Internship offers

Contact: kim-khoa.nguyen@etsmtl.ca

Project title: 5G distributed fabric and real-time bus

Short description:

What problem are we solving?

5G is revolutionary in many ways but what makes it unique is that it is the first generation of networking that makes connectivity as pervasive as the air we breathe in. Imagine the user landscape that would emerge from confluence of robotics and machine intelligence underpinned with this level of pervasive connectivity and very quickly lines will start to blur across consumers and producers of digital services and/or components that constitute these services so much so that the user becomes a part of the cloud, making the cloud pervasive. Demand side equations that dictate plan, design and operation of digital systems are seriously challenged by this landscape. The expectation is that demands for future systems will be vastly complex and will evolve rapidly in directions that are not currently anticipated to support new technologies. The complexity results from the inter-relationship, inter-action, and inter- connectivity of intelligent components (e.g., network nodes, access points, data centers) within a system and between this system and its dynamic environment. Managing the complexity of such systems with dynamically responsive evolving arrangement of intelligent components becomes the key challenge. This will create an increasing pressure for continuous optimization of resources bringing planning, design and operations into a continuum. In this continuum optimum operation through is achieved on an ongoing basis by appropriate sensing of condition; discerning of meaning; inferring of current/potential deviation from desired operation; deciding on action, and acting on these decisions to restore/maintain optimum operation.

How do we solve it?

In late 2017, Ciena introduced a new target end-state for network providers, the Adaptive Network. In an adaptive network, highly programmable infrastructure (both physical and virtual) becomes self-configuring and self-optimizing through automation guided by analytics and intent-based policies.

Self-Optimizing Fabric (SOF) is an the nth state implementation of the Adaptive Network targeting the pervasive cloud marketplace, a rendez vous of disparate consumers and providers to trade digital goods and services enabling dynamic compositions for cyber-physical systems of the future. Expectation is that consumers of the future (e.g. farming, pharma, healthcare, manufacturing) will be able to dynamically assemble and manage adaptive systems that meet their business needs, with a seamless composition of any of value elements offered by heterogonous disparate producers as a service under the pervasive cloud marketplace. Some resources the consumer may own, some may come, for example, from a Communication Service Provider, and others from the various Cloud Providers.

Put simply, SOF is an architecture construct for federation of disparate adaptive systems in a unified 'value fabric' optimized to meet overall objectives of the collaboration. In the desired nth state, the overall system will be a fluid federation of distributed intelligences embodied in multiple self-contained intelligence agents such that the arrangement of all parts of the system will be determined by emergence, i.e., the system will be self-organizing and self-optimizing.

Why is this part of ENCQOR?

The "*Evolution of Networked Services through a Corridor in Québec and Ontario for Research and Innovation*" partnership initiative, or ENCQOR for short. ENCQOR SOF initiative brings together many industry leaders in the 5G and AI technology spaces who together create a research platform to study 5G-oriented use cases and technologies. Notable members include ETS Montreal, Stanford University, TU-Dresden, and i2CaT, to name a few. ENCQOR SOF aims to implement a self-optimizing 'DC without borders' across the ENCQOR Corridor that fosters locality unaware incubation through north and south of Canada. SOF transforms the ENCQOR corridor to a discovery and verification testbed for our Adaptive Network vision curating a broad set of use cases e.g. multiaccess edge for autonomous device swarms, underpinned with 5G, AI and a broad suite of technologies that will constitute what we call the Adaptive Network. The four newly approved work packages within ENCQOR SOF initiative enable us to continue to implement, learn, and evolve our thinking and architecture vision alongside a wider audience.

Partners:

Ciena, ETS Montreal, MITACS

Requirements:

Working conditions

1. The intern is required to work at Ciena facility at Montreal for at least 50% of time. No working permit is required.
2. The interns will be funded according to the MITACS Accelerate program. In other words, the intern will work in blocks of 4 months. Details of the program can be found at: https://www.mitacs.ca/en/programs/accelerate
3. The PhD students will be working during 6 to 8 blocks. The Master's students will be working during 3 to 4 blocks.
4. The interns will be co-supervised by a professor at ETS Montreal and an industrial researcher, and possibly co-supervised by a professor at UC Berkeley or Stanford University.
5. The interns will be working in Montreal (at ETS campus and Ciena research center). A laptop will be provided during the intern.
6. The deliverable of the interns will include software components, technical reports, and conference/journal articles. PhD interns will be required to publish at least three articles to report the outcome of his/her project.

Technical skills:

- Programming languages: Java, Python, Go, Scripting: required
- Linux OS: required

- Networking: Ethernet, IP: required
- Architectures: SDN, NFV: required
- Machine learning algorithms: Required
- Open Platforms: Openstack, Kubernetes: Basic knowledge
- 5G control plane, data plane and management plane: Basic knowledge
- 3GPP SON systems: Basic knowledge
- Data Science, Artificial Intelligence: Basic knowledge
- Deep Learning: Basic knowledge
- Self-Optimizing systems design, models and algorithms: Basic knowledge
- Autonomic systems design, models and algorithms: Basic knowledge
- Complex Adaptive System (CAS): Basic knowledge

Intern project:

The synchronization of control loops presents a special problem. Control loop operate in different time domains and as such the synchronization within a specific time domain and between time domains pose specific challenges. The interns will need to consider the system as a whole from extremely fast RAN control loops to the larger but interconnected orchestration control loops. The interns will analyze the relationships between the different loops and model the queuing and synchronization requirements between the different instances of the loops. Armed with this analysis the interns will develop recommendations on how the relationships between the different timescale loops are represented as well as how information exchange and synchronization are managed through mechanisms such as different priority queues or other means of prioritizing messaging and synch protocols. Finally, an analysis of the performance of these models and prioritization mechanisms under different operating conditions for several use cases including the RAN, the RAN + fronthaul, the RAN + fronthaul + backhaul, and finally the system as a whole from the application to access.

Intern #1 (Ph.D) – P1.1: "Peering virtual resources for 5G service provisioning"

The goal of this intern project is to research and implement methods to support the federation of resources and components of the ENCQOR Distributed Fabric (EDF) in order to deliver end-to-end services to ENCQOR tenant.

In terms of implementation, the intern is required to develop new control and data transmission onto ENCQOR routers and compute nodes using the RINA framework.

In terms of research, the intern will investigate different peering and federating scenarios, like East-West peering, North-South peering, federation within a single jurisdiction, or between different jurisdictions. For each scenario, the intern will propose specific methods added to the control and data plane to achieve seamless federation

Intern #2 (Ph.D) – P2.1: "Real-time bus supporting disaggregated RANs communication in 5G networks"

The goal of this intern project is to investigate

- Research for requirements analysis for latency critical and time-based transport of CP, UP and telemetry, and associated KPI's definitions, Traffic projections & Information modeling
- Modeling of control loops, timescale synchronization, and prioritization
    - Identification of Control loops
    - Control loop prioritization
        - Soft control loop design
        - Hardware acceleration resource prioritization
- System Architecture for RT Bus
- Design, implementation and verification of the RT Bus

Intern #3 (Msc) – MSc1.1**: "EDF Implementation & Research"**

The goal of this intern is to implement mechanisms supporting the federation of resources in a multi-tenant environment within a single data center. This work relies heavily on the research results of PhD1.1.

This intern will be working on a "North-South control for federation of peered entities within a single data center (multiple jurisdictions)."

Intern #4 (Msc) – MSc1.2**: "EDF Implementation & Research"**

The goal of this intern is to implement mechanisms supporting the federation of resources across different data centers. This work relies heavily on the research results of PhD1.1.

This intern will be working on a East-West peering of heterogeneous fabrics across two data centers (common jurisdiction).

Intern #5 (Msc) – MSc2.1**: "Real-time Bus for network function (NF) disaggregation, data collection, and ingestion"**

The goal of this intern is to implement the IETF TAPS framework defined in [https://datatracker.ietf.org/wg/taps/documents/] to abstract both the transport technology defined in WP1 and the traditional TCP/IP, allowing the end-to-end connection across different domains.

This intern will be working on a Real-time Bus for network function (NF) disaggregation, data collection, and ingestion and Transport abstraction framework implementation.

Intern #6 (Msc) – MSc2.2**: "Real-time Bus for network function (NF) disaggregation, data collection, and ingestion"**

The goal of this intern is to support PhD2.1 in design, implementation, and verification of the real-time bus for network function (NF) disaggregation, data collection, and ingestion.

This intern will be working on a Real-time Bus for network function (NF) disaggregation, data collection, and ingestion and Design, implementation and verification of the real-time bus.

International students are welcome to apply!!