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5G Component Carrier Disabling Based on Downlink and Uplink Grant Characteristics

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5G COMPONENT CARRIER DISABLING BASED ON DOWNLINK AND UPLINK GRANT CHARACTERISTICS

Abstract

5G networks allow a user equipment (UE) such as a smartphone to connect to the network via different component carriers, but this can undesirably increase UE power consumption. To reduce power consumption, the UE selectively turns off 5G for individual component frequencies based on the available resources and slots associated with each component frequency. The UE detects the downlink and uplink resource blocks and slots for each component frequency, and if the resource blocks or slots are below corresponding thresholds, turns off 5G for the carrier.

Background

To increase available bandwidth, 5G networks support carrier aggregation, wherein a user equipment (UE) (e.g., a smartphone) connects to the network via different component carriers. Each component carrier is associated with a different frequency range (See, e.g., PCT Publication No. . WO 2016028102, U.S. Patent Pub. No. 20190103954). However, 5G networks employ carriers, such as millimeter-wave (mmWave) carriers, that require the UE to consume a relatively large amount of power. This power consumption can impact battery life, resulting in a poor user experience.

Description

An example of a UE, in this case a smartphone, connecting to a 5G network via multiple component carriers is illustrated at Figure 1, below:

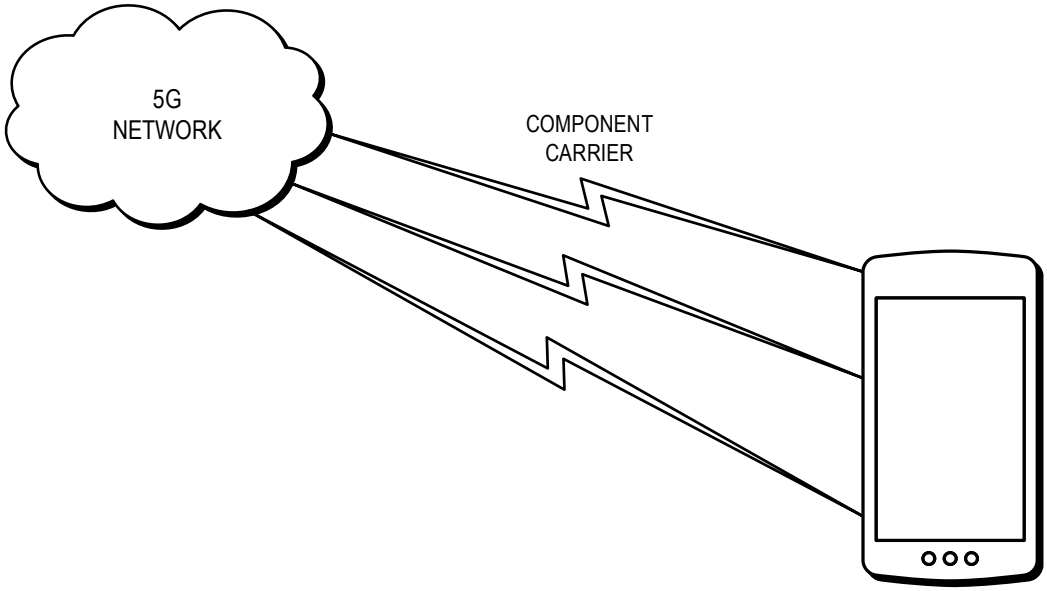

FIG. 1

In the illustrated example, the UE connects to the 5G network via three different component carriers, with each component carrier corresponding to a different frequency range. The network and UE aggregate the three component carriers in order to support increased communication bandwidth. However, as the number of component carriers increases, the required amount of power consumed at the UE increases, especially when the 5G network employs mmWave component carriers. In addition, this power consumption may not provide a commensurate benefit in cases where a given carrier has relatively few resource blocks or downlink (DL) or uplink (UL) slots available to carry data.

To reduce power consumption, the UE can selectively turn off 5G for individual component frequencies based on the available resources and slots associated with each component frequency. The method is illustrated below in Figure 2:

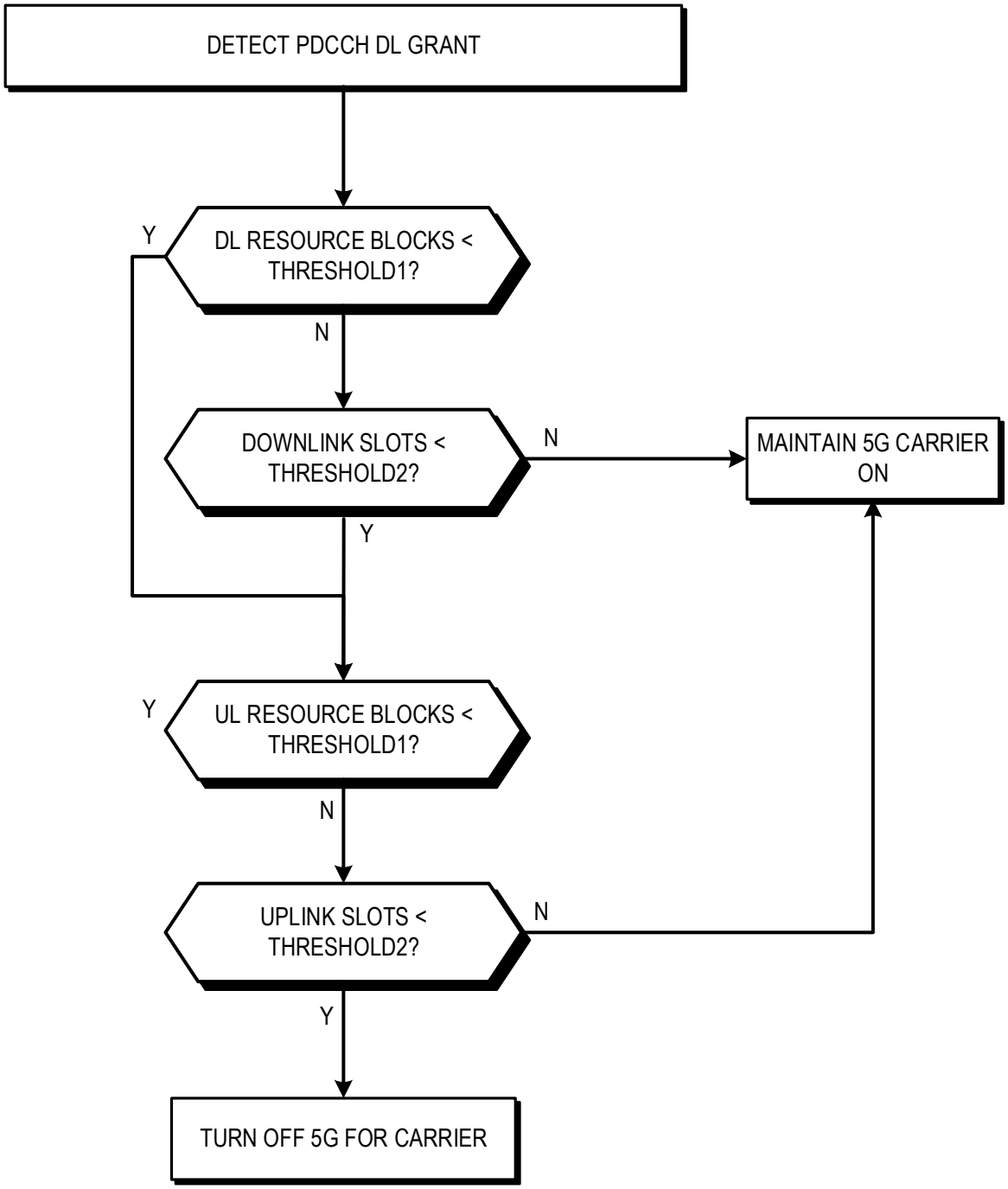

FIG. 2

As illustrated, the UE first detects an indication of a downlink grant for a carrier via the Physical Downlink Control Channel (PDCCH). In response to the downlink grant, the UE determines

whether the number of available DL Resource Blocks (RBs) for the channel is less than a threshold value. If so, the channel is a candidate for deactivating 5G, and the UE checks the UL characteristics as described below.

If the number of available DL RBs for the channel is equal to or greater than the threshold value, the UE determines whether the number of available DL slots for the channel is less than a threshold value. If so, the channel is a 5G deactivation candidate, and the UE proceeds to check UL characteristics as described below. If the number of available DL slots is greater than or equal to the threshold value, then the channel has been determined to have a sufficient number of available RBs and a sufficient number of available DL slots to warrant keeping the channel in 5G. Accordingly, the UE maintains the channel as a 5G channel.

If the channel is a candidate for 5G deactivation based on the channel's DL characteristics, as described above, the UE proceeds to check the characteristics of the UL associated with the channel. The UE first determines if the number of available UL RBs is below a threshold. If so, the characteristics of the channel are such that the amount of power consumption required to maintain the channel is not warranted. Accordingly, the UE turns off 5G for the channel by sending a Channel Quality Indicator (CQI) value of zero to the network.

If the number of available UL RBs is equal to or above the threshold, the UE determines whether the number of available UL slots is lower than a threshold. If so, the UE again determines that maintaining the channel in 5G is not warranted, and therefore sends the CQI value of zero to turn off 5G for the channel. If the number of available UL slots is greater than or equal to the threshold value, then the channel has been determined to have a sufficient number of available UL RBs and a sufficient number of available UL slots to warrant keeping the channel in 5G and the UE maintains the channel as a 5G channel.