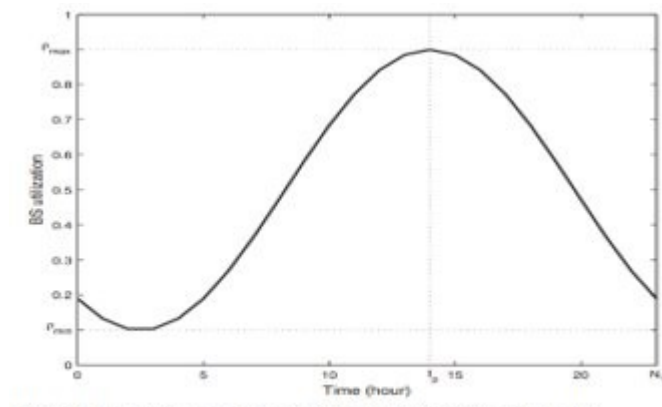


# Energy Saving Use-Cases Operation

## 1. Energy saving with cell utilization:

By monitoring the Base Station (BS) utilization or traffic load over a 24-hour period, the graph illustrates the fluctuations in traffic throughout the day, highlighting periods of both high and low utilization.



This enables us to conserve network energy during periods of low cell utilization. Let us demonstrate how to simulate this scenario using our RIC TaaP tester:

1. Ensure that FlexRIC is running in the background.
2. Set the simulation parameters as follows, then press **Start new** :

IntersideDistanceUEs = 1000      IntersideDistanceCells = 500      N\_UEs = 15

Connect to FlexRIC: (If true, FlexRIC need to be running) ☒

e2TermIp: 127.0.0.1

KPM\_E2functionID: 2      RC\_E2functionID: 3      MmWaveEnbNodes: 15

CenterFrequency (Hz): 3.5e9      Bandwidth (Hz): 20e6      IntersideDistanceUEs (m): 1000      IntersideDistanceCells (m): 500

Status: off      **Start new**      Stop      Reset

Warning: If there are no Cells/UEs on the grid after max 30s, please check if ns3 is running properly typing in terminal "ps -a" or "cat ns-3-mmwave-ora/ns3\_run.log"

**Cell energy states management:**      ES status: off      Turn ES xApp on      Turn ES xApp off

Observe simulation grid      Observe KPIs      Observe ES

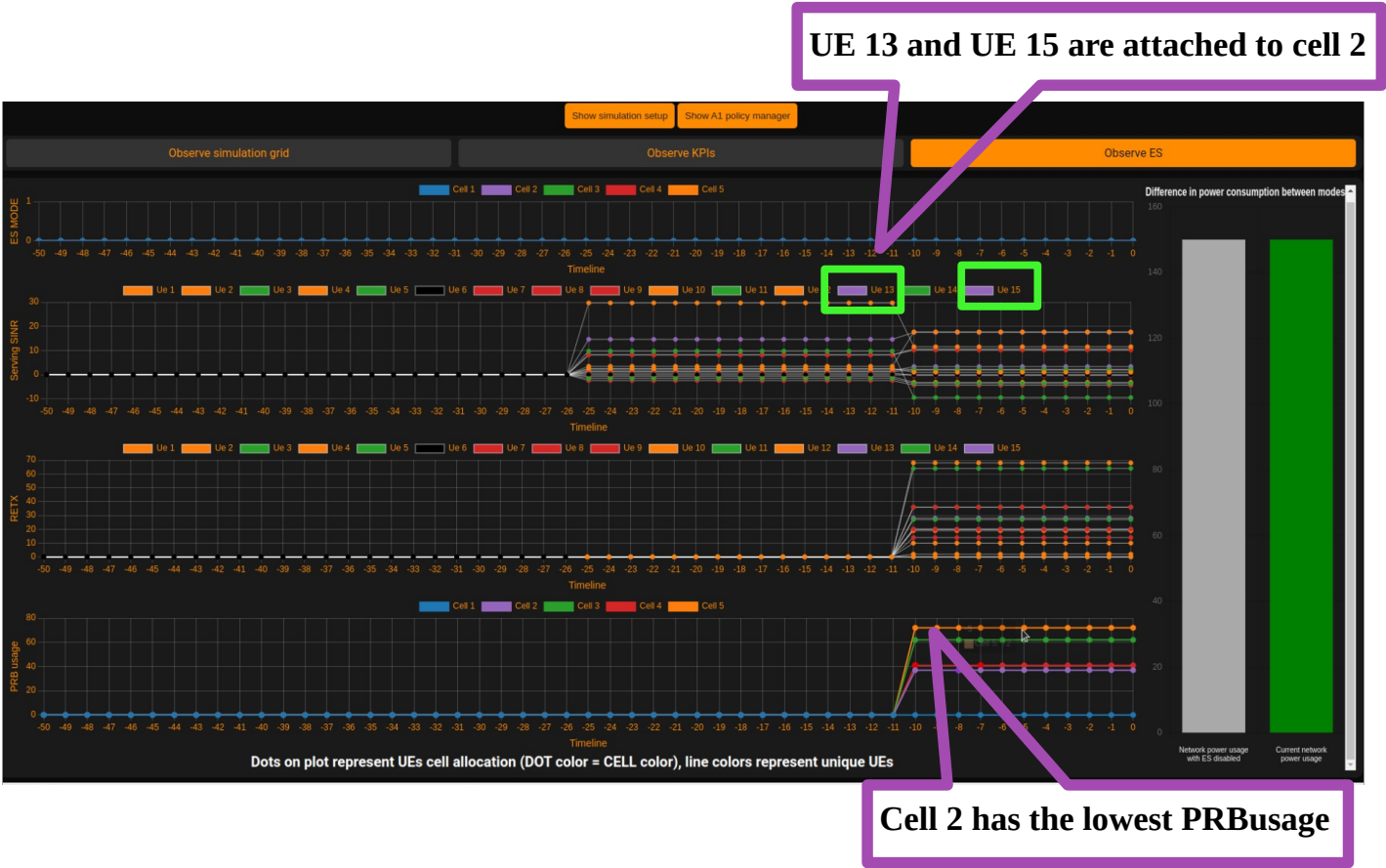
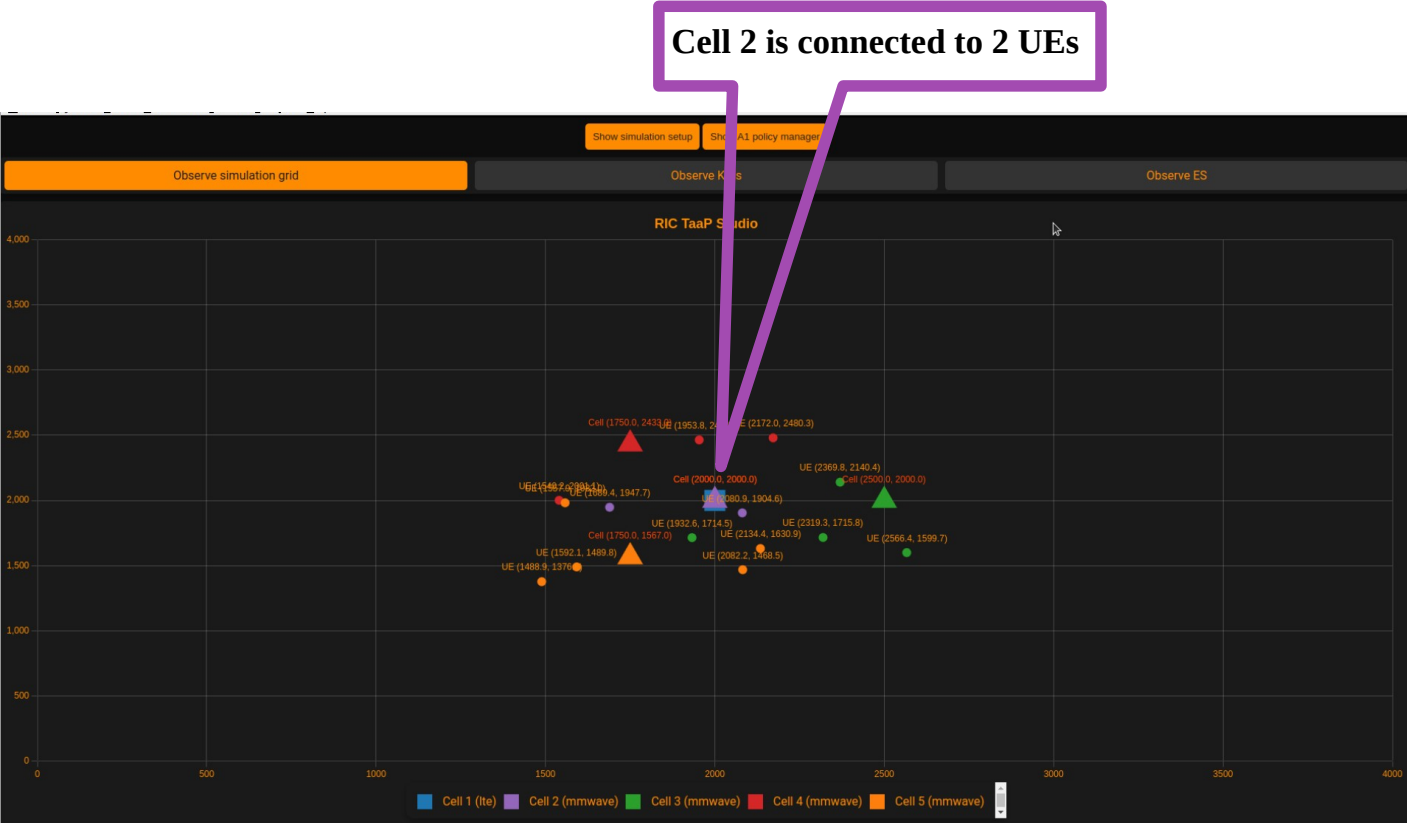
RIC TaaP Studio

1000      2000      3000      4000      5000      6000

**UE Data**      **Cell Data**

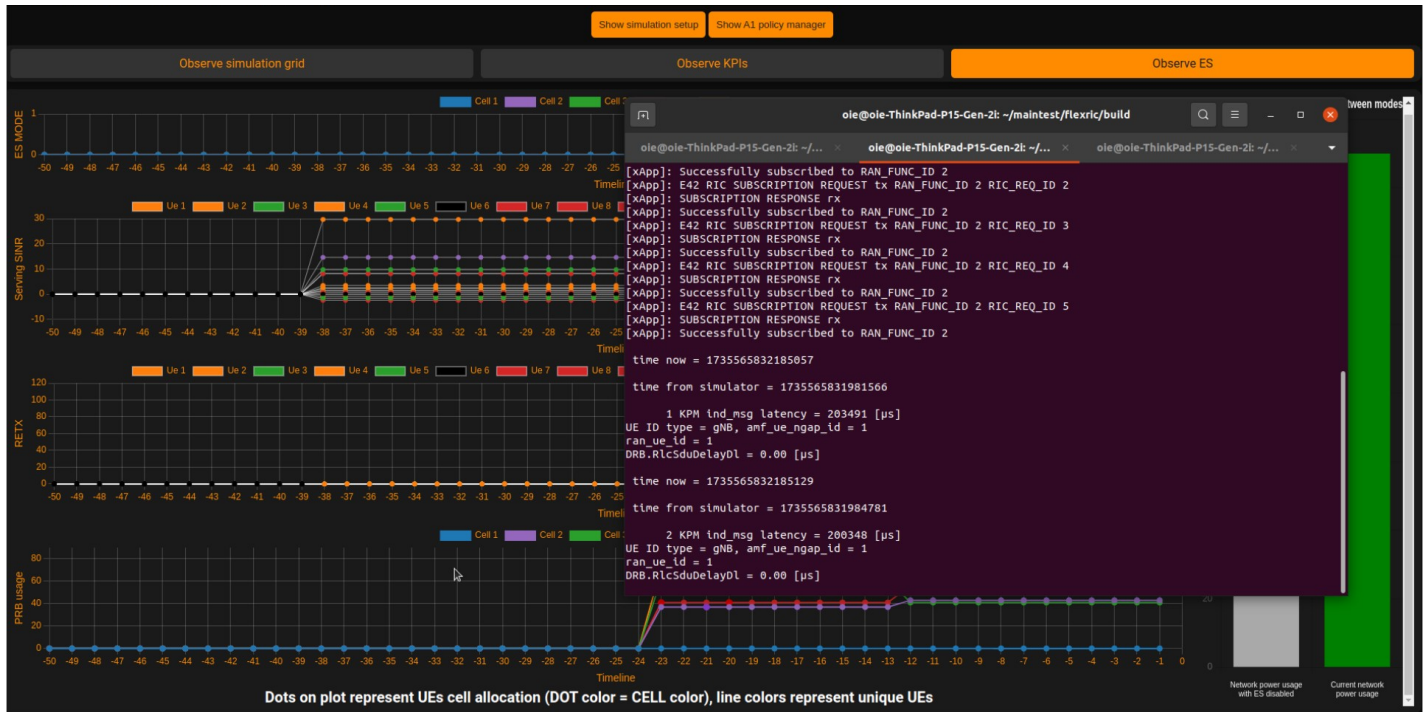
UE Data			Cell Data		
ue_id: 1	ue_id: 2	ue_id: 3	cell_id: 1	cell_id: 2	cell_id: 3
x_position: N/A	x_position: N/A	x_position: N/A	x_position: 2000	x_position: 2000	x_position: 2500
y_position: N/A	y_position: N/A	y_position: N/A	y_position: 2000	y_position: 2000	y_position: 2000
type: N/A	type: N/A	type: N/A	type: lte	type: mmwave	type: mmwave
LTE_Cell: 1	LTE_Cell: 1	LTE_Cell: 1	es_state: 0	es_state: 0	es_state: 0

After the nodes and UEs are running and appear in the simulator, we will observe the following:



3. Run the `xapp_energy_saving_with_CU` by executing the following command in the terminal:

```
./flexric/build/example/xapp/c/ctrl/xapp_energy_saving_with_CU
```



## What is the action of the xApp?

The xApp sends a RIC control message to Cell 2, instructing it to move the two UEs attached to it to the nearest cells and then power it down. Let us demonstrate this action in the following:

**UE 15 is attached to cell 5**

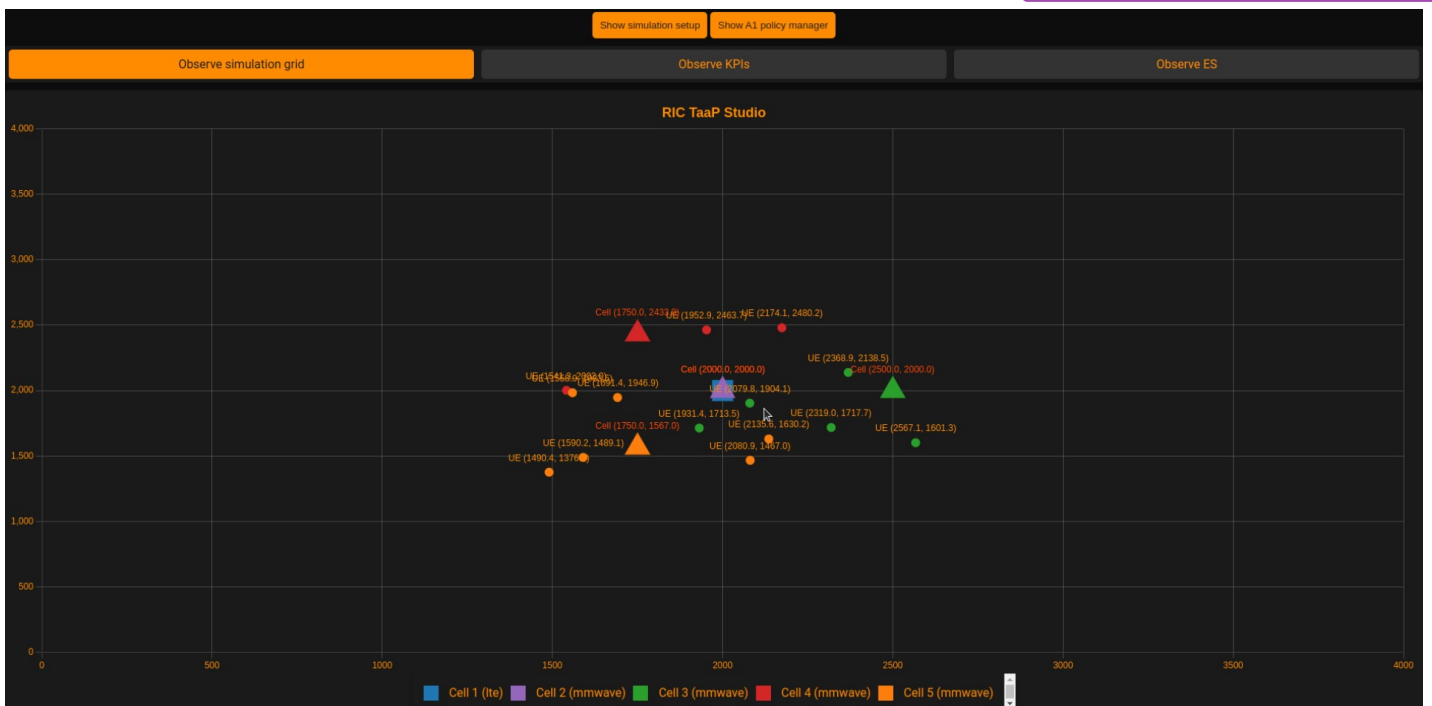
**UE 13 is attached to cell 3**

**Energy state flag for cell 2 = 1**  
**This means Cell 2 is turned off**



**After handover the PRBUUsage of cell 2 is equal to zero**

**Current network power after Es operation**



## 2. Energy saving with load balancing:

This approach focuses on optimizing network performance while minimizing energy consumption through intelligent resource allocation and dynamic load redistribution.

Let us demonstrate how to simulate this scenario using our RIC TaaP tester:

1. Ensure that FlexRIC is running in the background.
2. Set the simulation parameters as follows and press **Start new** :

The screenshot shows the RIC TaaP tester interface. Three callouts highlight specific parameters:

- IntersideDistanceUEs = 700** (Red callout pointing to the IntersideDistanceUEs (m) field)
- N\_UEs = 10** (Yellow callout pointing to the N\_Ues field)
- IntersideDistanceCells = 500** (Green callout pointing to the IntersideDistanceCells (m) field)

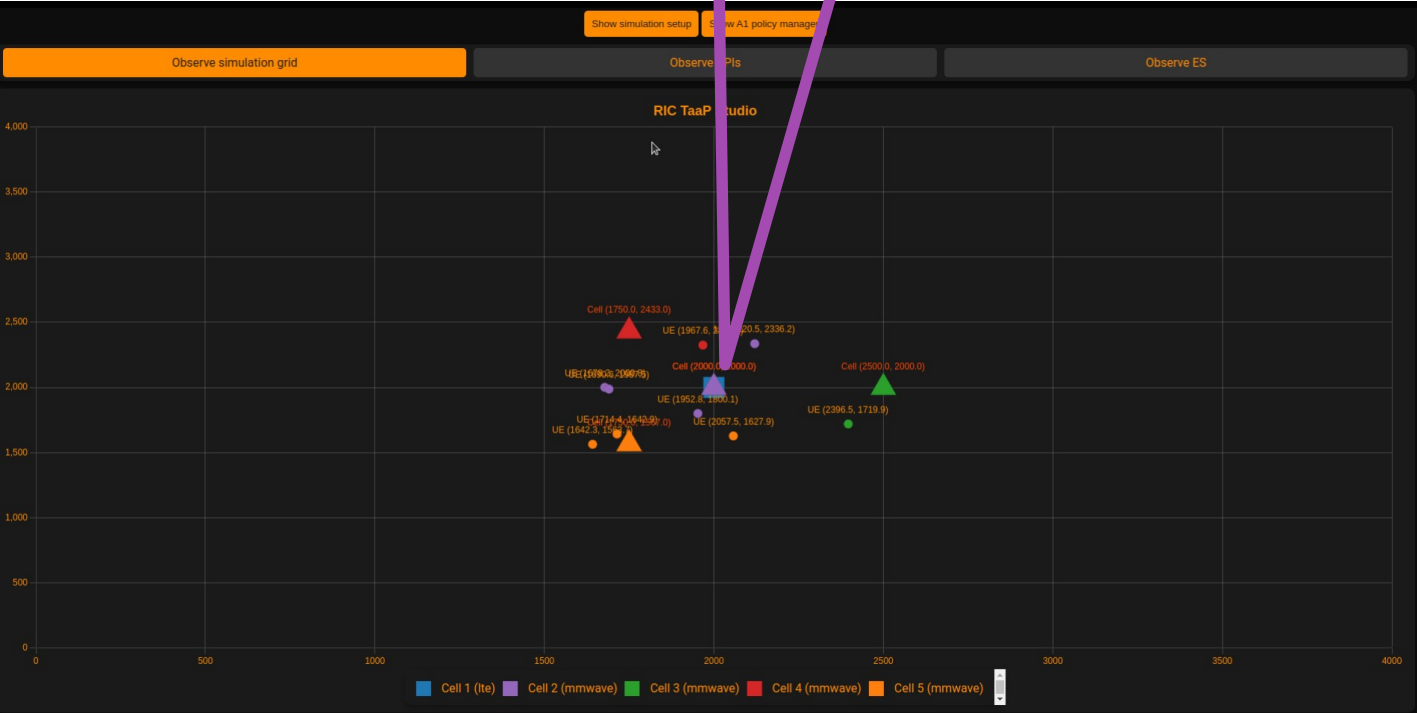
The interface includes the following sections:

- Connect to FlexRIC:** (If true, FlexRIC need to be running) ☒ **e2TermIp:** 127.0.0.1
- Parameters:**
  - hoSnrDifference (dB): 3
  - IncarnationPeriodicity (s): 0
  - SimTime (s): 300
  - KPM\_E2functionID: 2
  - RC\_E2functionID: 3
  - WaveEnbNodes: 4
  - N\_Ues: 10
  - CenterFrequency (Hz): 3.5e9
  - Bandwidth (Hz): 20e6
  - IntersideDistanceUEs (m): 700
  - IntersideDistanceCells (m): 500
- Status:** off. Buttons: **Start new**, Stop, Reset.
- Warning:** If there are no Cells/UEs on the grid after max 30s, please check if ns3 is running properly typing in terminal 'ps -a' or 'cat ns-3-mmwave-oran/ns3\_run.log'
- Cell energy states management:** ES status: off. Buttons: Turn ES xApp on, Turn ES xApp off.
- Observation:** Observe simulation grid, Observe KPIs, Observe ES.
- Graphs:**
  - ES MODE: Timeline from -50 to 0.
  - Saving SNR: Timeline from -50 to 0.
  - Difference in power consumption between modes: Timeline from -50 to 0.



After the nodes and UEs are running and appear in the simulator, we will observe the following:

Cell 2 is connected to 4 UEs



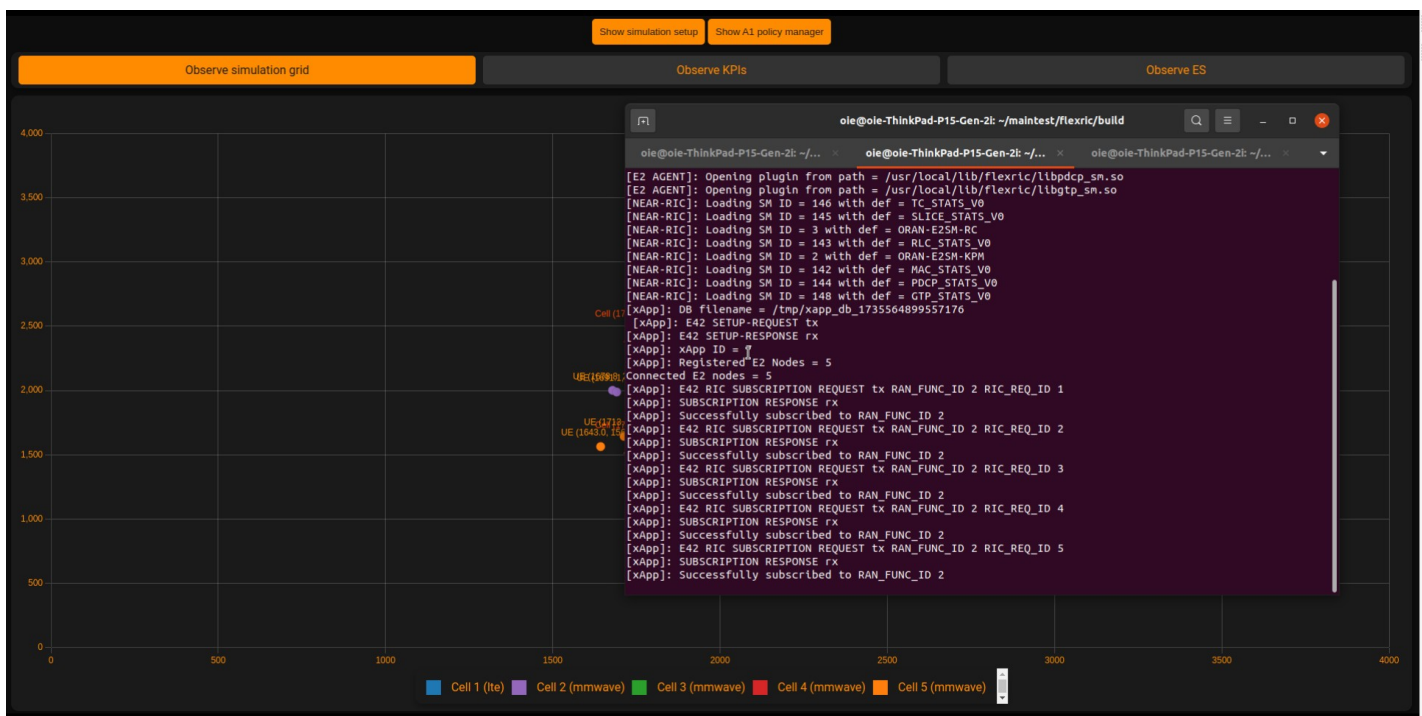
UE's 3,8,9 and 10 are attached to cell 2



Cell 2 has the biggest PRB usage

3. Run the `xapp_energy_saving_with_LB` by executing the following command in the terminal:

```
./flexric/build/example/xapp/c/ctrl/xapp_energy_saving_with_LB
```



## What is the action of the xApp?

The xApp sends a RIC control message to Cell 2, instructing it to move the UEs attached to it to the nearest cells and then power it down. Let us demonstrate this action in the following :

**UE 10 is attached to cell 5**

**UE 9 is attached to cell 3**

**UE 8 is attached to cell 4**

**UE 3 is attached to cell 5**

**Energy state flag for cell 2 =1**  
**This means Cell 2 is turned off**



**After handover the PRUsage of cell 2 is equal to zero**

### Current network power after Energy saving operation

