GLOBAL EDITION

Computer Security

Principles and Practice

FOURTH EDITION

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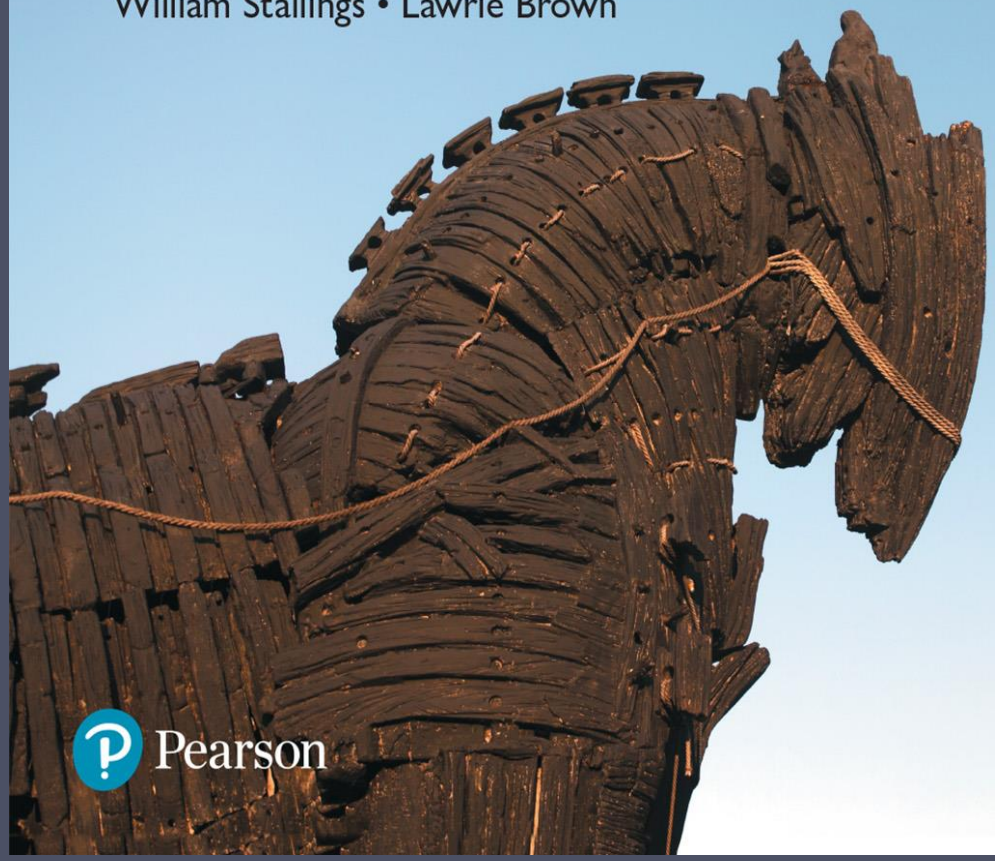

Pearson

Chapter 6

Intrusion Detection

Intruders

One of the key threats to security is the use of some form of hacking by an intruder, often referred to as a hacker or cracker.

Examples of Intrusion

- Defacing a Web server
- Guessing and cracking passwords
- Performing a remote root compromise of an e-mail server
- Copying a database containing credit card numbers
- Viewing sensitive data, including payroll records and medical information, without authorization
- Running a packet sniffer on a workstation to capture usernames and passwords
- Using a permission error on an anonymous FTP server to distribute pirated software and music files
- Dialing into an unsecured modem and gaining internal network access
- Posing as an executive, calling the help desk, resetting the executive's e-mail password, and learning the new password
- Using an unattended, logged-in workstation without permission

Intrusion Detection

Security Intrusion: A security event, or a combination of multiple security events, that constitutes a security incident in which an intruder gains, or attempts to gain, access to a system (or system resource) without having authorization to do so.

Intrusion Detection: A security service that monitors and analyzes system events for the purpose of finding, and providing real-time or near real-time warning of, attempts to access system resources in an unauthorized manner.

Intrusion Detection System (IDS) components

An IDS comprises three logical components:

- **Sensors:** Sensors are responsible for collecting data. The input for a sensor may be any part of a system that could contain evidence of an intrusion.
- **Analyzers:** Analyzers receive input from one or more sensors or from other analyzers. The analyzer is responsible for determining if an intrusion has occurred.
- **User interface:** The user interface to an IDS enables a user to view output from the system or control the behavior of the system.

Types of Intrusion Detection System (IDS)

IDSs are often classified based on the source and type of data analyzed, as:

- **Host-based IDS (HIDS):** Monitors the characteristics of a single host and the events occurring within that host, such as process identifiers and the system calls they make, for evidence of suspicious activity.
- **Network-based IDS (NIDS):** Monitors network traffic for particular network segments or devices and analyzes network, transport, and application protocols to identify suspicious activity.
- **Distributed or hybrid IDS:** Combines information from a number of sensors, often both host and network-based, in a central analyzer that is able to better identify and respond to intrusion activity.

False positive and false negative detection

Although the typical behavior of an intruder differs from the typical behavior of an authorized user, there is an overlap in these behaviors. Thus, a loose interpretation of intruder behavior, which will catch more intruders, will also lead to a number of **false positives**, or false alarms, where authorized users are identified as intruders.

On the other hand, an attempt to limit false positives by a tight interpretation of intruder behavior will lead to an increase in **false negatives**, or intruders not identified as intruders.

IDS Requirements

Following are the desirable for an IDS:

- Run continually with minimal human supervision.
- Be fault tolerant in the sense that it must be able to recover from system crashes and re-initializations.
- Resist subversion. The IDS must be able to monitor itself and detect if it has been modified by an attacker.
- Impose a minimal overhead on the system where it is running.
- Be able to be configured according to the security policies of the system that is being monitored.
- Be able to adapt to changes in system and user behavior over time.
- Be able to scale to monitor a large number of hosts.
- Provide graceful degradation of service in the sense that if some components of the IDS stop working for any reason, the rest of them should be affected as little as possible.
- Allow dynamic reconfiguration; that is, the ability to reconfigure the IDS without having to restart it.

Analysis Approaches

IDSs typically use one of the following alternative approaches to analyze sensor data to detect intrusions:

1. **Anomaly detection**: Involves the collection of data relating to the behavior of legitimate users over a period of time. Then current observed behavior is analyzed to determine with a high level of confidence whether this behavior is that of a legitimate user or alternatively that of an intruder.
2. **Signature or Heuristic detection**: Uses a set of known malicious data patterns (signatures) or attack rules (heuristics) that are compared with current behavior to decide if is that of an intruder. It is also known as misuse detection. This approach can only identify known attacks for which it has patterns or rules.

Host-Based Intrusion Detection (HIDS)

The **HIDS** monitors activity on the system in a variety of ways to detect suspicious behavior. In some cases, an IDS can halt an attack before any damage is done, but its main purpose is to detect intrusions, log suspicious events, and send alerts.

The primary benefit of a HIDS is that it can detect both external and internal intrusions, something that is not possible either with network-based IDSs or firewalls.

Host-based IDSs can use either anomaly or signature and heuristic approaches to detect unauthorized behavior on the monitored host.

Distributed Intrusion Detection

Either a centralized or decentralized architecture can be used. With a centralized architecture, there is a single central point of collection and analysis of all sensor data. This eases the task of correlating incoming reports but creates a potential bottleneck and single point of failure. With a decentralized architecture, there is more than one analysis center, but these must coordinate their activities and exchange information.

Figure 8.2 shows the overall architecture, which consists of three main components:

1. **Host agent module:** An audit collection module operating as a background process on a monitored system. Its purpose is to collect data on security-related events on the host and transmit these to the central manager.
2. **LAN monitor agent module:** Operates in the same fashion as a host agent module except that it analyzes LAN traffic and reports the results to the central manager.
3. **Central manager module:** Receives reports from LAN monitor and host agents and processes and correlates these reports to detect intrusion.

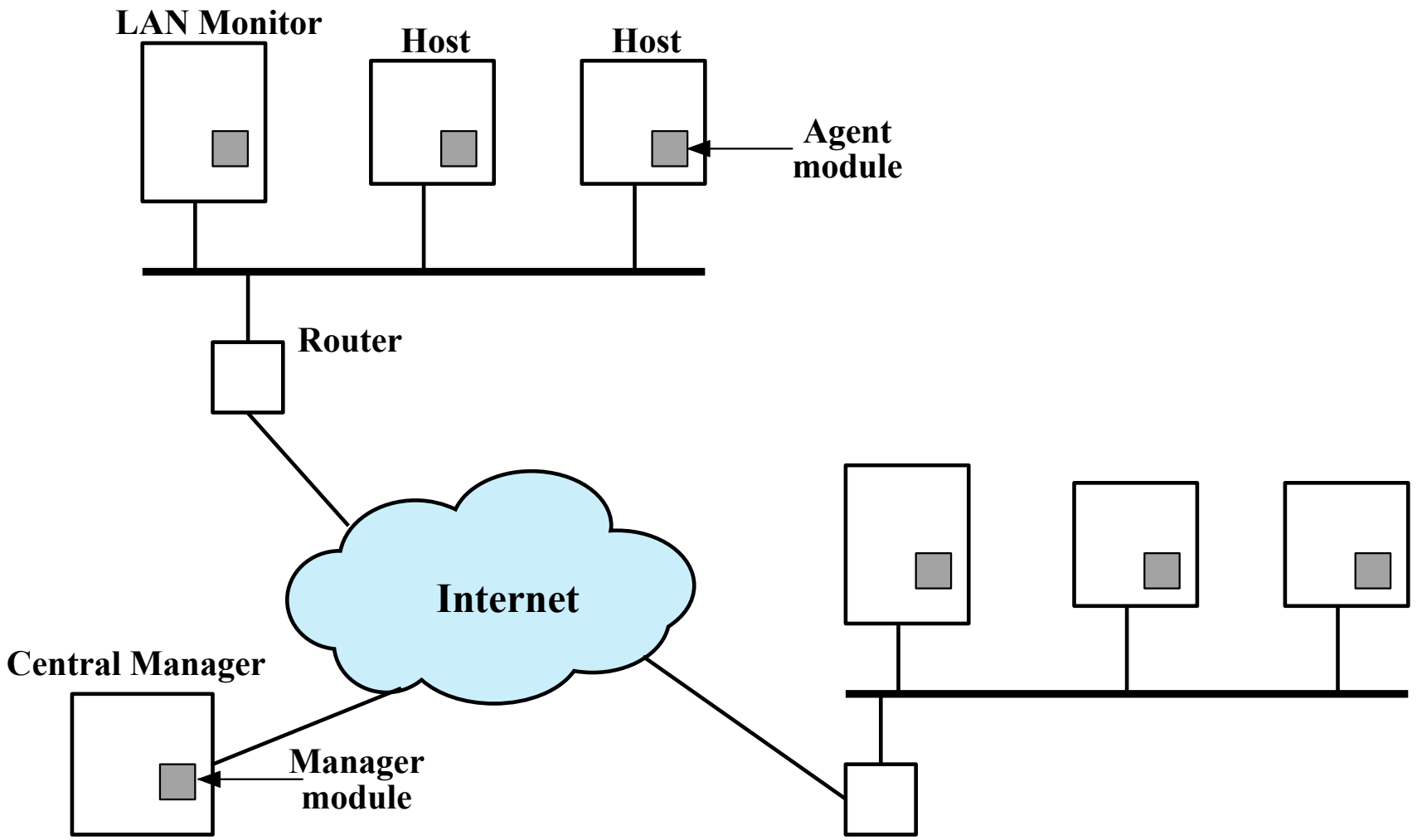

Figure 8.2 Architecture for Distributed Intrusion Detection

Network-Based IDS (NIDS)

- NIDS are typically included in the perimeter security infrastructure of an organization, either incorporated in, or associated with, the firewall.
- They typically focus on monitoring for external intrusion attempts, by analyzing both traffic patterns and traffic content for malicious activity.
- With the increasing use of encryption though, NIDS have lost access to significant content, hindering their ability to function well. Thus while they have an important role to play, they can only form part of the solution.
- A typical NIDS facility includes a number of sensors to monitor packet traffic, one or more servers for NIDS management functions, and one or more management consoles for the human interface.

Types of Network Sensors

Network Sensors can be deployed in one of two modes: inline and passive. An **inline sensor** is inserted into a network segment so that the traffic that it is monitoring must pass through the sensor.

More commonly, **passive sensors** are used. A passive sensor monitors a copy of network traffic; the actual traffic does not pass through the device. From the point of view of traffic flow, the passive sensor is more efficient than the inline sensor, because it does not add an extra handling step that contributes to packet delay.

Honeypots

Honeypots are decoy systems that are designed to lure a potential attacker away from critical systems.

Honeypots are designed to:

- Divert an attacker from accessing critical systems.
- Collect information about the attacker's activity.
- Encourage the attacker to stay on the system long enough for administrators to respond.

These systems are filled with fabricated information designed to appear valuable but that a legitimate user of the system would not access. Thus, any access to the honeypot is suspect. The system is instrumented with sensitive monitors and event loggers that detect these accesses and collect information about the attacker's activities.

Snort IDS

Snort is an open source, highly configurable and portable host-based or network-based IDS. Snort is referred to as a lightweight IDS, which has the following characteristics:

- Easily deployed on most nodes (host, server, router) of a network.
- Efficient operation that uses small amount of memory and processor time.
- Easily configured by system administrators who need to implement a specific security solution in a short amount of time.

Snort Architecture

A Snort installation consists of four logical components (Figure 8.9):

- **Packet decoder:** The packet decoder processes each captured packet to identify and isolate protocol headers at the data link, network, transport, and application layers.
- **Detection engine:** The detection engine does the actual work of intrusion detection. This module analyzes each packet based on a set of rules defined for this configuration of Snort by the security administrator.
- **Logger:** For each packet that matches a rule, the rule specifies what logging and alerting options are to be taken.
- **Alerter:** For each detected packet, an alert can be sent. The alert option in the matching rule determines what information is included in the event notification.

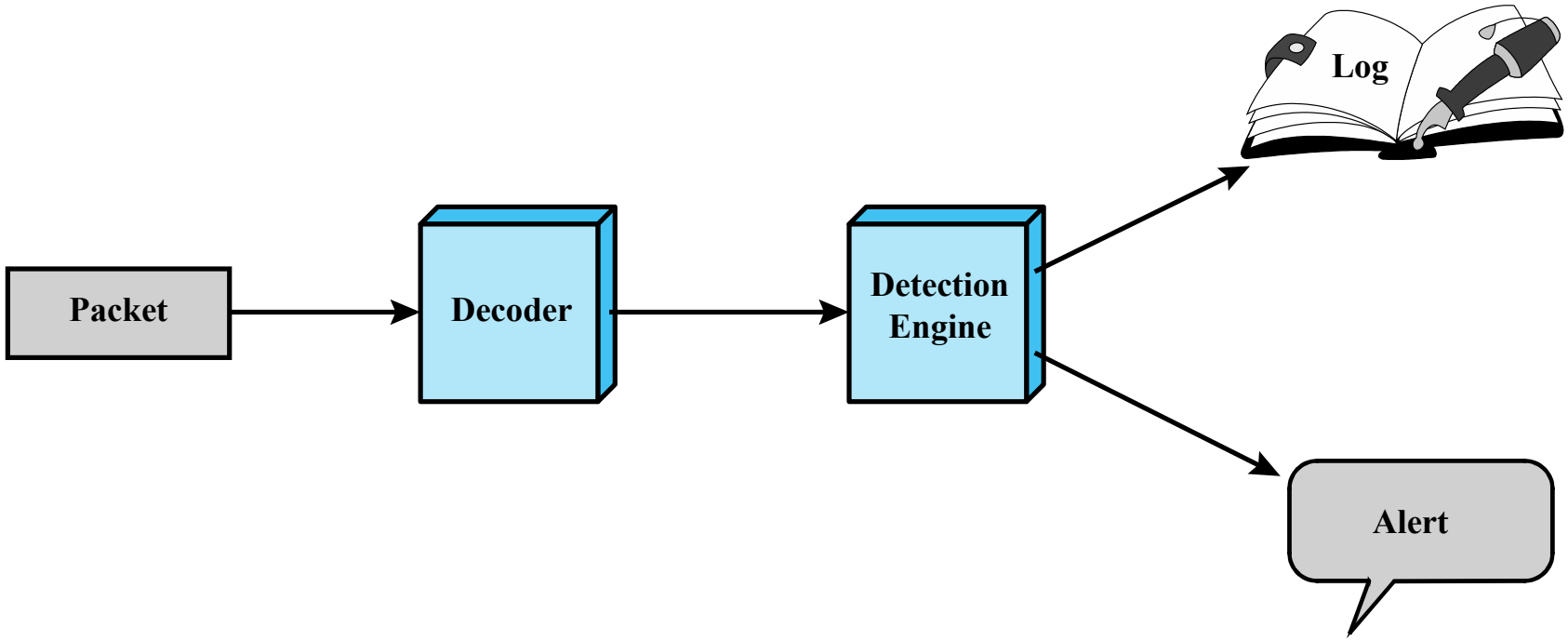

Figure 8.9 Snort Architecture

Firewalls

- Firewalls can be an effective means of protecting a local system or network of systems from network-based security threats while at the same time affording access to the outside world via wide area networks and the Internet.
- The firewall is inserted between the premises network and the Internet to establish a controlled link and to erect an outer security wall or perimeter.
- The aim of this perimeter is to protect the premises network from Internet-based attacks and to provide a single choke point where security and auditing can be imposed. The firewall may be a single computer system or a set of two or more systems that cooperate to perform the firewall function.
- The firewall, then, provides an additional layer of defense, insulating the internal systems from external networks.

Virtual Private Networks (VPN)

- A VPN uses encryption and authentication in the lower protocol layers to provide a secure connection through an otherwise insecure network, typically the Internet.
- VPNs are generally cheaper than real private networks using private lines but rely on having the same encryption and authentication system at both ends.
- The encryption may be performed by firewall software or possibly by routers. The most common protocol mechanism used for this purpose is at the IP level and is known as IPSec.

Thank You!