



# Cisco pxGrid

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## Cisco pxGrid and ISE



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**Note** From Cisco ISE Release 3.1, all pxGrid connections must be based on pxGrid 2.0. pxGrid 1.0-based (XMPP-based) integrations will cease to work on Cisco ISE from Release 3.1 onwards.

pxGrid Version 2.0, which is based on WebSockets, was introduced in Cisco ISE Release 2.4. We recommend that you plan and upgrade your other systems to pxGrid 2.0-compliant versions in order to prevent potential disruptions, if any, to integrations.

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Cisco Platform Exchange Grid (pxGrid) is an open and scalable Security Product Integration Framework that allows for bi-directional any-to-any partner platform integrations.

pxGrid 1.0 uses legacy Extensible Messaging and Presence Protocol (XMPP) implementation. pxGrid 1.0 is in maintenance mode, and will soon be removed. Cisco pxGrid 1.0 requires client SDK libraries (Java or C) to work with pxGrid.

pxGrid 2.0 uses REST and WebSocket interfaces. A client uses REST for control messages, queries and application data, and WebSockets for pushing events. For more information about pxGrid 2.0, see [Welcome to Learning Cisco Platform Exchange Grid \(pxGrid\)](#).

pxGrid can:

- Share context-sensitive information from the Cisco ISE session directory with other network systems, such as Cisco ISE ecosystem partner systems and other Cisco platforms.
- Enable third-party systems to invoke adaptive network control actions to quarantine users and devices in response to a network or security event. TrustSec information, such as tag definition, value, and description, pass from Cisco ISE via a TrustSec topic to other networks.
- Send endpoint profiles with Fully Qualified Names (FQNs) from Cisco ISE to other networks through an endpoint profile meta topic.
- Bulk download of tags and endpoint profiles.

- Publish and subscribe to SXP bindings (IP-SGT mappings) through pxGrid. For more information about SXP bindings, see the *Security Group Tag Exchange Protocol* section in the Segmentation chapter of the [Cisco ISE Administrators Guide](#).
- Cisco pxGrid Context-in enables ecosystem partners to publish topic information into Cisco ISE. This enables Cisco ISE to take action based on the identified asset in the ecosystem. For more information about Cisco pxGrid Context-in, see [pxGrid Context-In](#).



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**Note** pxGrid 1.0 is in maintenance mode and will soon be deprecated. We introduced pxGrid 2.0 in ISE 2.4. We highly encourage partners to switch their pxGrid client implementations to pxGrid 2.0.

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### pxGrid Overview

pxGrid has the following components:

- Controller: Handles Discovery, Authentication, and Authorization.
- Provider: Returns query results or publishes.
- Pubsub: Provides pxGrid services to providers and consumers.
- Subscriber: Once authorized, subscribers get the contextual information and alerts from topics that they subscribe to.

pxGrid provides the following functions:

- Discovery: Discovers service properties based on service name. The flow starts when a provider asks to “Register Service” with the pxGrid Controller. After registration, the consumer uses “Lookup Service” to discover the locations of the providers.
- Authentication: The pxGrid Controller authenticates the pxGrid client for access to services. Credentials are either username and password, or certificates (preferred).
- Authorization: When pxGrid gets an operation request, it consults with pxGrid Controller to authorize the request. pxGrid assigns the client to a pre-defined group.

### High Availability for pxGrid 1.0

With pxGrid 1.0, you can configure two nodes with the pxGrid persona operating in Active/Standby mode. Cisco pxGrid servers replicate information between the nodes through the PAN. When the PAN goes down, pxGrid server stops handling the client registration and subscription. You must manually promote the PAN to activate the pxGrid server.

You can see the pxGrid processes with the CLI command **show application status ise**. The following processes relevant to pxGrid 1.0 are:

- pxGrid Infrastructure Service
- pxGrid Publisher Subscriber Service
- pxGrid Connection Manager
- pxGrid Controller

On the Active pxGrid 1.0 node, these processes show as 'Running'. On the Standby pxGrid 1.0 node, they show as Disabled. If the Active pxGrid 1.0 `noshow logging application pxgrid.statede` goes down, the standby pxGrid node detects that loss, and starts the four pxGrid processes. Within a few minutes, these processes show as 'Running', and the Standby node becomes the Active node. You can verify that pxGrid is in standby on that node by running the CLI command `show logging application pxgrid`.

Cisco ISE does automatic failover to the secondary pxGrid node. If you bring the original primary pxGrid node back into the network, the original primary pxGrid node continues as the secondary role, and isn't promoted back to the primary role, unless you shut down the current primary.

### High Availability for pxGrid 2.0

pxGrid 2.0 nodes operate in an Active/Active configuration. For high availability, there should be at least two pxGrid nodes in the deployment. Large deployments can have up to four nodes for increased scale and redundancy. We recommend that you configure IP addresses for all nodes, so that if one node goes down, that node's clients connect to working node. When the PAN goes down, pxGrid server stops handling the activations. Manually promote the PAN to activate the pxGrid server. For more information about pxGrid deployments, see [ISE Performance & Scale](#).

All pxGrid service provider clients periodically reregister themselves with the pxGrid controller within a span of 7.5 minutes. If the client does not reregister, the PAN node assumes it's inactive, and deletes that client. If the PAN node goes down for more than 7.5 minutes, when it comes back up, it deletes all the clients with timestamp values older than 7.5 minutes. All those clients must then register again with the pxGrid controller.

pxGrid 2.0 clients use WebSocket and REST-based APIs for pub/sub and query. These APIs are served by the ISE application server on port 8910. The pxGrid processes shown by `show logging application pxgrid` don't apply to pxGrid 2.0.

### Loss Detection

In Cisco ISE 3.0, we added sequence IDs to pxGrid topics. If there is a break in transmission, the subscriber can recognize that by checking the gap in sequence of IDs. The subscriber notices the change in topic sequence ID, and asks for data based on the date of last sequence number. If the Publisher goes down, when it comes back up, topic sequence starts at 0. When the Subscriber sees sequence 0, they must clear the cache and start bulk download. If subscriber goes down, the publisher keeps assigning sequential IDs. When the subscriber reconnects, and sees a gap in sequence IDs, the subscriber asks for data from time of the last sequence number. Loss detection works with Session Directory, and TrustSec Configuration. With Session Directory, when the client detects a loss, they must clear the cache and start bulk download.

If you have an existing application that doesn't use sequence IDs, you don't have to use them. But using them provides benefits of loss detection and recovery from loss.

Session Directory sessions are batched and published by MnT asynchronously for every notify interval to `/topic/com.cisco.ise.session`.

Changes to TrustSec Security Groups are published to `/topic/com.cisco.ise.config.trustsec.security.group`.

Loss Detection is only supported for pxGrid 2.0, and is on by default.

To see code examples of using Loss Detection, see <https://github.com/cisco-pxgrid/pxgrid-rest-ws/tree/master/java/src/main/java/com/cisco/pxgrid/samples/ise>.

### Monitoring and Debugging

The following logs are available for pxGrid:

- pxgrid.log: pxGrid 1.0 processes activities
- pxgrid-server.log: pxGrid 2.0 activities and errors
- pxgrid-cm.log: pxGrid 1.0 connection logs
- pxgrid-controller.log: pxGrid 1.0 control messages logs
- pxgrid-jabberd.log: pxGrid 1.0 XMPP server logs
- pxgrid-pubsub.log: pxGrid 1.0 XMPP Pubsub logs

The **Log** page displays all the pxGrid 2.0 management events. Event info includes the client and capability names along with the event type and timestamp. Choose **Administration > pxGrid Services > Diagnostics > Log** to view the list of events. You can also clear the logs and resynchronize or refresh the list.

## pxGrid Summary Page

The pxGrid Summary page displays statistics of the current pxGrid 2.0 environment.

- Current Connections: Lists the connections to the controller
- Control Messages: Authentication, Authorization, and service Discovery
- REST APIs: Number of clients who connected using WebSockets or XMPP
- Pubsub Throughput: Amount of data published to clients
- Clients: Clients connected by REST or WebSocket
- Errors: Number of transmission errors, which caused client to ask for data transfer restart

## pxGrid Client Management

Clients must register and receive account approval to use pxGrid services in Cisco ISE. Clients use the pxGrid Client library through the pxGrid SDK to register. Cisco ISE supports both auto and manual registrations.

- **Clients:** Choose **Administration > pxGrid Services > Client Management > Clients** to view this window. Lists external client accounts for both pxGrid 1.0 and 2.0.
- **pxGrid Policy:** Choose **Administration > pxGrid Services > Client Management > pxGrid Policy** to view this window. Lists the available services that clients can subscribe to. You can edit a policy to change which groups can access to that policy. You can also create a new policy for a service that doesn't already have a policy.
- **Groups:** Choose **Administration > pxGrid Services > Client Management > Groups** to view this window. ANC is a predefined group. You can add more groups, and use them to limit access to services.

A pxGrid client can register itself with the pxGrid controller by sending the username via REST API. The pxGrid controller generates a password for the pxGrid client during client registration. The administrator can approve or deny the connection request.

- **Certificates:** Choose **Administration > pxGrid Services > Client Management > Certificates** to view this window. You can generate a new certificate to use the Cisco ISE internal Certificate Authority.

For information about creating certificates for pxGrid, see:

- [Deploying Certificates with Cisco pxGrid - Using Self-Signed Certificates Updates to Cisco ISE 2.0/2.1/2.2](#)
- [Deploying Certificates with Cisco pxGrid - Using External CA with updates to Cisco ISE 2.0/2.1/2.2](#)

## Control pxGrid Policies

You can create pxGrid authorization policies to control access to the services that pxGrid clients can access. These policies control which services are available to the pxGrid clients.

You can create different types of groups and map the available services to the pxGrid clients to these groups. Use the **Manage Groups** option in the **Client Management > Groups** window to add new groups. You can view the example authorization rules in the **Client Management > Policies** window.

To create an authorization policies for pxGrid clients:

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**Step 1** Choose **Administration > pxGrid Services > Client Management > Policy**, and then click **Add**.

**Step 2** From the **Service** drop-down list, choose one of the following options:

- com.cisco.ise.radius
- come.cisco.ise.sxp
- com.cisco.ise.trustsec
- com.cisco.ise.session
- com.cisco.ise.system
- com.cisco.ise.mdm
- com.cisco.ise.config.trustsec
- com.cisco.ise.config.profiler
- com.cisco.ise.pxgrid.admin
- com.cisco.ise.config.deployment.node
- com.cisco.ise.endpoint
- com.cisco.ise.config.anc
- com.cisco.ise.dnac
- com.cisco.ise.config.upn
- com.cisco.ise.pubsub

**Step 3** From the **Operation** drop-down list, choose one of the following options:

- <ANY>
- publish
- publish /topic/com.cisco.ise.session
- publish /topic/com.cisco.ise.session.group

- publish /topic/com.cisco.ise.anc
- <CUSTOM>—You can specify a custom operation if you select this option.

**Step 4** From the **Groups** drop-down list, choose the groups that you want to map to this service.

Predefined groups (such as EPS and ANC) and groups that you manually added are listed in this drop-down list.

**Note** Only the clients that are part of the groups included in the policy can subscribe to the service specified in that policy.


**Step 5** Click **Submit**.

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## Enable pxGrid Service

### Before you begin

- Enable the pxGrid persona on at least one node to view the requests from the Cisco pxGrid clients.
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**Step 1** In the Cisco ISE GUI, click the **Menu** icon () and choose **Administration > pxGrid Services**.

**Step 2** Check the checkbox next to the client and click **Approve**.

**Step 3** Click **Refresh** to view the latest status.

**Step 4** Select the capability you want to enable and click **Enable**.

**Step 5** Click **Refresh** to view the latest status.

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## pxGrid Diagnostics

- **XMPP**: The **Administration > pxGrid Services > Diagnostics > XMPP** page lists pxGrid 1.0 clients, external and internal. Also lists capabilities.
- **Websocket**: The **Administration > pxGrid Services > Diagnostics > Websocket** window lists pxGrid 2.0 clients (external and internal). It also lists the available pxGrid 2.0 topics, and the clients that publish or subscribe to each one.
- **Logs**: The **Administration > pxGrid Services > Diagnostics > Live Logs** window lists management events.
- **Tests**: Choose **Administration > pxGrid Services > Diagnostics > Tests > Health Monitoring test** and click **Start Test** to verify whether a client can access the Session Directory service. When the test is complete, you can view the log of the test activities.

## pxGrid Settings


Choose one of the following options in the **Administration > pxGrid Services > Settings** window:

- **Automatically approve new certificate-based accounts:** This option is disabled by default. It gives you control over connections to the pxGrid server. Enable this option only when you trust all clients in your environment.
- **Allow password based account creation:** Check this check box to enable username/password based authentication for pxGrid clients. If you enable this option, the pxGrid clients are not automatically approved.

## Generate Cisco pxGrid Certificate

### Before you begin

- You must not use the same certificate for Cisco ISE pxGrid server and pxGrid clients. You must use client certificates for the pxGrid clients. To generate client certificates, choose **Administration > System > Certificates**.
- Some versions of Cisco ISE have a certificate for Cisco pxGrid that uses NetscapeCertType. We recommend that you generate a new certificate.
- To perform the following task, you must be a Super Admin or System Admin.
- A Cisco pxGrid certificate must be generated from the primary PAN.
- If the Cisco pxGrid certificate uses the subject alternative name (SAN) extension, be sure to include the FQDN of the subject identity as a DNS name entry.
- Create a certificate template with digital signature usage and use that to generate a new Cisco pxGrid certificate.

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- Step 1** In the Cisco ISE GUI, click the **Menu** icon () and choose **Administration > pxGrid Services > Client Management > Certificates**.
- Step 2** From the **I want to** drop-down list, choose one of the following options:
- **Generate a single certificate (without a certificate signing request):** You must enter the Common Name (CN) if you select this option.
  - **Generate a single certificate (with a certificate signing request):** You must enter the Certificate Signing Request details if you select this option.
  - **Generate bulk certificates:** You can upload a CSV file that contains the required details.
  - **Download Root Certificate Chain:** You can download the root certificates and add them to the trusted certificate store. You must specify the host name and the certificate download format.
- Step 3** (Optional) Enter a description for this certificate.
- Step 4** Click the **pxGrid\_Certificate\_Template** link to download and edit the certificate template based on your requirements.
- Step 5** Enter the **Subject Alternative Name (SAN)**. You can add multiple SANs. The following options are available:
- **IP address:** Enter the IP address of the Cisco pxGrid client to be associated with the certificate.
  - **FQDN:** Enter the FQDN of the pxGrid client.


**Note** This field is not displayed if you select the **Generate Bulk Certificate** option.

**Step 6** From the **Certificate Download Format** drop-down list, choose one of the following options:

- **Certificate in Private Enhanced Electronic Mail (PEM) format, key in PKCS8 PEM format (including certificate chain):** The root certificate, the intermediate CA certificates, and the end entity certificate are represented in the PEM format. PEM-formatted certificates are BASE64-encoded ASCII files. Each certificate starts with the "-----BEGIN CERTIFICATE-----" tag and ends with the "-----END CERTIFICATE-----" tag. The end entity's private key is stored using PKCS\* PEM. It starts with the "-----BEGIN ENCRYPTED PRIVATE KEY-----" tag and ends with the "-----END ENCRYPTED PRIVATE KEY-----" tag.
- **PKCS12 format (including certificate chain; one file for both the certificate chain and key):** A binary format to store the root CA certificate, the intermediate CA certificate, and the end entity's certificate and private key in one encrypted file.

**Step 7** Enter the password for the certificate.

**Step 8** Click **Create**.

You can view the certificate that you created in the **Issued Certificates** window. To view this window, click the **Menu** icon () and choose **Administration > System > Certificates > Certificate Authority > Issued Certificates**.

**Note** From Cisco ISE 2.4 patch 13 onwards, the certificate requirements have become stricter for the pxGrid service. If you are using the Cisco ISE default self-signed certificate as the pxGrid certificate, Cisco ISE might reject that certificate after applying Cisco ISE 2.4 patch 13 or later. This is because the earlier versions of that certificate have the **Netscape Cert Type** extension specified as **SSL Server**, which now fails (a client certificate is also required now).

Any client with a noncompliant certificate fails to integrate with Cisco ISE. Use a certificate issued by the internal CA, or generate a new certificate with proper usage extensions:

- The **Key Usage** extension in the certificate must contain the **Digital Signature** and **Key Encipherment** fields.
- The **Extended Key Usage** extension in the certificate must contain the **Client Authentication** and **Server Authentication** fields.
- The **Netscape Certificate Type** extension is not required. If you want to include that extension, add both **SSL Client** and **SSL Server** in the extension.
- If you are using a self-signed certificate, the **Basic Constraints CA** field must be set to **True**, and the **Key Usage** extension must contain the **Key Cert Sign** field.

## Known Limitations in pxGrid Certificate Generation

pxGrid certificate generation in Cisco ISE follows the tabulated logic explained below:

Serial number	System Certificate (EAP)	Issuer Certificate	pxGrid Format	Support
1	Multiple Common Name	Single Common Name	PKCS8 , PKCS12	Yes, supported



<b>Serial number</b>	<b>System Certificate (EAP)</b>	<b>Issuer Certificate</b>	<b>pxGrid Format</b>	<b>Support</b>
2	Multiple Common Name	Multiple Common Name	PKCS12	Yes, supported
3	Multiple Common Name	Multiple Common Name	PKCS8	Not supported

