ENCQOR 5G Technology Development Challenge

5G Localization Use case in Mass Rail Transit

Challenge Launch Date	October 21 2019
Challenge Deadline	November 18 2019
Challenge Statement	5G technology has the potential to solve key challenges faced by transit operators in autonomous train operation (ATO). Position information has become a key feature in recent years to drive location and context aware services in mobile communications. However, providing position information with sufficient accuracy, high availability and coverage is still a very challenging task. Thales Canada is interested in working with an Ontario based academic institution to develop a 5G communications system for localization with sub 1m accuracy.
Project Partner	• Thales Canada Inc.
Timeline	• 1 Year
Available funding	• $100,000
Applicant Type	Ontario based academic institution

Location	Work can be completed remotely with scheduled online meetings and face-to-face workshops. Demonstration and testing will be scheduled and performed in different phases of the project according to the plan that will be established between the applicant and Thales. Final demonstration will be performed in a real life scenario in underground subway conditions.
Project Details	Thales is facing the challenge of accurate determination of train location which is a critical part of our ATO operation even more severely considering the inability to use a global positioning system (GPS) in subway tunnel environment. 4G Mobile radio communication systems provides signal structures, bandwidth, power levels and capabilities for the determination of location of the mobile terminal. However, these methods infer position information from received signals and include cell-ID, received signal strength (RSS) as well as time difference of arrival (TDOA) based methods. The challenge with these systems in a subway environment are: firstly all of these methods require signals from at least 3 different base stations (BSs) in order to calculate their position in 2D; for positioning the mobile terminal (MT)s operate independent from each other without any cooperation in the use of downlink signals; propagation delay based methods like TDOA require signal reception from 3 BSs in order to calculate a 2D MT. In subway environment layout of radio access network (RAN) there is normally only chance of receiving one or two different enode B's signals at a time. Multipath and non- line-of-sight (NLoS) propagation are present and potentially can cause severe positioning performance degradations.

	Even in the most perfect conditions presently reported the accuracy of 4G based solutions would not be satisfactory for the ATO operation of Thales Communication Based Train Control (CBTC) based system. Our need is to achieve sub 1m accuracy which is aligned with the general goals of horizontal accuracy reported by 5G vertical market studies. This would provide a unique and distinct advantage for 5G based communication solutions for Massive Rail Transit since no other communication system currently available is capable of delivering a communication solution with sufficient bandwidth and quality of service as well localization solution. The desired project focus is as follows: The project should demonstrate small scale 5G network with at minimum 2 enode B's and core network and 5G user equipment (UE) device optimized for location measurement using 5G new radio (NR). The setup should contain a number of "auxiliary 5G UE" devices that would, through co-operation algorithms, provide additional benefit to the measurement process enabling bias removal. The setup should be capable of demonstrating location measurement capabilities with only 2 enode B's and a possible number of co-operative fixed positioned UE devices in the tunnel. There are several possibilities to explore in this project: 1) Position of auxiliary devices in the system is known and determined in advance so this information can be used to remove measurement bias 2) In underground subways the train position on tracks can be bounded to known track/railway positions

	3) Machine learning approach The project shall provide answers to the following questions: 1) Multiple input multiple output (MIMO) order and number of antennas required on enode B and UE device 2) Minimum channel bandwidth requirements to accomplish positional accuracy measurement 3) Optimum Beamforming strategy, fixed, dynamic. 4) Algorithm proposal with simulation and characterization.
Project Goals/ Outcomes	Project goals will be to demonstrate through measurements, emulation and simulation following key performance objectives: 1) Optimum enode B configuration; 2) Accuracy vs distance Accuracy vs non-line of sight impact;
Applicant Capabilities	• 3 researchers (M.Sc. or Ph.D. level) capable of demonstrating end to end traffic • Strong background in wireless communications and 5G standards (Physical and media access control (MAC) layer). • Familiar with machine to control (MTC), machine to machine (M2M), Internet of Things and traffic generation, measurements and analysis. • Experienced in wireless channel modeling, statistical modelling, wireless channel emulation using commercial of the shelf channel emulators.

	• Experience in configuration of 5G enode B and core network. • Hands-on experience in using standard compliant event driven simulators (e.g., ns-3) and IoT testbeds.
Additional Information	NA