on CRAY-1	*SAIC*	*San Diego*	*1984*
Terak, DisplayWriter, IBM PC, Macintosh	*Cornell University*	*Ithaca*	*1985*
Netware, Corvus Omninet, TCP-IP / IPX / AppleTalk	*Cornell University*	*Ithaca*	*1988*
AppleShare, QuickMail, Farallon, NRC, Cisco, Sniffers	*Cornell Medical College*	*Manhattan*	*1991*
Solaris, Windows, Linux, Perl, SNMP, Wireshark, Cisco, Fluke	*FHCRC*	*Seattle*	*1993*
OneFS	*EMC Isilon*	*Seattle*	*2013*

Geek credentials: I missed punch-cards by one semester … grew up on shared machines (IBM and Cray) … my first network ran at 1Mb/s over Cat 2 (Corvus Omninet) carrying IPX + AppleTalk with IP encapsulated in both. I bored a vampire tap (once) … my first analyzer was a Network General Toshiba 286 laptop … and alpha versions of EtherPeek

Tools

Software

- I'm fond of ACD Canvas – drew my first network map with it in the late '80s
- I also use Microsoft Visio – it has some neat features (stay away from the clipart)
- My bud tells me that CAD is ideal for physical layer work
- I bet that there are plenty of other excellent diagramming tools out there

Printers

- I've only used color HP LaserJets … I bet other manufacturers produce excellent printers

  I'm addicted to 600 x 600 dpi
- I strongly recommend tabloid-size; in the USA, that translates into 11 x 17

  I find it hard to deliver useful diagrams on classic letter sized paper

Plotters

- I have never been successful with plotters
  - ❑ *In my experience, they are finicky, requiring dedicated technicians to maintain them*
  - ❑ *The cheap ones tend to be more expensive than lasers <u>and</u> only print at 300 x 300 dpi, which is too coarse for my kind of diagrams*
  - ❑ *Transporting folded / taped paper is easy; transporting a rolled map is hard*

Conventions

In these examples, the authors assume their audience understands these conventions:

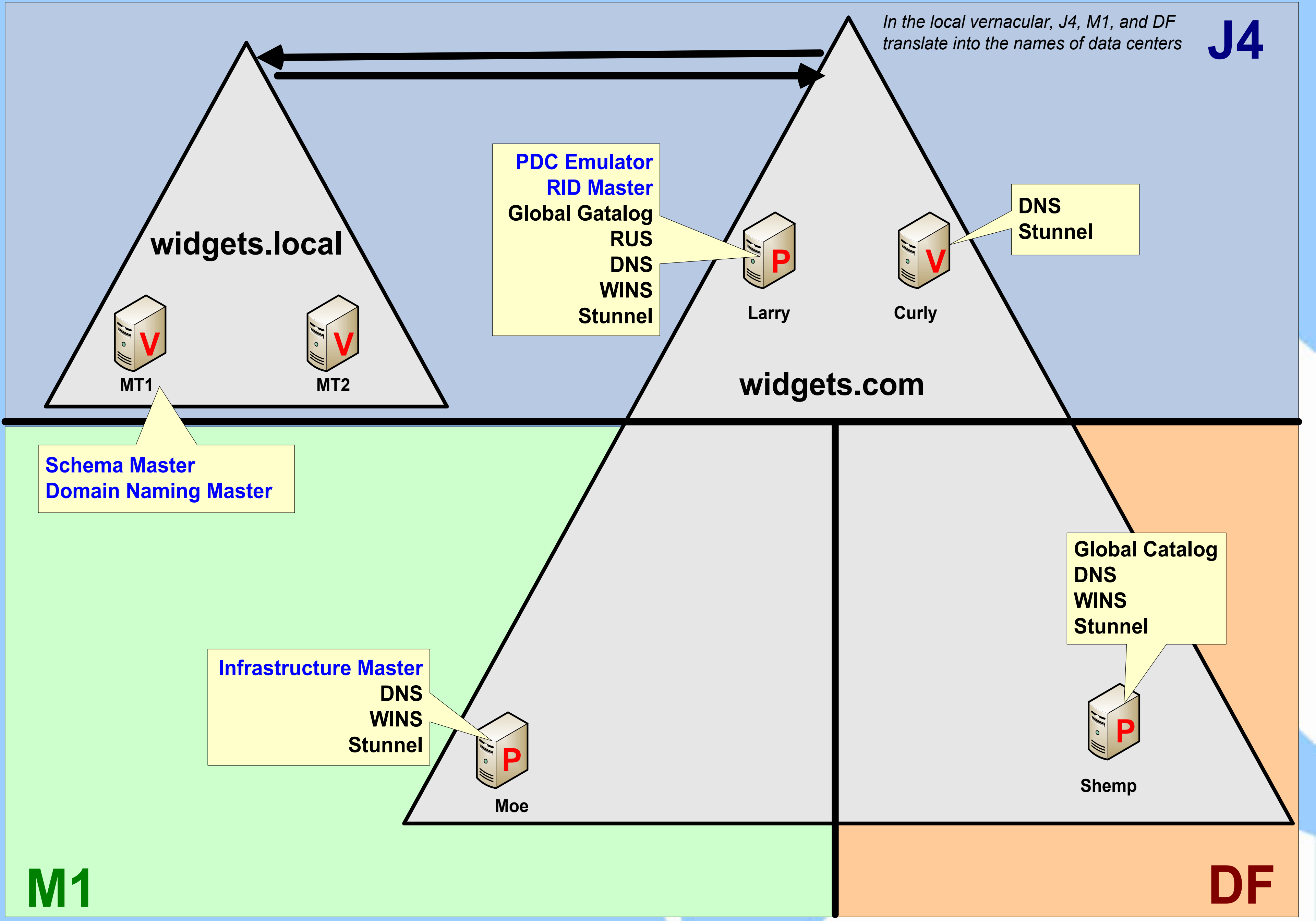
Infrastructure Naming

-esx	Switch (Layer 2 only, always Ethernet)
-fsx	Fibre Channel switch
-rtr	Router (Layer 3 only … might be a Layer 3 switch, might be a classical router)
sr	Server Room (aka Data Center)
-ups	Uninterruptible Power Supply

{building}{floor}-{type}
j4-esx denotes the Ethernet switch on the 4th floor of the J Building

j4sr-a-esx belongs to a redundant pair … you immediately know that its redundant partner is named *j4sr-b-esx. j4sr-x-esx* is short-hand for '*j4sr-a-esx* and *j4sr-b-esx*'

Host Naming
RFC 1178 names (aka theme-based naming) … the human brain is hardwired for language, associating massive amounts of context with *cutsey* names: one to two syllable strings. Take the fast path through cognitive hardware; avoid *process-switching* when you read a name



In the local vernacular, J4, M1, and DF translate into the names of data centers

PDC Emulator
RID Master
Global Gatalog
RUS
DNS
WINS
Stunnel

DNS
Stunnel

Schema Master
Domain Naming Master

Global Catalog
DNS
WINS
Stunnel

Infrastructure Master
DNS
WINS
Stunnel

What do you notice?

What is the most important thing to know about this diagram?

I don't know what those triangles do, but they must be important

- ✓ What do the triangles tell you?
- ✓ What do the rectangles tell you?
- ✓ This diagram shines at illustrating what services you lose when a given data center goes off-line

- ❑ What does *stunnel* do for us?

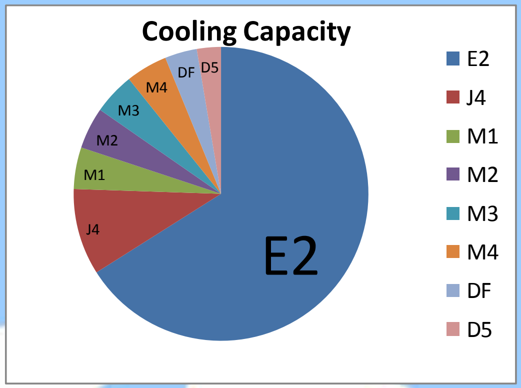
  Encrypted access to LDAP (listens on TCP Port 636 … we hadn't figured out how to enable Windows-native encrypted LDAP-access: stunnel was a hack)

- ❑ Bet there's lot more info that could be packed into this diagram

  Perhaps around what these AD-specific services do, how they relate to each other. For example, I know this installation provides Kerberos and LDAP services … but you can't tell that from the drawing

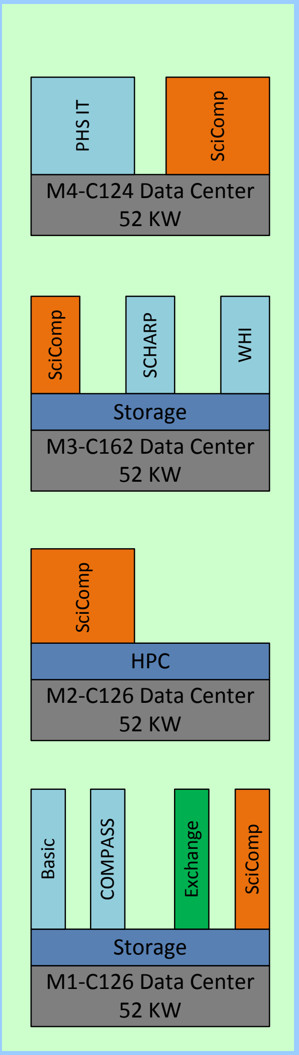
The deeper your content knowledge, the richer your diagrams

Services by Data Center



*Arnold, Thomas, Yale, E …
are the names of buildings
containing data centers*

*PHS, SciComp, SCHARP,
WHI, Basic, Compass … are
all names of departments*



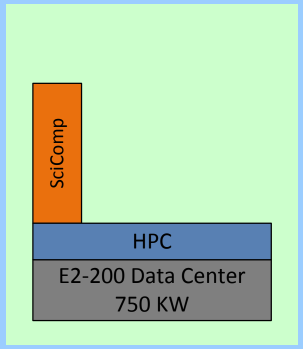
PHS IT
SciComp
M4-C124 Data Center
52 KW

SciComp
SCHARP
WHI
Storage
M3-C162 Data Center
52 KW

SciComp
HPC
M2-C126 Data Center
52 KW

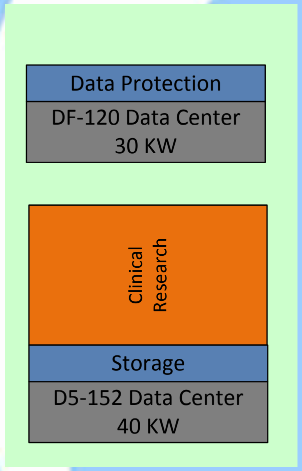
Basic
COMPASS
Exchange
SciComp
Storage
M1-C126 Data Center
52 KW

Arnold



SciComp
HPC
E2-200 Data Center
750 KW

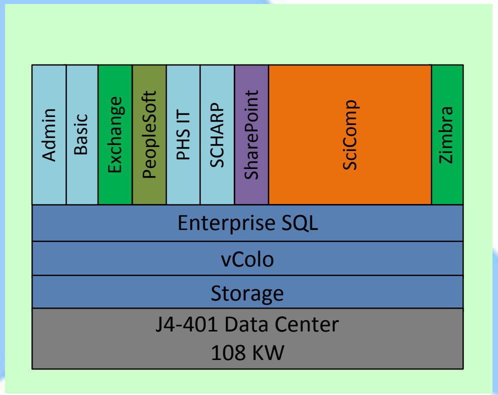
E Building



Data Protection
DF-120 Data Center
30 KW

Clinical Research
Storage
D5-152 Data Center
40 KW

Thomas



Admin
Basic
Exchange
PeopleSoft
PHS IT
SCHARP
SharePoint
SciComp
Zimbra
Enterprise SQL
vColo
Storage
J4-401 Data Center
108 KW

Yale

skendric 201210-15

What do you notice?

What is the most important thing to know about this diagram?

The Arnold Building is tall and the Yale Building is wide

✓ The only effective component of this diagram is the pie chart in the top corner

Which tells us that the E2 Data Center contributes almost two-thirds of the company's cooling capacity and therefore of its Data Center capacity

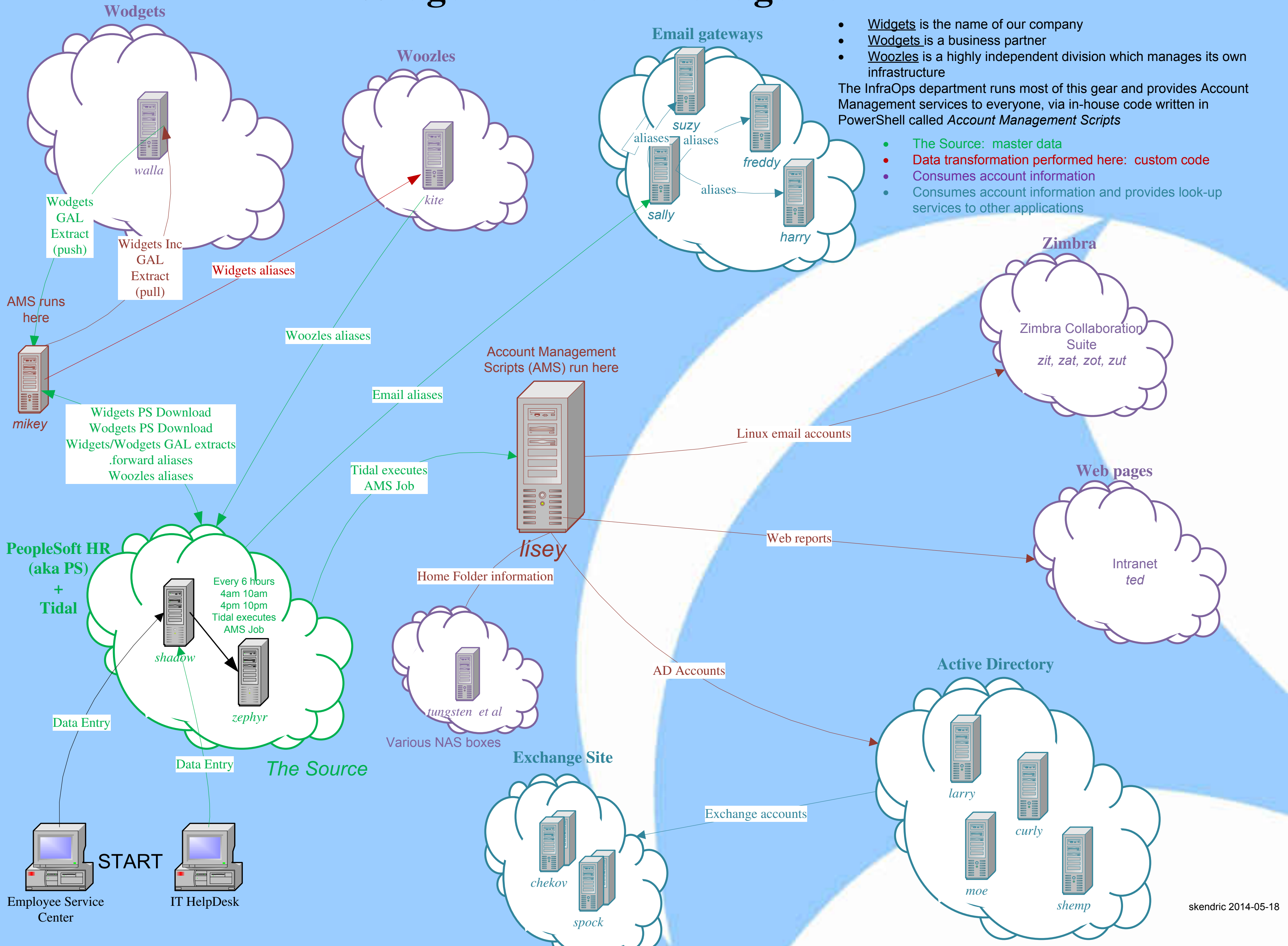
❑ You sure couldn't tell that by looking at the rest of the diagram: the rest of the diagram suggests that the Arnold Building is the most important

Although, on closer inspection, perhaps the Yale Building is also important, as it seems to contain a lot of services

❑ And why are department names (SCHARP, WHI) equivalent to what are clearly services (Exchange, SharePoint)?

The author is confused

Widgets Account Management



- Widgets is the name of our company
- Wodgets is a business partner
- Woozles is a highly independent division which manages its own infrastructure

The InfraOps department runs most of this gear and provides Account Management services to everyone, via in-house code written in PowerShell called *Account Management Scripts*

- The Source: master data
- Data transformation performed here: custom code
- Consumes account information
- Consumes account information and provides look-up services to other applications

What do you notice?

Step back, take in the diagram holistically, what do you notice?

- *I don't know what The Source is, but it sure is important*
- *I don't know what Lisey does, but it sure is important*

What does color tell me?

- *Green implies master data or stuff directly produced from master data*
- *Red implies downstream transformations of the master data*
- *Blue means "provides directory services to other stuff"*
- *Purple means "consumes the information"*

More tips

- What does italics tell me?
- What does the use of tower-server icons tell me?
- Notice how we can infer function from the naming scheme
- Notice that we cannot infer Operating System

  The relevant sys admins are bilingual and don't care about OS

Why don't the Zimbra and Intranet clouds contain servers?

Inconsistency consumes brain cycles and erodes your audience's trust

Voice Map

Conclusion: this diagram tries to show us where we are resilient to failure and where we are vulnerable

Legend

- 🟧 POTS line
- 🟥 CAMA Trunk
- 🟩 PRI
- 🟦 Gigabit Ethernet
- Functional Clump
- Highly-Available Cluster

skendric 2014-05-18

DIDs

Widgets 2-way DIDs
737-464-xxxx
x1000-3050
x3057
x3100-3799
x4000-5319
x5327-5332
x5334-7999

SIP Dialing

From Widgets to CHIL:
820-XXXX*
From CHIL to Widgets:
737-464-XXXX*

*Replace XXXX with the extension of the person being called

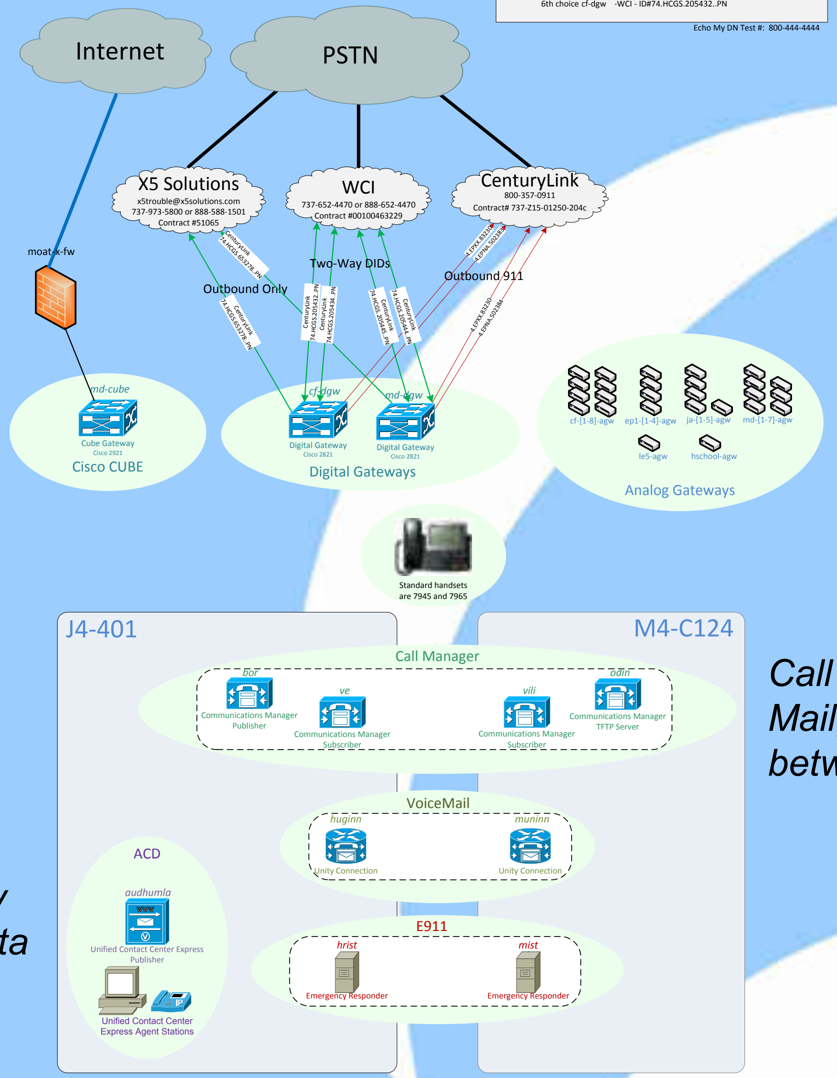
Call Routing

```
Inbound
   1st  choice  cf-dgw   - WCI - ID#74.HCGS.205432..PN
   2nd choice  cf-dgw   - WCI - ID#74.HCGS.205434..PN
   3rd  choice  md-dgw - WCI - ID#74.HCGS.205445..PN
   4th  choice  md-dgw - WCI - ID#74.HCGS.205444..PN


Outbound
To PSTN
               1st choice  md-dgw - X5 - ID#74.HCGS.653278..PN
               2nd choicecf-dgw   - X5 - ID#74.HCGS.653278..PN
               3rd choice md-dgw - WCI - ID#74.HCGS.205444..PN
               4th choice md-dgw - WCI - ID#74.HCGS.205445..PN
               5th choice cf-dgw   -WCI - ID#74.HCGS.205434..PN
               6th choice cf-dgw   -WCI - ID#74.HCGS.205432..PN
```

Echo My DN Test #: 800-444-4444

Inbound & Outbound Call Routing … that's neat, helps understand how resilient we are to equipment & carrier failure


Internet
PSTN
X5 Solutions
x5trouble@x5solutions.com
737-973-5800 or 888-588-1501
Contract #51065
WCI
737-652-4470 or 888-652-4470
Contract #00100463229
CenturyLink
800-357-0911
Contract# 737-Z15-01250-204c
moat-x-fw
CenturyLink 74.HCGS.653278..PN
Outbound Only
CenturyLink 74.HCGS.653278..PN
Two-Way DIDs
CenturyLink 74.HCGS.205432..PN
CenturyLink 74.HCGS.205434..PN
CenturyLink 74.HCGS.205445..PN
CenturyLink 74.HCGS.205444..PN
Outbound 911
4.EPXX.83230
4.EPNA.502383
4.EPXX.83230
4.EPNA.502384
md-cube
Cube Gateway
Cisco 2921
Cisco CUBE
cf-dgw
Digital Gateway
Cisco 2821
md-dgw
Digital Gateway
Cisco 2821
Digital Gateways
cf-[1-8]-agw
ep1-[1-4]-agw
ja-[1-5]-agw
md-[1-7]-agw
le5-agw
hschool-agw
Analog Gateways
Standard handsets are 7945 and 7965
J4-401
M4-C124
Call Manager
bor
Communications Manager Publisher
ve
Communications Manager Subscriber
vili
Communications Manager Subscriber
odin
Communications Manager TFTP Server
VoiceMail
huginn
Unity Connection
muninn
Unity Connection
ACD
audhumla
Unified Contact Center Express Publisher
Unified Contact Center Express Agent Stations
E911
hrist
Emergency Responder
mist
Emergency Responder

One IP-based trunk …
Two Digital Gateways employing Three carriers … although on closer inspection, we can see that CenturyLink just handles CAMA (911) trunks

And an amorphous blob of Analog Gateways … which don't relate to anything else

Call Manager, Voice Mail, and E911 split between two data centers

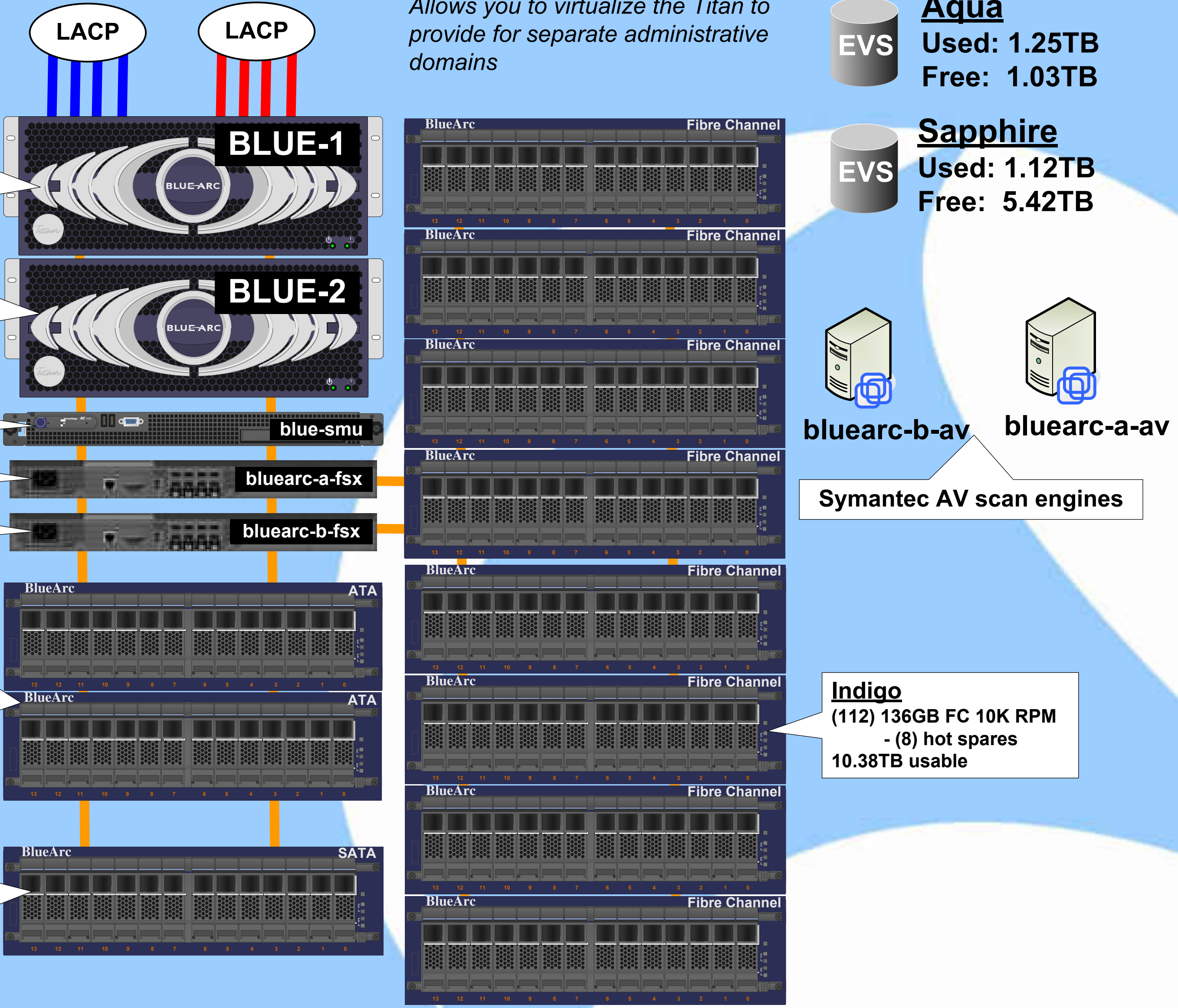
ACD lives entirely within a single data center

BlueArc Storage Cluster

2008-12-15

Our data centers contain redundant pairs of Ethernet switches: a Red switch and a Blue switch

EVS = Enterprise Virtual Server Allows you to virtualize the Titan to provide for separate administrative domains



Indigo
Used: 6.01TB
Free: 4.37TB

Aqua
Used: 1.25TB
Free: 1.03TB

Sapphire
Used: 1.12TB
Free: 5.42TB

BlueArc Titan 2100
Protocols: CFS, NFS, iSCSI
Interfaces: (4) 1Gb Ethernet

BlueArc Titan 2100
Protocols: CFS, NFS, iSCSI
Interfaces: (4) 1Gb Ethernet

Management Interface

Brocade 3250

Brocade 3250

Symantec AV scan engines

Sapphire
(28) 233GB ATA 7.2K RPM
- (4) hot spares
6.54TB usable

Aqua
(14) 233GB SATA 7.2K RPM
- (2) hot spares
2.28TB usable

Indigo
(112) 136GB FC 10K RPM
- (8) hot spares
10.38TB usable

What do you notice?

What is the most important thing to know about this diagram?

It consumes a lot of rack space

- ❑ What do the Blue and Red lines tell us?
- ❑ How is Blue-1 attached to the Ethernet network?
- ❑ How is Blue-2 attached to the Ethernet network?
- ❑ What protocols does Blue support?
- ❑ What do the orange lines tell us?
- ❑ What does listing space to the second decimal place tell us?
- ❑ What information do the stacks of anatomically correct tray icons give us?

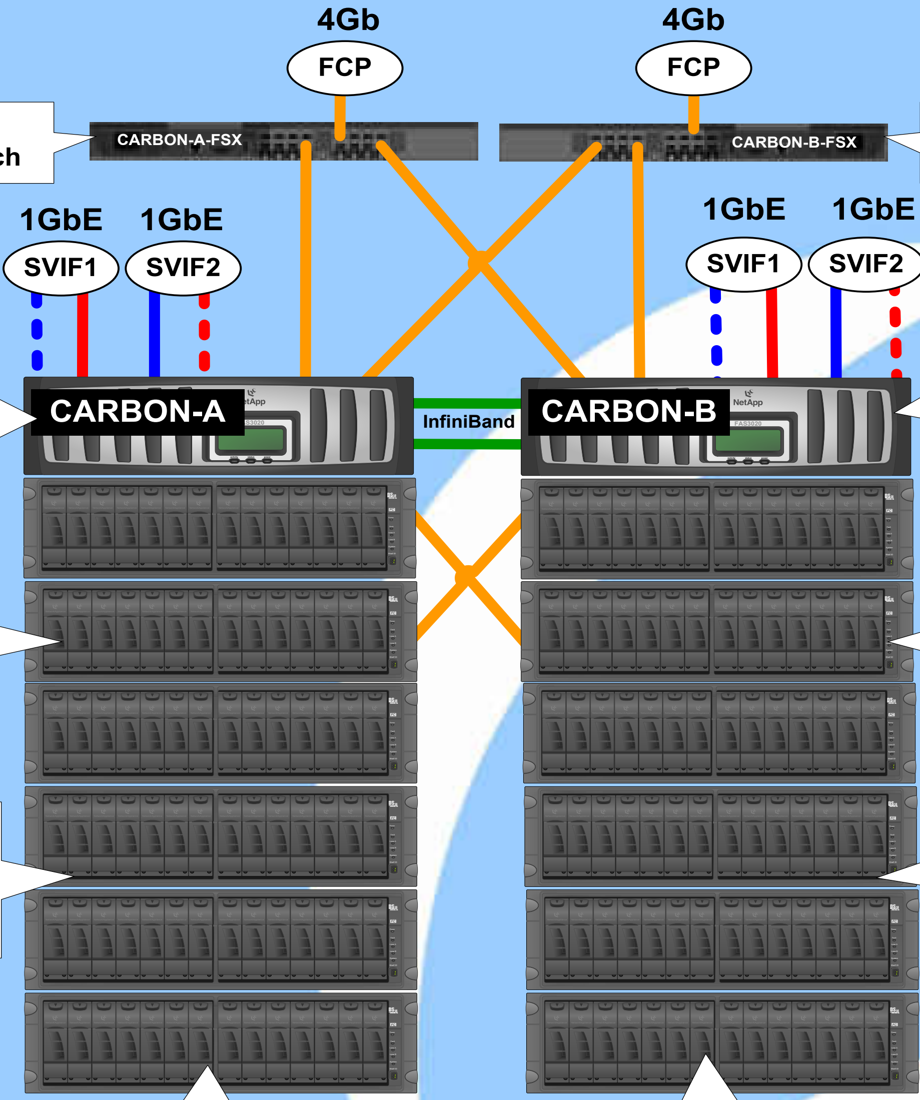
- ✓ Notice the consistent naming schemes
- ✓ This diagram shines at mapping EVS to physical trays

- ❑ The rest … not so much … mostly a disorganized catalogue

This is a good start – the author was new to storage and new to diagramming, but took the plunge and started drawing. As you gain experience and expertise, hopefully, you return to your diagrams and refine them

Carbon Storage Cluster

2008-12-15



Brocade 200E
16 Port Fibre Channel Switch

Brocade 200E
16 Port Fibre Channel Switch

<u>NetApp FAS3020 (OT 7.24)</u>
Protocols: iSCSI, FCP
Interfaces: (4) 1Gb Ethernet
(2) Fibre Channel
Licenses: FCP, SME, SMSQL
FlexClone

<u>NetApp FAS3020 (OT 7.24)</u>
Protocols: iSCSI, FCP
Interfaces: (4) 1Gb Ethernet
(2) Fibre Channel
Licenses: FCP, SME, SMSQL
FlexClone

<u>Root 114GB</u>
(3) 133GB 1oK RPM FC
- Data disks: 1
- Parity disks: 2

<u>Root 114GB</u>
(3) 133GB 1oK RPM FC
- Data disks: 1
- Parity disks: 2

<u>Aggr0 7.54TB</u>
(81) 133GB 10K RPM FC
- Data disks: 68
- Parity disks: 10
- Hot spares: 3

<u>Aggr0 7.54TB</u>
(81) 133GB 15K RPM FC
- Data disks: 68
- Parity disks: 10
- Hot spares: 3

Volumes: 42
Provisioned: 8.31TB

Volumes: 41
Provisioned: 6.33TB

What do you notice?

What is the most important thing to know about this diagram?

- *This thing is highly-available: everything comes in pairs*
- *And it has a lot of disk shelves*

❑ Not clear how the lower trays communicate with anything else

❑ Nor where those top 4GB FCP Ports are headed

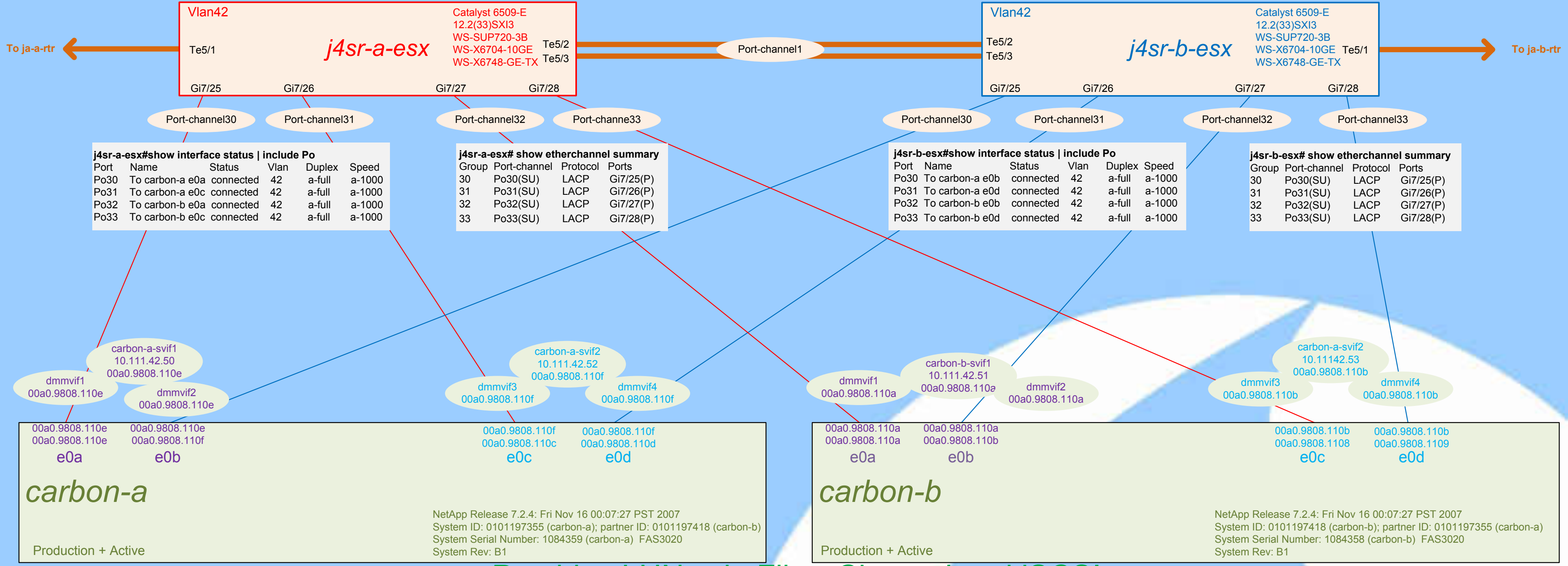
✓ Notice the consistent use of color to tell us about network interfaces

Don't even need a legend

✓ This diagram shines at illustrating choices around volume / shelf mapping and configuration

And telling us what is possible (licensing & protocols)

Serves as an operator's quick reference: neat



```
j4sr-a-esx#show interface status | include Po
Port   Name               Status     Vlan   Duplex   Speed
Po30   To carbon-a e0a    connected  42     a-full   a-1000
Po31   To carbon-a e0c    connected  42     a-full   a-1000
Po32   To carbon-b e0a    connected  42     a-full   a-1000
Po33   To carbon-b e0c    connected  42     a-full   a-1000
```

```
j4sr-a-esx# show etherchannel summary
Group  Port-channel  Protocol  Ports
30     Po30(SU)      LACP      Gi7/25(P)
31     Po31(SU)      LACP      Gi7/26(P)
32     Po32(SU)      LACP      Gi7/27(P)
33     Po33(SU)      LACP      Gi7/28(P)
```

```
j4sr-b-esx#show interface status | include Po
Port   Name               Status     Vlan   Duplex   Speed
Po30   To carbon-a e0b    connected  42     a-full   a-1000
Po31   To carbon-a e0d    connected  42     a-full   a-1000
Po32   To carbon-b e0b    connected  42     a-full   a-1000
Po33   To carbon-b e0d    connected  42     a-full   a-1000
```

```
j4sr-b-esx# show etherchannel summary
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30     Po30(SU)      LACP      Gi7/25(P)
31     Po31(SU)      LACP      Gi7/26(P)
32     Po32(SU)      LACP      Gi7/27(P)
33     Po33(SU)      LACP      Gi7/28(P)
```

NetApp Release 7.2.4: Fri Nov 16 00:07:27 PST 2007
System ID: 0101197355 (carbon-a); partner ID: 0101197418 (carbon-b)
System Serial Number: 1084359 (carbon-a) FAS3020
System Rev: B1

NetApp Release 7.2.4: Fri Nov 16 00:07:27 PST 2007
System ID: 0101197418 (carbon-b); partner ID: 0101197355 (carbon-a)
System Serial Number: 1084358 (carbon-b) FAS3020
System Rev: B1

Provides LUNs via Fibre Channel and iSCSI

To a handful of Exchange 2003 and MS SQL Servers

```
/etc/rc
hostname carbon-a

vif create lacp dmmvif1 -b ip e0a
vif create lacp dmmvif2 -b ip e0b

vif create lacp dmmvif3 -b ip e0c
vif create lacp dmmvif4 -b ip e0d

vif create single svif1 dmmvif1 dmmvif2

vif create single svif2 dmmvif3 dmmvif4

ifconfig svif1 `hostname`-svif1 netmask 255.255.254.0 mediatype auto partner svif1
ifconfig svif2 `hostname`-svif2 netmask 255.255.254.0 mediatype auto partner svif2

route add default 10.111.42.1 1
routed on
options dns.domainname fhcrc.org
options dns.enable on
options nis.enable off
savecore
```

```
/etc/hosts
10.111.42.50   carbon-a carbon-a-svif1
10.111.42.52   carbon-a-svif2
140.107.42.13  loghost
```

```
carbon-a> ifconfig -a
e0a: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0e (auto-1000t-fd-up) flowcontrol full
        trunked dmmvif1
e0b: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0e (auto-1000t-fd-up) flowcontrol full
        trunked dmmvif2
e0c: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0f (auto-1000t-fd-up) flowcontrol full
        trunked dmmvif3
e0d: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0f (auto-1000t-fd-up) flowcontrol full
        trunked dmmvif4
lo: flags=1948049<UP,LOOPBACK,RUNNING,MULTICAST,TCPCKSUM> mtu 8160
        inet 127.0.0.1 netmask 0xff000000 broadcast 127.0.0.1
        ether 00:00:00:00:00:00 (VIA Provider)
dmmvif1: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0e (Enabled virtual interface)
        trunked svif1
dmmvif2: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0e (Enabled virtual interface)
        trunked svif1
dmmvif3: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0f (Enabled virtual interface)
        trunked svif2
dmmvif4: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0f (Enabled virtual interface)
        trunked svif2
svif1: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        inet 10.111.42.50 netmask 0xfffffe00 broadcast 10.111.43.255
        partner svif1 (not in use)
        ether 02:a0:98:08:11:0e (Enabled virtual interface)
svif2: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        inet 10.111.42.52 netmask 0xfffffe00 broadcast 10.111.43.255
        partner svif2 (not in use)
        ether 02:a0:98:08:11:0f (Enabled virtual interface)
```

```
carbon-b> ifconfig -a
e0a: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0a (auto-1000t-fd-up) flowcontrol full
        trunked dmmvif1
e0b: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0a (auto-1000t-fd-up) flowcontrol full
        trunked dmmvif2
e0c: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0b (auto-1000t-fd-up) flowcontrol full
        trunked dmmvif3
e0d: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0b (auto-1000t-fd-up) flowcontrol full
        trunked dmmvif4
lo: flags=1948049<UP,LOOPBACK,RUNNING,MULTICAST,TCPCKSUM> mtu 8160
        inet 127.0.0.1 netmask 0xff000000 broadcast 127.0.0.1
        ether 00:00:00:00:00:00 (VIA Provider)
dmmvif1: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0a (Enabled virtual interface)
        trunked svif1
dmmvif2: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0a (Enabled virtual interface)
        trunked svif1
dmmvif3: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0b (Enabled virtual interface)
        trunked svif2
dmmvif4: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        ether 02:a0:98:08:11:0b (Enabled virtual interface)
        trunked svif2
svif1: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        inet 10.111.42.51 netmask 0xfffffe00 broadcast 10.111.43.255
        partner svif1 (not in use)
        ether 02:a0:98:08:11:0a (Enabled virtual interface)
svif2: flags=948043<UP,BROADCAST,RUNNING,MULTICAST,TCPCKSUM> mtu 1500
        inet 10.111.42.53 netmask 0xfffffe00 broadcast 10.111.43.255
        partner svif2 (not in use)
        ether 02:a0:98:08:11:0b (Enabled virtual interface)
```

```
/etc/rc
hostname carbon-b

vif create lacp dmmvif1 -b ip e0a
vif create lacp dmmvif2 -b ip e0b

vif create lacp dmmvif3 -b ip e0c
vif create lacp dmmvif4 -b ip e0d

vif create single svif1 dmmvif1 dmmvif2

vif create single svif2 dmmvif3 dmmvif4

ifconfig svif1 `hostname`-svif1 netmask 255.255.254.0 mediatype auto partner svif1
ifconfig svif2 `hostname`-svif2 netmask 255.255.254.0 mediatype auto partner svif2

route add default 10.111.42.1 1
routed on
options dns.domainname fhcrc.org
options dns.enable on
options nis.enable off
savecore
```

```
/etc/hosts
127.0.0.1      localhost
10.111.42.51   carbon-b carbon-b-svif1
10.111.42.53   carbon-b-svif2
140.107.42.13  loghost
```

carbon / Ethernet-IP

skendric 2011-06-24

What do you notice?

What is the most important thing to know about this diagram?

Hope the text is useful, because there sure is a lot of it

Carbon and j4sr-x-esx are the most important things

We lost the Fibre Channel detail … but gained insight into the Ethernet/IP side of the box

Notice the inclusion of both host-specific configuration files and of dynamic 'show' output describing the NICs

Allows the observer to sanity-check how the host is configured

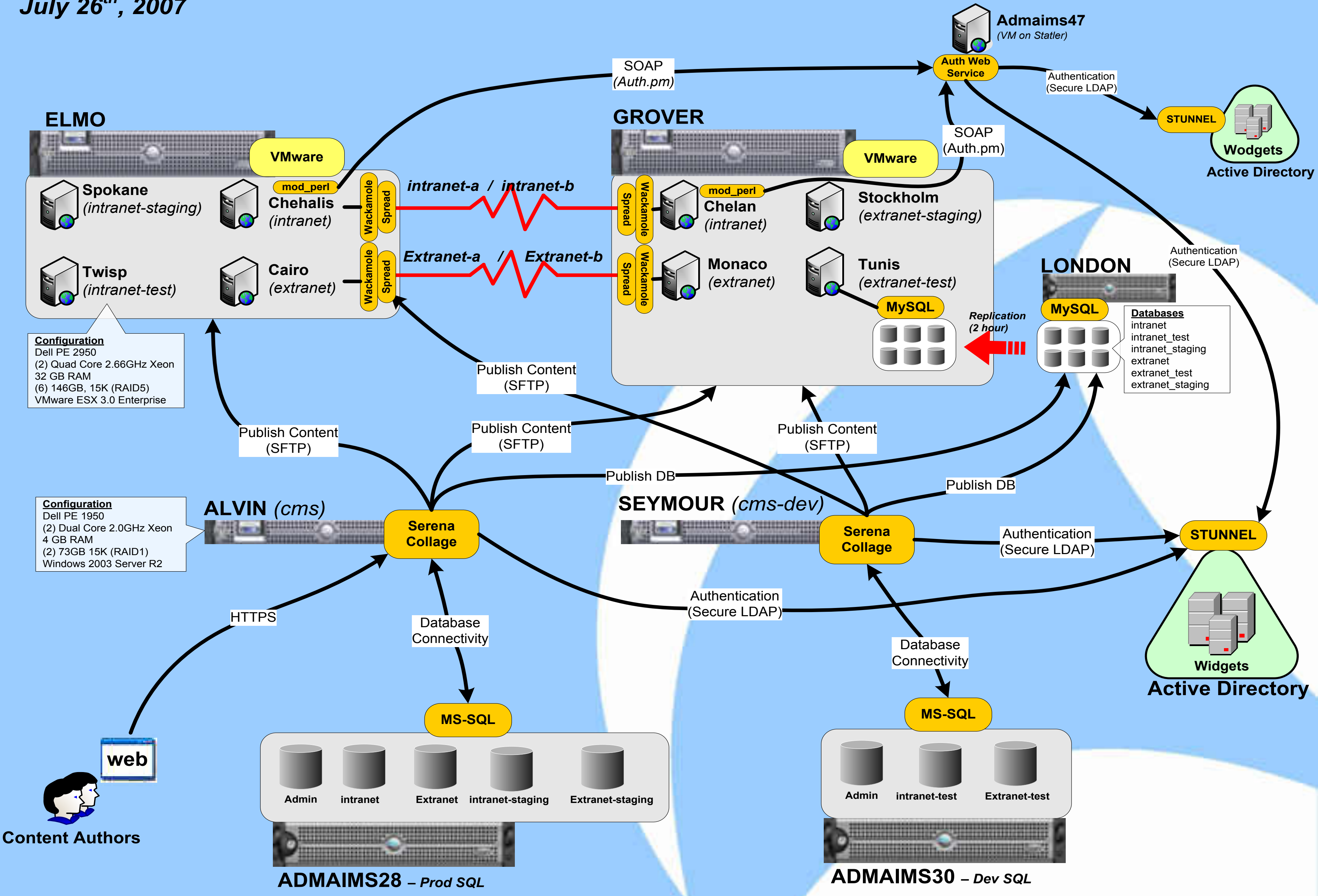
The author wanted to illuminate complex host-to-Ethernet switch configuration

We had struggled painfully to configure the host physical and virtual interfaces … the 'svif' and 'dmmvif' parts … and to line those up with the correct switch LACP configurations

This template became popular – we have nearly a dozen of these now

CMS Phase II Server Architecture

July 26th, 2007



Configuration
Dell PE 2950
(2) Quad Core 2.66GHz Xeon
32 GB RAM
(6) 146GB, 15K (RAID5)
VMware ESX 3.0 Enterprise

Databases
intranet
intranet_test
intranet_staging
extranet
extranet_test
extranet_staging

Configuration
Dell PE 1950
(2) Dual Core 2.0GHz Xeon
4 GB RAM
(2) 73GB 15K (RAID1)
Windows 2003 Server R2

What do you notice?

What is the most important thing to know about this diagram?

Yellow is important (major software components)

This thing tells you about data flows

- ✓ Which hosts are virtual and which are physical?

  Anatomically correct rack-mountable icons are physical; the more abstract desktop icons are virtual

- ✓ Where does the Extranet database live?

  Admaims28 ... not clear to me what the Extranet database on London does, but perhaps if I knew more about CMS, I could make a guess

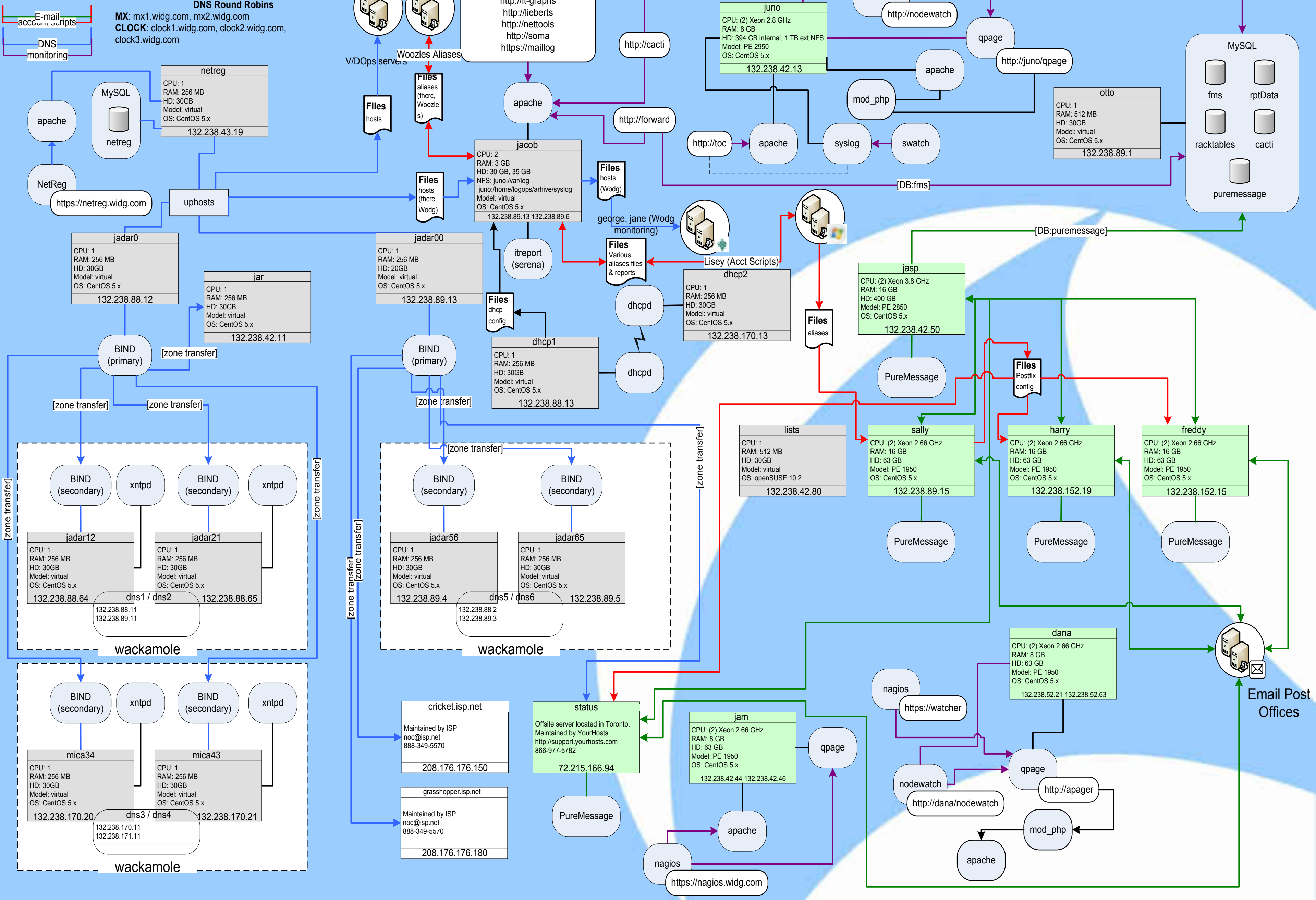
- ✓ This diagram shines at illustrating which protocols carry what kind of traffic to which hosts

  Want to figure out why Web content has quit traveling from Staging to Production? This diagram would give you a head start

Serves as a Web master's quick reference: neat

Linux Core: Dependency Diagram

December 4, 2009



E-mail
account scripts
DNS
monitoring

DNS Round Robins
MX: mx1.widg.com, mx2.widg.com
CLOCK: clock1.widg.com, clock2.widg.com, clock3.widg.com

apache
MySQL
netreg
NetReg
https://netreg.widg.com
uphosts

netreg
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.43.19

V/DOps servers
Woozles Aliases

Files
hosts

Files
aliases (fhcrc, Woozles)

http://it-graphs
http://lieberts
http://nettools
http://soma
https://maillog

apache
http://cacti
http://forward

Files
hosts (fhcrc, Wodg)

jacob
CPU: 2
RAM: 3 GB
HD: 30 GB, 35 GB
NFS: juno:/var/log
juno:/home/logops/arhive/syslog
Model: virtual
OS: CentOS 5.x
132.238.89.13 132.238.89.6

Files
hosts (Wodg)

george, jane (Wodg monitoring)

itreport (serena)

Files
Various aliases files & reports

Lisey (Acct Scripts)

Files
dhcp config

dhcpd
dhcpd

dhcp1
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.88.13

dhcp2
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.170.13

Files
aliases

[DB:cacti, racktables]

nodewatch
http://nodewatch
qpage
http://juno/qpage
apache
mod_php
http://toc
apache
syslog
swatch

juno
CPU: (2) Xeon 2.8 GHz
RAM: 8 GB
HD: 394 GB internal, 1 TB ext NFS
Model: PE 2950
OS: CentOS 5.x
132.238.42.13

otto
CPU: 1
RAM: 512 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.89.1

[DB:fms]

MySQL
fms
rptData
racktables
cacti
puremessage

[DB:puremessage]

jadar0
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.88.12

jar
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.42.11

jadar00
CPU: 1
RAM: 256 MB
HD: 20GB
Model: virtual
OS: CentOS 5.x
132.238.89.13

BIND (primary)
[zone transfer]
[zone transfer]
[zone transfer]
[zone transfer]

BIND (secondary)
xntpd
BIND (secondary)
xntpd

jadar12
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.88.64

jadar21
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.88.65

dns1 / dns2
132.238.88.11
132.238.89.11

wackamole

BIND (secondary)
xntpd
BIND (secondary)
xntpd

mica34
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.170.20

mica43
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.170.21

dns3 / dns4
132.238.170.11
132.238.171.11

wackamole

BIND (primary)
[zone transfer]
[zone transfer]
[zone transfer]
[zone transfer]
[zone transfer]

BIND (secondary)
BIND (secondary)

jadar56
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.89.4

jadar65
CPU: 1
RAM: 256 MB
HD: 30GB
Model: virtual
OS: CentOS 5.x
132.238.89.5

dns5 / dns6
132.238.88.2
132.238.89.3

wackamole

cricket.isp.net
Maintained by ISP
noc@isp.net
888-349-5570
208.176.176.150

grasshopper.isp.net
Maintained by ISP
noc@isp.net
888-349-5570
208.176.176.180

status
Offsite server located in Toronto.
Maintained by YourHosts.
http://support.yourhosts.com
866-977-5782
72.215.166.94

PureMessage

jam
CPU: (2) Xeon 2.66 GHz
RAM: 8 GB
HD: 63 GB
Model: PE 1950
OS: CentOS 5.x
132.238.42.44 132.238.42.46

qpage
apache
nagios
https://nagios.widg.com

jasp
CPU: (2) Xeon 3.8 GHz
RAM: 16 GB
HD: 400 GB
Model: PE 2850
OS: CentOS 5.x
132.238.42.50

PureMessage

Files
Postfix config

lists
CPU: 1
RAM: 512 MB
HD: 30GB
Model: virtual
OS: openSUSE 10.2
132.238.42.80

sally
CPU: (2) Xeon 2.66 GHz
RAM: 16 GB
HD: 63 GB
Model: PE 1950
OS: CentOS 5.x
132.238.89.15

harry
CPU: (2) Xeon 2.66 GHz
RAM: 16 GB
HD: 63 GB
Model: PE 1950
OS: CentOS 5.x
132.238.152.19

freddy
CPU: (2) Xeon 2.66 GHz
RAM: 16 GB
HD: 63 GB
Model: PE 1950
OS: CentOS 5.x
132.238.152.15

PureMessage
PureMessage
PureMessage

dana
CPU: (2) Xeon 2.66 GHz
RAM: 8 GB
HD: 63 GB
Model: PE 1950
OS: CentOS 5.x
132.238.52.21 132.238.52.63

nagios
https://watcher
nodewatch
http://dana/nodewatch
qpage
http://apager
mod_php
apache

Email Post Offices

What do you notice?

What is the most important thing to know about this diagram?

I sure hope those Grey and Green boxes are important

This thing tells us about machine resources and dataflows

✓ Grey boxes are virtual; Green boxes are physical

Distinguishing between the two was important to the author; in fact, I find it easy to do precisely this

✓ Tracking machine resources (CPU, RAM, storage) was important to this author

We were exhausting all three, adding RAM & CPU, scrambling to physicalize previously virtual boxes: This diagram tracks those parameters easily

✓ Notice the use of color in lines, e.g. Green lines trace SMTP mail exchange

Green is overloaded: myself, I'm OK with that – I know a little about DNS and SMTP and a lot about this environment, and I find this use of color contributing to my understanding rather than confusing me

❑ Too dense, too many overlapping lines: time to expand to multiple sheets

Rewards study

MMZ Routing

What do you notice?

- Color — Must mean something
- Redundancy — Some services are redundant; others are not
- Complexity — The two Orange boxes are complicated

Color

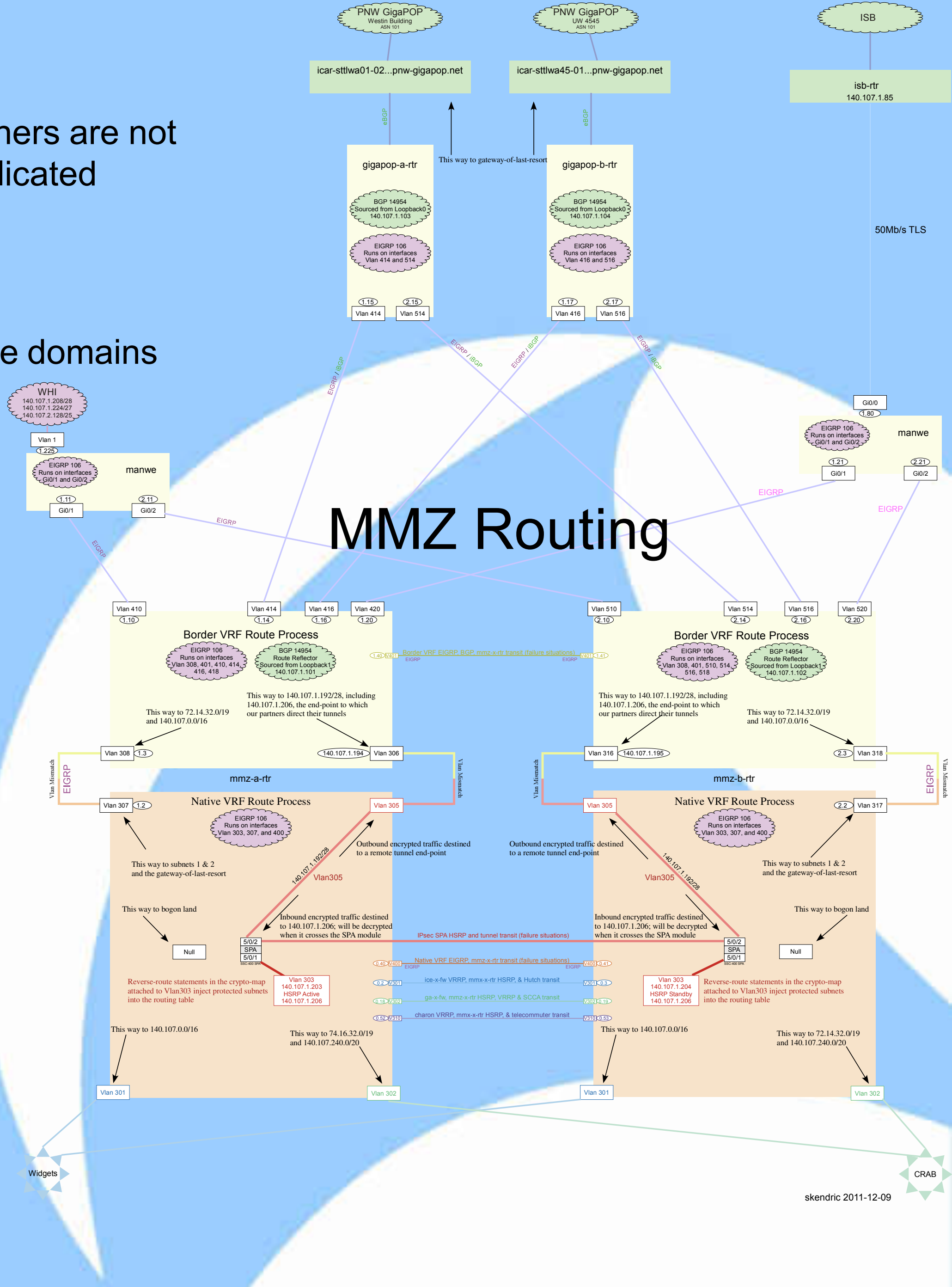
- Green denotes BGP, Purple denotes EIGRP
- Yellow and Orange distinguish richly filtered route domains

Redundancy

- Yes, some partners connect via redundant gear, others do not

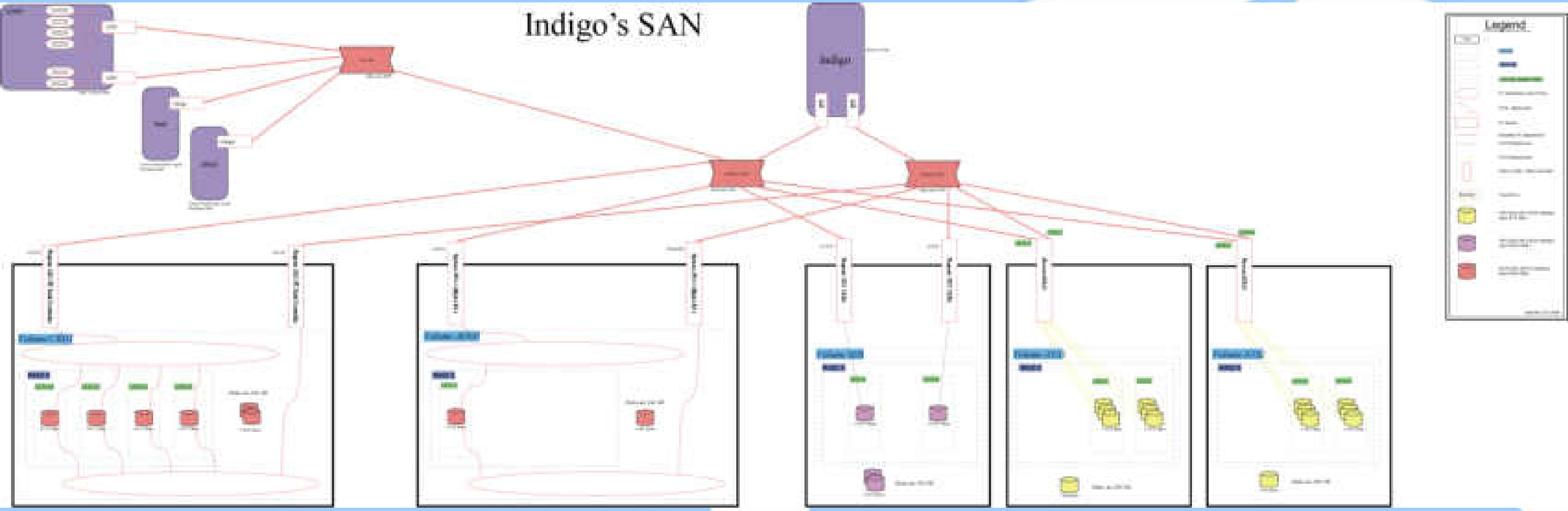
Complexity

- The two Orange boxes support site-to-site VPN tunnel encryption via complex routing
- And HSRP addresses to devices not shown here, notably firewalls and telecommuter VPN servers
- In addition, the bottom four boxes really belong just to two physical chassis' … which have been carved into Virtual Routing Forwarding (VRF) instances



skendric 2011-12-09

Indigo’s SAN



What do you notice?

What is the most important thing to know about this diagram?

This thing is mostly air

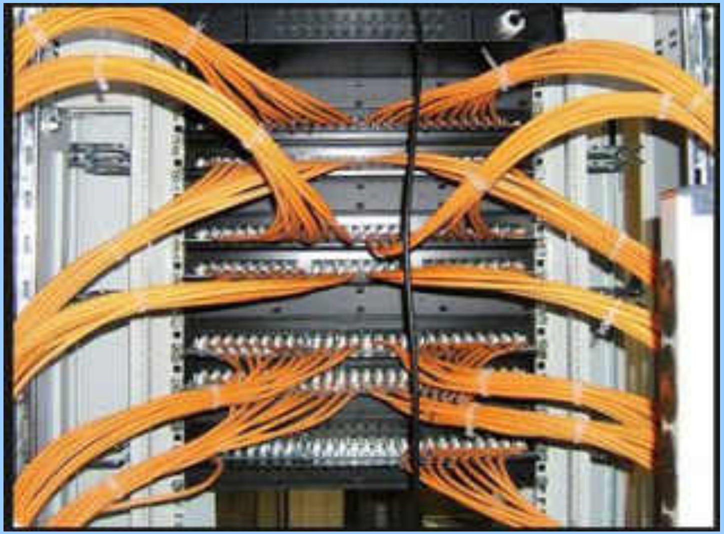
And somehow, those black boxes and red lines must be important

- ✓ Notice the consistent use of color to distinguish between drive attachment: Fibre Channel, SATA, and ATA
- ✓ You can kind of tell which trays are dual-attached and which aren’t

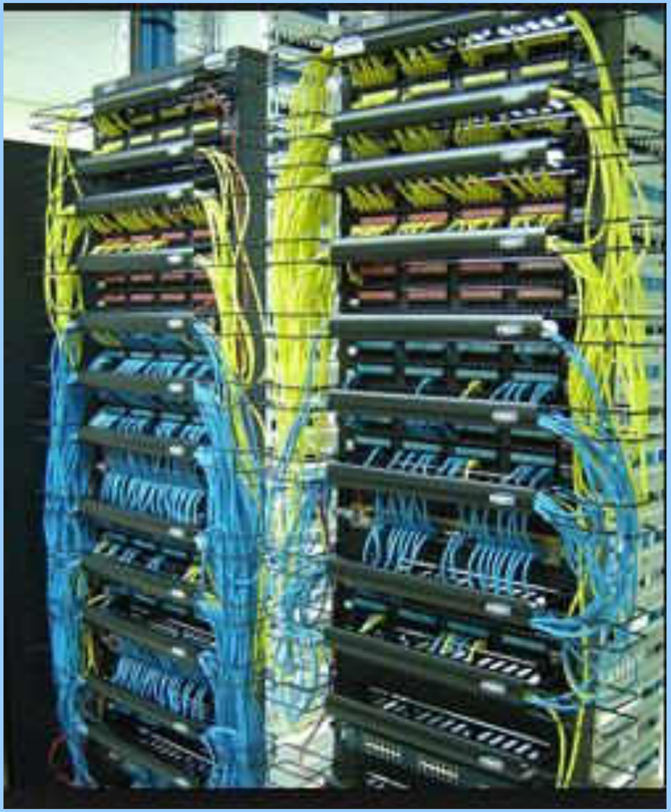
- □ But the fact that the drives inside a tray are connected via one (or two) Fibre Channel loops, while initially interesting, turned out not to be important
- □ What a fabulous waste of space

I predicted that I would need to learn more about the internal workings of a tray, in order to trouble-shoot future problems, and so left myself space to grow … but ended up not being involved again in this device’s exploits

Diagrams evolve as your understanding deepens and your needs change



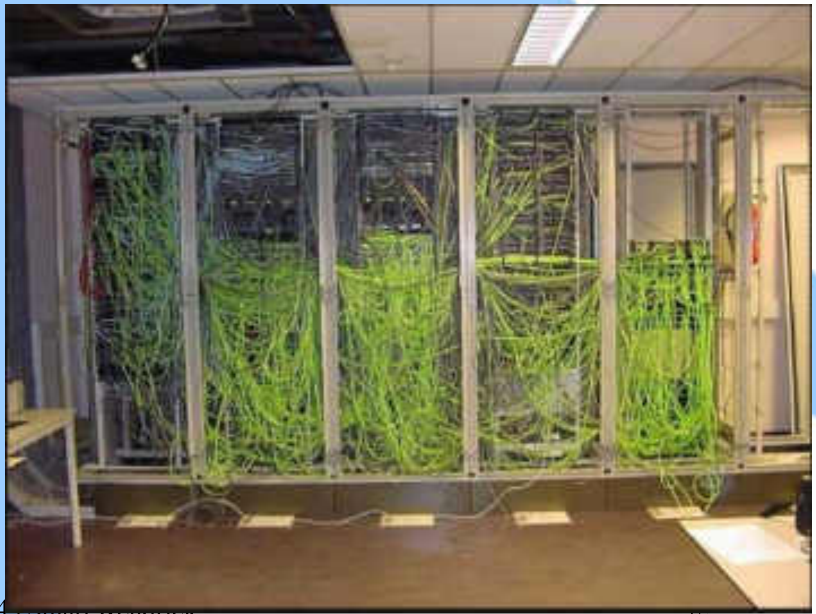
You can pay up front, or you can pay later

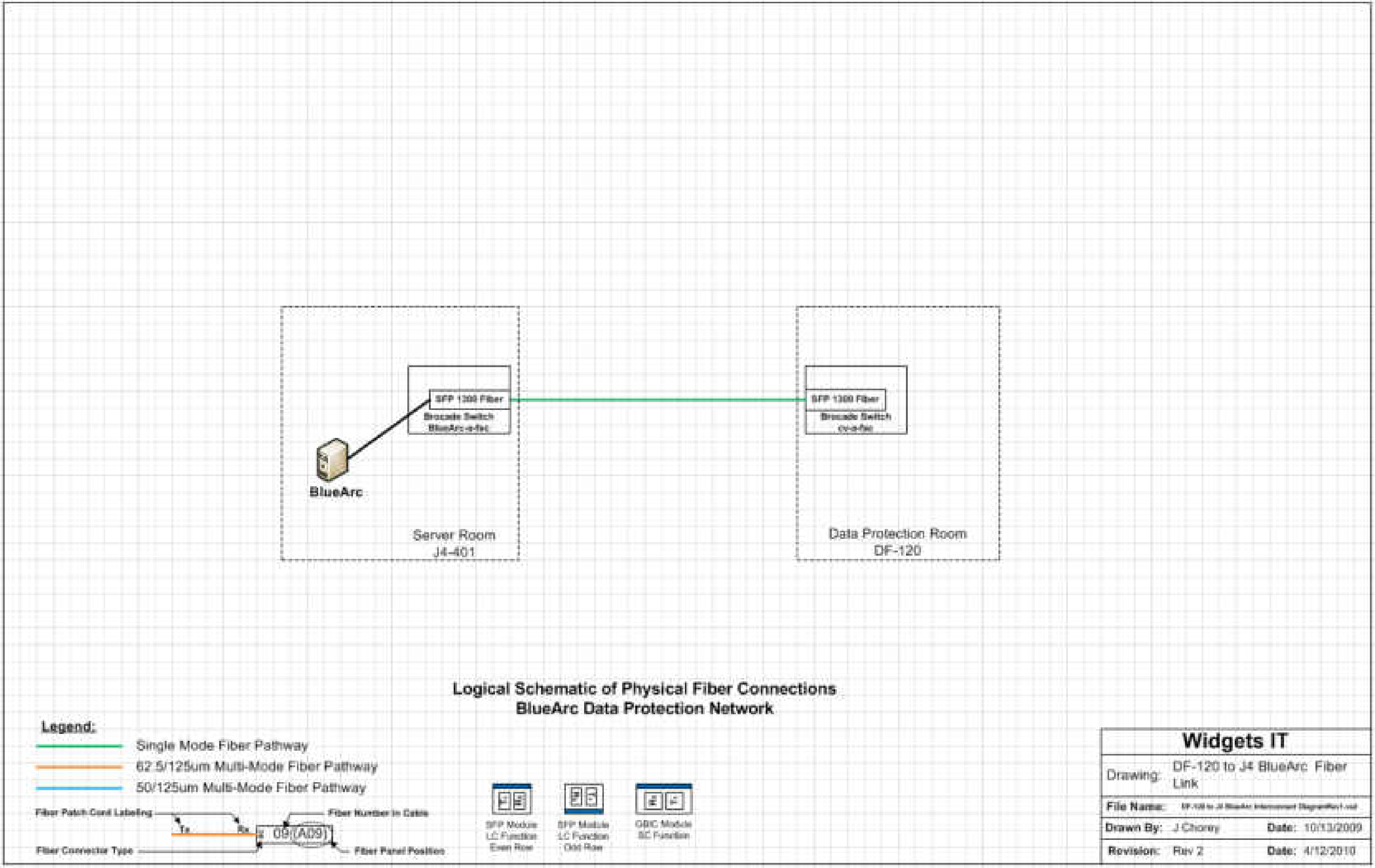


Paying up front is hard, but you save money in the long run

If you pay later, you pay with (exorbitant) interest
This is *Technical Debt*

Skilled physical layer people are hard to find and worth their weight in gold. Look for folks coming from the telco and submariner spaces





Logical Schematic of Physical Fiber Connections
BlueArc Data Protection Network

Widgets IT

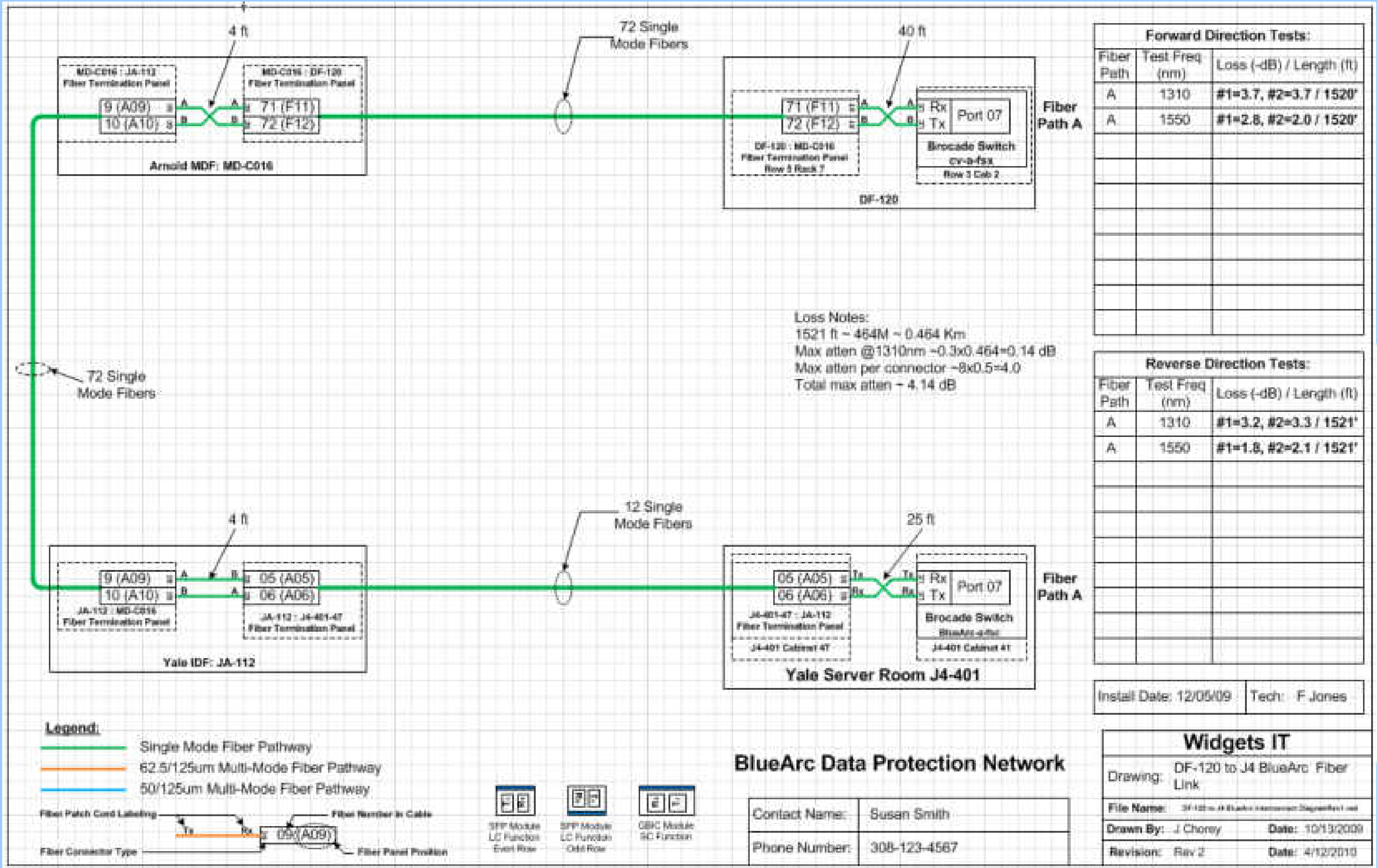
Drawing: DF-120 to J4 BlueArc Fiber Link

File Name: [illegible]

Drawn By: J Chorny Date: 10/13/2009

Revision: Rev 2 Date: 4/12/2010

One little fiber optic link between the Server Room and the Data Protection Room
How hard can it be?



Loss Notes:
1521 ft ~ 464M ~ 0.464 Km
Max atten @1310nm ~0.3x0.464=0.14 dB
Max atten per connector ~8x0.5=4.0
Total max atten ~ 4.14 dB

Legend:

🟩 Single Mode Fiber Pathway
🟧 62.5/125um Multi-Mode Fiber Pathway
🟦 50/125um Multi-Mode Fiber Pathway

Forward Direction Tests:		
Fiber Path	Test Freq (nm)	Loss (-dB) / Length (ft)
A	1310	#1=3.7, #2=3.7 / 1520'
A	1550	#1=2.8, #2=2.0 / 1520'

Reverse Direction Tests:		
Fiber Path	Test Freq (nm)	Loss (-dB) / Length (ft)
A	1310	#1=3.2, #2=3.3 / 1521'
A	1550	#1=1.8, #2=2.1 / 1521'

Install Date: 12/05/09	Tech: F Jones

BlueArc Data Protection Network

Contact Name:	Susan Smith
Phone Number:	308-123-4567

Widgets IT

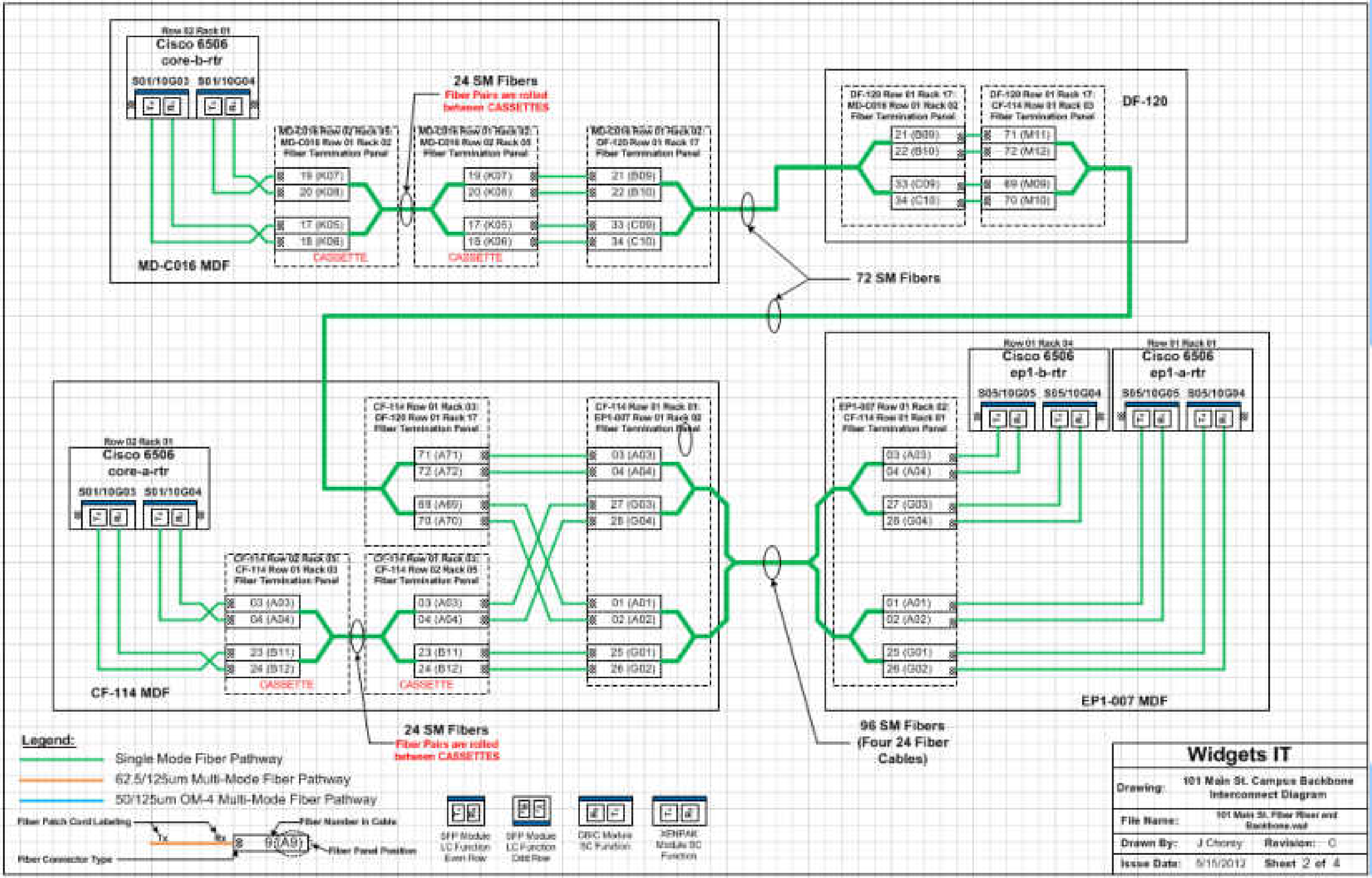
Drawing: DF-120 to J4 BlueArc Fiber Link

File Name: [illegible]

Drawn By: J Chorey Date: 10/13/2009

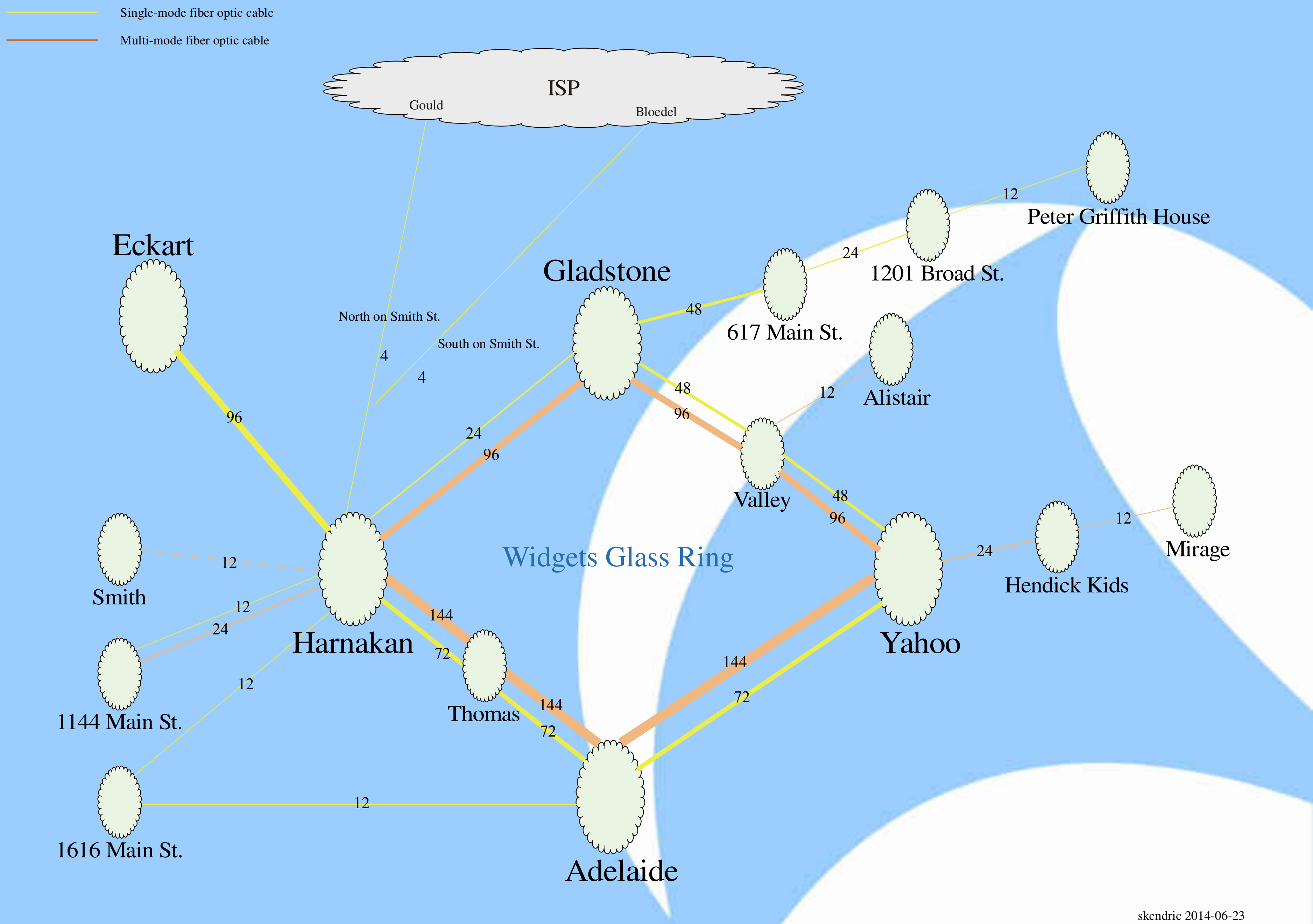
Revision: Rev 2 Date: 4/12/2010

This is what it takes to earn the moniker *Skilled*



Here tracking the connections between the two campus core routers and the two E Building routers

Widgets Outside Glass Cabling Plant



skendric 2014-06-23

What do you notice?

What is the most important thing to know about this diagram?

Some of those buildings sit on a diamond … well, ahh … I guess … a ring
Which means that those buildings are hardened against fiber cuts

- ✓ This diagram shines at telling you what happens when a fiber conduit gets cut
- ✓ And you can tell how many raw strands you have running between buildings

Some diagrams have a narrow focus: that's OK, particularly if they tell the story clearly

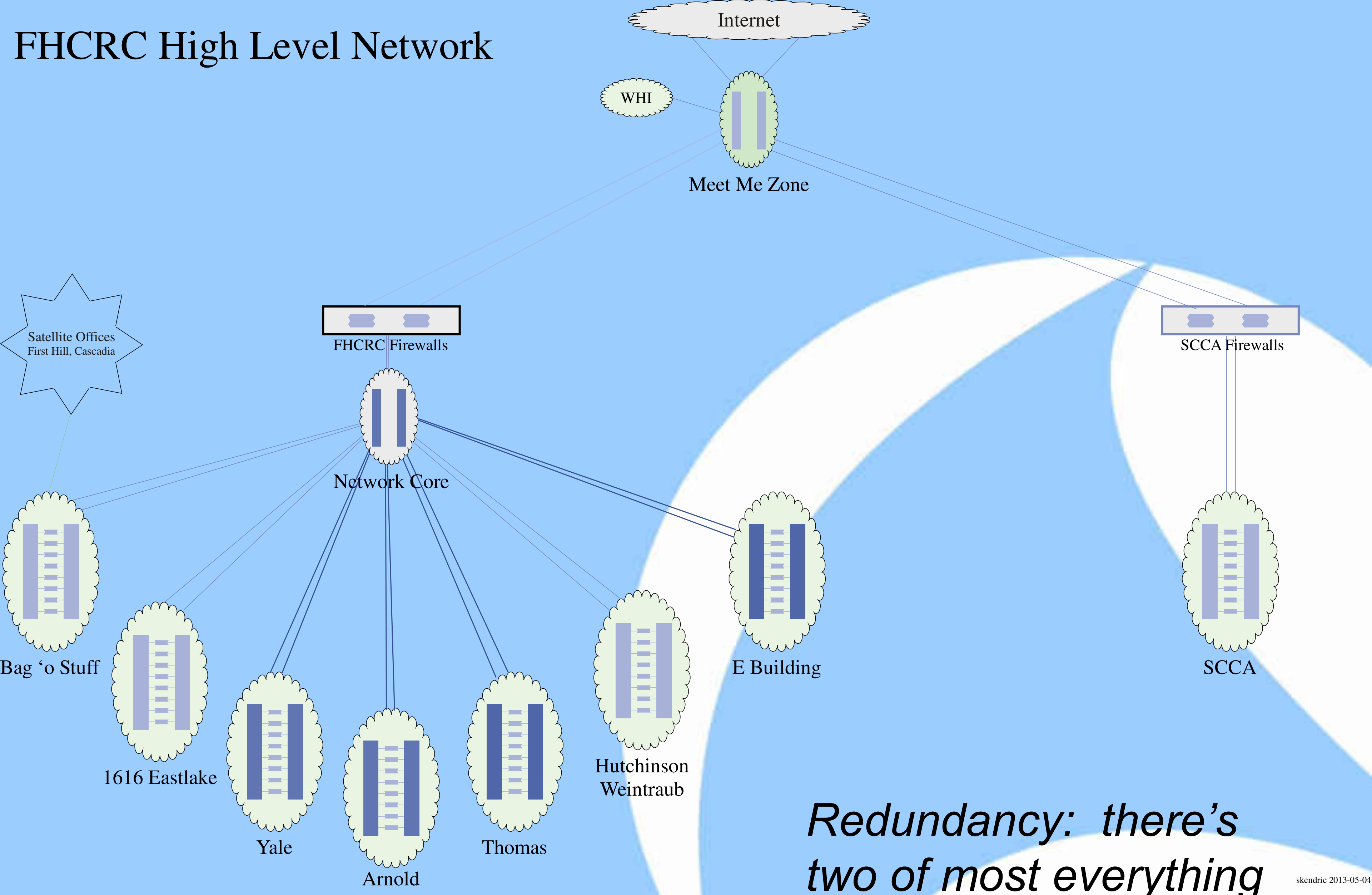
OK, let‘s get serious

Major jump in expertise here

> *The cabling diagrams we just saw were drawn by an IT professional with ~40 years experience. He dumbed down his CAD templates into Visio so that the rest of us could contribute – we have dozens of these diagrams now, hopefully more on the way*

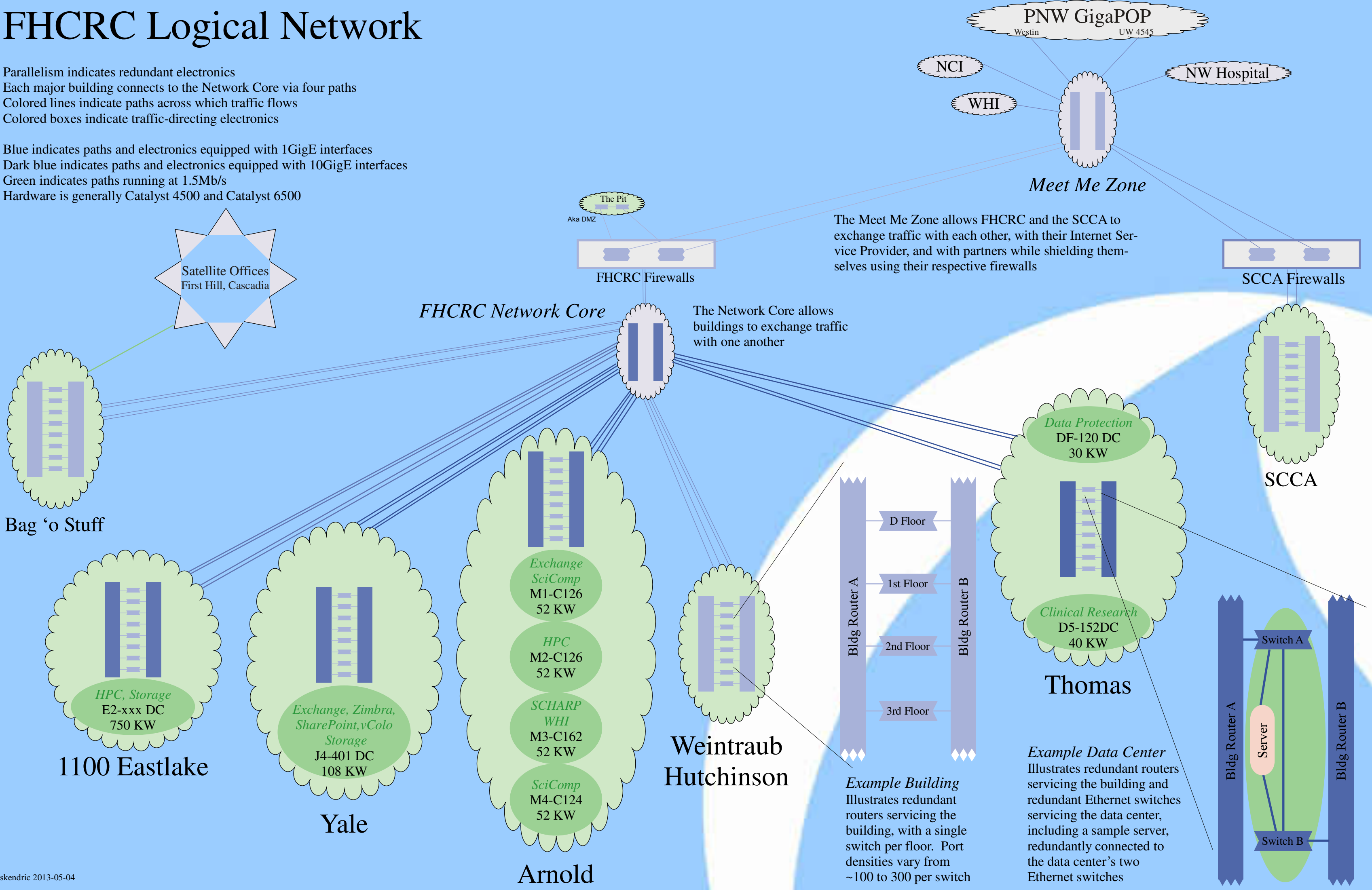
I’m headed toward showing off the best I have to offer: twenty years working in one environment, nearly two decades of developing and evolving the ‘LAN/MAN Map’

FHCRC High Level Network



Redundancy: there's two of most everything

FHCRC Logical Network



Parallelism indicates redundant electronics
Each major building connects to the Network Core via four paths
Colored lines indicate paths across which traffic flows
Colored boxes indicate traffic-directing electronics

Blue indicates paths and electronics equipped with 1GigE interfaces
Dark blue indicates paths and electronics equipped with 10GigE interfaces
Green indicates paths running at 1.5Mb/s
Hardware is generally Catalyst 4500 and Catalyst 6500

PNW GigaPOP
Westin
UW 4545

NCI

WHI

NW Hospital

Meet Me Zone

The Meet Me Zone allows FHCRC and the SCCA to exchange traffic with each other, with their Internet Service Provider, and with partners while shielding themselves using their respective firewalls

The Pit
Aka DMZ

FHCRC Firewalls

SCCA Firewalls

Satellite Offices
First Hill, Cascadia

FHCRC Network Core

The Network Core allows buildings to exchange traffic with one another

Bag ‘o Stuff

SCCA

Data Protection
DF-120 DC
30 KW

Clinical Research
D5-152DC
40 KW

Thomas

HPC, Storage
E2-xxx DC
750 KW

1100 Eastlake

Exchange, Zimbra, SharePoint,vColo Storage
J4-401 DC
108 KW

Yale

Exchange SciComp
M1-C126
52 KW

HPC
M2-C126
52 KW

SCHARP WHI
M3-C162
52 KW

SciComp
M4-C124
52 KW

Arnold

Weintraub Hutchinson

Bldg Router A
Bldg Router B
D Floor
1st Floor
2nd Floor
3rd Floor

Example Building
Illustrates redundant routers servicing the building, with a single switch per floor. Port densities vary from ~100 to 300 per switch

Example Data Center
Illustrates redundant routers servicing the building and redundant Ethernet switches servicing the data center, including a sample server, redundantly connected to the data center’s two Ethernet switches

Bldg Router A
Switch A
Server
Switch B
Bldg Router B

skendric 2013-05-04

Same as the last one … but with a little more detail, plus explanatory text

How to densify

So the last several diagrams might be suitable for management … but hardly useful for techs

We want:

- IP addresses to ping
- 10Mb | 100Mb | 1GigE | 10GigE
- How much throughput do I have between location X and location Y?
- A sense of physicality … the location of data centers and even key servers
- The service providers, circuit IDs, NOC telephone numbers
- Security gear – firewalls, IPS, proxies – because they break things
- Where's the weird stuff? The hacks, the one-offs, the complicated parts?
- Where is the creaky stuff – degrading, overloaded, fragile?

And above all, relationships – how this chunk depends on that other chunk

Shapes for devices

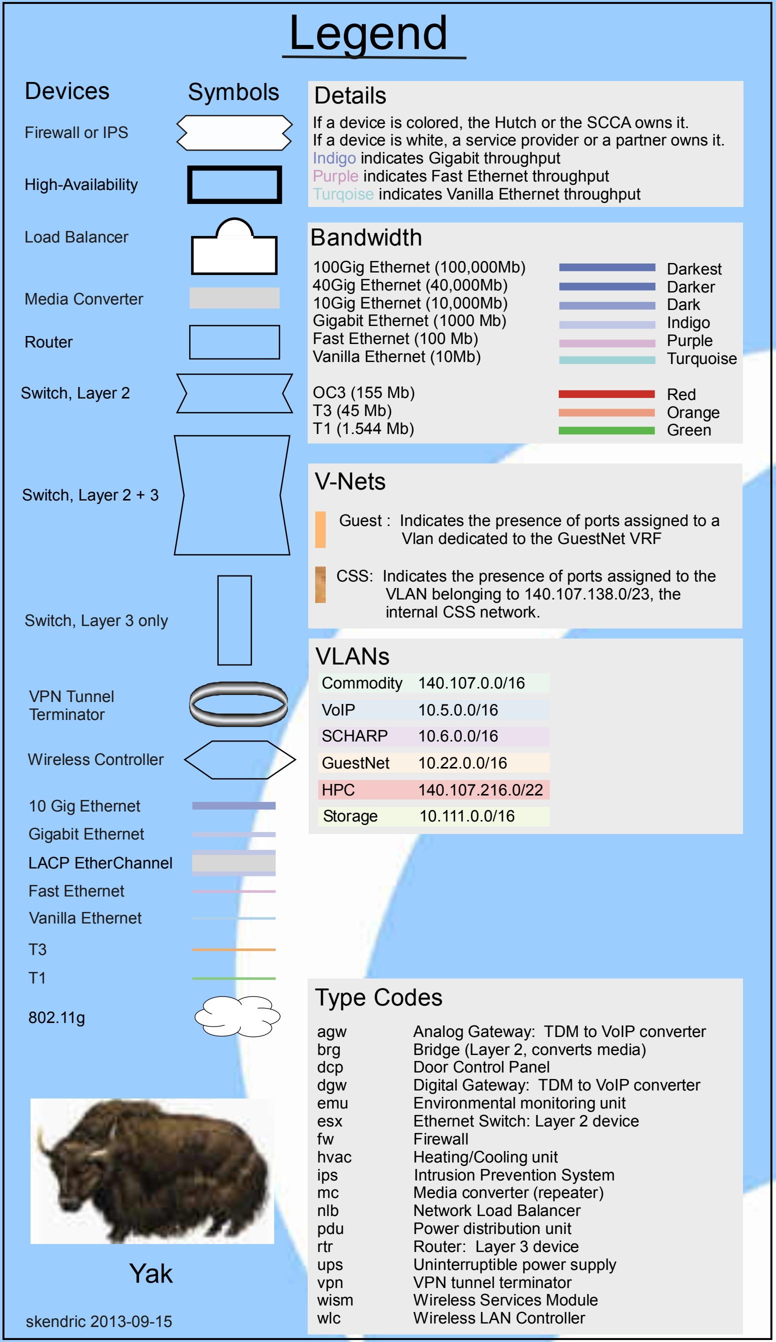
Security (FW or IPS)

Router
Layer 2 Switch

Layer 3 Switch

Versioning scheme
- Minor change
  Just change the date
- Major change
  New animal

In 1993, we started with Armadillo



Legend

Devices	Symbols
Firewall or IPS	
High-Availability	
Load Balancer	
Media Converter	
Router	
Switch, Layer 2	
Switch, Layer 2 + 3	
Switch, Layer 3 only	
VPN Tunnel Terminator	
Wireless Controller	
10 Gig Ethernet	
Gigabit Ethernet	
LACP EtherChannel	
Fast Ethernet	
Vanilla Ethernet	
T3	
T1	
802.11g	

Yak

skendric 2013-09-15

Details

If a device is colored, the Hutch or the SCCA owns it.
If a device is white, a service provider or a partner owns it.
Indigo indicates Gigabit throughput
Purple indicates Fast Ethernet throughput
Turqoise indicates Vanilla Ethernet throughput

Bandwidth

100Gig Ethernet (100,000Mb)	▬	Darkest
40Gig Ethernet (40,000Mb)	▬	Darker
10Gig Ethernet (10,000Mb)	▬	Dark
Gigabit Ethernet (1000 Mb)	▬	Indigo
Fast Ethernet (100 Mb)	▬	Purple
Vanilla Ethernet (10Mb)	▬	Turquoise
OC3 (155 Mb)	▬	Red
T3 (45 Mb)	▬	Orange
T1 (1.544 Mb)	▬	Green

V-Nets

Guest : Indicates the presence of ports assigned to a Vlan dedicated to the GuestNet VRF

CSS: Indicates the presence of ports assigned to the VLAN belonging to 140.107.138.0/23, the internal CSS network.

VLANs

Commodity	140.107.0.0/16
VoIP	10.5.0.0/16
SCHARP	10.6.0.0/16
GuestNet	10.22.0.0/16
HPC	140.107.216.0/22
Storage	10.111.0.0/16

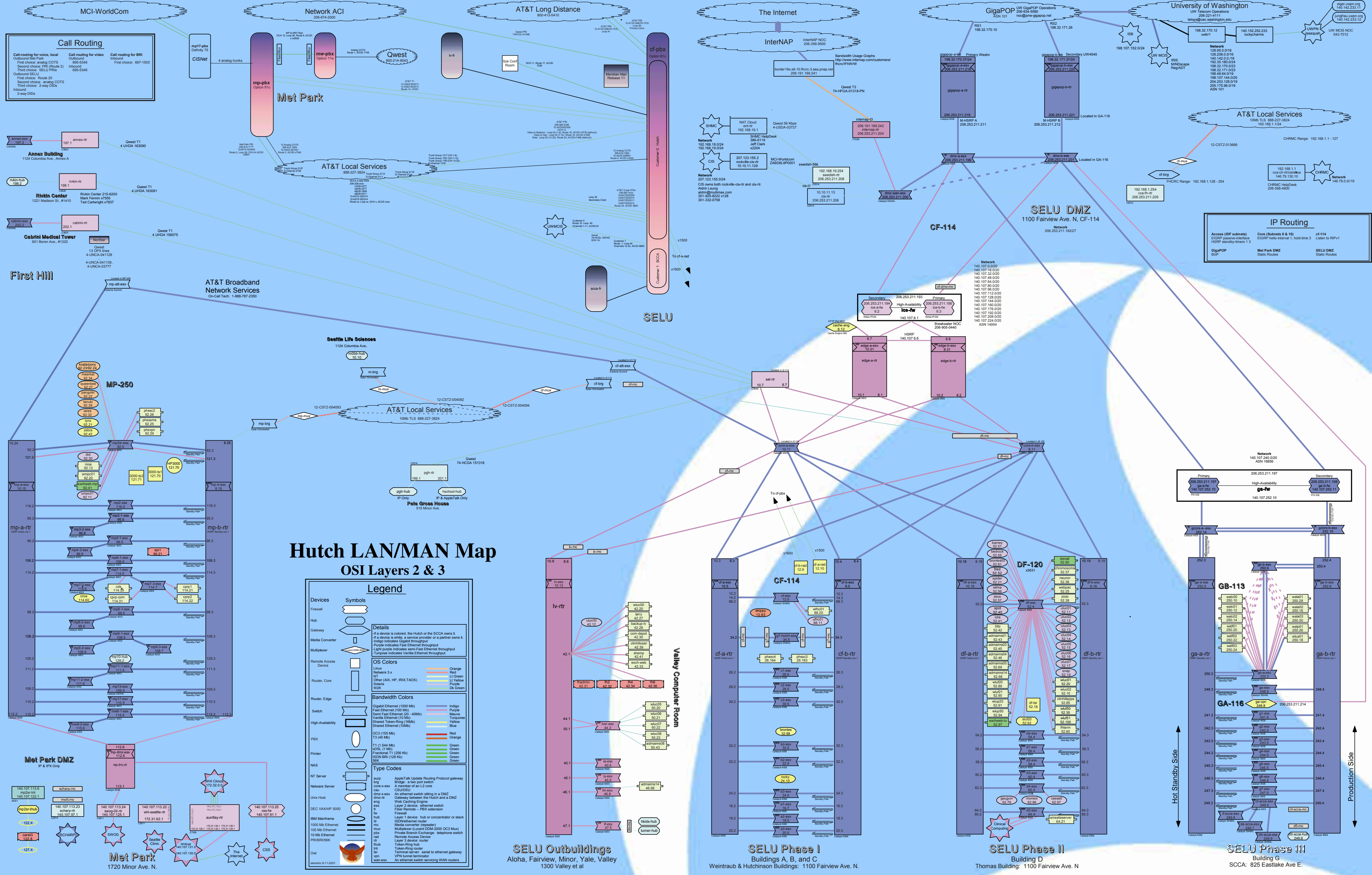
Type Codes

agw	Analog Gateway: TDM to VoIP converter
brg	Bridge (Layer 2, converts media)
dcp	Door Control Panel
dgw	Digital Gateway: TDM to VoIP converter
emu	Environmental monitoring unit
esx	Ethernet Switch: Layer 2 device
fw	Firewall
hvac	Heating/Cooling unit
ips	Intrusion Prevention System
mc	Media converter (repeater)
nlb	Network Load Balancer
pdu	Power distribution unit
rtr	Router: Layer 3 device
ups	Uninterruptible power supply
vpn	VPN tunnel terminator
wism	Wireless Services Module
wlc	Wireless LAN Controller

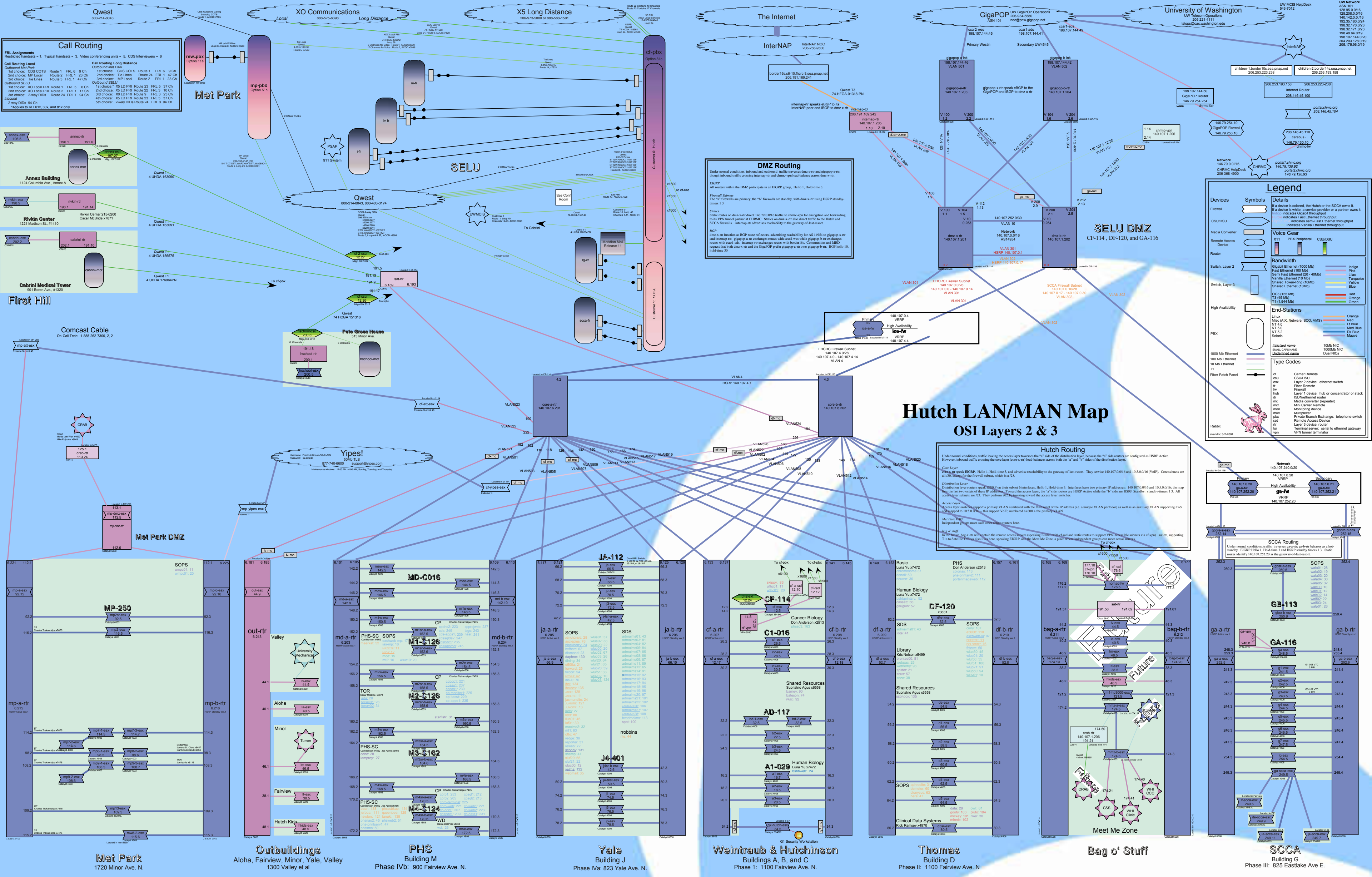
Color for throughput
- *Blue for GigE and above*
- *Purple for 100Mb*
- *Turquoise for 10Mb*
- *Green for T1*

Shading for VLANs

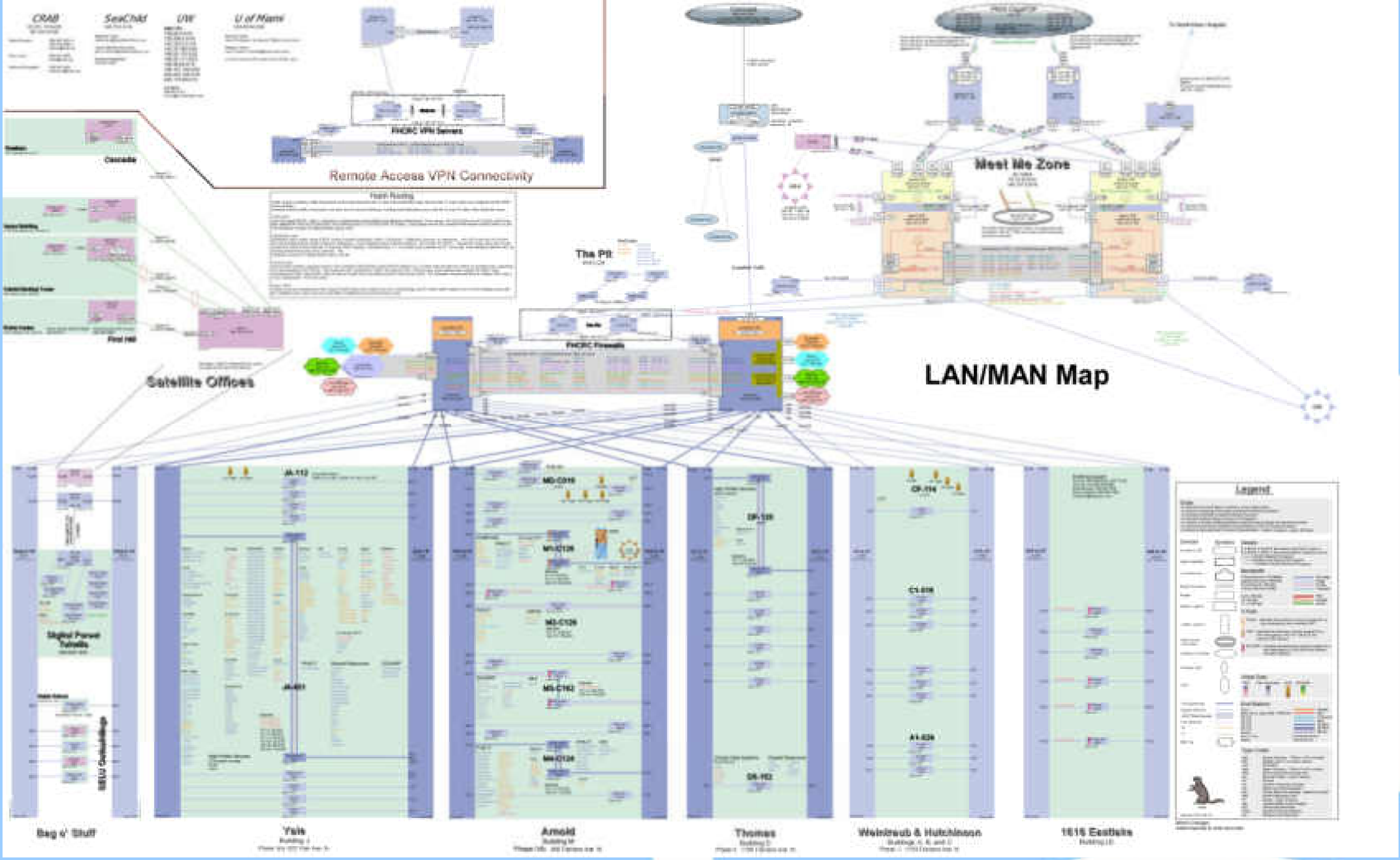
Structured naming convention for infrastructure gear



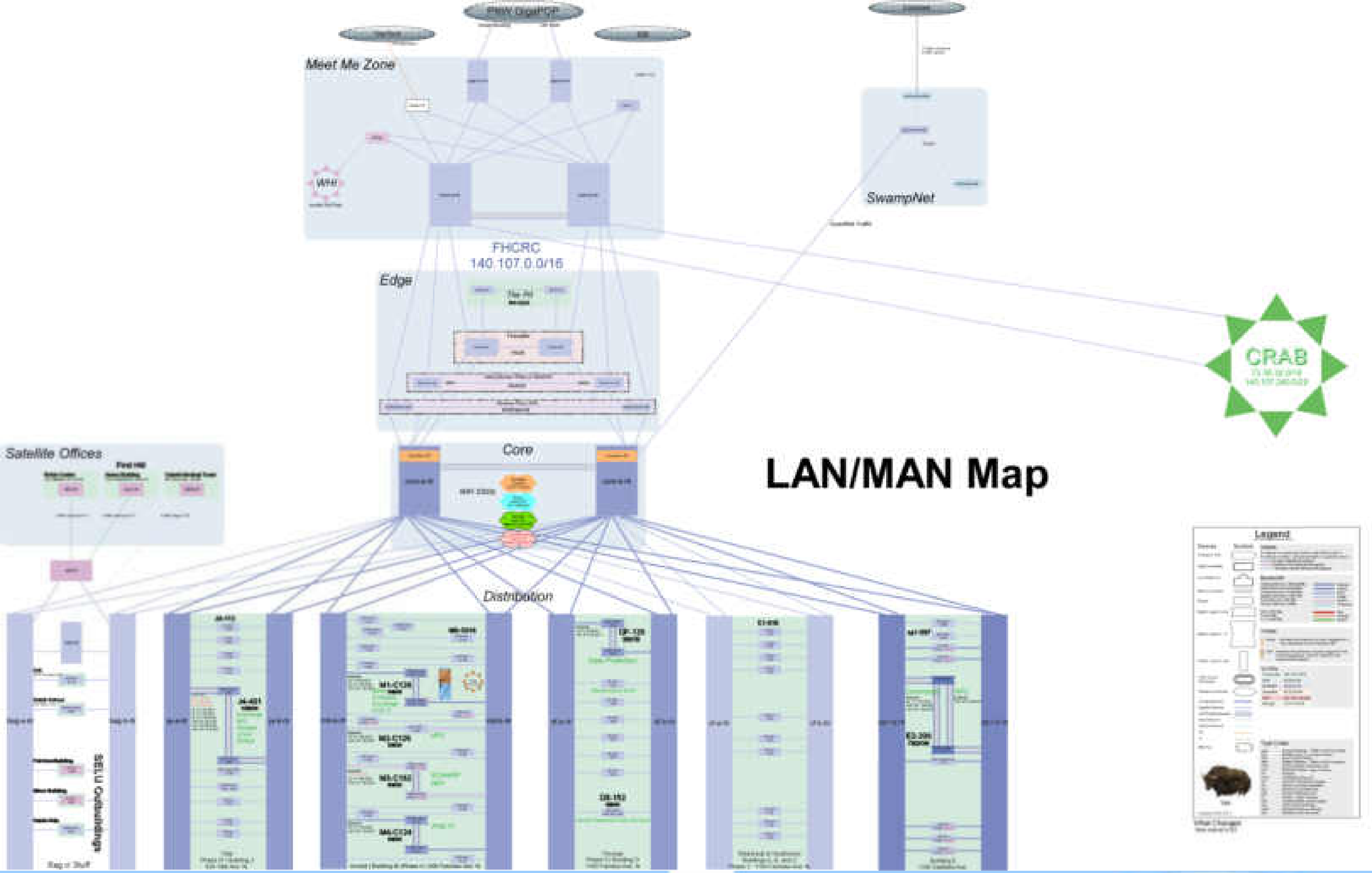
This is Owl, circa 2001



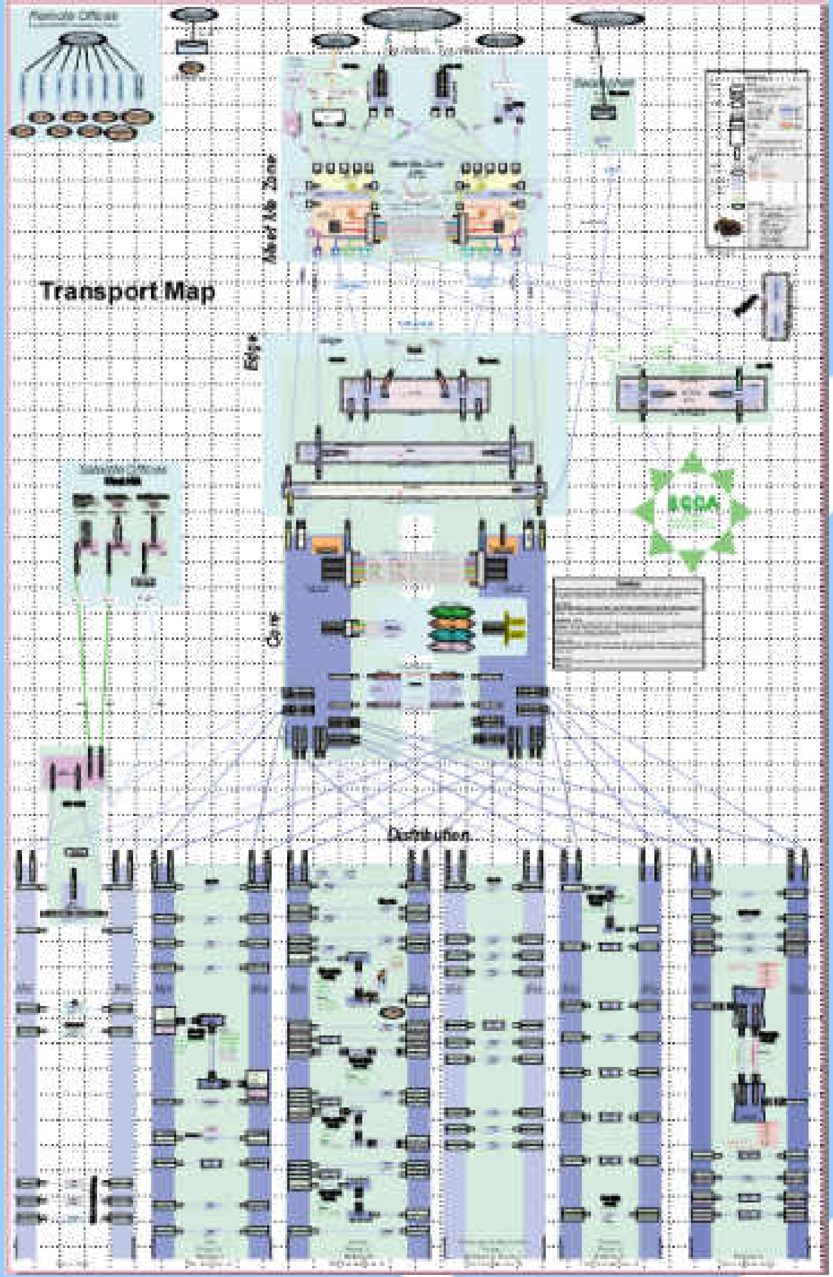
This is Rabbit, circa 2004



This is Xerus, circa 2012



This is Yak, circa Q4 2013



And this is Yak, circa Q4 2013

Complexity

If you struggle to draw it, this is a sign that you're not smart enough to support it

Debugging is twice as hard as writing the code in the first place. Therefore, if you write the code as cleverly as possible, you are, by definition, not smart enough to debug it. --Brian Kernighan

Drawing feeds back into design – if you can't draw it, then perhaps you would be better off simplifying your design, giving up features in exchange for supportability.

Increasingly, people seem to misinterpret complexity as sophistication, which is baffling - the incomprehensible should cause suspicion rather than admiration. --Niklaus Wirth

I have seen diagrams communicate the costs of business decisions. Imagine this conversation with your CIO:

- *Yes, new Product A will deliver features xyz while old Product B does not*
- *But are you happy with the uptime of the Product B? No?*
- *Let's compare the diagrams – see how much more complicated Product A is?*
- *The technical folks warn us that Product A will be harder to fix when it breaks*
- *Are you OK with increasing downtime in exchange for features xyz?*

Diagrams give you a way to communicate risk upward, downward, sideways

Communication is a good thing

Nuggets

When you step back, what do you notice first? Is what you notice first the most important message that you want your diagram to convey?

Building a diagramming culture took us a decade+

The deeper your content knowledge, the richer your diagrams

As you progress, your understanding of technology deepens … so do your diagrams … your early diagrams will reflect your ignorance and errors … your later diagrams will reflect the profundity of your insights … you cannot short-circuit this process

Don't waste pixels on anatomically correct icons

Consistency and a concise vocabulary supports densifying the information content

When things break – when you experience a major service disruption – return to your diagram: does your diagram explain what happened? If not, what can you add so that it does?

Practicalities

In my experience, each diagram has one and only one owner

We encourage anyone to make changes; in practice, only the owner ever does

Create a map wall, where you post your diagrams

- *Posting the latest version as a PDF to a Web server supports trouble-shooting substantially (everyone can glance at the map without having to physically walk to the map wall) but is hard to maintain – only your most conscientious staff will publish the maps they own this way*
- *Senior staff will prefer to have their own private printed copies*

People vary in their reading and writing skills:

- *Some folks can neither read nor write*
- *Some folks can read maps but stumble when trying to produce them*
- *And some folks think in pictures and find speaking in this medium to be natural*
- *In my experience, trouble-shooting skill and map drawing go together*
- *Skilled trouble-shooters can sketch a model of the problem on the white board, even if they have never fired up Canvas or Visio*

Mechanics

- *Put your name on the diagram*
- *Keep a change log*
- *Archive old versions every now and then*

Software Tips

Visio implements smart connectors – very useful when you're moving boxes around and want those lines to move automatically

Cabling and org charts

Visio makes it easy to waste space using anatomically correct icons

I recommend indulging that urge until you get sick of it … that's how I overcame my stencil addiction. It took me years to get clean.

Canvas scales

- *sophisticated color control*
- *precise object placement*
- *efficient zooming*

Some day, I would like to take a class in each … I know I'm only barely touching their feature sets

You know you are succeeding when:

Staff take copies of your diagram home with them when they are on-call

Your diagram rewards study

- *As you examine it, deeper and more subtle insights arise in your mind*
- *Sophisticated diagrams offer insights to the casual observer … and revelations to the studious*

Peers approach you with additions, corrections, and requests for enhancements

- *Every reasonably interesting diagram I have produced contains errors all the time … I built the big diagrams over many years, as colleagues found and fixed mistakes, and I introduced new ones*
- *And your peers complain when the maps you post on the wall are out-of-date*

Management ask their staff to drop you e-mail whenever they make changes

This doesn't work well … as your peers often don't understand the diagrams well enough to know what changes you are drawing and which you aren't … but it is flattering

Project sponsors require diagrams before allowing the project to close

Well-intended, but I haven't seen this work – senior staff produce diagrams whether required to or not, junior staff don't have the skills and so produce content-free drawings which satisfy the sponsors but are not in fact useful in the field

Thank You!

On-Line Resources

Rapid Problem Resolution by Paul Offord

LinkedIn Protocol Analysis & Troubleshooting Group

Old Comm Guy http://www.lovemytool.com

Trouble-shooting & Training Outfits		Based Here (will travel for $$)
James Baxter	http://www.packetiq.com	Daytona Beach, FL
Tony Fortunato	http://www.thetechfirm.com	Toronto, Canada
Chris Greer	http://www.packetpioneer.com	Central/South America
Paul Offord	http://www.advance7.com	London (international)
Mike Pennacchi	http://www.nps-llc.com	Seattle, WA
Ray Tompkins	http://www.gearbit.com	Austin, TX
…		

Conferences

Sharkfest http://www.sharkfest.org San Francisco, CA

Follow-up

stuart.kendrick.sea {at} gee mail dot com

This deck visible at http://www.skendric.com/seminar