Carnegie Mellon University
Software Engineering Institute

Cyber DEM Python

Release 0.0.6

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README

1.1 Overview

Cyber DEM Python provides a Python API for the Cyber Data Exchange Model (Cyber DEM). Cyber DEM Python provides methods to instantiate Cyber DEM objects and events, serialize and deserialize objects and events, and manipulate instantiated objects. It also provides basic searching and file management methods.

1.2 Status

Cyber DEM Python is based on the Cyber DEM standard that is currently in DRAFT format, and therefore subject to change. For the most up to date version and documentation for Cyber DEM Python see the Cyber DEM Python GitHub page: https://github.com/cmu-sei/cyberdem-python.

1.3 Getting Started

These instructions will help you install a copy of the package on your local machine.

1.3.1 Install with pip

```
$ pip3 install cyberdem
```

1.3.2 Installing from source

1. Download Cyber DEM Python and unzip the download folder
2. From within the top-level cyberdem folder (where setup.py is located) run

```
$ pip3 install .
```

3. To test that cyberdem is installed properly run

```
$ python3
>>> from cyberdem import base
>>> print(base.System())
System(
```

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```
    id: 3bb3512e-dc75-4b86-b234-25040a79b9b9
)
```

You may also try running the example.py file downloaded with the zip file.

```
$ python3 example.py

Creating new FileSystem path ./test-fs.

QUERY 1
--------
['description', 'id', 'name', 'version', '_type']
('Rapid SCADA software', '0f717dfa-...', 'Rapid SCADA', '5', 'Application')
('PfSense Firewall', '2720359e-...', 'PfSense', '2.4.2', 'Application')
(None, '2f6ac399-...', None, None, 'Application')
(None, 'd36e99ce-...', None, None, 'Application')
('Firefox browser', 'df8478d6-...', 'Firefox', '60', 'Application')
(None, '0eaacdbc-...', None, None, 'Application')
(None, '6265eb88-...', None, None, 'Application')

QUERY 2
--------
['description', 'name']
(None, None)
...
(None, None)
(None, None)
('PfSense Firewall', 'PfSense')
(None, None)
('Firefox browser', 'Firefox')
('Rapid SCADA software', 'Rapid SCADA')
...

QUERY 3: SELECT id FROM Application,OperatingSystem WHERE name='PfSense' OR os_
↪type='LinuxRedHat'
--------
['id']
('19a6f4b3-89ce-4aa5-8a94-a065833a3a53',)
('f177a5e0-f56a-4c11-b655-39e6c0cac873',)

Updating app versions...
Application(
    id: 19a6f4b3-89ce-4aa5-8a94-a065833a3a53
    name: PfSense
    version: 2.5.0
)
OperatingSystem(
    id: f177a5e0-f56a-4c11-b655-39e6c0cac873
    os_type: LinuxRedHat
    version: 8.0
)
```

You will see a folder called “test-fs” in the directory in which you ran the example.py script. This folder has subfolders containing each type of Cyber DEM object/event.

1.4 License

1.5 Acknowledgements

• SISO Cyber DEM Product Development Group

CHAPTER

TWO

BASE CLASSES

class cyberdem.base.**Application**(*version=None*, ***kwargs*)

Representation of an Application object.

Inherits *_CyberObject*.

Parameters

- **version** (*string, optional*) – Version of the application.
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *_CyberObject* class

Example

```
>>> from cyberdem.base import Application
>>> kwargs = {
...     'version': '2.4.2',
...     'name': 'PfSense',
...     'description': 'PfSense Firewall'
...     }
>>> my_app = Application(**kwargs)
```

class cyberdem.base.**BlockTrafficEffect**(*is_random=None*, *percentage=None*, ***kwargs*)

Completely block all traffic over a communication channel.

Inherits *Disrupt*. No additional attributes.

Parameters **kwargs** (*dictionary, optional*) – Arguments to pass to the *Disrupt* class

Example

```
>>> from cyberdem.base import BlockTrafficEffect
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'is_random': False,
...     'percentage': .7,
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Continue',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> blocktraffic_effect = BlockTrafficEffect(**kwargs)
```

class cyberdem.base.**CPULoadEffect**(*percentage=None*, ***kwargs*)

Artificial increase in CPU load.

Inherits `Degrade`.

Parameters

- **`percentage`** (*`float, optional`*) – Percentage of CPU usage between 0.0 and 100.0
- **`kwargs`** (*`dictionary, optional`*) – Arguments to pass to the `Degrade` class

Example

```
>>> from cyberdem.base import CPULoadEffect
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'percentage': 70,
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> cpuload_effect = CPULoadEffect(**kwargs)
```

class `cyberdem.base.`**`CyberAttack`**(*event_time=None*, *targets=None*, *target_modifiers=None*, *phase=None*, *duration=None*, *actor_ids=None*, *source_ids=None*, ***kwargs*)

Representation of a CyberAttack object.

Inherits `_CyberAction`. No additional attributes.

Example

```
>>> from cyberdem.base import CyberAttack
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'target_modifiers': {"characteristic":"value"},
...     'phase': 'Continue',
...     'duration': timedelta(seconds=10),
...     'actor_ids': [attacker_1.id]
... }
>>> generic_attack = CyberAttack(**kwargs)
```

class `cyberdem.base.`**`CyberDefend`**(*event_time=None*, *targets=None*, *target_modifiers=None*, *phase=None*, *duration=None*, *actor_ids=None*, *source_ids=None*, ***kwargs*)

Representation of a CyberDefend object.

Inherits `_CyberAction`. No additional attributes.

Example

```
>>> from cyberdem.base import CyberDefend
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'target_modifiers': {"characteristic":"value"},
...     'phase': 'Start',
...     'source_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
```

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```
... }
>>> generic_defend = CyberDefend(**kwargs)
```

class cyberdem.base.**CyberRecon**(*recon_type=None*, ***kwargs*)

Representation of a CyberRecon object.

Inherits *_CyberAction*.

Parameters

- **recon_type** (value from the *ReconType* enumeration, optional) – Type of reconnaissance
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *_CyberAction* class

Example

```
>>> from cyberdem.base import CyberDefend
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'recon_type': 'NetworkMap',
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'source_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> recon_event = CyberRecon(**kwargs)
```

class cyberdem.base.**Data**(*sensitivity=None*, *data_type=None*, *encrypted=None*, *status=None*, *confidentiality=None*, ***kwargs*)

Representation of a Data object

Inherits *_CyberObject*.

Parameters

- **sensitivity** (value from *SensitivityType* enumeration, optional) – [desc]
- **data_type** (value from *DataType* enumeration, optional) – [desc]
- **encrypted** (value from *EncryptionType* enumeration, optional) – [desc]
- **status** (value from *DataStatus* enumeration, optional) – [desc]
- **confidentiality** (*float, optional*) – [desc]
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *_CyberObject* class

Example

```
>>> from cyberdem.base import Data
>>> kwargs = {
...     'sensitivity': 'FOUO',
...     'data_type': 'File',
...     'confidentiality': 0.6,
...     'name': 'Foo File',
...     'description': 'Foobarred file'
...     }
>>> my_data = Data(**kwargs)
```

class cyberdem.base.**DataExfiltration**(*event_time=None*, *targets=None*, *target_modifiers=None*, *phase=None*, *duration=None*, *actor_ids=None*, *source_ids=None*, ***kwargs*)

Data exfiltration is the unauthorized copying, transfer or retrieval of data from a computer or server. Data exfiltration is a malicious activity performed through various different techniques, typically by cybercriminals over the Internet or other network.

Inherits `CyberAttack`. No additional attributes.

Parameters **kwargs** (*dictionary, optional*) – Arguments to pass to the `CyberAttack` class

Example

```
>>> from cyberdem.base import DataExfiltration
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'event_time': datetime.today(),
...     'phase': 'End',
...     'targets': [the_target.id],
...     'duration': timedelta(hours=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> exfil = DataExfiltration(**kwargs)
```

class cyberdem.base.**Degrade**(*event_time=None*, *targets=None*, *target_modifiers=None*, *phase=None*, *duration=None*, *actor_ids=None*, *source_ids=None*, ***kwargs*)

To deny access to, or operation of, a target to a level represented as a percentage of capacity

Inherits `Deny`. No additional attributes.

Parameters **kwargs** (*dictionary, optional*) – Arguments to pass to the `Deny` class

Example

```
>>> from cyberdem.base import Degrade
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> degrade_effect = Degrade(**kwargs)
```

class cyberdem.base.**DelayEffect**(*seconds=None*, ***kwargs*)

Increased time for data to travel between two points

Inherits `Degrade`.

Parameters

- **seconds** (*float, optional*) – Number of seconds to delay delivery of data
- **kwargs** (*dictionary, optional*) – Arguments to pass to the `Degrade` class

Example

```
>>> from cyberdem.base import DelayEffect
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'seconds': 22.5,
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'duration': timedelta(minutes=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> delay_effect = DelayEffect(**kwargs)
```

class `cyberdem.base.`**`Deny`**(*event_time=None*, *targets=None*, *target_modifiers=None*, *phase=None*, *duration=None*, *actor_ids=None*, *source_ids=None*, ***kwargs*)

To prevent access to, operation of, or availability of a target function by a specified level for a specified time, by degrade, disrupt, or destroy (JP3-12)

Inherits *`_CyberEffect`*. No additional attributes.

Parameters **`kwargs`** (*`dictionary, optional`*) – Arguments to pass to the *`_CyberEffect`* class

Example

```
>>> from cyberdem.base import Deny
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> deny_effect = Deny(**kwargs)
```

class `cyberdem.base.`**`Destroy`**(*event_time=None*, *targets=None*, *target_modifiers=None*, *phase=None*, *duration=None*, *actor_ids=None*, *source_ids=None*, ***kwargs*)

To completely and irreparably deny access to, or operation of, a target.

Inherits *`Deny`*. No additional attributes.

Parameters **`kwargs`** (*`dictionary, optional`*) – Arguments to pass to the *`Deny`* class

Example

```
>>> from cyberdem.base import Destroy
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> destroy_effect = Destroy(**kwargs)
```

class `cyberdem.base.`**`Detect`**(*acquired_information=None*, ***kwargs*)

To discover or discern the existence, presence, or fact of an intrusion into information systems.

Inherits `_CyberEffect`.

Parameters

- **acquired_information** (*dictionary, optional*) – information obtained during detection
- **kwargs** (*dictionary, optional*) – Arguments to pass to the `_CyberEffect` class

Example

```
>>> from cyberdem.base import Detect
>>> from datetime import datetime, timedelta
>>> info = {'siem log': 'file permission change on user-ws-2'}
>>> kwargs = {
...     'acquired_information': info,
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> detect_effect = Detect(**kwargs)
```

class cyberdem.base.**Device**(*device_types=None*, *is_virtual=None*, *role=None*, *device_identifier=None*, *network_interfaces=None*, ***kwargs*)

Representation of a Device object.

Inherits `_CyberObject`.

Parameters

- **device_types** (list of values from the `DeviceType` enumeration, optional) – Type(s) of device (ex. “Sensor”, “Printer”)
- **is_virtual** (*boolean, optional*) – whether the device is a virtual device
- **role** (*string, optional*) – [desc]
- **device_identifier** (*string, optional*) – [desc]
- **network_interfaces** (*list of lists, optional*) – mapping of interface names to addresses
- **kwargs** (*dictionary, optional*) – Arguments to pass to the `_CyberObject` class

Example

```
>>> from cyberdem.base import Device
>>> kwargs = {
...     'device_type': ['Generic'],
...     'is_virtual': False,
...     'device_identifier':
↪'(01)12345678987654(55)120717(55)A12345B(55)4321',
...     'name': 'The Server',
...     'description': 'Generic server description'
...     }
>>> net_ints = [['eth0','204.105.24.23'], ['eth1','192.168.10.101']]
>>> my_device = Device(network_interfaces=net_ints, **kwargs)
```

class cyberdem.base.**Disrupt**(*is_random=None*, *percentage=None*, ***kwargs*)

To completely but temporarily deny access to, or operation of, a target for a period of time.

Inherits *Deny*.

Parameters

- **is_random** (*boolean, optional*) – whether or not the disruption is uniform or random
- **percentage** (*float, optional*) – Percentage of bits to drop between 0.0 and 100.0
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *Deny* class

Example

```
>>> from cyberdem.base import Disrupt
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'is_random': False,
...     'percentage': .7,
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> disrupt_effect = Disrupt(**kwargs)
```

class cyberdem.base.**DropEffect**(*percentage=None*, ***kwargs*)

Packet dropping.

Inherits *Degrade*.

Parameters

- **percentage** (*float, optional*) – Percentage of packets to drop between 0.0 and 100.0
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *Degrade* class

Example

```
>>> from cyberdem.base import DropEffect
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'percentage': 99.5,
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> pdrop_effect = DropEffect(**kwargs)
```

class cyberdem.base.**HardwareDamageEffect**(*damage_type=None*, ***kwargs*)

Physical damage to a device.

Inherits *Destroy*.

Parameters

- **damage_type** (value from the *HardwareDamageType* enumeration, optional) – type of damage
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *Destroy* class

Example

```
>>> from cyberdem.base import HardwareDamageEffect
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'damage_type': 'PhysicalDestruction',
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(days=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> hwdamage_effect = HardwareDamageEffect(**kwargs)
```

class `cyberdem.base.`**`HardwareDegradeEffect`**(*degrade_type=None*, *percentage=None*, ***kwargs*)

Degradation, but not destruction of, hardware.

Inherits *`Degrade`*.

Parameters

- **`degrade_type`** (*`string, optional`*) – value from the *`HardwareDegradeType`* enumeration
- **`percentage`** (*`float, optional`*) – The effectiveness of the hardware for the duration of the effect - between 0.0 and 100.0
- **`kwargs`** (*`dictionary, optional`*) – Arguments to pass to the *`Degrade`* class

Example

```
>>> from cyberdem.base import HardwareDegradeEffect
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'degrade_type': 'BlueScreen',
...     'percentage': 90,
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> hw_effect = HardwareDegradeEffect(**kwargs)
```

class `cyberdem.base.`**`JitterEffect`**(*milliseconds=None*, ***kwargs*)

Class for JitterEffect object.

Inherits *`Degrade`*.

Parameters

- **`milliseconds`** (*`float, optional`*) – [desc]
- **`kwargs`** (*`dictionary, optional`*) – Arguments to pass to the *`Degrade`* class

Example

```
>>> from cyberdem.base import JitterEffect
>>> from datetime import datetime, timedelta
```

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```
>>> kwargs = {
...     'milliseconds': 22.5,
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'duration': timedelta(minutes=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> jitter_effect = JitterEffect(**kwargs)
```

class cyberdem.base.**LoadRateEffect**(*percentage=None*, *rate_type=None*, ***kwargs*)

Impact on data upload or download rate.

Inherits *Degrade*.

Parameters

- **percentage** (*float, optional*) – Percentage of maximum achievable rate between 0.0 and 100.0
- **rate_type** (*string, optional*) – value from the *LoadRateType* enumeration
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *Degrade* class

Example

```
>>> from cyberdem.base import LoadRateEffect
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'percentage': 22.5,
...     'rate_type': 'Upload',
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> loadrate_effect = LoadRateEffect(**kwargs)
```

class cyberdem.base.**Manipulate**(*description=None*, ***kwargs*)

The effect of controlling or changing information, information systems, and/or networks to create physical denial effects, using deception, decoying, conditioning, spoofing, falsification, and other similar techniques.

Inherits *_CyberEffect*.

Parameters

- **description** (*string, optional*) – information obtained during detection
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *_CyberEffect* class

Example

```
>>> from cyberdem.base import Manipulate
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'description': "ransomware encrypted drives",
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
```

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```
...     'duration': timedelta(hours=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> manipulate_effect = Manipulate(**kwargs)
```

class cyberdem.base.**ManipulationAttack**(*description=None*, *attack_content=None*, ***kwargs*)

Controls or changes information, information systems, and/or networks to create physical denial effects, using deception, decoying, conditioning, spoofing, falsification, and other similar techniques.

Inherits *CyberAttack*.

Parameters

- **description** (*string, optional*) – Describes the "what and how" of the manipulation attack
- **attack_content** (*string, optional*) – could contain the details of the manipulation attack itself OR the manipulated message after the attack
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *CyberAttack* class

Example

```
>>> from cyberdem.base import DataExfiltration
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'event_time': datetime.today(),
...     'phase': 'End',
...     'targets': [the_target.id],
...     'duration': timedelta(hours=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> exfil = DataExfiltration(**kwargs)
```

class cyberdem.base.**MemoryUseEffect**(*percentage=None*, ***kwargs*)

Artificial increase in memory usage.

Inherits *Degrade*.

Parameters

- **percentage** (*float, optional*) – Percentage of memory to use between 0.0 and 100.0
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *Degrade* class

Example

```
>>> from cyberdem.base import MemoryUseEffect
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'percentage': 70,
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> memuse_effect = MemoryUseEffect(**kwargs)
```

class cyberdem.base.**Network**(*protocol=None*, *mask=None*, ***kwargs*)

Representation of a Network object.

Inherits *_CyberObject*.

Parameters

- **protocol** (value from the *NetworkProtocolType* enumeration, optional) – protocol used on the network
- **mask** (*string, optional*) – network mask
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *_CyberObject* class

Example

```
>>> from cyberdem.base import Network
>>> kwargs = {
...     'protocol': 'OSPF',
...     'mask': '255.255.255.0',
...     'name': 'Network 10',
...     'description': 'User network'
... }
>>> my_network = Network(**kwargs)
```

class cyberdem.base.**NetworkLink**(*is_logical=None*, *physical_layer=None*, *data_link_protocol=None*, *bandwidth=None*, *latency=None*, *jitter=None*, *network_interfaces=None*, ***kwargs*)

Representation of a NetworkLink object.

Inherits *_CyberObject*.

Parameters

- **is_logical** (*boolean, optional*) – the link is logical (rather than physical)
- **physical_layer** (value from the *PhysicalLayerType* enumeration, optional) – what type is the physical layer
- **data_link_protocol** (value from the *DataLinkProtocolType* enumeration, optional) – data link protocol
- **bandwidth** (*integer, optional*) – Max data transfer rate of the link in bps
- **latency** (*integer, optional*) – network link latency in milliseconds
- **jitter** (*integer, optional*) – variability in the latency, measured in milliseconds
- **network_interfaces** (*list of lists, optional*) – mapping of interface names to addresses
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *_CyberObject* class

Example

```
>>> from cyberdem.base import NetworkLink
>>> kwargs = {
...     'is_logical': False,
...     'physical_layer': 'Wired',
...     'data_link_protocol': 'Ethernet',
...     'bandwidth': 5,
...     'name': 'Link 10',
```

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```
...     'description': 'User network link'
... }
>>> net_ints = [['eth1','192.168.10.100'], ['eth0','192.168.10.101']]
>>> my_link = NetworkLink(network_interfaces=net_ints, **kwargs)
```

class cyberdem.base.**OperatingSystem**(*os_type=None*, ***kwargs*)

Representation of a OperatingSystem object.

Inherits *Application*.

Parameters

- **os_type** (value from the *OperatingSystemType* enumeration, optional) – Type of operating system
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *Application* class

Example

```
>>> from cyberdem.base import OperatingSystem
>>> kwargs = {
...     'os_type': 'MicrosoftWindows',
...     'name': 'User machine',
...     'description': 'For employees in foo department',
...     'version': '10'
... }
>>> my_os = OperatingSystem(**kwargs)
```

class cyberdem.base.**OtherDegradeEffect**(*percentage=None*, *description=None*, ***kwargs*)

Generic degradation effect.

Inherits *Degrade*.

Parameters

- **percentage** (*float, optional*) – Percentage of impacted capability's remaining availability between 0.0 and 100.0
- **description** (*string, optional*) – Human-interpretable or machine-readable description of the effect
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *Degrade* class

Example

```
>>> from cyberdem.base import OtherDegradeEffect
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'degrade_type': 'BlueScreen',
...     'percentage': 90,
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'phase': 'Start',
...     'duration': timedelta(seconds=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> other_effect = OtherDegradeEffect(**kwargs)
```

class cyberdem.base.**PacketManipulationEffect**(*manipulation_type=None*, *attack_content=None*, ***kwargs*)

Packet manipulation cyber effect: duplication, corruption, reordering, drop.

Inherits *Manipulate*.

Parameters

- **manipulation_type** (value from *PacketManipulationType* enumeration, optional) – type of manipulation
- **percentage** (*float, optional*) – Percentage of packets to affect between 0.0 and 100.0
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *Manipulate* class

Example

```
>>> from cyberdem.base import PacketManipulationEffect
>>> from datetime import datetime, timedelta
>>> kwargs = {
...     'manipulation_type': 'Dropped',
...     'percentage': 1,
...     'description': "dropping packets",
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'duration': timedelta(hours=5)
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> packet_effect = PacketManipulationEffect(**kwargs)
```

class cyberdem.base.**Persona**(*name=None*, *description=None*, ***kwargs*)

Representation of a Personna object.

Inherits *_CyberObject*. No additional attributes.

Example

```
>>> from cyberdem.base import Persona
>>> kwargs = {
...     'name': 'Attacker 1',
...     'description': 'nation-state actor'
... }
>>> attacker_1 = Persona(**kwargs)
```

class cyberdem.base.**PhishingAttack**(*message_type=None*, *header=None*, *body=None*, ***kwargs*)

The fraudulent practice of sending messages purporting to be from reputable sources in order to induce individuals to reveal sensitive information or unknowingly initiate another attack.

Inherits *CyberAttack*.

Parameters

- **message_type** (value from the *MessageType* enumeration, optional) – type of message. Ex. “Email”
- **header** (*string, optional*) – Originator, From, To, Subject, Reply To
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *CyberAttack* class

Example

```
>>> from cyberdem.base import PhishingAttack
>>> from datetime import datetime
>>> kwargs = {
...     'message_type': 'Email',
...     'header': 'From: Your Name <yourname@foo.bar>, To: My Name ␣
↪      <myname@bar.foo>, Subject: foo the bar',
...     'event_time': datetime.today(),
...     'targets': [the_target.id],
...     'actor_ids': ["77545b7d-3900-4e34-a26f-eec5eb954d33"]
... }
>>> phish = PhishingAttack(**kwargs)
```

class `cyberdem.base.`**`Relationship`**(*related_object_1*, *related_object_2*, *relationship_type=None*, *id=None*, *privileges=None*)

Represents a relationship between two CyberObjects.

Given two CyberObjects A and B, where A administers B, the `related_object_1` would be the id of A and `related_object_2` would be the ID of B, preserving the ordering of "A administers B".

Parameters

- **related_object_1** (*UUIDv4 string, required*) – ID of a CyberObject
- **related_object_2** (*UUIDv4 string, required*) – ID of a CyberObject
- **relationship_type** (*string, optional*) – value from *RelationshipType*
- **id** (*string, optional*) – unique ID (UUIDv4)
- **privileges** (*list of strings, optional*) – [desc]

Example

```
>>> # Where my_application is installed on my_device
>>> from cyberdem.base import Application, Device, Relationship
>>> my_application = Application()
>>> my_device = Device()
>>> my_rel = Relationship(
...     my_device.id, my_application.id,
...     relationship_type='ResidesOn', privileges=['priv1', 'priv2'])
```

class `cyberdem.base.`**`Service`**(*service_type=None*, *address=None*, ***kwargs*)

Representation of a Service object.

Inherits *Application*.

Parameters

- **service_type** – value from the *ServiceType* enumeration, optional
- **address** (*string, optional*) –
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *Application* class

Example

```
>>> from cyberdem.base import Service
>>> kwargs = {
...     'service_type': 'EmailServer',
...     'version': '15.2.595.4',
```

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```
...     'name': 'Mail Server 1',
...     'description': 'external exchange server'
... }
>>> my_service = Service(**kwargs)
```

class `cyberdem.base.`**`System`**(*system_type=None*, ***kwargs*)

Representation of a System object.

Inherits `_CyberObject`.

Parameters

- **`system_type`** (value from the `SystemType` enumeration, optional) – Type of system
- **`kwargs`** (*`dictionary, optional`*) – Arguments to pass to the `_CyberObject` class

Example

```
>>> from cyberdem.base import System
>>> kwargs = {
...     'system_type': 'SCADA',
...     'name': 'MTU',
...     'description': 'Network 1 MTU'
... }
>>> my_system = System(**kwargs)
```

class `cyberdem.base.`**`_CyberAction`**(*event_time=None*, *targets=None*, *target_modifiers=None*, *phase=None*, *duration=None*, *actor_ids=None*, *source_ids=None*, ***kwargs*)

Passive superclass for all Cyber DEM CyberActions.

Inherits `_CyberEvent`. Included for completeness of the Cyber DEM standard.

class `cyberdem.base.`**`_CyberDEMBase`**(*id=None*, ***kwargs*)

Superclass for all Cyber DEM Objects and Events

Will create an appropriate `id` if one is not given.

Parameters **`id`** (*`string, optional`*) – string formatted UUIDv4

Raises **`ValueError`** – if a given `id` is not a valid string representation of a UUIDv4

class `cyberdem.base.`**`_CyberEffect`**(*event_time=None*, *targets=None*, *target_modifiers=None*, *phase=None*, *duration=None*, *actor_ids=None*, *source_ids=None*, ***kwargs*)

Passive superclass for all Cyber DEM CyberEffects.

Inherits `_CyberEvent`. No additional attributes.

class `cyberdem.base.`**`_CyberEvent`**(*event_time=None*, *targets=None*, *target_modifiers=None*, *phase=None*, *duration=None*, *actor_ids=None*, *source_ids=None*, ***kwargs*)

Superclass for all CyberDEM CyberEvents

CyberEvents are non-persistent cyber events, as opposed to persistent CyberObjects.

Inherits `_CyberDEMBase`. Optionally sets the event_time, targets, cyber event phase, duration, actor_ids, and/or source_ids parameters for any CyberEvent subclass.

Parameters

- **`event_time`** (*`datetime.datetime, optional`*) – Time at which the event started
- **`targets`** (*`list, optional`*) – One or more IDs identifying the CyberObject(s) targeted in the event

- **target_modifiers** (*dictionary, optional*) – mapping of target characteristics to values
- **phase** (value from *CyberEventPhaseType* enumeration, optional) – The cyber event phase of the event
- **duration** (*datetime.timedelta, optional*) – Length of time the event lasted
- **actor_ids** (*list, optional*) – Time ordered list of IDs of the perpetrators involved in this Cyber Event
- **source_ids** (*list, optional*) – Time ordered list of IDs of the simulations that this Cyber Event came from.
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *_CyberDEMBase* class

class cyberdem.base.**_CyberObject**(*name=None*, *description=None*, ***kwargs*)

Superclass for all CyberDEM CyberObjects

CyberObjects are persistent objects on a network or other cyber infrastructure.

Inherits *_CyberDEMBase*. Optionally sets the name and/or description parameters for any CyberObject subclass.

Parameters

- **name** (*string, optional*) – The name of the object
- **description** (*string, optional*) – A description of the object
- **kwargs** (*dictionary, optional*) – Arguments to pass to the *_CyberDEMBase* class

cyberdem.base.**load_cyberdem_object**(*instance_dict*)

Given a dictionary representing a Cyber DEM object or event, return an instance of that object/event.

Parameters **instance_dict** (*dict, required*) – representation of a Cyber DEM object or event

Example

```
>>> from cyberdem import base
>>> foo = {"_type": "Application", "name": "foo", "description": "bar"}
>>> bar = base.load_cyberdem_object(foo)
>>> type(bar)
<class 'cyberdem.base.Application'>
```

CHAPTER

THREE

FILESYSTEM

Methods for saving, searching, and retrieving Cyber DEM objects and events.

`class cyberdem.filesystem.FileSystem`(*path*)

Create a directory structure and file storage and retrieval methods.

Creates file storage, retrieval, and query methods for storing and retrieving CyberObjects, CyberEvents, and Relationships.

Parameters **`path`** (*`string, required`*) – directory path to store Cyber DEM json files; can be existing directory or non-existing

Example

```
>>> from cyberdem import filesystem
>>> fs = filesystem.FileSystem("./test-fs")
Using existing FileSystem at ./test-fs
>>> fs.path
'./test-fs'
```

`get`(*id*, *obj_type=None*)

Get an object by ID

Parameters

- **`id`** (*`string, required`*) – UUID of object to retrieve
- **`obj_type`** (*`string, optional`*) – Cyber DEM type of the id. Ex. “Application”

Returns instance of the requested object

Return type cyberdem instance

Example

```
>>> my_object = fs.get("82ca4ed1-a053-4fc1-b1cc-f4b58b4dbf8c",                ␣
↪         "Application")
>>> str(my_object)
Application(
    id: 82ca4ed1-a053-4fc1-b1cc-f4b58b4dbf8c
)
```

`load_flatfile`(*filename*)

Loads Cyber DEM objects and actions from a flat json file into the FileSystem

Parameters **`filename`** (*`string, required`*) – the json file load

Example

```
>>> fs = FileSystem('./test-fs')
>>> fs.load_flatfile('cyberdem_input.json')
```

query(*query_string*)

Search the FileSystem for a specific object or objects

Parameters **query_string** (*string, required*) – SQL formatted query string

Returns attribute names (headers), values of matching objects

Return type 2-tuple of lists

Example query strings

- `SELECT * FROM *` (you probably shouldn't do this one…)
- `SELECT attr1,attr2 FROM * WHERE attr3=value`
- `SELECT id,name,description FROM Device,System WHERE name='my device'`
- `SELECT id FROM * WHERE (name='foo' AND description='bar') OR version<>'foobar'`

Example

```
>>> query = "SELECT id FROM * WHERE name='Rapid SCADA'"
>>> fs.query(query)
(['id'], [('9293510b-534b-4dd0-b7c5-78d92e279400',)])
>>> query = "SELECT id,name FROM Application"
>>> headers,results = fs.query(query)
>>> headers
['id','name']
>>> results
[('9293510b-534b-4dd0-b7c5-78d92e279400',),             ('46545b7a-
↪1840-4e34-a26f-aef5eb954b25','My application')]
```

save(*objects, overwrite=False*)

Save Cyber DEM objects and events to the FileSystem as json files

Parameters

- **objects** (Cyber DEM class instance from `base`, or a list of objects) – Cyber DEM object or event instance (or list of instances)
- **overwrite** (*bool, optional*) – allow object with the same ID as one already in the FileSystem to overwrite the existing file, defaults to False

Raises **Exception** – if object is already in FileSystem and overwrite is set to False

Example

```
>>> from cyberdem.base import Service
>>> my_service = Service(
        name='httpd', description='Apache web server',                    ␣
↪    version='2.4.20', service_type='WebService',                        ␣
↪address='192.168.100.40')
>>> fs.save(my_service)
>>>
```

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```
$ ls ./test-fs/Service
82ca4ed1-a053-4fc1-b1cc-f4b58b4dbf8c.json
```

`save_flatfile`(*output_path=None*, *ignore=[]*)
Saves objects and actions in the filesystem to one flat json file.

Parameters

- **output_path** (*string, optional (defaults to filesystem path)*) – location and path to save the flat file (ex. 'resultscd_output.json')
- **ignore** (*list of strings, optional*) – list of Cyber DEM objects or actions (as strings) not to indclude in the file

Example

```
>>> fs = FileSystem('./test-fs')
>>> fs.save_flatfile(ignore=['Application'])
```

CHAPTER

FOUR

ENUMERATIONS

class `cyberdem.enumerations.`**`CyberEventPhaseType`**

CyberDEM CyberEventPhaseType enumeration

Options 'Continue', 'ContinueWithChanges', 'End', 'Start', 'Suspend'

class `cyberdem.enumerations.`**`DataLinkProtocolType`**

CyberDEM DataLinkProtocolType enumeration

Options 'ATM', 'Bluetooth', 'Ethernet', 'LocalTalk', 'PPP', 'TokenRing', 'VLAN', 'WiFi', '1553Bus'

class `cyberdem.enumerations.`**`DataStatus`**

CyberDEM DataStatus enumeration

Options 'Compromised', 'Corrupted', 'Erased', 'Intact', 'Manipulated', 'NonDecryptable'

class `cyberdem.enumerations.`**`DataType`**

CyberDEM DataType enumeration

Options 'Code', 'Credentials', 'File'

class `cyberdem.enumerations.`**`DeviceType`**

CyberDEM DeviceType enumeration

Options 'Communications', 'ComputerNode', 'Controller', 'Generic', 'HMI', 'IoT', 'Monitoring', 'Networking', 'PortableComputer', 'Printer', 'Scanner', 'Security', 'Sensor', 'Storage'

`_check_prop`(*value*)

Checks to see if `value` is an allowed enumeration value.

Overrides the *`_check_prop()`* function from the super *`_CyberDEMEnumeration`*

Campares the given value to the allowed options for the current enumeration class (sub-class to *`_CyberDEMEnumeration`*).

Parameters **`value`** (*`list, required`*) – user-provided value for the enumeration type

Raises **`ValueError`** – if the values in `value` are not in the allowed options.

class `cyberdem.enumerations.`**`EncryptionType`**

CyberDEM EncryptionType enumeration

Options 'AES', 'DES', 'RSA', 'SHA', 'TripleDES', 'TwoFish'

class `cyberdem.enumerations.`**`HardwareDamageType`**

CyberDEM HardwareDamageType enumeration

Options 'BootLoop', 'HardDriveErased', 'PhysicalDestruction',

class cyberdem.enumerations.**HardwareDegradeType**
CyberDEM HardwareDegradeType enumeration

Options 'BlueScreen', 'Display', 'Keyboard', 'Mouse', 'RandomText', 'Reboot', 'Sound'

class cyberdem.enumerations.**LoadRateType**
CyberDEM LoadRateType enumeration

Options 'Download', 'Upload'

class cyberdem.enumerations.**MessageType**
CyberDEM MessageType enumeration

Options 'Chat', 'Email', 'SocialMedia', 'Text'

class cyberdem.enumerations.**NetworkProtocolType**
CyberDEM NetworkProtocolType enumeration

Options 'ARP', 'ICMP', 'InternetProtocol', 'IPsec', 'NAT', 'OSPF', 'RIP'

class cyberdem.enumerations.**OperatingSystemType**
CyberDEM OperatingSystemType enumeration

Options 'Android', 'AppleiOS', 'AppleMacOS', 'BellLabsUnix', 'BSDUnix', 'CiscoIOS', 'DECHP_UX', 'DECVMS', 'Firmware', 'GNUUnix', 'IBMOS_2', 'LinuxRedHat', 'MicrosoftDOS', 'MicrosoftWindows', 'OpenSolaris', 'Ubuntu'

class cyberdem.enumerations.**PacketManipulationType**
CyberDEM PacketManipulationType enumeration

Options 'Corruption', 'Dropped', 'Duplication', 'Redordering'

class cyberdem.enumerations.**PhysicalLayerType**
CyberDEM PhysicalLayerType enumeration

Options 'Wired', 'Wireless'

class cyberdem.enumerations.**ReconType**
CyberDEM ReconType enumeration

Options 'Account', 'ARPScan', 'Device', 'DNS', 'Domain', 'LDAPScan', 'NetBiosScan', 'NetworkMap', 'NTP', 'OSScan', 'Ping', 'PingScan', 'PortScan', 'PortSweep', 'Service', 'SMTP', 'SNMPSweep', 'TraceRoute', 'UNIX-Linux', 'Vulnerability', 'Windows'

class cyberdem.enumerations.**RelationshipType**
CyberDEM RelationshipType enumeration

Options 'Administers', 'ComponentOf', 'ContainedIn', 'ProvidedBy', 'ResidesOn'

class cyberdem.enumerations.**SensitivityType**
CyberDEM SensitivityType enumeration

Options 'Confidential', 'CosmicTopSecret', 'FOUO', 'FVEY', 'GDPR', 'HIPPA', 'NATOConfidential', 'NATORestricted', 'NATOSecret', 'PII', 'Proprietary', 'Public', 'Secret', 'SecretNoForn', 'TS', 'TS_SCI', 'Unclassified'

class cyberdem.enumerations.**ServiceType**
CyberDEM ServiceType enumeration

Options 'ChatServer', 'DatabaseServer', 'DomainNameServer', 'EmailServer', 'FileShare', 'Forum', 'SocialMediaServer', 'WebService'

class cyberdem.enumerations.**SystemType**
CyberDEM SystemType enumeration

Options ‘C2’, ‘Generic’, ‘ICS’, ‘SCADA’

`class cyberdem.enumerations._CyberDEMEnumeration`

Super class for all CyberDEM enumerations

`_check_prop(value)`

Checks to see if `value` is an allowed enumeration value.

Campares the given value to the allowed options for the current enumeration subclass.

Parameters `value` (*required*) – user-provided value for the enumeration type

Raises `ValueError` – if the `value` is not in the allowed options of the enumeration class.

CHAPTER

FIVE

WIDGETS

Helper functions for using and integrating Cyber DEM Python with your code.

`cyberdem.widgets.`**`generate_network`**(*num_devices*, *num_users*, *filesystem*, *purpose='enterprise'*, *heterogeneity=0*, *network='192.168.0.0/16'*)

Create a network of a given size and purpose.

Given basic parameters, create cyber Objects such as devices, network links, software, accounts, and their relationships to each other.

Parameters

- **`num_devices`** (*`int, required`*) – total number of workstations, routers, printers, etc.
- **`num_users`** (*`int, required`*) – total number of users on the network; affects the number of accounts and the amount of data and applications
- **`filesystem`** (*`Cyber DEM FileSystem, required`*) – where to save the generated assets
- **`purpose`** (*`string, optional (default='enterprise') choose from 'enterprise', 'scada', 'backbone'`*) – general purpose of the network; affects the types of devices chosen, network architecture, and balance of user workstations to network devices
- **`heterogeneity`** (*`int, optional (default=0) chose from 0-5`*) – variety of applications and operating systems on the network; zero is completely homogeneous (for example, an all Windows network), five is as much variety as possible given the purpose of the network
- **`network`** (*`string, optional (default 192.168.0.0/16)`*) – the network address range to use

Example

```
>>> from cyberdem.widgets import generate_network
>>> from cyberdem.filesystem import FileSystem
>>> fs = FileSystem('./test-fs')
>>> generate_network(10, 10, fs)
```

`cyberdem.widgets.`**`network_summary`**(*filesystem*, *count_only=False*, *top_N=None*, *ignore=[]*, *pprint=False*)

A summary count of CyberObjects in the FileSystem

Parameters

- **`filesystem`** (*`FileSystem`*, required) – where the CyberObjects are stored
- **`count_only`** (*`boolean, optional (default=false)`*) – if true, provides only a high level count of CyberObjects
- **`top_N`** (*`integer, optional`*) – only show the top N results of each object type/name

- **ignore** (*list, optional*) – don't include specified CyberObject types
- **pprint** (*boolean, optional (default=false)*) – line and tab delimited print out for quick command line reading

Example

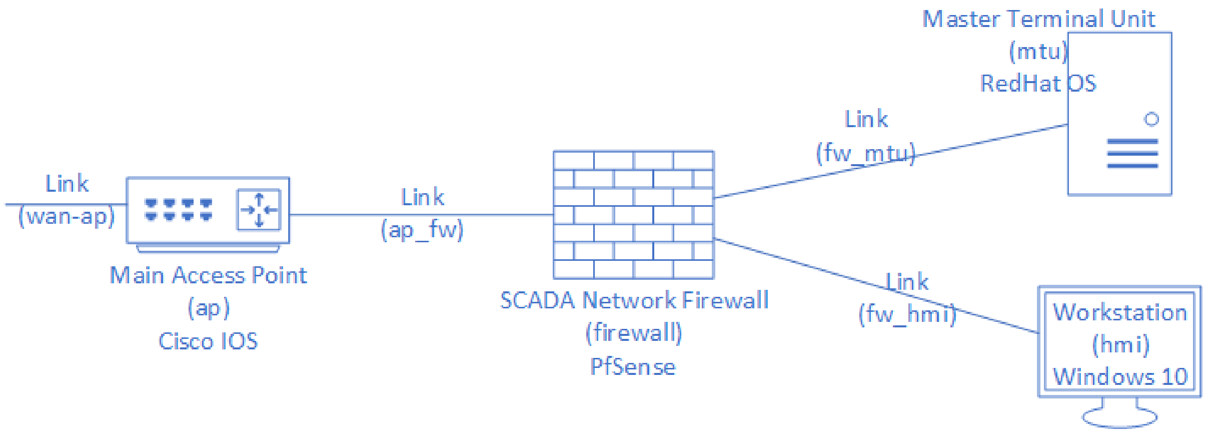
```
>>> from cyberdem.widgets import network_summary
>>> from cyberdem.filesystem import FileSystem
>>> fs = FileSystem('./test-fs')
>>> summary = network_summary(fs, top_N=5, pprint=True)
>>> print(summary)
```

CHAPTER

SIX

EXAMPLE

The following is an example script covering the use of the modules and methods in Cyber DEM Python. It models the toy SCADA network in the figure below and instantiates a series of events on a particular attack chain.



License for example.py

```
'''
Cyber DEM Example Script

Cyber DEM Python

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```

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```
DM20-0711
'''
```

Import the necessary modules.

```
from cyberdem.filesystem import FileSystem
from cyberdem.base import *
from datetime import datetime, timedelta
```

Set up the file system to store Cyber DEM objects and events.

```
    fs = FileSystem('./test-fs')
```

Instantiate a set of known cyber objects representing the toy network. Save each of the objects to the file system.

```
    ap = Device(
        name="Access Point", description="Main access point", is_virtual=False,
        network_interfaces=[["eth0", "10.10.30.40"], ["eth1", "192.168.10.2"]])
    fs.save(ap)

    firewall = Device(
        name="Firewall", description="Firewall", is_virtual=False,
        network_interfaces=[
                ["eth0", "192.168.10.3"], ["eth1", "192.168.10.4"],
                ["eth2", "192.168.10.5"]])
    fs.save(firewall)

    mtu = Device(
        name="MTU", description="Master Terminal Unit", is_virtual=False,
        network_interfaces=[["eth0", "192.168.10.6"]])
    fs.save(mtu)

    hmi = Device(
        name="HMI", description="HMI Workstation", device_types=['HMI'],
        is_virtual=False, network_interfaces=[["eth0", "192.168.10.7"]])
    fs.save(hmi)

    wan_ap = NetworkLink(
        name='WAN-AP', description='WAN to AP link', physical_layer='Wired',
        is_logical=False, data_link_protocol='Ethernet')
    fs.save(wan_ap)

    ap_fw = NetworkLink(
        name='AP-FW', description='AP to FW link', physical_layer='Wired',
        is_logical=False, data_link_protocol='Ethernet')
    fs.save(ap_fw)

    fw_mtu = NetworkLink(
        name='FW-MTU', description='FW to MTU link', physical_layer='Wired',
        is_logical=False, data_link_protocol='Ethernet')
```

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```
    fs.save(fw_mtu)

    fw_hmi = NetworkLink(
        name='FW-HMI', description='FW to HMI link', physical_layer='Wired',
        is_logical=False, data_link_protocol='Ethernet')
    fs.save(fw_hmi)

    cisco_ios = OperatingSystem(
        name='Cisco IOS', description='AP OS is Cisco IOS', version='15.4(3)M',
        os_type='CiscoIOS')
    fs.save(cisco_ios)

    redhat = OperatingSystem(
        name='RedHat', description='RedHat OS', version='8',
        os_type='LinuxRedHat')
    fs.save(redhat)

    win_10 = OperatingSystem(
        name='Windows 10', description='HMI OS is Win10',
        version='Win 10, 2004', os_type='MicrosoftWindows')
    fs.save(win_10)

    pfsense = Application(
        name='PfSense', description='PfSense Firewall', version='2.4.2')
    fs.save(pfsense)

    firefox = Application(
        name='Firefox', description='Firefox browser', version='60')
    fs.save(firefox)

    rapid_scada = Application(
        name='Rapid SCADA', description='Rapid SCADA software', version='5')
    fs.save(rapid_scada)

    httpd_service = Service(
        name='httpd', description='Apache web server', version='2.4.20',
        service_type='WebService', address='192.168.100.40')
    fs.save(httpd_service)

    generic_admin = Persona(
        name="Network admin", description="Runs the systems")
    fs.save(generic_admin)

```

Create and save extra CyberObjects (4 of each type) for background data.

```
    obj_types = [
        Application, Data, Device, Network, NetworkLink, Persona,
        System, OperatingSystem, Service, Deny, Detect, Manipulate,
        DataExfiltration, Destroy, Degrade, Disrupt, PacketManipulationEffect,
        ManipulationAttack, PhishingAttack, BlockTrafficEffect,
        HardwareDamageEffect, LoadRateEffect, DelayEffect, JitterEffect,
```

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```
        CPULoadEffect, MemoryUseEffect, DropEffect, HardwareDegradeEffect,
        OtherDegradeEffect]
    for ot in obj_types:
        for _ in range(0, 4):
            fs.save(ot())

```

Create and save relationships between the known CyberObjects.

```
    fs.save(Relationship(ap.id, wan_ap.id))
    fs.save(Relationship(ap.id, ap_fw.id))
    fs.save(Relationship(ap.id, cisco_ios.id))
    fs.save(Relationship(firewall.id, ap_fw.id))
    fs.save(Relationship(firewall.id, fw_mtu.id))
    fs.save(Relationship(firewall.id, fw_hmi.id))
    fs.save(Relationship(
        redhat.id, firewall.id, relationship_type='ResidesOn'))
    fs.save(Relationship(mtu.id, fw_mtu.id))
    fs.save(Relationship(redhat.id, mtu.id, relationship_type='ResidesOn'))
    fs.save(Relationship(
        httpd_service.id, mtu.id, relationship_type='ResidesOn'))
    fs.save(Relationship(
        rapid_scada.id, mtu.id, relationship_type='ResidesOn'))
    fs.save(Relationship(hmi.id, fw_hmi.id))
    fs.save(Relationship(win_10.id, hmi.id, relationship_type='ResidesOn'))
    fs.save(Relationship(firefox.id, hmi.id, relationship_type='ResidesOn'))

```

Create the CyberEvents of an attack on the toy network.

```
    # phishing attack via email targeting the SCADA administrator
    fs.save(PhishingAttack(
        message_type='Email', targets=[generic_admin.id],
        event_time=datetime(2020, 9, 18)))
    # actor on the HMI ping scans the network block
    scada_netblock = NetworkLink(network_interfaces=[["etho", "192.168.10.0"]])
    fs.save(scada_netblock)
    fs.save(CyberRecon(
        recon_type="PingScan", event_time=datetime(2020, 9, 19),
        targets=[scada_netblock.id], duration=timedelta(seconds=300),
        source_ids=[hmi.id]))
    # actor using the HMI installs a malicious file on the MTU
    fs.save(Manipulate(
        description="installation of malicious file",
        event_time=datetime(2020, 9, 19), targets=[mtu.id],
        source_ids=[hmi.id]))
    fs.save(Manipulate(
        description="malicious code changes readings on MTU",
        event_time=datetime(2020, 9, 19), targets=[mtu.id], phase='Continue'))

```

Query the file system for objects/events with various characteristics.

```
    headers, resp = fs.query("SELECT * FROM Application")
    print(f'\nQUERY 1: SELECT * FROM Application\n--------\n{headers}')
    for line in resp:
        print(line)

    query2 = (
        "SELECT description,name FROM * "
        "WHERE (is_logical=False AND physical_layer<>'Wired') OR "
        "event_time<>'2020-09-18'")
    # @TODO query2 is not currently returning what is expected
    headers, resp = fs.query(query2)
    print(f'\nQUERY 2\n--------\n{headers}')
    for line in resp:
        print(line)

    query3 = (
        "SELECT id FROM Application,OperatingSystem "
        "WHERE name='PfSense' OR os_type='LinuxRedHat'")
    headers, resp = fs.query(query3)
    print(f'\nQUERY 3: {query3}\n--------\n{headers}')
    for line in resp:
        print(line)

```

Reinstantiate objects found in the last query, update their version numbers, and re-save to the filesystem.

```
    # change some property and re-save the instance
    print("\nUpdating app versions...")
    for line in resp:
        app = fs.get(line[0])
        try:
            del app.description
        except AttributeError:
            pass
        if isinstance(app, Application):
            app.version = '2.5.0'
        else:
            app.version = '8.0'
```

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