**3GPP TSG-RAN WG1 Meeting #109-e R1-** **220xxxx**

**e-Meeting, May 9– May 20, 2022**

**Agenda Item: 9.7.1**

**Source: Moderator (Huawei)**

**Title: FL summary#3 for performance evaluation for NR NW energy savings**

**Document for: Discussion and Decision**

# Introduction

For the following email discussion:

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| [109-e-R18-NW\_ES-02] Email discussion on performance evaluation by May 20 – Yi (Huawei)   * Check points: May 12, May 18, May 20 |

When making comments and uploading the input, please see the guidance in [R1-2203012](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_109-e/Docs/R1-2203012.zip) with recommended naming convention and [R1-2203013](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_109-e/Docs/R1-2203013.zip) concerning the deadline(s) for each check point respectively.

FL observes many re-uploaded files, perhaps due to submission conflict. You may want to upload an empty file with file type of .checkout to lock the submission from others for 30 minutes. For example,

* CompanyC uploads an empty file named *xxx-v003-CompanyB-CompanyC.checkout*
* CompanyC then has 30 minutes to upload *xxx-v003-CompanyB-CompanyC.docx*
* If no update is uploaded in 30 minutes, other companies can ignore the .checkout file.

In this round, companies are invited to make your input/check for FL proposals/questions tagged with FL5 prior to 19:00 UTC on May 18, as well as to enter contact information below. Note some remaining proposals (provided in section 1.1) in previous rounds are intended for email approval. Please directly indicate your objection in email for these proposals if you cannot live with any of it– FL will try to address critical details/concerns/down-selection by using new following-up proposals, so that we have a milestone progress based on the current proposals even if we cannot agree on something new within the remaining time of this meeting.

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| --- | --- | --- |
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## Recommendations for possible GTW treatment/email approval:

|  |
| --- |
| The following are recommended for **email approval**.  For FL 4/FL5 Proposal 4, companies are invited to further check the values in square bracket to be down-selected. Based on comments from one company, the whole bullet for BS antenna configuration is now for further check.  For FL4/FL5 Proposal 7, it is not very clear to FL whether one company propose to add BS energy efficiency for the first sub-bullet or into the second sub-bullet (as current). For the former case, given the discussion along with FL1 Proposal 3.1-2 it might require more discussion on its intention and proper variation in order to fit RAN1 evaluation. That’s the reason that FL put it into the second one at the moment. The note you proposed is added.  **Revised FL4/FL5 Proposal 4**   * For FR1, for single CC case, at least the following should be considered for reference configuration   Set 1   * + Common     - Duplex: TDD     - system BW: 100 MHz     - SCS: 30 kHz     - [BS antenna configuration:       * (Mg, Ng, M, N, P) = (1, 1, 8, 16, 2),       * (M, N, P, Mg, Ng; Mp,Np) = (8, 4, 2, 1, 1; 4,4),       * (M, N, P, Mg, Ng; Mp,Np) = (12, 8, 2, 1, 1; 4, 8) ]   + DL     - [number of TRP: 1]     - TX chain: 64     - Power level: [TR38.802/38.104]   + UL     - RX chain: 64   Set 2,   * + Common     - Duplex: FDD     - system BW: 20 MHz     - SCS: 15 kHz   + DL     - TX chain: [4/8/16/32]     - Power level [TR38.802/38.104]   + UL     - RX chain: [4/8/16/32] * For FR2, for single CC case, at least the following should be considered for reference configuration   + Common     - Duplex: TDD     - system BW: [100/400]MHz     - SCS: 120 kHz     - [BS antenna configuration: (Mg, Ng, M, N, P) = (1, 1, 8, 16, 2)]   + DL     - [number of TRP: 1]     - TX chain: [2/84]     - Power level: [TR38.802/38.104]   + UL     - RX chain: [2/84] * Note the above applies to at least non-sleep mode. FFS the reference configuration if scaling can be applied to sleep mode.   **Revised FL4/FL5 Proposal 7:**   * 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. And this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios, including coverage, dropping rate, BS energy efficiency and combination of KPIs like total energy consumption, UPT-aware EE etc.   **FL4/FL5 Proposal 8**  At least urban macro is prioritized for FR1. FFS the baseline deployment assumption for FR2.  **FL4/FL5 Proposal 9**   * 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. * FFS other traffic models that can be optionally considered. |

# Energy consumption model for BS

## Framework for modeling BS energy consumption

Almost all contributions that have relevant discussion on this aspect confirm that on high level, some reference configurations (which could be differently represented in contributions e.g. as nominal configurations), and multiple BS power states including sleep/non-sleep states with relative power values are needed. In addition to what has been considered in SID, majority among these companies also confirm that the use of scaling for non-sleep state is needed. It appears to be commonly acknowledged that this framework similar to UE power saving model can be agreeable as the BS power consumption model framework. Therefore, the following proposal can be considered and it is noted that this proposal does not intend to preclude any finer modifications/differentiation among e.g. FR1 and FR2, UL and DL, other potential improvement etc. Other details for each ‘component’ can be further discussed in following sub-sections.

**FL1 Proposal 2.1-1**

* **For evaluation purpose, the energy consumption modeling for a BS include at least the following:**
  + **Reference configuration**
  + **Multiple power state(s) including sleep/non-sleep mode(s) with relative power values/units, and associated transition times**
  + **Scaling method to be applied for non-sleep mode.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Xiaomi | Y |  |
| Spreadtrum | Y | There are different types of BS, e.g. macro cell, micro cell, small cell. How to model the different types of BS? Using different sets for modeling or absorbed into scaling methods (e.g. power level and antenna ports number)? |
| OPPO | Y |  |
| IDCC | Y |  |
| Vodafone | Y | Although we see the importance on showcasing absolute gains rather than just relative |
| Intel | Y, partially | We are generally fine, except the scaling part.  We think it is commonly understood that scaling applies to active states only. However, we think BS energy consumption modeling and considerations can be different considering various architectures.  We are ok with applicability with scaling method. However, scaling method only applied to non-sleep modes might not fully represent how power may need to scale when different components of BS, e.g. TRPs, are in sleep mode.  Let’s consider reference configuration assumes 1 TRP. Now, if we would like to extend the model to a network with 5 TRPs, how the scaling applies, if some of the TRPs are in sleep, for example if 2 out of 5 TRPs are not actively transmitting/receiving and in micro-sleep.  Then to calculate energy consumption of that network based on reference configuration, how to correctly capture the status of the TRPs and whether that can be a component in micro-sleep value that can be scaled by the number of TRPs that are not active.  We don’t have a good formulation to capture this, so for our suggestion is to remove the “scaling method to be applied to non-sleep mode”. Once sleep/non-sleep modes can be further developed, we should be able to come back to the scaling methods.  Although not critical, we prefer to use term “energy states” instead of “power states”. |
| NOKIA/NSB | Y, partially | We are generally fine with the main contents proposed.  Besides, we want to address the below issues:   * There can be multiple Reference configurations, i.e. depends on BS types if Micro BS is further considered. * For a sleep mode, the transition time and transition energy that is associated with should be defined as well.   For each scaling of the non-sleep modes, the (de-)activation time to apply a scaling should be defined. |
| LG Electronics | Y,  partially | In general, we are fine with Proposal 2.1-1.  Considering the additional power consumed during state transition, we can add transition energy in the second sub-bullet, as follows.   * **For evaluation purpose, the energy consumption modeling for a BS include at least the following:**   + **Reference configuration**   + **Multiple power state(s) including sleep/non-sleep mode(s) with relative power values/units, and associated transition times/energy**   + **Scaling method to be applied for non-sleep mode.** |
| China Telecom | Y | We are generally fine with the proposal 2.1-1. |
| DOCOMO | Y |  |
| CMCC | Y | Support. |
| Panasonic | Y |  |
| Samsung | Yes | We are fine with FL’s proposal in general.  From our perspective, it is straightforward to use the BS energy consumption model similar as UE power saving model. We are okay to further discuss the details of energy consumption models for scenarios, e.g. FR1 and FR2, sTRP and mTRP, and channels, e.g. UL and DL. Also, we would like to simplify the cases for baseline evaluation. |
| Apple | Y | Transition energy should be added in addition to transition time. |
| ZTE, Sanechips | Y | For sleep mode transition, not only the transition times but also the additional transition energy shall be discussed. So, the following modifications are recommended.  Suggested update:   * For evaluation purpose, the energy consumption modeling for a BS include at least the following:   + Reference configuration   + Multiple power state(s) including sleep/non-sleep mode(s) with relative power values/units, and associated transition times and additional transition energy   + Scaling method to be applied for non-sleep mode. |
| Fraunhofer IIS | Y | We share similar view as Spreaturm on the different type of BS. |
| vivo | Y | We are fine with the proposal and LGE’s modification since transition energy should also be defined. |
| HW/HiSi | Y | We Support the **Proposal.**  Regarding some comments raised above for different types of base station, we think this is related with the Proposal 2.1-4. We think the proposal here is regarding the framework with respective to a given base station decided in proposal 2.1-4.  Considering Base-station has various types, such as Macro/ micro/ small cell, it is worthy considered to construct separately models for typical type of base-station. However, considering the TU in RAN1, some type of BS should be prioritized and other types of BS could be discussed later or reported by companies.  The multi Base-station case could be studied after we finished the single station model. |
| Fujitsu | Y | We are generally fine with the proposal 2.1-1. |
| Qualcomm | Y w/ update | * For evaluation purpose, the energy consumption modeling for a BS includes at least the following:   + Reference configuration   + Multiple power state(s) including sleep/non-sleep mode(s) with relative power ~~values/units~~, and associated transition times   + Power scaling method ~~to be applied for non-sleep mode~~.   + Note: separate considerations for FR1 and FR2 in modelling energy consumption.   Comment: the power scaling may be also needed of sleep mode. |
| CATT | Y | We are OK with the proposal.   * The reference configuration could be considered to have one as the baseline for the comparison in the evaluation. * The definition of the gNB sleeping states needs to be specified in order to have common assumption in the evaluation since different definitions were made from companies’ contributions |
| MediaTek | Y | We generally support moderator proposal with the following comments that may also resolve questions from previous responses:   * It is suggested to specify a single reference model with multiple scaling factors for different BS types or ISD ranges can balance model simplicity (looks focus of multiple companies) and model diversity (e.g. Intel’s intention to include TRP and Nokia’s suggestion in multiple BS reference models) * We support separation of FR1 and FR2 due to very different implementations and power consumption characteristics   We prefer using analogous terminologies, i.e., “power state” as TR 38.840, with the intention to avoid the confusion when capturing both network power consumption and UE power consumption as evaluation metrics. |
| Ericsson1 | Needs update | We are OK with the proposal in general, but with following updates.  Support LG suggestion to add transition energy.  For scaling, we tend to agree with Intel/Qualcomm comment. We think scaling should also be applied/considered for microsleep e.g. for antenna scaling. Suggest updating last bullet as follows and leave the details for further discussion.   * + Scaling method to be applied for at least for non-sleep mode     - FFS : Scaling applied or not for sleep mode |
| FL | FL consideration:   * Different BS can be considered in other proposals, leading to detailed difference for modeling without affecting the framework. Some companies have a comment with a concrete solution, i.e. using multiple scaling factors to address that and there is similar consideration that one baseline is useful. * Transition energy is adding while there is different preference on ‘energy’ vs ‘power’ for state. Since the duration generally last for a while (more than one symbol), perhaps ok to use ‘energy’ and we can be consistent as long as we keep use ‘energy’ without confusion. * Scaling applicability to sleep modes can be studied. Perhaps it also relates to the definition of sleep mode that is to be further defined. As we start from UE power saving model, ‘at least’ is added similar to one suggestion given.   **FL2 Proposal 2.1-1a**   * **For evaluation purpose, the energy consumption modeling for a BS includes at least the following:**   + **Reference configuration**     - **FFS a baseline for comparison in evaluation with multiple scaling in consideration of other aspects, e.g. TRP/BS types etc, if any dependency**     - **Note FR1 and FR2 to be separately considered for detailed parameters**   + **Multiple ~~power~~ energy state(s) including sleep/non-sleep mode(s) with relative power ~~values/units~~, and associated transition times/energy**   + **Scaling method to be applied at least for non-sleep mode.**     - **FFS : Scaling applied or not for sleep mode**     - **FFS (de-)activation time for applying the scaling** | |
| Huawei, HiSilicon | Yes with update | 1. It would be fine to use energy consumption other than power consumption. However, regarding the change from “power state” to “energy state”, we have concerns on that. In our view, “power state” means the average energy consumption in a relatively short time unite, e.g. slot or symbol. “energy state” seems refer to some long term state. In TR 38.840, UE power saving SID defines “power state” which is the power consumption per each slot. Considering this, we don’t prefer to change it to “energy state” in NES study. We didn’t see any reason for this change. 2. Regarding the FFS bullet of (de-)activation time for applying the scaling, we would like to have better understanding on it. How does it impact the energy evaluation? Or if the intention to investigate the impact on the scheduling due to the adjustment on some components on BS? If the answer is yes, maybe we could add “whether/how to model” before the bullet considering not all the scaling needs activation/de-activation time. |
| Spreadtrum | Yes partially | We share the similar view as HW on “(de-)activation time for applying the scaling”. It seems complicating the model, if we consider the “transition” time for scaling… |
| ZTE,Sanechios | Y with update | For the FFS under reference configuration, considering there is no much point in comparing the simulation results of different BS types, “baseline for comparison” is unclear and misleading. Minor update is suggested.  **Suggested update on Proposal 2.1-1a**   * + - **FFS a baseline ~~for comparison~~ in evaluation with multiple scaling in consideration of other aspects, e.g. TRP/BS types etc, if any dependency** |
| Futurewei | Y with updates | The texts in red should be removed since the understanding is that further details and discussions on all aspects of the listed sub-bullets. |
| Apple |  | We are generally fine with the modified proposal. But we would also like some clarification on “FFS (de-)activation time for applying the scaling” before agreeing on the FFS. Alternatively we can remove the FFS for now and continue the discussion.  A question after seeing the discussion regarding “energy” vs “power” and “energy state” vs “power state”: of course we all know the difference between energy and power literally speaking. Companies seem to think energy consumption should be used for BS, but we have been using power consumption for UE. I am puzzled why this difference between BS and UE. Not the most critical issue here, but would be good to understand. |
| intel | Y with update | The FFS sub-bullet under Reference configuration is not clear. Suggest to remove it. Regarding scalability to sleep/non-sleep mode, we think it would be better to agree on a definition of sleep and non-sleep mode first and understand better the scope of each mode.  Please note that as mentioned in our email, we are not against the scaling method. We think it should be considered, but more finer description for sleep vs non-sleep especially for multi-TRP cases is needed first.  **FL2 Proposal 2.1-1a**   * **For evaluation purpose, the energy consumption modeling for a BS includes at least the following:**   + **Reference configuration**     - **~~FFS a baseline for comparison in evaluation with multiple scaling in consideration of other aspects, e.g. TRP/BS types etc, if any dependency~~**     - **Note FR1 and FR2 to be separately considered for detailed parameters**   + **Multiple ~~power~~ energy state(s) including sleep/non-sleep mode(s) with relative power ~~values/units~~, and associated transition times/energy**   + **~~Scaling method to be applied at least for non-sleep mode.~~**     - **~~FFS : Scaling applied or not for sleep mode~~**     - **~~FFS (de-)activation time for applying the scaling~~** |
| CATT | Y | We are generally OK with the revision. However, the aspects need to be clarified. Our suggestion of modification as follows,   * **For evaluation purpose, the energy consumption modeling for a BS includes at least the following:**   + **Reference configuration**     - **~~FFS~~ a baseline reference configuration is used for the comparison of network energy saving techniques in evaluation ~~with multiple scaling in consideration of other aspects, e.g. TRP/BS types etc, if any dependency~~**     - **Note FR1 and FR2 to be separately considered for detailed parameters**   + **Multiple ~~power~~ energy state(s) including sleep/non-sleep mode(s) with relative power ~~values/units~~, and associated transition times/energy**   + **Scaling method to be applied at least for non-sleep state ~~mode~~.**     - **FFS : Scaling applied or not for sleep mode**     - **FFS (de-)activation time for applying the scaling** |
| NOKIA/NSB | Partially | With below re-wording proposal:  FL2 Proposal 2.1-1a   * For evaluation purpose, the energy consumption modelling for a BS includes at least the following:   + Reference configuration     - FFS a baseline for comparison in evaluation with multiple scaling in consideration of other aspects, e.g. TRP/BS types etc, if any dependency     - Note FR1 and FR2 to be separately considered for detailed parameters   + Multiple ~~power~~ energy state(s) including sleep/non-sleep mode(s) with relative power ~~values/units~~, and associated transition times/energy   + Scaling method to be applied at least for non-sleep mode.     - FFS : Scaling applied or not for sleep mode     - FFS (de-)activation time for applying the scaling a given energy saving techniques |
| Qualcomm | Should update | * + - 1. From our understandings, the reference configuration is for purpose of BS energy consumption modelling. The baseline configuration for network energy savings evaluation can be discussed separately. Hence, FFS under the reference configuration seems not needed.       2. It is not clear what “energy state” means. We should keep power state since at the end we model the relative power for different states (except for additional transition energy in sleep mode).       3. It is reasonable to build separate BS power models for FR1 and FR2. We don’t think FR2 BS power model is a scaled version of FR1 BS power model. Hence, we proposed to add **a note**. * **For evaluation purpose, the energy consumption modeling for a BS includes at least the following:**   + **…**   **Note: BS power models for FR1 and FR2 are separately modelled.** |
| DOCOMO | Yes Partially | We are generally fine with the revision. However, we share similar view with HW/HiSi.   * “power state” should be used rather than “energy state” to align with 38.840 * Clarification on “(de-)activation time for applying the scaling” is needed. We are fine to remove the FFS. |
| LG Electronics | Y, update | Looking at Proposal again, it seems unclear what the last FFS points mean. Therefore, it would be better to remove two FFS points in the last bullet at this moment.  **FL2 Proposal 2.1-1a**   * **For evaluation purpose, the energy consumption modeling for a BS includes at least the following:**   + **Reference configuration**     - **FFS a baseline for comparison in evaluation with multiple scaling in consideration of other aspects, e.g. TRP/BS types etc, if any dependency**     - **Note FR1 and FR2 to be separately considered for detailed parameters**   + **Multiple ~~power~~ energy state(s) including sleep/non-sleep mode(s) with relative power ~~values/units~~, and associated transition times/energy**   + **Scaling method to be applied at least for non-sleep mode.**     - **~~FFS : whether or not to applied scaling for sleep mode~~**     - **~~FFS (de-)activation time for applying the scaling~~** |
| MediaTek2 | Y with update | Thanks moderator for the update. We have the following comments:  While we study energy saving, the methodology should base on “power” that normalizes the time scale for the following reasons:   * For fair comparison, companies’ results are normalized w.r.t. their simulation times, which means we are comparing the average “power” consumption * The metric UPT is data “rate” in unit of bits/sec that normalizes the time, and we should use UPT (bits/sec) / “power” (J/sec) to calculate correct EE index   By using “power” values, we can get rid of cumbersome time scale translations. In this regard, the methodology is to define “power values” for “power” states instead of “energy” state.  For transition between power states, there can be transition energy. For example, there models “power level” as well as transition “energy” for UE deep sleep. We use “energy” since it only occurs once per sleep and the unit needs also carefully specified for calculating its contribution to final average power consumption     |  |  |  | | --- | --- | --- | | Sleep type | Additional transition energy:  (Relative power x ms) | Total transition time | | Deep sleep | 450 | 20 ms |       By the above the following revision to 2nd bullet is suggested:  **Multiple power ~~energy~~ state(s) including sleep/non-sleep mode(s) with relative power ~~values/units~~, and associated transition times/energy** |

Another general aspect is that there is converged preference that the time domain granularity of BS energy consumption model should be in a dynamic level, e.g. per slot basis [2][3][4][7][9][10][11] etc.. The following can be considered.

**FL1 Proposal 2.1-2**

* **The BS energy consumption model can be used to evaluate the power consumption of BS per slot.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Xiaomi | Y |  |
| Spreadtrum | Y | The symbol level model should be studied. It can be absorbed into scaling methods in some companies’ contribution. Therefore, suggest adding a NOTE, e.g. the power consumption of BS for symbol(s) can be modeled in the scaling method. |
| OPPO | N | We think symbol-level evaluation is more reasonable. |
| IDCC | N | We think symbol-level evaluation is needed. However, this may be be achieved by scaling slot level power, for example using time and frequency occupancy. |
| Intel | Y | While we see that symbol level modeling can be made more accurate by considering different combination of signal/channels, we think for evaluation purposes, approximate model based on per slot assumption is sufficient and may not result in significantly different observation than symbol level model. It may be too cumbersome to assess transmission status on symbol by symbol level and evaluate in the SLS. Having said that we agree that based on per slot value, several important cases (e.g., 1 SSB transmission) can be identified for scaling. Alternatively, some quantization can be considered, such as if a transmission occupies half slot or less, a common scaling is applied and transmission occupying more than half slot are treated same way as per slot. |
| NOKIA/NSB | Y | Generally we are fine with the Proposal 2.1-2. But suggest to have below rewording:  FL1 Proposal 2.1-2   * The BS energy consumption model can be used to evaluate the powerenergy consumption of BS per slot.   NOTE: When we talk about something that is given for a certain time period it has to be energy not power |
| LG Electronics | Y | The power consumption of BS per slot can be considered as a baseline. |
| China Telecom | Y | We share the similar as Spreadtrum. We agree to evaluate the energy consumption in slot. However, since the techniques such as symbol-level ON/OFF can be adopted and the duration of the transmission may less than a slot. We suggest to take this into consideration by the scaling method.  And we agree with Nokia/NSB that the **power consumption** should be replaced by the **energy consumption**, not only for this proposal, but for all the proposals. |
| DOCOMO | Y | Scaling for symbol-level can be considered if necessary. |
| CMCC | Y with more clarification | We agree to evaluate the power consumption of BS per slot. However, further clarification is helpful to let us on the same page regarding the definition of per slot power consumption of different sleep states and non-sleep state.  For sleep states, such as the power consumption of deep sleep defines the power consumption when BS is in deep sleep within the slot.  For non-sleep state, the power consumption can be defined by PRB utilization in a slot. For example, the energy consumption of 100% PRB utilization is defined for reference configuration, the PRB utilization of other values, such as 50%, can be scaled with respect to the energy consumption of 100% PRB utilization. However, the definition of 50% PRB utilization should be carefully studied, one state is that 50% symbols in a slot are occupied for transmission, another state is that all the symbols are used for transmission with 50% PRB occupation, or even a combination of the above two states. The power consumptions of different working states are not same although the PRB utilization is 50%. So, at least a clarification on the definition of power consumption of non-sleep state per slot is needed. |
| Panasonic | Y | We support the comment from Spreadtrum, DOCOMO and other companies regarding symbol level scaling. |
| Samsung | Yes | Fine with FL’s proposal. |
| Apple | Y | A clarification question: if we have the energy consumption model on per-slot level, do we assume e.g. data is always scheduled with a full slot? Or some additional scaling w.r.t. the transmission duration will be considered? |
| ZTE, Sanechips | Y | In TR38.840, slot-based power consumption model is used for UE. Similar solution can be considered for BS model.  And evaluating the power consumption of BS per slot is reasonable and simple considering the SLS simulations.  In addition, the number of symbols occupied in a slot should be considered as a scaling factor for power consumption in the unit of slot. |
| Fraunhofer IIS | Y | Symbol-level granularity evaluation is preferred. |
| Vivo | Y | In our view, basic BS energy consumption model is defined in terms of slot granularity. For the active transmission or reception occupying part of slot (e.g. symbol-level occupation), it could be done by time-domain scaling. |
| HW/HiSi | Y | From the perspective of SLS, it is reasonable to use TTI/slot as time unit, and the power can be calculated per TTI/slot. If the time unit for SLS is set to symbol, the complexity of the evaluation would increase a lot.  We acknowledge that the calculation based on symbol level could be more accurate. Actually, since we have the scaling method, it seems not such important to focus on the time unit. For example, if only 2 symbols in a slot(14os) is occupied, the actual power for these 2 symbols is 1/7 of the power of 14os. Thus, we recommend to introduce the symbol level power calculation in scaling method. |
| Fujitsu | Y | Symbol-level adaptation can be evaluated by the application of scaling. |
| Qualcomm | N | Purpose of the proposal is unclear. More clarification is necessary. Does the proposal discuss whether the power is averaged over a slot like UE power model or something else? |
| CATT | Y | The gNB energy consumption might be different per symbol. However, the energy consumption should be measured in average per slot, which is the similar measured as the power model in Rel-16 UE power saving study. |
| MediaTek | Y | Given sub-slot power consumption graduality can be achieved by e.g., symbol-level power scaling, defining per-slot power values for the power states looks reasonable. For companies to better understand the proposal, it will be useful to include an (example) table for further discussion. |
| Ericsson1 | N | The modelling should be based on power consumption per symbol. Unlike a UE, the gNB may transmit/receive multiple channels/signals to/from multiple UEs and it is rather inflexible to handle all these variations starting from a slot-based model and scaling back to various Tx/Rx/sleep operations in one slot. For example, we would like to check with slot-level proponents how following cases will be handled :   * Different symbols have different Tx/Rx BW * Some symbols with DL and some symbols with UL * Some symbols are empty while other symbols have Tx/Rx |
| FL | FL considerations:   * The main motivation for the proposal is to achieve a dynamic model for BS energy consumption, e.g. slot or symbol level. * At least slot level is achievable for all for comparison. If a symbol level calculation is provided, the total energy can still be compared per slot. It is perhaps not so meaningful to compare the energy of each symbol even though the model can enable that purpose. That said, to clarify some questions, transmission on only few symbols of a slot is possible or no transmission is also possible, leading to a smaller energy value for that slot. It may be averaged or by other way. To be discussed with FFS.   **FL2 Proposal 2.1-2a:**   * **For evaluation purpose, the BS energy consumption model can be used to evaluate the energy ~~power~~ consumption of BS per slot.**   + **Note at least symbol-level energy consumption of BS can be calculated by scaling.**   + **FFS the scaling method details or other means that enable the following for evaluation,**      - **Different symbols have different Tx/Rx BW**     - **Some symbols with DL and some symbols with UL**     - **Some symbols are empty while other symbols have Tx/Rx** | |
| Huawei, HiSilicon | Yes | We are in general fine with the FL2 proposal. Regarding the FFS cases in the last bullet, one way could be scaling the energy of slot-level energy consumption under different Tx/Rx BW etc. and linearly combine them. We agree that this can be further discussed in the scaling part. |
| Spreadtrum | Yes partially | Suggesting removing the FFS part. The scaling method should be included in the proposal of scaling. This proposal only solved the time unit of energy model. |
| ZTE, Sanechips | Y with updates | We are generally OK with the proposal.  We agree with Spreadtrum that in this stage, it is not necessary to determine the scaling details. We should consider first the scaling of the slot-level energy consumption. For scaling method of the symbol-level energy consumption, it’s better to be discussed in the scaling section.  Therefore, the modification is suggested.  **Suggested update FL2 Proposal 2.1-2a:**   * **For evaluation purpose, the BS energy consumption model can be used to evaluate the energy ~~power~~ consumption of BS per slot.**   + **Note at least symbol-level energy consumption of BS can be calculated by scaling.**   + **FFS: the scaling method details for symbol-level energy consumption ~~or other means that enable the following for evaluation,~~**      - **~~Different symbols have different Tx/Rx BW~~**     - **~~Some symbols with DL and some symbols with UL~~**     - **~~Some symbols are empty while other symbols have Tx/Rx~~** |
| Futurewei | Y with updates | The intention of the proposal is to have the BS consumption model “able to support” evaluation of the energy consumption of the BS at slot/symbol level. Saying it ‘can be used..’ sounds confusing since we don’t have a consumption model yet. |
| Apple |  | We support ZTE’s update. We can discuss the details separately. |
| Intel | Y with updates | It is not clear whether the following bullet intends to calculate energy consumption at the symbol level for any possible combination of signal/channels or not. If yes, we think that is unnecessarily complicating the evaluation, since there can be many possible scenarios. Some approximation can still be obtained for scaling such as based on whether occupancy in number of symbols is above or below a threshold.   * + **Note at least symbol-level energy consumption of BS can be calculated by scaling.**   To this end, we suggest following update  **FL2 Proposal 2.1-2a:**   * **For evaluation purpose, the BS energy consumption model can be used to evaluate the energy ~~power~~ consumption of BS per slot.**   + **~~Note at least~~ FFS: How ~~symbol-level~~ energy consumption of ~~BS~~ signal(s)/channel(s) occupying less than a slot can be calculated by scaling.**   + **FFS the scaling method details or other means that enable the following for evaluation,**      - **Different symbols have different Tx/Rx BW**     - **Some symbols with DL and some symbols with UL**     - **Some symbols are empty while other symbols have Tx/Rx** |
| CATT | Y | We are Ok to use average energy consumption per slot. We support the update from ZTE since we needs to consider the static component of gNB energy consumption. |
| NOKIA/NSB | Yes, Partially | We are fine with the main bullet.  For the sub-bullet with FFS, we think the frequency domain scaling, with number of REs be counted and scaled per slot could solve the modelling issue of BW varying per symbol. Moreover, if the applying of the DL-only and UL-only per slot respectively for both non-sleep and sleep state, it could tackle the modelling issue for some symbols with DL and other symbols for UL, as well as for some symbols associated with Tx/Rx while other symbols are empty. |
| Qualcomm | Further discussion | It seems there is some confusion on energy vs. power in some discussions. For total energy consumption over an observed period, it will be aggregated energy of non-sleep and sleep modes, which can then be normalized to the slot level. For energy computation for a non-sleep or sleep mode, we need to know the time duration of the mode and power: the time duration is known (e.g., according to traffic/scheduling in SLS); however, the power is under discussion – the main element of the power model.  Now the key question we should ask here is whether the power is average per slot level as done in UE power model or is average per symbol level? We have the same understandings as Ericsson on modelling power per symbol level due to different nature between UE and BS.  Moreover, the proposed method for calculating everything per slot and then downscaling it the value per symbol, implies that there is a need to estimate the total energy consumed in the slot and then calculate the total amount of PRBs is used per channel type and then estimate the relative energy per channel type in order to get the final energy consumption per symbol. This seems to be complicated and unnecessary effort is involved. |
| DOCOMO | Y | We are generally fine with the proposal but prefer ZTE’s revision. |
| MediaTek2 | Clarification needed | Thanks moderator the updated proposal. We have the following comments:  By “energy consumption per slot”, we assume normalization over time and defining a “power” consumption model.  For a operation, the “energy consumption” is a fixed absolute value. It is because we would like normalize to a common time scale, scaling is required.  By the above, we would like to suggest the following revision:   * **For evaluation purpose, the BS ~~energy~~ power consumption model can be used to evaluate the energy ~~power~~ consumption of BS per slot.**   + **Note at least the average power consumption of symbol-level ~~energy consumption~~ operations of BS can be calculated by scaling.**   + **FFS the scaling method details or other means that enable the following for evaluation,**      - **Different symbols have different Tx/Rx BW**     - **Some symbols with DL and some symbols with UL**     - **Some symbols are empty while other symbols have Tx/Rx** |

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| About the below modified proposal discussed via GTW,  ***FL2 Proposal 2.1-2a:***   * ***For evaluation purpose, the BS energy consumption model should at least support the power consumption of BS on slot-level.***   + ***Note that at least the power consumption of symbol-level operations of BS can be calculated.***   + ***FFS whether and how the above can be extended to symbol level***   Please share your view on  **FL3 Question 1:**   * Whether the energy consumption model should be able to support evaluation on slot level or symbol level, for example, whether/how does the slot-level model handle the following cases provided as example   1. Different symbols have different Tx/Rx BW   2. Some symbols with DL and some symbols with UL   3. Some symbols are empty while other symbols have Tx/Rx | | | |
| Company | Slot/Symbol? | | Comment |
| Apple | Slot | | We don’t have any concrete model, but for the examples mentioned, we prefer some simple mechanisms, by scaling or by a linear combination of some slot-level power consumption values.  Considering SLS is to be conducted for the evaluation, it becomes very complicated if symbol-level model is used. We should have a manageable model that can still capture the first-order information. |
| BT | Symbol | | Our rationale is that the energy consumption model should be reasonably accurate to capture the energy cost of **functions** performed by gNBs and UEs to enable assessment of enhancements. Functions like synchronization are enabled on symbol-level – we are not clear how examples like that can reliably assessed with slot granularity.  Where slots contain repetitive patterns of symbols, templates could be used to simplify assessment, but those templates need to be derived based on a realistic symbol composition. |
| China Telecom | Slot | | We support the slot level to simplify the simulation. Though there can be symbols for DL/UL in one slot, or the symbols used for transmission is actually less than a slot, the total energy consumption can be acquired by scaling. The purpose of SLS is to evaluate the energy consumption and provide guideline for further enhancement, the slot level simulation is enough. |
| OPPO | Symbol | | We are more supportive of symbol-level power consumption modelling, but can live with slot-level modelling as long as we have consensus on the scaling method.  Here we have one clarification question on slot-level power modelling. As shown in the following figure, assume a typical case that the BWP of one UE is partially overlapped with SSB bandwidth, then there would be three types of slots: SSB-only slot, data-only slot, and slot contains both SSB and data. How should we make power consumption assumptions during the evaluation for these three slot types? |
| DOCOMO | Slot with scaling or symbol | | We slightly prefer slot level model with scaling for simplicity. However, we are also fine with symbol level model. As pointed out by the proponents of symbol level model, various kinds of scaling definitions would be required assuming different combination of channels/signals in slots. If more accurate modeling is preferrable by companies, we are fine with symbol level model. |
| Samsung | Slot | | ***FL2 Proposal 2.1-2a*** – Fine with FL’s proposal. From our perspective, for evaluation, the slot-level energy consumption model is sufficient. In general, potential techniques for NES can be studied on symbol-level, but from simulation perspective including SLS, the slot-level evaluation is much simple to align with time unit.  **Question 1 -** Regarding the above examples, we think it can be addressed with the one or multiple scaling models according to channels and signals, e.g. using the scaling for BW and the scaling for symbol occupied in a slot. Based on the scaling models, it can be normalized and linear-combined in a slot. |
| CMCC | Slot | | The power for DL slot with 100% RB utilization (PDL) and the power for UL slot with 100% RB utilization (PUL)can be defined in the power model for reference.  Then, the realistic power can be scaled based on  PRealistic=α\*β\*PDL+η\*PUL  Where, α and η defines the symbol occupation factor for DL and UL, respectively. Since the energy consumption of 100% symbol occupation is defined for reference power, the other symbol occupations can be scaled by α or η. The value of α and η can be discussed further, such as whether α is equal to 0.1 for 10% DL symbol occupation.  β defines the RB utilization factor for all the DL symbols that have transmission. The proponents of symbol-level propose to consider different power when different symbols have different Tx/Rx BW. However, we are wondering whether the power can be changed in symbol-level, and whether the power can be directly scaled by the BW. So, we propose that RB utilization for all the DL symbols can be used to represent the case that different symbols may have different Tx BW. For UL, considering the relatively small energy consumption of UL, no RB utilization scaling is needed for UL.  Note that the scaling of symbol occupation or RB utilization on static power are not discussed here and can be further discussed.  The question proposed by FL3 can be solved by the aboved scaling function.   * 1. Different symbols have different Tx/Rx BW   The proponents of symbol-level propose to consider different power when different symbols have different Tx/Rx BW. However, we are wondering whether the power can be changed in symbol-level, and whether the power can be directly scaled by the BW. So, we propose that RB utilization for all the DL symbols can be used to represent the case that different symbols may have different Tx BW. For UL, considering the relatively small energy consumption of UL, no scaling is needed for UL.   * 1. Some symbols with DL and some symbols with UL   The power for DL and UL is separately calculated based on the reference power and the symbol occupation of DL and UL symbols.   * 1. Some symbols are empty while other symbols have Tx/Rx   The symbol occupation factor α and η are used to define the symbols that have Tx/Rx. |
| ZTE, Sanechips | Slot | | For the evaluation of energy saving solutions, the power consumption model of BS per-slot is sufficient, only the occupation of symbols within a slot need to be considered, and the power consumption of BS per slot is reasonable and simple considering the SLS simulations.  For the transmission of some reference signal,e.g., SSB, CSI-RS, it can be modeled based on scaling rules.  Considering the NW scheduling in real implementation, it is more realistic to assume it as per-TTI/slot scheduling mechanism, instead of per-symbol scheduling.  We also agree with the comments by CATT during GTW session, some of the NW operation involves more than 1 symbol, for example, channel coding, modulation, and resource mapping, etc. Therefore, if a symbol-level model is considered, the assumption of NW operation within a symbol will be diverse.  The power consumption model discussion may also impact on the discussion of other power states, or the associated transition/activation. For example, for micro-sleep state, most companies believe no transmission time is needed for slot-level model. However, if symbol-level model is introduced, we may need to re-consider the transition time for micro-sleep with a finer granularity, for example, how many symbols it is needed for NW to switch in/out from micro-sleep. There are similar issues for other potential NW ES techniques, for example, spatial/power domain adaptation. |
| LG Electronics | Slot, but can accept Symbol as well | | Two Options are being discussed.  Option 1: Define power consumption of BS on slot-level and apply linear scaling with the number of active symbols  Option 2: Define power consumption of BS on symbol-level  We think eventually two options are equivalent.  Ex1) For Option 1,   |  |  | | --- | --- | |  | Relative power | | DL only slot | A | | UL only slot | B |   Ex2) For Option 2,   |  |  | | --- | --- | |  | Relative power | | DL only symbol | A/14 | | UL only symbol | B/14 |   As shown above, we will just agree scaled relative power values depending on which option is adopted. In that sense, both of options function and we prefer adopting majority view between two options.  As to power scaling based on Tx/Rx BW, it is not preferred to fine-scale according to the number of RBs. |
| vivo | Slot | | We support the slot level since per-symbol modeling is not a reasonable method considering implementation.  For Tx power state, the baseband processing such as encoding, scheduling and etc. can’t be integrated in symbol-level modeling. For Rx power state, as mentioned by CATT in GTW, it may not be reasonable to model it in symbol level since buffering is performed in slot-level. Considering this, slot-level granularity is preferred for defining all the power states.  On the FL3 Question 1: it could have some simplified handling on the mentioned 3 cases:  Case 1: First we don’t think this is a very typical case in the evaluation. Even if this needs to be defined, it can be assumed the maximum BW is used for frequency-domain scaling  Case 2: Considering the fact that DL part is the dominant part, we can consider DL only  Case 3: This can handling directly by scaling. |
| Intel | slot | | While symbol or slot level power consumption models could be made to work, there are different pros/cons for each one of them. One could in theory define a slot level power consumption that is identical to symbol level power consumption model. So in the end, while there is no right answer and this really depends on how companies think would be easier for modeling and evaluations.  For the symbol level, it could be difficult to model power models for one or two symbol gaps of idle period between transmitted symbols. For example, one or two symbols followed by one symbol gap and another one or two symbols of signal/channels. While gNB might not be leveraging signal/channels in the one symbol gap, a single symbol is not really sufficient to power down components for significant power saving, especially for larger SCS.  In this case, more accurate modeling of sub-symbol transition for various sleep modes might be needed.  Additionally, processing preparation for signals and channels can take more than single symbol, and assigning per symbol level power consumption might not accurately represent power consumption associated with the transmission. For example, transmission of a single PDCCH, can’t be really expressed in terms of a single transmission symbol power as it should also include scheduling processing performed to assemble the DCI contents, which includes beamforming and link adaptation calculations based on feedback from the UE.  For slot model, there needs to be more a statistical average power consumption estimate depending on symbol usage within the slot. While this may require further discussion on how power consumption model (e.g. scaling) should be done as a function of symbol occupancy of potentially different signal/channels, from evaluation purposes, is possible to update the model in slot by slot manner.  It should be noted that for the slot based model does not mean there needs to be separate power consumption value for different combination of signals and channels. As mentioned, it could be feasible to have similar modeling regardless of per symbol or per slot modeling. One of the main limitation of per symbol modeling is lack of defining some minimum power associated with even a single symbol transmission.  Per-symbol definition naturally result in completely linear scaling of power in terms of number of symbols. This might be ok if the power consumption is only measured from the PA, even though PA is dominant component for power consumption at the gNB, it is not the only component that consumes power.  Per-slot definition would allow to define some minimum power values, even if few symbols are used. Some scaling functions could be used to mimic per-symbol definition. Therefore, per-slot definition would likely enable more robust modeling of the gNB power consumption.  On the other hand, for SLS evaluation, it is reasonable to use slot-level model, where a reference value is assumed for the slot. Complexity of evaluation can be manifold if symbol level granularity is used.  Based on these discussions, among the two, our preference would be slot-level.  To address the 3 issues if slot-level model is used, scaling can be used to achieve energy consumption of a signal/channel occupying less than a slot. Whether scaling needs to be done at the symbol level or some approximation can be used, that can be further discussed. For example, if a slot occupies both DL and UL symbols, it can be simplified to have DL-only slot-level power since DL transmission power is more dominant. Similar to UE power saving study, some approximations can be adopted for different combinations of symbol(s)-level signal/channel transmissions in same or different direction in a slot with same or different BW which may be adequate for the evaluation purposes. |
| IDCCV | Slot (can accept symbol) | | We think both methods can work but we prefer slot level with scaling due to its simplicity. |
| Nokia/Nsb | symbol-level with scaling on top of slot-level | | We think the symbol-level modeling is an important aspect for evaluation of Rel18 NW EE study.  However, different from explicit symbol-level modeling as proposed by company, we prefer the approach of symbol-level modeling with scaling on top of slot-level model.  Considering of SLS is likely to be used for the evaluation of Rel18 NW EE study, the complexity for SLS need to be carefully considered, where to our view, the (slot-level+scaling) modeling approach requires less simulation computation effort than symbol-by-symbol counting approach. And the approximate numbers via scaling on top of slot-level modeling is sufficient for the evaluations of the study.  Also, we prefer the modelling framework in TR38.840 for UE power saving to be used as the starting point and be adapted to the Rel18 NW energy saving study. Generally, the UE power consumption model in TR38.840 was defined on a per slot granularity, in relative terms, and separately for UL and DL.  Moreover, the UE power consumption modelling as per TR 38.840 defines power consumption values explicitly for a list of DL and UL slot types assuming certain combination of channels and signals received and transmitted in a slot by the UE. For example, DL slots include PDCCH-only, PDCCH+PDSCH, SSB/CSI-RS, etc. The same approach could be used in principle for the BS energy consumption for DL as well. However, it may be tedious to explicitly define all the slot types. Alternatively, e.g. for DL, a single DL energy consumption value assuming a BS DL transmission over a 14-OFDM symbol slot could be defined. The different slot types can then be simply derived by scaling the single DL energy consumption value by the number of occupied OFDM symbols. For example, for 2-symbol PDCCH-only slot, a scaling by 2/14 can be applied. This latter modeling approach may be slightly less accurate; However, its accuracy may be sufficient for the purpose of this study.  Furthermore, to our view, the slot-level modeling can be adapted to handle the following case that raised by company:   * 1. Different symbols have different Tx/Rx BW   We think the frequency domain scaling, with number of REs be counted and scaled per slot could solve the modelling issue of BW varying per symbol.   * 1. Some symbols with DL and some symbols with UL   If symbol-level DL power is to be calculated, then the UL symbols in the slot are excluded.   * 1. Some symbols are empty while other symbols have Tx/Rx   As our example in above, for example if 2-symbol PDCCH-only DL slot is to be calculated, a scaling by 2/14 can be applied on top of the slot-level, and the remaining 12/14 symbols are accounted for BS micro sleep. |
| Fujitsu | Symbol, but can live with slot level as well | |  |
| Panasonic | Symbol level | | On the question mentioned in the FL3, we are supportive to handle the three listed cases, no matter the calculation is based on model of slot or symbol level.  The goal of discussion is to achieve a evaluation methodology capable of evaluating and exploring the network energy saving gain with proper gNB scheduling strategy and corresponding techniques. To this end, the model should support different slot types/formats already supported by the specification, which may not necessarily be exhaustive but should be representative. Hence we are okay to support:  Symbol level model which can construct different slot types/format; or  Slot level model which can support partial or full slot transmission with DL and/or UL symbols scaled in time, frequency, antenna and power domain.  To be more flexible and forward compatible, symbol level model is more preferable. |
| Huawei, HiSilicon | Slot level model extensive to symbol level by scaling | | We prefer slot level power consumption model. The reason is: 1) it can simplify the work load including the system level simulation and the power model itself; 2) As commented by some companies, some operation may be operated for several symbols, this would increase the difficulties of symbol level power modelling; 3) slot level power model could be scaled to support necessary symbol level power consumption by scaling. 4) It is not necessary of the symbol level model considering maybe not all of the combinations of symbols shall exist especially when a slot based scheduling is performed;  For the **FL3 Question 1,** we have the following answers inline**:**   * Whether the energy consumption model should be able to support evaluation on slot level or symbol level, for example, whether/how does the slot-level model handle the following cases provided as example   1. Different symbols have different Tx/Rx BW  1. As an example, we can define the slot level power consumption value with respect to the bandwidth in the reference configuration and the symbol numbers, e.g. 14 symbols, in a slot, respectively for UL and DL. The per symbol level power consumption can be obtained by applying the bandwidth scaling rule and then to be further scaled by 1/14 for DL and UL, respectively. The power consumption of the slot can be obtained according to the combination rules, e.g. linearly combining based on the symbol ratio in the slot. 2. We agree with CMCC that we should clarify firstly how fast the bandwidth of TX/RX shall be changed.    1. Some symbols with DL and some symbols with UL 3. The method/example is provided in the answers of the previous question.    1. Some symbols are empty while other symbols have Tx/Rx 4. The empty symbols can be modelled as micro sleep. The scaling and combination rules can be similarly applied as mentioned above. |
| MediaTek3 | Slot | | The following please check our reasons for suggesting slot-level model:   * **Slot-level power model is more generic**: As state by CATT/Fang-Chen, it can include power consumption component that cannot be modelled per symbol. * **Slot-level power model can fallback to symbol-level power model under “uniform power” assumption:**    + Assuming that a slot-level power state is “uniform” over symbols in a slot, the slot-level power model can generate the same power values as based on symbol-level power model.   + For example, one can provide the power value for 6 symbol DL traffic + 4 symbol micro sleep + 4 symbol UL traffic by **proportional averaging** over the three per-slot power states (DL traffic, Micro sleep, UL traffic) over the symbol ratios in a slot, specifically as follows:   *The slot-level average power of (6 symbol DL traffic + 4 symbol micro sleep + 4 symbol UL traffic) = (6/14) \* (power of DL traffic power state) + (4/14) \* (power of micro sleep) + (4/14) \* (power of UL traffic power state)*     * + Note: the same rule can be utilized, together with frequency-domain scaling, to provide the desired power values of Ajit’s cases.   Since whether gNB has strictly per-symbol processing depends on gNB implementation, we see slot-level power model can be more generic to include all implementation possibilities. On the other hand, **as an way forward, we may include a simple scaling rule based on “uniform power” assumption, which can include Ericsson/Ajit’s proposal(s) based on symbol-level model**. |
| Ericsson3 | Reflect Symbol level power consumption | | Thanks for further comments. Considering the comments, we suggest below updates to the proposal. To study different techniques, the model should reflect adaptivity e.g. based on number of symbols for PDCCH/SSB/CSI-RS, etc, which seems to be the view of several other companies. Then how to model it, it is good to make decision after checking detailed proposals. Our concern (explained on the reflector) of long discussions on scaling for many different slot formats and ad hoc scaling formulas has not been addressed by the proponents yet. We would be OK if some simple scaling formulas can be used, but are not convinced it is possible considering there can be multiple UEs with various different settings/mix of channels/signals in a slot, slot structure can vary slot-by-slot. So, while our preference is to agree to a detailed model directly than take high-level decision in one direction at this point, we would be OK with the below update.   * ***For evaluation purpose, the BS energy consumption model should at least support the power consumption of BS on slot-level.***   + ***Note that ~~at least the~~ symbol-level power consumption ~~of symbol-level operations of BS~~ to reflect different BW/occupancy/ tx-rx direction of different symbols in a slot is considered ~~can be calculated~~.***     - 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.   + ***~~FFS whether and how the above can be extended to symbol level~~*** |
| FL4 | Please continue the discussion based on the above. | | |
| Xiaomi | Thanks for all the discussions. from our understanding, both slot-level/symbol-level model can work. and we prefer slot-level model as the comment made by MTK.  We think the main bullet is not very clear. We  understand the intention is to build a slot-level mode, and we are not against it. but the wording “support the power consumption of BS on slot-level” seem not very clear. Because even we are building a symbol-level model ,we can still support the power consumption of BS on slot-level evaluations, that is by adding energy consumption on each symbols together.  We suggest the following modification shown in blue(the main change it to change “support” to “include”):  FL2 Proposal 2.1-2a:   * For evaluation purpose, the BS energy consumption model should at least include ~~support the~~ slot-level power consumption model of BS ~~on slot-level~~.   + Note that at least the power consumption of symbol-level operations of BS can be calculated.   + FFS whether and how the above can be extended to symbol level | | |
| **FL4 Proposal 2.1-2b:**   * For evaluation purpose, the BS energy consumption model should at least support the energy consumption of BS on slot-level.   + Note that symbol-level power consumption to reflect different BW/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. | | | |
| Qualcomm |  | Slot level makes sense for UE power modeling. However, it may be more complicated for BS power modeling since the BS has to serve multiple UEs in the same slot. We will have many different slot types; hence more complex to define slot types (e.g., a slot may have SSB, PDCCH and PDSCH where PDCCH/PDSCH for multiple UEs may be FDMed). Furthermore, it could be complex to do SLS since we would need to track the slot type. What if an actual slot type in SLS is not the one with a defined power state? If we don’t want such a situation to happen, we will need to restrict the scheduler to some selected supported slot types, which would not capture a real scenario. Alternatively, we would need to exhaustively search for all possible slot types so that the scaling method supporting scaling power model from one slot type to another slot type is properly defined.  On the other hand, symbol level power modeling makes modelling workload less and SLS simpler. In particular, we don’t have to define a slot type to define power. We just need to define the power for 100% frequency occupancy for a symbol. For evaluation we look into a symbol to see the frequency occupation (regardless of which signals/channels FDMed in the symbol) and then derive the according power based on some simple scaling rule. | |
| LG Electronics | We share the same view with Ericsson and support the suggested proposal in the above comments by Ericsson3. | | |

* 1. **Issue#1-1**

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| There seems to be preference to align the terminology for easy discussion or consistent evaluation purpose.  **FL4 (low priority) Question 1-1:**   * In addition to power state, which one(s) of the following set of terminologies are preferred   + Set-1: power model, power consumption, power saving, power saving gain   + Set-2: energy model, energy consumption, energy saving, energy saving gain | | |
| Company | Set1/2, or? | Comment |
| CMCC | Set2 | From our understanding, energy is power multiplied by time. Since the model is used for calculating the energy of BS for a period of time, so, we propose to use Set-2 with “energy”. |
| China Telecom | Set2 | Power model/energy model: we think the difference between the two terminologies isn’t too much, but for align with other terminologies, we think energy model should be used.  Energy consumption: the consumption should be a terminology based on a period of time, so the energy consumption is obviously more suitable.  Energy saving/energy saving gain: what we want to save is the energy instead of the power. The power can be the same, but the energy can be less with the flexible and finer-granularity potential techniques adopted. So the energy saving is more suitable here. |
| Nokia/Nsb | Case-by-case | Depends on what we are trying to say. And we share with same view as last round comments by Mediatek2, where for defining a “power” consumption model, it is energy consumption over a certain time unit, i.e. energy consumption per slot or on slot-level. |
| Qualcomm |  | It is fine to use either “energy consumption model” or “power consumption model”. However, when we define the energy consumption model for non-sleep state, we will define the power value that is normalized to the power of a state (to be discussed later). When we define the energy consumption model for sleep states, we will define the power value for sleep state and energy value for state transition. |
| LG Electronics |  | We're okay with the term "power model" in set-1, but the rest of the terms don't seem to differ much between the two sets. |
| ZTE, Sanechips | Set 1 | Set 1 seems more consistent with the power state, relative power in the GTW agreements.  Meanwhile, set 2 is also acceptable if the duration for energy consumption is concluded, for example, per slot. |
| Huawei, HiSilicon | Set1 | Per the discussion above, both slot level or symbol level model, it is about the energy consumption in the time unit, which is power consumption. Considering this, we prefer power model other than energy model.  However, it is OK to use energy consumption when we calculate the energy consumed by gNB by using the power model of gNB. |
| FL5 | Please continue to comment if you think there is anything important. | |
| Apple | Set 1 | We prefer to use “power” overall, even though the only difference between power and energy is whether it is normalized to a time duration or not. Using “power” has the advantage that it is already normalized in time, so we do not need to mention the time duration being considered. This also makes comparison easy. In addition, we have been using “power” instead of “energy” for UE power saving, and we do not see any fundamental difference between UE and BS which suggests that “energy” is more suitable for BS.  (Of course there is one exception for transition energy, where “energy” should be used regardless.) |
| Intel | Set 1 | Since evaluation methodology is following UE PS SI, it makes sense to follow a similar approach to avoid confusion regarding terminologies. For transition, it makes sense |

To further adapt the framework of UE power consumption modeling to BS side, views seem to be a bit split in terms of the considerations of UL and DL and of corresponding channels, unlike what has been done at UE side. For example, [2] focus on the DL part while also mention that power consumption of UL part can be considered relative to that of DL. A few others generally consider that UL and DL are separately modeled while [6][17][26] consider the DL and UL should be modeled together (possibly depending on duplex, e.g. TDD). It seems that in the case of separate modeling, what mostly differentiates in the model presented in companies input is to have separate relative power values in DL transmission and UL reception at BS, for non-sleep model. And modeling/evaluation for DL only or UL only should be possible in order to verify the scheme/gains for one direction only. A gNB is generally considered as sleep when data is communicating in neither DL nor UL. Thus, the following can be considered.

**FL1 Proposal 2.1-3**

* **For evaluation, the BS energy consumption for DL and UL can be separately modelled, allowing DL-only transmission or UL-only reception at least for non-sleep mode.**
* **Study whether/how to adopt channel/signal-specific modelling for some cases**

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| **Company** | **Y/N** | **Comments** |
| Xiaomi | Y(for the first bullet) | In fact we are not quite sure what is the meaning of second bullet. What is “channel/signal-specific” modeling? And what is the relation between “channel/signal-specific” modeling and separate DL/UL modeling？ |
| Spreadtrum | Y | As mentioned in some companies’ contribution, modeling of UL-only reception can be simplified due to tight time frame. |
| OPPO | Y | We suggest to study a simple modelling which is independent of specific channels/signals, e.g., a unified model for all the DL channels/signals. |
| IDCC | Y |  |
| Vodafone | Y |  |
| Intel | Y, partially | We agree that energy consumption states in DL and UL can be simplified and we may not need specific handling of different possible combinations of channels. Nonetheless, we think some categorization can still be useful, such as PDCCH + PDSCH channel are expected to be processed in a common block, whereas other channel/signal transmission comprising background activity, such as SSB, RS could be processed with less power. However, if majority agrees to go move forward with single DL active state, we can accept that for sake of progress. |
| NOKIA/NSB | Y | Generally we are fine. But we could like the clarification from @FL on: How to understand the 2nd-bullet bullet with “channel or signal specific modelling for some cases”, is it something targeting for slot type, such as SSB-only, PDCCH-only? Could you please elaborate a bit. Thanks! |
| LG Electronics | Y | For the simplicity, we can consider DL-only or UL-only per slot. In addition, for the sleep mode, we prefer to model BS energy consumption only for DL-only transmission, which means that the BS does not need a transition time/energy to wake up for UL reception. |
| DOCOMO | Y | We also would like a clarification on the second bullet. |
| CMCC | Y | Support. |
| Samsung |  | Regarding the 1st bullet, we are okay to study the BS energy consumption models for both DL and UL in general. However, we prefer to define the unified models for DL and UL to simplify the simulation assumption. Our suggestion is as following:   * **For evaluation, define the BS energy consumption model including both DL and UL at least for non-sleep mode.**   For the 2nd bullet, it is fine with us. |
| Apple |  | We would like to clarify what it means exactly to separately model energy consumption for DL and UL. Does it mean that e.g. if we can simulate DL and UL separately and evaluate the energy consumption for DL and UL separately? Or it only means in the power model itself, we define power state for DL and UL separately? (e.g. either we only have DL-only/UL-only slots, or we add the two power values up if the slot has both DL and UL.) |
| ZTE, Sanechips | Y | We are generally OK with the first bullet.  However, for the second bullet, we think it is unclear and needs to be further clarified, i.e., what the channel/signal-specific modeling means and what “some cases” refers to. |
| Fraunhofer IIS | Y |  |
| vivo | Y | We prefer a unified state for DL and UL separately for basic energy consumption model. Does the first bullet mean this?  Another question is: besides active state, what’s the energy value for a slot that has no DL or UL active and also doesn’t enter into a sleep state? Whether to define an idle state to address this should also be discussed. |
| HW/HiSi | Y | From our view, for active mode, only one active mode for DL tx only and one active mode for UL only is sufficient.  The factor that influence power is the time-domain / frequency domain utilized ratio/spatial domain RF chain ratio/power spectrum density, no matter what types of signal transmitted. So it is not necessary to have many channel specific DL modes. |
| Fujitsu | Y |  |
| Qualcomm | Y w/ update | Study whether~~/how to adopt~~ channel/signal-specific power modeling is necessary ~~for some cases~~ |
| CATT | Y | Although the Tx/Rx at gNB are aggregated signaling processing for all UEs, the individual channel model should be model to reflect some system loads with some channel transmissions only. |
| MediaTek | Y (only for 1st bullet with condition) | If separated power states for non-sleep DL and UL operations are to be defined, it will be necessary to keep minimum power states, e.g. only data/traffic and RS-only/background operations for either DL or UL, for efficient system-level simulations. Also it will be necessary to define some “combining rule” for the slot with simultaneous DL and UL processing. For the sake of progress, we can accept defining DL power states first and FFS for UL power states and the “combining rule”.  For 2nd bullet, the amount of resources in time/frequency/space/power is more relevant to BS power consumption while we think it is not necessary to define specific power states for different PHY channels. In our view, defining only data/traffic and RS-only/background operations for either DL or UL is sufficient. In this regard, we are not supportive of 2nd bullet. |
| Ericsson1 | Needs update | In our view, a DL-only evaluation without considering UL transmission or vice-versa does not provide accurate picture as both Tx and Rx can prevent the gNB from going to a sleep state. So, at least when modeling sleep states and transitions to/from sleep states, both DL and UL should be jointly considered.  Then at least for TDD, energy consumption in non-sleep state would be DL only or UL only. We propose the following update.   * For evaluation, at least for non-sleep mode (slots/symbols) and TDD, the BS energy consumption for DL and UL can be separately modelled, allowing DL-only transmission or UL-only reception ~~at least for non-sleep mode~~. * FFS: Impact of UL reception/DL transmission on sleep states and on transitions to/from sleep state. * FFS: FDD case * Study whether/how to adopt channel/signal-specific odelling ~~for some cases~~ |
| FL | Considerations/clarifications as below:   * Channel/signal-specific intends to represent slot type, e.g. active DL is represented for a slot only has SSB as one explicit state. This is one DL-only transmission without modelling UL. This is assumed true at least for active/non-sleep mode. * For simultaneous DL and UL (e.g. in FDD), it is not included in previous proposal but can be added as FFS. * There is split view. Some prefer DL-only at this moment and some consider UL needs to be considered. A slight majority prefer a simplified UL power odelling, if it is to be considered.   **FL2 Proposal 2.1-3a**   * **For evaluation, at least for non-sleep mode (slots/symbols) and TDD, the BS energy consumption for DL and UL can be separately modelled, allowing DL-only transmission or UL-only reception ~~at least for non-sleep mode~~.**   + **FFS: whether UL model can be simplified based on DL model**   + **FFS: the impact of UL-only or DL-only on sleep modes and associated transition** * **Study whether~~/how to adopt~~ channel/signal-specific energy modelling is necessary ~~for some cases~~** * **FFS: FDD** | |
| Huawei, HiSilicon | Yes | For FDD case, we think it could be combined based on UL-only model and DL-only model. Maybe we can revise the last bullet:   * **FFS: FDD, e.g. including combination the UL only model and DL only model in TDD to figure out the simultaneously UL reception and DL transmission** |
| Spreadtrum | Yes |  |
| ZTE, Sanechips |  | For the following sub-bullet, some suggestion is as below.   * + **FFS: whether UL model can be simplified ~~based on DL model~~**   For the following sub-bullet, clarification provided by proponent is appreciated.   * + **FFS: the impact of UL-only or DL-only on sleep modes and associated transition**   For the FDD model, we think it also includes some time slot that is DL-only(no reception in UL) or UL-only(no transmission in DL). Therefore, we prefer to update it to be more generic   * **FFS: FDD, e.g. based on TDD power consumption model** |
| Futurewei | Y with updates | Putting ‘FFS:FDD’ gives the wrong impression that we may not have a model for FDD. |
| Apple |  | The meaning of the two FFS sub-bullets under the first bullet are unclear to us. We could simply remove FFS for now, and agree on the main bullets first. The other details can be further discussed. |
| Intel | Y with minor updates | We don’t think we need to use (slots/symbols) next non-sleep mode. It should be valid in general.  **FL2 Proposal 2.1-3a**   * **For evaluation, at least for non-sleep mode ~~(slots/symbols)~~ and TDD, the BS energy consumption for DL and UL can be separately modelled, allowing DL-only transmission or UL-only reception ~~at least for non-sleep mode~~.**   + **FFS: whether UL model can be simplified based on DL model**   + **FFS: the impact of UL-only or DL-only on sleep modes and associated transition** * **Study whether~~/how to adopt~~ channel/signal-specific energy modelling is necessary ~~for some cases~~** * **FFS: FDD** |
| CATT | Y | The energy consumption is per slot. Thus, we agree with Intel’s revision. |
| NOKIA/NSB | Yes | Understand the intention of FL to agree on at least the TDD case with non-sleep mode. And further expand and discuss others. |
| Qualcomm |  | Our suggested **update**:   * + **FFS: whether UL-only reception energy consumption model can be derived from DL-only transmission energy consumption model ~~simplified based on DL model~~**   **FFS: the impact of UL reception and/or DL transmission ~~UL-only or DL-only~~ on sleep modes and associated transition** |
| DOCOMO | Yes |  |
| MediaTek2 | Y with update | Thanks for moderator update. Since we actually assume normalization w.r.t. time (i.e. per slot) and refer to “power”, the following revision is suggested:  **FL2 Proposal 2.1-3a**   * **For evaluation, at least for non-sleep mode (slots/symbols) and TDD, the BS ~~energy~~ power consumption for DL and UL can be separately modelled, allowing DL-only transmission or UL-only reception ~~at least for non-sleep mode~~.**   + **FFS: whether UL model can be simplified based on DL model**   + **FFS: the impact of UL-only or DL-only on sleep modes and associated transition** * **Study whether~~/how to adopt~~ channel/signal-specific ~~energy~~ power modelling is necessary ~~for some cases~~** * **FFS: FDD** |
| Qualcomm |  | Our suggested **update**:   * + **FFS: whether UL-only reception energy consumption model can be derived from DL-only transmission energy consumption model ~~simplified based on DL model~~**   **FFS: the impact of UL reception and/or DL transmission ~~UL-only or DL-only~~ on sleep modes and associated transition** |

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| Based on discussion over last round as well as email, the following can be considered:  **FL3 Proposal 2**   * For evaluation, at least for non-sleep mode and TDD, the BS energyconsumption for DL and UL can be separately modelled, allowing DL-only transmission or UL-only reception.   + FFS: whether UL-only reception energy consumption model can be derived from DL-only transmission energy consumption   + FFS: the impact of UL reception and/or DL transmission on sleep modes and associated transition * FFS: whether the model for FDD can be based on the model for TDD   **FL3 Proposal 2-1**   * Study whether channel/signal-specific energy modelling is necessary, e.g.   + SSB only   + PDCCH only   + PRACH only   + Etc. | | |
| Apple | Y | Fine with both proposals |
| BT | Y | UL and DL processes that have a significant dependence on should be analyzed are encouraged. |
| China Telecom | Y | Fine with both proposals. |
| OPPO |  | Support proposal 2. |
| DOCOMO | Y | Fine with both proposals. |
| Samsung | Yes | Fine with FL’s proposal. Regarding the Proposal 2-1, we are okay to discuss whether channel/signal-specific energy modelling is necessary, but we don’t think it is necessary because it seems to be covered by the scaling in FL3 Proposal 6. |
| CMCC | Y | Support FL3 Proposal 2.  gNB may simultaneously transmit PDCCH, PDSCH, SSB, or CSI-RS in a slot for UEs in the cell, from our perspective, we could not find the use case to consider channel/signal-specific energy modelling. |
| ZTE, Sanechips |  | We are OK with proposal 2.  **For proposal 2-1**  Network has to simultaneously transmit multiple DL channels/reference signals to one or more UEs in the cells based on a proper scheduling strategy. A channel/signal-specific energy modelling is difficult to model the actual scenarios . What’s more, when other factors such as bandwidth remain the same, there is little difference among different transmission type. Therefore, we don’t think a channel specific power consumption model is needed. |
| LG Electronics | Y | We are fine with both proposals. In addition, for the sleep mode, we prefer to model BS energy consumption only for DL-only transmission, which means that the BS does not need a transition time/energy to wake up for UL reception. |
| vivo | Y | We are fine with the proposals.  For FL3 Proposal 2, as we mentioned in 1st round comment, whether/how to define idle state, where BS is neither transmitting nor receiving but also doesn’t enter into any sleep state. In the discussed baseline scenario, i.e. without any sleep mode, this idle state will exists in evaluation. What’s the power value for this state should also be defined.  So we suggest updates as below:   * For evaluation, at least for non-sleep mode and TDD, the BS energyconsumption for DL and UL can be separately modelled, allowing DL-only transmission or UL-only reception.   + FFS: whether UL-only reception energy consumption model can be derived from DL-only transmission energy consumption   + FFS: the impact of UL reception and/or DL transmission on sleep modes and associated transition   + FFS: whether/how to define idle state, where BS is neither transmitting nor receiving but also doesn’t enter into any sleep state. |
| Intel | Y | Fine with Proposal 2.  For Proposal 2-1, some general categories can be identified depending on level of power consumption in each direction, such as PDCCH or PDSCH may be assumed to have similar reference power value per slot, whereas SSB, TRS may assumed a lower reference value than PDCCH/PDSCH per slot. Similar approach can be used for UL too. |
| IDCC | Y |  |
| Nokia/Nsb | Y |  |
| Fujitsu | Y |  |
| Panasonic | Y in general | On the proposal 2, we would like to clarify the meaning of “separate”. Does it imply the model support only DL or UL slot? We do not support if this is the intention. If not, the below amendment is proposed:  For evaluation, at least for non-sleep mode and TDD, the BS energyconsumption for DL and UL can be ~~separately~~ individually modelled, e.g. allowing DL-only transmission or UL-only reception |
| Huawei, HiSilicon | Y | We are fine with proposal 2.  For proposal 2-1, we don’t think channel-specific modelling is needed, considering gNB shall transmit signals for different UEs. We are fine with the proposal for further discussion.  However, do we need to assume the baseline is no channel-specific modelling is needed based on the majority view? It can be modelled for a given channel if justified. Therefore, a bullet is preferred to be added for proposal 2 or 2-1:   * As a baseline, non-channel/signal specific modelling is assumed and further Study for a specific channel whether channel/signal-specific energy modelling is necessary, if needed, e.g.   + SSB only   + PDCCH only   + PRACH only   + Etc. |
| MediaTek3 | Y (with update) | As per our agreement last week (quoted below),   |  | | --- | | **FL2 Proposal 2.1-1a**   * **For evaluation purpose, the energy consumption modeling for a BS includes at least the following:**   + **…**   + **Multiple power state(s) including sleep/non-sleep mode(s) with relative power, and associated transition time/energy** |   We would like to suggest the following revision to utilize terminologies based on “power”. Also since we have proposal to merge some UL-only power to DL-only power (e.g. ACK/NACK reception power as part of DL traffic power for simplicity of simulation), the first bullet is also revised.  **Proposal 2**   * For evaluation, at least for non-sleep mode and TDD, the BS ~~energy consumption~~ power states for DL and UL can be separately modelled, allowing DL-only transmission or UL-only reception.   + FFS: whether UL-only reception ~~energy~~ power consumption ~~model~~ can be derived from or merged to DL-only transmission ~~energy~~ power consumption   + …   For **Proposal 2-1**, our preference is to have simplified power states, e.g., DL RS and DL traffic, but we can live the proposal for further study. |
| Ericsson3 | Needs update | For FL3 proposal 2, we suggest promoting the following bullet to one level higher.   * + *FFS: the impact of UL reception and/or DL transmission on sleep modes and associated transition* |
| According to the input, given that the added FFS and Note is anyway for study purpose, FL suggests the following version for email approval. Also two sub-bullets are promoted since they can be out of non-sleep mode.  FL tend to consider “separately” is the same as “individually” as the proposal is for evaluation purpose, therefore even we admit it may not be the case in reality that there is only DL, it can be modeled assuming no UL for example.  Also, there is a separate proposal set for power vs energy, so the current proposal remain for this point.  **FL4 Proposal 2**   * For evaluation, at least for non-sleep mode and TDD, the BS energyconsumption for DL and UL can be separately modelled, allowing DL-only transmission or UL-only reception.   + FFS: whether UL-only reception energy consumption model can be derived from DL-only transmission energy consumption * FFS: the impact of UL reception and/or DL transmission on sleep modes and associated transition * FFS: whether/how to define an idle state, where BS is neither transmitting nor receiving but also doesn’t enter into any sleep mode. * FFS: whether the model for FDD can be based on the model for TDD   **FL4 Proposal 2-1**   * Study whether channel/signal-specific energy modelling is necessary, e.g.   + SSB only   + PDCCH only   + PRACH only   + Etc.   + Note, categorization of the above, if necessary, is possible, e.g. based on energy consumption level | | |
| Company | Y/N | Comments |
| Xiaomi |  | Y for Proposal 2  Not sure for proposal 2-1.  From our understanding, DL ,UL can be separately modelled, just as what we did in R17 UE power saving SI.  And if we have already built a slot-level model, for the specific channels mentioned above, the consumed energy can be calculated by scaling, that is according to how many symbols the channel occupied within a slot. maybe we still don’t really get the essence of Proposal 2-1, but currently we don’t think Proposal 2-1 is necessary. |
| CMCC | Y | Support FL4 Proposal 2.  For FL4 Proposal 2-1, we think it is not needed to study. |
| China Telecom | Y | We are fine with the proposal 2.  Our answer to FL4 proposal 2-1 can be found below. |
| Nokia/Nsb | Y |  |
| Qualcomm | Y |  |
| LG Electronics | Y | We are fine with both proposals. |
| vivo | Y | Support Proposal 2.  For Proposal 2-1, we don’t think it is needed. If possible, we can conclude that channel/signal-specific energy modelling is not necessary. |
| ZTE, Sanechips | Y with proposal 2 | Support FL4 Proposal 2.  For FL4 Proposal 2-1, we don’t think it is needed for study. More clarification can be seen our reply to Proposal 2-2. |
| DOCOMO | Y | Support Proposal 2. Regarding Proposal 2-1, we are fine with it but according to the companies’ comment, it would not make sense that only a specific channel/signal is transmitted in a slot because there are multiple UEs in a cell. |
| Huawei, HiSilicon | Y | Support FL4 Proposal 2.  For FL4 Proposal 2-1, agree with CMCC that this does not needs to be studied. |

* 1. **Issue#2-1**

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| For further study of Proposal 2-1,  **FL4 Proposal 2-2**   * For channel/signal-specific energy modelling for non-sleep mode and TDD, it is   + Option 1: Necessary and [why & which channels & how, e.g. categorization?]   + Option 2: Not necessary and [why?] | | |
| Company | Option 1/2 | Answers |
| Xiaomi | 2 | From our understanding, DL ,UL can be separately modelled, just as what we did in R17 UE power saving SI.  And if we have already built a slot-level model, for the specific channels mentioned above, the consumed energy can be calculated by scaling, that is according to how many symbols the channel occupied within a slot. maybe we still don’t really get the essence of Proposal 2-1, but currently we don’t think Proposal 2-1 is necessary. |
| CMCC | Option 2 | gNB may simultaneously transmit PDCCH or SSB in a slot for multiple UEs in the cell, from our perspective, we could not find the scenario that gNB transmit one channel/signal in a slot, such as PDCCH only slot. If it is needed in some scenario, PDCCH only slot or SSB only slot can be calculated by the symbol occupation scaling and RB utilization / BW scaling on the power of non-sleep mode. |
| China Telecom | Option 2 | We agree that the channel-specific energy modelling may not be needed since the situation can hardly happen. The modelling can be achieved by simplifying the modelling for the common case just for evaluating some techniques based on the light common channels/signals. |
| Nokia/Nsb | Option-2 | The explicit modeling with Option-1 could provide more precise modelling. However, it may be tedious to explicitly define all the slot types.  For simplicity, we prefer Option-2, where a single DL energy consumption value assuming a BS DL transmission over a 14-OFDM symbol slot could be defined. The different slot types can then be simply derived by scaling the single DL energy consumption value by the number of occupied OFDM symbols. For example, for 2-symbol PDCCH-only slot, a scaling by 2/14 can be applied. This latter modeling approach may be slightly less accurate, however its accuracy may be sufficient for the purpose of this study. |
| Qualcomm | 2 |  |
| LG Electronics | Option 1 | In gNB, since the energy consumption for DL transmission where PA is used dominates the energy consumption of UL reception where PA is not used, at least DL channel/signal-specific energy modeling is necessary for modeling for non-sleep mode. At least RS transmission (e.g., SSB) and data (e.g., PDSCH or PDCCH+PDSCH) transmission should be considered for channel/signal-specific energy modeling, similar to TR38.840. |
| vivo | Option 2 |  |
| ZTE, Sanechips | Option **2** | **It is not necessary .**  Network has to simultaneously transmit multiple DL channels/reference signals, for example, CSI-RS, PDCCH, PDSCH, etc., to one or more UEs in the cells. A channel/signal-specific energy modelling cannot reflect the actual scenarios. If there is only CSI-RS, or PDCCH transmitted in a specific slot, scaling rule can be applied to derive the power value.  Therefore, we don’t think a channel specific power consumption model is needed. |
| DOCOMO | Option 2 | We tend to agree that Option 2 is more reasonable because gNB simultaneously transmit different channels/signals in a slot for different UEs. |
| Huawei, HiSilicon | Option 2 | In our view, the power model of gNB of non-sleep mode depends on the used TRX chains, PSD, RB occupancy ratio etc. The transmitted channels, e.g. PDCCH, PDSCH, etc. are not the key factor.  This is different from UE power model, considering UE only needs to receive/transmit the signal/channel for the UE. However, for gNB, different channels/signals for multiple UEs shall be transmitted/received. |
| FL observation is that in case of slot-level modeling with scaling, most of the response so far prefer to model the transmission or reception on a set of symbols within a slot using linear scaling/averaging operation based on the energy consumed in a slot with 14 OS. However, this may also relate to the discussion of details about e*xplicit symbol-level power modelling* vs. *scaling slot-level power to symbol level.*  Is it helpful to draw a conclusion as a step forward?  **FL5 Proposal 2-2**  For evaluation based on BS energy consumption model, for non-sleep mode and TDD, no channel/signal-specific (i.e. slot type) to be defined. | | |
| **Company** | **Y/N** | **Comments** |
| Apple | Y with comments | One clarification question: is this for transmission only or for both transmission and reception? Comments from companies seemed to be mostly considering DL transmissions.  If it is for transmission, the BS power consumption depends more on e.g. transmit power, time occupancy etc, not much on what type of channel/signal is being transmitted. So we agree with the proposal.  For reception, we actually wonder if it may make a difference in terms of which channel/signal is being received, because the amount of processing can be different. For UE power model, we do have such differentiation.  On the other hand, if majority companies prefer not to differentiate even for reception for simplicity, we could also be flexible. |
| Intel | N | While we may not need to differentiate all the combinations of signal/channels during non-sleep modes, from power consumption perspective there is clear distinction for processing hundreds/thousands of Mbps data with PDSCH vs. sending just CSI-RS or SSB. For example, if a slot-level reference power value is assumed for DL-only non-sleep mode, Option 2 seems to suggest similar proportional scaling for 4 symbol RS/SSB and 4 symbol PDSCH (assuming they occupy same BW) which should be different in our view, at least from power consumption perspective.  To resolve concerns on complexity of the modeling and number of signal/channel combinations that needs to be considered, we can consider supporting two simple cases, (1) non-sleep(active) state that comprises of only SSB/CSI-RS/TRS like signals within a slot, and (2) all other cases that has mixture of other signal/channels.  This would be similar to what LGE has commented.  It should be noted that it would be still possible to apply scaling for BW and symbol occupancy on top of these two non-sleep state distinctions. |
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* 1. **Issue#2-2**

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| **FL4 Question 2-3**   * Do you think UL-only reception energy consumption model can be derived from DL-only transmission energy consumption for non-sleep mode and TDD? | | |
| Company | Y/N | How, if Y |
| Xiaomi | N |  |
| CMCC | N | For DL transmission, the energy from PA is non-negligible, which is much higher than the energy from LNA for UL reception, and we could not derive the relationship between energy consumption for PA and LNA. So, we prefer to separately model the BS energy consumption for DL and UL. |
| China Telecom | N | We share the similar view as CMCC that the influence of PA can be different in DL and UL. The model should be separately considered. |
| Nokia/Nsb | Please check our comments | To our understanding, the original proposal from the FL is that “**FFS: whether UL model can be simplified based on DL model**”, and the wording proposal “derived” by company is a bit miss leading and confusing.  To our view, the UL model can be simplified based on the same modelling approach as DL.  For the power consumption modelling per slot for UL, there are two options proposed:  With Option-1, Here for UL for simplicity, we don’t need to model all the UL slot types, we can explicitly model the power consumption value only for the significant ones, i.e. PUSCH, or long PUCCH.  With Option-2: We can simply model a single power consumption value with 14 OFDM symbol |
| Qualcomm | N | It is more reasonable to define separate power number for UL reception. |
| LG Electronics | N | We share the same view with CMCC. The UL-only reception energy consumption model should be separately defined from DL-only. |
| vivo | N | Agree with CMCC. |
| ZTE, Sanechips | N | The components involved in the DL transmission, and UL reception are quite different.The power of UL-only reception is different from DL-only transmission. It is unclear for us about how to derive UL-only reception from DL-only transmission. Therefore, we think the power consumption model for DL transmission and UL reception should be separately modeled.  However, we think a slot (for example, S slot) with a combination of UL+DL can be simplified as DL transmission, and the UL-only model can be also simplified. |
| DOCOMO | N | Share the same view with CMCC. |
| Huawei, HiSilicon | N | In our view, the UL-only reception energy consumption is much smaller than DL. And DL energy consumption is related to TRX chains, BW, PSD, PA efficiency, while UL energy is only related to TRX chains. So deriving or scaling from DL may not be suitable. |
| Also related to the discussion of channel/signal specific modeling. If no further request, the proposal can be considered together in **FL4 Question 2-2/FL5 Proposal 2-2.**  **No need of further input unless you think differently.** | | |
| Apple | N | It is not clear to us how to derive UL power consumption from DL model, because the processing is very different.  It is unclear to us how this is covered by P2-2. P2-2 is about whether to differentiate different channels/signals, and this one is about whether UL model is derived based on DL model. But if the intention is to simply say that we discuss two aspects together, that is fine with us. |
| Intel | N | We agree with view above and we don’t think UL-only reception energy consumption can be derived from DL. Processing and components used are quite different. |

* 1. **Issue#2-3**

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| **FL4 Question 2-4**   * ~~For non-sleep mode and TDD, w~~ What may be the potential impact of UL reception and/or DL transmission on sleep modes and associated transition? | |
| Company | Comments |
| CMCC | For clarification, the proposal may be discussed for sleep mode?   * For ~~non-~~sleep mode and TDD, what may be the potential impact of UL reception and/or DL transmission on sleep modes and associated transition?   From our understanding, the antenna elements, RF part, and baseband part are shared for DL and UL, if gNB goes to a sleep state that turns off the RF or base band part, then both DL and UL cannot be available. However, for the sleep state, such as micro sleep, that gNB only turns off the TX chain and PA part, UL reception is still available since the RX chain and LNA part is still active. |
| Nokia/Nsb | Somehow the Proposal 2-4 is overlapped with Proposal-5? Could it be clarified if different?  And for a quick reply to this proposal, we think the impact of DL and UL activity depends on the specific sleep mode. For the micro sleep, it is essentially micro DTX i.e. even if there is UL the micro DTX can still be applied in absence of DL. And as compared to the micro DTX, some deeper sleep modes like cell off clearly implies there is no DL nor UL. |
| Qualcomm | We should first discuss how sleep modes look like, and then discuss how UL Rx and/or DL Tx impact on each mode. |
| LG Electronics | For the sleep mode, we prefer to model BS energy consumption only for DL-only transmission, which means that the BS does not need a transition time/energy to wake up for UL reception. |
| vivo | It is related with how sleep mode is defined. |
| ZTE, Sanechips | It depends on the definition of sleep modes.  For the DL transmission, the main component of power consumption is PA, while for UL transmission is LNA. While for other components of UL/DL operation are common, such as baseband processing.  Therefore, if a sleep mode doesn’t require BS to switch off the common components, the impact of DL transmission/UL reception can be separately discussed. |
| DOCOMO | It depends on the definition of sleep modes. |
| Intel | We can directly focus discussion on the definitions of sleep/non-sleep states in the modeling. |

* 1. **Issue#2-4**

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| **FL4 Question 2-5**   * ~~For non-sleep mode and TDD, d~~ Do you consider there is need to define an idle state, where a BS is neither transmitting nor receiving but also doesn’t enter into any sleep mode? | |
| Company | Comments |
| Xiaomi | From our understanding, that “idle state” is kind of a sleep mode from our thinking. it is sleep mode from RF- level(the baseband processing is still on in “idle mode”), and the transition period can be very short form this idle mode to active mode(can be modelled as zero transition time) |
| CMCC | Yes. In our network, this state is used for network energy saving, which can save 10% energy consumption, and has no impact on network performance. This state is used to model short inactivity gaps when no data is transmitted, where the inactivity periods are too short to disable and restart more energy consuming resources, but power savings can still be made by putting inactive logic into a low power state. However, we propose to use micro sleep state to name it instead of idle state, because in this state, gNB still saves energy by some methods, such as putting inactive logic into a low power state. |
| China Telecom | We think the idle state can be kind of sleep mode, otherwise the definition is not needed. Such a mode should be defined in the sleep modes such as the micro sleep mode but not a state for the non-sleep mode, the power consumption can be little lower than the active mode. |
| Nokia/Nsb | We don’t see the need for Idle, because micro sleep would be more energy efficient |
| Qualcomm | Yes, some BS implementation may have such mode. In addition, the power consumption for this mode could be a good reference point for defining some scaling rule for non-sleep mode scenarios e.g., interpretation between idle mode and maximum BS Tx or Rx capability. |
| LG Electronics | Yes, the sleep mode such as micro sleep which can be switched to active mode without delay can be considered idle state. |
| vivo | As discussed, one of baseline scenario may be cells without any sleep mode. This idle state will definitely exist in this baseline evaluation. What’s the power value for this state should also be defined. We are fine with either of the following ways:  Option 1: define idle state as one power state for BS power model  Option 2: The power value of idle state refers to one defined specific power state, e.g. micro sleep as some companies suggest. |
| ZTE, Sanechips | **There is no need to define an idle state**.  As described above, idle state indicates that the BS has no transmission or reception but does not enter any sleep state. This state only occurs before the sleep states are introduced. If the sleep state is introduced, the BS can enter micro sleep state at least when there is no transmission or reception.  The definition of idle state is not helpful in comparing the advantages and disadvantages of different BS energy saving mechanisms in evaluation. Therefore, there is no need to define an idle state. |
| DOCOMO | We don’t think it is needed. It should be kind of sleep mode. |
| Huawei, HiSilicon | We think the micro sleep should be this “idle” state. |
| FL5 | Unless one response explicitly reply Yes, most of the other responses consider no need to define such a state as IDLE, instead consider it as (micro) sleep mode. It appears to be the FL consideration that such a BS can enter to sleep mode by implementation to save some power already, unless it does not want to. So the mentioned case that the gNB does not enter to sleep seems not such relevant to the study.  On the other hand, depending on how long the BS stay in this situation, it may even be possible that the gNB go into a deeper sleep mode. Therefore, it might need some clarification that whether the gNB is waiting for something (?) that may occur in a short time such that it does not (or cannot) go into a deeper sleep mode or even any sleep mode.  Continue discussion using this table, if needed. |
| Apple | This really depends on how we define micro sleep state. If micro sleep state is defined with minimum transition time (negligible), it means that the BS can transition into micro sleep even with a very short duration of inactivity. In this case, there is no need to define a separate idle state.  We actually wonder if it is better to discuss this together with the definition of sleep states. |
| Intel | From our understanding “idle” described by the question is simply another form of sleep mode. There doesn’t seem to be a need to create another terminology for our discussions. We can simply use idle mode or sleep modes for our context of discussions, which one that seems to be preferrable.  If the intention of idle state in the proposal is to distinguish from micro-sleep (for which part(s) of RF/PA can be off), we don’t see a clear need for that. As ZTE mentioned, this state can be assumed for legacy BS which does not enter sleep mode. Hence, for evaluation purposes, we can assume legacy BS only remains in non-sleep modes. |

* 1. **Issue#2-5**

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| **FL5 Question 2-6**   * Whether and how to model the case of simultaneous DL transmission and UL reception? * Whether and if yes, how the model for FDD can be defined based on the model for TDD? | | |
| **Company** | **Y/N** | **Comments** |
| Apple |  | For TDD, the power consumption of simultaneous DL and UL in a slot can be a weighted sum of DL-only and UL-only power consumption per slot based on the duration of DL and UL.  FDD may need a bit further discussion as FDD may correspond to different reference configuration. With proper scaling model defined for TDD, we think FDD power consumption for simultaneous DL and UL can be a simple summation of DL and UL power consumption. |
| Intel |  | In our view, we can work with TDD models for evaluation and discuss later what aspects can be leveraged for conclusion based FDD |

There are also contributions proposing to consider different BS types or BS categorizations in the modeling [3][4][5][18][20][22], e.g. macro BS, small cell or AAS gNB, possibly accounting for different scenarios and relative power value variations. This is one aspect that is different from the UE power saving model. Similarly, [3][18] also consider split of a BS, e.g. radio unit (RU) vs. baseband unit (BBU), or functional blocks. Since macro BS is widely adopted in previous study in IMT-2020 and also included as in above, the following can be considered.

**FL1 Proposal 2.1-4**

* **At least macro BS can be assumed for energy consumption model.**
* **Study whether/how to further adapt the energy consumption model considering different BS types/categorizations/components.**

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| **Company** | **Y/N** | **Comments** |
| Xiaomi | Y |  |
| Spreadtrum | Y | As commented for FL1 Proposal 2.1-1, we are open for modeling the different BS types. If the scaling method (e.g. power level and antenna ports number) cannot describe the difference among different BS types, we need to define several sets of modeling (e.g. macro BS, AAS gNB and small cell BS). |
| OPPO | Y |  |
| IDCC | Y |  |
| Vodafone | Y |  |
| Intel | N | We think at least two BS types should be considered, such as one macro and one small cell. Based on listed scenarios in SID, modeling of small cell BSs are important, such as for SLS evaluation of 2-layer HetNet like deployment where several small cell BSs may exist under a macro BS and it is expected that energy states of a small cell BS can be simpler. |
| NOKIA/NSB | Y | Agree to start with focusing on Macro BS.  For FR2, it makes more sense to have Micro BS being considered and modeled (if needed). |
| LG Electronics | Y | The macro BS can be a baseline and the energy consumption for different BS types/categorizations/components can be scaled or derived from the energy consumption model for the macro BS. |
| DOCOMO | Y |  |
| CMCC | Y | Since macro BS is widely used in the deployment, we support macro BS can be assumed for energy consumption model.  We do not see the need to adapt the energy consumption model considering different BS components. From our understanding, the energy consumption of BBU is mainly related to the number of baseband units, more baseband units, higher energy consumption, the network energy saving scheme or the downlink PRB utilization rate has little impact on the energy consumption of BBU. The energy consumption of AAU is mainly related to the sleep states of BS, different sleep states can save 10%-80% energy consumption of AAU. Therefore, energy consumption of BBU can be seen as static energy. Finally, the static energy consumption of BBU superimposed the dynamic energy consumption of AAU is the energy consumption of BS. There is no need to further adapt the energy consumption model considering different BS components. |
| Panasonic | Y with revision | We propose to also consider other different base station types, as also mentioned by the example scenarios in the SID. So we think the second bullet should be “Study how to further adapt the energy consumption model considering different BS types/categorizations/components.” |
| Samsung |  | We are okay with the first bullet.  For the second bullet, we have concerns on how to define the each energy consumption models for each BSs and components. Moreover, the effectiveness of potential techniques would be different according to BS types with different capabilities. So, we prefer to determine the common energy saving model. |
| Apple | Y | We are fine to start with macro BS, but we also feel that we may need a model for micro BS, which can be potentially achieved by scaling. |
| ZTE, Sanechips | Y | We generally agree the proposal 2.1-4.  For the first bullet, we agree that the macro BS should be considered for energy consumption model.  For the second bullet, it is recommended that only one base station type can be taken as the reference configuration. If other types of BS need to be discussed, the power consumption of the BS can be obtained through the scaling rules of the time domain, frequency domain, spatial domain and the power domain. Therefore, the proposal can be modified as follows.  The absolute power consumption for different BS types can be different, but BS power consumption model is a relative power consumption model, instead of an absolute power consumption model. And we don’t think we intend to compare the PS gain among different BS type. Hence, there is no need to directly define power consumption models for different BS type. |
| Fraunhofer IIS | Y | In our view, at least the differentiation of macro BS and small cell BS makes a lot of sense. The macro is one of the models but we most likely need at least 2 variations of the model (for different types). |
| Vivo | N | Agree with Intel that different BS types should be taken into account. As stated in SID, different scenarios with different BS type (macro, micro and small cell) may be involved in evaluation. Instead of prioritizing one specific scenario, a framework should be determined first. In our view, the following two methods are possible:  Option 1: Define energy state per BS type  Option 2: Define energy state for one specific BS type (e.g., Macro BS) and perform scaling (power, antenna and etc.) for other BS types.  In our view, different BS type may involve different hardware structure, simple scaling may not be reasonable. Besides, for sleep state, there is no scaling according to the following proposal. Then it means that for a specific sleep mode, the energy consumption for different BS types is the same. We are not sure this is a reasonable assumption. |
| HW/HiSi | Y | Support to focus on Macro BS to the whole structure of power modelling. Additional type of BS could be considered later or reported by individual companies. |
| Fujitsu | Y |  |
| Qualcomm | Y w/ update | * At least macro cell BS for FR1 and micro cell BS for FR2 can be assumed for energy consumption model. * Study whether/how to further adapt the energy consumption model considering different BS types (e.g., micro and small cell BS in FR1)~~/categorizations/components~~. |
| CATT | Y | We are OK to have a baseline deployment scenario with macro BS only. We could have different deployment scenario with different types of BS. |
| MediaTek | Y (small update on QC revision) | We support QC revision with “adapt” in 2nd bullet further revised to “adapt/scale” since power model of different BS types can be approximated by a set of power scaling factors. |
| Ericsson1 | Clarification needed | From description above, it is not clear if the term “macro-BS” includes BS with AAS support which is common in current deployments. Massive MIMO AAS BS should be considered as the starting point as discussed in our contribution.  So, the terminology used in the proposal needs to be clarified. Another option is to directly discuss reference configurations and avoid discussion on terminology. |

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| There are large support to start from Macro BS and there are some preference to support different modeling for different BS types. At least we should start from somewhere for the discussion, for understanding the difference among different BS types.  That said, in addition to the above, further questions are added to help the discussion.  **FL3 Proposal 3**   * As a starting point, macro cell BS with massive MIMO for FR1 is assumed for energy consumption model.   **FL3 Proposal 3-1**   * Study whether/how to adapt the energy consumption model considering different scenarios/BS types/categorizations/components, e.g.   + If no scaling is applied for sleep mode, whether a macro cell BS share the same power as a small cell BS and if not, how to handle it.   + How to handle the power systems loss including DC-DC converter loss, main power supply loss, active cooling. | | |
| Apple | Y | A minor suggestion on P3-1: “Whether/How to handle the power systems loss” |
| BT | Y, update | Massive MIMO is ambiguous. Also systems like 4T4R may still form a large portion of a RAN, so it is preferable to address those deployment if possible.  All major elements of power consumption should be considered, at least to set the perspective of the scale of proposed enhancements in the SI, e.g. are we addressing 1% of the overall consumption or say 30%.  **Proposal 3**   * As a starting point, macro cell BS with ~~massive MIMO~~ antenna configurations with [4/8/32/64] transceiver ports for FR1 is assumed for energy consumption model.   **Proposal 3-1**   * Study ~~whether/~~how to adapt the energy consumption model considering different scenarios/BS types/categorizations/components, e.g.   + If no scaling is applied for sleep mode, whether a macro cell BS share the same power as a small cell BS and if not, how to handle it.   How to handle the power systems loss including DC-DC converter loss, main power supply loss, active cooling. |
| China Telecom | Y | The macro cell BS with massive MIMO for FR1 can be a good start point.  And for further study for the small cell, we think the number of sleep mode can even less than the macro cell. We should find out what components are common and can be shut down in which modes, then the power can be acquired by referring to the power of active/corresponding sleep of macro cell and the active power of small cell.  For the second bullet, we think some of the power system loss may not needed since they have no influence on the evaluation of energy consumption and the potential techniques. The modification from APPLE seems fine. |
| OPPO |  | Support proposal 3 as a starting point. |
| DOCOMO | Y | Fine with the proposal |
| Samsung |  | FL’s Proposal 3 – Fine with us.  FL’s Proposal 3-1 – We are generally fine with main bullet, but don’t support the 2nd sub-bullet. We don’t think the DC-DC converter loss, main power supply loss and active cooling are the scope of RAN1 (and not even 3GPP). Therefore, we would like to suggest to remove the last sub-bullet. And for the clarification on the 1st sub-bullet, we updates as below:  **FL3 Proposal 3-1**   * Study whether/how to adapt the energy consumption model considering different scenarios/BS types/categorizations/components, e.g.   + The scaling according to different BS types for sleep and non-sleep mode. ~~If no scaling is applied for sleep mode, whether a macro cell BS share the same power as a small cell BS and if not, how to handle it.~~   ~~How to handle the power systems loss including DC-DC converter loss, main power supply loss, active cooling.~~ |
| CMCC | Y | Support |
| ZTE, Sanechips |  | We are OK with proposal 3.  **For proposal 3-1**  We agree to take macro cell BS as the starting point. For other types of BS energy consumption modeling, we can discuss it after determining the macro BS energy consumption model. Therefore, we suggest to modify proposal 3-1 as follows.  **FL3 Proposal 3-1**   * Study whether/how to adapt the energy consumption model considering different scenarios/BS types/categorizations/components, e.g.   + FFS details.   + ~~If no scaling is applied for sleep mode, whether a macro cell BS share the same power as a small cell BS and if not, how to handle it.~~   + ~~How to handle the power systems loss including DC-DC converter loss, main power supply loss, active cooling.~~ |
| LG Electronics | Y | We are fine with both proposals as a starting point, and also fine with modifications from Apple and BT. |
| vivo | Y (partially) | We are fine with the main bullet and 1st sub-bullet of the proposal.  For the second sub-bullet, we don’t quite understand the motivation. In our opinion, there is no need to consider them since it seems the power consumption there is out of scope of communication. Similarly in UE power saving, power consumption for screen and etc. is not considered. |
| OPPO2 |  | We would like to clarify the macro cell BS follows parameter configuration of UMa scenario in Table 7.2-1 in TR38.901 and propose the following update for proposal 3:   * As a starting point, macro cell BS (i.e., UMa scenario in Table 7.2-1 in TR38.901) with massive MIMO for FR1 is assumed for energy consumption model.   For proposal 3-1, it is appreciated to provide the detailed cell configuration parameters if other scenarios/BS types are considered. |
| Intel | Y | Fine with Proposal 3 and 3-1.  We think we do not need to mention massive MIMO in the proposal 3. Agreeing the reference configuration is sufficient.  We support the minor updates from Apple and BT on the following.  “Whether/How to handle the power systems loss”  Study ~~whether/~~how to adapt the energy consumption model considering different scenarios/BS types/categorizations/components |
| IDCC | Y |  |
| Nokia/Nsb | Y |  |
| Fujitsu | Y | We support the modification from BT on “antenna configurations with [4/8/32/64] transceiver ports” |
| Panasonic | Y | We are okay. |
| Huawei, HiSilicon | Y, with update | For proposal 3, it is good that we can have a model as a starting model. Regarding the TRX chain numbers raised by BT, we think it can be aligned with the reference configuration for TDD in FR1, as a starting point.  For the proposal 3-1, we also have concern on the second bullet. For the energy consumption of “the power systems loss including DC-DC converter loss, main power supply loss, active cooling.”, it is out of scope of 3GPP and may vary case by case. It seems not possible to be reasonably modelled in 3GPP. Similarly, in UE power saving energy, the power consumption other than the modem part, e.g. the screen, CPU power consumption, are not modelled due to the similar reasons. We think the second bullet should be removed. |
| MediaTek3 | Y | For Proposal 3, although we prefer to utilize power consumption model since we agree to define “power” states and relative “power”. But we can live with “energy consumption model”  For Proposal 3-1, we also suggest to start with whether/how for 2nd subbullet (power systems loss) as proposed by Apple |
| Ericsson3 | Needs update | Agree with Huawei comment on proposal 3-1. |
| There is general support of Proposal 3 except for the term of ‘massive MIMO’, for which more detailed/clarification is preferred by companies. Therefore the following can be suggested for email approval. Further details or down-selection of values can be next step.  **FL4 Proposal 3**   * As a starting point, macro cell BS with antenna configurations of [4/8/32/64, to be aligned with ref. config.] transceiver ports for FR1 is assumed for energy consumption model.   For Proposal 3-1, there is preference to remove “whether” from the main bullet and to add “whether” onto the second sub-bullet. There is also preference to remove all details. It is FL understanding that they are the controversial parts that require a bit more discussion and listing the example areas might help further discussion, thus suggests to agree it as it is. More discussion can be continued using FL4 Question 3-2.  **FL4/FL5 Proposal 3-1**   * Study whether/how to adapt the energy consumption model considering different scenarios/BS types/categorizations/components, e.g.   + If no scaling is applied for sleep mode, whether a macro cell BS share the same power as a small cell BS and if not, how to handle it.   + How to handle the power systems loss including DC-DC converter loss, main power supply loss, active cooling. | | |
| Company | Y/N | Comments |
| CMCC | Y | Support |
| China Telecom | Y | Support. |
| Nokia/Nsb | Y |  |
| Qualcomm | Y w/ update | Since the antenna configuration is discussed in reference configuration (issue#4), we do not need to include it in the proposal.  We prefer to have separate energy consumption models for FR1 and FR2. In particular, we strongly believe that FR2 energy consumption model should not be simply scaled from FR1 counterpart.:  **FL4 Proposal 3**   * As a starting point, macro cell BS ~~with antenna configurations of [4/8/32/64, to be aligned with ref. config.] transceiver ports~~ for FR1 and micro cell BS for FR2 are ~~is~~ assumed for energy consumption model. |
| LG Electronics | Y, partially | One comment for the second sub-bullet. As several companies pointed out, it is unclear how RAN1 can handle such power losses. Thus, we prefer to delete the second sub-bullet or change to Whether/How to handle the power systems loss including DC-DC converter loss, main power supply loss, active cooling. |
| vivo | Y (Partially) | For the 2nd sub-bullet, we still don’t hear any technical reason for this yet from proponents. We prefer to remove the whole sub-bullet. |
| ZTE, Sanechips | Y | We are generally OK with the proposal 3 and proposal 3-1.  As discussed in reference configuration, the number of TX/RX chain is used, while in proposal 3, transceiver ports is used for antenna configurations. It is better to use the same terms. Therefore, the following modification is suggested.  **Proposal 3**   * As a starting point, macro cell BS with antenna configurations of [4/8/32/64, to be aligned with ref. config.] transceiver chains ~~ports~~ for FR1 is assumed for energy consumption model. |
| DOCOMO | Y | Support |
| Huawei, HiSilicon | Y with update | Add whether for the last bullet:   * Whether and how to handle the power systems loss including DC-DC converter loss, main power supply loss, active cooling. |
| Apple | Y (partially) | It is also a bit unclear to us how to handle the 2nd bullet in RAN1. |
| Intel |  | Suggest to work with what was available during GTW.  Possible Agreement  As a starting point,   * macro cell BS for FR1 is assumed for energy consumption model. * micro cell BS for FR2 is assumed for energy consumption model.   The text, “[4/8/32/64, to be aligned with ref. config.]” is bit problematic, as for the modeling purpose, it is completely fine to have multiple antenna configurations (to aid modeling of spatial power saving techniques), but for reference model, it is preferred to have a single configuration (or at the very least minimum set of configurations). Having a single set of configuration would facilitate potential calibration efforts and aid alignment of companies evaluations.  For proposal 3-1, it generally states study, so there isn’t much to comment. With that said, we think this should be discussed together with Proposal 2.1-4. |

* 1. **Issue#3-1**

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| Some of the options have been mentioned in the discussion of other proposals but better to setup a question dedicated for collection/discussion of company views.  **FL4/FL5 Question 3-2**   * In addition to macro cell BS, whether and which other BS do you think is significantly different from macro that needs to be separately considered?   + Option 1: None;   + Option 2: Yes, [e.g.], and the model for other BS can be obtained from macro cell BS by scaling, therefore no other special modelling needed;   + Option 3: Yes, and special modeling is needed by [which and why] | | |
| Company | Option | Comment |
| CMCC | Option 2 | In addition to macro cell BS, small cell BS can also be considered. However, to consider the workload and effort of modelling, we prefer to obtain the model for small cell BS by scaling from macro cell BS. |
| China Telecom | Opition 2 |  |
| Nokia/Nsb | Option 2 |  |
| Qualcomm |  | What is the FL view on modelling FR1 and FR2 energy consumption if our suggested addition in FL4 proposal 3 is not taken into account? |
| LG Electronics | Option 2 | If there is a consensus that other BS needs to be considered, it can be obtained by scaling the energy consumption model of macro cell BS. |
| vivo | Option 3 | In addition to macro cell BS, small cell BS can also be considered.  If option 2 is used, we have the following questions:  Question 1: How to perform scaling? Transmit power, antenna scaling only for small cell BS? One additional scaling factor for small cell BS type applied to all the non-sleep power states?  Question 2: is there scaling for sleep modes? If yes, the same scaling factor as non-sleep power states?  For option 3, the same framework could be used for macro cell and small cell. Only different power value for macro cell and small cell needs to be determined. We prefer option 3 since it is simple and clear. |
| ZTE, Sanechips | Option 2 | Only one type of base station used may not satisfy the evaluation of different BS energy saving scenarios. But there is no need to define power consumption model for all BS types.  The absolute power consumption for different BS types can be different, but BS power consumption model we discussed is a relative power consumption model. If other types of BS need to be discussed, the power consumption of the BS can be obtained through the scaling rules of the time domain, frequency domain, spatial domain and the power domain. |
| DOCOMO | Option 2 |  |
| Huawei, HiSilicon | Option 1 | Considering the limited time, we prefer to focus on the power saving for macro BS. |
| Apple | Option 1 or Option 2 |  |
| Intel | Option 3 | It would be good to have a secondary BS type that is based on small compact form factor (targeting pico-cells). These small form factor BS, typically have completely different power classes design and functional requirements, and it would be difficult to perform some simple scaling based on macro BS that could be composed of multiple physical nodes (e.g. CU/DU/RU), or completely ignore such BS types exists. Having a second BS type will be particular useful to investigate spatial domain techniques that disable micro/pico cells and offload users to macro sites. |

[3][20] mention that the BS energy consumption model may need to reflect the technology trend for potential improvements or being future proof.

**FL1 Proposal 2.1-5**

* **Study whether/how to further adapt the energy consumption model in consideration of technology trend in e.g. a few years.**

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| **Company** | **Y/N** | **Comments** |
| Xiaomi | Y |  |
| Spreadtrum | Y | As mentioned in SID, the green fields and non-backward compatibility can be considered. |
| OPPO |  | This can be discussed in a case-by-case manner. A general consideration of technology trend might be too vague and it might cause some aggressive/impractical assumptions. |
| IDCC | Y |  |
| Vodafone |  | Agree with OPPO’s view. We sort of see the opposite of the proposal, not to adapt on new trends but rather for current configurations that will stay for a while such as DSS. |
| Intel | Y | We think it is very important that develop model remains flexible enough so that different functional splits of future BS architectures can be accommodated into the developed model. One good example is defining multiple sleep modes, such as up to 4. This may allow modeling of architectures such as different groups of HW components can be operated in a distributed manner. |
| NOKIA/NSB | Y | To our view, it is an important issue need to be clarified for this study, on whether the BS power consumption should reflect today’s base stations or future BS technologies. And it is understood from the FL’s proposal that, the modelling consideration is on future BS technologies. |
| DOCOMO | Y |  |
| CMCC | Y | Support. |
| Panasonic | Y | In our opinion, this should be reflected by the scaling method in the power model. |
| Samsung | N | Without knowing the future technology trend for now, it is difficult for us to be on the same page of what we agreed on. Anyhow, even without this proposal, it can be discussed based on company’s contribution. |
| Apple |  | This proposal is too generic and we are not sure what it implies exactly. Does it mean we need to be very aggressive on the power model? By how much? |
| ZTE, Sanechips | N | It is helpful to establish a energy consumption model that conforms to the future technology trend.  However, at present, it is unclear know what the future techniques are, and the impacts on the energy consumption model and specifications are unknown. We cannot clearly tell which parts of the energy consumption model should be adjusted to align with the potential trends. Therefore, we don’t think it is critical to discuss the details of the energy consumption model with future technological trends now. |
| Fraunhofer IIS |  | We share similar view as OPPO. |
| Vivo |  | We are unclear how such proposal can guide the future work. What can be achieved by the current implantation is also important. This can be discussed case by case. |
| HW/HiSi |  | We agree with OPPO and VDF that the technology trend might be vague for the study.  At least the current technology (R17) or implementation should be well modeled.  Enhanced technology could be reported by companies and with corresponding energy saving result. |
| Fujitsu |  | We feel sympathy with Oppo’s view. It is necessary to discuss how to avoid impractical assumptions when considering future trend. |
| Qualcomm | Y |  |
| CATT | N | We consider our implementation with most advanced technologies. The technology trend does not provide a realistic implementation possibility. In particular, this is a proprietary implementation issue unless companies might be willing to reveal their implementation of gNB in detail. |
| MediaTek | N | Experience from UE power saving works shows a relative power consumption model is good enough even with multiple generations of chip evolution. In this regard, it may not be really worthy of accommodating future trends, particularly considering the limited study time. |
| Ericsson1 |  | We agree with the intention. RAN1 has to agree on a model according to the SID schedule and as discussed in our contribution, the modeling effort in the SI should already avoid both overly conservative estimates, assuming older technology, and highly optimistic estimates presuming technology disruptions. However, we do not see a strong need to make separate RAN1 agreement regarding this. |
| FL3 | The proposal can be revisited later. | |

[3] proposes to clarify that the study does not consider multi-RAT mode. There was a relevant discussion in RAN plenary on consideration for LTE, and the outcome is that ‘no impact to LTE expected in case of DSS’. This proposal can be further considered if clarification is deemed necessary.

## Reference configuration

Generally both FR1 and FR2 are considered. And there is good convergence on the inclusion of frequency, BW size, antenna configuration, SCS, number of component carriers (CC), and power level. There are also channel/signal specific configurations proposed. In view of proposed parameters, the following can be considered. Note currently it is proposed with square bracket even if it is proposed by an operator. Some parameters may be missing due to lack of proposals but can be further discussed/determined within this meeting. TDD structure is listed in [5][18]. This can be further discussed/determined along with other (missing) parameters.

**FL1 Proposal 2.2-1**

* **At least TDD should be included for evaluation of FR1 and FR2. FFS FR1 FDD.**
* **For FR1, at least the following should be considered for reference configuration**
  + **DL**
    - **frequency range [2.6 GHz]**
    - **system BW [100 MHz]**
    - **SCS [30 kHz]**
    - **number of CC [1]**
    - **TX [64]**
    - **Power level [FFS]**
    - **[common signal/RS, SSB periodicity 20 ms x 2 per slot]**
    - **FFS other channel/signal, e.g. PDCCH/PDSCH**
  + **UL**
    - **system BW [100 MHz]**
    - **SCS [30 kHz]**
    - **number of CC [1]**
    - **RX [1]**
* **For FR2, at least the following should be considered for reference configuration**
  + **DL**
    - **frequency range [28 GHz]**
    - **system BW [400 MHz]**
    - **SCS [120 kHz]**
    - **number of CC [16]**
    - **TX chain [2]**
    - **Power level [FFS]**
    - **[common signal/RS, SSB periodicity 20 ms x 2 per slot]**
    - **FFS other channel/signal, e.g. PDSCH**
  + **UL**
    - **system BW [400 MHz]**
    - **SCS [120 kHz]**
    - **number of CC [16]**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Xiaomi | Y(generally) | Detailed values can be changed based on further discussion |
| Spreadtrum | Partial Y | The reference configuration is used as the reference of BS energy consumption. The reference should be single CC. For CA case, the energy consumption of multi CC can be multiples of that of single CC. |
| OPPO |  | Detailed parameters/values can be further discussed. |
| IDCC | Y | Final values can be decided based on further discussion. |
| Intel | Y, partially | We have following suggestion for revision   * Carrier frequency : ~~2.6 GHz~~ 4GHz * Add for both FR1 and FR2, Number of TRP: 1 * BS Power level in FR1 and 2 can follow the assumption in TR 38.802   FR2: Number of CC: ~~16~~ 1 |
| NOKIA/NSB | Y, partially | For FR2, we have the following proposal regarding system BW and number of CC   * For FR2, at least the following should be considered for reference configuration   + DL     - frequency range [28 GHz]     - system BW [~~400~~100 MHz]     - SCS [120 kHz]     - number of CC [~~16~~1]     - TX chain [2]     - Power level [FFS]     - [common signal/RS, SSB periodicity 20 ms x 2 per slot]     - FFS other channel/signal, e.g. PDSCH   + UL     - system BW [~~400~~100MHz]     - SCS [120 kHz]     - number of CC [~~16~~1] |
| LG Electronics | Y,  partially | We are fine except for the number of CCs for FR2. We prefer 1 CC evaluation as the baseline for both FR1 and FR2, and companies can extend evaluation assumption to CA case if needed. |
| China Telecom | Y, partially | We are generally fine with the proposal.  However, for the frequency range for FR1, we think the 4GHz may be more representative and common. We suggest to modify the reference configuration as follow:  • Carrier frequency : 4GHz [2.6GHz]  The details for other parameters can be further discussed. |
| DOCOMO | Y, partially | We have the following suggestions for revision:   * FR1   + frequency range [~~2.6 GHz~~ 4 GHz] * FR2   + system BW [~~400 MHz~~ 100 MHz]   + number of CC [~~16~~ 1] |
| CMCC | Y, partially | For FR1 UL, why the RX number is [1]? From our deployment, the RX number is 64. So, we propose to modify the RX number to [64].  Yes for the FR1 frequency range, we think 2.6GHz needs to considered due to large scale deployment. |
| Panasonic | Y |  |
| Samsung |  | Suggest to reformulate as following:   * **For FR1, at least the following should be considered for reference configuration**   + **Common**     - **Duplex: TDD**     - **frequency range [2.6 GHz]**     - **system BW [100 MHz]**     - **SCS [30 kHz]**     - **FFS other channel/signal, e.g. PDCCH/PDSCH**   + **DL**     - **number of CC [1]**     - **TX [64]**     - **Power level [FFS]**     - **[common signal/RS, SSB periodicity 20 ms x 2 per slot]**   + **UL**     - **number of CC [1]**     - **RX [1]** * **For FR2, at least the following should be considered for reference configuration**   + **Common**     - **Duplex: TDD**     - **frequency range [28 GHz]**     - **system BW [400 MHz]**     - **SCS [120 kHz]**     - **FFS other channel/signal, e.g. PDSCH**   + **DL**     - **number of CC [16]**     - **TX [2]**     - **Power level [FFS]**     - **[common signal/RS, SSB periodicity 20 ms x 2 per slot]**   + **UL**     - **number of CC [16]**     - **RX [1]** |
| Apple |  | We also think 1 CC should be the baseline for both FR1 and FR2. |
| ZTE, Sanechips | Y with some update | **For FR1 & FR2:**   1. The impact of carrier frequency are not easy to be reflected in the power consumption model. In a CA scenario, multiple carrier frequency may be involved, and different combinations of carrier frequency can be considered. It is complicated to model these carrier frequency one by one, the discussion will be lengthy and controversial. Therefore, clarifications about the necessity of carrier frequency are appreciated.   In our understanding, there is no need to consider carrier frequency in the reference configuration. Two categories, i.e., FR1 and FR2, are sufficient.  It is also noticed that in TR38.840, the carrier frequency is not mentioned in reference configuration.   1. In TR38.840, the configuration of some channel, e.g., PDCCH BD times, will impact UE power consumption. However, for BS model, these similar impact is not foreseen.   Therefore, the configuration of the common signal/RS and other channel/signal should be considered in the simulation assumption, which needn’t to be considered in the reference configuration.  **For FR1:**   1. For FR1, 1 RX is not reasonable for BS, 64R is recommended.   **For FR2:**   1. For 400 MHz system bandwidth, the SLS workload will overburden. The 100 MHz system bandwidth is recommended. 2. For FR2, one CC should be used as the reference configuration. 3. Same as FR1, the configuration of the common signal/RS and other other channel/signal should be considered in the simulation assumption, which needn’t to be considered in the reference configuration. 4. For UL, the configuration of the receiving antenna is missing.   To sum up, we suggest  **Proposal 2.2-1**   * **At least TDD should be included for evaluation of FR1 and FR2. FFS FR1 FDD.** * **For FR1, at least the following should be considered for reference configuration**   + **DL**     - **~~frequency range [2.6 GHz]~~**     - **system BW [100 MHz]**     - **SCS [30 kHz]**     - **number of CC [1]**     - **TX [64]**     - **~~Power level [FFS]~~**     - **~~[common signal/RS, SSB periodicity 20 ms x 2 per slot]~~**     - **~~FFS other channel/signal, e.g. PDCCH/PDSCH~~**   + **UL**     - **system BW [100 MHz]**     - **SCS [30 kHz]**     - **number of CC [1]**     - **RX [64~~1~~]** * **For FR2, at least the following should be considered for reference configuration**   + **DL**     - **~~frequency range [28 GHz]~~**     - **system BW [100 ~~400~~ MHz]**     - **SCS [120 kHz]**     - **number of CC [1 ~~16~~]**     - **TX chain [2]**     - **Power level [FFS]**     - **~~[common signal/RS, SSB periodicity 20 ms x 2 per slot]~~**     - **~~FFS other channel/signal, e.g. PDSCH~~**   + **UL**     - **system BW [100 ~~400~~ MHz]**     - **SCS [120 kHz]**     - **number of CC [1 ~~16~~]**     - **RX chain [2]** |
| Fraunhofer IIS | Y |  |
| vivo | Y, partially | For FR1 UL, 1 Rx is not typical; For FR2 UL, Rx number is missing.  For FR2, number of CC should be 1 for reference configuration. |
| HW/HiSi | Y | For the proposed configuration, we are OK to put the values in square brackets for further discussion. And we think 4GHz seems be more assumed in 3GPP study for FR1 TDD. Therefore, maybe 4GHz could be utilized.  Besides the proposal on TDD FR1, we think FR1 FDD should be also considered, which has also good commercial deployment today. And the reference configuration template is listed as following:   * BS DL: FR1 FDD   + SCS: 15 kHz   + Number of carrier: 1 Component carrier (CC)   + System bandwidth: 20 MHz   + Transmit antenna configuration: [8, 16 or 32] Tx   + Power levels: [FFS] dBm |
| Fujitsu | Y, partially | Simulation assumption in TR38.802 including frequency range, system BW and number of CC can be the baseline for reference configuration. |
| Qualcomm | Y w/ update | * At least TDD with massive MIMO should be included for evaluation of FR1 and FR2. FFS FR1 FDD. * For FR1, at least the following should be considered for reference configuration   + DL     - Carrier frequency ~~range~~ [2.6 GHz]     - system BW [100 MHz]     - SCS [30 kHz]     - number of CC [1]     - ~~TX~~ The number of TxRUs [64]     - Tx Power level and corresponding PA efficiency [FFS]     - [common signal/RS, SSB periodicity 20 ms x 2 per slot]     - FFS other channel/signal, e.g. PDCCH/PDSCH * For FR2, at least the following should be considered for reference configuration   + DL     - frequency range [28 GHz]     - system BW [400 MHz] system BW [100 MHz]     - SCS [120 kHz]     - number of CC [16] number of CC [1]     - TX chain [2]     - Tx Power level and corresponding PA efficiency [FFS]     - [common signal/RS, SSB periodicity 20 ms x 2 per slot]     - FFS other channel/signal, e.g. PDSCH   + UL     - system BW [400 MHz] system BW [100 MHz]     - SCS [120 kHz]     - number of CC [16] number of CC [1]   Comment: That needs to be more specific for SSB, SIB1 and Ros |
| CATT | Y/partially | For FR1, the UL Rx = 1 is not an usual case in the gNB deployment.  For FR2,   * The BW should be 100 MHz. * Number of CC should be [1] |
| MediaTek | Y with updates | * For FR1, it looks both 2.6 GHz and 4 GHz are both of interest. Given macro cell in FR1 will be the reference configuration, 2.6 GHz looks more reasonable, yet we can include 4 GHz when 2 CC case is considered (e.g. for inter-band SSB-less study). Accordingly, the following revision for FR1 is suggested:   + - **Frequency range [2.6 GHz; +4 GHz for 2 CC case]**     - **system BW [100 MHz]**     - **SCS [30 kHz]**     - **number of CC [1 or 2]** * For FR2, it is common understanding that wider spectrum is available, and thus a smaller total BW than FR1 looks not common. In this regard, the following revision is suggested:   + - **system BW [~~400 MHz~~ 100 MHz]**     - **SCS [120 kHz]**     - **number of CC [~~16~~ 4]**     Structure suggested by Samsung looks good to us. |
| Ericsson1 | Needs update | We support the revisions from DOCOMO.  Additionally, suggest making below updates. Regarding common signal/RS, it may need some clarification and hence for now suggest starting with SSB periodicity 20 ms.   * + FR1, UL     - RX [~~1~~ 64]   + FR2     - RX [~~1~~ 64]     - TX[~~2~~ 64]   + [~~common signal/RS,~~ SSB periodicity 20 ms ~~x 2 per slot~~] |
| FL | Consideration/clarification:   * For carrier frequency, add ‘if needed’ and would like to hear more companies view. * For FR2, note it is RF chain number. But proposal from companies is added for potential consideration or clarification. * Adding FDD FR1. * Assuming other parts are stable, square bracket is removed.   **FL2 Proposal 2.2-1a**   * **~~At least TDD should be included for evaluation of FR1 and FR2. FFS FR1 FDD.~~** * **For FR1, for single CC case (FFS multiple CC), at least the following should be considered for reference configuration**   **Set 1**   * + **Common**     - **Duplex: TDD**     - **frequency range, if needed: 4 GHz, optional 2.6 GHz**     - **system BW: 100 MHz**     - **SCS: 30 kHz**     - **FFS: other channel/signal, e.g. PDCCH/PDSCH**   + **DL**     - **number of CC: 1**     - **number of TRP: [1]**     - **number of TxRU ~~TX~~: 64**     - **Power level [~~FFS~~ TR38.802 as starting point, FFS PA efficiency]**     - **[common signal/RS if needed: SSB periodicity 20 ms ~~x 2 per slot~~]**   + **UL**     - **number of CC: 1**     - **RX: [64 ~~1~~]**   **Set 2, Optional**   * + **Common**     - **Duplex: FDD**     - **system BW: 20 MHz**     - **SCS: 15 kHz**   + **DL**     - **number of CC: 1**     - **number of TxRU: 8/16/32**     - **Power level [FFS]** * **For FR2, for single CC case (FFS multiple CC), at least the following should be considered for reference configuration**   + **Common**     - **Duplex: TDD**     - **frequency range, if needed: 28 GHz**     - **system BW: ~~400~~ 100MHz**     - **SCS: 120 kHz**     - **FFS other channel/signal, e.g. PDCCH/PDSCH**   + **DL**     - **number of CC: ~~16~~ 1**     - **number of TRP: [1]**     - **TX chain: [2/64]**     - **Power level [~~FFS~~ TR38.802 as starting point, FFS PA efficiency]**     - **[common signal/RS if needed: SSB periodicity 20 ms ~~x 2 per slot~~]**   + **UL**     - **number of CC: ~~16~~ 1**     - **RX chain: [1/2/64]** | |
| Huawei, HiSilicon | Yes with some update | For the PA efficiency part, we think it does not belong to the reference configuration. It could be discussed in BS power model, if the group thinks necessary. We think the “FFS PA efficiency” should be removed here.  For FDD part, we can add the UL part and we prefer to remove optional for FDD considering FDD also has good commercial deployement.  **Set 2~~, Optional~~**   * + **Common**     - **Duplex: FDD**     - **system BW: 20 MHz**     - **SCS: 15 kHz**   + **DL**     - **number of CC: 1**     - **number of TxRU: 8/16/32**     - **Power level [FFS]**   + **UL**     - **number of CC: 1**     - **RX chain: 8/16/32** |
| Spreadtrum | Yes |  |
| ZTE, Sanechips |  | For the carrier frequency, as we commented in the first round of discussion, we think we don’t need it in the reference configuration. The reasons are as below   1. In TR38.840, there is no carrier frequency involved in reference configuration of UE power consumption model, either.  |  | | --- | | 8.1.1 UE power consumption model for FR1 **Reference Configuration for FR1**  - Downlink: TDD  - Subcarrier spacing (SCS): 30 kHz  - Number of carrier: 1CC,  - System Bandwidth: 100 MHz |  1. Since there are more than 1 carrier frequency listed, it already implies that the power consumption model can be applied to different carrier frequency. 2. It is a relative power consumption model, instead of absolute power consumption model   Hence, we suggest to remove the carrier frequency in the reference configuration.  For PA efficiency, we also think it can be included in scaling factor discussion. |
| Apple |  | For FR2, it has “TX chain: [2/64]” for DL, and “RX chain: [1/2/64]” for UL. We wonder why we need to consider a case where the # of RX chain is smaller than # of TX chain. |
| Intel | Y with update | We agree that Set 2 should be optional and Set 1 is baseline  For FR2, we suggest using 400MHz for system BW as baseline, other values optional. |
| CATT | Y | We are OK with the update. The Tx power level for gNB should be set based on TS38.104.  Power amplifier efficiency is an implementation issue and does not need to be included in the system configuration. |
| NOKIA/NSB | Yes |  |
| Qualcomm |  | * The carrier frequency is only needed for SLS but not needed for BS power modelling. * We should keep PA efficiency since it is directly related to PA power consumption that is majority of BS power consumption. Without a reference on PA efficiency, BS power consumption models to be proposed will be very diverse. In addition, it also gives us the baseline for discussing the scaling later. As being said, we propose to update “**FFS PA efficiency**” to “**PA efficiency (FFS value)**”. * Does the BS energy consumption power consider power systems loss (e.g., DC-DC converter loss, main power supply loss, active cooling)? If not, why? It should be noted that we should know how significant a PHY/MAC enhancement can contribute to the overall BS energy savings. Hence, we propose to add **FFS power system loss** in the reference configuration. * In general the suggested parameters are accepted, with the suggested modifications **(in dark blue)** * **For FR2, for single CC case (FFS multiple CC), at least the following should be considered for reference configuration**   + **Common**     - **Duplex: TDD**     - **frequency range, if needed: 28 GHz**     - **system BW: ~~400~~ 100MHz**     - **SCS: 120 kHz**     - **FFS other channel/signal, e.g. PDCCH/PDSCH**   + **DL**     - **number of CC: ~~16~~ 1**     - **number of TRP: [1]**     - **TX chain: [2/64]**     - **Power level [~~FFS~~ TR38.802 as starting point, FFS PA efficiency]**     - **[common signal/RS if needed: SSB periodicity 20 ms ~~x 2 per slot~~]**   + **UL**     - **number of CC: ~~16~~ 1**     - **RX chain: [1/2/64]** |
| CMCC | Y | We agree with ZTE and Qualcomm that the carrier frequency is not needed for power model. If it is needed in some cases that we have not identified, we prefer to still use 2.6 GHz as mandatory and 4 GH as optional, since we found most companies did not have concerns on 2.6 GHz for carrier frequency in the 1st round of comment. |
| DOCOMO | Yes with clarification | We are generally fine with the update, but have one question. There are multiple candidate values for TxRU/TX chain/RX chain. Does it mean we need to evaluate for all the cases or they will be down-selected to one candidate at later stage? Note that single value is defined for the UE power model. |
| LG Electronics | Y with partially | Considering the limited time, it is desirable to focus only on the configuration that all companies agree on. Therefore, we think that Set 1 is sufficient with reference configuration and Set 2 is not necessary. |
| MediaTek2 | Y with clarification | Thanks moderator for the updated proposal. We would like to ask for clarification on the following two items:   * Does “number of TRP: [1]” mean we have one gNB serve a cell? That is more advanced multi-TRP deployment is optionally included in SLS. * For FR2 UL, does “RX chain: [**64**]” mean there are 64 **panels** in gNB so that up to 64 data streams can be received and processed by gNB? |

|  |  |
| --- | --- |
| If there are multiple values in square bracket, they are to be down-selected in probably next meeting unless we have explicit agreements on optional ones or both. If there is single value, it is to be confirmed.  Also, the proponent (Ericsson) may want to clarify the previous questions on the meaning of FR2 UL [64].  **FL3 Proposal 4**   * For FR1, for single CC case (FFS multiple CC), at least the following should be considered for reference configuration   Set 1   * + Common     - Duplex: TDD     - system BW: 100 MHz     - SCS: 30 kHz     - [other channel/signal, e.g. PDCCH/PDSCH]   + DL     - [number of TRP: 1]     - TX chain: 64     - Power level: [TR38.802/38.104, FFS PA efficiency]     - [common signal/RS: SSB periodicity 20 ms]   + UL     - RX chain: 64   Set 2, Optional   * + Common     - Duplex: FDD     - system BW: 20 MHz     - SCS: 15 kHz   + DL     - TX chain: [8/16/32]     - Power level [FFS]   + UL     - RX chain: [8/16/32] * For FR2, for single CC case (FFS multiple CC), at least the following should be considered for reference configuration   + Common     - Duplex: TDD     - system BW: [100/400]MHz     - SCS: 120 kHz     - [other channel/signal, e.g. PDCCH/PDSCH]   + DL     - [number of TRP: 1]     - TX chain: [2/64]     - Power level: [TR38.802/38.104, FFS PA efficiency]     - [common signal/RS: SSB periodicity 20 ms]   + UL     - RX chain: [2/64] | |
| BT | We prefer to add 4T4R into Set 2 (FDD), these constitute significant part of deployments.  Set 2, Optional   * + Common     - Duplex: FDD     - system BW: 20 MHz     - SCS: 15 kHz   + DL     - TX chain: [4/8/16/32]     - Power level [FFS]   + UL     - RX chain: [4/8/16/32] |
| China Telecom | Fine with the proposal. And we prefer to also define the configurations for multi-CC case at least for FR1. |
| OPPO | * We want to clarify the meaning of the FFS bullet for common parameters (other channel/signal) or simply remove it. * For FR2, we want to change the number of TX/RX chain from 64 to 8.   We propose the following updates:   * + Common     - Duplex: TDD     - system BW: 100 MHz     - SCS: 30 kHz     - ~~[other channel/signal, e.g. PDCCH/PDSCH]~~   + Common     - Duplex: TDD     - system BW: [100/400]MHz     - SCS: 120 kHz     - ~~[other channel/signal, e.g. PDCCH/PDSCH]~~   + DL     - [number of TRP: 1]     - TX chain: [2/8~~64~~]     - Power level: [TR38.802/38.104, FFS PA efficiency]     - [common signal/RS: SSB periodicity 20 ms]   + UL     - RX chain: [2/8~~64~~] |
| DOCOMO | Fine with the proposal in general. However, the clarification on the meaning of “FR2 UL [64]” is appreciated. |
| Samsung | Regarding the PA efficiency, we are still not clear whether it is necessary for evaluation. In light of minimizing variations for reference configuration, we suggest to remove the following: FFS multiple CC, FFS PA efficiency, number of TRP. Other updates are fine. |
| CMCC | Support |
| ZTE, Sanechips | We are okay with proposal 4. Moreover, we prefer to remove the configuration of common signal/channel, for example,“[common signal/RS: SSB periodicity 20 ms]”, o[other channel/signal, e.g. PDCCH/PDSCH]. |
| LG Electronics | We would like to clarify what optional reference configuration Set 2 implies. From our understanding, Set 1 is the baseline reference configuration for FR1, but companies can compare performance with respect to Set 2 if needed. Would it be the correct understanding?  In addition, for FR2, there are multiple candidate values for some parameters, e.g., 2 or 64 TRX chains. Will we down-select one of multiple candidate values? Or, are all of candidate values defined as reference configuration for FR2? |
| vivo | We are fine with the proposal |
| OPPO2 | For evaluation purpose, we think the BS antenna configuration should also be aligned, and we propose to use configuration (Mg, Ng, M, N, P) = (1, 1, 8, 16, 2) for both FR1 and FR2. For FR1, the 256 antenna elements can be mapped to 64 TX/RX chains; For FR2, the 256 antenna elements can be mapped to 2/8 TX/RX chains.  The following updates are proposed:   * + Common     - Duplex: TDD     - system BW: 100 MHz     - SCS: 30 kHz     - BS antenna configuration: (Mg, Ng, M, N, P) = (1, 1, 8, 16, 2)   + Common     - Duplex: TDD     - system BW: [100/400]MHz     - SCS: 120 kHz     - BS antenna configuration: (Mg, Ng, M, N, P) = (1, 1, 8, 16, 2) |
| Intel | For the power levels, it might be good to simply list the values instead referencing other TR/TSs, which may potentially include multiple values. |
| IDCC | We are fine with the proposal. |
| Nokia/Nsb | OK |
| Panasonic | We are okay. |
| Huawei, HiSilicon | We believe FR1 FDD case should be investigated considering it is also commonly deployed in field. For the values in square brackets with slash symbol of “/”, our assumption is it shall be down selected to a single value. |
| MediaTek3 | While we generally support the proposal, clarification for the following is appreciated:   * What does “[other channel/signal, e.g. PDCCH/PDSCH]” mean? Or we can remove it, as suggested by OPPO, if not deemed necessary * For FR2, what does it mean with “RX chain: 64” |
| Ericsson3 | For FR1, the BS antenna configuration (M, N, P, Mg, Ng; Mp,Np) = (8, 4, 2, 1, 1; 4,4).  For FR2, we suggest to keep it FFS for now. |
| @LGE, If there are multiple values in a square bracket, they are to be down-selected. If there is single value, it is to be confirmed.  For FDD case, it was originally set to optional for company to report, however now seems interest increase per operator so ‘optional’ is removed. It might be fine to generate an FDD model for comprehensive use from FL perspective, as the outcome of this SI.  There is no clarification for FR2 UL [64]. It’s FL understanding that it might be misunderstanding of chain vs ports from original proponent. So removed.  There are multiple PA efficiency related study points already. FL consider it would be fine to remove this FFS until others are stable.  **FL4 Proposal 4**   * For FR1, for single CC case, at least the following should be considered for reference configuration   Set 1   * + Common     - Duplex: TDD     - system BW: 100 MHz     - SCS: 30 kHz     - BS antenna configuration: [       * (Mg, Ng, M, N, P) = (1, 1, 8, 16, 2),       * (M, N, P, Mg, Ng; Mp,Np) = (8, 4, 2, 1, 1; 4,4),       * (M, N, P, Mg, Ng; Mp,Np) = (12, 8, 2, 1, 1; 4, 8) ]   + DL     - [number of TRP: 1]     - TX chain: 64     - Power level: [TR38.802/38.104]   + UL     - RX chain: 64   Set 2,   * + Common     - Duplex: FDD     - system BW: 20 MHz     - SCS: 15 kHz   + DL     - TX chain: [4/8/16/32]     - Power level [TR38.802/38.104]   + UL     - RX chain: [4/8/16/32] * For FR2, for single CC case, at least the following should be considered for reference configuration   + Common     - Duplex: TDD     - system BW: [100/400]MHz     - SCS: 120 kHz     - [BS antenna configuration: (Mg, Ng, M, N, P) = (1, 1, 8, 16, 2)]   + DL     - [number of TRP: 1]     - TX chain: [2/8]     - Power level: [TR38.802/38.104]   + UL     - RX chain: [2/8]   Note the above applies to at least non-sleep mode. FFS the reference configuration if scaling can be applied to sleep mode. | |
| Company | Comments |
| Xiaomi | Just a question, Is the reference configuration is only for non-sleep mode? On last online session, some companies propose the scaling can also be applied to sleep mode, and if it is, then there should be reference configuration for sleep mode. |
| CMCC | We prefer to use the typical macro cell BS that with 192 antenna elements mapping to 64 TxRu: (M, N, P, Mg, Ng; Mp,Np) = (12, 8, 2, 1, 1; 4, 8) |
| China Telecom | We are fine with the proposal. Just a little question: will the reference configuration for multi-cc be discussed in the future or just discuss the case when necessary. |
| Qualcomm | The PA efficiency is directly related to PA power consumption that is majority of BS power consumption. It is a factor providing the ratio between the PA transmit power and the PA power consumption. Without a reference on PA efficiency, BS power consumption models to be proposed will be very diverse. In addition, it also gives us the baseline for discussing the scaling later. As being said, we propose   * + DL     - Power level: [TR38.802/38.104] with PA efficiency (FFS value) |
| LG Electronics | Thanks Moderator for answering our question. With the Moderator’s clarification, we may add a NOTE saying that [x/y] implies one among x and y will be down-selected in next meeting. |
| vivo | We are fine with the proposal. |
| ZTE, Sanechips | We are generally okay with proposal 4, except for the BS antenna configurations.  For the detailed BS antenna configurations, it depends on NW implementation. Moreover, the exact BS antenna configurations for different scenarios can be different according the typical SLS evaluation assumptions in the legacy TRs. Then it will be debatable whether the power model can be applied for some scenarios, or how to apply the scaling rule.  For the determination of power consumption model, the more important factor is the number of TX/RX chain. Therefore,**we suggest to discuss the antenna configuration in the evaluation assumption of SLS, instead of the reference configuration.** |
| DOCOMO | We are fine with the proposal. |
| Intel | Few comments.  (1) FR1 BS antenna configuration:  None of the listed values (Mg, Ng, M, N, P) = (1, 1, 8, 16, 2), (M, N, P, Mg, Ng; Mp,Np) = (8, 4, 2, 1, 1; 4,4), (M, N, P, Mg, Ng; Mp,Np) = (12, 8, 2, 1, 1; 4, 8), are actually 64 Tx/Rx chains.  We should have antenna configuration that match up with Tx/Rx chains, this means supporting antenna configuration that result in Mp\*Np = 64. Our suggestion would be using  (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1;4,8) (dH, dV) = (0.5λ, 0.8λ) This is also aligned with values in Table A.2.1-4: Antenna configurations for below and above 6GHz in TR 38.802.  (2) FR2 antenna configuration  The baseline BS antenna configuration seems to a single panel implementation. We suggest using a multi-panel baseline with 1 port per polarization:  (M, N, P, Mg, Ng; Mp, Np) = (4,8,2,2,2;1,1) or (4,8,2,2,2;2,2)  (dH, dV) = (0.5λ, 0.8λ) (dg,H, dg,V) = (4.0λ, 3.6λ)  This would effectively give same total antenna array configuration as (Mg, Ng, M, N, P) = (1, 1, 8, 16, 2) but should be able to address Tx/Rx chain value of 2 or 8. Since it is difficult to see how Tx/Rx chain of 8 will be supported by (Mg, Ng, M, N, P) = (1, 1, 8, 16, 2).  At the very least, it would be good to clarify the antenna element spacing for the configuration as well.  (3) FR1 FR2 Power level: [TR38.802/38.104]  TR38.802 contain various different power value depending on deployment and setup. 38.104 equally has multiple power values depending on the coverage area size of the BS. For the widest coverage BS, there is no upper limit of conducted power for FR1.  Having the power level referenced to TR or TS doesn’t really help narrowing the options.  Our suggestion is not use a reference but simply list few candidates sets that companies are considering.  We think 47 dBm for macro-cell type, and 24 dBm for small cell type is a good starting point, but welcome other suggestions. |

## Power states and transition time

Relative power value should be clearly defined. A few companies mentioned that similar to UE power saving model, the deepest sleep mode consumes the least power and is considered as the basic power unit.

**FL1 Proposal 2.3-1**

* **In the evaluation, the power consumption value is normalized relatively to the deepest sleep mode to be defined for BS energy consumption model.**

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| **Company** | **Y/N** | **Comments** |
| Xiaomi |  | Does that mean the power for deepest sleep mode is ‘1’, and other state is ‘n’(n>=1)? Is that really suitable for the real case? In fact we are not sure, and hope to get clarified. |
| Spreadtrum | Y | For simplicity |
| OPPO |  | It is reasonable to normalize the power consumption value to a mode, we can further discuss whether it is the deepest sleep mode.  The goal is to control the dynamic range among different power consumption modes. |
| IDCC | Y | It is reasonable to use normalization. But the reference state can be decided after agreeing on the states. For example, deep sleep may be used as reference with power level [1] but hibernating state may have power smaller than [1]. |
| Vodafone | Y | We agree to have the evaluation done relatively but it is also important to convey the absolute gains obtained from the different techniques |
| Intel | Y | We could just agree that deepest sleep mode is assigned relative value 1, and power values for other states are obtained relative to that. |
| NOKIA/NSB | Y | @FL: try to further check our understanding, so the “deepest sleep mode” here you refer to is the BS Standby state as in our Tdoc, or so-called Hibernate state in Ericsson’s presentation/Tdoc, is it correct understanding? |
| LG Electronics | Y | Agree with Proposal 2.3-1 but it is first necessary to discuss how many BS power saving modes will be defined considering the SSB periodicity and the transition time. Since gNB should transit to active mode periodically in order to transmit the periodic signal such as SSB, some sleep modes may not be able to be reached depending on the periodicity of SSB if transition time corresponding to the sleep mode is longer than SSB periodicity. Therefore, among multiple sleep modes, it is needed to determine whether to allow a sleep mode for which transition time can be longer than periodicity of SSB/SIB1. |
| China Telecom | Y | We are fine with the proposal 2.3-1. But we think the details should be clarified after further defining the sleeping states. |
| DOCOMO | Y | Share the similar view to Intel. The deepest sleep mode is assigned relative value 1 and other states have relative values. |
| CMCC | Y | Support. |
| Panasonic |  | We suggest to firstly discuss what sleep modes to be supported. It may not be necessary to the deepest sleep mode. |
| Samsung | Yes | Support |
| Apple | Y |  |
| ZTE, Sanechips | Y | This is an effective and simple method. |
| Fraunhofer IIS | Y | We are fine with the proposal. However, we think the deepest state needs more clarification. Also, we think we should have an FFS on how to provide aggregate network energy usage in mixed scenarios. Certainly [1] unit for a macro BS will not correspond to [1] unit for a small cell. |
| Vivo | Y |  |
| HW/HiSi | Y | Support the proposal. Similar as UE power saving, the most energy saving mode can be normalized to 1.  Actually, we think the point made here should be a normalized power model is utilized, and maybe it is not very important to use which state as the reference state with normalized power of 1. |
| Fujitsu | Y | In addition, the simulation result of BS energy consumption in a particular case can be further normalized with that in full load case. |
| Qualcomm | N | Let us discuss sleep states first, and then discuss how to normalize the power. In particular, it is important to first discuss how many sleep states are sufficient and theirs corresponding characteristics. |
| CATT | N | We need to define the sleep state first. The power model for gNB is much different to that for UE in Rel-16 UE power saving study. The UE could go into the deep sleep state based on gNB configuration of DRX without any interruption of network access. The deep sleep state is considered as part of normal UE operation. Thus, the deep sleep state is used as the reference for the normalization of other UE power consumption in UE power model. For gNB, the deep sleep state is not a normal operation and is an inactive to provide network access to UE. Thus, we should use one state of gNB normal operation, such as micro sleep, which all components of gNB in ready state for transmission/reception but no signal processing in Tx/Rx chains. |
| MediaTek | N | In UE power modelling, it is actually based on setting PDCCH-only power to be 100, and other power values are normalized w.r.t. PDCCH-only power. The reason is PDCCH-only is most common operation for UE vendors to conduct measurement, and more confident measurement values can be obtained. The deep sleep value is actually not the base value, and it can be seen in the power value table of TR 38.840, the value can be optionally set to 0.5.  Following the same consideration, we suggest to define “SSB-only” power value as 100 and define the values for other power states. |
| Ericsson1 | N | In our view, it makes sense to exclude e.g. hibernate sleep (discussed in our contribution) from the deepest sleep state used as reference for scaling, i.e. value 1. |
| Futurewei | Y |  |
| LG Electronics | Y | We think it is desirable to discuss the power of each sleep mode after the total framework such as the number of sleep modes is determined first. It seems necessary to discuss why and when a hibernate state with lower relative power than the Deepest sleep mode is needed. |
| FL3 | This proposal can be revisited later. | |

Views on different power states are quite diverse. For consideration of sleep mode, there are more sleep modes preferred in general. Particularly, 4 modes are considered in [3][6][16][18][20]. 3 modes are considered in [4][5][7][10][11][14][15][17][21] while two modes are considered in [2][8][18]. Depending on BS split/types, there may also be multiple preference from companies. More discussion is needed.

**FL1 Proposal 2.3-2**

* **Study how to define sleep modes and determine the characteristics for each mode from one or multiple of the below**
  1. **Relative power level range or power saving range**
  2. **Transition time range**
  3. **BS breakdown/components that can be turned off**
  4. **Other approaches are not precluded**
* **Study the assumption of order for BS entering/resume from a sleep mode to another mode (sleep or non-sleep), i.e. state machine which may have impact on the additional transition energy.**

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| **Company** | **Y/N,**  **Preferred option** | **Comments** |
| Xiaomi | Y(generally) | for the second bullet, “**order for BS entering/resume from a sleep mode to another mode**”, our view is that ,to simplify power modeling, sleep mode can only turn into non-sleep mode. Currently we see no needs to discuss the power consumption/transition from one sleep mode to another sleep mode. |
| Spreadtrum | Y, prefer a) and b) | c) can be discussed, but we are not sure companies can have the consensus. In UE power model, the sleep modes defined in an abstract way, e.g. time of sleep, relationship b/w sleep energy and transition energy.  For state machine, we are not sure how complicated it should be. In UE power model, we only assume the transition b/w sleep mode and non-sleep mode. The prerequisite is UE will perform a definite sleep mode after a non-sleep behavior. UE simply follows the semi-static tasks and the limited NW- triggered states. BS may face more dynamic situation? |
| OPPO | Y |  |
| IDCC | Y |  |
| Vodafone | Y |  |
| Intel | Y | We think 4 sleep modes are needed to flexibly consider different functional splits at BS and how different groups of HW components can be turned on/off, some of which may need longer activation/deactivation time. We think modeling considers all of a), b), and c) and these considerations are inter-related. For example, 1 first group of components may consume more power and/or longer activation time than a second group or vice versa.  Additionally, we should further discuss the 2nd bullet if possible.  We think there is value in discussing how the BS enter/exit sleep modes (SM). For example, whether deeper SM can be entered directly (e.g entered from active mode only) or need to be entered from a previous SM state.  This is related to the question discussed during GTW for Ericsson sleep mode state transition diagram.  Lastly, we should add a 3rd bullet.  Study energy consumption during transition time to and from a sleep mode |
| NOKIA/NSB | Y, prefer a+b | The sleep modes can be defined based on a and b (from the list above) plus the transition energy, similarly to their definition for the UE power model. |
| LG Electronics | Y,  At least a) b) | For the state transition model, it is necessary to discuss whether to transition step by step or direct when switching between active mode and each sleep mode. For example, assuming that there are four sleep modes, BS may transition from sleep mode 1 to the deepest sleep mode 4 via sleep modes 2 and 3. Alternatively, in another state transition model, the BS may directly transit any of the sleep modes from active mode. |
| China Telecom | Y at least a) + b) | For the sleep modes, at least a) and b) should be defined. As for c), we think it can be discussed and related to the specific value of a) and b), but the details may not be needed for the study at this stage, a general definition of c) is enough.  For the state transition model, whether the transition of state can happen between the two SM directly should be studied. |
| DOCOMO | Y |  |
| CMCC | Option a) and b) | Fundamentally, the energy consumption of BS is related to the BS components that can be turned off, different working states of these components define different level of power consumption. So, option c) is the nature of different sleep modes’ definition. This can be used for discussion, but not easy for specification. However, BS works in different states cost different power, and BS turns off different components or ramps up different components require different transition time. So, the relative power level and transition time can be used to define sleep modes in energy consumption model. |
| Panasonic | Y in general | Besides the a/b/c of the first bullet, we also propose to clarify and consider the possible gNB activities in different sleep modes, e.g. what processing requires which BS components to be on. Because even when gNB is neither transmitting nor receiving, some processing is still needed, e.g. common signal/message preparation, scheduling preparation and high layer signaling processing. |
| Samsung |  | For the 1st bullet, we think at least three network states need to be investigated, and there could be further refinement during discussion. So suggest to revise the wording to “Study how to define sleep modes, how many states to evaluate, and how to determine the characteristics for each mode from one or multiple of the below”  For the 2nd bullet, in terms of transition between sleep modes, we think it is beneficial to investigate it for NWES. So suggest to revise the wording to “Study the assumption of order for BS entering/resume from a sleep mode to another mode (sleep or non-sleep) and the associated additional transition energy, i.e. state machine which may have impact on the additional transition energy.” |
| Apple |  | At least a and b are needed for a sleep mode. In addition, transition energy is also needed. C can be discussed as it may help clarify the motivation for different sleep modes, but we do not see a need to formally agree on it.  Some assumptions need to be made regarding the state transitions. We wonder if it is really necessary to define the transition from one sleep mode to another sleep mode, but we are open to discuss. |
| ZTE, Sanechips | Y, b | Similar to UE power saving, option b is preferred.  The BS can enter the low power consumption state (sleep mode) by shutting down some components. The power consumption of BS with different components shutting down is different. However, whether a base station can shut down some components depends on the transition time. The base station can shut down components only when the time conditions(the time of no traffic transmission is longer than or equal to the time of component ramp up/ramp down) are met.  In addition, the power levels affect the transmission services of the BS. When there is no service transmission and BS enters into sleep mode, the influence of the BS power level is small.  Therefore, option b is the most direct and simple way to define sleep mode. |
| Fraunhofer IIS | Y |  |
| vivo | Y (generally) | We are generally fine with the proposal. It may be better to study whether the sleep mode definition is shared between DL and UL, or separate. We may add one bullet:  d) Joint or separate sleep for DL and UL |
| HW/HiSi | Y, prefer a, b | Since the BS implementation could be various, and the definition of turning off level is various, we think define only 2 sleep modes is easier for the study. The first is dynamic sleep, which could recover to active mode quickly. And the second is deep sleep, which represent the most energy saving mode.  For bullet c), we share the view from Spreadtrum that it may not be easy to align among different vendors regarding which component should be switched off under a power state, considering there is no definition on which component switching off in UE power model. This can be discussed as reference during the meeting but may not be used as the definition of the sleep modes. |
| Fujitsu | Y, prefer b | Follow the definition for the UE power consumption model in TR38.840. The sleep duration has direct impacts on UE behavior. |
| Qualcomm |  | * **Study how to define sleep modes and determine the characteristics for each mode from one or multiple of the below**   1. **Relative power ~~level range or power saving range~~**   2. **Transition time ~~range~~**   3. **BS breakdown/components that can be turned off**   4. **Other approaches are not precluded**   **Note: Values for both baseline cases, i.e., 1) for macro BS in FR1 and 2) for micro BS in FR 2.** |
| CATT | Y | (b) and (c). The sleep state in gNB is to provide the gNB energy consumption reduction with limited impact to the services. The change of relative power level would not provide meaningful power consumption reduction for gNB. |
| MediaTek | Y (remove c)) | We are generally supportive of the proposal as well as the revision by QC. Since for sleep states, it looks not necessary to breakdown detailed components, and c) is suggested to be removed.  For the state machine, we would like to suggest the simple model in open published paper, e.g. [THIS IEEE paper](https://ieeexplore.ieee.org/document/8088616) and illustration as below, which can save companies’ valuable time and provide a common reference.  Diagram  Description automatically generated |
| Ericsson1 | Needs update | Suggest below update. For c), we think it is covered by the relative power and the transition time, which is also how the UE sleep states were defined.   * Study how to define sleep modes and determine the characteristics for each mode from one or multiple of the below   1. Relative power ~~level range or power saving range~~   2. Transition time ~~range~~   3. ~~BS breakdown/components that can be turned off~~   4. Other approaches are not precluded * Study the assumption of order for BS entering/resume from a sleep mode to another mode (sleep or non-sleep), i.e. state machine which may have impact on the additional transition energy. |
| FL | Based on the discussion over email, the following can be considered. Note whether it is from active state or not may be a further step of discussion.  **FL2 Proposal 2.3-2a**   * **Study how to define sleep modes and determine the characteristics for each mode from one or multiple of the below**   1. **Relative power ~~level range or power saving range~~**   2. **Transition time ~~range~~**   3. **~~BS breakdown/components that can be turned off~~**   4. **Transition energy**   5. **Other approaches are not precluded**   6. **Note: BS breakdown/components that can be turned off can be considered when defining the specific values of the characteristics for sleep modes.** * **Study the assumption of order for BS entering/resume from a sleep mode to another mode (sleep or non-sleep), i.e. state machine which may have impact on the additional transition energy.** | |
| Huawei, HiSilicon | Yes |  |
| Spreadtrum | Yes |  |
| ZTE, Sanechips | Yes |  |
| Apple | Yes |  |
| Intel | Yes |  |
| CATT | Yes |  |
| NOKIA/NSB | Yes |  |
| Qualcomm | Yes w/ a note | We propose to add a **note** under the first bullet:  **Note: separate considerations for FR1/macro BS and FR2/micro BS should be pursued** |
| DOCOMO | Yes |  |
| MediaTek2 | Yes | Thanks for moderator update for the proposal. We are supportive of current proposal. Since the proposal is “study how to define”, QC’s note may already be included as part of the study. |

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| Same proposal can be considered since the comment on BS type/FR is included in other proposals.  **FL3 Proposal 5**   * Study how to define sleep modes and determine the characteristics for each mode from one or multiple of the below   1. Relative power   2. Transition time   3. Transition energy   4. Other approaches are not precluded   5. Note: BS breakdown/components that can be turned off can be considered when defining the specific values of the characteristics for sleep modes. * Study the assumption of order for BS entering/resuming from a sleep mode to another mode (sleep or non-sleep), i.e. state machine which may have impact on the additional transition energy. | | |
| Apple | Y |  |
| China Telecom | Y |  |
| OPPO | Y |  |
| DOCOMO | Y |  |
| Samsung | Y w/ updates | Fine with FL’s proposal with updates.  In terms of Note, we don’t think it is necessary because it’s already included in d). For the further clarification on transition aspects, we would like to add ‘from non-sleep mode’ to discriminate each 1st and 2nd bullets similar as stated by China Telecom/Hang Yin. In addition, we would like to update on 2nd bullet as below.  **FL3 Proposal 5**   * Study how to define sleep modes and determine the characteristics for each mode from one or multiple of the below   a) Relative power  b) Transition time from non-sleep mode  c) Transition energy from non-sleep mode  d) Other approaches are not precluded  ~~e) Note: BS breakdown/components that can be turned off can be considered when defining the specific values of the characteristics for sleep modes.~~   * Study the assumption of order for BS entering/resuming from a sleep mode to another mode (sleep or non-sleep) and the associated additional transition time and energy, i.e. state machine which may have impact on the additional transition energy. |
| CMCC | Y |  |
| ZTE, Sanechips | Yes |  |
| LG Electronics | Y |  |
| vivo | Y (with update) | For a BS entering a specific sleep mode, whether TX and RX components are turned off jointly or separately should be made clear. Then we suggest the updates below:   * Study how to define sleep modes and determine the characteristics for each mode from one or multiple of the below   1. Relative power   2. Transition time   3. Transition energy   4. Other approaches are not precluded   5. Note: BS breakdown/components that can be turned off can be considered 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), i.e. state machine which may have impact on the additional transition energy. |
| Intel | Y | We think both of the bullets are quite important and a common understanding on these are necessary. |
| IDCC | Y |  |
| Nokia/Nsb | Y |  |
| Fujitsu | Y |  |
| Panasonic | Y | We support the proposal and think the note is helpful. |
| Huawei, HiSilicon | Y |  |
| MediaTek3 | Y | Support FL version as well as the revision by vivo |
| Ericsson3 | Y |  |
| FL suggest to keep the note with adding ‘for discussion purpose’, which is similar to the discussion of UE power saving model where those implementation aspects are not captured in the definition but used during the discussion for understanding.  Two other study points are added which seems closely relevant to the definition of sleep modes. However, the suggestion of adding ‘from non-sleep mode’ may need some more discussion, given the state machine is not yet clear. The following is essentially stable, so can be considered for email approval.  **FL4 Proposal 5**   * Study how to define sleep modes and determine the characteristics for each mode from one or multiple of the below   1. Relative power   2. Transition time   3. Transition energy   4. Other approaches are not precluded   5. Note: BS breakdown/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 additional transition time and energy, i.e. state machine which may have impact on the additional transition energy. | | |
| Company | Y/N | Comments |
| Xiaomi | Y |  |
| CMCC | Y |  |
| China Telecom | Y |  |
| Qualcomm | Y |  |
| LG Electronics | Y | We are fine with Proposal 5. |
| vivo | Y |  |
| ZTE, Sanechips | Y | We are generally OK with the proposal 5. |
| DOCOMO | Y |  |
| Huawei, HiSilicon | Y |  |

* 1. **Issue#5-1**

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| **FL4/FL5 Question 5-1**   * How many sleep models (SM) are preferred and what is the (a) characteristic of each mode, including the domains in Proposal 5, and (b) whether you consider DL and UL jointly or separately?   + Option 1: Two SM   + Option 2: Three SM   + Option 3: Four SM | | |
| Company | Option | Characteristic/domain/separation between DL&UL? |
| Xiaomi | Option 2 | Sleep mode 1(light sleep): as we commented above, it is a RF-level sleep, as the “idle state” in Issue 2-4. base band is still working. Transistion time can be very short.  Sleep mode 2(Medium sleep): All RF parts and some of baseband processing parts are sleeping, transition time is comparatively longer then light sleep.  Sleep mode 2(Deep sleep): All RF parts and most of baseband processing parts are sleeping, transition time is even longer then medium sleep.  Curently, we don’t quite see the need to separate into DL sleep mode and UL sleep mode. From our understanding, when gNB is in sleep mode, it is in sleep mode for both DL and UL. |
| CMCC | Option 2 | The energy consumption of base station is mainly related to the working states of BB, RF, TRX chains, and PA units, different working states of these units and different duration of the sleep interval define different level of base station sleep states. We propose to consider three SM, including deep sleep, light sleep, and micro sleep, targeting different modes of base station operation.  **Deep sleep state:** DL and UL are jointly considered. In deep sleep state, base station is in the lowest energy consumption state and a long sleep period is possible. To minimize energy consumption during the long sleep period, most of the PA, TRX, and RF units are turned off, leaving a minimum set of resources of BB units in operation. Wakeup from this state requires a certain amount of time and energy to restart the RF, TRX and PA units before useful activity can take place. The transition time for deep sleep state is second level.  **Light sleep state:** DL and UL are jointly considered. The light sleep state is used to model the mode where some PA, TRX and related analog processing units in RF are turned off, which implements the function of turning off some TRXs, such as 64 TRX turns off to 32 TRX. The light sleep state disables fewer energy consuming resources than deep sleep, and can therefore be restarted more quickly. The transition time for light sleep state is millisecond level.  **Micro sleep state:** DL and UL are separately considered. Micro sleep state is used to model short inactivity gaps when no data is transmitted, where the inactivity periods are too short to disable and restart more energy consuming resources, but power savings can still be made by putting inactive logic into a low power state. The transition time for micro sleep state is symbol level. |
| China Telecom | Option 2 | Just as the TR 38.840, we think 3 sleep mode may be enough for the evaluation of the NES  Micro sleep state: the transition time can be really short and the power level can be just a little bit lower, where the components may not be shut down only to have no data transmitted or received, something like the symbol on-off happens.  Light sleep state: the network is in low/medium load, part of the components of BS can be shut down, such as the TRX/beams can be reduced to a half, or the power level of the BS can be cut down.  Deep sleep state: there is nearly no load in the network. Most components can be turned off, the BS only need to detect the wake-up signals. |
| Nokia/Nsb | Option 2 or Option 3 | Regarding (a), to our view, there can be 3 or 4 sleep states to be defined, i.e.   * Micro-SM: Immediate transition is assumed for power saving study purpose from or to this state. * [Light-SM] and Deep-SM: Time interval for the sleep should be larger than the total transition time entering and leaving this state. And we may further discuss on whether light-SM is needed or simply to define the Deep-SM is enough * Standby/deep dormancy: It corresponds to cell shutdown (i.e., no SSB/SIB1 transmissions)   Regarding (b), depends on the proposed techniques, the DL and UL can be separately or jointly. |
| LG Electronics | Option 2 or Option 3 | For the characteristics of each mode, we can refer to the IEEE paper (P. Lähdekorpi, M. Hronec, P. Jolma and J. Moilanen, “Energy efficiency of 5G mobile networks with base station sleep modes,” 2017 IEEE Conference on Standards for Communications and Networking (CSCN), 2017).  Active mode and Sleep mode 1 can be considered as normal operation, so gNB is able to transmit and receive signals/channels without additional delay. Some of sub-components (e.g., power amplifier) of gNB can be deactivated during Sleep mode 1. Sleep modes 2 to 4 are the power saving modes with different power consumption and deactivation/activation times. In these modes, gNB doesn’t transmit or receive anything but reacts to incoming DL user traffic by waking up.  For sleep modes, we prefer to model BS energy consumption only for DL-only transmission, which means that the BS does not need a transition time/energy to wake up for UL reception.  Alternatively, we can adopt three SM which are consistence with UE power saving model. |
| vivo | Option 2/3 | We prefer to have at least second-level, mini-second-level, micro second-level sleep mode.  Regarding (b), we think UL reception can be available for a sleep mode. |
| ZTE | Option 2 | Three SM can be defined for NW energy saving.   1. For SM 1(micro sleep), the BS can switch in and out with a microsecond level transition time, which can be ignored in the slot-level power consumption.   For SM2(light sleep), it takes BS a longer transition time between the sleep state and the active state, which need hundreds of milliseconds transition time.  While for SM3 (deep sleep), transition time in a level of second can be considered. And the deep sleep corresponds to cell off state.  It depends on the definition of sleep modes. If a sleep mode doesn’t require BS to switch off the common components, it can be separately discussed for DL and UL, otherwise, joint consideration is needed. |
| DOCOMO | Option 2 | Basically we share the similar view with CMCC. On top of the characteristics, we assume different transition time and energy consumption for different sleep modes. More precisely, deeper sleep mode has longer transition time with larger energy consumption. |
| Huawei, HiSilicon | Option 1 | Sleep mode means no transmission or reception. So it is no needed to discuss DL sleep or UL sleep separately.  And for sleep mode, it is understood that the more energy saving achieved, the more transition time and energy required. So apart from the dynamic sleep mode and deep sleep mode, other sleep mode is highly related to the implementation and is unnecessary to align the definition for the sleep mode among different vendors.  Using two sleep modes, we think it is sufficient for the study. |
| Apple | Option 2 | We think 3 sleep modes would be sufficient, micro sleep, light sleep and deep sleep. Micro sleep state has minimum transition time and can be used for idle state when the BS has no transmission/reception. |
| Intel | Option 3 | For (a) Our preferene is to consider 4 sleep modes. Having just 2 sleep modes might not be sufficient to capture the potential BS architecture design choices, especially ones that have functional splits implemented by different physical nodes.  For (b) sleep mode could be defined as neither active DL nor active UL. Therefore, may not need to define a separate sleep mode for UL while DL is active, or sleep mode for DL while UL is active. |

For non-sleep mode, which could possibly be split into DL and UL (if agreed), for each direction, there could be different approaches for determining the power value/unit. It is FL understanding that [21] may be proposing a different approach from those in [3]. Further, [3] proposes not to consider specially the case of simultaneous UL and DL.

**FL1 Proposal 2.3-3**

* **For evaluation purpose, the power consumption for DL/UL (if agreed) in active mode is determined based on one of the following**

1. **Explicit power consumption values per slot-type (FFS definitions)**
2. **A single power consumption value linearly scaled by the number of occupied symbols over 14**
3. **Interpolation between a base power state and a peak power state (FFS definitions)**

* **FFS dependency on other conditions e.g. scenario, RB utilization**
* **FFS whether there is need to adapt the model for simultaneous UL and DL in active mode for this SI.**

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| **Company** | **Y/N,**  **Preferred option** | **Comments** |
| Xiaomi | Y(generally) | For the last bullet, our thinking is we can first identify which components are shared by DL and UL, and which component are operating separately for DL /UL. And by such classification, we can model for simultaneous UL and DL in active mode. And this FFS is also related to **FL1 Proposal 2.1-3** |
| Spreadtrum | Y, prefer c), also fine for a) | For b), we are not sure the energy consumption is only scaled with symbols number. Maybe, it is also scaled with bandwidth (or loading). Moreover, b) can be included in c) as a factor of interpolation.  For a), we think per-slot-type PHY channel(s) may not be practical, since gNB should perform multi-tasks, e.g. broadcast, unicast for multiple UEs. |
| OPPO | Y | A base power value can be defined and it reflects power consumption for full bandwidth occupancy in a symbol. Scaling approach can be applied on top of it. |
| IDCC | Y |  |
| Intel | Y (a, b) | We think (b) should be further generalized.  For example, a set of quantized (scaled) values based on number of occupied symbols, e.g. 1 ~ 7 occupied symbols apply a specific scaling, 8 ~ 14 occupied symbols doesn’t apply any scaling, etc.  Linear scaling should still be covered by this generalization. |
| NOKIA/NSB | Y, prefer b) |  |
| LG Electronics | Y, prefer a) | At least the power consumption value for each DL signals/channels in active mode should be defined per slot-type.  Alternatively, we can accept (b) if RB utilization is considered as well as symbol-level utilization. |
| China Telecom | Y, prefer b) |  |
| DOCOMO | Y |  |
| CMCC | N | More clarification of the three options is helpful. For option a), what is the meaning of “explicit power consumption value”, is this means that a static power is assumed without consider the symbol or RB occupation? For option b), this approach does not consider the RB utilization in frequency domain, which also has impact on BS power consumption. For option c), how to obtain the interpolation?  From our understanding, the power consumption for active mode can be defined by PRB utilization in a slot. For example, the energy consumption of 100% PRB utilization is defined for reference configuration, the PRB utilization of other values, such as 50%, can be scaled with respect to the energy consumption of 100% PRB utilization. However, the definition of 50% PRB utilization should be carefully studied, one state is that 50% symbols in a slot are occupied for transmission, another state is that all the symbols are used for transmission with 50% PRB occupation, or even a combination of the above two states. The power consumptions of different working states are not same although the PRB utilization is 50%. |
| Panasonic |  | The third bullet should be supported. It can be defined by the number of DL and UL symbols in a slot. |
| Samsung |  | Okay to study the power consumption for DL/UL in active mode. |
| Apple | Y | We are fine to discuss further to down-select.  On b), by “linearly scaled”, does it cover the case where there is a baseline power even if there is no tx/rx on a symbol? |
| ZTE, Sanechips | Y, b | Network has to simultaneously transmit multiple DL traffic to one or more UEs in the cells based on a proper scheduling strategy. When other factors such as bandwidth remain the same, there is little difference among different transmission type, and what matters for DL power consumption is the symbol occupation. Therefore, a single power consumption value linearly scaled by the number of occupied symbols is suggested. |
| Fraunhofer IIS | Y |  |
| vivo | Y, prefer b) |  |
| HW/HiSi | Y | The first bullet seems to resolve how to capture the symbol level scaling of energy consumption. If symbol level power is adopted, we think the linear scaling from 14 symbol could be considered. For this bullet, we prefer b.  For active mode, we think the power is including PA part, RF chain part and the static power part. The PA part determined by the PA efficiency (), the number of activated RF chains (), scheduled RB occupancy ratio (), other factors () like the power spectrum density (PSD). The RF chain part contains dynamic power part for the activated RF chain except the PA part. The static power part is the same as the power consumption for the dynamic sleep mode  The simultaneous DL and UL transmission case in active mode could be deprioritized after the separate DL or UL active mode are finished. |
| Fujitsu | Y for UL | For DL, we prefer to considering RB utilization here because it directly impacts the energy consumption of PA. |
| Qualcomm | C | What does “values per slot-type” mean in a)? Slot-type in terms of size, i.e., 7 mini slots of 2 symbols, or 2 mini-slots of 7 symbols? Or, in terms of content, e.g. with SSB, or without SSB. |
| CATT | N | The definition is not clear in defining the actual gNB behavior in power consumption. (a) needs to be clarified. The power consumption of the channel combination would be used for defining the average power consumption per slot as those defined in UE power model in TR38.840. The linear scaling of symbols in (b) is not correct since there is a static component of gNB power consumption. (c) is too far away from the reality in the measure of gNB power consumption. |
| MediaTek | N | We somehow think this proposal is not necessary since the purpose looks already address in the proposal of reference power states and the proposal of power scaling factors/formulas. |
| Ericsson1 | N | This discussion seems to be linked to FL1 Proposal 2.1-2.In our view, it is preferable to have symbol level modeling instead of discussing separate scaling factor for ‘slot to symbol’ level modeling.  Also, regarding c), if a micro-sleep state is introduced, it is unclear how the conditions for micro-sleep and base power state would be different. It would be good to get a clarification on this from the proponents. |
| FL3 | This proposal can be considered later. | |

## Scaling

The scaling approach is proposed to be reused by majority companies with same or different scaling factors. Among various aspects, the BWP size, number of CC in CA, antenna configurations and power spectrum density (PSD) gain most support. Again, if DL- and UL-only is agreed, scaling can be separately applied to e.g. DL BWP and UL BWP. The exact values need further discussion. In general, the following seems agreeable.

**FL1 Proposal 2.4-1**

* **For evaluation, the scaling in a BS energy consumption model can be applied based on the following,**
  + **antenna port**
  + **BWP in one CC and number of CC in CA**
  + **PA related aspects.**
  + **FFS other domain scaling**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| **Xiaomi** |  | Other factors should be considered,such as, TRX chain , RB utilization |
| Spreadtrum | Y | For BWP in one CC, we are not sure. It is common understanding that PA is dominant for energy consumption of transmission. If PSD is not largely variant, the bandwidth in one CC may cause different total power output. If PSD can be largely variant, maybe gNB can keep the constant total power output. |
| OPPO |  | For simplicity, we can assume the PSD is constant, then bandwidth scaling can be applied. Here we suggest to replace “BWP” with “used PRB”. |
| IDCC | Y |  |
| Intel | Y, partially | Further discuss how to take PA scaling into account, whether to absorb into BW scaling or consider separately |
| NOKIA/NSB | Y, partially | Regarding “PA related aspects”, we prefer to rewording with “PSD” or transmit power scaling |
| LG Electronics | Y but need clarification for antenna port | Similar to UE power consumption scaling for adaptation, the linear scaling formula can be applied to BS power consumption for CC/BW, the transmission power, or occupied symbols.  However, regarding antenna port, it is necessary to clarify if gNB typically implements PA per each of antenna ports. If this is the case, we can adopt linear scaling model also for antenna port, similar to UE power consumption model. Otherwise, we may consider the formula other than linear scaling formula especially for antenna port. |
| China Telecom | Y | What “the PA related aspects” includes need further discussed.  Besides, the scaling in time domain should also be considered if the power defined for power state is based on the slot level. |
| DOCOMO | Y |  |
| CMCC | N | We propose to separately consider BWP in one CC and number of CC in CA.   * + BWP in one CC   + number of CC in CA |
| Panasonic |  | Scaling based on symbol number per slot should be supported. |
| Samsung |  | Fine |
| Apple |  | Y |
| ZTE, Sanechips | Y with update | We generally agree the proposal. Some further descriptions are shown as follows.   1. The number of symbols occupied in a slot should be considered as a scaling factor for power consumption when per slot power consumption are adopted. 2. The impact of PA related aspect can be incorporated into max transmission power adaptation, i.e, power level. 3. “BWP” is a UE specific terminology. From NW perspective, it is more appropriate to use bandwidth. 4. It should be clarified that whether “antenna port” refers to the “physical antenna port”, or “antenna port of some specific channel/signal”. Moreover, for FR2, TX chain is used. The corresponding adaptation impact on scaling factors needs consideration.   To sum up, the modified proposal is shown as follows.  **Proposal 2.4-1**   * **For evaluation, the scaling in a BS energy consumption model can be applied based on the following,**   + **the number of symbols occupied in a slot**   + **antenna ~~port~~ adaptation**   + **~~BWP~~ bandwidth in one CC and number of CC in CA**   + **Transmission power level ~~PA related aspects.~~**   + **FFS other domain scaling** |
| Fraunhofer IIS | Y | We support the proposal. |
| vivo | Y, partially | First, the scaling rule for DL and UL should be discussed separately.  Second, for frequency domain scaling in DL, what’s the assumption behind:  Assumption 1: PSD is constant  Assumption 2: total transmission power is constant.  If assumption 1 is valid, transmit power scaling is enough to address this.  If assumption 2 is valid, additional BW scaling needs to be justified. In TR38.840, the UE Tx power consumption model is dependent on the output power, but not transmission BW.  Third, what does “PA related aspects” mean? Suggest to change to total output power.  Last, time domain scaling should be added, e.g. the number of symbols occupied in a slot as ZTE suggests. |
| HW/HiSi | Y | Maybe, the first bullet can be revised to the number of antenna ports? In our understanding, this impacts the number of activated number of TRX chains.  For the second bullet, maybe BWP can be revised to bandwidth of the transmission/reception? In addition, for CA case, it also depends on the implementation, e.g., separate or common RF chain.  We can have further discussion on the other domain scaling. |
| Fujitsu |  | The energy consumption of PA depends on the number of occupied RBs more than the size of BWP. Rather than including BWP in one CC here, RB utilization can be included here or in FL1 proposal 2.3-3. |
| Qualcomm |  | * For evaluation, the scaling in a BS energy consumption model can be applied based on the following,   + The number of antenna ports   + BWP in one CC ~~and number of CC in CA~~   + The number of CCs   + Transmit power   + PA efficiency (per transmit power & supply voltage) ~~related aspects.~~   + FFS other domain scaling   **Comment**: It is not clear why we need scaling for “BWP in one CC” – can you clarify it? |
| CATT |  | PA related aspects are not related to actual gNB power consumption. This was also discussed and agreed in Rel-16 UE power consumption. |
| MediaTek | Y (update on ZTE revision) | We are supportive of ZTE revision with the following revision:   * **~~BWP~~ Ratio of total occupied RBs in a slot in one CC and number of CC in CA** |
| Ericsson1 | Needs update | Agree with Nokia comment to replace PA aspect with PSD or transmit power.  Also suggest replacing BWP with BW to reflect the frequency-domain scaling.  Also, at this point, prefer to keep the main bullet broader by capturing that the scaling can be based on one or more of the following. |
| FL | The following can be considered.  **FL2 Proposal 2.4-1a**   * **For evaluation, the scaling in a BS energy consumption model can be applied based on one or more of the following,**   + **Number of used antenna ports**   + **Occupied BW~~P~~/RBs in a slot in one CC ~~and~~**   + **number of CCs in CA**     - **FFS dependency of RF sharing**   + **PSD, transmit power or PA efficiency (per transmit power & supply voltage) ~~PA related aspects~~**     - **FFS dependency on BW scaling**   + **number of symbols occupied within a slot**   + **FFS other domain scaling**   + **FFS scaling is linearly or else, for each domain** | |
| Huawei, HiSilicon | Yes with update | Regarding the part of PA efficiency, we are not sure whether the modeling needs RAN4 involvement. Maybe RAN1 should first focus on PSD and transmit power part. And leave PA efficiency for RAN4 check. |
| Spreadtrum | Yes partially | Suggest moving the FFS points of Proposal 2.1-2a to this proposal under “number of symbols”   * + **FFS the scaling method details or other means that enable the following for evaluation,**      - **Different symbols have different Tx/Rx BW**     - **Some symbols with DL and some symbols with UL**     - **Some symbols are empty while other symbols have Tx/Rx** |
| ZTE, Sanechips | Yes | We are okay with these scaling factors in general. |
| Apple | Yes |  |
| Intel | Y with updates | We suggest to include # TRPs below  **FL2 Proposal 2.4-1a**   * **For evaluation, the scaling in a BS energy consumption model can be applied based on one or more of the following,**   + **Number of used antenna ports**      - **FFS on how to address energy consumption scaling when antenna elements/panels are adapted for antenna port(s)**   + **Occupied BW~~P~~/RBs in a slot in one CC ~~and~~**   + **number of CCs in CA**     - **FFS dependency of RF sharing**   + **PSD, transmit power or PA efficiency (per transmit power & supply voltage) ~~PA related aspects~~**     - **FFS dependency on BW scaling**   + **number of symbols occupied within a slot**   + **number of TRPs**   + **FFS other domain scaling**   + **FFS scaling is linearly or else, for each domain** |
| CATT | Y | Since we are using relative energy consumption, the factor of PA efficiency would be crossed out between the target channel energy consumption and the reference energy consumption (e.g., sleep state). We don’t agree with PA efficiency. |
| NOKIA/NSB | Yes |  |
| Qualcomm | Yes | @Huawei/HiSilicon: We only need values for PA efficiency. I wonder why RAN4 check is necessary? |
| DOCOMO | Yes |  |
| LG Electronics | Yes with clarification | Before adopting the linear scaling from UE power saving model, it is necessary to clarify if gNB typically implements PA per each of the antenna ports. Depending on the gNB PA implementation, we can determine whether apply the linear scaling formula or consider the formula other than the linear scaling formula for the antenna port. |
| MediaTek2 | Y with update | Thanks moderator for the updated proposal. We have two comments:   * Less antenna ports used doesn’t mean less physical antenna element used, but the power consumption should be related to the number of used physical antenna elements. In this regard, the scaling w.r.t. number of used antenna ports should be revised. * The scaling w.r.t. PA efficiency looks overlapped with scaling w.r.t. transmit power. Given supply voltage may not be a proper simulation factor, we also suggest to merge/simplify this part of scaling factors.   By the above, the following revision is suggested:  **FL2 Proposal 2.4-1a**   * **For evaluation, the scaling in a BS energy consumption model can be applied based on one or more of the following,**   + **Number of used ~~antenna ports~~ physical antenna elements**     - **FFS: Mapping to number of used antenna ports**   + **Occupied BW~~P~~/RBs in a slot in one CC ~~and~~**   + **number of CCs in CA**     - **FFS dependency of RF sharing**   + **PSD, transmit power ~~or PA efficiency (per transmit power & supply voltage) PA related aspects~~**     - **FFS dependency on BW scaling**   + **number of symbols occupied within a slot**   + **FFS other domain scaling**   + **FFS scaling is linearly or else, for each domain** |

|  |  |  |
| --- | --- | --- |
| Whether scaling is linear or not is a next step question.  **FL3 Proposal 6**   * For evaluation, the scaling in a BS energy consumption model can be applied based on one or more of the following,   + Number of used physical antenna elements     - FFS: Mapping to number of used antenna ports   + Occupied BW/RBs in a slot in one CC   + number of CCs in CA     - FFS dependency of RF sharing   + number of TRPs   + PSD, transmit power, FFS: PA efficiency (per transmit power & supply voltage)     - FFS dependency on BW scaling   + number of symbols occupied within a slot   + FFS other domain scaling   + FFS scaling is linearly or else, for each domain   **FL3 Question 6-1**  For PA efficiency defined by per transmit power and supply voltage, how to handle supply voltage in modeling and/or any other aspect needs additional handling, except for transmit power? | | |
| **Company** | **P6** | **xxx** |
| **Q6-1** | **xxx** |
| Apple | P6 | OK |
|  |  |
| China Telecom | P6 | Fine |
|  |  |
| OPPO | P6 | We think the occupied RBs could be different in a symbol-level rather than slot-level and would like to propose the following update.   * + Occupied BW/RBs in a slot/symbol in one CC |
|  |  |
| DOCOMO | P6 | Fine |
|  |  |
| Samsung | P6 | Regarding the PA efficiency, we don’t think it is the scope of RAN1, but RAN4’s expertise. So we would like to remove “FFS: efficiency (per transmit power & supply voltage)” in the proposal.  For further calcification, in terms of the scaling of number of symbols occupied within a slot, is it possible to be different according to signals, e.g. SSB, CSI-RS, PDXCH, etc.? |
| Q6-1 | From our perspective, the FL’s Question 6-1 belongs to RAN4 expertise. |
| CMCC | P6 | Similar as the FL3 Question 1 of Issue#1 (copied as below), the case that some symbols with DL and some symbols with UL in a slot should be also considered for scaling.   * + Occupied BW/RBs for DL and UL in a slot in one CC   + number of DL and UL symbols occupied within a slot   **FL3 Question 1:**   * Whether the energy consumption model should be able to support evaluation on slot level or symbol level, for example, whether/how does the slot-level model handle the following cases provided as example   1. Different symbols have different Tx/Rx BW   2. Some symbols with DL and some symbols with UL   3. Some symbols are empty while other symbols have Tx/Rx |
| ZTE, Sanechips | P6 | We are generally OK with the proposal.  In the reference configuration, number of TX/RX chain is used. However, in the proposal 6, the terms antenna elements and antenna ports are used. Would moderator please clarify the linkage between these different terms? |
| Q6-1 | For the study of NW ES techniques, the power saving gain is an important KPI and should be quantized in the evaluations.  For the evaluation of power saving gain, we think the PA efficiency, if needed, can be modeled as transmission power versus consumed power. For other factors, it is difficult for modeling in the perspective of evaluation. |
| LG Electronics | P6 | Fine |
|  | Q6-1 | In our view, it is necessary to clarify if gNB typically implements PA per antenna port or antenna element, and so on. If gNB’s PA per antenna port can be assumed, we can adopt linear scaling model with the number of activated antenna port, similar to UE power consumption model. |
| vivo | P6 | We are still not clear that how to apply scaling based on occupied BW/RBs in a slot in one CC, PSD, transmit power. In our understanding, transmit power=occupied BW in a slot in one CC\*PSD. If transmit power scaling is done for Tx -related power state, there is no need to scale BW or PSD again. On the other hand, if scaling is done for BW and PSD, there is no need to have transmit power scaling. Could someone explain the motivation of scaling for occupied BW, PSD and transmit power? |
| Q6-1 | We are open to discuss this |
| OPPO2 | P6 | One more comment for proposal 6: Since we considered TX/RX chains for simulation, impacts of turning off TX/RX chain on BS energy consumption model may also be considered. We further would like to propose the following update.   * + Number of used physical antenna elements or used TX/RX chains     - FFS: Mapping to number of used antenna ports     - FFS: Mapping between used TX/RX chains and used antenna ports |
| Intel | P6 | Looks fine to us |
| Q6-1 | For this meeting, it could be challenging to define a power consumption model factoring PA efficiency and bias voltages used. gNB may utilize advanced techniques to improve PA efficiency, such as use of digital pre-distortion (DPD) and envelop tracking (ET). Use of such techniques further complicate the power consumption model for PAs.  Maybe we should simply ask companies to provide further information in the modeling of how this was accounted for, and discuss in the next meeting how RAN1 can conclude a modeling for this aspect (if needed). |
| IDCC | P6 | We are ok with the proposal. |
|  | Q6-1 | We prefer to discuss this a little bit later. |
| Nokia/Nsb | P6 | OK |
|  | Q6-1 | In our Tdoc, we have the below PA modelling proposed, where the power consumption of the RF power amplifier (PA) may be modeled as follows:  Where:   * = Number of active transmit antenna elements, * ' = transmitted power per antenna element (in linear scale), corrected with feeder losses (~0.6-1.5 dB), * is the PA efficiency for operating at a given , meaning that there is a defined mapping table between PA power efficiency and Pt. * Base (W) is a base power factor that depends on the max output power of PA(Pmax). It impacts the mapping between PA power efficiency and Pt, meaning that PA with different Pmax have different mapping table between PA power efficiency and Pt.   So in short, regarding the Q6-1, apart from transmitted power per antenna element, for a PA with given Pmax, the mapping table between PA power efficiency and Pt should be agreed to be defined. Therefore, we propose:  **FFS: the mapping between PA power efficiency and Pt is defined relative to the Pmax value (i.e. the same mapping is then applicable to different Pmax values, where Pmax can be set based on the BS type and number of transmit antenna).** |
| Panasonic | P6 | We are basically okay but just a minor updates:   * number of different types of symbols occupied within a slot |
| Q6-1 | We think it is okay to discuss the PA efficiency impact to energy saving in the study item stage to see how large is the impact.  The main thing to look at should be the non-linear growing power consumption along with higher PSD. This can be discussed on how to reflect in the power domain scaling in the network power model. |
| Huawei, HiSilicon | P6 | 1. The power scaling due to the number of activated TRX chains should be modelled. There one additional bullet needs to be added; 2. We have not agreed yet to model the PA efficiency per transmit power & supply voltage. For simplicity, a PA efficiency value could be assumed also. Therefore, we should remove “per transmit power & PA”  * For evaluation, the scaling in a BS energy consumption model can be applied based on one or more of the following,   + Number of used TRX chains;   + Number of used physical antenna elements     - FFS: Mapping to number of used antenna ports   + Occupied BW/RBs in a slot in one CC   + number of CCs in CA     - FFS dependency of RF sharing   + number of TRPs   + PSD, transmit power, FFS: PA efficiency value ~~(per transmit power & supply voltage)~~      - FFS dependency on BW scaling   + number of symbols occupied within a slot   + FFS other domain scaling   + FFS scaling is linearly or else, for each domain |
| Q6-1 | We are wondering why we should consider the voltage here. And it is true that this should be RAN4 expertise. If RAN1 would like to model it in the study, a simple way is to assume one or two PA efficiency values under different transmit power range for simplicity.  If RAN4 has more guidance, we can consider RAN4’s modelling methodology. |
| MediaTek3 | P6 | Support |
| Q6-1 | We tend to think the handling can be abstracted as different power-domain scaling formulas for different BS types; otherwise, how to model those additional effects, e.g., power supply, in SLS is difficult to realize |
| Ericsson3 | P6 | Our understanding is that all the listed options may not be used. Suggest below updates.   * *For evaluation, the scaling in a BS energy consumption model can be ~~applied~~ considered based on one or more of the following,*   + *Number of used physical antenna elements/TRX chains*     - *FFS: Mapping to number of used antenna ports*   + *Occupied BW/RBs in a slot/symbol in one CC*   + *number of CCs in CA*     - *FFS dependency of RF sharing*   + *number of TRPs*   + *PSD, transmit power, FFS: PA efficiency (per transmit power & supply voltage)*      - *FFS dependency on BW scaling*   + *number of symbols occupied within a slot*   + *FFS other domain scaling*   + *FFS scaling is linearly or else, for each domain*   Also agree with Huawei comment regarding the per transmit power and supply voltage. |
| Q6-1 | This appears to be implementation/RAN4 aspect. Our preference is to avoid RAN1 discussion on this. |
| For spatial domain scaling, there are some comments to explicitly consider TRx chain given antenna port does not change the energy consumption significantly.  For number of symbols within a slot, it is possible in FL understanding in multiple approaches which is to be further discussed, e.g. by defining channel/signal specific slot type, or scaled by different relative power and/or symbols.  For PA efficiency, there are both explicit support and negative positions. As this is one aspect different from UE power saving, it is perhaps good to leave some more time for companies to understand. Therefore FFS is kept but simplifed.  The updated proposal 6 can be considered for email approval.  **FL4 Proposal 6**   * 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 to number of used antenna ports     - FFS: Mapping between used TX/RX chains and used antenna ports   + Occupied BW/RBs for DL and UL in a slot/symbol in one CC   + number of CCs in CA     - FFS dependency of RF sharing   + number of TRPs   + PSD, transmit power     - FFS dependency on BW scaling     - FFS: PA efficiency value (& to check whether RAN1 aspect is relevant)   + number of DL and UL symbols occupied within a slot   + FFS other domain scaling   + FFS scaling is linearly or else, for each domain | | |
| Company | Y/N | Comments |
| Xiaomi |  | Just a question from our side, for the first and the fourth sub-bullet, how the impact would be different by number of TX/RX chains and number of TRPs? From our understanding is the two factors are quite similar. Maybe only adopt one of them is enough. |
| CMCC | Y |  |
| China Telecom | Y |  |
| Nokia/Nsb | Y |  |
| Qualcomm | Y | Generally speaking, the PA efficiency is the ratio between the PA transmitted power and the PA power consumption (as commented by ZTE and Nokia). It is not linearly scaled with transmission power.  If transmitted power is to be changed, the PA efficiency needs to be scaled (e.g., decreasing transmitted power by 3dB will not reduce the power consumption of the PA to half but to more, as the power consumption will be higher due to reduced PA efficiency) |
| vivo |  | A clarification for the fifth sub-bullet:  It means PSD & transmit power or PSD/transmit power. Besides, why/how to perform scaling based on PSD is not clear to us. |
| ZTE, Sanechips | Y |  |
| DOCOMO | Y |  |
| Please continue the discussion on Question 6-1 with more comments from Nokia/NSB.  **FL4/FL5 Question 6-1**  For PA efficiency defined by per transmit power and supply voltage, how to handle supply voltage in modeling and/or any other aspect needs additional handling, except for transmit power?  FFS: the mapping between PA power efficiency and Pt is defined relative to the Pmax value (i.e. the same mapping is then applicable to different Pmax values, where Pmax can be set based on the BS type and number of transmit antenna). | | |
| Company | Comments | |
| Qualcomm | We would like to add that Pmax can also be based on supply voltage. | |
| LG Electronics | We wonder if RAN1 would be the right place to discuss above topic. | |
| ZTE, Sanechips | From evaluation perspective, it is difficult for modeling the PA efficiency with more factors than transmission power. | |
| Huawei, HiSilicon | Agree this is not RAN1 expertise. | |
| Apple | We are not sure how this should be modeled, and RAN1 does not seem to have all the expertise. | |
| Intel | Actually RAN1 doesn’t need to model the PA efficiency. The PA efficiency is simply defined as ratio of output power/supplied power. The actual values of typical PA efficiency values feasible for FR1 and FR2 could be up for debate and this is something that should be discussed in RAN4.  However, once the PA efficiency information is available, it should be possible to leverage them in the power modeling.  Of course, there is some challenge into how to correctly model situations where BS uses advanced DPD and envelope tracking techniques. For this, we don’t why RAN1 cannot discuss them given that power scaling for BW, antenna, and other aspects are all discussed in RAN1. We don’t fundamentally understand the distinction of RAN1 being able to discuss power modeling aspect of antennas and its sub-components, but not being able to discuss PA which is simply a component of the antenna. | |

* 1. **Issue#6-1**

|  |  |
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| **FL5 Question 6-1**   * For (what) sleep mode, do you think scaling of (which domain/parameter) may/can be applied, or no need is foreseen. | |
| **Company** | **Comments** |
| Intel | Sleep modes should generally represent cases of lack of transmission and reception activity. Unlike UE power consumption modeling where components are collocated, gNB may have some components collocated, some are distributed.  Let’s consider reference configuration assumes 1 TRP. Now, if we would like to extend the model to a network with 5 TRPs, how the scaling applies, if some of the TRPs are in sleep, for example if 2 out of 5 TRPs are not actively transmitting/receiving and in micro-sleep.  Then to calculate energy consumption of that network based on reference configuration, how to correctly capture the status of the TRPs and whether there can be a component in micro-sleep value that can be scaled by the number of TRPs that are not active. In our view, micro-sleep values can be scaled for the number of TRPs that are not active.  Hence, we think it is important to first work on definition of sleep modes to better understand operation of the network in that sleep mode. |
|  |  |

# Methodology

## KPI

For evaluation methodology and KPI, the baseline may need to be clarified [5][13][17]. Due to lack of input and common view, companies are invited to share your answer for the question.

**FL1 Proposal 3.1-1**

* **Companies view are invited to clarify the baseline for evaluation for this SI**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Spreadtrum | For simplicity, the energy consumption without energy savings can be considered as baseline |
| OPPO | The energy consumption without energy savings can be considered as baseline. |
| IDCC | Energy consumption without energy savings can be considered as baseline. |
| Intel | Baseline may assume without modeling of any sleep modes |
| NOKIA/NSB | The baseline(s) for evaluation can be defined based on the reference configuration, the number of UEs per cell/network, and traffic model.  For the calibration, we can assume 1 single stationary UE per cell, and a single load level. The load can be bursty (FTP3) or constant (% of PRB utilization). |
| LG Electronics | Energy efficiency should be included as one of KPIs in evaluation methodology for network energy savings, considering LSs from SA working group. |
| China Telecom | The baseline for evaluation should be defined as the state without any sleep modes or energy saving techniques. |
| DOCOMO | The reference configuration can be defined as baseline. |
| CMCC | Simulation assumption in TR 38.840 with reference configurations agreed in energy consumption model section can be considered, considering the evaluation scenarios. For the baseline performance, implement based schemes need to be considered, for example, gNB can delay some burst packets to later adjacent slots so as to reserve more consecutive slots for sleep, with the increase of latency. |
| Panasonic | As proposed in our contribution, to facilitate the study, the energy saving gain compared with the baseline reference configuration should be the main KPI |
| Samsung | At least the following KPIs should be considered:   * Energy saving gain (ESG) * UPT * Latency * Coverage |
| Apple | Two baselines can be considered: (1) energy consumption without any sleep modes; (2) energy consumption with sleep modes that can be achieved by implementation without spec impact. It is especially important to have (2) because this is what can be done without any newly defined features. |
| ZTE, Sanechips | The power consumption without any ES techniques can be considered as the baseline. |
| Vivo | We think the following could be considered as baseline:   1. Operation without any energy saving 2. Operation with implementation-based energy saving   For the baseline 2, it would verify the need of any spec-oriented energy saving scheme. One example of baseline 2 would implementation-based sleep mode transition. However, the detailed method for determination of sleep mode should be defined or reported for baseline 2. |
| HW/HiSi | Firstly, it is obvious that the enhanced technology, such as gNB DTX is not baseline.  Secondly, some implementation enhancement, not defined from standard perspective, is not regarded as baseline. Because such kind of techniques may be not available to align among all companies.  So, we think the baseline should be normal transmission, with R15/16/17 specifications adopted. The parameter is defined in reference configuration. Other parameters and technologies not defined in reference configuration should be reported by companies, if utilized. |
| Fujitsu | Full load case can be the baseline for the evaluation. Furthermore, normalized energy consumption, for which the simulation result of energy consumption is further normalized with that of full load case, can be used for easy understanding. |
| Qualcomm | R17 should be the baseline |
| CATT | The baseline system operation needs to be specified in order to capture the energy saving gain of gNB energy saving techniques. An example of the baseline transmission is as follows,   * Periodic SSB transmission at each cell, e.g., [20 ms]   + Including periodic RACH resource for initial access and random access procedures * Periodic system broadcast information at a cell, e.g., [160 ms]   + Including paging transmission * Resource allocation and transmission of DL/UL control channels   + CORESET is located at each slot for UE PDCCH monitoring   + UL control channel resource is allocated for each slot     - Periodic SR resource allocation * Baseline for scenario specific system configurations   + MIMO     - Periodic CSI-RS transmission, e.g., [10 ms]     - Periodic CSI feedback, e.g., [20 ms]   + CA/DC     - PDCCH and CSI-RS configuration in SCell |
| MediaTek | * BS/gNB: Given simple sleep mechanism has been published since at least 2017 (e.g. [THIS IEEE paper](https://ieeexplore.ieee.org/document/8088616)), it is more reasonable to set BS/gNB power consumption with a simple sleep mechanism as baseline. * UE: UEs with traffic and C-DRX parameters as specified in TR 38.840. |
| Ericsson1 | Baseline should be Rel-17. |
| Futurewei | Proposal seems not necessary as it is already being currently discussed. |
| FL3 | Some response consider a BS model with/without sleep mode as baseline, with/without implementation based energy saving techniques as baseline, with R15 or R17 specifications as baseline, or with reference configurations as baseline. It may be good to think about more on this aspect. |

The SID has already listed multiple potential KPIs for consideration. In addition to the most natural KPI of energy/power saving gain, energy efficiency (EE) in unit of bit per Joule is drawing more interest. As this is a new KPI for PHY study, some discussion is needed. Companies are invited to share your consideration for the definition of EE.

**FL1 Proposal 3.1-2**

* **Companies view are invited to clarify the definition of energy efficiency for evaluation.**

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| **Company** | **Comments** |
| Xiaomi | For empty to low traffic, energy efficiency can be expressed by consumed energy per time unit. For medium to high traffic, energy efficiency can be expressed by consumed energy per time unit or consumed energy per bit. |
| Spreadtrum | EE is usually defined as capacity over energy consumption or coverage area over energy consumption, as mentioned in TR 21.866. For simplicity, it can be regarded an energy consumption for a given scenario (with fixed capacity and/or coverage area). Or, the capacity (equal to UPT in some cases) and coverage area should be stated in the evaluation results. |
| OPPO | We agree with the FL summary, i.e., energy efficiency (EE) is defined in unit of bit per Joule. |
| Intel | We think similar to UE power saving study, we could use mean energy consumption per slot as KPI to compute energy consumption and compare different techniques and baseline |
| NOKIA/NSB | Please find our propose in the following:  We propose multi-dimensional NW EE KPIs that jointly consider the energy consumption of the network and system/UE performance. In our Tdoc, we list UPT-aware, cell throughput-aware,data volume aware, EE KPIs. On the contrary, if the evaluation was based on comparing a set of independent KPIs, (say X % network energy saving gain, Y % UPT gain, and Z % latency gain), it would be challenging to derive any conclusion.  In accordance with the proposed BS power consumption model, the network power consumption is expressed as a relative power consumption to the most power-efficient sleep state and is unitless. Therefore, the energy consumption in the NW EE metrics should be unitless (i.e. not be expressed as Joule) |
| LG Electronics | The definition of EE from TR 38.913 Clause 7.19 is as follows:   * where refers to the weights of every deployment scenario where the network energy efficiency is evaluated and,   + where **V1**= Refers to the traffic per second served by a base station (in bits/s),   + = Refers to the power consumed by a base station to serve V1 (in Watt = Joule/s), and   + = Refers to the weight for each traffic load level.   According to the above equation captured from TR 38.913, the absolute power value is required to calculate EE. However, according to the objective of SID or the UE power saving model in TR 38.840, the relative power can be used to define gNB power consumption model. Therefore, the definition of EE may need to be modified so that it can also be calculated based on a relative power value.  A simple solution could be to replace the absolute power in EE formula with the relative power (i.e., new EE = ratio of throughput to reference power consumed by gNB). Given the relationship between absolute power and relative power, the original EE value calculated by the absolute power can be derived from the new EE value calculated by the relative power. Therefore, the EE value calculated by relative power can also be considered as a valuable KPI for evaluation methodology. |
| China Telecom | We share the similar view as Nokia/NSB. The traditional definition of EE is in unit of bit/Joule. While the KPIs in multiple dimensions can be considered for the NES, we proposed a more general expression of EE = the concerned KPI/energy consumption, the concerned KPI can be UPT/throughput/latency/coverage. With this method, the performance can be better valued and associated with the specific scenarios and techniques.  Besides, as Nokia pointed, if we want to jointly considered several KPIs at the same time, then using the gain in percentage instead of the absolute value would be better, and the EE can be unitless. |
| DOCOMO | By referring 38.840, energy consumption is defined as the power value averaged over the operation within a slot. Then the energy efficiency is defined as bit per Joule over the operation within a slot. |
| CMCC | Given that power saving gain will be evaluated based on BS power model with relative power value, how to get conclusion with evaluation results of both EE and power saving gain needs to be studied. |
| Panasonic | Energy efficient in bit per Joule requires much more details to define than the power model using normalized values, i.e. we need to define more realistic power values of different power states in units of Watts and even for breakdown of components. We have no issue with this but have concern on how this will be converged. |
| Samsung | We think the listed KPIs including coverage is sufficient for PHY study. However, we are okay to discuss for new KPI such as EE. |
| Apple | For simplicity, the energy efficiency can be defined as the energy consumption (relative, no unit) divided by the number of bits for a given duration. |
| ZTE, Sanechips | Energy saving gain is more meaningful in a long term duration. However, energy efficiency is more of a short term definition in the previous discussion. Moreover, the energy efficiency also depends on other factors such as modulation order, transmission layer, etc.  For the evaluation of the impacts of NW ES techniques, using other KPIs such as UPT, latency, etc, is more straightforward compared with energy efficiency. |
| Fraunhofer IIS | We think we should stick to the conventional definition of EE as stated by OPPO. |
| HW/HiSi | Based on the discussion in power model of BS, it seems majority companies want to use a relative unit power model for the study. Therefore, Energy Efficiency in unit of bit per Joule is impossible under this power model.  Secondly, based on the comments above, we feel the intention of this EE metric seems how to tradeoff among multiple fundamental KPIs, e.g. power saving gain, UPT loss, system throughput. We think we should focus on which set of fundamental KPIs should be studied first. After that, we can discuss whether this new EE metric is needed or not. In our understanding, in 3GPP, the study is always based on multiple KPIs and considering the tradeoff among them, the conclusion can be made in previous discussions, even without a new metric based on the multiple fundamental KPIs.  To evaluate the power saving benefit on BS, we think at least the energy saving gain vs baseline can be used. Also, the energy value per slot mentioned by intel can be also utilized. |
| Fujitsu | For evaluation in this SI, energy efficiency can be defined as a ratio between the aggregated UPT in the simulated area and the energy consumption by all the network nodes in the area. |
| CATT | The absolute energy efficiency requires the measure of energy consumption of gNB, which is implementation dependent. The power model is proposed to use relative power in relation to the reference state. If relative power model is used, the energy efficiency should be unitless. |
| MediaTek | While a single EE metric may be easy to compare different energy saving schemes, there can be critical information loss. For example, Scheme A and Scheme B can achieve the following EE values:  EE(Scheme A) 90% UPT / 80% energy consumption = 1.25  EE(Scheme B) 60% UPT / 40% energy consumption = 1.5  We may recommend Scheme B because of better EE, but Scheme A may actually be a better solution with much confined UPT loss.  In this regard, we would like to suggest to capture EE value (preferably based on simple formula) together with at least UPT, network power consumption and UE power consumption results. |
| Ericsson1 | “Energy efficiency” can have different definitions from consumed energy per maximum capacity to consumed energy per delivered bits and so on. If such KPI is to be introduced in RAN1 (there are already definitions in other WGs/specs), how it reflects the intention of the SI should be studied. Temporary high energy efficiency is not a good measure for evaluating network energy consumption, and this is generally evaluated over a longer time, e.g., 24 hours, which is normally out of scope for RAN1 evaluations. It should be discussed how KPIs that can be directly measured from RAN1 evaluations such as such as BS energy consumption, and BS energy saving gains (derived from the power model under discussion) relate to an additional energy efficiency KPI. |
| LG Electronics | Rather than considering too many KPIs, we think UPT-aware EE in addition to EE is sufficient for KPIs. Of course, the definition of EE can be further discussed. |
| FL3 | Further discuss the need of introduction of EE in consideration of other KPIs, e.g. those already being considered in proposal 3.1-3. |

For study of the impact on system performance, UPT can be considered as adopted in UE power saving study and proposed by majority contributions. It may also be combined for joint consideration with EE. Other KPIs for system impact evaluation may vary depending on techniques and scenarios, and companies view are split.

For UE side impact evaluation, it seems the below can be considered.

**FL1 Proposal 3.1-3**

* **For network performance impact evaluation, at least UPT should be considered,** 
  + **FFS in combination with other KPIs e.g. UTP-aware EE, UPT/latency, UPT-UE power etc.**
* **For UE performance impact balance, UE power consumption/access delay/latency can be considered,** 
  + **FFS in combination with energy consumption of BS.**
* **Note, this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios**

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| **Company** | **Y/N** | **Comments** |
| Xiaomi | Y(generally fine) | For the first bullet, when the traffic load is from empty to low, for network performance impact evaluation, our thinking is packet latency seems a more suitable KPI than UPT. |
| Spreadtrum | Y | UPT should be considered in a certain form, e.g. combined form or individual form.  The additional UE power consumption should be stated in the evaluation results. |
| OPPO | Y |  |
| IDCC | Y |  |
| Intel | Y | Agree |
| NOKIA/NSB | Y,partially | Network performance can be evaluated with cell throughput aware and data volume aware EE. FFS in combination with other KPIs.  UE performance can be evaluated with UPT-aware EE. FFS in combination with other KPIs (e.g. UE power consumption). |
| LG Electronics | Y | In our understanding, if above performance metrics are to be reported, performance loss or gain needs to be compared with the reference configuration. Would it be the correct understanding? |
| China Telecom | Y |  |
| DOCOMO | Y | We agree with the FL summary. |
| CMCC | Y,partially | For UE power consumption, if it means to evaluate power consumption increment for each enhancement schemes as what has been done in UE power saving item, maybe the evaluation work load will be high. |
| Panasonic | Y |  |
| Samsung |  | Generally, we are okay with FL’s proposal. In addition, we are considering that coverage is also one of important key factors for NW and UE performance. |
| Apple | Y | For the 2nd bullet, we prefer to change “can be considered” to “should be considered”, similar as the 1st bullet. |
| ZTE, Sanechips | **Y** | For network performance impact, we think UPT and latency are sufficient as the KPIs for NW ES evaluation. |
| Fraunhofer IIS | **Y** | The UPT/reliability needs to be further studied. |
| Vivo | Y (generally) | We are generally fine with the proposal. For the second bullet, we suggest to revise it according to SID:  **For UE performance impact balance, UE power consumption/access delay/latency ~~can~~ should be considered** |
| HW/HiSi | Y | The BS power saving gain should be obtained with acceptable/minimized loss of the BS/UE performance metrics.  So, the UE UPT loss should be also focused/reported when adopting BS power saving technologies. |
| Fujitsu | Y |  |
| Qualcomm | Y w/ update | FL1 Proposal 3.1-3   * For network performance impact evaluation, at least UPT and coverage and total energy consumption including UE energy consumption should be considered,   + FFS in combination with other KPIs e.g. UTP-aware EE, UPT/latency, UPT-UE power etc. * For UE performance impact balance, UE power consumption/access delay/latency can be considered,   + FFS in combination with energy consumption of BS. * Note, this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios |
| CATT | Y | We would like to clarify that the main KPI is the energy saving gain of the proposed gNB energy saving techniques comparing to the baseline gNB operation not the Energy efficiency.  Average UPT/latency among UEs in the system if system level simulation is used for evaluation. The other matrices, such as UE power consumption, should be captured. |
| MediaTek | Y with update | Typical performance index should include UE dropping/satisfaction rate, and thus revision to UE performance impact is suggested as follows:   * For UE performance impact balance, UE power consumption/access delay/latency and UE dropping/satisfaction rate can be considered, |
| Ericsson1 | Needs update | We are OK consider UPT impact and UE power consumption/latency. Prefer rewording as below (UPT impact falls under both NW and UE performance impact).   * ~~For network performance impact evaluation,~~ at least UPT should be considered,   + FFS in combination with other KPIs e.g. UTP-aware EE, UPT/latency, UPT-UE power etc. * ~~For UE performance impact balance,~~ UE power consumption/access delay/latency can be considered,   + FFS in combination with energy consumption of BS. * Note, this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios |
| LG Electronics | Needs update | Although vivo shared the understanding, we did not hear a clear answer to the meaning of “should be considered”. Therefore, we support adding a note as below to the proposal for clarification.  Note: This doesn’t imply that all of above KPIs should be reported for all evaluation results  Alternatively, we can just support the revised proposal from Intel in the email discussion.  **Revised FL1 Proposal 3.1-3   [Intel]**  **In order to evaluate impact to UE when a network energy saving technique is used, at least the following can be considered**   * **~~For network performance impact evaluation, a At least UPT should be considered in certain form, e.g.~~**   + **~~FFS in combination with other KPIs e.g. UTP-aware EE, UPT/latency, UPT-UE power etc.~~** * **~~For UE performance impact balance~~ UPT, UE power consumption/access delay/latency ~~can should be considered,~~** * **~~FFS in combination~~ These KPIs are evaluated along with energy consumption of BS.**   + **FFS: KPI for energy consumption of BS**   **Note, this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios** |

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| To clarify the reason of “should be” – this is used in SID. It is FL understanding that energy saving gain (for sure needed)/performance impact (loss) will be compared with reference configuration (plus scaling).  Although some consider to clarify the KPIs e.g. UPT-aware EE, it does not harm to list some of these joint KPIs for motivating study.  Given the discussion also over email, the following can be considered.  **FL3 Proposal 7:**   * For BS energy consumption evaluation, in addition to the energy saving gain,   + At least UPT/UE power consumption/access delay/latency can be considered for performance impact evaluation   + Note: this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios, including coverage, dropping rate, and combination of KPIs like total energy consumption, UPT-aware EE etc. | | |
| Apple | Y |  |
| BT | Y |  |
| China Telecom | Y |  |
| OPPO | Y |  |
| DOCOMO | Y |  |
| Samsung | Y |  |
| CMCC | Y |  |
| ZTE, Sanechips | Y |  |
| LG Electronics | Y | We can accept FL3 Proposal 7, but prefer to including BS energy efficiency as one of KPIs, considering Liasons from other WGs. |
| vivo | Y (with update) | We still prefer the wording “should be” for proposal 7.  As we mentioned in email reflector, this wording is aligned with SID. In our understanding, “should be considered” doesn’t mean all companies should provide the results for all the listed KPIs in every simulation. Each company has freedom to provide their results for one or more KPIs. Here “should be considered” means it should be considered as a factor for drawing conclusions as long as the result is provided. |
| Intel | Y | We think the Note can be generalized and mentioning examples are not necessary.   * + Note: this does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios~~, including coverage, dropping rate, and combination of KPIs like total energy consumption, UPT-aware EE etc~~. |
| IDCC | Y |  |
| Nokia/Nsb | Y |  |
| Fujitsu | Y |  |
| Panasonic | Y |  |
| Huawei, HiSilicon | Y with update | We support Intel’s revision. |
| MediaTek3 | Y | Support the proposal and think it is useful to keep examples in 2nd subbullet |
| Ericsson3 | Y | Also OK with Intel revision. |
| FL suggests the following for email approval. The examples are already conditioned with “when found appropriate” so it is expected that further justification/explanation will come up in order to use it for proper evaluation. Given the explanation from companies on “should”, it does not seem to change much by whatever.  **FL4 Proposal 7:**   * 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 does not preclude to consider other KPIs when found appropriate for certain techniques/scenarios, including coverage, dropping rate, BS energy efficiency and combination of KPIs like total energy consumption, UPT-aware EE etc. | | |
| Company | Y/N | Comments |
| CMCC | Y |  |
| Nokia/Nsb | Y |  |
| Qualcomm | Y |  |
| LG Electronics | Y | We can accept FL4 Proposal 7, but as mentioned in FL3, we prefer to including BS energy efficiency as one of KPIs, considering Liasons from other WGs. In addition, given the explanation from companies on “should”, we would like to suggest adding the following note:  Note: This doesn’t necessarily mean that UPT/UE power consumption/access delay/latency are considered for all evaluation results. |
| vivo | Y |  |
| ZTE, Sanechips | Y | We are more supportive of Intel’s revision. The Note can be generic and it does need to capture all the details. |
| DOCOMO | Y |  |
| Huawei, HiSilicon | Y with revision | For the note, it was already said as “when found appropriate”. Therefore, we assume that the group is not clear on whether the KPI in the list is appropriate or not for the time being. We prefer to delete them. To us, some of them is even not clearly defined in 3GPP.  Agree with ZTE and Intel. |

* 1. **Issue#7-1**

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| **FL5 Question 7-1**   * The baseline for energy saving study/evaluation for BS includes at least NR R15 mandatory features. Optional features from R15 onwards (e.g. CA, MIMO) as well as implementation-based energy saving techniques should be explicitly reported if used in the evaluation baseline. * For detailed baseline EVA parameters, can the reference configuration be used or other parameters/assumptions are required? E.g., the following, * Periodic SSB transmission at each cell, e.g., [20 ms]   + Including periodic RACH resource for initial access and random access procedures * Periodic system broadcast information at a cell, e.g., [160 ms]   + Including paging transmission * Resource allocation and transmission of DL/UL control channels   + CORESET is located at each slot for UE PDCCH monitoring   + UL control channel resource is allocated for each slot     - Periodic SR resource allocation * Baseline for scenario specific system configurations   + MIMO     - Periodic CSI-RS transmission, e.g., [10 ms]     - Periodic CSI feedback, e.g., [20 ms]   + CA/DC     - PDCCH and CSI-RS configuration in SCell | |
| **Company** | **Comments** |
| Apple | We think whatever implementation-based energy saving techniques based on R15/R16/R17 specs without requiring additional spec support should be considered in the baseline. But it is difficult to agree on exactly what implementation-based approach is. For whatever techniques being evaluated, there is typically a corresponding implementation-based approach that is comparable. E.g. for time-domain adaptation, there is a similar time-domain implementation-based approach that can be done. In this case, additional power saving gain and/or performance improvement needs to be provided to justify the proposed technique.  On the detailed proposal on EVA parameters, we do not think periodic CSI should be mandated (especially the ones with small periodicity), because the gNB can potentially use aperiodic CSI. |
| Intel | Looks fine to us |

* 1. **Issue#7-2**

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| **FL5 Proposal 7-2**   1. Similar to UE power saving study, percentage of energy consumption reduction from the baseline is used to express BS energy saving gain. 2. 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. 3. For system level impact evaluation, use IMT-2020 simulation assumptions as a starting point. | |
| **Company** | **Comments** |
| Apple | OK in principle |
| Intel | Agree with item 1) and 2). For item 3), we think discussion on reference configuration is still ongoing. If that is agreed, 3) does not seem to be needed anymore. |

* 1. **Issue#7-3**

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| Companies are invited to input on  **FL5 Proposal 7-3**   * Necessary parameters/assumptions/input for basic calibration. | |
| **Company** | **Comments** |
| Intel | While calibration of results has been beneficial in earlier work and would be technically the proper step to take, if we lack agreement on multiple different parameters, it may be difficult to achieve good alignment in SLS. We are fine to consider this, but in the given timeline it is not probably feasible to wait till we can fully converge.  While calibration of results has been beneficial in earlier work and would be technically the proper step to take, if we lack agreement on multiple different parameters, it may be difficult to achieve good alignment in SLS. |

## Evaluation scenario

Among the listed example scenarios in SID, i.e.

* 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

The first and third scenario gain most of support in the initial round of contrition view summary. If we go with this approach for down-selection, FR2 will be completely deprioritized which may be less preferable since it is expected to establish more insight of the saving potential especially for scenario with large energy consumption. Therefore, companies are invited to further consider your priority for evaluation scenarios. Note it is not necessary to be limited by the exact bullet from the above scenarios – as they are examples in no order, other combinations from/than those can also be considered.

**FL1 Proposal 3.2-1**

* **Companies are invited to further consider priority for evaluation scenarios for BS energy saving study.**

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| **Company** | **Comments** |
| Spreadtrum | Urban scenarios should be prioritized. |
| OPPO | Urban scenarios should be prioritized. |
| IDCC | Urban scenarios should be prioritized. |
| Vodafone | Urban scenarios should be prioritized, making sure that DSS scenarios are covered within the evaluation. |
| Intel | Urban scenario with Massive MIMO, 2-layer Hetnet |
| NOKIA/NSB | We have the following proposal in our Tdoc for prioritization of the evaluation scenarios:  RAN1 to prioritize evaluations in the following scenarios:   * Urban macro in FR1 without DSS and with CA, with/without massive MIMO, * Rural macro in FR1 without DSS and with CA, and * Urban micro in FR1 and FR2   RAN1 to focus on NR-only scenarios and consider with lower priority evaluations in the following scenarios:   * EN-DC/NR-DC macro with FDD Pcell and TDD/Massive MIMO on higher FR1/FR2 frequency, and * Scenarios “With DSS” |
| LG Electronics | We prefer to prioritize NR-only scenarios with massive MIMO in FR1 and FR2, while EN-DC and DSS scenarios can be considered as low priorities. |
| China Telecom | The Urban scenarios should be prioritized. And the SSB-less with inter-band CA should also be considered. |
| DOCOMO | Urban macro/micro scenario for both FR1 and FR2 should be prioritized. |
| CMCC | We think the third scenarios that is Urban/Rural macro in FR1 can be first priority, and it also including TDD massive MIMO. And then the first and second scenarios can be second priority. |
| Panasonic | In the study item phase, we think the intention of this SID is to avoid such discussion on priority. If it is needed, this should be done in RAN plenary and then update the SID. |
| Samsung | We share the view from FL. We prefer to prioritize the following cases as starting points:   * 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) |
| Apple | Urban scenarios |
| ZTE, Sanechips | We think scenarios in FR1 including Uma and Umi, should be considered as high priority for BS energy saving evaluation. Other scenarios are optional.  FR2 scenarios are suggested to be considered as low priority considering the deployment status and SLS workload. |
| Vivo | Urban scenarios should be prioritized. |
| HW/Hisi | We prefer to focus on studying Urban Macro case. Others can be reported and studied by companies. |
| Fujitsu | Prioritizing urban macro scenario is fine to us. |
| Qualcomm | Urban Micro TDD with massive MIMO for both FR1 and FR2. It is optional for Urban Macro & Rural for FR1. |
| CATT | Urban Macro & Rural for FR1 should be prioritized. |
| MediaTek | To be more specific, Dense Urban for FR1 in TR 38.840 can be prioritized |
| Ericsson1 | This can be based on Table A.2.1-1. Urban Macro should be prioritized. |

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| It seems almost all consider Urban Macro can be prioritized. At this moment there is no need to make hard prioritization, thus further prioritization from other scenarios is still possible.  **FL3 Proposal 8**   * At least urban macro with massive MIMO is prioritized for FR1. | |
| Apple | OK |
| BT | Massive MIMO is vague.  **Proposal 8**  At least urban macro with ~~massive MIMO~~ [8/32/64T] is prioritized for FR1. |
| China Telecom | Fine. |
| OPPO | OK |
| DOCOMO | “with massive MIMO” may lead confusing that the scenario only suitable for spatial domain enhancement study. Actually, other domain techniques could be applied as well in the urban macro scenario. So, we suggest following update.  At least urban macro ~~with massive MIMO~~ is prioritized for FR1. |
| Samsung | We prefer to prioritize both FR1 and FR2 in order to provide full picture of NES for NR. As discussed in Proposal 4, FR2 should be included as follow:  **FL3 Proposal 8**  At least urban macro with massive MIMO for FR1 and FR2 beam-based scenarios are prioritized. |
| CMCC | Y |
| ZTE, Sanechips | Y |
| LG Electronics | Fine. |
| vivo | Fine |
| Intel | ok |
| IDCC | Fine. |
| Nokia/Nsb | OK |
| Fujitsu | We support the modification from BT. |
| Panasonic | We are okay. |
| Huawei, HiSilicon | Considering the wording of “at least”, we think it is OK to be agreed. As pointed by moderator, other scenarios could be prioritized in addition based on the discussion in future.  For the comment saying “massive MIMO” is vague, maybe we can add a note to refer to the TRX chains agreed for reference configuration. |
| MediaTek3 | Fine to go with it, and more specific setting (by citing a specific table in a TR) will be useful to align companies’ simulations. |
| Ericsson3 | Our understanding of the proposal is that this is not prioritizing FR1 only, but that it is explaining what is prioritized for FR1. With that understanding, we are OK with the proposal, but we suggest below formulation.   * *For FR1, at least urban macro with massive MIMO is prioritized* * *For FR2, baseline deployment assumption is FFS.* |
| Ericsson understanding is correct and suggestion is adopted. Given that we probably will agree on some parameters with massive MIMO separately, as reference configuration, perhaps there is no need to insist an explicit description about antenna configurations here. Therefore the following is revised.  **FL4 Proposal 8**   * At least urban macro is prioritized for FR1. FFS the baseline deployment assumption for FR2. | |
| Xiaomi | OK with the Proposal. |
| CMCC | Support |
| China Telecom | Support. |
| Nokia/Nsb | Y |
| Qualcomm | OK |
| LG Electronics | We are fine with FL4 Proposal 8. |
| vivo | support |
| ZTE, Sanechips | We are OK with the proposal. Evaluation for FR1 and Urban Macro scenario for FR1 should be prioritized. |
| DOCOMO | Y |
| Intel | support |

## Traffic model

One of the objective of SID is highlighted as below:

*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.*

Several contributions contribute to this. In general, there is an aligned understanding that the load at least refers to the PRB utilization while there is proposal that it also concerns other factors e.g. number of UEs per cell. [3] propose to agree on a definition used in other standard, i.e. the load levels defined by ETSI in ES 202 706-1, which may be reasonably reused. To allow unbalanced load, [6][18] propose to adopt non-uniform UE distributions.

**FL1 Proposal 3.3-1**

* **The load for evaluation for BS energy saving study refers to the network load levels defined by ETSI in ES 202 706-1, where ‘idle/empty’ refers to ‘unloaded’ cell, ‘low load’ refers to ‘low load’ utilizing 30% PRB and ‘medium load’ refers to ‘medium load’ utilizing 50% PRB.**
* **Non-uniform UE distribution can be considered. Other approaches that are used for achieving different loads among carrier/cells should be clearly stated.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Spreadtrum | Y | Idle/empty load can be referred to 5~10% load to address the common signal/channel, e.g. SSB/SIB/… |
| IDCC | Y |  |
| Intel |  | Resource utilization (RU) corresponding to a specific load should consider a range of RU values. During evaluations, it is quite difficult to simulated a fixed RU in all cells, let alone in a single cell due to dynamics of the scheduling and traffic burstiness.  Suggest changing low load to be 5% ~ 25% RU, medium load to be 25% ~ 50%.  Also, we would like to clarify that “unloaded” cell still may need to send SSB, and SIBx and can results in some RU measured in the evaluations, and it does not necessarily correspond to 0% RU. |
| NOKIA/NSB | Y |  |
| LG Electronics |  | We prefer to define the level of traffic load based on resource utilization, e.g., 20% and 40% RU correspond to low and medium load, respectively.  Regarding non-uniform UE distribution, does it mean non-uniform load across gNBs for a given frequency, or across carriers? |
| DOCOMO | Y |  |
| CMCC |  | We are ok to use PRB utilization to define the load. And different load status such as ‘idle/empty’, 10%, 30%, 50% can be considered. |
| Panasonic |  | We need more discussion before agreeing on this, as 30% resource utilization ratio is a bit too high for low load.  We also support non-uniform load/UE distribution. The method can be FFS, e.g. different UE numbers per cell or using multiple data flows per cell. |
| Samsung | Yes | For the 1st bullet, we are okay to define the load level according to resource utilizing. We would like to define at least three load levels. |
| Apple |  | We are generally fine with the proposal, but feel the proposed values may be a bit too large. Using a range (as proposed by Intel) also seems to make sense. |
| ZTE, Sanechips | **Y** | Even we think up to 30% PRB utilization is sufficient for NW ES evaluation, we are okay to optionally consider higher PRB utilization cases, such as 50%.  Considering the workload of SLS, we think we need to clarify the mandatory simulation cases, otherwise, the simulation results will be diverse. And it is not beneficial to draw observation/conclusion.  In our views, idle/empty load and low load needs be considered. Other resource utilization (RU) cases, for example, 5%, 15%, 30% also need to be evaluated.  In CA case, the UE distribution is per cell. And different UE distribution among different cells is allowed. We agree that the UE distribution should be clarified.  Moreover, we think it should be clarified that whether common signal/channel is accounted in the PRB utilization calculation. |
| Fraunhofer IIS | **Y** | From our point of view “idle/empty” is a very important scenario. We can start from ETSI levels, but eventually we need to be a bit more flexible depending on what needs to be studied. For example “idle” could be from 0-1% , so that we can study the maximum power saving as well as how well the traffic is handled when it does arrive. |
| Vivo | Y | One clarification for the resource utilization ratio: it means occupied RB for data only or for data+signaling?  Response to LG’s question: it is non-uniform UE distributionin simulated geographic area, e.g. non-uniform across cells. |
| HW/HiSi | Y | 30%/50% could be treated as typical value of load level for network energy saving study. The load level for SSB/RS only could be reported / calculated for certain configuration. |
| Fujitsu | Y | We also think using a range is more suitable for the evaluation. |
| Qualcomm | Y with clarification | Per ETSI in ES 202 706-1, load level is defined by the PRBs occupancy level by **User Plane (UP) data activity** during a defined observation period. Does this mean load level or PRB utilization for loaded scenarios does not contain REs for non-data channels (e.g., CSI-RS, PTRS and PDCCH in downlink)?  Add also ‘High load’ utilizing 70% of the PRBs, for evaluating PA related techniques |
| CATT | Y | We are OK with the proposal. |
| MediaTek | Y with revision | * For traffic load, we suggest to use range for load. For example low-load as 10% < RU <= 30% and medium load as 30% < RU <= 50% to accommodate evaluation variations * For achieving the target RU, we suggest to increase UE number instead of changing packet size or mean packet inter-arrival time. Without aligned methodology, companies may see diverse results and fail to achieve useful consensus for the study. |
| Ericsson1 | Needs further discussion | We suggest discussing further the applicability of ETSI model to the dynamic system simulations typically performed by RAN1, e.g. whether/how the RU definition, traffic model and other assumptions in RAN1 could be aligned with the definitions in ETSI model. |
| LG Electronics | Needs further discussion | As we commented in before, the clarification is needed for the non-uniform UE distribution that whether it mean non-uniform load across gNBs for a given frequency, or across carriers.  Regarding the terminology, we prefer to use the term resource utilization rather than the word X% PRB for everyone to have the same understanding. |
| FL3 | To be further discussed. | |

The proposed traffic models based on contributions for the study include:

1. FTP3: 0.5MB, 200ms
2. FTP3 IM: 0.1MB, 2s
3. VOIP
4. XR: 30/45Mbps
5. C-DRX : 40/160/320ms cycle, on-duration 4/8/10

Similar to UE power saving study, multiple models can be considered.

**FL1 Proposal 3.3-2**

* **FTP3, FTP3 IM and VOIP can be considered in the evaluation.**
* **FFS other traffic models that can be optionally considered.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Spreadtrum | Y |  |
| OPPO | Y |  |
| IDCC | Y |  |
| Intel | Y | We suggest including XR traffic model, at least as an option. Periodic XR traffic may offer energy saving opportunity at the BS. |
| NOKIA/NSB | Y, partially | We prefer to prioritize the FTP3 with 0.5MS, 200ms for the evaluation of this study |
| LG Electronics | Y | Similar to UE power saving, FTP model 3 and VoIP can be considered for the performance evaluation. |
| China Telecom | Y |  |
| DOCOMO | Y |  |
| CMCC | Y |  |
| Panasonic | Y |  |
| Samsung | Yes | Okay |
| Apple | Y,  partially | We prefer to prioritize one FTP model among the two: FTP3: 0.5MB, 200ms to reduce the workload. The load will be controlled anyway. |
| ZTE, Sanechips | **Y** |  |
| vivo | Y |  |
| HW/HiSi | Y | The packet size should be agreed for SLS, and the traffic model agree in UE power saving could be utilized. The arriving rate and UE number per cell could be adjusted to fit the load level. |
| Fujitsu | Y |  |
| Qualcomm | Y |  |
| CATT | Y |  |
| MediaTek | Y | Regarding the inclusion of XR, we think it may easily violate the low/medium load condition in the SID. If frequent data traffic characteristics is the main consideration for including XR, it can be sufficient to include VoIP. |
| Ericsson1 | Y |  |

**Issue#9**

|  |  |  |
| --- | --- | --- |
| Based on some offline comments, the below proposal is further clarified.  **FL3 proposal 9** *[=>Please check the revised FL3 proposal 9]*   * FTP3 (0.5MB, 200ms), FTP3 IM (0.1MB, 2s) and VOIP can be considered in the evaluation. * FFS other traffic models that can be optionally considered. | | |
| Apple |  | I assume “Revised FL1 Proposal 3.3-2” proposed for email approval supersedes this one? |
| China Telecom | Y |  |
| OPPO | Y |  |
| DOCOMO | Y |  |
| Samsung |  | Same question as Apple. |
| FL3 | To Apple, Samsung, all  Sorry for the confusion.  The intention is to clarify the details of FTP3 and FTP IM in parentheses, however, I missed the FFS part that is added in the email for approval.  Revised as below:  **Revised FL3 proposal 9**   * FTP3 (0.5MB, 200ms), FTP3 IM (0.1MB, 2s) and VOIP can be considered in the evaluation, FFS: with possible further prioritization. * FFS other traffic models that can be optionally considered. | |
| ZTE, Sanechips | Y |  |
| LG Electronics | Y | Based on TR 38.840, we suggest the following modification for FL3 proposal 9:  **Revised FL3 proposal 9**   * 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. * FFS other traffic models that can be optionally considered. |
| vivo | Y |  |
| Intel | Y | We suggest to include XR traffic models, at least as optional model. Periodic XR traffic seems to offer good opportunities for energy saving. |
| IDCC | Y |  |
| Nokis/Nsb | Y |  |
| Fujitsu | Y |  |
| Panasonic | Y |  |
| Huawei, HiSilicon | Y | We support the current proposal. No need to introduce too many traffic models. |
| MediaTek3 | Y (with Update) | We suggest to include a table, following TS 38.840 for clarify:  **Proposal 9 (revised)**   * FTP3 ~~(0.5MB, 200ms)~~, FTP3 IM ~~(0.1MB, 2s)~~ and VOIP traffics as described in the following table can be considered in the evaluation.  |  |  |  |  | | --- | --- | --- | --- | |  | FTP traffic | Instant messaging | 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 setting | Period = 160 ms  Inactivity timer = [40] ms | Period = 320 ms  Inactivity timer = 80 ms | Period = 40 ms  Inactivity timer = 10 ms |  * FFS other traffic models that can be optionally considered. |
| Ericsson3 | Y | OK with Revised FL3 proposal 9. |
| Thanks @MTK. However, since there might be further prioritization among those three, we can capture this nice table later. Some details in your table can be good reference for company to check.  For email approval:  **FL4 Proposal 9**   * 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. * FFS other traffic models that can be optionally considered. | | |
| Company | Y/N | Comments |
| CMCC | Y |  |
| China Telecom | Y |  |
| Nokia/Nsb | Y | Regarding inter-arrival time, it is OK to start with 200ms, but perhaps it would make sense to also have even longer inter-arrival time to test deep sleep at some point |
| Qualcomm | Question | The above models are borrowed from the model in UE power (TR 38.840) that was mainly targeting DL. On the other hand, for NES, we are likely performing both UL and DL traffic. For FTP traffic, it is typical to have smaller traffic in UL than in DL; so suggesting the following update:  FTP3 (0.5MB as packet size for DL and 0.5MB as packet size for UL, 200ms as mean inter-arrival time) |
| LG Electronics | Y | We are fine with FL4 Proposal 9. |
| vivo | Y |  |
| ZTE, Sanechips | Y | We think that the traffic models of current proposal are sufficient and clear for evaluation. |
| DOCOMO | Y |  |
| Huawei, HiSilicon | Y |  |
| Intel | Y | Intel |

## Simulation assumption

SLS is explicitly mentioned in the SID thus should be considered. Additionally, [7][14] propose numerical methods for e.g. handover drop rate analysis and [10] propose LLS for e.g. power saving signal detection. The following can be considered.

**FL1 Proposal 3.4-1**

* **At least SLS should be considered in the evaluation. Other method, including numerical analysis and LLS for KPI(s) other than UPT can also be considered.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Spreadtrum | Y |  |
| OPPO |  | The high priority can be given for baseline simulations, which is based on system level simulations. |
| IDCC | Y |  |
| Intel | Y | Agree with proposal |
| NOKIA/NSB | Y | We think SLS is sufficient for this study |
| LG Electronics | Y | We agree that SLS should be the baseline for performance evaluation. |
| China Telecom | Y |  |
| DOCOMO | Y | SLS is mandatory. LLS is optional if needed. |
| CMCC | Y |  |
| Panasonic | Y |  |
| Samsung |  | The contexts are fine. Since the objective#2 in the SID already captured “evaluating system-level network energy consumption”, we don’t see the value of this proposal. |
| ZTE, Sanechips | **Y** |  |
| vivo | Y |  |
| Huawei, HiSilicon | Y |  |
| Fujitsu | Y |  |
| Qualcomm | Y |  |
| CATT | Y |  |
| MediaTek | Y |  |
| Ericsson1 | Y |  |
| Futurewei | Y |  |

For other assumption parameters, the following are proposed in contributions: IMT-2020, 38.802, 38.840 and 38.830. It may be good to look into the overall SLS parameters first to check if some of them can be referred to.

The simulation assumptions proposed by companies for this meeting may be provided later.

# Other issues/discussion points/missing proposals

If there is any other important issue/discussion point/missing proposal that you consider should be discussed, please share your proposal below.

|  |  |  |
| --- | --- | --- |
| **Company** | **Domain (optional, for potential categorization)** | **Issue content/comments/questions** |
| OPPO |  | In this meeting, we should at least nail down the details of section 2.2 to section 2.4. |
| Qualcomm |  | Does the energy consumption power consider power systems loss (e.g., DC-DC converter loss, main power supply loss, active cooling)? If not, why? It should be noted that we should know how significant a PHY/MAC enhancement can contribute to the overall BS energy savings.  [FL]: The current consideration is to incorporate the discussion of e.g. cooling part into the discussion of different BS type/components. Perhaps can based on the relevant proposals to motivate the discussion. |
|  |  |  |
|  |  |  |
|  |  |  |

# Simulation results

It seems there is no strong need to treat the initial simulation results submitted for the first meeting for this SI. Therefore, there is no particular proposal set along that.

# References

|  |  |  |  |
| --- | --- | --- | --- |
|  | RP-[220297](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_95e/Docs/RP-220297.zip) | Revised SI: Study on network energy savings for NR | Huawei |
|  | [R1-2203172](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203172.zip) | Discussion on performance evaluation for network energy saving | Huawei, HiSilicon |
|  | [R1-2203224](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203224.zip) | NW energy savings performance evaluation | Nokia, Nokia Shanghai Bell |
|  | [R1-2203341](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203341.zip) | Discussion on performance evaluation of network energy savings | Spreadtrum Communications |
|  | [R1-2203481](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203481.zip) | Evaluation Methodology and Power Model for Network Energy Saving | CATT |
|  | [R1-2203575](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203575.zip) | Discussions on NW energy savings performance evaluation | vivo |
|  | [R1-2203603](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203603.zip) | Discussion on NW energy saving performance evaluation | ZTE, Sanechips |
|  | [R1-2203662](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203662.zip) | Discussion on network energy saving performance evaluation methods | China Telecom |
|  | [R1-2203830](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203830.zip) | Discussions on performance evaluation of network energy saving | xiaomi |
|  | [R1-2203919](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203919.zip) | NW energy savings performance evaluation | Samsung |
|  | [R1-2204073](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204073.zip) | On network energy savings evaluation methodology and power model | Panasonic |
|  | [R1-2204100](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204100.zip) | Base station energy consumption model, evaluation methodology, and KPIs for network energy saving | FUTUREWEI |
|  | [R1-2204256](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204256.zip) | On NW energy savings performance evaluation | Apple |
|  | [R1-2204318](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204318.zip) | Discussion on network energy saving performance evaluation | CMCC |
|  | [R1-2204391](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204391.zip) | Discussion on NW energy savings performance evaluation | NTT DOCOMO, INC. |
|  | [R1-2204628](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204628.zip) | Discussion on performance evaluation for network energy savings | LG Electronics |
|  | [R1-2204686](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204686.zip) | NW energy savings performance evaluation | MediaTek Inc. |
|  | [R1-2204811](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204811.zip) | Discussion on Network Energy Saving Evaluations | Intel Corporation |
|  | [R1-2204831](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204831.zip) | Performance evaluation for network energy saving | InterDigital, Inc. |
|  | [R1-2204881](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204881.zip) | Modeling and evaluation methodology for network energy saving | Ericsson |
|  | [R1-2205045](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2205045.zip) | NW energy savings performance evaluation | Qualcomm Incorporated |
|  | [R1-2205083](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2205083.zip) | Initial views on NW energy savings performance evaluation | Fujitsu Limited |
|  | [R1-2203226](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203226.zip) | Others | Nokia, Nokia Shanghai Bell |
|  | [R1-2203605](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203605.zip) | Consideration about NW energy saving | ZTE, Sanechips |
|  | [R1-2204320](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204320.zip) | Discussion on network energy saving scheme in deployment | CMCC |
|  | [R1-2204883](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204883.zip) | Other aspects related to network energy saving | Ericsson |
|  | [R1-2204918](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204918.zip) | Disucssion on information assistance for network energy saving | Huawei, HiSilicon |
|  | [R1-2205160](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2205160.zip) | Evaluation results of network energy saving | CATT |
|  | [R1-2205175](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_109-e/Inbox/R1-2205175.zip) | Initial evaluation results for network energy saving scheme | vivo |

# Annex –

## A. agreements

|  |
| --- |
| **FL2 Proposal 2.1-1a**   * 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 |

## B. SID

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. |