

## I. IDENTIFICATION DATA

<b>Thesis title:</b>	<b>On Bandwidth-Delay-Constrained Least-Delay-Variation Problem in Smart Grid Ethernet Networks</b>
<b>Author's name:</b>	<b>Ing. Tomas Hegr</b>
<b>Type of thesis :</b>	Doctoral thesis
<b>Faculty/Institute:</b>	Faculty of Electrical Engineering, CTU/CVUT in Prague
<b>Department:</b>	Dept. of Telecommunication Engineering
<b>Thesis reviewer:</b>	Ing. Alexandru-Mihnea Moucha, PhD.
<b>Reviewer's department:</b>	Dept. of Computer Systems, FIT, CTU/CVUT in Prague

## II. EVALUATION OF INDIVIDUAL CRITERIA

<b>Assignment</b>	<b>extraordinarily challenging</b>
<i>How demanding was the assigned project?</i>	
<p>At the first glance the topic does not seem complicated (a property usually very complicated things tend to display). To review, it is about the delay of multicast communication in Ethernet networks – seemingly well-known things. The moment when the reader understands that these networks are not daily-use computer networks but industrial networks, with extremely tight constraints, networks on which the life, health and work of the people rely on (as it happens in electricity distribution grids), the full blow of complexity hits in. We tend to take electricity for granted, at a flip of a switch, forgetting how complicated the chain of production and distribution is (and how expansive it is – covering large portions of the entire planet) and especially forgetting the fact that all this network requires tight control, as the simplest laws of electric circuits is that you have to consume exactly as much as you produce (not more, not less) and this control must be done in real-time. In conclusion, I categorise this work as very challenging, fact which can be easily seen in the content of the thesis.</p>	

<b>Fulfilment of assignment</b>	<b>fulfilled</b>
<i>How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.</i>	
<p>I consider that the thesis not only fulfilled the requirements but it actually went beyond them, through the multiplicity of studies, different approaches, different points of view on the problematic. This can be seen by the fact that this is not an open-and-closed chapter of study, the work can continue, as it is clearly stated in the conclusions. What really impressed me was actually the application of so-many techniques (especially mathematics and algorithms) to “nail” the problem – this is exactly what an engineering specialist is supposed to do: try to solve a problem as efficient as possible using as much knowledge as is possible.</p>	

<b>Methodology</b>	<b>outstanding</b>
<i>Comment on the correctness of the approach and/or the solution methods.</i>	
<p>The methodology involved in this thesis is very complex. Only the skill of the author makes it breakable in pieces which are easier to present and digest. Not only that the area of networking today is very complex but so are the invented solutions to various problems. The thesis presents the problematic, the possible solutions at a theoretical level, the application of the solutions on the given problematic and the results in a continuous flow. This denotes the fact that the author masters the understanding and abstraction of the problematic, the various possible solutions and how to adapt the solutions to the specific problem while being able to measure and quantise the improvement different approaches and tune-up bring.</p>	

<b>Technical level</b>	<b>Choose an item.</b>
<i>Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?</i>	
Please insert your comments here.	

<b>Formal and language level, scope of thesis</b>	<b>A - excellent.</b>
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*Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?*

The thesis is excellently written, a pleasure to read. The number of grammar mistakes is minimal, being dominated by misspelled words with no impact on the clarity of the text.

### Selection of sources, citation correctness

**A - excellent.**

*Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?*

I do not think it is necessary to comment on this topic, as it is very clear the PhD candidate masters the work with scientific literature. What I would praise him for is the deep level of understanding so many pieces of so many areas: from networking, through mathematics, to genetic algorithms.

Parenthesis: I would like to remark something which caught my eye: the philosophical quotations at the beginning of each chapter. Sincerely I see this for the first time in a thesis and it is a nice touch. It made me think on the fact that a PhD title is "doctor of philosophy", not "engineering", thus a person who thinks more widely than in his own field.

### Additional commentary and evaluation (optional)

*Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.*

The overall quality of the thesis is excellent. It is obvious that the proposed multi-tree BDLDV has potential, the simulations prove this, and the results may impact areas of networking which are not only SGs.

Regarding one of the conclusions (the last one), the only problem I see in the distribution of multimedia in multicast streams in the closed networks of local providers, is that local providers are pushing Layer 3 technologies (routing) as close as possible towards the end users (down to the access layer, except the end users themselves). Thus the network of the provider relies more on routing and label switchrouting (MPLS) more than classic switching. These networks come with the inherent jitter from CEF punt (label not found) cases and I do not see an immediate adaption of the BDLDV for it. On the other hand, for multimedia streaming (except very few cases in which a line is dedicated anyway) the delay constraints are far more laxed than in the case of Power Distribution Grids. On the other hand, maybe service providers will migrate to SDNs...

As a personal touch, for me this thesis represented the first contact with Industrial Ethernet and the Power Supply Grid / Smart Grid as myself I am a "classic" network engineer (classic meaning that my speciality is business-oriented data networks). I found the area of Smart Grids very interesting and challenging and the thesis, besides introducing me to this problematic, brought me insights of the ASIC hardware latencies of different business and industrial switches. A classic network infrastructure engineer is always aware of these, but in the business realm, we consider a very good AVVID (Architecture for Voice Video and Integrated Data) when we have 150 ms RTT (round-trip-time). We never face delays of microseconds in the business-oriented networks (with extremely little exceptions).

## III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

*Summarize your opinion on the thesis and explain your final grading. Pose questions that should be answered during the presentation and defense of the student's work.*



## THESIS REVIEWER'S REPORT

My personal point of view is that the thesis and the work are both excellent and I consider that the PhD candidate proved the fact that he can do research on his own and achieve significant results. With this in mind, I kindly recommend the thesis for defence.

Date: **27.10.2019**

Signature: ing. Alex Moucha, PhD