

Traffic analysis and forecasting for adaptive network resource management in 5G/6G networks

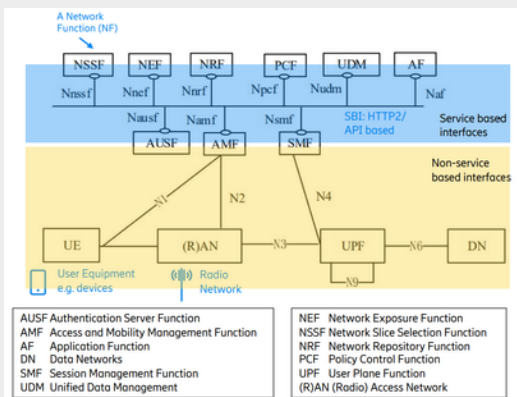
HOW QUICKLY CAN VIRTUALIZED NETWORK SERVICES ADAPT TO DYNAMIC TRAFFIC DEMANDS AND CHANGING WORKLOADS IN A 5G ENVIRONMENT?

Introduction

5G and 6G networks must handle fluctuating traffic in real-time. Virtualized Network Functions (VNFs), like the User Plane Function (UPF), provide flexibility but raise challenges around latency and session continuity during reconfiguration[1]. Previous research on VNF reconfigurations defined a Session Reassignment Cost[2], but there were no measurements presented.

Background

It's important to understand the architecture of the network before diving into the research question and methodology.

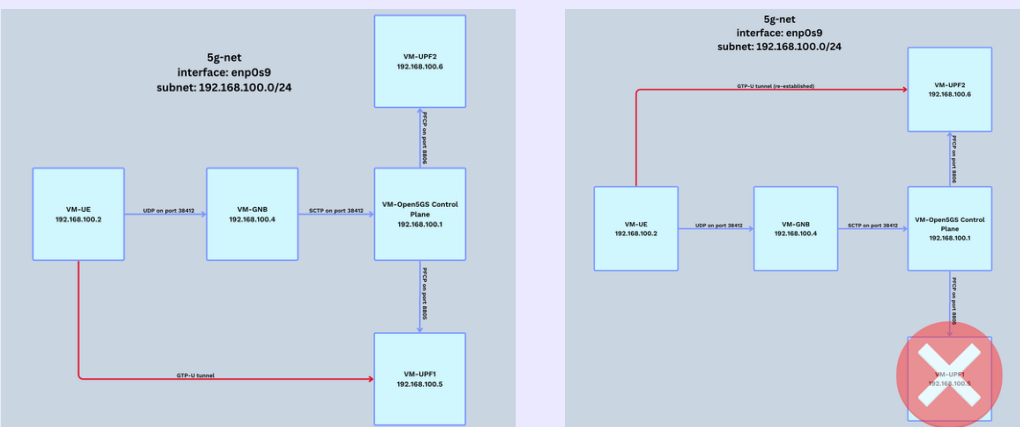
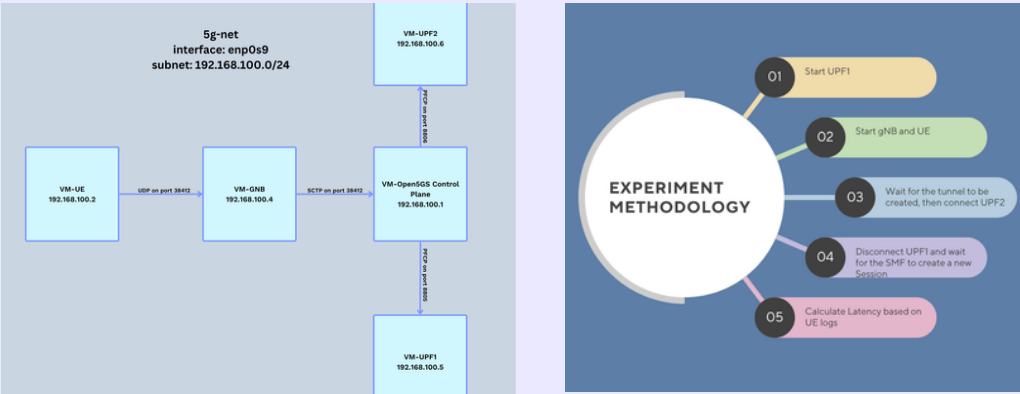


Research Question

This research project explores the impact of network reconfigurations on user sessions. More specifically, it analyses the latency generated when users migrate from one user plane to another and the impact it has the user.

Methodology & Results

We are using Open5GS[3](v2.7.5) to emulate the 4G network and UERANSIM[4](v3.2.7) to emulate the traffic and user sessions. They are distributed across 5VMs to ensure an isolated environment.



This experiment process produced the following results, over a total of 50 samples:

Metric	Latency (seconds)
Minimum latency	0.259
Maximum latency	55.009
Average (mean) latency	18.040
Sample standard deviation	13.810

These results highlight inconsistency and volatility in the session handover process, as well as the inability to maintain connectivity during the session migration.

Observations & Limitations

- Open5GS lacks full support for PDU Session Modification
- SMF periodically loses the association with UPF2, causing the latency window to be bigger than expected
- Running 5VM on a single device represented a heavy load that caused delays in tunnel recreation and overall flow of the signals between VMs

Conclusion & Next Steps

Conclusion:

- Session migration is not truly possible, only a teardown and a recreation
- The latency window is really small in an ideal scenario when the system can handle the entire load

Next Steps:

- In the future, 5G Network are trying to include SSC mode 3, to allow session migration without a connectivity drop
- Despite Open5GS being one of the most popular and used, it would be interesting to use other tools to emulate the network
- Kubernetes can be used to orchestrate all of the microservices

References

- [Mobile network architecture evolution toward 5G](#)
- [Dynamic upf placement and chaining reconfiguration in 5g networks](#)
- Open5GS - [open5gs.org](#)
- UERANSIM - [UERANSIM on github](#)