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NETWORK LISTEN FUNCTION WITH EMBEDDED AUXILIARY RECEIVER

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ABSTRACT

In-band network listen mechanisms employed in Time Division Duplex (TDD) systems often lead to service disruptions. This proposal provides a novel technique that optimizes network listen (NL) operation by enabling synchronized NL receive functions during locally blank physical resource blocks (PRBs), which may help to expose neighbor radio utilization of resources on a regular basis. This novel technique may facilitate in-band network listen functionality, while ensuring that service is not disrupted, even for a slot duration.

DETAILED DESCRIPTION

On-channel TDD network listen (NL) in a radio unit (RU) and/or a next Generation node B (gNB or gNodeB) normally requires a downlink "silent period" to be enacted in which the RU/gNB ceases transmissions and switches to the receive (RX) mode for sniffing nearby gNB signals. This creates a slot-duration gap in downlink continuity, which, of course, adversely affects availability and latency (especially for Ultra-Reliable Low-Latency Communication (URLLC) sessions). These gaps can be as high as 15-20 milliseconds (ms) in commercially available chipsets.

During New Radio (NR) gNB operation, not all physical resource blocks (PRBs) are utilized unless the system is running at absolute full capacity. PRB selection by the Layer 2 (L2) scheduler tends to seek blocks that have the lowest interference from neighbors.

This proposal provides a radio system that enables synchronized NL receive functions during locally blank PRBs, which should expose neighbor gNB utilization of the same on a regular basis. Figure 1, below, illustrates example details for the system in which an NL radio provides a synchronized NL that receiver will: a) recover frequency and phase information and discipline the local gNB reference oscillator and b) be able to recover reference signals and cell broadcast frames as well for network management, location and ranging operations.

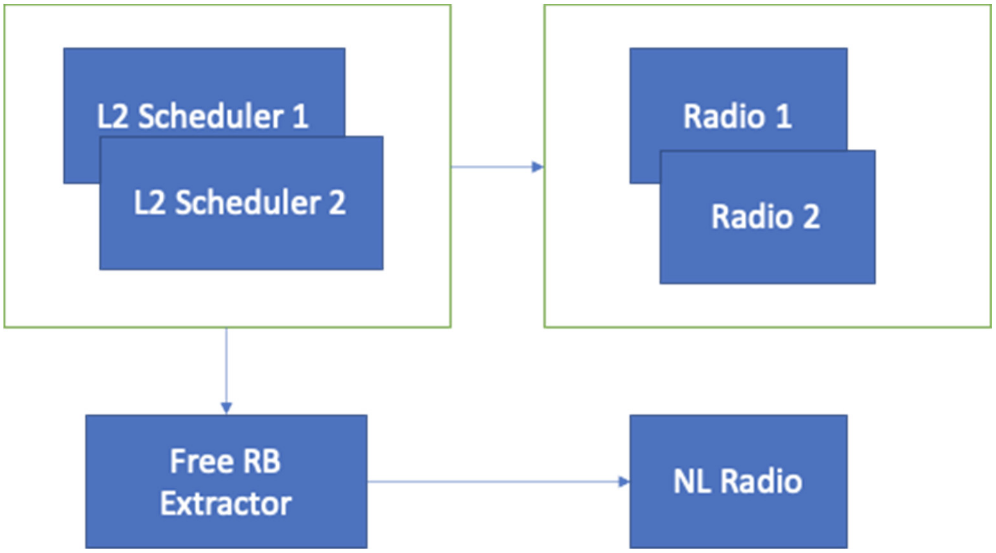

Figure 1: Example NL Receiver System

Some of Self-Organizing Network (SON) algorithms rely on NL detected neighbor cell information for carrying out Physical Cell Identifier (PCI) and/or Root-Sequence-Index (RSI) selection, automated neighbor relations, channel selection, etc. such that the local gNB sees no burden or availability detriment.

Unlike in 4G or other systems, synchronization (synch) signals are not carried on empty PRBs in 5G NR. Thus, filtering will not end up hearing self-transmissions. This makes a 5G NR system the perfect candidate for implementing the system of this proposal.

In some instances, it may be possible that adjacent cells are transmitting on different parts of a channel, for example, sync signals and broadcast signals being transmitted on different parts of the same channel. In order to detect cells or to synchronize with those cells, rather than always allocating PRBs starting from zero (0) a L2 scheduler can divide the bandwidth into multiple parts (e.g., sub-bands). As a result, the scheduler can skip one part at time in each slot while scheduling users in which the "left out" part can be used for NL scanning. In this manner, the scheduler can complete scanning the full band in a few of slots, which may help to more predictably detect cells.

Figure 2, below, is a message sequencing diagram for an example call flow illustrating example operations that may be performed utilizing the system of this proposal.

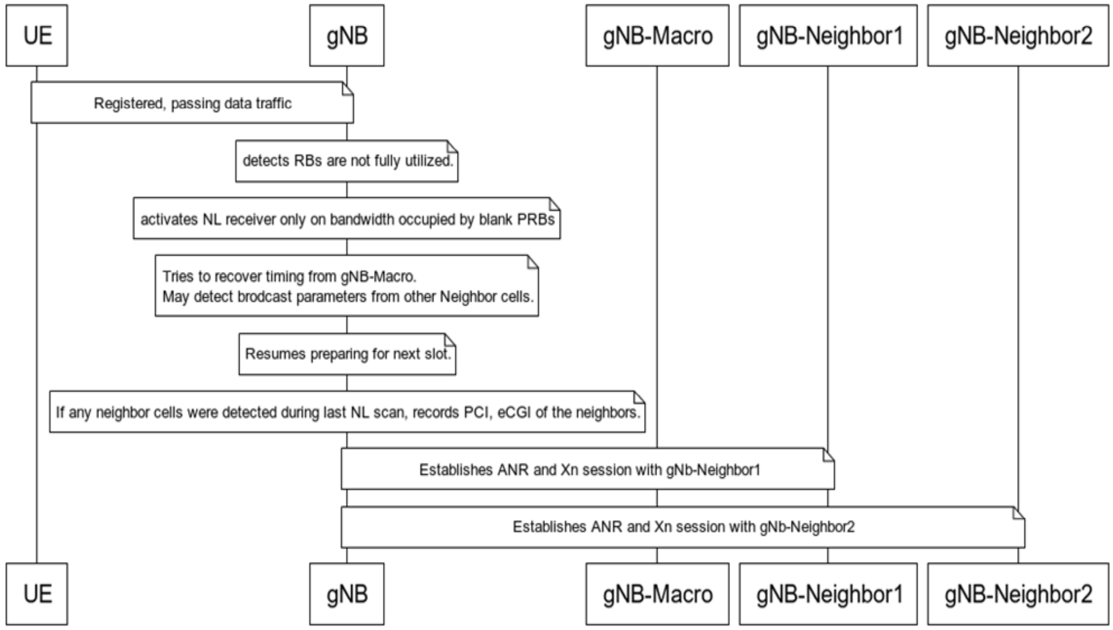

Figure 2: Example Call Flow

An implementation that provides multi-protocol and auxiliary functions on a common, real- time processing platform may enable the unique functionality of this system by 1) having precise timing and sync between radio subsystems through a common reference, 2) foreknowledge of local PRB scheduling, and 3) control plane (CP) and/or Operations, Administration, and Maintenance (OAM) utilization of auxiliary RX information elements.

It should be noted that the system of this proposal does not involve any variation of synchronization mechanisms known in the art. Rather, the distinction of this proposal from the common art is *when* listening is performed and *how* listening is performed. The proposal builds upon the general principles of over-the-air synchronization by providing an "at the ready" NL receiver that does not require the TDD transceiver from switching over from TX to RX and back, reserving and then consuming numerous slots, which represent downlink capacity.

Consider additional example details regarding PRB allocation for implementations involving a large number of neighboring gNBs that are trying to sync from one single source and/or from each other. As a gNB starts up on the network, it uses a conventional NL function to assess TDD configuration and frame start timing. It also learns reference signal allocation from the neighboring gNBs. Phase/frequency sync may then be maintained utilizing techniques of this proposal with greatly reduced overhead, since the reference frames of neighbors are now known. Therefore, a greater number of gNBs can easily be accommodated utilizing techniques of this proposal. Additionally, there may not be such a high density of gNBs so as to create prohibitive capacity limitations due to excessive frequency reuse.

Further for the system of this proposal, the NL receiver may utilize either Multimedia Broadcast Single Frequency Network (MBSFN) frames (meant for user equipment) or sync signals themselves to facilitate the NL functionality.

In summary, this proposal may provide for: 1) blanking downlink PRBs corresponding to the sync frames/signals from neighbors and 2) acquiring sync signals with an "always on" auxiliary NL receiver, which requires no turnaround time. The savings in availability of the gNB downlink (long-term, while sync is being maintained) is substantial and many slots may be preserved that would otherwise be consumed in the TX to RX to TX mode changes of a gNB having conventional NL functions. Thus, the techniques of this proposal may not completely replace the normal NL mode, but rather may provide for optimizing the ongoing sync mechanism with much less overhead.