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Telecommunication Networks – TKN

Master's thesis

Fine-grained QoS management for Mixed-criticality Traffic in Wi-Fi 7

Abstract

New Wi-Fi standard 802.11be comes with several novel features to increase throughput and reliability in wireless communication. For example, Enhanced Distributed Channel Access (EDCA) enables configuring channel access for different access categories (ACs) to prioritize critical traffic, aiming for bounded latency. Another feature, multi-link operation (MLO), enables the concurrent use of multiple links that can be dynamically assigned to such ACs (or QoS classes) to reduce the impact of wireless channel conditions on critical traffic. Leveraging these features, we can combine (i) a high-level link-to-AC mapping via MLO and (ii) a low-level AC-based channel access via EDCA to achieve better QoS guarantees. Accordingly, the main goal of this thesis is to develop joint link assignment and channel access strategies to reduce latency and jitter for high-priority traffic with minimal impact on the best-effort traffic.

Objectives

In the context of the thesis, you are going to:

- develop link assignment strategies for mixed-criticality traffic using MLO.
- investigate the optimal EDCA parameters for mixed-criticality traffic, combined with the link assignment strategies.
- evaluate latency and jitter improvements of the proposed strategies.

Requirements

It is a big plus to be experienced in (or strongly motivated to learn) the following:

- Fundamentals of wireless communication, particularly Wi-Fi.
- Understanding of channel access mechanisms, e.g., DCF, EDCA etc.
- Programming skills in C++
- Network simulators, i.e., OMNeT++

Literature

- E. Khorov, I. Levitsky and I. F. Akyildiz, "Current Status and Directions of IEEE 802.11be, the Future Wi-Fi 7," in IEEE Access, vol. 8, pp. 88664-88688, 2020, doi: 10.1109/ACCESS.2020.2993448.
- G. Naik, D. Ogbe and J.M. J. Park, "Can Wi-Fi 7 Support Real-Time Applications? On the Impact of Multi Link Aggregation on Latency," IEEE International Conference on Communications (ICC), Montreal, QC, Canada, 2021, doi: 10.1109/ICC42927.2021.9500256.
- P. Serrano, A. Banchs, P. Patras and A. Azcorra, "Optimal Configuration of 802.11e EDCA for Real-Time and Data Traffic," in IEEE Transactions on Vehicular Technology, vol. 59, no. 5, pp. 2511-2528, Jun 2010, doi: 10.1109/TVT.2010.2043274.

Thesis Checkpoints

Title
Initial Assessment
Beta Version of Proposal (only between student and supervisor)
Initial presentation (after a few weeks of initial reading, literature study, and tooling)
Written Proposal (Proposal can be submitted only if both fields below are marked with Yes by direct supervisor and referee)
Can register Thesis (including finalized title)?
(opt. Intermediate presentation -- useful to get quality feedback for the direction of the thesis, good idea to do it when starting the ev
Beta Version of Thesis (1 time chance of feedback from referee)
Code review
Written thesis
Final presentation (comprehensive overview, selected results)

Contact:
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Website:
www.tkn.tu-berlin.de

Notes

Lab Rules

As the lab is shared among all of us we ask you to follow one simple rule. Failing that, we will restrict access to the lab and our resources.

0. Make sure that your working in/with the lab does not negatively impact other people's work

To give some examples:

1. Do not change the hardware configuration or unplug any cables.
    Feel free to connect your Laptop to a monitor if there is an unconnected VGA cable on the desk.
    However you must not disconnect any peripherals of any Lab computer in the room.
    When leaving make sure you select the right input mode of the monitor such that it again shows the screen of the Lab computer.
2. Do not execute code you did not write.
    This not only extends to binaries downloaded from the Internet, but also source code, scripts, command lines, etc. We will be happy to supply you with any software you might need. Please ask your supervisor.

3. Do not execute the sudo or su command.

4. Do not shut down or reboot computers.
    If a computer crashed please inform our administrators.

5. Do not monopolize resources.
    A good rule of thumb is to not use more than max. 6 CPU cores and max. 8 GB memory p machine, so fellow users can still log in.

6. Do not print more than you need.
    If you print something, be sure to pick it up from the printer.

7. Do not take hardware out of the lab without permission.
    If you need to take hardware home, please check this equipment out with HaJo Kraus.

8. Do not leave the lab (nor your machine) unlocked when you leave.
    We are not responsible for any theft.

9. Do not litter.
    Clean up after yourself.

Thank you!

Paderborn, 22 May 2018

* Please be aware of the following
when working in the CCS lab. * Regularly check your thesis wiki page, and read both the new_students_infopage and

wiki pages. * After a settling-in period of 2 months (Bachelor thesis) or 3 months (Master thesis), the student and their supervisor(s) can agree on working together on the topic. This agreement is formalized when the thesis proposal is accepted by the supervisor. However, both parties reserve the right to withdraw from further cooperation before the final submission of the proposal. Once the proposal is accepted by the supervisor, it has to be registered with the examination office, otherwise the thesis will be canceled. * Submission is possible before the official deadline of the examination office, but not before 50% of the official time. * https://www.tu.berlin/en/studying/organizing-your-studies/study-and-examination-regulations/

Log

We assume there will be a meeting between you and your supervisor at least every two weeks. In the meantime, please indicate your progress by email. If there is no log entry for more than one month, we have to assume the thesis is to be canceled.

- YYYY-MM-DD: <what happened in the last week(s), outcome of discussions within the meetings, plans for the next week, deliverables...>

End-of-thesis Checkpoints

Once you are finished with your thesis, collect all of your simulation output files (.sca, .vec) in `scratch-shared/` and remove all of the output files which are not used in the final written thesis. Create a `README.txt` documenting the points below.

task
Add thesis to our BibDB
Final git commit (hash) for the developed simulation code/model. Create a branch called `thesis-final`
Final git commit (hash) for the scripts used to parse the raw data to obtain the csvs; include the command for starting the scripts; Cr
Directory location and structure of the result files and parsed files (if applicable)
Final SVN commit for the written thesis, the final presentation
Final git commit (hash) for the scripts used for plotting in the final written thesis; Create a branch called `thesis-final`
Copy all documents (proposal, thesis, pptx) to SVN:/theses/tkn/<year>.<thesis-type>.<bibtexkey>

After fulfilling the tasks, report the information to your supervisor via email and they will update the status column.

For the supervisor: Check *After the thesis is submitted* point in How to supervise a thesis page