Mobile Computing Project Description

Group-Specific Version

WiSe 2022/2023

Group 04

<u>Important Note:</u> in addition to this document, it is essential that the notifications and announcements posted in the corresponding Moodle course or made within the lecture are considered!

Content

1 Introduction

This semester's Mobile Computing module consists of a project related to the topic of mobile computing. The project is introduced in this document. Students will work in groups. The group arrangements and project assignments will be carried out via the CampUAS course.

In case of questions or problems, a corresponding E-Mail including a detailed problem description can be sent to mobilecomputing@e-technik.org. In case of major difficulties, a meeting may be scheduled to explain the problem further. But please always try to solve the issues and research answers on your own first.

The project deals with implementing a 5G core, including Radio Access Networks (RAN), Data Networks (DN) and Network Slicing. This will involve applying previously learned practices from other modules, such as Software Engineering, Cloud Computing, and Digital Switching and Routing. Keywords such as GitHub, Scrum, Virtual Machine, Containers, Routing, Switching and Software-defined Networking. All project work must be realized and implemented based on virtualization technologies such as VirtualBox, LXC and/or Docker. The general scope of the project is presented in more detail below, including the definition of the requirements and recommendations, as well as the submission and evaluation guidelines.

2 Project Organization

The following are important dates which shall be considered:

6th December 2022 – Deadline for the arrangement of groups

Deadline for arranging groups by the students themselves via the CampUAS and GitHub Classroom. The group election starts on 22nd November. In case of a suitable group partner cannot be found, please send an E-Mail including your personal information to mobilecomputing@e-technik.org before the deadline. In this case, a group will be assigned randomly.

7th December 2022 – Announcement of the assigned projects

Each group will receive a more specified topic on implementing a 5G core, including Radio Access Networks, Data Networks and Network Slicing.

13th December 2022 – Start of the project work

Start working on the set project task. Each group must appoint a group leader and design a project plan. This is required in the first working week! (Projekt Planning). After that, an updated version of the project plan is required each week to document the project's progress. You upload these to CampUAS each time. All further developments will be documented in GitHub, e.g., documentation, configuration files, Dockerfiles, etc.

28th February 2023 – Submission deadline of the project results according

Submission of the project results according to the submission guidelines. The submission will be carried out via CampUAS and GitHub.

28th February 2023 – Submission deadline of presentation and demonstration

Presentation and Demonstration of the Mobile Computing Project (15 to max. 20 minutes) recorded with Panopto and uploaded to CampUAS.

- The components of the presentation should be the following, e.g.:
  - Content/Overview
  - Goal
  - Problem
  - Solution
  - Results
  - Summary/Outlook/Conclusion

3 Assessment and Project Structure

The project exam consists of a software project including documentation (submission period of ten weeks) with presentation (min. 15, max. 20 minutes).

Assessment of the project work:

- Project planning (25%):
  - What are the tasks to work on?
  - Which group member works on what?
  - When are these tasks to be performed?
  - What is the progress? (weekly updates)
  - Who is the group leader?
- Project presentation (25%):
  - If possible, should it be equally distributed across all group members
- Project documentation and GitHub Repository (50%):
  - Documentation (min. 20 pages):
    - Format of documentation (formatting/consistency)
    - Outline of the document, e.g.:
      - Introduction/explanation of the topic
      - Requirements and project planning
      - Realization/implementation
      - Conclusion
      - References (primary sources?) (Harvard style referencing)
    - Spelling/grammar
    - Representations, e.g., pictures, diagrams, Wireshark traces (readability?)
    - Project planning
  - README file in GitHub (Guide including all steps required to put the configured emulation into operation)
  - Project structure in GitHub

4 General Scope of the Project

A fundamental 5G design principle is the Service Based Architecture (SBA). It provides the basis for comprehensive modularization, which in turn is the prerequisite for being able to compile and combine network functions flexibly as required according to the use cases to be supported. In practical implementation, this requires using the design principle of network softwarization, i.e., the application of NFV (Network Functions Virtualisation) and SDN (Software-defined Networking) for the realization of Network Function instances and their interaction. If besides, the design principle of multi-tenant capability is to be implemented, network slicing will be useful. Here, two or more logical networks, parallel running network slices, are formed. They enable several tenants, e.g., a mobile network operator, a fixed network operator and an MVNO (Mobile Virtual Network Operator) for eMBB, a Smart Grid Provider and a service provider for autonomous vehicles for URLLC, in order to operate several, here 5, logical communication networks with different characteristics in parallel on one physical network platform. (Trick, 2021)

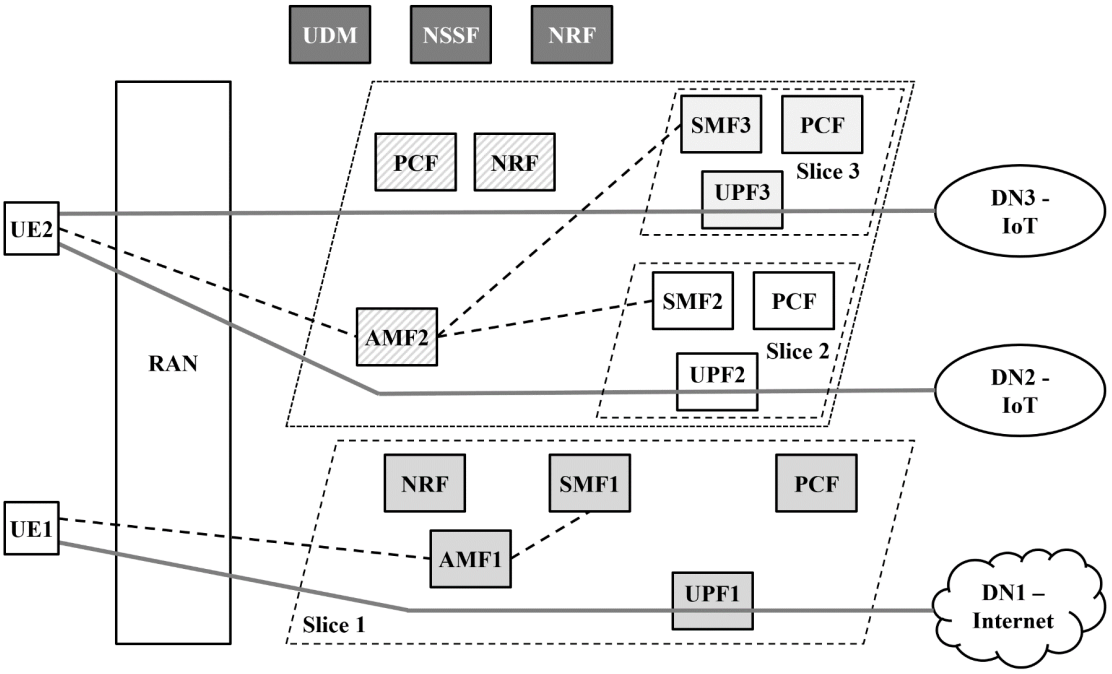

Figure 1 – Examples for network slicing in 5G core (Trick, 2021)

The task of this project consists of providing one or several services with a specific functionality to different tenants. To ensure the separation of the services and end-users, the concept of network slicing must be utilized. Furthermore, a set of RANs and possibly DNs are connected via slices. And last but not least the 5G core with its SBA has to be implemented, possibly with several network functions.

The concept of network slicing and SBA is introduced in the corresponding Mobile Computing lecture of Prof. Lehmann and various literature such as (Trick, 2021).

A more detailed project topic is communicated to each project group at the beginning of the project work.

All project work will use open-source implementations or projects for realization. These include, for instance:

- Open5GS (Open5GS, 2022)
- OpenAirInterface (OpenAirInterface, 2022)
- UERANSIM (GÜNGÖR, 2022)
- SRSRAN (SRSRAN, 2022)
- Open vSwitch (A Linux Foundation Collaborative Project, 2016)
- VirtualBox (Oracle, 2022)
- LXC (Canonical Ltd., 2022)
- Docker (Docker Inc., 2022)
- GitHub (GitHub, Inc., 2022)
- etc.

5 Group-specific Project Description

- Provisioning of a 5G-SA (stand alone) system using Open5GS (Open5GS, 2022) under the requirements documented within this project description
- Configuration of the following network slices including their characteristics according to Table 1. Please see (Cox, 2021, p. 38) or (Stallings, 2021, pp. 307-315) for more information. Please note that the configurations and characteristics are not valid in terms of the 5G standardisation, but are used for emulating the network slices within this project.
- Define suitable 5QI values for the slices using the parameters mentioned in (Cox, 2021, pp. 282-285) or (Stallings, 2021, pp. 299-306)

Table 1 – Description of required Network Slices

SST	SD	APN/DNN	Description
1	1	internet	Access to a file sharing platform and streaming platform for Tenant Group A
1	2	internet2	Access to a file sharing platform and streaming platform for Tenant Group B
2	1	voip	Access to SIP call server for Tenant Group A
2	2	voip2	Acccess to SIP call server for Tenant Group B

- The project network is required to be implemented with the following group-secific requirements:
  - 5G-RAN: OAI-RAN (OpenAirInterface, 2022)
  - Control Plane: Multiple SMF/NRF/PCF (for each SST)
  - User Plane: Single UPF
  - Additional aspect: Integration of TAC/TAI for nearby UPF (see (Cox, 2021, pp. 64-65) for more information)
- The following Figure 2 visualises these requirements in context of the general project task

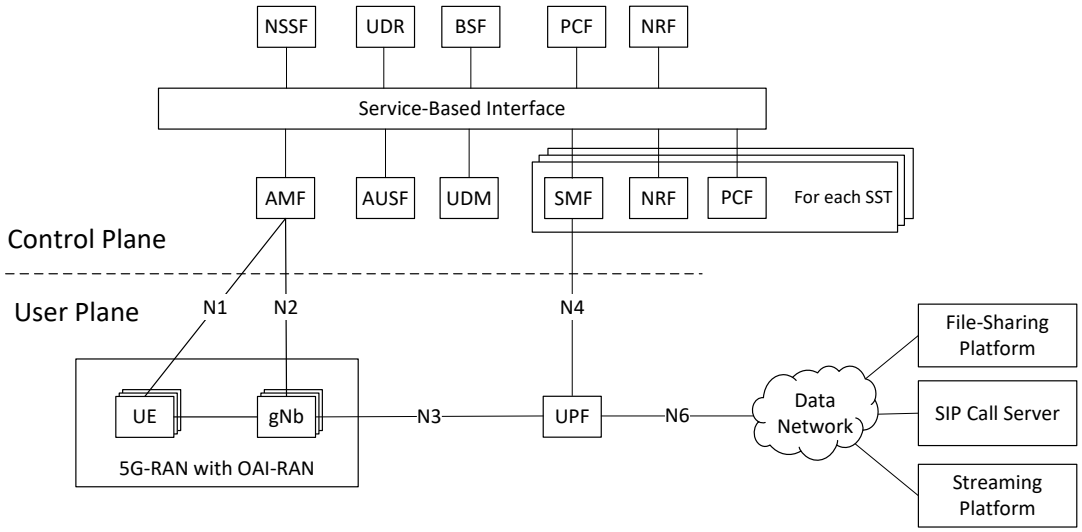

Figure 2 – Context of group-specific requirements in context of general project task

- Please note that the figure shall only improve the understanding of the project task and does not represent the final network architecture. Especially the requirement “additional aspect” is not shown in the figure, which might change the architecture to a certain degree
- Components implementing the service functionality of the slices (file sharing platform, streaming platform and SIP call server) of the slices are maintained within the data network. Recommended implementations for the service functionality are:
    - File Sharing Platform: NextCloud (NextCloud, 2022)
    - Streaming Platform: owncast (Owncast, 2022)
    - SIP Call Server: Kamailio (Kamailio, 2022)
- Services must be accessible by a corresponding UE software (i.e. the file sharing platform and streaming platform must be accessible via a Browser). Command-Line tools are not sufficient
- Utilisation of a virtualisation technology such as LXC (Canonical Ltd., 2022), Docker (Docker Inc., 2022), etc. is not a requirement, but is heavily recommended
- Utilisation of suitable IP subnets, which would also be valid in a real-world environment
- Requirements on documentation:
    - Figure and description of the complete network infrastructure including all used components, network functions, containers, etc. including their IP and other essential configurations
    - Detailed evaluation of the implementation with regard to the defined network slices (i.e. use Wireshark Flow Graphs to show correct communication between components)

6 References

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