IPv6 in Basic Networking
Who am I?

- Wido den Hollander (1986)
- Co-owner and CTO @ PCextreme B.V.
  - Dutch hosting company
- CloudStack VP
  - Integrated Ceph into CloudStack
  - Work on the KVM Hypervisor code
  - Integrated IPv6 in Basic Networking
Who is PCextreme B.V.?

- Dutch hosting company since 2004
- 25 employees
- 50,000 customers
- >100,000 shared hosting packages
- Running a *public cloud* on Apache CloudStack with IPv6 and Ceph storage
- CloudStack zones in Amsterdam, Barcelona, Miami, Tokyo and Los Angeles
Hello IPv6!

Did you dare to touch it yet?
if (ipv4addresses.length < 5%) {
    System.out.println("IPv4 is almost exhausted");
}
# IPv4 vs IPv6

<table>
<thead>
<tr>
<th>IPv4</th>
<th>IPv6</th>
</tr>
</thead>
<tbody>
<tr>
<td>32-bit (4,294,967,296 addresses)</td>
<td>128-bit (3.402823669×10³⁸ addresses)</td>
</tr>
<tr>
<td>/24 (255 addresses)</td>
<td>/64 (1.844674407×10¹⁹ addresses)</td>
</tr>
<tr>
<td>Broadcast</td>
<td>Multicast</td>
</tr>
<tr>
<td>ARP</td>
<td>Neighbor Discovery</td>
</tr>
<tr>
<td>DHCP</td>
<td>Stateless Address Autoconfiguration</td>
</tr>
<tr>
<td>NAT</td>
<td>Routed Addresses</td>
</tr>
<tr>
<td>iptables</td>
<td>ip6tables</td>
</tr>
<tr>
<td>ICMP is a nice to have</td>
<td>ICMP(v6) is mandatory</td>
</tr>
<tr>
<td>Virtual Routers (VRRP)</td>
<td>Router Advertisements</td>
</tr>
<tr>
<td>169.254.0.0/16</td>
<td>fe80::/10</td>
</tr>
<tr>
<td>0.0.0.0/0</td>
<td>::/0</td>
</tr>
</tbody>
</table>
2001:db8::/32

Reserved for example and documentation use in RFC3849
No more NAT

With IPv6 each host on the Internet will get a publicly routed address.

This means that there is no more need for NAT.

Routers will become true routers again instead of packet translators.
Firewalling

NAT != Firewall

With IPv6 you can still use stateful firewalling

ip6tables with ESTABLISHED,RELATED
Link-Local

fe80::/10

Mandatory for each IPv6 host and is used for communication in that (Layer 2) network segment

Router Advertisements, Gateways, Neighbor Discovery, Duplicate Address Detection all work over Link-Local
Link-Local

root@ubuntu1604:~# ip -6 addr show dev ens3
2: ens3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 state UP qlen 1000
   inet6 2001:db8:100:0:45b:2cff:fe00:bb/64 scope global
      valid_lft 86391sec preferred_lft 14391sec
   inet6 fe80::45b:2cff:fe00:bb/64 scope link
      valid_lft forever preferred_lft forever
root@ubuntu1604:~#
root@ubuntu1604:~# ip -6 route show
2001:db8:100::/64 dev ens3  proto kernel  metric 256  expires 86385sec
fe80::/64 dev ens3  proto kernel  metric 256  pref medium
default via fe80::5054:ff:fe59:c2b3 dev ens3  proto ra  metric 1024
expires 165sec hoplimit 64 pref medium
root@ubuntu1604:~#
Link-Local

root@ubuntu1604:~# ping6 -c 3 fe80::5054:ff:fe59:c2b3%ens3
PING fe80::5054:ff:fe59:c2b3%ens3(fe80::5054:ff:fe59:c2b3) 56 data bytes
64 bytes from fe80::5054:ff:fe59:c2b3: icmp_seq=1 ttl=64 time=0.719 ms
64 bytes from fe80::5054:ff:fe59:c2b3: icmp_seq=2 ttl=64 time=0.644 ms
64 bytes from fe80::5054:ff:fe59:c2b3: icmp_seq=3 ttl=64 time=0.942 ms

--- fe80::5054:ff:fe59:c2b3%ens3 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2004ms
rtt min/avg/max/mdev = 0.644/0.768/0.942/0.128 ms
root@ubuntu1604:~#
Router Advertisements

Using multicast routers advertise themselves on the network

They advertise the prefix/subnet and their Link-Local Address

(And lifetime, priority, DNS servers, DNS domain)
Router Advertisements

Hello! I am a router in this network

My address is fe80::5054:ff:fe59:c2b3

The subnet in this network is 2001:db8:100::/64

Oh, if you wanted to know, the DNS servers you can use are 2001:db8:200:1::53 and 2001:db8:200:2::53
StateLess Address AutoConfiguration

Routers advertise the subnet for a network using a combination of the subnet and its MAC, the host generates an address. This is *Autoconfiguration without a database*. 
root@ubuntu1604:~# ip addr show dev ens3
2: ens3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc
    pfifo_fast state UP group default qlen 1000
    link/ether 06:5b:2c:00:00:bb brd ff:ff:ff:ff:ff:ff
    inet6 2001:db8:100:0::45b:2cff:fe00:bb/64 scope global
        valid_lft 86368sec preferred_lft 14368sec
    inet6 fe80::45b:2cff:fe00:bb/64 scope link
        valid_lft forever preferred_lft forever
root@ubuntu1604:~#
Linux and BSD

Make sure Privacy Extensions are disabled

net.ipv6.conf.all.use_tempaddr = 0
net.ipv6.conf.default.use_tempaddr = 0
Use MAC as identifier

netsh interface ipv6 set privacy state=disabled store=persistent
netsh interface ipv6 set global randomizeidentifiers=disabled store=persistent
Basic Networking

Directly connected to the network/internet
Address selection

We know the subnet and MAC!
Obtaining the address

The Management Server calculates the IPv6 Address the Instance will obtain using the subnet and MAC address
Obtaining the address

mysql> select * from vlan \G
*************************** 1. row ***************************
  id: 1
    uuid: 5e8b1050-ab7c-4fcc-8c67-cac1528cdfd5
  vlan_id: vlan://untagged
    vlan_gateway: 192.168.200.1
    vlan_netmask: 255.255.255.0
    vlan_type: DirectAttached
  data_center_id: 1
    network_id: 204
  physical_network_id: 200
    ip6_gateway: 2001:db8:100::1
      ip6_cidr: 2001:db8:100::/64
    ip6_range: NULL
    removed: NULL
    created: 2017-04-11 05:58:55
1 row in set (0.00 sec)

mysql>
## Obtaining the address

<table>
<thead>
<tr>
<th>NIC 1 (Default)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
</tr>
<tr>
<td>Network Name</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>IP Address</td>
</tr>
<tr>
<td>Secondary IPs</td>
</tr>
<tr>
<td>Gateway</td>
</tr>
<tr>
<td>Netmask</td>
</tr>
<tr>
<td>IPv6 IP Address</td>
</tr>
<tr>
<td>IPv6 Gateway</td>
</tr>
<tr>
<td>IPv6 CIDR</td>
</tr>
</tbody>
</table>
Security Grouping

Works just like with IPv4
Security Grouping

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Start Port</th>
<th>End Port</th>
<th>CIDR</th>
<th>Add</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCP</td>
<td>22</td>
<td>22</td>
<td>0.0.0.0/0</td>
<td></td>
</tr>
<tr>
<td>ICMP</td>
<td>-1</td>
<td>-1</td>
<td>0.0.0.0/0</td>
<td></td>
</tr>
<tr>
<td>TCP</td>
<td>80</td>
<td>80</td>
<td>0.0.0.0/0</td>
<td></td>
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</table>
Live demos are dangerous. They always fail.
TODO

• System VMs should get IPv6
• Cloud-init doesn’t work over IPv6 (config drive?)
• Prefix Delegation
  • Route a subnet to a Instance
• Advanced Networking (?)
When

Apache CloudStack 4.10
Thank you!

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- https://www.pcrestreme.com/