Rapid5GS

Rapid5GS & The Open5GS Project

Building Your Own LTE Core

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Why are we talking about this?

1. There's an ever-growing demand for resilient and locally controlled wireless infrastructure.
2. LTE/5G are mature, secure, hardened, and economical wireless standards. They are perfect for serving users and devices in the rural broadband, medical iot, military, utility context and more.
3. Traditionally, deployment of these networks has required substantial cellular expertise, complicated/expensive software, and hard-to-get domain knowledge for basic deployment.
4. Deployment of the packet core has historically been one of the most complicated parts of an LTE/5G deployment.

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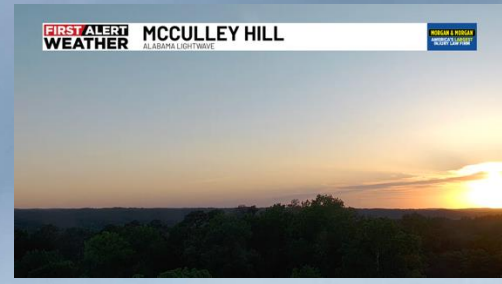
Why not just deploy wi-fi?

LTE / 5G Delivers Benefits Like

1. Coverage range
2. Device density
3. Mobility & handoff
4. Licensed spectrum (CBRS)
5. SIM-based security and control

Every Tool In The Toolbox

In areas already served by cellular LTE coverage, high-capacity fixed wireless deployments like this Mimosa microcell on McCulley Hill paired with a WBRC weather camera remain a practical solution for dense customer clusters or bandwidth-heavy needs. Not every site requires an LTE core—this is where Wi-Fi or 5GHz FWA still plays a valuable role.



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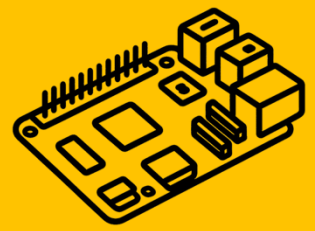
So what is an LTE/5G Network?

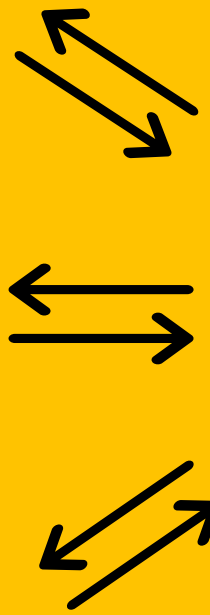
1. EPC = Enhanced Packet Core (Like Open5GS!)
2. RAN = Radio Access Network
3. UE = User Equipment

UE / Smartphone

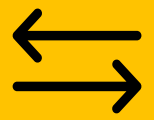
UE / Broadband CPE

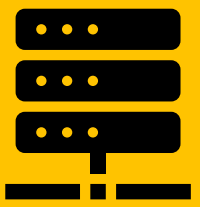


UE / IOT Device

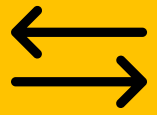


eNodeB (LTE) / gNodeB (5G) RAN





EPC / 5GC



WAN / INTERNET

These components are interchangeable across brands.

That's part of the LTE/5G magic!

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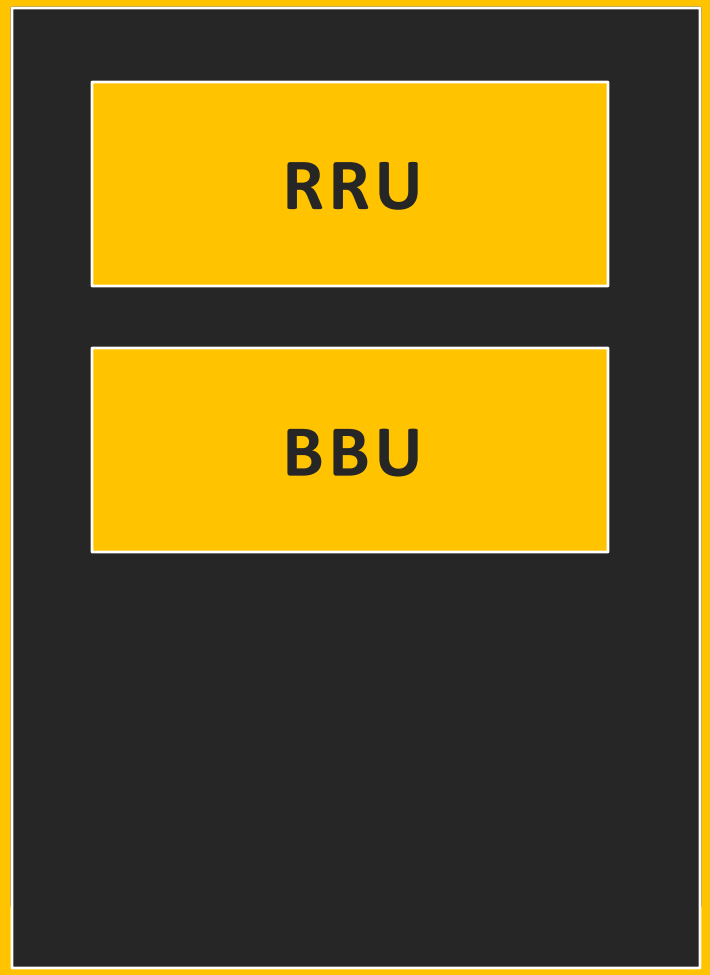
RAN 5G

What is RAN?

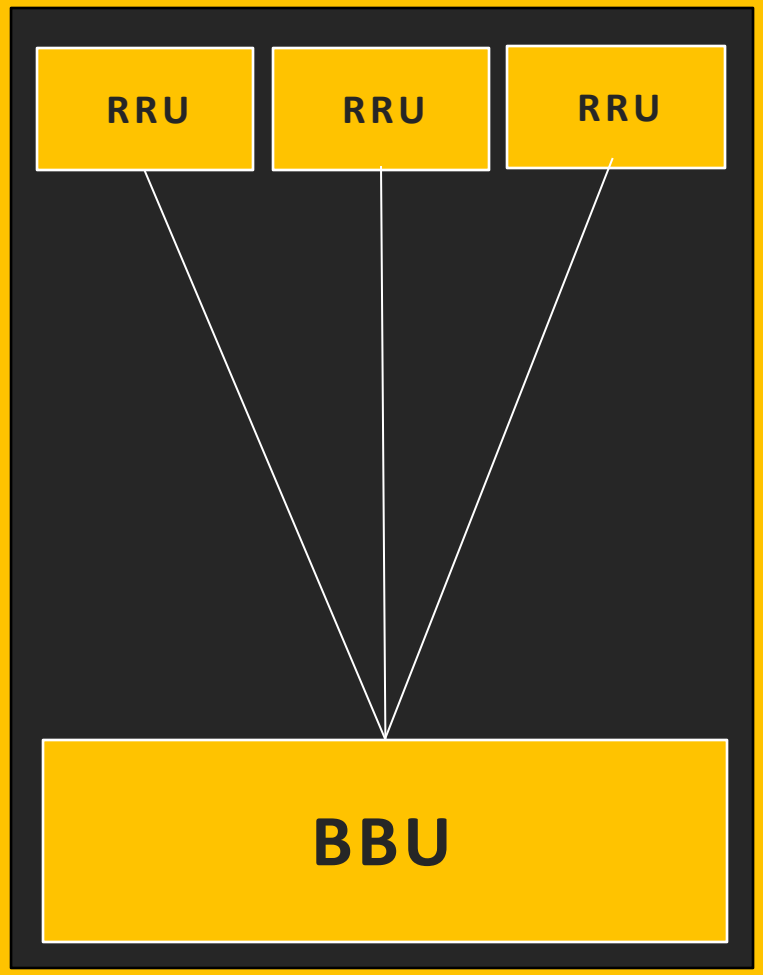
The RAN is the part of the mobile network that connects user devices to the core network using radio signals.

1. **RAN = Radio Access Network**
2. **eNodeB = evolved Node Base Station**
3. **RRU/RRH = Remote-Radio Unit/Head**
4. **BBU = Base-Band Unit**

eNB Example #1, Baicells



eNB Example #2, Nokia



Radio Transmission – Manages uplink/downlink signals, power control, and antenna technologies (e.g., MIMO)

Resource Scheduling – Dynamically allocates time/frequency radio resources to users

Mobility Management – Performs intra-LTE handovers and coordinates UE transitions between neighboring cells

Channel Setup – Configures physical/logical RF channels for data transfer

Performance Monitoring – Collects signal metrics, detects radio link failures, and supports self-optimization

Interface Management – Coordinates with other eNodeBs via X2 and connects to the core network over S1

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LTE Small Cell

Baicells 430

RAN Example #1

The BBU and RRU functions are integrated into a single device. No external controller. Cabinet electronics limited to power and basic networking functions.

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LTE Macro Site
Nokia AZQC

RAN Example #2

In this example, the BBU and RRU functions are split. The BBU lives in the compound at the base of the tower site. This specific site has three RRUs, one for each 120-degree section of coverage on this tower. **This makes up one complete eNB in the network.**

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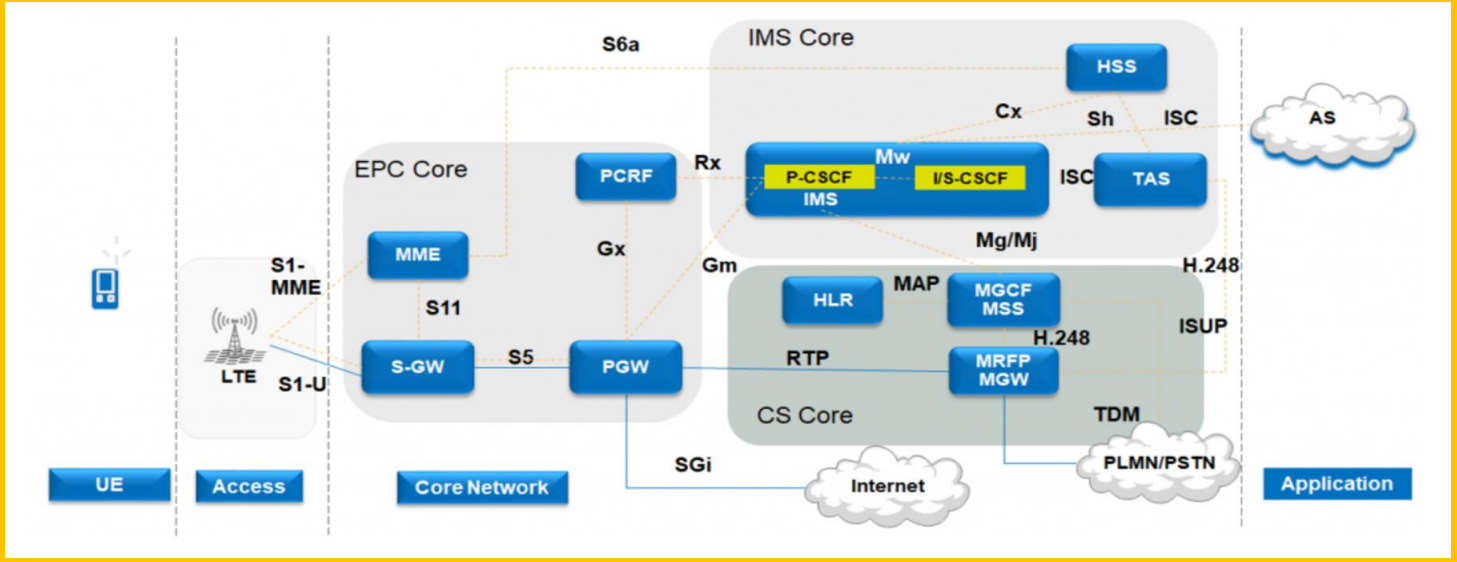
Core Introduction

The Evolved Packet Core (EPC) is the heart of the LTE network — it manages data sessions, subscriber mobility, authentication, and connectivity to the internet.
Every LTE connection flows through the EPC, which intelligently routes traffic, enforces policies, and ensures secure, seamless service for users on the move.



LTE can get complicated quickly! This diagram shows example EPC architecture for a mature packet core network that fully supports voice and data functions. For a basic core deployment though, you won't need to customize plumbing or configuration of these with Rapid5GS.

MME, Mobility Management Entity – Handles UE registration, authentication, and mobility. Coordinates handovers in conjunction with eNodeBs. It's the brain of the control plane.

SGW, Serving Gateway - Routes and forwards user data between the eNodeB and the Packet Gateway (PGW). Acts as the anchor during handovers.

PGW, Packet Data Network Gateway - Connects users to external IP networks (internet or private). Handles IP address allocation, QoS, and policy enforcement.

PCRF, Policy and Charging Rules Function - Applies QoS rules and charging policies based on the user's plan and network conditions.

HSS = Home Subscriber Server - Central database for user profiles, authentication, and service permissions (like SIM verification).

Interfaces: S1, S5, S11, SGi, etc. - The EPC communicates using standardized interfaces to connect the RAN, core, and external networks.

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What is Open5GS?

1. Open-source LTE/5GC core written in C
2. Modular, high-quality codebase
3. Implements all major LTE/5G core components: MME, SGW, PGW, HSS, PCRF, AMF, SMF, and more.
4. Maintained and widely used in labs, testbeds, and production

LEARN MORE

www.open5gs.org

Open5GS

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What is Rapid5GS?

🛠️ **Built for Fixed Wireless and Private LTE Operators**
Designed to help small ISPs, community networks, and edge lab deployments bring LTE/5G core networks online **quickly and reliably**.

⚙️ **Zero-Hassle Installation**
A **single-line install command** sets up a full EPC/5GC core — including networking, web interface, and logging — in minutes.

💻 **Runs on Commodity Hardware**
Works out-of-the-box on a **mini PC with two NICs** and minimal system resources. No special hardware or cloud services needed.

🌐 **Automatic Network Configuration**
Rapid5GS handles **IP allocation, NAT, routing tables**, and system tuning so you don't have to.

🚀 **Instant Core Network with Open5GS**
Installs and configures Open5GS with sensible defaults — ready to connect to your eNodeB immediately.

🧪 **Ideal for Labs, Testbeds, and Real-World Deployments**
Whether you're testing in a lab or delivering production LTE service, Rapid5GS gets you online faster.

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One-Liner Install

Rapid5GS makes setting up a core network extremely simple.

Just install Ubuntu 24.04 LTS or Debian 12, run the one-liner install command, and you're up and running.

No manual config files. No iptables rules. No advanced Linux knowledge required. Rapid5GS is one of the closest things to plug-and-play for deploying a distributed LTE/5GNSA core network.

🛠️ Built primarily in Bash, Rapid5GS uses native system utilities to avoid unnecessary dependencies and minimize points of failure.

Ubuntu

debian

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Installation Script (install.sh)

The installation script provides a guided, step-by-step process to set up your Open5GS core network. It handles:

- → Automatic dependency installation and configuration
- → Network interface setup and routing rules
- → Database initialization and configuration
- → Web interface deployment
- → System service configuration
- → Health check setup

Simply run the script with sudo privileges, and it will guide you through the entire installation process with clear prompts and explanations.

install.sh – Your Gateway To LTE/5G

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Control Interface (control.sh)

The control interface provides powerful tools for monitoring and managing your network:

- **EPC Throughput Monitor:** Real-time view of network traffic and performance
- **eNB Status:** Monitor connected base stations and their status
- **UE Status:** Track connected user devices and their activities
- **Live MME Logs:** Real-time monitoring of the Mobility Management Entity
- **Live SMF Logs:** Real-time monitoring of the Session Management Function

This interface makes it easy to monitor your network's health and troubleshoot issues without diving into complex configuration files or logs.

control.sh – Your LTE/5G Core Control Panel

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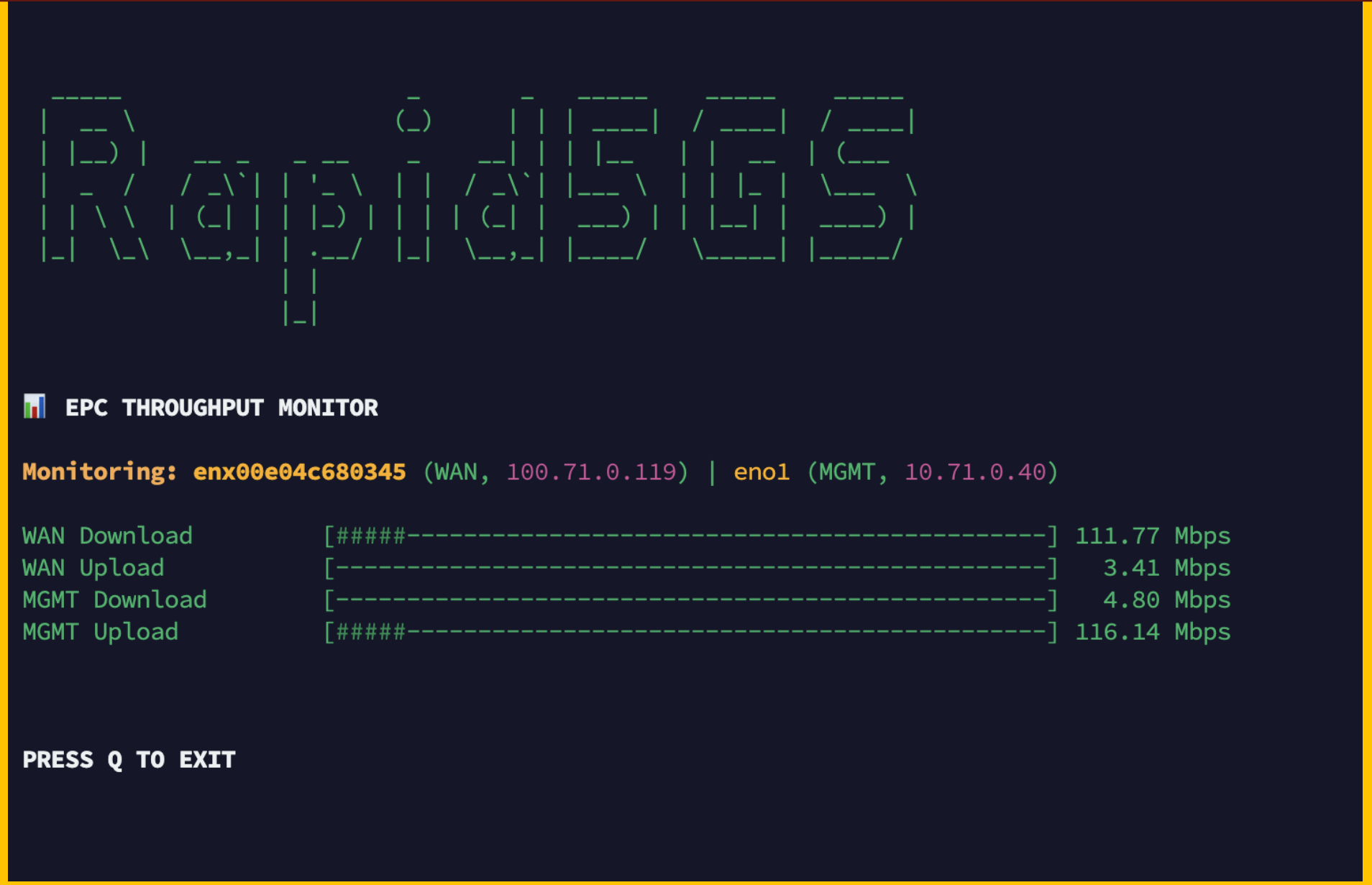

control.sh – EPC Throughput Monitor

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control.sh – EPC Throughput Monitor

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IMSI	STATUS	LAST SEEN	APNs with IPs
901700[redacted]	attached	05/06/25,11:32:24PM	edge (A) (10.99.0.53)
901700[redacted]	attached	05/07/25,12:04:56AM	ue-mgmt (A) (10.99.1.150)
901700[redacted]	attached	05/07/25,12:04:57AM	ue-mgmt (A) (10.99.1.161) 50m (A) (10.99.1.162
901700[redacted]	attached	05/06/25,11:32:22PM	ue-mgmt (A) (10.99.0.24)
901700[redacted]	attached	05/07/25,12:04:56AM	ue-mgmt (A) (10.99.1.158) 50m (A) (10.99.1.159
901700[redacted]	attached	05/06/25,11:32:22PM	edge (A) (10.99.0.31)
901700[redacted]	attached	05/07/25,12:04:56AM	50m (A) (10.99.1.155)
901700[redacted]	attached	05/07/25,12:04:58AM	ue-mgmt (A) (10.99.1.176) 50m (A) (10.99.1.178
901700[redacted]	attached	05/07/25,12:04:58AM	ue-mgmt (A) (10.99.1.177)
901700[redacted]	attached	04/04/25, 9:47:32AM	edge (A) (10.99.0.246) 50m (D) (10.45.0.90) u
901700[redacted]	attached	05/06/25,11:32:23PM	edge (A) (10.99.0.43)
901700[redacted]	attached	05/06/25,11:32:21PM	50m (A) (10.99.0.8) ue-mgmt (A) (10.99.0.12)
901700[redacted]	attached	04/04/25, 9:47:28AM	ue-mgmt (A) (10.99.0.189) 50m (A) (10.99.0.196
901700[redacted]	attached	05/07/25,12:04:57AM	ue-mgmt (A) (10.99.1.166) 50m (A) (10.99.1.167
901700[redacted]	attached	05/06/25,11:32:21PM	ue-mgmt (A) (10.99.0.6)
901700[redacted]	attached	05/20/25,10:37:07AM	edge (A) (10.99.1.189) ue-mgmt (A) (10.99.1.19
901700[redacted]	attached	05/07/25,12:04:57AM	ue-mgmt (A) (10.99.1.160) 50m (A) (10.99.1.163
901700[redacted]	attached	04/04/25, 9:47:28AM	edge (A) (10.99.0.188)
901700[redacted]	attached	05/07/25,12:04:58AM	ue-mgmt (A) (10.99.1.172) 50m (A) (10.99.1.173
901700[redacted]	attached	04/04/25, 9:47:28AM	ue-mgmt (A) (10.99.0.182) 50m (A) (10.99.0.195
901700[redacted]	attached	05/07/25,12:04:56AM	ue-mgmt (A) (10.99.1.153) 50m (A) (10.99.1.154
901700[redacted]	attached	04/04/25, 9:47:27AM	ue-mgmt (A) (10.99.0.176) 50m (A) (10.99.0.184
901700[redacted]	attached	05/07/25,12:04:57AM	ue-mgmt (A) (10.99.1.164) 50m (A) (10.99.1.165
901700[redacted]	attached	05/07/25,12:04:58AM	ue-mgmt (A) (10.99.1.174) 50m (A) (10.99.1.175
901700[redacted]	attached	05/06/25,11:32:21PM	edge (A) (10.99.0.7) ue-mgmt (A) (10.99.0.13)
901700[redacted]	attached	05/06/25,11:32:23PM	edge (A) (10.99.0.30) ue-mgmt (A) (10.99.0.34)
901700[redacted]	attached	05/07/25,12:04:56AM	ue-mgmt (A) (10.99.1.156) 50m (A) (10.99.1.157
901700[redacted]	attached	05/06/25,11:32:22PM	50m (A) (10.99.0.15) ue-mgmt (A) (10.99.0.25)
901700[redacted]	attached	05/06/25,11:32:22PM	50m (A) (10.99.0.9) ue-mgmt (A) (10.99.0.23)
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901700[redacted]	attached	05/07/25,12:04:57AM	edge (A) (10.99.1.170) ue-mgmt (A) (10.99.1.17
901700[redacted]	attached	05/07/25,12:04:56AM	ue-mgmt (A) (10.99.1.151) 50m (A) (10.99.1.152

PRESS Q TO QUIT, OR R TO REFRESH

control.sh
UE Status Screen

1. See IMSI of attached UE.
2. Is UE attached/detached.
3. When did device first attach (IN A HUMAN FRIENDLY TIMESTAMP!)
4. See IP assigned to APN that UE requested. Can sometimes be more than one as seen here!

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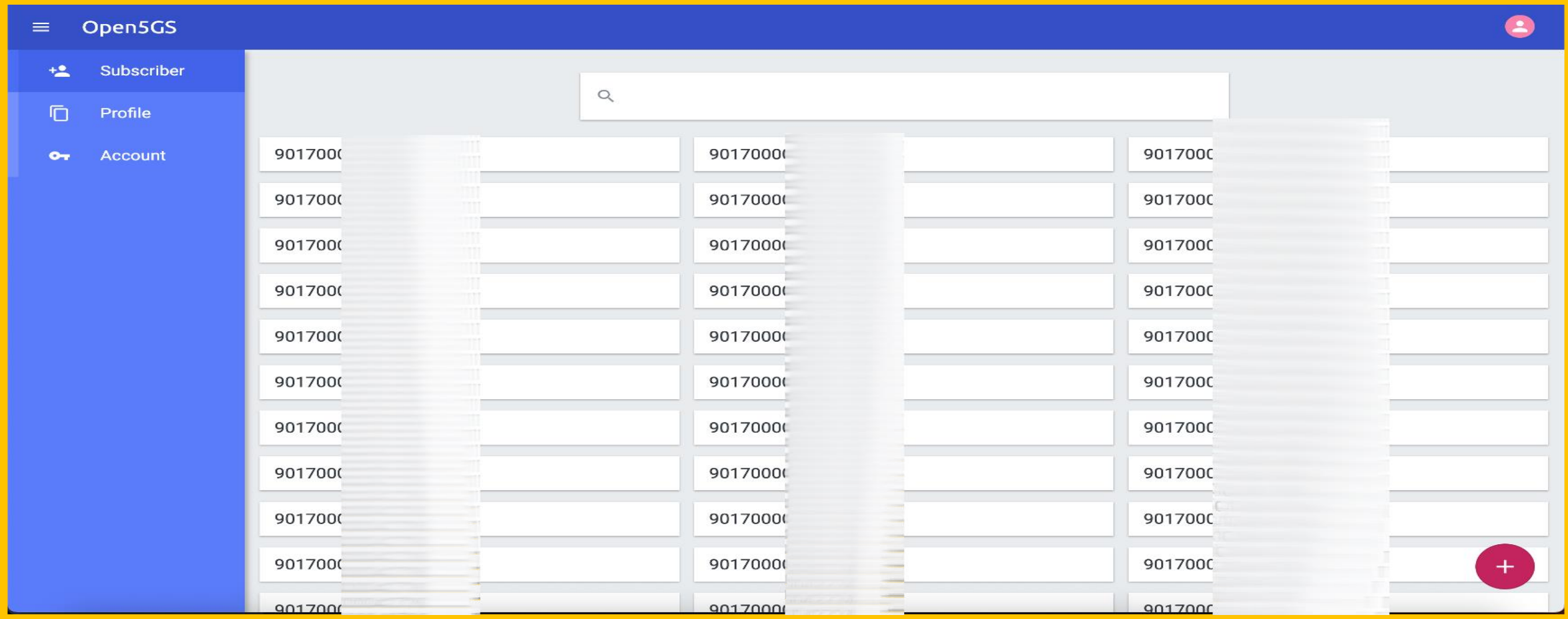
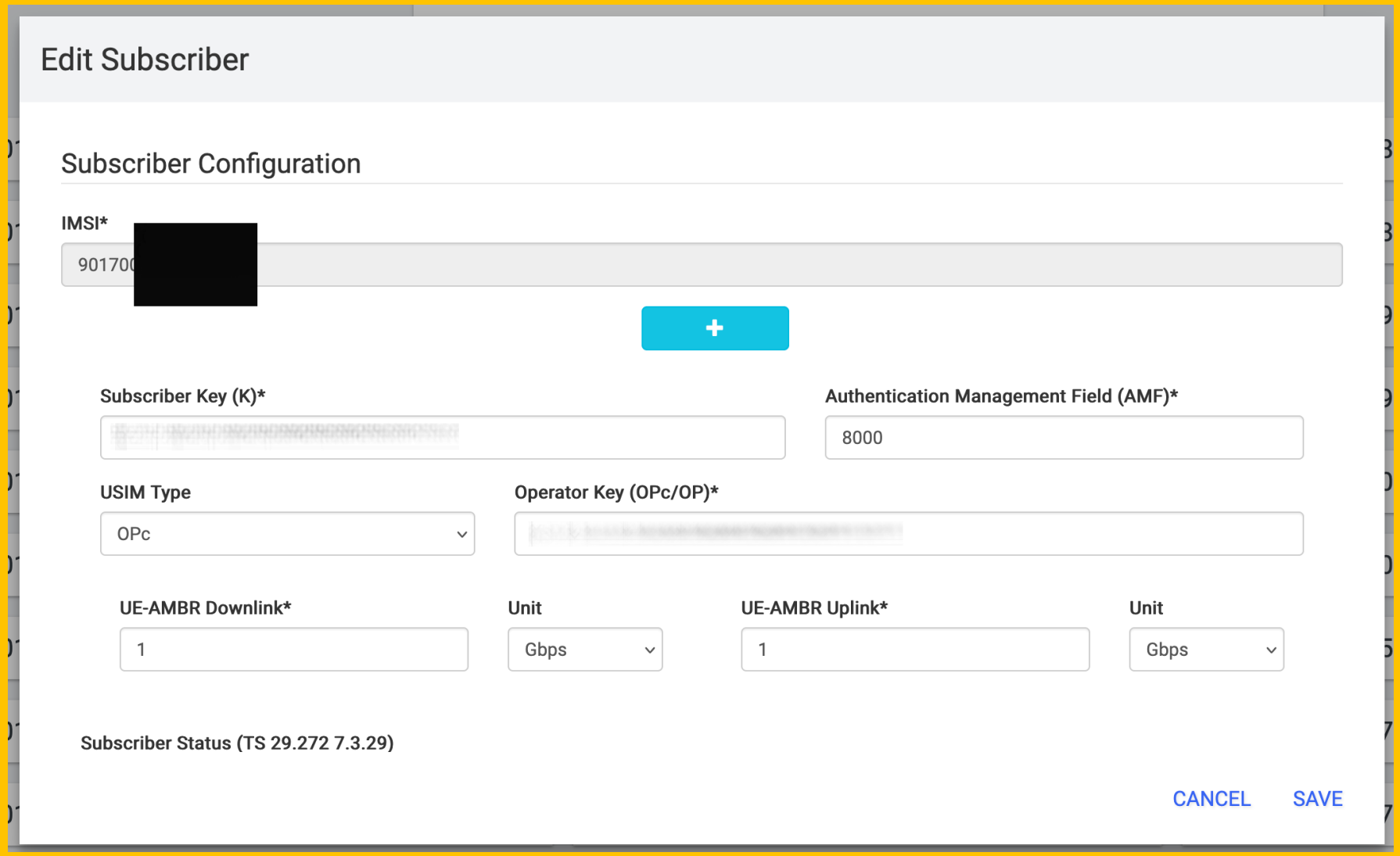
Open5GS HSS Web Control

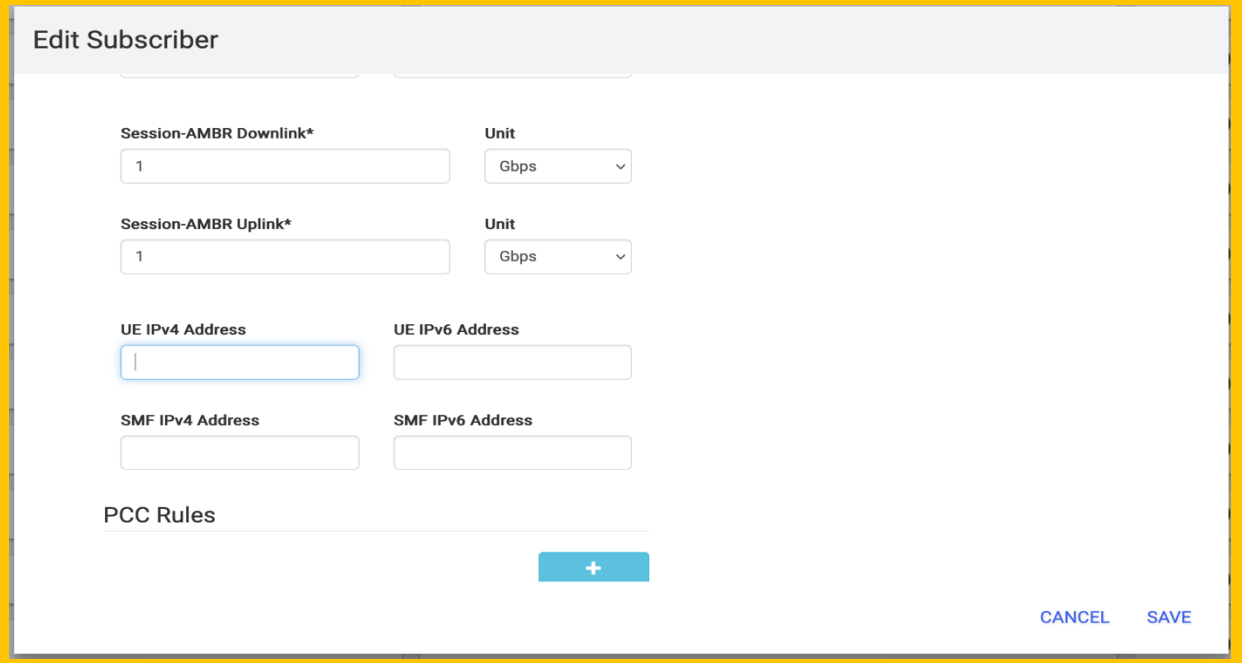


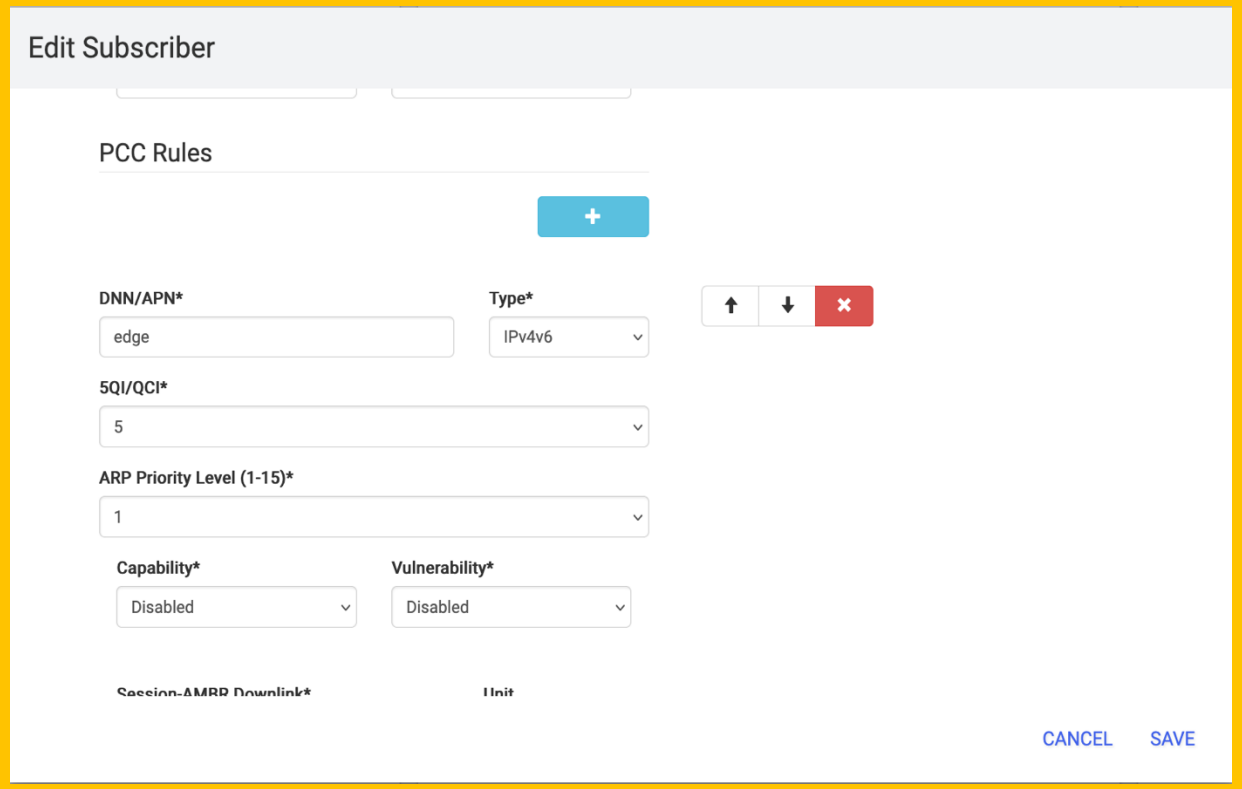
Open5GS HSS Web Control



Open5GS HSS Web Control

You can traffic shape your UE limiting available bandwidth to the subscriber IMSI.





Open5GS also allows you to set numerous APNs to your IMSI with different traffic profiles on each one.

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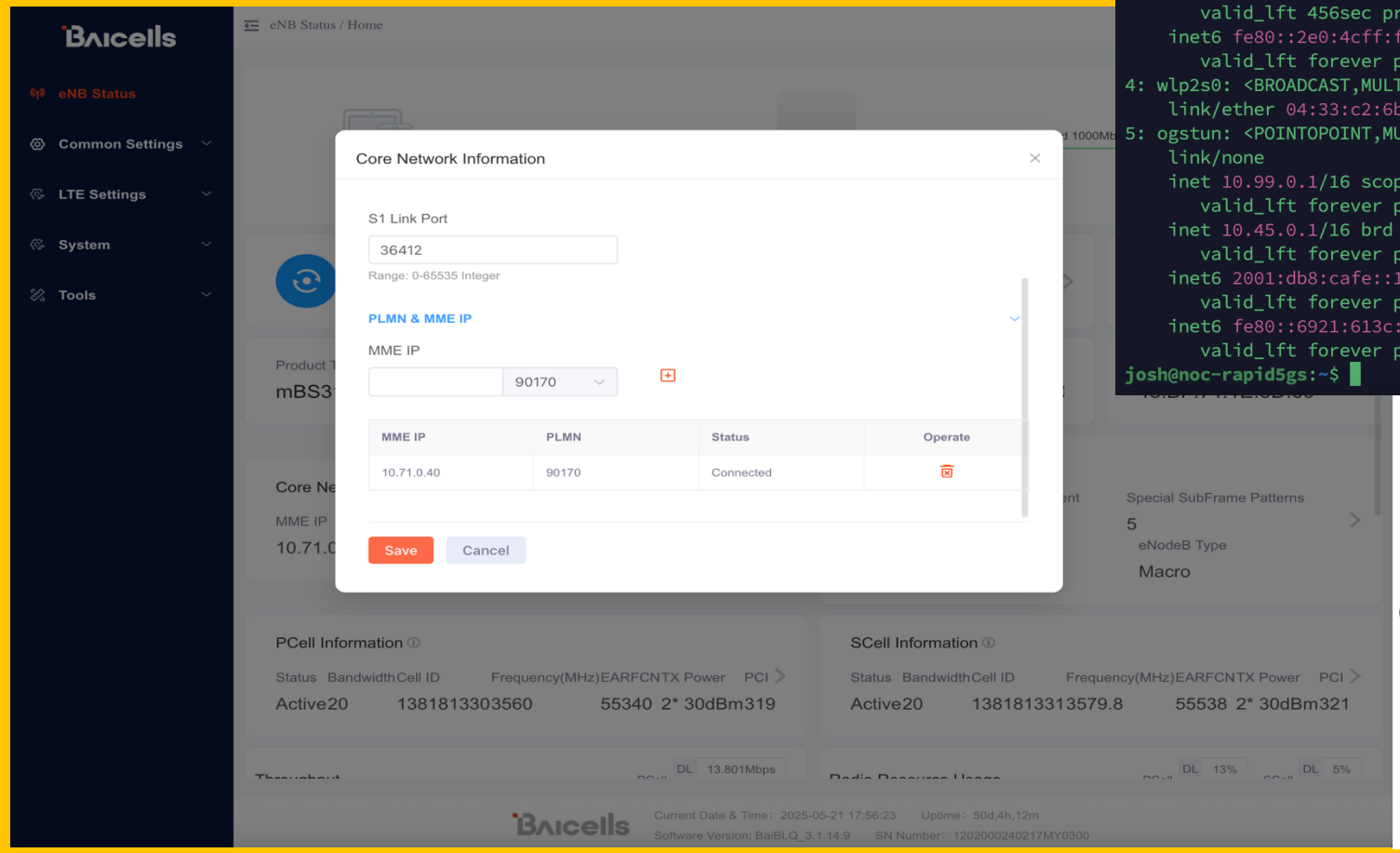
Connecting your first RAN device to Open5GS

```
josh@noc-rapid5gs:~$ ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host noprefixroute
       valid_lft forever preferred_lft forever
2: eno1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether f8:75:a4:44:ed:5a brd ff:ff:ff:ff:ff:ff
    altname enp0s31f6
    inet 10.71.0.40/23 brd 10.71.1.255 scope global eno1
       valid_lft forever preferred_lft forever
    inet6 fe80::fa75:a4ff:fe44:ed5a/64 scope link
       valid_lft forever preferred_lft forever
3: enx00e04c680345: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 00:e0:4c:68:03:45 brd ff:ff:ff:ff:ff:ff
    inet 100.71.0.119/23 brd 100.71.1.255 scope global dynamic enx00e04c680345
       valid_lft 456sec preferred_lft 456sec
    inet6 fe80::2e0:4cff:fe68:345/64 scope link
       valid_lft forever preferred_lft forever
4: wlp2s0: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN group default qlen 1000
    link/ether 04:33:c2:6b:16:6a brd ff:ff:ff:ff:ff:ff
5: ogstun: <POINTOPOINT,MULTICAST,NOARP,UP,LOWER_UP> mtu 1400 qdisc fq_codel state UP group default qlen 500
    link/none
    inet 10.99.0.1/16 scope global ogstun
       valid_lft forever preferred_lft forever
    inet 10.45.0.1/16 brd 10.45.255.255 scope global ogstun
       valid_lft forever preferred_lft forever
    inet6 2001:db8:cafe::1/48 scope global
       valid_lft forever preferred_lft forever
    inet6 fe80::6921:613c:b5f0:4149/64 scope link stable-privacy
       valid_lft forever preferred_lft forever
josh@noc-rapid5gs:~$
```



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Planned For V2

1.) **Support for custom IP pools** defined during the installation process. Right now, everything is FULL NAT on the gateway itself. This will eliminate double-NAT and allow direct assignment of publics to end user devices.

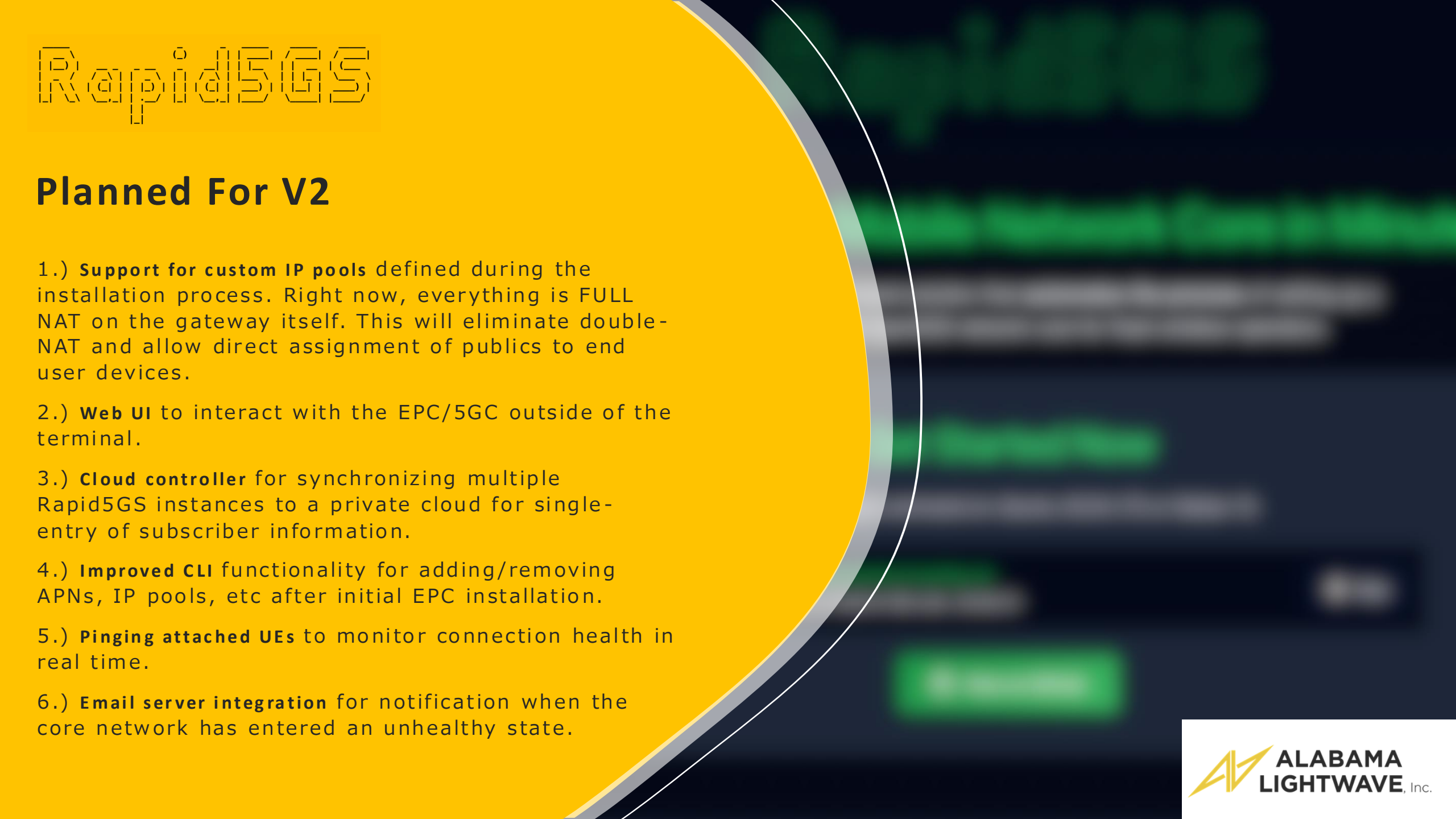
2.) **Web UI** to interact with the EPC/5GC outside of the terminal.

3.) **Cloud controller** for synchronizing multiple Rapid5GS instances to a private cloud for single-entry of subscriber information.

4.) **Improved CLI** functionality for adding/removing APNs, IP pools, etc after initial EPC installation.

5.) **Pinging attached UEs** to monitor connection health in real time.

6.) **Email server integration** for notification when the core network has entered an unhealthy state.



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What hardware do you need for a barebones LTE deployment with Rapid5GS?

Global Telecom Titan 5000

(UE)

Baicells NOVA436Q

(RAN)

KP Performance 65 Degree Sector

(ANTENNA)

Lenovo ThinkCentre M715q

(EPC/5GC)

These are the main things you need for a lab deployment. There's other smaller accessories like jumpers, power supplies, an extra LAN adapter for the EPC/5GC, etc that should be purchased. Do research or ask a consultant before buying a bunch of stuff! :)

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RapidSGS

Why Owning the Core Matters

1. Lower latency, tighter control, and better performance.

2. Operates independently — no need for “the cloud” or internet access.

3. A local core enables a true zero-trust environment — the most secure model.

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Q/A & Resources

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rapid5gs.com

alabamalightwave.com

Let's Build Something Together

- Software Automation
- Network Planning & Deployment
- Marketing Support

JOSH@LAMBERTMAIL.XYZ

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