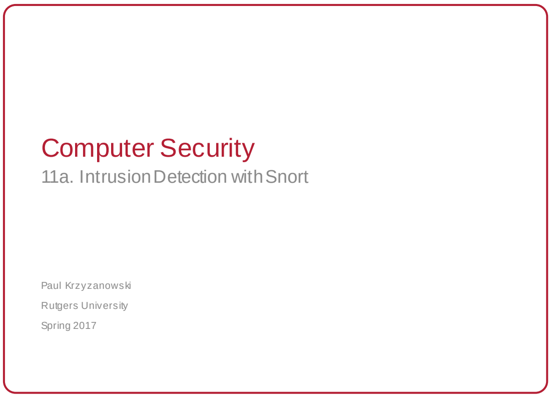

Computer Security

11a. Intrusion Detection with Snort

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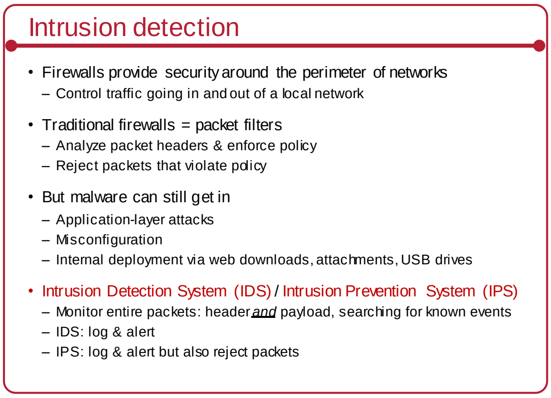
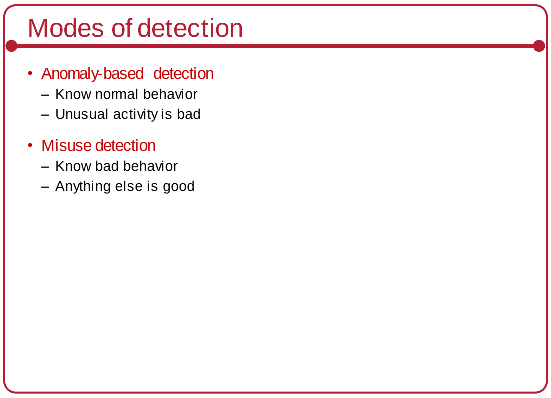


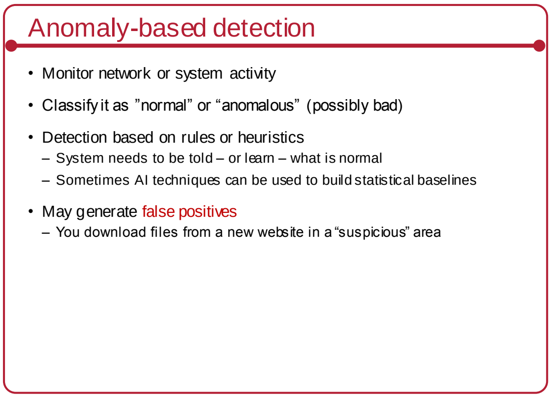
Intrusion detection

- Firewalls provide security around the perimeter of networks
  - Control traffic going in and out of a local network
- Traditional firewalls = packet filters
  - Analyze packet headers & enforce policy
  - Reject packets that violate policy
- But malware can still get in
  - Application-layer attacks
  - Misconfiguration
  - Internal deployment via web downloads, attachments, USB drives
- Intrusion Detection System (IDS) / Intrusion Prevention System (IPS)
  - Monitor entire packets: header *and* payload, searching for known events
  - IDS: log & alert
  - IPS: log & alert but also reject packets



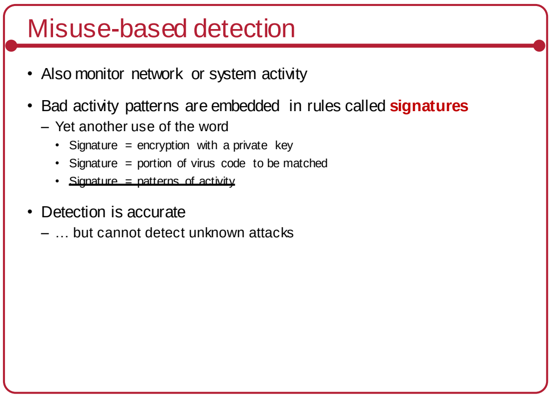
Modes of detection

- Anomaly-based detection
  - Know normal behavior
  - Unusual activity is bad
- Misuse detection
  - Know bad behavior
  - Anything else is good



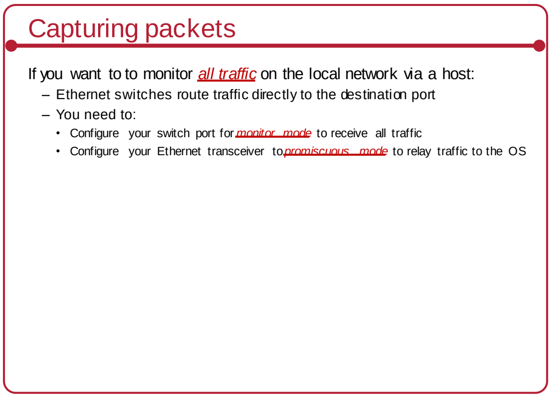
Anomaly-based detection

- Monitor network or system activity
- Classify it as "normal" or "anomalous" (possibly bad)
- Detection based on rules or heuristics
  - System needs to be told – or learn – what is normal
  - Sometimes AI techniques can be used to build statistical baselines
- May generate false positives
  - You download files from a new website in a "suspicious" area



Misuse-based detection

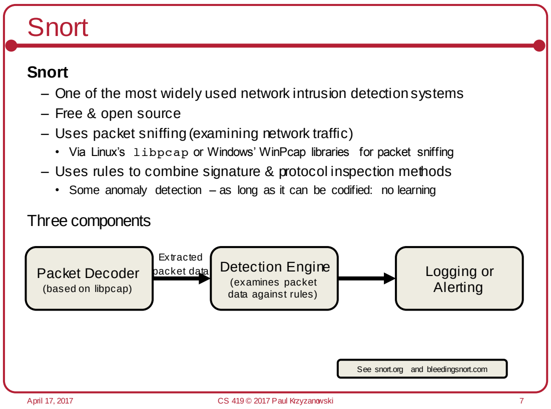
- Also monitor network or system activity
- Bad activity patterns are embedded in rules called **signatures**
  - Yet another use of the word
    - Signature = encryption with a private key
    - Signature = portion of virus code to be matched
    - Signature = patterns of activity
- Detection is accurate
  - … but cannot detect unknown attacks



Capturing packets

If you want to to monitor *all traffic* on the local network via a host:

- Ethernet switches route traffic directly to the destination port
- You need to:
  - Configure your switch port for *monitor mode* to receive all traffic
  - Configure your Ethernet transceiver to *promiscuous mode* to relay traffic to the OS



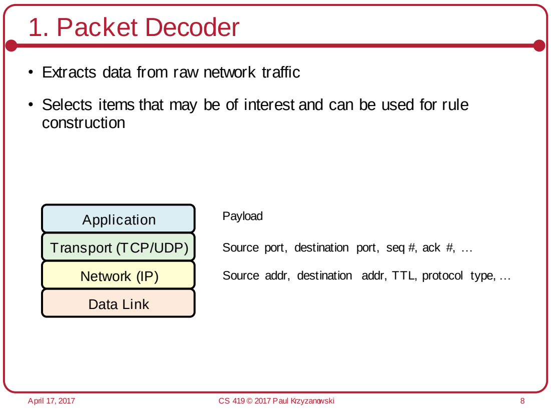
Snort

Snort

- One of the most widely used network intrusion detection systems
- Free & open source
- Uses packet sniffing (examining network traffic)
  - Via Linux's `libpcap` or Windows' WinPcap libraries for packet sniffing
- Uses rules to combine signature & protocol inspection methods
  - Some anomaly detection – as long as it can be codified: no learning

Three components

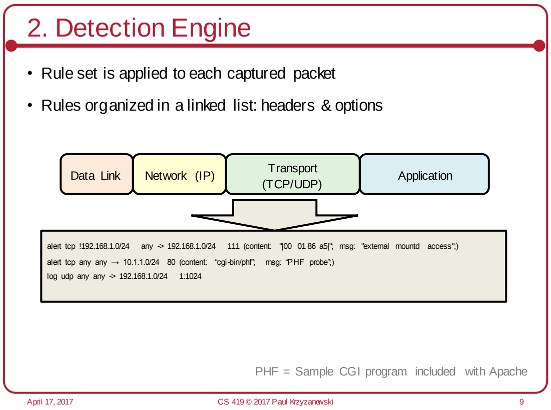
See snort.org and bleedingsnort.com



1. Packet Decoder

- Extracts data from raw network traffic
- Selects items that may be of interest and can be used for rule construction

Application
Payload
Transport (TCP/UDP)
Source port, destination port, seq #, ack #, …
Network (IP)
Source addr, destination addr, TTL, protocol type, …
Data Link

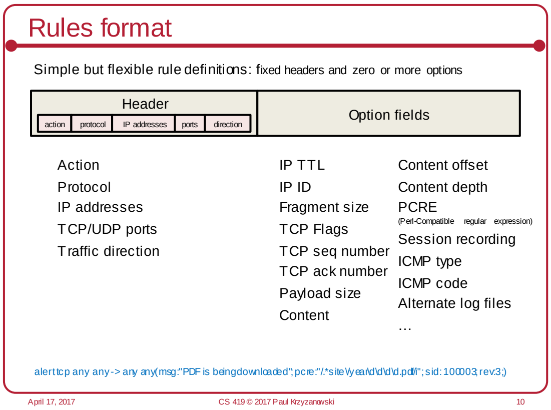


2. Detection Engine

- Rule set is applied to each captured packet
- Rules organized in a linked list: headers & options

```
alert tcp !192.168.1.0/24 any -> 192.168.1.0/24 111 (content: "|00 01 86 a5|"; msg: "external mountd access";)
alert tcp any any → 10.1.1.0/24 80 (content: "cgi-bin/phf"; msg: "PHF probe";)
log udp any any -> 192.168.1.0/24 1:1024
```

PHF = Sample CGI program included with Apache



Rules format

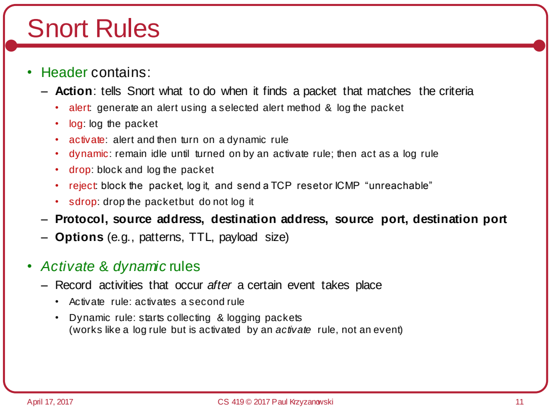
Simple but flexible rule definitions: fixed headers and zero or more options

Action
Protocol
IP addresses
TCP/UDP ports
Traffic direction

IP TTL
IP ID
Fragment size
TCP Flags
TCP seq number
TCP ack number
Payload size
Content

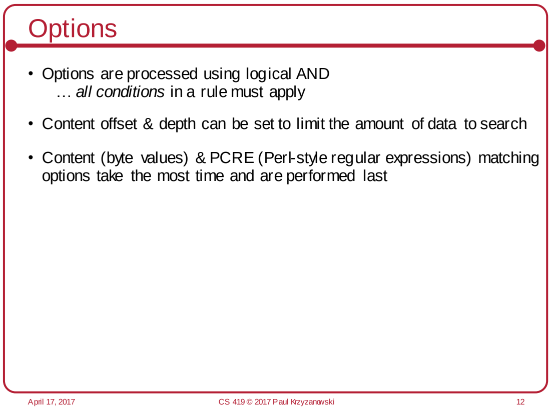
Content offset
Content depth
PCRE
(Perl-Compatible regular expression)
Session recording
ICMP type
ICMP code
Alternate log files
…

```
alert tcp any any -> any any(msg:"PDF is being downloaded"; pcre:"/.*site\/year\d\d\d\d.pdf/i"; sid: 100003; rev:3;)
```



Snort Rules

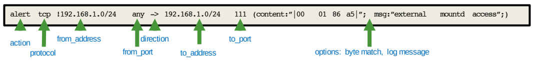
- Header contains:
  - **Action**: tells Snort what to do when it finds a packet that matches the criteria
    - alert: generate an alert using a selected alert method & log the packet
    - log: log the packet
    - activate: alert and then turn on a dynamic rule
    - dynamic: remain idle until turned on by an activate rule; then act as a log rule
    - drop: block and log the packet
    - reject: block the packet, log it, and send a TCP reset or ICMP "unreachable"
    - sdrop: drop the packet but do not log it
  - **Protocol, source address, destination address, source port, destination port**
  - **Options** (e.g., patterns, TTL, payload size)
- *Activate & dynamic* rules
  - Record activities that occur *after* a certain event takes place
    - Activate rule: activates a second rule
    - Dynamic rule: starts collecting & logging packets
      (works like a log rule but is activated by an *activate* rule, not an event)



Options

- Options are processed using logical AND
  … *all conditions* in a rule must apply
- Content offset & depth can be set to limit the amount of data to search
- Content (byte values) & PCRE (Perl-style regular expressions) matching options take the most time and are performed last

Sample Rule

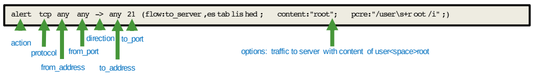


```
alert  tcp !192.168.1.0/24   any -> 192.168.1.0/24   111 (content:"|00   01 86 a5|"; msg:"external   mountd  access";)
```

Match

- any IP address *except* anything from 192.168.1.0/24
- on any port
- with a destination of 192.168.1.0/24
- port 111
- using TCP

Sample Rule: notify of root ftp logins



```
alert  tcp  any  any  ->  any  21  (flow:to_server ,es tab lis hed ;   content:"root";   pcre:"/user\s+r oot /i" ;)
```

Match

- any source address and port
- any destination address
- port 21 (FTP port)
- using TCP
- Flow: traffic going to the server on an established TCP connection
- Content contains *root* – the most unique string in the attack
  - Enables fast pattern matching – no need to test regular expression if *root* is missing
- Content contains "user", at least one space, followed by "root", ignoring case

3. Logging/Alerting

- Choice of formats for logging
  - Human readable format
  - tcpdump format
- Alerting
  - Send to syslog
  - Write to alert text file
- Logging/alerting can be turned off based on performance/annoyance needs

Where to get rules

- Without IDS rules, snort is just a packet sniffer
- You can write your own rules
- Snort.org has 23499 community rules for various known exploits
- Plus
  - Sourcefire-certified (now Cisco) rules
  - Bleeding Snort Rules (bleeding edge – beta – rules)
  - Other plces … but watch out!
- Ruleset size continues to grow
  - Snort spends up to 80% of its time pattern matching

https://www.researchgate.net/publication/237067602_Hybrid_Pattern_Matching_Algorithm_for_Intrusion_Detection_Systems

Anomaly Detection

- Anomaly detection via inference is difficult
- Not enough training data
  - We have a lot of data for normal activities
  - Not much for realistic attacks
- Even normal data drifts
  - Changes in behavior over time & legitimate unpredictable behavior
  - Attacker can attack incrementally
- Normal activities not well understood
  - Attack may be in the bounds of normal statistics
- False alerts are costly
  - System administrators will spend a lot of time poring over data

The end