MÄLARDALEN UNIVERSITY
SWEDEN

Västerås, July 30th, 2019

My comments are summarized in two parts. The first part focuses on answering the required questions and issues raised by the Science and Research office at CTU, and the second part focuses on my personal suggestions after reviewing the thesis.

Part (1):

- To what extent the subject of the thesis is relevant to the current needs of the scientific community?

Devising scheduling algorithms for low-power wireless networks is of paramount importance. With the rapid growth of IoT applications, it is mandatory to provide such algorithms with real-time requirements. This thesis targets TDMA scheduling for cluster-tree WSNs, which is a hot topic.

- To what extent the main objectives of the work have been fulfilled?

The thesis has clearly fulfilled all the objectives that were defined in terms of literature review on related works, design and implementation of scheduling algorithms, support QoS requirements and verify the algorithms through extensive simulations.

- To what extent the methods used in the thesis are appropriate?

The scheduling methods are efficient and smart in such a way that provides reliability, timeliness, and energy efficiency, while addressing collision avoidance.

- What the main results and contributions of the work are?

The main contributions are modeling cluster tree topology in single and multiple collision domains, scheduling algorithms for single and multiple collision domains, implementation and verification through Opnet Modeler.

Main simulation results are in terms of e2e delay, energy consumption and reliability.

- To what extent the work is important for the further development of science?

Real-time support is one of the main requirements in many IoT applications. It is interesting to see that this work continues in future by providing more realistic scenarios and evaluations, where it tackles a factory use case, while performing tests

in a factory environment.

- Whether the thesis satisfies the conditions of a creative scientific work?

This PhD thesis satisfies the conditions of a creative and novel scientific work.

Part (2):

- I have a general question regarding the wireless technology used in this thesis. Is IEEE 802.15.4/ZigBee beacon-enabled cluster tree employed in industries nowadays? What are the main competitors to this technology in industry? and how do you see the future of this technology in industrial monitoring and industrial automation?

- It is needed to add a table that qualitatively compares related works on devising scheduling algorithms with the IEEE 802.15.4

- In page 120, under the other publication, is it a technical report? it has not been mentioned in the reference.

- Were the Opnet results of single collision domain published? I see that paper [8] focuses on MATLAB evaluations.

- This work concentrates on packet scheduling over time. It is interesting to have some discussion on the possibility of extending this work on packet scheduling over time and frequency.

- Did you also follow advancements in other relevant technologies, such as WirelessHART, ISA100.11a and 6TiSCH? These works consider scheduling over frequency and time. Moreover, 6TiSCH is IPv6-based implementation for IoT networks. BLE also supports a channel hopping mechanism.

- It is good to know the correlation between the packet inter-arrival (data generation rate) and reliability of the system when varying number of retries.

- Considering the collision avoidance issue in a cluster tree topology is a complex problem. I would like to ask for the possible industrial use cases of such network topology. Is it necessary to support nodes' mobility in this topology?

- It seems that the scheduling algorithms are executed before the run time of the simulation. Is it possible to run the scheduling policy on the fly for the scenarios where we have dynamics in the network? For instance, the traffic is changing over time.

- Evaluations were conducted in Opnet network simulator. Did the student considered evaluating the algorithms in a real testbed? What will be the consequences of a real-world scenario on the overall performance?

- In this work, it is assumed that the network has periodic data flows. Perhaps this is not a generic assumption as there are many industrial use cases where alarm messages are generated sporadically with real-time support. How does the proposed algorithm support such traffic in the network?

- Future networks are adopting new technologies such as SDN controller that provide a central management for the network. This is the fundamental requirement to support Fog/Edge computing paradigm in order to ensure real-time application requirements. This work focuses mainly on distributed algorithms for WSNs, and the student indicates that distributed algorithms are well suited for WSNs with scarce resources. Does it mean that WSNs and IoT networks will function better in conventional distributed networks and there is no future on integrating Fog/Edge computing within WSNs?

Sincerely,

Dr. Hossein Fotouhi
Data Communication Group
Mälardalen University
SE-72123 Västerås, Sweden
Email: hossein.fotouhi@mdh.se