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| Title | **Definitions and Operations of small BSs** |
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| Re: | Call for Contributions: Multi-tier Networks (16-13-0108-01-000q) |
| Abstract | This contribution proposes to add some description on BS type and BS supported in IEEE P802.16q |
| Purpose | To discuss and adopt the proposed texts in IEEE P802.16q AWD |
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# BS Type and BS Subscription Type

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# Introduction

This contribution proposes some texts that describe general operation of small BSs such as small BS type, subscription type, identifier, MS network entry with small BS, etc.

# Editorial Instruction

* Black text: the text is existing in the base standard
* ~~Red text: with strike-through~~: the texts is removed from the amendment standard
* Blue text without underline:the text is added in the amendment standard without underline
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# Proposed Texts

----------------- Start of the text proposal --------------------------------------------------------------------------------------

[*Change subclause 17.1 on page 26 as follows:*]

**17.1 General**

A small BS is a base station controlled by at least one macro BS or an ASN gateway, with smaller transmission power/cell size than that of the macro base station. Small BSs provide different cell coverage and perform different roles according to their types. For example, a Femto BS is typically installed by a subscriber in the home or SOHO to provide the access to closed or open groups of users as configured by the subscriber and/or the access provider. The Femto BS is typically connected to the service provider’s network via one (or multiple) wired and/or wireless broadband connection (cable, DSL, WirelessMAN-OFDMA systems, etc.)

Small BSs operate in licensed spectrum and may use the same or different frequency as macro BSs. Their coverage may overlap with a macro BS.

Small BSs are intended to serve public users like an Open Subscriber Group (OSG), or to serve a Closed Subscriber Group (CSG), which is a set of subscribers authorized by the small BS owner or the network service provider. CSG can be modified by the service level agreement between the subscriber and the network service provider.

**17.1.1 Small BS subscription types**

A small BS may belong to one of the following subscription types:

1. CSG-Closed small BS: A CSG-Closed small BS is accessible only to the MSs, which are in its CSG, except for emergency services. MSs that are not the members of the CSG, should not try to access CSG-Closed small BSs.
2. CSG-Open small BS: A CSG-Open small BS is primarily accessible to the MSs that belong to its CSG, while other MSs, outside CSG, may also access such small BS, and will be served at lower priority. CSG-Open small BS will provide service to such MSs as long as the QoS of MS in its CSG is not compromised.
3. OSG (Open Subscriber Group) small BS: An OSG small BS is accessible to any MS.

**17.1.2 small BS state diagram**

A small BS transitions through multiple states during its operation, as illustrated in Figure xxx. On Power-On, it enters the Initialization State. In this state, procedure like configuration of radio interface parameters and time/frequency synchronization should be performed. After attachment to service provider’s core network, which may include synchronization to the Macro BS, it enters the Operational State. In the Operational State, if the small BS becomes unattached to the service providers network or if it fails to meet operational requirements (may include failed synchronization), it reverts to the Initialization State.

In the Operational State, normal and duty-cycle modes are supported. In duty-cycle mode, the small BS reduces radio interface activity in order to reduce interference to neighbor cells. A further functional description of duty-cycle mode of small BS can be found in 17.4.2.

In Standby State, only standby mode is supported. In standby mode, the small BS deactivates its air interface to reduce power consumption and interference to neighbor cells. A further functional description of standby mode of small BS can be found in 17.4.3.



Figure xxx – Functional overview of small BS states and operational modes

**17.1.3 Closed subscription group identifier (CSG ID)**

A large number of small BSs may be configured with the same CSG, which has the same group of authorized MSs. A common identifier may be assigned to all CSG small BSs that are part of the same CSG. An MS may use this identifier for accessibility check for the CSG small BSs.

The common identifier, CSG ID, is used to identify the BSs belonging to the same CSG. CSG ID shall be unique within the same operator ID. The CSG ID may be derived from the full BS ID as a part of the BS ID or may be provided by the CSG small BS through DCD message or may be pre-provisioned by the network. How to derive the CSG ID from BS ID is out of scope. The MS’s CSG white list may contain the CSG ID and/or BS ID of allowable small BSs.

**17.1.3.1 CSG white list**

The CSG white list, is a list of small BSs to which the MS is subscribed and can access. These small BSs are identified based on the common identifier defined in 17.1.3.

The MS’s local white list may contain the allowable BS IDs or common identifiers of CSGs and relevant information to help derivation of the allowable BS IDs from common identifier. Besides this the whitelist may include absolute/relative location information of CSG small BS, such as GPS information and overlay Macro ABS BSID.

An MS subscribed to CSG(s) should be configured with a CSG White List for its accessibility check. The CSG white list may be provided to the MS by the service provider through the network using messaging that is outside the scope of this standard.

**17.1.4 Small BS initialization and network exit**

**17.1.4.1 Small BS initialization**

The small BS shall perform small BS initialization procedures to register itself to the network and to configure itself through the backhaul connection. The details of small BS initialization procedure including obtaining and configuring small BS air interfaces operation parameters through the backhaul connection are out of scope of this specification.

**17.1.4.2 Small BS network exit**

The small BS network exit procedure is performed through the backhaul network and may be triggered either by the small BS or the other network entities. Before powering down or changing to the initialization state, the small BS may first trigger its attached MSs, if any, to handover to the neighbor cells, if feasible, or to proceed with MS network exit procedure. Which of the two procedures for MS the small BS should trigger before network exit depends on the network policy decision which is out of scope of this standard. When the backhaul link of the small BS is down or the connection with the service provider network is lost for a configurable pre-defined time, the small BS shall consider itself de-attached from the network. In such a case, the small BS shall follow the same procedure performed before power down or transition to Initialization State.

**17.1.5 Network synchronization**

A small BS shall be synchronized with the overlay BS network at least in all cases where interference in UL or DL can occur, where the synchronization means the aligned frame boundary, and the aligned DL / UL split in TDD systems. The network synchronization may be achieved by small BS scanning of the preamble transmitted by the Macro BSs. For this option, if the small BS can successfully detect the Macro BS preamble, it shall synchronize its downlink transmission with the received preamble signal from Macro BSs. The small BS scanning of Macro BS preamble for network synchronization may be performed before small BS activation or during the inactive interval of duty-cycle mode. The small BS may also achieve network synchronization from GPS or backhaul network (e.g., IEEE Std 1588™).

**17.1.6 Network entry**

The network entry procedure shall be the same as described as in 6.3.9 with the exception of procedures described in this subclause.

**17.1.6.1 MS network entry with small BS**

An MS may prefer its subscribed CSG small BS, while other small BSs may also be chosen as candidates.

During network entry, the MS acquires the BS ID from the DCD message transmitted by the detected small BS. In addition to the BS ID, the MS may also acquire CSGID and BS subscription type[TBD] from the DCD message. BSID or the acquired or derived CSGID is the identifier for the MS to determine whether it is authorized to access to the detected BS, and may help the MS to quickly exclude the CSG small BS to which it is not subscribed. If the MS supports CSG white-list capability, it may have BS IDs of all CSG small BSs to which the MS is subscribed and is authorized to access. If the small BS is excluded, the MS should continue the scanning until a suitable BS is detected.

**17.1.6.2 small BS reselection by the MS**

When the MS performs initial network entry or network reentry with a small BS, it first performs initial ranging by sending the RNG-REQ message. The MS may include one or more CSGID(s) as part of the RNG-REQ message to the small BS, if one or more CSGID(s) is(are) provisioned in the MS. If the small BS is a CSG small BS, it may have one or more CSGID(s) provisioned in it as well. If it is an OSG small BS, then there shall be no CSGID provisioned for it.

If the small BS is an OSG small BS, then the small BS ignores the CSGID(s) (if sent by the MS) in the RNG-REQ and goes ahead with the next steps. If the small BS is a CSG small BS, the small BS receives the RNG-REQ and, if needed, it looks at the received CSGID(s) and checks if it matches with at least one of its CSGID(s). If there is match of the CSGID, then the small BS knows that the MS is a member of the small BS and goes ahead with the next steps.

If the received CSGID(s) from the MS does not match any of the CSGID(s) of the small BS itself, and the small BS is a CSG-Closed small BS, the small BS shall send a RNG-RSP and in the RNG-RSP it indicates the rejection of access for this MS. In order to help the MS to attach to nearby small BSs, the small BS may provide “Redirection Info” to the MS in the RNG-RSP message. The “Redirection Info” consists of the BS ID, preamble index, and center frequency of other nearby cells. Since the small BS can not be sure that the MS is not its member as the MS may not have included all the CSGIDs in its white list in RNG-REQ, the small BS provides its CSGID(s) and sets the Ranging Abort bit=1 with the Ranging Abort Timer = 65535 in the RNG-RSP in this case so that the MS can perform the accessibility check for the small BS.

If there are no CSGIDs included in the RNG-REQ, then the normal network entry procedure as in 6.3.9 applies.

If the small BS has CSGID info of nearby small BSs, then it may filter the “Redirection Info” based on the CSGID(s) provided by the MS in the RNG-REQ message and only provide the OSG small BSs as well as CSG small BSs with matching CSGID(s) to the MS in the “Redirection Info”. After receiving the “Redirection Info”, the MS may attach to the other candidate BSs.

In case the MS does not support CSG white-list capability or does not have any CSGID(s) provisioned in its CSG white list, the “Redirection Info” may be provided in the REG-RSP message.

----------------- Start of the text proposal --------------------------------------------------------------------------------------