

IPv6 Address Subnetting

Subnetting (Example)

- Provider **A** has been allocated
2001:DB8::/32
 - will delegate **/48** blocks to its customers

Q. Find the blocks provided to the **first 4** customers

Subnetting (Example)

Original block: **2001:0DB8::/32**

Rewrite as a /48 block: **2001:0DB8:0000::/48**

**This is your
network prefix!**

How many /48 blocks are there in a /32?

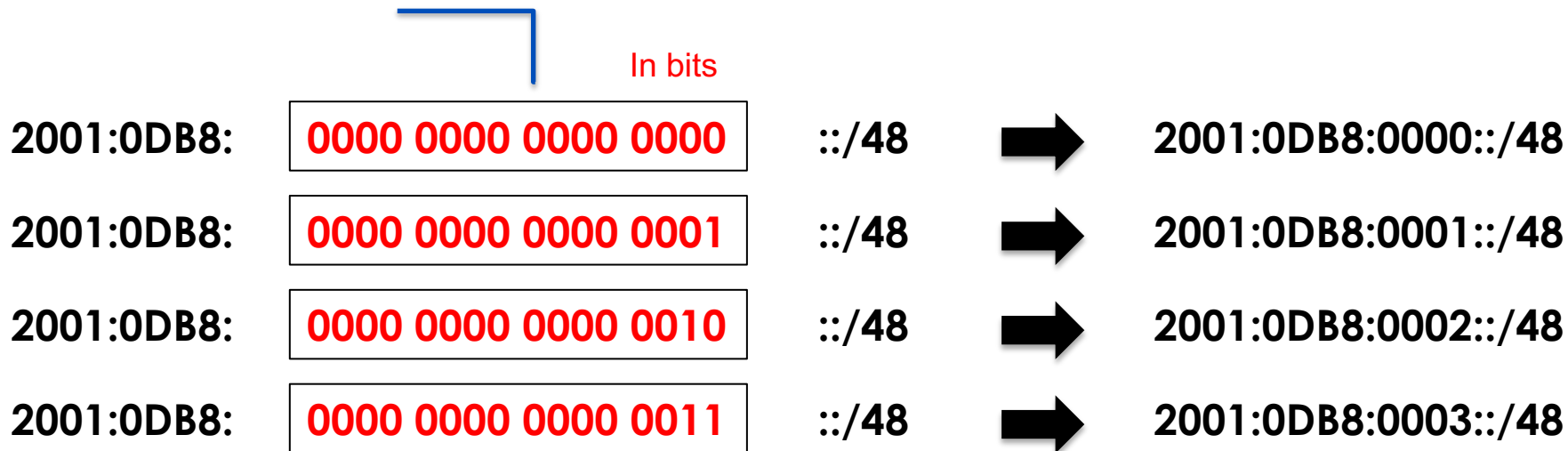
$$2^{16} = 65K$$

Find only the first 4 /48 blocks...

Subnetting (Example)

Start by manipulating the LSB of your network prefix – write in bits

2001:0DB8:0000::/48



Then write back into hex digits

Exercise 2.1: IPv6 subnetting

Identify the **first four /36** sub-prefixes out of 2406:6400::/32

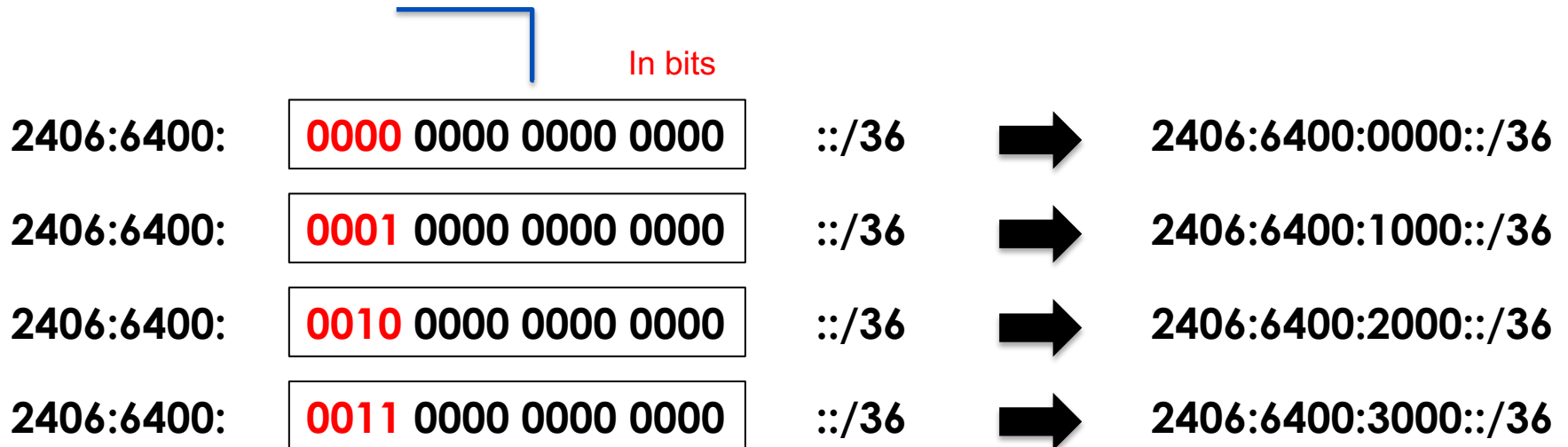
1. _____
2. _____
3. _____
4. _____

Hex	Binary
0	0000
1	0001
2	0010
3	0011
...	...
e	1110
f	1111

Exercise 2.1: IPv6 subnetting

Identify the **first four /36** sub-prefixes out of 2406:6400::/32

2406:6400:0000::/32



Exercise 2.2: IPv6 subnetting

Identify the **first four /35** blocks out of 2406:6400::/32

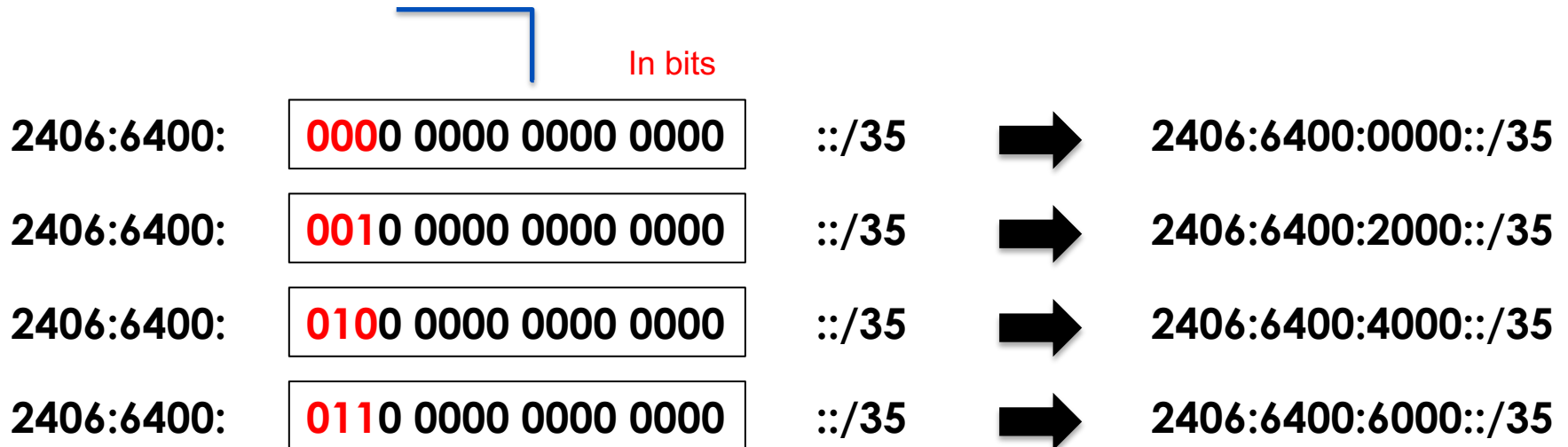
1. _____
2. _____
3. _____
4. _____

Hex	Binary
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
...	...
e	1110
f	1111

Exercise 2.2: IPv6 subnetting

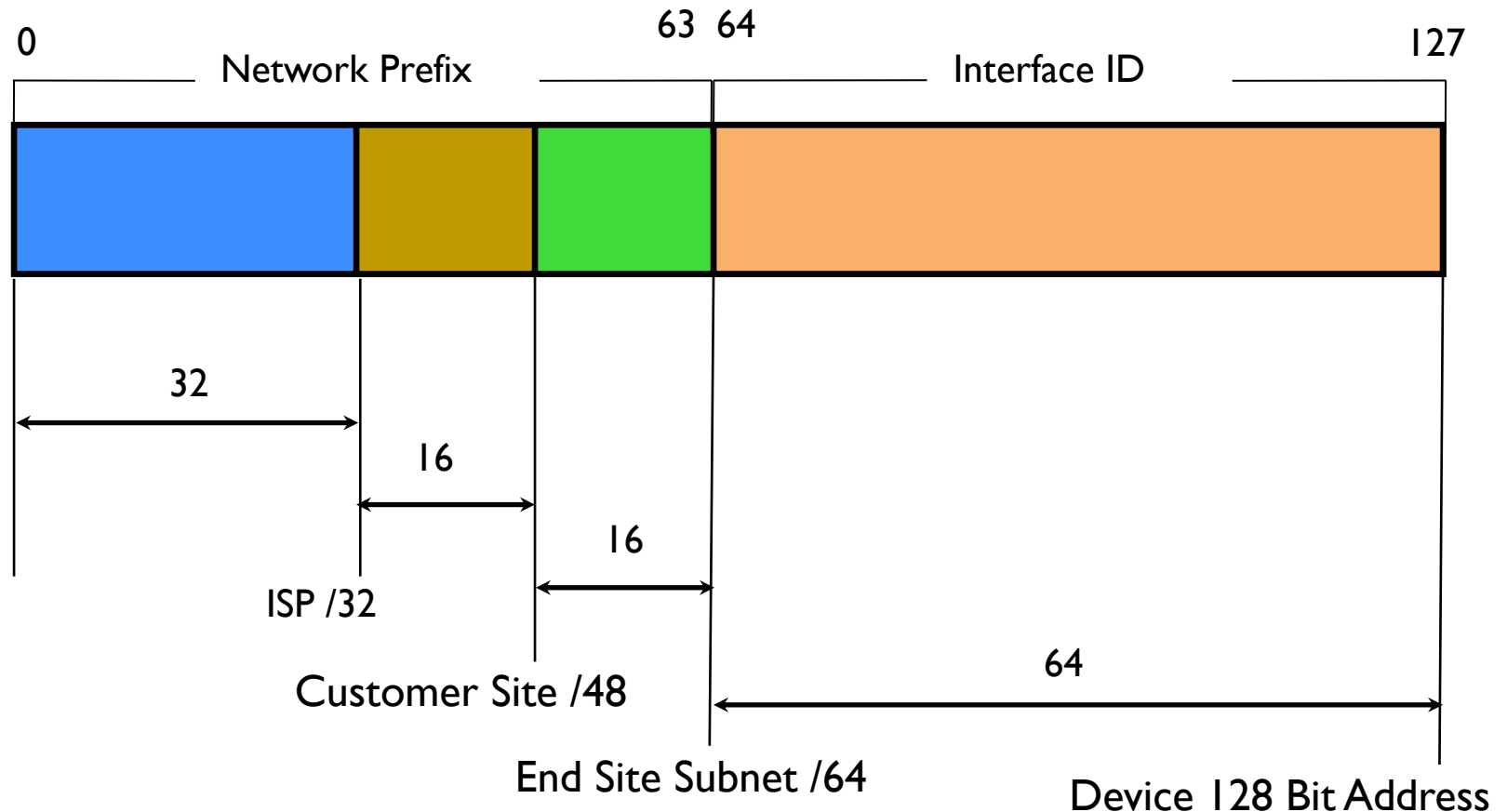
Identify the **first four /35** blocks out of 2406:6400::/32

2406:6400:0000::/32



IPv6 Address Planning

IPv6 Address Recap



IPv6 Address Planning

- Network Operators allocated /32 by RIRs
- Global Routing prefix /48
 - /56 (ISPs to end site)
 - upstream could filter anything smaller
 - Consider the **routing table size!**

IPv6 Address Planning

- Future traffic engineering needs?
 - Contiguous assignment vs Split assignment
- Shift in thought:
 - IPv4: number of hosts ☹️
 - IPv6: number of **subnets!**

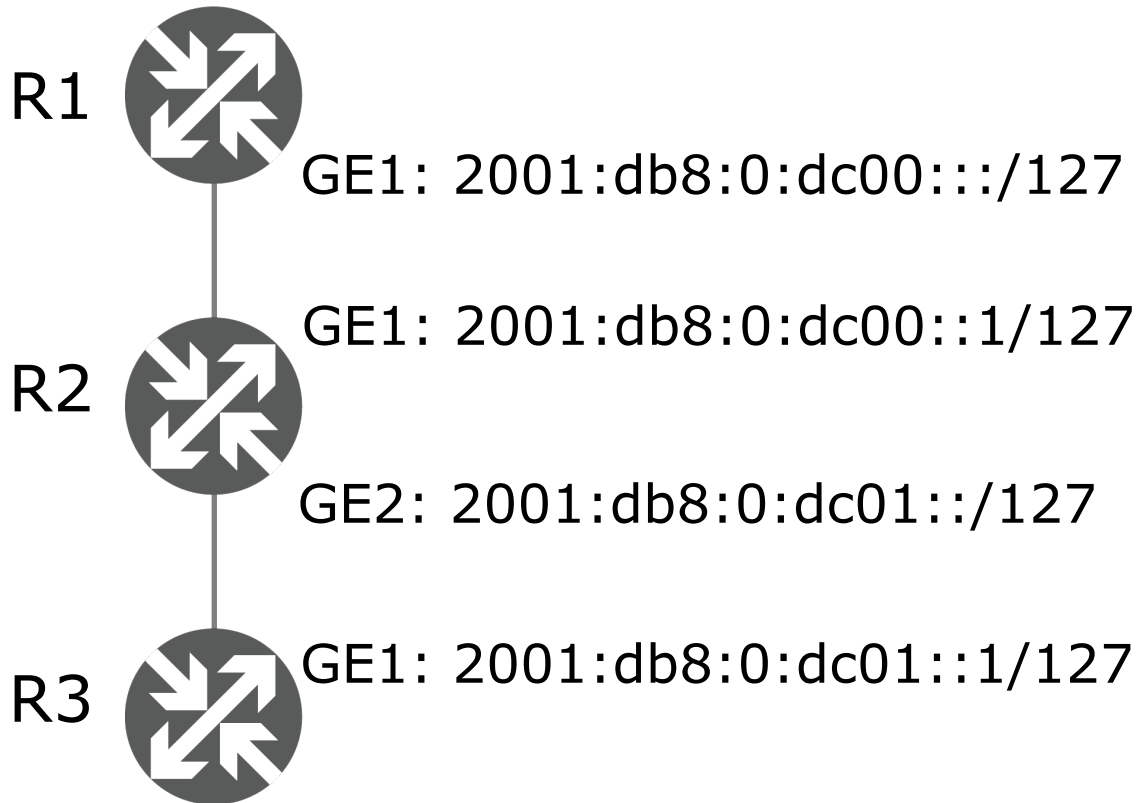
IPv6 Address Plan: ISP Infra

- Loopbacks
- Point-to-Point links
- Internal Server LAN
 - also called NOC LAN
 - not seen from outside
- External Server LAN
 - Mail, DNS, etc

IPv6 Address Plan: ISP Infra

- Dedicate a /40 (or /48) for the backbone infra
 - Every infrastructure assignment from this block!
 - Carried by IGP (NOT iBGP)
- Loopbacks
 - Generally one /48 (/60 and /64 also common) for all loopbacks
 - /128 as loopback
- Point-to-Point links (Ex: /48 for all P2P links)
 - Assign /64 per link (RFC3177); RFC6164/6547 recommends /127
 - Reserve /64 per link but use /127

Example



IPv6 Address Plan: ISP Infra

- Internal Server/NOC LAN
 - /60 (if different subnets within the NOC), or
 - /64
- External Server LAN
 - /64 (allows up to 2^{64} services to be hosted)

IPv6 Address Plan: Enterprise Customer

- Consider regional delegation
 - Aggregation in mind!
 - /40 per region?
- One /48 per customer
 - Could be transit customers or leased line customers
 - Could be given additional /48s as they grow (more than 65K subnets)
- We also see ISPs give:
 - /52 or /56 to mid-sized customers ()
 - /60 for very small customers
 - /64 to end sites **NOT recommended!!**

IPv6 Address Plan: Customer WAN links

- Dedicate a /48 block for customer WAN links
 - Helps to monitor customer links
 - Not to be mistaken with the trusted infra PtP block!
 - Actual addressing still the same:
 - Reserve /64 and use /127
- Carried in iBGP (not IGP)
 - Aggregated at the GW router or POP routers

IPv6 Address Plan: Broadband Customer

- Depends on your deployment
 - ND-RA for CPE WAN side
 - A /64 prefix on BRAS can still support 2^{64} CPEs through SLAAC
 - DHCPv6-PD for CPE LAN side
 - A /48 pool on each BRAS (65k /64s can be delegated)
- Dedicate a /40 (or bigger) for Broadband network
 - /48s out of the /40 to each BRAS
 - Announced in iBGP by BRAS

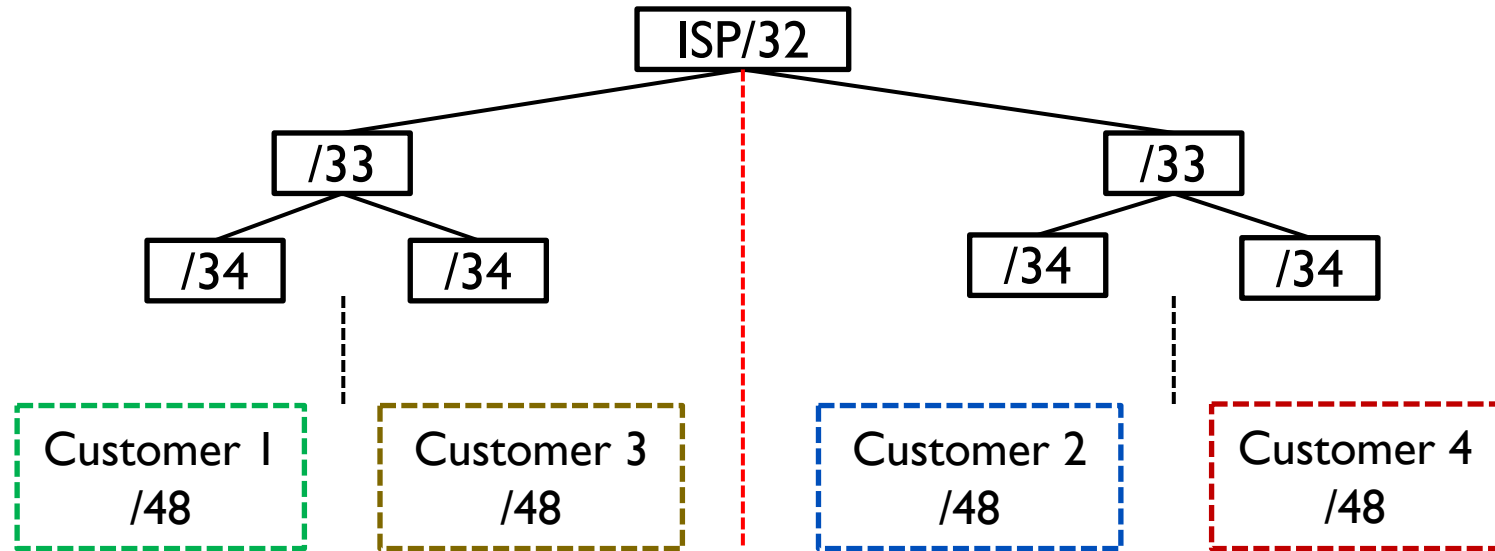
IPv6 Address Plan: DC services

- DC infra blocks from your infra block
 - Loopbacks
 - PtP links
- dedicate /40 for Data Center (hosted) services
 - Depends on DC architecture
 - Dedicated VLAN/subnet per service?
 - /64 per VLAN/subnet (2^{64} servers)
 - Dedicated subnet per customer (customer buys VMs/hosts services)?
 - /64 per customer or subnet (2^{64} VMs)
 - Announced in iBGP (DC border router)

IPv6 Address Plan: Traffic Shaping

- Borrow from IPv4
 - sub-aggregates to shape traffic
 - Difficult with contiguous assignment
- Assign customer prefixes (**that attract traffic**) from both ends of address space
 - Infrastructure prefix do not attract traffic

IPv6 Address Plan: Traffic Shaping



- Customer prefixes assigned from each /33 sub-prefix
 - Similar to IPv4 sub-aggregates!
 - Allows us to balance incoming traffic

IPv6 Address Plan: Routing

- IGP to carry next-hop reachability information
 - Infrastructure blocks (PtPs, loopbacks)
 - Aggregation desirable in IGP
- Customer prefixes (Enterprise, broadband, DC customers/services)
 - Sub-aggregates for traffic shaping (multihoming)
 - Consider regional delegation
 - iBGP carries all customer prefixes
 - Aggregation may interfere with traffic shaping
 - Aggregation necessary in eBGP (pull up routes)

IPv6 Address Planning: Example

- ISP has **2406:6400::/32** prefix
 - 16x /36s
 - easier to play at nibble boundaries

#	Prefix	Comments
1	2406:6400:0000::/36	First /33
2	2406:6400:1000::/36	
3	2406:6400:2000::/36	
4	2406:6400:3000::/36	
5	2406:6400:4000::/36	
6	2406:6400:5000::/36	
7	2406:6400:6000::/36	
8	2406:6400:7000::/36	
9	2406:6400:8000::/36	Second /33
10	2406:6400:9000::/36	
11	2406:6400:a000::/36	
12	2406:6400:b000::/36	
13	2406:6400:c000::/36	
14	2406:6400:d000::/36	
15	2406:6400:e000::/36	
16	2406:6400:f000::/36	

Example: High level plan

#	Prefix	Assignment	Comment
1	2406:6400:0000::/36	Infra + Cust	First /33
2	2406:6400:1000::/36	Customer	
3	2406:6400:2000::/36		
4	2406:6400:3000::/36		
5	2406:6400:4000::/36		
6	2406:6400:5000::/36		
7	2406:6400:6000::/36		
8	2406:6400:7000::/36		
9	2406:6400:8000::/36		Customer
10	2406:6400:9000::/36		
11	2406:6400:a000::/36		
12	2406:6400:b000::/36		
13	2406:6400:c000::/36		
14	2406:6400:d000::/36		
15	2406:6400:e000::/36		
16	2406:6400:f000::/36		

Example: High Level

#	Prefix	Assignment	Comment
1	2406:6400:0000::/36	Infra + Cust	First /33
1	2406:6400:0000:0000::/40	Backbone Infra (PtP, Loopbacks)	
2	2406:6400:0100:0000::/40	Enterprise Customer Reg1	
3	2406:6400:0200:0000::/40	Broadband Region1	
4	2406:6400:0300:0000::/40	Future Customers	
5	2406:6400:0400:0000::/40		
6	2406:6400:0500:0000::/40		
7	2406:6400:0600:0000::/40		
:			
:			
:			
:			
16	2406:6400:0f00:0000::/40		

Example: High Level

#	Prefix	Assignment	Comments
9	2406:6400:8000::/36	Customer	Second /33
1	2406:6400:8000::/40	Broadband Region2	
2	2406:6400:8100::/40	Enterprise Customer Reg2	
3	2406:6400:8200::/40	Future Customers	
4	2406:6400:8300::/40		
5	2406:6400:8400::/40		
6	2406:6400:8500::/40		
7	2406:6400:8600::/40		
:			
:			
:			
:			
16	2406:6400:8f00::/40		

Example: Infrastructure

#	Prefix	Assignment	Comments
1	2406:6400:0000::/36	Infra + Cust	First /33
1	2406:6400:0000::/40	Backbone Infra	
1	2406:6400:0000::/48	Loopbacks	
2	2406:6400:0001::/48	Point-to-Point	
3	2406:6400:0002::/48	Future Infra use	
4	2406:6400:0003::/48		
5	2406:6400:0004::/48		
6	2406:6400:0005::/48		
:			
:			
:			
:			
256	2406:6400:00ff::/48		

Example: Customer

#	Prefix	Assignment	Comments
1	2406:6400:0000::/36	Infra + Cust	First /33
2	2406:6400:0100::/40	Enterprise Customer Reg1	
1	2406:6400:0100::/48	Customer WAN links	
2	2406:6400:0101::/48	Customer 1.1	
3	2406:6400:0102::/48	Customer 1.2	
4	2406:6400:0103::/48	Future Customers	
5	2406:6400:0104::/48		
6	2406:6400:0105::/48		
7	2406:6400:0106::/48		
8	2406:6400:0107::/48		
:			
:			
256	2406:6400:01ff::/48		

Example: Customer

#	Prefix	Assignment	Comments
1	2406:6400:0000::/36	Infra + Cust	First /33
3	2406:6400:0200::/40	Broadband Reg1	
1	2406:6400:0100::/48	BRAS 1	
2	2406:6400:0101::/48	BRAS 2	
3	2406:6400:0102::/48	BRAS 3	
4	2406:6400:0103::/48	Future Customers	
5	2406:6400:0104::/48		
6	2406:6400:0105::/48		
7	2406:6400:0106::/48		
8	2406:6400:0107::/48		
:			
:			
256	2406:6400:01ff::/48		

Example: Customer

#	Prefix	Assignment	Comments
9	2406:6400:8000::/36	Customer	Second /33
1	2406:6400:8000::/40	Broadband Reg2	
1	2406:6400:8000::/48	BRAS1	
2	2406:6400:8001::/48	BRAS2	
3	2406:6400:8002::/48	BRAS3	
4	2406:6400:8003::/48	Future BRAS	
5	2406:6400:8004::/48		
:			
:			
:			
256	2406:6400:80ff::/48		

Example: Customer

#	Prefix	Assignment	Comments
9	2406:6400:8000::/36	Customer	Second /33
2	2406:6400:8100::/40	Enterprise Customer Reg2	
1	2406:6400:8100::/48	Customer 2.1	
2	2406:6400:8101::/48	Customer 2.2	
3	2406:6400:8102::/48	Future Customers	
4	2406:6400:8103::/48		
5	2406:6400:8104::/48		
:			
:			
:			
256	2406:6400:81ff::/48		



Questions

