**3GPP TSG RAN WG1 #118 R1-24xxxxx**

**Maastricht, NL, August 19th – 23rd, 2024**

**Source:** **Moderator (MediaTek)**

**Title:** **FL summary 1 for** **on-demand SIB1 in idle/inactive mode**

**Agenda item: 9.5.2**

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

Introduction

This document is used to assist the discussions for “9.5.2 On-demand SIB1 for idle/inactive mode UEs” study item of the Rel-19 working item on “Enhancements of network energy savings for NR” based on proposals from companies.

This contribution provides discussion points in Section 2, resulted RAN1 conclusion/agreement in Section 3 (TBD), and reference (companies tdoc list) in Section 4.

Discussion points

This section is used to discuss the critical factors that are brought up by multiple companies’ contributions. For each issue, a brief background is provided, and then proposals are bought up to collect company views.

## Issue 1: Cell Scenarios to be discussed for on-demand SIB1 (Case 1/2/3)

**Background**

The following is agreed in RAN1 #116b:

**Agreement**

For the further study of on-demand SIB1 for idle/inactive mode UE, RAN1 focuses its studies on the following cases:

* Case 1: Option 1+A+X
* Case 2: Option 1+B+X
* Case 3: Option 2+B+Y

Where the options 1/2/A/B/X/Y are defined below:

* On target cell of UL WUS transmission:
	+ Option 1: UE transmits UL WUS to NES Cell
	+ Option 2: UE transmits UL WUS to Cell A
* On configuration provision for UL WUS transmission
	+ Option A: UE obtains the UL WUS configuration from NES Cell
	+ Option B: UE obtains the UL WUS configuration from Cell A
* On receiving of SIB1
	+ Option X: UE receives on-demand SIB1 from NES Cell
	+ Option Y: UE receives on-demand SIB1 from Cell A

Most companies further discussed the cell scenarios to apply on-demand SIB1.

* Exemplary figure form [34] is shown below (while many companies also draw gorgeous figures)

[34, Fraunhofer, etc.]



Also, in RAN1 #117, the following is agreed:

**Agreement**

For SIB1 in idle/inactive mode, prioritize RAN1 discussions on Case 2 and Case 3

1. Case 2 (Option 1+B+X) is feasible from RAN1 perspective.
2. Further study Case 3, focusing on the additional NES benefits over Case 2, feasibility, complexity, and spec impact.

**For the 3 cases, companies’ views in RAN1 #118 can summarized as the table below:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Support** | **Not prefer** | **Comment** |
| Case 1 (1+A+X) | Lenovo[NEC]ETRICEWiTFraunhoferVodafoneDeutsche TKGoogleIntelDOCOMO | SamsungEricssonSpreadtrumCMCCNokia | NEC: RAN1 should discuss if isolated cell is applicable for the scenario of on-demand SIB1 for further studyCEWiT: Significant NES gainsFraunhofer:* Standardizing Case 1 only adds little extra effort on top of Case 2
* DCI-based approach and a SIB0 (PDSCH FDM-ed to SSB) are feasible to provide UL WUS configuration on SSB slots for Case 1

Samsung: * No or minimal energy saving gain in the evaluations
* Potential large specification impact
 |
| Case 2 (1+B+X) | SamsungNECETRIMTKPanasonicAppleQualcommEricssonHuawei HiSiliconSpreadtrumGoogleCMCCNokiavivoOPPOXiaomiCATTSonyZTEInterDigitalFujitsuLG |  | RAN1 #117 agreement: Case 2 is feasible from RAN1 perspective.ZTE: RAN1, RAN2 and RAN3 have considerate progress on case 2. |
| Case 3 (2+B+Y) | NECPanasonicAppleQualcommFUTUREWEIHuawei HiSiliconTejasGoogleCMCCSony | ETRIEricssonSpreadtrumNokiaVivoXiaomiCATTZTEInterDigitalFujitsuLG | Panasonic: Case 3 promises more NES gain and can share a same signaling and procedure framework with Case 2Apple: * From RAN1 perspective, Case 3 is feasible by reusing legacy on-demand OSI procedures.
* RAN2 to determine whether SIB1 of an NES cell can be incorporated in one of cell A’s SI message.

Tejas:* Minimal spec change using legacy on-demand OSI procedure

CMCC: * Up to 12%/6% additional NES gain compared to Case 2
* Need to assess RAN2/RAN3 workload

Ericsson:* Cell A and the NES Cell must exchange information to ensure the consistency of the transmitted SIB1
* Larger NES loss at cell A as Cell A needs to transmit whole SIB1 for NES cell(s)
* Increased latency of SIB delivery for all UEs due to excessive SI information Cell A must deliver
* Higher Tx power on cell A as UE can be far away from Cell A
* UE has to switch frequently between Cell A and NES Cell

vivo:* Marginal NES gain compared to Case 2
* More power consumption on Cell A
* Poor channel quality when UE is far away from Cell A
* UE camping on NES cell B needs to first access cell A which can send SIB1 of NES cell C to reselect to NES cell C

CATT:* Information exchange to determine the detailed SIB1 of the NES cell, may result a large latency in obtaining on-demand SIB1
* Additional NES benefit of case 3 over case 2 is not clear
* Crowded PRACH resource on Cell A to assist NES cells
* Similar to legacy CA but less efficient

ZTE:* For case 3, it may be not feasible to transmit on-demand SIB1 alongside Cell A's SIB1 within one slot.
* Extra energy loss of Cell A
* No additional NES benefits over case 2

InterDigital:* High UE Tx power due to worse UL coverage of Cell A
* Higher SIB overhead and energy consumption at Cell A to assist multiple NES cell (s)
* Require SIB1 content exchange over the Xn interface (RAN3 work)

Fujitsu* When the NES cell sends a SI change notification, the additional NES gain of Case 3 would be decreased.
* Burden on the PRACH capacity of Cell A to assist NES cell(s)
* Require additional inter-cell coordination signaling (RAN3 work)

MTK:* Feasibility: Case 3 provides more NES gain compared to Case 2
	+ 5.60% ~ 5.67% for 4/8 beams, low load, Cat 1 BS
	+ 10.43% ~ 11.10% for 4/8 beams, empty load, Cat 1 BS
	+ 1.79% ~ 3.13% for 4/8 beams, low load, Cat 2 BS
	+ 2.79% ~ 5.05% for 4/8 beams, empty load, Cat 2 BS
* Complexity: Higher signaling overhead at backhaul and/or Xn interface, and may result in larger latency in obtaining SIB1
* Spec impact: Larger RAN2/RAN3 spec impact due to the information change between Cell A and NES cell

Qualcomm:* Pros:
	+ ~2% NES gain over Case 2
	+ Potential less power consumption for a high mobility UE
	+ Less specification effort than Case 2
* Cons:
	+ Higher backhaul coordination overhead than Case 2
	+ Potential higher power consumption for a UE far away from Cell A

China Telecom:* Pros: additional energy saving gain
* Cons: extra energy loss of Cell A or performance degradation
 |

**Observing from above, the pros and cons of the Case 3 and Case 1 can be categorized as:**

**Case 3 (Options 2+B+Y):**

* **Pros:**
	+ - **Better NES gain than Case 2 (1.79%~11.10% according to [25, MTK])**
		- **Can reuse legacy on-demand OSI request procedure on Cell A**
	+ **Cons:**
		- **The signalling overhead at backhaul F1-AP and/or Xn interface may result in large latency in obtaining on-demand SIB1**
			* **May have large RAN3 spec impact.**
		- **Crowded PRACH resource on Cell A to assist multiple NES cells.**
		- **High UE Tx power due to worse UL coverage of Cell A**

**Case 1 (Options 1+A+X):**

* **Pros:**
	+ - **Most flexible NES cell deployment (standalone)**
		- **DCI-based approach and a SIB0 (PDSCH FDM-ed to SSB) are feasible** **to provide UL WUS configuration on SSB slots for Case 1**

 

**Figure. Illustration of DCI-based and SIB0 (PDSCH FDM-ed to SSB) apporach to to provide UL WUS configuration for Case 1 [34, Fraunhofer, etc.]**

* + **Cons:**
		- **Reserved PBCH payload not enough to provide UL WUS configuration to UE.**
		- **Defining a new MIB or pre-SIB1 for WUS configuration provisioning from NES Cell may not have evident NES gain and may have large spec impact.**

As RAN1 has agreed that Case 2 is feasible, here we would focus on discussing the feasibility of Case 3 and Case 1. Although Case 1 was not prioritized for further discussion in last RAN1 meeting, multiple companies still expressed their interests, so moderator put it on the table to test the temperature again. **Companies are recommended to check the pros/cons of Case 3 and Case 1 listed above and provide comments on the following FL proposals.**

### FL Proposal 1-1

**For on-demand SIB1 in idle/inactive mode, Case 3 (Option 2+B+Y) is feasible from RAN1 perspective.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | No | In Case 3, any NES gains achieved by not having to transmit OD-SIB1 from NES cell is offset by higher energy consumption at Cell A. Also, in Case 3 the impacts at UE due to higher power consumption and switching are higher than in Case 2. Given the list of pending issues already in the study, we think Case 3 can be deprioritized and more focus is given on making progress on Case 2.  |
| CMCC | Support, and | Based on our evaluation, Case 3 can obtain up to 12%/6% extra NES gain compared with Case 2. Thus, from energy saving perspective, Case 3 is feasible from RAN1 perspective.One more thing is that the legacy higher layer procedure (e.g., SIB1 acquisition, SI update, paging procedure) may need to be modified under Case 3. Therefore, whether Case 3 is supported should also depend on the workload and time budget of RAN2/RAN3. |
| Xiaomi | No | First of all, we don’t see the necessity to support different mechanism for on-demand SIB1, which complicates specification and UE/gNB implementation.Case 3 will bring significant specification impact as there are tons of issues need to be addressed one by one. For example, whether NES UE is only allowed to camp on cell A or it is also allowed to camp on NES cell. Considering SIB1 reception is the key step for UE camping on a certain cell, there is no sense to receive another cell’s SIB1 on cell A if this UE can only camp on cell A. If UE is allowed to camp on NES cell, the overall procedure for initial access is significantly changed. |
| Fraunhofer | support | If the proposal is solely about feasibility, then Case 3 is feasible, specially from RAN1 perspective. But RAN2/RAN3 perspectives are more important in Case 3.  |

### FL Proposal 1-2

**For on-demand SIB1 in idle/inactive mode, Case 1 (Option 1+A+X) is feasible from RAN1 perspective.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| Xiaomi |  | As agreed in previous meeting, case 1 is deprioritized. From our understanding, any discussion about case 1 happens only if we finish the discussion on case 2 and case 3. |
| Fraunhofer | Support | There are many situations where UL WUS configuration provided in NES cell will make specs simpler, e.g., UE coming back from out-of-coverage to NES Cell’s coverage, SIB1 re-acquisition every three hours for a UE in NES Cell, initial cell selection, re-selection from LTE to NES Cell and transition of a cell from non-NES state to NES state. There are other cases where Case 1 will help operators to adapt OD-SIB1 to their deployment based on scenarios [28]. A simple design for Case 1 is feasible where most things can be shared with Case 2, as pointed out in our contribution [34], thereby completing Case 2 to have a comprehensive OD-SIB1 solution fulfilling all operator needs. |
|  |  |  |

## Issue 2: Detailed design of PRACH as UL WUS and PRACH resources

**Background**

In RAN1 #116b, the following is agreed:

**Agreement**

For UL WUS design for SIB1 request, at least dedicated PRACH resource is the assumption for further study in RAN1

* FFS: Details on time, frequency, and/or PRACH preamble resources for UL WUS
* FFS: whether RACH resource for SIB1 request could be used for an initial access procedure and/or an on-demand SI procedure

Lenovo:

**Observation 2: For Case 2, the WUS configuration may provide different PRACH resources (i.e., separate ROs) for different NES cells. While for Case 3, common RACH resources (i.e., shared ROs) may be provided for WUS transmission for multiple NES cells.**

**Proposal 4: For Case 3 where WUS preambles are transmitted in a common PRACH resources (i.e., shared ROs), different preambles should be associated with different NES cells.**

NEC:

**Proposal 3: If WUS resources are configured independent of PRACH resources for other usages, discuss the cases of time and/or frequency overlap of WUS resources and RACH resources for other usages.**

**Proposal 4: Support PRACH transmission based on Type-1 (4-step) random access procedure for WUS.**

**Proposal 22:** **RAN1 to only support contention-based resources for WUS transmission.**

Transsion:

**Proposal 3 The UL WUS should follow a contention-based random access process.**

ETRI:

**Proposal 6: For the UL WUS configuration, up to two sets of preambles can be configured:**

**o Set of preambles for camping only (e.g., for Scenario/operation 1)**

**o Set of preambles for subsequent random access procedure (e.g., for Scenario/operation 2)**

**Proposal 7: Set of preambles for camping consists of a single preamble per SSB.**

Panasonic:

**Observation 7: The assumption on PRACH resource can be different based on if UL-WUS is sent to Cell A or NES cell.**

**Proposal 4: On the details on time, frequency, and/or PRACH preamble resources for UL-WUS, it is feasible to choose from the current table for PRACH resource mapping.**

**Proposal 5: It is possible to use Msg3 and/or Msg5 for on-demand SIB1 request.**

ASUS:

**Proposal 1: Existing procedures for on-demand OSI could be reuse for on-demand SIB1 as much as possible.**

**Proposal 4: RAN1 further discusses whether contention based random access procedure or non-contention based random access procedure is supported for requesting on-demand SIB1.**

Qualcomm:

**Proposal 2: For legacy UE-initiated triggering events for SIB1 acquisition, support conditional transmission of UL-WUS for OD-SIB1.**

* **Mechanisms for supporting conditional UL-WUS, e.g. based on validity of stored SIB1, is subject to RAN2’s decision.**

CMCC

**Proposal 4: Support associate specific WUS resource with both single cell and multiple cells.**

**Proposal 5: Support to reuse the legacy UL power control mechanism (including the method of determine the transmission power and power-ramping procedure) for on-demand SIB1 procedure.**

Nokia

**Observation-3: Designing dedicated PRACH resources for SIB1 request assuming a common preamble for requesting SIB1 used by all UEs. It allows UEs intended to request SIB1, to monitor on-demand SIB1 transmission that is requested by other UEs, without transmitting UL WUS.**

**Observation-4: Configuration of a common RNT may be required in order to enable UEs monitoring on-demand SIB1 without transmitting UL WUS.**

China Telecom

**Proposal 6: Support Option 2, i.e., The dedicated WUS resource uses an independent RACH resource pool with PRACH resource for other usages for on-demand SIB1.**

OPPO

**Proposal 1: For on-demand SIB1, sharing PRACH resource with RACH/OSI may not be necessary. Supporting dedicated PRACH for on-demand SIB1 is enough.**

**Network naturally does not need to differentiate different UE requesting SIB1, same WUS can be shared by multiple UEs. Thus, direct mapping between PRACH preamble and SSB index can be considered to further increase the RO resource efficiency.**

**Proposal 3: For spatial relationship, mapping between PRACH preamble and SSB can be considered to further enhance the RO resource efficiency.**

CATT

**Proposal 3: If on-demand SIB1 is supported, considering the following options to configure dedicated PRACH resource for UL WUS transmission.**

* **Option 1: The RO for UL WUS transmission is shared with the RO configured to legacy function such as random access and dedicated preamble is configured.**
* **Option 2: The RO for UL WUS transmission is dedicated RO resource configured by:**
	+ **Option 2\_1: One single RACH configuration with possible enhancement.**
	+ **Option 2\_2: Separate RACH configuration for UL WUS.**

InterDigital

**Proposal 6: The UL WUS configuration for OD-SIB1 provided to idle/inactive UE includes at least the following:**

1. **PRACH preambles and RACH occasions in time and frequency domains**
2. **Validity info (e.g. list of PCIs of NES cells)**

**Proposal 7: Support CBRA as baseline procedure for UL WUS transmission**

LG

**Proposal #6: To improve the efficiency of legacy on-demand SI procedures, study combining the on-demand SIB1 procedure with on-demand SI procedure.**

NTT DOCOMO

**Proposal 5:**

* **Supporting one WUS can trigger on-demand SIB1 associated with one or multiple SSBs.**

CAICT

**Proposal 2: Option 2 is preferred when considering whether UL WUS is cell-specific or shared among multiple cells .**

DENSO

**Proposal 4: For Msg1-based on-demand SIB1 procedure, the PRACH resources for on-demand SIB1 requests are selected from shared RO or dedicated RO, and the PRACH preamble for on-demand SIB1 requests is not used for initial access procedure and on-demand SI.**

Tejas

**Proposal 3: If association between SSB and SIB1 is to be maintained in case-3(Option 2+B+Y), UE must implicitly/explicitly specify to the CELL-A that under which the SSB index of NES cell the UE falls.**

**Observation 1: For case-3, if there is any update in the SIB1, then UE must switch between NES and**

**CELL A. This will increase the UE power consumption.**

**Proposal 6: For case 3, further study on how to handle UE switching between NES CELL and CELL**

**A, for getting updated SIB1.**

Sharp

**Proposal 1: The SIB1 request procedure for both assumption 1 and assumption 2 is supported.**

1. **Assumption 1: Firstly, a NES-capable UE connects to a Cell A, then the UE switches to a NES cell based on cell re-selection procedure.**
2. **Assumption 2: Firstly, a NES-capable UE in idle mode finds SSB on NES cell, then the UE access the Cell A to obtain UL-WUS configuration.**

**Proposal 2: For idle UEs detecting SSB on NES Cell, MIB in the SSB provides assistance information to find Cell A, e.g., GSCN offset and/or PCID of the associated Cell A. (Also Apple)**

Moderator tries to collect required information or IEs inside the UL-WUS configuration with clear majority support:

For contention based or contention free UL-WUS transmnission:

* **RAN1** **to only support contention-based resources for UL-WUS transmission.**
	+ **Support:** NEC, Transsion, InterDigital

About shared RO or separated RO for UL-WUS:

* **Option 1 (shared RO): The dedicated WUS resource shares the same PRACH resource pool with PRACH resource for other usages. E.g. IEs like *ra-ssb-OccasionMaskIndex* and *ra-PreambleIndex* can be reused to select the dedicated RO and/or preamble for WUS.**
	+ Lenovo (for Case 2), CATT, DENSO
* **Option 2 (separated RO): The dedicated WUS resource uses an independent RACH resource pool with PRACH resource for other usages.**
	+ Lenovo (for Case 3), China Telecom, OPPO, CATT, DENSO

### FL Proposal 2-1

**For further study of on-demand SIB1 in idle/inactive mode, as a baseline, RAN1 assumes contention-based resources for UL-WUS transmission.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Yes |  |
| CMCC | No support | From our understanding, since the dedicated PRACH resource is agreed for OD-SIB1 procedure in previous meeting, the OD-SIB1 procedure is at least Msg1-based procedure. Thus, CFRA resource should be considered for UL-WUS transmission as baseline, and whether CBRA resource can be used for OD-SIB1 should base on whether a common PRACH resource is introduced for OD-SIB1. |
| Xiaomi | Support. |  |
| Fraunhofer | Support |  |

### FL Proposal 2-2

**For further study of on-demand SIB1 in idle/inactive mode, as a baseline, it is assumed that the transmit power control of UL WUS transmission based on PRACH is applied in the same manner as the legacy PRACH transmission.**

* **FFS: Potential optimization of the power ramp-up procedure**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Yes | Since UL-WUS resources/procedures are based on PRACH (per previous agreement), it makes sense to reuse the legacy approach for Tx power control as baseline. |
| CMCC | Support |  |
| Xiaomi | Support. |  |
| Fraunhofer | support | The FFS is important but can be left for normative phase.  |

### FL Proposal 2-3

**For further study of on-demand SIB1 in idle/inactive mode related to dedicated PRACH resource usage, RAN1 to study the following options:**

* **Option 1 (shared RO): The dedicated WUS resource shares the same PRACH resource pool with PRACH resource for other usages.**
	+ **E.g. IEs like *ra-ssb-OccasionMaskIndex* and *ra-PreambleIndex* can be reused to select the dedicated RO and/or preamble for WUS.**
* **Option 2 (separated RO): The dedicated WUS resource uses an independent RACH resource pool with PRACH resource for other usages.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital |  | Fine to study the options, although the our preference is towards the option that has less spec impact and allows dedicated PRACH resources for UL WUS (i.e. no overlap) |
| CMCC | Support |  |
| Xiaomi | Support. |  |
| Fraunhofer | support | In our view both options have pros and cons. The proposal is fine as it is, but down-selection would be better left for normative phase.  |

## Issue 3: Parameters/contents inside the UL WUS configuration

**Background**

In RAN1 #117, it is agreed to use the Table I below from [R1-2405106, Ericsson] as a starting point to discuss the required parameters/contents inside the UL WUS configuration.

**Table I.**

|  |  |
| --- | --- |
| **Purpose** | **Parameters** |
| **To which cell does the config applies** | **NES-CellId** | PhysCellId  |
| ARFCN-ValueNR  |
| **WUS transmission** | **SIB1-RequestConfig**  | ss-PBCH-BlockPower |
| rach-OccasionsSIB1 | Prach-ConfigurationIndex |
| msg1-FDM |
| msg1-FrequencyStart |
| zeroCorrelationZoneConfig |
| preambleReceivedTargetPower |
| preambleTransMax |
| powerRampingStep |
| ra-ResponseWindow |
| ssb-perRACH-Occasion |
| sib1-RequestPeriod |
| sib1-RequestResource | ra-PreambleStartIndex |
| ra-AssociationPeriodIndex |
| ra-ssb-OccasionMaskIndex |
| rsrp-ThresholdSSB |
| prach-RootSequenceIndex |
| msg1-SubcarrierSpacing |
| restrictedSetConfig |
| tdd-UL-DL-ConfigurationCommon |
| **frequencyInfoUL** | frequencyBandList |
| absoluteFrequencyPointA |
| offsetToCarrier |
| p-Max |
| frequencyShift7p5khz |
| **SIB1 reception** | **pdcch-ConfigSIB1** | ssb-SubcarrierOffset |
| controlResourceSetZero |
| searchSpaceZero |
| **RAR Reception** | **pdcch-ConfigOD-SIB1-RAR** | controlResourceSet |
| monitoringSlotPeriodicityAndOffset |
| Duration |
| monitoringSymbolsWithinSlot |
| aggregationLevels |

Related proposals for this topic in RAN1 #118 are collected below:

NEC:

**Proposal 15: Discuss whether WUS resource configuration can reuse the legacy PRACH configuration table.**

**Proposal 27: WUS configuration should include the search space and CORESET configuration for receiving WUS response message.**

Transsion:

**Proposal 2 The content of the UL WUS configuration shall include the cell ID of the NES cells, the UL**

**WUS time-frequency resources, and the** **parameters related to the UL WUS transmit power.**

MTK:

**Proposal 4: For “to which cell does the config applies” inside the UL WUS configuration, the following is**

**suggested:**

* **Identifier of the cell(s): PCI → needed**
* **ARFCN: (absolute radio-freq channel number) → May not be needed**
	+ **If this ARFCN is for DL, then it seems not needed as it would be obtained later in SIB1.**

**Proposal 5: For “SIB1-RequestConfig IE for WUS transmission” inside the UL WUS configuration, the**

**following is suggested:**

* **IEs which are also included in SI-RequestConfig (Blue line below) → needed**
	+ **Those IEs are also used for Msg1 based OSI request in legacy NR.**
* **IEs which are not included in SI-RequestConfig but under RACH-ConfigCommon (Blue line below) → need further discussion**
	+ **Which of the IEs under RACH-ConfigCommon are needed?**
	+ **Why these IEs are not needed in SI-RequestConfig?**

**Proposal 6: For “frequencyInfoUL IE for WUS transmission” inside the UL WUS configuration, the following is suggested:**

* **frequencyInfoUL IE (Blue line) → needed**
	+ **UE would need the** **frequency information for UL-WUS transmission, before receiving on-demand SIB1.**

**Proposal 7: For “PDCCH-ConfigSIB1 IE for SIB1 reception” inside the UL WUS configuration, the following is suggested:**

* **PDCCH-ConfigSIB1 IE (Blue line) → not needed**
	+ **The same sub-IEs in MIB can be directly reused.**

**Proposal 8: For “pdcchConfigOD-SIB1-RAR IE for RAR reception” inside the UL WUS configuration, the**

**following is suggested:**

* **pdcchConfigOD-SIB1-RAR IE (Blue line) → needed**
	+ **UE would receive RAR first and then receive on-demand SIB1, so the PDCCH configuration for RAR reception needs to be configured in advance.**

Apple:

**Proposal 7: Add frequencyInfoDL in the UL WUS configuration to indicate the DL frequency information for the response to the UL WUS.**

Qualcomm:

**Proposal 5: Add** **parameter “SSB-positionInBurst” to the parameter table for the UL-WUS configuration.**

**Proposal 6: Support indication of (ssb-SubcarrierOffset, controlResourceSetZero, searchSpaceZero) inside UL-WUS configuration.**

* **FFS: In case of the reserved K SSB value is used for a NES cell with OD-SIB1, whether to repurpose thereserved pdcch-ConfigSIB1 to indicate PDCCH configuration of OD-SIB1 for Rel19 UEs.**

Fraunhofer/Vodafone/Deutsche Telekom/CEWiT:

**Proposal 5: Remove the parameters listed for “SIB1 reception” and “RAR Reception” from the**

**needed parameters for UL WUS configuration.**

Huawei, HiSilicon

**Proposal 2: For Case 2, at least the following information elements could be added to the required parameters/contents inside the UL WUS configuration**

* **The frequency location of UL BWP 0**
* **SSB pattern**

**Proposal 3: For Case 2, if Cell A assists more than one NES Cell, then cell A can provide the UL WUS configuration for each NES Cell.**

**Proposal 4: For Case 3, UL WUS configuration contains the parameters shown in Table II as a starting point.**

***Table II***

|  |  |
| --- | --- |
| ***Purpose*** | ***Parameters*** |
| ***To which cell does the config applies*** | ***NES-CellId*** | *PhysCellId* |
| *ARFCN-ValueNR* |
| ***WUS transmission*** | ***SI-RequestConfig*** | *SI-RequestResource* | *ra-PreambleStartIndex* |
| *ra-AssociationPeriodIndex* |
| *ra-ssb-OccasionMaskIndex* |

***Note: if the SI message includes more NES Cells SIB1, then the WUS configuration can include more NES-CellIds.***

Tejas Networks Limited

**Proposal 14: RAR response from CELL A/NES CELL is required for the UE, to avoid blind decoding of SIB1.**

**Proposal 15: Further study overall NES gain for on-demand SIB1 considering RAR for UL-WUS.**

**Observation 5: If the association between SSB and SIB1 is maintained, then pdcch-config SIB1 will be different for different SSBs. This can be a large overhead for FR2 as, at maximum, 64 SSB beams are possible.**

**Proposal 16: PDCCH-configSIB1 should be indicated by the NES cell (for case-2(1+B+X)) to the UE using MIB, instead of transmitting it in WUS configuration, for maintaining the association between SSB and SIB1. Hence for case-2(1+B+X), PDCCH-Config SIB1 should not be part of WUS.**

|  |  |
| --- | --- |
| **Purpose** | **Parameters** |
| **To which cell does the config applies** | **NES-CellId** | **PhysCellId**  |
| **ARFCN-ValueNR**  |
| **WUS transmission** | **SIB1-RequestConfig**  | **ss-PBCH-BlockPower** |
| **rach-OccasionsSIB1** | **Prach-ConfigurationIndex** |
| **msg1-FDM** |
| **msg1-FrequencyStart** |
| **zeroCorrelationZoneConfig** |
| **preambleReceivedTargetPower** |
| **preambleTransMax** |
| **powerRampingStep** |
| **ra-ResponseWindow** |
| **ssb-perRACH-Occasion** |
| **sib1-RequestPeriod** |
| **sib1-RequestResource** | **ra-PreambleStartIndex** |
| **ra-AssociationPeriodIndex** |
| **ra-ssb-OccasionMaskIndex** |
| **rsrp-ThresholdSSB** |
| **prach-RootSequenceIndex** |
| **msg1-SubcarrierSpacing** |
| **restrictedSetConfig** |
| **tdd-UL-DL-ConfigurationCommon** |
| **frequencyInfoUL** | **frequencyBandList** |
| **absoluteFrequencyPointA** |
| **offsetToCarrier** |
| **p-Max** |
| **frequencyShift7p5khz** |
| **~~SIB1 reception~~** | **~~pdcch-ConfigSIB1~~** | **~~ssb-SubcarrierOffset~~** |
| **~~controlResourceSetZero~~** |
| **~~searchSpaceZero~~** |
| **RAR Reception** | **pdcch-ConfigOD-SIB1-RAR** | **controlResourceSet** |
| **monitoringSlotPeriodicityAndOffset** |
| **Duration** |
| **monitoringSymbolsWithinSlot** |
| **aggregationLevels** |

Google

**Proposal 3: Support to introduce the following parameters for UL-WUS configuration based on the agreement in RAN1 #117.**

|  |  |
| --- | --- |
| **Purpose** | **Parameters** |
| **To which cell does the config applies** | **NES-CellId** | PhysCellId  |
| ARFCN-ValueNR  |
| **WUS transmission** | **SIB1-RequestConfig**  | ss-PBCH-BlockPower |
| rach-OccasionsSIB1 | Prach-ConfigurationIndex |
| msg1-FDM |
| msg1-FrequencyStart |
| zeroCorrelationZoneConfig |
| preambleReceivedTargetPower |
| preambleTransMax |
| powerRampingStep |
| ra-ResponseWindow |
| ssb-perRACH-Occasion |
| sib1-RequestPeriod |
| sib1-RequestResource | ra-PreambleStartIndex |
| ra-AssociationPeriodIndex |
| ra-ssb-OccasionMaskIndex |
| rsrp-ThresholdSSB |
| prach-RootSequenceIndex |
| msg1-SubcarrierSpacing |
| restrictedSetConfig |
| tdd-UL-DL-ConfigurationCommon |
| **frequencyInfoUL** | frequencyBandList |
| absoluteFrequencyPointA |
| offsetToCarrier |
| ~~p-Max~~ |
| frequencyShift7p5khz |
| **~~SIB1 reception~~** | **~~pdcch-ConfigSIB1~~** | ~~ssb-SubcarrierOffset~~ |
| ~~controlResourceSetZero~~ |
| ~~searchSpaceZero~~ |
| **RAR Reception** | **pdcch-ConfigOD-SIB1-RAR** | controlResourceSetRAR |
| searchSpaceRAR |
| ~~monitoringSlotPeriodicityAndOffset~~ |
| ~~Duration~~ |
| ~~monitoringSymbolsWithinSlot~~ |
| ~~aggregationLevels~~ |

CMCC

**Proposal 8: For specific content in WUS configuration, support the following aspects:**

* **Cell ID. This refers to “To which cell does the config applies” in Table I (from R1-2405106, Ericsson).**
* **Configuration for dedicated PRACH resource. This refers to “WUS transmission” in Table I.**
* **Configuration for RAR reception. This refers to “RAR reception” in Table I.**
* **Additional information if the NES cell is identified via an existing IE in MIB.**
* **Additional information if higher-layer procedure is enhanced, e.g., cell selection/reselection. Note that this shall be determined by RAN2/RAN3.**

Nokia

**Proposal-13: Barring specific UE should be indicated as parameters/contents inside the UL WUS configuration to avoid unnecessary SIB1 requests.**

vivo

**Observation 9: At least the following content should be contained in WUS configuration**

* **ID list of the applicable NES cells**
* **Time and frequency resource configuration for UL-WUS**
* **Preamble configuration for UL-WUS**
* **RAR configuration for WUS feedback**
* **UL information and Frequency of NES cell**
* **OD-SIB1monitoringWindow**
* **Tdd-UL-DL-ConfigurationCommon**
* **ssb-positionInBurst**
* **ss-PBCH-Power**

**Proposal 5: The design of the WUS configuration is related to the target scenarios of on-demand SIB1 and**

**where the WUS configuration is carried, and the WUS configuration design should be discussed in detail in**

**the R19 WI.**

OPPO

**Observation 9: The RACH capacity is not really a design target for on-demand SIB1, some parameters can be avoided to reduce the signaling overhead for Cell A, e.g. msg1-FDM.**

**Observation 10: For RAR related parameters can be decided later. If feedback can be avoided, the corresponding parameters are no longer needed.**

**Observation 11: For R19 on-demand SIB1, the target scenario is for small cells instead of macro cell. In this case, RAN1 should consider reducing the number of entries Prach-ConfigurationIndex to only focus on one PRACH format.**

Tejas:

**Proposal 12: Assume that the default SSB periodicity assumption of 20 msec cannot be made. Then for knowing about the search space configuration through MIB and to save the power consumption at UE side due to blind decoding of MIB, UE has to be indicated about the SSB configuration. This include SSB periodicity and SSB position in a burst.**

CATT**:**

**Proposal 4: If on-demand SIB1 is supported, at least *ssb-PositionsInBurst* of NES cell should be provided by cell A.**

Moderator tries to collect required information or IEs inside the UL-WUS configuration with clear majority support:

* Note: Whether to include IEs related to PDCCH monitoring of SIB1 reception (*pdcch-ConfigSIB1* in the table) is discussed under FL proposal 8-1.
* **Cell ID of the NES cell (s)**
	+ **Yes**: Transsion, MTK, Huawei, HiSilicon, Google, CMCC, vivo
	+ **No**: OPPO
* **Configuration of dedicated PRACH resource for UL-WUS**
	+ **Yes**: Transsion, MTK, Huawei, HiSilicon, Google, CMCC, vivo, OPPO
* **Configuration of the CORESET and search space for RAR reception**
	+ **Yes**: NEC, MTK, Tejas, Google, CMCC, vivo
* **Frequency information for UL-WUS transmission**
	+ **Yes**: MTK, Huawei, HiSilicon, Google, vivo, OPPO
* **Parameters related to the UL WUS transmission power**
	+ **Yes**: Transsion, MTK, Google
* ***SSB-positionInBurst***
	+ **Yes**: Qualcomm, Huawei, HiSilicon, vivo, Tejas, CATT
* ***ss-PBCH-BlockPower***
	+ **Yes**: Google, MTK, vivo

### FL Proposal 3-1

**For further study of on-demand SIB1 in idle/inactive mode, RAN1 assumes at least the following information are needed in the UL-WUS configuration:**

* **Cell ID of the NES cell (s)**
* **Configuration of dedicated PRACH resource, including at least**
	+ ***ra-PreambleStartIndex***
	+ ***ra-AssociationPeriodIndex***
	+ ***ra-ssb-OccasionMaskIndex***
* **Configuration of the CORESET and search space for RAR reception**
* **Frequency information for UL-WUS transmission**
* **Parameters related to the UL WUS transmission power**
* ***SSB-positionInBurst***
* ***ss-PBCH-BlockPower***

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Support |  |
| CMCC | Support | Support the existing bullets as baseline, and further study other IEs if needed. |
| Xiaomi | Support. |  |
| Fraunhofer | Not support | SSB-positionsInBurst which was overlooked on the previous agreement should be added, or a new spatial linkage between SSB and UL WUS reception should be defined. But we should have some discussion of the overhead of each parameter first. For example, RAR parameters are significant overhead, and it would be good to have them reduced. (Physical) Cell ID could be considered as an identifier of UL-WUS configuration, but outside UL-WUS configuration. When the UL-WUS configuration is transmitted on the NES cell itself (Case 1), this would not be needed.  |

## Issue 4: Supported operation for the NES cell with on-demand SIB1

**Background**

Which operations (Ex. SSB, paging, RACH receiving, OSI request …) should be supported for the on-demand SIB1 NES cell is widely discussed.

The following are related RAN1/RAN2 agreements.

**RAN1 #116b Agreement**

RAN1 to further study the following UE operation scenarios in the UL WUS design:

- Scenario 1: UE requests SIB1 to camp on NES cell

- Scenario 2: UE request SIB1 to perform random access procedure to make RRC connection to NES cell

**RAN1 #117 Conclusion**

For further study of on-demand SIB1 in idle/inactive mode, enabling or disabling specific operations (e.g. paging, RACH receiving, OSI request …) of the NES cell with on-demand SIB1 is up to RAN2.

**RAN2 #126 Agreement**

After UE successfully receives OD-SIB1 for that NES Cell and if it is a suitable cell, UE camps in the NES Cell “similar” to a legacy Cell.

**RAN2#126 Agreement**

RAN2 not to support on-demand SIB1 request that is combined with an initial access to perform RRC connection establishment/resume on the NES cell.

Companies’ view in RAN1 #118 are collected below.

* NEC:For the study of on-demand SIB1 operation, RAN1 to prioritise discussion of Scenario-1 (UE requests SIB1 to camp on NES cell).
* ETRI: Support both Operation 1 and Operation 2 for on-demand SIB1 for idle/inactive mode UEs.
	+ Operation 1: SIB1 request/reception not combined with the RACH procedure
	+ Operation 2: SIB1 request/reception combined with RACH procedure
* MTK:
	+ RAN1 assumes the same as RAN2 that “camping” is allowed for the NES cell according to the RAN2 #126 agreement.
	+ RAN1 assumes the same as RAN2 that Scenario 2 defined in RAN1 #116b is deprioritized according to the RAN2 #126 agreement.
* Apple: NES cell does not support initial cell selection.
	+ This can be achieved by setting ‘cellbarred’ in MIB as “barred” to bar legacy UEs and introduce other enhancements for NES-Capable UEs to perform cell reselection or other operations on the cell.
* Ericsson: UE operation Scenario 2 can be done by the UE sequentially triggering UL WUS to camp on the NES cell and then initiate RRC connection.
	+ RAN1 should not discuss the UE operation Scenario 1 or Scenario 2 more.
* FUTUREWEI: Scenarios for UE requesting SIB1 (e.g., to camp on NES Cell, to RACH and connect to NES Cell) can be discussed by RAN2.
* Spreadtrum: Scenario 1 and Scenario 2 can be combined, e.g. UE can transmit UL WUS to request SIB1 to camp on NES cell, and conditions for triggering UL WUS transmission includes UE will perform random access to connect to NES cell.
	+ Conditions for triggering UL WUS transmission can include signal strength (e.g.RSRP/SINR).
* Intel: RAN1 to further consider the impact of scenario 2 for UL WUS design.
* Nokia: RAN1 shall consider the RAN2 agreement on combining OD-SIB1 with initial access procedure, and no further discussion is needed in RAN1 for this aspect.
* Fujitsu: RAN2 agreed not to consider Scenario 2 (UE request SIB1 to perform random access procedure to make RRC connection to NES cell) and the corresponding discussion can be closed in RAN1.
* Sharp:
	+ Based on RAN2 agreement, SIB1 request signal is separated from RACH procedure for RRC connection. Scenario 1 is more likely to align with scenario for SIB1 request.
	+ RAN2 only agreed the NES cell can be camped after SIB1 is obtained.
* Xiaomi:
	+ UE can camp on NES cell following current cell selection/reselection procedure even if it obtains WUS configuration from cell A.

Considering the companies’ views above, moderator has the following proposal.

### FL Proposal 4-1

**For further study of on-demand SIB1 in idle/inactive mode, RAN1 assumes the same as RAN2 #126 agreement to prioritize discussion of Scenario-1 (UE requests SIB1 to camp on NES cell).**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Yes | Fine to focus on Scenario 1. We don’t see the need to reopen the discussion in RAN1 on those RAN2 has already discussed.  |
| CMCC | Support | RAN1 should align with RAN2 on this detail design. |
| Xiaomi | Support. |  |
| Fraunhofer | support | RAN2 already decides that UEs can camp on NES cell and that after camp things should be normal. Whatever happens after camping on NES cell is a new procedure, which should just follow legacy procedures.  |

## Issue 5: Using which signal/channel to transmit the UL WUS configuration to the UE

**Background**

For this issue, the following RAN2 agreement was agreed.

**RAN2 #126 Agreement**

Cell A’s SIB can be used to configure on-demand SIB1 related configuration for neighbour NES cells, e.g., via new SIB or the existing SIB.

**RAN2 #126 Agreement**

RRC release message assisted intra-cell WUS can be discussed as option of signaling details in stage 3.

The following company views are collected in RAN1 #118:

* **Option 1: SIBx of Cell A**
	+ Transsion, MTK, Ericsson, Google, CMCC, Nokia, Sony, Fujitsu, Sharp
		- **UL WUS configuration can be provided from different cell A.** (MTK)
		- **Provisioning of update of UL WUS configuration is done by the cell UE is camping on (**Ericsson, Panasonic**)**
		- **The update of UL WUS configuration after the UE camps on NES cell is under discussion in RAN2** (Fujitsu)
		- **For UE camping on Cell A, existing SI change procedure can update UL WUS configuration. For UE camping on NES cell, the UE doesn’t need to receive UL WUS configuration or update.** (ZTE)
* **Option 2:** **RRC (release) signaling of Cell A or NES cell**
	+ Qualcomm (NES cell), Nokia, Sony
* **Option 3: PDCCH inside Type 0-PDCCH CSS set on NES cell, e.x. DCI 1\_0**
	+ NEC
	+ Fraunhofer/Vodafone/Deutsche Telekom/CEWiT (If UL WUS configuration size ≤ 140 bits; Case 1),
	+ CEWiT
	+ DOCOMO
* **Option 4: PDSCH and scheduled by Type 0-PDCCH in CSS set** **on NES cell**
	+ Fraunhofer/Vodafone/Deutsche Telekom/CEWiT (PDSCH FDMed to SSB, if UL WUS configuration size > 140 bits; Case 1),
	+ NEC
	+ CEWiT
	+ DOCOMO
* **Option 5**: **Predefined configuration**
	+ CEWiT, Sony, DOCOMO
* **Option 6: PBCH payload from the NES cell, e.x. K\_ssb**
	+ NEC, PBCH, DOCOMO
* **Option 7: *pdcch-ConfigSIB1* on NES cell**
	+ NEC
* **Option 8: Paging information on Cell A**
	+ NEC

With the RAN2 #126 agreements quoted and companies’ views above, moderator has the following proposal:

### FL Proposal 5-1

**For further study of on-demand SIB1 in idle/inactive mode, RAN1 assumes the same as RAN2 #126 agreement that at least Option 1 (UL WUS configuration provided by SIBx of Cell A) is supported for Case 2 and Case 3.**

* **FFS the following options to provide the UL WUS configuration to the UE for Cases 1/2/3**
	+ - **Option 3: PDCCH inside Type 0-PDCCH CSS set on NES cell**
		- **Option 4: PDSCH and scheduled by Type 0-PDCCH in CSS set on NES cell**
		- **Option 5: Predefined configuration**
		- **Option 6: PBCH payload from the NES cell**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Yes | Fine to focus Option 1 |
| CMCC | Support | Option 1 should be baseline.BTW, regarding option 3-6 under this proposal:1. The information that Option 3, 5, and 6 can carry is quite limited.
2. For option 4, companies may first discuss whether Case 1 is supported
 |
| Xiaomi |  | With the main bullet, not sure why we need to discuss the FFS point. Does this means SIBx on cell A is not sufficient to provide WUS configuration? |
| Fraunhofer | support | Options 3 and 4 provide a good basis for discussion of Case 1. One aspect still not explored is that Option 5 (predefined configuration) could also help on reducing overhead on case 2.  |

### FL Proposal 5-2

**For further study of on-demand SIB1 in idle/inactive mode, using RRC (release) signalling of Cell A or NES cell to provide UL WUS configuration is left to RAN2 Stage 3 discussion as per RAN2 #126 Agreement.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Yes |  |
| CMCC | Support |  |
| Xiaomi | Support. |  |
| Fraunhofer | Not support | While details can be left for later stage, we could capture agreement that providing UL WUS configuration on RRC (release) signalling of Cell A or NES cell is beneficial.  |

### FL Proposal 5-3

**For further study of on-demand SIB1 in idle/inactive mode, RAN1 assumes provisioning of** **update of UL WUS configuration is done by the cell UE is camping on.**

* **FFS: Mechanism of UL WUS configuration update other than SIBx-based methods**

**Note: SIBx-based update of UL WUS configuration is left to RAN2 discussion.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Yes | On this, reuse of legacy SIBx update procedure is preferred |
| CMCC | Support | Support to reuse the legacy SI update procedure. |
| Xiaomi |  | We are generally fine with the proposal. However, we want to further clarify the definition of camping cell:Considering UE can receive SIB1 on both cell A(the one provide WUS configuration) and NES cell(the one transmits OD-SIB1), the key issue boil down to on which cell UE receives paging. Does the proposal mean UE arbitrarily select a cell to camp on? |
| Fraunhofer | support | Assuming in all cases we are considering SI updates |

## Issue 6: How UE identifies a NES cell is with on-demand SIB1

**Background**

In RAN1 #116b, the following is agreed:

**RAN1 #116b Agreement**

RAN1 to further study UE identification of NES cell with on-demand SIB1 based on one, both, or combination of the following options:

* Option 1: By WUS configuration
* Option 2: By PBCH payload of NES cell

In RAN2 #126, the following is agreed:

**RAN2 #126 Agreement**

NW need to bar the legacy UE from accessing the on-demand SIB1 cell (e.g. based on the existing barring mechanism).

Note: How to use *ssb-SubcarrierOffset* needs RAN1 confirmation.

About how UE identifies a NES cell is with on-demand SIB1, the following company views in RAN1 #118 are collected below:

* **Option 1: By WUS configuration**: MTK, Samsung, ETRI, Panasonic, Apple, Qualcomm, Ericsson, FUTUREWEI, Huawei, HiSilicon, CMCC, Nokia, China Telecom, Xiaomi, [Sony], InterDigital, LG, DOCOMO, CAICT, III, DENSO
* **Option 2: By PBCH payload of NES cell**:
	+ Samsung, Lenovo (cellBarred and kssb),
	+ NEC (spare bit in MIB or k\_ssb),
	+ ETRI (UE reinterprets a legacy field, e.g., k\_SSB=30 for FR1 and k\_SSB =14 for FR2, or a reserved bit in MIB of the cell as indicating the presence or absence of SIB1 transmission)
	+ Apple (Information of cell A can be provided in PBCH payload of NES cell)
	+ Qualcomm, Ericsson, CEWiT, FUTUREWEI, Spreadtrum, CMCC, China Telecom,
	+ vivo (indicating reserved value, i.e., *kssb*=30 for FR1 or *kssb*=14 for FR2)
	+ CATT (kSSB=30 for FR1 and kSSB=14 for FR2), ZTE (kssb)
	+ Sony, InterDigital, LG (spare bit in MIB or k\_ssb)
	+ DOCOMO (*kssb*=30 for FR1 or *kssb*=14 for FR2), Sharp (MIB), DENSO
* **Option 3**: DCI 1\_0: NEC

Observing from the RAN2 #126 agreement and companies’ views above, moderator have the following proposals:

### FL Proposal 6-1

**The usage of MIB for identification of an NES cell with on-demand SIB1 is left to RAN2 discussion.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital |  | Fine |
| CMCC | Support |  |
|  |  |  |

### FL Proposal 6-2

**For further study of on-demand SIB1 in idle/inactive mode, it is assumed UE identifies a NES cell with OD-SIB1 based on both** **K\_SSB and the UL-WUS configuration received by the UE.**

* **For a NES cell with OD-SIB1,** **K\_SSB is set to 30 for FR1 and set to 14 for FR2**
* **Actual K\_SSB value used for on-demand SIB1 reception is indicated within UL WUS configuration**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital |  | Generally ok with the proposal. It is not clear what the 2 sub-bullets in the proposal imply. Are they for down-selection or both are needed?  |
| CMCC | Support, and | Fine with the proposal.We are also open to discuss other potential methods. |
| Xiaomi | Support. |  |
| Fraunhofer | postpone | Identifying an NES Cell with OD-SIB1 directly on the NES cell is beneficial, especially during initial cell selection, so that UEs can skip the cell instead of staying a long time only to fail to decode SIB1. But Option 3 (DCI\_1\_0) should be a bit more studied as it is more flexible than using MIB values for the identification.  |

## Issue 7: Confirmation of reception of UL WUS transmission (RAR)

**Background**

In RAN2 #126, the following is agreed:

**Agreement**

RAN2 assumes the UE is expected to receive the RAR responding to the preamble transmission for Msg1-based on-demand SIB1 procedure, as the baseline.

About confirmation of reception of UL WUS transmission, the following company views in RAN1 #118 are collected:

* **Option 1: Do not support NW feedback to SIB1 request. UE starts to monitor type0-PDCCH after sending UL WUS.**
	+ Fraunhofer, Vodafone, Deutsche Telekom, CEWiT, OPPO
* **Option 2: Support RAR as NW feedback to SIB1 request**
	+ MTK, Ericsson, Tejas Networks, CAICT, Sharp (according to RAN2 #126 agreement), NEC (To further discuss RAR contents and other DCI-based response)
* **Option 3: No need for further RAN1 discussion**
	+ Spreadtrum, Nokia, (RAR agreed in RAN2, RAN2 to discuss RAR contents), Fujitsu (RAR agreed in RAN2, RAN2 to discuss RAR contents)

From moderator’s perspective, it is suggested that RAN1 can assume the same as RAN2 #126 agreement that RAR is supported, while the detailed discussion of RAR contents can be left to RAN2. It is noted that for legacy on-demand OSI procedure, RAR is also supported.

### FL Proposal 7-1

**For further study of on-demand SIB1 in idle/inactive mode, RAN1 assumes the same as RAN2 #126 agreement that RAR is supported as NW feedback to SIB1 request. The contents of RAR are left for RAN2 discussions.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Support |  |
| CMCC | Support |  |
| Xiaomi | Support. |  |

## Issue 8: Time domain on-demand SIB1 transmission behavior after BS receives a UL WUS

**Background**

In RAN1 #117, the following is agreed for time domain on-demand SIB1 transmission behavior:

**Agreement**

At least for Case-2: For further study of type 0 PDCCH monitoring occasions for on demand SIB1, after UE transmits the UL WUS in idle/inactive mode, RAN1 assumes following as a starting point:

1. Option 1: One or more type 0 PDCCH monitoring occasions for on demand SIB1 within a time window
	1. FFS: How the search space zero configuration is provided (e.g. from *searchSpaceZero* in MIB or from a new search space that is indicated by UL-WUS configuration)
	2. FFS: Details of the time window, including at least the starting time and duration
	3. FFS: Whether/how to support transmission of on-demand SIB1 with the association with SSB(s) based on a received UL-WUS

Companies’ views in RAN1#118 are collected below:

On how the search space zero configuration is provided:

**Option 1: *searchSpaceZero* for on-demand SIB1 is provided from MIB on NES cell**

* NEC, MTK, FUTUREWEI, Huawei, HiSilicon, Tejas, China Telecom, vivo, CATT, DOCOMO

**Option 2: *searchSpaceZero* for on-demand SIB1 is provided from UL WUS configuration**

* Panasonic, Nokia (using UL WUS transmission timing as starting reference point), Xiaomi, InterDigital, Sharp, DENSO

**Option 3: *searchSpaceZero* for on-demand SIB1 is provided from RAR of UL WUS**

* Tejas, LG

On starting time of the time window:

* **Option 1: Indicated in RAR** (NEC, Apple, Ericsson, DENSO)
* **Option 2: Indicated in WUS configuration** (ETRI, Panasonic, Qualcomm, Ericsson, CEWiT, ZTE, InterDigital, DOCOMO)
* **Option 3: First period after WUS acknowledgement from gNB** (NEC)

Reference time point for the window starting time:

* **Option 1: Some time related to RAR** (ETRI, MTK, Qualcomm, vivo, Xiaomi, CATT, Lenovo, DOCOMO)
* **Option 2: Some time related to UL WUS transmission** (Nokia, China Telecom, Xiaomi, CATT, LG, DOCOMO)

On duration of the time window:

* **Option 1: Indicated in RAR** (Ericsson, LG)
* **Option 2: Indicated in WUS configuration** (NEC, ETRI, Panasonic, Qualcomm, Ericsson, CEWiT, vivo, ZTE, InterDigital, DOCOMO)
* **Option 3: One or more legacy SIB1 periodicity indicated via DCI format 1\_0** (NEC)

On number of repetitions of the time window:

* **Option 1: Up to NW implementation** (Ericsson)
* **Option 2: Configured to UE** (CATT)
* **Option 3: Only transmit one time window** (ZTE)

On whether/how to support transmission of on-demand SIB1 with the association with SSB(s) based on a received UL-WUS in R19:

* **Yes**: vivo, Ericsson, FUTUREWEI
* **No**: CATT, InterDigital

### FL Proposal 8-1

**At least for Case-2: For further study of type 0 PDCCH monitoring occasions for on demand SIB1, on how the search space zero configuration is provided, RAN1 to down select from the following two options:**

* **Option 1: *searchSpaceZero* for on-demand SIB1 is provided from MIB on NES cell**
* **Option 2: *searchSpaceZero* for on-demand SIB1 is provided from UL WUS configuration**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Support | We prefer Option 2 to avoid any potential spec impact at MIB for differentiating the search space zero between legacy SIB1 and OD-SIB1.  |
| CMCC | Support, but | This may depend on the design of NES cell identification. For instance, if only K\_SSB is used for NES cell identification, there is no need to configure *searchSpaceZero* in WUS configuration for NES cell.Thus, it is better to first discuss the detail design on NES cell identification. |
| Xiaomi | Support. | We are open to discuss.  |

### FL Proposal 8-2

**At least for Case-2: For further study of type 0 PDCCH monitoring occasions for on demand SIB1, on the** **starting time and duration of the time window of type 0 PDCCH monitoring occasions, RAN1 to down select from the following two options:**

* **Option 1:** **starting time and duration are indicated in RAR** **of the UL-WUS transmission**
* **Option 2: starting time and duration are indicated in the UL WUS configuration**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Yes | We prefer Option 2 for keeping the approach simple for providing start time and duration info, as it is not expected to have multiple/different time windows for OD-SIB1. It is also not clear on the benefits if such info is provided in the RAR as in Option 1. |
| CMCC | Support | We prefer option 2. |
| Xiaomi | Support. | We prefer option 2. |

### FL Proposal 8-3

**At least for Case-2: For further study of type 0 PDCCH monitoring occasions for on demand SIB1, on** **reference time point to determine the window starting time, RAN1 to down select from the following two options:**

* **Option 1:** **The reference time point is defined based on the RAR reception time of the UL-WUS transmission**
* **Option 2: The reference time point is defined based on the UL-WUS transmission time**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Yes | Fine with the options |
| CMCC | Support | We prefer option 1. |
|  |  |  |

### FL Proposal 8-4

**At least for Case-2: For further study of type 0 PDCCH monitoring occasions for on demand SIB1, on number of repetitions of the time window, RAN1 to further study the following options:**

* **Option 1: Up to NW implementation**
* **Option 2: Configured to UE**
* **Option 3: No repetitions (only once)**

**Other options are not precluded.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Yes | We prefer Option 1 |
| CMCC | Support | We prefer Option 1, this can be implicitly indicated by starting time and duration of the time window. |
| Xiaomi |  | More clarification is needed. We are confused on the definition of repetition of time window. |

### FL Proposal 8-5

**At least for Case-2: For further study of type 0 PDCCH monitoring occasions for on demand SIB1, it is assumed to support transmission of on-demand SIB1 with the association with SSB(s) based on a received UL-WUS.**

* **FFS: details**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | No | We do not see the need to change the legacy assumption and restrict the OD-SIB1 transmission only in association with the SSB used for UL WUS reception. This is to avoid limiting the usability of OD-SIB1 only for the UE that transmits UL WUS. Other UEs under the cell coverage are unable to take advantage of the OD-SIB1 transmission. Even for the UE that transmits UL WUS, there is possibility it may miss due to movement when OD-SIB1 is transmitted only in a specific beam. It is also not clear how much of NES gains are achievable when OD-SIB1 is transmitted only in association with limited SSBs compared to legacy.  |
| CMCC | Support, and | Transmit OD-SIB1 on specific beam (e.g., the beam associated with the dedicated WUS signal) can save more energy form network perspective.Whether UE only receives OD-SIB1 on the specific beam can be further discussed. For instance, whether the beams that UE receive can be configurable. |
| Xiaomi | Support. |  |

## Issue 9: UL WUS transmission failure handling and retransmission procedure

**Background**

In RAN2 #126, the following is agreed:

**RAN2 #126 Agreement**

As baseline, upon random access procedure failure of OD-SIB1 request, UE regards OD-SIB1 can’t be acquired in the NES cell and considers it as barred. It doesn’t exclude the option to leave the determination to the UE implementation.

**Moderator note**: The definition of random access procedure failure in legacy includes:

* UE transmits PRACH for ‘*preambleTransMax*’ times but still no RAR received,
* UE did not receive msg4 before the contention resolution timer expires, … etc

For this issue, companies’ view in RAN1 #118 are collected below:

* NEC:
	+ Support N number of WUS transmission attempts before WUS procedure is considered unsuccessful. Value of N is indicated to UE using WUS configuration.
	+ Support power ramping for WUS transmission in subsequent WUS transmission attempts. Configuration of power ramping (preambleReceivedTargetPower, powerRampingStep) is provided within WUS configuration.
* MTK: For transmission failure and retransmission of UL WUS, RAN1 can assume the same as RAN2 that both follow the random access procedure according to the RAN2 #126 agreement.
* Fujitsu: It has been agreed in RAN2 that the legacy on-demand SI request procedure is reuse for handling UL WUS transmission failure. The discussion of this issue can be closed in RAN1.
* LG:
	+ RAN1 to discuss UL WUS transmission failure criterion and retransmission procedure when a UE does not receive SIB1 after transmitting UL WUS.
	+ Consider introducing a prohibit timer for UL WUS transmission to prevent from excessive UL overhead
* Sharp: The issues relating to SIB1 request failure and SIB1 request transmission should be discussed in RAN2.

As mentioned by MTK/Fujitsu/Sharp, RAN2 already had related agreements for this issue, and further discussions (if needed) can be handled by RAN2. Moderator hence have the following proposal.

### FL Proposal 9-1

**For further study of on-demand SIB1 in idle/inactive mode, RAN1 assumes the same as RAN2 #126 agreement that transmission failure and retransmission of UL WUS follow the random access procedure. Further discussions (if needed) are left to RAN2.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Yes | Fine with RAN2 to handle further discussions on UL WUS failures |
| CMCC | Support |  |
| Xiaomi | Support. |  |

## Issue 10: Whether to covert on-demand SIB1 from study into normative work

**Background**

About whether to on-demand SIB1 from study into normative work, this would be checked in RAN1 #105 while companies’ views are collected in RAN1 #118 below:

* Lenovo: Support to specify on-demand SIB1 in Rel-19 as a solution to achieve network energy saving.
* Ericsson: Specification of complex mechanisms for enabling on-demand SIB1 should be avoided considering the small gains in overall energy efficiency.
* FUTUREWEI: Support normative work for procedures and signaling method(s) to support on-demand SIB1 for UEs in idle/inactive mode.
* Intel: On demand SIB1 is technically feasible. Modest relative power saving is only available in scenarios with no or low load.
* Nokia: RAN1 considers Case 2 only for normative work.
* vivo: Support to specify on-demand SIB1 at least for case2 in R19.
* Xiaomi: Support to specify on-demand SIB1 in Rel-19.
* Sony: Support on-demand SIB1 for UEs in idle/inactive mode in Release 19.
* InterDigital: Support on-demand SIB1 for UEs in idle/inactive mode for normative work
* Fujitsu: Minimum specification impact for on-demand SIB1 support should be considered.
* LG: Consider the trade-off between energy saving gain and initial access latency, in order to decide whether to proceed on-demand SIB1 procedure as normative work in Release 19.

**A brief summary is provided below**

* **Support to covert on-demand SIB1 from study into normative work**: Lenovo, FUTUREWEI, Nokia, vivo, Xiaomi, Sony, InterDigital, ZTE (if significantly beneficial),
* **Need more check**: Ericsson (avoid complex mechanisms), LG (Consider the trade-off)

### FL Proposal 10-1

**RAN1 recommends specifying on-demand SIB1 at least for Case 2 (Option 1+B+X) in R19.**

* **FFS: Whether to recommend Case 3 (Option 2+B+Y) and/or Case 1 (Option 1+A+X)**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support or not** | **Comment** |
| InterDigital | Support |  |
| CMCC | Support |  |
| Xiaomi |  | Considering we have a check point on whether/how to specify on demand SIB1 in RAN#105 meeting, we are wondering what is the plan for the FFS point.  |
| Fraunhofer | support | OD-SIB1 has great benefits for saving network energy at zero/low load, thus we support the conversion to normative work. Case 2 and Case 1 can have a lot of synergy if a simple solution is chosen for Case 1 and the complete solution would be better if both are standardized.  |

## Issue 11: NES gain evaluation results (for reference only)

R1-2406022 Intel Corporation

**Observation 1:**

* **Case A (20 msec SIB1 periodicity) relative power saving gain for zero/low/light/medium cell load**
	+ **for 8 SSB beams: 17.4 – 24.6 % / 7.9 – 13.9 % / 4.6 – 8.5 % / 2.3 – 3.5 %**
	+ **for 4 SSB beams: 10.9 – 16.8 % / 1.9 – 5.2 % / 1.0 – 2.9 % / 0.5 – 1.5 %**

**Observation 2:**

* **Case D (40 msec SIB1 periodicity) relative power saving gain for zero/low/light/medium cell load**
	+ **o for 8 SSB beams: 10.6 – 16.3 % / 4.3 – 8.1 % / 2.4 – 4.6 % / 1.2 – 2.4 %**
	+ **o for 4 SSB beams: 6.1 – 10.1 % / 1.0 – 2.8 % / 0.5 – 1.5 % / 0.3 – 0.7 %**

**Observation 3:**

* **Case C (160 msec SIB1 periodicity) relative power saving gain for zero/low/light/medium cell load**
	+ **o for 8 SSB beams: 3.2 – 5.4 % / 1.2 – 2.3 % / 0.6 – 1.3 % / 0.3 – 0.6 %**
	+ **o for 4 SSB beams: 1.7 – 3.0 % / 0.2 – 0.7 % / 0.1 – 0.4 % / 0.1 – 0.2 %**

**Observation 4:**

* **Considering BS configured to maximize power consumptions, e.g. longer SIB1 periodicity, that are supported by current specifications, OD-SIB1 has limited power saving gains in the low single percentage range.**
* **Even with more favorable BS configurations, e.g. 40 msec SIB1 periodicity, the OD-SIB1 gains are still in the single digit percentage range in low traffic load scenarios.**

**Proposal 5:**

* **In addition to the text-based observations agree to include the plots generated by the FL to give a better overview of the results.**

R1-2406377 CATT

**Observation 8: The NES gain heavily depends on the ratio of the NES cell with empty system load.**

**Observation 9: The NES gain for case A (20ms SSB period with 20ms SIB1 period) is significantly higher than that for case D (20ms SSB period with 40ms SIB1 period).**

R1-2406410 ZTE Corporati on, Sanechips

**Observation 1: For Case C, FR1, it is observed that the maximum NES gain with cat 2 is 7.76% with empty load**

**and 8 SIB1 beams, suggesting that the necessity of the enhancement may not be justified.**

**Observation 5: For Cat 2 base station, the following is observed with 20ms SSB period and 160ms SIB1 period (Case C), FR1, on-demand SIB1 rate from 75% to 0%:**

**a) Case 3 has -0.23% ~ 0% NES gain over Case 2 in empty system load.**

**b) Case 3 has -0.15% ~ 0% NES gain over Case 2 in low system load.**

**c) Case 3 has -0.20% ~ 0% NES gain over Case 2 in light system load.**

**d) Case 3 has -0.14% ~ 0% NES gain over Case 2 in medium system load.**

**Observation 6: For Cat 2 base station, the following is observed with 20ms SSB period and 20ms SIB1 period (Case A), FR1, on-demand SIB1 rate from 75% to 0%:**

**a) Case 3 has -0.51% ~ 0% NES gain over Case 2 in empty system load.**

**b) Case 3 has -0.40% ~ 0% NES gain over Case 2 in low system load.**

**c) Case 3 has -0.27% ~ 0% NES gain over Case 2 in light system load.**

**d) Case 3 has -0.19% ~ 0% NES gain over Case 2 in medium system load.**

**Observation 7: For Cat 2 base station, the following is observed with 20ms SSB period and 40ms SIB1 period (Case D), FR1, on-demand SIB1 rate from 50% to 0%:**

**a) Case 3 has -0.63% ~ 0% NES gain over Case 2 in empty system load.**

**b) Case 3 has -0.63% ~ 0% NES gain over Case 2 in low system load.**

**c) Case 3 has -0.42% ~ 0% NES gain over Case 2 in light system load.**

**d) Case 3 has -0.27% ~ 0% NES gain over Case 2 in medium system load.**

**Proposal 1: Capture Observation 5~ Observation 7.**

R1-2405994 CMCC

**Observation 1: Under Case 1, for NES gain on on-demand SIB1:**

* **2.7%~16.4% NES gain can be obtained for Cat 1 BS, TDD structure under various SIB1 request rates.**
* **2.6%~15.1% NES gain can be obtained for Cat 1 BS, FDD structure under various SIB1 request rates.**
* **2.4%~11.3% NES gain can be obtained for Cat 2 BS, TDD structure under various SIB1 request rates.**
* **2.2%~9.3% NES gain can be obtained for Cat 2 BS, FDD structure under various SIB1 request rates.**
* **Note that the SIB1 request rate varies from 0% to 100% in Cat 1 BS scenario, and varies from 0% to 50% in Cat 2 BS scenario. And the assumption for cell load is empty load.**

**Proposal 1: Deprioritize Case 1 for on-demand SIB1 in Rel-19.**

**Observation 2: Under Case 3, for overall NES gain on on-demand SIB1:**

* **20.0%~21.6% NES gain can be obtained for Cat 1 BS, TDD structure under various SIB1 request rates.**
* **20.0%~24.1% NES gain can be obtained for Cat 1 BS, FDD structure under various SIB1 request rates.**
* **13.3%~14.8% NES gain can be obtained for Cat 2 BS, TDD structure under various SIB1 request rates.**
* **12.5%~15.9% NES gain can be obtained for Cat 2 BS, FDD structure under various SIB1 request rates.**
* **Note that the assumption for cell load is empty load.**

**Observation 3: Compared with the evaluation results on NES gain for Case 2, Case 3 can bring up to 12% extra**

**NES gain in Cat 1 BS scenario, and can bring up to 6% extra NES gain in Cat 2 BS scenario.**

R1-2406410 ZTE Corporation, Sanechips

**Observation 5: For Cat 2 base station, the following is observed with 20ms SSB period and 160ms SIB1 period (Case C), FR1, on-demand SIB1 rate from 75% to 0%:**

**a) Case 3 has -0.23% ~ 0% NES gain over Case 2 in empty system load.**

**b) Case 3 has -0.15% ~ 0% NES gain over Case 2 in low system load.**

**c) Case 3 has -0.20% ~ 0% NES gain over Case 2 in light system load.**

**d) Case 3 has -0.14% ~ 0% NES gain over Case 2 in medium system load.**

**Observation 6: For Cat 2 base station, the following is observed with 20ms SSB period and 20ms SIB1 period (Case A), FR1, on-demand SIB1 rate from 75% to 0%:**

**a) Case 3 has -0.51% ~ 0% NES gain over Case 2 in empty system load.**

**b) Case 3 has -0.40% ~ 0% NES gain over Case 2 in low system load.**

**c) Case 3 has -0.27% ~ 0% NES gain over Case 2 in light system load.**

**d) Case 3 has -0.19% ~ 0% NES gain over Case 2 in medium system load.**

**Observation 7: For Cat 2 base station, the following is observed with 20ms SSB period and 40ms SIB1 period (Case D), FR1, on-demand SIB1 rate from 50% to 0%:**

**a) Case 3 has -0.63% ~ 0% NES gain over Case 2 in empty system load.**

**b) Case 3 has -0.63% ~ 0% NES gain over Case 2 in low system load.**

**c) Case 3 has -0.42% ~ 0% NES gain over Case 2 in light system load.**

**d) Case 3 has -0.27% ~ 0% NES gain over Case 2 in medium system load.**

**Proposal 1: Capture Observation 5~ Observation 7.**

Resulted RAN1 conclusion/agreement

TBD.

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