Inter-BSS interference in WLANs

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Abstract

- **This contribution provides issues on inter-BSS interference mitigation among overlapping BSSs**

Multiple BSSs and Overlapping BSSs

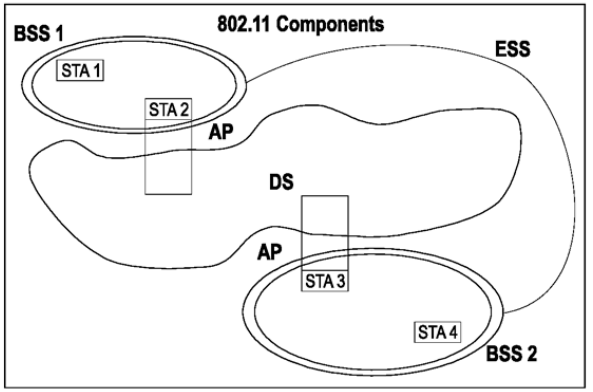
- **Explosion of data traffics drives Wi-Fi network deployment more densely which consist of multiple Basic Service Sets (BSSs)**
- **Multiple BSSs with high density deployment may result in an overlap of adjacent BSSs, a.k.a. Overlapping BSSs (OBSSs), which cause inter-BSS interference (IBI)**
- **Without no doubt, IBI is one of important problem needed to be solved for High Efficiency WLAN (HEW)**

Type of BSS [2]

- **IBSS(Independent BSS)**
  - A self-contained network, and in which no access to a distribution system (DS) is available.
- **Infrastructure BSS**
  - The infrastructure includes the distribution system medium (DSM), access point (AP), and portal entities.
  - It is also the logical location of distribution and integration service functions of an extended service set (ESS).
  - An infrastructure contains one or more APs and zero or more portals in addition to the distribution system (DS).

Type of BSS [2]

- **DS(Distributed System)**
  - Group of infrastructure BSSs interconnected
- **ESS (Extended Service Set)**
  - The large coverage network consisted of DS and infrastructure BSSs
- **MBSS (Mesh BSS)**
  - No central entity like the AP and infrastructure BSS



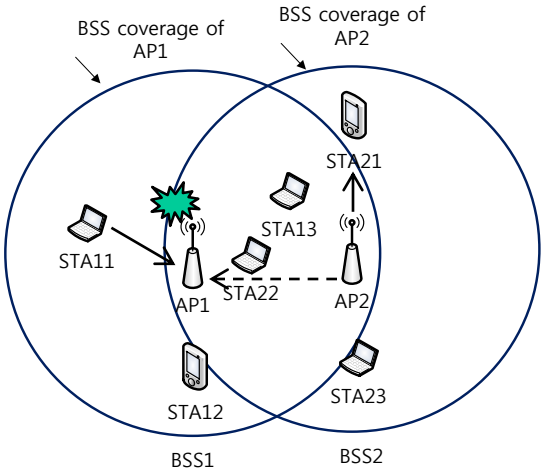
Inter-BSS Interference (IBI)

- **Inter-BSS interference stems from interference among multiple BSSs located nearby each other**

- **There are three types of inter-BSS interference**
  - AP-AP IBI
  - AP-STA IBI
  - STA-STA IBI

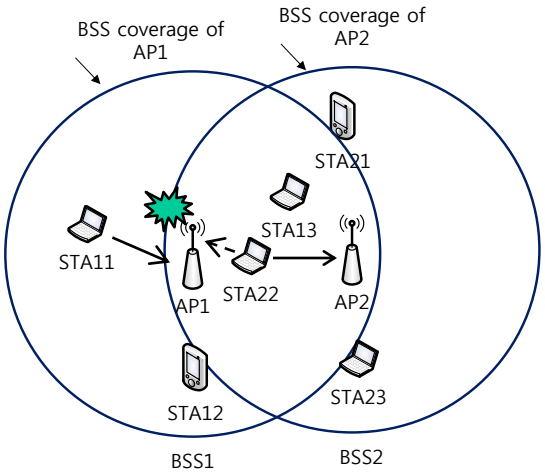
Inter-BSS Interference: AP-AP

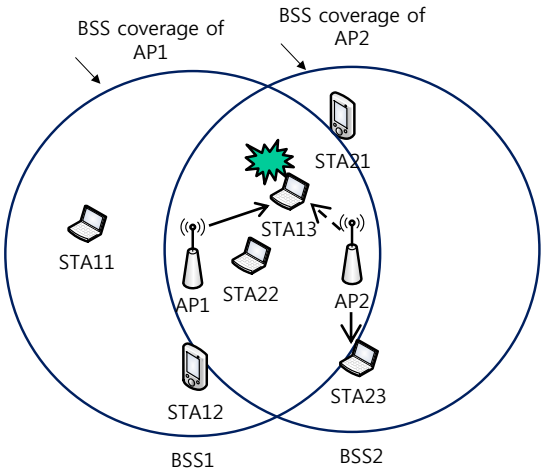
- **It occurs when a AP receiving data from its associated STA is interfered by a neighbor AP transmitting data to its associated STA, and vice versa.**



Inter-BSS Interference: AP-STA

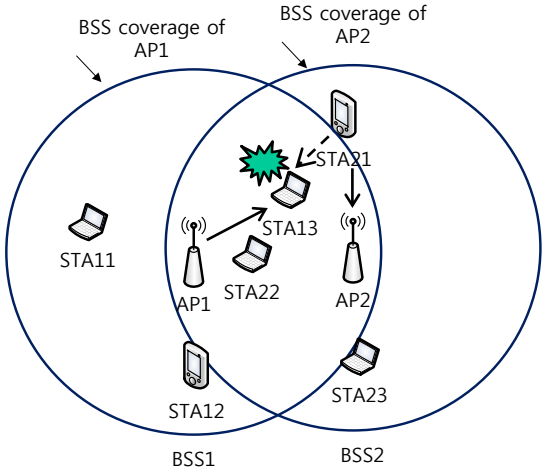
- **It occurs when a AP receiving data from its associated STA is interfered by a neighbor AP transmitting data to its associated STA, and vice versa.**





Inter-BSS Interference: STA-STA

- **It occurs when a STA receiving data from its associated AP is interfered by a neighbor STA transmitting data to its associated AP, and vice versa.**



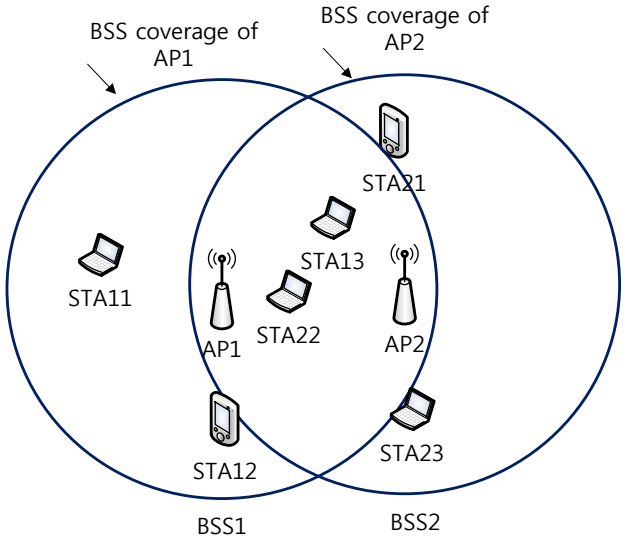
Overlapping Geography

- **It is possible to categorize overlapping geography based on inter-BSS interference classification**

- **Types of overlapping [1]**
  - AP-AP overlapping
  - BSS-BSS overlapping
  - STA-STA overlapping

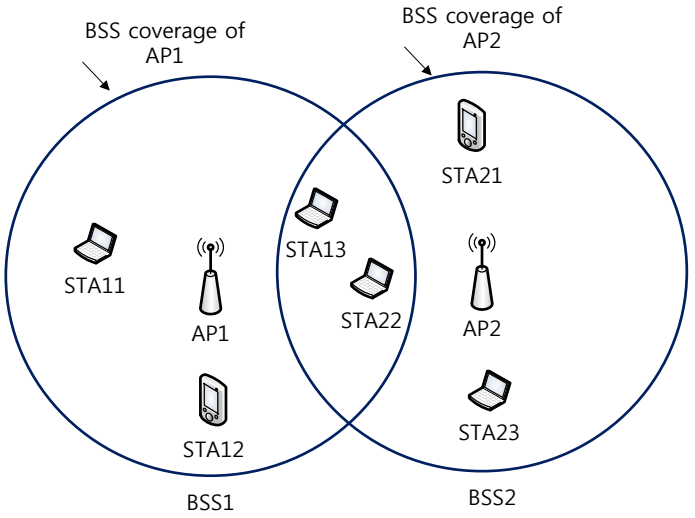
AP-AP Overlapping

- **AP1 and AP2 directly can hear each other**
- **APs and STAs might suffer from**
  - AP-AP IBI
  - AP-STA IBI
  - STA-STA IBI



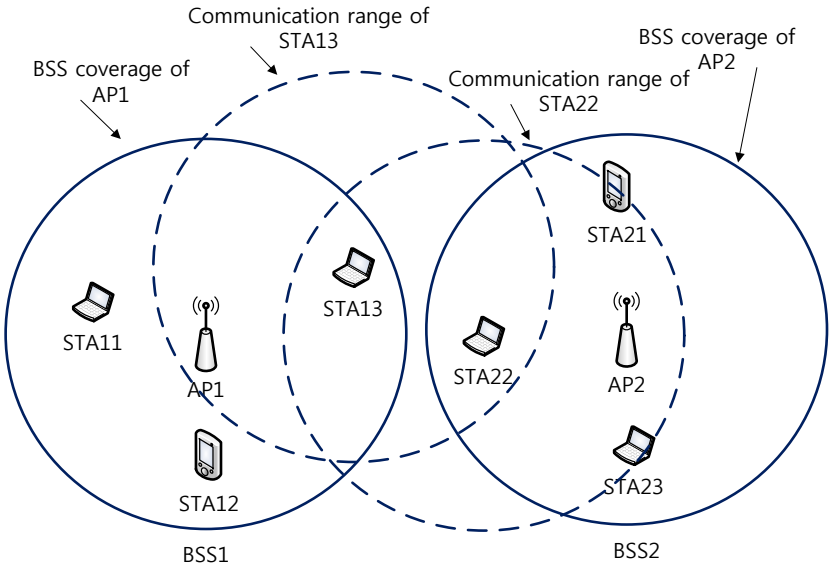
BSS-BSS Overlapping

- **AP1 and AP2 directly can NOT hear each other**
- **APs and STAs might suffer from**
  - AP-STA IBI
  - STA-STA IBI



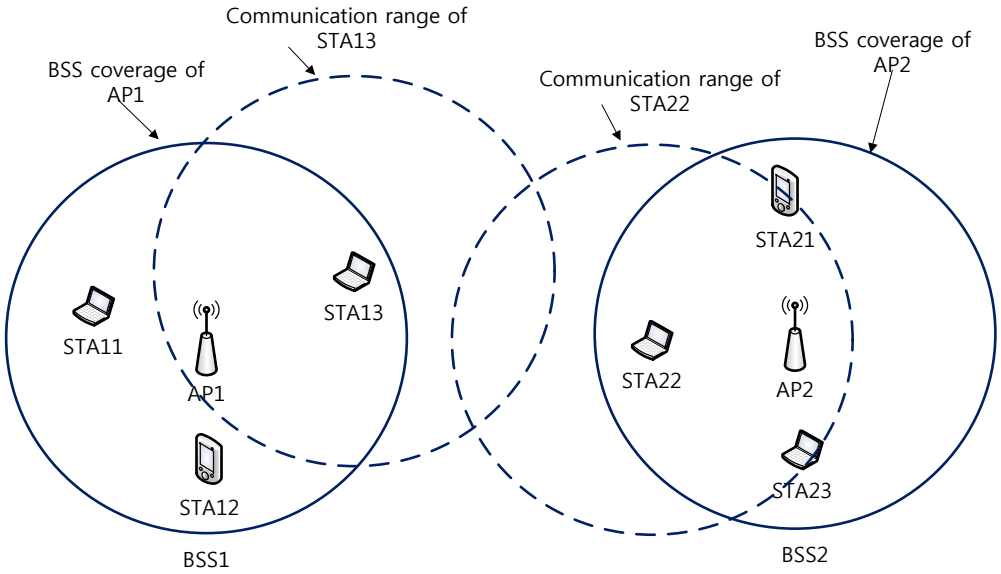
STA-STA Overlapping

- **AP1 and AP2 directly can NOT hear each other**
- **STAs might suffer from**
  - STA-STA IBI



No Overlapping: BSS-BSS Separation

- **There is no interference between BSSs**
- **Ideal spatial reuse is possible**



Comparison among Types of Overlap

- **AP-AP could get lot of co-channel interference. However, it might be favorable to mitigate interference since AP can hear each other directly**
- **BSS-BSS seems to difficult to mitigate co-channel interference since APs are blinded each other**

Type of overlapping	Inter-BSS interference: AP-AP	Inter-BSS interference: AP-STA	Inter-BSS interference: STA-STA	Amount of Inter-BSS interference	Hidden neighbor AP
AP-AP	YES	YES	YES	Heavy	-
BSS-BSS	-	YES	YES	Medium	YES
STA-STA	-	-	YES	Light	YES
No	-	-	-	-	-

Intuition on Inter-BSS Interference Mitigation (IBIM)

- **Which AP is being interfering on which channel? (Seen/Hidden)**
  - How to identify OBSSs which interfere MYBSS
- **“Stay on the channel” or “Switch to new channel”**
  - Determination based on what grounds?
  - What is useful information for decision?
- **Stay on the channel with which channel sharing method?**
  - Existing methods in WLAN is enough or Do we need a new one?
- **Select to new channel with which channel allocation method?**
  - Existing methods in WLAN is enough or Do we need a new one?

Issues related to IBIM

- **Identification of OBSSs which interfere MYBSS**
- **Exchanging necessary information among OBSSs to help IBIM**
- **Managing operating channels among OBSSs to avoid co-channel interference**

Identification of OBSSs which interfere MYBSS

- **Ways based on current WLAN spec.**
  - BSS color: 802.11ah-D2.0
  - Neighbor report: 802.11-2012
  - Reduced neighbor report: 802.11af-2012
  - Radio measurement: 802.11-2012
  - Active/Passive scanning: Beacon, probe request/response: 802.11-2012
- **Q: Current neighbor discovery for STAs to help association to an AP. Do we need methods or parameters for OBSS discovery under various OBSSs environment**

Exchanging Necessary Information among OBSSs to help IBIM

- **Ways based on current WLAN spec.**
  - Radio measurement: 802.11-2012
  - Active/Passive scanning: Beacon, probe request/response: 802.11-2012
  - Channel Load Report: 802.11-2012
  - Qload Report: 802.11aa-2012
  - RLSS (Registered Location Secure Server): 802.11af-2013
  - CAQ (Channel Availability Query): 802.11af-2013
- **Q: What information is required and how to exchange them among OBSSs to help IBIM?**

Managing Operating Channels among OBSSs to avoid Co-channel Interference

- **Ways based on current WLAN spec.**
  - LBT/CCA, TPC, DFS, ECS: 802.11-2012
  - Channel selection using QLoad report: 802.11aa-2012
  - Sharing in an OBSS situation; proportional vs. on-demand: 802.11aa-2012
  - CSM (Channel Schedule Management), NCC (Network Channel Control: 802.11af
- **Q: What AP management method is required for HEW on what condition?**
  - AP type: Managed vs. unmanaged
  - Coordination capability: Coordinated vs. uncoordinated
  - Decision topology: Centralized vs. distributed

Summary

- **Inter-BSS interference is one of important problems 11ax should solve to achieve High Efficiency WLAN (HEW)**
- **Three topics related to IBIM are considered**
  - Identification of OBSSs which interfere MYBSS
  - Exchanging necessary information among OBSSs to help IBIM
  - Managing operating channels among OBSSs to avoid Co-channel Interference

References

[1] Yue Fang et al, "A two-level carrier sensing mechanism for overlapping BSS problem in WLAN", LANMAN 2005

[2] IEEE Std. 802.11-2012

[3] IEEE Std. 802.11aa-2012

[4] IEEE Std. 802.11ad-2012

[5] IEEE Std. 802.11ac-2013

[6] IEEE Std. 802.11af-2013

[7] 802.11ah-D2.0