Netfilter and Encrypted, Non-Replayable, Spoofable, Single Packet Remote Authorization

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Agenda

- Vulnerabilities and trends
- Target enumeration
- Single Packet Authorization (SPA)
- Fwknop design and implementation
- Live demo
- Future development

Vulnerability Goulash

- IPsec ESP Information Leak Vulnerability
- Cisco IOS Firewall Authentication Proxy Buffer Overflow Vulnerability
- Check Point FW-1 Authentication Vulnerability
- OpenSSH 3.x scp Input Validation Vulnerability
- OpenSSH 3.x CRC32 Overflow

Potential Compromise vs. Convenience

- 50 new vulnerabilities per day
  - http://www.securityfocus.com/bid
  - http://www.idefense.com
- Authorization methods and strong encryption is not enough
- VPN access is essential!

Target Enumeration

```
#  nmap -P0 -p T:22,256 -sS -sV 192.168.10.1
Starting nmap 3.81 ( http://www.insecure.org/nmap/ ) at
2005-08-04 22:06 EDT
Interesting ports on 192.168.10.1:
PORT   STATE SERVICE VERSION
22/tcp     open     ssh     OpenSSH 3.9p1 (protocol 2.0)
256/tcp   closed   FW1-secureremote
Nmap finished: 1 IP address (1 host up) scanned in 0.139
seconds
```

Target Enumeration (cont'd)

```
# host www.yahoo.com
www.yahoo.akadns.net has address 216.109.117.206
```

```
# whois  216.109.117.206 | grep CIDR
CIDR:       216.109.112.0/20
```

```
# nmap -P0 -p T:22,256 -sS -sV -T Aggressive
216.109.112.0/20
```

Default Drop

```
# iptables -I INPUT 1 -p tcp --dport 22 -j DROP
```

Single Packet Authorization (SPA)

- Use packet filters to minimize execution paths
- Passive monitoring of packet data (all hail libpcap!)
- No traditional “server”

Single Packet Authorization (cont'd)

- Asymmetric or symmetric encryption
- Authorization packets can be spoofed
- Any IP protocol can be used
- Up to minimum MTU for data transmission
- Works across NAT

Single Packet Authorization vs. Port Knocking

- Both techniques use packet filters
- Much more data can be sent with SPA
- Protocols without a notion of a “port” can be used
- No port sequences to bust
- Replay attacks easily thwarted
- More difficult to detect (nothing to mistakenly identify as a port scan)

Fwknop

- pcap, file_pcap, Netfilter pcap writer data collection methods
- Rijndael symmetric block cipher
- Packets prepended with 16 bytes of random data
- Supports multiple remote users
- Message integrity verified via internal MD5 sum
- Integrates with NAT

Fwknop (cont'd)

- Built-in spoofing capability (Net::RawIP)
- Supports TCP, UDP, ICMP (default UDP/62201)
- Message replays stopped via MD5 sum cache
- Integrates with Netfilter policy via custom chains
- Supports access and command modes

Fwknop (con'td)

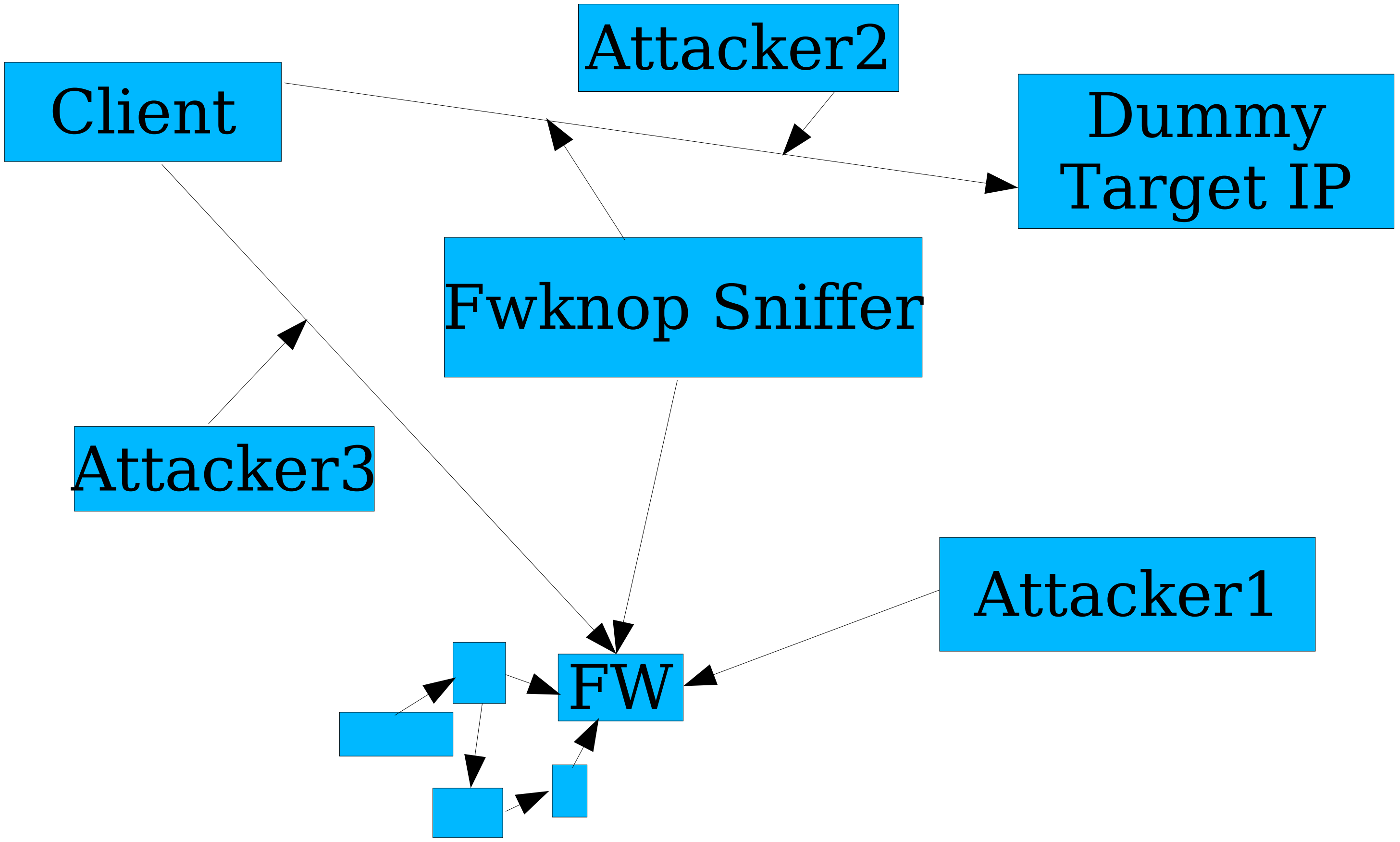
- Client runs on Linux, OS X, and FreeBSD (others?)
- Installer preserves configs across upgrades
- Server supports syslog messages and email alerts

```
Sep 13 21:15:58 orthanc fwknop: received valid encrypted packet
from: 192.168.10.2, remote user: mbr

Sep 13 21:15:58 orthanc fwknop: adding FWKNOP_INPUT ACCEPT
rule for 192.168.10.2 -> tcp/22 (10 seconds)

Sep 13 21:16:09 orthanc fwknop: removed iptables FWKNOP_INPUT
ACCEPT rule for 192.168.10.2 to tcp/22, 10 second timeout exceeded
```

Deployment Architecture



Fwknop Usage

- Standard /etc init script for server mode
- Debug modes for both client and server

- fwknop -A tcp/22,tcp/256 --Spoof-src www.yahoo.com -a <MY IP> -k <target>
- fwknop --Server-cmd "ping -c 3 www.yahoo.com" -s -k <target>

Packet Format

Random data: 7808936091987532

Username: mbr

Timestamp: 1123247144

Version: 0.9.1

Action: 1 (access mode)

Access: 0.0.0.0,tcp/22

MD5 sum: y6tuSWoS+py7ppsESNR78A

7808936091987532:mbr:1123247144:0.9.1:
0.0.0.0,tcp/22:y6tuSWoS+py7ppsESNR78A

Encrypted Packets

udp/62201 (128 bytes):

**Hul72UvwLqLqxiQLfTi7nXyjqIr37s8R9/JrYGcaP9PI4
ADNK9pqeFghA20pXHwdpQf/TAbxt1L+GSwAkJBSP
0USBRm6IK87+xBaVRpb9UNJ8HUw3DsRTXpcYXtq
rPQP**

**ISTLpc2VMs2jGOJsJOAwIWxKChKUOMS88PttezX6
u7TCsd7KVgzOIvjPRuSckjP/tbInEeMUK+53tKfvifNI
X5vODinG5Cyi96XZThF2NO53dWN1dzQMv3dwPfbZ
dCab**

Netfilter Integration

- Compatible with existing policy
- Most effective with connection tracking enabled
- Custom fwknop chains (FWKNOP_INPUT)
- Optional data collection via ULOG target

Example Netfilter Policy

```
Chain INPUT (policy ACCEPT)

FWKNOP_INPUT  all  --  0.0.0.0/0   0.0.0.0/0

ACCEPT               all  --  0.0.0.0/0   0.0.0.0/0    state
                                             RELATED,ESTABLISHED

ACCEPT     tcp  --  192.168.10.3     0.0.0.0/0      tcp dpt:80

ULOG    udp  --  0.0.0.0/0    0.0.0.0/0   udp dpt:62201 ULOG
copy_range 0 nlgroup 1 prefix `FWKNOP' queue_threshold 1


Chain FWKNOP_INPUT (1 references)

ACCEPT     tcp  --  *     *    192.168.10.2   0.0.0.0/0  tcp dpt:22
```

Fwknop Server Config

- fwknop.conf
  - Defines data collection mode, email alert address(es), and file paths
- access.conf
  - Defines access controls for fwknop clients

fwknop.conf

```
EMAIL_ADDRESSES              mbr@cipherdyne.org;
AUTH_MODE                    ULOG_PCAP;
PCAP_INTF                    eth1;
ENABLE_PCAP_PROMISC          Y;
PCAP_FILTER                  udp port 62201;
PCAP_PKT_FILE                /var/log/ulogd.pcap;
ENABLE_MD5_PERSISTENCE       Y;
```

access.conf

```
SOURCE: ANY;
DATA_COLLECT_MODE: ULOG_PCAP;
OPEN_PORTS: tcp/22;
PERMIT_CLIENT_PORTS: Y;
#ENABLE_CMD_EXEC: Y;
#CMD_REGEX: echo\s+\S+\s*>>;
KEY: <encryptkey>;
FW_ACCESS_TIMEOUT: 10;
REQUIRE_USERNAME: mbr;
```

IDS Alert Reduction

- Most IDS's are stateful
- Sessions can only be established after authorization

Live Demo…

Disadvantages

- Additional key management
- Some services not readily compatible
- Session “piggy backing”
- Adds extra layer and associated time delay
- Authorization packets not transferred over reliable communication mechanism

Future Development

- Integration with PGP/GPG key rings
- Add support for existing authentication infrastructure (LDAP, Kerberos, Radius, etc.)
- Client integration (SSH, Web browsers)
- GUI development
- Potential kernel stack extensions (NDIS driver on Windows, IP stack patch for Linux)

Questions?

http://www.cipherdyne.org/fwknop/

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