Offer #2023-07053

PhD Position F/M PhD : Energy efficient slicing for 6G networks using AI/ML technics

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

The Inria centre at Université Côte d'Azur includes 37 research teams and 8 support services. The centre's staff (about 500 people) is made up of scientists of different nationalities, engineers, technicians and administrative staff. The teams are mainly located on the university campuses of Sophia Antipolis and Nice as well as Montpellier, in close collaboration with research and higher education laboratories and establishments (Université Côte d'Azur, CNRS, INRAE, INSERM ...), but also with the regiona economic players.

With a presence in the fields of computational neuroscience and biology, data science and modeling, software engineering and certification, as well as collaborative robotics, the Inria Centre at Université Côte d'Azur is a major player in terms of scientific excellence through its results and collaborations at both European and international levels.

Context

Within the framework of a partnership

- collaboration between 2 Inria teams: neo and coati and a company Nokia,

Assignment

With the current energy crisis, the skyrocketing cost of energy, and the global awareness of the consequences of carbon emissions on our planet, it is crucial to reduce the global energy consumption related to Information and Communication Technologies, and in particular the one related to networks.

Indeed, while being commercialized worldwide, the 5G technology coupled with ultra high resolution video has been blamed for its high energy consumption [5G-power]. To answer this issue, industrials and researchers have started to look beyond 5G to define the next 6G with at its core the need to evolve towards greener networks. The 6G standard imposes a transmission energy efficiency target in its Key Parameter Indicators (1picoJ/bit). However, at the same time, 6G will introduce several technological breakthroughs with the integration of traditional terrestrial mobile networks with emerging space, aerial, and underwater networks to provide anytime, anywhere, network access. Another critical paradigm of 6G is the utilization of Artificial Intelligence (AI) techniques to provide context-aware information transmissions and personal-customized services, as well as to realize automatic network management [roadmap]. The growing ICT infrastructure, exploding data, and the AI-based services will result in surging energy consumption.

Thus, succeeding in the challenge of developing more energy efficient networks will require significant improvement in several directions [survey-green]: e.g. re-launching measurement campaigns, rethinking protocols, developing energy-efficient network management algorithms [algo], adopting energy harvesting techniques [harvesting], deciding if and when data should be sent, but also creating tools to allow the individuals to take informed decisions and have a sustainable Internet usage, in particular with the high definition video traffic.

We will focus on the provisioning and management of energy efficient network services.

With the advent of next generation networks implementing Software Defined Networks (SDN) and Network Function Virtualization (NFV), network services can be set up dynamically at the right time and at the right place. It has been shown that SDN can improve the energy efficiency of networks by allowing fast rerouting. This allows to turn off redundant parts of the networks used for backup in case of failures or over-dimensioning in case of sudden peaks of traffic [sdn-energy] but also to reconfigure the network when the demand has changed [reconfiguration]. The use of virtualization also reduces the use of specialized and

energy-intensive middleboxes and to provision network and data center resources only whenand where needed [nfv-energy].

However, with the multiplication of usages, connected cars, cities, factories, more generally with the development of the Internet of Things, the number of services a network has to handle increases drastically. At the same time, with the consideration of micro-services composed to build network functions which are then added to form network services, the size of the latter also increases. New methods have to be considered to be able to provision them on the fly in a fast and scalable way, while not increasing network energy consumption.

During the PhD we will tackle theses problems following the guidelines written below:
- First, we plan to refine existing power models as there are the foundations to discuss energy efficiency. We will make a special focus on video services, as video represents the majority of the Internet traffic and drives a significant share of the investment in terms of data centers and Internet links. We will start from the methods proposed in [power-models] proposed methods to estimate the carbon footprint of a typical streaming service.

- Second, we plan to explore how to use new AI methods for this challenge. AI/ML methods are envisioned as a way to progress towards green networks [AI-for-green]. In particular, new learning methods have been proposed to solve large scale combinatorial problems, some of which are at the core of network placement problems. As an example, [NIPS-billion] presents a reinforcement learning method to solve covering problems for billions-sized graphs. This RL method has a good potential to help provisioning network services, as placing services can be seen as a covering problem, see [covering]. We will thus investigate how to use these new AI methods to provide approximate solutions for provisioning a very large number of network services.

- Third, we plan to study how AI models can help to reconfigure the networks efficiently when (i) demand or (ii) energy availability has changed. (i) First, the level and nature of traffic strongly vary during the day. Second, with the development of smart cars, UAVs, extra-terrestrial networks, there will be a high mobility of end-nodes. Network services will thus have to be sufficiently instantiated, reconfigured, and stopped within a short time scale. (ii) Indeed, energy harvesting has been widely recognized as an important part for green communications. Part of such energy resources is uncontrollable but predictable (such as solar, winding, tide, and other renewable sources). Another part is partially controllable such as Radio Frequency energy harvesting [harvesting]. Another issue that will be faced during next winters in Europe concerns planned power cuts. The challenge is to find ways to manage the networks and the expected demands with such varying sources of energy? We will study how AI models using energy predictions can allow reconfiguring the network in advance to adapt to the changing energy availability, e.g. to choose when doing a large backup, to plan the switching off of some network parts.

References.
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Main activities

Research

Skills

Networking

Algorithms

Optimization

AI/Machine learning

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Remuneration

Duration: 36 months
Location: Sophia Antipolis, France
Gross Salary per month: 2082€ brut per month (year 1 & 2) and 2190€ brut per month (year 3)

General Information

- **Theme/Domain :** Networks and Telecommunications
  System & Networks (BAP E)
- **Town/city :** Sophia Antipolis
- **Inria Center :** Centre Inria d'Université Côte d'Azur
- **Starting date :** 2024-09-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2024-06-30

Contacts

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- **PhD Supervisor :**
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About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

Instruction to apply

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.