‘Assessment and Optimisation of Latency for Advanced Services in 5G Networks’

Applied technology | TNO, The Hague | Academic

Background

Currently, mobile network providers worldwide have deployed and operate networks of 2G (GSM/GPRS/EDGE; deployed since 1991), 3G (UMTS/HSPA; deployed since 2001) and 4G (LTE/LTE-A; deployed since 2009) technology. Following the approximate heartbeat of releasing a new generation every ten years, the 5G mobile networking technology is currently under development and to be first deployed in the year 2020. More than ever before, the development of 5G is driven by so-called ‘vertical sectors’ [1], such as ‘Automotive’, ‘Energy’, ‘Media & Entertainment’ and the ‘Factory of the Future’). For each such ‘vertical’, specific use cases are formulated, e.g. ‘Automated driving’ and ‘Information society on the road’ for the ‘Automotive’ vertical [2], while corresponding technological requirements are derived related to e.g. data rates, end-to-end latency and the number of supported devices (‘massive connectivity’).

Project description

The proposed graduation project concentrates primarily on the latency aspect, which is a demanding performance aspect for various 5G services, including e.g. ‘Automated Driving’ and the ‘Time-critical, reliable process optimisation inside digital factory’. In an end-to-end connection between an end device and (typically) a server or another end device, the experienced latency is determined by the delays incurred in the different segments of the end-to-end path, e.g. by the length of the Transmission Time Interval (the transmission duration of a single transport block in the radio interface), the congestion level in the radio access network (queuing/scheduling delays), possible differentiation mechanisms which may prioritise delay-sensitive services, processing times in the server and the summed propagation delay across the different hops in the end-to-end path. In relation to the latter aspect, 5G developments related to e.g. ‘Mobile Edge Computing’ are highly relevant, i.e. bringing processing/storage servers close to the air interface to reduce latencies.

The chief objective of the project is to determine attainable end-to-end latencies under realistic traffic/environment conditions and for different controllable scenario aspects regarding e.g. service differentiation and centralised/ distributed server deployment/configuration. Or, formulated conversely, the objective is to derive, for a given latency requirement, under what scenario circumstances and for which network configuration/deployment options this requirement can be satisfied.

Both TNO’s enhanced Hi5 platform (a testbed facility) and the system-level mobile network simulator will play a central role in the investigation, as they jointly enable performance experiments to be done in a controlled and realistic environment, through which the sought insights should be obtained. The Hi5 platform comprises a complete software based core network (Open5GCore, developed by Fraunhofer institute) which mirrors , in a prototypical form, the pre-standard 5G advancements on the core network, distributed management and virtualisation. The system-level mobile network simulator is an essential and continuously evolving resarch and consultancy tool which enables the performance and capacity assessment for mobile network technologies and features in realistic scenarios in terms of propagation, network and traffic aspects.

The assignment will comprise several tasks/phases:

- Get acquainted with the key aspects of 5G networking, the key verticals, the associated use cases and performance requirements. Generate a qualitative understanding of the how scenario/system aspects influence key performance metrics. Familiarize yourself with TNO’s Hi5 platform and system-level mobile network simulator.
- Study/model/develop solutions for and perform a qualitative assessment (what tradeoffs exist?) of various concepts that have an impact of the service’s delay performance, such as network slicing (incl. prioritised/differentiated scheduling), the ‘softwarised’ deployment of network functions (Software-Defined Networking (SDN) / Network Function Virtualisation (NFV)) and Mobile Edge Computing.
- Define experimental scenarios in terms of traffic, environment and system aspects. Prepare all inputs necessary to conduct the define experiments, which includes usage of the system-level mobile network simulator to generate detailed traces (traffic, SINRs, attainable instantaneous bit rates) that are to be fed into the Hi5 platform.
- Conduct experiments, analyse the results, assess the impact of the various concepts/solutions on the delay performance under different circumstances, optimise their instantiations.
- Formulate conclusions and recommendations.

The formulation of the definitive graduation project will be fine-tuned in a discussion between you and your TNO (and university) advisors. The project duration will be about 6-9 months depending on agreements made. During the execution of the assignment you will work together/discuss with different experts employed at TNO, and you will be asked to present your challenges and achievements at TNO-internal meetings. Furthermore, you will also obtain personal guidance to help develop your competences.

Requirements

You are pursuing a Master's degree in Electrical Engineering, Computer Science or related field, have at least basic knowledge of (wireless) communications and are motivated to expand your expertise in this domain. Good programming skills (particularly in C; C++/Linux expertise is a bonus) are essential, while good experimental skills are a plus. You are both a team player and an independent worker, proactive and (self-)critical by nature.

Company information

TNO is an independent research organisation whose expertise and research make an important contribution to the competitiveness of companies and organisations, to the economy and to the quality of society as a whole. Innovation with purpose is what TNO stands for. With 3500 people we develop knowledge not for its own sake but for practical application. To create new products that make life more pleasant and valuable and help companies innovate. To find creative answers to the questions posed by society. We work for a variety of customers: governments, the SME sector, large companies, service providers and non-governmental organisations. Working at TNO means working in a highly innovative, dynamic and challenging environment with ample oppportunity for creativity and personal development.

Contact

José Almodovar Chico (06 5280 3700, jose.almodovarchico@tno.nl) or Remco Litjens (06 5191 6092, remco.litjens @tno.nl).

References

[1] 5G-PPP, *'5G empowering vertical industries'*, vision paper, see https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf, February 2016.

[2] 5G-PPP, *'5G Automotive Vision'*, see https://5g-ppp.eu/wp-content/uploads/2014/02/5G-PPP-White-Paper-on-Automotive-Vertical-Sectors.pdf, October 2015.

[3] TNO, https://www.tno.nl/en/, 2016.

[4] Fraunhofer FOKUS, http://www.open5gcore.org/, 2016