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Hold 1

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DTU

Protocols and standards in IoT

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1 Introduction

1.1 Abstract

Forecasts say that in 2020 there will be 25 Billion devices connected to the internet. In 2014 it was estimated to be 3.7 Billion devices[1]. This put a big demand on common tehnologies such as wifi, http, relational databases, etc. This project investigate how to deal with these challenges by building a prototype of a system that meets these challenges. The system consist of multiple devices which connect in a local network and are made availerble via the internet. This is a fully realistic example of how to deal with the futura of IoT. The application consist of some battery powered devices that communicate wireless via the ZigBee protocol, a ZigBee/internet gateway and an application server where the backend, a database and a webportal is implemented. This report will focus on the devices, ZigBee protocol, gateway and communication between the gateway and application server. The report will losely touch the design of the application server.

1.2 Overview of this report

In section 1.3 is the bacground for the system described. Section 2 will give a Theoretical background on some of the technologies which will be used to implement the system. Section 3 will give a technical description on the implementation of the system and section 4 contains the conclution. I is sugested to read

1.3 Background

Internet of Things is the term that describes networks of physical devices that are connected to the internet. This can be anything like sensors, whearabels, fridges, heating systems, lightballs and what ever you else could imagine. As mentioned there is a high growth in the number of these devices. This project is about solving a common problem in lesure harbours. In leisure, harbors there are a limited number of moorings. Therefor each boat owner has his own mooring space. At each mooring space there are a sign which can be set to red or green. When the owner leave the harbor he should set the sign to green indicating that the mooring is free to use for guests. If he is away for less than a day he can set it to red indicating that the mooring is not free to use. When the owner returns home after some days he call the harbor master who then flip the sign to red indicating that the mooring is no longer free. A common problem is that the boat owners often don't set the

signs to green when they leave the harbor. The reason is it is easier to let it stay red instead of calling the harbor master when returning home. This often result in many unused moorings has red signs and make it difficult for guests to find free moorings. Another problem is the time the harbor master use on flipping the signs for people returning home to their berth. To solve these problems a system of electronically controlled signs is suggested. For more details about the sugested system refer to section 3.1

1.4 Abbreviations

AIS	Automatic Identification System
APL	Aplication Layer
APS	Application Support Layer
IoT	Internet of Things
MAC	Medium Access Layer
NWK	Network Layer
OSI-model	Open System Interconnection Reference Model
PHY	Physical Layer
PLME-SAP	Physical Layer Management Entity Service Access Point
SAP	Service Access Point
ZDO	ZigBee Device Object

2 Theroretical background

2.1 Wireless networks

Their exist many different wireless communication standards today all serving different purpose. There is the IEEE 802.11 specifications which define different protocols used for implementing WLAN which we mostly use for connecting our computers and smartphone to the internet. Then there are the mobile networks such as GSM, EDGE, UMTS, HSPA, etc. Which are used by phones to send voice or internet data. Some less know technollogies include AIS which is used to transfer data between commercial ships over VHF and satelite. They all have different purpose and theirfore also different demands. Eg. When handling voice calls over the mobile network the latency should not be to high and the protocol should suport the devices in using as litle power as posible. Here follow a list of important factors to consider when choosing a wireless tecnology.

- Bandwide
- Latency
- Power consumtion
- Maximum number of nodes in the network
- Range
- Reliability
- Cost
- interoparebility

For the purpose of this project we will later in the report argue that the ZigBee Standard is a good solution for communicating with the signs in the harbour.

2.2 ZigBee

2.2.1 Overview

ZigBee is a standard used to connect devices. It is managed by the ZigBee allianze which count mebers such as Texas Instruments, Philips, Silicon Labs, NXP, Samsung and many more. ZigBee aims at being relierble, secure, lowpower and easy for the consumer to use. ZigBee specify all the layers in the OSI-model

2.2.2 Layers

Overview of the layers ZigBee is build on top of the 802.15.4 standard which define the PHY and MAC layer. Therefore these layers are not defined by but implemented by ZigBee. On top of 802.15.4 ZigBee define the layers all the way up to and including the APL. The layers communicate via Service Access Points (SAP). An overview of the ZigBee model and the SAP that makes the services availerble between them are shown in figure from the ZigBee Alliance in fig. 1. below.

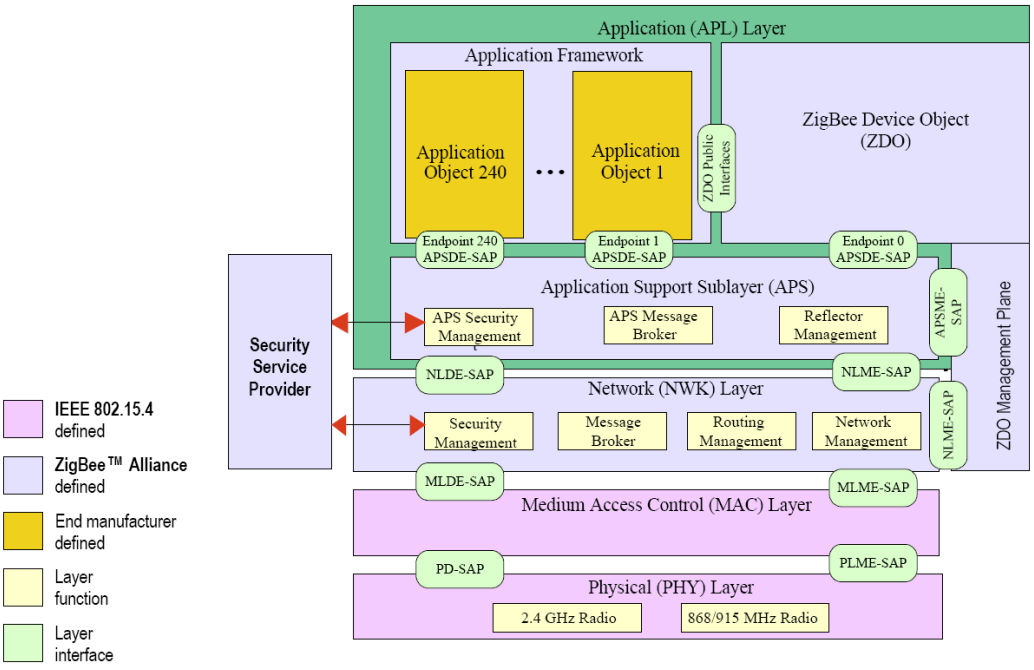

Figure 1: ZigBee Model[2]

802.15.4 The 802.15.4 standard specify the 2 lowest layers PHY and MAC. 802.15.4 does specifie roles of devices, but does not implement mesh or star networking torpology. Therefore are these funtionalities implemented by ZigBee at the higher layers.

Physical (PHY) The PHY is responsible for the physical part of the network. This is harware specific things like frequency, modulation, how to avoid coalition with other devices, receiver sensitivity, output power and other hardware specific parametters. The PHY provide service to the MAC layer via the PLME-SAP

Medium Access Layer (MAC)

Network Layer (NWK)

Application layer

Application Framework

Application Support Layer (APS)

ZigBee Device Object (ZDO)

2.2.3 ZigBee versus other technologies

ZigBee is not a high speed network. The maximum speed that can be achived on the ZigBee PRO standard is 250kbit/s on 2.4Ghz, 40kbit/s on 915Mhz and 20kbit/s on868Mhz which are the 3 bands the ZigBee can use[3]. This is not much compared with the latest public wlan standard 802.11ac which manage a data rate of up to some feew Ghz depending on the configuration [4].other standard which is worth mention in comparsion with ZigBee is bluetooth low energy and Z-wave. A litle more on those tech

2.3 Database system

2.3.1 The traditional SQL database

2.3.2 NoSQL databse

2.3.3 NoSQL versus SQL

3 Design of the harbour system

3.1 Requirements

The functional requerments of the system requirements is as follow

- The signs should automatically turn green when a boat leaves the mooring
- The signs should be operated from a remote plateform. E.g. a web platform

- The signs should be wireless controlled and battery powered as it is complicated and expencive to do cabling in the harbors.
- Each sign should be able to hold power for minimum of 7 years.

There are many possibilities for adding functionality to the system such as setting a predefined time when a sign should flip and let guest see which moorings is free and for how long. But these functionalities should be implemented on the server side and is therefore not considered important for this project as the focus is on the wireless communication between the signs, interconnection with the web platform/application server. The sensor which should sense if there is a boat at the mooring is simulated by a switch and the red green indication is simulated with an led. Again this is do to keeping the focus around the communication between devices and application server.

3.2 Acrhitecture

3.3 Harware

3.3.1 Texas Instruments CC2530 SoC

3.3.2 FlipDots

3.3.3 Raspbarry Pi

3.3.4 Aplication server

3.4 Implementaision

3.4.1 CC2530

Z-Stack

IAR

ZNP

3.4.2 Raspberry Pi

Linux

BCM2835 Driver

REST

Gateway implementation

3.4.3 Application Server

Amazon EC2

Nodejs

MongoDB

RESTfull API

Websocket

4 Conclusion

- unit_test_heap_initialize
  This tests returns **passed**.

5 References

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[4] 802.11ac A Survival Guide, *Matthew S. Gast*