

Maintenance

This guide describes tasks and configurations you might repeat throughout the life cycle of a deployment in your organization. It is for people who maintain PingGateway services for their organization.

Audit the deployment

The following sections describe how to set up auditing for your deployment. You can find information on how to include user ID in audit logs in [Recording User ID in Audit Events](#).

You can find more information about configuring the JMS event handler in [Audit framework](#).

Record access audit events in CSV

This section describes how to record access audit events in a CSV file, using tamper-evident logging. For information about the CSV audit event handler, refer to [CsvAuditEventHandler](#).

IMPORTANT

The CSV handler doesn't sanitize messages when writing to CSV log files.

Don't open CSV logs in spreadsheets or other applications that treat data as code.

Before you start, prepare PingGateway and the sample application as described in the [Quick install](#).

1. Set up secrets for tamper-evident logging:
 - a. Locate a directory for secrets, and go to it:

```
$ cd /path/to/secrets
```

- b. Generate a key pair in the keystore.

The CSV event handler expects a JCEKS-type keystore with a key alias of `signature` for the signing key, where the key is generated with the `RSA` key

algorithm and the SHA256withRSA signature algorithm:

```
$ keytool \  
-genkeypair \  
-keyalg RSA \  
-sigalg SHA256withRSA \  
-alias "signature" \  
-dnname "CN=ig.example.com,O=Example Corp,C=FR" \  
-keystore audit-keystore \  
-storetype JCEKS \  
-storepass password \  
-keypass password
```

NOTE

Because keytool converts all characters in its key aliases to lowercase, use only lowercase in alias definitions of a keystore.

c. Generate a secret key in the keystore.

The CSV event handler expects a JCEKS-type keystore with a key alias of `csv-key-2` for the symmetric key, where the key is generated with the HmacSHA256 key algorithm and 256-bit key size:

```
$ keytool \  
-genseckey \  
-keyalg HmacSHA256 \  
-keysize 256 \  
-alias "password" \  
-keystore audit-keystore \  
-storetype JCEKS \  
-storepass password \  
-keypass password
```

d. Verify the content of the keystore:

```
$ keytool \  
-list \  
-keystore audit-keystore \  
-storetype JCEKS \  
-storepass password
```

Keystore type: JCEKS
Keystore provider: SunJCE

Your keystore contains 2 entries

```
password, ... SecretKeyEntry,  
signature, ... PrivateKeyEntry,  
Certificate fingerprint (SHA1): 4D:...:D1
```

2. Set up PingGateway

- Set up PingGateway for HTTPS, as described in [Configure PingGateway for TLS \(server-side\)](#).
- Add the following route to PingGateway, replacing `/path/to/secrets/audit-keystore` with your path:

Linux

Windows

```
$HOME/.openig/config/routes/30-csv.json
```

```
{  
  "name": "30-csv",  
  "baseURI": "http://app.example.com:8081",  
  "condition": "${find(request.uri.path, '^/home/csv-audit')}",  
  "heap": [  
    {  
      "name": "AuditService",  
      "type": "AuditService",  
      "config": {  
        "eventHandlers": [  
          {  
            "class":  
"org.forgerock.audit.handlers.csv.CsvAuditEventHandler",  
            "config": {  
              "name": "csv",  
              "logDirectory": "/tmp/logs",  
              "security": {  
                "enabled": "true",  
                "filename": "/path/to/secrets/audit-  
keystore",  
                "password": "password",  
                "signatureInterval": "1 day"  
              },  
              "topics": [  
                "access"  
              ]  
            }  
          }  
        ]  
      }  
    }  
  ]  
}
```

```

        }
    ],
    "config": { }
}
],
"auditService": "AuditService",
"handler": "ForgeRockClientHandler"
}

```

The route calls an audit service configuration for publishing log messages to the CSV file, `/tmp/logs/access.csv`.

When a request matches `audit`, audit events are logged to the CSV file.

The route uses the `ForgeRockClientHandler` as its handler, to send the `X-ForgeRock-TransactionId` header with its requests to external services.

3. Test the setup:

- a. In your browser's privacy or incognito mode, go to <https://ig.example.com:8443/home/csv-audit>.

The home page of the sample application is displayed, and the file `/tmp/logs/tamper-evident-access.csv` is updated.

Record access audit events with a JMS audit event handler

IMPORTANT

This procedure is an example of how to record access audit events with a JMS audit event handler configured to use the ActiveMQ message broker. This example isn't tested on all configurations, and can be more or less relevant to your configuration.

You can find information about configuring the JMS event handler in [JmsAuditEventHandler](#).

Before you start, prepare PingGateway as described in the [Quick install](#).

1. Download the following files:

- [ActiveMQ binary](#). PingGateway is tested with ActiveMQ Classic 5.15.11.
- [ActiveMQ Client](#). Use a version that corresponds to your ActiveMQ version.
- [Apache Geronimo J2EE management bundle](#).
- [hawtbuf-1.11 JAR](#).

2. Add the files to the configuration:

- Create the directory `$HOME/.openig/extra`, where `$HOME/.openig` is the instance directory, and add `.jar` files to the directory.
3. Create a consumer that subscribes to the `audit` topic.

From the ActiveMQ installation directory, run the following command:

```
$ ./bin/activemq consumer --destination topic://audit
```

4. Set up PingGateway

a. Set up PingGateway for HTTPS, as described in [Configure PingGateway for TLS \(server-side\)](#).

b. Add the following route to PingGateway:

Linux	Windows
<pre>\$HOME/.openig/config/routes/30-jms.json</pre>	

```
{
  "name": "30-jms",
  "MyCapture" : "all",
  "baseURI": "http://app.example.com:8081",
  "condition" : "${request.uri.path ==
'/activemq_event_handler'}",
  "heap": [
    {
      "name": "AuditService",
      "type": "AuditService",
      "config": {
        "eventHandlers" : [
          {
            "class" :
"org.forgerock.audit.handlers.jms.JmsAuditEventHandler",
            "config" : {
              "name" : "jms",
              "topics": [ "access" ],
              "deliveryMode" : "NON_PERSISTENT",
              "sessionMode" : "AUTO",
              "jndi" : {
                "contextProperties" : {
                  "java.naming.factory.initial" :
"org.apache.activemq.jndi.ActiveMQInitialContextFactory",
                  "java.naming.provider.url" :
```

```

"tcp://am.example.com:61616",
    "topic.audit" : "audit"
  },
  "topicName" : "audit",
  "connectionFactoryName" :
"ConnectionFactory"
  }
}
},
"config" : { }
}
},
],
"auditService": "AuditService",
"handler" : {
  "type" : "StaticResponseHandler",
  "config" : {
    "status" : 200,
    "headers" : {
      "Content-Type" : [ "text/plain; charset=UTF-8" ]
    },
    "entity" : "Message from audited route"
  }
}
}
}

```

When a request matches the `/activemq_event_handler` route, this configuration publishes JMS messages containing audit event data to an ActiveMQ managed JMS topic, and the `StaticResponseHandler` displays a message.

5. Test the setup:

- a. In your browser's privacy or incognito mode, go to https://ig.example.com:8443/activemq_event_handler.

Depending on how ActiveMQ is configured, audit events are displayed on the ActiveMQ console or written to file.

Record access audit events with a JSON audit event handler

This section describes how to record access audit events with a JSON audit event handler. You can find more information about configuring the JSON event handler in [JsonAuditEventHandler](#).

1. Set up PingGateway

- a. Set up PingGateway for HTTPS, as described in [Configure PingGateway for TLS \(server-side\)](#).
- b. Add the following route to PingGateway:

Linux

Windows

```
$HOME/.openig/config/routes/30-json.json
```

```
{
  "name": "30-json",
  "baseURI": "http://app.example.com:8081",
  "condition": "${find(request.uri.path, '^/home/json-audit')}",
  "heap": [
    {
      "name": "AuditService",
      "type": "AuditService",
      "config": {
        "eventHandlers": [
          {
            "class":
"org.forgerock.audit.handlers.json.JsonAuditEventHandler",
            "config": {
              "name": "json",
              "logDirectory": "/tmp/logs",
              "topics": [
                "access"
              ],
              "rotationRetentionCheckInterval": "1
minute",
              "buffering": {
                "maxSize": 100000,
                "writeInterval": "100 ms"
              }
            }
          }
        ]
      }
    }
  ],
  "auditService": "AuditService",
```

```
"handler": "ReverseProxyHandler"
}
```

Notice the following features of the route:

- The route calls an audit service configuration for publishing log messages to the JSON file, `/tmp/audit/access.audit.json`. When a request matches `/home/json-audit`, a single line per audit event is logged to the JSON file.
- The route uses the `ForgeRockClientHandler` as its handler, to send the `X-ForgeRock-TransactionId` header with its requests to external services.

2. Test the setup:

- a. In your browser's privacy or incognito mode, go to <https://ig.example.com:8443/home/json-audit>.

The home page of the sample application is displayed and the file `/tmp/logs/access.audit.json` is created or updated with a message. The following example message is formatted for easy reading, but it is produced as a single line for each event:

```
{
  "_id": "830...-41",
  "timestamp": "2019-...540Z",
  "eventName": "OPENIG-HTTP-ACCESS",
  "transactionId": "830...-40",
  "client": {
    "ip": "0:0:0:0:0:0:1",
    "port": 51666
  },
  "server": {
    "ip": "0:0:0:0:0:0:1",
    "port": 8080
  },
  "http": {
    "request": {
      "secure": false,
      "method": "GET",
      "path": "http://ig.example.com:8080/home/json-audit",
      "headers": {
        "accept":
["text/html,application/xhtml+xml,application/xml;q=0.9, /;
q=0.8"],
        "host": ["ig.example.com:8080"],
```



```

        "user-agent": [ "Mozilla/5.0 ... Firefox/66.0" ]
    }
}
},
"response": {
    "status": "SUCCESSFUL",
    "statusCode": "200",
    "elapsedTime": 212,
    "elapsedTimeUnits": "MILLISECONDS"
},
"ig": {
    "exchangeId": "b3f...-29",
    "routeId": "30-json",
    "routeName": "30-json"
}
}
}

```

Record access audit events to standard output

This section describes how to record access audit events to standard output. You can find more information about the event handler in [JsonStdoutAuditEventHandler](#).

Before you start, prepare PingGateway and the sample application as described in the [Quick install](#).

1. Set up PingGateway

- a. Set up PingGateway for HTTPS, as described in [Configure PingGateway for TLS \(server-side\)](#).
- b. Add the following route to PingGateway:

Linux	Windows
<div style="border: 1px solid #ccc; padding: 10px; margin-top: 10px;"> <pre>\$HOME/.openig/config/routes/30-jsonstdout.json</pre> </div>	

```

{
  "name": "30-jsonstdout",
  "baseURI": "http://app.example.com:8081",
  "condition": "${find(request.uri.path,
'^/home/jsonstdout-audit')}",
  "heap": [
    {
      "name": "AuditService",

```

```

    "type": "AuditService",
    "config": {
      "eventHandlers": [
        {
          "class":
"org.forgerock.audit.handlers.json.stdout.JsonStdoutAuditE
ventHandler",
          "config": {
            "name": "jsonstdout",
            "elasticsearchCompatible": false,
            "topics": [
              "access"
            ]
          }
        }
      ],
      "config": {}
    }
  },
  "auditService": "AuditService",
  "handler": "ReverseProxyHandler"
}

```

Notice the following features of the route:

- The route matches requests to `/home/jsonstdout-audit`.
- The route calls the audit service configuration for publishing access log messages to standard output. When a request matches `/home/jsonstdout-audit`, a single line per audit event is logged.

2. In your browser's privacy or incognito mode, go to <https://ig.example.com:8443/home/jsonstdout-audit>.

The home page of the sample application is displayed, and a message like this is published to standard output:

```

{
  "_id": "830...-61",
  "timestamp": "2019-...89Z",
  "eventName": "OPENIG-HTTP-ACCESS",
  "transactionId": "830...-60",
  "client": {
    "ip": "0:0:0:0:0:0:0:1",
    "port": 51876
  },
}

```

```

"server": {
  "ip": "0:0:0:0:0:0:1",
  "port": 8080
},
"http": {
  "request": {
    "secure": false,
    "method": "GET",
    "path": "http://ig.example.com:8080/home/jsonstdout-
audit",
    "headers": {
      "accept":
["text/html,application/xhtml+xml,application/xml;q=0.9,/;q=0.
8"],
      "host": ["ig.example.com:8080"],
      "user-agent": ["Mozilla/5.0 ... Firefox/66.0"]
    }
  },
  "response": {
    "status": "SUCCESSFUL",
    "statusCode": "200",
    "elapsedTime": 10,
    "elapsedTimeUnits": "MILLISECONDS"
  },
  "ig": {
    "exchangeId": "b3f...-41",
    "routeId": "30-jsonstdout",
    "routeName": "30-jsonstdout"
  },
  "source": "audit",
  "topic": "access",
  "level": "INFO"
}

```

Trust transaction IDs from other products

Each audit event is identified by a unique transaction ID that can be communicated across products and recorded for each local event. By using the transaction ID, requests can be tracked as they traverse the platform, making it easier to monitor activity and to enrich reports.

The `X-ForgeRock-TransactionId` header is automatically set in all outgoing HTTP calls from one ForgeRock product to another. Customers can also set this header themselves from their own applications or scripts that call into the Ping Identity Platform.

To reduce the risk of malicious attacks, by default PingGateway doesn't trust transaction ID headers from client applications.

If you trust the transaction IDs sent by your client applications, consider setting Java system property `org.forgerock.http.TrustTransactionHeader` to `true`.

Add the following system property in `env.sh`:

```
# Specify a JVM option
TX_HEADER_OPT="-Dorg.forgerock.http.TrustTransactionHeader=true"

# Include it into the JAVA_OPTS environment variable
export JAVA_OPTS="${TX_HEADER_OPT}"
```

All incoming `X-ForgeRock-TransactionId` headers are trusted, and monitoring or reporting systems that consume the logs can allow requests to be correlated as they traverse multiple servers.

Safelist audit event fields for the logs

To prevent logging of sensitive data for an audit event, the Common Audit Framework uses a safelist to specify which audit event fields appear in the logs.

By default, only safelisted audit event fields are included in the logs. You can find information about how to include non-safelisted audit event fields or exclude safelisted audit event fields in [Including or excluding audit event fields in logs](#).

Audit event fields use JSON pointer notation, and are taken from the JSON schema for the audit event content. The following event fields are safelisted:

- `/_id`
- `/timestamp`
- `/eventName`
- `/transactionId`
- `/trackingIds`
- `/userId`
- `/client`
- `/server`
- `/ig/exchangeId`
- `/ig/routeId`
- `/ig/routeName`
- `/http/request/secure`

- `/http/request/method`
- `/http/request/path`
- `/http/request/headers/accept`
- `/http/request/headers/accept-api-version`
- `/http/request/headers/content-type`
- `/http/request/headers/host`
- `/http/request/headers/user-agent`
- `/http/request/headers/x-forwarded-for`
- `/http/request/headers/x-forwarded-host`
- `/http/request/headers/x-forwarded-port`
- `/http/request/headers/x-forwarded-proto`
- `/http/request/headers/x-original-uri`
- `/http/request/headers/x-real-ip`
- `/http/request/headers/x-request-id`
- `/http/request/headers/x-requested-with`
- `/http/request/headers/x-scheme`
- `/request`
- `/response`

Include or exclude audit event fields in logs

The safelist is designed to prevent logging of sensitive data for audit events by specifying which audit event fields appear in the logs. You can add or remove messages from the logs as follows:

- To include audit event fields in logs that aren't safelisted, configure the `includeIf` property of `AuditService`.

IMPORTANT

Before you include non-safelisted audit event fields in the logs, consider the impact on security. Including some headers, query parameters, or cookies in the logs could cause credentials or tokens to be logged, and allow anyone with access to the logs to impersonate the holder of these credentials or tokens.

- To exclude safelisted audit event fields from the logs, configure the `excludeIf` property of `AuditService`. You can find an example in [Exclude safelisted audit event fields from logs](#).

Exclude safelisted audit event fields from logs

Before you start, set up and test the example in [Recording access audit events in JSON](#). Note the audit event fields in the log file `access.audit.json`.

1. Replace `30-json.json` with the following route:

Linux	Windows
<pre>\$HOME/.openig/config/routes/30-json-excludeif.json</pre>	

```
{
  "name": "30-json-excludeif",
  "baseURI": "http://app.example.com:8081",
  "condition": "${find(request.uri.path, '^/home/json-audit-excludeif$')}",
  "heap": [
    {
      "name": "AuditService",
      "type": "AuditService",
      "config": {
        "config": {
          "filterPolicies": {
            "field": {
              "excludeIf": [
                "/access/http/request/headers/host",
                "/access/http/request/path",
                "/access/server",
                "/access/response"
              ]
            }
          }
        },
        "eventHandlers": [
          {
            "class":
"org.forgerock.audit.handlers.json.JsonAuditEventHandler",
            "config": {
              "name": "json",
              "logDirectory": "/tmp/logs",
              "topics": [
                "access"
              ],
              "rotationRetentionCheckInterval": "1 minute",
              "buffering": {
                "maxSize": 100000,
```

```

        "writeInterval": "100 ms"
      }
    }
  ]
}
},
"auditService": "AuditService",
"handler": "ReverseProxyHandler"
}

```

Notice that the AuditService is configured with an `excludeIf` property to exclude audit event fields from the logs.

2. In your browser's privacy or incognito mode, go to <https://ig.example.com:8443/home/json-audit-excludeif>.

The home page of the sample application is displayed and the file `/tmp/logs/access.audit.json` is updated:

```

{
  "_id": "830...-41",
  "timestamp": "2019-...540Z",
  "eventName": "OPENIG-HTTP-ACCESS",
  "transactionId": "830...-40",
  "client": {
    "ip": "0:0:0:0:0:0:0:1",
    "port": 51666
  },
  "http": {
    "request": {
      "secure": false,
      "method": "GET",
      "headers": {
        "accept":
["text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=
0.8"],
        "user-agent": ["Mozilla/5.0 ... Firefox/66.0"]
      }
    }
  },
  "ig": {
    "exchangeId": "b3f...-56",
    "routeId": "30-json-excludeif",
    "routeName": "30-json-excludeif"
  }
}

```

```
}  
}
```

3. Compare the audit event fields in `access.audit.json` with those produced in [Recording access audit events in JSON](#), and note that the audit event fields specified by the `excludeIf` property no longer appear in the logs.

Record user ID in audit events

The following sections provide examples of how to capture the AM user ID in audit logs.

Sample scripts are available in the `openig-samples.jar` file, to capture the user ID after SSO, CDSSO, OpenID, or SAML authentication. The scripts inject the user ID into the `RequestAuditContext` so that it is available when the audit event is written.

Using the notes in the sample scripts, adapt the script for your deployment. For example, configure which `user_info` field to capture in the audit event.

The audit service in these examples use a `JsonStdoutAuditEventHandler`, which writes audit events to standard output, but can be any other audit service.

Record user ID in audit logs after SSO authentication

Before you start, set up and test the example in [Cross-domain single sign-on \(CDSSO\)](#).

1. Add the following script to PingGateway:

Linux

Windows

```
$HOME/.openig/scripts/groovy/InjectUserIdSso.groovy
```

```
package scripts.groovy
```

```
import org.forgerock.openig.openam.SsoTokenContext
```

```
import org.forgerock.services.context.RequestAuditContext
```

```
/**
```

```
 * Sample ScriptableFilter implementation to capture the user  
id from the session
```

```
 * and inject it into the RequestAuditContext for later use  
when the audit event
```

```
 * is written.
```

```
 *
```

```
 * This ScriptableFilter should be added in the filter chain
```


at whatever point the

** desired user id is available - e.g. on the session after SSO.*

```
*
* "handler": {
*   "type": "Chain",
*   "config": {
*     "filters": [ {
*       "name": "SingleSignOnFilter-1",
*       "type": "SingleSignOnFilter",
*       "config": {
*         "amService": "AmService-1"
*       }
*     }, {
*       "type" : "ScriptableFilter",
*       "config" : {
*         "file" : "InjectUserIdSso.groovy",
*         "type": "application/x-groovy"
*       }
*     }
*   ],
*   "handler" : "ReverseProxyHandler",
* }
```

** When using the SSO/ CDSSO flow then the SsoTokenContext is guaranteed to exist and*

** be populated if there was no error. The RequestAuditContext is also guaranteed to*

** be available. Note also that if the SessionInfoFilter is present in the route then*

** a SessionInfoContext would be available in the context chain and could be queried*

** for user info.*

** Implementors may decide which user id field to capture in the audit event:*

** - The sessionInfo universalId - 'universalId' - is always available as*

** provided by AM and resembles -*

** e.g.*

"id=bonnie,ou=user,o=myrealm,ou=services,dc=openam,dc=forgerock,dc=org".

** - The sessionInfo username - mapped to 'username') resembles - e.g. "bonnie".*

** Field 'username' should be preferred to 'uid', which also*

```

points to 'username'.
*
* Additional error handling may be required.
*
* @see RequestAuditContext
* @see SsoTokenContext
* @see org.forgerock.openig.openam.SessionInfoContext
*/

def requestAuditContext =
context.asContext(RequestAuditContext.class)
def ssoTokenContext = context.asContext(SsoTokenContext.class)

// The sessionInfo 'universalId' is always available, though
'username' may be unknown
requestAuditContext.setUserId(ssoTokenContext.universalId)

// Propagate the request to the next filter/ handler in the
chain
next.handle(context, request)

```

The script captures the user ID after SSO or CDSSO authentication, and injects it into the RequestAuditContext so that it is available when the audit event is written.

2. Replace `sso.json` with the following route:

Linux	Windows
<pre>\$HOME/.openig/config/routes/audit-sso.json</pre>	

```

{
  "name": "audit-sso",
  "baseURI": "http://app.example.com:8081",
  "condition": "${find(request.uri.path, '^/home/audit-
sso$')}",
  "heap": [
    {
      "name": "AuditService",
      "type": "AuditService",
      "config": {
        "eventHandlers": [
          {
            "class":
"org.forgerock.audit.handlers.json.stdout.JsonStdoutAuditEvent

```

```

Handler",
    "config": {
        "name": "jsonstdout",
        "elasticsearchCompatible": false,
        "topics": [
            "access"
        ]
    }
},
"config": {}
}
},
{
    "name": "SystemAndEnvSecretStore-1",
    "type": "SystemAndEnvSecretStore"
},
{
    "name": "AmService-1",
    "type": "AmService",
    "config": {
        "agent": {
            "username": "ig_agent",
            "passwordSecretId": "agent.secret.id"
        },
        "secretsProvider": "SystemAndEnvSecretStore-1",
        "url": "http://am.example.com:8088/openam/"
    }
}
],
"auditService": "AuditService",
"handler": {
    "type": "Chain",
    "config": {
        "filters": [
            {
                "name": "SingleSignOnFilter-1",
                "type": "SingleSignOnFilter",
                "config": {
                    "amService": "AmService-1"
                }
            },
            {
                "type": "ScriptableFilter",
                "config": {

```

```

        "file" : "InjectUserIdSso.groovy",
        "type": "application/x-groovy"
    }
}
],
"handler": "ReverseProxyHandler"
}
}
}

```

Notice the following features of the route compared to `sso.json`:

- The route matches requests to `/home/audit-sso`.
- An audit service is included to publish access log messages to standard output.
- The chain includes a scriptable filter that refers to `InjectUserIdSso.groovy`.

3. Test the setup:

- In your browser's privacy or incognito mode, go to <https://ig.example.com:8443/home/audit-sso>. The `SingleSignOnFilter` redirects the request to AM for authentication.
- Log in to AM as user `demo`, password `Ch4ng31t`, and then allow the application to access user information.

The profile page of the sample application is displayed. The script captures the user ID from the session, and the audit service includes it with the audit event.

- Search the standard output for a message like this, containing the user ID:

```

{
  "_id": "23a...-23",
  "timestamp": "...",
  "eventName": "OPENIG-HTTP-ACCESS",
  "transactionId": "23a...-22",
  "userId":
  "id=demo,ou=user,dc=openam,dc=forgerock,dc=org",
  "client": {
    "ip": "0:0:0:0:0:0:0:1",
    "port": 57843
  },
  "server": {
    "ip": "0:0:0:0:0:0:0:1",
    "port": 8080
  },
  "http": {
    "request": {

```

```

        "secure": false,
        "method": "GET",
        "path": "http://ig.example.com/home/audit-sso",
        "headers": {
            "accept":
["text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,/;q=0.8"],
            "host": ["ig.example.com:8080"],
            "user-agent": [...]
        }
    },
    "response": {
        "status": "SUCCESSFUL",
        "statusCode": "200",
        "elapsedTime": 276,
        "elapsedTimeUnits": "MILLISECONDS"
    },
    "ig": {
        "exchangeId": "1dc...-26",
        "routeId": "audit-sso",
        "routeName": "audit-sso"
    },
    "source": "audit",
    "topic": "access",
    "level": "INFO"
}

```

Record user ID in audit logs after OpenID connect authentication

Before you start, set up and test the example in [AM as OIDC provider](#).

1. Set up the script:

a. Add the following example script to PingGateway:

Linux

Windows

```
$HOME/.openig/scripts/groovy/InjectUserIdOpenId.groovy
```

```
package scripts.groovy
```

```
import org.forgerock.services.context.AttributesContext
```

```

import org.forgerock.services.context.RequestAuditContext

/**
 * Sample script implementation supporting user id
 * injection in an OpenId scenario.
 * This sample captures the user id and injects it into
 * the RequestAuditContext for
 * later use when the audit event is written.
 *
 * This ScriptableFilter should be added in the filter
 * chain at whatever point the
 * desired user id is available - e.g. after OpenId client
 * authentication (in the
 * OAuth2 authentication filter chain) - as follows:
 *
 * "handler" : {
 *   "type" : "Chain",
 *   "config" : {
 *     "filters" : [ {
 *       "type" : "OAuth2ClientFilter",
 *       "config" : {
 *         ...
 *         "target" : "${attributes.target}",
 *         "registrations" : [
 * ClientRegistrationWithOpenIdScope" ],
 *       }
 *     }, {
 *       "type" : "ScriptableFilter",
 *       "config" : {
 *         "file" : "InjectUserIdOpenId.groovy",
 *         "type": "application/x-groovy"
 *       }
 *     } ],
 *   "handler" : "display-user-info-groovy-handler"
 * }
 * }
 *
 * The ClientRegistration associated with the above
 * OAuth2ClientFilter config will
 * require the 'openid' scope. The OAuth2SessionContext is
 * guaranteed to exist and
 * be populated on successful authentication. The userinfo
 * will then be populated
 * according to the OAuth2ClientFilter OpenId 'target'
 * configuration (e.g. in this

```

```

    * sample, on the AttributesContext). The 'target'
referenced will be populated
    * with a 'user_info' JSON value containing the userinfo.
It should be noted that
    * the OAuth2ClientFilter 'target' config is a config-time
expression, and cannot
    * be used in a ScriptableFilter to read runtime data. The
RequestAuditContext is
    * also guaranteed to be available.
    *
    * Implementors may decide which 'user_info' field to
capture in the audit event:
    * - The userinfo 'sub' field is the user's "complex" ID
marked with a type - e.g.
    *   "(usr!bonnie)".
    * - The userinfo 'subName' field is the user's username
(or resource name) - e.g.
    *   "bonnie".
    * - To capture the universalId (consistent with the
session info universalId),
    *   it is necessary to configure AM to provide it as a
claim in the id-token. To
    *   do this, edit the OIDC Claims Script to include the
following line just prior
    *   to the UserInfoClaims creation:
    *       computedClaims["universalId"] =
identity.universalId
    * - This will include 'universalId' in the userinfo which
we can use with audit
    *   e.g.
    "id=bonnie,ou=user,o=myrealm,ou=services,dc=openam,dc=forg
erock,dc=org"
    *
    * Additional error handling may be required.
    *
    * @see RequestAuditContext
    * @see AttributesContext
    */

```

```

def requestAuditContext =
context.asContext(RequestAuditContext.class)
def attributesContext =
context.asContext(AttributesContext.class)

```

```

// The OAuth2ClientFilter captures userinfo based on its

```

```

'target' configuration.
// In this sample 'target' is configured as the
AttributesContext with key "target".
// We can query this for 'user_info' values: 'sub',
'subName' or anything else
// made available via the OIDC Claims Script (see above).
def oauth2UserInfo =
attributesContext.getAttributes().get("target")
requestAuditContext.setUserId(oauth2UserInfo.get("user_info").get("sub"))

// Propagate the request to the next filter/ handler in
the chain
next.handle(context, request)

```

The script captures the user ID from the AuthorizationCodeOAuth2ClientFilter target object, by default at `${attributes.openid}`, and injects it into the RequestAuditContext so that it is available when the audit event is written.

b. Edit the script to get the attributes from the openid target:

Replace `attributesContext.getAttributes().get("target")`

with `attributesContext.getAttributes().get("openid")`.

2. Replace `07-openid.json` with the following route:

Linux

Windows

```
$HOME/.openid/config/routes/audit-oidc.json
```

```

{
  "name": "audit-oidc",
  "baseURI": "http://app.example.com:8081",
  "condition": "${find(request.uri.path, '^/home/id_token')}",
  "heap": [
    {
      "name": "AuditService",
      "type": "AuditService",
      "config": {
        "eventHandlers": [
          {
            "class":
"org.forgerock.audit.handlers.json.stdout.JsonStdoutAuditEvent
Handler",

```



```

        "config": {
            "name": "jsonstdout",
            "elasticsearchCompatible": false,
            "topics": [
                "access"
            ]
        }
    },
    ],
    "config": {}
}
},
{
    "name": "SystemAndEnvSecretStore-1",
    "type": "SystemAndEnvSecretStore"
}
],
"auditService": "AuditService",
"handler": {
    "type": "Chain",
    "config": {
        "filters": [
            {
                "name": "AuthorizationCodeOAuth2ClientFilter-1",
                "type": "AuthorizationCodeOAuth2ClientFilter",
                "config": {
                    "clientEndpoint": "/home/id_token",
                    "failureHandler": {
                        "type": "StaticResponseHandler",
                        "config": {
                            "status": 500,
                            "headers": {
                                "Content-Type": [
                                    "text/plain"
                                ]
                            }
                        },
                        "entity": "Error in OAuth 2.0 setup."
                    }
                }
            },
        ],
        "registrations": [
            {
                "name": "oidc-user-info-client",
                "type": "ClientRegistration",
                "config": {
                    "clientId": "oidc_client",

```

```

        "clientId": "oidc.secret.id",
        "issuer": {
            "name": "Issuer",
            "type": "Issuer",
            "config": {
                "wellKnownEndpoint":
"http://am.example.com:8088/openam/oauth2/.well-known/openid-
configuration"
            }
        },
        "scopes": [
            "openid",
            "profile",
            "email"
        ],
        "secretsProvider": "SystemAndEnvSecretStore-
1",
        "tokenEndpointAuthMethod":
"client_secret_basic"
    },
    {
        "type": "ScriptableFilter",
        "config": {
            "file": "InjectUserIdOpenId.groovy",
            "type": "application/x-groovy"
        }
    },
    {
        "handler": "ReverseProxyHandler"
    }
}

```

Notice the following features of the route compared to 07-openid.json :

- An audit service is included to publish access log messages to standard output.
- The chain includes a scriptable filter that refers to `InjectUserIdOpenId.groovy`.

3. Test the setup:

- a. In your browser's privacy or incognito mode, go to https://ig.example.com:8443/home/id_token. The AM login page is displayed.
- b. Log in to AM as user `demo`, password `Ch4ng31t`, and then allow the application to access user information.

The home page of the sample application is displayed. The script captures the user ID from the `openid` target, and the audit service includes it with the audit event.

- c. Search the standard output for a message like this, containing the user ID:

```
{
  "_id": "b64...-25",
  "timestamp": "2021...",
  "eventName": "OPENIG-HTTP-ACCESS",
  "transactionId": "b64...-24",
  "userId": "(usr!demo)",
  "client": {
    "ip": "0:0:0:0:0:0:1",
    "port": 64443
  },
  "server": {
    "ip": "0:0:0:0:0:0:1",
    "port": 8080
  },
  "http": {
    "request": {
      "secure": false,
      "method": "GET",
      "path": "http://ig.example.com:8080/home/id_token",
      "headers": {
        "accept":
["text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,/;q=0.8"],
        "host": ["ig.example.com:8080"],
        "user-agent": [...]
      }
    }
  },
  "response": {
    "status": "SUCCESSFUL",
    "statusCode": "200",
    "elapsedTime": 199,
    "elapsedTimeUnits": "MILLISECONDS"
  },
}
```

```

"ig": {
  "exchangeId": "1dc...-26",
  "routeId": "audit-oidc",
  "routeName": "audit-oidc"
},
"source": "audit",
"topic": "access",
"level": "INFO"
}

```

Record user ID in audit logs after SAML authentication

IMPORTANT

This example uses the deprecated `SamlFederationHandler`. The `SamlFederationHandler` is replaced by the [SamlFederationFilter](#) and will be removed in a future release.

Before you start, set up and test the `SamlFederationHandler` example under [SAML](#).

1. Set up the script:
 - a. Add the following example script to PingGateway:

Linux

Windows

```
$HOME/.openig/scripts/groovy/InjectUserIdSaml.groovy
```

```
package scripts.groovy
```

```
import org.forgerock.http.session.SessionContext
```

```
import org.forgerock.services.context.RequestAuditContext
```

```
/**
```

```
 * Sample ScriptableFilter implementation to capture the
 * user id obtained from a
```

```
 * SAML assertion. The IG SamlFederationHandler captures
 * this and locates it on
```

```
 * the SessionContext with the key as the configured SAML
 * 2 user id key. We then
```

```
 * take this and inject it into the RequestAuditContext
 * for later use when the
```

```
 * audit event is written.
```

```
 *
```

```

* This ScriptableFilter should be added in the filter
chain together with the
* SamlFederationHandler, as follows. Note that the
InjectUserIdSaml.groovy script
* operates on the response, injecting the userId as
captured by the handler.
*
* {
*     "condition" :
"${matches(request.uri.path, '^/api/saml')}",
*     "handler" : {
*         "type" : "Chain",
*         "config" : {
*             "filters" : [ {
*                 "type" : "ScriptableFilter",
*                 "config" : {
*                     "file" : "InjectUserIdSaml.groovy",
*                     "type": "application/x-groovy"
*                 }
*             } ],
*         "handler" : {
*             "name" : "saml_handler_SP0ne",
*             "type" : "SamlFederationHandler",
*             "config" : {
*                 "assertionMapping" : {
*                     "SP0ne_userName" : "uid",
*                     "SP0ne_password" : "mail"
*                 },
*                 "redirectURI" : "/api/home",
*                 "logoutURI" :
"http://openig.example.com:8082/api/after_logout",
*                 "subjectMapping" :
"SubjectName_SP0ne",
*                 "authnContext" :
"AuthnContext_SP0ne",
*                 "sessionIndexMapping" :
"SessionIndex_SP0ne"
*             }
*         }
*     }
* }
*
* The SessionContext and RequestAuditContext are
guaranteed to be available and the

```

```

    * SessionContext will have been populated with userinfo
    on successful authentication.
    *
    * Implementors may decide which user id field to capture
    in the audit event:
    * - This should be based on SAML attribute mappings and/
    or the subject mapping (if
    *   transient names are not used).
    * - Other attributes are available, such as 'uid' and
    'userName', though it must be
    *   noted that there is an expectation that the IDP makes
    available the user id.
    * - In this sample, 'SPOne_userName' maps to the 'uid'.
    *
    * Additional error handling may be required.
    *
    * @see RequestAuditContext
    * @see SessionContext
    */

// Propagate the request to the next filter/ handler in
the chain
next.handle(context, request)
    .then({ response ->
        def requestAuditContext =
context.asContext(RequestAuditContext.class)
        def sessionContext =
context.asContext(SessionContext.class)

        // Inject the user id as captured by the
SamlFederationHandler

requestAuditContext.setUserId(sessionContext.getSession().
get("SPOne_userName"))
        return response
    })

```

The script captures the user ID from the SessionContext subject or attribute mappings, provided by the SamlFederationHandler from the inbound assertions. It injects the user ID into the RequestAuditContext so that it is available when the audit event is written.

b. Replace `get("SPOne_userName"))` with `get("username"))`.

The script captures the user ID from the assertionMapping username, which is mapped in the route to cn.

2. Replace `saml.json` with the following route:

Linux	Windows
<pre>\$HOME/.openig/config/routes/audit-saml.json</pre>	

```
{
  "name": "audit-saml",
  "condition": "${find(request.uri.path, '^/saml')}",
  "heap": [
    {
      "name": "AuditService",
      "type": "AuditService",
      "config": {
        "eventHandlers": [
          {
            "class":
"org.forgerock.audit.handlers.json.stdout.JsonStdoutAuditEvent
Handler",
            "config": {
              "name": "jsonstdout",
              "elasticsearchCompatible": false,
              "topics": [
                "access"
              ]
            }
          }
        ],
        "config": {}
      }
    },
    {
      "name": "AuditService",
      "type": "Chain",
      "config": {
        "filters": [
          {
            "type": "ScriptableFilter",
            "config": {
              "file": "InjectUserIdSaml.groovy",
              "type": "application/x-groovy"
            }
          }
        ]
      }
    }
  ]
}
```



```

"server": {
  "ip": "0:0:0:0:0:0:1",
  "port": 8080
},
"http": {
  "request": {
    "secure": false,
    "method": "POST",
    "path":
"http://sp.example.com:8080/saml/fedletapplication/metaAli
as/sp",
    "headers": {
      "accept":
["text/html,application/xhtml+xml,application/xml;q=0.9,im
age/webp,/;q=0.8"],
      "content-type": ["application/x-www-form-
urlencoded"],
      "host": ["sp.example.com:8080"],
      "user-agent": [...]
    }
  },
  "response": {
    "status": "SUCCESSFUL",
    "statusCode": "302",
    "elapsedTime": 2112,
    "elapsedTimeUnits": "MILLISECONDS"
  },
  "ig": {
    "exchangeId": "1dc...-26",
    "routeId": "audit-saml",
    "routeName": "audit-saml"
  },
  "source": "audit",
  "topic": "access",
  "level": "INFO"
}

```

Monitor services

This page describes how to set up and maintain monitoring in your deployment.

Push to an OpenTelemetry service

PingGateway can push traces to an [OpenTelemetry](#) Protocol (OTLP) endpoint over HTTP. When you use it with other applications with OpenTelemetry support, the service helps you analyze the flows through PingGateway and the other applications to understand performance and system behavior.

IMPORTANT

This capability is available in [Technology preview](#). It isn't yet supported, may be functionally incomplete, and is subject to change without notice.

OpenTelemetry support is disabled by default. Enable it with the "openTelemetry" setting in `AdminHttpApplication(admin.json)`. Make sure the OTLP exporter targets the endpoint for the OpenTelemetry service in your deployment. The following example targets the default endpoint:

```
{
  "openTelemetry": {
    "tracing": {
      "enabled": true,
      "exporter": {
        "type": "otlp",
        "config": {
          "endpoint": "http://localhost:4318/v1/traces"
        }
      }
    }
  }
}
```

When tracing is enabled, traces always span requests entering PingGateway and any requests started by PingGateway; for example, proxied requests to the sample application. The span ends when PingGateway receives or returns a response or when an error arises during processing. If a `ClientHandler` or `ReverseProxyHandler` has the retry feature enabled, PingGateway records the number of retries as a `http.request.resend_count` span attribute in the trace.

Trace sampling is `alwaysOn` by default, meaning PingGateway samples every operation. Adjust this in the configuration settings as required for your deployment and traffic.

Use the `"tracing": true` decoration on other configuration objects or in `"globalDecorators"` to activate additional tracing points.

Access the monitoring endpoints

All ForgeRock products automatically expose a monitoring endpoint to expose metrics in a standard Prometheus format, and as a JSON format monitoring resource.

In PingGateway, metrics are available for each router, subrouter, and route in the configuration. When a TimerDecorator is configured, timer metrics are also available.

Learn more about PingGateway monitoring endpoints and available metrics in [Monitoring](#).

Monitor at the Prometheus Scrape Endpoint

NOTE

Prometheus metric names are deprecated and expected to be replaced with names ending in `_total`. The information provided by the metric is not deprecated. Other Prometheus metrics aren't affected.

All ForgeRock products automatically expose a monitoring endpoint where Prometheus can scrape metrics, in a standard Prometheus format.

When PingGateway is set up as described in the [Quick install](#), the Prometheus Scrape Endpoint is available at the following endpoints:

- <http://ig.example.com:8080/openig/metrics/prometheus/0.0.4>
- <http://ig.example.com:8080/openig/metrics/prometheus> (deprecated)

By default, no special setup or configuration is required to access metrics at these endpoints. The following example queries the Prometheus Scrape Endpoint for a route.

Tools such as Grafana are available to create customized charts and graphs based on the information collected by Prometheus. You can find more information on installing and running Grafana on [the Grafana website](#).

1. Set up PingGateway:

- Set up PingGateway for HTTPS, as described in [Configure PingGateway for TLS \(server-side\)](#).
- Add the following route to PingGateway:

Linux

Windows

```
$HOME/.openig/config/routes/myroute1.json
```

```
{
  "name": "myroute1",
  "handler": {
    "type": "StaticResponseHandler",
    "config": {
```

```

        "status": 200,
        "headers": {
            "Content-Type": [ "text/plain; charset=UTF-8" ]
        },
        "entity": "Hello world, from myroute1!"
    }
},
"condition": "${find(request.uri.path, '^/myroute1')}"
}

```

The route contains a StaticResponseHandler to display a simple message.

2. Test the setup:

- a. Access the route a few times, on <https://ig.example.com:8443/myroute1>.
- b. Query the Prometheus Scrape Endpoint:

```

$ curl -v \
--cacert /path/to/secrets/ig.example.com-certificate.pem \
https://ig.example.com:8443/openig/metrics/prometheus/0.0.
4

```

Metrics for myroute1 and _router are displayed.

Vert.x monitoring is enabled by default to provide additional metrics for HTTP, TCP, and the internal component pool. The metrics provide low-level information about requests and responses, such as the number of bytes, duration, and the number of concurrent requests.

Monitor the Common REST Monitoring Endpoint (deprecated)

All ForgeRock products expose a monitoring endpoint where metrics are exposed as a JSON format monitoring resource.

When PingGateway is set up as described in [Quick install](#), the Common REST Monitoring Endpoint is available at https://ig.example.com:8443/openig/metrics/api?_prettyPrint=true&_sortKeys=_id&_queryFilter=true

By default, no special setup or configuration is required to access metrics at this endpoint. The following example queries the Common REST Monitoring Endpoint for a route, and restricts the query to specific metrics only.

Before you start, prepare PingGateway as described in the [Quick install](#).

1. Set up PingGateway and some example routes, as described in the first few steps of Monitor the Prometheus Scrape Endpoint.

2. Query the Common REST Monitoring Endpoint:

```
$ curl "https://ig.example.com:8443/openig/metrics/api?_prettyPrint=true&_sortKeys=_id&_queryFilter=true"
```

Metrics for myroute1 and _router are displayed:

```
{
  "result" : [ {
    "_id" : "gateway._router.deployed-routes",
    "value" : 1.0,
    "_type" : "gauge"
  }, {
    "_id" : "gateway._router.route.default.request",
    "count" : 204,
    "_type" : "counter"
  }, {
    "_id" : "gateway._router.route.default.request.active",
    "value" : 0.0,
    "_type" : "gauge"
  }, {
    "...": "...",
    "_id" :
"gateway._router.route.myroute1.response.status.unknown",
    "count" : 0,
    "_type" : "counter"
  }, {
    "_id" : "gateway._router.route.myroute1.response.time",
    "count" : 204,
    "max" : 0.420135,
    "mean" : 0.08624678327176545,
    "min" : 0.045079999999999995,
    "p50" : 0.070241,
    "p75" : 0.096049,
    "p95" : 0.178534,
    "p98" : 0.227217,
    "p99" : 0.242554,
    "p999" : 0.420135,
    "stddev" : 0.046611762381930474,
    "m15_rate" : 0.2004491450567003,
    "m1_rate" : 2.8726563452698075,
    "m5_rate" : 0.5974045160056258,
    "mean_rate" : 0.010877725092634833,
    "duration_units" : "milliseconds",
```

```

    "rate_units" : "calls/second",
    "total" : 17.721825,
    "_type" : "timer"
  } ],
  "resultCount" : 11,
  "pagedResultsCookie" : null,
  "totalPagedResultsPolicy" : "EXACT",
  "totalPagedResults" : 11,
  "remainingPagedResults" : -1
}

```

Vert.x monitoring is enabled by default to provide additional metrics for HTTP, TCP, and the internal component pool. The metrics provide low-level information about requests and responses, such as the number of bytes, duration, the number of concurrent requests, and so on.

3. Change the query to access metrics only for `myroute1` :

`https://ig.example.com:8443/openig/metrics/api?_prettyPrint=true&_sortKeys=_id&_queryFilter=_id+sw+"gateway._router.route.myroute1"` ↗;

Note that metric for the router, `"_id" : "gateway._router.deployed-routes"`, is no longer displayed.

Monitor Vert.x metrics

NOTE

Vert.x metric names are deprecated and expected to be replaced with names ending in `_total`. The information provided by the metric is not deprecated. Other Prometheus metrics aren't affected.

Vert.x monitoring is enabled by default to provide metrics for HTTP, TCP, and the internal component pool. The metrics provide low-level information about requests and responses, such as the number of bytes, duration, the number of concurrent requests, and so on.

To disable Vert.x monitoring, add the following settings to `admin.json` and restart PingGateway:

```

{
  "vertx": {
    "metricsEnabled": false
  }
}

```

Protect monitoring endpoints

By default, no special credentials or privileges are required for read-access to the Prometheus Scrape Endpoint and Common REST Monitoring Endpoint.

To override this behavior, define an "metricsProtectionFilter" in `admin.json`. The following procedure gives an example of how to manage access to the monitoring endpoints.

1. Set up the procedure in Monitor at the Prometheus Scrape Endpoint, query the Prometheus Scrape Endpoint, and note that metrics for `myroute1` and `_router` are displayed:

```
$ curl -v  
"https://ig.example.com:8443/openig/metrics/prometheus"
```

2. Add the following script to the PingGateway configuration:

Linux

Windows

```
$HOME/.openig/scripts/groovy/BasicAuthResourceServerFilter  
.groovy
```

```
/*  
 * This script is a simple implementation of HTTP basic access  
 authentication on  
 * server side.  
 * It expects the following arguments:  
 * - realm: the realm to display when the user agent prompts  
 for  
 *   username and password if none were provided.  
 * - username: the expected username  
 * - passwordSecretId: the secretId to find the password  
 * - secretsProvider: the SecretsProvider to query for the  
 password  
 */  
  
import static  
org.forgerock.util.promise.Promises.newResultPromise;  
  
import java.nio.charset.Charset;  
import org.forgerock.util.encode.Base64;  
import org.forgerock.secrets.Purpose;  
import org.forgerock.secrets.GenericSecret;
```

```

String authorizationHeader =
request.getHeaders().getFirst("Authorization");
if (authorizationHeader == null) {
    // No credentials provided, return 401 Unauthorized
    Response response = new Response(Status.UNAUTHORIZED);
    response.getHeaders().put("WWW-Authenticate", "Basic
realm=\"\" + realm + "\"");
    return newResultPromise(response);
}

return secretsProvider.getNamed(Purpose.PASSWORD,
passwordSecretId)
    .thenAsync(password -> {
        // Build basic authentication string ->
        username:password
        StringBuilder basicAuthString = new
StringBuilder(username).append(":");
        password.revealAsUtf8{ p ->
basicAuthString.append(new String(p).trim()) };
        String expectedAuthorization = "Basic " +
Base64.encode(basicAuthString.toString().getBytes(Charset.defaultCharset()));
        // Incorrect credentials provided, return 403
        forbidden
        if
(!expectedAuthorization.equals(authorizationHeader)) {
            return newResultPromise(new
Response(Status.FORBIDDEN));
        }
        // Correct credentials provided, continue.
        return next.handle(context, request);
    },
        noSuchSecretException -> { throw new
RuntimeException(noSuchSecretException); });

```

The script is a simple implementation of the HTTP basic access authentication scheme. For information about scripting filters and handlers, refer to [Extend](#).

3. Add a "metricsProtectionFilter" setting in admin.json:

```

{
    ...,
    "heap": [
        {

```



```

    "name": "ClientHandler",
    "type": "ClientHandler"
  },
  {
    "name": "mySecretsProvider",
    "type": "Base64EncodedSecretStore",
    "config": {
      "secrets": {
        "password.secret.id": "cGFzc3dvcmQ="
      }
    }
  }
],
"metricsProtectionFilter": {
  "type": "ScriptableFilter",
  "config": {
    "type": "application/x-groovy",
    "file": "BasicAuthResourceServerFilter.groovy",
    "args": {
      "realm": "/",
      "username": "myUsername",
      "passwordSecretId": "password.secret.id",
      "secretsProvider": "${heap['mySecretsProvider']}"
    }
  }
},
...
}

```

Notice the following features of the configuration:

- The filter uses the script to protect the monitoring endpoint.
- The filter requires the username `myUsername` and a password provided by the `SecretsProvider` in the heap.

4. Restart PingGateway.

5. Query the Prometheus Scrape Endpoint without providing credentials, and note that an HTTP 401 Unauthorized is returned:

```

$ curl -v
"https://ig.example.com:8443/openig/metrics/prometheus"

```

6. Query the Prometheus Scrape Endpoint by providing correct credentials, and note that metrics are displayed:

```
$ curl -v  
"https://ig.example.com:8443/openig/metrics/prometheus" -u  
myUsername:password
```

7. Query the Prometheus Scrape Endpoint by providing incorrect credentials, and note that an HTTP 403 Forbidden is returned:

```
$ curl -v  
"https://ig.example.com:8443/openig/metrics/prometheus" -u  
myUsername:wrong-password
```

Manage sessions

Learn about PingGateway sessions in [Sessions](#).

Change PingGateway session configurations using the "session" in the [AdminHttpApplication\(admin.json \)](#) for administrative requests and the [GatewayHttpApplication\(config.json \)](#) or individual [Route](#) for other requests:

- Change the default stateful session settings by configuring an [InMemorySessionManager](#).
- Switch to stateless sessions by configuring a [JwtSessionManager](#).

Manage logs

Log messages in PingGateway and third-party dependencies are recorded using the Logback implementation of the Simple Logging Facade for Java (SLF4J) API. The following log levels are supported:

- TRACE
- DEBUG
- INFO
- WARN
- ERROR
- ALL
- OFF

You can find a full description of the options for logging in [the Logback website](#)[↗].

Default logging behavior

By default, log messages are recorded with the following configuration:

- When PingGateway starts, log messages for PingGateway and third-party dependencies, such as the ForgeRock Common Audit framework, are displayed on the console and written to `$HOME/.openig/logs/route-system.log`, where `$HOME/.openig` is the instance directory.
- When a capture point for the default CaptureDecorator is defined in a route, for example, when `"capture: "all"` is set as a top-level attribute of the JSON, log messages for requests and responses passing through the route are written to a log file in `$HOME/.openig/logs`.

When no capture point is defined in a route, only exceptions thrown during request or response processing are logged.

You can find more information in [Capturing log messages for routes and CaptureDecorator](#).

- By default, log messages with the level `INFO` or higher are recorded, with the titles and the top line of the stack trace. Messages on the console are highlighted with a color related to their log level.

The content and format of logs in PingGateway is defined by the reference `logback.xml` delivered with PingGateway. This file defines the following configuration items for logs:

- A root logger to set the overall log level, and to write all log messages to the `SIFT` and `STDOUT` appenders.
- A `STDOUT` appender to define the format of log messages on the console.
- A `SIFT` appender to separate log messages according to the key `routeId`, to define when log files are rolled, and to define the format of log messages in the file.
- An exception logger, called `LogAttachedExceptionFilter`, to write log messages for exceptions attached to responses.

```
<?xml version="1.0" encoding="UTF-8"?>
<configuration>

  <!--
    Prevent log flow attacks, by limiting repeated log messages.

    Configuration properties:
    * AllowedRepetitions (int): Threshold above which repeated
    messages are no longer logged.
    * CacheSize (int): When CacheSize is reached, remove the
```

```

oldest entry.
-->
<!--<turboFilter
class="ch.qos.logback.classic.turbo.DuplicateMessageFilter" />-->

<!-- Allow configuration of JUL loggers within this file,
without performance impact -->
<contextListener
class="ch.qos.logback.classic.jul.LevelChangePropagator" />

<appender name="STDOUT"
class="ch.qos.logback.core.ConsoleAppender">
  <withJansi>true</withJansi>
  <encoder>
    <pattern>%nopex[%thread] %highlight(%-5level)
%boldWhite(%logger{35}) @%mdc{routeId:-system} -
%replace(%message){'([\r\n])(.)',
'$1[CONTINUED]$2'}%n%highlight(%replace(%rootException{short})
{'(^|[\r\n])(.)', '$1[CONTINUED]$2'})</pattern>
  </encoder>
</appender>

<appender name="SIFT"
class="ch.qos.logback.classic.sift.SiftingAppender">
  <discriminator>
    <key>routeId</key>
    <defaultValue>system</defaultValue>
  </discriminator>
  <sift>
    <!-- Create a separate log file for each <key> -->
    <appender name="FILE-${routeId}"
class="ch.qos.logback.core.rolling.RollingFileAppender">
      <file>${instance.dir}/logs/route-${routeId}.log</file>

      <rollingPolicy
class="ch.qos.logback.core.rolling.SizeAndTimeBasedRollingPolicy">
        <!-- Rotate files daily -->
        <fileNamePattern>${instance.dir}/logs/route-${routeId}-
%d{yyyy-MM-dd}.%i.log</fileNamePattern>

        <!-- each file should be at most 100MB, keep 30 days
worth of history, but at most 3GB -->
        <maxFileSize>100MB</maxFileSize>
        <maxHistory>30</maxHistory>
        <totalSizeCap>3GB</totalSizeCap>

```

```

        </rollingPolicy>

        <encoder>
            <pattern>%nopex%date{"yyyy-MM-dd'T'HH:mm:ss,SSSXXX",
UTC} | %-5level | %thread | %logger{20} | @%mdc{routeId:-system} |
%replace(%message%n%xException){'([\r\n])(.)', '$1[CONTINUED]$2'}
</pattern>
        </encoder>
    </appender>
</sift>
</appender>

    <!-- Disable logs of exceptions attached to responses by
defining 'level' to OFF -->
    <logger
name="org.forgerock.openig.filter.LogAttachedExceptionFilter"
level="INHERITED" />

    <root level="${ROOT_LOG_LEVEL:-INFO}">
        <appender-ref ref="SIFT" />
        <appender-ref ref="STDOUT" />
    </root>
</configuration>

```

Using a custom Logback file

To change the logging behavior, create a new logback file at `$HOME/.openig/config/logback.xml`, and restart PingGateway. The custom Logback file overrides the default configuration.

To take into account edits to `logback.xml`, stop and restart PingGateway, or edit the `configuration` parameter to add a scan and an interval:

```
<configuration scan="true" scanPeriod="5 seconds">
```

The `logback.xml` file is scanned after both of the following criteria are met:

- The specified number of logging operations have occurred, where the default is 16.
- The `scanPeriod` has elapsed.

If the custom `logback.xml` contains errors, messages like these are displayed on the console but log messages aren't recorded:

```
14:38:59,667 |-ERROR in
ch.qos.logback.core.joran.spi.Interpreter@20:72 ...
14:38:59,690 |-ERROR in
ch.qos.logback.core.joran.action.AppenderRefAction ...
```

Change the global log level

The global log level is set by default to `INFO` by the following line of the default `logback.xml`:

```
<root level="${ROOT_LOG_LEVEL:-INFO}">
```

The log level set in `logback.xml` supercedes the log level set by environment variables. When the global log level is not set in `logback.xml`, set the global log level.

- To persist the log level for all future PingGateway instances:
 - Add an environment variable in `$HOME/.openig/bin/env.sh`, where `$HOME/.openig` is the instance directory:

```
export ROOT_LOG_LEVEL=DEBUG
```

- Alternatively, add a system property in `$HOME/.openig/bin/env.sh`, where `$HOME/.openig` is the instance directory:

```
export JAVA_OPTS="-DROOT_LOG_LEVEL=DEBUG"
```

If both an environment variable and system property is set, the system property takes precedence.

- To persist the log level for PingGateway instances launched from the same shell, add an environment variable in the shell before you start PingGateway:

Linux	Windows
<pre>\$ export ROOT_LOG_LEVEL=DEBUG \$ /path/to/identity-gateway-2024.11.0/bin/start.sh \$HOME/.openig</pre>	

- To persist the log level for a single PingGateway instance:

Linux	Windows
-------	---------

```
$ export ROOT_LOG_LEVEL=DEBUG /path/to/identity-gateway-2024.11.0/bin/start.sh $HOME/.openig
```

Change the log level for different object types

To change the log level for a single object type without changing it for the rest of the configuration, edit `logback.xml` to add a logger defined by the fully qualified class name or package name of the object and set its log level.

The following line in `logback.xml` sets the `ClientHandler` log level to `ERROR`, but doesn't change the log level of other classes or packages:

```
<logger name="org.forgerock.openig.handler.ClientHandler"
level="ERROR" />
```

To facilitate debugging, in `logback.xml` add loggers defined by the fully qualified package name or class name of the object. For example, add loggers for the following feature:

Feature	Logger
OAuth 2.0 client authentication: <ul style="list-style-type: none">AuthorizationCodeOAuth2ClientFilterClientCredentialsOAuth2ClientFilterResourceOwnerOAuth2ClientFilter	<code>org.forgerock.secrets.oauth2</code>
Expression resolution	<code>org.forgerock.openig.el</code> <code>org.forgerock.openig.resolver</code>
WebSocket notifications	<code>org.forgerock.openig.tools.notifications.ws</code>
Stateless session management	<code>org.forgerock.openig.jwt</code>
OAuth 2.0 and OpenID Connect and token resolution and validation	<code>org.forgerock.openig.filter.oauth2</code>
AM policies, SSO, CDSSO, and user profiles	<code>org.forgerock.openig.openam</code> <code>org.forgerock.openig.tools</code>

Feature	Logger
SAML	<code>org.forgerock.openig.handler.saml</code>
UMA	<code>org.forgerock.openig.uma</code>
WebSocket tunnelling	<code>org.forgerock.openig.websocket</code>
Secret resolution	<code>org.forgerock.secrets.jwkset</code> <code>org.forgerock.secrets.keystore</code> <code>org.forgerock.secrets.oauth2</code> <code>org.forgerock.secrets.propertyresolver</code> <code>org.forgerock.openig.secrets.Base64EncodedSecretStore</code>
AllowOnlyFilter	<code>org.forgerock.openig.filter.allow.AllowOnlyFilter.<filter_name></code>
Condition of a route	<code>org.forgerock.openig.handler.router.RouterHandler</code>
Header field size	<code>io.vertx.core.http.impl.HttpServerImpl</code>

Change the character set and format of log messages

By default, logs use the system default character set where PingGateway is running.

TIP

If your logs might contain characters that aren't in your system character set, edit `logback.xml` to change the `encoder` part of the SIFT appender.

The following lines add the date to log messages and change the character set:

```
<encoder>
  <pattern>%d{yyyyMMdd-HH:mm:ss} | %-5level | %thread |
%logger{20} | %message%n%xException</pattern>
  <charset>UTF-8</charset>
</encoder>
```


Learn more about what information you can include in the logs and its format in [PatternLayoutEncoder](#) and [Layouts](#) in the Logback documentation.

Log in scripts

The `logger` object provides access to a unique SLF4J logger instance for scripts. Events are logged as defined in by a dedicated logger in `logback.xml` and are included in the logs with the name of with the scriptable object.

To log events for scripts:

- Add logger objects to the script to enable logging at different levels. For example, add some of the following logger objects:

```
logger.error("ERROR")
logger.warn("WARN")
logger.info("INFO")
logger.debug("DEBUG")
logger.trace("TRACE")
```

- Add a logger to `logback.xml` to reference the scriptable object and set the log level. The logger is defined by the type and name of the scriptable object that references the script, as follows:
 - ScriptableFilter:
`org.forgerock.openig.filter.ScriptableFilter.filter_name`
 - ScriptableHandler:
`org.forgerock.openig.handler.ScriptableHandler.handler_name`
 - ScriptableThrottlingPolicy:
`org.forgerock.openig.filter.throttling.ScriptableThrottlingPolicy.throttling_policy_name`
 - ScriptableAccessTokenResolver:
`org.forgerock.openig.filter.oauth2.ScriptableAccessTokenResolver.access_token_resolver_name`

For example, the following logger logs trace-level messages for a ScriptableFilter named `cors_filter`:

```
<logger
name="org.forgerock.openig.filter.ScriptableFilter.cors_filter"
level="TRACE" />
```

The resulting messages in the logs contain the name of the scriptable object:

```
14:54:38:307 | TRACE | http-nio-8080-exec-6 |  
o.f.o.f.S.cors_filter | TRACE
```

Log the BaseUriDecorator

During setup and configuration, it can be helpful to display log messages from the BaseUriDecorator. To record a log message each time a request URI is rebased, edit `logback.xml` to add a logger defined by the fully qualified class name of the BaseUriDecorator appended by the name of the baseURI decorator:

```
<logger  
name="org.forgerock.openig.decoration.baseuri.BaseUriDecorator.baseURI" level="TRACE" />
```

Each time a request URI is rebased, a log message similar to this is created:

```
12:27:40| TRACE | http-nio-8080-exec-3 | o.f.o.d.b.B.b.  
{Router}/handler| Rebasing request to http://app.example.com:8081
```

Stop exception logging

To stop recording log messages for exceptions, edit `logback.xml` to set the level to OFF :

```
<logger  
name="org.forgerock.openig.filter.LogAttachedExceptionFilter"  
level="OFF" />
```

Reduce logging when propagating disconnections

When using HTTP/2 and propagating disconnections from the user-agent to the protected application, edit `logback.xml` to change the log level for the DefaultHttp2ConnectionDecoder to WARN:

```
<logger  
name="io.netty.handler.codec.http2.DefaultHttp2ConnectionDecoder"  
level="WARN" />
```

At the level of INFO , the logging for this component is noisy when PingGateway propagates disconnections.

Capture the context or entity of messages for routes

To capture the context or entity of inbound and outbound messages for a route or for an individual handler or filter in the route, configure a `CaptureDecorator`. Captured information is written to SLF4J logs.

IMPORTANT

During debugging, consider using a `CaptureDecorator` to capture the entity and context of requests and responses. However, increased logging consumes resources, such as disk space, and can cause performance issues. In production, reduce logging by disabling the `CaptureDecorator` properties `captureEntity` and `captureContext`, or setting `maxEntityLength`.

You can find more information about the decorator configuration in [CaptureDecorator](#).

Studio provides an easy way to capture messages while developing your configuration. The following image illustrates the capture points where you can log messages on a route:

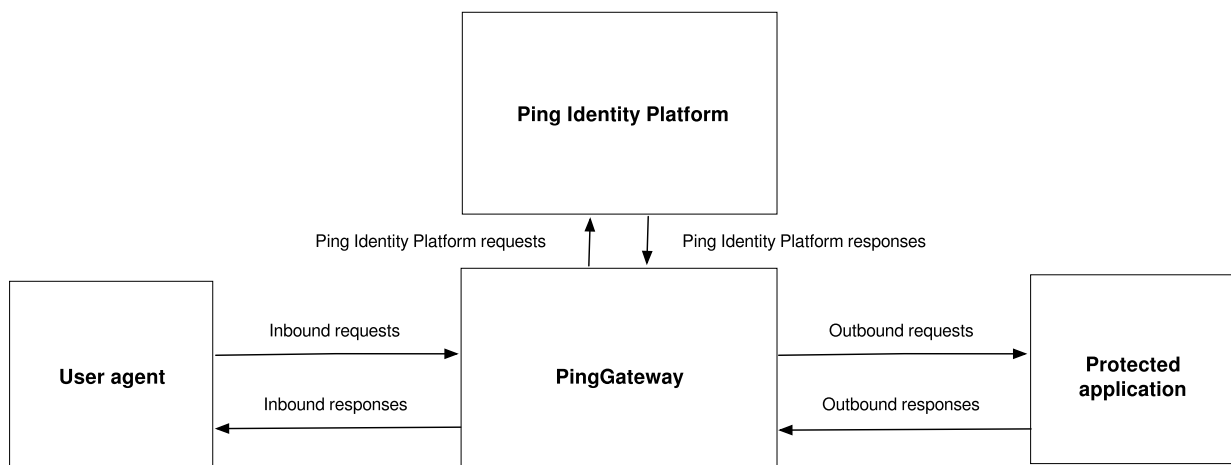


Figure 1. Capturing log messages for routes

Capture messages on a route in Studio

1. In Studio, select **ROUTES**, and then select a route with the **⋮** icon.
2. On the left side of the screen, select **Capture**, and then select capture options. You can capture the body and context of messages passing to and from the user agent, the protected application, and the Ping Identity Platform.
3. Select **Deploy** to push the route to the PingGateway configuration.

You can check the `$HOME/.openig/config/routes` folder to see that the route is there.

4. Access the route, and then check `$HOME/.openig/logs` for a log file named by the route, where `$HOME/.openig` is the instance directory. The log file should contain the messages defined by your capture configuration.

Limit repetitive log messages

To keep log files clean and readable, and to prevent log flow attacks, limit the number of repeat log messages. Add a custom `logback.xml` with a `DuplicateMessageFilter`. This filter detects duplicate messages, and after the specified number of repetitions, drops repeated messages.

The following example allows five repetitions of a log message and holds the last 10 repeated messages in the cache:

```
<turboFilter
class="ch.qos.logback.classic.turbo.DuplicateMessageFilter"
allowedRepetitions="5" CacheSize="10" />
```

The `DuplicateMessageFilter` has the following limitations:

- Filters out **all** duplicate messages. It doesn't filter per logger, or logger instance, or logger name.
- Detects repetition of raw messages, meaning that the following example messages are considered as repetition:

```
logger.debug("Hello {}", name0);
logger.debug("Hello {}", name1);
```

- Doesn't limit the lifespan of the cache. After the specified number of repetitions is reached, the repeated log messages never appear again, even if they're frequently hit.

Tune performance

Tune deployments in the following steps:

1. Consider the issues that impact the performance of a deployment. See [Define requirements and constraints](#).
2. Tune and test the downstream servers and applications:
 - a. Tune the downstream web container and JVM to achieve performance targets.
 - b. Test downstream servers and applications in a pre-production environment, under the expected load, and with common use cases.
3. Increase hardware resources as required, and then re-tune the deployment.

Define requirements and constraints

When you consider performance requirements, bear in mind the following points:

- The capabilities and limitations of downstream services or applications on your performance goals.
- The increase in response time due to the extra network hop and processing, when PingGateway is inserted as a proxy in front of a service or application.
- The constraint that downstream limitations and response times place on PingGateway.

Service level objectives

A service level objective (SLO) is a target that you can measure quantitatively. Where possible, define SLOs to set out what performance your users expect. Even if your first version of an SLO consists of guesses, it is a first step towards creating a clear set of measurable goals for your performance tuning.

When you define SLOs, bear in mind that PingGateway can depend on external resources that can impact performance, such as AM's response time for token validation, policy evaluation, and so on. Consider measuring remote interactions to take dependencies into account.

Consider defining SLOs for the following metrics of a route:

- Average response time for a route.

The response time is the time to process and forward a request, and then receive, process, and forward the response from the protected application.

The average response time can range from less than a millisecond, for a low latency connection on the same network, to however long it takes your network to deliver the response.

- Distribution of response times for a route.

Because applications set timeouts based on worst case scenarios, the distribution of response times can be more important than the average response time.

- Peak throughput.

The maximum rate at which requests can be processed at peak times. Because applications are limited by their peak throughput, this SLO is arguably more important than an SLO for average throughput.

- Average throughput.

The average rate at which requests are processed.

Metrics are returned at the monitoring endpoints. For information about monitoring endpoints, refer to [Monitoring](#). For examples of how to set up monitoring in

PingGateway, refer to [Monitor services](#).

Available resources

With your defined SLOs, inventory the server, networks, storage, people, and other resources. Estimate whether it is possible to meet the requirements, with the resources at hand.

Benchmarks

Before you can improve the performance of your deployment, establish an accurate benchmark of its current performance. Consider creating a deployment scenario that you can control, measure, and reproduce.

For information about running Ping Identity Platform benchmark tests, refer to the ForgeOps documentation on [benchmarks](#). Adapt the scenarios as necessary for your PingGateway deployment.

Tune PingGateway

Consider the following recommendations for improving performance, throughput, and response times. Adjust the tuning to your system workload and available resources, and then test suggestions before rolling them out into production.

Logs

Log messages in PingGateway and third-party dependencies are recorded using the Logback implementation of the Simple Logging Facade for Java (SLF4J) API. By default, logging level is INFO.

To reduce the number of log messages, consider setting the logging level to `error`. For information, refer to [Manage logs](#).

Buffering message content

PingGateway creates a `TemporaryStorage` object to buffer content during processing. For information about this object and its default values, refer to [TemporaryStorage](#).

Messages bigger than the buffer size are written to disk, consuming I/O resources and reducing throughput.

The default size of the buffer is 64 KB. If the number of concurrent messages in your application is generally bigger than the default, consider allocating more heap memory or changing the initial or maximum size of the buffer.

To change the values, add a `TemporaryStorage` object named `TemporaryStorage` , and use non-default values.

Caches

When caches are enabled, PingGateway can reuse cached information without making additional or repeated queries for the information. This gives the advantage of higher system performance, but the disadvantage of lower trust in results.

When caches are disabled, PingGateway must query a data store each time it needs data. This gives the disadvantage of lower system performance, and the advantage of higher trust in results.

All caches provide similar configuration properties for timeout, defining the duration to cache entries. When the timeout is lower, the cache is evicted more frequently, and consequently, the performance is lower but the trust in results is higher.

When you configure caches in PingGateway, make choices to balance your required performance with your security needs.

Learn more about PingGateway caches in [Caches](#).

WebSocket notifications

By default, PingGateway receives WebSocket notifications from AM for the following events:

- When a user logs out of AM, or when the AM session is modified, closed, or times out. PingGateway can use WebSocket notifications to evict entries from the session cache. For an example of setting up session cache eviction, refer to [Session cache eviction](#).
- When AM creates, deletes, or changes a policy decision. PingGateway can use WebSocket notifications to evict entries from the policy cache. For an example of setting up policy cache eviction, refer to [Notifications and the policy cache](#).
- When PingGateway automatically renews a WebSocket connection to AM. To configure WebSocket renewal, refer to the `notifications.renewalDelay` property of [AmService](#).

If the WebSocket connection is lost, during that time the WebSocket is not connected, PingGateway behaves as follows:

- Responds to session service calls with an empty `SessionInfo` result.

When the `SingleSignIn` filter receives an empty `SessionInfo` call, it concludes that the user is not logged in, and triggers a login redirect.

- Responds to policy evaluations with a deny policy result.

By default, PingGateway waits for five seconds before trying to reestablish the WebSocket connection. If it can't reestablish the connection, it keeps trying every five seconds.

To disable WebSocket notifications, or change any of the parameters, configure the `notifications` property in `AmService`. For information, refer to [AmService](#).

Tune the ClientHandler/ReverseProxyHandler

The ClientHandler/ReverseProxyHandler communicates as a client to a downstream third-party service or protected application. The performance of the communication is determined by the following parameters:

- The number of available connections to the downstream service or application.
- The connection timeout, which is the maximum time to connect to a server-side socket before timing out and abandoning the connection attempt.
- The socket timeout, which is the maximum time a request can take before a response is received after which the request is deemed to have failed.

Configure PingGateway in conjunction with PingGateway's first-class Vert.x configuration, and the `vertx` property of `admin.json`. For more information, refer to [AdminHttpApplication\(admin.json \)](#).

Vert.x options for tuning

Object	Vert.x Option	Description
PingGateway (first-class)	gatewayUnits	<p>The number of deployed Vert.x Verticles. This setting is effectively the number of cores that PingGateway operates across, or in other words, the number of available threads.</p> <p>Each instance operates on the same port on its own event-loop thread.</p> <p>Default: Number of available cores. (This is the optimal value.)</p>

Object	Vert.x Option	Description
root.vertx	eventLoopPoolSize	<p>The size of the pool available to service Verticles for event-loop threads.</p> <p>To guarantee that a single thread handles all I/O events for a single request or response, PingGateway deploys a Verticle onto each event loop.</p> <p>Configure <code>eventLoopPoolSize</code> to be greater than or equal to <code>gatewayUnits</code>.</p> <p>Default: 2 * number of available cores.</p> <p>For more information, refer to Reactor and Multi-Reactor.</p>
root.connectors. <connector>.vertx	acceptBacklog	<p>The maximum number of connections to queue before refusing requests.</p> <p>Default: 1024</p>
	sendBufferSize	<p>The TCP connection send buffer size.</p> <p>Set this property according to the available RAM and required number of concurrent connections.</p> <p>Default: Use the Java TCP send buffer size default settings that Java inherits from the operating system.</p>
	receiveBufferSize	<p>The TCP receive buffer size.</p> <p>Set this property according to the available RAM and required number of concurrent connections.</p> <p>Default: Use the Java TCP receive buffer size default settings that Java inherits from the operating system.</p>
	maxHeaderSize	<p>Set this property when HTTP headers manage large values (such as JWT).</p> <p>Default: 8 KB (8,192 bytes)</p>

Vert.x options for troubleshooting performance

Object	Vert.x Option	Description
root.vertx	blockedThreadCheckInterval and blockedThreadCheckIntervalUnit	The interval at which Vert.x checks for blocked threads and logs a warning. Default: 1 second
	maxEventLoopExecuteTime and maxEventLoopExecuteTimeUnit	The maximum execution time before Vert.x logs a warning. Default: 2 seconds
	warningExceptionTime and warningExceptionTimeUnit	The threshold at which warning logs are accompanied by a stack trace to identify cause. Default: 5 seconds
	logActivity	Whether to log network activity. Default: false

Set the maximum number of file descriptors and processes per user

Each PingGateway instance in your environment should have access to at least 65,536 file descriptors to handle multiple client connections.

Ensure that every PingGateway instance is allocated enough file descriptors. For example, use the **ulimit -n** command to check the limits for a particular user:

```
$ su - iguser
$ ulimit -n
```

It may also be necessary to increase the number of processes available to the user running the PingGateway processes.

For example, use the **ulimit -u** command to check the process limits for a user:

```
$ su - iguser
$ ulimit -u
```

Before increasing the file descriptors for the PingGateway instance, ensure that the total amount of file descriptors configured for the operating system is higher than 65,536.

If the PingGateway instance uses all of the file descriptors, the operating system will run out of file descriptors. This may prevent other services from working, including those required for logging in the system.

Refer to your operating system's documentation for instructions on how to display and increase the file descriptors or process limits for the operating system and for a given user.

Tune PingGateway's JVM

Start tuning the JVM with default values, and monitor the execution, paying particular attention to memory consumption, and GC collection time and frequency. Incrementally adjust the configuration, and retest to find the best settings for memory and garbage collection.

Make sure there is enough memory to accommodate the peak number of required connections, and make sure timeouts in PingGateway and its container support latency in downstream servers and applications.

PingGateway makes low memory demands, and consumes mostly YoungGen memory. However, using caches, or proxying large resources, increases the consumption of OldGen memory. For information about how to optimize JVM memory, refer to the Oracle documentation.

Consider these points when choosing a JVM:


- Find out which version of the JVM is available. More recent JVMs usually contain performance improvements, especially for garbage collection.
- Choose a 64-bit JVM if you need to maximize available memory.

Consider these points when choosing a GC:

- Test GCs in realistic scenarios, and load them into a pre-production environment.
- Choose a GC that is adapted to your requirements and limitations. Consider comparing the *Garbage-First Collector (G1)* and *Parallel GC* in typical business use cases.

The G1 is targeted for multi-processor environments with large memories. It provides good overall performance without the need for additional options. The G1 is designed to reduce garbage collection, through low-GC latency. It is largely self-tuning, with an adaptive optimization algorithm.

The Parallel GC aims to improve garbage collection by following a high-throughput strategy, but it requires more full garbage collections.

Learn more in [Best practice for JVM Tuning with G1 GC](#) .

Rotate keys

The following sections give an overview of how to manage rotation of encryption keys and signing keys, and include examples for key rotation based on use cases from the [Gateway guide](#).

About key rotation

Key rotation is the process of generating a new version of a key, assigning that version as the *active* key to encrypt or sign new messages, or as a *valid* key to decrypt or validate messages, and then deprovisioning the old key.

Why and when to rotate keys

Regular key rotation is a security consideration that is sometimes required for internal business compliance. Regularly rotate keys to:

- Limit the amount of data protected by a single key.
- Reduce dependence on specific keys, making it easier to migrate to stronger algorithms.
- Prepare for when a key is compromised. The first time you try key rotation shouldn't be during a real-time recovery.

Key revocation is a type of key rotation, done exceptionally if you suspect that a key has been compromised. To decide when to revoke a key, consider the following points:

- If limited use of the old keys can be tolerated, provision the new keys and then deprovision the old keys. Messages produced before the new keys are provisioned are impacted.
- If use of the old keys cannot be tolerated, deprovision the old keys before you provision the new keys. The system is unusable until new keys are provisioned.

Steps for rotating symmetric keys

The following steps outline key rotation and revocation for symmetric keys managed by a KeyStoreSecretStore. For an example, refer to Rotate keys in a shared JWT session.

1. Using OpenSSL, Keytool, or another key creation mechanism, create the new symmetric key. The keystore should contain the old key and the new key.
2. Provision the new key.
 - a. In the `mappings` property of `KeyStoreSecretStore`, add the alias for the new key after the alias for the old key. The new key is now valid. Because the old key is the first key in the list, it is the active key.
 - b. Move the new key to be the first key in the list. The new key is now the active key.
3. Deprovision the old key.

To ensure that no messages or users are impacted, wait until messages encrypted or signed with the old key are out of the system before you deprovision the old key.

- a. In the `mappings` property of `KeyStoreSecretStore`, delete the alias for the old key. The old key can no longer be used.
- b. Using OpenSSL, Keytool, or another key creation mechanism, delete the old symmetric key.

Steps for rotating asymmetric keys

The following steps outline the process for key rotation and revocation for asymmetric keys managed by a `KeyStoreSecretStore` or `HsmSecretStore`. For an example, refer to [Rotate keys for stateless access tokens signed with a KeyStoreSecretStore](#).

1. Create new asymmetric keys for signing and encryption, using OpenSSL, Keytool, or another key creation mechanism.
2. Provision the message consumer with the private portion of the new encryption key, and the public portion of the new signing key.

The message consumer can now decrypt and verify messages with the old key and the new key.

3. Provision the message producer, with the public portion of the new encryption key, and the private portion of the signing key. The message producer starts encrypting and signing messages with the new key, and stops using the old key.
4. Deprovision the message consumer with the private portion of the old encryption key, and the public portion of the old signing key. The message consumer can no longer decrypt and verify messages with the old key.

To ensure that no messages or users are impacted, wait until messages encrypted or signed with the corresponding old key are out of the system before you deprovision the old key.

5. Deprovision the message producer, with the public portion of the old encryption key, and the private portion of old signing key.

Key rotation for keys in a JWK set

When keys are provided by a JWK Set from AM, the key rotation is transparent to PingGateway. AM generates a key ID (`kid`) for each key it exposes at the `jwk_uri` . For more information, refer to [Mapping and rotating secrets](#) in AM's *Security guide*.

When PingGateway processes a request with a JWT containing a `kid` , PingGateway uses the `kid` to identify the key in the JWK Set. If the `kid` is available at the `jwk_uri` on AM, PingGateway processes the request. Otherwise, PingGateway tries all compatible secrets from the JWK Set. If none of the secrets work, the JWT is rejected.

Rotate keys for stateless access tokens signed with a KeyStoreSecretStore

This example extends the example in [Signed tokens with KeyStoreSecretStore](#) to rotate the keys that sign an access token and verify the signature.

Rotate Keys For Stateless Access Tokens Signed With a KeyStoreSecretStore

Before you start, set up and test the example in [Signed tokens with KeyStoreSecretStore](#).

1. Set up the new keys:

- a. Generate a new private key called `signature-key-new` , and a corresponding public certificate called `x509certificate-new.pem` :

```
$ openssl req -x509 \  
-newkey rsa:2048 \  
-nodes \  
-subj \  
"/CN=ig.example.com/OU=example/O=com/L=fr/ST=fr/C=fr" \  
-keyout keystore_directory/signature-key-new.key \  
-out keystore_directory/x509certificate-new.pem \  
-days 365  
  
... writing new private key to  
'keystore_directory/signature-key-new.key'
```

- b. Convert the private key and certificate files into a new PKCS#12 keystore file:

```
$ openssl pkcs12 \  
-export \  
-in keystore_directory/x509certificate-new.pem \  
-inkey keystore_directory/signature-key-new.key \  
-out keystore_directory/keystore-new.p12 \  

```

```
-passout pass:password \  
-name signature-key-new
```

c. List the keys in the new keystore:

```
$ keytool -list \  
-keystore "keystore_directory/keystore-new.p12" \  
-storepass "password" \  
-storetype PKCS12  
  
...  
Your keystore contains 1 entry  
Alias name: signature-key-new
```

d. Import the new keystore into `keystore.p12`, so that `keystore.p12` contains both keys:

```
$ keytool -importkeystore  
-srckeystore keystore_directory/keystore-new.p12  
-srcstoretype pkcs12  
-srcstorepass password  
-destkeystore keystore_directory/keystore.p12  
-deststoretype pkcs12  
-deststorepass password  
  
Entry for alias signature-key-new successfully imported  
...
```

e. List the keys in `keystore.p12`, to make sure it contains the new and old keys:

```
$ keytool -list \  
-keystore "keystore_directory/keystore.p12" \  
-storepass "password" \  
-storetype PKCS12  
  
...  
Your keystore contains 2 entries  
Alias name: signature-key  
Alias name: signature-key-new
```

2. Set up AM:

a. Copy the updated keystore to AM:

i. Copy `keystore.p12` to AM:

```
$ cp keystore_directory/keystore.p12
am_keystore_directory/AM_keystore.p12
```


ii. List the keys in the updated AM keystore:

```
$ keytool -list \
-keystore "am_keystore_directory/AM_keystore.p12" \
-storepass "password" \
-storetype PKCS12

...
Your keystore contains 2 entries
Alias name: signature-key
Alias name: signature-key-new
```

iii. Restart AM to update the keystore cache.

b. Update the KeyStoreSecretStore on AM:

- i. In AM, select  **Secret Stores** > keystoresecretstore.
- ii. Select the **Mappings** tab, and in `am.services.oauth2.stateless`
`.signing.RSA` add the alias `signature-key-new`.

The mapping now contains two aliases, but the alias `signature-key` is still the active alias. AM still uses `signature-key` to sign tokens.

iii. Drag `signature-key-new` above `signature-key`.

AM now uses `signature-key-new` to sign tokens.

3. Set up PingGateway:

- a. Set up PingGateway for HTTPS, as described in [Configure PingGateway for TLS \(server-side\)](#).
- b. Import the public certificate to the PingGateway keystore, with the alias `verification-key-new`:

```
$ keytool -import \
-trustcacerts \
-rfc \
-alias verification-key-new \
-file "keystore_directory/x509certificate-new.pem" \
-keystore "ig_keystore_directory/IG_keystore.p12" \
-storetype PKCS12 \
-storepass "password"

...
```



```
Trust this certificate? [no]: yes
Certificate was added to keystore
```

c. List the keys in the PingGateway keystore:

```
$ keytool -list \
-keystore "ig_keystore_directory/IG_keystore.p12" \
-storepass "password" \
-storetype PKCS12

...
Your keystore contains 2 entries
Alias name: verification-key
Alias name: verification-key-new
```

d. In `rs-stateless-signed-ksss.json`, edit the `KeyStoreSecretStore` mapping with the new verification key:

```
"mappings": [
  {
    "secretId": "stateless.access.token.verification.key",
    "aliases": [ "verification-key", "verification-key-
new" ]
  }
]
```

If the Router `scanInterval` is disabled, restart PingGateway to reload the route.

PingGateway can now check the authenticity of access tokens signed with `verification-key`, the old key, and `verification-key-new`, the new key. However, AM signs with the old key.

4. Test the setup:

a. Get an access token for the demo user, using the scope `myscope`:

```
$ mytoken=$(curl -s \
--user "client-application:password" \
--data
"grant_type=password&username=demo&password=Ch4ng31t&scope
=myscope" \
http://am.example.com:8088/openam/oauth2/access_token | jq
-r ".access_token")
```

b. Display the token:

```
$ echo ${mytoken}
```

c. Access the route by providing the token returned in the previous step:

```
$ curl -v \
--cacert /path/to/secrets/ig.example.com-certificate.pem \
--header "Authorization: Bearer ${mytoken}" \
https://ig.example.com:8443/rs-stateless-signed-ksss

...
Decoded access_token: {
  sub=demo,
  cts=0AUTH2_STATELESS_GRANT,
  ...
}
```

Deprovision Old Keys

1. Remove `signature-key` from the AM keystore:

a. Delete the key from the keystore:

```
$ keytool -delete \
-keystore "am_keystore_directory/AM_keystore.p12" \
-storepass "password" \
-alias signature-key
```

b. List the keys in the AM keystore to make sure `signature-key` is removed:

```
$ keytool -list \
-keystore "am_keystore_directory/AM_keystore-new.p12" \
-storepass "password" \
-storetype PKCS12
```

c. Restart AM.

2. Remove `verification-key` from the PingGateway keystore:

a. Delete the key from the keystore:

```
$ keytool -delete \
-keystore "ig_keystore_directory/IG_keystore.p12" \
-storepass "password" \
-alias verification-key
```

b. List the keys in the PingGateway keystore to make sure that `verification-key` is removed:

```
$ keytool -list \  
-keystore "ig_keystore_directory/IG_keystore.p12" \  
-storepass "password" \  
-storetype PKCS12
```

3. In AM, delete the mapping for `signature-key` from `keystoresecretstore`.
4. In PingGateway, delete the mapping for `verification-key` from the route `rs-stateless-signed-ksss.json`. If the Router `scanInterval` is disabled, restart PingGateway to reload the route.

Rotate keys in a shared JWT session

This section builds on the example in [Share JWT session between multiple instances of PingGateway](#) to rotate a key used in a shared JWT session.

When a JWT session is shared between multiple instances of PingGateway, the instances are able to share the session information for load balancing and failover.

Before you start, set up the example in [Set up shared secrets for multiple instances of PingGateway](#), where three instances of PingGateway share stateless sessions and use the same authenticated encryption key. Instance 1 acts as a load balancer, and generates a session. Instances 2 and 3 access the session information.

1. Test the setup with the existing key, `symmetric-key`:
 - a. Access instance 1 to generate a session:

```
$ curl -v http://ig.example.com:8001/log-in-and-generate-session  
  
GET /log-in-and-generate-session HTTP/1.1  
...  
  
HTTP/1.1 200 OK  
Content-Length: 84  
Set-Cookie: IG=eyJ...HyI; Path=/; Domain=.example.com;  
HttpOnly  
...  
Sam Carter logged IN. (JWT session generated)
```

- b. Using the JWT cookie returned in the previous step, access instance 2:

```
$ curl -v http://ig.example.com:8001/webapp/browsing?one -  
-header "cookie:IG=<JWT cookie>"
```

```
GET /webapp/browsing?one HTTP/1.1
...
cookie: IG=eyJ...QHyI
...
HTTP/1.1 200 OK
...
Hello, Sam Carter !! (instance2)
```

Note that instance 2 can access the session info.

c. Using the JWT cookie again, access instance 3:

```
$ curl -v http://ig.example.com:8001/webapp/browsing?two -
-header "Cookie:IG=<JWT cookie>"

GET /webapp/browsing?two HTTP/1.1
...
cookie: IG=eyJ...QHyI
...
HTTP/1.1 200 OK
...
Hello, Sam Carter !! (instance3)
```

Note that instance 3 can access the session info.

2. Commission a new key:

a. Generate a new encryption key, called `symmetric-key-new`, in the existing keystore:

```
$ keytool \
-genseckey \
-alias symmetric-key-new
-keystore /path/to/secrets/jwtsessionkeystore.pkcs12 \
-storepass password \
-storetype PKCS12 \
-keyalg HmacSHA512 \
-keysize 512
```

b. Make sure the keystore contains the old key and the new key:

```
$ keytool \
-list \
-keystore /path/to/secrets/jwtsessionkeystore.pkcs12 \
-storepass password \
-storetype PKCS12
```

```
...
Your keystore contains 2 entries
symmetric-key, ...
symmetric-key-new ...
```

- c. Add the key alias to `instance1-loadbalancer.json`, `instance2-retrieve-session-username.json`, and `instance3-retrieve-session-username.json`, for each PingGateway instance, as follows:

```
"mappings": [{
  "secretId": "jwtsession.encryption.secret.id",
  "aliases": ["symmetric-key", "symmetric-key-new"]
}]
```

If the Router `scanInterval` is disabled, restart PingGateway to reload the route.

The active key is `symmetric-key`, and the valid key is `symmetric-key-new`.

- d. Test the setup again, as described in step 1, and make sure instances 2 and 3 can still access the session information.

3. Make the new key the active key for generating sessions:

- a. In `instance1-loadbalancer.json`, change the order of the keys to make `symmetric-key-new` the active key, and `symmetric-key` the valid key:

```
"mappings": [{
  "secretId": "jwtsession.encryption.secret.id",
  "aliases": ["symmetric-key-new", "symmetric-key"]
}]
```

Don't change `instance2-retrieve-session-username.json` or `instance3-retrieve-session-username.json`.

- b. Test the setup again, as described in step 1, and make sure instances 2 and 3 can still access the session information.

Instance 1 creates the session using the new active key, `symmetric-key-new`.

Because `symmetric-key-new` is declared as a valid key in instances 2 and 3, the instances can still access the session. It isn't necessary to make `symmetric-key-new` the active key.

4. Decommission the old key:

- a. Remove the old key from all of the routes, as follows:

```
"mappings": [{  
  "secretId": "jwtsession.encryption.secret.id",  
  "aliases": ["symmetric-key-new"]  
}]
```

Key `symmetric-key-new` is the only key in the routes.

b. Remove the old key, `symmetric-key`, from the keystore:

i. Delete `symmetric-key`:

```
$ keytool \  
-delete \  
-alias symmetric-key \  
-keystore /path/to/secrets/jwtsessionkeystore.pkcs12 \  
-storepass password \  
-storetype PKCS12 \  
-keypass password
```

ii. Make sure the keystore contains only `symmetric-key-new`:

```
$ keytool \  
-list \  
-keystore /path/to/secrets/jwtsessionkeystore.pkcs12 \  
-storepass password \  
-storetype PKCS12  
  
...  
Your keystore contains 1 entry  
symmetric-key-new ...
```

c. Test the setup again, as described in step 1, and make sure instances 2 and 3 can still access the session information.

Secure and harden

The following sections describe options for securing and hardening your deployment:

General security considerations

Consider the following settings in PingGateway to secure your deployment:

Switch to production mode.

Prevent changes to your configuration by setting the run mode to `production`.
Learn more in [Operating modes](#).

Protect endpoints.

Restrict access to your monitoring data by protecting the Prometheus Scrape Endpoint and Common REST Monitoring Endpoint (deprecated). Learn more in [Protecting the monitoring endpoints](#).

Exclude sensitive data from logs.

- Prevent logging of sensitive data for audit events by excluding fields from the audit logs. Learn more in [Including or Excluding Audit Event Fields In Logs](#).
- When using a `CaptureDecorator`, mask captured header and attribute values to avoid disclosing information, such as token values or passwords. Learn more in [CaptureDecorator](#).

Limit the amount of information available to attackers during reconnaissance, the initial phase of an attack sequence.

- Reduce the global log level from `TRACE` or `DEBUG` to `INFO`. Learn more in [Changing Log Levels](#).
- Avoid using words that help to identify PingGateway in error messages, such as those produced by the entity in a `StaticResponseHandler`. Learn more in [StaticResponseHandler](#).

Secure responses from cross-site scripting.

- Sanitize any external input, such as the request, before incorporating it in the response.
- Specify `Content-Type` in the `headers` property of `StaticResponseHandler` when an entity is used. (Required by default, from PingGateway 7.)
- Set the response header `X-Content-Type-Options: nosniff` to prevent the user agent from interpreting the response entity as a different content type. (Set by default, from PingGateway 7.)
- Set a restrictive value in the `Cache-Control` response header. For example, setting `Cache-Control: private` indicates that all or part of the response message is intended for a single user and **MUST NOT** be cached by a shared cache.

Secure sessions.

Protect network traffic by using HTTPS where possible, and secure communications during stateless sessions by signing and encrypting JWTs. Learn more in [JwtSessionManager](#).

Secure cookies.

- Store a minimum amount of sensitive data in cookies, and only when necessary.

- Change the default name of cookies to prevent them from being easily associated with an application.
- Where possible, configure cookie properties to restrict how and where they can be used. Learn more about this in the reference documentation. Read about the cookie setting in [InMemorySessionManager](#) (stateful sessions) or in [JwtSessionManager](#) (stateless sessions). Read about the `authCookie` setting in [CrossDomainSingleSignOnFilter](#).

Consider the following general points to secure your deployment:

Keep up-to-date on patches.

Security vulnerabilities are the reason why you should keep your operating systems, web and application servers, and any other application in your environment up-to-date. Knowledge of vulnerabilities spreads fast across malicious users, who would not hesitate in trying to exploit them.

Ping Identity maintains a list of security advisories you should follow. You should also follow similar lists from all of your vendors.

Keep up-to-date on cryptographic methods and algorithms.

Different algorithms and methods are discovered and tested over time, and communities of experts decide which are the most secure for different uses. Do not use outdated algorithms for generating your keys.

Turn off unnecessary features.

The more features you have turned on, the greater the attack surface. If something is not being used, uninstall it, disable it, or protect access to it.

Limit access to the servers hosting PingGateway.

Make sure only authorized people can access your servers and applications through the appropriate network, using the appropriate ports, and presenting strong-enough credentials.

Ensure users connect to systems through the latest versions of TLS, and audit system access periodically.

Enforce security.

Don't expect your users to follow security practices on their own; enforce security when possible by requiring secure connections, password resets, and strong authentication methods.

Audit access and changes.

Audit logs record all events that have happened. Some applications store them with their engine logs, others use specific files or send the information to a different server for archiving. Operating systems have audit logs as well, to detect unauthorized login attempts and changes to the software.

PingGateway has its own audit logging service that adheres to the log structure common across the Ping Identity Platform. Learn more in [Audit the deployment](#).

Prevent log flow attacks.

Limit the number of repeat log messages by adding a custom `logback.xml` with a `DuplicateMessageFilter`. Learn more in [Limit Repetitive Log Messages](#).

Switch from development mode to production mode

After installation, PingGateway is by default in production mode. While you evaluate PingGateway or develop routes, it can be helpful to switch to development mode as described in [Operating modes](#). After deployment, it's essential to switch back to production mode to prevent unwanted changes to the configuration.

Troubleshoot

ForgeRock provides support services, professional services, training through ForgeRock University, and partner services to help you set up and maintain your deployments.

Getting support

Ping Identity provides support services, professional services, training, and partner services to assist you in setting up and maintaining your deployments. For a general overview of these services, see <https://www.pingidentity.com> [↗](#).

Ping Identity has staff members around the globe who support our international customers and partners. For details on Ping Identity's support offering, visit <https://www.pingidentity.com/support> [↗](#).

Ping Identity publishes comprehensive documentation online:

- The Ping Identity [Knowledge Base](#) [↗](#) offers a large and increasing number of up-to-date, practical articles that help you deploy and manage Ping Identity Platform software.

While many articles are visible to everyone, Ping Identity customers have access to much more, including advanced information for customers using Ping Identity Platform software in a mission-critical capacity.

- Ping Identity product documentation, such as this document, aims to be technically accurate and complete with respect to the software documented. It is visible to everyone and covers all product features and examples of how to use them.

Getting info about the problem

When trying to solve a problem, save time by asking the following questions:

- How do you reproduce the problem?
- What behavior do you expect, and what behavior do you have?
- When did the problem start occurring?
- Are there circumstances in which the problem doesn't occur?
- Is the problem permanent, intermittent, getting better, getting worse, or staying the same?

If you contact ForgeRock for help, include the following information with your request:

- The product version and build information. This information is included in the logs when PingGateway starts up. If PingGateway is running in development mode, and set up as described in the [Quick install](#), access the information at <http://ig.example.com:8080/openig/api/info> or <https://ig.example.com:8443/openig/api/info>.[↗]
- Description of the problem, including when the problem occurs and its impact on your operation.
- Steps you took to reproduce the problem.
- Relevant access and error logs, stack traces, and core dumps.
- Description of the environment, including the following information:
 - Machine type
 - Operating system and version
 - Web server or container and version
 - Java version
 - Patches or other software that might affect the problem

Start up

▼ [After a first startup, PingGateway doesn't restart or load routes.](#)

If PingGateway doesn't restart or load routes after a first startup, search `route-system.log` for lines containing `Error while starting...` or `Unable to start ...` and use the error message to debug the issue.

▼ [PID file already exists](#)

If PingGateway shuts down without using the `stop.sh` or `stop.bat` script, the PID file isn't removed and PingGateway can't restart. This can happen when you use the PingGateway service to stop or restart PingGateway, or when PingGateway is deployed in Docker.

Remove the PID file or change the configuration as described in [Allow startup when there is an existing PID file](#).

Resources

▼ [Requests redirected to AM instead of to the resource](#)

By default, AM 5 and later writes cookies to the fully qualified domain name of the server; for example, `am.example.com`. Therefore, a host-based cookie, rather than a domain-based cookie, is set.

Consequently, after authentication through PingAM, requests can be redirected to PingAM instead of to the resource.

To resolve this issue, add a cookie domain to the PingAM configuration. For example, in the AM admin UI, go to **Configure > Global Services > Platform**, and add the domain `example.com`.

▼ [Sample application not displayed correctly](#)

When the sample application is used with PingGateway in the documentation examples, the sample application must serve static resources, such as the `.css`. Add the following route to the PingGateway configuration:

```
{
  "name" : "00-static-resources",
  "baseURI" : "http://app.example.com:8081",
  "condition": "${find(request.uri.path, '^/css') or
matchesWithRegex(request.uri.path, '^/.*\.\.ico$') or
matchesWithRegex(request.uri.path, '^/.*\.\.gif$')}",
  "handler": "ReverseProxyHandler"
}
```

▼ [StaticResponseHandler results in a blank page](#)

Define an entity for the response, as in the following example:

```
{
  "name": "AccessDeniedHandler",
  "type": "StaticResponseHandler",
  "config": {
    "status": 403,
    "headers": {
      "Content-Type": [ "text/html; charset=UTF-8" ]
    },
    "entity": "<html><body><p>User doesn't have permission</p>
</body></html>"
  }
}
```

```
}  
}
```

Routes

▼ [No handler to dispatch to](#)

Symptom

The following errors are in `route-system.log`:

```
... | ERROR | main | o.f.o.h.r.RouterHandler | no handler to  
dispatch to
```

```
08:22:54:974 | ERROR | http-... | o.f.o.h.DispatchHandler |  
no handler to dispatch to for URI  
'http://ig.example.com/demo'
```

Cause

PingGateway is not configured to handle the incoming request or the request to the specified URI:

- "no handler to dispatch to": the router cannot find a route that accepts the incoming request. This error happens when none of the route conditions match the incoming request and there is no default route.
- "no handler to dispatch to for URI": the router cannot find a route that can handle the request to the specified URI because none of the route conditions match the request path (URI).

Solution

If the errors occur during the startup, they are safe to ignore. If the errors occur after the startup, do the following:

- Identify why the request matched none of the [Route](#) conditions, and adapt the conditions. You can find examples in [Example conditions and requests](#).
- Add a default handler to the [Router](#).
- [Add a default route](#) for when no condition is met.

▼ [Object not found in heap](#)

If you have the following error, you have specified `"handler": "Router2"` in `config.json` or in the route, but no handler configuration object named Router2 exists:

```
org.forgerock.json.fluent.JsonValueException: /handler:  
object Router2 not found in heap
```

```
        at
org.forgerock.openig.heap.HeapImpl.resolve(HeapImpl.java:351)
        at
org.forgerock.openig.heap.HeapImpl.resolve(HeapImpl.java:334)
        at
org.forgerock.openig.heap.HeapImpl.getHandler(HeapImpl.java:538)
```

Make sure you have added an entry for the handler, and that you have correctly spelled its name.

▼ [Extra or missing character / invalid JSON](#)

When the JSON for a route is not valid, PingGateway doesn't load the route. Instead, a description of the error appears in the log.

Use a JSON editor or JSON validation tool such as [JSONLint](#) to make sure your JSON is valid.

▼ [Route not used](#)

PingGateway loads all configurations at startup, and, by default, periodically reloads changed route configurations.

If you make changes to a route that result in an invalid configuration, PingGateway logs errors, but it keeps the previous, correct configuration, and continues to use the old route.

PingGateway only uses the new configuration after you save a valid version or when you restart PingGateway.

Of course, if you restart PingGateway with an invalid route configuration, then PingGateway tries to load the invalid route at startup and logs an error. In that case, if there is no default handler to accept any incoming request for the invalid route, then you have an error, `No handler to dispatch to`.

▼ [Skipped routes](#)

PingGateway returns an exception if it loads a route for which it can't resolve a requirement. For example, when you load a route that uses an `AmService` object, the object must be available in the AM configuration.

If you add routes to a configuration when the environment is not ready, rename the route to prevent PingGateway from loading it. For example, rename a route as follows:

```
$ mv $HOME/.openig/config/routes/03-sql.json
$HOME/.openig/config/routes/03-sql.inactive
```

If necessary, restart PingGateway to reload the configuration. When you have configured the environment, change the file extension back to `.json`.

Studio

▼ [Can't deploy routes in Studio](#)

Studio deploys and undeploys routes through a main router named `_router`, which is the name of the main router in the default configuration. If you use a custom `config.json`, make sure it contains a main router named `_router`.

You can find more information about creating routes in Studio in [Studio](#).

Timeout errors

▼ [Log is flushed with timeout exception warnings on sending a request](#)

Problem: After a request is sent to PingGateway, PingGateway seems to hang. An HTTP 502 Bad Gateway error is produced, and the PingGateway log is flushed with `SocketTimeoutException` warnings.

Possible cause: The `baseURI` configuration is missing or causes the request to return to PingGateway, so PingGateway can't produce a response to the request.

Possible solution: Configure the `baseURI` to use a different host and port to PingGateway.

Other problems

▼ [Incorrect values in the flat files](#)

Make sure the user running PingGateway can read the flat file. Remember that values include spaces and tabs between the separator, so make sure the values aren't padded with spaces.

▼ [Problem accessing URLs](#)

The following error can be encountered when using an `AssignmentFilter` as described in [AssignmentFilter](#) and setting a string value for one of the headers.

```
HTTP ERROR 500
    Problem accessing /myURL . Reason:
    java.lang.String cannot be cast to java.util.List
    Caused by:
    java.lang.ClassCastException: java.lang.String cannot be
    cast to java.util.List
```

All headers are stored in lists so the header must be addressed with a subscript. For example, rather than trying to set `request.headers['Location']` for a redirect in

the response object, you should instead set `request.headers['Location'][0]`. A header without a subscript leads to the error above.

▼ [URI Too Long error](#)

When a request is longer than 4096 bytes, it can cause an HTTP 414 URI Too Long response.

The default limit for request length is set by the Vert.x configuration `DEFAULT_MAX_INITIAL_LINE_LENGTH`. This default acts on the `connectors` property of `admin.json`.

When working with requests constructed with parameters and query strings, such as for SAML or token transformation, where the request can become long consider setting the Vert.x property `getMaxInitialLineLength` to increase the limit.

The following example configuration in `admin.json` increases the request length limit to 9999 bytes:

```
"connectors": [  
  {  
    "vertx": {  
      "maxInitialLineLength": 9999,  
      ...  
    }  
  }  
]
```

▼ ["Ignored" message logged](#)

The following log message indicates that the client or server side has disconnected and PingGateway has ignored the event.

```
[vert.x-eventloop-thread-2] DEBUG ... @system - Connection  
error. Ignored.  
[CONTINUED]java.nio.channels.ClosedChannelException: null
```

This type of error occurs when a network component closes the connection. This can occur when:

- A load balancer or firewall terminates or times out connections
- Third-party network changes prevent successful connections

Increase logging to provide more information, as described in [Manage logs](#).

Was this helpful?  

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