



FACULTY OF ELECTRICAL department
ENGINEERING of telecommunications
AND COMMUNICATION

MPA-KPM Project

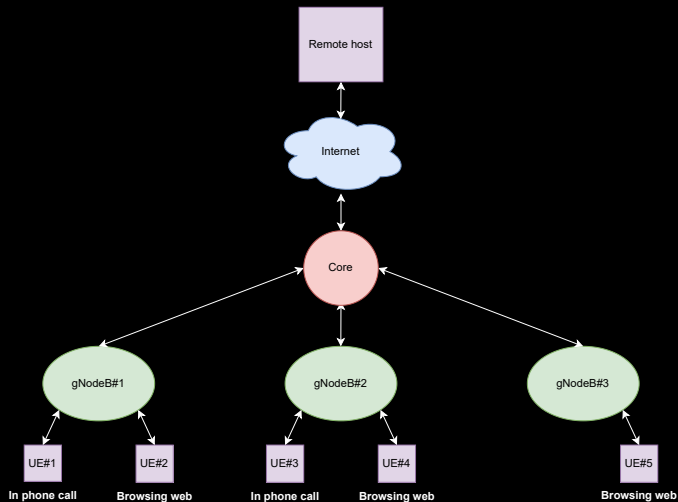
5G NR Simulation in NS-3

Assignment 11

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- **Objective:** Simulate a 5G NR network using the 5G-LENA module in NS-3 to explore network performance.
- **Network Scenario:**
 - 5 UEs: 2 on phone calls (different gNodeBs), 3 browsing the web (connected to a remote server).
 - 3 gNodeBs: 2 connected to 2 UEs, 1 connected to 1 UE.
 - Stationary mobility with GridScenarioHelper.

5G NR Simulation in NS-3 – Assignment 11



- **Adjustable Parameters:**
 - command-line arguments for flexible setup.
- **NR Setup:**
 - mmWave frequency (24-100 GHz),
 - two BWPs: 28 GHz (50 MHz) and 28.2 GHz.
 - Total transmission power: 35 dBm.
- **Traffic Types:**
 - voice call,
 - web browsing,
 - adjustable traffic and packet sizes.
- **Network Setup:** Static IP addresses, routing configured for communication between UEs, SGW/PGW, and a remote host.

- **Objective:** Simulate voice calls and web browsing traffic to observe network performance under different conditions.
- **Voice Call:** Managed by dedicated bearer:
 - `NrEpsBearer::GBR_CONV_VOICE`.
- **Web Browsing:** Managed by dedicated bearer:
 - `NrEpsBearer::NGBR_LOW_LAT_EMBB`.
- **Traffic Flow Templates (TFTs):** Filtering based on port numbers for both types of traffic.
- **UDP Clients & Servers:**
 - Configured for between UEs and the remote host.

- **Objective:** Measure network metrics:
 - throughput,
 - packet loss,
 - delay.
- **Done using FlowMonitor:**
 - logging,
 - outputting to CLI.
- **Adjusted parameters:**
 - `udpPacketSizeVoiceCall` = 50,
 - `totalTxPower` = 35 or 25.
- **More comprehensive logs:**
 - Logs for all components of the simulation are provided in project repository.

- **Focus on one flow:** Call traffic between two nodes on different eNodeBs.

Sim 1 (Low Traffic – 35 dBm)

Tx Packets: 900

Tx Bytes: 70200

Tx Offered: 6.24 Mbps

Rx Bytes: 70284

Packet Loss: 0.18%

Throughput:

6.22 Mbps

Mean Delay: 0.74 ms

Mean Jitter: 0.016 ms

Lost Packets: 2

Rx Packets: 831

Sim 2 (High Traffic – 35 dBm)

Tx Packets: 9000

Tx Bytes: 702000

Tx Offered: 62.4 Mbps

Rx Bytes: 700308

Packet Loss: 0.24%

Throughput:

62.21 Mbps

Mean Delay: 0.85 ms

Mean Jitter: 0.018 ms

Lost Packets: 22

Rx Packets: 8978

Sim 3 (High Traffic – 25 dBm)

Tx Packets: 9000

Tx Bytes: 702000

Tx Offered: 62.4 Mbps

Rx Bytes: 349794

Packet Loss: 50.3%

Throughput:

31.0 Mbps

Mean Delay: 22.5 ms

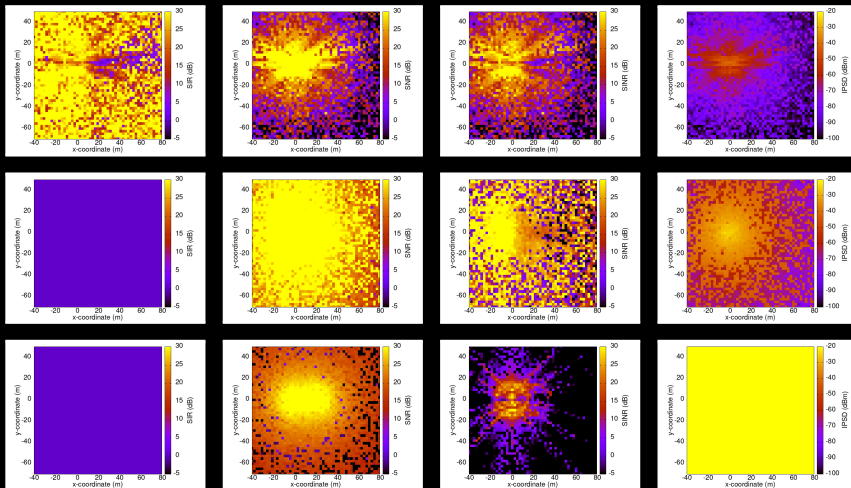
Mean Jitter: 0.03 ms

Lost Packets: 4527

Rx Packets: 4473

- **Objective:** Generate REMs to visualize 5G signal propagation, coverage, and interference.
- **REM Modes:**
 - Beam Shape: Visualizes beam configurations.
 - Coverage Area: Worst-case SINR and best-case SNR.
 - UE Coverage: Uplink with downlink interference in TDD.
- **Figures:** 12 plots for DL and UL.
 - Organized in 3 modes: Beam Shape (top), Coverage Area (middle), UE Coverage (bottom).
 - Metrics: SIR, SNR, SINR, IPSD.

Radio Environment Map (REM) Analysis



¹For DL, Organized in 3 modes: Beam Shape (top), Coverage Area (middle), UE Coverage (bottom), Metrics: SIR, SNR, SINR, IPSD.

■ **Simulation Setup:**

- 5G NR network with 2 UEs on voice calls, 3 UEs browsing the web.
- Adequate for analysis but doesn't reflect real-world complexity (more UEs, dynamic mobility, etc.).

■ **Simplified Models:**

- Static mobility, idealized propagation, interference, and traffic.
- No consideration for obstacles, weather, device variability, or hardware limitations.

■ **Challenges:**

- Debugging difficulties due to lack of line-by-line debugging tools in ns-3.

■ **Future Work:**

- Incorporate real-world factors for more accurate simulations.

Thank you!