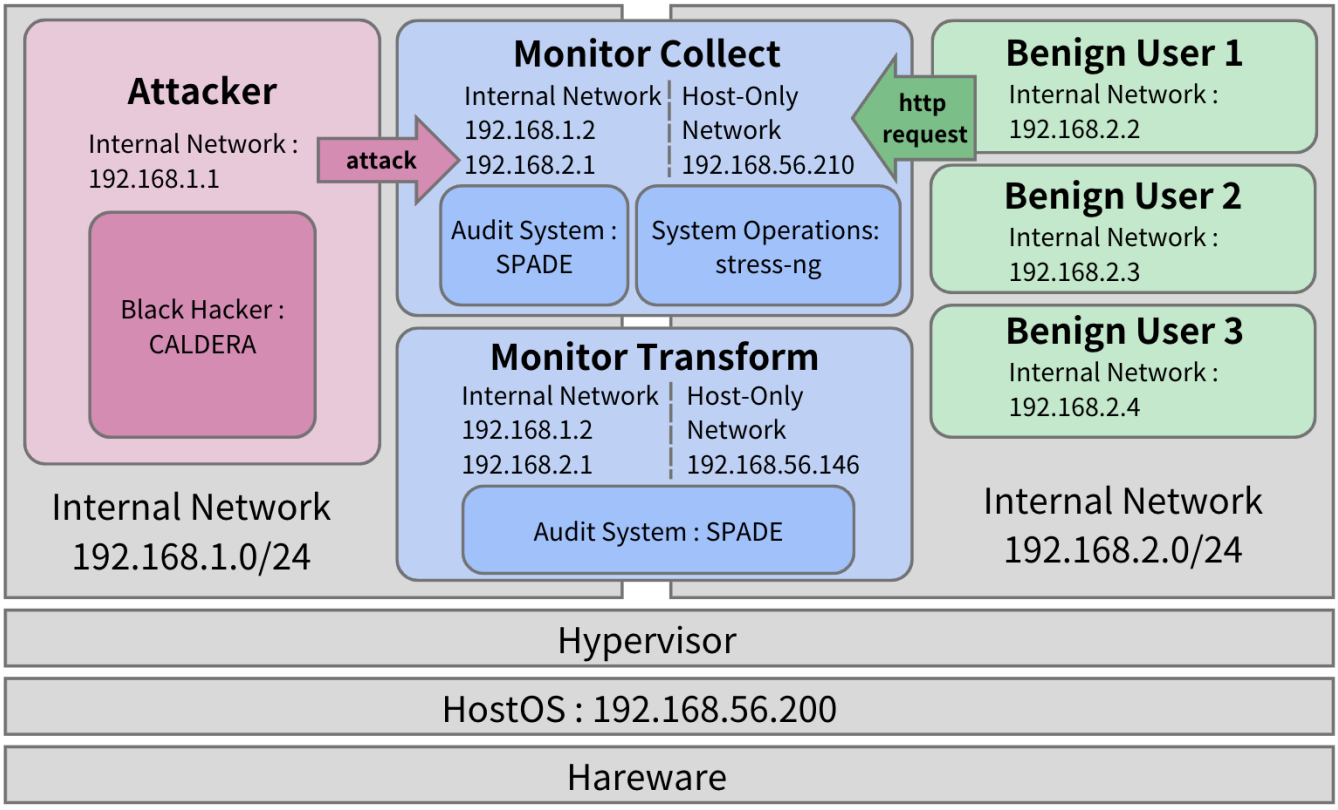
Various Attack Scenario Generation

Description

- **Motivation** : Many existing public intrusion datasets e.g. DARPA / ADFA are outdated and no longer representative of current environments.
- **Idea** : In order to expand public intrution data, we hope to develop algorithm to form synthetic dataset that can increase the diversity of the data.
- **Goal** :
    1. Attack Workload: Record audit logs of system attacked by CALDERA $\Rightarrow$ Given the audit logs, turn them into provenance graphs. *(Complete)*
    2. Benign Workload: Record audit logs of benign workload simulated by stress-ng or http request $\Rightarrow$ Given the audit logs, turn them into provenance graphs. *(Complete)*
    3. Generate Synthetic Dataset *(To be done)*



File Structure

▶ **File Structure**

File Description

- **VASG** :
    - `READEME.md`
    - **VMs** : ova files to be imported into VirtualBox

- `Offical_Server.ova` : Black Hacker VM
- `Benign_User.ova` : Benign User VM
- `Monitor_Collect.ova` : Monitor Host VM for collecting audit logs
- `Monitor_Transform.ova` : Monitor Host VM for transforming audit logs into provenance graph

- **Attack**

  - `attack.py` : runs attack workload (can either run all TTPs or specify one TTP via its ability_id)
  - **Collect+Filter**
    - `abilities_info.json` : information of each attack in CALDERA
    - `monitor_host.sh` : runs `ragdoll.py` + create pid file
    - `ragdoll.py` : connects to CALDERA and send exploit
    - `spade_collect.sh` : add reporter Audit in SPADE

      > this shell script is run in crontab of ***spade*** user.

    - `log_filter.py` : filters audit.log (whole system log) to filtered.log (attack log only)
  - **Transform**
    - `attack_transform.sh` : transform filtered.log to provenance.json and graph.dot
  - **Results**
    - **spade**
      - `processed.json` : successful attacks
      - `toSkip.json` : failed at retrieving files
      - `transformError.json` : nothing in JSON file
    - **logs** : stores filtered logs of each attack
    - **graphs** : stores provenance graph of each attack
    - **json** : stores json format of each attack

- **Benign**

  - `benign.py` : runs benign workload

  - **Collect+Filter**

    - `spade_collect.sh` : add reporter Audit in SPADE

      > this shell is run in crontab of ***spade*** user

    - `benign_collect.py` : runs the whole collection process of benign workload
    - `stress-ng.py` : record audit logs
    - `filter_stress-ng.py` : system audit logs $\to$ per task filtered logs

  - **Transform**

    - `benign_transform.py` : runs the whole transformation process of benign workload
    - `benign_transform.sh` : set up SPADE $\to$ transform $\to$ turn off

        - `move.py` : move .json and .dot to the corresponding folder
        - `graph_transform.py` : transform .dot into provenance graph

    - **Results**

        - **filtered_logs** : stores filtered logs of each class
        - **logs** : stores filtered logs of each task
        - **graphs** : stores provenance graph of each task
        - **json** : stores json format of each task
        - **debug_info**
            - `auto_log` : result of `benign_collect.py`
            - `stressng_final_result` : result of `graph_transform.py`
            - `success_tasks` : result of `graph_transform.py`

- **shared**

    - **task** : tasks of each class
    - `collect_error_log` : result of `stress-ng.py`
    - `transform_error_log` : result of `benign_transform.py`

        > `Success!` : successfully generated .dot and .json files. `[!] Processing JSON failed : no data in json` : failed to `add reporter Audit`

Requirements

> ❗ The below requirements are already set up inside given VMs. You don't have to re-install again.

- **Monitor Host** (Monitor_Collect & Monitor_Transform)

    - SPADE: This is the tool that can convert the logs recorded by Linux Audit System to provenance graph. Just strictly follow the document then you can setup SPADE.

    - stress-ng : this is the tool that simulates system operations.

        ```
        sudo apt install wget build-essential
        wget https://github.com/ColinIanKing/stress-ng/tarball/V0.18.01 -
        O stress-ng-0.18.01.tar.gz
        tar -xvf stress-ng-0.18.01.tar.gz
        cd ColinIanKing-stress-ng-*
        make
        sudo make install
        ```

        > ❗ Cannot use `sudo apt install stress-ng` because the version is too old.
        > (Ubuntu version on VM is 22.04, corresponding stress-ng version is 0.13.12; However, we need 0.18.01 to run some of the stress-ng commands)

    - **Plugins**

        ```
        ```

```
sudo apt update
sudo apt install vim git wget curl python3 python3-pip auditd
golang screen apparmor openssh-server
sudo systemctl start ssh
sudo systemctl enable ssh
sudo pip3 install --upgrade pip
sudo pip3 install beautifulsoup4 requests flask psutil
echo 'export PATH=$PATH:/home/{vm name}/.local/bin' >> ~/.bashrc
&& source~/.bashrc
```

- **Black Hacker** (Official_Server)
  - MITRE Caldera: an automated adversary emulation system which can replicate real-world attack scenarios.

```
git clone https://github.com/mitre/caldera.git --recursive
cd caldera
pip3 install -r requirements.txt
```

  - **Plugins**

```
sudo apt update
sudo apt install golang vim git python3-pip
```

Setup & Execution Steps

- **VM Information**

> ❗ For network setup : **The same internal network should have the same name.** Even with the same IP, the internal networks are distinct if their names are different.

  - **Monitor Host - Monitor_Collect & Monitor_Transform :**

> Monitor_Collect : SPADE will collect audit logs. Monitor_Transform : SPADE will transform filtered logs to provenance graph.

    - Accounts:

```
User: root
Password: root

User: spade
Password: spade

User: victim1
Password: victim1
```

```
su: root
```

- Network:

> three network interface cards

```
Adapter 1: NAT (for set-up)

Adapter 2: Internal Network
IP: 192.168.1.2 with Black Hacker
    192.168.2.1 with Benign User

Adapter 3: Host Only
IP: 192.168.56.210 for Monitor_Collect
    192.168.56.146 for Monitor_Transform
```

- **Black Hacker - Official_Server :**

> Caldera is installed on this vm.

- Account:

```
User: server
Password: server
```

- Network: two network interface cards

```
Adapter 1: Host Only
IP: 192.168.56.200

Adapter 2: Internal Network
IP: 192.168.1.1 with Monitor_Collect (Monitor_Transform does
not need to connect to Official_Server)
```

- **Benign User - Benign_User :**

> This VM will send http requests to Monitor_Collect. Not yet implemented.

- **VM setup:**

1. **Import virtual machines**
   - **Files** -> **Import Appliance** -> **File**: Choose the VM's `.ova` file -> **Machine Base Folder**: Import to your own place
2. **Change shared folder path**

    - Select machine -> **Settings** -> **Shared Folders** -> Select folder named **'shared'** in your own server
    - Ensure the permission of the shared folder is `777` or change the owner

3. **Take a snapshot**

    - Select machine -> **Snapshot** -> **Take**

- **Execution Steps:**

    - Record audit logs + Transform to graphs :

```
----------------------
| run attack workload |
----------------------
# run all TTPs
python3 ./VASG/Attack/attack.py --all

# run specified TTP via its ability_id
python3 ./VASG/Attack/attack.py --specify <ability_id>

----------------------
| run benign workload |
----------------------
# run all classes
python3 ./VASG/Benign/benign.py --all

# run specified class via its class name
python3 ./VASG/Benign/benign.py --specify <class_name>
```

Simple Result / Unit Test

All results are stored in the `Results` folder. Including : logs, graphs, json.

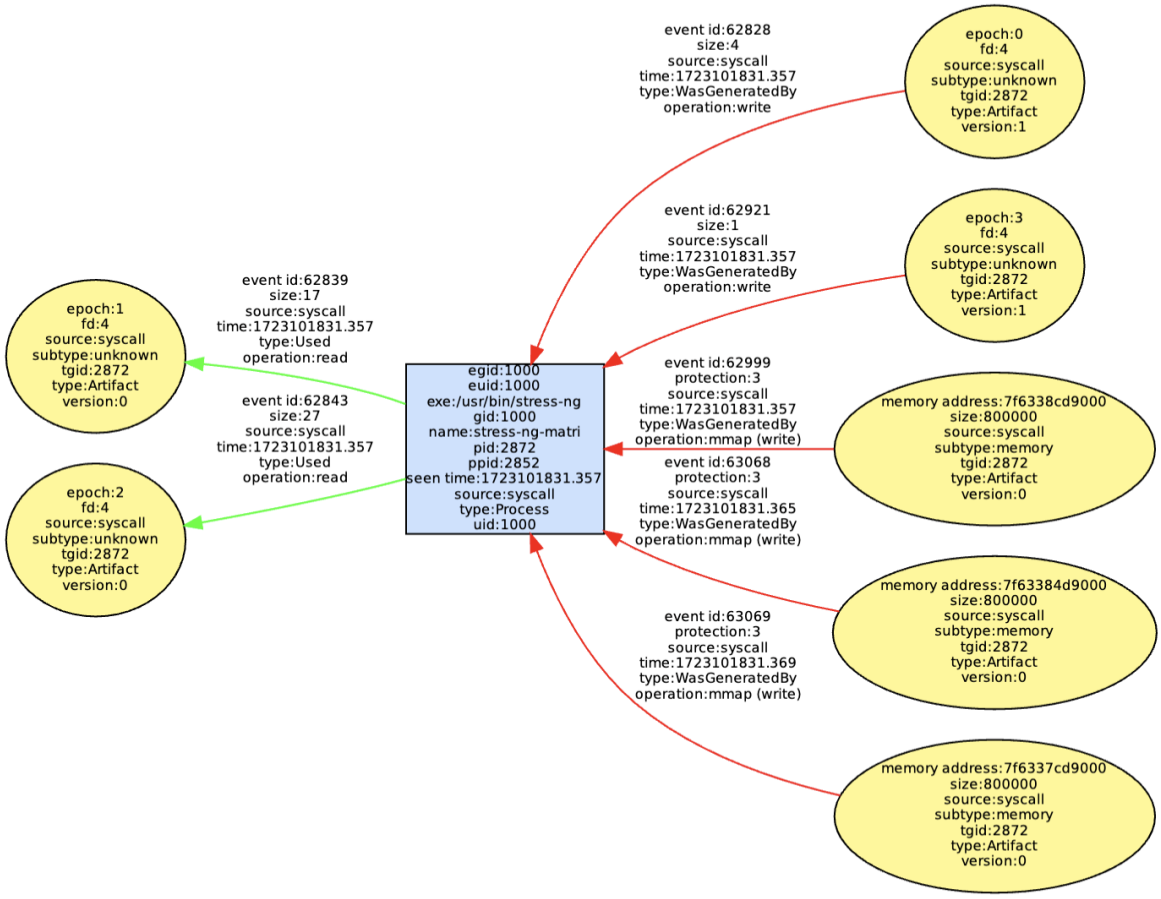
- **Benign** : This is the result of running `python3 benign.py --specify cpu`. Only the result for task `3d` is shown for demonstration.

    - **logs** The below is only a fragment. The full document is at `/VASG/Benign/Results/logs/cpu/3d.log`.

```
node=MonitorHost type=SYSCALL msg=audit(1724301255.996:62499):
arch=c000003e syscall=257 success=yes exit=4 a0=ffffff9c
a1=55cfac029a05 a2=1 a3=0 items=1 ppid=2902 pid=2927 auid=0 uid=0
gid=0 euid=0 suid=0 fsuid=0 egid=0 sgid=0 fsgid=0 tty=pts1 ses=5
comm="stress-ng-matri" exe="/usr/bin/stress-ng" key=(null)
node=MonitorHost type=SYSCALL msg=audit(1724301255.996:62500):
arch=c000003e syscall=1 success=yes exit=4 a0=4 a1=55cfac029a00
a2=4 a3=0 items=0 ppid=2902 pid=2927 auid=0 uid=0 gid=0 euid=0
suid=0 fsuid=0 egid=0 sgid=0 fsgid=0 tty=pts1 ses=5 comm="stress-
ng-matri" exe="/usr/bin/stress-ng" key=(null)
```

```
node=MonitorHost type=SYSCALL msg=audit(1724301255.996:62501):
arch=c000003e syscall=3 success=yes exit=0 a0=4 a1=55cfac029a00
a2=4 a3=0 items=0 ppid=2902 pid=2927 auid=0 uid=0 gid=0 euid=0
suid=0 fsuid=0 egid=0 sgid=0 fsgid=0 tty=pts1 ses=5 comm="stress-
ng-matri" exe="/usr/bin/stress-ng" key=(null)
node=MonitorHost type=SYSCALL msg=audit(1724301255.996:62502):
arch=c000003e syscall=257 success=yes exit=4 a0=ffffff9c
a1=55cfac029d60 a2=0 a3=0 items=1 ppid=2902 pid=2927 auid=0 uid=0
gid=0 euid=0 suid=0 fsuid=0 egid=0 sgid=0 fsgid=0 tty=pts1 ses=5
comm="stress-ng-matri" exe="/usr/bin/stress-ng" key=(null)
```

- **graphs**



- **json** The below is only a fragment. The full document is at `/VASG/Benign/Results/json/cpu/3d.json`.

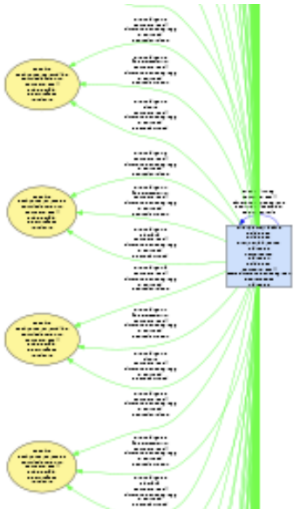
```
[
{"annotations":{"uid":"0","egid":"0","exe":"/usr/bin/stress-
ng","gid":"0","euid":"0","name":"stress-ng-
merge","pid":"2874","seen
time":"1724301563.648","source":"syscall","ppid":"2859"},"id":"45
81e2d3f9029516035b6b529dccdac8","type":"Process"}
,{"annotations":{"memory
address":"7fcc7fd3d000","size":"100000","subtype":"memory","tgid"
:"2874","source":"syscall","version":"0"},"id":"605c69c3e3b278b4a
4a730753ab3ade5","type":"Artifact"}
```

```
...
]
```

- **Attack** :
  - **logs** The below is only a fragment of T1014_dynamic-linker based rootkit (libprocesshider).log.

```
node=MonitorHost type=SYSCALL msg=audit(1721148779.776:1758):
arch=c000003e syscall=3 success=yes exit=0 a0=3 a1=ffffffff
a2=9cd180 a3=7fc06e29f748 items=0 ppid=2484 pid=2486 auid=1000
uid=1000 gid=1000 euid=1000 suid=1000 fsuid=1000 egid=1000
sgid=1000 fsgid=1000 tty=(none) ses=1 comm="python3"
exe="/usr/bin/python3.6" key=(null)
node=MonitorHost type=PROCTITLE msg=audit(1721148779.776:1758):
proctitle=707974686F6E33002F686F6D652F76696374696D312F726167646F6
C6C2E7079002D5700687474703A2F2F3139322E3136382E312E313A383838382F
77656174686572
node=MonitorHost type=SYSCALL msg=audit(1721148779.776:1759):
arch=c000003e syscall=3 success=yes exit=0 a0=5 a1=ffffffff
a2=9cd180 a3=7fc06e29f748 items=0 ppid=2484 pid=2486 auid=1000
uid=1000 gid=1000 euid=1000 suid=1000 fsuid=1000 egi
```

  - **graphs** The below is only a fragment of T1014_dynamic-linker based rootkit (libprocesshider).png.



  - **json** The below is only a fragment of T1014_dynamic-linker based rootkit (libprocesshider).json.

```
[
{"annotations":
{"cwd":"/home/victim1","uid":"1000","egid":"1000","exe":"/usr/bin
/python3.6","gid":"1000","euid":"1000","name":"python3","pid":"24
86","seen
time":"1721148779.776","source":"syscall","ppid":"2484"},"id":"b9
6de1d241e96ca867b6dec4e33ad584","type":"Process"}
,{"annotations":
{"path":"/proc/2486/fd","subtype":"directory","permissions":"0500
```

```
","epoch":"0","source":"syscall","version":"0"},"id":"d2fe60e6d03
896d93dd827dfa111bfa1","type":"Artifact"}
,{"annotations":{"event
id":"1761","flags":"O_RDONLY","source":"syscall","time":"17211487
79.776","operation":"open"},"from":"b96de1d241e96ca867b6dec4e33ad
584","to":"d2fe60e6d03896d93dd827dfa111bfa1","type":"Used"}
...
]
```

Additional Information

- **Some Warnings about Installing SPADE**
  - SPADE won't record events related to the user executing it, so you need to create a user. Here, it is user `spade`.
  - When you want to use reporter and storage, there is a strict ordering of the commands.

    ```
    add storage -> add reporter -> remove reporter -> remove storage
    ```

    > ❗ If you add reporter first, the events occur before you add storage would be discarded. ❗ If you remove storage first, nothing would be recorded (I don't know why and this is not mentioned in the document)

- Don't interrupt `automation.py` while it is running, otherwise, the VM may break. Please **power off the machine before** interrupting `automation.py`.

- When static IP is set, NAT will no longer work. To use NAT, you have to :

  ```
  cd /etc/netplan
  rm 01*
  sudo netplan apply
  reboot
  ```

  > When executing `sudo netplan apply`, all config files under `/etc/netplan` will be configured. To check network configurations, use `ifconfig`.

Troubleshooting

- **Benign** : Some classes may *fail to ssh*. When this happens, *rerun* those classes again.