

Using IoTWorX as a Gateway in Microsoft Azure Deployments

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1 Installing GENESIS64 with custom options

The GENESIS64 suite comes with many features and modules. To use GENESIS64 as an IoTWorX gateway, we can customize the installation with only the options that we need to minimize the install footprint on the gateway.

1.1 Pre-requisites

An on-premises computer or Azure VM (requires bi-directional VPN with Azure and building device protocols allowed). For sizing purposes, we have the following configuration running:

- Hardware: Intel NUC i7-5557U with 16GB RAM
- Operating system: Windows 10 Enterprise
- Gateway: IoTWorX
- Load: polling 6,500 data points in two buildings every 5 minutes
- System utilization: 11% CPU, 28% Memory

Install one of the following 64-bit Windows Operating Systems on the computer or VM

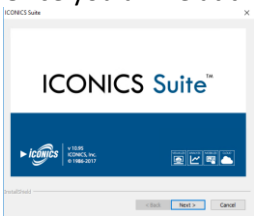
- Windows 10 Professional
- Windows 10 Enterprise
- Windows Server 2016

Install Microsoft .NET Framework 4.5

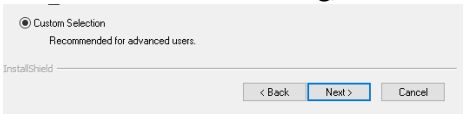
1.2 GENESIS64 Installation

After the pre-requisites above are met, install GENESIS64 by following the steps below:

1. Double click on '***setup.exe***' from the GENESIS64 installation folder.
2. On the dialog that shows up, click on '***Install***' to install additional required components.
    - The installation may ask for a reboot at various installation steps. Click Yes to reboot accordingly.
    - After reboot, relaunch '***setup.exe***' if the installation dialog doesn't show up automatically after logging in.
3. Repeat step 2 until all necessary required additional components are installed.
    - When asked about SQL server installation, click Yes.
4. Once you arrive at the installation welcome screen like below, click on Next.



5. At the license agreement dialog, read through the license agreement and select the first radio button to accept the terms, then click Next.
6. In the Suite selection dialog, select the Custom Selection radio button like below:



7. Click Next.

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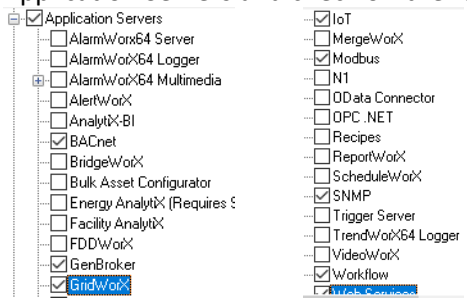
8. In the installation destination folder dialog, click on Browse if you wish to change the installation location, otherwise, click Next.
9. In the installation options screen, click on '***Deselect Options***' button near the bottom left.
10. From the list of options on the left, expand Server and check off the following:
    - Platform Services



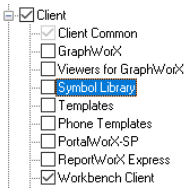
11. Under Server, expand Application Servers and check off the following:
    - BACnet
    - GenBroker
    - GridWorX
    - IoT
    - Modbus
    - SNMP
    - Workflow
    - Web Services



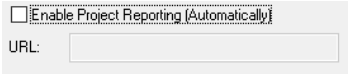
12. Under Server, expand Web Applications and check off the following:
    - Workbench Server



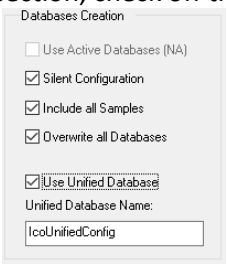
13. Expand Client and check off the following:
    - Client Common
    - Workbench Client



14. Check off Help if you want to install help on the gateway (Note that installing Help will consume an additional 900+MB).
15. Click Next.
16. In the user account dialog, click on the New User Information button near the bottom left.
17. Enter a password for the ICONICS_USER account that will run all ICONICS services.
18. Click OK.
19. Click Next.
20. In the Database Server dialog, uncheck Enable Project Reporting at the bottom left.



21. On the right Database Creation section, check off the following:
    - Silent Configuration
    - Include all Samples
    - Overwrite all Databases
    - Use Unified Database



22. Click Next and then click Install.
23. Restart the computer when requested.

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2 Setting up IoT Hub

2.1 Create a new IoT device

1. Login to the Azure portal.
2. Create a new IoT Hub that will receive published data.
   (follow this guide to create a new IoT Hub: https://docs.microsoft.com/en-us/azure/iot-hub/iot-hub-create-through-portal)
3. Open the configuration blade of the IoT Hub.
4. Click on IoT devices from the list of options on the left.
5. In the devices blade, select 'Add' at the top to create a new device.
6. Give the device an ID.
   NOTE: The device ID must be unique among all the devices for this hub.
7. Keep all other options as default.
8. Click on Save to create the new device.

2.2 Get device connection string

1. Once your gateway devices are created, re-open the IoT devices list.
2. Select the newly created device.
3. In the device details page, look for 'Connection string (primary key)'.
4. To the right of that field is a button to copy the connection string - click on the copy button to copy the connection string to the clipboard.
5. Store the connection string somewhere temporarily until it's needed in the subsequent sections.

2.3 Get IoT Hub subscriber connection string

1. From the IoT Hub configuration blade, click on Shared access policies.
2. Click on 'iothubowner'.
3. From the blade that opens on the right, look for 'Connection string – primary key' field.
4. To the right of the field is a button to copy the connection string – click on the copy button to copy the connection string to the clipboard.
5. Store the connection string somewhere temporarily until its needed in the subsequent sections.

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3 Setting up GENESIS64 for data publishing

3.1 Specify where devices are to be found

IoTWorX needs to know from where to get device data. In a typical installation, this is a BACnet IP device. To auto-discover BACnet devices in multiple subnets, a BACnet Broadcast Management Device (BBMD) is required per subnet. This BBMD device listens for queries from a management system on a specific IP address and port. In IoTWorX you need to create an entry in the Data Connectivity section to specify this IP address and port:

1. Open Workbench Desktop on the GENESIS64 machine/gateway that will be publishing data.
2. In the Project Explorer, expand your project, then Data Connectivity, then BACnet.
3. Right click on Ports.
4. Click on Add Port.
5. In the [NewPort] tab, in the Name section, enter a name for the port.

> ***For example, use the following convention***
> *Building or Equipment Name + "_BBMD, e.g. "HQ_BBMD".*

6. In the Port Settings section, select BACnetIP in the Channel Type.
7. In the Foreign Devices section, check the Foreign Devices checkbox in the section heading.



8. Add one or more BBMDs or devices to the Foreign Devices list - click Add and specify the IP address and port number (BACnet default port is 47808) of the device or BBMD that the gateway should query for device data.
9. Repeat for all the BBMDs that you want this gateway to query.

The number of ports is reflective of the number of NIC cards you want to use. In most cases, the gateway may have only one NIC card, so you should only need one port, with multiple foreign device registrations under it. If you have multiple NIC cards, you can add additional ports, following the steps above from "Add Port." If you have only one port, when you are done the configuration should be similar to that shown in Figure 1, which shows a network location with three foreign devices configured:

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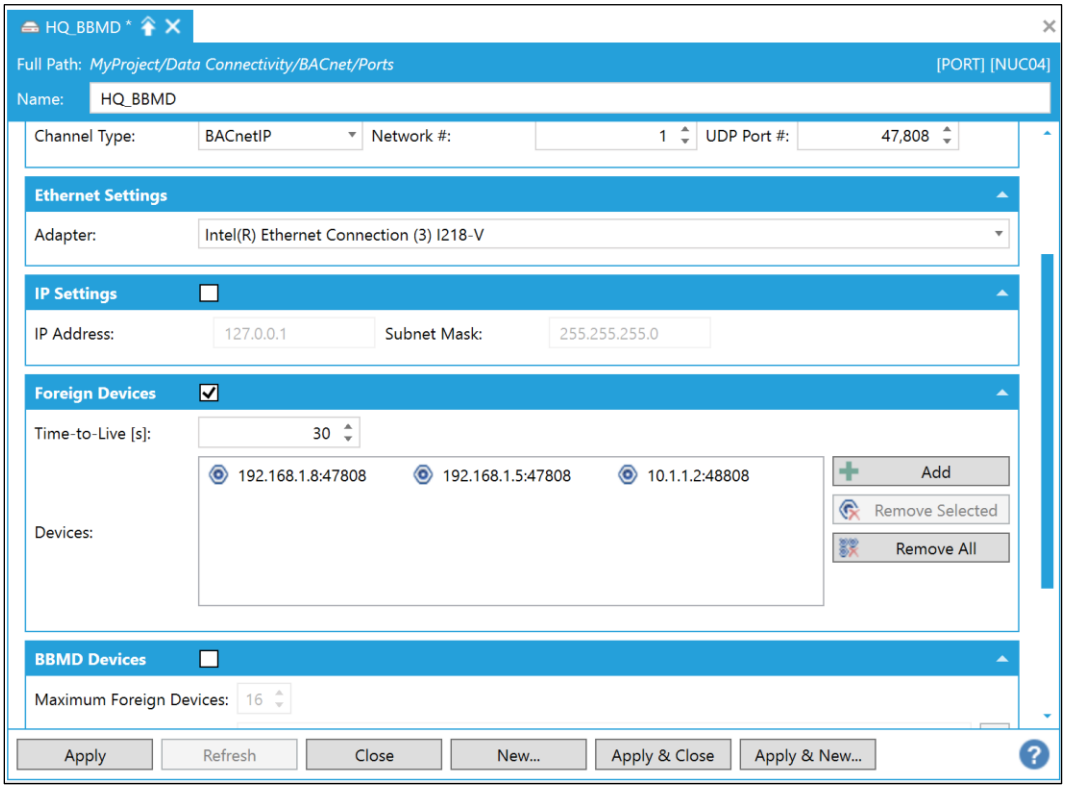

Figure 1 Network port configuration

3.2 Discover devices

The BACnet runtime in IoTWorX needs next to discover what devices can be accessed at that network location. If there are only a few devices, you can add them individually; if there are many – hundreds or even thousands – you can launch a network discovery.

3.2.1 Add a device manually

1. In the Project Explorer, expand your project, then Data Connectivity, then BACnet.
2. Right click on Devices and click on Add Device.
3. In the [NewDevice] tab, in the Device section, give the device a name.

> ***For example, use the following convention***
> *"Device_" + device id, e.g. Device_1210100*

4. In the Device Settings section, specify the id of the device to connect. This must be the real device id, that the device understands. This is typically given to you by the facilities engineering team or the controls engineer who configured the device.
5. In the Static Binding section heading, check the checkbox.
6. Click on the ellipsis '…' next to the MAC (hex) label.
7. Enter the IP address and port number for the device and click OK.
8. Click Apply.

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3.2.2 Add multiple devices through a network scan

1. In the Project Explorer, expand your project, then Data Connectivity, then BACnet.
2. Right click on Devices and click on Network Discovery.
3. In the Discover BACnet devices window, change the i-Am Delay (s) to 30 second.
4. Enter a range that IoTWorX will scan for devices, e.g. to scan from device id 1210100 to device id 1210200. The smaller the range, the quicker the scan will be.
5. Click Scan.
6. As devices are found, they will be shown in the Network Results section. Select some or all the devices with the checkboxes on the left and click Add Selected Device(s) to Cache above the list.
7. A progress bar should show up below the list indicating the progress of adding the devices and their objects to the IoTWorX BACnet connectivity cache. This may take a while depending on the speed and volume of devices added.
8. Once the progress is complete, click Close.

The devices should now appear in the Project Explorer pane on the left, followed by the objects in those devices, as shown in Figure 2:

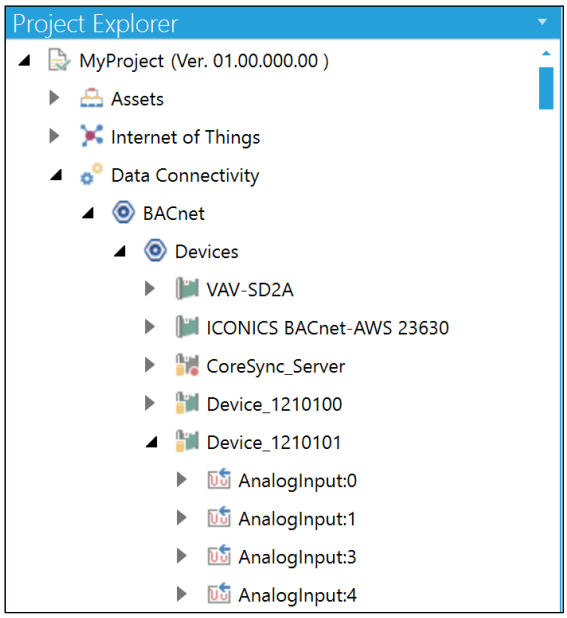

Figure 2 Devices shown in Project Explorer

3.3 Create a publish list

IoTWorX can get data from any of the devices listed in Project Explorer/BACnet/Devices, but you need to tell IoTWorX which data points in those devices to request data from and publish. You can specify the points manually or import a list of points from an Excel file (commonly called a 'Load Sheet'). If you want to create the list manually, follow the steps in Section 3.3.1 below; if you want to create by importing an Excel file, you need to prepare the Excel file by following the steps in Appendix A – Creating an Excel Load Sheet, and then follow the steps in Section 3.3.2.

3.3.1 Create a publish list manually

1. In the Project Explorer, expand your project and then Internet of Things.
2. Right click on Publish Lists.
3. Click on Add Publish List (Real Time).

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4. In the [NewPublisherList] tab, give the publish list a name.

   For example, use the following convention
   Building or Equipment name + "_PublishList", e.g. HQ_PublishList

5. In the Rate Setting (real time list) section adjust the publish rate settings.

   For example, use the following intervals
   Publish Rate: 5 minutes
   Refresh rate: 301 seconds
   Refresh Hold Off Time: 30 seconds
   Dynamic Tags Published: 50
   Sampling Rate: 150 seconds

   NOTE: If different publish rates are desired for different sets of points, please see Publishing Groups in Appendix B – Using Publish Groups.

6. Click on the 'Published Points' tab.
7. In the Points exposed by the publisher section, look for the link called '(Click here to add multiple tags)'.
8. Click on the link to bring up a data browser to add multiple tags.
9. Expand My Computer, expand Data Connectivity, and expand BACnet to show devices and data points discovered by IoTWorX.
10. Multi-select the desired published data points by holding Ctrl and clicking on the desired points
11. Click OK when finished with selection.
12. The selected points should now be added to the published points list.
13. Click on the '(Click to remove duplicates)' link to have the system check for duplicates.
    NOTE: This step is necessary to prevent duplicate tag publishing issues
14. Click Apply to save the Publish List.

3.3.2 Create a publish list by importing an Excel Load Sheet

1. In the Project Explorer, expand your project and then Internet of Things.
2. Right click on Publish Lists.
3. Click on Import.
4. In the Import Options window, select the Excel file to import and click OK.

Upon completion of 3.3.1 or 3.3.2, the Published Points tab should look like Figure 3:

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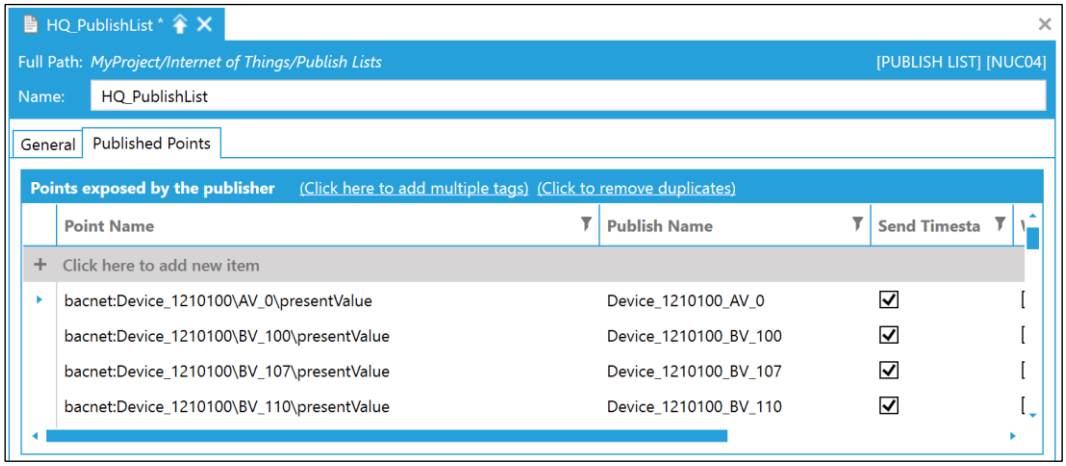

Figure 3 Publish Points in a Publish List

3.4 Create a custom encoder

IoTWorX requests the objects data points, formats the data received as a JSON package, and forwards it to IoT Hub. You create an 'encoder' to tell IoTWorX how to format the JSON.

1. In the Project Explorer, expand your project and then Internet of Things.
2. Right click on Custom Encoders.
3. Click on Add Encoder.
4. In the [NewEncoder] tab, give the encoder a name.

> ***For example, use the following convention***
> *Building name + "_encoder", e.g. "HQ_encoder" for one building*
> *Equipment name + "_encoder", e.g. "BCM-ETH_encoder" for one piece of equipment*
> *Group name + "_encoder", e.g. "Campus_encoder" for a group of buildings in a campus*

5. Change the Message Type to "One value for each message".
6. In the Value Format box edit the default entries and add keywords as necessary so that the Value Format contains the data you want to send to Azure IoT Hub. An example follows.

```
{
 "gwy": "HQ_IoTWorX",
 "name": "%PUBLISHNAME%",
 "value": "%VALUE%",
 "timestamp": "%NOWUTC.TEXT%",
 "status": "%STATUS.GOOD%"
}
```

> ***For example, use the following convention***
> *Building name + "_IoTWorX", e.g. "HQ_IoTWorX"*

7. Click Apply & Close to save your edits.

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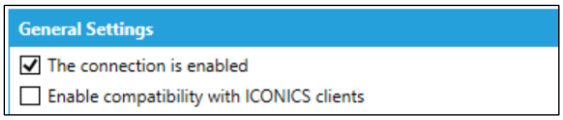
3.5 Create a publisher connection

IoTWorX sends the data to one or more cloud destinations. You specify the destination by creating a publisher connection. There is a one-to-one connection between a publish list, an encoder, and a publisher connection. For Microsoft Azure deployments, we send the data to an IoT Hub, and we specify the connection string of the hub and the encoder we want to use in the publisher connection.

1. In the Project Explorer, expand your project and then Internet of Things.
2. Right click on Publisher Connection.
3. Click on Add Publisher Connection.
9. Give the publisher connection a name.

> ***For example, use the following convention***
> *"To_" + IoT Hub name, e.g. "To_HQ_IoTHub"*

4. Ensure only the first of the following checkboxes are checked:



5. In the Connection Type, ensure Azure IoT Hub is selected.
6. In the Encoder, select the custom encoder you created above.
7. For the Heartbeat Rate, use 2 Minutes.
8. Scroll down to the 'Publish Lists' section.
9. Add the name of the publish list you created in Section 3.3 above to the Real Time Publish List field.
10. Scroll down to the 'IoT Hub Settings' section.
11. Copy the device connection string from section 1.2.
12. Paste it in the Connection String field.
13. For the Protocol, choose Automatic.
14. For the Max Message Size, enter 250,000 bytes.
15. Click Apply.

When you are done, it should be like Figure 4:

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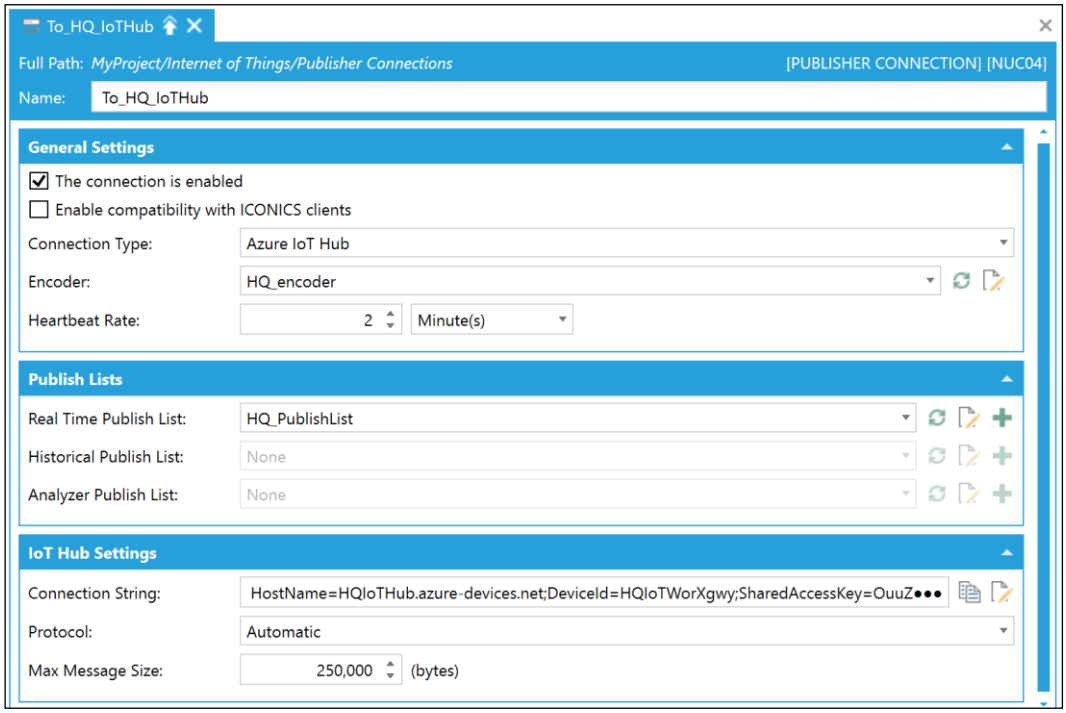

Figure 4 Publisher Connection

3.6 Start the publishing service

In Section 3.3 you specified which points IoTWorX should request; in Section 3.4 you specified how the data should be formatted before sending on to Azure; in Section 3.5, you specified where the data should be sent. Now you need to tell IoTWorX to start sending the data.

1. In the Project Explorer, expand your project and then Internet of Things.
2. In the ribbon, click on the Home tab.
3. Click on the traffic light icon for the Publisher to start the publisher service. It should turn green.
4. To be sure, check in Windows Task Manager that the 'FwxIotPublisherService' service is started.

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4 Viewing the data in Azure IoT Hub

You can easily check the data that is coming into Azure or view a sample of the data as it comes into Azure.

4.1 Verify that the data is being sent to Azure

1. Open the Azure portal and navigate to the IoT Hub specified in Section 2.
2. In the Monitoring section, click on Metrics.
3. In the filter bar at the top, pick “Telemetry Messages Sent” from the drop-down list.
4. If data is being sent from the gateway this should be visible in the chart. Since we configured messages to be sent every 5 minutes the chart should reflect batches of activity. Figure 5 shows the chart for a gateway polling data from multiple buildings.

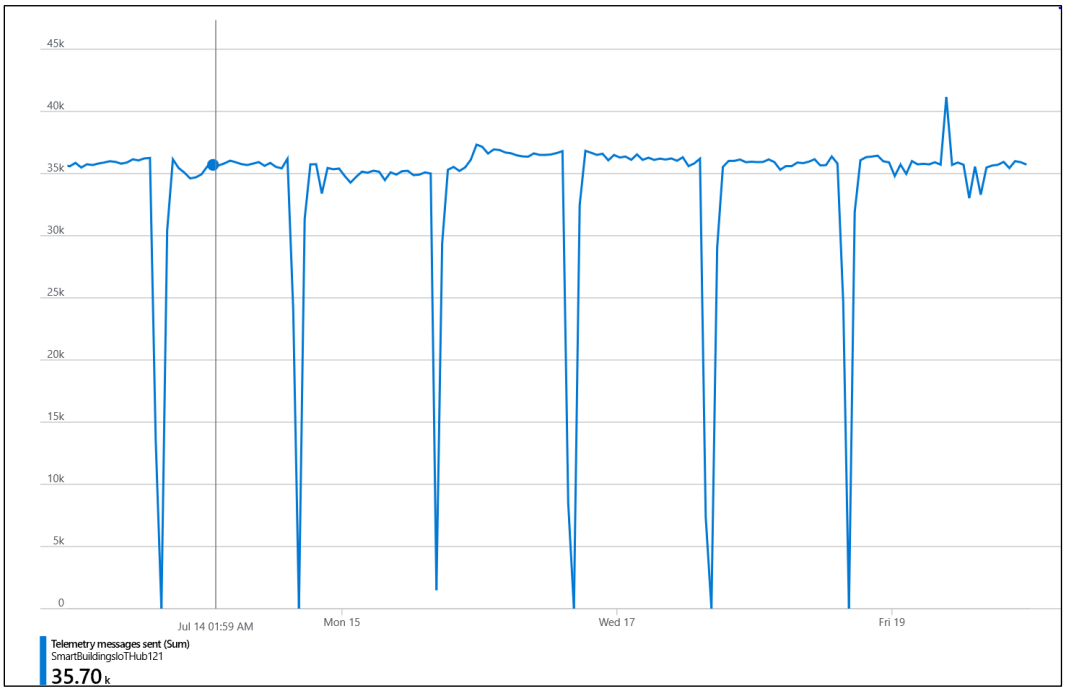

Figure 5 Telemetry Messages Sent

4.2 View a sample of the data being sent to Azure

1. Launch an application such as Azure Device Explorer, available as an MSI or as source code from GitHub Device Explorer repo.
2. In the Configuration tab, copy the IoT Hub connection string of the IoT Hub you got in Section 2.3 into the IoT Hub Connection String field, and click Update.
3. In the Management tab, click List.
4. In the Data tab, select the IoTWorX gateway in the Device ID drop-down list.
5. Click Monitor to see the data as it comes in to IoT Hub. It should look something like that shown in Figure 6.

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8/30/2019 3:40:06 PM> Device: [IoTWorXb121gwy],
Data:[{"gwy":"HQ_IoTWorX","name":"Device_1210100_AO_0","value":"3.5","timestamp":"2019-08-30T22:35:35.470Z","status":true}]Properties:
'gwRuntimeId': '9ac3dcfd-40f4-411d-a5a2-17f40ebe7331'
'encoder': 'HQ_encoder'
'deviceId': 'HQIoTWorXgwy'
'msgType': 'Refresh'

Figure 6 Data in Azure Device Explorer

Note that the key fields are those specified in 3.4 above, e.g.:

- "gwy" = "HQ_IoTWorX"
- "name" = “Device_1210100_AO_0” (%PUBLISHNAME%)
- "value" = “3.5” (%VALUE%)
- "timestamp" = “2019-08-30T22:35:35.470Z” (%NOWUTC.TEXT%)
- "status" = true (%STATUS.GOOD%)

At this point, IoTWorX is sending data from the building devices to Azure IoT Hub, and you can configure one or more applications to analyze the data.

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Appendix A – Creating an Excel Load Sheet

If you are creating a publish list by importing an Excel file as in Section 3.3.2, you need to prepare the Excel file. In the Excel file,

1. Create two sheets, one named **IotPublishList** the other named **IotPublishListElement**.
2. The IotPublishList contains information about the configuration of the publish list. Open that tab. In the first row, enter the following values to create columns for the list (Note the curly brackets around LocationPath, but not around any other):
    - {LocationPath}
    - Name
    - IsWriteEnabled
    - Type
    - CollectionRateSeconds
    - EnableCollectionTrigger
    - CollectionTrigger
    - PublishRateSeconds
    - EnablePublishTrigger
    - PublishTrigger
    - RefreshHoldOffTimeSeconds
    - BufferSize
    - PackageSize
    - StorageSize
    - RefreshRateSeconds
    - EnableRefreshTrigger
    - RefreshTrigger
    - DynamicSubscriptionLimit
    - SamplingRate
3. In the second row add the name for the publish list to create and values for the fields as follows:
    - {LocationPath}: This should always be **\Publish Lists**
    - Name: Your desired name of the publish list
    - IsWriteEnabled: **False** or **True**, depending upon IoTWorX can modify the value
    - Type: **2**
    - CollectionRateSeconds: 30 (but doesn't get used if we are getting BACnet points)
    - EnableCollectionTrigger: **False**
    - CollectionTrigger: Leave empty
    - PublishRateSeconds: **300**
    - EnablePublishTrigger: **False**
    - PublishTrigger: Leave empty
    - RefreshHoldOffTimeSeconds: **30**
    - BufferSize: **500000**
    - PackageSize: **5000**
    - StorageSize: **2000000**
    - RefreshRateSeconds: **301**
    - EnableRefreshTrigger: **False**
    - RefreshTrigger: Leave empty

    - DynamicSubscriptionLimit: **50**
    - SamplingRate: **150000** (but doesn't get used if we are getting BACnet points)
4. Add additional rows if you are creating multiple publish lists with one import.
5. The IotPublishListElement contains information about the data points in the publish list. Open that tab. In the first row, enter the following values to create columns for the list:
    - {LocationPath}
    - GUID
    - PublishTag
    - PublishName
    - SendTimestamp
    - IsWritable
    - PublishGroupID
6. Add rows for every data point to be polled by the gateway, with each row formatted as follows:
    - {LocationPath}: **\Publish Lists\ + Name of appropriate publish list**
    - GUID: A unique GUID per tag
    - PublishTag: Tag address of point
    - PublishName: Name of tag. Use **Device Name + '_' + Point Name**
    - SendTimestamp: True
    - IsWritable: False
    - PublishGroupID: Leave empty

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Appendix B – Using Publish Groups

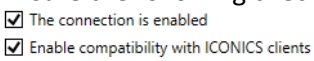
Publish groups can be used to define different publish rates for published points in the same publish list. To use publish groups, follow the steps below:

1. From the Internet of Things configuration tree, right click on ‘Publish Groups’.
2. Click on ‘Add Publish Group’.
3. In the configuration dialog, give the publish group a name.
4. Define the desired publish and sampling rate.
5. Click Apply to save this publish group.
6. Open the configuration dialog for your publish list.
7. Click on the Published Points tab.
8. For each point that you wish to associate to a publish group:
    a. Click on the drop down for the Publish Group column.
    b. Choose the desired publish group.
9. Click Apply to save the publish list.

Appendix C – Using GENESIS64 for data subscription

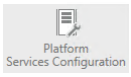
1. *Set up subscriber connection*

1. Open Workbench Desktop on the GENESIS64 machine that should receive IoT data.
2. From the Project Explorer, expand Internet of Things.
3. Right click on 

4. In the configuration dialog, give the subscriber connection a name.
5. Ensure the following checkboxes are checked:


6. Scroll down to the 'IoT Hub Settings' section.
7. Get the primary connection string obtained from section 1.3.
8. Paste the connection string in the 'Connection String' field.
9. Click Apply.

2. *Organize the browse structure of the published data*

1. To make the browsing of published data more user friendly, we will set the publisher service to create a virtual hierarchy based on the published tag address structure.
2. In the Workbench Desktop ribbon, click on the Tools tab.
3. Click on 

4. In the configuration dialog, click on 'Point Managers' tab.
5. Scroll down to the end and click on 'Internet of Things Point Manager'.
6. In the Parameters section below, look for the setting 'CreateVirtualHierarchy'.
7. Double click in the Value column of that setting.
8. Set the value to 'True'.
9. Click Apply to save the settings.

3. *Start the subscriber service*

1. In Workbench Desktop Project Explorer, click on the 'Internet of Things' configuration tree item.
2. From the ribbon, click on the Home tab.
3. Click on the traffic light icon for the Subscriber to start the subscriber service.
4. The Windows service called 'FwxIotSubscriberService' should be started.

4. *Visualize published data*

1. Data published from an ICONICS gateway is represented as a tag address.
2. To quickly visualize published data, open the Data Explorer application on the GENESIS64 machine subscribed to IoT Hub.
3. In Data Explorer, expand My Computer → Internet of Things.
4. You should see the subscriber connection name defined in section 3.1.
5. Expand the subscriber connection.
6. You should now see the publisher connection name defined in section 2.1.
7. Expand the publisher connection.

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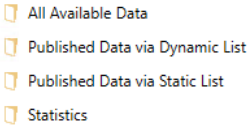
8. You should now see the following folders:



9. Expand the ‘Published Data via Static List’ folder.
10. You should see a folder structure that is reflects the structure from the list of published points.
11. Browse to and select one of the published points to see the most recent published value and timestamp on the right.
12. The same browsing process can be done in other ICONICS modules to visualize, analyze or log the published data.

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