Application Note:

Integrating xPico 200 Series with Microsoft Azure
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Contacts

Lantronix, Inc.
48 Discovery, Suite 250
Irvine, CA 92618, USA
Toll Free: 800-526-8766
Phone:  949-453-3990
Fax:  949-453-3995

Technical Support
Online: _www.lantronix.com/support_

Sales Offices
For a current list of our domestic and international sales offices, go to the Lantronix web site at _www.lantronix.com/about/contact_

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Revision History

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<tr>
<td>June 2020</td>
<td>A</td>
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<tr>
<td>June 2021</td>
<td>B</td>
<td>Update openssl command to generate a private key.</td>
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<td>C</td>
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1 Overview

This application note 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. Refer to the Microsoft Azure documentation for updated Azure instructions.

You can add a device to an IoT Hub in Azure using either a SAS Token, a self-signed X.509 certificate, or a CA-signed X.509 certificate. This document describes how to create an IoT Hub in Azure, the methods for adding a device, and examples for calling methods on an xPico 200 series device using the Device Explorer tool from the Azure IoT SDK.

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 baltimore-ca.pem: https://github.com/Azure/azure-iot-sdk-c/tree/master/certs (for the self-signed X.509 method)
2 Creating an IoT Hub in Microsoft Azure

To create an IoT Hub in Microsoft Azure:


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.**
3 Adding an xPico 200 Series Device to Azure IoT Hub

Use one of the methods described in this section to add the xPico 200 device to your IoT Hub in Microsoft Azure.

Adding a device using a SAS Token

To add a device:

STEP 1. 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**.
STEP 2. 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.

STEP 3. 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>
STEP 4. 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](image)

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

![Event Hub Data Screenshot](image)
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 a device using a self-signed X.509 certificate**

**To add a device:**

**STEP 1. Create a self-signed certificate**

1. Open a Linux, CygWin, or MinGW terminal.
2. Generate an openssl private key.

   ```
   $ openssl req -x509 -newkey rsa:4096 -nodes -keyout key.pem -out cert.pem -days 365
   ```

   Generating a 4096 bit RSA private key
   ................................................++
   .................................................................++
   writing new private key to 'key.pem'
   ----- 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.
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

**STEP 2. 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-----
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-----
```

**STEP 3. 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**.

![Azure IoT Hub](image)

4. Click **Certificates** on the left.
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
14. In the Certificate Details panel in Azure Portal, upload `verificationCert.pem` and
    click **Verify**.
15. Click the certificate you created. In Certificate Details, click the blue copy button next to Thumbprint to copy the thumbprint.

![Certificate Details]

STEP 4. Create a device in your IoT Hub

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

![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**.

**STEP 5. 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>

STEP 6. 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 iotubowner.
5. On the right, click the copy button next to **Connection string – primary key**

STEP 7. 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 Monitor](image)

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

```
Receiving events...
2/21/2023 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 a device using a CA-signed X.509 certificate**

**To add a device:**

**STEP 1. 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.
   ```bash
   chmod +x certGen.sh
   ```
5. Create the root and intermediate certificates using the following command:
   ```bash
   ./certGen.sh create_root_and_intermediate
   ```

**STEP 2. 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**.

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)

   **STEP 3. 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).

   ```bash
   ./certGen.sh create_device_certificate <Device ID>
   ```

**STEP 4. 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 baltimore-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>

**STEP 5. Obtain the connection string**

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

   ![Image of settings with Shared access policies highlighted]

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**

STEP 6. 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 with Monitor button highlighted](image)

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

![Event Hub Data in Device Explorer](image)

```
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.
4 Calling Methods on an xPico 200 Series Device

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.

Examples

ltrx_import_xml_config

Description: 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.

```
{"param":"
<?xml version="1.0" standalone="yes"?>
<!-- Automatically generated XML -->
<!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>
```
5. Verify that the SPI configuration settings have imported successfully.

```xml
/configrecord version = "0.1.0.1">
  <configgroup name = "SPI" instance = "1">
    <configitem name = "State">
      <value>disabled</value>
    </configitem>
  </configgroup>
</configrecord>
```

![Device Explorer screenshot showing Call Method on Device with IoT Hub, Device ID, Method name, and Method payload details. Return status and payload displayed as 200 and "XML import completed."
**ltrx_trusted_import_xml_config**

Description: 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.
   ```json
   {"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**

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

![Device Explorer screenshot](image)
**ltrx_read_xml_config**

Description: 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**

Description: 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.