

IPv6 MAGIC

(NO I DIDN'T CHOOSE THE TITLE)

U T A H S A I N T C O N F E R E N C E
O C T O B E R 1 1 , 2 0 1 2

W M . L U K E J E N K I N S
W E B E R S T A T E U N I V E R S I T Y

UPDATED SLIDES

- ✿ I didn't quite finish these slides before the due date, sorry. Get an updated slide deck here:
- ✿ <https://weberstate.box.com/utahsaintipv6>



June
2011

IPv6 Status Survey

Higher Education Institutions in Utah

Organisation (domain)	Web	Mail	DNS	NTP	XMPP
Brigham Young University (byu.edu)	FAIL	FAIL	0/8 0/8	FAIL	
College of Eastern Utah (ceu.edu)	FAIL	FAIL	0/4 0/4		
Dixie State College (dixie.edu)	FAIL	FAIL	0/2 0/2	FAIL	
LDS Business College (ldsbc.edu)	FAIL	FAIL (G)	0/1 0/2		
Salt Lake Community College (slcc.edu)	FAIL	FAIL	0/2 0/4		
Snow College (snow.edu)	FAIL	FAIL	0/2 0/2		
Southern Utah College (suu.edu)	FAIL	FAIL	0/3 0/3		
University of Utah (utah.edu)	FAIL	FAIL	0/2 0/2	FAIL	
Utah State University (usu.edu)	FAIL	FAIL	0/2 0/2	FAIL	FAIL
Utah Valley University (uvu.edu)	FAIL	FAIL	0/3 0/3	FAIL	
Weber State University (weber.edu)	FAIL	FAIL	1/3 1/5	FAIL	
Westminster College (westminstercollege.edu)	FAIL	FAIL (RC)	0/2 0/2		
UEN (Utah Education Network / Intermountain Gigapop) (uen.org)	ipv6	FAIL	0/0 0/2	FAIL	



October
2012

IPv6 Status Survey

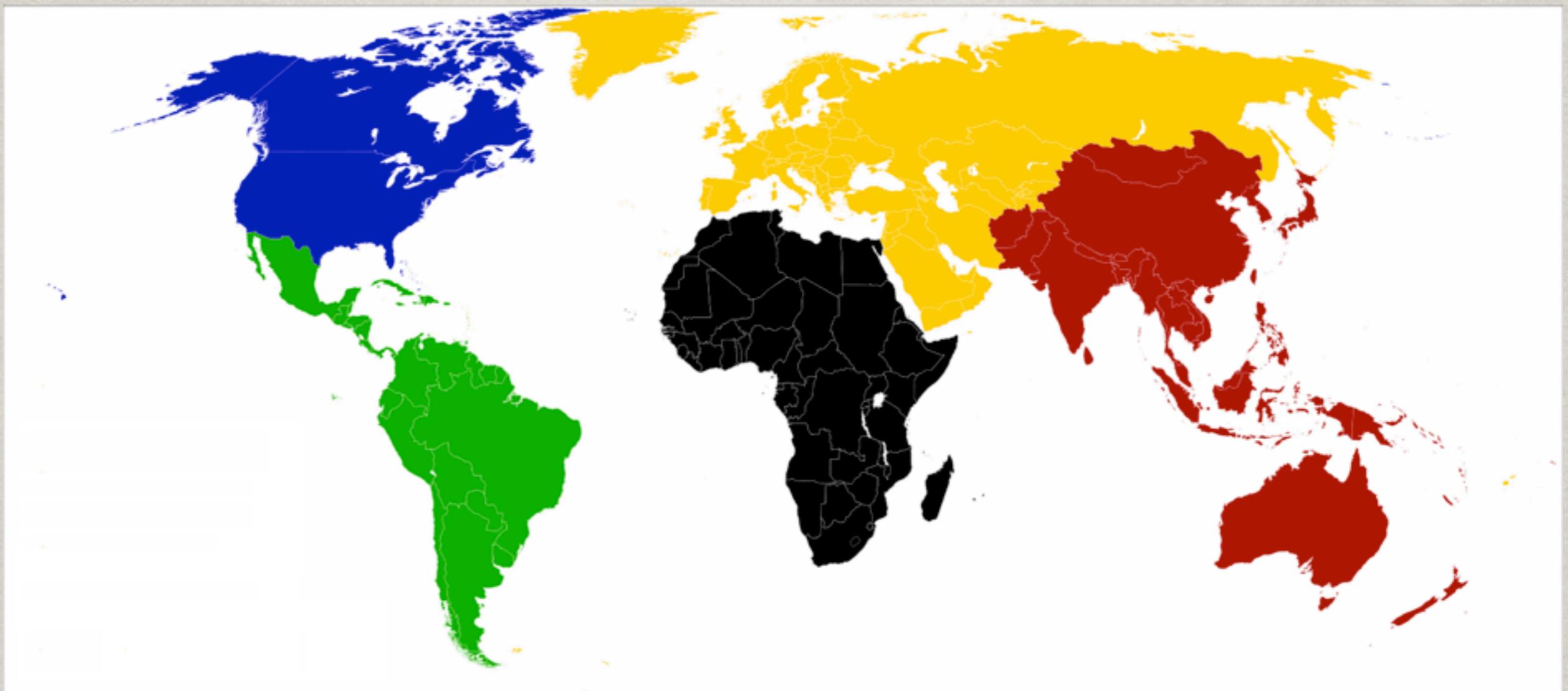
Higher Education Institutions in Utah

Organisation (domain)	Web	Mail	DNS	NTP	XMPP
Brigham Young University (byu.edu)	FAIL	FAIL	0/3 0/3	FAIL	
College of Eastern Utah (ceu.edu)	FAIL	FAIL	0/4 0/4		
Dixie State College (dixie.edu)	FAIL	FAIL	0/2 0/2	FAIL	
LDS Business College (ldsbc.edu)	FAIL	SUCCESS	0/1 0/2		
Salt Lake Community College (slcc.edu)	FAIL	FAIL	0/2 0/4		
Snow College (snow.edu)	FAIL	FAIL	0/2 0/2		
Southern Utah College (suu.edu)	FAIL	SUCCESS	0/3 0/3		
University of Utah (utah.edu)	SUCCESS	FAIL	0/2 0/2	FAIL	
Utah State University (usu.edu)	FAIL	FAIL	0/2 0/2		FAIL
Utah Valley University (uvu.edu)	FAIL	FAIL	0/3 0/3	FAIL	
Weber State University (weber.edu)	SUCCESS	SUCCESS	2/3 2/5	PROBLEM	
Westminster College (westminstercollege.edu)	FAIL	FAIL (RC)	0/2 0/2		

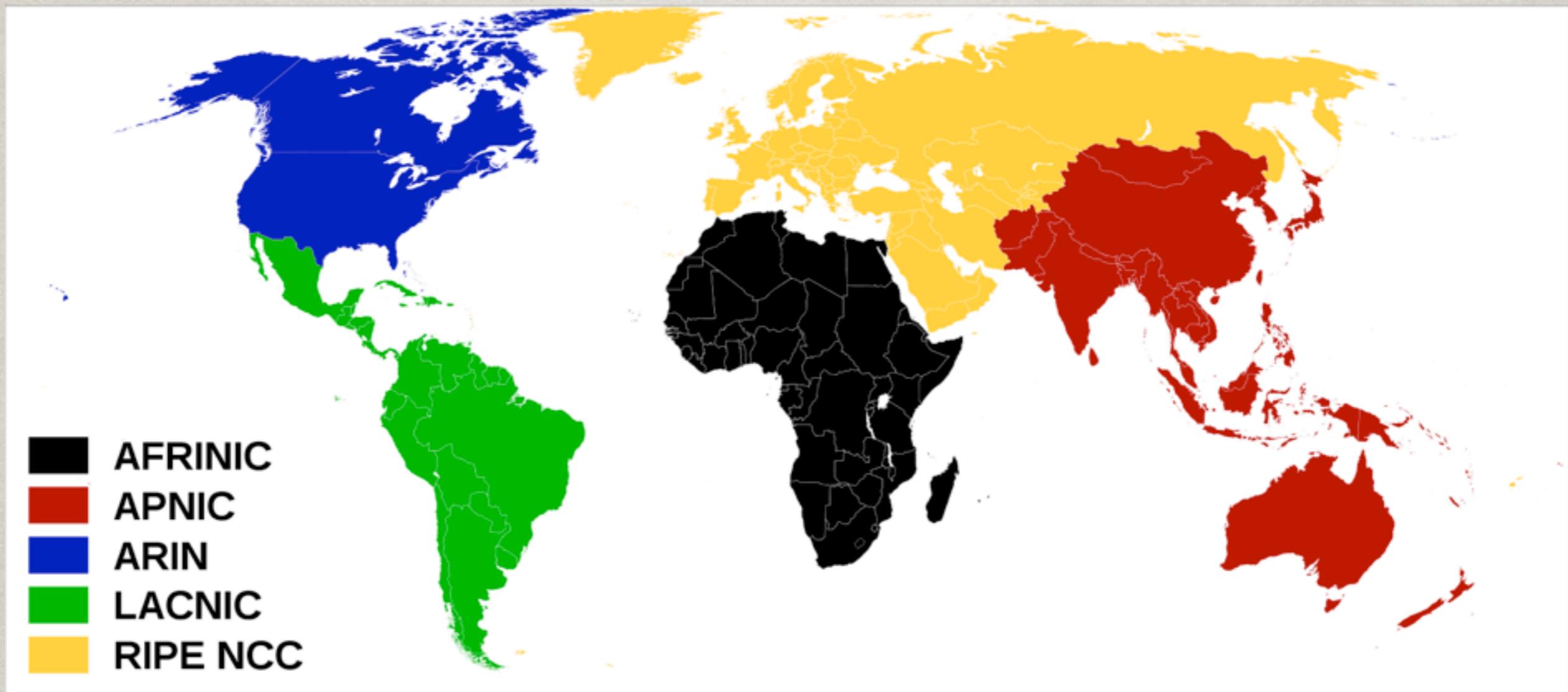
UEN (Utah Education Network / Intermountain Gigapop) (uen.org)	SUCCESS	FAIL	0/0 0/2	FAIL	
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TOPICS

- ✿ Why implement IPv6?
- ✿ Lessons WSU has learned
- ✿ Getting Started
- ✿ IPv6 Security



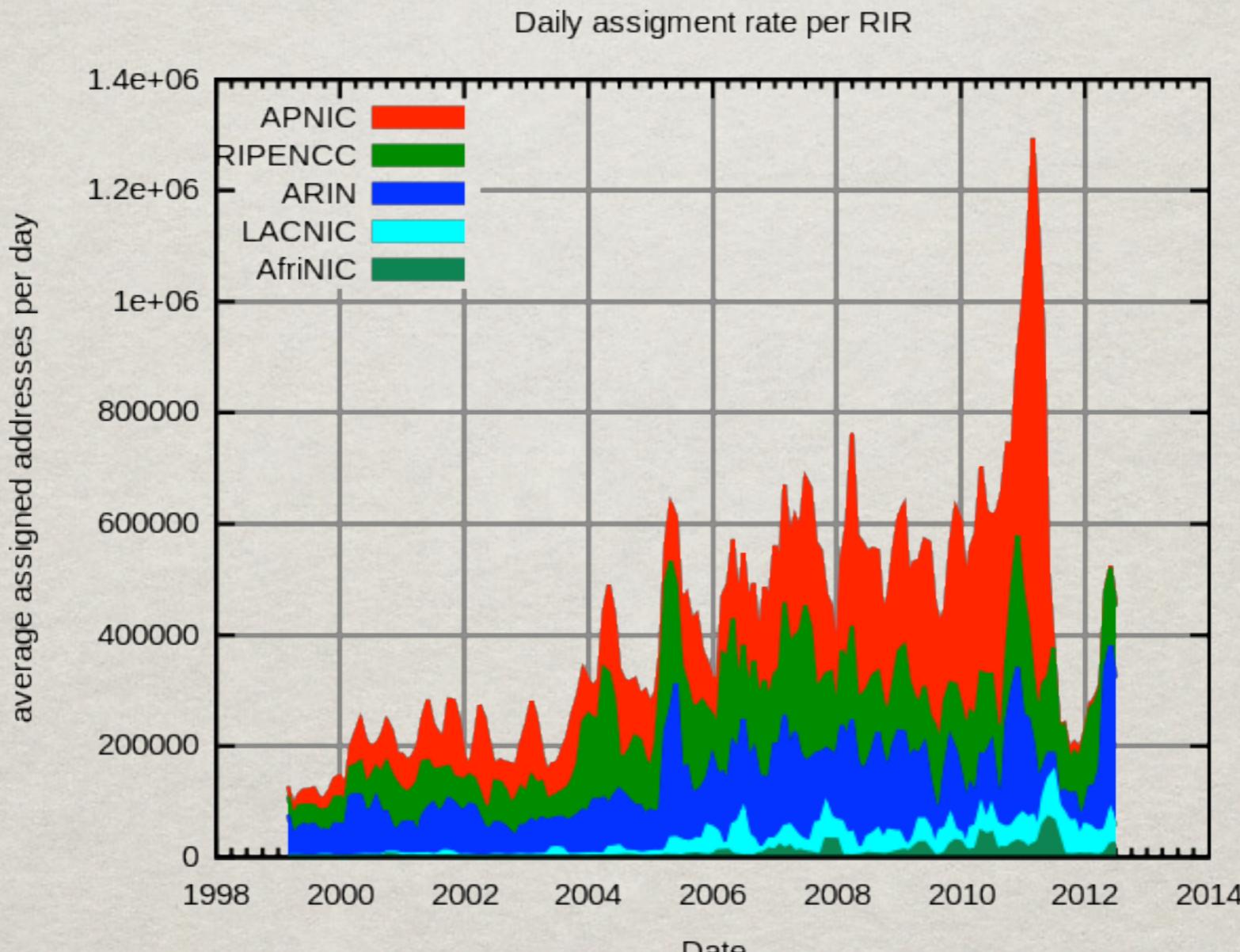
✿ What do the countries in red and yellow have in common?



- ✿ APNIC “ran out” of IPv4 address in April 2011, RIPE NCC in September 2012.
- ✿ Requests are now limited to blocks of 1,024 IPs.

Sources: <http://www.apnic.net/publications/press/releases> & <http://www.ripe.net/internet-coordination/ipv4-exhaustion>

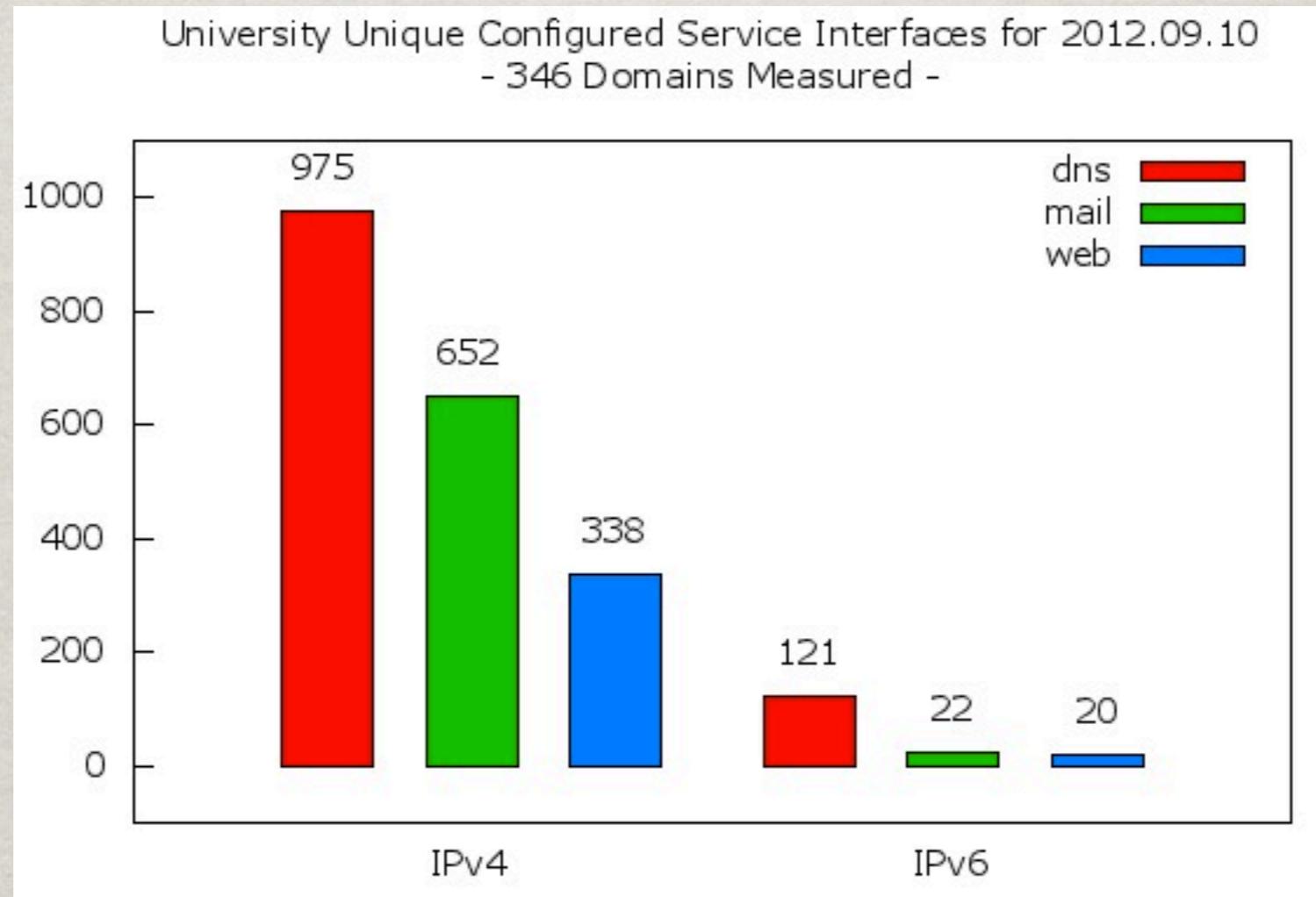
REGIONAL REGISTRIES



- ✿ IPv4 demand has gone up dramatically since the IANA pool was depleted

Source: http://en.wikipedia.org/wiki/Ipv4_depletion

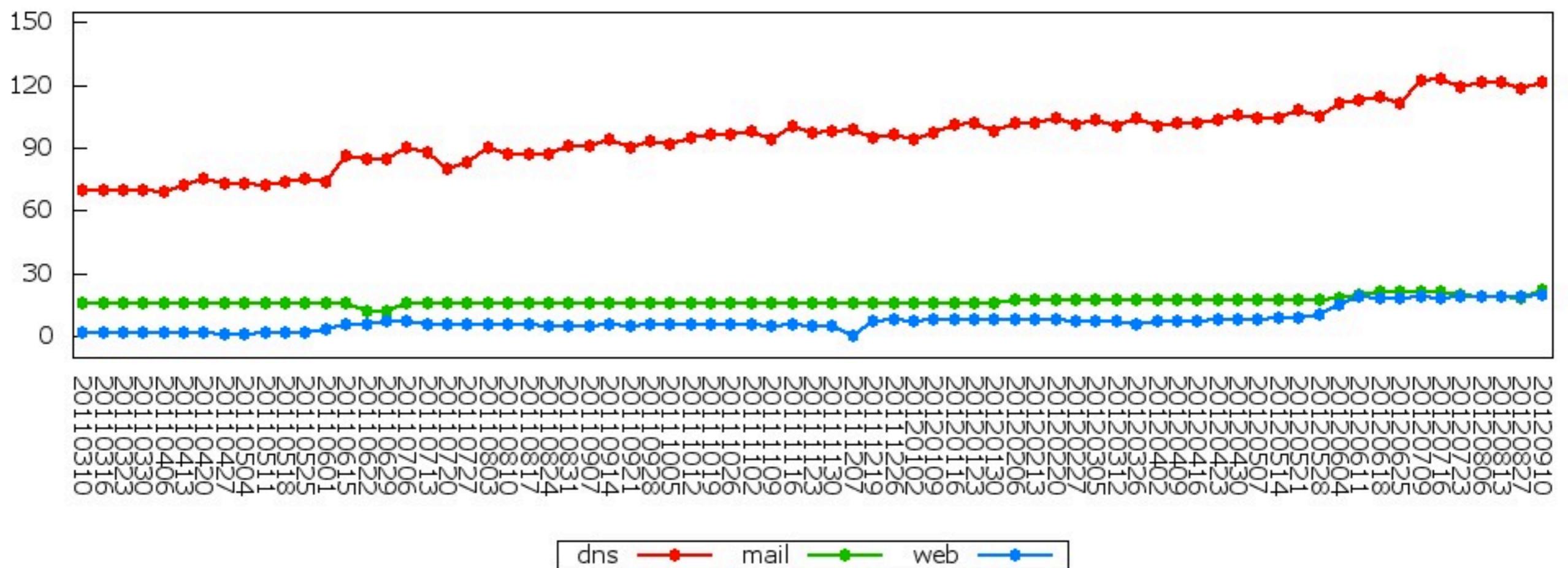
Estimating University IPv6 & DNSSEC External Service Deployment Status

University IPv6 & DNSSEC Statistics

Estimating University IPv6 & DNSSEC External Service Deployment Status

University IPv6 & DNSSEC Statistics

University Unique IPv6 Operational Service Interfaces Over Time



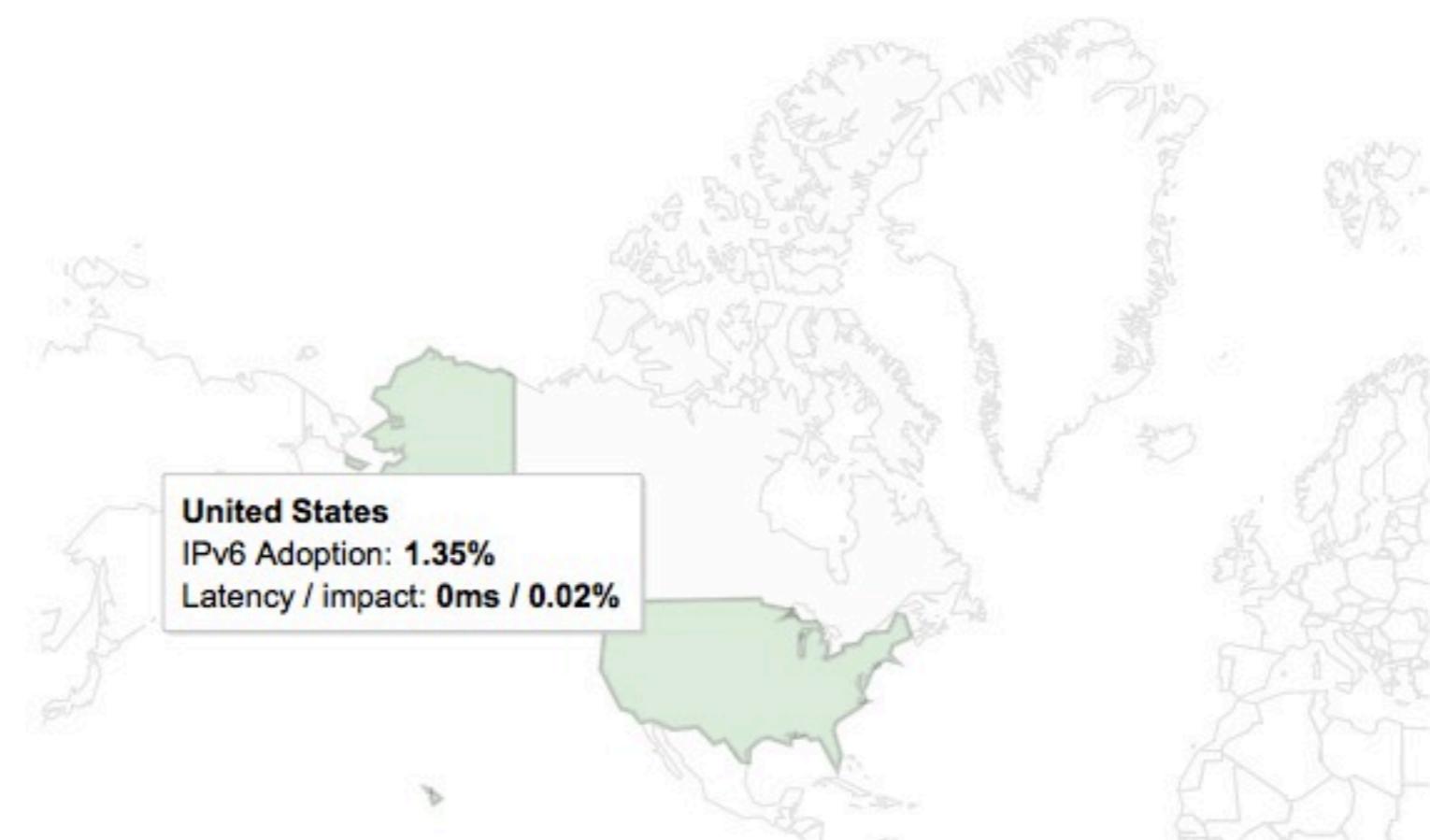
VERIZON LTE

- ✿ "The device shall support IPv6. The device may support IPv4. IPv6 and IPv4 support shall be per the 3GPP Release 8 Specifications (March 2009)". (section 3.2.4.1)
- ✿ "The device shall be assigned an IPv6 address whenever it attaches to the LTE network." (section 3.2.4.2)

[Overview](#)[FAQs](#)[Statistics](#)

Statistics

Google collects statistics about IPv6 adoption in the Internet on an ongoing basis. We hope that publishing this information will help Internet providers, website owners, and policy makers as the industry rolls out IPv6.

[IPv6 Adoption](#)[Per-Country IPv6 adoption](#)[Per-Country IPv6 adoption](#)

Source: <http://www.google.com/ipv6/statistics.html#tab=per-country-ipv6-adoption>

So WHY IPv6?

- ✿ You already have Native-IPv6/NATed-IPv4 wanting to view your services
- ✿ Either you provide IPv6, or they will use conversion servers that you do not control

TOPICS

- ✿ Why implement IPv6?
- ✿ **Lessons WSU has learned**
- ✿ Getting Started
- ✿ IPv6 Security

WHY WE CHOSE TO IMPLEMENT IPv6

- ➊ Because it was there
- ➋ Others were doing it for us
- ➌ Peers asking for help in testing their IPv6 implementations

DESIGN AND ROLLOUT

- ✿ Designed addressing plan
- ✿ Requested allocation from UEN
- ✿ Configured edge routers + firewalls
- ✿ Configured core routers
- ✿ Configured building routers
- ✿ Started offering services over IPv6

DESIGN AND ROLLOUT ADDRESSING PLAN

WSU IPv6	Campus	:	Building	Subnet	:	Host	/64
2001:1948:021	X	:	YY	ZZ	:	EUI-64	/64

- ✿ WSU was assigned 2001:1948:0210::/44
- ✿ 2001:1948:0210::/48 -> 2001:1948:021F::/48

DESIGN AND ROLLOUT ADDRESSING PLAN

WSU IPv6	Campus	:	Building	Subnet	:	Host	/64
2001:1948:021	X	:	YY	ZZ	:	EUI-64	/64

- ✿ The Campus Nibble (4-bits) used to split /48's
- ✿ 0 - Ogden Data Center, Core, Distribution
- ✿ 2 - Ogden Userland Access
- ✿ 4 - Davis Data Center, Core, Distribution
- ✿ 6 - Davis Userland Access

DESIGN AND ROLLOUT ADDRESSING PLAN

WSU IPv6	Campus	:	Building	Subnet	:	Host	/64
2001:1948:021	X	:	YY	ZZ	:	EUI-64	/64

- ✿ The Building Byte - Each building gets a /56
- ✿ Allows for up to 256 buildings per campus
- ✿ Core routers get a building byte

DESIGN AND ROLLOUT ADDRESSING PLAN

WSU IPv6	Campus	:	Building	Subnet	:	Host	/64
2001:1948:021	X	:	YY	ZZ	:	EUI-64	/64

- ✿ The Subnet Byte
- ✿ 256 /64 subnets per building
- ✿ Using standard designations for VLANs:
10 for Faculty/Staff, 20 for Labs, etc.
- ✿ IPv6 on existing IPv4 VLANs

DESIGN AND ROLLOUT ADDRESSING PLAN

WSU IPv6	Campus	:	Building	Subnet	:	Host	/64
2001:1948:021	X	:	YY	ZZ	:	EUI-64	/64

- ✿ Hosts currently use RFC 2462 IPv6 Stateless Address Auto Configuration
- ✿ /64 Subnets
- ✿ DHCPv6 is on our “to do” list.

DESIGN AND ROLLOUT ADDRESSING PLAN - LOOPBACKS

WSU IPv6	Campus	:	Loopback	::	Building	/128
2001:1948:021	X	:	FFFF	::	ZZ	/128

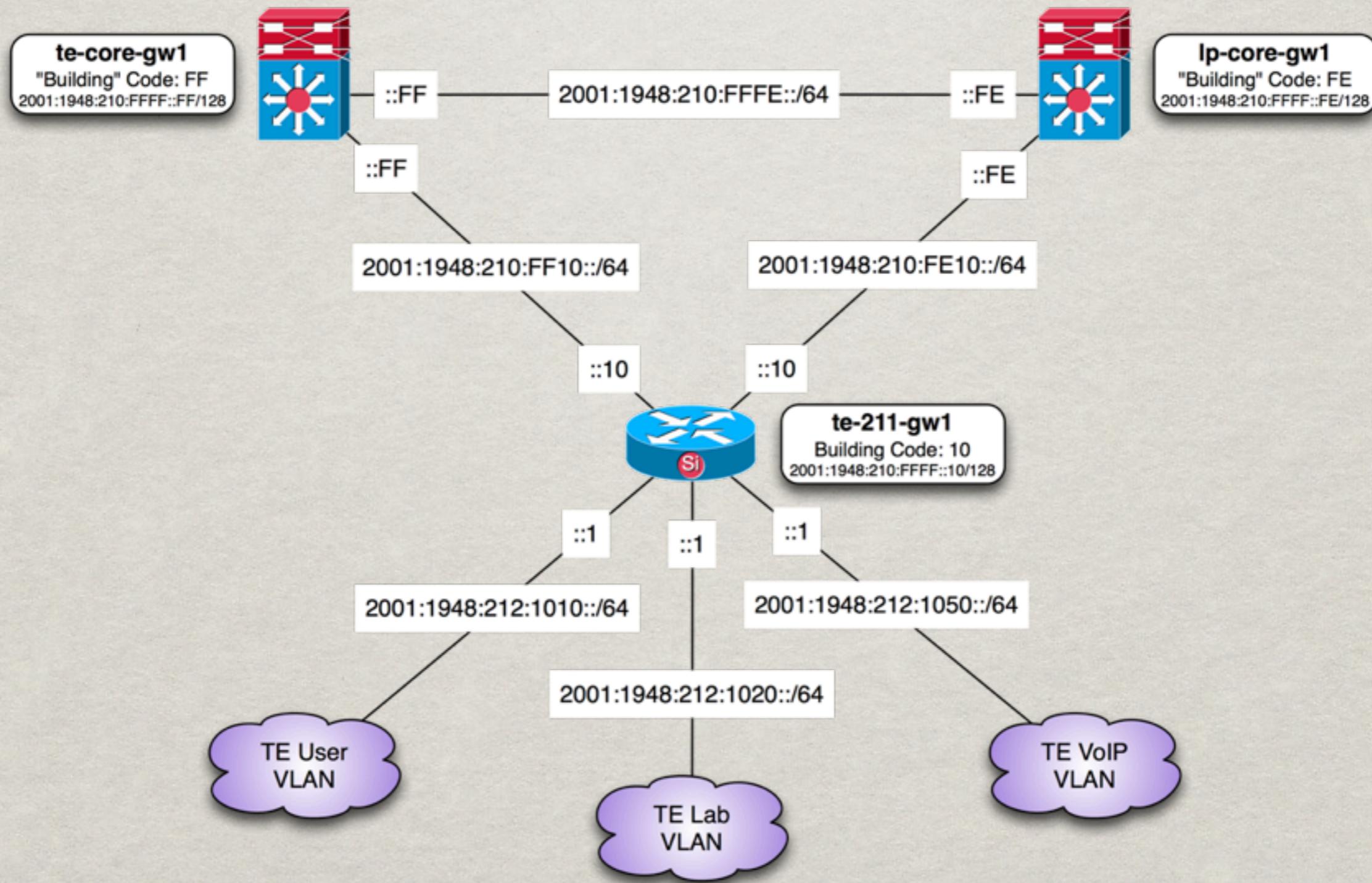
- ✿ Loopback addresses are in the form of:
 $2001:1948:021X:FFFF::ZZ/128$
- ✿ X is the campus and ZZ is the building byte
- ✿ Each device takes the host address of the building byte

DESIGN AND ROLLOUT ADDRESSING PLAN - ROUTED LINKS

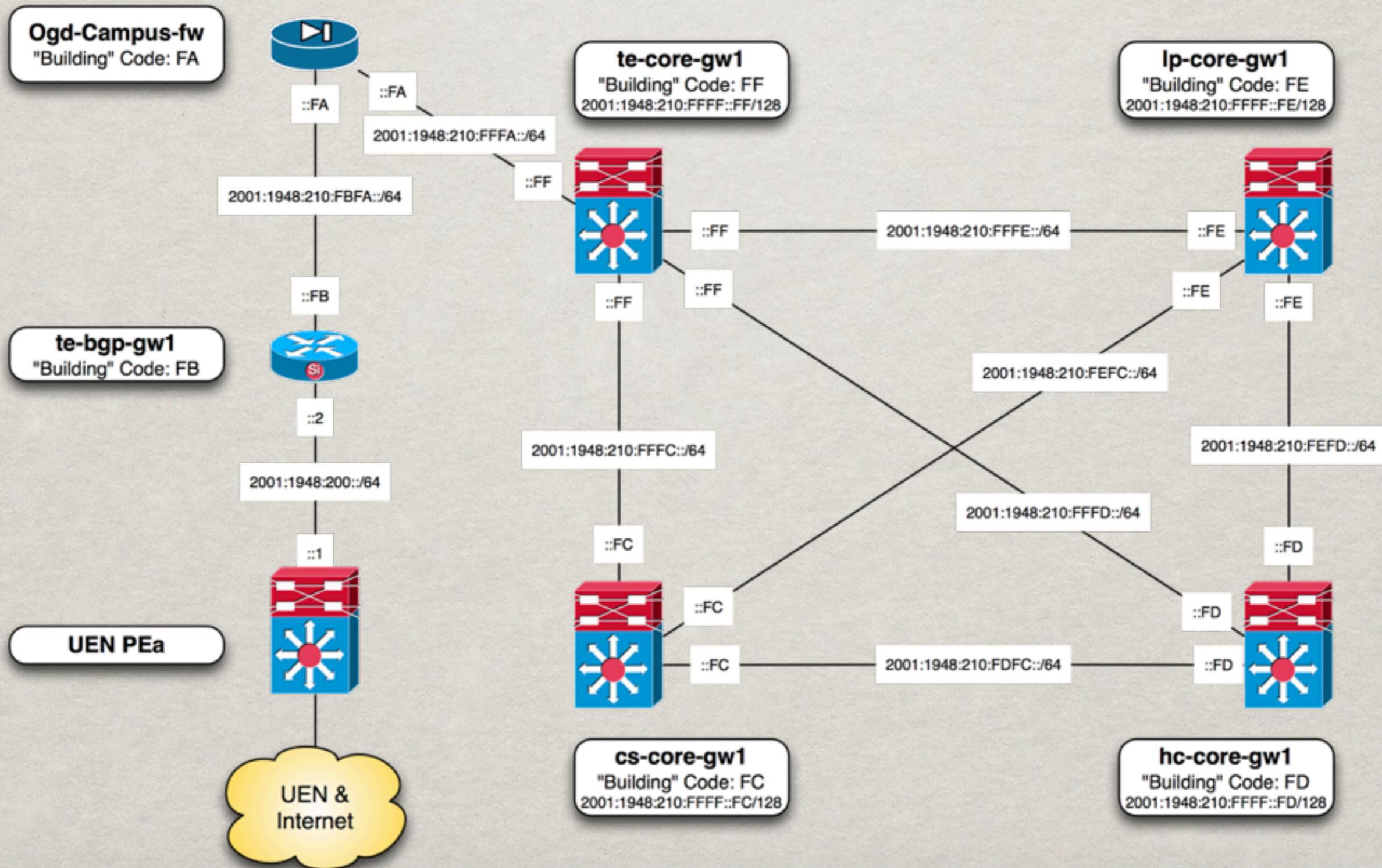
WSU IPv6	Campus	:	Building 1	Building 2	::	Host	/64
2001:1948:021	X	:	YY	ZZ	::	YY or ZZ	/64

- ✿ Routed links get a /64 in the form of:
2001:1948:021X:YYZZ::/64
- ✿ X is the campus, YY and ZZ are the two building bytes
- ✿ Each device takes the host address of the building byte

DESIGN AND ROLLOUT ADDRESSING PLAN EXAMPLE



DESIGN AND ROLLOUT ADDRESSING PLAN EXAMPLE



PROBLEMS & GOTCHAS

PART 1

- ✿ We have a Single Point of Failure due to lack of mpBGP support on current border router
- ✿ We had an elusive bug (CSCta72168) that caused our 3750s to drop ND & RA messages when IPv6 Multicast Routing was enabled
- ✿ EIGRPv6 Stub was not included in IP Base

PROBLEMS & GOTCHAS

PART 2

- ✿ Cisco wireless controllers go into bridged mode with IPv6 enabled (Major IPv6 improvements in 7.2 code)
- ✿ No hardware IPv6 support in our data center firewall (Cisco FWSM) - 80mbit/s max vs. multiple gigabit/s for IPv4
- ✿ IPv6 bug in FWSM code caused it to reboot when passing certain IPv6 UDP traffic (CsCti83875)

IPv6 at WSU Status Report

Chart Maintained
by Luke Jenkins

Last Updated
8 June 2011

Upstream Access

IPv6 Address Block Assignment

IPv6 Addressing Plan

Redundant IPv6 Links to UEN

IPv6 Peering with UEN (Ogden)

IPv6 Peering with UEN (Davis)

Redundant IPv6 Routers (Ogden)

Redundant IPv6 Routers (Davis)

Firewall IPv6 Enabled (Ogden)

Firewall IPv6 Enabled (Davis)

User-land Access

Core Routers IPv6 Enabled

Building Routers IPv6 Enabled

Secure Wireless IPv6 Enabled

IPv6 Access via VPN

Public Facing Services

DNS

dns1.weber.edu

dns2.weber.edu

dns3.weber.edu

dns4.weber.edu

dns5.weber.edu

dns6.weber.edu

email

All Nodes on SLES

IPv6 Spam Filtering

(Additional Steps Unknown)

weber.edu

IPv6 on Data Center Firewalls

IPv6 on Load Balancers

Enable IPv6 on VMWare

Replace all Win2k Nodes

(Additional Steps Unknown)

IPv6 at WSU Status Report

Chart Maintained
by Luke Jenkins

Last Updated
1 October 2012

Upstream Access

IPv6 Address Block Assignment

IPv6 Addressing Plan

Redundant IPv6 Links to UEN

IPv6 Peering with UEN (Ogden)

IPv6 Peering with UEN (Davis)

Redundant IPv6 Routers (Ogden)

Redundant IPv6 Routers (Davis)

Firewall IPv6 Enabled (Ogden)

Firewall IPv6 Enabled (Davis)

User-land Access

Core Routers IPv6 Enabled

Building Routers IPv6 Enabled

Secure Wireless IPv6 Enabled

IPv6 Access via VPN

Public Facing Services

DNS

dns1.weber.edu

dns2.weber.edu

dns3.weber.edu

dns4.weber.edu

dns5.weber.edu

dns6.weber.edu

email

Spam Filters (SMTP)

GroupWise Native

IMAP

POP3

weber.edu

IPv6 on Data Center Firewalls

IPv6 on Load Balancers

SUMMER 2011- SHOPPING LIST

- ✿ New edge device(s) that support mpBGP
- ✿ RA-Guard support in all access layer devices
- ✿ DHCPv6 support in our IPAM & OS X
- ✿ Better IPv6 support in Cisco Wireless

FALL 2012 - SHOPPING LIST

- ✿ New edge device(s) that support mpBGP
- ✿ RA-Guard support in all access layer devices

TOPICS

- ✿ Why implement IPv6?
- ✿ Lessons WSU has learned
- ✿ Getting Started
- ✿ IPv6 Security

GETTING STARTED

- ✿ Get an allocation
- ✿ Start working on peering
- ✿ Get it into the hands of those that will have to implement and support it
- ✿ Have it be part of your normal operating procedures

TOPICS

- ✿ Why implement IPv6?
- ✿ Lessons WSU has learned
- ✿ Getting Started
- ✿ IPv6 Security

IPV6 SECURITY

- ✿ (Security stuff goes here)

UPDATED SLIDES

✿ <https://weberstate.box.com/utahsaintipv6>

ANY QUESTIONS?