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IPv6 Design (Session 13233)

Kevin Manweiler, CCIE 5269
kmanweil@cisco.com

Junnie Sadler, CCIE 7708
jrsadler@cisco.com

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SHARE in Boston

Agenda

- **IPv6 Network Connectivity Design:**
  - **Major Design Decisions**
  - **IPv6 Address Considerations**
    - IPv6 Addressing Sizing
    - IPv6 Address Design

- **IPv4/6 IPAM (IP Address Management)**
- **IPv6 DHCP**
- **IPv6 DNS**
- **IPv6 QOS**
- **IPv6 NMS Considerations**
- **IPv6 Security Considerations**

- **Q&A**
- **References**

Customer X Topology

- **High Level Planning Steps Completed:**
  - Project Management Team and Critical Stake Holders Identified and Positioned
    - Current IPv6 Business Requirements Identified
    - Planning and Architecture Requirements
      - Infrastructure Assessment
        - Network Device Upgrade or Replace Strategy Accomplished
        - Application Testing and or Certification for IPv6 compliance

- **IPv6 Architectural / Design Standards:**
  - /48 Network Address from ARIN
  - Global addressing everywhere.
  - /128 Bit for Loopbacks
  - /127 for P2P connections between devices
  - Address Space Blocks setup for Internal and External reachability.
  - Addressing Block Sizes designed for Upper Level Growth
  - More !!!!

Infrastructure Overview

IPv4 to IPv6 Network Infrastructure

Things to consider: Where do they live ???
HW/SW --- Swapout or Upgrade ???
Do we design around our limitations???

Hardware – Can it support IPv6 ???
Software -- Does it support IPv6 ???
Feature – Does it support what you have today and are looking to use in the future ???.

- Devices Currently IPv6 Capable
- Devices Requiring Only Software Upgrade
- Hardware IPv6 Capable, requires IOS and FLASH Upgrade
- Hardware IPv6 Capable, requires IOS and DRAM Upgrade
- Hardware IPv6 Capable, requires IOS, DRAM and FLASH Upgrade
- Not IPv6 Capable
- Devices Requiring Further Analysis

IPv6 High Level Planning Steps

Business Case Identified/Justified

1. Evaluate effect on business model
2. Establish IPv6 project management team
3. Assess network hardware and software
4. IPv6 Training strategy
5. Obtain IPv6 prefix(es) / 48 or Larger (/44)
6. Decide IPv6 architectural solution
7. Test application software and services
8. Develop security policy
9. Develop procurement plan
10. Develop IPv6 exception strategy

Major Design Decisions

Addressing	Subnetting Scheme	Address Distribution	Co-existence Methodology	Migration Strategy	Tunneling methods
Provider Assigned (PA)	/64 subnet everywhere	Statically assigned	Dual Stack	Internet facing	ISATAP
Provider Independent (PI)	/64 with /127 infrastructure	Stateless Autoconfiguration (SLAC)	Tunneling	Core outwards	Toredo
/48 block (/44 if you can)	/64 with link local infrastructure	DHCP	Translation	Edge inward	6to4
Multiple /48 blocks (per region)			Separate Infrastructure	Forklift / Everywhere at once	
Unique-local addressing			Combinations/ permutations		

What's Missing from this Major Design Decision Slide ???????

IP v4 /v6 Routing Protocol ???
That is the ??? you have to make !!!

Current Single Routing Protocol – Dual Processes: OSPF / EIGRP /
Dual Routing Protocols – OSPF / EIGRP / ISIS ???
Single Routing Protocol -- ISIS

FAQ

Choosing a RP: Pro's and Con's ,the thing to keep in mind here is that IPv6 routing protocols are very similar to IPv4 routing protocols. Very little has changed. So the pro's and con's used to choose a RP for IPv4 will be the same for IPv6. (Stability, Performance, Knowledge, Training)

Dual or Separation leads to some operational simplicity. The separation reinforces which transport protocol you are troubleshooting. You also get a separation in the processes so that a problem in your IPv4 process doesn't bleed over to your IPv6 process and vice versa.

IP v4 /v6 Routing Protocol ???
That is the ??? you have to make !!!

Industry Trends: There are people that are sticking w/ the current RP in use because they understand it. There are also orgs that are implementing two different protocols. A prime reason for different protocols is that it allows for a transition. A popular transition reason is that they want to get away from EIGRP to an open standards protocol (most likely OSPF).

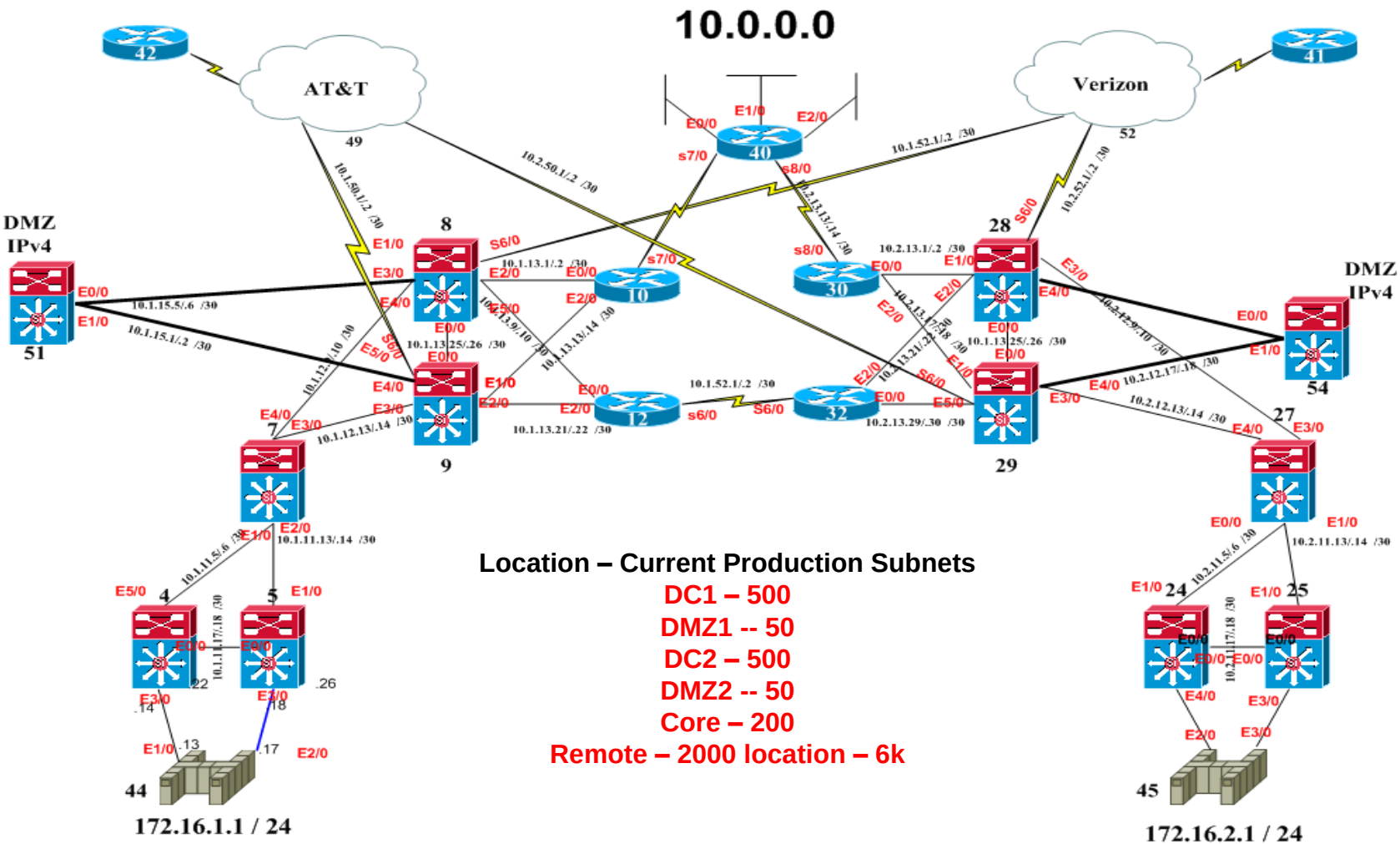
Most orgs are opting to stick w/ what they know and understand, unless they are being pressed into getting rid of EIGRP. EIGRP and OSPFv3 are the most popular. ISIS is still not that widely deployed outside of ISP networks.

Most orgs that I've dealt with are staying w/ the RP that they are familiar with.

They know how to design, implement and support that protocol .

They also don't have to do any extensive training or re-tooling of their existing NMS and management processes to accommodate a new RP.

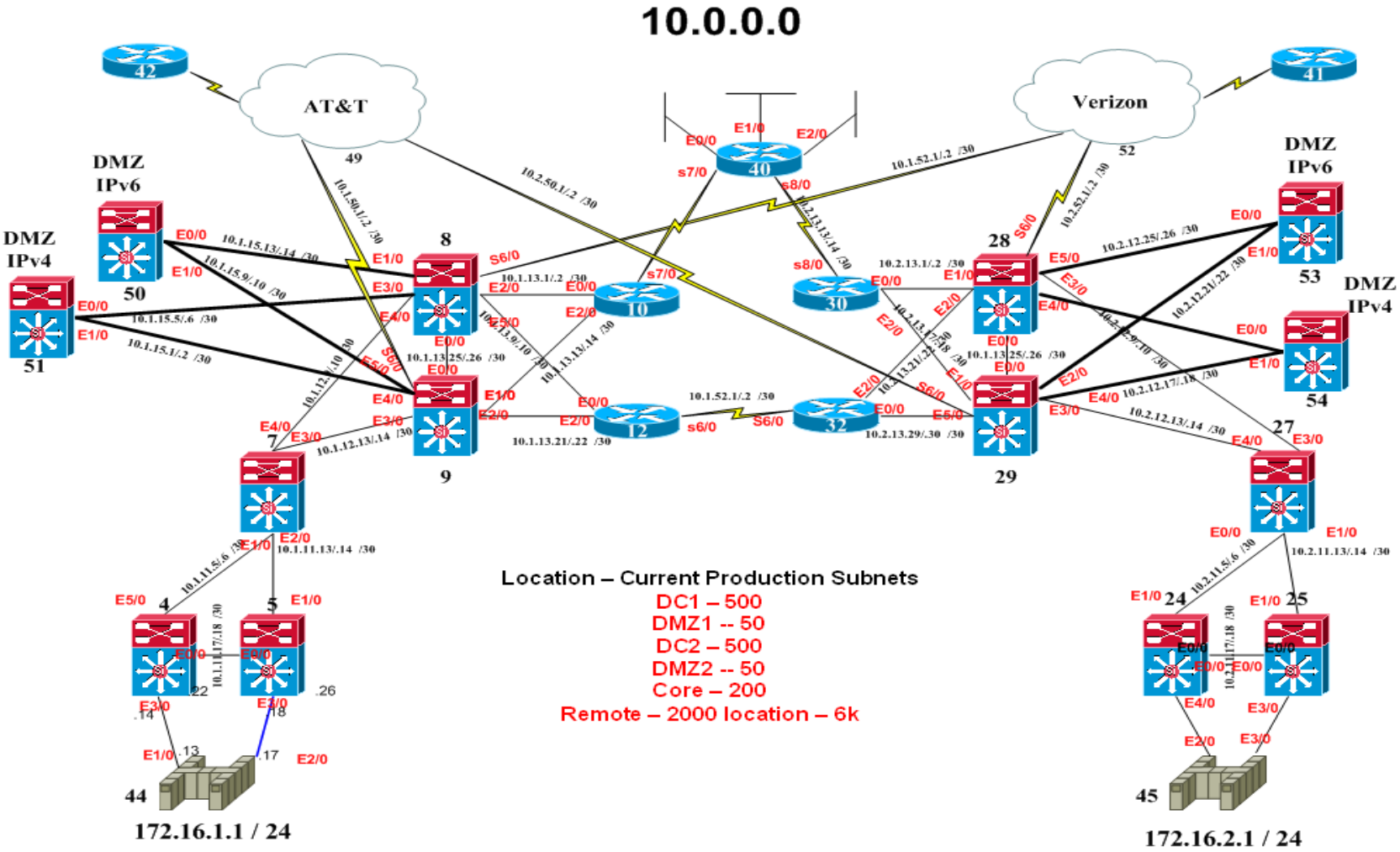
Current IPv4 Network



Data Center 1

Data Center 2

IPv6 Network Presence ??? Topology



IPv6 Address Considerations

ARIN Guidelines for Address Allocation

https://www.arin.net/policy/nrpm.html#six

6.5.8.2. Initial assignment size:

The initial assignment size will be determined by the number of sites justified below.

An organization qualifies for an assignment on the next larger nibble boundary when their sites exceed 75% of the /48s available in a prefix. For example:

More than 1 but less than or equal to 12 sites justified, receives a /44 assignment;

More than 12 but less than or equal to 192 sites justified, receives a /40 assignment;

More than 192 but less than or equal to 3,072 sites justified, receives a /36 assignment;

More than 3,072 but less than or equal to 49,152 sites justified, receives a /32 assignment; etc…

IPv6 Prefixes

- **Prefix** **IPv6 Addresses**

  /32 2^(128-32) = (4,294,967,296 /64 Subnets)

  /40 2 ^(128-40) = (33,554,430 /64 subnets)

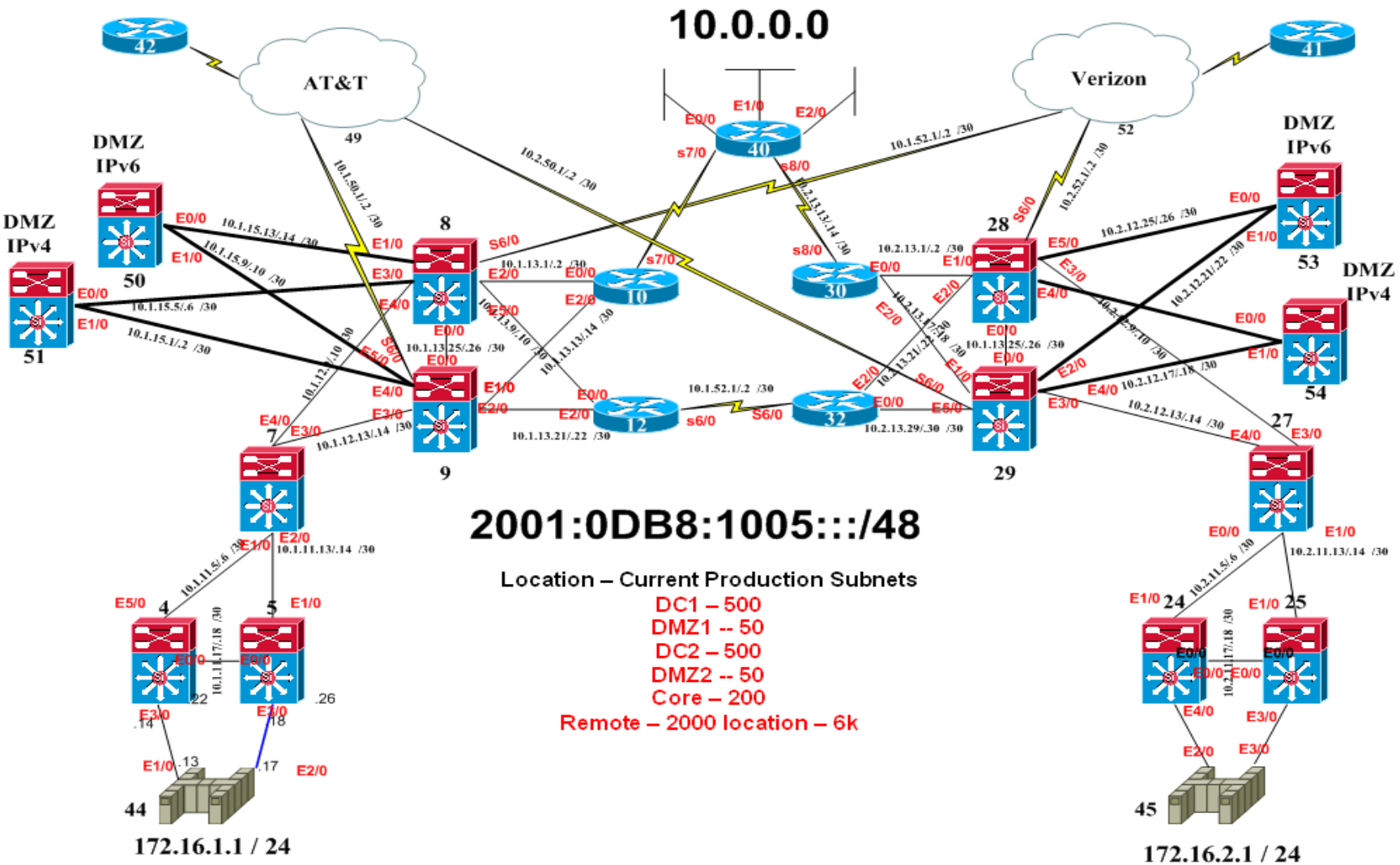
  /44 2 ^(128-44) = (2,097,151 /64 subnets)

  /48 2^(128-48) = (65,536 /64 subnets)
  1,208,925,819,614,629,174,706,176 (2^80) (septillion

  /56 2^(128-48) = (256 /64 subnets)

  /64 18,446,744,073,709,551,616 IPv6 addresses

IPv6 Network Presence ??? Topology



IPv6 Addressing Requirements: 2001:0DB8:1005:::/48

Location – Current Production Subnets
DC1 – 500
DMZ1 -- 50
DC2 – 500
DMZ2 -- 50
Core – 200
Remote – 2000 location – 6k

We must plan our IPv6 Address scheme to support current growth and future growth ???

IPv6 Addressing Requirements: 2001:0DB8:1005:::/48

Current / Future Growth Requirements:

Location ---- Current # of Subnet' ------ Planned Increase + Future Growth

Reserved ----- none ---------- ??????????????????

DC 1 ---------- 500 ---------- ??????????????????

DMZ1 ---------- 50 ---------- ??????????????????

Branch 1 --------- 3000 ---------- ??????????????????

Future Growth ---- ??? ---------- ??????????????????

Core ----------250 ---------- ??????????????????

Branch2 ----------3000 ---------- ??????????????????

DMZ2 ----------50 ---------- ??????????????????

DC2 ----------500 ---------- ??????????????????

Reserved -------- none ---------- ??????????????????

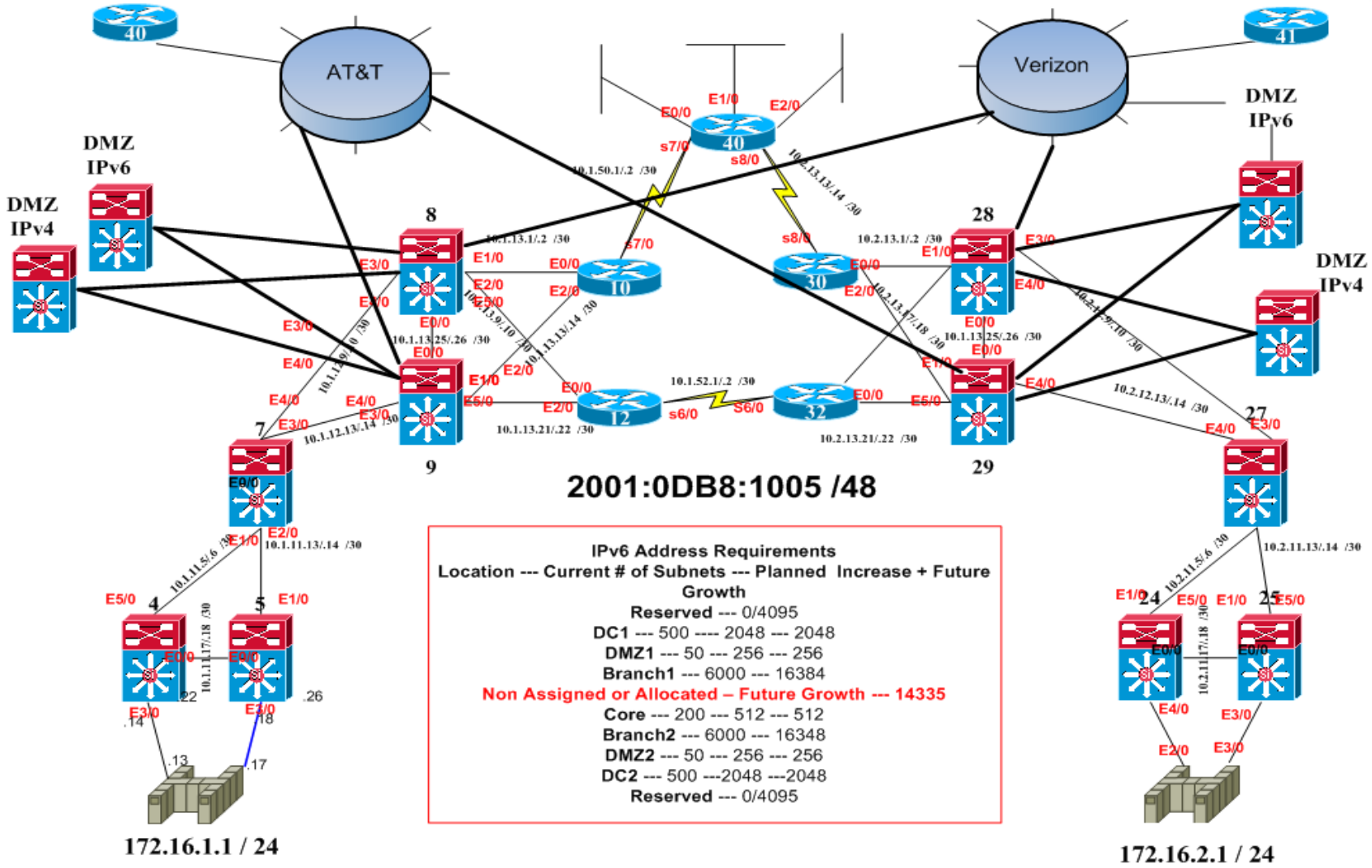
IPv6 Addressing Requirements: 2001:0DB8:1005:::/48

Location – Current Production Subnets – Growth – Future Reserved

DC1	**–**	**500**	**–**	**2048**	**–**	**2048**
DMZ1	**–**	**50**	**–**	**256**	**–**	**256**
DC1- Remote/Branch – 2000 location – 6k				**--- 16384**		
Core	**–**	**200**	**–**	**512**	**–**	**512**
Not Assigned – Future Growth			**–**			**14335**
DC2	**–**	**500**	**–**	**2048**	**–**	**2048**
DMZ2	**–**	**50**	**--**	**256**	**–**	**256**
DC2- Remote/Branch – 2000 location – 6k				**--- 16384**		

We must plan our IPv6 Address scheme to support current growth and future growth ???

IPv6 Network Presence ??? Topology



IPv6 Address Requirements

Location --- Current # of Subnets --- Planned Increase + Future Growth

Reserved --- 0/4095

DC1 --- 500 ---- 2048 --- 2048

DMZ1 --- 50 --- 256 --- 256

Branch1 --- 6000 --- 16384

Non Assigned or Allocated – Future Growth --- 14335

Core --- 200 --- 512 --- 512

Branch2 --- 6000 --- 16348

DMZ2 --- 50 --- 256 --- 256

DC2 --- 500 ---2048 ---2048

Reserved --- 0/4095

N:N:N:xxxx: /48 Address Breakdown

N	N	N	HEX																HEX	Decimal	Binary	Range	Region Subnets	
2001	0DB8	1005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Reserved	
			0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0FFF	4095	1111 1111 1111	4095	4095	
			0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1000	4096	1 0000 0000 0000	4096	DC 1	
			0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	17FF	6143	1 0111 1111 1111	6143	2048	
			0	0	0	1	0	1	1	1	1	1	1	1	1	1	0	0	17F8	6136	1 0111 1111 1000	6136	Loopback / P2P	
			0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	17FF	6143	1 0111 1111 1111	6143	top 8 subnets	
			0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1800	6144	1 1000 0000 0000	6144	DC 1	Reserved
			0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1FFF	8191	1 1111 1111 1111	8191	2047	
			0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	2000	8192	10 0000 0000 0000	8192	DMZ 1	
			0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	20FF	8447	10 0000 1111 1111	8447	256	
			0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	0	20FE	8446	10 0000 1111 1110	8446	Loopback / P2P	
			0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	20FF	8447	10 0001 0000 0010	8447	top 2 subnets	
			0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2100	8448	10 0001 0000 0000	8448	DMZ 1	Reserved
			0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	21FF	8703	10 0001 1111 1111	8703	256	

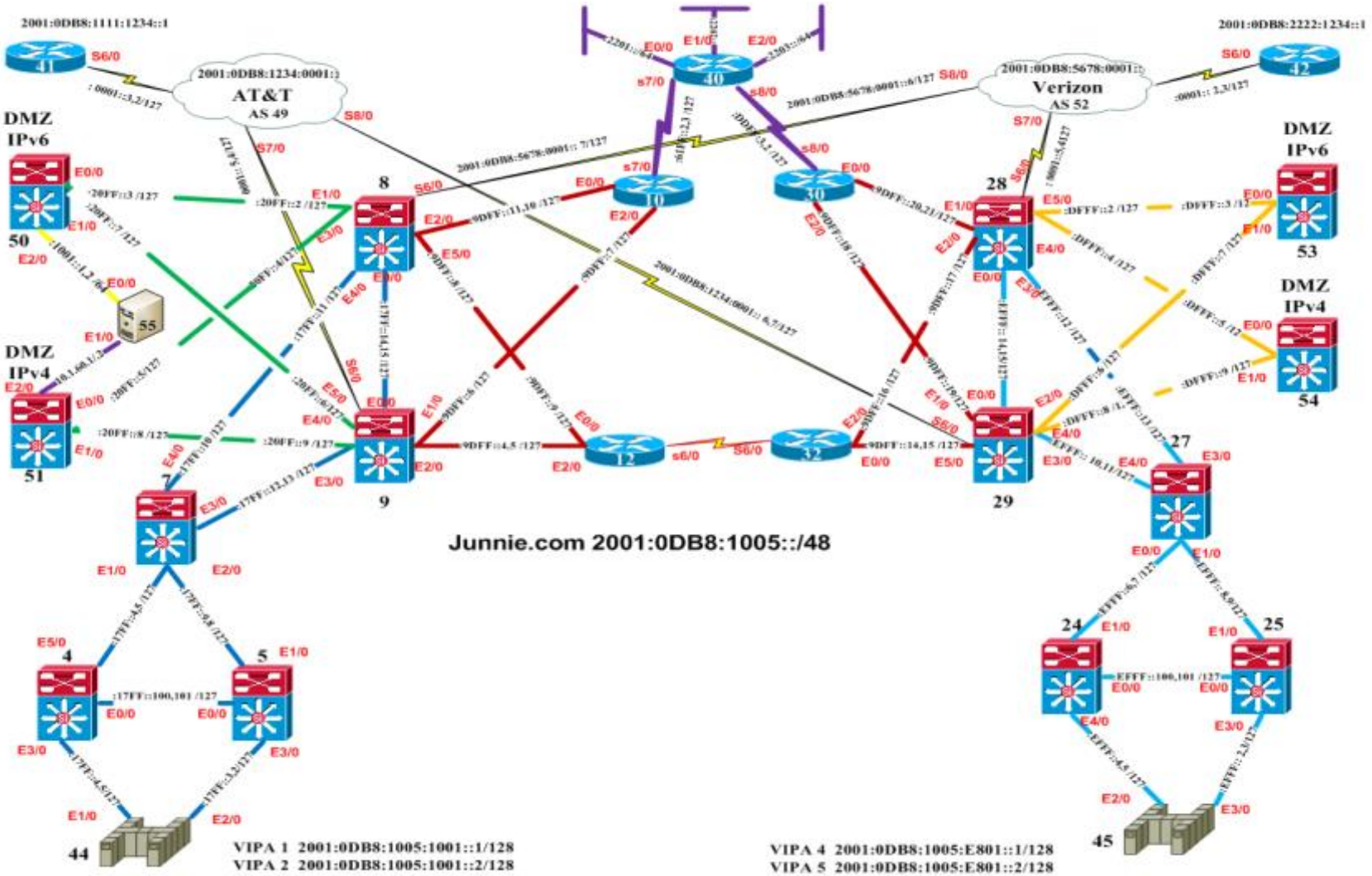
N:N:N:xxxx: /48 Address Breakdown

N	N	N	HEX	HEX	Decimal	Binary	Range	Region Subnets	
			0 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0	2200	8704	10 0010 0000 0000	8704	Branch	DC 1
			0 1 1 0 0 0 0 1 1 1 1 1 1 1 1 1	61FF	24708	110 0001 1111 1111	25087	16384	
			0 1 1 0 0 0 0 1 1 1 1 1 1 0 0 0	61F8	25080	110 0001 1111 1000	25080	Loopback / P2P	
			0 1 1 0 0 0 0 1 1 1 1 1 1 1 1 1	61FF	25087	110 0001 1111 1111	25087	top 8 subnets	
			0 1 1 0 0 0 1 0 0 0 0 0 0 0 0 0	6200	25088	110 0010 0000 0000	25088	Reserved	Future
			1 0 0 1 1 0 0 1 1 1 1 1 1 1 0 0	99FF	39423	1001 1001 1111 1111	39423	14335	
			1 0 0 1 1 0 1 0 0 0 0 0 0 0 0 0	9A00	39424	1001 1010 0000 0000	39424	512	
			1 0 0 1 1 0 1 1 1 1 1 1 1 1 1 0	9BFF	39935	1001 1011 1111 1111	39935	Core	Reserved
			1 0 0 1 1 1 0 1 1 1 1 1 1 1 1 0	9DFE	40446	1001 1101 1111 1110	40446	Loopback / P2P	
			1 0 0 1 1 1 0 1 1 1 1 1 1 1 1 1	9DFF	40447	1001 1101 1111 1111	40447	top 2 subnets	
			1 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0	9C00	39936	1001 1100 0000 0000	39936	512	
			1 0 0 1 1 1 0 1 1 1 1 1 1 1 1 0	9DFF	40447	1001 1101 1111 1111	40447	Core	
			1 1 0 1 0 0 1 0 0 1 0 0 0 0 0 0	DDF8	56824	1101 0010 0100 0000	56824	Loopback / P2P	
			1 1 0 1 1 1 0 1 1 1 1 1 1 1 1 0	DDFF	56831	1101 1101 1111 1110	56831	top 8 subnets	
			1 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0	9E00	40448	1001 1110 0000 0000	40448	16384	
			1 1 0 1 1 1 0 1 1 1 1 1 1 1 1 0	DDFF	56831	1101 1101 1111 1110	56831	Branch	DC 2

N:N:N:xxxx: /48 Address Breakdown

N	N	N	HEX	HEX	Decimal	Binary	Range	Region Subnets	
			1 1 0 1 1 1 1 0 0 0 0 0 0 0 0 0	DE00	56832	1101 1110 0000 0000	56832	256	
			1 1 0 1 1 1 1 0 1 1 1 1 1 1 1 0	DEFF	57087	1101 1110 1111 1110	57087	DMZ 2	Reserved
			1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 0	DFFE	57342	1101 1111 1111 1110	57342	Loopback / P2P	
			1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1	DFFF	57343	1101 1111 1111 1111	57343	top 2 subnets	
			1 1 0 1 1 1 1 1 0 0 0 0 0 0 0 0	DF00	57088	1101 1111 0000 0000	57088	256	
			1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 0	DFFF	57343	1101 1111 1111 1110	57343	DMZ 2	
			1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	E000	57344	1110 0000 0000 0000	57344	2048	
			1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1	E7FF	59391	1110 1111 1111 1111	59391	DC2	Reserved
				E7F7	59383	1110 0111 1111 0111	59383	Loopback / P2P	
				E7FF	59391	1110 1111 1111 1111	59391	top 8 subnets	
			1 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0	E800	59392	1110 1000 0000 0000	59392	DC2	
			1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 0	EFFF	61439	1110 1111 1111 1111	61439	2048	
			1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0	F000	61440	1111 0000 0000 0000	61440	Reserved	
			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	FFFF	65535	1111 1111 1111 1111	65535	4095	

IPv6 Network Topology



Enforcing Security Policy
L3-L7 Appliances

- Firewall for IPv6
- IPS for IPv6
- Email Security Appliance
- Web Security Appliance

Conclusion

"Dual stack where you can – Tunnel where you must"

Create a virtual team of IT representatives from every area of IT to ensure coverage for OS, Apps, Network and Operations/Management

Microsoft Windows Vista, 7 and Server 2008 will have IPv6 enabled by default—understand what impact any OS has on the network

Deploy it – at least in a lab – IPv6 won't biteThings to consider:

Focus on what you must have in the near-term (lower your expectations) but pound your vendors and others to support your long-term goals

Don't be too late to the party – anything done in a panic is likely going to go badly

Thank you.