TALLINNA TEHNIKAÜLIKOOL
INSENERITEADUSKOND

Elektroenergeetika ja mehhatroonika instituut

VÄHESE ENERGIATARBE JA LAIA ULATUSEGA JUHTMEVABA VÕRGU ARENDUS JA RAKENDUSALAD EESTIS

LOW POWER WIDE AREA WIRELESS NETWORK DEVELOPMENT AND APPLICATIONS IN ESTONIA

MAGISTRITÖÖ

Üliõpilane: Eva Aasmäe
/ nimi /
Üliõpilaskood: 143642

Juhendaja: Maido Hiiemaa
/ nimi /

Kokkuvõte

Antud magistritöö eesmärgiks oli uurida lähemalt LoRaWANi ning selle taga olevaid tehnoloogiaid. Samuti LoRaWANi iseloomustavate faktorite ja nende vaheliste suhete määratlemine, edasine analüüs, kuidas neid faktoreid arvesse võtta edaspidiste toodete arendamisel.

LoRaWANi ärimudelil on suur mõju selle edasisele levikule ja edule Asjade Interneti maailmas ning seetõttu analüüsiti ka seda põhjalikult. Erinevaid faktoreid uuriti lähedalt, et tuvastada põhinäitajad võrgu edu loomisel.

Teine lõputöö eesmärk oli leida perpesktiivikad tulevikusuunad, arvestades võrgu tehnoloogia iseärasusi ning võimeid. Võimalikud Asjade Interneti arengusuunad olid arutlusel ning tutvustati lähemalt ka hetkel arenduses olevaid tooteid. Teostati analüüs uue LoRaWANi spetsifikatsiooniga tutvustatud arengusuunale, milleks on positsioneerimine.

Viidi täide katse , kus näidati lihtsat andurit kasutades võrgu kasutamise lihtsust ning rakenduse teostamist väheste vahenditega.

Võrgu iseloomulikud tunnused leiti, neid ja nende vahelisi seoseid analüüsiti. Sama tehti ka LoRa positsioneerimise arengusuunda. Analüüsi tulemused andsid väärtuslikku informatsiooni, mida on võimalik tulevikus uute projektide arendusel arvesse võtta.

Autor usub, et lõputööks seatud eesmärgid said saavutatud ning tulemused sisaldavad väärtuslikku informatsiooni, mis on kasulik teema välja pakkunud firmale.

8. Conclusion

The LoRaWAN protocol enables a network with low power consumption and wide range. The network is suitable for low data rates, which means the applications that would be most suitable are remote monitoring devices, that do not acquire real-time data.

The LoRaWAN protocol uses LoRa modulation technology, which reduce the complexity of the receiver and enables inherent processing gain for the data transmission along with reducing interfering signals. Its key property is that it is both frequency and bandwidth scalable and is a constant envelope modulations scheme, enabling low-cost and low-power efficiency.

Selecting a spreading factor is among the important characteristics in communications between the end-device and gateways as it is a trade-off between communication range and data rate. Path loss was analysed, as it illustrates the difference between the power received and power transmitted and is affected by the range of the network. It is affected in real life by many factors, such as building and trees and even air humidity which absorbs radio frequency energy. Another factor affecting range is the receiver sensitivity, as receivers are designed with a certain sensitivity, not to process unnecessary signals. Link budget affects the range as the gains increase the range of a network and losses decrease it, and it is the relation of the two. It is an important characteristic for the wireless system manufacturers. While the manufacturers, or more specifically their system designers develop a product, they need to include a fade margin to the link budget. It is often zero, to illustrate the line-of-sight range or is just an estimated value according to a possible environment and provide more accurate link budget values.

Duty cycle is another characteristic for LoRaWAN, as it is the percentage of time during which the channel is occupied and compromises the actual capacity of a large-scale deployment. Due to the arising problem, a Fair Access Policy has been proposed as a solution to limit the data transmission and therefore enabling a bigger amount of end-devices to communicate with the gateway.

To assess the possible applications of LoRaWAN, the aforementioned characteristics were determined. Internet of Things is becoming a part of everyday life and therefore searches for the most cost-efficient solution to cover its needs. In a lot of ways, LoRaWAN might be the

answer, as it is a low-power and wide range network. It is suitable for applications in smart metering, smart city, agriculture and with the newly released standard even for GPS-free geolocation applications. Adding a positioning feature to the protocol is a big step ahead for the LoRaWAN applications and will definitely help its further acceptance.

The LoRa geolocation feature is still at testing phase and has stayed on the evaluation level with its announced parameters. To consider it as a feature that can be applied in the future, a further assessment of the technology was conducted. It showed that it has potential but also many questions to answer. Only further implementation can prove its capability of working in real world conditions.

While conducting a business model evaluation of the LoRaWAN, it suitability for the Internet of Things era was proven. It is created by a non-profitable association and therefore is a low-cost network. Since the Internet of Things intends to connect millions of devices, it is an important factor in choosing the network which to distribute.

The newly built NORAnet in Estonia, shows tremendous potential to become a leading network in the Internet of Thing era. The technology still has many problems to solve, but the LoRaWAN protocol was published less than two years ago, therefore it is still in early stages of development. Due to its many great features such as the low-power consumption, wide range and low-cost it is welcomed with opened arms. The distribution of the network will be determined by the next few years, as other technologies will try to catch up.