Intrusion Detection Systems (IDS)

Presented by

Erland Jonsson

Department of
Computer Science and Engineering

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- Motivation and basics (Why and what?)
- IDS types and detection principles
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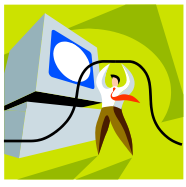
Why Intrusion Detection?



Intrusion Detection

- Intrusion Detection Systems (IDS) does not (a priori) protect your system
- It works as burglar alarm
- Intrusion Detection Systems constitute a powerful **complement** (to basic security)

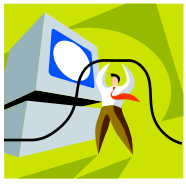
Motivation for Intrusion Detection

- Even it you do not succeed to stop the intrusion it is of value to know that an **intrusion** has indeed **occurred**, **how** it occurred and which **damage** that has been caused.

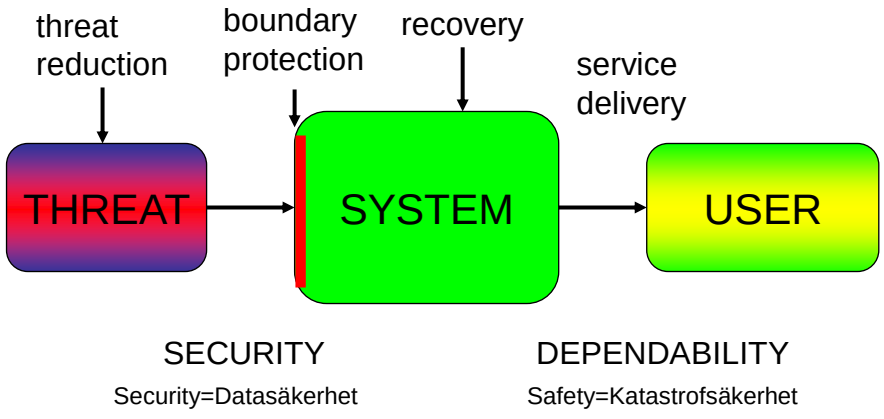
IDS are used for:

- detect intrusions and intrusion attempts
- give alarms
- stop on-going attacks (possibly)
- trace attackers
- investigate and assess the damage
- gather information for recovery actions

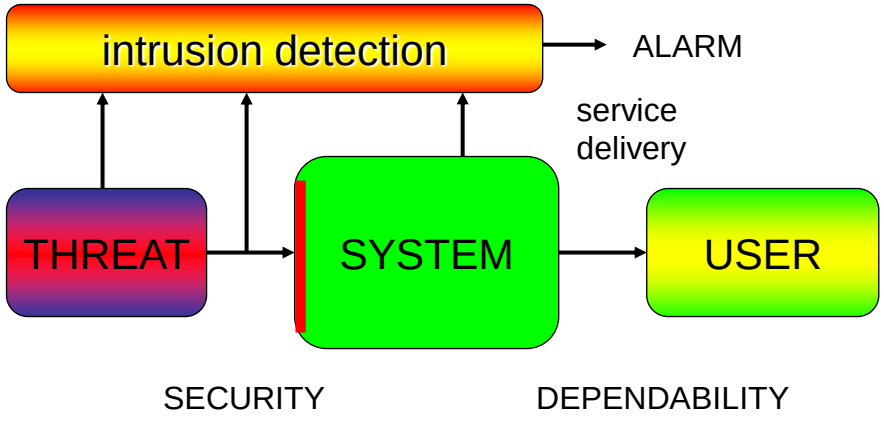
What is Intrusion Detection?



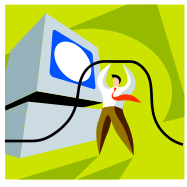
What is Security? - protection principles



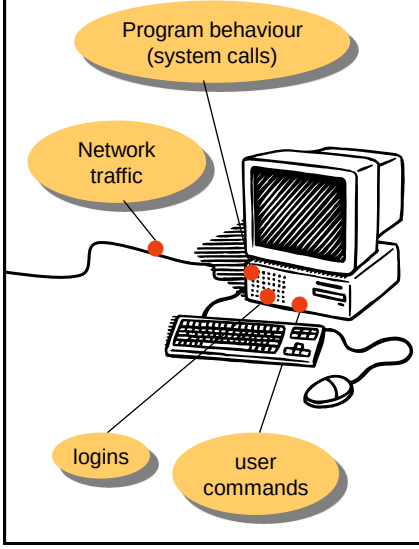
What is Security? - intrusion detection



How is detection accomplished?



Logging is the basis for ID – sensors for intrusion detection



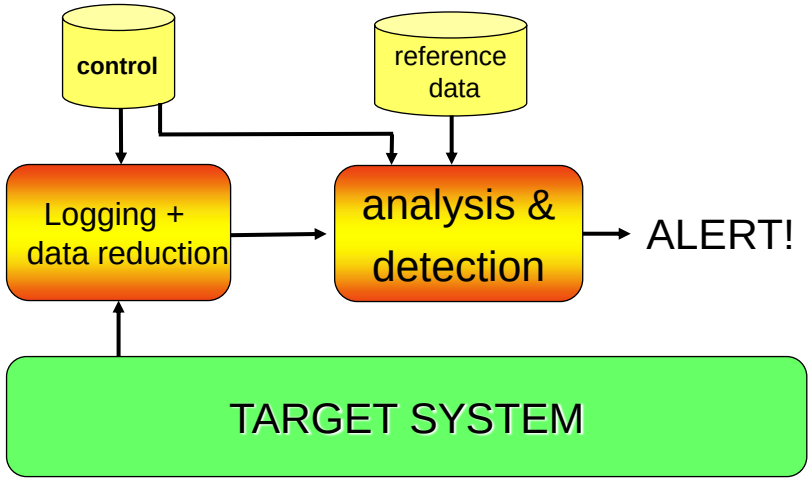
What do you log?

- Network traffic to detect ”network attacks”
- System calls to detect programs that behave suspiciously
- User commands to detect masquerading, i.e. when an attacker is using another user’s account
- Logins, in order to know who was active on the system when it was attacked

What do we want to detect

- ”Ordinary” intrusions
  - ”sniffing” of passwords
  - buffer overflow attacks
  - Availability attacks (DoS, denial-of-service) are common and hard to protect against
- Information gathering, i.e. ”attacks” aiming at open ports and weaknesses
  - port-scanning: nmap
  - Vulnerability scanning: satan, saint, nessus

Components in an Intrusion Detection System

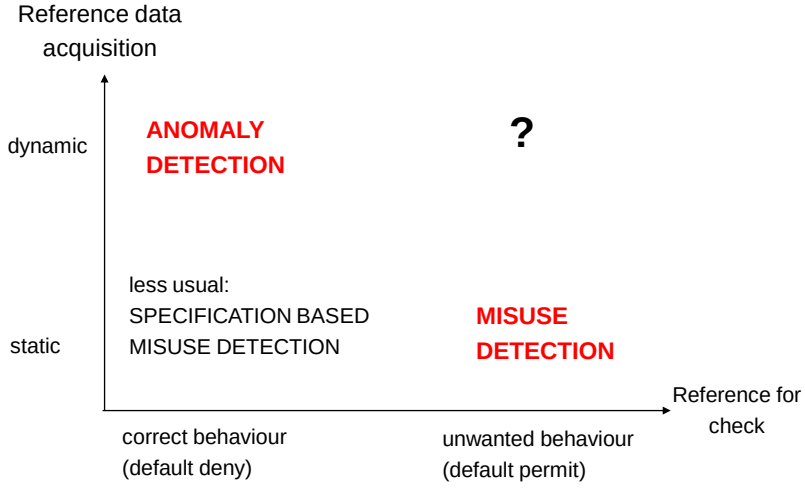


Principles of Intrusion Detection

There are two main principles:

- **misuse detection** (missbruksdetektering)
  - define what is ***"wrong"*** and **give *alarms for that*** ("default permit")
- **anomaly detection** (avvikelsedetektering)
  - define what is ***"correct"*** and **give *alarms for everything else*** ("default deny")

IDS Systems - overview



Key Data for IDS Systems

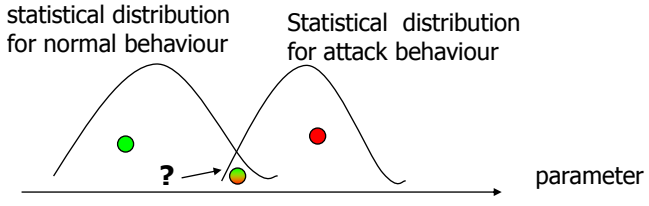
- **FIGURES-OF-MERIT** for IDS-systems
  Which attributes are interesting?
- no alarms should be given in the abscence of intrusions
- intrusion (attempts) must be detected
- probability of detection (“hit rate”) (upptäcktssannolikhet)
- rate of false positives (“false alarm rate”) (falskalarmrisk)
- rate of false negatives (“miss rate”) (misssannolikhet)

Key data for IDS Systems (cont’d)

	no alarm	alarm
intrusion	**MISS**	**OK**
no intrusion	**OK** normal state	**FALSE ALARM** problem area !?

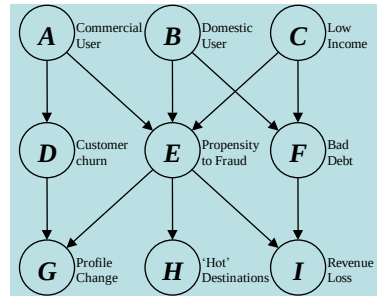
Detection problem

- Classification
  - the detection is a traditional clasification problem
  - Separate intrusion events from normal events
  - however, there is an overlap…..



Detection methods

- Rule based
- Pattern matching
- Expert systems
- Thresholds
- Statistical analysis
- Bayesian networks
- Neural networks
- Markov models
- etc

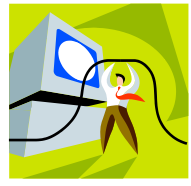


$\Pr\{A\}$	= 0.76	$\Pr\{B\}$	= 0.24	$\Pr\{C\}$	= 0.74
$\Pr\{D\|\neg A\}$	= 0.27	$\Pr\{D\|A\}$	= 0.73		
$\Pr\{E\|\neg A,\neg B,x\}$	= 0.01				
$\Pr\{E\|\neg A,B,\neg C\}$	= 0.02	$\Pr\{E\|\neg A,B,C\}$	= 0.04	$\Pr\{E\|A,x,x\}$	= 0.03
$\Pr\{F\|\neg B,x\}$	= 0.00	$\Pr\{F\|B,\neg C\}$	= 0.01	$\Pr\{F\|B,C\}$	= 0.04
$\Pr\{G\|\neg D,\neg E\}$	= 0.03	$\Pr\{G\|\neg D,E\}$	= 0.72		
$\Pr\{G\|\neg D,E\}$	= 0.84	$\Pr\{G\|D,E\}$	= 0.96		
$\Pr\{H\|\neg E\}$	= 0.58	$\Pr\{H\|E\}$	= 0.42		
$\Pr\{I\|\neg E,\neg F\}$	= 0.02	$\Pr\{I\|\neg E,F\}$	= 0.98		
$\Pr\{I\|E,\neg F\}$	= 1	$\Pr\{I\|E,F\}$	= 1		

Requirements on IDS Systems

- system response time (real-time behaviour?)
- fault tolerance (due to e.g. s/w, h/w, configuration, etc)
- ease of integration, usability and maintainability
- portability
- support for reference data updates (misuse systems) (cp virus programs)
- “excess” information (privacy aspects)
- the “cost” (CPU usage, memory, delays,...)
- host-based or network based?
- security of the IDS (protect the reference information) ?

Problems with IDS systems



A few practical problems

1. False alarms
2. Adaptivity/Portability
3. Scalability
4. Lack of test methods
5. Privacy concerns

Problem area 1

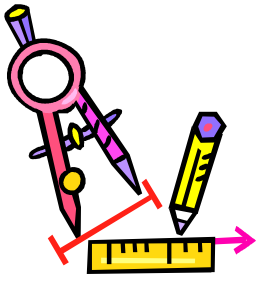
- False alarms
  - MANY alarms
  - If detection is 99% correct and the number of intrusions is 0.01% in the analysed information: 99% of all alarms will be false alarms!
  - There is a trade-off between covering all attacks and the number of false alarms
  - (False) alarm investigation is resource demanding

Problem area 2

- Adaptation/Portability
  - You can not buy a detection system that is adapted to your computer system
  - The services provided are often unique
  - The user behaviour varies
  - The adaptation of a (simple) network based IDS may require two weeks of work

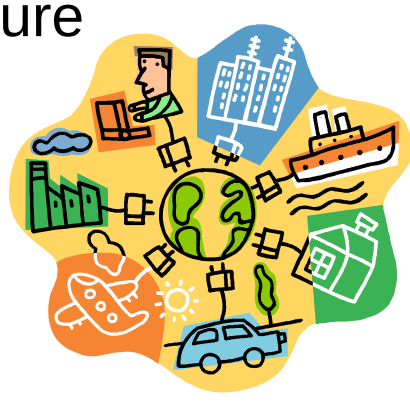
Problem area 4

- Test methods



  - there is normally no IDS specification that states what intrusions the system covers
  - Only (?) DARPA has made a comparative study, which has been much criticized (Lincoln Lab data 1999)

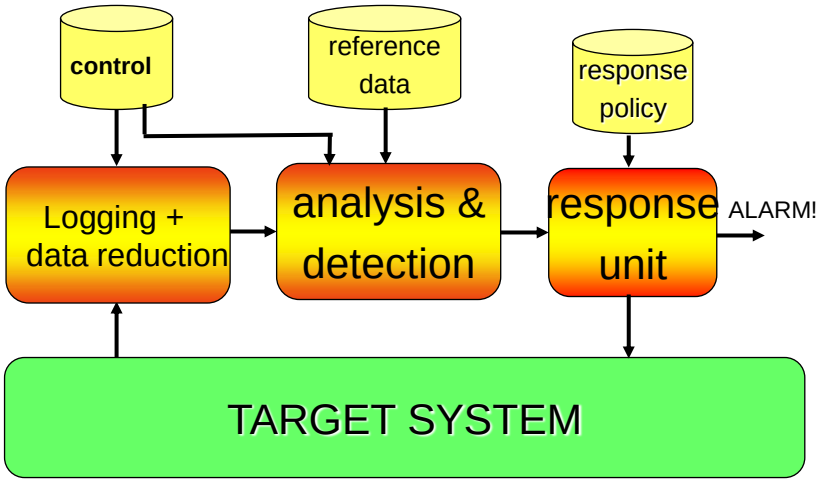
The future



Intrusion prevention systems (IPS)

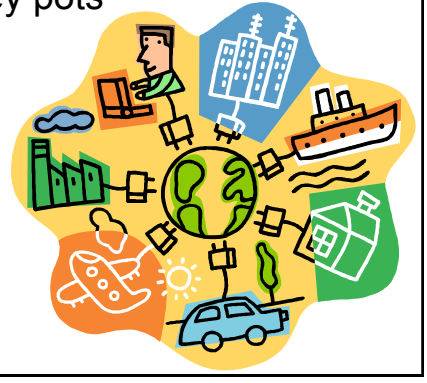
- Is ”hot” right now
- Gartner Group report: ”IDS is dead, long live IPS”
- The meaning of IPS is not well defined – it is rather a commercial term
- The ”best” interpretation is an IDS with some kind of response function, such as
  - reconfiguring a firewall
  - disrupt TCP connections
  - discontinue services
  - stop system calls (in runtime)

Components in an IDS with response function



The future

- "earlier" detection, detection of "unwanted behaviour", i.e. potential intrusion attempts, pro-active data collection more intelligent systems
- diversion, deflection, "honey pots"
- active countermeasures
- "strike back" !? (not to be recommend!)
- truly distributed systems (alert correlation)
- fraud detection



Future threats

- Threat 1: higher transmission rates make network data collection hard (or even impossible)
- Threat 2: increased use of encryption reduces the amount of useful data.

Future possibilities

- New detection methods
  - Visualization
    - Find patterns and anomolous behaviour
    - Use the qualities of the human brain!
- Combining methods
- Intrusion tolerance