Schedule

• RIPE NCC: Who are we?
• IPv4 exhaustion
• IPv6 address space
• IPv6 for mobile telephony
• Tips and hints
Who are we?

RIPE NCC
Located in Amsterdam
Not for profit membership organisation
One of five RIRs
Distribute IP addresses, ASNs etc

RIPE
Open community
Develops addressing policies
Working group mailing lists
IPv4 Address Pool Exhaustion
IPv4 Address Distribution

IANA → RIR → LIR → End User

Allocation: /0, /8, /22, /23, /25, /24

PA Assignment: /8

PI Assignment: /0, /8, /22, /23, /25, /24

1024 IPs
RIPE NCC’s last /8

- Each LIR gets one /22 (=1024 addresses)
- No PI

2187 /22 have been allocated since September 2012
IPv6 Basics

• 128 bits in IPv6
• 32 bits in IPv4
Address Notation

2001:0db8:003e:ef11:0000:0000:c100:004d
2001:0db8:003e:ef11:0000:0000:c100:004d
2001:db8:3e:ef11:0:0:c100:4d
Number of addresses (rounded off)

- IPv4
  - 4000000000

- IPv6
  - 3000000000000000000000000000000000000000
IPv6 Address Distribution

IANA

RIR

LIR

End User

/3

/12

/32

/60

/48

/48

4 billion subnets (/64s)

Allocation
PA Assignment
PI Assignment

4 billion subnets
(subnets (/64s))
IPv6 Ripeness

• Rating system:
  – One star if the LIR has an IPv6 allocation

  – Additional stars if:
    - IPv6 Prefix is announced on router
    - A route6 object is in the RIPE Database
    - Reverse DNS is set up

  – A list of all 4 star LIRs: http://ripeness.ripe.net/
2013 IPv6 RIPEness: **ALL** 9579 LIRs

- **No IPv6**: 36%
- **1 star**: 23%
- **2 stars**: 8%
- **3 stars**: 13%
- **4 stars**: 21%
IPv6 RIPEness in the region

Russia (1101)
- 47% 0*
- 19% 1*
- 13% 3*
- 7% 4*
- 14%

Ukraine (168)
- 34% 0*
- 18% 1*
- 12% 2*
- 10% 3*
- 31%

Belarus (17)
- 47% 0*
- 12% 1*
- 12% 4*
- 18% 3*
- 12%

Kazakhstan (50)
- 62% 0*
- 14% 1*
- 12% 2*
- 6% 3*
- 6%

Uzbekistan (18)
- 67% 0*
- 22% 1*
- 6% 2*
- 6% 4*
- 4%
How to get an IPv6 allocation

• To qualify, an organisation must:
  - Be an LIR
  - Have a plan for making assignments within two years

• Minimum allocation size /32

• Up to a /29

• Announcement as a single prefix recommended
Now what?
Philosophy change
IPv4 -> IPv6: What philosophy change?

How many IP addresses do I need?

How many subnets do I need?

Subnet always = /64
IPv4 -> IPv6: Как изменился подход?

Сколько адресов мне нужно?
Сколько подсетей мне нужно?
Каждая подсеть = /64
Assignments to customers

- /64  (1 subnet)
- /60  (16 subnets)
- /56  (256 subnets)
- /52  (4096 subnets)
- /48  (65536 subnets)
Default Allocation size = /32

• How many assignments can I make?
  - 4 billion /64’s
  - 268 million /60’s
  - 17 million /56’s
  - 1 million /52’s
  - 65536 /48’s
Classless Inter-Domain Routing (CIDR)
Why use only multiples of 4?
If $x$ is a multiple of 4

If $x$ is a multiple of 4, then $x = 4k$ for some integer $k$. This means that $x$ can be represented as a binary number with 48 fixed bits, followed by 26 hexadecimal digits that can take any values from $0$ to $F$, and 80 freely variable bits.

The hexadecimal representation of $x$ is $2001:00db8:0000:0000:0000:0000:0000:0007$. The first 48 bits are fixed, and the last 80 bits are variable.

The diagram illustrates the structure of the hexadecimal representation of $x$. The fixed bits are shown in blue, and the variable bits are shown in green.

The diagram also shows that the 26 hexadecimal digits can take any values from $0$ to $F$. The remaining 80 bits are freely variable.
If \( /x \) is NOT a multiple of 4

- 50 fixed bits
- 12 fixed hex digits
- 25 hex digits can take any values
- 78 freely variable bits

1 hex digit can only take certain values! example: 8, 9, a or b
Only certain hex values possible

fixed bits  variable bits

\[
\begin{array}{c}
1 & 0 & 0 & 0 \\
\end{array}
\]

\[
\begin{array}{c}
1 & 0 & 0 & 0 \\
1 & 0 & 0 & 1 \\
1 & 0 & 1 & 0 \\
1 & 0 & 1 & 1 \\
\end{array}
\]

8, 9, a or b only!
"Easy" & “complicated” ranges

• 2001:db8:7::/48

• 2001:db8:7:8000::/50
IPv6 Subnetting

IPv6 Subnetting

2001:0DB8:0000:0000:0000:0000:0000:0000

64 bits interface ID

/32 = 65536 /48
/48 = 65536 /64
/52 = 4096 /64
/56 = 256 /64
/60 = 16 /64

Contact Training Services: ts@ripe.net
Follow us on Twitter: www.twitter.com/TrainingRIPENCC
www.ripe.net
IPv4 vs IPv6 (rounded off)

IPv4

addresses: $4 \times 10^9$

allocations to members: $2 \times 10^6$

addresses: 2048

IPv6

subnets: $2 \times 10^{19}$

subnets: $4 \times 10^9$

in each allocation: 2048

in each allocation: $4 \times 10^9$
Why create an IPv6 addressing plan?

• Easier implementation of security policies
• Efficient addressing plans are scalable
• More efficient route aggregation

and most important...
Keep your mental health!

Addressing plan example

POP1
- mail
- www
- proxy
- usenet
- voip
- DNS
- switch
- layer 3 switch
- router

POP2
- cr1.pop2
- cr2.pop2
- colo 1
- colo 2
- R2

Point-to-Point
- customer 1
- customer 2

colocated
customer
groups
Solution POP1

<table>
<thead>
<tr>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001:db8:0000:0000::/56</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Internet Gateways</th>
</tr>
</thead>
<tbody>
<tr>
<td>POP1 2001:db8:0000::/48</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IP Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>cr1.pop1 2001:db8:0000::0100::/56</td>
</tr>
<tr>
<td>sw1 2001:db8:0000::0200::/56</td>
</tr>
<tr>
<td>cr2.pop1 2001:db8:0000::0300::/56</td>
</tr>
<tr>
<td>sw2 2001:db8:0000::0400::/56</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Loopback Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001:db6:0000:0000::/64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subnets</th>
</tr>
</thead>
<tbody>
<tr>
<td>mail server vlan</td>
</tr>
<tr>
<td>www server vlan</td>
</tr>
<tr>
<td>proxy server vlan</td>
</tr>
<tr>
<td>wanet server vlan</td>
</tr>
<tr>
<td>VoIP server vlan</td>
</tr>
<tr>
<td>DNS server vlan</td>
</tr>
</tbody>
</table>
Solution POP2

Customer Assignments

Colocation Customers (500)

P2P Customer 1 Subnet

P2P Customer 2 Subnet
Make an addressing plan (I)

• Number of hosts is irrelevant
• Multiple /48s per pop can be used
  - separate blocks for infrastructure and customers
  - document address needs for allocation criteria
• /64 for all subnets
  - autoconfiguration works
  - renumbering easier
  - less typo errors because of simplicity
Make an addressing plan (II)

• Routers:
  • Give all routers the same size block
  • Minimum: One /64 per interface
  • Allow for more interfaces in future
  • /56 or /52 typical for a router
Make an addressing plan (II)

• Use one /64 block (per site) for loopbacks
  - One /128 per device

One /64 = 18.446.744.073.709.551.616 IPv6 addresses
More On Addressing Plans for ISPs

• For servers you want manual configuration
• Use port numbers for addresses

- pop server 2001:db8:1::110
- dns server 2001:db8:1::53
- etc...
Point-to-Point Connections

- Reserve a /64, assign a /127
Customer assignments

• Give your customers enough addresses
  - Up to a /48

• For more addresses, send in request form
  - Alternatively, make a sub-allocation

• Every assignment must be registered in the RIPE database
Customers And Their /48

• Customers have no idea how to handle 65536 subnets!
• Give them information

http://bit.ly/116HCTg
IPv6 Address Management

• Your Excel sheet might not scale
  - There are 65,536 /48s in a /32
  - There are 65,536 /64s in a /48
  - There are 16,777,216 /56s in a /32

• Find a suitable IPAM solution
IPv6 &
Address Translation for
Mobile Telephony
IPv6 and IPv4 compatibility?

• IPv6 is a different protocol from IPv4
• IPv6 hosts cannot talk to IPv4 hosts directly
• Tools like 6in4 and other transition mechanisms let IPv6 hosts talk to each other
  - tunneling
  - translation
NAT64/DNS64

- Single-stack clients will only have IPv6
- Translator box will strip all headers and replace them with IPv4
- Requires some DNS “magic”
  - Capture responses and replace A with AAAA
  - Response is crafted based on target IPv4 address
- Usually implies address sharing on IPv4
NAT64/DNS64

Subscribers
IPv6
IPv6
IPv6

Provider
IPv6
NAT64
DNS64

Internet
IPv4
IPv6
Drawback

• Some applications don’t work on IPv6 only devices
  - Spotify, Netflix, Skype

• Solution?
  - 464XLAT
    - makes IPv4-only applications work on IPv6-only device
464XLAT

• NAT64+Stateless IP translation on device

• on IPv6 only mobile devices
  - Install CLAT demon locally
  - 464XLAT gives the mobile dummy IPv4 address
  - IPv4 only application can use IPv4 interface
    - and works!
  - CLAT translates IPv4 to IPv6 locally
  - NAT64 for accessing IPv4 networks
Deployment?

- T-Mobile US, Verizon
- phones
  - Nexus S, Galaxy Nexus, Galaxy S, Galaxy Note, Verizon LTE
- Android
  - CLAT open source
- Android 4.3
  - CLAT built in
Useful links & hints

- 464xlat details: [https://sites.google.com/site/tmoipv6/464xlat](https://sites.google.com/site/tmoipv6/464xlat)
- RFC 6877 (464XLAT)
- RFC 6146 (NAT64-in the core)
- RFC 6145 (IP/ICMP translation on the edge)
Useful information

Websites
- http://www.getipv6.info/
- http://www.ipv6actnow.org
- http://datatracker.ietf.org/wg/v6ops/
- http://www.ripe.net/ripe/docs/ripe-554.html

Mailing lists
- http://lists.cluenet.de/mailman/listinfo/ipv6-ops
- http://www.ripe.net/mailman/listinfo/ipv6-wg
More Questions?
Come to our 1 day free IPv6 training!
Only for RIPE NCC members: www.ripe.net/training
The End!