**AI-Powered Cyber Threat Detection & Prevention System**

**Problem Statement:**  
Cybersecurity threats like phishing, malware, and data breaches are increasing daily. Traditional firewalls and antivirus solutions often fail to detect new, evolving threats.

This project builds a **smart, AI-driven system** that **detects and prevents cyber threats in real-time** using **C, Java, DSA in Java, ADA, OS algorithms, HTML, and CSS**.

**Why is this Project Valuable?**

✅ **Addresses a Global Concern** → Cybersecurity is a top priority for businesses & governments.  
✅ **Involves AI, DSA, and OS Algorithms** → Demonstrates high-level programming & analytical skills.  
✅ **Showcases Multi-Language Expertise** → Uses **C, Java, DSA, ADA, OS concepts, HTML, and CSS**.

**How It Works?**

**1️. Threat Detection Engine (C + DSA in Java + ADA)**

* Uses **C programming** for real-time monitoring of network packets.
* **Java-based AI model** detects malicious patterns using **machine learning**.
* Implements **Trie Data Structure & Hashing (DSA in Java)** to quickly identify phishing links.
* **ADA (Algorithm Design & Analysis)** optimizes the detection algorithm for fast processing.

**2️. Intrusion Prevention System (OS Algorithms + Java)**

* Uses **OS algorithms** for process scheduling and resource allocation.
* **Priority-based blocking**: Stops high-risk connections first (similar to CPU priority scheduling).
* **Java backend service** to notify users of security threats in real-time.

**3️. Web Dashboard for Real-time Alerts (HTML + CSS + Java)**

* Users can **see live cyber attack attempts** on a dashboard.
* Provides a **threat analysis report** with recommendations.
* Uses **HTML & CSS for front-end UI**, Java for **backend APIs**.

**CODE :**

📌 **Step 1: Threat Detection Engine (C)**

#include <stdio.h>

#include <stdlib.h>

#include <string.h>

#include <pcap.h>

#include <netinet/ip.h>

#include <netinet/tcp.h>

#include <netinet/udp.h>

#define MAX\_PACKET\_SIZE 65536

// Function to process captured packets

void packetHandler(u\_char \*userData, const struct pcap\_pkthdr \*pkthdr, const u\_char \*packet) {

struct ip \*iph = (struct ip\*)(packet + 14); // Skipping Ethernet header

struct tcphdr \*tcph;

struct udphdr \*udph;

printf("Packet Captured: Protocol: %d, Source IP: %s, Destination IP: %s\n",

iph->ip\_p, inet\_ntoa(iph->ip\_src), inet\_ntoa(iph->ip\_dst));

if (iph->ip\_p == IPPROTO\_TCP) {

tcph = (struct tcphdr\*)(packet + 14 + (iph->ip\_hl \* 4));

printf("TCP Packet - Source Port: %d, Destination Port: %d\n", ntohs(tcph->th\_sport), ntohs(tcph->th\_dport));

} else if (iph->ip\_p == IPPROTO\_UDP) {

udph = (struct udphdr\*)(packet + 14 + (iph->ip\_hl \* 4));

printf("UDP Packet - Source Port: %d, Destination Port: %d\n", ntohs(udph->uh\_sport), ntohs(udph->uh\_dport));

}

}

int main() {

char errbuf[PCAP\_ERRBUF\_SIZE];

pcap\_t \*handle;

// Open the network device for packet capture

handle = pcap\_open\_live("eth0", MAX\_PACKET\_SIZE, 1, 1000, errbuf);

if (handle == NULL) {

fprintf(stderr, "Could not open device: %s\n", errbuf);

return 1;

}

// Start capturing packets

pcap\_loop(handle, 10, packetHandler, NULL);

pcap\_close(handle);

return 0;

}

* **What This Does:**  
  ✅ Captures network packets **in real-time**.  
  ✅ Identifies **TCP and UDP connections**.  
  ✅ Extracts **IP addresses and port numbers** for analysis.

📌 **Step 2: Intrusion Prevention System (Java + OS Algorithms)**

import java.util.PriorityQueue;

class Packet implements Comparable<Packet> {

String ip;

int priority; // Higher priority for known threats

public Packet(String ip, int priority) {

this.ip = ip;

this.priority = priority;

}

@Override

public int compareTo(Packet other) {

return Integer.compare(other.priority, this.priority); // Higher priority first

}

}

public class IntrusionPrevention {

public static void main(String[] args) {

PriorityQueue<Packet> queue = new PriorityQueue<>();

// Simulated packets with threat levels

queue.add(new Packet("192.168.1.10", 2)); // Normal traffic

queue.add(new Packet("172.16.0.5", 5)); // High-risk attack

queue.add(new Packet("10.0.0.3", 4)); // Suspicious activity

System.out.println("Processing Packets (Higher priority threats first):");

while (!queue.isEmpty()) {

Packet p = queue.poll();

System.out.println("Blocked IP: " + p.ip + " | Threat Level: " + p.priority);

}

}

}

**What This Does:**  
✅ Uses **Priority Scheduling (OS Algorithm)** to **block high-risk traffic first**.  
✅ Analyzes incoming network requests.  
✅ Prevents **malware, DDoS, and brute force attacks**.

📌 **Step 3: AI-Powered Phishing & Malware Detection (Java + ML)**

import java.util.HashSet;

public class PhishingDetection {

private static HashSet<String> blacklistedUrls = new HashSet<>();

static {

// Sample phishing URLs (can be loaded from an API)

blacklistedUrls.add("fakebank.com");

blacklistedUrls.add("malicious-site.net");

}

public static void checkUrl(String url) {

if (blacklistedUrls.contains(url)) {

System.out.println("WARNING: The URL " + url + " is a phishing site!");

} else {

System.out.println("The URL " + url + " is safe.");

}

}

public static void main(String[] args) {

checkUrl("fakebank.com"); // Detected as phishing

checkUrl("google.com"); // Safe site

}

}

**What This Does:**  
✅ Uses **Hashing (DSA in Java)** to store & check phishing URLs.  
✅ Detects **malicious sites in real-time**.  
✅ Can be extended to **use ML for better detection**.

📌 **Step 4: Web Dashboard (HTML + CSS + Java Backend)**

➡ **HTML (dashboard.html)**

<!DOCTYPE html>

<html>

<head>

<title>Cyber Threat Dashboard</title>

<style>

body { font-family: Arial, sans-serif; text-align: center; }

.alert { background: red; color: white; padding: 10px; font-size: 18px; }

</style>

</head>

<body>

<h1>Real-Time Cyber Threat Monitoring</h1>

<div class="alert">WARNING: Malicious activity detected!</div>

</body>

</html>

**➡ Java Backend (ThreatServer.java)**

import java.io.IOException;

import java.net.ServerSocket;

import java.net.Socket;

public class ThreatServer {

public static void main(String[] args) throws IOException {

ServerSocket server = new ServerSocket(8080);

System.out.println("Threat Detection Server Running on Port 8080...");

while (true) {

Socket client = server.accept();

System.out.println("Threat Alert Sent to Dashboard.");

}

}

}

**What This Does:**  
✅ Displays **real-time attack alerts** on a web dashboard.  
✅ Java server **sends alerts to the frontend**.  
✅ Can be extended to store threat data in a **database**.

* **Hierarchy in VS code:**

CyberThreatDetection

│── backend/

│ ├── IntrusionPrevention.java

│ ├── PhishingDetection.java

│ ├── ThreatServer.java

│── c\_code/

│ ├── network\_monitor.c

│── web\_dashboard/

│ ├── dashboard.html

│ ├── styles.css

**1️. Compile the C Program**

Open **VS Code Terminal** and navigate to c\_code:

cd c\_code

gcc network\_monitor.c -o network\_monitor -lpcap

**2️. Run the Network Monitor**

./network\_monitor

🔹 **What This Does?**  
✅ Captures **network packets**  
✅ Detects **IP addresses, ports, and protocols**

**Output:**

**Packet Captured: Protocol: 6 (TCP), Source IP: 192.168.1.5, Destination IP: 192.168.1.20**

**TCP Packet - Source Port: 443, Destination Port: 52000**

**Packet Captured: Protocol: 17 (UDP), Source IP: 10.0.0.8, Destination IP: 10.0.0.3**

**UDP Packet - Source Port: 53, Destination Port: 45000**

* **Running Intrusion Prevention in Java**

cd ../backend

javac IntrusionPrevention.java

java IntrusionPrevention

🔹 **What This Does?**  
✅ Blocks **high-priority threats first**  
✅ Uses **Priority Scheduling (OS Algorithm)**

**Output:**

**Processing Packets (Higher priority threats first):**

**Blocked IP: 172.16.0.5 | Threat Level: 5**

**Blocked IP: 10.0.0.3 | Threat Level: 4**

**Allowed: 192.168.1.10 | Threat Level: 2 (Normal Traffic)**

* **Running AI-Powered Phishing Detection**

javac PhishingDetection.java

java PhishingDetection

🔹 **What This Does?**  
✅ Checks URLs against **blacklisted phishing sites**  
✅ Can be extended to **use Machine Learning**

**Output :**

WARNING: The URL fakebank.com is a phishing site!

The URL google.com is safe.

* **Running Threat Server**

javac ThreatServer.java

java ThreatServer

🔹 **What This Does?**  
✅ **Sends real-time alerts** to the **web dashboard**

* **Running the Web Dashboard**

**1️. Open web\_dashboard/dashboard.html in Browser**

✅ Shows **live cyber attack alerts**  
✅ Can be upgraded with **threat analytics**

**Output :**

Threat Detection Server Running on Port 8080...

Threat Alert Sent to Dashboard.

**1️. Input for Network Monitoring (C Program)**

**📌 Source of Input:**  
🔹 **Live network traffic** captured using **pcap (WinPcap library)** in C.

**📌 How It Works?**  
✅ The program reads **packets from the network interface** (like Wi-Fi or Ethernet).  
✅ Extracts **IP addresses, ports, and protocols**.  
✅ Detects **suspicious patterns** based on predefined rules.

**📌 Example Input (Captured Packet Data):**  
A TCP packet traveling over the network:

Ex : Protocol: TCP, Source IP: 192.168.1.5, Destination IP: 192.168.1.20

Source Port: 443, Destination Port: 52000

**Input for Intrusion Prevention (Java)**

**📌 Source of Input:**  
🔹 **Network packets (from the C module)** analyzed using **priority scheduling (OS algorithm)**.

**📌 How It Works?**  
✅ Uses **priority queues** to determine which IPs are more dangerous.  
✅ Blocks IPs that show **suspicious behavior (e.g., too many requests in a short time)**.

Ex :

Packet[] packets = {

new Packet("192.168.1.10", 2), // Normal traffic

new Packet("172.16.0.5", 5), // High-risk attack

new Packet("10.0.0.3", 4) // Suspicious activity

};

**3️. Input for Phishing & Malware Detection (Java AI)**

**📌 Source of Input:**  
🔹 **Website URLs entered by the user** or extracted from **network traffic**.

**📌 How It Works?**  
✅ Compares **URLs against a blacklist** (hardcoded + real-time API).  
✅ Uses **hashing (DSA in Java) for fast lookups**.  
✅ Can integrate **Machine Learning** to detect unknown threats.

Ex :

Enter URL: fakebank.com

**4️. Input for Web Dashboard (HTML/Java Backend)**

**📌 Source of Input:**  
🔹 **Threat alerts generated by the Java backend** (Intrusion Prevention + AI Phishing Detection).

**📌 How It Works?**  
✅ The **backend sends alerts to the dashboard** when a cyber attack is detected.  
✅ The **dashboard displays real-time security warnings**.

**📌 Example Input (Threat Server Logs Sent to Dashboard):**

Ex :

Threat Alert Sent to Dashboard: Malicious IP 172.16.0.5 Blocked!

**🔹 Summary: How the System Works End-to-End?**

📡 **Network Monitor (C)** → **Detects packets** → Sends data to **Intrusion Prevention (Java)**  
🚦 **Intrusion Prevention** → **Blocks malicious IPs** → Sends threat alerts to **Threat Server**  
🧠 **Phishing Detector (Java AI)** → **Checks URLs for phishing**  
🌐 **Threat Server** → **Displays alerts on Web Dashboard (HTML/CSS + Java)**

👉 **The system processes real-time data, preventing cyber threats dynamically!**

**How are these getting inputs ?**

**1️. Intrusion Prevention System (Java) - Prioritizing Threats**

**How the system knows the threat priority?**

The **Intrusion Prevention System** (IPS) works with **network traffic** (captured by the **Network Monitoring C Program**) and applies a set of predefined rules, **algorithms**, and **behavior analysis** to determine the **priority** of a potential threat. The **priority** is often determined by the **risk level** of the threat, which is calculated based on various factors.

Here’s how it works:

**A. Factors Affecting Threat Priority**

1. **Behavioral Analysis:**
   * **Suspicious behavior** is detected when a particular IP address sends multiple requests or traffic to certain ports in a **short period**. For example, if an IP is trying to access an **admin login page** repeatedly (a brute-force attack), it will be considered **high priority**.
2. **Known Blacklisted IPs:**
   * **Malicious IPs** from previous **attacks** (blacklist) are considered **high-priority threats**. For instance, IPs listed in a **blocklist** (e.g., **botnets** or **malicious actors** known for cybercrimes) are flagged with higher priority.
3. **Volume of Requests (DDoS):**
   * If an IP sends an abnormal amount of traffic to the server in a short time, this indicates a **Distributed Denial of Service (DDoS)** attack. These types of attacks are considered **high-priority** because they can bring down entire systems.
4. **Specific Port Attacks (Port Scanning):**
   * If an IP attempts to connect to multiple ports in a very short time, it could indicate a **port scanning** attempt (used for exploiting vulnerabilities). This is also flagged as **high priority**.

**B. Priority Scheduling Algorithm**

After capturing the network traffic and identifying a suspicious IP or behavior, the **Intrusion Prevention System** uses a **priority queue** (or a **priority scheduling algorithm**) to decide which threats to block first.

* **High Priority (Severity 5)**: Malicious IP addresses from **blacklists**, attempts at **DDoS**, or **port scanning**.
* **Medium Priority (Severity 3)**: Suspicious but not immediately harmful behaviors like **repeated failed login attempts**.
* **Low Priority (Severity 1)**: General **network traffic** that doesn’t show any suspicious activity.

**Example of a Packet with Priority:**

java

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Packet packet1 = new Packet("192.168.1.100", 5); // High priority (known malicious IP)

Packet packet2 = new Packet("192.168.1.200", 3); // Medium priority (suspicious behavior)

Packet packet3 = new Packet("192.168.1.10", 1); // Low priority (normal traffic)

The system will **block high-priority IPs** (like 192.168.1.100), while it processes medium and low-priority traffic accordingly.

**Example:**

A DDoS attack is happening from 10.0.0.45 to the server, and the system sees that this IP has been flagged for **sending 1000 requests per second**. This is a **high-priority threat** that would be blocked immediately.

**2️. AI-Powered Phishing Detection (Java) - Identifying Phishing Websites**

**How the system knows a website is a phishing site?**

Phishing websites are designed to **look like legitimate websites** (e.g., fake bank sites), but their purpose is to steal sensitive information like **login credentials**, **credit card details**, etc. The **AI-powered phishing detection system** uses a combination of techniques to **identify phishing websites**.

**A. Factors that Determine Phishing**

1. **URL Analysis:**
   * Phishing sites often have **URL structures** that look similar to legitimate websites but contain slight differences, such as:
     + **"**[**https://www.paypa1.com**](https://www.paypa1.com)**"** instead of **"**[**https://www.paypal.com**](https://www.paypal.com)**"** (note the number 1 instead of the letter l).
     + **Subdomain variations** like **"bank-xyz.com"** (which could look like a fake bank site).

The system checks if the **domain** or **URL** matches known **phishing patterns** or is on a **blacklist** of previously identified phishing sites.

**B. How AI and DSA Help in Phishing Detection:**

1. **URL Hashing (DSA in Java):**
   * The system uses **hashing algorithms** (like **SHA-256**, **MD5**, or **DSA**) to generate a unique hash for every **URL**. The hash is then checked against a **predefined list of phishing URLs**.

**Example**: When a suspicious URL (fakebank.com) is entered, the system hashes the URL and compares it with the hash of known phishing sites stored in a database. If it matches, it’s flagged as **phishing**.

java

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String url = "http://fakebank.com";

String hashedURL = hash(url); // Use DSA for hashing

if (isPhishing(hashedURL)) {

System.out.println("Phishing site detected: " + url);

}

1. **Heuristic or Machine Learning Models:**
   * The system can also use **machine learning models** trained to recognize **patterns** typical of phishing websites. These models can look for specific patterns such as:
     + **Page Layouts**: Phishing sites often mimic legitimate sites but might have slight changes in layout, images, or URLs.
     + **SSL/TLS Certificates**: Many phishing sites don't use **SSL/TLS** encryption or have invalid certificates.
     + **Suspicious Features**: Such as fake login forms, strange domain names, etc.

The **AI module** evaluates these patterns to **categorize** the site as **phishing** or **legitimate**.

**C. Example of Phishing Detection:**

Let's say an employee clicks on a suspicious URL like http://fakebank.com. The system performs the following steps:

1. **URL Hashing**:
   * The system hashes the URL: fakebank.com → hash(fakebank.com)
   * It compares this hash with entries in a **phishing URL database**.
2. **Phishing Detection**:
   * The system finds that the **hash of "fakebank.com"** is in the database of known phishing sites.
   * The system flags the site as **phishing** and prevents the employee from visiting it.

**Phishing Detection Output:**

sh

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WARNING: The URL fakebank.com is a phishing site!