

# 5G NR PHY Algorithm Design and Implementation in MATLAB



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# Outline

- ❖ About Company
- ❖ Objective of 5G NR
- ❖ Approach to implement 5G NR
- ❖ Simulation Results and Analysis
- ❖ Benefits of MATLAB
- ❖ Future Work
- ❖ Conclusion

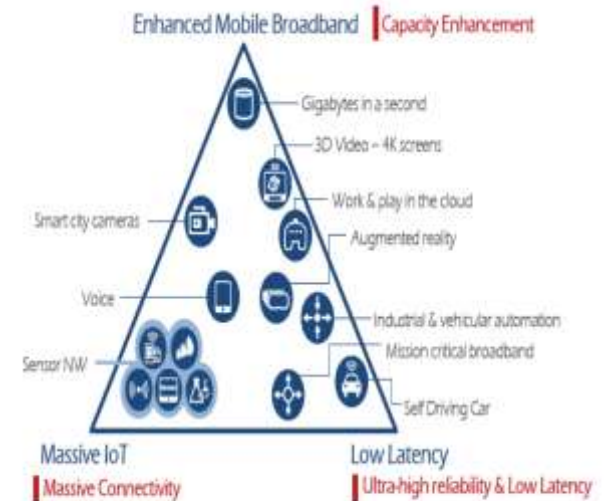
# About Company



- ❖ Established in November 2010 as a private limited company in India, we have built a strong core team that has expertise and experience across wireless technologies.
- ❖ We are working on NB-IoT, 4G and 5G cellular wireless technologies supplemented by Wi-Fi with specific focus on base station software.
- ❖ We have a complete LTE and NB-IoT network system and are now developing 5G system.

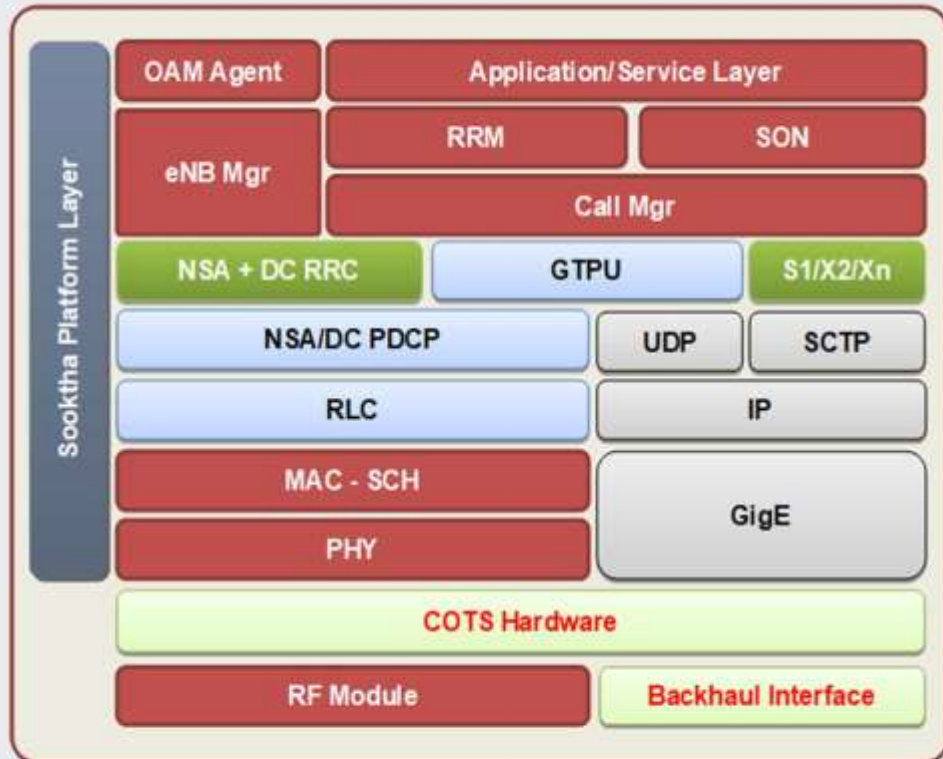
# Objective of 5G NR

- ❖ 5G NR is expected to be backbone of IoT, fixed and wireless devices.
- ❖ Issue of latency is dealt by changes in network architecture. Since delay is contributed by backhaul between Radio Access Network (RAN) and core network.
- ❖ New network topology involving Software Define Network (SDN), Network Function Virtualization (NF), and Mobile Edge Computing (MEC)/caching can be employed to reduce the latency significantly.

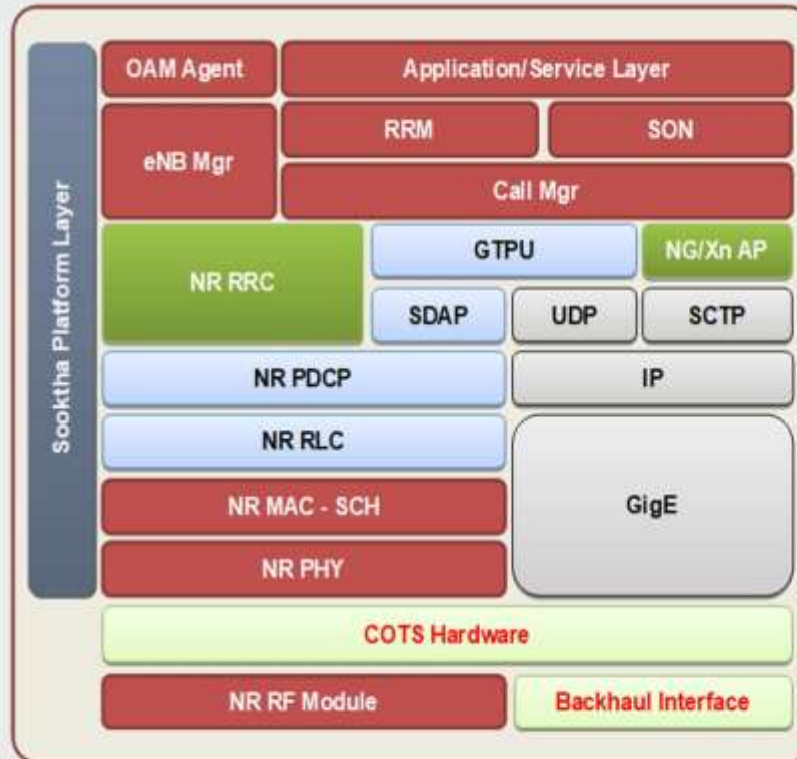


(Source: ETR graphic from ITU-R IMT 2020 requirements)

# Comparison of Architectures



LTE eNB Architecture



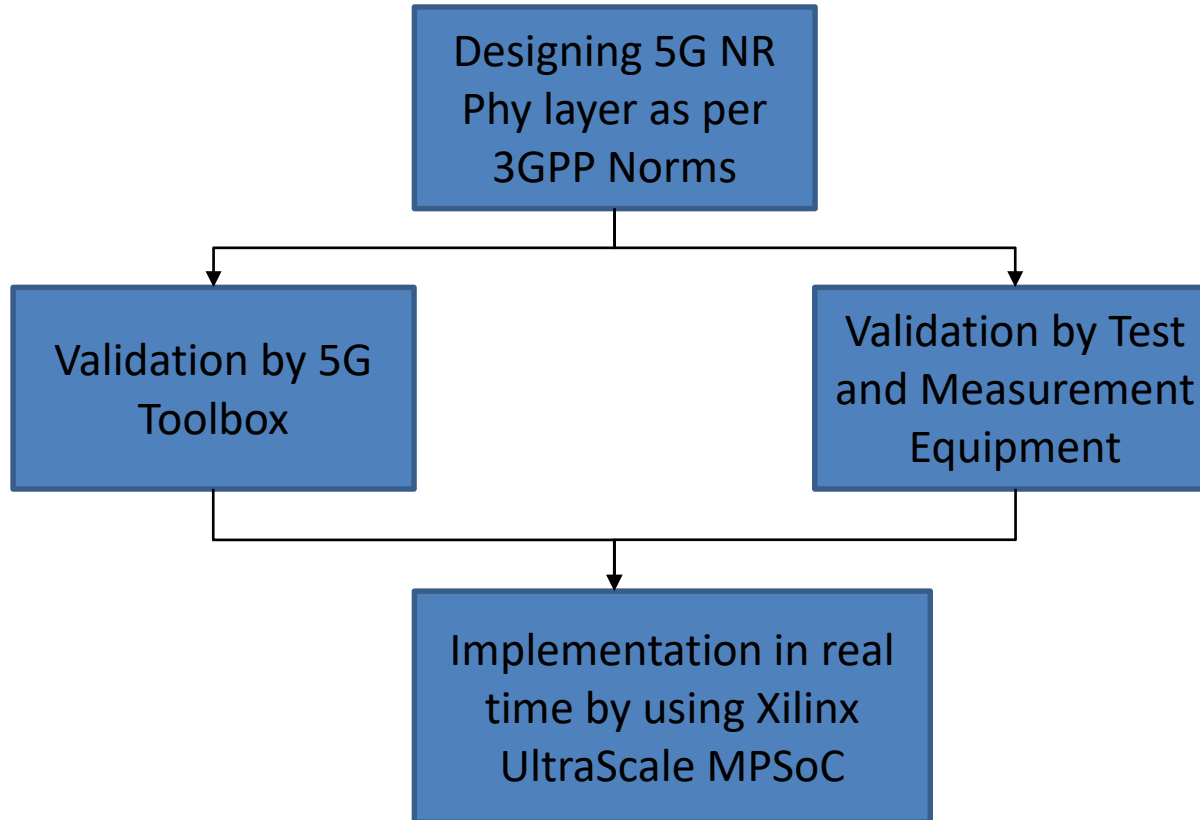
5G gNB Architecture



# Approach to Implement 5G NR PHY

- ❖ To design algorithms for 5G NR based on 3GPP specifications.
- ❖ Physical layer functionality implementation using 5G Toolbox.
- ❖ Toolbox functionality has to be tested against Test and Measurement equipment by Keysight.
- ❖ The designed algorithm has to be implemented in real time by using Xilinx Ultrascale MPSoC ZCU 102 board based on RTL implementation.

# Flow Chart of Approach to 5G NR

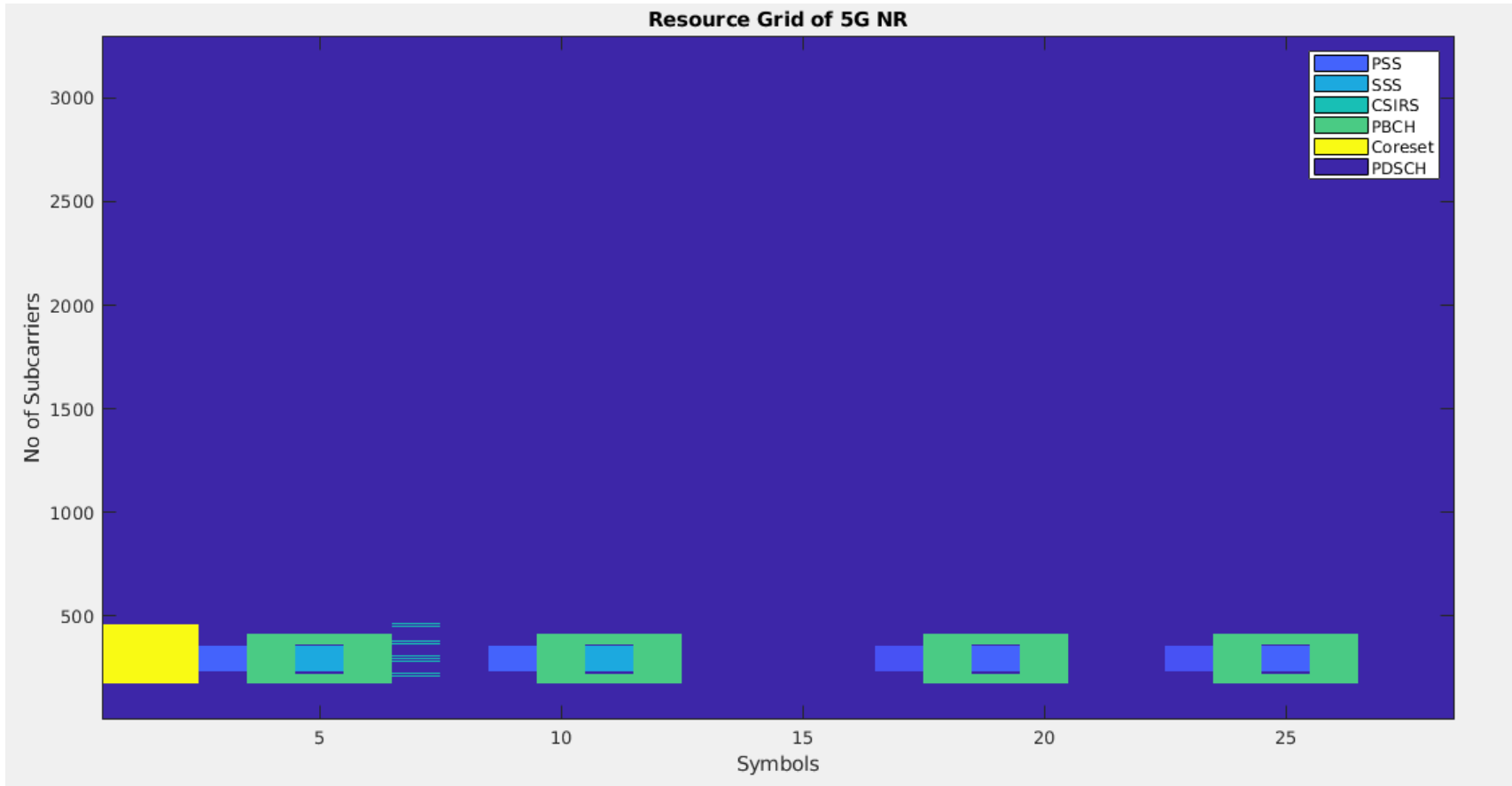


# Signal and Channels as per Specifications

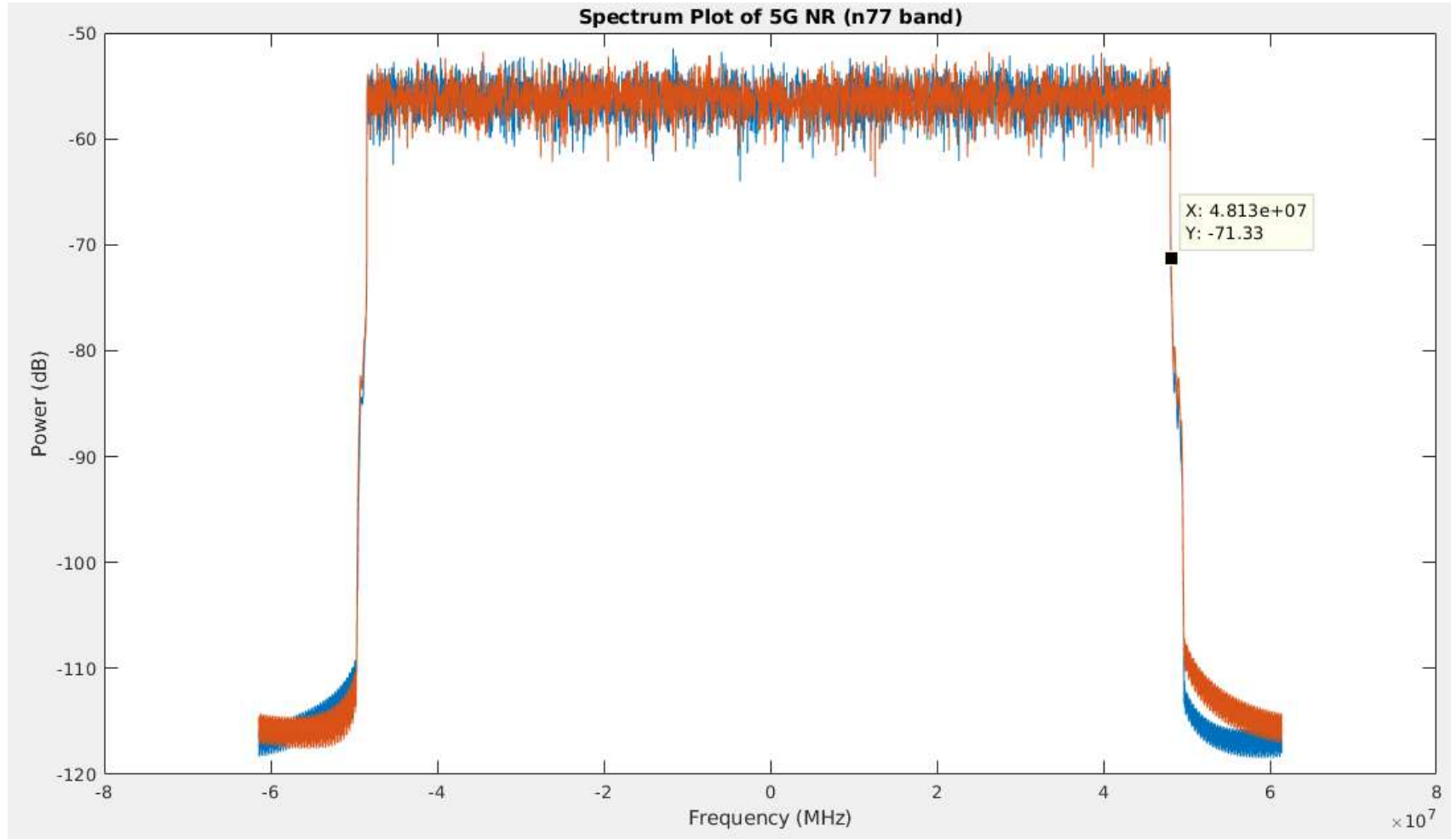
Sr. No	Signals and Channels	Used Specification and Section
1	PSS,SSS	38.211 P. No. 90
2	DMRS for PDSCH(Sequence Generation and Mapping)	38.211 P. No. 78
3	DMRS for PDCCH (Sequence Generation and Mapping)	38211 P. No. 84
4	PBCH with DMRS(Sequence Generation and Mapping)	38.211 P. No. 85
5	Synchronization Raster (For SS Block Synchronization)	38.104 P. No. 543
6	PDCCH (Coreset)(Control Channel Element, Resource Set, Scrambling, PDCCH Modulation and Mapping)	38.211 P. No. 76
7	PDSCH	38.211 P. No. 72
8	CSI-RS	38211 P.No 85
9	PBCH (Scrambling, Modulation and Mapping to Physical Resources)	38.211 P. No. 78



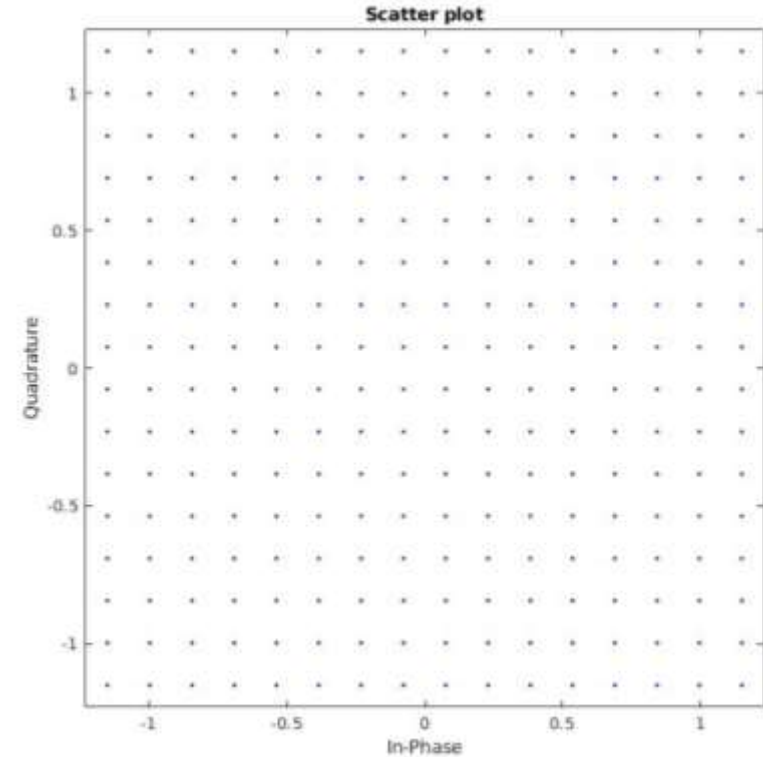
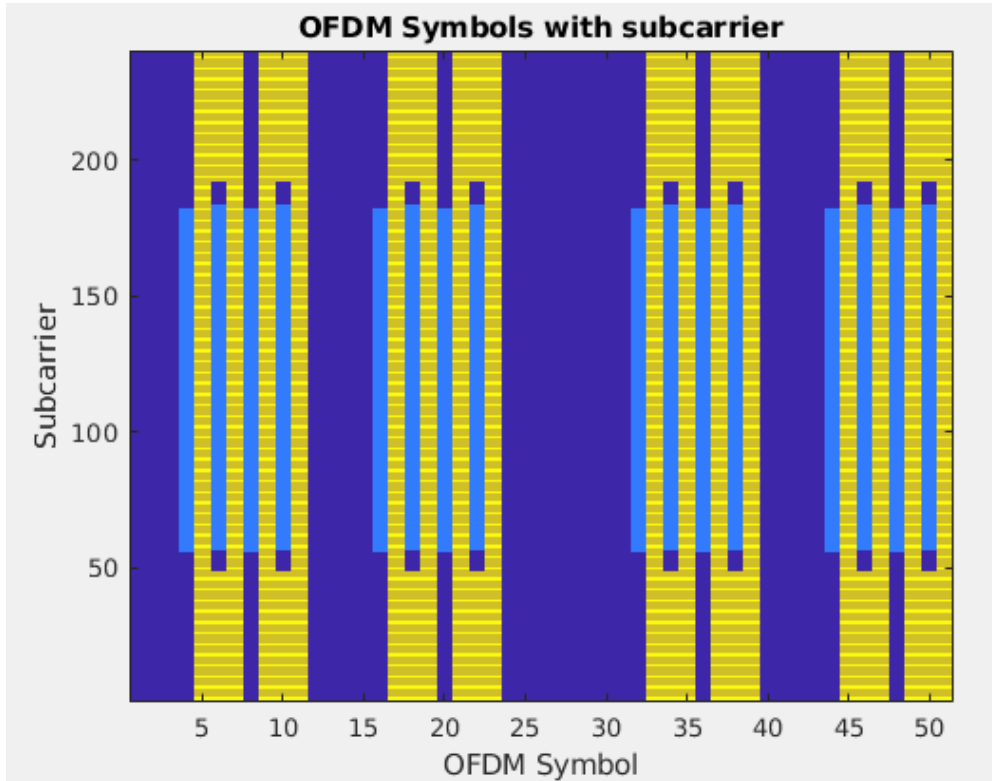
# Resource Grid of 5G NR



# Spectrum of 5G NR n77 band



# Synchronization Signal Block and Scatter



# Benefits of MATLAB

- ❖ 5G Toolbox was useful for 5G system design and compliance testing as per 3GPP Norms.
- ❖ The Toolbox functionality helped as a golden reference and reduced overall development time
- ❖ The open, editable MATLAB Code helped us in understanding key aspects of 5G PHY layer through simulation and identify issues early in our design process

# Future Scope

- ❖ To design and validate the different algorithms for waveform and validating them with test and measurement equipment.
- ❖ To be able to customize our product to India specifically rural connectivity or Internet of Things deployments, we may have to define new algorithms or waveforms and need a reliable reference platform to develop and test these algorithms and waveforms.
- ❖ To provide reliable service to sparse population with the NR 5G features.

# Conclusion

- ❖ To provide the Bottom to Top level architecture design with the help of MATLAB as algorithmic design and analysis tool at Phy layer.
- ❖ As a Basestation software designer company Sooktha leveraged from design and development of 5G NR.
- ❖ 5G Toolbox functions and golden reference signal helpful for Physical layer designing as per 3GPP specifications.