Detection 1

Logging and Traceability

who, what, when, where, how … why?

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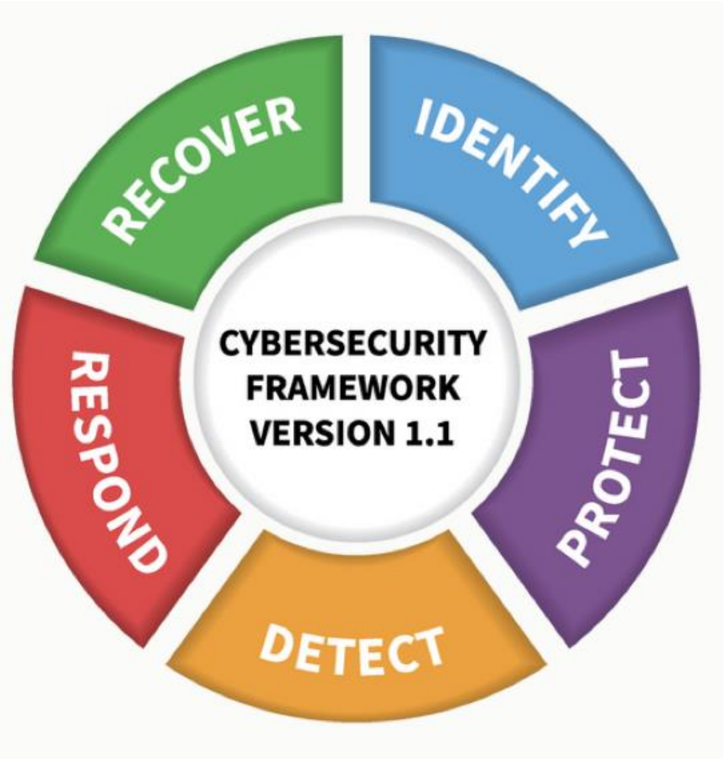
Introduction

- Logging basics
- Central logging
- Data Protection
- Network logging

Preamble

- Consider the NIST Cybersecurity elements from yesterday

- Identify
- Protect/Prevent
- Detect
- Respond+Recover



Preamble

- Consider the NIST Cybersecurity elements from yesterday

- *Identify*
- *Protect/Prevent*
- **Detect**
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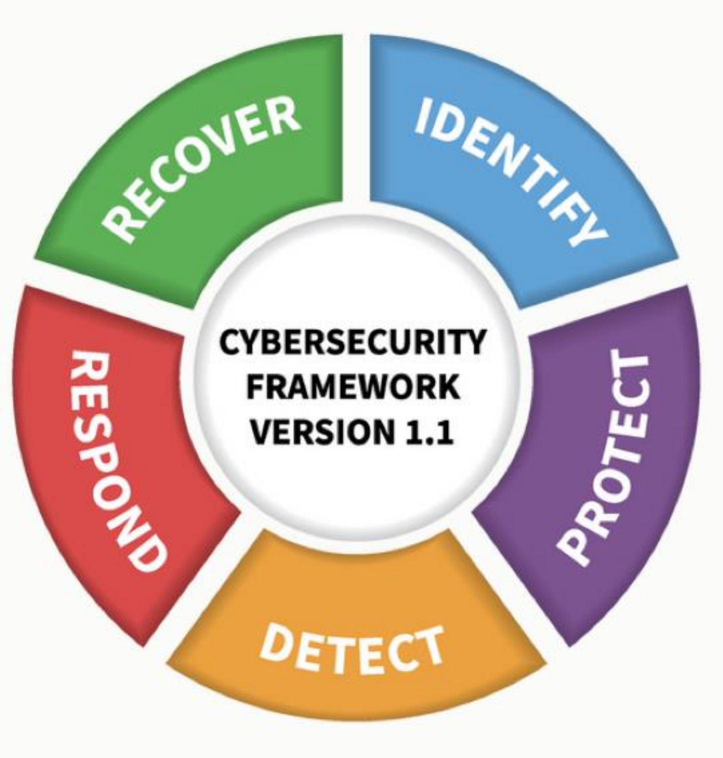


Preamble

- Assessing your risk and having visibility of your services and systems is **absolutely essential**

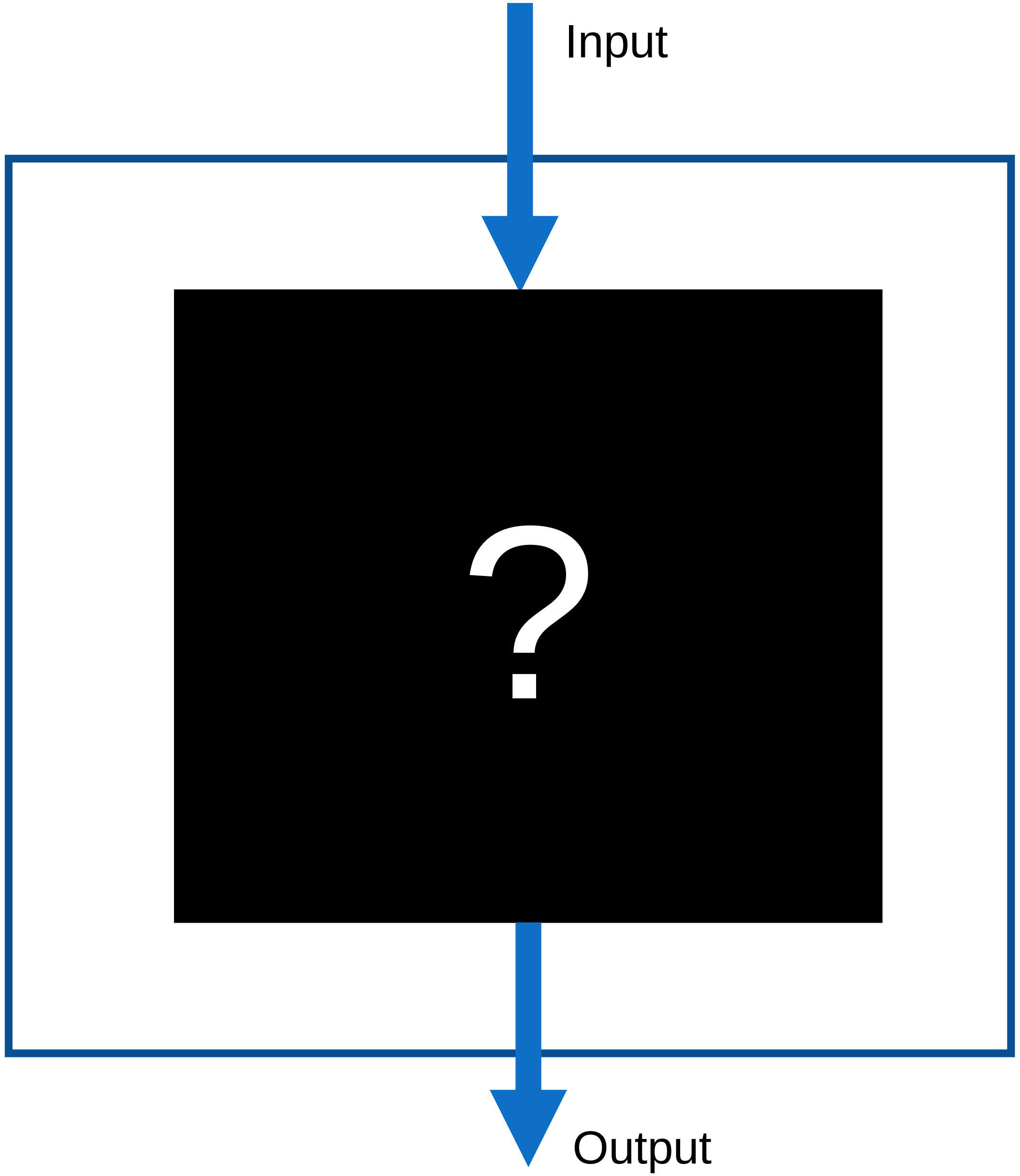
- Everything we’re about to discuss assumes that – to some extent – our area has been assessed for risk

Why do we log?

- To know what happened **in as much detail as necessary**

- Often, security concerns are an extension of operations
  - **What** happened?
  - **When** did it happen?
  - **Where** did it happen?

  - **How** did it happen?
  - **Why** did it happen?



Examples

- Why did this data transfer fail?
- Why did this job only complete partially?
- Which endpoints were involved in this process?
- What did the attacker do?

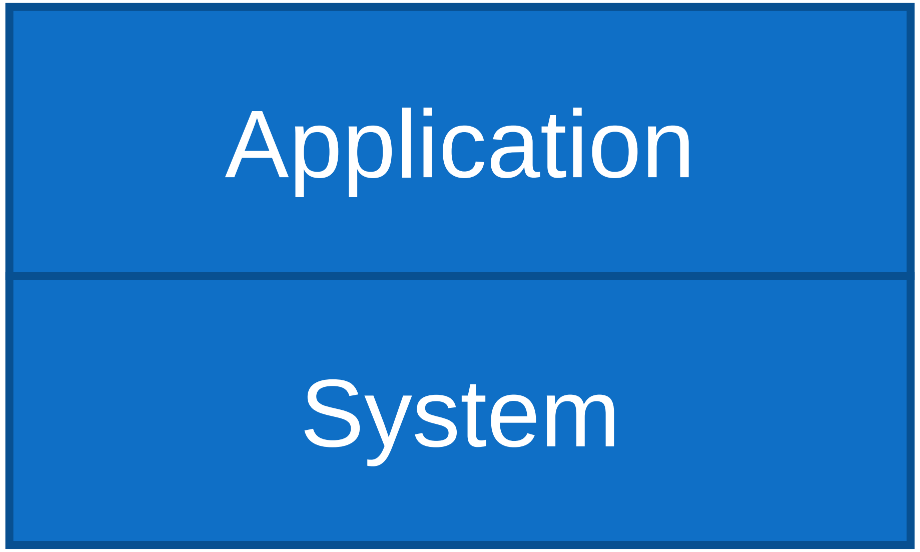
Day to day life

- Logs are an integral part of our technical lives

- But as we head heard yesterday, with this ubiquity comes careful consideration

Host/service logs

- Application logs
- System logs

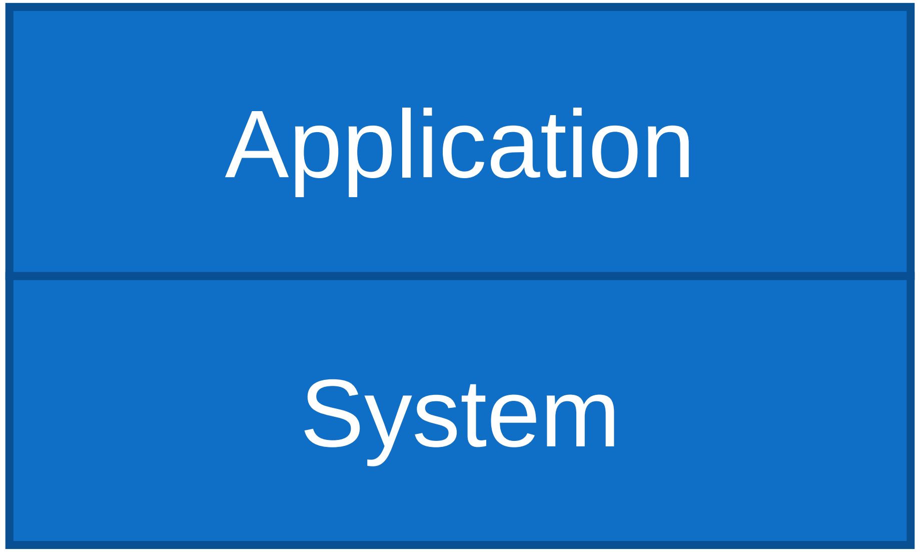


Application

System

Host/service logs

- Application logs
  - Apache
  - Drupal
  - Ceph
  - Dcache
  - ...

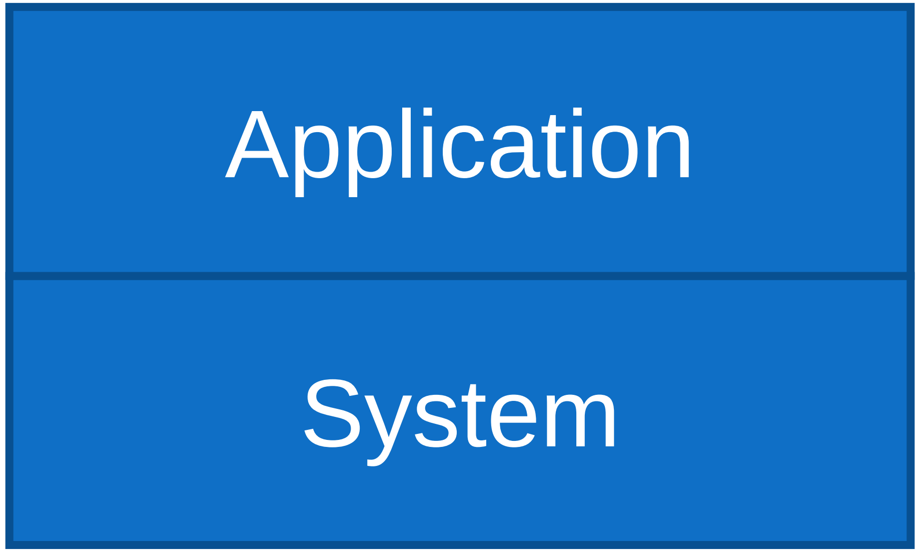


Application

System

Host/service logs

- Application logs
- These depend on the service
- Talk about this again in traceability, but: service owners are best placed to understand what is useful!



Application

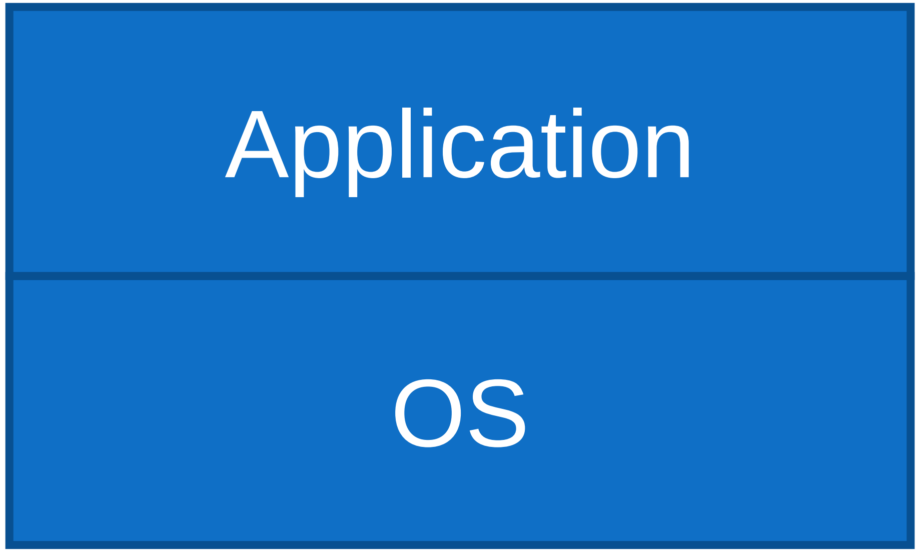
System

Host/service logs

- System logs

- Give us an understanding of the behaviour of the system itself
  - Direct access via `ssh`
  - System behaviour
  - Auditing over time

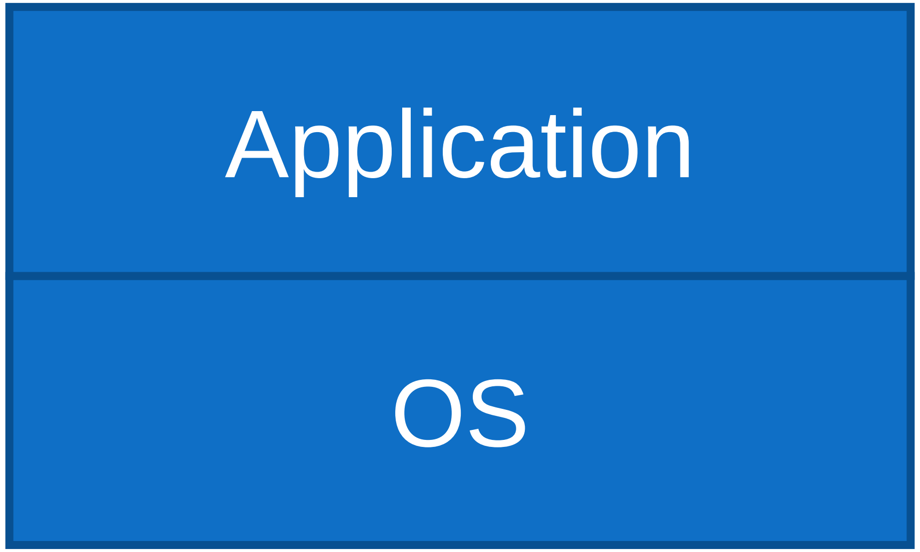
- (Paths will be for RHEL Distros)



Host/service logs

- System logs
  - `/var/log/audit.log`

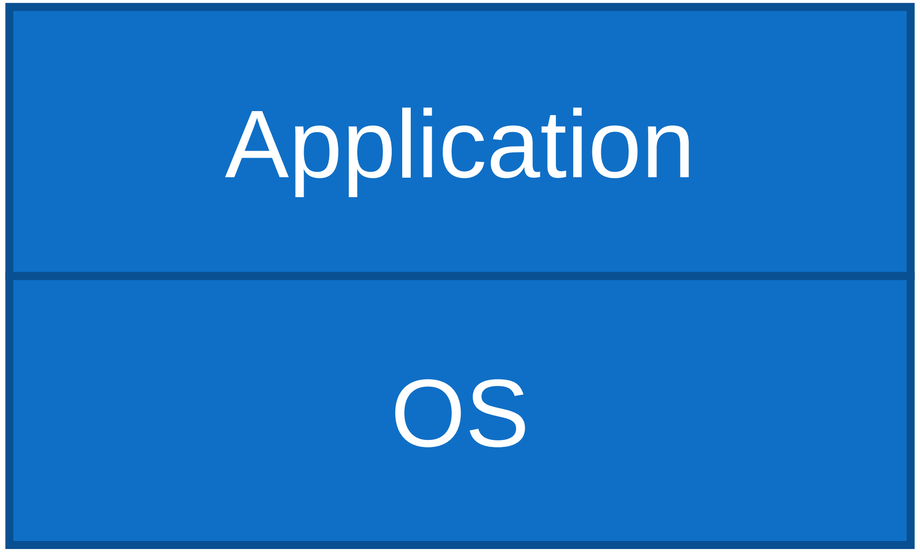
```
type=USER_AUTH msg=audit(1655751006.984:3758): pid=26347 uid=0 auid=4294967295 ses=4294967295
subj=system_u:system_r:sshd_t:s0-s0:c0.c1023 msg='op=pubkey_auth rport=35186 acct="centos" exe="/usr/sbin/sshd" hostname=?
addr=A.B.C.D terminal=? res=success'
type=USER_AUTH msg=audit(1655751006.984:3759): pid=26347 uid=0 auid=4294967295 ses=4294967295
subj=system_u:system_r:sshd_t:s0-s0:c0.c1023 msg='op=key algo=ssh-rsa size=4096
fp=SHA256:48:43:a1:08:47:36:a3:69:1a:d0:72:24:58:f3:e3:07:7d:99:ce:0b:bd:d5:cd:fb:10:bc:37:18:cf:f8:4a:a4 rport=35186 acct="centos"
exe="/usr/sbin/sshd" hostname=? addr=A.B.C.D terminal=? res=success'
type=USER_ACCT msg=audit(1655751006.994:3760): pid=26347 uid=0 auid=4294967295 ses=4294967295
subj=system_u:system_r:sshd_t:s0-s0:c0.c1023 msg='op=PAM:accounting grantors=pam_unix,pam_localuser acct="centos"
exe="/usr/sbin/sshd" hostname=X.Y.Z addr=A.B.C.D terminal=ssh res=success'
type=CRYPTO_KEY_USER msg=audit(1655751006.994:3761): pid=26347 uid=0 auid=4294967295 ses=4294967295
subj=system_u:system_r:sshd_t:s0-s0:c0.c1023 msg='op=destroy kind=session fp=? direction=both spid=26348 suid=74 rport=35186
laddr=A.B.C.D 6 lport=22  exe="/usr/sbin/sshd" hostname=? addr=A.B.C.D terminal=? res=success'
type=USER_AUTH msg=audit(1655751006.996:3762): pid=26347 uid=0 auid=4294967295 ses=4294967295
subj=system_u:system_r:sshd_t:s0-s0:c0.c1023 msg='op=success acct="centos" exe="/usr/sbin/sshd" hostname=? addr=A.B.C.D 6
terminal=ssh res=success'
type=CRED_ACQ msg=audit(1655751006.996:3763): pid=26347 uid=0 auid=4294967295 ses=4294967295
subj=system_u:system_r:sshd_t:s0-s0:c0.c1023 msg='op=PAM:setcred grantors=pam_env,pam_unix acct="centos" exe="/usr/sbin/sshd"
hostname=X.Y.Z addr=A.B.C.D terminal=ssh res=success'
type=LOGIN msg=audit(1655751006.996:3764): pid=26347 uid=0 subj=system_u:system_r:sshd_t:s0-s0:c0.c1023 old-auid=4294967295
auid=1000 tty=(none) old-ses=4294967295 ses=215 res=1
type=USER_ROLE_CHANGE msg=audit(1655751007.128:3765): pid=26347 uid=0 auid=1000 ses=215 subj=system_u:system_r:sshd_t:s0-
s0:c0.c1023 msg='pam: default-context=unconfined_u:unconfined_r:unconfined_t:s0-s0:c0.c1023 selected-
context=unconfined_u:unconfined_r:unconfined_t:s0-s0:c0.c1023 exe="/usr/sbin/sshd" hostname=X.Y.Z addr=A.B.C.D terminal=ssh
res=success'
type=USER_START msg=audit(1655751007.145:3766): pid=26347 uid=0 auid=1000 ses=215 subj=system_u:system_r:sshd_t:s0-s0:c0.c1023
msg='op=PAM:session_open
grantors=pam_selinux,pam_loginuid,pam_selinux,pam_namespace,pam_keyinit,pam_keyinit,pam_limits,pam_systemd,pam_unix,pam_lastlog
acct="centos" exe="/usr/sbin/sshd" hostname=X.Y.Z addr=A.B.C.D 6 terminal=ssh res=success'
```



Host/service logs

- System logs
  - `/var/log/audit.log`

- `aureport` can be used to get summary information

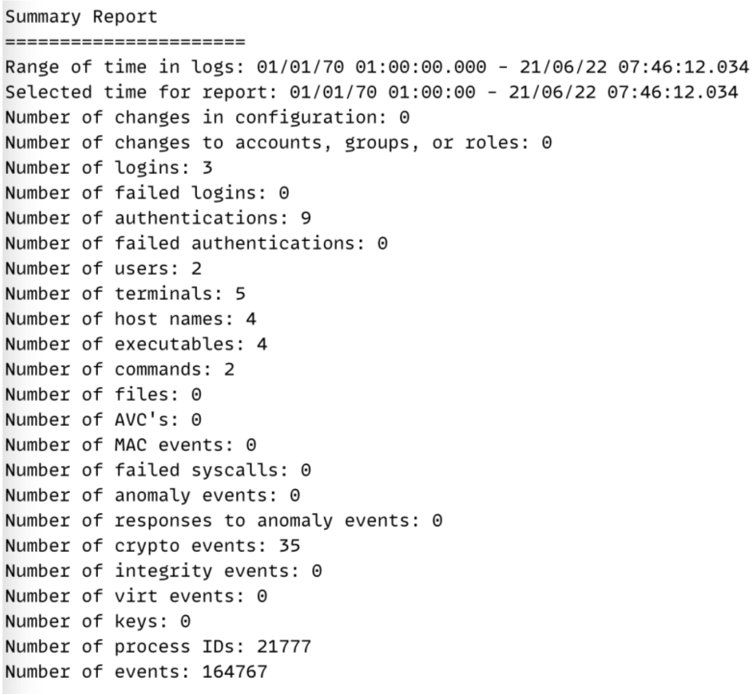


Application

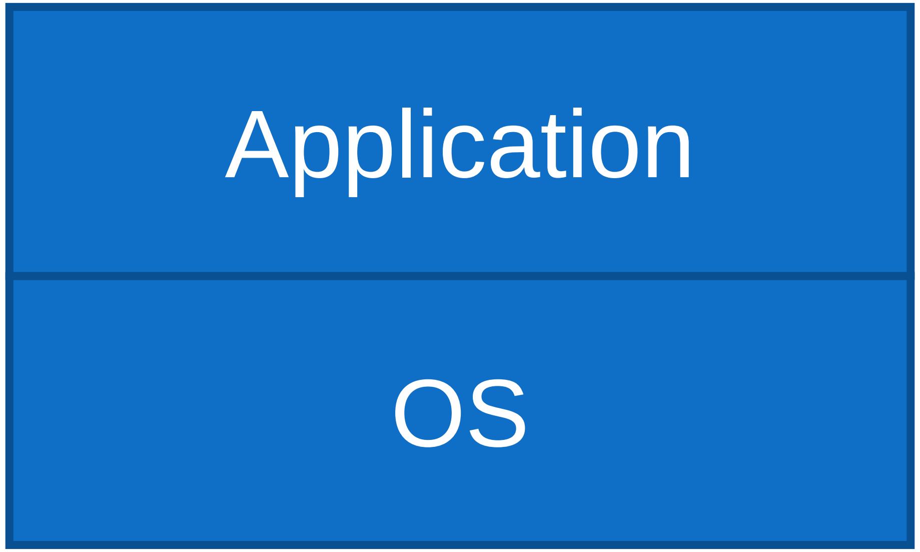
OS

Host/service logs

- System logs
  - `/var/log/audit.log`



```
Summary Report
======================
Range of time in logs: 01/01/70 01:00:00.000 - 21/06/22 07:46:12.034
Selected time for report: 01/01/70 01:00:00 - 21/06/22 07:46:12.034
Number of changes in configuration: 0
Number of changes to accounts, groups, or roles: 0
Number of logins: 3
Number of failed logins: 0
Number of authentications: 9
Number of failed authentications: 0
Number of users: 2
Number of terminals: 5
Number of host names: 4
Number of executables: 4
Number of commands: 2
Number of files: 0
Number of AVC's: 0
Number of MAC events: 0
Number of failed syscalls: 0
Number of anomaly events: 0
Number of responses to anomaly events: 0
Number of crypto events: 35
Number of integrity events: 0
Number of virt events: 0
Number of keys: 0
Number of process IDs: 21777
Number of events: 164767
```



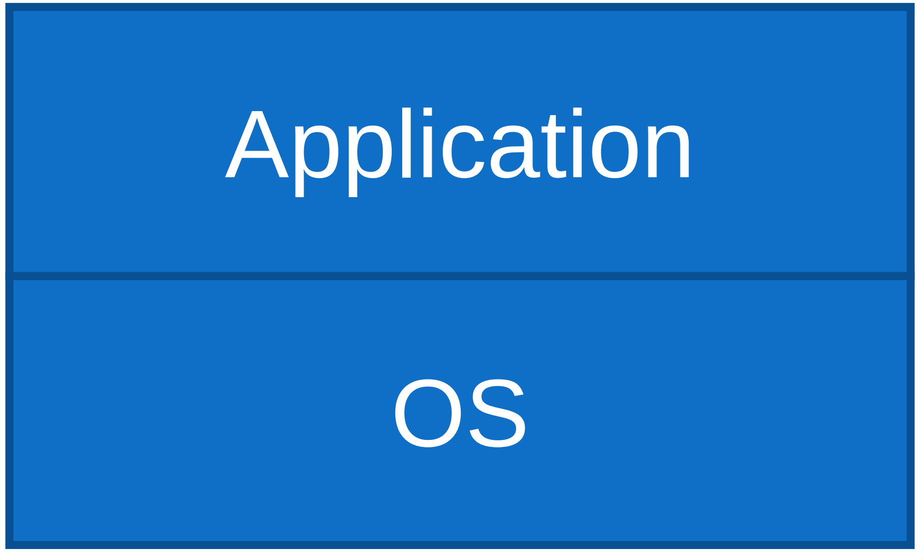
Application

OS

Host/service logs

- System logs
  - Auditbeat

- Part of the elasticsearch Beats set of tools that can also extract and effectively parse audit data



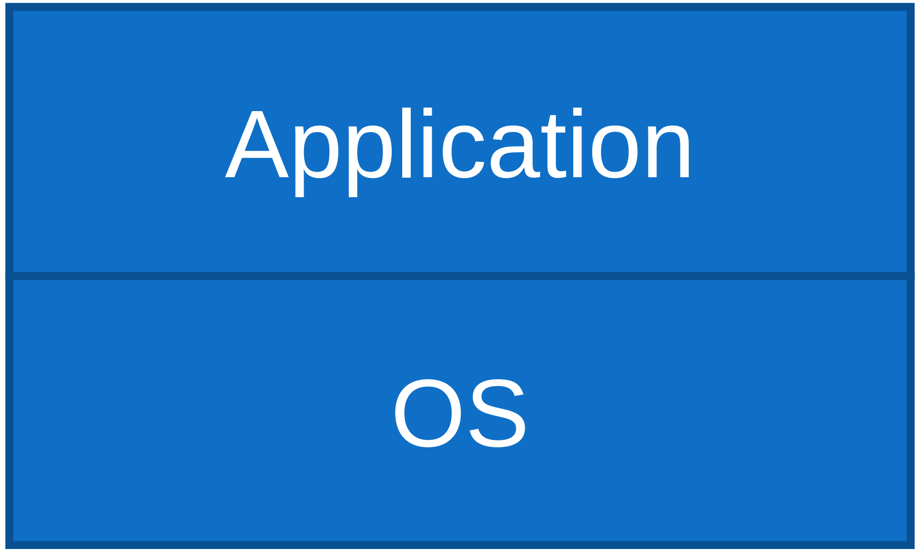
Application

OS

Host/service logs

- System logs
  - `/var/log/messages`

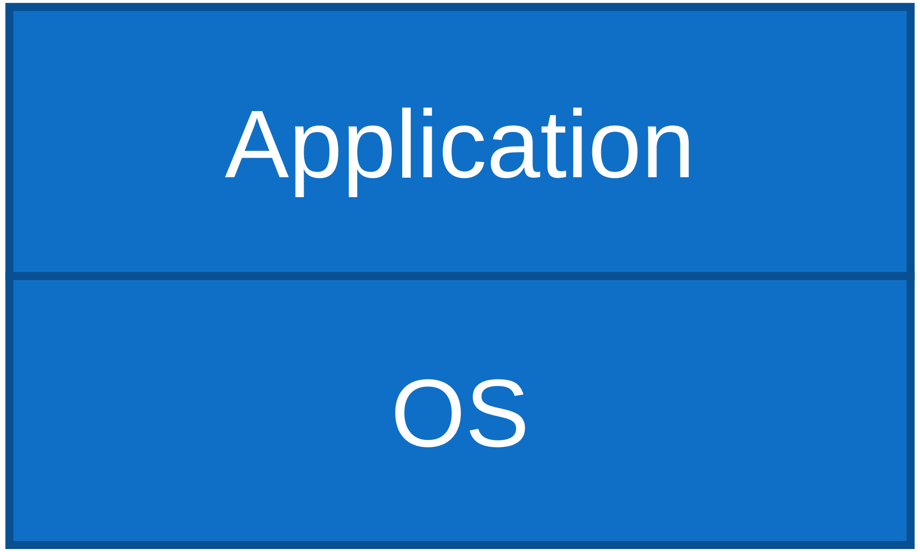
Records global log messages, system notifications including those during boot



Host/service logs

- System logs
  - `/var/log/secure`

Records successes and failures for users using `ssh` to access the system



Application

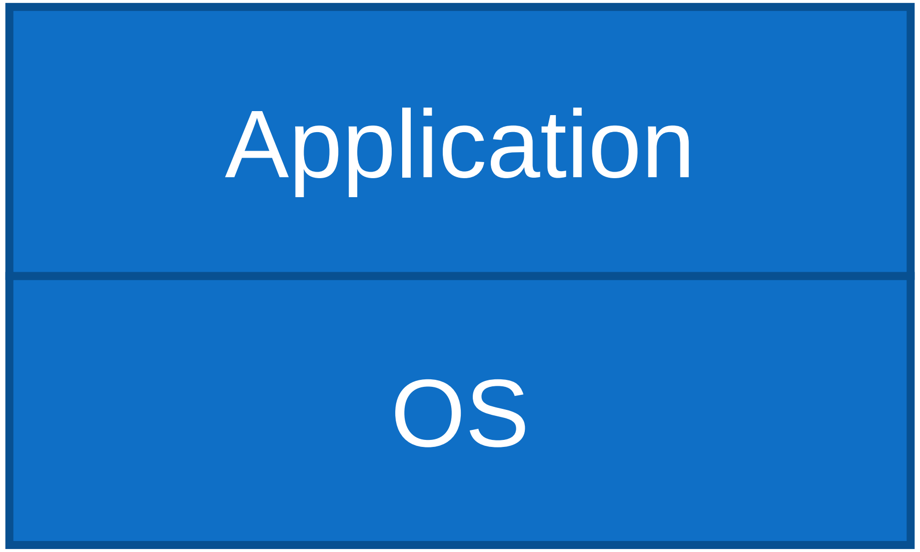
OS

Host/service logs

- System logs
  - `/var/log/secure`

```
Jun 19 22:18:36 hostname
sshd[26877]: Accepted
publickey for user from
A.B.C.D port 60096 ssh2: RSA
SHA256:…
```

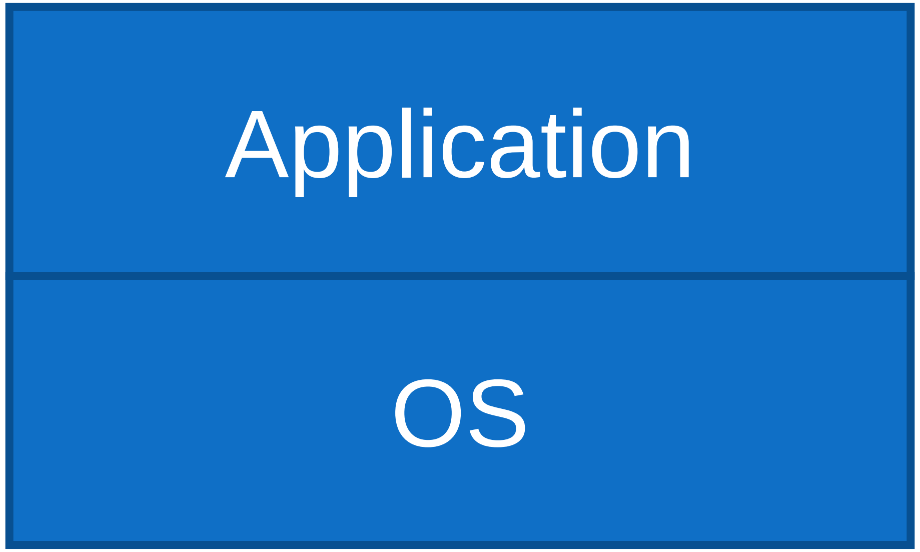
Success!



Host/service logs

- System logs
  - /var/log/secure

```
Jun 20 19:08:58 hostname
sshd[7555]: Invalid user admin
from A.B.C.D port 36844
```



Application

OS

Host/service logs

- System logs
  - `/var/log/secure`

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sshd[7555]: Invalid user admin
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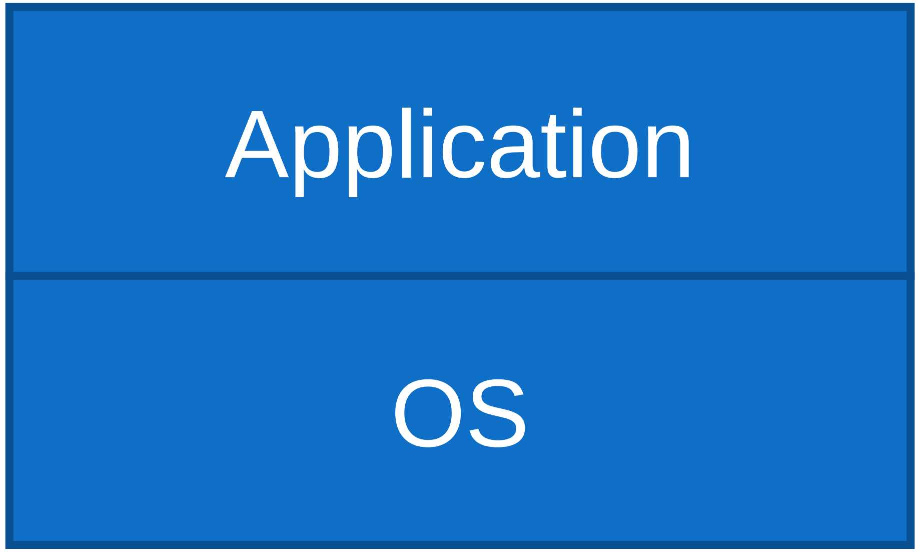


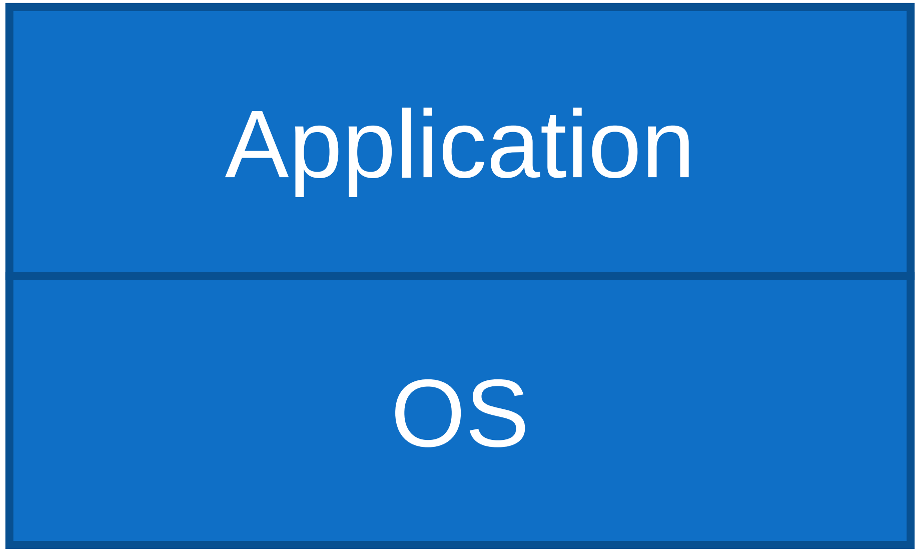
Host/service logs

- System logs
  - `/var/log/secure`

… this is why you harden your systems (although only a *real* problem if they succeed)

A primary source of checking for malicious access

Unless?



Application

OS

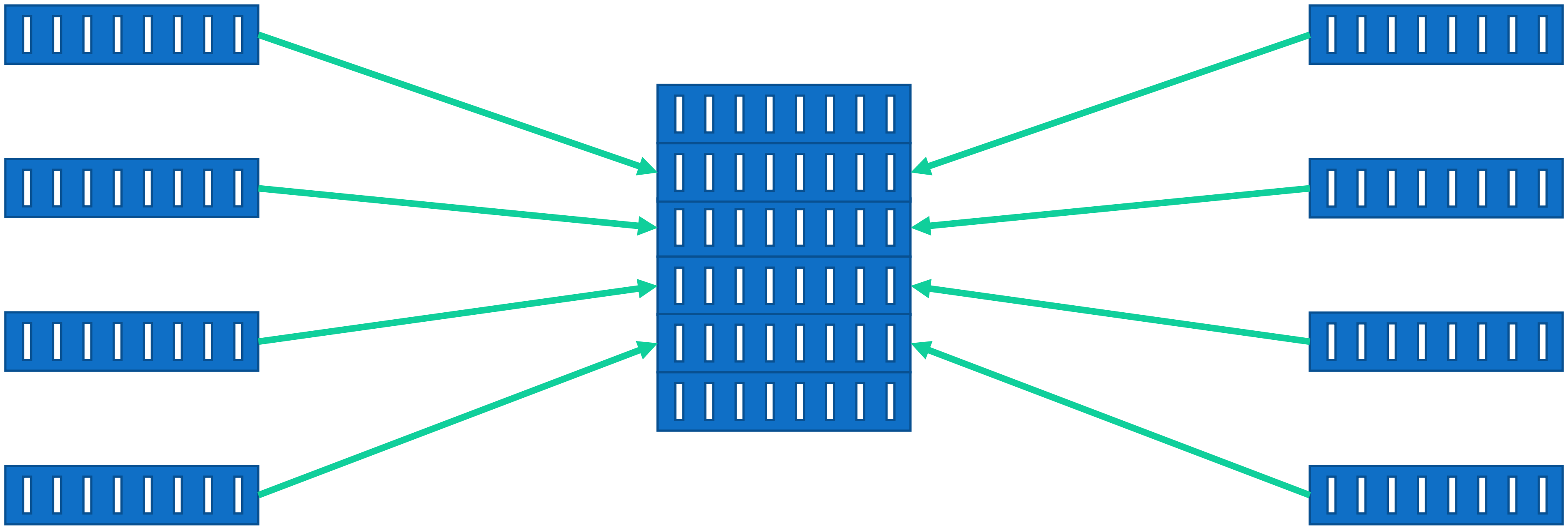
A successful attacker

- Gains access via a weak password (`password2023-2`)
- Installs a compiler, builds some code…
- … hides their tracks by truncating the logs

Central logging

- Logs are data
- Vulnerable to deletion or corruption
- Back them up!

Central logging



Central logging

- One of the single most important things to do for the security of a service

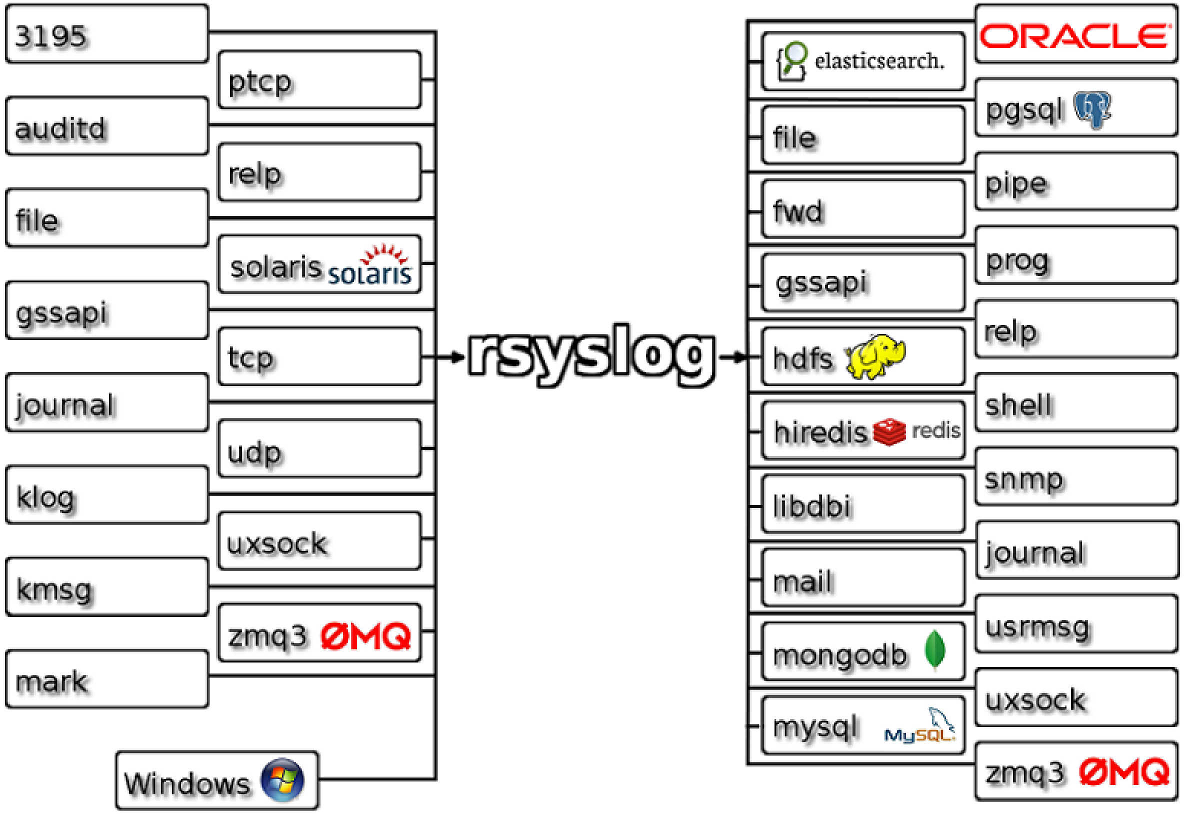
- Helps incident response

- Helps correlate logs between hosts

rsyslog

- `rsyslog` is a well-featured logging engine

- `rsyslog` and `syslog-ng` are both feature-rich successors to the original syslog



https://www.rsyslog.com

rsyslog and other tools

- Especially at this point, storing raw logs is not the most useful

- Use a tool like elasticsearch to allow better searching an querying of the data

OSSEC/Wazuh

- OSSEC is a very nice host-based IDS that will aggregate logs in a server/client topology
- Customisable rules
- Very flexible

https://www.ossec.net

OSSEC/Wazuh

- Wazuh is a modern development of OSSEC that integrates tightly with elasticsearch

- Important when considering defence in depth – having one exactly one tool to monitor your system is **not** optimal (necessary ☺)

wazuh.

https://wazuh.com/

Wazuh/OSQuery

- Wazuh can monitor many useful things at the host level
  - File integrity + checksums
  - Configuration Assessment
  - Extended Detection and Response

- OSQuery is a nice tool that provides an SQL interface to system information

wazuh.

https://wazuh.com/

osquery

https://osquery.io

System + application logs

- Discussed some key system logs

- Application logs are best understood by their service owners: how to choose what you need?

System + application logs

- We can’t store an infinite amount of logs

- And we don’t want to

“too much data looks like noise”

Data protection

- I am not a lawyer ☺

Data protection

- We are in an era where individual privacy rights are rightly taken particularly seriously
- This is not something that should hinder our security work

- GDPR
- CERN OC11
- Development of UK data protection laws
- Working with laws in other countries

GDPR and CSIRT activities

- In GDPR and associated findings the exchange of logs for incident response is recognized as a useful activity
- https://www.first.org/blog/20171211_GDPR_for_CSIRTs
- We **do** need to be careful about what we store, why, and for how long

Log retention

- In WLCG, for a long time 90 days was the retention period set by policy

- Now moving towards 180 days or more: why?

Log retention

- The number of incidents that have their beginning many months ago

- Only having logs for 90 or 180 days means we lose visibility

- 12 – or 13 – months is where we might set our sights

Log retention: practical matters

- Of course, there are practical matters
    - Logs take up room

- Central logging **also** makes capacity planning easier
    - Build to a set of services that are logged

- Continuous improvement is important

Log retention: practical matters

- Our architecture will suggest where and how many logs we can keep

- This can and should evolve over time

- Focus on sustainable development

Traceability

- For security, we want the logs that will help us piece together a set of events
  - When did someone gain access?
  - What did they do on the host?
  - Where did they go next?
  - What other hosts did they talk to?

Traceability

- Traceability is the ability for us to trace the activity associated with a particular user and/or particular workflow

- Want to be able to track the entire lifecycle
  - Initiation
  - Primary events
  - (External) communications
  - Closeout

Traceability

- Core system logs are essential; for application logs we want anything that helps piece these together

- Debug logs don’t help with this

- It is likely that this will **also** evolve over time

- Make a plan and iterate based on your risks and resources

Split traceability

- Our the, current circumstances, it is **highly likely** that the logs from a particular service – or even facility – will not be sufficient to track the activity of a user or group

- Why?

Split traceability

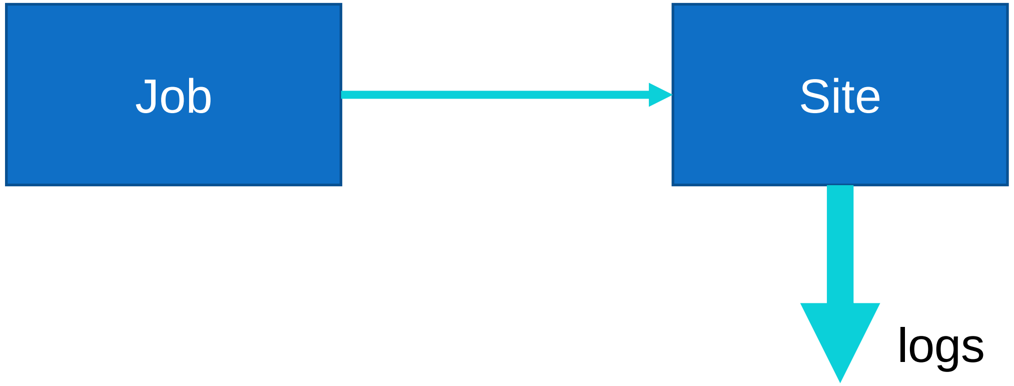
- In research and education, invariably work as part of a bigger infrastructure, federation or federation of federations

Split traceability

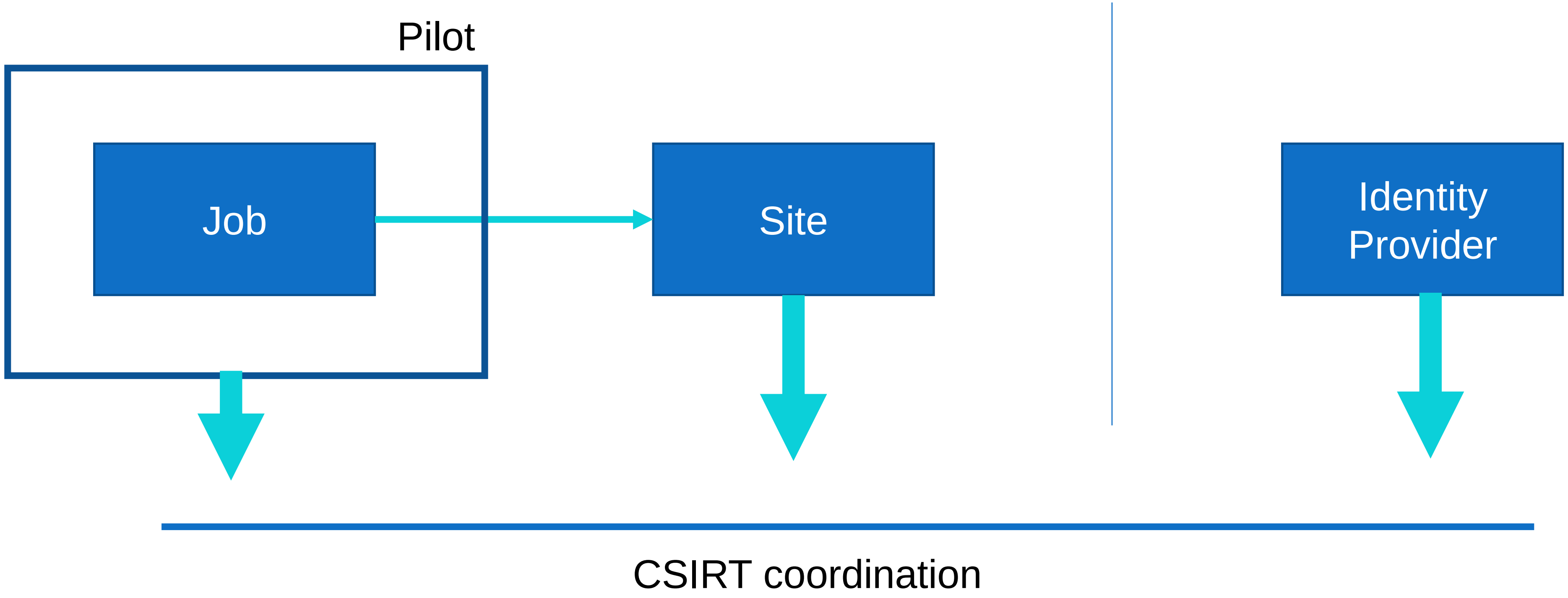
- Many (most!) of our activities involve many services composed together
  - WLCG pilot jobs
  - **Cloud services**

- We can **no longer** rely on the logs on a single host/in a single facility to assemble the full picture of a user’s activity

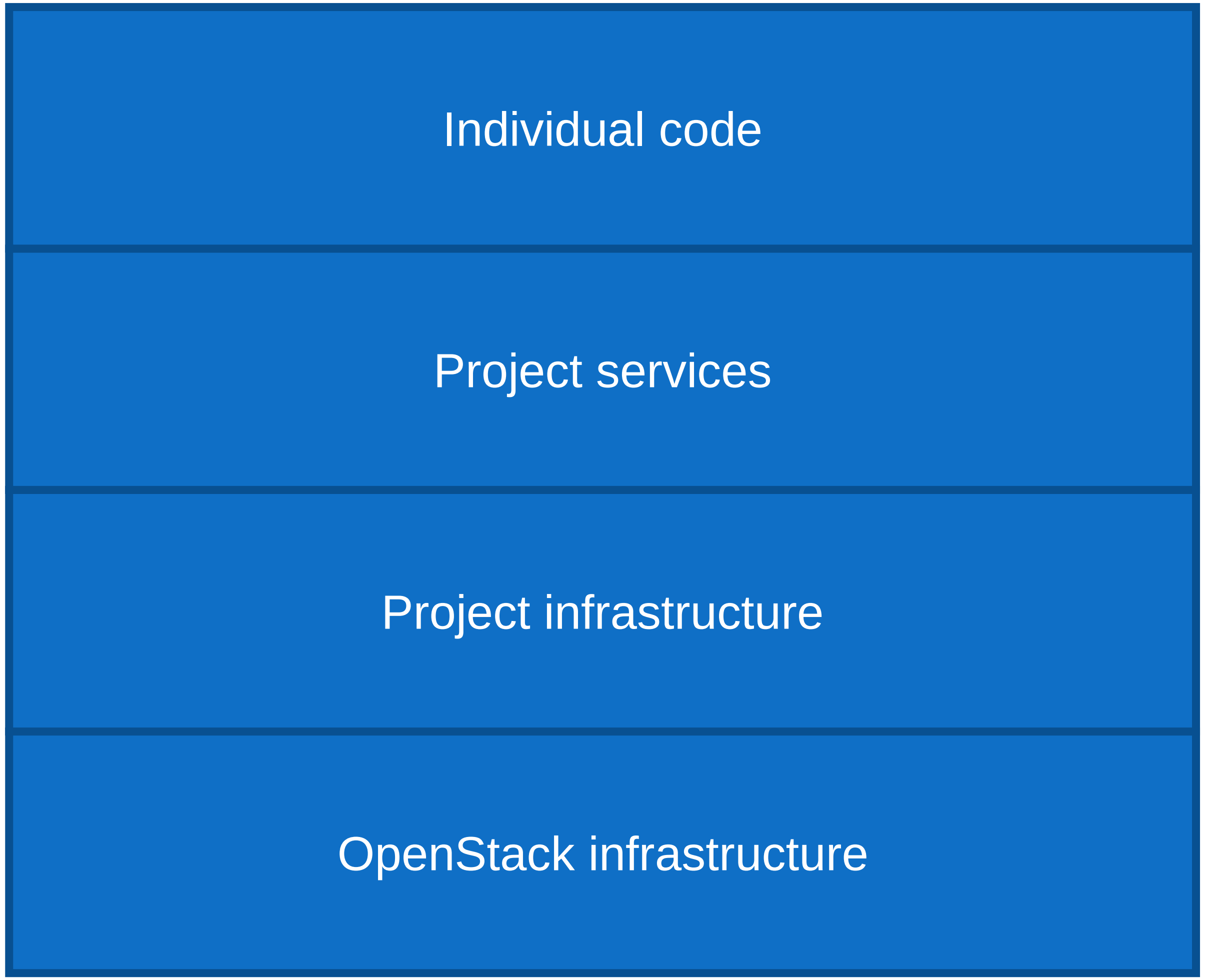
grid jobs: before



pilot jobs: after



Cloud services



Individual code

Project services

Project infrastructure

OpenStack infrastructure

How do we check we our traceability?

- Planning and policy
- Collaboration and cooperation
- **Testing**
- Find use cases that are appropriate for you and try them out!

Network logging

- We’ve talked about host based logs

- What’s happening on the network?

Sources of network logs

- Routers
- Host-based generators
- Monitoring

Netflow and sflow

- Netflow and sflow are different but similar methods of storing **metadata** about network connections
  - Endpoints/duration/…

- Most switches we'll use will generate one or the other

- Can generate on-host
  - `hsflowd`

Netflow came from Cisco

sflow came from InMon

Netflow and sflow

- Pros
  - Ubiquitous
  - Easy to generate

- Cons
  - Sampled

- In general, have **sampled** data from netflow and sflow
  - Useful for long term connections but not forensically useful

Netflow and sflow

- Netflows are especially useful at a high level
  - NRENS

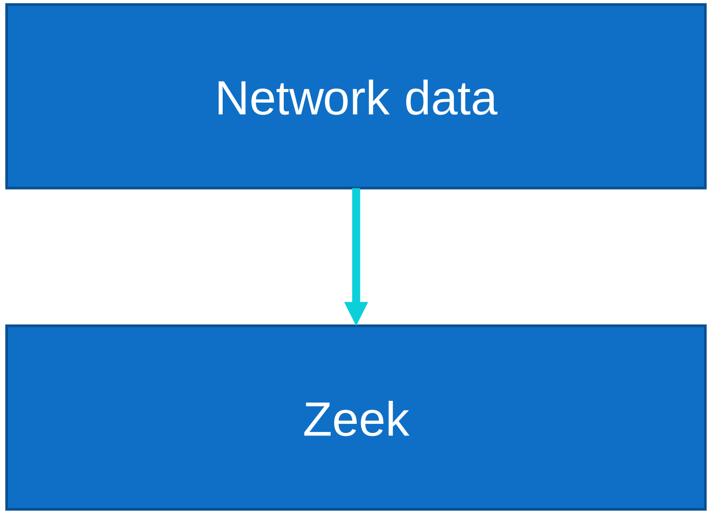
- You **can** produce 1:1 data, but…

Deep Packet Inspection

- Using a tool that analyses every packet it sees will yield rich information
  - Metadata
  - File information
  - Certificate information…
- Can’t see inside encrypted streams unless you do decryption

Zeek

- Zeek is an example of a current network IDS in broad use in the US and EU
  - Ingest data by taking tap of network traffic
  - Optical, port spanning or packet broker
- Single threaded, works by running a set of scripts against each packet
  - Scale out by building a zeek batch farm



Network data

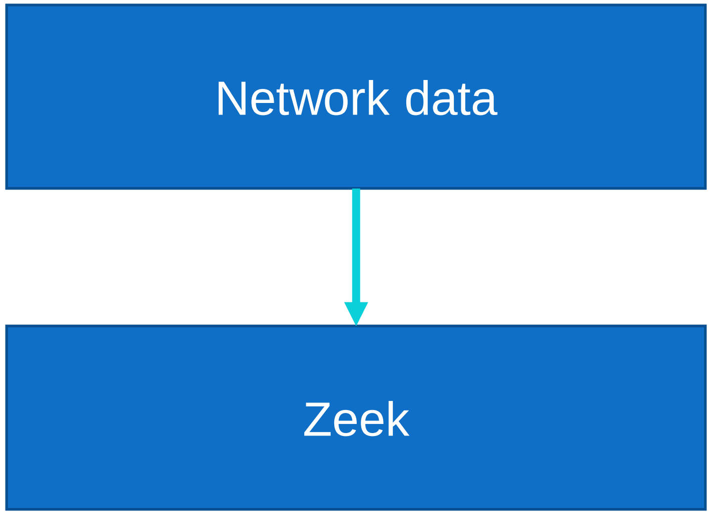
Zeek

Zeek

- This gives us forensic level results
  - Every packet is tracked

- But this is computationally expensive
  - Need care in choosing deployment

- More on this soon



Conclusions

- We need to retain logs that describe the activity of our users and services
  - For long enough to perform forensics
  - Following our legislation
  - Pragmatically for our environment

Conclusions

- We can identify logs in our services that will help with this
  - System
  - Application

- We can centrally log these
  - And **should!**

Conclusions

- We need to consider traceability in being able to piece together the events related to a particular user or activity

- This is **very likely** to require composition with other sources including other sites

Conclusions

- In addition to host-based logs, we can also log traffic from our networks
- {Net,s}flow generally give sampled, high-level metadata
- Deep packet inspection gives us greater, forensic detail
  - But more computationally intensive

Questions?