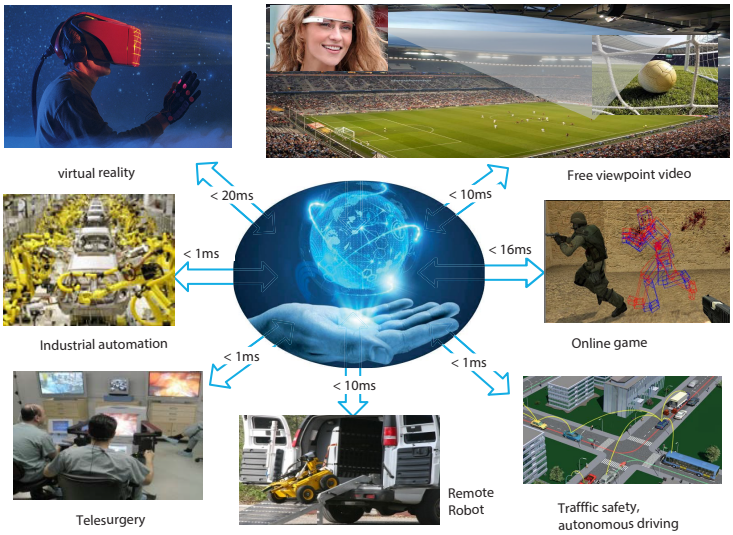
Call for a Master's thesis project



Title: Enhancing 5G Cellular Networks for the Tactile Internet Revolution

The challenge

Future Internet of Things (IoT) systems will have huge societal impact with technologies such as tele-healthcare, serious and entertainment online gaming, smart energy systems, and autonomous transport systems only if secure communications with ultra-low-latency will become a reality. In these technologies, it would be highly desirable that the round-trip time to send information from a source to a destination and back experiences latencies below 5ms. For example, in online music concerts with remote musicians in a virtual orchestra and scattered remote audience, the musicians may play "together" only if the audio and visual latency is less than 2ms. In power distribution grids, highly detrimental out-of-phase injections could be easily avoided if the sensors communicate with the controllers and actuators within less than 2 ms. In the field of virtual and augmented reality, visual feedback must be below 5 ms when related to a sound or tactile event to avoid "cybersickness", or the dizziness similar to uncomfortable traveling at the back of a car or in a ship.

Despite our society being fully connected thanks to wireless networks and Internet, currently there is neither fundamental design method nor technology capable to ensure real-time and secure communications. While the most cutting-edge current networks (e.g., the fifth generation of cellular wireless networks) will deliver very high data rates, they will also provide communication delays of the order of 25ms. This delay is unacceptable for many IoT services that are arising recently, such as surgery making use of robotic arms controlled by a skilled surgeon who is at far distance, or the automated steering of platoon of cars via wireless communications.

In this Master Thesis project, we propose to systematically undertake the study of the most prominent design principles for future near-to-zero latency IoT systems with focus at the networking level of 5G wireless cellular networks.

Approach

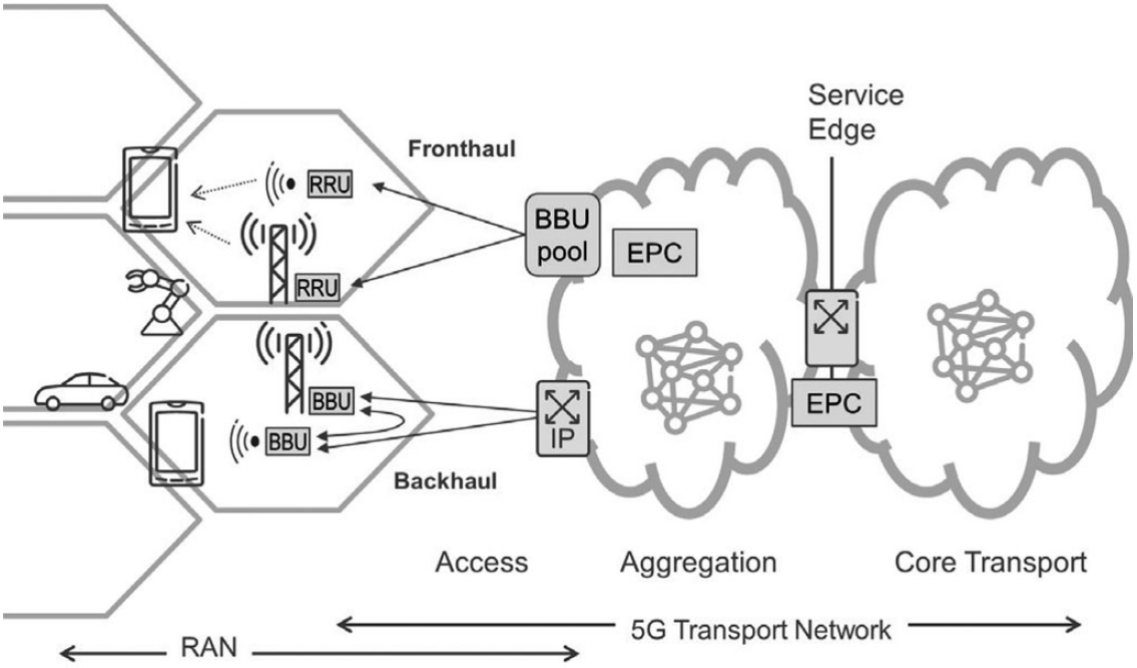


Figure: *5G network architecture*

The goal of this thesis work is to investigate in 5G wireless cellular communication networks the backhaul and fronthaul networks to support low latency communications. This will be achieved by investigating the following topics:

- Low-latency optical modulation formats for fronthaul, e.g., PAM-4 direct-detection;
- Network slicing (SDN/NFV): How to design network slices for applications with diverse requirements (how to logically isolate low-latency applications from other traffic);
- Dynamic and optimized placement of virtualized functions: Radio baseband processing (BBUs), mobile core (EPC), networked control applications;
- Optimized path computation and resource allocation for low-latency applications;
- Latency monitoring: Both NFV cloud and transport resources, and statistical modeling.

Contact information

This is a highly exciting project between the School of Electrical Engineering of KTH Royal Institute of Technology and ACREO, Stockholm, Sweden.

Those who are interested to work in an interdisciplinary field between mathematical network optimization and content distribution networks and learn new techniques and broaden the knowledge are encouraged to apply. Any Master's student who has good interest in mathematical optimization, networking, automatic control, wireless communication and signal processing, is welcome. Electrical engineering, engineering physics, computer sciences students with strong mathematical knowledge are encouraged to contact the persons below.

Starting time: from end of September 2016

Contact persons

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References

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[2] Ćiril Rožić, Dimitrios Klonidis, Ioannis Tomkos, ”A Survey of Multi-layer Network Optimization”, 20th International Conference on Optical Network Design and Modeling (ONDM 2016), May 9-12, 2016, Cartagena, Spain;

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