Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>	
Title	**HARQ Through RS UL Dedicated Channel**	
Date Submitted	**2007-11-14**	
Source(s)	Derek Yu, Hang Zhang, Peiying Zhu, Wen Tong, David Steer, Gamini Senarath, Mark Naden, G.Q. Wang Nortel 3500 Carling Avenue Ottawa, Ontario K2H 8E9	Voice: +1 613 763-1315 E-mail: [mailto:wentong@nortel.com] [mailto:pyzhu@nortel.com]
Re:	IEEE P802.16j/D1: IEEE 802.16j working group letter ballot #28.	
Abstract	The current baseline does not specify how to support HARQ for the RS UL_DCH. The RS UL_DCH supports signaling and data traffic associated with service flows, and hence HARQ needs to be supported. The sub-burst IE used for HARQ is not applicable to the RS UL_DCH. This contribution supplies text to support HARQ for the RS UL_DCH.	
Purpose	To incorporate the proposed text into the P802.16j Baseline Document IEEE P802.16j/D1 (August 2007).	
Notice	*This document does not represent the agreed views of the IEEE 802.16 Working Group or any of its subgroups*. It represents only the views of the participants listed in the "Source(s)" field above. It is offered as a basis for discussion. It is not binding on the contributor(s), who 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 802.16.	
Patent Policy	The contributor is familiar with the IEEE-SA Patent Policy and Procedures: <http://standards.ieee.org/guides/bylaws/sect6-7.html#6> and <http://standards.ieee.org/guides/opman/sect6.html#6.3>. Further information is located at <http://standards.ieee.org/board/pat/pat-material.html> and <http://standards.ieee.org/board/pat>.	

HARQ Through RS UL Dedicated Channel

Derek Yu, Hang Zhang, Peiying Zhu, Wen Tong, David Steer, Gamini Senarath, Mark Naden, G.Q. Wang

Nortel

Introduction

The RS UL_DCH supports signaling and data traffic associated with service flows, and hence HARQ on UL_DCH needs to be supported. As the UL_DCH is a persistence allocation and the resources are available periodically without any further signaling until it needs to be updated, such as, to a different size. As such, it is not possible to follow the current HARQ process of using embedded sub-burst IE inside HARQ UL MAP IE during HARQ BW allocation.

The current ACK/NAK for the UL HARQ transmission bursts from the MSs/RSs are sent using DL HARQ ACK IE. It contains an ACK/NAK bitmap and the order of bits follows the same order of the HARQ sub-burst allocations in the broadcasted HARQ UL MAP IE. As such, it also cannot be used for HARQ in UL_DCH.

This contribution supplies text to enable HARQ operation on the RS UL_DCH.

Proposal

The proposed HARQ operation on the RS UL_DCH follows the synchronous acknowledgement principle as in 802.16e. The high level design of the HARQ operations is synchronous NAK based and retransmission can either be synchronous or asynchronous depending on the needs. HARQ on RS UL_DCH is a hop-by-hop HARQ.

For HARQ on the UL_DCH, each RS cannot determine how many HARQ bursts are being transmitted by all the other RSs through their UL_DCH and their order of transmission. Hence, the NAK for different RSs cannot be combined into a broadcast bitmap to acknowledge HARQ bursts from all subordinate RSs on their dedicated channels. A unicast NAK bitmap is used for each RS and it is sent using a DL MAC control header.

For multihop centralized scheduling, it is not possible to dynamically allocated NAK resource for superordinate RSs that are two or more hops away from the MR-BS as the minimum round trip delay will be larger than the maximum of 3 frames delay for the transmission of synchronous NAK signaling. To effectively enable NAK signaling for the UL HARQ transmission on the dedicated channel, the MR-BS needs to allocate dedicated signaling channel in the downlink for the RS using RS DL DCH assignment IE.

For distributed scheduling, in stead of frequent/periodic resource allocation for synchronous NAK signaling, the superordinate station may allocate dedicated signaling channel in the downlink for its RSs when significant number of HARQ enabled service flows have been established.

With synchronous NAK, the NAK bitmap is only send when there are one or more bursts that are received in error. When it is not sent, this implicitly acknowledges the HARQ bursts are received successfully and they can be removed from the retransmission buffer at the sending RS.

Retransmission can be synchronous or asynchronous. For synchronous retransmission, the UL dedicated resource is used for retransmission. For asynchronous retransmission, additional resource will be allocated. Synchronous retransmission can work with both centralized and distributed allocation. Asynchronous retransmission can work with distributed allocation. However, for multi-hop centralized allocation, it may incur extra delay and signaling as an additional resource request to the MR-BS is needed. The additional retransmission resource is requested by indicating HARQ asynchronous retransmission request in the RS UL_DCH header and it is sent to the MR-BS. The asynchronous retransmission resource is allocated using RS_UL_DCH HARQ ASYNC RETX IE.

The proposed HARQ scheme is also applicable to transparent RS as long as the transparent RS is responsible for both receiving the HARQ bursts and sending all signaling in the DL dedicated signaling channel to the RS. The transparent RS can generate the necessary synchronous NAK and combine with all other signaling and send to the RS.

The following figures illustrate the HARQ operation under different scenarios. Figure 1 illustrates the operation for synchronous retransmission for both centralized and distributed allocation. Figure 2 illustrates the operation for asynchronous retransmission for distributed allocation. Lastly, Figure 3 illustrates the operation for asynchronous retransmission for centralized allocation.

Fundamentally, retransmission is done through resource from the same HARQ channel (same ACID). For synchronous retransmission, the next resource of the same ACID/HARQ channel is used for retransmission. For asynchronous retransmission, one time additional resource is allocated to the same ACID/HARQ channel for retransmission.

For synchronous retransmission described in Figure 1, the next occurrence of transmission resource for ACID 0 is used to retransmit burst A after the synchronous NAK bitmap. For CTC IR HARQ, the SPID is also provided together with the NAK bitmap.

In Figure 2, the additional asynchronous retransmission resource is allocated to ACID 0 for retransmission of burst A after the synchronous NAK that was sent on RS DL_DCH. The additional allocation is done through RS_UL_DCH HARQ ASYNC RETX IE.

In Figure 3, for centralized allocation, the request for asynchronous retransmission is sent from the superordinate RS to the MR-BS using RS UL_DCH HARQ asynchronous retransmission request header. The MR-BS then constructs the required RS_UL_DCH HARQ ASYNC RETX IE and forward to the superordinate RS for the one time retransmission resource allocation.

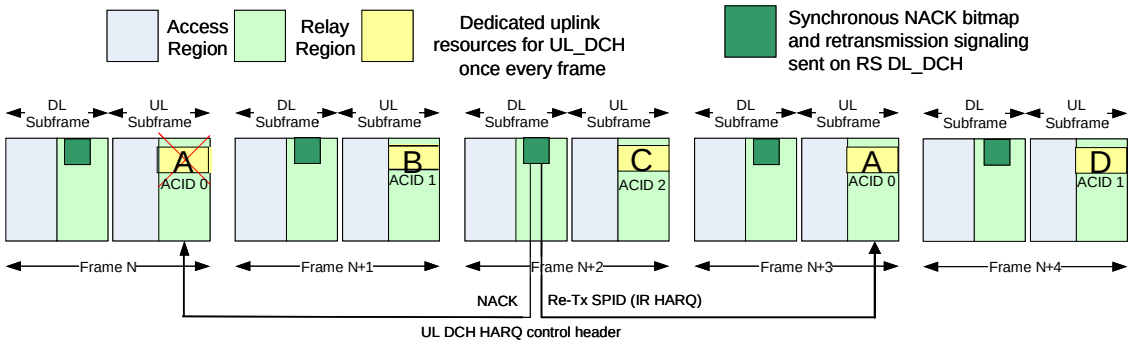

Figure 1: Synchronous retransmission for both centralized and distributed allocation.

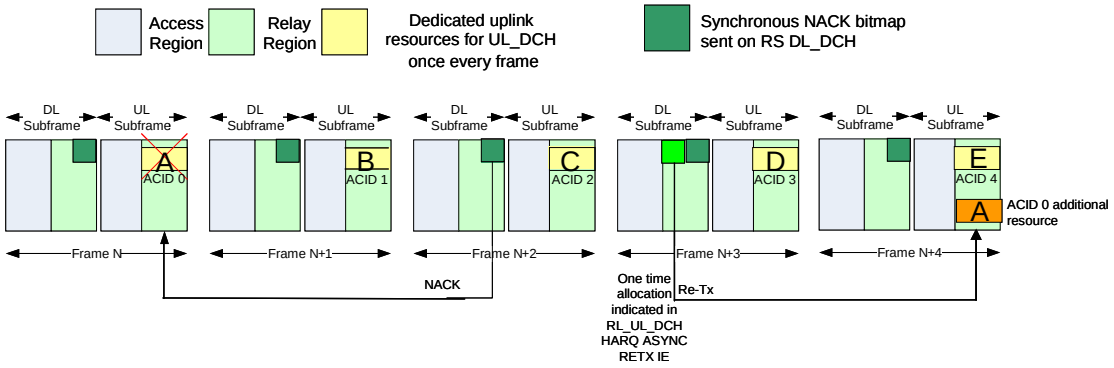

Figure 2: Asynchronous retransmission for distributed allocation.

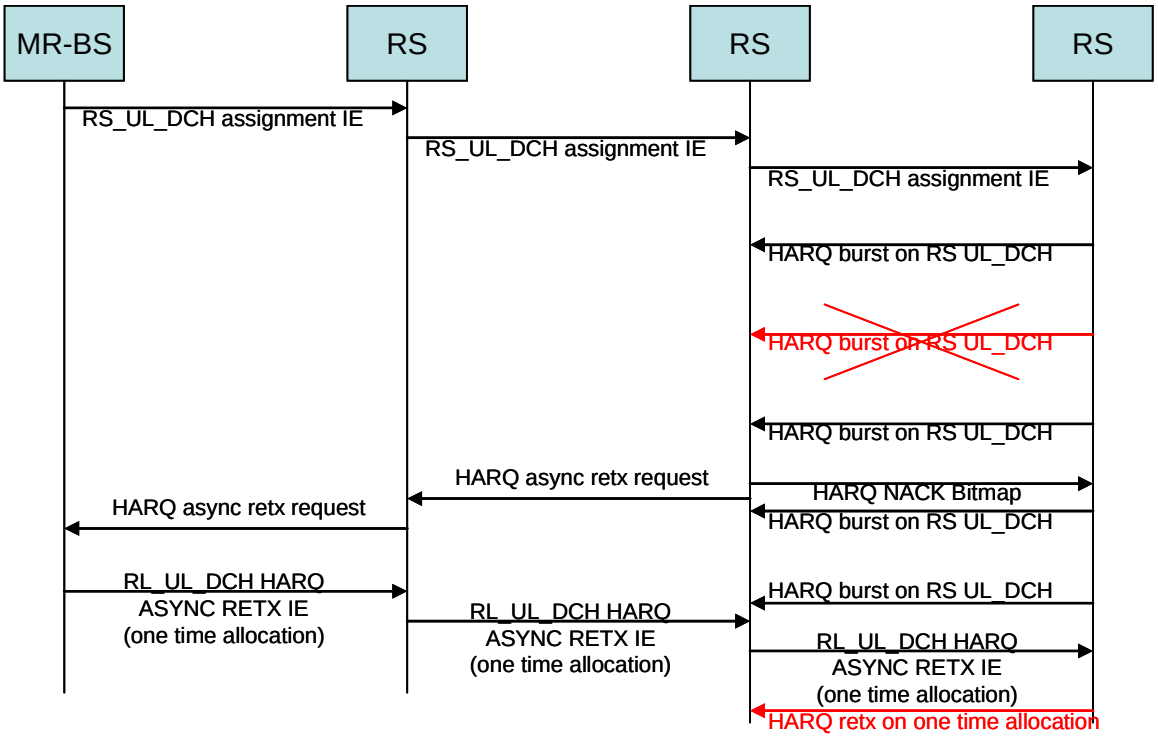

Figure 3: Asynchronous retransmission for centralized allocation.

Text Proposal

++++++++++++++++ Start Text Proposal ++

[Add the following subclause]

6.3.17.6 Uplink HARQ on Dedicated Channel

The HARQ on RS UL_DCH is a synchronous NAK based HARQ and retransmission can either be synchronous or asynchronous. HARQ on RS UL_DCH is a hop-by-hop HARQ. The transmission of HARQ NAK bitmap by the superordinate station is a synchronous NAK bitmap transmitted on RS DL_DCH.

Under centralized control, the MR-BS may choose to enable UL HARQ transmission on the RS UL_DCH by first allocating DL DCH resource to each RS along the path for downlink signaling using the RS_DL_DCH assignment IE. The MR-BS also enables one or more individual UL_DCH resource blocks or assigns a new UL_DCH resource block with HARQ enabled to each RS along the path for HARQ operation. The enabling of HARQ on an existing UL_DCH resource block is done by requesting a resource setting update using the RS_UL_DCH assignment IE.

Under distributed control, in stead of frequent DL allocations for synchronous NAK and retransmission signaling, the superordinate station may allocate a dedicated signaling channel in the downlink to its RSs for HARQ enabled service flows.

HARQ enabled packets from multiple MSs/RSs are multiplexed and transmitted through the UL DCH. Each DCH resource block can transmit a single HARQ burst at a time. For allocation of new UL DCH resource block with HARQ enabled or updating resource setting of existing resource blocks, a number of ACID is also assigned. Implicit sequential cycling of ACID is used for each occurrence of the periodically assigned resource. The first transmission after enabling HARQ is always HARQ channel 0 (ACID is 0). The ACID is incremented by 1 for each periodic transmission and reset to 0 when the maximum ACID number is reached.

The synchronous NAK bitmap and retransmission control signaling are sent by the superordinate station using the UL_DCH HARQ control header. The superordinate station that receives HARQ UL burst at i-th frame should transmit NAK signal at (i+j)-th frame. The NAK bitmap is sent only when one or more bursts that are received in error. When the subordinate RS does not receive the NAK bitmap, the corresponding HARQ bursts are considered to have been successfully received. The frame offset “j” is defined by the “HARQ ACK Delay for UL Burst” field in the DCD message.

For synchronous retransmission, the retransmission is sent within the same HARQ channel. It is sent on the next occurrence of the same HARQ channel after the synchronous NAK signal. The number of ACID is assigned to enable parallel HARQ transmissions during the synchronous NAK delay. For frequency (N) specified in RS_UL_DCH assignment IE that is larger than frame offset “j”, only 1 ACID is needed. The maximum number of ACID for a specific frame offset “j” is (j+1) which corresponds to periodic allocation on every frame.

For asynchronous retransmission, an additional one time resource is allocated to the HARQ channel that requires retransmission. The one time allocation is assigned using RS_UL_DCH HARQ ASYNC RETX IE and it also includes the retransmission details. In this case, the number of ACID needs to be large enough to allow for the maximum number of retransmission attempts before the ACID wrap around. Under centralized allocation, the superordinate station requests additional retransmission resources by indicating HARQ asynchronous retransmission request in the RS UL_DCH header and sending it to the MR-BS.

For transparent RS that is configured for receiving the HARQ bursts and sending all signaling in the DL dedicated signaling channel to the subordinate RS, the HARQ support on RS_UL_DCH can be used. The transparent RS generates the necessary synchronous NAK bitmap and combine with all other signaling and send to the RS. For asynchronous retransmission, the transparent RS sends RS UL_DCH header with indication of HARQ asynchronous retransmission request and sending it to the MR-BS. The MR-BS then send RS_UL_DCH HARQ ASYNC RETX IE directly to the retransmitting RS.

[Change the text in Subclause 6.3.2.1.2.2.2.2 on page 11]

6.3.2.1.2.2.2 RS UL DCH request header (RS_UL_DCH)

The RS requests a dedicated uplink resource through the RS_UL_DCH request header by specifying DCH Request. Under centralized allocation, it is also used to request HARQ retransmission resource from MR-BS for asynchronous retransmission by specifying HARQ asynchronous retransmission request. The MR-BS responses with RS_UL_DCH HARQ ASYNC RETX IE. The format of this header is illustrated in Figure 35c and described in Table 19c.

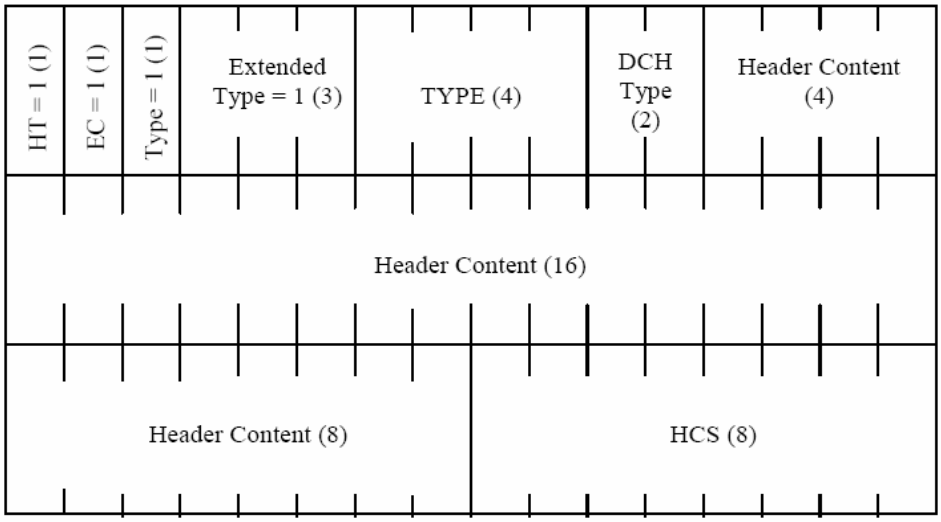

Figure 35c-RS_UL_DCH request header format

Table 19c-Description of fields in RS UL_DCH request header

Syntax	Size	Notes
MAC Header() {		
HT	1 bit	Shall be set to 1
EC	1 bit	Shall be set to 1
Type	1 bit	Shall be set to 1
Extended TYPE	3 bits	Shall be set to 001 for RS_UL_DCH request header
TYPE	4 bits	0000 = DCH Request 0001 = *Reserved* 0010 = HARQ asynchronous retransmission request ~~0001~~ 0011 – 1111 = *Reserved*
if (TYPE==0000) {		DCH Request
DCHTYPE	2 bits	00 = DCH Request Incremental 01 = DCH Request Aggregate 10 = DCH Request Rate Based 11 = Reserved
if (DCHTYPE == 00) {		DCH Request Incremental
Bandwidth request	16 bits	Number of bytes requested by the RS. Zero in this field indicated DCH release request.
N	4 bits	Allocation repeats once every N frames.
} else if (DCHTYPE == 01) {		DCH Request Aggregate
Bandwidth request	16 bits	Number of bytes requested by the RS. Zero in this field indicated DCH release request.
N	4 bits	Allocation repeats once every N frames.
} else if (DCHTYPE == 10) {		DCH Request Rate Based
Average rate	20 bits	Average data rate in units of bytes per second 18 MSB bits: magnitude 2 LSB bits: base-10 exponent
}		
RS CID	8 bits	8 LSB of ~~Reduced~~ Basic CID of RS
}		
if (TYPE == 0010) {		HARQ asynchronous retransmission request
RS CID	8 bits	8 LSB of Basic CID of the RS requiring HARQ asynchronous retransmission
Number of bursts	2 bits	
for (i=0;i< Number of bursts; i++) {		
DCH resource ID	3 bits	ID of the DCH resource that needs HARQ retransmission
ACID	5 bits	HARQ channel require asynchronous retransmission
}		
Padding	variable	
}		
HCS	8 bits	Header check sequence
}		

[Add the following table to the end of Subclause 6.3.2.1.3]

Table XXX—Type field encodings for DL MAC control header

Type field	MAC control header Type	Reference figure	Reference table
0	UL DCH HARQ control header		
1-15	Reserved		

[Add the following Subclause]

6.3.2.1.3.1 UL DCH HARQ control header

The UL_DCH HARQ control header is used by the superordinate station to send DCH HARQ control signaling. This includes the synchronous HARQ NAK bitmap and/or required details for synchronous retransmission.

The synchronous HARQ NAK bitmap indicates an error in the corresponding received RS UL_DCH HARQ bursts. The superordinate station that receives HARQ UL burst at i-th frame should transmit NAK signal at (i+j)-th frame. The frame offset "j" is defined by the "HARQ ACK Delay for UL Burst" field in the DCD message. The NAK bitmap is sent only when one or more bursts are received in error. For synchronous retransmission, the SPID list is included together with the bitmap for CTC IR HARQ.

The format of the header is shown in Figure XXX.

Table XXX - UL DCH HARQ control header format

Name	**Length (bits)**	**Description**
HT	1	Header type. Shall be set to 1
EC	1	Encryption control. Shall be set to 0
Type	4	Shall be set to 0000 for UL DCH HARQ control header
Control	4	Bit #0: Synchronous NAK bitmap Bit #1: CTC IR HARQ retransmission SPID Bit #2-3: Reserved
if (Synchronous NAK bitmap == 1) {		
NAK bitmap	8	HARQ NAK bitmap for the corresponding HARQ bursts sent in each DCH resource block. The LSB bit indicates NAK for resource block allocated with DCH resource ID of "0" and sequentially to the MSB bit. Each bit is set to 1 if the corresponding uplink DCH HARQ burst cannot be successfully received; otherwise, it shall be 0
}		
if (CTC IR HARQ retransmission SPID == 1) {		For CTC IR, specify SPID for retransmission bursts
SPID list	16	The least significant two bits specify SPID for resource block with DCH resource ID of "0" and sequentially to the

		most significant two bits
}		
Reserved	variable	
HCS	8	Header check sequence

[Change Table 496c in Subclause 8.4.5.9.1 as indicated]

Table 496c—R-link specific IE types

Type (hexadecimal)	Usage
00	RS_UL_DCH assignment IE
01	RS_BW-ALLOC IE
02	RS_DL_DCH assignment IE
03	RS_UL_DCH HARQ ASYNC RETX IE
~~02~~04-1F	Reserved

[Change Table 496d in Subclause 8.4.5.9.1.1 on page 192 as indicated]

Table 496d-RS_UL_DCH assignment IE format

Syntax	Size	Notes
RS_UL_DCH assignment IE() {		
Type	5 bits	RS UL DCH assignment IE = 0x00
Length	4 bits	Variable
RSCID	~~8 bits~~ 4,8,12,16 bits	~~Reduced basic CID of the RS~~ RS basic CID in RCID_IE format (see 8.4.5.3.20.1)
Update type	2 bits	00 = Normal 01 = Service flow based 10-11 = *Reserved*
If (Update type == 01) {		If service flow based update
Throughput size	24 bits	Amount of throughput update in byte/s
Access RSCID	~~8 bits~~ 4,8,12,16 bits	~~Reduced basic CID of t~~ The access RS of the MS that completed the service flow event. RS basic CID in RCID_IE format (see 8.4.5.3.20.1)
}		
Assignment type	2 bits	00 = Incremental (Add the specified resource to UL DCH) 01 = Aggregate (An aggregate assignment with no resource indicates all UL DCH removal) 10 = ~~Remove~~ Removal (Remove the specified resource from UL DCH) 11 = ~~Remove all~~ Tx profile and settings update

~~OFDMA symbol offset~~	~~8 bits~~	
DCH resource ID	3 bits	ID of the DCH resource being assigned or managed
If ((Assignment type == 00) || (Assignment type == 01) {		
HARQ type	2 bits	0b00 – Disabled 0b01 – HARQ Chase 0b10 – HARQ CTC IR 0b11 – HARQ CC IR
if (HARQ type != 0b00) {		
Retransmission mode	1 bit	0: Synchronous retransmission 1: Asynchronous retransmission
Number of ACID	5 bits	Number of HARQ channels associated with this assignment
}		
if (HARQ type == 0b10) {		
N_{EP}	4 bits	
N_{SCH}	4 bits	
} else {		
UIUC	4 bits	
Repetition coding indication	2 bits	0b00 – no repetition coding 0b01 – repetition coding of 2 0b10 – repetition coding of 4 0b11 – repetition coding of 6
}		
OFDMA symbol offset	8 bits	
Subchannel offset	8 bits	
Duration	10 bits	Resources allocated to DCH (in OFDMA slots)
Frequency (N)	4 bits	Allocation repeats once every N frames. To assign additional resource for asynchronous retransmission associated with the specified DCH resource ID, set N to 0 and assignment type to incremental.
}		
If (Assignment type == 11) {		
HARQ type	2 bits	0b00 – Disabled 0b01 – HARQ Chase 0b10 – HARQ CTC IR 0b11 – HARQ CC IR
if (HARQ type != 0b00) {		
Retransmission mode	1 bit	0: Synchronous retransmission 1: Asynchronous retransmission
Number of ACID	5 bits	Number of HARQ channels associated with this assignment
}		
if (HARQ type == 0b10) {		
N_{EP}	4 bits	
N_{SCH}	4 bits	
} else {		

UIUC	4 bits	
Repetition coding indication	2 bits	0b00 – no repetition coding 0b01 – repetition coding of 2 0b10 – repetition coding of 4 0b11 – repetition coding of 6
}		
}		

[Add the following Subclause]

8.4.5.9.1.3 RS DL DCH assignment IE

This IE is used for the initial allocation and subsequent updates of the downlink dedicated channel for the RS. The dedicated channel is used for DL signaling including MAC management messages.

Table XXX. RS_DL_DCH assignment IE format.

Syntax	Size	Notes
RS_DL_DCH assignment IE {		
Type	5 bits	RS_DL_DCH assignment IE = 0x02
Length	4 bits	
RSCID	4,8,12,16 bits	RS basic CID in RCID_IE format (see 8.4.5.3.20.1)
Assignment type	2 bits	00 = Aggregate (An aggregate assignment with no resource indicates DL DCH removal) 01 = Update 10-11 = Reserved
If (Assignment type == 00) {		
DIUC	4 bits	
Boosting	3 bits	
Repetition coding indication	2 bits	
OFDMA Symbol offset	8 bits	
Subchannel offset	8 bits	
No. OFDMA Symbols	7 bits	
No. Subchannels	6 bits	
Frequency (N)	4 bits	Allocation repeats once every N frames
}		
If ((Assignment type == 01) {		
DIUC	4 bits	
Boosting	3 bits	
Repetition coding indication	2 bits	
}		
}		

[Add the following Subclause]

8.4.5.9.1.4 RS_UL_DCH HARQ ASYNC RETX IE

RS_UL_DCH HARQ ASYNC RETX IE is transmitted to RSs to request the retransmission of HARQ bursts on RS UL_DCH. It includes the allocation of additional resources for retransmission. The corrupted HARQ bursts are indicated by their corresponding DCH resource ID and ACID. For CTC IR HARQ, the SPID is also included.

The format of the RS_UL_DCH HARQ ASYNC RETX IE is shown in Table XXX.

Table XXX. RS_UL_DCH HARQ ASYNC RETX IE format.

Syntax	Size	Notes
RS_UL_DCH HARQ ASYNC RETX IE () {		
Type	5 bits	RS_UL_DCH HARQ ASYNC RETX IE = 0x03
Length	4 bits	Variable
Number of bursts	3 bits	
for (i=0;i<Number of bursts; i++) {		
RSCID	4,8,12,16 bits	RS basic CID in RCID_IE format (see 8.4.5.3.20.1)
DCH resource ID	3 bits	ID of the RS_UL_DCH resource has transmission failure
ACID	5 bit	HARQ channel required retransmission
Duration	10 bits	Resources allocated for asynchronous retransmission (in OFDMA slots)
CTC IR HARQ retransmission SPID	1 bit	Retransmission SPID field indication
if (CTC IR HARQ retransmission SPID == 1) {		
SPID	2 bits	
}		
}		
}		

++++++++++++++++ End Text Proposal ++