Network Based IDS – Introduction & Experiences with Shadow

Data Security Nordic 2000
Tieturi

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I have…

…some Unix experience
…some programming experience (C, C++, Perl, shell-scripts)
…concentrated in information security last 5 years
…been working in PKI-, LDAP- and VPN-projects lately
…studied and evaluated IDS-tools last 2 years
…looked at several NIDS-tools e.g. Dragon, RealSecure NFR, Snort, eTrust ID (SessionWall-3),…
…been running Shadow in our company network last 2 years
…some IDS-related links at http://www.atbusiness.com/staff/japi/security.html#ids

Are you safe?

- How many network scans were targeted to your network last month?
  a) more than 10 b) 1-10 c) none d) don't know
- How many serious break-in attempts?
  a) more than 10 b) 1-10 c) none d) don't know
- How many succeeded break-ins?
  a) more than 10 b) 1-10 c) none d) don't know
- Does your ecommerce-site have correct product information and pricelist?
  a) yes b) no c) don't know
- Does your firewall protect you?
  a) yes b) no c) don't know

Security Survey

http://www.infosecuritymag.com/2000survey.pdf

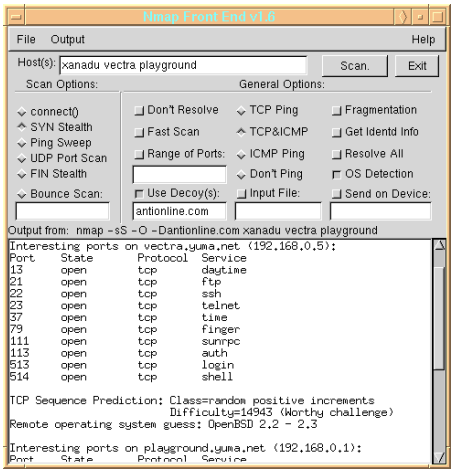
- Information Security Magazine annual survey
- Summer 2000 - 1,897 responses
- Outside breaches
  - Viruses/Trojans/Worms - 80%
  - Denial-of-Service - 37%
  - Exploits related to active program scripting - 37%
  - Attacks related to protocol weaknesses - 26%
  - Attacks related to insecure passwords - 25%
  - Buffer overflows - 24%
  - Attacks on bugs in Web-servers - 24%

Hacker attack

1. Map the network and services
2. Find vulnerabilities
3. Break-in
4. Take over the system, install backdoors
5. Cover tracks, attack neighbor nodes
6. Steal, copy, destroy, change, blackmail,…
7. Use the system as a stepping stone when attacking other systems

nmap

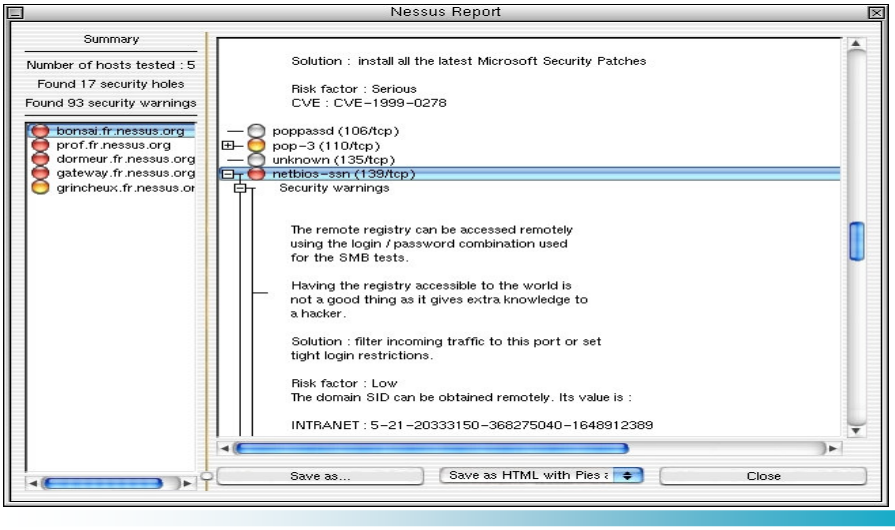
http://www.insecure.org/nmap/



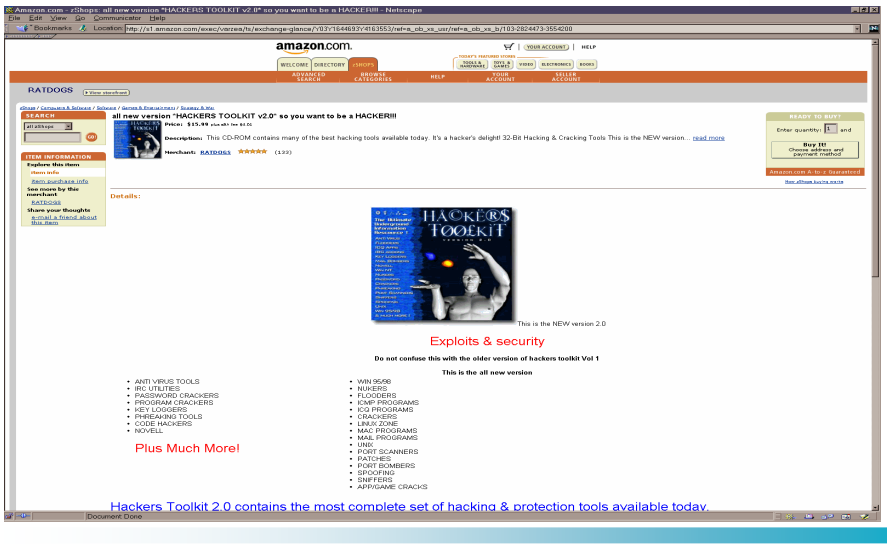
- Vanilla TCP connect() scanning
- TCP SYN (half open) scanning,
- TCP FIN, Xmas, or NULL (stealth) scanning
- TCP ftp proxy (bounce attack) scanning
- SYN/FIN scanning using IP fragments
- UDP raw ICMP port unreachable scanning
- ICMP scanning (ping-sweep)
- TCP Ping scanning
- Remote OS Identification
- Reverse-ident scanning

Nessus

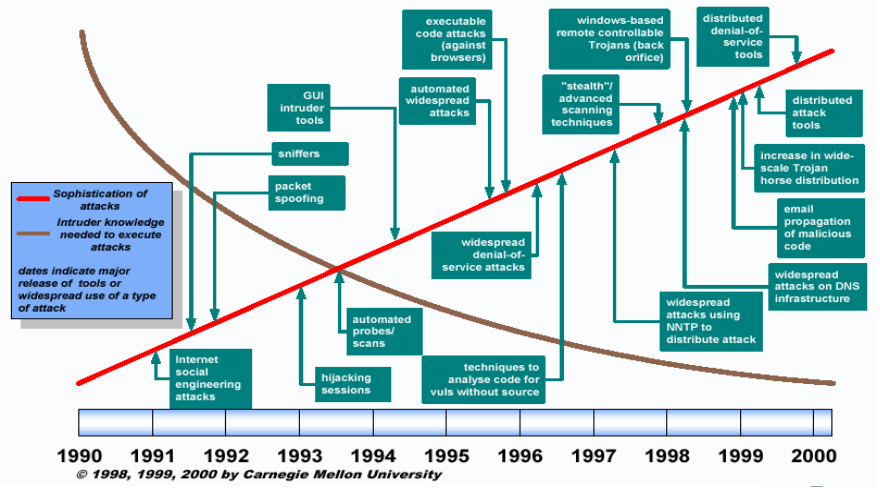
http://www.nessus.org/



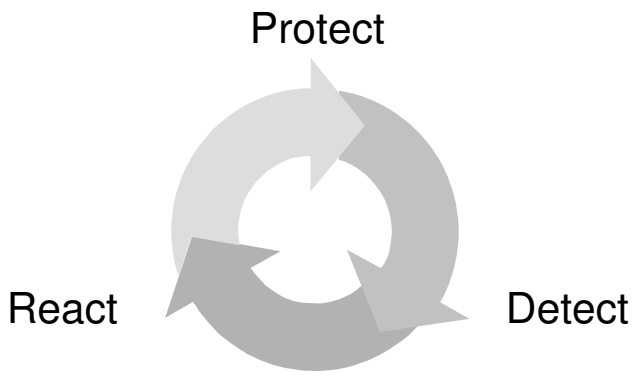
Hacker's toolkit - $15.99



Attack Sophistication vs. Required Intruder Knowledge



Security is a process!



Detection tools

- Intrusion Detection Systems
  - Server-based
  - Workstation-based
  - Application-based
  - Network-based (NIDS)
- Vulnerability Scanners
- System Integrity Verifiers
- Log File Monitors
- Deception Systems (honeypots)

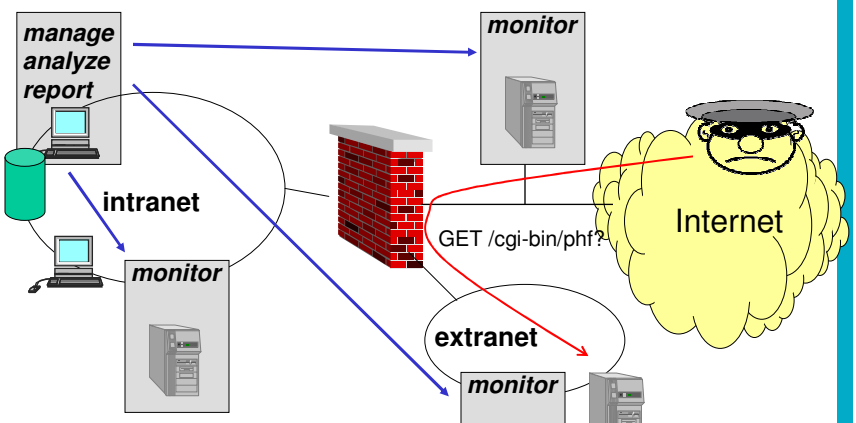
Why firewall alone is not enough?

- Firewall is a gatekeeper - we need a burglar alarm too
- Firewall doesn't recognize attacks attempted with allowed protocols: http, ftp, email, dns,…
- Firewall doesn't save enough history information
- Intranet is usually not protected with firewalls
- Firewall doesn't handle problems with protocols and applications
- How do you verify your firewalls configuration and function?
- Do you know all the services running in your network?
- Firewall software could have bugs also
- Multiple layer security is more effective

NIDS
Network Intrusion Detection System

- Listens to network traffic
- Notices known attacks
- Notices non-standard TCP/IP packets
- May launch protective actions
- Saves history
- Invisible for users and applications

Example NIDS setup



RealSecure, NetRanger, BlackIce,
Netprowler, Shadow, Dragon, Snort...

Good IDS-tool

- Invisible, needs few resources
- Reliable, fault-tolerant
- Easy to modify for different needs
- Adapt to changes, scalable
- Difficult to fool
- Notices abnormal behavior
- Easy to use, central administration
- Good reporting and analyzing features
- Large problem/fingerprint database

Why to have NIDS?

- Attacks are noticed in their early phase
- It's better that you find the problems instead of a hacker
- Traffic history of attack is saved => evidence
- Verify the adequacy of your security arrangements
- Makes it easier to negotiate security budget:-)

NIDS challenges

- Analyzing attacks require TCP/IP and security expert
- Fast networks
- Heavily loaded networks
- Switched networks
- TCP/IP problems: forged source IP's, flags,...
- Fragmented IP-packets
- Insertion attacks, "su ro^H^Hroot"
- Denial-of-service attacks against NIDS
- Encryption
- Keeping attack signatures up-to-date

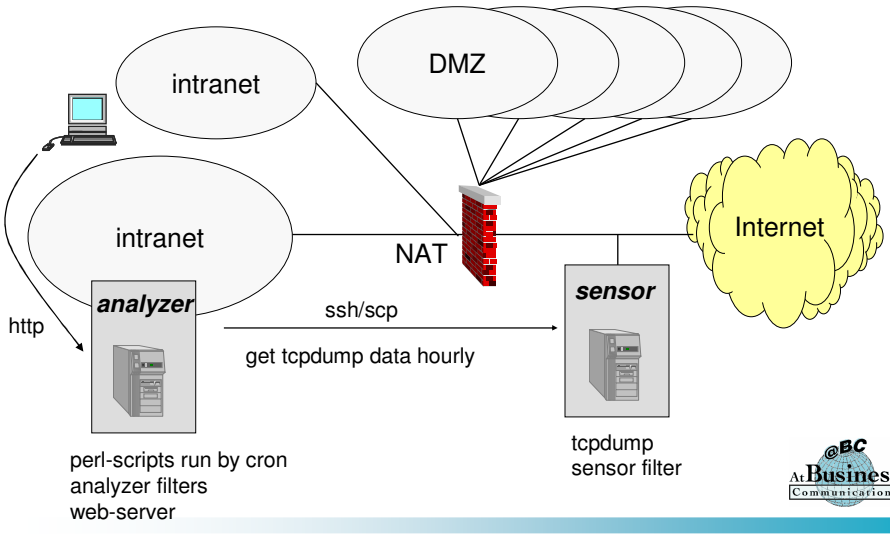
NIDS challenges

```
[**] WEB-CGI-bash shell [**]
10/16-00:07:44.900000 0:E0:1E:7F:A:10 -> 0:0:D1:ED:50:A9 type:0x800 len:0x18F
xx.xx.xx.xx:1822 -> yy.yy.yy.yy:80 TCP TTL:122 TOS:0x0 ID:23276  DF
*****PA* Seq: 0x1055FEB   Ack: 0x434B1054   Win: 0x2238
47 45 54 20 2F 78 2D 73 61 6A 74 69 6E 67 2F 63  GET /x-sajting/c
68 61 74 2F 69 6C 6D 65 65 74 2F 2F 62 61 73 68  hat/ilmeet//bash
66 75 6C 2E 67 69 66 20 48 54 54 50 2F 31 2E 31  ful.gif HTTP/1.1
0D 0A 41 63 63 65 70 74 3A 20 2A 2F 2A 0D 0A 52  ..Accept: */*..R
65 66 65 72 65 72 3A 20 68 74                    eferer: ht
```

Shadow
http://www.nswc.navy.mil/ISSEC/CID/

- Free NIDS tool based on
  - Unix
  - tcpdump
  - Perl
- You need
  - 2 Unix boxes with lots of disk-space
  - Unix experience
  - tcpdump experience
- Design philosophy
  - No alarms, but system/security administrator checks the reports when appropriate
  - Checks (TCP/UDP/IP) headers only

Our setup



Filters

- Sensor filters define what packets are captured
  - all ip except mail and ftp-data
  - how much payload is save
- Analyzer filters define interesting packets
  - abnormal IP-traffic
  - ports scans
  - network mapping
  - non-http connections to web-servers
  - known attack-signatures
  - icmp.filter, ip.filter, udp.filter, tcp.filter, site.filter,…

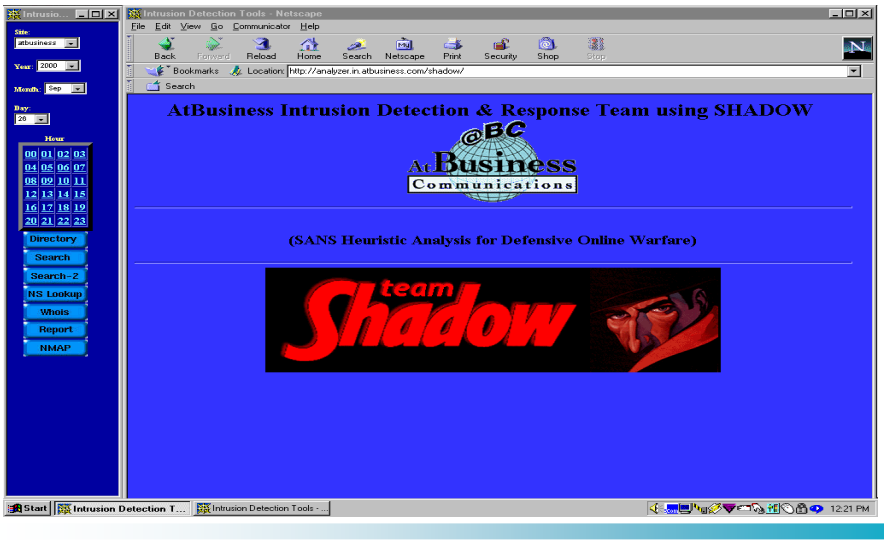
Tcpdump filters

- tcp and (tcp[13] & 2 != 0)
  - tcp packet with SYN-bit on (13th byte of the tcpheader)
- tcp and (tcp[13] & 2 != 0) and (dst port 143)
  - imap
- ip and ip[19] = 0xff
  - Broadcast packets
- ip and dst port 111
  - Portmapper
- ip[12:4] = ip[16:4]
  - Same src and dst ip-address => land-attack
- icmp[0] != 8 and icmp[0] != 0
  - icmp-packets other than echo requests & replies

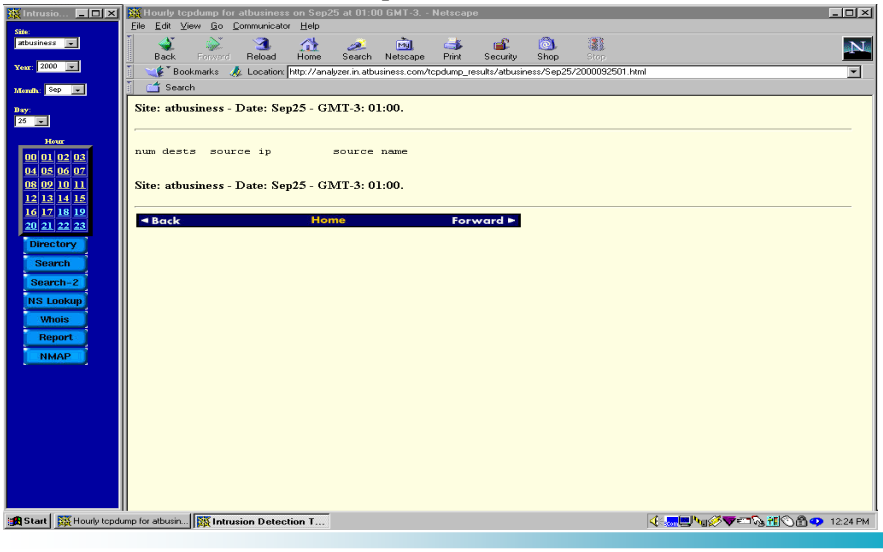
Example analyzer filter

```
ip and (not src host fw.atbusiness.com) and
(
 (dst host www.atbusiness.com and
 (
    (tcp and ((tcp[13] & 2 != 0) and (tcp[13] & 0x10 = 0))
            and (not dst port 80)
            and (not dst port 443))
 ))

or

 (dst host imap.atbusiness.com and
 (
    (tcp and ((tcp[13] & 2 != 0) and (tcp[13] & 0x10 = 0))
            and (not dst port 143))
 ))
)
```

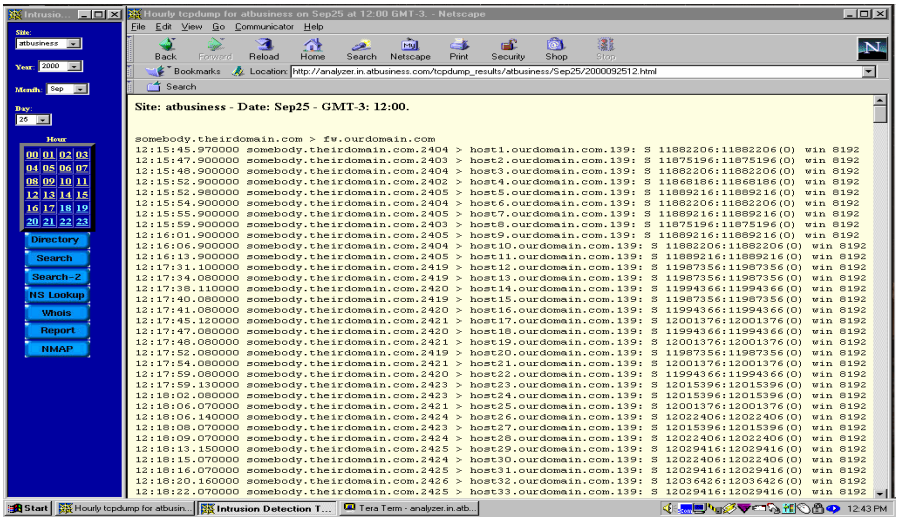

Shadow screendumps



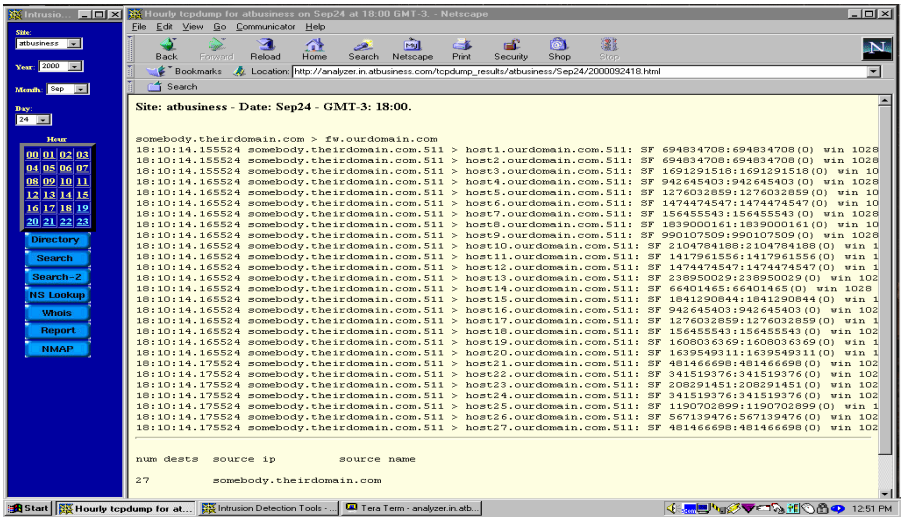
No problems



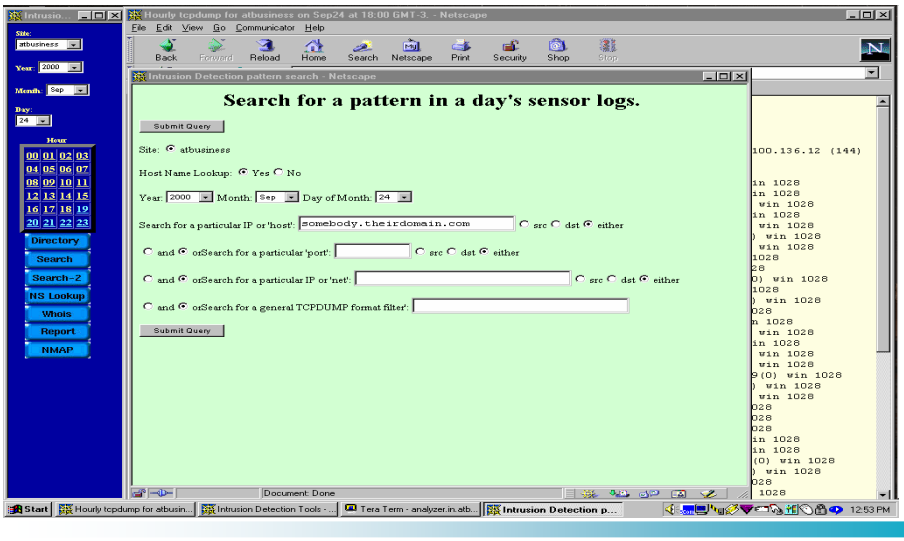
Netbios scan



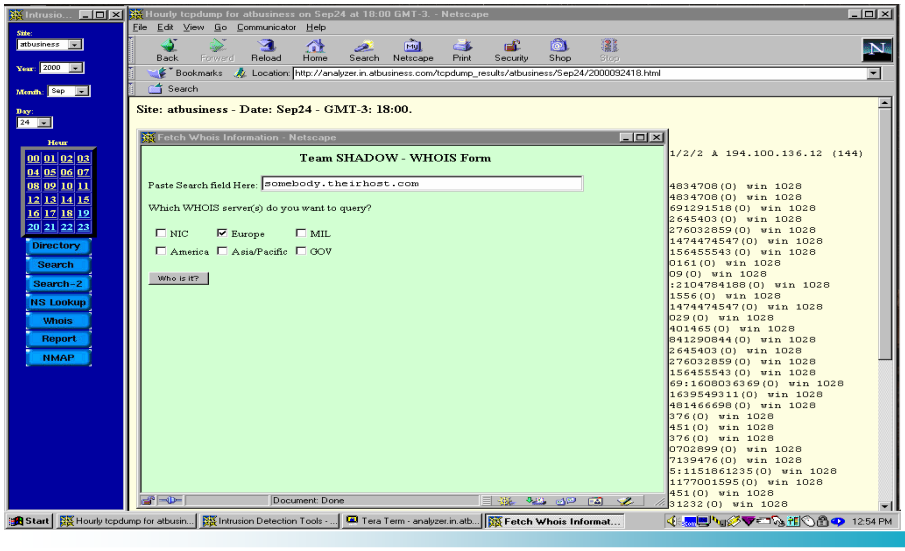
T0rnkit scan



What else he did?



Whois he?



Example scan (t0rnkit)

timestamp source.port dest.port flags beginning seq # ending seq # (bytes) options

```
18:10:14.155524 somebody.theirdomain.com.511 > host1.ourdomain.com.511: SF 694834708:694834708(0) win 1028
18:10:14.155524 somebody.theirdomain.com.511 > host2.ourdomain.com.511: SF 694834708:694834708(0) win 1028
18:10:14.155524 somebody.theirdomain.com.511 > host3.ourdomain.com.511: SF 1691291518:1691291518(0) win 1028
18:10:14.165524 somebody.theirdomain.com.511 > host4.ourdomain.com.511: SF 942645403:942645403(0) win 1028
18:10:14.165524 somebody.theirdomain.com.511 > host5.ourdomain.com.511: SF 1276032859:1276032859(0) win 1028
18:10:14.165524 somebody.theirdomain.com.511 > host6.ourdomain.com.511: SF 1474474547:1474474547(0) win 1028
18:10:14.165524 somebody.theirdomain.com.511 > host7.ourdomain.com.511: SF 156455543:156455543(0) win 1028
18:10:14.165524 somebody.theirdomain.com.511 > host8.ourdomain.com.511: SF 1839000161:1839000161(0) win 1028
18:10:14.165524 somebody.theirdomain.com.511 > host9.ourdomain.com.511: SF 990107509:990107509(0) win 1028
18:10:14.165524 somebody.theirdomain.com.511 > host10.ourdomain.com.511: SF 2104784188:2104784188(0) win 1028
```

SYN + FIN is not normal

Normally source port is random

Fast repeating connections

Port used by t0rnkit

Shadow - advantages

- Free
- Flexible
- Easy to modify/expand with perl
- Lots of tools available to work with tcpdumps
- No alarms - only reports
- Saves all traffic
- Possible to use in complex environment – we have several ”home nets”, separate net addresses for fws and NAT in use.

Shadow - disadvantages

- Can’t analyze IP payload
- Keeping filters up-to-date in large environment is difficult
- No real-time alarms
- Analyzing data requires lots of TCP/IP, Unix, Perl and tcpdump knowledge
- No real on-going development

Snort

http://www.snort.org/

- Based on tcpdump, analyzes also IP payload
- Lots of attack fingerprints available
- Saves only suspect traffic
- Very active development
- Lots of add-on tools
- Can analyze tcpdump-files created by Shadow
- Shadow sensor can be replaced by Snort
- Real-time alarms
- Difficult to configure for complex network

Shadow + Snort

- Snort can be used to get tcpdump data for Shadow
- Snort can be used to analyze Shadow tcpdumps
- IP-payload checked by Snort
- Real-time alerts by Snort
- Two systems see more than one!

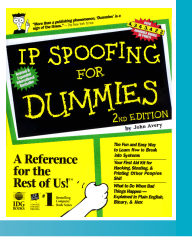
- Our current solution is to run Shadow dumps through Snort daily
- Better solution would be to replace Shadow sensor by Snort and let it feed Shadow analyzer

Scans to our network

	Sep-1999	Mar-2000	Sep-2000
ftp		2	6
telnet		1	1
http		1	1
pop2		3	
pop3	1		1
imap	1		
dns		3	3
sunrpc	2	4	4
socks	1	1	
linuxconf		1	1
netbios	1		18
hack'a'tack	2	2	1
subseven	1	2	2
netbus	1	2	1
ringzero		1	1
udp port 1	1		
rpc.statd exploit			2
t0rn			1
	11	23	43

2000

Jan 16
Feb 25
Mar 23
Apr 37
May 32
Jun 19
Jul 31
Aug 26
Sep 43
Oct 51 (24.10)



Response to scans

- Well-known companies get lots of scans per day
- NASA: 500.000 attacks per year
- I think that response to scans is worth while if you don't have to worry about serious attacks all the time
- Automate the reports and response as much as possible
- It's best that novice script-kiddies get a warning in the beginning of their "career", slap on the wrist

Recovering from the break-in (SANS)

- Remain calm; don't hurry.
- Notify your organization's management.
- Provide a game plan (with options if possible).
- Apply need-to-know.
- Use out-of-band communications; avoid email and other network-based communications channels.
- Take good notes, good enough to serve as evidence in a court of law.
- Contain the problem; pull the network cable.
- Back up the system(s), and collect evidence.
- Eradicate the problem and get back in business.
- Lessons learned, apply what you have learned.

Inform the administrators

Below is a log showing a connection attempts from a machine within your domain. The machines it connected to does not offer this "service" so this can only be assumed to be an IP space probe for vulnerable machines. Port 31789 belongs to trojan program called "Hack'A'tack".

We take this matter seriously, and hope that you will as well. Please take action on this issue as is appropriate and respond to this email-address with your actions. If possible, please sign your email digitally.

1. Apr 2000 (timezone is GMT + 2, Helsinki, Finland)

19:58:44.840000 hacker.evil.org.31790 > host1.ourdomain.com.31789: udp 1
19:58:44.840000 hacker.evil.org.31790 > host2.ourdomain.com.31789: udp 1
19:58:45.110000 hacker.evil.org.31790 > host3.ourdomain.com.31789: udp 1
19:58:45.110000 hacker.evil.org.31790 > host4.ourdomain.com.31789 : udp 1
19:58:45.120000 hacker.evil.org.31790 > host5.ourdomain.com.31789: udp 1
...

Real-world responses

“We identified the dialup account that was used for this port scan. The account belongs to an local hospital, but apparently is often 'stolen' (or perhaps used unauthorised from employees outside of the hospital). We will take this with their management - the account has been temporarily suspended. Thanks for letting us know.”

“First, thank for you attention. This scanners were in computer room and they is students. This campus was disconnected from Internet. About this episode was reported to warden, rector of PSTU and FSB. Two students was stand off Internet.”

“Sorry....our server is hacked. so... we are reinstalling the server…”

”We take a serious notice of this kind of hacking. The address that you are mail me about, is belong to a dial-up pool. We will find out which customer was used this address at this portion of time and will take care about that problem”

”Thank you for your report. While we are not allowed to give out specific information regarding subscriber identity, or specific action taken without legal process, we have identified the offending user and taken appropriate action against this account.”

Real-world responses

“We already had complaints yesterday and contacted our customer immediately. They noticed a breakin on Sunday (10.09.2000) themselves and had blocked the host on router level. They are currently cleaning up the system and investigating the issue. Thanks for the notice and sorry for the inconveniences.”

“The customer owning the machine used for the portscans has been warned, and he has ensured us to fix the security on his machine. If any new portscans from that machine will occur, we will disconnect the machine. Our apologies for the inconvenience.”

“My apology for any inconvenience that may have caused you. We had a Linux test box that sat outside our firewall. Unfortunately it was hacked and used for hacking other sites. It is now shutdown. Again, my apology.”

”Thank you for notification of this event. I want to assure you that we take such issues seriously as well. We allow some of our users to have personal machines in our IP address space, which this machine is one of. It appears that it was hacked, and we are tracing down how and by whom. Until such time as we can be sure that the incident will not repeat, this machine will be removed from the network. If you have any other concerns, please feel free to contact me directly.”

Planning

- Level of TCP/IP expertise in your company?
- Public Domain or commercial product?
- Where to put the sensors?
- Alarms or logs?
- How often and how the tool is updated?
- What does your security policy define?
- Who need to belong in CERT/CIRT?
- How to response?

First things first

5. Audit, response, investigation, IDS
4. Technology, products
3. Education
2. Security architecture, processes
1. Policies, guidelines