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
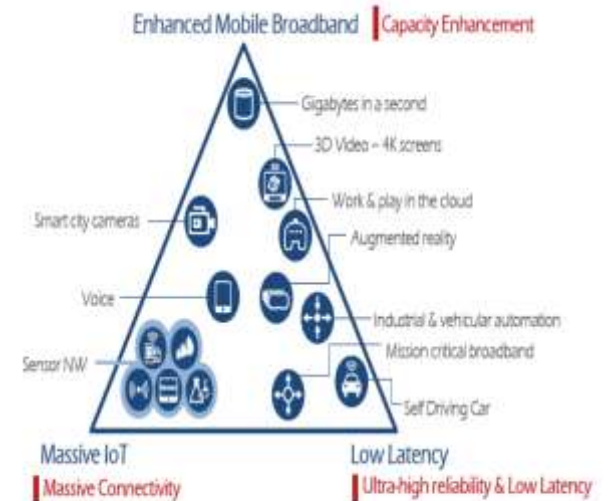- Benefits of MATLAB
- Future Work
- Conclusion

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.

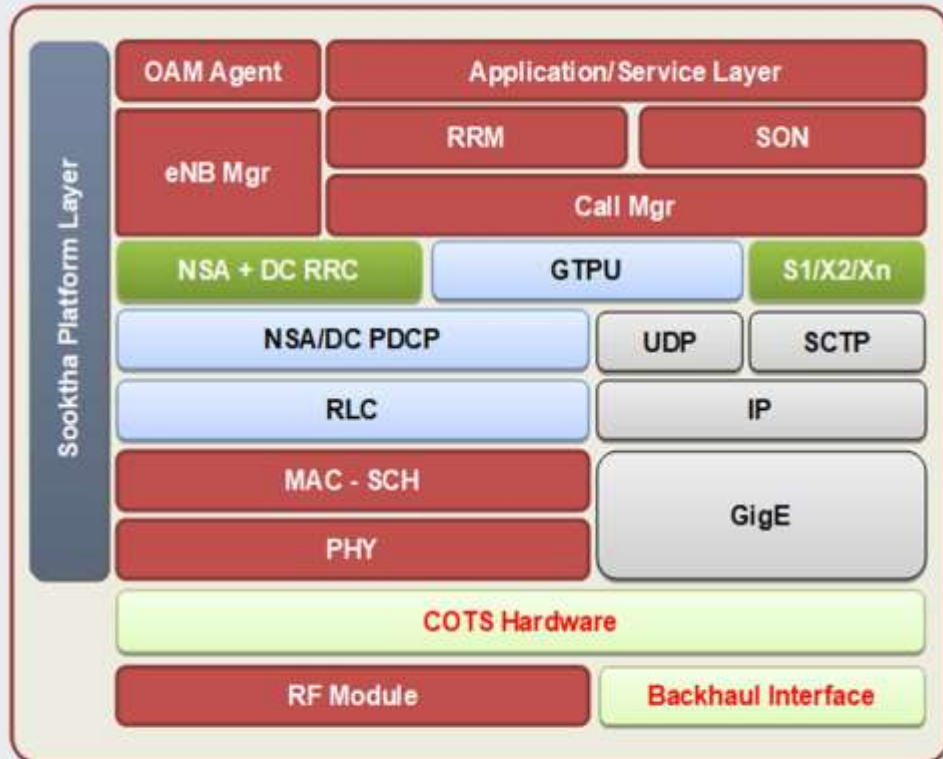❖ We have a complete LTE and NB-IoT network system and are now developing 5G system.

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.
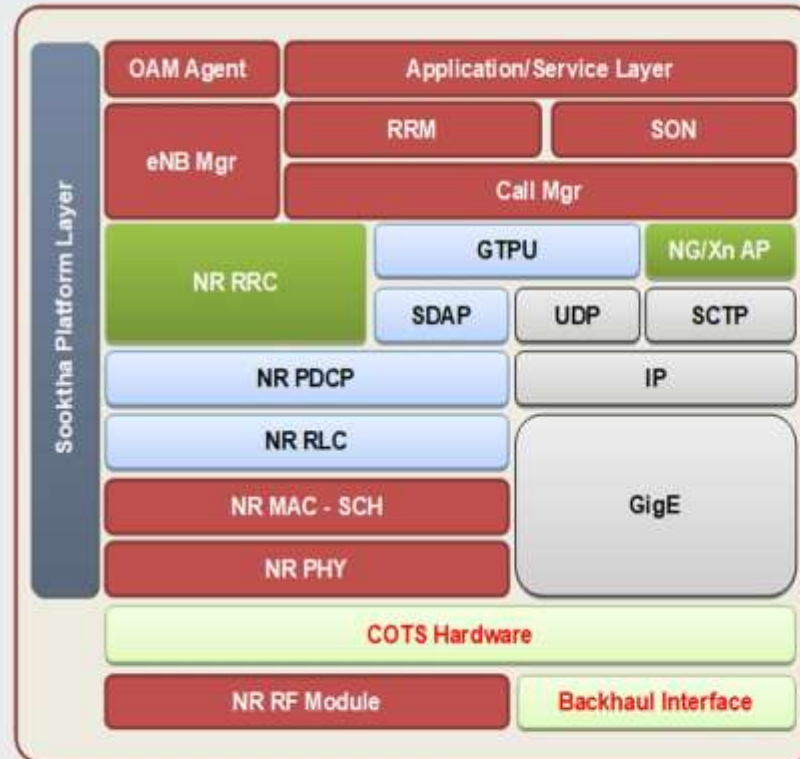

Enhanced Mobile Broadband | Capacity Enhancement

Gigabytes in a second
3D Video – 4K screens
Smart city cameras
Work & play in the cloud
Augmented reality
Voice
Industrial & vehicular automation
Mission critical broadband
Sensor NW
Self Driving Car

Massive IoT | Massive Connectivity

Low Latency | Ultra-high reliability & Low Latency

(Source: ETRI 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
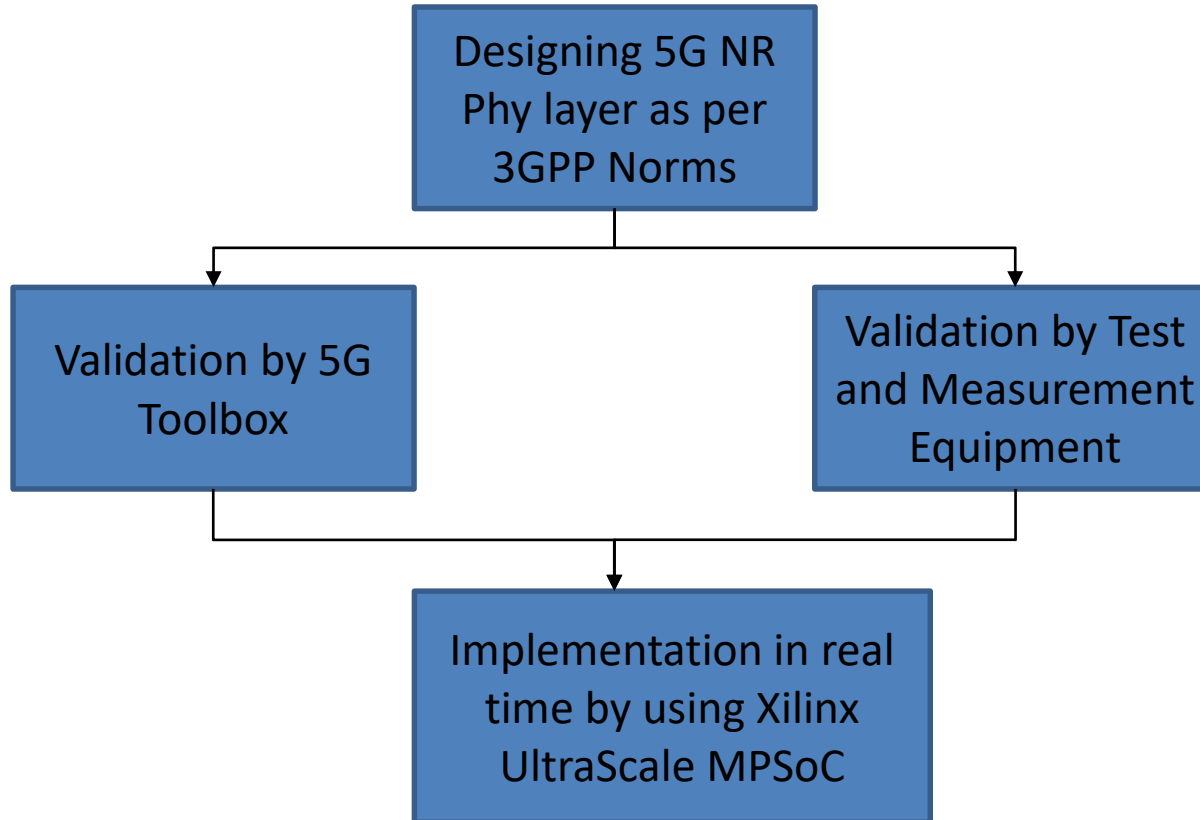
Signal and Channels as per Specifications

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

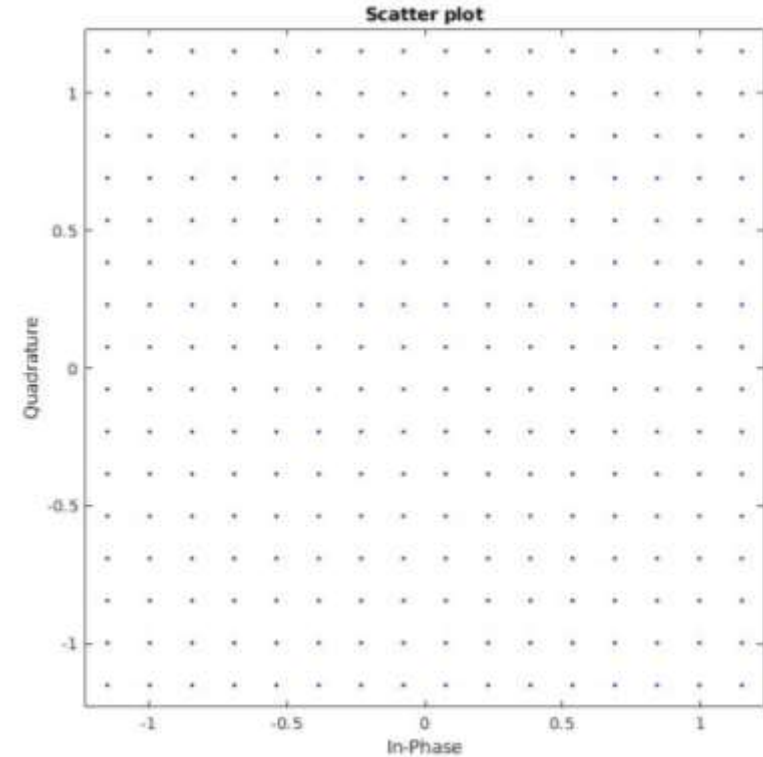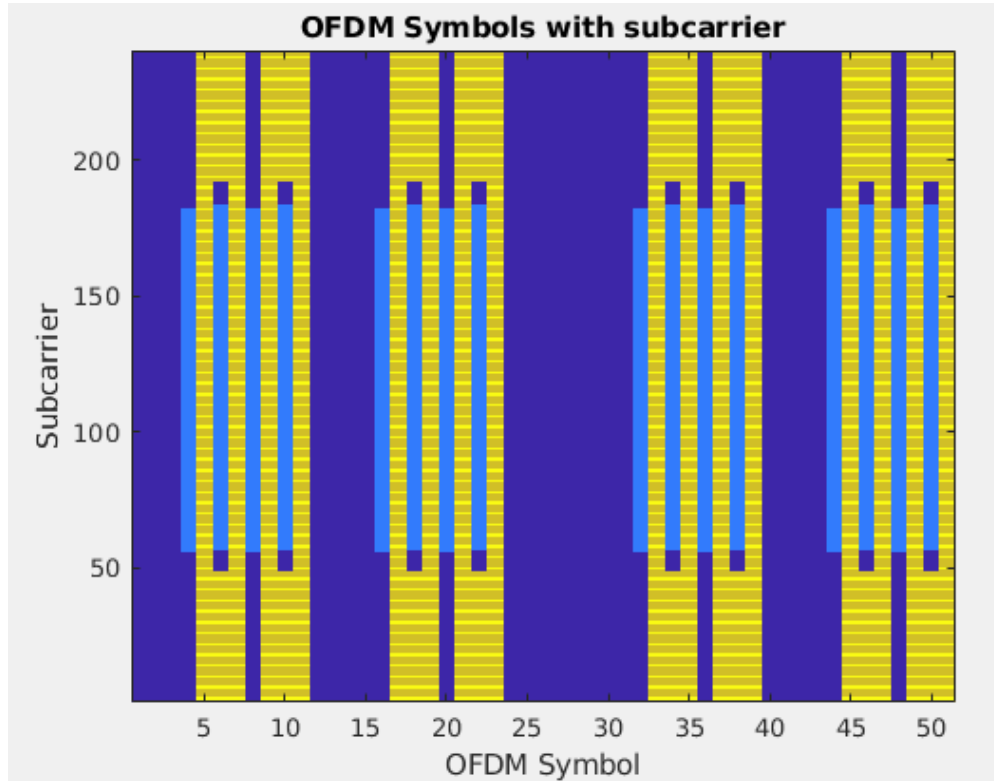# Resource Grid of 5G NR

Resource Grid of 5G NR
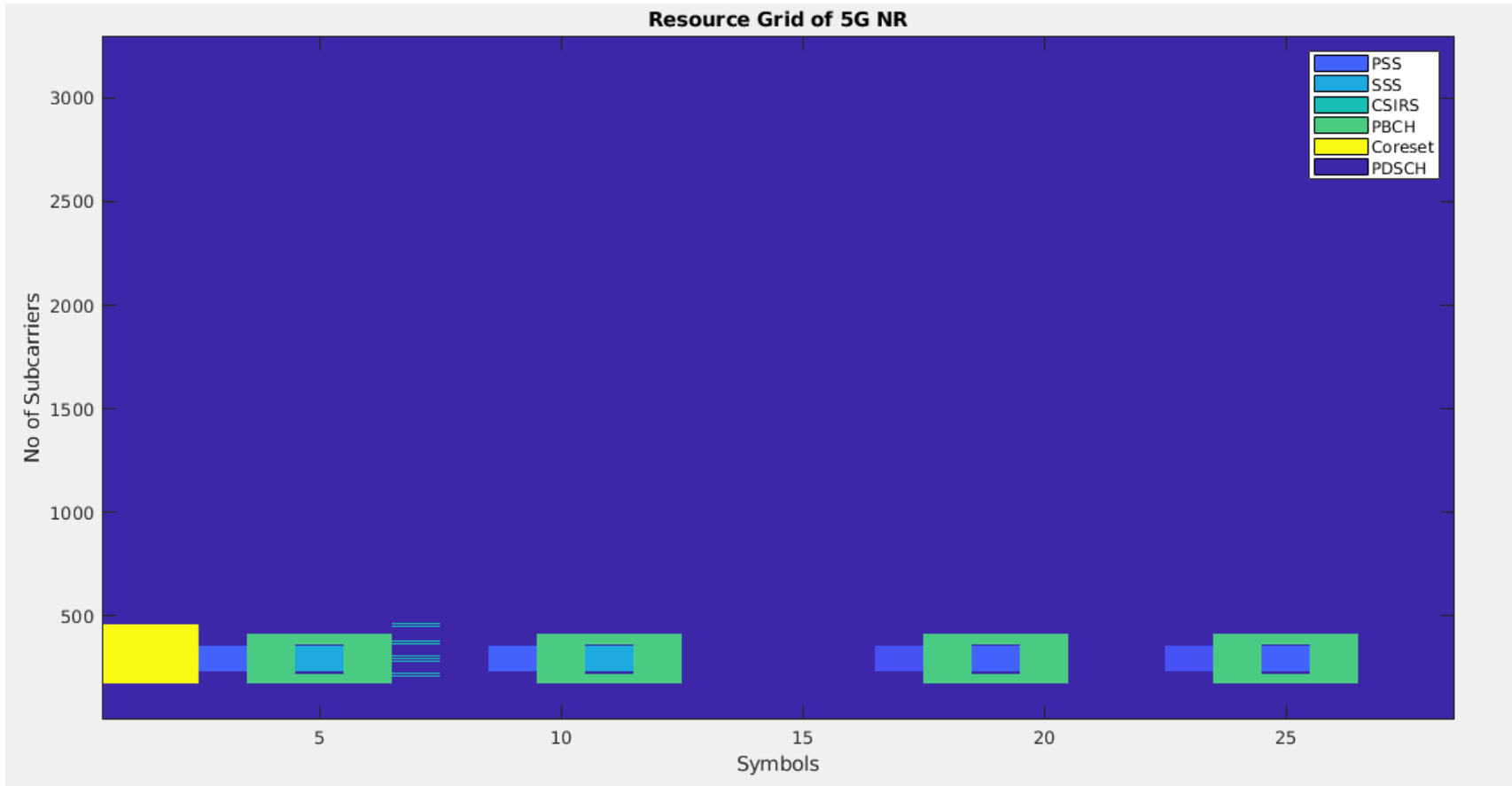
Spectrum of 5G NR n77 band
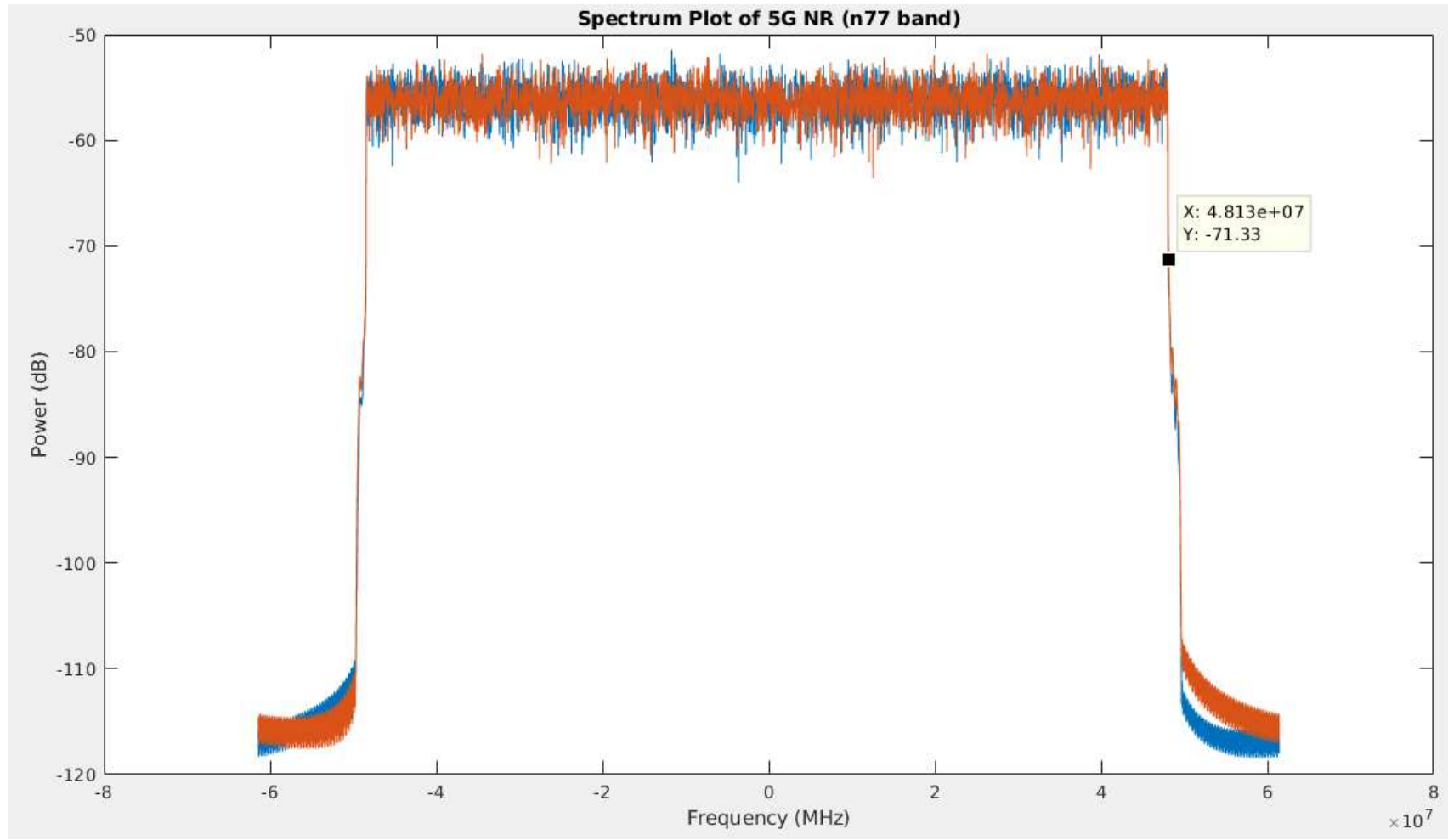
Synchronization Signal Block and Scatter

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.