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TECHNICAL SPECIFICATION

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**5G;**
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# Contents

# Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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# 1 Scope

The present document specifies and establishes the characteristics of the physical layer procedures for shared spectrum channel.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception".

[3] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".

[4] 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures".

[5] 3GPP TS 36.212: "Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding".

[6] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception".

[7] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[8] 3GPP TS 38.214: "NR; Physical layer procedures for data".

[9] 3GPP TS 38.300: "NR; NR and NG-RAN Overall Description; Stage 2".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

$CW_p$ Contention window for a given priority class

$CW_{\max,p}$ Maximum contention window for a given priority class

$CW_{\min,p}$ Minimum contention window for a given priority class

$T_{m\cot,p}$ Maximum channel occupancy time for a given priority class

| | |
|---|---|
| $T_{ulm\mathrm{cot},p}$ | Maximum Uplink channel occupancy time for a given priority class |
| $X_{\mathrm{Thresh}}$ | Energy detection threshold |
| $X_{\mathrm{Thresh\_max}}$ | Maximum energy detection threshold |

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

| | |
|---|---|
| AUL-DFI | Autonomous UL Downlink feedback indication |
| CAPC | Channel access priority class |
| COT | Channel Occupancy Time |
| LAA | Licensed Assisted Access |
| MCOT | Maximum Channel Occupancy Time |

# 4 Channel access procedure

## 4.0 General

Unless otherwise noted, the definitions below are applicable for the following terminologies used in this specification:

- A channel refers to a carrier or a part of a carrier consisting of a contiguous set of resource blocks (RBs) on which a channel access procedure is performed in shared spectrum.

- A channel access procedure is a procedure based on sensing that evaluates the availability of a channel for performing transmissions. The basic unit for sensing is a sensing slot with a duration $T_{sl} = 9\mu s$. The sensing slot duration $T_{sl}$ is considered to be idle if an eNB/gNB or a UE senses the channel during the sensing slot duration, and determines that the detected power for at least $4\mu s$ within the sensing slot duration is less than energy detection threshold $X_{\mathrm{Thresh}}$. Otherwise, the sensing slot duration $T_{sl}$ is considered to be busy.

- A *channel occupancy* refers to transmission(s) on channel(s) by eNB/gNB/UE(s) after performing the corresponding channel access procedures in this clause.

- A *Channel Occupancy Time* refers to the total time for which eNB/gNB/UE and any eNB/gNB/UE(s) sharing the channel occupancy perform transmission(s) on a channel after an eNB/gNB/UE performs the corresponding channel access procedures described in this clause. For determining a *Channel Occupancy Time*, if a transmission gap is less than or equal to $25\mu s$, the gap duration is counted in the channel occupancy time. A channel occupancy time can be shared for transmission between an eNB/gNB and the corresponding UE(s).

- A *DL transmission burst* is defined as a set of transmissions from an eNB/gNB without any gaps greater than $16\mu s$. Transmissions from an eNB/gNB separated by a gap of more than $16\mu s$ are considered as separate DL transmission bursts. An eNB/gNB can transmit transmission(s) after a gap within a *DL transmission burst* without sensing the corresponding channel(s) for availability.

- A *UL transmission burst* is defined as a set of transmissions from a UE without any gaps greater than $16\mu s$. Transmissions from a UE separated by a gap of more than $16\mu s$ are considered as separate UL transmission bursts. A UE can transmit transmission(s) after a gap within a *UL transmission burst* without sensing the corresponding channel(s) for availability.

- A *discovery burst* refers to a DL transmission burst including a set of signal(s) and/or channel(s) confined within a window and associated with a duty cycle. The *discovery burst* can be any of the following:

  - Transmission(s) initiated by an eNB that includes a primary synchronization signal (PSS), secondary synchronization signal (SSS) and cell-specific reference signal(s)(CRS) and may include non-zero power CSI reference signals (CSI-RS).

- Transmission(s) initiated by a gNB that includes at least an SS/PBCH block consisting of a primary synchronization signal (PSS), secondary synchronization signal (SSS), physical broadcast channel (PBCH) with associated demodulation reference signal (DM-RS) and may also include CORESET for PDCCH scheduling PDSCH with SIB1, and PDSCH carrying SIB1 and/or non-zero power CSI reference signals (CSI-RS).

# 4.1 Downlink channel access procedures

An eNB operating LAA Scell(s) on channel(s) and a gNB performing transmission(s) on channel(s) shall perform the channel access procedures described in this clause for accessing the channel(s) on which the transmission(s) are performed.

In this clause, $X_{Thresh}$ for sensing is adjusted as described in clause 4.1.5 when applicable.

A gNB performs channel access procedures in this clause unless the higher layer parameter *channelAccessMode-r16* is provided and *channelAccessMode-r16 =' semiStatic'*.

## 4.1.1 Type 1 DL channel access procedures

This clause describes channel access procedures to be performed by an eNB/gNB where the time duration spanned by the sensing slots that are sensed to be idle before a downlink transmission(s) is random. The clause is applicable to the following transmissions:

- Transmission(s) initiated by an eNB including PDSCH/PDCCH/EPDCCH, or
- Any transmission(s) initiated by a gNB.

The eNB/gNB may transmit a transmission after first sensing the channel to be idle during the sensing slot durations of a defer duration $T_d$ and after the counter $N$ is zero in step 4. The counter $N$ is adjusted by sensing the channel for additional sensing slot duration(s) according to the steps below:

1) set $N = N_{init}$, where $N_{init}$ is a random number uniformly distributed between 0 and $CW_p$, and go to step 4;

2) if $N > 0$ and the eNB/gNB chooses to decrement the counter, set $N = N - 1$;

3) sense the channel for an additional sensing slot duration, and if the additional sensing slot duration is idle, go to step 4; else, go to step 5;

4) if $N = 0$, stop; else, go to step 2.

5) sense the channel until either a busy sensing slot is detected within an additional defer duration $T_d$ or all the sensing slots of the additional defer duration $T_d$ are detected to be idle;

6) if the channel is sensed to be idle during all the sensing slot durations of the additional defer duration $T_d$, go to step 4; else, go to step 5;

If an eNB/gNB has not transmitted a transmission after step 4 in the procedure above, the eNB/gNB may transmit a transmission on the channel, if the channel is sensed to be idle at least in a sensing slot duration $T_{sl}$ when the eNB/gNB is ready to transmit and if the channel has been sensed to be idle during all the sensing slot durations of a defer duration $T_d$ immediately before this transmission. If the channel has not been sensed to be idle in a sensing slot duration $T_{sl}$ when the eNB/gNB first senses the channel after it is ready to transmit or if the channel has been sensed to be not idle during any of the sensing slot durations of a defer duration $T_d$ immediately before this intended transmission, the eNB/gNB proceeds to step 1 after sensing the channel to be idle during the sensing slot durations of a defer duration $T_d$.

The defer duration $T_d$ consists of duration $T_f = 16\mu s$ immediately followed by $m_p$ consecutive sensing slot durations $T_{sl}$, and $T_f$ includes an idle sensing slot duration $T_{sl}$ at start of $T_f$.

$CW_{min,p} \leq CW_p \leq CW_{max,p}$is the contention window. $CW_p$ adjustment is described in clause 4.1.4.

$CW_{min,p}$ and $CW_{max,p}$ are chosen before step 1 of the procedure above.

$m_p$, $CW_{min,p}$, and $CW_{max,p}$ are based on a channel access priority class $p$ associated with the eNB/gNB transmission, as shown in Table 4.1.1-1.

An eNB/gNB shall not transmit on a channel for a *Channel Occupancy Time* that exceeds $T_{m\,cot,p}$ where the channel access procedures are performed based on a channel access priority class $p$ associated with the eNB/gNB transmissions, as given in Table 4.1.1-1.

If an eNB/gNB transmits discovery burst(s) as described in clause 4.1.2 when $N > 0$ in the procedure above, the eNB/gNB shall not decrement $N$ during the sensing slot duration(s) overlapping with discovery burst(s).

A gNB may use any channel access priority class for performing the procedures above to transmit transmission(s) including discovery burst(s) satisfying the conditions described in this clause.

A gNB shall use a channel access priority class applicable to the unicast user plane data multiplexed in PDSCH for performing the procedures above to transmit transmission(s) including unicast PDSCH with user plane data.

For $p = 3$ and $p = 4$ , if the absence of any other technology sharing the channel can be guaranteed on a long term basis (e.g. by level of regulation), $T_{m\,cot,p} = 10ms$, otherwise, $T_{m\,cot,p} = 8ms$.

**Table 4.1.1-1: Channel Access Priority Class (CAPC)**

| Channel Access Priority Class ($p$) | $m_p$ | $CW_{min,p}$ | $CW_{max,p}$ | $T_{m\,cot,p}$ | allowed $CW_p$ sizes |
|---|---|---|---|---|---|
| 1 | 1 | 3 | 7 | 2 ms | {3,7} |
| 2 | 1 | 7 | 15 | 3 ms | {7,15} |
| 3 | 3 | 15 | 63 | 8 or 10 ms | {15,31,63} |
| 4 | 7 | 15 | 1023 | 8 or 10 ms | {15,31,63,127,255,511,1023} |

#### 4.1.1.1 Regional limitations on channel occupancy time

In Japan, if an eNB/gNB has transmitted a transmission after $N = 0$ in step 4 of the procedure above, the eNB/gNB may transmit the next continuous transmission, for duration of maximum $T_j = 4ms$, immediately after sensing the channel to be idle for at least a sensing interval of $T_{js} = 34\mu s$ and if the total sensing and transmission time is not more than $1000 \cdot T_{mcot} + \left\lceil \frac{T_{mcot}}{T_j} - 1 \right\rceil \cdot T_{js}\ \mu s$. The sensing interval $T_{js}$ consists of duration $T_f = 16\mu s$ immediately followed by two sensing slots and $T_f$ includes an idle sensing slot at start of $T_f$. The channel is considered to be idle for $T_{js}$ if it is sensed to be idle during the sensing slot durations of $T_{js}$.

### 4.1.2 Type 2 DL channel access procedures

This clause describes channel access procedures to be performed by an eNB/gNB where the time duration spanned by sensing slots that are sensed to be idle before a downlink transmission(s) is deterministic.

If an eNB performs Type 2 DL channel access procedures, it follows the procedures described in clause 4.1.2.1.

Type 2A channel access procedures as described in clause 4.1.2.1 are only applicable to the following transmission(s) performed by an eNB/gNB:

- Transmission(s) initiated by an eNB including discovery burst and not including PDSCH where the transmission(s) duration is at most $1ms$, or

- Transmission(s) initiated by a gNB with only discovery burst or with discovery burst multiplexed with non-unicast information, where the transmission(s) duration is at most $1ms$, and the discovery burst duty cycle is at most $1/20$, or

- Transmission(s) by an eNB/ gNB following transmission(s) by a UE after a gap of $25\mu s$ in a shared channel occupancy as described in clause 4.1.3.

Type 2B or Type 2C DL channel access procedures as described in clause 4.1.2.2 and 4.1.2.3, respectively, are applicable to the transmission(s) performed by a gNB following transmission(s) by a UE after a gap of $16\mu s$ or up to $16\mu s$, respectively, in a shared channel occupancy as described in clause 4.1.3.

#### 4.1.2.1 Type 2A DL channel access procedures

An eNB/gNB may transmit a DL transmission immediately after sensing the channel to be idle for at least a sensing interval $T_{short\_dl} = 25\mu s$. $T_{short\_dl}$ consists of a duration $T_f = 16\mu s$ immediately followed by one sensing slot and $T_f$ includes a sensing slot at start of $T_f$. The channel is considered to be idle for $T_{short\_dl}$ if both sensing slots of $T_{short\_dl}$ are sensed to be idle.

#### 4.1.2.2 Type 2B DL channel access procedures

A gNB may transmit a DL transmission immediately after sensing the channel to be idle within a duration of $T_f = 16\mu s$. $T_f$ includes a sensing slot that occurs within the last $9\mu s$ of $T_f$. The channel is considered to be idle within the duration $T_f$ if the channel is sensed to be idle for a total of at least $5\mu s$ with at least $4\mu s$ of sensing occurring in the sensing slot.

#### 4.1.2.3 Type 2C DL channel access procedures

When a gNB follows the procedures in this clause for transmission of a DL transmission, the gNB does not sense the channel before transmission of the DL transmission. The duration of the corresponding DL transmission is at most $584\mu s$.

### 4.1.3 DL channel access procedures in a shared channel occupancy

For the case where an eNB shares a channel occupancy initiated by a UE, the eNB may transmit a transmission that follows an autonomous PUSCH transmission by the UE as follows:

- If 'COT sharing indication' in AUL-UCI in subframe $n$ indicates '1', an eNB may transmit a transmission in subframe $n + X$, where $X$ is subframeOffsetCOT-Sharing, including PDCCH but not including PDSCH on the same channel immediately after performing Type 2A DL channel access procedures in clause 4.1.2.1, if the duration of the PDCCH is less than or equal to duration of two OFDM symbols and it shall contain at least AUL-DFI or UL grant to the UE from which the PUSCH transmission indicating COT sharing was received.

If a gNB shares a channel occupancy initiated by a UE using the channel access procedures described in clause 4.2.1.1 on a channel, the gNB may transmit a transmission that follows a UL transmission on scheduled resources or a PUSCH transmission on configured resources by the UE after a gap as follows:

- The transmission shall contain transmission to the UE that initiated the channel occupancy and can include non-unicast and/or unicast transmissions where any unicast transmission that includes user plane data is only transmitted to the UE that initiated the channel occupancy.
  - If the higher layer parameters *ul-toDL-COT-SharingED-Threshold-r16* is not provided, the transmission shall not include any unicast transmissions with user plane data and the transmission duration is not more than the duration of 2, 4 and 8 symbols for subcarrier spacing of 15, 30 and 60 kHz of the corresponding channel, respectively.
- If the gap is up to $16\mu s$, the gNB can transmit the transmission on the channel after performing Type 2C DL channel access as described in clause 4.1.2.3.
- If the gap is $25\mu s$ or $16\mu s$, the gNB can transmit the transmission on the channel after performing Type 2A or Type 2B DL channel access procedures as described in clause 4.1.2.1 and 4.1.2.2, respectively.

For the case where a gNB shares a channel occupancy initiated by a UE with configured grant PUSCH transmission, the gNB may transmit a transmission that follows the configured grant PUSCH transmission by the UE as follows:

- If the higher layer parameter *ul-toDL-COT-SharingED-Threshold-r16* is provided, the UE is configured by *cg-COT-SharingList-r16* where *cg-COT-SharingList-r16* provides a table configured by higher layer. Each row of the table provides a channel occupancy sharing information given by higher layer parameter *CG-COT-Sharing-r16*. One row of the table is configured for indicating that the channel occupancy sharing is not available.
  - If the 'COT sharing information' in CG-UCI detected in slot *n* indicates a row index that corresponds to a *CG-COT-Sharing-r16* that provides channel occupancy sharing information, the gNB can share the UE channel occupancy assuming a channel access priority class *p= channelAccessPriority-r16*, starting from slot

*n+O*, where *O=offset-r16* slots, for a duration of *D=duration-r16* slots where *duration-r16*, *offset-r16*, and *channelAccessPriority-r16* are higher layer parameters provided by *CG-COT-Sharing-r16*.

- If the higher layer parameter *ul-toDL-COT-SharingED-Threshold-r16* is not provided, and if 'COT sharing information' in CG-UCI indicates '1', the gNB can share the UE channel occupancy and start the DL transmission X= *cg-COT-SharingOffset-r16**14 symbols from the end of the slot where CG-UCI is detected, where *cg-COT-SharingOffset-r16* is provided by higher layer. The transmission shall not include any unicast transmissions with user plane data and the transmission duration is not more than the duration of 2, 4 and 8 symbols for subcarrier spacing of 15, 30 and 60 kHz of the corresponding channel, respectively.

For the case where a gNB uses channel access procedures as described in clause 4.1.1 to initiate a transmission and shares the corresponding channel occupancy with a UE that transmits a transmission as described in clause 4.2.1.2, the gNB may transmit a transmission within its channel occupancy that follows the UE's transmission if any gap between any two transmissions in the gNB channel occupancy is at most $25\mu s$. In this case the following applies:

- If the gap is $25\mu s$ or$16\mu s$, the gNB can transmit the transmission on the channel after performing Type 2A or 2B DL channel access procedures as described in clause 4.1.2.1 and 4.1.2.2, respectively.

- If the gap is up to $16\mu s$, the gNB can transmit the transmission on the channel after performing Type 2C DL channel access as described in clause 4.1.2.3.

## 4.1.4 Contention window adjustment procedures

If an eNB/gNB transmits transmissions including PDSCH that are associated with channel access priority class $p$ on a channel, the eNB/gNB maintains the contention window value $CW_p$ and adjusts $CW_p$ before step 1 of the procedure described in clause 4.1.1 for those transmissions as described in this clause.

### 4.1.4.1 Contention window adjustment procedures for transmissions by eNB

If an eNB transmits transmissions including PDSCH that are associated with channel access priority class $p$ on a channel, the eNB maintains the contention window value $CW_p$ and adjusts $CW_p$ before step 1 of the procedure described in clause 4.1.1 for those transmissions using the following steps:

1) for every priority class $p \in \{1,2,3,4\}$ set $CW_p = CW_{min,p}$

2) if at least $Z = 80\%$ of HARQ-ACK values corresponding to PDSCH transmission(s) in reference subframe $k$ are determined as NACK, increase $CW_p$ for every priority class $p \in \{1,2,3,4\}$ to the next higher allowed value and remain in step 2; otherwise, go to step 1.

Reference subframe $k$ is the starting subframe of the most recent transmission on the channel made by the eNB, for which at least some HARQ-ACK feedback is expected to be available.

The eNB shall adjust the value of $CW_p$ for every priority class $p \in \{1,2,3,4\}$ based on a given reference subframe $k$ only once.

For determining $Z$,

- if the eNB transmission(s) for which HARQ-ACK feedback is available start in the second slot of subframe $k$, HARQ-ACK values corresponding to PDSCH transmission(s) in subframe $k+1$ are also used in addition to the HARQ-ACK values corresponding to PDSCH transmission(s) in subframe $k$.

- if the HARQ-ACK values correspond to PDSCH transmission(s) on an LAA SCell that are assigned by (E)PDCCH transmitted on the same LAA SCell,

  - if no HARQ-ACK feedback is detected for a PDSCH transmission by the eNB, or if the eNB detects 'DTX', 'NACK/DTX' or 'any' state, it is counted as NACK.

- if the HARQ-ACK values correspond to PDSCH transmission(s) on an LAA SCell that are assigned by (E)PDCCH transmitted on another serving cell,

  - if the HARQ-ACK feedback for a PDSCH transmission is detected by the eNB, 'NACK/DTX' or 'any' state is counted as NACK, and 'DTX' state is ignored.

  - if no HARQ-ACK feedback is detected for a PDSCH transmission by the eNB

    - if PUCCH format 1b with channel selection is expected to be used by the UE, 'NACK/DTX' state corresponding to 'no transmission' as described in Clauses 10.1.2.2.1, 10.1.3.1 and 10.1.3.2.1 is counted as NACK, and 'DTX' state corresponding to 'no transmission' is ignored in [4].

    - Otherwise, the HARQ-ACK for the PDSCH transmission is ignored.

- if a PDSCH transmission has two codewords, the HARQ-ACK value of each codeword is considered separately

- bundled HARQ-ACK across M subframes is considered as M HARQ-ACK responses.

If the eNB transmits transmissions including PDCCH/EPDCCH with DCI format 0A/0B/4A/4B and not including PDSCH that are associated with channel access priority class $p$ on a channel starting from time $t_0$, the eNB maintains the contention window value $CW_p$ and adjusts $CW_p$ before step 1 of the procedure described in clause 4.1.1 for those transmissions using the following steps:

1) for every priority class $p \in \{1,2,3,4\}$ set $CW_p = CW_{min,p}$

2) if less than 10% of the UL transport blocks scheduled by the eNB using Type 2 channel access procedure (described in clause 4.2.1.2) in the time interval between $t_0$ and $t_0 + T_{CO}$ have been received successfully, increase $CW_p$ for every priority class $p \in \{1,2,3,4\}$ to the next higher allowed value and remain in step 2; otherwise, go to step 1.

$T_{CO}$ is computed as described in clause 4.2.1.0.3.

### 4.1.4.2 Contention window adjustment procedures for DL transmissions by gNB

If a gNB transmits transmissions including PDSCH that are associated with channel access priority class $p$ on a channel, the gNB maintains the contention window value $CW_p$ and adjusts $CW_p$ before step 1 of the procedure described in clause 4.1.1 for those transmissions using the following steps:

1) For every priority class $p \in \{1,2,3,4\}$, set $CW_p = CW_{min,p}$.

2) If HARQ-ACK feedback is available after the last update of $CW_p$ , go to step 3. Otherwise, if the gNB transmission after procedure described in clause 4.1.1 does not include a retransmission or is transmitted within a duration $T_w$ from the end of the *reference duration* corresponding to the earliest DL channel occupancy after the last update of $CW_p$, go to step 5; otherwise go to step 4.

3) The HARQ-ACK feedback(s) corresponding to PDSCH(s) in the reference duration for the latest DL channel occupancy for which HARQ-ACK feedback is available is used as follows:

   a. If at least one HARQ-ACK feedback is 'ACK' for PDSCH(s) with transport block based feedback or at least 10% of HARQ-ACK feedbacks is 'ACK' for PDSCH CBGs transmitted at least partially on the channel with code block group based feedback, go to step 1; otherwise go to step 4.

4) Increase $CW_p$ for every priority class $p \in \{1,2,3,4\}$ to the next higher allowed value.

5) For every priority class $\mathrm{p} \in \{1,2,3,4\}$, maintain $\mathrm{CW_p}$ as it is; go to step 2.

The *reference duration* and duration $T_w$ in the procedure above are defined as follows:

- The *reference duration* corresponding to a channel occupancy initiated by the gNB including transmission of PDSCH(s) is defined in this clause as a duration starting from the beginning of the channel occupancy until the end of the first slot where at least one unicast PDSCH is transmitted over all the resources allocated for the PDSCH, or until the end of the first transmission burst by the gNB that contains unicast PDSCH(s) transmitted over all the resources allocated for the PDSCH, whichever occurs earlier. If the channel occupancy includes a unicast PDSCH, but it does not include any unicast PDSCH transmitted over all the resources allocated for that PDSCH, then, the duration of the first transmission burst by the gNB within the channel occupancy that contains unicast PDSCH(s) is the *reference duration* for CWS adjustment.

- $T_w = \max(T_A, T_B + 1ms)$ where $T_B$ is the duration of the transmission burst from start of the *reference duration* in $ms$ and $T_A = 5ms$ if the absence of any other technology sharing the channel can not be guaranteed on a long-term basis (e.g. by level of regulation), and $T_A = 10ms$ otherwise.

If a gNB transmits transmissions using Type 1 channel access procedures associated with the channel access priority class $p$ on a channel and the transmissions are not associated with explicit HARQ-ACK feedbacks by the corresponding UE(s), the gNB adjusts $CW_p$ before step 1 in the procedures described in clause 4.1.1, using the latest $CW_p$ used for any DL transmissions on the channel using Type 1 channel access procedures associated with the channel access priority class $p$. If the corresponding channel access priority class $p$ has not been used for any DL transmissions on the channel, $CW_p = CW_{min,p}$ is used.

#### 4.1.4.3 Common procedures for CWS adjustments for DL transmissions

The following applies to the procedures described in clauses 4.1.4.1 and 4.1.4.2:

- If $CW_p = CW_{max,p}$, the next higher allowed value for adjusting $CW_p$ is $CW_{max,p}$.
- If the $CW_p = CW_{max,p}$ is consecutively used $K$ times for generation of $N_{init}$, $CW_p$ is reset to $CW_{min,p}$ only for that priority class $p$ for which $CW_p = CW_{max,p}$ is consecutively used $K$ times for generation of $N_{init}$. $K$ is selected by eNB/gNB from the set of values {1, 2, …,8} for each priority class $p \in \{1,2,3,4\}$.

### 4.1.5 Energy detection threshold adaptation procedures

An eNB/gNB accessing a channel on which transmission(s) are performed, shall set the energy detection threshold ($X_{\text{Thresh}}$) to be less than or equal to the maximum energy detection threshold $X_{\text{Thresh\_max}}$.

$X_{\text{Thresh\_max}}$ is determined as follows:

- If the absence of any other technology sharing the channel can be guaranteed on a long-term basis (e.g. by level of regulation) then:
  - $X_{\text{Thresh\_max}} = min\begin{Bmatrix} T_{max} + 10\text{dB}, \\ X_r \end{Bmatrix}$
    - $X_r$ is maximum energy detection threshold defined by regulatory requirements in dBm when such requirements are defined, otherwise $X_r = T_{max} + 10dB$;
- otherwise,
  - $X_{\text{Thresh\_max}} = max\begin{Bmatrix} -72 + 10 \cdot log\,10(BWMHz\,/20MHz)\;dBm, \\ \min\begin{Bmatrix} T_{\max}, \\ T_{\max} - T_A + (P_H + 10 \cdot log\,10(BWMHz\,/20MHz) - P_{TX}) \end{Bmatrix} \end{Bmatrix}$

  where:

  - $T_A$=5dB for transmissions including discovery burst(s) as described in clause 4.1.2, and $T_A = 10dB$ otherwise;
  - $P_H = 23dBm$;
  - $P_{TX}$ is set to the maximum eNB/gNB output power in dBm for the channel;
    - eNB/gNB uses the set maximum transmission power over a single channel irrespective of whether single channel or multi-channel transmission is employed
  - $T_{\max}$(dBm)= $10 \cdot log\,10\,(3.16228 \cdot 10^{-8}(mW/MHz) \cdot BWMHz\;(MHz))$;
  - $BWMHz$ is the single channel bandwidth in MHz.

### 4.1.6 Channel access procedures for transmission(s) on multiple channels

An eNB/gNB can access multiple channels on which transmission(s) are performed, according to one of the Type A or Type B procedures described in this Clause.

### 4.1.6.1 Type A multi-channel access procedures

An eNB/gNB shall perform channel access on each channel $c_i \in C$, according to the procedures described in clause 4.1.1, where $C$ is a set of channels on which the eNB/gNB intends to transmit, and $i = 0,1, \dots q - 1$, and $q$ is the number of channels on which the eNB/gNB intends to transmit.

The counter $N$ described in clause 4.1.1 is determined for each channel $c_i$ and is denoted as $N_{c_i}$. $N_{c_i}$ is maintained according to clause 4.1.6.1.1 or 4.1.6.1.2.

If a gNB configures a carrier without intra-cell guard bands as described in clause 7 in [8], the gNB may not transmit on channel $c_i \in C$ within the bandwidth of the carrier, if the gNB fails to access any of the channels of the carrier bandwidth.

#### 4.1.6.1.1 Type A1 multi-channel access procedures

Counter $N$ as described in clause 4.1.1 is independently determined for each channel $c_i$ and is denoted as $N_{c_i}$.

If the absence of any other technology sharing the channel cannot be guaranteed on a long term basis (e.g. by level of regulation), when the eNB/gNB ceases transmission on any one channel $c_j \in C$, for each channel $c_i \neq c_j$, the eNB/gNB can resume decrementing $N_{c_i}$ when idle sensing slots are detected either after waiting for a duration of $4 \cdot T_{sl}$, or after reinitialising $N_{c_i}$.

For determining $CW_p$ for channel $c_i$, any PDSCH that fully or partially overlaps with channel $c_i$, is used in the procedures described in clause 4.1.4.2.

#### 4.1.6.1.2 Type A2 multi-channel access procedures

Counter $N$ is determined as described in clause 4.1.1 for channel $c_j \in C$, and is denoted as $N_{c_j}$, where $c_j$ is the channel that has the largest $CW_p$ value. For each channel $c_i$, $N_{c_i} = N_{c_j}$.

When the eNB/gNB ceases transmission on any one channel for which $N_{c_i}$ is determined, the eNB/gNB shall reinitialise $N_{c_i}$ for all channels.

For determining $CW_p$ for channel $c_i$, any PDSCH that fully or partially overlaps with channel $c_i$, is used in the procedures described in clause 4.1.4.2.

### 4.1.6.2 Type B multi-channel access procedure

A channel $c_j \in C$ is selected by the eNB/gNB as follows:

- the eNB/gNB selects $c_j$ by uniformly randomly choosing $c_j$ from $C$ before each transmission on multiple channels $c_i \in C$, or
- the eNB/gNB selects $c_j$ no more frequently than once every 1 second,

where $C$ is a set of channels on which the eNB/gNB intends to transmit, $i = 0,1, \dots q - 1$, and $q$ is the number of channels on which the eNB intends to transmit.

To transmit on channel $c_j$

- the eNB/gNB shall perform channel access on channel $c_j$ according to the procedures described in clause 4.1.1 with the modifications described in clause 4.1.6.2.1 or 4.1.6.2.2.

To transmit on channel $c_i \neq c_j$, $c_i \in C$

- for each channel $c_i$, the eNB/gNB shall sense the channel $c_i$ for at least a sensing interval $T_{\text{mc}} = 25\mu s$ immediately before transmitting on channel $c_j$, and the eNB/gNB may transmit on channel $c_i$ immediately after sensing the channel $c_i$ to be idle for at least the sensing interval $T_{\text{mc}}$. The channel $c_i$ is considered to be idle for $T_{\text{mc}}$ if the channel is sensed to be idle during all the time durations in which such idle sensing is performed on the channel $c_j$ in given interval $T_{\text{mc}}$.

The eNB/gNB shall not transmit a transmission on a channel $c_i \neq c_j$, $c_i \in C$, for a period exceeding $T_{m\,cot,p}$ as given in Table 4.1.1-1, where the value of $T_{m\,cot,p}$ is determined using the channel access parameters used for channel $c_j$.

For the procedures in this clause, the channel frequencies of the set of channels $C$ selected by gNB, is a subset of one of the sets of channel frequencies defined in [6].

If a gNB configures a carrier without intra-cell guard band(s) as described in clause 7 in [8], the gNB may not transmit on channel $c_i \in C$ within the bandwidth of the carrier, if the gNB fails to access any of the channels of the carrier bandwidth.

#### 4.1.6.2.1 Type B1 multi-channel access procedure

A single $CW_p$ value is maintained for the set of channels $C$.

For determining $CW_p$ for channel access on channel $c_j$, step 2 of the procedure described in clause 4.1.4.1 is modified as follows

- if at least $Z = 80\%$ of HARQ-ACK values corresponding to PDSCH transmission(s) in reference subframe $k$ of all channels $c_i \in C$ are determined as NACK, increase $CW_p$ for each priority class $p \in \{1,2,3,4\}$ to the next higher allowed value; otherwise, go to step 1.

For determining $CW_p$ for a set of channels $C$, any PDSCH that fully or partially overlaps with any channel $c_i \in C$, is used in the procedure described in clause 4.1.4.2.

#### 4.1.6.2.2 Type B2 multi-channel access procedure

A $CW_p$ value is maintained independently for each channel $c_i \in C$ using the procedure described in clause 4.1.4.

For determining $CW_p$ for channel $c_i$, any PDSCH that fully or partially overlaps with channel $c_i$, is used in the procedure described in clause 4.1.4.2.

For determining $N_{init}$ for channel $c_j$, $CW_p$ value of channel $c_{j1} \in C$ is used, where $c_{j1}$ is the channel with largest $CW_p$ among all channels in set $C$.

## 4.2 Uplink channel access procedures

A UE performing transmission(s) on LAA Scell(s), an eNB scheduling or configuring UL transmission(s) for a UE performing transmission(s) on LAA Scell(s), and a UE performing transmission(s) on channel(s) and a gNB scheduling or configuring UL transmission(s) for a UE performing transmissions on channel(s) shall perform the procedures described in this clause for the UE to access the channel(s) on which the transmission(s) are performed.

In this clause, transmissions from a UE are considered as separate UL transmissions, irrespective of having a gap between transmissions or not, and $X_{\mathrm{Thresh}}$ for sensing is adjusted as described in clause 4.2.3 when applicable.

A UE performs channel access procedures in this clause unless the higher layer parameter *channelAccessMode-r16* is provided and *channelAccessMode-r16 =' semiStatic'.*

If a UE fails to access the channel(s) prior to an intended UL transmission to a gNB, Layer 1 notifies higher layers about the channel access failure.

### 4.2.1 Channel access procedures for uplink transmission(s)

A UE can access a channel on which UL transmission(s) are performed according to one of Type 1 or Type 2 UL channel access procedures. Type 1 channel access procedure is described in clause 4.2.1.1. Type 2 channel access procedure is described in clause 4.2.1.2.

If a UL grant scheduling a PUSCH transmission indicates Type 1 channel access procedures, the UE shall use Type 1 channel access procedures for transmitting transmissions including the PUSCH transmission unless stated otherwise in this clause.

A UE shall use Type 1 channel access procedures for transmitting transmissions including the autonomous or configured grant PUSCH transmission on configured UL resources unless stated otherwise in this clause.

If a UL grant scheduling a PUSCH transmission indicates Type 2 channel access procedures, the UE shall use Type 2 channel access procedures for transmitting transmissions including the PUSCH transmission unless stated otherwise in this clause.

A UE shall use Type 1 channel access procedures for transmitting SRS transmissions not including a PUSCH transmission. UL channel access priority class $p = 1$ in Table 4.2.1-1 is used for SRS transmissions not including a PUSCH.

If a DL assignment triggering SRS but not scheduling a PUCCH transmission indicates Type 2 channel access procedures, the UE shall use Type 2 channel access procedures.

If a UE is scheduled by an eNB/gNB to transmit PUSCH and SRS in contiguous transmissions without any gaps in between, and if the UE cannot access the channel for PUSCH transmission, the UE shall attempt to make SRS transmission according to uplink channel access procedures specified for SRS transmission.

If a UE is scheduled by a gNB to transmit PUSCH and one or more SRSs by a single UL grant in non-contiguous transmissions, or a UE is scheduled by a gNB to transmit PUCCH and/or SRSs by a single DL assignment in non-contiguous transmissions, the UE shall use the channel access procedure indicated by the scheduling DCI for the first UL transmission scheduled by the scheduling DCI. If the channel is sensed by the UE to be continuously idle after the UE has stopped transmitting the first transmission, the UE may transmit further UL transmissions scheduled by the scheduling DCI using Type 2 channel access procedures or Type 2A UL channel access procedures without applying a CP extension if the further UL transmissions are within the gNB Channel Occupancy Time. Otherwise, if the channel sensed by the UE is not continuously idle after the UE has stopped transmitting the first UL transmission or the further UL transmissions are outside the gNB Channel Occupancy Time, the UE may transmit the further UL transmissions using Type 1 channel access procedure, without applying a CP extension.

A UE shall use Type 1 channel access procedures for PUCCH transmissions unless stated otherwise in this clause. If a DL grant determined according to Clause 9.2.3 in [7, TS38.213] or a random access response (RAR) message for successRAR scheduling a PUCCH transmission indicates Type 2 channel access procedures, the UE shall use Type 2 channel access procedures.

When a UE uses Type 1 channel access procedures for PUCCH transmissions or PUSCH only transmissions without UL-SCH, the UE shall use UL channel access priority class $p = 1$ in Table 4.2.1-1.

A UE shall use Type 1 channel access procedure for PRACH transmissions and PUSCH transmissions without user plane data related to random access procedure that initiate a channel occupancy. In this case, UL channel access priority class $p = 1$ in Table 4.2.1-1 is used for PRACH transmissions, and UL channel access priority class used for PUSCH transmissions is determined according to Clause 5.6.2 in [9].

When a UE uses Type 1 channel access procedures for PUSCH transmissions on configured resource, the UE determines the corresponding UL channel access priority $p$ in Table 4.2.1-1 following the procedures described in Clause 5.6.2 in [9].

When a UE uses Type 1 channel access procedures for PUSCH transmissions with user plane data indicated by a UL grant or related to random access procedure where the corresponding UL channel access priority $p$ is not indicated, the UE determines $p$ in Table 4.2.1-1 following the same procedures as for PUSCH transmission on configured resources using Type 1 channel access procedures.

When a UE uses Type 2A, Type 2B, or Type 2C UL channel access procedures for PUSCH transmissions indicated by a UL grant or related to random access procedures, where the corresponding UL channel access priority $p$ is not indicated, the UE assumes that the channel access priority class $p = 4$ is used by the gNB for the *Channel Occupancy Time*.

A UE shall not transmit on a channel for a *Channel Occupancy Time* that exceeds $T_{ulm\,cot,p}$ where the channel access procedure is performed based on the channel access priority class $p$ associated with the UE transmissions, as given in Table 4.2.1-1.

The total *Channel Occupancy Time* of autonomous uplink transmission(s) obtained by the channel access procedure in this clause, including the following DL transmission if the UE sets 'COT sharing indication' in AUL-UCI to '1' in a subframe within the autonomous uplink transmission(s) as described in Clause 4.1.3, shall not exceed $T_{ulm\,cot,p}$, where $T_{ulm\,cot,p}$ is given in Table 4.2.1-1.

**Table 4.2.1-1: Channel Access Priority Class (CAPC) for UL**

| Channel Access Priority Class ($p$) | $m_p$ | $CW_{min,p}$ | $CW_{max,p}$ | $T_{ulm\,cot,p}$ | allowed $CW_p$ sizes |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 7 | 2 ms | {3,7} |
| 2 | 2 | 7 | 15 | 4 ms | {7,15} |
| 3 | 3 | 15 | 1023 | 6ms or 10 ms | {15,31,63,127,255,511,1023} |
| 4 | 7 | 15 | 1023 | 6ms or 10 ms | {15,31,63,127,255,511,1023} |
| NOTE 1: For $p = 3{,}4$, $T_{ulm\,cot,p} = 10ms$ if the higher layer parameter absenceOfAnyOtherTechnology-r14 or absenceOfAnyOtherTechnology-r16 is provided , otherwise, $T_{ulm\,cot,p} = 6ms$. NOTE 2: When $T_{ulm\,cot,p} = 6ms$ it may be increased to $8ms$ by inserting one or more gaps. The minimum duration of a gap shall be $100\mu s$. The maximum duration before including any such gap shall be $6ms$. | | | | | |

## 4.2.1.0 Channel access procedures and UL related signaling

### 4.2.1.0.0 Channel access procedures upon detection of a common DCI

If a UE detects 'UL duration and offset' field in DCI Format 1C as described in clause 5.3.3.1.4 of [5], the following are applicable:

- If the 'UL duration and offset' field indicates an 'UL offset' $l$ and an 'UL duration' $d$ for subframe $n$, then the scheduled UE may use channel access procedures Type 2 for transmissions in subframes $n + l + i$ where $i = 0,1, \ldots d - 1$, irrespective of the channel access Type signalled in the UL grant for those subframes, if the end of UE transmission occurs in or before subframe $n + l + d - 1$.

- If the 'UL duration and offset' field indicates an 'UL offset' $l$ and an 'UL duration' $d$ for subframe $n$ and the 'COT sharing indication for AUL' field is set to '1', then a UE configured with autonomous UL may use channel access procedures Type 2 for autonomous UL transmissions assuming any priority class in subframes $n + l + i$ where $i = 0,1, \ldots d - 1$, if the end of UE autonomous UL transmission occurs in or before subframe $n + l + d - 1$ and the autonomous UL transmission between $n + l$ and $n + l + d - 1$ shall be contiguous.

- If the 'UL duration and offset' field indicates an 'UL offset' $l$ and an 'UL duration' $d$ for subframe $n$ and the 'COT sharing indication for AUL' field is set to '0', then a UE configured with autonomous UL shall not transmit autonomous UL in subframes $n + l + i$ where $i = 0,1, \ldots d - 1$.

If a UE determines the duration in time domain and the location in frequency domain of a remaining channel occupancy initiated by the gNB from a DCI format 2_0 as described in clause 11.1.1 of [7], the following is applicable:

- The UE may switch from Type 1 channel access procedures as described in clause 4.2.1.1 to Type 2A channel access procedures as described in clause 4.2.1.2.1 for its corresponding UL transmissions within the determined duration in time and location in frequency domain of the remaining channel occupancy. In this case, if the UL transmissions are PUSCH transmissions on configured resources, the UE may assume any priority class for the channel occupancy shared with the gNB.

### 4.2.1.0.1 Channel access procedures for consecutive UL transmission(s)

For contiguous UL transmission(s), the following are applicable:

- If a UE is scheduled to transmit a set of UL transmissions using one or more UL grant(s) or DL assignment(s), and

  - if the UE cannot access the channel for a transmission in the set prior to the last transmission according to one of Type 1, Type 2, or Type 2A UL channel access procedures, the UE shall attempt to transmit the next transmission according to the channel access type indicated in the corresponding UL grant or DL assignment;

  - if the UE cannot access the channel for a transmission in the set prior to the last transmission according to Type 2B UL channel access procedure, the UE shall attempt to transmit the next transmission according to Type 2A UL channel access procedure.

- If a UE is scheduled by a gNB to transmit a set of UL transmissions including PUSCH or SRS symbol(s) using a UL grant, the UE shall not apply a CP extension for the remaining UL transmissions in the set after the first UL transmission after accessing the channel.

- If a UE is scheduled to transmit a set of consecutive UL transmissions without gaps including PUSCH using one or more UL grant(s), PUCCH using one or more DL grant(s), or SRS with one or more DL grant(s) or UL grant(s) and the UE transmits one of the scheduled UL transmissions in the set after accessing the channel according to one of Type 1, Type 2, Type 2A, Type 2B or Type 2C UL channel access procedures, the UE may continue transmission of the remaining UL transmissions in the set, if any.

- If a UE is configured to transmit a set of consecutive PUSCH or SRS transmissions on resources configured by the gNB, the time domain resource configuration defines multiple transmission occasions, and if the UE cannot access the channel according to Type 1 UL channel access procedure for transmitting in a transmission occasion prior to the last transmission occasion, the UE shall attempt to transmit in the next transmission occasion according to Type 1 UL channel access procedure. If the UE transmits in one of the multiple transmission occasions after accessing the channel according to Type 1 UL channel access procedure, the UE may continue transmission in the remaining transmission occasions in the set, wherein each transmission occasion starts at the starting symbol of a configured grant PUSCH within the duration of the COT.

- If a UE is configured by the gNB to transmit a set of consecutive UL transmissions without gaps including PUSCH, periodic PUCCH, or periodic SRS and the UE transmits one of the configured UL transmissions in the set after accessing the channel according to Type 1 UL channel access procedures, the UE may continue transmission of the remaining UL transmissions in the set, if any.

- A UE is not expected to be indicated with different channel access types for any consecutive UL transmissions without gaps in between the transmissions, except if Type 2B or Type 2C UL channel access procedures are identified for the first of the consecutive UL transmissions.

For UL transmission(s) with multiple starting positions scheduled by eNB, the following are applicable:

- If a UE is scheduled by an eNB to transmit transmissions including PUSCH Mode 1 using the Type 1 channel access procedure indicated in DCI, and if the UE cannot access the channel for a transmission according to the PUSCH starting position indicated in the DCI, the UE shall attempt to make a transmission at symbol 7 in the same subframe according to Type 1 channel access procedure. There is no limit on the number of attempts the UE can make using Type 1 channel access procedure.

- If a UE is scheduled by an eNB to transmit transmissions including PUSCH Mode 1 using the Type 2 channel access procedure indicated in DCI, and if the UE cannot access the channel for a transmission according to the PUSCH starting position indicated in the DCI, the UE may attempt to make a transmission at symbol 7 in the same subframe and according to Type 2 channel access procedure. The number of attempts the UE should make within the consecutively scheduled subframes including the transmission is limited to $w+1$, where $w$ is the number of consecutively scheduled subframes using Type 2 channel access procedure.

For contiguous UL transmissions(s) including a transmission pause, the following are applicable:

- If a UE is scheduled to transmit a set of consecutive UL transmissions without gaps using one or more UL grant(s), and if the UE has stopped transmitting during or before one of these UL transmissions in the set and prior to the last UL transmission in the set, and if the channel is sensed by the UE to be continuously idle after the UE has stopped transmitting, the UE may transmit a later UL transmission in the set using Type 2 channel access procedures or Type 2A UL channel access procedures without applying a CP extension.

- If a channel sensed by a UE is not continuously idle after the UE has stopped transmitting, the UE may transmit a later UL transmission in the set using Type 1 channel access procedure with the UL channel access priority class indicated in the DCI corresponding to the UL transmission.

For UL transmission(s) following autonomous UL transmission(s), the following are applicable:

- If a UE is scheduled by an eNB to transmit on channel $c_i$ by a UL grant received on channel $c_j$, $i \neq j$, and if the UE is transmitting using autonomous UL on channel $c_i$, the UE shall terminate the ongoing PUSCH transmissions using the autonomous UL at least one subframe before the UL transmission according to the received UL grant.

- If a UE is scheduled by a UL grant received from an eNB on a channel to transmit a PUSCH transmission(s) starting from subframe $n$ on the same channel using Type 1 channel access procedure and if at least for the first scheduled subframe occupies $N_{\mathrm{RB}}^{\mathrm{UL}}$ resource blocks and the indicated PUSCH starting position is OFDM symbol zero, and if the UE starts autonomous UL transmissions before subframe $n$ using Type 1 channel access procedure on the same channel, the UE may transmit UL transmission(s) according to the received UL grant from subframe $n$ without a gap, if the priority class value of the performed channel access procedure is larger than or equal to priority class value indicated in the UL grant, and the autonomous UL transmission in the subframe preceding subframe $n$ shall end at the last OFDM symbol of the subframe regardless of the higher layer parameter *endingSymbolAUL*. The sum of the lengths of the autonomous UL transmission(s) and the scheduled UL transmission(s) shall not exceed the maximum channel occupancy time corresponding to the priority class value used to perform the autonomous uplink channel access procedure. Otherwise, the UE shall terminate the ongoing autonomous UL transmission at least one subframe before the start of the UL transmission according to the received UL grant on the same channel.

For UL transmission(s) following configured grant UL transmission(s), the following are applicable:

- If a UE is scheduled to transmit UL transmission(s) starting from symbol $i$ in slot $n$ using Type 1 channel access procedures without CP extension with a corresponding CAPC, and if the UE starts configured grant UL transmissions before symbol $i$ in slot $n$ using Type 1 channel access procedures with a corresponding CAPC, and the scheduled UL transmission(s) occupies all the RBs of the same channels occupied by the configured grant UL transmission(s) or all the RBs of a subset thereof, the UE may directly continue to transmit the scheduled UL transmission(s) to the corresponding CAPC from symbol $i$ in slot $n$ without a gap, if the CAPC value of the performed channel access procedure is larger than or equal to the CAPC value corresponding to the scheduled UL transmission(s). The sum of the transmission durations of the configured grant UL transmission(s) and the scheduled UL transmission(s) shall not exceed the MCOT duration corresponding to the CAPC value used to transmit the configured grant UL transmission(s). Otherwise, the UE shall terminate the configured grant UL transmission(s) by dropping the transmission on the symbols of at least the last configured grant UL transmission before symbol $i$ in slot $n$ and attempt to transmit the scheduled UL transmission(s) according to the corresponding CAPC. The symbols of the PUSCH transmission with a configured grant in a slot is dropped according to the mechanism in Clause 11.1 of [7, TS 38.213] relative to a last symbol of a CORESET where the UE detected the scheduling DCI. In this case, if the UE cannot terminate the configured grant UL transmission(s), the UE ignores the scheduling DCI.

#### 4.2.1.0.2 Conditions for maintaining Type 1 UL channel access procedures

If a UE receives a DCI indicating a UL grant scheduling a PUSCH transmission using Type 1 channel access procedures or indicating a DL assignment scheduling a PUCCH transmission using Type 1 channel access procedures, and if the UE has an ongoing Type 1 channel access procedures before the PUSCH or PUCCH transmission starting time:

- If the UL channel access priority class value $p_1$ used for the ongoing Type 1 channel access procedures is same or larger than the UL channel access priority class value $p_2$ indicated in the DCI, the UE may transmit the PUSCH transmission in response to the UL grant by accessing the channel by using the ongoing Type 1 channel access procedure.

- If the UL channel access priority class value $p_1$ used for the ongoing Type 1 channel access procedure is smaller than the UL channel access priority class value $p_2$ indicated in the DCI, the UE shall terminate the ongoing channel access procedure.

- The UE may transmit the PUCCH transmission in response to the DL grant by accessing the channel by using the ongoing Type 1 channel access procedures.

#### 4.2.1.0.3 Conditions for indicating Type 2 channel access procedures

An eNB/gNB may indicate Type 2 channel access procedures in the DCI of a UL grant or DL assignment scheduling transmission(s) including PUSCH on one or more channels or PUCCH on a channel, respectively, as follows:

If the UL transmissions occur within the time interval starting at $t_0$ and ending at $t_0 + T_{CO}$, where

- $T_{CO} = T_{m\,cot,p} + T_g$,

- $t_0$ is the time instant when the eNB/gNB has started transmission on the carrier according to the channel access procedure described in clause 4.1.1,

- $T_{m\,cot,p}$ value is determined by the eNB/gNB as described in clause 4.1.1,

- $T_g$ is the total duration of all gaps of duration greater than $25us$ that occur between the DL transmissions of the eNB/gNB and UL transmissions scheduled by the eNB/gNB, and between any two UL transmissions scheduled by the eNB/gNB starting from $t_0$,

then,

- the eNB/gNB may indicate Type 2 channel access procedures in the DCI if the eNB/gNB has transmitted on the channel(s) according to the channel access procedures described in clause 4.1.1 or the multi-channel access procedures in clause 4.1.6, or
- the eNB may indicate using the 'UL duration and offset' field that the UE may perform a Type 2 channel access procedure for transmissions(s) including PUSCH on a channel in a subframe $n$ when the eNB has transmitted on the channel according to the channel access procedure described in clause 4.1.1, or
- the eNB may indicate using the 'UL duration and offset' field and 'COT sharing indication for AUL' field that a UE configured with autonomous UL may perform a Type 2 channel access procedure for autonomous UL transmissions(s) including PUSCH on a channel in subframe $n$ when the eNB has transmitted on the channel according to the channel access procedure described in clause 4.1.1 and acquired the channel using the largest priority class value and the eNB transmission includes PDSCH, or
- the eNB/gNB may schedule UL transmissions on a channel, that follow a transmission by the eNB/gNB on that channel with Type 2A channel access procedures for the UL transmissions as described in clause 4.2.1.2.1 after a duration of $25\mu s$.

The eNB/gNB shall schedule UL transmissions between $t_0$ and $t_0 + T_{CO}$ without gaps between consecutive UL transmissions if they can be scheduled contiguously. For a UL transmission on a channel that follows a transmission by the eNB/gNB on that channel using Type 2A channel access procedures as described in clause 4.2.1.2.1, the UE may use Type 2A channel access procedure for the UL transmission.

If the eNB/gNB indicates Type 2 channel access procedure for the UE in the DCI, the eNB/gNB indicates the channel access priority class used to obtain access to the channel in the DCI.

For indicating a Type 2 channel access procedure, if the gap is at least $25\mu s$, or equal to $16\mu s$, or up to $16\mu s$, the gNB may indicate Type 2A, or Type 2B, or Type 2C UL channel procedures, respectively, as described in clauses 4.2.1.2.

#### 4.2.1.0.4 Channel access procedures for UL multi-channel transmission(s)

If a UE

- is scheduled to transmit on a set of channels $C$, and if the UL transmissions are scheduled to start transmissions at the same time on all channels in the set of channels $C$, or
- intends to perform an uplink transmission on configured resources on the set of channels $C$, and if UL transmissions are configured to start transmissions at the same time on all channels in the set of channels $C$,

the following is applicable:

- if Type 1 channel access procedure is indicated or intended for the scheduled or configured UL transmissions, respectively, to be transmitted on the set of channels $C$,
    - the UE may transmit on channel $c_i \in C$ using Type 2 channel access procedure as described in clause 4.2.1.2,
        - if the channel frequencies of the set of channels $C$ is a subset of the sets of channel frequencies defined in clause 5.7.4 in [2], and
        - if Type 2 channel access procedure is performed on channel $c_i$ immediately before the UE transmission on channel $c_j \in C$, $i \neq j$, and
        - if the UE has accessed channel $c_j$ using Type 1 channel access procedure as described in clause 4.2.1.1,
            - where channel $c_j$ is selected by the UE uniformly randomly from the set of channels $C$ before performing Type 1 channel access procedure on any channel in the set of channels $C$.
    - the UE may transmit on channel $c_i \in C$ using Type 1 channel access procedure as described in clause 4.2.1.1

- the UE may not transmit on channel $c_i \in C$ within the bandwidth of a carrier, if the UE fails to access any of the channels, of the carrier bandwidth, on which the UE is scheduled or configured with UL resources.

- the UE may not transmit on a channel within the bandwidth of a carrier if the UE is configured without intra-cell guard band(s) on an UL bandwidth part as described in clause 7 of [8], and the UE fails to access any of the channels of the UL bandwidth part.

### 4.2.1.1 Type 1 UL channel access procedure

This clause describes channel access procedures by a UE where the time duration spanned by the sensing slots that are sensed to be idle before a UL transmission(s) is random. The clause is applicable to the following transmissions:

- PUSCH/SRS transmission(s) scheduled or configured by eNB/gNB, or

- PUCCH transmission(s) scheduled or configured by gNB, or

- Transmission(s) related to random access procedure.

A UE may transmit the transmission using Type 1 channel access procedure after first sensing the channel to be idle during the sensing slot durations of a defer duration $T_d$, and after the counter $N$ is zero in step 4. The counter $N$ is adjusted by sensing the channel for additional sensing slot duration(s) according to the steps described below.

1) set $N = N_{init}$, where $N_{init}$ is a random number uniformly distributed between 0 and $CW_p$, and go to step 4;

2) if $N > 0$ and the UE chooses to decrement the counter, set $N = N - 1$;

3) sense the channel for an additional sensing slot duration, and if the additional sensing slot duration is idle, go to step 4; else, go to step 5;

4) if $N = 0$, stop; else, go to step 2.

5) sense the channel until either a busy sensing slot is detected within an additional defer duration $T_d$ or all the sensing slots of the additional defer duration $T_d$ are detected to be idle;

6) if the channel is sensed to be idle during all the sensing slot durations of the additional defer duration $T_d$, go to step 4; else, go to step 5;

If a UE has not transmitted a UL transmission on a channel on which UL transmission(s) are performed after step 4 in the procedure above, the UE may transmit a transmission on the channel, if the channel is sensed to be idle at least in a sensing slot duration $T_{sl}$ when the UE is ready to transmit the transmission and if the channel has been sensed to be idle during all the sensing slot durations of a defer duration $T_d$ immediately before the transmission. If the channel has not been sensed to be idle in a sensing slot duration $T_{sl}$ when the UE first senses the channel after it is ready to transmit, or if the channel has not been sensed to be idle during any of the sensing slot durations of a defer duration $T_d$ immediately before the intended transmission, the UE proceeds to step 1 after sensing the channel to be idle during the sensing slot durations of a defer duration $T_d$.

The defer duration $T_d$ consists of duration $T_f = 16\mu s$ immediately followed by $m_p$ consecutive sensing slot durations where each sensing slot duration is $T_{sl} = 9\mu s$, and $T_f$ includes an idle sensing slot duration $T_{sl}$ at start of $T_f$.

$CW_{min,p} \leq CW_p \leq CW_{max,p}$ is the contention window. $CW_p$ adjustment is described in clause 4.2.2.

$CW_{min,p}$ and $CW_{max,p}$ are chosen before step 1 of the procedure above.

$m_p$, $CW_{min,p}$, and $CW_{max,p}$ are based on a channel access priority class $p$ as shown in Table 4.2.1-1, that is signalled to the UE.

### 4.2.1.2 Type 2 UL channel access procedure

This clause describes channel access procedures by UE where the time duration spanned by the sensing slots that are sensed to be idle before a UL transmission(s) is deterministic.

If a UE is indicated by an eNB to perform Type 2 UL channel access procedures, the UE follows the procedures described in clause 4.2.1.2.1.

#### 4.2.1.2.1 Type 2A UL channel access procedure

If a UE is indicated to perform Type 2A UL channel access procedures, the UE uses Type 2A UL channel access procedures for a UL transmission. The UE may transmit the transmission immediately after sensing the channel to be idle for at least a sensing interval $T_{\text{short\_ul}} = 25\mu s$. $T_{\text{short\_ul}}$ consists of a duration $T_f = 16\mu s$ immediately followed by one sensing slot and $T_f$ includes a sensing slot at start of $T_f$. The channel is considered to be idle for $T_{\text{short\_ul}}$ if both sensing slots of $T_{\text{short\_ul}}$.are sensed to be idle.

#### 4.2.1.2.2 Type 2B UL channel access procedure

If a UE is indicated to perform Type 2B UL channel access procedures, the UE uses Type 2B UL channel access procedure for a UL transmission. The UE may transmit the transmission immediately after sensing the channel to be idle within a duration of $T_f = 16\mu s$. $T_f$ includes a sensing slot that occurs within the last $9\mu s$ of $T_f$. The channel is considered to be idle within the duration $T_f$ if the channel is sensed to be idle for total of at least $5\mu s$ with at least $4\mu s$ of sensing occurring in the sensing slot.

#### 4.2.1.2.3 Type 2C UL channel access procedure

If a UE is indicated to perform Type 2C UL channel access procedures for a UL transmission, the UE does not sense the channel before the transmission. The duration of the corresponding UL transmission is at most $584\mu s$.

## 4.2.2 Contention window adjustment procedures

If a UE transmits transmissions using Type 1 channel access procedures that are associated with channel access priority class $p$ on a channel, the UE maintains the contention window value $CW_p$ and adjusts $CW_p$ for those transmissions before step 1 of the procedure described in clause 4.2.1.1, as described in this clause.

### 4.2.2.1 Contention window adjustment procedures for UL transmissions scheduled/configured by eNB

If a UE transmits transmissions using Type 1 channel access procedures that are associated with channel access priority class $p$ on a channel, the UE maintains the contention window value $CW_p$ and adjusts $CW_p$ for those transmissions before step 1 of the procedure described in clause 4.2.1.1, using the following procedure:

- If the UE receives an UL grant or an AUL-DFI, the contention window size for all the priority classes is adjusted as following:
    - If the NDI value for at least one HARQ process associated with HARQ_ID_ref is toggled, or if the HARQ-ACK value(s) for at least one of the HARQ processes associated with HARQ_ID_ref received in the earliest AUL-DFI after $n_{ref}$+3 indicates ACK,
        - for every priority class $p \in \{1,2,3,4\}$, set $CW_p = CW_{min,p}$;
    - Otherwise, increase $CW_p$ for every priority class $p \in \{1,2,3,4\}$ to the next higher allowed value;
- If there exists one or more previous transmissions $\{T_0, \ldots, T_n\}$ using Type 1 channel access procedure, from the start subframe(s) of the previous transmission(s) of which, N or more subframes have elapsed and neither UL grant nor AUL-DFI was received, where N = max (*contentionWindowSizeTimer*, $T_i$ burst length+1) if *contentionWindowSizeTimer* > 0 and N = 0 otherwise, for each transmission $T_i$, $CW_p$ is adjusted as following:
    - increase $CW_p$ for every priority class $p \in \{1,2,3,4\}$ to the next higher allowed value;
    - The $CW_p$ is adjusted once
- Else if the UE transmits transmissions using Type 1 channel access procedure before N subframes have elapsed from the start of previous UL transmission burst using Type 1 channel access procedure and neither UL grant nor AUL-DFI is received,
    - the $CW_p$ is unchanged.

- If the UE receives an UL grant or an AUL-DFI indicates feedback for one or more previous transmissions $\{T_0, \dots, T_n\}$ using Type 1 channel access procedure, from the start subframe(s) of the previous transmission(s) of which, N or more subframes have elapsed and neither UL grant nor AUL-DFI was received, where N = max (*contentionWindowSizeTimer*, $T_i$ burst length+1) if *contentionWindowSizeTimer* > 0 and N = 0 otherwise, the UE may recompute $CW_p$ as follows:
  - The UE reverts $CW_p$ to the value used to transmit at $n_{T0}$ using Type 1 channel access procedure.
  - The UE updates $CW_p$ sequentially in the order of the transmission $\{T_0, \dots, T_n\}$
    - If the NDI value for at least one HARQ process associated with HARQ_ID_ref' is toggled, or if the HARQ-ACK value(s) for at least one of the HARQ processes associated with HARQ_ID_ref' received in the earliest AUL-DFI after $n_{Ti}$+3 indicates ACK,
      - for every priority class $p \in \{1,2,3,4\}$ set $CW_p = CW_{min,p}$.
    - Otherwise, increase $CW_p$ for every priority class $p \in \{1,2,3,4\}$to the next higher allowed value.
- If the UE transmits transmissions using Type 1 channel access procedure before N subframes have elapsed from the start of previous UL transmission burst using Type 1 channel access procedure and neither UL grant nor AUL-DFI is received,
  - $CW_p$ is unchanged.

HARQ_ID_ref is the HARQ process ID of UL-SCH in reference subframe $n_{ref}$. The reference subframe $n_{ref}$ is determined as follows

- If the UE receives an UL grant or an AUL-DFI in subframe $n_g$ , subframe $n_w$ is the most recent subframe before subframe $n_g - 3$ in which the UE has transmitted UL-SCH using Type 1 channel access procedure.
  - If the UE transmits transmissions including UL-SCH without gaps starting with subframe $n_0$ and in subframes $n_0, n_1, \cdots, n_w$ and the UL-SCH in subframe $n_0$ is not PUSCH Mode 1 that starts in the second slot of the subframe, reference subframe $n_{ref}$ is subframe $n_0$.
  - If the UE transmits transmissions including PUSCH Mode 1 without gaps starting with second slot of subframe $n_0$ and in subframes $n_0, n_1, \cdots, n_w$ and the, reference subframe $n_{ref}$ is subframe $n_0$ and $n_1$,
  - otherwise, reference subframe $n_{ref}$ is subframe $n_w$.

HARQ_ID_ref' is the HARQ process ID of UL-SCH in reference subframe $n_{Ti}$. The reference subframe $n_{Ti}$ is determined as the start subframe of a transmission $T_i$ using Type 1 channel access procedure and of which, N subframes have elapsed and neither UL grant nor AUL-DFI was received.

If the AUL-DFI with DCI format 0A is indicated to a UE that is activated with AUL transmission and transmission mode 2 is configured for the UE for grant-based uplink transmissions, the spatial HARQ-ACK bundling shall be performed by logical OR operation across multiple codewords for the HARQ process not configured for autonomous UL transmission.

If $CW_p$ changes during an ongoing channel access procedure, the UE shall draw a counter $N_{init}$ and applies it to the ongoing channel access procedure.

The UE may keep the value of $CW_p$ unchanged for every priority class $p \in \{1,2,3,4\}$, if the UE scheduled to transmit transmissions without gaps including PUSCH in a set subframes $n_0, n_1, \cdots, n_{w-1}$ using Type 1 channel access procedure, and if the UE is not able to transmit any transmission including PUSCH in the set of subframes.

The UE may keep the value of $CW_p$ for every priority class $p \in \{1,2,3,4\}$ the same as that for the last scheduled transmission including PUSCH using Type 1 channel access procedure, if the reference subframe for the last scheduled transmission is also $n_{ref}$.

#### 4.2.2.2 Contention window adjustment procedures for UL transmissions scheduled/configured by gNB

If a UE transmits transmissions using Type 1 channel access procedures that are associated with channel access priority class $p$ on a channel, the UE maintains the contention window value $CW_p$ and adjusts $CW_p$ for those transmissions before step 1 of the procedure described in clause 4.2.1.1, using the following steps:

1) For every priority class $p \in \{1,2,3,4\}$, set $CW_p = CW_{min,p}$;

2) If HARQ-ACK feedback is available after the last update of $CW_p$, go to step 3. Otherwise, if the UE transmission after procedure described in clause 4.2.1.1 does not include a retransmission or is transmitted within a duration $T_w$ from the end of the *reference duration* corresponding to the earliest UL channel occupancy after the last update of $CW_p$, go to step 5; otherwise go to step 4.

3) The HARQ-ACK feedback(s) corresponding to PUSCH(s) in the *reference duration* for the latest UL channel occupancy for which HARQ-ACK feedback is available is used as follows:

   a. If at least one HARQ-ACK feedback is 'ACK' for PUSCH(s) with transport block (TB) based feedback or at least 10% of HARQ-ACK feedbacks are 'ACK' for PUSCH CBGs transmitted at least partially on the channel with code block group (CBG) based feedback, go to step 1; otherwise go to step 4.

4) Increase $CW_p$ for every priority class $p \in \{1,2,3,4\}$ to the next higher allowed value;

5) For every priority class $p \in \{1,2,3,4\}$, maintain $CW_p$ as it is; go to step 2.

The HARQ-ACK feedback, *reference duration* and duration $T_w$ in the procedure above are defined as the following:

- For the purpose of contention window adjustment in this clause, HARQ-ACK feedback for PUSCH(s) transmissions are expected to be provided to UE(s) explicitly or implicitly where explicit HARQ-ACK is determined based on the valid HARQ-ACK feedback in a corresponding CG-DFI as described in clause 10.5 in [7], and implicit HARQ-ACK feedback is determined based on the indication for a new transmission or retransmission in the DCI scheduling PUSCH(s) as follows:

  - If a new transmission is indicated, 'ACK' is assumed for the transport blocks or code block groups in the corresponding PUSCH(s) for the TB-based and CBG-based transmission, respectively.

  - If a retransmission is indicated for TB-based transmissions, 'NACK' is assumed for the transport blocks in the corresponding PUSCH(s).

  - If a retransmission is indicated for CBG-based transmissions, if a bit value in the code block group transmission information (CBGTI) field is '0' or '1' as described in clause 5.1.7.2 in [8], 'ACK' or 'NACK' is assumed for the corresponding CBG in the corresponding PUSCH(s), respectively.

- The *reference duration* corresponding to a channel occupancy initiated by the UE including transmission of PUSCH(s) is defined in this clause as a duration starting from the beginning of the channel occupancy until the end of the first slot where at least one PUSCH is transmitted over all the resources allocated for the PUSCH, or until the end of the first transmission burst by the UE that contains PUSCH(s) transmitted over all the resources allocated for the PUSCH, whichever occurs earlier. If the channel occupancy includes a PUSCH, but it does not include any PUSCH transmitted over all the resources allocated for that PUSCH, then, the duration of the first transmission burst by the UE within the channel occupancy that contains PUSCH(s) is the *reference duration* for CWS adjustment.

- $T_w = \max(T_A, T_B + 1ms)$ where $T_B$ is the duration of the transmission burst from start of the *reference duration* in $ms$ and $T_A = 5ms$ if the absence of any other technology sharing the channel cannot be guaranteed on a long-term basis (e.g. by level of regulation), and $T_A = 10ms$ otherwise.

If a UE transmits transmissions using Type 1 channel access procedures associated with the channel access priority class $p$ on a channel and the transmissions are not associated with explicit or implicit HARQ-ACK feedbacks as described above in this clause, the UE adjusts $CW_p$ before step 1 in the procedures described in clause 4.2.1.1, using the latest $CW_p$ used for any UL transmissions on the channel using Type 1 channel access procedures associated with the channel access priority class $p$. If the corresponding channel access priority class $p$ has not been used for any UL transmission on the channel, $CW_p = CW_{min,p}$ is used.

### 4.2.2.3 Common procedures for CWS adjustments for UL transmissions

The following applies to the procedures described in clauses 4.2.2.1 and 4.2.2.2:

- If $CW_p = CW_{max,p}$, the next higher allowed value for adjusting $CW_p$ is $CW_{max,p}$.
- If the $CW_p = CW_{max,p}$ is consecutively used $K$ times for generation of $N_{init}$, $CW_p$ is reset to $CW_{min,p}$ only for that priority class $p$ for which $CW_p = CW_{max,p}$ is consecutively used $K$ times for generation of $N_{init}$. $K$ is selected by UE from the set of values {1, 2, …,8} for each priority class $p \in \{1,2,3,4\}$.

## 4.2.3 Energy detection threshold adaptation procedure

A UE accessing a channel on which UL transmission(s) are performed, shall set the energy detection threshold ($X_{\text{Thresh}}$) to be less than or equal to the maximum energy detection threshold $X_{\text{Thresh\_max}}$.

$X_{\text{Thresh\_max}}$ is determined as follows:

- If the UE is configured with higher layer parameter *maxEnergyDetectionThreshold-r14* or *maxEnergyDetectionThreshold-r16*,
    - $X_{\text{Thresh\_max}}$ is set equal to the value signalled by the higher layer parameter;
- otherwise
    - the UE shall determine $X'_{\text{Thresh\_max}}$ according to the procedure described in clause 4.2.3.1;
    - if the UE is configured with higher layer parameter *energyDetectionThresholdOffset-r14* or *energyDetectionThresholdOffset-r16*
        - $X_{\text{Thresh\_max}}$ is set by adjusting $X'_{\text{Thresh\_max}}$ according to the offset value signalled by the higher layer parameter;
    - otherwise
        - the UE shall set $X_{\text{Thresh\_max}} = X'_{\text{Thresh\_max}}$.

If the higher layer parameter *absenceOfAnyOtherTechnology-r16* is not configured to a UE, and the higher layer parameter *ul-toDL-COT-SharingED-Threshold-r16* is configured to the UE, the gNB should use the gNB's transmit power in determining the resulting energy detection threshold *ul-toDL-COT-SharingED-Threshold-r16*.

For the case where a UE performs channel access procedures as described in clause 4.2.1.1 for a UL transmission and CG-UCI is absent in the UL transmission or CG-UCI is present in the UL transmission and indicates COT-sharing information other than 'COT sharing not available', $X_{\text{Thresh\_max}}$ is set equal to the value provided by the higher layer parameter *ul-toDL-COT-SharingED-Threshold-r16*, if provided.

### 4.2.3.1 Default maximum energy detection threshold computation procedure

If the higher layer parameter *absenceOfAnyOtherTechnology-r14* or *absenceOfAnyOtherTechnology-r16* is provided

- $X'_{\text{Thresh\_max}} = min\begin{Bmatrix} T_{max} + 10\text{dB} \\ X_r \end{Bmatrix}$ where
    - $X_r$ is Maximum energy detection threshold defined by regulatory requirements in dBm when such requirements are defined, otherwise $X_r = T_{max} + 10dB$

otherwise

- $X'_{\text{Thresh\_max}} = max\begin{Bmatrix} -72 + 10 \cdot log10(BWMHz/20MHz)\ dBm, \\ \min\begin{Bmatrix} T_{\max}, \\ T_{\max} - T_A + (P_H + 10 \cdot log10(BWMHz/20MHz) - P_{TX}) \end{Bmatrix} \end{Bmatrix}$

where

- $T_A = 10dB$;
- $P_H = 23dBm$;
- $P_{TX}$ is set to the value of $P_{CMAX\_H,c}$ as defined in [3];
- $T_{max}$(dBm)= $10 \cdot log\,10\,(3.16228 \cdot 10^{-8}(mW/MHz) \cdot BWMHz\ (MHz))$;
    - $BWMHz$ is the single channel bandwidth in MHz.

## 4.3 Channel access procedures for semi-static channel occupancy

Channel access procedures based on semi-static channel occupancy as described in this Clause, are intended for environments where the absence of other technologies is guaranteed e.g., by level of regulations, private premises policies, etc. If a gNB provides UE(s) with higher layer parameters *channelAccessMode-r16 ='semiStatic'* by SIB1 or dedicated configuration, a periodic channel occupancy can be initiated by the gNB every $T_x$ within every two consecutive radio frames, starting from the even indexed radio frame at $i \cdot T_x$ with a maximum channel occupancy time $T_y = 0.95T_x$, where $T_x = period$ in $ms$, is a higher layer parameter provided in *SemiStaticChannelAccessConfig* and $i \in \left\{0,1,\ldots,\frac{20}{T_x} - 1\right\}$. For determining a *Channel Occupancy Time* based on semi-static channel access procedures, duration of any transmission gap within $T_y$ is counted in the channel occupancy time.

In the following procedures in this clause, when a gNB or UE performs sensing for evaluating a channel availability, the sensing is performed at least during a sensing slot duration $T_{sl} = 9us$, unless longer sensing duration is required (e.g. by level of regulation), in which case sensing is performed within a duration of $T_{sl} = 16\mu s$. When sensing is performed within a duration of $T_{sl} = 16\mu s$, the channel is considered to be idle if the channel is sensed to be idle for total of at least $5\mu s$ with at least $4\mu s$ of sensing occurring in the last $9\mu s$ time interval in the sensing duration. The corresponding $X_{Thresh}$ adjustment for performing sensing by a gNB or a UE is described in clauses 4.1.5 and 4.2.3, respectively.

A channel occupancy initiated by a gNB and shared with UE(s) satisfies the following:

- The gNB shall transmit a DL transmission burst starting at the beginning of the channel occupancy time immediately after sensing the channel to be idle for at least a sensing slot duration $T_{sl}$. If the channel is sensed to be busy, the gNB shall not perform any transmission during the current period.
- The gNB may transmit a DL transmission burst(s) within the channel occupancy time immediately after sensing the channel to be idle for at least a sensing slot duration $T_{sl}$ if the gap between the DL transmission burst(s) and any previous transmission burst is more than $16\mu s$.
- The gNB may transmit DL transmission burst(s) after UL transmission burst(s) within the channel occupancy time without sensing the channel if the gap between the DL and UL transmission bursts is at most $16\mu s$.
- A UE may transmit UL transmission burst(s) after detection of a DL transmission burst(s) within the channel occupancy time as follows:
    - If the gap between the UL and DL transmission bursts is at most $16\mu s$, the UE may transmit UL transmission burst(s) after a DL transmission burst(s) within the channel occupancy time without sensing the channel.
    - If the gap between the UL and DL transmission bursts is more than $16\mu s$, the UE may transmit UL transmission burst(s) after a DL transmission burst(s) within the channel occupancy time after sensing the channel to be idle for at least a sensing slot duration $T_{sl}$ within a $25\mu s$ interval ending immediately before transmission.
- A UE may be indicated by the gNB to transmit UL transmission burst(s) within the channel occupancy time without sensing the channel or after sensing the channel to be idle for at least a sensing slot duration $T_{sl}$ within a $25\mu s$ interval ending immediately before transmission.
- The gNB and UEs shall not transmit any transmissions in a set of consecutive symbols for a duration of at least $T_z = \max(0.05T_x, 100\mu s)$ before the start of the next period.

If a UE fails to access the channel(s) prior to an intended UL transmission to a gNB, Layer 1 notifies higher layers about the channel access failure.

# Annex X (informative): Change history

| Change history | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2018-04 | RAN1#92 bis | R1-1804453 | | | | First version | 0.0.1 |
| 2018-04 | RAN1#92 bis | R1-1805351 | | | | Removal of FeLAA agreements | 0.0.2 |
| 2018-04 | RAN1#92 bis | R1-1805352 | | | | Addition of FeLAA agreements | 0.0.3 |
| 2018-04 | RAN1#92 bis | R1-1805416 | | | | First endorsed version | 0.1.0 |
| 2018-05 | RAN1#92 bis | R1-1805788 | | | | Correction to FeLAA agreements and alignment with other specifications | 0.1.1 |
| 2018-05 | RAN1#92 bis | R1-1805790 | | | | Second endorsed version | 0.2.0 |
| 2018-05 | RAN1#93 | R1-1807911 | | | | Update based on agreements at RAN1 #93 | 0.2.1 |
| 2018-06 | RAN1#93 | R1-1807932 | | | | Endorsed version | 1.0.0 |
| 2018-06 | RAN#80 | | | | | Spec under change control further to RAN approval decision | 15.0.0 |
| 2018-09 | RAN#81 | RP-181795 | 0001 | 1 | F | Correction on RRC parameters for FeLAA in 37.213 | 15.1.0 |
| 2018-09 | RAN#81 | RP-181795 | 0002 | - | F | Correction on starting position of Partial PUSCH Mode 1 for FeLAA in 37.213 | 15.1.0 |
| 2018-09 | RAN#81 | RP-181795 | 0003 | - | F | Correction on COT length for AUL transmission | 15.1.0 |
| 2019-03 | RAN#83 | RP-190444 | 0004 | - | F | Corrections on channel access procedures in 37.213 | 15.2.0 |
| 2019-12 | RAN#86 | RP-192636 | 0005 | - | B | Introduction of channel access procedures to unlicensed spectrum for NR-based access | 16.0.0 |
| 2020-03 | RAN#87-e | RP-200185 | 0007 | - | F | Corrections to NR-based access to unlicensed spectrum | 16.1.0 |
| 2020-06 | RAN#88-e | RP-200687 | 0008 | - | F | Corrections to NR-based access to unlicensed spectrum | 16.2.0 |
| 2020-06 | RAN#88-e | RP-200687 | 0009 | - | F | Additional corrections to NR-based access to unlicensed spectrum | 16.2.0 |
| 2020-09 | RAN#89-e | RP-201805 | 0010 | - | F | Corrections to NR-based access to unlicensed spectrum | 16.3.0 |
| 2020-12 | RAN#90-e | RP-202381 | 0011 | - | F | CR to 37.213 to correct CP extension and LBT type for SRS | 16.4.0 |
| 2020-12 | RAN#90-e | RP-202381 | 0012 | - | F | CR to 37.213 CR to correct CAPC for RACH | 16.4.0 |
| 2020-12 | RAN#90-e | RP-202381 | 0013 | - | F | CR to 37.213 to correct channel access for SRS | 16.4.0 |
| 2021-03 | RAN#91-e | RP-210049 | 0014 | - | F | Correction on LBT for consecutive UL transmission triggered by DL assignments | 16.5.0 |
| 2021-03 | RAN#91-e | RP-210049 | 0015 | - | F | Correction on LBT Type and CP Extension Indication for Semi-Static Channel Occupancy | 16.5.0 |
| 2021-03 | RAN#91-e | RP-210049 | 0016 | - | F | Correction on Channel Occupancy Time for Semi-Static Channel Access | 16.5.0 |
| 2021-03 | RAN#91-e | RP-210049 | 0017 | - | F | Correction on Channel Access for Multi-Channel transmission | 16.5.0 |
| 2021-06 | RAN#92-e | RP-211234 | 0018 | - | F | Correction on the conditions for DL channel access procedure | 16.6.0 |
| 2021-06 | RAN#92-e | RP-211234 | 0019 | - | F | Clarifying the conditions for indicating Type 2 LBT for wideband scheduled PUSCH | 16.6.0 |
| 2021-12 | RAN#94-e | RP-212961 | 0020 | - | F | UL transmissions in wideband operation | 16.7.0 |
| 2021-12 | RAN#94-e | RP-212961 | 0021 | - | F | Changes of channel access procedure in TS 37.213 according to MIIT regulation | 16.7.0 |
| 2021-12 | RAN#94-e | RP-212961 | 0024 | - | F | Alignment CR for TS 37.213 | 16.7.0 |
| 2022-03 | RAN#95-e | RP-220247 | 0025 | - | F | Correction on channel access procedures for consecutive UL transmissions | 16.8.0 |
| 2022-03 | RAN#95-e | RP-220247 | 0029 | - | F | Rel-16 editorial corrections for TS 37.213 | 16.8.0 |
| 2022-06 | RAN#96 | RP-221599 | 0033 | - | F | Rel-16 editorial corrections for TS 37.213 | 16.9.0 |
| 2022-09 | RAN#97-e | RP-222399 | 0038 | - | F | Rel-16 editorial corrections for TS 37.213 | 16.10.0 |
| 2022-12 | RAN#98-e | RP-222871 | 0039 | - | F | Rel-16 Corrections for sensing slot in channel access procedures | 16.11.0 |

# History

| Document history | | |
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