System requirements specification

Distributed IOT Environmental Monitoring

Mr. FJ Fourie

26047799

Document Identification

|  |  |
| --- | --- |
| Project Title: | System Requirements Specification – Distributed IOT Environmental Monitoring |
| Document Number: | SyRS-DIEM\_v1.0 |
| System / Sub-System: | Distributed IOT Environmental Monitoring |
| Document Issue Date: | 2018-03-17 |
| Client: | Prof A. Helberg and Dr M Ferreira – NWU |
| Client Reference: | Distributed IOT Environmental Monitoring |

Origination and Approval

|  |  |  |  |
| --- | --- | --- | --- |
| Checked by Party | Individual Name | Signature | Date |
| Author: | Mr FJ Fourie |  | 2018-03-17 |
| Quantity Assurance: |  |  |  |
| Technical Approval: | Prof A. Helberg |  |  |
| Project Manager: | Dr Leenta Grobler |  |  |

Acceptance

|  |  |  |  |
| --- | --- | --- | --- |
| Checked by | Individual Name | Signature | Date |
| Approved by: | Prof A. Helberg |  |  |

Distribution List

|  |  |  |
| --- | --- | --- |
| Company | Individual Name | Date |
| NWU | Dr Leenta Grobler |  |
| NWU | Prof A. Helberg |  |
| NWU | Dr M Ferreira |  |

Security Levels and Restrictions

|  |  |  |
| --- | --- | --- |
| Level | Description | Applicable Level |
| 1 | Strictly Confidential – not to be distributed |  |
| 2 | Company Confidential – distributed inside company |  |
| 3 | Client Confidential – distributed to limited clients and contractors | X |
| 4 | Public Domain – distributed freely |  |

Contact Information

|  |  |
| --- | --- |
| Contact Person | Mr FJ Fourie |
| Company | NWU – EERI474 2018 |
| Street Address | 30 Esselen Street |
| Telephone Number | 071 372 1097 |
| Email address | fjfourie29@gmail.com |
| Web site | None |

DOCUMENT REVISION HISTORY

|  |  |  |  |
| --- | --- | --- | --- |
| Date | Responsible person | Description | Revision No. |
| 2018-03-17 | FJ Fourie | Document creation | 1.1 |
|  |  |  |  |
|  |  |  |  |

Table of Contents

[Document Identification 1](#_Toc509215062)

[Origination and Approval 1](#_Toc509215063)

[Acceptance 1](#_Toc509215064)

[Distribution List 1](#_Toc509215065)

[Security Levels and Restrictions 2](#_Toc509215066)

[Contact Information 2](#_Toc509215067)

[DOCUMENT REVISION HISTORY 2](#_Toc509215068)

[1 Introduction and scope 5](#_Toc509215069)

[1.1 Identification 5](#_Toc509215070)

[1.2 Intended use 5](#_Toc509215071)

[1.3 Background 5](#_Toc509215072)

[1.4 System Overview 5](#_Toc509215073)

[1.5 Document Overview and Use 6](#_Toc509215074)

[2 Applicable and other referenced documents 7](#_Toc509215075)

[2.1 Applicable documents 7](#_Toc509215076)

[2.2 Other referenced documents 7](#_Toc509215077)

[3 Meanings, Acronyms, and Abbreviations 8](#_Toc509215078)

[3.1 Meanings 8](#_Toc509215079)

[3.2 Acronyms 9](#_Toc509215080)

[3.3 Abbreviations 9](#_Toc509215081)

[4 Requirements 10](#_Toc509215082)

[4.1 Identification of External Interfaces 10](#_Toc509215083)

[4.1.1 Back-end operator controlled program 10](#_Toc509215084)

[4.2 Identification of States and Modes 10](#_Toc509215085)

[4.3 System Function and Performance Requirements 10](#_Toc509215086)

[4.3.1 Measure efficiency of split type air-conditioning units 10](#_Toc509215087)

[4.3.2 Communication between the sensor consoles and back-end program by way of IOT 10](#_Toc509215088)

[4.3.3 Analyse and display data 10](#_Toc509215089)

[4.4 Relationships between States and Modes 11](#_Toc509215090)

[4.5 System External Interface Requirements 11](#_Toc509215091)

[4.5.1 Back-end operator controlled program I/F 11](#_Toc509215092)

[4.6 System Environmental Requirements 12](#_Toc509215093)

[4.6.1 Classes of environment 12](#_Toc509215094)

[4.6.2 Operational Environment 12](#_Toc509215095)

[4.7 External Resource Utilization Requirements 12](#_Toc509215096)

[4.8 System Physical Requirements 13](#_Toc509215097)

[4.9 Other System Qualities 13](#_Toc509215098)

[4.10 Design and Construction Requirements 13](#_Toc509215099)

[4.10.1 General Design and Construction Requirements 13](#_Toc509215100)

[4.10.2 Characteristics of sub-ordinate elements 13](#_Toc509215101)

[4.11 Precedence of requirements 13](#_Toc509215102)

[5 Verification requirements 14](#_Toc509215103)

[6 Value Model 15](#_Toc509215104)

# Introduction and scope

## Identification

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

## 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.

## 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.

## 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.

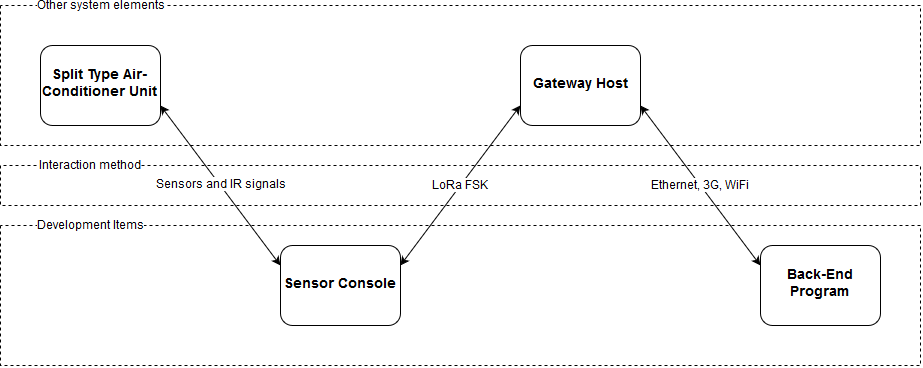


Figure 1: High level system overview

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.

## 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.

# Applicable and other referenced documents

## Applicable documents

|  |  |
| --- | --- |
| Document identifier | document description |
| GREENOVATE ENGINEERING 2018 | Research topics |

## 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 |

# Meanings, Acronyms, and Abbreviations

## 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. |

## 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 |

## Abbreviations

|  |  |
| --- | --- |
| ABBREVIATION | EXPLANATION |
| e.g. | For example |
| REQID | Requirement Identifier |
| IR | Infrared |
|  | Millimetre |
|  | Milliampere |
|  | Microampere |
|  | Voltage |

# Requirements

## Identification of External Interfaces

### 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.

## 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

## System Function and Performance Requirements

### Measure efficiency of split type air-conditioning units

The system needs to be able to determine an indication of efficiency of split type air-conditioning units at agreed upon intervals. REQID 0001

### 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

### Analyse and display data

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

## Relationships between States and Modes

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

Ek nikss hier verander nie besluit oor die will shall crap

## System External Interface Requirements

### Back-end operator controlled program I/F

The back-end operator controlled program interface shall be user friendly so that any person with computer experience can quickly learn to use it. REQID 0003

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 0010

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 0011

## System Environmental Requirements

The following environments are envisioned.

### 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.

### Operational Environment

The sensor consoles will be installed directly adjacent to the split type air-conditioning units. REQID 0030

The sensor console will not be exposed to ambient temperature outside operational ranges as specified on data sheets of -20 ⁰C to 60 ⁰C. REQID 0031

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 0032

## 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:

PIC Microcontroller (active mode):

LoRa Module (transmission mode):

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

The system shall not consume more than 200

## System Physical Requirements

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

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

The housing of the unit needs to adequately protect the sensor console requiring an IP rating of at least IP 31.

## Other System Qualities

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

The back-end program will have a professional look.

The housing of the sensor console will be labelled as well as the wires that will be used in the installation.

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

## Design and Construction Requirements

### General Design and Construction Requirements

The system needs to make use of IOT. REQID 0040

### Characteristics of sub-ordinate elements

The final unit must make use of a microcontroller. REQID 0041

The sensor console will pose no risk or irritation to employees and staff in the offices. REQID 0042

The sensor console will be housed inside a neat and safe casing with an IP rating of IP 31. REQID 0043

Wiring will be done neatly and professionally being tied together and put inside cable housing where possible. REQID 0044

To prove the concept of the system at least three sensor consoles will be produced. REQID 0045

A complete report on the research, design and construction of the system will be written in the form of the EERI 474 project report. REQID 0046

A guide on how to operate the back end program will be created as well as an installation guide for the installation of the sensor consoles. REQID 0047

The sensor console should have a max range of 1 km from the gateway this takes normal office obstructions into account. REQID 0048

## 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.

# Verification requirements

* If the system cannot gather data from a split type air-conditioning unit and transfer the data to a point a mark of <40% (fail) will 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% would be in order.
* 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% would be fair.
* 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.

# 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 |  |