IPv6 Security

Rabat, Maroc
28 - 30 Mars 2007

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Acknowledgements

- János Mohácsi, NIIF/HUNGARNET - Hungary
- Octavio Medina, Octavio Medina, Laurent Toutain, ENST
- Bernard Tuy, Jérôme Durand, Emmanuel Goiffon, Renater
- Peter Kirstein, Steve Hailes, Piers O'Hanlon, UCL
- Wolfgang Fritsche, IABG
- Jim Bound, Hewlett Packard
- Patrick Grostete, Cisco
- Mohsen Souissi, AFNIC
- Alain Durand, Sun Microsystems
- Bill Manning, ISI
- Alain Baudot, France Telecom R&D
- Pedro Lorga, FCCN
- And many others

What is new with IPv6?

- Security was considered from the start in IPv6
- Some of the key improvements:
  - IPsec useable with the core protocols
  - Cryptographically Generated Addresses (CGA)
  - SEcure Neighbor discovery (SEND)
  - Making intrusion harder

Threats to be Countered in IPV6

- Scanning Gateways and Hosts for weakness
- Scanning for Multicast Addresses
- Unauthorised Access Control
- Firewalls
- Protocol Weaknesses
- Distributed Denial of Service
- Transition Mechanisms
- Worms/Viruses
  - There are already worms that use IPv6 (Rbot.DUD,

Scanning Gateways and Hosts

- Subnet Size is much larger
  - About 500,000 years to scan a /64 subnet@1M addresses/sec
- But…
  - NMAP does support IPv6 network scanning
  - IPv6 Scanning methods are changing
    - DNS based, parallelised scanning, common numbering
  - Compromising a router at key transit points
    - Can discover addresses in use

Scanning Multicast Addresses

- New Multicast Addresses - IPv6 supports new multicast addresses that can enable an attacker to identify key resources on a network and attack them
  - For example, and all DHCP servers (FF05::5)
    - All-node/all-router multicast addresses are in IPv4 (2240.0.1,2) already
      - Though these can provide for new DoS opportunities
  - Addresses must be filtered at the border in order to make them unreachable from the outside
    - IPv6 specs forbids the generation of ICMPv6 packets in response to messages to global multicast addresses that certain requests

Security of IPv6 addresses

- Cryptographically Generated Addresses (CGA) IPv6 addresses [RFC3972]
  - Host-ID part of address is an encoded hash
    - Binds IPv6 address to public key
  - Used for securing Neighbor Discovery [RFC3971]
  - Is being extended for other uses [RFC4581]
- Private addresses as defined [RFC 3041]
  - prevents device/user tracking from
  - makes accountability harder
- Host-ID could be a token to access to a network

Autoconfiguration/Neighbor Discovery

- Neigbor Discovery (cf Address Resolution Protocol)
  - Can suffer similar problems of ARP cache poisoning
- Better solution with SEcure Neighbor Discovery (SEND) [RFC3971]
  - Uses CGA
    - Linux implementation: DoCoMo's Open Source SEND Project
- DHCPv6 with authentication is possible
- ND with IPSec also possible

Unauthorised Access Control

- Policy implementation in IPv6 with Layer 3 and Layer 4 is still done in firewalls
- Some design considerations!
  - Filter site-scoped multicast addresses at site boundaries
  - Filter IPv4 mapped IPv6 addresses on the wire

Action	Src	Dst	Src port	Dst port
permit	a:b:c:d::e	x:y:z:w::v	any	ssh
deny	any	any		

Unauthorised Access control

- Non-routable + bogon (unallocated) address filtering slightly different
  - in IPv4 easier deny non-routable + bogons
  - in IPv6 simpler to permit legitimate (almost)

Action	Src	Dst	Src port	Dst port
deny	2001:db8::/32	host/net		
permit	2001::/16	host/net	any	service
permit	2002::/16	host/net	any	service
permit	2003::/16	host/net	any	service
Deny	3ffe::/16	host/net	any	service
deny	any	any		

L3- L4 Spoofing

- While L4 spoofing remains the same, IPv6 address are globally aggregated making spoof mitigation at aggregation points easy to deploy
- Can be done easier since IPv6 address is hierarchical
- However host part of the address is not protected
  - You need IPv6 <– >MAC address (user) mapping for accountability!

Amplification (DDoS) Attacks

- There are no broadcast addresses in IPv6
  - This would stop any type of amplification attacks that send ICMP packets to the broadcast address
  - Global multicast addresses for special groups of devices, e.g. link-local addresses, etc.
- IPv6 specifications forbid the generation of ICMPv6 packets in response to messages to global multicast addresses
  - Many popular operating systems follow the specification
  - Still uncertain on the danger of ICMP packets with global multicast source addresses

Mitigation of IPv6 amplification

- Be sure that your host implementations follow the ICMPv6 spec [RFC 4443]
- Implement Ingress Filtering
  - Defeating Denial of Service Attacks which employ IP Source Address Spoofing [RFC 2827]
- Implement ingress filtering of IPv6 packets with IPv6 multicast source address

Mixed IPv4/IPv6 environments

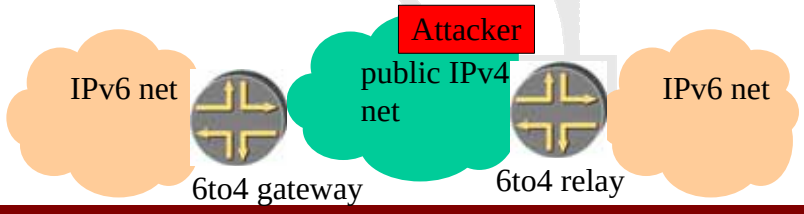
- There are security issues with the transition mechanisms
  - Tunnels are extensively used to interconnect networks over areas supporting the “wrong” version of protocol
  - Tunnel traffic many times has not been anticipated by the security policies. It may pass through firewall systems due to their inability check two protocols in the same time
- Do not operate completely automated tunnels
  - Avoid “translation” mechanisms between IPv4 and IPv6, use dual stack instead
  - Only authorized systems should be allowed as tunnel end-points

IPv6 transition mechanisms

- ~15 methods possible in combination
- Dual stack:
  - enable the same security for both protocol
- Tunnels:
  - ip tunnel – punching the firewall (protocol 41)
  - gre tunnel – probable more acceptable since used several times before IPv6

L3 – L4 Spoofing in IPv4 with 6to4

- For example, via 6to4 tunnelling spoofed traffic can be injected from IPv4 into IPv6.
  - IPv4 Src: Spoofed IPv4 Address
  - IPv6 Src: 2002:: Spoofed Source



Other threats

- IPv6 Routing Attack
  - Use traditional authentication mechanisms for BGP and IS-IS.
  - Use IPsec to secure protocols such as OSPFv3 and RIPng
- Viruses and Worms
- Sniffing
  - Without IPsec, IPv6 is no more or less likely to fall victim to a sniffing attack than IPv4
- TCP ICMP attacks – slight differences with ICMPv6
  - http://tools.ietf.org/html/draft-gont-tcpm-icmp-attacks-05
- Application Layer Attacks
  - Even with IPsec, the majority of vulnerabilities on the Internet today are at the application layer, something that IPsec will do nothing to prevent
- Man-in-the-Middle Attacks (MITM)
  - Without IPsec, any attacks utilizing MITM will have the same likelihood in IPv6 as in IPv4
- Flooding
  - Flooding attacks are identical between IPv4 and IPv6

Vulnerability testing/assessment

- Testing tools
  - Ettercap, nmap, LSOF, Snoop, DIG, Etherape, Wireshark, Fping, Ntop, SendIP, TCPDump, WinDump, IP6Sic, NetCat6, Ngrep, THC Amap
- Assessment tools
  - SAINT, nessus, ndpmon,

Firewalls

- IPv6 architecture and firewall - requirements
  - No need to NAT – same level of security with IPv6 possible as with IPv4 (security and privacy)
    - Even better: e2e security with IPSec
  - Weaknesses of the packet filtering cannot be hidden by NAT
  - IPv6 does not require end-to-end connectivity, but provides end-to-end addressability
  - Support for IPv4/IPv6 transition and coexistence
  - Not breaking IPv4 security
- There are some IPv6-capable firewalls now
  - Cisco ACL/PIX, iptables, ipfw, Juniper NetScreen

Firewalls L4 issues

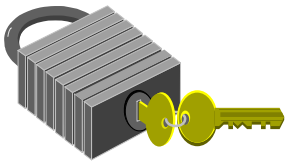
- FTP
  - Complex: PORT, LPRT, EPRT, PSV, EPSV, LPSV (RFC 1639, RFC 2428)
  - Virtually no support in IPv6 firewalls
- HTTP seems to be the next generation file transfer protocol with WEBDAV and DELTA
- Other non trivially proxy-able protocol:
  - No support (e.g.: H.323)

Security: VPNs

- Layer 2 solutions
  - MPLS
- **IPSe**curity
  - IPSec - Suite of protocols
- Other solutions
  - E.g. OpenVPN, Tinc, yavipin

Security: IPSec

- General IP Security mechanisms
  - From the IETF IPsec Working Group
    - http://tools.ietf.org/wg/ipsec/
    - IP Security Architecture: RFC 4301
- Applies to both IPv4 and IPv6:
  - **Mandatory for IPv6**
  - Optional for IPv4
- Applicable to use over LANs, across public & private WANs, & for the Internet
- IPSec is a security framework
  - Provides suit of security protocols
  - Secures a pair of communicating entities



IPsec protocol overview

- IPsec services
  - Authentication
    - AH (Authentication Header - RFC 4302)
  - Confidentiality
    - ESP (Encapsulating Security Payload - RFC 4303)
  - Replay protection, Integrity
  - Key management
    - IKEv2 (Internet Key Exchange - RFC4306)
- Implementations
  - Linux-kernel (USAGI), Cisco IOS-12.4(4)T, BSD&OSX(Kame)

Summary

- IPv6 has potential to be a foundation of a more secure Internet
- Elements of the IPv6 security infrastructure
  - Firewalls, IPSec, AAA, etc.

  are mature enough to be deployed in production environment.
- Other elements are in prototype state
  - CGA, SEND, PANA, VPNs

  But even these are ready for experimental deployment