Evolution of Carrier Aggregation (CA) for 5G

What's New in Mobile CA

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5G New Radio Spectral CA

CA is a technology that combines two or more carriers into one data channel to enhance the data capacity of a network. Using existing spectrum, CA helps mobile network operators (MNOs) provide increased uplink and downlink data rates. CA has been crucial in increasing user throughput in 4G and it will be just as important for 5G.

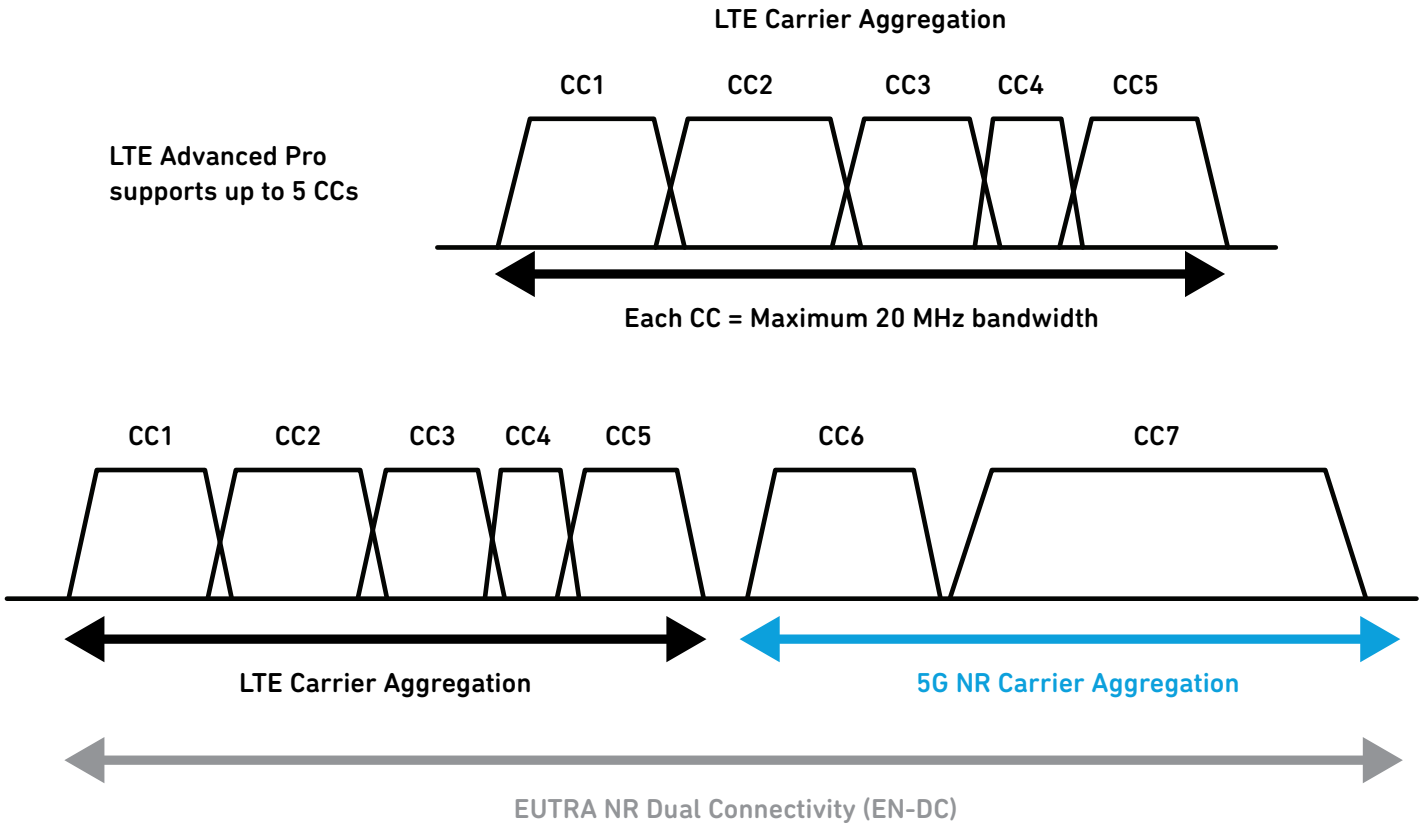
For 4G, CA allows MNOs to increase bandwidth and utilize fragmented frequency resources to provide higher data rates for user equipment. It improves peak data rates up to 2 Gbps as well as optimizes user throughput at low load.

CA in 5G new radio (NR) will provide multi-connectivity with asymmetric upload and download, providing even more bandwidth, to a single user; up to 700 MHz is available in millimeter wave frequencies. In the sub-7 GHz band, up to 400 MHz of instantaneous bandwidth can be achieved using four 100 MHz channels.

5G New Radio CA and Dual Connectivity

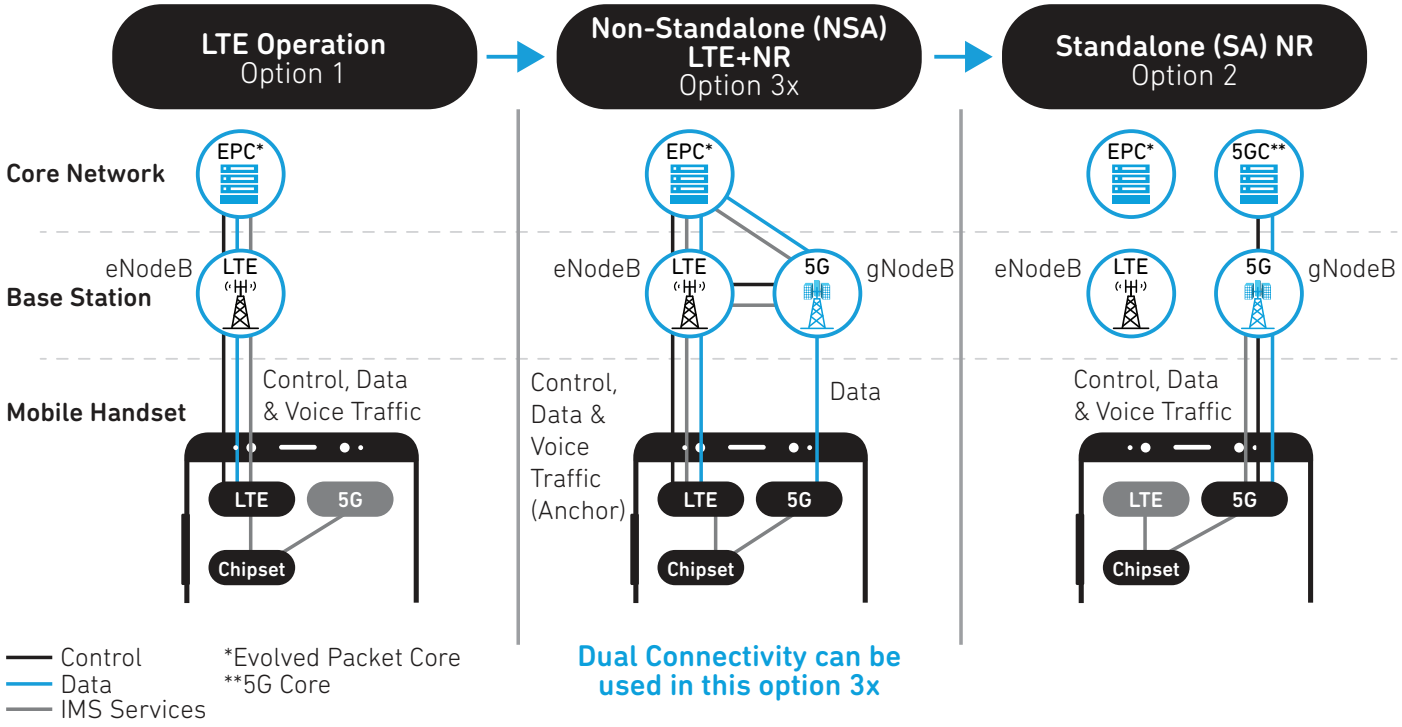
4G LTE-Advanced Pro supports up to 5 component carriers (CC) as shown in Figure 1. 5G NR CA now supports up to 16 contiguous and non-contiguous CCs and can aggregate new 5G bands up to approximately 1 GHz of spectrum. Dual connectivity allows a user equipment to simultaneously transmit and receive data on multiple CCs from cwo cell groups (i.e. a master eNB and secondary eNB). Using EUTRA + NR – dual connectivity (EN-DC) allows networks to take advantage of 4G and 5G spectrum to increase user throughput, provide mobile signal robustness and support load-balancing among eNBs.

Figure 1: LTE and 5G NR carrier aggregation.



As the networks evolve from LTE to 5G, CA must also evolve. To facilitate a quick conversion to 5G, 3GPP presented MNOs with multiple options as shown in Figure 2 below. These options establish the evolution from LTE to non-standalone (NSA) and finally to 5G NR standalone (SA). NSA utilizes a scheme very similar to CA, combining an LTE anchor band for control and a 5G NR band to deliver faster data rates, as shown in option 3x. This option is where EUTRA + NR – dual connectivity (EN-DC) is introduced. In EN-DC, both LTE and 5G NR carriers are used simultaneously.

Figure 2: Progressive transition of 5G NR deployment.

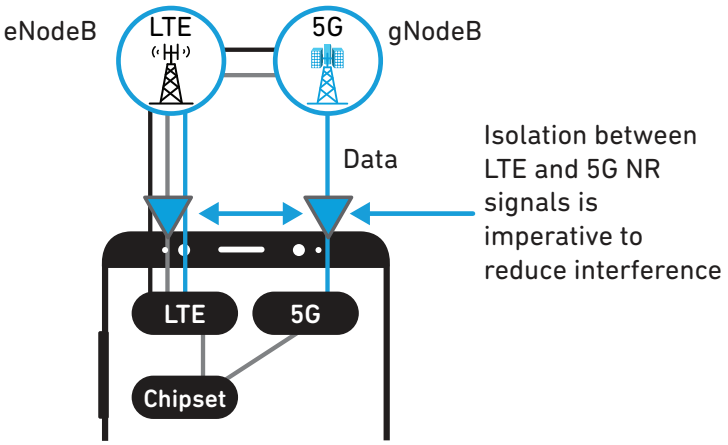


Design Challenges with EN-DC

With EN-DC, two high power signals are transmitted from one phone: the LTE anchor signal and the NR data signal. This configuration requires two complete uplink signal paths in the small area of a mobile phone, which presents major design challenges for engineers, as seen in Figure 3.

High isolation between these two signal paths is critical in limiting intermodulation products and meeting out-of-band emissions specifications. However, there are additional considerations related to signal conditioning and RF module design that are similarly important factors.

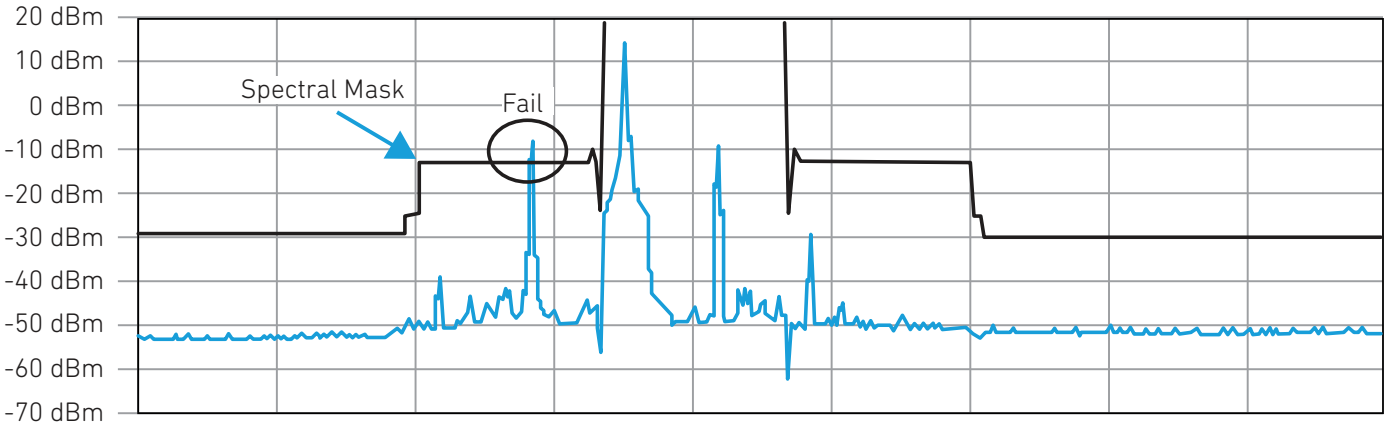
Figure 3: EN-DC antenna isolation.



For example, Figure 4 shows the spectrum captured in a B41+ n41 EN-DC where the two transmit signals (LTE and NR) were not properly managed. In this scenario, two antennas were used to support the EN-DC transmit signals and the spectrum below shows a measurement at one of the two antennas. We see the primary transmit signal at this antenna, the coupled power from the second transmit signal and the intermodulation products that arise from non-linear components in the transmit path. The low frequency intermodulation product in this example causes the phone to fail the 3GPP spectral mask requirements.

Engineers must be prudent in their phone designs when EN-DC is used. Qorvo is at the forefront of these difficult RF challenges and has the expertise to help phone makers solve these complexities.

Figure 4: EN-DC spectral emissions mask considerations.



For more CA help, try our 2 and 3 CA calculators on Qorvo's Design Hub:
www.qorvo.com/design-tools

Maximum Power Reduction Calculators

Uplink 2 and 3 CA tools that calculate maximum power reduction for two and three component carriers.