Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Changes in P802.16-REVd/D2-2003 for Bulk ACK/NACK Feedbacks**
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Re:	IEEE 802.16d
Abstract	This document contains suggestions on the changes in IEEE P802.16-REVd/D2-2003 that would help transmitting bulk type of ACK/NACK feedbacks for the groups of blocks.
Purpose	The document is submitted for review by 802.16 Working Group members
Notice	
Release	
Patent Policy and Procedures	

Changes in P802.16-REVd/D2-2003 for

Bulk ACK/NACK Feedbacks

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1. Introduction

When transmitting SDU fragments or SDUs, a PDU is constructed with a number of (negotiated) fixed-sized blocks (except the last block of an SDU) whose feedback of ACK/NACK will be sent based on the corresponding BSNs in ARQ-enabled connections. Whether the PDU is successfully received or not, a group (or bulk) of sequential blocks has the same state of ACK or NACK. This situation is more frequent when transmitting subsequent PDUs before receiving ACK/NACK feedbacks. Figure C1 illustrates an example of bulk type of ACK/NACK.

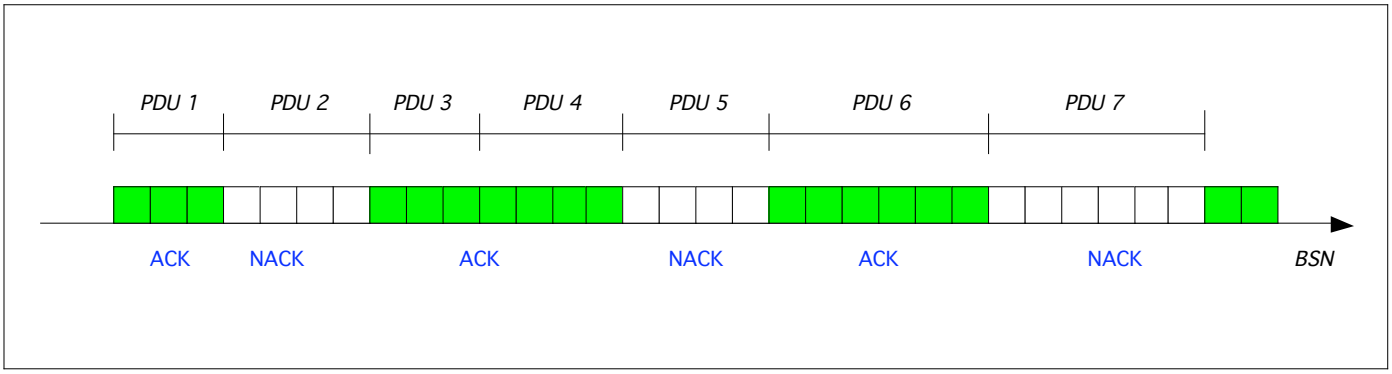


Figure C1. An example of bulk type of ACK/NACK

Let us consider the following ACK/NACK patterns where each bit set to "1" indicates the corresponding ARQ block has been received without errors (the first bit "1" means that the corresponding BSN is ARQ_RX_WINDOW_START):

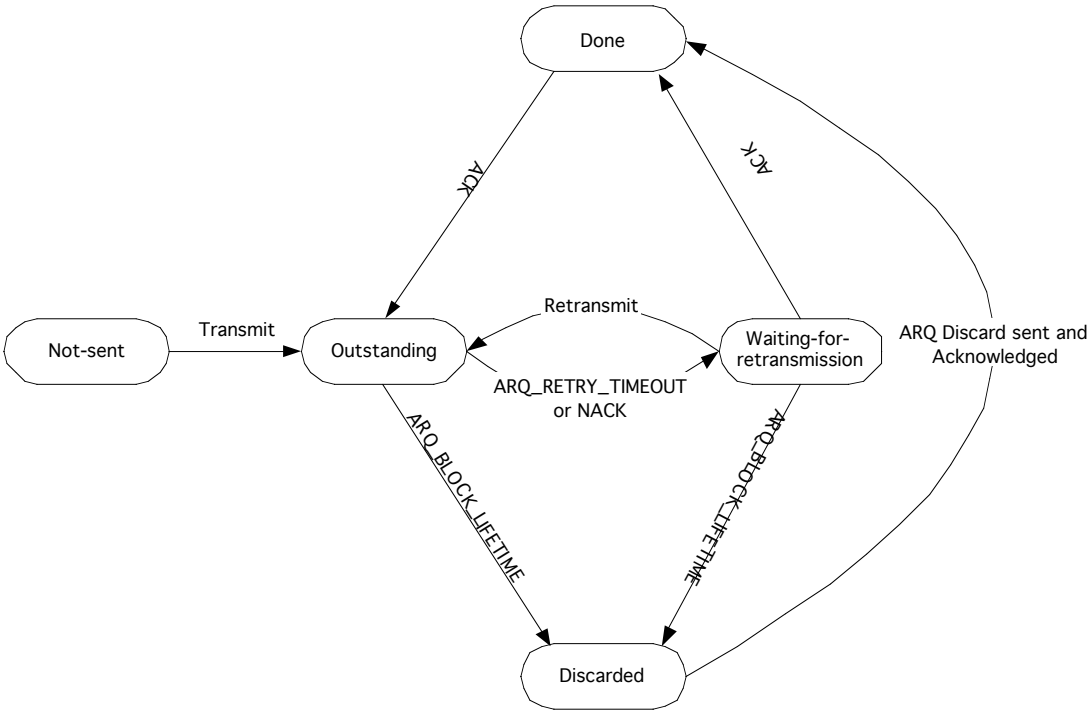
```
1 0111 1111 1111 1111 1111 1100 0000 0000 …
1 0011 1111 1111 1111 1111 1100 0000 0000 …
1 0001 1111 1111 1111 1111 1100 0000 0000 …
1 0000 1111 1111 1111 1111 1100 0000 0000 …
1 0000 0111 1111 1111 1111 1100 0000 0000 …
1 0000 0011 1111 1111 1111 1100 0000 0000 …
```

Figure C2. Examples of ACK/NACK pattern

The most appropriate feedback type of these patterns is the Cumulative with Selective ACK which needs a total of eight bytes of ARQ_feedback_IE with four bytes of ACK Map. If we give some changes in the Cumulative ACK entry, a more efficient way of ARQ feedback is possible with less overhead: two bytes of ACK Map is sufficient to feedback the ACK/NACK patterns illustrated in Figure C2 using the proposed changes in the ARQ_feedback_IE and the associated redefinition of the ACK Map. This Document describes changes suggested for 802.16d Working Document IEEE P802.16-REVd/D2-2003 to facilitate bulk types of ACK/NACK feedback.

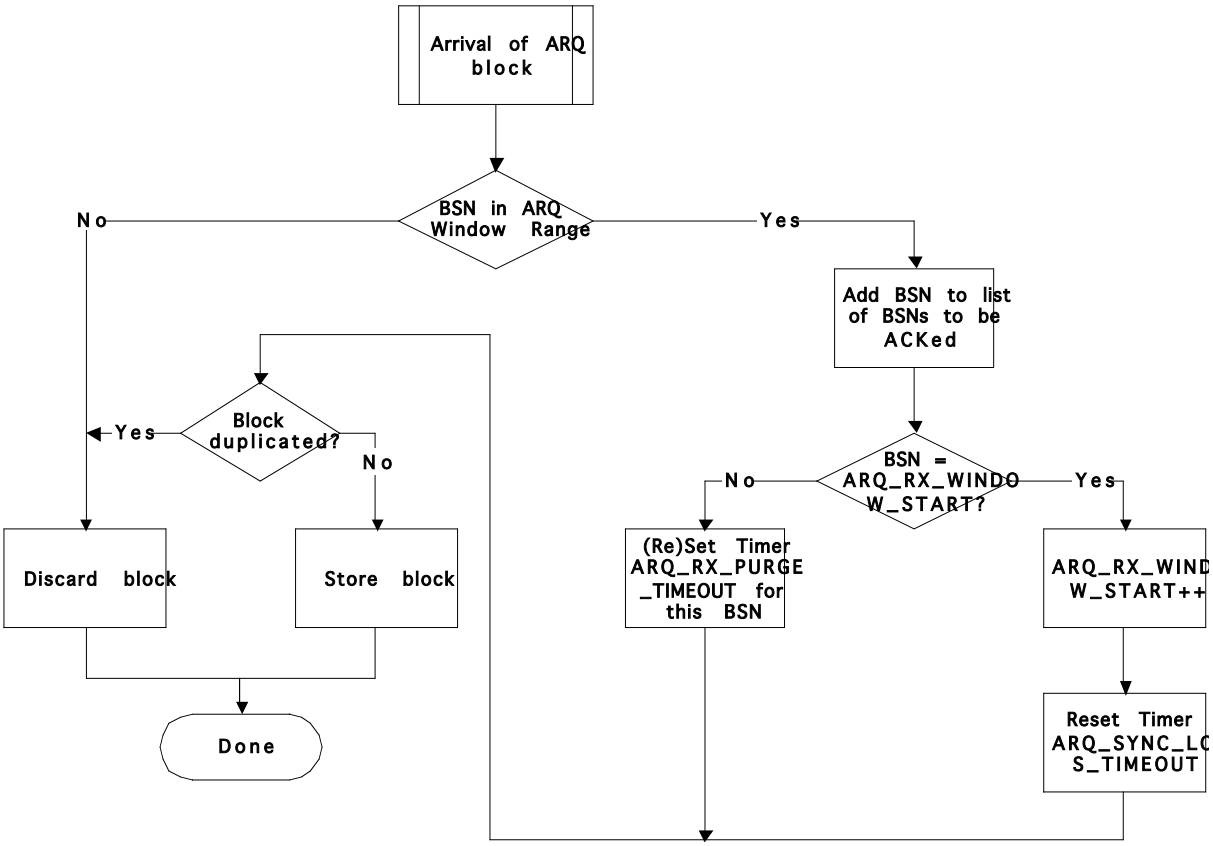
Additionally, we also propose some changes in the ARQ transmit block states (Figure 34) and the ARQ block reception (Figure 37) to give more completeness to IEEE P802.16-REVd/D2-2003 Document.

An ARQ block has the following states associated with corresponding state-transition events:



In the event of "Discarded" state, the sender usually transmits a Discard message; the only way to acknowledge the message is through the ARQ feedback message; before sending the Discard message a number of corresponding blocks can be acknowledged. Hence, whether the Discard message has been sent or not, the corresponding blocks should go to the "Done" state immediately after reception of ACK.

The current ARQ block reception procedure is as follows:



There are some problems in this reception machine with respect to updating the *ARQ_RX_WINDOW_START* and the *ARQ_RX_HIGHEST_BSN*. There are no flows in the following cases:

- Reception of BSN ≥ *ARQ_RX_HIGHEST_BSN*
- Reception of BSN = ARQ_RX_WINDOW_START = ARQ_RX_HIGHEST_BSN
- Reception of BSN which updates *ARQ_RX_WINDOW_START* with amount of Δ (> 1)

Our proposal provides the steps for these events including an enhanced procedure at the event of “Block duplicated”.

2. Changes in IEEE 802.16d

[in 6.4.4.2]
Replace Table 88—ARQ Feedback IE

Syntax	Size	Notes
ARQ_feedback_IE (LAST) {	variable	
CID	16 bits	The ID of the connection being referenced.
LAST	1 bit	0 = More ARQ feedback IE in the list. 1 = Last ARQ feedback IE in the list.
ACK Type	2 bits	0x0 = Selective ACK entry 0x1 = Cumulative ACK entry 0x2 = Cumulative with Selective ACK entry 0x3 = Reserved
BSN	11 bits	
Number of ACK Maps	2 bits	If ACK Type == 01, the field is reserved and set to 00. Otherwise the fields indicates the number of ACK maps: 0x0 = 1, 0x1 = 2, 0x2 = 3, 0x3= 4.
if (ACK Type!= 01) {		
for (i=0; i< Number of ACK Maps + 1; ++i) {		
ACK Map	16 bits	
}		
}		
}		

to

Syntax	Size	Notes
ARQ_feedback_IE (LAST) {	variable	
CID	16 bits	The ID of the connection being referenced.
LAST	1 bit	0 = More ARQ feedback IE in the list. 1 = Last ARQ feedback IE in the list.
ACK Type	2 bits	0x0 = Selective ACK entry 0x1 = Cumulative with Bulk ACK entry 0x2 = Cumulative with Selective ACK entry 0x3 = Reserved
BSN	11 bits	
Number of ACK Maps	2 bits	The field indicates the number of ACK maps: If ACK Type == 01, 0x0 = 0, 0x1 = 1, 0x2 = 2, 0x3= 3. Otherwise, 0x0 = 1, 0x1 = 2, 0x2 = 3, 0x3= 4.
if (ACK Type!= 01) {		
for (i=0; i< Number of ACK Maps + 1; ++i) {		
ACK Map	16 bits	ACK Map has different formats according to ACK Type. See ACK Map.
}		
}		
}		

[in 6.4.4.2]
Insert new Table 89—ACK Map at the just above line of "ACK Map" definition in 6.4.4.2 as follows:

Syntax	Size	Notes
ACK_Map {	16 bits	
if (ACK Type == 01) {		
Bulk Configuration	1 bit	0: The number of bulks is 2 1: The number of bulks is 3
if (Bulk Configuration == 0) {		
Bulk ACK Map	2 bits	Indicates the bitmap of ACK/NACK of the corresponding bulks.
Bulk Length	6 bits	
Bulk Length	6 bits	
Reserved	1 bits	
}		
else if (Bulk Configuration == 1) {		
Bulk ACK Map	3 bits	Indicates the bitmap of ACK/NACK of the corresponding bulks.
Bulk Length	4 bits	
Bulk Length	4 bits	
Bulk Length	4 bits	
}		
}		
else {		
Selective ACK Map	16 bits	Indicates the bitmap of ACK/NACK of the corresponding blocks.
}		
}		

[in 6.4.4.2]
Replace

"**ACK Map**
Each bit set to one indicates the corresponding ARQ block has been received without errors. The bit corresponding to the BSN value in the IE, is the most significant bit of the first map entry. The bits for succeeding block numbers are assigned left-to-right (MSB to LSB) within the map entry. If the ACK Type is 0x2, then the most significant bit of the first map entry shall be set to one and the IE shall be interpreted as a cumulative ACK for the BSN value in the IE. The rest of the bitmap shall be interpreted similar to ACK Type 0x0."

to

"**Bulk ACK Map**
Each bit set to one indicates the corresponding ARQ bulk has been received without errors. The first bit in the map entry should be set to zero when this is the first ACK Map entry. The bits for succeeding bulks are assigned left-to-right (MSB to LSB) within the map entry.

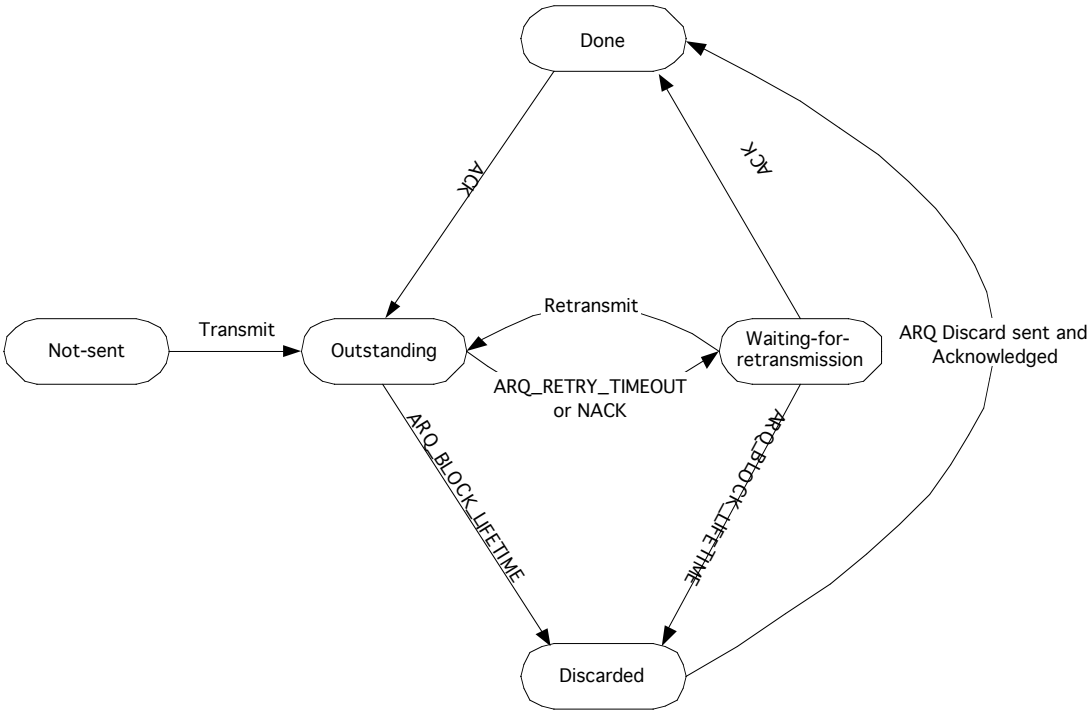
Bulk Length
Bulk Length indicates the number of blocks (or BSNs) in the corresponding bulk to be acknowledged or not. If the corresponding bulk is the first one in the first ACK Map entry, the corresponding Bulk Length value indicates that the blocks from the BSN in ARQ_feedback_IE (Table 88) to the BSN + Bulk Length value have not been successfully received. Otherwise, the corresponding Bulk Length value indicates that the blocks from the next BSN of the last BSN of the just previous bulk to the BSN + Bulk Length value have been successfully received or not according to the corresponding bit value in the Bulk ACK Map.

Selective ACK Map

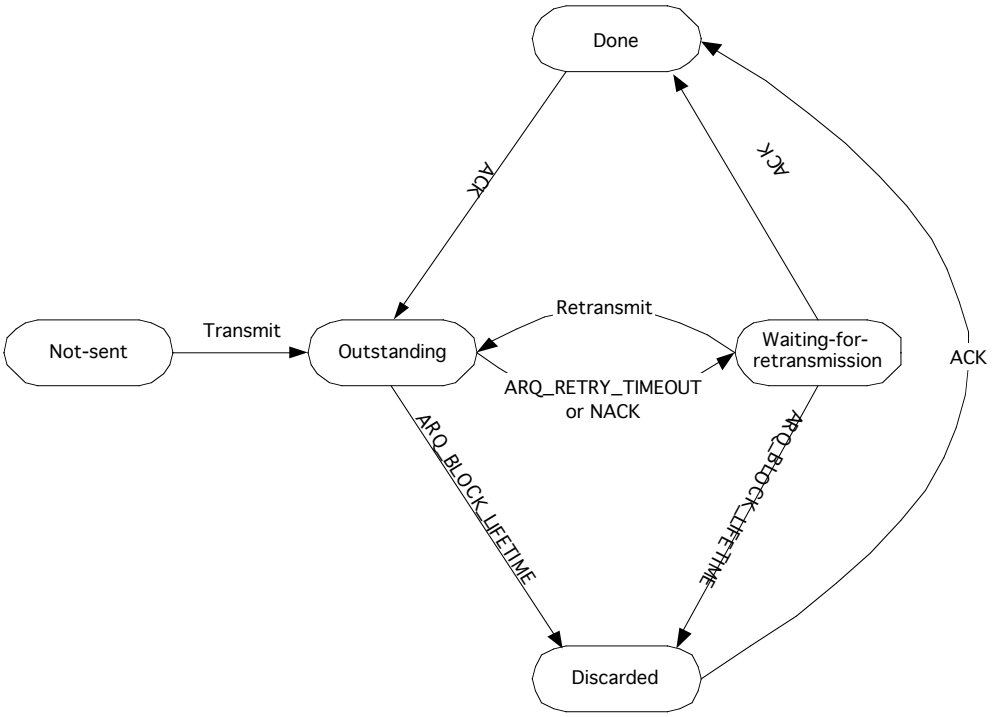
Each bit set to one indicates the corresponding ARQ block has been received without errors. The bit corresponding to the BSN value in the IE, is the most significant bit of the first map entry. The bits for succeeding block numbers are assigned left-to-right (MSB to LSB) within the map entry. If the ACK Type is 0x2, then the most significant bit of the first map entry shall be set to one and the IE shall be interpreted as a cumulative ACK for the BSN value in the IE. The rest of the bitmap shall be interpreted similar to ACK Type 0x0."

[in 6.4.4.6.2]

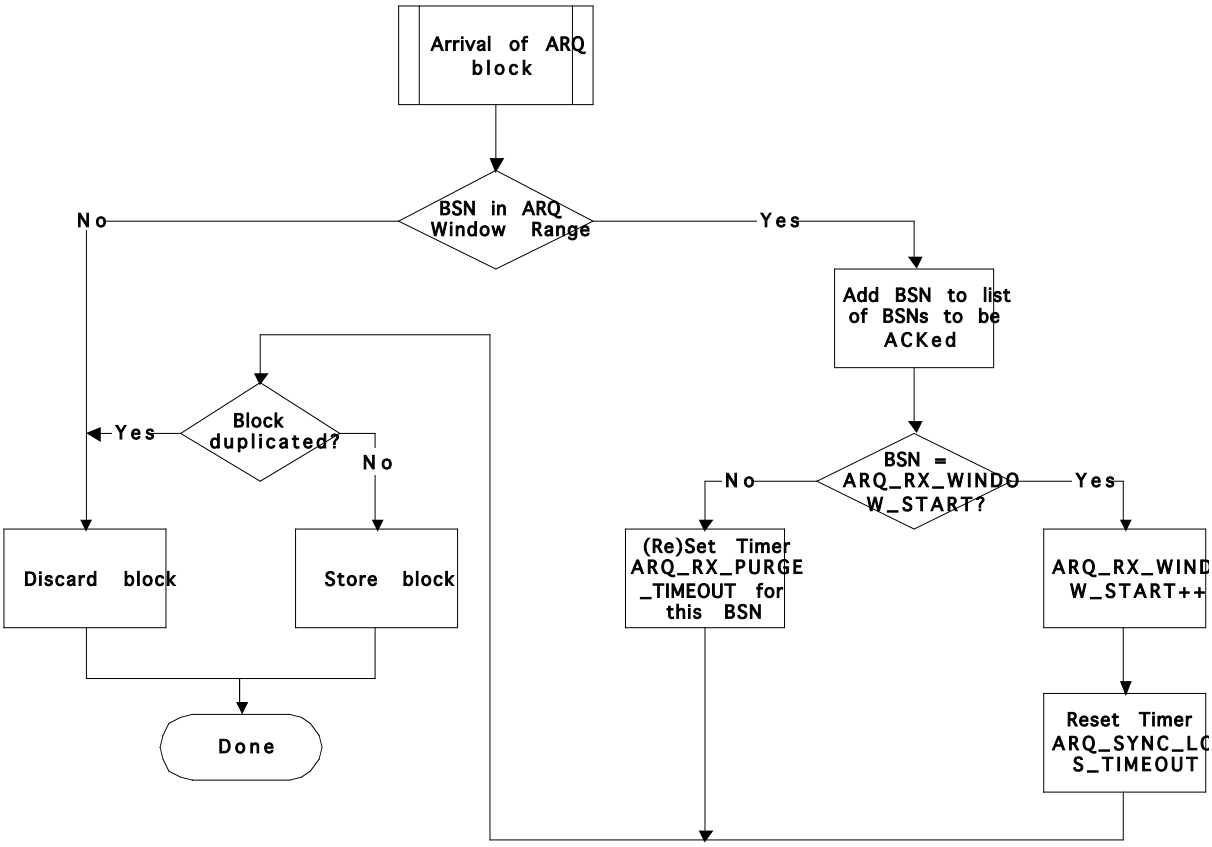
Replace Figure 34—ARQ transmit block states



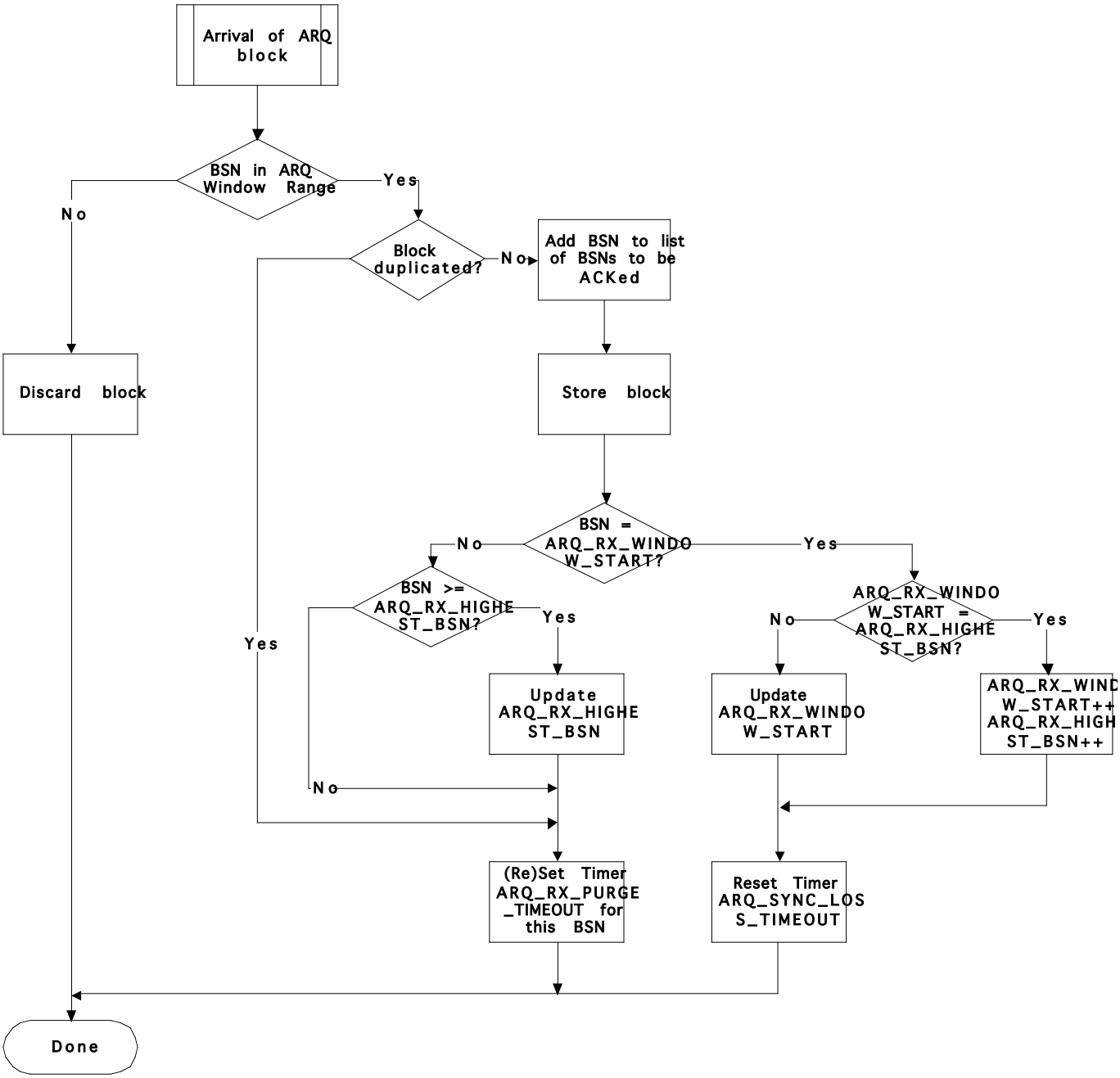
to



[in 6.4.4.6.3]
Replace Figure 37—ARQ block reception



to



[in 6.4.4.6.3]
Replace

"For each ARQ block received, an acknowledgment shall be sent to the transmitter. Acknowledgment for blocks outside the sliding window shall be cumulative. Acknowledgments for blocks within the sliding window may be either for specific ARQ blocks (i.e., contain information on the acknowledged ARQ block numbers), or cumulative (i.e., contain the highest ARQ block number below which all ARQ blocks have been received correctly) or a combination of both (i.e., cumulative with selective)."

to

"For each ARQ block received, an acknowledgment shall be sent to the transmitter. Acknowledgment for blocks outside the sliding window shall be cumulative. Acknowledgments for blocks within the sliding window may be either for specific ARQ blocks (i.e., contain information on the acknowledged ARQ block numbers), or cumulative (i.e., contain the highest ARQ block number below which all ARQ blocks have been received correctly), or cumulative with additional information on the acknowledged groups of

subsequent blocks (i.e., cumulative with bulk ACK) or a combination of both (i.e., cumulative with selective).”