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Abstract: [This document proposes a scheme to enhance performance of retransmission for 802.15.3]

Purpose: [This document is provided in support of 802.15.3b activities.]

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Schemes and Design to Enhance Retransmission for 802.15.3 Systems

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Outline

- CE requirements for home theater applications
- Signal processing in wireless systems
- Current 802.15.3 PHY & MAC
- Proposed scheme & design
- Summary
- Conclusion

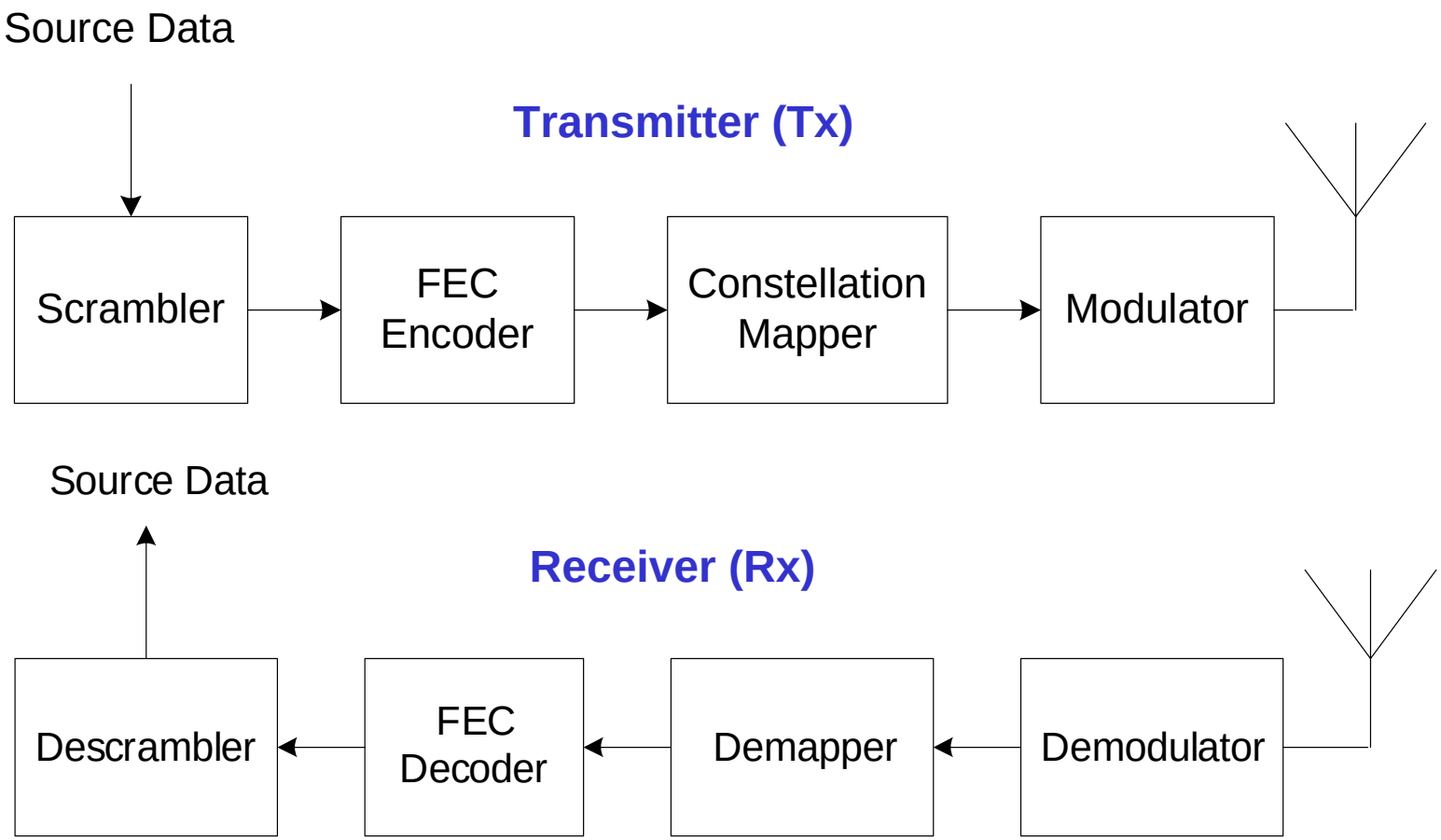
CE Requirement for Home Theaters

- Home Theatre CE applications require very low error rates (e.g. one MPEG packet loss in >2 hours)
- Benchmark packet size and Packet Error Rate (PER) values for UWB PHY evaluation (1024 byte and PER 8%) may be too high for such CE applications

- Retransmission is unavoidable to achieve PER goal

Signal Processing in Wireless Systems

Signal Processing in Wireless Systems

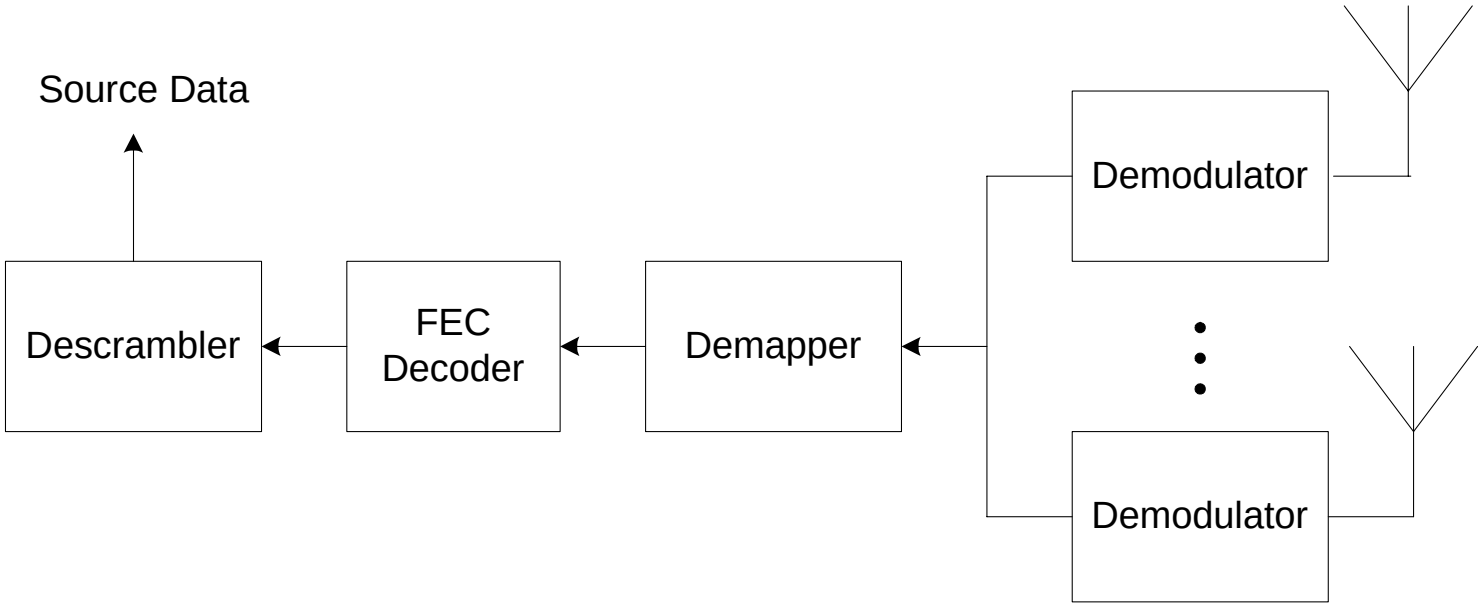


Multiple Antenna at Rx to Increase SNR – 1

- Combination of
  - Two frames can get about 3dB gain
  - Three frames about 4.7dB
  - Four frames about 6dB
- Condition for combination
  - Same data
- Combination can be performed at different blocks in Rx
  - Combined at demapper – same modulation at transmitter
  - Combined at decoder – same encoder at transmitter

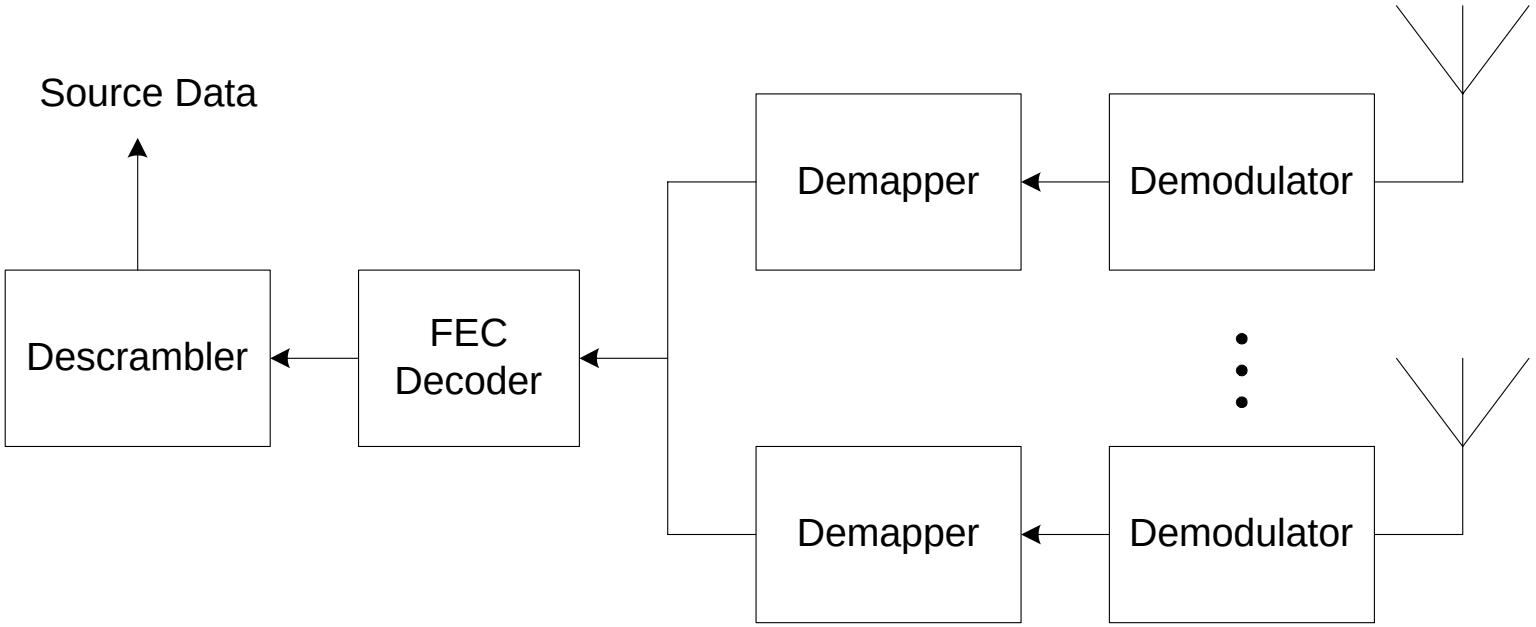
Multiple Antenna at Rx – 2

Multiple demodulators combined at demapper



Multiple Antenna at Rx – 3

Multiple demodulators and demappers combined at FEC decoder

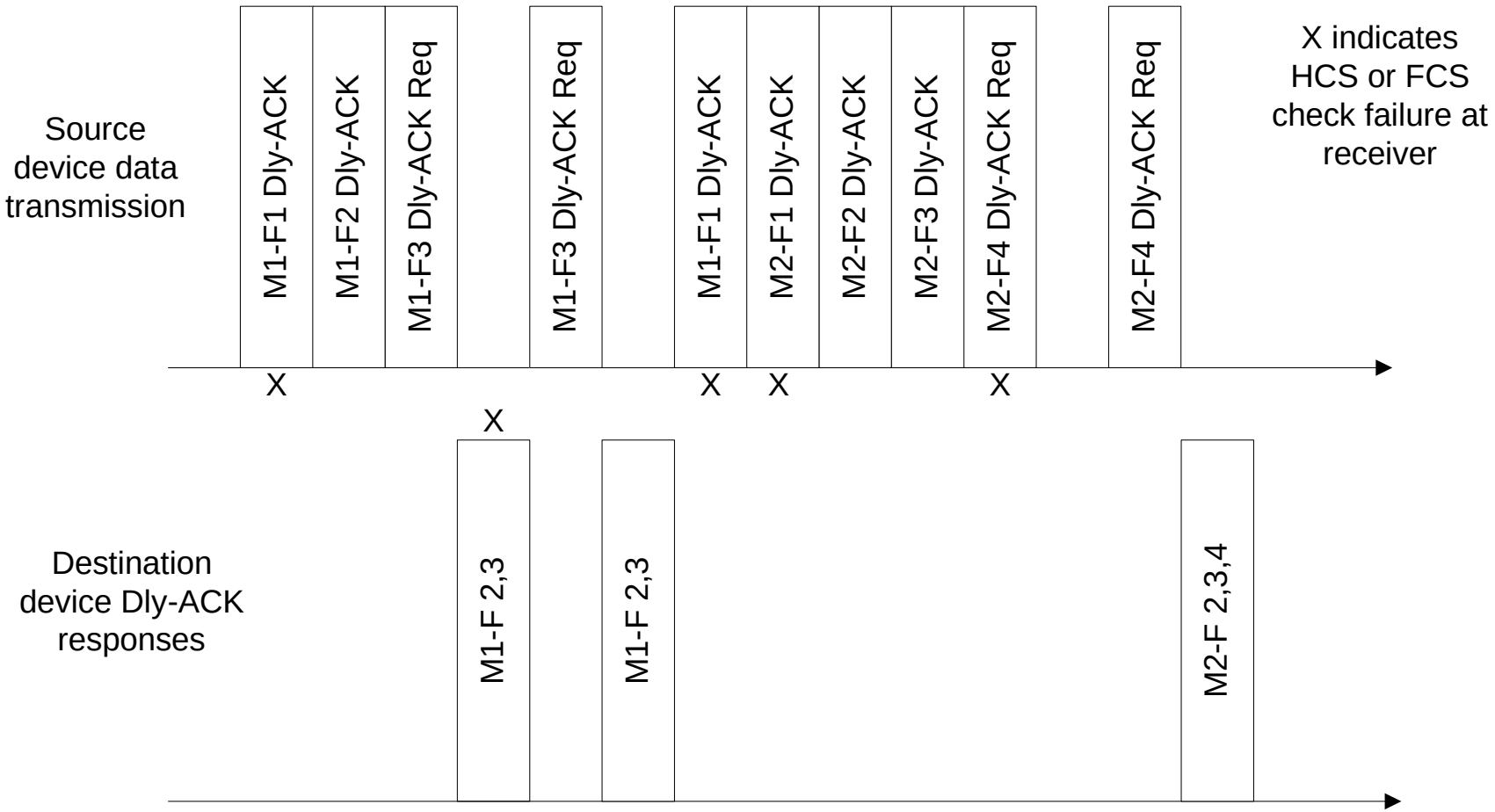


Retransmission

- Retransmission can be considered & treated as multiple antennas
- Original & retransmitted frames can be combined to increase SNR

Current 802.15.3 PHY & MAC

Block ACK – Dly-ACK



Problem for Combined Demodulation

- Scrambler is controlled by PHY
  - The 15-bit seed value chosen shall correspond to the seed identifier. The seed identifier value is set to 00 when the PHY is initialized and is incremented in a 2-bit rollover counter for each frame that is sent by the PHY. In other words, seeds are chosen incrementally and circularly.
- Retransmission is controlled by MAC

- Retransmitted frames may be scrambled with different scramblers
- Bit stream after scramblers from same frame may be different

- Different bit streams cannot be combined in demodulation

Proposed Scheme & Design

1 – New Scrambler Setting

- Besides of using increment and circular seed setting, the retransmitted frames are assigned with the same scrambler seeds as the originally transmitted frames.
- In addition to the same scrambler setting, the retransmitted frames are encoded with the same encoder, as the originally transmitted frames.
- Doing these results in same payload, which makes it possible for combined demodulation in receivers.

1 – New Scrambler Setting

- To accomplish these functions, scrambler setting should be controlled by MAC
- To make it clear, following statement (or similar) should be added into both “retransmission” in MAC and “scrambler” in PHY
  - scrambler seed is assigned by MAC and retransmitted frames have same scrambler seeds as those in originally transmitted frames

2 – Demodulation of Header

- One task of header demodulation is to get parameters from PHY header necessary to demodulate payload data, i.e.,
  - Seed identifier of scrambler
  - Data rate of MAC frame body
  - Payload length
- Same data & same scrambler seed & same rate ➔ same payload length

2 – Demodulation of Header

- If payload is modulated using the same parameters
- If multiple headers are received

- Only one header is required to be demodulated to get PHY Header
- Due to the small size, headers can be demodulated many time in one frame time

2 – Demodulation of Header

	Retransmitted frame (HCS checking)	
Original transmitted frame (HCS checking)	11	10
	01	00

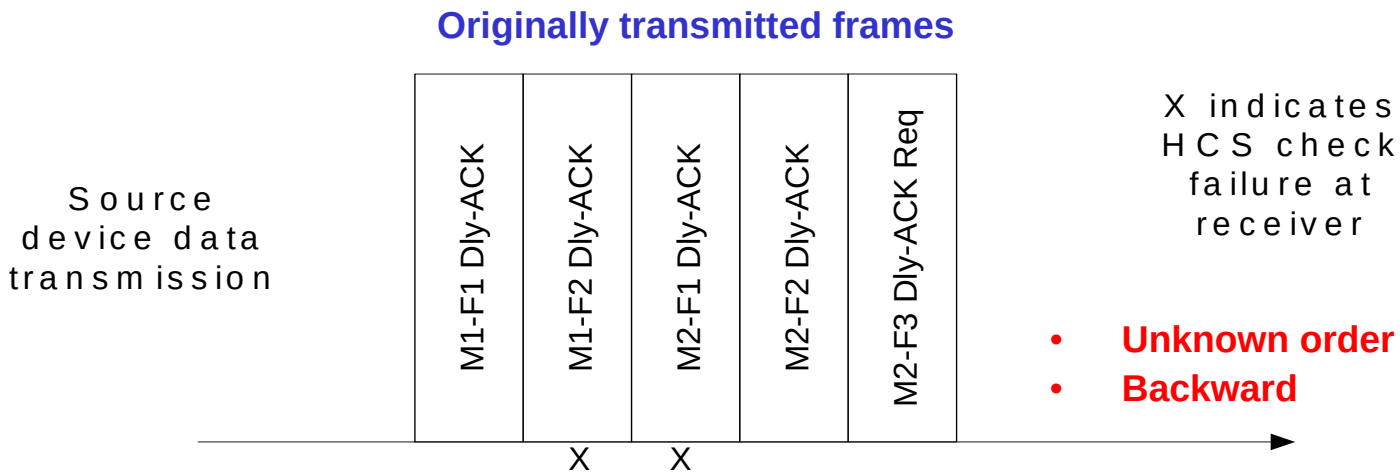
- In cases of 11, 10 & 01, try header demodulation until one header is correctly extracted
- In cases of 00, after above try, combined demodulation can be performed

3 – Frame Numbering

- Another task of header demodulation is to get frame number – MSDU number and Fragment number – for packet assembly at MAC layer
- In order to combine frames, we need to identify frames with the same frame numbers

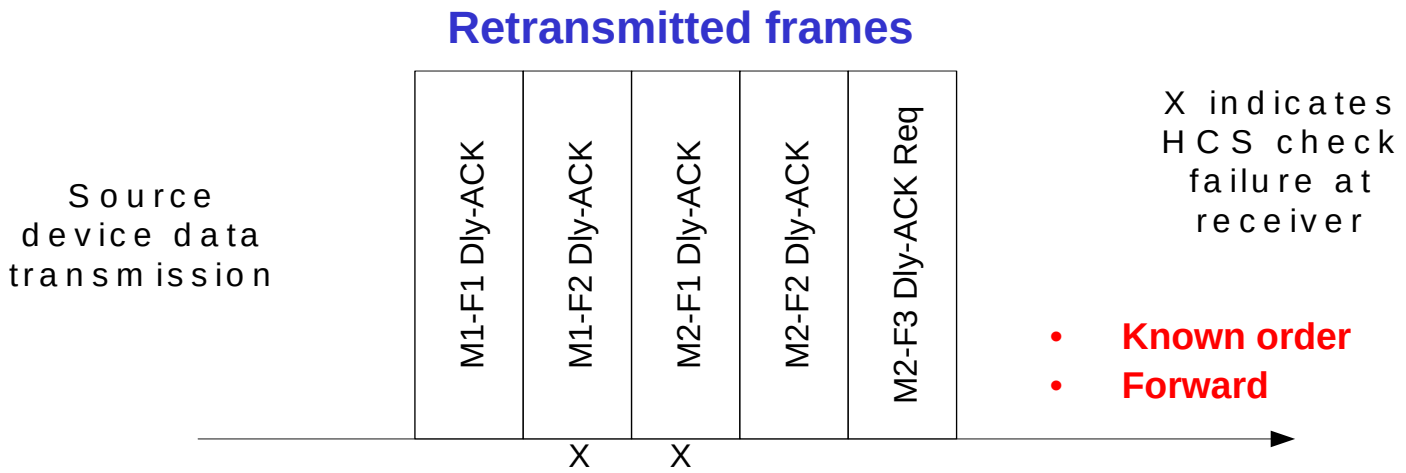
- However frame number can also be “extracted” as long as the following rule is used
  - Frames including retransmitted frames are transmitted in sequential order in bursts
  - MSDU(i) is sent before MSDU(j) if i<j
  - Fragment(m) is sent before Fragment(n) if i=j & m<n

3 – Frame Numbering



- From the 4th frame with ‘MSDU2 Fragment 2’, we can deduce the previous frame is ‘MSDU2 Fragment 1’;
- Since there is no frame with ‘Fragment 0’, the 2nd frame must be ‘MSDU 1’;
- From the first frame with ‘MSDU 1 Fragment 1’, we can deduce that the second frame should be either ‘MSDU 1 Fragment 2’ or ‘MSDU 2 Fragment 1’. Based on previous deduction, we can conclude that the second frame is ‘MSDU 1 Fragment 2’.

3 – Frame Numbering



- From the 1st frame with ‘MSDU1 Fragment 1’, we can deduce the next frame will be ‘MSDU1 Fragment 2’;
- The 3rd frame will be ‘MSDU 2 Fragment 1’.

4 – Header

Octets:1	3	1	1	2	2
Stream Index	Fragmentation Control	SrcID	DestID	PNID	Frame Control

Bits: b15-b11	b10	b9	b8-b7	b6	b5-b3	B2-b0
Reserved	More Data	Retry	ACK policy	SEC	Frame Type	Protocol Version

b8-b7	ACK policy type
00	No ACK
01	Immediate ACK
10	Burst ACK
11	Burst ACK Request

b5-b3	Frame type
000	Beacon frame
001	Imm-ACK frame
010	Dly-ACK frame
011	Command frame
100	Data frame
110-111	Reserved

4 – Header

- ‘Retry’ bit makes headers in original frames and retransmitted frames different
- Remove ‘retry’ bit or leave it unprotected to make same header
- Same header makes combined demodulation of header possible

- Caution: there won’t be two different frames with the same MSDU number in one burst

5 – Demodulation of Payload

- If payload is modulated using the same parameters
- If multiple frames are received

- Due to limitation of processing power, payload can be demodulated only one time in one frame time
- Combined demodulation can be used

Complicity Analysis

- Little change to current PHY & MAC specification

- Slightly extra processing for payload data
- A little more processing for header
- Memory to store frames

- Low-end devices
  - No extra memory for data storage
  - Do not store frames
  - Perform demodulation on single frame

Summary

- MAC controlled scrambler setting
  - Scrambler seed is assigned by MAC and retransmitted frames have same scrambler seeds as those in originally transmitted frames
- Frames including retransmitted frames are transmitted in order in bursts
  - Frames including retransmitted frames are transmitted in sequential order in bursts

Conclusion

- A new scheme & design is proposed to enhance performance of retransmission in block ACK
- The scheme causes little change for current 802.15.3 PHY & MAC
- Backward compatible to devices with traditional demodulation

Thank you