Advances In Single Packet Authorization

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Agenda

- Vulnerabilities vs. IDS/IPS
- Why another authentication / authorization method?
- Single Packet Authorization (SPA)
- Fwknop design and implementation
- New Features
- Disadvantages
- Future directions
- Live demo

Security Software Vulnerabilities

- Cisco IOS Firewall Authentication Proxy Buffer Overflow Vulnerability
- IPsec ESP Information Leak Vulnerability
- Check Point FW-1 Authentication Vulnerability
- OpenSSH GSSAPI Credential Disclosure Vulnerability

Cleartext IDS Over Encrypted Protocols

- WEB-MISC SSLv3 invalid timestamp attempt
- EXPLOIT SSLv2 Client_Hello with pad Challenge Length overflow attempt
- EXPLOIT gobbles SSH exploit attempt
- EXPLOIT ssh CRC32 overflow NOOP
- EXPLOIT ssh CRC32 overflow filler

Cleartext IDS Over Encrypted Protocols (cont'd)

```
print 'A'x1000;
```

```
(.)\1{500}
```

Target Enumeration

```
# 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
```

Why Another Auth Method?

- Existing methods assume TCP/IP stack access
- Some application layer functions are available
- Strong crypto NOT enough
- Nmap

Goal: Minimize Available Code Paths

- Packet filters
- Stateful firewalls

```
# iptables -I INPUT 1 -j DROP
```

Main Question

Are DEFAULT DENY packet filters and simultaneous authenticated access compatible?

Answer: YES

- Authentication information passively collected (firewall logs, passive OS fingerprinting, netlink sockets, libpcap, libipq, etc.)
- Packet filter is dynamically reconfigured to allow temporary access
- Port Knocking

Single Packet Authorization

- Default deny stance for all protected services
- Packet filters reconfigured after SPA packet is received
- Uses passive monitoring strategy from the IDS world
- Encrypted, non-replayable, spoofable
- Any IP protocol can be used
- Up to minimum MTU number of bytes

Single Packet Authorization (cont')

- Integrates well with long-running protocols
- Adds authorization to previously unauthorized sessions
- Reduces false positive potential
- Nmap by itself cannot detect protected services (requires **some** packet to be generated in response to a scan).
- 0-day vulnerabilities more difficult to exploit

Single Packet Authorization vs. Port Knocking

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

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
- Not well suited to client protection
- libpcap vulnerabilities

Fwknop

- pcap, file_pcap, Netfilter pcap writer data collection methods
- Supports Rijndael and GnuPG
- Packets prepended with 16 bytes of random data
- Message integrity verified via internal MD5 sum

Fwknop (cont'd)

- Integrates with NAT
- Built-in spoofing capability (Net::RawIP)
- Supports TCP, UDP, ICMP (default UDP/62201)
- Message replays stopped via MD5 sum cache

Fwknop (cont'd)

- Integrates with Netfilter policy via custom chains
- Supports access and command modes

New Features

- Supports multiple remote users and GPG signing keys
- OpenSSH-4.2p1 client integration
- Server side UNIX crypt() verification
- NAT Man-in-the-middle attacks prevented through automatic IP resolution via http://www.whatismyip.com/
- Client and server components separated (fwknop and fwknopd)

GPG Keys

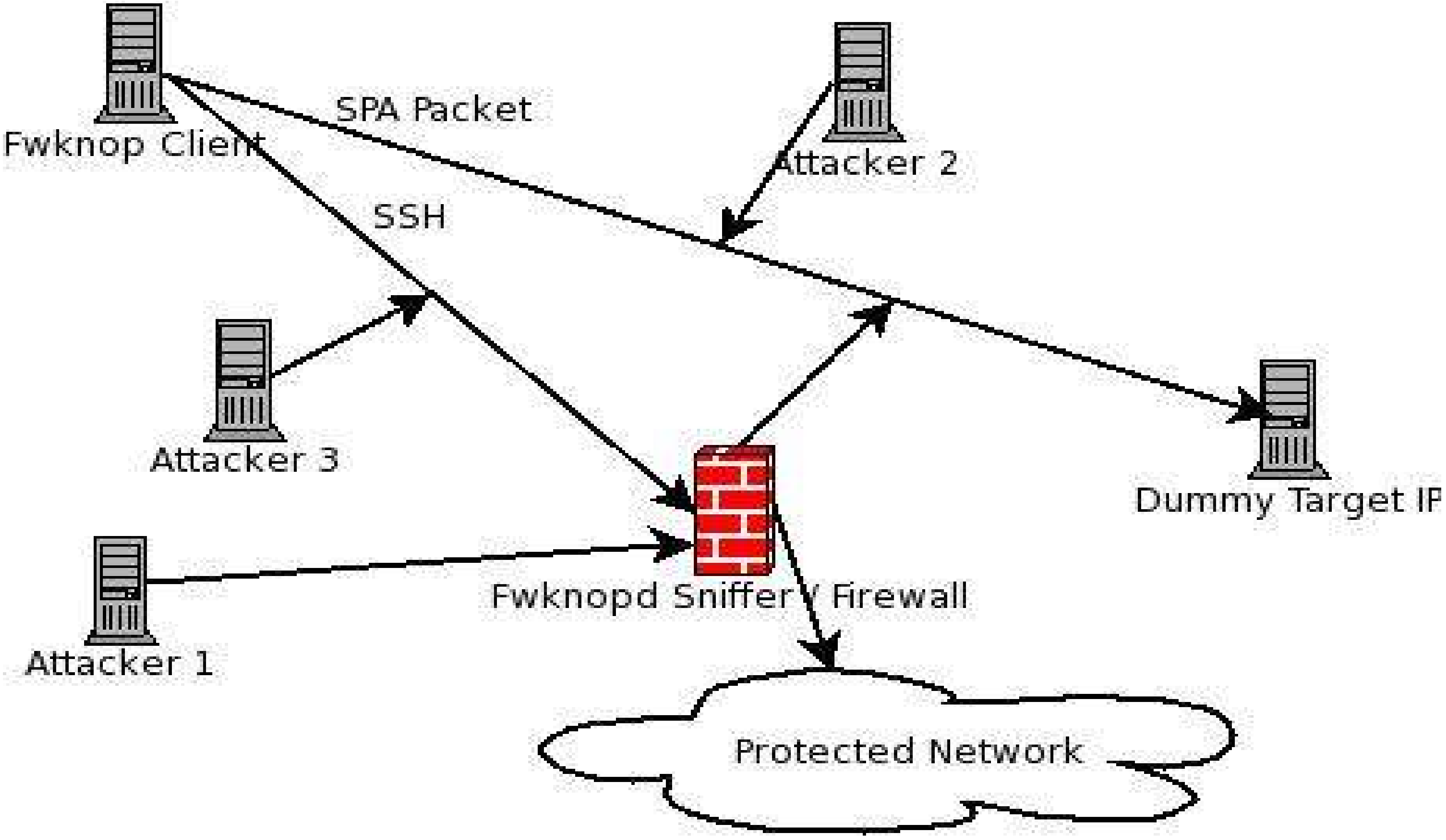
```
[fwknopd]$  gpg --gen-key
[fwknopd]$  gpg -a --export <keyID> > server.asc
[fwknopd]$  gpg --import client.asc
[fwknopd]$  gpg --edit-key <clientKeyID>
Command> sign
```

SSH Usage

```
$ ssh -K “-A tcp/22 --gpg-recip ABCD1234 --gpg-sign 1234ABCD -w” user@host
GPG signing password:
    ->(netfilter reconfigured)<-
Password:


$ ssh -K “--last” user@host
```

Deployment Architectures



Packet Format

Random data: 7808936091987532

Username: mbr

Timestamp: 1123247144

Version: 0.9.6

Action: 1 (access mode)

Access: 123.123.123.123,tcp/22

MD5 sum: y6tuSWoS+py7ppsESNR78A

<optional server authentication criteria>

7808936091987532:mbr:1123247144:0.9.6:

0.0.0.0,tcp/22:y6tuSWoS+py7ppsESNR78A

Encrypted (Rijndael) 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
- Custom fwknop chains (FWKNOP_INPUT)
- Most effective with connection tracking enabled
- Optional data collection via ULOG target

Example Netfilter Policy

```
Chain INPUT (policy DROP)

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
```

/etc/fwknop/fwknop.conf

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

/etc/fwknop/access.conf

```
SOURCE: ANY;
DATA_COLLECT_MODE: PCAP;
OPEN_PORTS: tcp/22;
PERMIT_CLIENT_PORTS: Y;
#ENABLE_CMD_EXEC: Y;
KEY: <encryptkey>;
GPG_DECRYPT_ID: ABCD1234;
GPG_DECRYPT_PW: <password>;
GPG_REMOTE_ID: 1234ABCD;
FW_ACCESS_TIMEOUT: 10;
REQUIRE_USERNAME: mbr;
```

IDS Alert Reduction

- Most IDS's are stateful
- Sessions can only be established after authorization
- Less probability of arbitrary malicious sessions

Future Directions

- Add support for additional authentication infrastructures (LDAP, Kerberos, Radius, etc.)
- Additional client integration (VPN clients, Web browsers)
- GUI development
- Potential kernel stack extensions (NDIS driver on Windows, IP stack patch for Linux)

Live demo…

Questions?

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

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