

Future of Gigabit Mobile BB in 5G era

C S Rao /Anand /Arpita

Targeting 1 Tbps to 10Tbps per Sq.km in 5G deployments

Vision: Aim for meeting 1000x times more wireless data traffic in 5G RAN networks compared to 2020.

Drivers:

- Mobile BB as alternative to FTTH / FTTC.
- 600GB of Avg Usage per month per user @ Avg 20GB per day per user
- Meeting Golden Sq.Km Area deployment needs
- Use of ultra-high resolution video streaming on high resolution screens at different form factors.
- Ubiquity of cloud-based applications & Mobile Interactive gaming
- Trend of the IOT & Smart City Apps
- Digital Immersive world of AR/VR & Video conferencing
- Dedicated QoS requirements (Network Slicing) for customers within the Golden Sq. Km Area

Expectations from 5G Technology:

- 5G at near zero latency.
- Gbps Data era of consumer broadband speeds.
- To provide 10x improvement over 4G in terms of Avg and Peak data rates in user experience.

5G Deployment to provide the Terabit capacity per Sq.km and end user Gigabit data rates:

1. **Macro Site Deployment scenario 1** considered at 64QAM, 4x4 MIMO, & 100MHz channel in FR1 Range at 3.5GHz band with ISD of 250mtrs (16 sites/sq.km)
2. **Macro Site Deployment scenario 2** considered at 256QAM, 8x8 MIMO(AAS), & 2x400MHz channel in FR2 Range at mmWave band in 24/26/39GHz with ISD of 200mtrs (25 sites/sq.km)
3. RRH, BBU, vRAN, C-RAN & vBBU with relevant 3GPP defined RU, DU & CU network architecture will be considered for deployment along with NGFI(NextGen Fronthaul Interface).
4. Small cells in 5G & WiFi 6 to complement the coverage & capacity needs for in-building deployments.
5. mm Wave Integrated Access cum Backhaul (IAB) of Rel.15/16 to be used as a deployment methodology for Macro/Smallcells
6. AAS with 3D Beamforming and MU-MIMO deployments considered for maximizing diversity gains in dense urban areas.
7. Development of Mobile Edge Computing nodes at the 5G FH/MH/BH layer of the network to facilitate very low latency for AR/VR & related video & interactive gaming applications including IoT with Robotics.
8. AI/ML based network optimization, network selection and Self organizing algorithms to enable end user devices to use the best possible network/node/cell/beam available to the device.
9. 5G Rel.15 & Rel.16 compatible RAN infrastructure with ISD of 250mtrs in **3.5GHz band** offers the site throughput of approx. **100Gbps/sq.km** for 2020 and beyond.
10. 5G Rel.15 & Rel.16 compatible RAN infrastructure with ISD of 200mtrs in **mmWave band** offers the site throughput of **6TBps/sq.km** for 2020 and beyond.



Scenario 1: Dense Subs base & Per Sub Consumption Drives Area capacity of 5G PoP to be supported.

- Consumption per subscriber **per day** : 20 GB
- Subscriber density : 100,000 users / Sq.km

These requirements necessitate a **FR1 Range 5G POP** that can support ~ **0.1 to 0.2 Tbps / Sq.km**

Cell/Area throughput and Traffic data volume per sq.km area with ISD 250mtrs(4x4) considering 64/128 QAM and 4x4/ 8x8 MIMO with 100MHz channel bandwidth in 3.5GHz band for 5G cell site

QAM	MIMO	Cell Throughput (Gbps)	Site Throughput (Gbps)	Total traffic Data Volume available at Site in TB/Month	Area throughput /sq.km (Gbps) ISD 250mtrs (4x4 Matrix)	Total traffic Data Volume available in 1x1 Sq.Km/Month in TB	Number of subscribers/Site estimated to be supported at Service Packs GB/Month		Number of subscribers/Sq.km estimated to be supported at Service Packs GB/Month	
							Consumer Service Packs	Enterprise Service Packs	Consumer Service Packs	Enterprise Service Packs
							600	1000	600	1000
64	4	2.0	6.1	1983	98	31726	3305	1983	52877	8991
	8	4.1	12.2	3966	196	63452	6610	3966	105754	63452
128	4	2.4	7.1	2313	114	37014	3,856	2,313	61,690	37,014
	8	4.8	14.3	4627	228	74028	61,690	30,845	9,87,034	4,93,517

Scenario 2: Dense Subs base & Per Sub Consumption Drives Area capacity of 5G PoP to be supported.

- Consumption per subscriber **per day** : 20 GB
- Subscriber density : 100,000 users / Sq.km

These requirements necessitate a **mmWave 5G POP** that can support ~ **1.6 to 6.5 Tbps / Sq.km**

Cell/Area throughput and Traffic data volume per sq.km area with ISD 200mtrs(5x5) considering 256 QAM/ 4x4 & 8x8 MIMO/ 400MHz channel width in 24/26/39GHz mmWave band for 5G cell site

QAM	MIMO	Cell Throughput (Gbps)	Site Throughput (Gbps)	Total traffic Data Volume available at Site in TB/Month	Area throughput/ sq.km (Gbps) ISD 200mtrs (5x5 Matrix)	Total Traffic Data Volume available in 1x1 Sq.Km/Month in TB	Number of subscribers/Site estimated to be supported at Service Packs GB/Month		Number of subscribers/Sq.km estimated to be supported at Service Packs GB/Month	
							Consumer Service Packs	Enterprise Service Packs	Consumer Service Packs	Enterprise Service Packs
							600	3000	600	3000
256	8	21.8	65.3	21151	1632	5,28,768	35,251	7,050	8,81,280	1,76,256
	16	43.5	130.6	42301	3264	1057536	70,502	14,100	17,62,560	3,52,512

Cell/Area throughput and Traffic data volume per sq.km area with ISD 200mtrs(5x5) considering considering 256 QAM/ 4x4 & 8x8 MIMO/ 800MHz channel width in 24/26/39GHz mmWave band for 5G cell site

QAM	MIMO	Cell Throughput (Gbps)	Site Throughput (Gbps)	Total traffic Data Volume available at Site in TB/Month	Area throughput /sq.km (Gbps) ISD 200mtrs (5x5 Matrix)	Total Traffic Data Volume available in 1x1 Sq.Km/Month in TB	Number of subscribers/Site estimated to be supported at Service Packs GB/Month		Number of subscribers/Sq.km estimated to be supported at Service Packs GB/Month	
							Consumer Service Packs	Enterprise Service Packs	Consumer Service Packs	Enterprise Service Packs
							600	3000	600	3000
256	8	43.5	130.6	42301	3264	10,57,536	70,502	14,100	17,62,560	3,52,512
	16	87.0	261.1	84603	6528	2115072	1,41,005	28,201	35,25,120	7,05,024

Conclusions:

- Area throughput of **100Gbps/Sq.km** and total Traffic data volume of **31,726 TB per sq.km/month** is supported in 5G NR FR1 deployments for an ISD of 250mtrs.
- Such area throughputs will support **52K Subscribers** for consumer subscription packs of **600 GB per month** and **8K subscribers** for enterprise subscription packs of **1000GB per month** for scenario 1.
- Area throughput of **3.2Tbps/Sq.km** and total Traffic data volume of **10,57,536 TB per sq.km/month** is supported in 5G NR FR2 deployments for an ISD of 200mtrs.
- Such area throughputs will support **1.7M Subscribers** for consumer subscription packs of **600 GB per month** and **0.3M subscribers** for enterprise subscription packs of **3000GB per month** for scenario 2.
- **Tbps throughputs** at 5G NR PoP is supported on **mmWave band** and FR1 also, provided spectrum holding of per Telco is in the range of **4x100MHz** or more.
- **User eMBB era of Gbps speeds per subscriber** is supported in 5G Networks in mmWave band @subscribers densities of **2000/sq.km**.