Frame Exchange Control for Uplink Multi-user transmission

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Background

- **In the 11ax PAR, it is said that "the project may include the capability to handle multiple simultaneous communications in both the spatial and frequency domains, in both the uplink (UL) and downlink (DL) direction", [1].**
  - DL MU-MIMO has already been supported in 11ac.
  - UL multi-user transmission was discussed in previous meetings, including UL MU-MIMO and UL OFDMA.
  - UL MU transmission is identified as a candidate technology to improve the network efficiency in dense deployment case.
    - The feasibility of supporting OFDMA and UL MU-MIMO has been analyzed in [2] and [3].

Motivation

- **A general UL MU transmission procedure has been introduced in [3].**
- **Further design for UL MU transmission protocol needs to be discussed, in particular:**
  - Multi-user polling and information indication
  - The policy for multiple frame transmission in a UL MU TXOP
  - Multi-user acknowledgement
  - Error recovery
- **In this contribution, we introduce some considerations for UL MU transmission in a TXOP.**

Analysis

- **The following issues should be considered to define a complete UL MU transmission protocol**
  - Multiple UL MU frame exchanges in a TXOP
    - How to define frame exchange sequence in a UL MU TXOP, allowing multiple UL MU PPDU transmissions with less overhead
  - Multi-user acknowledgement
    - How, for the AP, to respond to the received UL MU PPDUs with acknowledgement frame?
  - Error recovery
    - How to initiate the error recovery procedure when UL MU transmission fails?
  - Flexible UL MU transmission scheduling
    - Allow scheduling of UL MU transmission from new STAs during a UL MU TXOP

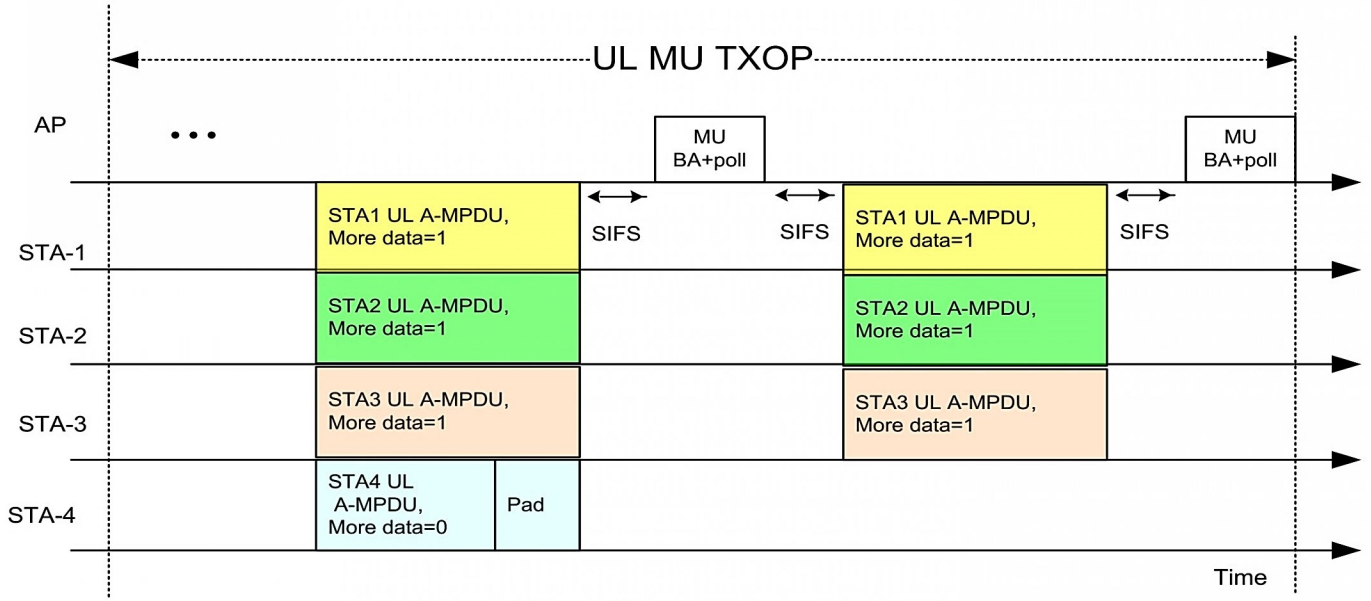
Analysis

- **AP's responsibility in UL MU transmission**
  - Schedule for or trigger a UL MU transmission
  - Poll multiple STAs' UL data and feedback ACK to multiple STAs.
  - Initiate the error recovery procedure when needed
  - Provision assistant information for UL MU transmission control
    - Power control
    - Time and frequency synchronization
- **STA's responsibility in UL MU transmission**
  - Send UL PPDUs as indicated by AP
  - Perform power/time/frequency adjustment
  - Obey the transmission duration as indicated by AP
    - Easy for AP to control the transmission within the TXOP limit
    - Easy for AP to acknowledge multiple STAs at the same time

Multi-user acknowledgement and Polling

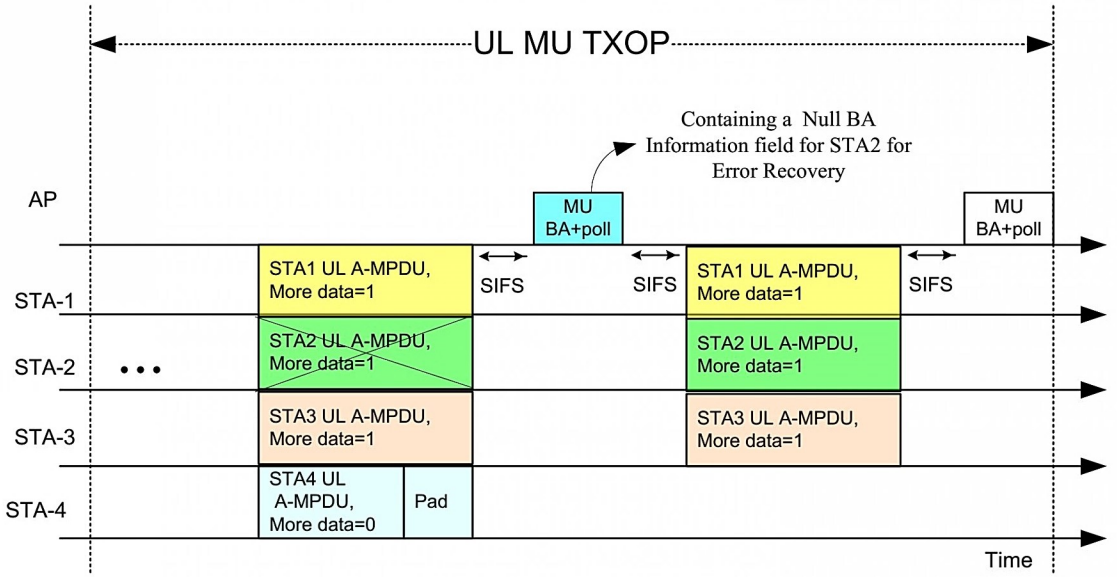
- **A multi-user acknowledgement and Polling scheme should provide following functions:**
  - Acknowledgement to received UL MU PPDUs, allowing Error indication
  - Polling and UL MU transmission resource allocation
  - Providing transmission control information, e.g. time/frequency/power adjustment
- **Principle and justice**
  - To achieve the above purposes with less overhead
  - To keep compatibility with legacy devices
- **A scheme using multi-user BA+Poll frame is introduced**
  - The multi-user BA + Poll frame combines the functions of BA, scheduling control, error indication
  - The multi-user BA + Poll frame can reuse the current BA frame structure, eg. Similar to Multi-TID BA variant
  - The multi-user BA + Poll frame can be sent in non-HT format
  - No additional scheduling/poll frame needed

Multi-user acknowledgement and Polling



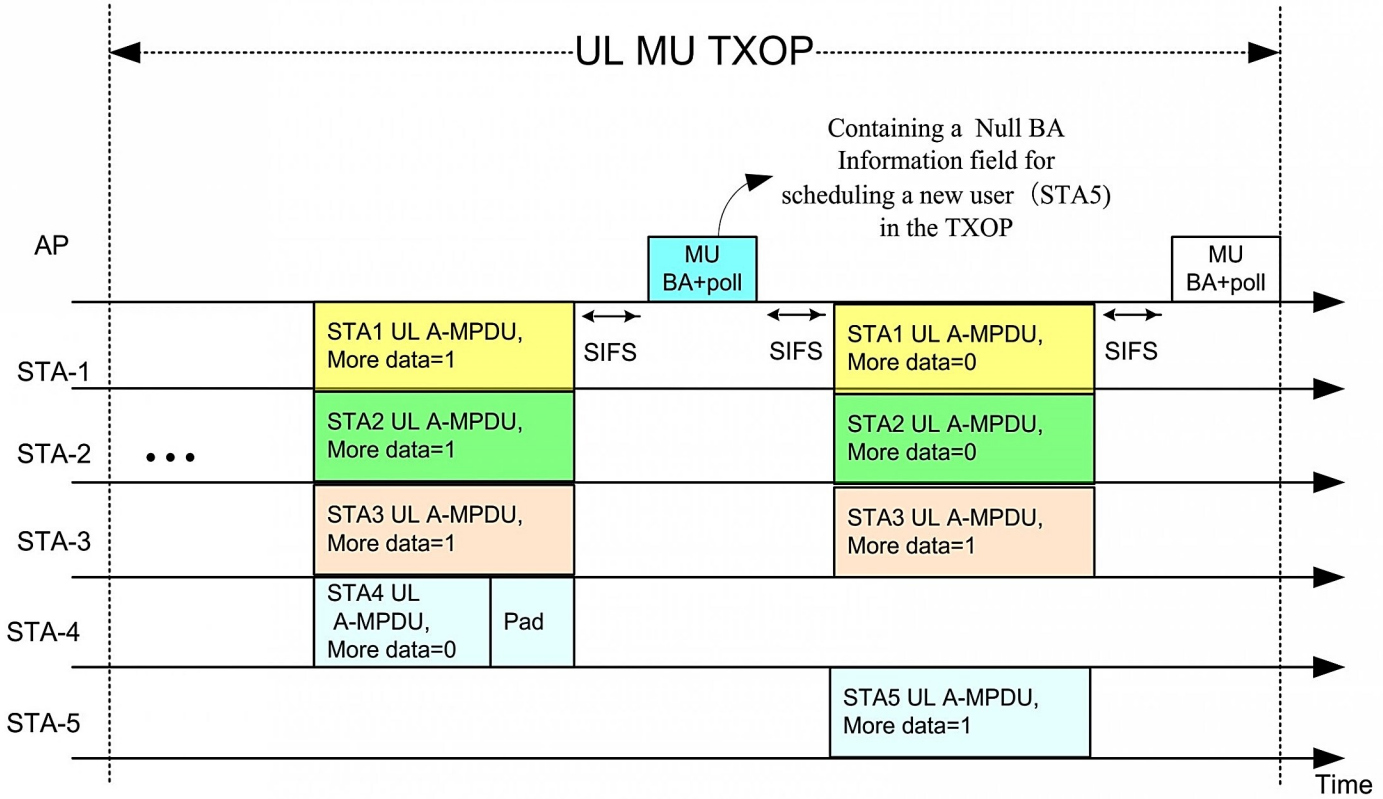
- **The multi-user BA+Poll frame used during a UL MU TXOP can:**
  - acknowledge the previous UL MU transmission
  - schedule the next UL transmission for the current group triggered by more data bit in UL MU PPDUs
    - The Duration/ID field can be reused for the next UL MU PPDU TxTime calculation

Error Recovery



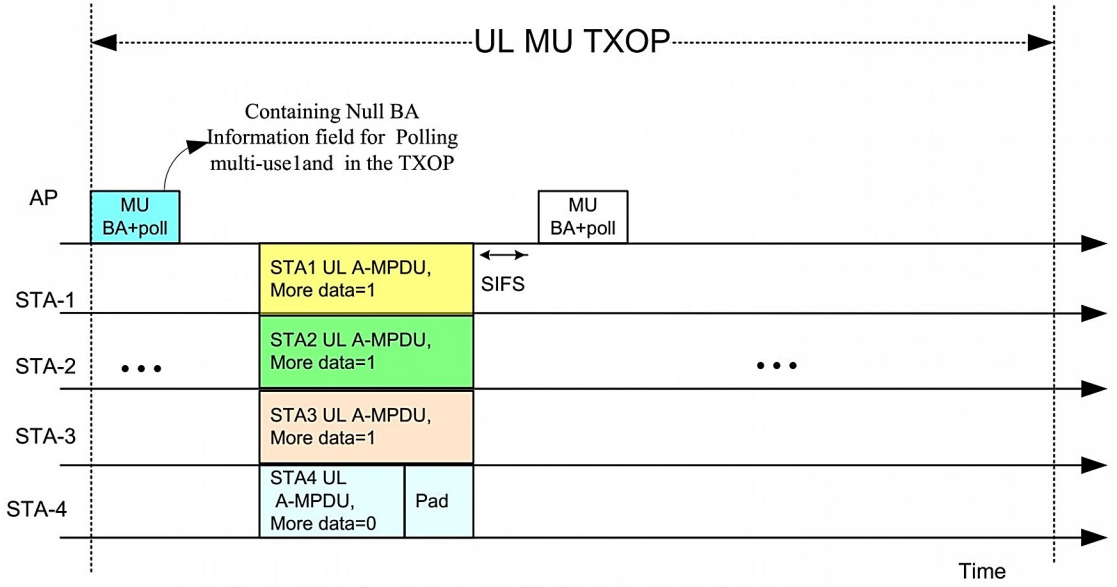
- **When one of the UL MU STAs' data fails, AP can use the multi-user BA+ Poll frame for error recovery**
  - indicate receiving failure to the transmitter, a null BA information field can be designed in the BA+Poll frame
  - both error indication and scheduling can be combined in same BA +Poll frame. Each STA corresponds to a BA information field, the BA information fields can be a BA+Poll info field or a null BA info field
  - a STA can trigger retransmission in the next UL MU transmission when receiving the failure indication

Schedule new user(s) during the UL MU TXOP



- **AP can use the multi-user BA+ Poll frame to poll a new STA within the UL MU TXOP**
  - Poll new STA(s) for UL MU transmission
  - Indicate the time/frequency/power adjustment information and UL resource allocation for the new STA(s) by using BA information field for the new user.

Scheduling STAs at the beginning of a TXOP



- **AP can use the multi-user BA+Poll frame as a UL MU scheduling frame that transmitted as a initial frame of a TXOP.**
  - When transmitted as a scheduling frame, the multi-user BA+Poll frame is no longer a control response frame
  - The new BA can use the null BA information fields to schedule multi-users of the UL MU TXOP, example of the null BA information fields is shown in slide 12

Conclusion

- **UL MU TXOP needs a new scheme to allow flexible UL MU transmission.**
- **In this proposal, we discussed a new control scheme with a multi-user BA+Poll frame**
  - to achieve the acknowledgement, polling and resource allocation , error indication and assistant UL transmission control indication.
  - to provide the scheme with minimum overhead
  - to keep compatibility with legacy devices

Reference

- [1] 11-14-0165-01-0hew-802-11-hew-sg-proposed-par
- [2] 11-09-1036-00-00ac-uplink-mu-mimo-sensitivity-to-power-differences-and-synchronization-errors
- [3] 11-14-0802-00-00ax-consideration-on-ul-mu-transmission