Intrusion Detection and Malware Analysis

IDS Taxonomy and Architecture

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IDS functionality

Restrict access to legitimate service
Prevent malicious events from entering a system
Detect malicious activity
Repair infected data/events

Preventive

Live events

Misuse-centric

Automatic
IDS functionality

- Restrict access to legitimate service
- Prevent malicious events from entering a system
**IDS functionality**

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- Detect malicious activity
- Repair infected data/events
IDS functionality

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- Detect malicious activity
- Repair infected data/events

- Preventive
- Live events

- Misuse-centric
- Automatic
IDS design issues / taxonomy

- **Location**
  - network
  - host/operation system
  - host/application

- **Detection methods**
  - signature-based ("misuse detection")
  - anomaly-based
  - behavior based
Network IDS

Exemplary data: network dump

0x0000: 0030 85a2 a8ff 0016 cbb5 d720 0800 4500 .0............E.
0x0010: 01e4 8771 4000 4006 8c36 c0a8 11db d155 ...q@.0...6.....U
0x0020: 8193 c721 0050 2e4d 453e 9262 6ab5 5018 ...!P.ME>bj.P.
0x0030: ffff 27fc 0000 4745 5420 2f69 672f 696d ..’...GET./ig/images
0x0040: 6167 6573

Advantages
- easy to deploy
- wide coverage
- early detection

Disadvantages
- high false alarm rates
- high performance requirements
Exemplary data: system call traces

execve("/bin/cat", ["cat", "/etc/passwd"], [/* 42 vars */]) = 0
open("/etc/passwd", O_RDONLY\|O_LARGEFILE) = 3
fstat64(3, {st_mode=S_IFREG\|0644, st_size=1214, ...}) = 0
read(3, "root:x:0:0:root:/root:/bin/bash\n"..., 32768) = 1214
close(3) = 0

Advantages
- high accuracy
- precise context (-)

Disadvantages
- difficult to deploy
- extra load on a host
- late detection
Exemplary data: application logs

WAIT #1: nam='SQL*Net message from client' ela= 5 p1=1413697536
UPDATE users set password = encrypt('my_new_password')
PARSE #6:c=0,e=981,p=0,cr=0,cu=0,mis=1,r=0,dep=1,og=0
WAIT #6: nam='db file sequential read' ela= 9604 p1=19 p2=133999
EXEC #1:c=30000,e=116691,p=36,cr=35,cu=10,mis=0,r=1,dep=0

Advantages
- high accuracy
- precise context

Disadvantages
- difficult to deploy (-)
- extra load on a host
- late detection
Signature-based IDS

- Detection of attacks by matching a set of known misuse patterns ("signatures") against a stream of events
- Signature example:
  ```
  alert tcp any $EXTERNAL -> $HOME 143
  (content: "|90C8 C0FF FFFF|/bin/sh"; msg: "IMAP exploit");
  ```

- Advantages
  - low false alarm rates
  - precise diagnostics

- Disadvantages
  - insensitivity to attack variations
  - difficulty of signature maintenance
Anomaly-based IDS

- Detection of attacks by measuring deviation from statistical models of normality
  - traffic characteristics
  - protocol compliance
  - packet/connection content
  - system call sequences

- Advantages
  - detection of unknown attacks
  - adjustment to traffic/process drift

- Disadvantages
  - high false alarm rates
  - anomalies $\neq$ attacks
Behavior-based IDS

- Detection of attacks according to some general behavioral patterns
- Advantages
  - high accuracy
  - robustness to attack variation
- Disadvantages
  - difficulty to define general features
  - ad-hoc rules
Generic IDS architecture

- **Meta-level:**
  - intrusion description languages
  - alarm correlation tools

- **Event engines:**
  - signature-based detection
  - classification
  - anomaly detection

- **Audit streams:**
  - network traffic
  - security audit logs
  - application logs
Deployment issues

- Different devices:
  - router
  - firewall
  - NIDS
  - HIDS

- Scalability:
  - handling $X$ devices, $Y$ users and $Z$ applications

- Management challenges:
  - lots of alerts
  - alert correlation
  - incident diagnostics
Intrusion Detection vs. Prevention

How do you upgrade from intrusion detection to intrusion prevention?

Prevention issues:
- real-time operation (performance)
- timeliness (immediate action)
- getting access to events / OS interaction
- decision making (thresholds etc.)
- persuasion of human decision makers / operational issues
Intrusion Detection vs. Prevention

How do you upgrade from intrusion detection to intrusion prevention?
Intrusion Detection vs. Prevention

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s/D/P/
Intrusion Detection vs. Prevention

How do you upgrade from intrusion detection to intrusion prevention?

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- Prevention issues:
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Components of network IDS

- **Detection:**
  - signature-based detection
  - classification
  - anomaly detection

- **Feature extraction:**
  - analysis of protocol headers
  - byte-level sequence analysis
  - content parsing

- **Audit:**
  - packet capture and de-fragmentation
  - TCP stream re-assembly
Take-home message

- There is **no** “one-size-fits-all” IDS!
- IDS are only as useful as the administrators are willing to analyze alerts and take management decisions.
- Intrusion prevention systems require a much higher degree of automation and more development / installation effort.