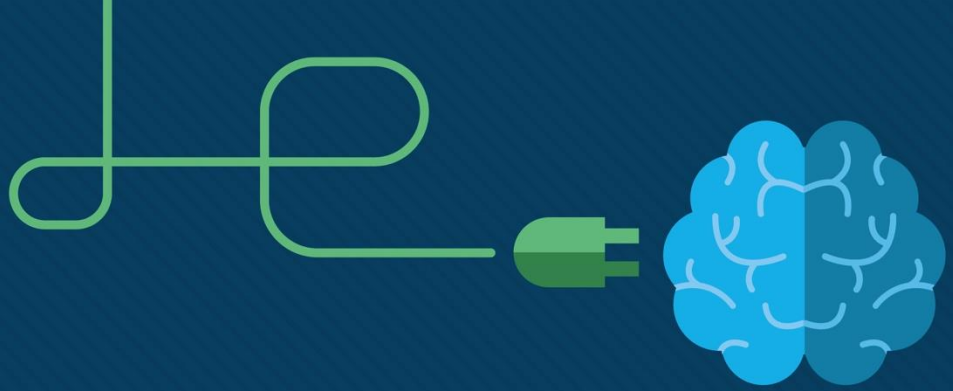


# Module 25: Network Security Data

CyberOps Associate v1.0

# Module Objectives

**Module Title**: Network Security Data

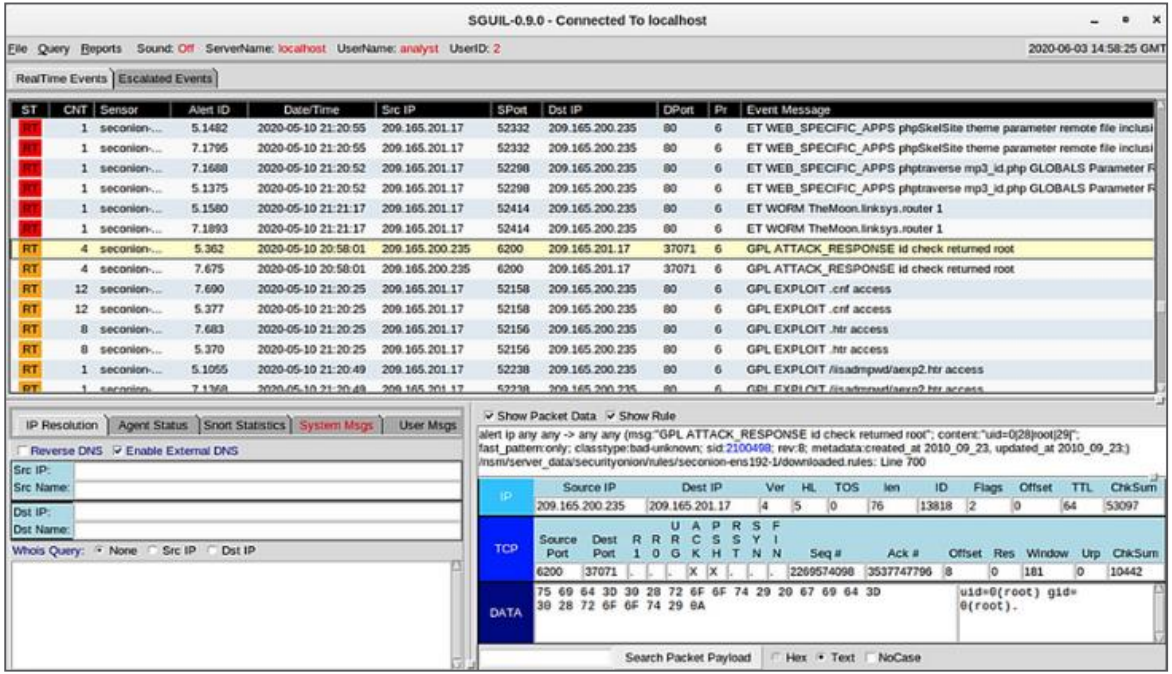
**Module Objective**: Explain the types of network security data used in security monitoring.

| Topic Title | Topic Objective |
|---|---|
| **Types of Security Data** | Describe the types of data used in security monitoring. |
| **End Device Logs** | Describe the elements of an end device log file. |
| **Network Logs** | Describe the elements of a network device log file. |

# 25.1 Types of Security Data

# Alert Data

- Alert data consists of messages generated by intrusion prevention systems (IPSs) or intrusion detection systems (IDSs) in response to traffic that violates a rule or matches the signature of a known exploit.
- A network IDS (NIDS), such as Snort, comes configured with rules for known exploits.
- Alerts are generated by Snort and are made readable and searchable by the Sguil and Squert applications, which are part of the Security Onion suite of NSM tools.




**Sguil Console Showing Test Alert from Snort IDS**

# Session and Transaction Data

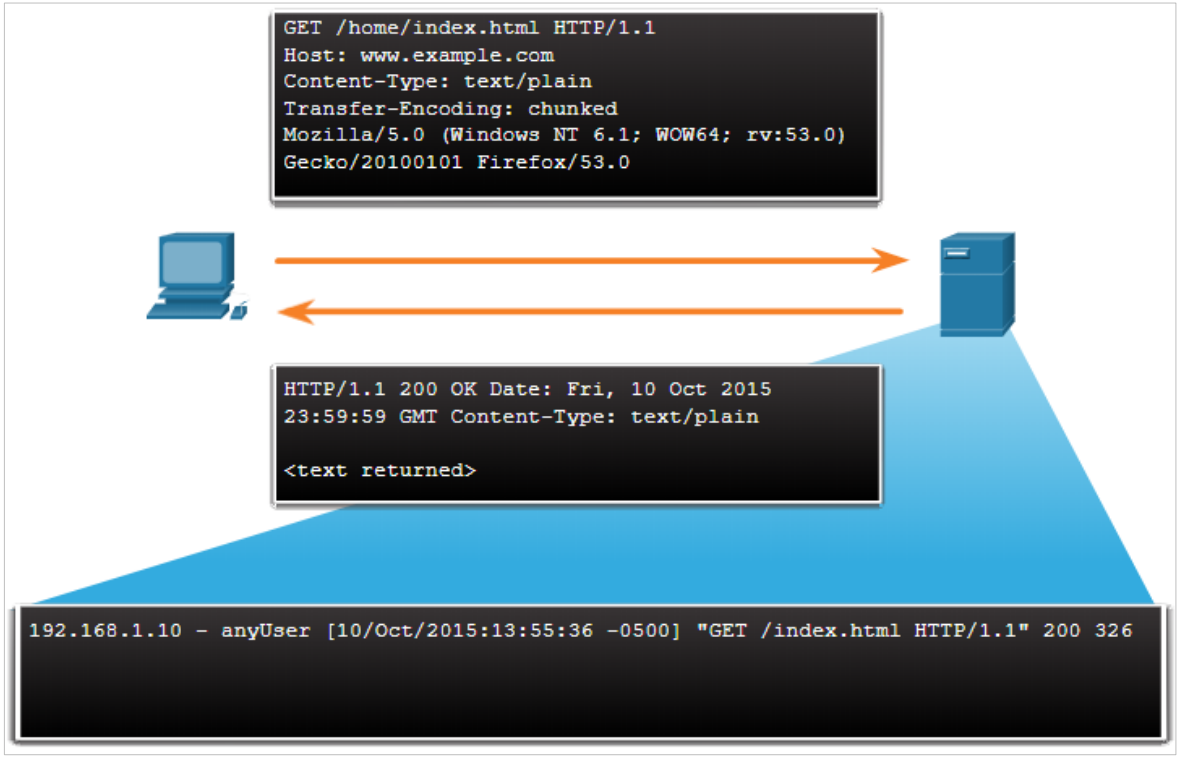
- Session data is a record of a conversation between two network endpoints.
- It includes **the five tuples** of source and destination IP addresses, source and destination port numbers, and the IP code for the protocol in use.
- Data about the session includes a session ID, the amount of data transferred by source and destination and information related to the duration of the session.
- The figure shows a partial output for three HTTP sessions from a Zeek connection log.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ts | uid | id.orig_h | id.orig_p | id.resp_h | id.resp_p | proto | service | duration | orig_bytes | resp_bytes | orig_pkts | resp_pkts |
| 1320279567 | CEv1Z54N5gT3PwJLog | 192.168.2.76 | 52034 | 174.129.249.33 | 80 | tcp | http | 0.082899 | 389 | 1495 | 5 | 4 |
| 1320279567 | CI6Ueb3SkSJHwASNN4 | 192.168.2.76 | 52035 | 184.72.234.3 | 80 | tcp | http | 2.56194 | 905 | 731 | 9 | 8 |
| 1320279567 | CaTMSv1Sb8HtFunqjj | 192.168.2.76 | 52033 | 184.72.234.3 | 80 | tcp | http | 3.345539 | 1856 | 1445 | 15 | 13 |

1. **ts**: session start timestamp
2. **uid**: unique session ID
3. **id.orig_h**: IP address of host that originated the session (source address)
4. **id.orig_p**: protocol port for the originating host (source port)
5. **id.resp_h**: IP address of host responding to the originating host (destination address)
6. **id.resp_p**: protocol of responding host (destination port)
7. **proto**: transport layer protocol for session
8. **service**: application layer protocol
9. **duration**: duration of the session
10. **orig_bytes**: bytes from originating host
11. **resp_bytes**: bytes from responding host
12. **orig_packets**: packets from the originating host
13. **resp_packets**: packets from responding host

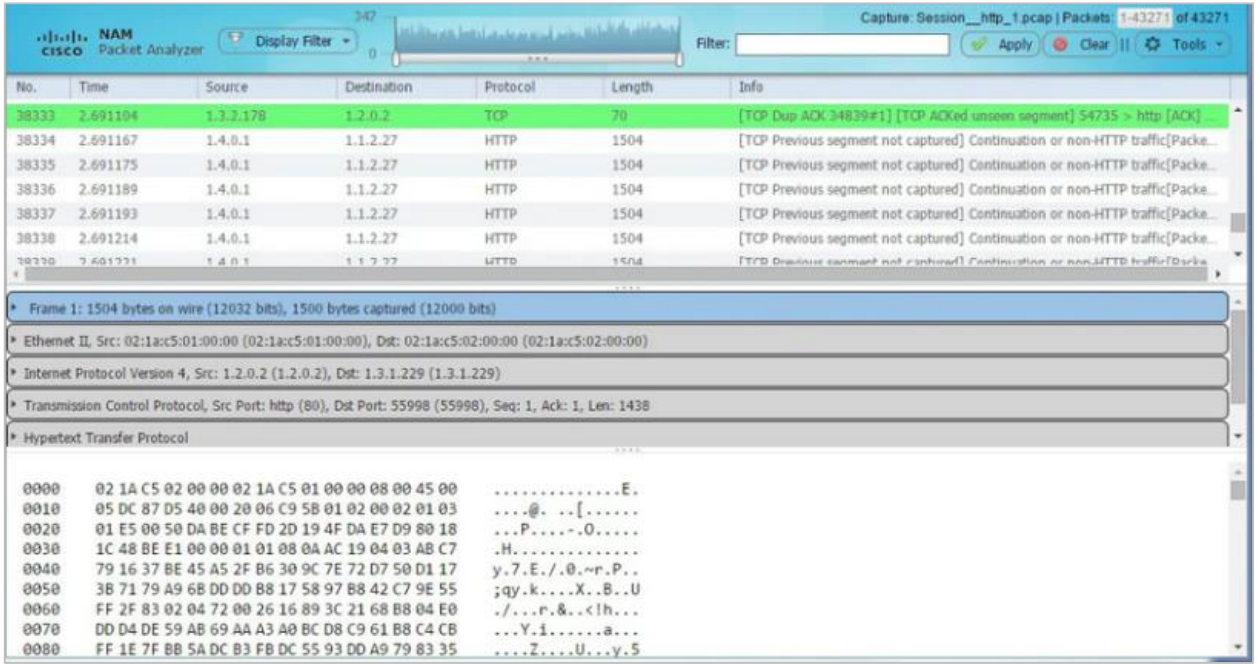
# Session and Transaction Data (Contd.)

- Transaction data consists of the messages that are exchanged during network sessions.
- These transactions can be viewed in packet capture transcripts.
- The transactions that represent the requests and replies would be logged in an access log on a server or by a NIDS like Zeek.
- A session might include the downloading of content from a webserver, as shown in the figure.



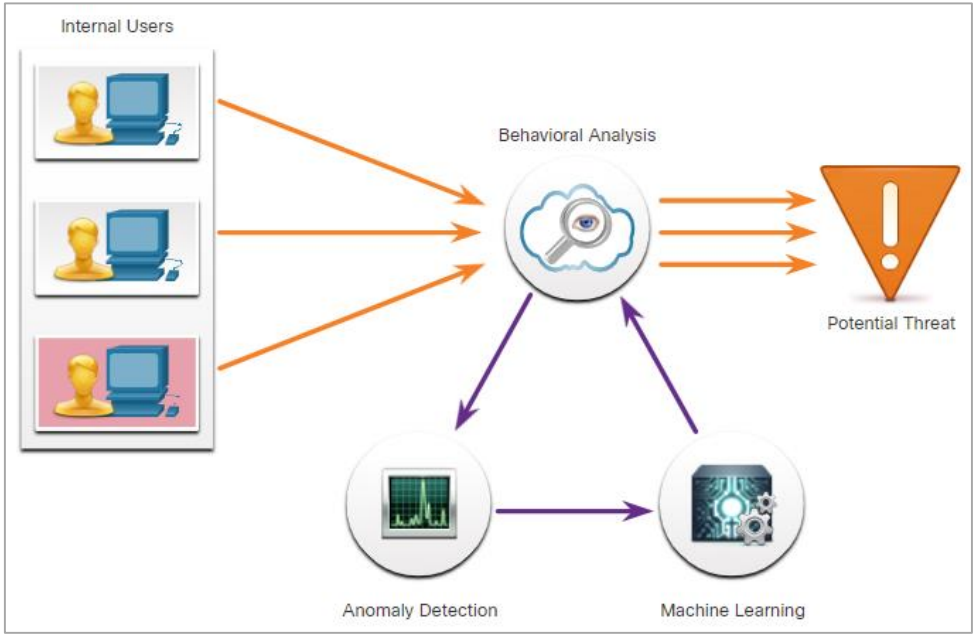
# Full Packet Captures

- Full packet captures are the most detailed network data that is generally collected.
- It contains the actual content of the conversations such as text of email messages, the HTML in web pages, and the files that enter or leave the network.
- Extracted content can be recovered from full packet captures and analyzed for malware or user behavior that violates business and security policies.
- The figure here shows the interface for the Network Analysis Monitor component of Cisco Prime Infrastructure system, which can display full packet captures.



# Statistical Data

- Statistical data is about network traffic which is created through the analysis of other forms of network data.
- Statistics can be used to characterize normal amounts of variation in network traffic patterns in order to identify network conditions that are significantly outside of those ranges.
- An example of an NSM tool that utilizes statistical analysis is Cisco Cognitive Threat Analytics.
- It is able to find malicious activity that has bypassed security controls or entered the network through unmonitored channels (including removable media) and is operating inside an organization's environment.
- The figure shows an architecture for Cisco Cognitive Threat Analytics.



# 25.2 End Device Logs

# Host Logs

- Host-based intrusion detection systems (HIDS) run on individual hosts.
- Many host-based protections submit logs to a centralized log management servers which can be searched from a central location using NSM tools.
- Microsoft Windows host logs are visible locally through Event Viewer. Event Viewer keeps four types of logs:
  - **Application logs** – These contain events logged by various applications.
  - **System logs** – These include events regarding the operation of drivers, processes, and hardware.
  - **Setup logs** – These record information about the installation of software, including Windows updates.
  - **Security logs** – These record events related to security, such as logon attempts and operations related to file or object management and access.
  - **Command-line logs** – Attackers who have gained access to a system, and some types of malware, execute commands from the command-line interface (CLI) rather than a GUI. Logging command line execution will provide visibility into this type of incident.

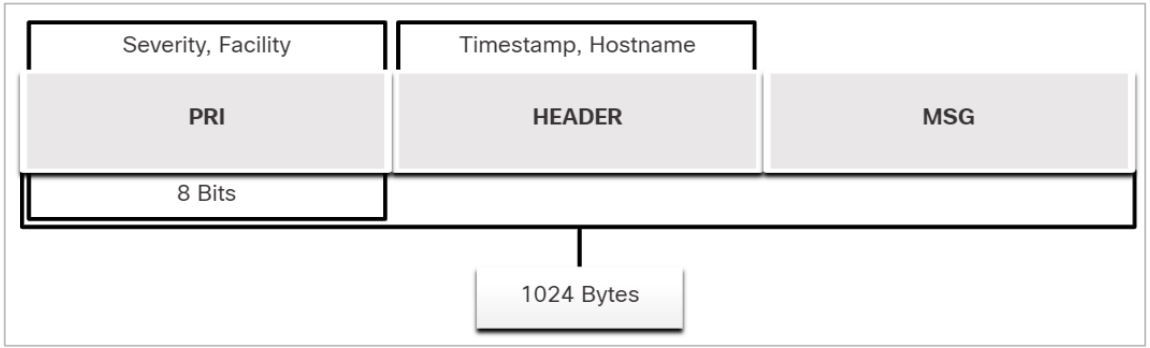
# Host Logs (Contd.)

The table explains the meaning of the five Windows host log event types.

| Event Type | Description |
|---|---|
| Error | It is an event that indicates a significant problem such as loss of data or functionality. For example, if a service fails to load during startup, an error event is logged. |
| Warning | It is an event that is not necessarily significant but may indicate a possible future problem. For example, when disk space is low, a warning event is logged. If an application recovers from an event without loss of functionality or data, it can classify the event as a warning event. |
| Information | It describes the successful operation of an application, driver, or service. For example, when a network driver loads successfully, it may be appropriate to log an information event. Note that it is generally inappropriate for a desktop application to log an event each time it starts. |
| Success Audit | It is an event that records an audited security access attempt that is successful. For example, a user's successful attempt to log on to the system is a success audit event. |
| Failure Audit | It is an event that records an audited security access attempt that fails. For example, if a user tries to access a network drive and fails, the attempt is logged as a failure audit event. |

# Syslog

- Syslog incudes specifications for message formats, a client-server application structure, and network protocol. It is a client/server protocol.
- Many different types of network devices can be configured to use the syslog standard to log events to centralized syslog servers.
- The full format of a Syslog message has three distinct parts: PRI (priority), HEADER, MSG (message text).
  - The PRI consists of two elements, the Facility and Severity of the message, which are both integer values.
  - The Facility consists of sources that generated the message, such as the system, process, or application.
  - The Severity is a value from 0-7 that defines the severity of the message.



# Syslog (Contd.)

**Facility**

- Facility codes between 15 and 23 (local0-local7) are not assigned a keyword or name.
- They can be assigned to different meanings depending on the use context. Also, various operating systems have been found to utilize both facilities 9 and 15 for clock messages.

**Severity**

| Value | Severity |
|---|---|
| 0 | **Emergency**: system is unusable |
| 1 | **Alert**: action must be taken immediately |
| 2 | **Critical**: critical conditions that should be corrected immediately and indicates failure in a system |
| 3 | **Error**: a failure that is not urgent, should be resolved within a given time |
| 4 | **Warning**: an error does not presently exist; but, an error will occur in the future if the condition is not addressed |
| 5 | **Notice**: an event that is not an error, but that is considered unusual. Does not require immediate action. |
| 6 | **Informational**: messages issued regarding normal operation |
| 7 | **Debug**: messages of interest to developers |

# Syslog (Contd.)

**Priority**

- The Priority (PRI) value is calculated by multiplying the Facility value by 8, and then adding it to the Severity value, as shown below

**Priority = (Facility * 8) + Severity**

- The Priority value is the first value in a packet and occurs between angled brackets <>.

# Server Logs

- Server logs are an essential source of data for network security monitoring.
- DNS proxy server logs which document all the DNS queries and responses that occur on the network are especially important.
- Two important log files are Apache webserver access logs and Microsoft Internet Information Server (IIS) access logs.

### Apache Access Log

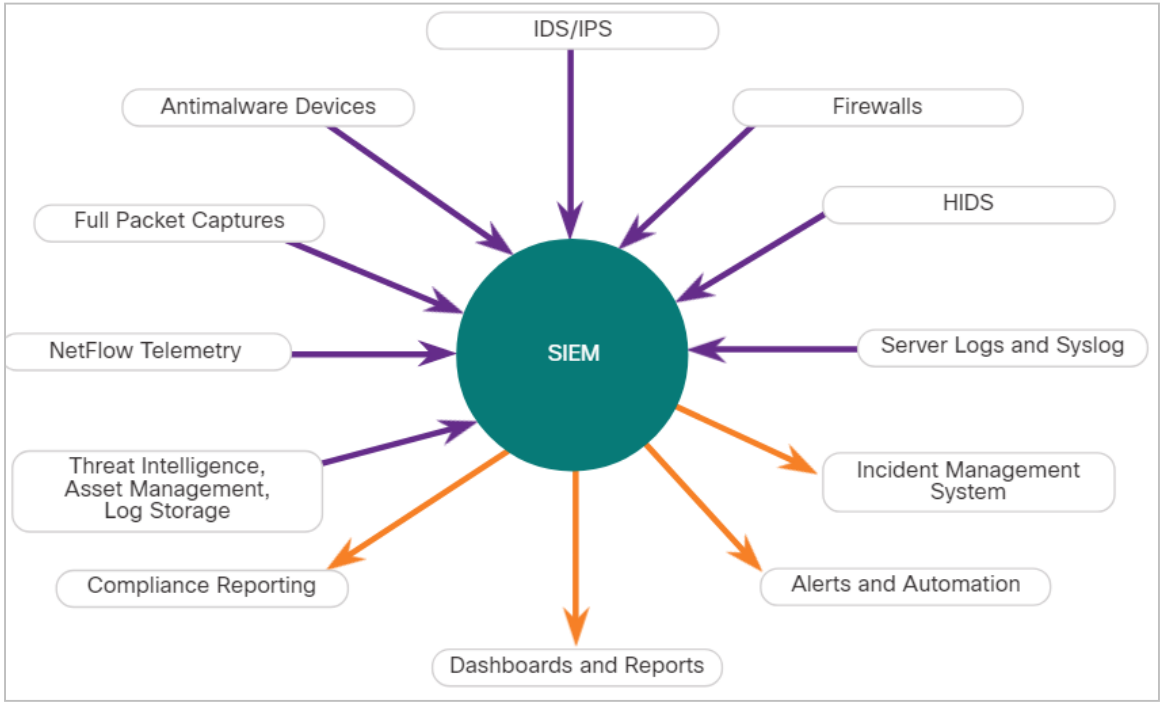
```
203.0.113.127 – dsmith [10/Oct/2016:10:26:57 - 0500] "GET /logo_sm.gif HTTP/1.0“ 200 2254
""http://www.example.com/links.html"" "Mozilla/5.0 (Windows NT 6.1; Win64; x64; rv:47.0) Gecko/20100101
Firefox/47.0"
```

### IIS Access Log

```
6/14/2016, 16:22:43, 203.0.113.24, -, W3SVC2, WEB3, 198.51.100.10, 80, GET, /home.htm, -, 200, 0, 15321,
159, 15, HTTP/1.1, Mozilla/5.0 (compatible; MSIE 9.0; Windows Phone OS 7.5; Trident/5.0; IEMobile/9.0),
-, http://www.example.com
```

# SIEM and Log Collection

Security Information and Event Management (SIEM) technology is used in many organizations to provide real-time reporting and long-term analysis of security events, as shown in the figure.




**SIEM Inputs and Outputs**

# SIEM and Log Collection (Contd.)

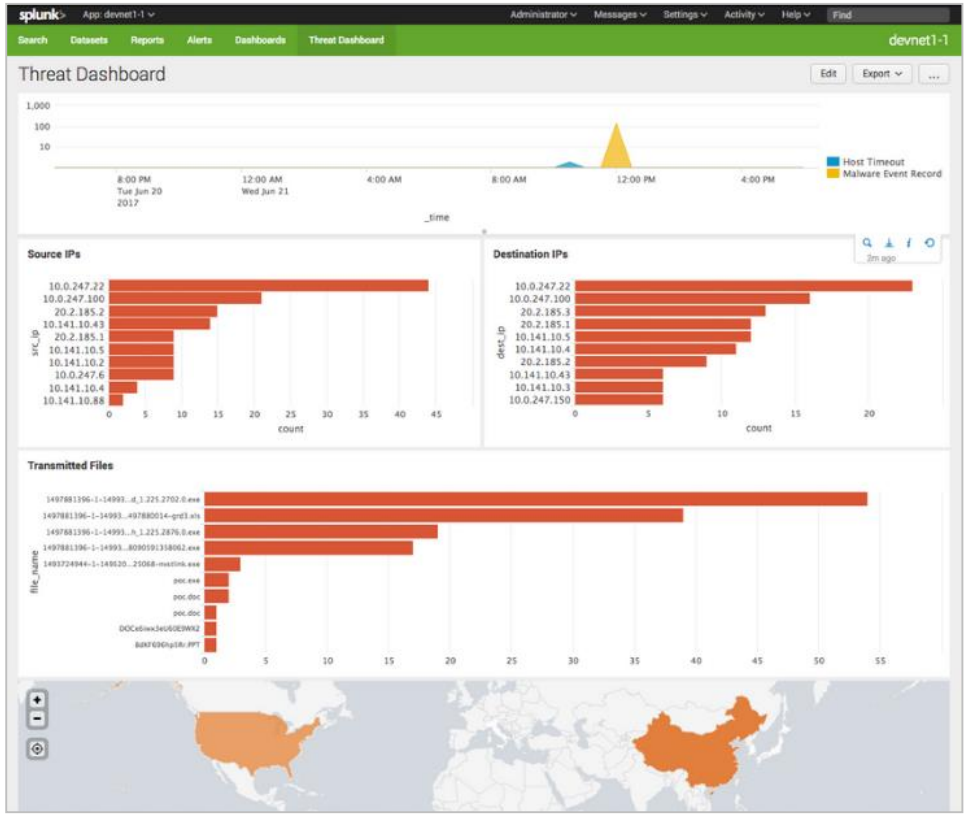
SIEM combines the essential functions of SEM and SIM tools to provide a view of the enterprise network using the following functions:

- **Log collection** – Event records from sources throughout the organization provide important forensic information and help to address compliance reporting requirements.
- **Normalization** – This maps log messages from different systems into a common data model, enabling the organization to connect and analyze related events, even if they are initially logged in different source formats.
- **Correlation** – This links logs and events from disparate systems or applications, speeding detection of and reaction to security threats.
- **Aggregation** – This reduces the volume of event data by consolidating duplicate event records.
- **Reporting** – This presents the correlated, aggregated event data in real-time monitoring and long-term summaries, including graphical interactive dashboards.
- **Compliance** – This is reporting to satisfy the requirements of various compliance regulations.

# SIEM and Log Collection (Contd.)

- A popular SIEM is Splunk, which is made by a Cisco partner.
- The figure shows a Splunk Threat Dashboard. Splunk is widely used in SOCs.
- Because of the lack of cybersecurity professionals to monitor and analyze the large volume of security data, it is important that tools from multiple vendors can be integrated into a single platform.
- Integrated security platforms go beyond SIEM and SOAR to unify multiple security technologies into a unified team.

**Splunk Threat Dashboard**



# 25.3 Network Logs

# Tcpdump

- The tcpdump command line tool is a very popular packet analyzer.
- It can display packet captures in real time or write packet captures to a file.
- It captures detailed packet protocol and content data.
- Wireshark is a GUI built on tcpdump functionality.
- The structure of tcpdump captures varies depending on the protocol captured and the fields requested.

# NetFlow

- NetFlow is a protocol that was developed by Cisco as a tool for network troubleshooting and session-based accounting.
- NetFlow provides an important set of services for IP applications, including network traffic accounting, usage-based network billing, network planning, security, Denial-of-Service monitoring capabilities, and network monitoring.
- It also provides information about network users and applications, peak usage times, and traffic routing.
- It records information about the packet flow including metadata. Cisco developed NetFlow and then allowed it to be used as a basis for an IETF standard called IPFIX.
- NetFlow information can be viewed with tools such as the nfdump.
- nfdump provides a command line utility for viewing NetFlow data from the nfcapd capture daemon, or collector.

# NetFlow (Contd.)

- An example of a basic NetFlow flow record, in two different formats, is shown in the figure.

```
Date      flow start       Duration  Proto Src IP Addr:Port     Dst IP Addr:Port  Flags Tos Packets Bytes
Flows2017-08-30 00:09:12.596  00.010    TCP   10.1.1.2:80       -> 13.1.1.2:8974     .AP.SF  0   62
3512   1
```

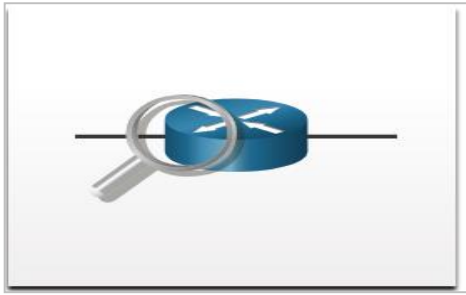
```
Traffic Contribution: 8% (3/37)Flow information:IPV4 SOURCE ADDRESS:10.1.1.2IPV4 DESTINATION
ADDRESS:13.1.1.2INTERFACE INPUT:Se0/0/1TRNS SOURCE PORT:8974TRNS DESTINATION PORT:80IP TOS:0x00IP
PROTOCOL:6FLOW SAMPLER ID:0FLOW DIRECTION:Inputipv4 source mask:/0ipv4 destination mask:/8counter
bytes:205ipv4 next hop address:13.1.1.2tcp flags:0x1binterface output:Fa0/0counter packets:5timestamp
first:00:09:12.596timestamp last:00:09:12.606ip source as:0ip destination as:0
```

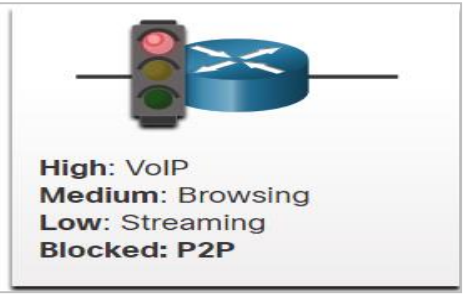
- A large number of attributes for a flow are available. The IANA registry of IPFIX entities lists several hundred, with the first 128 being the most common.
- NetFlow is a useful tool in the analysis of network security incidents. It can be used to construct a timeline of compromise, understand individual host behavior, or to track the movement of an attacker or exploit from host to host within a network.

# Application Visibility and Control

- The Cisco Application Visibility and Control (AVC) system combines multiple technologies to recognize, analyze, and control over 1000 applications.
- These include voice and video, email, file sharing, gaming, peer-to-peer (P2P), and cloud-based applications.
- AVC uses Cisco next-generation network-based application recognition version 2 (NBAR2), also known as Next-Generation NBAR, to discover and classify the applications in use on the network.
- The NBAR2 application recognition engine supports over 1000 network applications.

# Application Visibility and Control (Contd.)




**Application Recognition**
Identify applications using L3 to L7 data.
1000+ applications
- Cloud services
- Cisco WebEx
- YouTube
- Skype
- P2P

NBAR2

**Metrics Collection**
Collect metrics for export to management tool
- Bandwidth usage
- Response time
- Latency
- Packet loss
- Jitter
- P2P

Netflow9 Flexible Netflow IPFIX

**Management and Reporting**
Provision the network, collect data, and report on applications performance
- Report generation
- Policy Management

Cisco Prime Other 3rd Party Software

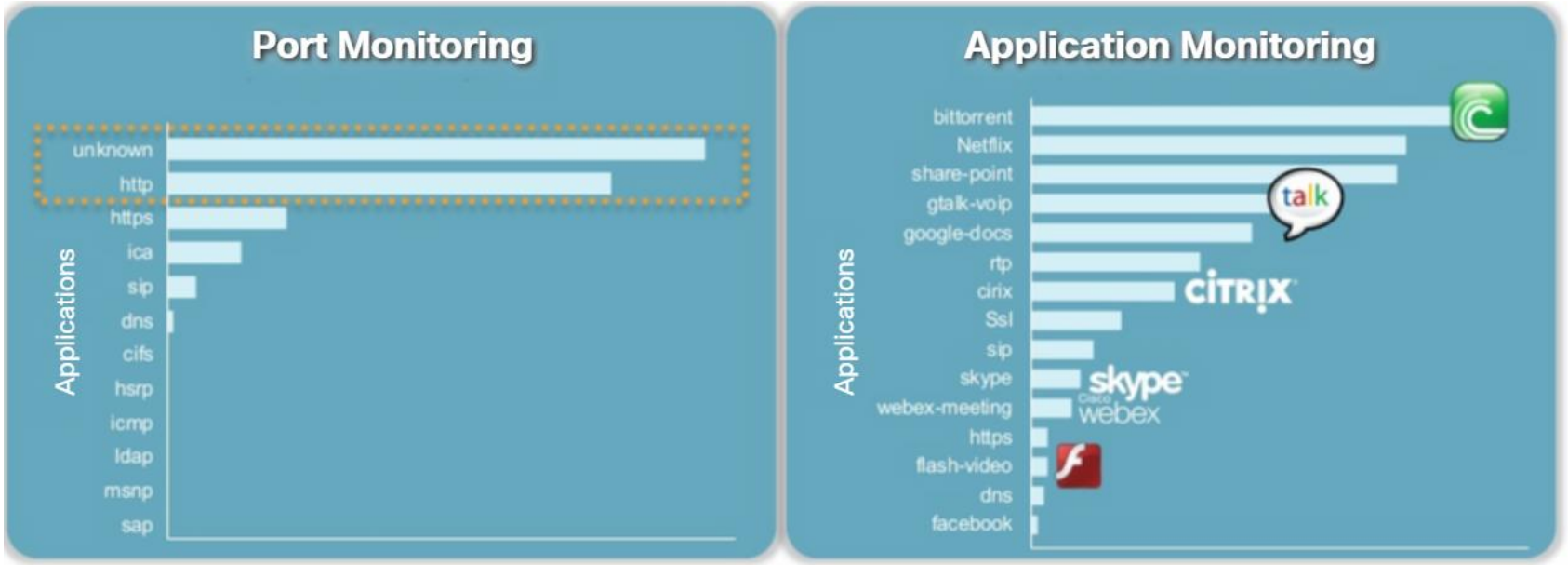
**Control**
Control application use to maximize network performance
- Application prioritizarion
- Application bandwidth enforcement

QoS

# Application Visibility and Control (Contd.)

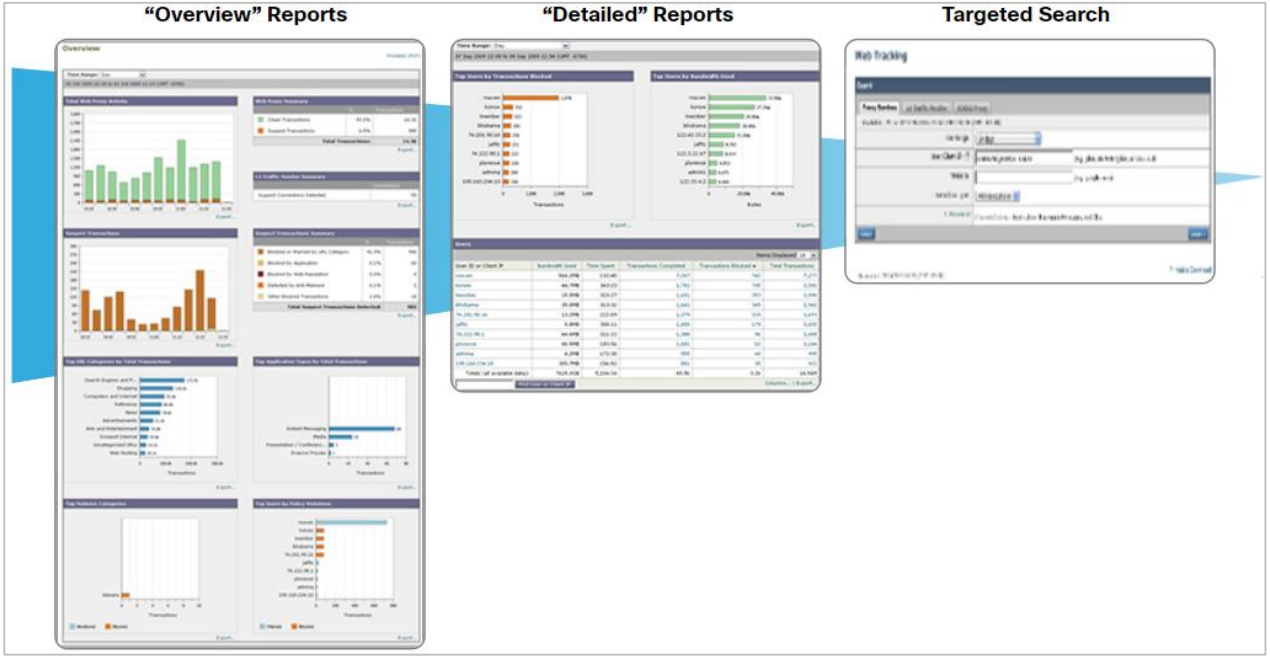
## Port Monitoring vs. Application Monitoring

A management and reporting system analyzes and presents the application analysis data into dashboard reports for use by network monitoring personnel. Application usage can also be controlled through quality of service classification and policies based on the AVC information.



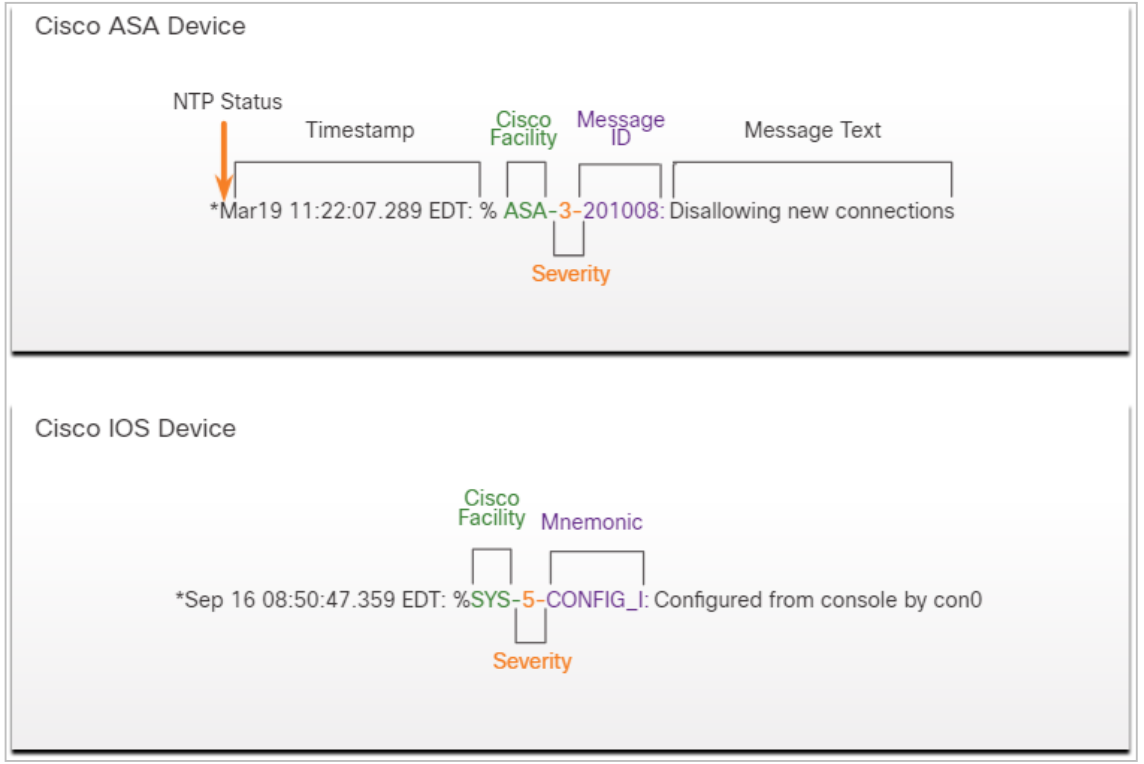
# Content Filter Logs

- Devices that provide content filtering, such as the Cisco Email Security Appliance (ESA) and the Cisco Web Security Appliance (WSA), provide a wide range of functionalities for security monitoring.
- The figure shows the dashboards from Cisco content filtering devices. By clicking components of the Overview reports, more relevant details are displayed. Target searches provide the focused information.



# Logging from Cisco Devices

- Cisco security devices can be configured to submit events and alerts to security management platforms using SNMP or syslog.
- The figure shows a syslog message generated by a Cisco ASA device and a syslog message generated by a Cisco IOS device.
- There are two meanings used for the term facility in Cisco syslog messages.
- The first is the standard set of Facility values that were established by the syslog standards.
- The other Facility value is assigned by Cisco and occurs in the MSG part of the syslog message.



# Proxy Logs

- Proxy servers, such as those used for web and DNS requests, contain valuable logs that are a primary source of data for network security monitoring.
- The proxy server requests the resources and returns them to the client and generates logs of all requests and responses.
- These logs can then be analyzed to determine which hosts are making the requests, whether the destinations are safe or potentially malicious, and to also gain insights into the kind of resources that have been downloaded.
- Web proxies provide data that helps determine whether responses from the web were generated in response to legitimate requests or have been manipulated to appear to be responses but are in fact exploits.
- It is also possible to use web proxies to inspect outgoing traffic as means of data loss prevention (DLP).
- DLP involves scanning outgoing traffic to detect whether the data that is leaving the web contains sensitive, confidential, or secret information.

# Proxy Logs (Contd.)

## Cisco Umbrella

- Cisco Umbrella, formerly OpenDNS, offers a hosted DNS service that extends the capability of DNS to include security enhancements.
- Cisco Umbrella applies many more resources to managing DNS than most organizations can afford. Cisco Umbrella functions in part as a DNS super proxy in this regard.
- The Cisco Umbrella suite of security products apply real-time threat intelligence to managing DNS access and the security of DNS records.
- An example of a DNS proxy log appears below.

```
"2015-01-16 17:48:41","ActiveDirectoryUserName",
"ActiveDirectoryUserName,ADSite,Network",
"10.10.1.100","24.123.132.133","Allowed","1 (A)",
"NOERROR","domain-visited.com.",
"Chat,Photo Sharing,Social Networking,Allow List"
```

# Next-Generation Firewalls

- Next-Generation or NextGen Firewall devices extend network security beyond IP addresses and Layer 4 port numbers to the application layer and beyond.
- NexGen Firewalls are advanced devices that provided much more functionality than previous generations of network security devices.
- One functionality is reporting dashboards with interactive features that allow quick point-and-click reports on very specific information without the need for SIEM or other event correlators.
- NextGen Firewall devices (NGFW) use Firepower Services to consolidate multiple security layers into a single platform.
- Firepower services include application visibility and control, Firepower Next-Generation IPS (NGIPS), reputation and category-based URL filtering, and Advanced Malware Protection (AMP).

# Next-Generation Firewalls (Contd.)

Common NGFW events include:

- Connection Event
- Intrusion Event
- Host or Endpoint Event
- Network Discovery Event
- Netflow Event

**Services Provided by NGFW**

# Packet Tracer - Explore a NetFlow Implementation

In this Packet Tracer activity, you will do the following:

- Explore an implementation of NetFlow.

# Packet Tracer - Logging from Multiple Sources

In this Packet Tracer activity, you will do the following:

- Use Packet Tracer to compare network data generated by multiple sources including syslog, AAA, and NetFlow.

# 25.4 Network Security Data Summary

# What Did I Learn in this Module?

- Alert data consists of messages that are generated by intrusion prevention systems (IPSs) or intrusion detection systems (IDSs) in response to traffic that violates a rule or matches the signature of a known exploit.
- Within the Security Onion suite of NSM tools, alerts are generated by Snort and are made readable and searchable by the Sguil, Squert, and Kibana applications.
- Session data will include identifying information such as the five tuples of source and destination IP addresses, source and destination port numbers, and the IP code for the protocol in use.
- Data about the session typically includes a session ID, the amount of data transferred by source and destination, and information related to the duration of the session.
- Full packet captures contain the actual contents of data conversations, such as the text of email messages, the HTML in webpages, and the files that enter or leave the network.
- Statistical data is created through the analysis of various forms of network data.

# What Did I Learn in this Module? (Contd.)

- Host-based intrusion detection systems (HIDS) run on individual hosts.
- Syslog incudes specifications for message formats, a client-server application structure, and network protocol.
- Server logs are an essential source of data for network security monitoring.
- DNS proxy server logs document all the DNS queries and responses that occur on the network.
- DNS proxy logs are useful for identifying hosts that may have visited dangerous websites and for identifying DNS data exfiltration and connections to malware command-and-control servers.
- SIEM combines the essential functions of security event management (SEM) and security information management (SIM) tools to provide a comprehensive view of the enterprise network using log collection, normalization, correlation, aggregation, reporting, and compliance.

# What Did I Learn in this Module? (Contd.)

- The tcpdump command line tool is a very popular packet analyzer. It can display packet captures in real time or write packet captures to a file.
- NetFlow provides valuable information about network users and applications, peak usage times, and traffic routing.
- Cisco Application Visibility and Control uses Cisco next-generation network-based application recognition version 2 (NBAR2), also known as Next-Generation NBAR.
- Devices such as the Cisco Email Security Appliance (ESA) and the Cisco Web Security Appliance (WSA), provide a wide range of functionalities for security monitoring by utilizing content filtering.
- Proxy servers are devices that act as intermediaries for network clients.
- NextGen Firewall devices extend network security beyond IP addresses and Layer 4 port numbers to the application layer and beyond.


CISCO