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Opportunistic Mobile Network Access

Shivank Nayak

Sathish Karunakaran

Jibu Joseph

Qin Zhang

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ABSTRACT

A neutral host network (NHN) is a mobile network in which wireless coverage is provided by infrastructure that is shared across operators. A neutral host network may provide mobile services such as LTE over unlicensed spectrum. The sharing of infrastructure and use of unlicensed spectrum produces cost savings for operators, which in turn lowers end-user cost.

This disclosure provides techniques for a mobile device to seamlessly transition data carriers between the network of a traditional service provider and an NHN without impacting voice connectivity.

KEYWORDS

- neutral host network
- NHN
- LTE
- dual standby
- network selection
- protocol stack
- wireless service provider
- wireless carrier
- mobile network

BACKGROUND

When small cells are deployed within spaces such as stadiums, malls, etc., the owner of the space, e.g., a landlord, controls access to wireless infrastructure, e.g., base stations, uninterrupted power supply, equipment racks, etc. Traditionally, each operator that provides

service to the space deploys dedicated infrastructure. However, dedicated infrastructure may be difficult or costly to install if a space has tight confines. A solution that has recently emerged is to have commonly deployed infrastructure that is used by multiple service providers. In this scenario, the landlord becomes a neutral host that is impartial to service providers and provides small-cell mobile services.

Wireless mobile services are provided by such neutral host networks (NHN) or similar technologies often over unlicensed spectrum. Owing to use of common infrastructure and unlicensed spectrum, NHN services are of relatively low cost to the end user, and hence often preferred. An NHN may have agreements with some operators, wherein their subscribers attach to the NHN in the absence of the operator's own coverage. However, NHNs are predominantly deployed independently, e.g., a mobile device acquires an NHN cell if the user so desires and permits.

An NHN is often configured in a data-only fashion, e.g., without voice services. Thus, in a typical scenario, the NHN provides data coverage while the user's traditional service provider provides both voice and data. Therefore, a user transitioning to an NHN still needs some access to their traditional service provider in order to retain voice capability.

DESCRIPTION

This disclosure describes seamless transition of a mobile device between an NHN and a traditional mobile service provider such that there is no impact to voice connectivity. The mobile device determines an appropriate time and location to start searching for NHN cells. If an NHN is found, the mobile device transitions to a dual-stack mode, wherein a primary stack handles the traditional service provider and a secondary stack handles the NHN. The NHN cell is acquired at the secondary stack, and data services are migrated to the NHN cell. Voice services may remain

on the primary stack, e.g., if the user's traditional service provider does not have a VoIP agreement with the NHN operator. As the user moves out of coverage area of the NHN, data services with the traditional service provider are re-established on the primary stack, and the secondary stack is wound down. In this manner, data continuity is provided across transitions to and from NHNs, with no impact to voice connectivity.

Certain definitions are made in order to clarify exposition.

- *Primary carrier*: user's traditional mobile service provider or cellular subscription.
- *Macro cell*: primary carrier network cell using, e.g., LTE or similar technologies.
- *Primary stack*: radio software protocol stack that acquires/provides service over primary carrier.
- *Secondary stack*: radio software protocol stack that acquires and provides service over NHN.
- *Dual standby*: a mode of a mobile device wherein two parallel protocol stacks share the same radio-frequency front-end, and each stack provides services simultaneously with the other.

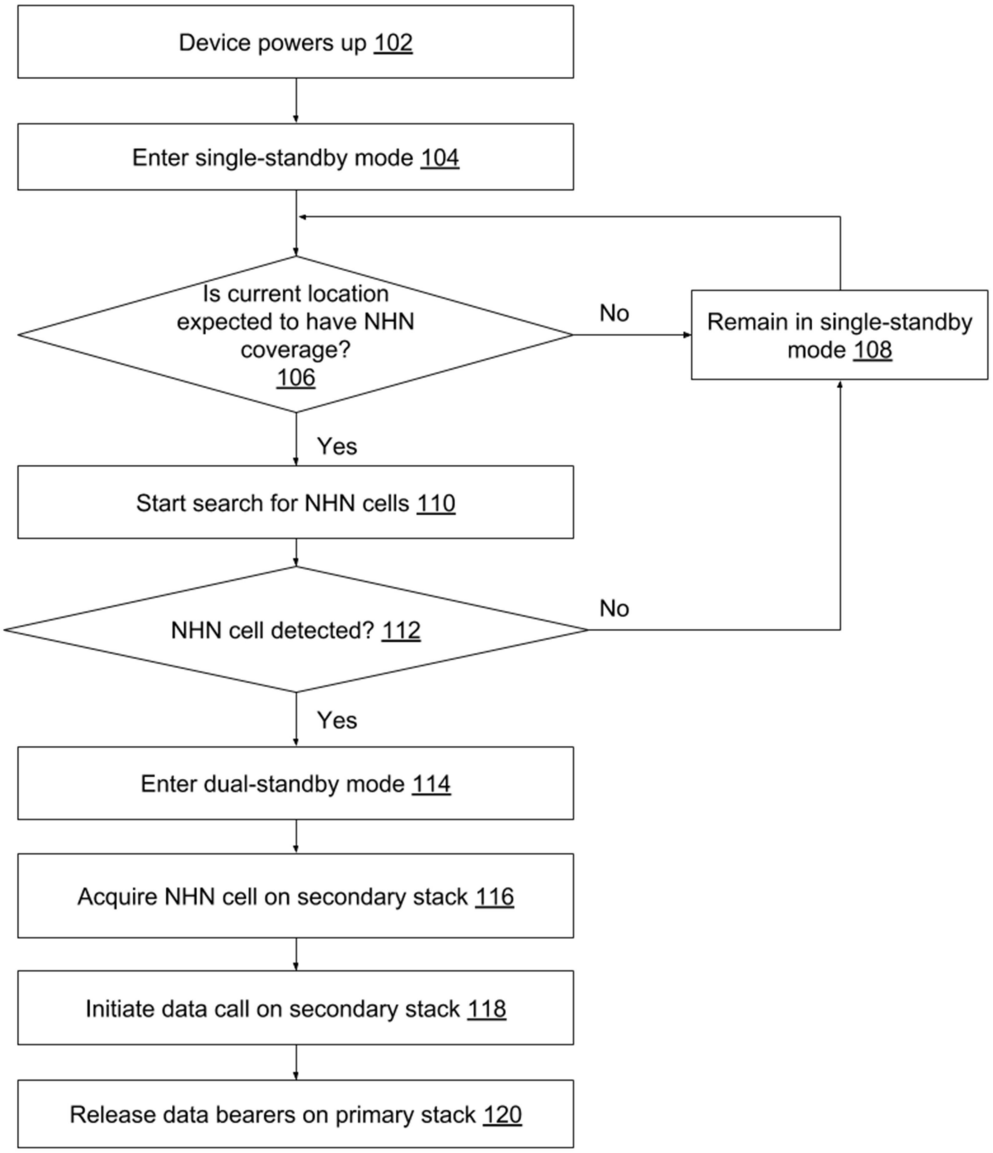

Fig. 1: Primary carrier to NHN transition

Fig. 1 illustrates an example process for the transition of a mobile device from primary carrier to NHN, per techniques of this disclosure. Upon power-up (102), the mobile device enters single-standby mode (104). In this mode, the primary stack is active while the secondary stack is dormant. The device acquires the primary carrier network for voice and data services.

Based on a pre-acquired location information database, the mobile device determines if the current location is expected to have NHN coverage (106). The location information database

may be fetched from a central server that hosts a database of macro-cells or locations where NHN cells are found. A preferred list of NHN networks is configured on the device and updated via server push. Additionally, or alternatively, the mobile device creates a local database of preferred and available NHN cells. The cells are marked with location identities, e.g., cell-id, LAC, TAC, etc., of the primary carrier cell where the cells were found.

If NHN deployment is detected in areas without other cellular coverage, the database entries for such NHNs are marked with device location. To construct the database, the mobile device performs periodic and infrequent scans for NHN networks, e.g., when the mobile device is in idle mode. Whenever an NHN cell is found, the device location, current acquired macro cell, and its neighbors are noted in the database as NHN-coverage areas. Once NHN service is acquired, the corresponding NHN network is added to the list of available/allowed NHN networks.

If the current location is not expected to have NHN coverage, the mobile device remains in single-standby mode (108). If the current location is expected to have NHN coverage, the mobile device starts a search for NHN cells (110). If an NHN cell is not found (112), the mobile device remains in single-standby mode.

If an NHN cell is detected (112), the mobile device dynamically transitions to dual-standby mode (114). In dual-standby mode, two parallel radio protocol stacks are active simultaneously. A primary protocol stack continues handling the primary carrier, including voice calls, while the NHN cell is acquired on the secondary protocol stack (116).

Once the NHN is successfully acquired, a data call is initiated over NHN (118), and data connectivity of the mobile device is migrated to the NHN cell. Data bearers on primary stack are released (120).

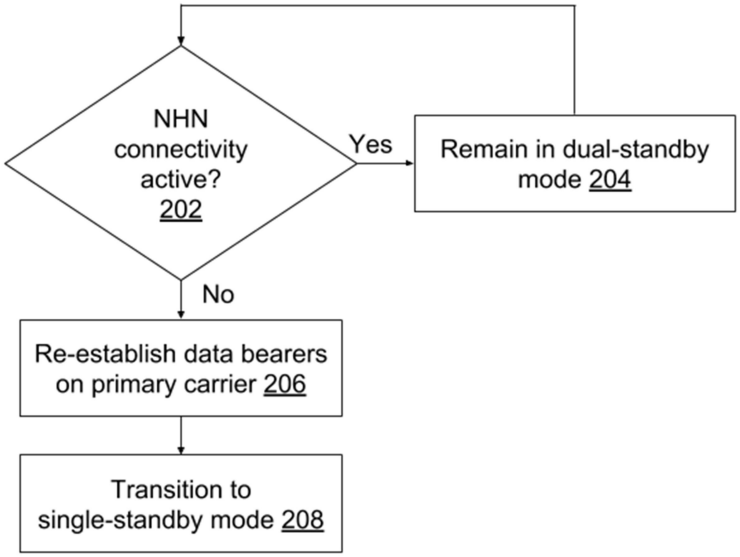

Fig. 2: NHN to primary carrier transition

Fig. 2 illustrates an example process for transition of a mobile device from NHN to the primary carrier. If NHN connectivity is active (202), the mobile device remains in dual-standby mode (204). Upon losing NHN connectivity, e.g., due to the mobile device moving out of NHN coverage area, data bearers on the primary carrier are re-established (206), thereby ensuring data continuity. The secondary stack is wound down, and the device transitions to single-standby mode (208).

In some mobile devices, when a voice call is initiated on a primary stack, the NHN on the secondary stack may not have access to RF resources. In such cases, when a voice call is originated, data activity is automatically shifted to the primary stack, which usually provides for concurrent voice and data as for example in WCDMA (3G) or LTE (4G) technologies. Upon end of the voice call, data activity is moved back to the secondary stack (NHN).

CONCLUSION

A neutral host network (NHN) is a mobile network in which wireless coverage is provided by infrastructure that is shared across operators. A neutral host network may provide mobile services such as LTE over unlicensed spectrum. The sharing of infrastructure and use of unlicensed spectrum produces cost savings to operators, which in turn lowers end-user cost. This disclosure provides techniques for a mobile device to seamlessly transition data carriers between the network of the traditional service provider and an NHN without impacting voice connectivity.