The overall objective of the DIANA project-team is to design, implement and evaluate advanced networking architectures. To do so, the team works to provide service transparency and programmable network deployments in the context of both wired and next generation wireless cellular networks. The team's methodology includes advanced measurement techniques, design and implementation of architectural solutions, and their validation in adequate experimental facilities. The DIANA team designed, deployed and operates R2lab, a wireless testbed designed with reproducibility as its central characteristics. The team collaborates with Eurowe to deploy and operate an open programmable platform to test post-5G services. Recently, the team enriched R2lab with 5G professional radio units and compute resources managed by Kubernetes clusters to provide an experimental cloud-native environment to test with open source (e.g. RAN) software and some commercially licensed software (e.g. Amarisoft) for 5G/6G networks. This position is open in the DIANA project-team at Inria Center at Université Côte d'Azur, in the frame of several major French and European projects on 5G/6G networks.

The challenges towards the aforementioned objective are multiple. First, an efficient network management that takes into account the quality of experience of end users and that troubleshoots the network in case of failures and service degradation. Second, it will bring to the community a new solution able to accommodate the efficiency and granularity of existing monitoring solutions for mobile edge networks. This will allow a better understanding of the efficiency and granularity of existing monitoring solutions for mobile edge networks. The efficient placement of these functions and services, and the orchestration of communications between them and with the users, requires the deployment of a monitoring plane allowing to discover and profile the available computing resources at the edge in real time and, in parallel, provide stakeholders (operators, providers and end users) with a sufficient level of information on the capacity and connectivity of these resources to be able to optimize network management and Quality of Experience (QoE) of end users. We aim in this thesis on contributing to the deployment and evaluation of this monitoring plane. This thesis has two main outcomes. First, it will allow a better understanding of the efficiency and granularity of existing monitoring solutions for mobile edge networks. Second, it will bring to the community a new solution able to accommodate the different users requests in a flexible manner and to cover the different parts of a mobile edge system by bridging together different views on the system. Indeed, an efficient and flexible monitoring plane is key for a network management that improves the end users quality of experience and that troubleshoots the network in case of failures and service degradation.

Number of users, devices and services, and must track the whole system in an efficient and time dynamics, the measurement plane has to be of low cost, able to scale with the collection of all these metrics in an accurate and timely way represents a real challenge. But rather on a complex set of metrics such as the bitrate in both directions, the jitter, the packet loss rate, the context of mobility, the device properties, etc. The collection of all these metrics in an accurate and timely way represents a real challenge.

Further, and given the large number of devices foreseen at the edge and their mobility and time dynamics, the measurement plane has to be of low cost, able to scale with the number of users, devices and services, and must track the whole system in an efficient manner. This is another challenge facing the development of a monitoring plane for future edge networks. The first objective of this thesis is to go over the existing solutions for mobile edge monitoring, and benchmark them to evaluate their capacity to accommodate the requirements of different applications during the service orchestration phase. We will focus in particular on how information is collected, what information is collected, and to which extent existing solutions can improve the service optimization at the edge by taking into account the requirements of applications and the amount of available resources, both in the network and the computing infrastructure. For this study, we will follow an experimental approach and deploy scenarios over wireless platforms such as Mininet WiFi, R2lab wireless platform or the SophiaNode platform. We will be evaluating the performance of existing solutions (according to the above criteria), and how well the orchestration of resources at the

**Informations générales**

- Département/Domaine : Réseaux et télécommunications
- Système & réseaux (BAP E)
- Ville : Sophia Antipolis
- Centre Inria : Centre Inria Université Côte d'Azur
- Date de prise de fonction souhaitée : 2023-10-01
- Durée de contrat : 3 ans
- Date limite pour postuler : 2023-12-31

**Contexte et atouts du poste**

This position is open in the Diana project-team at Inria Center at Université Côte d'Azur, in the frame of several major French and European projects on 5G/6G networks.

**Mission confiée**

Networks are witnessing a revolution nowadays with the advent of virtualization and software-defined networking allowing to deploy network functions and services in data centres, placed at the edge of the network. The efficient placement of these functions and services, and the orchestration of communications between them and with the users, requires the deployment of a monitoring plane allowing to discover and profile the available computing resources at the edge in real time and, in parallel, provide stakeholders (operators, providers and end users) with a sufficient level of information on the capacity and connectivity of these resources to be able to optimize network management and Quality of Experience (QoE) of end users. We aim in this thesis on contributing to the deployment and evaluation of this monitoring plane.

This thesis has two main outcomes. First, it will allow a better understanding of the efficiency and granularity of existing monitoring solutions for mobile edge networks. Second, it will bring to the community a new solution able to accommodate the different users requests in a flexible manner and to cover the different parts of a mobile edge system by bridging together different views on the system. Indeed, an efficient and flexible monitoring plane is key for a network management that improves the end users quality of experience and that troubleshoots the network in case of failures and service degradation.

**Principales activités**

The challenges towards the aforementioned objective are multiple. First, an efficient network management that takes into account the quality of experience of end users does not only depend on simple network metrics such as the delay, or physical proximity, but rather on a complex set of metrics such as the bitrate in both directions, the jitter, the packet loss rate, the context of mobility, the device properties, etc. The collection of all these metrics in an accurate and timely way represents a real challenge.

Further, and given the large number of devices foreseen at the edge and their mobility and time dynamics, the measurement plane has to be of low cost, able to scale with the number of users, devices and services, and must track the whole system in an efficient manner. This is another challenge facing the development of a monitoring plane for future edge networks. The first objective of this thesis is to go over the existing solutions for mobile edge monitoring, and benchmark them to evaluate their capacity to accommodate the requirements of different applications during the service orchestration phase. We will focus in particular on how information is collected, what information is collected, and to which extent existing solutions can improve the service optimization at the edge by taking into account the requirements of applications and the amount of available resources, both in the network and the computing infrastructure. For this study, we will follow an experimental approach and deploy scenarios over wireless platforms such as Mininet WiFi, R2lab wireless platform or the SophiaNode platform. We will be evaluating the performance of existing solutions (according to the above criteria), and how well the orchestration of resources at the

**Consignes pour postuler**

- équipe Inria : DIANA
- Directeur de thèse : Barakat Chadi / Chadi.Barakat@inria.fr

**A propos de l'Inria**

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 200 équipes-projets agiles, en général composées de partenaires académiques, impliquent plus de 3500 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'Institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde.

Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 180 start-up. L'Institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

Attention : Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n’est pas garanti.

**Informations détaillées**

- **Thème/Domaine : Réseaux et télécommunications**
- **Système & réseaux (BAP E)**
- **Ville : Sophia Antipolis**
- **Centre Inria : Centre Inria Université Côte d'Azur**
- **Date de prise de fonction souhaitée : 2023-10-01**
- **Durée de contrat : 3 ans**
- **Date limite pour postuler : 2023-12-31**

**Contacts**

- **Équipe Inria : DIANA**
- **Directeur de thèse : Barakat Chadi / Chadi.Barakat@inria.fr**

**Mission confiée**

Networks are witnessing a revolution nowadays with the advent of virtualization and software-defined networking allowing to deploy network functions and services in data centres, placed at the edge of the network. The efficient placement of these functions and services, and the orchestration of communications between them and with the users, requires the deployment of a monitoring plane allowing to discover and profile the available computing resources at the edge in real time and, in parallel, provide stakeholders (operators, providers and end users) with a sufficient level of information on the capacity and connectivity of these resources to be able to optimize network management and Quality of Experience (QoE) of end users. We aim in this thesis on contributing to the deployment and evaluation of this monitoring plane.

This thesis has two main outcomes. First, it will allow a better understanding of the efficiency and granularity of existing monitoring solutions for mobile edge networks. Second, it will bring to the community a new solution able to accommodate the different users requests in a flexible manner and to cover the different parts of a mobile edge system by bridging together different views on the system. Indeed, an efficient and flexible monitoring plane is key for a network management that improves the end users quality of experience and that troubleshoots the network in case of failures and service degradation.

**Principales activités**

The challenges towards the aforementioned objective are multiple. First, an efficient network management that takes into account the quality of experience of end users does not only depend on simple network metrics such as the delay, or physical proximity, but rather on a complex set of metrics such as the bitrate in both directions, the jitter, the packet loss rate, the context of mobility, the device properties, etc. The collection of all these metrics in an accurate and timely way represents a real challenge.

Further, and given the large number of devices foreseen at the edge and their mobility and time dynamics, the measurement plane has to be of low cost, able to scale with the number of users, devices and services, and must track the whole system in an efficient manner. This is another challenge facing the development of a monitoring plane for future edge networks. The first objective of this thesis is to go over the existing solutions for mobile edge monitoring, and benchmark them to evaluate their capacity to accommodate the requirements of different applications during the service orchestration phase. We will focus in particular on how information is collected, what information is collected, and to which extent existing solutions can improve the service optimization at the edge by taking into account the requirements of applications and the amount of available resources, both in the network and the computing infrastructure. For this study, we will follow an experimental approach and deploy scenarios over wireless platforms such as Mininet WiFi, R2lab wireless platform or the SophiaNode platform. We will be evaluating the performance of existing solutions (according to the above criteria), and how well the orchestration of resources at the
edge can benefit from a larger spectrum of measurement data towards a better management of edge network resources and a better Quality of Experience / Quality of Service for end users.

Departing from the results of the previous study, the second objective of this thesis is to come up with a new flexible monitoring solution able to cover the different parts of a mobile edge system such as the wireless channel and the edge cloud part, and to customize the level of information provided based on the requirements of the network management plane. This new solution will mainly consist on bridging the wireless channel view with the cloud and network view in one view able to shed light on the different events that can happen inside the network and on the computing nodes of the edge cloud. We will devise experimentation scenarios to prove the flexibility of our monitoring solution and its efficiency to accommodate the different monitoring requests.

Compétences
Strong knowledge in network protocols, mobile networks, network measurement, data analytics.
Strong programming skills: python, scripting, java/C++, etc.

Avantages
- 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 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
- Contribution to mutual insurance (subject to conditions)

Rémunération
Gross Salary per month: 2051€ brut per month (year 1 & 2) and 2158€ brut per month (year 3)