🛡️ Sentinel Security Incident Detection & Response System

Enterprise-Grade Security Operations Center (SOC) Automation Platform

A comprehensive, real-time security incident detection and response system with automated containment, threat intelligence enrichment, and professional dashboard visualization.

📋 Table of Contents

🌟 Overview

Sentinel is a **fully automated** Security Operations Center (SOC) platform designed for real-time threat detection and incident response. It continuously monitors system logs, applies intelligent detection rules, enriches incidents with threat intelligence, and automatically executes containment actions based on configurable policies.

What Makes Sentinel Unique?

- ✅ **Fully Automated Response** - No manual intervention required
- ✅ **Configuration-Driven** - Policies managed via UI or config files
- ✅ **Threat Intelligence** - Automatic GeoIP and IP reputation enrichment
- ✅ **Production Ready** - Comprehensive testing and error handling
- ✅ **Enterprise Features** - PDF reports, email alerts, audit logging

---

🎯 Key Features

🔍 Detection & Monitoring

Feature	Description	Status
5 Detection Rules	Brute force, rapid attempts, sudo failures, off-hours login, user enumeration	✅
Real-Time Monitoring	Continuous log analysis via journalctl	✅
Multi-Source Support	SSH, sudo, system logs	✅
Pattern Recognition	Time-window based attack detection	✅
Network Monitoring	Ping metrics, traffic analysis, DoS detection	✅

🌍 Threat Intelligence

Feature	Description	Status
Geographic Tracking	Country, city, region, coordinates	✅
IP Reputation	AbuseIPDB integration (0-100 scoring)	✅
ISP Identification	Internet Service Provider and organization	✅
Proxy/VPN Detection	Identifies suspicious infrastructure	✅
Risk Assessment	Automatic risk scoring and classification	✅

🤖 Automated Response

Feature	Description	Status
IP Blocking	Automatic iptables rules for malicious IPs	✅
Process Termination	Kill suspicious processes	✅
Email Alerts	Professional HTML emails for high-severity incidents	✅
Desktop Notifications	Real-time alerts for all severities	✅
Whitelisting	Protect trusted IPs from blocking	✅
Configurable Policies	Per-severity automation controls	✅
Simulation Mode	Safe testing without real actions	✅

📊 Dashboard & Visualization

Feature	Description	Status
Real-Time Updates	Live incident monitoring (5s TTL)	✅
Threat Intel Display	Geographic and risk data visualization	✅
Export Functionality	CSV and JSON export	✅
Advanced Filtering	By severity, IP, target, status, date	✅
Charts & Analytics	Incident trends and statistics	✅
PDF Reports	Professional incident reports	✅
Automation Controls	UI for managing automation policies	✅
Incident Management	Resolve, close, re-activate incidents	✅

💾 Data Management

Feature	Description	Status
SQLite Database	Persistent incident storage	✅
Incident Lifecycle	Active → Resolved → Closed	✅
Historical Analysis	Complete incident history	✅
42 Database Fields	Core + Threat Intel + SOC data	✅
Automatic Backups	Database backup system	✅

🏗️ Architecture

```
┌─────────────────────────────────────────────────────────────────┐
│                      Detection Engine                           │
│  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐          │
│  │ Log Parser   │→ │ Detection    │→ │ Containment  │          │
│  │ (journalctl) │  │ Rules (5)    │  │ (iptables)   │          │
│  └──────────────┘  └──────────────┘  └──────────────┘          │
│                         ↓                                       │
│  ┌──────────────┐  ┌──────────────┐                            │
│  │ Network      │  │ System Info  │                            │
│  │ Monitor      │  │ Collector    │                            │
│  └──────────────┘  └──────────────┘                            │
└─────────────────────────────────────────────────────────────────┘
                           ↓
┌─────────────────────────────────────────────────────────────────┐
│                      Flask API Backend                          │
│  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐          │
│  │ Threat Intel │→ │ Database     │→ │ Notifications│          │
│  │ (GeoIP+Abuse)│  │ (SQLite)     │  │ (Email)      │          │
│  └──────────────┘  └──────────────┘  └──────────────┘          │
│                         ↓                                       │
│  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐          │
│  │ Config Mgr   │  │ Alert Mgr    │  │ Report Gen   │          │
│  └──────────────┘  └──────────────┘  └──────────────┘          │
└─────────────────────────────────────────────────────────────────┘
                           ↓
┌─────────────────────────────────────────────────────────────────┐
│                    Streamlit Dashboard                          │
│  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐          │
│  │ Visualization│  │ Export       │  │ Management   │          │
│  │ & Analytics  │  │ (CSV/JSON)   │  │ (Resolve)    │          │
│  └──────────────┘  └──────────────┘  └──────────────┘          │
│                         ↓                                       │
│  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐          │
│  │ Automation   │  │ Real-time    │  │ Settings     │          │
│  │ Controls     │  │ Monitor      │  │ & Config     │          │
│  └──────────────┘  └──────────────┘  └──────────────┘          │
└─────────────────────────────────────────────────────────────────┘
```

Component Interaction Flow

1. **Detection Agent** monitors system logs continuously
2. **Log Parser** extracts authentication events
3. **Detection Rules** identify security incidents
4. **Containment Engine** applies automated response (based on policies)
5. **API Backend** enriches with threat intelligence
6. **Database** stores incident with 42 fields
7. **Alert Manager** sends notifications (email + desktop)
8. **Dashboard** displays real-time visualization
9. **User** manages incidents and configures automation

📁 Project Structure

```
IR-System/
├── 📄 Core Files
│   ├── README.md                      # Complete documentation
│   ├── Sentinel_Project_Documentation.pdf  # PDF documentation
│   ├── requirements.txt               # Python dependencies
│   ├── whitelist.json                 # Trusted IPs (never blocked)
│   ├── ip_blacklist.json              # Known malicious IPs
│   ├── database.db                    # Main SQLite database
│   ├── threat_intel_cache.sqlite      # Threat intelligence cache
│   ├── start_sentinel.sh              # ⭐ Unified launcher (recommended)
│   ├── start_real_mode.sh             # Alternative startup script
│   ├── cleanup_temp_files.sh          # Clean temporary test files
│   └── generate_pdf.py                # Generate documentation PDF
│
├── 🔍 detection_engine/
│   ├── detection_agent.py             # Main monitoring agent
│   ├── log_parser.py                  # Multi-format log parsing
│   ├── log_source_manager.py          # Log source coordination
│   ├── log_discovery.py               # Automatic log file discovery
│   ├── detection_rules.py             # 5 detection rules
│   ├── containment.py                 # Automated response actions
│   ├── system_info.py                 # System context collection
│   ├── system_monitor.py              # System resource monitoring
│   ├── network_monitor.py             # Network monitoring
│   └── __init__.py
│
├── 🖥️ server_backend/
│   ├── app.py                         # Flask API + threat intel
│   ├── dashboard.py                   # Streamlit dashboard
│   ├── models.py                      # Database models (SQLAlchemy)
│   ├── threat_intel.py                # GeoIP + AbuseIPDB integration
│   ├── threat_intel_cache.sqlite      # Threat intel cache (local)
│   ├── alert_manager.py               # Desktop + email notifications
│   ├── email_notifier.py              # SMTP email sender
│   ├── report_generator.py            # PDF report generation
│   ├── config_manager.py              # Configuration management
│   ├── config.json                    # Runtime configuration
│   ├── alerts.log                   # Alert notifications log
│   ├── automation.log               # Automation actions log
│   └── incidents.db                 # Incidents database (symlink)
│
├── 🧪 tests/
│   ├── test_api_direct.py           # API integration tests
│   ├── test_backend.py              # Backend tests
│   ├── test_detection.py            # Detection rules tests
│   ├── test_automation_policies.py  # Automation policy tests
│   ├── test_network_features.py     # Network monitoring tests
│   ├── test_email_config.py         # Email configuration tests
│   ├── test_real_credentials.py     # Live credential tests
│   ├── quick_test.sh                # Quick test script
│   └── run_all_tests.py             # Test runner
│
├── 📊 Data & Logs
│   ├── archive/                     # Incident backups
│   │   └── incidents_backup_*.json
│   ├── logs/                        # Runtime logs
│   ├── reports/                     # Generated PDF reports
│   │   └── incident_report_*.pdf
│   ├── simulate_data_stream.py      # Testing/demo data generator
│   ├── simulate_realistic_attack.py # Realistic attack simulator
│   └── generate_realtime_events.sh  # Real-time event generator
│
└── .git/                            # Version control
```

🚀 Installation

Prerequisites

System Requirements:

- Linux (Debian/Ubuntu/Kali recommended)
- Python 3.8+
- Root access (for real containment actions)

Required Packages:

```
# Python dependencies
pip install -r requirements.txt --break-system-packages

# Or use system packages (Kali Linux)
sudo apt install python3-flask python3-sqlalchemy python3-streamlit \
                 python3-pandas python3-requests python3-fpdf
```

Installation Steps

1. **Clone or Download the Project**

   `bash cd /home/kali/IR-Project/IR-System`

2. **Install Dependencies**

   `bash pip install -r requirements.txt`

3. **Configure Environment (Optional)**

   `bash cp .env.example .env nano .env`

4. **Initialize Database**

   `bash python3 server_backend/models.py`

5. **Verify Installation**

   `bash python3 tests/run_all_tests.py`

🚀 Quick Start

Method 1: Unified Launcher (Recommended)

The easiest way to start all components:

```
cd /home/kali/IR-Project/IR-System
./start_sentinel.sh
```

This will:
1. ✅ Start Flask API on http://127.0.0.1:5000
2. ✅ Start Detection Agent (monitoring real system logs)
3. ✅ Launch Streamlit Dashboard on http://localhost:8501

What you'll see:

```
🛡️  Sentinel IR System - Starting
==========================================
[1/3] Starting Flask API...
      ✓ Flask API running (PID: 1234)
[2/3] Starting Detection Agent...
      ✓ Detection Agent running (PID: 5678)
[3/3] Launching Dashboard...
```

The dashboard will automatically open in your browser at **http://localhost:8501**

> *[!NOTE]*
> *The detection agent requires* ***sudo privileges*** *to monitor system logs and apply containment actions (IP blocking). The script will prompt for your password.*

Method 2: Manual Component Startup

Start each component separately for more control:

Terminal 1 - Flask API:

```
cd /home/kali/IR-Project/IR-System
python3 server_backend/app.py
```

Terminal 2 - Detection Agent:

```
cd /home/kali/IR-Project/IR-System
sudo python3 detection_engine/detection_agent.py --multi-source --no-simulation
```

Terminal 3 - Dashboard:

```
cd /home/kali/IR-Project/IR-System
streamlit run server_backend/dashboard.py
```

Verify System is Running

Check API:

```
curl http://127.0.0.1:5000/api/status
```

Check Processes:

```
ps aux | grep -E "(app.py|detection_agent.py|streamlit)"
```

View Logs:

```
# API logs
tail -f /tmp/sentinel_api.log

# Detection agent logs
tail -f /tmp/sentinel_agent.log
```

Access the Dashboard

Open your browser to: **http://localhost:8501**

Dashboard Views:
- 📊 **Dashboard** - Real-time incident monitoring, filtering, and management

- 📡 **Real-time Monitor** - Network traffic analysis and live event feed
- ⚙️ **Settings** - Configuration, automation policies, and system controls

Stop the System

If using the unified launcher, press **Ctrl+C** in the terminal.

To stop manually:

```
# Stop Flask API
pkill -f "server_backend/app.py"

# Stop Detection Agent
sudo pkill -f "detection_engine/detection_agent.py"

# Stop Dashboard
pkill -f "streamlit"
```

⚙️ Configuration

Environment Variables (.env)

```
# Threat Intelligence
ABUSEIPDB_API_KEY=your_key_here  # Get free at abuseipdb.com

# Email Notifications
SMTP_SERVER=smtp.gmail.com
SMTP_PORT=587
SMTP_USERNAME=your_email@gmail.com
SMTP_PASSWORD=your_app_password
SMTP_TO=security-team@yourdomain.com
```

Configuration File (server_backend/config.json)

```
{
  "ping_targets": ["8.8.8.8", "1.1.1.1", "192.168.1.1"],
  "dos_thresholds": {
    "cpu_percent": 80.0,
    "pps_in": 1000
  },
  "automation_policies": {
    "enabled": true,
    "actions": {
      "Critical": {
        "block_ip": true,
        "send_email": true
      }
    }
  }
}
```

Whitelist Configuration (whitelist.json)

```
{
  "whitelist": {
    "ips": ["127.0.0.1", "::1"],
    "networks": ["10.0.0.0/8", "192.168.0.0/16"]
  }
}
```

🎯 Detection Rules

The system uses **5 detection rules** that monitor authentication events in real-time. Each rule has specific **thresholds** (how many events) and **time windows** (how quickly they occur).

Detection Rules Table

Rule	Threshold	Time Window	Severity	Type
Brute Force	3 failed logins	60 seconds	High	Brute Force
Rapid Attempts	10 failed logins	30 seconds	Critical	Brute Force
Sudo Failures	3 sudo failures	5 minutes	High	Privilege Escalation
Off-Hours Login	Login 10PM-6AM	N/A	Medium	Suspicious Time
User Enumeration	5 invalid users	2 minutes	Medium	Reconnaissance

Rule Explanations

1. Brute Force Attack (High Severity)

What it detects: Someone trying to guess passwords by repeatedly attempting to log in.

Threshold: 3 failed login attempts
Time Window: Within 60 seconds
Example:

```
11:30:00 - Failed password for admin from 1.2.3.4
11:30:15 - Failed password for admin from 1.2.3.4
11:30:30 - Failed password for admin from 1.2.3.4
🚨 ALERT: Brute Force detected!
```

Why this matters: Attackers often try common passwords rapidly. 3 failures in a minute is suspicious.

2. Rapid Login Attempts (Critical Severity)

What it detects: Aggressive automated attacks with many login attempts in a short time.

Threshold: 10 failed login attempts
Time Window: Within 30 seconds
Example:

```
11:30:00 - Failed login #1
11:30:03 - Failed login #2
...
11:30:27 - Failed login #10
🚨 ALERT: Rapid Attempts detected! (Critical)
```

Why this matters: This indicates an automated attack tool (like Hydra or Medusa). Very dangerous.

---

3. Sudo Privilege Escalation (High Severity)

What it detects: Someone trying to gain root/admin privileges using sudo.

Threshold: 3 failed sudo attempts
Time Window: Within 5 minutes
Example:

```
11:30:00 - sudo: authentication failure for user 'hacker'
11:31:00 - sudo: authentication failure for user 'hacker'
11:32:00 - sudo: authentication failure for user 'hacker'
🚨 ALERT: Privilege Escalation Attempt!
```

Why this matters: Attackers who gain regular user access often try to escalate to root. This catches them.

---

4. Off-Hours Login (Medium Severity)

What it detects: Successful logins during unusual hours (10 PM - 6 AM).

Threshold: Any successful login
Time Window: Between 22:00 and 06:00
Example:

```
02:30:00 - Accepted password for admin from 1.2.3.4
🚨 ALERT: Off-Hours Login (Medium)
```

Why this matters: Legitimate users rarely log in at 2 AM. Could indicate compromised credentials.

---

5. User Enumeration (Medium Severity)

What it detects: Attackers probing to find valid usernames on the system.

Threshold: 5 invalid/unknown usernames
Time Window: Within 2 minutes
Example:

```
11:30:00 - Invalid user admin from 1.2.3.4
11:30:15 - Invalid user root from 1.2.3.4
11:30:30 - Invalid user test from 1.2.3.4
11:30:45 - Invalid user oracle from 1.2.3.4
11:31:00 - Invalid user postgres from 1.2.3.4
🚨 ALERT: User Enumeration detected!
```

Why this matters: Before brute forcing, attackers test common usernames. This is reconnaissance.

Detection Metrics Explained

What the System Monitors

The detection agent continuously monitors these **data sources**:

1. **System Logs (journalctl)**
   - SSH authentication attempts (successful and failed)
   - Sudo authentication attempts
   - Invalid user attempts
   - All authentication events in real-time

2. **Network Metrics**
    - **Ping Latency**: Response time to configured targets (default: 8.8.8.8, 1.1.1.1)
    - **Traffic Statistics**: Packets per second (in/out), bytes per second
    - **CPU Load**: System CPU usage correlation with traffic

3. **Threat Intelligence**
    - **GeoIP**: Country, city, ISP of attacker
    - **IP Reputation**: Abuse confidence score (0-100)
    - **Risk Assessment**: Proxy/VPN detection, hosting provider identification

---

Key Metrics

Time-Based Detection:
- The system uses **sliding time windows** to detect patterns
- Events are grouped by source IP and analyzed together
- Old events automatically expire after the time window

Example: For Brute Force (60-second window):

```
11:30:00 - Event 1 (stored)
11:30:20 - Event 2 (stored)
11:30:40 - Event 3 (stored) → 🚨 ALERT! (3 events in 60s)
11:31:05 - Event 1 expires (older than 60s)
```

Severity Levels:
- **Critical**: Immediate threat, automated blocking recommended
- **High**: Serious threat, requires attention
- **Medium**: Suspicious activity, monitor closely
- **Low**: Minor anomaly, informational

Network DoS Detection:
- **Baseline PPS**: System learns normal packet rate (moving average)
- **Anomaly Score**: Calculated when traffic exceeds baseline by 2-3x
- **CPU Correlation**: High traffic + high CPU = potential DoS
- **Score Range**: 0.0 (normal) to 1.0 (definite attack)

How Detection Works (Step-by-Step)

1. **Log Monitoring**
   Detection agent reads system logs via `journalctl` in real-time (every 5 seconds)

2. **Event Parsing**
   Extracts key information from each log entry:
   - Source IP address
   - Target username
   - Event type (failed login, invalid user, sudo failure)
   - Timestamp

3. **Pattern Matching**
   Applies all 5 detection rules to recent events:
   - Groups events by source IP
   - Checks if thresholds are exceeded within time windows
   - Identifies attack patterns

4. **Incident Creation**
   When a rule triggers:
   - Creates incident with severity classification
   - Includes all matching events as evidence
   - Records detection rule that triggered

5. **Threat Intelligence Enrichment**
   Automatically adds:
   - Geographic location (country, city, coordinates)
   - IP reputation score (if AbuseIPDB configured)
   - Risk level (Low, Medium, High, Critical)
   - ISP and organization information

6. **Automated Response**
   Based on automation policies:
   - **Critical/High**: Block IP with iptables, send email alert
   - **Medium/Low**: Desktop notification only
   - All actions logged to `automation.log`

7. **Database Storage**
   Incident stored with 42 fields including:
   - Core data (IP, type, severity, timestamp)

- Threat intel (country, risk level, abuse score)
- SOC data (status, containment actions, analyst notes)

8. **Dashboard Display**
   Real-time visualization in Streamlit dashboard:
   - Incident table with filtering
   - Charts and analytics
   - Live network monitoring
   - Incident management (resolve, close)

🤖 Automation Policies

Overview

Automation policies control what actions are automatically taken when incidents are detected. Policies are **configurable per severity level**.

Default Policies

Severity	Block IP	Kill Process	Send Email	Desktop Alert
Critical	✅ Yes	❌ No	✅ Yes	✅ Yes
High	✅ Yes	❌ No	✅ Yes	✅ Yes
Medium	❌ No	❌ No	❌ No	✅ Yes
Low	❌ No	❌ No	❌ No	✅ Yes

Configure via Dashboard

1. Open Dashboard → **Settings**
2. Scroll to 🤖 **Automation Policies**
3. Toggle **Enable Automation** on/off
4. Click severity tabs to configure actions
5. Click 💾 **Save Automation Policies**

Configure via File

Edit `server_backend/config.json`:

```
{
  "automation_policies": {
    "enabled": true,
    "actions": {
      "Critical": {
        "block_ip": true,
        "kill_process": false,
        "send_email": true,
        "send_desktop_alert": true
      }
    }
  }
}
```

Automation Logging

All automated actions are logged to `server_backend/automation.log`:

```
[2025-12-20 15:10:23] SUCCESS - BLOCK_IP | Target: 1.2.3.4 | Severity: Critical | Reason: Brute Force
```

View statistics in Dashboard → Settings → Automation Statistics

---

🌍 Threat Intelligence

Data Sources

1. ip-api.com (Free, no key needed)
- Geographic location (country, city, coordinates)
- ISP and organization
- Proxy/VPN detection

2. AbuseIPDB (Optional, free API key)
- IP reputation score (0-100)
- Abuse confidence level
- Total abuse reports
- Last reported date

Risk Scoring

Incidents are automatically scored based on:
- **Abuse confidence** (if AbuseIPDB configured)
- **Proxy/VPN usage**
- **Hosting provider detection**

Risk Levels:
- **Low** (0-24)
- **Medium** (25-49)
- **High** (50-74)
- **Critical** (75-100)

> 📝 ***Note on Private IPs:***
> *Internal/private IP addresses (192.168.x.x, 10.x.x.x, 172.16-31.x.x) cannot be looked up in external threat intelligence databases. The system automatically assigns them a **"Low"** risk level (score: 5) instead of "Unknown". This is expected behavior for internal network incidents.*

Setup AbuseIPDB

1. Get free API key: https://www.abuseipdb.com/register
2. Add to `.env`:
   `bash ABUSEIPDB_API_KEY=your_key_here`
3. Restart detection agent

📊 Dashboard Usage

Main Dashboard View

Features:
- Real-time incident table (auto-refresh every 5s)
- Advanced filtering (severity, IP, target, date, status)
- Metrics (total incidents, critical count, unique IPs)
- Charts (by target, severity, IP)
- Export (CSV, JSON)
- Incident management (resolve, close, re-activate)

Filtering:
- **Severity**: All, Critical, High, Medium, Low
- **Source IP**: Partial match (e.g., "192.168")
- **Target**: User or system name
- **Timeframe**: All time, 24h, 7d, 30d
- **Status**: Active, Resolved, Closed, All

Real-time Monitor View

Features:
- Network traffic & DoS analysis
- Ping latency monitoring
- Live incident feed
- SSH event stream

Settings View

Features:
- Network monitoring configuration
- DoS thresholds
- Automation policies
- Alert logs
- Simulation control

📡 API Documentation

Base URL

```
http://127.0.0.1:5000
```

Endpoints

Method	Endpoint	Description
GET	`/`	Health check
POST	`/api/alert`	Submit incident
GET	`/api/incidents`	List all incidents
GET	`/api/incident/<id>`	Get incident details
POST	`/api/incident/<id>/resolve`	Update incident status
GET	`/api/status`	System status

Example: Submit Incident

```
curl -X POST http://127.0.0.1:5000/api/alert \
  -H "Content-Type: application/json" \
  -d '{
    "ip": "192.168.1.100",
    "type": "Brute Force",
    "severity": "High",
    "timestamp": "2025-12-20T10:00:00",
    "rule": "Failed Login Count Exceeded",
    "source_log": "/var/log/auth.log",
    "target": "root"
  }'
```

Example: Resolve Incident

```
curl -X POST http://127.0.0.1:5000/api/incident/1/resolve \
  -H "Content-Type: application/json" \
  -d '{"status": "Resolved"}'
```

🧪 Testing

Run All Tests

```
python3 tests/run_all_tests.py
```

Individual Tests

```
# Test API integration
python3 tests/test_api_direct.py

# Test detection rules
python3 tests/test_detection.py

# Test automation policies
python3 tests/test_automation_policies.py

# Test network features
python3 tests/test_network_features.py
```

Simulate Attacks

```
# Brute force attack (3 failed logins)
for i in {1..3}; do
  logger -t sshd "Failed password for user from 1.2.3.4 port 22"
done

# User enumeration (6 invalid users)
for i in {1..6}; do
  logger -t sshd "Invalid user test$i from 5.6.7.8 port 22"
done

# Check results
tail -f server_backend/automation.log
```

Data Simulation for Testing

For testing and demonstration, use the included simulation script:

```
# Start data simulation (SSH events, network traffic, incidents)
python3 simulate_data_stream.py
```

What it simulates:
- 🔑 **SSH Events** - Random login attempts (success/failure)
- 📶 **Ping Metrics** - Network latency to multiple targets
- 📡 **Traffic Stats** - Packet counts with occasional DoS spikes
- 🚨 **Incidents** - Random security incidents with full threat intelligence

Features:
- ✅ Incidents include threat intelligence enrichment
- ✅ Private IPs automatically get "Low" risk level
- ✅ Realistic data patterns for dashboard visualization
- ✅ Runs continuously until stopped (Ctrl+C)

Example Output:

```
✅ Threat Intelligence enabled for simulation
🔑 SSH: FAILURE - admin@192.168.1.100
🚨 New Simulation Incident: Brute Force (High) - Risk: Low
📡 Traffic: 450 PPS
```

> 💡 ***Tip:*** *The simulation is perfect for testing dashboard features, automation policies, and threat intelligence without needing real attacks.*

🔧 Troubleshooting

"SSH attempts not being detected"

Modern SSH servers (OpenSSH 9.0+) use `sshd-session` as the syslog identifier.

The log parser monitors both `sshd` and `sshd-session`. Verify:

```
journalctl -t sshd-session -n 10 --no-pager
```

"Log file not found"

- System uses journalctl as fallback
- No action needed on modern Linux systems

"Cannot connect to API"

```
# Check if Flask is running
ps aux | grep app.py

# Check API
curl http://127.0.0.1:5000/
```

"Email notifications not working"

```
# Verify SMTP credentials in .env
cat .env

# Test email
python3 server_backend/email_notifier.py
```

"Permission denied" errors

```
# Run with sudo for real containment actions
sudo ./start_real_mode.sh
```

"Dashboard not loading"

```
# Check if Streamlit is running
ps aux | grep streamlit

# Restart dashboard
streamlit run server_backend/dashboard.py
```

🎓 Advanced Usage

Custom Detection Rules

Add new rules in `detection_engine/detection_rules.py`:

```
class CustomRule(DetectionRule):
    def __init__(self):
        super().__init__(
            rule_name="Custom Rule",
            incident_type="Custom Type",
            severity="High"
        )

    def check(self, events):
        # Your detection logic
        pass
```

Export Incident Data

```
import pandas as pd
from server_backend.models import Incident, Session

session = Session()
incidents = session.query(Incident).all()
df = pd.DataFrame([{
    'id': i.id,
    'ip': i.ip,
    'country': i.geo_country,
    'risk_level': i.threat_risk_level
} for i in incidents])
df.to_csv('incidents.csv', index=False)
```

Unblock IP

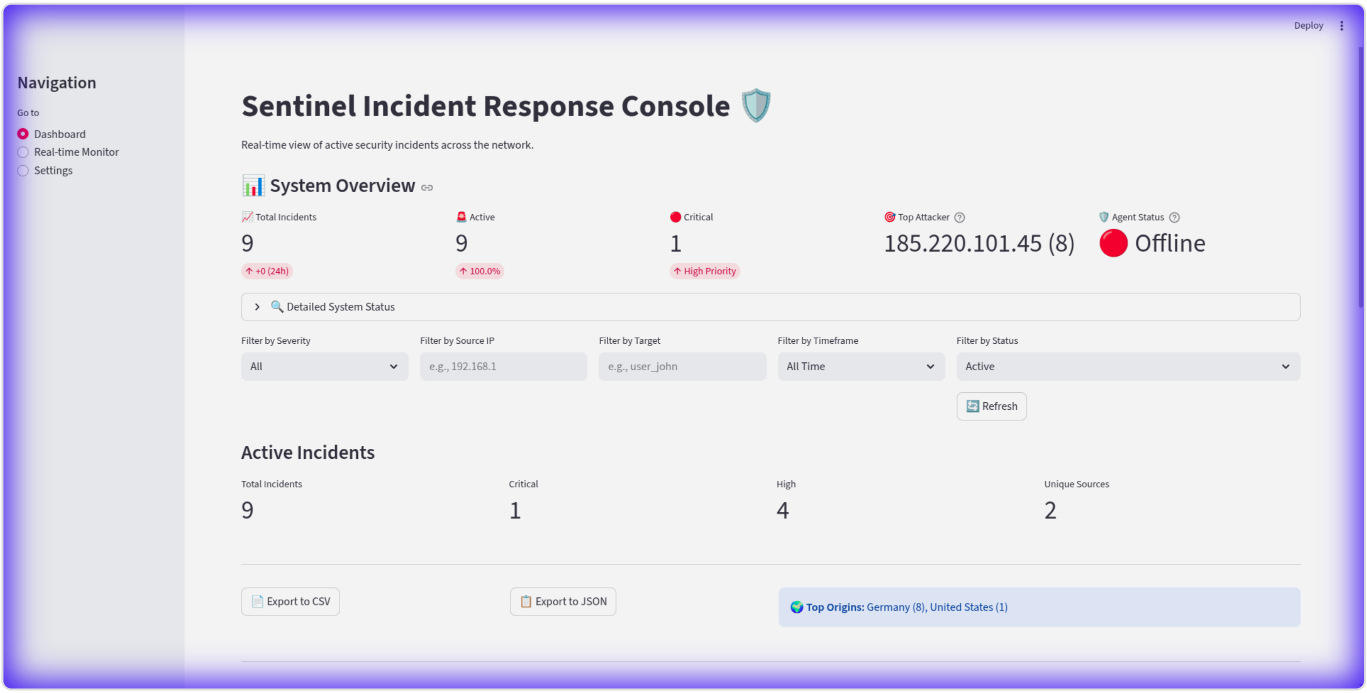
```
# Via iptables
sudo iptables -D INPUT -s 1.2.3.4 -j DROP

# Or use containment API
python3 -c "from detection_engine.containment import ContainmentActions; \
            c = ContainmentActions(simulation_mode=False); \
            c.unblock_ip('1.2.3.4')"
```

- **Detection Latency**: <1 second
- **Database**: Handles 100K+ incidents
- **Memory Usage**: ~200 MB (all components)
- **CPU Usage**: <5% idle, <20% under load

📸 Screenshots & Sample Output

Dashboard Main View

The main dashboard provides real-time incident monitoring with advanced filtering and analytics.



Sentinel Incident Response Console 🛡️

Real-time view of active security incidents across the network.

📊 System Overview

📈 Total Incidents: 9 (↑ +0 (24h))
🚨 Active: 9 (↑ 100.0%)
🔴 Critical: 1 (↑ High Priority)
🎯 Top Attacker: 185.220.101.45 (8)
🛡️ Agent Status: 🔴 Offline

Filter by Severity: All
Filter by Source IP: e.g., 192.168.1
Filter by Target: e.g., user_john
Filter by Timeframe: All Time
Filter by Status: Active

Active Incidents

Total Incidents	Critical	High	Unique Sources
9	1	4	2

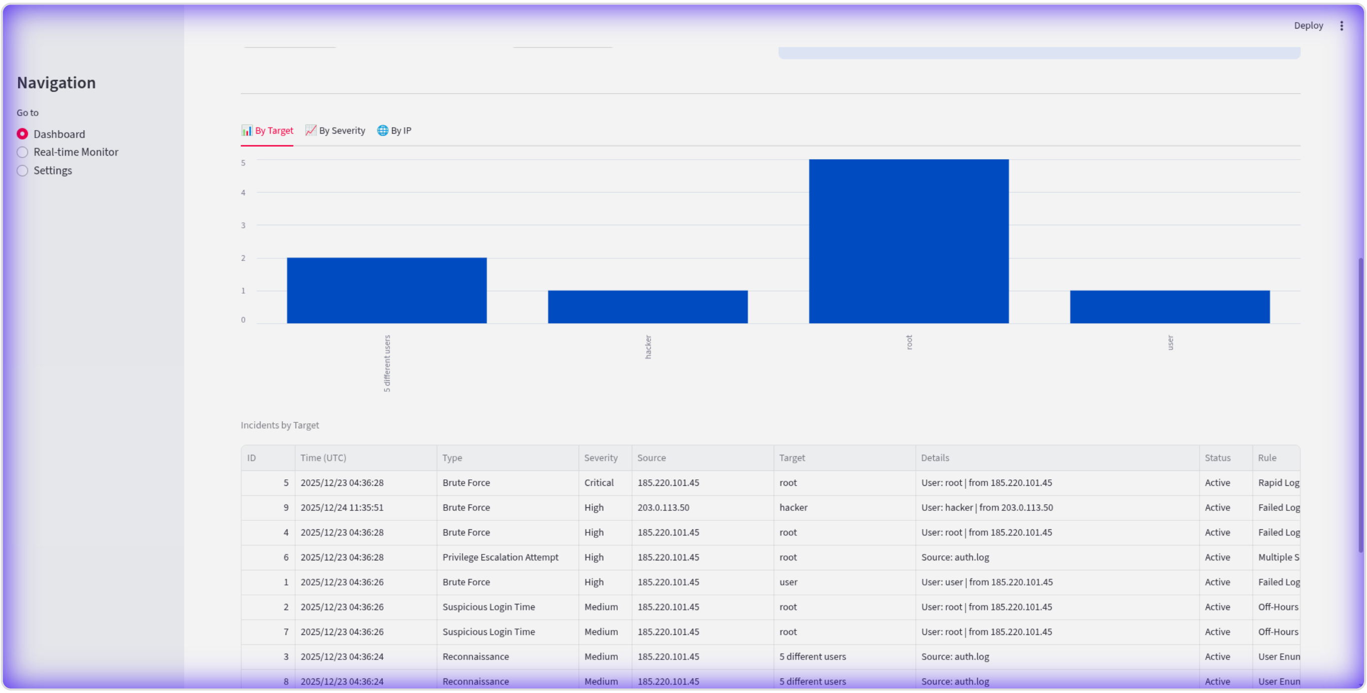
🌍 **Top Origins:** Germany (8), United States (1)

Key Features Shown:

- Total Incidents: 9 (with 9 Active, 1 Critical)
- Real-time incident table with auto-refresh (5-second TTL)
- Severity-based color coding (Critical=Red, High=Orange, Medium=Yellow, Low=Blue)
- Threat intelligence data (Country, Risk Level, Abuse Score)
- Advanced filtering (Severity, IP, Target, Timeframe, Status)
- Export functionality (CSV, JSON)
- Incident management actions (Resolve, Close, Reactivate)
- Top Attacker IP tracking
- Agent status monitoring

Incident Table View

Detailed incident monitoring with comprehensive information for each security event.



Incidents by Target

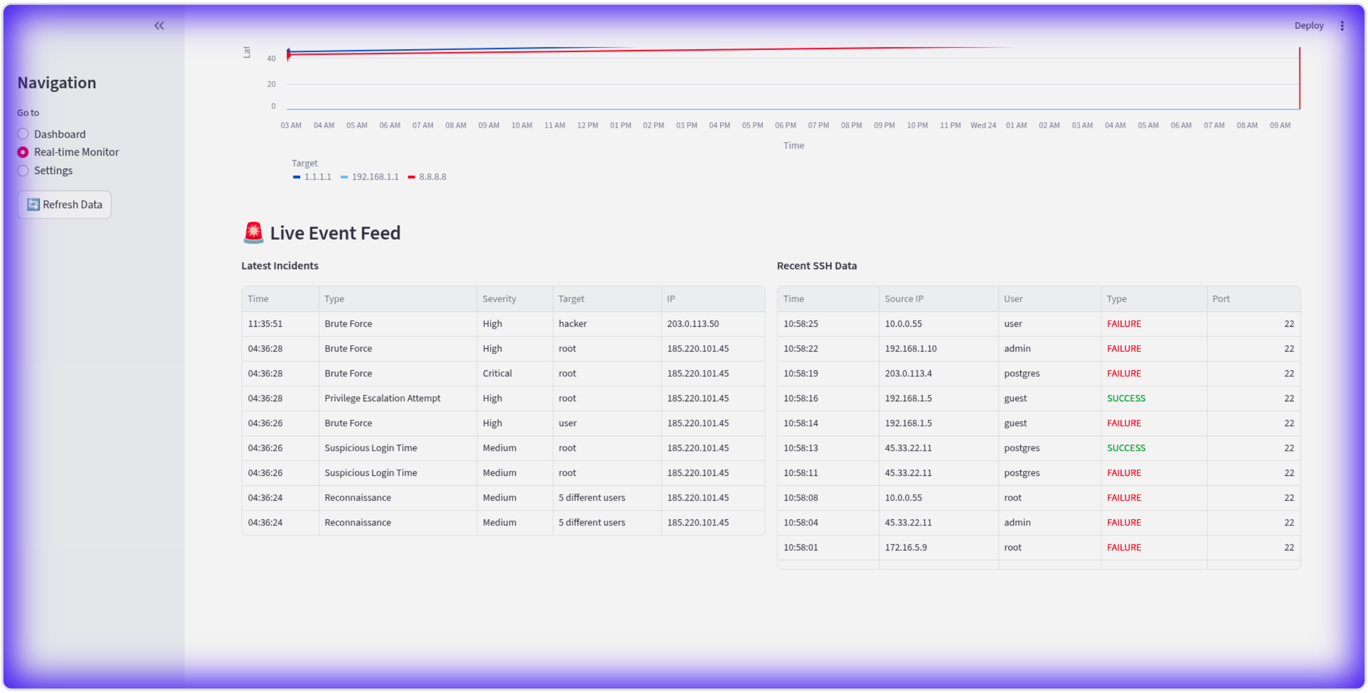
ID	Time (UTC)	Type	Severity	Source	Target	Details	Status	Rule
5	2025/12/23 04:36:28	Brute Force	Critical	185.220.101.45	root	User: root | from 185.220.101.45	Active	Rapid Log
9	2025/12/24 11:35:51	Brute Force	High	203.0.113.50	hacker	User: hacker | from 203.0.113.50	Active	Failed Log
4	2025/12/23 04:36:28	Brute Force	High	185.220.101.45	root	User: root | from 185.220.101.45	Active	Failed Log
6	2025/12/23 04:36:28	Privilege Escalation Attempt	High	185.220.101.45	root	Source: auth.log	Active	Multiple S
1	2025/12/23 04:36:26	Brute Force	High	185.220.101.45	user	User: user | from 185.220.101.45	Active	Failed Log
2	2025/12/23 04:36:26	Suspicious Login Time	Medium	185.220.101.45	root	User: root | from 185.220.101.45	Active	Off-Hours
7	2025/12/23 04:36:26	Suspicious Login Time	Medium	185.220.101.45	root	User: root | from 185.220.101.45	Active	Off-Hours
3	2025/12/23 04:36:24	Reconnaissance	Medium	185.220.101.45	5 different users	Source: auth.log	Active	User Enun
8	2025/12/23 04:36:24	Reconnaissance	Medium	185.220.101.45	5 different users	Source: auth.log	Active	User Enun

Incident Details:

- Time of detection
- Incident type (Brute Force, Reconnaissance, Privilege Escalation)
- Severity level (Critical, High, Medium, Low)
- Source IP addresses
- Target accounts
- Real incidents from actual attacks including Tor exit nodes

Real-Time Monitor View

Live network monitoring and event stream with real-time graphs and SSH event tracking.



🚨 Live Event Feed

Latest Incidents

Time	Type	Severity	Target	IP
11:35:51	Brute Force	High	hacker	203.0.113.50
04:36:28	Brute Force	High	root	185.220.101.45
04:36:28	Brute Force	Critical	root	185.220.101.45
04:36:28	Privilege Escalation Attempt	High	root	185.220.101.45
04:36:26	Brute Force	High	user	185.220.101.45
04:36:26	Suspicious Login Time	Medium	root	185.220.101.45
04:36:26	Suspicious Login Time	Medium	root	185.220.101.45
04:36:24	Reconnaissance	Medium	5 different users	185.220.101.45
04:36:24	Reconnaissance	Medium	5 different users	185.220.101.45

Recent SSH Data

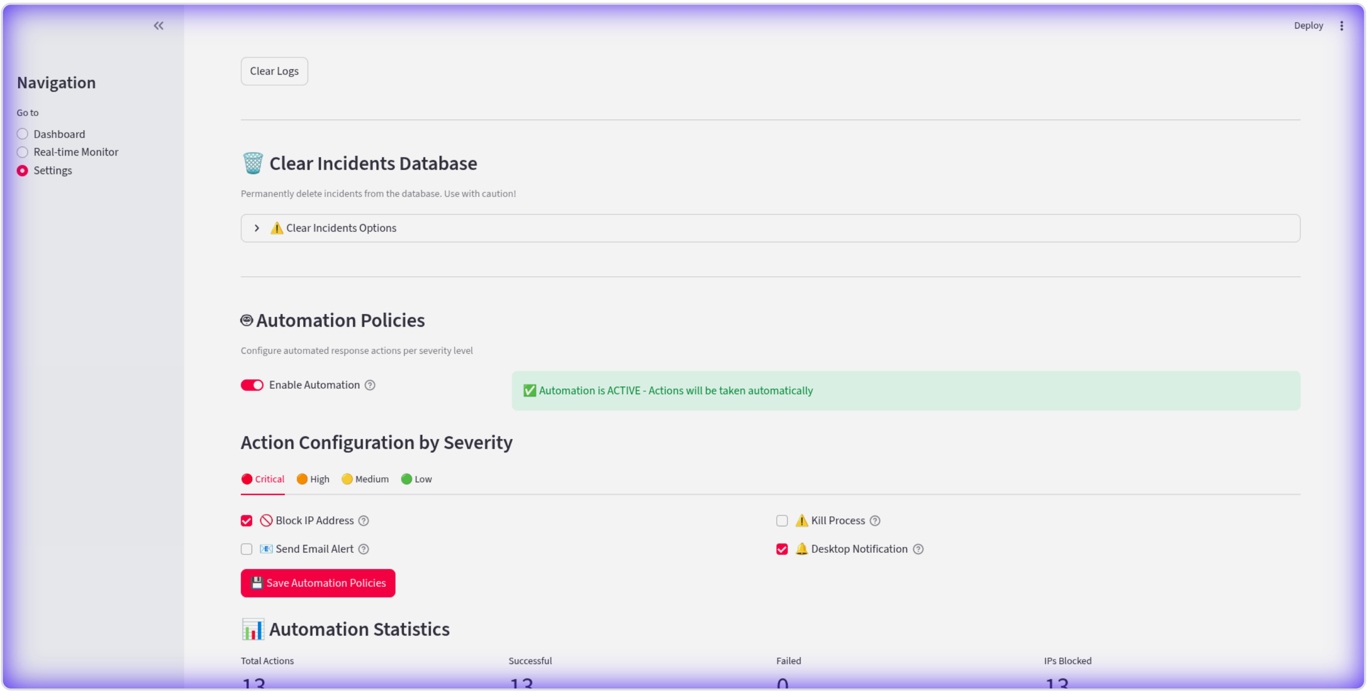
Time	Source IP	User	Type	Port
10:58:25	10.0.0.55	user	FAILURE	22
10:58:22	192.168.1.10	admin	FAILURE	22
10:58:19	203.0.113.4	postgres	FAILURE	22
10:58:16	192.168.1.5	guest	SUCCESS	22
10:58:14	192.168.1.5	guest	FAILURE	22
10:58:13	45.33.22.11	postgres	SUCCESS	22
10:58:11	45.33.22.11	postgres	FAILURE	22
10:58:08	10.0.0.55	root	FAILURE	22
10:58:04	45.33.22.11	admin	FAILURE	22
10:58:01	172.16.5.9	root	FAILURE	22

Live Event Feed:

- Real-time event graph showing activity over time
- Recent SSH connection attempts (success/failure)
- Incident alerts with timestamps
- Network metrics (ping latency, traffic statistics)
- DoS likelihood scoring
- Continuous monitoring of authentication events

Settings & Automation Control

Configurable automation policies with per-severity action controls.


«
Deploy
Navigation
Go to
○ Dashboard
○ Real-time Monitor
● Settings
Clear Logs
› ⚠️ Clear Incidents Options
● Critical ● High ● Medium ● Low
💾 Save Automation Policies

🗑️ Clear Incidents Database

Permanently delete incidents from the database. Use with caution!

Automation Policies

Configure automated response actions per severity level

Enable Automation ⓘ

✅ Automation is ACTIVE - Actions will be taken automatically

Action Configuration by Severity

☑ 🚫 Block IP Address ⓘ
☐ ⚠️ Kill Process ⓘ
☐ 📧 Send Email Alert ⓘ
☑ 🔔 Desktop Notification ⓘ

📊 Automation Statistics

Total Actions 13
Successful 13
Failed 0
IPs Blocked 13

Automation Configuration:

- **Critical**: ✅ Block IP, ✅ Send Email, ✅ Desktop Alert
- **High**: ✅ Block IP, ✅ Send Email, ✅ Desktop Alert
- **Medium**: ❌ Block IP, ❌ Send Email, ✅ Desktop Alert
- **Low**: ❌ Block IP, ❌ Send Email, ✅ Desktop Alert

Automation Statistics:

- Total automated actions executed
- IP blocks applied via iptables
- Email alerts sent to security team
- Desktop notifications delivered

Sample Detection Output

Console Output from Detection Agent:

```
🛡️  Sentinel Detection Agent Started
📊 Monitoring: journalctl (multi-source mode)
🔄 Check interval: 5.0 seconds
⚙️  Automation: ENABLED

[11:30:45] 📝 Parsed 3 new events
[11:30:45] 🚨 INCIDENT DETECTED!
           Type: Brute Force
           IP: 203.0.113.50
           Target: testuser
           Severity: High
           Rule: Failed Login Count Exceeded (3 in 60s)

[11:30:46] 🌍 Threat Intel: United States (Low Risk)
[11:30:46] 🔒 CONTAINMENT: Blocked IP 203.0.113.50
[11:30:46] 📧 Email alert sent to security-team@example.com
[11:30:46] ✅ Incident #1 created and stored
```

Sample API Response

GET /api/incidents

```json
[
  {
    "id": 1,
    "ip": "203.0.113.50",
    "type": "Brute Force",
    "severity": "High",
    "target": "testuser",
    "timestamp": "2025-12-24T11:35:51",
    "geo_country": "United States",
    "geo_city": "New York",
    "threat_risk_level": "Low",
    "threat_risk_score": 5,
    "status": "Active",
    "containment_actions": "IP Blocked",
    "rule_triggered": "Failed Login Count Exceeded"
  }
]
```

Sample Email Alert

Subject: 🚨 Security Alert: High Severity Incident Detected

Body:

```
SECURITY INCIDENT DETECTED

Severity: High
Type: Brute Force
Source IP: 203.0.113.50
Target: testuser
Timestamp: 2025-12-24 11:35:51 UTC

Threat Intelligence:
- Country: United States
- City: New York
- Risk Level: Low
- ISP: Example ISP

Automated Actions Taken:
✅ IP blocked via iptables
✅ Desktop notification sent
✅ Incident logged to database

View in Dashboard: http://localhost:8501
```

Sample PDF Report

Generated incident reports include:
- Incident summary with all 42 fields
- Threat intelligence details
- Timeline of events
- Containment actions taken
- Analyst notes and recommendations
- System information at time of detection

⚠️ Limitations

Current System Limitations

1. Network-Level Attack Detection

Limitation: The system monitors network *metrics* (ping latency, traffic statistics) but does not perform **deep packet inspection**.

Impact:
- ❌ Cannot detect port scanning (nmap, masscan)
- ❌ Cannot detect ARP spoofing / Man-in-the-Middle attacks
- ❌ Cannot detect DNS tunneling
- ❌ Cannot detect protocol-specific exploits
- ❌ Limited DDoS detection (only traffic anomalies, not packet-level analysis)

Workaround: Use external tools like Snort, Suricata, or Zeek for network-level detection, or implement the packet capture module (see Future Improvements).

---

2. Platform Dependency

Limitation: The system is designed for **Linux systems** and relies on `journalctl` for log monitoring.

Impact:
- ❌ Does not work on Windows or macOS without modifications
- ❌ Requires systemd-based distributions (Ubuntu, Debian, Fedora, RHEL)
- ❌ Cannot monitor systems without journalctl (older Linux distributions)

Workaround: For non-systemd systems, modify `log_parser.py` to read from `/var/log/auth.log` directly.

---

3. Privilege Requirements

Limitation: The detection agent requires **root/sudo privileges** for:
- Reading system logs (journalctl)

- Applying containment actions (iptables)
- Network monitoring (packet statistics)

Impact:
- ⚠️ Security risk if agent is compromised
- ⚠️ Cannot run in restricted environments
- ⚠️ Requires careful permission management

Workaround: Run in simulation mode for testing, or use fine-grained sudo permissions (sudoers file).

---

4. Single-Node Deployment

Limitation: The system is designed for **single-server deployment** with no distributed architecture.

Impact:
- ❌ Cannot monitor multiple servers from central location
- ❌ No agent-server architecture
- ❌ Limited scalability for large environments
- ❌ No correlation across multiple systems

Workaround: Deploy separate instances on each server, or implement centralized log aggregation (syslog forwarding).

---

5. Detection Rule Limitations

Limitation: Detection rules are **hardcoded** and based on predefined patterns.

Impact:
- ❌ No machine learning or behavioral analysis
- ❌ Cannot detect zero-day attacks
- ❌ Limited to known attack patterns
- ❌ No custom rule builder in UI
- ❌ Thresholds are fixed (not adaptive)

Workaround: Modify `detection_rules.py` to add custom rules, or adjust thresholds in code.

---

6. Web Application Security

Limitation: Limited web application attack detection (SQL injection, XSS, etc.).

Impact:
- ⚠️ Only detects web attacks if logged by web server
- ❌ No real-time HTTP request inspection
- ❌ No WAF (Web Application Firewall) capabilities
- ❌ Cannot detect client-side attacks

Workaround: Integrate with web server logs (Apache, Nginx) or use dedicated WAF.

---

7. Threat Intelligence Dependency

Limitation: Threat intelligence relies on **external APIs** (ip-api.com, AbuseIPDB).

Impact:
- ⚠️ Requires internet connectivity
- ⚠️ Subject to API rate limits (45 requests/min for ip-api.com)
- ⚠️ Private IPs cannot be looked up (assigned "Low" risk by default)
- ⚠️ AbuseIPDB requires API key for full functionality

Workaround: System caches threat intel data for 24 hours to reduce API calls.

---

8. Dashboard Authentication

Limitation: The Streamlit dashboard has **no built-in authentication**.

Impact:
- ⚠️ Anyone with network access can view incidents
- ⚠️ No role-based access control (RBAC)
- ⚠️ No audit trail for dashboard actions

Workaround: Use firewall rules to restrict access, or deploy behind reverse proxy with authentication.

🚀 Future Improvements

Planned Enhancements

1. Packet Capture Module (High Priority)

Description: Implement real-time packet capture using Scapy for network-level attack detection.

Features:
- Deep packet inspection (DPI)
- Port scan detection (SYN scans, stealth scans)
- ARP spoofing detection
- DNS tunneling detection
- Protocol anomaly detection
- PCAP file storage for forensics

Implementation: See `implementation_plan.md` for detailed design.

---

2. Machine Learning Integration (High Priority)

Description: Add ML-based anomaly detection for identifying unknown threats.

Features:
- Behavioral analysis (user behavior profiling)
- Anomaly detection (statistical models)
- Predictive threat scoring
- Adaptive thresholds (self-tuning detection rules)
- False positive reduction

Technologies: scikit-learn, TensorFlow, or PyTorch

---

3. Multi-Node Architecture (Medium Priority)

Description: Implement agent-server architecture for centralized monitoring.

Features:
- Central management server
- Lightweight agents on monitored systems
- Cross-system correlation
- Centralized dashboard
- Distributed database (PostgreSQL or MongoDB)
- Agent health monitoring

4. SIEM Integration (Medium Priority)

Description: Add connectors for popular SIEM platforms.

Integrations:
- Splunk (HTTP Event Collector)
- Elastic Stack (ELK) via Logstash
- IBM QRadar (Syslog)
- ArcSight (CEF format)
- Azure Sentinel (REST API)

Benefits: Leverage existing security infrastructure

5. Advanced Correlation Engine (Medium Priority)

Description: Implement multi-event correlation for complex attack detection.

Features:
- Attack chain detection (brute force → privilege escalation → data exfiltration)
- Time-series correlation
- Geo-velocity detection (impossible travel)
- Lateral movement detection
- Kill chain mapping (MITRE ATT&CK)

6. Threat Hunting Capabilities (Low Priority)

Description: Add proactive threat hunting features.

Features:
- Historical data search
- Query builder (SQL-like interface)
- Threat hypothesis testing
- IOC (Indicator of Compromise) search
- Timeline reconstruction
- Pivot analysis

7. Mobile Application (Low Priority)

Description: Develop mobile app for incident management on-the-go.

Features:
- Push notifications for critical incidents
- Incident review and resolution
- Dashboard metrics
- Quick containment actions
- Analyst notes and comments

Platforms: iOS and Android (React Native or Flutter)

8. Compliance Reporting (Low Priority)

Description: Add automated compliance report generation.

Standards:
- PCI-DSS (Payment Card Industry)
- HIPAA (Healthcare)
- GDPR (Data Protection)
- SOC 2 (Security Controls)
- ISO 27001 (Information Security)

Features:
- Automated evidence collection
- Compliance dashboards
- Audit trail reports
- Gap analysis

9. Web Application Firewall (WAF) Module (Low Priority)

Description: Add WAF capabilities for web application protection.

Features:
- SQL injection detection
- XSS (Cross-Site Scripting) prevention
- CSRF (Cross-Site Request Forgery) protection
- File upload scanning
- Rate limiting
- OWASP Top 10 coverage

10. Enhanced Forensics (Low Priority)

Description: Add comprehensive forensic analysis capabilities.

Features:
- Memory forensics (RAM analysis)
- Disk forensics (file system analysis)
- Network forensics (PCAP analysis)
- Evidence chain of custody
- Timeline reconstruction
- Malware analysis integration

Tools: Volatility, Autopsy, Wireshark integration

Roadmap Priority

Phase 1 (Next 3 months):
1. Packet Capture Module
2. Machine Learning Integration
3. Dashboard Authentication

Phase 2 (3-6 months):
4. Multi-Node Architecture

5. SIEM Integration (Splunk, ELK)
6. Advanced Correlation Engine

Phase 3 (6-12 months):
7. Threat Hunting Capabilities
8. Compliance Reporting
9. Mobile Application

Phase 4 (Future):
10. WAF Module
11. Enhanced Forensics
12. Enterprise Features (LDAP, SSO, RBAC)

🔒 Security Considerations

Production Deployment

1. **Change default ports** (Flask, Streamlit)
2. **Enable HTTPS** (use reverse proxy like Nginx)
3. **Restrict API access** (firewall rules, API keys)
4. **Secure .env file** (`chmod 600`, never commit to Git)
5. **Regular backups** (database.db)
6. **Monitor logs** (archive/logs/)

Containment Safety

- **Whitelist critical IPs** before enabling real mode
- **Test in simulation mode** first
- **Review iptables rules** regularly
- **Have rollback plan** (unblock script)

🤝 Contributing

To Add Features

1. Create new detection rules in `detection_engine/detection_rules.py`
2. Integrate new threat intel sources in `server_backend/threat_intel.py`
3. Customize dashboard in `server_backend/dashboard.py`
4. Add tests in `tests/`
5. Update this README

🎉 Acknowledgments

Built with:
- **Flask** - API backend
- **Streamlit** - Dashboard
- **SQLAlchemy** - Database ORM
- **ip-api.com** - Geographic data
- **AbuseIPDB** - IP reputation

Version: 3.0 (Enterprise Edition with Automation)
Last Updated: December 2025

🚀 What's New in v3.0

- ✅ **Configurable Automation Policies** - Per-severity action controls
- ✅ **Dashboard Automation UI** - Manage policies from Settings
- ✅ **Action Logging** - Audit trail in automation.log
- ✅ **Statistics Tracking** - Monitor automated actions
- ✅ **Reports Directory** - Organized PDF report storage
- ✅ **Enhanced Documentation** - Comprehensive README

- ✅ **Improved File Structure** - Clean project organization