# Introduction

- **HTTP (Hypertext Transfer Protocol)** is the foundation of communication on the web, enabling browsers, mobile apps, and services to exchange data with servers.
- However, **HTTP by itself is insecure** because data travels in plain text, making it vulnerable to interception, tampering, and impersonation.
- To protect users and services, basic security mechanisms must be applied to HTTP applications. These ensure **confidentiality**, **integrity**, and **authenticity** of the communication.

# Basic Security for HTTP Applications and Services

**1. Use HTTPS (TLS Encryption)**

- **HTTPS (HTTP Secure)** encrypts communication between client and server using **TLS (Transport Layer Security)**.
- Protects against:
    - **Eavesdropping** – attackers reading sensitive data (e.g., passwords, credit card numbers).
    - **Data Tampering** – attackers modifying requests or responses.
    - **Impersonation** – attackers pretending to be the real server.
- Always redirect **HTTP traffic to HTTPS**.

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**2. Authentication**

Ensures that only authorized users or services can access resources.

**Common methods:**

- **Basic Authentication** – username and password encoded in Base64 (weak; must be used with HTTPS).
- **Token-based Authentication** – e.g., **OAuth2 tokens** for secure access.
- **API Keys** – simple but less secure if leaked.

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**3. Authorization**

Defines **what authenticated users can do**.

**Implement:**

- **Role-Based Access Control (RBAC)** or
- **Attribute-Based Access Control (ABAC)**

**Examples:**

- A **customer** can view their own orders.
- An **admin** can view and manage all orders.

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**4. Input Validation & Sanitization**

Prevents **injection attacks** such as:

- **SQL Injection**
- **Command Injection**
- **Cross-Site Scripting (XSS)**

**Best practices:**

- Always **validate** and **sanitize** user inputs before processing.
- Use **prepared statements** or **parameterized queries**.
- Apply strong **validation rules** for all input fields.

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**5. Session Management**

https used for sending cookie  js cant read cookie  your cookie can be used by cross-site

- Use **Secure**, **HttpOnly**, and **SameSite** cookies for session IDs.
- **Regenerate session tokens** after login/logout.
- **Invalidate sessions** on logout or after inactivity.

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**6. Rate Limiting & Throttling**

- Prevents **Denial of Service (DoS)** and **brute-force** attacks.
- Limit the number of requests per client within a defined timeframe.

rate limiting: 100 request /minute allowed and rest blc
throttling:  after 100 request delay of 10 sec

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**7. Error Handling & Logging**

- Never reveal **sensitive details** in error messages (e.g., stack traces, database errors).
- **Log** all security-related events (failed logins, suspicious activities).
- **Monitor logs** regularly for unusual behavior or anomalies.

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**8. Security Headers**

Use HTTP response headers to enhance security:

| Header | Purpose |
|---|---|
| **Content-Security-Policy (CSP)** | Mitigates XSS by controlling resources the browser is allowed to load. |
| **Strict-Transport-Security (HSTS)** | Forces clients to connect via HTTPS only. |
| **X-Frame-Options** | Prevents clickjacking attacks. |

Here's a **clean, structured, and presentation-ready version** of your content on **Identity Management and Web Services** 👇

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# A. Identity Management and Web Services

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## a. What is Identity Management?

- **Identity Management (IdM)** is the process of **defining, authenticating, and managing users (identities)** and their **access rights** in applications and services.
- It ensures that the **right individuals or services** have the **right access to resources** at the **right time**.

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## b. Key Components of Identity Management

**1. Authentication**

Verifying **who the user or service is**.
Common methods include:

- **Username & Password**
- **Multi-Factor Authentication (MFA)**
- **Certificates / Biometrics**

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**2. Authorization**

Determining **what the authenticated entity is allowed to do**.

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**3. User Provisioning**

Managing the lifecycle of user accounts:

- Creating
- Updating
- Deleting users

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**4. Single Sign-On (SSO)**

- Allows users to **log in once** and gain access to **multiple applications** without re-authenticating.

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**5. Federated Identity**

- Enables users to use **external identity providers (IdPs)** such as:
    - Google
    - Microsoft
    - Okta

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**6. Identity Federation Standards**

| Standard | Purpose / Description |
| --- | --- |
| **SAML (Security Assertion Markup Language)** | XML-based protocol used for **enterprise SSO**. |

| Standard | Purpose / Description |
| --- | --- |
| **OAuth 2.0** | **Authorization framework** used to grant access to APIs. |
| **OpenID Connect (OIDC)** | Adds **authentication** capabilities on top of OAuth 2.0. |

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### c. Identity Management in Web Services

- Web services often require **machine-to-machine authentication** (not just human users).
- Common methods include:

| Method | Description |
| --- | --- |
| **API Keys** | Simple tokens identifying calling applications. |
| **OAuth 2.0 Tokens (Bearer Tokens)** | Used for secure, delegated API access. |
| **Mutual TLS** | Both client and server present digital certificates for verification. |
| **JWT (JSON Web Tokens)** | Used for **stateless authentication** between client and server. |

Here's a **professionally formatted and well-organized version** of your topic on **Authorization Patterns**, ideal for study notes, reports, or slides 👇

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## B. Authorization Patterns

**Introduction**

**Authorization** determines what an **authenticated identity** is allowed to do.
Different authorization patterns are used depending on a system's complexity, security needs, and flexibility requirements.

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**a. Role-Based Access Control (RBAC)**

- Access is based on **roles** assigned to users.

- **Example:**
    - User with role **"Admin"** → can create, update, delete.
    - User with role **"Viewer"** → can only read.
- **Advantages:**
    - Simple to implement.
    - Widely used in **enterprise applications**.
- **Limitation:**
    - Becomes difficult to manage with many roles or complex conditions.

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**b. Attribute-Based Access Control (ABAC)**

- Access decisions are based on **attributes** of:
    - The **user**,
    - The **resource**, and
    - The **environment**.

**Example:**

- User attribute → department = "Finance"
- Resource attribute → document_type = "Payroll"
- Policy → "Finance users can access Payroll documents during business hours."

**Advantages:**

- Highly flexible and context-aware.
  **Limitation:**
- More **complex** to configure and manage than RBAC.

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**c. Policy-Based Access Control (PBAC)**

- Uses **policies and rules** (often defined in policy languages like **XACML**).
- Access is granted or denied based on policy evaluation.

**Example:**
Policy:

"Allow access if user.role = 'Manager' AND request.time < 6 PM."

**Advantages:**

- Ideal for **large, dynamic systems** with changing rules.
  **Limitation:**
- Requires a **policy engine** and can be complex to maintain.

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**d. Discretionary Access Control (DAC)**

- The **resource owner** decides who can access their resources.
- Common in **file-sharing** and **collaboration platforms**.

**Example:**

- A **Google Drive file owner** shares a document with specific people.

**Advantages:**

- Flexible and user-friendly.
  **Limitation:**
- Can lead to **inconsistent or insecure** sharing policies.

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**e. Mandatory Access Control (MAC)**

- Access is based on **security labels or classifications** such as:
  - **Top Secret**
  - **Confidential**
  - **Public**

cannot read above its level but can read below level but for writing its opposite it true

**Example:**

- A "Top Secret" document can only be accessed by users with a matching clearance level.

**Advantages:**

- Provides **strong, centralized security**.
  **Common Use:**
- Government and military systems.
  **Limitation:**
- Very restrictive and less flexible.

what permissions the app is requesting information about the user

**f. OAuth 2.0 Scopes & Claims**

In APIs and web services, **authorization** is often expressed using **scopes** and **claims**.

**Example:**

scope = "read:orders write:orders"

- A token with only read:orders **cannot modify data**.
- **JWT (JSON Web Tokens)** can also include:
    - **Roles**
    - **Permissions**
    - **Attributes**

**Advantages:**

- Fine-grained, API-level access control.
- Integrates well with modern web and mobile systems.

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# Security Considerations and Challenges

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**Introduction**

- **Security Considerations** are the **important factors, best practices, and safeguards** that must be applied when designing, building, or operating an application, system, or web service.
- In simple terms, it's like **locking your house, installing cameras, and checking that all windows are closed** — the preventive steps to keep something secure.
- **Security Challenges**, on the other hand, are like **burglars finding new tricks, forgetting to lock the door, or giving the key to the wrong person** — the **problems and risks** that make it difficult to apply and maintain security in the real world.

When designing or securing HTTP applications and web services, both **considerations** and **challenges** must be carefully addressed.

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# Security Considerations

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**1. Confidentiality, Integrity, Availability (CIA Triad)**

- **Confidentiality:** Prevent unauthorized access to sensitive data.
  *Use HTTPS and encryption techniques.*
- **Integrity:** Ensure that data is not altered during transmission.
  *Use digital signatures and hashing.*
- **Availability:** Keep services accessible and reliable.
  *Apply rate limiting, DDoS protection, and regular backups.*

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**2. Authentication & Identity Protection**

- Use **strong authentication** (MFA, OAuth 2.0).
- Store passwords securely using **salted hashing algorithms** (e.g., Argon2).
- Avoid transmitting credentials in plain text.

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**3. Authorization Controls**

- Enforce **least privilege** — give users only the access they need.
- Validate authorization **for every request**, not just at login.
- Use consistent authorization models such as **RBAC** or **ABAC**.

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**4. Secure Data Handling**

- Encrypt sensitive data:
  - **In transit** → use **TLS**
  - **At rest** → use **AES** or database encryption.
- Avoid exposing excessive data in APIs.
  *Example: do not include sensitive fields in JSON/XML responses.*

---

**5. Web & API Security**

- Protect against **OWASP Top 10** vulnerabilities:

    - SQL Injection
    - XSS
    - Insecure Deserialization
    - Broken Access Control
- Always **validate and sanitize inputs** using whitelisting and parameterized queries.
- Implement **rate limiting** to prevent abuse and brute-force attacks.

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**6. Session & Token Security**

- Use **secure cookies** with HttpOnly and Secure flags.
- **Expire sessions** after inactivity.
- Use **short-lived tokens** with refresh mechanisms.
- Prevent replay attacks using **nonce** values or **timestamps**.

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**7. Security Headers**

Apply HTTP response headers to harden security:

| Header | Purpose |
|---|---|
| **Strict-Transport-Security (HSTS)** | Forces HTTPS connections. |
| **Content-Security-Policy (CSP)** | Prevents XSS attacks. |
| **X-Frame-Options** | Protects against clickjacking. |
| **X-Content-Type-Options** | Prevents MIME-type sniffing. |

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## Security Challenges

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**1. Evolving Threat Landscape**

- New vulnerabilities (zero-days) are discovered regularly.
- Attackers innovate faster than defense mechanisms evolve.

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**2. Identity & Access Management (IAM) Complexity**

- Managing users across multiple systems is challenging.
- Handling **OAuth**, **SAML**, and **OIDC** securely can be difficult.
- Revoking compromised tokens or accounts quickly is critical but hard to automate.

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**3. Scalability vs. Security**

- Large-scale systems must balance **performance** with **security**.
- Example: **Rate limiting** protects APIs but may frustrate legitimate users.

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**4. Human Factors**

- Weak passwords, phishing, and social engineering remain top threats.
- Developers may unintentionally introduce insecure code due to tight deadlines.

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**5. API Security**

- APIs are frequent attack targets as they expose business logic.
- Securing **public** APIs vs. **internal** APIs requires different approaches.

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**6. Cloud & Microservices Security**

- Distributed systems increase the **attack surface**.
- Managing **service-to-service authentication** is harder.
- **Misconfigured cloud services** are a common cause of breaches.

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**7. Compliance & Privacy Requirements**

general data protection regulation

- Laws like **GDPR**, **HIPAA**, and **PCI-DSS** require strict controls.
- Challenge: Maintaining compliance while ensuring usability and performance.

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**8. Insider Threats**

- Malicious or careless employees with legitimate access can cause damage.
- Such attacks are harder to detect than external ones.

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**Case Study: Facebook's Cambridge Analytica Data Misuse** 2018

- **Issue:** Unauthorized use of user data by third-party applications. used for targeted political ads
- **Consideration:** Facebook **should have restricted access** through stricter controls.
- **Challenge:** Balancing **privacy** with **business and analytics needs**.

Here's a **clear, formatted, and easy-to-understand version** of your topic on **Intrusion, Physical Theft, and Abuse of Privileges**, along with the **answer to the question** at the end 👇

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# Intrusion, Physical Theft, and Abuse of Privileges

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**1. Intrusion**

- **Definition:**
  Unauthorized access to a **computer system**, **network**, or **application** — carried out either by an **outsider (hacker)** or an **insider (employee)** without proper authorization.
- **Risks:**
  - Data breaches
  - Unauthorized data modification
  - Compromise of system integrity
- **Examples:**
  - A hacker breaking into a university's grading system.
  - A **SQL Injection attack** on a website to extract confidential data.
  - Installing **keyloggers** on lab computers to capture passwords.

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**2. Physical Theft**

- **Definition:**
  The **stealing of physical IT assets** such as laptops, servers, hard drives, or backup media.
- **Risks:**
  - **Loss of sensitive data** (especially if unencrypted).
  - **Loss of hardware** and operational downtime.
  - Potential **entry point for future cyberattacks**.
- **Examples:**
  - A **stolen laptop** containing unencrypted student records.
  - Theft of a **USB drive** with financial or exam data.
  - A **missing server** from the university data center.

---

**3. Abuse of Privileges**

- **Definition:**
  Misuse of **legitimate access rights** by a user with **higher privileges** such as an administrator, manager, or employee.
- **Characteristics:**
  - **Harder to detect** than external attacks.
  - Often involves **insiders** who already have system access.
- **Examples:**
  - A **system administrator** copying confidential files for personal gain.
  - An **employee** viewing HR or salary records without permission.
  - **Insider trading** using confidential company financial data.

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**Question**

**Scenario:**
In a university system —

1. A hacker breaks into the **student database**.

2. A staff member loses a **laptop with unencrypted exam papers**.
3. A lab technician uses their **admin rights to change grades**.

---

**Answer**

| Incident | Category | Explanation |
|---|---|---|
| Hacker breaks into the student database | **Intrusion** | Unauthorized external access to the system. |
| Staff member loses a laptop with unencrypted exam papers | **Physical Theft** | Loss of physical hardware containing sensitive data. |
| Lab technician changes grades using admin rights | **Abuse of Privileges** | Insider misuse of legitimate administrative access. |

# Malware Infection, Intrusion Detection, and Prevention Techniques

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**What is Malware?**

- **"Malware"** stands for **Malicious Software** — programs designed to **harm**, **steal**, or **control** computer systems.
- It can damage files, steal sensitive data, spy on users, or slow down computers and networks.

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## 1. Malware Infection

**Definition:**

A **malware infection** occurs when malicious software (such as a **virus**, **worm**, **trojan**, or **ransomware**) enters a computer or network, leading to data loss, system slowdown, or data theft.

**Example:**
You download a free game from an untrusted website.
After installing it, your computer becomes very slow — the file secretly contained a **virus** that sends your personal data to hackers.
👉 That's a **malware infection**.

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**How Malware Infects Systems**

- Opening **infected email attachments**
- Clicking **malicious links**
- Using **unpatched or outdated software**
- Plugging in **infected USB drives or removable media**
- Installing **fake updates or pirated software**
- Using **weak passwords** or poor security settings

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## 2. Intrusion Detection

**Definition:**

**Intrusion Detection** means identifying when someone or something is trying to **attack or misuse** a computer system or network.

This is done using an **Intrusion Detection System (IDS)** — a tool that monitors **network traffic** or **system activity** for suspicious behavior.

**Example:**
An IDS detects that someone from another country tried to log into your company server **100 times in one minute** — it raises an alert.
👉 That's **intrusion detection**.

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**Types of Intrusion Detection Systems (IDS):**

1. **Network-based IDS (NIDS):**
    - Monitors **network traffic** across multiple systems.
    - Detects suspicious packets or patterns.
2. **Host-based IDS (HIDS):**
    - Monitors **activities on individual computers** (hosts).
    - Checks log files, file changes, and system processes.

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**Benefits of IDS:**

- Early warning of attacks.
- Helps identify **malware** or **hacker activity**.
- Supports **investigation** and **incident response**.

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## 3. Intrusion Prevention

**Definition:**

**Intrusion Prevention** goes beyond detection — it **blocks or stops** malicious activities **before** they cause damage.

This is achieved using an **Intrusion Prevention System (IPS)** that can automatically **block malicious traffic** in real time.

**Example:**
When the IPS notices 100 failed login attempts, it **blocks the hacker's IP address immediately.**
👉 That's **intrusion prevention**.

---

**How IPS Works**

- Monitors network traffic **in real-time**.
- **Blocks or drops** suspicious packets automatically.
- Updates its **security rules** and **signatures** regularly to detect new threats.

---

## 4. Prevention Techniques

**Definition:**

Prevention techniques are the **best practices and tools** used to **protect computers and networks** from malware and hackers.
They focus on **stopping attacks before they happen**.

---

**How Can We Secure Our System?**

- Keep the **operating system updated**.
- Install a **trusted antivirus or endpoint protection** software.
- Use **strong and unique passwords**.

- Enable **Multi-Factor Authentication (MFA)**.
- **Backup important data** regularly.
- Avoid installing **unknown or pirated software**.

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**How Can We Secure Our Network?**

- Use a **firewall** to block unwanted traffic.
- Set up **IDS** and **IPS** for real-time monitoring and protection.
- **Block unused network ports**.
- Use a **VPN** for secure remote access.
- Continuously **monitor network activity** for unusual behavior.

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## 5. Anti-Malware Software

**Definition:**

**Anti-Malware Software** is designed to **detect, remove, and protect** against malicious software and cyberattacks.
It acts like a **security guard** for your system.

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**Main Functions of Anti-Malware Software**

- **Scan** the system for malicious files.
- **Detect** suspicious behavior or potential threats.
- **Remove or quarantine** infected files.
- **Block** access to harmful websites and downloads.
- **Monitor** system activity in real time.

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**How Anti-Malware Works**

- Scans files and programs for **known malware signatures**.
- Observes **suspicious or abnormal activity**.
- Moves infected files to **quarantine** to prevent spread.

- Regularly **updates virus definitions** to detect new threats.
- Sends **alerts or notifications** when a threat is found.

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**Popular Anti-Malware Software**

- **Windows Defender**
- **Avast / AVG**
- **Kaspersky**
- **McAfee**

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## Network-Based Intrusion Detection System (NIDS)

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**Definition**

A **Network-Based Intrusion Detection System (NIDS)** is a security system that **monitors network traffic** in real time to **detect suspicious or malicious activities** such as hacking attempts, malware, or unauthorized access.
It acts like a **security camera** for your network — continuously watching all the data that flows in and out.

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**Key Features**

- **NIDS** stands for **Network-Based Intrusion Detection System**.
- Monitors **network traffic (data packets)** across routers, switches, and firewalls.
- Detects **unauthorized access**, **malware infections**, or **network-based attacks**.
- Provides **real-time alerts** to administrators about suspicious activities.

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**How NIDS Works**

1. **Collects** network traffic from routers, switches, or firewalls.
2. **Analyzes** the data packets for any abnormal or suspicious behavior.

3. **Compares** traffic against known attack signatures or behavioral patterns.
4. **Sends alerts** to system administrators if any threats or irregularities are detected.

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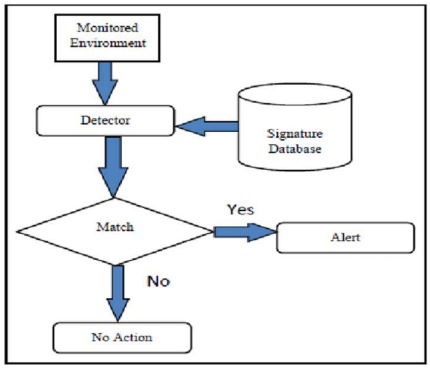
**Detection Methods**

**1. Signature-Based Detection**

- Detects attacks using **known attack patterns** or predefined rules.
- Works similarly to an **antivirus**, which scans for known threat signatures.
- **Advantages:** Fast and accurate for known threats.
- **Limitations:** Cannot detect **new or unknown (zero-day)** attacks.

**Example:**
Like a detective who only catches criminals whose faces are already in the database — if a new criminal appears, they go unnoticed.

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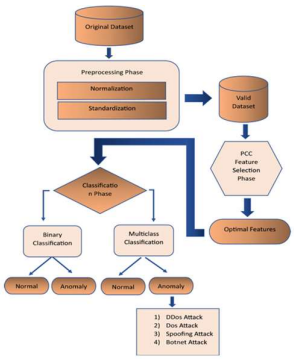
**2. Anomaly-Based Detection**

- Detects attacks by identifying **unusual or abnormal behavior** in the network.
- Can discover **new or unknown threats** that don't match known signatures.
- **Limitations:** Can sometimes generate **false alarms (false positives)**.




**Example:**
Like a security guard who knows every employee's normal schedule — if someone tries to enter at an unusual time or location, the guard becomes suspicious.

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**Common NIDS Tools**

- **Snort** – Open-source and widely used for signature-based detection.
- **Suricata** – Supports both detection and prevention (can act like an IPS).
- **Zeek (formerly Bro)** – Focuses on detailed **network behavior analysis**.
- **Cisco IDS/IPS** – A **commercial enterprise-grade solution**.

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**Key Components of NIDS**

| Component | Description |
|---|---|
| **Sensors** | Software or hardware placed at key network points (near firewalls or routers) to capture data packets. |
| **Analysis Engine** | The "brain" of NIDS that examines captured data for attack signatures or abnormal behavior. |
| **Management Console** | Central interface where administrators view alerts, logs, and configure system settings. |
| **Alerting Mechanism** | Sends notifications (email, SMS, SIEM reports) when threats or suspicious activities are detected. |

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**Benefits of NIDS**

- Detects **attacks in real time**.

- Protects the **entire network**, not just individual systems.
- Aids in **incident investigation and response**.
- Provides **logs and detailed reports** for analysis and auditing.

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**Limitations of NIDS**

- Cannot easily inspect **encrypted traffic** (like HTTPS).
- May **miss internal (insider) attacks** within the network.
- Requires **frequent updates** to stay effective against new threats.
- Can generate **false positives** if not properly tuned or configured.

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