GTRI
GLOBAL TECHNOLOGY RESOURCES INC.

IPv6 Security

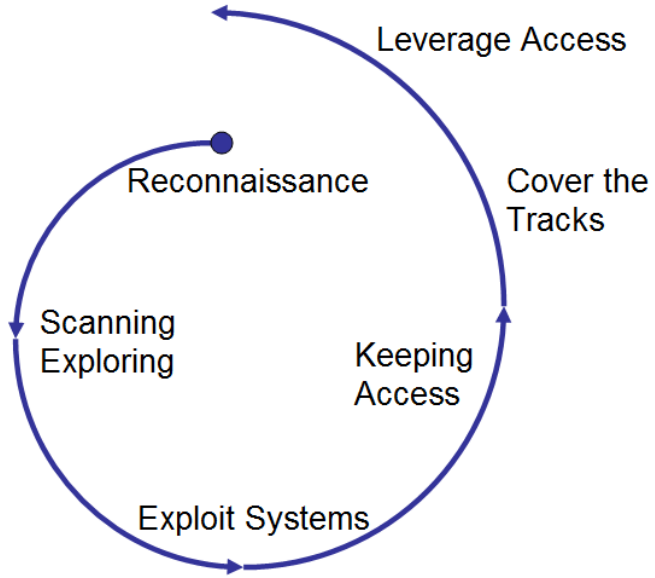
Scott Hogg
GTRI - Director of Technology Solutions
Chair - Rocky Mountain IPv6 Task Force
CCIE #5133, CISSP #4610

IPv6 Security

- Even if you haven't started using IPv6 yet, you probably have some IPv6 running on your networks already and didn't know it
- Do you use Linux, MacOS X, BSD, or MS Vista/Windows 7?
  - They all come with IPv6 capability, some even have IPv6 enabled by default (IPv6 preferred)
  - They may try to use IPv6 first and then fall-back to IPv4
  - Or they may create IPv6-in-IPv4 tunnels to Internet resources to reach IPv6 content
  - Some of these techniques take place regardless of user input or configuration
- If you are not protecting your IPv6 nodes then you have just allowed a huge back-door to exist

IPv6 Security Threats

- There isn't much of a hacker community focusing on IPv6 today but that is likely to change as IPv6 becomes more popular – IPv6 will gain the hacker's attention
- Many vendors (Cisco, Juniper, Microsoft, Sun, Open Source) have already published IPv6 bugs/vulnerabilities
- Attacks at the layers below and above the network layer are unaffected by the security of IPv6



Reconnaissance

- Enumeration, checking registries (whois), DNS (nslookup, dig, etc.), Google Hacking
- Ping sweeps, port scans, application vulnerability scans
- IPv6 makes the ping sweeps problematic
  - The address space is too large to scan
  - Brute-force scanning a /64 is not practical
  - “At a very conservative one probe per second, such a scan may take some 5 billion years to complete.” - RFC 5157 IPv6 Implications for Network Scanning
  - “And even at a scan rate of 1 million probes per second (more than 400 Mbps of traffic), it would take more than 28 years of constant scanning to find the first active host” - Sean Convery, Darrin Miller

Reconnaissance (Cont.)

- There are ways to speed up the discovery of hosts on a /64 prefix
  - Ping FF02::1 may give results
  - Node Information Queries (RFC 4620) – BSD
  - Scanning for specific EUI-64 addresses using specific OUIs
  - Scanning IPv4 and getting IPv6 info
  - Scanning 6to4, ISATAP, Teredo addresses
  - Attackers may find one host and leverage the neighbor cache
- Attackers will look in other places for IPv6 addresses
  - DHCPv6 logs, DNS servers, server logs, NMSs, Google

IPv6 Privacy Addressing

- Privacy of addresses in an issue with IPv6
  - EUI-64 addresses are derived from the host's MAC
  - That could be used to track user's activity and thus identity
- Temporary host portions of an IPv6 address intended to protect the identity of the end-user
  - MD5 hash of the EUI-64 concatenated with a random number that can change over time
  - Different implementations rotate the address at different frequencies – can be disabled
- Forensics and troubleshooting are difficult with privacy addresses
- Dynamic DNS and firewall state will also need to update
- Difficulty creating granular firewall policy when IP addresses change often

IPv6 Attack Tools

- THC IPv6 Attack Toolkit

  - parasite6, alive6, fake_router6, redir6, toobig6, detect-new-ip6, dos-new-ip6, fake_mld6, fake_mipv6, fake_advertiser6, smurf6, rsmurf6
- Scanners
  - Nmap, halfscan6, Scan6, CHScanner
- Packet forgery
  - Scapy6, SendIP, Packit, Spak6
- DoS Tools
  - 6tunneldos, 4to6ddos, Imps6-tools

ICMPv6

- More powerful than ICMPv4
- ICMPv6 uses IPv6 extension header # 58 (RFC 2463)

Type	Description
1	Destination Unreachable
2	Packet to Big
3	Time exceeded
4	Parameter problem
128	Echo Request
129	Echo Reply
130	Multicast Listener Query – sent to ff02::1 (all nodes)
131	Multicast Listener Report
132	Multicast Listener Done – sent to ff02::2 (all routers)
133	Router Solicitation (RS) – sent to ff01::2 (all routers)
134	Router Advertisement (RA) – sent to ff01::1 (all nodes)
135	Neighbor Solicitation (NS) – sent to ff02:0:0:0:0:1:ff00::/104
136	Neighbor Advertisement (NA)
137	Redirect message

PING

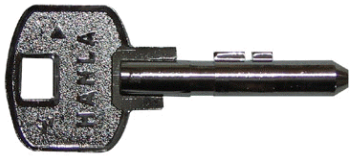
MLD

Prefix Advertisement

Router Redirection

ARP Replacement

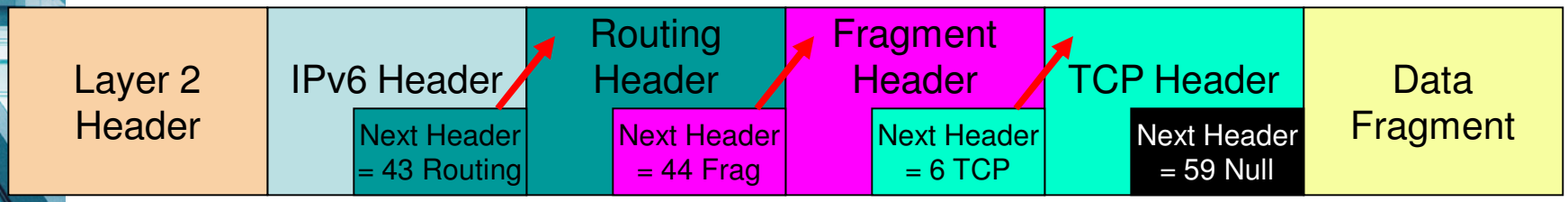
LAN Threats



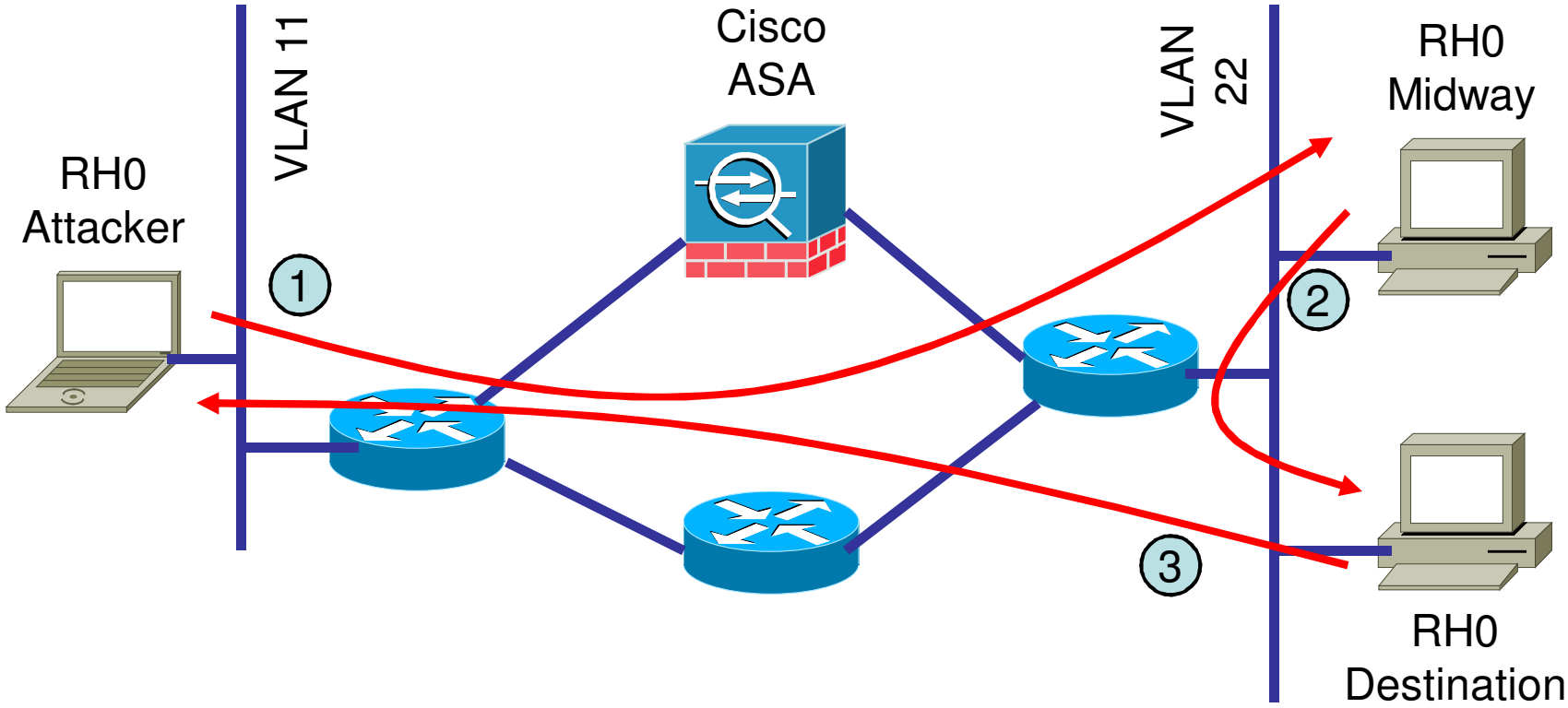
- IPv6 uses ICMPv6 for many LAN operations
  - Stateless auto-configuration
  - Neighbor Discovery Protocol (NDP)
  - IPv6 equivalent of IPv4 ARP
- Spoofed RAs can renumber hosts or launch a MITM attack
- Forged NA/NS messages to confuse NDP
- Redirects – same as ICMPv4 redirects
- Forcing nodes to believe all addresses are on-link
- DHCPv6 spoofing, resource consumption

Extension Headers (EHs)

- Extension Headers
  - Each header should not appear more than once with the exception of the Destination Options header
  - Hop-by-Hop extension header should only appear once.
  - Hop-by-Hop extension header should be the first header in the list because it is examined by every node along the path.
  - Destination Options header should appear at most twice (before a Routing header and before the upper-layer header).
  - Destination Options header should be the last header in the list if it is used at all.
- Header Manipulation – Crafted Packets
- Large chains of extension headers
  - Separate payload into second fragment
  - Consume resources - DoS
- Invalid Extension Headers – DoS



Routing Header 0 Attack

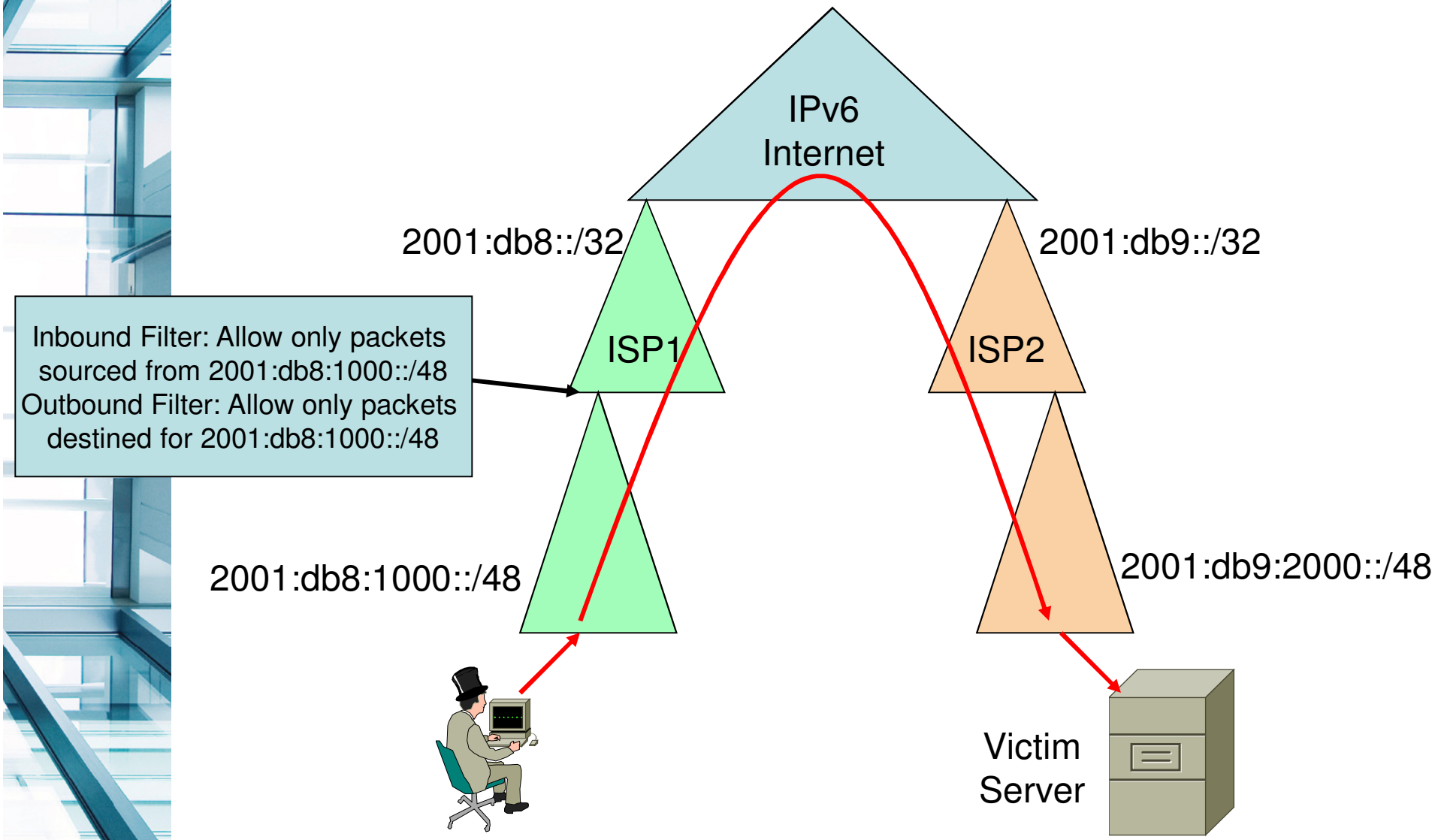


- Routers can be configured to block RH0
- Firewalls, Windows, Linux and MacOS all block RH0 by default

IPv6 Rate Limiting

- HbH option packets like “Router Alert” packets are processed by each network device along the forwarding path
  - Resource consumption attack potential
- ASR, ISR, CRS, 7600 can rate-limit IPv6 packets
- Attackers send packets that initiate ICMPv6 unreachable – resource consumption
  - Disable ICMPv6 unreachable messages on interfaces, null 0, and loopback 0
  - **`no ipv6 unreachables`**

Hierarchy and Traceback



Layer-3/4 Spoofing

- Spoofing of IPv6 packets is easy (Scapy6)
- IPv6 BOGON (Martians) Filtering
  - Filter traffic from unallocated space and filter router advertisements of bogus prefixes
  - Permit Legitimate Global Unicast Addresses
- Hierarchical addressing and ingress/egress filtering
- Use Inbound Infrastructure ACLs (iACLs) that deny packets sent to infrastructure IPv6 addresses
- Use IPv6 Receive ACL (rACLs) on Cisco devices
- Unicast-RPF Checks (BCP38/RFC 2827)

Transition Mechanism Threats

- Dual Stack - Preferred
  - You are only as strong as the weakest of the two stacks.
  - Running dual stack will give you at least twice the number of vulnerabilities
- Manual Tunnels - Preferred
  - Filter tunnel source/destination and use IPsec
  - If spoofing, return traffic is not sent to attacker
- Dynamic Tunnels
  - 6to4 Relay routers are “open relays”
  - ISATAP – potential MITM attacks
  - Attackers can spoof source/dest IPv4/v6 addresses
- Protocol Translation – Not recommended
- Deny packets for transition techniques not in use
  - Deny IPv4 protocol 41 forwarding unless that is exactly what is intended – unless using 6to4 tunneling
  - Deny UDP 3544 forwarding unless you are using Teredo-based tunneling

IPv6 Firewalls

- Don’t just use your IPv4 firewall for IPv6 rules
- Don’t just blindly allow IPsec or IPv4 Protocol 41 through the firewall
- Separate firewall policy for IPv6
- Look for vendors that support Extension Headers, Fragmentation, PMTUD, and granular filtering of ICMPv6 and multicast
- Some hosts may have multiple IPv6 addresses so this could make firewall troubleshooting tricky
- Layer-2/Transparent firewalls are more difficult to implement with IPv6 because of the required ICMPv6 ND/NS/NUD/RA/RS messages

IPv6-Capable Firewalls

- Many vendors already have IPv6 capabilities
  - Cisco Router ACLs, Reflexive ACLs, IOS-based Firewall, PIX, ASA
  - CheckPoint, Juniper, Fortinet, others
  - ip6tables, ip6fw, ipf, pf, pfSense, m0n0wall
  - Windows XP SP2, Vista IPv6 Internet Connection Firewall
- IPv6 firewalls may not have all the same full features as IPv4 firewalls
  - UTM/DPI/IPS/content filtering features may only work for IPv4
  - Vendors are working toward feature parity

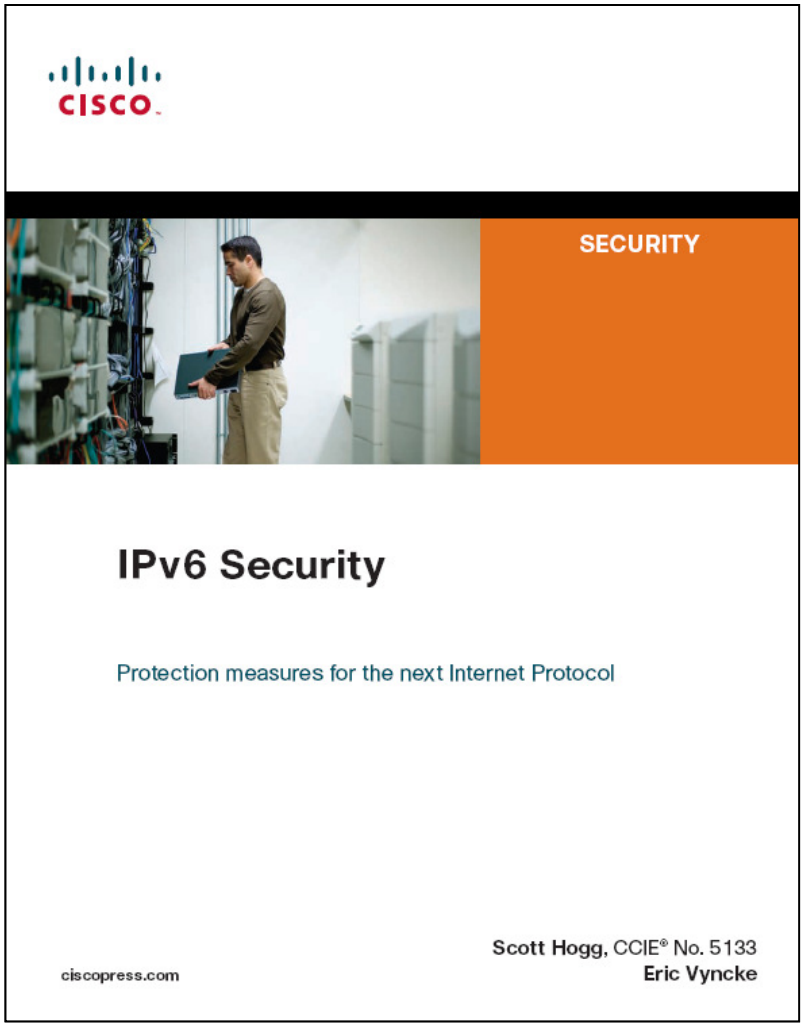
IPv6 Intrusion Prevention

- Few signatures exist for IPv6 packets
- IPSs should send out notifications when non-conforming IPv6 packets are observed
- Faulty parameters, bad extension headers, source address is a multicast address
- IPv6-Capable IPSs
  - Cisco 4200 IDS appliances, AIP (v7.X)
  - Sourcefire 3D IPS, Snort 2.8 Beta and 3.0 Alpha
  - Check Point IPS-1 (NFR Sentivist)
  - Juniper/NetScreen ScreenOS
  - IBM/ISS Proventia/RealSecure
  - Command Information Assure6
  - SandVine PTS 8210, PTS 14000, PTS 24000
  - Ipoque Protocol and Application Classification Engine (PACE) library for OpenDPI
  - Enterasys IPS

IPv6 Security Summary

- IPv6 is no more or less secure than IPv4
  - Lack of IPv6 knowledge and experience is a serious issue
- Learn about IPv6 and strive to achieve equal protections for IPv6 as with IPv4
- Ask your vendors about IPv6-capable products
- Use a NAC/802.1X solution and Ethernet port security while you wait for SEND
- Perform RFC2827-like IPv6 perimeter and Unicast Reverse Path Forwarding (Unicast RPF) checks throughout the network
- Use manual tunnels instead of dynamic tunnels and filter on tunnel endpoints
- Leverage IPsec for everything possible (No NAT)
- Deny packets for transition techniques not in use

IPv6 Security Book



shogg@gtri.com 303-949-4865