# A Smart Approach to Health Sector Using LPWAN

Inz. Ritankar Sahu(M.Sc Student)

February 23, 2021

Silesian University of Technology, Gliwice, Poland
In Association with JM elektronik sp. z o.o. Gliwice, Poland

**Abstract**

In the health sector throughout the entire world, a major problem is shortage of full skilled medical and non-medical stuffs. In Poland, that's also a big problem faced since few decades. For medical field there are so many substitution discovered to reduce the workload. Although sometimes they are costly or sometimes they are inexpensive, yet those applications and systems literally reduced a huge workload of medical practitioners. But to reduce the workload of non medical workers, or sometimes to replace the human effort with artificial intelligence, a smart and comparatively inexpensive system can be developed and deployed using smart sensors, smart devices and LPWAN(Low Power Wide Area Network) networking based on the concept of IoT–SCADA(Internet of Things – Supervisory Control and Data Acquisition) system.

**Key-Words:** LPWAN, LoRaWAN, Wireless, IoT–SCADA, Adeunis, Smart Sensor, Client–Server Model, Star Topology, Smart Hospital.

## Contents

**1 Introduction** **2**

**2 Technical Aspect** **2**

2.1 Purpose . . . . . 2

2.2 System Description . . . . . 2

2.3 Hierarchical Model . . . . . 3

**3 Implementation Scheme** **4**

**4 Resource Detail** **5**

4.1 Description . . . . . 5

4.1.1 Adeunis ARF8276A MOTION . . . . . 5

4.1.2 Adeunis ARF8275A COMFORT . . . . . 5

4.1.3 Adeunis ARF8180BCB . . . . . 6

4.1.4 Adeunis ARF7943AA/ARF7943BA . . . . . 6

**5 Conclusion** **6**

# 1 Introduction

In the year 2014, a sociological research conducted by the scientists from The College of Economics and Social Sciences under Warsaw University of Technology[1], to understand the current situation of the national medical backbone. The research had shown that, surprisingly at that time Poland and Estonia had the least number of physicians working in the health sector, among the whole European Union. Hence, it can be easily guessed that the number of non medical workers must also be significantly low in the sector. There may be many reason for that, but the problem of lack of service always remains. As solution, two ways can be thought of.

- Employing more people.
- Substitute the human effort with artificial intelligence.

For the first solution, there are a lots of constraints to be taken care of, such as – availability, skills, responsibility, and many more. But for the second option those constraints can be easily eliminated by using numerous mathematical algorithms. As an example it can be said that the inter-premises environmental control system development doesn't require huge technical expertise or complex scientific research work, yet such a system can be easily and harmlessly deployed to tune and control a few environmental parameters such as humidity, temperature, air flow, water supply etc. without large human effort. Only one or two people can easily take care of a huge hospital, without having any special expertise. In this article, it is briefly discussed, how to design a smart hospital using "Adeunis" smart devices, and how to create an IoT–SCADA system using LoRaWan communication to observe and control the whole system effortlessly without or with least possible number of human resources.

# 2 Technical Aspect

## 2.1 Purpose

According to a research work conducted in 2018[2] there are many facilities can be obtained by the implementation of smart hospital. Along with them there are many auxiliary privileges can be obtained this way. Those are explained below:

- Due to the establishment of wireless technology, many complications can be solved.
- Once again for the wireless application, spaces can be saved.
- The service can be very perfect and prominent.
- Human involvement can be reduced.
- The service will be on for all the time.
- Accessibility will not be restricted within only the hospital premises, hence the emergency situations can be handled faster.
- Maintenance will be easier and smooth.
- And finally the system will be more cost effective than contemporary systems.

## 2.2 System Description

Supervisory Control and Data Acquisition(SCADA) system is a typical control system for high level process supervisory management. In practice, SCADA systems are very similar to Distributed Control Systems and Hierarchical Control Systems. It consists of undermentioned components.

- Computers (Standard Desktop/Laptop PC, Servers, etc.).
- Network Data Communication (TCP/IP, RS232, RS485, etc.).
- Database (Standard Oracle DB, Microsoft DB, etc.).
- Machine Interface (Sensors, Actuators, PLCs, HMIs etc.).

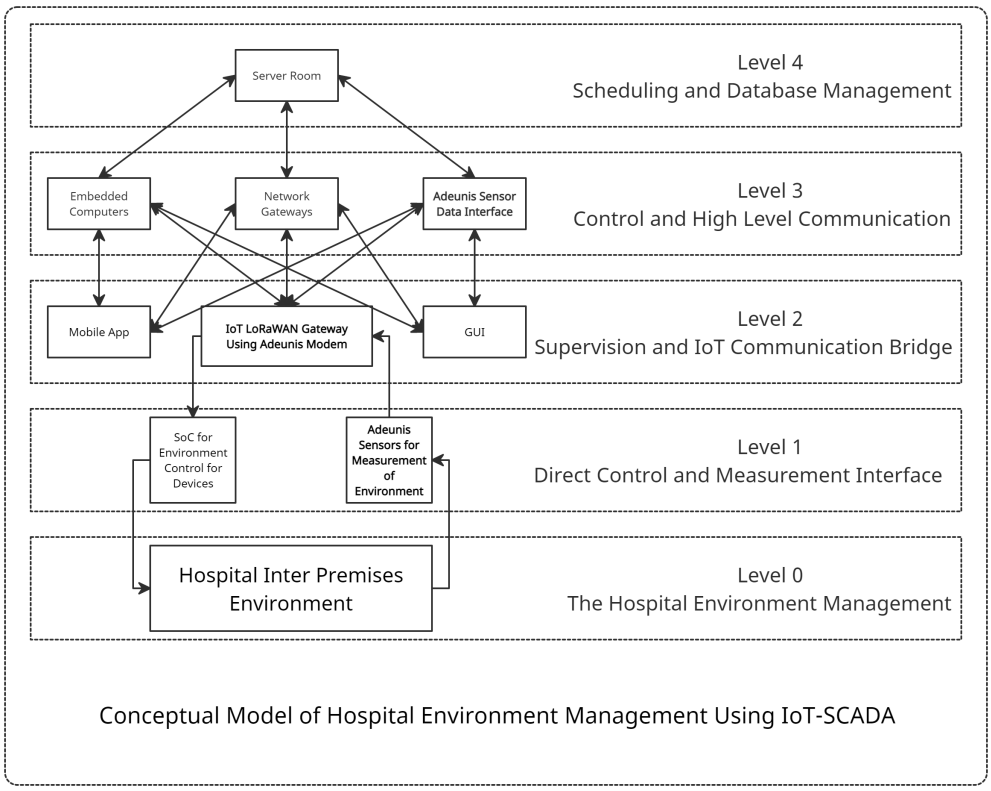


Figure 1: Hierarchical Model of Hospital Environment Control

- GUI for human machine interface (PC Software GUI).

IoT–SCADA architecture comprising all these components but not according to the regular industrial standards rather substituted by IoT standardized components. Hence, the IoT standard model will consists of components like:

- Computers – Microcontroller Based Embedded Computers, Standard Desktop/Laptop PC, Servers(if needed).
- Network Data Communication – Low power wide area network. The most feasible one will be LoRaWAN (Long Range Wide Area Network).
- Database – Customized Database management system using MySQL, MongoDB, Cloud DB etc.
- Machine Interface – Smart Sensors with LoRaWAN connectivity, SoC(System on Chip) Controllers etc.
- GUI for human machine interface – Mobile app, HTTP Interface, Software GUI etc.

## 2.3 Hierarchical Model

A hierarchical model (see Figure 1[1]) clearly shows that, how to design such a system to control, supervise, and maintain the inter premises environment of a hospital, not only with very low number of human resource, but also from the outside of the hospital premises. The model is built with five interconnected conceptual layers having different functions. They are as follows:

**Level–4** That's the highest level of the whole hierarchy which contains the main server having the control plans and database for each part of the whole system. It schedules all the tasks according to predetermined control scheme and algorithms.

[1] Self Drawing

**Level–3** That level contains three different subsystems namely Embedded Computers, Network Gateways and Smart Sensor Interface. The main function of this level is to assure first stage of communication between multiple levels of the whole system and ensure the data link along with proper protection.

**Level–2** That level also contains three different subsystems namely Mobile App, GUI and LoRaWAN Gateway. This level has mainly three targets. They are:

- Ensure the proper and secured interface between system and user.
- Establish a bridge between direct control level and high level communication level using LoRaWAN gateway bridge technology.
- Restrict user access to the direct control level by creating isolation encapsulation.

**Level–1** That level directly measures the environmental parameters to send them to LoRa gateway as well as controls the appliances to change the environmental parameters according to the instruction sent from server. It is having mainly two types of devices. They are:

- Sensors – Mainly Adeunis Smart Sensors for different purposes.
- SoC Controllers – Different kind of system on chip (SoC) type microcontroller based logic control systems to control environment management appliances.

**Level–0** Technically level 0 is a hypothetical level. That consists of a few environmental attributes to be controlled either as a whole or for individual sectors. They are as follows:

- Humidity.
- Temperature.
- Air Flow.
- Lighting System.

# 3 Implementation Scheme

**Level–0** From the perspective of control engineering, level–0 is actually a Plant which has to be controlled with one or more control algorithms to establish it as a close loop stable control system. In the previous section, it's described that which attributes to be controlled to turn a hospital into a partial smart hospital.

**Level–1** In this level, there are two types of devices as previously said. According to the application perspective, Adeunis smart sensors are very efficient to maintain the measurement operation and also those cane be interfaced directly using LoRaWAN communication protocol. That's a big advantage as it's not necessary to create separate LoRa interface for sensor access. Those can be directly connected to LoRaWAN gateway which is also designed with an Adeunis Modem and a single board embedded system in 'Level 2'. The other type of device in 'Level 1' is direct control device which may be any type of system on chip (SoC) having ability to be interfaced with LoRaWAN Gateway in 'Level 2'.

**Level–2** The LoRaWAN bridge in this level can be designed with 'Adeunis' long range modem and an embedded microcomputer with LoRa sub module integrated. That bridge will be working in addressed mode to have an intermediate level control over 'Level 2'. Other subsystems in this level can be made using different programming environments as per requirement. The main purpose of those two subsystems are to provide the user facility to access the system from anywhere and also to ensure a better UX (User Experience).

**Level–3** The 'Adeunis' sensor interface in this level works between the LoRaWAN bridge and the main server which contains the SCADA system software. That interface converts the information both ways in a full duplex mode. It can be accessed from also mobile app or GUI from 'Level 2'. All three subsystems of this level are full duplex interfaces between user and SCADA server, and also SCADA server and LoRaWAN gateway.

**Level–4** The server room is actually a subsystem which is nothing but a high configuration PC. That has the SCADA software installed in it along with a big database and server facility. It controls the entire system according to defined algorithms, and stores data retrieved from the system. When needed, it can even make plots and other graphical representation of the system.

Figure 2: Adeunis Smart Sensors for Temperature Humidity and Luminosity Measurement


Figure 3: Adeunis Radio Communication Device (MoDem)

# 4 Resource Detail

The whole system can be designed using many different types of devices and softwares. The main focus will be on several devices from 'Adeunis RF'. That company has a lot of smart sensors and other IoT communication devices to offer. Additionally all of them can be remotely configured. That's a big advantage in the field of IoT. For this project few of the sensors and communication devices can be used. They are as follows.

## 4.1 Description

### 4.1.1 Adeunis ARF8276A MOTION

That sensor[3] is used for four functions. Such as presence, luminosity, alert button, dry contact input. It can be used to measure the luminous intensity of different sensitive sectors of a hospital, such as ICU(Intensive Care Unit) or Surgical Room and many others. ARF8276A MOTION works with the protocol LoRaWAN® EU863-870. So it's easy and cost effective as no special LoRa interface will be needed to handle it.

### 4.1.2 Adeunis ARF8275A COMFORT

That sensor[4] is used to measure the humidity level of the area. It can be used to measure the specific humidity level of different sectors of the hospital where it's needed to be dry, semi dry or sometimes

humid air presence. Such as the surgical general ward needs to be in dry condition and so on. ARF8275A COMFORT also works with LoRaWAN® EU863-870 protocol.

#### 4.1.3 Adeunis ARF8180BCB

This sensor[5] is a wide range (-55°C, + 155°C) thermal sensor for environmental measurement. It can be used to read the temperature of specific segments of the hospital, such as Incubation Room, Maternity Room and so many other. ARF8180BCB is compatible with LoRaWAN® EU863-870 protocol too.

#### 4.1.4 Adeunis ARF7943AA/ARF7943BA

With the brand name 'ARF 868 LP'[6], that device is a long distance (1 km) low power (25 mW) radio trans-receiving modem. It can be interface with a micro computer using RS232/RS485 or USB serial port having RF rate from 2.4 to 57.6 kbps. That complies with multi-mode communication such as transparent, addressed and repeater. Along with a micro computer, using addressed mode, it can serve the purpose of a LoRaWAN gateway having more than 500 channels connected, and can establish the LoRaWAN bridge for the entire hospital.

## 5 Conclusion

As a result of study, the smart approach to the non medical sector of any hospital can be very useful conforming reduction of work load, higher efficiency of appliances control, emergency response and cost effective support. A specialized model of such approach should be implemented to any of the hospital just for a field run parallel with the existing system to compare the efficiency in future. It can be said from the perspective of science, engineering and technology that the IoT-SCADA system will be far more effective to provide much better, almost flawless support than manually controlled systems.

## References

[1] Kludacz, M., & Piekut, M. (2014, August 29). Availability of medical staff in Poland in comparison to other EU countries. Open Access Scientific Journals Online; International Scientific Publications. https://www.scientific-publications.net/en/ Journal of International Scientific Publications, Economy & Business, ISSN 1313-2555, Volume 8, 2014, Pages: 822-836

[2] Ilyashenko, O., Ilin, I., & Kurapeev, D. (2018). Smart Hospital concept and its implementation capabilities based on the incentive extension. SHS Web of Conferences. https://doi.org/10.1051/shsconf/20184400040 Volume 44, 2018 IV International Scientific Conference "The Convergence of Digital and Physical Worlds: Technological, Economic and Social Challenges" (CC-TESC2018)

[3] MOTION: IoT brightness and presence sensor | Adeunis. (n.d.). Capteurs IoT, Smart Building & Solutions IoT | Adeunis. Retrieved February 23, 2021, from https://www.adeunis.com/en/produit/motion-presence-brightness-2/

[4] Comfort: temperature / humidity | Adeunis. (n.d.). Capteurs IoT, Smart Building & Solutions IoT | Adeunis. Retrieved February 23, 2021, from https://www.adeunis.com/en/produit/comfort-temperature-humidity-2/

[5] Dual external temperature sensor | Adeunis. (n.d.). Capteurs IoT, Smart Building & Solutions IoT | Adeunis. Retrieved February 23, 2021, from https://www.adeunis.com/en/produit/temp-2s-temperature-2/

[6] ARF868 LP MODEM | Adeunis. (n.d.). Capteurs IoT, Smart Building & Solutions IoT | Adeunis. Retrieved February 23, 2021, from https://www.adeunis.com/en/produit/arf-868-lp-set-up-radio-transmission-for-long-distance-broadcasting/