
AWSIoTDeviceDefenderAgentSDK

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AWS IoT Device Defender Agent SDK (Python)

Example implementation of an AWS IoT Device Defender metrics collection agent, and other Device Defender Python samples.

The provided sample agent can be used as a basis to implement a custom metrics collection agent.

1.1 Prerequisites

1.1.1 Minimum System Requirements

The Following requirements are shared with the [AWS IoT Device SDK for Python](#)

- Python 2.7+ or Python 3.3+ for X.509 certificate-based mutual authentication via port 8883 and MQTT over WebSocket protocol with AWS Signature Version 4 authentication
- Python 2.7.10+ or Python 3.5+ for X.509 certificate-based mutual authentication via port 443
- OpenSSL version 1.0.1+ (TLS version 1.2) compiled with the Python executable for X.509 certificate-based mutual authentication

1.1.2 Connect your Device to AWS IoT

If have never connected your device to AWS IoT before, please follow the [Getting Started with AWS IoT Guide](#). Make sure you note the location of your certificates, you will need to provide the location of these to the Device Defender Sample Agent.

1.2 Notes on the sample agent implementation

client id: The sample agent requires that the client id provided matches a “thing name” in your AWS IoT account. This only for the sake of making the sample easy to get started with. Device Defender only requires that metrics be published for things that are registered in your account, and does not impose any additional requirements on client id

beyond those of the AWS IoT Platform. To customize this behavior, you can modify the way the agent generates the MQTT topic for publishing metrics reports, to use a value other than client id as the thing name portion of the topic.

metric selection: The sample agent attempts to gather all supported Device Defender metrics. Depending on your platform requirements and use case, you may wish to customize your agent to a subset of the metrics.

1.3 Quickstart

1.3.1 Installation

1. Clone the repository

```
git clone https://github.com/aws-samples/aws-iot-device-defender-agent-sdk-python.git
```

1. Install Using pip

Pip is the easiest way to install the sample agent, it will take care of installing dependencies

```
pip install /path/to/sample/package
```

1.3.2 Running the Sample Agent

```
python agent.py --endpoint your.custom.endpoint.amazonaws.com --rootCA /path/to/  
↪rootca --cert /path/to/device/cert --format json -i 300
```

Command line options

To see a summary of all commandline options:

```
python agent.py --help
```

Test Metrics Collection Locally

```
python collector.py -n 1 -s 1
```

1.4 AWS IoT Greengrass Integration

1.4.1 Overview

AWS IoT Device Defender can be used in conjunction with AWS Greengrass. Integration follows the standard Greengrass lambda deployment model, making it easy to add AWS IoT Device Defender security to your Greengrass Core devices.

1.4.2 Prereqs

1. Greengrass environment Setup
2. Greengrass core configured and running
3. Ensure you can successfully deploy and run a lambda on your core

1.4.3 Using Device Defender with Greengrass Core devices

Create Your Lambda Package

For this portion will be following the general process outlined [here](#)

1. Clone the AWS IoT Device Defender Python Samples Repository

```
git clone https://github.com/aws-samples/aws-iot-device-defender-agent-sdk-python.  
↪git
```

2. Create, and activate a virtual environment (optional, recommended)

```
pip install virtualenv  
virtualenv metrics_lambda_environment  
source metrics_lambda_environment/bin/activate
```

3. Install the AWS IoT Device Defender sample agent in the virtual environment Install from PyPi

```
pip install AWSIoTDeviceDefenderAgentSDK
```

Install from downloaded source

```
cd aws-iot-device-defender-agent-sdk-python  
#This must be run from the same directory as setup.py  
pip install .
```

4. Create an empty directory to assemble your lambda, we will refer to this as your “lambda directory”

```
mkdir metrics_lambda  
cd metrics_lambda
```

5. Complete steps 1-4 from this [guide](#)
6. Unzip the Greengrass python sdk into your lambda directory

```
unzip ../aws_greengrass_core_sdk/sdk/python_sdk_1_1_0.zip  
cp -R ../aws_greengrass_core_sdk/examples/HelloWorld/greengrass_common .  
cp -R ../aws_greengrass_core_sdk/examples/HelloWorld/greengrasssdk .  
cp -R ../aws_greengrass_core_sdk/examples/HelloWorld/greengrass_ipc_python_sdk .
```

7. Copy the AWSIoTDeviceDefenderAgentSDK module to the root level of your lambda

```
cp -R ../aws-iot-device-defender-agent-sdk-python/AWSIoTDeviceDefenderAgentSDK .
```

8. Copy the Greengrass agent to the root level of your lambda directory

```
cp ../aws-iot-device-defender-agent-sdk-python/samples/greengrass/greengrass_core_  
↪metrics_agent/greengrass_defender_agent.py .
```

9. Copy the dependencies from your virtual environment or your system, into the the root level of your lambda

```
cp -R ../metrics_lambda_environment/lib/python2.7/site-packages/psutil .
cp -R ../metrics_lambda_environment/lib/python2.7/site-packages/cbor .
```

10. Create your lambda zipfile *Note: you should perform this command in the root level of your lambda directory*

```
rm *.zip
zip -r greengrass_defender_metrics_lambda.zip *
```

Configure and deploy your Greengrass Lambda

1. Upload your lambda zip file
2. Select the Python 2.7 runtime, and enter `greengrass_defender_agent.function_handler` in the Handler field
3. Configure your lambda as a long-lived lambda
4. Configure the following environment variables:
 - **SAMPLE_INTERVAL_SECONDS:** The metrics generation interval. This defaults to 300 seconds *Note: 5 minutes (300 seconds) is the shortest reporting interval supported by AWS IoT Device Defender*
 - **PROCFS_PATH:** The destination path that you will configure for your `/proc` resource as shown below.
5. Configure a subscription from your lambda to the AWS IoT Cloud *Note: For AWS IoT Device Defender, a subscription from AWS IoT Cloud to your lambda is not required*
6. Create a local resource to allow your lambda to collect metrics from the Greengrass Core host
 - Follow the instructions [here](#)
 - Use the following parameters:
 - **Resource Name:** Core Proc
 - **Type:** Volume
 - **Source Path:** `/proc`
 - **Destination Path:** `/host_proc` (make sure the same value is configured for the `PROCFS_PATH` environment variable above)
 - Group owner file access permission: “Automatically add OS group permissions of the Linux group that owns the resource”
 - Associate the resource with your metrics lambda
7. Deploy your lambda to your Greengrass Group

Troubleshooting

Reviewing AWS IoT Device Defender device metrics using AWS IoT Console

1. Temporarily modify your publish topic in your Greengrass lambda to something such as `metrics/test`
2. Deploy the lambda
3. Add a subscription to the temporary topic in the “Test” section of the iot console, shortly you should the metrics your Greengrass Core is emitting

1.5 Metrics Report Details

1.5.1 Overall Structure

Long Name	Short Name	Required	Type	Constraints	Notes
header	hed	Y	Object		Complete block required for well-formed report
metrics	met	Y	Object		Complete block required for well-formed report

Header Block

Long Name	Short Name	Required	Type	Constraints	Notes
report_id	rid	Y	Integer		Monotonically increasing value, epoch timestamp recommended
version	v	Y	String	Major. Minor	Minor increments with addition of field, major increments if metrics removed

Metrics Block

TCP Connections

Long Name	Short Name	Parent Element	Required	Type	Constraints	Notes
tcp_connections	tc	metrics	N	Object		
established_connections	ec	tcp_connections	N	List		ESTABLISHED TCP State
connections	cs	established_connections	N	List		
remote_addr	rad	connections	Y	Number	ip:port	ip can be ipv6 or ipv4
local_port	lp	connections	N	Number	>0	
local_interface	li	connections	N	String		interface name
total	t	established_connections	N	Number	>= 0	Number established connections

Listening TCP Ports

Long Name	Short Name	Parent Element	Required	Type	Constraints	Notes
listening_tcp_ports	tp	metrics	N	Object		
ports	pts	listening_tcp_ports	N	List	> 0	
port	pt	ports	N	Number	>= 0	ports should be numbers > 0
interface	if	ports	N	String		Interface Name
total	t	listening_tcp_ports	N	Number	>= 0	

Listening UDP Ports

Long Name	Short Name	Parent Element	Required	Type	Constraints	Notes
listening_udp_ports	up	metrics	N	Object		
ports	pts	listening_udp_ports	N	List	> 0	
port	pt	ports	N	Number	> 0	ports should be numbers > 0
interface	if	ports	N	String		Interface Name
total	t	listening_udp_ports	N	Number	>= 0	

Network Stats

Long Name	Short Name	Parent Element	Required	Type	Constraints	Notes
network_stats	ns	metrics	N	Object		
bytes_in	bi	network_stats	N	Number	Delta Metric, >= 0	
bytes_out	bo	network_stats	N	Number	Delta Metric, >= 0	
packets_in	pi	network_stats	N	Number	Delta Metric, >= 0	
packets_out	po	network_stats	N	Number	Delta Metric, >= 0	

1.5.2 Sample Metrics Reports

Long Field Names

```
{
  "header": {
    "report_id": 1529963534,
    "version": "1.0"
  },

```

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```

"metrics": {
  "listening_tcp_ports": {
    "ports": [
      {
        "interface": "eth0",
        "port": 24800
      },
      {
        "interface": "eth0",
        "port": 22
      },
      {
        "interface": "eth0",
        "port": 53
      }
    ],
    "total": 3
  },
  "listening_udp_ports": {
    "ports": [
      {
        "interface": "eth0",
        "port": 5353
      },
      {
        "interface": "eth0",
        "port": 67
      }
    ],
    "total": 2
  },
  "network_stats": {
    "bytes_in": 1157864729406,
    "bytes_out": 1170821865,
    "packets_in": 693092175031,
    "packets_out": 738917180
  },
  "tcp_connections": {
    "established_connections": {
      "connections": [
        {
          "local_interface": "eth0",
          "local_port": 80,
          "remote_addr": "192.168.0.1:8000"
        },
        {
          "local_interface": "eth0",
          "local_port": 80,
          "remote_addr": "192.168.0.1:8000"
        }
      ],
      "total": 2
    }
  }
}

```

Short Field Names

```
{
  "h": {
    "rid": 1529963534,
    "v": "1.0"
  },
  "met": {
    "tp": {
      "pts": [
        {
          "if": "eth0",
          "pt": 24800
        },
        {
          "if": "eth0",
          "pt": 22
        },
        {
          "if": "eth0",
          "pt": 53
        }
      ],
      "t": 3
    },
    "up": {
      "pts": [
        {
          "if": "eth0",
          "pt": 5353
        },
        {
          "if": "eth0",
          "pt": 67
        }
      ],
      "t": 2
    },
    "ns": {
      "bi": 1157864729406,
      "bo": 1170821865,
      "pi": 693092175031,
      "po": 738917180
    },
    "tc": {
      "ec": {
        "cs": [
          {
            "li": "eth0",
            "lp": 80,
            "rad": "192.168.0.1:8000"
          },
          {
            "li": "eth0",
            "lp": 80,
            "rad": "192.168.0.1:8000"
          }
        ]
      }
    }
  }
}
```

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```
    ],  
    "t": 2  
  }  
}  
}
```

1.6 API Documentation

Can you can find the API documentation [here](#)

1.7 References

- [AWS Lambda: Creating a Deployment Package \(Python\)](#)
- [Monitoring with AWS Greengrass Logs](#)
- [Troubleshooting AWS Greengrass Applications](#)
- [Access Local Resources with Lambda Functions](#)

1.8 License

This library is licensed under the Apache 2.0 License.

1.9 Support

If you have technical questions about the AWS IoT Device SDK, use the [AWS IoT Forum](#). For any other questions about AWS IoT, contact [AWS Support](#).

AWSIoTDeviceDefenderAgentSDK

2.1 AWSIoTDeviceDefenderAgentSDK

2.1.1 AWSIoTDeviceDefenderAgentSDK.agent

```
class AWSIoTDeviceDefenderAgentSDK.agent.IoTClientWrapper (endpoint, root_ca_path,  
certificate_path,  
private_key_path,  
client_id)
```

Bases: `object`

Wrapper around the AWS Iot Python SDK.

Sets common parameters based on the AWS Iot Python SDK's [Basic PubSub](#) sample.

```
publish (publish_to_topic, payload)  
    Publish to MQTT
```

```
subscribe (subscribe_to_topic, callback)  
    Subscribe to MQTT
```

```
connect ()  
    Connect to AWS IoT
```

```
AWSIoTDeviceDefenderAgentSDK.agent.parse_args ()  
    Setup Commandline Argument Parsing
```

```
AWSIoTDeviceDefenderAgentSDK.agent.custom_callback (self, userdata, message)
```

2.1.2 AWSIoTDeviceDefenderAgentSDK.collector

```
class AWSIoTDeviceDefenderAgentSDK.collector.Collector (short_metrics_names=False)  
    Bases: object
```

Reads system information and populates a metrics object.

This implementation utilizes `psutil` to make parsing metrics easier and more cross-platform.

Parameters `short_metrics_names` (*bool*) – Toggle short object tags in output metrics.

`listening_ports` (*metrics*)

Iterate over all inet connections in the LISTEN state and extract port and interface.

`static network_stats` (*metrics*)

`static network_connections` (*metrics*)

`collect_metrics` ()

Sample system metrics and populate a metrics object suitable for publishing to Device Defender.

2.1.3 AWSIoTDeviceDefenderAgentSDK.metrics

`class` `AWSIoTDeviceDefenderAgentSDK.metrics.Metrics` (*short_names=False*,
last_metric=None)

Bases: `object`

A collection of system metric values, providing facilities for output in a Device Defender compliant format.

Features: Serialization Format: Metrics can be exported in either `cbor` or JSON format.

Delta metrics: if the class is initialized with an existing metrics object, for certain metrics, the difference between the old and current metric value will be calculated and stored.

Selectable metric tags: allow for verbose metrics tags, for easier debugging, or short mnemonic tags, reducing the amount of data transmitted and stored in memory.

Initialize a new metrics object.

Parameters

- `short_names` (*bool*) – Toggle short object tags in output metrics.
- `last_metric` (*Metrics object*) – Metric object used for delta metric calculation.

`network_stats`

Retrieve network TCP and UDP stats aggregated across all interfaces.

`listening_ports` (*protocol*)

`add_listening_ports` (*protocol, ports*)

Add a set of listening ports for a particular protocol.

Parameters

- `protocol` (*string*) – TCP or UDP, all others invalid and will not be added
- `ports` (*list*) – List of Dictionaries, each dictionary should have a “port” and optionally an “interface” key. Example Dictionary: { ‘port’: 80, ‘interface’: ‘eth0’ }

`add_network_stats` (*bytes_in, packets_in, bytes_out, packets_out*)

Add cumulative network stats across all network interfaces. If a previous metrics object was supplied, attempts to calculate and store delta metric.

Parameters

- `bytes_in` (*int*) – Number of bytes received on this interface
- `bytes_out` (*int*) – Number of bytes sent from this interface
- `packets_in` (*int*) – Number of packets received on this interface
- `packets_out` (*int*) – Number of packets sent from this interface

add_network_connection (*remote_addr*, *remote_port*, *interface*, *local_port*)

Add network connection details.

Parameters

- **remote_addr** (*string*) – Ip address of the remote peer, can be ipv4 or ipv6
- **remote_port** (*int*) – Port of the remote peer
- **interface** (*string*) – Name of local network interface associated with the connection
- **local_port** (*int*) – Local port of the connection

network_connections

to_json_string (*pretty_print=False*)

Convert the metrics to a json string suitable for AWS IoT Device Defender.

Parameters **pretty_print** (*bool*) – Set to true if you would like json to be formatted in a more human-friendly format.

to_cbor ()

Returns a cbor serialized metrics object.

2.1.4 AWSIoTDeviceDefenderAgentSDK.tags

class AWSIoTDeviceDefenderAgentSDK.tags.**Tags** (*short_names=False*)

Bases: `object`

Abstract field name selection for metrics reports.

HEADER = ('header', 'hed')

METRICS = ('metrics', 'met')

REPORT_ID = ('report_id', 'rid')

VERSION = ('version', 'v')

TCP_CONN = ('tcp_connections', 'tc')

ESTABLISHED_CONNECTIONS = ('established_connections', 'ec')

CONNECTIONS = ('connections', 'cs')

REMOTE_ADDR = ('remote_addr', 'rad')

REMOTE_PORT = ('remote_port', 'rp')

LOCAL_PORT = ('local_port', 'lp')

LOCAL_INTERFACE = ('local_interface', 'li')

STATUS = ('status', 's')

LISTENING_TCP_PORTS = ('listening_tcp_ports', 'tp')

LISTENING_UDP_PORTS = ('listening_udp_ports', 'up')

PORTS = ('ports', 'pts')

PORT = ('port', 'pt')

NETWORK_STATS = ('network_stats', 'ns')

BYTES_IN = ('bytes_in', 'bi')

BYTES_OUT = ('bytes_out', 'bo')

```
PACKETS_IN = ('packets_in', 'pi')
PACKETS_OUT = ('packets_out', 'po')
TOTAL = ('total', 't')
get(tag)
header
metrics
report_id
version
tcp_conn
connections
established_connections
remote_addr
remote_port
local_port
local_interface
listening_tcp_ports
listening_udp_ports
ports
interface_stats
interfaces
bytes_in
bytes_out
packets_in
packets_out
total
```

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