



Dissertation thesis evaluation

Name of student: *Ing. Jiří Dostál*
Thesis title: *Time and Frequency Transfer in Local Networks*
Reviewer: *Ing. Tomáš Horváth, Ph.D.*
Institution: *Faculty of Electrical Engineering and Computer Science, Brno University of Technology, Czech Republic*

The introduction provides a brief overview of accurate time transmission issues. The composition of the dissertation thesis corresponds well with the presented results. Nevertheless, to further improve the visual impression, it would be appropriate to combine/merge some of the chapters.

The second chapter deals with the particular possibilities of accurate time transmission in more details. The description of each solution matches with the associated implementation suggestions. In my opinion, the chapter should focus not only on the technical description, but also on the related works that have already been published in this field. Most references point to RFC documents that are adequate, but they do not emphasize the current state-of-the-art technologies/methods since the most recent referenced publication dates back to 2011. The author proves his knowledge in the field, yet it should be combined with focus on the very current situation followed by his own solution/s.

Chapter 3, overview of our approach, is also based on a single source, specifically a reference to work proposed by his supervisor. However, at least, the author describes his own contribution/s and novelty on top of the referenced work. Here, it would also be beneficial to refer the claim that "principle description is out of scope this Dissertation thesis". Are there any references related to an issue of timestamping? Additionally, chapter 4 could be used as a subchapter of Chapter 3.2.

Chapter 5 describes the contribution/s of the dissertation thesis. Replacing a "universal counter" with an embedded solution using the FPGA array is an obvious contribution made by the author. Also, the presented results correspond to an improvement, and at least a reduction of the counter, which is replaced by the embedded solution. Chapter 7 describes the issue of future development of adapters for time transfer in the Virtex 5 field, so the author describes his use of Zynq All Programmable SoC platform. Chapter 9 is composed only of two pages and provides rather general information that could be included in the results as a subchapter. And finally, chapter 10 could be placed at the beginning of the thesis as it describes background of the issue/s related to the CESNET network.



The overall contribution of the author is evident and undeniable. However, there are some imperfections that need to be mentioned. At first, the results could be described in more details. It is disputable why the author published his results only in conference papers and did not rather focus on high-quality journals. The formal presentation of the thesis is weak. It contains a relatively high number of misspellings/typing errors ("0.9 sec", "wit", "transfe", "nubmers", "feede"). Explanation of abbreviations is not ordered according to the first occurrence as some of the abbreviations are defined several times, yet other abbreviations are not defined at all. Moreover, the table description is supposed to be placed above the table itself. According to figures, some of them are not converted to vector graphics. The total amount of the referenced literature is rather small; I believe there are a number of scientific publications that could be used to present a robust state-of-the-art of the dissertation thesis.

The above-mentioned imperfections of the thesis are not crucial. After all, the results of the proposed work demonstrate the dissertation thesis contains novelty of the given solution that is proven by the optimization of the current adapters.

The author of the dissertation has demonstrated the ability to conduct research and achieve scientific results. In accordance with par. 47, letter (4) of the Law Nr. 111/1998 (The Higher Education Act) I recommend the thesis for the presentation and defense with the aim of receiving the Ph.D. degree.

I have the following questions about the dissertation thesis:

- 1) Why did you choose the GPS method for accurate time transmission to be compared with an embedded counter?
- 2) Describe alternative approaches and principles of accurate time transfer over optical fiber?

28th January 2019

Tomas Horvath

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Review of the dissertation thesis of Ing. Jiří Dostál, "Time and Frequency Transfer in Local Networks"

To Whom It May Concern:

I, Javier Díaz Alonso, as Full Professor of the University of Granada, Computer Architecture and Technology Department and as an expert on the field on time and frequency transfer with Ethernet protocols, have participated on the review of the dissertation thesis of Ing. Jiří Dostál entitled "Time and Frequency Transfer in Local Networks".

A) PhD summary:

This dissertation thesis focuses on network protocols and methods for time distribution over optical fibers. The main result of this research is IEEE 1588 timestamper implemented on FPGA as well as a TIC with different architectures and options. This is used for an atomic clock comparison for which different architectures for precise time measurements are presented. The thesis also includes a long distance evaluation of IEEE 1588 performance and time services in CESNET network. At the end is mentioned the ongoing and proposed work but the text lack of a proper comparison with other time transfer optical fiber protocols.

B) Items evaluated

1. Up-to-dateness of the dissertation.

It is acceptable although it would be nice to provide better review of some novel techniques as well as ongoing projects related with time transfer techniques over optical fibers.

2. Formal structure and organization of the dissertation.

The document structure is sound. It has a proper structure and balance between the state of the art review, the theoretical aspects as well as the implementation and validation.

3. Completion of the dissertation objectives.

The objectives have been completed according the manuscript claims and results.

4. Assessment of the methods used in the dissertation.

The methodology and methods are appropriate for the field and shows an appropriate expertise on very advance techniques.

5. Evaluation of the results and contributions of the dissertation.





The work is appropriate for a PhD degree. Nevertheless, the manuscript can be improved by providing a better implementation detail of the work done (it is really concise). Even for an expert on the field, some chapters are difficult to follow or to reproduce due to the lack of details of the implementation. Many of the work details are missing and although the manuscript points out to the author publications as reference for further details, for the sake of completeness and easy reading, it would be desirable to include most details in the text.

6. Remarks, objections, notes, and questions for the defense.

An action to take to improve the work is related with the different sections methods validation. A more systematic approach would be required on most of the cases instead of providing direct measures and straightforward results. Some "spikes" on some graphs are presented. They have been identified by the author but no explanations are provided. A deeper experimental analysis would probably solve this issue.

As additional consideration, there are some missing experiments that I would suggest to add as part of the Thesis manuscript instead of being proposed as the future work. The PhD includes the utilization of satellite time transfer techniques as well as NTP/PTP protocols but some other most advance methods are missing and, as consequence, a proper coverage of the current state of the art is not presented. For instance, White-Rabbit can be used as a simple and straight forward technique to include as reference solution (Cesnet already has the required equipment for this experiments). In addition, many other alternatives would be desirable for adding to the text (for instance ELSTAB). Such discussion, even at the theoretical level, would better clarify the innovation and performance of the described contribution compared with other state of the art techniques.

7. The overall evaluation of the dissertation.

The overall evaluation of the thesis is satisfactory.

C) Final conclusion:

As summary, on my opinion the author of the dissertation proved the ability to conduct research and achieve scientific results. In accordance with par. 47, letter (4) of the Law Nr. 111/1998 (The Higher Education Act) I do recommend the thesis for the presentation and defense with the aim of receiving the Ph.D. degree.

Granada, February 21th, 2019

Javier Díaz Alonso, Full professor of the University of Granada



FACULTY OF ELECTRICAL ENGINEERING
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Doc. Ing. Jaroslav Roztočil, CSc.
ASSOCIATE PROFESSOR



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February 11, 2019, Prague

Dissertation Thesis Assessment

Author: **Ing. Jiří Dostál**

Title: **Time and Frequency Transfer in Local Networks**

Faculty: Faculty of Information Technology, Czech Technical University in Prague

Supervisor: RNDr. Ing. Vladimír Smotlacha, Ph.D.

Dissertation thesis deals with a very topical issue of time and frequency transfer using optical networks and specialized network protocols.

a) Formal structure and organization of the dissertation

The dissertation has a total length of 95 pages including attachments (70 pages of actual text) and is structured in twelve chapters. The graphic layout is acceptable.

Chapter 1 (Introduction) contains:

- Introduction to the problem
- Declaration of the main goals of the thesis: distant atomic clock time scale comparison over optical link, IEEE 1588 evaluation, contribution to CESNET network time services
- Contents

Chapter 2 (Background and State-of-the-Art):

- Survey of the current methods and technologies in the field of time and frequency transfer in local networks and network protocols

Chapter 3 (Overview of Our Approach):

- Description of a method of time transfer via optical networks
- Timestamping method of event identification

Of major importance are chapters 4 to 10, where the solution of the individual sub-objectives is presented.



Chapter 11 describes possible further improvements for the methods developed by the author.

Chapter 12 summarizes the results and includes resume of author's publications.

b) Completion of the dissertation objectives

The main objectives declared in Chapter 1 were, in my view, fully met.

c) Assessment of the methods used in the dissertation

I do not have any major issues with the methods used in the dissertation. Solutions of the specific sub-objectives (IEEE 1588 timestamper, atomic clock comparison over optical network, architectures for precise time measurements, running processor on external frequency, long distance evaluation of IEEE 1588 performance and contribution to time services in CESNET network) are presented in Chapters 4 through 10.

d) Evaluation of the results and contributions of the dissertation

Results of the dissertation are explicitly described in Chapter 12. All of the original results presented in par. 12.2 are valuable and usable in practice. The most notable achievement, in my opinion, is the design and realization of optical network adapters with embedded counters (based on FPGA) for comparison of precise time scales of atomic clocks using time transfer via optical transfer networks. I can attest to functionality and reliability of these adapters from personal experience. They are utilized for long-term atomic clocks comparison between the Laboratory of Precise Time and Frequency, FEE CTU, and the Laboratory of the National Time and Frequency Standard, IPE CAS.

e) Publications

Ing. Jiří Dostál has 16 published works, including 10 papers for international conferences. Five peer reviewed papers were published in prestigious IEEE conferences EWDTS and ICECS. Therefore, I rate Ing. Dostál's publication activity as good and sufficient for dissertation defense.

f) Remarks, objections, notes, and questions for the defense

- Page 15, text under Fig. 2.10, "The 80 ns jitter .." should be "The 80 ps jitter ..."



- Is it possible to repeat the measurement according to Fig. 5.5 with current adapters?
- The formula (5.1) is valid only for a symmetric link. In the real case, the optical path is always asymmetrical. How can this asymmetry be corrected?
- What other influences can negatively affect the time transfer over optical fiber?
- How these effects will affect the accuracy of time scale comparison?

g) The overall evaluation of the dissertation

The dissertation presents modern approaches in the field of time and frequency transfer in local networks, especially optical ones. The results of the dissertation are applicable in industrial and scientific practice. The proposed adapters are successfully used for highly accurate time transfer between the Laboratory of the National Time and Frequency Standard and CESNET, Academy of Sciences of the Czech Republic and FEE CTU.

The author has proved his ability to achieve original research outcomes and to propose new methods in the area of time and frequency transfer in computer networks. In accordance with par. 47, letter (4) of the Law Nr. 111/1998 (The Higher Education Act) I do recommend the thesis for the presentation and defense with the aim of receiving the Ph.D. degree.

Doc. Ing. Jaroslav Roztočil, CSc.

February 11, 2019