5G (ENCQOR) Technology Development Challenge

Cognitive Machine-Type Communications for Massive IoT

Challenge Launch Date	• February 26, 2019
Challenge Deadline	• March 26, 2019
Challenge Statement	5G networks are anticipated to transform modern societies by providing an ultra-reliable, high speed communications infrastructure that will serve smart city applications, industrial automation, and connected vehicles. However, IoT applications have both diverse communication requirements and unique traffic characteristics that make traditional wireless network configuration and operation inefficient. As such, specialized network architectures and radio resource management schemes are paramount to facilitating scalable deployments that adapt to the massive IoT traffic patterns. The challenge in this project is to develop cognitive techniques that support machine-type communications (MTC) such as (but not limited to): dynamic discontinuous reception (DRX) control, anticipatory scheduling, and adaptive coverage mechanisms. The work includes: 1) understanding and modeling IoT traffic characteristics with emphasis on a particular application, 2) proposing and developing cognitive MTC techniques, in particular L2 and L1 functions, and 3) an end-to-end practical evaluation on a 5G testbed.
Project Partner	• Ericsson Canada Inc.
Timeline	• 2 Years
Available funding	• $150,000 CAD
Applicant Type	• **Ontario based College/University**
Location	• Work can be completed remotely with scheduled online meetings and face-to-face workshops
Project Details	• **The main scope includes:** ○ **Modeling Massive IoT Traffic** ▪ Developing individual device and spatiotemporal geographical models of IoT traffic, including periodicity and long-term application demands. ○ **Cognitive and Anticipatory MTC** ▪ Proposing IoT centric L2 and L1 mechanisms for MTC that are 3GPP Rel 15.2 standard compliant. This can include

	predictive resource allocation, adaptive DRX and deep coverage mechanisms. The proposed mechanisms shall satisfy a set of predefined requirements such as energy consumption, latency and network availability. ▪ Enable the network to perform a series of sensing, perception, reasoning and learning to leverage the IoT traffic model and provide autonomous context-aware network decisions. ▪ Consider both single or joint (multi-dimensional) decisions and with different time granularities (e.g. on a millisecond, second or minute scale) over a finite time-horizon. ○ **Incorporating Robustness** ▪ The developed solutions should consider imperfect predictions such as time-varying network resources and stochastic traffic demands – and adopt artificial intelligence (AI) or statistical techniques to provide robust network decisions. ○ **Testbed Implementation and Evaluation** ▪ The proposed MTC solutions are to be prototypes on a 5G testbed comprising real IoT sensors running the application of interest. • **Deliverables:** ○ Data traffic models for massive IoT deployments with emphasis on a particular IoT use case. The models are to be generated using real data collected from measurements. ○ A dynamic optimization, machine learning or artificial intelligence framework (implemented in a 3GPP standard compliant network simulator) used to provide the cognitive decisions such as predictive scheduling and DRX. ○ Systematic closed-form non-heuristic models that derive risks and gains of the candidate decisions, based on errors in the prediction models where applicable. ○ The proposed MTC techniques and framework should be integrated with a 5G testbed and evaluated under practical IoT traffic patterns and deployment scenarios. ○ A detailed report explaining the key findings of the study and the details of using the developed cognitive MTC algorithms. • **This challenge strategically important for the development of the industry and the ENCQOR consortium since it:** ○ Supports the development of scalable MTC for 5G IoT applications. ○ Provides an IoT testbed and platform to test 3GPP compliant MTC L2 and L1 mechanisms that meet QoS requirements with efficient spectral efficiency.

	○ Builds a strong MTC and IoT knowledge and competence in the Canadian academia.
Project Goals/ Outcomes	• Provide data traffic models for massive IoT deployments with emphasis on a particular IoT use case. • Design ML/AI-based techniques for cognitive network management. The goal is to develop proactive cross-layer network functions (L2/L1) for IoT applications that adaptively optimize network efficiency and device QoS in real-time. Some examples include DRX management, adaptive coverage and proactive scheduling. • Demonstrate at least one of the proposed cognitive MTC schemes on a 5G testbed employing IoT sensors running the application of interest. • Provide error models for sensed and predicted information which can be further used in 1) performance evaluation of existing MTC network management, and 2) the development of anticipatory network management paradigms. • Incorporate robustness in the proposed MTC techniques that account for the aforementioned error models and meet the performance requirements under imperfect prediction.
Applicant Capabilities	• 3 researchers (M.Sc. or Ph.D. level) • Strong background in wireless communications and 5G standards (Physical and MAC layer). • Familiar with MTC, M2M, IoT and anticipatory/crowd sensing applications, architecture and requirements. • Experienced in statistical modelling, machine learning, data analytics, linear/non-linear optimization and artificial intelligence. • Hands-on experience in using standard compliant event driven simulators (e.g., ns-3) and IoT testbeds.
Additional Information	• N/A