Introduction to Zeek

ZeekWeek'21

Oct 13-15

Who Are We?

Keith Lehigh

- UISO @ Indiana University
- 10 yrs running Zeek on large .edu network
- Zeek LT Member

Fatema Bannat Wala

- Security Engineer @ ESnet/LBNL
- Big Fan of Zeek ever since it was Bro!
- 6 yrs of Network defense
- Zeek LT Member / Zeek Training Subgroup Lead

Goals

You should be able to :

- Run Zeek on CLI
- Configure Zeek
- Understand basic functions of Zeek
- Be familiar with filesystem layout
- Process Zeek logs
- Perform basic customization
- Interact with some common frameworks
- Be familiar with cluster config (time permitting)

Housekeeping

- Github Link- Docker How to doc
  - https://github.com/zeek/zeek-training/tree/master/Intro-to-Zeek'21
- Docker image
  - Zeek v4.0.3 installed on the image- https://hub.docker.com/repository/docker/zeekurity/zeek-training-2021
  - # docker pull zeekurity/zeek-training-2021
  - Path inside the container to training resources used during this training: /zeek/training-res/
- Zeek Official Document:
  - https://docs.zeek.org/en/v4.0.3/

Who Uses Zeek?

Zeek Users

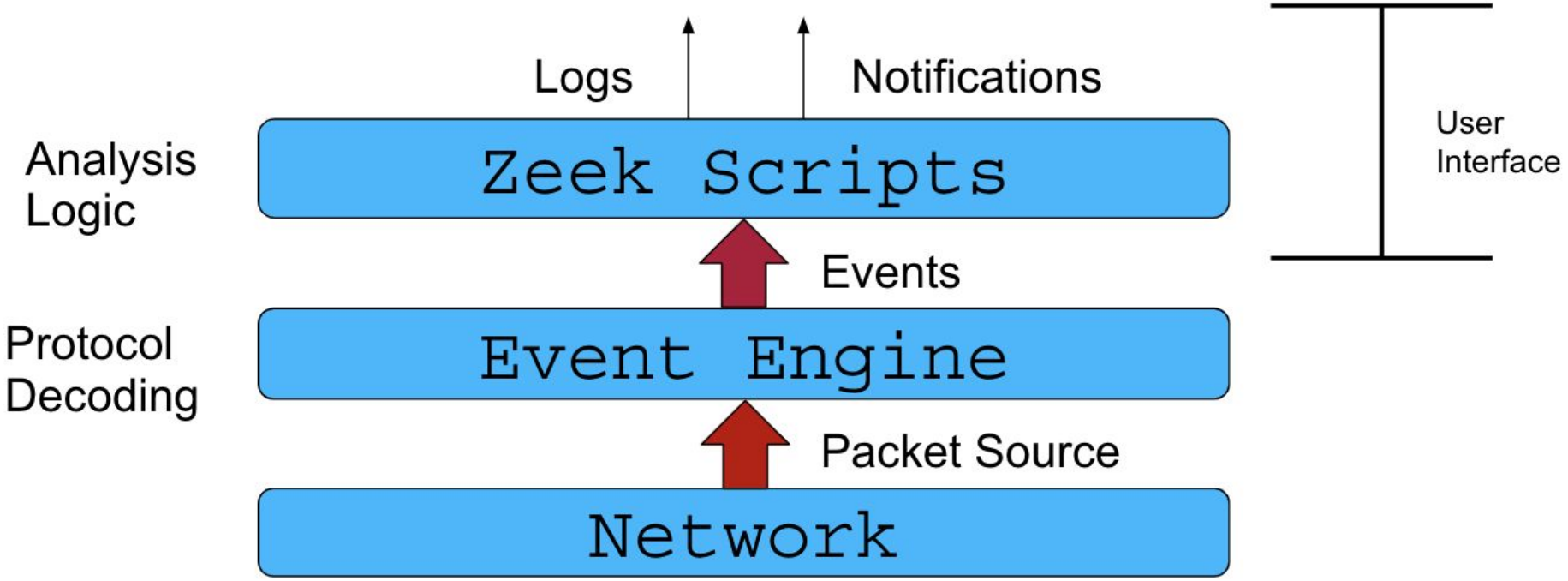
- Malware Researchers
- Network Defenders - Blue teams
  - .edu / .gov / private sector
  - Forensics, Monitoring, Detection
- Network Researchers
- People building Zeek in their products

What Is Zeek?

Zeek Platform

- 25 years old, long history in academia
- Domain Specific Network Monitoring Language
- Policy Neutral
- Leave your IDS ideas behind

Zeek Architecture



Analyzers

- Protocol Analyzers
  - ➢ Most popular - SMTP / HTTP / SSL / DNS / DHCP
  - ➢ Authentication - SSH / KERBEROS / RADIUS
  - ➢ MS protocols - RPC / NTLM / SMB / RDP
  - ➢ Interesting ones - SOCKS / TUNNEL / IRC / FTP
- File Analyzers
  - ➢ EXTRACT / HASH / PE / X509
- Spicy!
  - ➢ C++ parser generator that makes it easy to create robust parsers for network protocols, file formats, and more..

Dynamic Protocol Detection

- Hints from known_ports
- Failure to attach or no known_ports
  - Try analyzers and signatures until success
- Successful protocol parsing reflected in:
  - conn.log proto field
  - files.log analyzers field
- DPD detects known protocols on unknown ports
  - Non-standard port doesn't mean it is bad
  - But it sure is interesting
    - known_services.log can be a goldmine

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Running Zeek

Docker / Zeek Usage

Docker Setup

- Github Link- Docker How to doc
  - https://github.com/zeek/zeek-training/tree/master/Intro-to-Zeek'21
- Docker image
  - Zeek v4.0.3 installed on the image- https://hub.docker.com/repository/docker/zeekurity/zeek-training-2021
    - # docker pull zeekurity/zeek-training-2021
    - # docker run -it zeekurity/zeek-training-2021 /bin/bash
  - Path inside the container to training resources used during this training: /zeek/training-res/

Verifying if Zeek installed correctly:

/zeek/bin/zeek –h

export PATH=/zeek/bin/:$PATH

Running Zeek : CLI

Different Zeek CLI running options:

1. zeek –r capture.pcap
2. zeek –C –r capture.pcap
3. zeek –r capture.pcap my-script.zeek
4. zeek –r capture.pcap local
5. zeek –r capture.pcap local –e ‘redef Site::local_nets += { 192.168.125.0/24 };’
6. zeek –r modbus.pcap protocols/modbus/track-memmap.zeek

Running Zeek : CLI

Run the command lines below and compare output. 10 Minutes!

zeek -C -r /zeek/training-res/capture.pcap

zeek -C -r /zeek/training-res/capture.pcap local
WARNING: No Site::local_nets have been defined. It's usually a good idea to define your local networks.

zeek -C -r /zeek/training-res/capture.pcap local -e ‘redef Site::local_nets += { 192.168.125.0/24 };’
<no warning this time>

zeek -r /zeek/training-res/modbus.pcap protocols/modbus/track-memmap.zeek

Running Zeek online: try.zeek.org

Running Zeek online - Get familiar with try.zeek website and running some simple scripts on the website

Go to your web-browser and type “try.zeek.org” website.

Try out running zeek on scripts as well as provided pcaps on the server!

Can you share your custom #tryzeek script with others?

Running Zeek : only with scripts

Running Zeek with just scripts without any pcaps. Printing hello world like examples. This will show another way of running Zeek

zeek /zeek/training-res/hello-world.zeek

dump-events

Handiest tool in the Zeek toolbox :

zeek –r <pcap> misc/dump-events

For Ex, Run:
zeek -C -r /zeek/training-res/capture.pcap misc/dump-events

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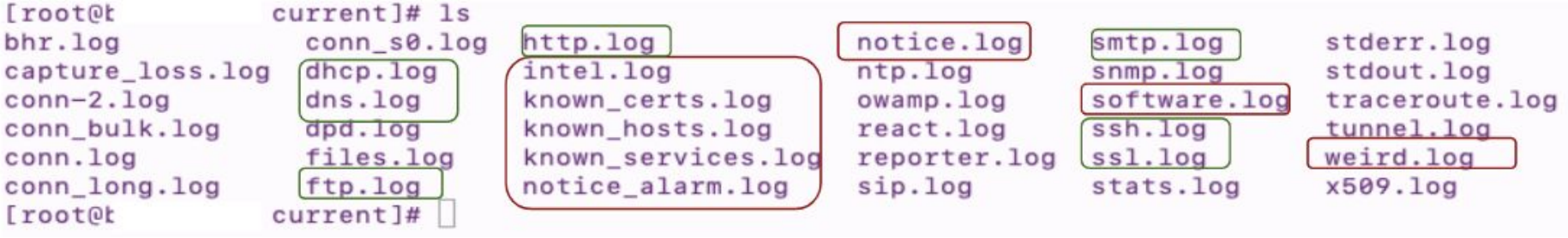
What Does Zeek Do?

Logs

Logs



- All the logs are written in ASCII log files (tsv format)
- Zeek generates the log files for the protocols it sees in your network traffic (more than 50 protocols currently parsed)
- Apart from conventional protocol log files, interesting logs pertaining to noticeable/statistical activity (weird.log, notice.log etc.)

Logs

- Pop to shell
  ```
  # rm *.log
  # zeek -C -r /zeek/training-res/ssl.pcap
  ```
- Show log header/footer
- Show conn.log
- Show files.log
- Show ssl.log

Alerting

Alerting

- ACTION_LOG - log to notice.log
- ACTION_EMAIL - email notices

Notices

Intel::Notice

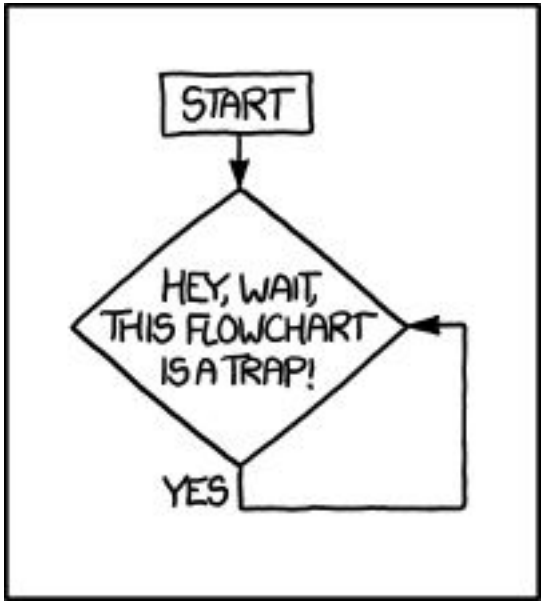
Heartbleed::SSL_Heartbeat_Attack

Scan::Address_Scan
Scan::Port_Scan

SSL::Certificate_Expired

SSH::Interesting_Hostname_Login
SSH::Watched_Country_Login
SSH::Password_Guessing

Custom Logic



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Filesystem Layout

- Not an exhaustive tour!
- Default Path : /opt/zeek/ or /usr/local/zeek
  - bin/
  - etc/
  - include/ - ignoring today
  - lib/ - ignoring today
  - logs/
  - share/
  - spool/

Filesystem Layout

- bin/
  - zeek-cut
    - Extract columns from zeek logs (non-JSON)
    - Convert Unix epoch
  - zeek-wrapper
    - Deprecation wrapper
    - ZEEK_IS_BRO environment variable
      - Define to rid yourself of deprecation warnings
  - zeekctl
    - Cluster management tool (more on that later!)

Filesystem Layout

- etc/
  - network.cfg
    - Define your local networks
  - node.cfg
    - Configure a cluster
  - zeekctl.cfg
    - Configure cluster management tool

Filesystem Layout

- current directory
  - Default Log Path (CLI mode, logs overwritten each run)
- logs/
  - current
    - Default Log Path (cluster-mode)
  - YYYY-MM-DD
    - Logs archived to this dir,rotated hourly by default

Filesystem Layout

- share/
  - zeek/base/
    - Base scripts
  - zeek/policy/
    - Additional scripts
  - zeek/site/
    - Site specific scripts

Filesystem Layout

- spool/
  - state.db
    - cluster worker state
  - zeekctl-config.sh
    - Cluster management variables
  - worker-1
    - .pid
    - .cmdline
    - .env_vars
  - logger
    - logs (current is just a symlink)

Zeek Script Example

Break to look at policies in zeek/share

```
# cd /zeek/share/zeek
# find . –name ‘*.zeek’ | less
```

10 Minute Break

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Anatomy of a Zeek Script

Pop out & take a look at

less /zeek/share/zeek/base/protocols/http/main.zeek

Customizing Zeek

- /zeek/share/zeek/site/local.zeek
  - local customizations
    - Can be done inline or separate script
  - enable or disable scripts
  - change variables

Customizing Zeek

Loading additional scripts:

nano /zeek/share/zeek/site/local.zeek

@load policy/protocols/http/header-names

zeek –h
$ZEEKPATH

Zeek file search path order :
. (current directory)
/usr/local/zeek-4.0.3/share/zeek
/usr/local/zeek-4.0.3/share/zeek/policy
/usr/local/zeek-4.0.3/share/zeek/site

Customizing Zeek

- Zeek scripts have an export section.
  - Redefinable variables
  - main.zeek is best place to start looking

```
# less /zeek/share/zeek/base/protocols/http/main.zeek

export {

    # This setting changes if passwords used in
    # Basic-Auth are captured or not.
    option default_capture_password = F;
}
```

Customizing Zeek

Value

```
redef SSH::password_guesses_limit = 15;
```

Table

```
redef SSH::ignore_guessers += {
   [192.168.1.2/32] = 192.168.1.20/32 };
```

Boolean

```
redef HTTP::log_server_header_names = T;
```

Customizing Zeek

10 Minute Exercise!

cp /zeek/share/zeek/site/local.zeek .

Log server header names in HTTP
@load policy/protocols/http/header-names

Log http usernames and passwords
redef HTTP::default_capture_password = T;

Start with : /zeek/training-res/http-auth.pcap

zeek -C -r /zeek/training-res/http-auth.pcap local.zeek

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Package Manager (zkg)

- Package Manager
  - zkg
  - https://packages.zeek.org

- Can add new scripts or analyzers
  - Analyzer examples :
    - QUIC
    - PerfSonar
  - Scripts :
    - BZAR
    - DHCP OUI data

Let’s Use zkg!

- List all zeek packages and install a few
  - # zkg refresh
  - # zkg list all
  - # zkg install cve-2020-0601
- Check if they got installed
  - # zkg list installed
  - # ls /zeek/share/zeek/site
- Let’s load the packages
  - Add *@load packages* in site/local.zeek

Let’s Use zkg!

- zkg load/unload and info
  ```
  # zkg unload cve-2020-0601
  # zkg info cve-2020-0601
  ```
- Remove and uninstall all the packages
  ```
  # zkg purge
  # zkg list installed
  ```
- Other useful zkg commands
  remove, pin, unpin, upgrade, refresh

Zkg Exercise

10 minutes..

Running Zeek with zkg installed packages, specifically with JA3.

```
# zkg install ja3
# zeek -C -r /zeek/training-res/ssl.pcap local
# less ssl.log
```

Zkg Exercise

Extract a file from a file transfer connection using file-extract zkg package

zkg install file-extraction

Add all file types extraction to the config of the package:

nano /zeek/share/zeek/site/packages/file-extraction/config.zeek
@load ./plugins/extract-all-files.zeek

zeek -C -r extract.pcap local

What all files got extracted from the pcap?
ls extract_files/

10 Minute Break

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Basic Zeek Log Usage

General Approaches

Scope your searches.
- Less logs, less confusion.
- Also respect your user's privacy.

Baseline your network, if you can.

Iterative process.
- Build your command lines one command at a time.

Use CUID & FUID to pivot around logs.

Log Processing Tools

zeek-cut - Extracts columns from an ASCII zeek log on standard input.

$ zeek-cut ts id.orig_h host uri < http.log

```
1320279600.688672    192.168.2.76    www.zeek.org /
1320279600.921091    192.168.2.76    www.zeek.org /css/pygments.css
1320279600.924479    192.168.2.76    www.zeek.org /css/print.css
```

$ zeek-cut –d ts id.orig_h host uri < http.log

```
2011-11-02T20:19:37-0400    192.168.2.76    slashdot.org    /
2011-11-02T20:19:37-0400    192.168.2.76    a.fsdn.com      /sd/topic1
2011-11-02T20:19:37-0400    192.168.2.76    a.fsdn.com      /sd/topic2
```

Log Processing Tools

sort - sort lines of text files

$ zeek-cut id.orig_h resp_bytes <conn.log | sort -rnk2 | head

```
172.16.238.131  13871
172.16.238.1    2887
172.16.238.131  1724
172.16.238.1    714
172.16.238.131  459
172.16.238.131  456
172.16.238.131  451
172.16.238.131  448
172.16.238.131  447
```

Log Processing Tools

uniq - report or filter out repeated lines in a file

```
$ zeek-cut id.orig_h id.resp_p <conn.log | sort | uniq -c | sort -rnk1
```

```
  14  172.16.238.131    53
  11  172.16.238.131    53
   1  172.16.238.131    80
   1  172.16.238.131    5353
   1  172.16.238.131    53
   1  172.16.238.131    53
   1  172.16.238.131    22
   1  172.16.238.131    123
```

Log Processing Tools

awk - pattern-directed scanning and processing language

Find hosts with http not on port 80

```
$ awk '$8 == "http" && $6 != 80 { print $0 }' conn.log
```

Total resp_bytes for host :

```
$ awk ‘{ if ( $3 ~ /192.168.125.105$/ ) sum+=$10 } END { print sum }’
```

Log Processing Exercise

zeek -C -r /zeek/training-res/capture.pcap local

1) Show the top 5 destination ports in descending order.

2) List the connections by increasing order of duration, i.e., the longest conns at end.

3) Find all connections that are longer than 5 seconds.

4) Find all IP addresses of web servers that send more than 1 KB back to a client.

5) Show a breakdown of the number of connections by service.

Logging Framework

- Streams
  - Define fields and types
- Filters
  - Each stream has a default filter
  - Where to go, how to get there
  - path_func
  - Pred
  - Writers
    - Generally ASCII (can be Kafka)
    - JSON : **redef** LogAscii::use_json = **T**;

Logging FW Exercise

- # zeek -C -r /zeek/training-res/capture.pcap /zeek/training-res/logging.zeek
- Run and observe changes in conn.log
- Now comment out first “return” line and uncomment the next
- What is different about conn.log this time?
- Now, comment out first “zeek_init” section and uncomment the next one
- What new log was created?

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Notice Framework

- Notices are “interesting events” (as opposed to normal protocol logs)
- Notices have built-in suppression (to avoid repeated events)
  - Generally controlled/defined by the script writer
- Hooks allow modification of notices as they are passed through the framework
  - Use ”break” to suppress a given notice, based on some characteristic (such as src IP)

Notice Exercise

- Detecting scan: Uncomment the following line in local.zeek:
  # nano /zeek/share/zeek/site/local.zeek
  @load misc/scan
- Run against mal.pcap
  # zeek -C -r /zeek/training-res/mal.pcap local
- Look at newly generated notice.log file
- Custom notice generation:
  - Run notice.zeek against mal.pcap
  - Comment/uncomment the sections and observe the changes

Intel Framework

Automatically watch traffic for malicious indicators

What can Zeek watch for?

- ADDR
- URL
- SOFTWARE
- EMAIL
- DOMAIN
- USER_NAME
- FILE_HASH
- FILE_NAME
- CERT_HASH

Intel Framework

Where does it look?

Conn::IN_ORIG
Conn::IN_RESP
Files::IN_HASH
Files::IN_NAME
DNS::IN_REQUEST
DNS::IN_RESPONSE

SMTP::IN_RCPT_TO
SMTP::IN_FROM
SMTP::IN_TO
SMTP::IN_RECEIVED_HEADER
SMTP::IN_REPLY_TO
HTTP::IN_HOST_HEADER

Intel Framework

file changes trigger reload
  ex. : $ mv intel.new intel.dat
  but …..

Old entries are *not* removed without restart
  but …..

policy/frameworks/intel/removal
  Boolean (meta.remove) to remove entries on file update
  Just deleting entry from file won't remove it from worker store

policy/frameworks/intel/do_notice
  raise notices when Intel is seen

Intel Framework

1. Enable Intel FW in local.zeek:

   ```
   @load frameworks/intel/seen
   @load frameworks/intel/do_notice
   ```

2. Intel.dat - define the intelligence data to match

   ```
   #fields indicator indicator_type  meta.source    meta.do_notice
   zeek.org                          Intel::DOMAIN  source1        T
   ```

3. Tell zeek about the intel file - load an intelligence file:

   ```
   redef Intel::read_files += {
         "/some/path/intel.dat",
   };
   ```

Intel Framework Exercise

Edit local.zeek to enable intel FW:

```
# nano /zeek/share/zeek/site/local.zeek

@load frameworks/intel/seen
redef Intel::read_files += {"/zeek/training-res/intel.dat",};
```

Run zeek against mal.pcap:

```
# zeek –C –r /zeek/training-res/mal.pcap local
```

Observe the type of indicator and seen.where fields:

```
# less intel.log
```

Need hints on Intel types? See : share/zeek/base/frameworks/intel/main.zeek

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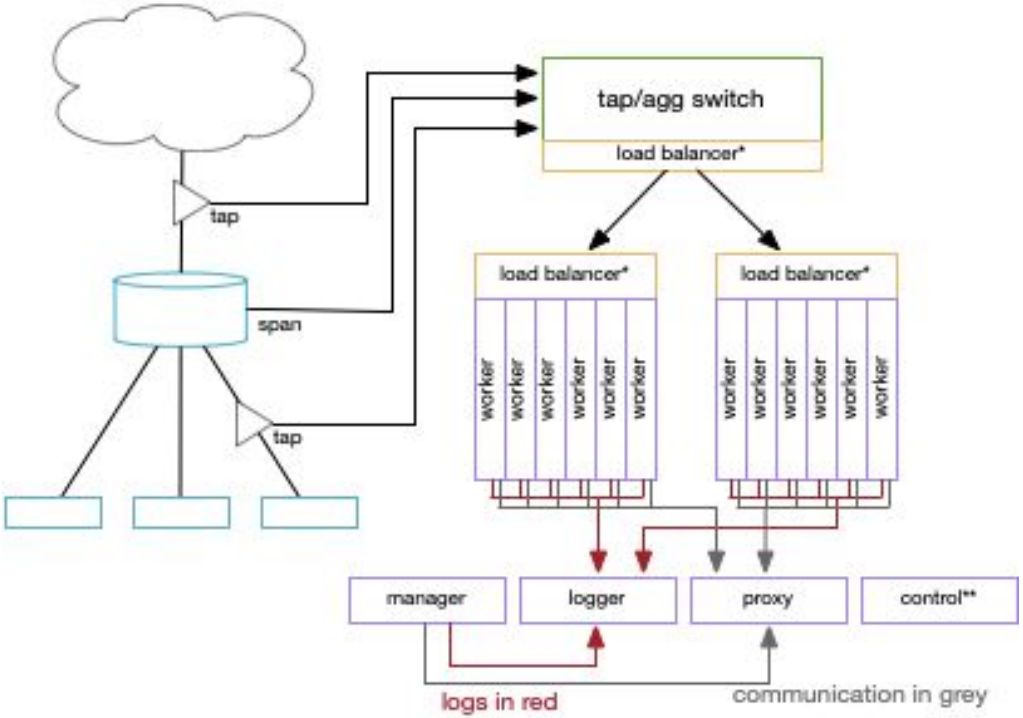
Zeek Cluster Architecture

Courtesy - Mike Dopheide (ESnet)



Zeek Cluster Nodes

- Scripts in share/zeek/base/framework/cluster/nodes

- Worker
  - Turn packets into logs!
- Proxy
  - Synchronize state between workers
  - Evolving into “data nodes” under zeek/broker
- Manager
  - Manage cluster
  - sumstats
- Logger
  - Receive logs over network, write ‘em (usually to log files locally)

node.cfg

- Cluster configuration
- Pop out to shell to show off node.cfg

zeekctl

- Python script used to run Zeek Cluster
- copy scripts, binaries, etc between nodes
  - This means you *must* have the same OS, etc for all Zeek nodes
- Uses ssh when connecting across nodes

zeekctl commands

Python script used to run Zeek Cluster

zeekctl deploy
- check config for each type of node
- install Zeek config
- restart

zeekctl start
zeekctl status
zeekctl stop

Running Zeek : Cluster

A Minimal Starting Configuration:

```
# nano /zeek/etc/node.cfg
        interface=eth0     # change this according to your listening interface, find it by doing ifconfig
```

Running Zeek : Live

1. Loading all current scripts into zeek
   # zeekctl install

2. Starting Zeek in sniffing mode
   # zeekctl start

3. Taking a look at the logs folder
   # cd /zeek/logs/current
   # ls

4. Stop Zeek
   # zeekctl stop

More Zeek Resources

Zeek Documentation:
https://docs.zeek.org/en/master/

Zeek packages:
https://packages.zeek.org/packages

Zeek btest pcaps:
https://github.com/zeek/zeek/tree/master/testing/btest/Traces

Zeek Github source:
https://github.com/zeek/zeek

Zeek online:
https://try.zeek.org/#/?example=hello

Thanks for attending!
Enjoy Zeeking

Stay Connected

Website - Zeek.org

Mailing List - zeek@lists.zeek.org

Slack - http://bit.ly/ZeekOrgSlackInvite

Find out more ways to connect at: https://zeek.org/community/