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December 2021

## Opportunistic Data Network Selection For User Equipment With Multiple Subscriber Identification Module Cards

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### Recommended Citation

Sasindran, Sooraj and Ramachandran, Amruth, "Opportunistic Data Network Selection For User Equipment With Multiple Subscriber Identification Module Cards", Technical Disclosure Commons, (December 09, 2021)

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## OPPORTUNISTIC DATA NETWORK SELECTION FOR USER EQUIPMENT WITH MULTIPLE SUBSCRIBER IDENTIFICATION MODULE CARDS

### Abstract

A user equipment (UE) includes multiple subscriber identification module (SIM) cards to connect to different networks, including any available opportunistic data network. To support connection to 5G opportunistic data networks, the UE employs the primary network stack (the network stack associated with the primary SIM card) to connect to a 5G communications network (e.g., a 5G cellular network), and further employs the primary network stack to periodically scan for opportunistic data networks. In response to detecting a 5G opportunistic data network, the primary network stack transfers the 5G connection capability to a secondary network stack (a network stack associated with a secondary SIM card), and the UE connects to the 5G opportunistic data network via the secondary network stack, while connecting the primary network stack to another communications network (e.g., a Long-Term Evolution (LTE) or 4G communications network). The UE is thereby able to detect and connect to 5G opportunistic data networks, even when only one of the multiple SIM cards is able to have 5G capability at one time.

### Background

Opportunistic networks are networks of unknown or uncertain availability (e.g., ad hoc networks) that, when present, can support improved network quality or an improved experience for the user of a UE. Conventionally, a multi-SIM UE (that is, a UE having multiple SIMs) supports connection to an opportunistic data network by switching from single standby mode to dual standby mode in response to entering a specified geofence area, the geofence area indicating the potential presence of an opportunistic data network. In the dual standby mode, the UE modem scans for the presence of the opportunistic data network (ODN) using a secondary

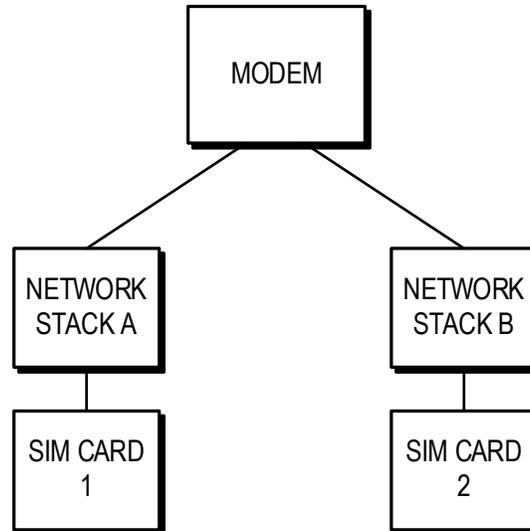
network stack, while maintaining connection to a traditional Mobile Network Operator (MNO) network with the primary network stack. In response to detecting the ODN with the secondary network stack, the modem can connect to the ODN via the secondary network stack, while the primary network stack maintains connection to the MNO network.

However, in some cases the modem of the UE is configured so that only one network stack is permitted to employ 5G connectivity. Accordingly, if the primary stack of the UE is connected to a 5G MNO network in the dual standby mode, the secondary stack cannot scan for, and therefore cannot detect the 5G ODN. The user is therefore unable to take advantage of the services of the 5G ODN.

### **Description**

As described further below, a UE having multiple SIM cards and associated network stacks can detect and connect to a 5G ODN by employing a periodic scanning scheme. In particular, the UE employs a primary network stack to periodically scan for available 5G ODNs. In response to detecting a 5G ODN, the UE transfers 5G connectivity from the primary network stack to a secondary network stack. The UE then connects to the 5G ODN with the secondary network stack and connects the primary network stack (now having LTE/4G connectivity) to a 4G MNO. The UE can then employ the 5G ODN for specified services, such as Internet data services. By employing the periodic scanning scheme, the UE is able to detect and connect to 5G ODNs even when the UE can only assign 5G connectivity to one network stack at a time.

Figure 1, below, illustrates components of an example UE:

**FIG. 1**

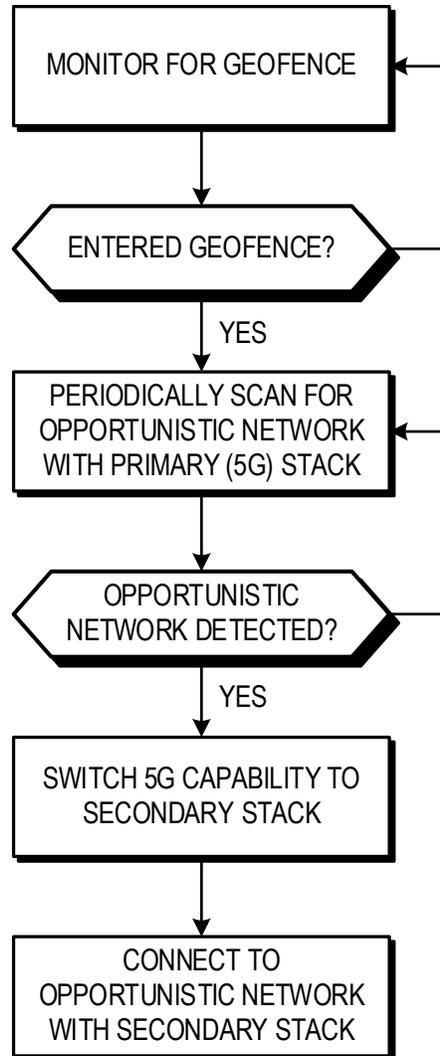
In the depicted example, the UE includes a modem configured to connect to one or more networks, including MNO networks and ODNs. To connect to the networks, the modem employs network stacks, with each network stack assigned by the modem to connect to a corresponding network. Each network stack is associated with a corresponding SIM card. Thus, in the example shown, the UE includes two SIM cards, designated SIM card 1 and SIM card 2, each with a corresponding network stack, designated Stack A and Stack B, respectively.

The modem is capable of connecting to either or both of 5G networks (that is, networks that comply with the 5G network protocols) and LTE/4G networks (networks that comply with LTE/4G network protocols and referred to hereinafter as 4G networks). To connect to a network, the modem employs one of Stack A and Stack B according to conventional network connection techniques. Further, the modem can configure either stack to connect to either type of network, and can change the configuration of either stack to change the connectivity of the network stack. Thus, for example, the modem can configure either Stack A or Stack B to

connect to a 5G network and can also configure either Stack A or Stack B to connect to a 4G network. A network stack that is configured to connect to a 5G network is referred to herein as having 5G connectivity and, similarly, a network stack that is configured to connect to a 4G network is referred to herein as having 4G connectivity. Thus, the modem can configure either Stack A or Stack B to have either 5G connectivity or 4G connectivity, and can dynamically change the connectivity of Stack A or Stack B. However, the modem is configured such that only one of Stack A and Stack B can have 5G connectivity at a time.

In operation, the modem maintains connection to a 5G MNO using one of the network stacks, designated the primary network stack. For purposes of example, it is assumed that Stack A is the primary network stack. As noted above, conventionally a UE employs another network stack, designated the secondary network stack, to scan for available ODNs. However, because the primary network stack is assigned the 5G connectivity for the UE, employing a secondary network stack (e.g., Stack B) to scan for ODNs would mean that the modem could not detect 5G ODNs (because the secondary network stack can only be assigned 4G connectivity).

Accordingly, to detect and connect to 5G ODNs, the UE employs a periodic scanning process, as illustrated at Figure 2:

**FIG. 2**

As illustrated, to implement the ODN periodic scanning process, the UE first monitors whether the UE has entered a specified geofencing area for a 5G ODN. It is assumed that the UE is employing the primary network stack (Stack A) with 5G connectivity to maintain a connection to a 5G MNO. In response to determining that the UE has entered the geofencing area, the modem periodically scans for the 5G ODN using the primary network stack. Because the primary network stack has 5G connectivity, the periodic scans are able to detect the 5G ODN. In

response to detecting a signal of sufficient strength from the ODN, the modem transfers 5G connectivity to a secondary network stack (Stack B) and configures the primary network stack for 4G connectivity. The modem then connects to the 4G MNO with the primary network stack and connects to the 5G ODN using the secondary network stack. The modem can then use the connection with the 5G ODN for specified services, such as Internet data services.

In some cases, the modem only uses the connection with the 5G ODN for services when the quality of the connection is above a threshold level. In response to the connection with the 5G ODN falling below the threshold, the modem can reassign one or more of the services to the primary network stack but maintain the connection with the 5G ODN via the secondary network stack, and reassign the services back to the secondary network stack when the connection quality rises above the threshold level. The UE can also monitor the demand for services on the primary network stack and, in response to that demand rising above a threshold, disconnect from the ODN, reassign 5G connectivity to the primary network stack, connect to the 5G MNO with the primary network stack, and provide services via the 5G MNO.

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