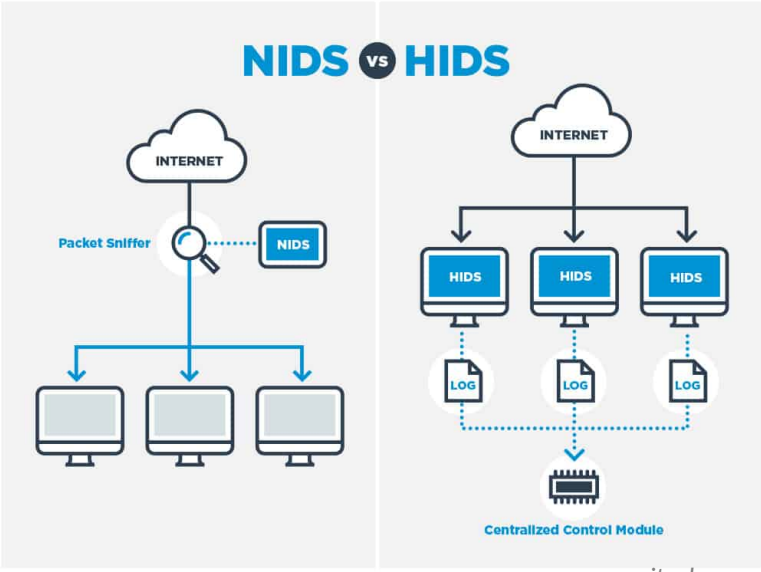
Network Traffic Analysis with Malcolm

Malcolm Development Team • Cybersecurity R&D • Idaho National Lab

Intrusion Detection Systems

- HIDS: Host Intrusion Detection Systems
  - Agents run on individual hosts or devices on a network
- NIDS: Network Intrusion Detection Systems
  - Monitor and analyze network traffic for anomalies: suspicious activity, policy violations, etc.
  - Generally passive/out-of-band; otherwise it's an Intrusion Prevention System
  - Detection methods
    - Signature-based detection (e.g., Suricata)
    - Statistical anomaly-based detection (e.g., Random Cut Forest)
    - Stateful protocol analysis detection (e.g., Zeek)



comparitech.com

IDS: Types of Attacks

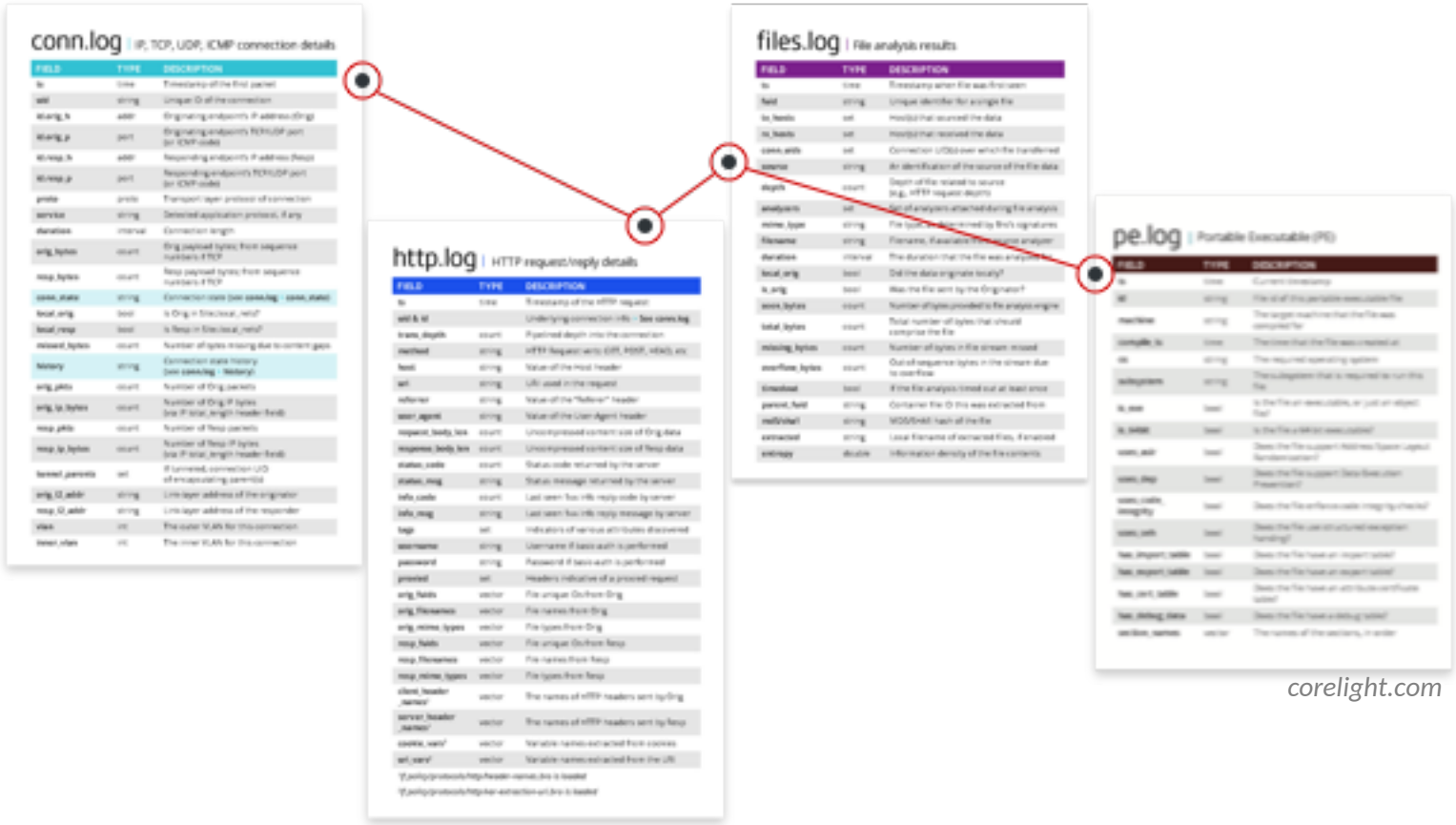
- Scanning Attack
  - Determine network topology
  - IDS highlights connections from one host to many other hosts in the network, or connection attempts to sequential IP addresses and/or ports
- Denial of Service Attack
  - Interrupt service by flooding requests or flaws in protocol implementations
  - IDS identifies large volume of traffic from or to a particular host or invalid connection states (e.g., TCP SYN/ACK with no ACK)
- Penetration Attack
  - Gain access to system resources by exploiting a software or configuration flaw
  - Trickier, but IDS may detect vulnerable software versions or simply alert on unusual operations (e.g., a “write” operation in an already-configured environment with mostly “read” operations)

- Extensible, open-source passive network analysis framework
- More than just an Intrusion Detection System:
  - Packet capture (like TCPDUMP)
  - Traffic inspection (like Wireshark)
  - Intrusion detection (like SNORT)
  - Log recording (like NetFlow and syslog)
  - Scripting framework (like python™)

Strengths 👍	Weaknesses 👎
• Analyzes both link-layer and application-layer behavior • Content extraction • Behavioral analysis • Session correlation • Can add support for uncommon protocols through scripts/plugins	• Session metadata only (not full payload) • Setup and configuration can be complicated • Produces flat textual log files which can be unwieldy for in-depth analysis

Zeek Log Files

- Network Protocols
- Files
- Detection
- Network Observations



corelight.com

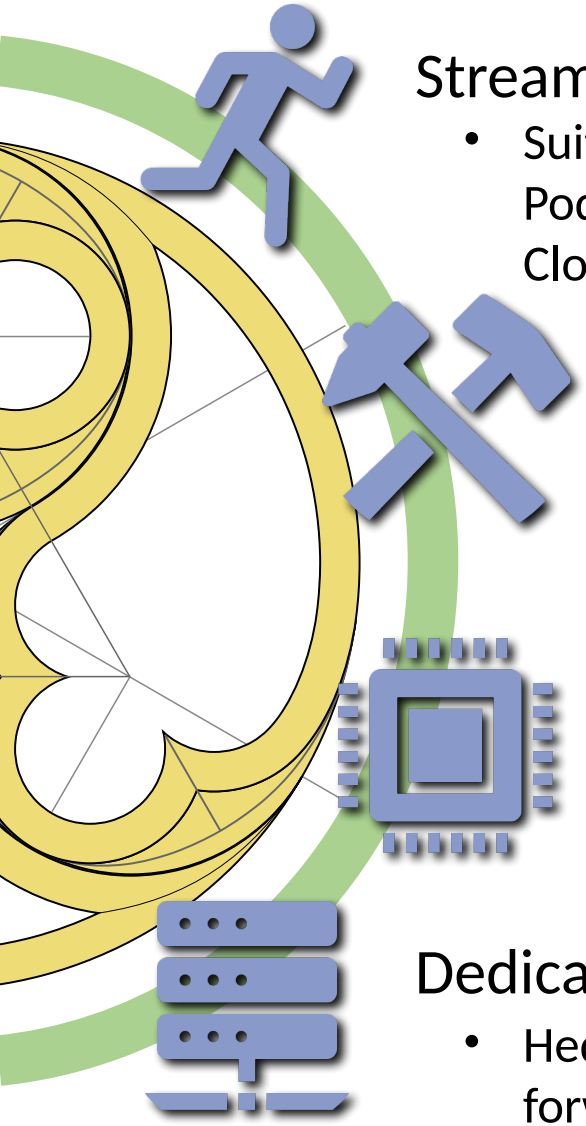
Arkime

Strengths 👍	Weaknesses 👎
• Large scale index packet capture and search tool • Packet analysis engine with support for many common IT protocols • Web interface for browsing, searching, analysis and PCAP carving for exporting • PCAP payloads (not just session header/metadata) are viewable and searchable	• Minimal OT protocol support • Adding new protocol parsers requires C programming

Malcolm

A powerful open-source network traffic analysis tool suite.

https://idaholab.github.io/Malcolm



Streamlined deployment

- Suitable for field use (hunt or incident response) or SOC deployment. Runs in Docker or Podman on Linux, macOS and Windows. ISO installer for bare metal installations. Cloud deployable with Kubernetes. Provides easy-to-use web-based user interfaces.

Industry-standard tools

- Uses Arkime, Zeek, and Suricata for traffic analysis; Logstash for parsing and enrichment; OpenSearch or Elasticsearch for indexing; and Dashboards and Arkime for visualization. Also leverages OpenSearch Anomaly Detection, NetBox, Strelka, CyberChef, and other proven tools for analysis of traffic and artifacts.

Expanding control systems visibility

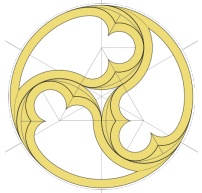
- Analyzes more protocols used in operational technology (OT) networks than other open-source or paid solutions. Ongoing development is focused on increasing the quantity and quality of industrial control systems (ICS) traffic.

Dedicated sensor appliance

- Hedgehog Linux, a hardened Linux distribution for capturing network traffic and forwarding its metadata to Malcolm.

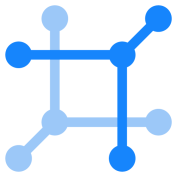
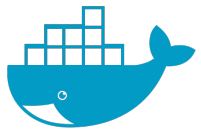
Malcolm Origins and Milestones

- 2018.Q2 – Development begins under USBR/CISA work agreement
- 2018.Q3 to 2019.Q2 – Malcolm field-tested at USBR facilities
- 2019.Q2 – Initial public release
- 2021.Q1 – 1k stars on GitHub
- 2022.Q3 – Malcolm-based simulated engagements begin at INL's ICS Control Environment Lab Resource (CELR)
- 2022.Q3 – Malcolm discussed during session of the U.S. House of Representatives Homeland Security Committee
- 2022.Q4 – NetBox provides asset inventory and interaction analysis
- 2023.Q1 – Kali releases "Purple" distro bundling Malcolm
- 2023.Q2 – Cloud deployable with K8s
- 2024.Q2 – 2k stars on GitHub, community discussions board and new training offerings
- 2024.Q3 – First public Malcolm user conference, Mal.Con24
- 2025.Q2 – Keycloak provides SSO and role-based access control
- 2025.Q4 – Google Threat Intelligence integration
- 2026.Q1 – Enhanced file scanning with Strelka







Malcolm What Can It Do For Me?

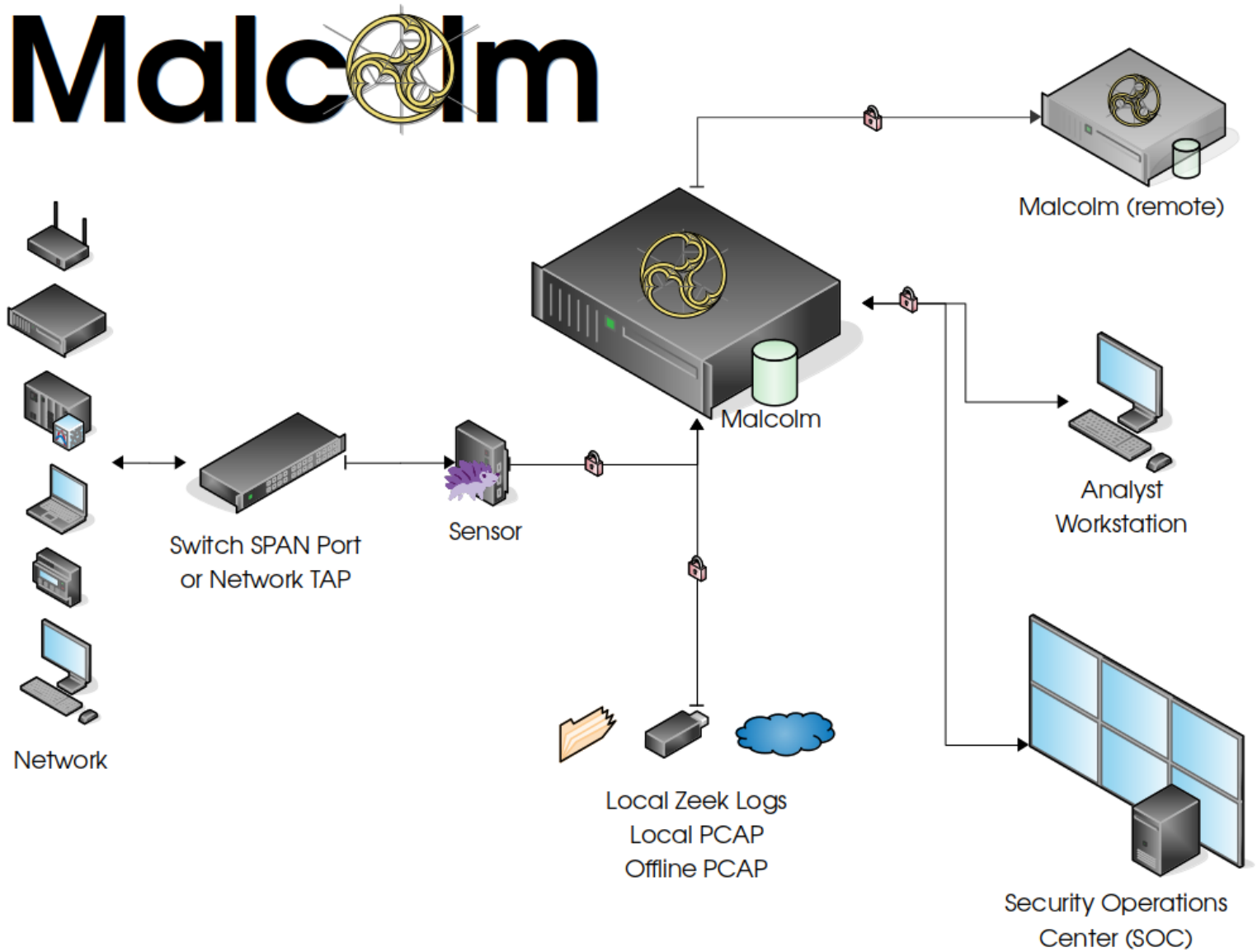
- Get to know your network: Malcolm **characterizes** traffic by devices and the protocols they use to communicate.
- Understand risks and threats: Malcolm **identifies** active exploits, potential attack vectors, and vulnerable devices and protocols.
- Increase visibility: Malcolm **highlights** inbound, outbound, and internal communications to inform decisions and improve security posture.

What can network traffic reveal about my cybersecurity posture?

- A **lot**!
- Malcolm can be used to validate cyber best practices and uncover red flags in network configuration, including:
  - Proper network segmentation
  - East-West (cross-segment) and North-South traffic
  - Unsecure or outdated protocols
  - Unexpected protocols
  - Rogue devices and services
  - Suspicious file transfers
  - Sensitive unencrypted information (e.g., PII, PCII, cleartext credentials)
  - … and much more

Image credit: kelsercorp.com

Malcolm


Malcolm (remote)
Malcolm
Analyst
Workstation
Switch SPAN Port
or Network TAP
Sensor
Network
Local Zeek Logs
Local PCAP
Offline PCAP
Security Operations
Center (SOC)

Malcolm Supported Protocols

https://idaholab.github.io/Malcolm/docs/protocols.html

Internet layer (IP, TCP/IP)
ANSI C12.22
Border Gateway Protocol (BGP)
Building Automation and Control (BACnet)
Bristol Standard Asynchronous Protocol (BSAP)
Distributed Computing Environment / Remote Procedure Calls (DCE/RPC)
Dynamic Host Configuration Protocol (DHCP)
Distributed Network Protocol 3 (DNP3)
Domain Name System (DNS)
EtherCAT
EtherNet/IP / Common Industrial Protocol (CIP)
FTP (File Transfer Protocol)
Genisys
GE Service Request Transport Protocol (SRTP)
Google Quick UDP Internet Connections (gQUIC)
Highway Addressable Remote Transducer over IP (HART-IP)
Hypertext Transfer Protocol (HTTP)
IPsec
Internet Relay Chat (IRC)
Lightweight Directory Access Protocol (LDAP)
Kerberos
Modbus
MQ Telemetry Transport (MQTT)
MySQL
NT Lan Manager (NTLM)
Network Time Protocol (NTP)
Omron Factory Interface Network Service (OMRON FINS)
Open Platform Communications Unified Architecture (OPC UA) Binary
Open Shortest Path First (OSPF)
OpenVPN
Oracle
PostgreSQL
Process Field Net (PROFINET)
Redis
Remote Authentication Dial-In User Service (RADIUS)
Remote Desktop Protocol (RDP)
Remote Framebuffer / Virtual Network Computing (RFB/VNC)
Remote Operations Controller (ROC) Plus
S7comm / Connection Oriented Transport Protocol (COTP)
Secure Shell (SSH)
Secure Sockets Layer (SSL) / Transport Layer Security (TLS)
Session Initiation Protocol (SIP)
Server Message Block (SMB) / Common Internet File System (CIFS)
Simple Mail Transfer Protocol (SMTP)
Simple Network Management Protocol (SNMP)
SOCKS
STUN (Session Traversal Utilities for NAT)
Synchrophasor (IEEE C37.118)
Syslog
Tabular Data Stream (TDS)
Telnet / remote shell (rsh) / remote login (rlogin)
TFTP (Trivial File Transfer Protocol)
WebSocket
WireGuard
various tunnel protocols (e.g., GTP, GRE, Teredo, AYIYA, IP-in-IP, etc.)

* *Industrial control systems protocols indicated with bold*

Malcolm Components

https://idaholab.github.io/Malcolm/docs/components.html

Capture & Analysis

- Arkime
- SURICATA
- zeek

File Scanning

- STRELKA
- yara
- ClamAV
- CAPA

Forwarding & Enrichment

- fluentbit
- logstash
- beats

Storage

- OpenSearch

Anomaly Detection

- Anomaly Detection Plugin
- Alerting
- Alerting Plugin

Asset Management

- netbox

Visualization

- OpenSearch Dashboards
- Arkime

Payload Analysis

- CyberChef
- Arkime session PCAP export to WIRESHARK

Framework

- docker
- podman
- kubernetes

Configuring and Running Malcolm

- Runs natively in Docker or Podman, use ISO installer for VM or bare metal install, or cloud deploy with Kubernetes or Amazon Machine Image (AMI)
- Recommended system requirements: 64+GB RAM, 16+ CPU cores, “enough” storage for PCAP and logs
- Documentation and source code on GitHub: https://idaholab.github.io/Malcolm
- Walkthroughs on YouTube: “Malcolm Network Traffic Analysis”

Dashboards

Visualize traffic or track down security concerns with dozens of pre-built dashboards, or create your own

Arkime

Delve into session details including full packet payloads

NetBox

Model and document your network infrastructure

CyberChef

Slice and dice data with this web app for encryption, encoding, compression and data analysis

Documentation

Read the Malcolm user guide

Artifact Upload

Upload previously-captured PCAP files or archived Zeek logs for analysis

Keycloak Authentication

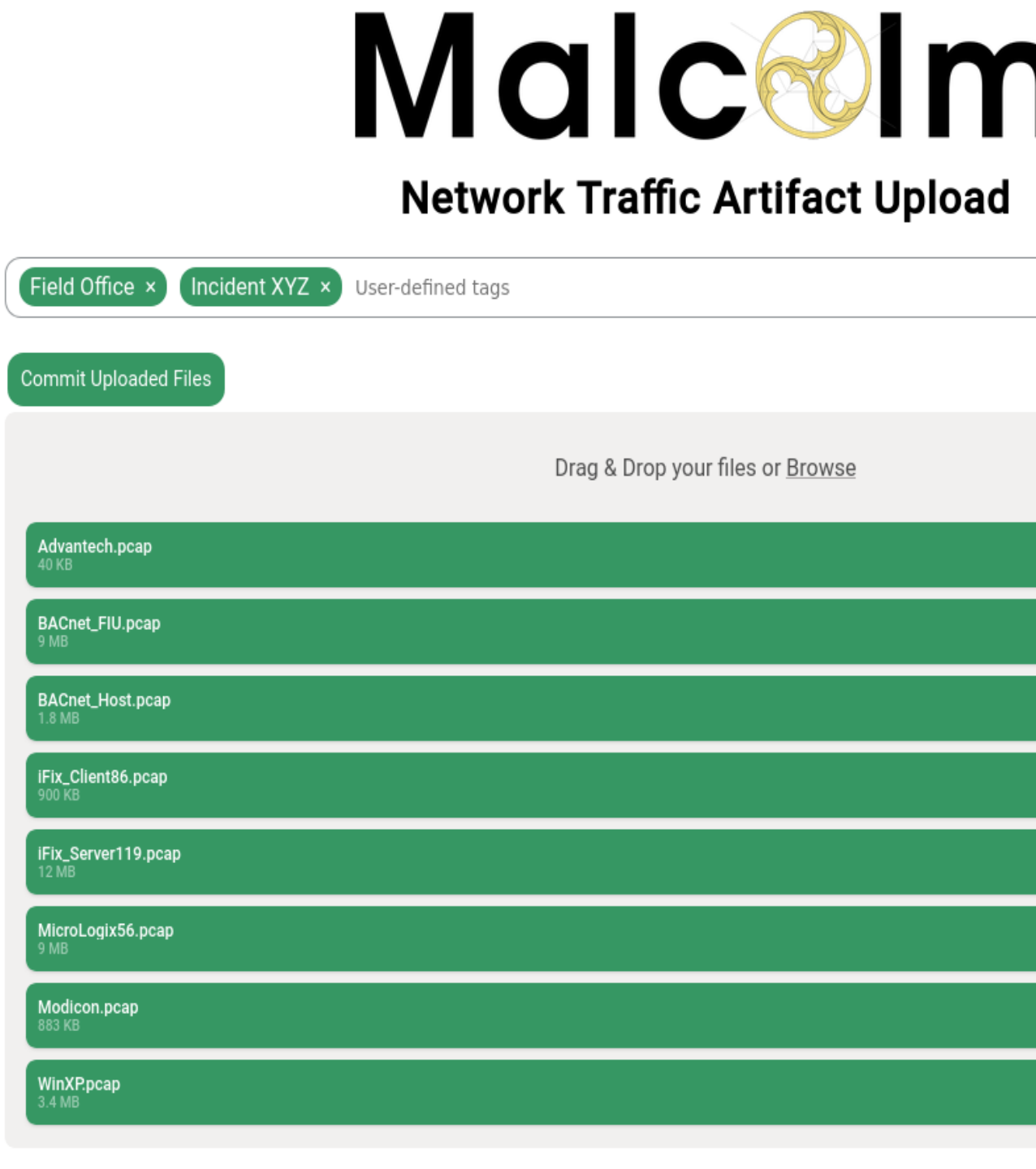
Malcolm is using Keycloak for authentication

Extracted Files

Browse the preserved extracted files carved and scanned by Malcolm

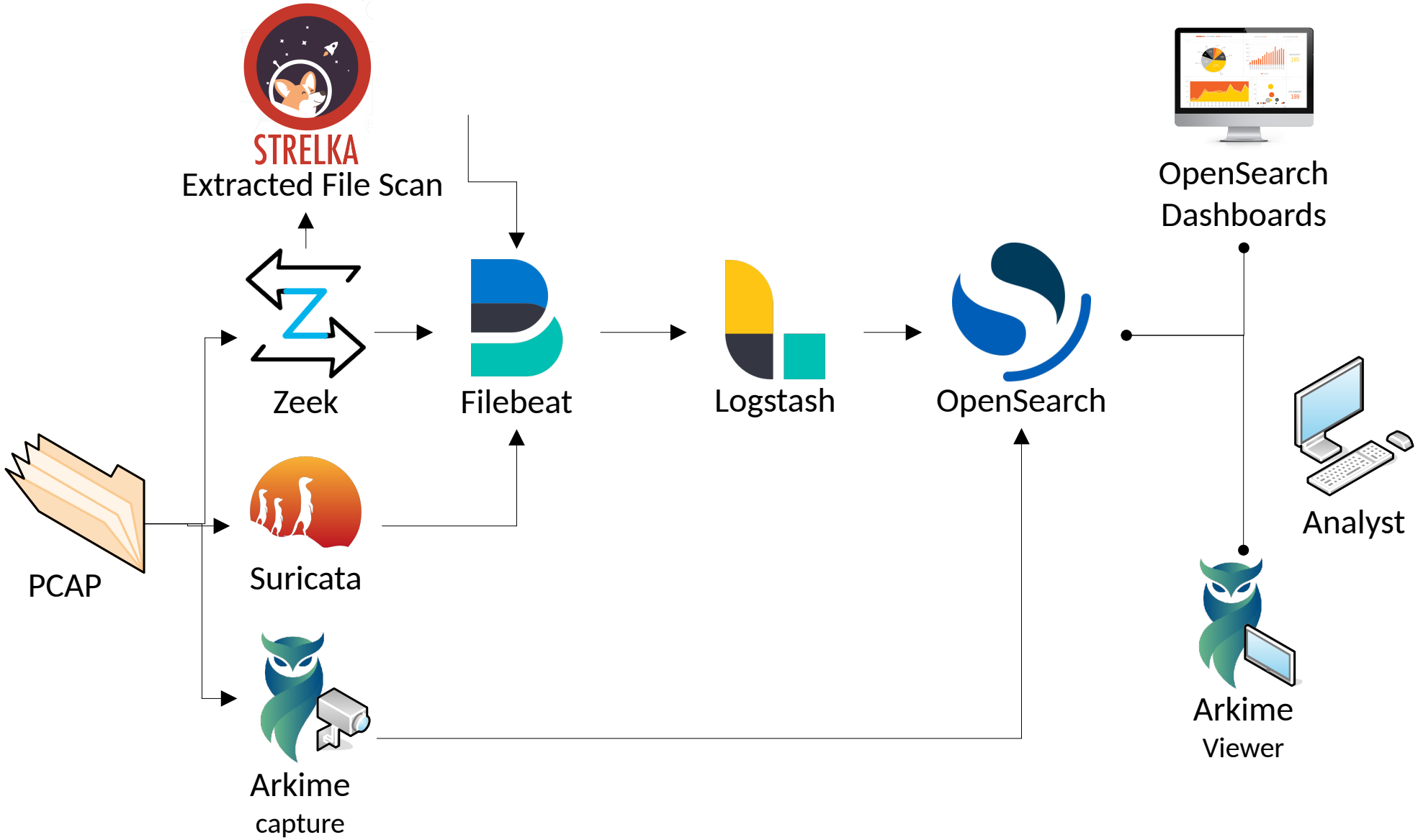
Importing Traffic Captures for Analysis

- Upload PCAP files or archived Zeek logs
- Specify tags for search and filter
- Specify NetBox site



Malcolm Data Pipeline

https://idaholab.github.io/Malcolm/



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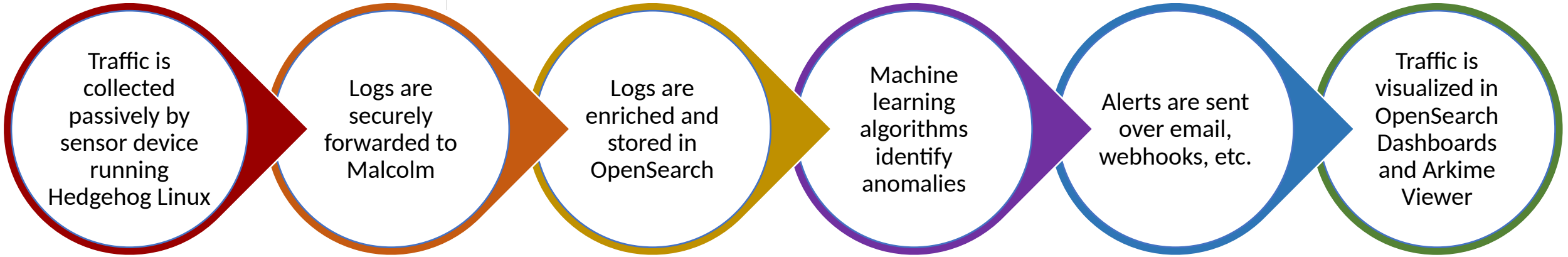


- Zeek, Arkime, and Suricata generate metadata about network communications
- Full PCAP is stored locally on the sensor
- Files transfers are detected, and the files scanned for threats
- PCAP may also be uploaded to or captured by Malcolm without requiring a dedicated sensor

- Communications between the sensor and aggregator are TLS-encrypted
- Sensor data including resource utilization, syslog, audit logs, temperatures, and more may also be forwarded
- Other third-party logs (e.g., Windows event logs, server host logs, etc.) may be shipped using Fluent Bit or Beats

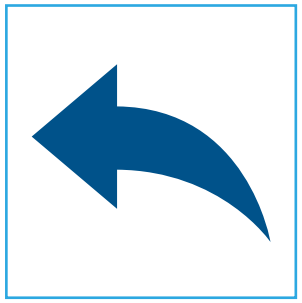
- Lookups are performed for GeoIP, ASN, MAC-to-vendor, community ID, domain name entropy, etc.
- Network events are normalized across protocols and data sources
- Best-guess techniques are applied to identify obscure OT traffic
- Enriched metadata may be forwarded to higher-tiered Malcolm instance

- Default detectors are provided for action and result, flow size, and MIME types of file transfers
- Custom detectors may be created for any aspect of any supported protocol

- Alerts may be triggered by exceeded thresholds, anomalies detected, custom queries, etc.

- Dozens of custom dashboards are provided for all supported protocols
- PCAP payloads are retrieved from sensor on demand
- Create custom visualizations via drag-and-drop interface
- Malcolm authenticates users from its own list, with SSO via Keycloak, or using Active Directory / LDAP

Log Enrichment



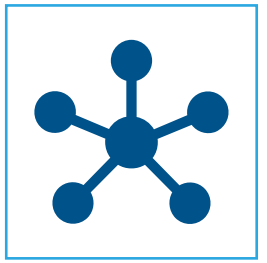
Reverse DNS

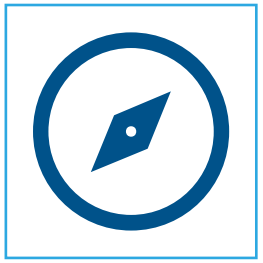
Domain Name Entropy Calculation

Severity Scoring

Tagging

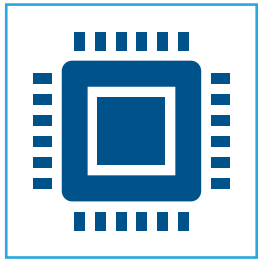
GeoIP and ASN Lookups





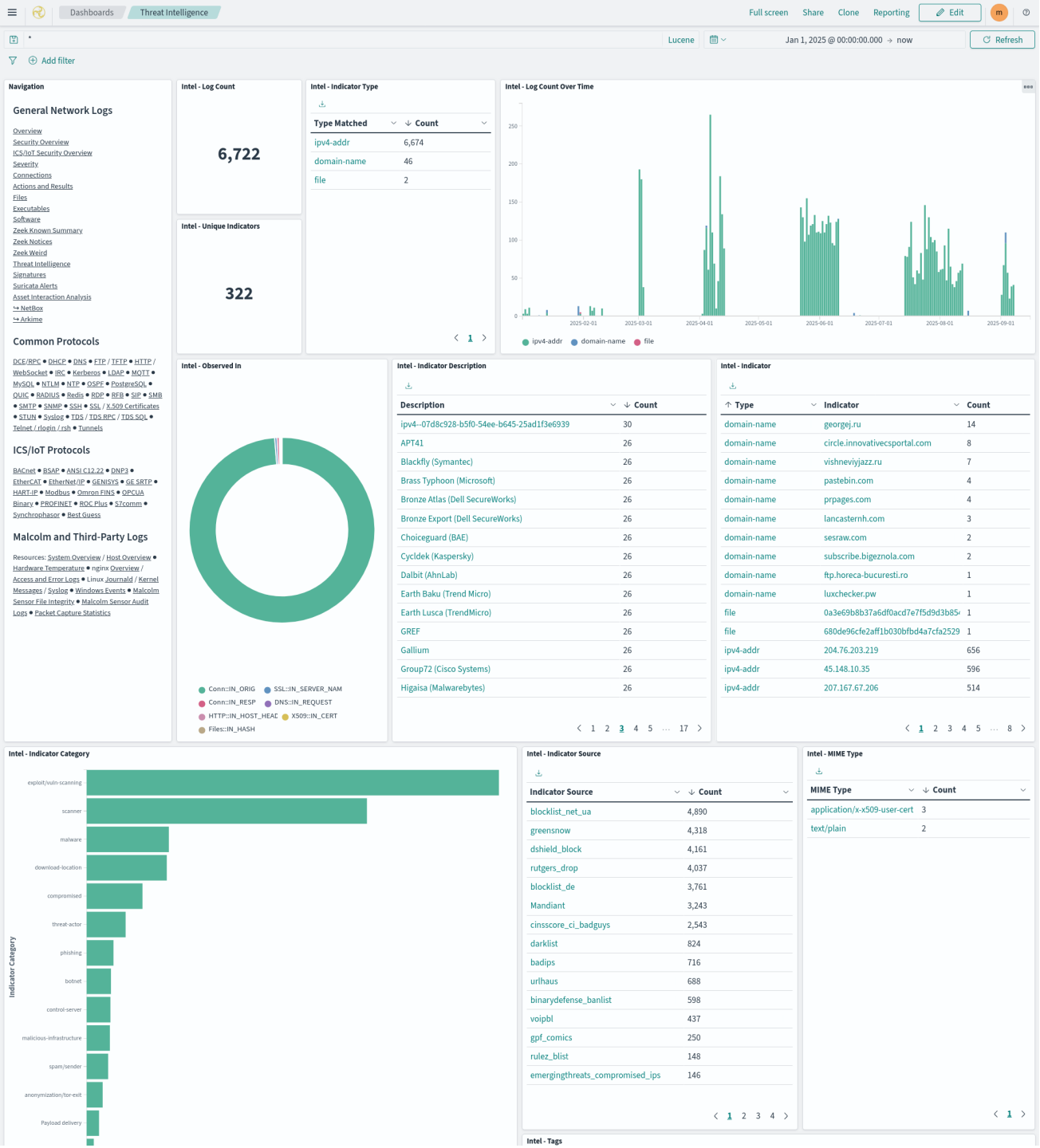
Network Direction

Hardware Vendor OUI Lookups



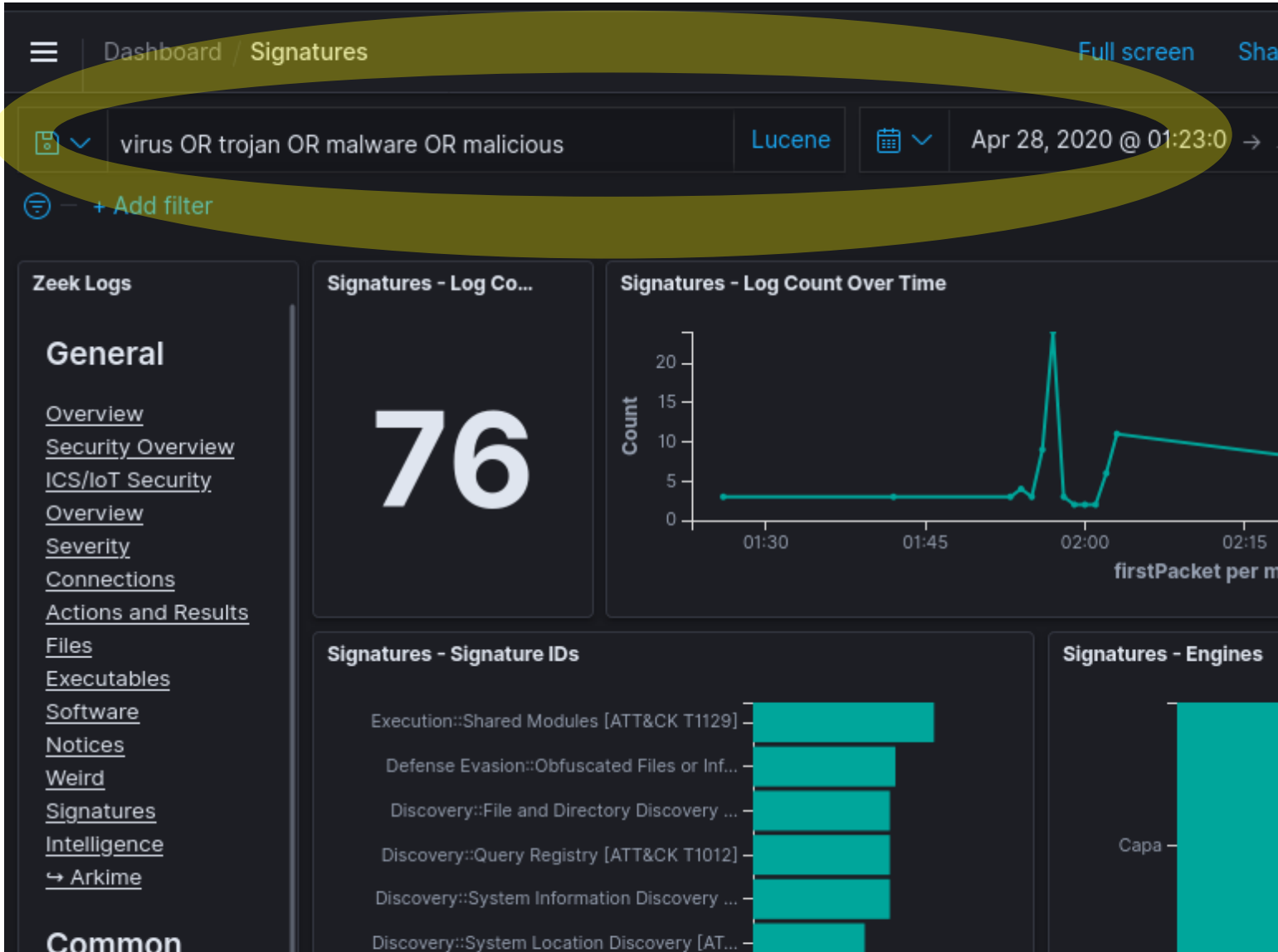
OpenSearch Dashboards

- Front end for Zeek logs and Suricata alerts
- Prebuilt visualizations for all supported protocols
- WYSIWYG editors to create custom visualizations and dashboards
- Drill down from high-level trends to specific items of interest



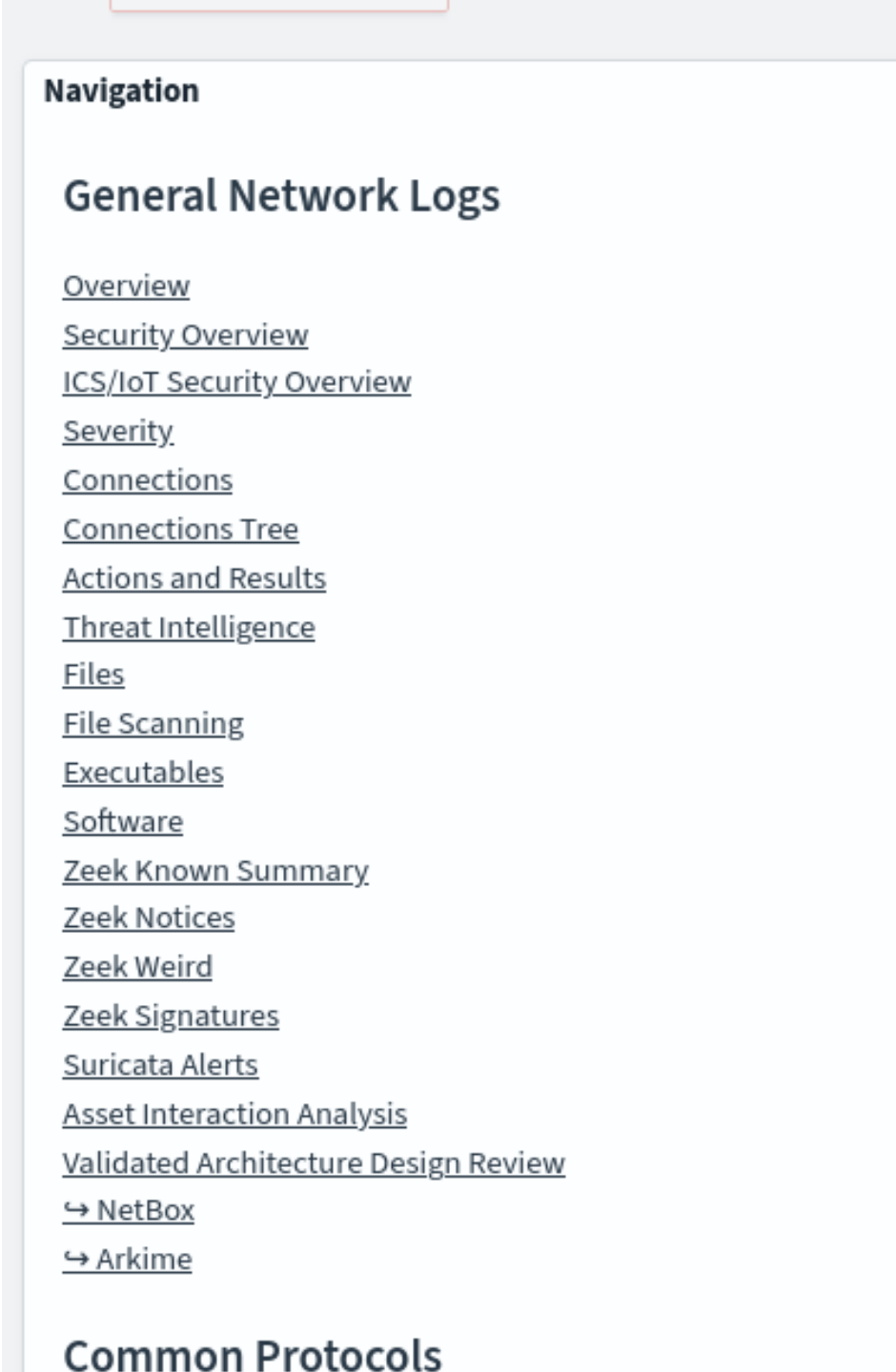
Dashboards Filters and Search

- Time filter: define search time frame
- Query bar: write queries in Lucene syntax or DQL (Dashboards Query Language)
- Filter bar: define filters using a UI
  - Pin filters as you move across dashboards
- Save queries and filters for reuse



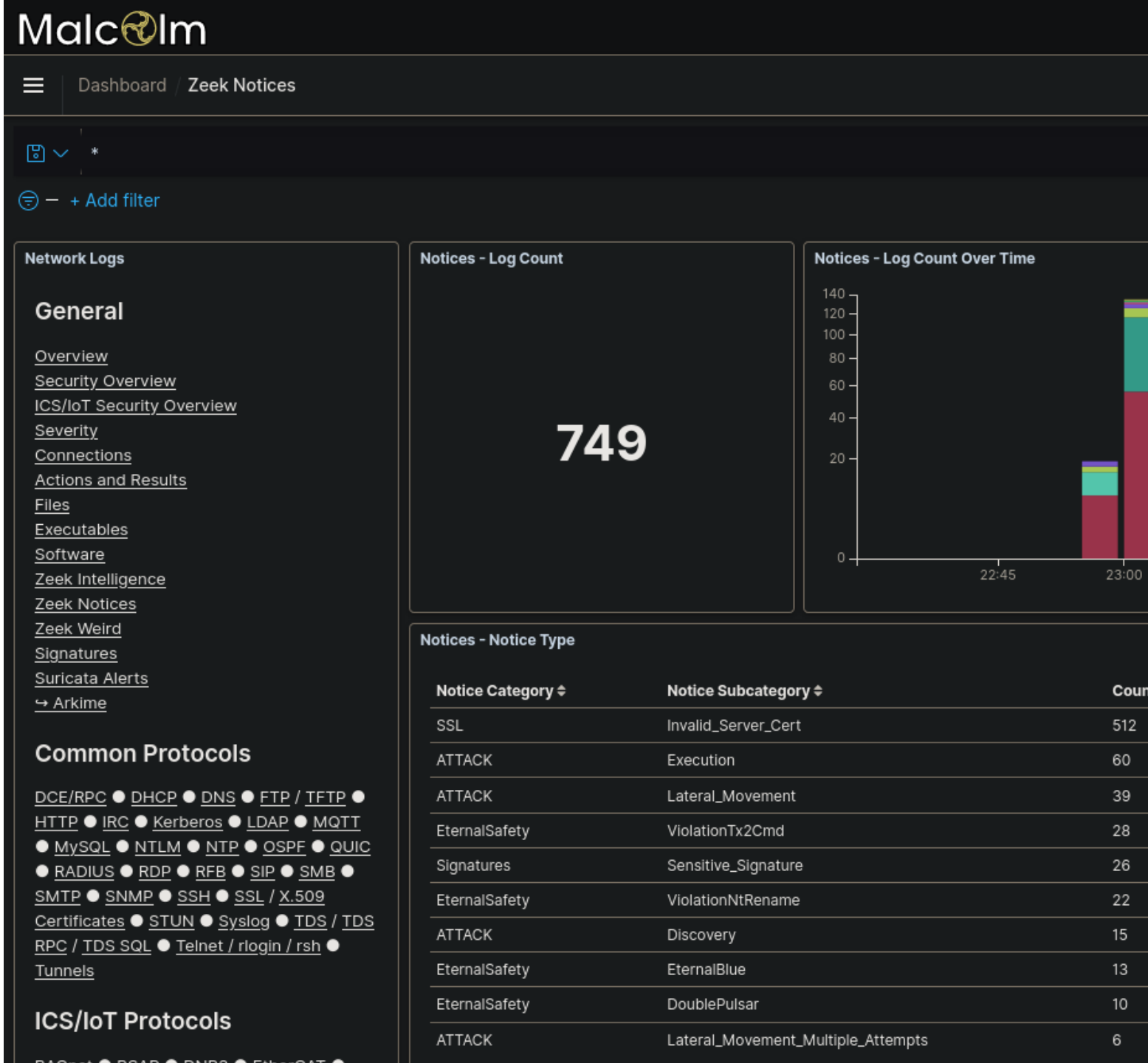
Overview Dashboards

- High-level view of trends, sessions and events
- Populated from logs across all protocols
- Good jumping-off place for investigation



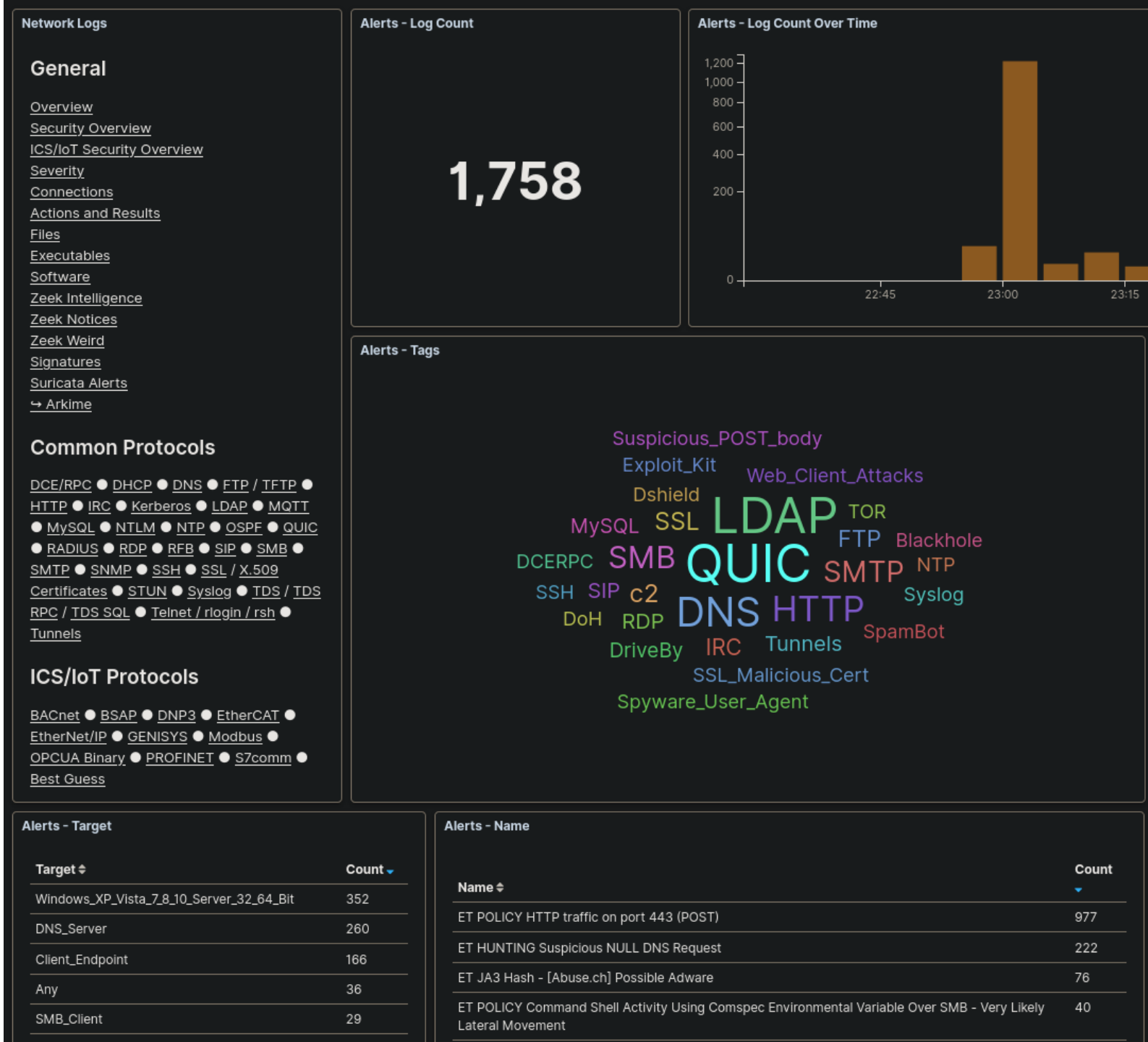
Zeek Notices

- Zeek notices are things that are odd or potentially bad
- In addition to Zeek's defaults, Malcolm raises notices for recent critical vulnerabilities and attack techniques

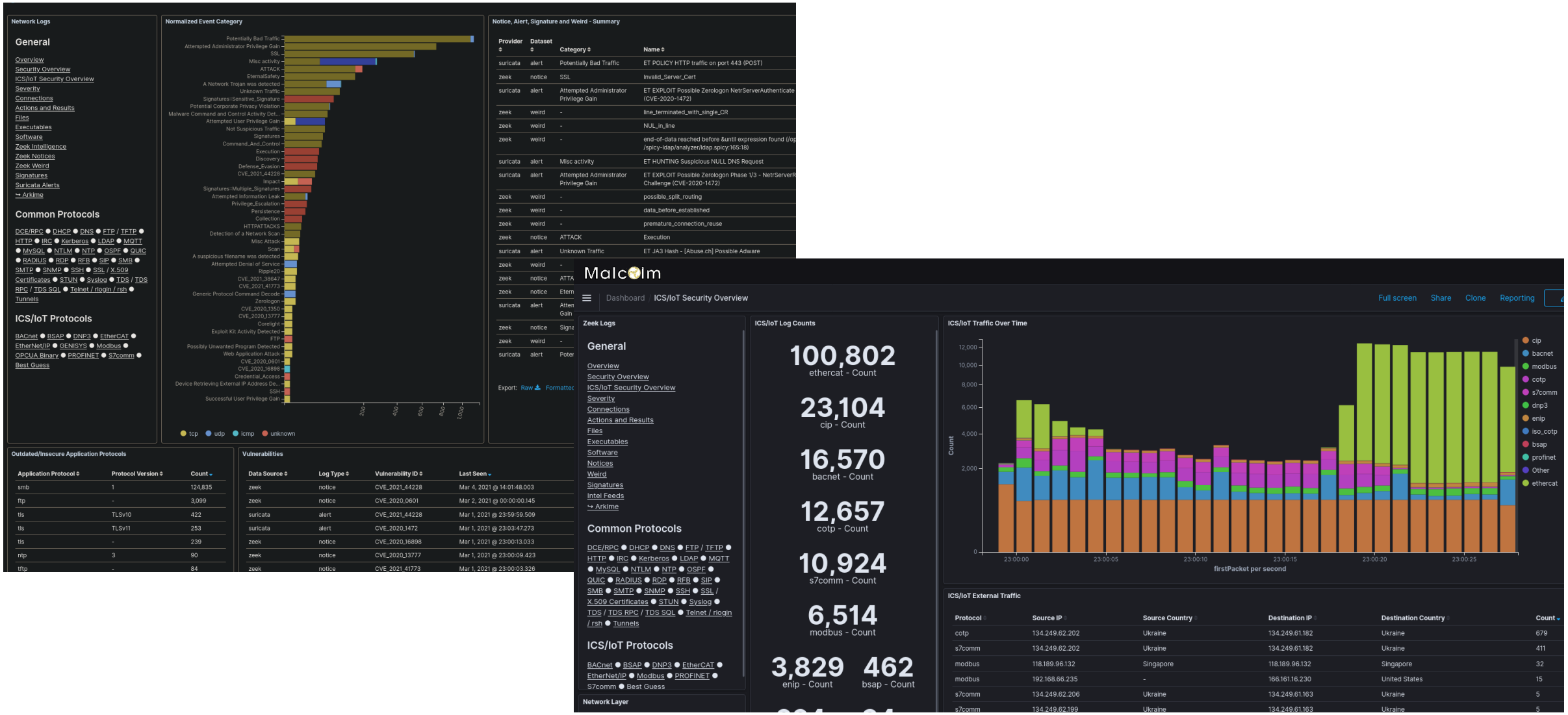


Suricata Alerts

- Protocol-aware Suricata signatures generate alerts for suspect traffic
- Use the default Emerging Threats Open ruleset or custom signatures from other sources

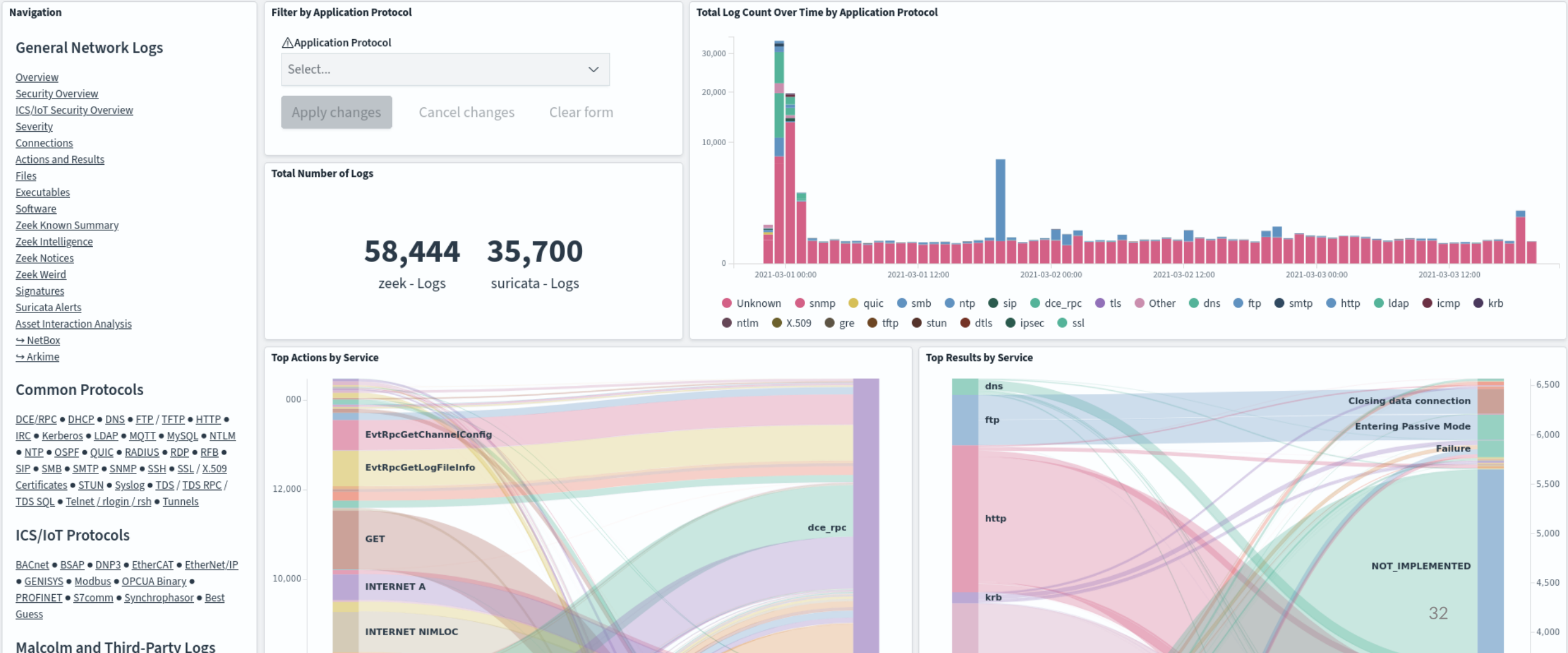


Security & ICS/IoT Security Overviews



Actions and Results

- Malcolm normalizes “action” (e.g., write, read, create file, logon, logoff, etc.) and “result” (e.g., success, failure, access denied, not found) across protocols

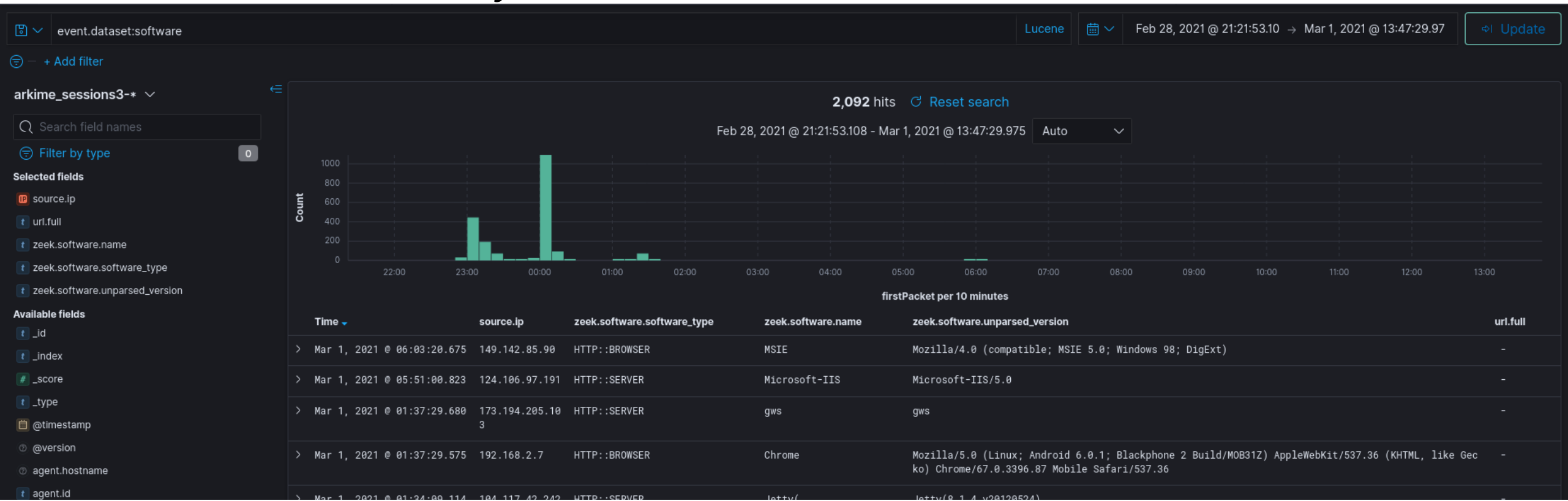


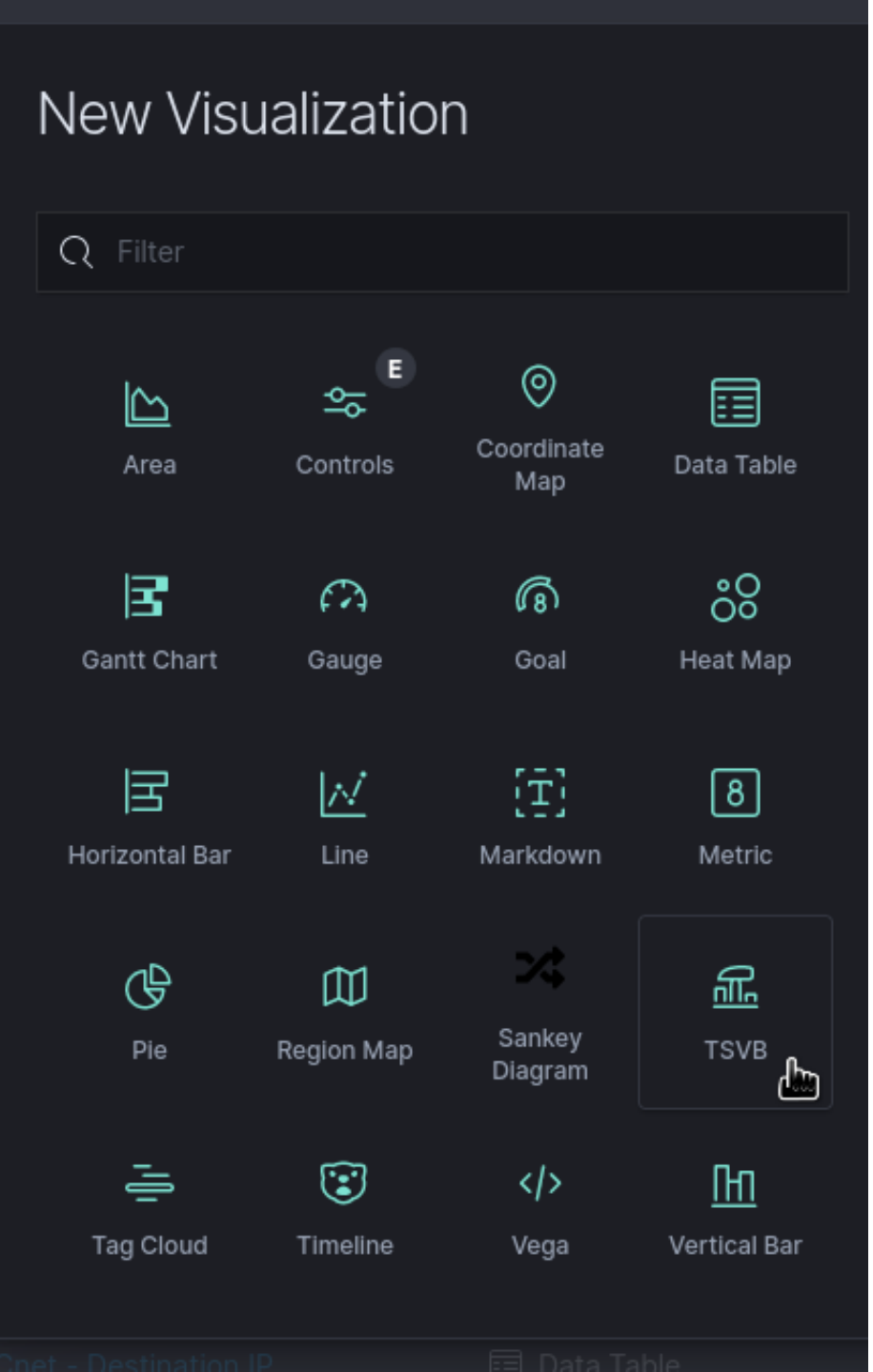
Protocol Dashboards

- Highlight application-specific fields of interest
- Grouped by common IT protocols and ICS/IoT protocols
- Dashboards also included for host logs (Windows event logs, syslog, Journald messages, etc.) and other data sources (system resource utilization, packet capture statistics, sensor temperature, etc.)

Discover

- Field-level details of logs matching filter criteria
- Create and view saved searches and column configurations
- View other events just before and after an event





Custom Visualizations

- Create new visualizations from scratch or based on existing charts or dashboards

Search Syntax Comparison

	Arkime	Dashboards (Lucene)	Dashboards (DQL)
Field exists	`event.dataset == EXISTS!`	`_exists_:event.dataset`	`event.dataset:*`
Field does not exist	`event.dataset != EXISTS!`	`NOT _exists_:event.dataset`	`NOT event.dataset:*`
Field matches a value	`port.dst == 22`	`destination.port:22`	`destination.port:22`
Field does not match a value	`port.dst != 22`	`NOT destination.port:22`	`NOT destination.port:22`
Field matches at least one of a list of values	`tags == [external_source, external_destination]`	`tags:(external_source OR external_destination)`	`tags:(external_source or external_destination)`
Field range (inclusive)	`http.statuscode >= 200 && http.statuscode <= 300`	`http.statuscode:[200 TO 300]`	`http.statuscode >= 200 and http.statuscode <= 300`

Search Syntax Comparison (cont.)

	Arkime	Dashboards (Lucene)	Dashboards (DQL)
Field range (exclusive)	`http.statuscode > 200 && http.statuscode < 300`	`http.statuscode:{200 TO 300}`	`http.statuscode > 200 and http.statuscode < 300`
Field range (mixed exclusivity)	`http.statuscode >= 200 && http.statuscode < 300`	`http.statuscode:[200 TO 300}`	`http.statuscode >= 200 and http.statuscode < 300`
Match all search terms (AND)	`(tags == [external_source, external_destination]) && (http.statuscode == 401)`	`tags:(external_source OR external_destination) AND http.statuscode:401`	`tags:(external_source or external_destination) and http.statuscode:401`
Match any search terms (OR)	`(zeek_ftp.password == EXISTS!) || (zeek_http.password == EXISTS!) || (zeek.user == "anonymous")`	`_exists_:zeek_ftp.password OR _exists_:zeek_http.password OR zeek.user:"anonymous"`	`zeek_ftp.password:* or zeek_http.password:* or zeek.user:"anonymous"`

Search Syntax Comparison (cont.)

	Arkime	Dashboards (Lucene)	Dashboards (DQL)
Global string search (anywhere in the document)	all Arkime search expressions are field-based	`microsoft`	`microsoft`
Wildcards	`host.dns == "*micro?oft*"` (`?` for single character, `*` for any characters)	`dns.host:*micro?oft*` (`?` for single character, `*` for any characters)	`dns.host:*micro*ft*` (`*` for any characters)
Regex	`host.http == /.*www\.f.*k\.com.*/`	`zeek_http.host: /.*www\.f.*k\.com.*/`	Dashboards Query Language does not currently support regex
IPv4 values	`ip == 0.0.0.0/0`	`source.ip:"0.0.0.0/0" OR destination.ip:"0.0.0.0/0"`	`source.ip:"0.0.0.0/0" OR destination.ip:"0.0.0.0/0"`
IPv6 values	`(ip.src == EXISTS! || ip.dst == EXISTS!) && (ip != 0.0.0.0/0)`	`(_exists_:source.ip AND NOT source.ip:"0.0.0.0/0") OR (_exists_:destination.ip AND NOT destination.ip:"0.0.0.0/0")`	`(source.ip:* and not source.ip:"0.0.0.0/0") or (destination.ip:* and not destination.ip:"0.0.0.0/0")`

Search Syntax Comparison (cont.)

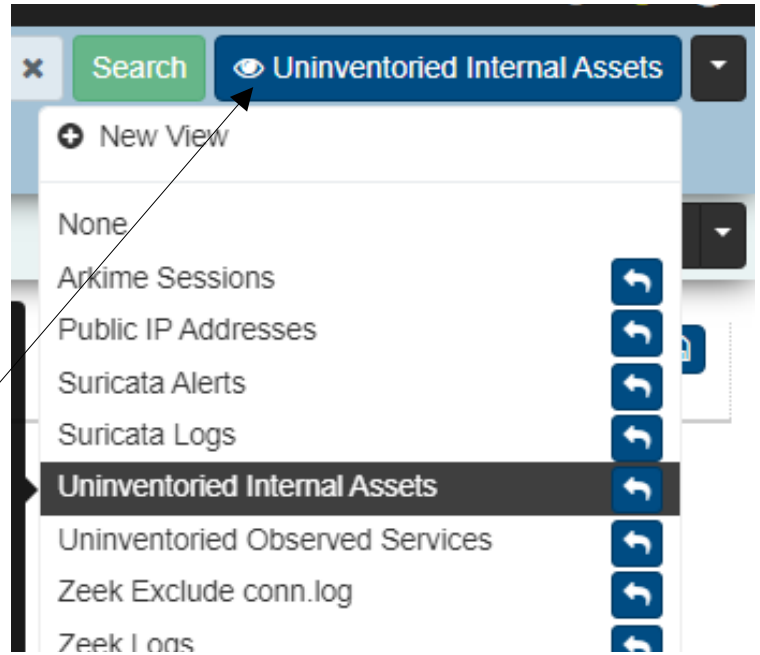
	Arkime	Dashboards (Lucene)	Dashboards (DQL)
GeoIP information available	`country == EXISTS!`	`_exists_:destination.geo OR _exists_:source.geo`	`destination.geo:* or source.geo:*`
Log type	`event.dataset == notice`	`event.dataset:notice`	`event.dataset:notice`
IP CIDR Subnets	`ip.src == 172.16.0.0/12`	`source.ip:"172.16.0.0/12"`	`source.ip:"172.16.0.0/12"`
Search time frame	Use Arkime time bounding controls under the search bar	Use Dashboards time range controls in the upper right-hand corner	Use Dashboards time range controls in the upper right-hand corner
GeoIP information available	`country == EXISTS!`	`_exists_:destination.geo OR _exists_:source.geo`	`destination.geo:* or source.geo:*`

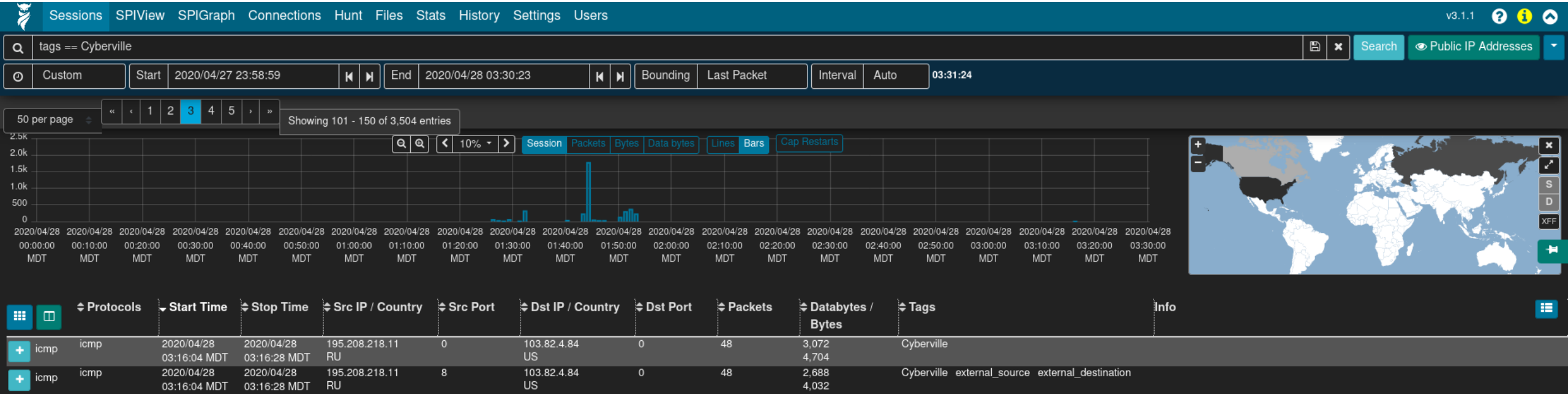
Arkime

- Front end for enriched Zeek logs, Suricata alerts **and** Arkime sessions
  - Malcolm's custom Arkime data source adds full support for Zeek and Suricata logs to Arkime, including ICS protocols
- Filter by data source (Zeek, Suricata or Arkime); or, view together
- "Wireshark at scale": full PCAP availability for
  - viewing packet payload
  - exporting filtered and joined PCAP sessions
  - running deep-packet searches

Arkime Filters and Search

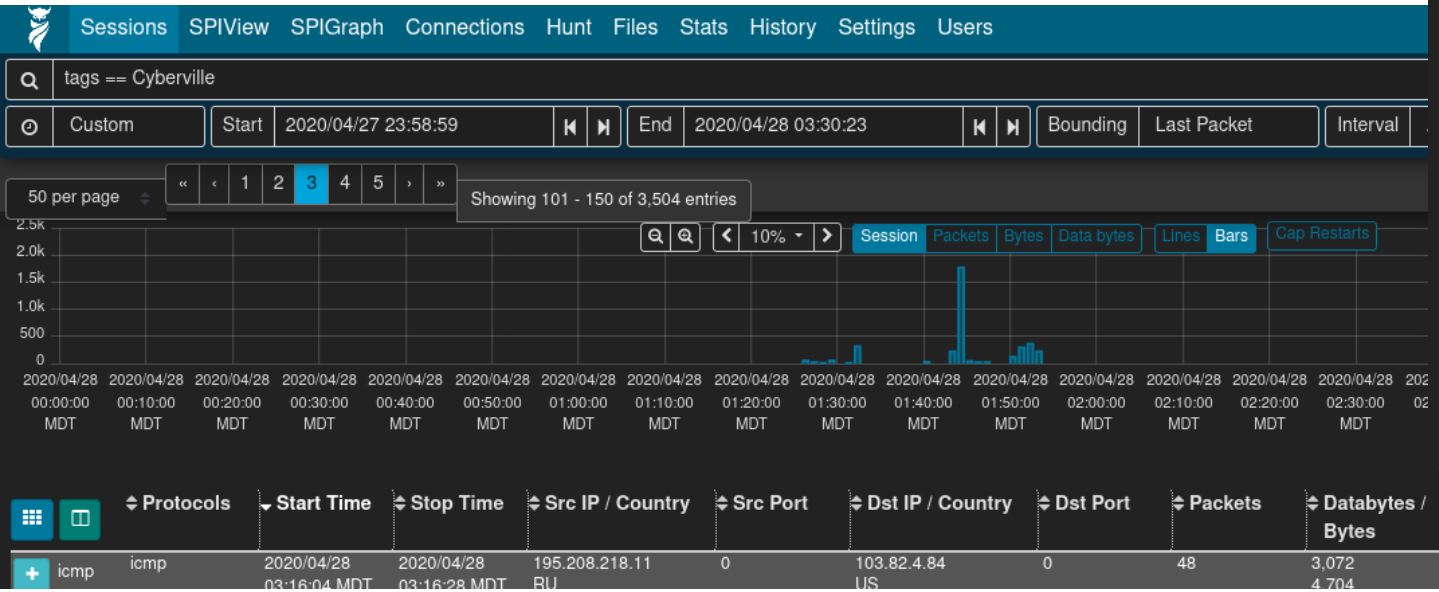
- Time filter: define search time frame
- Map filter: restrict results to geolocation
- Query bar: write queries in Arkime syntax
- Views: overlay previously-specified filters on current search

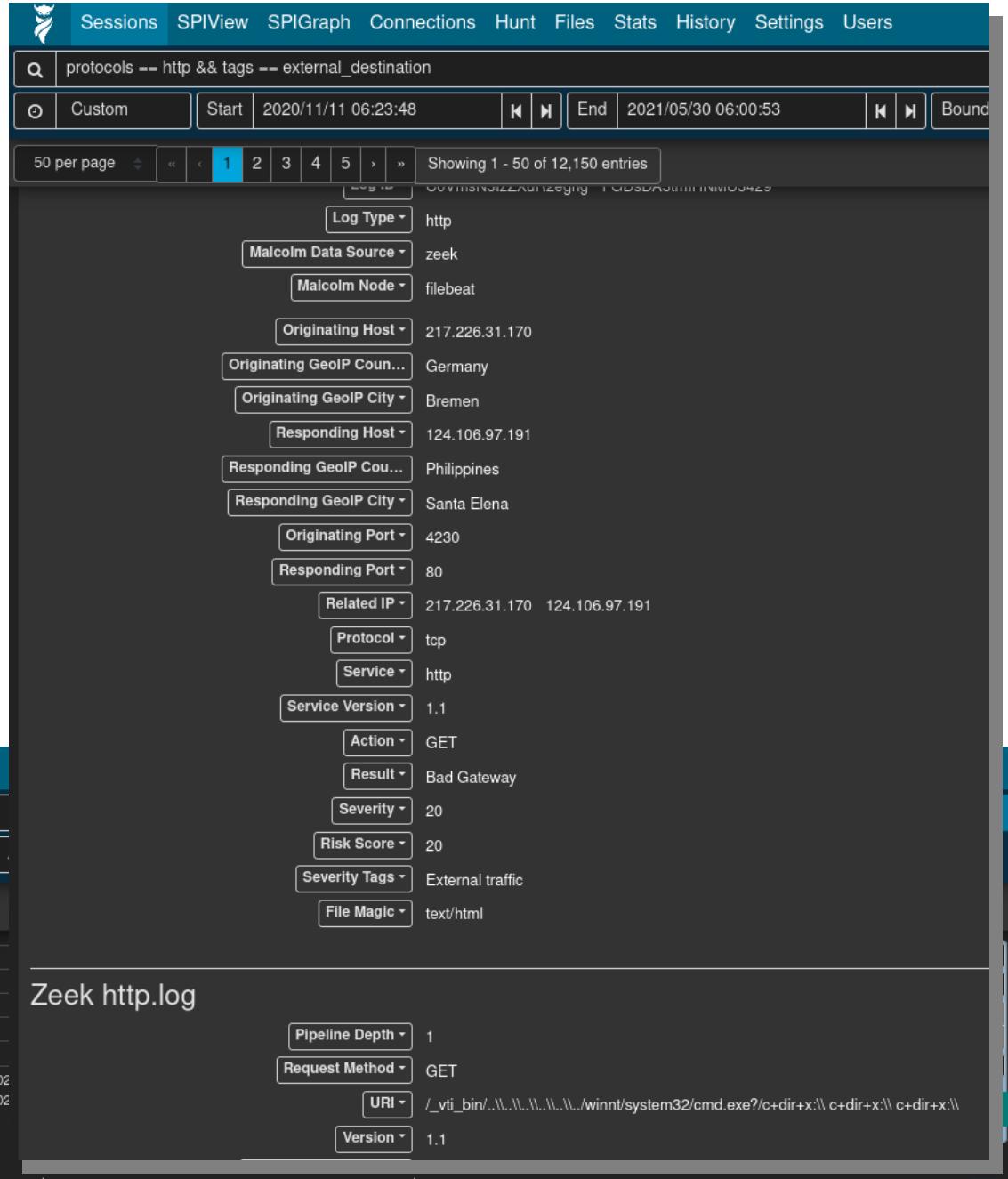




Sessions

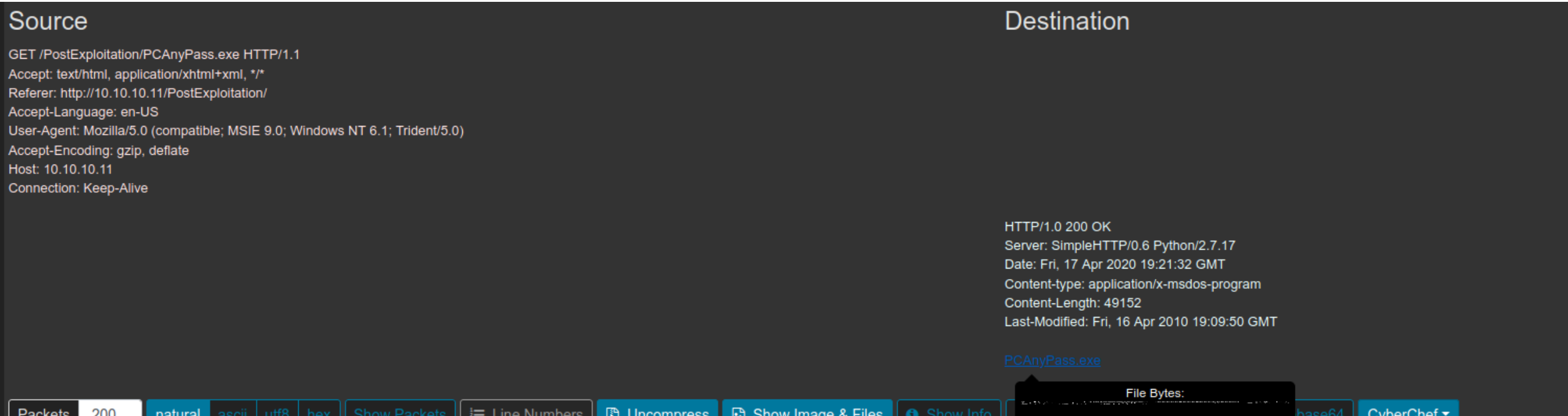
- Field-level details of sessions/logs matching filters
- Similar to Dashboards' Discover





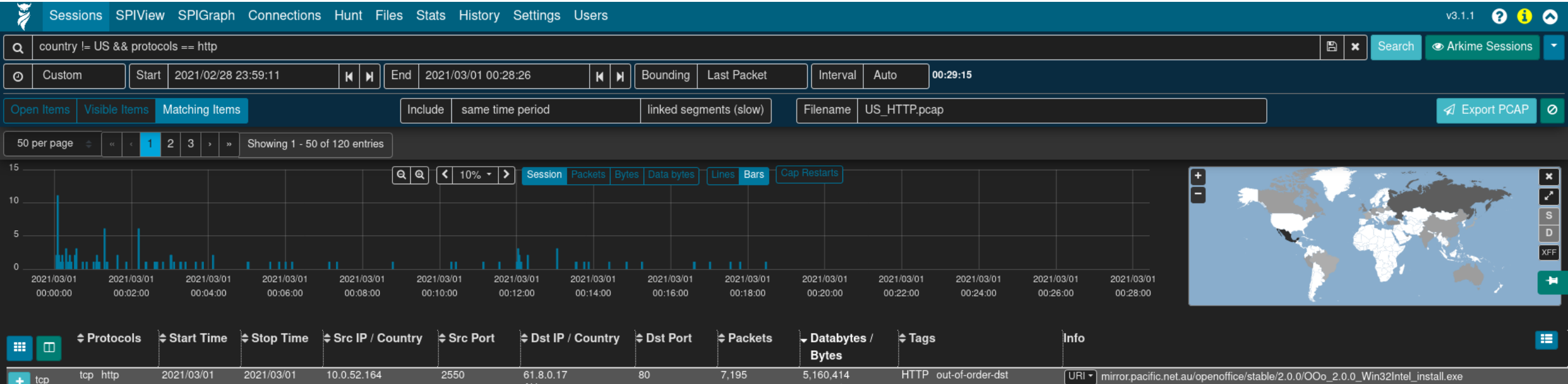
Packet Payloads

- Displayed for Arkime sessions with full PCAP (i.e., not Zeek logs)
- File carving on the fly
- Download session PCAP
- Examine payload with CyberChef



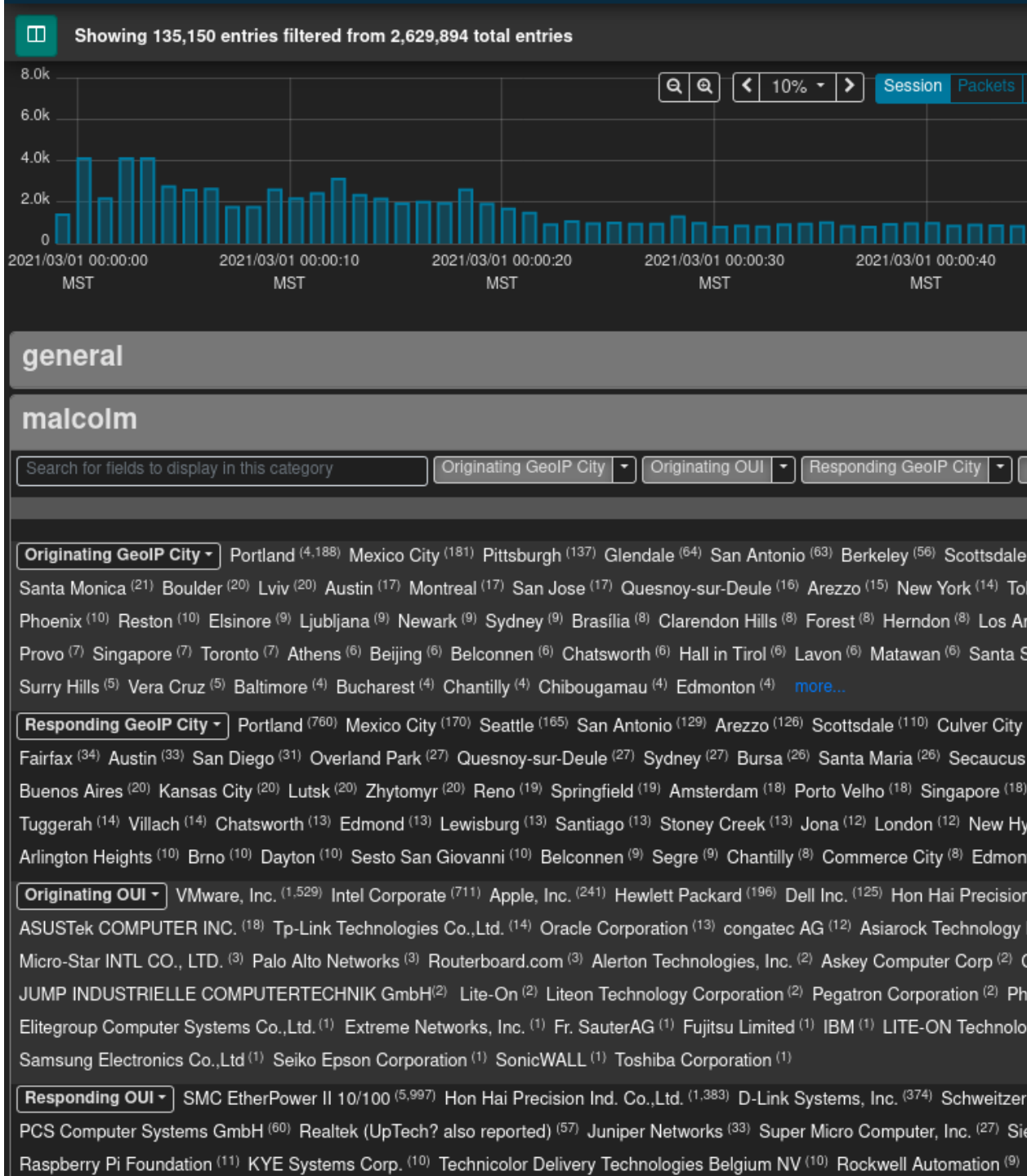
Export PCAP

- Creates a new PCAP file from filtered sessions
- Include open, visible or all matching sessions
- Apply “Arkime Sessions” view to sessions first
- Narrow as much as possible prior to exporting (huge PCAP files are a pain)



SPIView

- Explore “top *n*” and field cardinality for all fields of both Arkime sessions and Zeek logs
- Apply filters or pivot to Sessions or SPIGraph view for field values of interest
- Limit search to ≤ 1 week before using (it runs many queries)

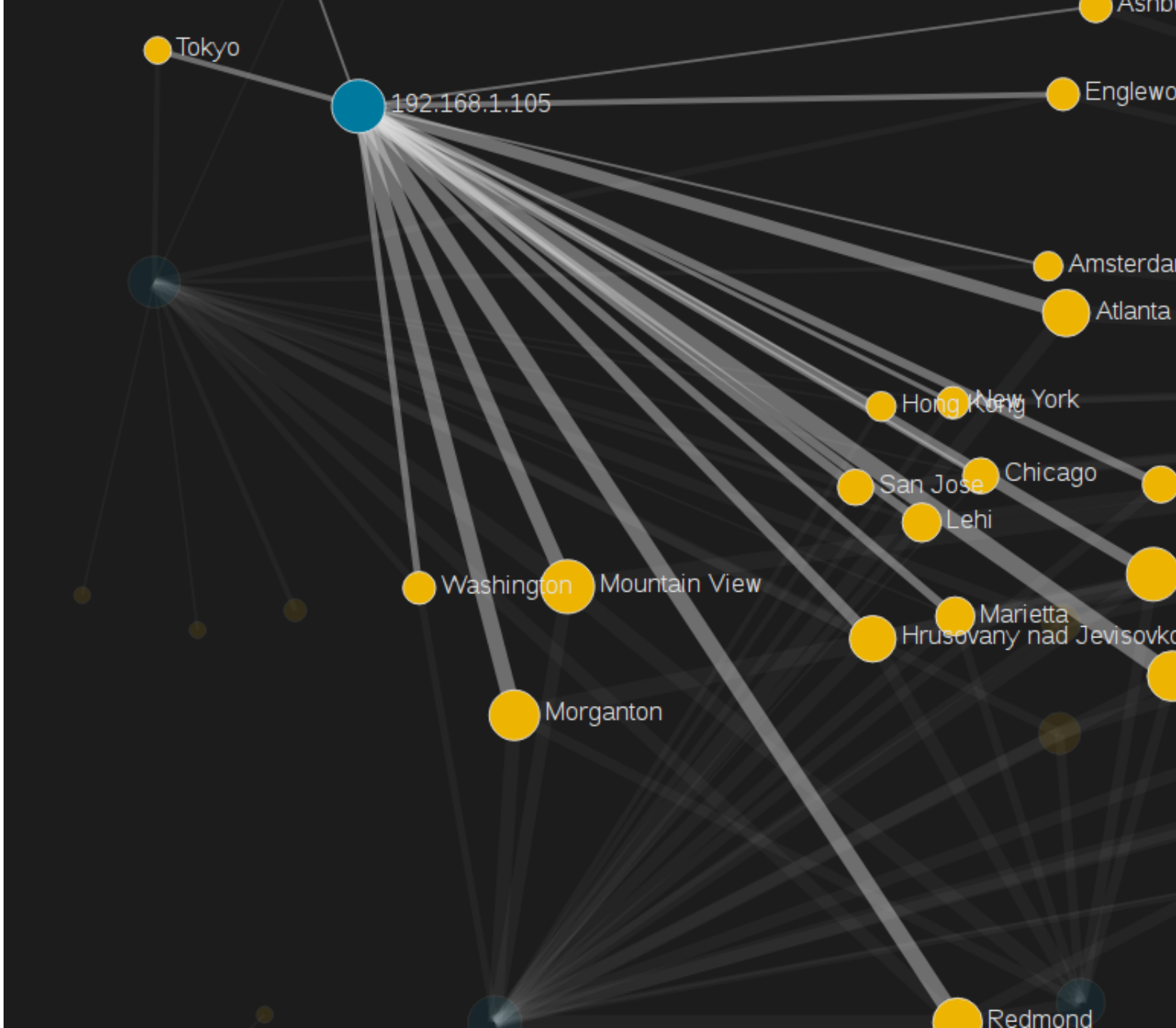


SPIGraph

- View “top *n*” field values chronologically and geographically
- Identify trends and patterns in network traffic

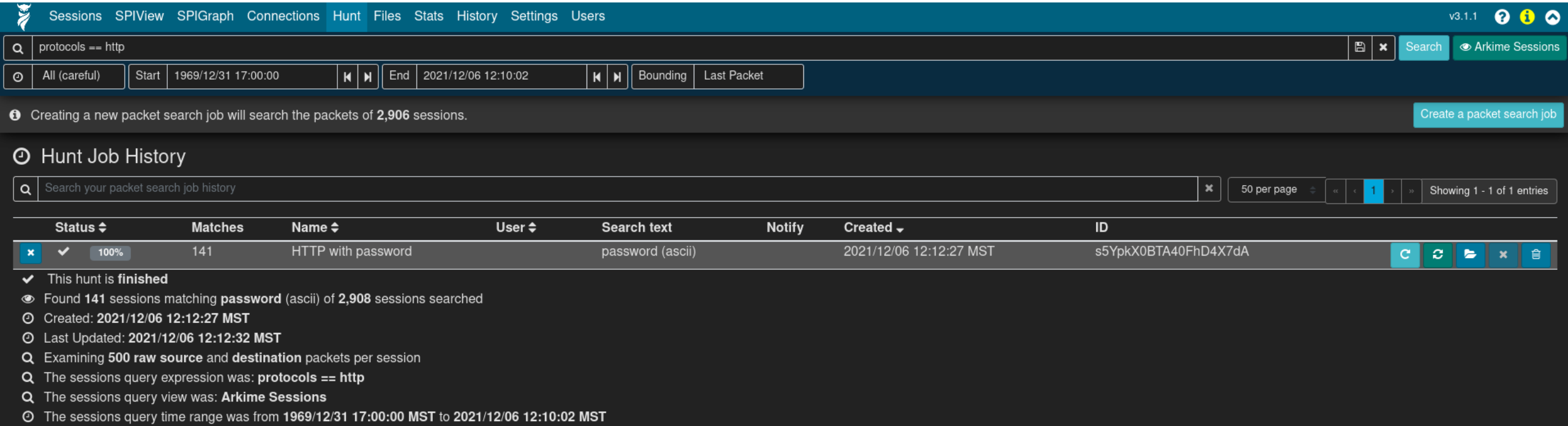
Connections

- Visualize logical relationship between hosts
- Use any combination of fields for source and destination nodes
- Compare current vs. previous (baseline) traffic



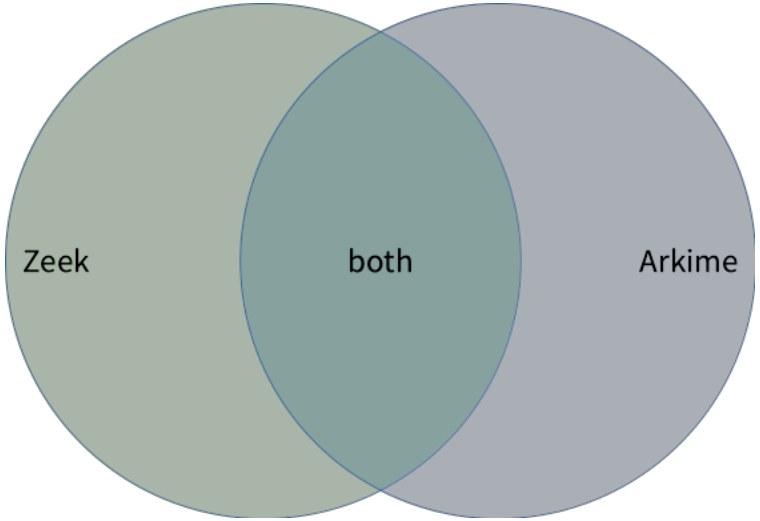
Packet Search (“Hunt”)

- Deep-packet search (“PCAP grep”) of session payloads
- Search for ASCII, hex codes or regular expression matches
- Apply “Arkime Sessions” view to sessions first



Data Source Correlation

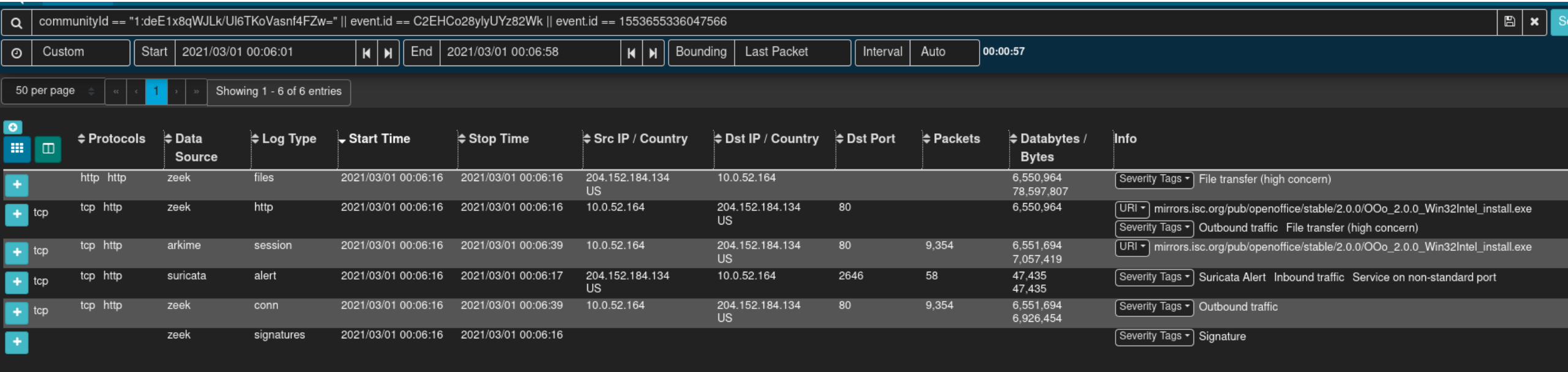
- Search syntax is different between Arkime and Dashboards (and in some cases, so are field names)
  - See search syntax comparison table, Malcolm and Arkime docs
- Despite considerable overlap, there are differences in protocol parser support among Zeek, Suricata and Arkime
  - Learning the strengths of each will help you more effectively find the good stuff



Correlate Zeek or Suricata Logs and Packet Payloads

- Correlate Zeek or Suricata logs and Arkime sessions using common fields
- `communityId` fingerprints flows to bridge data sources
- `rootId`/`event.id` filters logs for the same session
- Filter community ID OR'ed with `event.id` to see all Arkime sessions and Zeek or Suricata logs for the same traffic

```
communityId == "1:r7tGG//fXP1P0+BXH3zXETCtEFI=" || event.id == "CQcoro2z6adgtGlk42"
```



Verify Network Segmentation with NetBox and Asset Interaction Analysis

- Flat networks are problematic (and unfortunately common)
- Security-minded network design incorporates segregating (isolating) and segmenting (dividing) assets into zones with differing levels of trust and well-defined boundaries
  - Enterprise
  - DMZ
  - Operation and Control
  - Supervisory Control
  - Process
  - etc.

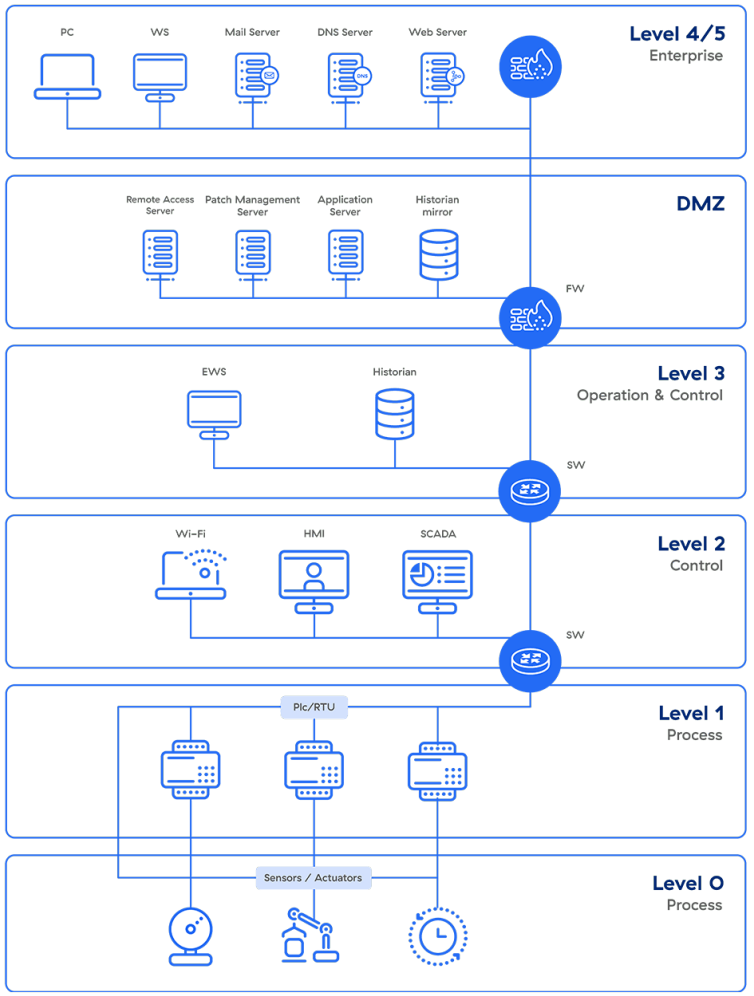
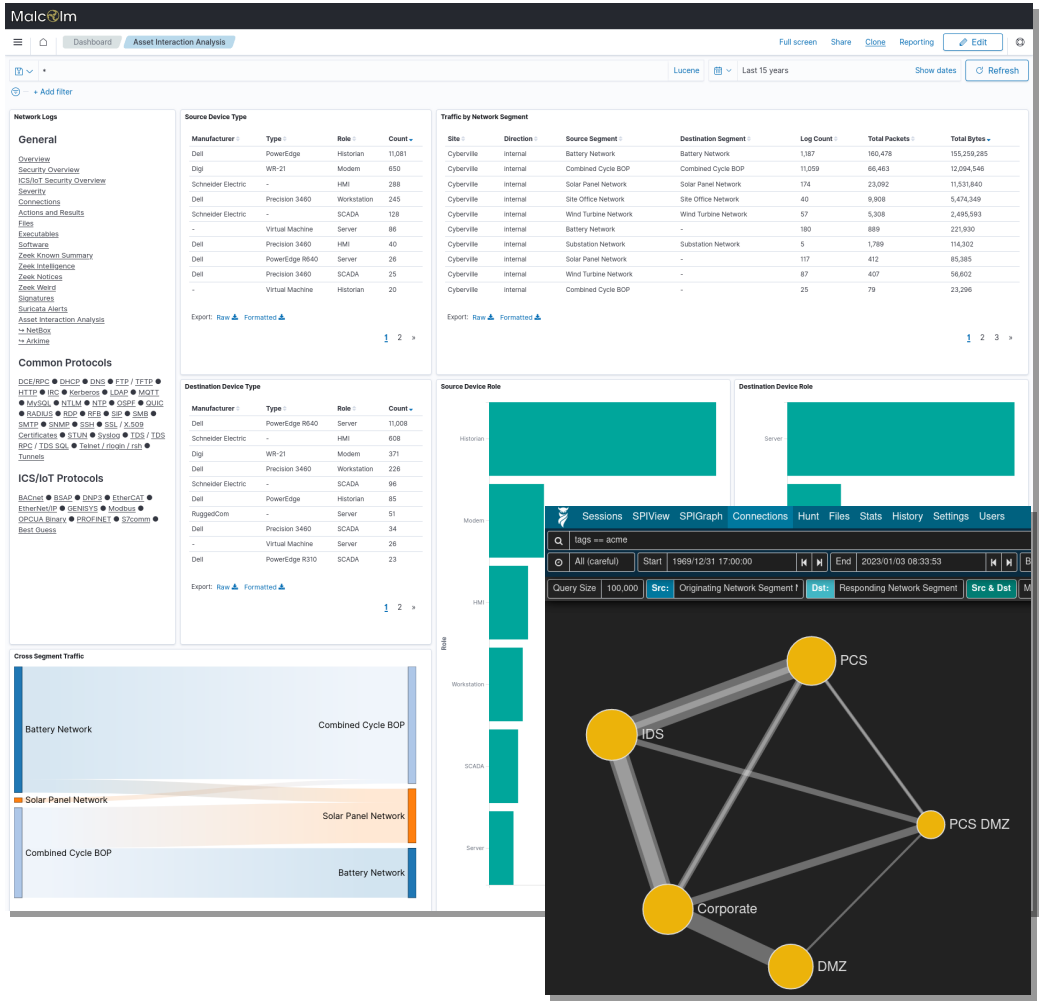


Image credit: Zscaler.com

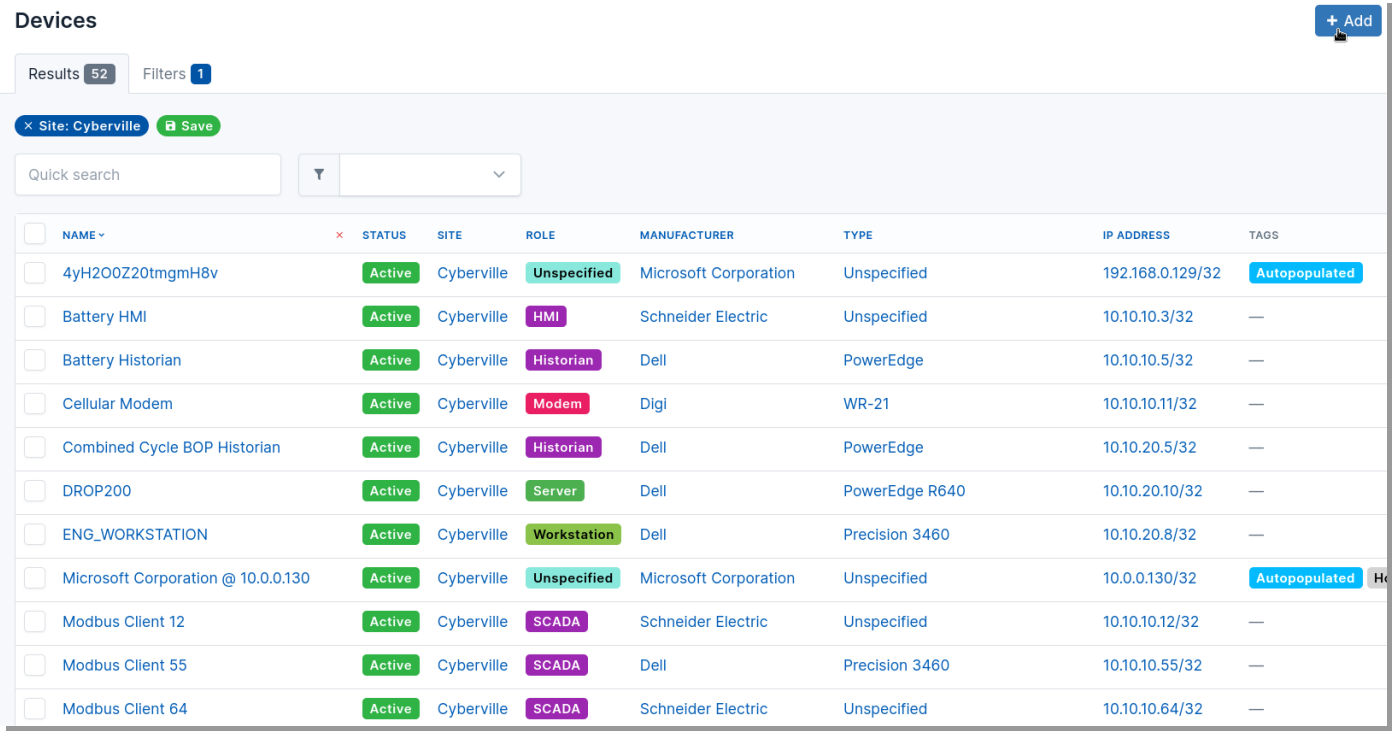
Verify Network Segmentation with NetBox and Asset Interaction Analysis

- Network prefixes are identified by name and CIDR subnet in NetBox
- Observed network traffic is cross-referenced against inventory
- Malcolm dashboards such as **Asset Interaction Analysis** highlight relationships among network segments



Pinpoint Rogue Devices and Services

- Networked devices can be inventoried in NetBox
  - Name
  - IP address
  - Manufacturer
  - SKU or model number
  - Role
- Expected services (application protocols) can be specified for the devices that provide them

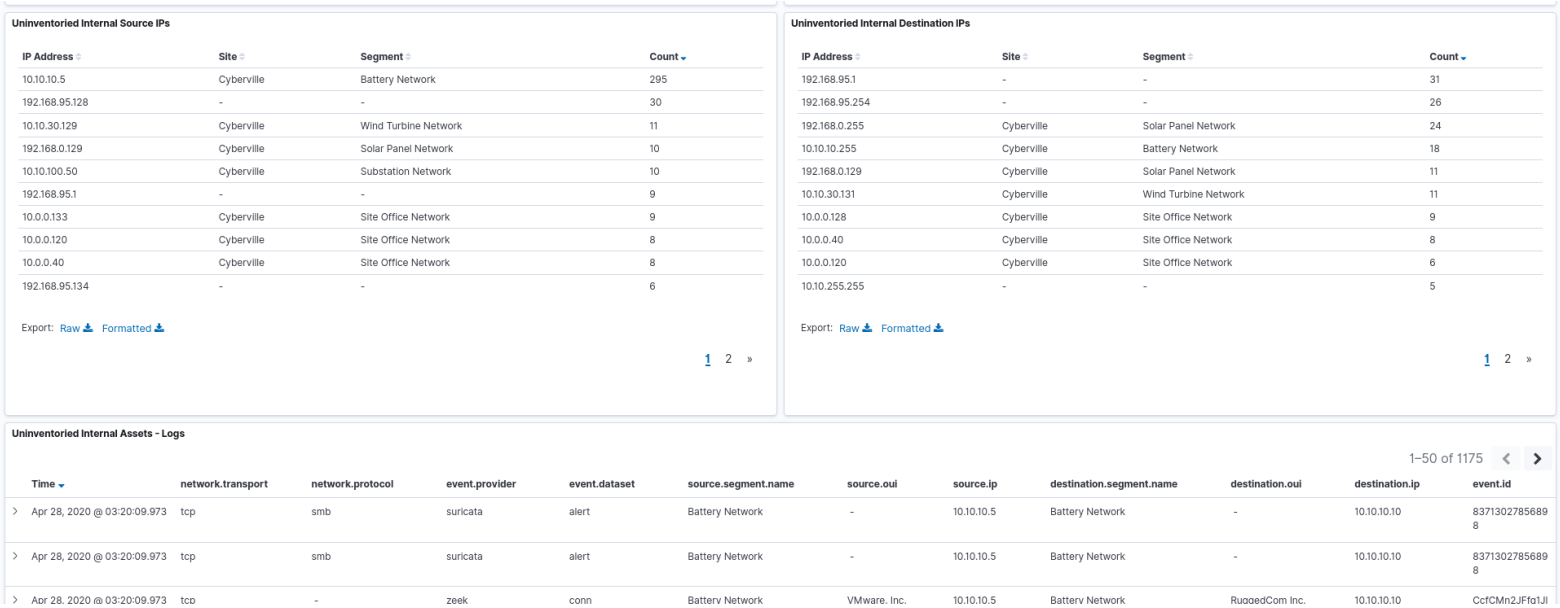


NAME	STATUS	SITE	ROLE	MANUFACTURER	TYPE	IP ADDRESS	TAGS
4yH2O0Z20tmgmH8v	Active	Cyberville	Unspecified	Microsoft Corporation	Unspecified	192.168.0.129/32	Autopopulated
Battery HMI	Active	Cyberville	HMI	Schneider Electric	Unspecified	10.10.10.3/32	—
Battery Historian	Active	Cyberville	Historian	Dell	PowerEdge	10.10.10.5/32	—
Cellular Modem	Active	Cyberville	Modem	Digi	WR-21	10.10.10.11/32	—
Combined Cycle BOP Historian	Active	Cyberville	Historian	Dell	PowerEdge	10.10.20.5/32	—
DROP200	Active	Cyberville	Server	Dell	PowerEdge R640	10.10.20.10/32	—
ENG_WORKSTATION	Active	Cyberville	Workstation	Dell	Precision 3460	10.10.20.8/32	—
Microsoft Corporation @ 10.0.0.130	Active	Cyberville	Unspecified	Microsoft Corporation	Unspecified	10.0.0.130/32	Autopopulated
Modbus Client 12	Active	Cyberville	SCADA	Schneider Electric	Unspecified	10.10.10.12/32	—
Modbus Client 55	Active	Cyberville	SCADA	Dell	Precision 3460	10.10.10.55/32	—
Modbus Client 64	Active	Cyberville	SCADA	Schneider Electric	Unspecified	10.10.10.64/32	—

Pinpoint Rogue Devices and Services

- Dashboards highlight “uninventoried” devices and services (observed but not accounted for in NetBox)
  - Zeek Known Summary
  - Asset Interaction Analysis

- Premade Arkime views
  - Uninventoried Internal Assets
  - Uninventoried Observed Services



Uninventoried Internal Source IPs

IP Address	Site	Segment	Count
10.10.10.5	Cyberville	Battery Network	295
192.168.95.128	-	-	30
10.10.30.129	Cyberville	Wind Turbine Network	11
192.168.0.129	Cyberville	Solar Panel Network	10
10.10.100.50	Cyberville	Substation Network	10
192.168.95.1	-	-	9
10.0.0.133	Cyberville	Site Office Network	9
10.0.0.120	Cyberville	Site Office Network	8
10.0.0.40	Cyberville	Site Office Network	8
192.168.95.134	-	-	6

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Uninventoried Internal Destination IPs

IP Address	Site	Segment	Count
192.168.95.1	-	-	31
192.168.95.254	-	-	26
192.168.0.255	Cyberville	Solar Panel Network	24
10.10.10.255	Cyberville	Battery Network	18
192.168.0.129	Cyberville	Solar Panel Network	11
10.10.30.131	Cyberville	Wind Turbine Network	11
10.0.0.128	Cyberville	Site Office Network	9
10.0.0.40	Cyberville	Site Office Network	8
10.0.0.120	Cyberville	Site Office Network	6
10.10.255.255	-	-	5

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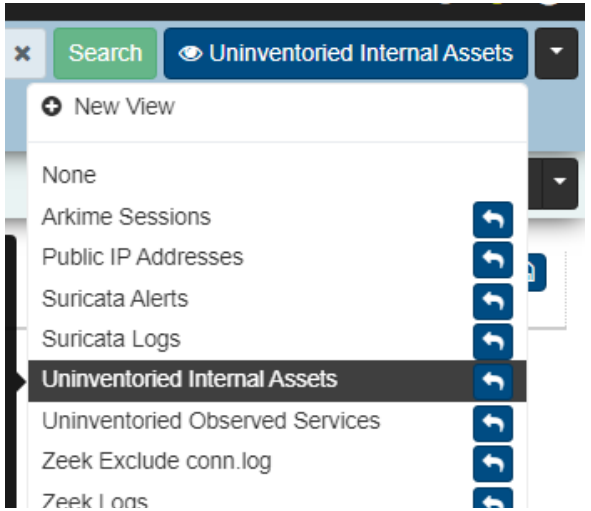
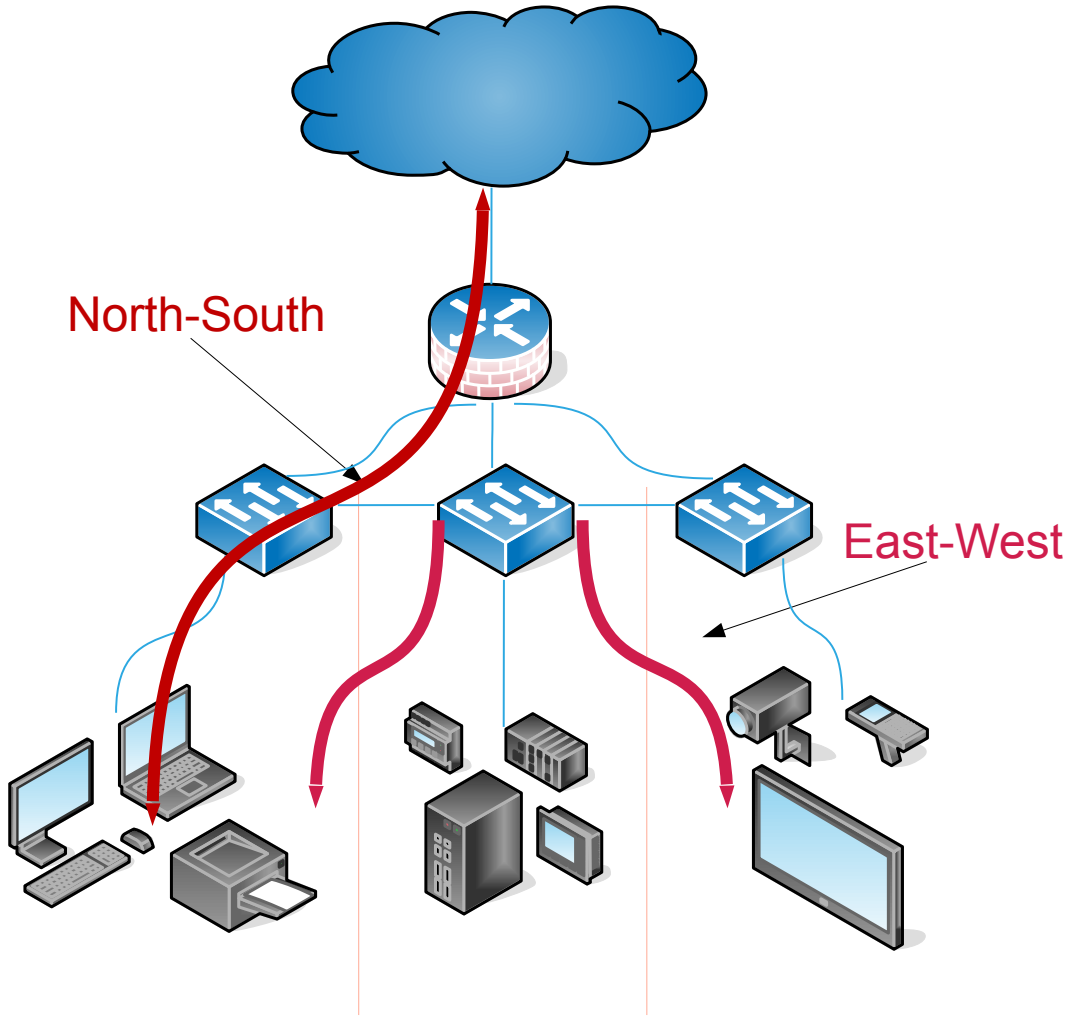
Uninventoried Internal Assets - Logs

1–50 of 1175

Time	network.transport	network.protocol	event.provider	event.dataset	source.segment.name	source.oui	source.ip	destination.segment.name	destination.oui	destination.ip	event.id
Apr 28, 2020 @ 03:20:09.973	tcp	smb	suricata	alert	Battery Network	-	10.10.10.5	Battery Network	-	10.10.10.10	83713027856898
Apr 28, 2020 @ 03:20:09.973	tcp	smb	suricata	alert	Battery Network	-	10.10.10.5	Battery Network	-	10.10.10.10	83713027856898
Apr 28, 2020 @ 03:20:09.973	tcp	-	zeek	conn	Battery Network	VMware, Inc.	10.10.10.5	Battery Network	RuggedCom Inc.	10.10.10.10	CcfCMn2JFfa1JI



Survey East-West and North-South Traffic

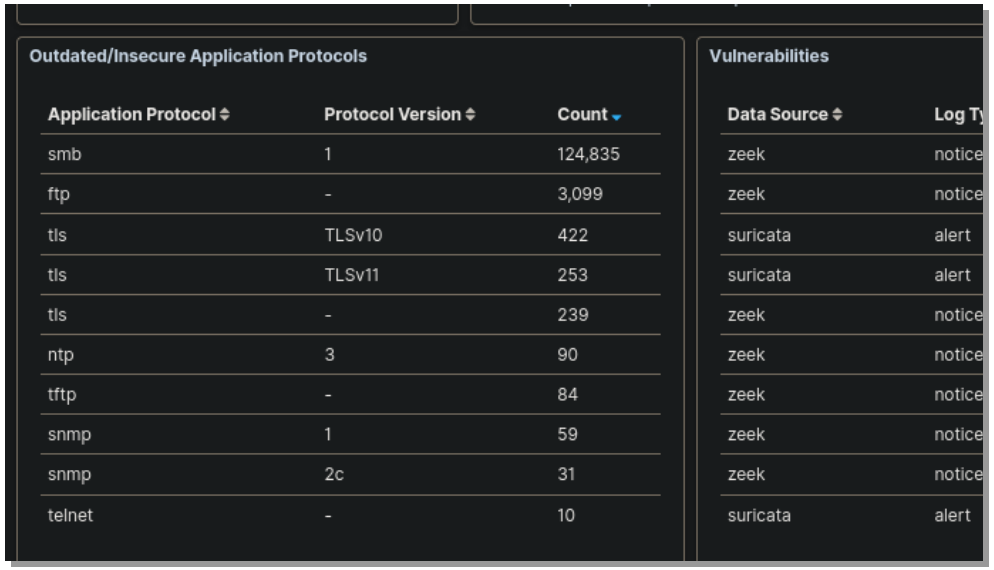


`network.direction` field

- `internal`: East-West
- `inbound`: “Southbound”
- `outbound`: “Northbound”

Review Observed Network Protocols

- Unsecure or outdated protocols
  - SSH < v2
  - TLS < v1.2
  - NTP < v4
  - VNC < v3.8
  - RDP < v6
  - LDAP < v3
  - FTP/TFTP
  - SMB < v3
  - telnet/rlogin/rsh
  - etc.



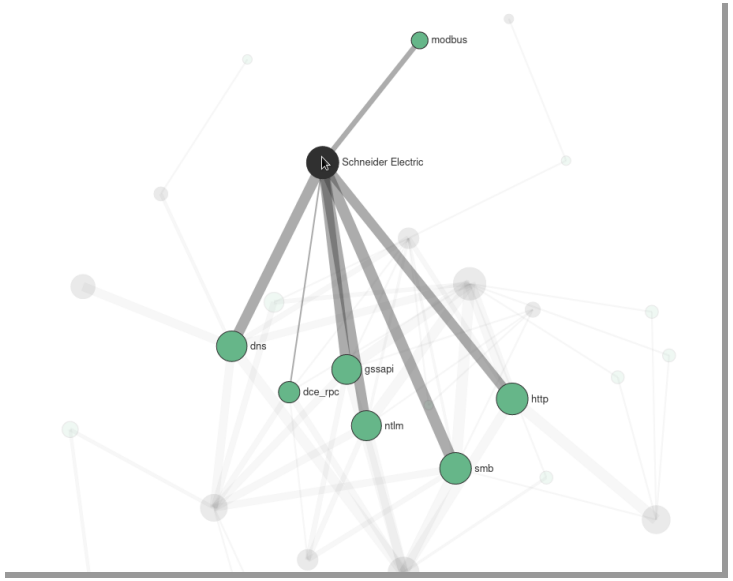
Outdated/Insecure Application Protocols

Application Protocol	Protocol Version	Count
smb	1	124,835
ftp	-	3,099
tls	TLSv10	422
tls	TLSv11	253
tls	-	239
ntp	3	90
tftp	-	84
snmp	1	59
snmp	2c	31
telnet	-	10

Vulnerabilities

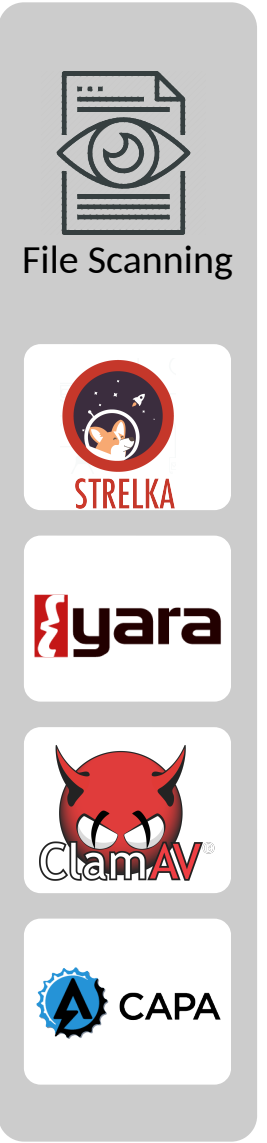
Data Source	Log Ty
zeek	notice
zeek	notice
suricata	alert
suricata	alert
zeek	notice
zeek	notice
zeek	notice
zeek	notice
zeek	notice
zeek	notice
suricata	alert

- Unexpected protocols (traffic that should not be present in a network segment)
  - IPv6
  - DNS
  - DHCP
  - Remote desktop
  - Automatic software updates



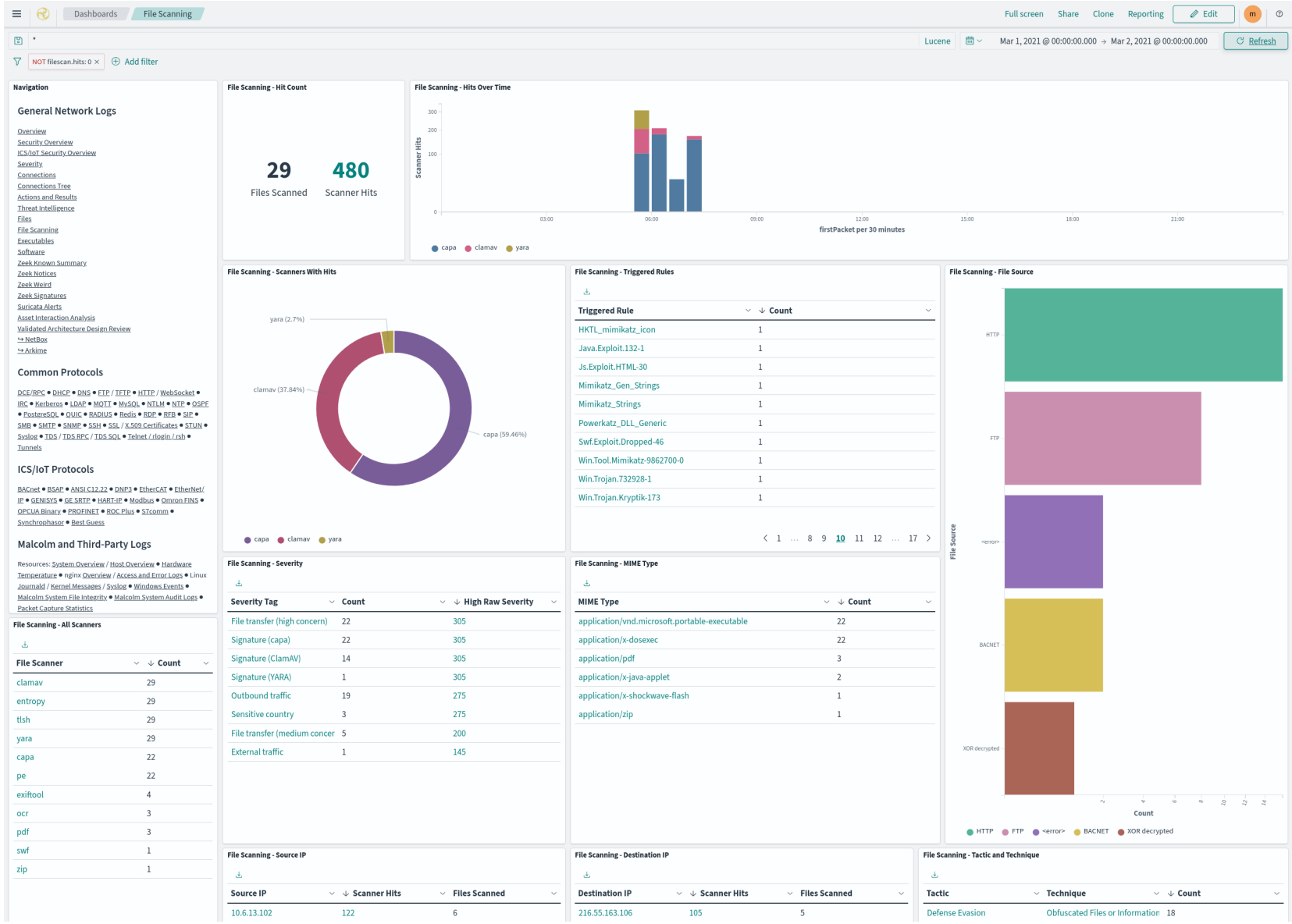
Investigate Suspicious File Transfers

- File transfers are detected in network traffic
  - SMB/CIFS (Windows file shares)
  - SMTP (Email)
  - HTTP (Web downloads)
  - etc.
- Files automatically extracted by Zeek and scanned with Strelka
  - YARA - general-purpose scanner to identify and classify malware
  - ClamAV - antimalware toolkit able to detect many types of malware, including viruses
  - capa - executable capabilities analyzer
  - Dozens of other customizable scanners



File Scanning Dashboard

Summarizes hits from file scanning engines and provides full Strelka scan reports for files extracted from network traffic.



File Transfers: Preserved Files

Files identified as potentially malicious are flagged and optionally preserved for further investigation

HTTP-F0joG01ZpxOl9fc...	text/plain	9.1KiB	HTTP	Cbr24h1HZxRCaZTFkc F0joG01ZpxOl9fcSN8	2024-08-01 17:11:09
HTTP-F0xURA1fatUCF6x...	application/octet-stream	200.0B	HTTP	CP83GU157AS9a3MMG5 F0xURA1fatUCF6xke6	2024-08-01 17:06:49
HTTP-F1AUDG3YVEB45Pl...	application/x-executable	2.5MiB	HTTP	CKl3cA387MUBTT3hG9 F1AUDG3YVEB45Plu3	2024-08-01 17:19:48
HTTP-F1CbYm1PWuPjHV3...	text/html	6.9KiB	HTTP	CSxEQV3MW30sI3U5sh F1CbYm1PWuPjHV3hEc	2024-08-01 17:09:40
HTTP-F1GA1N2fe1qQo4p...	application/octet-stream	160.0B	HTTP	C8gQXv40SN245pNi4d F1GA1N2fe1qQo4pd93	2024-08-01 17:38:03

200 packets | natural | Packet Options | Src Dst | UnXOR Brute GZip Header | UnXOR | Unbase64

Source (10.10.10.5:3453)

```
GET /__utm.gif HTTP/1.0
Accept: */*
Cookie: tJDITvSBUfmkbv6PCGOUWJ8BLelApsLN4/NnJAtbb1cCAso8DUXqXgxUEjENFDZkSYkWM/Udc9Hk9Z1+3heBnnGwJftTDeuEgdLKtS52v
/XlKfTHiEXKvakotKJYevVY4tWeQjH5waD8mFQYSIYeZ2v7Ws7DdHyOCzKooJaEwg8=
Host: {F14G-c2-host-header}
User-Agent: Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 5.1)
Connection: Keep-Alive
Pragma: no-cache
```

Destination (10.10.10.11:80)

```
HTTP/1.1 200 OK
Date: Mon, 20 Apr 2020 20:22:44 GMT
Content-Type: application/octet-stream
Content-Length: 160

__utm.gif
```

192.168.1.31	33	3
192.168.146.1	32	2
192.168.106.131	27	7
10.0.2.15	15	3
192.168.204.211	1	1

Extracted File Downloads

Click the `zeek.files.extracted_uri` value to download the file, if available.

Complete Scan Results

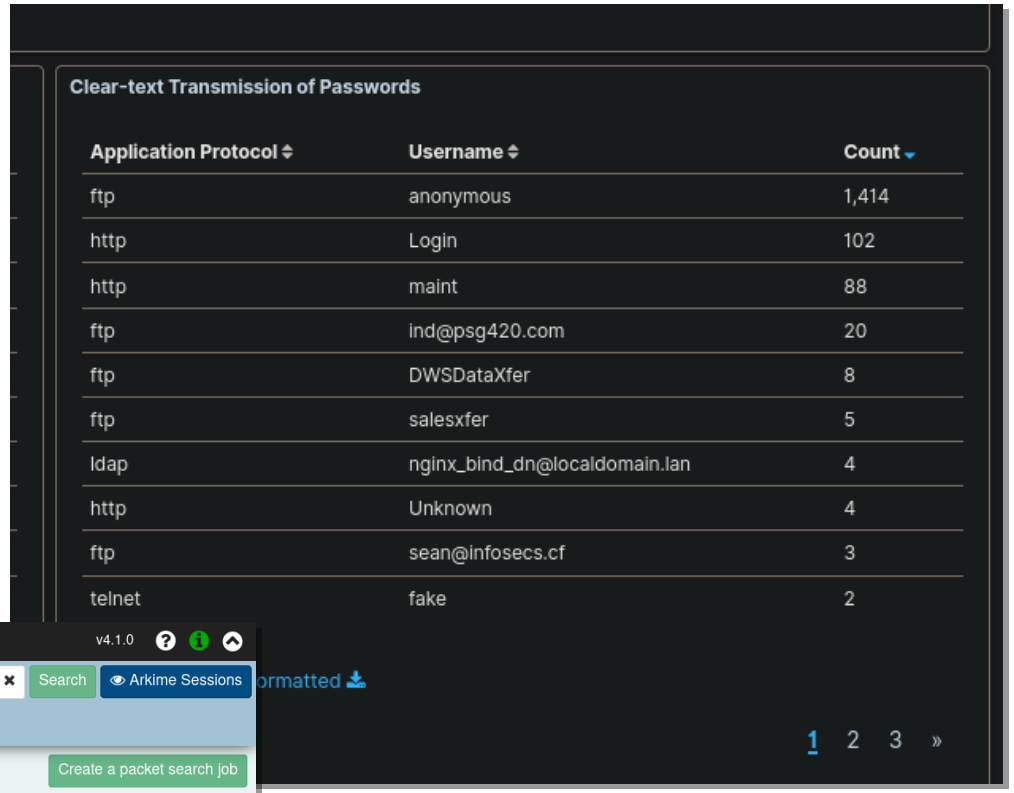
Some scan result fields aren't indexed. Expand a document and click **JSON** to view the full data in the `strelka` field.

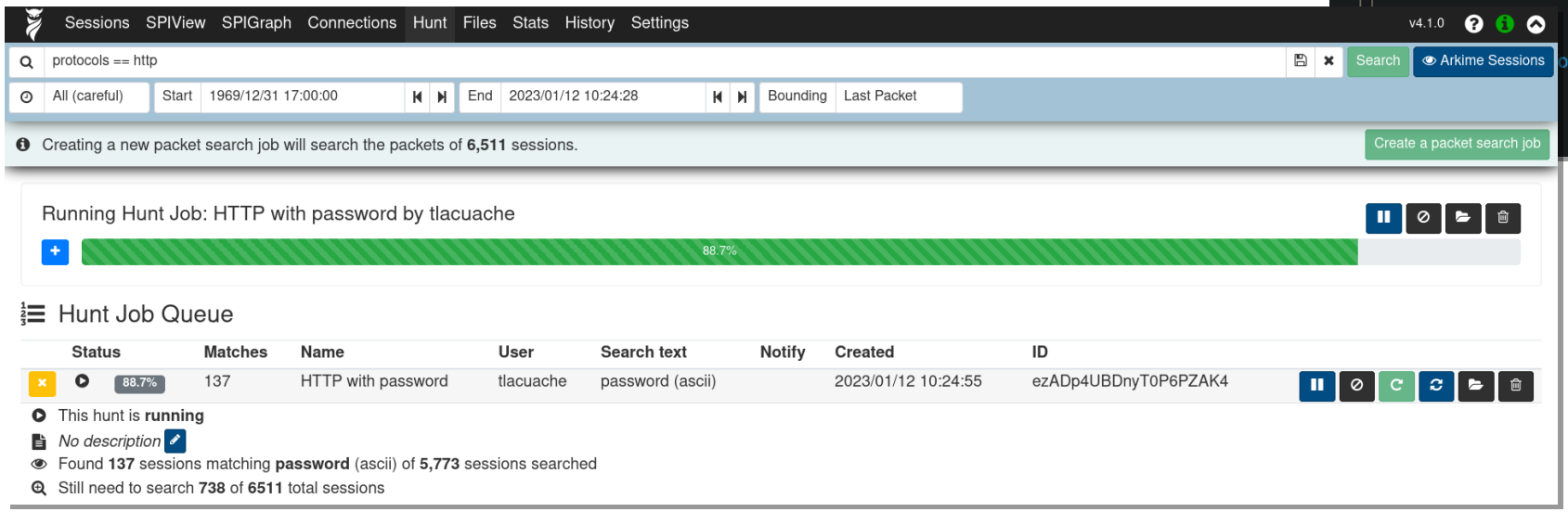
File Scanning - Logs

Time	source.ip	destination.ip	file.mime_type	zeek.files.filename
Mar 1, 2021 @ 07:06:16.928	10.0.52.164	204.152.184.134	application/x-dosexec, application/vnd.microsoft.portable-executable	OOo_2.0.0_Win32Intel_install.exe
Mar 1, 2021 @ 07:03:45.422	10.0.52.164	61.8.0.17	application/x-dosexec, application/vnd.microsoft.portable-executable	OOo_2.0.0_Win32Intel_install.exe
Mar 1, 2021 @ 07:00:56.237	10.0.2.15	212.98.162.62	application/x-dosexec, application/vnd.microsoft.portable-executable	KB971033.exe
Mar 1, 2021 @ 07:00:53.373	10.0.2.15	83.69.233.156	application/x-dosexec, application/vnd.microsoft.portable-executable	calc.exe

Examine Sensitive Unencrypted Data

- Observed cleartext credentials are normalized (e.g., **`related.user`** and **`related.password`**) for ease of locating them across protocols
- Arkime Hunt feature can deep-packet search session payloads for strings, hex codes, or regular expression matches





Towards the Future

- Hunt- and IR-focused analytics and correlation capabilities
- Support generic (Sigma) rules and analytics
- Cross-reference against Common Security Advisory Framework (CSAF) and KEV (Known Exploited Vulnerabilities) catalog

- Improve cloud deployment
- Improve upgrade workflow
- Revamp installation/configuration tool with GUI
- Distributed rule/policy management for network sensors
- Explore the possibility of ML/AI/LLM integrations
- Improve integration and correlation of third-party and host logs
- Increase OT/ICS protocol support

Malcolm

Thank you!

Visit Malcolm on GitHub to read the docs, make suggestions, report issues and st★r to show your support!

Malcolm is open-source software developed at Idaho National Lab