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

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| P2P TWT Harmonization | | | | |
| Date: 2025-04-08 | | | | |
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**Abstract**

No available CID; but soliciting the following change regardless.

**Revisions:**

* Rev 0: Initial version of the document.
* Rev 1: Fine tune the unavailability language, add NOTE in regard to the desired behavior at an AP in response to receiving unavailability signaling
* Rev 2: Additional co-author
* Rev 3: Updates after F2F discussion and to align 11mf with expected 11bn direction to decouple Power Mgmt mode and Power State from Unavailability
* Rev 4: Updates after F2F discussion

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

***Comment:***

There are some minor usages of “unavailable” / “unavailability” that we can set aside:

* The “unavailable TDD slot”, from 10.38.6.2.2 (SP with TDD channel access(11ay)), but that is clearly a different concept distinguished by the following “TDD”.
* An “unavailable” link due to RF conditions:
  + From 10.44.2.3 (Usage of REDS) “A pair of source REDS and destination REDS exchange frames via either the direct link or the relay link until this link is determined to become unavailable due to, for example, blockage or channel degradation.”; also 11.34.3 (Relay operation-type change procedure).
  + From 11.10.15.2 (Measurement Pilot frame generation by an AP) “In case the medium is determined by the carrier-sense mechanism (see 10.3.2.1 (CS mechanism)) to be unavailable at the TMPTT, the AP shall delay the actual transmission”
* An “unavailable channel”:
  + Seems to be a synonym for a disallowed channel under the 20/40 MHz 11.15.6 Exemption from OBSS scanning – see 11.15 20/40 MHz (BSS operation)
  + Related usage under 11.42.8 (White space map (WSM))

Really, however, the *main* usage of “unavailability” is in relation to a STA not being available for communication while otherwise in active state, and is used in multiple places in 802.11REVme including relation to TWT:

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| 11.2.1 General  (#101)A non-AP STA can be in one of two power management modes:   * Active mode: The STA receives and transmits frames at any time if the STA is in awake state. A non-HE STA remains in the awake state. **An HE STA remains in the awake state, unless the STA is unavailable. A STA that is unavailable is not capable of receiving PPDUs. A STA is permitted to be unavailable as described in 26.14.3 (Opportunistic power save), 26.14.1 (Intra-PPDU power save for non-AP HE STAs), and 26.8.4.4 (TWT Information frame exchange for flexible wake time).(11ax)** * Power save (PS) mode: The STA enters the awake state to receive or transmit frames. The STA remains in the doze state otherwise. |
| 11.2.3.6 AP operation  An AP shall maintain for each currently associated STA a Power Management status that indicates in which power management mode the STA is currently operating. APs that implement and signal their support of APSD shall maintain for each currently associated STA an APSD and an access policy status that indicates whether the STA is presently using APSD and shall maintain the schedule (if any) for the STA. An AP shall, depending on the power management mode of the STA, temporarily buffer BUs destined to the STA. An AP implementing APSD shall, if a STA is using APSD and is in PS mode, temporarily buffer BUs destined to that STA. No BUs addressed directly to STAs operating in the active mode shall be buffered for power management reasons. **An HE AP should not transmit to an HE STA if the STA might be unavailable, as defined in 26.8.4.4 (TWT Information frame exchange for flexible wake time) and 26.14.3 (Opportunistic power save), unless the transmission is solicited by the STA.(11ax)** |
| 11.2.3.9 STAs operating in the active mode  A STA operating in this mode shall have its receiver activated continuously, **(11ax)unless the STA is allowed to be temporarily unavailable through the opportunistic power save mechanism defined in 26.14.3 (Opportunistic power save) or through the intra-PPDU power save mechanism defined in 26.14.1 (Intra-PPDU power save for non-AP HE STAs) or 26.8.4.4 (TWT Information frame exchange for flexible wake time); such STAs do not need to interpret the TIM elements in Beacon frames** |
| 26.8.4.4 TWT Information frame exchange for flexible wake time  A non-AP HE STA that transmits a TWT Information frame with flexible TWT to a peer STA   * May go to doze state after receiving the acknowledgment sent in response to the TWT Information frame if it is in PS mode (i.e., the PM subfield of the Frame Control field of the TWT Information frame is 1). * **May be unavailable if it is in active mode (i.e., the PM subfield of the Frame Control field of the TWT Information frame is 0).** * Shall be in the awake state at the time indicated in the Next TWT subfield of the TWT Information frame.(#1201) * Shall be in the PS mode if the PM subfield of the TWT Information frame was 1 and in active mode if the PM subfield of the TWT Information frame was 0. |
| 26.14.1 Intra-PPDU power save for non-AP HE STAs  Intra-PPDU power save is the power save mechanism for an HE STA to enter the doze state **or become unavailable until the end of a received PPDU** that is identified as an intra-BSS PPDU. The STA can enter the doze state if it is in PS mode and **can become unavailable if it is in active mode (see 11.2.3.2 (Non-AP STA power management modes)).** |
| 26.14.3 Opportunistic power save  26.14.3.1 General  In the aperiodic mode, an OPS AP sends an OPS frame or a FILS Discovery frame at any time to provide the scheduling information for all OPS non-AP STAs for the OPS period that follows the transmission of the OPS frame or FILS Discovery frame. Based on this information, **the OPS non-AP STAs that are in active mode may be unavailable during the OPS period**, and the OPS non-AP STAs that are in PS mode may be in doze state during the OPS period  etc |

We see this same “unavailability” term in relation to the P2P TWT sub-features of Channel Usage, where this P2P TWT sub-feature is also built on TWT:

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| 11.21.15 Channel usage procedures  **(#3145)(#6018)To indicate its unavailability, a non-AP STA may transmit a Channel Usage Request frame with the Usage Mode field of the Channel Usage element set to 3 and without a Channel Entry field to inform the AP about its unavailability during the peer-to-peer TWT agreement, also referred to as unavailability notification(#6018).** Otherwise, the non-AP STA (#4337)shall set the Usage Mode field to 0, 1 or 2.  NOTE 8—If the Usage Mode field set to 3, it is possible that the Channel Usage Request frame does not include a Channel Entry field. **In such case, the TWT element indicates the unavailability of the requesting non-AP STA for communication with the AP during the peer-to-peer TWT schedule.(#3145)**  **(#3145)Upon receiving a Channel Usage Request frame with a TWT element configured as a TWT request and a Channel Usage element with the Usage Mode field set to 3 (Unavailability indication(#6018))** that does not carry a Channel Entry field, an AP that supports peer-to-peer TWT scheduling shall transmit a Channel Usage Response frame that includes a Channel Usage element without a Channel Entry field and a TWT element configured as a TWT response (i.e., TWT Request field set to 0) with a TWT Setup Command field indicating Accept TWT and all other fields of that TWT element set to the same value as the fields of the TWT element carried in the Channel Usage Request frame. In this case, the Timeout Interval Value field of the TIE, if any, in the Channel Usage Response frame includes the same value as that of the Channel Usage Request frame. |

We see that this usage is very highly aligned with the main usage of “unavailability”, *except the actual normative language on the AP just misses the mark*:

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| 11.21.15 Channel usage procedures  (#1024)An AP that successfully sets up (#3150)a peer-to-peer TWT agreement (#3146)after receiving a Channel Usage Request frame with a TWT Elements field from a non-AP STA may indicate the lifetime of the (#3150)peer-to-peer TWT agreement for the corresponding TWT element(s) in the Timeout Interval Value field of the (#3146)TIE that it includes in the Channel Usage Response frame and shall set the corresponding Timeout Interval Type field to 5. **An AP that successfully sets up (#3150)a peer-to-peer TWT agreement (#3156)shall consider the non-AP STA to be in power save mode and doze state at the start of the peer-to-peer TWT SP** and back to its original power management mode (#8073)(i.e., the power management mode it had before entering the peer-to-peer TWT SP) at the end of the peer-to-peer TWT SP unless the AP receives a frame addressed to it from the non-AP STA within the time that overlaps with the peer-to-peer TWT SP(#8074), in which case, for the remaining portion of that peer-to-peer TWT SP, the AP shall consider the power management mode and power state of the non-AP STA based on the information carried in the frame received from the non-AP STA. |

Do we really want two different “unavailability” concepts related to TWT that lead to subtly different requirements? Is there anything wrong with the main definition of “unavailability” that would make it unsuitable for P2P TWT agreements negotiated via the Channel Usage procedure?

The author argues “No” and “No”.

As well, 11mf is establishing a direction for unavailability whereby it is decoupled from Power Mgmt mode and Power State – i.e., a superseding process that occurs for a time then leaves the non-AP STA in its status quo ante.

***Accordingly, the author proposes the following changes (indicated via Word track changes):***

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| 10.23.2.2 EDCA backoff procedure  Each EDCAF shall maintain a MAC variable CW[AC], which shall be initialized to the value of the parameter CWmin[AC], for that EDCAF’s AC.  For the purposes of this subclause, (#159)transmission success or failure of an MPDU is defined as follows:   * After transmitting an MPDU (even if it is carried in an A-MPDU, (11ax)as part of a VHT or S1G MU PPDU, (11ax)or as part of an HE MU PPDU that is sent using TXVECTOR parameter NUM\_USERS > 1) that requires an immediate response:   + The STA shall wait for a timeout interval of duration aSIFSTime + aSlotTime + aRxPHYStartDelay, starting when the MAC receives a PHY-TXEND.confirm primitive. If a (#3038)PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive does not occur during the timeout interval, the transmission of the MPDU has failed.   + If a (#3038)PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive does occur during the timeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to (#4179)receive a response MPDU(#109) that either does not have a TA field or is sent by the recipient of the MPDU requiring a response. (#4179)Anything else, including the reception of any other frame, is defined to be a failure. * The nonfinal (re)transmission of an MPDU that is delivered using the GCR unsolicited retry retransmission policy (10.23.2.12.2 (Unsolicited retry procedure)) is defined to be a failure. * In all other cases, the transmission of the MPDU is considered to be a successful transmission.(#159)   The TXNAV timer is a single timer, shared by the EDCAFs within a STA, that is initialized with the duration from the Duration/ID field in the frame most recently successfully transmitted by the TXOP holder, except for PS-Poll frames. The TXNAV timer begins counting down from the end of the transmission of the PPDU containing that frame. The Reservation Allocation Vector (RAV) timer for a mesh STA that has dot11MCCAActivated true is initialized with the MCCAOP Duration in the MCCAOP Reservation field at the start of an MCCAOP reservation. The RAV timer begins counting down from the start of an MCCAOP reservation (see 10.24.3.9.2 (Access during an MCCAOP by mesh STAs that are not the MCCAOP owner)).  The backoff procedure shall be invoked by an EDCAF (11ax)if any of the following events occurs:  a) An MA-UNITDATA.request primitive is received that causes an MPDU corresponding to the EDCAF’s AC to be queued for transmission such that all of the following are true:  1) One of the transmit queues associated with that AC has now become nonempty(#2222)  2) Any other transmit queues associated with that AC are empty  3) The backoff counter has a value of 0 for that AC  4) The medium is busy on the primary channel as indicated by any of the following:   * Physical CS * Virtual CS * A nonzero TXNAV timer value * For a mesh STA that has dot11MCCAActivated true, a nonzero RAV timer value   b) For the EDCAF that is the TXOP holder, the transmission of the final PPDU transmitted by the TXOP holder during the TXOP has completed, the final PPDU does not solicit an HE TB PPDU, and the TXNAV timer has expired.(11ax)  c) For the EDCAF that is the TXOP holder, the transmission of an MPDU in the initial PPDU of a TXOP fails, as defined in this subclause, and the initial PPDU does not solicit an HE TB PPDU.(11ax)  d) A transmission attempt by the EDCAF collides internally with another EDCAF of an AC that has higher priority, that is, two or more EDCAFs in the same STA are granted a TXOP at the same time.  e) The transmission of at least one MPDU in the final PPDU transmitted by the TXOP holder during the TXOP for that AC has completed, the PPDU contains an MPDU that solicits an HE TB PPDU and the TXNAV timer has expired.(11ax)  f) The transmission of all MPDUs in the initial PPDU of a TXOP fails, as defined in this subclause, and the PPDU contains an MPDU that solicits an HE TB PPDU.(11ax)  g) If explicitly indicated, such as in 26.17.2.3.3 (Non-AP STA scanning behavior).(11ax)  h) The EDCAF is permitted to initiate a TXOP (see 10.23.2.4 (Obtaining an EDCA TXOP)) but chooses not to.(#3653)  In addition, the backoff procedure may be invoked by an EDCAF if:  i) For the EDCAF that is the TXOP holder, the transmission by the TXOP holder of an MPDU in a non-initial PPDU of a TXOP fails, as defined in this subclause and an MPDU in the non-initial PPDU does not solicit an HE TB PPDU.(11ax)  j) For the EDCAF that is the TXOP holder, the transmission by the TXOP holder of all MPDUs in a non-initial PPDU of a TXOP fails, as defined in this subclause, and the PPDU contains an MPDU that solicits an HE TB PPDU.(11ax)  NOTE 1—If the transmission by the TXOP holder of an MPDU in a non-initial PPDU of a TXOP failed, the STA can perform either a PIFS recovery, as described in 10.23.2.8 (Multiple frame exchange sequences in an EDCA TXOP(#109)), perform a backoff as described in item i) (#1107)above, or wait for the TXNAV timer to expire and invoke the backoff procedure per item b) above. How it chooses among these options is implementation dependent.  A STA that performs a backoff within its existing TXOP per item i) (#1108)above shall not extend the TXNAV timer value (see 10.23.2.8 (Multiple frame exchange sequences in an EDCA TXOP(#109))).  NOTE 2—In other words, the backoff is a continuation of the TXOP, not the start of a new TXOP.  If the backoff procedure is invoked for (M133)reason a), g) or h) above, CW[AC] and QSRC[AC] shall be left unchanged.(#3653)  If the backoff procedure is invoked for (M133)reason b) or e)(11ax) above, CW[AC] shall be set to CWmin[AC], and QSRC[AC] shall be set to 0.(#3653)  If the backoff procedure is invoked for reason c), f), i), or j) above and the failure is due to the signaled unavailability of the recipient, CW[AC] and QSRC[AC] should be left unchanged if permitted by regulatory rules. Otherwise, if the backoff procedure is invoked for (M133)reason c), d), f), i), or j)(11ax) above, CW[AC] and QSRC[AC] shall be updated as follows:(#3653)   * If QSRC[AC] is less than dot11ShortRetryLimit,   + QSRC[AC] shall be incremented by 1.   + CW[AC] shall be set to the lesser of CWmax[AC] and 2QSRC[AC] × (CWmin[AC] + 1) – 1. * Else   + QSRC[AC] shall be set to 0.   + CW[AC] shall be set to CWmin[AC].   NOTE 3—An HE STA updates its local MIB variables related to CWmin and CWmax as defined in 26.2.7 (EDCA operation using MU EDCA parameters).(11ax) |
| 11.2.1 General  (#101)A non-AP STA can be in one of two power management modes:   * Active mode: The STA is always in the awake state. The STA receives and transmits frames at any time if the STA is not unavailable. * Power save (PS) mode: The STA may switch between power states, to receive or transmit frames while not unavailable or to doze.   A STA in PS mode can be in one of two power states:   * Awake: STA receives and transmits frames at any time that the STA is not unavailable and is fully powered. * Doze: STA is not able to transmit or receive (11ba)non-WUR PPDUs and consumes very low power.   A STA that is unavailable is not capable of receiving PPDUs. A non-HE STA is never unavailable. A STA is permitted to be unavailable in the circumstances described in 11.21.15 (Channel usage procedures), 26.8.4.4 (TWT Information frame exchange for flexible wake time), 26.14.1 (Intra-PPDU power save for non-AP HE STAs) and 26.14.3 (Opportunistic power save). |
| 11.2.3.6 AP operation  An AP shall maintain for each currently associated STA a Power Management status that indicates in which power management mode the STA is currently operating. APs that implement and signal their support of APSD shall maintain for each currently associated STA an APSD and an access policy status that indicates whether the STA is presently using APSD and shall maintain the schedule (if any) for the STA. An AP shall, depending on the power management mode of the STA, temporarily buffer BUs destined to the STA. An AP implementing APSD shall, if a STA is using APSD and is in PS mode, temporarily buffer BUs destined to that STA. No BUs addressed directly to STAs operating in the active mode shall be buffered for power management reasons. An HE AP should not transmit to an HE STA if the STA might be unavailable (see 11.2.1 (General)).  An AP that transmits PPDUs containing frames addressed to a STA while the STA is unavailable should not take into account the failed transmission of the frames contained in the PPDUs for the AP’s rate selection algorithm. As defined in 10.23.2.2 (EDCA backoff procedure), it is encouraged that the EDCA function for the AC used to transmit these frames does not take their failure into account, unless required by regulatory rules. |
| 11.2.3.7 Receive operation for STAs in PS mode  A STA that is in PS mode and is not unavailable shall operate as follows to receive a BU from the AP:  ***<bulleted list>***  ***TGmf editor: After the final bullet of the bulleted list, please insert***  These requirements for a STA in PS mode do not apply while the STA is unavailable. |
| 11.2.3.9 STAs operating in the active mode  A STA operating in active mode shall have its receiver activated continuously, (11ax)unless the STA is unavailable (see 11.2.1 (General)). A STA that is operating in active mode does not need to interpret the TIM elements in Beacon frames. |
| 11.21.15 Channel usage procedures   * (#1024)An AP that successfully sets up (#3150)a peer-to-peer TWT agreement (#3146)after receiving a Channel Usage Request frame with a TWT Elements field from a non-AP STA may indicate the lifetime of the (#3150)peer-to-peer TWT agreement for the corresponding TWT element(s) in the Timeout Interval Value field of the (#3146)TIE that it includes in the Channel Usage Response frame and shall set the corresponding Timeout Interval Type field to 5. An AP that successfully sets up (#3150)a peer-to-peer TWT agreement (#3156)shall consider the non-AP STA to be unavailable from the start of the peer-to-peer TWT SP and until the end of the peer-to-peer TWT SP, unless, if the AP receives a frame addressed to it from the non-AP STA within the time that overlaps with the peer-to-peer TWT SP(#8074), then the AP shall consider the peer-to-peer TWT SP and the unavailability to have ended and shall consider the power management mode and power state of the non-AP STA to be determined based on the information carried in the frame received from the non-AP STA. |
| 26.8.4.4 TWT Information frame exchange for flexible wake time  A non-AP HE STA that transmits a TWT Information frame with flexible TWT to a peer STA   * May go to doze state after receiving the acknowledgment sent in response to the TWT Information frame if it is in PS mode (i.e., the PM subfield of the Frame Control field of the TWT Information frame is 1). * May be unavailable after receiving the acknowledgment sent in response to the TWT Information frame if it is in active mode (i.e., the PM subfield of the Frame Control field of the TWT Information frame is 0). * Shall be in the awake state at the time indicated in the Next TWT subfield of the TWT Information frame.(#1201) * Shall, at the time indicated in the Next TWT subfield of the TWT Information frame, be in PS mode if the PM subfield of the TWT Information frame was 1 and in active mode if the PM subfield of the TWT Information frame was 0.   A non-AP HE STA that receives a TWT Information frame with flexible TWT from a peer STA   * May go to doze state after transmitting the acknowledgment if it is in PS mode. * May be unavailable after transmitting the acknowledgment if it is in active mode. * Shall be in the awake state at the time the peer STA indicated in the Next TWT subfield of the TWT Information frame. * At the time indicated in the Next TWT subfield of the TWT Information frame, shall be in PS mode if the STA was in PS mode when it received the TWT Information frame and in active mode if the STA was in active mode when it received the TWT Information frame. |
| 26.8.4.4 TWT Information frame exchange for flexible wake time  A non-AP HE STA that transmits a TWT Information frame with flexible TWT to a peer STA   * May become unavailable after receiving the acknowledgment sent in response to the TWT Information frame. * Shall be in the awake state at the time indicated in the Next TWT subfield of the TWT Information frame.(#1201) * At the time indicated in the Next TWT subfield of the TWT Information frame, shall be in PS mode if the PM subfield of the TWT Information frame was 1 and in active mode if the PM subfield of the TWT Information frame was 0.   A non-AP HE STA that receives a TWT Information frame with flexible TWT from a peer STA   * May become unavailable after transmitting the acknowledgment. * Shall be in the awake state at the time the peer STA indicated in the Next TWT subfield of the TWT Information frame. * At the time indicated in the Next TWT subfield of the TWT Information frame, shall be in PS mode if the STA was in PS mode when it received the TWT Information frame and in active mode if the STA was in active mode when it received the TWT Information frame.   The STA, once in the awake state, shall follow the rules that correspond to the power management mode of the STA, which are defined in 11.2.3 (Power management in a non-DMG infrastructure network) for the active and PS modes and in 26.8 (TWT operation) when the STA operates within TWT SPs. |
| 26.14.1 Intra-PPDU power save for non-AP HE STAs  Intra-PPDU power save is the power save mechanism for an HE STA to become unavailable until the end of a received PPDU that is identified as an intra-BSS PPDU.  A non-AP HE STA that has dot11IntraPPDUPowerSaveOptionActivated equal to true operates in intra-PPDU power save mode.  A non-AP HE STA that is in intra-PPDU power save mode may become unavailable until the end of a PPDU currently being received if one of the following conditions is met:  …  A non-AP HE STA that is in intra-PPDU power save mode and has become unavailable shall continue to operate its NAV timers and to consider the medium busy until the end of the PPDU.  A non-AP HE STA that is in intra-PPDU power save mode may discard a PPDU identified as an inter-BSS PPDU as defined in 26.2.2 (Intra-BSS and inter-BSS PPDU classification) until the end of the PPDU.  NOTE—The STA can contend for access to the medium immediately on the expiry of the NAV timers. |
| 26.14.3 Opportunistic power save  26.14.3.1 General  An OPS non-AP STA is a non-AP HE STA that sets the OPS Support subfield in the HE MAC Capabilities Information field in the HE Capabilities element to 1.  An OPS AP is an AP HE STA that sets the OPS Support subfield in the HE MAC Capabilities Information field in HE Capabilities element to 1.  The objective of the opportunistic power save mechanism is to allow OPS non-AP STAs to be unavailable so that they can save power for a defined period.  The opportunistic power save mechanism has two modes: aperiodic and periodic.  In the aperiodic mode, an OPS AP sends an OPS frame or a FILS Discovery frame at any time to provide the scheduling information for all OPS non-AP STAs for the OPS period that follows the transmission of the OPS frame or FILS Discovery frame. Based on this information, OPS non-AP STAs may be unavailable during the OPS period.  In the periodic mode, an OPS AP splits a beacon interval into several periodic broadcast TWT SPs and provides, at the beginning of each SP, the scheduling information for all OPS non-AP STAs. Based on this information, OPS non-AP STAs may be unavailable until the next TWT SP.  26.14.3.3 STA operation for opportunistic power save  With aperiodic opportunistic power save, if an OPS non-AP STA with AID N that is in the awake state receives a TIM element and an OPS element in an OPS frame or a FILS Discovery frame from the associated OPS AP, then the STA may be unavailable until the end of the OPS period indicated in the OPS element, if the bit N in the traffic indication virtual bitmap carried in the Partial Virtual Bitmap field of the current TIM element is 0, unless other conditions not related to operation with the OPS AP require the STA to be in the awake state. At the end of the OPS period, the STA shall be in the awake state, unless determined otherwise by other power save protocols.  With periodic opportunistic power save, if an OPS non-AP STA with AID N that is in the awake state receives from the associated OPS AP a TIM element with bit N of the traffic indication virtual bitmap field equal to 0 in a TIM frame or FILS Discovery frame within a broadcast TWT SP with the Broadcast TWT Recommendation field set to 3, then the STA may be unavailable during the TWT SP and until the next TWT SP with the Broadcast TWT Recommendation field set to 3, unless other conditions not related to operation with the OPS AP require the STA to be in the awake state.  An OPS non-AP STA shall not operate with TIM broadcast procedure if its associated AP is an OPS AP. |