Application Note:

Integrating xPico 200 Series with Microsoft Azure
Overview

This document describes how to integrate an xPico 200 series device with Microsoft Azure. The Microsoft Azure service and the Azure portal may change. This document serves as an example but may not be up to date. Check the Microsoft Azure documentation for updated Azure instructions.

A device can be added to an IoT Hub in Microsoft Azure using a SAS Token, a self-signed X.509 certificate, or a Certificate Authority-signed X.509 certificate. Follow the instructions below to create an IoT Hub in Microsoft Azure if you have no already done so, and then follow the instructions for using either a SAS Token, self-signed X.509 certificate, or CA-signed X.509 certificate.

Prerequisites

You will need the following software:

- Visual Studio Code: https://code.visualstudio.com/download
- Device Explorer: https://github.com/Azure/azure-iot-sdks/releases
- D-TRUST.pem, DigiCert.pem, and balitmore-ca.pem: https://github.com/Azure/azure-iot-sdk-c/tree/master/certs (for the self-signed X.509 method)

Creating an IoT Hub in Microsoft Azure

In order to add a device to Microsoft Azure, you must have an IoT Hub created in Azure portal. Follow these steps to create an IoT Hub in Microsoft Azure, or skip to one of the following sections if you have already created an IoT Hub.

2. Click Create a resource.
3. In the **Search the Marketplace** field, type “IoT Hub” and select it from the results.

4. Click **Create**.

5. On the **Basics** tab, select a **Subscription**, select a **Resource Group** or create a new one by clicking **Create new** and typing a name, select a **Region**, and enter a globally unique **IoT Hub Name**. This information will be publicly available, so do not use private information.
6. Click **Next: Size and scale**.

7. On the **Size and scale** tab, select a **Pricing and scale tier**, specify the **IoT Hub units**, and under **Advanced Settings**, choose the number of **Device-to-cloud partitions** (most likely four).

8. Click **Review + create**.

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**Adding an xPico 200 series using a SAS Token**

After you have created an IoT Hub in Microsoft Azure, follow these steps to integrate an xPico 200 series device with Microsoft Azure using a SAS Token.

Create a device in your IoT Hub:

2. Click **Home** if you are not already at the home page.

3. Click your **IoT Hub**.

4. On the left, click **IoT devices**.

5. Click **New** at the top.
6. Enter a unique name for the device in **Device ID**. Under **Authentication type**, select **Symmetric key**. Leave **Auto-generate keys** checked. Leave **Connect this device to an IoT hub** set to **Enable**. Click **Save**.

7. Click **Home**.

8. Click your **IoT Hub**.
9. Click **Shared access policies** on the left.

10. Under **Policy**, click **iothubowner**.

11. On the right, click the copy button next to **Connection string – primary key**.
Next, generate a SAS Token for the device:

2. If you are not signed in to Azure, you will be prompted to sign in to Azure and select a subscription.
3. In the bottom-left, click AZURE IOT HUB and then click the menu button.
4. Select Set IoT Hub Connection String.
5. A prompt will appear at the top of the window. Enter the connection string you copied earlier and press Enter.
6. A device list will be shown under AZURE IOT HUB. Right-click the device you created and select **Generate SAS Token for Device**.

7. A prompt will appear at the top of the window. Specify the expiration time in hours and press **Enter**.

8. The SAS Token will be generated, shown in the output, and automatically copied to the clipboard.

Configure the xPico 200 series device via Web Manager or CLI:

1. Set the **Line 1 protocol** to Azure IoT.
2. Set the Azure Configuration as follows:
   - **State**: Enabled
   - **Hub Name**: The name of the IoT Hub in Azure
   - **Device ID**: The Device ID set in Azure when the device was created
   - **Security**: Security Keys
   - **SAS Token**: The SAS Token generated in Visual Studio Code
   - **MQTT Local Port**: <Random>

Test the integration:

1. Using TeraTerm, connect to the xPico 200 series device via serial connection on line 1.
2. Click **Setup > Terminal**.
3. Under **New-line**, set **Receive** and **Transmit** to LF and click **OK**.
4. Open **Device Explorer**.
5. Under **IoT Hub Connection String**, paste the connection string you obtained earlier and click **Update**.
6. In the **Data** tab, select your device next to **Device ID** and click **Monitor**.

7. In TeraTerm, type some characters and hit **Enter**. The data will appear under **Event Hub Data** in Device Explorer.

![Device Explorer Screenshot](image-url)

**Event Hub Data**

```
Receiving events...
2/21/2020 7:27:06 PM> Device:[LantronixTest], Data:[hello world]
```
8. In the **Messages To Device** tab, select your device next to **Device ID**, type some characters next to **Message**, and click **Send**. The data will appear in TeraTerm.

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**Adding an xPico 200 series using a self-signed X.509 certificate**

After you have created an IoT Hub in Microsoft Azure, follow these steps to integrate an xPico 200 series device with Microsoft Azure using a self-signed X.509 certificate.

Create a self-signed certificate:

1. Open a Linux, CygWin, or MinGW terminal.
2. Generate an openssl private key.
   
   ```
   $ openssl genrsa -des3 -out server.key 4096
   Generating RSA private key, 4096 bit long modulus
   ...........................................................................++
   ................................................................................
   ................................................++
   e is 65537 (0x10001)
   Enter pass phrase for server.key:
   Verifying - Enter pass phrase for server.key:
   ```
3. Generate a certificate signing request (CSR).
   
   ```
   $ openssl req -new -key server.key -out server.csr
   ```
   Enter pass phrase for server.key:
   You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter ".", the field will be left blank.
-----
Country Name (2 letter code) [AU]:US
State or Province Name (full name) [Some-State]:CA
Locality Name (eg, city) []:Irvine
Organization Name (eg, company) [Internet Widgits Pty Ltd]:Lantronix
Organizational Unit Name (eg, section) []:Engineering
Common Name (e.g. server FQDN or YOUR name) []:<device IP address>
Email Address []:

Please enter the following ‘extra’ attributes
to be sent with your certificate request
A challenge password []:<secret>
An optional company name []:

4. Remove the passphrase from the key.
$ cp server.key server.key.org

$ openssl rsa -in server.key.org -out server.key
Enter pass phrase for server.key.org:
writing RSA key

5. Generate a self-signed certificate.
$ openssl x509 -req -days 365 -in server.csr -signkey server.key -out server.pem
Signature ok
subject=/C=US/ST=CA/L=Irvine/O=Lantronix/OU=Engineering/CN=<device IP address>
Getting Private key

Configure the xPico 200 series device via Web Manager or CLI:

1. Create a new TLS Credential.

2. Set the Private Key to the contents of server.key, which can be opened with a text editor such as Notepad. Include both the beginning and ending lines as well:
   -----BEGIN RSA PRIVATE KEY-----
   <Your base64 encoded private key will be in here.>
   -----END RSA PRIVATE KEY-----

3. Set the Certificate to the contents of server.pem, which can be opened with a text editor such as Notepad. Include both the beginning and ending lines as well:
   -----BEGIN CERTIFICATE-----
   <Your base64 encoded certificate will be in here.>
   -----END CERTIFICATE-----

Register the X.509 self-signed certificates to your IoT Hub:

2. Click Home if you are not already at the home page.
3. Click your IoT Hub.

![Image of Microsoft Azure dashboard with selected IoT Hub]

4. Click Certificates on the left.

![Image of Microsoft Azure dashboard with selected Certificates]

5. Click Add at the top.
6. Enter a certificate name, select your `server.pem` file, and click **Save**.

7. Click the certificate you created to open Certificate Details on the right.

9. Next to the Verification Code, click the blue copy button to copy the code.

10. In a Linux, CygWin, or MinGW terminal, create the verification key.
    $ openssl genrsa -out verification.key 2048

11. Create the verification certificate using the verification key.
    $ openssl req -new -key verification.key -out verification.csr

12. Specify the verification code copied previously when prompted.

13. Create the proof of possession certificate using the verification certificate.
    $ openssl x509 -req -in verification.csr -CA server.pem -CAkey server.key -CAcreateserial -out verificationCert.pem -days 1024 -sha256

15. Click the certificate you created. In Certificate Details, click the blue copy button next to Thumbprint to copy the thumbprint.

Create a device in your IoT Hub:
1. Click **Home** if you are not already at the home page.

2. Click your **IoT Hub**.

3. On the left, click **IoT devices**.

4. Click **New** at the top.
5. Enter a unique name for the device in **Device ID**. Under **Authentication type**, select **X.509 Self-Signed**. Paste the thumbprint you copied earlier under **Primary Thumbprint** and **Secondary Thumbprint**. Leave **Connect this device to an IoT hub** set to **Enable**. Click **Save**.

Configure the xPico 200 series device via Web Manager or CLI:

1. Create a new TLS Credential.
2. Set the **Private Key** to the contents of server.key, which can be opened with a text editor such as Notepad.
3. Set the **Certificate** to the contents of server.pem, which can be opened with a text editor such as Notepad.
4. Set **Trusted Authority 1** to the contents of D-TRUST.PEM, **Trusted Authority 2** to the contents of DigiCert.pem, and **Trusted Authority 3** to the contents of baltimore-ca.pem.
5. Set the **Line 1 protocol** to Azure IoT.
6. Set the Azure Configuration as follows:
   - **State**: Enabled
   - **Hub Name**: The name of the IoT Hub in Azure
   - **Device ID**: The Device ID set in Azure when the device was created
   - **Security**: X.509
   - **Credential Name**: <the name of the TLS credential>
   - **MQTT Local Port**: <Random>

   Obtain the connection string:

   1. In Azure Portal, click **Home**.
2. Click your IoT Hub.

3. Click **Shared access policies** on the left.

4. Under **Policy**, click **iothubowner**.
5. On the right, click the copy button next to **Connection string – primary key**

![Image of Azure portal with Connection string highlighted]

**Test the integration:**

1. Using TeraTerm, connect to the xPico 200 series device via serial connection on line 1.
2. Click **Setup > Terminal**.
3. Under **New-line**, set **Receive** and **Transmit to LF** and click **OK**.
4. Open **Device Explorer**.
5. Under **IoT Hub Connection String**, paste the connection string you obtained earlier and click **Update**.
6. In the **Data** tab, select your device next to **Device ID** and click **Monitor**.

![Device Explorer: Data tab](image)

7. In TeraTerm, type some characters and hit **Enter**. The data will appear under **Event Hub Data** in Device Explorer.

```
Event Hub Data
Receiving events...
2/21/2020 7:27:06 PM > Device:[LantronixTest], Data:[hello world]
```
8. In the Messages To Device tab, select your device next to Device ID, type some characters next to Message, and click Send. The data will appear in TeraTerm.

Adding an xPico 200 series using a CA-signed X.509 certificate

After you have created an IoT Hub in Microsoft Azure, follow these steps to integrate an xPico 200 series device with Microsoft Azure using a CA-signed X.509 certificate.

Generate the root and intermediate certificates:

2. Open a Linux, CygWin, or MinGW terminal.
3. Go to the directory storing the files that you downloaded.
4. Set certGen.sh as an executable.
   chmod +x certGen.sh
5. Create the root and intermediate certificates using the following command:
   ./certGen.sh create_root_and_intermediate

Register the certificates to your IoT Hub:

2. Click Home if you are not already at the home page.
3. Click your IoT Hub.

4. Click Certificates on the left.

5. Click Add at the top.
6. Enter a certificate name, select your `azure-iot-test-only.root.ca.cert.pem` file, and click **Save**.

```
Add Certificate

Learn more about certificates.

Certificate Name * ○
LantronixTest

Certificate .pem or .cer file. * ○
"azure-iot-test-only.root.ca.cert.pem"
```

7. Click the certificate you created to open Certificate Details on the right.

9. Next to the Verification Code, click the **blue copy button** to copy the code.
10. From the terminal used earlier, generate the verification certificate.
   
   `./certGen.sh create_verification_certificate <Verification Code copied in the previous step>`

11. In the Certificate Details panel in Azure Portal, upload `verification-code.cert.pem` and click **Verify**.

![Certificate Details Panel](image)

Create a device in your IoT Hub:

1. Click **Home** if you are not already at the home page.
2. Click your IoT Hub.

3. On the left, click IoT devices.

4. Click New at the top.
5. Enter a unique name for the device in **Device ID**. Under **Authentication type**, select **X.509 CA Signed**. Click **Save**.

6. From the terminal used earlier, generate the device certificate (new-device.key.pem and device.cert.pem).
   
   ```
   ./certGen.sh create_device_certificate <Device ID>
   ```

   Configure the xPico 200 series device via Web Manager or CLI:

   1. Create a new TLS Credential.
   2. Set the **Private Key** to the contents of new-device.key.pem, which can be opened with a text editor such as Notepad.
   3. Set the **Certificate** to the contents of new-device.cert.pem, which can be opened with a text editor such as Notepad.
   4. Set **Higher Authority 1** to the contents of azure-iot-test-only.root.ca.cert.pem.
   5. Set **Trusted Authority 1** to the contents of D-TRUST.PEM, **Trusted Authority 2** to the contents of DigiCert.pem, and **Trusted Authority 3** to the contents of balitmore-ca.pem.
   6. Set the **Line 1 protocol** to Azure IoT.
   7. Set the Azure Configuration as follows:
      - **State**: Enabled
      - **Hub Name**: The name of the IoT Hub in Azure
      - **Device ID**: The Device ID set in Azure when the device was created
      - **Security**: X.509
      - **Credential Name**: <the name of the TLS credential>
      - **MQTT Local Port**: <Random>
Obtain the connection string:

1. In Azure Portal, click **Home**.
2. Click your **IoT Hub**.
3. Click **Shared access policies** on the left.

4. Under **Policy**, click **iothubowner**.

<table>
<thead>
<tr>
<th>Policy</th>
<th>Permissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>iothubowner</td>
<td>registry write, service connect, device connect</td>
</tr>
<tr>
<td>service</td>
<td>service connect</td>
</tr>
<tr>
<td>device</td>
<td>device connect</td>
</tr>
<tr>
<td>registryRead</td>
<td>registry read</td>
</tr>
<tr>
<td>registryReadWrite</td>
<td>registry write</td>
</tr>
</tbody>
</table>
5. On the right, click the copy button next to **Connection string – primary key**

Test the integration:

1. Using TeraTerm, connect to the xPico 200 series device via serial connection on line 1.
2. Click **Setup > Terminal**.
3. Under **New-line**, set **Receive** and **Transmit** to LF and click **OK**.
4. Open **Device Explorer**.
5. Under **IoT Hub Connection String**, paste the connection string you obtained earlier and click **Update**.
6. In the **Data** tab, select your device next to **Device ID** and click **Monitor**.

![Device Explorer Screenshot]

7. In TeraTerm, type some characters and hit **Enter**. The data will appear under **Event Hub Data** in Device Explorer.

![Event Hub Data]

- Receiving events...
- 2/21/2020 7:27:06 PM> Device:[LantronixTest], Data:[hello world]
8. In the **Messages To Device** tab, select your device next to **Device ID**, type some characters next to **Message**, and click **Send**. The data will appear in TeraTerm.

![Device Explorer screenshot](image)

**Calling methods on an xPico 200 series directly**

After you have created an IoT Hub in Microsoft Azure and have added the xPico 200 series device using any of the three methods above, you can call the following methods directly in **Device Explorer**. The line protocol on the device does not need to be set to Azure IoT to call methods.

- **ltrx_import_xml_config** – imports XML configuration or performs action
- **ltrx_trusted_import_xml_config** – imports XML configuration or performs action. Compared to **ltrx_import_xml_config**, **ltrx_trusted_import_xml_config** is intended for programmers who have already tested their XML. The XML header must be left out. It has less error checking than **ltrx_import_xml_config** and eliminates multiple passes. It does not need to cache the XML in flash memory and is faster. While **ltrx_import_xml_config** saves the configuration if successful, **ltrx_trusted_import_xml_config** does not, like a CLI command.
- **ltrx_read_xml_status** – reads XML status
- **ltrx_read_xml_config** – reads XML configuration

The following examples show how to use these methods. In all examples, the device must be added to an IoT Hub in Microsoft Azure, and Azure State must be Up.
**ltrx_import_xml_config**: Import XML (configgroup: SPI)

1. Open Device Explorer and click the **Call Method on Device** tab.
2. Select your device next to **Device ID**.
3. Type **ltrx_import_xml_config** next to **Method name**.
4. Next to **Method payload**, copy and paste the below XML and then click **Call Method**.

```json
{"param":"
<?xml version="1.0" standalone="yes"?>
<!DOCTYPE configrecord [
<!ELEMENT configrecord (configgroup+)>
<!ELEMENT configgroup (configitem+)>
<!ELEMENT configitem (value+)>
<!ELEMENT value (#PCDATA)>
<!ATTLIST configrecord version CDATA #IMPLIED>
<!ATTLIST configgroup name CDATA #IMPLIED>
<!ATTLIST configgroup instance CDATA #IMPLIED>
<!ATTLIST configitem name CDATA #IMPLIED>
<!ATTLIST configitem instance CDATA #IMPLIED>
<!ATTLIST value name CDATA #IMPLIED>
]>
<configrecord version = "0.1.0.1">
  <configgroup name = "SPI" instance = "1">
    <configitem name = "State">
      <value>disabled</value>
    </configitem>
  </configgroup>
</configrecord>
"}
5. Verify that the SPI configuration settings have imported successfully.

ltrx_trusted_import_xml_config: Trusted import XML (configgroup: SPI)

1. Open Device Explorer and click the Call Method on Device tab.
2. Select your device next to Device ID.
3. Type ltrx_trusted_import_xml_config next to Method name.
4. Next to Method payload, copy and paste the below XML and then click Call Method. ("param":
   <configrecord version = "0.1.0.1">
     <configgroup name = "SPI" instance = "1">
       <configitem name = "State">
         <value>disabled</value>
       </configitem>
     </configgroup>
   </configrecord>
"
5. Verify that the SPI configuration settings have imported successfully.

**ltrx_read_xml_status**: Read XML status

1. Open Device Explorer and click the **Call Method on Device** tab.
2. Select your device next to **Device ID**.
3. Type **ltrx_read_xml_status** next to **Method name**.
4. Next to **Method payload**, copy and paste the below XML and then click **Call Method**.

```
{"param":"Access Point;Line"}
```
5. Verify that the Access Point and Line status have been returned successfully.

ltrx_read_xml_config: Read XML configuration

1. Open Device Explorer and click the Call Method on Device tab.
2. Select your device next to Device ID.
3. Type ltrx_read_xml_config next to Method name.
4. Next to Method payload, copy and paste the below XML and then click Call Method.
   
   ```xml
   {"param":"Access Point;Line"}
   ```
5. Verify that the Access Point and Line configuration have been returned successfully.

**ltrx_trusted_import_xml_config**: Status Action

1. Open Device Explorer and click the **Call Method on Device** tab.
2. Select your device next to **Device ID**.
3. Type **ltrx_trusted_import_xml_config** next to **Method name**.
4. Next to **Method payload**, copy and paste the below XML and then click **Call Method**.

   ```xml
   "param":"{
   "configrecord version = "0.1.0.1"
   "configgroup name = "xml import control"
   "configitem name = "action"
   "value name = "group"">interface</value>
   "value name = "optional group instance">wlan0</value>
   "value name = "optional item"></value>
   "value name = "optional item instance"></value>
   "value name = "name">renew</value>
   </configitem>
   </configgroup>
   </configrecord>
   "}
   ```
5. Verify that the DHCP IP address has been renewed successfully.