IDS

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Outline

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What is an IDS/IPS?

An IDS is an **Intrusion Detection System**.

Any device/software monitoring either a *network* or *system(s)* to detect anomalous activity with *probably* malicious intent and inform the user (and log).

An IPS is an **Intrusion Prevention System**.

Any device/software monitoring either a *network* or *system(s)* to detect anomalous activity with *probably* malicious intent and avoid the event from taking place.

Many devices combine features from both IDS and IPS and Firewalls.

Monitoring

We can monitor lots of things:

- applications logs
- system state
- behaviour patterns
- network traffic

Monitoring

We can monitor lots of things:

- log of applications -> **log monitors**
- system state -> **integrity checkers**
- behaviour patterns -> **armoring**
- network traffic -> **sniffers**

An IDS combines most of these functions

Locus of detection

- Distributed
  - Installed on hosts
  - Analyze local information
  - Detect problems
  - Communicate to coordinator there is a problem
- Centralized
  - Hosts send information to global coordinator
  - Coordinator analyzes all information
  - Detects problems

Types of IDS (IPS)

- Host-based IDS (HIDS)
  - Usually Installed on servers (hosts)
  - Monitors local user activity
  - Monitors local program activity
  - Monitors system logs
- Network-based IDS (NIDS)
  - Sensors are installed *on the network*
  - Monitors anomalous network activity (deep packet inspection)
  - Logs/acts on that activity

Network IDS can be host focused also

IDS vs Firewalls

- Firewalls -> door locks/doors/fence/gate
  - Do not react
  - **Prevent** intent
  - Medicine: gloves, hygiene, vaccines,...
  - *You lock your home door to prevent entry*
- IDS -> Alarm/Motion Detector
  - Dynamic and reactive
  - **React** on intent
  - Medicine: antivirals, antibiotics, ...
  - *You have a friend to came over trying to steal*

Types of IDS

- Signature based IDS (rules)
  - Has database of “wrong” signatures, compares incoming traffic to those signatures
  - Most common used (we’ll use it)
- Anomaly based IDS
  - Learns the *right* behaviour of the system (network)
  - Generates alerts on deviating actions (strange packets)

Signature based IDS

- Anti-virus are signature based HIDS in fact.
- Pros:
  - Low false positives
  - Fast and known
- Cons:
  - Polymorphic payloads
  - *0-day* attacks

Anomaly based IDS

- AI fueled
- Pros:
  - Polymorphic payloads
  - *0-day* attacks
- Cons:
  - High false positives
  - Requires labeled data

IDS Evaluation

We (everybody) will use traditional Machine Learning metrics to evaluate IDS:

- True Positives (TP): A real attack is detected
- True Negatives (TN): Good traffic is detected as good
- False Positives (FP): Regular traffic is tagged as an attack
- False Negatives (FN): Attacks are not detected

So, an IDS is:

- **Acurate**: if it detects all attacks
- **Precise**: if it never marks good traffic as an attack

IDS Evaluation

- The true positive rate: TP / (TP + FN)
  - TP + FN is the total number of attacks
- The false positive rate: FP / (FP + TN)
  - FP + TN is the total size of good traffic

IDS Evaluation

- Missing attacks lead to severe problems.
- False alarms lead to the system being ignored or disabled.

We **must** aim for accuracy **and** precision.

IDS Evaluation

Supose:

```
- 1% traffic are attacks
- 90% accuracy (TP rate)
- 10% FP rate
```

We detect an alarm: is it true? Probability of it being true?

IDS Evaluation

- 1% traffic are attacks:
  - 1000 events: 990 good + 10 attacks
- 90% accuracy:
  - TPR: 90%, attacks: 10
  - 10*90% -> 9 alarms generated by attacks
  - **1 attack goes undetected**
- 10% FP rate
  - FP: 10%, good events: 990
  - 990*10% -> 99 false alarms
- P(attacks/alarms) = 9/(9+99) = 0.08333 (8.3%)

An alarm is probably a false alarm: **92% of the times!!!**

IDS problems

- Difficult tuning for “OK but not too much”
- Anomaly detectors may be trained by the attacker!
  - Attacker, over time, overwhelms normality
  - Train detector to attack-like behavior:
    - small doses
    - gradually over long periods of time
  - frog-boiling
- alarm behavior can itself be disruptive/taxing
  - may be used to deny service: log space filling, etc.
  - attacker could
    - trigger some alarm (lots of alarms)
    - use confusion for his real attack

Defeat an IDS

- **Fragmentation**: split packets artificially
- **Spoofing**: alter TCP sequences
- **DoS**: raise tons of alarms
- **Train detectors**: generate over long periods of time alarms

How/Where of the IDS

- IDS' tasks are heavier than firewall's
- Should have access to lots of traffic
- Options:
  - Put between firewall/network (or router/network) -> will analyze all internet traffic
  - Use mirroring ports
  - Use several sniffers reporting back to central server

Outline

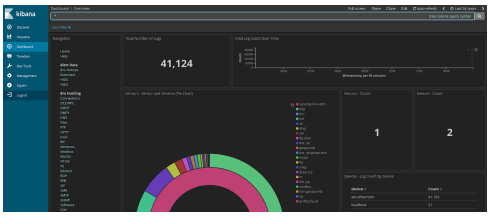
Snort

- Signature based IDS
- Can act as IPS
- Released in 1997, still actively maintained
- Rulesets freemium (free after 1 month)
- Huge community

Suricata

- Signature based IDS
- Can act as IPS
- Released in 2009, still actively maintained
- Fast and modern architecture
- Shared tools with Snort

Security Onion



- Complete linux distro with several tools for IDS/analytics/etc.
- Includes Elasticsearch, Logstash, Kibana, Snort, Suricata, Sguil, Squert, etc.
- Requires min 4GB RAM....

Outline

Snort

- We can use snort as:
  - packet sniffer (-v)
  - packet logger (-l)
  - network intrusion detector (-c)
- Files on:
  - /etc/snort/
    - snort.conf
    - rules/
  - /var/log/snort

Snort rules

```
alert tcp any any -> 193.144.10.50/32 80
(flags:SF; msg: "files";)
```

Rule Header

```
alert tcp any any -> 193.144.10.50/32 80
```

Rule Options

```
(flags:SF; msg: "files";)
```


Snort rules: Header

```
alert tcp any any -> 193.144.10.50/32 80
(flags:SF; msg: "files";)
```

- alert: action
- tcp: protocol
- any any: source address and port
- -> : direction
- 193.144.10.50/32 80: destination address and port

Snort rules: Header: Action

```
alert tcp any any -> 193.144.10.50/32 80
(flags:SF; msg: "files";)
```

Available actions

- alert: Alerts and logs the packet when activated.
- log: Only logs the packet if activated.
- pass : Ignores or drops the packet and traffic matching.
- activate : Alerts and activates a dynamic rule(s).
- dynamic : Ignored, unless activated by the **activate** rule, then acts as a log rule.
- drop : blocks and logs the packet
- reject : blocks the packet, logs it, and send a TCP RST if protocol is TCP or an ICMP port unreach if it's UDP.
- sdrop : block the packet but do not log it

Snort rules: Header: Protocol

```
alert tcp any any -> 193.144.10.50/32 80
(flags:SF; msg: "files";)
```

We have available:

- tcp
- udp
- icmp
- ip

Work is on supporting: ARP, OSPF, RIP, etc.

Snort rules: Header: IP

```
alert tcp any any -> 193.144.10.50/32 80
alert tcp 193.144.12.0/24 any -> $INTERNAL_SERVER 80
alert tcp any any -> ![193.144.10.0/24,193.144.8.250] 80
```

- **any** is any IP address (0.0.0.0/0)
- IPs specified as CIDR notation.
- $INTERNAL_SERVER defined in configuration (snort.conf)
- **!** is the negation
- Groups using *[]* and comma separated, without spaces!

Snort rules: Header: Direction

```
alert tcp any any -> 193.144.10.50/32 80:83
alert tcp 193.144.12.0/24 any <> $INTERNAL_SERVER :30
alert tcp any !1024:65000 ->
    ![193.144.10.0/24,193.144.8.250] 80:
```

- -> from left (source IP and port) to right (destination IP and port)
- <> any direction (left to right or viceversa)
- *<- is not defined!!!!*

Snort rules: Options

```
alert tcp any any -> 193.144.10.50/32 80
(flags:SF; msg: "files";)
```

Format is: **name: value;**

- flags:SF; -> TCP flags to match (SYN FIN)
- msg: “files”; -> message to insert into alert

Snort rules: Options

```
alert tcp any any -> 193.144.10.50/32 80
(flags:SF; msg: "files"; sid: 1000001; rev:2; )
```

- sid:1000001; -> Rule ID, should be > 1000000
- rev: 1; -> Rule revision