

Issues on BSS Color Bits Collision

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Introduction

- **11ax defines operations depending whether the detected frame is Intra-BSS frame or not [1].**
- **To determine the origin of a frame, BSS color can be used [1].**
 - HE PPDU includes 6 bits of BSS color subfield in HE-SIG-A field [1].
 - Total 64 BSS color values are available.
 - Due to the lack of BSS color values, there may be the case* that neighboring BSSs use the same BSS color value.
 - * This case is referred as “BSS color collision” hereinafter.
 - BSS color collision problem may result in inappropriate operations.
- **We propose to refine power save and NAV-related operations when BSS color collision is detected.**

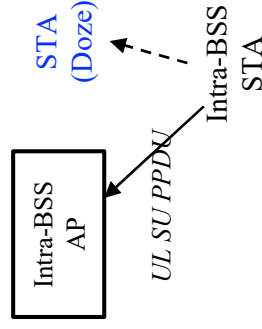
Possibility of BSS Color Collision

- **Distributed assignment**
 - Taking into account the characteristic of “distributed” system, neighboring APs may select the same value for BSS color.
 - Although APs scan surroundings before selecting BSS color value, there is a case that APs are hidden each other.
- **Especially, in the real-world measurement [2], there are locations at which more than 64 APs are audible.**
- **After the dense deployment of 11ax APs, BSS color collision can be highly probable.**
- **Therefore, it is necessary to discuss 11ax power save and NAV-related operations with BSS color collision.**

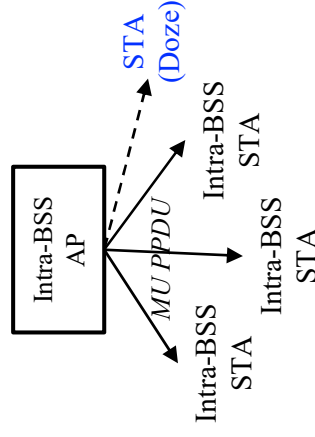
Recap: Power Save During Intra-BSS PPDU

- HE STA may enter the doze state until the end of a received PPDU including the same BSS color, if the PPDU is [1]
 - 1. HE SU PPDU and UL/DL flag indicates UL
 - 2. HE MU PPDU and any of STA identifiers in HE-SIG-B does not match its own STAID or that of a broadcast/multicast identifier
 - 3. HE Trigger-based PPDU

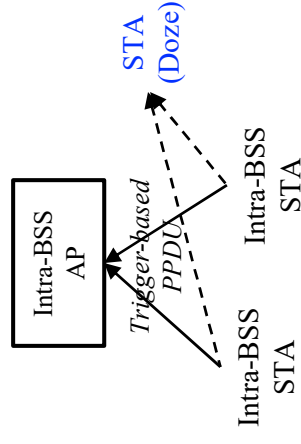
1. HE SU PPDU



2. HE MU PPDU

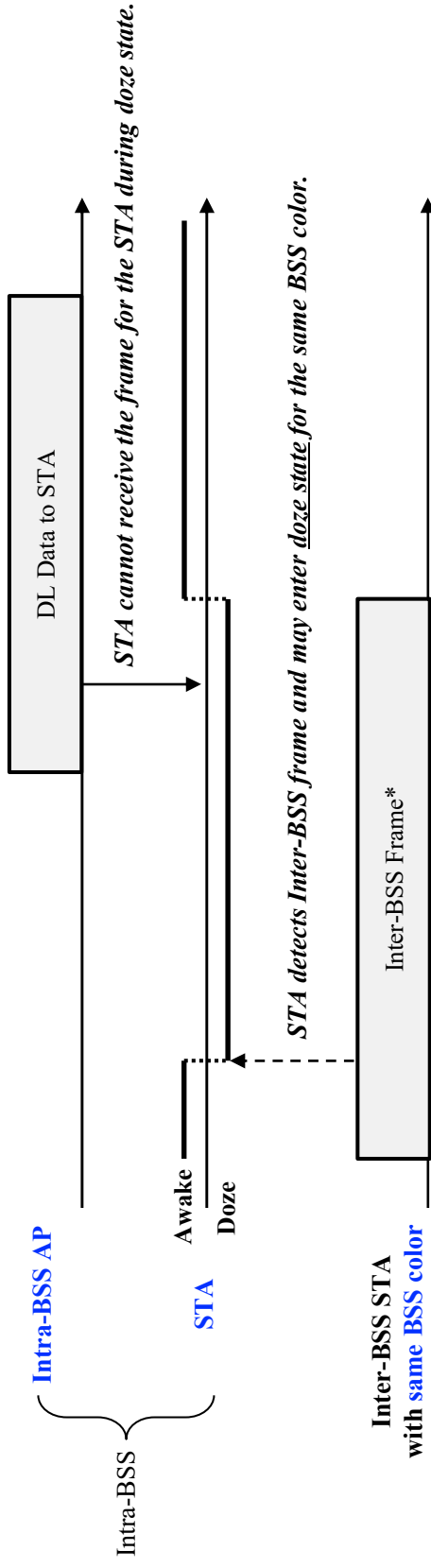


3. HE Trigger-based PPDU



Problem 1: Power Save During Inter-BSS PPDU

- If Inter-BSS uses the same BSS color value,



* The frame includes HE-SIG-A and the frame is SU UL PPDU, MU PPDU which does not carry STAID that should be decoded by STA, or Trigger-based PPDU.

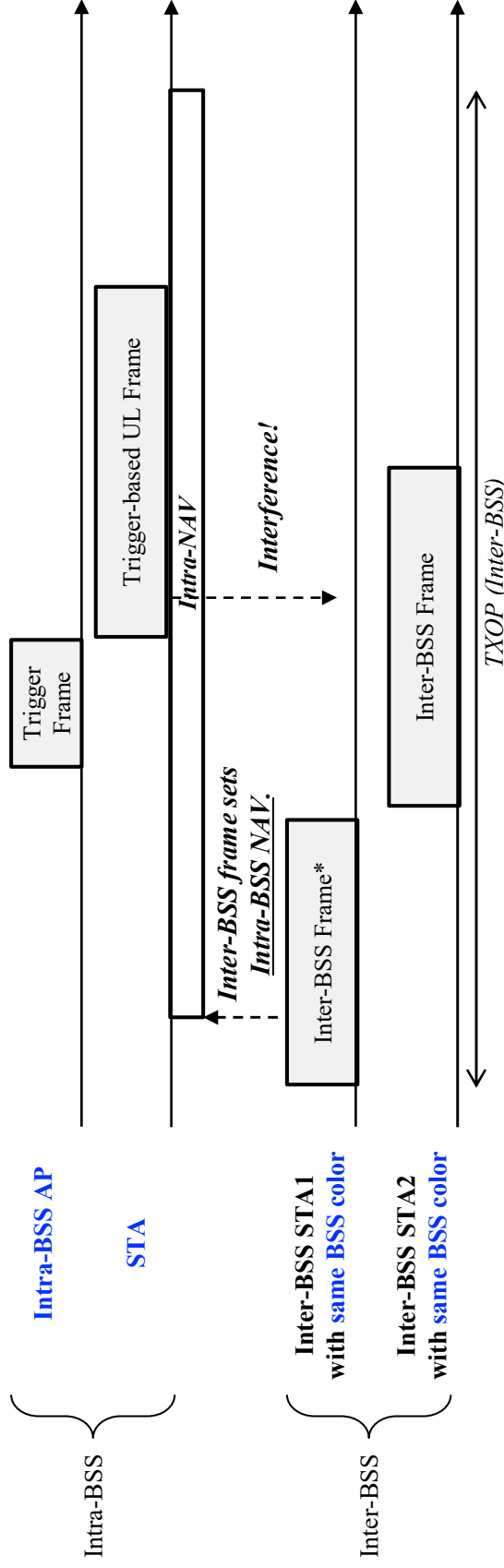
- STA can enter doze state for particular Inter-BSS PPDU's because of the same BSS color value.
- During doze state, STA cannot receive the frame for the STA.

Recap: Two NAVs

- *A STA maintains two NAVs (Mandatory or optional TBD) [1].*
 - One for Intra-BSS frames
 - Another for other frames (Inter-BSS frames or Frames that cannot be determined to be Intra- or Inter-BSS)
- *To determine which BSS is the origin of a frame, the HE STA may use BSS color [1].*
- **By using two NAVs,**
 - In case that STA sets NAV by Intra-BSS frame and Inter-BSS frame sequentially,
 - NAV set by Intra-BSS is not updated by Inter-BSS.
 - STA can consider NAV set by Inter-BSS to determine whether to respond to Trigger frame from Intra-BSS.
 - CF-End from Intra-(Inter-)BSS can reset only NAV set by Intra-(Inter-)BSS.

Problem 2a: Incorrect Intra-BSS NAV Setting

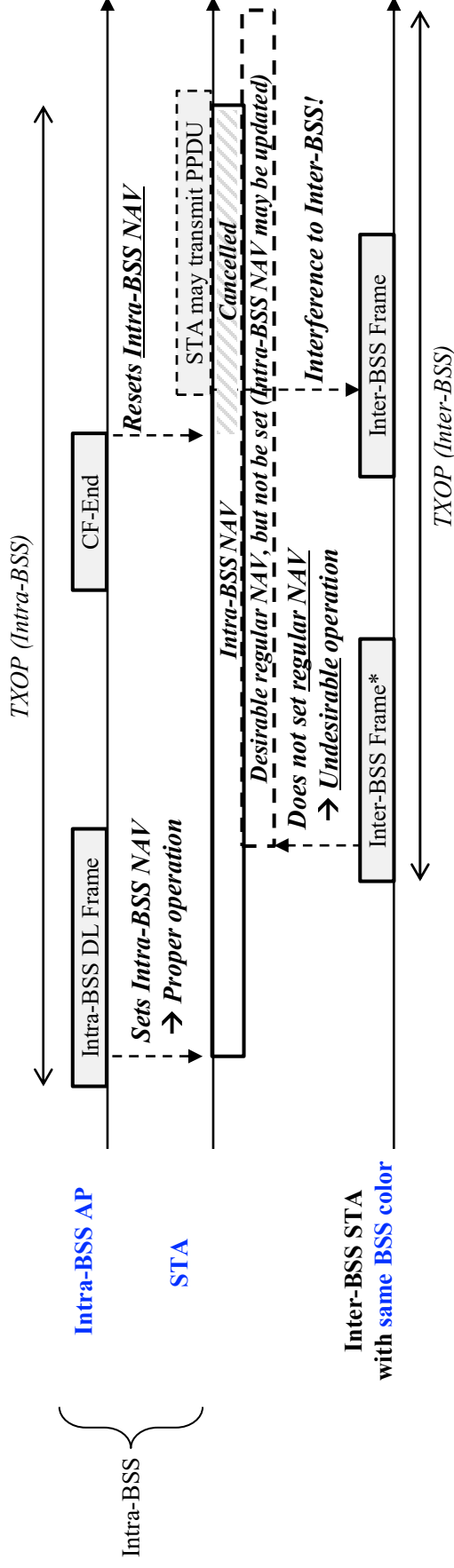
- If Inter-BSS uses the same BSS color value,



- Intra-BSS NAV may be set by Inter-BSS frame after decoding HE-SIG-A of the frame.
- STA can respond to Trigger frame sent by Intra-BSS AP.
- This causes interference to packet reception of Inter-BSS STA.

Problem 2b: Not Setting Regular NAV

- If Inter-BSS uses the same BSS color value,



* The frame includes HE-SIG-A and the frame is SU UL PPDU, MU PPDU which does not carry STAID that should be decoded by STA, or Trigger-based PPDU.

- Desirable regular NAV is not set.
- If CF-End frame resets Intra-BSS NAV, STA can result in packet collision.

Proposed Operations (1)

- After STA detects BSS color collision, STA cannot identify the frame with the same BSS color value as Intra-BSS or Inter-BSS using BSS color.
- In case that STA has detected BSS color collision,
 - The STA should not perform operations (e.g., intra-PPDU power save or Intra-BSS NAV setting) based on the same BSS color
 - Operation to different BSS color, such as applying OBSS PD level for channel access, can be permitted.
 - Report/Resolution procedure may be required.
- For Problem 1, after STA detects BSS color collision,
 - The STA shall not enter the doze state during the frame using the same BSS color

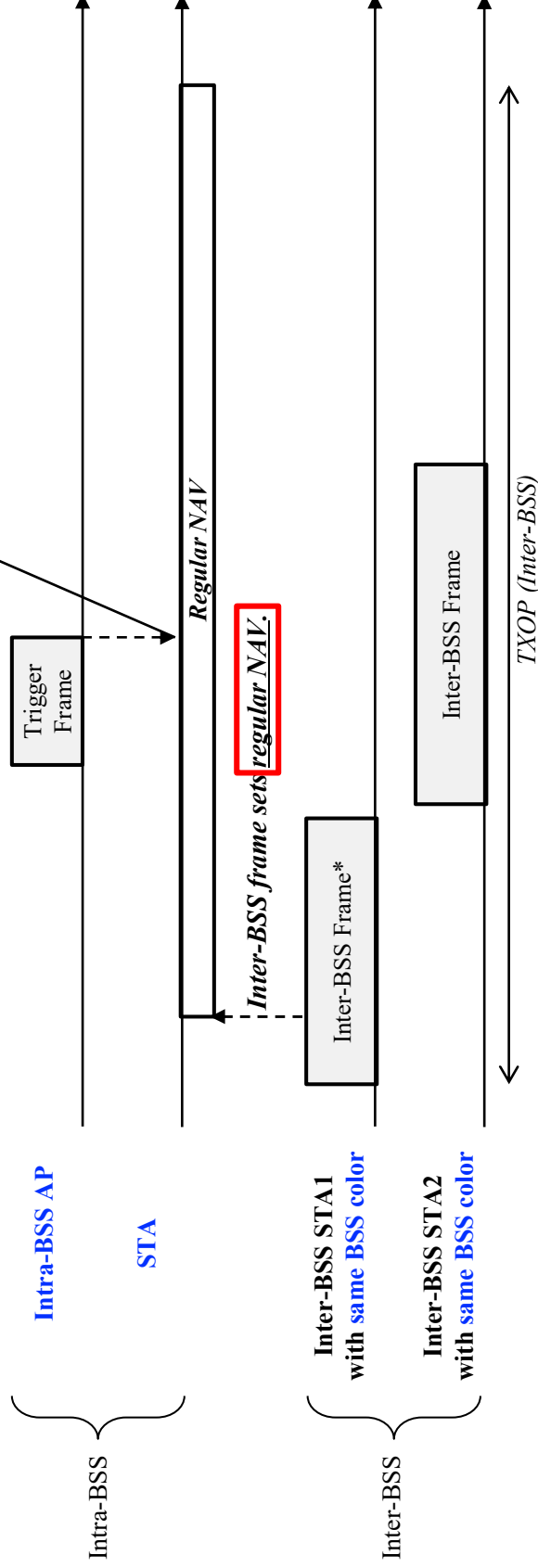
Proposed Operations (2)

- **For Problem 2a and 2b, after STA detects BSS color collision,**
 - The STA shall not update its Intra-BSS NAV based on TXOP Duration in HE-SIG-A. Also the STA can update its regular NAV based on TXOP Duration in HE-SIG-A.
 - Case 1) The STA receives a PPDU with the different BSS color.
 - Proper regular NAV is updated using TXOP Duration in HE-SIG-A
 - Case 2) The STA receives a PPDU with the same BSS color.
 - Case 2a) Decoding MAC is possible.
 - E.g., SU PPDU / MU PPDU carrying STA's AID or broadcast AID in HE-SIG-B
 - Proper Intra-BSS NAV or regular NAV is updated using Duration in MAC header.
 - Case 2b) Decoding MAC is not possible.
 - E.g., MU PPDU not carrying STA's AID and broadcast AID in HE-SIG-B / Trigger-based PPDU
 - Only regular NAV is updated using TXOP Duration in HE-SIG-A.
- → Regular NAV protects Inter-BSS transmissions.

Proposed Operations (3)

- Applying the solution in Slide 10, after STA detects BSS color collision,
- For Problem 2a,

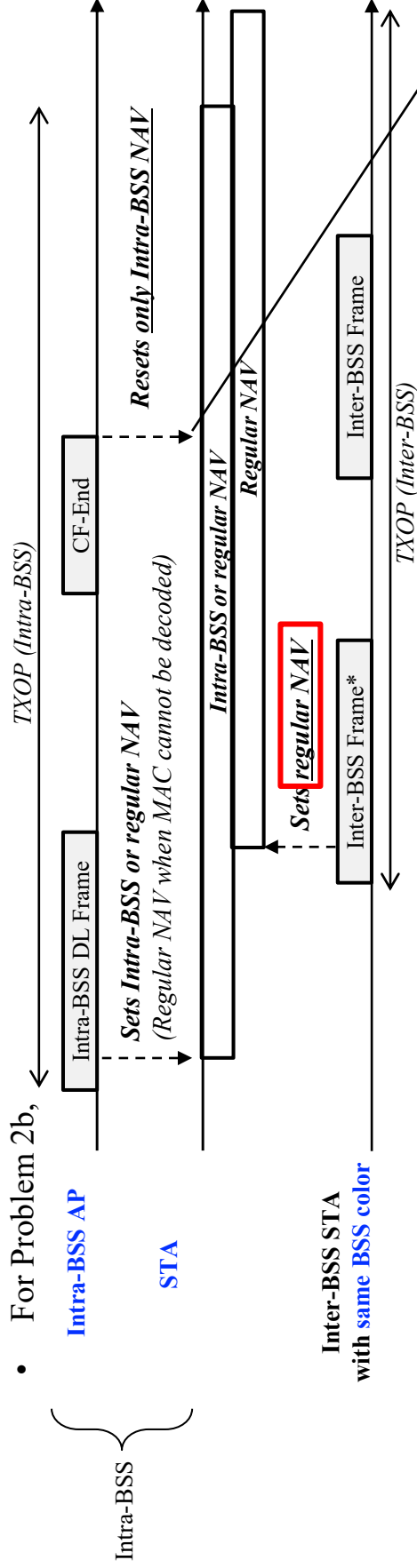
- STA does not determine that NAV was set by a frame originating from the AP sending the Trigger frame.
 - STA can consider NAV in determining whether to respond.



* The frame includes HE-SIG-A and the frame is SU UL PPDU, MU PPDU which does not carry STAID that should be decoded by STA, or Trigger-based PPDU.

Proposed Operations (4)

- Applying the solution in Slide 10, after STA detects BSS color collision,



* The frame includes HE-SIG-A and the frame is SU UL PPDU, MU PPDU which does not carry STAID that should be decoded by STA, or Trigger-based PPDU.

- Although STA receives CF-End from Intra-BSS, regular NAV remains.

- We also need that CF-End from Inter-BSS should not reset NAV if STA cannot determine whether NAV is set by Intra-BSS or Inter-BSS.

- For the case that STA sets regular NAV by Intra-BSS frame and receives CF-End from OBSS
- “When a STA receives a CF-End from an OBSS STA, if the last NAV update was caused by an Intra-BSS frame, the STA should not reset its NAV” [1].

Conclusions

- **BSS color collision is unavoidable with limited BSS color bit space and distributed BSS color assignment.**
- **We propose that after BSS color collision is detected,**
 - STA shall not enter the doze state during the frame using the same BSS color.
 - STA shall not update its Intra-BSS NAV based on TXOP Duration in HE-SIG-A.
 - STA that receives a CF-End frame from Inter-BSS should not reset NAV set by a PPDU which cannot be identified as Intra- or Inter-BSS.

References

- [1] 11-15/0132r15 Specification Framework for TGax**
- [2] 11-15/1336r1 BSS Color Size Measurements**

Straw Poll 1

- Do you agree to add the following text into 11ax SFD ?
 - 6.3.z An HE non-AP STA that is in intra-PPDU power save mode shall not enter the doze state, if the detected frame cannot be identified as Intra-BSS or Inter-BSS.

- Y
- N
- A

Straw Poll 2

- Do you agree to add the following text into 11ax SFD ?
6.y.z A STA that receives a valid HE-SIG-A in a HE PPDU and cannot identify the frame as Intra-BSS or Inter-BSS shall not update its Intra-BSS NAV with the information from the TXOP Duration field in the HE-SIG-A.
- Y
- N
- A

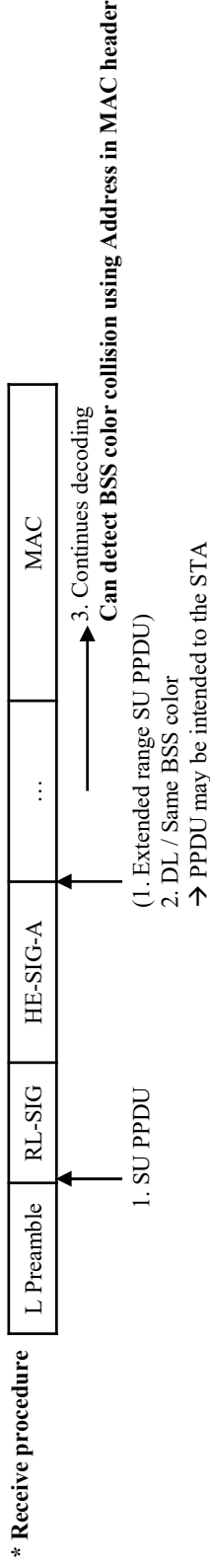
Straw Poll 3

- Do you agree to add the following text into 11ax SFD ?
6.y.z An HE STA that receives a CF-End frame should not reset its NAV if the most recent NAV update was due to a PPDU which cannot be identified as Intra-BSS or Inter-BSS.

- Y
- N
- A

Appendix: Detection of BSS Color Collision

- BSS color collision may be detected by a STA in some methods.
 - E.g., during normal packet reception procedure
 - HE SU DL PPDU



- HE MU PPDU of which HE-SIG-B includes STAID with the same STAID or STAID of a broadcast STAID

