5G in Maritime Sector: Do Open-Source based Solutions Work?

GCE NODE og Eyde-klyngen Seminar
4G vs. 5G: Forskjellen er enorm!

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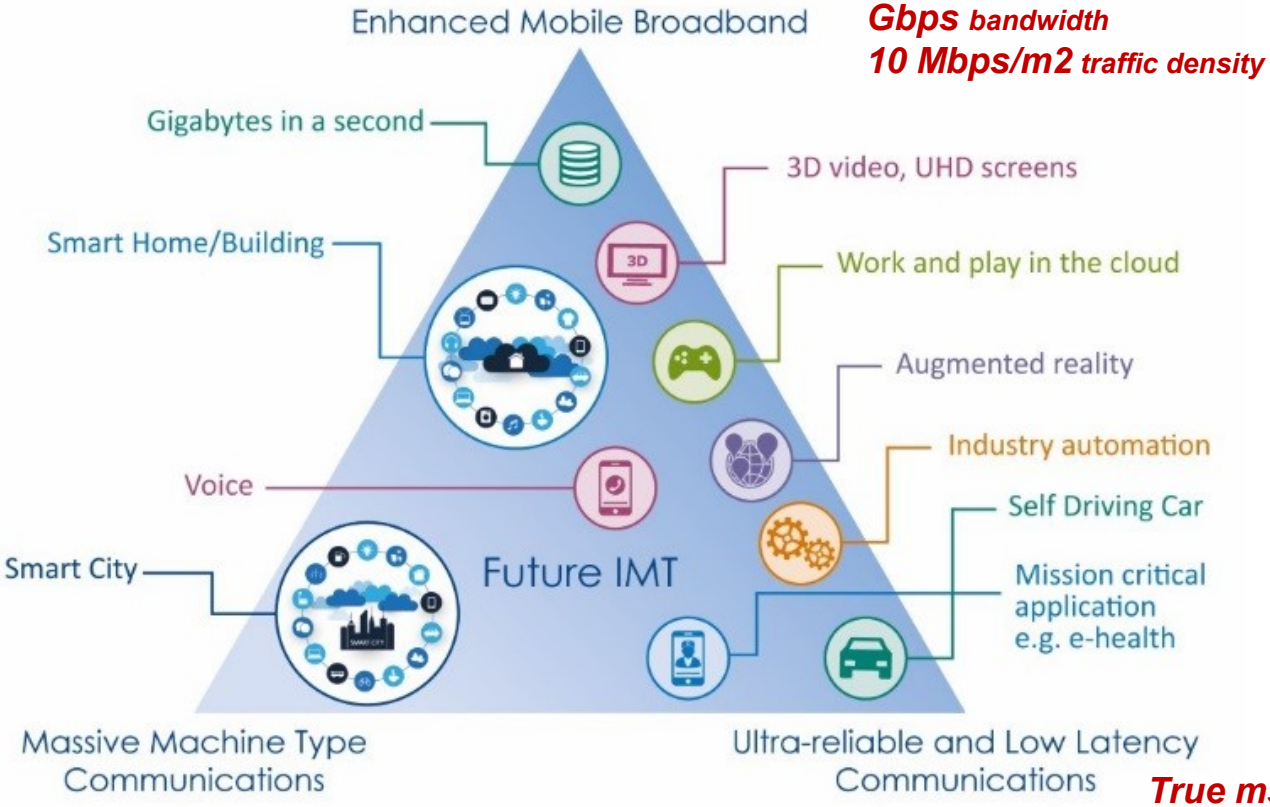
5G Vision – at the Outset (2018)

3GPP Workshop on IMT2020 submission - Bruxelles, Belgium, 24-25 Oct. 2018



- 5G use cases/technology pillars
  - Enhanced mobile broadband (eMBB)
  - Massive machine type communications (mMTC)
  - Ultra-reliable low latency communication (URLLC)

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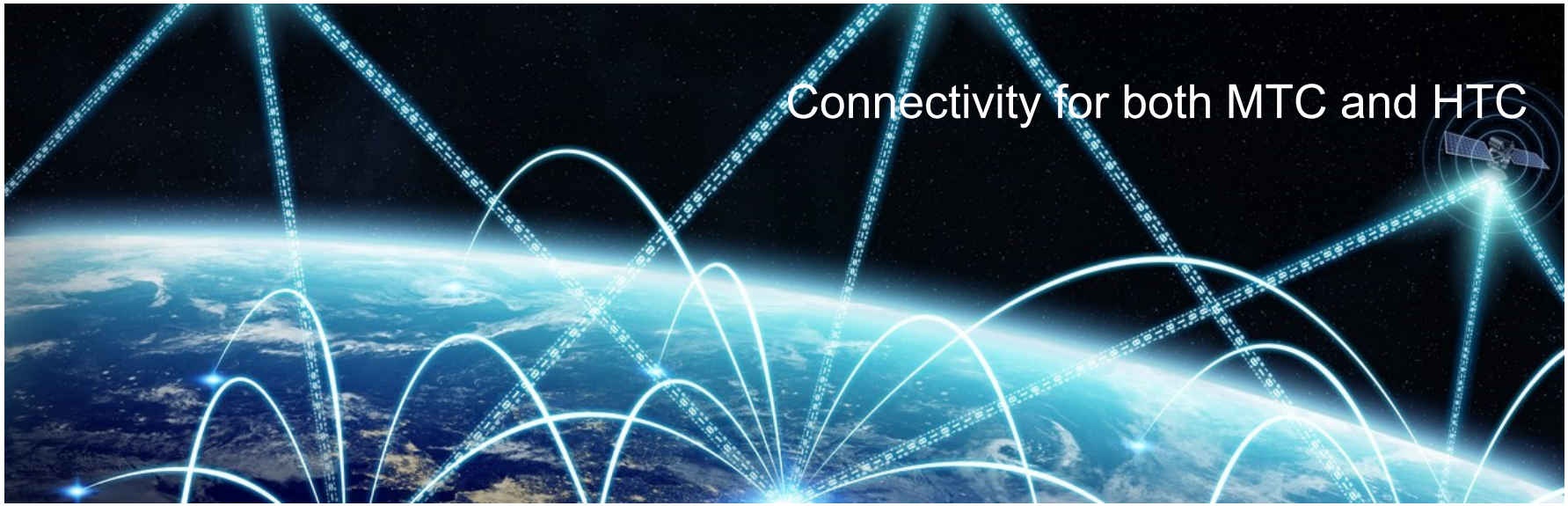
5G for Maritime Applications

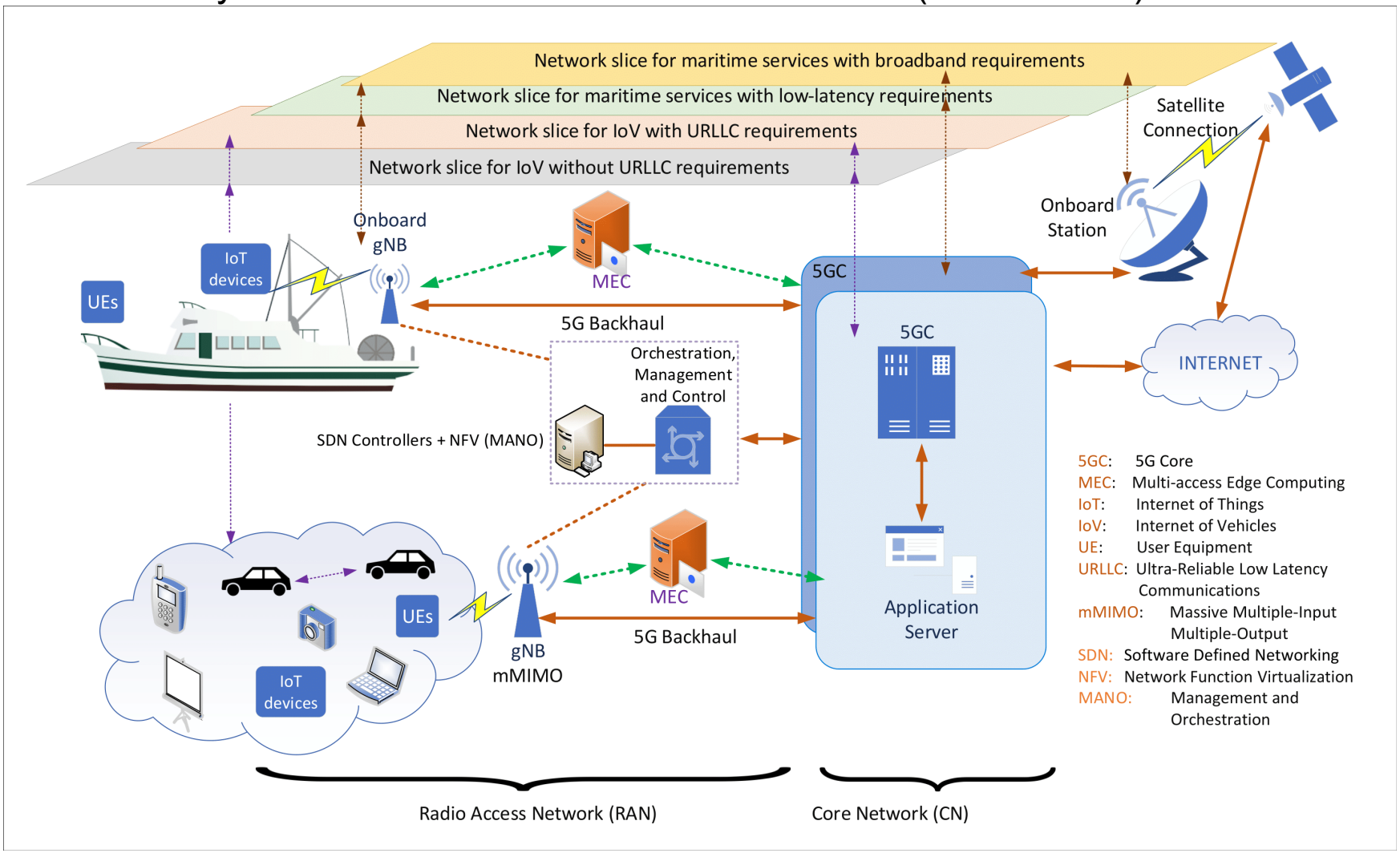


Why Do We Go for Open-Source?

- Telenor Maritime
  - New possibilities
  - Customer needs/requirements
  - Competition
- UiA
  - Tighter cooperation with industry
  - Opportunities for Master- and Bachelor students for their thesis work
  - Competence building towards 6G

EEA Collaborative Project – SOLID-B5G

- Project title and acronym
  - A Massive MIMO Enabled IoT Platform with Networking Slicing for Beyond 5G IoV/V2X and Maritime Services (SOLID-B5G)



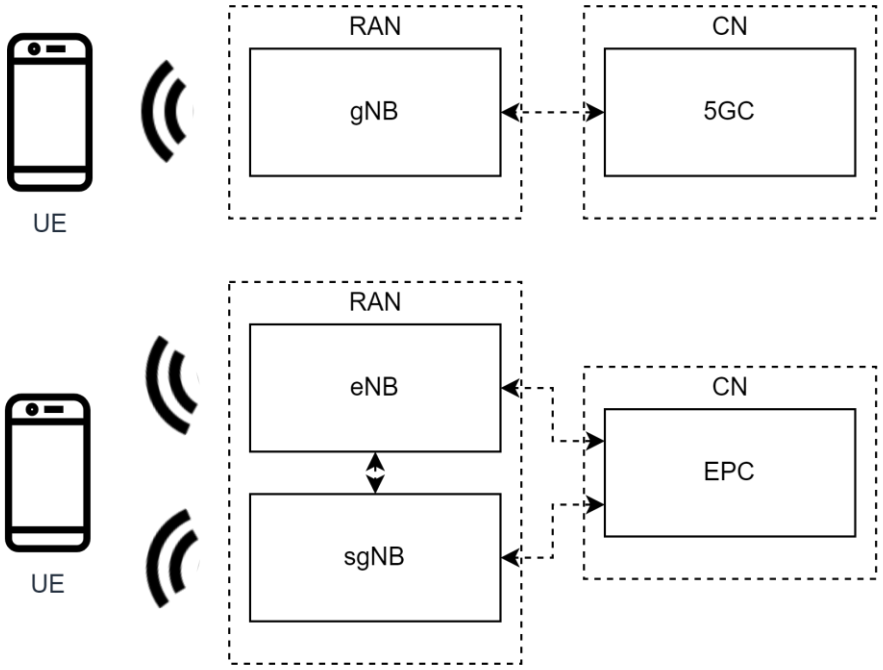
SOLID-B5G Project Overview

- Project overview
  - Financed by the EEA RO-NO Grants Call 2019
  - Partners: University “Politehnica” of Bucharest (UPB)/RO; Beia Consult International SRL (BEIA)/RO; Beam Innovation SRL (BEAM)/RO; UiA/NO; Telenor Maritime AS/NO; Universitat Politècnica de València (UPV)/ES; Memorial University of Newfoundland (MUN)/CA
  - Budget: ~1.2 M€ (60% RO partners and 40% NO partners)
  - Project duration: 40 months: January 2021 – April 2024
- Project objective
  - The main goal of the SOLID-B5G project is to develop breakthrough beyond state-of-the-art solutions in orchestration, management and control of resources, in the context of network slicing and edge computing based on massive IoT enabled radio access network (RAN) and core network (CN) for B5G IoV/V2X and maritime applications
- Work packages
  - WP1: Project management
  - WP2: Scenarios and requirements
  - WP3: RAN (concurrent transmissions)
  - WP4: Network slicing and edge computing
  - WP5: Implementation and experiments
  - WP6: Dissemination and exploitation

System Design

5G SA versus 5G NSA

- 5G SA: 5GC and gNB
- 5G NSA: EPC, eNB and sgNB



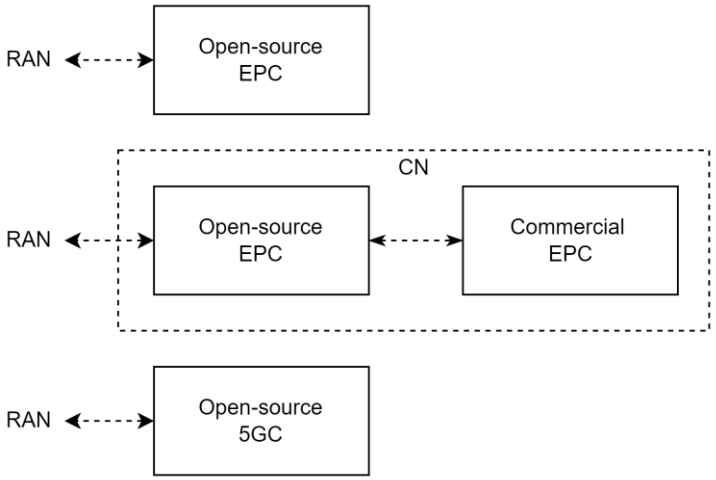
5G SA: 5G Standalone
5G NSA: 5G Non-Standalone
5GC: 5G Core network
UE: User Equipment
EPC: Evolved Packet Core (4G core network)
gNB: next generation NodeB (5G base station)
eNB: evolved NodeB (4G base station)
sgNB: secondary gNB

RAN Implementations

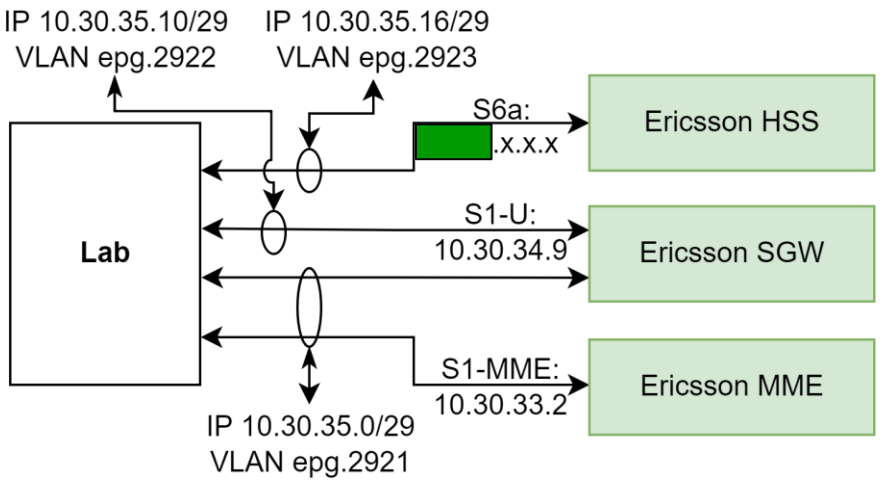
- Two open-source RAN software suites have been implemented
- Both HTC and MTC are implemented
  - For HTC, four types of UEs are supported
  - For MTC, only LTE-M is supported so far.
- Software suite I
  - Release 15 compatible
  - Supports all LTE bandwidth options
  - MIMO features
  - 5G NSA supported. eNB and sgNB implemented in one entity
  - 5G SA not supported as of June 2022
  - Limited support of 5G New Radio (NR) numerologies
- Software suite II
  - Release 15 compatible
  - Supports 5, 10, 20, up to 100 MHz bandwidth
  - MIMO features
  - 5G NSA supported. Both eNB and sgNB implemented
  - 5G SA implemented gNB
  - Limited support of 5G NR numerologies

CN Implementations

- Open-source EPC
- Open-source EPC with commercial Ericsson EPC
- Open-source 5GC



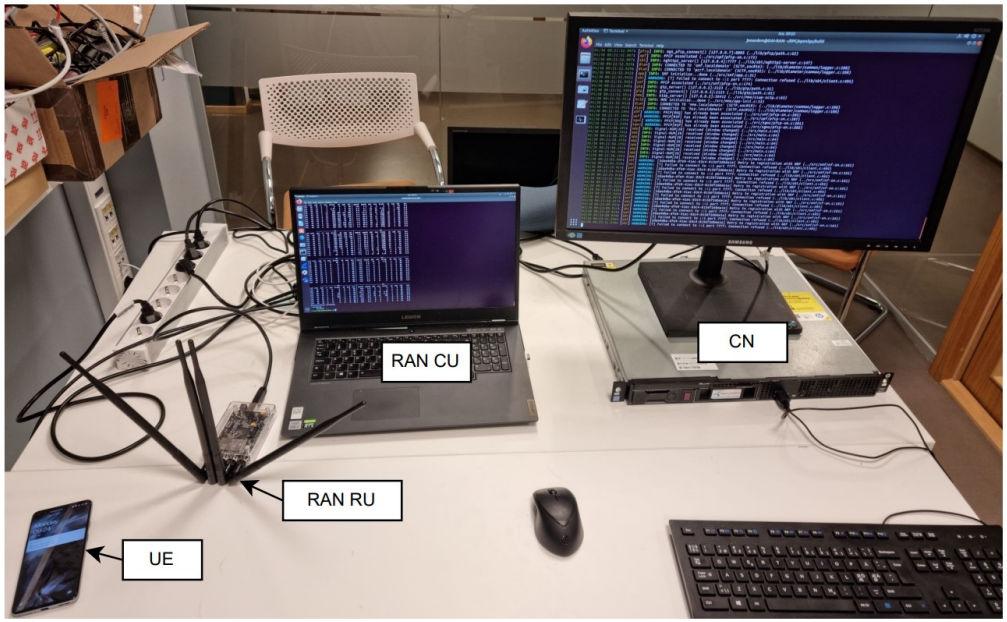
5GC: 5G Core network
EPC: Evolved Packet Core (4G core network)
HSS: Home Subscriber Server
SGW: Serving Gateway
MME: Mobility Management Entity



System Implementations

Typical Experiment Configuration

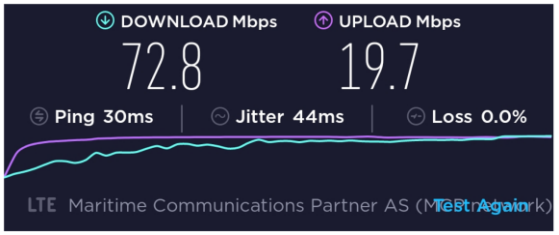
- End-to-end
- UE to RAN RU over-the-air
- RAN RU to RAN CU (/DU) using USB3.0
- RAN DU to RAN CU using Ethernet cable
- RAN CU to CN using Ethernet cable (or local network interface)

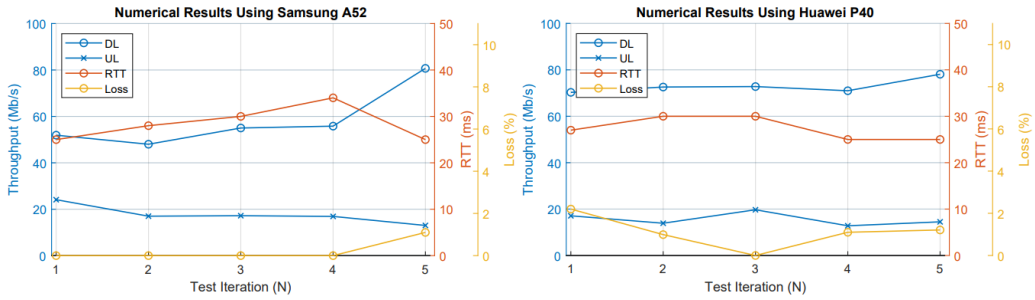


RU: Radio Unit
CU: Centralized Unit

Experiment 2: Open-Source RAN with Open-Source MME and Ericsson HSS

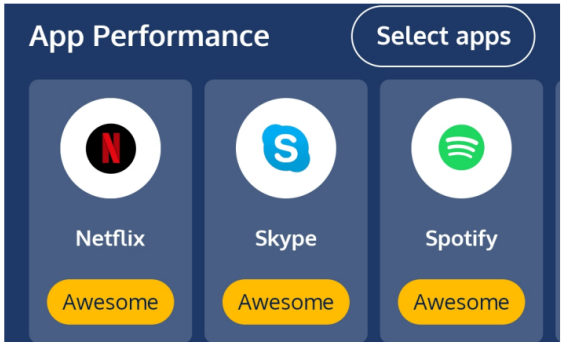
- Tested with Samsung A52 and Huawei P40
- Expected throughput 100 PRBs: 100/33 Mbps UL/DL
- Achieved throughput: 72.8/19.7 Mbps UL/DL





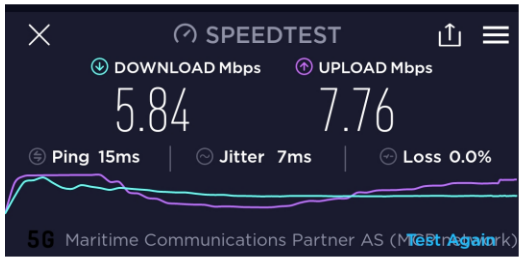
HSS: Home Subscriber Server
MME: Mobility Management Entity
PRB: Physical Resource Block
UL/DL: Uplink/Downlink

- Downloads maximum available video quality
- Achieves "Awesome" APP performance

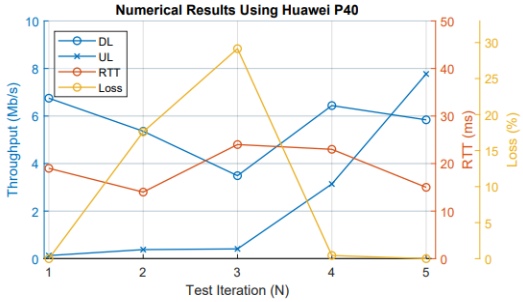


Experiment 6: Open-Source 5G NSA with Ericsson EPC

- Tested with Huawei P40
- Expected throughput 106 PRBs: 12/12 Mbps UL/DL
- Achieved throughput: 5.84/7.76 Mbps UL/DL

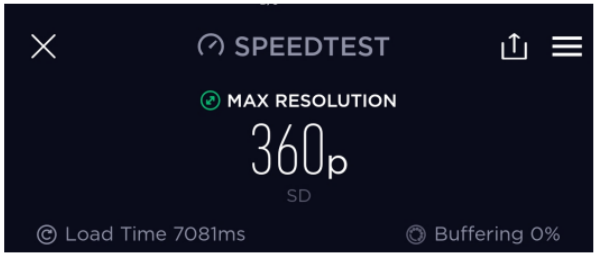


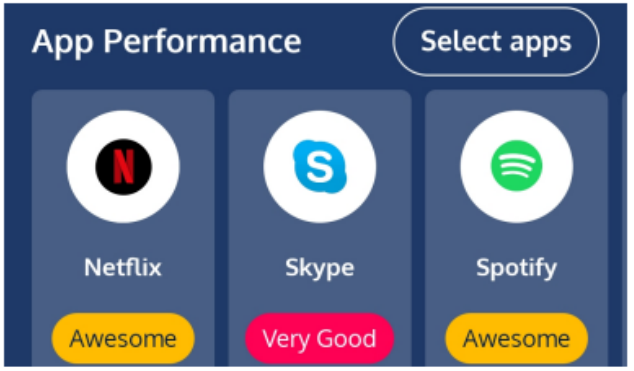
a) Measured throughput on 5G NSA.



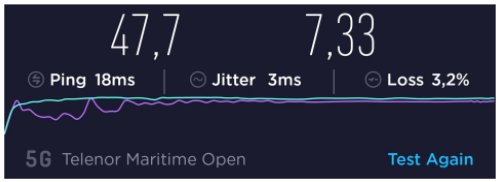
b) Overview of multiple throughput tests.

- Downloads video of low quality
- Achieves "Awesome" and "Very Good" APP performance

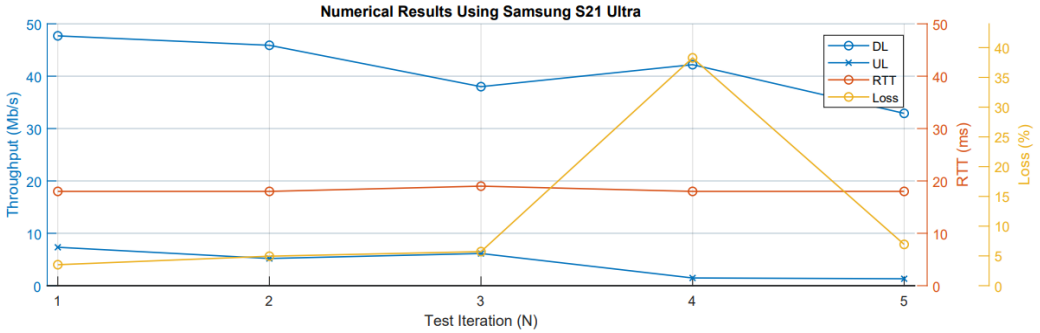




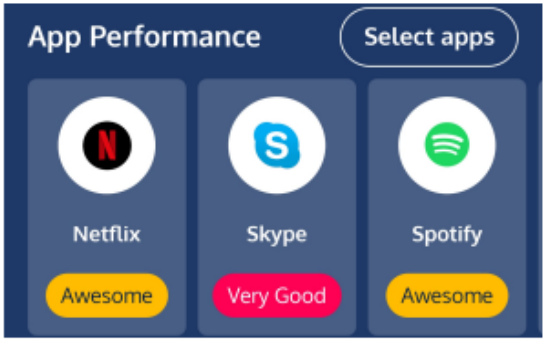
Experiment 8: Open-Source 5G SA with Open-Source 5GC



- Tested with Huawei P40
- Expected throughput 106 PRBs: 58/12 Mbps DL/UL
- Achieved throughput: 47.7/7.33 Mbps DL/UL



- Downloads maximum available video quality
- Achieves "Awesome" and "Very Good" APP performance



Conclusions

- 5G does not mean only higher data rates than 4G by eMBB. mIoT and URLLC are coming
- Open-source based solutions provide great potential for building dedicated 5G networks including both RAN and CN
  - IoT connectivity
  - Edge computing
  - Network slicing
  - SDR, SDN, NFV, containers, Kubernetes, etc.
- Telenor Maritime and UiA have made initial prototype implementations and experiments
  - Promising results have been achieved
  - More efforts are needed
- Do we go forward towards private 5G networks?
- Enormous market opportunities: maritime, offshore, Industrial IoT, oil platforms, smart farm, smart …
- Open for further collaborations