

Title: Intelligent Service Mesh for 5G Core Networks

The 5G Core has evolved to a service-based architecture, leaving behind the monolithic approach with specialized hardware. The new core is composed of multiple Network Functions (NFs) composed of Network Function Services (NFSs) that expose HTTP APIs. NFSs communicate using service-based interfaces (SBI) over HTTP/2, with one of the important functions performed by SBI is automatic registration and discovery of other NFs.

The new release of 3GPP's 5G specification, Release 16, includes the option to provide the communication between the NF instances in an indirect manner (see [TS 23.501](#) Annex E). In Fig. 1, options C and D include an element that provides the indirect communication, called Service Communication Proxy (SCP). The SCP may perform the discovery and selection of a producer instance depending on discovery and selection parameters included in the request. For that, the SCP can interact with the NF Repository Function (NRF), which stores the profiles of all NF/NF service instances and the SCP could use it to obtain 3GPP specific information needed for instance selection and routing.

The purpose of the SCP is to:

- Offload discovery and selection tasks from the API consumers so that they can become lighter and focus on the business logic, and avoid several different implementations (with potentially different behaviour) for discovery and selection within the network
- Enable routing and selection of service producers based on knowledge not known to the consumer (e.g. network load, network topology)

The goal of standardizing such a functional architecture was to achieve an architecture that can be mapped well to a cloud-native microservice-based implementation, as well as support technologies such as a service mesh to maximally leverage cloud technologies.

In this thesis, you will implement an SCP prototype based on requirements specified in the 5G standards for such a component, using available technologies that can satisfy them. Furthermore, you will identify gaps where the development of new components would be needed and research how to close those. Research results may be used to feed back into the standardisation process of 3GPP. You will evaluate the feasibility of a [carrier-grade](#)-service-mesh-based SCP based on the proposed design and implementation in terms of performance (throughput and latency), reliability, scalability and monitorability.

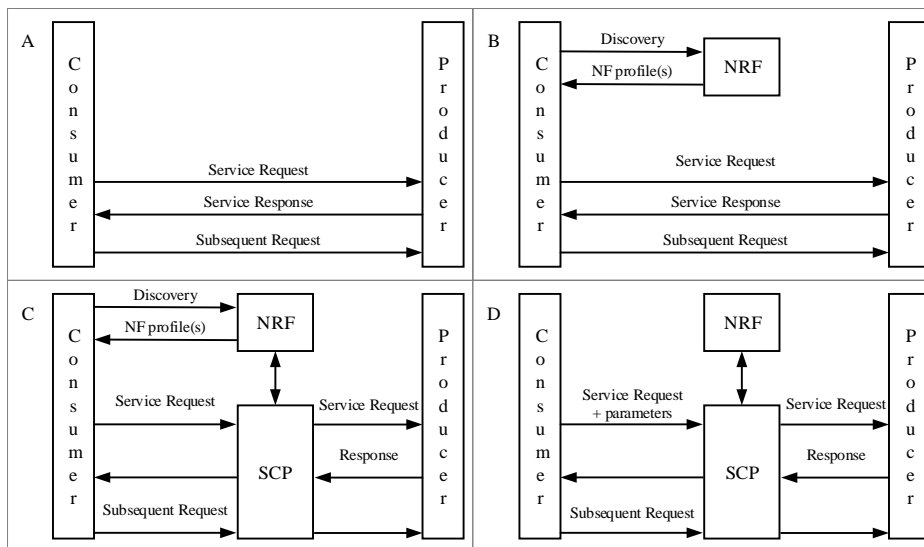


Figure 1: Communication options for NF/NF services interaction (TS 23.501)

The master thesis will cover:

- Study 5G requirements for SCP (protocols to support, capabilities, security, ...)
- Link between 3GPP APIs (NRF) and Service Mesh. How can it be done and interfaced with the existing service mesh functionality? Can this be implemented with open source only? (e.g. Istio service mesh) Or is it necessary to develop extra components? Can it be done by enhancing the service request with selection parameters?
- Performance evaluation of the implementation (e.g. there are no available performance tests for Istio for HTTP/2). What is the performance penalty for adding 3GPP-aware functionality?
- Can performance be enhanced? E.g. comparison of HTTP/2 vs. gRPC
- Addition of any useful functionality developed during the thesis to relevant open source projects. Open source release of the SCP prototype and presentation of relevant results to relevant fora (e.g. 3GPP standardization contribution)
- Gap analysis regarding SCP specification in 3GPP standards.

Suggestions on the technology stack:

- Kubernetes
- Istio, eventually enhanced via Lua filters in Envoy proxy or other means
Sidecar API <https://istio.io/docs/reference/config/networking/v1alpha3/sidecar/>

Duration:

- 6 months
- Please see <http://www.snet.tu-berlin.de/menue/theses/faq/> for the whole workflow of writing a thesis at SNET.

Literature:

- 3GPP TS 29.500: 5G System; Technical Realization of Service Based Architecture; Stage 3 (Versions after 16.0.0 – applies for all 3GPP documents)
- 3GPP TS 29.501: 5G System; Principles and Guidelines for Services Definition; Stage 3
- 3GPP TS 29.510: 5G System; Network function repository services; Stage 3
- 3GPP TS 29.571: 5G System; Common Data Types for Service Based Interfaces; Stage 3
- Nginx <https://www.nginx.com/resources/wiki/>
- What is a Service Mesh? <https://glasnostic.com/blog/what-is-a-service-mesh-istio-linkerd-envoy-consul>
- What is Istio, <https://istio.io/docs/concepts/what-is-istio/>
- Service Mesh (in German), <https://www.heise.de/developer/artikel/Alle-11-Minuten-verliebt-sich-ein-Microservice-in-Linkerd-4511406.html>