### Internet of Things (IoT) – MQTT with Amazon Web Services (AWS)

#### For Use with the JNIOR Series 4

#### Last updated: December 4, 2019

The following information describes how to use the JNIOR Series 4 and its MQTT communication protocol with Amazon Web Services.

If you have any questions or want to use the JNIOR and MQTT with another broker, please contact INTEG via e-mail at **support@integpg.com** or via phone at 724-933-9350 with any questions. INTEG can adapt the MQTT application running on the JNIOR to meet your specific needs.

## Overview

The INTEG JNIOR automation controller is capable of being an edge device for the Internet of Things (IoT) applications using the MQTT protocol. The JNIOR can both publish and subscribe to topics using an MQTT broker.

The JNIOR implements the complete MQTT protocol including CONNECT, CONNACK, PUBLISH, PUBACK, SUBSCRIBE, SUBACK and UNSUBSCRIBE. The JNIOR can also provide all three Quality of Service levels.

The JNIOR topics are structured as follows:

#### DIGITAL INPUTS

jnior/'serial number'/DIN#

where DIN# is 1 - 12 representing the JNIOR digital inputs

and the data provided in the payload is as follows:

"State" - "HIGH" or "LOW" (on or off) "Counter" - value of the counter (counter increments each time input goes low to high) "UsageMeter" - value of the usage meter (timer increases when the input is 'high')

#### **RELAY OUTPUTS**

jnior/'serial number'/ROUT#

where ROUT# is 1 - 16 representing the JNIOR relay outputs

and the data provided in the payload is as follows:

"State" - "HIGH" or "LOW" (on or off) "UsageMeter" - value of the usage meter (timer increases when the output is 'high')

#### ANALOG INPUTS

jnior/'serial number'/AI#

where AI# is 1 - 8 representing the JNIOR analog inputs

and the data provided in the payload is as follows:

"value" - analog input reading

#### ANALOG OUTPUTS

jnior/'serial number'/AO#

where AI# is 1 - 4 representing the JNIOR analog outputs

and the data provided in the payload is as follows:

"value" - analog output reading

#### **TEMPERATURE SENSORS**

jnior/'serial number'/temperature

where temperature is a digital temperature sensor connected to the JNIOR

and the data provided in the payload is as follows:

"tempF" - temperature in Fahrenheit "tempC" - temperature in Celsius

#### **HUMIDITY SENSORS**

jnior/'serial number'/humidity

where humidity is a digital humidity sensor connected to the JNIOR

and the data provided in the payload is as follows:

"value" - humidity reading

#### ALL DATA

jnior/'serial number'/# acts as a wildcard and the broker can subscribe to all topics

# In all of the above, 'serial number' is the serial number of the JNIOR which distinguishes the source of each topic.

The MQTT application when installed on the JNIOR enables the JNIOR to both publish and subscribe to topics. The application can be installed on any of the JNIOR Series 4 controllers – Models 410, 412, 414. All of the JNIOR digital inputs, relay outputs, and JNIOR expansion modules such as analog signals, temperature signals and humidity signals can be integrated. The digital signal status is only published when the status is changed. The analog signals can be sent on a change in value or time basis.

### **Amazon Web Services**

The JNIOR is capable of interacting with Amazon Web Services (AWS) using a secure MQTT protocol connection. AWS brings a variety of features and functions for gathering data from IoT devices and then acting upon this data whether it is through data storage, text alerts, email messages, etc. How to use the 'data' is very dependent upon the user's application for the data.

The remainder of this document will describe how to enable the JNIOR to communicate with AWS and discuss a simple example where a text or email via AWS is sent each time a JNIOR input goes 'on' or a temperature exceeds a predefined limit. The document does not describe all the various features of AWS nor go into detail on how to exactly configure and use AWS.

To have the JNIOR connect to AWS, you need to create an AWS 'Thing'. Since AWS uses a secure connection, the first step is to create the necessary security certificates on the AWS site and then transfer these files to the JNIOR. You then run the Certificate Manager on the JNIOR to properly register the JNIOR.

Below is a picture from the AWS Internet of Things Device Management web page for the INTEG account. You can see that we have two Things.

AWS IoT	× 📑				
aws Ser	vices 🗸 Resource Groups 🗸	*		🗘 integ-aws 🕶 Oreg	on • Support •
0					Create
AWS IOT	Things		Card	✓ Search things	Create ?
Monitor	jnior-rick1	*** jnior-dev	•••		Ċ
Onboard	JNIORTYPE	JNIORTYPE			
Manage					
Things Types					
Groups					
Jobs					
Greengrass					
Secure					
Defend					
Act					
Test					
Software					
Settings					
Learn					
and diff if i					_

Below is a screen picture of the jnior-dev Thing.

Thi	<mark>ngs</mark> ≻ jnior-dev		
	THING jnior-dev JNIORTYPE		Actions -
Ľ	Details	Thing ARN	Edit
	Security	A thing Amazon Resource Name uniquely identifies this thing.	
	Groups	arn:aws:iot:us-west-2:372787147340:thing/jnior-dev	
	Shadow	iiiiiiiiiiiiiiiiiiiiiiiiiiiiiiii	
	Interact	Туре	
	Activity		
	Jobs	Q JniorType	***
	Violations		

By clicking on the Security link and then Create certifcate, the three security files will be created as shown in the following two screen pictures.

aws	Services - Resource	Groups 🗸 🔭	û integ-aws ▾ 0	regon 👻 Support 👻
÷	Things > jnior-dev			Ģ
	THING jnior-dev JNIORTYPE		Actions ~	() ()
	Details	Certificates		
	Security	Create certificate View other options		
	Groups	Create certificate View other options		
	Shadow			
	Interact	c1274e40c034a5191 0826938bcd830466f		
	Activity			
	sdoL			
	Violations			
				Ŷ

#### Certificate created!

Download these files and save them in a safe place. Certificates can be retrieved at any time, but the private and public keys cannot be retrieved after you close this page.

In order to connect a device, you need to download the following:

A certificate for this thing	0826938bcd.cert.pem	Download
A public key	0826938bcd.public.key	Download
A private key	0826938bcd.private.key	Download

You also need to download a root CA for AWS IoT: A root CA for AWS IoT Download



Using Windows FTP or the JNIOR web page, the first and third security files shown above (the certificate and private key) should be transferred to the JNIOR root directory.

Once the files have been transferred, the security files can be ingested in the JNIOR using the certificate manager command as shown in the following two screen pictures.

į) kev-aws		410 (S/N 614050022) JANOS v1. logout 'jnio
Input/Output Configuration	Console Folders Reg	gistry Syslog Peers About
		Clear End Session
Copyright (c) 2012-2018 II Local time: Wed Sep 19 13 System up time: 2 Hours 42 kev-aws /> help certmgr CERTMGR	TEG Process Group, Inc. 27:12 EDT 2018 Proce	., Gibsonia PA USA.
-V     Verify in:       -C [file]     Regeneratt       -A file     Add intern       -S file     Verify sig       -K file     Install R       -D [file]     Decode and       -E file     Export ce:       -P file     Export put       -B     Export in       -G [len]     Generate 1       -x file     Create Ce:	talled keys and certific e Certificate [Install f ediate certificate mature on certificate A Key Pair dump certificate [file tificate to file binary rey pair [bit length] tificate Signing Reques fault credentials	file] e]
SSL Certificate Management		~
kev-aws /> certmgr -c c12	4e40e0-certificate.pem.	crt
		Ins 52

#### 410 (S/N 614050022) JANOS v1.7 (i) kev-aws logout 'jnior Input/Output Configuration Console Folders Registry Syslog Peers About Clear End Session ONION HOUGE ITO (D/ N OTIOSOULL) Funiting Office ..... 0110 Copyright (c) 2012-2018 INTEG Process Group, Inc., Gibsonia PA USA. Local time: Wed Sep 19 13:27:12 EDT 2018 Process ID: 6 System up time: 2 Hours 42:26.919 kev-aws /> help certmgr CERTMGR Verify installed keys and ce: Regenerate Certificate [Insta Add intermediate certificate Verify signature on certific $-\nabla$ Verify installed keys and certificate -C [file] Regenerate Certificate [Install file] -A file -S finc -K file -D [file] -E file ¬ file Verify signature on certificate Install RSA Key Pair Decode and dump certificate [file] Export certificate to file Export public key to file Export in binary Generate key pair [bit length] Create Certificate Signing Request -G [len] -x file -R Restore default credentials SSL Certificate Management. V kev-aws /> certmgr -k c1274e40c0-private.pem.key < > Ins 48

The next step is to load the JNIOR application for MQTT-AWS. Below is a picture of the JNIOR web page Console tab showing that the 'mqtt-temp' process is running.

# **NOTE:** Custom versions of the MQTT application can be developed to meet specific customer needs.

(j) kev-aws					410 (5	5/N 614050	022) JANOS v1. logout 'jnio
Input/Output Configuration	Console	Folders	Registry	Syslog	Peers	About	
					Clear	End	Session
<pre>Welcome to the JNIOR Model Copyright (c) 2012-2018 IN Local time: Wed Sep 19 09; System up time: 00:28.928 kev-aws login: jnior kev-aws password: ***** kev-aws /&gt; ps 0: Idle Process 1: Network Service 2: Svstem 3: Run/flash/mqtt-te 4: web Server 7: Console/10.0.0.11 6: Secure Transport 7 total 35.692 up</pre>	WTEG Proce 44:00 EDT emp.jar 12:54651	ss Group,	Inc., Gib	sonia PA			
kev-aws />							
<							>
							Ins 11

The screen picture below verifies that the JNIOR has made a secure connection to the AWS server.

i) kev-aws				410	(S/N 614050022) JANG	OS v1.7-rc0 ogout 'jnior
Input/Output	Configuration	Console Folde	ers Registry	Syslog Pee	ers About	
					Clear End Sessi	on
Server/Conne	netstat       ion active (100       ection count: 7       c Remote Port       i       i       i       i       i       i       i       i       i       i       i       i       i       i		TLS v1.2 AES	/256 SHA256	State LISTEN LISTEN LISTEN LISTEN LISTEN ESTABLISHED ESTABLISHED	^
kev-aws /> kev-aws />						
kev-aws /> kev-aws />						
kev-aws />						>

Once the JNIOR side is completed and the AWS Thing created for the JNIOR, you can use the AWS test feature to 'subscribe' to the JNIOR topics. Below are several screen pictures first showing subscribing to a specific topic for JNIOR Input 1 and then the general wild card for all topics. Screen pictures are also provided of the payload for the various topics.

Subscriptions	jnior/614050022/DIN1	Export Clear Pause
Subscribe to a topic Publish to a topic jnior/614050022/DIN1 ×	Publish Specify a topic and a message to publish with a QoS of 0. jnior/614050022/DIN1  1  2  1 ("message": "Hello from AWS IoT console" 3 }	Publish to topic
	jnior/614050022/DIN1 Sep 19, 2018 10:03:54 PM -0400  {     "State": "HIGH",     "Counter": 60,     "UsageMeter": 48.3911 }	Export Hide

MQTT client ③		Connected as iotconsole-1537403422631-2
Subscriptions	jnior/614050022/#	Export Clear Pause
Subscribe to a topic Publish to a topic jnior/614050022/# ×	Publish Specify a topic and a message to publish with a QoS of 0. jnior/614050022/#	Publish to topic
	jnior/614050022/temperature Sep 19, 2018 9:29:22 PM -0400	Export Hide 🦱
	{ "tempF": 75.65, "tempC": 24.25 }	

```
Export Hide
jnior/614050022/DIN4 Sep 19, 2018 8:50:20 PM -0400
  {
 "State": "HIGH",
 "Counter": 5,
 "UsageMeter": 0.00879639
}
                                                                                            Export Hide
jnior/614050022/DIN4
                             Sep 19, 2018 8:59:37 PM -0400
  {
 "State": "LOW",
 "Counter": 5,
 "UsageMeter": 0.163602
}
                                                                                            Export Hide
jnior/614050022/ROUT1
                                Sep 19, 2018 8:59:42 PM -0400
  {
 "State": "HIGH",
 "UsageMeter": 5.53002
}
                                                                                            Export Hide
jnior/614050022/ROUT1
                                Sep 19, 2018 8:59:44 PM -0400
  {
 "State": "LOW",
 "UsageMeter": 5.53054
}
                                                                                            Export Hide
jnior/614050022/temperature
                                    Sep 19, 2018 8:58:18 PM -0400
  {
 "tempF": 75.65,
 "tempC": 24.25
}
```

jnior/614050022/humidity	Sep 19, 2018 8:54:15 PM -0400	Export	Hide
47.5			

# **AWS** Actions and Notifications

You can then utilize the AWS IoT functionality with their Simple Nework Notification service to monitor and react to various JNIOR I/O signals to implement a variety of actions including sending a text and email when certain parameters are met.

On the AWS IoT Act web page, you create various rules. The screen picture below indicates we have defined two rules so far.

Din1High is a rule related to digital input 1 going 'high'.

OverTemp is a rule related to the temperature reading going above a preset value.

aws	Services 🗸	Resource Groups 👻	*			4	integ-aws 👻	Oregon 👻	Support 👻	
AWS IOT		Rules			Card	•	Search rules		Create	Д ?
Monitor Onboard		Din1High ENABLED	•••• OverTer DISABLED	•••• np						Ś
Manage Greengrass Secure										
Defend Act										
Test										
Software										
Settings										
Learn										

Below is a screen picture of the rule for Din1High. The 'action' is to send a text message using a SnS push notification.

Din1High		
ENABLED		Actions *
Overview	Description	
	Digital Input 1 is ON	
	Cancel Update	
	Rule query statement	
	Using SQL version (2)	
	2016-03-23 •	
	Rule query statement	
	SELECT State FROM 'jnios/614050022/DIN1' WHERE State - 'HIGH'	
	Attribute 💿	
	State	
	Topic filter 💿	
	jnior/614050022/DIN1	
	Condition 3	
	State = 'HIGH'	
	Cancel Update	
	Actions	
	Actions are what happens when a rule is triggered. Learn more	
	Send a message as an SNS push notification Remove E	dit ▶
	Add action	
	Error action	
	Optionally set an action that will be executed when something goes wrong with processing your rule.	

Add action

Using the AWS Simple Network Notification, we can configure a topic and subscription that are used for the action above.

aws Services	*	Resource Groups 👻 🔦					
SNS dashboard	Т	Topics					
Topics Applications		Publish to topic Create new topic Actions -					
Subscriptions	Fi						
Text messaging (SMS)							
		Name	ARN				
		send-digital-input-1-high-al	am:aws:sns:us-west-2:372787147340:send-digital-input-1-high-alert				
		] send-digital-input-2-alert	arn:aws:sns:us-west-2:372787147340:send-digital-input-2-alert				
		] send-over-temp-txt-message	am:aws:sns:us-west-2:372787147340:send-over-temp-txt-message				

aws Services	🗸 Resource Groups 🖌 🖌		Ĺ	Ĵ integ-aws ▾ Ore					
SNS dashboard Topics Applications Subscriptions Text messaging (SMS)	Topic details: send-digital-input-1-high-alert								
	Publish to topic Other topic actions -								
	Topic ARN       am:aws:sns:us-west-2:372787147340:send-digital-Input-1-high-alert         Topic owner       372787147340         Region       us-west-2         Display name       in1-high								
	Subscriptions								
		scription actio	ns 🔻						
	Filter								
	Subscription ID	Protocol	Endpoi	Subscriber					
	arn:aws:sns:us-west-2:372787147340:send-digital-input-1-high-alert:f62fa7e3-503a-4e4e-a	sms	+1412:	372787147340					
	arn:aws:sns:us-west-2:372787147340:send-digital-input-1-high-alert:ca233df0-8bf7-498b-b	email	jniorsales@integpg.com	372787147340					

aws serv	vices 🗸	Resource Groups 🗸 🗙	🗘 integ-aws 🕶 Oregon 👻 Support 👻						
SNS dashboard	•	Subscriptions							
Topics Applications		Create subscription Request confirmations Actions -							
Subscriptions Text messaging (SMS)		Filter							
		Subscription ARN Proto Endpoint	Topic ARN						
		am:aws:sns:us-west-2:372787147340:send-over-temp-txt-message:37851a87-0cf9-4b5b-b sms +14129	arn:aws:sns:us-west-2:372787147340						
		am:aws:sns:us-west-2:372787147340:send-digital-input-2-alert:54dc35ff-6ebd-4f2f-a805-d sms +141297	arn:aws:sns:us-west-2:372787147340						
		arn:aws:sns:us-west-2:372787147340:send-digital-input-1-high-alert:ca233df0-8bf7-498b-b email jniorsales@integpg.com	arn:aws:sns:us-west-2:372787147340						
		arn:aws:sns:us-west-2:372787147340:send-digital-input-1-high-alert:f62fa7e3-503a-4e4e-a sms +141297	am:aws:sns:us-west-2:372787147340						
		arn:aws:sns:us-west-2:372787147340:send-over-temp-txt-message:a565562f-353d-4869-8 sms +17248	am:aws:sns:us-west-2:372787147340						

We can also create a rule where the action is triggered when the value of the temperature reading exceeds 75.5 degrees Farenheit.

<sup>RULE</sup> OverTemp			
ENABLED		Act	ions <del>-</del>
Overview	Description		Edit
	Over 75.5		
	Rule query statement		Edit
	The source of the messages you want to process with this rule.		
	SELECT tempF FROM 'jnior/614050022/temperature' WHERE tempF > 75.5		
	Using SQL version 2016-03-23		
	Actions		
	Actions are what happens when a rule is triggered. Learn more		
	Send a message as an SNS push notification Remove send-over-temp-txt-message	Edit	Þ
	Add action		
	Error action		
	Optionally set an action that will be executed when something goes wrong with processing your rule.		
	Add action		