Network Security: The Principles of Threats, Attacks and Intrusions (Part 2)

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What is an Intrusion?

Sequence of related actions by a malicious adversary that results in occurrence of security threats to target computer or network

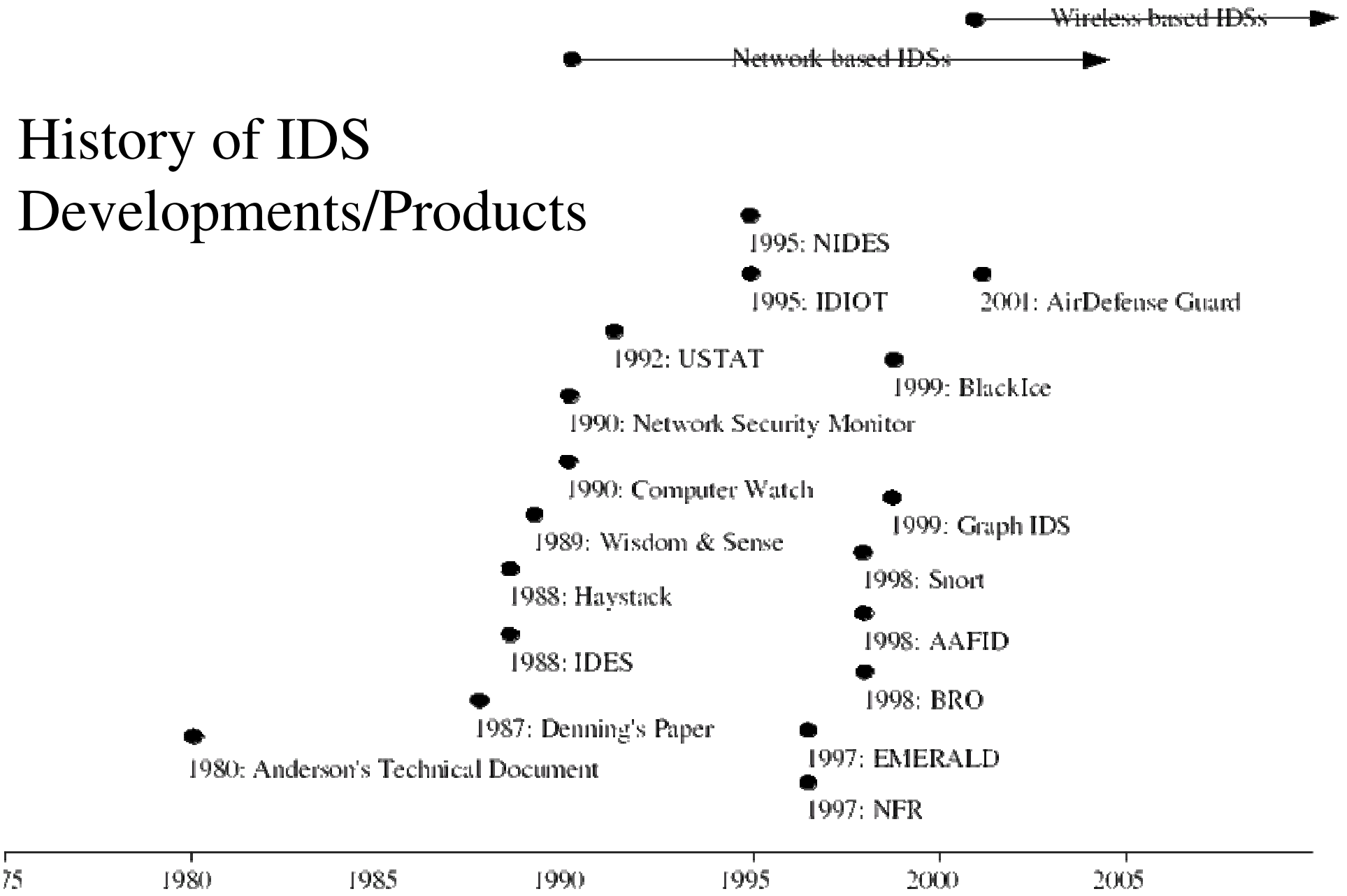
Indicators:

- Repetition of unusual behaviour
- Exploitation of known vulnerabilities
- Inconsistent packet sequences or routes
- Unexplained problems
- Suspicious traffic content

Major Reasons for Using Intrusion Detection Systems are..

- To detect intruders, attacks, abuse...
- To detect probes
- To provide active network security
- To provide a means of deterrent
- To collect data on system behavior so as to recover after intrusion
- To indirectly provide useful information

History of IDS Developments/Products

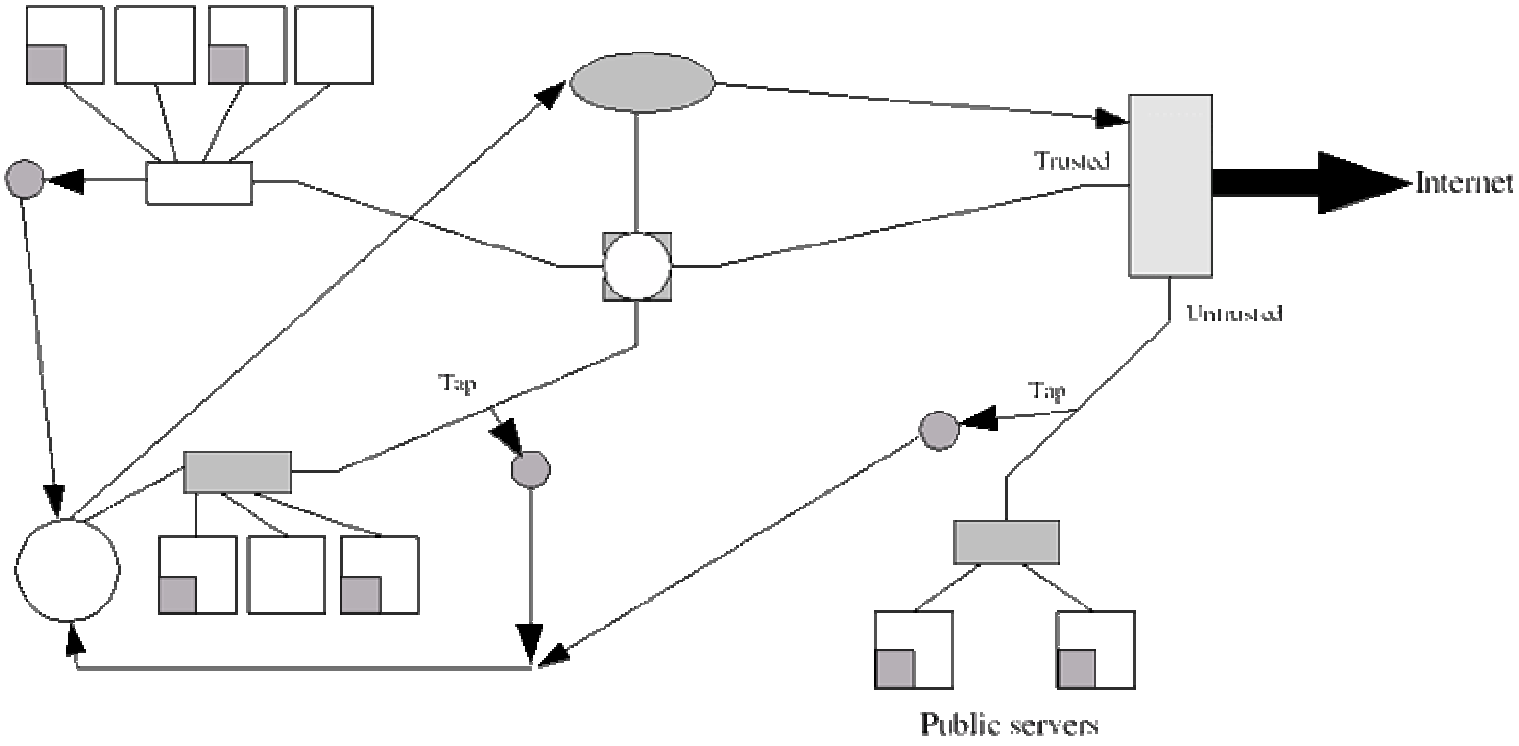


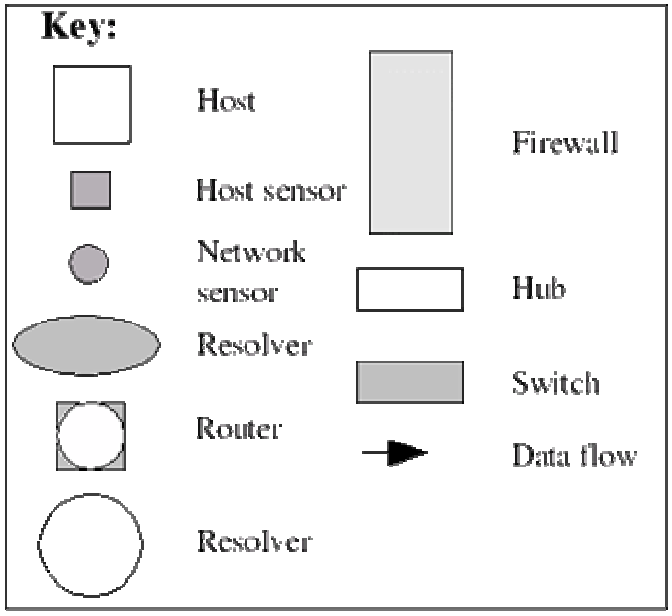
IDS Goals

- Differentiate normal from damaging actions
- Scalable
- Variety of network systems and architectures
- Adapts in response to new attacks
- Reports attacks in real-time
- Co-operates with other security mechanisms

IDS Goals

- Increase monitoring at suspicious points
- Protect against being attacked itself
- Function in face of network failure
- Minimal performance impact
- Generate audit information
- Reflect security policy of organisation





IDS Architecture

IDS Architecture Components

- Sensors - data gathering for the IDS
- Monitors - process the collected data
- Resolver - determines appropriate responses
- Controller - configuration of components in a distributed system

Modern IDS apply these components in a cascading fashion, ie - allowing higher level system overviews to be gained as a user ascends through the tree

IDS Techniques

- Misuse Detection (M-IDS) - attempts to match observed v expected behaviour (eg signature analysis, Petri nets, state transition diagrams, genetic algorithms)
- Anomaly Detection (A-IDS) - models expected behaviour (eg statistical, expert systems, neural networks)

IDS Techniques

- Location of Sensors - network-based (no processing overheads and difficult to attack) *or* host-based (performance impact but good data collection)
- Monitor Processing Patterns - real-time (cf. batch) detection of significant benefit (performance issues)
- Distributed Correlation - simple interfaces (eg Shadow) or hierarchical (eg GrIDS)

Capabilities of IDS

- Second level of defense if primary security fails
- Clear view and summary (eg Tripwire)
- Extracts information useful in tracking intrusions
- Identifies nature of abuse - (eg systems modifications for later backdoor use)
- IDS logs as evidence in legal cases

Capabilities of IDS

- IDS can assist in detecting mis-configurations
- Combined with network security scanners, security holes can be revealed - eg finding particular firewall is vulnerable to certain attacks
- IDS can determine which resources are targeted
- New attacks every month - simplifies detection
- IDS works well with security policy

Limitations of IDS

- Reporting tool - cannot stop ongoing intrusions
- Cannot trace intrusion with poor authentication
- Can only trace intrusion to point of entry to system
- Must be aware of security policy
- Attackers may attack IDS systems
- Depends upon seeing *all* traffic
- Models event - systems react in different ways
- Widely spread attacks may be ignored
- New attacks continually being discovered
- Scaling problems

Current Development in IDS

- Distributed and scalable IDS
- Use of AI and pattern matching
- Embedded IDS in network devices
- Use in other areas - telephone / credit card systems
- Adaptation to new technologies
- Automatic recognition of new attacks (adaptive AI)
- IDS which responds to attacks in progress
- IDS standards/groups (eg CIDF, IDWG, IDSC ….)

Intrusion Detection Systems and Products

- Manual Review Techniques
- Full-scale IDS may not always be appropriate:
  - connect dummy service to ports (eg IMAP (143), SMB (139), HTTP (80) - trigger script when attacked
  - use log files and audit info to build critical log
  - use simple monitors such as NetMon and FileMon

Types of IDS

- Host-based (HIDS)
  - searches for mis-configurations and dangerous settings, unusual privileges etc
- Network-based (NIDS)
  - checks host security policies, dangerous or unnecessary services
- Hybrid

Vary according to whether:

fixed/wireless

commercial/freeware

operating system

Host-Based IDS

- GFi LANgaurd SELM Windows *Commercial*
  http://www.gfi.com/lanselm/index.html
- EMERALD eXpert-BSM Solaris *Commercial*
  http://www.sdl.sri.com/projects/emerald/releases/eXpert-BSM/
- ISS BlackICE Windows *Commercial*
  http://blackice.iss.net
- Symantec Host IDS Windows/Solaris *Commercial*
  http://enterprisesecurity.symantec.com/products
- LIDS Linux *GPL* http://www.lids.org

Network-Based IDS

- AirDefense Guard *(Wireless IDS)* Hardware *Commercial*
  www.airdefense.net/products/airdefense_ids.shtm
- NetDetector Solution Hardware *Commercial*
  www.niksun.com/index.php?id=194
- Network Flight Recorder Security Hardware *Commercial*
- RealSecure Network Sensor
  Windows/Linux/Solaris/Nokia *Commercial*
- Symantec ManHunt Solaris/Linux *Commercial*
- Shoki *nix *GPL* http://shoki.sourceforge.net
- Snort *nix *GPL* http://www.snort.org
- Sourcefire Intrusion MS Hardware *Commercial*

Hybrid IDS

- Prelude *nix *GPL* http://www.prelude-ids.org
- RealSecure Network Sensor Windows/*nix *Commercial* www.iss.net/products_services

Example NIDS: SNORT

- Lightweight IDS system capable of performing real-time traffic analysis and packet logging
- Can perform protocol analysis, content searching/matching.
- Can be used to detect a variety of attacks and probes, eg:
  - buffer overflows
  - stealth port scans
  - CGI attacks
  - SMB probes
  - OS fingerprinting attempts

Example IDS: SNORT

- Snort has three primary uses. It can be used as:
  - a packet sniffer like tcpdump
  - a packet logger (useful for network traffic debugging, etc)
  - a full network intrusion detection system
- Snort/IDS operates from a script rule file applied to each packet monitored
- Provides specialised access to IP packets, eg fragmentation bit checks
- Example rule:

```
alert tcp any any -> 192.168.0.1/24 111 {content: "|00 01 86 A5|";
                                         msg: "mountd access";  }
```

Example IDS: BlackIce

Host-based IDS for Windows and carries out extensive port analysis

- Four levels: Paranoid, Nervous, Cautious, Trusting
- Provides back-trace of intruders via NetBios
- Uses signature files to detect known attacks
- Real time network usage graph
- Links to full protocol stack
- http://blackice.iss.net

Example IDS: ZoneAlarm

ZoneAlarm (= Firewall + IDS)

- www.zonelabs.com
- Personal firewall with security settings of High, Medium, Low for both LAN and Internet connections, and a mail attachment check setting
- Alerts occur when access to an unauthorised port is attempted. ZoneAlarm advises what likely cause is and how indicative of an attack it is
- Access is allowed/denied for programs on the host PC to connect to the Internet
- ZoneAlarm Pro $US50 for single user and $US1800 for 50 users
- ZoneAlarm - free for home users

Tools Supporting Active Security

- Mapping Tools
- System Scanning Tools
- System Integrity Checkers
- Honeytraps

IDS Support Tools - Mapping Tools

Network Mappers

- Commercial and free tools available - nmap and Cheops-NG
- Carry out - DNS zone transfers, address/port scanning, host requests, promiscuous monitoring
- nmap sends variety of packets with illegal flags, ICMP echos, fragmented packets etc to hosts and analysing responses
- eg recognise Linux with kernels older than 2.0.35 by using packet with SYN and illegal flags set

IDS Support Tools - Mapping Tools

- Cheops *nix *GPL (no longer supported)* www.marko.net/cheops/
- Cheops-NG *nix *GPL* http://cheops-ng.sourceforge.net/
- nmap *nix/Windows *GPL* http://www.insecure.org/nmap

IDS Support Tools - System Scanning Tools

- Tools used to detect and report on vulnerabilities in computer or network
- Uses database of known vulnerabilities and attempts matching to these records
- For an attacker these tools allow location of potential specific targets, eg
  - open HTTP port with a known vulnerability

IDS Support Tools - System Scanning Tools

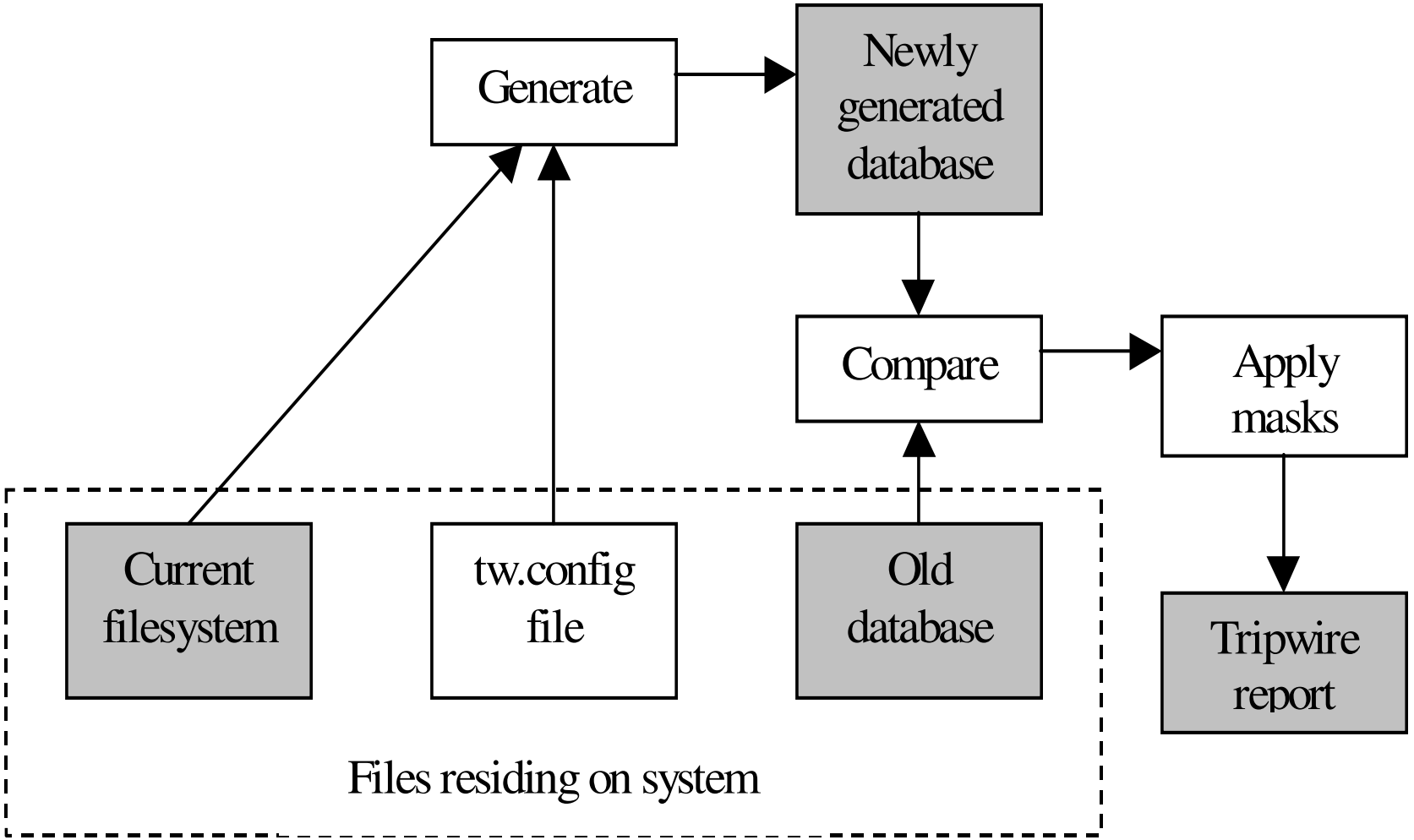
- Core Impact Windows *Commercial*
- GFi LANguard NSS Windows *Commercial/Freeware*
- ISS Internet Scanner *Commercial*
- Nessus *nix *GPL* www.nessus.org
- Rapid7 NeXpose Linux/Windows *Commercial*
- Retina Windows *Commercial*

IDS Support Tools - System Integrity Checkers

- Detect anomalies which may indicate that data on computer has been tampered with
- Cannot detect intruders until after intrusion and so are not real-time like IDSs
- Stores hashed snapshot of file systems and compares to current system state and reports discrepancies

IDS Support Tools - System Integrity Checkers

- Tripwire is best example
- Commonly support hashing algorithms, eg - MD4/5, SHA, ITU CRC-16 and -32 signatures
- Reference database based upon initial trusted system
- Only reports changes already present in system
- Last line of defence - system is already compromised!



Structure of the Tripwire system

IDS Support Tools - System Integrity Checkers

- Aide *nix *GPL*
- Chkrootkit *nix *Open Source*
- Integrit *nix *GPL*
- Ionx Data Sentinel Windows *Commercial*
- GFi LANguard SIM Windows *Commercial/Freeware*
- Osiris *nix *Open Source*
- Samhain *nix *GPL*
- Tripwire *nix/Windows *Commercial* and *Open Source*

IDS Support Tools - Honeytraps

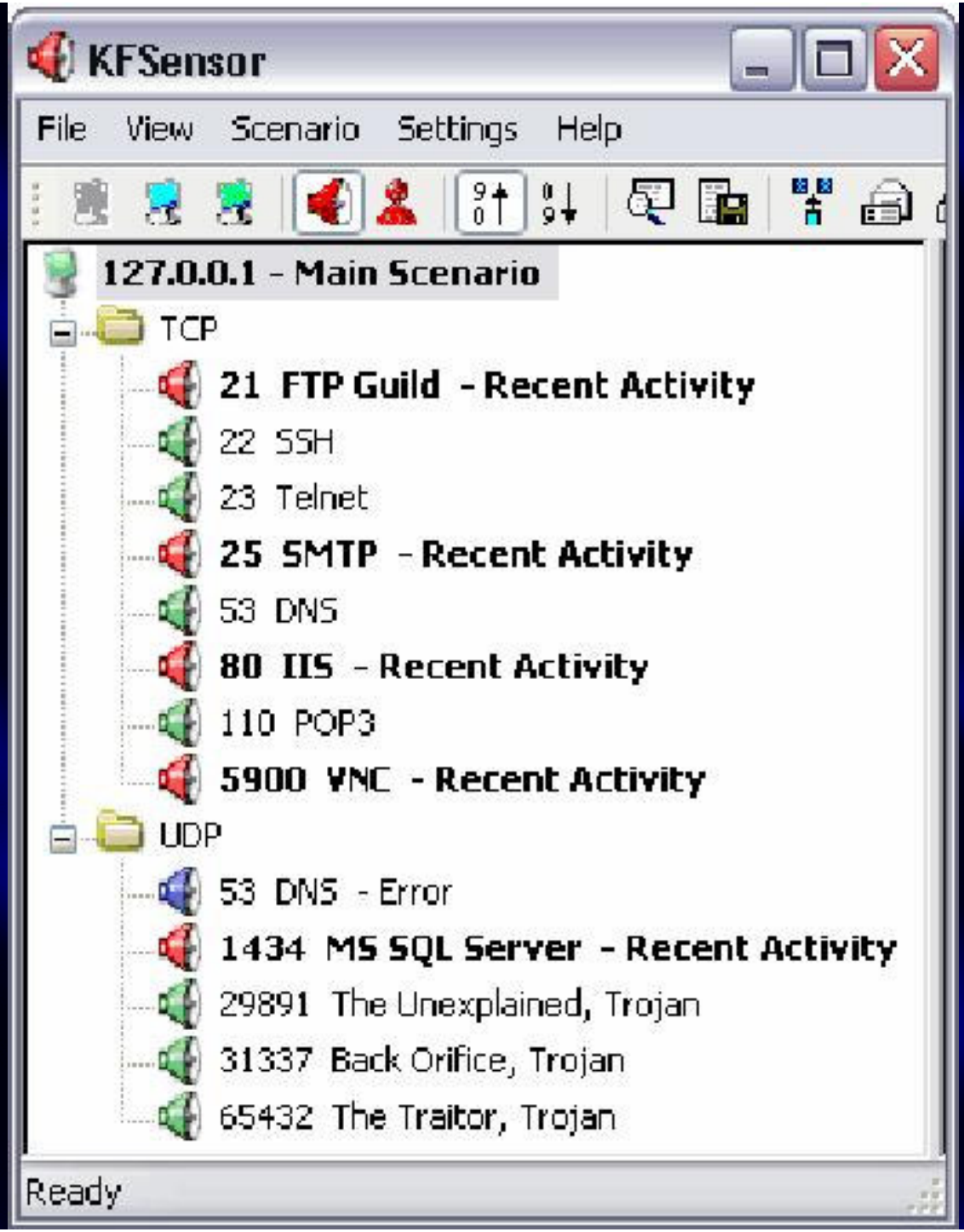
Current IDS methodologies have shortcomings:

- problem recognising novel attacks
- occurrence of false positives
- reporting of attacks of no interest

- Honeytrap system – simulated or real system that exists for sole purpose of being attacked!
- Looks and behaves like real system
- Must not be launching pad
- Must gather valuable information on attacker

IDS Support Tools - Honeytraps

- Bait and Switch *nix *BSD*
- KeyFocus Sensor Windows *Commercial*
- NetBait Enterprise i386-based *Commercial*
- Symantec Decoy Server Solaris *Commercial*
- Verizon NetFacade *nix *Commercial*



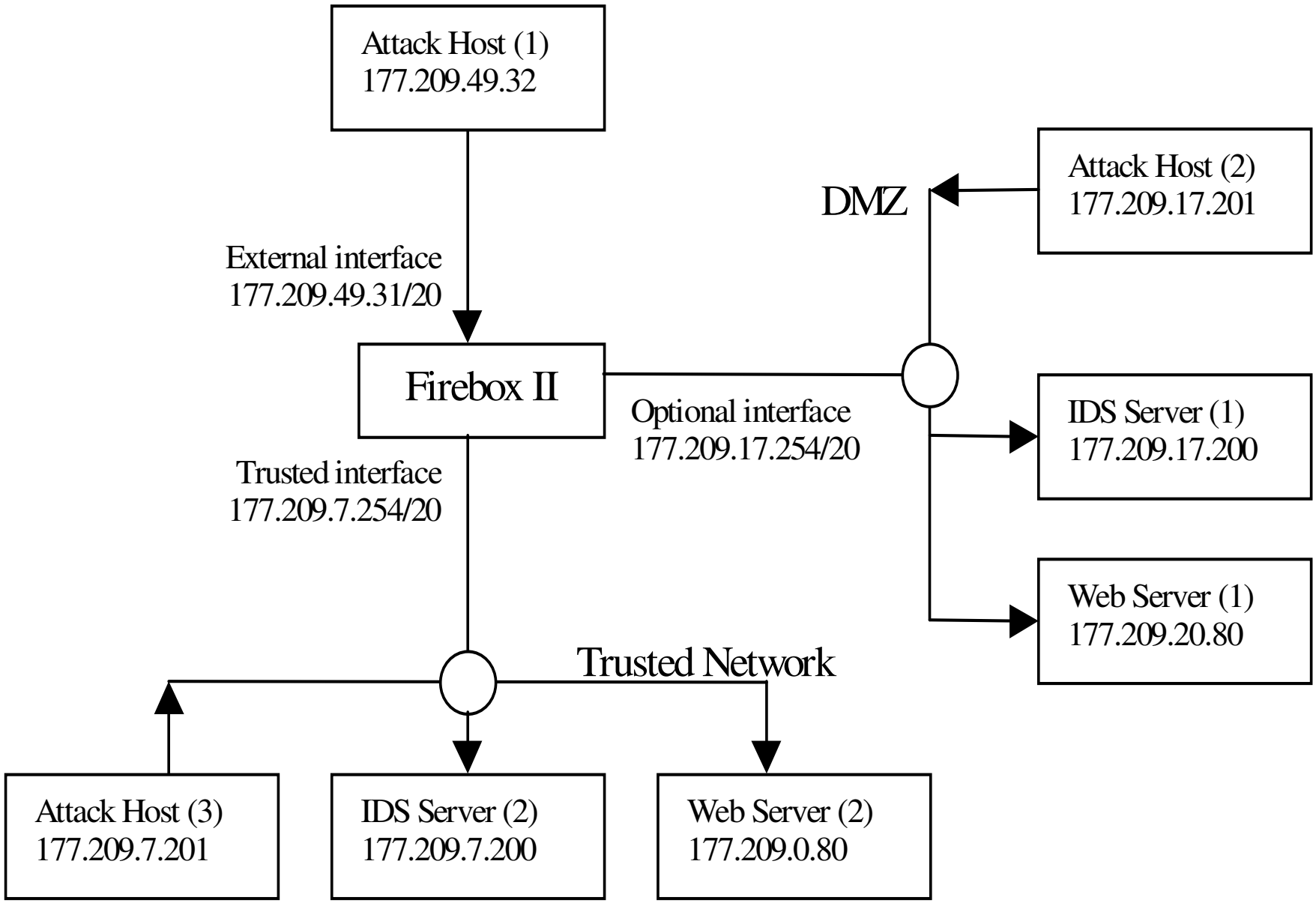
KFSensor Honeypot Output

IDS Standards

- Common Intrusion Detection Framework (CIDF)
  - Common protocols and interface standards (1999)
- Intrusion Detection Working Group (IDWG)
  - Produced 4 Internet Drafts (2002)
- Open Security Evaluation Criteria (OSEC)
  - Evaluation of and tests on products (2003)
- Intrusion Detection Systems Consortium (IDSC)
  - Vendor consortium promoting product adoption by defining common terminology, integrity, standards

Intrusion Detection Experiments

- Watchguard firewall used as testbed for Intrusion Detection Analysis
  - simulates small office network
  - single public server
  - limited set of machines on firewall's trusted network
  - unspecified number of machines on external network



Firewall testbed

Intrusion Detection Case Study

Sample Firewall policy might be ….

- Incoming FTP traffic allowed (via proxy) only if destined for 204.137.98.164 - public server located in optional network
- Outgoing FTP traffic allowed without restriction
- Incoming HTTP traffic allowed (via proxy) only if destined for 204.137.98.165
- Outgoing HTTP traffic allowed without restriction Incoming SMTP traffic was allowed only to 177.209.49.31 (external firewall interface)
- Outgoing SMTP traffic was allowed only from 177.209.0.25 (hypothetical SMTP server on trusted network)
- Configuration access to firewall allowed from internal networks
- IP Masquerading was disabled
- Port Autoblocking was disabled
- All other ports and services were blocked

Intrusion Detection Case Study

1. Scan Web server (2) and IDS server (2) from Attack host (3) (all machines on a common network segment)
2. Scan Web server (1) and IDS server (1) from Attack host (3) (attack on *optional from trusted network*)
3. Scan Web server (2) and IDS server (2) from Attack host (2) (attack on *trusted from optional network*)
4. Scan Web server (1) and IDS server (1) from Attack host (1) (*external* attack on *optional network*)
5. Scan Web server (2) and IDS-server (2) from Attack host (1) (*external* attack on *trusted network*)

Intrusion Detection Case Study

- Scan 1 gives baseline of what attacks IDS tools are capable of recognising, and corresponds to an internal attack on trusted network
- Scan 2 simulates internal attack against optional network
- Scan 3 simulates result if machine on optional network is compromised and then attacks internal machines
- Scan 4 -very common case - external attacker attempts to access machines on optional network
- Scan 5 is same situation for trusted network

Intrusion Detection Case Study

Conclusions

- IDS can highlight problems with Firewall configurations
- Out-of-box configurations may be dangerous
- Firewalls protect inaccessible machines well
- Firewalls do not protect against application-level attacks
- Firewalls are themselves vulnerable to attack
- IDS tools can recognise many attacks
- IDS tools have different detection sets
- Network IDS recognise attacks from their area of coverage
- Network scanning tools are susceptible to false readings
- Firewalls offer minimal detection capabilities