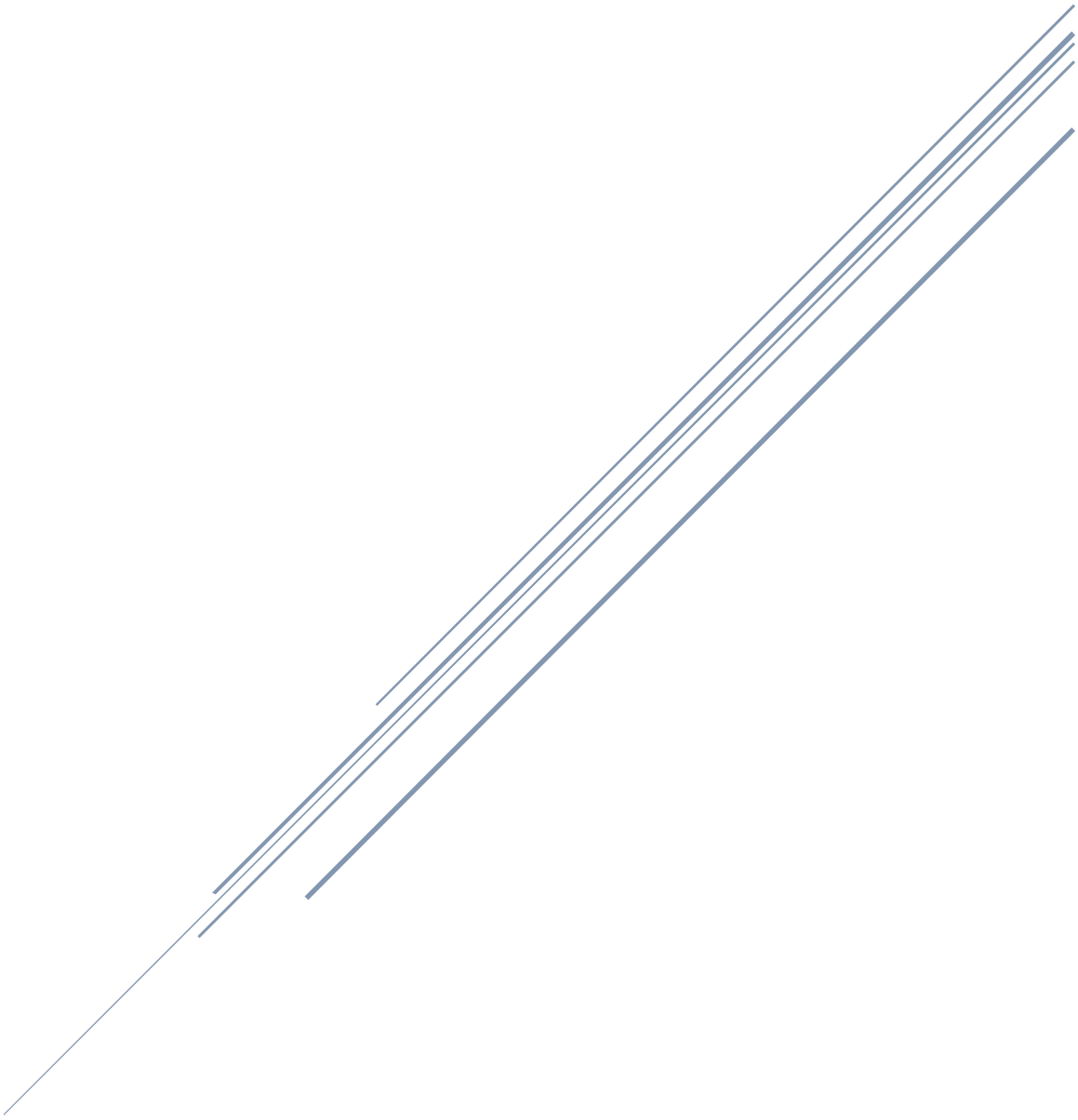
SYSTEM REQUIREMENTS SPECIFICATION

Distributed IOT Environmental Monitoring



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DOCUMENT REVISION HISTORY

Date	Responsible person	Description	Revision No.
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Table of Contents

1 Introduction and scope

1.1 Identification

This system specification pertains to the Distributed IOT Environmental Monitoring system being developed by the North West University (NWU).

1.2 Intended use

This project is intended to be used to optimise use of split type air conditioning in industrial and commercial settings. The project is intended to provide real time on screen efficiency measurements for each air conditioning unit. It will provide data to identify energy inefficient units to be replaced or repaired. This should aid the property management industry to better plan preventive maintenance and replacement and curb inefficient electricity use.

1.3 Background

There is currently a large number of split type air-conditioning units used in large commercial buildings. Most entities that manage these buildings deal with split type air-conditioning units in one of two ways. They either replace them after they have functioned for a predetermined period [1] or after the air-conditioning unit has stopped functioning. This is inconvenient, inefficient, cost intensive and has a negative ecological impact.

Currently there is no efficiency monitoring system commercially available for the split type air-conditioning units. Keeping ineffective split type air-conditioning units in operation results in wasted electricity, with the resultant increased electricity costs. This impacts on the profitability of a business. A system to measure and communicate the performance of an air-conditioning unit is required to determine when it needs to be replaced for optimum efficiency.

1.4 System Overview

The item that will be developed is a sensor console to monitor the split type air-conditioning unit as well as a back-end program to provide the measurements to the client. The sensor console will interact with the existing split type air-conditioning unit as well the existing IOT gateway. A back-end program will be developed that will interact with the existing gateway.

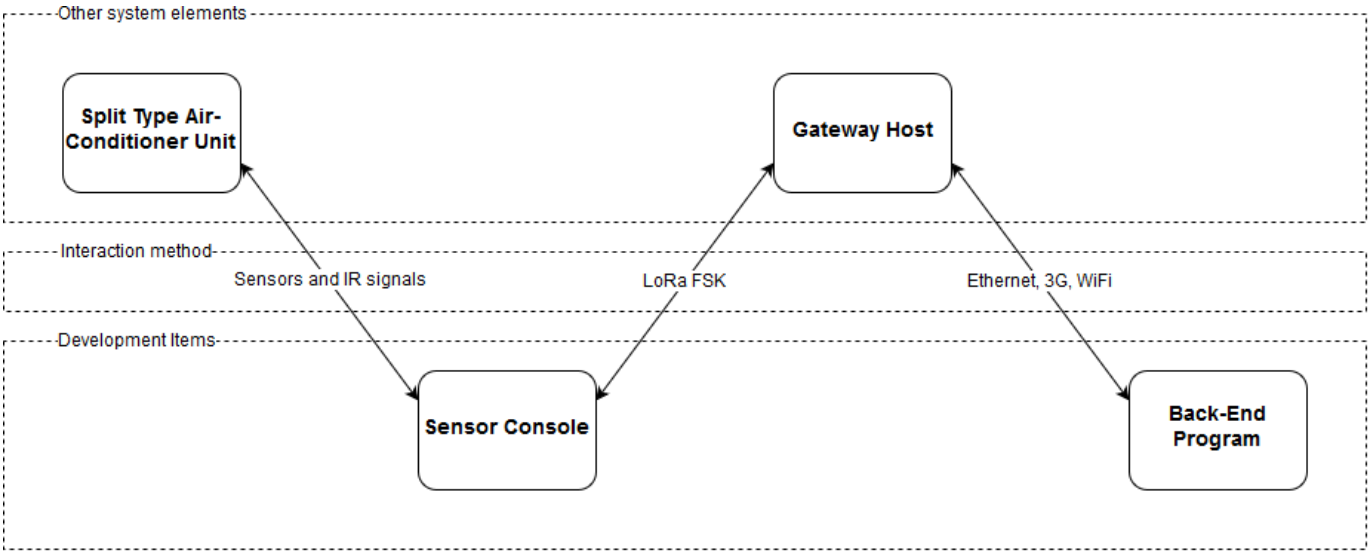


Figure 1: High level system overview

In Figure 1 the system overview reflects what will be developed and how it will interact with the already existing systems. There will be monitoring and communication between the already existing split type air-conditioning units and the developed sensor consoles by means of sensors and IR signals. The developed sensor consoles will send and receive data to and from an already existing gateway host by means of LoRa. Finally, the back-end program that will be developed will communicate with the existing gateway host in order to receive and send data to and from the sensor consoles.

1.5 Document Overview and Use

This SyRS is intended to be used by the client and their appointed contractors to develop the Distributed IOT Environmental Monitoring system. Unless explicitly stated herein all contents of this SyRS is to be treated as client confidential by any contractor. At the discretion of the client this SyRS may be disclosed or distributed to any party deemed to have a stake in the development of this system or the management of the system development.

2 Applicable and other referenced documents

2.1 Applicable documents

DOCUMENT IDENTIFIER	DOCUMENT DESCRIPTION
GREENOVATE ENGINEERING 2018	Research topics

2.2 Other referenced documents

Unless explicitly stated, any requirement in this specification that is found to be in conflict with the referenced standards shall be considered to be subservient to said standard.

DOCUMENT IDENTIFIER	DOCUMENT DESCRIPTION
ISO 5151:2017	Non-ducted air conditioners and heat pumps -- Testing and rating for performance
STS 1 1998 ISSUE XII	DEPARTMENT OF PUBLIC WORKS: STANDARD SPECIFICATION FOR AIR CONDITIONING AND VENTILATION INSTALLATIONS
SANS 60335-2-40/ ICE 60335-2-40	Electrical Safety of Air-conditioning.
SANS 1125:2004	Room air conditioners and heat pumps
SANS 10147:2014	Refrigerating Systems, including plant associated with air-conditioning systems
IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

3 Meanings, Acronyms, and Abbreviations

3.1 Meanings

Unless otherwise explicitly stated here all words and terms shall be interpreted as per the latest edition of the United Kingdom variant of the Oxford English dictionary.

TERM	DEFINITION
SHALL	Expresses a characteristic which must be present in the item of specification, thus a binding requirement
SHOULD	Expresses a goal or target to be pursued but not necessarily achieved
MAY	Expresses permissive guidance
WILL	Expresses a declaration of intent on the part of a party
STATE	The state of a system refers to a state of being of the system.
MODE	The mode of a system refers to the state of doing of a system. Typically modes are encapsulated within states.

3.2 Acronyms

ACRONYM	DEFINITION
NWU	North West University
SYRS	System Requirements Specification
TBD	To Be Defined
IOT	Internet of things
COP	Coefficient of performance
FSK	Frequency-shift keying
ISO	International Organization for Standardization
SANS	South African National standards
IEC	International Electro-technical Commission
LORA	Long range wide area network
GUI	Graphical user interface
IP	Ingress Protection

3.3 Abbreviations

ABBREVIATION	EXPLANATION
e.g.	For example
REQID	Requirement Identifier
IR	Infrared
mm	Millimetre
mA	Milliampere
μA	Microampere
V	Voltage

4 Requirements

4.1 Identification of External Interfaces

4.1.1 Back-end operator controlled program

The operator will be able to monitor and control the split type air-conditioning units from the back-end program.

4.2 Identification of States and Modes

The system shall have the following states and modes as defined in Section 3.1

- State – Gathering data
- State – Transmitting and receiving data
- State – Analyse data
- Mode – Locked
- Mode – Display information

4.3 System Function and Performance Requirements

4.3.1 Measure efficiency of split type air-conditioning units

The system shall provide an indication of efficiency of split type air-conditioning units at agreed upon intervals. REQID 0001

4.3.2 Communication between the sensor consoles and back-end program by way of IOT

The sensor consoles need to be able to send and receive data to and from the back-end program by making use of LoRa. REQID 0002

4.3.3 Analyse and display data

Analyse the data received from the sensor consoles and display pertinent information to the operator inside a GUI. REQID 0003

4.4 Relationships between States and Modes

The sensor consoles shall constantly be monitoring the split type air-conditioning units and thus be in a data gathering state. In the data gathering state the sensor console shall be monitoring the split type air-conditioning units gathering data from it. At specific times per day the sensor console's LoRa modules shall activate and be in a transmitting and receiving data state for a specific period. In the transmitting and receiving data state the sensor console will transfer data to the back-end program and receive data from the back-end program. At specific times per day the sensor consoles shall transmit data to the back-end program. When the data is received at these specific times, the back-end program shall log and analyse the data. In the *analyse data* state the back-end program shall analyse the received data from the sensor consoles. The back-end program shall be in a *locked* mode from where only the operator will have access. Once an operator unlocks the back-end program the program shall enter the *information displaying* mode. In the information displaying mode the back-end program shall display the analysed data to the operator providing access to information generated from the data. On completion, the operator shall log out of the back-end program and it shall enter the locked mode again. In the locked mode the information shall not be accessible.

4.5 System External Interface Requirements

4.5.1 Back-end operator controlled program I/F

The back-end operator controlled program interface shall be user friendly so that any person or employee with computer experience that are required to use the program can quickly learn to use it. REQID 0004

The back-end operator controlled program interface shall be able to lock and require credential verification to access information in order to protect against unauthorised access. REQID 0005

The back-end operator controlled program interface shall display information on the split type air-conditioning units that has value to the operator such as the run time and an indication of efficiency of each unit. REQID 0006

4.6 System Environmental Requirements

The following environmental requirements are set.

4.6.1 Classes of environment

For the purposes of this SyRS only the operational environment is defined, with transportation and storage environments being contained within the parameter envelopes of the operational environment.

4.6.2 Operational Environment

The sensor consoles will be installed directly adjacent to the split type air-conditioning units. REQID 0007

The sensor console will not be exposed to ambient temperature outside operational ranges as specified on data sheets of -20 ºC to 60 ºC. REQID 0008

The sensor console will be near single phase electrical power plug to draw power from. The power outlet needs to supply 220-240 V at 50 Hz and be able to deliver 0.1 A. REQID 0009

4.7 External Resource Utilization Requirements

The sensor console will make use of an external power supply and the following is the main power consuming components.

Temperature sensors: $2(5V \times 5.5\mu A) = 55\mu W$ REQID 0010

PIC Microcontroller (active mode): $5V \times 1mA = 5mW$ REQID 0011

LoRa Module (transmission mode): $3.3V \times 38.9mA = 128.37mW$ REQID 0012

Thus power usage taking other small components and variations from data sheets into account is:

$(55\mu W + 5mW + 128.37mW) * 120\% = 160.11\ mW$ REQID 0013

The system shall not consume more than 200 mW REQID 0014

4.8 System Physical Requirements

The sensor consoles shall be easily wall mountable so not heavier than 1 kg and not larger than 100 mm x 200 mm. REQID 0015

The sensor console shall be a single easy to handle unit for this reason it needs to be in an enclosure. REQID 0016

The housing of the unit shall adequately protect the sensor console, therefore the housing shall have a IP rating of at least IP 31. REQID 0017

4.9 Other System Qualities

The sensor consoles shall exhibit high quality workmanship insofar as cabling and wiring is concerned. REQID 0018

The back-end program shall have a professional look. REQID 0019

The housing of the sensor console shall be labelled. REQID 0020

The installation wires shall be labelled. REQID 0021

There shall be LED’s in the housing of the console in order to indicate start up and transmission modes as well as an error state. REQID 0022

4.10 Design and Construction Requirements

4.10.1 General Design and Construction Requirements

The system shall to make use of IOT. REQID 0023

4.10.2 Characteristics of sub-ordinate elements

The final unit shall make use of a microcontroller. REQID 0024

The sensor console shall pose no risk or irritation to employees and staff in the offices. REQID 0025

The sensor console shall be housed inside a neat and safe casing with an IP rating of IP 31. REQID 0026

Wiring shall be done neatly and professionally being tied together and put inside cable housing where possible. REQID 0027

To prove the concept of the system at least three sensor consoles shall be produced. REQID 0028

A complete report on the research, design and construction of the system shall be written in the form of the EERI 474 project report. REQID 0029

A guide on how to operate the back end program shall be created as well as an installation guide for the installation of the sensor consoles. REQID 0030

The sensor console shall have a max range of 1 km from the gateway this takes normal office obstructions into account. REQID 0031

4.11 Precedence of requirements

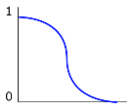
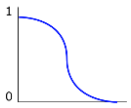
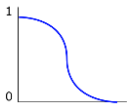
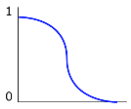
All requirements stated herein are subservient to requirements of safety. Should the satisfaction of a requirement lead to the safety requirement being violated the contractor is required to notify the Prof A. Helberg.

5 Verification requirements

- If the system cannot gather data from a split type air-conditioning unit and transfer the data to the back end program a mark of <40% (fail) shall be awarded.
- If the system is capable of getting a basic approximation of the performance of a split type air-conditioning unit and can transfer it using IOT to a back-end program and display the data a mark of 60% shall be awarded.
- If an accurate approximation the performance of a split type air-conditioning unit can be determined and it can be transferred over IOT and displayed on a back-end program a mark of 70% shall be awarded.
- If the system can accurately approximate the performance of a split type air-conditioning unit and can then transmit the data over IOT where the data is then processed into information and displayed in a program that neatly and functionally shows the information to the operator. This will result in a mark of 75%+ where all additional value adding functionality and features will result in increased marks.

6 Value Model

Note: The utility function of a cost item can be expressed mathematically as a sigmoid function mapping cost extremes to utility scores from [0,1] with the slope as indicated.

Measure of effectiveness	Minimum acceptable	Maximum acceptable	Relative Importance	Utility function
Cost of a single sensor console	R 300	R 1000	100	
Power usage of sensor consoles	0 W	1 W	80	
Weight of the sensor console	0.1 kg	2 kg	60	
Size of the sensor console	50 mm x 50 mm	200 mm x 200 mm	60	
IP rating of housing	IP 20	IP 64	40