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# Corrections and clarifications on connections, service flows, CID and SFID

## 1 Current text ambiguities and inconsistencies

### *1.1 Transport connection and management connection*

The standard defines two fundamentally different kinds of connections:

- Management connections
- Transport connections

Unfortunately, there are ambiguities in the standard because it does not clearly specify to what kind of connection an operation or message applies, leading to some confusion on what the BS or SS can do. For instance, it is not clear whether a DSx operation can be applied to management connections or not. Dynamic services require a SFID (SS-initiated DSA_RSP, BS-initiated DSA_REQ, DSC_REQ, DSD_REQ), so are not applicable to management connections, because management connections don't have an SFID. This is in contradiction with 6.3.14.9.4: "if a Basic, Primary Management, or Secondary Management Connection of an SS is deactivated, that SS is deregistered and shall re-register."

### *1.2 Mapping between CID and connection*

A connection has one and only one CID, however, it is not clear from the standard if a given CID can map to more than one connection. Or, to put it in another way, it is not clear whether the UL and DL share a common unique CID address space, or whether they each have their own distinct CID addressing spaces. The lack of clear distinction between management and transport connection adds to the ambiguity.

In the definition section, the standard implies that a CID uniquely identifies a connection within a shared UL and DL addressing space:

> §3 (p7) - 3.13 **connection identifier** (CID): A16-bit value that identifies a connection to equivalent peers in the MAC of the base station (BS) and subscriber station (SS). It maps to a service flow identifier (SFID), [...]
>
> §3 (p7) - 3.12 **connection**: A unidirectional mapping between base station (BS) and subscriber station (SS) medium access control (MAC) peers for the purpose of transporting a service flow's traffic. Connections are identified by a connection identifier (CID).
> §3 (p11) - 3.60 **transport connection identifier**: A unique identifier taken from the CID address space that uniquely identifies the transport connection.
>
> §3 (p11) 3.61 **transport connection**: A connection used to transport user data

In the MAC section, it is also stated that the mapping between CID and connections is unique within each downlink and uplink channel, which seems to imply separate addressing spaces:

> § 6.3.1.1 (p 33): The CID can be considered a connection identifier even for nominally connectionless traffic like IP, since it serves as a pointer to destination and context information. The use of a 16-bit CID permits a total of 64K connections within each downlink and uplink channel.
>
> § 6.3.1.1 (p33): The CIDs for these connections shall be assigned in the RNG-RSP and REG-RSP messages. The message dialogs provide three CID values. The same CID value is assigned to both members (uplink and downlink) of each connection pair.

It is generally agreed that CID uniquely corresponds to either one transport connection or a pair of management connections (1 uplink and 1 downlink), within a shared addressing space. However, without a clarification some vendors could understand the text differently, and have the same CID used in the uplink and downlink, but mapping to two different transport connections. This choice has an important impact in terms of implementation and it is important to clarify the standard to that respect.

### *1.3 Mapping between connection and service flow*

There are ambiguities in the text to determine the possible mapping between connection and service-flows and these ambiguities are linked to the ambiguities mentioned in the two previous sections. Section §6.3.14 (QoS) is the main section where this mapping is detailed but nowhere in this section it is clearly stated that the QoS framework applies only to transport connections though only transport connections have an SFID. This ambiguity is reinforced by §3 and in particular by the definition of a CID:

> § 3.13 **connection identifier** (CID): […] It maps to a service flow identifier (SFID), which defines the Quality of Service (QoS) parameters of the service flow associated with that connection.

Section §6.3.14 raises another ambiguity: can a transport CID map to two different service flows? Although figure 95 states that the mapping between service flow and connection is 1-1 and although there exists a 1-1 mapping between SFID and Service flow (first paragraph of §6.3.14), it is not clear from this section whether a given CID can simultaneously map to an uplink service flow and a downlink service flow. Although the definition (§3) of a transport CID and the fact that service flow applies to transport connections implicitely impose a 1-1 mapping, the standard as it is written is ambiguous on that matter and this should be clarified to allow building interoperable products complying to the standard.

## 2 Proposed Text Changes

[Modify §3]

[Insert before 3.9]

3.9 **broadcast connection**: the management connection used by the base station (BS) to send MAC management messages on a downlink to all subscriber station (SS). The broadcast connection is identified by a well-known CID (See Table 343).

3.12 **connection**: A unidirectional mapping between base station (BS) and subscriber station (SS) medium access control (MAC) peers ~~for the purpose of transporting a service flow's traffic~~. Connections are identified by a connection identifier (CID). The MAC defines two kinds of connections: management connections and transport connections. ~~All traffic is carried on a connection, even for service flows that implement connectionless protocols, such as Internet Protocol (IP). See also: connection identifier.~~

3.13 **connection identifier** (**CID**): A 16-bit value that identifies a transport connection or a UL/DL pair of associated management connections (i.e. belonging to the same SS) to equivalent peers in the MAC of the base station (BS) and subscriber station (SS). The CID address space is common between UL and DL and Table 343 specifies how it is partitioned among the different type of connections. ~~It maps to a service flow identifier (SFID), which defines the Quality of Service (QoS) parameters of the service flow associated with that connection.~~ Security associations (SAs) also exist between keying material and CIDs. See also: connection. ~~service flow identifier.~~

3.27 **initial ranging connection** ~~identifier~~: a management connection used by the subscriber station (SS) and the base station (BS) during the initial ranging process. The initial ranging connection is identified by a ~~A~~ well-known CID (See Table 343) ~~that is used by a subscriber station (SS) during the initial ranging process~~. This CID is defined as constant value within the protocol since an SS has no addressing information available until the initial ranging process is complete.

[Insert before 3.29]

3.29 **management connection**: a connection used for the purpose of transporting MAC management messages (See: basic connection, primary management connection, broadcast connection, initial ranging connection) or standards-based messages (See: secondary management connection) required by the medium access control layer. Table 14 specifies which MAC management message is transmitted on which of the management connections.

~~3.60 transport connection identifier: A unique identifier taken from the CID address space that uniquely identifies the transport connection.~~

3.61 **transport connection**: A connection used for the purpose of transporting a service flow's traffic. All data traffic is carried on a transport connection, even for service flows that implement connectionless protocols, such as Internet Protocol (IP). It maps to a service flow identifier (SFID), which defines the Quality of Service (QoS) parameters of the service flow associated with that connection.

[Modify § 5.2]

The packet CS resides on top of the IEEE Std 802.16 MAC CPS. The CS performs the following functions, utilizing the services of the MAC:

a) Classification of the higher layer protocol PDU into the appropriate transport connection

[Modify § 5.2.2]

Classification is the process by which a MAC SDU is mapped onto a particular transport connection for transmission between MAC peers. The mapping process associates a MAC SDU with a transport connection, which also creates an association with the service flow characteristics of that connection. This process facilitates the delivery of MAC SDUs with the appropriate QoS constraints.

[Modify § 6.1]

[…]

The MAC is connection-oriented. For the purposes of mapping to services on SSs and associating varying levels of QoS, all data communications are in the context of a transport connection. Service flows may be provisioned when an SS is installed in the system. Shortly after SS registration, transport connections are associated with these service flows (one connection per service flow) to provide a reference against which to request bandwidth.

Additionally, new transport connections may be established when a customer's service needs change. A transport connection defines both the mapping between peer convergence processes that utilize the MAC and a service flow. The service flow defines the QoS parameters for the PDUs that are exchanged on the connection.

The concept of a service flow on a transport connection is central to the operation of the MAC protocol. Service flows provide a mechanism for uplink and downlink QoS management. In particular, they are integral to the bandwidth allocation process. An SS requests uplink bandwidth on a per connection basis (implicitly identifying the service flow). Bandwidth is granted by the BS to an SS as an aggregate of grants in response to per connection requests from the SS.

Transport c~~C~~onnections, once established, may require active maintenance. The maintenance requirements vary depending upon the type of service connected. For example, unchannelized T1 services require virtually no connection maintenance since they have a constant bandwidth allocated every frame. Channelized T1 services require some maintenance due to the dynamic (but relatively slowly changing) bandwidth requirements if compressed, coupled with the requirement that full bandwidth be available on demand. IP services may require a substantial amount of ongoing maintenance due to their bursty nature and due to the high possibility of fragmentation. As with connection establishment, modifiable connections may require maintenance due to stimulus from either the SS or the network side of the connection.

Finally, transport connections may be terminated. This generally occurs only when a customer's service requirements ~~contract~~ changes. The termination of a transport connection is stimulated by the BS or SS.

All three of these transport connection management functions are supported through the use of static configuration and dynamic addition, modification, and deletion of service flows ~~connections~~.

[Modify § 6.3.1.1]

Each SS shall have a 48-bit universal MAC address, as defined in IEEE Std 802®-2001. This address uniquely defines the SS from within the set of all possible vendors and equipment types. It is used during the initial ranging process to establish the appropriate connections for an SS. It is also used as part of the authentication process by which the BS and SS each verify the identity of the other.

Connections are identified by a 16-bit CID. At SS initialization, two pairs of management connections (uplink and downlink) shall be established between the SS and the BS and a third pair of management connections may be optionally generated. The three pairs of management connections reflect the fact that there are inherently three different levels of QoS for management traffic between an SS and the BS. The basic connection is used by the BS MAC and SS MAC to exchange short, time-urgent MAC management messages. The primary management connection is used by the BS MAC and SS MAC to exchange longer, more delay-tolerant MAC management messages. Table 14 specifies which MAC Management messages are transferred on which of these two connections. Table 14 also specifies MAC management messages transported on the Broadcast Connection. Finally, the Secondary Management Connection is used by the BS and SS to transfer delay tolerant, standards-based [Dynamic Host Configuration Protocol (DHCP), Trivial File Transfer Protocol (TFTP), SNMP, etc.] messages. These messages are carried in IP datagrams, as specified in 5.2.6. Messages carried on the Secondary Management Connection may be packed and/or fragmented For the SCa, OFDM, and OFDMA PHY layers, management messages shall have CRC. Use of the secondary management connection is required only for managed SS.

The CIDs for these connections shall be assigned in the RNG-RSP and REG-RSP messages. The message dialogs provide three CID values. The same CID value is assigned to both members (uplink and downlink) of each connection pair.

For bearer services, the BS initiates the set-up of service flows ~~connections~~ based upon the provisioning information distributed to the BS. The registration of an SS, or the modification of the services contracted at an SS, stimulates the higher layers of the BS to initiate the setup of the service flows ~~connections~~. When admitted or active, service flows are uniquely associated with transport connections. MAC management messages shall never be transferred over transport connections. Bearer or data services shall never be transferred on the Basic, Primary, or Secondary Management connections.

The CID can be considered a connection identifier even for nominally connectionless traffic like IP, since it serves as a pointer to destination and context information. ~~The use of a 16-bit CID permits a total of 64K connections within each downlink and uplink channel.~~

Requests for transmission are based on these CIDs, since the allowable bandwidth may differ for different connections, even within the same service type. For example, an SS unit serving multiple tenants in an office building would make requests on behalf of all of them, though the contractual service limits and other connection parameters may be different for each of them.

Many higher layer sessions may operate over the same wireless CID. For example, many users within a company may be communicating with Transmission Control Protocol (TCP)/IP to different destinations, but since they all operate within the same overall service parameters, all of their traffic is pooled for request/grant purposes. Since the original local area network (LAN) source and destination addresses are encapsulated in the payload portion of the transmission, there is no problem in identifying different user sessions.

The type of service and other current parameters of a service are implicit in the CID; they may be accessed by a lookup indexed by the CID.

[Modify § 6.3.14]

The principal mechanism for providing QoS is to associate packets traversing the MAC interface into a service flow as identified by the transport CID. A service flow is a unidirectional flow of packets that is provided a particular QoS. The SS and BS provide this QoS according to the QoS Parameter Set defined for the service flow.

[Modify § 6.3.14.2]

(b) CID: the connection ID of the transport connection ~~Mapping to an SFID~~ that exists only when the service flow is ~~connection has an~~ admitted or active. ~~Service flow.~~ The relationship between SFID and transport CID, when present, is unique. An SFID shall never be associated with more than one transport CID, and a transport CID shall never be associated with more than one SFID.

[Modify § 6.3.14.3]

The major objects of the architecture are represented by named rectangles in Figure 95. Each object has a number of attributes; the attribute names which uniquely identify it are underlined. Optional attributes are denoted with brackets. The relationship between the number of objects is marked at each end of the association line between the objects. For example, a service flow may be associated with from 0 to N (many) PDUs, but a PDU is associated with exactly one service flow. The service flow is the central concept of the MAC protocol. It is uniquely identified by a 32-bit (SFID). Service flows may be in either the uplink or downlink direction. There is a one-to-one mapping between admitted and active service flows (32-bit SFID) and transport connections (16-bit CID). ~~Admitted and active service flows are mapped to a 16-bit CID~~.

Outgoing user data is submitted to the MAC SAP by a CS process for transmission on the MAC interface. The information delivered to the MAC SAP includes the CID identifying the transport connection across which the information is delivered. The service flow for the connection is mapped to MAC transport connection identified by the CID.

[Edit Figure 95] Transport Connection

[Modify § 6.3.14.9.4]

Any service flow can be deactivated with a DSC command by sending a DSC-REQ message, referencing the SFID, and including a null ActiveQoSParamSet. ~~However, if a Basic, Primary Management, or Secondary Management Connection of an SS is deactivated, that SS is deregistered and shall re-register. Therefore, care should be taken before deactivating such service flows.~~ If a service flow that was provisioned is deactivated, the provisioning information for that service flow shall be maintained until the service flow is reactivated.

Any service flow can be deleted with the DSD messages. When a service flow is deleted, all resources associated with it are released. If a service flow for a provisioned service is deleted, the ability to re-establish the service flow for that service is network management dependent. Therefore, care should be taken before deleting such service flows. ~~However, the deletion of a provisioned service flow shall not cause an SS to reinitialize.~~