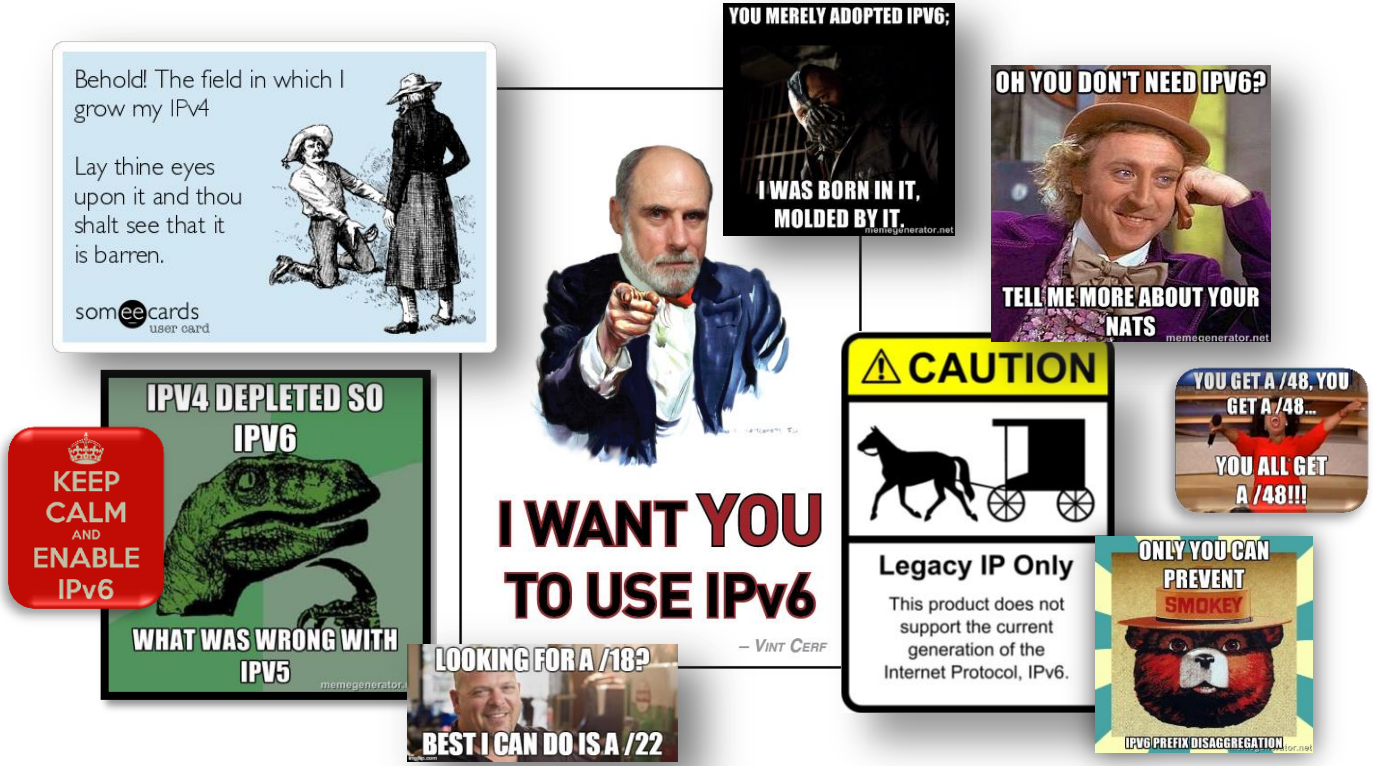

IPv6 Business Conference

Organized by SWISS IPv6 COUNCIL

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Managing the Network with the Right IPv6 Address Plan

Tom Coffeen, IPv6 Evangelist

Infoblox
CONTROL YOUR NETWORK

WHY ENTERPRISE IT NEEDS AN IPv6 ADDRESSING PLAN

- It helps them accurately gauge the size and type of IPv6 allocation their organization needs
  - This helps ensure that their ultimate addressing plan retains its scalability and flexibility, meeting the network growth and change requirements in the years to come
- It requires a baseline of IPv6 knowledge and training that will help facilitate other IPv6 adoption plan tasks and IPv6 operations

SOME BASIC GUIDELINES FOR IPv6 ADDRESS PLANNING

THERE IS NO PRACTICAL EQUIVALENT TO IPv4 ADDRESS CONSERVATION IN IPv6

Stars in the Milky Way: 400 billion

Galaxies in the Universe: 170 billion

$$(4.0 \times 10^{11}) \cdot (1.7 \times 10^{11}) = 6.8 \times 10^{22}$$

$$\frac{(3.4 \times 10^{38})}{(6.8 \times 10^{22})} = 5.0 \times 10^{15}$$

IPv6 offers *5 quadrillion times more* addresses than there are estimated stars in the Universe…

THE EARLY ENTERPRISE IPv6 ADOPTER

An uncontroversial fact: A /48 (281 trillion Internets) is more than enough address space for any enterprise

But then so is a /64 (4.3 billion Internets)…

Or a /80 (65K Internets)...

Or a /96 – an entire Internet just for your enterprise!

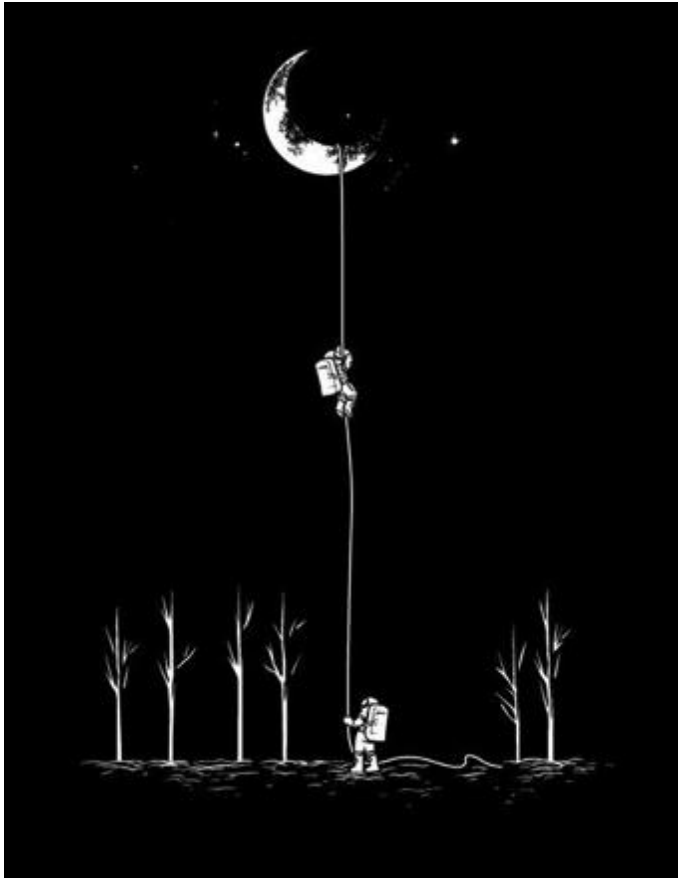
“The Unix philosophy basically involves giving you enough rope to hang yourself. And then a couple of feet more, just to be sure.”

-Anonymous

If you’re used to “making do” with 10.0.0.0/8 (let’s call that one meter of rope).

A /48 gives you enough rope to get to the moon…

…one billion times.

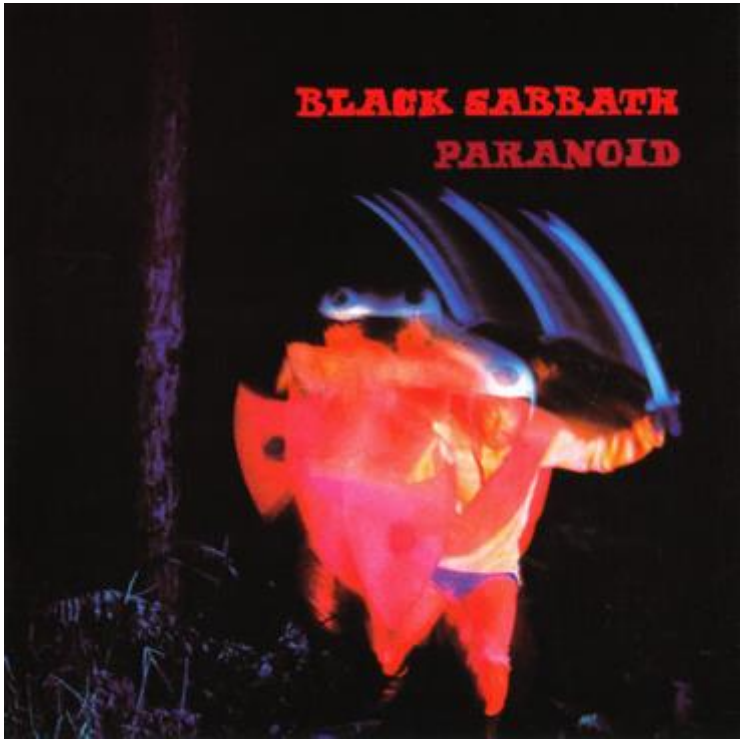


IPv4 THINKING

- The **single biggest risk** to an effective ipv6 addressing plan

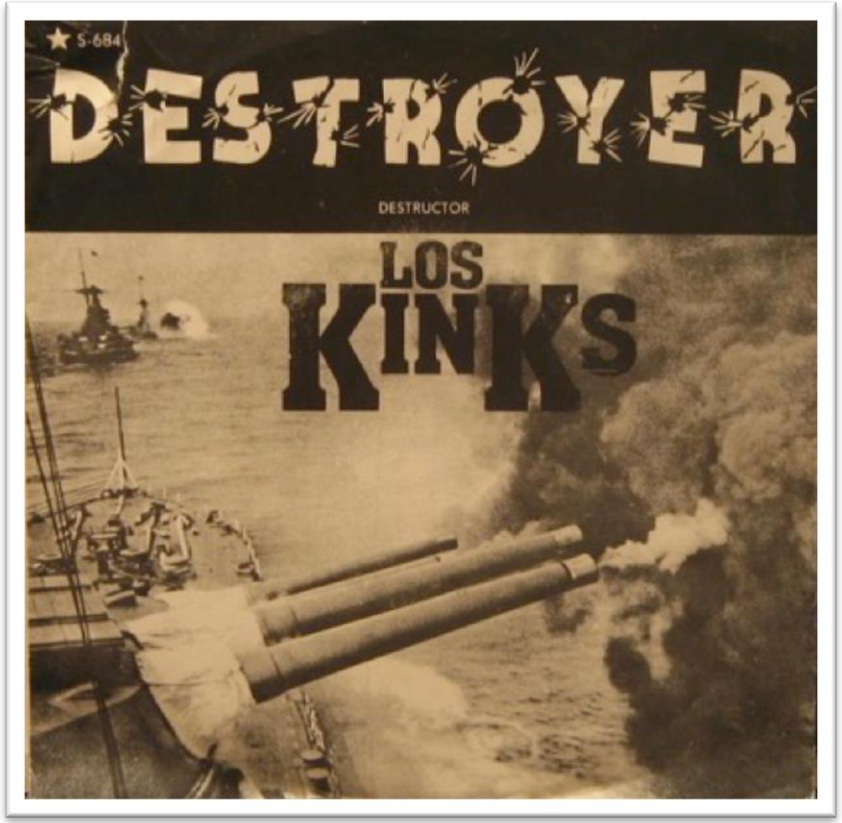
IPv4 Thinking	IPv6 Reality
Must not waste host addresses	No host address conservation required
Must alloate subnets by single bits (see above)	Subnetting done 4 bits at a time (i.e., “nibble boundaries”)
Must make do with initial allocation size	An allocation large enough to fit your best design is available

OMG!OMG!OMG!OMG!OMG!OMG!OMG!OMG!OMG!OMG!OMG!OMG!O



MUST. NOT. WASTE.
IP ADDRESSES!

PARANOIA, THE…



- /64 per interface
- /48 per site
- Nibble boundaries

Please sir, I want some more.

Enterprise administrators don’t have a history of getting addresses directly from RIRs.

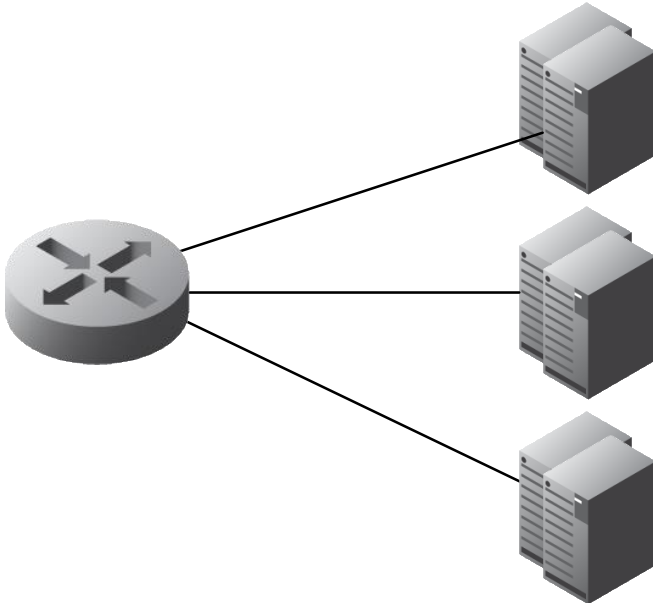
Also, not that you asked but I'm glad you'll be giving me a Provider Independent allocation. I got a Provider Assigned allocation from my ISP but I really don't want to have to renumber when I switch ISPs (or have to use an ugly hack like ULA with IPv6 NPT).

And I'll take some more cold gruel while you're at it…

IPv4 INTERFACE ASSIGNMENT

- /24 or 255.255.255.0 = 254 host addresses (75% utilization)
  - Assuming you can consistently use /24s, operationally efficient:
    - provides a tidy boundary for ACLs and routing summarization
    - room for growth on the segment

IPv4 INTERFACE ASSIGNMENT

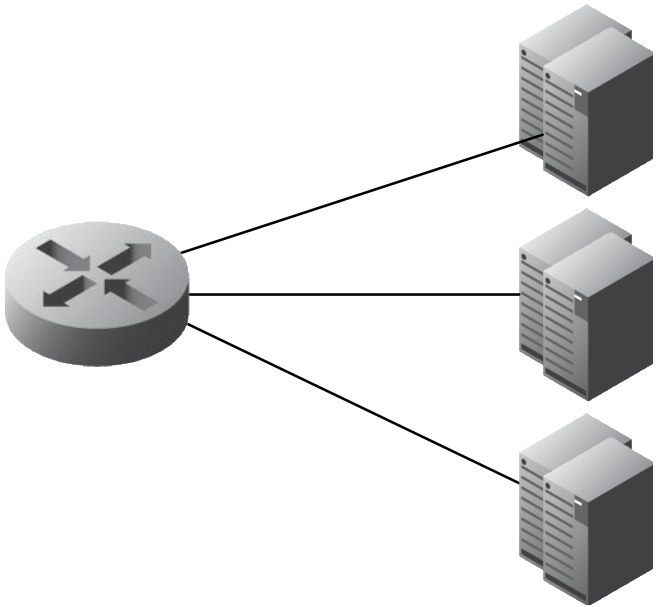


8 hosts → /28 (255.255.255.240) = 14 host addresses (57% utilization)

30 hosts →
Option 1:
/27 (255.255.255.228) = 30 host addresses (100% utilization)
Option 2:
/26 (255.255.255.192) = 62 host addresses (48% utilization)

119 hosts →
Option 1:
/25 (255.255.255.128) = 126 host addresses (94% utilization)
Option 2:
/24 (255.255.255.0) = 254 host addresses (47% utilization)

IPv6 INTERFACE ASSIGNMENT



8 hosts → /64
E.g., 2001:db8:2112:1::/64

2000 hosts → /64
E.g., 2001:db8:2112:2::/64

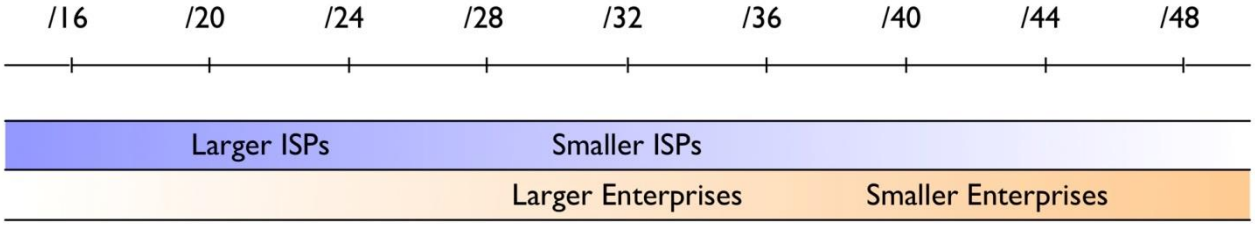
<$1.8x10^{19}$ hosts → /64
E.g., 2001:db8:2112:3::/64

THE LIMITATIONS OF IPv4 ADDRESS PLANNING (AND HOW IPv6 HELPS)

- There are never enough addresses with IPv4
  - This makes a consistent address plan more difficult to accomplish
- IPv4 doesn't easily permit mapping hierarchy and network structure into address plan while also providing for sufficient host addressing
- IPv6, however, provides unlimited host addresses and sufficient bits to accommodate representing network structure

A PROPER IPv6 ADDRESS PLAN REQUIRES A SUFFICIENTLY LARGE IPv6 ALLOCATION

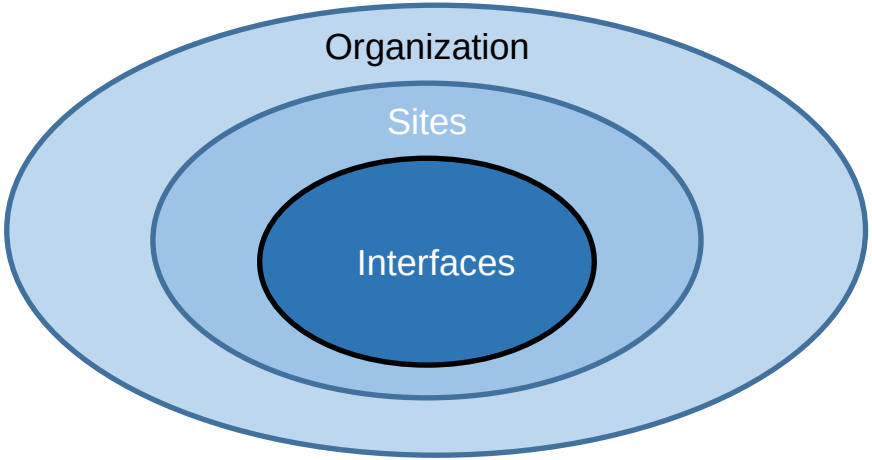
HOW BIG SHOULD MY ORGANIZATIONAL IPv6 ALLOCATION BE?



- Most enterprises receive a /32 to a /44
- A /48 is assigned per *site* within the organization

THE 3 MOST IMPORTANT IPv6 SUBNET SIZES

- Organizational allocation
- Site assignment
- Interface subnets



WHAT CONSTITUTES A SITE?

- Characteristics of sites in IPv6
  - Logical construct
  - Definition that makes operational sense
    - Based on network topology, routing and security policy, etc
    - Based on what best maximizes operational efficiency
  - Often assigned a /48
    - Sites can receive larger or smaller allocations depending on what makes operational sense
      - Address conservation generally not a concern
  - Not enough /48s? Back to the RIR or ISP
    - RIRs hold contiguous bits in reserve

IPv6 SITE ASSIGNMENT

Corporate HQ campus

Home network

Data center

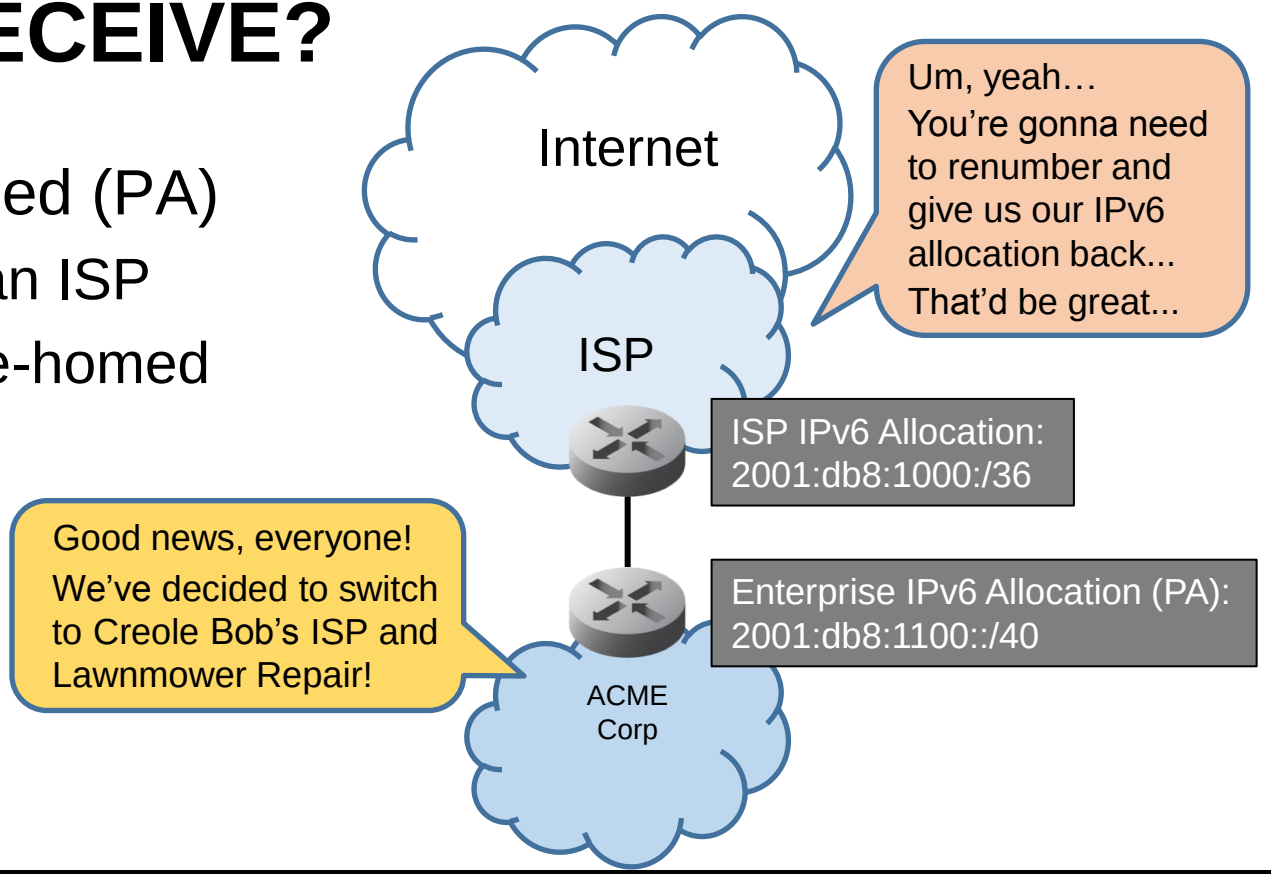
Laptop at the end of an HE 6to4 tunnel

Regional office

German fire truck

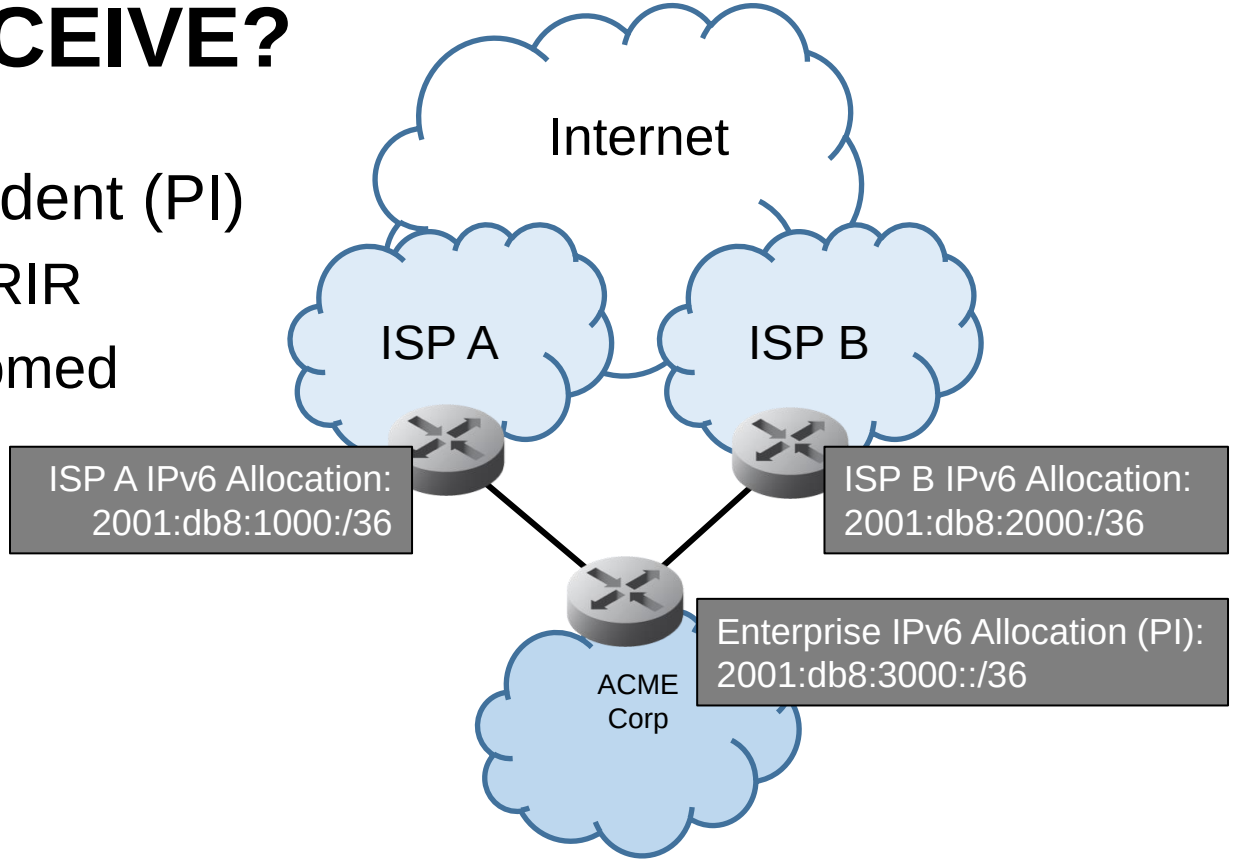
WHAT TYPE OF IPv6 ALLOCATION SHOULD I RECEIVE?

- Provider Assigned (PA)
  - Assigned by an ISP
  - Best for single-homed networks
  - *Non-portable*

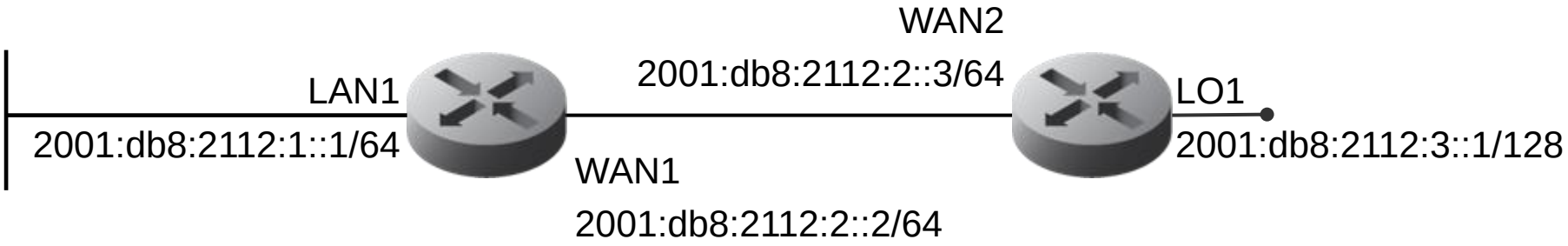


WHAT TYPE OF IPv6 ALLOCATION SHOULD I RECEIVE?

- Provider Independent (PI)
  - Assigned by a RIR
  - Best for multihomed networks
  - *Portable*



IPv6 INTERFACE ASSIGNMENT



- LAN/VLAN Interfaces: /64
- Point-to-point links: /64
- Loopback interfaces: /128

SUBNETTING IN IPV6 SHOULD BE DONE ON NIBBLE BOUNDARIES

NIBBLE BOUNDARIES IN IPv6 (ORGANIZATIONAL ALLOCATION)

Prefix	Subnet groups per /32	/48 subnets per group
/32	1	65,536
/36	16	4,096
/40	256	256
/44	4,096	16
/48	65,536	1

NIBBLE BOUNDARIES IN IPv6 (SITE ASSIGNMENT)

Prefix	Subnet groups per /48	/64 subnets per group
/48	1	65,536
/52	16	4,096
/56	256	256
/60	4,096	16
/64	65,536	1

NIBBLES MAKE PREFIXES MORE LEGIBLE

Subnet bits a multiple of 4	
Prefix:	2001:db8:1::/48
Range:	2001:db8:1:0000:0000:0000:0000:0000 2001:db8:1:ffff:ffff:ffff:ffff:ffff

Subnet bits not a multiple of 4	
Prefix:	2001:db8:1::/49
Range:	2001:db8:1:0000:0000:0000:0000:0000 2001:db8:1:7fff:ffff:ffff:ffff:ffff 2001:db8:1:8000:0000:0000:0000:0000 2001:db8:1:ffff:ffff:ffff:ffff:ffff

MAPPING LOCATION OR FUNCTION INTO IPv6 ADDRESS PREFIXES

2001:db8:1:LXXX::[/52 - /64]

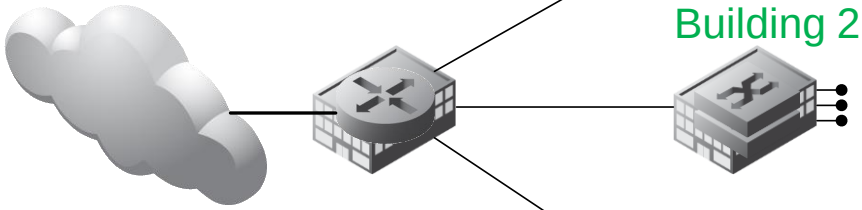
Location (16 sites)
2001:db8:1:[0-f]nnn::/52

Interface subnets (4096 per location)
2001:db8:1:n[0-f][0-f][0-f]::/64

Prefix	Assignment
2001:db8:1:0000::/52	Reserved
2001:db8:1:1000::/52	Building 1
2001:db8:1:2000::/52	Building 2
…	…
2001:db8:1:f000::/52	[Location 16]

Prefix	Assignment
2001:db8:1:1000::/64	Reserved
2001:db8:1:1001::/64	VLAN1
2001:db8:1:1002::/64	VLAN2
…	…
2001:db8:1:1fff::/64	[Subnet 4096]

MAPPING LOCATION OR FUNCTION INTO IPv6 ADDRESS PREFIXES



Building 1…..... 2001:db8:1:1000::/52
VLAN1…..... 2001:db8:1:1001::/64
VLAN2, etc... 2001:db8:1:1002::/64

Building 2…..... 2001:db8:1:2000::/52
VLAN1…..... 2001:db8:1:2001::/64
VLAN2, etc... 2001:db8:1:2002::/64

Building 3…..... 2001:db8:1:3000::/52
VLAN1…..... 2001:db8:1:3001::/64
VLAN2, etc... 2001:db8:1:3002::/64

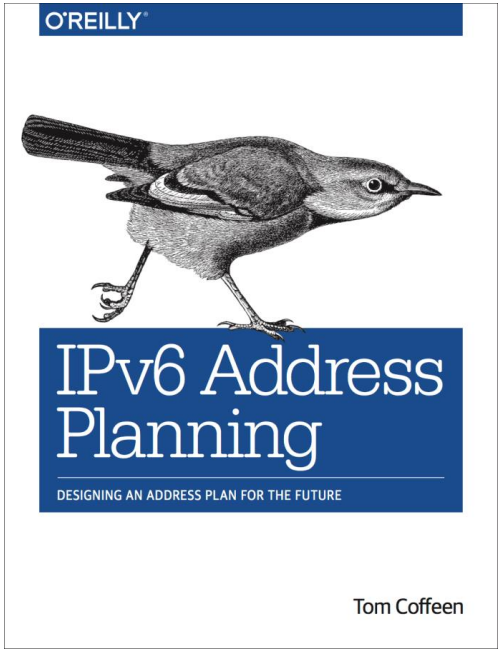
A SIMPLE PLAN

- 5 RIRs with IPv6 5 /32s (one per RIR)
  - Country and core of RIR are /36s
    - Core has core networks and external DMZs; /40s
    - Countries have sites: i.e., grouping of buildings or single buildings at the same location; /40s
      - Sites are /56s of /48s for applications; i.e., DHCP client(s), customer/printing/etc. environments
      - Applications are /48s and they contain /64s (subnets)

CHANGES

- Current site allocation at /48
  - 65K /64s per /48
- IoT deployments
  - Too many gateways
- IPv6 addressing for containers
  - Still relying largely on IPv4 and NAT
- IETF Draft: Unique IPv6 Prefix Per Host
  - Conceived for IPv6-only wi-fi deployment
- Homenet
  - /48 per CPE

IPv6 ADDRESS PLANNING, O'REILLY



- For IT network architects, engineers, and administrators
- Comprehensive overview and current best-practices for designing, deploying, and maintaining an effective IPv6 addressing plan

Questions?

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