

Department of Electrical and **Computer Engineering**

IoT Platform for Condition Monitoring

Background

FACULTY OF ENGINEERING

- Our team is working with MOOG Focal: an Atlantic Canadian division of MOOG and leader in the design and manufacturing of highly reliable marine rotary and data transfer solutions.
- Our client is currently investigating ways to connect their existing condition monitoring devices including, their 923-slip ring sensor, to the cloud to improve visualization and analytics. inside slip rings, Focal's 923-sensor collects various
- Designed to be placed directly types of data relating to the environment it's placed, and the device it's attached to such as temperature, humidity, shock, RPM and much more.
- Data analytics and visualization, however, is currently, only possible through a wired connection to a local computer running Focal's proprietary GUI software.

Project Objectives

Our project concerned two main layers of IoT platform development:

Embedded Systems Layer

- Establish a live connection with a sensor to stream real-time data into a local IoT gateway device connecting to the cloud.
- Setup a local database for incoming data storage.
- Implement an application/service for local analysis and visualization.
- Configure IoT gateway device and cloud connection.

Cloud Layer

- Configure cloud gateway service for data ingestion.
- Setup real-time processing/analytics engine.
- Configure and link warm and cold storage services.
- Design and implement cloud visualization; real-time dashboard.

For our embedded systems layer our team chose EdgeX Foundry: an open-source cross platform, vender neutral IoT solution. EdgeX Foundry is comprised of loosely-coupled microservices deployed through Docker containers. The three main microservices are as follows:



923-Slip Ring Sensor



Group 12: Usman Kamran, Vineet Saxena, Evan Terry External Supervisors: Mr. Deepak Jagannathan, Mr. Ian MacKay Internal Supervisor: Dr. Larry Hughes

Design Overview

Embedded Systems Layer

• **Device Modbus** microservice extracts data from the sensor and sends it to the core data micro service.

• **Core Data** microservice sends the data to the local Redis NoSQL database so that it can be retrieved by the export microservice. • **Export** microservice pushes the data to the Azure Cloud Layer via an MQTT protocol.

After completing a comprehensive analysis of several popular cloud solutions available (AWS, Google Cloud etc.) we determined a Microsoft Azure-based architecture would be best suited.



seen below.



Cloud Layer

Our cloud architecture consists of cloud services that perform a variety of functions: • **IoT Hub:** Acts as the cloud gateway.

- Stream Analytics: is the data processing engine. It enables real-time data formatting, sorting, error correction and many other
- functions to be applied to the incoming data. • **Cosmos DB:** is the real-time warm
- storage/database service. It allows temporary storage and low latency querying of collected data.
- **Blob Storage:** is the cold storage service. It allows bulk, long-term storage of collected data.
- **Power BI:** is the visualization interface. It allows real-time dashboarding of incoming data and even report generation.



Thank you to Mr. Deepak Jagannathan and the MOOG Focal team for sponsoring our project. Also a thank you to our internal supervisor, Dr Larry Hughes, for his recommendations throughout the duration of the project.





Results

Our team was successfully able to connect the Model 923 sensor to the Azure cloud layer using EdgeX Foundry. All results can be

1. Incoming data from sensor, as seen on device Modbus microservice

2022/03/28 02:11:53 modbus: sending 01 03 00 0b 00 01 f5 c8 2022/03/28 02:11:53 modbus: received 01 03 02 73 60 9d 5c

Image: Second	2. Data	persisted in	n local data	Dase.	
SORTED SET event:readings:24227ee-9ca0-4784a24d No limit 248 B SORTED SET event:readings:241b4414-4619-4ba5-8824 No limit 146 B SORTED SET event:readings:241b4414-4619-4ba5-8824 No limit 146 B SORTED SET event:readings:24b6167-3864-4d7e-9ced No limit 146 B SORTED SET event:readings:26b61647-3864-4d7e-9ced No limit 146 B SORTED SET event:readings:26b7167-3427+a67f No limit 146 B SORTED SET event:readings:66b14eb4-2baa-41a1-9e4a No limit 146 B SORTED SET event:readings:66b14eb4-2baa-41a1-9e4a No limit 146 B		Q Filter by Key Name or Patt	tern 📃 🛱		
SORTED SET event.readings.524227ee-9ca0-478f-a24d No limit 146 B STRING 3dee0b8c-f579-4b35-b3c1-6fc0a7857f17 No limit 250 B SORTED SET event.readings.27b44t4-4d619-4ba5-682d No limit 146 B SORTED SET event.readings.26b616f7-386d-4d7e-98ed No limit 146 B SORTED SET event.readings.26b616f7-386d-4d7e-98ed No limit 146 B SORTED SET event.readings.26b616f7-386d-4d7e-98ed No limit 146 B SORTED SET event.readings.26b616f7-386d-4d7e-97ed No limit 146 B SORTED SET event.readings.26b716/0-340-966-41ce-970 No limit 146 B SORTED SET event.readings.26b716/0-340-966-41ce-970 No limit 146 B SORTED SET event.readings.26b14eb4-2baa-41a1-9e4a No limit 146 B SORTED SET event.readings.26b14eb4-2baa-41a1-9e4a No limit 146 B	STRING	241b5100-b114-4f5a-a5b1-e6c86	0358ad99 No limit	270 B	
STRING 3dee0b8c-f979-4b35-b3c1-6fc0a7857f17 No limit 250 B SORTED SET event.readings:2f1b4414-d619-4ba5-882d No limit 146 B SORTED SET event.readings:2c1b6167-386d-4d7e-98ed No limit 146 B SORTED SET event.readings:2c1b6167-386d-4d7e-98ed No limit 146 B SORTED SET event.readings:2c1b6167-386d-4d7e-98ed No limit 146 B SORTED SET event.readings:2c4d73ad3-9656-41ce-970 No limit 146 B SORTED SET event.readings:e6a14eb4-2baa-41a1-9e4a No limit 146 B Sorter Set event.readings:e6a14eb4-2baa-41a1-9e4a No limit 146 B Sorter Set event.readings:e6a14eb4-2baa-41a1-9e4a No limit 146 B Sorter Set event.readings:e6a14eb4-2baa-41a1-9e4a No limit 146	STRING	3117a233-d07d-4488-9565-b412	2a2d0d3c9 No limit	274 B	
SORTED SET event:readings:2f1b414-d619-4ba5-682d No limit 146 B SORTED SET event:readings:2cb6167-386d-4d7e-98ed No limit 146 B SORTED SET event:readings:2d173ad3-9656-41ce-970 No limit 146 B SORTED SET event:readings:2d173ad3-9656-41ce-970 No limit 146 B SORTED SET event:readings:2d173ad3-9656-41ce-970 No limit 146 B SORTED SET event:readings:e6a14eb4-2baa-41a1-9e4a No limit 146 B SORTED SET event:readings:e6a14eb4-2baa-41a1-9e4a No limit 146 B SorteD SET event:readings::e6a14eb4-2baa-41a1-9e4a No limit 146 B SorteD SET event:readings::e6a14eb4-2baa-41a1-9e4a No limit 146 B SorteD SET event:readings::e6a14eb4-2baa-41a1-9e4a	SORTED SET	event:readings:524227ee-9ca0	-478f-a24d No limit	146 B	
SORTED SET event.readings.a5d7/16f0-340b-4405-850 No limit 146 B SORTED SET event.readings.20t61677-396d-4d7e-98ed No limit 146 B SORTED SET event.readings.e84b05057-7975-4271-a671 No limit 146 B SORTED SET event.readings.20t73ad3-9656-410e-970 No limit 146 B SORTED SET event.readings.e6a14eb4-2baa-41a1-9e4a No limit 146 B SORTED SET event.readings.e6a14eb4-2baa-41a1-9e4a No limit 146 B	STRING	3dee0b8c-f979-4b35-b3c1-6fc0	0a7857f17 No limit	250 B	
SORTED SET event.readings:2cb616f7-386d-4d7e-98ed No limit 146 B SORTED SET event.readings:26413-347f-4d52521551611 No limit 146 B SORTED SET event.readings:26173ad3-9656-410e-970 No limit 146 B SORTED SET event.readings:26172abc3-4181-9e4a No limit 146 B Control SCON ddata persisted in cloud database Edecode14880.82 No limit 146 B Control SCON clouds a persisted in clouds database Edecode14880.82 No limit 146 B Control SCON clouds a persisted in clouds database Edecode1488.88 Edecode1488.88 No limit 146 B Control SCON clouds a persisted in clouds database Edecode1886 Edecode1886 Edecode1886 Edecode1886 Edecode1886 Edecode1886 Edecode1886 Edecode1886 Edecode1886	SORTED SET	event:readings:2f1b4414-d619-	4ba5-882d No limit	146 B	
STRING 08108a24-1326-4df3-a17f-d62521551611 No limit 250 8 SORTED SET event.readings:e84b0505-7975-4271-a67f No limit 146 8 SORTED SET event.readings:e6a14eb4-2baa-41a1-9e4a No limit 146 8 SORTED SET event.readings:e6a14eb4-2baa-41a1-9e4a No limit 146 8 SORTED SET event.readings:e6a14eb4-2baa-41a1-9e4a No limit 146 8	SORTED SET	event:readings:a5d716f0-340b	-4405-850 No limit	146 B =	
SORTED SET event:readings::2d173ad3-9656-41ce-970 No limit 146 B SORTED SET event:readings::2d17ad3-9656-41ce-970 No limit 146 B	SORTED SET	event:readings:2cb616f7-386d-	-4d7e-98ed No limit	146 B	
SQRTED SET event.readings:2d173ad3-9656-41ce-970 No limit 146 B SQRTED SET event.readings:e6014eb4-2baa-41a1-9e4a No limit 146 B	STRING	08108a24-1326-4df3-a17f-d625/	21551611 No limit	250 B	
	SORTED SET	event:readings:e84b0505-7975	5-4271-a67f No limit	146 B	
<pre>Description of the second of the second</pre>	SORTED SET	event:readings:2d173ad3-9656	-41ce-970 No limit	146 B	
Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procession Image: Stand Procestine Image: Stand Procession	SORTED SET	event:readings:e6a14eb4-2baa	-41a1-9e4a No limit	146 B	
	R	🗈 temperature-data 🎽 🗙		d databa	se.
	R All Refresh wick Access coal & Attached Storage Accounts (Preview) Cosmos DB Accounts (Preview) Cosmos DB Accounts (Preview) Containerone Containe	Image: Demperature-date → × All Image: Demograture-date → × Id Image: Demograture-date → × Image: Demograture-date → × Image: Demograture-date → ×	Discard Delete Refresh "id": "624c5e9e-b054-48b8-8dea-e9119 "device": "Temperature-Device", "origin": 1648427414166964500, "readings": [{ "id": "8474568e-b9c1-48d0-b7 "origin": 1648427414166964500, "readings": [{ "id": "8474568e-b9c1-48d0-b7 "origin": 1648427414166964500, "readings": [{ "id": "8474568e-b9c1-48d0-b7 "origin": 1648427414166964500, "readings": [{ "device": "Temperature", "value": "2002-03-280", "valueType": "Uintl6" } "PartitionId": 0, "EventEnqueuedUccTime": "2022-03-281 "IoTHub": { "MessageId": null, "CornectionDeviceId": "EdgeX", "ConnectionDeviceId": "EdgeX", "ConnectionDeviceId": "EdgeX", "contectionDeviceId": "EdgeX", "contectionDeviceId=: "EdgeX", "contectionDeviceId=: "EdgeX", "contectionDeviceId=: "EdgeX", "contectionDeviceId=: "EdgeX",	866434a", 7b-a7ab4bcfe033", 0, e", T00:31:20.0146027Z", 00:30:14.2380000Z", "637839123905248014", 0:14.2380000Z" pyL4=/docs/-dtYAM4pyL4BAAAAAAA 624101e40000\"",	ΑΑΑΑ==/",

Acknowledgements