Recent advances in IPv6 insecurities
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Hello, my name is
Episode 2

“In a distant future ... IPv6 will come. Maybe. Hopefully never!”
The future is here already
Let’s start with the basics
IPv4

4 octets

4.294.967.296 addresses

192.168.1.1
IPv6

16 octets
340.282.366.920.938.463.463.374.607.431.768.211.456 addresses
2a01:2b3:4:a::1
2 octets each, hexadecimal

Separated by colons

Leading zeros are omitted

The longest chain of :0:0: is replaced with ::

2a01:2b3:4:a::1
Subnets are /64

4,294,967,296 x the size of the Internet!
No broadcasts
Multicasts, but they are local only
Features!

Autoconfiguration

IPSEC

Mobility

Enough addresses!
IPv6 header layout

<table>
<thead>
<tr>
<th>Field</th>
<th>Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version</td>
<td>0-3</td>
</tr>
<tr>
<td>Class</td>
<td>4-7</td>
</tr>
<tr>
<td>Flow Label</td>
<td>8-15</td>
</tr>
<tr>
<td>Payload</td>
<td>16-23</td>
</tr>
<tr>
<td>Next Header</td>
<td>24-31</td>
</tr>
<tr>
<td>Hop Limit</td>
<td>24-31</td>
</tr>
</tbody>
</table>

- 128 bit Source Address
- 128 bit Destination Address
IPv6 header layout

- No header length
- No identification
- No checksum
- No fragmentation
- No options
Every option is an extension header

- Fragmentation
- Source routing
- IPSEC
- Destination Options
- ...

IPv6 Header
Next Header = 43

Routing Header
Next Header = 44

Fragment Header
Next Header = 17

UDP Header

Data
IPv6 is much simpler than IPv4
... in theory.
IPv6 Vulnerabilities (CVE)

Not counting my CVE entries

Bar chart showing IPv6 vulnerabilities from 2002 to 2010.
Kids, in 2005 ...
The THC-IPv6 Attack Toolkit
ARP Spoofing => ND spoofing

1. NS:
   - ICMP Type = 135
   - Src = A
   - Dst = All-Nodes Multicast
   - Query = Who-has IP B?

2. NA:
   - ICMP Type = 136
   - Src = B
   - Dst = A
   - Data = MAC

parasite6:
   - Answers to every NS, claims to be every system on the LAN 😊
Duplicate Address Detection DOS

1. NS:
   ICMP Type = 135
   Src = :: (unspecified)
   Dst = All-Nodes Multicast Address
   query= Who-has IP A?

2. No reply if nobody owns the IP address.

**dos-new-ipv6:**
Answer to every NS, claim to be every system on the LAN 😊
MITM with Redirects
MITM with Redirects

(V)ictim  (A)ttacker  (R)outer  (T)arget

redir6
DHCP => Autoconfiguration

1. RS:
   ICMP Type = 133
   Src = ::
   Dst = FF02::2
   query= please send RA

fake_router6:
Sets any IP as default router, defines network prefixes and DNS servers 😊

2. RA:
   ICMP Type = 134
   Src = Router Link-local Address
   Dst = FF02::1
   Data= options, prefix, lifetime, autoconfig flag, DNS
Kick the default router!

1. Send own RA
2. Spoof RA of default router with 0 lifetime
3. Resend own RA just to be sure 😊

We are getting back to this one
Kill all routers and clients think everything is local
(it’s in the standard)
RA => Systems become dual stack

- Can be port scanned on IPv6
  - No filtering on IPv6? Full port access
- Prefer IPv6
  - Will use your tunnel / MITM
How about announcing remote network addresses local? (Paypal, ...
RA flooding!

Cisco ASA/PIX, Cisco IOS
Windows 2008, 7, Vista
old Linux
more... ?
Cisco:
Just fixed for IOS, ASA soon
(CSCti24526 , CSCti33534)
Microsoft

“We consider this issue to be by design. [and will not fix this]”

Even Apple got this problem right!
“Remote alive scans (ping scans) as we know them are unfeasible on IPv6”

some jerk

(OK, that was me in 2005)
How to identify remote systems?

- Broadcasts
- Search-engines / databases
- Scan the whole range
- DNS
- Combining them
- Common addresses
Search Engines

Dumped various IPv6 directories

\[\downarrow\]

14,651 possible domains & subdomains identified
DNS

14,651 domains
bruteforcing 3000 hostnames

↓

40,193 DNS entries found
1,846 unique hostnames found
DNS Results

14,456 unique IPv6 addresses found

↓

12,942 networks

5434 unique host addresses
Host addresses analysis

Autoconfiguration
- MAC address $\Rightarrow$ ~24 bit key space per vendorID
- Privacy option $\Rightarrow$ bad luck
- Fixed random $\Rightarrow$ bad luck

by hand
- Pattern $\Rightarrow$ got one, got all
- Random $\Rightarrow$ bad luck

DHCP
- Sequential
- Got one, got all
- Usually easy to find
by hand

::1, ::2, ::3, ...
::service_port
::1:service_port, ::2:service_port, ...
::service_port:1, ::service_port:2, ...
The IPv4 address
Funny stuff (::b00b:babe, etc.)
etc.
DHCP
::1000-2000
::100-200
::1:0-1000
::1:1000-2000
IPv6 Host Address Distribution

- Autoconfiguration
- Easy DHCP/Hand
- IPv4 address
- Random/Privacy
- Hard DHCP/Hand

Smiley face
Alive Scanning

12,942 networks bruteforcing 2000 host addresses

↓

379,223 alive systems

↓

7,895 networks

1975 unique host addresses
Alive Scanning

379,223 alive systems
↓
13,402 reverse DNS entries
↓
3,922 unique domains
7,860 unique hostnames
DNS Reverse Hostnames
do {
    new_dns=dns_brute(new_alive);
    new_alive=alive_brute(new_dns);
} while (new_dns || new_alive)
Conclusion

DNS bruteforcing: 90% of systems in DNS with 1900 words
Conclusion

Alive bruteforcing: 66% of systems with 2000 addresses scanned in 1-20 seconds
Conclusion

Combined (and use of brain) ~90-95% of hosts are found
THERE IS MORE!
Taking over the Multicast Listener Discovery Protocol for fun and denying multicast traffic
How does MLD work?

- Sends periodically MLD general query messages.
- MLD Report: “I am a multicast DNS server” to all routers.
- DNS multicast traffic flows to the network.
- Sends specific address query message.
- MLD Report: “I am (still) a multicast DNS server”.
- Spoofs “A” MLD Done message.
First we want to become the MLD query router

if (router1 < router2)
    master(router1);
A: Sends periodically MLD general query messages. MLD Report: “I am a multicast DNS server” to all routers.

Spoofs MLD general query message as fe80::

Spoofs “A” MLD Done message.

DNS multicast traffic flows to the network.
Problem: We must send an MLD general query message regularly
Solution:
Spoof query message with multicast all-router MAC address!
Spoofs "A" MLD Done message

Spoof MLD general query message as fe80::

Send general query as fe80:: with special MAC
Anybody sniffing?
Send a ping to the target with an unused multicast MAC address

(Windows, Linux, more?)
Side channels in IPv6?

IPv6 *is* a side channel.
Don’t be scared.
IPv6

complex

intellectual challenge

tired ... ?

be an explorer!
Join researching IPv6!
How to get IPv6 to your home (1/4)

1. Create an account at Sixxs: http://www.sixxs.net/
2. Request tunnel (static if possible for you, heartbeat otherwise)
3. Request a subnet (a week later)
4. a) Configure a static tunnel:

```
ip tunnel add sixxs mode sit local [Your IPv4 Endpoint] remote [Sixxs IPv4 Endpoint]
ip link set sixxs up
ip link set mtu 1280 dev sixxs
ip tunnel change sixxs ttl 64
ip -6 addr add [Your IPv6 Endpoint]/[Prefix Length] dev sixxs
ip -6 ro add default via [Your IPv6 endpoint] dev sixxs
```
4. b) Configure a heartbeat tunnel:
   a) Install aiccu
   b) Configure aiccu.conf:
      username xxxx-SIXXS
      password xxxxxxxxxxx
      tunnel_id T<your tunnel id>
      daemonize true
      automatic true
      ipv6_interface sixxs
   c) Start aiccu
5. Configure your local network card
   ip -6 addr add [Your IPv6 subnet]::1/[Prefix Length] dev eth0

6. Use fake_router6 for your local subnet:
   fake_router6 eth0 <Your IPv6 subnet>::/<Prefix Length>
   2a01:4f8:100:2283::2
What is new in thc-ipv6 since the 2005-2007 release?

- DNS6 bruteforcer
- More payloads for fake_router6
- Implementation test-case tool
- Fast traceroute6
- Fuzzer for IPv6
- Flood tools for RA and NA
- Several library bugfixes & enhancements
What is new in the current thc-ipv6 source state?

• alive6 rewritten with 250% new functionality
• Flood & spoofing for all multicast protocols
• DHCPs6 spoofer
• DHCPc6 flooder
• DNS6 spoofer
• ... more new tools than fit the slide
• Enhancements for all previous tools
• Several library bugfixes & enhancements
How to get access to the current thc-ipv6 source code state?

Send in patches and new tools!

Small and limited updates will still get into the public version.

Complete public release in ~2011.
http://www.thc.org/thc-ipv6
Central information resource for IPv6 security (wiki, forum, news):

www.ipv6security.info
www.ipv6hacking.info

(Online after Xmas 2010)
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Thanks!

And have fun exploring IPv6!