Controlling Quality of Service for Edge Offloading

Zwischenbericht | Call 14 | Stipendium ID 4531

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1   Einleitung

We are embracing the development of the Internet of Things (IoT) and the prevalence of ubiquitously connected smart and mobile devices. This leads to the growing quantity of data produced at the edge of the network and, consequently, to a network traffic explosion. Centralized Cloud architecture imposes high network latency and computation offloading from such devices to the remote Cloud may result in longer response time and higher network cost. Therefore, in this thesis we exploit Edge computing resources deployed in a fully distributed manner, with offloading tasks to the geographically proximate Edge nodes. In addition, with the proliferation of smart and wearable devices, we are facing the mobility of data sources. Therefore, our goal is to ensure seamless mobility support and location awareness while investigate novel strategies for monitoring and controlling Quality of Service - QoS (response time, availability, responsiveness) in Edge deployment.

2   Status

Kurzbeschreibung der Haupttätigkeiten
Erkenntnisse zur Vorgangsweise
Kurzbeschreibung der erreichten Ergebnisse
Besondere Erfolge/ Probleme
Gab es große Abweichungen zum Plan? Warum?

2.1   Meilenstein 1 - 2019Q4 - Exploration and preparation of the data traces

Computation offloading and mobility management are considered to be a key technologies of Edge computing. Our publication in which we used the control theory to realize handoffs among Edge servers for efficient application offloading was nominate for the best paper award on the IEEE ICFC 2019 conference.

In addition, providing a seamless data and user mobility in the Edge computing is still an open challenge and therefore set as our next research focus. We defined the next research questions which we would like to answer: "How to make the proactive control decisions based on the user mobility predictions in order to improve QoS in the Edge offloading?", and "What is the effect of a wrong mobility prediction on the offloaded services?"

A solution would often require fast relocation of service instances and task scheduling based on the real-world mobility traces. Hence, we found the real-world data set coming from Crawdad data repository (https://crawdad.org/epfl/mobility/20090224/). This dataset contains mobility traces with GPS coordinates of 531 taxis in San Francisco collected over 30 days. We will use them for the analysis of our approach. We focus on finding the proper data traces in an early stage, as one of the main challenges and difficulties for many researches after identifying a new research ideas is to find a proper data sets that can be used in the evaluation of their proposed approaches. We filter and

prepare this data set for usage and analysis. Now we can easily analyze longitude and latitude of each taxi/user over different hours or days and analyze their trajectories, extract only those on the desired area and much more.

2.2   Meilenstein 2 - 2020Q1 - Project and website setup

In this milestone I was on the maternity leave ("Mutterschutz"). Nevertheless, as defined in submitted planning document, blog posts on my Netidee project web page were continuously published and updated. The outcome is the following:

Published articles:
- Welcome to the Edge: Edge computing - why is it a hot topic nowadays? (26.11.2019)
- Do we need computation offloading? When and where? (18.01.2020)
- Edge node selection and handoff control: Considering dense Edge deployment (16.03.2020)
- Efficient offloading architecture model – Technical details (1.5.2020)

Following topics are planned:
- Related work (systematic literature review)
- Interruption-free client mobility demands and use cases
- Presentation of mobility support approaches (reactive and proactive approaches)
- Applicable machine learning technologies for user mobility prediction and control
- Experimental and simulation environment and setup
- Evaluation results on Facerecognizer and Navigator real-world application models using the real-world mobility traces
- QoS in the context of smart cities

2.3   Meilenstein 3 - 2020Q2 - Related work survey and simulations

This is an ongoing phase when the "Zwischenbericht" document is submitted.

We performed a comprehensive literature review and related work survey. After investigating state-of-the-art, we got a confirmation that distributed systems, such as Edge and Fog, have latency constraints and mobility support as their key properties and mobility and service continuity is still an open challenge. Only few works consider user behavior and user mobility prediction. Mobility as a specific niche is considered within Mobile Edge Computing (MEC). However, this area is still very far from a generalized solution, or even from a solution capable of providing overall mobility and service continuity when considering strict QoS requirements. Our work tries to close this gap.

Research on Edge computing is still in its infancy and at the time we write, no real-world MEC infrastructure is available to perform our experiments. Existing simulators such as IFogSim and EdgeCloudSim do not support either mobility models or do not allow to specify when and where to migrate services. Therefore, we continue with the development of our simulation framework. The programming of simulator is still going and it would be used get the result and answer a research question defined in 2019Q4 milestone. Based on the obtained results, we plan to publish a paper.

3 Zusammenfassung Planaktualisierung

Alle Anpassungen des Planungsdokuments kurz zusammengefasst

So far there are no significant obstacles or deviations from planned activities for this period of time. Research activities in the phase 2019Q4, 2020Q1, and 2020Q2 successfully finished with part of activities in milestone 3 - 2020Q2 ongoing.

Due to the COVID-19 outbreak, and inability to organize a proper child care and kindergarten facilities being closed I took a one year maternity leave ("Karenz"). Working from home I will give my best to continue my activities, 2020Q3, 2020Q4, 2021Q1, as planned.