**3GPP TSG RAN WG1 #106-e R1-2108262**

**e-Meeting, May 16 –27, 2021**

**Source: Moderator (OPPO)**

**Title: FL summary for AI 8.11.1.1 – resource allocation for power saving (before 1st check point)**

**Agenda item: 8.11.1.1**

**Document for:** **Discussion and Decision**

Introduction

In the latest version of Rel-17 [WID](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Docs/RP-202846.zip) for NR sidelink enhancement, the objective for enhancing resource allocation (RA) to reduce UE power consumption in mode 2 is captured as followed.

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| 2. Resource allocation enhancement:   * Specify resource allocation to reduce power consumption of the UEs [RAN1, RAN2]   + Baseline is to introduce the principle of Rel-14 LTE sidelink random resource selection and partial sensing to Rel-16 NR sidelink resource allocation mode 2.   + Note: Taking Rel-14 as the baseline does not preclude introducing a new solution to reduce power consumption for the cases where the baseline cannot work properly.   + This work should consider the impact of sidelink DRX, if any. |

This contribution provides a summary of the submitted contributions, email discussion topics and outcomes during RAN1#106-e meeting. Note that, all past outcomes including agreements, conclusions and working assumptions reached during this WI are captured in Section 5 (5 Appendix) of this document.

Collection of agreements / conclusion in RAN1#106-e

To be collected once agreement is reached.

Topics for email discussion

[106-e-NR-R17-Sidelink-01] Email discussion on resource allocation for power saving– Kevin (OPPO)

* 1st check point: August 19
* 2nd check point: August 25
* 3rd check point: August 27

## Topic #1: Remaining issues in periodic-based partial sensing – additional monitoring occasions not in (pre-)configured Preserve

**Background**: In RAN1#105-e, one remaining issue on UE monitoring periodic sensing occasions is relating to whether the UE should mandatory monitor occasions corresponding to P\_RSVP\_Tx when it is not included in the set of (pre-)configured *P*reserve values. The intention of monitoring occasions corresponding to P\_RSVP\_Tx of the TX UE is to avoid persistent collisions in every transmission period, for which it may be seen more important than monitoring occasions corresponding to other *P*reserve values. Therefore, the following question is asked.

### Question before 1st check point

**Question 3.1: In periodic-based partial sensing, if a single set of *Preserve* values is (pre-)configured and P\_RSVP\_Tx is not included, should the monitoring of periodic sensing occasions corresponding to P\_RSVP\_Tx be made mandatory?**

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| **Company** | **Mandatory (Yes/No)** | **Comments / reasons** |
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### Proposals before 2nd check point

FL observations and comments based on inputs received in Sec. 3.1.1:

* TBD

## Topic #2: Remaining issues in periodic-based partial sensing – working assumption on k values

**Background**: In RAN1#105-e, a working assumption on the k value when it is (pre-)configured for periodic-based partial sensing was made.

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| Agreement:   * For the k value in periodic-based partial sensing for resource (re)selection,   + By default, the UE monitors the most recent sensing occasion for a given reservation periodicity before the resource (re)selection trigger slot n or the first slot of the set of Y candidate slots subject to processing time restriction.   + If (pre-)configured, UE additionally monitors periodic sensing occasions that correspond to a set of values which can be (pre-)configured with at least one value     - (Working assumption) Possible values correspond to the most recent sensing occasion for a given reservation periodicity before the resource (re)selection trigger slot n or the first slot of the set of Y candidate slots, and the last periodic sensing occasion prior to the most recent one for the given reservation periodicity are included.     - FFS: whether/which other values and details of the (pre-)configuration (e.g. max number of values or sensing occasions)     - FFS: whether a value denotes a specific occasion to monitor or the earliest occasion to start the monitoring.   + FFS relationship between periodic-based partial sensing occasions and SL-DRX   + Note:     - This is for the case when the resource (re)selection triggering slot n is expected by UE |

Based on reviewing the Tdocs submitted in this meeting, 1 company suggested to remove the (pre-)configurability of the k value, 4 companies suggested to support more than 2 values for k, 2 companies suggested to set an upper bound of k values, and 4 companies explicitly mentioned to confirm the working assumption. However, it is observed no simulation result is provided in this meeting showing benefits from monitoring periodic sensing occasions other than according to the existing working assumption. Therefore, from moderator’s perspective, it is proposed to confirm the WA so that we can move forward to discussing the format / how to indicate the k value.

According to the first GTW session on (August 16th), some concerns are raised on confirming the working assumption due to the following reasons:

* If k value is (pre-)configured, additional sensing occasions should not include the most recent one.
* If k value is only restricted to the most recent one and the one before, it does not provide a lot of flexibility.
* Relationship between periodic sensing occasions and SL-DRX is unclear.

From the discussions in the past few meetings, it is clear that periodic sensing occasions most recent to the time of resource (re)selection contain the most up-to-date information. Simulation results have shown that the most recent one and the one before that would provide the most performance gain. And hence the flexibility is not a critical issue in selecting periodic sensing occasions. As for periodic-based partial sensing operation when SL-DRX is configured, it is still an FFS point in the last meeting’s agreement.

### Proposals before 1st check point

**Proposal 3.2:**

* **Option 1: Confirm the working assumption made in RAN1#105-e for periodic-based partial sensing.**
* **Option 2: Update the working assumption as:**
  + (Working assumption) Possible value include the last periodic sensing occasion prior to the default occasion for the given reservation periodicity.
* **Option 3: Update the working assumption as:**
  + (Working assumption) Possible values include the last 3 periodic sensing occasions prior to the default occasion for a given reservation periodicity.
* **Option 4: Come back after a decision is made on UE performing partial sensing in SL-DRX inactive duration**

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| **Company** | **Option 1, 2, 3 and/or 4** | **Comments** |
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### Proposals before 2nd check point

FL observations and comments based on inputs received in Sec. 3.2.1:

* TBD

## Topic #3: Periodic-based partial sensing – sensing occasions between slot n and first slot of Y

**Background**: In RAN1#105-e, one of the remaining issues in periodic-based partial sensing is related to whether UE monitoring periodic sensing occasions between slot n or the first slot of the set of Y candidate slots should be part of resource (re)selection or re-evaluation/pre-emption checking. Observing from the Tdoc review in this meeting, the reasons cited that the monitoring of these sensing occasion should be part of resource (re)selection include (supported by 9 companies):

* Reduced power consumption from not monitoring sensing occasions before slot n
* More up-to-date/accurate CBR measurements
* Aligned with the LTE-V2X rule
* Identification and reporting of candidate resources set can be later than slot n in aperiodic transmissions

On the other hand, the main reason for monitoring the occasions as part of re-evaluation / pre-emption checking is to align with R16 behaviour (supported by 3 companies).

Based on the above reasons and support, the following is proposed by the moderator.

### Proposals before 1st check point

**Proposal 3.3:**

* **Alt. 1: In periodic-based partial sensing, UE monitoring of periodic sensing occasions between triggering slot n and the first slot of the selected Y candidate slots subject to processing time restriction is performed as part of resource (re)selection**
* **Alt. 2: In periodic-based partial sensing, UE monitoring of periodic sensing occasions between triggering slot n and the first slot of the selected Y candidate slots subject to processing time restriction is performed as part of re-evaluation and pre-emption checking**

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| **Company** | **Alt. 1 or 2** | **Comments** |
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### Proposals before 2nd check point

FL observations and comments based on inputs received in Sec. 3.3.1:

* TBD

## Topic #4: Contiguous partial sensing – triggering conditions

**Background**: In RAN1#104-e, it was agreed to further study the condition(s) in which contiguous partial sensing is performed by UE. In RAN1#105-e, the discussion on a set of triggering conditions was started, but without a successful outcome due to lack of time. I think we are quite close to an agreeable description. Let’s continue this discussion, aiming for an agreement to close the issue in this meeting.

Taking the latest version from last meeting’s discussion and removing the controversial points, the following is proposed.

### Proposals before 1st check point

**Proposal 3.4: Conditions in which contiguous partial sensing is performed by UE, when at least all of the followings are met:**

* **L1 is triggered to perform resource (re)selection in a mode 2 Tx pool**
  + **Contiguous partial sensing is performed before and/or after the resource (re)selection trigger**
  + **Note, contiguous partial sensing for re-evaluation and pre-emption checking are discussed separately**
* **The resource pool is (pre-)configured to enable partial sensing**
* **Partial sensing is configured by higher layer in the UE**

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| **Company** | **Comments** |
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### Proposals before 2nd check point

FL observations and comments based on inputs received in Sec. 3.4.1:

* TBD

## Topic #5: Resource (re)selection process in resource pool with reservation for another TB enabled (PBPS+CPS)

**Background**: In the last meeting (#105-e), RAN1 started discussion on L1 resource (re)selection process for periodic transmissions, where it was proposed (also by majority views) that periodic-based partial sensing (PBPS) and contiguous partial sensing (CPS) should be performed by the Tx UE to detect both SPS and dynamic reservations from other UEs. In addition, sensing results from both partial sensing schemes should apply to the same resource selection window (RSW) and same set of Y candidate slots. However, the main contention point was whether the same process should be applied for aperiodic transmission as well, since there is no guarantee that the selected Y candidate slots from PBPS will be always available / fall within the RSW of aperiodic transmissions, due to e.g., short PDB for the aperiodic transmission or sparse Y.

To this end, it is proposed to handle them in separate proposals, Proposal 3.5-1 and Proposal 3.5-2.

### Proposals before 1st check point

**Proposal 3.5-1: When a resource (re)selection procedure is triggered for periodic transmission in a mode 2 Tx pool with periodic reservation for another TB (sl-MultiReserveResource) enabled, if UE performs both periodic-based and contiguous partial sensing schemes,**

* **A set of candidate resource (*SA*) is initialized according to the set of selected *Y* candidate slots from the periodic-based partial sensing**
* **UE performs resource exclusion from the set *SA* based on sensing results of the two partial sensing schemes and according to step 6) of Rel-16 TS 38.214 Sec. 8.1.4**
  + **FFS whether PSCCH decoding and RSRP measurement performed during SL DRX active duration should be also used during the resource exclusion**
* **FFS whether/how to exclude resources due to non-monitored slots during periodic-based and contiguous partial sensing**
* **Note, re-evaluation and pre-emption checking based on periodic-based and contiguous partial sensing schemes is considered separately.**

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| **Company** | **Comments** |
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**Proposal 3.5-2: When a resource (re)selection procedure is triggered for an aperiodic transmission in a mode 2 Tx pool, if UE performs contiguous partial sensing,**

* **The resource selection window (RSW) is [*n+T1*, *n+T2*], and *T1* and *T2* are defined in the same way according to step 1) of Rel-16 TS 38.214 Sec. 8.1.4**
* **If UE has an on-going periodic-based partial sensing process in the same mode 2 Tx pool and there are at least *Ymin* (pre-)configured slots from the periodic-based partial sensing *Y* candidate slots located within the RSW of the triggered resource (re)selection procedure,** 
  + **A set of candidate resource (*SA*) is initialized according to all the slots of the set of selected *Y* candidate slots that are located within the RSW**
  + **UE performs contiguous partial sensing according to the initialized candidate resource set (*SA*)**
    - **FFS details of *TA* and *TB***
* **If UE is not performing periodic-based partial sensing or less than *Ymin* (pre-)configured slots of an on-going periodic-based partial sensing *Y* candidate slots are located within the RSW of the triggered resource (re)selection procedure in the same mode 2 Tx pool,**
  + **UE performs contiguous partial sensing based on [*n+TA*, *n+TB*]**
    - **FFS details of *TA* and *TB***
  + **A set of candidate resource (*SA*) is initialized for all candidate single-slot resources after the contiguous partial sensing in the remaining RSW [*n+TB+Tproc0+Tproc1*, *n+T2*]**
* **UE performs resource exclusion from the set *SA* based on at least all available sensing results and according to step 6) of Rel-16 TS 38.214 Sec. 8.1.4**
  + **FFS whether PSCCH decoding and RSRP measurement performed during SL DRX active duration should be also used during the resource exclusion**
* **FFS whether/how to exclude resources due to non-monitored slots**
* **Note, re-evaluation and pre-emption checking for aperiodic transmission is considered separately.**

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| **Company** | **Comments** |
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### Proposals before 2nd check point

FL observations and comments based on inputs received in Sec. 3.5.1:

* TBD

## Topic #6: Random resource selection – in a resource pool with mixed RA schemes

**Background**: The issue of a low priority randomly selected transmission colliding with higher priority transmission in a resource pool configured with mixed RA schemes (full/partial sensing and random selection) and the low priority transmission is performed by a UE with no sensing capability (e.g., Type A and Type B UEs) such that it cannot perform re-evaluation / pre-emption checking to re-select its resource has been identified and raised for several meetings by many companies. Various solutions are proposed in this meeting.

### Proposals before 1st check point

**Proposal 3.6: For random resource selection in a resource pool (pre-)configured with full/partial sensing and random resource selection, select one of the followings**

* **Option 1: A priority threshold value or a range of priority levels is (pre-)configured for the resource pool, below or within which random resource selection is allowed** 
  + **Note, lower value means higher priority**
* **Option 2: Increase the priority for the transmission based on random selection and indicate the new priority value in the priority field in the 1st-stage SCI**
  + **An extra field is added in SCI for indicating the original priority value associated with QoS requirement, or**
  + **A 1-bit field in the SCI indicates that the UE is performing random resource selection.**
* **Option 3: Different RSRP thresholds or increased RSRP threshold value is (pre-)configured for different resource allocation scheme.**
* **Option 4: UE reports whether one candidate resource overlaps with resources reserved by random resource selection UE to higher layer for further resource selection.**
* **Option 5: Set priority of transmission with random resource selection to lowest priority; or set priority of transmission with random resource selection to be lower than**
* **Option 6: Higher priority is given to the resources reserved by random selection, to preserve these selected resources from being pre-empted by other UEs. E.g., a 1-bit field in the SCI indicates that the UE is performing random resource selection.**

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| **Company** | **Yes/No** | **Comments** |
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### Proposals before 2nd check point

FL observations and comments based on inputs received in Sec. 3.6.1:

* TBD

## Topic #7: Re-evaluation and pre-emption checking

**Background**: In RAN1#103-e, the following agreement on re-evaluation and pre-emption checking is made. In this meeting, further progress should be made on this topic for UE performs random resource selection or partial sensing.

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| Agreements:   * Re-evaluation and pre-emption checking are not supported by UEs that do not perform any sensing (i.e. PSCCH reception) * Re-evaluation and pre-emption checking are supported by UEs that perform sensing   + FFS details and any conditions(s) in which re-evaluation and pre-emption can be performed * FFS whether/how re-evaluation and pre-emption can be supported by UEs performing random resource selection that do perform sensing * Note: details about sensing in this context, including when it is performed, are not decided yet. |

### Proposals before 1st check point

**Proposal 3.7: For a resource pool (pre-)configured with at least partial sensing and UE is configured by its higher layer for partial sensing,**

* **Re-evaluation and pre-emption checking are performed for all pre-selected and reserved resources, respectively**
  + **Pre-emption checking is performed when *sl-PreemptionEnable* is provided and enabled**
* **The triggering of re-evaluation and pre-emption checking is at least at ‘m – T3’**
* **The higher layer indicates a set of resources and a set of resources for re-evaluation and pre-emption checking, respectively**
  + **FFS whether MAC layer should indicate the set of resources earlier such that L1 is able to determine the timing to start partial sensing**
* **Periodic-based partial sensing and contiguous partial sensing schemes are supported for resource re-evaluation and pre-emption checking**

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| **Company** | **Yes/No** | **Comments** |
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### Proposals before 2nd check point

FL observations and comments based on inputs received in Sec. 3.6.1:

* TBD

Contribution summary for power saving RA

## Periodic-based partial sensing

* On *P*reserve, to determine periodic sensing occasions
  + The UE may additionally monitor occasions corresponding to , whether this additional monitoring should be made mandatory or it is up to UE implementation?
    - UE implementation / not mandated: [1/HW, HiSi], [2/Nokia, NSB], [3/vivo], [19/ETRI], [20/MTK], [25/DCM], [32/E///], [33/CATT, GH]
    - Mandatory: [6/Sony], [16/OPPO], [17/QC], [28/IDC]
* Value for k
  + Confirm the working assumption made in #105-e (i.e., k = the most recent two occasions)
    - Yes: [2/Nokia, NSB], [16/OPPO], [20/MTK], [32/E///]
    - Modify/remove the working assumption: [25/DCM]
    - Simulation results:
      * [1/HW, HiSi]: We observed k = most recent two outperforms k = most recent one with an increase of 20m in communication range at PRR = 99%
  + Maximum or additional values for k
    - Maximum value for k
      * More than 2 (pre-configured): [11/Futurewei], [19/ETRI]
      * 4: [1/HW, HiSi], [22/Intel]
      * 8: [1/HW, HiSi]
      * [23/Apple]: when more than the most recent sensing occasion for a given resource reservation periodicity *Preserve* needs to be monitored, the product of the resource reservation periodicity *Preserve* and its corresponding *k* value is upper bounded by a (pre)configured threshold.
      * [29/ZTE, Sanechips]: The upper boundary of k value should be (pre-)configured. UE determines k value by UE implementation.
  + How to indicate/represent the k value:
    - [1/HW, HiSi]: an integer value representing number of k values (2, 4 or 8)
    - [2/Nokia, NSB]: the (pre-)configuration can be implemented e.g. with ‘enabled’, rather than with a specific k value.
    - [3/vivo], [24/Sharp], [11/Futurewei], [31/ITL]: using a bitmap
      * For a candidate slot , UE shall monitor slots if the *k*-th bit in the bitmap is (pre-)configured as ‘1’, where is the most recent sensing occasion before the resource selection triggering slot *n* or the first slot of the *Y* candidate slots. [24/Sharp]
    - [16/OPPO]: k = [the most recent one, the last one before the most recent one]
      * It is then up to the UE to derive the exact k value for the equation.
* Monitoring sensing occasions between slot n or the first slot of the set of Y candidate slots should be part of resource (re)selection or re-evaluation/pre-emption checking
  + Part of resource (re)selection procedure:
    - Reasons:
      * Reduced power consumption from not monitoring sensing occasions before slot n, since the sensing occasions would contain more up-to-date reservation information.
      * More up-to-date/accurate CBR measurements from inclusion of periodic sensing occasions and contiguous partial sensing results between n and first slot of Y for resource (re)selection.
      * Aligned with the LTE-V2X rule.
      * For aperiodic transmission, identification and reporting of candidate resources set can be later than the triggering slot n (i.e., *TA* and *TB* can be positive values).
    - Support company:
      * [1/HW, HiSi], [2/Nokia, NSB], [12/NEC], [23/Apple], [16/OPPO], [18/CMCC], [21/LGE], [30/ASUSTeK], [33/CATT, GH]
  + Part of re-evaluation/pre-emption checking procedure:
    - Reasons:
      * Align with R16 procedure.
    - Support company:
      * [17/QC], [26/Xiaomi], [32/E///]
* Identification of Y candidate slots (within resource selection window)
  + When PSFCH is configured, HARQ RTT related timing restriction should be considered when UE determines the “Y” candidate slots. [10/Fujitsu]
  + Specify a new list of X for partial sensing or set new rules for partial sensing on X with the existing list sl-TxPercentageList. [11/Futurewei], [21/LGE]
  + Minimum number of candidate slots Y (*Ymin*) is determined based on [21/LGE]
    - Transmission packet priority, [6/Sony], [10/Fujitsu], [12/NEC], [16/OPPO], [18/CMCC], [22/Intel] (1..32), [28/IDC]
    - QoS requirement,
    - congestion/interference level, [6/Sony], [10Fujitsu], [33/CATT, GH]
    - HARQ feedback enabled/disabled,
    - remaining PDB,
    - resource re-evaluation or pre-emption checking enabled/disabled, or
    - number of PSCCH/PSSCH resources to be selected [23/Apple]
  + The selected Y candidate slots include at least the slots corresponding to the resources subject to pre-emption check and/or re-evaluation. [24/Sharp]
* Conditions and timing to perform periodic-based partial sensing
  + When a resource pool enables periodic reservation, periodic-based partial sensing shall be always performed with no conditions under which the UE may disable it. [1/HW, HiSi]
  + When UE performs aperiodic transmission in a resource pool where periodic transmission is enabled, a ‘default’ periodic-partial sensing regardless of resource (re)selection triggering can be performed to avoid collisions with other UE’s periodic traffic. [21/LGE], [20/MTK]
  + In resource pool with enabled semi-persistent reservations, the use of periodic-based partial sensing for transmissions without semi-persistent reservation is left up to UE implementation [22/Intel]
* Others (e.g., how to handle insufficient sensing results, additional conditions to perform PBPS)
  + When the number of candidate slots for which periodic-based partial sensing is performed is less than the (pre-)configured min. Y candidate slots (Ymin), down select one of the followings for resource selection. [21/LGE], [1/HW, HiSi], [16/OPPO]
    - Reuse Rel-14/Rel-16 mechanism, i.e., a UE performs random resource selection in the exceptional resource pool [1/HW, HiSi], [21/LGE]
      * If optimizations are introduced, they should be for high-QoS traffic (the priority value is lower than a priority value threshold configured for the resource pool), where a UE performs random resource selection in the resource pool configured to allow performing random resource selection.
    - Random resource selection in a normal resource pool configured with random resource selection [21/LGE], [16/OPPO], [12/NEC]
    - Resource selection only based on contiguous partial sensing [21/LGE]
      * Plus all applicable periodic-based partial sensing results (e.g. there may still be some Y candidate slots within the RSW) [16/OPPO]
  + The maximum number of monitored occasions for a UE performing periodic-based partial sensing should be limited, e.g., by (pre-)configuration [3/vivo]
  + UE uses assistance information messages in order to obtain the required sensing information for carrying out reliable resource selection. [9/Fraunhofer]
    - To utilize assistance information from assistance entities, providing a set of resources that power saving UEs can use for increased reliability in their resource selection procedure. [27/Convida]
  + Up to UE implementation to handle when the UE has insufficient sensing results [18/CMCC]
  + When a single set of Preserve values is (pre-)configured, the UE mandatorily monitors Preserve corresponds to all values from the (pre-)configured set *sl-ResourceReservePeriodList* in case of unmonitored slots. [18/CMCC]
  + In periodic-based partial sensing, an upper limit of the number of RSRP threshold increments or the maximum value of increased RSRP threshold can be configured. When the upper limit or the maximum value is reached, UE increases the number of determined set of slots. [18/CMCC]
  + Periodic-based partial sensing can be performed by TX UE at least when *TRSVP* is provided and not equal to zero, in addition to the conditions agreed in RAN1#104b-e. [7/Samsung]
  + Sensing occasions including the most recent one before the first candidate slot subject to UE processing time (Tproc,0+Tproc,1) is (pre-)configured [21/LGE]
  + A candidate resource is excluded from the idle resource set if a collision is detected over any sensing occasion with a reference to each of the *Cresel* transmissions [21/LGE]
  + When a collision is detected with a reference to the monitored Prsvp\_RX, any candidate slot corresponding to the M multiples of Prsvp\_RX is excluded from the idle resource set if Prsvp\_RX is below a threshold, as same as in the NR-V2X rule [21/LGE]
  + A slot is excluded if all of the *k* sensing occasions for each *Preserve* were not monitored for this slot. And each sensing occasions is treated independently for the SL-RSRP based candidate resource exclusion. [22/Intel], [12/NEC]
  + If periodic-based partial sensing information is not sufficient, [22/Intel]
    - UE selects resources based on partial sensing procedures designed for dynamic transmissions
    - UE is not allowed to use semi-persistent reservation
  + Sufficient amount of periodic-based partial sensing information is determined by the following condition: [22/Intel]
    - *N*⸱*PTX* > *Preserve\_threshold* where
      * *N* – number of TBs transmitted without semi-persistent reservation configured for given PTX
      * *PTX* – reservation period for transmission
      * *Preserve\_threshold* – pre-configured threshold which is one of the *Preserve* values
  + Periodic-based partial sensing is applied regardless is zero or not, and all sensing results corresponding to a set of *Y* candidate slots, *k*, and Preserve are available. [25/DCM]
    - FFS when only a part of periodic-based partial sensing results is available
  + For periodic-based partial sensing RA, resource exclusion/selection should be performed at packet arriving time of slot n as well as the resource (re-)selection triggering time. [33/CATT, GH]
  + For periodic-based partial sensing RA, an additional resource (re-)selection checking time should be defined at the first slot of the set of Y candidate slots subject to processing time restriction. [33/CATT, GH]
    - Resource selection checking is based on the completed periodic-based partial sensing at the additional resource (re-)selection checking time.
    - The detected unavailable pre-selected resource(s) after checking should be re-selected.
  + Periodic-based partial or contiguous partial sensing can be (pre-)configured to operate independently or jointly in one resource pool. [29/ZTE, Sanechips]

## Contiguous partial sensing

* Conditions to perform contiguous partial sensing
  + All traffic types: periodic and aperiodic (without periodic reservation) transmissions
    - [1/HW, HiSi], [16/OPPO],
  + Conditions in which contiguous partial sensing is performed by UE, at least all of the followings are met: [1/HW, HiSi], [16/OPPO], [25/DCM]
    - L1 is expected to be triggered or is triggered to perform resource (re)selection procedure in a mode 2 Tx resource pool.
    - The resource pool is (pre-)configured to enable partial sensing.
    - Partial sensing configured by higher layer in the UE.
  + Min. contiguous partial sensing window length (*WCPSmin*) is (pre-)configured per resource pool. [21/LGE]
  + Condition(s) in which contiguous partial sensing is performed by UE, at least all of the followings are met: [33/CATT, GH]
    - The resource pool is (pre-)configured to enable contiguous partial sensing
    - Contiguous partial sensing configured by higher layer in the UE
* Sensing window [n+*TA*, n+*TB*] determination
  + *TA* and *TB* values are dependent on:
    - Resource pool with enabled/disabled periodic reservation: [1/HW, HiSi]
    - Periodic or aperiodic traffic: [7/Samsung], [16/OPPO], [25/DCM], [28/IDC]
    - TB -TA, depends on the remaining value of the PDB, the minimum resource selection window for a specific transmission, and CBR/CR metrics [32/E///]
    - The maximum contiguous partial sensing window is 31 slots. [28/IDC]
    - Minimum contiguous sensing duration (not larger than 31 logical slots) should be defined and (pre-)configured at least considering priority and latency requirements. [33/CATT, GH]
  + For periodic transmissions,
    - [1/HW, HiSi], [18/CMCC]: *n*+*T*A = and *n*+*T*B =  (including aperiodic Tx in periodic reservation RP and Y slots within PDB)
    - [18/CMCC] for Y slots not within PDB: and, where is a (pre-)configured value of the contiguous partial sensing window size
    - [3/vivo]: TA = max(0, T1-31), TB = T1-Tproc,0- Tproc,1
    - [16/OPPO]: *n*+*T*A ≥ and *n*+*T*B ≤
    - [20/MTK]: *n*+*T*A ≥ and *n*+*T*B ≥ , where is the last Y candidate slot
    - [10/Fujitsu]: and
    - [11/Futurewei]: *n*+*T*A ≥ and *n*+*T*B = *n+[T*B,min, *T*B,max*]*
    - [26/Xiaomi]: and
    - [22/Intel]:
      * Two alternatives for TA:
        + TA within a range: –max(*tn-M*, resource selection window size) ≤ TA ≤ 1 slot, where tn-N is the distance in physical slots to the slot that is *M* logical slots before the slot with physical index n
        + TA within a range: –max((∆A + tn-*M*), resource selection window size) ≤ TA ≤ 1 slot, where tn-N is the distance in physical slots to the slot that is *M* logical slots before the slot with physical index n, the value of ∆A depends on the maximum time required for switching from sleep state to the monitoring/sensing state
      * TB = ∆B – T3 ≤ PDB, where the value ∆B is determined by slot corresponding to the last retransmission of a given TB or HARQ feedback, T3 is processing delay in slots
    - [23/Apple]: and
    - [7/Samsung]: and
    - [21/LGE]: and *,* where *WCPS* isnot smaller than a (pre-)configured *WCPSmin*
    - [24/Sharp]: (subject to processing time) and , where is the minimum of values
    - [12/NEC]: [y\_k -31, y\_k – T\_1 – T\_proc,0]
    - [25/DCM]: and , where is the resource selection timing
    - [28/IDC]: *n+TA =* and *n+TB =* , where is the first slot of the *Y* candidate slots.
    - [29/ZTE, Sanechips], [19/ETRI]: [*n*1, *n*2-*T*proc], where n1 and n2 are respectively the triggering times for the start and end of the contiguous partial sensing window indicated by higher layer
  + For aperiodic transmissions,
    - [1/HW, HiSi]: *n*+*T*A = and *n*+*T*B = (periodic reservation disabled RP)
    - [3/vivo]: TA = max(0, T1-31), TB = T1-Tproc,0- Tproc,1
    - [7/Samsung]: and , where is the first logical slot in the resource selection window
    - [20/MTK]: *n*+*T*A ≥ and *n*+*T*B ≥ , where is the last Y candidate slot
    - [10/Fujitsu]: andare positive integers and
    - [11/Futurewei]: *T*A = 1 and TB < 31-
    - [16/OPPO]: *T*A ≥ 0, 0 ≤ TB-TA ≤ 31, T2-TB ≥ Ymin
    - [18/CMCC]: and
    - [23/Apple]: and
    - [22/Intel]:
      * TA = 1 slot or TA ≤ ∆A, where ∆A is the max time for UE to switch from a sleeping state to monitoring state needs to be considered. ∆A = 1 meaning that the monitoring window starts at slot ‘n+1’
      * TB = ∆B – T3 ≤ PDB, where the value ∆B is determined by slot corresponding to the last retransmission of a given TB or HARQ feedback, T3 is processing delay in slots
    - [25/DCM]: and , where and is the resource selection timing
    - [28/IDC]: *TA* and *TB* can be zero or positive, the sensing window (*TB*-*TA*) is (pre-)configured per priority and can be zero.
    - [29/ZTE, Sanechips], [19/ETRI]: [*n*1, *n*2-*T*proc], where n1 and n2 are respectively the triggering times for the start and end of the contiguous partial sensing window indicated by higher layer
* Definition of resource selection window (RSW), candidate resource set (SA)
  + [1/HW, HiSi], [25/DCM]:
    - In a periodic reservation enabled RP, SA is initialised based on Y candidate slots regardless of transmission type (periodic or aperiodic). Only one SA is initialised for both periodic-based and contiguous partial sensing and reported to MAC.
    - When periodic reservation is disabled in a RP, Y candidate slots are selected within a RSW (which is defined per R16) and SA is initialised for the selected Y. Only contiguous partial sensing is performed by UE for resource exclusion.
  + RSW for contiguous partial sensing in periodic transmissions is between [n+T1, n+T2] as per R16
    - [7/Samsung], [16/OPPO]
  + RSW for contiguous partial sensing in aperiodic transmissions is between [n+T1, n+T2] as per R16
    - [16/OPPO]
  + UE selected Y candidate slots after resource (re)selection trigger slot n: [1/HW, HiSi], [25/DCM]
    - Y candidate slots is selected with a constraint of , where is (pre-)configured. [25/DCM]
  + RSW window or a set of slots for selection is confined within a selected/configured resource set. [17/QC]
  + For aperiodic transmission, RSW is determined as: [21/LGE]
    - *T1 ≥ WCPSmin*, the (pre-)configured min. contiguous partial sensing window length
    - *T2 ≥ T1+ WSELmin*, the min. selection window length, which is (pre-)configured per priority, similar to T2min defined in Rel.16 NR-V2X
  + For aperiodic transmission,when the resource (re)selection is triggered at slot n, if a PDB is shorter than the sum of min. contiguous partial sensing window length (*WCPSmin*) and min. selection window length (*WSELmin*), [21/LGE]

If *PDB > WSELmin*,

Resource selection based on the contiguous partial sensing on [*n, n+PDB- WSELmin- TProc,0 - TProc,1*] duration, where and are the required UE processing time.

Else if PDB = WSELmin,

Random resource selection within PDB in a resource pool, if allowed

Else (down-select)

Alt 1. Transmission drop

Alt 2. Random resource selection on the exceptional resource pool

* + When a resource (re)selection procedure is in a mode 2 Tx pool with reservation for another TB enabled, if UE is configured with both periodic-based and contiguous partial sensing for the resource (re)selection procedure, the sensing results of the two schemes does not have be applied to the same resource selection window. [33/CATT, GH]

## Random resource selection (including mixed full/partial sensing with random selection in a same pool)

* Identified issue 1: Randomly selected transmission by UE with no sensing capability and no re-evaluation and pre-emption checking in a resource pool configured with mixed RA schemes [1/HW, HiSi] – shown PRR degradation to full sensing UE, [2/Nokia, NSB], [7/Samsung], [11/Futurewei], [16/OPPO], [25/DCM],
  + Observations from simulations
    - [1/HW, HiSi]: 1~4% PRR degradation to full sensing UEs
    - [17/QC]: Considerable PRR degradation only to random selection UEs
  + Solutions
    - A priority threshold is configured for a resource pool, at which reduced sensing UEs can select resources in a pool configured for mixed types of RA [2/HW, HiSi] – results
    - Introduce priority threshold to enable/disable transmissions based on random resource selection within certain priority levels [22/Intel], [14/CAICT]
    - Introduce minimum time gap ZR (in physical slots) between transmissions of the same TB based on random resource selection, among the following alternatives [22/Intel]
      * Alt.1: ZR = Tproc,0 + Tproc,1
      * Alt.2: ZR = Z (same as for SL HARQ feedback minimum time gap for PSFCH periodicity K=1)
    - Increase the priority for UE with random selection [28/IDC] [19/ETRI] [20/MTK] and use the corresponding priority value in the priority field in the 1st-stage SCI. [2/Nokia, NSB], [11/Futurewei]
      * An extra field is added in SCI for indicating the original priority value associated with QoS requirement. [2/Nokia, NSB]
        + For backward compatibility with Rel-16 UEs, support of applying conditions (such as resource selection per a TB or consecutive TBs, CBR conditions, etc.) to control random resource selection may be considered.
      * A 1-bit field in the SCI indicates that the UE is performing random resource selection. [11/Futurewei]
    - Different RSRP thresholds or increased RSRP threshold value is (pre-)configured for different resource selection scheme; [18/CMCC], [23/Apple] Or UE reports whether one candidate resource overlaps with resources reserved by random resource selection UE to higher layer for further resource selection. [18/CMCC]
    - For NR SL random resource selection, consider partitioning of candidate SL resources into sub-pools to reduce collision probability and improve PRR of high priority traffic. [7/Samsung], [11/Futurewei]
      * Assign a priority threshold on the sub-pool for random resource selection [11/Futurewei], [6/Sony]
      * For a resource pool enables combination of full sensing, partial sensing and random selection, it could be pre-segregated into corresponding portions for each sensing/selection scheme to achieve more efficient resource utilization [8/Pana]
    - UEs carrying out sensing are restricted in its usage of resource pools with random resource selection enabled. [9/Fraunhofer]
    - Set priority of UE with random resource selection to lowest priority; or set priority of UE with random resource selection to be lower than [16/OPPO]
    - Higher priority is assigned to the resources reserved by a UE performing random selection, to preserve these selected resources from being pre-empted by other UEs. [3/vivo], [9/MTK], [22/ETRI]
    - Excludes resources reserved by UE performing random selection without re-evaluation / pre-emption checking, regardless of their priorities [25/DCM]
    - Random selection UE with high priority can reserve the resource by sending reservation indication before its data transmission [29/ZTE, Sanechips]
* Identified issue 2: Persistent collision between a random resource selecting UE with other UEs due to same reservation period [1/HW, HiSi], [2/Nokia, NSB]
  + Due to contiguous NACK for multiple TBs across consecutive periods, when using random selection, reception of NACK across multiple periods of a periodic reservation is a condition for (re-)selecting resources by using exclusion (to turn on sensing). FFS how many periods are required to trigger (re-)selection. [1/HW, HiSi], [2/Nokia, NSB]
  + For periodic transmissions, UE alternates between two resources (e.g., one periodic resource for odd-numbered transmissions and another one for even-numbered transmissions. [11/Futurewei]
  + UE with reception capability of PSFCH can reselect the resource according to the HARQ feedback information to reduce periodically collision occasions. [33/CATT, GH]
  + UEs with different reception capabilities, they are configured with different priorities for the reserved resources by random selection. [33/CATT, GH]
* Assistant information can be provided via sidelink signalling to the UEs performing random selection, e.g, [4/Spreadtrum]
  + among multiple resource pools pre-configured to power saving UEs with random selection permitted
  + RSU can instruct such UEs at least one resource pool to be used via sidelink signaling
  + selection of resource pool can be based on RSU’s CBR measurements
* For aperiodic traffic, if random selection is selected, a random selection dedicated resource pool can only be used [4/Spreadtrum]
* Resource pools with random resource selection enabled are defined with PSFCH disabled. [9/Fraunhofer]
  + Restrict the maximum number of blind retransmissions to be carried out based on the priority of the transmission
* The frequency that a UE performs random resource selection should be restricted (e.g., a minimum duration can be defined between two consecutive triggering of random selections) [26/Xiaomi]
* Conditions / cases in which the UE perform random resource selection in a resource pool: [22/Intel]
  + UE does not have sidelink RX chain to perform sidelink sensing (i.e. Type A UE)
  + UE is configured to operate in power saving resource allocation mode
  + Remaining PDB lower than a given PDB threshold [14/CAICT]
* For random resource selection, the starting subchannel indexes for the reserved resources are pseudo-randomly changed based on Source ID. [19/ETRI]
* In random selection, HARQ feedback can be enabled under the following conditions: [21/LGE]
  + When the priority value of a packet is below a threshold (e.g. pre-emption priority value)
  + When PDB is smaller than a (pre-)configured threshold if periodic transmission is not allowed in a resource pool
  + When the randomly selected resource is reused for periodic transmission
* When UE randomly selected a resource for periodic transmission, the resource is reselected based on the NR-V2X SPS resource reservation procedure for the following periodic transmissions, similar to LTE-V2X operation, within the number of periods (*Cresel*). [21/LGE]
* After the final periodic transmission of the number of periods (Cresel) based on the randomly selected resource, the first transmission resource of the next set of periodic transmissions is randomly selected in a RSW except the previous randomly selected resource. [21/LGE]
* Support priority based resource set report and resource selection. UE should reserve resources for multiple TBs if partial sensing is allowed in the pool and *sl-MultiReserveResource* is configured with {enable}. [12/NEC]
* A non-sensing UE sharing a resource pool with sensing UEs shall select/reserve resources for consecutive transmissions with a separation/gap large enough so that the sensing UE can react accordingly if a collision happens, i.e., trigger resource re-evaluation/re-selection or pre-emption. [32/E///], [28/IDC]
* A UE can be configured to perform random selection in a resource pool based on the priority of the TB. [28/IDC]

## Re-evaluation and pre-emption checking

* Re-evaluation and pre-emption checking procedures for partial sensing RA should reuse that defined in Rel-16 full sensing RA as much as possible with following changes: [1/HW, HiSi], [16/OPPO]
  + After,
    - Sensing occasions corresponding to are monitored for re-evaluation and pre-emption checking to detect periodic reservations
    - A maximum 31 slots prior to are monitored for re-evaluation and pre-emption checking to detect aperiodic reservations
  + The following R16 principles are followed: [16/OPPO]
    - Re-evaluation and pre-emption checking is done for every pre-selected and reserved resources
    - Pre-emption checking is performed when *sl-PreemptionEnable* is 'enabled’
    - The triggering slot (n) is at ‘m – T3’
    - The higher layer indicates a set of resources and a set of resources for re-evaluation and pre-emption checking, respectively
      * FFS whether MAC layer should indicate the set of resources earlier such that L1 is able to determine the timing to start partial sensing.
* Both periodic-based and contiguous partial sensing schemes are supported for resource re-evaluation and pre-emption checking (for detecting different resource reservation types: SPS reservation and resource assignments in SCI). [16/OPPO], [23/Apple], [6/Sony] (at least PBPS)
  + Re-evaluation and pre-emption checking is performed for every TB / reservation period
    - Some TBs/periods can be skipped [6/Sony]
  + For periodic-based partial sensing, the same process should be followed as per resource (re)selection (including *Preserve* and k values)
  + FFS periodic sensing occasion(s) within the Y candidate slots
* Periodic-based partial sensing is not used for re-evaluation/pre-emption checking. [19/ETRI]
* Contiguous sensing after resource selection triggering is to be used for re-evaluation/pre-emption. [32/E///]
* Re-evaluation and pre-emption checks for UE performing random resource selection
  + Yes (for Type D UEs): [16/OPPO], [17/QC], [23/Apple], [25/DCM], [27/Convida], [28/IDC], [32/E///], [6/Zhejiang Lab]
  + No: [1/HW, HiSi], [11/Futurewei], [33/CATT, GH]
* When HARQ-feedback is enabled, detection of a number of NACKs on PSFCH occasions corresponding to a UE’s own PSSCH transmissions can be used to trigger re-evaluation and pre-emption for partial sensing RA.
  + [1/HW, HiSi]
* Partial sensing should be enhanced by either priority adjustment or signalling, to support re-evaluation / pre-emption checking while maintaining the power saving performance [10/Fujitsu]
* In order to achieve power saving gain, when performing re-evaluation/pre-emption after contiguous partial sensing based resource selection, the end of checking window should be fixed to n + TB + T2. [33/CATT, GH]
* For periodic traffic transmissions, if resource (re)selection is not triggered, periodic-based partial sensing should be performed based on the following rules considering pre-emption: [33/CATT, GH]
  + When *sl-PreemptionEnable* is provided, PBPS should be performed continuously.
  + When *sl-PreemptionEnable* is not provided, PBPS should not be performed.
* Define a new short-term sensing window and/or reuse/enhance resource re-evaluation mechanism for power sensitive UE [13/Lenovo, MotM]
* At least for resource(s) selected by period-based partial sensing, when performing re-evaluation or pre-emption, [26/Xiaomi]
  + Option 1: reuse the set of candidate slots in resource (re)selection
  + Option 2: the set of candidate slots only includes the slots of transmission resource for re-evaluation or pre-emption
* For pre-emption check in case of periodic-based partial sensing, support configurability among the following two options [22/Intel]
  + Option 1: Pre-emption check and periodic-based partial sensing are enabled for every TB transmission
  + Option 2: Pre-emption check and periodic-based partial sensing are enabled for resource reselection events
* Both re-evaluation and pre-emption checking with power saving mode(s) can be enabled/disabled by resource pool (pre-)configuration. [7/Samsung]
* The procedure of pre-emption check and re-evaluation check in Rel-16 NR V2X is reused for Rel-17 power saving mode with a fixed sensing window size of W=31 slots 🡺 [m-W, m-T3-Tproc,0). [7/Samsung]
* Maximum distance shorter than 32 slots between any two resources indicated by a single SCI is supported for power reduction in resource re-evaluation or pre-emption checking. Details of parameters are FFS. [21/LGE]
* Conditions and cases in which the UE should perform re-evaluation and pre-emption checking: [21/LGE]
  + When random resource selection is performed by a UE that is capable of sensing
    - if additional sensing is possible within remaining PDB
    - if there are any sensing results available for transmission of other packets
  + When the number of the periodic-based partial sensing slots before resource (re)selection is below a threshold
  + When only the contiguous partial sensing is performed before resource (re)selection in a resource pool where the periodic transmission is enabled
  + When the priority value of a packet is above a threshold (e.g., pre-emption priority value) [28/IDC]
  + When the congestion/interference level in a resource pool is above a threshold
  + When the required reliability level of a packet transmission is above a threshold
  + When the number of retransmissions of a packet is below a threshold
  + For selected resources for which sensing results more than a threshold in a contiguous partial sensing window are not available (e.g., the resources selected in the latter part of a selection window)
  + HARQ-ACK enabled/disabled [10/Fujitsu]
* For resource re-evaluation or pre-emption checking in a resource pool where partial sensing is configured, UE performs contiguous partial sensing over the window *[, ],* whereis the timing of every selected resource, and [21/LGE]

andin periodic transmission,

andin aperiodic transmission,

where *WCPS* is the length of contiguous partial sensing window and the slot n is the resource (re)selection triggering time.

* In periodic transmission, for resource re-evaluation or pre-emption checking in a resource pool where partial sensing is configured, UE performs periodic-based partial sensing before the selected resources for each one of *Cresel* transmissions by monitoring the slots of the timing below: [21/LGE]

whereis the r-th selected resource,are the periodicities for periodic-based partial sensing, and *k(>0)* is the (pre-)configured integer values.

* In periodic transmission, for resource re-evaluation or pre-emption checking in a resource pool where partial sensing is configured, UE continues periodic-based partial sensing after the resource selection by monitoring the slots of the timing below within PDB: [21/LGE]

whereis the most recent monitoring occasion for candidate slot *y* for resource selection,are the periodicities for periodic partial sensing, and *m* is an integer greater than zero.

* In determining the idle resources (*SA*) or in resource reselection based on resource re-evaluation or pre-emption checking in a resource pool where periodic-based partial sensing is configured, a resource is reselected among the following resources with prioritization (lower priority number means higher priority). [21/LGE]

Priority 1. Idle resources in *Y* candidate slots in the range *(RCPS)*, where the conflict with other UE’s transmission resource is detected by contiguous partial sensing

Priority 2. Idle resources in *Y* candidate slots outside the range *RCPS*

Priority 3. Idle resources except *Y* candidate slots in the range *RCPS*

Priority 4. Idle resources except *Y* candidate slots outside the range *RCPS*

* At least for Unicast and Groupcast option 2, when UE capable of SL reception performs random resource selection, if HARQ NACK or no HARQ feedback is received for the previous transmission, the resource re-evaluation or pre-emption checking is performed on the next retransmission resource. If HARQ ACK is received, no re-evaluation or pre-emption checking is performed. [21/LGE]
* The pre-emption priority for power saving UE is separately (pre-)configured from that for vehicle UE. [21/LGE]
* For re-evaluation/pre-emption check of a resource at UE performing periodic-based partial sensing and contiguous partial sensing, [25/DCM]
  + The UE uses the same set of Y candidate slots as that determined in the corresponding resource selection.
    - Sensing slots for periodic-based partial sensing are the same.
    - Sensing slots for contiguous partial sensing includes additionally slots within
* For re-evaluation/pre-emption check of a resource at UE performing random resource selection [25/DCM]
  + When a UE selects at slot *n* resource(s) randomly from a window of *[n+T1, n+T2]*, the UE monitors slots of *[n+, m−]* and performs re-evaluation/pre-emption check at slot *m*, where
    - *= [1]* and *m+* is the slot index of the selected/reserved resource
  + A set of Y candidate slots within *[m+T1, m+T2]* is determined in the same way as partial sensing.
* For semi-persistent reservation, the UE can skip pre-emption for certain reservation periods. The number of skip periods is (pre-)configured per priority. [28/IDC]

## Congestion control for power saving RA

* CBR measurement needs adaptation for Rel-17 UE with partial sensing or sidelink DRX configuration, to take into account power consumption reduction [1/HW, HiSi]
* CBR is calculated based on N measurable slots, where N is (pre-)configured. [16/OPPO]
* UE is not mandated to perform measurement for CBR/CR outside the DRX active time. [3/vivo]
  + Enhancements to CBR/CR calculations are needed due to reduced measurements
* If UE performs periodic-based partial sensing, CBR in slot n can be measured by UE in M periodic partial sensing occasions before slot n, M periodic partial sensing occasions could be a subset of the configured partial sensing occasions. [33/CATT, GH]
* The evaluation of CR and the definition of for power saving resource allocation schemes reuse the design for full sensing resource allocation schemes. [23/Apple]
* If P-UE has no PSCCH/PSSCH reception capability, a (pre-)configured CBR value is used for PHY parameter selection, as in LTE-V2X operation. [21/LGE]
* If P-UE has PSCCH/PSSCH reception capability, the following CBR value is used for PHY parameter selection: [21/LGE]
  + CBR measured in the partial sensing slots if the number of decoded PSCCH/PSSCH slots is above a threshold
  + a (pre-)configured CBR value, otherwise
* Measured CBR in slot n is the ratio of sub-channels whose SL RSSI exceed a (pre-)configured threshold to all the sub-channels in the partial sensing slots within a window [n-a, n-1], where a is (pre-)configured. [21/LGE]
* RSSI measurement should be adjusted based on PSCCH/PSSCH reception types. CBR measure occasion should be adjusted based on monitoring occasions. CBR/CR window should be adjusted considering DRX configuration. [12/NEC]
* Restriction of transmission parameter based on the CBR measurement is performed per active period of a DRX cycle. [13/Lenovo, MM]
  + Restriction of transmission parameter based on the CBR measurement is performed per active period of a DRX cycle
* CR and CBR, need to be redefined to reflect the limited sensing operation of power saving UEs, i.e., UEs performing partial sensing. [32/E///]

## Sidelink DRX

* Sensing related
  + A UE can perform sensing during its SL inactive time. [1/HW, HiSi], [10/Fujitsu], [11/Futurewei], [16/OPPO], [18/CMCC], [21/LGE], [25/DCM], [28/IDC], [29/ZTE, Sanechips], [33/CATT, GH]
    - Different settings can be configured for periodic partial sensing in DRX active and inactive periods, e.g., maximum number of sensing occasions. [11/Futurewei]
  + Up to the UE’s implementation to decide whether to perform sensing during DRX inactive time or sensing is limited to its DRX ON duration. [2/Nokia/ NSB], [3/vivo], [8/Pana], [17/QC], [22/Intel], [32/E///]
  + SL reception of PSCCH and RSRP measurement for sensing should not be supported during SL DRX inactive time [4/Spreadtrum], [6/Zhejiang Lab]
  + [23/Apple]:
    - UE performs sensing after its sidelink data arrival, even if the sensing occasion is in its sidelink DRX off duration
    - UE does not perform sensing before its sidelink data arrival, if the sensing occasion is in its sidelink DRX off duration
  + A UE based on partial sensing RA scheme should determine a partial sensing window considering an ON state / active period of DRX operation [6/Sony], [9/Fraunhofer]
  + RX UE aligns its partial sensing occasions according to the received SL DRX configurations, either from the TX UE in the case of unicast, or from pre-configuration in the case of groupcast or broadcast transmissions. [9/Fraunhofer]
  + Sensing window is adjusted into DRX active time with configured sensing window. Sensing is not performed if no sensing slot is within active time (e.g., use random selection instead) [7/Samsung]
  + A SL DRX semi-static active time could be backward extended for sensing purpose when a SL transmission triggering slot is near to the beginning of semi-static active time. The extension could be same size as the sensing window, truncated or extended by a fixed value [8/Pana]
  + A SL DRX semi-static active time could be forward extended for a SL UE to complete its transmission, reception, decoding, etc [8/Pana]
  + The extension of SL DRX semi-static active time could be triggered by previous SL or DL signalling [8/Pana]
  + For periodic-based partial sensing, it may be beneficial to refine the determination rule of “k” for a given periodicity when SL DRX is configured, from power saving perspective. [10/Fujitsu]
  + For contiguous partial sensing, when SL DRX is configured, the corresponding slots can be monitored regardless of whether they overlap with SL DRX active time or not. [10/Fujitsu]
  + Additional DRX configuration can be configured for Tx UE performing periodic partial sensing considering multiple resource reservation periods. [13/Lenovo, MotM]
  + Defined partial sensing procedure (periodic and contiguous) need to be fulfilled irrespective of the SL DRX status [22/Intel]
  + UE should keep sensing during SL active duration. [26/Xiaomi]
* Transmission related
  + Resource selection window is adjusted (within remaining PDB) according to SL-DRX active time of RX UE. Exceptional resource pool is used if there is no available slot for resource selection. [7/Samsung]
  + For periodic traffic, the transmitting UE can signal the time when the receiving UE expects the next transmission so that the receiving UE can align the DRX with the data reception for better power saving. [11/Futurewei]
  + In order to reduce the chance of collisions, only packets with a numerical priority value below a given threshold (high priority Tx) could be scheduled outside of the DRX ON duration of the RX UE [17/QC]
  + For unicast and groupcast, the Tx UE retransmits on the resources outside of the Rx UE's ON duration only if it receives a NAK in response to the (re)transmission inside the ON duration indicating reservations [17/QC]
  + For partial sensing UE, sensing results obtained by SL DRX operation in active time are used for resource (re)selection, resource re-evaluation/pre-emption checking, in addition to the partial sensing results. [21/LGE]
  + If RX UE performs SL DRX operation, TX UE selects at least the resources for the initial transmission and a (pre-)configured number of retransmissions in RX UE’s SL DRX ON duration or active time. The remaining retransmission resources can be selected in OFF duration, which is expected to be an active time extended based on the reception during active time. [21/LGE], [28/IDC]
    - At least the initial Tx: [3/vivo], [10/Fujitsu], [16/OPPO], [33/CATT, GH]
  + When RX UE performs SL DRX operation, if TX UE detects DTX of a certain transmission and the next retransmission is expected outside the RX UE’s SL DRX active time, TX UE triggers resource reselection for the next transmission resource so that the reselected resource is within the active time. [21/LGE]
  + TX UE performs random resource selection when resource (re)selection is triggered within a range of a threshold from the start of RX UE’s SL DRX ON duration. [21/LGE]
  + If RX UE performs SL DRX operation, [21/LGE]
    - the target resource ratios are separately configured for RX UE SL DRX ON and OFF duration in TX UE’s resource allocation for periodic transmission,
    - the RSRP threshold is separately adjusted until each target resource ratio is achieved in RX UE SL DRX ON and OFF duration in TX UE’s resource allocation for periodic transmission, and
    - TX UE deprioritizes or excludes resources that are affected by the interference caused by RF On and Off operations due to Uu link DRX operation. Details are FFS.
  + If information about the SL DRX active time of one or more of the recipients of a transmission is known, this should be considered when selecting the candidate resources [22/Intel], [16/OPPO], [10/Fujitsu], [12/NEC], [26/Xiaomi]
  + When TX-UE has a TB to be transmitted to RX-UE, and if a SL resource scheduled by gNB is not included in active time in the RX-UE, TX-UE skips transmission at the resource and reports the misalignment by HARQ-ACK report to the gNB. [25/DCM]
  + For P2P communication, the transmission resources selected by Tx UE need to be within the DRX active time of Rx UE. [33/CATT, GH], [23/Apple]
  + The Tx UE can take the Rx UE’s *drx-RetransmissionTimer* running duration into consideration for determining the allowable transmission time, in order to ensure that the transmission resources selected by the Tx UE can be within Rx UE’s DRX active time. [33/CATT, GH]
* Others
  + SCI is used to align SL DRX wake-up time between TX UE and RX UE(s) [7/Samsung]
  + Since power saving UEs are required to be active based on their location, we propose to enable these UEs to wake up and carry out transmissions only when they are in a pre-configured region. [9/Fraunhofer]
  + RAN1 study on the transmission of assistance indication like go-to-sleep to aid Rx UE(s) enter early DRX sleep state. [13/Lenovo, MotM]
  + Study wake-up signal in sidelink to enhance power saving from Rx-UE’s perspective. [20/MTK], [15/Hyundai] (including GTS)
  + SL-DRX configuration can be transmitted via SCI or can be included in contents of the inter-UE coordination information [15/Hyundai]

## Others

* Switching between RA schemes (full sensing, partial sensing, random selection)
  + In a resource pool configured with more than one resource allocation scheme, possible conditions / criteria should be studied for switching between RA schemes (full/partial sensing, random selection) [3/vivo], [7/Samsung], [11/Futurewei], [12/NEC], [20/MTK], [21/LGE], [26/Xiaomi], [27/Convida], [33/CATT, GH]
    - E.g., UE battery/power status, available resource ratio, CR, a timer or counter, higher layer configuration, priority, remaining PDB, based on UE implementation, CBR, sensing results, DRX configuration, HARQ error rate, etc
* Others others
  + When HARQ feedback is enabled for a TB, the resource selection based on the mixture of blind and HARQ feedback-based retransmissions of the TB is supported. [21/LGE], [22/Intel]
  + Minimum distance between any two resources signalled by a single SCI is (pre-)configured for transmission of a TB having a priority value lower than a (pre-)configured threshold. [21/LGE]
  + SCI indicates at least one of the following information using the reserved bits [21/LGE]
    - Type of UE: power-saving UE or vehicle UE [28/IDC]
    - Type of RA scheme: partial sensing based or the random resource selection
  + To reduce time for transmission of a TB and improve power saving, randomly pick one out of N first in time candidate resources, where the value of N is pre-configured [22/Intel]
  + Sidelink bandwidth adaptation for transmission / reception is supported as a power saving feature [22/Intel], [27/Convida], [28/IDC], [9/Fraunhofer]
  + Partial sensing can be enabled / disabled per transmission priority level and the quality-of-service requirements [22/Intel]
  + For power saving, UE can skip PSSCH demodulation depending on sidelink transmission priority level [22/Intel]
  + In resource selection after resource identification, UE selects preferentially resource at earlier time in the identified resource set [25/DCM]
  + Support power saving mechanism with reduced PSCCH and PSSCH decoding for UE [28/IDC]
  + Support different initial RSRP thresholds for resources reserved by PUE. [28/IDC]
  + Inter-UE coordination is supported for power consumption reduction [6/Sony]
  + Proposals from [13/Lenovo, MotM]:
    - RAN1 study the cross-slot scheduling enhancement with a time gap specified between data(+2nd SCI) and 1st SCI, 1st SCI contains information whether the intended recipient is a pedestrian or Vehicular UEs for power saving purposes.
    - Design additional resource reservation indication/signalling for collision avoidance.
    - Mechanism of sensing result sharing by RSU or other UE can be considered for VRU to achieve power saving.
    - Support SL Tx/Rx performed in a power saving manner by configuring a resource pool partition for resource alignment among multiple UEs.
      * A resource pool partition is configured by a set of disjoint resource patterns.
      * Each resource pattern can be configured with features about controlling selection opportunities for different type of services and thus facilitating resource avoidance.
      * For a resource pool selected for use, a UE can further (re-)select resource pattern(s) based on sensing results.
      * Resource alignment can be performed by indicating identity of resource pattern among UEs.
  + Proposals from [8/Pana]:
    - The sidelink UE can take sidelink information (including the sensing/resource allocation timing) into account for the UE assistance information for network to inform the gNB for a better coordination with Uu at the network.
    - SL reception type B or D capable UE should be allowed to be operated as SL reception type A depending on the usage scenario and the requirement.
    - The decision that SL reception type B or D capable UE is operated as SL reception type A should be by the network when UE is under network coverage. The SL reception type B or D capable UE could either: 1) inform the network its recommended reception type and ask for confirmation, or 2) inform its SL requirements and power reduction capability to the network and let the network to determine the suitable reception type.
    - The reception type D can have a sub reception type that a UE Support SL signals only for PSCCH sensing and not receive PSSCH
    - No SL transmission is allowed if a UE is in Type A and without a valid synchronization.
    - To allow 1st SCI only reception in rel.17, and its power modelling of 1st SCI only reception is [0.6]\* power consumption level of “PSCCH/PSSCH RX”
  + Proposals from [14/CAICT]:
    - It is suggested to clarify whether the resource pool is shared between Mode1 and Mode2, and whether periodic resource reservation is supported for Mode1 in the shared resource pool, when to configure k
    - Use partial sensing to re-evaluate the reserved resources in the next period at least
    - Send RAN2 a LS about the impact on SL DRX by contiguous partial sensing
  + Proposals from [3/vivo]
    - Power saving mechanisms to reduce power consumption of PSFCH transmission should be supported
    - SL pathloss based OLPC for PSFCH transmission should be considered for sidelink power saving.
    - Longer PSFCH period should be considered for sidelink power saving. [12/NEC]

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Appendix (outcomes of past meetings)

## RAN1#103-e (26/Oct – 13/Nov 2020)

**Conclusion**

* SL reception Type A and Type D should be used as the reference for evaluation and designing of SL power saving features in R17.
  + Type A: UE is not capable of performing reception of any SL signals and channels, FFS with exception of performing PSFCH and S-SSB reception (aim to conclude in RAN1#104-e)
  + Type D: UE is capable of performing reception of all SL signals and channels defined in R16. It does not preclude UE to perform reception of a subset of SL signals/channels
  + If there are evaluations with assumptions other than the above reference, the detailed assumptions need to be reported
  + Note: the types and the associated capability defined here are not intended to be defined as Rel-17 UE features as is.

Agreements:

* Partial sensing based RA is supported as a power saving RA scheme
  + FFS details
* Random resource selection is supported as a power saving RA scheme
  + FFS any changes or enhancement
  + FFS on conditions to apply random resource selection

Agreements:

* In R17, a SL Mode 2 Tx resource pool can be (pre-)configured to enable full sensing only, partial sensing only, random resource selection only, or any combination(s) thereof
  + FFS details, including usage, potential restrictions, whether/how any enhancement or condition is needed for the coexistence of full sensing and power saving RA scheme(s) in a same resource pool, etc.

Agreements:

* Re-evaluation and pre-emption checking are not supported by UEs that do not perform any sensing (i.e. PSCCH reception)
* Re-evaluation and pre-emption checking are supported by UEs that perform sensing
  + FFS details and any conditions(s) in which re-evaluation and pre-emption can be performed
* FFS whether/how re-evaluation and pre-emption can be supported by UEs performing random resource selection that do perform sensing
* Note: details about sensing in this context, including when it is performed, are not decided yet.

Agreements:

* Further study congestion control based on CBR and CR for power saving RA schemes
  + Identify necessary changes from R16 CBR/CR (if any), including transmission resource selection and transmission parameters that can be adjusted and applicable to power savings RA schemes
  + Note: this is not intended to require all UEs to perform sensing for the purpose of CBR measurement

## RAN1#104-e (25/Jan – 05/Feb 2021)

Agreements**:**

* Random resource selection is applicable to both periodic and aperiodic transmissions
  + FFS conditions for random resource selection

**Conclusion:**

* PSFCH reception is not included for Type A UE
* S-SSB reception is not included for Type A UE
* SL reception Type B is additionally added
  + Type B: Same as Type A with an exception of performing PSFCH and S-SSB reception
* Note: the same conditions as in RAN1#103-e regarding the context of the discussion of Type A and Type D still apply (also applicable to type B)

Agreements**:** In a resource pool (pre-)configured with at least partial sensing, if UE performs periodic-based partial sensing, at least when the reservation for another TB (when carried in SCI) is enabled for the resource pool and resource selection/reselection is triggered at slot n, it is up to UE implementation to determine a set of Y candidate slots within a resource selection window, where

* FFS condition(s) and timing(s) for which periodic-based partial sensing is performed by UE
* The resource selection window is [n+T1, n+T2]
  + As a baseline, T1 and T2 are defined in the same way as in R16 NR-V2X according to step 1 [TS 38.214 Sec. 8.1.4]
  + Further discuss whether or not to introduce a threshold to re-define T1 and T2 such that
    - T1≥ 0 (subject to processing time constraint Tproc, 1), and T2 ≤ remaining PDB
    - T2-T1 *≤* (pre-)configured threshold
* A minimum value for Y is (pre-)configured from a range of values, FFS details
* FFS any restriction to determine Y candidate slots (including its relationship with SL-DRX)
* FFS whether the resource selection window [n+T1, n+T2] should be confined within a set of periodic set of resources and its relationship with SL-DRX
* Note: The terminology “periodic-based partial sensing” is based on the “partial sensing” used in LTE-V and it is intended to be used for the design and discussion of partial sensing in Rel-17.

Agreements**:** In a resource pool (pre-)configured with at least partial sensing, if UE performs periodic-based partial sensing, at least when the reservation for another TB (when carried in SCI) is enabled for the resource pool and resource selection/reselection is triggered at slot n, the UE monitors slots of at least one ~~a set of~~ periodic sensing occasion~~s~~, where a periodic sensing occasion is a set of slots according to 

if tvSL is included in the set of Y candidate slots.

* *P*reserve is a periodicity value from the configured set of possible resource reservation periods allowed in the resource pool (*sl-ResourceReservePeriodList*). Down select to one:
  + Option 1: *P*reserve corresponds to all values from the configured set *sl-ResourceReservePeriodList*
  + Option 2:  *P*reserve corresponds to a subset of values from the configured set *sl-ResourceReservePeriodList*
    - FFS how to determine the subset (e.g., by (pre-)configuration, UE determination)
  + Option 3:  *P*reserve is a common divisor among values in the configured set *sl-ResourceReservePeriodList*
  + Option 4: FFS others
* k ~~equals to~~is selected according to (down select to one)
  + Option 1: Only the most recent sensing occasion ~~within sensing window~~ for a given reservation periodicity before the resource (re)selection trigger or the set of Y candidate slots subject to processing time restriction
  + Option 2: The two most recent sensing occasions ~~within sensing window~~ for a given reservation periodicity before the resource (re)selection trigger or the set of Y candidate slots subject to processing time restriction
  + Option 3: All possible sensing occasions after
  + Option 4: Only one periodic sensing occasion for one reservation period. The k value is up to UE implementation. Max value for k is (pre-)configured.
  + Option 5: k is (pre-)configured, including multiple values
  + Option 6: (pre-)configuration of a bitmap, same as in LTE-V
  + Option 7: FFS others
* FFS relationship between periodic sensing occasions and SL-DRX
* FFS condition(s) and timing(s) for which periodic-based partial sensing is performed by UE
* Note: companies are encouraged to show performance data for the down selections

Agreements:

* In a resource pool (pre-)configured with at least partial sensing, if UE performs contiguous partial sensing and resource (re-)selection is triggered in slot n, support the following option:
  + Option 1: For the purpose of resource (re-)selection, the UE monitors slots between [*n*+*T*A, *n*+*T*B] and performs identification of candidate resources, in or after slot *n*+*T*B, based on all available sensing results, including periodic-based partial sensing results (if applicable).
    - FFS *T*A, *T*B (including the possibility of equal to zero, positive or negative) and remaining details (in particular, whether there should be exclusion of slots, changes in TA/TB values for different purposes, etc.)
    - FFS whether n can be replaced by e.g., index of some of Y candidate slots
  + FFS condition(s) in which contiguous partial sensing is performed by UE
  + FFS interaction with SL-DRX, if any
  + FFS interaction with periodic-based partial sensing, if any
  + Other options are not precluded
  + Note: This option is not to replace random resource selection only without sensing or re-evaluation and pre-emption checking

## RAN1#104b-e (12 – 20 April 2021)

**Conclusion:**

* In periodic-based partial sensing,
  + It is not necessary to further discuss whether or not to introduce a threshold to re-define T1 and T2.

**Agreements:**

* In periodic-based partial sensing,
* For the set of *P*reserve values, down-select to one of the following in RAN1#105-e
  + - Alt.1: *P*reserve corresponds to all values from the configured set *sl-ResourceReservePeriodList*
    - Alt.2: A set of *P*reserve values is (pre-)configured and includes up to the full set of values from the configured set *sl-ResourceReservePeriodList*
      * FFS if support multiple sets of *P*reserve values based on one or more metrics
      * FFS whether/how to restrict the set of values
* For the k value, down-selection to one of the following in RAN1#105-e (further refinement of each of the alternatives is possible)
  + - * + Alt 1: Option 1 as in RAN1#104-e
        + Alt 2: A modified Option 5 as in RAN1#104-e, where the modification is such that it also includes option 1

FFS how to (pre-)configure (e.g. including bitmap), whether a maximum number of k values is needed, and whether it can be up to UE implementation to select a k value based on the (pre-)configuration

* + - * + FFS details, e.g., sensing before the resource (re)selection trigger or the first slot of the set of Y candidate slots subject to processing time restriction, etc.
      * Note: companies are encouraged to provide more evaluations

**Agreement:**

* When periodic-based partial sensing is potentially performed by UE in a mode 2 Tx resource pool provided by higher layer, at least all of the followings are met:
  + Periodic reservation for another TB (sl-MultiReserveResource) is enabled for the resource pool
  + The resource pool is (pre-)configured to enable partial sensing
  + Partial sensing configured by higher layer in the UE

## RAN1#105-e (10 – 27 May 2021)

Agreement:

* For the set of *P*reserve values in periodic-based partial sensing,
  + If no (pre-)configuration (i.e., by default), *P*reserve corresponds to all values from the (pre-)configured set *sl-ResourceReservePeriodList*.
  + Otherwise, a single set of *P*reserve values can be (pre-)configured, where the set of P*reserve* values are restricted to a subset of the (pre-)configured set *sl-ResourceReservePeriodList*
    - This is per mode 2 Tx resource pool (pre-)configuration
    - A UE by implementation may also monitor other *sl-ResourceReservePeriodList* values not part of the restricted subset
      * In particular, the UE may additionally monitor occasions corresponding to P\_RSVP\_Tx
        + FFS whether the monitoring can be mandatory

Agreement:

* In periodic-based partial sensing for resource (re)selection, the UE at least monitors in periodic sensing occasion(s) for a given reservation periodicity before the first slot of the selected Y candidate slots subject to processing time restriction for the identification of candidate resources.

  o   The processing time restriction includes *Tproc,0SL*  and *Tproc,1SL*.

  o   Aspects relating to sensing during SL DRX are to be discussed separately

* Relationship to re-evaluation and pre-emption operation for periodic-based partial sensing to be discussed separately
  + FFS details including whether monitoring of periodic sensing occasions between triggering slot n and the first slot of the selected Y candidate slots subject to processing time restriction is performed as part of resource (re)selection or re-evaluation and pre-emption checking

Agreement:

* For the k value in periodic-based partial sensing for resource (re)selection,
  + By default, the UE monitors the most recent sensing occasion for a given reservation periodicity before the resource (re)selection trigger slot n or the first slot of the set of Y candidate slots subject to processing time restriction.
  + If (pre-)configured, UE additionally monitors periodic sensing occasions that correspond to a set of values which can be (pre-)configured with at least one value
    - (Working assumption) Possible values correspond to the most recent sensing occasion for a given reservation periodicity before the resource (re)selection trigger slot n or the first slot of the set of Y candidate slots, and the last periodic sensing occasion prior to the most recent one for the given reservation periodicity are included.
    - FFS: whether/which other values and details of the (pre-)configuration (e.g. max number of values or sensing occasions)
    - FFS: whether a value denotes a specific occasion to monitor or the earliest occasion to start the monitoring.
  + FFS relationship between periodic-based partial sensing occasions and SL-DRX
  + Note:
    - This is for the case when the resource (re)selection triggering slot n is expected by UE

Agreement:

* For random resource selection,
  + Reuse the maximum distance separation of 32 logical slots for a HARQ retransmission resource reserved by a prior SCI for the same TB, which was defined in R16 for full sensing operation.
  + SL HARQ feedback enabled transmission is supported (FFS applicable conditions if any)
    - The minimum HARQ feedback time gap (Z) shall be respected between any two selected resources of a TB where a HARQ feedback for the first of these resources is expected.
* FFS the impact of resource collision when random resource selection is performed by a UE which does not perform sensing / re-evaluation and pre-emption checking in a resource pool with mixed RA schemes (e.g. for low priority or any priority transmissions).
  + Including study potential solution(s) if the impact is not negligible (e.g. threshold based, raising priority, minimum time gap, pattern based, a priori SCI reserving initial transmissions, resource pool partitioning, and etc.).

Agreement**:** In contiguous partial sensing for resource (re)selection, *TA* and *TB* values can be zero, positive or negative

* *TA* and *TB* values or range depend on different operating scenarios or conditions (e.g., periodic/aperiodic traffic, predictability of triggering slot n, remaining PDB, re-evaluation/pre-emption checking, HARQ feedback, CBR/CR parameter, power saving, etc)
  + FFS details
* FFS: details of how periodic-based partial sensing and contiguous partial sensing are used for re-evaluation and pre-emption checking. Including how to reduce UE’s power consumption (caused by additional sensing operation of re-evaluation/pre-emption) after its resource selection, with the considerations of different operating scenarios or conditions (e.g., pre-emption enabled/disabled, HARQ-ACK enabled/disabled, etc).