Frame Format adjustment Proposal

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AUT/DO

Frame Format adjustment Proposal

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Problems identified in 236.
• The connectivity functionality is decreased compared to the 82 draft.
  – Does not allow AP-to-AP transfers.
  – Infra Station to/from Ad-Hoc station not possible.
  – There is a problem with Sta-to-Sta Acknowledgement.
• More complex Filtering requirements in 236
  – Different address field filters for station and AP
  – Different fields involved as source for returning the CTS or Ack response.
  – Frame overhead is significantly increased.

Connectivity model:

Basic adjustment Proposal:

236 Proposal

Suggested approach:

DT8 is a sequence number (generated per MSDU).
  – Need low probability of two stations using same sequence.
  – Long Sequence length desirable for duplicate detection and it determines the uniqueness probability.
  – Sequence can be generated using a counter with a unique (odd) increment value per station.
• Probability that a "DT8 match" will cause a problem with data communication is negligible.
  – Only relevant during Data collisions.
  – and only when colliding Data PDUs have approx. equal length.
  – Further reduction when Data/Ack uses different DT8 than for the RTS/CTS.
• Suggest that RTS/CTS have different DT8 than Data/Ack.
  – Includes 4-bit Fragment number.

What was the function of the MPDUID:

• Matches RTS, CTS, Data, Ack together for a given MSDU.
  – Mechanism: Use Hash to create a unique value per source.
• Used to detect and eliminate duplicates.
  – Mechanism: Include a Sequence number in the Hash.
To resolve the problem:
• The functions are OK, but the proposed mechanisms were a problem, so:
  – Change the mechanism to serve both purposes.
  – Use a sequence number per MSDU with a minimum sequence length and unique sequence.

Conclusion: Change the 20B2 MPDUID mechanism.
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Field Definitions:

- **FC**: Function and Control Field (2 Bytes)
  - Identifies PDU Type and contain necessary control bits.
  - Same as the B3 or doc 84/264 proposal.

- **MID**: MSDU-Identification Field (2 Bytes).
  - Contains a 12-bit "Dialog Token" (DT).
    - This is a sequence number used to identify PDUs that belong together, like RTSCTS and DataAck.
    - It is also used for duplicate detection (if retry bit in FC).
  - Contains a 4-bit Fragment number (FF)
  - Dur: Duration Field (2 Bytes).
    - This field contains the time in use from the end of the current frame until the end of the Ack, for the next Data/Ack exchange.

- **RA**: Recipient Address (6 Bytes).
  - Identifies IEEE address of the direct wireless recipient.
    - This is the AP address when the PDU is destined to the AP, or needs to go via the AP to a final destination.
    - This is the final Destination Address when the ToAP=1.
  - **BID**: BSSID (6 Bytes) (when ToAP=0).
    - Uniquely identifies the BSS.
    - By using the 48-bit IEEE address of the AP.
    - Or the Ad-Hoc station that initiated the creation of the BSS.

- **SA**: Source Address (6 Bytes)

Field Definitions (cont'd):

- **RA**: Recipient Address (6 Bytes).
- **BID**: BSSID (6 Bytes) (when ToAP=0).
- **SA**: Source Address (6 Bytes)

Resulting Frame Header Formats:

- **RTS**: FC, MID, Dur, RA = 12
- **CTS**: FC, MID, Dur = 6
- **Data**: FC, MID, Dur, RA, BID/DA, SA = 24
- **Ack**: FC, MID, Dur = 6
- **Mngt**: FC, MID, Dur, RA, BID/DA, SA = 24
- **Poll**: FC, MID, Dur, RA, 3ID = 14

Savings compared to Doc 94/236 and 2083:

- **RTS + CTS + Data + Ack = 48 Bytes** (was 60 -20 %)
- **Data + Ack = 30 Bytes** (was 34 -11.8 %)

- All Header sizes are mod 2 Bytes.

- Data and Management Header size are, mod 4 Byte.

Resulting changes compared to 2083:

- **MID functionality restored.**
  - Does restore the AP-to-AP functionality and other as was available in 2083, but was inadvertently lost in 2083.
  - MID contains a 12 bit random number rather than a Hash.
  - Eliminates need for 8 Byte address fields in RTS, CTS, and Ack.

- **Sequence# and Fragment# fields eliminated / moved.**
  - MID allows Duplicate detection, and contains the FF.

- **Address Filtering and Duration fields always on fixed field position In Header.**

- **Reduced / Simplified address comparison requirements and processing.**
  - BSSID filtering only needed on BC/MC frames.

- **Header lengths have been considerably decreased.**

Different address field filters:

- **Improved Frame ordering of 84/254 simplifies address field filtering.**
  - Variability of Address fields is resolved in the transmitter.
  - Receive rules are static and requires no real-time processing.

- **The 248 proposal requires additional receiver complexity:**
  - Real time filter complexity in the receiver.
    - Different rules for AP and a Station.
    - RTS and Data have different filtering rules.
    - The field used as return address in the Ack is different:
      - For an AP it is the SA or TA field.
      - For an infrastructure station it is the BSSID.
      - For an Ad-Hoc station it is the SA field.

AP Filtering (248):

- **All RTS**: RTS: FC DA SA DUR
- **CTS**: CTS: FC DA
- **Data**: Data: FC BSSID DA SA S# F# DUR
- **(or to AP)**: Ack: FC DA
- **AP to AP**: Data: FC RA DA TA S# F# DUR SA
- **AP to AP**: Ack: FC DA

- Address Filtering = Field copy

AP's filter always on first address field.

- The Sta to AP works because BSSID=Maddr(AP)

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#### Station Filtering (248):

- **All RTS:** RTS: FC DA DA DA DA DUR
- **CTS:** DA DA DA
- **DS to Sta:** Data: FC DA DA SA SA SA DUR
- **Ack:** DA DA DA DA DA DA DA DUR
- **AP to Sta:** Data: FC DA DA SA SA SA DUR
- **Ack:** DA DA DA DA DA DA DA DUR
- **STA to STA:** Data: FC DA DA SA SA SA DUR
- **Ack:** DA DA DA DA DA DA DA DUR

- **Address Filtering**
- **Field copy**

Stations filter depending on type.

The field used for Ack address depends on From bit.

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#### 248/254 Filtering:

- **All RTS:** RTs: FC MID DUR RA
- **CTS:** FC MID DUR
- **STA to STA:** Data: FC MID DUR RA BID SA
- **Ack:** FC MID DUR
- **AP to STA:** Data: FC MID DUR RA BID SA
- **Ack:** FC MID DUR
- **AP to AP:** Data: FC MID DUR RA BID SA
- **Ack:** FC MID DUR

- **Address Filtering**
- **Field copy**
- **Matching**

Very consistent filtering independent of AP/Sta or type.

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#### Conclusion:

- The 2082 version MPDU functions are restored and repaired and combined with fragment numbering in the MID concept.
  - All connectivity functionality is restored.
  - Duplicate filtering function improved compared to 238.
  - No need for separate Fragment number field.
- All other 236 changes are adopted.
- Frame format field sequence is adapted for consistent filtering implementations.
  - No unique formats needed to support all connectivity cases.

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#### Where are we?

- Connectivity problems in 238 are recognised and considered valid.
  - WDS support
  - All station to station cases.
- There are two proposals that try to correct the 238/2083 flaw.
- Mechanisms proposed are different.
  - Differences in WDS support mechanism.
  - A separate frame format with 6 more bytes is suggested in 248.
  - Difference in implementation complexity.
  - Especially filtering differences.
  - Difference in Frame overhead.

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#### How does this compare with 248:

- Both proposals offer the same functionality.
- The main difference is:
  - Guaranteed uniqueness versus acceptable failure mode.
  - High overhead versus low overhead.
  - Differences in real-time filtering complexity.
- The 248 proposal can be improved to reduce the field order to ease filtering.
  - This does not solve the separate WDS frame format, unless an extra address field is added to every frame for uniformity.

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#### Mis correlation probability is very low:

- It compares to the lost frame probability of an Ethernet network.
  - 802.3 with 10x-2 SER will have 5e-8 packet failure rate when using 512 byte frames.
  - Higher layers are designed to cope with that.
- Doc 270 does not take all factors into account.
  - The collision probability is not considered.
    - Mis correlation only on issue when there is an medium access collision with an approximate equal length frame.
  - Doc 270 assumes a high danger of repeated matching errors.
  - We did take bimodal frame length distribution into account.
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Conclusion:

- The misscorrelation failure mode does not affect stability even in the extreme case.
  - The number of frames retransmitted does not increase.
- In those cases it is possible that the "Max-entry limit" failure will be higher than the misscorrelation error.
- It does compare very well with a wired "lost frame" failures.
- We should adopt the most efficient implementation.
  - and reduce complexity at the same time.

Motion:

- Move:
  To adopt the Frame Formats and associated mechanisms as defined in 94/254.

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MID Match effects:

- Collisions on approx. Equal Length frames can have a MID matching problem.

MID match effects in RTS/CTS:

- MID collisions are only relevant during an actual collision on the medium.
  - The MID value of the CTS and Ack frames are only relevant for those stations that are waiting for a CTS or Ack during a small window following an RTS or Data fragment respectively.
  - So only when two or more sources generate a CTS or Ack in response to an RTS in the same window are relevant.
  - This is only when an RTS collides with an other RTS.
  - or when a Data frame collides with an other Data frame with approximately the same length.
  - Only this results in an Ack within the Ack_Time-out window.
  - If not both transmitters conclude that the transmission was a success, while likely only one succeeded.
  - Note that the data is going to the correct destination.
- Collisions of RTS and Data are not relevant for the MID match failure mode.
What is the probability:

- The DT# in the MID uses a PRN generator with sequence length of 4K.
- So the MID match probability is:
  - "Collision Probability/4K".
- This does not take into account the frame length distribution, which will be application dependent.
- Let's assume a file transfer environment:
  - Many small length frames with a number of lengths <64 Bytes. These are higher layer dependent.
  - Most frames are 64 Bytes will be at the maximum size.
  - There will be occasional frames with lengths in between.
  - Assume that in a busy network the Long/Short frame ratio is 70%
  - So the probability that two equal length frames collide is less than .5

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The failure mode is then:

- If RTS collision: Two stations will generate the subsequent Data frame which will collide.
  - Detection of this collision is very likely when the subsequent DataAck does use a different MID then the RTS/CTS.
- If Data Collision: Two transmitters that generated the data frames, will both assume that the transmission was successful.
  - Although that is possible, it is more likely that only one actually came through. So assume probability is 50%.
  - A lost frame goes undetected in this case.
  - In cases that none get through there is no merging issue.
- The probability of this occurring depend on the network load, and is approximately:
  - "Collision Probability / 4K / 2 (equal length) 2 (only one is successful)"
  - Assuming a collision probability at 5% is approx. 2 x 10^-6
  - This means that the higher layers need to recover less than 2x10^-6

Is this acceptable:

- Please note that this is NOT the same as the "undetected error rate", because that concerns with the probability that a received frame is not flagged to be in error, while it is.
- The resulting error rate of less than approx. 3 out of 10^6 frames is lost at the MAC level is considered very acceptable, In a "Best effort" service scenario.
- Conclusion:
  - The MID non-uniqueness is no issue, and does not reduce the functionality.
  - No special provisions are needed to resolve its effects.