

Exhibit 1029

Joint Multichannel CSMA

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Introduction

- Currently, 80MHz/160MHz PHY transmission is considered in 11ac to improve the throughput.
- If the 40MHz channel bonding mechanism of 11n is extended to support 80MHz/160MHz channel operation, because of the large continuous channel bandwidths, the opportunity of 80MHz /160MHz transmission will be lower in OBSS scenario.
- In order to increase 80MHz/160MHz channel access opportunity, we propose a flexible mechanism to use correlated multichannel CSMA to support continuous and none continuous 80MHz /160MHz channel bandwidths access.

Concept used in this contribution

- **Channel bonding**

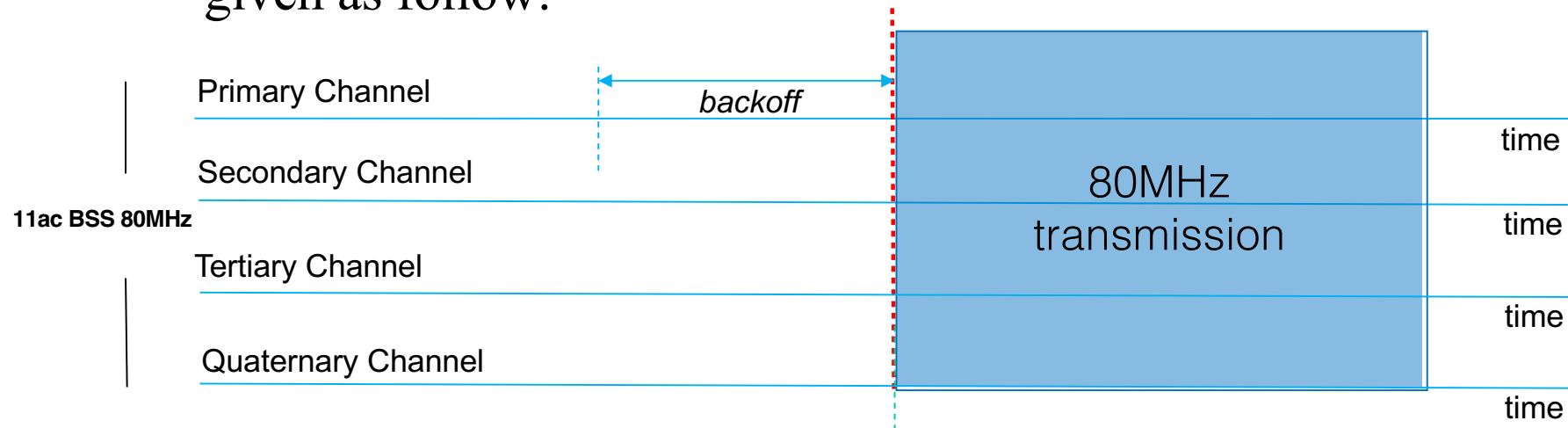
- In 11n, channel bonding is based on adjacent channels, i.e. 40MHz/80MHz channel bonding operation is respectively based on 2/4 adjacent 20MHz channels.

- **Primary channel**

- In 11n, channel bonding, primary channel is the channel which is occupied by its own BSS with the CSMA mechanism. The primary channels lies in the whole bandwidth with the interval of 40MHz.
- In 11ac, 80MHz channel can be divided into two continuous or non continuous 40MHz. Each 40MHz consist of primary channel and secondary channel.

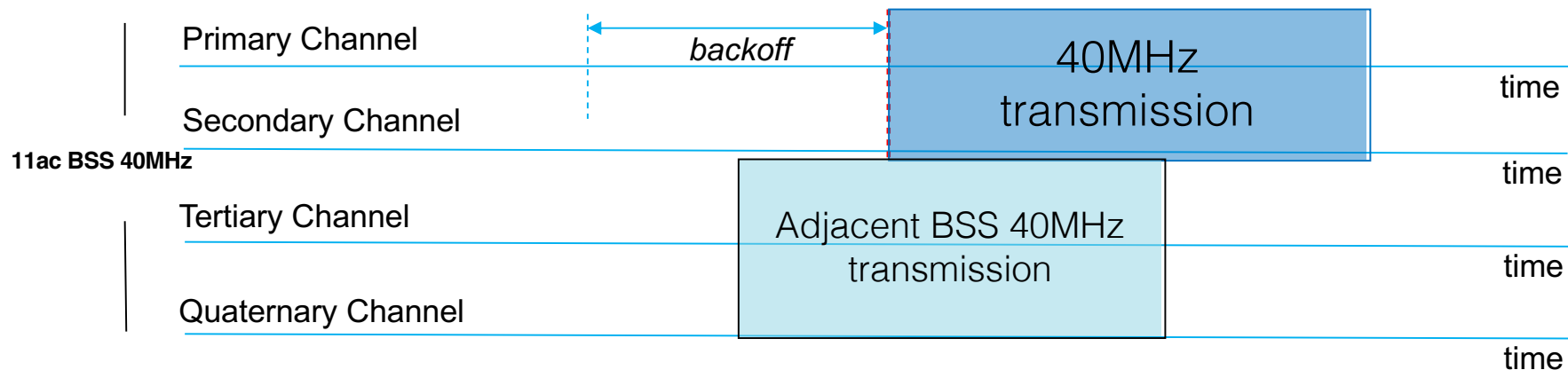
Legacy Channel bonding (1)

- In 11n, the 40 MHz channel bonding is implemented by simultaneously bonding two adjacent 20MHz.
- Directly extend the above mechanism to 11ac. Then the 80MHz channel bonding operation and CSMA backoff is given as follow:



Legacy Channel bonding (2)

- If the adjacent channels are occupied by other BSS, the 80MHz transmission is not available.

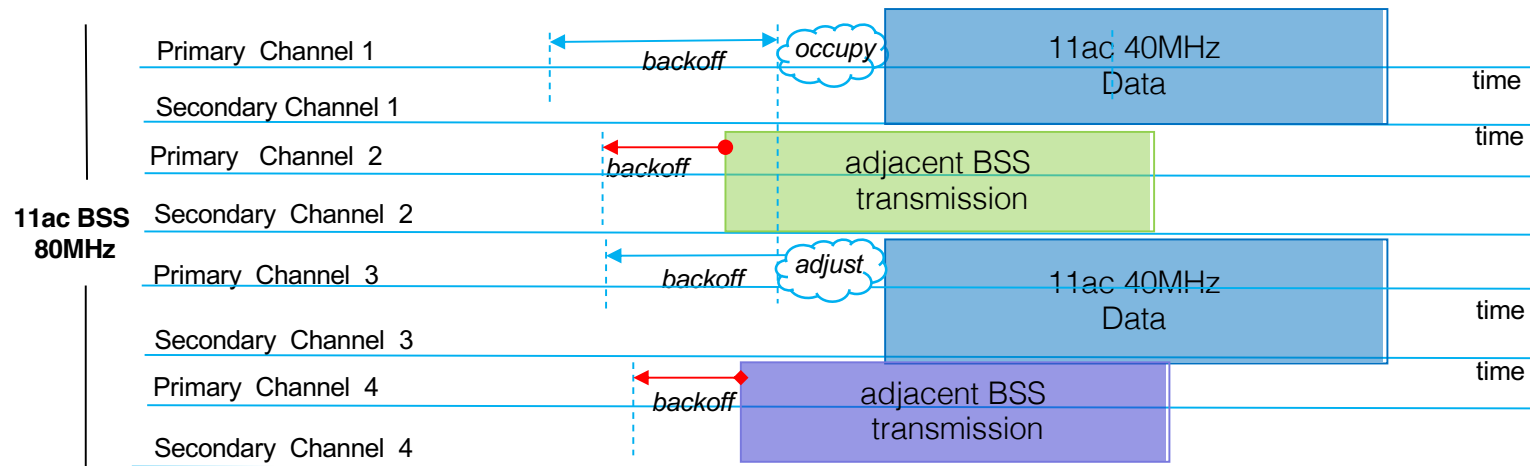


Joint multichannel CSMA

- In order to increase the opportunity of 80MHz/160MHz transmission, the joint multichannel CSMA mechanism is proposed.
- **Main ideas** of joint multichannel CSMA
 - For 80MHz channel, apply the CSMA mechanism on two primary channels simultaneously with 40 MHz channel bonding operation. Adjust the backoff counter value of the 2nd primary channel after the 1st primary channel is occupied(the detail is given in next page)
 - 160MHz channel can use the same mechanism.
 - Support non-contiguous & contiguous multichannel transmission

Joint multichannel CSMA of 80MHz

- 80MHz access with 2 correlated primary channel CSMA , i.e. joint multichannel CSMA
- Assume 40MHz channel bonding and corresponding non-overlapping channel management in 11n to ensure the compatibility with 11 n.



- Primary channel 2&4 are occupied by adjacent 11n BSS
- 11ac BSS adjust the backoff counter value of primary channel 3 after occupying primary channel 1 to zero

Advantages of joint multichannel CSMA (1)

- 1) Improve the channel utilization
- 2) Increase the opportunity of 80MHz transmission
- 3) flexible transmission mode
 - Contiguous multi-channel transmission mode
 - Non-contiguous multi-channel transmission mode

Advantage of joint multichannel CSMA (2)

4) Support new priority management mechanism

The priority of channel contention could be controlled by the backoff counter value. In this proposal due to multiple backoff counters for 80/160MHz channel, more flexible priority management could be supported. Besides the current priority management in 11n, we suggest the priority be considered with two more aspects

- The BSS which occupies one certain primary channel would have high priority of aggregating other primary channels
- The BSS would have high priority of aggregating the idle primary channels with large RSSI

Comparison

- OBSS scenario assumption:
 - One 11ac BSS coexists with several(4&5) 11n BSS
 - 12 available 20MHz channels, traditional Non-overlapping channel management of 11n
 - Adjacent 11n BSS transmit over different 40MHz channels, after that 11ac BSS starts to transmit.

	Num of adjacent 11n BSS	Probability of 80MHz transmission	Average transmission bandwidth
Joint multichannel CSMA	4	100% / 90%	80MHz / 76MHz
Legacy channel bonding	4	60%	60MHz
Joint multichannel CSMA	5	96% / 80%	78MHz / 72MHz
Legacy channel bonding	5	50%	50MHz

notes: “/” — non-contiguous multichannel / contiguous multichannel transmission

Requirement in PHY

- **Non-contiguous multichannel transmission mode needs the non-contiguous channel aggregation technique**
 - Need two non-contiguous 40MHz aggregation for 80MHz channel
 - Currently, two non-contiguous 80MHz aggregation is considered to support 160MHz transmission [2].

Summary

- **Main ideas** of joint multichannel CSMA
 - For 80/160MHz channel, apply the CSMA mechanism on multiple primary channels simultaneously. Adjust the backoff counter value of the 2nd primary channel after the 1st primary channel is occupied.
- Joint multichannel CSMA can
 - Increase the opportunity of 80MHz transmission
 - Improve the channel utilization
 - Support non-contiguous & contiguous transmission mode
 - Support new priority management mechanism

Reference

- [1] Laurent Cariou, *et al*, Multi-channel Transmissions, IEEE 802.11-09/1022r0, Oct. 2009
- [2] Youhan Kim, *et al*, 160 MHz PHY Transmission, IEEE 802.11-10/0378r1, May. 2010
- [3] Roberta Fracchia, *et al*, On the feasibility of 1Gbps for various MAC/PHY architectures, IEEE 802.11-08/0307, Mar. 2008