IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| CR for Medium Sync Recovery related CIDs | | | | |
| Date: 2022-07-25 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Dibakar Das | Intel |  |  | dibakar.das@intel.com |
| Dmitry Akhmetov |  |  |  |  |
| Laurent Cariou |  |  |  |  |
|  |  |  |  |  |

Abstract

This submission addressed the following CIDs relative to 11be draft 2.1:

13867 10049 10133 10422 10850 11137 11251 11451 11580 11614 12668 12669 13059 13401 13404 13402 13403 10256 10356 10360 10862 10851 11139 11452 11581 12670 13003 13405 13934 13935 13936 13937 14092 12744

Revisions:

R0: initial version

R2: Following offline discussion updates to resolutions for deferred CIDs: 11581, 11452, 13402, 13404.

| **CID** | **Page** | **Section** | **Comment** | **Proposed Change** | **Resolution** |
| --- | --- | --- | --- | --- | --- |
| 13867 | 459.58 | 35.3.16.8 | It seems that the name of field Â¡Â°Medium Synchronization Information fieldÂ¡+/- should be fixed. | Â¡Â°Medium Synchronization Information fieldÂ¡+/- should be modified to Â¡Â°Medium Synchronization Delay Information fieldÂ¡+/-. | **Accepted.** |
| 10049 | 459.58 | 35.3.16.8.1 | Please fix this "Medium Synchronization Information field" to "Medium Synchronization Delay Information subfield". | as in comment | **Accepted.** |
| 10133 | 459.32 | 35.3.16.8.1 | "Mbps" is not conforming to ANSI standards. | change to "Mbit/s" | **Revised.**  Changed to Mb/s.  **TGbe editor:** Apply the changes tagged with #10133 in this document |
| 10422 | 460.02 | 35.3.16.8.1 | It is not invloved in the text when MediumSyncDelay timer does not expire .Will the MediumSyncDelay timer be suspended when MediumSyncDelay OFDM ED based recovery procedure operates successfully?  Please clarify it with more details | as the comment | **Revised.**  The conditions in which the timer expires is described in the previous paragraph. We clarify it a bit more in the revised text.  **TGbe editor:** Apply the changes tagged with #10422 in this document |
| 10850 | 459.19 | 35.3.16.8.1 | Is the reference related to the definition for medium synchronication or nonsimultaneous transmit and receive (NSTR) link pair? If the case is for the former one, there is no definition on in 3.2 (Definitions specific to IEEE 802.11) so need to add the missing part according to the indicated reference. If it infers to NSTR link pair, which is already defined, no further text is required. | As in comment | **Revised.**  The definition is for the latter. We remove the reference as suggested.  **TGbe editor:** Apply the changes tagged with #10850 in this document |
| 11137 | 459.46 | 35.3.16.8.1 | Unclear antecedent for "it" and curious "any" in "A STA shall not start any MediumSyncDelay timer unless it is one of the following:" | Try "A STA shall not start a MediumSyncDelay timer unless the STA is one of the following:" | **Accepted.** |
| 11251 | 459.25 | 35.3.16.8.1 | What happens after the MediumSyncDelay timer expires? What action does the STA perform? | The spec needs to define the action that the STA performs after it recovers from loss of medium synchronization | **Reject.**  The spec only needs to define the behavior associated with the STA when the timer is running. When the timer has expired, it is implicit that the STA will follow behavior already defined in this or other sections regarding channel access. |
| 11451 | 459.32 | 35.3.16.8.1 | Replace 'non-HT duplicated PPDU' with 'non-HT duplicate PPDU' | As in comment | **Accepted.** |
| 11580 | 459.27 | 35.3.16.8.1 | "may not" is ambiguous and should be replaced according to the style guide. | as in comment | **Revised.**  Replaced “may not” with “may choose not to”.  **TGbe editor:** Apply the changes tagged with #11580 in this document |
| 11614 | 459.24 | 35.3.16.8.1 | How does a STA know it has lost medium synchronization? Based on the paragraph in line 18 page 459, the "lost medium synchronization" is based on whether or not the STA ends its transmission at the same time as the transmission of the other STA in the same NSTR link pair. Does it mean the STAs in a NSTR link pair are required to detect the transmission end time of other STA in the same NSTR link pair? | Please clarify how a STA know it has lost medium synchronization. | **Reject.**  The definition seems to be already clear enough. With respect to the commenter’s specific second question, it indeed means that the STAs in the same link pair detect the transmission end time for each other. |
| 12668 | 459.21 | 35.3.16.8.1 | Need to clarify how the non-AP STA affiliated with non-AP MLD and is operating on a NSTR link pair will know if it has lost medium synchronization? Since the lost of medium synchronization is defined for the NSTR case as "when the other STA, which is affiliated with the same MLD and operates on that link pair, transmits a  PPDU, except when both STAs ended a transmission at the same time" - please clarify how the non-AP STA which is working on specific link will know whether the transmission occurs on the other link (of the NSTR link pair) has completed at the same time as its transmission or not?! | Need to add details how the non-AP STA which is working on specific link will know whether the transmission occurs on the other link (of the NSTR link pair) has completed at the same time as its transmission or not | **Reject.**  A STA that is part of an NSTR link pair needs to be able to track the events at the other STA of the pair for PPDu alignment. For example, see 35.3.16.6:  “A STA of an MLD operating on a link that is part of an NSTR link pair for that MLD shall follow the  channel access procedure described below:  1) The STA may initiate transmission on a link when the medium is idle as indicated by the  physical and virtual CS mechanism and one of the following conditions is met:  a) The STA obtained an EDCA TXOP following the procedure in 10.23.2.4 (Obtaining an  EDCA TXOP).  b) The backoff counter of the STA is already zero, and the STA operating on the other link of  NSTR link pair of the affiliated MLD obtains an EDCA TXOP following the procedure in  10.23.2.4 (Obtaining an EDCA TXOP)…”  As such no additional details need to be added. |
| 12669 | 459.54 | 35.3.16.8.1 | It is not clear whether the non-AP STA affiliated with non-AP MLD which is operating on a NSTR link pair and has set the MediumSyncDelay timer to a nonzero value is allowed to transmit. Can you clarify this point? | Add a sentence that will clarify whether the non-AP STA affiliated with non-AP MLD which is operating on a NSTR link pair and has set the MediumSyncDelay timer to a nonzero value is allowed to transmit and in which conditions. | **Reject.**  This is already clarified in the next subsection:  “If a STA is capable of obtaining a TXOP while the MediumSyncDelay timer has a nonzero value, it shall  perform the following when the timer has a nonzero value:  — If it is a non-AP STA, it shall transmit an RTS frame to its associated AP as the initial frame an  obtained TXOP.  — If it is an AP, it shall transmit an RTS frame to an associated non-AP STA as the initial frame in an  obtained TXOP following the NSTR mobile AP multi-link operation defined in 35.3.19 (NSTR  mobile AP MLD operation).  — Shall not attempt to initiate more than MSD\_TXOP\_MAX TXOPs since the start of the timer.  Otherwise, it shall perform CCA until the MediumSyncDelay timer has expired before it initiates a  transmission.” |
| 13059 | 459.18 | 35.3.16.8.1 | In my opinion, an additional exclusion rule is needed: If the TX PPDU duration in one link is less than the time remaining in the received PPDU on the other link as indicated by the RX PPDU SIG field, then the STA in the other link does not lose medium synchronization; in essence, as long as the STA is able to decode a Rx PPDU in the other link, the STA should not be considered to have lost medium synchronization.  "A STA affiliated with a non-AP MLD that belongs to a NSTR link pair is considered to have lost medium synchronization (due to UL interference) when the other STA, which is affiliated with the same MLD and belongs to that link pair, transmits a PPDU, except under the following condition:  --Both STAs ended a transmission at the same time. | Please include the exclusion scenario mentioned in the comment | **Reject.**  The exception case for short Tx PPDU duration is already captured in the aMediumSyncThreshold field. The proposed comment would add complexity and does not consider the case that the STA might miss any other PPDU on link 1 during its TX time on link 2. |
| 13401 | 459.62 | 35.3.16.8.1 | Some frame may not include Duration field. When such frame is received, is MediumSyncDelay timer reset to 0? | Clarify the text per the comment. | **Reject.**  The intended behavior is indeed to reset the timer on any valid MPDU (e.g., PS-Poll) which is also captured in the current text. |
| 13404 | 459.57 | 35.3.16.8.1 | It seems this sentence assumes that Medium Synchronization Delay Information in a link applies to the link only. It should not be the case since the Medium Synchronization Delay Information is in Common Info of ML element. | Fix the issues mentioned in the comment | **Revised.**  The Medium Synchronization Delay Information applies equally for all links in the MLD. We clarify this later in this section.  **TGbe editor:** Apply the changes tagged with #13402 in this document |
| 13402 | 460.35 | 35.3.16.8.2 | The spec should be clear about whether different APs of an AP MLD can give different Medium Synchronization Delay Information. It seeems the informaiton should be same for all the links of an AP MLD. However since the informaiton is for the backoff procedure of each link, it is reasonable that different links have different values. Probably it is better to move this to EHT Operation element as optional field. | Fix the issues mentioned in the comment | **Revised.**  We modified the text to clarify that the Medium Synchronization Delay Information is same for all STAs affiliated with an MLD.  **TGbe editor:** Apply the changes tagged with #13402 in this document |
| 13403 | 460.43 | 35.3.16.8.2 | It seems this sentence assumes that Medium Synchronization Delay Information in a link applies to the link only. It should not be the case since the Medium Synchronization Delay Information is in Common Info of ML element. | Fix the issues mentioned in the comment | **Revised.**  Changed the wording to clarify this.  **TGbe editor:** Apply the changes tagged with #13403 in this document |
| 10256 | 460.19 | 35.3.16.8.2 | Missing word "in" | Revise to "...as the initial frame in an obtained TXOP." | **Accepted.** |
| 10356 | 460.26 | 35.3.16.8.2 | "... more than MSD\_TXOP\_MAX TXOPs ..."  MSD\_TXOP\_MAX is deleted from the spec. | Change it to "... more than the maximum number of TXOPs that is specified by the Medium Synchronization Maximum Number Of TXOPs subfield in the Multi-Link element ..." | **Revised.**  Change it to refer directly to the “dot11MSDTXOPMAX” parameter.  **TGbe editor:** Apply the changes tagged with #10356 in this document |
| 10360 | 460.20 | 35.3.16.8.2 | "If it is a non-AP STA, it shall transmit an RTS frame to its associated AP as the initial frame an obtained TXOP."  It should be something like "If it is a non-AP STA, it shall transmit an RTS frame to its associated AP as the initial frame in an obtained TXOP." | As in comment. | **Accept.** |
| 10862 | 460.20 | 35.3.16.8.2 | "as the initial frame an obtained TXOP" should be "as the initial frame in an obtained TXOP" | as in comment | **Accept.** |
| 10851 | 460.44 | 35.3.16.8.2 | The field names might be confusing if they are called together, so the Medium Synchronization Maximum Number Of TXOPs and Medium Synchronization OFDM ED Threshold subfields should be Medium Synchronization Maximum Number Of TXOPs subfield and Medium Synchronization OFDM ED Threshold subfield. | As in comment | **Revised.**  Made corresponding change.  **TGbe editor:** Apply the changes tagged with #10851 in this document |
| 11139 | 460.50 | 35.3.16.8.2 | "the non-AP STA does not initiate any TXOP and follow the same rules" reads like "and follow" shold be read as "and does not follow" which seems unlikely, or the sentence is ungrammatical | Try "NOTE--If either the intra-BSS NAV or the Basic NAV is nonzero in the non-AP STA affiliated with the non-AP MLD when it starts the MediumSyncDelay timer, the non-AP STA does not initiate any TXOP and follows the same rules as an HE STA to respond to any RTS or MU-RTS frame until both NAVs expire." | **Accept.** |
| 11452 | 460.35 | 35.3.16.8.2 | As per 35.3.4.4, Beacons and Probe Response frames do not carry the Medium Synchronization Delay Information subfield. Update the text accordingly. | Replace the text with 'An AP affiliated with an MLD may include the Medium Synchronization Delay Information field in a Basic Multi-Link element carried in a (Re)Association Response frame.' | **Revised.**  Clarified that the field is only present in Association Response and ML Probe Response frames.  **TGbe editor:** Apply the changes tagged with #11452 in this document |
| 11581 | 460.42 | 35.3.16.8.2 | default value setting should not be mandated. | change to "the default values for dot11MSDOFDMEDthreshold is -72 dBM and default value for dot11MSTXOPMAX is 1" | **Revised.**  Made changes along the lines suggested by commenter.  **TGbe editor:** Apply the changes tagged with #11581 in this document |
| 12670 | 460.26 | 35.3.16.8.2 | Please add a note that the value of MSD\_TXOP\_MAX TXOPs in the sentence in P460L26 is defined by the dot11MSDTXOPMAX (detailed in P460L42) | As in comment | **Revised.**  Change it to refer directly to the “dot11MSDTXOPMAX” parameter.  **TGbe editor:** Apply the changes tagged with #12670 in this document |
| 13003 | 460.17 | 35.3.16.8.2 | Is the STA capable of obtaining a TXOP or the STA intends to? To me, it's "intends to". | Change to "If a STA intends to obtain a TXOP ..." | **Reject.**  **T**he commenter is right that in typical implementations, this behavior is dependent on intention of a STA. However, during previous round of discussions on this wording, it was observed that “capable of obtaining..” covers the use-case of some implementations which are not even capable of doing EDCA while the timer is running. |
| 13405 | 460.48 | 35.3.16.8.2 | It doesn't make sense to set MediumSyncDelay timer if the the value in MediumSyncDelay timer is smaller than NAV timer value. | Update the MediumSyncDelay timer setting rule. | **Reject.**  If the Medium Sync Delay timer is lower than remaining NAV timer value, the channel access behavior of the STA does not change since its prevented from using EDCA while the NAV timer is running. As such no additional text is needed. |
| 13934 | 460.11 | 35.3.16.8.2 | please add mib variable to indicate whether the STA is able to obtain a TXOP during blindness period or not | add mib variable for this STA | **Revised.**  Added corresponding Mib variable.  **TGbe editor:** Apply the changes tagged with #13934 in this document. |
| 13935 | 460.22 | 35.3.16.8.2 | This AP should be affiliated with mobile AP MLD, not regular AP MLD. Please clarify it | clarify this AP is affiliated with mobile AP MLD | **Revised.**  It is somewhat clarified in an earlier text that only AP affiliated with NSTR Mobile AP MLD can lose medium sync. However, added additional clarification.  **TGbe editor:** Apply the changes tagged with #13935 in this document |
| 13936 | 460.36 | 35.3.16.8.2 | this paragraph should be moved to usage of ML element for ML discovery | move this paragraph to another subclause | **Revised.**  Removed the second sentence since it’s a duplicate of an existing text in clause 9:  **“**The Medium Synchronization Delay Information subfield in the Common Info subfield is not present if the Basic Multi-Link element is sent by a non-AP STA.”.    **TGbe editor:** Apply the changes tagged with #13936 in this document |
| 13937 | 460.52 | 35.3.16.8.2 | what is time period for aCCAtime, this sentence is not clear, please clarify it. | please clarify the period of aCCAtime | **Reject.**  The definition of aCCATime is in REVme and also indirectly referred inside the reference with the sentence in question. |
| 14092 | 460.08 | 35.3.16.8.2 | When a STA of a non-AP MLD operating in EMLSR mode initiates the frame exchanges with an AP affiliated with an AP MLD on one of the EMLSR links, the other STAs affiliated with the same non-AP MLD on the EMLSR links are blind. This is similar to the blindness problem of the NSTR non-AP MLD operation. | The medium access recovery rules for a non-AP MLD operating in EMLSR mode need to be further clarified. | **Reject.**  The recovery rules for EMLSR is already described in the spec and the commenter failed to raise any specific issues with the current rules. |
| 12744 | 460.22 | 35.3.16.8.2 | If an AP affiliated with an NSTR mobile AP MLD that has a nonzero MediumSyncDelay timer is operating in the non-primary link the AP cannot directly transmit an RTS frame as an initial frame of an obtained TXOP if the other AP affiliated with the same MLD in the primary link has not gained a TXOP for transmission. | The rule of transmiting an RTS frame as an initial frame of an obtained TXOP for an AP affiliated with an NSTR mobile AP MLD that has a nonzero MediumSyncDelay timer needs to be clarified. | **Reject.**  The commenter failed to identify any specific issue with the current approach. The scenario described in the comment follows from general channel access rules of NSTR Mobile AP MLD. |

***TGbe editor: revise the following paragraph in P422L62 of 11be draft 2.1 as follows*:**

The Common Info field of the Basic Multi-Link element carried in the Beacon frame or Probe Response  
frame, which is not a Multi-Link probe response, shall include MLD MAC address, the Link ID Info, the  
BSS Parameters Change Count, and the MLD Capabilities and Operations subfields, and may include the  
EML Capabilities subfield as defined in 35.3.18 (Enhanced multi-link multi-radio operation).The Common Info field of a Basic Multi-Link element carried in the Beacon frame or Probe Response frame, which is not a Multi-Link probe response, shall not include the Medium Synchronization Delay Information subfield (##11452).

***TGbe editor: revise the following clause as follows*:**

**35.3.16.8 Medium access recovery procedure**

**35.3.16.8.1 General**

A STA affiliated with a non-AP MLD or an NSTR mobile AP MLD that operates on an NSTR link pair (#10850) is  
considered to have lost medium synchronization   
when the other STA, which is affiliated with the same MLD and operates on that link pair, transmits a  
PPDU, except when both STAs ended a transmission at the same time.

A STA that has lost medium synchronization as described above shall start a MediumSyncDelay timer and begin counting down from (#10422) the  
end of that transmission if that transmission is longer than aMediumSyncThreshold unless its previous  
MediumSyncDelay timer has not expired. The STA may choose not to (#11580) (re)start the MediumSyncDelay timer if the  
transmission event is shorter than or equal to aMediumSyncThreshold. The aMediumSyncThreshold is set  
to 72 µs.  
NOTE 1—The value of 72 µs is chosen to cover at least the PPDU lengths of RTS/CTS/ACK frames using non-HT or  
non-HT duplicated PPDU format with 6 Mb/s(#10133) data rate, as well as the PPDU lengths of most typical BlockAck frames.

When a non-AP MLD is operating in the EMLSR mode, a STA affiliated with a non-AP MLD that is  
operating on one of the EMLSR links is considered to have lost medium synchronization if it is not able to  
perform CCA during frame exchanges that includes the link switch delays between an AP affiliated with an  
AP MLD and one of the other STAs operating on the other EMLSR links, which are affiliated with the same  
non-AP MLD. The STA that has lost medium synchronization shall start a MediumSyncDelay timer and begin counting down (#10422)  
immediately after returning to the listening operation if the duration of the loss of medium synchronization  
is longer than aMediumSyncThreshold; otherwise, the STA may not start the MediumSyncDelay timer.

NOTE 2—The link switch delays include the delay switching from the listening operation to the frame exchanges and  
the delay switching from the frame exchanges to the listening operation.

A STA shall not start any MediumSyncDelay timer unless it is one of the following:  
— a non-AP STA affiliated with a non-AP MLD operating on an NSTR link pair or  
— a non-AP STA affiliated with a non-AP MLD operating on an EMLSR link or  
— an AP affiliated with an NSTR mobile AP MLD operating on the nonprimary link of an NSTR link  
pair.

The MediumSyncDelay timer is a single timer, shared by all EDCAFs within a STA, whose value is set to  
dot11MSDTimerDuration. The STA initializes dot11MSDTimerDuration to aPPDUMaxTime defined in  
Table 36-70 (EHT PHY characteristics). A non-AP STA shall update dot11MSDTimerDuration with the  
value contained in the Medium Synchronization Information field, if present, of the Basic Multi-Link  
element in the most recent frame received from its associated AP. In addition, the timer resets to zero when  
any of the following events occur:  
— The STA receives a PPDU with a valid MPDU.  
— The STA receives a PPDU whose corresponding RXVECTOR parameter TXOP\_DURATION is not  
UNSPECIFIED.

If a STA that operates on a NSTR link pair has lost medium synchronization, due to transmission by another  
STA that is affiliated with the same MLD and operates on that link pair, and its previous MediumSyncDelay  
timer has not expired, then at the end of that transmission it shall continue the previous MediumSyncDelay  
timer except that the STA shall update the timer value as described above if that transmission is longer than  
aMediumSyncThreshold.

**35.3.16.8.2 MediumSyncDelay OFDM ED based recovery procedure**

A STA that is capable of obtaining a TXOP while the MediumSyncDelay timer has a nonzero value shall use  
dot11MSDOFDMEDthreshold instead of dot11OFDMEDThreshold as specified in 36.3.20.6.3 (CCA  
sensitivity for the primary 20 MHz channel(#11304)) in order to detect a channel busy condition in the  
primary 20 MHz channel if the MediumSyncDelay timer has a nonzero value.

If a STA is capable of obtaining a TXOP while the MediumSyncDelay timer has a nonzero value, it shall  
perform the following when the timer has a nonzero value:  
— If it is a non-AP STA, it shall transmit an RTS frame to its associated AP as the initial frame an  
obtained TXOP.  
— If it is an AP affiliated with an NSTR mobile AP MLD (#13935) then the AP shall transmit an RTS frame to an associated non-AP STA as the initial frame in an  
obtained TXOP and follow the rules defined in 35.3.19 (NSTR  
mobile AP MLD operation).  
— Shall not attempt to initiate more than dot11MSDTXOPMAX (#10356, 12670) TXOPs since the start of the timer.  
Otherwise, it shall perform CCA until the MediumSyncDelay timer has expired before it initiates a  
transmission.

A STA that has a nonzero MediumSyncDelay timer shall not transmit any PPDU using OBSS PD-based  
spatial reuse operation.

An AP affiliated with an AP MLD may include the Medium Synchronization Delay Information subfield in the Common Info field of the Basic Multi-Link element carried in transmitted (Re-)Association Response, or Multi-Link(#11452) Probe Response frames to provide medium synchronization information used by the AP MLD (#13402). (#13936)

The default value of dot11MSDOFDMEDthreshold is –72 dBm and the default value of dot11MSDTXOPMAX is 1, respectively(#11581). Each (#13403) non-AP STA affiliated with a non-AP MLD shall set dot11MSDTXOPMAX and dot11MSDOFDMEDthreshold to the most recent values carried in the Medium Synchronization Maximum Number Of TXOPs subfield (#10851) and Medium Synchronization OFDM ED Threshold subfield, respectively, if they are present in the Common Info field of the Basic Multi-Link element received by any non-AP STA affiliated with the same non-AP MLD from its associated AP affiliated with the AP MLD with which the non-AP MLD has performed ML setup(#13402).

NOTE—If either the intra-BSS NAV or the Basic NAV is nonzero in the non-AP STA affiliated with the non-AP MLD  
when it starts the MediumSyncDelay timer, the non-AP STA does not initiate any TXOP and follows the same rules as an  
HE STA to respond to any RTS or MU-RTS frame until both NAVs expire.

During the aCCAtime (see 36.3.20.6.3 (CCA sensitivity for the primary 20 MHz channel(#11304)))  
immediately following the end of the transmission event that caused loss of medium synchronization and  
subsequent initiation of the MediumSyncDelay timer at the non-AP STA, if the received signal strength  
exceeds the –62 dBm threshold for the primary 20 MHz channel and no start of a PPDU is detected, the STA  
should defer for EIFS beginning when the received signal strength falls below the threshold.

***TGbe editor: revise the following sentence in P434L12 of 11be draft 2.1 as follows*:**

The Common info field of the Basic Multi-Link element carried in the (Re)Association Response frame  
shall include the MLD MAC address, the MLD Capabilities and Operations, the EML Capabilities, the Link  
ID Info, and the BSS Parameters Change Count subfields and may include the Medium Synchronization Delay Information subfield (#11452).

***TGbe editor: insert the following entry to the dot11StationConfig TABLE in P891L51 of 11be draft 2.2:***

Dot11StationConfigEntry ::= SEQUENCE

{

dot11MSDTXOPInitImplemented TruthValue(#13934),

}

***TGbe editor: insert the following entry to the dot11StationConfig TABLE in P871L9 of 11be draft 2.2:***

(#13934) dot11MSDTXOPInitImplemented OBJECT-TYPE  
SYNTAX TruthValue  
MAX-ACCESS read-only  
STATUS current  
DESCRIPTION  
"This is a capability variable.  
Its value is determined by device capabilities.  
This attribute, when true, indicates the ability of the EHT STA to obtain a TXOP when the MediumSyncDelay timer of the MAC has nonzero value."  
::= { dot11StationConfigEntry <Last assigned + 1> }