2018-00514 - [CORDIS2018-NEO] Content-aware caching in Multi-access Edge Computing (MEC) architectures

Level of qualifications required: Graduate degree or equivalent
Fonction: PhD Position

About the research centre or Inria department

The Inria Sophia Antipolis - Méditerranée center counts 37 research teams and 9 support departments. The center's staff (about 600 people including 400 Inria employees) is composed of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrators. 1/3 of the staff are civil servants, the others are contractual. The majority of the research teams at the center are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Six teams are based in Montpellier and a team is hosted by the computer science department of the University of Bologna in Italy. The Center is a member of the University and Institution Community (ComUE) “Université Côte d’Azur (UCA).

Context

CONTEX

Global mobile data traffic is expected to increase by seven times in the next 5 years [Cis17]. The growth is due to the development of the Internet of Things (IoT) with 30 billion of connected objects by 2020 [Nor16], and to the shift from connection-centric communications, such as phone calls, to content centric communications, such as video streaming, fueled by the surge of users’ generated contents spread through social networks. In the near future Augmented Reality (AR) services can put further strain on the wireless infrastructure: it has been estimated that, at high human density places, wireless networks should be able to deliver up to 100 Gb/s/m² to support such services, a rate that is far from achievable with current technologies [Kni17]. Virtual reality applications are even more demanding in terms of rates and latencies [Che16]. Wireless network densification, with the introduction of small cells ranging from micro- to pico- and femto-cells, increases transmission capacity per area unit by enhancing frequency reuse, but it risks to move the bottleneck from the radio access to the Mobile Operator (MO) backhaul and core network.

At the same time the Multi-access Edge Computing (MEC) industry initiative [MEC14] is pushing a new network infrastructure where IT and cloud-computing capabilities are located within the Radio Access Network (RAN) in close proximity to mobile subscribers. The initiative envisions a MEC server closely managing a set of small cells. MEC will enable the development of low-latency context-aware and context-optimized applications, which can tap into real-time information about local-access network conditions exposed by the base stations. Moreover, by opening the radio network edge to third-party partners (e.g. Mobile Virtual Network Operators, MVNOs, or Content Providers, CPs) MEC platforms will enable new value-added services and then potential new revenues for operators, vendors and third-parties.

The goal of this project is to investigate how to allocate and exploit edge storage and computation resources in a multi-tenant, MEC-enabled cellular network in order to reduce backhaul traffic and address the challenges of new application services (in particular IoT ones).

REFERENCES

Assignment

A usual assumption in caching systems like Content Delivery Networks (CDNs) is that the cacheable objects have been defined elsewhere (e.g. by the content provider) and caching decisions are oblivious to the actual information objects store. In this project, we pursue a radical shift from mainstream research proposing to “look inside the content.” Many objects currently cached in the network are often strongly related because they are i) different versions of the same content (e.g. webpages and videos adapted for the capabilities of different user terminals or different access technologies), ii) partially substitute contents (the list of related videos suggested by Youtube, or IoT sensor data related to close-by time instances) [Spy16], iii) pieces of the same larger content (e.g. different chunks of the same video), or more in general iv) complementary contents, i.e. contents for which popularity changes are positively correlated (e.g. the episodes of the same serie, or the contents of the same Youtube channel). Nowadays, MOs cannot take advantage of such relations, because they ignore what is the actual information in the cached object. In MEC, caching will be a service that can be managed by the Content Provider (CP) itself, and then relations among different objects can be effectively exploited. While current caching policies react to requests for a given object A, by simply deciding if storing A and which other objects should be evicted to make space for it (if needed), content insight significantly enlarges the space of possible options. Requests for object A can lead to store it but also to prefetch the complementary object B, or can lead to store object C from which object A can be produced after some computations, or to store object D that is a lower-quality, smaller-size version of object A, or finally to merge content A to content E already stored in the cache (like in IoT data fusion).

The design space becomes then richer: computation joins network capacity and storage as an additional resource to be traded off, and the quantification of user’s satisfaction may include the possibility to use only partially substitute contents. A new family of caching strategies need to be designed. While motivated by the new opportunities offered by the MEC technological paradigm, this research line is intrinsically fundamental and likely to have scientific impacts on other application scenarios.

Main activities

Research activity

Skills

We are looking for candidates who are self-motivated and would like to conduct high quality research, and publish in top venues. Candidates should have a Master’s Degree (or equivalent) in Electrical Engineering, Computer Science, or a closely related area, preferably with a focus on networking or communications. They are also expected to have very good analytical skills (Probability Theory, Algorithm, Optimization). Good programming skills and experience in popular simulation environments is a plus. A good level of written and spoken English is mandatory (knowledge of French is not required). Finally, the selected candidate will be well organized and able to integrate and work well in groups. The position duration is normally 3 years, with a maximum duration of 4 years.

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
• Flexible working hours
• Sports facilities

**Remuneration**

Duration: 36 months  
Location: Sophia Antipolis, France  
Gross Salary per month: 1982€ brut per month (year 1 & 2) and 2085€ brut/month (year 3)