IEEE P802.22  
Wireless RANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| [802.22b Functions] | | | | |
| Date: 2013-08-08 | | | | |
| Author(s): | | | | |
| Name | Company | Address | Phone | email |
| Changwoo Pyo | NICT | 3-4, Hikarino-oka, Yokosuka, 239-0847, Japan |  | cwpyo@nict.go.jp |
| Zhang Xin | NICT | 20 Science Park Road, #01-09A/10 TeleTech Park, Singapore |  | amy.xinzhang@ieee.org |
| Chunyi Song | NICT | 3-4 Hikarion-Oka, Yokosuka, Japan |  | songe@ieee.org |
| Keiichi Mizutani | NICT | 3-4 Hikarion-Oka, Yokosuka, Japan |  | mizk@nict.go.jp |
| Pin-Hsun Lin | NICT | 3-4 Hikarion-Oka, Yokosuka, Japan |  | pslin@nict.go.jp |
| Gabriel Porto Villardi | NICT | 3-4 Hikarion-Oka, Yokosuka, Japan |  | gpvillardi@nict.go.jp |
| Masayuki Oodo | NICT | 3-4 Hikarion-Oka, Yokosuka, Japan |  | moodo@nict.go.jp |
| Ryuhei Funada | NICT | 3-4 Hikarion-Oka, Yokosuka, Japan |  | funada@nict.go.jp |
| Hiroshi Harada | NICT | 3-4 Hikarion-Oka, Yokosuka, Japan |  | harada@ieee.org |

Abstract

This document is a revision of initialization and network association (7.14) for 802.22b systems and provies definitions related with the revision.

**Notice:** This document has been prepared to assist IEEE 802.22. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

**Release:** The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE’s name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE’s sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.22.

**Patent Policy and Procedures:** The contributor is familiar with the IEEE 802 Patent Policy and Procedures

<[**http://standards.ieee.org/guides/bylaws/sb-bylaws.pdf**](http://standards.ieee.org/guides/bylaws/sb-bylaws.pdf)>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair Apurva Mody <[apurva.mody@ieee.org](mailto:apurva.mody@ieee.org)> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.22 Working Group. **If you have questions, contact the IEEE Patent Committee Administrator at <**[**patcom@ieee.org**](mailto:patcom@ieee.org)**>**.

**Summary**

**7.9 ARQ mechanism**

**7.9.1 ARQ block usage**

**7.9.2 ARQ Feedback IE format**

**7.9.3 ARQ state machine parameters**

**7.9.4 ARQ procedures**

**7.9.5 ARQ-enabled connection setup and negotiation**

**7.9.6 ARQ operation**

**7.9.6.3 Receiver state machine**

**7.9.6.4 ARQ for relaying**

In 802.22b systems, there are two ARQ modes. The first mode is an end-to-end ARQ mode that is performed between an MR-BS and an S-CPE; the second mode is a two-link ARQ mode that is performed both between an MR-BS and an R-CPE and between an R-CPE and an S-CPE. The support of ARQ mode is performed during the network entry. In the end-to-end ARQ mode, the ARQ operation is same as 7.9.4. An R-CPE does not have an additional ARQ functionality. In another ARQ mode, ARQ operation between an R-CPE and an S-CPE is same as 7.9.4. In two-link ARQ mode, the ARQ operation is divided into two links that are relay link between MR-BS and R-CPE and access link between R-CPE and S-CPE. The detailed procedure for two-link ARQ mode is described in the 6.3.4.6.4.1.

**7.9.6.4.1 Two-link ARQ mode**

For access link between R-CPE and S-CPE, the ARQ state machine runs between the R-CPE and the S-CPE. For relay link between MR-BS and R-CPE, the ARQ state machine runs between the MR-BS and the R-CPE. The MR-BS schedules retransmission to the R-CPE when ARQ block is corrupted in the relay link. The R-CPE schedules retransmission to the S-CPE when ARQ block is corrupted in the access link.

The ARQ feedback IE described in the x.x.x is used by the MR-BS and R-CPE to ACK/NAK to corresponding data transmitted between MR-BS and R-CPE. The ARQ feedback IE is transported either as a packed payload (“piggybacked”) within a packed MAC PDU or as a payload of a standalone MAC PDU defined in x.x.x.

In downlink ARQ operation, when MR-BS sends ARQ block to R-CPE, it waits for the ARQ feedback IE from R-CPE. When ARQ block is corrupted in the relay link, the R-CPE sends NAK to MR-BS, and MR-BS schedules the retransmission of the corresponding ARQ block to R-CPE. When MR-BS receives ACK from R-CPE, it waits for the ACK from the S-CPE relayed by R-CPE. R-CPE may modify the ARQ feedback IE received from S-CPE to inform only ACK to MR-BS. When MR-BS receives ACK from S-CPE, it clears the buffer corresponding to ARQ block. When ARQ block is corrupted in the access link, R-CPE shall not send NAK to MR-BS and shall schedule the retransmission of ARQ blocks to S-CPE. R-CPE shall discard the ARQ block when ARQ block transmission failed in the access link after a timeout of the ARQ\_BLOCK\_LIFETIME. MR-BS or R-CPE discards the corresponding ARQ block after the timeout of its ARQ\_BLOCK\_LIFETIME. MR-BS and RS ARQ\_BLOCK\_LIFETIME are independently operated in MR-BS and R-CPE respectively.

In uplink ARQ operation, when R-CPE receives ARQ block correctly from S-CPE, R-CPE sends ARQ block to MR-BS. When MR-BS receives ARQ block correctly, MR-BS sends ACK to R-CPE and the R-CPE sends ACK to S-CPE. When ARQ block is corrupted in the relay link, the retransmission shall be scheduled from R-CPE to MR-BS. R-CPE discards the corresponding ARQ block after a timeout of ARQ\_BLOCK\_LIFETIME in R-CPE.

**Table xx — ARQ Feedback IE format**

**7.9.6.4.2 ARQ State machine**

The ARQ state machine operation in R-CPE and receiver in MR-BS is the same as described in x.x.x and x.x.x. In case of transmitter state machine in MR-BS, an ARQ block may be in one of the following five states—not sent, outstanding for R-ACK, outstanding for S-CPE-ACK, waiting for retransmission, and data discard. Outstanding for R-ACK is the state waiting for receiving acknowledged from R-CPE. When R-ACK received, the state transits to outstanding for S-CPE-ACK. In this state, MR-BS receives S-CPE-NACK or after ARQ\_BLOCK LIFE\_TIME, the state transits to discard. If MR-BS receives S-CPE-ACK in the state of outstanding for R-ACK or waiting for retransmission, the state transits to done. Other state transition descriptions are the same as transmitter state machine defined in x.x.x. The ARQ Tx block state sequence in MR-BS is shown in Figure 52a.



**7.10 Scheduling services**

Scheduling services represent the data handling mechanisms supported by the MAC scheduler for data transport on a connection. Each connection is associated with a single data service. Each data service is associated with a set of QoS parameters that quantify aspects of its behavior (these parameters are managed using the DSA and DSC messages). Four services (7.7.8.9.9) are supported: Unsolicited Grant Service (UGS), Real-time Polling Service (rtPS), Non-real-time Polling Service (nrtPS), and best effort (BE). A description of each of these services and some of the applications they aim at supporting are described in the paragraphs that follow. Mandatory QoS parameters associated with each of these services are also identified. A detailed description of all supported QoS parameters can be found in 7.7.8.9.

The UGS is designed to support real-time data streams consisting of fixed-size data packets sent at periodic intervals, such as T1/E1 and Voice over IP without silence suppression. The mandatory QoS service flow parameters for this scheduling service are Maximum Sustained Traffic Rate, Maximum Latency, Tolerated Jitter, and Request/Transmission Policy. If present, the Minimum Reserved Traffic Rate parameter shall have the same value as the Maximum Sustained Traffic Rate parameter.

The rtPS is designed to support real-time data streams consisting of variable-sized data packets that are issued at periodic intervals, such as MPEG video. The mandatory QoS service flow parameters for this scheduling service are Minimum Reserved Traffic Rate, Maximum Sustained Traffic Rate, Maximum Latency, and Request/Transmission Policy.

The nrtPS is designed to support delay-tolerant data streams consisting of variable-sized data packets for which a minimum data rate is required, such as FTP. The mandatory QoS service flow parameters for this scheduling service are Minimum Reserved Traffic Rate, Maximum Sustained Traffic Rate, Traffic Priority, and Request/Transmission Policy.

The BE service is designed to support data streams for which no minimum service level is required and therefore may be handled on a space-available basis. The mandatory QoS service flow parameters for this scheduling service are Maximum Sustained Traffic Rate, Traffic Priority, and Request/Transmission Policy.

**7.10.2 Upstream request/grant scheduling**

Upstream request/grant scheduling is performed by the BS with the intent of providing each associated CPE with bandwidth for upstream transmissions or opportunities to request bandwidth. By specifying a scheduling service and its associated QoS parameters, the BS scheduler can anticipate the throughput and latency needs of the upstream traffic and provide polls and/or grants at the appropriate times. Table 177 summarizes the scheduling services and the poll/grant options available for each. The following subclauses define service flow scheduling services for upstream operations.

In 802.22b systems, an RS-SCH message may be used to ensure QoS requirements for UGS and rtPS are met.

**7.10.2.1 UGS**

The UGS service offers fixed-size grants on a real-time periodic basis, which eliminate the overhead and latency of CPE requests and assure that grants are available to meet the flow’s real-time needs. The BS shall provide allocations to the CPE, in both the DS or US via MAP IEs, at periodic intervals based upon the Maximum Sustained Traffic Rate of the service flow. The size of these grants shall be sufficient to hold the fixed-length data associated with the service flow (with associated generic MAC header and Grant management subheader) but may be larger at the discretion of the BS scheduler. In order for this service to work correctly, the Request/Transmission Policy (7.7.8.9.10) setting shall be such that the CPE is prohibited from using any contention request opportunities for this connection.

The Grant Management subheader (7.6.1.2.3) is used to pass status information from the CPE to the BS regarding the state of the UGS service flow. The most significant bit of the Grant Management field is the Slip Indicator (SI) bit. The CPE shall set this flag once it detects that this service flow has exceeded its transmit queue depth. Once the CPE detects that the service flow’s transmit queue is back within limits, it shall clear the SI flag. The flag allows the BS to provide for long-term compensation for conditions, such as lost maps or clock rate mismatches, by issuing additional grants. The poll-me (PM) bit may be used to request to be polled for a different, non-UGS connection.

The BS shall not allocate more bandwidth than the Maximum Sustained Traffic Rate parameter of the Active QoS parameter set, excluding the case when the SI bit of the Grant Management field is set. In this case, the BS may grant up to 1% additional bandwidth for clock rate mismatch compensation.

In 802.22b systems, to meet a UGS service flow’s need, the MR-BS and the R-CPE along the path shall grant fixed size bandwidth to its S-CPE on a real-time periodic basis. The MR-BS or the R-CPE may send RS scheduling information (RS-SCH) in advance to its S-CPE to indicate when and how much bandwidth it will schedule for the service in the future.

**7.10.2.2 rtPS**

The rtPS service offers real-time, periodic, unicast request opportunities, which meet the flow’s real-time needs and allows the CPE to specify the size of the desired grant. This service requires more request overhead than UGS, but supports variable grant sizes for optimum data transport efficiency.

The BS shall provide periodic unicast request opportunities. In order for this service to work correctly, the Request/Transmission Policy setting (7.7.8.9.10) shall be such that the CPE is prohibited from using any contention request opportunities for that connection. The BS may issue unicast request opportunities as prescribed by this service even if prior requests are currently unfulfilled. This results in the CPE using only unicast request opportunities in order to obtain upstream transmission opportunities. The CPE could still send a bandwidth request by sending the BR subheader in a MAC PDU on an existing upstream transmission as well. All other bits of the Request/Transmission Policy are irrelevant to the fundamental operation of this scheduling service and should be set according to network policy.

In 802.22b systems, to meet an rtPS service flow’s need, the MR-BS and the R-CPE along the path shall poll its S-CPE or grant dynamic size bandwidth to its S-CPE on a real-time periodic basis. The MR-BS or the R-CPE may send RS scheduling information (RS-SCH) to its S-CPE to indicate when it will schedule a poll in the future.

**7.7.28 RS-SCH message**

This message may be used for the coordination of the uplink allocation. It is sent by an MR-BS to an R-CPE or sent by an R-CPE to an S-CPE.

**Table xx — RS-SCH message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| RS-SCH\_Message\_Format() { |  |  |
| Management Message Type = xx | 8 bits |  |
| N\_FID | 8 bits | The number of FIDs included |
| For(i=0;i<N\_FID;i++) { |  |  |
| FID | 16 bits | The FID for the CPE |
| Allocation Frame Offset | 8 bits | In terms of number of frames |
| Bandwidth | 8 bits | In number of bytes |
| } |  |  |
| } |  |  |

**7.11 Bandwidth management**

**7.11.1 Bandwidth Requests**

Bandwidth Requests (or simply, Requests) refer to the mechanism that CPEs use to indicate to the BS that they need upstream bandwidth allocation. Two types of bandwidth requests are available in the MAC layer (with proper PHY support).

**7.11.1.1 Contention-based Request**

In this case, a Request comes as a subheader appended to the generic MAC header (see 7.6.1.2.1), which may or may not contain payload. Typically, a Request will not contain a payload if it is the first Request made for the connection. It may contain a payload otherwise.

Because the upstream burst profile can change dynamically, all requests for bandwidth shall be made in terms of the number of bytes needed to carry the MAC header and payload, but not the PHY overhead. The Bandwidth Request message may be transmitted during any upstream allocation, except during any initial ranging interval, UCS notification interval, and SCW.

Bandwidth Requests may be incremental or aggregate. When the BS receives an incremental Bandwidth Request, it shall add the quantity of bandwidth requested to its current perception of the bandwidth needs of the connection. When the BS receives an aggregate Bandwidth Request, it shall replace its perception of the bandwidth needs of the connection with the quantity of bandwidth requested. The Type field in the bandwidth request header indicates whether the request is incremental or aggregate. The self-correcting nature of the request/grant protocol requires that CPEs shall periodically use aggregate Bandwidth Requests. The period may be a function of the QoS of a service and of the link quality.

**7.11.1.2 CDMA Request**

In addition to the transmission of bandwidth requests by the CPE, the PHY also supports the use of a CDMA-based mechanism for the purpose of upstream bandwidth allocation.

As detailed in the PHY spec, the PHY has available a subset of Ranging codes that shall be used for CDMA Bandwidth Requests. The CPE, upon needing to request bandwidth, shall select, with equal probability, a Ranging Code from the code subset allocated to Bandwidth Requests. This Ranging Code shall be modulated onto a Ranging Subchannel and transmitted during the appropriate upstream allocation. The Ranging Subchannel shall be selected among the ones reserved by the MAC for the upstream transmission.

Upon detection, the BS shall provide an upstream allocation for the CPE. The BS does not respond with an allocation on the CPE’s Basic FID. Instead, it broadcasts a CDMA\_Allocation\_IE, which specifies the transmit region and Code that were used by the CPE. This allows a CPE to determine whether it has been given an allocation by matching these parameters with the parameters it used. The CPE shall use the allocation to transmit a MAC PDU with the Bandwidth Request subheader and/or data (this is indicated by the Usage field—see Table 37). The CPE may only omit the Bandwidth Request PDU when the BS indicated so in the CDMA\_Allocation\_IE (see Table 37).

If the BS does not issue the upstream allocation described above, or the MAC PDU with the bandwidth request subheader does not result in a subsequent allocation of any bandwidth, the CPE shall assume that the Ranging Code transmission resulted in a collision and follow the contention resolution as specified in 7.13.

**7.11.1a Bandwidth Request for Relay**

In 802.22b systems, the bandwidth request message, mechanism, and capability defined for the CPE and BS/MR-BS shall be applicable for the R-CPE. Capability of incremental BRs is only mandatory if the R-CPE is a distributed scheduling R-CPE.

**7.11.1a.1 Bandwidth Request by a distributed scheduling R-CPE**

A distributed scheduling R-CPE directly handles the bandwidth requests it receives from its S-CPEs.

A distributed scheduling R-CPE may receive bandwidth requests from its S-CPEs via the MAC signaling header, the grant management subheader or the CDMA bandwidth request code.If the distributed scheduling R-CPE has available uplink bandwidth in DRZ, it shall simply allocate the bandwidth for the S-CPEs. If not, the distributed scheduling R-CPE shall require the bandwidth to the MR-BS.

To forward traffic upstream, a distributed scheduling R-CPE may request uplink bandwidth via a stand-alone bandwidth request header. A distributed scheduling R-CPE may combine the bandwidth requests that arrive from S-CPEs together by using a Container message or with the bandwidth needs of queued packets into one bandwidth request header per QoS class.

The distributed scheduling R-CPE may transmit a BW request header soon after it receives a BW request header from one of its S-CPEs (timed to yield an uplink allocation sequential to the arrival of those packets) instead of waiting for the actual packets to arrive in order to reduce delay in relaying traffic (see Figure 52b).



**7.11.1a.2 Bandwidth Request by a centralized scheduling R-CPE**

In centralized scheduling mode, the MR-BS shall determine the bandwidth allocations (i.e., MAPs) for all links in its cell. As a result, centralized scheduling R-CPEs shall receive the MAPs from the MR-BS for the links to/from their CPEs before they can transmit them.

For the same reason, centralized scheduling R-CPEs shall forward all bandwidth request headers and bandwidth request CDMA ranging code information they receive from CPEs to the MR-BS. The centralized scheduling R-CPEs may combine bandwidth request by using a Container message.

If the centralized scheduling R-CPE has available uplink bandwidth, it shall simply forward the bandwidth request information to the MR-BS. Otherwise, the centralized scheduling R-CPEs shall request uplink bandwidth from the MR-BS using CDMA ranging codes.

If the centralized scheduling R-CPE needs bandwidth for a MAC management message to a CPE, the centralized scheduling R-CPE shall either send a CRZ CDMA ranging code dedicated for that purpose or a BR header. In response, the MR-BS shall allocate bandwidth for a management message in the DL-MAP it sends to the centralized scheduling R-CPE for broadcast.

**7.11.2 Grants**

For a CPE, bandwidth requests reference individual FIDs while each bandwidth grant is addressed to the CPE’s SID, not to individual FIDs. Since it is nondeterministic which request is being honored, when the CPE receives a shorter transmission opportunity than expected (scheduler decision, request message lost, etc.), no explicit reason is given. In all cases, based on the latest information received from the BS and the status of the request, the CPE may decide to perform backoff and request again, discard the SDU, or possibly fragment the SDU to fit the allocation.

A CPE may make use of a US-MAP IE that is broadcast, directed at a multicast polling group of which it is a member, or directed at its SID. In all cases, the US-MAP IE burst profile (e.g., UIUC = 3, 5, or 7) is used, even if the BS is capable of receiving the CPE with a more efficient burst profile. To take advantage of a more efficient burst profile, the CPE should transmit a Bandwidth Request to the BS on its Basic FID using the Bandwidth Request subheader. Unicast polling of a CPE would normally be done by allocating a US- MAP IE directed at its SID. Also note that, in a US-MAP IE directed at its SID, the CPE may make bandwidth requests for any of its connections.

The procedure followed by CPEs is shown in Figure 28. Note that it is the CPE’s local scheduler that decides which connections get the granted bandwidth.

**7.11.2.1 Bandwidth grant for Relay with a distributed scheduling R-CPE**

If the bandwidth request comes from a distributed scheduling R-CPE, the MR-BS shall address the bandwidth grant to the R-CPE’s Basic FID. The distributed scheduling R-CPE may schedule a MAC PDU or relay MAC PDU on the bandwidth allocation it receives.

An MR-BS may send its distributed scheduling R-CPEs uplink scheduling information ahead of time via an RS-SCH management message. This message indicates when a given uplink bandwidth allocation will be granted to the distributed scheduling R-CPE (i.e., in how many frames), the size of the allocation, and the intended CID. The actual bandwidth grant is issued to the distributed scheduling R-CPE using a Data Grant IE in an upcoming ULMAP. In the case of periodic bandwidth grants, the scheduling information need only be sent once (see Figure 52c).

When a distributed scheduling R-CPE receives an RS-SCH management message with uplink scheduling information from the MR-BS, it shall look up the target CPE of the given FID. Based on this scheduling information and the target CPE of the FID, the distributed scheduling R-CPE can determine the appropriate bandwidth allocations and associated RS UL allocation frame offset on the uplinks it controls.



**7.11.2.2 Bandwidth grant for Relay with a centralized scheduling R-CPE**

For centralized scheduling, when an MR-BS allocates bandwidth to forward a packet to/from a given station, it shall allocate bandwidth on all links (relay and access) that make up the path to/from that station taking into account the processing delay and link qualities at each R-CPE.

**7.11.3 Polling**

Polling is the process by which the BS allocates to the CPEs bandwidth specifically for the purpose of making bandwidth requests. These allocations may be to individual CPEs or to groups of CPEs. Allocations to groups of connections and/or CPEs actually define bandwidth request contention IEs. The allocations are not in the form of an explicit message, but are contained as a series of IEs within the US-MAP.

Note that polling is done on CPE basis. Bandwidth is always requested on a FID basis and bandwidth is allocated on a CPE basis.

**7.11.3.1 Polling for Relay**

The polling procedure defined in 7.11.3 for the CPE and the MR-BS may be used between the CPE/R-CPE. If an R-CPE is regularly polled, it can transmit a bandwidth request header to the MR-BS as soon as it detects impending uplink traffic in order to reduce delay (see Figure 55a).

An MR-BS or a distributed scheduling R-CPE may inform a CPE of upcoming polling via an RS-SCH management message (see Figure 55b).

For centralized scheduling, only the MR-BS may establish a polling process with a CPE or centralized scheduling R-CPE in the MR-cell.





**7.16 Channel descriptor management**

As previously presented, channel descriptor messages (i.e., DCD and UCD) are broadcast by the BS/MR-BS to all associated CPEs at periodic intervals as well as broadcast by the distributed scheduling R-CPE to the assocated CPEs in its local cell at periodic interval. Among other things, these channel descriptors define burst profiles, which are used by US-MAP and DS-MAP messages for allocating upstream and downstream transmissions, respectively. Once broadcast by the BS/MR-BS or the distributed scheduling R-CPE and received by its associated CPEs, a given channel descriptor shall remain valid until a new channel descriptor message with a different value for the Configuration Change Count field, is again broadcast by the BS/MR-BS or or the distributed scheduling R-CPE, respectively. When this happens, this new channel descriptor shall overwrite all the information of the previous descriptor. When the distributed scheduling R-CPE receives a new downstream channel descriptor for channel switching from the BS/MR-BS, the distributed scheduling R-CPE shall immediately broadcast the new downstream channel descriptor with the same information of channel switching (i.e., channel action, action mode, and action frame number) to the associated CPEs in the local cell in order to the operating channel in the local cell be changed to the same channel of the BS/MR-BS’s cell at the same time.

Once channel descriptors are known to all CPEs in an IEEE 802.22b BS/MR-BS’s cell, the BS/MR-BS shall set the UCD/DCD Count value in an AZ, contained in US-MAP and DS-MAP messages, equal to the Configuration Change Count of the desired channel descriptor. Once channel descriptors are known to all CPEs in the distributed scheduling R-CPE’s local cell, the distributed scheduling R-CPE shall set the UCD/DCD Count value in a DRZ, contained in US-MAP and DS-MAP messages, equal to the Configuration Change Count of the desired channel descriptor. This way, a BS/MR-BS and a distributed scheduling R-CPE can easily indicate to its associated CPEs which burst profile is to be used for a given allocation, and hence provide high flexibility to the BS/MR-BS or the distributed scheduling R-CPE in controlling which burst profile to use at any given time by simply changing the UCD/DCD Count value.

Figure 53 describes the procedure to migrate from one upstream channel descriptor to the next, while Figure 54 focuses on the same procedure but for the downstream channel.

Finally, note that the Configuration Change Count shall be incremented by 1 modulo 256 for every new migration of channel descriptor. After issuing a DS-MAP or US-MAP message with the Configuration Change Count equal to that of the new generation, the old channel descriptor ceases to exist and the BS/MR-BS and the distributed scheduling R-CPE shall not refer to it anymore. When migrating from one generation to the next, the BS/MR-BS or the distributed scheduling R-CPE shall schedule the transmissions of the UCD and DCD messages in such a way that each CPE has the possibility to successfully hear it at least once.

**7.18 QoS**

**7.18.9.3 Dynamic Service Addition**

**7.18.9.3.1 CPE-initiated DSA**

**7.18.9.3.1.1 MR-BS and centralized scheduling R-CPE behaviour during CPE-initiated DSA**

When a DSA-REQ message is sent from a CPE, the centralized scheduling R-CPE and the MR-BS may deal with the message in the following way:

— The centralized scheduling R-CPE may add the acceptable QoS parameter set to the DSA-REQ if it cannot support the requested QoS parameter set. It then sends the DSA-REQ to the MR-BS using the primary management CID of the CPE.

— The centralized scheduling R-CPE may include Per-RS QoS TLV in the DSA-REQ to the MR-BS. The Per-RS QoS TLV in this case represents the maximum latency at the centralized scheduling R-CPE to relay the requested QoS parameter set. If the MR-BS receives Per-RS QoS TLV, the MR-BS shall consider the value in Per-RS QoS TLV and ones in the requested QoS parameter set.

— The centralized scheduling R-CPE may get the updated SF parameters and confirmation code from DSA-RSP and DSA-ACK sent from the MR-BS and the CPE, respectively.

— Upon receiving the DSA-REQ from the CPE via the centralized scheduling R-CPE, the MR-BS sends back a response to the CPE in the same way defined for non-relay systems. The admission control algorithm is out of scope of this standard.

— If the service flow parameters is changed, the MR-BS shall send a DSC-REQ to the centralized scheduling R-CPE before sending DSA-RSP to the SS.

**7.18.9.3.2 BS-initiated DSA**

**7.18.9.3.2.1 MR-BS and centralized scheduling R-CPE behaviour during MR-BS-initiated DSA**

When an MR-BS initiates a DSA-REQ message to a CPE via a centralized scheduling R-CPE, the centralized scheduling R-CPE and the MR-BS may deal with the message in the following way.

— If the service flow parameters are changed, the MR-BS shall send a DSC-REQ to the centralized scheduling R-CPE before sending the DSA-REQ to the CPE in the same manner as defined above.

— The MR-BS may include Per-RS QoS TLV in the DSA-REQ to centralized scheduling R-CPE. If the centralized scheduling R-CPE receives Per-RS QoS TLV, the centralized scheduling R-CPE shall use values in Per-RS QoS TLV instead of the ones in the service flow parameters.

— When the centralized scheduling R-CPE can support the requested QoS parameter set, it sends the DSA-REQ to the CPE using the primary management CID of the CPE.

— When the centralized scheduling R-CPE cannot support the requested QoS parameter set in the DSA-REQ, it sends DSA-RSP with CC set to reject-RS-not-supported-parameter-value to the MR-BS indicating that it can support the requested QoS parameter set. The DSA-RSP may contain the acceptable QoS parameter set the centralized scheduling R-CPE can support.

— The centralized scheduling R-CPE may get the updated SF parameters and confirmation code from DSA-RSP and DSA-ACK sent from the CPE and the MR-BS, respectively.

**7.18.9.4 Dynamic Service Change**

**7.18.9.4.1 CPE-initiated DSC**

**7.18.9.4.1.1 MR-BS and centralized scheduling R-CPE behaviour during CPE-initiated DSC**

When a DSC-REQ message is sent from a CPE, a centralized scheduling R-CPE and the MR-BS may deal with the message in the following way:

— The centralized scheduling R-CPE may add the acceptable QoS parameter set to the DSC-REQ if it cannot support the requested QoS parameter set. It then sends the DSC-REQ to the MR-BS using the primary management CID of the CPE.

— The centralized scheduling R-CPE may include Per-RS QoS TLV in the DSC-REQ to the MR-BS. The Per-RS QoS TLV in this case represents the maximum latency at the centralized scheduling R-CPE to relay the requested QoS parameter set. If the MR-BS receives Per-RS QoS TLV, the MR-BS shall consider the value in Per-RS QoS TLV and ones in the requested QoS parameter set.

— The centralized scheduling R-CPE may get the updated SF parameters and confirmation code from DSC-RSP and DSC-ACK sent from the MR-BS and the CPE, respectively.

— Upon receiving the DSC-REQ from the CPE via the centralized scheduling R-CPE, the MR-BS sends back a response to the CPE in the same way defined for non-relay systems. The admission control algorithm is out of scope of this standard.

— If the service flow parameters are changed, the MR-BS shall send a DSC-REQ to the centralized scheduling R-CPE before sending DSC-RSP to the CPE.

**7.18.9.4.2 BS-initiated DSC**

**7.18.9.4.2.1 MR-BS and centralized scheduling R-CPE behaviour during MR-BS-initiated DSC**

When an MR-BS initiates a DSC-REQ message to a CPE via a centralized scheduling R-CPE, the centralized scheduling and the MR-BS may deal with the message in the following way:

— If the service flow parameters are changed, the MR-BS shall send a DSC-REQ to the centralized scheduling R-CPE before sending the DSC-REQ to the CPE.

— The MR-BS may include Per-RS QoS TLV in DSC-REQ to centralized scheduling R-CPE. If the centralized scheduling R-CPE receives Per-RS QoS TLV, the centralized scheduling R-CPE shall use values in Per-RS QoS TLV instead of the ones in the service flow parameters.

— When the centralized scheduling R-CPE can support the requested QoS parameter set, it sends the DSC-REQ to the CPE using the primary management CID of the CPE.

— When the centralized scheduling R-CPE cannot support the requested QoS parameter set in the DSC-REQ, it sends DSC-RSP with CC set to reject-RS-not-supported-parameter-value to the MR-BS indicating that it cannot support the requested QoS parameter set. The DSC-RSP may contain the acceptable QoS parameter set the centralized scheduling R-CPE can support.

— The centralized scheduling R-CPE may get the updated SF parameters and confirmation code from DSC-RSP and DSC-ACK sent from the CPE and the MR-BS, respectively.

**7.18.9.5 Dynamic Service Deletion**

**7.18.9.5.1 CPE-initiated DSD**

**7.18.9.5.1.1 MR-BS and centralized scheduling R-CPE behaviour during CPE-initiated DSD**

When a DSD-REQ message is sent from a CPE, the centralized scheduling R-CPE relays it to the MR-BS using the primary management CID of the CPE. After processing the DSD-REQ, the MR-BS replies with a DSD-RSP using the CPE primary management CID. When the centralized scheduling R-CPE receives the DSD-RSP, it deletes the service flow information and relays it to the CPE.

**7.18.9.5.2 BS-initiated DSD**

**7.18.9.5.2.1 MR-BS and centralized scheduling R-CPE behaviour during MR-BS-initiated DSD**

When an MR-BS initiates a DSD-REQ message to a CPE via a centralized scheduling R-CPE using the primary management CID of the CPE, the centralized scheduling R-CPE relays it to the CPE using the primary management CID of the CPE. When the centralized scheduling R-CPE receives a DSD-RSP sent from the CPE, it deletes the service flow information and relays it to the MR-BS.

**7.7.8.9 Service Flow encodings**

**7.7.8.9.19 Per-RS QoS**

**Table xx — Per-RS QoS information elements**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Element ID**  **(1 byte)** | **Length** | **Value** | **Scope** |
| Per-RS QoS | 21 | Variable | Compound | DSA-REQ/RSP  DSC-REQ/RSP |

Per-RS QoS value is as following.

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type (1byte)** | **Length (1byte)** | **Value** |
| RS\_Basic\_CID |  | 2 | RS Basic CID |
| Maximum Latency for the RS |  | 4 | Milliseconds |

The value of Maximum Latency for the R-CPE specifies the maximum interval between the reception of an MAC PDU at the R-CPE’s Air Interface that is receiving the MAC PDU and the Air Interface that is forwarding the MAC PDU.

**7.7.24 Confirmation codes**

**Table 173 — Confirmation codes**

|  |  |
| --- | --- |
| **CC** | **Status** |
| 0x00 | OK/success |
| 0x01 | reject-other |
| 0x02 | reject-unrecognized-configuration-setting |
| 0x03 | reject-temporary / reject-resource |
| 0x04 | reject-permanent / reject-admin |
| 0x05 | reject-not-owner |
| 0x06 | reject-service-flow-not-found |
| 0x07 | reject-service-flow-exists |
| 0x08 | reject-required-parameter-not-present |
| 0x09 | reject-header-suppression |
| 0x0A | reject-unknown-transaction-id |
| 0x0B | reject-authentication-failure |
| 0x0C | reject-add-aborted |
| 0x0D | reject-exceed-dynamic-service-limit |
| 0x0E | reject-not-configured-for-the-request-SAID |
| 0x0F | reject-fail-to-establish-the-requested-SA |
| 0x10 | reject-not-supported-parameter |
| 0x11 | reject-not-supported-parameter-value |
| 0x12 | reject-invalid-key-sequence-number |
| 0x13 | reject-RS-not-supported-parameter-value |
| 0x14–0xFF | *Reserved* |