ARQ Block usage for 16m

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*<http://standards.ieee.org/faqs/affiliationFAQ.html>

Venue:

Re: MAC: Data Plane; in response to the TGm Call for Contributions and Comments 802.16m-08/033 for Session 57

Base Contribution:

None

Purpose:

Discuss and adopt the proposed text changes into SDD document

Notice:

ARQ parameters in 16e

- Fixed ARQ Block Size
  - ARQ block size can be 16, 32, 64, 128, 256, 512, 1024 (bytes) referring to ARQ_BLOCK_SIZE TLV
  - ARQ_BLOCK_SIZE is decided during REG_REQ, REG_RSP, DSA_REQ, DSA_RSP

- 11-bit BSN Length
  - ARQ_BSN_MODULUS = 2048, BSN = 0 ~ 2047
  - Max ARQ_WINDOW_SIZE is limited to 1024 (=BSN_MODULUS/2)

- Maximum ARQ throughput = (ARQ_WINDOW_SIZE) * (ARQ_BLOCK_SIZE) * 8 / (ARQ RTT)
  - ARQ RTT is dependant on 5ms frame structure and transmitter/receiver processing delay, and HARQ capability when HARQ is applied
  - ARQ RTT can be 20ms to 6sec (MAX ARQ_BLOCK_LIFETIME)

16e ARQ Protocol Issues-ARQ block size (1/3)

- In 16e,
  - ARQ block size is decided at registration or connection setup.
  - ARQ window is a fixed value (depends on ARQ BSN) and average ARQ RTT does not change.
- Practically, small ARQ block size is chosen considering UL coverage extension
  - Small ARQ block size facilitates UL Coverage extension by power boosting occupying small number of sub-channels in UL frame
  - Small ARQ block size has other benefits
    - Less padding overhead making PHY burst (i.e. PHY burst is not exact times of ARQ block)
    - More fragmentation and packing flexibility when composing MPDU.
- Problems with small ARQ block size
  - Small ARQ block Limits ARQ throughput.
  - When same amount of packets are transmitted, overhead due to ARQ feedback information is increased compared with larger ARQ block.

16e ARQ Protocol Issues-ARQ block size (2/3)

- Max ARQ throughput (ARQ window = 1024)

ARQ RTT (msec)	ARQ block size (bytes)			
	16	32	64	128
	ARQ Throughput (Bits/sec)			
20	6.5	13.1	26.2	52.4
40	3.3	6.5	13.1	26.2
60	2.1	4.3	8.7	17.4
100	1.3	2.6	5.2	10.4
1000	0.13	0.26	0.52	1.04

- ARQ throughput vs. coverage

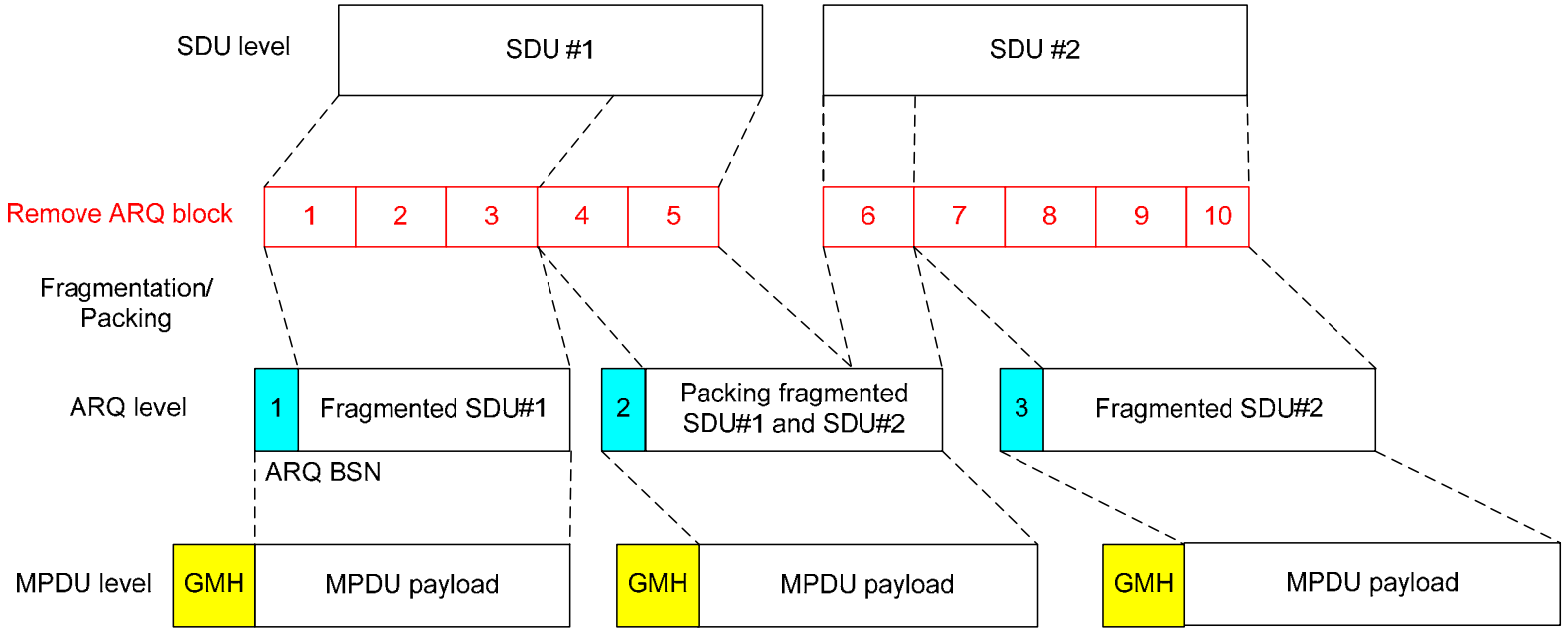
	Larger ARQ block size	Smaller ARQ block size
Throughput	Increase	Decrease
UL Coverage	Decrease	Increase

Achieving better coverage and throughput tradeoff

- Flexible ARQ block size is required depending on ARQ packet transmission condition (e.g. channel condition)
  - Good channel conditions
    - → Throughput maximization can be achieved using larger ARQ block
  - Poor channel condition
    - → Coverage extension can be achieved using smaller ARQ block

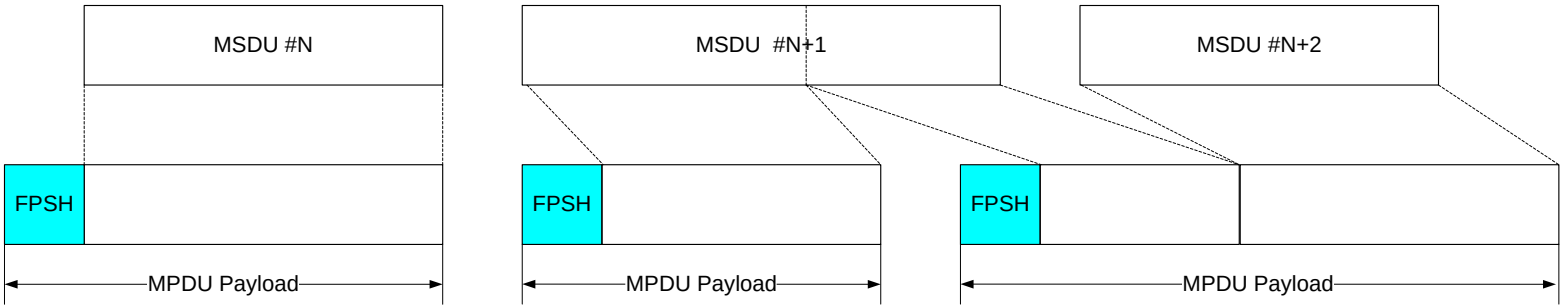
Proposed ARQ block usage for 16m

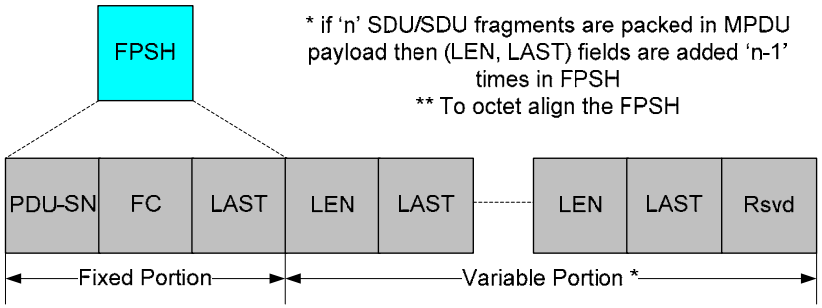
- Fixed size ARQ block concept is removed in the initial transmission
- MPDU payload, which may be variable length, is the ARQ block.
  - MPDU is composed either by fragmenting an SDU or Packing multiple SDUs.
- Variable ARQ block size = size of MAC PDU payload – packing/fragmentation header (if there is no other sub/extended header)



ARQ block Generation

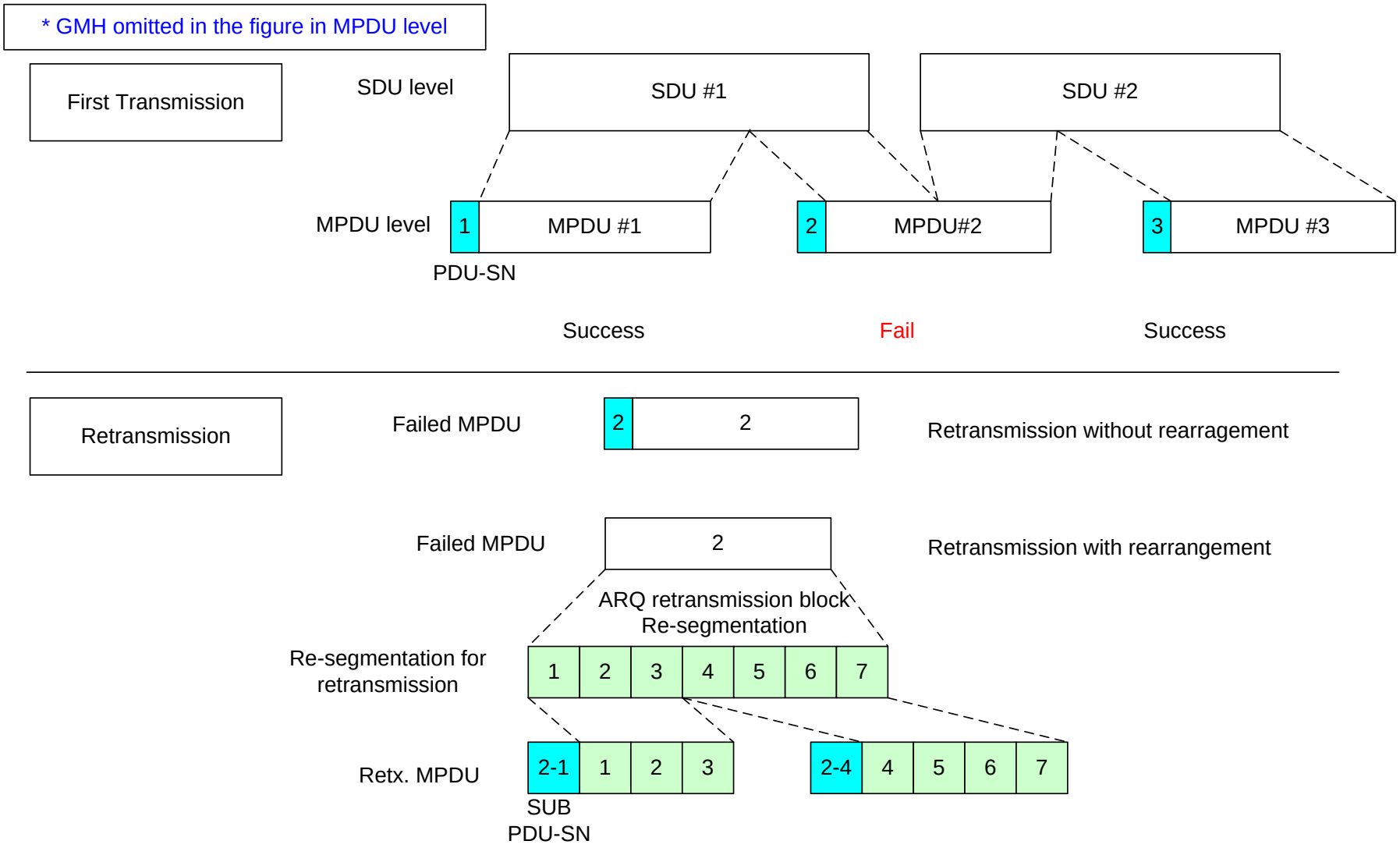
- ARQ block consists of one or more SDUs or SDU fragments
- ARQ block contains fragmentation and packing sub-header (FPSH)
  - PDU-SN
    - PDU Sequence number to identify the ARQ block
    - PDU-SN represents MPDU sequence number because MPDU contains one ARQ block
  - FC* (Fragmentation Control, used for reassembling fragmented SDUs)
  - LAST, LEN (These two fields identified number of SDU/SDU fragments packed together)





*** See Contribution # for details**

Proposed ARQ retransmission scheme (1/3)

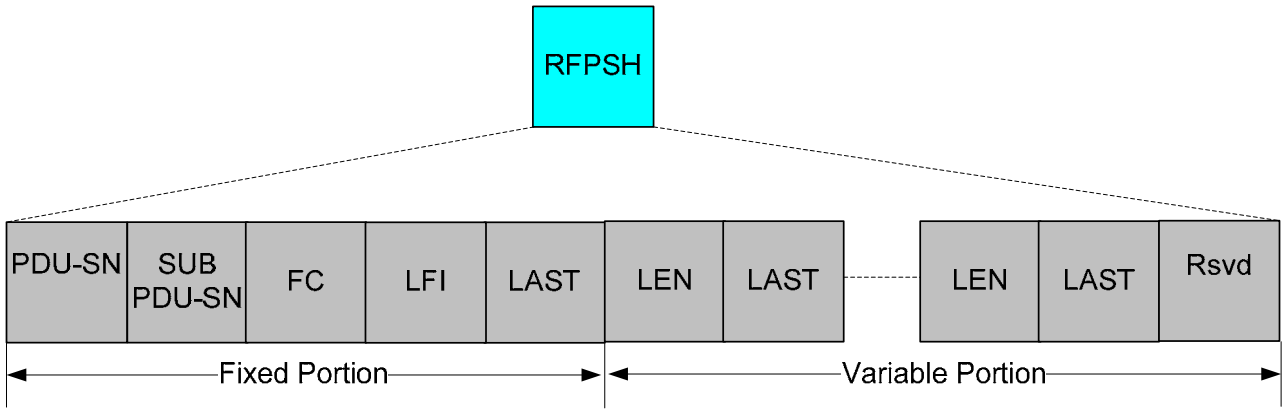


Proposed ARQ retransmission scheme (2/3)

- If the transmission of ARQ block fails
  - The failed ARQ block is segmented into fixed size ARQ retx. block
  - Each ARQ retx. block is assigned a sequence number (SUB_PDU-SN).
  - During the retransmission one or multiple ARQ retx. blocks may be packed together.
  - Receiver can send ARQ feedback requesting the retransmission of entire ARQ retx. blocks or part of ARQ retx. block

Proposed ARQ retransmission scheme (3/3)

- During retransmission, a different sub-header is used (RFPSH)
- The difference between FPSH (used in the initial transmission) and RFPSH (used in the retransmission) is that the following fields are added:
  - SUB_PDU-SN: Represents ARQ retx. Block Sequence number
  - LFI (Last Fragment Inclusion Indicator) indicates if the retransmitted PDU contains the last fragment of original PDU or not
- The PDU-SN in RFPSH indicates the failed MPDU.
- The retransmitted PDU consists of one or more ARQ retx. Blocks of a single failed MPDU.
- If multiple ARQ retx. blocks are packed, the SUB_PDU-SN of the first ARQ retx. block is used in the RFPSH.



Proposed text change in SDD (1/2)

[Insert the following text in section 10 in IEEE 802.16m-08/003r4]

*---------- **Text Starts** ----------*

10.x ARQ

10.x.1 ARQ block usage

ARQ block is formed from one or more SDU/SDU fragments. ARQ block sequence number (PDU-SN) is assigned to each ARQ block. One of ARQ blocks is selected for transmission encapsulated into a PDU. PDU-SN is included in FPSH (Fragmentation and Packing Subheader) (see 10.x.x subheader section).

The transmission and retransmission of the ARQ blocks is shown in figure xx. The transmitter retransmits the lost ARQ blocks based on the ARQ feedback received from the receiver. If the transmission of ARQ block fails, retransmitted ARQ block is transmitted with or without rearrangement. When rearrangement is used, ARQ block is segmented into fixed size ARQ retx. block. When ARQ block is not an integer multiple of ARQ retx. block, the last ARQ retx. block is formed less size than ARQ retx. block size. Each ARQ retx. block is assigned a sequence number (SUB_PDU-SN). During the retransmission, one or multiple ARQ retx. blocks is selected and encapsulated into retransmitted PDU. SUB_PDU-SN is included in RFPSH(Retransmission FPSH) (see 10.x.x subheader section).

Proposed text change in SDD (2/2)

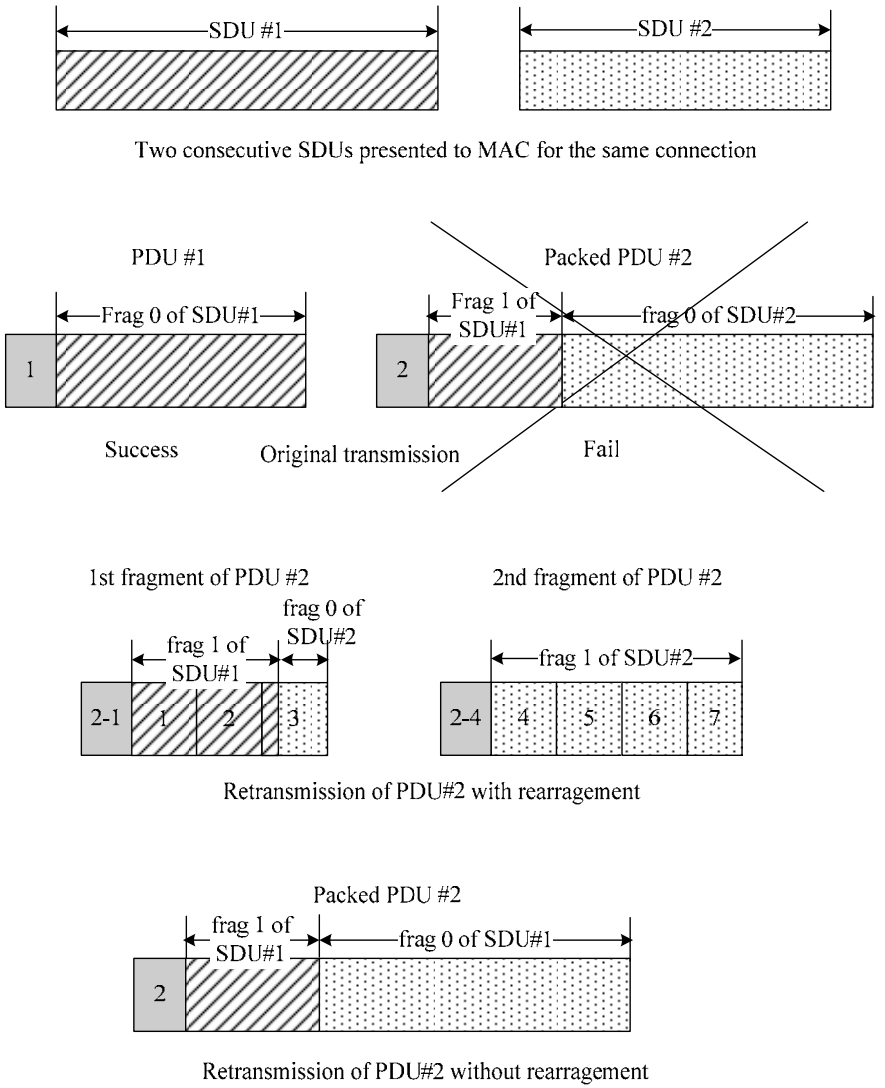


Figure xx—Block usage examples for ARQ with and without rearrangement