

More Reliable GroupCast Proposal Presentation

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Abstract

This proposal specifies the enhancements to the 802.11 MAC that enables improved link reliability for groupcast audio video stream transmission.

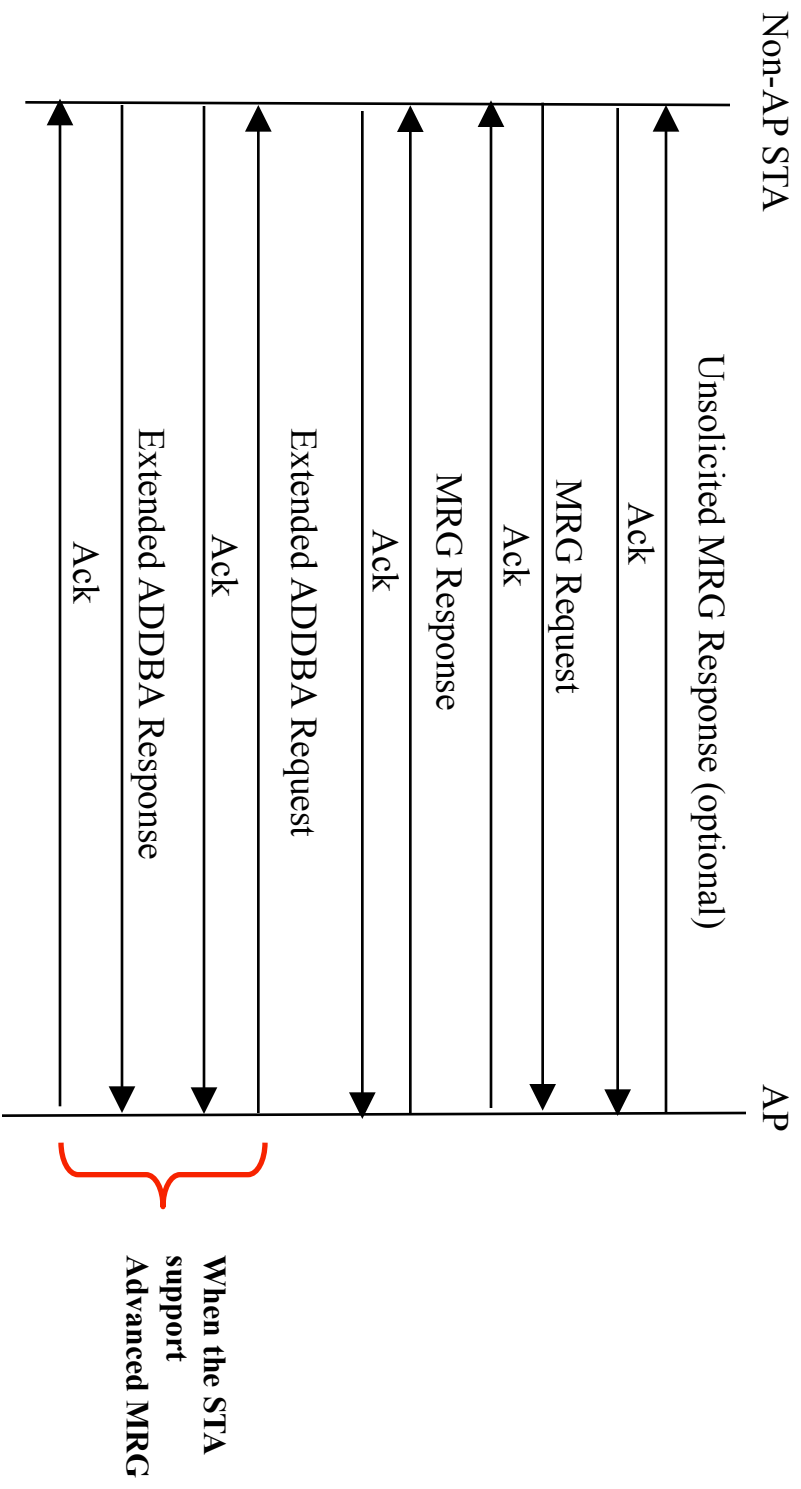
Features

- **Three Ack policies** to support the various types of the target applications and provide the flexibility to meet the needs of different scalability and implementation complexity
 - Directed
 - Unsolicited retries
 - Block Ack
- **Compatible to non-802.11a stations**
 - Concealment of retried group addressed frames
- **Extension of RTS/CTS** for group addressed frame transmission protection
 - Alleviate the hidden node and OBSS problem by reserving the medium and protecting the following group addressed frame transmissions
- **MRG-SP Power Management mode** to reduce MAC delivery latency for group addressed streams
 - Transmits the group addressed frames via EDCA within Scheduled Service Periods

MRG Service Capability

- **More Reliable Groupcast (MRG) Service allows a non-AP STA to request greater reliability for one or more group addressed streams**
- **Two levels of MRG capabilities**
 - Robust AV Streaming
 - Directed
 - Unsolicited retries
 - Retry concealment
 - MRG-SP power management
 - Advanced MRG
 - The above
 - Block Ack
- Advertised in Extended Capabilities information element

MRG Service Setup



Robust AV Streaming Action Frames

- Robust AV Streaming Action Frames

Action field value	Meaning
0	MRG Request
1	MRG Response
2 – 255	Reserved

- MRG Request Frame

	Category	Action	Dialog Token	MRG Request Elements
Octets	1	1	1	variable

- MRG Response Frame

	Category	Action	Dialog Token	MRG Response Elements
Octets	1	1	1	variable

MIRG Request Element

Element ID	Length	Group Address	MIRG Ack Policy	MIRG Power Management Mode	TSPEC Element	Schedule element (optional)
Octets	1	6	1	1	57	0 or 14

- MIRG Ack Policy

Value	MIRG Ack Policy	Notes
0	MIRG-Service-Cancel	
1	MIRG-Directed	
2	MIRG-Unsolicited-Retry	
3	MIRG-Block-Ack	
4-255	Reserved	

- MIRG Power Management Mode

Value	MIRG Power Management Mode	Notes
0	Reserved	
1	All-Active/Any-PS or FMS	
2	MIRG-SP	
3-255	Reserved	

MRG Response element

	Element ID	Length	Group Address	MRG Ack Policy	MRG Power Management Mode (optional)	Schedule Element (optional)
Octets	1	1	6	1	1	0 or 14

Block Ack Action Frames

Action field values	Meaning
0	ADDBA Request
1	ADDBA Response
2	<i>DELBA (Extended)</i>
3	Extended ADDBA Request
4	Extended ADDBA Response
5-255	Reserved

Extended ADDBA Request Frame

Order	Information
1	Category
2	Action
3	Dialog Token
4	Block Ack Parameter Set
5	Block Ack Timeout Value
6	Block Ack Starting Sequence Control
7	Extended Block Ack Parameter Set
8	ADDBA MRG Group Address

- Extended Block Ack Parameter Set field

Bits	B0	B1	B15
	ADDBA MRG Group Address Present	Reserved	
Octets	←-----2-----→		

Extended ADDBA Response Frame

Order	Information
1	Category
2	Action
3	Dialog Token
4	Status Code
5	Block Ack Parameter Set
6	Block Ack Timeout Value
7	Extended Block Ack Parameter Set
8	ADDBA MRG Group Address

DELBA Frame Format

Order	Information
1	Category
2	Action
3	<i>DELBA Parameter Set</i>
4	Reason Code
5	DELBA MRG Group Address

- **DELBA Parameter Set**

Bits	B0	B9	B10	B11	B12	B15
	Reserved		DELBA MRG Group Address Present	Initiator	TID	
Octets			←-----2-----→			

- **DELBA MRG Group Address is included if DELBA MRG Group Address Present field is set**

MIRG Ack Policy and Power Management Mode Modification

- **The MIRG AP may update the ack policy and power management mode by either:**
 - Transmitting unsolicited MIRG Response frames individually addressed to each MIRG group member with new MIRG ack policy and power management setting,
- or**
- Transmitting an unsolicited MIRG Response frame in group cast addressed to the MIRG group address with new MIRG ack policy and power management setting.

MRG Service Takedown

- **To cancel a MRG agreement between a non-AP STA and an AP, either**
 - Non-AP STA sends an MRG Request frame with the Ack Policy set to MRG-Service-Cancelor
 - AP transmits an individually addressed MRG Response frame with the Ack Policy set to MRG-Service-Cancel.
- **AP may cancel the MRG service for an MRG stream by either**
 - transmitting a series of individually addressed MRG Response frames with the Ack Policy set to MRG-Service-Cancel to each non-AP STA group memberor
 - transmitting a group addressed MRG Response frame with the Ack Policy set to MRG-Service-Cancel.
- **Such cancellation shall also cause the Block Ack agreement to be cancelled.**

MRG-Directed Ack

- **Similar to DMS, but**
 - Work with MRG-SP power management
 - Enable AP to switch to other Ack policies
- **Transmit group addressed MSDUs as individually addressed frames to a MRG group member in an A-MSDU frame format**
- **Low efficiency, not a scalable solution, high delay, but provides best reliability**

MRG-Unsolicited-Retry

- **Transmit each MSDU multiple times, subject to the lifetime limit.**
 - Retransmitted frames sent with the RA set to the MRG Concealment address (next slide) to avoid duplicated frames at non-802.11aa STAs
 - When retransmitting an MPDU, for all retransmissions, the AP shall invoke its backoff procedure.
- **Low efficiency, scalable solution, delay depends on implementation, provides limited reliability**

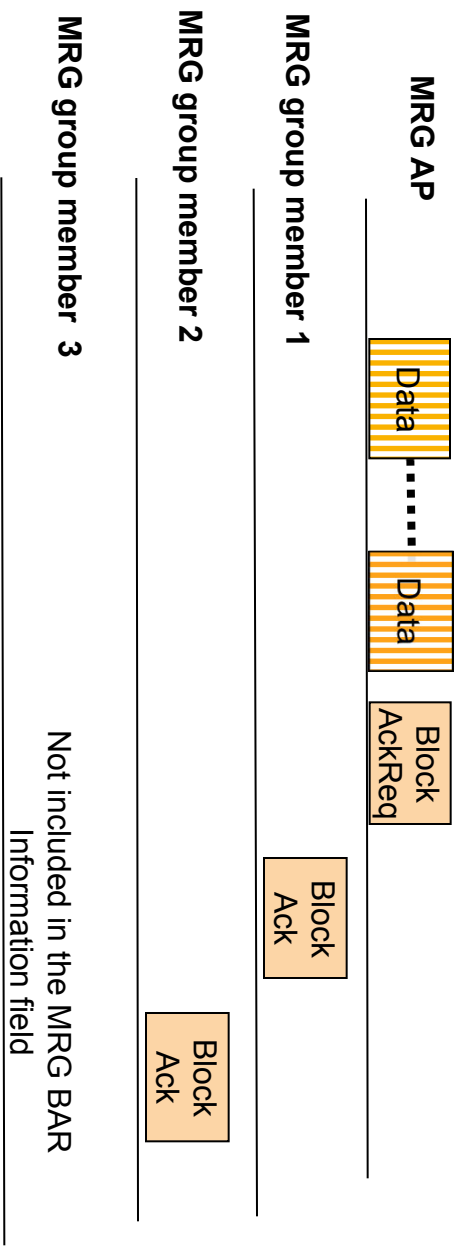
Concealment of MRG Transmissions

- Prevents duplicate group addressed frames from being passed up the MAC-SAP of MRG-incapable STAs
- MSDUs retransmitted via the MRG-Unsolicited-Retry or MRG-Block-Ack Ack policies shall be sent in an A-MSDU frame format with the RA set to the *MRG Concealment address*
 - To-be-assigned-by-ANA

MRG-Block-Ack

- **Extend the Block Ack mechanism to group cast.**
- **Only support immediate block ack policy**
- **The extent of efficiency, delay and reliability provided are flexible and dependent on implementation, scalable.**

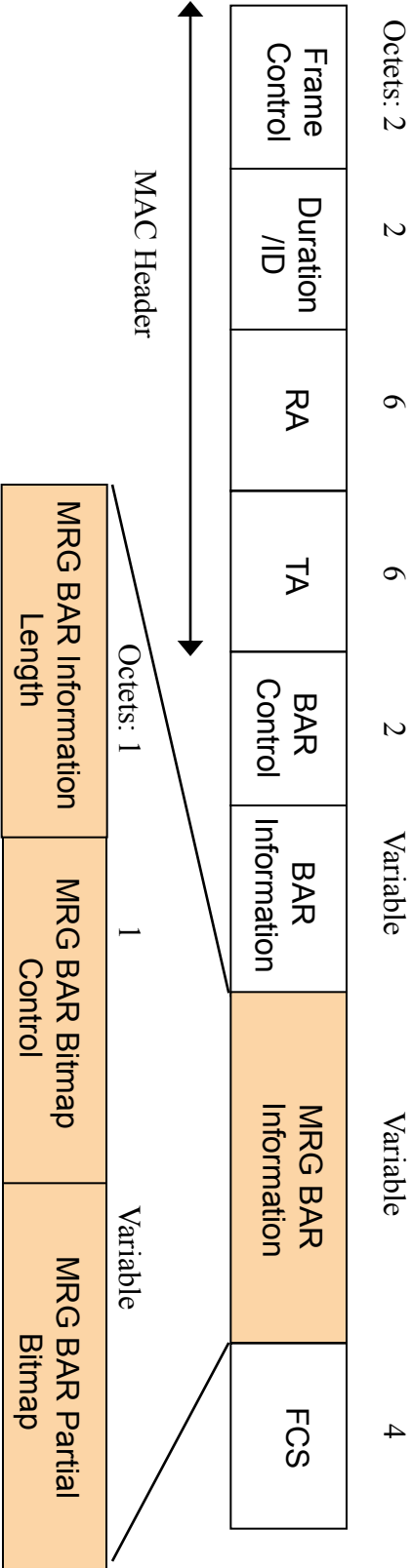
MRG BlockAckReq with Immediate Block Ack Policy



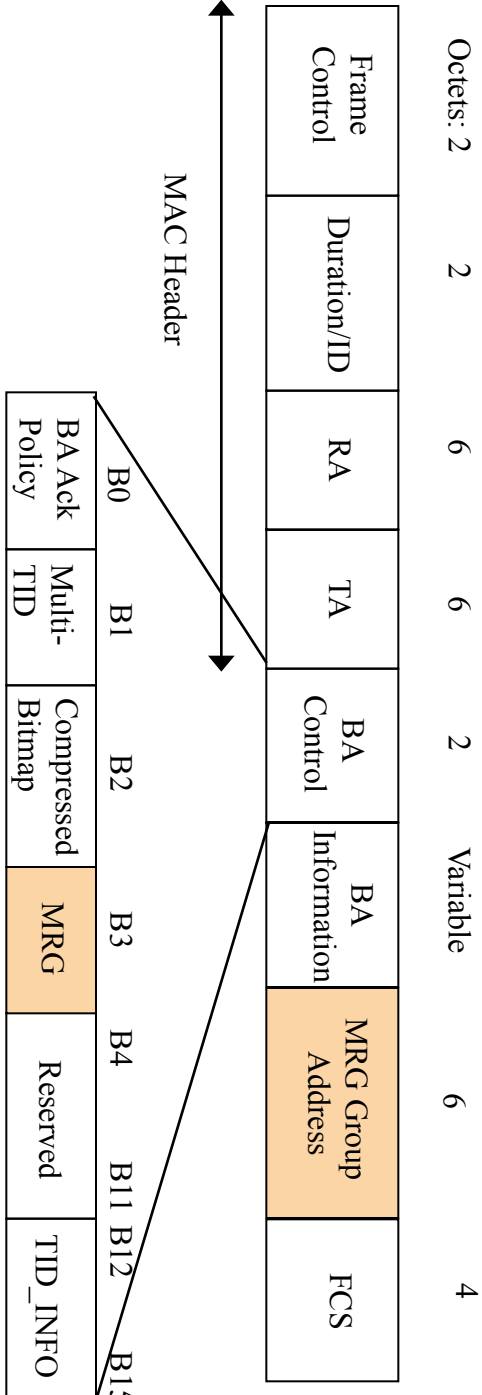
- MRG BAR Information field in MRG BlockAckReq contains a list of MRG group members from which this BlockAckReq is requesting a BlockAck response.
- The MRG group members in the list shall send their BlockAck in the order that they are specified in the MRG BAR Information field.

MRG BlockAckReq Frame

- Send to MRG group address
- Include MRG BAR Information

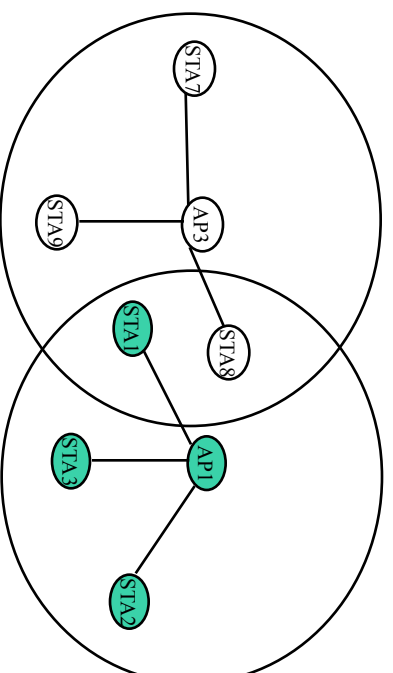
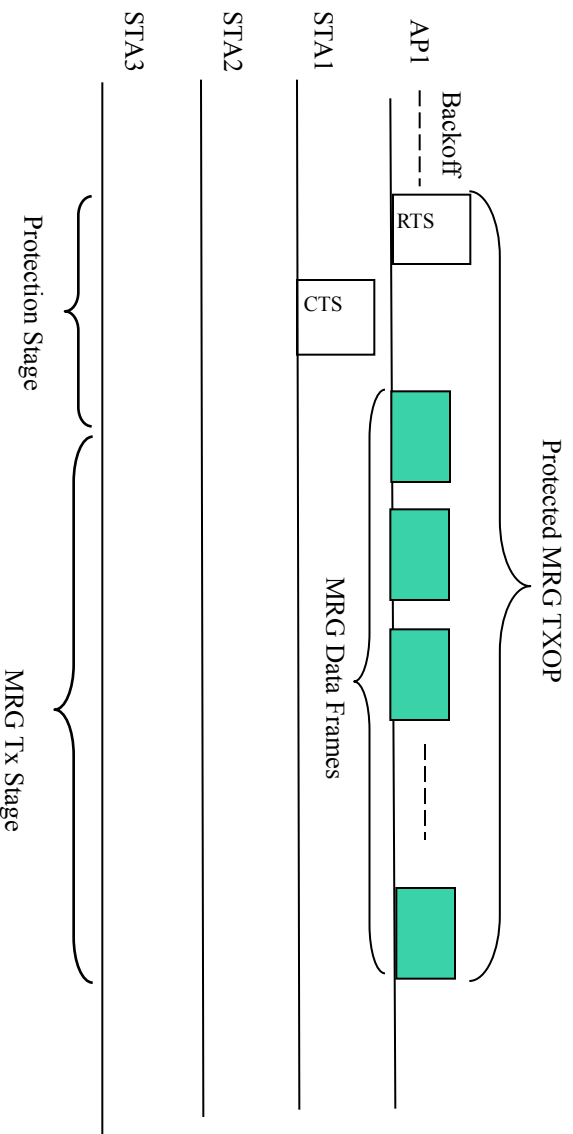


MRG Block Ack Frame



Collision Avoiding Procedure

- MRG AP may select one MRG group member and use one RTS/CTS or other protection method to protect the following group addressed frame transmission.



MRG-SP

- **An AP advertises the MRG service periods in MRG Response element**
 - Contain Schedule element (schedule info, service start time, service interval, specification interval)
 - Non-AP STA group member shall wakes up at the service start time
 - The Service Period ends when the AP transmits the QoS group addressed frame with the EOOSP bit set to 1.
- **Shall not be transmitted simultaneously via the MRG-SP and either the All-Active/Any-PS or FMS Power Management modes.**

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Backup Slides

Complexities of Sequence Counter

- Mechanism 1 (mech1): one sequence counter for all groupcast traffic, non-QoS frames, and management frames
 - As per today
- Mechanism 2 (mech2): one sequence counter per group addressed stream
- In the next 4 slides we show the pros and cons of each

Mech1 - Cons

- **If there is 1 seq# counter for all GA frames yet one BA agreement per GA, and the AP transmits multiple GA streams (or mgmt frames or non-QoS frames), then the RX does not know whether the holes it has in its BA bitmap are due to missing frames in the 11a GA stream or other frames. The RX must hold onto the packets until:**
 - Workaround 1: New frames cause its BA window to advance, so that the oldest frames can be released up the MAC-SAP. Problem: guaranteed large delays; delays are unbounded if new packets arrive slowly [Unacceptable]
 - Workaround 2: AP sends unicast BAR frames regularly to advance the BA window in clients. The AP has additional processing to match holes against each 11a GA stream as only it knows which are genuine holes and which are not. Up to a lifetime limit, the AP retries the missing packets, sending a unicast BAR and getting a BA. If there are holes from other packets or the lifetime limit is exceeded, the AP has to perform an additional BAR/BA exchange to get the client to release buffered packets up the MAC-SAP. And this additional BAR/BA needs to happen with each group member, even for groups with 10-20-100 members (e.g. the broadcast group) and so this scales poorly.
 - Workaround 3: Same as 2 except that the BARs are sent GA, and the BAR schedules the BAs immediately afterwards. The AP can transmit a GA BAR with an empty BA schedule if the AP only wishes to advance the BA window of the group. This is a new BAR format, and requires new ADDBA.request/response formats also.
- **In processing BAs, the AP must keep track of the holes per GA stream**
- **In order to reduce the need for an additional BAR to advance the BA window in clients, the AP should sequence frames for one GA and its exchanges of BAR and BAs before sending frames for another GA**
- **Repair requests (NACKs) are challenging/impossible, since a client detecting a missing sequence number cannot ascribe that to a missing MSDU for a GA of interest.**

Mech1 - Pros

- **No additional seq# counter required within the AP**
- **No possibility of duplicate removal in legacy clients causing side-effects (e.g. an implementation that does duplicate removal before group address filtering still does not over-remove frames)**
- **Allows frames sent via the legacy No-Ack/No-Retry Ack policy to be reused as initial transmissions (much less overhead in mixed cells)**
- **The requirement for regular BARs and BAs to all STAs seems like a hack, and a hack that would stay with 802.11 ever afterwards, even in an all-802.11aa world. Yet the overhead of the hack is still likely less than the overhead of transmitting the group address stream twice, so the long term pain is modest but the short term benefits are high.**

Mech2 - Pros

- **Simple BA behavior: holes are immediately visible to AP and client as missing packets**
 - no extra latency
 - no extra BARs needed to update the BA bitmap window
- **Should be compatible with legacy duplicate removal if group address filtering occurs before duplicate removal.**
 - From 802.11:2007, there is near silence as to which happens first. Only in the unmaintained Annex C, for unicast, is there is address filtering on p906 then dup removal later on p908. For multicast, there is filtering on p906 yet no dup removal at all on p908. But that would be the place for it, so it looks much like dup removal after address filtering is the nominal implementation.
- **In the long term, when all devices in a group are 11aa-enabled, there is no additional overhead from duplicate streams or extra BARs**

Mech2 - Cons

- **Separate seq# counter for legacy (No Ack/No Retry) GA frames and for each GA stream are different, so correlation between the two streams is impossible.**
 - If a BSS has both kinds of clients for a GA stream, the stream needs to be sent twice: via No Ack/No Retry and via 11aa, and the No Ack/No Retry frames don't assist the reliability of the 11aa stream (yet this is still better than MC2UC for 2 clients)
- **Should be compatible with legacy duplicate removal (if group address filtering occurs before duplicate removal, as per the nominal implementation described under "Pros"), yet not guaranteed.**
- **Extra seq# counters needed within APs**
- **Duplicate detection requires the RX to maintain a cache of <Address1, TID, seq#> for GA streams of interest**

Sequence Counter Summary

- **Mech1 (one sequence counter for all groupcast traffic, non-QoS frames, and management frames) using Workaround 3 seems to have the lowest near-term overhead**