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

Submission Title: [DATA-ACK Based Ranging Sequence]
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Re: [802.15.4a.]

Abstract: [Proposal on PHY/MAC ranging extensions]

Purpose: [Promote discussion on 15.4a PHY/MAC ranging extensions]

DATA-ACK Based Ranging Sequence

➢ Proposal on 15.4a PHY/MAC ranging extensions

Required Features for Ranging

- ➢ Non-interruptible message sequences for round trip measurement

- ➢ Timestamps of message sequence to higher layer

- ➢ Preamble type control (preamble length)

- ➢ Ranging Quality Indication

Non-interruptible Message Sequence

➢ DATA-ACK Sequence is a non-interruptible message sequence per 15.4 MAC definitions

➢ There are several reasons, not to return the ranging information in the ranging response packet:

  ➢ Avoiding new MAC services (e.g., DATA-DATA-like sequences)

  ➢ Avoiding time critical processing of return information (especially in case of secure ranging mechanisms)

Timestamps of Message Sequence (1)

➢ MCPS-DATA service primitive timestamp parameter is already available in the 15.4b MAC

➢ Additional timestamp parameter has to be added for the ACK packet

➢ Timestamps have to be extended for high resolution

   ➢ minimum resolution t.b.d.

Timestamps of Message Sequence (2)

MCPS-DATA Service Primitive

MCPS-DATA.confirm (

    msduHandle,

    ....

    Timestamp*,   /* **high resolution** time stamp of transmitted DATA packet *\

    TimestampAck   **/* high resolution timestamp of received ACK packet ***

)

MCPS-DATA.indication (

    SrcAddrMode,

    .....

Additions to Existing
Service Primitive

    Timestamp*,   /* **high resolution** time stamp of received DATA packet *\

    TimestampAck,   **/* high resolution timestamp of transmitted ACK packet ***

    ....

)

Timestamps of Message Sequence (3)

PD-DATA Service Primitive

PD-DATA.indication (

    psduLenght,

    psdu,

    psduLinkQuality,

    TimestampOffset,   **/* high resolution timestamp offset of received PSDU,**

                                   shall include multipath resolution *

)

Addition to Existing
Service Primitive

Preamble Type Control (1)

➢ Data transfer and ranging are different types of services for higher layer

➢ Service type is associated with a certain preamble length

➢ Service type selection should be fast, because service type change could be required after each message sequence

➢ MAC should know service type of a received message, because it has impact on MAC behavior

➢ Service type is requested from higher layer per service primitive (MCPS-DATA)

Preamble Type Control (2)
Impact on MAC behavior
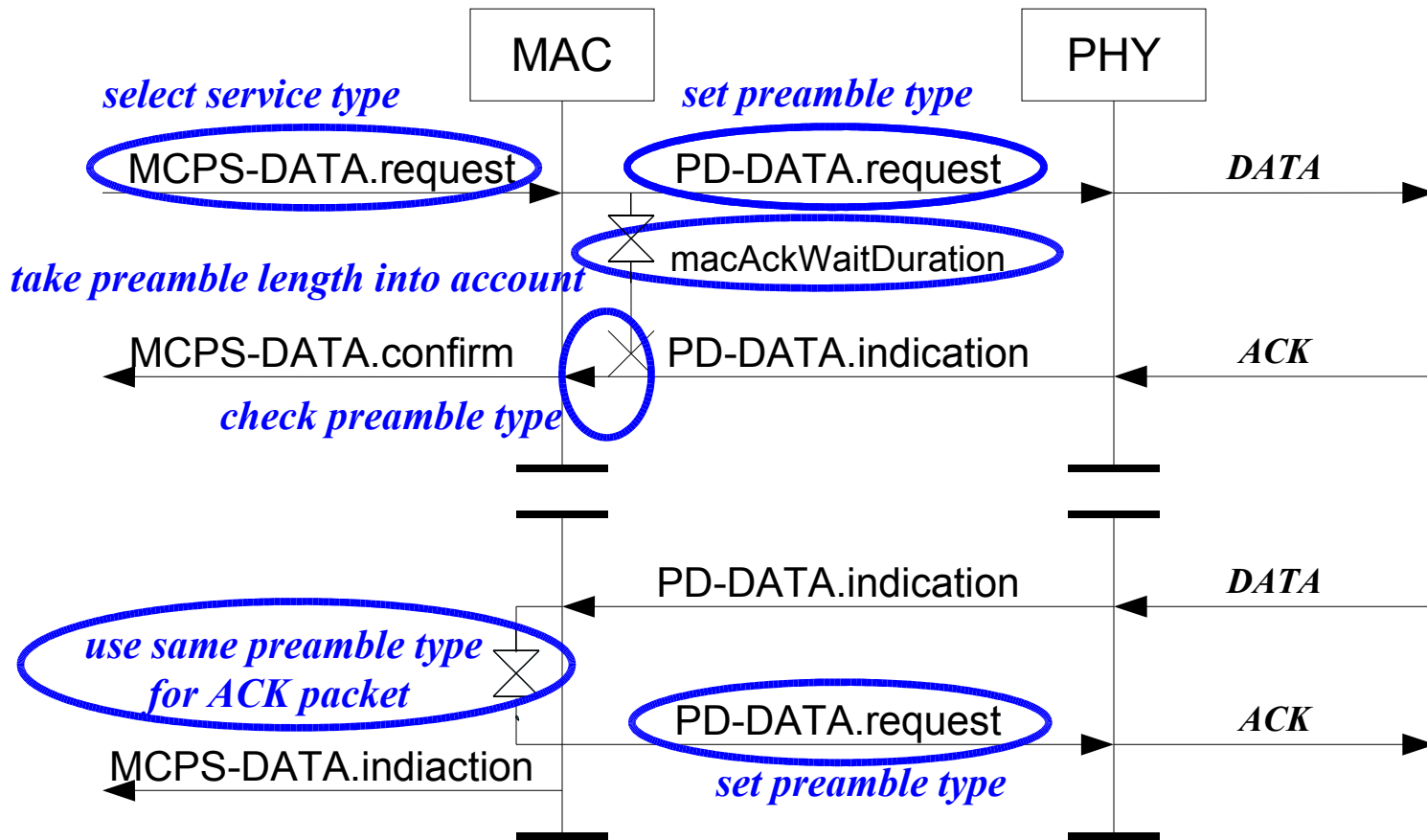
Preamble Type Control (3)

MCPS-DATA Service Primitive

MCPS-DATA.request (

    msduHandle,

    ...

    ServiceType   /* type of service, preamble length associated *

)

MCPS-DATA.indication (

    SrcAddrMode,

    .....

    ServiceType   /* this is optional, but might improve support for application *

    ....

)

Additions to Existing Service Primitive

Preamble Type Control (4)

PD-DATA Service Primitive

PD-DATA.request (

psduLenght,

psdu,

PreambleType   **/* sets preamble length ***

)

PD-DATA.indication (

psduLenght,

psdu,

psduLinkQuality,

PreambleType   **/* indicates preamble length to MAC ***

)

Additions to Existing Service Primitive

Preamble Type Control (5)

➢ Receiver has to detect service type of a message (slide 7)

➢ A new identifier is put into the PHY frame

➢ **PHY level coding avoids additional structure in MAC for ranging & avoids backward compatibility issues (4/4b MAC on 4a PHY)**

➢ Identifier indicates preamble length to PHY and service type to MAC and higher layer

➢ Identifier can be utilized in PHY to determine the quality of a received preamble

Preamble Type Control (6)

➢ 1) New identifier as additional field in PHY packet

preamble	SFD	PTI	PHR	PSDU

PTI = Preamble Type Identifier

e.g.,   0x0 = 50 us
          0x1 = 500 us
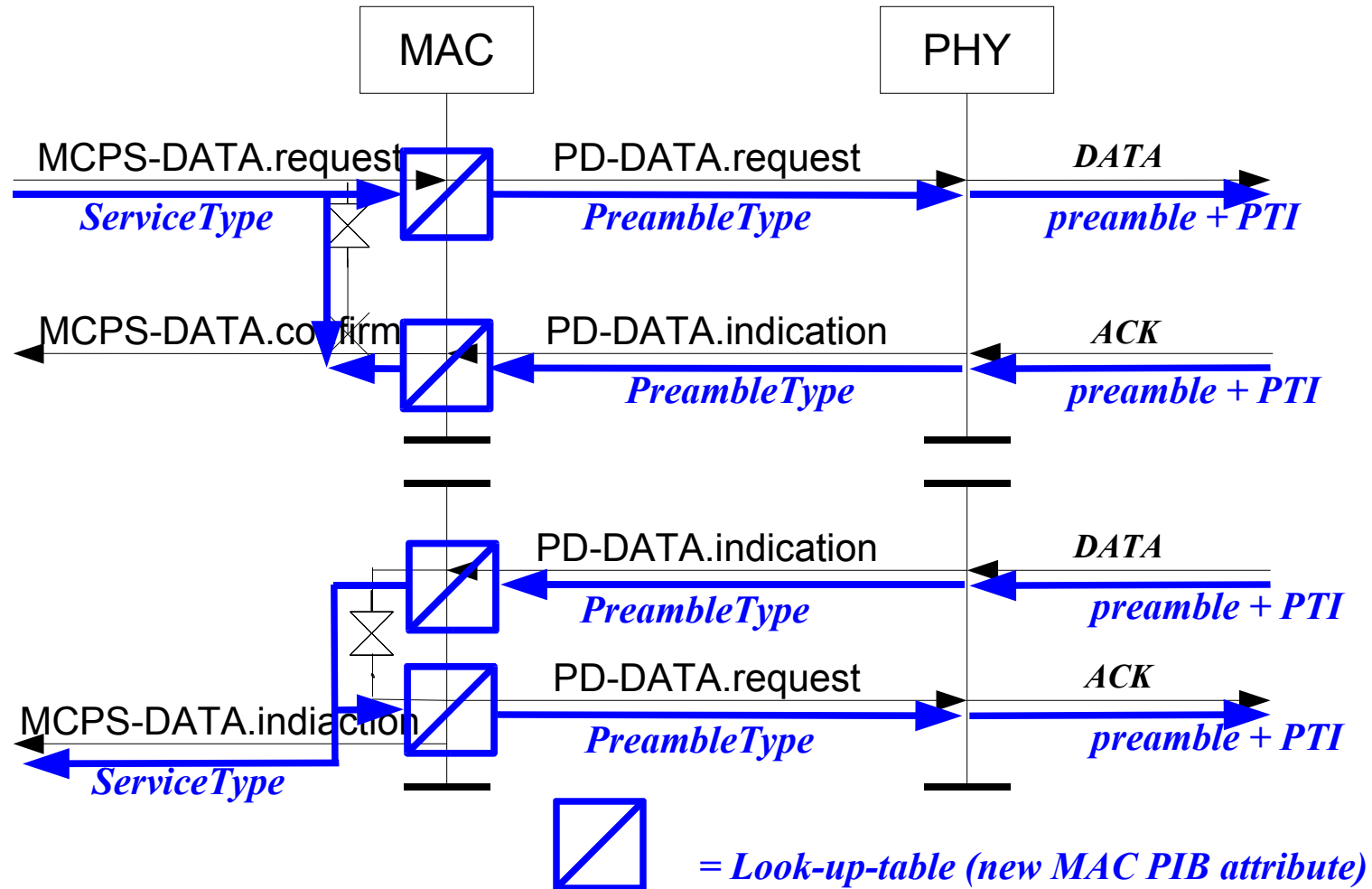   0x2 = 4000 us

          .....

➢ 2) For improved robustness identifier should be coded and can be optionally combined with the SFD, similar to Access Codes in 802.15.1

preamble	SFD+PTI	PHR	PSDU

Preamble Type Control (7)
Preamble type control flow

= Look-up-table (new MAC PIB attribute)

Ranging Quality Indication

➢ ppduLinkQuality and mpduLinkQuality indicate the strength and/or quality of a received packet (LQI) to the higher layer in existing PHY/MAC

➢ Those are 8 bit fields and could be extended to accommodate additional bits for ranging (e.g., the figure of merit)

...	FoM*	LQI

t.b.d.   8 bit
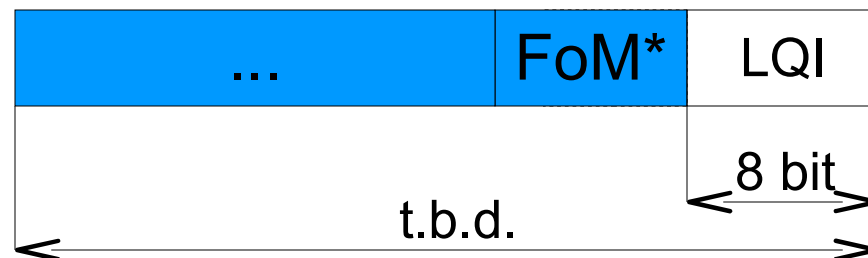
Extended ppduLinkQuality/mpduLinkQuality parameters, * figure of merit

Summary

- ➢ Utilization of DATA-ACK sequence for ranging

- ➢ Additions/extensions:

    - ➢ Additional parameters in PD-DATA and MCPS-DATA service primitives

    - ➢ Additional code in PHY frame (PTI)

    - ➢ Additional ranging MAC PIB attribute (look-up-table)

- ➢ Avoids much ranging structure in MAC (bits in MAC frames, management functions) & backward compatibility issues

- ➢ Additional ranging functions (e.g., capability indication) could be done by higher layer protocols / application layer protocols