# Offer #2024-07478

# PhD Position F/M Energy-efficient QoE-aware Beyond 5G Future Mobile Networks

**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: COATI and DIANA,
- public with French National Research Agency (ANR),PEPR 5G

## Assignment

**For a better knowledge of the proposed research subject** :
Muhammad Jawad Khokhar, Thibaut Ehlinger, Chadi Barakat, "From Network Traffic Measurements to QoE for Internet Video", in proceedings of IFIP Networking, Warsaw, Poland, May 2019. where we develop a methdology to collect all data needed to estimate the QoE, but it specific to youtube videos, there should be a way to extend it to your local videos.

Mathilde Jay, Vladimir Ostapenco, Laurent Lefèvre, Denis Trystram, Anne-Cécile Orgerie, et al.. An experimental comparison of software-based power meters: focus on CPU and GPU. CCGrid 2023 - 23rd IEEE/ACM international symposium on cluster, cloud and internet computing, May 2023, Bangalore, India. pp.1-13, 10.1109/CCGrid57682.2023.00020 . hal-04030223v2

Muhammad Umair Khan, Shanza Abbas, Scott Uk-Jin Lee, Asad Abbas,
Measuring power consumption in mobile devices for energy sustainable app development: A comparative study and challenges, Sustainable Computing: Informatics and Systems, Volume 31, 2021,

**Collaboration** :
The recruited person will be in connection with Chadi Barakat, Frédéric Giroire, Joanna Moulierac and Thierry Turletti.

## Main activities

The upcoming beyond 5G networks (B5G) will be enabler for a plethora of new applications that are known to be computing intensive, bandwidth greedy and delay sensitive, such as video streaming, virtual reality, gaming, autonomous driving, and video surveillance. The resource and energy consumption of these applications will depend on their demand and design but also on the way they are managed within the network (e.g. where to put the computing and network functions, the management of communication patterns, the coding/transcoding for video and audio). This management will determine the amount of resources utilised and energy consumed, but will also determine the Quality of Experience perceived by the users of an application. The challenge here is to manage the network in an efficient and intelligent way taking into account the requirements of the application while utilising the available resources in the most efficient way. This will first pass by modelling the computing and network requirements of new applications in the context of B5G networks, and then will rely on establishing the link between their requirements and needs, and the perceived Quality of Experience by the end users. We propose to establish this link by experimenting with an application in various network setups and

various loads, then building models relating resource utilisation to network traffic following a machine learning and data-driven approach. The next phase will be to showcase how the built models can help better tune the network to efficiently utilise its resources, and consequently the consumed energy, without sacrificing the end users Quality of Experience.

In this PhD, we will explore this topic by focusing on popular services such as gaming, virtual reality, web browsing and video streaming. We will browse the literature for relevant work on modelling their quality of service and quality of experience, and design an experimental framework to run the services in a controlled environment where we can measure and analyse the consumed energy and the quality of experience at the application and user level . Our aim is to understand the balance between the two performance metrics (energy and QoE), and find optimal configurations of both network and services that lead to the best possible gain: minimising energy consumption without considerably losing in terms of end user quality of experience. We will then use the result of this study for an optimal placement of network functions and appropriate adaptation of their trafic that allow to reach the optimal balance alongside the two studied dimensions.

This project fits within a larger collaborative project, the PEPR 5G and next generation networks, involving a large number of French research laboratories working on networking. This will be a unique opportunity to collaborate within the networking community. Experimentation will be carried out on our local platforms R2Lab and SophiaNode, and the upcoming Slices European platform.

## Skills

**Technical skills and level required :** Networking skills, programming and experimentation

**Languages :** english

## 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: 2100€ 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 :** 2024-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2024-09-30

## Contacts

- **Inria Team :** COATI
- **PhD Supervisor :**
  Mouliérac Joanna / Joanna.Moulierac@inria.fr

## 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.

## 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.