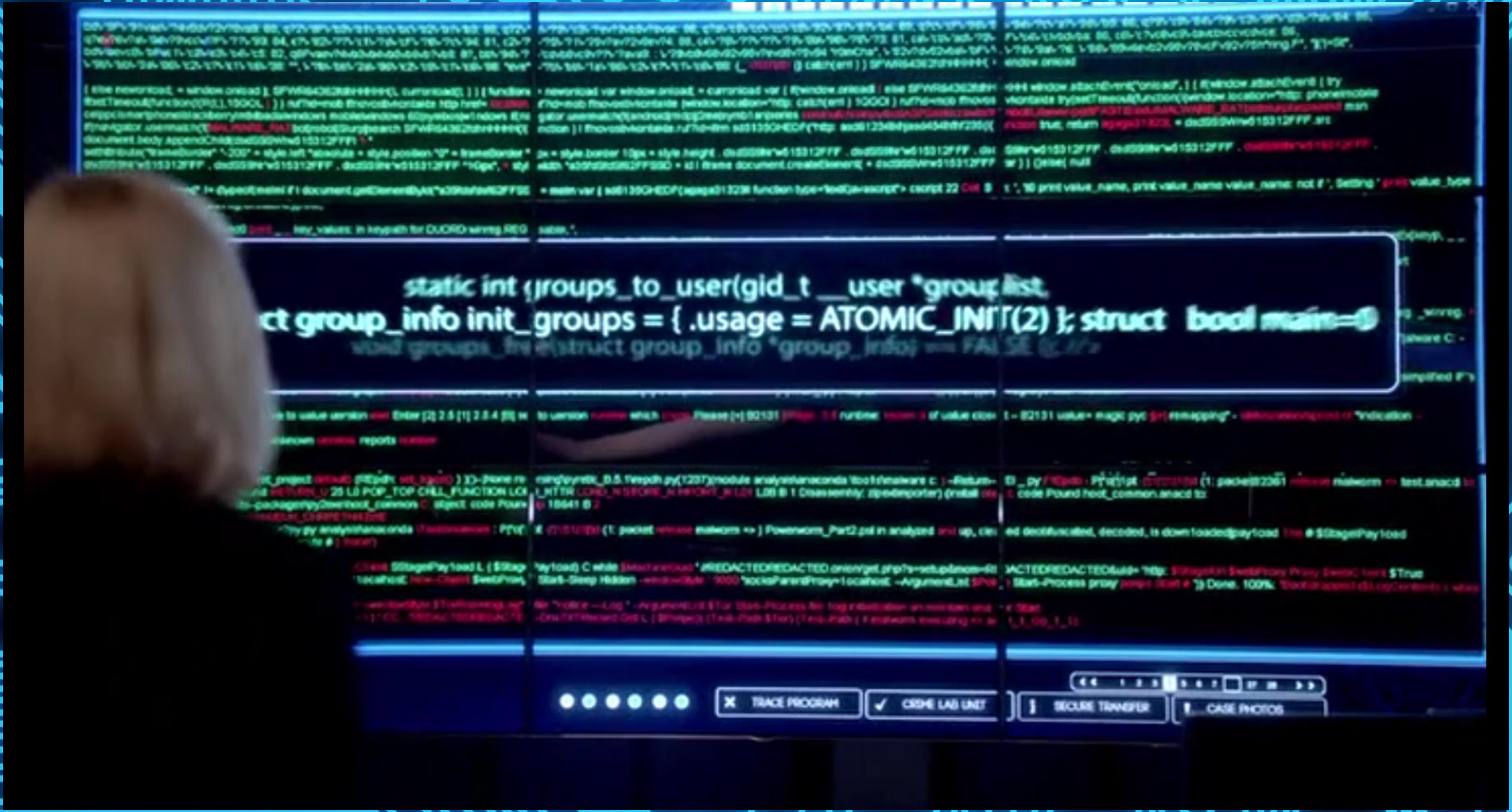
Processing 3,000,000,000 Log Entries Per Week

Landy Bible – Information Security Analyst – The University of Tulsa



```
static int groups_to_user(gid_t __user *grouplist,
ct group_info init_groups = { .usage = ATOMIC_INIT(2) }; struct  bool main=0
void groups_free(struct group_info *group_info) == FALSE
```

Department of Justice · Federal Bureau of Investigation

14:54:18
19:54:19
Processing 3,000,000,000
Log Entries Per Week
Landy Bible – Information Security Analyst – The University of Tulsa
DELL
DELL
DELL

THE UNIVERSITY of TULSA

@ljb2of3

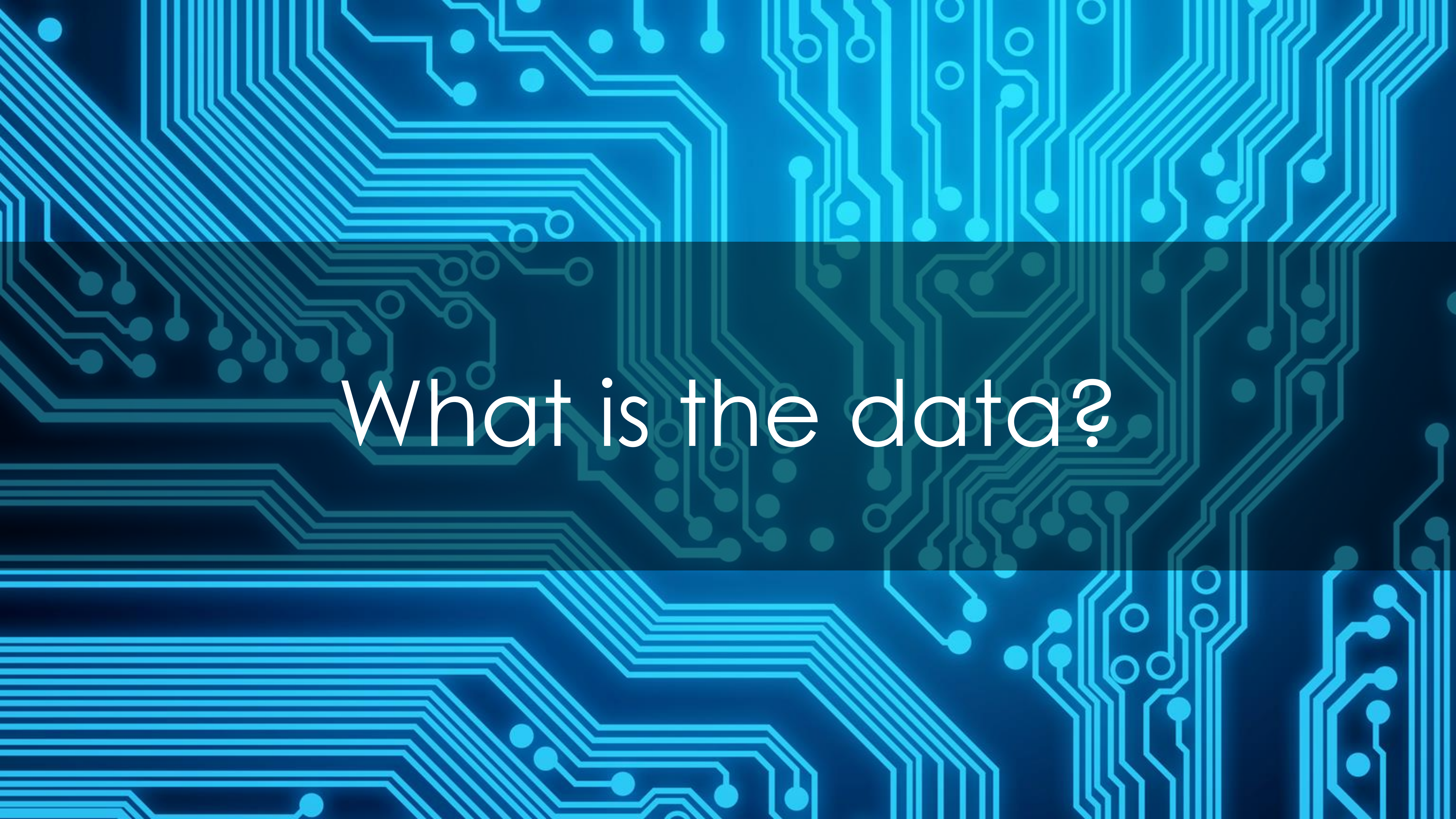
GitHub Repo has slides and setup guide

It’s All About The Data

What is the interesting data?

How do you collect it?

How do you search it?



What is the data?

What are the questions?

- How many computers are active on the network?
- How many connections does our email server get?
- Which countries are our servers connecting to?
- Are there any computers running port scans?
- Which computers are sending emails?
- What computer was assigned a particular IP address?
- On which ports are our servers accepting connections?

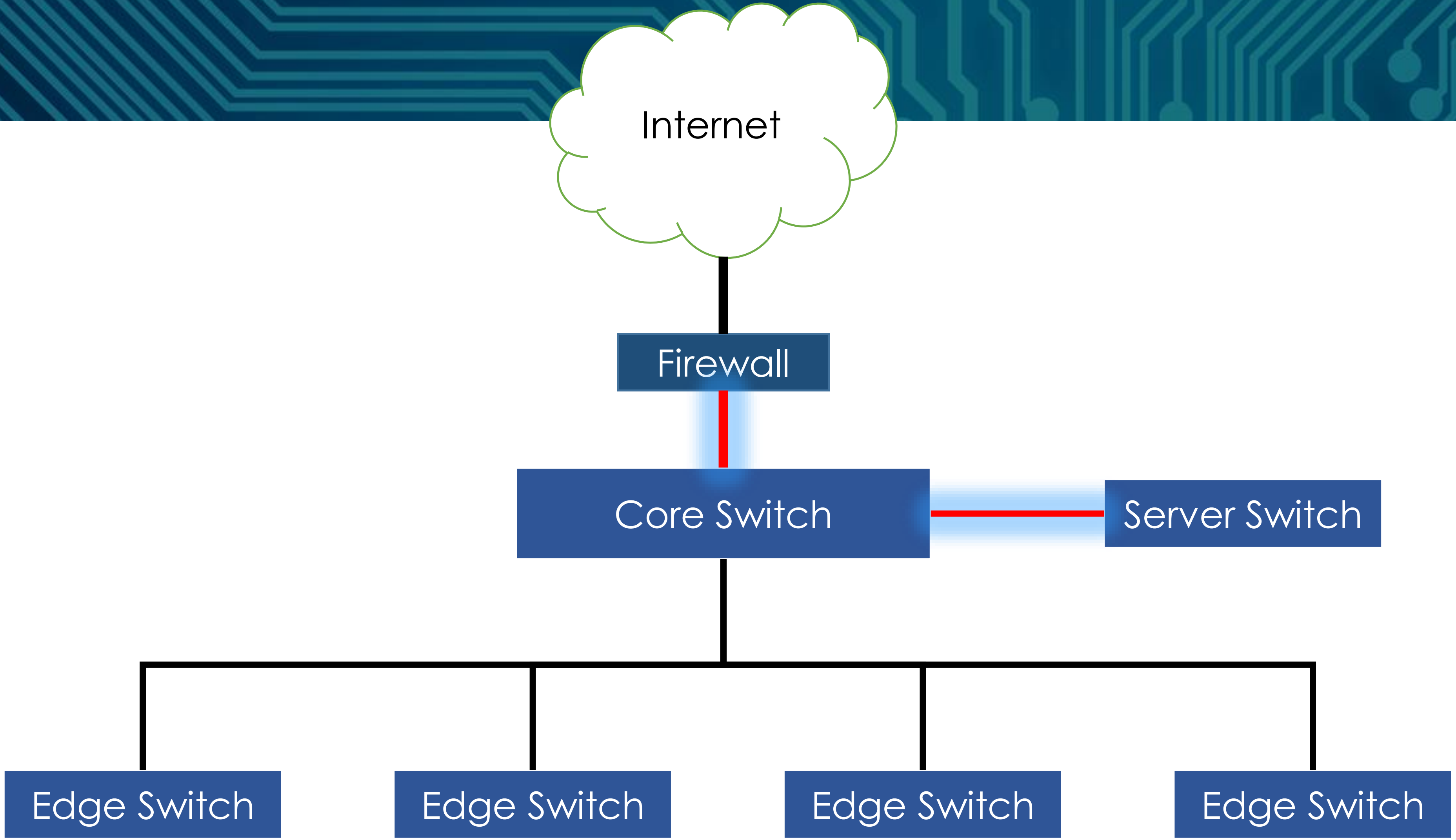
What is The Interesting Data?

- Network connection details
  - Source and Destination IP & Port
  - Protocol Information
  - Connection State
- DNS Requests
- DHCP Assignments
- HTTP Requests

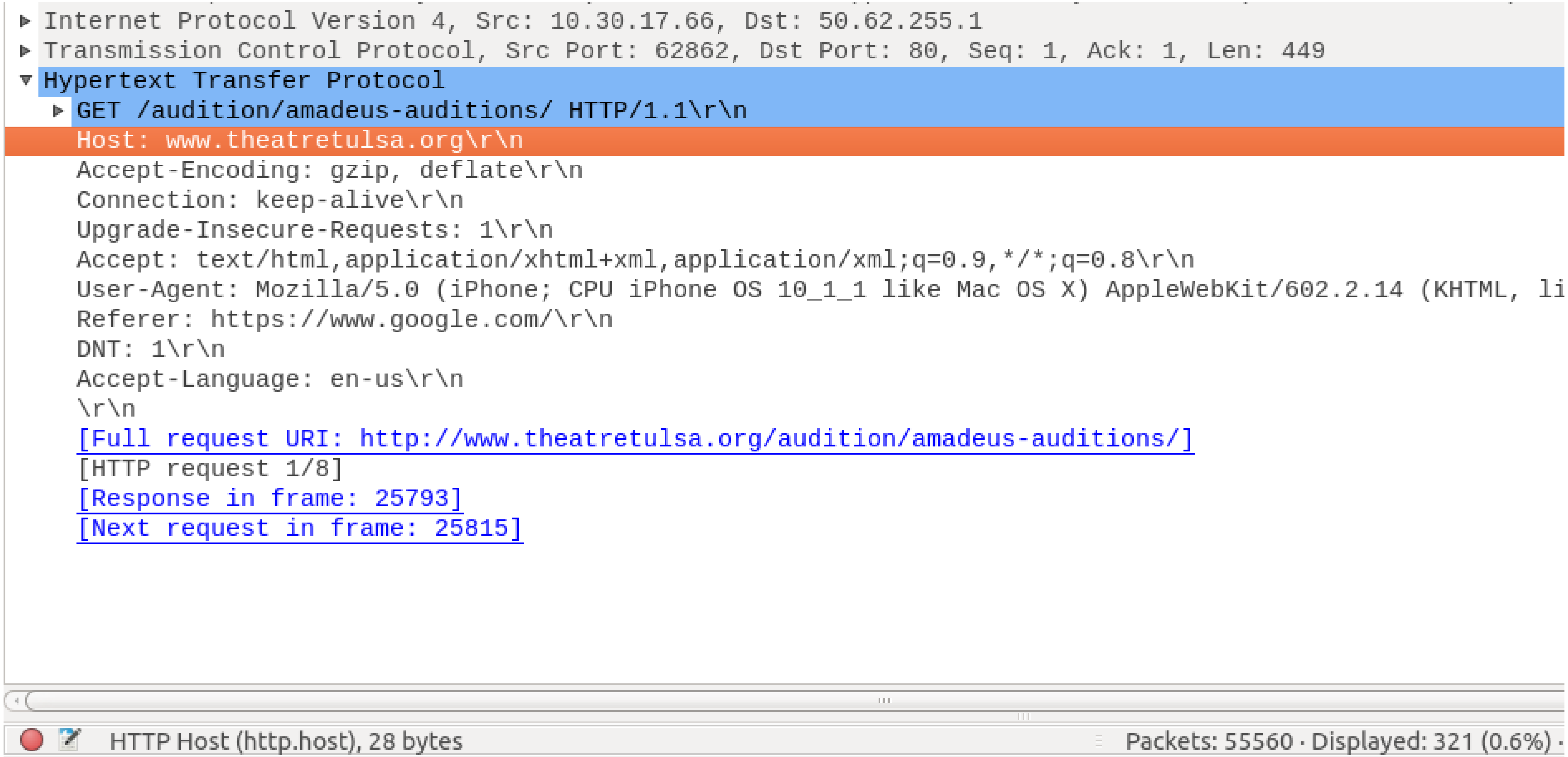
How do you collect it?

How do you collect it?

- Mirror ports or Network taps
- Placement is key
  - Insert in a place where interesting traffic will flow
    - At the network border
    - Between client and server networks
  - Change your network topology if needed
- Tap Aggregation
  - Combine several taps into one output


Internet
Firewall
Core Switch
Server Switch
Edge Switch
Edge Switch
Edge Switch
Edge Switch

Wireshark Example



```
▶ Internet Protocol Version 4, Src: 10.30.17.66, Dst: 50.62.255.1
▶ Transmission Control Protocol, Src Port: 62862, Dst Port: 80, Seq: 1, Ack: 1, Len: 449
▼ Hypertext Transfer Protocol
  ▶ GET /audition/amadeus-auditions/ HTTP/1.1\r\n
    Host: www.theatretulsa.org\r\n
    Accept-Encoding: gzip, deflate\r\n
    Connection: keep-alive\r\n
    Upgrade-Insecure-Requests: 1\r\n
    Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8\r\n
    User-Agent: Mozilla/5.0 (iPhone; CPU iPhone OS 10_1_1 like Mac OS X) AppleWebKit/602.2.14 (KHTML, li
    Referer: https://www.google.com/\r\n
    DNT: 1\r\n
    Accept-Language: en-us\r\n
    \r\n
    [Full request URI: http://www.theatretulsa.org/audition/amadeus-auditions/]
    [HTTP request 1/8]
    [Response in frame: 25793]
    [Next request in frame: 25815]
```

```
HTTP Host (http.host), 28 bytes          Packets: 55560 · Displayed: 321 (0.6%) ·
```

How Do You Collect It?

- Bro Network Security Monitor
    - http://www.bro.org/
    - Fully passive traffic analysis off a network tap
    - Comprehensive logging of activity for forensics
    - Support for many application-layer protocols
        - DNS, FTP, HTTP, IRC, SMTP, SSH, SSL, etc…

Bro Log Example – conn.log

```
{
  "ts": 1500310758.9116,
  "uid": "Cuj5Ui0hNjQwxBZr2",
  "id.orig_h": "10.30.17.66",
  "id.orig_p": 62862,
  "id.resp_h": "50.62.255.1",
  "id.resp_p": 80,
  "proto": "tcp",
  "service": "http",
  "duration": 11.649768,
  "orig_bytes": 3478,
  "resp_bytes": 336832,
  "conn_state": "SF",
  "local_orig": true,
  "local_resp": false,
  "missed_bytes": 203253,
  "history": "ShADadtcfF",
  "orig_pkts": 182,
  "orig_ip_bytes": 12954,
  "resp_pkts": 112,
  "resp_ip_bytes": 149099,
  "tunnel_parents": [  ]
}
```

Bro Log Example – http.log

```
{
"ts": 1500310758.9826,
"uid": "Cuj5Ui0hNjQwxBZr2",
"id.orig_h": "10.30.17.66",
"id.orig_p": 62862,
"id.resp_h": "50.62.255.1",
"id.resp_p": 80,
"trans_depth": 1,
"method": "GET",
"host": "www.theatretulsa.org",
"uri": "\/audition\/amadeus-auditions\/",
"user_agent": "Mozilla\/5.0 (iPhone; CPU iPhone OS 10_1_1 like Mac OS X)
AppleWebKit\/602.2.14 (KHTML, like Gecko) Version\/10.0 Mobile\/14B100
Safari\/602.1",
"referrer": "https:\/\/www.google.com\/",
"version": "1.1",
"request_body_len": 0,
"response_body_len": 42910,
"status_code": 200,
"status_msg": "OK",
"tags": [ ],
"resp_fuids": [ "Fe2BNf4EtOZGGyffYi" ],
"resp_mime_types": [ "text\/html" ]
}
```

Bro Log Example – http.log (x8)

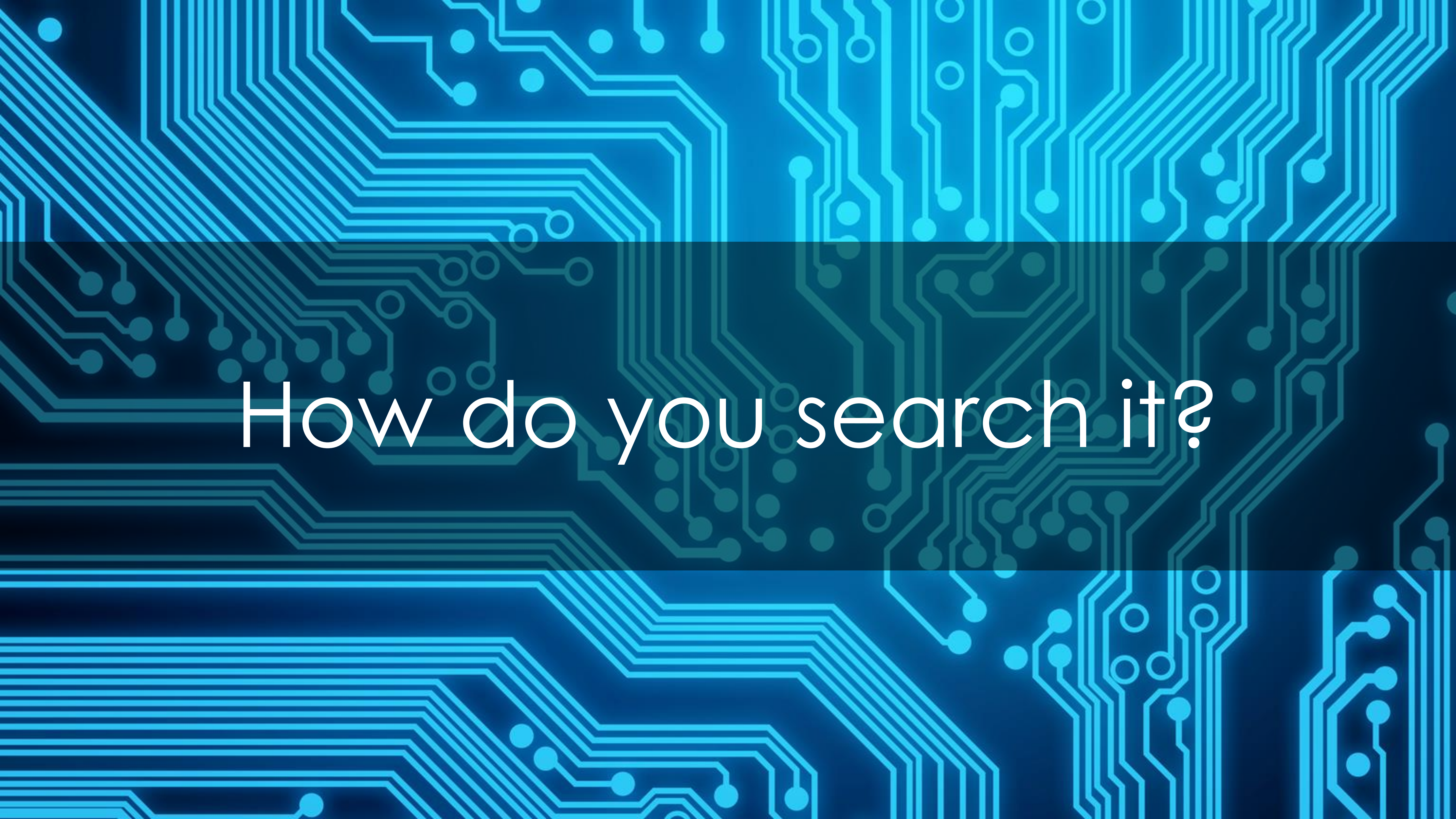
```
"uri":"/audition/amadeus-auditions/"

"uri":"/wp-includes/js/wp-emoji-release.min.js?ver=4.7.5"

"uri":"/wp-content/themes/Divi/epanel/shortcodes/css/shortcodes.css?ver=3.0"

"uri":"/wp-content/themes/Divi/epanel/shortcodes/css/shortcodes_responsive.css?ver=3.0"

"uri":"/wp-includes/js/jquery/jquery.js?ver=1.12.4"

"uri":"/wp-content/themes/Divi/includes/builder/scripts/frontend-builder-scripts.js?ver=2.5.5"

"uri":"/wp-content/uploads/2015/10/93TT_Brochure-BKG-s1_rev3-TULLCa.jpg"

"uri":"/wp-content/plugins/jetpack/_inc/genericons/genericons/Genericons.svg"
```

Bro Log Example – files.log

```
{
"ts": 1500310761.4586,
"fuid": "Fe2BNf4EtOZGGyffYi",
"tx_hosts": [ "50.62.255.1" ],
"rx_hosts": [ "10.30.17.66" ],
"conn_uids": ["Cuj5Ui0hNjQwxBZr2"],
"source": "HTTP",
"depth": 0,
"analyzers": [ "MD5", "SHA1" ],
"mime_type": "text\/html",
"duration": 0.008051,
"local_orig": false,
"is_orig": false,
"seen_bytes": 42910,
"missing_bytes": 0,
"overflow_bytes": 0,
"timedout": false,
"md5": "fa7fa21df2e0e30f425e6f2fed51755c",
"sha1": "6ff743f581caceda059ac3e13e8f99c578f67df9"
}
```

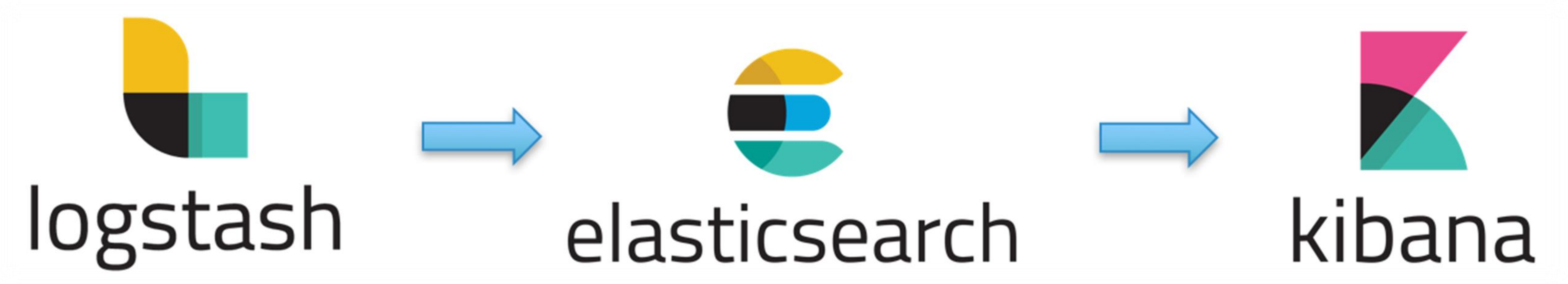
Bro Logs

- conn.log
- dce_rpc.log
- dhcp.log
- dns.log
- dpd.log
- files.log
- http.log
- kerberos.log
- known_hosts.log
- known_services.log
- notice.log
- ntlm.log
- snmp.log
- software.log
- ssl.log
- stats.log
- weird.log
- x509.log



How do you search it?

How do you search it?



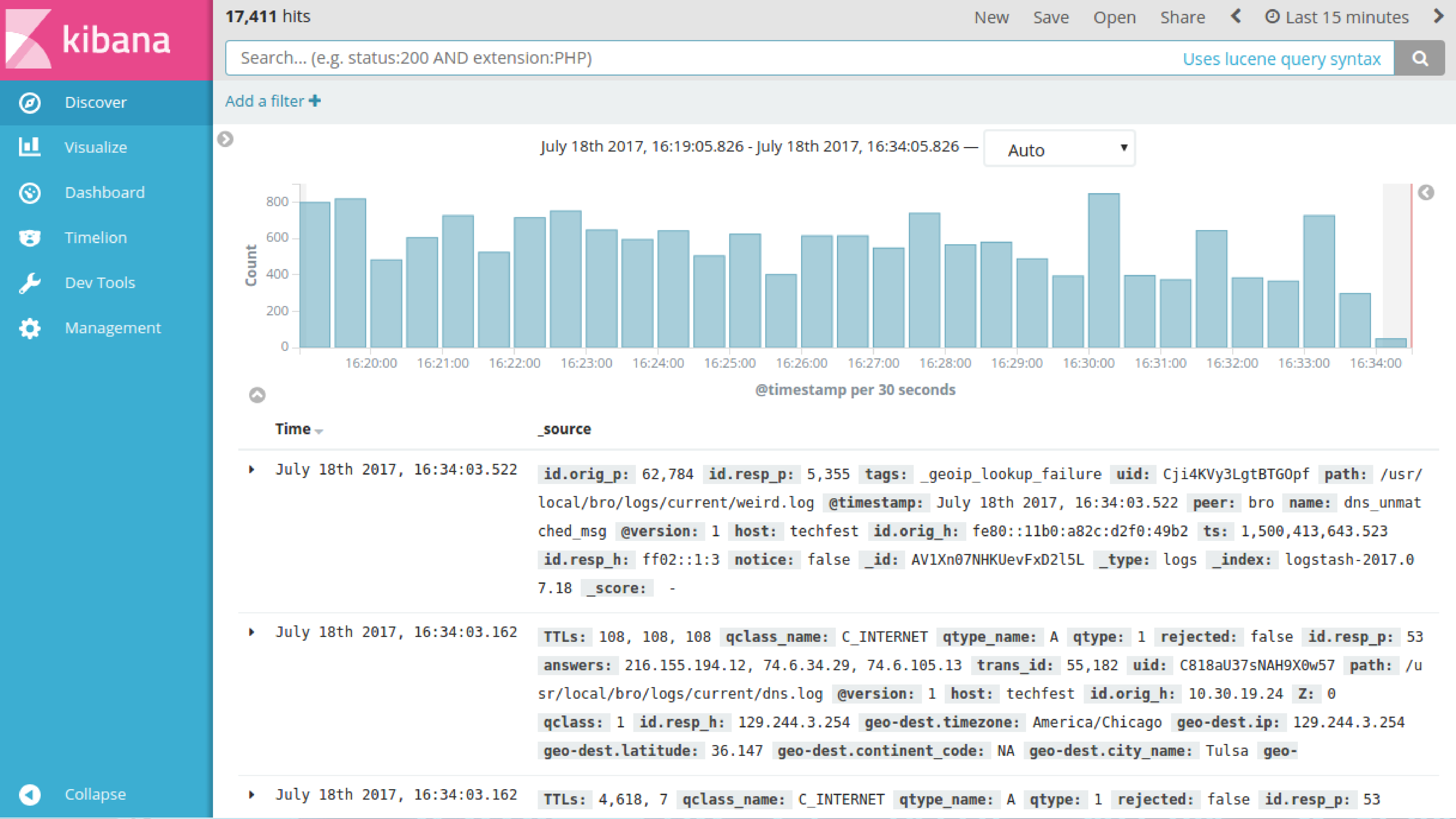
Log Input
+
Enrichment

Log Storage
+
Search API

Search UI

Logstash Configuration

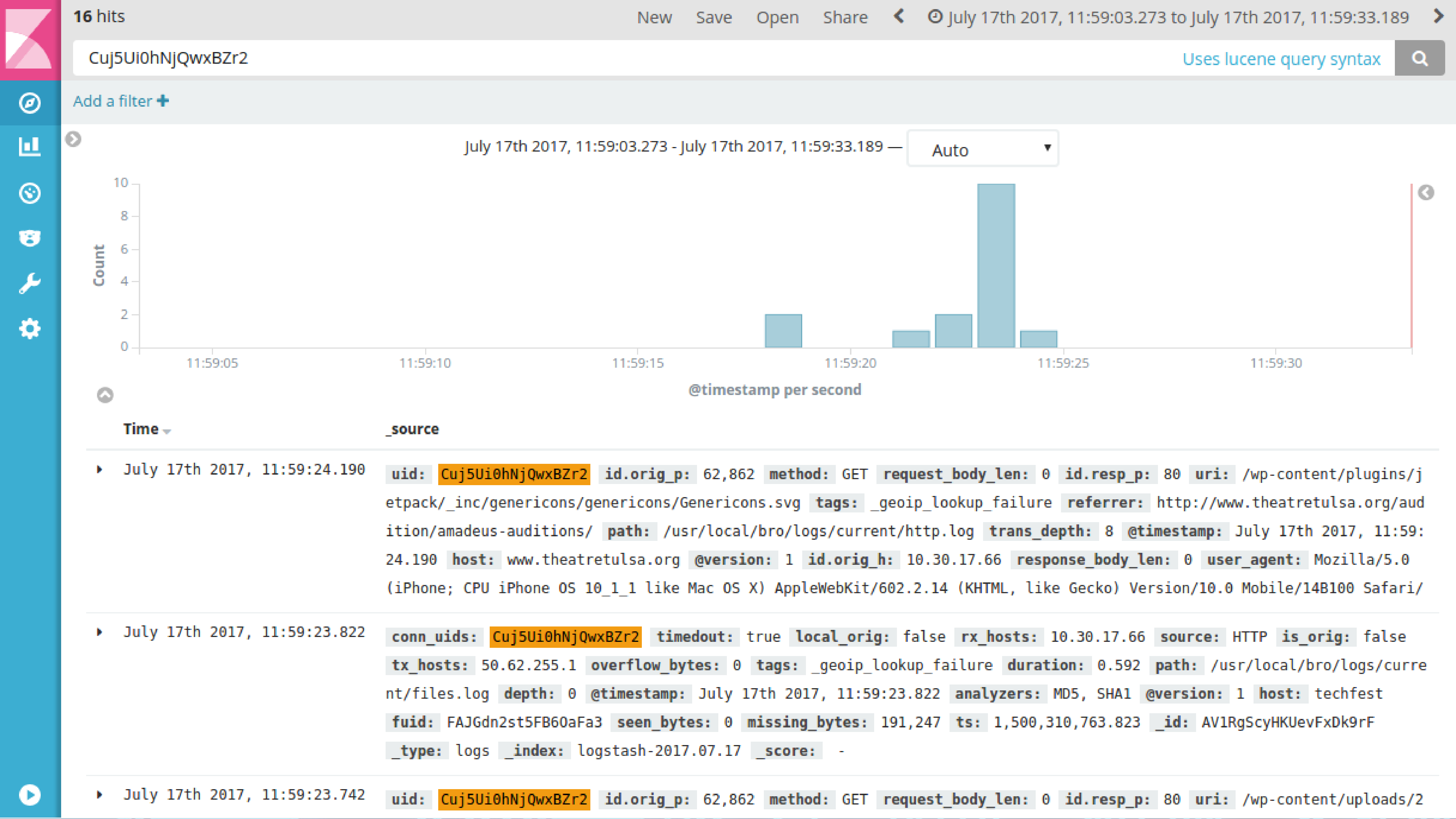
```
input {
  file {
    path => ‘/usr/local/bro/logs/current/*.log’
  }
}
filter {
  date {
    match => [‘ts’,’UNIX’]
  }
}
output {
  elasticsearch {
  }
}
```



17,411 hits

July 18th 2017, 16:19:05.826 - July 18th 2017, 16:34:05.826 —

```
July 18th 2017, 16:34:03.522   id.orig_p: 62,784 id.resp_p: 5,355 tags: _geoip_lookup_failure uid: Cji4KVy3LgtBTGOpf path: /usr/
                               local/bro/logs/current/weird.log @timestamp: July 18th 2017, 16:34:03.522 peer: bro name: dns_unmat
                               ched_msg @version: 1 host: techfest id.orig_h: fe80::11b0:a82c:d2f0:49b2 ts: 1,500,413,643.523
                               id.resp_h: ff02::1:3 notice: false _id: AV1Xn07NHKUevFxD2l5L _type: logs _index: logstash-2017.0
                               7.18 _score: -

July 18th 2017, 16:34:03.162   TTLs: 108, 108, 108 qclass_name: C_INTERNET qtype_name: A qtype: 1 rejected: false id.resp_p: 53
                               answers: 216.155.194.12, 74.6.34.29, 74.6.105.13 trans_id: 55,182 uid: C818aU37sNAH9X0w57 path: /u
                               sr/local/bro/logs/current/dns.log @version: 1 host: techfest id.orig_h: 10.30.19.24 Z: 0
                               qclass: 1 id.resp_h: 129.244.3.254 geo-dest.timezone: America/Chicago geo-dest.ip: 129.244.3.254
                               geo-dest.latitude: 36.147 geo-dest.continent_code: NA geo-dest.city_name: Tulsa geo-

July 18th 2017, 16:34:03.162   TTLs: 4,618, 7 qclass_name: C_INTERNET qtype_name: A qtype: 1 rejected: false id.resp_p: 53
```



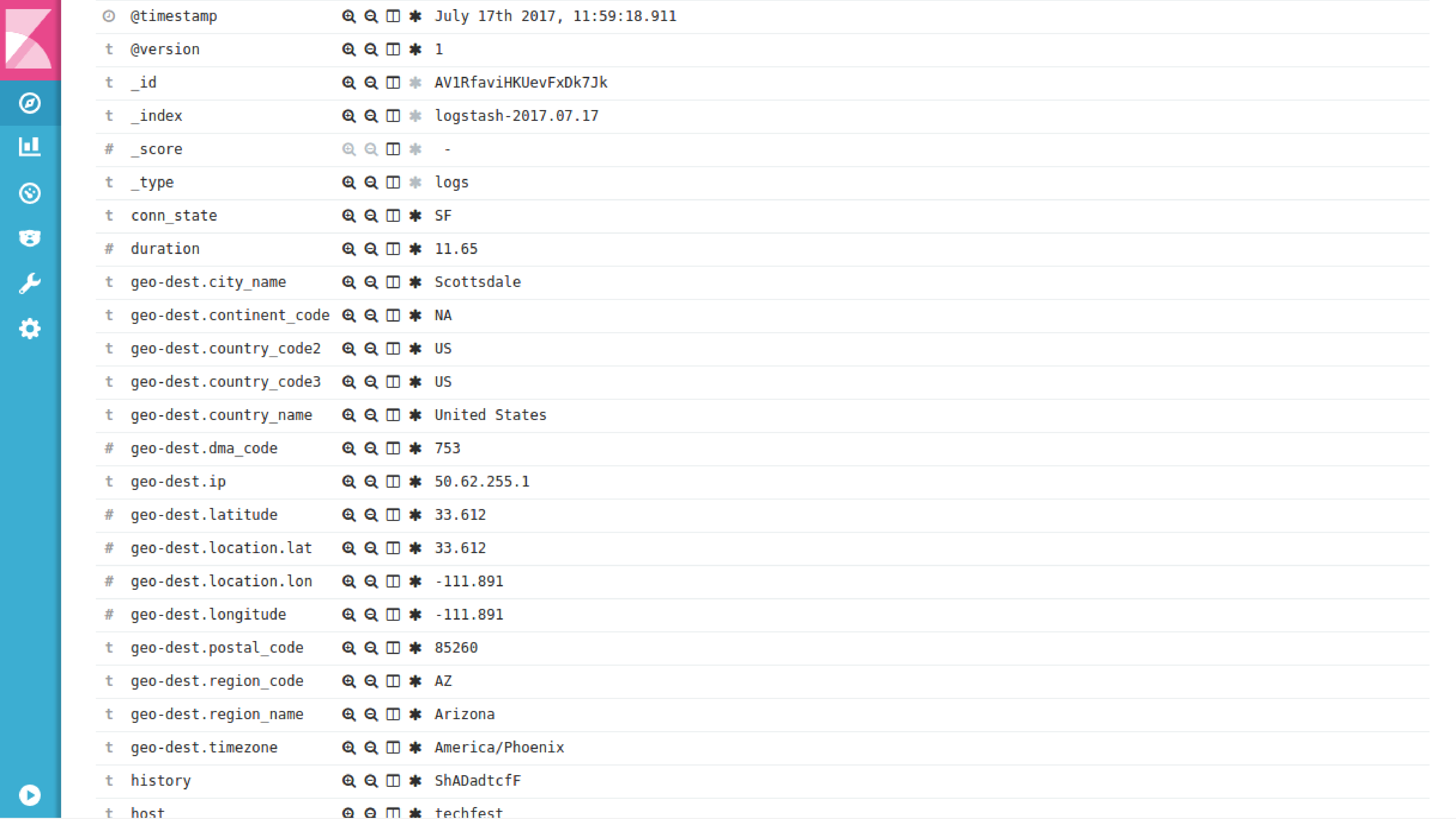
16 hits

July 17th 2017, 11:59:03.273 to July 17th 2017, 11:59:33.189

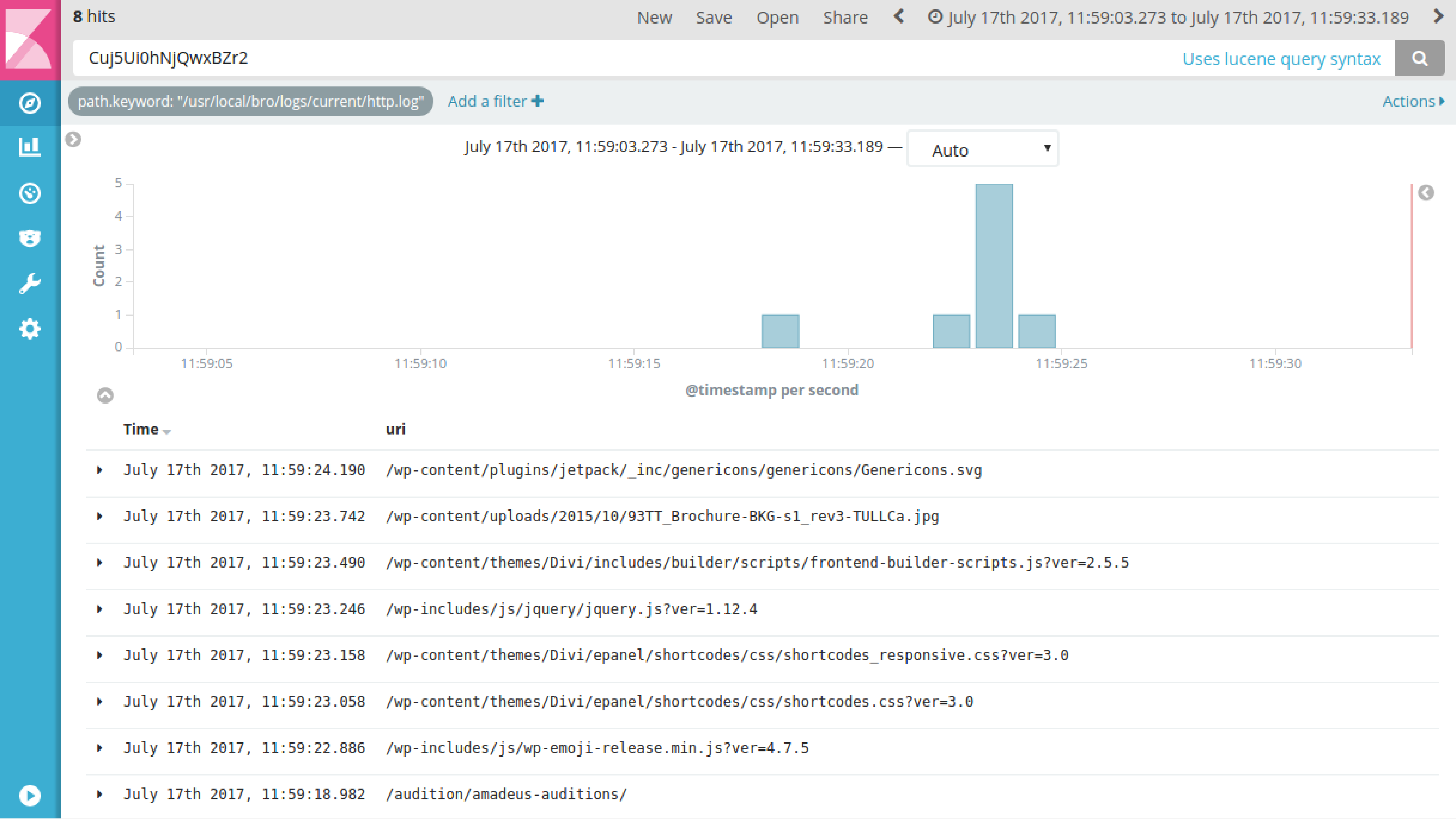
Cuj5Ui0hNjQwxBZr2

July 17th 2017, 11:59:03.273 - July 17th 2017, 11:59:33.189 —

```
Time    _source

July 17th 2017, 11:59:24.190    uid: Cuj5Ui0hNjQwxBZr2 id.orig_p: 62,862 method: GET request_body_len: 0 id.resp_p: 80 uri: /wp-content/plugins/jetpack/_inc/genericons/genericons/Genericons.svg tags: _geoip_lookup_failure referrer: http://www.theatretulsa.org/audition/amadeus-auditions/ path: /usr/local/bro/logs/current/http.log trans_depth: 8 @timestamp: July 17th 2017, 11:59:24.190 host: www.theatretulsa.org @version: 1 id.orig_h: 10.30.17.66 response_body_len: 0 user_agent: Mozilla/5.0 (iPhone; CPU iPhone OS 10_1_1 like Mac OS X) AppleWebKit/602.2.14 (KHTML, like Gecko) Version/10.0 Mobile/14B100 Safari/

July 17th 2017, 11:59:23.822    conn_uids: Cuj5Ui0hNjQwxBZr2 timedout: true local_orig: false rx_hosts: 10.30.17.66 source: HTTP is_orig: false tx_hosts: 50.62.255.1 overflow_bytes: 0 tags: _geoip_lookup_failure duration: 0.592 path: /usr/local/bro/logs/current/files.log depth: 0 @timestamp: July 17th 2017, 11:59:23.822 analyzers: MD5, SHA1 @version: 1 host: techfest fuid: FAJGdn2st5FB6OaFa3 seen_bytes: 0 missing_bytes: 191,247 ts: 1,500,310,763.823 _id: AV1RgScyHKUevFxDk9rF _type: logs _index: logstash-2017.07.17 _score: -

July 17th 2017, 11:59:23.742    uid: Cuj5Ui0hNjQwxBZr2 id.orig_p: 62,862 method: GET request_body_len: 0 id.resp_p: 80 uri: /wp-content/uploads/2
```



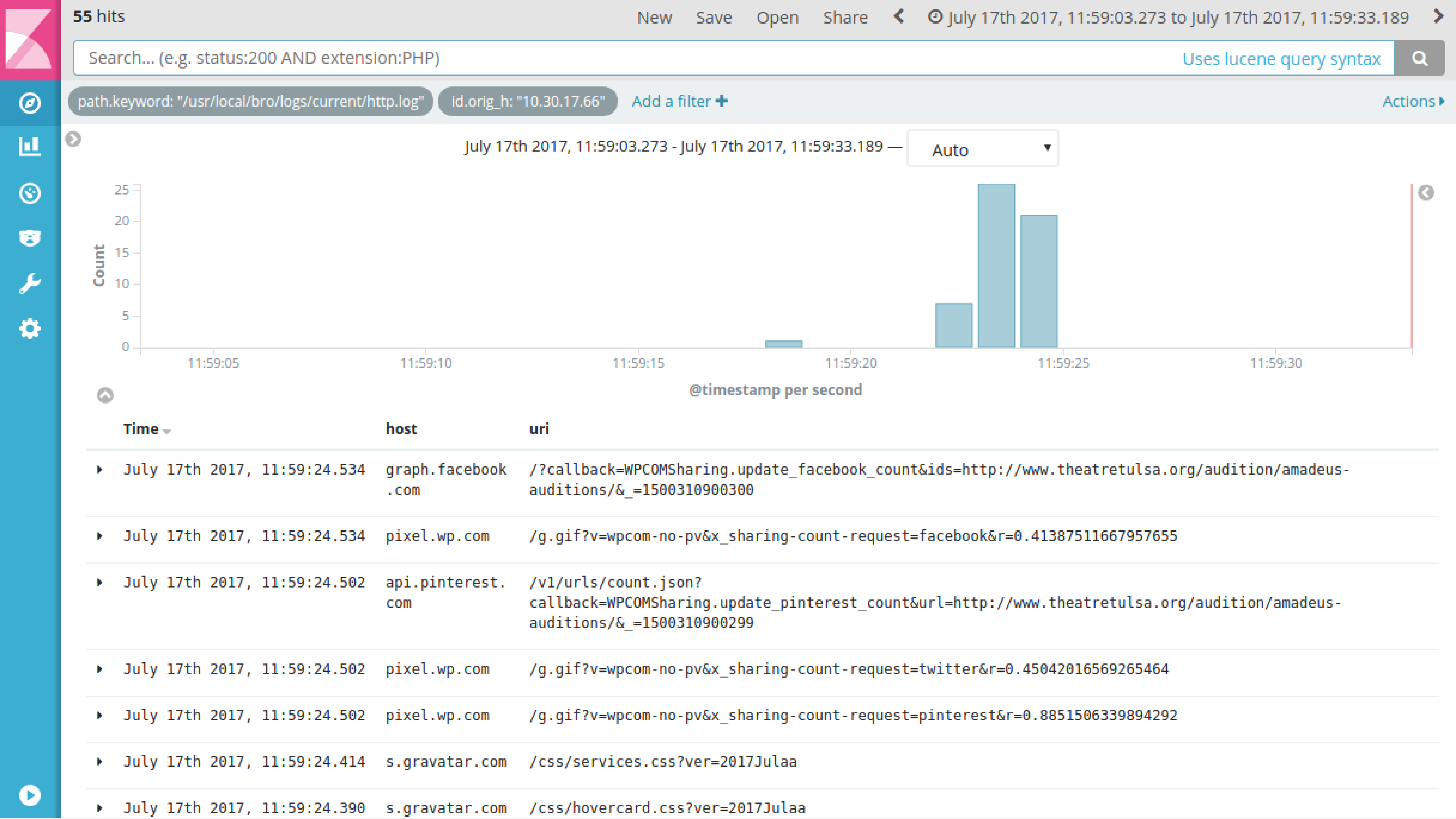
	@timestamp	July 17th 2017, 11:59:18.911
t	@version	1
t	_id	AV1RfaviHKUevFxDk7Jk
t	_index	logstash-2017.07.17
#	_score	-
t	_type	logs
t	conn_state	SF
#	duration	11.65
t	geo-dest.city_name	Scottsdale
t	geo-dest.continent_code	NA
t	geo-dest.country_code2	US
t	geo-dest.country_code3	US
t	geo-dest.country_name	United States
#	geo-dest.dma_code	753
t	geo-dest.ip	50.62.255.1
#	geo-dest.latitude	33.612
#	geo-dest.location.lat	33.612
#	geo-dest.location.lon	-111.891
#	geo-dest.longitude	-111.891
t	geo-dest.postal_code	85260
t	geo-dest.region_code	AZ
t	geo-dest.region_name	Arizona
t	geo-dest.timezone	America/Phoenix
t	history	ShADadtcfF
t	host	techfest



Cuj5Ui0hNjQwxBZr2

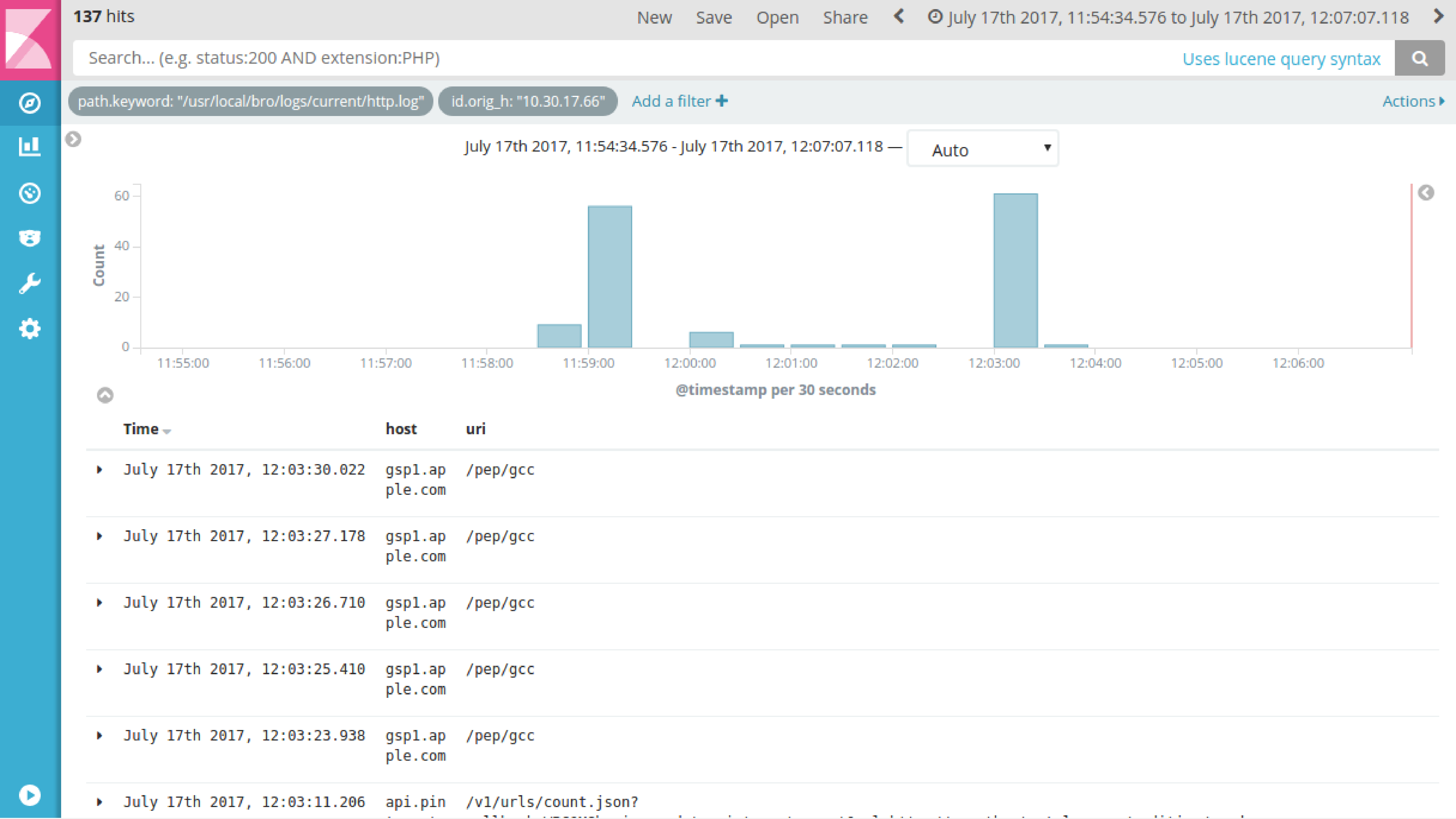
path.keyword: "/usr/local/bro/logs/current/http.log"

Time	uri
July 17th 2017, 11:59:24.190	/wp-content/plugins/jetpack/_inc/genericons/genericons/Genericons.svg
July 17th 2017, 11:59:23.742	/wp-content/uploads/2015/10/93TT_Brochure-BKG-s1_rev3-TULLCa.jpg
July 17th 2017, 11:59:23.490	/wp-content/themes/Divi/includes/builder/scripts/frontend-builder-scripts.js?ver=2.5.5
July 17th 2017, 11:59:23.246	/wp-includes/js/jquery/jquery.js?ver=1.12.4
July 17th 2017, 11:59:23.158	/wp-content/themes/Divi/epanel/shortcodes/css/shortcodes_responsive.css?ver=3.0
July 17th 2017, 11:59:23.058	/wp-content/themes/Divi/epanel/shortcodes/css/shortcodes.css?ver=3.0
July 17th 2017, 11:59:22.886	/wp-includes/js/wp-emoji-release.min.js?ver=4.7.5
July 17th 2017, 11:59:18.982	/audition/amadeus-auditions/



55 hits
New
Save
Open
Share
July 17th 2017, 11:59:03.273 to July 17th 2017, 11:59:33.189
Search... (e.g. status:200 AND extension:PHP)
Uses lucene query syntax
path.keyword: "/usr/local/bro/logs/current/http.log"
id.orig_h: "10.30.17.66"
Add a filter +
Actions
July 17th 2017, 11:59:03.273 - July 17th 2017, 11:59:33.189 —
Auto
25
20
15
10
5
0
Count
11:59:05
11:59:10
11:59:15
11:59:20
11:59:25
11:59:30
@timestamp per second

Time	host	uri
July 17th 2017, 11:59:24.534	graph.facebook.com	/?callback=WPCOMSharing.update_facebook_count&ids=http://www.theatretulsa.org/audition/amadeus-auditions/&_=1500310900300
July 17th 2017, 11:59:24.534	pixel.wp.com	/g.gif?v=wpcom-no-pv&x_sharing-count-request=facebook&r=0.41387511667957655
July 17th 2017, 11:59:24.502	api.pinterest.com	/v1/urls/count.json?callback=WPCOMSharing.update_pinterest_count&url=http://www.theatretulsa.org/audition/amadeus-auditions/&_=1500310900299
July 17th 2017, 11:59:24.502	pixel.wp.com	/g.gif?v=wpcom-no-pv&x_sharing-count-request=twitter&r=0.45042016569265464
July 17th 2017, 11:59:24.502	pixel.wp.com	/g.gif?v=wpcom-no-pv&x_sharing-count-request=pinterest&r=0.8851506339894292
July 17th 2017, 11:59:24.414	s.gravatar.com	/css/services.css?ver=2017Julaa
July 17th 2017, 11:59:24.390	s.gravatar.com	/css/hovercard.css?ver=2017Julaa



137 hits

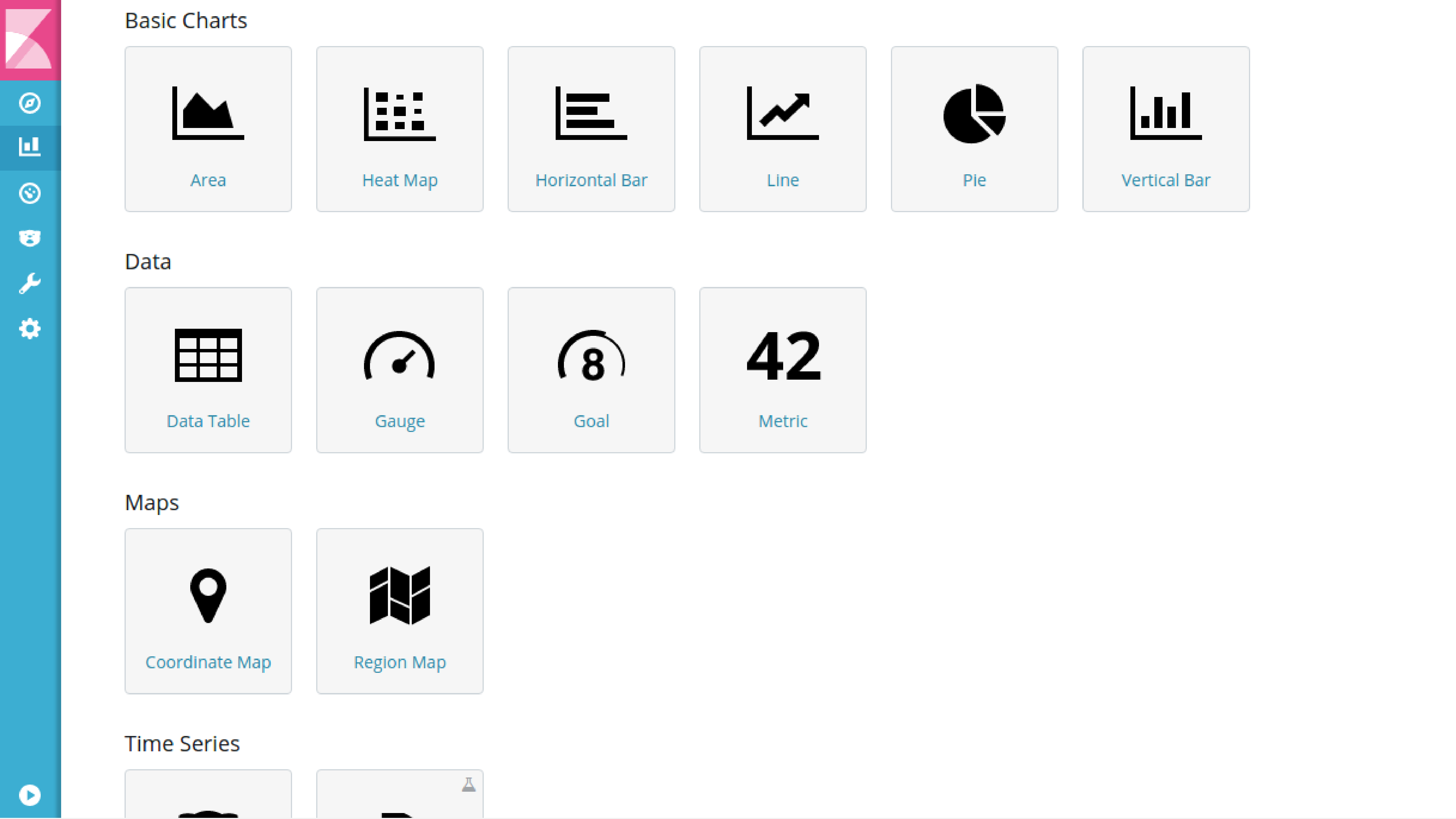
July 17th 2017, 11:54:34.576 to July 17th 2017, 12:07:07.118

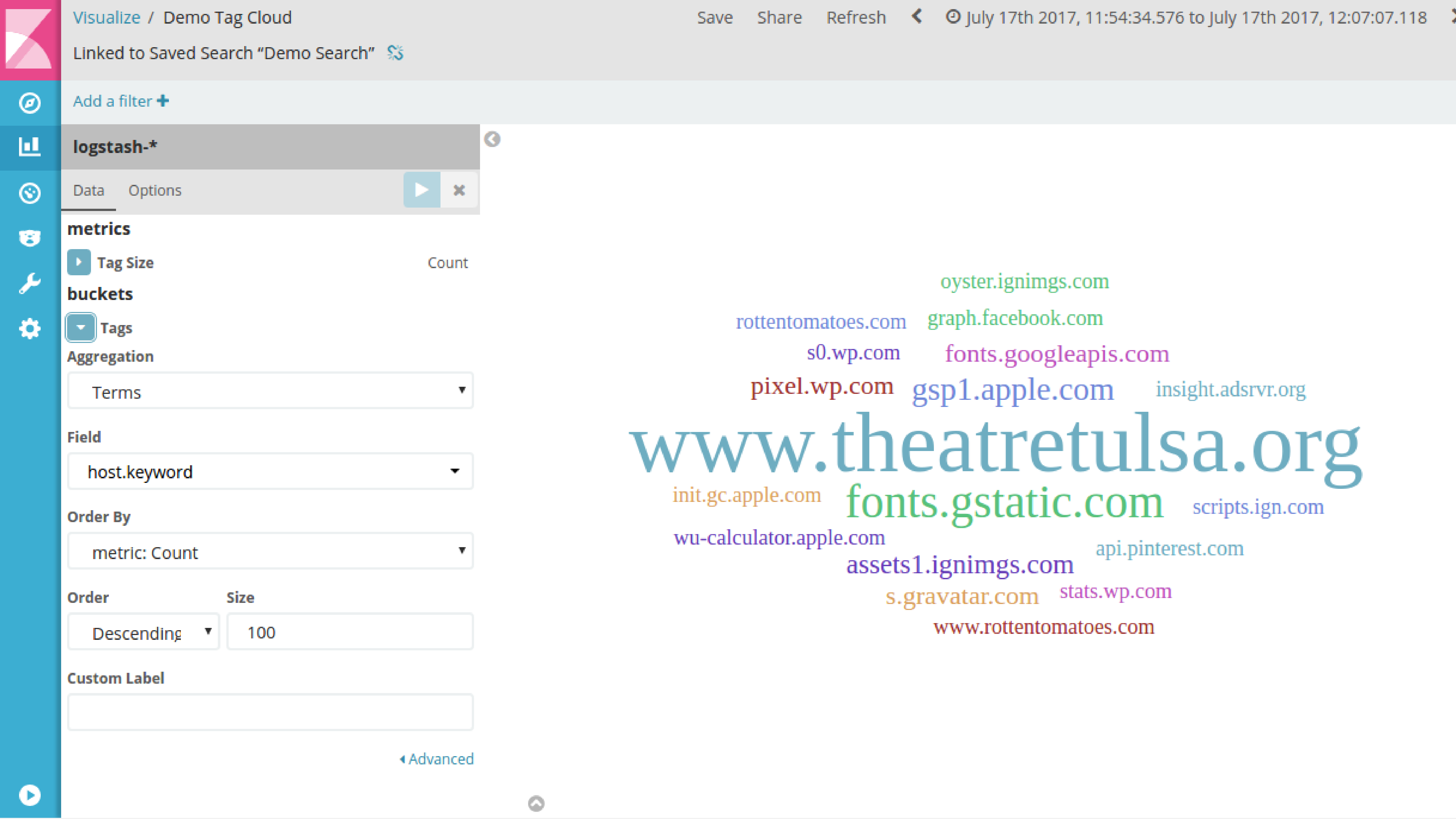
path.keyword: "/usr/local/bro/logs/current/http.log"

id.orig_h: "10.30.17.66"

July 17th 2017, 11:54:34.576 - July 17th 2017, 12:07:07.118 — Auto

Time	host	uri
July 17th 2017, 12:03:30.022	gsp1.apple.com	/pep/gcc
July 17th 2017, 12:03:27.178	gsp1.apple.com	/pep/gcc
July 17th 2017, 12:03:26.710	gsp1.apple.com	/pep/gcc
July 17th 2017, 12:03:25.410	gsp1.apple.com	/pep/gcc
July 17th 2017, 12:03:23.938	gsp1.apple.com	/pep/gcc
July 17th 2017, 12:03:11.206	api.pin	/v1/urls/count.json?


Basic Charts
Area
Heat Map
Horizontal Bar
Line
Pie
Vertical Bar
Data
Data Table
Gauge
Goal
8
Metric
42
Maps
Coordinate Map
Region Map
Time Series



Visualize / Demo Tag Cloud

Save Share Refresh

July 17th 2017, 11:54:34.576 to July 17th 2017, 12:07:07.118

Linked to Saved Search “Demo Search”

Add a filter +

logstash-*

Data Options

metrics

Tag Size Count

buckets

Tags

Aggregation: Terms

Field: host.keyword

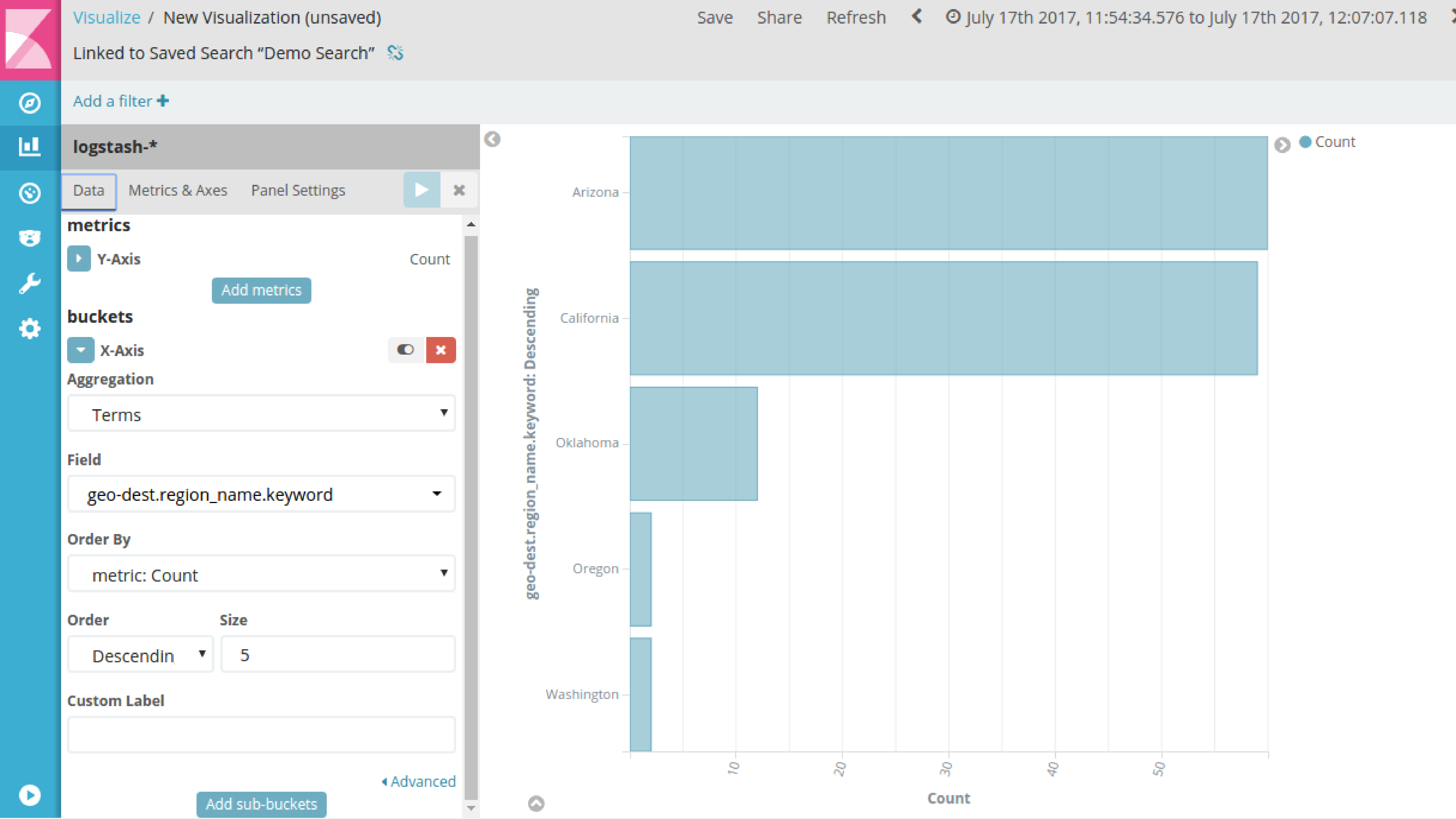
Order By: metric: Count

Order: Descending

Size: 100

Custom Label:

Advanced



July 17th 2017, 11:54:34.576 to July 17th 2017, 12:07:07.118

logstash-*

metrics

Y-Axis Count

buckets

X-Axis

Aggregation: Terms

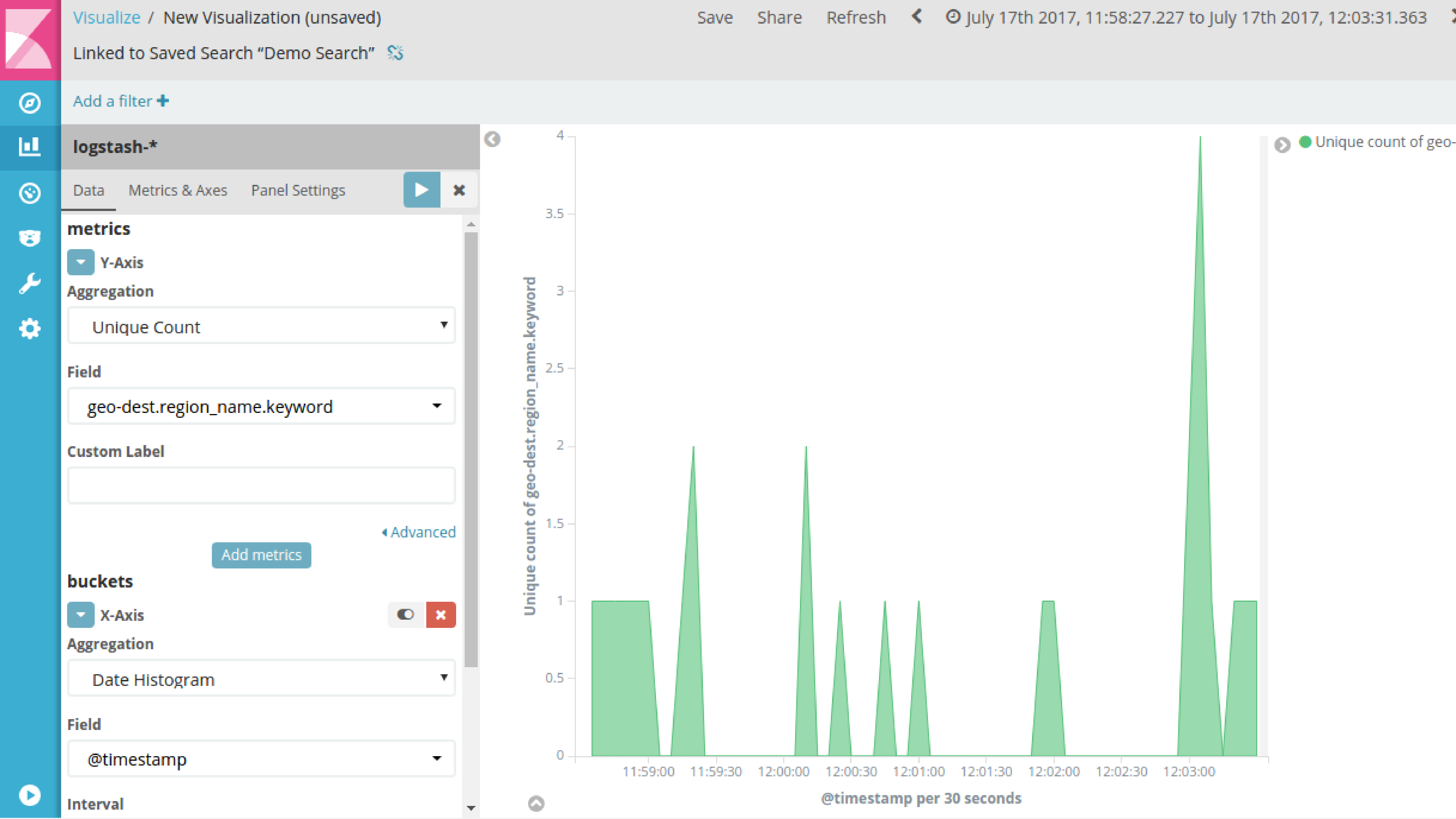
Field: geo-dest.region_name.keyword

Order By: metric: Count

Order: Descendin

Size: 5

Custom Label



Visualize / New Visualization (unsaved)
Save
Share
Refresh
July 17th 2017, 11:58:27.227 to July 17th 2017, 12:03:31.363
Linked to Saved Search “Demo Search”
Add a filter +
logstash-*
Data
Metrics & Axes
Panel Settings
Advanced
Add metrics
4
3.5
3
2.5
2
1.5
1
0.5
0
Unique count of geo-dest.region_name.keyword
11:59:00
11:59:30
12:00:00
12:00:30
12:01:00
12:01:30
12:02:00
12:02:30
12:03:00
@timestamp per 30 seconds
● Unique count of geo-

metrics

Y-Axis

Aggregation: Unique Count

Field: geo-dest.region_name.keyword

Custom Label:

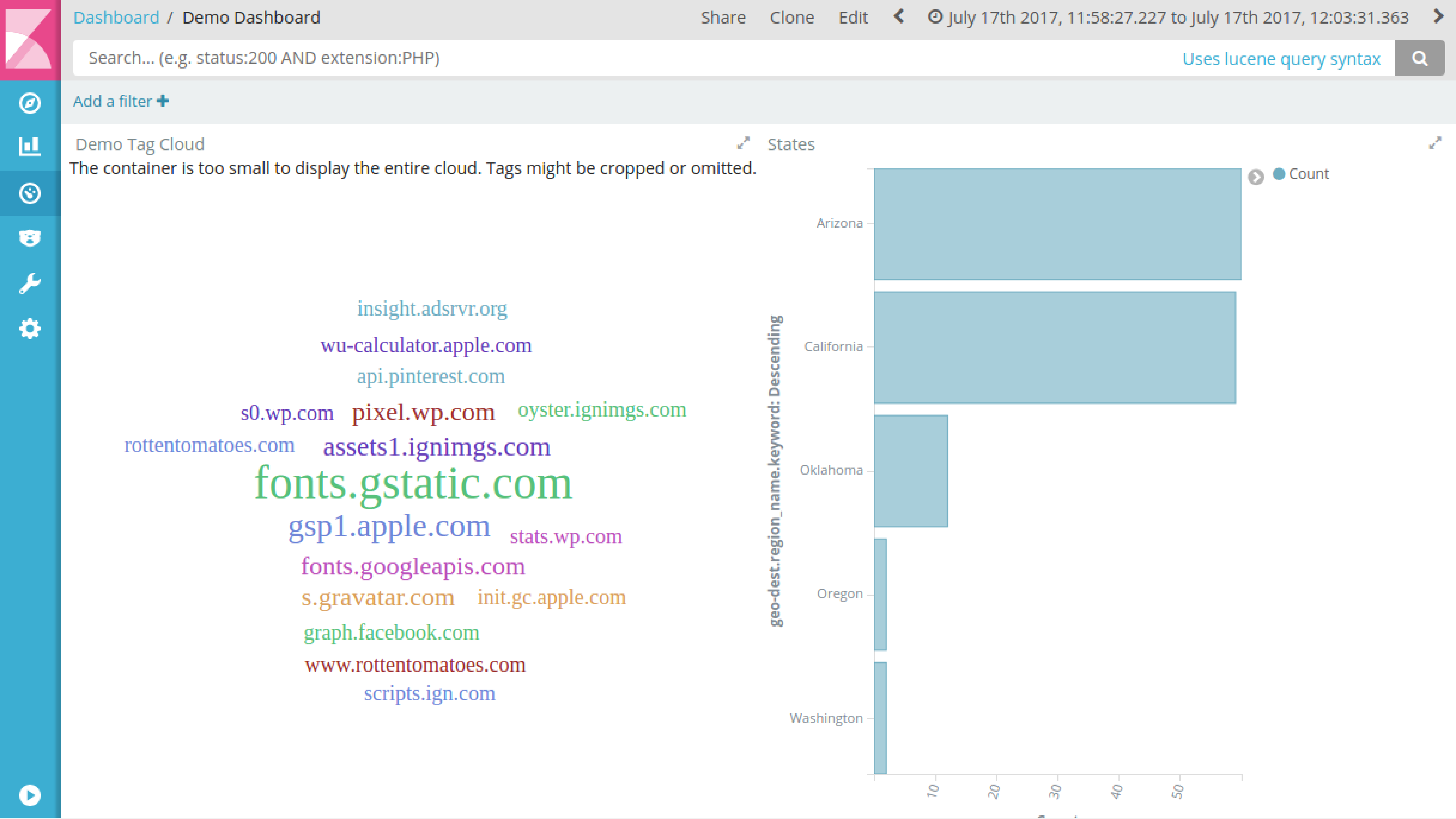
buckets

X-Axis

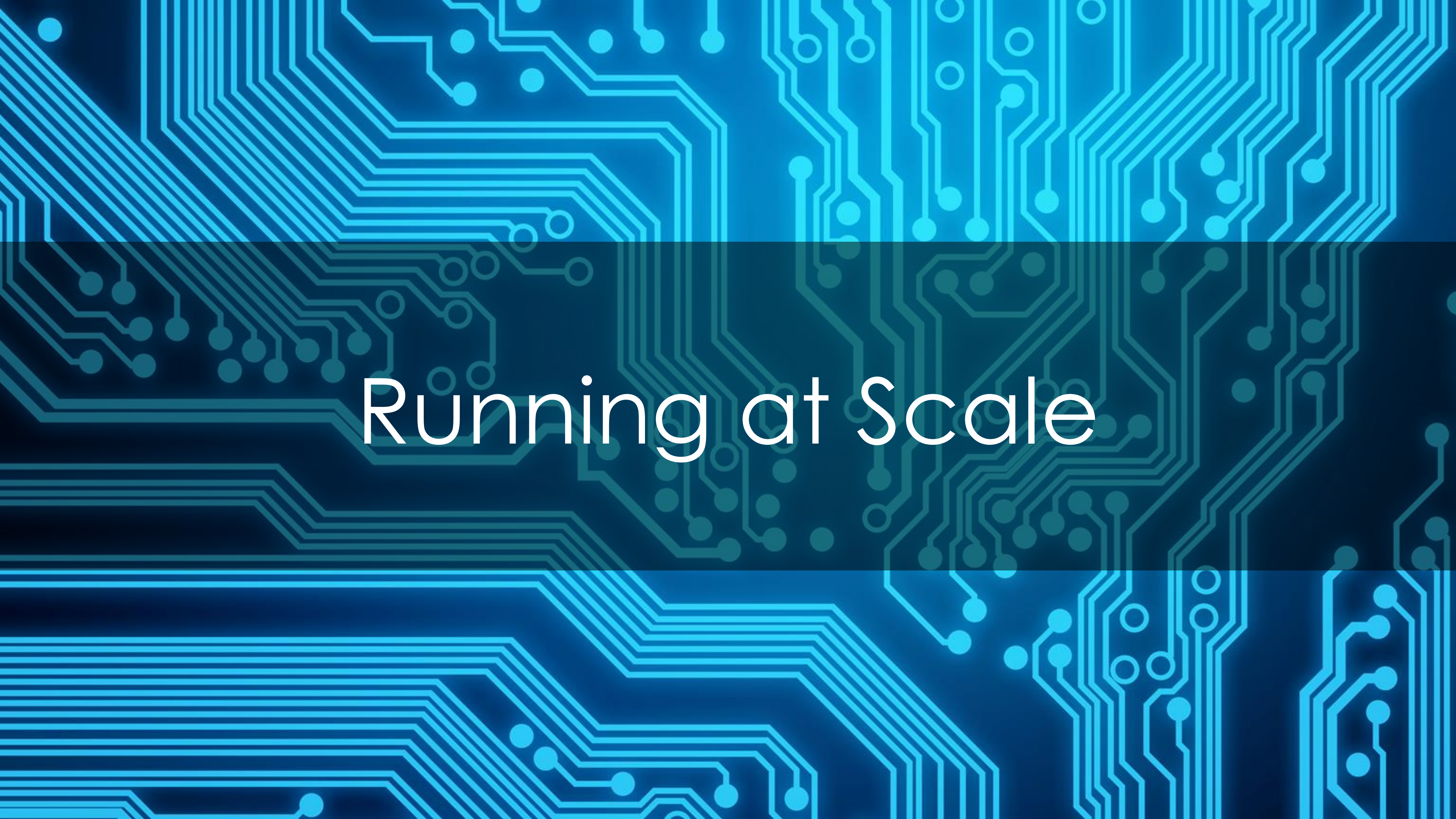
Aggregation: Date Histogram

Field: @timestamp

Interval


Dashboard / Demo Dashboard
Share
Clone
Edit
July 17th 2017, 11:58:27.227 to July 17th 2017, 12:03:31.363
Search... (e.g. status:200 AND extension:PHP)
Uses lucene query syntax
Add a filter +
Demo Tag Cloud
States

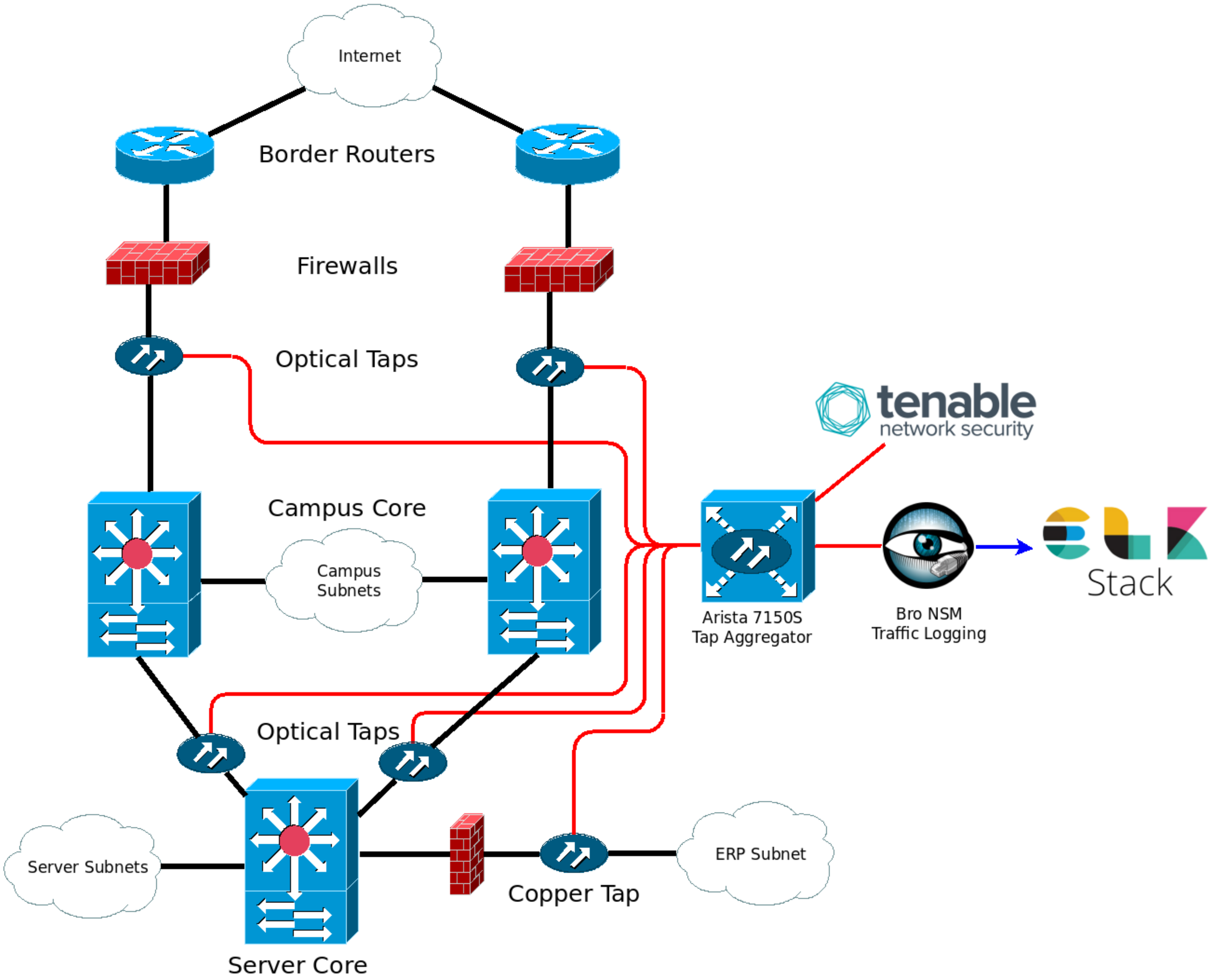
The container is too small to display the entire cloud. Tags might be cropped or omitted.

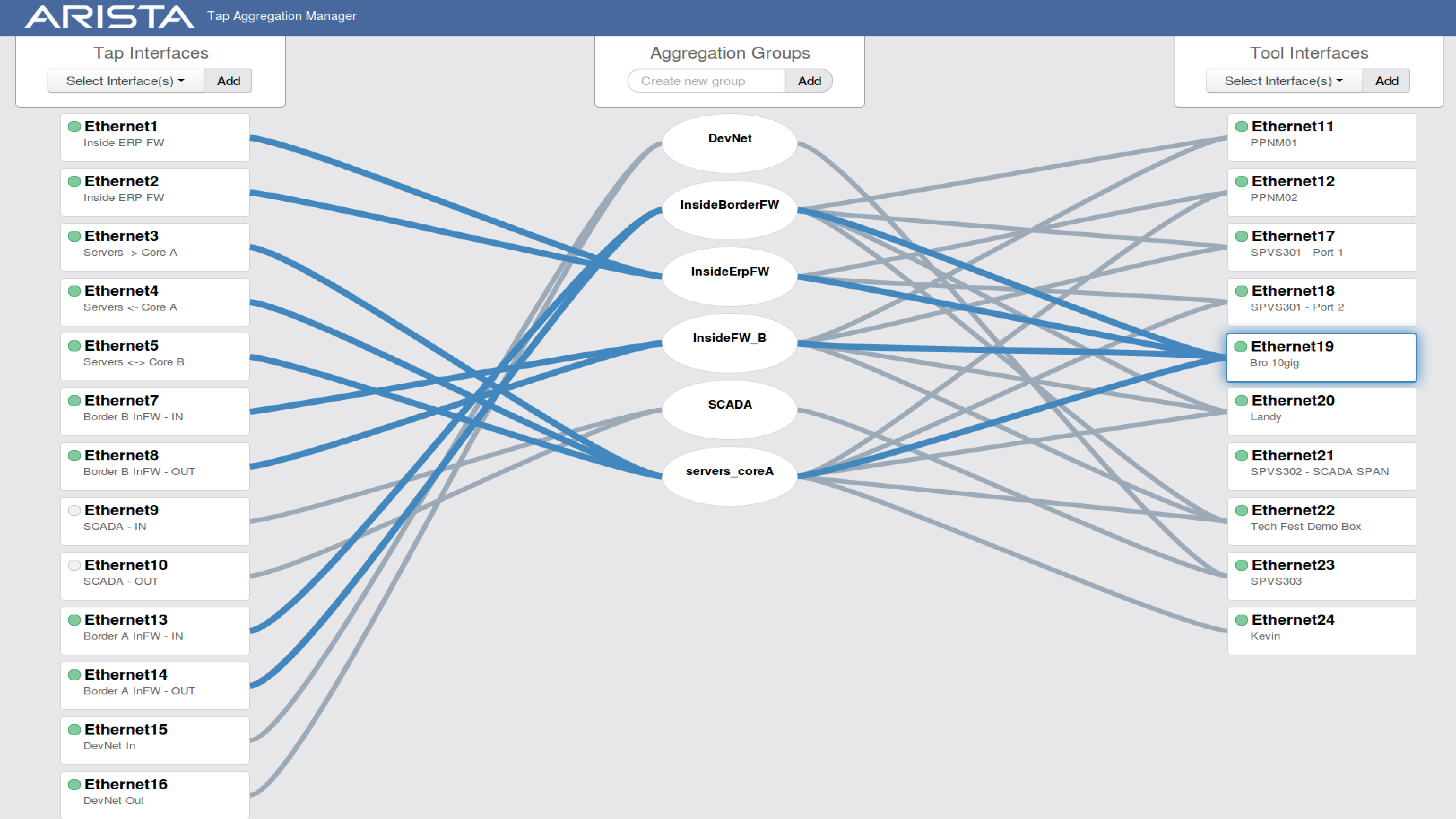


Running at Scale

Running at Scale

- 6 tap points
  - 3 optical 10gig taps
  - 2 copper 1gig tap
  - 1 optical 10gig mirror port
  - 11 tap inputs to aggregator
- 1 Bro Server
  - 10gig input
  - Custom compiled capture driver – PF_ring clustered mode
- 3 Redis nodes
  - Log buffering
  - Not clustered, planning to replace with Kafka cluster


Internet
Border Routers
Firewalls
Optical Taps
tenable network security
Campus Core
Campus Subnets
Arista 7150S Tap Aggregator
Bro NSM Traffic Logging
ELK Stack
Optical Taps
Server Subnets
Copper Tap
ERP Subnet
Server Core



Tap Aggregation Manager

Tap Interfaces

- Ethernet1 Inside ERP FW
- Ethernet2 Inside ERP FW
- Ethernet3 Servers -> Core A
- Ethernet4 Servers <- Core A
- Ethernet5 Servers <-> Core B
- Ethernet7 Border B InFW - IN
- Ethernet8 Border B InFW - OUT
- Ethernet9 SCADA - IN
- Ethernet10 SCADA - OUT
- Ethernet13 Border A InFW - IN
- Ethernet14 Border A InFW - OUT
- Ethernet15 DevNet In
- Ethernet16 DevNet Out

Aggregation Groups

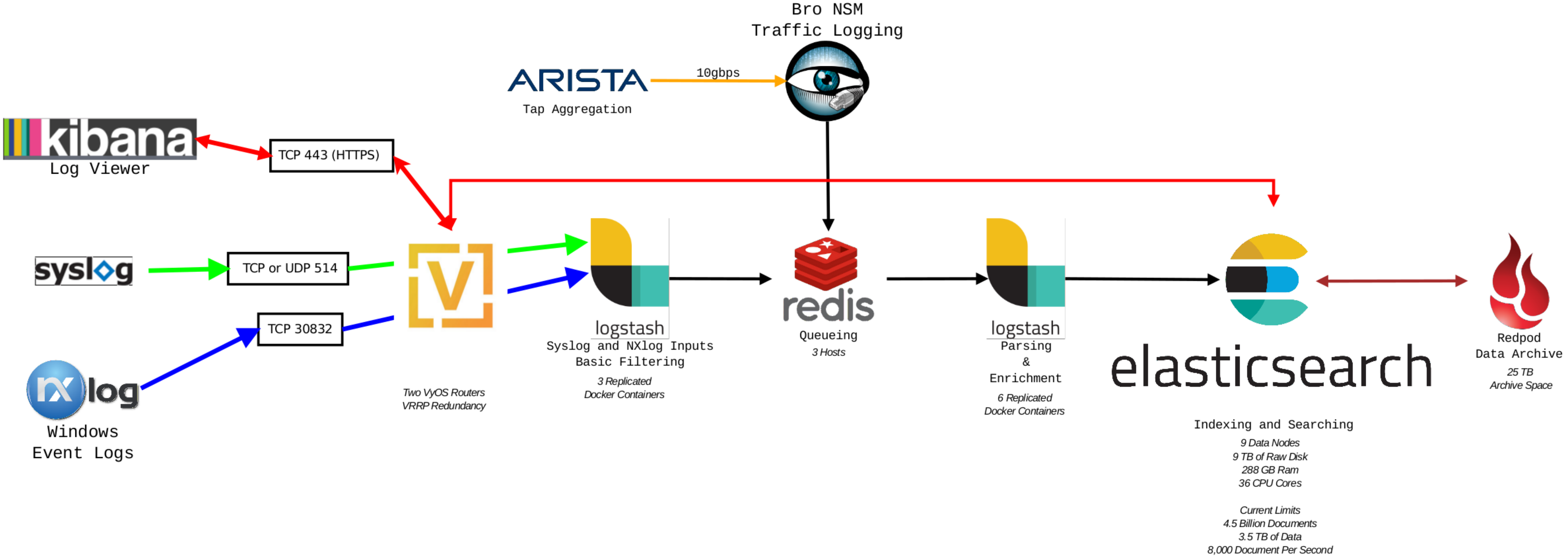
- DevNet
- InsideBorderFW
- InsideErpFW
- InsideFW_B
- SCADA
- servers_coreA

Tool Interfaces

- Ethernet11 PPNM01
- Ethernet12 PPNM02
- Ethernet17 SPVS301 - Port 1
- Ethernet18 SPVS301 - Port 2
- Ethernet19 Bro 10gig
- Ethernet20 Landy
- Ethernet21 SPVS302 - SCADA SPAN
- Ethernet22 Tech Fest Demo Box
- Ethernet23 SPVS303
- Ethernet24 Kevin

Running at Scale

- 9 Logstash Containers
  - 3 Syslog / windows input
  - 6 Indexers
- 12 Elasticsearch Nodes
  - 3 Masters
  - 9 Data Nodes
    - Quad core, 32 GB RAM, 1 TB disk
- 1 Archive Server
  - 25 TB for snapshot archival
- Several misc. servers / containers
  - Automation, scripts, other data processors



Bro NSM
Traffic Logging

Tap Aggregation

10gbps

Log Viewer

TCP 443 (HTTPS)

TCP or UDP 514

TCP 30832

Windows
Event Logs

Two VyOS Routers
VRRP Redundancy

Syslog and NXlog Inputs
Basic Filtering

3 Replicated
Docker Containers

Queueing

3 Hosts

Parsing
&
Enrichment

6 Replicated
Docker Containers

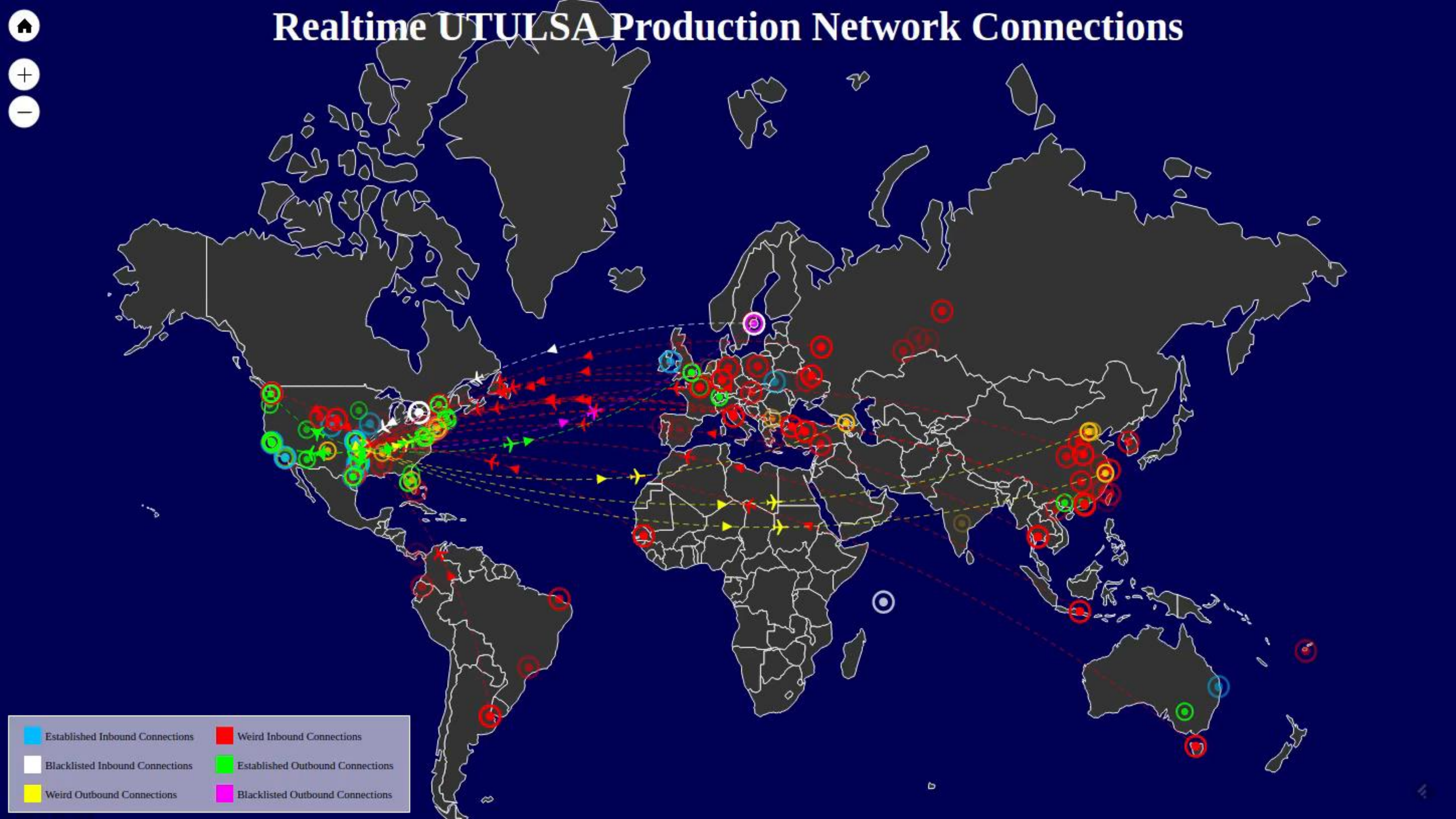
Indexing and Searching

9 Data Nodes
9 TB of Raw Disk
288 GB Ram
36 CPU Cores

Current Limits
4.5 Billion Documents
3.5 TB of Data
8,000 Document Per Second

Redpod
Data Archive

25 TB
Archive Space

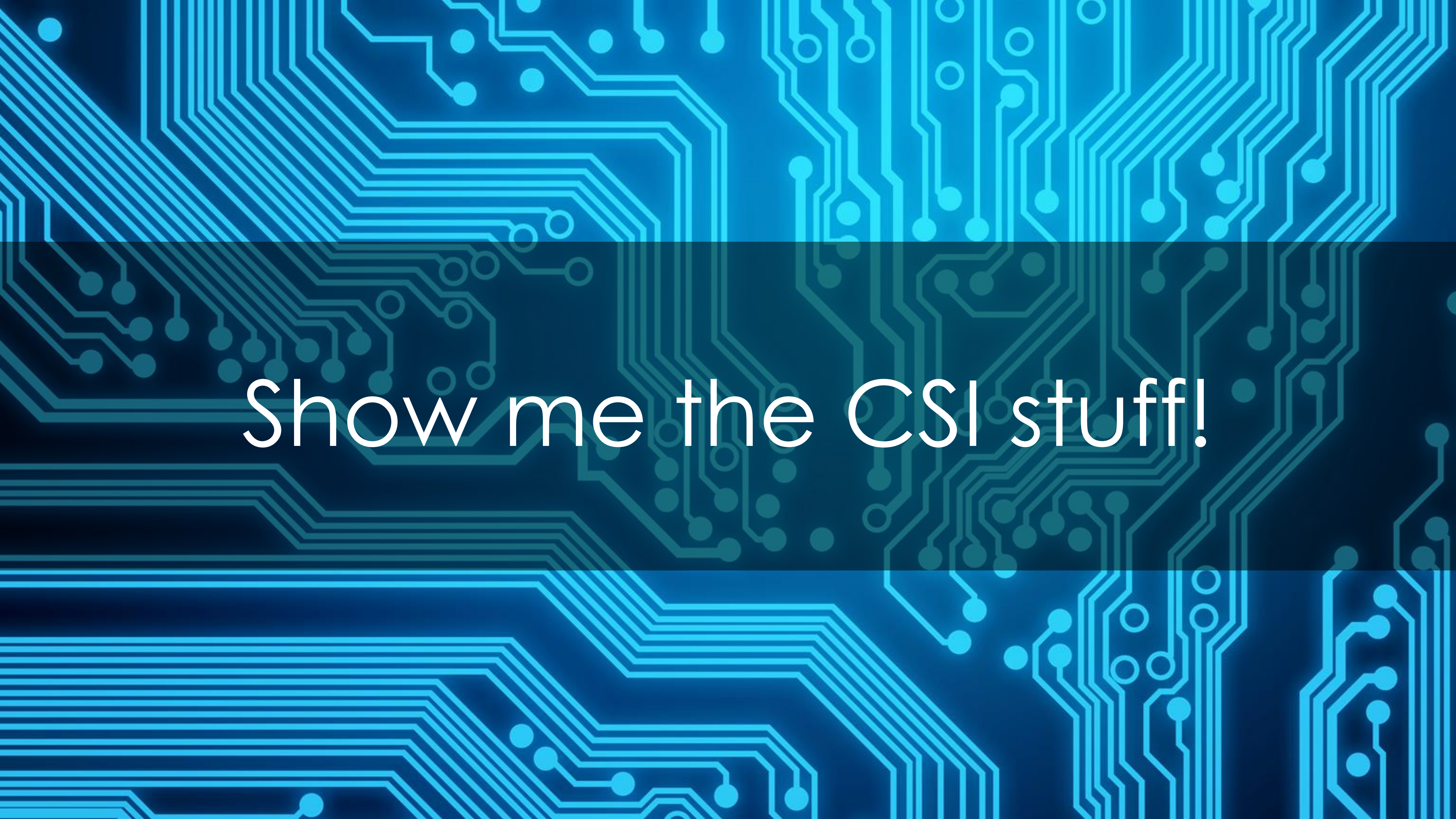


Realtime UTULSA Production Network Connections

🟦 Established Inbound Connections
⬜ Blacklisted Inbound Connections
🟨 Weird Outbound Connections
🟥 Weird Inbound Connections
🟩 Established Outbound Connections
🟪 Blacklisted Outbound Connections

Running at Scale

- Configuration Management
  - Cobbler / SaltStack
- Monitoring
  - Telegraf / InfluxDB / Grafana / PRTG
- High Availability
  - Elasticsearch Replicas
  - Docker Swarm
  - Service Discovery



Show me the CSI stuff!

Show me the CSI stuff!

- EventType[Authentication] MAC[64:A5:C3:xx:yy:zz] AP[USS-1838-D24] SSID[TUwpa] BSSID[20:B3:99:xx:yy:zz]
- EventType[Registration] MAC[28:5A:EB:xx:yy:zz] IP[0.0.0.0] AP[USS-1918-D8] SSID[TUwpa] BSSID[20:B3:99:xx:yy:zz]
- EventType[Roam] MAC[2C:0E:3D:xx:yy:zz] AP[FS-Lobby-A17] FromAP[FS-200-A10] BSSID[20:B3:99:xx:yy:zz]
- EventType[De-registration] MAC[EC:9B:F3:xx:yy:zz] BSSID[20:B3:99:xx:yy:zz]
- EventType[Authentication] MAC[A8:88:08:xx:yy:zz] AP[NVG-824-A12] SSID[TUwpa] BSSID[20:B3:99:xx:yy:zz]

Show me the CSI stuff!

- EventType[Authentication] **MAC[64:A5:C3:xx:yy:zz] AP[USS-1838-D24]** SSID[TUwpa] BSSID[20:B3:99:xx:yy:zz]
- EventType[Registration] **MAC[28:5A:EB:xx:yy:zz]** IP[0.0.0.0] **AP[USS-1918-D8]** SSID[TUwpa] BSSID[20:B3:99:xx:yy:zz]
- EventType[Roam] **MAC[2C:0E:3D:xx:yy:zz] AP[FS-Lobby-A17]** FromAP[FS-200-A10] BSSID[20:B3:99:xx:yy:zz]
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Questions?

Twitter / Github: @ljb2of3

TECHFest

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FRI, JUL 21ST

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