**3GPP TSG-RAN WG1 Meeting #110 R1-220xxxx**

**Toulouse, France, August 22 – 26, 2022**

**Agenda Item: 9.7.1**

**Source: Moderator (Huawei)**

**Title: FL summary for Post-110-R18- NW\_ES2**

**Document for: Discussion and Decision**

# Introduction

This triggers the email discussion of the following:

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| * [Post-110-R18- NW\_ES2] Email discussion on remaining details of NW EnSav performance evaluation methodology by September 1 – Yi (Huawei) |

Input for all 3rd round of proposals are expected by UTC 23:59pm Sep 1 (roughly 24h from now on).

Agreements made during the meeting week are captured in Annex-E for your information. The moderator summary we had last week are in [R1-2208216](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/R1-2208216.zip).

## Recommendations for email approval:

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# Energy consumption model for BS

## Remaining issues for power consumption model

### Inter-sleep mode transition

* *FFS: Optionally, a state machine where BS may transit between sleep modes without entering non-sleep mode can be considered. Companies are to report the involved sleep modes and the assumptions for inter-sleep mode transition time used in their evaluations.*

Several issues were mentioned based on the assumption of always existence of non-sleep state during transition [15]. According to FL understanding, the major concern seems to be the unrealisticness for BS predicting the UE traffic. On the other hand, it is not crystal clear to FL that how this can be overcome by using the proposed algorithm. If the traffic is not predictive at all, the BS may still go to deeper sleep while there is traffic coming later, and the threshold does not help. In this case the gNB actually waste some time that could be used for deeper sleep from the beginning thus less energy saving, while the consequence to UE is the same. Also, it is not clear how BS should monitor the traffic in order to perform this algorithm during sleeping, and whether this consumes further energy. Frequent check during inter-sleep states seems to be required and the delay/transition time could be longer since the one-shot transition is interrupted. Overall, the prediction of UE traffic is a common project. In the study, with currently 3 sleep states introduced, the gap between each other seems sufficient for gNB to select one – if the load/traffic is large, micro sleep without transition can be choosed; if the traffic is further reduced, either light or deep sleep for Category 1 and light sleep (with transition time close to paging circle) for Category 2 can be considered. FL consider the original proposal is good enough, for the interest of study. If results draw more attention in the next meeting, we can consider whether to bring more simulations based on that.

**Proposal 2.1.1-1:**

* **For initial evaluations, there is always a non-sleep mode assumed between adjacent sleep modes.**
* **Companies are encouraged to check the results, if provided, based on an incremental state machine (details in** [R1-2206979](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206979.zip)**) where BS may transit between sleep modes without entering non-sleep mode, and discuss whether this can be an additional power consumption model for further evaluations.**

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| **Company** | **Comments** |
| CATT | In our understanding, the transition time of deep/light sleep is to the micro sleep, which is also considered in Rel-16 UE power saving since the gNB’s wakeup from deep/light sleep might not at the symbol/slot for immediate DL Tx/UL Rx. gNB could easily transition to non-sleep state of DL Tx or UL Rx without transition time. Thus, the transition time should be defined in the same way is to transition between deep/light sleep and micro sleep (standby for any active Tx/Rx). The transition time between deep/light sleep mode to micro sleep in standby active Tx/Rx should be considered as the same as transition between deep/light sleep mode to active Tx/Rx. |
| ZTE, Sanechips | We support that there is always a non-sleep mode assumed between adjacent sleep modes.  For network power consumption modeling and evaluation, transition between sleep modes without entering non-sleep mode doesn’t result in significantly difference in evaluation results in terms of power saving gain, latency, etc, but greatly increases the simulation complexity.  For the transition between sleep modes, more discussion are required within the limited remaining SI phase, for example, how to trigger the transition into a deeper/lighter sleep state, how to calculate the associated transition energy. In the  From our understanding, the benefits of considering transition between sleep modes are not clear, we do not think an additional power consumption model is needed. |
| CMCC | Support that there is always a non-sleep mode assumed between adjacent sleep modes. |
| Samsung | We are fine with FL’s proposal for initial evaluation. |
| Intel | We think the intention of the first bullet is that only transition between [non-sleep/micro-sleep] mode and light sleep/deep sleep mode is assumed. We support this proposal..For evaluation purpose, we think modeling BS transitions from sleep to [non-sleep/micro-sleep] mode (and vice versa) is sufficient. It may be possible in real implementations that BS may enter different sleep modes in stages (e.g., BS enters light sleep mode first, then deep sleep mode). While we are open to state transitions models that allow switching from one sleep mode to another, as well as transitions model that only allow sleep mode to change to an active state, our preference is to have one transition model for evaluations. We expect potential insights obtained from evaluations with either models may not be significantly different and support of a single transition model is preferred.  Although BS may not predict arrival of traffic with certainty, in our view BS is never fully off and it’s backhaul and controller are expected to be always functioning so that BS can receive traffic requests and wake up from sleep modes. Depending on imminent or upcoming transmissions/receptions, BS can enter appropriate sleep modes. |
| LG Electronics | We are generally OK with Proposal 2.1.1-1 and we still think it is worth considering and evaluating the incremental state machine. |
| OPPO | We support the transition between non-sleep mode and sleep as always for the simulation purpose. |
| vivo | We support the proposal. |
| DOCOMO | We are fine with FL’s proposal for initial evaluation. |
| Huawei, HiSilicon | We don’t prefer to consider very complicated models to transit among different sleep modes. The power model is used for evaluation and transition energy and time are already considered when UE transits to/from a sleep mode to non-sleep mode. It can certainly reflects the energy consumption of transits.  Regarding the transitions among different sleep state, it may be impacted a lot by the implementation algorithm. Therefore, even if we consider to model gNB transit among different sleep modes, it would be also different from realistic and just add more difficulties to align results/observations from companies. |
| Ericsson1 | In our understanding transition between sleep states is implicitly covered by transition energy assumption for the evaluations. It is sufficient to model the transition between active state and each of the sleep state. |
| Qualcomm1 | If the discussion is for computing the additional transition energy, we don’t think the proposal is needed since companies can provide the numbers or it can be computed based on a formula (prefer the former approach).  However, if the discussion is for modelling power state transition in simulations, we suggest updating the proposal as follows:   * For evaluation purpose, BS may transition from a sleep state to a non-sleep state or transition from a non-sleep state to a sleep state.   In SLS, if we model transition between different sleep states (e.g., to go into deep sleep from active state, we have to model transition as active 🡪 micro sleep 🡪 light sleep 🡪 deep sleep), it will complicate the simulation effort while we may not get additional insights. Note that transition between different sleep modes may be used in computing the additional transition energy. |

#### Second round

Only single company prefer to keep the possibility of further considering the incremental state transition. Given the response so far,

**Proposal 2.1.1-1-rev1:**

* **For initial evaluations, there is always a non-sleep mode assumed between adjacent sleep modes.**
* **The study of incremental state machine is deprioritized, however can still be considered if there is sufficient justification from proponents.**

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| **Company** | **Comments** |
| LG Electronics | We can accept the proposal if the majority of companies insist that the evaluation of the incremental state machine is not beneficial. |
| Nokia/Nsb | We are fine to assume that, for evaluation of state transition, the non-sleep mode is always assumed between any two adjacent sleep modes. In other words, it is sufficient to model the transition between active state and each of the sleep state. |
| MediaTek | Support with minor revision to make some progress.  One thing to clarify, unlike UE power saving, BS has scheduling tasks. The incremental state machine may reflect the BS wake up latency to a data scheduling request during BS deep/light sleep. As a compromise, we suggest removing the second bullet and capturing a note as follows.  **Proposal 2.1.1-1-rev1:**   * **For initial evaluations, there is always a non-sleep mode assumed between adjacent sleep modes.** * **~~The study of incremental state machine is deprioritized, however can still be considered if there is sufficient justification from proponents.~~** * **Note: current assumption does not include the latency to a data scheduling request received during BS deep/light sleep modes.** |
| DOCOMO | We are fine with the proposal. |
| vivo | We support the proposal |
| Fujitsu | We are fine with the proposal. |
| ZTE, Sanechips | We are okay with the proposal. |
| CATT | We are OK with the proposal |
| Huawei, HiSilicon | We are fine with the proposal. |
| Intel | Support the proposal |

#### 3rd round

Not sure how many companies checked the updated Note from MTK and whether okey with that. From my perspective, as there is no UL reception during sleep mode, it is the case that scheduling request from UE is not considered. However there is separate proposal about scheduling delay to be considered, which might be able to provide some analysis. Therefore, it might not be the case as the note added from MTK.

For the time being, we can take the following without explicitly deprioritizing the incremental state machine. Please only indicate if you object this proposal; otherwise no need for input of support.

**Proposal 2.1.1.2-1:**

**For initial evaluations, there is always a non-sleep mode assumed between adjacent sleep modes.**

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| **Company** | **Comments** |
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### Handling of low-power UL signal

* *FFS: Details on how to use the above table for low power uplink reception (e.g. for WUS).*

WUS reception would in the end, if adopted, be one kind of UL channel/signal. There does not seem to be any difference from other UL channel/signals. Therefore it is not clear why it cannot be considered as normal UL-only reception as in active UL in the power consumption model, whatever the DL state is (despite the name of DL as sleep or active). From implementation point of view, if a separate receiver is used, this then could be applied to all other UL channel for this given implementation as well. Overall for a given implementation, with processing components for UL (partially) shared or non-shared with DL, the difference can be reflected in the power states values and transition times. FL consider it is sufficient to let companies report the details including the assumption of power states and transition time before/after the reception of the low-power-UL channel/signal.

**Proposal 2.1.2-1:**

**Companies to report the assumption details of power states and transition times before/after the reception of a low-power UL channel/signal, if used.**

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| **Company** | **Comments** |
| CATT | The Power model of low-power UL channel would depend on the receiver sensitivity, which would decide the coverage of the signals. The low-power UL channel has specific designed to minimize the power consumption. The proponent should provide detailed front end receiver architecture and the receiver sensitivity of the operation frequency band for the low power uplink reception in order to define the power model. |
| ZTE, Sanechips | Compared with DL transmission, the power consumption of UL reception is very small. But the exact power value of the low power UL reception depends on detailed implementation, we think it is okay to let companies to report the details including transition time/energy, etc.  Furthermore, we agree with FL that this low-power UL reception should be applied to other UL signals, we don’t need to limit it to WUS. |
| CMCC | The energy consumption for UL reception and processing only accounts about 10% of BS energy consumption. In such a small account of energy, the difference of energy consumption for receiving WUS or normal channel/signal can be ignored. |
| Samsung | We support the proposal.  For Cat 2 of reference configuration set 1, RAN1 agreed on the transition time to be 640ms and 10s, for light sleep and deep sleep, respectively. If gNB would like to go to sleep, gNB cannot monitor UL transmission during the transition time and sleeping time. If a packet arrives at a UE when gNB just starts SM transition, the UL latency can be seconds which is clearly not acceptable.  Allowing reception of WUS not impacting the SM transition could avoid such situation. If there is no UL traffic, the gNB can sleep for a long time while keep monitoring the WUS, if there is UL traffic arrives, UE would send a WUS to wake up the gNB to avoid large UL latency. |
| Intel | It is not clear whether a separate receiver component is assumed to be functional only for receiving WUS. If so, proponents could provide what would be the operating model and assumptions, including transition between low power UL reception state to other DL/UL states and whether such state can be approximately assumed to be same as micro-sleep mode or not with same relative power.  If this is part of a potential enhancement, then it might be better if proponents can provide details including potential changes to the reference power model when such receivers are utilized.  In our view, introducing a separate UL state for receiving a certain type of signal/channel (characteristics of which is unclear) for WUS is not necessary for defining power state model for the reference scenario. |
| LG Electronics | We agree with the FL comments and the proposal. Further discussions can be considered depending on the assumption details and evaluation results reported by companies in favor of low-power WUS. |
| OPPO | We agree with FL proposal. But we think the simplest way is to model it as active UL power consumption. |
| vivo | We are OK with the proposal.  We think a sleep state that is able to have low-power UL reception is needed. For current active UL only state, it is assumed that only PA is switched off and almost all other Tx components are switched on. If there is no traffic arrival and gNB is only monitoring WUS reception, it is beneficial to have a Tx sleep state with capability of low power UL reception where almost all the Tx component are switched off but Rx component is able to receive. The power value of this Tx sleep state could be even smaller than that for light sleep. Besides, the transition time and energy to active UL could be 0, which means gNB could maintain such low power state when there is no need for DL transmission. |
| DOCOMO | We support the FL proposal.  The difference between normal UL channel/signal and low-power UL channel/signal reception would be small considering the amount of the UL power consumption compared to that of DL. |
| Huawei, HiSilicon | According to the working assumption of set1, the power consumption values are 5.5 and 6.5 for micro sleep state and active UL only state respectively for Category 1 gNB assumption. The gap is already small enough.  We think the uplink detection power shall not be significantly reduced for WUS signal compared with some other signals/channels, assuming the reception bandwidth and Rx chains number are the same. |
| Ericsson1 | OK to leave any additional modelling with sufficient justification to the proponents. |
| Qualcomm1 | Suggest making the following update:   * **Companies to report ~~the assumption details of power states and transition times before/after~~ the power consumption model for the reception of a low-power UL channel/signal~~, if used~~.** |

#### Second round

A slight majority seems ok with the proposal while preference to use a special design for UL WUS reception is mentioned. For the interest of study, perhaps OK to keep the proposal in general with requirement on clarification from proponents in more details.

**Proposal 2.1.2-1-rev1:**

**Companies to report the assumption details of for the reception of a low-power UL channel/signal, if used, including power states and transition times before/after the reception, receiver details and other impact/change on the power consumption model.**

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| **Company** | **Comments** |
| LG Electronics | We are OK with the proposal. |
| Nokia/Nsb | To our understanding from 1st round discussion, the majority view is having the same receiver type assumed for both legacy UL channel/signals and WUS. Same as our view, for this study, it is sufficient to assume the same receive type for legacy UL channel/signals and WUS. |
| MediaTek | Support **Proposal 2.1.2-1-rev1.**  We think Rel-18 NWES can focus the baseline assumption on the BS receiver. We are open to discuss more advanced received assumption with sufficient details provided. |
| DOCOMO | We are fine with the proposal. |
| vivo | We are OK with the proposal. |
| Fujitsu | We are fine with the proposal. |
| ZTE, Sanechips | We are okay with the proposal. |
| CATT | Since the UL low power WUS receiver would be included as the additional front-end device, the receiver sensitivity is critical to be included with the proposed change as follows,  **receiver details, such as architecture and receiver sensitivity, and other impact/change on the power consumption model.** |
| Huawei, HiSilicon | We are fine with the proposal. |
| Intel | Support the intention of proposal. We think companies are interested in a low power UL state. To this end, we suggest to revise main bullet as  **Companies to report the assumption details ~~of~~ for the low-power reception of an ~~low-power~~ UL channel/signal, if used, including power states and transition times before/after the reception, receiver details and other impact/change on the power consumption model.** |
| Qualcomm2 | Suggest the following update:  **Companies to report the assumption details ~~of~~ for the reception of a low-power UL channel/signal, ~~if used,~~ including power states, additional transition energy, and transition times ~~before/after the reception~~, receiver details and other impact/change on the power consumption model.** |

#### 3rd round

Updated with some suggestions from companies, as below. The receiver details e.g. architecture may not be easily to report, so it is taken as example. These should be enough for information and interested companies to report. Please only indicate if you object this proposal; otherwise no need for input of support.

**Proposal 2.1.2.2-1:**

**Companies to report the assumption details for the reception of a low-power UL channel/signal, if used, including power states, additional transition energy, and transition times, receiver details (e.g. architecture and receiver sensitivity), and other impact/change on the power consumption model.**

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| **Company** | **Comments** |
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### Total transition time and additional transition energy

*FFS: Details on how transition energy is defined.*

There was some confusion by defining the total transition time using micro-sleep instead of non-sleep mode as reference. Since immediate transition time is assumed from micro-sleep to non-sleep, the calculation of total transition time would be the same between using micro-sleep and using non-sleep as reference, if there is no state machine, i.e. inter-sleep state transition is considered.

Clarification on how to calculate the additional transition energy is needed. Although BS power ramping could be more complicated, for modeling and evaluation purpose, it could be simpler to use a same methodology as UE power saving study, since a large portion of BS power consumption is contributed from given power states instead of transition. Further, micro-sleep is more proper as reference state since the relative power could be varying per different configurations/loads during non-sleep.

**Proposal 2.1.3-1:**

**The additional transition energy represents the energy that BS enters from non-sleep mode to a sleep mode and BS leaves the same sleep mode to non-sleep mode. For evaluation purpose, it is calculated as**

**where**

* **is the difference of the relative power between sleep mode and micro sleep**
* **is the corresponding total transition time of sleep mode , which is a two-way time, assuming no inter-sleep state transition.**

Note values will be directly given (from FL) once relative power values and transition times are determined. Therefore we only need to generally align on how the additional energy is obtained for this proposal. For details about “”, let’s see how the values will look like and for example, whether rounding is needed or not (as UE power saving did).

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| **Company** | **Comments** |
| CATT | The formula is correct. However, the transition energy and transition time should have only single value similar to that defined in Rel-16 UE power saving. The transition energy should be defined as single value of the transition between deep/light sleep and micro sleep, which is standby of active Tx/Rx. |
| ZTE, Sanechips | Proposal 2.1.3-1 is a good start to calculate the additional transition energy between sleep mode and non-sleep mode.  What’s more, a condition should be met that the BS power consumption when the BS enter into a deeper sleep mode should lass than that of the BS enter into a lower sleep mode. |
| CMCC | As FL’s clarification, the calculation of total transition time would be the same between using micro-sleep and using non-sleep as reference, we prefer to use non-sleep as reference. It is more realistic for network operation, when the conditions are satisfied, BS will wake up to active mode for DL transmission or UL reception.  Besides, the additional transition energy may be also defined as the energy that BS enters from non-sleep mode to a sleep mode for the consistent definition for transition time and transition energy.  Furthermore, in Proposal 2.1.3-1, represents the energy that BS enters from **non-sleep mode** to a sleep mode , is the difference of the relative power between sleep mode and **micro sleep**, could FL clarify why is using non-sleep mode as reference and is using micro sleep as reference. |
| Samsung | Fine with minor update to align with **Proposal 2.1.1-1**  **Rev Proposal 2.1.3-1:**  **The additional transition energy represents the energy that BS enters from non-sleep mode to a sleep mode and BS leaves the same sleep mode to non-sleep mode. For evaluation purpose, it is calculated as**  **where**   * **is the difference of the relative power between sleep mode and a non-sleep mode ~~micro sleep~~** * **is the corresponding total transition time of sleep mode , which is a two-way time, assuming no inter-sleep state transition.** |
| Intel | We are fine with the formula. It needs to be clarified that here sleep mode *i* corresponds to light and deep sleep modes only.  There was some confusion during discussions that took place in RAN1 # 110 whether non-sleep mode such as active DL or active UL should be considered instead of micro-sleep for obtaining . Note that we have agreed that transition between non-sleep to micro-sleep takes zero transition time and energy. Hence, assuming transition between micro-sleep to/from sleep mode *i* for representing transition energy corresponding to transition between non-sleep mode (active DL or active UL) to sleep mode *i* seems to be a reasonable approximate model and a cleaner/simpler approach. Otherwise, multiple values of transition time and energy need to be reported for sleep mode *i* depending on transition to/from active DL or active UL states. |
| LG Electronics | From our perspective, the formula needs to be more clarified. In our understanding, *Ei* and *T*i are two-way energy and time, respectively, but it is necessary to clarify why delta is the difference between sleep mode i and non-sleep mode and why 1/2 term is required. |
| OPPO | We are fine with the proposal |
| Vivo | We are OK with the proposal. should be the difference of the relative power between sleep mode and micro sleep. Suggest to change to .  Just a clarification on the total transition energy: it should be the energy for sleep mode *i* in transition time + additional transition energy **.** |
| DOCOMO | Share the similar view to CMCC/Samsung, and fine with the updated proposal by Samsung. It is weird to calculate from the difference of the relative power between sleep mode and micro-sleep if take Proposal 2.1.1-1 that non-sleep mode is always assumed for the transition. |
| Huawei, HiSilicon | We are fine with the proposal and it follows the similar principle of that in UE power saving. |
| Ericsson1 | Our preference is to agree to a value directly if possible, and no need to agree to a formula.  The additional transition energy from active state to sleep mode (SM) k and vice versa should be calculated using where is the power level and half the transition time of ith sleep mode, respectively.  For TDD, we think the transition energies should be 90 for active to light sleep, ~620 for active to deep sleep. |
| Qualcomm1 | Agree with Ericsson on providing values for additional transition energy.  For Set1 FR1 & power model Cat1, we propose additional transition energy is 90 for light sleep and 760 for deep sleep. |

#### Second round

The intention of the proposal is to help companies to obtain the additional energy savings, as said, the formula is not intended to be reflected as a hard requirement in TR. Now seems more comments are received. The experience of UE power saving study is not discarded but appears not being well acknowledged/understood.

My learning from offline discussion with UE power saving delegates implies such an explanation: transition between different loads within non-sleep model is not assumed with additional energy. Thus, for transition from non-sleep to deep/light sleep, the additional energy consists of that from micro to deep/light, and does not consist any from non-sleep to micro sleep (0 additional energy is agreed). Therefore is P3-P2( or P1). And as one example, in UE power saving study, according to Table 18/19 of TR38.840, the additional energy for deep->active is obtained by (45-1(neglected for simplicity))\*20 ms/2=450. The same applies to light->active but an additional rounding is applied for some reason (maybe beauty). Regarding the formula from Ericsson, it appears to consider incremental state transition.

Because in the end the only needed thing is a number/value as clarified in the beginning, FL would alternate the discussion to agree on the values for set 1 without the formula. The texts part may still be useful for TR, as if they are missing, people may get confused again in future (since they are missing in the TR of UE power saving). Also because for micro sleep, 0 is assumed for energy and time, the sleep model can be applied to any sleep from definition perspective.

**Proposal 2.1.3-1-rev2~~1~~:**

* **The additional transition energy represents the energy that BS enters from non-sleep mode to a sleep mode and BS leaves the same sleep mode to non-sleep mode.**
* **The total transition time of sleep mode , which is a two-way time, assuming no inter-sleep state transition for the initial evaluations (*as proposal in section 2.1.1.1*).**
* **(Working Assumption) for set 1, the additional energy (unit in relative power\*(duration in *ms*)) is**

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| **Power state** | Additional transition energy | |
| Category 1 | Category 2 |
| Deep sleep | ~~[1350]~~ 1250 | ~~[22500]~~ 12000 |
| Light sleep | [90] | [1088] |

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| **Company** | **Comments** |
| LG Electronics | We are Ok with the proposal based on the FL’s explanation. |
| Nokia/Nsb | Regarding 1st bullet point, for clarification on transition energy per one-way, we propose the following re-wording:   * **The additional transition energy represents the energy that BS enters from non-sleep mode to a sleep mode ~~and~~ or BS leaves the same sleep mode to non-sleep mode.**   Regarding the 3rd bullet point, and based on the latest agreement, the additional energy is “unit in relative power times (duration in ms)”, the word “relative” is missing.  And the proposed numbers by the FL is fine for us |
| MediaTek | Total energy for a given sleep transition duration is summarized below.   |  |  | | --- | --- | | Cat 1 | Cat 2 | | Micro sleep for 6ms = 55\*6 = 330  Light sleep for 6ms = 25\*6 + 90 = 240 | Micro sleep for 640ms = 5.5\*640 = 3520  Light sleep for 640ms = 2.1\*640 + 1088 = 2432 | | Light sleep for 50ms = 25\*50+90 = 1340  Deep sleep for 50ms = 1\*50+1350 = 1400 | Light sleep for 10s = 2.1\*10000 + 1088 = 22088  Deep sleep for 10s = 1\*10000+22500 = 32500 |   It is logical for BS to enter deep sleep because the total energy consumption for deep sleep is lower than light sleep. Based on the current values, it is not logical for BS to enter deep sleep for sleep duration of 50ms since light sleep has less energy consumption (e.g., 1340 < 1400 for Cat 1 and 22088 < 32500 for Cat 2). Therefore, we suggest the following update.   |  |  |  | | --- | --- | --- | | **Power state** | Additional transition energy | | | Category 1 | Category 2 | | Deep sleep | ~~[1350]~~ 1250 | ~~[22500]~~ 12000 | | Light sleep | [90] | [1088] |   Note that similar design logic is used for deep and light sleep’s additional transition energy in UE power saving study. |
| DOCOMO | We are fine with the proposal and the suggestions by Nokia/NSB. |
| FL | My understanding of the transition energy is two way also.  The values are updated per UE power saving expert above. |
| vivo | We are OK with the proposal. |
| ZTE, Sanehips | 1. We are agree that the transition time is the time duration required by two-way transition. 2. Regarding the values suggested by MTK, it should be noticed that for SCS=30KHz (FR1 TDD), a factor of 2 should be multiplied to the time duration, therefore, the energy for different time duration should be updated as below. In this sense, the transition energy in the original proposed is also consistent with the principle with UE PS power consumption model.  |  |  | | --- | --- | | Cat 1 | Cat 2 | | Micro sleep for 6ms = 55\*6\*2 = ~~330~~ 660  Light sleep for 6ms = 25\*6 \*2+ 90 = ~~240~~ 390 | Micro sleep for 640ms = 5.5\*640\*2= ~~3520~~ 7040  Light sleep for 640ms = 2.1\*640\*2 + 1088 = ~~2432~~ 3776 | | Light sleep for 50ms = 25\*50\*2+90 = ~~1340~~ 2590  Deep sleep for 50ms = 1\*50\*2+1350 = ~~1400~~ 1450 | Light sleep for 10s = 2.1\*10000\*2 + 1088 = ~~22088~~ 43088  Deep sleep for 10s = 1\*10000\*2+22500 = ~~32500~~ 42500 |   However, if the same transition time/energy/power value of sleep modes are also applicable to FR1 FDD(the table provided by MTK) and FR2, the transition energy should updated.  Similar with UE power model, we think the transition time/energy/power value of sleep modes can be the same for the three reference configuration sets to reduce the duplicated discussion. For the difference of power consumption value among different sets, it can be reflected by the power values of active states. In this case, the update suggested by MTK is reasonable to guarantee the similar design logic is applied to all the reference sets. |
| CATT | We would support the original values and can not agree with MediaTek’s calculation. The transition is one side. |
| Huawei, HiSilicon | MTK’s proposal is to decide the transition energy to make the total energy for deep sleep in the transition timer of deep sleep smaller than that of a light sleep. Otherwise, if deep sleep energy has a larger energy consumption, the gNB does not have intention to go to deep sleep.  The principle seems reasonable. However, if we take this as the design principle to decide the transition energy overhead, we should also consider that the transition energy should make corresponding transition time to be the switching point of the relationship. E.g. taking Cat.2 as an example, the total energy of gNB to keep in micro sleep for (640-1)ms should be smaller than the total energy of gNB to keep in light sleep for 639ms. Otherwise, the gNB shall be still tentative to go to light sleep when the time gap is 639ms.  Therefore, we made some update to make the transition time as a switching point regarding the relationship of the total energy consumed by the two sleep modes. Based on MTK’s table, we give our suggestion:    Total energy calculation   |  |  | | --- | --- | | Cat 1 | Cat 2 | | Micro sleep for 6ms = 55\*6 = 330  Light sleep for 6ms = 25\*6 + ~~90~~150 = ~~240~~300 | Micro sleep for 640ms = 5.5\*640 = 3520  Light sleep for 640ms = 2.1\*640 + ~~1088~~2142 = ~~2432~~3486 | | Light sleep for 50ms = 25\*50+~~90~~150 = ~~1340~~1400  Deep sleep for 50ms = 1\*50+~~1350~~1326 = ~~1400~~1376 | Light sleep for 10s = 2.1\*10000 + ~~1088~~2142 = ~~22088~~23142  Deep sleep for 10s = 1\*10000+~~22500~~13140 = ~~32500~~23140 |   Corresponding proposals:   |  |  |  | | --- | --- | --- | | **Power state** | Additional transition energy | | | Category 1 | Category 2 | | Deep sleep | ~~[1350]~~ ~~1250~~1326 | ~~[22500]~~ ~~12000~~13140 | | Light sleep | [~~90~~150] | ~~[1088]~~ 2142 | |
| Intel | With regards to MTK’s suggestion, additional transition energy for entering deep sleep is expected to be larger than light sleep. That’s why gNB is expected to enter deep sleep when it can stay in deep sleep for prolonged duration. In other words, overall duration the gNB is expected to be in a sleep mode should be determining factor whether to enter the sleep mode or not. If we refer to the agreed table, we captured that time interval for the sleep should be larger than the total transition time entering and leaving this state, and in practice, it should be much larger than transition time actually. Frequent transition in/out of deep sleep is not expected.  We understand that for Cat 2 transition energy for deep sleep is much larger than that of light sleep (i.e., gNB could be in light sleep for few seconds and even then consume less power than deep sleep transition), which can be adjusted if needed. Otherwise, we prefer to support the original values.  It should be clarified that during the transition time period, relative power of sleep mode *i* is assumed to be consumed, and the additional transition energy Ei, is the additional energy spent during the transition period. This can be added in a bullet. |
| Qualcomm2 | We don’t see 1st and 2nd bullets are needed.  For Set1 FR1 & power model Cat1, we propose additional transition energy is 90 for light sleep and 760 for deep sleep. |
| Ericsson2 | As we mentioned earlier, our preference is to agree to a value directly if possible.  For TDD Cat 1, the transition energies should be 90 for active to light sleep, ~620 for active to deep sleep. |

#### 3rd round

There are general support for the texts part although one or two companies do not consider it is needed. We can of course directly agree to a value for each case, as being proposed in the third bullet, while if we were asked how the values comes, I would hope we could at least tell the consideration behind those values, which is what we are discussing here. The formula is already removed and there should be no implication on how the energy is obtained by some high level texts.

Further, for the values of energy, they can be diverging with a same reason if we do not have any logic behind. It is not clear to FL that how the value much smaller than 1000 for Cat 1 deep sleep come, and it may also require a reason how the much smaller value for Cat 2 deep sleep can be realized by implementation. Note we all agreed to firstly agree on the relative power values and transition times, considering after that the additional energy values can be deterministic. Thus, proposals on the values are not expected to come free.

Good thing is that there seems to be a general trend to make the values smaller for deep sleep. Change on the values for light sleep is also mentioned by one company but lack of support from others. My suggestion is below which takes some good numbers in between without changing the calculation too much (but still close to some proposals). If it is not agreeable, we can take the original values as calculated. We do not need to manually change the values, as in practical the BS should assume large enough time interval applies and if really go to deep sleep, there could be sufficient time assumed.

**Proposal 2.1.3.2-1:**

* **During the transition time period,** **relative power of sleep mode is assumed to be consumed. Additional transition energy and total transition time spent in two-way (ramping down and up) during the transition period is considered.**
* **(Working Assumption) for set 1, the additional energy (unit in relative power\*(duration in *ms*)) is**

|  |  |  |
| --- | --- | --- |
| **Power state** | Additional transition energy | |
| Category 1 | Category 2 |
| Deep sleep | 1000 | 18000 |
| Light sleep | 90 | 1200 |

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Ok with proposed values. We suggest to not go below 1000 for Cat 1 deep sleep transition energy. |
| LG Electronics | Support Proposal 2.1.3.2-1. If it is not agreeable, we are also fine with values proposed in second round. |
| Samusng | We can go with the updated **Proposal 2.1.3.2-1** for the progress. However, we would like to clarify the additional transition energy of deep sleep in Category 2, we think it should be smaller than 12200, if calculated with 1200 of light sleep’s additional transition energy. |
| FL | To Samsung:  Thanks for being flexible. The idea not to use a much lower value for Cat 2 deep only to match the light sleep is because in practical if a BS can safely go to deep sleep which is second level for Cat 2, it is likely that sufficient large time internal can be ensured (much larger than transition time), therefore a bit larger E for deep sleep may not be concerned. It only becomes problem when time interval almost same as transition time. |
| DOCOMO | Fine with the proposal. |
| vivo | OK with the proposal |
| MediaTek | Okay with the proposed values.  Agree with FL as in practical the BS should assume large enough time interval applies and if really go to deep sleep, there could be sufficient time assumed. With the updated values, a reasonable duration for BS to go deep sleep would be 16s for Cat 2, which is agreeable to us.   |  |  | | --- | --- | | Cat 1 | Cat 2 | | Micro sleep for 6ms = 55\*6 = 330  Light sleep for 6ms = 25\*6 + 90 = 240 | Micro sleep for 640ms = 5.5\*640 = 3520  Light sleep for 640ms = 2.1\*640 + 1200 = 2544 | | Light sleep for 50ms = 25\*50+90 = 1340  Deep sleep for 50ms = 1\*50+1000 = 1050 | Case 1 (not reasonable for a 10s sleep duration)  Light sleep for 10s = 2.1\*10000 + 1200 = 22200  Deep sleep for 10s = 1\*10000+18000 = 28000  Case 2 (reasonable for a 16s sleep duration)  Light sleep for 16s = 2.1\*16000 + 1200 = 34800  Deep sleep for 16s = 1\*16000+18000 = 34000 | |
| Nokia/Nsb | For category 2, the proposed values are Not OK for us, as the total energy consumption to enter deep sleep is higher that light sleep. Hence, we propose the following values for additional transition energy to deep and light sleep, where the total energy consumption for a transition to deep sleep is 1\*10000+10000= 20000 brings gain as compared to light sleep with 2,1\*10000+1000=22000.   |  |  | | --- | --- | | **Power state** | Additional transition energy  [relative power\*ms] | | Category 2 | | Deep sleep | ~~18000~~ 10000 | | Light sleep | ~~1200~~ 1000 |   Additionally, as raised by ZTE in the last round discussion, since the power consumption is provided per slot (with 30 Khz SCS for set 1 FR1, so 1 slot=0.5ms), and the transition time is in ms, the relative power should be multiplied by 2, so as to obtain the relative power per ms, where the additional transition energy is expressed as [relative power per ms \* transition time in ms].  Furthermore, we want to ask FL to confirm that the formula used for transition energy calculation, is not considered anymore. |
| ZTE, Sanechips | Okay with the proposal. |
| FL to Nokia/NSB | The original values are obtained based on the formula  However it lead to some potential issue as multiple companies stated above, thus some adjustment is pursued. However this is not due to the issue of this formula - rather this formula is fine, but due to averaging the power values and transition times, the outcome of those lead to some unexpected transition energy. Therefore, the formula itself is not to be agreed.  As for the number Nokia/NSB proposed, as explained by FL, we should not be manually free to change the number only because of the willingness to satisfy that the energy of light sleep should be larger than that for deep sleep. In practical the time interval for BS living in deep sleep should also not be strictly the same as transition time. Thus, as you can see from MTK response above, with a bit further time allowed for deep sleep, it should be Ok for BS to have larger savings. The transition time in principle means how long the implementation require for BS going to deep sleep, which does not necessarily guarantee a larger saving in all cases.  So, as a tradeoff, a medium smaller value are taken from FL – not too smaller than it is calculated (i.e. 22500) nor too larger than some companies expected (e.g. 620, 760), allowing sufficient room for gNB to transfer according to proper traffic. An alternative way is to enlarge the energy consumed in light sleep (see Huawei/HiSi response) – however since light sleep may have impact on evaluations of techniques, FL feel sensitive to change it in any obvious level; only 1088->1200, which is assumed to be Ok given Cat 2 transition time is relatively large. The change of making the energy of light sleep smaller is more problematic, increasing the risk of mis-matching and not motivated by any reason (to FL). |
| Ericsson3 | OK with light sleep transition energy of 90.  For deep sleep, the value 1000 is too high - as explained earlier, it should be closer to 600. Prefer to keep it in brackets [600-1000]. |

### Power values for ref. conf. set 2 and set 3

Although there were some input during the meeting (see [Power state and transition time-offlineThursday\_v02.docx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/drafts/9.7(FS_Netw_Energy_NR)/9.7.1/FLS3/Power%20state%20and%20transition%20time-offlineThursday_v02.docx)), in general it seems incomplete and would be better to allow for another round of input considering that companies may understand more on how we use the input to determine the values. In the first round, please companies provide your values based on the [Templates](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/drafts/9.7(FS_Netw_Energy_NR)/9.7.1/Post-110-R18-NW_ES2/Template_collection%20of%20relative%20power_EnSav_v00.xlsx) in the [folder](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/drafts/9.7(FS_Netw_Energy_NR)/9.7.1/Post-110-R18-NW_ES2/Template_collection%20of%20relative%20power_EnSav_v00.xlsx) for set 2 and set 3 reference configuration respectively. Plan is to draw Working Assumptions (as that for set 1) for this post email discussion. The input for set 1 is also attached in the xls sheet for information.

Other comments can be provided below, if any.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | We could complete set 2 and set 3 at next meeting when more inputs would be provided. |
| Intel | Please find inputs to the excel sheet attached. In our view, at least Set 1 TDD values can be considered for initial evaluation based on reference configuration. |

#### Second round

Based on the input so far ([Template\_collection of relative power\_EnSav\_v04\_QCOM\_NokiaNsb.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/drafts/9.7(FS_Netw_Energy_NR)/9.7.1/Post-110-R18-NW_ES2/Template_collection%20of%20relative%20power_EnSav_v04_QCOM_NokiaNsb.xlsx) [~~Template\_collection of relative power\_EnSav\_v03\_HW&HiSi\_QCOM.xlsx~~](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/drafts/9.7(FS_Netw_Energy_NR)/9.7.1/Post-110-R18-NW_ES2/Template_collection%20of%20relative%20power_EnSav_v03_HW%26HiSi_QCOM.xlsx)),

**Proposed working assumption 2.1.4.1-1**

**The recommended values for set 2 can be**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power state** | **Relative Power *P*** | | **Total transition time *T*** | |
| **Category 1** | **Category 2** | **Category 1** | **Category 2** |
| Deep sleep | 1 | 1 | 50 ms | 20 ~~10~~ s |
| Light sleep | 22.5 | 1.45 ~~1.5~~ | 6 ms | 2 s ~~few seconds~~ |
| Micro sleep | 52.5 | 2.35 ~~3~~ | 0 | 0 |
| Active DL | 275 | 9.1 ~~12.6~~ | N.A. | |
| Active UL | 95 | 3.6 ~~4.7~~ |

**The recommended values for set 3 can be**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power state** | **Relative Power *P*** | | **Total transition time *T*** | |
| **Category 1** | **Category 2** | **Category 1** | **Category 2** |
| Deep sleep | 1 | 1 | 50 ms | 10 s |
| Light sleep | 25 | 1.75 | 6 ms | few seconds |
| Micro sleep | 55 | 3 | 0 | 0 |
| Active DL | 235 | 8.4 | N.A. | |
| Active UL | 125 | 4.25 |

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/Nsb | For Set 2 FR1, we propose the following values which fit into Category 2 (as per working assumptions).   |  |  |  | | --- | --- | --- | | **Power state** | **Relative Power *P*** | **Total transition time *T*** | | **Category 2** | **Category 2** | | Deep sleep | 1 | 10 s | | Light sleep | 1.4 | few seconds | | Micro sleep | 1.7 | 0 | | Active DL | 5.6 | N.A. | | Active UL | 2.5 | |
| MediaTek | For Set 2 and 3, we suggest being more specific and replace “few seconds” to 2 seconds. |
| DOCOMO | We also prefer to have specific values for Light sleep of Cat. 2 in set 2/3. It seems the transition times are same among different sets, e.g., 50 ms, 10 s, and 6 ms for Deep sleep of Cat.1, Deep sleep of Cat.2, and Light sleep of Cat.1, respectively. With this manner, the total transition time for Light sleep of Cat.2 in Set2/3 could be 640 ms similar to Set 1 in the working assumption. |
| FL | Values updated per Nokia/NSB input and MTK good suggestion.  As for the concrete values, I’m open to either 2 seconds or 640 ms. When we agreed set 1 I believe there was some reason or some compromise made. So if some of the companies do not contribute to set 2, there might be some difference shown in the end.  Let’s check if there are more preference. |
| vivo | To determine Set 2 power value, the agreed Set 1 value should be a reference or a baseline. Compared to Set 1, we understand the power value may be a little lower than that for Set 1 since the total transmission power and number of TxRu/RxRus are smaller. However, the ratio of active DL state for Cat 1 and Cat 2 has too much difference in the proposal, i.e. 275/280>90% and 12.6/32<40%. We think the power value for Active DL state in Cat 2 should be set larger, e.g. 32\*80%=25.6.  For Set 3, similar observation exists for power state of Active DL in Cat 2 and Active UL in Cat 1.  For the value of active DL power state in Cat 2, e.g. 32\*70%=22.4 could be considered;  For the value of active UL power state in Cat 1, what’s the reason why the value is even larger than that for Set 1? We suggest 110\*70%=77 for further consideration since there is smaller number of RxRUs compared to Set 1. |
| ZTE, Sanechips | We agree with vivo that the agreed Set 1 value should be a reference or a baseline for other reference configuration sets.  For the transition time and associated power values of sleep modes for set 2(FR1 FDD) and (set 3)FR2 should be the same with set 1(FR1 TDD). Therefore, the duplicated discussion about these values can be avoided.  Moreover,our values have been added in the draft folder. The suggested values should be updated accordingly. |
| CATT | We are OK with Set 3. Since the values of Set 2 is quite close to those of Set 1, we suggest to have same value as that of Set 1 since there is negligible difference in gNB design in support of TDD and FDD in FR1. This would help to compare the results of FDD and TDD in FR1. |
| Intel | For sleep mode power and transition times for different categories, we suggest to keep the values agreed for Set 1 TDD. Few seconds is not precise enough for evaluation, eg., in Set 3. We are Ok with active state power values. |
| Ericsson2 | Not OK. Our proposed values for Set 2 and Set 3 are as follows (added in the excel sheet, and as per R1-2207437). Transition times for light sleep and deep sleep should be 5ms (also OK with 6ms) and 50ms.   |  |  |  | | --- | --- | --- | |  | **Set2** | **Set 3** | | Active DL | 160 | 70 | | Active UL | 84 | 40 | | “Micro”-sleep | 42 | 20 | | “Light”-sleep | 25 | 15 | | “Deep”-sleep | 1 | 1 | |

#### 3rd round

Based on the input so far ([Template\_collection of relative power\_EnSav\_v06\_ZTE\_Ericsson.zip](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/drafts/9.7(FS_Netw_Energy_NR)/9.7.1/Post-110-R18-NW_ES2/Template_collection%20of%20relative%20power_EnSav_v06_ZTE_Ericsson.zip)),

the average values for set 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power state** | **Relative Power *P*** | | **Total transition time *T*** | |
| **Category 1** | **Category 2** | **Category 1** | **Category 2** |
| Deep sleep | 1 | 1 | 50 ms | 12 s |
| Light sleep | 23.3 | 2.63 | 6 ms | 1.4 s |
| Micro sleep | 49 | 4.9 | 0 | 0 |
| Active DL | 237 | 39.4 | N.A. | |
| Active UL | 91.3 | 5.73 |

the average values for set 3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power state** | **Relative Power *P*** | | **Total transition time *T*** | |
| **Category 1** | **Category 2** | **Category 1** | **Category 2** |
| Deep sleep | 1 | 1 | 50 ms | 10 s |
| Light sleep | 20 | 1.75 | 5.5 ms | 2 s |
| Micro sleep | 37.5 | 3 | 0 | 0 |
| Active DL | 152.5 | 8.4 | N.A. | |
| Active UL | 82.5 | 4.25 |

Given companies preference/comments to take values close to that for set 1 or with same logic as that for set 1 to keep consistence, the following may be considered. Note if it is not agreeable to you, please suggest a way forward that you think all may be acceptable, using a simply principle, e.g. reuse all the values for set 1, strictly use the average values from the input, or etc. Note the proposal is to take it as WA so we still have chance to correct it next meeting.

**Proposed working assumption 2.1.4.2-1**

* **FFS: The relative power values for reference configuration set 2 and set 3 is**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power state** | **Relative Power *P* for Category 1** | | **Relative Power *P* for Category 2** | |
| **Set 2** | **Set 3** | **Set 2** | **Set 3** |
| Deep sleep | 1 | 1 | 1 | 1 |
| Light sleep | 23 | 20 | 2.6 | 1.8 |
| Micro sleep | 50 | 38 | 5 | 3 |
| Active DL | 240 | 152 | 40 | 8.4 |
| Active UL | 90 | 80 | 5.8 | 4.2 |

* **The total transition time for set 2 and set 3 is the same as that for set 1.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | OK with WA for progress |
| CATT | We still think that the values of Set 2 should be same as those of Set 1. However, we are OK if no companies object on it. |
| LG Electronics | We are OK with proposed working assumption. |
| Samsung | Fine with working assumption. |
| DOCOMO | Fine with WA. |
| vivo | OK with the WA |
| MediaTek | Okay |
| Nokia/Nsb | Regarding Set 2, we cannot support it for this meeting.  Especially for Category 2, some company provides a set of values, which is too much bias from other companies’ proposed value. It happened for Set1, and it should be avoided for Set 2.  More precisely, we can’t agree on some power consumption values provided by companies which are identical between Set 1 and Set 2. We expect to see lower values for set 2, as we consider lower number of Tx, lower total DL transmit power.  However, for the transition time, we propose to have the same values for Set 2 as for Set 1 (as it was proposed for category 1).  We prefer to come back for this at next meeting |
| ZTE, Sanechips | Okay with the WA.  We agree that the absolute power value for set 1 and set2 can be different due to the configuration of TxRU, bandwidth, and transmission power.  However, it is aimed to define a relative power model. The ratio of power values between different states can be similar for set1 and set 2. Therefore, the power value can be same for set 1 and set 2 for a relative power consumption model. |
| FL | See update |
| Ericsson3 | OK to keep values as FFS– as we mentioned in the meeting, we do not think averaging the values from different proponents will work. For example, the reference configuration for FDD and TDD are different but deep sleep : active ratio seems similar for both which we think is not accurate. We are OK to discuss with other proponents on a reasonable set of values in next meeting. We prefer to capture the FFS as below.   |  |  | | --- | --- | | Set 2 | Set 3 | | 1 | 1 | | 23 | [15 – 20] | | [42 – 50] | [20 - 38] | | [160 - 240] | [70 – 152] | | [84 – 90] | [40 - 80] | |

## Scaling

The scaling based on a single formula gains general support in the first round while three companies prefer per domain scaling in the second round. Further offline of offline discussion led to three alternatives to be further discussed (see Recommendation part in the [document](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/drafts/9.7(FS_Netw_Energy_NR)/9.7.1/FLS3/offline/R1-2208216%20110-NWES%20EVA%20FLS3_v01_update_FL3_proposals-Friday%20offline.docx)), which seems to bring the discussion back to the starting point: slot level v.s. symbol level, jointly v.s. separately. Also, the Alt 4 recorded in the documents seems incomplete, so further clarification/corrections may be required.

The attempt to address the non-linear PA is expected, which is FFS in previous proposal and draw an increased interest from the feedback. Some clarification may be useful on how some proposed scaling methods can accurately reflect the non-linear effects and/or whether simplified approach e.g. by jointly scaling is sufficient. Both jointly or separately scaling approach could work. With properly selected factors these two may not differ greatly, given low load as the primary study interest.

Comments for CA, time-domain may be addressed separately.

**Proposal 2.2-1**

* **The BS power consumption for active DL is provided by**
  + **Alt 1:** 
    - : a static part of which the power is not scaled based on reference configurations. Value is to be determined based on
      * Option 1: P3
      * Option 2: a\*P4 where a<1
      * Note Option 1 and Option 2 are listed for the purpose of deriving , and is not to be reflected once the value of is obtained.
    - : a dynamic part of the power that is scaled based on reference configurations, given by
      * **Alt 1-1: +**
      * **Alt 1-2:**
      * , , is the percentage of active TRxRUs, resource usage in frequency domain and scaling factors in power domain.
      * is PA efficiency, for simplicity, may be a fixed value for certain load
  + **Alt 2:** 
    - , , is the static part, and , , is the scaling factor of frequency/spatial/power domain, respectively
    - In time domain,
      * when slot level model is provided, a time domain scaling factor is linearly applied using the number of active symbols within a slot. Companies to describe how to scale for symbols with different frequency domain allocations.
      * If an explicit symbol level model is provided, scaling is not applied
  + **Alt 3: (1-x)\*P3 + x\*(a + (1-a)\*)\*P4**
    - x is resource usage, in percentage
    - a < 1, e.g. =0.3
    - is function of PA efficiency
  + **Additional notes applicable for all alternatives,**
    - In time domain,
      * when slot level model is provided, a time domain scaling factor is linearly applied on , if applicable, or on ***P***, according to the number of active symbols within a slot. Companies to describe how to scale for symbols with different frequency domain allocations.
      * If an explicit symbol level model is provided, scaling is not applied.
    - In frequency domain, for inter-band CA, the power consumption is assumed as
  + Alt 1-F-1: the sum of the power consumption of each cell
  + Alt 1-F-2: using a scaling factor that can be >1
    - In spatial domain, for M-TRP, the power consumption is assumed as
  + Alt 1-S-1: the sum of the power consumption of each TRP
  + Alt 1-S-2: using a scaling factor that can be >1
    - Note: system simulation evaluations can be per slot regardless of detailed approach for calculating symbol-level power consumption (already agreed).

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | The power scaling model should be defined for individual domain, e.g., time, frequency, spatial, and power with simple model of static component + dynamic component.  The static component is the fraction of fixed power consumption associated with the overall power consumption in a given domain. When the power scaling in time domain to derive the power consumption for fractions number of the Tx symbols in a slot, the static component is the power consumption of option 1 of micro sleep “P3”. However, the static component of frequency, spatial and power domain scaling is not equal to “P3” since they are the fraction of total active Tx/Rx, which is option 2 of a\*P4.  The dynamic component would be defined in association with the variation in time, frequency, spatial and power domain.  For joint power scaling model, we should discuss it once we finalize the individual power scaling for each domain. |
| ZTE, Sanechips | For Alt 1-1, regarding the static part of the power, P3 is a good choice because the power consumption of micro sleep should be the minimum value of the power consumption of active DL. For the dynamic part, Alt 1-1 can reflect the impact of the frequency domain, spatial domain, and power domain on the power consumption of active DL.  For Alt 2, it is similar with UE power consumption model. It is assumed that scaling factor of individual domain can be directly multiplied if adaptation in multiple domains is considered in the evaluation. It should be noted that with this assumption, it should be additionally consider a lower bound of scaling, i.e., the active DL power consumption should be larger than micro sleep even adaptation in multiple domains is used. That is, the power consumption of active DL is equal to min(P3, Alt 2).  What’s more, with a proper design, Alt 1 and Alt 2 may not differ greatly from evaluation respective. Considering the scaling factor calculation for multi-domain adaption, alt-1 is slightly preferred. And we are also okay with the majority views.  For the power consumption model, slot level is simple and preferred.  For the time domain scaling, the power consumption should be calculated according to the number of active symbols within a slot. And the symbol without active DL should be treated as micro sleep. Therefore, the time domain scaling can be α\*P4+(1-α)\*P3, wherein P4 is the power for active DL, P3 is the power of micro-sleep, α is the ratio of active DL occupation within a slot.  For the scaling of inter-band CA, Alt 1-F-1is preferred. For inter-band CA, the RF chains and other components of difference cells are independent. Therefore, the total energy consumption of multiple cells is basically equal to the sum of the power consumption of each cell. |
| Samsung | We slightly prefer **Alt 1** for scaling for active DL.  Regarding the, we think **P3** in Option 1 seems reasonable. During micro sleep mode, we are assuming the gNB consumes minimum power to stand by the transmission or reception. It’s would be not affected by the scaling in the any domains. So, we support Option1.  In terms of to simplify the power consumption, we support **Alt 1-2** for evaluation with the following further clarification. Given Alt 1-2, the scaling factor of power domain can be reflected in conjunction with the scaling factor of frequency domain. Also, PA efficiency have already considered to determine the **P3** and **P4**.  In time domain, we also think the scaling should be applied only to . In the cases with different frequency domain allocations, total power consumption from each power consumption of different frequency domain allocations in symbol level, are calculated, and it would be normalized to 14 symbols in a slot.  Regarding the frequency domain in additional notes, we don’t think it is necessary to be restricted only for inter-band CA. Hence, we would like to generalize the wording from for inter-band CA to CA. |
| Intel | We support Alt 1, where we are fine with either Option 1 or 2 for the  **,** assuming P3 a\*P4 for the chosen a. For example, a = 19.6% results in P3 a\*P4 for FR1 Set 1 scenario.  For  **,** our view is power and frequency domain scaling can be jointly modeled. For example, we can assume fixed PSD and power consumed can be scaled linearly with occupied BW.  We support **Alt 1-2: ,** where **, b** and **c** are constants that correspond to % power consumed due to fixed and variable components where BW is scaled from reference configuration. For example, b = 0.6, c can be 0.4. Valid values of X are {5, 10, 20, 40, 80, 100 MHz}. Values of b and c can be further discussed. If changes to PSD needs to be modeled, then companies could potentially use the occupied bandwidth ratio, X/100, as the changes to the total power (stemming from changes to PSD) as an approximation. For example, if PSD is decreased by 50%, then X = 50 can be used.  And,  **=** 0.7^(64/N – 1), valid values of N = 32, 16, 8, 4.  Assuming slot level power modelling, as agreed in RAN1 # 109, a time domain scaling factor such as is linearly applied on , based on number of active symbols in the slot. Below, we provide a simple illustration and an example for relative power per slot for 5MHz, 4 OS, 32 antenna transmission in a slot.  P = P3 +  **= 55 + = 82.9**    It is not clear what resource usage *x* implies (time or frequency or both) in Alt-3 and why/how static component would vary with resource usage. Different alternatives were intended to model scaling in frequency and spatial domains only, and time domain scaling is to be applied afterwards based on notes after “**Additional notes applicable for all alternatives**”.  Before discussing inter-band CA, we need to confirm scaling for intra-band CA first since the above alternatives only consider single cell case. We are OK to consider Alt 1-F-1: the sum of the power consumption of each cell for inter-band CA.  For M-TRP, we support Alt 1-S-1: the sum of the power consumption of each TRP. In our view, different TRPs can be in active state and micro-sleep independently depending on activity. In other words, P = Pstatic + Pdynamic is computed separately for each TRP, and then added up. |
| LG Electronics | We support Alt 1-2 in favor of per domain scaling with the slot-level. ***P*dynamic** can be linearly scaled by the number of active TRxRUs, resource usage and scaling factor in power domain. |
| OPPO | We prefer Alt-2 for its simplicity. |
| vivo | We prefer Alt. 1-1 since it can handle scaling in spatial, frequency and power domain. For Alt. 1-1, we have the following comments:   1. Definition of is not clear. Is it the ratio of PSD between this transmission and reference configuration. 2. is preferred to be a fixed value.   For Alt. 1-2, it seems a transmission with different PSD compared to reference configuration can’t be handled.  For Alt. 2, the formula seems not correct and the definition of F, N and P are not clear.  For Alt. 1-3, it is not clear to handle scaling of TxRUs and PSD.  For Inter-band CA, we support Alt 1-F-1 since the RF is not shared between carriers. |
| DOCOMO | We slightly prefer Alt.1.  Regarding in Alt.1, we think Option 1 is reasonable because the power consumption in micro sleep should reflect the static power consumption in the active DL mode.  Regarding in Alt.1, we would like to hear more companies’ views. For accuracy, we slightly prefer non-linear scaling, but it would be difficult to reach consensus with non-linear model considering the limited time. If so, we are fine to go with liner scaling. |
| Huawei, HiSilicon | 1. We prefer Alt. 1-1, which is composed of the individual power consumption of corresponding component of gNB, e.g. static part that cannot be dynamically switched off, TRX chains and PA. 2. Alt.2 assumes each scaling factors in each domain. However, we need to select proper value of , , , , , to emulate the gNB power consumption. It would introduce large analysis work based on the power consumption test results. Therefore, it is not preferred. 3. Alt.1-2, due to the similar reason as Alt.2, it is not preferred by us. Also, the Alt.1-2 cannot reflect the impact on power consumption due to transmission power adaptation. 4. For Alt.3, our understanding is ” **(a + (1-a)\*)\*P4”** in the formula is the power consumption while the gNB is with full bandwidth transmission and full number of TRX chains used in the in reference configuration. And P3 is the power consumption of micro sleep state, i.e. without any transmission and reception. Alt.3 does a linearly combination between the power consumption without transmission and with transmission with full bandwidth/full TRX chains by using the resource usage ratio of X. Our concern on Alt.3 is it cannot reflect the scaling due to the adaptation of TRX chains in spatial domain and due to the adaption of transmission power.   Therefore, we prefer Alt.1-1 considering it can reflect all the scaling in frequency, spatial and power domain. The PA efficiency  is also considered in Alt. 1-1. |
| Ericsson1 | Our preference is to agree to scaling with values because it is difficult to compare the different options without understanding the values to be plugged into the formula. Our preference is as below.  P\_DL (for FR1 TDD)= P4 \* ( [0.4] + [0.6] \* sf\*sp) \* ([0.4] + [0.6]\*sa)   * , , is the percentage of active TRxRUs, resource usage in frequency domain and scaling factors in power domain, respectively. |
| Qualcomm1 | Joint vs. Split scaling  We support jointly scaling of frequency and power domains, as the power consumption is dependent also on the transmitted power which is a factor of the resource utilization in the frequency domain (e.g., number of PRBs) and the power domain (e.g., PSD).  Separately scaling for frequency and power will not support combined frequency and power scaling (e.g., reducing to 20% of the BW and increasing the PSD by 3dBs).  Even in case of only frequency domain scaling (where the PSD is kept unchanged), the scaling of the frequency domain will have to include transmitted power calculation assuming some nominal PSD  Linear vs nonlinear scaling of the PA  PA power consumption constitutes the majority of the gNB power consumption and therefore should be modeled correctly. Incorrect modeling will not allow to analyze techniques.  PA power consumption depends on the transmitted power scaled by a nonlinear factor PAE (PA efficiency). The PAE depends on the backoff from a certain reference output power. µ in figure 25 ‘Power amplifier basics’ in our contribution R1-2207246, reflects general PAE curve. Such curves maybe found in any PA datasheet or can be obtain in lab tests for companies with appropriate PAs (e.g., NW vendors).  The PAE varies with the transmitted power in the non-saturated working range of the PA. Only when in saturation (impacting both gain and impairment introduced by the PA), does the PAE also saturates to a near constant. For simplicity, a nominal PAE value can be taken for full frequency resource utilization and nominal PSD.  Given above discussion, we prefer to go with updated Alt.3   * + **Alt 3: The power consumption of DL transmission for a frequency resource utilization x and a power domain parameter is (1-x)\*P3 + x\*(a + (1-a)\*)\*P4**     - x is resource usage, in percentage     - a < 1, e.g., a = [0.3]     - **P3** and **P4** are relative power values of micro sleep and active DL transmission, respectively     - is function of frequency resource utilization and power domain parameter |

For active UL, since PA is not concerned, the scaling approach may be simplified as below, with “**Additional notes applicable for all alternatives**” applied as well.

**Proposal 2.2-2**

* **The BS power consumption for active UL is provided by**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | We need to discuss the UL power scaling similar to DL power scaling. |
| ZTE, Sanechips | Compared with DL transmission, the power consumption of UL reception is very low. Since the PA can be muted when there is no DL transmission, the scaling rule/factor for UL is different from DL |
| Samsung | We are okay with FL’s proposal with minor updates to align with BS power consumption for DL.  **Rev Proposal 2.2-2**   * **The BS power consumption for active UL is provided by**   Regarding the **,** it can be equal to for active DL. |
| Intel | Support the proposal, assuming time domain, carrier domain scaling is not considered above. |
| LG Electronics | After the details of DL scaling are defined, BS power consumption for active UL can be similarly discussed. |
| OPPO | OK |
| DOCOMO | It would be better to discuss BS power consumption for active UL based on the outcome from that of DL. |
| Ericsson1 | Similar comment as DL. Our preference is as follows.  P\_UL (for FR1 TDD) = P5 \* ( [0.8] + [0.2] \* sf) \* ([0.4] + [0.6]\*sa)   * , is the percentage of active TRxRUs and resource usage in frequency domain, respectively. |
| Qualcomm1 | Our reference for scaling power consumption of uplink reception P5 in terms of frequency resource utilization and antenna as follows:  P(sf, sa) = P5 \* ( [0.8] + [0.2] \* sf) \* ([0.1] + [0.9]\*sa)   * , is the percentage of active TRxRUs and frequency domain resource, respectively. |

### Second round for DL

There is clear majority preferring Alt 1 while half-half between alt 1-1 and alt 1-2. As a reading, FL consider to start with Alt 1-1, since it reflects the power domain adaptation explicitly in the formula, and include an attempt for addressing PA efficiency. For further progress, it is important to agree on the values, therefore some tentative values are added with square bracket. Please comment.

For the study, it needs to be clear on what a function is – therefore, both alt 1-1 or alt 3 has the willingness to look into PA efficiency, however are incomplete as the function is missing in details. Some companies commented the value can be fixed in Alt 1-1, which might be also the case for Alt 3 however then it seems lose its most valuable point. For initial evaluations, FL consider we could use a fixed value for now and keep the possibility to further investigate non-linear effect by the function.

Other comments for CA/mTRP can be addressed using a simpler approach.

**Proposal 2.2-1-rev2 ~~1~~**

**At least for FR1 TDD,**

* **the BS power consumption for active DL is provided by**
  + - : a static part of which the power is not scaled based on reference configurations. Value is to be determined based on
      * Category 1: [55] ~~[5.5]~~
      * Category 2: [5.5] ~~[55]~~
    - : a dynamic part of the power that is scaled based on reference configurations based on **+** , where
      * + is

Category 1: [95] ~~[9.5]~~

Category 2: [9.5] ~~[95]~~

* + - * + is

Category 1: [65] ~~[8.5]~~

Category 2: [8.5] ~~[65]~~

* + - * + is the PA efficiency

For initial evaluations,

FFS whether/how to use a non-linear function to derive the value.

* + - * + , , is the percentage of active TRxRUs, resource usage ratio in frequency domain and ratio of simulated total DL power level ~~PSD~~ between this transmission and reference configuration
* **FFS: the BS power consumption for active UL is provided by**
* **Notes,**
  + In time domain,
    - when slot level model is provided, a time domain scaling factor is linearly applied on , if applicable, or on ***P***, according to
      * **(1-alpha)\*P3 + alpha\*P4** where alpha represents the number of active DL symbols within a slot
      * The symbol without active DL is to be treated as micro sleep.
      * Companies to describe how to scale for symbols with different frequency domain allocations.
    - If an explicit symbol level model is provided, scaling is not applied
    - (Already agreed) system simulation evaluations can be per slot regardless of detailed approach for calculating symbol-level power consumption
  + In frequency domain, for at least inter-band CA, the total power consumption of BS is calculated as the sum of the power consumption of each cell
  + In spatial domain, for M-TRP at least with separate RF chains, the total power consumption of BS is assumed as the sum of the power consumption of each TRP.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG Electronics | We have three comments on the below bullets.   * + - : a dynamic part of the power that is scaled based on reference configurations based on **+** , where       * + is   Category 1: [9.5]  Category 2: [95]   * + - * + is   Category 1: [8.5]  Category 2: [65]   * + - * + is the PA efficiency   For initial evaluations,  Firstly, Category 1 and 2 above should be reversed. Because ***Pdynamic*** is eventually P4-P3, which is 225 (=280-55) for Cat 1, and 26.5 (=32-5.5) for Cat 2. More specifically, the equation ***Pdynamic*** = 1\* + 1\*1/0.5\* should be satisfied when the other scaling factor is 1 and the eta value is 0.5 (i.e., ).  Secondly, if the eta value is less than 0.5, the formula may be problematic because when the eta value is less than 0.5 and all of the scaling factors are equal to 1, ***Pdynamic*** becomes greater than P4-P3. Therefore, it should be noted that if eta value assumed to be less than 0.5, and need to be adjust accordingly.  Lastly, in the case of CA, there is a "In frequency domain, for CA, the total power consumption of BS is calculated as the sum of the power consumption of each cell" bullet, which is OK for simplicity, but simple summation may not be applicable in the intra-band CA. |
| Nokia/Nsb | Just double check of our understanding, shall we have the Category 1 and Category 2 in **Proposal 2.2-1-rev1** to be align with the Category 1 and Category 2 in **Proposal 2.1.3-1-rev1?** It seems it needs to be swapped to be aligned?  And we agree with the proposed BS power consumption for active DL P such aswith the following assumptions for FR1:   * : 1,79: a static part of which the power is not scaled based on reference configurations, not obtained from P3 nor P4 values. * : a dynamic part of the power that is scaled based on reference configurations based on **+** , where   + - is 1,62     - is 10,6     - is the PA efficiency       * For initial evaluations,     - , , is the percentage of active TRxRUs, resource usage ratio in frequency domain and ratio of PSD between this transmission and reference configuration   for the scaling in time domain, we propose this formula: **(1-alpha)\*P3 + alpha\*P4** where alpha represents the number of active DL symbols within a slot.  For the scaling in frequency domain (CA), the total power consumption of BS is assumed as the sum of the power consumption of each cell, if separate RG chains are assumed. Same for the scaling in spatial domain (M-TRP). |
| MediaTek | **REV-Proposal 2.2-1-rev1**  **At least for FR1 TDD,**   * **the BS power consumption for active DL is provided by**   + - : a static part of which the power is not scaled based on reference configurations. Value is to be determined based on       * Category 1: ~~[5.5]~~ [55]       * Category 2: ~~[55]~~ [5.5]       * [MTK] align with the agreement. Cal 1 = 55 for Micro sleep.     - : a dynamic part of the power that is scaled based on reference configurations based on **+** , where       * + is   Category 1: ~~[9.5]~~ [95]  Category 2: ~~[95]~~ [9.5]   * + - * + is   Category 1: ~~[8.5]~~ [65]  Category 2: ~~[65]~~ [8.5]   * + - * + is the PA efficiency   For initial evaluations,  FFS whether/how to use a non-linear function to derive the value.   * + - * + , , is the percentage of active TRxRUs, resource usage ratio in frequency domain and ratio of ~~PSD~~ simulated total DL power level between this transmission and reference configuration         + [MTK] there is no PSD in the agreed reference configuration, only total DL power level. Since the total DL power is given in dB, the ratio can be , for X = 0, …, 55. * **FFS: the BS power consumption for active UL is provided by** * **Notes,**   + In time domain,     - when slot level model is provided, a time domain scaling factor is linearly applied on ~~, if applicable, or on~~ ***~~P~~***, according to the number of active symbols within a slot. The symbol without active DL is to be treated as micro sleep. Companies to describe how to scale for symbols with different frequency domain allocations.     - [MTK] To evaluate 4 symbols, it can be alt#1) 4/14\* + ; or alt#2) 4/14\*P + 10/14\*P3 (micro sleep). We prefer keeping alt#1 only for simplicity.     - If an explicit symbol level model is provided, scaling is not applied     - (Already agreed) system simulation evaluations can be per slot regardless of detailed approach for calculating symbol-level power consumption   + In frequency domain, for CA, the total power consumption of BS is calculated as the sum of the power consumption of each cell   In spatial domain, for M-TRP, the total power consumption of BS is assumed as the sum of the power consumption of each TRP. |
| FL | Thanks for spotting this.  Values for Cat 1 and Cat 2 are swapped for now without update. Need to look at more input for determination.  LGE is correct that the formula needs to meeting the P4 when all scaling factor=1, which seems correct based on my current values. The PAE value could be a problematic, which is the reason we have an FFS whether/how to use a non-linear function to derive the value.  Suggestions from MTK on scaling factor in power domain is reflected, and that for time domain can be also addressed with update, I think. |
| vivo | We are generally fine with the direction of the proposal.  Still one clarification on : Is the PSD defined per TxRU or per node? There may be the following two interpretations:  **Interpretation 1**: is the ratio of PSD per TxRU (i.e. Total DL power/(Number of TxRUs \* Syst BW)) between this transmission and reference configuration;  **Interpretation 2:**  is the ratio of PSD per Node (i.e. Total DL power/ Syst BW) between this transmission and reference configuration.  As we understand, is the part for per PA power consumption adjustment since is multiplied. Then **Interpretation 1** is more reasonable for this formula.  If is updated as ratio of total DL power as MTK indicates, we don’t think and is needed in the second part. It should be   * + - : a dynamic part of the power that is scaled based on reference configurations based on **+** , where |
| ZTE, Sanechips | We are generally okay with the FL proposals.  For the time domain scaling, “(1-alpha)\*P3 + alpha\*P4” is actually equivalent to “ + alpha\*”, and it alpha is the ratio of the number of active DL symbols within a slot to the number of symbols within a slot (i.e., 14)   * + - when slot level model is provided, a time domain scaling factor is linearly applied on , if applicable, or on ***P***, according to       * **(1-alpha)\*P3 + alpha\*P4** where alpha represents the ratio of the number of active DL symbols within a slot to the number of symbols within a slot       * The symbol without active DL is to be treated as micro sleep.       * Companies to describe how to scale for symbols with different frequency domain allocations. |
| CATT | We don’t agree with the proposal.  First, the static part would be different for different scaling. For example, the scaling in time domain when only fraction of symbols transmitted within the slot has the static component is the micro sleep. When the scaling in frequency domain (CA), the static component is the fraction of the active transmission of single cell, e.g., 0.4\*280.  For dynamic component, we don’t agree to have the formula for joint scaling among different component before the scaling for each domain is agreed. In addition, the PAE (power amplifier added efficiency) changes with the Tx power level and is not a single value. We don’t think the current formula is accurate or correct. |
| Huawei, HiSilicon | We are generally fine with it with the following updates on the numbers considering the power consumption due to PA is usually at least 60%.   * + - : a dynamic part of the power that is scaled based on reference configurations based on **+** , where       * + is   Category 1: [~~95~~57] ~~[9.5]~~  Category 2: [~~9.5~~7.3] ~~[95]~~   * + - * + is   Category 1: [~~65~~84] ~~[8.5]~~  Category 2: [~~8.5~~9.6] ~~[65]~~   * + - * + is the PA efficiency   For initial evaluations,  FFS whether/how to use a non-linear function to derive the value.   * + - * + , , is the percentage of active TRxRUs, resource usage ratio in frequency domain and ratio of simulated total DL power level ~~PSD~~ between this transmission and reference configuration |
| Intel | For sake of progress, we are OK to have structure as follows  with following revision  If we want to average across companies, we think 110 which is 50% of 225 (i.e., P4 – P3) is more reasonable for  **.** Moreover, we suggest to keep same as **.** Companies can report values of , and default value be set to 1.   * + - is 110 for Cat 1, 13.25 for Cat 2     - is 110 for Cat 1, 13.25 for Cat 2     - is the PA efficiency. Default value is 1       * Companies report if different value is used   Although the formula (1-alpha)\*P3 + alpha\*P4, where alpha represents the number of active DL symbols within a slot, results in same value, we could consider representation in terms of Pstatic and Pdynamic, such as Pstatic + alpha\*Pdynamic .  For intra-band CA, we think scaling factor is needed. |
| Qualcomm2 | We don’t support the proposal  **Our alternative proposal:**  The power consumption of DL transmission in frequency, power and antenna domain is provided by  = (1-) +   * P3 and P4 are relative power values of micro sleep and active DL transmission, respectively   + - is the resource usage ratio in frequency domain (percentage)     - is the ratio of PSD (in dB) between the DL transmission and reference configuration     - is percentage of active TRxRUs.     - when = 1     - α and are provided in the below table  |  |  |  | | --- | --- | --- | | Parameters | FR1 | FR2 | |  | [31%] | [8%] | |  | [0.86] | [0.24] | |  | [0.025] | [0.01] | |

### 3rd round

FL consider we had good discussion and relatively deep understanding of each other proposal. There are clear merits and drawbacks for the original Alt 2 - it is simple but not accurate. The static part does not really need to change per domain as in the end each alt will have one static part; and the dynamic part for Alt 2 does not consider joint scaling or consider each domain in independent way which seems lack of accuracy. Therefore if we could go with a number of values for Alt 1-1, from FL perspective, not see other merits that Alt 2 holds and not clear why need to first agree on scaling for each domain.

For Alt 1-1 the values and other comments (PSD, time domain, CA etc), they are addressed as below. The numbers can be picked up in future discussion.

We understand QC does not like alts. But to FL, there is no other support for Alt 3 either, especially when it comes into details, and it is, as explained from the beginning, preferred to be clarified whether other Alts can be sufficient as a tradeoff between simplicity and accuracy. This may also require RAN4 expertise but we are probably lack of time.

FL consideration is below:

**Option 1: take revised-Alt 1 as Working Assumption, and add explicit discussion point for further discussion of Alt 3 in the next meeting.**

**Option 2: Take revised-Alt 1 as baseline scaling method, and Alt 3 can be optionally considered and reported with justified accuracy.**

**Option 3: down select from revised-Alt 1 and Alt 3 next meeting.**

**Revised Alt 1-update:**

**At least for FR1 TDD,**

* **the BS power consumption for active DL is provided by**
  + - : a static part of which the power is not scaled based on reference configurations. Value is to be determined based on
      * Category 1: [55]
      * Category 2: [5.5, 1.79]
    - : a dynamic part of the power that is scaled based on reference configurations based on , where
      * + is

Category 1: [0, 57, 110]

Category 2: [0, 7.3, 1.62]

* + - * + is

Category 1: [225, 84, 115]

Category 2: [26.5, 9.6, 10.6]

* + - * + is the PA efficiency

For initial evaluations, ,

The and should be reported along with , which may not be perfectly the candidate values in the current list

FFS whether/how to use a non-linear function to represent .

* + - * + , , is the percentage of active TRxRUs, resource usage ratio in frequency domain and the ratio of PSD per TxRU between the DL transmission and reference configuration, respectively.

*For information:In frequency domain, the PSD per TxRU is assumed as the average DL power in watts per Hz for a given total DL power and the DL TXRUs provided in the reference configuration. For example, the set 1 has total DL power of 55dBm = 316W for 100 MHz and 64 TXRUs, and PSD per TxRU can be determined by -23dBm = 5 µW per Hz.*

* **FFS: the BS power consumption for active UL is provided by**

**Alt 3**

The power consumption of DL transmission in frequency, power and antenna domain is provided by

= (1-) +

* P3 and P4 are relative power values of micro sleep and active DL transmission, respectively
  + - is the resource usage ratio in frequency domain (percentage)
    - is the ratio of PSD (in dB) between the DL transmission and reference configuration
    - is percentage of active TRxRUs.
    - when = 1
    - α and are provided in the below table

|  |  |  |
| --- | --- | --- |
| Parameters | FR1 | FR2 |
|  | [31%] | [8%] |
|  | [0.86] | [0.24] |
|  | [0.025] | [0.01] |

* **Notes,**
  + In time domain,
    - when slot level model is provided, a time domain scaling factor is linearly applied on , if applicable, or on ***P***, according to
      * **(1-alpha)\*P3 + alpha\*P4** where alpha represents the ratio of the number of active DL symbols within a slot to the number of symbols within a slot
      * The symbol without active DL is to be treated as micro sleep.
      * Companies to describe how to scale for symbols with different frequency domain allocations.
    - If an explicit symbol level model is provided, scaling is not applied
    - (Already agreed) system simulation evaluations can be per slot regardless of detailed approach for calculating symbol-level power consumption
  + In frequency domain, for at least inter-band CA, the total power consumption of BS is calculated as the sum of the power consumption of each cell
    - For intra-band CA, a scaling factor of [0.75] is assumed on
  + In spatial domain, for M-TRP at least with separate RF chains, the total power consumption of BS is assumed as the sum of the power consumption of each TRP.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | We support Option 2. Revised Alt-1 is already inclusive and broad enough to include different implementations and proposals. We suggest minor correction so that  **=** 110 and  **=** 115 equals to 225 which is total value of (P4 – P3). Vice versa is also OK, i.e.,  **=** 115 and  **=** 110. This is just to ensure that when all scaling factors are 1, the sum equals to P4 -P3.  is  Category 1: [57, 110]  Category 2: [7.3]   * + - * + is   Category 1: [84, ~~110~~ 115]  Category 2: [9.6] |
| CATT | We don’t agree.  We have raised the concern on the technical issue on either Revised Alt 1 or alt 3. |
| LG Electronics | We are generally fine with this proposal, but have several comments/questions for clarifications.   * We agree with Intel that adjustment for and for Cat 1 as well as for Cat 2 is needed since PA efficiency could be 0.5 or 1. * As MediaTek and Huawei suggested, for the definition of , PSD can be changed to simulated total DL power level. In addition, its unit needs to be clarified between dB and linear scale. We have similar comments also for the definition of in Alt-3. For example,   + - * + , , is the percentage of active TRxRUs, resource usage ratio in frequency domain and the ratio of simulated total DL power level (in linear scale) per TxRU between the DL transmission and reference configuration, respectively. * For intra-band CA case, scaling can be applied but it seems unclear whether the scaling factor of 0.75 is applied to or . For example,   + In frequency domain, for at least inter-band CA, the total power consumption of BS is calculated as the sum of the power consumption of each cell     - For intra-band CA, a scaling factor of [0.75] is applied on |
| Samsung | We think the **Revised Alt 1** seems more reasonable for the scaling of BS power consumption, so we slightly prefer **Option 1** because the Revised Alt 1 seems necessary to be further discussed in the next meeting. Even if we still consider the **Alt 1-2 ()** is more straightforward way for in the previous proposal, but to open the discussion for power domain adaptation, we can compromise the scaling including PAE and . However, for , we don’t think is necessary, but it could be further discussed for the details of , if needed. The impact of and on power consumption would be entangled at PA aspects. Furthermore, we would like to further clarify the values, for initial evaluation, we think it seems reasonable to be Category 1: [225] Category 2: [26.5] based on (). Therefore, to simplify the evaluation and reflect practical network appropriately, we suggest the following revised proposal as below:  Regarding the PAE, we think seems too high. We would like to add as PAE.  Others seems fine with us for initial evaluation  **Revised Alt 1:**  **At least for FR1 TDD,**   * **the BS power consumption for active DL is provided by**   + - : a static part of which the power is not scaled based on reference configurations. Value is to be determined based on       * Category 1: [55]       * Category 2: [5.5]     - : a dynamic part of the power that is scaled based on reference configurations based on , where       * + ~~is~~   ~~Category 1: [57, 110]~~  ~~Category 2: [7.3]~~   * + - * + is   Category 1: [84, 110, 225]  Category 2: [9.6, 26.5]   * + - * + is the PA efficiency   For initial evaluations, ,  other values can be reported  FFS whether/how to use a non-linear function to represent .   * + - * + , , is the percentage of active TRxRUs, resource usage ratio in frequency domain and ratio of simulated DL power level per TxRU between the DL transmission and reference configuration. * **FFS: the BS power consumption for active UL is provided by**   **Alt 3**  The power consumption of DL transmission in frequency, power and antenna domain is provided by  = (1-) +   * P3 and P4 are relative power values of micro sleep and active DL transmission, respectively   + - is the resource usage ratio in frequency domain (percentage)     - is the ratio of PSD (in dB) between the DL transmission and reference configuration     - is percentage of active TRxRUs.     - when = 1     - α and are provided in the below table  |  |  |  | | --- | --- | --- | | Parameters | FR1 | FR2 | |  | [31%] | [8%] | |  | [0.86] | [0.24] | |  | [0.025] | [0.01] |  * **Notes,**   + In time domain,     - when slot level model is provided, a time domain scaling factor is linearly applied on , if applicable, or on ***P***, according to       * **(1-alpha)\*P3 + alpha\*P4** where alpha represents the ratio of the number of active DL symbols within a slot to the number of symbols within a slot       * The symbol without active DL is to be treated as micro sleep.       * Companies to describe how to scale for symbols with different frequency domain allocations.     - If an explicit symbol level model is provided, scaling is not applied     - (Already agreed) system simulation evaluations can be per slot regardless of detailed approach for calculating symbol-level power consumption   + In frequency domain, for at least inter-band CA, the total power consumption of BS is calculated as the sum of the power consumption of each cell     - For intra-band CA, a scaling factor of [0.75] is assumed   + In spatial domain, for M-TRP at least with separate RF chains, the total power consumption of BS is assumed as the sum of the power consumption of each TRP. |
| FL | To LGE:   * It seems more proper to take the interpretation 1 as vivo commented in the last round, since antenna domain needs to be scaled additional to PA aspect. Therefore it is clarified as per TxRU. * For intra band-CC, since the idea is to consider shared RF, the static part is not expected to be changed. Therefore, scaling is applied on P\_dynamic.   To Samsung:   * One of the intention of Alt 1 is to consider joint scaling of spatial domain with power domain, thus thank you for your open and flexible. On the other hand, my understanding is that spatial domain/RF chain requires part of power consumption not completely coupled with power domain. For example, in the UL part, when there is no PA, the power can be scaled with spatial domain independently. So is still needed. * To address your concern, FL consider it can be included by adding 0 value for without removing this component at this moment. * Note PAE=0.6 is my typo in the initial version and is revised back to 0.5 |
| vivo | We support Option 1 or Option 2 in general.  For **Revised Alt 1-update**, we have the following comments:   * + - 1. We are not OK to change the definition of only. If a transmission occupy half the frequency domain resource and PSD is not changed, =1/2 and =1/2 if is the ratio of simulated DL power per TxRU between the DL transmission and reference configuration. In this case, will be scaled by 1/2\*1/2=1/4 following current formula. We think this is not reasonable. There could be two solutions to handle this:   Solution 1: is the ratio of PSD per TxRU between the DL transmission and reference configuration and the formula is  Solution 2: is the ratio of simulated DL power per TxRU between the DL transmission and reference configuration and the formula is updated by deleting as   * + - 1. For selection of the value of  **and ,** it should be guaranteed that the total power consumption value is P4 when =1. However, it is not the case since value is not decided. In our understanding, candidate values of  **and** should be listed per different value. Since the value is in bracket, we can live with it in current version. |
| MediaTek | Support Option 2: Take Revised-Alt 1 as baseline scaling method, Alt 3 can be optionally considered and reported with justified accuracy.  For power domain, we agree with vivo that using simulated total DL power level is misleading. We are okay to use PSD per TxRU if the definition of PSD can be provided clearly.   * + , , is the percentage of active TRxRUs, resource usage ratio in frequency domain and the ratio of ~~simulated DL power~~ PSD per TxRU between the DL transmission and reference configuration, respectively.   + Note: In frequency domain, the PSD per TxRU is assumed as the average DL power in watts per Hz for a given total DL power and the DL TXRUs provided in the reference configuration. For example, the set 1 has total DL power of 55dBm = 316W for 100 MHz and 64 TXRUs, and PSD per TxRU can be determined by -23dBm = 5 µW per Hz.   + [MTK] it is unclear to us how to calculate PSD per TxRU. We suggest adding a note if possible. |
| Nokia/Nsb | We support option 2. We prefer to take **revised-Alt 1 as baseline scaling method with the following proposed coefficient.**  **At least for FR1 TDD,**   * **the BS power consumption for active DL is provided by**   + - : a static part of which the power is not scaled based on reference configurations. Value is to be determined based on       * Category 1: [55]       * Category 2: [5.5]       * [Nokia/Nsb]: We propose Category 2: [1.79], where the static power should be fixed regardless of the reference configurations and the BS sleep state. Therefore, it should not be equal to micro-sleep power consumption.     - : a dynamic part of the power that is scaled based on reference configurations based on , where       * + is   Category 1: [57, 110]  Category 2: [7.3]  [Nokia/Nsb]: Category 2: [1.62]   * + - * + is   Category 1: [84, 110]  Category 2: [9.6]  [Nokia/Nsb]: Category 2: [10,6]   * + - * + is the PA efficiency   For initial evaluations, a fixed PA efficiency factor is assumed ,  other values can be reported  [Nokia/Nsb]: 0,35 PA efficiency factor could be assumed as starting point.  FFS whether/how to use a non-linear function to represent .   * + - * + , , is the percentage of active TRxRUs, resource usage ratio in frequency domain and ratio of simulated DL power level per TxRU between the DL transmission and reference configuration. |
| ZTE, Sanechips | We agree with vivo that the value, and are coupled, therefore, value should be reported along with and . For the two values in Category 1, they correspond to =0.5, and 1, respectively. And for Category 1, the and corresponds to =0.5.  And if other value can be reported by companies, the and should be clarified as well.   * + - : a dynamic part of the power that is scaled based on reference configurations based on , where       * + is   Category 1: [57, 110]  Category 2: [7.3]   * + - * + is   Category 1: [84, 110]  Category 2: [9.6]   * + - * + is the PA efficiency   For initial evaluations, ,  ~~other values can be reported~~  For other values assumed in evaluation, if any, the and should be reported.  FFS whether/how to use a non-linear function to represent .  For definition,we think it should be the ratio between the PSD in the simulation and reference configuration. Also, the limitation that “per TxRU” should be removed.  For example, if the TxRU number is reduced by half, the simulated total DL power level is also reduced to an half, which has impact on .   * + - * + , , is the percentage of active TRxRUs, resource usage ratio in frequency domain and the ratio ~~of simulated DL power per TxRU~~ between the PSD in simulation and reference configuration, respectively. |
| FL | See update, including   * PSD explanation * New candidate values from Nokia (new values for PAE of 0.35 is not taken, since 0.34 is already there) * A sub-bullet to explain that the candidate values are somewhat associated, thus may not perfectly be one of the current candidate values. This is along with ZTE suggested and somewhat address vivo comments. |
| ZTE, Sanechips | One clarification question to FL.  For the following definition of PSD per TxRU, does the following highlight part refer to number of active TxRUs, or number of TxRU in reference configuration？For example, if the number of  **Interpretation 1**: is the ratio of PSD per TxRU (i.e. Total DL power/(Number of TxRUs \* Syst BW)) between this transmission and reference configuration.  For the scaling factors,we prefer to keep the candidate set minimal to make sure the results from different companies are comparable. Otherwise, the point to discuss power consumption model/scaling factors are diminished.  However, if companies would like to list their preferred values in the proposal. We prefer to list our values as well.   * + - * :         + Category 2: [5.5]       * is         + Category 2: [12.5]       * is         + Category 2: [7]       * is the PA efficiency         + =0.5 |
| Ericsson3 | Considering the status of the discussion, we do not think the listed alternatives are suited for down-selection. We are OK to continue the discussion and finalize in the next meeting. |
| CATT | For the sake of progress, we could accept the feature lead’s Alt1 update with different values. We could not agree on the proposal of Alt 3.  The static component of the power scaling should include the power consumption of all static components in time, frequency, spatial, and power domain. The static component of DL active transmission in time domain should also includes the common processing cross-symbols, such as channel encoding, network control function, and data processor. Thus, the static component of network energy consumption should include the power consumption of cross-symbol component distributed to each symbol. Thus, the static component for active DL should have the power consumption of micro sleep and cross-symbol processing, network control function, and data processing.  The static component of frequency and power domain for each antenna could be included in  The PAE (power added efficiency) of power amplifier (PA) is not a linear function of PA power consumption and affected by different temperature. The PAE varies in input power. It is not straight forward to model the effect of PAE in the power scaling. Thus, it would be simple to have the value of  as 1 as the starting point. However, we could accept the average value of 0.34 for PA efficiency. If the PA efficiency is 0.34, the value of needs to be divided by 3.  For frequency domain power scaling, the power consumption scaling is due to the reduction of RF BW and not the fraction of resource blocks used within the system RF BW. The value should be defined as the ratio of RF BW and maximum system BW.  Our suggestions of modifications in “blue” are as follows  **At least for FR1 TDD,**   * **the BS power consumption for active DL is provided by**   + - : a static part of which the power is not scaled based on reference configurations. Value is to be determined based on       * Category 1: [55, 140]       * Category 2: [5.5, 1.79, 16]     - : a dynamic part of the power that is scaled based on reference configurations based on , where       * + is   Category 1: [0, 57, 110]  Category 2: [0, 7.3, 1.62, 12]   * + - * + is   Category 1: [225, 84, 115, 30]  Category 2: [26.5, 9.6, 10.6, 4]   * + - * + is the PA efficiency   For initial evaluations, ,  The and should be reported along with , which may not be perfectly the candidate values in the current list  FFS whether/how to use a non-linear function to represent .   * + - * + , , is the percentage of active TRxRUs, ~~resource usage ratio~~ the radio of RF bandwidth and maximum system BW in frequency domain and the ratio of PSD per TxRU between the DL transmission and reference configuration, respectively.   *For information:In frequency domain, the PSD per TxRU is assumed as the average DL power in watts per Hz for a given total DL power and the DL TXRUs provided in the reference configuration. For example, the set 1 has total DL power of 55dBm = 316W for 100 MHz and 64 TXRUs, and PSD per TxRU can be determined by -23dBm = 5 µW per Hz.*   * **FFS: the BS power consumption for active UL is provided by** |

# Methodology

## KPI

For UPT loss and latency requirements, the metrics are “one or more”. Therefore not mandating to report all cases. Depending on techniques and affected channels, coverage may not be a common KPI that should be pursued, however could be an interest for those affecting common signals. The following is suggested.

**Proposal 3.1-1:**

* **In the energy saving gain evaluation, along with the reported load and evaluated technique(s), one or more of the following UPT (loss) ranges are considered**
  + **Less than 5%, less than 25%, less than 50% or average UPT**
* **In the energy saving gain evaluation, along with the reported load and evaluated technique(s), one of more of the following latency type can be optionally considered**
  + **User plane latency,** **calculated as the delay between the time when a packet arrivals and the time when the packet is decoded for the service performance**
  + **Scheduling latency,** **calculated as the delay between the time when a packet arrivals and the time when the packet is scheduled**
  + **Other latency e.g. (de-)activation of spatial element**
* **Coverage can be optionally reported**
* **EE (energy efficiency) and other metrics can be optionally considered with clarified definition, if reported.**
* **Note for potential new channel/signals, e.g. WUS from UE, the assumption for detection reliability at BS side is reported (performance and complexity impact would subject to results and further discussion).**

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| **Company** | **Comments** |
| CATT | We are generally fined with the proposal. The UPT loss/gain would depend on the network energy saving techniques and their associated power saving gain. We need to look at the values of UPT loss and network power saving gain in bundle. |
| ZTE, Sanechips | Okay. |
| Samsung | From our perspective, at least user plane latency should be prioritized same as UPT. In addition, for user plane latency, the actual value is more of interest compared with percentage increase. The percentage increase doesn’t matter as long as the user plane latency requirement is satisfied. Considering both UPT and latency are evaluated for UE PS, same rule should apply here. Therefore, we suggest to further investigate scheduling latency used in UE PS for evaluating NWES techniques properly. We suggest the following revised proposal as below:  **Rev Proposal 3.1-1:**   * **In the energy saving gain evaluation, along with the reported load and evaluated technique(s), one or more of the following UPT (loss) ranges or User plane latency ranges are considered**   + **Less than 5%, less than 25%, less than 50% or average UPT**   + **FFS Details of user plane latency requirement, e.g. less than 10 ms or less than 20 ms target user plane latency.** * **In the energy saving gain evaluation, along with the reported load and evaluated technique(s), ~~one of more of~~ the following latency type can be optionally considered**   + **~~User plane latency,~~****~~calculated as the delay between the time when a packet arrivals and the time when the packet is decoded for the service performance~~**   + **Scheduling latency,** **calculated as the delay between the time when a packet arrivals and the time when the packet is scheduled**   + **Other latency e.g. (de-)activation of spatial element** * **Coverage can be optionally reported** * **EE (energy efficiency) and other metrics can be optionally considered with clarified definition, if reported.** * **Note for potential new channel/signals, e.g. WUS from UE, the assumption for detection reliability at BS side is reported (performance and complexity impact would subject to results and further discussion).** |
| Intel | We are fine in principle. We think UPT and energy saving gain are observed together. We suggest to report to observed UPT values for the different network configurations assumed, along with energy saving gain. Note that access delay was also listed among the options in RAN1 # 109 agreement. We suggest including it and to be reported when applicable.  It would be good if “coverage” as a metric can be clarified. Is coverage defined as number of UEs in outage, where outage is defined by certain SINR/geometry threshold? Or is coverage defined by maximum distance to the attached UE in the evaluation? Or is it defined by counting number of UEs with certain amount of loss in traffic (e.g. due to excessive delay)? Or something else? It not immediately clear, how “coverage” as a metric will be provided by the companies. If companies can provide an explicit formula, that would be great. |
| LG Electronics | We are OK with the revised proposal from Samsung except for the description of scheduling latency. Based on our understanding, we suggest the following modification as below:   * **In the energy saving gain evaluation, along with the reported load and evaluated technique(s), ~~one of more of~~ the following latency type can be optionally considered**   + **~~User plane latency,~~****~~calculated as the delay between the time when a packet arrivals and the time when the packet is decoded for the service performance~~**   + **Scheduling latency,** **calculated as the delay between the time when a first packet arrivals and the time when the packet is scheduled**   + **Other latency e.g. (de-)activation of spatial element** |
| OPPO | **OK** |
| Vivo | We agree that UPT loss is considered along with energy saving gain. However, we don’t quite understand the intention of exact value for UPT loss here. We think it is challenging for system-level evaluation to align the UPT loss to an exact value. In our view, company could report UPT loss and energy saving gain for the evaluated techniques freely. |
| DOCOMO | We are fine with the proposal. |
| Huawei, HiSilicon | We think the coverage metric should be reported. Actually, the loss of 5% UPT can reflect the coverage performance degradation in certain level. |
| Ericsson1 | 1st bullet : For UPT loss, we think proponent can directly report UPT loss and we do not understand the motivation for agreeing to a range of values.  2nd bullet : For antenna adaptation, our preference is to agree to a value than leaving it for optional consideration.  For optional KPIs, our view is proponent can directly explain details along with evaluations rather than RAN1 making agreement. |
| Qualcomm1 | We don’t think we need 2nd – 5th bullets since we already had RAN1#109e agreements to report NES gain and UPT. Other metrics are optional.  Agreement  For BS energy consumption evaluation, in addition to the energy saving gain,   * At least UPT/UE power consumption/access delay/latency should be considered for performance impact evaluation * Note: this doesn’t necessarily mean that all the above are considered for all evaluation results. However, multiple KPIs are expected to be evaluated for a given technique. And this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios.   For the first bullet, we can update it as follows:   * **In the energy saving gain evaluation, along with the reported load and evaluated technique(s), the UPT comparison is based on 5%tile and 50%tile.** |

### Second round

In general, UPT and latency is KPI in addition to the energy saving gain. Thus it is assumed, if reported, to be reported together with saving gain. This can be clarified and seems to be aligned with companies understanding.

For UPT loss ranges or latency ranges, one or two proponents consider it is good to set some requirement/QoS target, while the other intention, from FL perspective, is to set several ranges which can make it easier for sorting the results later on, instead of taking each UPT loss/latency value on the table for a single observation. Considering the second intention can also be done when more results are available and the primary goal for now is to make agreements for performing evaluations, we could consider to set requirements next time, if other companies are convinced about the need.

Note as one company mentioned some KPIs are already agreed in the last meeting, and others are not precluded(“this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios”), this proposal is not intended to extend the common KPI list, and for any other KPIs, just to optionally report them is fine.

**Proposal 3.1-1-rev1:**

* **In the evaluation, at least UPT (loss) or User plane latency can be reported together with energy saving gain**
  + **FFS whether to set exact requirements/QoS target for drawing observations**
* **Other KPIs can be optionally reported, conditioned with clear definition/descriptions provided**
* **Note for potential new channel/signals, e.g. WUS from UE, the assumption for detection reliability at BS side is reported (performance and complexity impact would subject to results and further discussion).**

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| **Company** | | **Comments** |
| LG Electronics | | We are OK with the proposal. |
| Nokia/Nsb | | As we have raised in several rounds, the latency for (de-)activation of spatial elements is an important factor needs to be carefully considered during the performance evaluation, especially for adaptation of antenna port techniques. Thus, we had the following rewording proposals to capture this issue:  **Proposal 3.1-1-rev1:**   * **In the evaluation, at least UPT (loss), ~~or~~ User plane latency, latency for (de-)activation of spatial element, can be reported together with energy saving gain**   + **FFS whether to set exact requirements/QoS target for drawing observations** * **Other KPIs can be optionally reported, conditioned with clear definition/descriptions provided** * **Note for potential new channel/signals, e.g. WUS from UE, the assumption for detection reliability at BS side is reported (performance and complexity impact would subject to results and further discussion).** |
| MediaTek | | **Rev-Proposal 3.1-1-rev1:**   * **In the evaluation, at least UPT (loss) or User plane latency can be reported together with energy saving gain**   + **FFS whether to set exact requirements/QoS target for drawing observations** * **~~Other KPIs can be optionally reported, conditioned with clear definition/descriptions provided~~** * [MTK] the agreement in RAN1#109-e seems sufficient. * **Note for potential new channel/signals, e.g. WUS from UE, the assumption for detection reliability at BS side is reported (performance and complexity impact would subject to results and further discussion).**   **Agreement** in RAN1#109-e  For BS energy consumption evaluation, in addition to the energy saving gain,   * At least UPT/UE power consumption/access delay/latency should be considered for performance impact evaluation   Note: this doesn’t necessarily mean that all the above are considered for all evaluation results. However, multiple KPIs are expected to be evaluated for a given technique. And this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios. |
| DOCOMO | | We are fine with the proposal. |
| FL | | Wang to keep the “Other KPI xxx” since it add one point that definition should be provided along with other KPIs. |
| vivo | | We are OK with the proposal |
| ZTE,Sanechips | | 1. We think in the first round discussion, more companies prefer to keep scheduling latency (which is clearer from SLS evaluation perspectives), instead of UP latency. 2. For this following bullets, we prefer to keep it as it is, with more information compared with the agreements in the last meeting, like the condition.  * **Other KPIs can be optionally reported, conditioned with clear definition/descriptions provided** |
| CATT | | UPT/latency, system throughput and UE power saving value should be reported together. UE WUS should also include the procedure how WUS is transmitted. |
| Huawei, HiSilicon | We are OK with the proposal | |
| Intel | OK in principle. We think system impact such as capacity should also be reported, e.g., in terms of avg number of satisfied UEs in a cell, where X => 90% packets are successfully received for a satisfied UE | |
| Qualcomm2 | As we discussed earlier, the user plane latency is already captured in UPT.  In general, we don’t think this proposal is needed given we already had agreements in RAN1#109e quoted in the first round. | |

### 3rd round

To QCOM, as replied previously, there could be some value added by the proposal, e.g. gain and UTP loss is expected to be reported as a bundle, instead of one of them. And other KPI should be reported with clear definitions.

Since there is different view on the priority of individual KPIs, might be good to avoid such discussion by using general terms at this stage. Other KPI/latency type can still be considered. If this is still not agreeable, this proposal will be dropped. Please only indicate if you object this proposal; otherwise no need for input of support.

**Proposal 3.1.2-1:**

* **In the evaluation, at least UPT (loss)/latency impact is expected to be reported together with energy saving gain**
  + **FFS whether to set exact requirements/QoS target for drawing observations.**
* **Other KPIs can be optionally reported, conditioned with clear definition/descriptions provided.**
* **Note for potential new channel/signals, e.g. WUS from UE, the assumption for detection reliability at BS side is reported (performance and complexity impact would subject to results and further discussion).**

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| **Company** | **Comments** |
| Intel | We are OK, but it would only be fair if companies report what is the impact to system when a certain energy saving technique is implemented. For example, system capacity performance can be compared for baseline and proposed technique. System capacity can be evaluated in terms of number of UEs that are satisfied, see comment in previous round. We suggest to keep it at least as optional metric to be reported. |
|  |  |

## C-DRX Configurations

FL consider one of the purpose of implementing UE C-DRX is for UE power saving purpose when evaluating BS energy consumption techniques. It may be a first step to understand what could be the consequence of implementing some BS EnSav techniques while maintaining the same C-DRX configurations as prior study. There are several companies prefer this approach while one company prefers to use different values e.g. shorter DRX inactivity timer. Considering the situation, the proposal is not changed.

**Proposal 3.2 -1:**

**It is up to company report the use of UE C-DRX.**

* **for alignment, the configuration if reported can be**

|  |  |  |  |
| --- | --- | --- | --- |
| **Traffic type** | **FTP** | **IM** | **VoIP** |
| Model | FTP model 3 | FTP model 3 | As defined in R1-070674.  Assume max two packets bundled. |
| Packet size | 0.5 Mbytes | 0.1 Mbytes |
| Mean inter-arrival time | 200 ms | 2 sec |
| DRX Period | 160 ms | 320 ms | 40 ms |
| DRX Inactivity timer | 100 ms | 80 ms | 10 ms |
| On duration | FR1: 8 ms  FR2: 4 ms | FR1: 10 ms  FR2: 5 ms | FR1: 4 ms  FR2: 2 ms |

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | We are OK with the assumption |
| ZTE, Sanechips | Okay. |
| Samsung | As we commented earlier online. For DRX Inactivity timer, the values are too large and not necessary. It only increases the UE power consumption without any benefits. For NWES, gNB should aim for short time transmission to achieve long sleep time. Considering we are focusing on low/medium load scenario, the resource is sufficient. One shot retransmission or up to 1 retransmission would be the typical case. There is no need to configure such large values and require UE to keep monitoring PDCCH for a long time after receiving a new grant.  Although some companies think the same parameter of UE PS should be kept, however, the scenario of UE PS is quite different. The traffic load of a cell could be high for UE PS evaluation. For high traffic load scenario, high code rate with HARQ retransmission would be beneficial for SE, as a result, there can be multiple retransmissions and the time gap between the initial transmission and last retransmission can be large.  Based on the above reason, we suggest to change DRX Inactivity timer to 20ms for FTP and IM. |
| LG Electronics | We are OK with the proposal. |
| OPPO | OK |
| Vivo | We are generally fine with the C-DRX proposal here.  One comment on the traffic type: we still prefer to list a sparse traffic model to facilitate the evaluation for idle UE evaluation, e.g.   |  |  | | --- | --- | | **Traffic mode: Heartbeat** (\*TR38.875) | | | Model | FTP model 3 | | Packet size | 100 Bytes | | Mean inter-arrival time | 60 seconds | |
| DOCOMO | We are fine with the proposal. |
| Huawei, HiSilicon | If it allows company to report whether the C-DRX is utilized, our preference is to follow the assumption in 38.840, i.e. to keep the two options of inactivity timer to allow company to report.     |  |  |  |  | | --- | --- | --- | --- | | **Traffic type** | **FTP** | **IM** | **VoIP** | | Model | FTP model 3 | FTP model 3 | As defined in R1-070674.  Assume max two packets bundled. | | Packet size | 0.5 Mbytes | 0.1 Mbytes | | Mean inter-arrival time | 200 ms | 2 sec | | DRX Period | 160 ms | 320 ms | 40 ms | | DRX Inactivity timer | 100 ms/40ms | 80 ms/200ms | 10 ms/25ms | | On duration | FR1: 8 ms  FR2: 4 ms | FR1: 10 ms  FR2: 5 ms | FR1: 4 ms  FR2: 2 ms | |
| Ericsson1 | OK to use the values for alignment. |
| Qualcomm1 | We are fine with the proposal |

### Second round

It is already agreed that other parameter (e.g. packet size and arrival rate) adjustment to the agreed three models can be optionally considered and reported. Thus perhaps no need to change per vivo comment.

For C-DRX configurations, multiple other options are raised although slightly a majority is ok with the proposal. It is not clear now whether an alignment is needed or not, assuming we won’t want to agree on a set of different values which could significantly increase the workload. For flexibility, the below is suggested; if not agreeable, the whole C-DRX configurations can be up to proponents.

**Proposal 3.2 -1-rev1:**

**It is up to company report the use of UE C-DRX.**

* **the baseline configuration for C-DRX, if reported, can be as below;**
* **Other inactivity timer values can be optionally reported**

|  |  |  |  |
| --- | --- | --- | --- |
| **Traffic type** | **FTP** | **IM** | **VoIP** |
| Model | FTP model 3 | FTP model 3 | As defined in R1-070674.  Assume max two packets bundled. |
| Packet size | 0.5 Mbytes | 0.1 Mbytes |
| Mean inter-arrival time | 200 ms | 2 sec |
| DRX Period | 160 ms | 320 ms | 40 ms |
| DRX Inactivity timer | 100 ms | 80 ms | 10 ms |
| On duration | FR1: 8 ms  FR2: 4 ms | FR1: 10 ms  FR2: 5 ms | FR1: 4 ms  FR2: 2 ms |

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG Electronics | We are OK with the proposal. |
| Nokia/Nsb | OK |
| MediaTek | Okay. It would be better to provide optional values in the table.   |  |  |  |  | | --- | --- | --- | --- | | **Traffic type** | **FTP** | **IM** | **VoIP** | | Model | FTP model 3 | FTP model 3 | As defined in R1-070674.  Assume max two packets bundled. | | Packet size | 0.5 Mbytes | 0.1 Mbytes | | Mean inter-arrival time | 200 ms | 2 sec | | DRX Period | 160 ms | 320 ms | 40 ms | | DRX Inactivity timer | 100 ms  (Optional: 20ms) | 80 ms  (Optional: 20ms) | 10 ms | | On duration | FR1: 8 ms  FR2: 4 ms | FR1: 10 ms  FR2: 5 ms | FR1: 4 ms  FR2: 2 ms | |
| DOCOMO | We are fine with the proposal. |
| FL | As there are other values proposed, either shorter or longer timer, perhaps it is flexible enough as current format. |
| Vivo | We are OK with the proposal |
| ZTE, Sanechips | Okay with the proposal |
| CATT | We are OK with the proposal |
| Huawei, HiSilicon | We are OK with the proposal |
| Intel | OK |

### 3rd round

Same proposal is considered. If this is still not agreeable, this will be dropped. Please only indicate if you object this proposal; otherwise no need for input of support.

**Proposal 3.2.2-1:**

**It is up to company report the use of UE C-DRX.**

* **the baseline configuration for C-DRX, if reported, can be as below;**
* **Other inactivity timer values can be optionally reported**

|  |  |  |  |
| --- | --- | --- | --- |
| **Traffic type** | **FTP** | **IM** | **VoIP** |
| Model | FTP model 3 | FTP model 3 | As defined in R1-070674.  Assume max two packets bundled. |
| Packet size | 0.5 Mbytes | 0.1 Mbytes |
| Mean inter-arrival time | 200 ms | 2 sec |
| DRX Period | 160 ms | 320 ms | 40 ms |
| DRX Inactivity timer | 100 ms | 80 ms | 10 ms |
| On duration | FR1: 8 ms  FR2: 4 ms | FR1: 10 ms  FR2: 5 ms | FR1: 4 ms  FR2: 2 ms |

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson3 | * We prefer to clarify the baseline configuration is only for alignment e.g. **the baseline configuration for C-DRX (for alignment/calibration), if reported, can be as below;** |
|  |  |

## Simulation assumption

There does not seem to be any comment regarding the SLS assumptions after third round. One offline comment is to remove the details about common signal configurations except for SSB periodicity. FL understands that those details seem to be natural based on current specifications. If there is no major concern, they can be kept.

**Proposal 3.3-1:**

* **For FR1, adopt the Reference SLS configurations in Annex-A in R1-2208216 as baseline SLS assumptions.**
  + **Other carrier frequencies can be optionally considered.**
* **For FR2 adopt the Reference SLS configuration used in RP-180524 for IMT-2020 as initial SLS assumption.**
  + **Further adjustment can be discussed in the next meeting.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | We are OK with the proposal |
| ZTE, Sanechips | For FR1 FDD, the frame structure definition is not needed. |
| Samsung | Fine |
| Intel | We are generally OK with the proposal.  We would like to clarify the following for FR1:   1. There are two columns in R1-2208216, we assume TDD column corresponds to Set 1 and FDD column corresponds to set 2 for FR1. It would be good to confirm.   2) The Mp, Np values for TDD FR1 case needs to be clarified. We assume (Mp,Np) = (4,8), but it seems to be missing in R1-2208216.  3) The O2I penetration model should be clarified, whether low-loss or high-loss model is assumed for Uma.  4) We assume ‘3D/HF-Uma’ is referring to ‘Uma mode in 38.901’. It would be good to confirm.  5) We assume traffic model defined in R1-2208216 does not apply, and we use RAN1’s previous agreements on traffic model. It would be good to clarify.  6) We assume the CSI feedback periodicity is not fixed as stated R1-2208216, but companies can provide the details of the CSI feedback assumption. It would be good to clarify, whether CSI feedback should be fixed to every 5 slots or not.  7) We assume common RS section is just for reference and not fixed and ultimately each company are to provide detailed information for the simulation. If so, it would be good to clarify. We assume the gNB can update the SIB1 periodicity to other 20msec without impacting legacy UEs behaviors as this is supported by specification. The UE is still expected to perform monitoring per 20msec, but this is different from gNB sending SIB1 every 20msec. For the SIB1 frequency resource, our suggestion is to use 48 or 96 as its better divisible by 16.  We would like to clarify the following for FR2:  8) We assume Dense Urban Config B of RP-180524 is expected to be used as reference. If so, it would be good to clarify.  9) The number of gNB TXRU for Config B is set to 8. For our agreed reference, the TXRU is 2. Therefore, we assume the antenna setup needs to be clarified/revised. Our suggestion is  2 TxRU (M, N, P, Mg, Ng; Mp, Np) = (4,8,2,2,2;1,1)  (dH, dV) = (0.5λ, 0.8λ) (dg,H, dg,V) = (4.0λ, 3.6λ)  10) The number of UE TXRU for Config B is set to 4. We assume this may need to be clarified/revised.  11) traffic model for Config B is full buffer. We assume the traffic model in RP-180524 is not applicable for our SI. It would be good to clarify.  12) UE density for Config B is set to 10 per TRxP. Based on agreed traffic model, the only method to vary load is the change the UE density. We assume UE density in RP-180524 is not applicable for our SI. It would be good to clarify.  13) The power limitations for the BS for Config B is defined to be different than what we agreed. We assume the TRxP power in RP-180524 is not applicable for our SI. It would be good to clarify |
| LG Electronics | We are OK with the proposal. |
| OPPO | OK |
| vivo | We are OK with the proposal. |
| DOCOMO | We are generally fine with the proposal.  For FR2, as there are many assumption tables in RP-180524, it is better to explicit indicate which table will be used.  E.g.   * **For FR1, adopt the Reference SLS configurations in Annex-A in R1-2208216 as baseline SLS assumptions.**   + **Other carrier frequencies can be optionally considered.** * **For FR2 adopt the Reference SLS configuration used in Config.B in Table2 of RP-180524 for IMT-2020 as initial SLS assumption.**   **Further adjustment can be discussed in the next meeting.** |
| Ericsson1 | Below are some initial comments.  Common RS : further discussion is needed, e.g. we are not OK with 20ms periodicity for SIB1 transmission.  Traffic model : Needs further discussion as we agreed only to ranges during last week.  CSI reporting: the parameters can be up to proponent instead of a specific assumption in R1-2208216.  FR2 assumption : Needs more discussion. |
| Qualcomm1 | Here are our initial comments for FR1   * We should map the parameters to Set1 FR1 and Set2 FR1 respectively since some parameters were already agreed (e.g., duplexing, numerology, BW, traffic model, load). We suggest removing these parameters from the table. * For frame structure, we prefer to use DDDSUDDSUU where S has 10D:2G:2U for Set1 FR1. For Set2 FR1, suggest removing “full downlink” * For carrier frequency, we prefer to use 4GHz for Set1 FR1 * For antenna configuration for Set2 FR1, (M,N,P,Mg,Ng) = (12, 8, 2, 1, 1) * For common RS, only the periodicity is needed. Other rows should be up to the company for reporting. |

### Second round

The proposal and SLS details were shared from the beginning of this meeting. It may be good to proceed something rather than simply postponed to next meeting. Thus, for FR2, although there is preference to further discuss it, FL consider a possible way forward is to take it as WA with update per others input, so that interested companies may bring initial results. Other questions that are not feedback by FL can be further clarified next time.

For questions on FR1, changes are made in the Annex directly. O2I penetration – is it something we can let companies report? We can take this way at the moment without explicitly setting any. For some suggestions from QC, I do not take as the proposals are relatively stable for long, assuming they are not critically controversial.

**Proposal 3.3-1-rev 2~~1~~:**

* **For FR1, adopt the Reference SLS configurations in Annex-A in R1-220xxxx *(to be replaced by the tdoc number of this document)* as baseline SLS assumptions.**
  + **Other carrier frequencies can be optionally considered.**
  + **FFS SIB1 configuration: 20ms periodicity, SIB1 time resource=1 slot, and SIB 1 frequency resource 24 RBs**
* **(Working Assumption): For FR2 adopt the Reference SLS configuration used in Dense Urban Config.B in Table2 of RP-180524 for IMT-2020 with the following clarification/update as initial SLS assumption.**
  + BS antenna configurations
    - 2 TxRU (M, N, P, Mg, Ng; Mp, Np) = (4,8,2,2,2;1,1)
    - (dH, dV) = (0.5λ, 0.8λ) (dg,H, dg,V) = (4.0λ, 3.6λ)
  + Traffic model & UE density
    - Follow previous agreements with adjusted UE density
  + Total transmit power per TRxP
    - Value scaled from that in set 3 reference configuration considering BW
  + **Further adjustment/clarification can be discussed in the next meeting.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG Electronics | We are OK with the proposal. |
| Nokia/Nsb | OK.  On common RS configuration, further discussion and agreements would be needed on SIB1 configuration, e.g. we propose 20ms periodicity, SIB1 time resource=1 slot, and SIB 1 frequency resource 24 RBs. |
| MediaTek | Okay. |
| DOCOMO | We are fine with the proposal. |
| FL | There were multiple comments in previous round to eliminate the SIB1 related configurations from baseline. I think it may be ok to up to companies to report. For now, I added an FFS back which means it can still be simulated per company while a study/discussion point will be set next meeting. Let’s see if we need some alignment or not on SIB1 configurations after some results are available. |
| Vivo | We are OK with the proposal |
| Fujitsu | We are fine with the FFS SIB1 configuration.  As most parameters for FR1 are based on TR38.802, we prefer 4.0GHz for set1 ref. configuration and suggest putting “4.0GHz or 2.6GHz” in the table. |
| ZTE, Sanechips | For carrier frequency, we think we can add “other options can be also considered” to be more generic. |
| CATT | We are OK with the proposal |
| Huawei, HiSilicon | I think SIB1 configuration should be aligned. And usually, gNB shall have low coding rate to guarantee the performance of SIB1. Therefore, we think 48RBs is more suitable for the configuration.   * + **FFS SIB1 configuration: 20ms periodicity, SIB1 time resource=1 slot, and SIB 1 frequency resource ~~24~~48 RBs** |
| Intel | For FR1:  O2I penetration loss model details is missing. The configuration should clarify whether high or low, or mixture of high&low model is used.  If companies are all ok, since the goal of the evaluation to mainly check power consumptions aspects, we suggest using low-loss O2I penetration model applied to UMa.` |
| Qualcomm2 | For Set1 FR1, we prefer 4GHz carrier frequency. We support Fujitsu’s suggestion of putting “4.0GHz or 2.6GHz” in the table, and companies can report the number they use. |

### 3rd round

The following update can be considered. Carrier frequency change added in the Annex with “4.0GHz or 2.6GHz”. Further with the “other carrier frequencies to be optionally considered”, there should be sufficient room for companies to choose.

For low-loss O2I penetration, FL asked whether this can be up to company in the last round. Now Intel propose something specific, so added in the annex as well.

**Proposal 3.3.2-1:**

* **For FR1, adopt the Reference SLS configurations in Annex-A in R1-220xxxx *(to be replaced by the tdoc number of this document)* as baseline SLS assumptions.**
  + **Other carrier frequencies can be optionally considered.**
  + **FFS SIB1 configuration: 20ms transmission repetition periodicity, SIB1 time resource=1 slot, and SIB 1 frequency resource 24/48 RBs etc.**
* **(Working Assumption): For FR2 adopt the Reference SLS configuration used in Dense Urban Config.B in Table2 of RP-180524 for IMT-2020 with the following clarification/update as initial SLS assumption.**
  + BS antenna configurations
    - 2 TxRU (M, N, P, Mg, Ng; Mp, Np) = (4,8,2,2,2;1,1)
    - (dH, dV) = (0.5λ, 0.8λ) (dg,H, dg,V) = (4.0λ, 3.6λ)
  + Traffic model & UE density
    - Follow previous agreements with adjusted UE density
  + Total transmit power per TRxP
    - Value scaled from that in set 3 reference configuration considering BW
  + **Further adjustment/clarification can be discussed in the next meeting.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Samsung | We are fine with Proposal 3.3.2-1, and also support the changes on carrier frequency: [4 GHz or 2.6 GHz] |
| MediaTek | For SIB1, 20ms periodicity may be misleading. We suggest an update as follows.   * + **FFS SIB1 configuration: 20ms transmission repetition periodicity (option: 40ms considering it could be up to NW implementation and much larger data than MIB), SIB1 time resource=1 slot, and SIB 1 frequency resource 48 RBs**   + [MTK] According TS 38.331, SIB1 has a periodicity of 160ms and the default transmission repetition periodicity of SIB1 is 20 ms. Since SIB1 is much larger than MIB, so having a longer repetition period than MIB, e.g., 40 ms from real field log, is more reasonable.   + [38.331] the SIB1 is transmitted on the DL-SCH with a periodicity of 160 ms and variable transmission repetition periodicity within 160 ms as specified in TS 38.213 [13], clause 13. The default transmission repetition periodicity of SIB1 is 20 ms but the actual transmission repetition periodicity is up to network implementation. |
| Nokia/Nsb | It seems our early proposal of “24 RBs” is missing:  **Proposal 3.3.2-1:**   * **For FR1, adopt the Reference SLS configurations in Annex-A in R1-220xxxx *(to be replaced by the tdoc number of this document)* as baseline SLS assumptions.**   + **Other carrier frequencies can be optionally considered.**   + **FFS SIB1 configuration: 20ms periodicity, SIB1 time resource=1 slot, and SIB 1 frequency resource 24/48 RBs**   Moreover, from the latest agreements: “For FR2, urban micro is prioritized, with ISD=200 m is assumed”. But according to the Config.B in Table2 of RP-180524 for IMT-2020, the target scenario is Dense Urban with 1 Macro layer, and a Total transmit power per TRxP 37 dBm for 40 MHz bandwidth. Thus, it seems Config B with Macro is NOT fit for the prioritized FR2 micro as agreed in this meeting(?) If it is the case, we may need another Config instead targeting on prioritized micro. |
| FL | See update.  For FR1 SIB1 configurations, it is grateful MTK provide more suggestions. However given it is FFS, perhaps minimized changes can be expected, and only clarification change is made;  For FR2, FL also noticed that, therefore it is Working Assumption. There is no other suggestion for FR2 although FL has encouraged the proponent of FR2 to provide one. Consider this may be better than nothing, and if companies can be Ok to evaluate those based on dense urban, it may be acceptable as optional results anyway. |
| Ericsson3 | After further checking we have below comments :   * As commented earlier, for common RS, more discussion is needed. So, the row “SSB time resource” should be removed in this version. * For “3D/HF-Uma based on TR 38.901”, can moderator please clarify what is specifically being referred to in 38.901? Prefer to remove the row.   In addition to above, we prefer to add a bullet saying - “Modifications to the baseline can be discussed in RAN1#110bis-e.” |

# Others

Other issues can be further considered/discussed in the next meeting.

### Additional proposal for being captured into TR

In the evaluation,

* a load (L)% of a cell is a percentage of resources used for UE specific PDSCH/PUSCH.
* The following load scenarios are considered.

|  |  |
| --- | --- |
| Load scenario | Characteristics |
| Idle/empty load | * Include cell-specific signals and channels, and * L = 0 |
| low load | * Include cell-specific signals and channels, and * 0 < L≤15 |
| Light load | * Include cell-specific signals and channels, and * 15~~0~~ < L≤30 |
| Medium load | * Include cell-specific signals and channels, and * 30 < L≤50 |
| For CA, the companies report whether the load is defined per CC or across all CCs. | |

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG Electronics | We are OK with the proposal. |
| MediaTek | Okay. |
| DOCOMO | We are fine with the proposal. |
| vivo | We are OK with the proposal |
| ZTE, Sanechips | We are OK with the proposal |
| Intel | OK |
| Qualcomm2 | We suggest updating the RAN1#110 agreement so that there is no mismatch between the agreements and TR |

### 3rd round

Not sure what QCOM meant as the proposal is to update the RAN1#110 agreement. But seems agreeable to all. Please only indicate if you object this proposal; otherwise no need for input of support.

**Proposal 4.1.2:**

**Update the RAN1 agreements with the following changes**

In the evaluation,

* a load (L)% of a cell is a percentage of resources used for UE specific PDSCH/PUSCH.
* The following load scenarios are considered.

|  |  |
| --- | --- |
| Load scenario | Characteristics |
| Idle/empty load | * Include cell-specific signals and channels, and * L = 0 |
| low load | * Include cell-specific signals and channels, and * 0 < L≤15 |
| Light load | * Include cell-specific signals and channels, and * 15~~0~~ < L≤30 |
| Medium load | * Include cell-specific signals and channels, and * 30 < L≤50 |
| For CA, the companies report whether the load is defined per CC or across all CCs. | |

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| --- | --- |
| **Company** | **Comments** |
|  |  |
|  |  |

# References

|  |  |  |  |
| --- | --- | --- | --- |
| [1] | [R1-2205755](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2205755.zip) | BS Energy Consumption Model and Sleep States | FUTUREWEI |
| [2] | [R1-2205860](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2205860.zip) | Discussion on performance evaluation for network energy saving | Huawei, HiSilicon |
| [3] | [R1-2205999](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2205999.zip) | Discussion on performance evaluation of network energy savings | Spreadtrum Communications |
| [4] | [R1-2206053](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206053.zip) | Discussions on NW energy savings performance evaluationns on | vivo |
| [5] | [R1-2206074](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206074.zip) | NW energy savings performance evaluation | Nokia, Nokia Shanghai Bell |
| [6] | [R1-2206141](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206141.zip) | On network energy savings evaluation methodology and power model | Panasonic |
| [7] | [R1-2206172](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206172.zip) | Discussion on NW energy savings performance evaluation | Fujitsu |
| [8] | [R1-2207685](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/R1-2207685.zip) | Discussion on NW energy savings performance evaluation | OPPO |
| [9] | [R1-2206411](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206411.zip) | Evaluation Methodology and Power Model for Network Energy Saving | CATT |
| [10] | [R1-2207694](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/R1-2207694.zip) | Discussion on Network energy saving performance evaluations | Intel Corporation |
| [11] | [R1-2206665](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206665.zip) | Performance evaluation for network energy saving | InterDigital, Inc. |
| [12] | [R1-2206696](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206696.zip) | Discussion on BS energy saving model and evaluation | China Telecom |
| [13] | [R1-2206838](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206838.zip) | NW Energy Savings Performance Evaluation | Samsung |
| [14] | [R1-2206925](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206925.zip) | Discussion on network energy saving performance evaluation | CMCC |
| [15] | [R1-2206979](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206979.zip) | NW energy savings performance evaluation | MediaTek Inc. |
| [16] | [R1-2207037](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2207037.zip) | Discussion on performance evaluation for network energy savings | LG Electronics |
| [17] | [R1-2207059](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2207059.zip) | Discussion on NW energy saving performance evaluation | ZTE, Sanechips |
| [18] | [R1-2207079](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2207079.zip) | Evaluation and power model for network energy savings | Rakuten Mobile, Inc |
| [19] | [R1-2207245](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2207245.zip) | NW energy savings performance evaluation | Qualcomm Incorporated |
| [20] | [R1-2207343](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2207343.zip) | On NW energy savings performance evaluation | Apple |
| [21] | [R1-2207418](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2207418.zip) | Discussion on NW energy savings performance evaluation | NTT DOCOMO, INC. |
| [22] | [R1-2207437](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2207437.zip) | Network energy consumption modeling and evaluation | Ericsson |
| [23] | [R1-2208216](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110/Inbox/R1-2208216.zip) | FL summary#3 for EVM for NR NW energy savings | Moderator (Huawei) |

# Annex –

## A. Reference SLS configurations

**Table A The evaluation assumption for BS power consumption model**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Parameters | | |
| Basic parameters | Channel model | 3D/HF-Uma based on TR 38.901 | 3D/HF-Uma based on TR 38.901  (low-loss O2I penetration model) |
| Device deployment | 80% indoor, 20% outdoor | 80% indoor, 20% outdoor |
| Inter-site distance | 500m | 500m |
| Network Topology | 7\*3 Sector | 7\*3 Sector |
| Carrier Frequency | 2.1GHz | 4.0GHz or 2.6GHz |
| Multiple access | OFDMA | OFDMA |
| Duplexing | FDD (for set 2 ref. config) | TDD (for set 1 ref. config.) |
| Numerology | 15KHz,  14 OFDM symbol slot | 30kHz,  14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (104RB for 15kHz SCS and 20 MHz BW) | TDD: 2.08% (272 RB for 30kHz SCS and 100 MHz bandwidth) |
| Simulation bandwidth | Follow reference configuration, (equal split of 10 MHz for UL and DL) | Follow reference configuration |
| Frame structure | ~~Full downlink~~ | DDDSU |
| UT attachment | Based on RSRP | Based on RSRP |
| Wrapping around method | Geographical distance based wrapping | Geographical distance based wrapping |
| Traffic model | Follow previous RAN1 agreements | Follow previous RAN1 agreements |
| BS parameters | BS antenna height | 25 m | 25 m |
| BS noise figure | 5 dB | 5 dB |
| BS antenna element gain | 8 dBi | 8 dBi |
| Antenna configuration at TRxP | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ | For 64T:  ~~(M,N,P,Mg,Ng; Mp,Np) = (12,8,2,1,1;4,8) (dH, dV)=(0.5, 0.8)λ;~~  (M, N, P, Mg, Ng, MP, NP,) = (8, 8, 2, 1, 1, 4, 8).  based on 38.802 |
| UE parameters | UE power class | 23dBm | 23dBm |
| UE noise figure | 9 dB | ~~7~~ 9 dB |
| UE antenna element gain | 0 dBi | 0 dBi |
| UE antenna height | Outdoor UEs: 1.5 m; Indoor Uts: 1.5m or consider floor height | Outdoor UEs: 1.5 m; Indoor Uts: 1.5m or consider floor height |
| Antenna configuration at UE | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2)  (dH, dV)=(0.5, N/A)λ | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2)  (dH, dV)=(0.5, N/A)λ |
| Transmission parameters | Modulation | Up to 256 QAM | Up to 256 QAM |
| Transmission scheme | SU-MIMO | SU-MIMO |
| SU dimension | For 4Rx: Up to 4 layers | For 4Rx: Up to 4 layers |
| DL CSI measurement | Non-precoded CSI-RS based | Precoded CSI-RS based |
| DL codebook | Type I/II codebook | non-PMI transmission |
| SRS transmission | N/A | For UE 4 Tx ports: Non-precoded SRS |
| CSI feedback | Company to report the assumptions | Company to report the assumptions |
| Interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement |
| Scheduling | PF | PF |
| Receiver | MMSE-IRC | MMSE-IRC |
| Channel estimation | Non-ideal | Non-ideal |
| Common RS | SSB~~/SIB1~~ period | 20ms | 20ms |
| SSB time resource | ~~Slot#0~slot#3,~~ Slot#0, slot#1, 2 SSB per slot  4 symbols for each SSB | ~~Slot#0, slot#1~~ Slot#0~slot#3, 2 SSB per slot  4 symbols for each SSB |
| SSB frequency resource | 20RB | 20RB |
| ~~SIB1 time resource~~ | ~~slot#10 ~ slot#17~~  ~~slot#10 ~ slot#13~~ | ~~slot#10 ~ slot#13~~  ~~slot#10 ~ slot#17~~ |
| ~~SIB1 frequency resource~~ | ~~40RB~~ | ~~40RB~~ |

(M, N, P, Mg, Ng; Mp, Np)

- M: Number of vertical antenna elements within a panel, on one polarization

- N: Number of horizontal antenna elements within a panel, on one polarization

- P: Number of polarizations

- Mg: Number of panels in a column;

- Ng: Number of panels in a row;

- Mp: Number of vertical TXRUs within a panel, on one polarization

- Np: Number of horizontal TXRUs within a panel, on one polarization

## B. Agreements for EVM@RAN1#109-e

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| [**R1-2205308**](file:///C:\Users\w00250081\AppData\Local\Temp\Docs\R1-2205308.zip) **FL summary#1 for performance evaluation for NR NW energy savings Moderator (Huawei)**  Agreement  For evaluation purpose, the energy consumption modeling for a BS includes at least the following:   * Reference configuration   + FFS other details   + Note FR1 and FR2 to be separately considered for detailed parameters * Multiple power state(s) including sleep/non-sleep mode(s) with relative power, and associated transition time/energy * Scaling method to be applied at least for non-sleep mode.   + FFS other details including scaling for sleep mode   [**R1-2205402**](file:///C:\Users\w00250081\AppData\Local\Temp\Docs\R1-2205402.zip) **FL summary#2 for performance evaluation for NR NW energy savings Moderator (Huawei)**  Agreement  For evaluation purpose, the BS energy consumption model should at least include the power consumption of BS on slot-level.   * Note that symbol-level power consumption to reflect different BW (or RB utilization) / time-occupancy / tx-rx direction of different symbols in a slot is considered.   + FFS details (e.g. explicit symbol-level power modelling, scaling slot-level power to symbol level power for various cases, etc.)   + Note: system simulation evaluations can be per slot regardless of detailed approach for calculating symbol-level power consumption.   Agreement   * For evaluation, at least for non-sleep mode and TDD, the BS powerconsumption for DL and UL are separately modelled, allowing DL-only transmission or UL-only reception.   + FFS: whether UL-only reception energy consumption model can be derived/simplified from DL-only transmission energy consumption model * FFS: the impact of UL reception and/or DL transmission on sleep modes and associated transition time/energy * FFS: whether/how to define an idle state, where BS is neither transmitting nor receiving but also doesn’t enter into any sleep mode or define it as sleep mode * FFS: whether the model for FDD can be based on the model for TDD   Agreement   * For evaluation purpose,   + Study how to define sleep modes and determine the characteristics for each mode from one or multiple of the below     - Relative power     - Transition time     - Transition energy     - Other approaches are not precluded     - Note: BS components that can be turned off can be considered for discussion purpose when defining the specific values of the characteristics for sleep modes.   + Study whether sleep mode is defined for DL(TX) and UL(RX) jointly or separately   + Study the assumption of order for BS entering/resuming from a sleep mode to another mode (sleep or non-sleep) and the associated transition time and energy, i.e. state machine which may have impact on the transition energy.   Agreement   * For evaluation, the scaling in a BS energy consumption model can be considered based on one or more of the following,   + Number of used physical antenna elements, or TX/RX chains     - FFS: Mapping between used TX/RX chains and used antenna ports     - FFS: Mapping between physical antenna elements and TX/RX chains   + Occupied BW/RBs for DL and/or UL in a slot/symbol in one CC   + number of CCs in CA     - FFS dependency of RF sharing   + number of TRPs   + PSD or transmit power     - FFS dependency on BW scaling     - FFS: PA energy efficiency value   + number of DL and/or UL symbols occupied within a slot   + FFS other domain scaling   + FFS scaling is linearly or else, for each domain * Above does not necessarily imply that BS energy consumption model that takes into account all listed scaling factors will be developed   Agreement  For BS energy consumption evaluation, in addition to the energy saving gain,   * At least UPT/UE power consumption/access delay/latency should be considered for performance impact evaluation * Note: this doesn’t necessarily mean that all the above are considered for all evaluation results. However, multiple KPIs are expected to be evaluated for a given technique. And this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios.   Agreement  At least urban macro is prioritized for FR1. FFS the baseline deployment assumption for FR2.  Agreement   * FTP3 (0.5MB as packet size, 200ms as mean inter-arrival time), FTP3 IM (0.1MB as packet size, 2s as mean inter-arrival time) and VOIP can be considered in the evaluation * FFS: with possible further prioritization, different model between DL and UL, and/or other traffic models that can be optionally considered. * FFS associated scenarios/configurations, e.g. C-DRX.   [**R1-2205468**](file:///C:\Users\w00250081\AppData\Local\Temp\Docs\R1-2205468.zip) **FL summary#3 for performance evaluation for NR NW energy savings Moderator (Huawei)**  Agreement  For evaluation and BS energy consumption modeling purpose, for single CC case, at least the following in table should be considered for reference configuration   * + Note: other TX-RX RU number and corresponding BS antenna configuration can be considered in SLS assumptions  |  |  |  |  | | --- | --- | --- | --- | |  | Set 1 FR1 | Set 2 FR1 | Set 3 FR2 | | Duplex | TDD | FDD | TDD | | System BW | 100 MHz | 20 MHz | 100 MHz | | SCS | 30 kHz | 15 kHz | 120 kHz | | Number of TRP | 1 | 1 | 1 | | Total number of DL TX RUs | 64 | (working assumption) 32 | 2 | | Total DL power level | 55dBm | [49dBm] – to be further discussed and finalized in future meetings | 43dBm – to be further discussed and finalized in future meetings  EIRP limited to 78dBm – to be further discussed and finalized in future meetings | | Total number of UL Rx RUs | 64 | (working assumption) 32 | 2 |   Agreement  As a starting point,   * macro cell BS for FR1 is assumed for energy consumption model. * FFS: micro cell BS for FR2 is assumed for energy consumption model.   Agreement  The evaluation baseline for energy saving study/evaluation for BS includes at least NR R15 mandatory without capability features. Optional features from R15 onwards (e.g. CA, MIMO) as well as implementation-based energy saving techniques should be explicitly reported and described if used in the evaluation baseline.   * FFS: need of alignment for certain configurations/implementation-based schemes.   Agreement   * Similar to UE power saving study, percentage of energy consumption reduction from the baseline is used to express BS energy saving gain. * SLS is considered as baseline evaluation method. Other method, including numerical analysis and LLS can also be considered. At least one of the methods should be selected and used for evaluation of a specific technique (selection and criteria is up to proponent).   Working assumption  For evaluation, for energy consumption modelling for FDD and the case of simultaneous DL transmission and UL reception for non-sleep mode, study the following with potential down-selection in RAN1#110   * Option 1: the power consumption is the total of DL and UL power consumption * Option 2: the power consumption for UL is neglected * Other option is not precluded * Note the DL (or UL) power consumption can be obtained using a same approach as that obtained from the DL (or UL)-only in TDD model   Final summary in [R1-2205551](file:///C:\Users\w00250081\AppData\Local\Temp\Docs\R1-2205551.zip). |

## C. SID abstraction

Study Item (SI) for network energy savings for NR is approved in [1]. For the study of performance evaluation for this SI, the relevant objectives include below

|  |
| --- |
| 1. Definition of a base station energy consumption model [RAN1]  * Adapt the framework of the power consumption modelling and evaluation methodology of TR38.840 to the base station side, including relative energy consumption for DL and UL (considering factors like PA efficiency, number of TxRU, base station load, etc), sleep states and the associated transition times, and one or more reference parameters/configurations.  1. Definition of an evaluation methodology and KPIs [RAN1]  * The evaluation methodology should target for evaluating system-level network energy consumption and energy savings gains, as well as assessing/balancing impact to network and user performance (e.g. spectral efficiency, capacity, UPT, latency, handover performance, call drop rate, initial access performance, SLA assurance related KPIs), energy efficiency, and UE power consumption, complexity. The evaluation methodology should not focus on a single KPI, and should reuse existing KPIs whenever applicable; where existing KPIs are found to be insufficient new KPIs may be developed as needed.   Note: WGs will decide KPIs to evaluate and how.  The study should prioritize idle/empty and low/medium load scenarios (the exact definition of such loads is left to the study), and different loads among carriers and neighbor cells are allowed.  The following example scenarios (mapping between scenarios and network loads is left to the study) including single-carrier and multi-carrier deployments are used as the starting point for discussion on prioritized scenarios for the study.  The following example scenarios are listed in no particular order.   * Urban micro in FR1, including TDD massive MIMO (note: this scenario can also model small cells) * FR2 beam-based scenarios (note: this scenario can also model small cells) * Urban/Rural macro in FR1 with/without DSS (no impact to LTE expected in case of DSS) * EN-DC/NR-DC macro with FDD PCell and TDD/Massive MIMO on higher FR1/FR2 frequency   Note 1: legacy UEs should be able to continue accessing a network implementing Rel-18 network energy savings techniques, with the possible exception of techniques developed specifically for greenfield deployments.  Note 2: the study of energy savings specifically for IAB is not part of the scope.  The study should coordinate with RAN4 as needed. |

## D. Contact list per RAN1#109-e

|  |  |  |
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## E. Agreements during RAN1#110

**Agreement**

For non-sleep mode, the relative power value in power model table for UL reception and/or DL transmission is provided based on reference configuration.

**Agreement**

For set 2 FR1 FDD TxRx reference configuration, confirm the WA as 32 in reference configuration.

**Agreement**

The total DL power level is 49 dBm for set 2 FR1 FDD reference configuration.

**FL2 Proposal 2.1.6-1 –rev2**

**For the purpose of evaluation, adopt the following as BS power consumption model. These entries for this table is per reference configuration set.**

* **FFS: One or multiple values for relative power and transition time.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power state** | **Characteristic** | Relative Power | Additional transition energy3 | **Total transition time** |
| Deep sleep1 | There is neither DL transmission nor UL reception.  Time interval for the sleep should be larger than the total transition time entering and leaving this state. | P1=1 | E1 | T1 |
| Light sleep | There is neither DL transmission nor UL reception.  Time interval for the sleep should be larger than the total transition time entering and leaving this state.  (P2>P1) | P2 | E2 | T2 |
| Micro sleep | There is neither DL transmission nor UL reception.  Immediate transition is assumed for network energy saving study purpose from or to a non-sleep state. | P3 | 0 | 0 |
| Active DL | There is only DL transmission. | P4 | NA | NA |
| Active UL | There is only UL reception.  ~~FFS: Whether multiple P5 values are needed to address low power UL mode~~ | P5 | NA | NA |
| Note 1: Depending on implementations, there could be a state that the power is lower than deep sleep and requires larger total transition time, e.g. hibernating sleep or Quasi-off, which is not explicitly modeled in this study for evaluation purpose.  Note 3: Unit in relative power times duration. FFS: Details on how transition energy is defined. | | | | |

* For simultaneous DL and UL transmission for FDD, the power for UL reception is neglected in this study.
* FFS: Optionally, a state machine where BS may transit between sleep modes without entering non-sleep mode can be considered. Companies are to report the involved sleep modes and the assumptions for inter-sleep mode transition time used in their evaluations.
* FFS: Details on how to use the above table for low power uplink reception (e.g. for WUS).

**Working Assumption**

**For reference configuration set 1, the values are provided as below. FFS set2 and set 3.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power state** | **Relative Power *P*** | | **Total transition time *T*** | |
| Deep sleep | 1 | 1 | Cat 1:  50ms | Cat 2:  10s |
| Light sleep | Cat 1: 25 | Cat 2: 2.1 | Cat 1: 6 ms | Cat 2: 640 ms |
| Micro sleep | Cat1: 55 | Cat 2: 5.5 | 0 | 0 |
| Active DL | Cat 1: 280 | Cat 2: 32 | N.A. | N.A. |
| Active UL | Cat 1: 110 | Cat 2: 6.5 | N.A. | N.A. |

**Alternative Proposal 3.1.1.1-1**

For evaluation purpose,

* a load (L) of a cell is a percentage of resources used for UE specific PDSCH / PUSCH
* The following load scenarios are considered

|  |  |
| --- | --- |
| Load scenario | Characteristics |
| Idle/empty load | * Include cell-specific signals and channels, and * L = 0 |
| low load | * Include cell-specific signals and channels, and * 0 < L≤15 |
| Light load | * Include cell-specific signals and channels, and * 0 < L≤ ~~[~~30~~]~~ |
| Medium load | * Include cell-specific signals and channels, and * ~~[~~30~~]~~ < L≤ ~~[~~50~~]~~ |
| For CA, the companies report whether the load is defined per CC or across all CCs. | |

**FL2 Proposal 3.3.1.1-1:**

* **For FR1, urban micro can be optionally considered.**
* **For FR2, urban micro is prioritized, with ISD=200 m is assumed.**

**FL1 Proposal 3.2-1:**

**It is up to company report which traffic model is used among the agreed three traffic models in their evaluations.**

* **Other models may be used as well. Parameter (e.g. packet size and arrival rate) adjustment can be optionally considered and reported.**

**FL2 Proposal 2.3.1-1:**

**For set 3 FR2 reference configuration, the total DL power level and EIRP limit is set as 33 dBm and 63 dBm respectively. Note EIRP limit is also scaled with the number of TxRU.**

**Alternative Proposal 3.1.3-1:**

**For evaluation purpose, network energy saving gain is computed based on the energy consumptions for a technique and the baseline over the same duration.**