

Training Course: Hacking IPv6 Networks v4.0

Instructor: Fernando Gont

Overview

The IPv6 protocol suite has been designed to accommodate the present and future growth of the Internet, by providing a much larger address space than that of its IPv4 counterpart, and is expected to be the successor of the original IPv4 protocol suite. The imminent exhaustion of the IPv4 address space has resulted in the deployment of IPv6 in a number of production environments, with many other organizations planning to deploy IPv6 in the short or near term.

There are a number of factors that make the IPv6 protocol suite interesting from a security standpoint. Firstly, being a new technology, technical personnel has much less confidence with the IPv6 protocols than with their IPv4 counterparts, and thus it is likely that the security implications of the protocols be overlooked when they are deployed on production networks. Secondly, IPv6 implementations are much less mature than their IPv4 counterparts, and thus it is very likely that a number of vulnerabilities will be discovered in them before their robustness matches that of the existing IPv4 implementations. Thirdly, security products such as firewalls and NIDS's (Network Intrusion Detection Systems) usually have less support for the IPv6 protocols than for their IPv4 counterparts. Fourthly, the security implications of IPv6 transition/co-existence technologies on existing IPv4 networks are usually overlooked, potentially enabling attackers to leverage these technologies to circumvent IPv4 security controls in unexpected ways.

The imminent global deployment of IPv6 has created a global need for security professionals with expertise in the field of IPv6 security, such that the aforementioned security issues can be mitigated.

While there exist a number of training courses about IPv6 security, they either limit themselves to a high-level overview of IPv6 security, and/or fail to cover a number of key IPv6 technologies that are vital in all real IPv6 deployment scenarios. During the last few years, SI6 Networks has offered its flagship course “Hacking IPv6 Networks”, providing in-depth hands-on IPv6 security training to networking and security professionals around the world.

Hacking IPv6 Networks (version 4.0) is a renewed edition of SI6 Networks' IPv6 security training course, with an a tremendous increase in hands-on exercises, and newly incorporated materials based on recent developments in the area of IPv6 security. The training is carried out by **Fernando Gont**, a renowned IPv6 security researcher.

Learning Objectives

This course will provide the attendee with in-depth knowledge about IPv6 security, such that the attendee is able to evaluate and mitigate the security implications of IPv6 in production environments.

The attendee will be given an in-depth explanation of each topic covered in this course, and will learn -- through hands-on exercises -- how each feature can be exploited for malicious purposes. Subsequently, the attendee will be presented with a number of alternatives to mitigate each of the identified vulnerabilities.

This course will employ a range of open source tools to evaluate the security of IPv6 networks, and to reproduce a number of IPv6-based attacks. During the course, the attendee will perform a large number of exercises in a network laboratory (with the assistance of the trainer), such that the concepts and techniques learned during this course are reinforced with hands-on exercises. The attendee will be required to perform a large number of IPv6 attacks, and to envision mitigation techniques for the corresponding vulnerabilities.

Who Should Attend

Network Engineers, Network Administrators, Security Administrators, Penetration Testers, and Security Professionals in general.

Participants Are Required To

Participants are required to have a good understanding of the IPv4 protocol suite (IPv4, ICMP, ARP, etc.) and of related components (routers, firewalls, etc.). Additionally, the attendee is expected to have knowledge about basic IPv4 troubleshooting tools, such as: ping, traceroute, and network protocol analyzers (e.g., tcpdump). Basic knowledge of IPv6 is desirable, but not required.

What to bring

Attendees willing to perform the hands-on exercises are expected to bring a laptop with VirtualBox already installed, and an empty memory stick (of at least 8 GB) or a DVD drive. The minimum requirements for the laptop are: Intel Core Duo, 1.66 GHz, 4GB of RAM. Ethernet and WI-FI network interface cards.

Course Length

3 days

Topics covered by this course

- **Introduction to IPv6**
 - IPv4 address exhaustion
 - IPv6 service
 - IPv6 transition/deployment mechanisms
 - IPv6: current state of affairs
 - Brief comparison between IPv6 and IPv4
 - IPv6 security overview

- **IPv6 Addressing Architecture**
 - IPv6 address types
 - IPv6 address analysis
 - Implications for address scanning attacks & possible mitigations
 - Privacy implications & possible mitigations
 - Implications for end-to-end connectivity

- **IPv6 Header Fields**
 - IPv6 header overview
 - Basic header fields
 - Security assessment

- **IPv6 Extension Headers (EHs)**
 - General implications of EHs
 - Security implications of specific IPv6 EHs
 - Security implications of specific IPv6 options
 - IPv6 EHs in the real world
 - Exploitation of IPv6 EHs
 - Troubleshooting IPv6 EHs
 - Network reconnaissance with IPv6 EHs
 - Recent advances

- **IPsec**
 - Virtual Private Network (VPN) traffic leakages

- **Internet Control Message Protocol version 6 (ICMPv6)**
 - ICMPv6 error messages
 - ICMPv6 informational messages
 - Network reconnaissance with ICMPv6

- **Neighbor Discovery for IPv6**
 - Address resolution in IPv6
 - Address resolution messages and options

- Neighbor Discovery cache
- Neighbor Discovery attacks
- Neighbor Discovery security controls
- Evasion of Neighbor Discovery security controls
- System configuration options

- **Stateless Address Auto-configuration (SLAAC)**
 - SLAAC operation
 - SLAAC messages and options
 - Duplicate Address Detection (DAD)
 - Troubleshooting SLAAC
 - SLAAC attacks
 - DAD attacks
 - SLAAC security controls
 - Evasion of SLAAC security controls
 - System configuration options

- **Dynamic Host Configuration Protocol version 6 (DHCPv6)**
 - Sample DHCPv6 traffic
 - Security implications of DHCPv6
 - DHCPv6 attacks
 - DHCPv6 security controls

- **Multicast Listener Discovery (MLD)**
 - Sample MLD traffic
 - Security implications of MLD
 - MLD attacks
 - MLD security controls

- **Upper-Layer Attacks**
 - TCP-based attacks
 - UDP-based attacks
 - Possible mitigations

- **DNS Support for IPv6**
 - Network reconnaissance
 - Exploiting DNS reverse mappings

- **IPv6 Firewalls**
 - Known limitations
 - Evasion of IPv6 firewalls

- **Security Implications of IPv6 for IPv4-only Networks**
 - IPv6 attacks on IPv4-only networks
 - Mitigating IPv6 attacks on IPv4-only networks

- **Transition/Co-existence Technologies**
 - Automatic tunneling mechanisms
 - Attacks on automatic tunneling mechanisms
 - Mitigations

- **Network Reconnaissance in IPv6**
 - Host scanning in IPv6
 - Port scanning in IPv6

- **IPv6 Deployment Considerations**
 - Designing an IPv6 address plan
 - Operating System hardening
 - Other considerations

About the Instructor

Fernando Gont specializes in the field of communications protocols security, working for private and governmental organizations from around the world.

Gont has worked on a number of projects for the UK National Infrastructure Security Co-ordination Centre (NISCC) and the UK Centre for the Protection of National Infrastructure (CPNI) in the field of communications protocols security. As part of his work for these organizations, he has written a series of documents with recommendations for network engineers and implementers of the TCP/IP protocol suite, and has performed the first thorough security assessment of the IPv6 protocol suite.

Gont is currently working as a security consultant and researcher for SI6 Networks (<http://www.si6networks.com>). Additionally, he is a member of the Centro de Estudios de Informatica (CEDI) at Universidad Tecnológica Nacional/Facultad Regional Haedo (UTN/FRH) of Argentina, where he works in the field of Internet engineering. As part of his work for these organizations, he is active in several working groups of the Internet Engineering Task Force (IETF), and has published more than 20 IETF RFCs (Request For Comments) and more than a dozen IETF Internet-Drafts. Gont has also produced the SI6 Network's IPv6 Toolkit (<http://www.si6networks.com/tools/ipv6toolkit> -- a portable and comprehensive security toolkit for the IPv6 protocol suite), and runs the IPv6 Hackers mailing-list (<http://www.ipv6hackers.org>).

Gont has been a speaker at a number of conferences and technical meetings about information security, operating systems, and Internet engineering, including: CanSecWest 2005, Midnight Sun Vulnerability and Security Workshop/Retreat 2005, FIRST Technical Colloquium 2005, Kernel Conference Australia 2009, DEEPSEC 2009, HACK.LU 09, HACK.LU 2011, DEEPSEC 2011, IETF 83, LACSEC 2012, Hackito Ergo Sum 2012, Hack In Paris 2013, German IPv6 Kongress 2014, H2HC 2014, and Troopers 2014. Additionally, he is a regular attendee of the Internet Engineering Task Force (IETF) meetings.

More information about Fernando Gont is available at his personal web site: <http://www.gont.com.ar>.

Fernando Gont's contact information & bio

e-mail:

fgont@si6networks.com || fernando@gont.com.ar

web:

<http://www.si6networks.com> || <http://www.gont.com.ar>

Linkedin Profile:

<https://www.linkedin.com/in/fernandogont>

Employer and/or affiliations:

SI6 Networks

Brief biography:

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More information about Fernando Gont is available at his personal web site:
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“IPv6 Extension Headers in the Wild”. 10th SLO IPv6 Summit. June 9th, 2015. Ljubljana, Slovenia.

“Reflections on IPv6 Security”. 10th SLO IPv6 Summit. June 9th, 2015. Ljubljana, Slovenia.

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“Network Security Defense”. 8th Regional CaribNOG Meeting. September 29-October 3, 2014. Willemstad, Curacao.

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“IPv6 Network Security Assessment and Trouble-shooting”. IPv6 Security Summit 2014. June 12, 2014. Ljubljana, Slovenia.

“IPv6 Fragmentation and IPv6 Extension Headers in the Real World”. IPv6 Kongress 2014. May 22-23, 2014. Frankfurt, Germany.

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“Practical Security Assessment of IPv6 Networks and Devices”. IPv6 Security Summit, Troopers 14. March 17-18, 2014. Heidelberg, Germany.

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“Tutorial: Seguridad IPv6”. Tutorial. LACNIC XV, May 15-20, 2011. Cancun, Mexico.

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“Introducción a la Internet Engineering Task Force (IETF)”. INET 2010. Montevideo, Julio 2, 2010, Uruguay.

“An Overview of IPv6 Transition/Co-existence Technologies”. LACNOG 2010, October 19-22, 2010. Sao Paulo, Brazil.

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“Moving the Endpoint Identifier (EID) Option to Obsolete Status”. 79th IETF Meeting, November 7-12, 2010. Beijing, China.

“Security Assessment of the IPv6 Flow Label”. 79th IETF Meeting, November 7-12, 2010. Beijing, China.

“Mitigating Teredo Routing Loop Attacks”. 79th IETF Meeting, November 7-12, 2010. Beijing, China.

“Deprecation of ICMP Source Quench messages”. 79th IETF Meeting, November 7-12, 2010. Beijing, China.

“Results of a Security Assessment of the Internet Protocol (IP)”. UK CPNI offices, April 23, 2009. London, United Kingdom.

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“Results of a Security Assessment of the TCP and IP protocols and Common Implementation Strategies”. BSDCan 2009 Conference, May 8-9, 2009. Ottawa, Canada.

“Security Assessment of the Transmission Control Protocol (TCP)”. LACNIC XII, May 25-29, 2009. Panama City, Panama.

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“Security Assessment of Common Implementation Strategies of the TCP and IP Protocols”. Kernel Conference Australia 2009, July 15-17, 2009. Brisbane, Australia.

“Some insights about the recent TCP DoS (Denial of Service) vulnerabilities”. HACK.LU 09 Conference, October 28-30, 2009. Luxembourg.

“Ongoing work at the IETF on TCP and IP security” (lightning talk). HACK.LU 09 Conference, October 28-30, 2009. Luxembourg.

“TCP for DNS security considerations”. 76th IETF Meeting, November 9-13, 2009. Hiroshima, Japan.

“Security Assessment of the Internet Protocol version 4”. 76th IETF Meeting, November 9-13, 2009. Hiroshima, Japan.

“Recommendations for filtering ICMP messages”. 76th IETF Meeting, November 9-13, 2009. Hiroshima, Japan.

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“Servicios de directorio de Internet”, Congreso Internacional de Ingeniería en Computación, September 23- 26, 2008, Ixtlahuaca, México.

“Redes móviles”, foro realizado en el marco del Congreso Internacional de Ingeniería en Computación, September 23-26, 2008. Ixtlahuaca, México.

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“Results of a Security Assessment of the TCP & IP Protocols”. ekoparty Security Conference - 4th edition, October 2-3, 2008. Buenos Aires, Argentina.

“Port randomization”, 73rd IETF Meeting, November 16-21, 2008. Minneapolis, MN, USA.

“ICMP attacks against TCP”, 73rd IETF Meeting, November 16-21, 2008. Minneapolis, MN, USA.

“On the generation of TCP timestamps”, 73rd IETF Meeting, November 16-21, 2008. Minneapolis, MN, USA.

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“Mejoras de seguridad en TCP”, Evento de Seguridad Informática, LACNIC X, May 21-25, 2007, Isla Margarita, Venezuela.

“Ataques ICMP contra TCP”, Jornada de Seguridad Informática organizada por ANTEL, August 15, 2007. Montevideo, Uruguay.

“Randomización de puertos”, Jornada de Seguridad Informática organizada por ANTEL, August 15, 2007. Montevideo, Uruguay.

“Improving TCP’s Resistance to Blind Attacks through Ephemeral Port Randomization”, CACIC 2007, II Workshop de Arquitecturas, Redes y Sistemas Operativos, October 1-5, 2007. Corrientes y Resistencia, Argentina.

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“Mejorando la seguridad de TCP/IP mediante aleatorización de parámetros de protocolo”, ekoparty security conference, November 30 and December 1, 2007. Buenos Aires, Argentina.

“Ataques ICMP contra TCP” (videoconferencia), June 6th, 2006, Buenos Aires, Argentina, sponsored by the Argentinian Section of the IEEE, The Argentinian Chapter of the IEEE Computer Society, and RETINA. (<http://vc.ieee.org.ar/abstract-vc-gont-retina-06-06.txt>)

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“Reacción de TCP a errores ICMP”, Primeras Jornadas de Divulgación Electrónica de UTN/FRH. October 23-26, 2006, Buenos Aires, Argentina.

“Ataques de reseteo de conexión contra TCP”, Primeras Jornadas de Divulgación Electrónica de UTN/FRH. October 23-26, 2006, Buenos Aires, Argentina.

“TCP UTO (User Timeout Option)”, 67th IETF Meeting, November 5-10, 2006, San Diego, CA, U.S.A.

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“Hackeando TCP”, Ciclo de charlas abiertas, UTN/FRH, August 2005, Buenos Aires, Argentina.

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“Ataques ICMP contra TCP”, CaFeConf 2005 (4tas Jornadas de Software Libre y GNU/Linux), October 2005, Buenos Aires, Argentina.

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“ICMP attacks against TCP”, 64th IETF Meeting, November 6-11, 2005, Vancouver, BC, Canada.

“TCP’s reaction to soft errors”, 64th IETF Meeting, November 6-11, 2005, Vancouver, BC, Canada.

“TCP User Timeout Option”, 64th IETF Meeting, November 6-11, 2005, Vancouver, BC, Canada.