Techniques for intrusion detection

Techniques used in intrusion detection

- **Techniques:**
- Statistical analysis
- Neural Networks and machine learning
- Rule-based and signature techniques
- State-transition analysis
- Immune systems based techniques
- Data mining

Statistical analysis approach

- The user or system behaviour (set of attributes) is measured by a number of variables over time.
- Examples of such variables are:
  - user login, logout,
  - number of files accessed in a period of time,
  - usage of disk space, memory, CPU, etc.
- The frequency of updating can vary from minutes to months.
- The system stores *mean* values for each variable used for detecting exceeds that of a predefined threshold.
- More sophisticated model: short- and long-term user profiles.

Neural networks and machine learning

- Neural networks use their learning algorithms to learn about the relationship between input and output
- The main purpose is to learn the behaviour of actors in the system (e.g., users, processes).
- The advantage of using neural networks over statistics:
  - a simple way to express nonlinear relationships between variables;
  - learning about relationships automatically.
- The disadvantage:NNs are still a computationally intensive technique.
- It has been shown that NNs can be used to predict behaviour of users and super-users (roots);
- Other machine learning techniques may be used

Rule-based (expert) systems

- Rule-based (expert) systems: work on a previously defined set of rules describing an attack.
- All security related events are translated in terms of **if-then-else rules**.
- Inference engine maybe used to infer conclusions.
- **Examples**: Wisdom & Sense and ComputerWatch (developed at AT&T).

Computer Immunology

- Stored patterns are used for monitoring of system calls to check whether the sequence generated is listed in the knowledge base; if not — an alarm is generated.
- **Example:** pattern of normal behaviour:
- **open, read, mmap, mmap, open, getrlimit, mmap, close** (system calls in UNIX)
- Information about all sequences of the **length, say, 3** may be stored in knowledge base;
- If the input sequence of calls is
- **open, read, mmap, open, open, getrlimit, mmap**, **close**
- then 4 mismatches will be found

- **Advantages:** potentially very low false alarm rate if the knowledge base complete enough
- **Disadvantages:** if an attacker uses legitimate
- actions on the system to gain unauthorized access, no alarm is generated.

Signature based method

Example of a signature: alert icmp $EXTERNAL_NET any -> $HOME_NET any (msg:"MISC large ICMP"; dsize: >800; reference:arachnids,246; classtype:bad-unknown; sid:499;)

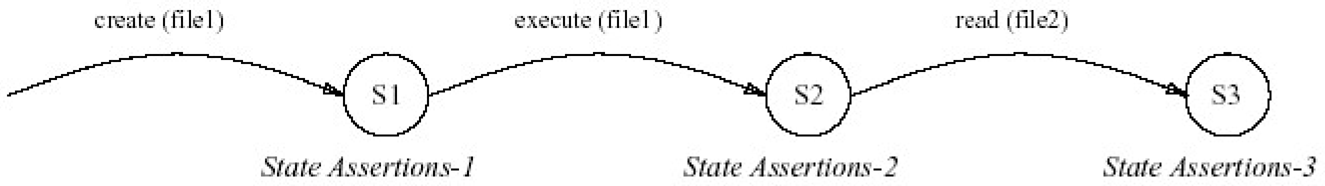
Alarm will be raised if a ICMP packet incoming from the external network, associated with any port and having a size more than 800 bytes

- **Advantages:**
- very low false alarm rate;
- simple algorithms, easy implementation.
- **Disadvantages:**
- difficulties in updating information on new types of attacks;
- Unable to detect unknown attacks (knowledge based)

State-transition analysis

- an attack is described with a set of goals and transitions that must be achieved by an *intruder* to compromise a system.
- Transitions are represented on state-transition diagrams.

- Inference engine matches current audit records with attacks descriptions: event driving, forward chaining



Computer Immunology

- Analogies with immunology => technique that constructs a model of *normal behaviour of (UNIX) network services*, rather than that of individual users.
- S.Forest at al., **Sense of Self for UNIX Processes,**1996
- This model consists of *short sequences of system calls* made by the processes.
- The assumption is *attacks that exploit flaws in the application code are likely to take unusual execution paths.*
- The model consists of two parts :
  - audit data representing the appropriate behaviour of services;
  - knowledge base with all the known “good” sequences of system calls.

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Computer Immunology

- **Advantages:**
  - Potentially very low false alarm rate (if knowledge base complete enough)
  - Updating the knowledge base can be done on-line
- **Disadvantages** :
  - if an attacker uses legitimate actions to gain unauthorized access, no alarm will be generated
  - Arguments of system calls are not taken into account

User intention identification

- This technique models normal behaviour of users by the set of high-level tasks they have to perform on the system.
- These tasks are taken as series of actions, which in turn are matched to the appropriate audit data.
- If mismatch is encountered, an alarm is produced.

Data mining

- set of techniques that use the process of extracting *previously unknown* information from large stores of data.
- Data mining techniques are suitable for large volumes of audit data (off-line processing).
- DM is less useful for stream analysis of network traffic.
- Based on analysis of co-occurrences and correlations of event records, DM may produce
  - Decision trees
  - Association rules
- as a concise representations of discovered relationships

Data mining

- **Example of the rule, generated by DM:**

- **if** for the past 2 seconds, the *count of connections to*
- *the same host* is greater than 4; **and** the *the percentage*
- *of those that have the same service* is greater than 75%; **and**
- *the percentage of those that have the "S0" flag* is greater
- than 75%, **then** there is a *syn flood* attack.

- (taken from **Real Time Data Mining-based Intrusion Detection,** Wenke Lee at al.)