IPv6 Threats

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Document Markings

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Agenda

Overview and Context

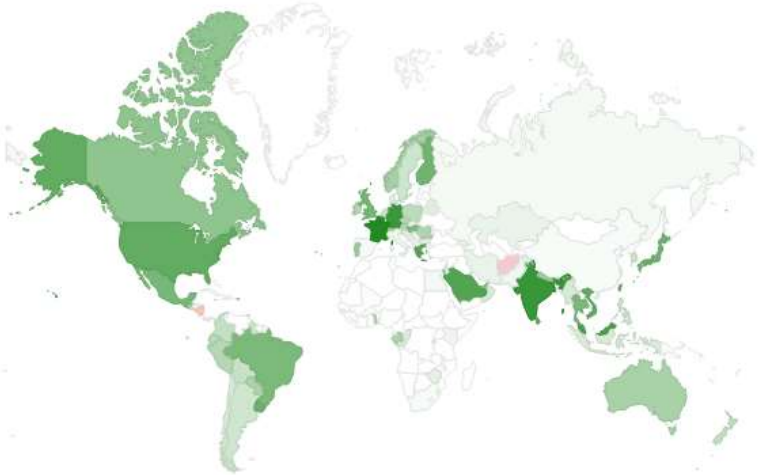
IPv6 and IPv4 Threat Comparison

IPv6 Attacks

Resources

Key Context for Threat Vectors

Per-Country IPv6 adoption



World | Africa | Asia | Europe | Oceania | North America | Central America | Caribbean | South America

The chart above shows the availability of IPv6 connectivity around the world.

- Regions where IPv6 is more widely deployed (the darker the green, the greater the deployment) and users experience infrequent issues connecting to IPv6-enabled websites.
- Regions where IPv6 is more widely deployed but users still experience significant reliability or latency issues connecting to IPv6-enabled websites.
- Regions where IPv6 is not widely deployed and users experience significant reliability or latency issues connecting to IPv6-enabled websites.

https://www.google.com/intl/en/ipv6/statistics.html#tab=per-country-ipv6-adoption

Additional Context for Threat Vectors

Mobile

- IPv6 support varies by carrier
- Most modern phones are capable of IPv6

Cloud

- The big cloud vendors support IPv6, but not universally on all their products and services
- Makes determination of what uses IPv6 and where difficult, plus it can change as support is added or modified

Transition Points

- Translation of IPv4 to IPv6 and vice versa
- Tunneling of various types

Additional Context for Threat Vectors

Experience and Implementation

- IPv6 policies and IPv4 policies may have similar goals but different implementations at Policy Enforcement Points (PEP).
  - Example: DNS traffic detection and response
  - Example: Firewall and router rules/ACLs
- Do operators and analysts have the experience with IPv6 that they have with IPv4?

IPv6 and IPv4 Similarities

Sniffing

Application Layer

Rogue Devices (Physical Layer)

Attacker-in-the-Middle

Flooding

Do you see a lot of IPv6 oddities? Will it be harder to baseline normal traffic?

https://www.hpc.mil/images/hpcdocs/ipv6/cisco_ipv6_and_ipv4_threat_comparison_and_best_practice_0304.pdf

IPv6 Attacks

Reconnaissance

- Huge number of addresses makes host and service discovery much different
- Attackers can use multicasts if not filtered at security boundaries
- Many IPv4 recommended practices like default deny, IP filtering, and more will still apply to IPv6

IPv6 Attacks

Unauthorized Access

- Site-to-site traffic may be direct instead of via VPN, resulting in potential eavesdropping or injection.
- Disparities between IPv4 PEPs (mature) and IPv6 PEPs (less mature) are likely to create issues.
- Temporary addresses can make ACLs and other controls more difficult to define and manage.
- Router advertisements can also be vulnerable without router advertisement guard (RA guard).

IPv6 Attacks

Header Manipulation and Fragmentation

- Header manipulation could potentially cause the default ”accept” of IPv6 packets to also process headers and forward the packet(s).
- RFC 2460 dictates that fragments should not overlap (different from IPv4), so they can be dropped if they do overlap.
- Out-of-order packets could still be potentially used to bypass detection, similar to IPv4 and old IDS evasions.

IPv6 Attacks

Spoofing Layer 3 and Layer 4

- Can use similar address filtering in IPv6 compared to IPv4 to prevent spoofing outside the source network range.
- The huge size of network ranges means attackers have lots of addresses to choose from even with address filtering in place.

IPv6 Attacks

ARP and DHCP attacks compared to IPv6

- Stateless configuration for IPv6 means DHCP does not have to be ubiquitous, but can still be an attack vector
- Neighbor Discovery Protocol (NDP) replaces ARP
- NDP can use Securing Neighbor Discovery (SEND) as a security extension – RFC 3971 and RFC 6494

IPv6 Attacks

Routing and Router Protocol Attacks

- Mismatched vendor implementations could cause issues.
- Routing protocols are spotty in terms of how they handle IPv6
  - BGP and Intermediate System to Intermediate System (IS-IS) both extended to support IPv6 to some degree.
  - OSPF and RIP need IPsec
- Example: CVE-2020-16898 “Bad Neighbor” attack allows remote code execution on Windows because of improperly handled ICMPv6 Router Advertisement packets

IPv6 Attacks

Translation, Transition, and Tunneling

- Tunneling can be used for evasion of detection rules or protection rules (e.g. firewall rules)
- Translation can also make it more difficult to trace attacks for cyber threat intelligence purposes
- Automatic tunneling may not be secure (packet forgery, DoS?)
- Example: Windows IPv6 or 6to4 tunnel for Windows SMB to bypass firewall IPv4 firewall rules. See “Exfiltration with IPv6 tunnels on Windows” at https://insights.sei.cmu.edu/blog/exfiltration-with-ipv6-tunnels-on-windows/
- Other examples?

Other Concerns

Automatic addressing (SLAAC) and other options for IPv6 introduce a lot of flexibility, which in turn makes asset management, ACLs, and understanding topology more difficult.

NDP can be susceptible to Denial-of-Service (accidentally or on purpose) through cache exhaustion.

Resources

CISA's "Internet Protocol Version 6 Considerations for Trusted Internet Connections 3.0"

- https://www.cisa.gov/sites/default/files/publications/CISA%20IPv6%20Considerations%20for%20TIC%203.0.pdf

Cisco's "IPv6 and IPv4 Threat Comparison and Best-Practice Evaluation"

- https://www.hpc.mil/images/hpcdocs/ipv6/cisco_ipv6_and_ipv4_threat_comparison_and_best_practice_0304.pdf

RFC 3971 and RFC 6494 (and more)

- https://www.rfc-editor.org/rfc/rfc3971.html
- https://www.rfc-editor.org/rfc/rfc6494