Project: IEEE P802.15 Working Group for Wireless Personal Area Networks(WPANs)

Submission Title: Suggested baseline for optional TG4m ranging

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Source: Mi-Kyung Oh, Jae-Hwan Kim, Jae-Young Kim, and Sangsung Choi (ETRI), Soo-Young Chang (SYCA)

Contact: ohmik@etri.re.kr

Voice: +82 42 860 6831, E-Mail: ohmik@etri.re.kr

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Abstract: This contribution presents a suggested baseline for optional TG4m ranging

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Outline

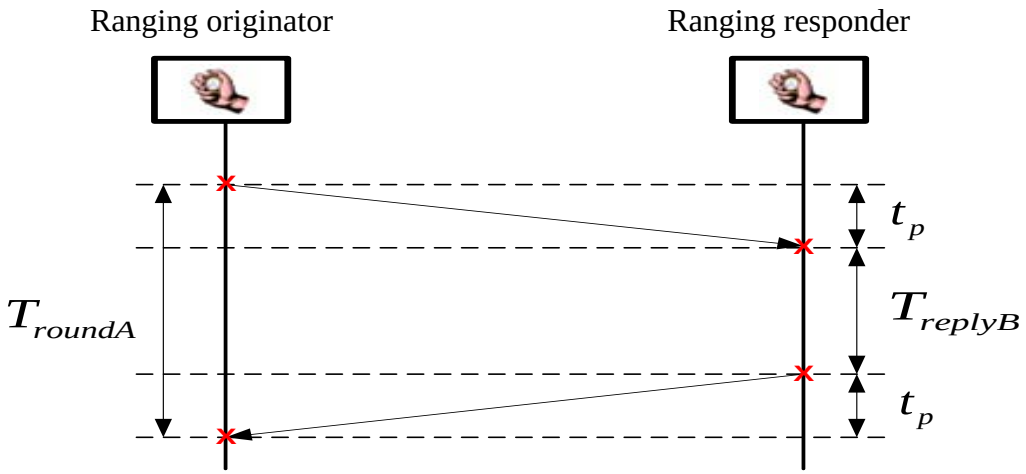
- The goal of this document is to suggest a baseline for optional TG4m ranging
- Initially, Doc.12-167-00 started to discuss about RF localization issue
- Doc. 12-247-02 discussed about MAC extensions to support localization requirements for TVWS
- Doc. 12-334-02 proposed the optional RF localization for TG4m

TG4m Ranging

- Support for ranging is optional
- Ranging procedure for TG4m
  - Basically two-way ranging (TWR) as in 15.4a
- A TVWS WPAN PHY that supports ranging shall support a ranging counter

Ranging Overview

- Distance estimation based on TWR



Time of Flight (ToF) :

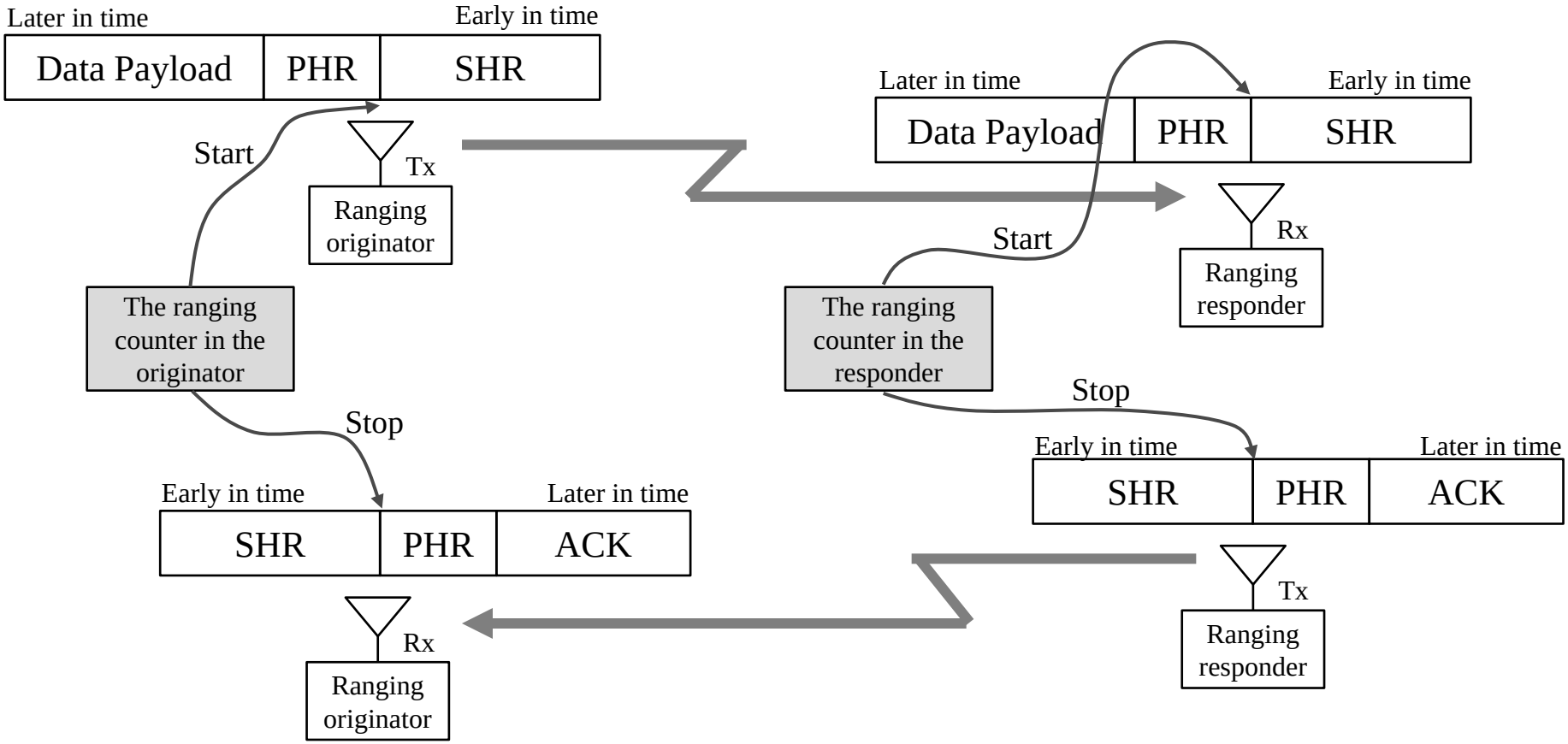
$$t_p = \frac{T_{roundA} - T_{replyB}}{2}$$

Distance d = ToF x speed of light

- A ranging counter at each node is required to obtain T_{roundA} & T_{replyB}

Ranging Counter

- The complete two-way ranging exchange (15.4-2011)



Ranging Counter

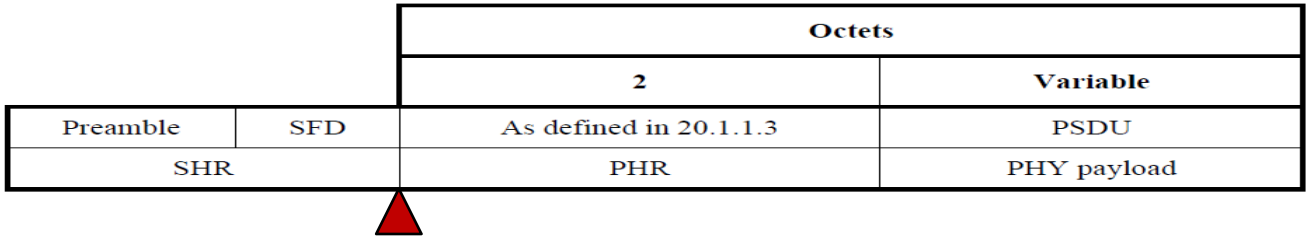
- In the ranging originator
  - The difference of the counter start and stop value represents *TroundA*, which is the total elapsed time from the departure of the first message to the arrival of the acknowledgement.
- In the ranging responder
  - The difference of the counter start and stop value represents *TreplyB*, which is the total elapsed time from arrival of the data message to the departure of the acknowledgement.
- After these values are all brought together at a common computing node, the time of fight and distance can be calculated

RMARKER & Ranging Bit

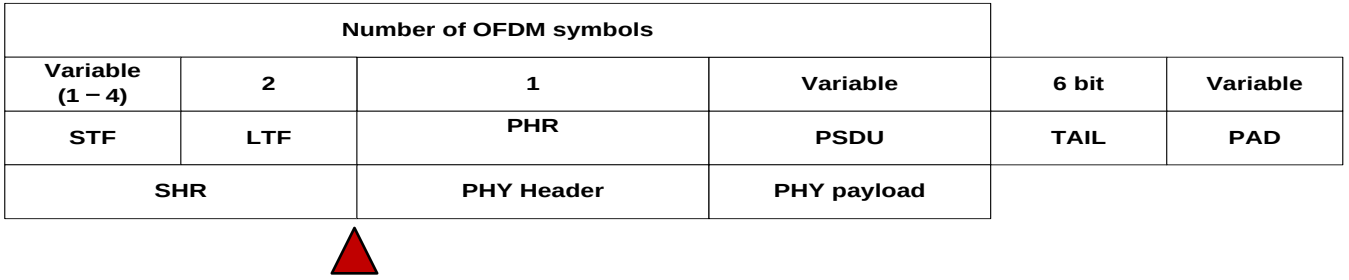
- To obtain the counter start & stop value in the ranging originator and responder, the known instant (i.e., *ranging marker* : RMARKER) in a frame should be determined
- Transmitting PHYs for frames used in ranging should have a bit called the *ranging bit* so that this particular frame is intended for ranging
  - The ranging bit enables efficient implementation of ranging operation at the receiver
    - Efficient on/off of ranging counter
    - Triggering a timing correction logic for enhancing accuracy

RMARKER

- RMARKER for FSK PHY



- RMARKER for OFDM PHY



Ranging Bit

- For indicating the ranging bit
  - Use one of reserved bits in FSK/OFDM PHY PHR

FSK PHR

Bit string index	0-1	2	3	4	5–15
Bit mapping	R_1–R_0	PC	FCS	DW	L_{10}–L_0
Field name	Reserved	Parity Check	FCS Type	Data Whitening	Frame Length

OFDM PHR

Bit string index	0-5	6-7	8-18	19-27	28-43	44-49
Bit mapping	R_5-R_0	RA_1-RA_0	L_{10}-L_0	S_8-S_0	H_{15}-H_0	T_5-T_0
Field name	Reserved	Rate	Frame Length	Scrambling seed	HCS	Tail

  - Requirements on the ranging bit in the PHY will be investigated

ToA Estimation

- In order to achieve precise instant for the received RMARKER, Time of Arrival (ToA) estimation should be performed at the receiver
- Ranging Sequence for ToA estimation
  - FSK PHY
    - Doc. 12-334-02 suggested the preamble-like sequence for ToA estimation
    - Use preamble sequence in SHR
  - OFDM PHY
    - Sequence with good autocorrelation property is required for timing acquisition
    - Use STF sequence in SHR
  - Inserting additional ranging sequence will be investigated

Conclusion

- For ranging counter operation
  - RMARKER
    - Boundary between SHR & PHR for both FSK/OFDM PHYs
  - Ranging bit
    - Use one of reserved bits in PHR
  - ToA estimation
    - Use SHR for both FSK/OFDM PHYs
- Informative Annex for FSK/OFDM PHY based ranging will be added for guideline