

OPINION

on a PhD Thesis

for the award of educational and scientific PhD degree

field of higher education – 5. Technical sciences
professional field – 5.3. Communication and Computer Engineering
PhD Program – Communication Networks and Systems

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PhD Theme: Development and research of a platform for low-energy wireless communications for the Internet of Things

Member of the scientific jury: Prof. Dr. Ventsislav Georgiev Trifonov

1. Topic and actuality of the dissertation

The proposed topic for the dissertation is relevant to modern research and development trends. "Internet of Things" is an area that includes several technological solutions related to the construction of networks of sensors for data collection, using radio communications and requiring real-time operation at low energy consumption.

These networks enter our society and industry and become part of the global Internet network that forms a critical infrastructure in our existence as humans.

The actuality is proved in the analysis of the literary sources in the first chapter of the dissertation.

After getting acquainted with the work and the contributions of the author, I believe that he has very correctly defined the problems in this contemporary topic and has tried to find a scientific and practical solution to the goals set in the dissertation.

2. Research methodology

The research methodology is based on

- Conducted literature analysis of 130 sources (analytical part)
- Definition of problems forming the purpose of doctoral studies (analytical part).
- Development of a theoretical model for solving the problems (theoretical part)
- Development of software (platform) to solve problems (application part)
- Testing of the platform in order to validate its functionality (experimental part)
- Practical proof that the platform fulfills the goals of scientific work – through diagrams, statistical models and real working of the developed software (practical and application part).

The latter makes a very good impression on me, because there is not only a theoretical assumption, but also a practical proof of its functionality.

The methodology is developed and can be seen in the 4 heads of the dissertation.

3. Thesis contributions

Scientific contributions are properly formed and correct, as follow:

- the use of the Linearly Changing Frequency (Chirp) method, which contributes to greater data protection, thus using the narrower bandwidth used in wireless communications.
 - development of a multiparameter approach to determine the coverage performance in low-energy wireless networks in urban environments.
 - synthesis and program implementation of an algorithm, for the implementation of an RF gateway
 - the conduct of the experimental investigations in an indoor and outdoor area.
 - study of the influence of signal/noise ratio on the quality of wireless coverage in a specific open area.
 - synthesis of a comparative evaluation between the practically obtained results with the simulation ones in the same radio coverage area, the object of investigations being the parameters of the end device, of the RF gateway, the attenuation in the coaxial line, etc.
 - a terminal device of a communication system with the use of the low energy LoRaWAN protocol for wireless communications with remote control of electrical contacts with feedback of the contacts status has been realized.
 - an energy efficient solar-powered end device has been realized, which has been tested in a period of 3 years under different meteorological conditions.
- For me, these contributions are real and applicable. They present a high level of preparation of the dissertant – scientific and practical.

4. Publications and citations of dissertation publications

Scientific publication in publications that are referenced and indexed in world-famous databases of scientific information: - 1 issue.

Posted with Scopus, SJR 0,189.

In this publication, the lead author is the doctoral student.

Scientific publication in non-refereed journals with scientific review or in edited collective volumes:

Attached to the dissertation are Annex 5 publications, one of which is independent.

The publications are in Bulgarian

No citation information attached.

All publications are related to the topic of the dissertation and the results achieved in it.

Also, the publications show that the PhD candidate has worked with a team whose focus is on the topic of proposed PhD work and in this team the doctoral student has its significant role and contribution.

5. Authorship of the results obtained

After getting acquainted with the scientific and applied contributions proposed by the author, the results of the research on the platform developed by him and the applied source code there is no doubt that the PhD student is the author of these results.

Opinions, recommendations and remarks on the dissertation

Opinion:

1. I appreciate very highly the applied part of the PhD thesis.
2. The candidate should strengthen his publication activity because he can achieve much better scientific results with the data from the conducted studies
3. An operating system can be replaced from Ubuntu to a version of Real Time OS, which will achieve even better results
4. It is possible to replace Grafana with a "lighter" software product or simply export to analysis and visualization systems installed on a separate server and on a single-board one.
5. Instead of applying the JSON formats, UML (or analogous) models of the algorithms of operation of the displayed systems could be applied.

My final opinion is that this is an excellent doctoral thesis.

Remarks:

1. On page 19 the sentence "LoRaWAN (distant communication energy efficient)" is not clear.
2. In the tasks of page 35 have been crossed out in Problem 3. Please explain what the author meant?
3. Fig.3.21. it is not clear why it is presented. She is generally famous.
4. Conclusion 1 on page 127 is not clear to me. Please explain it?
5. *"Proven algorithms for encryption of messages using the low-energy LoRaWAN protocol that ensure the security and reliability of the transmitted data have been established and studied,"* in my opinion, is not entirely correct. These algorithms are also used for electronic payments, which is the result of proving their security.

The contribution of the PhD student is that he has found a way to implement them in his solution and ensure their functionality under low energy consumption requirements.

6. Conclusion

I believe that the presented dissertation **meets the** requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria. The results achieved give me grounds **to propose to** acquire the educational and scientific degree "PhD" for

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professional field - 5.3. Communication and computer equipment

PhD Program - Communication Networks and Systems

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