CE 817 - Advanced Network Security

Lecture 6

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Acknowledgments: Some of the slides are fully or partially obtained from other sources. Reference is noted on the bottom of each slide, when the content is fully obtained from another source. Otherwise a full list of references is provided on the last slide.

Intrusion Detection — How?

- Where do sensors go?
- How do you put them there?

Sensors

Locations

- Outside the firewall?
- We know there are bad guys there; what's the point?
- Just inside? What's the threat model?
- On sensitive internal nets?
- In front of each sensitive host?
- In "dark space"?

What's Dark Space?

- A block of address space not used by real machines and not pointed to by DNS entries
- There is no legitimate reason to send packets to such addresses
- Therefore, any host sending to such addresses is up to no good
- Commonly used to detect scanning worms

What's the Purpose?

- Inside the firewall? Detect data exfiltration
- Sensitive internal nets: detect threats aimed at them
- Watching each host? Detect attacks on inside hosts from other hosts on the same LAN
- Dark space? Detect scanning worms (and attackers)

Auto-Quarantine

- Many organizations implement “auto-quarantine”
- This is especially common for university residence hall networks
- Machines that do too much scanning (and in particular attempt to probe dark space) are assumed to be virus-infected
- They’re moved to a separate net; the only sites they can contact are Windows Update, anti-virus companies, and the like

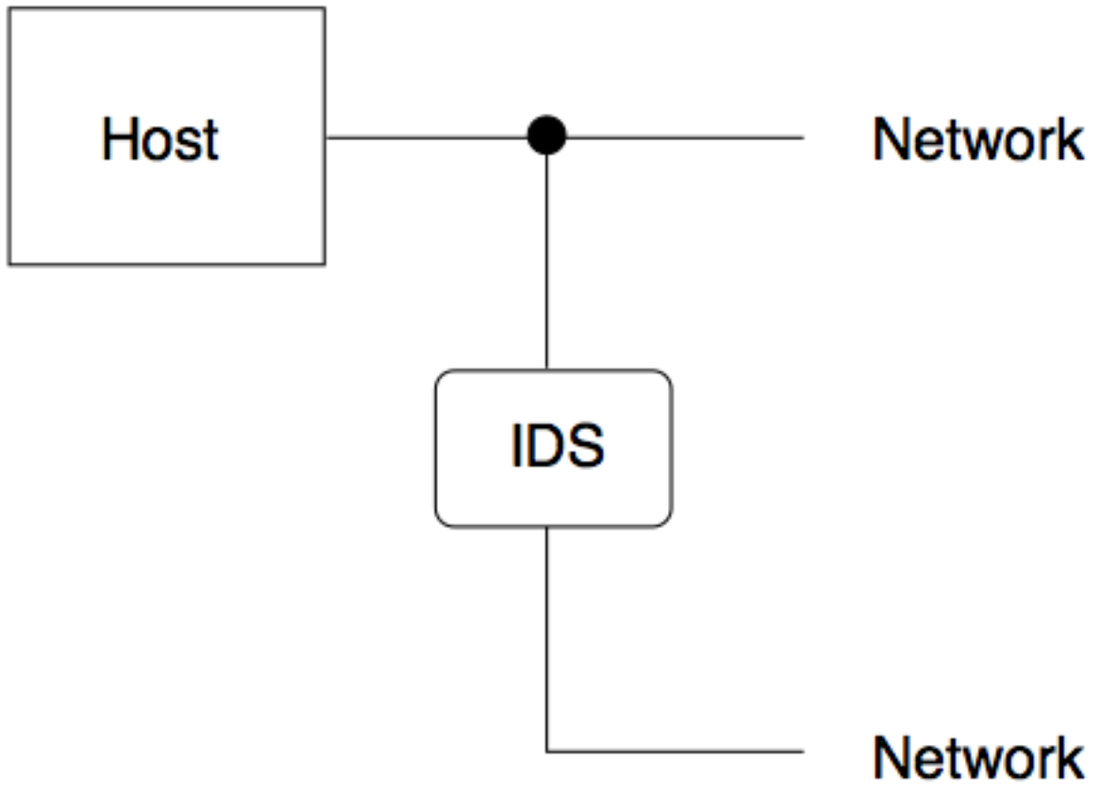
Honeypots and Honeynets

- Special-purpose host or network designed to be attacked
- Equipped with many monitoring options
- Lure the attacker in deeper
- Waste the attacker’s time; study the attacker’s technique
- Note well: keeping honeypot (and dark space) addresses secret is vital

Host- or Net-Resident?

- Suppose you want to monitor each host. Where does the monitor live?
- Dedicated in-line hardware: good, but expensive
- On the host: cheap, but subvertible

Net-Resident: Parallel

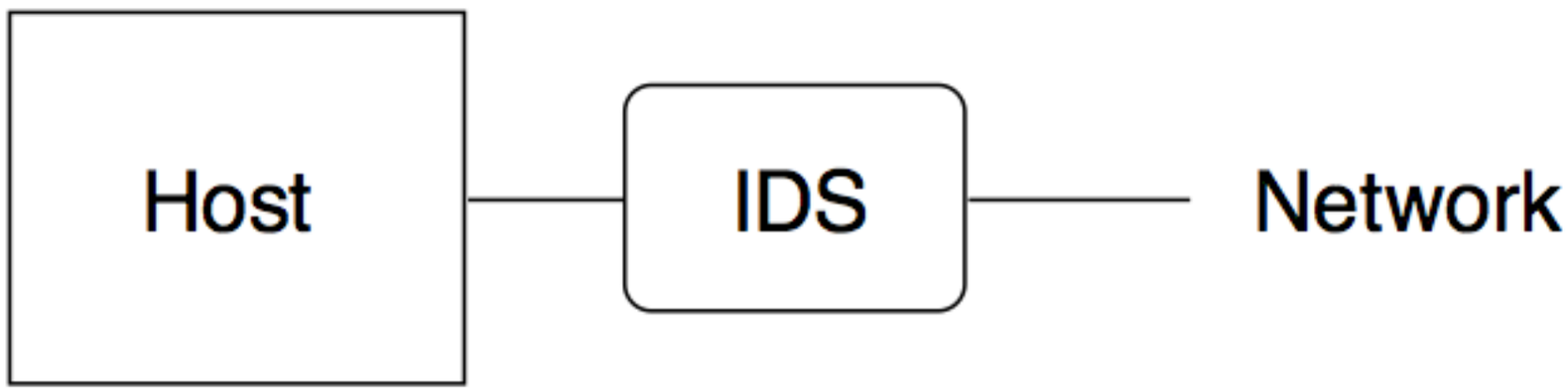


- Very unobtrusive
- But — need special hardware to tap an Ethernet
- Need some network connection to the IDS

Tapping an Ethernet

- Cannot simply wire IDS to jack
- Best solution: one-way tap gear
- Some switches have a monitoring port (AKA spanning port, mirroring port, etc) — can receive copies of data from any other port
- For 10BaseT nets, use a hub instead of a switch

Net-Resident: Serial

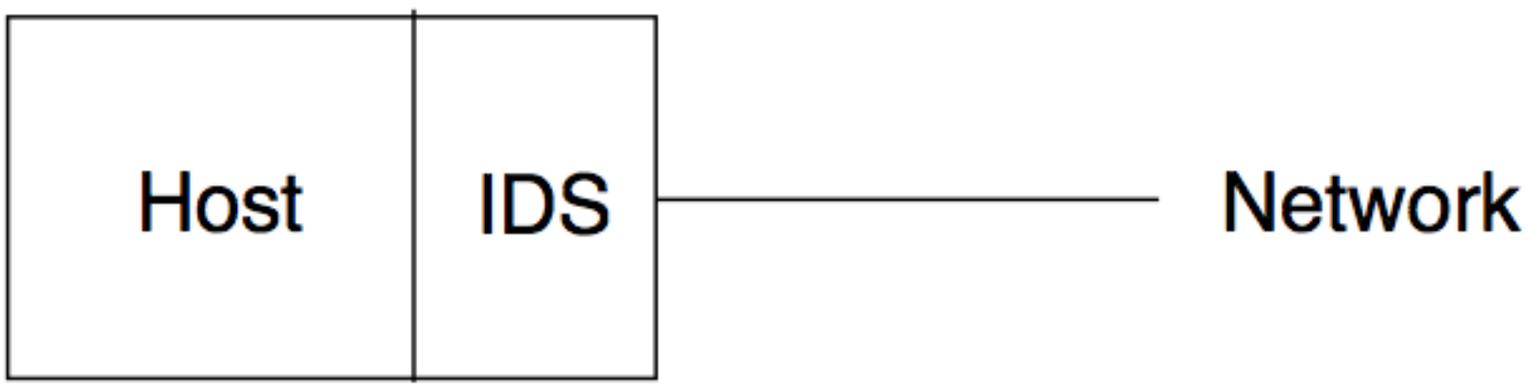


- Can’t miss packets
- But — if it crashes, the host is unreachable
- Can the IDS box be hacked?

TCP Normalization

- Attackers can play games with TCP/IP to confuse network-resident IDS
- Example: overlapping fragments:
    - s u n o r m
    - r o o t
- Which fragment is honored?
- TTL games: give some packets a TTL just high enough to reach the IDS, but not high enough to reach the destination host
- Solution: TCP normalizer, to fix these

Host-Resident Monitor



- No special hardware needed
- IDS sees exactly what host sees
- But — subvertible
- Useful precaution: immediately transmit IDS data elsewhere

The Big Advantages of Host IDS

- More time
- More context
- Everything is reassembled
- Look at entire item, not streams

Extrusion Detection

- Detect bad things leaving your network
- Detect sensitive things leaving your network
- Finds theft of inside information, either by attacker or by rogue insider
- Can be done in the network or in application gateways

Simple Logging

Simple Logging

- I (Steven Bellovin) ran this command for a while, on two hosts:
  - tcpdump -p -l "tcp[13] == 0x2 and dst $us"
- What does it do?
- Logs all TCP SYN-only packets addressed to us (tcp[13] is the flags byte in the TCP header; 0x2 is SYN)

Some Results

- About 85 probes apiece, during a 30-hour run
- 63 different ports scanned
- Some obvious: http, ssh, Windows file-sharing, SMTP, web proxy
- Some strange: 49400–49402, 8081–8090, 81–86
- Some threatening: terabase, radmin-port
- Most probers looked at one port; one looked at 46 ports

The Most Probed Ports

Scans	*Port*
3	ms-wbt-server
3	ssh
5	8000
5	http-alt
6	ms-sql-s
6	radmin-port
7	BackupExec
8	smtp
9	WebProxy
9	http

What Did The Probers Want?

- WebProxy and SMTP are probably for spam email and connection-laundering
- The others look like probes for known vulnerabilities
- http could have been a “spider” or it could be looking for known holes

Bad Neighborhoods

- I see more probes here than elsewhere. Why?
- There are different “neighborhoods” — ranges of IP addresses — in cyberspace
- University networks are good hunting grounds — few firewalls, good bandwidth, many poorly-administered machines
- Newly-allocated network blocks have few hosts, and aren’t scanned as much

Finding Compromised Hosts

Finding Compromised Hosts

- Suppose you've identified a compromised host. Now what?
- Get data: IP address and (when feasible) MAC address
- Find it

Databases

- Must be able to map IP address to location
- Must be able to map IP address to person
- Difficult on campus — wide-open nets
- Primary reason for host registration in many places

Layer 2 Data

- Enterprise-grade switches are “managed”
- They can map an IP address or a MAC address to a physical port
- Especially useful if the attacker is forging addresses. . .

Switch Data

Home + Switch View + Port View + Jacks View + Search Jacks + Search Host

MAC Address:	0003BA1077F7
Submit	Reset

0003BA1077F7 is not staticly registered

Location	First Seen	Last Seen
cs-4-1.net:5/15	02-aug-2004 16:03:27	13-nov-2006 18:08:29
cepsr-7-1.net:6/9	09-may-2006 21:39:18	31-oct-2006 14:52:13

ARP cache		
IP	MAC	Last Seen
128.59.16.72	0003BA1077F7	13-nov-2006 22:17:50

- Note that a single MAC address has shown up on two different switch ports, in different buildings. This is reasonable for a laptop, but not for a server!

Acknowledgments/References

- [Bellovin06] COMS W4180 — Network Security Class Columbia University, Steven Bellovin, 2006.