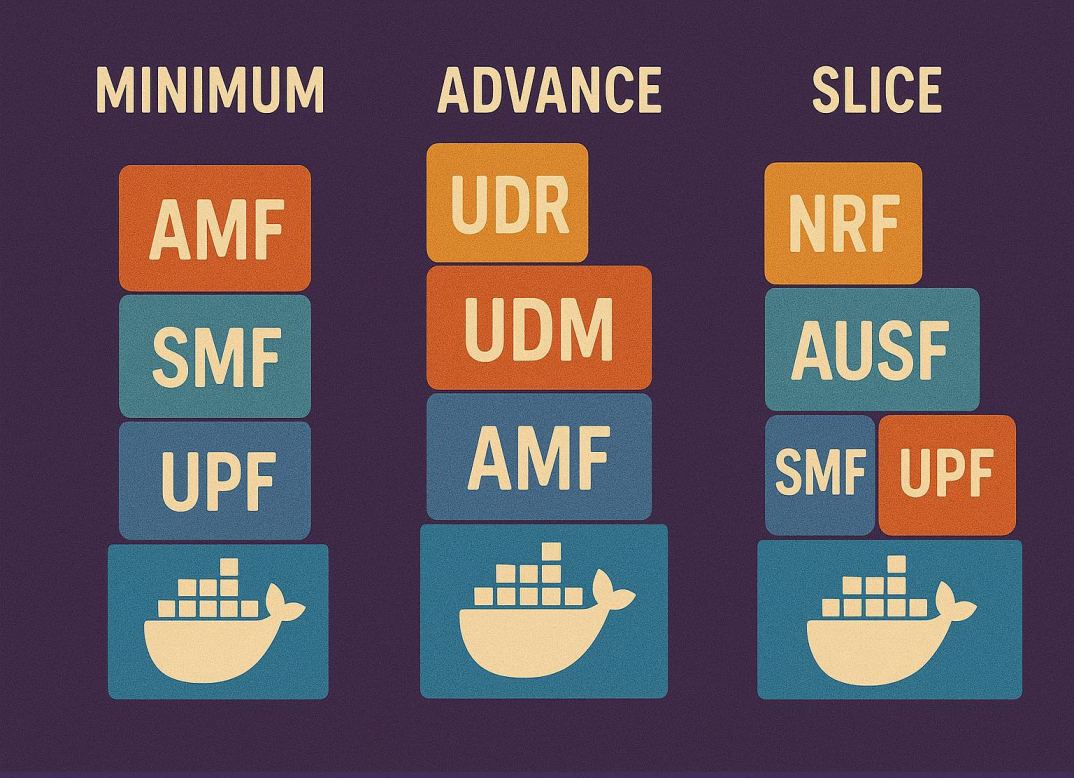
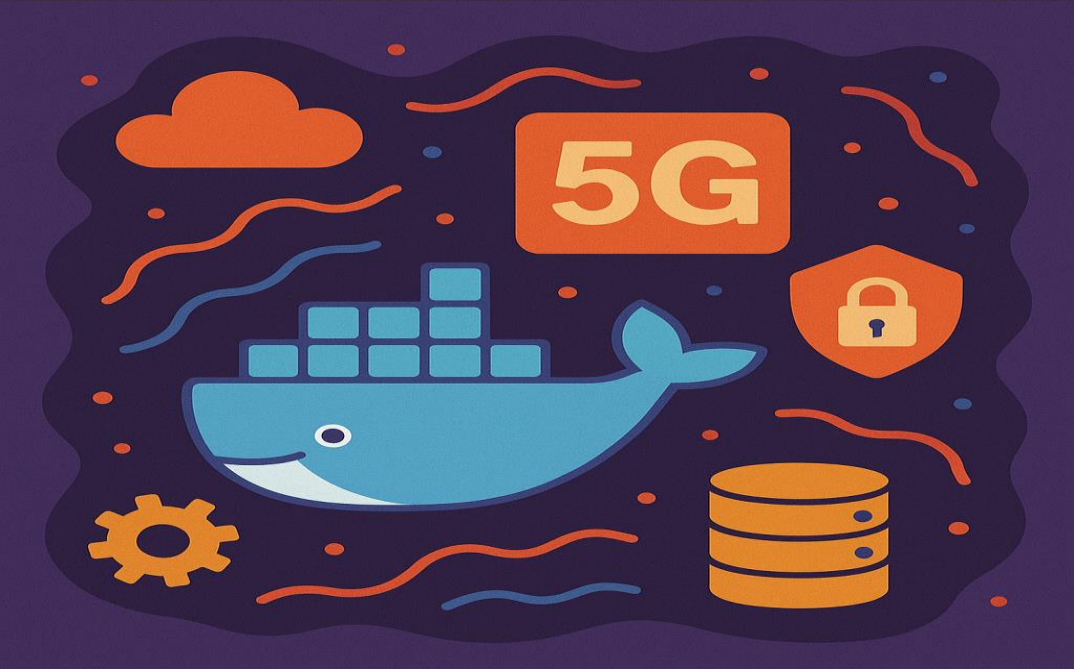
How to design 5G private Network in limited cost?

PPT discussed about All kind of possible solutions which helps to design cost effective private 5G network [Small scale to Full scale solution]

Presented By SHASHVAT , Researcher ,IITDELHI





1.Virtual Setup

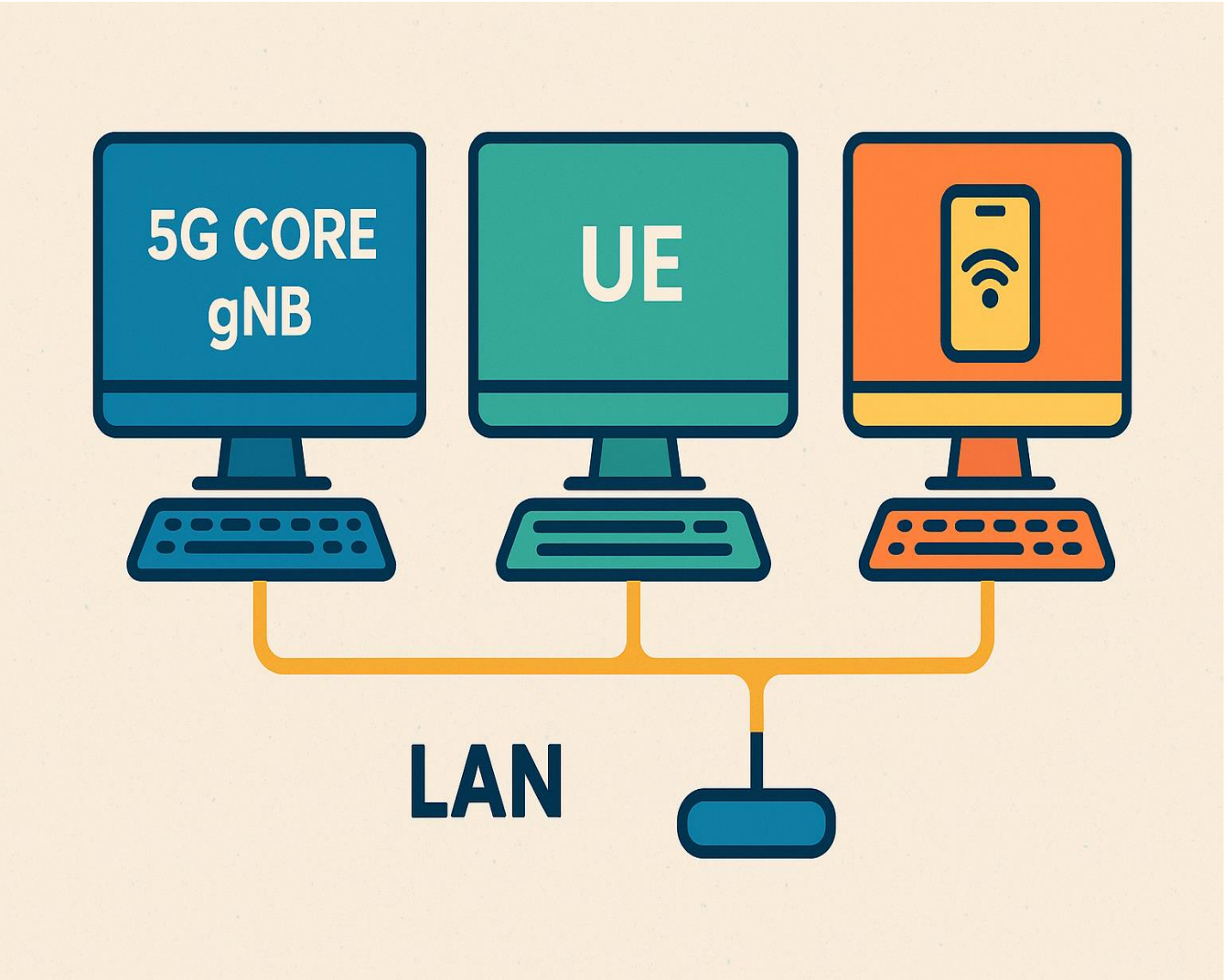
Benefits-

- **Virtual setup with Docker container, All the 5G entities and RAN present in as Docker Component.**
- **Easy to install by docker compose.**
- **Good for Those who want to learn 5G functionality.**
- **Good for students and small research project ,Helpful to Give training for beginner.**
- **All the solution based on open source following 3GPP standard.**
- **5G private network can be install in your laptop.**

Limitations-

- **Limited working due to docker,**
- **Command line interface create complexity.**
- **RAN present virtually.**
- **Installation and working based on Command Line create complexity.**

2.Build in setup



- Benefit-
- 5G Core ,RAN(with out SDR) , UE , all can be built in different or same machine

- Build in solutions is NOT virtual ,They run with binary files.

- Private 5G network work with Local LAN inside lab.

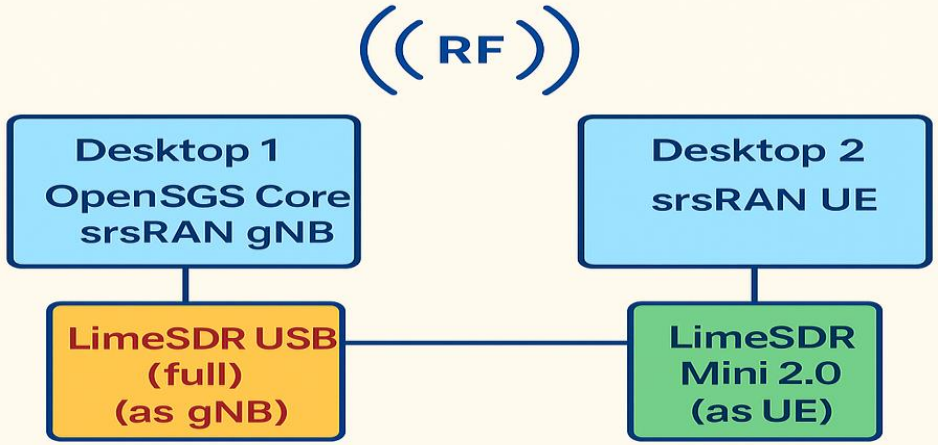
- Good for researcher and startup to test applications in real time environment. Cost effective

- Limitation-
- Real SDR not present
- Installation and working based on Command Line create complexity.

3.Build in setup with SDR(radio)

- Benefits-
- 5G Core ,RAN(with SDR) , UE , all can be built in different or same machine and connected with radio.
- Build in solutions is NOT virtual ,They run with binary files and radio.
- Private 5G network work with Local LAN with radio inside lab.
- Good for researcher and startup to test applications

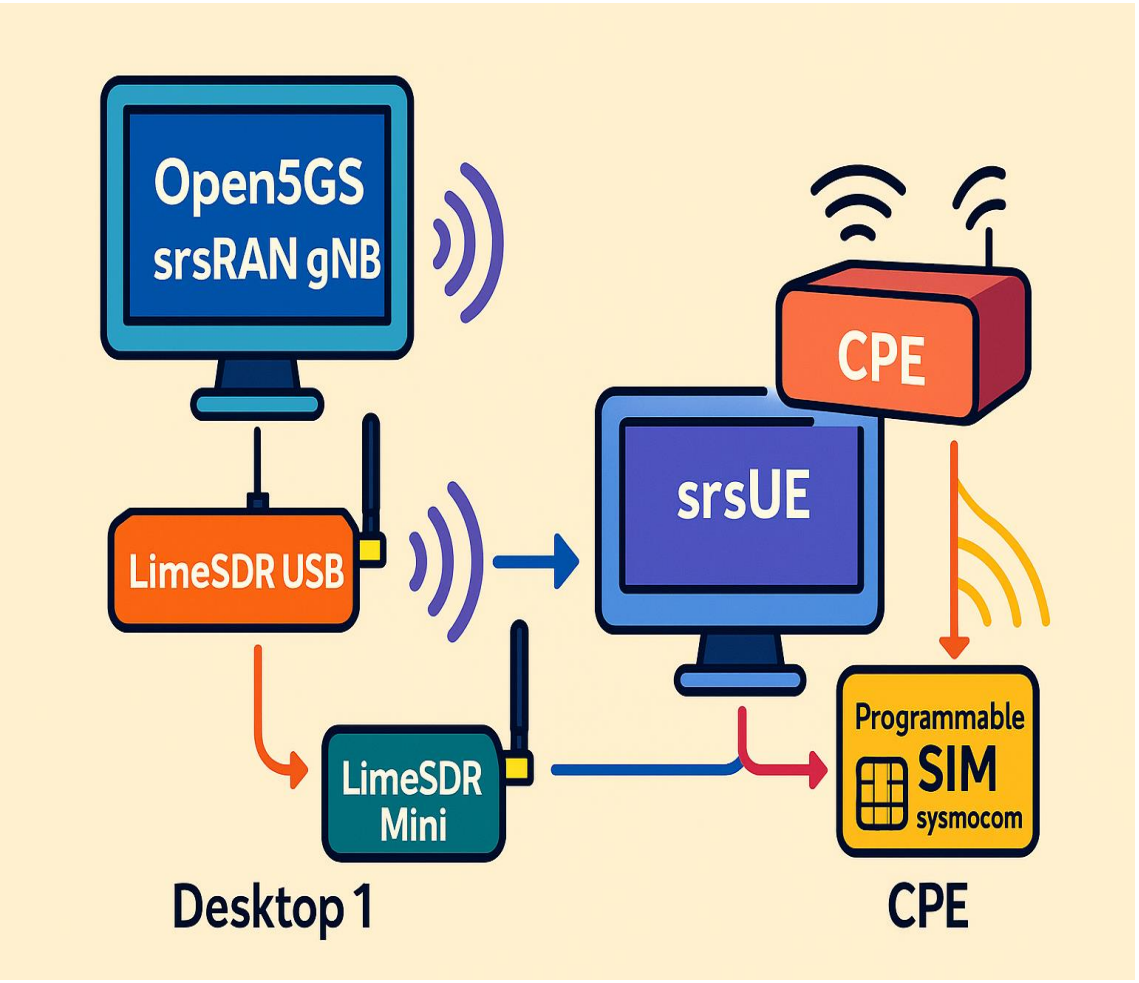
in real time environment. Cost effective but cost of radio added. Real SDR present All the solution based on open source following 3GPP.



- Limitations-
- Installation and working based on Command Line create complexity.
- Radio cost involve, recommended radio LIME SDR, B21 etc. market issue.
- Two LIME SDR or USRP board required.

NOTE – Government permission required to setup radio in lab, according to Government of India rule “Generation of radio frequency without authority permission is ILLEGAL”.

4.Build in setup with SDR(radio) and Programmable Sim card



- Benefits-
- 5G Core ,RAN(with SDR) , UE(Connect with smart phone or CPE device) , all can be built in different or same machine and connected with radio and programable sim card.
- Build in solutions is NOT virtual ,They run with binary files and radio .
- Private 5G network work with Local LAN with radio inside lab.
- UE can connect Lab 5G radio by smart phone and CPE device through programable sim card.
- Good for researcher and startup to test applications

in real time environment. Cost effective but cost of radio and programable sim card added. Real SDR and Sim card present All the solution based on open source following 3GPP standard.

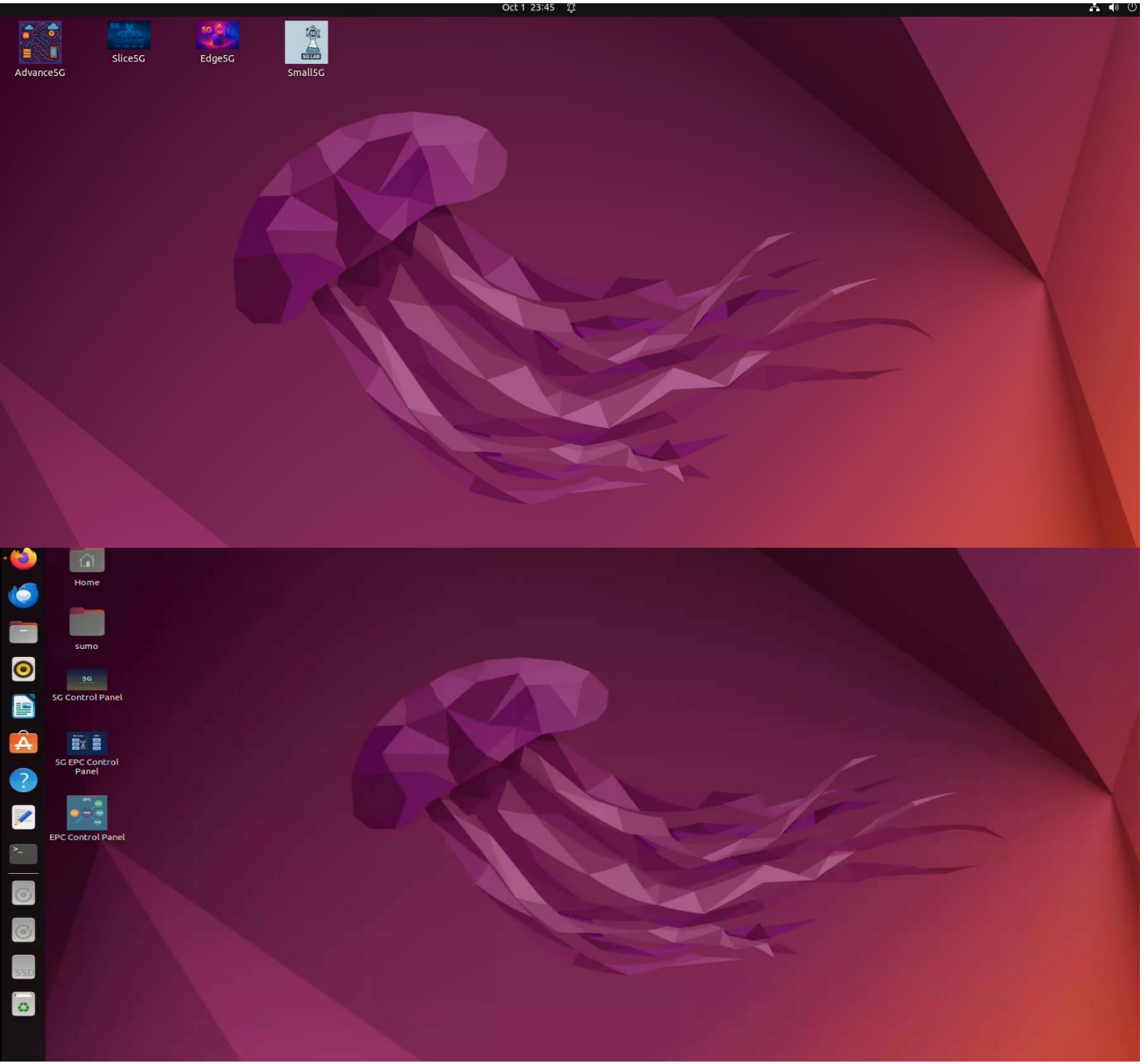
- Limitations-
- Installation and working based on Command Line create complexity.
- Radio cost involve, recommended radio LIME SDR, B21 etc. market issue.
- Cost of programable Sim card also added.

NOTE – Government permission required to setup radio and use of programable sim card in lab, according to Government of India rule “Generation of radio frequency and use of programable sim card without authority permission is ILLEGAL”.

5.Full Scale 5G Lab

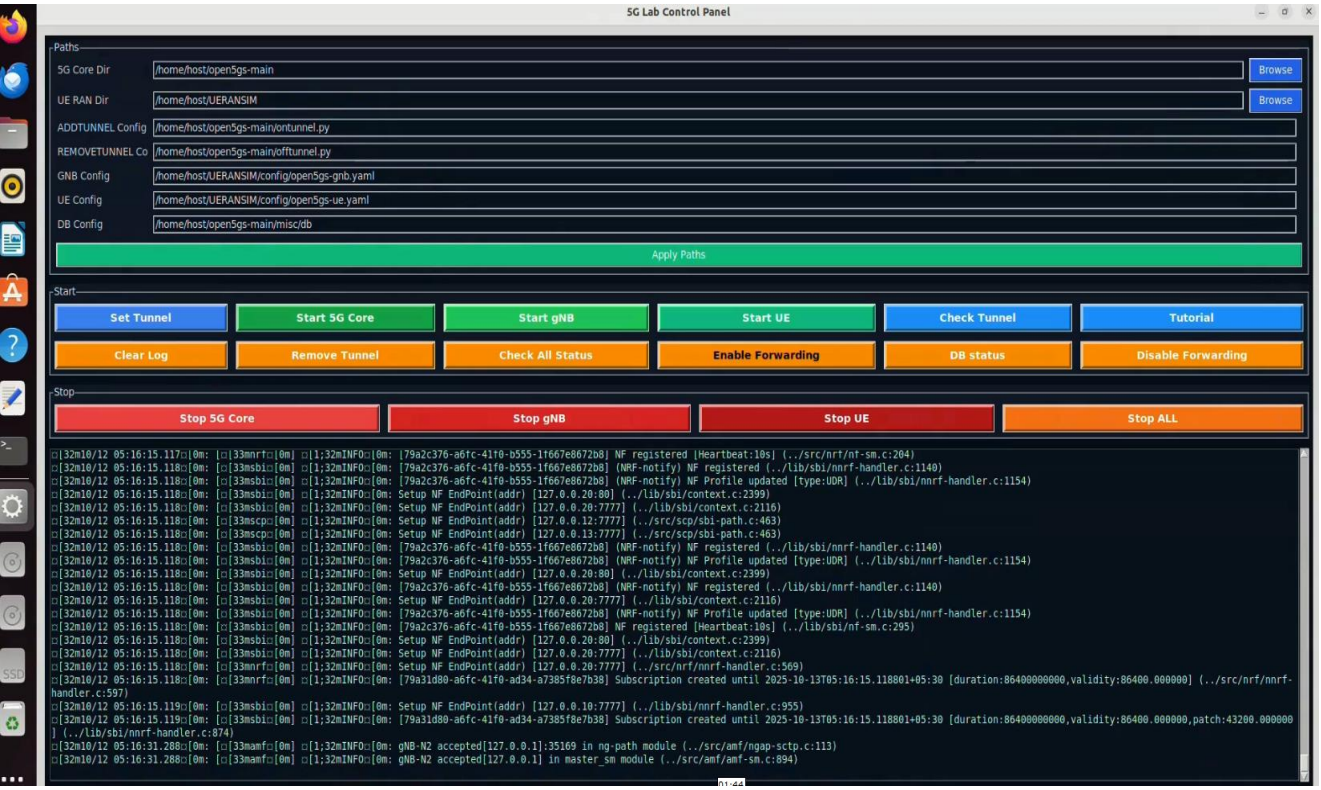
- Govt of India initiative Bhart 5G Lab see URL
- https://www.bharat5glabs.gov.in/main
- **What is Bharat 5G Labs?**
- **Bharat5GLabs** is a national initiative by the Government of India to set up **100 5G use case labs** across academic institutions. The goal is to foster R&D, innovation, and hands-on development of 5G and beyond (6G) technologies, especially in academic, startup, and student communities
- All the labs are connected through a centralized portal (the Bharat 5G Portal), which acts as a knowledge sharing, coordination, and resource platform.
- Supported organization CDOT ,CDAC ,IIT DELHI etc to build use case lab
- Wireless 4 Scale Laboratory Pvt Ltd (IITD startup) ,
- https://ios-mcn.org/ they building Indian repository to Indian 5G core setup

5G Desktop Lab: my proposed solutions

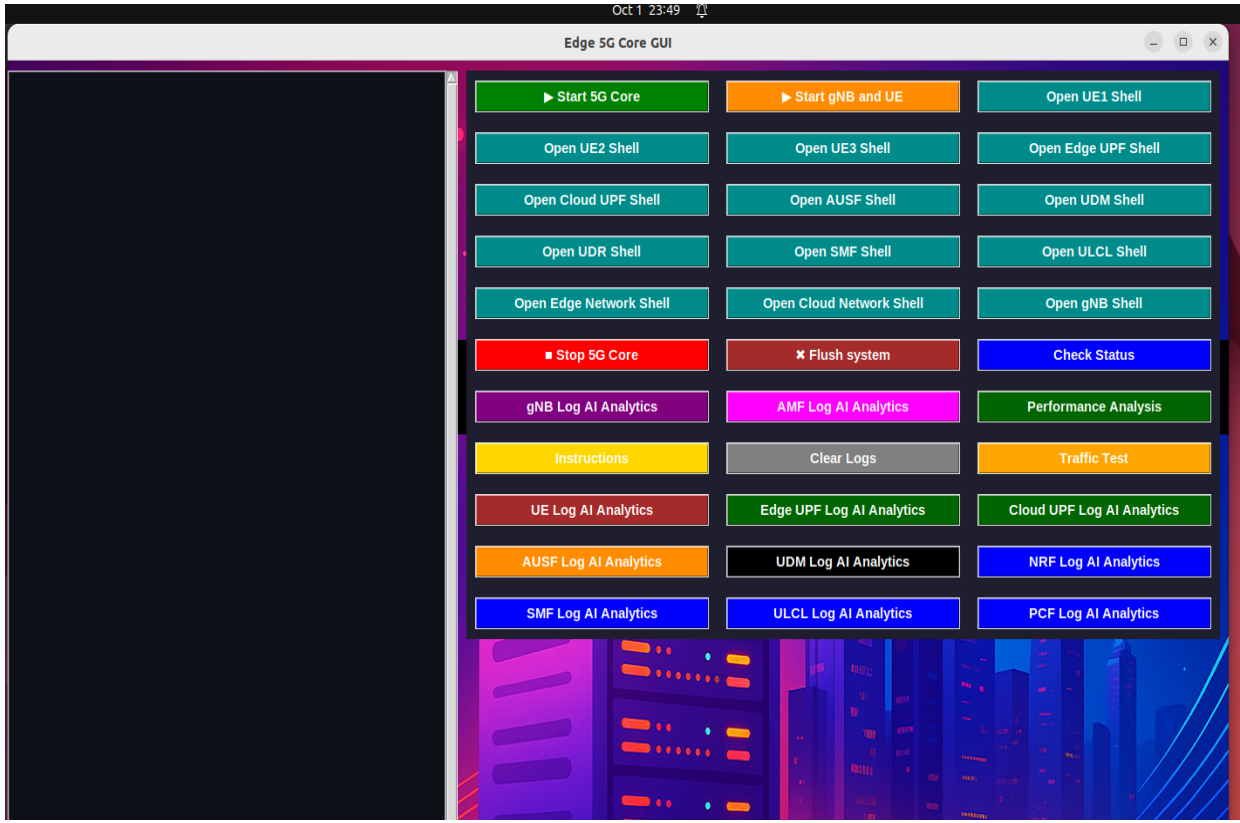


- 5G Desktop Lab is solution to setup 5G virtual ,build and radio environment inside desktop or laptop with desktop icons and easy GUI.
- Start in single click ,emerged with monitor tool and AI Log analysis
- Desktop lab in institute helps to easy working of 5G etc.
- Integrated with Different Use cases.
- Low cost and portable solution.
- Tutorials and troubleshooting with GUI dash board.
- Remove Installation and working of Command Line create complexity.

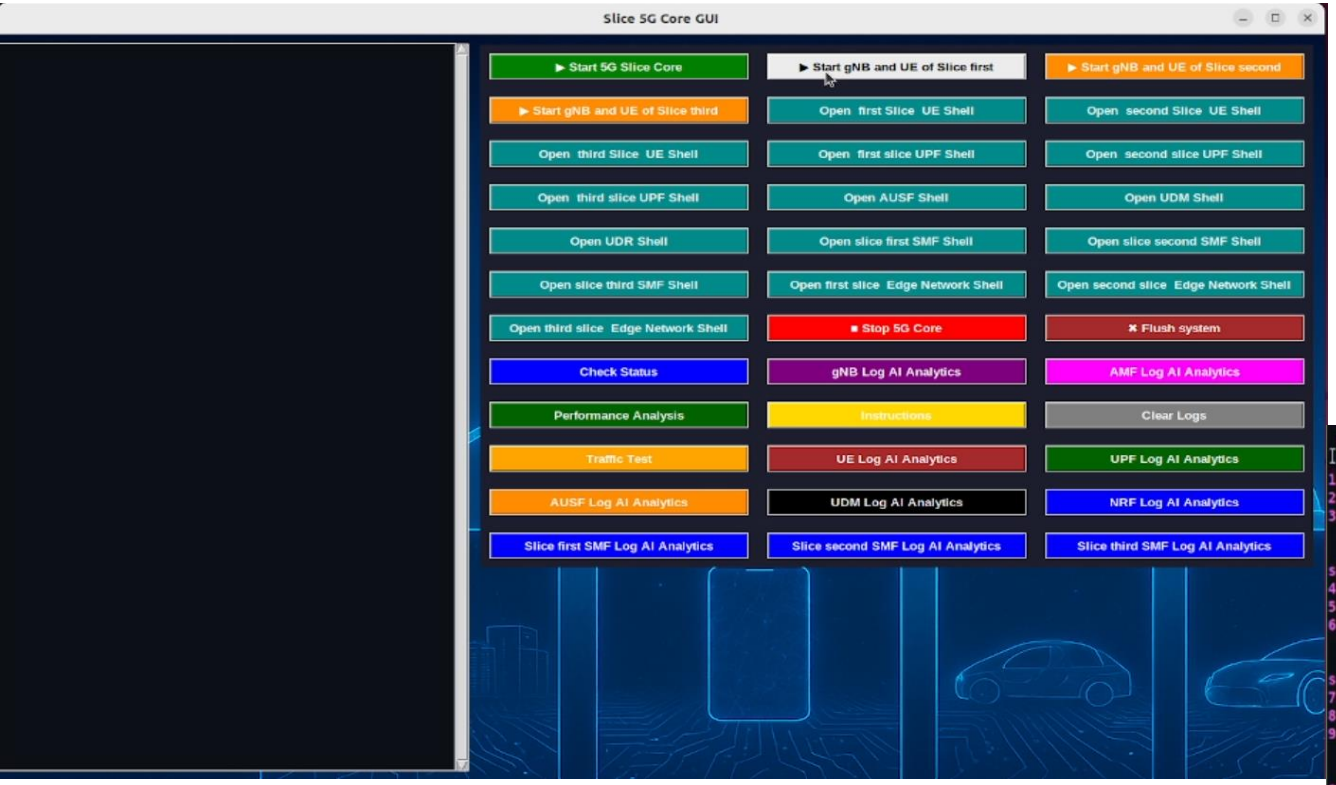
EASY GUI



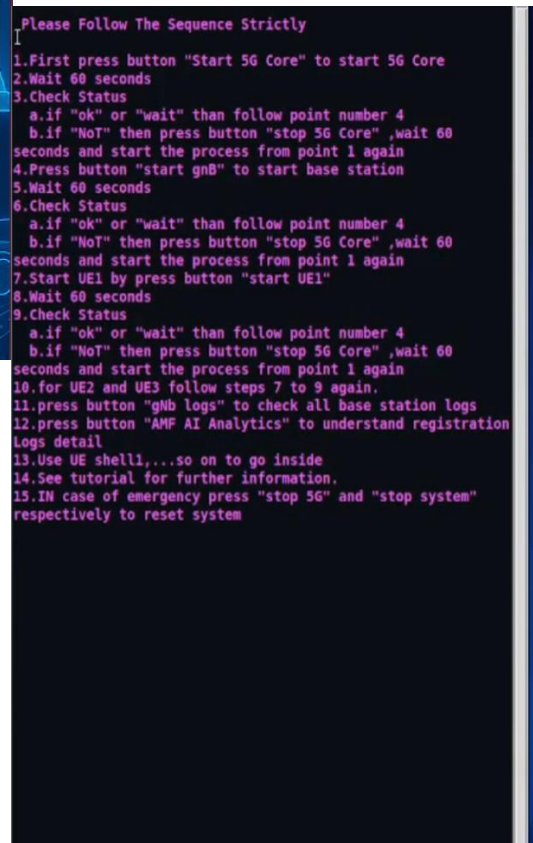
Easy GUI Helps to easy use
Attached with Monitor tool and AI Log analysis

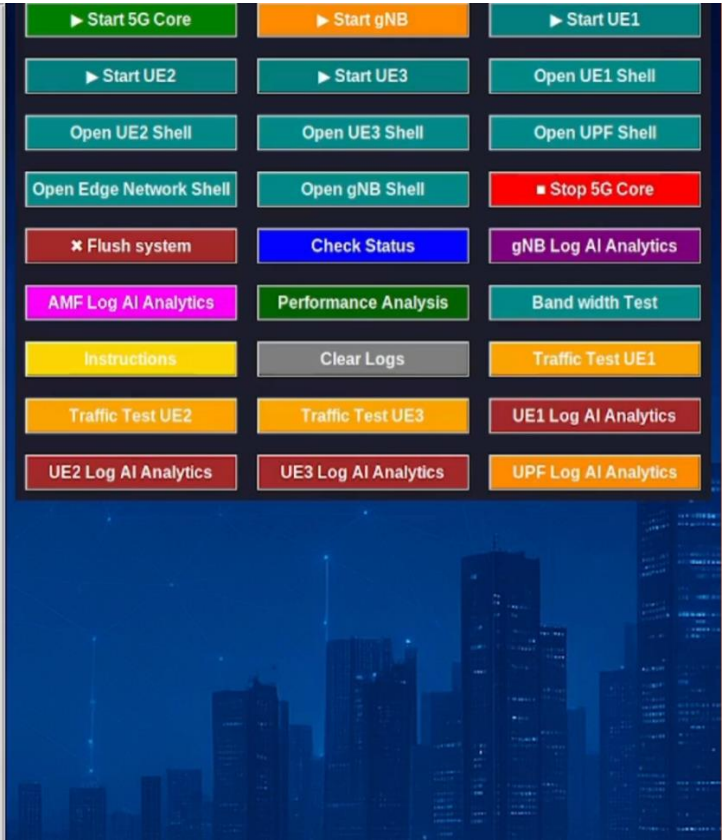


EASY GUI



Easy GUI Helps to easy use
Attached with Monitor tool and AI Log analysis





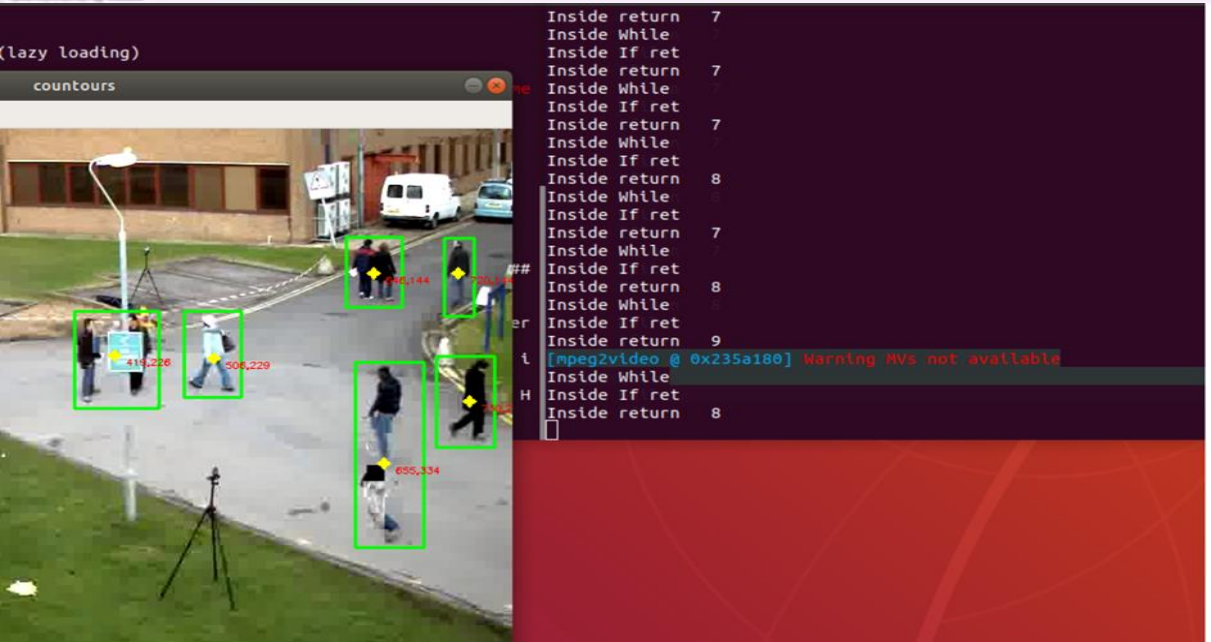
5G Desktop Design with…

Setup Name	5G Components	Remarks
Small 5G	AMF, SMF, NRF, UPF (basic), Single gNB, 3 UEs, External Data Network	Minimal component design using Docker. Easy to use with GUI. Suitable for beginners. Includes AI-based log analysis, network testing, and monitoring tools.
Advanced 5G	AMF, SMF, NRF, PCF, AUSF, UDM, UDR, UPF (advanced), 1 gNB, 5 UEs, External Data Network	More comprehensive 5G component design using Docker. Easy to use with GUI. Suitable for advanced learners. Includes AI-based log analysis and network testing.
Slice 5G	Three network slices with individual UPF, SMF, NRF. Common components: AMF, PCF, AUSF, UDM, UDR. Dedicated gNB and UE per slice (scalable). External Data Network for each slice.	Slice-based 5G design with Docker. Easy to use with GUI. Useful for researchers and students exploring network slicing. Includes AI-based log analysis, network testing, and monitoring tools.
Edge 5G	Edge and Cloud UPFs with uplink classifier, plus AMF, SMF, NRF, PCF, AUSF, UDM, UDR. Single gNB, multiple UEs. Dedicated cloud and edge data networks.	Edge network design with Docker. Easy to use with GUI. Useful for researchers and students studying edge computing. Includes AI-based log analysis, network testing, and monitoring tools.
Physical 5G (without SDR)	Build files (non-virtual binaries) for 5G Core, EPC (4G/5G), gNB, and multiple UEs. Integrated edge network based on standard use cases.	Alternative to SDR-based 5G. Good for application testing, performance analysis, and private network design.
Physical 5G (with SDR)	Build files (non-virtual binaries) for 5G Core, EPC (4G/5G), gNB, and multiple UEs. Connects with SDR hardware (USRP, LimeSDR). Integrated edge network based on standard use cases.	Lab-scale private 5G with real radio and edge computing. Good for application testing, analysis, and realistic network evaluation.
Full-Scale 5G Environment	Full-scale 5G with MIMO, rack servers, smartphones, and CPE devices. Private 5G with real radio and edge computing.	Suitable for enterprise/private lab deployments. Enables full-scale application testing, analysis, and real-world cellular environment experiments.

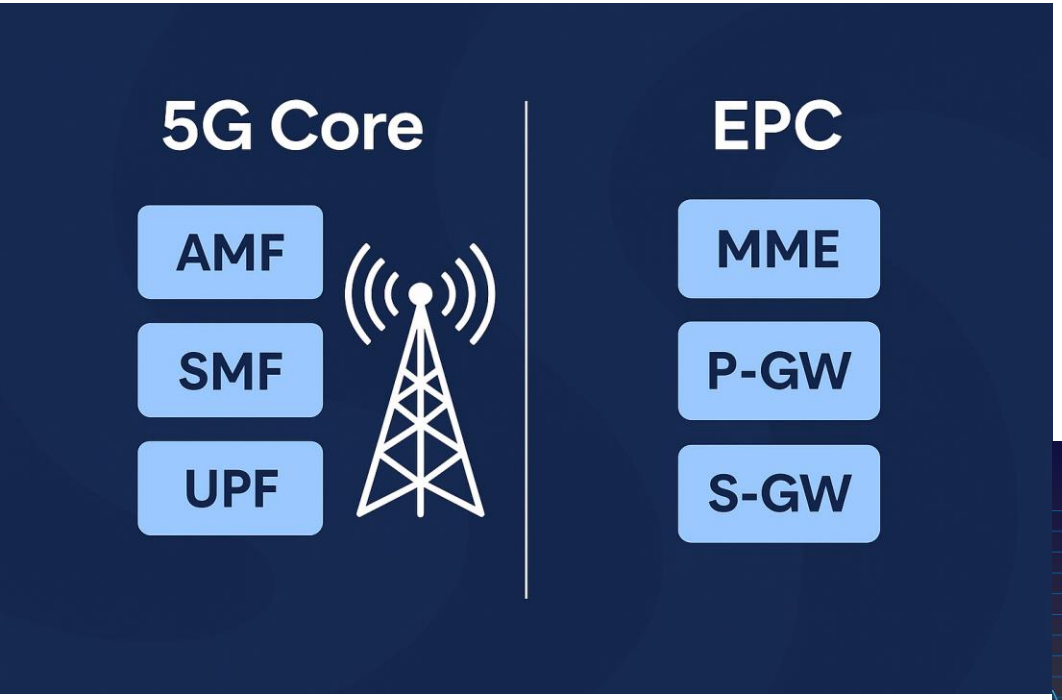
USE CASE

V2X vehicular communication With SUMO .

Traffic Simulations with 5G and Edge



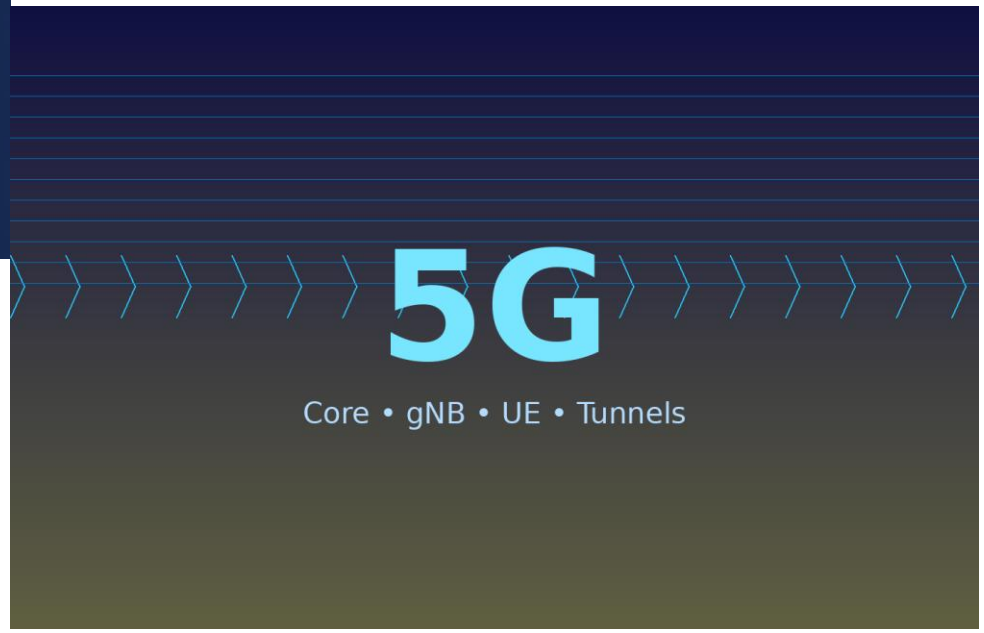
Video analytics with 5G and Edge



DEMO LINK

https://www.youtube.com/watch?v=7rR3TRZAUGQ&t=55s

https://www.youtube.com/watch?v=WkIymK58qyY



Visit my channel in YouTube :-
@FutureLabswith5GandBeyond

Mail me for more details :-
unlocking5gandbeyond@zohomail.in,
setup.shasha@gmail.com