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

For Use with the JNIOR Series 4

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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 se	ervices 🗸 Resource Groups 🗸	*		🗘 integ-aws 🕶 Orego	on ▼ Support ▼
AWS 10T	Things		Card	Q Search things	Create 🗘
Monitor Onboard	jnior-rick1 JNIORTYPE	*** jnior-dev JNIORTYPE			\odot
Manage Things Types Groups					
Jobs					
Greengrass Secure					
Defend					
Act					
Test					
Software					
Learn					,

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/inior-dev	
	Shadow	····· ، ······ ······ ·······	
	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 ~	(9) (6)
	Details	Certificates		
	Security			
	Groups	Create certificate View other options		
	Shadow			
	Interact	c1274e40c034a5191 0826938bcd830466f		
	Activity			
	Jobs			
	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.

i) kev-aws		410 (S/N 614050022) JANOS v1.7 logout 'jnior'
Input/Output Configuration	Console Folders Registry Syst	log 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	TEG Process Group, Inc., Gibsonia 27:12 EDT 2018 Process ID: 6 :26.919	PA USA.
-VVerify in:-C [file]Regenerate-A fileAdd inter-S fileVerify sig-K fileInstall RK-D [file]Decode and-E fileExport ce:-P fileExport pul-BExport in-G [len]Generate L-RRestore de	talled keys and certificate Certificate [Install file] ediate certificate nature on certificate A Key Pair dump certificate [file] tificate to file lic key to file binary ey pair [bit length] tificate Signing Request fault credentials	
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 HED (D/ N OFFODOLL) Funiting Offod 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.

i) kev-aws					410 (5	5/N 614050	022) JANOS v1. logout 'jnior
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 /> ps 0: Idle Process 1: Network Service 2: System 3: Run/flash/mqtt-te 4: web Server 7: Console/10.0.0.11 6: Secure Transport 7 total 35.692 up</pre>	410 (S/N ITEG Proce 44:00 EDT emp.jar 12:54651 otime	61405002 ss Group, 2018	2) running Inc., Gib Process ID	JANOS v1 sonia PA : 7	.7 USA.		
kev-aws />							
<							>
							Ins 11

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

(İ) kev-aws				410	(S/N 614050022) J	ANOS v1.7-rc0 logout 'jnior'
Input/Output	Configuration	Console Folde	ers Registry	Syslog Pee	ers About	
				(Clear End Se	ssion
kev-aws /> r LAN connect: Server/Conne Local Port 1: 2: 2: 9200 3: 80 4: 44: 5: 2: 6: 55965 7: 80 * encrypted	booket hetstat ion active (100 booket c Remote Port c Remote Port	<pre>Mbps) Remote IP</pre>	TLS v1.2 AE	S/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

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										
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	F	ilter				
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	arn:aws:sns:us-west-2:372787147340:send-over-temp-txt-message			

aws Services	→ Resource Groups → 🍾	众 integ-aws ▼ Orego							
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								
	Create subscription Request confirmations Confirm subscription Other subs	scription actions •							
	Filter								
	Subscription ID	Protocol Endpoint 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 Services	•	Res	source Groups 🗸 🔸	۵	integ-aws 🔻	Oregon 👻	Support 👻			
SNS dashboard Topics Applications Subscriptions Text messaging (SMS)		Sub Crea Filter	ubscriptions Create subscription Request confirmations Actions -							
			Subscription ARN Proto Endpoint		Topic ARN					
			arn:aws:sns:us-west-2:372787147340:send-over-temp-txt-message:37851a87-0cf9-4b5b-b sms +14129		am:aws:sns	:us-west-2:372	2787147340			
			arn:aws:sns:us-west-2:372787147340:send-digital-input-2-alert:54dc35ff-6ebd-4f2f-a805-d sms +141297		am:aws:sns	:us-west-2:372	2787147340			
			arn:aws:sns:us-west-2:372787147340:send-digital-input-1-high-alert:ca233df0-8bf7-498b-b email jniorsales@integpg.com		am:aws:sns	:us-west-2:372	2787147340			
			arn:aws:sns:us-west-2:372787147340:send-digital-input-1-high-alert:f62fa7e3-503a-4e4e-a sms +141297		am:aws:sns	:us-west-2:372	2787147340			
			am:aws:sns:us-west-2:372787147340:send-over-temp-txt-message:a565562f-353d-4869-8 sms +17248		am:aws:sns	:us-west-2:372	2787147340			

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

^{RULE} OverTemp					
ENABLED		Act	ions 🗕		
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				