Intrusion Detection, Snort, and Network Security Monitoring

Cybersecurity

Network Security Day 2

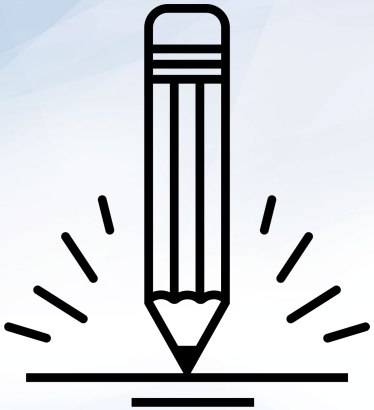
Class Objectives

By the end of class, you will be able to:

- Interpret and define Snort rules and alerts.
- Explain how intrusion detection systems work and how they differ from firewalls.
- Use Security Onion and its suite of network security monitoring tools to trace the path of network attacks.
- Collect and analyze indicators of attack and indicators of compromise using NSM tools.
- Apply knowledge of NSM, Snort rules, and Security Onion to establish situational awareness within a network.

Before we get started, we need to launch an instance of **Security Onion**.

This will generate alert data that we'll use to complete the labs.



Activity: Security Onion Setup

Follow along as we set up Security Onion to generate alert data.

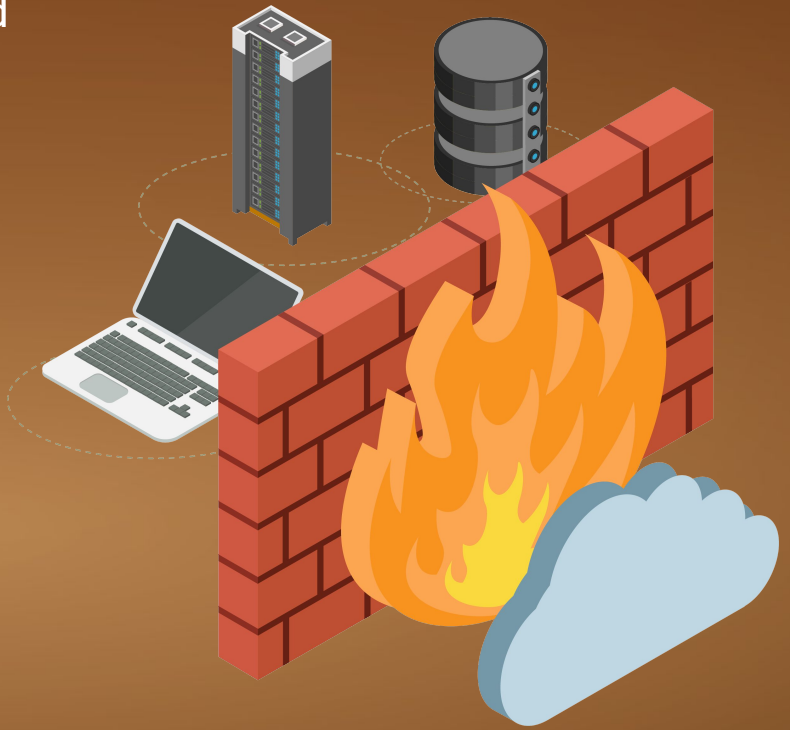
Suggested Time:
10 Minutes

Recap

Firewalls protect networks by using rules to make decisions. Firewalls are designed to allow traffic from trusted sources and block traffic from untrusted sources.

- Firewalls do have limitations. They can be easily fooled through packet manipulation by clever attackers.
- For example, attackers can send malicious data through a firewall by hijacking or impersonating a trusted machine.

  This is why it's crucial to have an effective defense in depth methodology to help protect sensitive data.



Today's Class

Today, we will build upon the defense in depth methodology by using intrusion detection systems (IDS).

We will learn how to use network security monitoring (NSM) and the Snort IDS engine to analyze indicators of attack (IOA) and indicators of compromise (IOC), perform network forensics, and acquire intelligence and situational awareness of our networks.

- The first half of the day will introduce intrusion detection and prevention systems. We will learn how to physically interconnect IDS systems and how to read, write, and interpret Snort rules.

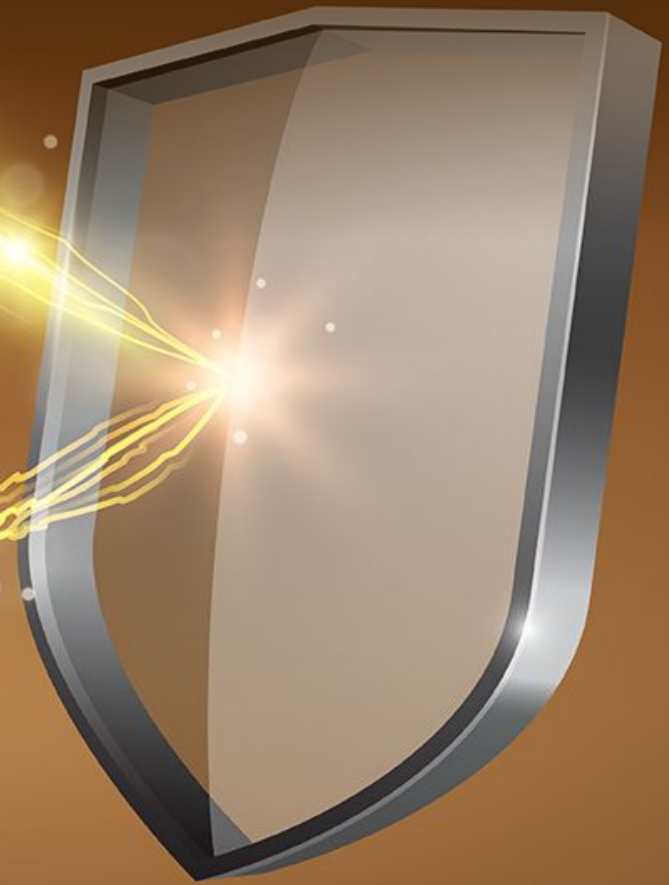
- The second half of the day will introduce Security Onion and the role NSM tools play in network security.

Introduction to Intrusion Detection and Snort

Intrusion Detection Systems

Unlike firewalls, an IDS detects and alerts of an attack.

- IDS are *passive*. They do not respond to attacks, they only log and document information for future analysis.
- IDS helps organizations establish situational awareness of attackers, allowing them to harden defenses.



IDS Types

There are two types of IDS:

01 Signature-based IDS

A signature-based IDS compares patterns of traffic to predefined signatures.

- Good for identifying well-known attacks.
- Can be updated as new attack signatures are released.
- Vulnerable to attacks through packet manipulation.
- Unable to detect zero-day attacks.

02 Anomaly-based IDS

An anomaly-based IDS compares patterns of traffic against a well-known baseline.

- Good for detecting suspicious traffic that deviates from well-known baselines.
- Excellent at detecting when attackers probe and sweep a network.
- Prone to false alerts.
- Assumes network behavior does not deviate from well-known baselines.

Intrusion Detection Architecture

Intrusion detection systems have two basic architectures:

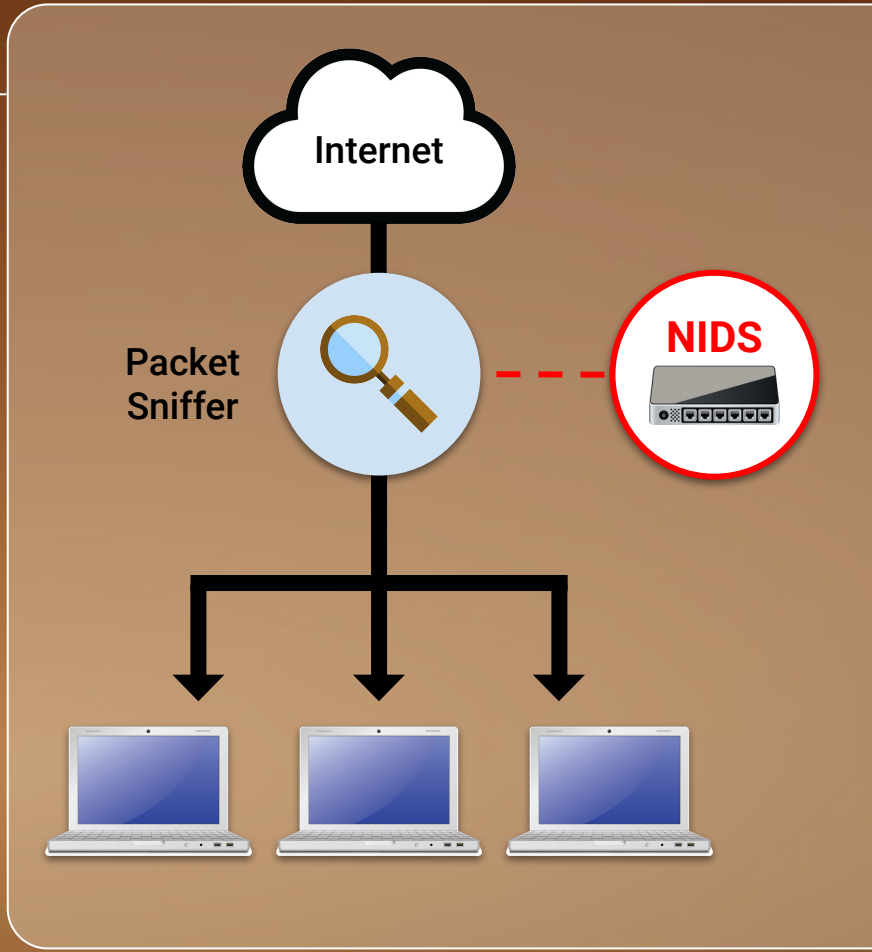
Network intrusion detection (NIDS) filters an entire subnet on a network.

Host-based intrusion detection (HIDS) runs locally on a host-based system or user's workstation or server.

Intrusion Detection Architecture

Network intrusion detection (NIDS) filters an entire subnet on a network.

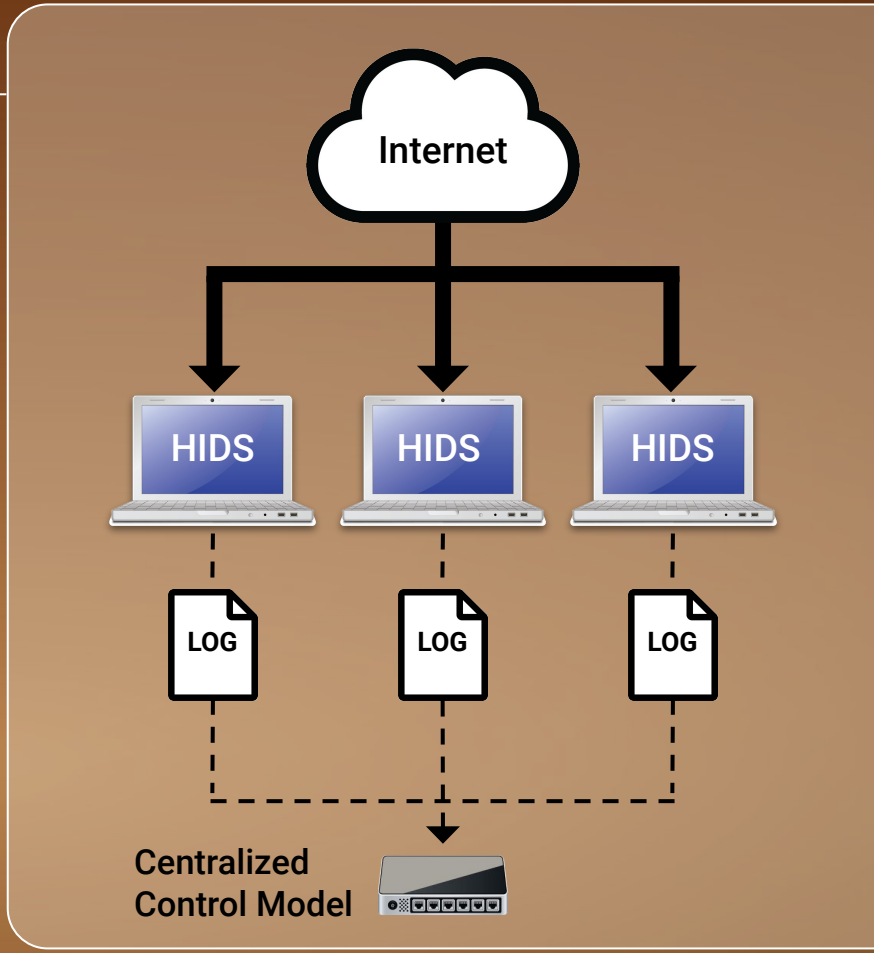
- Matches all traffic to a known library of attack signatures.
- Passively examines network traffic at points that it's deployed.
- Relatively easy to deploy and difficult to detect by attackers.



Intrusion Detection Architecture

Host-based intrusion detection (HIDS) runs locally on a host-based system or user's workstation or server.

- Acts as a second line of defense against malicious traffic that successfully gets past a NIDS.
- Examines entire file systems on a host, compares them to previous snapshots or baselines, and generates an alert if there are significant differences between the two.



Intrusion Prevention System

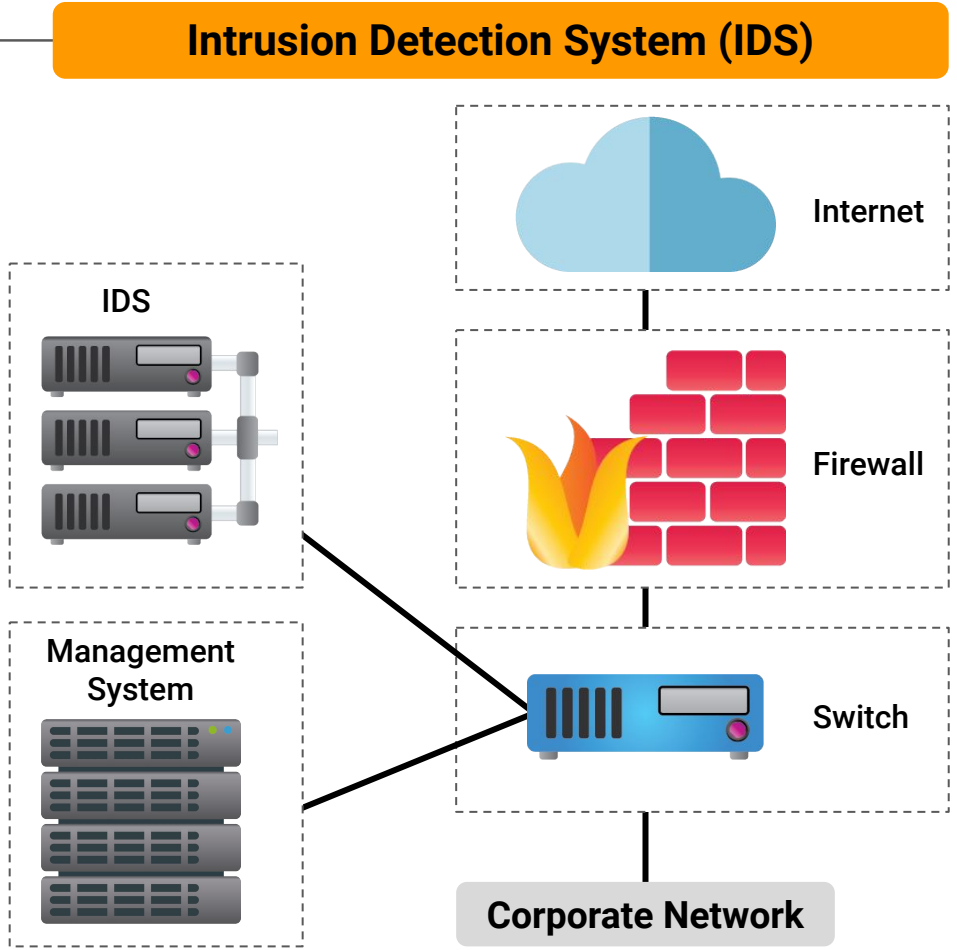
An **Intrusion Prevention System (IPS)** can do everything an IDS can, but can **also** respond to attacks.

IPS can react to packets by blocking malicious traffic, preventing it from being delivered to a host on the network.

IDS vs. IPS

IDS connects via a network tap or mirrored SPAN port.

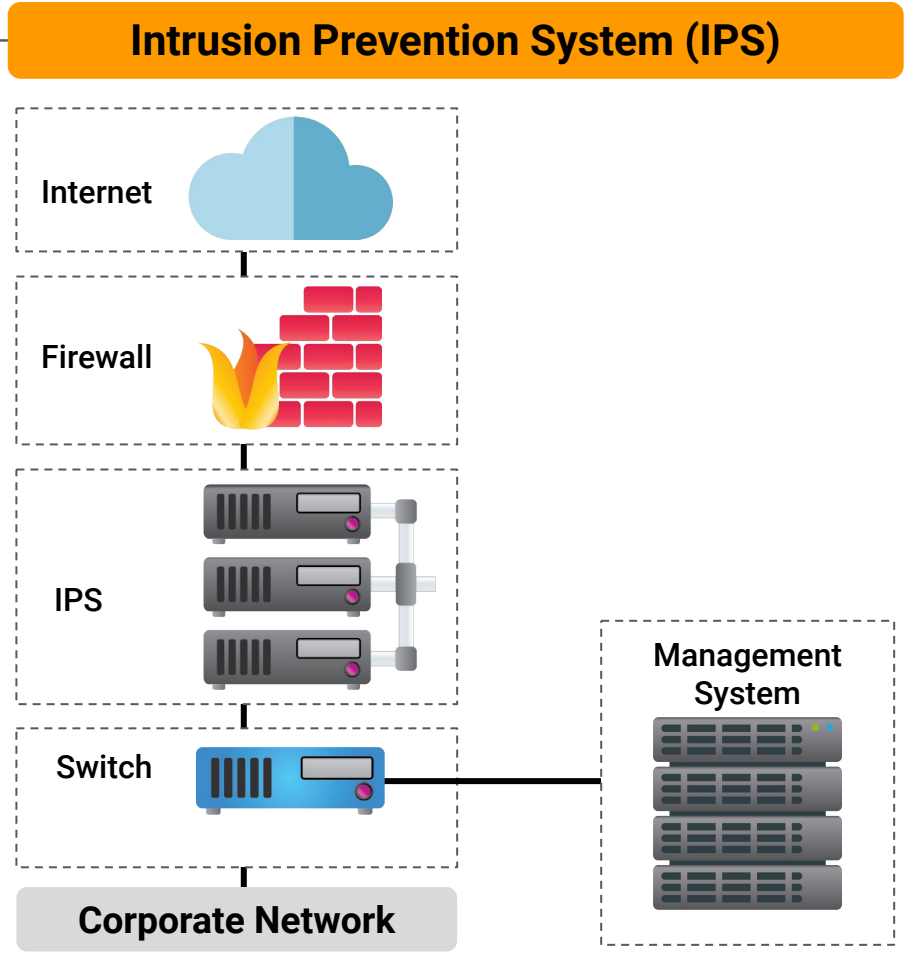
- **Network TAP** (Test Access Port) is a hardware device that provides access to a network. Network taps transit both inbound and outbound data streams on separate channels at the same time, so all data will arrive at the monitoring device in real time.
- **SPAN** (Switched Port Analyzer), also known as **port mirroring,** sends a mirror image of all network data to another physical port, where the packets can be captured and analyzed.
- IDS requires an administrator to react to an alert by examining what was flagged.



IDS vs. IPS

IPS connects **inline** with the flow of data, typically between the firewall and network switch.

- Requires more robust hardware due to the amount of traffic flowing through it.
- IPS will automatically take action by blocking and logging a threat, thus it doesn't require administrative intervention.



IDS Alerts

An **alert** is a message that is sent to an analyst's console as an indicator of attack (IOA).

An IDS system generates alerts when a **Snort rule** detects malicious traffic that matches a signature.

```
alert ip any any -> any any {msg: "IP Packet Detected";}
```

IDS Alerts

Indicators can be either:

01 Indicator of Attack (IOA)

Indicators of attack indicate attacks happening in real time.

- Proactive approach to intrusion attempts.
- Indicate that an attack is currently in progress but a full breach has not been determined.
- Focus on revealing the intent and end goal of an attacker, regardless of the exploit or malware used in the attack.

02 Indicator of Compromise (IOC)

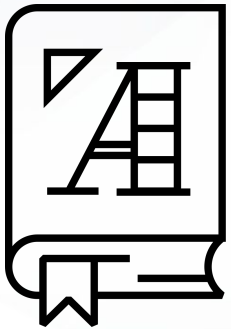
Indicators of compromise indicate previous malicious activity.

- Indicate that an attack has occurred, resulting in a breach.
- Used to establish an adversary's techniques, tactics, and procedures (TTPs).
- Expose all the vulnerabilities used in an attack, giving network defenders the opportunity to revamp their defense as part of their mitigation strategy.

Snort

There are many varieties of intrusion detection systems, but today's class will focus on **Snort**, the world's most popular open-source solution.

- **Network security monitoring (NSM)** is the process of identifying weaknesses in a network's defense.
- It also provides organizations with situational awareness of their network.



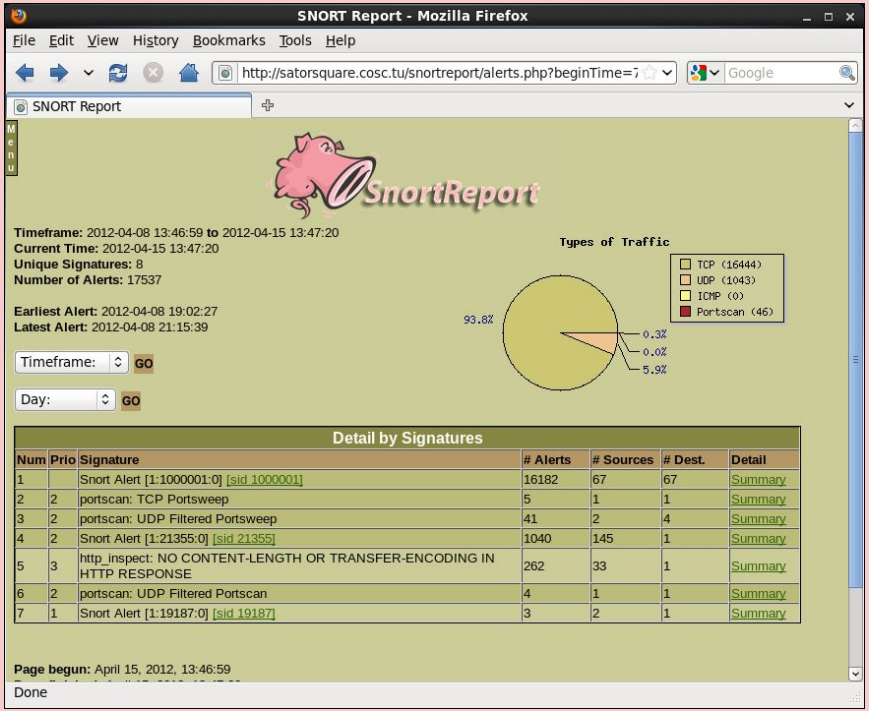
Snort is a free, open source network IDS/IPS.

Snort

Snort is a free, open source network IDS/IPS. It can perform real-time traffic analysis and can log packets on a network.

Snort adds additional layers of defense that can be applied at various layers of the defense in depth model, including:

- Perimeter IDS and IPS architecture
- Network IDS and IPS architecture
- Host IDS and IPS architecture



Snort Configuration Modes

Snort can operate in three modes:

01

Sniffer Mode
Reads network packets and displays them on screen.

02

Packet Logger Mode
Performs packet captures by logging all traffic to disk.

03

Network IDS Mode
Monitors network traffic, analyzes it, and performs specific actions based on administratively defined rules.

Snort Rules

Snort uses rules to detect and prevent intrusions. It operates by:

01 Reading a configuration file.

02 Loading the rules and plugins.

03 Capturing packets and monitoring traffic for patterns specified in rules.

04 When traffic matches a rule pattern, generating an alert and logging the matching packet for later inspection.

Snort Rules

Rules can direct Snort to monitor the following information:

01

OSI Layer
We can watch for IP and TCP data.

02

Source and Destination Address
Where the traffic is flowing from and to.

03

Byte Sequences
Patterns contained in data packets that might indicate malware, etc.

Snort Rules

```
alert ip any any -> any any {msg: "IP Packet Detected";}
```

This rule logs the message **“IP Packet Detected”** when it detects an IP packet.

Snort Rules

Rule Header

Rule Option

alert
Action Snort will take when triggered.

any
Applies to packets coming from any source IP address.

10.199.12.8
The destination IP address.

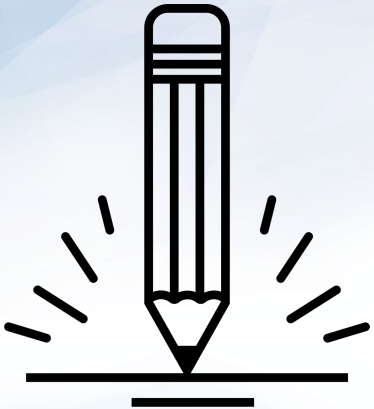
```
alert tcp any any -> 10.199.12.8 21 {msg: "TCP Packet Detected";}
```

tcp
Applies rule to all TCP packets.

any
Applies the rule to packets from any port.

21
Applies the rule to traffic to destination port 21.

{msg: "TCP Packet Detected";}
The message printed with the alert.



Activity: IDS and Snort

Today, you will play the role of an SOC analyst for the California Department of Motor Vehicles (DMV).

In this activity, you will strengthen your knowledge of concepts related to Snort and intrusion detection systems.

Suggested Time:
10 Minutes

Time’s Up! Let’s Review.

Networking Security Monitoring and Security Onion

Network Security Monitoring Case Study

On November 24, 2014, a group of attackers released confidential information from Sony Pictures that contained personally identifiable information (PII) for all employees, including full names, home addresses, social security numbers, and financial information.

It was discovered that assailants had lurked on Sony's network for 17 months.

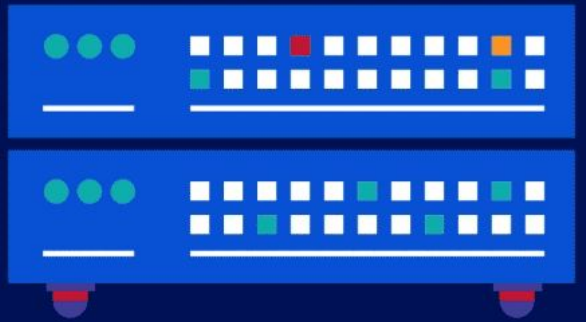
- A number of executives and upper management were fired.
- PII of all employees was exposed.
- Sony suffered massive damage to its reputation.
- Sony had to pay massive fines for violating federal regulations.

(thenextweb.com)

If Sony had a strong **network security monitoring** program, they would have discovered the attack much sooner—perhaps within hours—stopped it, and gotten a better understanding of the TTPs of the attacker.

Network Security Monitoring

Network security monitoring use a variety of data analysis tools to detect and stop threats after most front-end layers are compromised.



(Source)

NSM Strengths

NSM allows organizations to:

- Track adversaries through a network and determine intent.
- Acquire intelligence and situational awareness.
- Be proactive by identifying vulnerabilities.
- Be reactive through incident response and network forensics.
- Provide insights about advanced persistent threats.
- Uncover and track malware.

NSM Weaknesses

NSM has its limitations:

- Cannot read encrypted traffic.
- Powerful hardware and CPU requirements mean higher costs.
- Difficulty reading radio transmissions, meaning attackers can use mobile radio communications to obfuscate attacks.
- NSM is an invasive process that monitors and records all network data.
- Placement of an NSM can be limited at certain areas of the network.

NSM Stages and Processes

NSM operates in two stages, each involving two processes:

01 **Detection**

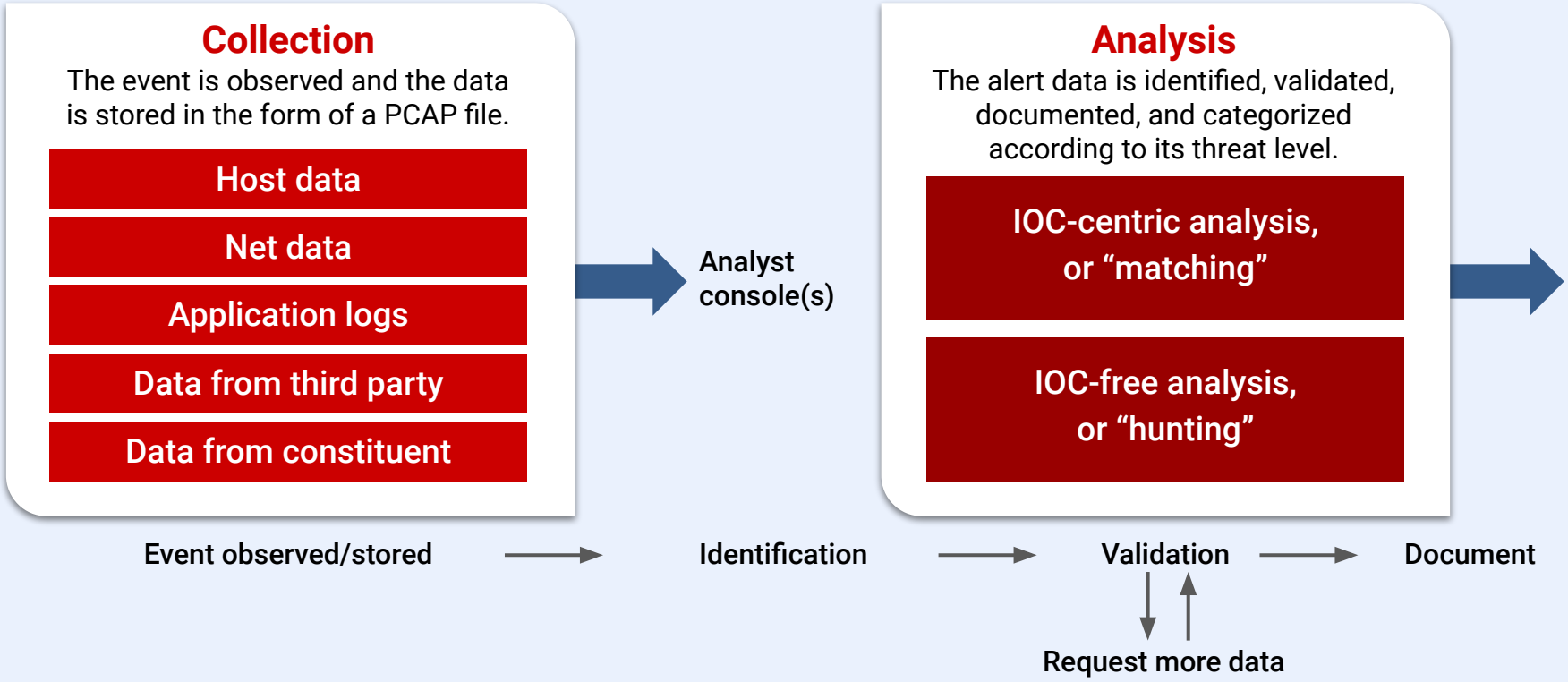
An alert is generated in the Sguil analyst console.

02 **Response**

A security team responds to a security incident.

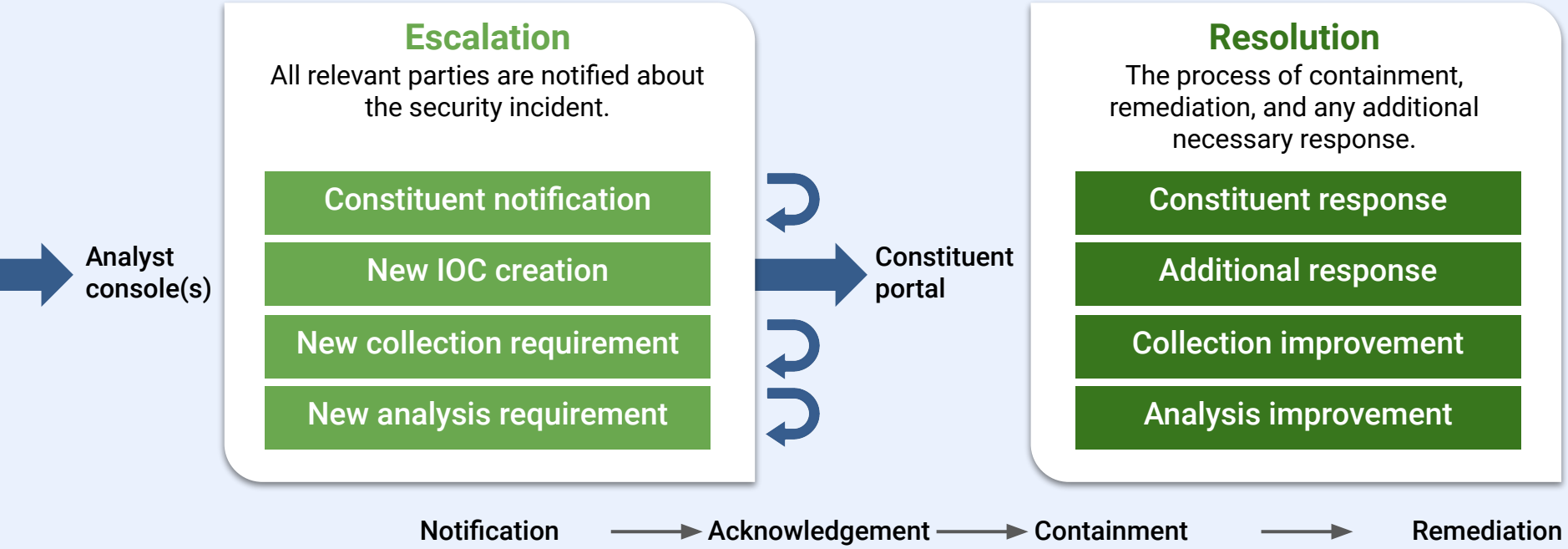
NSM Stages and Processes

Detection An alert is generated in the Sguil analyst console.



NSM Stages and Processes

Response A security team responds to a security incident.



Intrusion detection systems are generally placed at strategic points in a network where traffic is most vulnerable.

These devices are typically placed next to a router or switch that filters traffic.

NSM Sensor Connectivity

IDS can be physically connected to a network in two ways:

01 SPAN or Mirrored Port

A SPAN port is a function of an enterprise-level switch that allows you to mirror one or more physical switch ports to another port.

A mirror image of all data will flow across both ports equally.

02 Network TAP

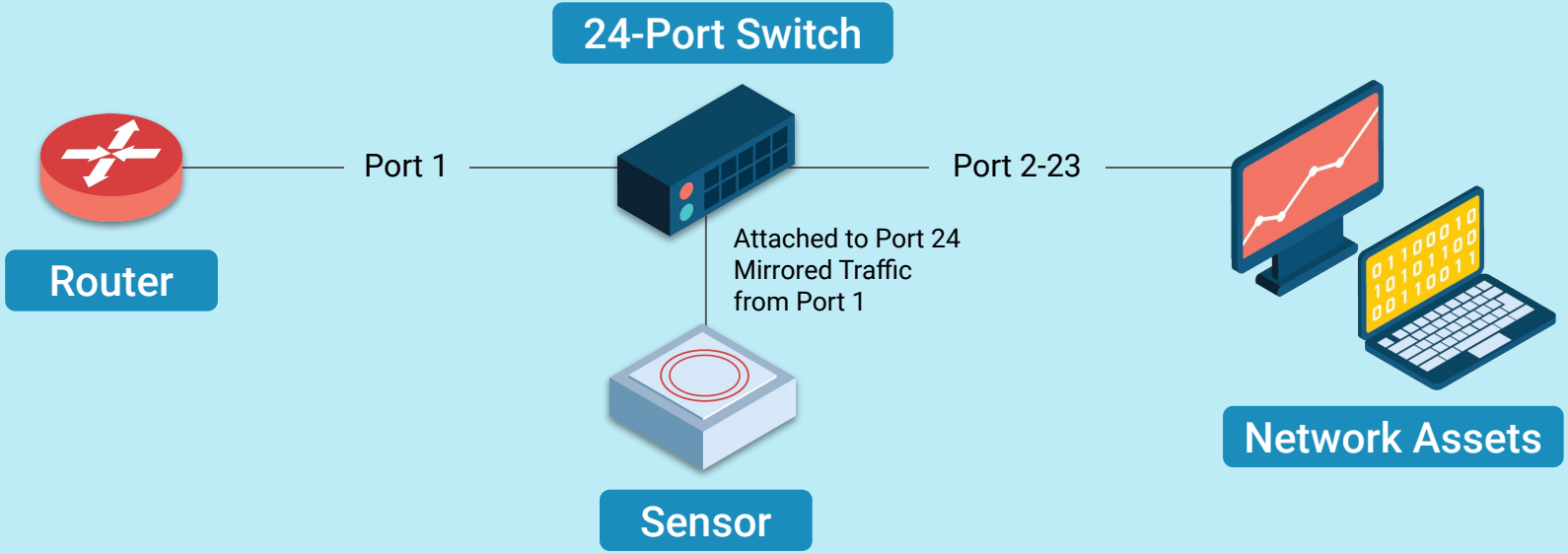
The most common type of TAP is an aggregated TAP, in which a cable connects the TAP monitor port with the NIC on the sensor. This specific placement allows traffic to be monitored between the router and switch.

NSM Sensor Connectivity

01

SPAN or Mirrored Port

A SPAN port is a function of an enterprise-level switch allowing you to mirror one or more physical switch ports to another port. A mirror image of all data flows across both ports equally. This allows the IDS to perform packet captures on all inbound and outbound traffic within a network.



NSM Sensor Connectivity

02

Network Tap

The most common type of TAP
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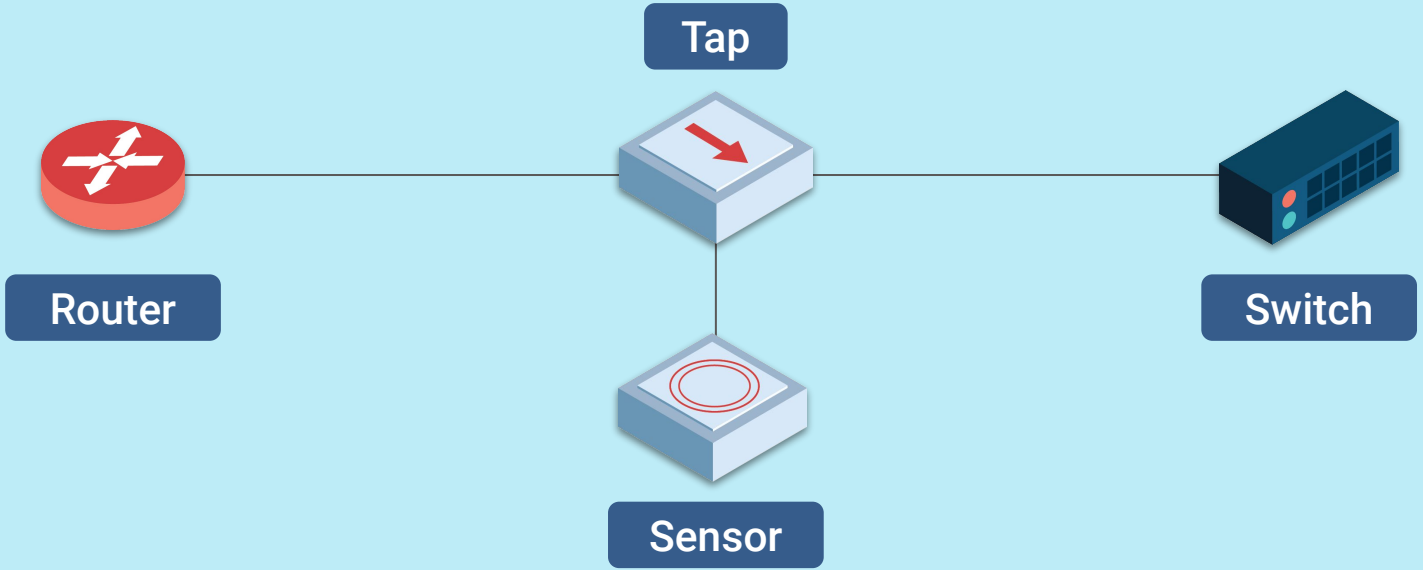
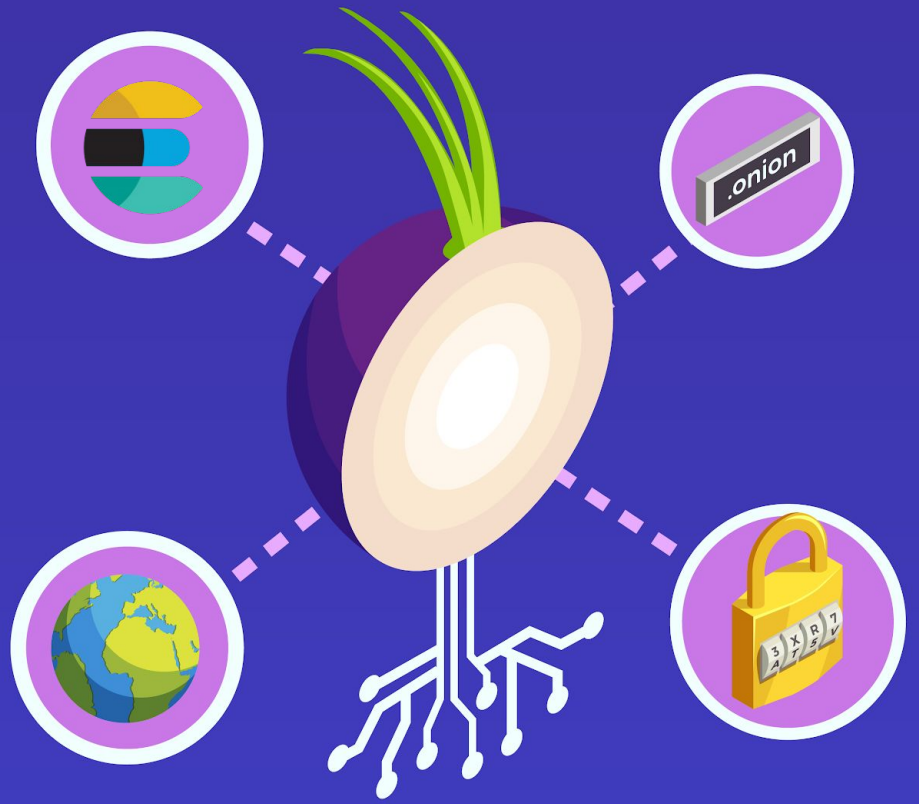


Security Onion

Today we'll work with Security Onion, a network security monitoring platform that provides context, intelligence, and situational awareness of a network.

Security Onion is an Ubuntu-based, open source Linux distribution that contains many NSM tools used to protect networks from attacks.



Security Onion and NSM

We'll also use a few NSM tools for incident detection and response:

01

Sguil

Pulls alert data from Snort, allowing us to more thoroughly analyze alerts.

02

Transcript

Provides a view of PCAP transcripts that are rendered with TCP flow.

03

NetworkMiner

Performs advanced network traffic analysis through extraction of artifacts contained in PCAP files.

Sguil

Sguil has six key functions that help with analysis:

01 Performs simple aggregation of alert data records.

02 Makes available certain types of metadata.

03 Allows queries and review of alert data.

04 Allows queries and review of session data.

05 Allows easy transitions between alert or session data and full content data.

06 Counts and classifies events, enabling escalation and other incident response decisions.

Sguil

Sguil has four main sections:

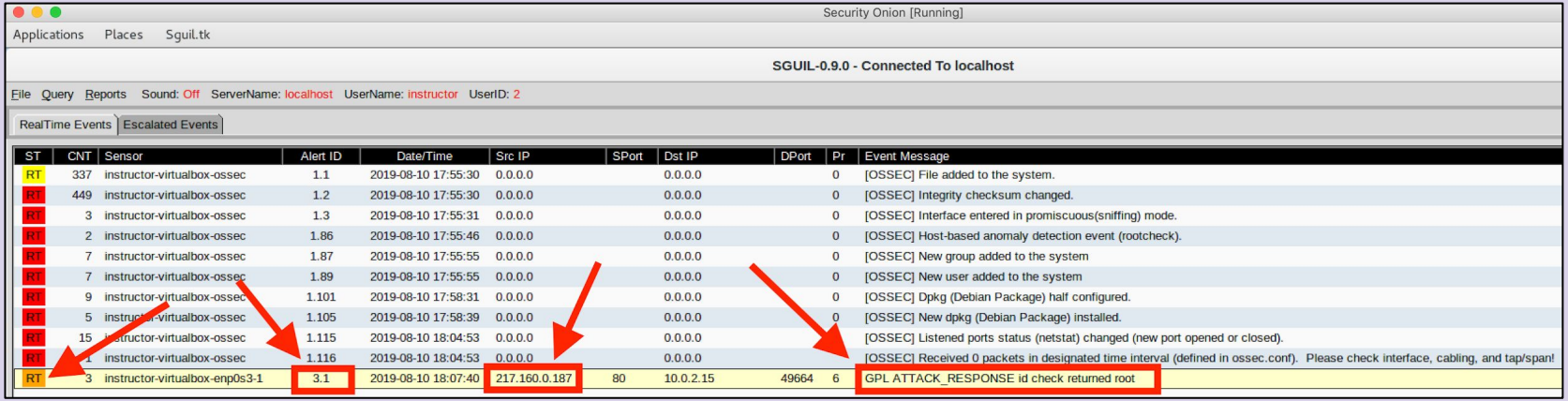
01 Alert Panel

02 Snort Rule

03 Packet Data

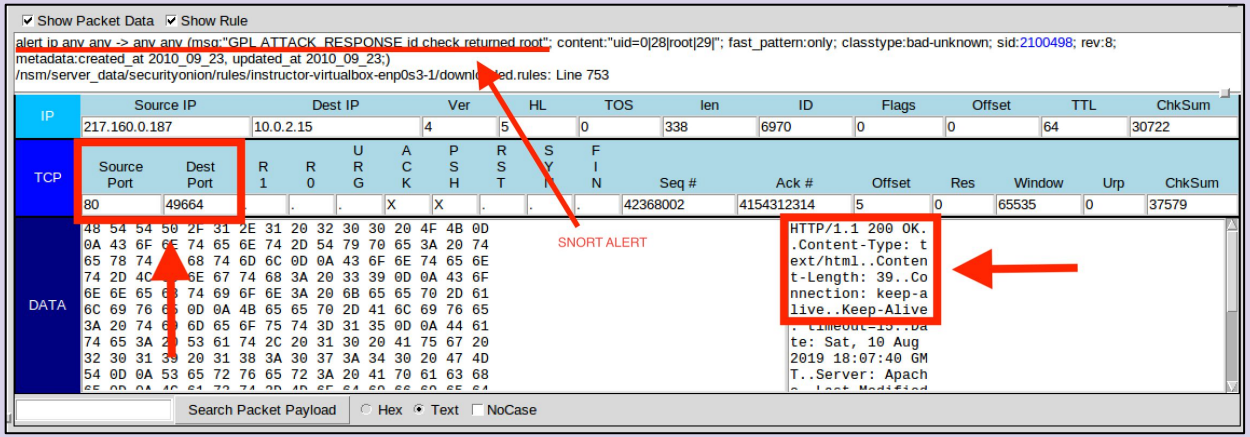
04 IP Resolution

Sguil Alert Panel



ST or Status	Colors indicate severity levels of real-time"or "RT" events. Red Critical, possible data breach in progress. Must be resolved immediately. Orange Moderate, high potential for data breach. Requires immediate review. Yellow General, low potential for data breach. Requires review.
Alert ID	A randomly generated numerical ID created by Sguil.
Source IP	IP address of the source identified by the alert.
Event Message	The message generated by the Snort rule option.

Sguil Snort Rule and Packet Data

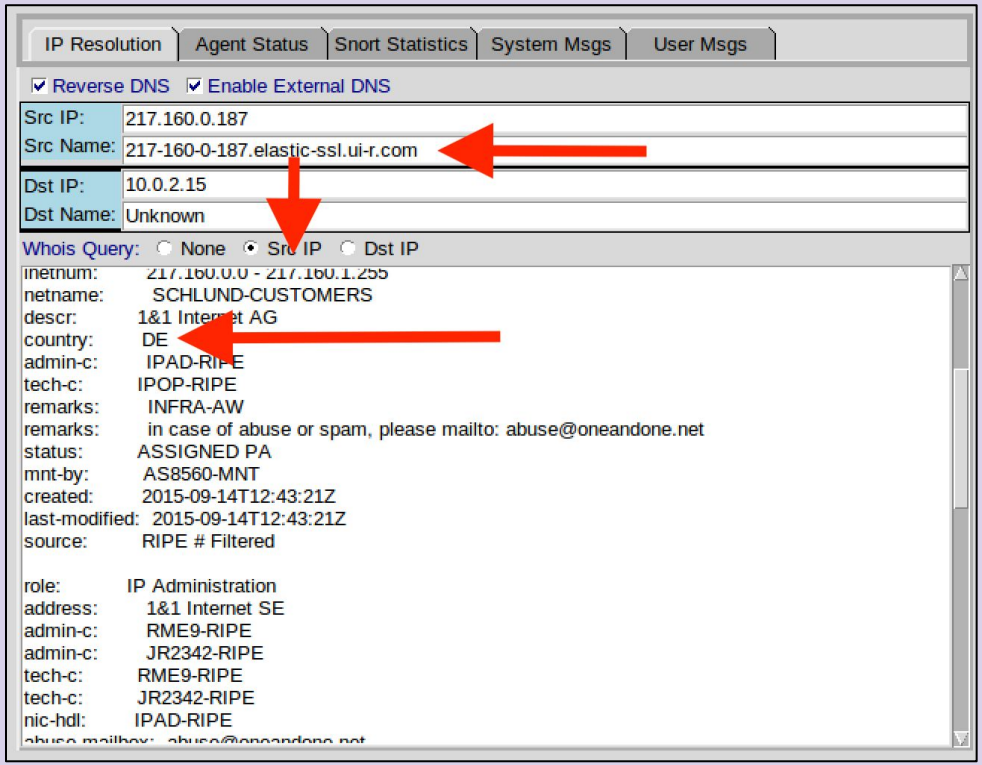


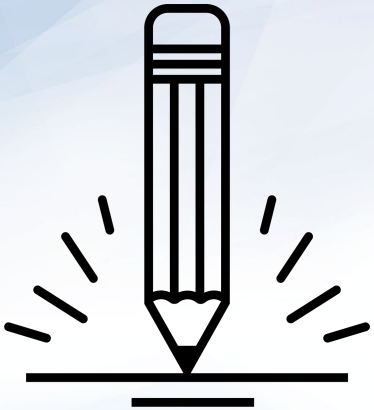
Snort Rule	Packet Data
In the top portion of this window is the Snort NIDS engine that generated alert data when traffic matched one of its rules. • Alert data is an indicator of attack. An analyst may have to determine if it represents benign or malicious activity. • Alert data from the Snort NIDS stores entries in the Event Messages column that begin with text like “ET” (for Emerging Threats, an IDS rule source).	The lower, more colorful part of this window is the portion of Sguil that performs network packet analysis. • The packet analyzer presents a detailed view of the data capture that includes packet header information and data streams presented in hex and text form.

Sguil's IP Resolution

This section of Sguil's analyst console provides reverse DNS lookup information.

- This information is used to reveal identifying information about the attacker, including domain name registries and IP addresses.
- Other information may include country of origin, and possibly the names, email addresses, and/or phone numbers of the DNS registrants.





Activity: Security Onion and NSM

In this activity, you will reinforce your knowledge of Security Onion and network security monitoring.

Suggested Time:
20 Minutes

Time’s Up! Let’s Review.

Countdown timer

15:00

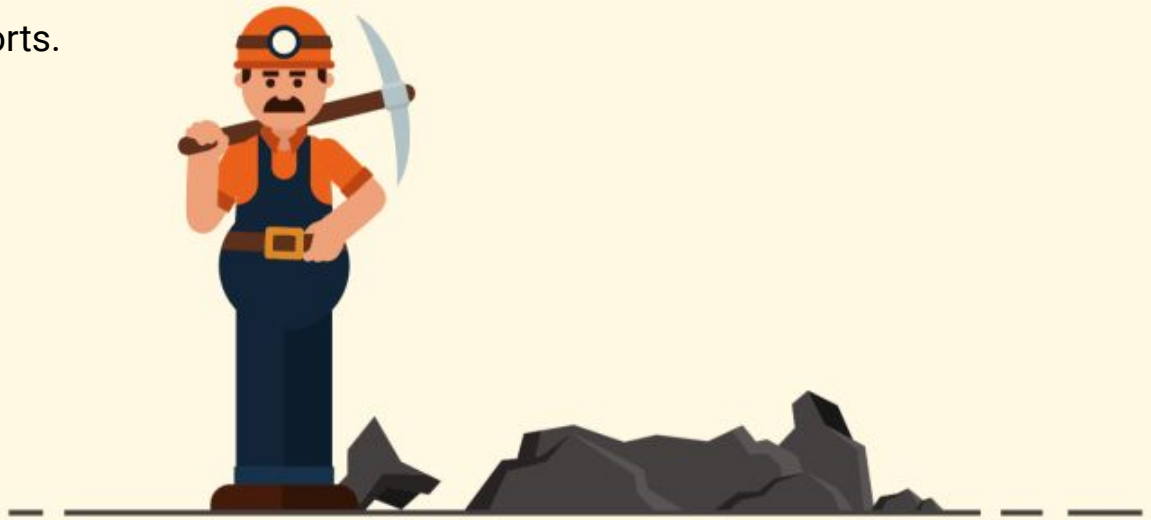
(with alarm)

Alert:
FTP File Extraction

Security Onion Demo Setup

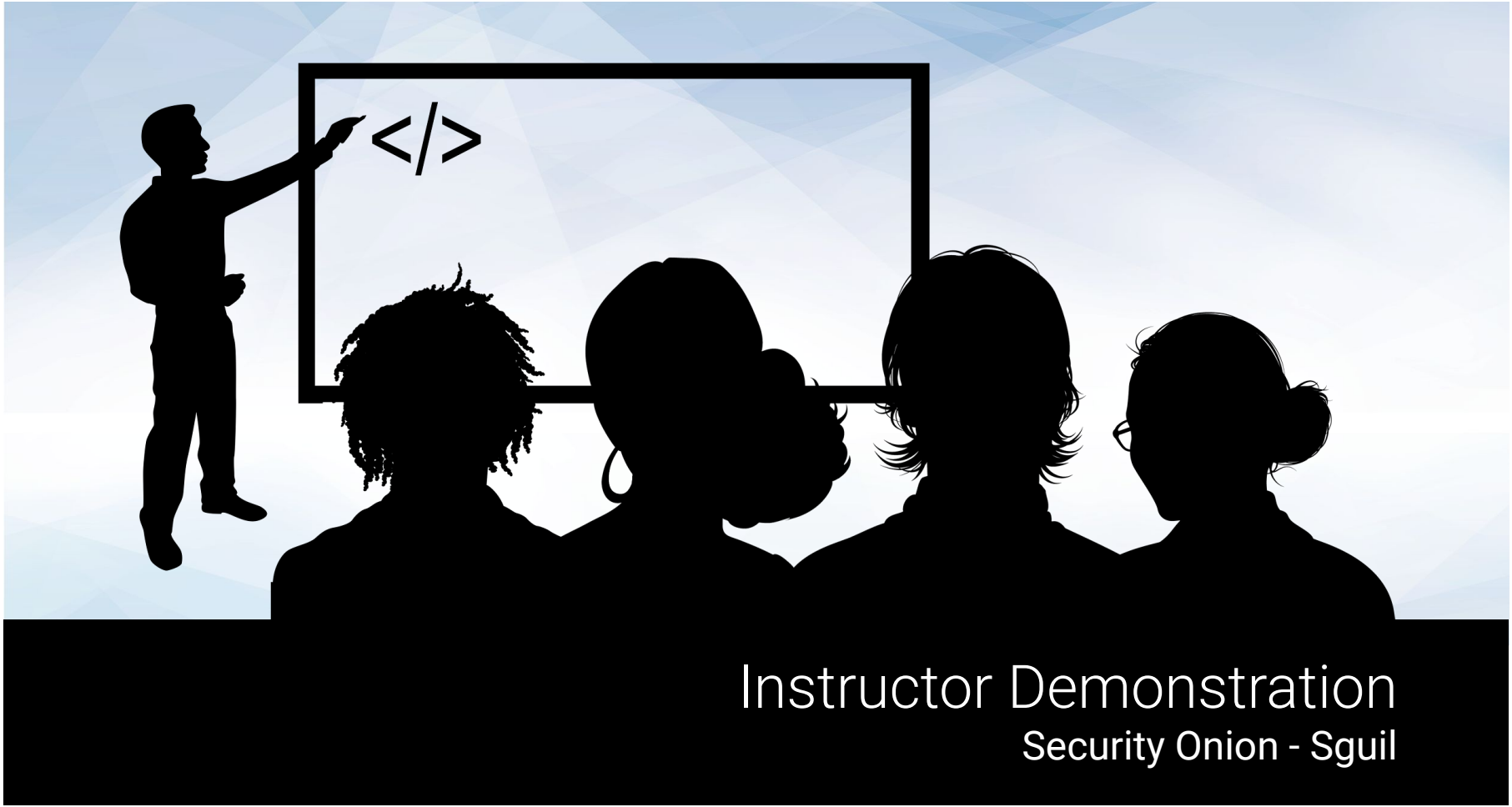
Sometimes, an alert requires an analyst to do some data mining.

- A security analyst must have a thorough understanding of how NSM tools are integrated.
- These skills help speed up incident and response efforts.



(Source)

In the next guided tour, we'll use Sguil as the starting point for learning other NSM tools for security investigations.



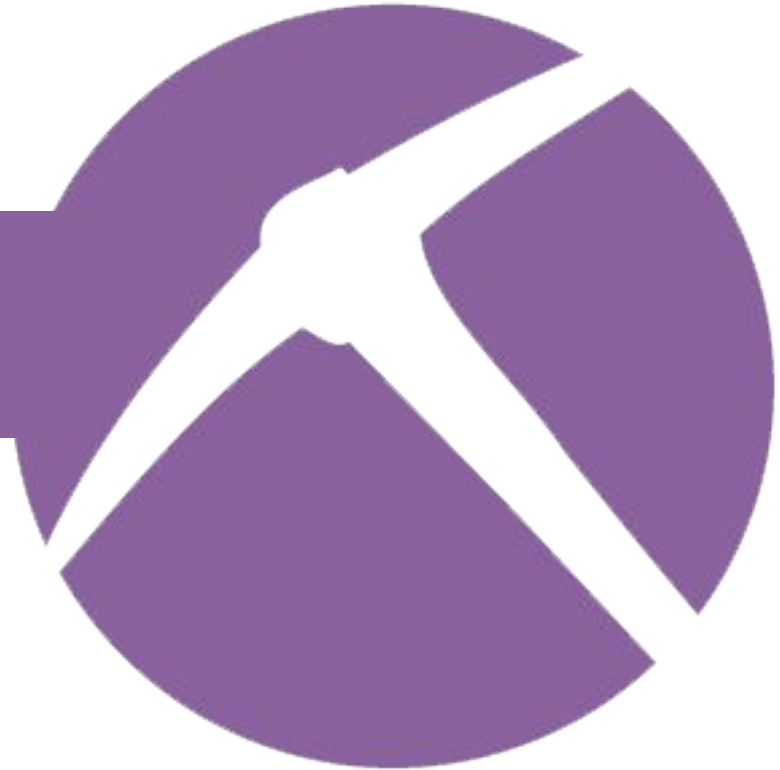
Instructor Demonstration

Security Onion - Sguil

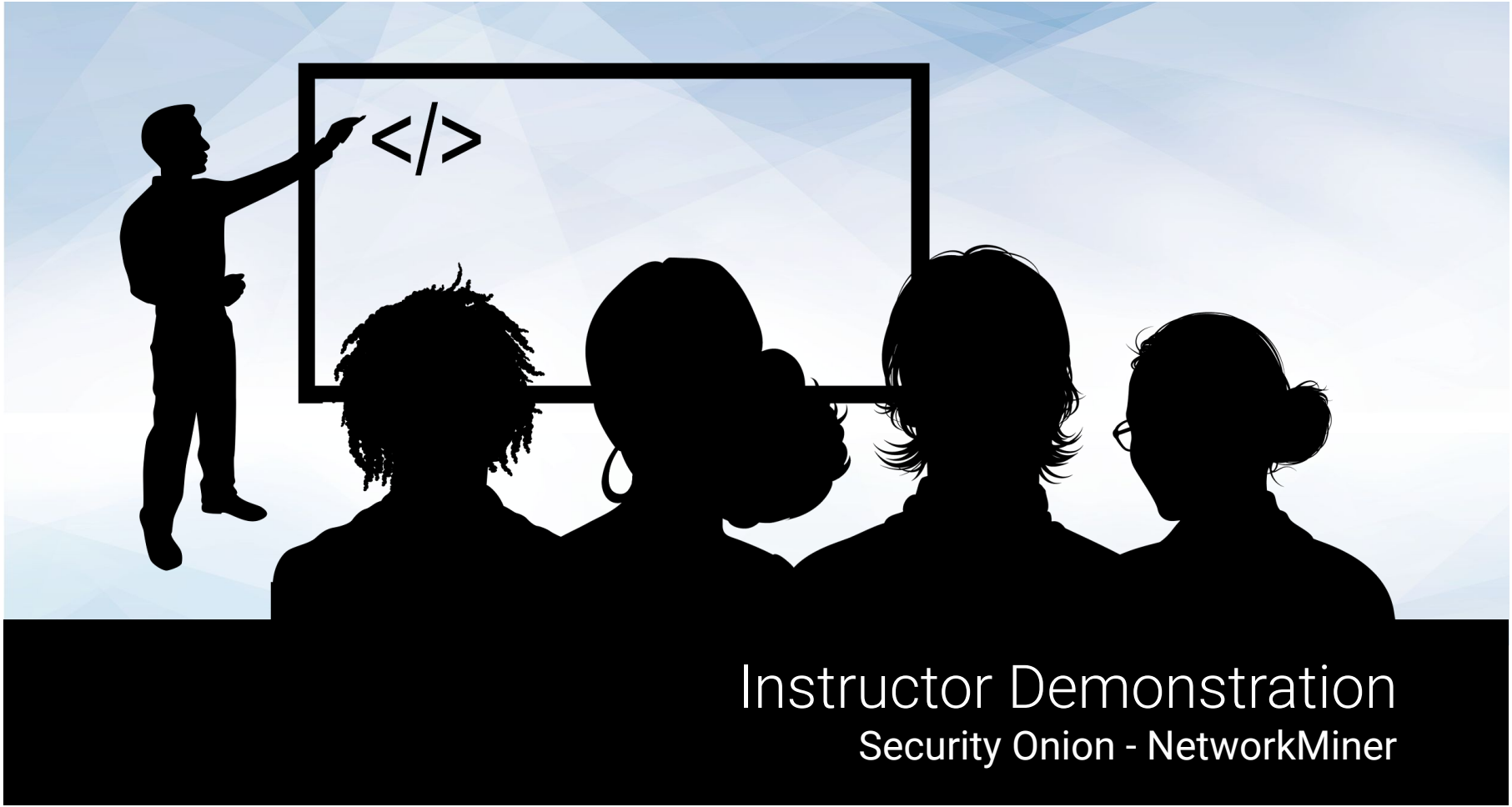
Security Onion and NetworkMiner Demo

Now that we now know there was a drive-by attack, we must search for any files that were downloaded to the host.

We'll use a forensics tool called **NetworkMiner** to extract any files that were installed on the user's machine, and put together an attacker profile.

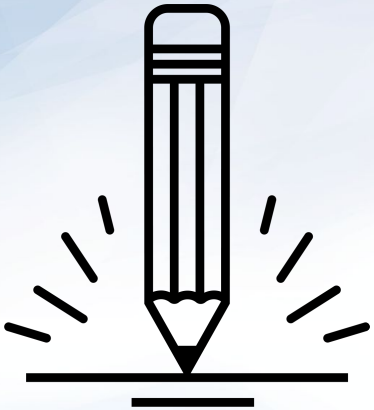


- Network Miner is an NSM tool that performs advanced Network Traffic Analysis (NTA) of extracted artifacts, presented through an intuitive interface.



Instructor Demonstration

Security Onion - NetworkMiner



Activity: Alert - FTP File Extraction

In this activity, you will examine an alert to determine if any systems were breached and if any data was supplanted or exfiltrated from the network.

Suggested Time:
20 Minutes

Time’s Up! Let’s Review.

Questions?


The End