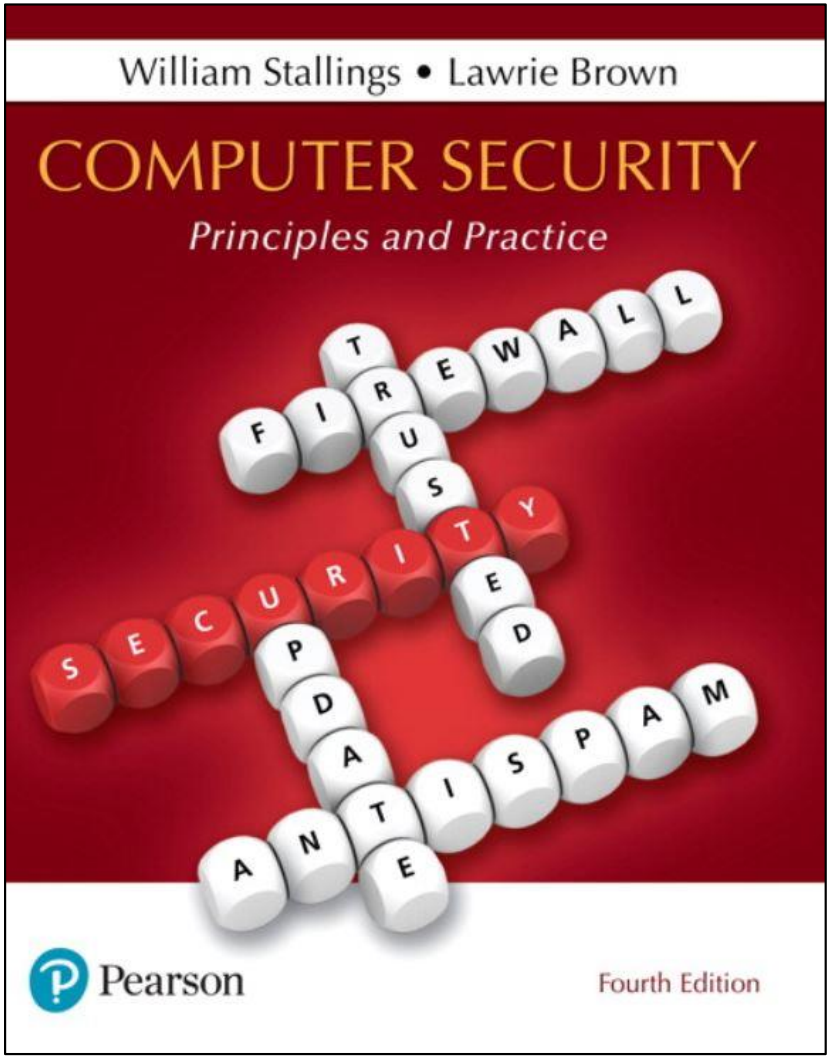
# Computer Security: Principles and Practice

Fourth Edition




## Chapter 8

Intrusion Detection

# Classes of Intruders – Cyber Criminals

- Individuals or members of an organized crime group with a goal of financial reward
- Their activities may include:
  - Identity theft
  - Theft of financial credentials
  - Corporate espionage
  - Data theft
  - Data ransoming
- Typically they are young, often Eastern European, Russian, or southeast Asian hackers, who do business on the Web
- They meet in underground forums to trade tips and data and coordinate attacks

# Classes of Intruders – Activists

- Are either individuals, usually working as insiders, or members of a larger group of outsider attackers, who are motivated by social or political causes
- Also know as hacktivists
  - Skill level is often quite low
- Aim of their attacks is often to promote and publicize their cause typically through:
  - Website defacement
  - Denial of service attacks
  - Theft and distribution of data that results in negative publicity or compromise of their targets

# Classes of Intruders – State-Sponsored Organizations

- Groups of hackers sponsored by governments to conduct espionage or sabotage activities
- Also known as Advanced Persistent Threats (APTs) due to the covert nature and persistence over extended periods involved with any attacks in this class
- Widespread nature and scope of these activities by a wide range of countries from China to the USA, UK, and their intelligence allies

# Classes of Intruders – Others

- Hackers with motivations other than those previously listed
- Include classic hackers or crackers who are motivated by technical challenge or by peer-group esteem and reputation
- Many of those responsible for discovering new categories of buffer overflow vulnerabilities could be regarded as members of this class
- Given the wide availability of attack toolkits, there is a pool of "hobby hackers" using them to explore system and network security

# Intruder Skill Levels – Apprentice

- Hackers with minimal technical skill who primarily use existing attack toolkits
- They likely comprise the largest number of attackers, including many criminal and activist attackers
- Given their use of existing known tools, these attackers are the easiest to defend against
- Also known as “script-kiddies” due to their use of existing scripts (tools)

# Intruder Skill Levels – Journeyman

- Hackers with sufficient technical skills to modify and extend attack toolkits to use newly discovered, or purchased, vulnerabilities
- They may be able to locate new vulnerabilities to exploit that are similar to some already known
- Hackers with such skills are likely found in all intruder classes
- Adapt tools for use by others

# Intruder Skill Levels – Master

- Hackers with high-level technical skills capable of discovering brand new categories of vulnerabilities
- Write new powerful attack toolkits
- Some of the better known classical hackers are of this level
- Some are employed by state-sponsored organizations
- Defending against these attacks is of the highest difficulty

# Examples of Intrusion

- Remote root compromise
- Web server defacement
- Guessing/cracking passwords
- Copying databases containing credit card numbers
- Viewing sensitive data without authorization
- Running a packet sniffer
- Distributing pirated software
- Using an unsecured modem to access internal network
- Impersonating an executive to get information
- Using an unattended workstation

# Intruder Behavior

- Target acquisition and information gathering
- Initial access
- Privilege escalation
- Information gathering or system exploit
- Maintaining access
- Covering tracks

# Table 8.1 Examples of Intruder Behavior (1 of 4)

**(a) Target Acquisition and Information Gathering**

- Explore corporate website for information on corporate structure, personnel, key systems, as well as details of specific Web server and OS used.
- Gather information on target network using DNS lookup tools such as dig, host, and others; and query WHOIS database.
- Map network for accessible services using tools such as NMAP.
- Send query email to customer service contact, review response for information on mail client, server, and OS used, and also details of person responding.
- Identify potentially vulnerable services, for example, vulnerable Web CMS.

# Table 8.1 Examples of Intruder Behavior (2 of 4)

**(b) Initial Access**

- Brute force (guess) a user's Web content management system (CMS) password.
- Exploit vulnerability in Web CMS plugin to gain system access.
- Send spear-phishing e-mail with link to Web browser exploit to key people.

**(c) Privilege Escalation**

- Scan system for applications with local exploit.
- Exploit any vulnerable application to gain elevated privileges.
- Install sniffers to capture administrator passwords.
- Use captured administrator password to access privileged information.

# Table 8.1 Examples of Intruder Behavior (3 of 4)

**(d) Information Gathering or System Exploit**

- Scan files for desired information.
- Transfer large numbers of documents to external repository.
- Use guessed or captured passwords to access other servers on network.

**(e) Maintaining Access**

- Install remote administration tool or rootkit with backdoor for later access.
- Use administrator password to later access network.
- Modify or disable anti-virus or IDS programs running on system.

# Table 8.1 Examples of Intruder Behavior (4 of 4)

**(f) Covering Tracks**

- Use rootkit to hide files installed on system.
- Edit logfiles to remove entries generated during the intrusion.

# Definitions

- Security Intrusion:

  Unauthorized act of bypassing the security mechanisms of a system

- Intrusion Detection:

  A hardware or software function that gathers and analyzes information from various areas within a computer or a network to identify possible security intrusions

# Intrusion Detection System (IDS)

- Host-based IDS (HIDS)
  - Monitors the characteristics of a single host for suspicious activity
- Network-based IDS (NIDS)
  - Monitors network traffic 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

- Comprises three logical components:
  - Sensors - collect data
  - Analyzers - determine if intrusion has occurred
  - User interface - view output or control system behavior

# IDS Requirements

- Run continually
- Be fault tolerant
- Resist subversion
- Impose a minimal overhead on system
- Configured according to system security policies
- Adapt to changes in systems and users
- Scale to monitor large numbers of systems
- Provide graceful degradation of service
- Allow dynamic reconfiguration

# Analysis Approaches

## Anomaly detection

- Involves the collection of data relating to the behavior of legitimate users over a period of time
- Current observed behavior is analyzed to determine whether this behavior is that of a legitimate user or that of an intruder

## Signature/Heuristic detection

- Uses a set of known malicious data patterns or attack rules that are compared with current behavior
- Also known as misuse detection
- Can only identify known attacks for which it has patterns or rules

# Anomaly Detection

- A variety of classification approaches are used:
  - Statistical
    - Analysis of the observed behavior using univariate, multivariate, or time-series models of observed metrics
  - Knowledge based
    - Approaches use an expert system that classifies observed behavior according to a set of rules that model legitimate behavior
  - Machine-learning
    - Approaches automatically determine a suitable classification model from the training data using data mining techniques

# Signature or Heuristic Detection

- **Signature approaches**
  - Match a large collection of known patterns of malicious data against data stored on a system or in transit over a network
  - The signatures need to be large enough to minimize the false alarm rate, while still detecting a sufficiently large fraction of malicious data
  - Widely used in anti-virus products, network traffic scanning proxies, and in NIDS
- **Rule-based heuristic identification**
  - Involves the use of rules for identifying known penetrations or penetrations that would exploit known weaknesses
  - Rules can also be defined that identify suspicious behavior, even when the behavior is within the bounds of established patterns of usage
  - Typically rules used are specific
  - SNORT is an example of a rule-based NIDS

# Host-Based Intrusion Detection (HIDS)

- Adds a specialized layer of security software to vulnerable or sensitive systems
- Can use either anomaly or signature and heuristic approaches
- Monitors activity to detect suspicious behavior
  - Primary purpose is to detect intrusions, log suspicious events, and send alerts
  - Can detect both external and internal intrusions

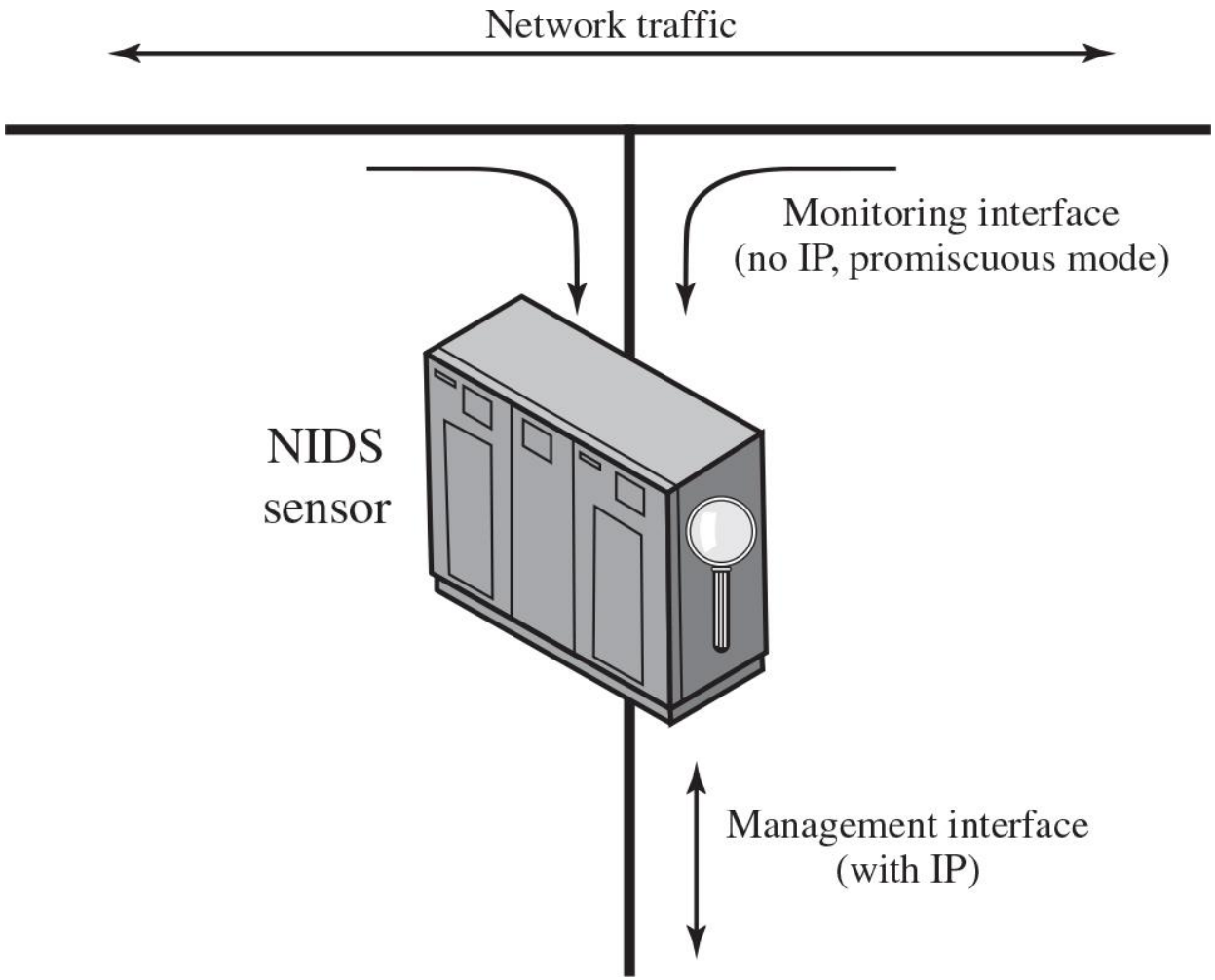
# Data Sources and Sensors

- A fundamental component of intrusion detection is the sensor that collects data
- Common data sources include:
  - System call traces
  - Audit (log file) records
  - File integrity checksums
  - Registry access

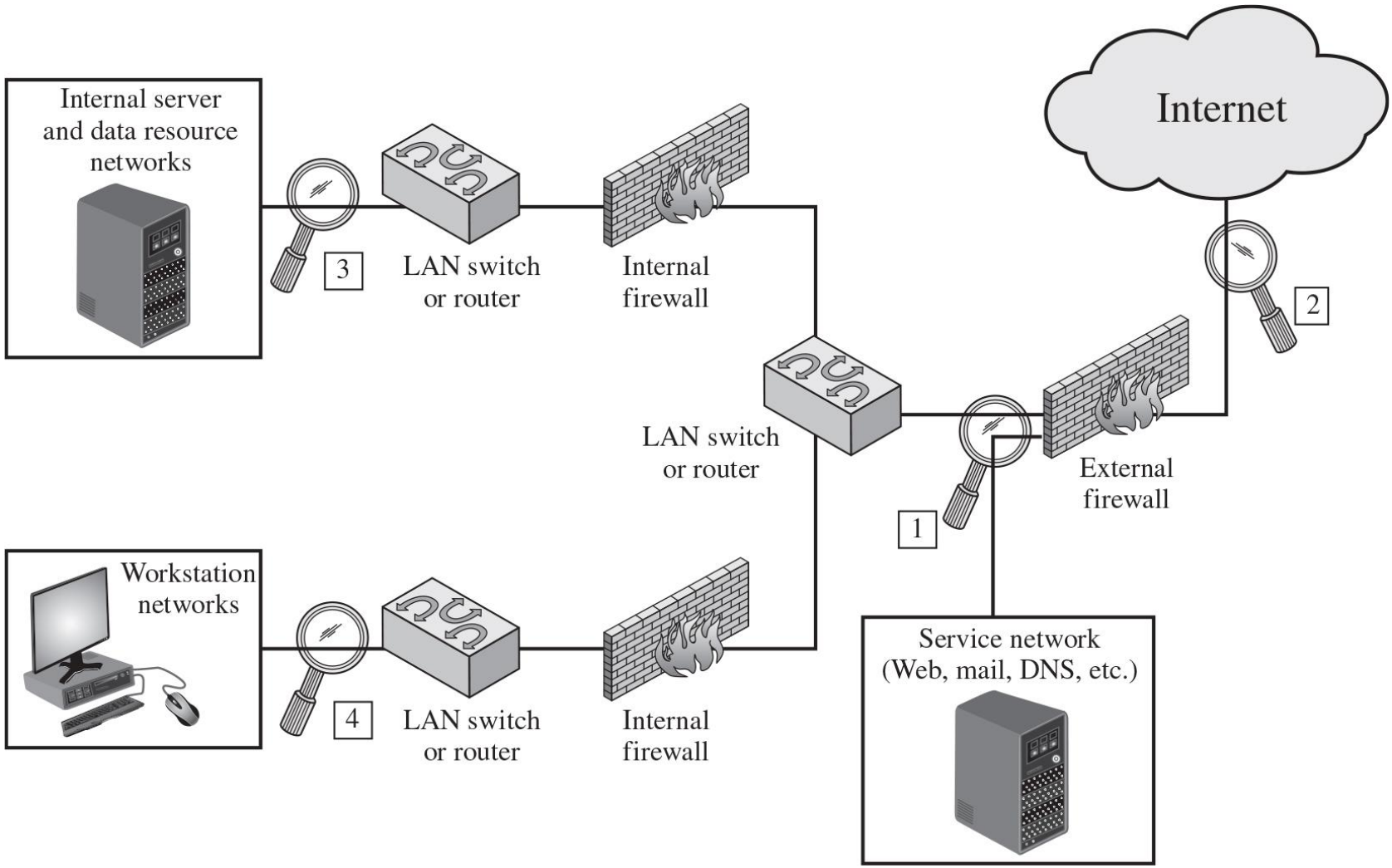
# Network-Based IDS (NIDS)

- Monitors traffic at selected points on a network
- Examines traffic packet by packet in real or close to real time
- May examine network, transport, and/or application-level protocol activity
- Comprised of a number of sensors, one or more servers for NIDS management functions, and one or more management consoles for the human interface
- Analysis of traffic patterns may be done at the sensor, the management server or a combination of the two

# Figure 8.4 Passive NIDS Sensor



# Figure 8.5 Example of NIDS Sensor Deployment



# Intrusion Detection Techniques

Attacks suitable for Signature detection

- Application layer reconnaissance and attacks
- Transport layer reconnaissance and attacks
- Network layer reconnaissance and attacks
- Unexpected application services
- Policy violations

Attacks suitable for Anomaly detection

- Denial-of-service (DoS) attacks
- Scanning
- Worms

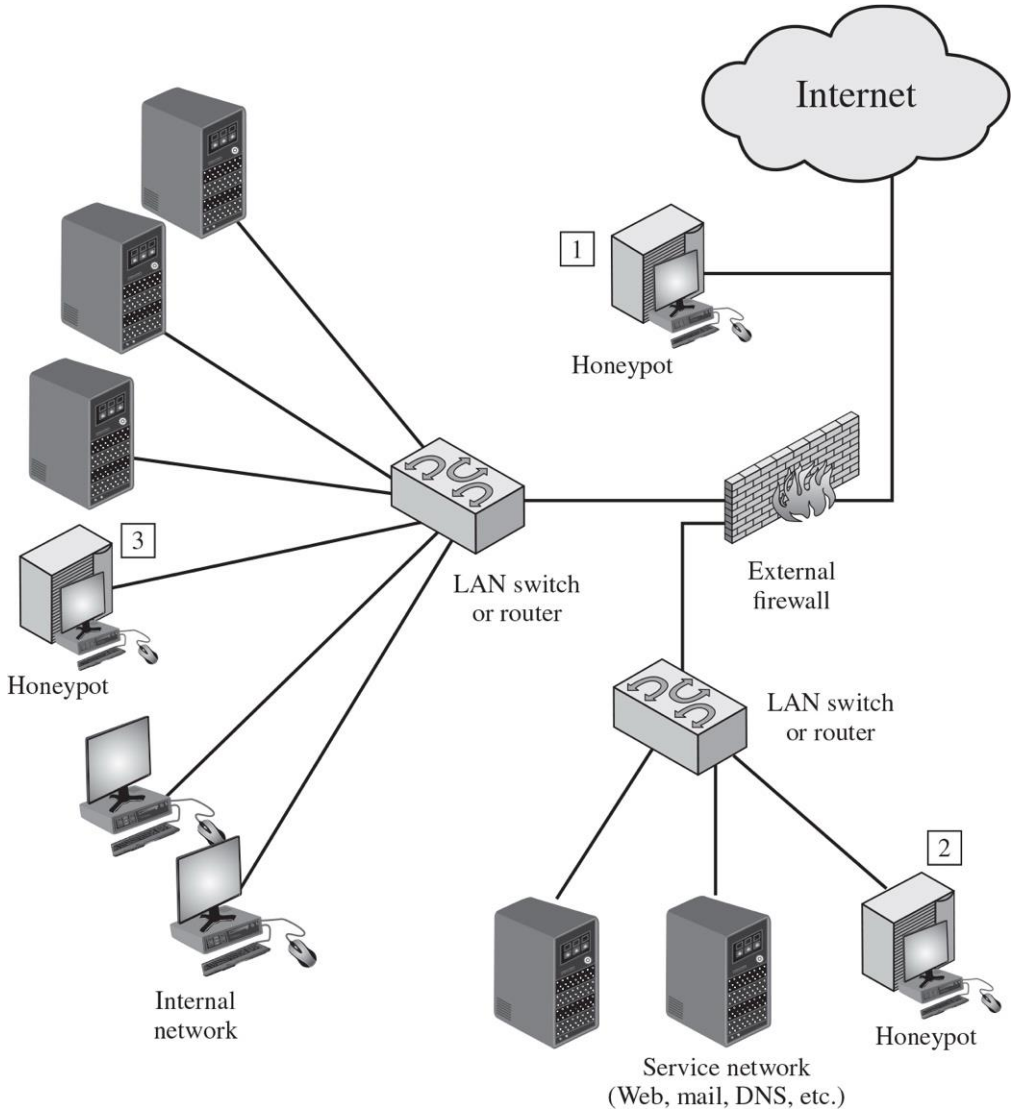
# Logging of Alerts

- Typical information logged by a NIDS sensor includes:
  - Timestamp
  - Connection or session ID
  - Event or alert type
  - Rating
  - Network, transport, and application layer protocols
  - Source and destination IP addresses
  - Source and destination TCP or UDP ports, or ICMP types and codes
  - Number of bytes transmitted over the connection
  - Decoded payload data, such as application requests and responses
  - State-related information

# Honeypots

- Decoy systems designed to:
  - Lure a potential attacker away from critical systems
  - Collect information about the attacker's activity
  - Encourage the attacker to stay on the system long enough for administrators to respond
- Systems are filled with fabricated information that a legitimate user of the system wouldn't access
- Resources that have no production value
  - Therefore incoming communication is most likely a probe, scan, or attack
  - Initiated outbound communication suggests that the system has probably been compromised

# Figure 8.8 Example of Honeypot Deployment



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