Service Cloaking and Anonymous Access; Combining Tor with Single Packet Authorization (SPA)

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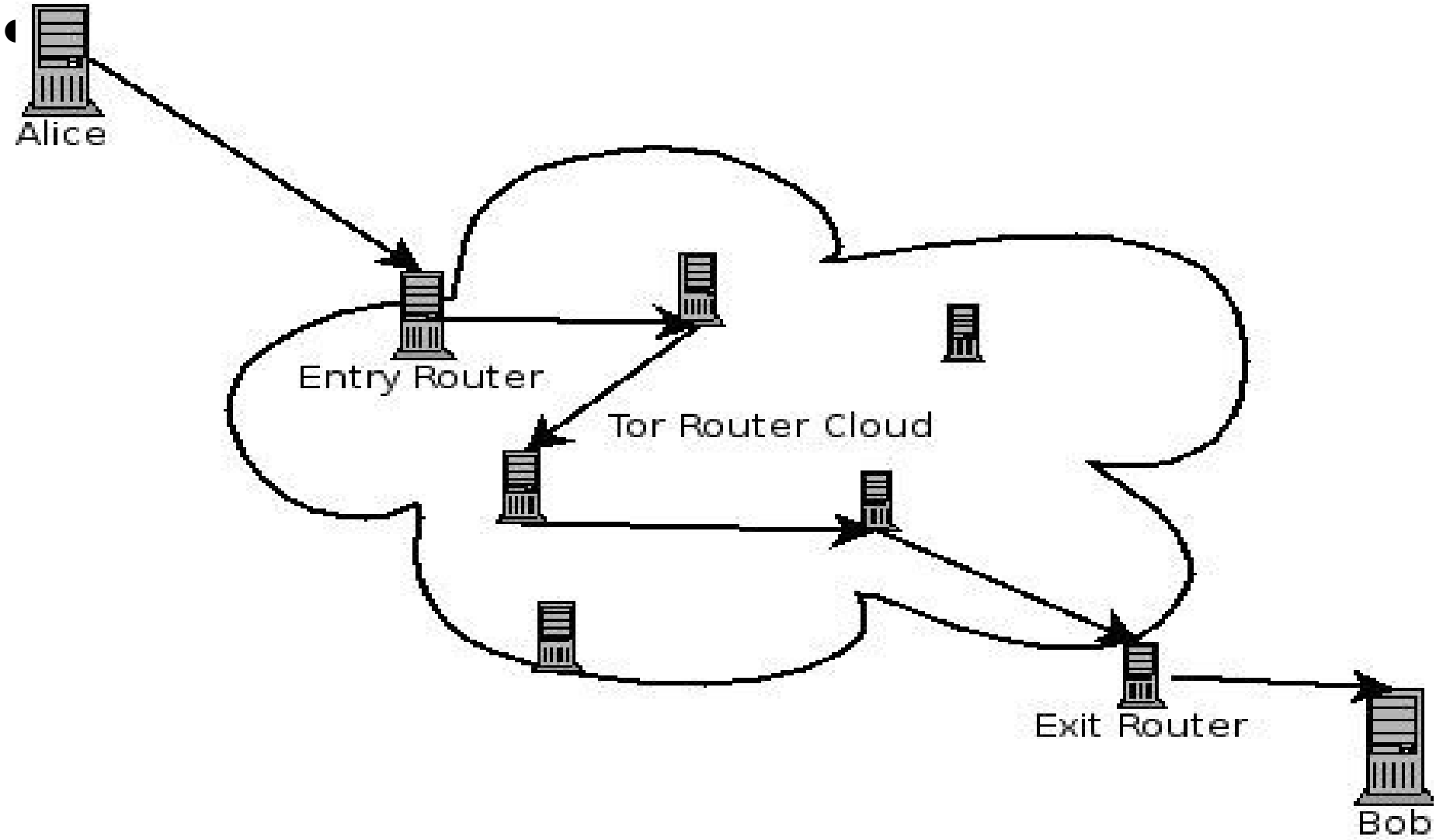
Agenda

- The Onion Router (Tor) and anonymous service access
- Default-drop packet filters and Single Packet Authorization
- SPA over Tor
- fwknop-0.9.7 release and new features
- Live demonstration

Tor

- Network of virtual circuits
- Packets take a random path through several servers (onion routers)
- No individual router knows the complete path through the router cloud
- Compatible with any application with SOCKS support
- Traffic is encrypted

Tor Virtual Circuit



Single Packet Authorization

- Use default-drop packet filters to minimize code execution paths
- Authentication and authorization data is passively monitored via libpcap (or the ulogd pcap writer)
- No traditional “server” in the Berkeley sockets sense

Default-Drop

- A default-drop packet filter is the next best thing to Marcus Ranum's perfect firewall:

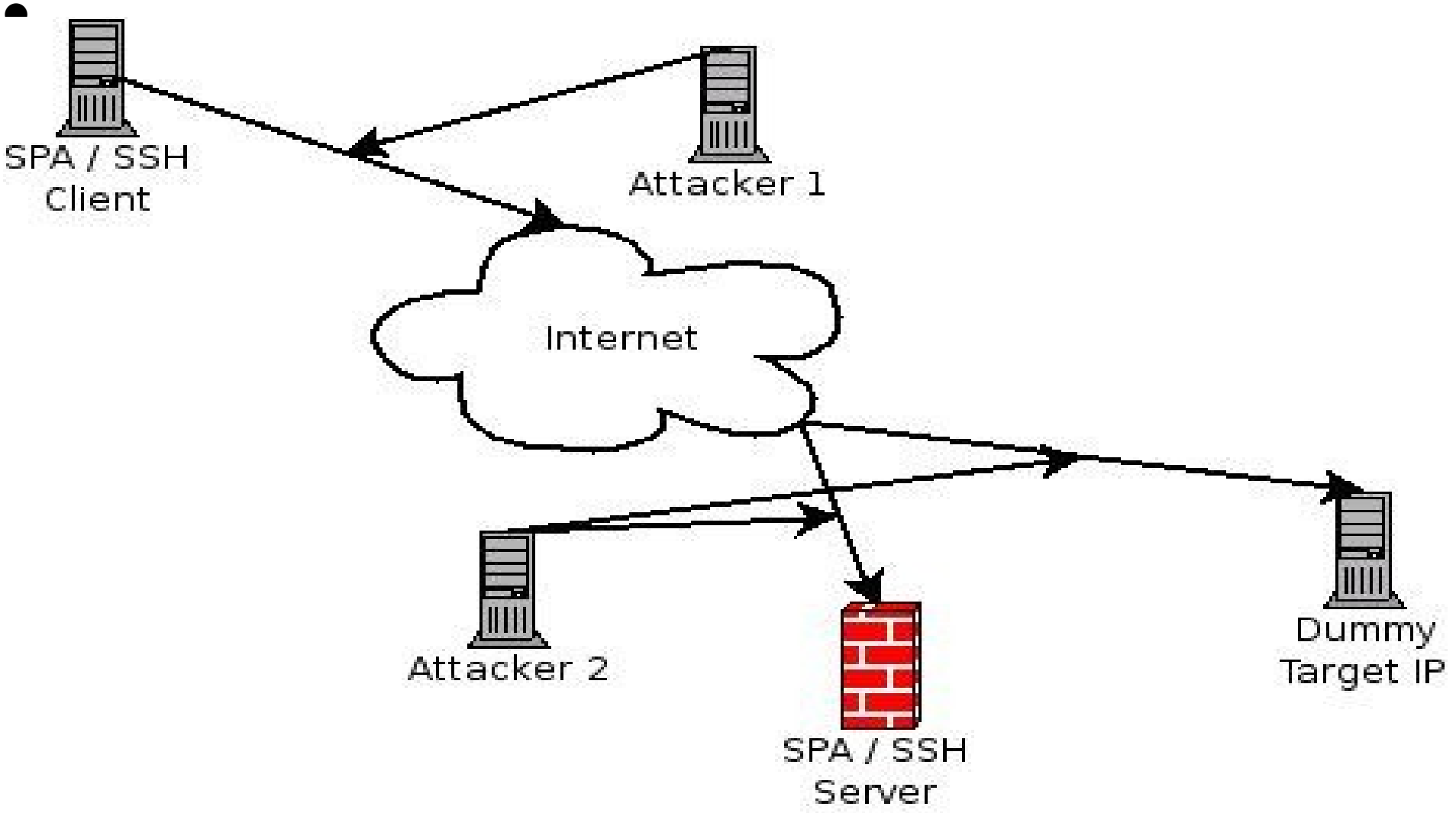
Single Packet Authorization (cont'd)

- Up to minimum MTU of data can be sent
- Large data size makes it possible to use 2048-bit GnuPG keys
- Replay attacks easily thwarted by MD5 calculation and storage on the server side
- Authorization packets can be spoofed (except over Tor)

SPA vs. Port Knocking

- Similarities:
  - Both use default-drop packet filters
  - Both can timeout ACCEPT rules but use connection tracking to allow a TCP session to remain established
- Differences:
  - SPA solves the replay problem
  - SPA is compatible with asymmetric ciphers
  - SPA cannot be broken by trivial sequence busting attacks
  - SPA does not look like a port scan

Who can sniff what?



Security Through Obscurity?

- No more than passwords, shared keys, or GnuPG private keys
- SPA is additive, i.e. other security mechanisms already built into various protocols still apply

http://bastille-linux.org/jay/obscurity-revisited.html

SPA over Tor

- Why not just always run client SSH connections (or other services) over Tor?
  - Still need SPA and default-drop packet filter since an attacker can also run connections over Tor
- Sending the SPA packet over Tor adds another layer; traffic analysis (which Tor is designed to thwart) is made more difficult

SPA over Tor (cont'd)

- Tor uses TCP for transport (we will interface to Tor via the socat SOCKS 4a proxy)
- Cannot influence TCP stacks used to build virtual circuit (passive OS fingerprinting of these stacks still works)
- Port knocking is essentially incompatible with Tor; must run SPA
  - Over socat proxy, Nmap -sS never sets up a virtual circuit. Nmap -sT sets up a circuit, but many different TCP stacks (i.e. different source IP's) get involved unless a real server is available

Tor and Bi-directional Communication

- Using TCP for transport implies bi-directional communication is required
- Technically, SPA model of single blind UDP packet does not fit the Tor transport requirement
- Cannot simply include SPA data within a TCP SYN packet
- Must have a real TCP server that is accessible on the server side

Tor and Bi-directional Communication (cont'd)

- In ENABLE_TCP_SERVER mode, fwknop spawns a minimal TCP server
  - Runs as “nobody” on port 62201 (configurable)
  - Does bind(), listen()
  - Loops over successive accept() and recv() calls with no other code
  - Session is FINished by server after first TCP data packet is sent by the client
  - Number of potential vulnerabilities in this server is less than the potential vulnerabilities in a more complex server (SSH)
  - Data is still acquired via pcap by fwknopd instead via the minimal server, so SPA packets to other ports continue to work

Making a Connection

- Tor is designed to make the exit router hard to predict
- Must send SSH connection over the open Internet (unless Tor MapAddress is used)

SYN Scan (over socat)

[tor-client]$ socat TCP4-LISTEN:62201,fork SOCKS4A:localhost:70.x.x.x:62201,socksport=9050

[tor-client]# nmap -sS -P0 -p 62201 127.0.0.1

Starting Nmap 4.01 (http://www.insecure.org/nmap/) at 2006-07-09 19:21 EDT

Interesting ports on localhost.localdomain (127.0.0.1):

PORT STATE SERVICE

62201/tcp open unknown

Nmap finished: 1 IP address (1 host up) scanned in 0.043 seconds

[ssh-server]# tcpdump -i eth0 -l -nn port 62201

(NOTHING HERE, a virtual circuit is never established)

Connect() Scan (over socat)

[tor-client]$ socat TCP4-LISTEN:62201,fork SOCKS4A:localhost:70.x.x.x:62201,socksport=9050

[tor-client]$ nmap -sT -P0 -p 62201 127.0.0.1

Starting Nmap 4.01 (http://www.insecure.org/nmap/) at 2006-07-11 07:19 EDT

Interesting ports on localhost.localdomain (127.0.0.1):

PORT STATE SERVICE

62201/tcp open unknown

Nmap finished: 1 IP address (1 host up) scanned in 0.007 seconds

Connect() Scan (over socat) cont'd

[ssh-server]# tcpdump -i eth0 -l -nn port 62201

19:23:03.236140 IP 64.74.207.50.20087 > 70.x.x.x.62201: S 478646557:478646557(0) win 5840 **<mss 1460,sackOK,timestamp 288052901 0,nop,wscale 7>**

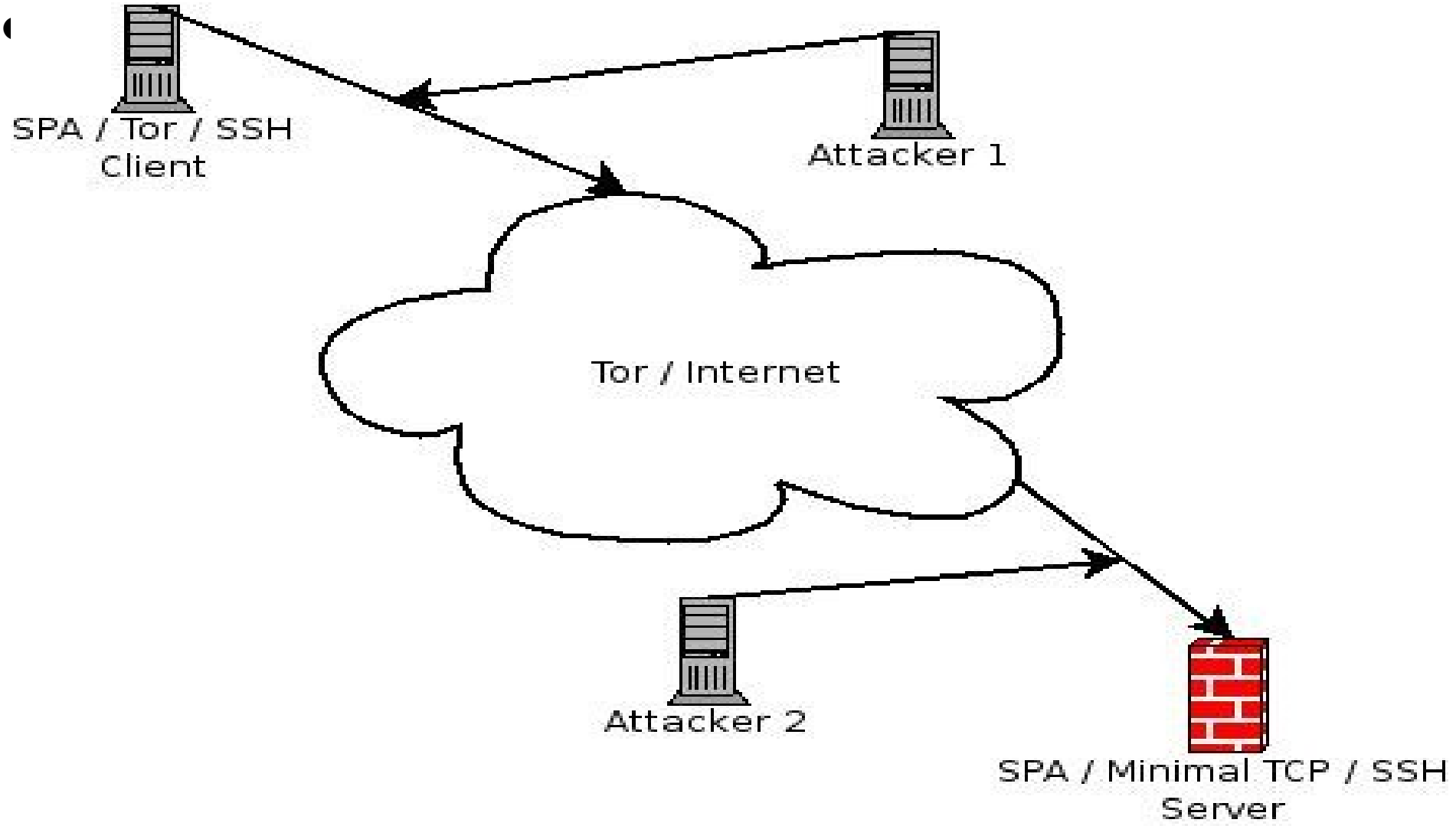
19:23:09.316140 IP 82.224.104.98.4984 > 70.x.x.x.62201: S 1512871859:1512871859(0) win 64240 **<mss 1460,nop,nop,sackOK>**

19:23:18.315758 IP 128.2.141.33.59959 > 70.x.x.x.62201: S 1531387242:1531387242(0) win 65535 **<mss 1460,nop,nop,sackOK,nop,wscale 1,nop,nop,timestamp 79586290 0>**

Operating Systems Running Tor

```
# fwknopd --os --fw-log /var/log/messages

[+] Entering OS fingerprinting mode.

[+] Parsing iptables log: /var/log/messages

[+] 80.190.x.x

     S4:64:1:60:M*,S,T,N,W2          Linux:2.5::Linux 2.5 (sometimes 2.4)

[+] 24.9.x.x

     32768:64:1:60:M*,N,W0,N,N,T     FreeBSD:5.0-5.1::FreeBSD 4.8-5.1 (or MacOS X)

[+] 210.17.x.x

     16384:64:1:64:M*,N,N,S,N,W0,N,N,T     OpenBSD:3.0-3.5::OpenBSD 3.0-3.5
```

Who can sniff what? (revisited)



fwknop-0.9.7 Release

- fwknop_serv minimal TCP server
- Added --Last-host for recalling specific command line arguments
- OpenSSH-4.3p2 patch to integrate fwknop client execution
- Updated to Crypt::CBC-2.18
- Updated to not advertise fwknop client to www.whatismyip.com
- Documentation updates and bugfixes

Live Demonstration...

Questions?

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http://www.cipherdyne.org/

Updated slides:
http://www.cipherdyne.org/fwknop/docs/talks/dc14_fwknop_slides.pdf