### **IEEE P802.11 Wireless LANs**

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| Max Channel Switch Time Harmonization | | | | |
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**Abstract**

No available CID; but soliciting the following change regardless.

**Revisions:**

* Rev 0: Initial version of the document.
* Rev1: Changes after discussion at 11mf and offline
* Rev2: Refinements after further offline discussion

***TGme editor: Please note Baseline is 11me D7.0. Edits are expressed via Word track changes:***

***Comment:***

The definition of Max Channel Switch Time (“MCST element”; which*, for avoidance of doubt,* does not signify multicast) is inconsistent in many ways. It is the time between a start event and an end event, but how are each defined (and are they the most useful definitions?):

* Is the start time
  + a) the TBTT of the last beacon frame or
  + b) the actual transmit time of the last beacon?
* Is the end time
  + 1) when the AP is first ready to communicate on the new channel,
  + 2) the TBTT of the first beacon on the new channel or
  + 3) the actual time of the first beacon transmitted on the new channel (which may be later than TBTT due to channel access delays)?
  + 4) an upper bound on the actual time of the first beacon transmitted on the new channel (which may be later due to channel access delays)?

From below, we see a mix of “a” and “b” and a mix of “2” and “4”.

Meanwhile, if the AP is ready to transmit on the new channel but (say) half a Beacon Interval before the next TBTT, the general intent of the protocol seems suboptimal:

* Communication has to wait until for that half a BI the next TBTT (which is bad for QoS traffic), and/or
* The AP should send an extra beacon at half a BI before its normal beacon, with undefined expectations in terms of countdown timers (e.g., for Quiet element), and/or
* The AP should disrupt its TSF: it should advance the TSF by half a BI so that the TBTT is aligned with the AP’s readiness to transmit on the new channel. However, dozing STAs might take an extended time to detect these time-translated beacons.

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| 9.4.2.216 Max Channel Switch Time element  The Max Channel Switch Time element indicates the time delta between the **time** **the last beacon is transmitted by the AP in the current channel** and the **expected time of the first beacon** transmitted by the AP in the new channel. The format of the element is defined in Figure 9-835 (Max Channel Switch Time element format).  …  The Switch Time field indicates(#2047) the maximum time delta between the **TBTT of** **the last Beacon frame transmitted by the AP** in the current channel and **the TBTT of the first Beacon frame** in the new channel, expressed in TUs.(#3420) |
| 11.8.8.2 Selecting and advertising a new channel in a non-DMG infrastructure BSS  … When the AP includes the Max Channel Switch Time element(#6), the AP shall **transmit the first Beacon frame in the new channel no later than the time indicated in the Switch Time field of the Max Channel Switch Time element** after the **last Beacon frame transmitted in the current channel**, unless the AP determines that it is unable to operate on the new channel.(#1812)  … A STA that receives a Max Channel Switch Time element from its associated AP should not transmit a frame to the AP on the new channel until it receives a frame on the new channel from the AP. |
| 11.9.3.2 Selecting and advertising a new channel in an infrastructure BSS  … When the AP includes the Max Channel Switch Time element(#6), the AP shall transmit the first Beacon frame in the new channel no later than the time indicated in the Switch Time field of the Max Channel Switch Time element after the last Beacon frame transmitted in the current channel, unless the AP determines that it is unable to operate on the new channel(#7160).  … (#6)A STA that receives a Max Channel Switch Time element from its associated AP should not transmit a frame to the AP on the new channel until it receives a frame on the new channel from the AP. |

What seems to make better sense is:

* Start time for Switch Time should be a stable, well-defined time – i.e., TBTT of last beacon on the old channel aka “a”
* End time for Switch Time should a) be stable and well-defined (i.e., when frames are scheduled for transmission, not when actually transmitted) and b) be as early as possible, which might be between TBTTs. If the end time is between TBTTs, the AP should just schedule for transmission a broadcast unsolicited Probe Response (UPR). Alternatively, the end time can be an upper bound, if coupled with expected client behaviors that provide for earlier operation if possible.

In terms of conformance and interop:

* The spec has internally inconsistent requirements, so conformance is not possible by definition
* Industry testing of the MCST element suggests that preserving the notion of an “upper bound” is advised
* The author is aware of an implementation that doesn’t follow 2) or 3) and can indicate much later than 1) (and so the question of whether the AP follows a) or b) is moot). Non-AP STAs waking up at TBTT + MCST will find that the AP is (already) available but might not receive a beacon (or UPR), so might need to wait for up to a BI to get a beacon (or might actively scan the AP, leading to an unfortunate synchronized burst of probe requests)
* In general we see opportunities for improvement:Remove inconsistencies
* Align with some industry expectations on APs
* Be more explicit about optimal client behavior (but without making legacy non-compliant):

***Accordingly, REVmf editor, please make the following changes indicated via Word track changes:***

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| 9.4.2.17 Channel Switch Announcement element  For an AP channel switch, the AP first becomes unavailable for communications on the current channel and later becomes available for communications on the new channel. The time at which the AP first becomes unavailable for communications on the current channel is referred to as the start of the switch.For nonmesh STAs, the Channel Switch Count field is set to the number of TBTTs until the STA sending the Channel Switch Announcement element starts a switch to the new channel. The value 1 indicates that the start of the switch occurs at the next TBTT (the next Beacon frame is created assuming the new channel), and the value 0 indicates that the start of the switch occurs at any time after the frame containing the element is transmitted.  For mesh STAs, the Channel Switch Count field is encoded as an octet with bits 6 to 0 set to the time, in units of 2 TU when the MSB (bit 7) is 0, or in units of 100 TU when the MSB (bit 7) is 1, until the mesh STA sending the Channel Switch Announcement element starts a switch to the new channel. An octet with bits 6 to 0 indicates that the start of the switch occurs at any time after the frame containing the element is transmitted. For example, a duration of 200 TU until the start of the switch is encoded as X'82' and a duration of 10 TU until the start of the switch is encoded as X'05'. |
| 9.4.2.51 Extended Channel Switch Announcement element  For nonmesh STAs, the Channel Switch Count field indicates the number of target beacon transmission times (TBTTs) until the STA sending the Channel Switch Count field starts a switch to the new channel. A Channel Switch Count field set to 1 indicates that the start of the switch occurs immediately before the next TBTT. A Channel Switch Count field set to 0 indicates that the start of the switch occurs any time after the frame containing the Channel Switch Count field is transmitted.  For mesh STAs, the Channel Switch Count field is encoded as an octet with bits 6 to 0 set to the time, in units of 2 TU when the MSB (bit 7) is 0, or in units of 100 TU when the MSB (bit 7) is 1, until the mesh STA sending the Channel Switch Count field starts a switch to the new channel. Bits 6 to 0 set to 0 indicates that the start of the switch occurs at any time after the frame containing the Channel Switch Count field is transmitted. For example, a duration of a 200 TU until the start of the switch is encoded as X'82' and a duration of 10 TU until the start of the switch is encoded as X'05'. |
| 9.4.2.216 Max Channel Switch Time element  The Max Channel Switch Time element indicates the time delta between the TBTT of the AP’s last beacon in the current channel and the time by which the AP expects to have transmitted its first beacon in the new channel. The format of the element is defined in Figure 9-835 (Max Channel Switch Time element format).  …  The Switch Time field indicates(#2047) the maximum time delta between the TBTT of the last Beacon frame transmitted by the AP in the current channel and the time by which the AP expects to have transmitted its first beacon, accounting for channel access delays in the new channel, and assuming that operation on the new channel is determined to be allowed, expressed in TUs.(#3420).  NOTE 1 – The last Beacon transmitted on the current channel is identified by the Channel Switch Count field equal to 1 or 0 in the (Extended) Channel Switch Announcement element.  NOTE 2 – For instance, an AP switching to a channel subject to DFS-related regulatory requirements calculates the Switch Time field assuming that there is no DFS-related signal that would disallow operation on the new channel.  A diagram of a channel switch  Description automatically generated |
| 11.8 DFS procedures  11.8.8 Selecting and advertising a new channel  11.8.8.2 Selecting and advertising a new channel in a non-DMG infrastructure BSS  When an AP transmits (#7160)an Extended Channel Switch Announcement frame or a frame containing a Channel Switch Announcement element or an Extended Channel Switch Announcement element, it should include a Max Channel Switch Time element in the frame if the Channel Switch Count field is nonzero and it may include the element if the field is 0.(#6027) When the AP that has dot11MaxChannelSwitchTimeEnhancedActivated equal to false includes the Max Channel Switch Time element(#6), the AP shall transmit the first Beacon frame in the new channel no later than the time indicated in the Switch Time field of the Max Channel Switch Time element after the last Beacon frame transmitted in the current channel, unless the AP determines that it is unable to operate on the new channel.(#1812) When the AP that has dot11MaxChannelSwitchTimeEnhancedActivated equal to true includes the Max Channel Switch Time element, the AP shall transmit the first Beacon frame in the new channel no later than the time indicated in the Switch Time field of the Max Channel Switch Time element after the TBTT of the last Beacon frame transmitted in the current channel, unless the AP determines that it is unable to operate on the new channel.(#1812).  ...  A STA that has dot11MaxChannelSwitchTimeEnhancedActivated equal to false and receives a Channel Switch Announcement element may choose not to perform the specified switch, but to take alternative action. (#6)A STA that has dot11MaxChannelSwitchTimeEnhancedActivated equal to false and receives a Max Channel Switch Time element from its associated AP should not transmit a frame to the AP on the new channel until it receives a frame on the new channel from the AP.  NOTE <Editor to assign and renumber notes accordingly> — Having non-APs waiting for a frame from their associated AP aids in preventing storms of spurious frames.  (#6)NOTE 2—Whether or not a Max Channel Switch Time element is included, regulations might forbid a STA from transmitting on the new channel until it receives an enabling signal (e.g., a Beacon frame or broadcast unsolicited Probe Response frame).  A non-AP STA that has dot11MaxChannelSwitchTimeEnhancedActivated equal to true and receives a Channel Switch Announcement element in a frame from its associated AP should perform the specified switch. If the STA also received a Max Channel Switch Time element in the same frame and performed the indicated channel switch, the STA:   * Should attempt to receive frames on the new channel for min(ST, one Beacon Interval) before the Switch Time elapses, where ST equals the Switch Time field in the Max Channel Switch Time element, and * Should not transmit a frame to the AP on the new channel until the STA receives a Beacon or Probe Response frame on the new channel from the AP.   If the STA receives a Timestamp field in a protected Beacon frame on the new channel from the AP, and:   * The Timestamp field indicates that the BSS has not been stopped and started during the channel switch then the STA shall not perform authentication and association in response to the completed channel switch and rather should continue its existing association. * The Timestamp field indicates that the BSS has been stopped and started during the channel switch, then the STA shall attempt to associate to the AP.   Otherwise, if the STA receives at least one Timestamp field in a Probe Response or unprotected Beacon frame on the new channel from the AP, and   * If, based on the received timestamp(s), the STA determines that the BSS has not been stopped and started during the channel switch, then the STA should not perform authentication and association in response to the completed channel switch and rather should continue its existing association. * If, based on received timestamp(s), the STA determines that the BSS has been stopped and started during the channel switch, then the STA should attempt to associate to the AP.   A non-AP STA that has dot11MaxChannelSwitchTimeEnhancedActivated equal to true, that receives a Channel Switch Announcement element from its associated AP and that will not perform the specified switch, should take alternative action such as performing FT, deauthenticating or disassociating before the start of the channel switch. |
| 11.9 Extended channel switching (ECS)  11.9.3 Selecting and advertising a new channel and/or operating class  11.9.3.2 Selecting and advertising a new channel in an infrastructure BSS  When an AP transmits (#7160)an Extended Channel Switch Announcement frame or a frame containing a Channel Switch Announcement element or an Extended Channel Switch Announcement element, it should include a Max Channel Switch Time element in the frame if the Channel Switch Count field is nonzero and it may include the element if the field is 0.(#6027) When the AP that has dot11MaxChannelSwitchTimeEnhancedActivated equal to false and that includes the Max Channel Switch Time element(#6), the AP shall transmit the first Beacon frame in the new channel no later than the time indicated in the Switch Time field of the Max Channel Switch Time element after the TBTT of the last Beacon frame transmitted in the current channel, unless the AP determines that it is unable to operate on the new channel(#7160).  …  When a STA with dot11DSERequired equal to false and dot11MaxChannelSwitchTimeEnhancedActivated equal to false receives an Extended Channel Switch Announcement element, it may choose not to perform the specified switch, but to take alternative action. (#6)A STA that has dot11MaxChannelSwitchTimeEnhancedActivated equal to false and receives a Max Channel Switch Time element from its associated AP should not transmit a frame to the AP on the new channel until it receives a frame on the new channel from the AP.  (#6)NOTE 1—Whether or not a Max Channel Switch Time element is included, regulations in certain regulatory domains might(#3091) forbid a STA from transmitting on a new channel until it has received an enabling signal (e.g., a Beacon frame or broadcast unsolicited Probe Response frame).(#4054)  (#6)NOTE 2—As an alternative to performing the specified channel switch, a STA might choose to move to a different BSS.  A non-AP STA that has dot11DSERequired equal to false and dot11MaxChannelSwitchTimeEnhancedActivated equal to true and receives an Extended Channel Switch Announcement frame or element in a frame from its associated AP should perform the specified switch. If the STA also received a Max Channel Switch Time element in the same frame and performed the indicated channel switch, the STA:   * Should attempt to receive frames on the new channel for min(ST, one Beacon Interval) before the Switch Time elapses, where ST equals the Switch Time field in the Max Channel Switch Time element, and * Should not transmit a frame to the AP on the new channel until the STA receives a Beacon or Probe Response frame on the new channel from the AP.   If the STA receives a Timestamp field in a protected Beacon frame on the new channel from the AP, and:   * The Timestamp field indicates that the BSS has not been stopped and started during the channel switch then the STA shall not perform authentication and association in response to the completed channel switch and rather should continue its existing association. * The Timestamp field indicates that the BSS has been stopped and started during the channel switch, then the STA shall attempt to associate to the AP.   Otherwise, if the STA receives at least one Timestamp field in a Probe Response or unprotected Beacon frame on the new channel from the AP, and   * If, based on the received timestamp(s), the STA determines that the BSS has not been stopped and started during the channel switch, then the STA should not perform authentication and association in response to the completed channel switch and rather should continue its existing association. * If, based on received timestamp(s), the STA determines that the BSS has been stopped and started during the channel switch, then the STA should attempt to associate to the AP.   A non-AP STA that has dot11DSERequired equal to false and dot11MaxChannelSwitchTimeEnhancedActivated equal to true, that receives a Channel Switch Announcement element from its associated AP and that will not perform the specified switch, should take alternative action such as performing FT, deauthenticating or disassociating before the start of the channel switch.  If dot11RSNAOperatingChannelValidationActivated is true and a channel switch is requested while a security handshake is in progress, the handshake should be aborted.  If the STA chooses to perform the specified switch and dot11RSNAOperatingChannelValidationActivated is true and the AP has indicated OCVC(#3505), after switching to the new channel the STA shall wait a random delay uniformly-distributed in the range between (Ed1)0 and 5000 µs, and then initiate the SA query procedure once any applicable conditions for transmitting on the new channel are met (e.g., channel access procedures, DFS or enablement procedures). This procedure shall be initiated whether or not the switch was based on a protected Management frame that contained the new operating channel information. The STA may pause Data frame transmission and may (#3683)discard any received Data frames until the SA query procedure has completed successfully for additional protection.  If a STA initiates SA query procedure to validate a channel switch, any existing SA query procedure for channel switch validation shall be abandoned. |
| C.3 MIB detail  Dot11StationConfigEntry ::= SEQUENCE  { …  dot11DSERequired TruthValue,  dot11ExtendedChannelSwitchActivated TruthValue,  **…**  (11bc)dot11EBCSAPGroupID OCTET STRING,  dot11MaxChannelSwitchTimeEnhancedActivated TruthValue  }  …  (11bc)dot11EBCSAPGroupID OBJECT-TYPE  SYNTAX OCTET STRING (SIZE(2))  MAX-ACCESS read-write  STATUS current  DESCRIPTION  "This is a control variable.  It is written by an external management entity or the SME. Changes take effect as soon as practical in the implementation. This variable specifies the EBCS AP group ID. The range of value is 00-00 to 7F-FF. The value 0000 means the AP does not belong to any EBCS AP group."  DEFVAL {‘0000’H}  ::= { dot11StationConfigEntry 224 }  dot11MaxChannelSwitchTimeEnhancedActivatedActivated OBJECT-TYPE  SYNTAX TruthValue  MAX-ACCESS read-write  STATUS current  DESCRIPTION  "This is a control variable.  It is written by the SME or external management entity.This attribute, when true, indicates that the capability of the station to perform enhanced channel switching with Max Channel Switch Time is enabled."  DEFVAL { false }  ::= { dot11StationConfigEntry 225 } |
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