Advanced 5G Antenna System for Mobile Traffic Tracking

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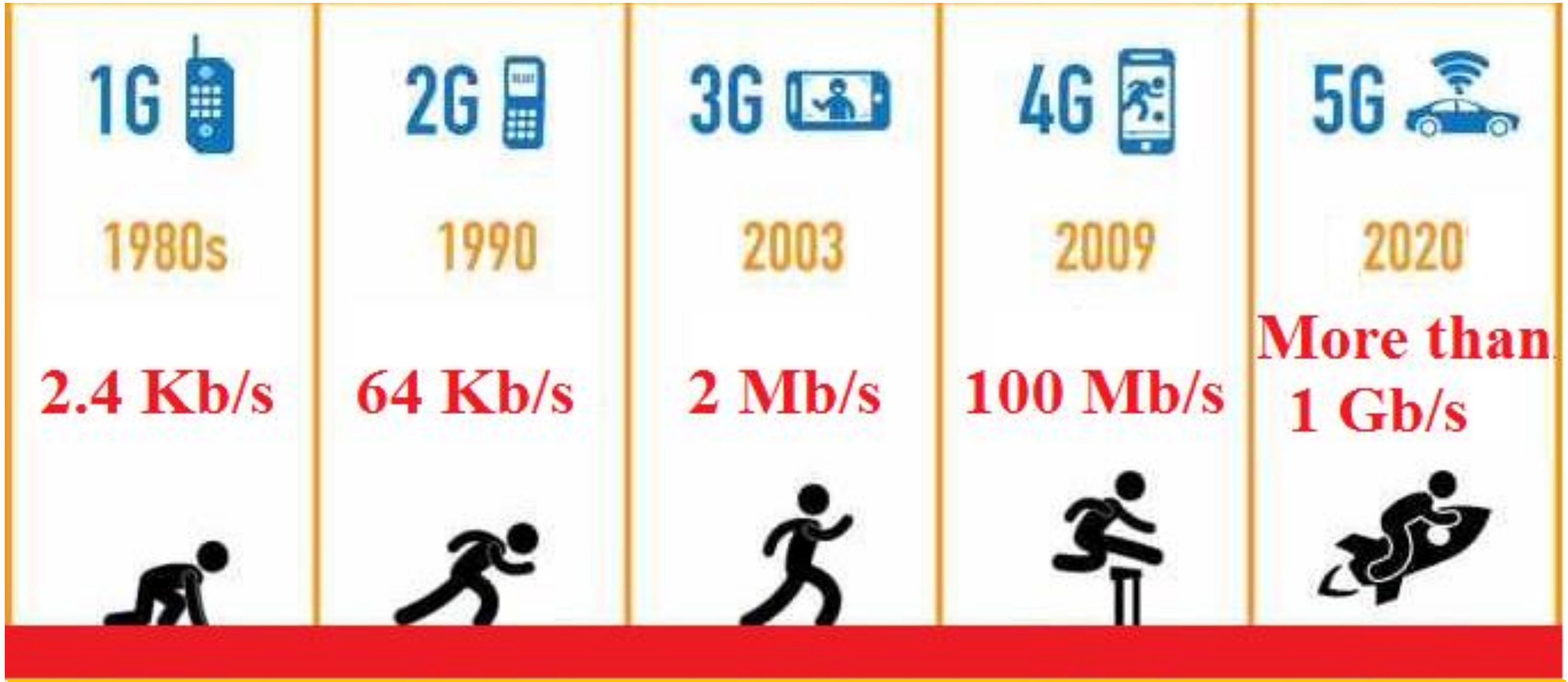
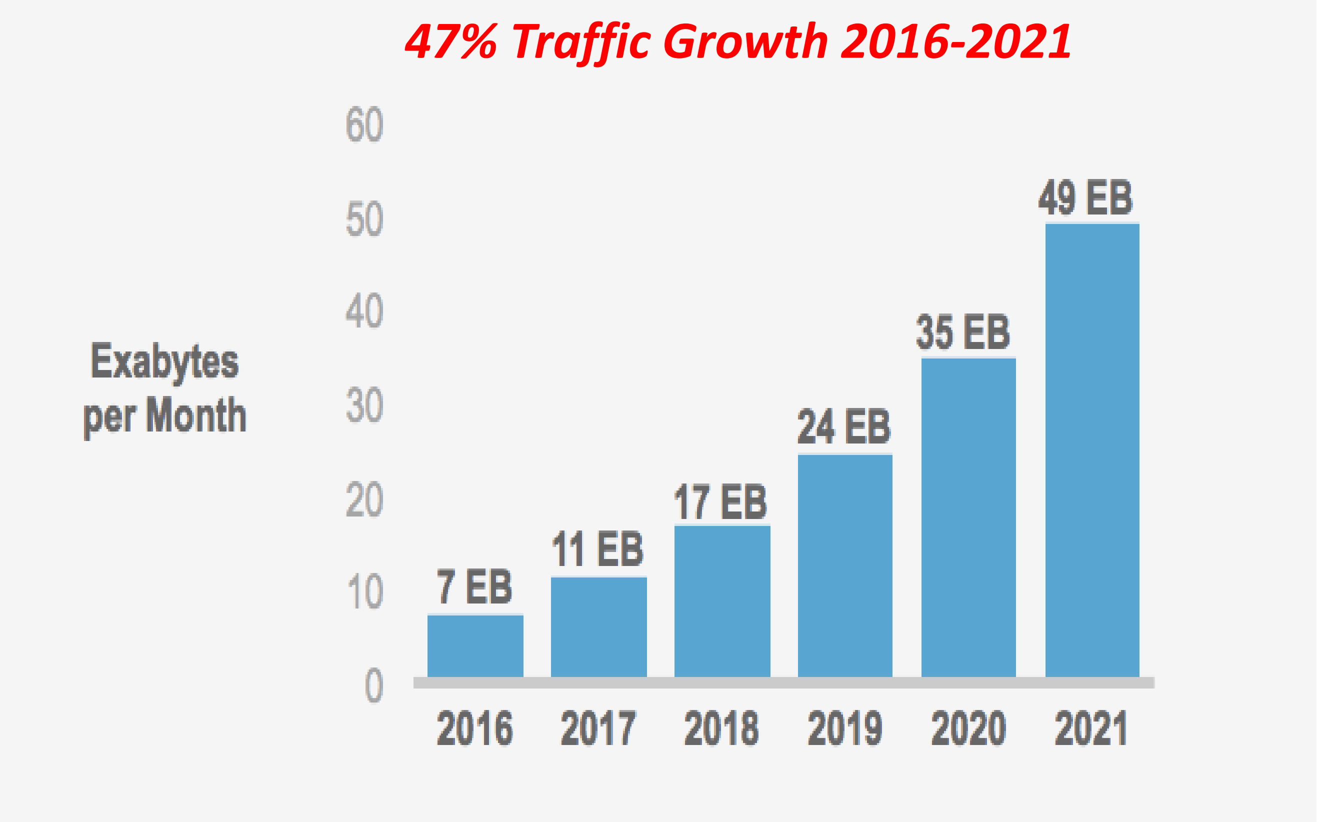
FASMETRICS

1. Wireless Communication Evolution



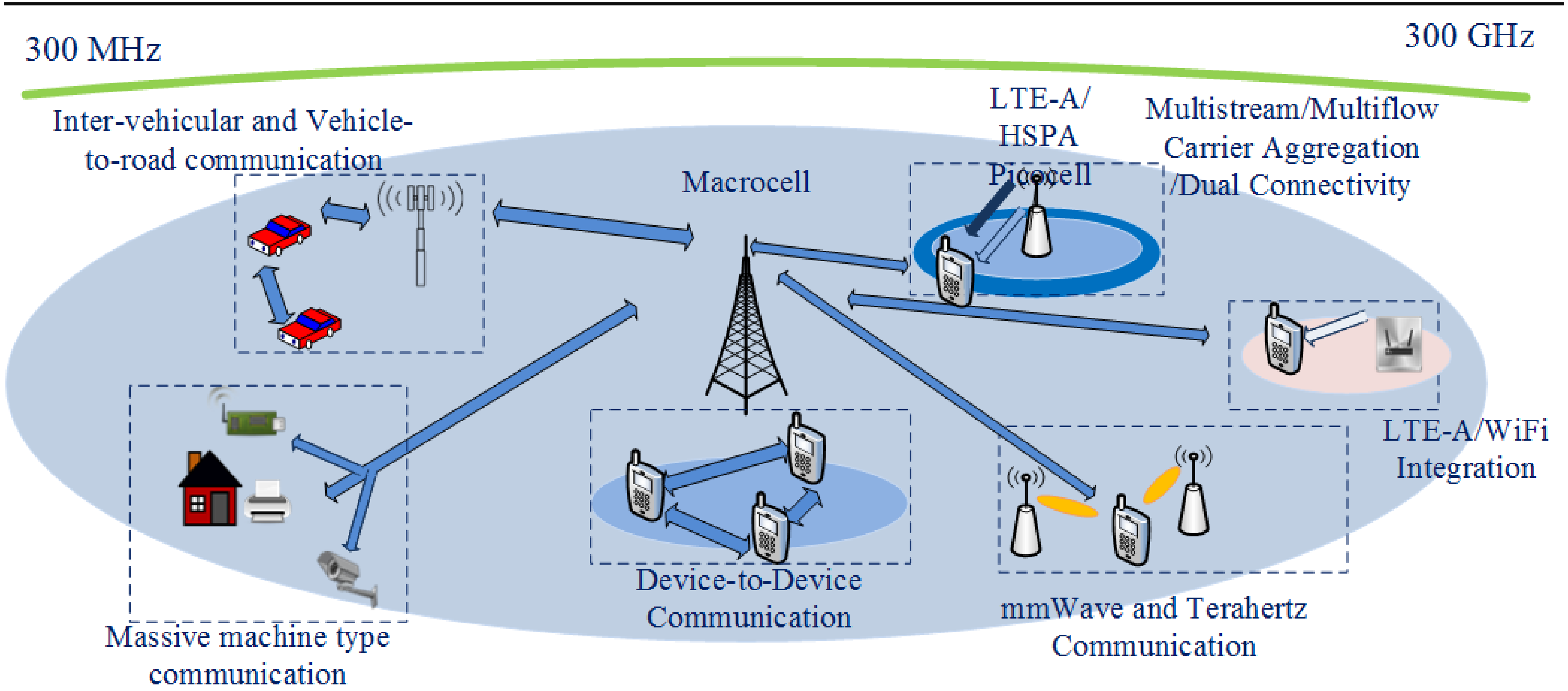
• Basic Voice Service • Analog-based Protocols	• Designed for voice • Improved Coverage and capacity • First Digital Standard(GSM,CDMA)	• Design for voice and some data consideration • First mobile broadband	• Designed Primarily for data • IP-based protocols (LTE) • True mobile broadband	• High Speed, High capacity • Better Coverage and no dropped calls, much low latency and better performance

2. Global Mobile Data Traffic Growth



Source: Cisco VNI Global Mobile Data Traffic Forecast, 2016-2021

3. Network Architecture in Future 5G Mobile System



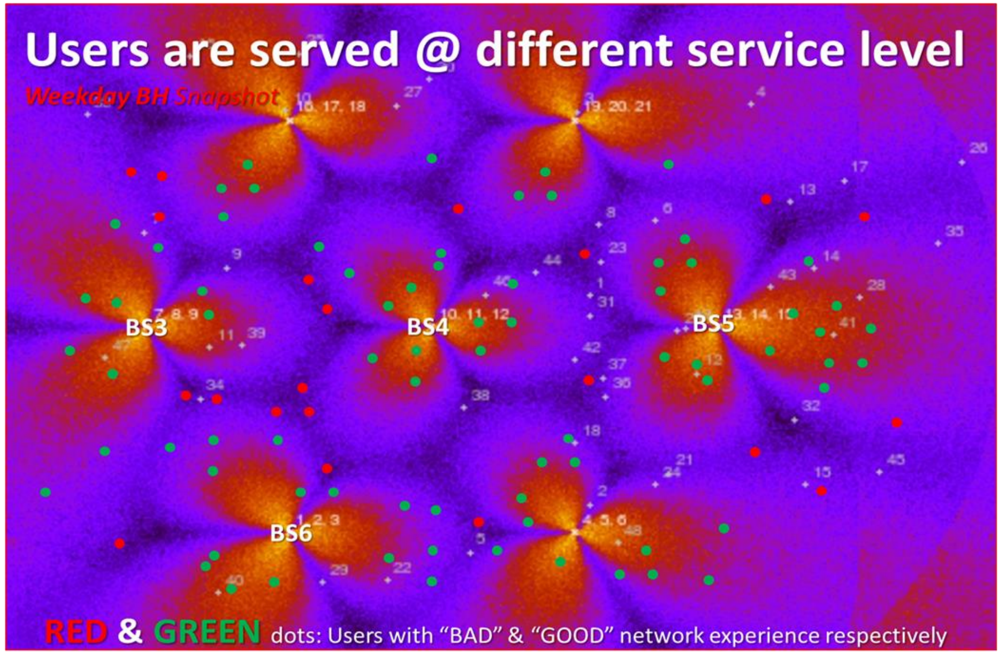
Source:The 5th Generation Mobile Wireless Networks- Key Concepts, Network Architecture and Challenges

4. Mobile Traffic Distribution in Current and Future 5G System

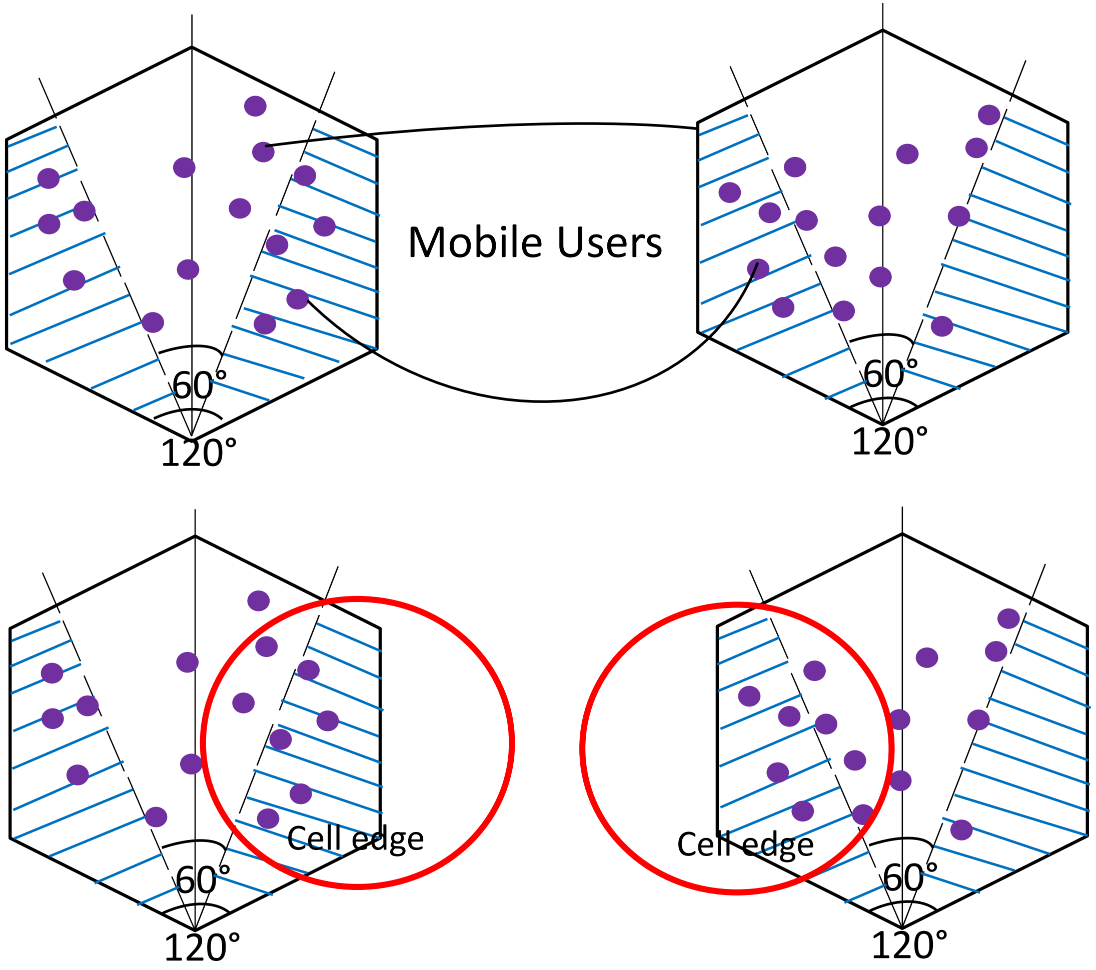
Mobile traffic in the network is mostly unevenly distributed

➡ Unevenly distributed radio resources among users

➡ High Access Failure Rate, Drop Call Rate, Low throughput…

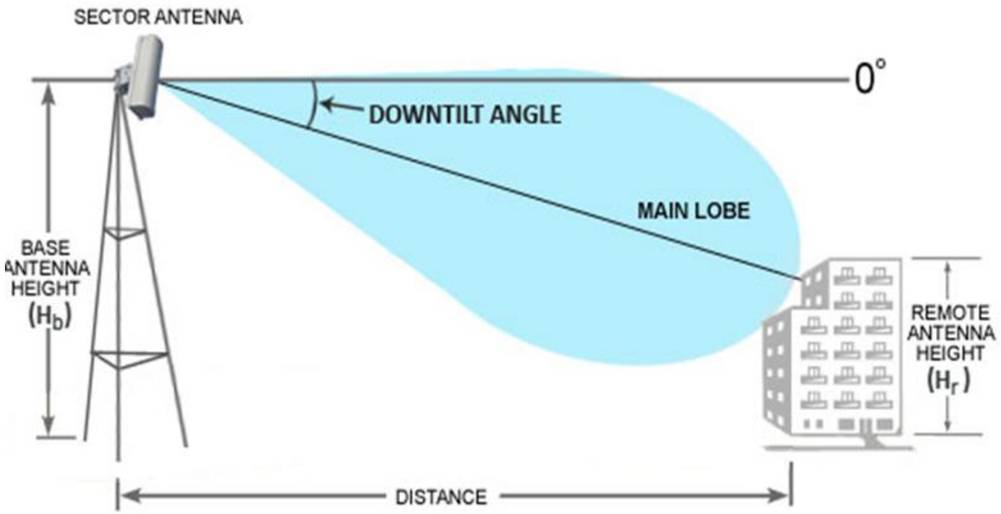


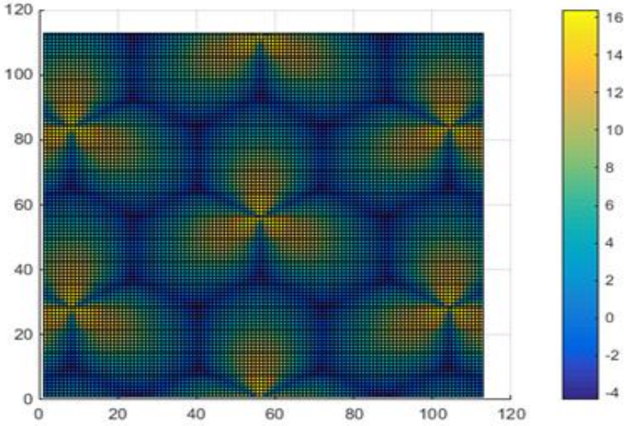
Two Snapshots of Randomly distributed mobile Traffic



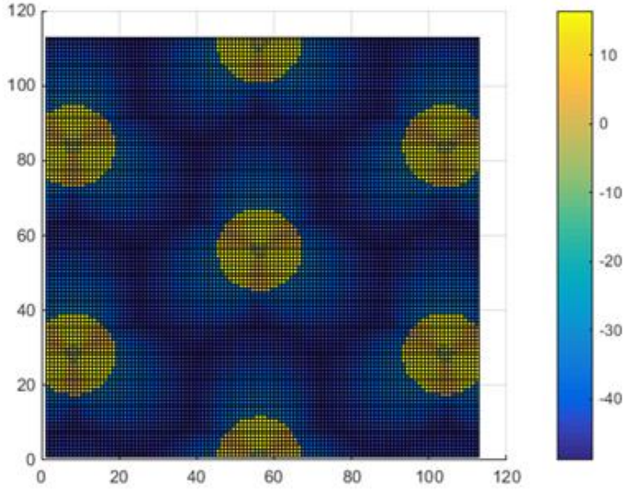
5. *Current Activity for Dynamic Mobile Traffic in the system (Basestation Antenna Side)*

Remote Electrical Tilt (RET): By changing the amplitude or phase of the antenna array elements, the elevation pattern of the antenna array can be downtilted





At tilt angle=3°



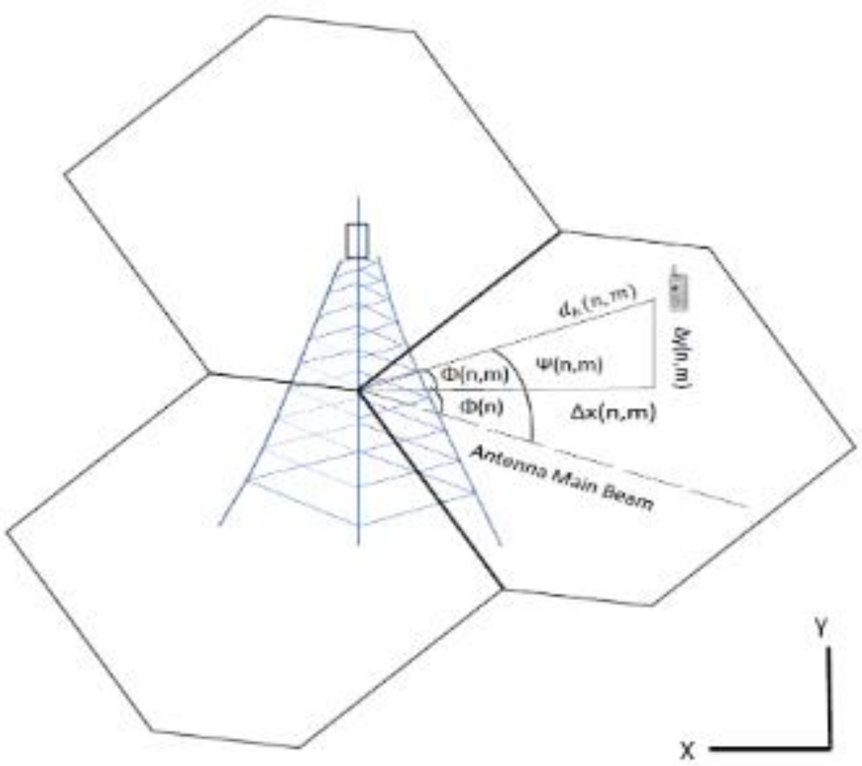
At tilt angle=10°

- Tackle the interference at the cell edge, boost the radio links near the basestation. However, at the expense of cell radius, which needs additional basestations in the cluster

6. New Propose-Dynamic Radio Planning by Basestation Antenna Azimuth

- Here, we propose a dynamic antenna azimuth fine tuning and control system which can automatically adjust the antenna's azimuth headings to follow such high usage areas in time and space.

7. Theoretical Approach



$$P_{n,m} = 10\log_{10}(P) + G(\theta_{n,m}, \varphi_{n,m}) \quad L_{n,m} + G_m$$

$$\phi_{n,m} = \arctan\left(\frac{\Delta y(n,m)}{\Delta x(n,m)}\right)$$

$$\varphi_{n,m} = \Phi_{n,m} + \Phi_n$$

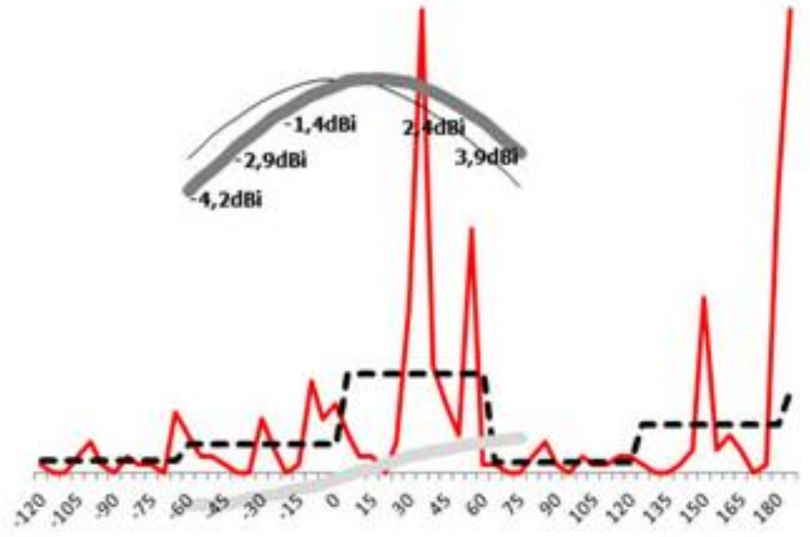
$$L_{n,m} = \left(\frac{4\pi d_{n,m} f}{c}\right)^2$$

$$SINR_m = \frac{P_{n,m}}{I_{n,m} + P_n}$$

$$C_m = B\log_2\left(1 + SINR_m\right)$$

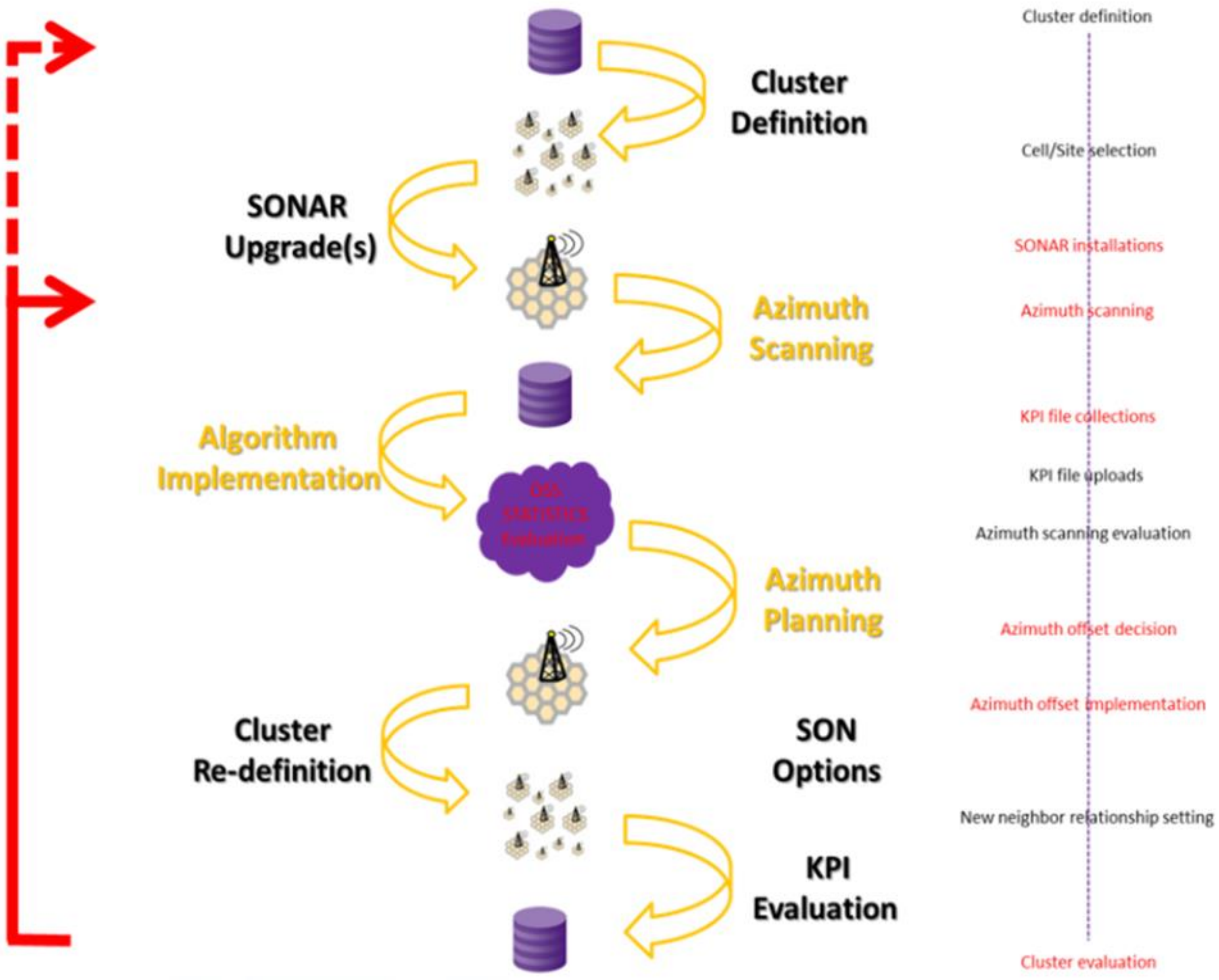
- Based on the BS-MS link budget and Shannon Capacity law, the overall cell performance in a power limited radio access network can be improved.

8. The Automatic Antenna Azimuth Planning Implementation



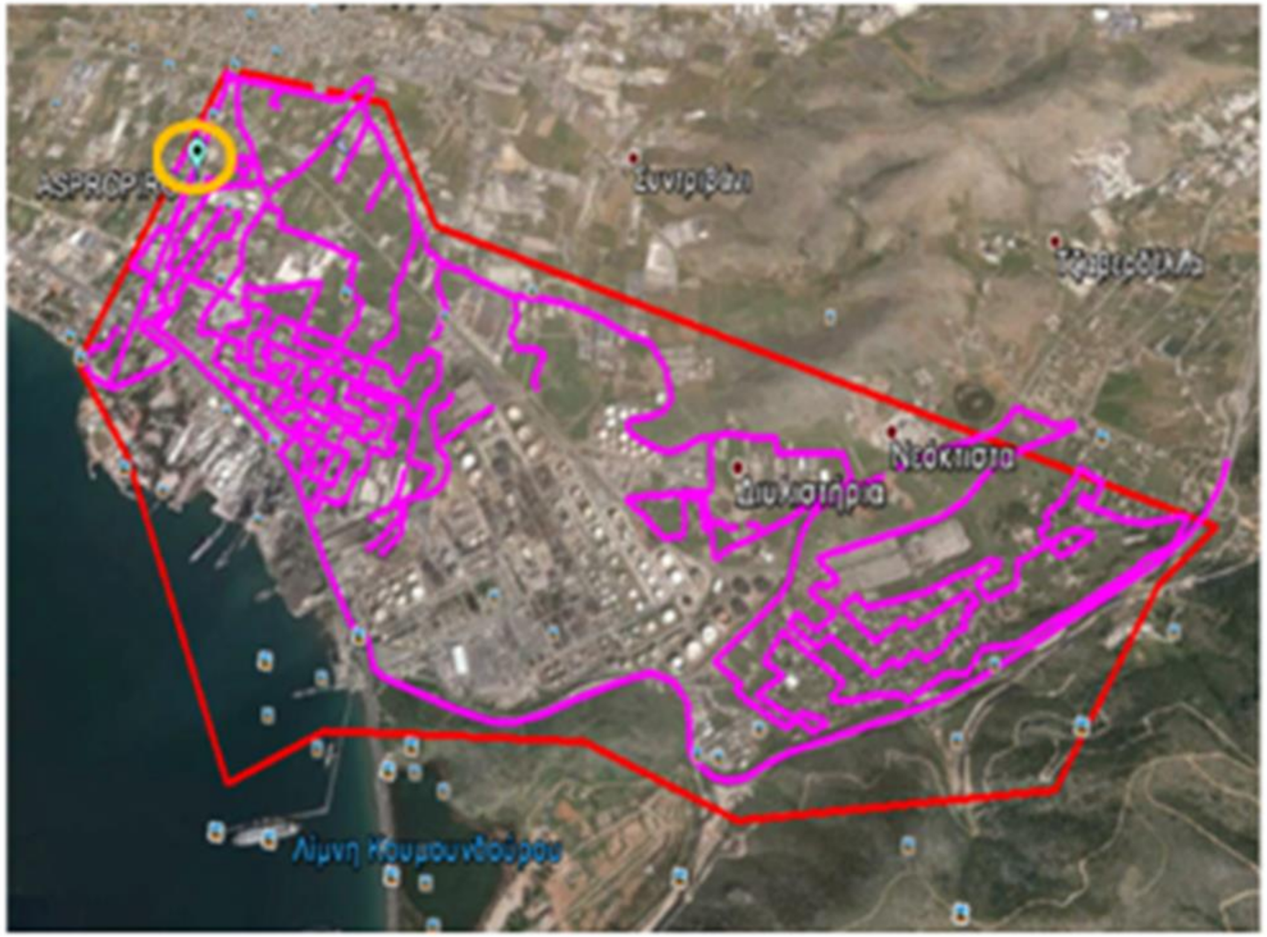
- An automatic antenna azimuth planning is presented which can steer basestation antenna’s azimuth automatically by a control unit through remote management software based on the Antenna Interface Standards Group (AISG) protocols.
- Antenna Azimuth Steering Range ±60°, Azimuth step 5°, Azimuth Angle Accuracy≤0.05°

9. Testing Procedures Overview



10.Live Test in Mobile Network

A. Drive Testing-Service Area Of ASPROPIRG

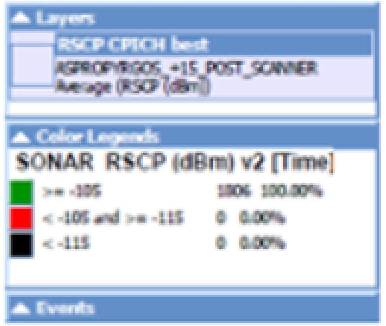


The trial area selected here is Thriasio Pedio. The number of cells in this area implemented the antenna azimuth steering units is 35 and the total number of cells in this area is over 100. One of the selected cells used to perform this trial test is called Aspropirgos which is a seafront area located in the northwest outside of Athens.

10.Live Test in Mobile Network

B. Confirmation of Coverage-drive testing for ASPROPIRG_L

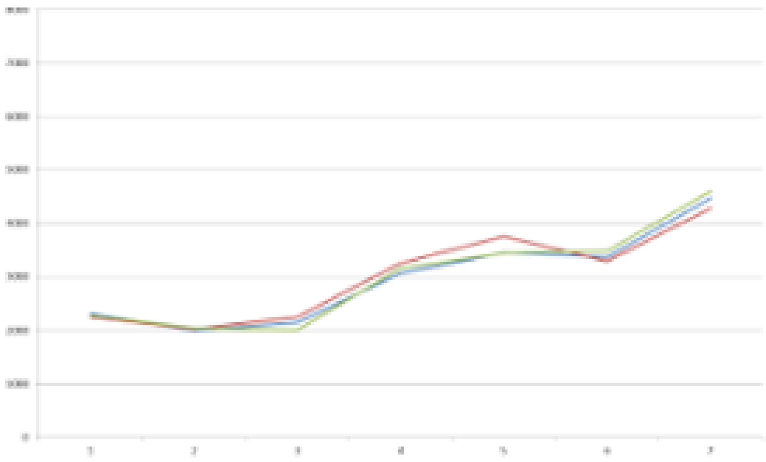
The GEO coverage of the chosen cell before and after the antenna azimuth offset to15̊ is the same

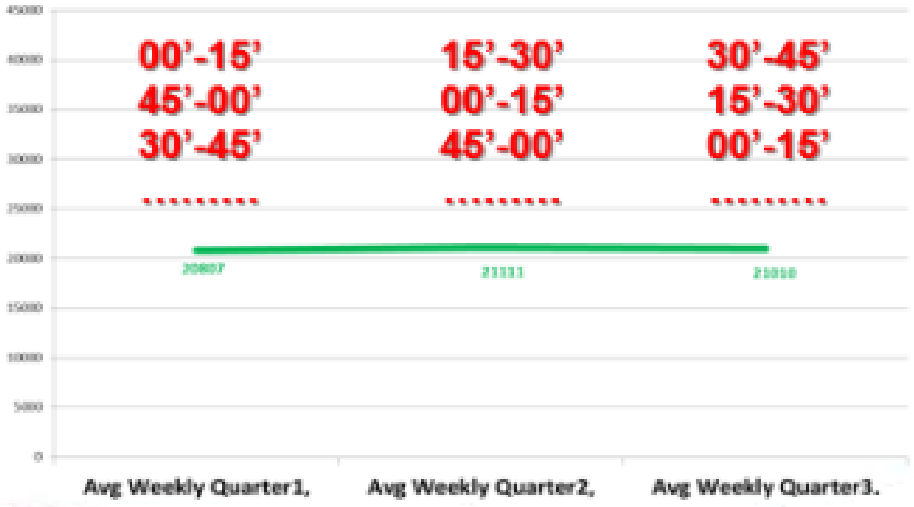


10.Live Test in Mobile Network

C. Dynamic Antenna Azimuth Scanning

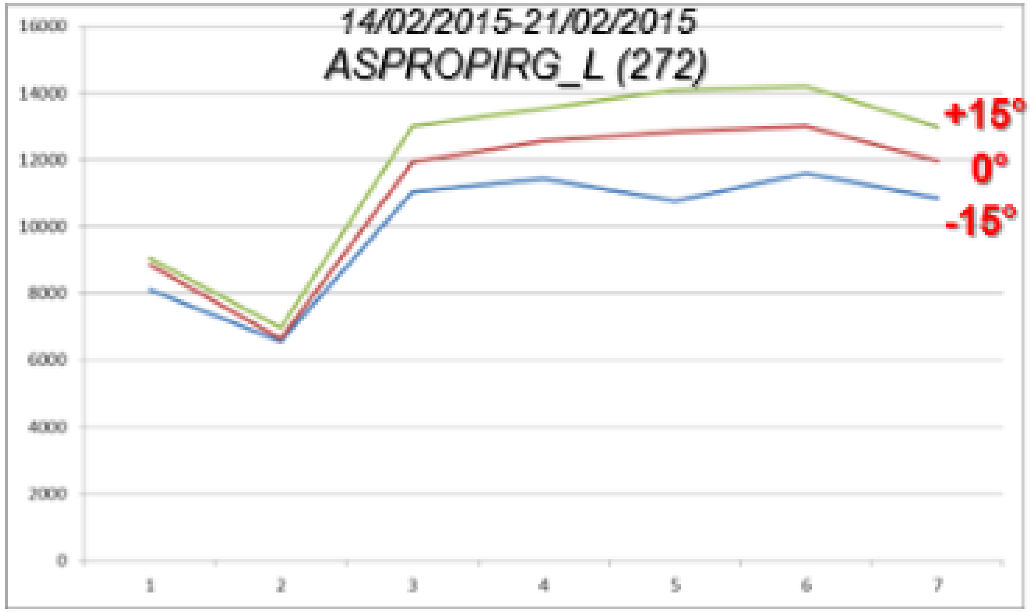
-15		0		15	
START	END	START	END	START	END
0:00	0:15	0:[illegible]	0:30	0:30	0:45
0:45	1:00	1:00	1:15	1:15	1:30
1:30	1:45	1:45	2:00	2:00	2:15
2:15	2:30	2:30	2:45	2:45	3:00
3:00	3:15	3:15	3:30	3:30	3:45
3:45	4:00	4:00	4:15	4:15	4:30
4:30	4:45	4:45	5:00	5:00	5:15
5:15	5:30	5:30	5:45	5:45	6:00
6:00	6:15	6:15	6:30	6:30	6:45
6:45	7:00	7:00	7:15	7:15	7:30
7:30	7:45	7:45	8:00	8:00	8:15
8:15	8:30	8:30	8:45	8:45	9:00
9:00	9:15	9:15	9:30	9:30	9:45
9:45	10:00	10:00	10:15	10:15	10:30
10:30	10:45	10:45	11:00	11:00	11:15
11:15	11:30	11:30	11:45	11:45	12:00
12:00	12:15	12:15	12:30	12:30	12:45
12:45	13:00	13:00	13:15	13:15	13:30
13:30	13:45	13:45	14:00	14:00	14:15
14:15	14:30	14:30	14:45	14:45	15:00
15:00	15:15	15:15	15:30	15:30	15:45
15:45	16:00	16:00	16:15	16:15	16:30
16:30	16:45	16:45	17:00	17:00	17:15
17:15	17:30	17:30	17:45	17:45	18:00
18:00	18:15	18:15	18:30	18:30	18:45
18:45	19:00	19:00	19:15	19:15	19:30
19:30	19:45	19:45	20:00	20:00	20:15
20:15	20:30	20:30	20:45	20:45	21:00
21:00	21:15	21:15	21:30	21:30	21:45
21:45	22:00	22:00	22:15	22:15	22:30
22:30	22:45	22:45	23:00	23:00	23:15
23:15	23:30	23:30	23:45	23:45	0:00



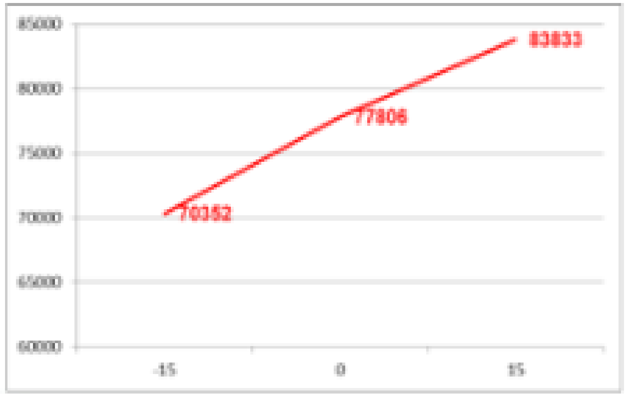


10.Live Test in Mobile Network

D. ASPROPIRG_L Weekly Traffic Usage

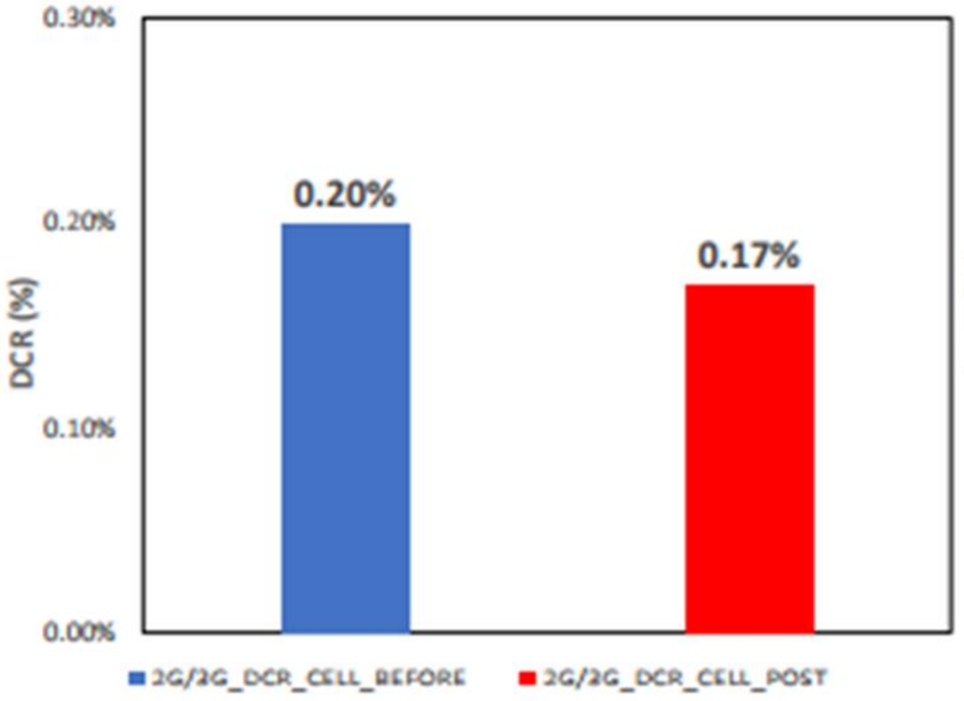


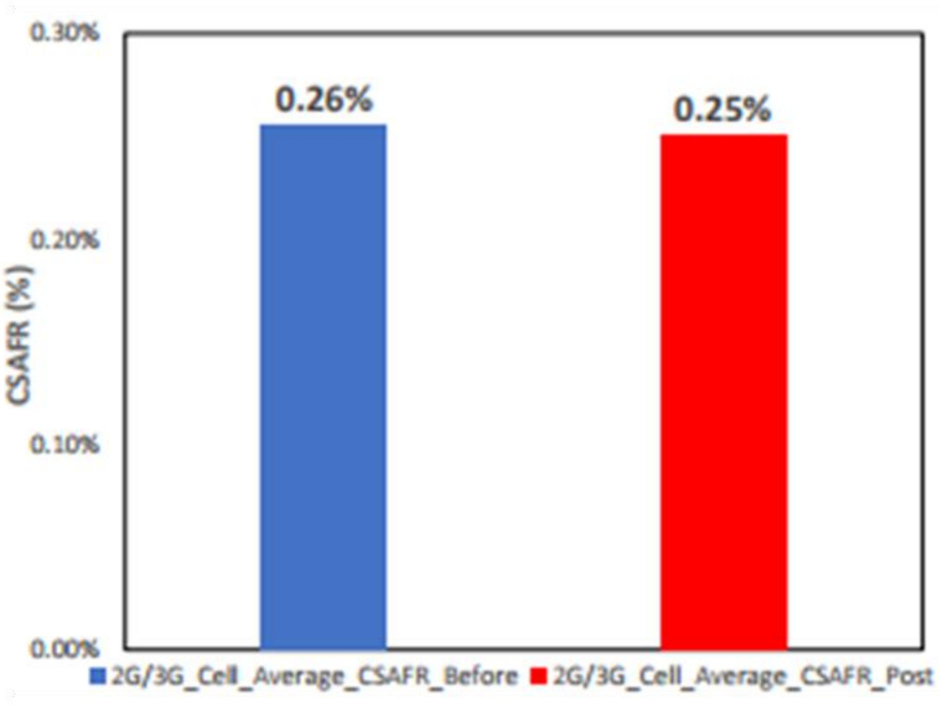
	-15	0	15
Day 1	8108	8855	9054
Day 2	6556	6640	6984
Day 3	11045	11925	13013
Day 4	11441	12577	13539
Day 5	10770	12836	14079
Day 6	11591	13017	14192
Day 7	10841	11956	12972
Weekly	**70352**	**77806**	**83833**



11. Evaluation Results

A. Drop Call Rate(DCR) & Access Failure Rate (AFR)

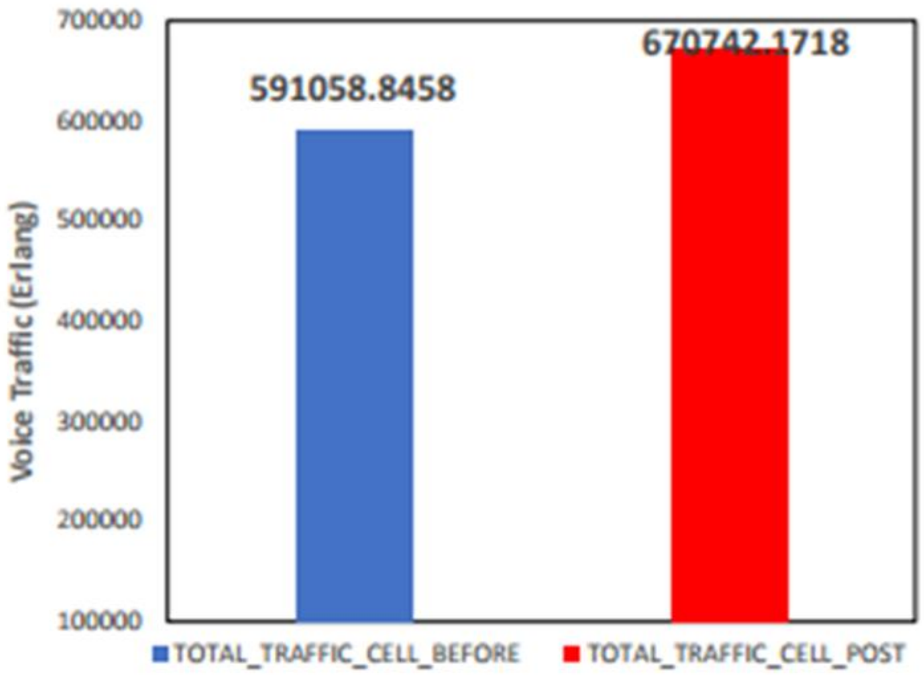


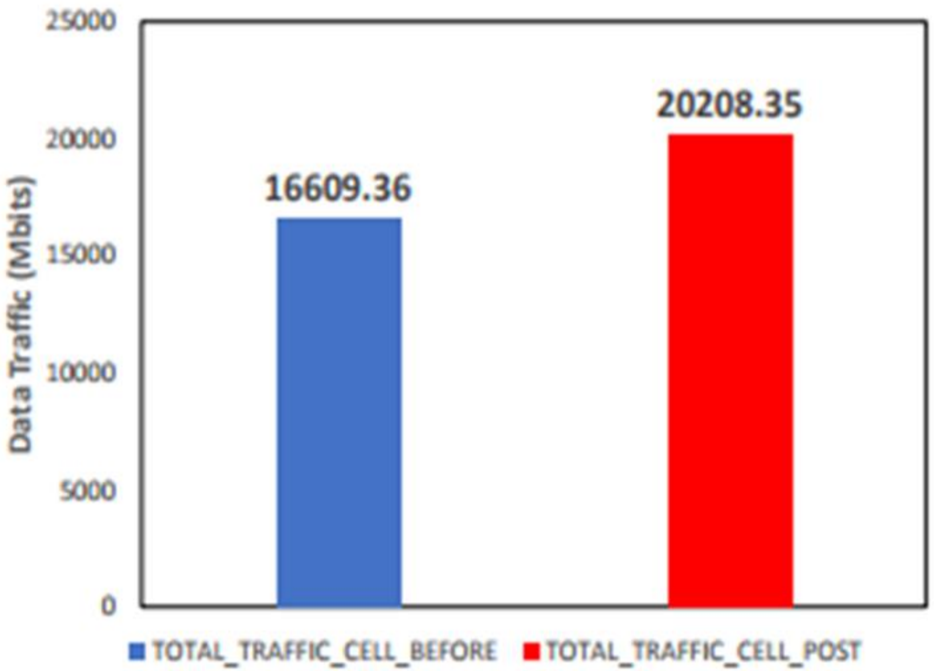


- DCR and AFR is reduced by 15% and 4% respectively by steering the azimuth to 15̊

11. Evaluation Results

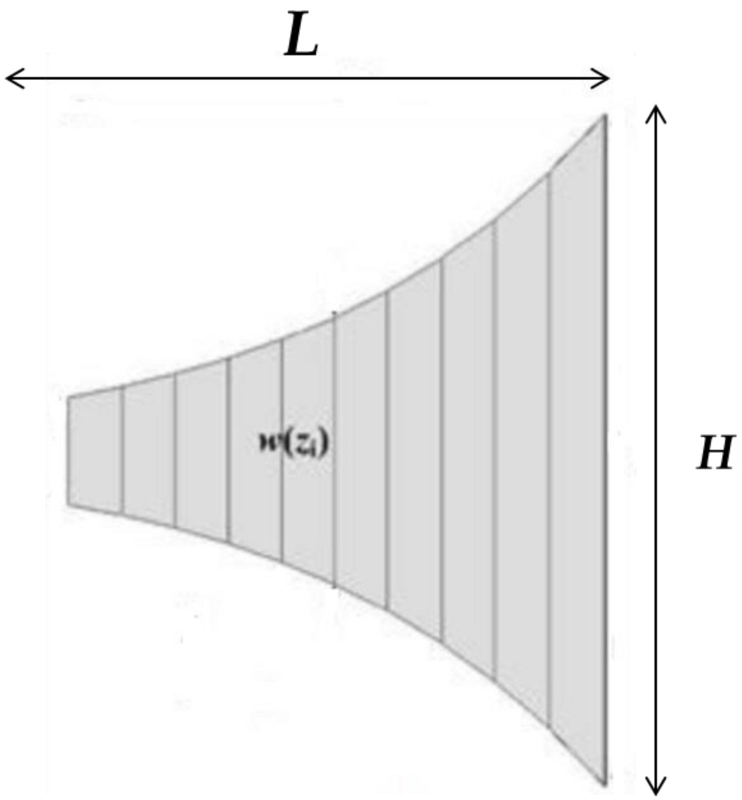
B. Voice Traffic (Erlang) & Data Traffic (Mbits)



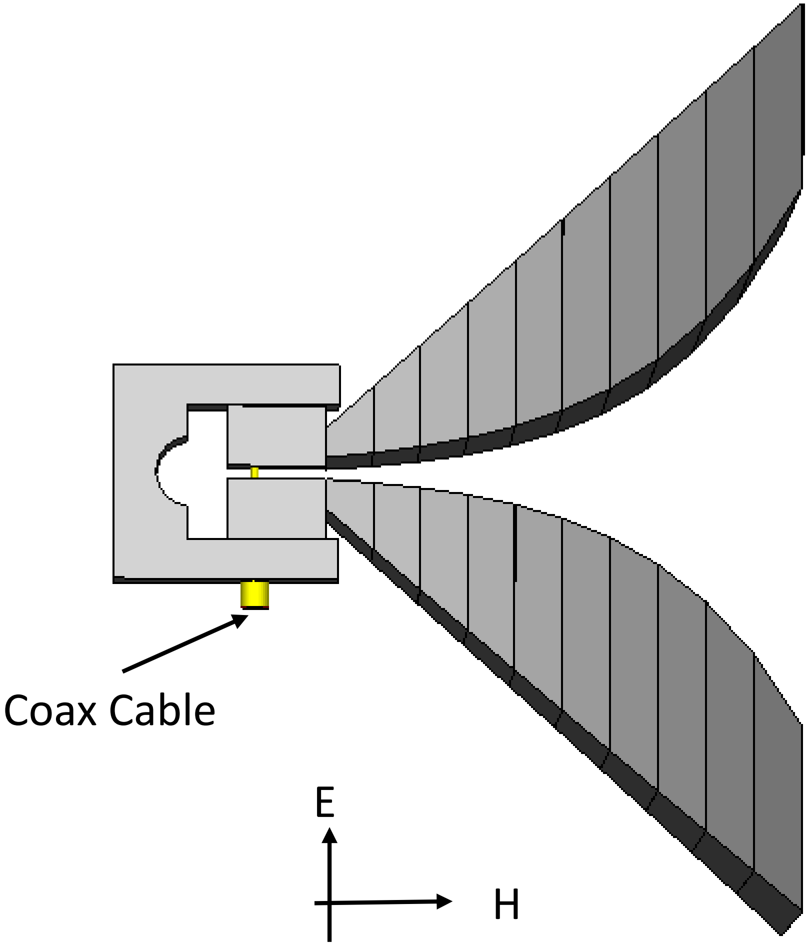


- **Voice Traffic and Data Traffic is increased by 13.5% and 21.7% respectively by steering the azimuth to 15°**

12. TEM Horn Antenna Design

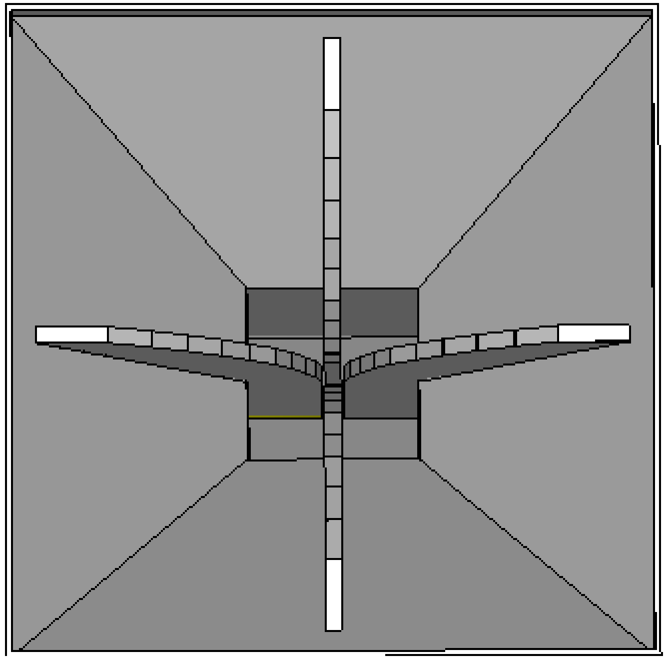


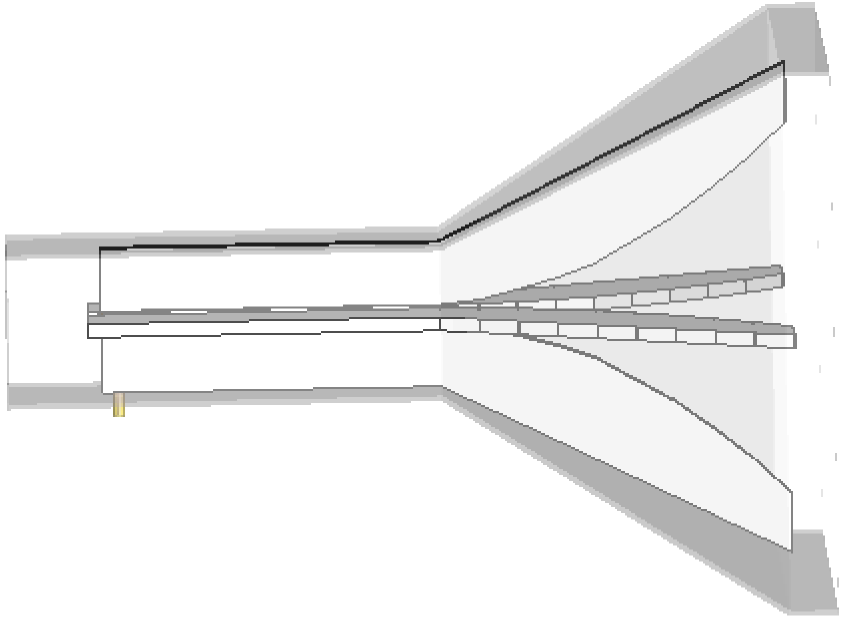
Horn Exponential Plate



TEM Horn Antenna Overview

13. Dual Polarised Quad-Ridge Horn Antenna Design for 5G

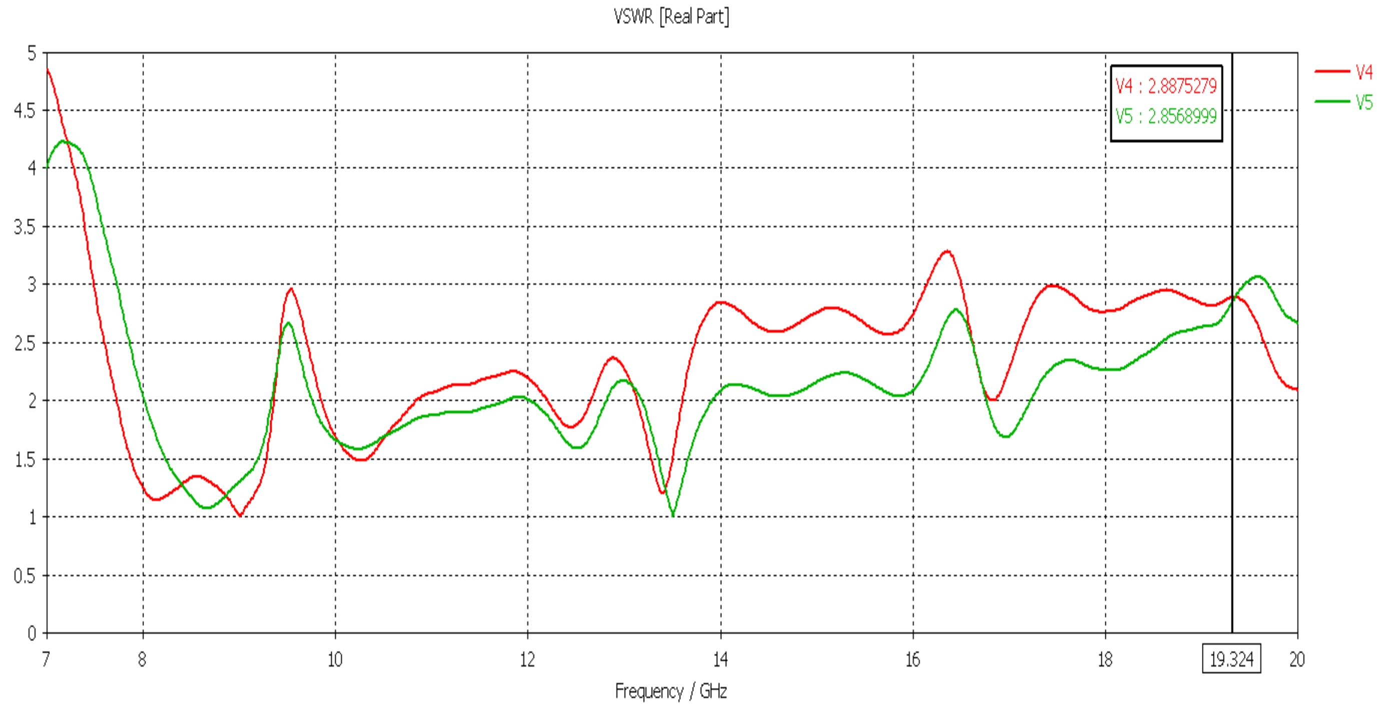


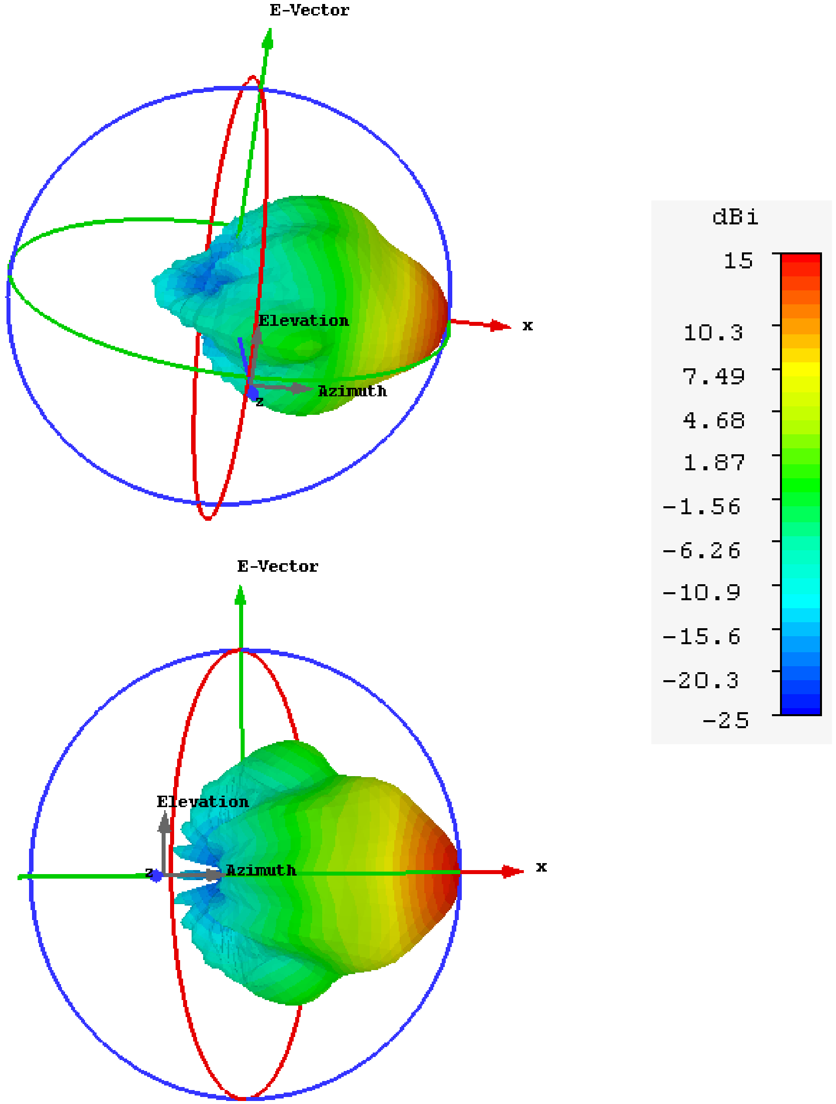


$$Z = 0.02x + Z_o e^{kx} \quad 0 \le x \le L$$

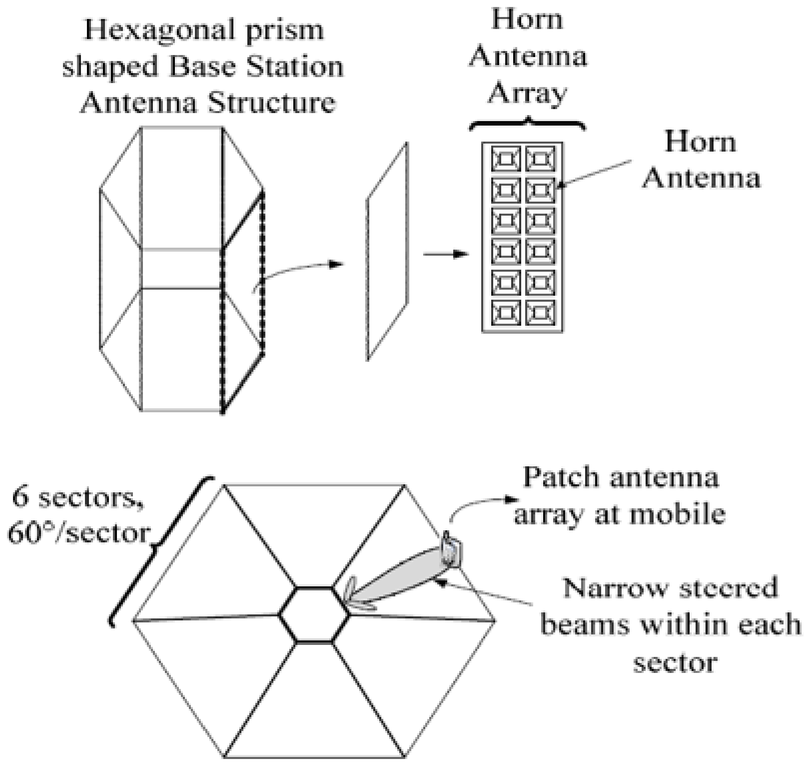
K= $(1/L)\ln(Z(L)/Z_o)$

14. 5G Dual Polarised Quad-Ridge Horn Antenna Results

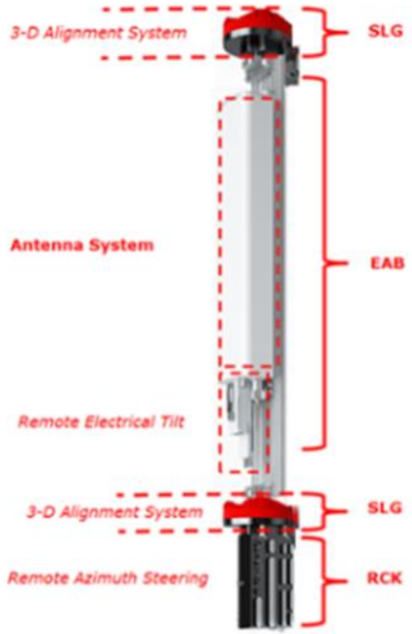




15. Future Results Expectation



5G Horn Antenna Array



Automatic Antenna azimuth steering mountings

More Capacity /Reduced cost per bit ?

16. Conclusion

1) *Antenna azimuth mounting is introduced with current network*

2) *The need of antenna azimuth planning is explained*

3) *Antenna azimuth steering can be used with the combined 5G Horn Antenna array to improve the current and future network performance*