IEEE P802.11
Wireless LANs

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| 4.2 Spatial sharing and interference mitigation |
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Abstract

This document proposes specification text for subcaluse 4.2 of the SFD describing Spatial sharing and interference mitigation.

1. **Spatial sharing and interference mitigation**
2. **General**

This subclause describes mechanisms to enable spatial sharing and interference mitigation for operation in not only one channel, but also multi-channel configuration within a PBSS/infrastructure BSS and in a uncoordinated OBSS environment.

Spatial sharing mechanisms allow SPs belonging to different STAs in the same spatial vicinity to be scheduled concurrently over one or multiple 2.16GHz channels, and for interference mitigation. Alternatively, the AP or PCP can use CBAPs to mitigate interference.

The SPSH and Interference Mitigation field in the DMG Capabilities element indicates whether a STA supports spatial sharing.

A STA that supports spatial sharing, as indicated in the SPSH and Interference Mitigation field equal to 1 in the STA’s DMG Capabilities element, shall support the directional channel quality measurements described in 8.4.2.20.16 (Directional Channel Quality request) and 8.4.2.21.15 (Directional Channel Quality report).

1. **Spatial sharing and interference assessment**

The AP or PCP should request STAs to perform and report spectrum and radio resource measurements described in 10.11 (Radio measurement procedures) to assess the possibility to perform spatial sharing and for interference mitigation.

The AP or PCP should use the directional channel quality described in 8.4.2.20.16 (Directional Channel Quality request) and 8.4.2.21.15 (Directional Channel Quality report) to assess the possibility for spatial sharing of SPs over one or multiple 2.16GHz channels.

An SP to be assessed for spatial sharing with other scheduled (existing) SPs or considered to be reallocated in the beacon interval is hereby termed as a candidate SP. There might be multiple candidate and existing SPs at one time, and an SP may simultaneously assume the role of candidate and existing SP depending upon the context it is used for spatial sharing and interference assessment.

STAs that participate in one or multiple SPs and that support spatial sharing over one or multiple 2.16GHz channels should perform beamforming training with each other before engaging in any other communication or performing any measurements described in this subclause.

For the purpose of spatial sharing with an existing SP over one channel, the AP or PCP should request source STA and destination STA involved in a candidate SP to perform measurements only after the STAs have beamforming trained with each other. The AP or PCP can infer that the STAs in a candidate SP have a beamformed link with each other if the Beamforming Training field within the DMG TSPEC used to set up the candidate SP was set to 1 and at least one beacon interval has elapsed since the candidate SP was first scheduled.

For the purpose of spatial sharing with multiple existing SPs over multiple channels, the AP or PCP should request multiple source EDMG STAs and multiple destination EDMG STAs involved in multiple candidate SPs to perform measurements only after the STAs have beamforming trained with each other. According to the channel allocation, i.e. channel bonding and channel aggregation, the Directional Channel Quality Request and Report measurement types shall support the request and report for measurements on multiple channels, and measurements reports averaged over multiple channels. Also, the EDMG spatial sharing mechanism shall enable an EDMG STA to perform concurrent measurements employing multiple RX antenna configurations as are used for receiving multiple streams from the target EDMG STA based on the same measurement configuration and to report the average of the results of concurrent measurements using multiple RX antenna configurations in order to reduce the overhead of the measurement report.

If the AP or PCP transmits a Directional Channel Quality request to a STA involved in a candidate SP to assess the possibility for spatial sharing with another existing SP, it shall set the Target STA to the corresponding peer STA’s MAC address involved in the candidate SP and shall set the Measurement Method field to indicate ANIPI.

If the candidate SP has already been allocated channel time, the AP or PCP should additionally transmit a Directional Channel Quality request to the STAs involved in the existing SP to assess the possibility for spatial sharing with the candidate SP. In the Directional Channel Quality request, the AP or PCP shall set the Target STA to the corresponding peer STA involved in the existing SP and shall set the Measurement Method field to indicate ANIPI.

NOTE—When the AP or PCP transmits a Directional Channel Quality request to a STA of an existing SP, it intends to assess the channel quality during transmission by STAs belonging to the candidate SP. Similarly, when the AP or PCP transmits a Directional Channel Quality request to a STA of a candidate SP, it intends to assess the channel quality during transmission by STAs belonging to the existing SP.

If a recipient STA that receives a Directional Channel Quality request frame is already beamformed trained with the target STA specified by the AID field within the frame, then the recipient STA shall carry out the measurement employing the same receive antenna configuration as is used by the recipient STA when receiving frames from the target STA. If the AID field is set to the broadcast AID or an unknown AID, then the recipient STA shall perform the measurements using a quasi-omni antenna pattern.

Figure 10-44 (Example of spatial sharing assessment) illustrates an example of spatial sharing assessment between two SPs. In this example, SP1 is the existing SP and SP2 is the candidate SP. The AP or PCP transmits a Directional Channel Quality request to STAs C and D to measure over SP1’s channel allocation, and transmits a Directional Channel Quality request to STAs A and B to measure over SP2’s channel allocation. The relation of the Measurement Start Time and Measurement Duration fields in the Directional Channel Quality request message is shown in Figure 10-44 (Example of spatial sharing assessment), while the field Number of Time Blocks is the ratio (Measurement Duration/Measurement Unit).

If a non-AP and non-PCP STA receives a Directional Channel Quality request from its AP or PCP, it should perform the measurements as indicated in the request and shall report back to the AP or PCP using the Directional Channel Quality report. The report shall be formatted and transmitted as per specified in the Directional Channel Quality request. The non-AP and non-PCP STA shall set the Report Mode field (8.4.2.21 (Measurement Report element)) in the report frame to indicate whether it performed the measurement as requested by the AP or PCP.



Figure 10-44—Example of spatial sharing assessment

1. **Achieving spatial sharing and interference mitigation**

An AP or PCP can estimate the channel quality across STAs participating in the BSS and implement spatial sharing and interference mitigation based on the results of the measurements performed by the STAs associated with the AP or PCP.

An AP or PCP should schedule a candidate SP that overlaps with an existing SP in its beacon interval only after it receives a Directional Channel Quality report from the STAs involved in the candidate SP.

If a candidate SP is already scheduled in the beacon interval, the AP or PCP should schedule this candidate SP time-overlapping with an existing SP in its beacon interval only after it receives a Directional Channel Quality report from the STAs involved in the existing SP.

The AP or PCP should schedule a candidate SP during a period of time in the beacon interval where the PBSS/infrastructure BSS performance is expected to be maximized. The determination of performance maximization should be based on measurement reports received by the AP or PCP, but is implementation dependent and beyond the scope of this standard.

The decision process at the AP or PCP to perform spatial sharing of a candidate and an existing SP is implementation dependent and beyond the scope of this standard.

The candidate SP is referred to as a time-overlapped SP following the allocation by the AP or PCP of a candidate SP overlapping in time with an existing SP.

Figure 10-45 (Example of spatial sharing between SP1 and SP2) illustrates an example of the resulting SP schedule in the beacon interval for the spatial sharing between the two SPs shown in Figure 10-44 (Example of spatial sharing assessment).

The AP or PCP should periodically transmit a Directional Channel Quality request to each spatial sharing capable STA involved in a time-overlapped and existing SP scheduled under spatial sharing. In the Directional Channel Quality request that the AP or PCP transmits to each STA, the AP or PCP shall set the Target STA to the peer STA involved in the same SP and shall set the Measurement Method field to indicate RSNI.



Figure 10-45—Example of spatial sharing between SP1 and SP2

If a spatial sharing capable non-AP and non-PCP STA receives a Directional Channel Quality request from its AP or PCP, it should perform the measurements as indicated in the request and shall report the results back to the AP or PCP using the Directional Channel Quality report. The report shall be formatted and transmitted as per specified in the corresponding Directional Channel Quality request.

The AP or PCP should stop the spatial sharing of two or more SPs if it determines that the link quality of any of the links involved in the spatial sharing has dropped below acceptable levels. This determination should be based on Directional Channel Quality reports received by the AP or PCP, but is implementation dependent and beyond the scope of this standard.

The STA may include the Traffic Scheduling Constraint Set field with the ADDTS Request frame sent to the AP or PCP for the purpose of interference mitigation. The AP or PCP should consider the information in the Traffic Scheduling Constraint Set field specified by a STA in its SP schedule.

Specific algorithms to realize spatial sharing and interference mitigation among SPs between different STAs is implementation dependent and beyond the scope of this standard.

1. **PBSS and infrastructure BSS stability in OBSS scenarios**

Except when performing FST (10.33 (Multi-band operation)), the AP or PCP limits the frequency with which it changes the operating PBSS/infrastructure BSS channel to alleviate the instability and ripple effect that might result from frequent channel changes in OBSS scenarios. Upon a channel switch, the AP or PCP of a PBSS/infrastructure BSS shall select a random number, N, uniformly distributed between [0, SwitchInterval-1] and shall not attempt a new channel switch until N beacon intervals have elapsed since the preceding channel switch. The initial value of SwitchInterval is aMinSwitchInterval and it is doubled upon every new channel switch up to a maximum value of aMaxSwitchInterval. The AP or PCP resets SwitchInterval to aMinSwitchInterval if it remains on the same operating channel for a minimum of aMaxSwitchInterval consecutive beacon intervals.

NOTE—The AP or PCP can keep the SP schedule stable across beacon intervals and minimize schedule changes. This is to allow for STAs to associate with the PBSS/infrastructure BSS or add or modify their SP reservations. Stability in the allocation schedule in a beacon interval allows a PBSS/infrastructure BSS to assess the interference pattern produced by OBSSs and adapt to the environment by scheduling SPs over periods of time in the beacon interval when less interference is expected.