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Wireless Personal Area Networks

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Re:	[]
Abstract	[Suggested updatds for AV PHY.]
Purpose	[To assist in comment resolution.]
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1. Technical updates

1.1 Updates for MAC to select/detect PHY mode of piconet

Add the following row to Table 3c in 6.3.2 as shown:

Table 3c—Elements of PiconetDescription

Name	Type	Valid range	Description
PHYMode	Enumeration	2.4_GHZ, SC_MMWAVE, HSI_MMWAVE, AV_MMWAVE	The PHY that is being used in the piconet that was found.

Add the following row to Table 3e in 6.3.3 as shown:

Table 3c—MLME-START primitive parameters

Name	Type	Valid range	Description
PHYMode	Enumeration	2.4_GHZ, SC_MMWAVE, HSI_MMWAVE, AV_MMWAVE	The PHY that will be used in the piconet to be started.

6.3.3.1 MLME-START.request

Change the primitive definition in 6.3.3.1 as shown

```
MLME-START.request          (
                            BSIDLength,
                            BSID,
                            SECMode,
                            MinDepSuperframePercent,
                            DesiredDepSuperframePercent,
                            PHYMode
                            )
```

1.2 Channel probing information in directional ACK

Add the following to the acronyms

RSSIr received signal strength indication relative
SINR signal to noise and interference ratio

Add the following to 12.1.7.3

The Receive Status field shall be formatted as illustrated in Figure 1.

Bits: 7	**2**	**4**	**2**	**4**	**3**	**1**
Reserved	Current MCS status	FER	Suggested CES length	SINR	RSSIr	Valid

Figure 1—Receive status field format for mmWave PHY

The Valid bit shall be set to one if the information in the Receive Status field is valid and shall be set to zero otherwise.

The RSSIr field contains the amount that the recieved frame was above the sensitivity of the MCS used. The range of the RSSIr field is from 0 dB to 28 dB in 2 dB steps with 0b0000 corresponding to less than or equal to 0 dB,0b1110 corresponding to greater than 28 dB, and 0b1111 is reserved. For example, a RSSIr value that is greater than or equal to 8 B but less than 10 dB would be encoded as 0b0100.

The SINR field contains the estimated signal to noise and interference ratio of the received frame. The range of the SINR field is from 0 dB to 28 dB in 2 dB steps with 0b0000 corresponding to less than or equal to 0 dB, 0b1110 corresponding to greater than 28 dB, and 0b1111 reserved. For example, an SINR value that is greater than or equal to 18 dB but less than 20 dB would be encoded as 0b1001.

Valid values of the Suggested CES Length field are:

— 0b00 → Suggest long CES length
— 0b01 → Suggest short CES length
— 0b10–0b11 → Reserved

The FER field contains the exponent of the estimate of the FER ranging from 10^{-1} to 10^{-10} in steps of -1 with 0b0000 corresponding to an FER exponent of less than or equal to -1 (i.e., an FER greater than or equal to 10^{-1}), 0b1001 corresponding to an FER exponent of greater than -10 (i.e., an FER of less than 10^{-10}), and 0b1010-0b111 Reserved. For example, an FER field value of 0b0110 indicates an exponent of -2.2 and that the FER was less than or equal to 10^{-2} but was greater than $10^{-2.2}$.

Valid values of the Current MCS Status fied are:

— 0b00 → Current MCS is inadequate
— 0b01 → Current MCS is adequate
— 0b10 → Current MCS is more than adequate, a lower MCS would be adequate
— 0b11 → Reserved

Add the following to subclause 12.4.3.8.

The directional LRP payload shall be formatted as illustrated in Figure 2.

octets: 2	**3**
HCS	Recieve status field

Figure 2—Directional LRP payload format

The HCS field contains the two octet HCS, as defined in <xref 12.2.4.2.1 or 11.2.9>, calculated over the Receive Status Field.

The Receive Status field is defined in 12.1.7.3.

1.3 AV OFDM retransmission procedure

Only one additional rule is required:

Data identified as video by the source DEV may be passed by the destination DEV to the higher layers even if the data was received in error.

All other rules for retransmission are adequately covered by 802.15.3, which says:

“During the CAP, retransmissions shall follow the backoff rules as specified in 8.4.2.

During CTAs within a CFP when an Imm-ACK or Dly-ACK is expected, but is not received during RIFS, the source DEV shall start the retransmission of the frame (or new frame if the failed frame’s retransmission limit has been met) at the end of RIFS as long as there is enough channel time remaining in the CTA for the entire frame exchange.

A DEV determines the number of times a frame is retried before the DEV gives up on that frame and discards it. If the DEV gives up on a fragment of an MSDU/MCDU, the DEV shall discard all MPDUs of that MSDU/MCDU.”

Not only are no other rules required, any other rules, such as those in DF3, are either out of scope (they describe implementation details) or incorrectly restrain the source and destination.

1.4 Aggregation for various PHY modes

Note that the decision to aggregate or not aggregate is up to the transmitter and is an implementation dependent decision that can depend on the application. Thus, no rules need to be defined as to when a transmitter aggregates frames. All that needs to be defined is the format of the frames once they have been aggregated.

1.5 Omni LRP preamble usage

Add the following paragraph to subclause 12.4.3:

The first omni LRP packet in a CTA shall be sent using the short omni LRP preamble. Subsequent frames shall use the the long omni LRP preamble. All omni ACK packets shall use the short preamble. The short omni LRP preamble shall be used for frames sent in a CP. The beacon frame shall use the long omni LRP preamble.”

1.6 AV PHY HCS

The AV PHY HCS is defined in 12.4.1.4 Header check sequence. To clarify, change the paragraph in 12.4.3 as shown:

~~The HRPDU shall~~ The HRP Header field, MAC Header field, and ~~Header Check Sequence (~~HCS~~)~~ field, as defined in <xref 12.4.1.4>,~~s~~ shall be sent using HRP mode 0 modulation, as defined in Table 1.

1.7 Channel 2 mandatory

In order to make sure that AV OFDM DEVs interoperate, it is important that there is at least one common RF channel. For cost considerations, initial implementation may only implement 1 channel. Thus, we selected channel 2 as mandatory.

1.8 ACKs sent at same rate

This rule is OK for omni-ACKs, but doesn't work for HRP and directional ACKs. This also points out that there is no description of HR0, HRRX, HRTX and HRTR in the draft.

Add the following sentence to 8.12:

HRP frames in the AV OFDM PHY shall be ACKed with the directional ACK, as described in 12.4.4.5.

Add a two bit field to the DEV capabilities field format named "HRP modes" with the following definition:

The HRP Mode field indicates the HRP capabilities of an AV capable DEV, as described in <xref 12.4>. Valid values for the field are:

0 → HR0
1 → HRRX
2 → HRTX
3 → HRTR

Add the following text to the beginning of 12.4:

Typical video and audio consumer electronics are configured either as a source of data, e.g., a video disc player, or as a sink, e.g., a display. For these applications, the data flow is highly asymmetric in the same direction. Thus, AV PHY DEVs shall implement one of the following configurations:

— HR0: The DEV implements LRP transmit and receive functions.
— HRRX: The DEV implements HRP receive, LRP transmit and LRP receive functions.
— HRTX: The DEV implements HRP transmit, LRP transmit and LRP receive functions.
— HRTR: The DEV implements HRP transmit, HRP receive, LRP transmit and LRP receive functions.

1.9 Two outer encoders, Figure 187

The first pair should be RS outer encoders and the next outer interleavers. This is a cut-n-paste error.

1.10 Changing RS encoding for unified FEC scheme.

The RS encoding is an integral part of the overall PHY design, including the length of the headers to ensure that the date fits into a minimum number of symbols. The simulations and design were done in combination with the interleaver and inner encoder. One criteria for selecting the encoder was its low overhead, almost half of the RS(255,239) but, according to our simulations and measurements, provides enough protection.

1.11 Interleaver explanation

Replace 12.4.2.7 with the following:

The outer interleaver shall output the octets from $i = 0$, $k = 0$ first to $i = depth\text{-}1$, $k = N\text{-}1$ last, where *depth* is the depth of the outer interleaver and N is the lenght of RS code. With M parallel convolutional inner encoders for each RS codeword, the outer interleaver shall give the RS octets of b(0,0), …, b(*depth*-1,0) to the first convolutional encoder with lsb first. All octets of $b(i,k\times M+m)$, $i = 0, \ldots, depth\text{-}1$, $k = 0, 1, \ldots, N/M\text{-}1$, shall be output to the m^{th} convolutional encoder. The number of parallel convolutional encoders is specified in <xref 12.4.2.8>.

The outer block interleaver shall be operated with a *depth* = 4 for HRP data and a *depth* = 2 for the combination of the HRP Header, MAC Header and HCS fields. LRP modes do not use an outer block interleaver.

The combination of HRP header, MAC header and HCS field has 92 octets that is encoded into 112 octets by adding, 16 parity octets for error protection and 4 tail octets to terminate the convolutional code.

For the combination of the HRP Header, MAC Header and HCS fields, the first 48 octets are encoded using RS(56, 48, t=4) while the next 44 octets are encoded using RS(52, 44, t = 4). The second codeword is followed by 4 tail octets set to zero. The transmitted order of those octets, the method to insert the tail octets , and the method of interleaving for the outer interleaver are the same as those used for data.

1.12 Stations on page 119

Editorial mistake, should be “DEVs”

1.13 Table 166, page 122

16-QAM-TCM should be just 16-QAM

1.14 1 bit for UEP MCS

One bit for UEP for all subframes is sufficient because the MCS of each subframe uniquely identifies the type of modulation, including UEP. There are three EEP modes, mode indices 0-2, two UEP mode indices, 3-4, and two msb only retransmissions that EEP modulation, mode indices 5-6.

1.15 Long omni LRP format

Yes, this is a editorial mistake, the editor will fix the text.

1.16 SAP for video

Streaming uncompressed video has unique requirements that are not necesarily supported by the current 802.2 SAP. In particular, the follwing capabilities are required at this interface:

— Start a stream based on application requirements (throughput, latency, frame size, etc.)
— Identify the data as associated with a specific stream
— Indicate the data as one that can be passed up in error
— Specify that unequal error protection is acceptable.
— Identify to the receiving layer that the data is in error.

To accomplish this, one new SAP needs to be defined and another SAP modified.

Add the rows shown to Table 36 as shown.

Modify the MAC SAP with the following information.

Table 36—MAC-ISOCH-DATA and MAC-ASYNC-DATA primitive parameters

Name	Type	Range	Descripthion
DataType	Enumeration	VIDEO, AUDIO, DATA, UNCOMPRESSED_VIDEO, UNCOMPRESSED_AUDIO	Indicates the type of data that is sent in the stream.
UEPAllowed	Boolean	TRUE, FALSE	Indicates if UEP is allowed for the transmission of the data.
ErrorsFreeData	Boolean	TRUE, FALSE	Indicates if the data that was received contains errors or is free from errors.

1.16.1 MAC-ISOCH-DATA.request

Change the primitive definition as shown:

```
MAC-ISOCH-DATA.request      (
                            RequestID,
                            StreamIndex,
                            TransmitTimeout,
                            MaxRetries,
                            SNAPHeaderPresent,
                            ACKRequested,
                            ConfirmRequested,
                            Length,
                            Data,
                            DataType,
                            UEPAllowed
                            )
```

1.16.2 MAC-ISOCH-DATA.indication

Change the primitive definition as shown:

```
MAC-ISOCH-DATA.indication   (
                            TrgtID,
                            OrigID,
                            StreamIndex,
                            SNAPHeaderPresent,
                            Length,
                            Data,
                            DataType,
                            ErrorFreeData
                            )
```

Insert the following subclause after A.2

A.3 Stream SAP

The Stream SAP is used to transfer time sensitive data streams. Examples of the data intended for this interface include audio and video, particularly uncompressed audio and video. The primitives defined for this SAP are listed in Table 37.

Table 37—Stream SAP primitives

Name	Request	Confirm	Indication	Response
ST_INITIATE	A.3.1.1	A.3.1.2	A.3.1.3	X
ST_MODIFY	A.3.1.4	A.3.1.5	X	X
ST_END	A.3.1.6	A.3.1.7	A.3.1.8	X
ST_DATA	A.3.2.1	A.3.2.2	A.3.2.3	X

A.3.1 Stream creation, modification and deletion

These primitives are used to start, change or stop a stream connection. The paramters for the primitives are defined in Table 38.

Table 38—ST_INITIATE, ST_MODIFY and ST_END primitive paramters

Name	Type	Range	Descripthion
RequestID	Integer	0-255	A unique value created by the originating DEV to match the request primitive to the repsonse primitve
TargetAddress	DEVAddress	Any valid MAC address as defined in 7.1	The address of the target of the primitve.
SourceAddress	DEVAddress	Any valid MAC address as defined in 7.1	The address of the Source of the stream.
StreamIndex	Integer	Any vaild stream index, as defined in 7.2.3.	The index of the stream that was created or the index of the stream to be modified or ended.
MinThroughput	Integer	$(1\text{-}2^{64})\text{-}1$	The minimum required throughput in bits per second at the MAC SAP.
DesiredThroughput	Integer	$(1\text{-}2^{64})\text{-}1$	The desired throughput in bits per second at the MAC SAP.
MaxTransmitDelay	Duration	$(1\text{-}2^{64})\text{-}1$	The maximum delay in microseconds
TypicalFrameSize	Integer	0-pMaxFrameBodySize	The typical size, in octets, of an MSDU that would be presented to the MAC SAP.
SECMode	Boolean	TRUE, FALSE	Indicates if security is applied to the stream.

Table 38—ST_INITIATE, ST_MODIFY and ST_END primitive paramters

Name	Type	Range	Descripthion
ReliabiltiyExponent	Integer	0-31	The negative power of 10 that is the that is the maximum FER including retries and frames lost to MaxTransmitDelay. For example, a value of 4 corresponds to an FER < 10^{-4}. If the value of the parameter is zero, then the parameter is ignored.
TimeOut	Integer	0-65535	The time in milliseconds for the primitive to complete.
AvailableThroughput	Integer	$(1-2^{64})-1$	The estimate of the throughput in bits per second available in the allocated stream
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the request
ReasonCode	Enumeration	REQUEST_TIMEOUT, NOT_ASSOCIATED, TARGET_UNAVAILABLE, TERMINATED_BY_PNC, TERMINATED_BY_DEST, INVALID_STREAM_INDEX, TRANSMIT_DELAY_ UNSUPPORTED RESOURCES_ UNAVAILABLE, OTHER	The reason for a ResultCode of FAILURE.

A.3.1.1 ST_INITIATE.request

This primitive is used to setup a data stream. The semantics of this primitive are:

```
ST_INITIATE.request          (
                             RequestID,
                             TargetAddress,
                             MinThroughput,
                             DesiredThroughput,
                             MaxTransmitDelay,
                             TypicalFrameSize,
                             SECMode,
                             ReliabilityExponent,
                             TimeOut
                             )
```

The primitive parameters are defined in Table 38.

A.3.1.2 ST_INITIATE.confirm

This primitive is used to report the result of a request to set up a data stream. The semantics of this primitive are:

```
ST_INITIATE.confirm          (
                             RequestID,
                             StreamIndex
                             AvailableDataRate,
                             ResultCode,
                             ReasonCode
                             )
```

The primitive parameters are defined in Table 38.

A.3.1.3 ST_INITIATE.indication

This primitive is used to report that the creation of a stream by another DEV. The semantics of this primitive are:

```
ST_INITIATE.indication       (
                             SourceAddress,
                             StreamIndex
                             )
```

The primitive parameters are defined in Table 38.

A.3.1.4 ST_MODIFY.request

This primitive is used to modify the parameters of an existing data stream. The semantics of this primitive are:

```
ST_MODIFY.request            (
                             RequestID,
                             StreamIndex,
                             MinThroughput,
                             DesiredThroughput,
                             MaxTransmitDelay,
                             TypicalFrameSize,
                             SECMode,
                             ReliabilityExponent,
                             TimeOut
                             )
```

The primitive parameters are defined in Table 38.

A.3.1.5 ST_MODIFY.confirm

This primitive is used to report the result of a request to modify the parameters of an existing data stream. The semantics of this primitive are:

```
ST_MODIFY.confirm          (
                           RequestID,
                           StreamIndex
                           AvailableDataRate,
                           ResultCode,
                           ReasonCode
                           )
```

The primitive parameters are defined in Table 38.

A.3.1.6 ST_END.request

This primitive is used to setup a data stream. The semantics of this primitive are:

```
ST_END.request             (
                           StreamIndex,
                           TimeOut
                           )
```

The primitive parameters are defined in Table 38.

A.3.1.7 ST_END.confirm

This primitive is used to report the result of a request to set up a data stream. The semantics of this primitive are:

```
ST_END.confirm             (
                           StreamIndex
                           ResultCode,
                           ReasonCode
                           )
```

The primitive parameters are defined in Table 38.

A.3.1.8 ST_END.indication

This primitive is used to report that the creation of a stream by another DEV. The semantics of this primitive are:

```
ST_END.indication          (
                           StreamIndex,
                           ReasonCode
                           )
```

The primitive parameters are defined in Table 38.

A.3.2 Stream data interface

These primitives are used to send stream data and report the reception of stream data. The paramters for the primitives are defined in Table 39.

Table 39—ST_DATA primitive paramters

Name	Type	Range	Descripthion
RequestID	Integer	0-255	A unique value created by the originating DEV to match the request primitive to the repsonse primitve
SourceAddress	DEVAddress	Any valid MAC address as defined in 7.1	The address of the source of the data.
DestinationAddress	DEVAddress	Any valid MAC address as defined in 7.1	The address of the destination of the data.
StreamIndex	Integer	Any vaild stream index, as defined in 7.2.3.	The index of the stream that was created or the index of the stream to be modified or ended.
TransmitTimeout	Integer	$(1\text{-}2^{32})\text{-}1$	The maximum allowed delay in microseconds from when the data is presented to the SAP until the frame has finished transmission and the acknowledgement, if required, is received.
SNAPHeaderPresent	Boolean	TRUE, FALSE	TRUE indicates that an LLC/SNAP header is present in the data frame.
ConfirmRequested	Boolean	TRUE, FALSE	Indicates when a confirm primitive is required for the request.
Length	Integer	$0\text{-}(1\text{-}2^{32})\text{-}1$	The length of the Data in octets.
Data	Octet string		The information to be sent in the stream connectin.
DataType	Enumeration	VIDEO, AUDIO, DATA, UNCOMPRESSED_VIDEO, UNCOMPRESSED_AUDIO	Indicates the type of data that is sent in the stream.
UEPAllowed	Boolean	TRUE, FALSE	Indicates if UEP is allowed for the transmission of the data.
ErrorsFreeData	Boolean	TRUE, FALSE	Indicates if the data that was received contains errors or is free from errors.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the request
ReasonCode	Enumeration	TRANSMIT_TIMEOUT, NOT_ASSOCIATED, TARGET_UNAVAILABLE, INVALID_STREAM_INDEX, OTHER	The reason for a ResultCode of FAILURE.

A.3.2.1 ST_DATA.request

This primitive is used to send stream data to another DEV. The semantics of this primitive are:

```
ST_DATA.request          (
                         RequestID,
                         StreamIndex,
                         TransmitTimeout,
                         SNAPHeaderPresent,
                         ConfirmRequested
                         Length,
                         Data,
                         DataType,
                         UEPAllowed
                         )
```

The primitive parameters are defined in Table 39.

A.3.2.2 ST_DATA.confirm

This primitive is used to send stream data to another DEV. The semantics of this primitive are:

```
ST_DATA.request          (
                         RequestID,
                         StreamIndex,
                         TransmitDelay,
                         ResultCode,
                         ReasonCode
                         )
```

The primitive parameters are defined in Table 39.

A.3.2.3 ST_DATA.indication

This primitive is used to send stream data to another DEV. The semantics of this primitive are:

```
ST_DATA.request          (
                         SourceAddress,
                         DestinationAddress,
                         StreamIndex,
                         SNAPHeaderPresent,
                         Length,
                         Data,
                         DataType,
                         ErrorFreeData
                         )
```

The primitive parameters are defined in Table 39.

1.17 Comment 70

The relevant part of the PAR states: “Data rates will be at least 1 Gbps under normal operating conditions with a typical range of no less than 10 m.”

Under normal opertating conditions, the LRP is only used for control and the HRP, which is Gbps rates, is used for data transfer.

Suggest reject.

1.18 Comment 75, starting piconets

The procedure for starting an AV piconet is the same as for a regular piconet, the PNC scans the channels and then begins sending beacons. The beacon is sent in the base rate, which is defined in DF3 as LRP modes 0-2. No change is required. As this is already defined.

Suggest reject.

1.19 Comment 78, adjacent AV piconets

Various coexistence mechanisms are available in the 802.15.3 MAC to handle the case of overlapping piconets. These methods include:

- passive scanning,
- dynamic channel selection,
- the ability to request channel quality information,
- transmit power control, and
- dependent piconet capability.

In addition, with beam formed transmitters, the interference footprint is constrained in such a way that very little energy is received by nearby piconets. This has been shown with two systems running simultaneously in the same room on the same frequency while providing high quality video.

Suggest reject.

1.20 Comment 87, directional ACK

The overhead for the ACK is 2 octets PHY header, 10 octets MAC header, 2 octets HCS, 33, 34 or 65 octets MAC subheader and 2 octet additional HCS. This gives 49, 50 and 71 octets. At 5 Mb/s the duration is 78 µs, 80 µs and 113.6 µs. Typical aggregated packets for highest rate HRP are about 200 µs long and carry 100,000 octets of data. Directional ACK is 6 µs long and SIFS is 2 µs, so the increase of 72 µs would be significant, changing the throughput from roughly 200/(200+2+6+2) ~ 95% to 200/(200+2+78+2) ~ 70%.

Since this is a significant difference in throughput, suggest reject.

1.21 Comment 99, video bandwidth

Suggest accept, add 300 kHz video bandwidth to the description of the TX mask. Note that the other two PHYs do not define either RBW or VBW.

1.22 Comment 91, directional ACK

Suggest resolve as in Comment 87.

1.23 Comment 98, similar transmit masks

Suggest reject: Three PHY modes have been provided to address different use cases in a way that allows low power, low cost devices. Because of this, the spectral mask that can be readily achieved is different for each of the three PHYs. In addition, due to the use of directional antennas, the interference from nearby networks is significantly less than systems with near omni transmit patterns. Thus the requirements for the transmit masks are more relaxed.

1.24 Comment 104, sampling rate for AV PHY

Suggest reject: The sampling rate for the AV PHY was selected to make it easy to synthesize with the crystal oscillators that are typically available in consumer electronic AV devices.

1.25 Comment 130, integrity code for subframes

The fields in 7.2.7.5 all occur in the MAC header, which is sent with every subframe. The only change is to increment the SFC for each subframe in the frame.

Add the following to 12.4.4.2:

The SFC shall be incremented for each subframe in the frame, even if security is not applied to the subframe.

1.26 Comment 138, fields in the AV PHY extension headers

The Frame Type field and Type field are now defined as part of the update for the video SAP.

Add the following parameter to the ST_DATA and MAC_ISOCH_DATA primitives: VideoPixelInfoSet which is a set of paramters that is comprised of InterlacedFieldIndication, VideoFrameNumber, HPosition and VPosition whose definitions are cross referenced to 12.4.4.1.

All other fields are adequately defined.

1.27 Comment 42: SIFS/MIFS

Add the following text to 7.4.7 after Table 49a (or where appropriate)

The Supported IFS field indicates the minimum value of the IFS that is supported by the DEV. The minimum allowed IFS for either SIFS or MIFS may also be constrained by the PHY mode in use. A DEV may use the shortest SIFS or MIFS supported by the destination DEV. The SIFS and MIFS used may be different.