**3GPP TSG RAN WG1 #104-e R1-2101412**

**e-Meeting, January 25 – February 05, 2021**

**Source: Moderator (OPPO)**

**Title: FL summary for AI 8.11.1.1 – resource allocation for power saving**

**Agenda item: 8.11.1.1**

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

Introduction

In the latest revised Rel-17 WID for NR sidelink enhancement [1], the objective for enhancing RA to reduce UE power consumption in mode 2 has been updated 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#104-e meeting.

Collection of agreements / conclusion in RAN1#104-e

Agreements**:**

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

Topics for email discussion

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

* 1st check point: Jan 28
* 2nd check point: Feb 2
* 3rd check point: Feb 4

## Topic #1: PSFCH and S-SSB reception for Type A UE

**Background**: In the last meeting RAN1#103-e, there was an FFS item on whether a Type A UE should be capable of performing PSFCH and S-SSB reception as an exception.

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| * + 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) |

From reviewing contributions submitted to this meeting,

* Main reasons for not to support PSFCH reception for Type A UEs:
  + Minimum reception capability, same as PUE in LTE-V
  + Likely only perform broadcast transmissions as it cannot receive any data, and receiving HARQ feedback is not required in SL broadcast
* Main reason to support PSFCH reception was mainly to improve communication reliability
* The main reason not to support S-SSB reception was that the UE can always sync to network or GNSS timing, same as in LTE-V
* The main reason to support S-SSB reception was that S-SSB transmitted from UE synchronized to eNB/gNB is prioritized over GNSS

### Proposals before 1st check point (Jan 28)

**Proposal 1 (for conclusion):**

* PSFCH reception is not supported for Type A UE
* S-SSB reception is not supported 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

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| **Company** | **Comments** |
| OPPO | Agree |
| Fraunhofer | Agree |
| Apple | Agree |
| Ericsson | First of all, we would like to remark that the UE Type definition, i.e., A, D (or B), are not related to UE capabilities but just as a reference for evaluation and designing the power saving features.  We do not think that having S-SSB reception support but not having PSFCH reception support is justified from a product perspective. If companies think that there should be a UE that is not capable of receiving any signal, we can be fine with an additional UE Type where neither S-SSB nor PSFCH can be received.  Therefore, we are OK to define two types of UE, i.e., Type A and Type B as in proposal 1, to be used as a baseline to define and design power saving features. |
| CATT | Since these types are used as the reference for evaluation and designing of SL power saving features in R17, it’s better to add another type( B1 )which supports S-SSB reception but not PSFCH reception. |
| Qualcomm | We agree with the proposal and would like to reiterate that these types are only for evaluation and to facilitate discussion but do not define UE capabilities. |
| Lenovo&MM | Agree |
| CMCC | We are basically fine with this proposal.  As per the conclusion made in the last meeting, these UE types were defined as the reference for evaluation, and have nothing to do with the UE capability covered by UE feature. From this perspective, we are ok to define Type A UE without any reception capability to obtain the lower bound of the power consumption level and the system performance level. On the other hand, it is mentioned that supporting the reception of PSFCH is beneficial for higher reliability, and supporting the reception of S-SSB allows the UE to synchronized to a cell or other reference UEs when GNSS is not available or reliable. To our understanding, this Type B UE is a special case of Type D UE. It seems optional to us; however, we do not have strong objections to define the Type B UE as a trade-off. |
| NEC | Agree |
| vivo | Agree with FL’s proposal |
| FUTUREWEI | Agree with proposals. The types discussed are for evaluations not for defining UE capabilities. For clarification, is the Type B listed above different from the Type B discussed in the previous meeting? |
| ETRI | Agree only for design of power saving features |
| Panasonic | Agree with FL’s proposal for the purpose of evaluation. |
| Sony | Agree with the proposal. |
| NTT DOCOMO | We are fine with the FL’s proposal, based on discussions in the last GTW session. From actual device perspective, no reception unit seems feasible for a P-UE. |
| CAICT | Agree |
| Sharp | Agree with FL’s proposal. |
| Xiaomi | We are fine with FL’s proposal. |
| ZTE | Agree with FL’s proposal. |
| LGE | We’re fine with the FL proposal to separate Type A and Type B UE. Type A UE may represent the operation of LTE-V2X P-UE. For Type B UE, continual full S-SSB search may require significant power consumption. So we need to study more how to minimize the power consumption for S-SSB reception. The recommended proposal is as follows.  **Proposal 1**   * Type A UE supports neither PSFCH nor S-SSB reception * Type B UE supports both PSFCH and S-SSB reception   + FFS whether/how to minimize power consumption for S-SSB reception |
| Samsung | Agree with FL’s proposal. |
| Fujitsu | Agree |
| MediaTek | We agree with FL’s proposal. |
| Intel | Agree with the first two bullets  For the last bullet we disagree that Type-B is the same as Type A. In our opinion type B can also be viewed as a Type D UE that is configured to only receive PSFCH and S-SSB. Therefore we propose to replace the last bullet with the following text:  FFS if Type B UE, that is capable to receive only PSFCH and SSB is needed, or this functionality can be considered as a part of Type-D UE operation |
| Huawei, HiSilicon | We wish to emphasise that the UE’s here are only “*reference UEs for the purpose of evaluation and design*” as agreed in 103e, and thus are *not* real UEs. The capabilities of real UEs will be decided at the end of the release. What we are discussing here is with reference to what the evaluations and designs will be considered, not what is inside any particular real UE. Thus the word “supported” leads to incorrect understandings. And the statement in the 3rd bullet that these are already SL reception types (seeming to write 38.202 already) leads to similar incorrect understandings. The structure of the proposal should be such as:  For reference UEs:   * PSFCH reception is not included for Type A UE * S-SSB reception is not included for Type A UE * Type B is additionally defined.   + Type B: Same as Type A with addition of PSFCH and S-SSB reception   We are OK with the basis of the proposal. Type A refers to the reception type which costs minimal power consumption, i.e. no reception behaviour at all. This serves as a lower bound for power consumption, which is informative. And this is also aligned with LTE-V. Introducing of Type B is fine, although we think Type-D UE has already covered Type-B UE reception behaviour. |
| Convida Wireless | We are generally ok with the FL’s proposal. |
| Bosch | We also see that it should not take us too long to discuss UE capability at this point.  For the reference UE (for evaluation purpose), we support the FL proposal.  We also prefer Huawei’s suggestion to replace “supported” 🡪 “included”. This will let us clearly focus on the actual role of these reference Types A, B, & D. |
| Nokia, NSB | Ok. |

## Topic #2: Periodic-based partial sensing (determination of Y candidate slots for periodic transmission)

**Background**:



Figure 1

In R14 LTE sidelink, the partial sensing scheme is optimized for periodic traffic type only, where

* UE performs monitoring of subframes in sensing occasions according to for a set of Y candidate subframes determined within the resource selection window
* The smallest denominator was set to 100ms for Pstep and 20/50ms reservation periodicities were not taken into consideration.
* Period sensing occasions within the sensing window are determined by the kth bit of the higher layer parameter *gapCandidateSensing*.

From reviewing contributions submitted in this meeting, the above Rel-14 LTE sidelink partial sensing scheme can be taken as the baseline, but some enhancements are needed for a power constrained UE configured with partial sensing to perform periodic transmission in NR sidelink mode 2. First of all, it is aimed to confirm the same principle as in LTE-V that a UE first determines a set of Y candidate slots within the resource selection window when resource selection is triggered in slot n.

### Proposal before 1st check point (Jan 28)

**Proposal 2**: If UE is configured to perform partial sensing and provided with a resource reservation interval () from higher layer, it is up to UE implementation to determine Y candidate slots within a resource selection window, where

* The resource selection window is defined in the same way as in R16 NR-V2X according to step 1 [TS 38.214 Sec. 8.1.4].
* UE determination of Y candidate slots should exclude slots in which its own SL and UL transmissions occur in the resource selection window.
* Due to integer multiple of resource reservation periods, UE determination of Y candidate slots should exclude slots that would coincide with its own SL and UL transmissions within the corresponding periodic sensing occasions.
* Periodic sensing occasions that correspond to the set of Y candidate slots should align with the SL-DRX ON duration as much as possible (if configured) and/or as early as possible to maximize number of contiguous sensing slots before the resource selection trigger in slot n.
* FFS min and max Y candidate slots should be applied (e.g., a range of Y values per priority level)

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| **Company** | **Comments** |
| OPPO | We are OK with the 1st sub-bullet. Not support for the other bullets   * For the 2nd and 3rd bullet: UE should not exclude the slot that is used for UL transmission. Whether to prioritize between UL and SL is up to UE hardware implementation. If there are two sets of RF, UE can transmit UL and SL (if they are in different carrier) at the same time, in that case, there is no necessary to exclude the slots for UL transmission. In legacy resource exclusion procedure of sensing, only the slots for SL transmission is considered, not for UL transmission. We suggest to follow legacy behaviour. * For the 4th bullet: the relationship between DRX and sensing is discussing in another email thread [104-e-NR-R17-SL-LS-01], it is not necessary to discuss that here again. * For the last bullet: in LTE-V2X, only min Y slots was applied. We are not convinced to apply max Y slots. No intension to introduce additional feature unless performance gain can be justified. |
| Fraunhofer | For the determination of the selection window for periodic transmissions, we prefer to stick to the same procedure as defined in Rel-16. Exclusions based on UL transmissions can be left out.  We agree that the candidate slots should align with the DRX ON duration as much as possible. |
| Apple | We are fine with the main bullet and the first sub-bullet.  For the second and third sub-bullets, we share the views from OPPO that only SL transmissions slots should be considered. The prioritization between SL and UL can be handled separately with the existing R-16 rule.  For the fourth sub-bullet, we are fine in general. But some clarification is needed, such as how to quantify “as much as possible”, “as early as possible”?  For the fifth sub-bullet, we think only the lower bound on Y can be applied, and we do not mention the example that range of Y is per priority level. |
| Ericsson | We do not see the need to introduce a new scheme for periodic transmissions. We propose to reuse the LTE mechanism (where the 2nd and 3rd sub-bullets do not need to be specified and can be left to UE implementation) and discuss the potential enhancements needed to address the periodicities introduced in NR (see Section 3.3.1) and any other potential issue.  We have two comments regarding the sub-bullet on DRX. First, it is probably a good idea to leave the discussion for later, when more about the DRX procedure is known. In general, a wider discussion on the connection between SL DRX and partial sensing has to take place. Besides that, we believe that aspects may be left to UE implementation, like for the other bullets. |
| InterDigital | When SL DRX is not configured, we agree that determination of Y can be UE’s implementation. But when SL DRX is configured, Y should be selected based on the DRX ON duration of the reception UE(s) which is the target of the transmission, instead of the UE itself.   * For the 2nd and 3rd, we prefer to reuse the R16 procedure, in which SL Tx slots can be considered but not UL slots. * We agree with the principle of the 4th bullet that periodic sensing should align with the SL DRX ON duration as much as possible (if configured). * For the 5th bullet, we do not see the motivation to consider Y max.   We assume that this proposal is applicable to the first TB of periodic traffic.   * should be greater than 0ms. |
| CATT | In principle we should reuse Rel-16 procedure as much as possible. For this particular proposal, we don’t agree with the sub-bullet regarding DRX alignment. In fact, it’s more efficient that sensing operation is allowed in SL DRX inaction duration without the restriction of its own SL DRX configuration. We should discuss the details related to DRX issue. |
| Qualcomm | We think that we need to discuss the different scenarios (Tx UE doing power savings, Rx UE doing power savings, or both UEs) and then discuss the general design(s) with evaluation results prior to discussing this level of detail.  For example, if the transmitter isn’t receiving data, e.g. P2V-only application, then it isn’t clear why some of the points would apply, e.g. the one about DRX.  Similarly, when both UEs are doing power savings, it is more efficient to fully align their DRX and partial sensing windows.  We should also consider whether some aspects need to specified or can be left up to UE implementation. |
| Lenovo&MM | Rel-14 LTE sidelink partial sensing scheme can be taken as the baseline and select the resource(s) for periodic transmission. FFS, the sensing scheme for aperiodic transmission  The relationship between partial sensing and SL DRX on duration should be further clarified such that the partial sensing slots are defined by the partial sensing configuration or SL DRX on duration. |
| CMCC | We have concerns regarding the 2nd, 4th and last bullets.  For the 2nd bullet, in LTE-V, the determination of Y candidate slots is up to UE implementation as long as Y is higher than the (pre-)configured higher layer parameter *minNumCandidateSlot*. The intention of introducing additional rules is not clear to us.  For the 4th bullet, regarding the alignment of DRX ON duration and the sensing occasion, we think that the relationship of SL DRX pattern with the sensing window and resource selection window, e.g., whether they are configured and performed independently, or configured independently but the sensing and selection should be performed during ON duration, or aligned as much as possible by configuration, should be separately discussed.  For the last bullet, we are ok to discuss per priority level configured Y value, however, we still think that the principle of minimum values should be kept. |
| NEC | Main bullet: Fine, as the main bullet is reusing the principle of LTE, we are OK with it.   * 1st sub-bullet: OK * 2nd and 3rd sub-bullet: Are the intention to exclude slots that will be used for UE's future transmissions? Besides, as an exclusion set, we think Y should also exclude the resources reserved by hypothetical SCI in non-monitored slots, because these resources will not be excluded if they are selected as candidate slots in legacy Rel.14 partial sensing (step 5 is not performed). * 4th sub-bullet: we are not sure whether "periodic sensing occasions" will exist in NR partial sensing. Periodic sensing occasions apply to LTE partial because the allowed periods are in periodic manner e.g., 100,200…1000. But for NR, as explained in the background of next topic, if the considered periods include e.g., 99ms, 97ms, etc., the whole sensing occasions will not be periodic.   5th sub-bullet: min Y candidate slots configured from higher layer is enough and we can FFS the details for Y's configuration |
| vivo | 1. Same view as OPPO. UE may perform priority comparison between UL and SL, and may drop the UL transmission in some cases, there is no need to exclude the UL slots from the window in advance. 2. We agree that the periodic sensing occasion should align with the DRX ON duration as much as possible, however, how to achieve this should not be up UE implementation and needs further discussion. so we would like to remove ‘up to UE implementation’ from the main bullet and add a FFS point on the determination of Y 3. minY is to avoid high collision probability, the benefit of setting a maximum value for Y is not clear.   **Proposal 2**: If UE is configured to perform partial sensing and provided with a resource reservation interval () from higher layer, ~~it is up to UE implementation to~~ UE should determine Y candidate slots within a resource selection window, where   * The resource selection window is defined in the same way as in R16 NR-V2X according to step 1 [TS 38.214 Sec. 8.1.4]. * UE determination of Y candidate slots should exclude slots in which its own SL ~~and UL transmissions~~ occur in the resource selection window. * Due to integer multiple of resource reservation periods, UE determination of Y candidate slots should exclude slots that would coincide with its own SL ~~and UL transmissions~~ within the corresponding periodic sensing occasions. * Periodic sensing occasions that correspond to the set of Y candidate slots should align with the SL-DRX ON duration as much as possible (if configured) and/or as early as possible to maximize number of contiguous sensing slots before the resource selection trigger in slot n. * FFS min ~~and max~~ Y candidate slots should be applied (e.g., a range of Y values per priority level)   FFS how to determine the Y candidate slots |
| FUTUREWEI | * First bullet: ok * Second bullet: ok. A question about the wording. In 38.214, step 2 of clause 8.1.4 states “…The UE shall monitor slots which can belong to a sidelink resource pool within the sensing window except for those in which its own transmissions occur. …” To be consistent with the spec, perhaps the adjectives “SL and UL” can be removed * Third bullet: unclear if needed. Its wording effectively encompasses the wording of the second bullet * Fourth bullet: ok. |
| ETRI | We agree with other companies’ concerns, i.e., no need to exclude UL transmission and define max Y. Rel-14 LTE sidelink partial sensing scheme can be reused as much as possible with additional consideration of SL DRX. |
| Panasonic | We agree the main and the 1st sub-bullet.  For the 2nd and the 3rd sub-bullets, we think these can up to implementation.  For the 4th sub-bullet, we are generally fine with the principle and we think it should be separately discussed. Also, it’s hard to understand how to determine “as much as possible (if configured) and/or as early as possible”  For the 5th sub-bullet, we propose to reword as “FFS details of Y candidate slots (e.g., …)” |
| Sony | We think we should reuse the existing scheme for periodic traffic basically. For the 2nd and 3rd sub-bullet, only SL transmission should be excluded from the candidate slots.  On the sidelink DRX in 4th sub-bullet, we are basically OK with aligning sensing operation with the sidelink DRX configuration. But “as much as possible” and “as early as possible” are unclear. We need to further discuss the details. |
| NTT DOCOMO | * Main bullet: intention of ‘provided with a resource reservation interval () from higher layer’ is unclear for us. Only for periodic transmission from the UE performing partial sensing? If correct, one comment: = 0 means aperiodic transmission. Is it OK to include this case? * 1st bullet: OK * 2nd bullet: ‘UL’ is unnecessary as some companies mentioned above. * 3rd bullet: ‘UL’ is unnecessary as some companies mentioned above. In addition, ‘Due to integer multiple of resource reservation periods’ is unclear for us. ‘resource reservation periods’ means resource reservation periods configured to the resource pool, right? This should be clarified. At last, ‘the corresponding periodic sensing occasion’ is completely FFS and discussed in the next section, right? If correct, this FFS should be added as sub-bullet. * 4th bullet: ‘as much as possible’ is unclear for us. RAN1 will discuss further for this or up to UE? Similarly, ‘as early as possible’ is also. Postponing discussion for DRX is fine for us. * 5th bullet: range restriction of Y value should be the same as LTE. Different mechanism would be unnecessary. |
| CAICT | Generally we agree with the proposal. For the 2nd and 3rd sub-bullets, the prioritization between the SL and UL transmissions should be considered when to exclude the occasions colliding with the candidate resources. |
| Sharp | In our view it is possible that the use of partial sensing is not “semi-static” (for example, it may depend on whether partial sensing is enabled in the selected resource pool), so the first sentence in the main bullet should simply say “For partial sensing, …”. And this comment applies to other proposals in this document as well.  Details in sub-bullets 2, 3, and 4 are premature at the moment. For sub-bullet 5, it may be better to just say “FFS restriction on values of Y”.  Besides, considering both pre-emption check and re-evaluation are supported for partial sensing, selecting Y slots only by UE implementation is not enough, the selected Y slots should include at least and subject to re-evaluation and pre-emption check respectively, instead of up to UE implementation only. |
| Xiaomi | In LTE V2x partial sensing treats periodic and aperiodic traffic in the same way. Therefore, we would like to clarify why only periodic traffic is considered in the main bullet.  In addition, in LTE V2x, the determined Y candidate subframes must satisfy the corresponding sensing requirement, i.e. UE must guarantee that it has sensed in the corresponding subframes for each candidate subframe. However, from the current wording of main bullet, it seems that the Y candidate slots can be arbitrarily selected. Therefore we suggest to clarify this in the main bullet.  In subbullet 1 there is n but it is not defined. In main bullet it should state “when resource selection is triggered in slot n, ……”  Sub-bullet 2,3,4 propose some additional constraints on determining Y candidate slot. A word “periodic sensing occasion” appears in 3rd and 4th sub-bullet, but it has not been defined in LTE V2x or previous agreement. If it is related to the discussion of what kind of sensing requirement should be satisfied, we suggest to delay the discussion after making decision in that topic, or use some other words to replace it.  For subbullet 4, it is not clear whether SL-DRX on duration is of Tx UE or Rx UE. We understand the motivation if it is of Rx UE, but still think it can be discussed after we define the sensing requirement for partial sensing. |
| ZTE | For the second and third bullet, from our understanding, UE is not capable to know when its uplink transmission scheduling would be when performing sensing. Thus, it is hard for UE to exclude uplink slot during sensing duration. However, the collision between sidelink transmission and uplink transmission should be solved by other approaches. For the forth bullet, we should firstly discuss the relationship between sidelink DRX and partial sensing, and then go into such detailed discussion. |
| LGE | We think the resource selection procedure based on partial sensing can be improved for power saving. For example, if short-term sensing is used for resource re-evaluation or pre-emption checking, the longer interval between the selected resources, the more STS power is consumed due to longer sensing duration. If the intervals between the selected resources are short, the overall STS duration becomes shorter and the power consumption is minimized. Therefore, the adjacent resources are prioritized for resource selection over the distributed resources. For this, the selection window length needs to be (pre-)configured as short.  In this sense, the following modifications are proposed for the bullets.   * 1st bullet is modified as follows.   The resource selection window [n+T1, n+T2] is randomly selected by UE while satisfying:   * + T1 ≥ 0 and T2 *≤* remaining PDB   + T2-T1 *≤* (pre-)configured threshold * Clarifications on 2nd and 3rd bullet are need. Any slots not monitored by UE due to SL transmission are excluded from Y candidate slots. * 4th bullet is removed. DRX operation and sensing are independent operation, and they don’t need to be correlated. According to main sentence, as candidate slots thereby partial sensing slots are determined by UE implementation, the alignment between partial sensing slot and DRX on duration cannot be specified. * 5th bullet is modified as follows.   FFS whether min and max Y candidate slots are applied (e.g., a range of Y values per priority level) |
| Samsung | For the determination of selection window and candidate slots, we prefer to reuse legacy LTE and NR Rel-16 procedure as much as possible. Therefore 1st bullet seems OK for us, but for 2nd and 3rd bullets, we agree with other companies’ concern on excluding UL transmission.  We agree with 4th bullet in principle, but current wording may lead to ambiguity. We suggest to discuss DRX related details as a separate issue. |
| Fujitsu | We think that we need to discuss firstly which is the base to design the sensing scheme: the traffic type that the UE is about to transmit or the traffic type(s) that is ongoing in the resource pool. We prefer to design the sensing scheme based on the ongoing traffic type(s) in the resource pool. To sense other UE’s periodic reservations, Rel.14 LTE partial sensing mechanism can be reused.   * For the 2nd and 3rd bullet, it is not necessary to exclude UL slots from the Y candidate slots. * Regarding the 4th bullet, it is not relevant with the determination of Y candidate slots. It seems that it is overlapped with section 3.3. In addition, clarification of “as early as possible” is needed. For the alignment of sensing occasions and DRX on duration, we share the same view as OPPO that it is under discussion in another email thread [104-e-NR-R17-SL-LS-01], we do not need to discuss it here. * For the 5th bullet, we are fine to configure min Y values per priority level. In addition of priority level, other factors can also be considered, such as whether HARQ feedback is enabled or disabled. |
| MediaTek | We are OK with the 1st, 2nd, and 3rd sub-bullets. NR-SL partial sensing should follow LTE-SL design. We also agree with the 4th sub-bullet in principal.  For the 5th sub-bullet, we don’t see a need to include max of Y. As mentioned in the main bullet of the proposal, it’s up to UE implementation to select Y slots. In LTE-SL, UE can select a minimum of Y subframes, but max is not needed. We suggest the following change:  **Proposal 2**: If UE is configured to perform partial sensing and provided with a resource reservation interval () from higher layer, it is up to UE implementation to determine at least Y candidate slots within a resource selection window, where   * The resource selection window is defined in the same way as in R16 NR-V2X according to step 1 [TS 38.214 Sec. 8.1.4]. * UE determination of Y candidate slots should exclude slots in which its own SL and UL transmissions occur in the resource selection window. * Due to integer multiple of resource reservation periods, UE determination of Y candidate slots should exclude slots that would coincide with its own SL and UL transmissions within the corresponding periodic sensing occasions. * Periodic sensing occasions that correspond to the set of Y candidate slots should align with the SL-DRX ON duration as much as possible (if configured) and/or as early as possible to maximize number of contiguous sensing slots before the resource selection trigger in slot n. * ~~FFS min and max Y candidate slots should be applied (e.g., a range of Y values per priority level)~~ |
| Intel | We propose following modifications to FL proposal:  **Proposal 2**: If UE ~~is configured to~~ performs partial sensing and provided with a resource reservation interval () from higher layer, ~~it is up to UE implementation to determine Y candidate slots within a resource selection window, where~~   * The resource selection window is defined and determined by UE in the same way as in R16 NR-V2X according to step 1 [TS 38.214 Sec. 8.1.4]. * ~~UE determination of Y candidate slots should exclude slots in which its own SL and UL transmissions occur in the resource selection window.~~ * In our view the bullet above is a separate discussion topic and procedures defined in Rel.16 can be reused at least as a starting point. * ~~Due to integer multiple of resource reservation periods, UE determination of Y candidate slots should exclude slots that would coincide with its own SL and UL transmissions within the corresponding periodic sensing occasions.~~ * In our view the bullet above is a separate discussion topic and procedures defined in Rel.16 can be used at least as a starting point. * ~~Periodic sensing occasions that correspond to the set of Y candidate slots should align with the SL-DRX ON duration as much as possible (if configured) and/or as early as possible to maximize number of contiguous sensing slots before the resource selection trigger in slot n.~~ * We prefer to finalize details of partial sensing operation first and then discuss impact/interaction w/ SL-DRX . * ~~FFS min and max Y candidate slots should be applied (e.g., a range of Y values per priority level)~~ * In our view, above bullet relates to resource selection window size determination which is not supposed to change comparing to Rel.16 |
| Huawei, HiSilicon | For the main bullet, it can be understood that if the UE is configured to perform partial sensing in a resource pool, a UE can select resources based on the limited Y sensing slots. However, it is not clear the relationship between the provision of resource reservation interval and monitoring behaviour. A UE cannot predict the service type, aperiodic or periodic, for future packets, and so cannot know which slots would be part of partial monitoring. Although the procedure is not defined yet, this does mean the UE cannot know what to sense in the past for this periodic transmission to select resources. However, this part of the proposals does not seem to depend on needing any knowledge of Prsvp\_TX, so there is no need to use “provided with a resource reservation interval ()) from higher layer” as a condition for monitoring.  The first sub-bullet is OK, as mode 2 RA sensing in Rel-16 should be reused as much as possible, and this includes resource selection window.  For the second sub-bullet, the candidate slots should be the slots in a resource pool which has already excluded by applying the bitmap. It does not relate to UL transmission. How to choose Y candidate slots can be left to UE implementation, same as in LTE-V, e.g. exclude slots of its own SL transmissions and/or slots would coincide with its own SL transmissions due to resource reservation periods. Hence, both second and third sub-bullets can be up to UE implementation which is already covered by main bullet. These two sub-bullets are not needed.  For the fourth sub-bullet, at this stage, RAN1 does not have a clear understanding on SL DRX (re-)configuration, of which design is under RAN2 discussion, as well as the relation between SL DRX and partial sensing configuration. RAN1 should focus on the basic and critical designs for partial sensing first and then consider the coordination of SL DRX and partial sensing. Taking this bullet later would allow a more meaningful agreement than “as much as possible”.  We are OK with the fifth bullet.  Therefore, the proposal should be modified as follows:  **Proposal 2**: If UE is configured to perform partial sensing ~~and provided with a resource reservation interval () from higher layer~~, it is up to UE implementation to determine Y candidate slots within a resource selection window, where   * The resource selection window is defined in the same way as in R16 NR-V2X according to step 1 [TS 38.214 Sec. 8.1.4]. * ~~The resource selection window is defined in the same way as in R16 NR-V2X according to step 1 [TS 38.214 Sec. 8.1.4].~~ * ~~The resource selection window is defined in the same way as in R16 NR-V2X according to step 1 [TS 38.214 Sec. 8.1.4].~~ * ~~Periodic sensing occasions that correspond to the set of Y candidate slots should align with the SL-DRX ON duration as much as possible (if configured) and/or as early as possible to maximize number of contiguous sensing slots before the resource selection trigger in slot n.~~ * FFS min and max Y candidate slots should be applied (e.g., a range of Y values per priority level) |
| Convida Wireless | The same procedure that are defined in Rel-16 should be reused. SL Tx slots can be considered but UL slots may not be considered. In addition, our view is that the candidate slots should align with the DRX ON duration as much as possible. |
| Bosch | We are fine with the main-bullet. If the proposal targets periodic resource /SPS sensing only, then we do not need to repeat Rel-16 sensing procedure again (i.e., Prsvp\_TX). We are also fine to remove this sentence completely to fit periodic and aperiodic sensing: “~~and provided with a resource reservation interval () from higher layer~~”  We agree with the 1st and the 5th sub-bullet.  We agree with the majority of companies to delete 2nd, 3rd sub-bullets.  We would like to postpone 4th sub-bullet until we discuss and agree on DRX design. |
| Nokia, NSB | For main bullet, suggest modification as shown below.  *Proposal 2: If UE is configured to perform partial sensing ~~and provided with a resource reservation interval () from higher layer~~, it is up to UE implementation to determine Y candidate slots within a resource selection window, …*  We support the first sub-bullet and the 5th sub-bullet.  We are not agreed with the 2nd, 3rd, and the 4th sub-bullets. For the 2nd and 3rd sub-bullets, there is no need to exclude the UL slots. The DRX issue in the 4th sub-bullet shall be discussed in somewhere else. |

**Proposal 2’**: If UE is configured to perform partial sensing and provided with a resource reservation interval () from higher layer in slot n, it is up to UE implementation to determine Y candidate slots within a resource selection window, where

* The resource selection window is defined in the same way as in R16 NR-V2X according to step 1 [TS 38.214 Sec. 8.1.4].
* FFS whether a range of minimum Y values is (pre-)configured per priority level as in LTE-V

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| **Company** | **Comments** |
| OPPO | We are fine with main bullet and 1st sub-bullet.  For the 2nd sub-bullet, we want to clarify that in LTE-V, the minimum Y is configured as follows, not configured per priority level. The intension to configure minimum Y per priority level is not clear. We prefer to take LTE-V mechanism as baseline. Then we suggest to remove “per priority level” in the sub-bullet.  p2x-SensingConfig-r14 SEQUENCE {  minNumCandidateSF-r14 INTEGER (1..13),  gapCandidateSensing-r14 BIT STRING (SIZE (10))  } OPTIONAL, -- Need OR  **Proposal 2’**: If UE is configured to perform partial sensing and provided with a resource reservation interval () from higher layer in slot n, it is up to UE implementation to determine Y candidate slots within a resource selection window, where   * The resource selection window is defined in the same way as in R16 NR-V2X according to step 1 [TS 38.214 Sec. 8.1.4]. * ~~FFS whether a~~ A range of minimum Y values is (pre-)configured ~~per priority level~~ as in LTE-V |
| LGE | R16 resource selection can be enhanced for power saving when partial sensing and additional short-term sensing (STS) to avoid collision with aperiodic traffic are used.  The problem of R16 procedure to determine Y candidate slots is depicted in Fig 1. UE determines a selection window [n+T1, n+T2] within PDB and Y candidate slots. After identifying the idle resources among the candidate resources based on sensing, the idle resources are reported to MAC layer for final resource selection.  If the selection window is chosen as wide, and the candidate resources are determined so that the interval between candidate resources is long (e.g. more than STS window length), the resultant total short-term sensing duration over the selected resources becomes quite long, as shown in Fig 1, which requires high power consumption. This is problematic for power saving UE.    This high power consumption due to short-term sensing can be solved at the stage of determining the selection window and the Y candidate resources. If UE choose a shorter selection window, the candidate resources can also be determined within the short selection window. Then the STS windows prior to the selected resources significantly overlap each other, thus the total sensing duration will be very short, as shown in Fig 2. This will greatly save power in performing short-term sensing, compared to that required in the procedure depicted in Fig 1.    With the observation above, we strongly recommend the group to consider the power saving benefit of this ‘burst-type’ resource selection for P-UE. Following the claimed advantage, we propose the following and hope FL to capture it for further discussion.  **Proposal 2’**: If UE is configured to perform partial sensing and provided with a resource reservation interval () from higher layer in slot n, it is up to UE implementation to determine Y candidate slots within a resource selection window, where   * The resource selection window [n+T1, n+T2] is randomly selected by UE while satisfying:   + T1 ≥ 0 and T2 *≤* remaining PDB   + T2-T1 *≤* (pre-)configured threshold * FFS whether a range of minimum Y values is (pre-)configured per priority level as in LTE-V |
| NEC | Regarding determination of Y, we think if it’s totally up to UE implementation will cause resource collision due to non-monitored slots and thus waste power for partial sensing UE. At this early stage of Rel.17, we have chance to do some enhancements just like want we done for full sensing in step 5.  For the non-monitored slots, the specified way in LTE/NR full sensing is to exclude all the possible reserved resources with allowed reservation periods of the resource pool. i.e., step 5 is captured in full sensing to exclude the hypothetical reserved resources. However, step 5 is not performed in Rel.14 partial sensing.  The selection of Y candidate resources within the selection window is up to UE implementation in current Rel.14 partial sensing specification. If we reuse the legacy procedure, as a consequence, UE has possibility to select all the slot as the candidate resources and will not exclude the collided slots reserved by others due to the non-monitored slots.  Hence, we propose to add one sub bullet as   * FFS any restrictions to determine Y candidate slots.   1st sub-bullet: ok  2nd sub-bullet: We didn't observe that min Y is configured per priority in LTE-V and propose to delete "~~as in LTE-V~~".  In addition, In LTE-V, the min selection window is [n+4,n+20] which contains at least 17 subframes, considering some subframes which the UE cannot monitor, it's feasible to set *minNumCandidateSF* as [1, 13] because even the largest candidate value 13 is less than the minimum resource selection window 17.  In NR sidelink, the resource selection window size depends on subcarrier spacing configuration μ, RRC parameter T2\_min, remaining PDB and UE implementation. The minimum window size it’s no longer a fixed value as LTE sidelink. So we think the range of *minNumCandidateSF* in NR should be carefully designed and propose:  FFS how to (pre-) configure the range of minimum Y values. e.g., consider priority level, resource selection window size, etc. |
| NTT DOCOMO | We support the proposal. Regarding how to determine Y, it is OK with up to UE implementation. UE can select Y slots so that power saving performance gets better if the UE want to do so. Even in any case of Y slot selection, resource collision is avoided by re-evaluation/pre-emption check. |
| Apple | We think in LTE V2X, the minimum Y values is (pre-)configured independent of priority level. Here, we prefer to keep the same design as LTE V2X, i.e., removal of “per priority level”. Otherwise, we are fine with the proposal. |
| ETRI | We prefer Apple’s modification. |
| Qualcomm | The proposal seems too restrictive at such an early stage and could limit communications between two power savings UEs. Evaluations and analysis of different scenarios (Tx/Rx/Interferer, power saving/non-power saving) are needed before agreeing on the scheme. |
| Fujitsu | For the main bullet, we think it is too early to conclude that the Y candidate slots can be determined up to UE implementation. Unlike Rel.14 LTE-V2X, Rel.16 NR-V2X supports HARQ-ACK feedback. When the HARQ-ACK feedback is enabled, the UE should ensure the HARQ RTT related minimum time gap between any two selected resources of a TB. In such circumstance, if the Y candidate slots are determined totally up to UE implementation, it is possible that there are many un-selectable resources considering that the resources within the HARQ RTT minimum time gap cannot be selected. As a result, reliability performance may be impacted due to the limited number of selectable resources.  We are fine with the 1st sub-bullet.  For the 2nd sub-bullet, we are fine in general. Since per priority configured min Y is not supported in LTE-V2X, we propose to remove “as in LTE-V”. From our understanding, the intention is to FFS whether “a minimum Y value” is (pre-)configured per priority level, but not “a range of minimum Y values” is (pre-)configured per priority level. Therefore, we propose to change “a range of minimum Y values” into “a minimum Y value”. |

### Proposals before 2nd check point (Feb 2)

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

* TBD

### Proposals before 3rd check point (Feb 4)

FL observations and comments based on inputs received in Sec. 3.2.2:

* TBD

## Topic #3: Periodic-based partial sensing (determination of periodic sensing occasions for periodic transmission)

**Background**: Continuation from Topic #2, as it is mentioned that in R14 LTE-V the smallest denominator was set to 100ms for Pstep and 20/50ms reservation periodicities were not taken into consideration, the whole R14 partial sensing was based on an assumption that the reservation periodicity of PUE’s transmission will always be in an integer multiple of 100ms. And k (*gapCandidateSensing*) is (pre-)configured according to the set of possible resource reservation periods allowed in the resource pool. In R16 NR sidelink, the set of up to 16 (pre-)configured possible resource reservation periodicities can be much smaller ([1:99], 100, 200, …, 1000) to cater for wider range of traffic patterns especially ones with short latency requirement. As such, it would be very difficult and dangerous to continue assuming a common denominator can be used in periodic-based partial sensing for NR sidelink. As such, the k value will no longer need to be based on a bitmap which identifies a set of periodic sensing occasions that are integer multiple of 100ms to cover other allowed reservation periodicities in the resource pool.

### Proposals before 1st check point (Jan 28)



Figure 2

**Proposal 3**: If UE is configured to perform partial sensing and provided with a resource reservation interval () from higher layer, the UE monitors slots of a set of periodic sensing occasions, where a periodic sensing occasion is a set of slots according to if is included in the set of Y candidate slots.

* is a periodicity value from the configured set of possible resource reservation periods allowed in the resource pool (*sl-ResourceReservePeriodList*)
  + Option 1: corresponds to all values from *sl-ResourceReservePeriodList*
  + Option 2: corresponds to a subset of values from *sl-ResourceReservePeriodList*
    - FFS how to determine the subset
* k equals to
  + Option 1: Only the most recent sensing occasion for a reservation period (k=1)
  + Option 2: The two most recent sensing occasions for a reservation period (k = [1, 2])
  + Option 3: All possible sensing occasions before
  + Option 4: FFS others

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| --- | --- |
| **Company** | **Comments and option selection for and k** |
| OPPO | We are OK with the proposal in principle. While it needs to clarify that down selection from these options should be considered later. |
| Fraunhofer | We agree with the proposal as such, with the option to decide on the and k values as FFS. |
| Apple | We are fine with the proposal with modification.  For Preserve, we support Option 2. If Option 1 is selected, then the sensing efforts will be large especially with small resource reservation periods. For example, if the resource reservation period is 1 ms, then no power saving gain can be achieved at all. Here, we may configure a resource reservation period threshold, and only apply the configured resource reservation periods which are larger than the threshold.  For k, we prefer to add an option that the k is by (resource pool) configuration. Any integer value between 1 and a configured value is used to determine the number of sensing occasions. This is restricted within the sensing window [n-T0, n-Tproc,0). |
| Ericsson | Regarding Preserve, we think that the easiest thing is to have full configurability (from the values in *sl-ResourceReservePeriodList*), avoid a fruitless discussion, and focus on more important issues.  Moreover, for the values of k only Option 1 should be considered. That is aligned with the procedure in 8.1.4. |
| InterDigital | We are OK with the proposal |
| CATT | We are OK to discuss the selection of and k values later. |
| Qualcomm | Similar to Proposal 2, we think we need to consider the general principle prior to discussing the details. |
| Lenovo&MM | For , option 1 is our preference.  For k, option 1 is our preference. |
| CMCC | We are OK with the 2 options, and meanwhile, we would like to add a third option that corresponds to the common devisor of all values from *sl-ResourceReservePeriodList.* In our views, by supporting option 3, both options in the proposal can be achieved by setting specific *gapCandidateSensing* bitmap indications, which can be up to implementation. In addition, by supporting option 3, the k value should be modified to be the ratio of sensing window size and the derived . |
| NEC | **Preserve: Option 1/option 2.** Option 1 is preferred because we should exclude all the reservations. Option 2 contains more flexibility (including option 1) which we can also accept.  **K: Option 1.** Concerns: for a small and large index of slot y, when we take k = 1, it's possible that y- doesn't belong to the sensing window, e.g., later than n-Tproc. K-1 may make the occasion out of sensing window. Or, as alternative, we just define sensing occasions based on k and for Rel.17 partial sensing because we're also trying to define additional sensing occasions out of legacy sensing window in other topics.  Considering figure 2 above, we think only option 1 is aligned with existing sensing procedure. According to legacy SPS scaling mechanism and spec, only reservation received in the last Preserve will be scaled to the resource selection window. The other reservations (k=2,3,…) except the last one(k=1) will not be scaled according to the legacy method and will have no impact to the resource exclusion in selection window (due to Q = 1 in step 6 (c)). |
| vivo | * Regarding   We are ok with both options, but option2 is preferred from the perspective of power saving. For example, if two periods are configured in a pool, one period is an integer multiple of the other, can be set to the larger one of the two periods, which not only reduces the time instances of periodic sensing but also ensures that the UE can detect packets of both periodicities.  We suggest adding a FFS on the conditions on using option1 or option2.   * Regarding the value of k   I think we need to discuss some basic principles for determining the location of sensing occasions before choosing one or more options. For example, whether the periodic sensing occasions can be after slot n or . whether a (pre-)configured bitmap like *gapCandidateSensing* in LTE V2X will be reused to determine the k values. |
| FUTUREWEI | We agree with the proposal. FFS for the values of *P*reserve and k |
| ETRI | We are generally fine with FL’s proposal. Regarding and k values, it can be discussed further. |
| Panasonic | We are ok with the proposals. |
| Sony | We are OK with the proposal and down-selecting later. |
| NTT DOCOMO | Support the proposal’s direction and prefer option 1 + option 1. |
| CAICT | For , we prefer option1 since it would lead to a serious conflict between SL TXs if a subset of values from *sl-ResourceReservePeriodList* is configured for partial sensing. Besides, it is hard to determine which subset to configure for option2.  For k, we prefer option3 considering it seems to have higher reliability than option1 and option2. |
| Sharp | Regarding the values of k, since the UE cannot predict where slot n is before it comes, it has to monitor the slots in a periodic manner anyway, so it is unclear why restricting the values of k here helps.  Besides, we have 2 further clarifications. 1) Considering the topic#4 and #5, we suggest to add “at least the UE monitors…”, since probably in partial sensing, the periodic slots are not the only monitored slots. 2) the issue related to periodic reservation in SCI format 1-A has not been decided yet, thus, should be a value with conversion from ‘ms’ to logical slot (of a resource pool), since the terminology is used in the proposal. |
| Xiaomi | As shown in Figure 2, the resource selection happens at slot n, and UE sensing behaviour happens before slot n. Y candidate slots are determined at slot n, but not before slot n. Therefore, we suggest to rewording the main bullet such as “When resource selection is triggered in slot n, given a slot in the set of Y candidate slots, UE should have monitored in slots …”. |
| ZTE | For the first bullet, we agree with option 1. For the second bullet, we understands that all options are under the assumption that the bitmap is set with all “1”, or there is no such bitmap mechanism for sensing indication anymore. But we think firstly, we should discuss whether to reuse legacy bitmap mechanism for partial sensing. |
| LGE | The main sentence of the proposal is generally ok.   * For , option 2 is preferred for power saving purpose. Actually option 1 is a special case of option 2. * For value k, sensing over multiple slots for the same reservation period is redundant so not necessary. In this sense, sensing only one slot for each reservation period is reasonable. We propose option 4 as follows.   + Only one sensing occasion for one reservation period. A value k for a specific sensing occasion is UE implementation. Max value k is (pre-)configured. |
| Samsung | We are OK with the proposal if down-selection will be made later.  Otherwise we prefer full configurability for both and k. |
| Fujitsu | * Regarding , we prefer option 2. Since the periodicities ranging from 100 ms to 1000 ms are integer multiples of 100 ms, it is not necessary to take all the values from *sl-ResourceReservePeriodList.* * Regarding *k*, the earliest sensing occasion should be equal to the maximum periodicity in the current resource pool. On the other hand, for some extreme short periodicities (e.g., 1 ms ~ 3 ms), since the processing time needs to be guaranteed for resource selection, the UE cannot perform sensing for the most recent sensing occasions. Considering the above points, we propose the following for *k.*   + For the reservation period ≧a certain value (e.g., 100 ms), *k*=1.   + For the reservation period < a certain value (e.g., 100 ms), *k* is the minimum integer which makes falling into the sensing window. |
| MediaTek | We are fine with the proposal with and k as FFS. Downselection should be done later. |
| Intel | Agree with modification aiming to support coexistence with dynamic transmissions that will require sensing in a window of size max(resource selection window, SCI signaling window) prior to resource reselection time instance.  Our preferred option for “Preserve” – make it fully configurable  Our preferred option for “k” is k = 1. Other k values seem overcomplicate design and do not serve power saving purpose. |
| Huawei, HiSilicon | For the main bullet, same comments as that for proposal 2, i.e., “and provided with a resource reservation interval () from higher layer” should be removed.  Please could the FL clarify if the proposal is to support all the options under Preserve and k, or to down-select now or later? We assume downselection is intended.  On , Option 1. Support all values that were already supported in Rel-16, since it should be backward compatible for Rel-16 design in Rel-17.  On k, Option 4 (k is a configurable set). We doubt that all options should be supported individually, but configuration could cover all or most.  Unlike in LTE-V where partial sensing deals with periodic traffic only, NR partial sensing would suffer more collisions due to aperiodic traffic, hence restriction on k =1 only would more likely result in un-reliable decision on corresponding candidate slot due to failure of a SCI decoding at a given periodicity, e.g. caused by aperiodic transmission. We do not see much more value in option 2 than option 1. The value of k can be configurable to provide flexibility. |
| Convida Wireless | We are fine with the proposal with down selection for options. |
| Bosch | In principle, we are fine with the FL proposal. If we are going to down select, then our preference is to be able to (pre-)configure both P\_reserve and k. |
| Nokia, NSB | We shall agree with some general principles to support various periodicities for partial sensing, before we discuss this detailed proposal. |

**Proposal 3’**: If UE is configured to perform partial sensing and provided with a resource reservation interval () from higher layer, the UE monitors slots of a set of periodic sensing occasions, where a periodic sensing occasion is a set of slots according to if is included in the set of Y candidate slots.

* is a periodicity value from the configured set of possible resource reservation periods allowed in the resource pool (*sl-ResourceReservePeriodList*). Down select among:
  + Option 1: corresponds to all values from *sl-ResourceReservePeriodList*
  + Option 2: corresponds to a subset of values from *sl-ResourceReservePeriodList*
    - FFS how to determine the subset
  + Option 3: is (pre-)configurable from values in *sl-ResourceReservePeriodList*
  + Option 4: is a common devisor among values in *sl-ResourceReservePeriodList*
* k equals to (down select to one)
  + Option 1: Only the most recent sensing occasion for a reservation period (k=1)
  + Option 2: The two most recent sensing occasions for a reservation period (k = [1, 2])
  + 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: FFS others

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| **Company** | **Comments** |
| OPPO | We support FL’s proposal. |
| NEC | As they are down-select options, we're ok with current proposal.  One clarification for the "down select among" is the intention to down select at least one option for Preserve? We think "down select to one" is applicable to Preserve too. |
| NTT DOCOMO | Agree with the current proposal keeping options for future down-selection. |
| LGE | Support FL’s proposal.  For , option 1 always requires max power consumption. Option 4 is unclear as value 1 is always a common divisor, which means monitoring all slots. From power consumption perspective, a subset of values are preferred. But rather than making a rule for decision by UE, network can (pre-)configured the required values. As a result, option 3 is preferred.  For k value, as we commented earlier, sensing over multiple slots for the same reservation period is redundant, so not necessary. In this sense, sensing only one slot for each reservation period is reasonable. Option 4 is preferred as it is a superset including the option 1. |
| Apple | We prefer to add “k is (pre-)configured” as a more reliable sensing option. At this moment, we may include all possible options and down-select later.  For , we think Option 2 covers Option 3, since Option 3 can be considered as one way (i.e., configuration) of determining the subset. |
| ETRI | We support FL’s proposal. As commented by NEC, it might be better to modify into “Down select to one” instead of “Down select among”. |
| Qualcomm | Similar to our comment on Proposal 2’, it’s too early to restrict the design of the partial sensing scheme. Different combinations of Tx/Rx UEs need to be investigated first. |
| Fujitsu | We are fine with the main bullet and the 2nd sub-bullet.  For , we think that the FFS in option 2 includes the subset determination methods provided by option 3 and option 4. |

### Proposals before 2nd check point (Feb 2)

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

* TBD

### Proposals before 3rd check point (Feb 4)

FL observations and comments based on inputs received in Sec. 3.3.2:

* TBD

## Topic #4: Contiguous-based partial sensing (when is provided by higher layer) – re-evaluation and pre-emption checking for periodic transmission

**Background**: Continuation from Topic #3, partial sensing for a periodic transmission in a resource pool that allows aperiodic transmissions (which is all SL Tx pools), should also take into consideration of resource reservation by aperiodic transmissions. In various submitted contributions to this meeting, it is proposed that an additional sensing (short-term sensing/extended partial sensing) should be performed by the UE for periodic transmissions to take into account of aperiodic resource reservations.

Furthermore, it was agreed in the last meeting (RAN1#103-e) that “re-evaluation and pre-emption checking are supported by UEs that perform sensing”, it is also proposed in contributions that the additional sensing can also be used for the purpose of re-evaluation and pre-emption checking.

### Proposals before 1st check point (Jan 28)



Figure 3

**Proposal 4:** If UE is configured to perform partial sensing and provided with a resource reservation interval () from higher layer, the UE additionally monitors slots

* Option 1: from slot ty0 -32, where ty0 is the first slot in the set of Y candidate slots, until before the last transmission for the TB, except for slots in which its own SL and UL transmissions occur
* Option 2: from slot n-32 until before the last transmission for the TB, except for slots in which its own SL and UL transmissions occur

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| **Company** | **Option 1, 2 or others** | **Comments** |
| OPPO |  | Firstly, it needs to clarify in the main bullet that this proposal targets for period traffic. For aperiodic traffic, UE cannot predict the arriving time of the packet so that it cannot sense the slots before slot n (packet arrival time).  In our view, considering the aperiodic traffic in the RP, UE should do short term sensing (e.g., 32 slots) before slot n. furthermore, UE should do short term sensing (e.g., 32 slots) before each selected resource for re-evaluation/pre-emption check.  For option 1 and 2, as we commented in proposal 2, UL transmission should be removed. Furthermore, for option 1, whether the UE should monitor from ty0 -32 depends on whether the time position of the corresponding slot is before or after slot n. For option 2, if the time gap between slot n and the first selected resource is > 32 slots, UE does not need to sense the slots between [n+1, ty0 -32]. |
| Fraunhofer |  | We prefer to retain the procedure used in Rel-16 for re-evaluation/pre-emption. Based on the proposal, exclusions based on UL transmissions can be removed. |
| Apple |  | We have the following comments about the proposal:   1. We assume this is for resource re-evaluation and pre-emption checking. We may mention it in the proposal. 2. Why “resource reservation interval” is mentioned in the main bullet? Do you intend to mean the periodic resource reservation? Note that for aperiodic resource reservation, the resource reservation interval of 0 ms is also provided by higher layer. 3. In the figure, why a UE starts the contiguous-based sensing for resource re-evaluation before n (slot for resource selection) in the case of partial sensing? A UE is not supposed to perform sensing for resource re-evaluation until the resource is selected. Here, is the slot n the initial periodic data arrival time or the data arrival time after one period? 4. We should consider another option that the sensing for resource re-evaluation could start from m-32 until m-T3 to avoid collision with aperiodic reservation from another UE, where m is the slot of the selected resource. |
| Ericsson |  | We do not agree with this proposal. First, we should anchor the behaviour of the sensing mechanism for aperiodic transmissions (see 3.5) and once it has been agreed, we can revisit the issue defined in this proposal. |
| InterDigital |  | For resource (re)selection, the UE should perform short-term sensing before slot n.  For pre-emption and re-evaluation, the UE should perform short-term sensing from slot n+1 to m-T3. |
| CATT |  | The intended use case of the proposal should be further clarified. Also, we think It’s better to discuss this proposal after detail mechanism of sensing has been decided. |
| Qualcomm |  | We prefer to discuss this issue after Proposals 4 and 5 are settled. |
| Lenovo&MM | Option 1 | Option 1 is acceptable to us. |
| CMCC |  | The intention of this proposal is not quite clear to us:   * Does this proposal intend to solve the case when a resource pool which is shared by both periodic and aperiodic transmissions, and to introduce an additional sensing window on top of the partial sensing slots to avoid the potential collision caused by the aperiodic transmissions? * Or, it is intended to study the re-evaluation and pre-emption mechanism for the partial sensing? |
| NEC | Option 1 | If this proposal is intended for UE's periodic traffic, should be excluded.  Partial sensing cares about candidate resources Y, so we think ty0 -32 could be the starting sensing time in this proposal. |
| vivo | Option1 | 1. UL transmission should be removed. 2. Option2 may introduce unnecessary sensing occasion compared with option1 when n-32< ty0 -32 |
| ETRI |  | We slightly prefer option 1. However as mentioned by several companies, this proposal should be limited for periodic traffic. |
| Sony |  | We need to make agreement for the other topics and then we can revisit this topic later. |
| NTT DOCOMO | Option 1 with update | * UL transmission is unnecessary. * Option 2 includes unrequired slot for sensing for aperiodic reservation. * Option 1 should be updated as ‘ty0 -31’ since SCI in ty0 -32 cannot reserve resource in ty0. |
| CAICT |  | It is better to separate the issues on sensing to avoid the conflict with aperiodic traffic and sensing for pre-emption and re-evaluation apart.   1. To avoid the conflict with aperiodic traffic, slots from ty0-32 to ty0 shall be sensing, except the slots for its own SL/UL transmissions. 2. For pre-emption and re-evaluation, slots from n-32 until before the last transmission for the TB shall be sensing, except the slots for its own SL/UL transmissions. |
| Sharp |  | We agree with Ericsson and Qualcomm that the issue is discussed after proposal 5 concluded. |
| Xiaomi | Option1 | The sensing behaviour before n and after n should be distinguished. From our understanding, what we are discussing in the behaviour of resource selection, which happens at slot n. Sensing before slot n cannot be determined at slot n, as you cannot go back to sense; you can only determine whether sensing requirement is satisfied or not. But sensing after slot n can be determined at slot n. Therefore, sensing before slot n should be discussed together with sensing requirement issue; while sensing after slot n can be discussed in pre-emption and pre-evaluation issue. |
| ZTE | neither | Firstly, we share the same view with OPPO that if n is defined as packet arrival time, it is not capable for UE to predict the packet arrival timer. Then if n is defined as resource (re-)selection trigger time indicated by MAC, we think the example shown in proposal 5 is a more reasonable solution that short term sensing is triggered after n. So firstly, we should give a clear definition of n. |
| LGE | See comments | We need to separate two operations.  1) short-term sensing (STS) for resource (re)selection  Before resource (re)selection, STS is performed over [n-TA, n–Tproc,0] to detect any possible periodic traffic, where TA = max interval between reserved resources that can be indicated by a SCI.  We didn’t make any decision on the content of SCI, so it’s safer at this stage to say TA is based on the SCI content. If Rel.16 SCI rule is reused, TA is 31 slots.  2) STS for resource re-evaluation/pre-emption checking  After resource (re)selection, STS is performed over [STSk, mk-T3] for k=0,…,K, where mk is the timing of the k-th reserved resource and K is the number of reserved resources, and STSk is determined as max(n+1, mk - TA).  If the candidate slots are apart from each other more than 31 slots, sensing over a duration exceeding 31 slots is not performed for power saving. |
| Samsung |  | We also prefer to clarify the intention of this proposal. If that’s common understanding that resource reservation interval provided by higher layer corresponds to periodic traffic, then we’re fine. In addition, UL transmission should be removed similarly as in topic#3.  We slightly prefer option 1. |
| Fujitsu |  | There should be two windows with different functions. One is short sensing window which is defined as . It is used for sensing aperiodic reservations. The other is defined as re-evaluation/pre-emption sensing window, used for re-evaluation/pre-emption check. If pre-emption is disabled in current resource pool, the re-evaluation/pre-emption sensing window is from the slot until before the first-in-time selected resource. If pre-emption check is enabled in current resource pool, the re-evaluation/pre-emption sensing window is from the slot until before the last-in-time selected resource. |
| MediaTek |  | We do not support this. Sensing for re-evaluation/pre-emption can be performed separately from the sensing for aperiodic traffic detection in the pool. That is, sensing can be performed in [n-32,n] and [m-32, m-T3]. We should also add this as another option. |
| Intel |  | We prefer Option 2 but are open to discuss it later. |
| Huawei, HiSilicon | Principles of option 1, but needs modifications | First of all, it seems the current proposals ignore an essential issue when a UE will report SA to the high layer and how to use the sensing results in the short sensing window by the UE to detect aperiodic reservations from other UEs.  Before ty0, a short sensing window is defined for the purpose to handle aperiodic reservations from other UEs, and therefore the sensing results obtained from the short sensing window and partial sensing slots can be used to determine and report the candidate resources set SA to the high layer. Considering the largest gap resource reservation by a single SCI and UE processing time, the time interval should be from ty0 – 31 to ty0 - tproc,0 –T1 to cover the most relevant 32 slots.  After ty0, if the re-evaluation is triggered based on specific conditions for the selected resource by MAC, additional slots can be monitored for re-evaluating the resources. If the re-evaluation is not triggered, no more monitoring is needed after ty0.  Thus the problem in the proposal is that there is no distinction between sensing before ty0 and re-evaluation after ty0. This structure needs to be reflected in the proposal before it is possible to consider the whole procedure.  The SL and UL part should be deleted, as mentioned above for proposal 2. Similar with other proposals, the dependence on Prsvp\_TX needs to be removed, because the UE is performing this procedure to detect traffic from other UEs, without depending on the periodic or aperiodic nature of its own traffic. |
| Convida Wireless |  | The proposal 4 could be discussed later. |
| Bosch |  | In our understanding, if “resource reservation interval ()” is stated in the main bullet, then we are targeting periodic reservation. In this case, option 2 works well. However, we are open for discussions. |
| Nokia, NSB |  | This proposal can be discussed later after we made some progress on the design. |

### Proposals before 2nd check point (Feb 2)

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

* TBD

### Proposals before 3rd check point (Feb 4)

FL observations and comments based on inputs received in Sec. 3.4.2:

* TBD

## Topic #5: Contiguous-based partial sensing (when is NOT provided by higher layer) – re-evaluation and pre-emption checking for aperiodic transmission

**Background**: For UE with aperiodic traffic, data packets could arrive at any time for SL transmission without any prior knowledge. Therefore, it is not possible for a power constrained UE to predict and perform monitoring of slots before the resource selection trigger. From reviewing the contributions submitted to this meeting, in general, there are two partial sensing schemes, but both based on sensing in a contiguous manner.

### Proposals before 1st check point (Jan 28)

|  |  |
| --- | --- |
| Option 1 | Option 2 |

**Proposal 5:**

* When resource selection is triggered in slot n and resource reservation interval () is NOT provided from higher layer,
  + Option 1: In slot n, UE performs random resource selection
    - For a UE that performs sensing and for the purpose of re-evaluation and pre-emption checking, the UE monitors slots starting from n+1 until before the last transmission for the TB, except for slots in which its own SL and UL transmissions occur
  + Option 2: In slot , UE reports a set of candidate single-slot resources (*SA*) to the higher layer after performing resource exclusion based on sensing results obtained during for resource selection within the resource selection window .
    - Alt. 1: is fixed
    - Alt. 2: is dependent on the remaining PDB
    - Alt. 3: FFS
    - Alt. 4: is based on received HARQ feedback
    - For re-evaluation and pre-emption checking, the UE monitors slots starting from n+1 until before the last transmission for the TB, except for slots in which its own SL and UL transmissions occur
* Option 1 and Option 2 are both supported, or only one option is supported
  + FFS how UE selects Option 1 or 2 when both are supported

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1, 2 or both** | **Comments** |
| OPPO | Option 1 and option 2 | We are OK with these two options in principle. While we suggest to discuss the details later. |
| Fraunhofer | Both | We are fine with the proposal, since both option 1 and 2 are possible actions that can be done by type D UEs. |
| Apple | Both with modifications | In both options, the sensing for resource re-evaluation could be starting from m-32 to m-T3 just to avoid the collision with aperiodic resource reservation. Specifically,  In Option 1, the sensing does not start at n+1, rather start from m-32.  In Option 2, the sensing for resource selection is from n+1 to n+TA-Tproc,1 and the sensing for resource re-evaluation is from m-32 to m-T3. |
| Ericsson | Option 1 and Option 2 | We are OK to support both options and the conditions to trigger each of them when supported by the UE, but at this point further discussion on is necessary. Thus, our proposal is to include Alt. 4 in in the Proposal 5. (Alt. 4: T\_A is based on received HARQ feedback) |
| InterDigital | Both | We are ok with the proposal and support both options. |
| CATT | Both (but details needs to further modified) | Details needs to be further discussed. Particularly, for option 1 we think it should be FFS on whether to support re-evaluation and pre-emption for UEs perform sensing but operate random selection. This incurs more power consumption with no performance gain. |
| Qualcomm | Both options | We observed that both schemes provide significant performance for the power saving UE over random selection only. We also note that Option 1 could be viewed as a special case of Option 2 where TA = 0.  We share the view that details should be discussed later and suggest a more general proposal to agree on the principle without yet defining the precise timeline. That discussion would also include what can be left up to UE implementation. |
| Lenovo&MM | Both options | Both options should be considered at this stage. |
| CMCC | Both | We are ok with both options. |
| NEC | Both are ok | Firstly, in the main bullet, for aperiodic traffic, may be provided by higher layer with 0ms.  Secondly, in the first option, the monitoring window can be FFS between [n-1, m-T3] or [m-32, m-T3], because if the first selected resources m is in later of the selection window, it's possible that m-32 > n – 1, then UE can start to monitor from m-32 to save power. |
| vivo | Both (but needs more discussion and clarifications on details) | Just to make sure if we understand correctly. Option1 is to perform resource selection first and then re-evaluate the resources being selected. Option 2 is to do sensing first, use the sensing results for resource selection, and possibly also re-evaluate the selected resources. If so, then we are fine with the principle of two options. But more clarifications on the start/end of sensing and details such as the value of are needed.  ‘UL’ transmission should be removed. |
| ETRI | OK with Both | At this point, we are OK with both. Details should be discussed further. |
| Panasonic | Both |  |
| Sony | Both options | We are OK with both options. |
| NTT DOCOMO | Option 1 as random selection  Option 2 as partial sensing | We are OK with directions of both options. Two comments below.   * Option 1 does random selection first and then re-evaluation/pre-emption check will be performed, right? If correct, this option 1 is one of random selection mechanism, not partial sensing in my understanding based on the agreements at the last meeting. Clarification is preferred. * For option 2, Alt 3 is preferred. In this meeting, details can be FFS. |
| CAICT | Option1 and Option2 | Both options can be supported and FFS the details of the two options. |
| Sharp | Both | Basically, we share similar view as vivo. Besides, the last transmission seems not clear enough to us, since MAC layer provides the selected SL grant and the UE is not able to know which resource within the grant would be the last transmission when doing the re-evaluation/pre-emption check. Thus, we propose to define m as the last resource within a period. |
| Xiaomi |  | From our point of view, if T2 is large enough, e.g. 100ms, UE can change the start of selection window to T+32. Any collision from aperiodic traffic can be thus avoided. |
| ZTE | Option 2 | We agree with option 2 but we think re-evalution/pre-emption is an independent issue which is irrespective to short term sensing discussion. |
| LGE | Option 2 with modification | Option 2 is generally ok, but the following modifications are necessary.   * TA = max interval between resources that can be indicated by a SCI.   We didn’t make any decision on the content of SCI, so it’s safer at this stage to say TA is based on the SCI content. If Rel.16 SCI rule is reused, TA is 31 slots.   * TA < T2 < remaining PDB   + Otherwise resource re-evaluation and pre-emption checking are not performed. * Short-term sensing is performed over [mk-TA, mk-T3] for k=0,…,K, where mk is the timing of the k-th reserved resource and K is the number of reserved resources.   If the selected resources are apart from each other more than TA, sensing over a duration exceeding TA is not performed for power saving. |
| Samsung | Both | We are OK with both options at high level and the details can be discussed later. We agree with QC’s comment that use a more general proposal to agree on principle without touch exact timing. |
| Fujitsu | Option 2 | For re-evaluation and pre-emption checking, as we commented in proposal 4, the range of sensing slots depends on whether pre-emption is enabled or not in current resource pool. |
| MediaTek | Option 2 | We support Option2. |
| Intel | Please see comments | In our understanding, RAN1 needs to decide on start time for partial sensing window (e.g. time instance ‘n+1’) and end time of partial sensing window that may be dependent on ether time instance of last retransmission or HARQ ACK feedback. Other details are already covered by Rel.16 procedure for resource selection. Separately RAN1 can discuss whether min bound on partial sensing window size needs to be introduced or can be left up to UE implementation.  In addition, in resource pools with disabled semi-persistent reservations UE may still have periodic traffic with predictable arrival time and thus resource reselection trigger time instances. In such cases UE can start partial sensing at time instance [n-32] i.e. before resource reselection trigger. **We ask feature lead to add this option for RAN1 discussion/consideration**. |
| Huawei,  HiSilicon | Both options could work with modifications. Only one of them would be chosen. | For the main bullet, similar as our comments above in proposal 2, a UE cannot predict the next transmission is periodic or aperiodic before a TB reception in PHY. So the provision of resource reservation interval which is transported along with the TB cannot be a judgement for traffic type, periodic or aperiodic.  The proposal should have an applicability to partial sensing being configured.  For option 1 and option 2, it should be clarified what the scenario is under discussing. The whole issue of 3.5 is under partial sensing agenda which means all the options should take the partial sensing procedure into account. Specifically, for option 1, we think the random selection is different from what is defined in Rel-14. Considering the partial sensing procedure which Y candidate slots are selected in PHY as SA and reported to MAC, MAC would only randomly select a set of resources among the reported SA and instruct the PHY to re-evaluate the set of resources. So the starting point of sensing window would not relate to slot n+1 only but involve ty0, the first candidate resource. That is the window should start from max (ty0-31, n+1) to .  Similarly, for option 2, the windows for resource selection and re-evaluation should be designed separately. A UE in PHY needs to report candidate resource set to MAC before the first slot among Y candidate slots. Therefore, the window for resource selection should start from max (ty0-31, n+1) until ty0 - tproc,0 –T1.  Option 2 has a problem that sensing from before the defined interval appears not to be considered.  On the other hand, as we explained in other questions, it is no need to consider UL transmission to determine candidate slots, and SL transmission impact can be handled by UE implementation. Therefore, we suggest two options are changed as following.   * + Option 1: In slot n, UE performs random resource selection     - For a UE that performs sensing and for the purpose of re-evaluation and pre-emption checking, the UE monitors slots starting from ~~n+1~~ max (ty0-31, n+1) until before the last transmission for the TB, except for slots in which its own SL and UL transmissions occur   + Option 2: In slot , UE reports a set of candidate single-slot resources (*SA*) to the higher layer after performing resource exclusion also taking into account ~~based on~~ sensing results obtained during for resource selection within the resource selection window .     - For re-evaluation and pre-emption checking, the UE monitors slots starting from ~~n+1~~ until before the last transmission for the TB, except for slots in which its own SL and UL transmissions occur |
| Convida Wireless | Both options 1 and 2 | We are fine with both option 1 and option 2. |
| Bosch | Both, Option 1 & 2 | We are also fine with both options. |
| Nokia, NSB | Both options | Both option 1 and option 2 shall be supported in general for partial sensing. We shall agree the general principle and then work out the details, especially for option 2. |

**Proposal 5’:**

* When resource (re-)selection is triggered in slot n and resource reservation interval () is NOT provided from higher layer,
  + Option 1: In slot n, UE performs random resource selection
    - For re-evaluation and pre-emption checking, the UE monitors slots after the random resource selection
      * FFS details of the monitoring, including timing, duration and exceptions
  + Option 2: For the purpose of resource (re-)selection, the UE monitors slots between and performs resource selection based on sensing results.
    - FFS and remaining details
    - For re-evaluation and pre-emption checking, the UE monitors additional slots.
      * FFS details of the additional monitoring, including timing, duration and exceptions
  + Other options are not precluded
  + FFS which one or multiple option(s) to be supported

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | We support FL’s proposal. |
| NEC | We support the proposal 5' with following suggestions.   * Resource reservation interval () = 0 ms is preclude in 3.2, 3.3 and 3.5, we think = 0 ms is the aperiodic case and should added in the main bullet of this proposal.   In Option 1: For re-evaluation and pre-emption checking, the UE monitors slots after the resource selection trigger. |
| NTT DOCOMO | We support the proposal with update in main bullet as   * When resource (re-)selection is triggered in slot n and resource reservation interval () is NOT provided from higher layer or resource reservation interval () = 0 is provided from higher layer, |
| LGE | We support FL’s proposal and both options.  Option 1 can be used as a random resource selection if e.g. remaining PDB is not sufficient for constructing a sensing window [n+1, n+TA] followed by a resource selection window.  If the remaining PDB is sufficient, option 2 can be used rather than random resource selection as it guarantees the sensing duration [n+1, n+TA] before resource (re)selection. |
| Apple | We think this proposal discusses two different parts: resource selection and resource re-evaluation/pre-emption checking. Option 1 and Option 2 are differentiated at resource selection, while the sub-bullets of Option 1 and Option 2 are targeted for resource re-evaluation/pre-emption checking.  We suggest removing the resource re-evaluation/pre-emption checking part in this proposal (i.e., sub-bullet of Option 1 and the second sub-bullet of Option 2) to make the proposal focusing on resource selection only. A separate proposal could be made on resource re-evaluation/pre-emption checking. |
| ETRI | We support FL’s proposal with including ‘0 ms’ case. |
| Qualcomm | We support the general direction and would like to propose the following change to Option 2 so that it remains general at this point, similar to Option 1:   * + Option 2: For the purpose of resource (re-)selection, the UE monitors slots between and performs resource selection based on sensing results.     - FFS , and remaining details     - For re-evaluation and pre-emption checking, the UE monitors additional slots.       * FFS details of the additional monitoring, including timing, duration and exceptions   For re-evaluation and pre-emption checking in Option 1, we agree with the feature-lead’s wording of sensing after resource selection.  We’d like to add a sentence to clarify that these options are in addition to random selection without any sensing or re-evaluation/pre-emption checking:   * + FFS which one or multiple option(s) to be supported   + These options are in addition to random selection only without sensing or re-evaluation and pre-emption checking. |
| Fujitsu | We are generally fine with the proposal but with the following concerns:  For option 2, if both periodic and aperiodic traffics are ongoing in the resource pool, the UE also needs to monitor the slots in the sensing occasions corresponding to the Y candidate slots. Otherwise, collision(s) between the UE’s aperiodic transmission and other UE’s periodic transmission may happen. |

### Proposals before 2nd check point (Feb 2)

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

* TBD

### Proposals before 3rd check point (Feb 4)

FL observations and comments based on inputs received in Sec. 3.5.2:

* TBD

Contribution summary

## Partial sensing for periodic transmissions

* Selection of Y candidate slots
  + LTE-V based selection of Y ≥ min candidate slots according to Tx priority, CBR level, HARQ enabling, subcarrier spacing or re-evaluation/pre-emption enabling: [2][5][8][9][14][17][20][21][22, multiple sets of Y][25][29]
  + Same as resource selection window, which size is left up to UE implementation, subject to T2min constrain on minimum size [13]
  + If HARQ feedback is enabled, HARQ RTT related timing restriction should be considered when determining the candidate slots [17]
* Determination of sensing slots
  + Slots that belong to (y – k\*reservation period), where y is included in Y candidate slots [2][3][4][8][11][12][13][14][28][22][25][29][34][35][6]
    - K=1, multiple, or by configuration
    - Reservation period according to the configured set of periodicity in the resource pool, or a subset
* X% of candidate resources is based on the total number candidate resources only within the Y candidate slots [2][25]
* X% for partial sensing UE is separately configured from that for full sensing UE [9]
* A short-term / extended sensing / continuous sensing (e.g., 32 slots) to account for aperiodic traffic [2][3][4][6][10][11][12][13][17][18][19][21][22][24][25][27][28][30][33][34][35][29]
  + Option 1: before 1st candidate slot
  + Option 2: before the resource selection in slot n
* Introduce reduced adaptive sensing windows with varying sensing intervals across time to enhance the UE's capability to save power as well as achieve adequate sensing results [16]

## Partial sensing for aperiodic transmissions

* Scheme 1: At packet arrival in slot n, UE performs random selection as well as sensing for re-evaluation and pre-emption checking until the last retransmission of a TB [2][9][10][13][14][22][32]
* Scheme 2: At packet arrival in slot n, UE performs sensing for a short period (e.g., 32 slots), then select resources based on sensing results. UE continue sensing for re-evaluation and pre-emption checking until the last retransmission of a TB [2][4][9][12][13, UE implement][14][29][32][35]
* Selection between scheme 1 and 2 (or adaptive sensing window) is based on HARQ feedback [14][30]

## Random resource selection

* When random selection is performed, re-evaluation and pre-emption checking is disabled [3][5]
* Higher priority is assigned to the resources which is randomly selected by a UE, to preserve these selected resources from being pre-empted by UEs performing sensing [6][12]
* When a resource is randomly selected, the same resource is reused periodically based on the SPS resource reservation procedure [9]
* Random resource selection should be applicable to both periodic and aperiodic transmissions [13]
  + random resource selection is applied for initial transmission and all retransmissions of a TB
* Conditions in which random resource selection can be applied
  + Random resource selection is enabled in a SL resource pool [13][22]
  + One of the following criteria is met [13]:
    - UE does not have sidelink RX chain to perform sensing (i.e. sidelink TX only UE)
    - Battery level is below preconfigured threshold [22]
  + Tx priority is within a preconfigured range of values [24]
  + Sensing accuracy [22]
  + Selection between random resource selection and partial sensing according to the system load [7]
  + Selection between random resource selection and partial sensing based on a pre-configured condition, such as SL congestion, packet reliability [12][22][27]
* UE performing random resource selection should respect PSSCH to PSFCH HARQ time gap, if UE monitors PSFCH and requests for sidelink HARQ feedback, otherwise the gap can be ignored [13]
  + UE ensures a minimum time gap Z between any two selected resources of a TB where a HARQ feedback for the first of these resources is expected
* Random resource selection preserves sidelink resource reservation signalling principle as defined for sidelink transmissions in Rel.16 [13]
  + Maximum distance in logical slots for the first and last sidelink transmissions in a SCI is less than 32
* For random resource selection, the resources are selected among the partial sensing slots [9]
* PSFCH resources associated with the randomly selected resources are separately configured from those for full/partial sensing based selected resources [9]
* Pseudo-random frequency hopping for periodic reservation based on CRC bits of the associated PSCCH [10]
* The frequency that a UE performs random resource selection should be restricted [27]
* For random resource selection, consider partitioning of candidate SL resources to reduce collision probability [28]
* Enhancements for random resource selection [35]:
  + Option 1: Restrict priority level for transmissions
  + Option 2: sensing UE excludes random selection UE’s reserved resources regardless of priority
  + Option 3: random selection based on a resource pattern

## Re-evaluation and pre-emption checking

* For the UE performing sensing, support re-evaluation for random selection resources [24] [29]
* Conditions for performing re-evaluation and pre-emption checking
  + When multiple NACKs are received [3]
  + ACK/NACK ratio is below a threshold [9]
  + Re-evaluation or pre-emption checking is (pre-)configured [9]
  + Number of partial sensing slots before resource (re)selection triggering is below a threshold [9]
  + TX priority value is higher than the pre-emption priority value [9][24]
  + Interference/congestion level is above a threshold [9]
* Re-valuation/pre-emption is configurable for Type D UEs [8]
* The pre-emption priority used by power saving UE is separately (pre-)configured from that used by full-sensing UE [9]
* When performing resource re-evaluation or pre-emption, burst type of resources are prioritized in resource (re)selection [9]
* The transmission resources reserved by power saving UEs are not pre-empted. Transmission resources reserved for transmissions destined to power saving sidelink UEs are not pre-empted [11]
* Due to re-evaluation and pre-emption, UE can re-select resources in noncandidate slots if aperiodic resource sensing is performed [2]
* For semi-persistent reservation, the UE can skip pre-emption for certain reservation periods. The number of skip periods is (pre-)configured per priority [24]
* UE is only required to sense in the slots in which the SL transmission may reserve a resource overlapping with the resource to be pre-empted or re-evaluated [27]
* Re-evaluation and pre-emption is based on reduced sensing performed between the UE’s resource selection time and resource re-evaluation/pre-emption checking time [29]
* Supports re-evaluation and pre-emption at least on subsequent periods [30]

## Type A UE performing PSFCH and S-SSB reception

* PSFCH (no) / S-SSB (no): [3][6][15][21][26]
  + Reasons: maximum power saving, same as in LTE-V,
* PSFCH (no) / S-SSB (yes): [7][35]
  + Reasons: support only broadcast which does not require HARQ feedback, S-SSB from UE synchronized to eNB/gNB is prioritized over GNSS
* PSFCH (yes) / S-SSB (yes): [9][12][14][22, S-SSB not considered][31]
  + Reasons: reliable communication, power saving from less retransmissions, essential for communicating with others,

## Impact of SL-DRX on partial or full sensing

* SL-DRX parameters should be exchanged between Tx and Rx UEs for the purpose of aligning resource selection of Tx UE and the DRX ON period of Rx UE [2][5][6][9][11][18][27][29][30]
* If sensing is limited within DRX ON period, sensing accuracy and resource collision will be affected [2][3]
* PSCCH monitoring for sensing should be allowed during SL-DRX inactive period [2][3][5]
* DRX may increase latency for full sensing UEs [7]
* SL DRX and partial sensing are independent operation. SL DRX and partial sensing operation are specified separately from each other in Rel.17 [9][21][24]
* If the sensing is not restricted by DRX operation, then there will be no impacts on the resource selection [10]
* The full-time SL sync search should be avoided during SL DRX operation for power saving [12]
* The design of SL DRX cycle needs to ensure that UE partial sensing behavior is respected (i.e. UE wake up time intervals for the purpose of partial sensing need to be aligned with On duration intervals, as well as traffic characteristics) [13][17][21][22]
* No separate TX/RX alignment procedure is specified in RAN1 for partial sensing [14]
* The (partial) sensing operation and the resource selection performed by a UE takes into account the active time defined by SL DRX configuration, if (pre-)configured [14][16][17][20][21][29][30]
* The very initial transmission should be within the current “Active Time” of the Rx UE [17]
* It should be left to the UE’s implementation to decide whether sensing is limited to its DRX active time interval or it can also be performed outside of the active time [32]
* Consider PSCCH is used to align sidelink DRX wake-up time between TX UE and RX UE(s) [28]
* Sensing slots corresponding to selection target shall be included in DRX on-duration of the TX-UE [35]
  + If a sensing slot is not included in DRX on-duration, the corresponding selection target is excluded from identified resource set of the resource allocation
  + If a selection candidate is not included in DRX on-duration of RX-UE, the candidate is excluded from identified resource set of the resource allocation
  + If PSFCH occasion corresponding to a selection candidate is not included in DRX on-duration of PSCCH/PSSCH TX-UE, the candidate is excluded from identified resource set of the resource allocation
* UE can perform sensing during the part of sensing window within the DRX active time only, in case of periodic traffic with PDB ≥ 100ms[38]

## Resource pool configuration with mixed RA

* 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 [3]
* Power constrained UEs occupy a sub-pool of the shared resource pool [7][11]
* Separation of resources is (pre-)configured where a specific portion of resource pool is allocated for each resource allocation mechanism (e.g., smaller bandwidth/frequency resource) [14][15][16][20][24]
* Different RSRP thresholds or increased RSRP threshold value is (pre-)configured for different resource selection scheme [25][29]
* UE reports whether one candidate resource overlaps with resources reserved by random resource selection UE to higher layer for further resource selection [25]
* 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 [14][24]
* Resource pool should not be shared among random selection UE and UEs configured with other RA schemes, unless random selection UE can reserve resources by sending reservation indication [21]

## Wake-up / go-to-sleep signals for SL-DRX

* Introduce wake up / go to sleep indication on sidelink (or keep sleep / keep awake indication) signals/triggers for UE power saving management [2][12][13][18][23]
  + Reuse the existing R16 WUS/GTS principle [2]

## Congestion control for partial sensing

* CBR could be measured with fewer OFDM symbols in a slot to save power [3]
* Calculation of CBR/CR should take the reception time (e.g., DRX ON duration) into account [6][22]
* For UE with no PSCCH/PSSCH reception capability or number of sensing slots is less than a threshold, a (pre-)configured CBR value is used for PHY parameter selection [9]
* CBR measurement calculation is based on number of sub-channels of the partial sensing slots within the measurement window [9]
* Restriction of transmission parameter based on the CBR measurement is performed per active period of a DRX cycle [18]
* The evaluation of CR and the definition of CR\_limit for power saving resource allocation schemes reuse the design for full sensing resource allocation schemes [29]

## Inter-UE coordination for power saving

* Inter-UE coordination should be used for power saving as well, where a UE selects resources based on coordination / assistance information from another UE [3][7][16][18][19][20][22][31]
* Inter-UE signaling to negotiate sidelink resources (e.g. PSCCH monitoring intervals) where UE(s) are expected to monitor PSCCH resources and perform sensing for sidelink communication [13]
* The resource allocation for power saving considers new aspects introduced in Rel-17 NR sidelink such as inter-UE coordination, sidelink DRX and so on [28]
* Support a UE informing other UEs of its reception and transmission availability [32]

## Indication of power-saving UE transmissions

* Using a reserved bit in SCI to indicate the type of UE or RA scheme [9][10][11][24]

## Other techniques for power saving

* Power control
  + SL pathloss based OLPC for PSFCH [6]
* UL/SL prioritization procedure
  + A (pre)configured offset value can be added to the priority value of P-UE’s SL TX to avoid the frequent dropping [9]
* SL processing and transmission capability
  + Support of PSSCH TX with 2 layers, high modulation order, and SL-SSB TX can be reduced [9]
* Power saving in SL data reception
  + A monitoring interval and a retransmission interval in a period are (pre-)configured. The first transmission of a TB is always limited in the monitoring interval. Only the retransmissions of a TB are allowed in the retransmission interval. Thus, a receiving UE only receives/decodes PSCCHs/PSSCHs in the monitoring interval and then determines whether to turn on in the retransmission interval [10]
* Longer PSFCH period for power limited UE [6][4]
* The CSI reporting procedure and HARQ-ACK based (re)transmission should be enhanced to ensure that the CSI report/retransmission can be received by the CSI requesting UE with discontinuous reception [6]
* Reserved bits of SCI format 1-A can be used to transmit some bits of the destination ID (shortened destination ID) [7][16]
* The second stage SCI contains a field to indicate when the UE is expected to receive the next transmission [7]
* NR supports adaptation(switching) of sidelink power saving resource allocation schemes in time (i.e. b/w random, partial or full sensing-based resource selection) [13][12][22][8]
* Introduce the notion of sidelink power saving states / modes and associate with these states / modes certain set of sidelink power saving features developed in Rel.17 [13]
* Sidelink bandwidth / slot adaptation for transmission / reception is supported as a power saving feature [13]
* To utilize the geographical location of group UEs and destination-L2 ID, as the reference parameters for partial sensing, in the application layer connection-less group. And to utilize the destination-L2 ID, as the reference parameter for partial sensing, in the application layer managed group [17]
* Cross-slot scheduling enhancement for power saving purpose [18]
* Dedicated BWP can be configured for power saving UEs and S-SSB BW should be (pre-)configured within the dedicated BWP [21]
* Reduced max number of retransmission per TB for power saving UEs [22]
* Support different initial RSRP thresholds for resources reserved by PUE [24]
* 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 [25]
* Support an adaptive frequency search space based on the channel activity, VRU traffic conditions [30]
* Support sidelink cross-slot scheduling allowing only decoding 2nd and/or 3rd retransmission(s) after a minimum configured time gap [30]

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Appendix (past meeting outcomes)

## 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