Become an Ericsson Fellow

Announcement for the 2024-2025 Competition

Submissions Due by March 28, 2024

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Open to Students within:

Computer Science, Computer Engineering, Information & Technology, Electrical/bio-med, Systems Engineering

Open to both domestic and international students

Ericsson supports future leaders in wireless communications by supporting experiential and project-based learning. The Carleton-Ericsson partnership also enhances talent development programs by supporting research projects, creating graduate student internships and establishing a prestigious Ericsson fellowship program. This prestigious fellowship program provides Carleton graduate students the opportunity to conduct hands-on research alongside Ericsson experts in state-of-the-art facilities. This is a competitive fellowship program that recruits the best and brightest to be the future leaders of the 5G revolution.

Funding Available (Awards are for one year with a potential renewal for a second year)

- MASC $40,000/year
- PHD $50,000/year

NEW STUDENTS APPLYING to Carleton

Prospective applicants are required to apply through the graduate studies program. Include your intention to apply for the Ericsson Fellowship in your statement and include a one-page statement of interest in one of the three research topics listed below. If selected, your incoming supervisor will also need to supply a Letter of Support.

CURRENT STUDENTS at Carleton

Apply through your Department. Submit the following documents: a one-page statement of interest in one of the three research topics listed below, transcripts, CV, and letter of support from your Supervisor. Note: if you currently hold funding, Ericsson funding will replace funding up to the existing fellowship amount, including release from TA duties to undertake your placement with Ericsson.
You must indicate which topic you are interested to apply for and submit a one-page statement of research interest in your application.

Evaluation Criteria (for both new and renewing fellowships):

- NSERC awards criteria and PhD and Master’s level
- Ericsson-specific
- Career interest and synergy with Ericsson’s goals
- Ability to act as Ericsson ambassador
- Proven leadership and communication

There are 6 topics to choose from to participate in this exciting and dynamic program:

1. Intelligent multi-objective link adaptation in 5G NR; Ericsson Supervisors: Medhat Elsayed, Majid Bavand
2. 3D Stacked Antenna Technology; Ericsson Supervisor: Pierre-Andre Laporte
3. Assurance: AI framework/model for anomaly detection & future prediction; Ericsson Supervisor: Sachin Kumar
4. 5G New Radio Positioning; Ericsson Supervisor: Xiao Lu
5. Radio Log Anomaly Detection (RLAD) – RU Smart Debugging Tool; Ericsson Supervisor: Brian Le
6. Networks for RAN processing; Ericsson Supervisor: Glenn Parsons
7. Quantum 6G Technologies; Ericsson Supervisors: Roland Smith, Dr. Hazeem Ibrahim

Detailed Descriptions Attached:

Topic 1:

**Intelligent multi-objective link adaptation in 5G NR**

Traditionally, link adaptation algorithms are based on control theory and use feedback loop to select the modulation and coding scheme (MCS), transport block size (TBS), and number of resources needed for transmission, with the aim to maintain a predefined BLER target as per 3GPP recommendations. The legacy approaches prevail in adaptability to different network conditions. However, this flexibility comes with the price of slow convergence and marginal performance gains under rapid channel variations or fluctuating interference. This will increase delay and lower reliability, which is undesirable in the context of delay-sensitive applications.

Recently, A/I-based link adaptation, such as deep reinforcement learning, has emerged as a solution to the dynamic interference scenario. AI models are capable of outputting suitable MCS values given the current channel condition, thus, reduce the convergence time, maximize throughput, and minimize retransmission efforts. However, AI powered solutions suffer from ability to cope with data drifts and concept drifts and lack of consideration for delay in their training.

The goal of this project is to investigate the use of federated learning for link adaptation to address above expectations.

**Purpose:**
In this project it is expected that the applicant builds an AI-powered link adaptation solution that recommends MCS, TBS, RB allocation by considering throughput maximization, transmission delay minimization, while satisfying QoS and being resilient to data drift and concept drift. Federated learning is an emerging distributed learning approach that aims to train a global machine learning model by aggregating the parameters of several local models that can be potentially used to address the data drift problem.

**Intended Impact:**
This project can be produced as a RAN feature in baseband in CR and MWSRS and be sold as a license feature to Ericsson’s customer to generate more revenue for the company.

**Research Scope:**
The research shall consider the following scope in system model and simulations for training the model and for an analysis in the interference plane:
- 5G NR protocol stacks shall be considered
- Multiple cells (at least 3 cells)
- Multiple sites in each cell (at least 100 site connected users per cell)
- Each cell shall have an independent scheduler
- Propagation traffic and MAC layer
- 5G eRAN channel model (or alternatively OFDM-C and CDL-E channel models)
- Traffic from user activities in one cell shall create interference towards adjacent cells
- 1000MHz bandwidth is used (availability in important power in simulation can change this requirement)
- Possibility of transmission to multiple SIMs in each slot with non-overlapping RB allocation (SU-MIMO)

**Outcomes:**
- **Project deliverables:**
  - Survey the literature of AI powered link adaptation in 5G NR with more focus on federated learning
  - Simulation in RAN
  - Train an AI model that recommends the value for MCS, TBS, RB allocation as output
- **Model development:**
  - The model shall consider the following factors
    - Throughput maximization
    - Delay minimization
    - Data transfer
    - Resilience to data drift and concept drift
- **Compare the proposed solution with legacy (A) algorithms and other AI-powered solutions under different traffic scenarios and channel conditions**
- **The patents and publish scientific papers**

**Participants:**
A Bachelor, Masters, or Ph.D. students under the joint guidance of a professor from Carleton University and Ericsson.

**Ericsson Participants:**
Medhat Elsayed, Tuong Nguyen, Majid Bavand
**Topic 2:**

**Ericsson-Carleton University – 3D Stacked Antenna Technology**

**Motivation & Background:**
More antenna gain is needed in many radio product segments, especially for frequencies above 6 GHz which do experience a stronger path loss. Larger array gain can be achieved by:
1. Increasing the number of transceiver chains, which in turn increases the radio power consumption, the antenna calibration complexity as well as the surface area/wind load.
2. Increasing the sub-array aperture, which makes the feed network more complex and thus increases splitter power losses as well as the surface area/wind load.
3. Using a 3D stacked antenna where active antenna elements are augmented with passive elements that have some tunable reactive loads. The tunable reactive loads and the active beamforming weights are co-optimized to form the beams in the intended directions. Some examples with simulation results are shown on the next slide.

**Purpose:** To understand the fundamental design space and the design trade-offs of a 3D stacked antenna arrays and to prove the technology by means of a hardware prototype.

**Intended Impact:** This project will lay out the fundamental principles of a new antenna technology and prove the concept viability with a hardware prototype.

**Research Scope:**
1. Understand the fundamental principles behind the 3D stacked antenna arrays with focus on MIMO antennas and circuits.
2. Electromagnetic simulations of a prototype using HFSS targeting the 6 GHz frequency band.
3. Build and test the array hardware prototype, considering:
   - The ease of integration with existing Ericsson radio products.
   - The Passive Inter-Modulation (PIM) aspect.
4. Work with antenna experts to identify value adding opportunities for Ericsson.
5. Prepare presentations/publications including IPR generation in collaboration with Ericsson.
6. Organize seminars.

**Outcomes:**
1. Overview of the 3D stacked antenna technology design space and design trade-offs.
2. Build a 3D stacked antenna array hardware prototype.
3. Over-the-air measurements of the hardware prototype.
4. Presentations/seminar/publications and IPRs with Ericsson partners

**Participants:**
- A Masters/PhD student under the guidance of a professor in collaboration with Ericsson’s mentors.

**Ericsson Participants:**
- Pierre-André Laporte, Shady Eltahawy

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**Topic 3:**

**Assurance: AI framework/model for anomaly detection & future prediction**

Many of the challenges in analyzing network data, typically come in time-series data (e.g., metrics, alerts). While analyzing time series data, we must ensure that the outliers, much as we do in static data. If you’ve worked with data in any capacity, you know how much pain outliers cause for an analyst. These outliers are called “anomalies” in time series jargon. Tackling anomaly detection requires an array of approaches, including statistical analysis, machine learning, and deep learning.

Being able to quickly observe and identify the abnormality in the 5G/6G network /slice and predict the probable issue /cause. How can we use AI/ML model/processing solutions (monitoring, troubleshooting, visualizing, etc.) and enable easier adoption for anomaly detection for 5G/6G network/slice.

**Purpose:** Using AI/ML solutions (existing or build new models) to read the network/slice (metrics/alerts/topology) data and train the model to detect the anomalous & predict the cause in near real time.

**Intended Impact:** This project will produce an Ericsson-only solution/offerings to customers to aid with anomaly detection and help to assure network/service/slice quality.

**Research Scope:**
1. Understand the landscape, players, partners, current AI/ML tools and models.
2. Research into industry best practices and solution for anomaly detection for timeseries data.
3. Continuously perform low/no analysis to determine best value propositions for Ericsson.
4. Work with experts to understand pain points and quick wins.
5. Create a model that continuously learns from the real-time data (on a daily/monthly basis).
6. Develop capabilities in generating insights needed to drive meaningful outcomes.
7. Develop capabilities in performing large-scale (in real-time) data analysis.
8. Develop capabilities to associate between different data sets (metrics, alerts, topologies) to the anomalies.
9. Prepare presentations/publications including IPR generation in joint collaboration with Ericsson.
10. Organize seminars.

**Outcomes:**
1. Overview of landscape and latest trends, practices, tools used in industry for anomaly detection.
2. Clearly articulate “no go” offering as distinct and visible solution.
3. Deliver solution that tightly integrates manual analysis and detect the anomaly in near real-time.
4. Presentations/seminar/publications and IPRs with Ericsson partners.
5. Plug and play solutions that can be offered as standalone solutions.

**Participants:**
- A Masters/PhD student under the guidance of a professor in collaboration with CR partners

**Ericsson Participants:**
- Sachin Kumar, Stephanie Thouamy

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Assurance topic 2: Smart & efficient solution to augment the data in streaming pipeline

Many of the challenges in data processing pipeline is the enrichment of data with dynamic data sets. And it will increase the processing complexity if need to do it at large scale. Being able to enrich the data with predefined rules for dynamic data sets.

Purpose: Smart & efficient solution (including the AI/ML, as well) to enrich the input data from stream (Kafka, REST or other) and enrich it with the dynamic data provided by another source. And output the enriched data to the target stream (Kafka, REST or other).

Intended Impact: This project will provide an Ericsson-only offering to customers to add data enrichment with dynamic data sets.

Research Scope:
1. Understand the landscape, players, partners, current tools and foundations.
2. Research into industry best practices and solutions offerings.
3. Conduct case study analysis to determine best value propositions offering for Ericsson.
4. Work with experts to understand pain points and quick wins.
5. Create a solution that continuously evolves based on current challenges.
7. Prepare presentations/pods incl. marketing generation in joint collaboration with Ericsson.
8. Data formatting transformation capabilities will increase the scalability.
9. Organize workshops.

Outcomes:
1. Overview of landscape and latest trends, practices, tools used industry.
2. Clearly articulate "value" offering as feasible and viable solution.
3. Deliver solution that is performant and reduce the complexity.
5. Pilot and play solution that can be offered and to customers.

Note: if this domain breaks a significant amount of uncertainties, the research scope and outcomes may change to reflect new findings as well as new priorities; this will be re-evaluated on a regular basis.

Participants:
A Masters/PhD student under the guidance of a professor in collaboration with CI partners

Ericsson Participants: Sachin Kumar, Stephanie Thoumy

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Topic 4:

5G New Radio Positioning

5G positioning assumes a pivotal role in the realization of various envisioned 5G industrial applications and sectors, encompassing logistics, smart transportation, autonomous drones and vehicles, localized sensing, digital twins, and immersive augmented/virtual reality experiences. 3GPP Release 16 has defined the specifications for positioning signals and the positioning architecture for the Next Generation RAN Access Network (NG-RAN), applicable for positioning User Equipment (UE) with NR eNB Transmission Points (TPS) and LTE eNodeB access with Transmission Points (TPs). This enabled positioning architecture extends the capabilities of 5G, enabling highly accurate positioning not only in indoor environments but also outdoors, surpassing the accuracy achievable with LTE or Global Navigation Satellite Systems (GNSS) alone. This precision can reach the decimeter or even centimeter level. In addition to enhanced accuracy, 5G NR introduces novel positioning techniques, such as positioning based on multi-cell round trip time (multi-RTT) measurements and exploiting multiple antennas' beam measurements to enable downlink angle of departure (DL-AoD) and uplink angle of arrival (UL-AoA) estimations.

However, there is currently a gap in the availability of resource allocation algorithms to effectively apply these positioning methods with 5G NR signals, as well as analytical tools to optimize positioning performance. This project’s primary objectives encompass the design of positioning algorithms for 5G NR signals and the development of a comprehensive framework for the analysis and optimization of positioning techniques within the 5G context.

Purpose: Developing new methods for positioning based on 5G NR signals, extending 5G positioning capabilities with mmWave frequency bands, and an analytical evaluation framework for 5G positioning, analysis and optimization of resource allocation for 5G positioning, developing information theoretical models for 5G positioning.

Intended Impact: This project will provide Ericsson with new methods, analytical and evaluation frameworks for optimization of 5G positioning techniques.

Research Scope:
1. Review the state-of-the-art literature on 5G positioning.
2. Identify important open problems of applying positioning for 5G use cases.
3. Develop new positioning methods based on 5G NR signals.
5. Design algorithms based on beamforming for 5G New Radio services.
6. Study positioning for time-critical communications (TCC).
7. Study positioning for Internet of Things (IoT) applications.
8. Study security issues and privacy protection for 5G positioning.
9. Study positioning for Ericsson 5G Virtual Cloud.
10. Study high-end opportunities for positioning.
11. Study integrated communication and positioning design.

Outcomes:
1. Survey of existing solutions in the literature.
4. Analytical frameworks for developing 5G NR positioning systems.
5. Information theoretical models of 5G positioning.
6. Knowledge of privacy protection in 5G positioning and location-based services.
7. Patents, publications, and presentations.

Note: As state-of-the-art research necessarily involves a significant amount of uncertainties, the research scope and outcomes may change to reflect new findings as well as new priorities; this will be re-evaluated on a regular basis.

Participants:

Ericsson Participants: Xiao Lu
**Topic 5**

Radio Log Anomaly Detection (RLAD) – RU Smart Debugging Tool

Troubleshooting for Ericsson cellular network is very challenging. The RLAD project is to design an advance debugging tool to employ Machine Learning and AI techniques.

**Purpose:** Using an advanced ML method to improve Ericsson's debugging experience and to diagnostic a problem instantly. This tool is a steppingstone to become AI quality tool for the future.

**Intended Impact:** The RLAD debugging tool will speed up the troubleshooting of Ericsson Radio products and its potential is enormous. It helps to reduce the customer TR turn-around time, system testing, and system integration, TR screening, etc.

**Research Scope:**
1. Our project already developed the data pipeline to get the DCMs from the CD-Zone and ready to use as the training sample. We have developed 4 ML models for the time-series data and we're in the process of fine-tune and validate the models. The 4 models are:
   - **GT2** (Generative Pre-trained Transformer)
   - **FDVX** (Deep Transformer for Anomaly Detection in Multivariate Time Series)
   - **LAD** (Unsupervised Anomaly Detection on Multivariate Time Series)
   - **GNN** (Graph Neural Network based Anomaly Detection in Multivariate Time Series)
2. We're also developing other ML models for the static data (CDU command) as well.
3. We would like the revise her to validate our design, help to improve the results and continue the research in ML for enhancing the application to be AI quality.
4. How to enhance the data labeling, use of other ML algorithms, develop a knowledge graph, some rule-based methods to have better results.

**Outcomes:**
1. Better data labeling strategy.
2. Enhance the ML model for better accuracy.

**Participants:**
A Masters/PhD student under the guidance of a professor in collaboration with CR partners

**Ericsson Participants:**
Brian Le

**Topic 6**

Networks for RAN processing

With Moore's law slowing down and large advanced ASIC's being limited by max retole there is need to move into disaggregated processing. The disaggregated processing can spread over multi, multi package or multi node, all interconnected with a variety of interconnect technology. This introduces new and complex integration and scaling challenges as Ericsson RAN processing nodes consisting of a mix of Ericsson in-house ASICs and COTS devices.

To allow for effective disaggregated communication that is scalable, small to large configurations, we need to look at the datacenter solution. The problem we need to solve is how do we deploy this technology for the NCC (network on chip), Ericsson custom ASIC and the ASC COTS. Hence, can we find a scalable solution that fits the three segments?

**Purpose:** Identify and quantify transport technologies and architectures to support the RAN processing.

**Intended Impact:** This project will provide background for product decisions and standards contributions.

**Research Scope:**
1. Understand the landscape, players, partners, Ericsson Green Core Architecture, Ericsson ASIC IP
2. Research industry best practices and solution offerings.
3. Continuously perform market buys analysis to determine best value propositions for Ericsson
4. Work with expert system integrators, ASIC architects to understand pain points and quick wins
5. Can an Ethernet packet network meet the goals of these use cases?
6. Can an IP packet network meet the goals of these use cases?
7. How does encryption and security affect performance and scalability?
8. Comparison of Ethernet transport technologies to traditional PCE / CW in power, scalability, size, area
9. Prepare presentations/presentations including IP representation in joint collaboration with Ericsson
10. Organize seminars

**Outcomes:**
1. Overview of landscape and latest trends, practices of the industry
2. Use case simulation testing (e.g., low latency, high bandwidth, encrypted)
3. Presentations/Workshops/presentations and VOs with Ericsson partners

**Participants:**
A Masters/PhD student under the guidance of a professor in collaboration with CR partners

**Ericsson Participants:**
Glenn Parsons, Ulf Parikholem
### Master's Selection criteria

The merit review will be similar to Tri-council applications and will be carried out by the Ericsson Fellowship Committee:

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<tr>
<th>Criteria</th>
<th>Description</th>
<th>Weight</th>
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<td><strong>Academic excellence</strong></td>
<td>As demonstrated by past academic results, transcripts, awards and distinctions.</td>
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<tr>
<td>Indicators of academic excellence:</td>
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<td>50%</td>
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<td>· Academic record</td>
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<td>· Scholarships and awards held</td>
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<td>· Duration of previous studies</td>
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<td>· Type of program and courses pursued</td>
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<td>· Course load</td>
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<td>· Relative standing (if available)</td>
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<td><strong>Research potential</strong></td>
<td>As demonstrated by the applicant’s research history, interest in discovery, the proposed research, its potential contribution to the advancement of knowledge in the field, and any anticipated outcomes.</td>
<td>30%</td>
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<tr>
<td>Indicators of research potential:</td>
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<tr>
<td>· Quality and originality of contributions to research and development</td>
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<tr>
<td>· Relevance of work experience and academic training to field of proposed research</td>
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<td>· Significance, feasibility and merit of proposed research</td>
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Judgment and ability to think critically  
Ability to apply skills and knowledge  
Initiative and autonomy;  
Research experience and achievements relative to expectations of someone with the candidate’s academic experience.

Personal characteristics and interpersonal skills  
As demonstrated by the applicant’s past professional and relevant extracurricular interactions and collaborations.

Indicators of personal characteristics and interpersonal skills:  
- Work experience  
- Leadership experience  
- Project management including organizing conferences and meetings  
- The ability or potential to communicate theoretical, technical or scientific concepts clearly and logically in written and oral formats  
- Involvement in academic life;  
- Volunteerism/community outreach.

PHD Selection criteria  
The merit review will be similar to Tri-council applications and will be carried out the Ericsson Fellowship Committee:

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<th>Criteria</th>
<th>Description</th>
<th>Weight</th>
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| Research ability and potential | Indicators of research ability and potential:  
Quality of research proposal  
specific, focused and feasible research question(s) and objective(s)  
clear description of the proposed methodology  
significance and expected contributions to research  
Relevant training, such as academic training, lived experience and traditional teachings  
Research experience and achievements relative to the applicant's stage of study, lived experience and knowledge systems  
Quality of contributions and extent to which they advance the field of research. Contributions may include: publications, patents, reports, posters, abstracts, monographs, presentations, creative outputs, knowledge translation outputs, community products, etc.  
Demonstration of sound judgment and ability to think critically  
Demonstration of responsible and ethical research conduct, including honest and thoughtful inquiry, rigorous analysis, commitment to safety and to the dissemination of research results and adherence to the use of professional standards  
Enthusiasm for research, originality, initiative, autonomy, relevant community involvement and outreach  
The ability or potential to communicate theoretical, technical and/or scientific concepts clearly and logically in written and oral formats | 50% |
| Relevant experience and achievements obtained within and beyond academia | Indicators of relevant experience and achievements obtained within and beyond academia:  
Scholarships, awards and distinctions (amount, duration and prestige)  
Academic record:  
Transcripts  
Duration of previous studies  
Program requirements and courses pursued  
Course load  
Relative standing in program (if available)  
Professional, academic and extracurricular activities as well as collaborations with supervisors, colleagues, peers, students and members of the community, such as: | 50% |
<table>
<thead>
<tr>
<th>teaching, mentoring, supervising and/or coaching</th>
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<tr>
<td>managing projects</td>
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<td>participating in science and/or research promotion</td>
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<td>community outreach, volunteer work and/or civic engagement</td>
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<td>chairing committees and/or organizing conferences and meetings</td>
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<td>participating in departmental or institutional organizations, associations, societies and/or clubs</td>
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