Become an Ericsson Fellow

Announcement for the 2024-2025 Competition

Submissions Due by March 28, 2024

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 application.

Recently, AI/ML-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.

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

Intended Impact : This project can be productified as a RAN feature in baseband in CR and MSRBS 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 KPI analysis in inference phase:

- 5G NR protocol stack shall be considered
- Multiple cells (at least 3 cells)
- Multiple UEs in each cell (at least 100 RRC connected users per cell)
- Each cell shall have an independent scheduler
- Mix of full buffer traffic, file transfer, ping
- 5G SCM channel model (or alternatively CDL-C and CDL-E channel models)
- Traffic from user activities in one cell shall create interference towards adjacent cell
- 100MHz of BW with numerology 1 (limitation in computational power in simulation can change this requirement)
- Possibility of transmission to multiple UEs in each slot with non overlapping RB allocation (SU-MIMO)

Outcomes:

Project deliverables

- Survey the literature of AI powered link adaption in 5G NR with more focus on federated learning
- Simulation in NS3
- Train an AI model that recommends the values for MCS, TBS, RB allocation as output
- The model shall consider the following factors
  - Throughput maximization
  - Delay minimization
  - QoS assurance
  - Resilience to data drift and concept drift
- Compare the proposed solution with legacy LA algorithms and other AI-powered solutions under different traffic scenarios and channel conditions
- File patents and publish scientific papers

Participants :

A Bachelor, Masters, or Ph.D. student under the joint guidance of a professor from Carleton University and Ericsson Participants of this project

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 either:

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 wideband antennas and circuits.
2. Electro-Magnetic 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/seminars/publications and IVDs with Ericsson partners

Note: since this domain involves a significant amount of uncertainty, 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 Ericsson's mentors.

Ericsson Participants:

Pierre-Andre Laporte, Shady Elkamhawy

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 (eg metrics, alerts). While analyzing time series data, we must make sure of 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 anomalies & predict the cause in near real time.

Intended Impact : This project will produce an Ericsson-only solution/offering 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 offerings for anomaly detection for timeseries data
3. Continuously perform make/buy analysis to determine best value propositioned offerings for Ericsson
4. Work with experts to understand pain-points and quick wins
5. Create a model that continuously learns based on the historic data (say last month data)
6. Develop capabilities in generating views, insights needed to draw meaningful outcomes
7. Develop capabilities in performing on large scale (millions data point per second)
8. Develop capabilities to associate 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 'telco-' offering as distinct and viable solution
3. Deliver solution that tangibly reduces manual analysis and detect the anomaly in real time.
4. Presentations/seminars/publications and IVDs with Ericsson partners
5. Plug and play solution that can be offered aaS to customers

Note: since this domain involves a significant amount of uncertainty, 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 CR partners

Ericsson Participants :

Sachin Kumar k, Stephanie Thoumy

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 produce an Ericsson-only offering to customers to aid with 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 solution offerings
3. Continuously perform make/buy analysis to determine best value propositioned offerings for Ericsson
4. Work with experts to understand pain-points and quick wins
5. Create a solution that continuously evolve based on current challenges
6. Develop capabilities with highly available, scalable & no data loss
7. Prepare presentations/publications including IPR generation in joint collaboration with Ericsson
8. Data formatting/transformation capabilities will increase the usabilities
9. Organize seminars

Outcomes:

1. Overview of landscape and latest trends, practices, tools used in industry
2. Clearly articulate 'telco-' offering as distinct and viable solution
3. Deliver solution that is performant and reduce the complexity.
4. Presentations/seminars/publications and IVDs with Ericsson partners
5. Plug and play solution that can be offered aaS to customers

Note: since this domain involves a significant amount of uncertainty, 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 CR partners

Ericsson Participants :
Sachin Kumar k, Stephanie Thoumy

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 and virtual reality experiences. 3GPP Release 16 has defined the specifications for positioning signals and the positioning architecture for the Next Generation Radio Access Network (NG-RAN), applicable for positioning User Equipment (UE) with NR gNB Transmission Reception Points (TRPs) or LTE ng-eNB access with Transmission Points (TPs). This evolved 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 antenna 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 resource allocation algorithms for positioning using 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, an analytical and 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. Identifying important open problems of applying positing for 5g use cases
3. Develop new positioning methods based on 5g NR signals
4. Design resource management and allocation algorithms for positioning in 5G networks
5. Design AI/ML based data driven positioning for location-based services.
6. Study positioning for time-critical communication (TCC)
7. Study positioning for Internet-of-things applications
8. Study security issues and privacy protection for 5G positioning
9. Study positioning for Ericsson Connected Vehicle Cloud
10. Study high-band opportunities for positioning
11. Study integrated communication and positioning design
12. System-level simulations for 5g positioning

Outcomes:

1. Survey of existing solutions in the literature.
2. Novel methods for positioning based on 5G NR signals
3. Novel resource allocation algorithms for positioning in 5G networks
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: since state-of-the-art research necessarily involves a significant amount of uncertainty, 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 of Machine Learning and AI techniques.

Purpose : Using an advanced ML methods 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 DCGMs from the CD-Zone and ready to use as the training sample. We developed 4 ML models for the time-series data and we're in the process to fine tune and validate the models. The 4 models namely:
   - GPT-2 (Generative Pre-trained Transformer),
   - TranAD (Deep Transformer Networks for Anomaly Detection in Multivariate Time Series Data)
   - USAD (UnSupervised Anomaly Detection on Multivariate Time Series)
   - GDN (Graph Neural Network based Anomaly Detection in Multivariate Time Series)
2. We're also developing other ML models for the static data (COLI command) as well.
3. We would like the researcher 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-base methods to have better result.

Outcomes:

1. Better data labeling strategy,
2. Enhance the ML models for better acruacy.

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 reticle there is a need to move into disaggregated processing. The disaggregated processing can spread over multi-die, 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 inhouse ASIC's and COT's 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 NOC (network on chip), Ericsson custom ASIC and the ASIC COTS. Hence, can we find a scalable solution that fits the three segments?

How can transport technologies and techniques such as TSN or RoCE be applied to overcome the challenges, allowing for efficient processing and scalability with maintained security?

Purpose : Identify and quantify transport technologies and architecture 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 Many Core Architecture, Ericsson ASIC IP
2. Research into industry best practices and solution offerings
3. Continuously perform make/buy analysis to determine best value propositioned offerings 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 zero trust affect performance and scalability?
8. Comparison of Ethernet transport technologies to traditional PCIe / CXL in power, scalability, die area
9. Prepare presentations/publications including IPR generation in joint collaboration with Ericsson
10. Organize seminars

Outcomes:

1. Overview of landscape and latest trends, practices of in industry
2. Use case simulation testing (e.g., low latency, high bandwidth, encrypted)
3. Presentations/seminars/publications and IVDs with Ericsson partners

Note: since this domain involves a significant amount of uncertainty, 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 CR partners

Ericsson Participants :
Glenn Parsons, Ulf Parkholm

Topic 7:

Quantum 6G radio technologies.

Quantum technology is influencing 6G evolution in the areas of security and computing, each of which has funded research. Quantum radio technology, yet unfunded, has potential benefits in 6G Joint Communications and Sensing (JCAS) research including significant improvements in radar sensing, the later achieved though quantum processing gains. An assessment and viability analysis of quantum 6G radio technologies with the potential to influence 6G evolution is proposed.

Purpose : Leveraging published and prototyped expertise in quantum radar including signal generation, amplification, transmission, reception and correlation, assess the viability of this technology for next generation 6G radios. Research will assess theoretical viability of replacing cryogenic JPA signal generation with room temperature maser signal generation. Higher power amplification will be considered as will parametric signal reception and correlation. The outcome of this work is a report including a proposal to validate key viable elements leading to an end-to-end prototype.

Intended Impact : This project will produce a detailed technical report, with recommendations for quantum technologies to be incorporated into 6G radios.

Research Scope :

1. Understand and document current building blocks of state-of-the-art quantum radar technology focusing on signal generation which currently employs a Josephson parametric amplifier (JPA) used to generate two-mode squeezed vacuum (TMSV) entanglement.
2. Detail remaining key circuit elements of amplification, transmission, reception and correlation, with detailed focusing on reception and correlation and mathematics including time varying correlation. Document the end-to-end radar and detail signal link budgets including quantum processing gains.
3. JCAS operation requires demands replacing the JPA with a room temperature maser. Update the solution, detailing circuit changes and expected signal levels, still assuming TMSV entanglement. Updating link budget and end-to-end solution.
4. 6G cannot rely on static/fixed tones; therefore, alternate means to TMSV entanglement must be considered. Assess alternate means published in literature, which may be applicable and afford greater independence of generated signals.
5. Reassess amplification, considering room thermal effects as an exponential function of temperature.
6. Consider receiver designs used in quantum radar, currently matched filter and assuming fixed time offsets. Propose time variant solutions, to allow for varying distances between RBS and UE.
7. Mathematically assess alternate solution options and propose key elements of potential 3GPP solution.
8. Review and present report.

Outcomes:

1. Overview of landscape and latest research in quantum radar transmission, detailing core elements related to generation, amplification, transmission, and reception.
2. Overview latest research in room temperature elements, to replace cryogenic components such as JPA, and detail a quantum radar solution with room temperature components, including possible tradeoffs related to temperature / noise effects.
3. Change the solution from radar to communications, where radar correlation becomes data signal detection. Propose a communications solution based on quantum radar.
4. Propose necessary research to validate key items.
5. Presentations/seminars/publications and IvDs with Ericsson

Note: since this domain involves a significant amount of uncertainty, 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 PhD student under the guidance of a professor in collaboration with Ericsson staff.

Ericsson Participants :
Roland Smith, Dr. Hazeem Ibrahim.

Selection Criteria:

Master's Selection criteria

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

Criteria	Description	Weight
Academic excellence	As demonstrated by past academic results, transcripts, awards and distinctions. Indicators of academic excellence: · Academic record · Scholarships and awards held · Duration of previous studies · Type of program and courses pursued · Course load · Relative standing (if available)	50%
Research potential	As demonstrated by the applicant's research history, their interest in discovery, the proposed research, its potential contribution to the advancement of knowledge in the field, and any anticipated outcomes. Indicators of research potential: · Quality and originality of contributions to research and development · Relevance of work experience and academic training to field of proposed research · Significance, feasibility and merit of proposed research	30%

	· 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.	20%

PHD Selection criteria

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

Criteria	Description	Weight
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%

	teaching, mentoring, supervising and/or coaching managing projects participating in science and/or research promotion community outreach, volunteer work and/or civic engagement chairing committees and/or organizing conferences and meetings participating in departmental or institutional organizations, associations, societies and/or clubs	