



## Edge-Cloud Intelligence in Self-Diagnostic of Land Mobile Radio Systems

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# Outline

- Introduction
- Related work
- Scientific Contributions
- Self-diagnostic analytics in IIoT
- Experiment
- Discussion of results
- Conclusions & Future works

# Introduction

- The research challenge is to develop architectural frameworks capable of integrating edge and cloud resources
- An intelligent platform based on the widely accepted 3-tier architecture.
- The goal is to develop a new automated data workflow capable of performing remote monitoring and sensing of critical infrastructures by powering *lloT sensors*.





# Related work





**Intelligent maintenance** 

#### **Reactive maintenance**

#### **Preventive maintenance**

Manzanilla-Salazar et al. proposed a solution using Key Performance Indicators (KPIs) to detect failures

# Scientific Contributions

- An edge-cloud intelligence approach
  - achieve an automated self-diagnostic process
  - combining edge and cloud analytics
  - generating early warnings.
- We propose a new automated data workflow capable of harmonizing different machine learning models
  - collaborate for an automated self-diagnostics of LMR systems.
- Real-world IIoT data streams of seven remote sites

### Self-diagnostic analytics in IIoT IIoT Stream Data Lifecycle

- Two types of IIoT data streams: *accumulated data streams* and *continuous data streams*.
- Stream data lifecycle is supported in the proposed platform to:
  - (1) continuously analyze and monitor incoming data tuples aiming to detect problems and understand them;
  - (2) understand component or system behavior under a variety of conditions to constantly enhance further the current component or system; and
  - (3) trigger specific actions to respond to changes when certain thresholds in the system are identified.

### Self-diagnostic analytics in IIoT Computational Resources



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### Self-diagnostic analytics in IIoT IIoT Automated Data Workflow



# Experiment

- Architecture Implementation
  - Sensors -> general-purpose sensors (motion, temperature, humidity, wind) and commercial sensors (MOTOTRBO, RF Sensor)
  - Edge Nodes -> Cisco IR829 Industrial Integrated Services Routers (IR829)
  - Cloud -> AWS services
- IIoT Data Streams
  - IIoT data from site related sensors
  - IIoT data from RF sensors

### Scenario 1: Self-diagnostics at the remote site



Real-time incoming data streams

#### Scenario 1: Self-diagnostics at the remote site



#### Self-diagnostics using Prophet model for Site A

#### Scenario 1: Self-diagnostics at the remote site



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Self-diagnostics using SARIMA model for Site B

### Scenario 2: Self-diagnostics of the LMR network level



### Scenario 2: Self-diagnostics of the LMR network level

				runtick	
				outpost_id	
ACCURACY OF PREDICTED RESULTS				vswrLow	
				vswrHigh	
				vswrMedian	
	Precision	Recall	F1 Score	transmitter_id	
				fwdPwrMedian	
FundDame	0.72	0.02	0.81	က္ fwdPwrLow	
I wai wi	0.72	0.95	0.01	timeZone	
No event	0.94	0.77	0.85	rfTime.\$date	
				⊥ localTime.\$date	
Accuracy			0.83	refPwrLow	
Magra Average	0.83	0.85	0.83	refPwrMedian	
Macio Average	0.85	0.85	0.05	index	
Weighted Average	0.86	0.83	0.84	createdAt.\$date	
				fwdPwrHigh	
				site id	



# Conclusions and Future Works

- Preliminary results obtained from exploring the integration of IIoT sensors with edge and cloud resources, having as the main goal to develop self-diagnostics of LMR systems.
- The platform was implemented to generate an intelligent management based solution for monitoring RF sites.
- The implemented automated data workflow was capable of harmonizing three machine learning models that collaborate for an automated self-diagnostics of LMR systems.
- We will also work towards a centralized scheduler which will dynamically manage the load balance during the entire IIoT stream data lifecycle of the automated data workflow in order to avoid running out of storage and processing capacity at the edge nodes

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https://www.mitacs.ca/en/impact/how-internet-things-can-support-radio-infrastructure