**3GPP TSG RAN meeting #98-e RP-22xxxx**

**Electronic Meeting, December 12-16, 2022**

## Status Report to TSG

**Agenda item:** 9.2.5

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **WI / SI Name** |  | | | | |
| included in this status report | Study Item:  Yes | Core part:  No | Performance part:  No | | Testing part:  No |
| **Acronym** | FS\_Netw\_Energy\_NR | | | | |
| **Unique ID** | 940080 | | | | |
| **TSG Tdoc of latest approved WI/SI description (if any)** | RP-221443 | | | | |
| **Target Completion Date**  **(indicate if changed)** | Study Item:  12/2022 | Core part: | Performance part: | Testing part: | |
| **Overall Completion level** | Study Item:  100 % | Core part: | Performance Part: | Testing part: | |

Note: Overall completion level percentage numbers should use one of the colors below:

* xx%: Normal progress, no RAN plenary action needed
* xx%: Progress behind schedule, may need RAN plenary intervention. If so, SR should clearly define requested action
* xx%: Progress critically behind, RAN plenary shall intervene. SR should define requested action

**Source:**

|  |  |  |
| --- | --- | --- |
| **Leading WG** | | RAN1 |
| **Rapporteur** | **Name** | Yi Wang |
| **Company** | Huawei |
| **Email** | wangyi6@huawei.com |

## 1 Work plan related evaluation

|  |  |
| --- | --- |
| **Do you want to modify the time budget for this WI/SI compared to what was endorsed at the last RAN meeting?** | No |

*If you answered No: Then please remove the Excel file from the zip file of this status report.*

*If you answered Yes: Then please fill out the attached Excel template to request a modification of the time budgets for your WI /SI. The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI. The basis are the endorsed time budgets of the last RAN meeting. Please highlight all changes of the values.  
 One time unit (TU) corresponds to ~ 2 hours in the meeting.  
 If this status report covers a WI with Core and Performance part, then please have one line for each in the attached Excel table.  
 Note: If no Excel table is attached, then this means no time budget change.*

**Additional explanations/motivations for the time budget changes in the attached Excel table:**

## 2. Detailed progress in RAN WGs since last TSG meeting (for all involved WGs)

NOTE: Agreements and Open issues impacted cross-TSG aspects shall be explicitly highlighted

## 2.1 RAN1

#### 2.1.1 Agreements

##### 2.1.1.1 RAN1#110bis-e

***TR work***

endorsed in principle

* [R1-2209679](file:///C:\Users\w00615726\AppData\Local\Temp\Docs\R1-2209679.zip) TR 38.864 v0.2.0 for study on network energy savings for NR Huawei

And the updated draftTR is further endorsed in [**R1-2210792**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210792.zip)as v0.3.0 for inclusion of agreements.

***NW energy saving performance evaluation***

Agreement

Capture in TR that,

* The BS power model defined in this study is a simplified model for the purposes of evaluations, considering single-RAT NR BSs only. This does not mean a BS cannot benefit from the identified techniques when serving multi-RAT.

Transition among power states, transition time, are implementation specific, and different BS types may support a different number of power states with different characteristics, i.e., power consumption values and required transition time.

Agreement

All calculation of energy consumption should use the same time unit (companies to indicate which time unit they used).

Agreement

* The BS power consumption for active DL transmission is provided by
  + : a static part of power for BS in active, which is not scaled based on reference configurations.
    - Baseline:
    - Optional:
  + : a dynamic part of power for BS in active, which is scaled based on reference configuration.
    - Baseline: , where , , is the fraction of active TRxRUs, the ratio of RF bandwidth and maximum system BW and the ratio of PSD per TxRU between the DL transmission and reference configuration, respectively
      * + is the power part related to PA.
        + For simplicity

A = baseline: 0.4; optional: [0.1, 0.7]

For

If one value of is used for evaluation, = for any sf, sp

If two values of are used for evaluation, = 0.76 if ; otherwise,

Companies to report the assumption used in evaluation.

* The BS power consumption for active UL transmission is provided by
  + : a static part of power for BS in active, which is not scaled based on reference configurations.
  + : a dynamic part of power for BS in active, which is scaled based on reference configuration and is the percentage of active TRxRUs
  + Baseline
    - when no scaling is applied (i.e. scaling factor is 1)
* For multi-carrier: the total power consumption of BS is calculated as is the sum of the power consumption of each CC;
  + for intra-band multi-carrier with contiguous CCs, the power consumption of each additional CC is scaled by [0.7].
* For multi-TRP, the total power consumption of BS is assumed as is the sum of the power consumption of each TRP
  + Company to report whether Pstatic is shared among TRPs (if shared, Pstatic is accounted once)
* Company to additionally report the assumption for antenna adaptation delay, e.g. immediate, with a transition time of [1-3] ms, etc.
* In time domain,
  + The power consumption in a slot is the sum of the power consumption associated with symbols in the slot. The symbol may correspond to uplink symbol, downlink symbol, or symbol without uplink and downlink.
  + Company to report how the summation is performed along with evaluation results.
* Other values for the above scaling formula, and other scaling approaches can be optionally reported, including
  + At least = 1 is supported. Additional one or two more values are FFS.
  + PUL = P5 (0.8+ 0.2 sf) \* (0.4+ 0.6\*sa).
    - Sf is the ratio of RF BW to the maximum system BW

Agreement

* For FR1 SLS assumptions, add parameters in the below table as additional SLS parameters.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | Set 1 FR1 | Set 2 FR1 |
| **1** | **Channel model** | 3D-Uma as in TR 38.901 | 3D-Uma as in TR 38.901 |
| **2** | **percentage of high loss and low loss building type** | 100% low loss | 100% low loss |
| **3** | **Guard band ratio on simulation bandwidth** | TDD: 2.08% (272 RB for 30kHz SCS and 100 MHz bandwidth) | FDD: 6.4% (104RB for 15kHz SCS and 20 MHz BW) |
| **4** | **HARQ scheme** | Ideal | Ideal |
| **5** | **Max HARQ retransmission** | 3 | 3 |
| **6** | **Target BLER** | 10% of first transmission | 10% of first transmission |
| **7** | **Power control parameters** | Open loop,  P0=-80dBm, alpha=0.8 | Open loop,  P0=-80dBm, alpha=0.8 |
| **10** | **SS blocks per SSB burst** | Up to 8 | Up to 4 |
| **11** | **SSB time resource** | 4 symbols for each SSB | 4 symbols for each SSB |
| **12** | **SSB frequency resource** | 20 RBs | 20 RBs |

* For (Set 3) FR2 SLS assumptions, use Table below as baseline assumptions

|  |  |  |  |
| --- | --- | --- | --- |
| **BS type** | Micro | **UE BWP** | 100 Mhz |
| **Network layout and inter-site distance** | 21 cells Wraparound (ISD=200m, as agreed) | **UE height** | 1.5m |
| **Channel model** | UMi | **UE noise figure** | 13 dB |
| **Link direction** | Downlink | **UE antenna element gain** | 5 dBi |
| **Frequency range** | 30GHz | **UE receiver** | MMSE-IRC |
| **Duplex** | TDD | **UE deployment** | 20% Outdoor in cars: 30km/h,  80% Indoor in houses: 3km/h |
| **Frame structure** | DDDSU (S: 10D:2G:2U) | **Traffic model and C-DRx configuration** | follow previous RAN1 agreement |
| **Subcarrier spacing** | 120 kHz | **UE density/NW Load** | Follow previous RAN1 agreements |
| **Simulation bandwidth** | 100 MHz | **Maximum supported Modulation and coding scheme** | Up to 256QAM |
| **Number of carriers** | 1 CC | **Guard band ratio on simulation bandwidth** | 7.8% (64 RB for 120kHz SCS and 100 MHz bandwidth) |
| **Slot size** | 14 OFDM symbols | **Channel estimation** | Ideal |
| **BS antenna configuration** | 2 TxRU:  Baseline:  [(M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1;1,1); (dH, dV) = (0.5λ, 0.5λ) (dg,H, dg,V) = (2.5λ, 2.5λ)  Optional:  (M, N, P, Mg, Ng)=(8:16:2:2:2)] | **HARQ scheme** | Ideal |
| **Total Tx power** | 33 dBm, EIRP limited to 63 dBm (as agreed in ref. conf. set 3) | **Max HARQ retransmission** | 3 |
| **BS height** | 10m | **Target BLER** | 10% of first transmission |
| **BS noise figure** | 7 dB | **Power control parameters** | Open loop, Alpha=1, P0=-106 dBm |
| **BS antenna element gain** | 8 dBi | **Scheduling algorithm** | PF |
| **UE antenna configuration** | 2T/4R, (M, N, P, Mg, Ng; Mp, Np) = (1,2,2,1,1;1,2),  (dH, dV) = (0.5λ, N/Aλ) | **Cell selection algorithm** | RSRP Slow Fading |
| **UE max transmit power** | 23 dBm | **SS blocks per SSB burst** | Up to 64 |

* Other parameters can be optionally reported.
* Company can optionally report the actual total DL transmit power allocation for the baseline and the proposed technique, if different from the agreed reference configuration.
* For TDD frame structure of e.g. DDDSU, the S slot is assumed as S = 10 DL symbols : 2 Guard symbols :2 UL symbols.
* Additionally, for FR1, include the following SLS assumptions as an optional scenario:
  + BS antenna configuration: 4T
  + BS Total Tx power: derived based on the scaling methodology
  + SS blocks per SSB burst: reduced to 1
  + Other assumptions are same as those corresponding to Set 2 reference configuration.
  + Additional transition energy is calculated taken into account the discussion and agreements for additional transition energy for Set 1/2/3
  + Company to report the details

***Network energy saving techniques***

Agreement

The following are description of a potential energy saving techniques being discussed in RAN1. The benefits and performance impact of the candidate techniques are subject to further RAN1 evaluations, while RAN1 is discussing the following techniques may have potential impact to other WGs (FFS: RAN4 impact). The impact is not an exhaustive list nor represent definitive list of impacts to WGs and is subject to further changes as RAN1 progress work for the SI.

The description of the technique does not imply the technique will be automatically captured to the TR, but assumed to be the basis for the description in the TR if agreed. Note that this is only to be used as a starting point to finalized the TR in November.

* Note: further merging of techniques (e.g. #A-6 and #A-1) is not precluded.
* Time domain technique description available in:
  + Proposal #2-1H of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #2-2J of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #2-3H of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #2-4H of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #2-6J of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
* Frequency domain technique description available in:
  + Proposal #3-1I of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #3-2F of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #3-3F of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
* Spatial domain technique description available in:
  + Proposal #4-1J of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #4-2G of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
* Power domain technique description available in:
  + Proposal #5-1I of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #5-2H of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #5-3H of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #5-4H of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3
  + Proposal #5-5D of [R1-2210620](file:///D:\Docs\R1-2210620.zip) Section 3

***Moderator summaries***

R1-2210301 FL summary#1 for R18 NW\_ES Moderator (Huawei)

R1-2210302 FL summary#2 for R18 NW\_ES Moderator (Huawei)

R1-2210303 FL summary#3 for R18 NW\_ES Moderator (Huawei)

R1-2210348 Discussion Summary #1 for energy saving techniques of NW energy saving SI Moderator (Intel Corporation)

R1-2210349 Discussion Summary #2 for energy saving techniques of NW energy saving SI Moderator (Intel Corporation)

R1-2210592 FL summary#4 for R18 NW\_ES Moderator (Huawei)

R1-2210593 Comment collection for draftTR 38.864 Moderator (Huawei)

R1-2210619 Discussion Summary #3 for energy saving techniques of NW energy saving SI Moderator (Intel Corporation)

R1-2210620 Discussion Summary #4 for energy saving techniques of NW energy saving SI Moderator (Intel Corporation)

R1-2210744 Discussion Summary #5 for energy saving techniques of NW energy saving SI Moderator (Intel Corporation)

R1-2210793 Post-meeting comment collection for draftTR 38.864 v0.3.0 Moderator (Huawei)

##### 2.1.1.2 RAN1#111

***TR work***

Endorsed in principle as version 0.4.0 in

* [R1-2212483](file:///D:\Docs\R1-2212483.zip) TR 38.864 update for study on network energy savings for NR Huawei

TR update including conclusion is further endorsed as version 0.5.0 in R1-2213007 as per post meeting email discussion of

* Email discussion for TR update approval and conclusion. To start on Nov 28 until 30.

***NW energy saving performance evaluation***

**Agreement**

The following TP is endorsed for Section 6 of TR38.864

=== draftTP0: start ===

Various techniques in time, frequency, spatial and power domains are studied. Companies’ simulation results as well as evaluation assumption details are gathered in [ref.]. In this document, results as well as some notable assumptions and setting are explicitly present in relevant tables. Also, the categorization of techniques in terms of technical domain and results presentation/tabulation are for study/evaluation purpose. This does not preclude to further merge or combine certain techniques.

=== end ===

**Agreement**

The following TP is endorsed for Section 6.1.1.2 of TR38.864

6.1.1.2 Analysis of performance and impacts

===draftTP A-1-1: start ===

The following table captures the simulation results for the schemes that use simplified version of SSB, such as only PSS or only PSS and SSS without PBCH, or PSS and SSS with partial PBCH.

* **Table 6.1.1-x: BS energy savings by simplified SSB**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **UPT/access delay/latency/UE power consumption** | **Reference configuration** | **Baseline configuration/assumption** |
| **CMCC**  **[R1-2211692]** | SSB and SIB1 repetition period 40ms, for other 20ms occasions, only PSS and SSS are transmitted. | cat.2 | Zero | 15.7% | / | Set 1 | Baseline: normal SSB/SIB1 transmission, with 20ms repetition period for both. |
| SSB and SIB1 repetition period 40ms, for other 20ms occasions, only PSS and SSS are transmitted. | cat.1 | Zero | 28.3% | / | Baseline: normal SSB/SIB1 transmission, with 20ms repetition period for both. |
| **vivo**  **[R1-2211018, R1-2212541]** | SSB structure adaptation including light SSB (ES scheme: 20ms light-SSB and SIB1, 20ms RACH listening only PSS and SSS for light-SSB) | Cat1 | Zero | 0.9% | 0% | Set 1 | Baseline scheme: 20ms SSB and SIB1, 20ms RACH listening |
| SSB structure adaptation including light SSB (ES scheme: 160ms light-SSB, 20ms UEWUS listening only PSS and SSS for light-SSB) | Cat1 | Zero | 1.2% | 0% | Set 1 | Baseline scheme: 160ms SSB, 20ms UEWUS listening |
| SSB structure adaptation including light SSB (ES scheme: 160ms light-SSB, 80ms UEWUS listening only PSS and SSS for light-SSB) | Cat1 | Zero | 2.4% | 0% | Baseline scheme: 160ms SSB, 80ms UEWUS listening |
| SSB structure adaptation including light SSB (ES scheme: 160ms light-SSB, 160ms UEWUS listening only PSS and SSS for light-SSB) | Cat1 | Zero | 4.4% | 0% | Baseline scheme: 160ms SSB, 160ms UEWUS listening |
| SSB structure adaptation including light SSB (ES scheme: 20ms light-SSB and SIB1, 20ms RACH listening only PSS and SSS for light-SSB) | Cat2 | Zero | 0.7% | 0% | Baseline scheme: 20ms SSB and SIB1, 20ms RACH listening |
| SSB structure adaptation including light SSB (ES scheme: 160ms light-SSB, 20 UEWUS listening only PSS and SSS for light-SSB) | Cat2 | Zero | 0.8% | 0% | Baseline scheme: 160ms SSB, 20ms UEWUS listening |
| SSB structure adaptation including light SSB (ES scheme: 160ms light-SSB, 80ms UEWUS listening only PSS and SSS for light-SSB) | Cat2 | Zero | 0.8% | 0% | Baseline scheme: 160ms SSB, 80ms UEWUS listening |
| SSB structure adaptation including light SSB (ES scheme: 160ms light-SSB, 160ms UEWUS listening only PSS and SSS for light-SSB) | Cat2 | Zero | 0.8% | 0% | Baseline scheme: 160ms SSB, 160ms UEWUS listening |
| **CEWiT**  **[R1-2212429]** | simplified SSB with repetition period 20ms, only PSS and SSS with partial PBCH are transmitted in simplified SSB | Cat.1 | Zero | 2.4% |  | Set 1 | Baseline: normal SSB/SIB1 transmission, with 20ms repetition period for both. |

Based on the simulation results, at empty load, one result shows that BS energy saving gain can be achieved by 15.7%-28.3% with only PSS and SSS transmitted from SSB, and half-reduced SIB1 transmission One company show that the gain from light SSB only ranges from 0.8% to 4.4%, which slightly increases as the listening periodicity of WUS from UE becomes larger. One result shows that simplified SSB with PSS, SSS and partial PBCH, for empty load and Set 1 reference configuration, 2.4% BS energy savings can be achieved.

No impact on UPT was observed due to empty load.

=== end ===

**Agreement**

The following TP is endorsed for Section 6.1.1.2 of TR38.864

=== draftTP A-1-3: start ===

The following table captures the simulation results for the schemes by which transmission occasion of one or more common signals/channels, which is SIB1 and SSB based on the submitted results, can be skipped.

* **Table 6.1.1-x: BS energy savings by skipping one or more common signals/channels**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **Load scenario** | **ES gain (%)** |  | **BS Category/Reference configuration/Baseline configuration/assumption** | **Other evaluation methodology/assumption details/other performance impact** |
| **OPPO [R1-2211458]** | Transmission occasion of SIB1 with 24 RBs for 20 ms periodicity is skipped | low load(RU-10%) | 2.6% | Cat 1  Set 1  SIB1 with 24 RBs for 20 ms periodicity, SSB with 20 RBs for 20 ms periodicity | | SLS FTP3 (0.5MB as packet size, 200ms as mean inter-arrival time)  UPT/Access delay/Latency: almost similar with the baseline |
| low load(RU-0.2%) | 3.9% | SLS IM (0.1MB as packet size, 2s as mean inter-arrival time)  UPT/Access delay/Latency: almost similar with the baseline |
| **Samsung [R1-2212543]** | the number of SSB adaptation | Medium load: 42 % RU | 1.9%, 2.8%, 3.3% | Cat 1  Set 1  8 SSBs for FR1 and ssb-periodicity = 20 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 4, 2, 1 |
| Light load: 24 % RU | 3.1%, 6.1%, 7.6% |
| Low load: 7.5 % RU | 5.5%, 11.0%, 13.8% |
| Low load: 2 % RU | 7.2%, 14.3%, 17.9% |
| Medium load: 42 % RU | 2.0%, 3.0%, 3.5% | Cat 2  Set 1  8 SSBs for FR1 and ssb-periodicity = 20 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 4, 2, 1 |
| Light load: 24 % RU | 2.8%, 4.2%, 4.9% |
| Low load: 7.5 % RU | 4.4%, 6.6%, 7.7% |
| Low load: 2 % RU | 5.3%, 7.9%, 9.2% |
| Medium load: 42 % RU | 3.3%, 5.0%, 5.8%, 6.3%, 6.5%, 6.6% | Cat 1  Set 3  64 SSBs for FR2 and ssb-periodicity = 20 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 32, 16, 8, 4, 2, 1 |
| Light load: 24 % RU | 4.3%, 17.6%, 19.5%, 20.5%, 21.0%, 21.3% |
| Low load: 7.5 % RU | 7.1%, 13.6%, 16.9%, 18.5%, 19.3%, 19.7% |
| Low load: 2 % RU | 8.3%, 15.9%, 19.7%, 21.6%, 22.6%, 23.0% |
| Medium load: 42 % RU | 4.0%, 5.9%, 6.9%, 7.4%, 7.7%, 7.8% | Cat 2  Set 3  64 SSBs for FR2 and ssb-periodicity = 20 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 32, 16, 8, 4, 2, 1 |
| Light load: 24 % RU | 5.4%, 8.1%, 9.5%, 10.2%, 10.5%, 10.7% |
| Low load: 7.5 % RU | 8.2%, 12.2%, 14.3%, 15.3%, 15.8%, 16.1% |
| Low load: 2 % RU | 9.6%, 14.4%, 16.8%, 18.0%, 18.6%, 18.9% |
| Medium load: 42 % RU | 1.1%, 2.2%, 2.7% | Cat 1  Set 1  8 SSBs for FR1 and ssb-periodicity = 40 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 4, 2, 1 |
| Light load: 24 % RU | 1.6%, 3.2%, 4.0% |
| Low load: 7.5 % RU | 3.1%, 6.1%, 7.7% |
| Low load: 2 % RU | 4.2%, 8.3%, 10.3% |
| Medium load: 42 % RU | 1.0%, 1.6%, 1.8% | Cat 2  Set 1  8 SSBs for FR1 and ssb-periodicity = 40 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 4, 2, 1 |
| Light load: 24 % RU | 1.5%, 2.2%, 2.5% |
| Low load: 7.5 % RU | 2.3%, 3.5%, 4.0% |
| Low load: 2 % RU | 2.8%, 4.2%, 4.9% |
| Medium load: 42 % RU | 1.9%, 3.6%, 4.4%, 4.8%, 5.0%, 5.2% | Cat 1  Set 3  64 SSBs for FR2 and ssb-periodicity = 40 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 32, 16, 8, 4, 2, 1 |
| Light load: 24 % RU | 2.6%, 5.0%, 6.1%, 6.7%, 7.0%, 7.2% |
| Low load: 7.5 % RU | 4.0%, 7.6%, 9.4%, 10.4%, 10.8%, 11.0% |
| Low load: 2 % RU | 4.8%, 9.2%, 11.4%, 12.5%, 13.1%, 13.3% |
| Medium load: 42 % RU | 2.1%, 3.1%, 3.6%, 3.9%, 4.0%, 4.1% | Cat 2  Set 3  64 SSBs for FR2 and ssb-periodicity = 40 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 32, 16, 8, 4, 2, 1 |
| Light load: 24 % RU | 2.9%, 4.3%, 5.1%, 5.4%, 5.6%, 5.7% |
| Low load: 7.5 % RU | 4.4%, 6.7%, 7.8%, 8.3%, 8.6%, 8.8% |
| Low load: 2 % RU | 5.4%, 8.1%, 9.4%, 10.1%, 10.4%, 10.6% |
| Medium load: 42 % RU | 0.6%, 1.1%, 1.4% | Cat 1  Set 1  8 SSBs for FR1 and ssb-periodicity = 80 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 4, 2, 1 |
| Light load: 24 % RU | 1.0%, 2.3%, 3.0% |
| Low load: 7.5 % RU | 2.5%, 5.9%, 7.6% |
| Low load: 2 % RU | 4.5%, 10.7%, 13.8% |
| Medium load: 42 % RU | 0.5%, 0.8%, 0.9% | Cat 2  Set 1  8 SSBs for FR1 and ssb-periodicity = 80 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 4, 2, 1 |
| Light load: 24 % RU | 0.7%, 1.1%, 1.3% |
| Low load: 7.5 % RU | 1.2%, 1.8%, 2.1% |
| Low load: 2 % RU | 1.4%, 2.1%, 2.5% |
| Medium load: 42 % RU | 1.0%, 1.8%, 2.3%, 2.5%, 2.6%, 2.6% | Cat 1  Set 3  64 SSBs for FR2 and ssb-periodicity = 80 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 32, 16, 8, 4, 2, 1 |
| Light load: 24 % RU | 1.3%, 2.6%, 3.2%, 3.5%, 3.7%, 3.7% |
| Low load: 7.5 % RU | 2.1%, 4.1%, 5.0%, 5.5%, 5.8%, 5.9% |
| Low load: 2 % RU | 2.6%, 5.0%, 6.2%, 6.8%, 7.1%, 7.2% |
| Medium load: 42 % RU | 1.1%, 1.6%, 1.8%, 2.0%, 2.0%, 2.1% | Cat 2  Set 3  64 SSBs for FR2 and ssb-periodicity = 80 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 32, 16, 8, 4, 2, 1 |
| Light load: 24 % RU | 1.5%, 2.2%, 2.6%, 2.8%, 2.9%, 2.9% |
| Low load: 7.5 % RU | 2.3%, 3.5%, 4.1%, 4.4%, 4.5%, 4.6% |
| Low load: 2 % RU | 2.9%, 4.3%, 5.0%, 5.4%, 5.5%, 5.6% |
| Medium load: 42 % RU | 0.3%, 0.6%, 0.7% | Cat 1  Set 1  8 SSBs for FR1 and ssb-periodicity = 160 | | FTP3 Model. For each load, reduced the number of SSB transmissions: 4, 2, 1 |
| Light load: 24 % RU | 0.5%, 1.3%, 1.6% |
| Low load: 7.5 % RU | 1.5%, 3.5%, 4.5% |
| Low load: 2 % RU | 3.3%, 7.8%, 10.1% |
| Medium load: 42 % RU | 0.3%, 0.4%, 0.5% | Cat 2  Set 1  8 SSBs for FR1 and ssb-periodicity = 160 | | FTP3 model. For each load, reduced the number of SSB transmissions: 4, 2, 1 |
| Light load: 24 % RU | 0.4%, 0.6%, 0.7% |
| Low load: 7.5 % RU | 0.6%, 0.9%, 1.0% |
| Low load: 2 % RU | 0.7%, 1.1%, 1.3% |
| Medium load: 42 % RU | 0.5%, 0.9%, 1.1%, 1.3%, 1.3%, 1.3% | Cat 1  Set 3  64 SSBs for FR2 and ssb-periodicity = 160 | | FTP3 model. For each load, reduced the number of SSB transmissions: 32, 16, 8, 4, 2, 1 |
| Light load: 24 % RU | 0.7%, 1.3%, 1.6%, 1.8%, 1.9%, 1.9% |
| Low load: 7.5 % RU | 2.6%, 7.1%, 9.3%, 10.4%, 11.0%, 11.2% |
| Low load: 2 % RU | 6.0%, 16.0%, 21.0%, 23.5%, 24.8%, 25.4% |
| Medium load: 42 % RU | 0.5%, 0.8%, 0.9%, 1.0%, 1.0%, 1.1% | Cat 2  Set 3  64 SSBs for FR2 and ssb-periodicity = 160 | | FTP3 model. For each load, reduced the number of SSB transmissions: 32, 16, 8, 4, 2, 1 |
| Light load: 24 % RU | 0.8%, 1.1%, 1.3%, 1.4%, 1.5%, 1.5% |
| Low load: 7.5 % RU | 1.2%, 1.8%, 2.1%, 2.2%, 2.3%, 2.3% |
| Low load: 2 % RU | 1.5%, 2.2%, 2.6%, 2.8%, 2.8%, 2.9% |

Based on the results,

* One company observed that statically skipping certain SIB1 transmission occasions under Set 1 reference configuration for BS Category 1 can achieve energy saving gain by 2.6%~3.9% compared to the baseline of 20 ms SSB&SIB1 repetition periodicity at low load. No impact to UPT was observed. There is no random access procedure modelled in the simulation, therefore the impact on access delay/latency is not shown.
* One company observed that static adaptation of number of SSB can achieve energy saving gain by 0.3%~25.4% at different scenarios with FTP3 model. The gain generally increases when the traffic load becomes lighter while decreases as the SSB periodicity becomes larger. For a same traffic load and SSB periodicity, the gain increases as the number of SSB can be reduced. For FR2 with larger number of SSB for baseline, there is generally larger gain observed than FR1. Due to reduced number of SSB, access delay is increased. Performance of dynamic adaptation of SSB numbers is not provided. There is no random access procedure modelled in the simulation, therefore the impact on access delay/latency is not shown.

=== end ===

**Agreement**

The following TP is endorsed for Section 6.1.1.2 of TR38.864

=== draftTP A-1-5: start ===

The following show the BS energy savings by configuration/adaptation of longer periodicity of common signals and/or uplink random access opportunities.

* **Table 6.1.1-x: BS energy savings by adapting SSB/SIB1 periodicities**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **UPT/Access delay/latency/UE power consumption, etc.** | **Baseline configuration/assumption/Other notable setting** |
| **CMCC  [R1-2211692]** | SSB periodicity 20ms, SIB repetition period 40ms. | cat.2 | Zero | 13.7% |  | Baseline: normal SSB/SIB1 transmission, with 20ms repetition period for both. |
| SSB and SIB1 repetition period 40ms. | 17.6% |  |
| SSB periodicity 20ms, SIB repetition period 40ms. | cat.1 | Zero | 25.7% |  |
| SSB and SIB1 repetition period 40ms. | 28.7% |  |
| **vivo [R1-2211018, R1-2212541]** | Period adaptation of common signals and channels (ES scheme: 160ms SSB and SIB1, 160ms RACH listening) | Cat1 | Zero | 78.8% | UE power consumption: 0% | Baseline scheme: 20ms SSB and SIB1, 20ms RACH listening |
| Cat2 | 16.6% | UE power consumption: 0% |
| **NOKIA/NSB [R1-2211097]** | SSB/SIB1/RO monitoring period= 160ms | Cat 2 | Zero, Low, Light, Medium | 48.4%, 44.3%, 43.7%, 39.9% | UPT: 0 Mbps, 83 Mbps, 70 Mbps, 55 Mbps | SSB/SIB1/random-access occasion (RO) monitoring periodicity @ 20ms UEs are initially in RRC\_idle state |
| SSB/SIB1/RO monitoring period= 640ms | Zero, Low, Light, Medium | 53.6%, 49.0%, 48.8%, 46.1% | UPT: 0 Mbps, 29 Mbps, 27 Mbps, 25 Mbps |
| SSB/SIB1/RO monitoring period= 1280ms | Zero, Low, Light, Medium | 83.6%, 51.3%, 51.7%, 50.6% | UPT: 0 Mbps, 11.2 Mbps, 11 Mbps, 10.5 Mbps |
| **Spreadtrum [R1-2211241]** | Prolonging the periodicity of SSB/SIB1/paging: 1) SSB burst periodicity is 160ms, and SIB1 repetition periodicity is 160ms.  2) PF periodicity at gNB side is 160ms (T=1280ms, N=8).  3) gNB can enter light sleep for Cat 1, but can only enter micro sleep for Cat 2. | Cat 1 | Zero | Set 1- Set 3: 23.8%, 19.6%, 16.3% |  | 1) SSB burst periodicity is 20ms, and SIB1 repetition periodicity is 20ms.  2) PF periodicity at gNB side is 20ms (T=1280ms, N=64).  3) gNB can enter light sleep for Cat 1, but can only enter micro sleep for Cat 2. |
| Cat 2 | Set 1- Set 3: 9.3%, 8.3%, 9.4% |  |
| Transmission window of SSB/SIB1/paging: 1) SSB burst periodicity is 20ms, and SIB1 repetition periodicity is 20ms. 2) PF periodicity at gNB side is 20ms (T=1280ms, N=64). 3) gNB can enter light sleep for Cat 1, but can only enter micro sleep for Cat 2. | Cat 1 | Set 1- Set 3: 23.8%, 19.6%, 16.3% |  | 1) The transmission window periodicity is 1280ms, and the transmission window duration is 160ms. 2) SSB burst periodicity is 20ms within the transmission window, and SIB1 repetition periodicity is 20ms within the transmission window. 3) PF periodicity at gNB side is 160ms (T=1280ms, N=8) within the transmission window. 4) gNB can enter light sleep for Cat 1, and can enter both light sleep and micro sleep for Cat 2 (at the tail of the transmission window). |
| Cat 2 | Set 1- Set 3: 51.5%, 47.3%, 20.6% |  |
| **Intel [R1-2212563]** | Increasing the common channel/signal periodicity | Cat 1 | Low | 40.1% | UPT: 819.66 Mbps  Avg EE\* (baseline): 5.10 Avg EE (ES scheme): 9.17 | Baseline: SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 160 msec periodicity.  EE\* is defined as cell throughput (in Mbps) / average power consumption (in relative power), and averaged from all BS. |
| 45.0% | UPT: 819.66 Mbps  Avg EE (baseline): 5.10  Avg. EE (ES scheme): 10.60 | Baseline: SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 640 msec periodicity |
| Light | 14.6% | UPT: 611.45Mbps  Avg EE (baseline): 2.66 Avg. EE (ES scheme): 3.31 | Baseline: SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 160 msec periodicity |
| 16.8% | UPT: 611.45Mbps  Avg EE (baseline): 2.66 Avg. EE (ES scheme): 3.46 | Baseline:SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 640 msec periodicity |
| Medium | 6.2% | UPT: 457.92Mbps  Avg EE (baseline): 1.50 Avg. EE (ES scheme): 1.63 | Baseline:SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 160 msec periodicity |
| 7.1% | UPT: 457.92Mbps  Avg EE (baseline): 1.50 Avg. EE (ES scheme): 1.65 | Baseline:SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 640 msec periodicity |
| Cat2 | Low | 8.2% | UPT: 819.66Mbps  Avg EE (baseline): 35.82 Avg. EE (ES scheme): 39.23 | Baseline:SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 160 msec periodicity |
| 10.9% | UPT: 819.66Mbps  Avg EE (baseline): 35.82 Avg. EE (ES scheme): 40.09 | Baseline:SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 1280 msec periodicity |
| Light | 5.1% | UPT: 611.45Mbps  Avg EE (baseline): 20.75 Avg. EE (ES scheme): 22.00 | Baseline:SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 160 msec periodicity |
| 5.8% | UPT: 611.45Mbps  Avg EE (baseline): 20.75 Avg. EE (ES scheme): 22.19 | Baseline:SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 1280 msec periodicity |
| Medium | 3.0% | UPT: 457.92Mbps  Avg EE (baseline): 12.44 Avg. EE (ES scheme): 12.89 | Baseline:SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms ES scheme: SSB/SIB1/PRACH: 160 msec periodicity |
| 3.4% | UPT: 457.92Mbps  Avg EE (baseline): 12.44 Avg. EE (ES scheme): 12.96 | Baseline:SSB/PRACH: 20 msec periodicity; SIB periodicity 40ms. ES scheme: SSB/SIB1/PRACH: 1280 msec periodicity |
| **CATT [R1-2211210]** | Adaptation of common signals and channels | Cat 1 | Zero load | 10.2%, 72.7%, 84.8% |  | Baseline: 20ms SSB;  ES scheme: SSB: 40ms, 80ms, 160ms for each load |
| Low load | 3.4%, 18.8%, 19.7% |  | Baseline: SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);SSB periodicity 20ms;CSI-RS/TRS 10ms;  ES scheme: SSB: 40ms, 80ms, 160ms for each load |
| Light load | 1.9%, 5.2%, 5.6% |  | Baseline: SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);SSB periodicity 20ms;CSI-RS/TRS 10ms;  ES scheme: SSB: 40ms, 80ms, 160ms for each load |
| Medium load | 1.3%, 2.2%, 2.6% |  | Baseline: SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);SSB periodicity 20ms;CSI-RS/TRS 10ms;  ES scheme: SSB: 40ms, 80ms, 160ms for each load |
| **Fujitsu [R1-2211085]** | SSB/SIB1 period= 40ms | Cat2 | Zero, low, light, medium | 17.9%, 13.7%, 11.1%, 8.6% |  | Baseline scheme: 20 ms SSB/SIB1 period |
| SSB/SIB1 period= 80ms | Zero, low, light, medium | 26.8%, 20.6%, 16.7%, 12.8% |  |
| SSB/SIB1 period= 160ms | Zero, low, light, medium | 31.4%, 24.1%, 19.4%, 15.0% |  |
| SSB/SIB1 period= 40ms | Zero, low, light, medium | 18.3%, 12.6%, 9.4%, 6.9% |  |
| SSB/SIB1 period= 80ms | Zero, low, light, medium | 27.4%, 18.8%, 14.1%, 10.4% |  |
| SSB/SIB1 period= 160ms | Zero, low, light, medium | 32.0%, 22.0%, 16.5%, 12.1% |  |
| **Ericsson [R1-2212154]** | 40ms SSB+SIB1 | Cat1 | Zero | 0.9% |  | Baseline scheme: 20ms SSB + 160ms SIB1  ES: one SSB. Energy calculation: per symbol energy consumption is modeled. |
| 80ms SSB+SIB1 | 48.5% |  |
| 160ms SSB+SIB1 | 72.6% |  |
| 40ms SSB+SIB1 | -6.2% |  | Baseline scheme: 20ms SSB + 160ms SIB1  ES: Four SSBs. Energy calculation: per symbol energy consumption is modeled. |
| 80ms SSB+SIB1 | 43.8% |  |
| 160ms SSB+SIB1 | 70.5% |  |
| **Qualcomm [R1-2212128]** | Adaptation of Common Signals and Channels | Category 1 | No Load | 13.9% | Access delay/latency: additiona 20 ms;  UE power consumption increment: 99% | Note: "SSB period of 40 ms" without any network traffic either in DL or UL. Therefore, there are no statistics for UPT, latency, etc.. |

Based on the results with static configurations from 9 sources, it can be observed that longer SSB/SIB1 periodicity can bring BS with significant energy savings in most cases, compared to a selected baseline, for both BS Categories, under all reference configurations. When other configurations/settings are the same, the saving gain generally increase as the periodicity becomes larger, and decrease as the traffic load increases or the number of SSBs increases. Particularly, there are two companies providing results with SSB periodicity larger than 160ms which is the maximum value that is currently supported, i.e., being 640ms and 1280ms, and observed that together with longer SIB1/RACH/RO monitoring periodicities, then depending on the traffic load, the BS energy saving gain can be 53.6%~7.1% and 83.6%~3.4%, respectively, compared to a baseline with 20ms SSB periodicity.

The scheme does not affect the UPT for empty load case. When traffic occurs and load increases, the UPT also significantly decreases. The latency/access delay/UE power consumption increases proportionally as the periodicity of SSB/SIB increases compared to a corresponding baseline.

Performance of dynamic SSB/SIB1 periodicity adaptation is not provided.

=== end ===

**Agreement**

The following TP is endorsed for Section 6.1.1.2 of TR38.864

=== draftTP A-1-7: start ===

The following show the BS energy savings by configuration/adaptation of transmission patterns of common signals, i.e. Paging or SSB based on the submitted results.

* **Table 6.1.1-x: BS energy savings by adapting Paging/SSB transmission patterns**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **UPT/access delay/latency/UE power consumption** | **Reference configuration** | **Baseline configuration/assumption** | **Other evaluation methodology/assumption details/notable settings** |
| **Intel [R1-2212563]** | Enhanced Paging by increasing the number of consecutive POs within a PF by factor of M while reducing PF density by a factor of M. This keeps the total number of POs same within the DRX cycle. | Cat1 | Zero, Paging load 2% | 21.2% |  | Set 1 | Paging Parameters: N = T/4; Ns = 4; Enh. Paging†: N = T/4;  Ns = 4; M = 4 | No C-DRX used for UEs; CSI feedback based on SRS; SIB1 BW: 48 PRB; SSB/PRACH/SIB1: 80 msec periodicity; Number of SSB: 1  Paging load is the average load per simulation run time.  Paging events were randomly generated.  Same as below results. The value of T is larger than 160ms. |
| Zero, Paging load 0.2% | 4.0% |  | Paging Parameters: N = T/16; Ns = 2; Enh. Paging†: N = T/16; Ns = 2; M = 4 | No C-DRX used for UEs; CSI feedback based on SRS; SIB1 BW: 48 PRB; SSB/PRACH/SIB1: 80 msec periodicity; Number of SSB: 1 |
| Zero, Paging load 2% | 42.3% |  | Paging Parameters: N = T/4; Ns = 4; Enh. Paging†: N = T/4;  Ns = 4; M = 4 | No C-DRX used for UEs; CSI feedback based on SRS; SIB1 BW: 48 PRB; SSB/PRACH/SIB1: 160 msec periodicity; Number of SSB: 1; |
| Zero, Paging load 0.2% | 6.7% |  | Paging Parameters: N = T/16; Ns = 2; Enh. Paging†: N = T/16; Ns = 2; M = 4 | No C-DRX used for UEs; CSI feedback based on SRS; SIB1 BW: 48 PRB; SSB/PRACH/SIB1: 160 msec periodicity; Number of SSB: 1; |
| Zero, Paging load 3.6% | 18.9% |  | Paging Parameters: N = T/4; Ns = 4; Enh. Paging†: N = T/4;  Ns = 4; M = 4 | No C-DRX used for UEs; CSI feedback based on SRS; SIB1 BW: 48 PRB; SSB/PRACH/SIB1: 80 msec periodicity; Number of SSB: 4; SSB and SIB1 contained in same slot. 1 SSB per slot along with SIB1 to maximize SSB/SIB1 packing; |
| Zero, Paging load 0.5% | 0.2% |  | Paging Parameters: N = T/16; Ns = 2; Enh. Paging†: N = T/16; Ns = 2; M = 4 | No C-DRX used for UEs; CSI feedback based on SRS; SIB1 BW: 48 PRB; SSB/PRACH/SIB1: 80 msec periodicity; Number of SSB: 4; SSB and SIB1 contained in same slot. 1 SSB per slot along with SIB1 to maximize SSB/SIB1 packing; |
| Zero, Paging load 3.6% | 26.4% |  | Paging Parameters: N = T/4; Ns = 4; Enh. Paging†: N = T/4;  Ns = 4; M = 4 | No C-DRX used for UEs; CSI feedback based on SRS; SIB1 BW: 48 PRB; SSB/PRACH/SIB1: 160 msec periodicity; Number of SSB: 4; SSB and SIB1 contained in same slot. 1 SSB per slot along with SIB1 to maximize SSB/SIB1 packing; |
| Zero, Paging load 0.5% | 0.3% |  | Paging Parameters: N = T/16; Ns = 2; Enh. Paging†: N = T/16; Ns = 2; M = 4 | No C-DRX used for UEs; CSI feedback based on SRS; SIB1 BW: 48 PRB; SSB/PRACH/SIB1: 160 msec periodicity; Number of SSB: 4; SSB and SIB1 contained in same slot. 1 SSB per slot along with SIB1 to maximize SSB/SIB1 packing; |
| **Qualcomm [R1-2212128]** | Adaptation of Common Signals and Channels | Category 1 | No Load | 10.3% | UE power consumption: -4% | FR2 Set 3 |  | "Compact SSB" without any network traffic either in DL or UL. Therefore, there are no statistics for UPT, latency, etc.. |

Based on the results,

* One company observed that for BS category 1 and at empty load case, statically adapting paging configuration could provide BS energy savings by 0.3%~6.7% when paging load (resource used for paging) is 0.2%~0.5%, and the gain can be up to 42.3% when paging load is increased up to 3.6%. The gain could also increases as the number of SSB increases. Performance of dynamically adapting paging configurations is not provided. The above energy saving gains were achieved with SSB periodicity of 80ms or 160ms.
* One company observed that having compact SSB (i.e., no time gap between consecutive SSBs) could provide 10.3% network energy saving for BS category 1 and at empty load case in FR2 when SSB periodicity is 20ms. Furthermore, UE power saving can be improved by 4%.

=== end ===

Agreement

The following TP is endorsed for Section 6.1.1.2 of TR38.864

=== draftTP A-1-8: start ===

The following show the BS energy savings by dynamically adapting common signals, i.e. RACH based on the submitted results.

* **Table 6.1.1-x: BS energy savings by dynamically adapting RACH periodicity/occasions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **UPT/access delay/latency/UE power consumption** | **Reference configuration** | **Baseline configuration/assumption/notable settings** | **Other evaluation methodology/assumption details** |
| **Ericsson**  **[R1-2212154]** | PRACH periodicity= 20ms | Cat1 | Zero | 14.4% | Access delay/latency: 10ms increase | Set 1 | Baseline scheme: 20 ms SSB, 40ms SIB1 period, 10ms PRACH periodicity.  Per symbol energy consumption is modeled.  ES scheme: adapting PRACH periodicity for energy efficiency via dynamic PRACH occasions adaptation. Note separate evaluation performed for different PRACH periodicities (i.e. no switching between these settings). | 1 SSB |
| PRACH periodicity= 40ms | 20.9% | Access delay/latency: 30ms increase |
| PRACH periodicity= 80ms | 22.2% | Access delay/latency: 70ms increase |
| PRACH periodicity= 20ms | 17.3% | Access delay/latency: 10ms increase | four SSBs |
| PRACH periodicity= 40ms | 23.9% | Access delay/latency: 30ms increase |
| PRACH periodicity= 80ms | 24.9% | Access delay/latency: 70ms increase |

Based on the results with multiple static RACH occasion configurations, ~~it is~~ one company observed that adaptation of RACH occasions can achieve BS energy savings by 14.4%~24.9% for BS Category 1 at empty load case under FR1 TDD compared to 10ms RACH periodicity without adaptation. The gain generally increases as PRACH periodicity increases for the same number of SSBs. Performance of dynamic RACH configuration is not provided.

On UPT/access delay/latency, this scheme increases access delay/latency from 10ms to 70ms, proportional to the increased PRACH periodicity.

=== end ===

**Agreement**

The following TP is endorsed for Section 6.1.1.2 of TR38.864

The following show the BS energy savings by scheduling of SIB1 by SSB, without PDCCH for SIB1, with repetition period 20ms.

* **Table 6.1.1-x: BS energy savings by scheduling of SIB1 by SSB**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **UPT**  **Access delay/latency**  **UE power consumption**  **Other KPI(s), if any** | **Reference configuration** | **Baseline configuration/assumption** | **Traffic model** | **Other evaluation methodology/assumption details - Part 1 (other than power modeling aspects)** | **Other evaluation methodology/assumption details - Part 2 (power modeling aspects)** |
| **CEWiT+B417:R417**  **[R1-2212429,** R1-2212765] | Scheduling of SIB1 by SSB, without PDCCH for SIB1, with repetition period 20ms | Cat.1 | Zero | 4.8% |  | Set 1 | Baseline: normal SSB/SIB1 transmission, with 20ms repetition period for both. |  | numerical analysis | •SIB1: PDCCH: 3 symbols; PDSCH: 12 OFDM symbols including DMRS. •ղ=1, A=0.4. •Time unit for power model is ms. power consumption is calculated in a 20ms long period |
| **CEWiT**  **[R1-2212429, [R1-2212765]** | Scheduling of SIB1 by SSB, without PDCCH for SIB1, 4 beams, with repetition period 20ms | Cat.1 | Zero | 11.4% |  | Set 1 | Baseline: normal SSB/SIB1 transmission, with 20ms repetition period for both. |  | numerical analysis | •SIB1: PDCCH: 3 symbols; PDSCH: 12 OFDM symbols including DMRS.  •ղ=1, A=0.4. •Time unit for power model is ms. power consumption is calculated in a 20ms long period |
| **CEWiT**  **[R1-2212429, R1-2212765]** | Scheduling of SIB1 by SSB, without PDCCH for SIB1, 8 beams, with repetition period 20ms | Cat.1 | Zero | 14.8% |  | Set 1 | Baseline: normal SSB/SIB1 transmission, with 20ms repetition period for both. |  | numerical analysis | •SIB1: PDCCH: 3 symbols; PDSCH: 12 OFDM symbols including DMRS.  •ղ=1, A=0.4. •Time unit for power model is ms. power consumption is calculated in a 20ms long period |

It is observed on one source that using SSB to schedule SIB1 can obtain 4.8%~14.8% BS energy savings for Set 1 reference configuration for BS Category 1, compared to SSB/SIB1 periodicity of 20 ms for both.

=== end ===

**Agreement**

The following capture the results for waking up gNB triggered by UE wake up signal (WUS).

* **Table 6.1.1-x: BS energy savings by UE wake up signal (WUS)**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **UPT** | **Access delay/latency** | **UE power consumption** | **Reference configuration** | **Baseline configuration/assumption** | **Traffic model** | **Other evaluation methodology/assumption details/notable settings** |
| **MTK [R1-2212259]** | UE\_can\_wake\_up\_gNB | Cat 1 | Low | 49.3% | 0.00% | 0.00% | 0.07% | Set 1 | All 21 cells active | VoIP | SLS; DRX (40, 4, 10); 9 out of 21 cells remian active. BS power consumption value is sum of 21 cells. |
| Cat 2 | 51.9% | 0.00% | 0.00% | 0.07% |
| **ZTE, Sanechips [R1-2211903]** | UE WUS is used to wake up a gNB in an energy saving state without DL transmission including SSB/SIB1 | 1 | low | 7.4%  19.6%  23.8% | 0.66%  2.59%  5.04% |  |  | Set 1 | no WUS, cell is in a normal state with {20ms/40ms} SSB/SIB periodicity | FTP3 | UE mobility. slot-level; Pstatic=P3, η(s\_f,s\_p )=1; time-domain scaling for SSB; time and frequency domain scaling for SIB.  WUS period=20ms/80ms/160ms for each load. |
| light | 4.9%  12.7%  15.5% | 0.11%  0.43%  0.86% |  |  |
| 2 | low | 6.2%  6.4%  6.5% | 0.66%  2.59%  5.04% |  |  | no WUS, cell is in a normal state with {20ms/40ms} SSB/SIB periodicity |
| light | 4.5%  4.6%  4.7% | 0.11%  0.43%  0.86% |  |  |
| **vivo [R1-2211018, R1-2212541]** | UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: 160ms SSB, 20ms/80ms/160ms UEWUS) | Cat 1 | 0% | 29.7%  66.6%  80.7% |  |  | 0.00%  0.00%  0.00% | Set 1 | legacy BS, where all cells are always in the normal mode. Normal mode: 20ms SSB and SIB1, 20ms RACH listening | NaN  NaN  NaN | SLS No UE DRX 100% detection reliability |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: 160ms SSB, 20ms/80ms/160ms UEWUS) | 0.002% | 27.3%  60.4%  72.8% | 0.8%  15.5%  21.7% | 5.68%  38.73%  39.53% | 0.00%  0.00%  0.00% | FTP3, mean packet interval of 10s, packet size of 100bytes |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: 160ms SSB, 20ms/80ms/160ms UEWUS) | 20.55%  20.81%  20.49% | 0.8%  4.3%  6.0% | 3.4%  4.5%  8.6% | 9.70%  20.72%  32.51% | 0.98%  1.46%  1.66% | FTP3, mean packet interval of 200ms, packet size of 0.5Mbytes |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: 160ms SSB, 20ms/80ms/160ms UEWUS) | 41.79%  41.17%  41.35% | -2.4%  0.3%  0.1% | 2.7%  6.0%  7.2% | 8.95%  14.55%  20.53% | 1.13%  1.51%  1.97% |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: no SSB, 20ms/80ms/160ms UEWUS) | 0% | 32.1%  69.6%  83.7% |  |  | 0.00%  0.00%  0.00% | NaN  NaN  NaN |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: no SSB, 20ms/80ms/160ms UEWUS) | 0.002% | 29.4%  63.3%  75.6% | 0.8%  16.5%  24.2% | 4.17%  38.05%  39.53% | 0.00%  0.00%  0.00% | FTP3, mean packet interval of 10s, packet size of 100bytes |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: no SSB, 20ms/80ms/160ms UEWUS) | 20.71%  20.51%  20.66% | -0.1%  6.4%  6.6% | 3.9%  7.0%  8.7% | 11.04%  20.31%  29.07% | 1.08%  1.33%  1.65% | FTP3, mean packet interval of 200ms, packet size of 0.5Mbytes |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: no SSB, 20ms/80ms/160ms UEWUS) | 41.74%  41.91%  42.07% | -2.2%  -0.7%  -0.6% | 1.3%  6.6%  7.5% | 10.32%  16.58%  18.21% | 1.13%  1.63%  1.84% |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: 160ms SSB, 20ms/80ms/160ms UEWUS) | Cat 2 | 0% | 19.1%  19.4%  19.4% |  |  | 0.00%  0.00%  0.00% | NaN  NaN  NaN |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: 160ms SSB, 20ms/80ms/160ms UEWUS) | 0.002% | 18.1%  18.3%  18.3% | 0.76%  5.40%  11.79% | 0.58%  8.98%  20.16% | 0.00%  0.00%  0.00% | FTP3, mean packet interval of 10s, packet size of 100bytes |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: 160ms SSB, 20ms/80ms/160ms UEWUS) | 20.58%  20.28%  20.76% | 0.5%  1.0%  -0.4% | 0.69%  1.02%  2.88% | 7.93%  9.93%  17.27% | 0.64%  0.56%  0.99% | FTP3, mean packet interval of 200ms, packet size of 0.5Mbytes |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: 160ms SSB, 20ms/80ms/160ms UEWUS) | 41.46%  41.22%  41.04% | -2.4%  -2.1%  -1.8% | 0.05%  0.30%  0.45% | 5.94%  10.07%  11.62% | 0.99%  1.10%  0.96% |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: no SSB, 20ms/80ms/160ms UEWUS) | 0% | 20.3%  20.6%  20.6% |  |  | 0.00%  0.00%  0.00% | NaN  NaN  NaN |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: no SSB, 20ms/80ms/160ms UEWUS) | 0.002% | 19.2%  19.4%  19.5% | 0.85%  4.17%  10.53% | 2.63%  9.83%  20.86% | 0.00%  0.00%  0.00% | FTP3, mean packet interval of 10s, packet size of 100bytes |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: no SSB, 20ms/80ms/160ms UEWUS) | 20.55%  20.61%  21.26% | 0.5%  0.3%  -1.0% | 0.36%  0.61%  2.21% | 8.30%  10.14%  17.32% | 0.71%  0.73%  1.11% | FTP3, mean packet interval of 200ms, packet size of 0.5Mbytes |
| UE WUS to wake up a ES gNB without or with sparse SSB/SIB1 and RACH monitoring  (the cells without traffic are switching to ES mode ES mode: no SSB, 20ms/80ms/160ms UEWUS) | 42.05%  41.38%  41.74% | -3.1%  -2.3%  -2.9% | 0.10%  0.21%  0.36% | 7.48%  9.16%  10.22% | 1.26%  0.98%  1.04% |
| **NOKIA/NSB [R1-2211097]** | Wake up of gNB triggered by UE wake up signal (WUS) @ 20ms | Cat 2 | Low | 45.6% | 13,01 Mbps |  |  | Set 1 | SSBs/SIB1s/RO monitoring @ 20ms default periodicity UEs are initially in RRC\_idle state | UL - IM | SLS+Post-processing |
| Wake up of gNB triggered by UE wake up signal (WUS) @ 160ms | 51.9% | 6,08 Mbps |  |  |
| Wake up of gNB triggered by UE wake up signal (WUS) @ 640ms | 52.5% | 2,15 Mbps |  |  |
| Wake up of gNB triggered by UE wake up signal (WUS) @ 1280ms | 66.7% | 1,16 Mbps |  |  |
| **Samsung [R1-2212543]** | Wake up of gNB triggered by UE wake up signal (WUS), @10 ms WUS periodicy | Cat 1 | Low | 70.3%  64.0%  57.2% |  | 0.00%  0.00%  0.00% |  | Set 2 | SR periodicity = 10ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE | SLS No UE DRX 100% detection reliability (one shot transmission). slot level, WUS detection power is 90. |
| Wake up of gNB triggered by UE wake up signal (WUS), @15 ms WUS periodicy | 76.4%  69.4%  61.8% |  | 0.00%  0.00%  0.00% |  | SR periodicity = 15ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE |
| Wake up of gNB triggered by UE wake up signal (WUS), @10 ms WUS periodicy | 80.1%  73.7%  66.7% |  | 0.00%  0.00%  0.00% |  | SR periodicity = 10ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE | SLS No UE DRX 100% detection reliability (one shot transmission). slot level, WUS detection power is 55. |
| Wake up of gNB triggered by UE wake up signal (WUS), @15 ms WUS periodicy | 83.7%  76.5%  68.8% |  | 0.00%  0.00%  0.00% |  | SR periodicity = 15ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE |
| Wake up of gNB triggered by UE wake up signal (WUS), @10 ms WUS periodicy | 92.8%  86.2%  79.0% |  | 0.00%  0.00%  0.00% |  | SR periodicity = 10ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE | SLS No UE DRX 100% detection reliability (one shot transmission). slot level, WUS detection power is 10. |
| Wake up of gNB triggered by UE wake up signal (WUS), @15 ms WUS periodicy | 93.0%  85.7%  77.8% |  | 0.00%  0.00%  0.00% |  | SR periodicity = 15ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE |
| Wake up of gNB triggered by UE wake up signal (WUS), @5 ms WUS periodicy | 45.0%  39.2%  32.8% |  | -29.56%  -28.9%  -29.41% |  | SR periodicity = 10ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE | SLS No UE DRX 100% detection reliability (one shot transmission). slot level, WUS detection power is 90. |
| Wake up of gNB triggered by UE wake up signal (WUS), @5 ms WUS periodicy | 39.1%  32.6%  25.7% |  | -45.37%  -45.15%  -45.51% |  | SR periodicity = 15ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE |
| Wake up of gNB triggered by UE wake up signal (WUS), @10 ms WUS periodicy | 67.1%  60.2%  52.7% |  | -22.44%  -22.85%  -22.79% |  | SR periodicity = 15ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE |
| Wake up of gNB triggered by UE wake up signal (WUS), @5 ms WUS periodicy | 64.7%  58.5%  51.8% |  | -29.56%  -28.9%  -29.41% |  | SR periodicity = 10ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE | SLS No UE DRX 100% detection reliability (one shot transmission). slot level, WUS detection power is 55. |
| Wake up of gNB triggered by UE wake up signal (WUS), @5 ms WUS periodicy | 60.8%  54.1%  46.7% |  | -45.37%  -45.15%  -45.51% |  | SR periodicity = 15ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE |
| Wake up of gNB triggered by UE wake up signal (WUS), @10 ms WUS periodicy | 78.0%  70.9%  63.2% |  | -22.44%  -22.85%  -22.79% |  | SR periodicity = 15ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE |
| Wake up of gNB triggered by UE wake up signal (WUS), @5 ms WUS periodicy | 90.0%  83.4%  76.3% |  | -29.56%  -28.9%  -29.41% |  | SR periodicity = 10ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE | SLS No UE DRX 100% detection reliability (one shot transmission). slot level, WUS detection power is 10. |
| Wake up of gNB triggered by UE wake up signal (WUS), @5 ms WUS periodicy | 88.9%  81.6%  73.8% |  | -45.37%  -45.15%  -45.51% |  | SR periodicity = 15ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE |
| Wake up of gNB triggered by UE wake up signal (WUS), @10 ms WUS periodicy | 92.0%  84.7%  76.8% |  | -22.44%  -22.85%  -22.79% |  | SR periodicity = 15ms | FTP3, mean packet interval of 2s, UL traffic only, 1/5/10 UE |
| **Qualcomm**  **[R1-2212128]** | Wake up of gNB triggered by UE two symbol wake up signal (WUS) | Category 1 | No Load | 18.7% |  | | | FR2 Set 3 | "light SSB" combined with UL WUS and on demand SIB 1 | | |

For UE WUS signal triggering SSB/SIB1/RACH for RRC IDLE/INACTIVE/CONNECTED mode, based on results from 4 sources, it is observed that, with UE WUS signal triggering a BS of 100% detection assumption,

* With C-DRX, at low load, one source observed about 50% network energy savings with marginal UE power increment, without UPT loss observed. The scheduling delay when switching to a new gNB is not modelled.
* For the evaluations with assumption of RRC\_IDLE/INACTIVE mode without C-DRX,
  + without DL transmission including DL common signals before gNB reception of WUS, with WUS period of 20ms, 80ms and 160ms, at zero or low load, the network energy savings could be 7.4%~32.1% (6.2%~45.6%), 19.6%~69.6% (6.4%~51.9%), 23.8%~ 83.7% (6.5%~52.5%) respectively by using Category 1 (Category 2) BS power model. The savings can increase as the WUS period increases, and decrease as the traffic load increases. When WUS period is 20ms, marginal UPT loss, access delay/latency increment and UE power consumption increment are observed. The UPT loss and access delay/latency increases as WUS periodicity increases, while there is marginal UE power consumption increment.
  + With sparse SSB of 160ms periodicity transmitted before gNB reception of WUS, at zero or low load, 27.3%~29.7% (18.1%~19.1%), 60.4%~66.6% (18.3%~19.4%), 72.8%~80.7% (18.3%~19.4%) network energy savings can be achieved with WUS period of 20ms, 80ms and 160ms respectively by using Category 1 (Category 2) BS power model. When WUS period is 20ms, marginal UPT loss, access delay/latency increment and UE power consumption increment are observed. The UPT loss and access delay/latency increases as WUS periodicity increases, while there is marginal UE power consumption increment.
* Note: gNB coordination for WUS reception is assumed. Resource configuration for WUS is not specifically modelled, while one source assumes the configuration of WUS can be obtained from a camping cell. For the case of no DL transmission, also gNB synchronization is further assumed.
* Note: For evaluation results from 2 source, it is assumed that UE achieves timing for the UL WUS transmission from the other cell. For evaluation results from 2 source, it is assumed that UE achieves synchronization with the gNB targeted for energy saving utilizing discovery signal from the same cell, and one source assumed the discovery signal contains PSS only and its use is to help the UE to get synchronized and to be able to transmit an uplink trigger signal. The differentiation of multiple gNBs which has detected the WUS is not modelled.
  + The detection of WUS is assumed to be ideal. False triggering for detection of targeting gNB is not considered.

For UE WUS signal triggering gNB to wake up in case of uplink traffic arrival, for RRC\_CONNECTED without C-DRX and without DL common signals/DL transmission other than PDCCH carrying UL grant, with the assumption of a separate receiver used and 100% detection assumption, at low load, 1 source observed that,

* With WUS detection power of 10, 55 or, with 90 which has the same active UL power
  + When the WUS periodicity is same as the baseline of SR periodicity, 77.8%~93%, 66.7%~92.8% or 57.2%~76.4% network energy savings could be achieved respectively;
  + When the WUS periodicity is smaller than the SR periodicity of the baseline, 76.3%~92%, 46.7%~78% or 25.7%~67.1% network energy savings could be achieved respectively;
  + For each case, the gain generally increases as the WUS periodicity increases and decreases as the traffic load increases. The gain could also increase as the gNB detection power decreases.
  + There is latency reduction observed, which could increase as the periodicity of WUS decreases. The gain can be up to 45%.
* The assumption is that gNB needs to wake up to detect SR but can detect WUS during sleep state. gNB is assumed to be in a state such that the main UL receiver is still in deep sleep when detecting wake-up signal and gNB is able to wake up from deep sleep to active in one slot after WUS detection. The WUS receiver is assumed to be active only when detection of WUS signal and becomes 0 power in other time.

When combined with a light version of SSB and on demand SIB1, one source observed 18.7% network energy savings at low load for FR2, assuming the light version of SSB contains PSS only and its use is to help the UE to get synchronized and to be able to transmit an uplink trigger signal.

=== end ===

**Agreement**

The following captures the results for adaptation of UE DTX/DRX.

* **Table 6.1.1-x: BS energy savings by adaptation of UE DTX/DRX**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **UPT** | **Access delay/latency/UE power consumption/Other KPI(s), if any** | **a) Reference configuration**  **b) Baseline configuration/assumption**  **c) Traffic model**  **d) Other evaluation methodology/assumption details/notable settings** | | | |
| **MTK [R1-2212259]** | DRX\_offset\_alignment | Cat 1 | Low | 29.8% | 0.91% | Access delay/latency: 0.92%  UE power consumption: 2.17% | Set 1  Random DRX offset (granularity = 5 ms)  VoIP  SLS; DRX (40, 4, 10); DRX offset aligned to 0 | | | |
| Cat 2 | 13.7% | 0.91% |
| **OPPO [R1-2211458]** | DRX align | Cat 1 | low load(RU-9.3%) | 4.7% | 361.08Mbps(-15.5%) | Access delay/latency: 78.03ms(+50%) | Set 1  UE-specific DRX, SSB with 20 RBs for 20 ms periodicity | | FTP (0.5MB as packet size, 200ms as mean inter-arrival time) | SLS, C-DRX config: FTP (160,100,8), DRX align |
| low load(RU-0.15%) | 6.7% | 85.91Mbps(-8.7%) | Access delay/latency: 143.55ms(+3.83%) | IM (0.1MB as packet size, 2s as mean inter-arrival time) | SLS, C-DRX config: IM (320,80,10), DRX align |
| DRX align and dropping SSB outside UE active time | low load(RU-9.3%) | 14.4% | 361.08Mbps(-15.5%) | Access delay/latency: 78.03ms(+50%) | FTP (0.5MB as packet size, 200ms as mean inter-arrival time) | SLS, C-DRX config: FTP (160,100,8), DRX align and dropping SSB outside UE active time |
| low load(RU-0.15%) | 70.1% | 85.91Mbps(-8.7%) | Access delay/latency: 143.55ms(+3.83%) | IM (0.1MB as packet size, 2s as mean inter-arrival time) | SLS, C-DRX config: IM (320,80,10), DRX align and dropping SSB outside UE active time |
| **ZTE, Sanechips [R1-2211903]** | DRX alignment | 1 | low | 0.3%  0.9% | 5%  1.30% | unfinished packet ratio=(total number of unfinished packet for baseline-total number of unfinished packet for enhanced)/total number of unfinished packet for baseline: 50%, 54.5% for each BS caterogy | Set 1  UE-specific CDRX  FTP3  CDRX pattern for FTP3  CDRX alignment in a cell | | | |
| 2 | 0.2%  0.4% | 5%  1.30% |
| **Spreadtrum [R1-2211241]** | traffic concentration (in a transmission window | Cat 1 | Low | 37.8%  34.9%  30.9% |  |  | a) For each BS Category: Set 1, Set 2, Set 3  b)- 1) There are 5% load (UE specific data) in 40 slots every 20ms. The load is frequency multiplexed with SSB burst and SIB1 in 2 slots every 20ms. 2) Scaling: Sf≈0.21 in 2 slots every 20ms, and Sf≈0.05 in 38 slots every 20ms  c)-1) The load is concentrated in first 10ms. There are 10% load (UE specific data) in the first 20 slots every 20ms, zero load in the last 20 slots every 20ms. The load is frequency multiplexed with SSB burst and SIB1 in 2 slots every 20ms. 2) gNB can enter light sleep for Cat 1, but can only enter micro sleep for Cat 2. 3) Scaling: Sf≈0.26 in 2 slots every 20ms, and Sf≈0.1 in 18 slots every 20ms  d)- 1) 160ms duration in total. 2) SSB burst periodicity is 20ms, and SIB1 repetition periodicity is 20ms. Two SSBs and the corresponding SIB1 share a slot. SSB burst and SIB1 take 40 PRBs. 3) PF periodicity at gNB side is 20ms (T=1280ms, N=64). Paging is transmitted in another slot every PF assuming one PO is effective in each PF. Paging takes 40 PRBs. 4) Scaling: Sa=1, Sp=1, P\_static=P3. Numerial evaluation resutls. | | | |
| Cat 2 | 31.1%  27.7%  29.2% |  |  |
| Offload between cells (the offloaded cell is turned off) | Cat 1 | Low | 57.7%  53.5%  47.9% |  |  | a) For each BS Category: Set 1, Set 2, Set 3  b)-1) Cell #1 and cell #2: There are 5% load (UE specific data) in 40 slots every 20ms. The load is frequency multiplexed with SSB burst and SIB1 in 2 slots every 20ms. 2) Scaling: Sf≈0.21 in 2 slots every 20ms, and Sf≈0.05 in 38 slots every 20ms  c)-1) The load in cell #1 is shifted to cell #2.  1.1) Cell #1: There are zero load. There are only SSB burst and SIB1 in 2 slots every 20ms. gNB can enter light sleep for Cat 1, but can only enter micro sleep for Cat 2. 1.2) Cell #2: There are 10% load (UE specific data) every 20ms. The load is frequency multiplexed with SSB burst and SIB1 in 2 slots every 20ms. 2) Scaling: 2.1) Cell #1: Sf≈0.16; 2.2) Cell #2: Sf≈0.26 in 2 slots every 20ms, and Sf≈0.1 in 38 slots every 20ms  d)-1) 160ms duration in total. 2) SSB burst periodicity is 20ms, and SIB1 repetition periodicity is 20ms. Two SSBs and the corresponding SIB1 share a slot. SSB burst and SIB1 take 40 PRBs. 3) PF periodicity at gNB side is 20ms (T=1280ms, N=64). Paging is transmitted in another slot every PF assuming one PO is effective in each PF. Paging takes 40 PRBs. 4) Scaling: Sa=1, Sp=1, P\_static=P3. Numerial evaluation results. | | | |
| Cat 2 | 46.5%  44.3%  46.6% |  |  |
| **Intel [R1-2212563]** | Enhanced C-DRX | Cat1 | Light | 2.8% | Baseline: 122.3 Mbps ES: 86.4 Mbps | Avg EE (baseline): 5.20 Avg EE (ES): 4.82 | a)Set1  c) FTP3  d) SLS CSI feedback based on SRS; SIB1 BW: 48 PRB; SSB/PRACH/SIB1: 160 msec periodicity; Number of SSB: 1; Slot-level model For scaling: A = 0.4; η(s\_f,s\_p )=1 for any sf, sp; | Baseline DRX Parameters: DRX Cycle: 80 msec; ON duration 4ms, Inactivity Timer: 40msec For Enh C-DRX, cycle is 80ms and gNB is active for 20ms. | | |
| Medium | 29.7% | Baseline: 93.2 Mbps ES: 29.6 Mbps | Avg EE (baseline): 1.87 Avg EE (ES): 2.33 |
| Low | 2.3% | Baseline: 111.2 Mbps ES: 186.5 Mbps | Avg EE (baseline): 8.81 Avg EE (ES): 9.37 | Baseline DRX Parameters: DRX Cycle: 160 msec;ON duration 8ms, Inactivity Timer: 100msec For Enh C-DRX, cycle is 160ms and gNB is active for 80ms | | |
| Light | 2.3% | Baseline: 98.1 Mbps ES: 66.6 Mbps | Avg EE (baseline): 5.31 Avg EE (ES): 4.66 | Baseline DRX Parameters: DRX Cycle: 160 msec;ON duration 8ms, Inactivity Timer: 100msec For Enh C-DRX, cycle is 160ms and gNB is active for 40ms | | |
| Light | 2.6% | Baseline: 98.1 Mbps ES: 164.3 Mbps | Avg EE (baseline): 5.31 Avg EE (ES): 5.31 | Baseline DRX Parameters: DRX Cycle: 160 msec;ON duration 8ms, Inactivity Timer: 100msec For Enh C-DRX, cycle is 160ms and gNB is active for 80ms | | |
| Medium | 30.9% | Baseline: 75.0 Mbps ES: 28.2 Mbps | Avg EE (baseline):1.97 Avg EE (ES): 2.54 | Baseline DRX Parameters: DRX Cycle: 160 msec; Inactivity Timer: 100msec For Enh C-DRX, cycle is 160ms and gNB is active for 40ms | | |
| Medium | 4.8% | Baseline: 75.0 Mbps ES: 116.6 Mbps | Avg EE (baseline):1.97 Avg EE (ES): 2.04 | Baseline DRX Parameters: DRX Cycle: 160 msec; Inactivity Timer: 100msec For Enh C-DRX, cycle is 160ms and gNB is active for 80ms | | |
| **CATT [R1-2211210]** | Adaptation of DTX/DRX | Cat 1 | Low load | 71.4% |  |  | Set1 | SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);SSB periodicity 20ms;CSI-RS/TRS 10ms; | FTP3, inter-arrival time = 200ms, packet size = 0.5Mbytes | SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);DTX configuration: gNB starting offset of DTX on locate before UE DRX on duration in order to support UE wakeup;SSB periodicity: 20ms; CSI-RS/TRS periodicity: 10ms. |
| Light load | 62.6% |  |  | FTP3, inter-arrival time = 200ms, packet size = 0.5Mbytes |
| Medium load | 47.8% |  |  | FTP3, inter-arrival time = 200ms, packet size = 0.5Mbytes |

Based on 6 sources results, semi-static UE C-DRX alignment achieves BS energy savings gain by 0.2%~71.4% depending on the traffic, UE DRX configurations, and the assumed baseline e.g. random DRX offset per UE, or gNB is always ON to provide service to the UE. At low or light traffic load cases, 4 sources show that the gain can be 14.4%~71.4%, while 3 sources show less than 6.7% gain, depending on whether BS and UE active duration are aligned or not; at medium load case, 2 sources show network energy saving gain can be 4.8%~47.8%. According to one source, dropping SSB outside UE active time can achieve the energy savings by 14.4%~70.1% and it is assumed that the UE active durations are aligned and the potential impact on synchronization and UE measurement outside the UE duration is not considered.

On UPT, one result shows there is marginal negative impact while one result shows it can be up to 15.5%. Also, one result shows that the impact on UPT varies: when the UE DRX cycle is 160ms and gNB active time is 80ms, the UPT is increased while in other configurations, there can be large UPT loss.

On access delay/latency, one result shows marginal increment while one result shows the increment can be up to 50%. Also, about 50% unfinished packet ratio is observed from one source compared to the baseline without UE C-DRX alignment during the evaluation period. The increments are related to the DRX configuration.

Additionally, one source shows that at low and medium load, the average EE is increased up to 28.93% when UE DRX alignment is assumed, whereas for light load case, average EE decreases up to 12.24% when UE DRX alignment is assumed.

=== end ===

**Agreement**

The following capture the results for adaptation of SSB and/or SIB1.

* **Table 6.1.1-x: BS energy savings by adaptation of SSB and/or SIB1**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **UPT** | **Access delay/latency/UE power consumption/Other KPI(s), if any** | **Reference configuration** | **Baseline configuration/assumption** | **Traffic model/Other evaluation methodology/assumption details/notable settings** |
| **CATT [R1-2211210]** | Adaptation of SSB/SIB1 | Cat 1 | Low load | 22.0% |  |  | set1 | SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);SSB periodicity 20ms;CSI-RS/TRS 10ms; | FTP3, inter-arrival time = 200ms, packet size = 0.5Mbytes. SLS;Cell OFF:Without normal SSB/SIB/CSI-RS transmission within Cell off duration;On demand SSB transmission is trigger by neighbour cell with 300ms transmission duration and 20ms SSB. For the case with DRX, DTX configuration: gNB starting offset of DTX on locate before UE DRX on duration in order to support UE wakeup; A=0.4; η(s\_f, s\_p)=1. |
| 43.4% |  |  | SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);SSB periodicity 20ms;CSI-RS/TRS 10ms;DTX configuration: gNB starting offset of DTX on locate before UE DRX on duration in order to support UE wakeup; |
| **Ericsson [R1-2212154]** | 20ms Discovery signal (4 symbols) + no SIB1 | Cat1 | Zero | 2.6% / 5.9% |  |  | Set 1 | Baseline scheme: 20ms SSB + 160ms SIB1 | one SSB/ four SSBs  Energy calculation: per symbol energy consumption is modeled.  According to Rel-15 specification, SIB1 can be transmitted with variable transmission repetition periodicity within a 160 ms period, including one SIB1 PDSCH transmission every 160ms or even sparser. |
| **Qualcomm [R1-2212128]** | on-demand SIB1 | Cat 1 | Empty load | 5.8% / 7.7% / 8.6% |  |  | Set 1 | **Baseline**: 20ms periodicity for SSB/SIB1/RO, one beam **Enhanced**: 20%/10%/5% SIB1 Tx rate, C-WUS with 20ms periodicity |  |
| 32.1% / 36.6% / 38.8% |  |  | **Baseline**: 20ms periodicity for SSB/SIB1/RO, 8 beams **Enhanced**: 20%/10%/5% SIB1 Tx rate, C-WUS with 20ms periodicity |  |

One source shows that with a 4-symbol Discover signal (DRS), and without SIB1 transmission and for on-demand SIB1, 2.6% and 5.9% energy savings can be achieved for one SSB and four SSB respectively, at empty load with baseline of 20ms SSB/160ms SIB1 periodicity.

One source shows on-demand SSB can achieve BS energy savings by 22.0%/43.4% at low load compared to a baseline of 20ms SSB/SIB1 periodicity with or without gNB DTX configuration.

One source is provided with on-demand SIB1 at empty load with baseline of 20ms SSB/SIB1 periodicity, 5.8%~8.6% BS energy savings can be achieved at SIB1 transmission rate of 20%~5% for one SSB beam, and the gains can increase to 32.1%~38.8% for 8 beams case for a same SIB1 transmission rate range.

Performance impact of on demand SSB/SIB was not provided.

=== end ===

**Agreement**

The following capture the results by multi-carrier energy savings enhancements.

* **Table 6.1.1-x: BS energy savings by multi-carrier enhancements**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **KPI** | **Baseline configuration/assumption** |
| **Huawei，HiSilicon**  **[R1-2210858]** | Inter-band SSB-less on Scell | Cat 2 | 0% load(zero) | 14.4% |  | 4 SSB beams with 20ms period, 20RB  2 SSB per slot, and 4 symbols for each SSB, when the SSB is transmitted on a carrier |
| 10% load(low) | 9.3% |
| 20% load(light) | 7.4% |
| 30% load(medium) | 5.7% |
| **ZTE, Sanechips**  **[R1-2211903]** | SSB-less SCell | 1 | zero load | 97.4% |  | SSB20ms for baseline; set 1; |
| 93.9% | SSB80ms for baseline; set 1; |
| 88.4% | SSB160ms for baseline; set 1; |
| 2 | 83.8% | SSB20ms for baseline; set 1; |
| 82.4% | SSB80ms for baseline; set 1; |
| 82.1% | SSB160ms for baseline; set 1; |
| 1 | 97.3% | SSB20ms for baseline; set 2; |
| 93.8% | SSB80ms for baseline; set 2; |
| 88.3% | SSB160ms for baseline; set 2; |
| 2 | 82.1% | SSB20ms for baseline; set 2; |
| 80.7% | SSB80ms for baseline; set 2; |
| 80.4% | SSB160ms for baseline; set 2; |
| SSB-less SCell with DL traffic | 1 | low | 58.4% | UPT:801.79, SSB-less UPT：812.57  UPT gain: 1.3%;  SCell activation delay reduced by 6ms | SSB20ms for baseline; set 1; with DL traffic;  SCell activation delay =12 ms |
| 35.2% | UPT:804.41, SSB-less UPT：812.57  UPT gain: 1.0%;  Scell activation delay reduced by 6ms | SSB80ms for baseline; set 1; with DL traffic;  Scell activation delay =12 ms |
| 21.2% | UPT:804.54, SSB-less UPT：812.57  UPT gain: 1.0%  Scell activation delay reduced by 6ms | SSB160ms for baseline; set 1; with DL traffic;  Scell activation delay =12 ms |
| 2 | 15.2% | UPT:801.79, SSB-less UPT：812.57  UPT gain: 1.3%;  Scell activation delay reduced by 6ms | SSB20ms for baseline; set 1; with DL traffic;  Scell activation delay =12 ms |
| 7.4% | UPT:804.41, SSB-less UPT：812.57  UPT gain: 1.0%;  Scell activation delay reduced by 6ms | SSB80ms for baseline; set 1; with DL traffic;  Scell activation delay =12 ms |
| 6.1% | UPT:804.54, SSB-less UPT：812.57  UPT gain: 1.0%;  Scell activation delay reduced by 6ms | SSB160ms for baseline; set 1; with DL traffic;  Scell activation delay =12 ms |
| 1 | 72.7% | UPT:115.80, SSB-less UPT：119.41  UPT gain: 3.1%;  Scell activation delay reduced by 6ms | SSB20ms for baseline; set 2; with DL traffic;  Scell activation delay =12 ms |
| 51.7% | UPT:118.20, SSB-less UPT：119.41  UPT gain: 1.0%;  Scell activation delay reduced by 6ms | SSB80ms for baseline; set 2; with DL traffic;  Scell activation delay =12 ms |
| 34.9% | UPT:118.70, SSB-less UPT：119.41  UPT gain: 0.6%;  Scell activation delay reduced by 6ms | SSB160ms for baseline; set 2; with DL traffic;  Scell activation delay =12 ms |
| 2 | 24.9% | UPT:115.80, SSB-less UPT：119.41  UPT gain: 3.1%;  Scell activation delay reduced by 6ms | SSB20ms for baseline; set 2; with DL traffic;  Scell activation delay =12 ms |
| 16.9% | UPT:118.20, SSB-less UPT：119.41  UPT gain: 1.0%;  Scell activation delay reduced by 6ms | SSB80ms for baseline; set 2; with DL traffic;  Scell activation delay =12 ms |
| 15.5% | UPT:118.70, SSB-less UPT：119.41  UPT gain: 0.6%  Scell activation delay reduced by 6ms | SSB160ms for baseline; set 2; with DL traffic;  Scell activation delay =12 ms |
| SSB-less Scell with UL traffic | 2 | low | 39.4% | Scell activation delay reduced by 6ms | SSB20ms for baseline; set1; with UL traffic;  Scell activation delay =12 ms |
| 22.4% | SSB80ms for baseline; set1; with UL traffic;  Scell activation delay =12 ms |
| 18.7% | SSB160ms for baseline; set1; with UL traffic;  Scell activation delay =12 ms |
| **Vivo**  **[R1-2211018 R1-2212541]** | Inter-band CA with SSB-less carriers/Scell (ES scheme: CC 1: 20ms SSB and SIB1(with 48 PRB), 20ms RACH listening;  CC 2: neither transmission nor reception) | Cat 1 | 0% | 14.7% | UE power consumption: 0% | Baseline scheme: CC 1: 20ms SSB and SIB1(with 48 PRB), 20ms RACH listening;  CC 2: only 20ms SSB |
| Cat 2 | 0% | 5.1% |
| **Intel**  **[R1-2212563]** | inter-band SSB-less Scell | Cat1 | Low | 3.0% | UPT: 1639.3 Mbps;Avg EE (baseline): 6.56; Avg EE (ES): 6.81 | Baseline: CC# 2 (Scell): 160 msec SSB, no SIB1/PRACH, ES: CC# 2 (Scell): no SSB/SIB1/PRACH, |
| Cat1 | Light | 1.0% | UPT:1222.9 Mbps;Avg EE (baseline): 2.96; Avg EE (ES): 3.00 |
| Cat1 | Medium | 0.3% | UPT: 915.8Mbps;Avg EE (baseline): 1.57; Avg EE (ES): 1.57 |
| **MTK**  **[R1-2212259]** | Scell\_w/o\_SIB1 | Cat 1 | Light | 2.3% | UPT: 0.00%; Access delay/latency: 0%; UE power consumption: 0% | Scell has SSB and SIB1 |
| Cat 2 | 1.1% |
| Scell\_w/o\_SSB\_SIB1 | Cat 1 | 7.9% |
| Cat 2 | 1.3% |
| **CMCC**  **[R1-2211692]** | Scell with simplified SSB: Scell with only PSS/SSS, with 20ms periodicity. Pcell with normal SSB, SIB1 and also SIB information for Scell. | Cat.2 | Zero | 5.7% | N/A | Baseline: normal SSB on Scell. Pcell with normal SSB, SIB1 and also SIB1 information for Scell. |
| Cat.1 | 10.5% |  |
| **Vivo**  **[R1-2211018 R1-2212541]** | SSB/SIB-less carrier operation with assistance of anchor carrier (ES scheme: CC 1: 20ms SSB and SIB1(with 72 PRB), 20ms RACH listening;  CC 2: only 20ms RACH listening) | Cat 1 | 0% | 14.8% |  | Baseline scheme: CC 1: 20ms SSB and SIB1(with 48 PRB), 20ms RACH listening;  CC 2: 20ms SSB and SIB1(with 48 PRB), 20ms RACH listening |
| Cat 2 | 0% | 9.1% |  |
| **CATT**  **[R1-2211210]** | Multi-carrier energy savings enhancements | Cat 1 | Low load | 25.7% |  | SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms); SSB periodicity 20ms;CSI-RS/TRS 10ms;Rel-17 Scell activation/deactivation; |
| Light load | 24.1% |  |
| Medium load | 15.5% |  |
| Low load | 30.3% |  |
| Light load | 29.1% |  |
| Medium load | 20.3% |  |
| **Qualcomm**  **[R1-2212128]** | Dynamic UE-group Pcell  switching | Cat 1 | Medium  (39% RU for 1 CC; 22% RU across 2 CCs) | 37.5% | UPT: -14% | **Assumption**: Number of Ues changes from 25 to 20 **Baseline**: Keep 2 CCs activated **Enhancement**: deactivate 1 CC and keep 1CC activated |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **UPT** | **Access delay/latency/UE power consumption/Other KPI(s), if any** | **Reference configuration** | **Baseline configuration/assumption** | **Traffic model/Other evaluation methodology/assumption details/notable settings** |
| **CMCC [R1-2211692]** | SSB/SIB1-less scheme: gNB has 2 co-deployed CCs, both of them are available for UE with single carrier operation to access, but only CC1 has normal SSB and SIB1 with default 20ms transmission period. CC2 only has PSS/SSS for synchronization. | cat.2 | Zero | 31.4% | / | CC1 carries SIB1 of CC2, the power consumption of CC1 increases 1.73% for FDM SIB of both CC. | set 1 | Baseline scheme: gNB has 2 co-deployed CCs, both of them are available for UE with single carrier operation to access, so both CC1 and CC2 has SSB and SIB1 with default 20ms transmission period. As shown in Figure.5 (a). | numerical analysis.  •SIB1:  -Baseline: for both CC1 and CC2, PDCCH: 2 symbols, 48RB; PDSCH: 12RBs, 12 OFDM symbols including DMRS. -SSB/SIB1-less scheme: no SIB1 on CC2, but CC1 carries SIB1 for CC2, so the TBS will be doubled. The number of PDSCH PRBs is 24 RBs, 12OFDM symbols. PDCCH still occupies 2 OFDM symbols, 48 PRBs. •SSB1 and SSB are transmitted in different slots, e.g. value in Table 13-11 is assumed to be 5ms. •ղ=1, A=0.4. •Time unit for power model is slot. power consumption is calculated in a 40ms long period |
| cat.1 | 56.5% | / | CC1 carries SIB1 of CC2, the power consumption of CC1 increases 1.41% for FDM SIB of both CC. |
| **Huawei, HiSilicon [R1-2210858]** | SIB-less on ES CC | Cat 2 | 0% load(zero) | 33.6% | N/A | N/A | Set 2 | 4 SIB1 with 20ms period,20RB | FTP3 IM.  NO C-DRX; Subband based CSI-feedback in every 5 slots.  slot level with time-domain scaling; A=0.4; η=1, 0.76(s\_f\*s\_p<0.5) |
| 10% load(low) | 26.2% | N/A | N/A |
| 20% load(light) | 19.0% | N/A | N/A |
| 30% load(medium) | 16.0% | N/A | N/A |
| dual SIB on Anchor CC | 0% load(zero) | -7.5% | N/A | N/A |
| 10% load(low) | -6.7% | N/A | N/A |
| 20% load(light) | -6.1% | N/A | N/A |
| 30% load(medium) | -5.5% | N/A | N/A |
| SIB-less on ES CC | 0% load(zero) | 20.2% | N/A | N/A | 4 SIB1 with 40ms period,20RB |
| 11.2% | N/A | N/A | 4 SIB1 with 80ms period,20RB |
| 5.9% | N/A | N/A | 4 SIB1 with 160ms period,20RB |
| 10% load(low) | 15.7% | N/A | N/A | 4 SIB1 with 40ms period,20RB |
| 9.3% | N/A | N/A | 4 SIB1 with 80ms period,20RB |
| 4.0% | N/A | N/A | 4 SIB1 with 160ms period,20RB |
| **ZTE, Sanechips [R1-2211903]** | (SSB and SIB)-less cell | 1 | zero | 97.9%  95.4%  91.1% |  |  | Set 1 | Baseline: SSB+SIB: {20ms+40ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: (SSB+SIB1)-less for non-anchor cell | FTP3 for Set 1. IM for Set 2.  slot-level; Pstatic=P3, η(s\_f,s\_p )=1;  time-domain scaling for SSB;  time and frequency domain scaling for SIB.  For the multiplexing pattern of two SIBs in the anchor cell (when applicable), TDM is considered in the evaluations. |
| low | 64.3%  43.6%  28.0% |  |  |
| SIB-less cell | zero | 19.3%  24.6%  23.5% |  |  | Baseline: SSB+SIB: {20ms+40ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: SIB1-less for non-anchor cell |
| low | 15.5%  13.6%  8.8% |  |  |
| anchor cell with dual SIB transmission | zero | -14.1%  -18.9%  -18.1% |  | energy increase for anchor cell with SIB1 transmission for SIB1-less cell | Baseline: SSB+SIB: {20ms+40ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: (SSB+SIB1)-less for non-anchor cell, anchor cell with SIB1 transmission for SIB1-less cell |
| low | -11.6%  -10.5%  -6.8% |  |
| (SSB and SIB)-less cell | zero | 98.4%  96.2%  92.6% |  |  | Set 2 | Baseline: SSB+SIB: {20ms+20ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: (SSB+SIB1)-less for non-anchor cell |
| low | 80.3%  59.4%  42.4% |  |  |
| SIB-less cell | zero | 40.7%  38.4%  37.0% |  |  | Baseline: SSB+SIB: {20ms+20ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: SIB1-less for non-anchor cell |
| low | 28.0%  16.0%  11.5% |  |  |
| anchor cell with dual SIB transmission | zero | -17.6%  -12.4%  -12.0% |  | energy increase for anchor cell with SIB1 transmission for SIB1-less cell | Baseline: SSB+SIB: {20ms+20ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: (SSB+SIB1)-less for non-anchor cell, anchor cell with SIB1 transmission for SIB1-less cell |
| low | -17.8%  -10.8%  -7.7% |  |
| (SSB and SIB)-less cell | 2 | zero | 85.8%  83.6%  82.8% |  |  | Set 1 | Baseline: SSB+SIB: {20ms+40ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: (SSB+SIB1)-less for non-anchor cell |
| low | 24.5%  13.4%  9.4% |  |  |
| SIB-less cell | zero | 12.1%  7.0%  3.7% |  |  | Baseline: SSB+SIB: {20ms+40ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: SIB1-less for non-anchor cell |
| low | 10.8%  6.2%  3.3% |  |  |
| anchor cell with dual SIB transmission | zero | -8.0%  -4.6%  -2.4% |  | energy increase for anchor cell with SIB1 transmission for SIB1-less cell | Baseline: SSB+SIB: {20ms+40ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: (SSB+SIB1)-less for non-anchor cell, anchor cell with SIB1 transmission for SIB1-less cell |
| low | -7.5%  -4.3%  -2.3% |  |
| (SSB and SIB)-less cell | zero | 87.5%  82.6%  81.4% |  |  | Set 2 | Baseline: SSB+SIB: {20ms+20ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: (SSB+SIB1)-less for non-anchor cell |
| low | 42.9%  23.6%  19.1% |  |  |
| SIB-less cell | zero | 28.2%  9.8%  5.3% |  |  | Baseline: SSB+SIB: {20ms+20ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: SIB1-less for non-anchor cell |
| low | 23.9%  8.0%  4.3% |  |  |
| anchor cell with dual SIB transmission | zero | -14.1%  -4.9%  -2.6% |  | energy increase for anchor cell with SIB1 transmission for SIB1-less cell | Baseline: SSB+SIB: {20ms+20ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; Enhanced: (SSB+SIB1)-less for non-anchor cell, anchor cell with SIB1 transmission for SIB1-less cell |
| low | -13.8%  -4.6%  -2.5% |  |
| **NOKIA/NSB [R1-2211097]** | SSB-less at 20 ms period of RO | CAT2 | Unloaded/low/light/Medium | 27.5%  26.1%  26.0%  22.7% | /  135 Mbps  105 Mbps  74 Mbps |  | SET 1 | Intra-band/collocated cells with non-CA case, consisting of:  \* Coverage cell with 20 ms periodicity of SSB/SIB1 Tx and RO monitoring \* Capacity cell with 20 ms periodicity of SSB/SIB1 Tx and RO monitoring UEs initially in RRC Idle state. | DL-FTP3. SLS+Post-processing |
| SSB-less at 160 ms period of RO | Unloaded/low/light/Medium | 51.8%  48.2%  47.3%  43.2% | /  85 Mbps  72 Mbps  56 Mbps |  |
| SIB1-less at 20 ms period of RO | Unloaded/low/light/Medium | 43.1%  40.5%  40.1%  36.5% | /  132 Mbps  104 Mbps  73 Mbps |  |
| SIB1-less at 160 ms period of RO | Unloaded/low/light/Medium | 53.8%  51.2%  47.3%  43.2% | /  84 Mbps  72 Mbps  56 Mbps |  |
| SSB&SIB1-less at 20 ms period of RO | Unloaded/low/light/Medium | 52.7%  50.6%  52.7%  44.4% | /  135 Mbps  105 Mbps  74 Mbps |  |
| SSB&SIB1-less at 160 ms period of RO | Unloaded/low/light/Medium | 55.1%  53.1%  54.9%  46.8% | /  85 Mbps  72 Mbps  56 Mbps |  |
| **CATT [R1-2211210]** | Adaptation of SSB/SIB1 | Cat 1 | Low load | 22.0% |  |  | set1 | SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);SSB periodicity 20ms;CSI-RS/TRS 10ms; | FTP3, inter-arrival time = 200ms, packet size = 0.5Mbytes. SLS;Cell OFF:Without normal SSB/SIB/CSI-RS transmission within Cell off duration;On demand SSB transmission is trigger by neighbour cell with 300ms transmission duration and 20ms SSB. For the case with DRX, DTX configuration: gNB starting offset of DTX on locate before UE DRX on duration in order to support UE wakeup; A=0.4; η(s\_f, s\_p)=1. |
| 43.4% |  |  | SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);SSB periodicity 20ms;CSI-RS/TRS 10ms;DTX configuration: gNB starting offset of DTX on locate before UE DRX on duration in order to support UE wakeup; |
| **Fujitsu [R1-2211085]** | SSB&SIB-less | Cat2 | Zero  low  light  medium | 34.5%  27.0%  21.7%  16.7% |  |  | Set 1 | Baseline scheme: 20 ms SSB/SIB1 period | BS goes into mico-sleep on symbolc w/o TX/RX  simplified SSB which contains SSS and PSS is transmitted with periodicity of 160 ms No UE DRX. A=0.4, η=1 |
| Zero  low  light  medium | 36.0%  24.7%  18.4%  13.5% |  |  | Set 2 |
| **Ericsson [R1-2212154]** | 20ms Discovery signal (4 symbols) + no SIB1 | Cat1 | Zero | 2.6% / 5.9% |  |  | Set 1 | Baseline scheme: 20ms SSB + 160ms SIB1 | one SSB/ four SSBs  Energy calculation: per symbol energy consumption is modeled.  According to Rel-15 specification, SIB1 can be transmitted with variable transmission repetition periodicity within a 160 ms period, including one SIB1 PDSCH transmission every 160ms or even sparser. |
| **Qualcomm [R1-2212128]** | on-demand SIB1 | Cat 1 | Empty load | 5.8% / 7.7% / 8.6% |  |  | Set 1 | **Baseline**: 20ms periodicity for SSB/SIB1/RO, one beam **Enhanced**: 20%/10%/5% SIB1 Tx rate, C-WUS with 20ms periodicity |  |
| 32.1% / 36.6% / 38.8% |  |  | **Baseline**: 20ms periodicity for SSB/SIB1/RO, 8 beams **Enhanced**: 20%/10%/5% SIB1 Tx rate, C-WUS with 20ms periodicity |  |

Observation includes the results for techniques that are also evaluated under #A-6. The following is observed.

In general, for SSB and/or SIB saved from one carrier of two carriers, 8 resources observed BS energy savings gain, by 5.1%~97.4% for empty load, 3.0%~58.4% for low load, and 1.0%~7.9% for light load, 0.3%~5.7% for medium load. When traffic load is low, network may turn off SCell for energy saving. The results are for FR1 only.

With one of two carriers having simplified SSB and no SIB1, one result shows BS energy saving gain can be achieved by 31.4%~56.5% compared with a baseline of both carriers having SSB and SIB1 periodicity of 20ms; the same source company result also show that with CA configured where SIB1 is already carried by PCell, compared with normal SSB on SCell, the gain of simplified SSB on SCell can be 5.7%~10.5%.

With SIB-less only from one of two carriers and SSB is still transmitted,

* one result shows that 33.6%~16.0% BS energy saving gain can be achieved compared with a carrier has 20ms SIB1 periodicity and both SSB and SIB1 are transmitted, and the gain decreases as the traffic load increases,. Meanwhile, the SIB1 carried on another carrier increase the energy of that carrier by 7.5%~5.5%, resulting a total saving across two carries by 26.1%~10.5%. The gain decreases to 4.0% when the baseline SIB1 periodicity increases to 160ms;
* one result shows BS energy saving gain can be 3.3%~40.7% compared with baseline of SSB+SIB periodicity of {20ms+20ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell; meanwhile, the SIB1 carried on another carrier increase the energy of that carrier by 2.0%~17.8%, resulting a total saving across two carries by 1.3%~22.9%;
* one result shows at different loads, compared to baseline of 20 ms SSB/SIB1 periodicity, that BS energy savings can be achieved by 53.8%~36.5% with RO periodicity of 20ms and 160ms;
* also one result show less than 2.3% BS energy savings when compared with a baseline of SCell having SIB1.

With SSB-less only from one of two carriers, for CA in which case the SIB is already saved from SCell, with assumption that UE is able to acquire sync from a carrier from another band,

* at different loads, compared to a baseline of 20 ms SSB/SIB1 periodicity, one result shows BS energy savings by 27.5%~22.7% and 51.8%~43.2% when the RO periodicity is 20ms and 160ms respectively;
* two results show that BS energy savings can be 5.1%~14.7% at different loads, compared to a baseline of 20ms SSB periodicity;
* one result shows with the same load, BS energy saving gain can be 6.1%~15.2% for DL traffic, and 18.7%~39.4% for UL traffic compared with baseline of SSB periodicity of {20ms, 80ms, 160ms}. The BS energy saving gain from SSB-less cell with UL traffic is 12.6%~24.2% larger than SSB-less cell with DL traffic;
* one result also shows that when the baseline Scell SSB periodicity is 160ms, only 0.3%~3% BS energy savings can be achieved, and one another shows BS energy savings by less than 7.9% if compared with Scell having SIB1.
* UE measurement is based on SSB(s) transmitted in the other carrier of the two carriers

With both SSB-less and SIB1-less from one of two carriers for non-CA operation, with assumption that UE is able to acquire sync from a carrier from another band,

* compared to baseline of 20 ms SSB/SIB1 periodicity on both carriers, one result shows BS energy savings by 55.1%~44.4% with RO periodicity of 20ms~160ms at different loads, and one result shows 9.1%~14.8% energy savings at empty load if an anchor carrier carries additional SIB1 for another carrier;
* at different loads, compared to baseline of 20 ms SSB/SIB1 periodicity, one result shows BS energy savings by 36.0%~13.5% when combined with simplified SSB (i.e. PSS and SSS only);
* one result shows that with baseline of SSB+SIB periodicity of {20ms+20ms, 80ms+80ms, 160ms+160ms} for anchor cell and non-anchor cell, BS energy savings can be 9.4%~97.9% if an anchor carrier carries the SSB and SIB1 for another carrier depending on the traffic load. Meanwhile, the SIB1 carried on another carrier increase the energy of that carrier by 2.0%~17.8%, resulting a total saving across two carries by 7.4%~80.1%.
* Comparison with CA is not provided
* UE measurement is not considered

For source results where SSB is not transmitted in SCell, performance impact(s) due to lack of AGC and cell measurement results before SCell access and activation is not provided.

For source results where SSB is not transmitted in neighbour cell, mobility performance impact(s) due to SSB-less operation in neighbour cell(s) is not provided.

In most results for SSB and/or SIB saved from one carrier of two carriers, the UPT is not negatively impacted while one result shows slightly increased UPT. One source shows that the SCell activation delay can also be reduced to 6ms from the baseline.

No negative impact observed on UE power consumption for the above schemes.

Additionally, SSB-less SCell for CA can slightly improve the average EE, reported by one result.

One company showed that UE-group Pcell switching together with Scell dormancy could provide network energy saving by up to 37.5% for two-CC CA scenario with FR1 Set 1. However, UPT degrades by 14% if one Scell goes to dormant state.

=== end ===

**Agreement**

The following capture the results for semi-statically configured bandwidth part of UEs within a carrier. The evaluation is performed with different traffic, e.g. medium traffic to light traffic for Set 1, and low traffic to very low traffic for Set 3, and the reduced BW of 80 MHz is applied as NES mode compared with baseline BW of 100 MHz.

* **Table 6.1.1-x: BS energy savings by BWP adaptation within carrier**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Company** | **BS Category** | **Load scenario** | **ES gain (%)** | **KPI** | **Reference configuration** | **Baseline configuration/assumption** |
| **Samsung**  **[R1-2212543]** | Cat 1 | Baseline traffic: 42.8 % RU Reduced traffic: 28.47 % RU | 38.2% | UPT: 6.05%; Packet latency: 6.44%; Scheduling latency: No increase | Set1 | Baseline: full 100MHz with 55 dBm  NES mode: 80 MHz with 54 dBm |
| Cat 2 | 27.8% |
| Cat 1 | Baseline traffic: 7.5 % RU Reduced traffic: 2.75 % RU | 52.2% | UPT: 14.67%; Packet latency: 17.2%; Scheduling latency: No increase |
| Cat 2 | 17.6% |
| Cat 1 | Baseline traffic: 32.1 % Reduced traffic: 25.7 % | 17.4% | UPT: 28.24%; Packet latency: 39.4%; Scheduling latency: No increase | Set3 | Baseline: full 100MHz with 49 dBm  NES mode: 80 MHz with 48 dBm |
| Cat 2 | 17.8% |

One source observed BS energy savings by 17.4%~52.2% at the expense of UPT loss by 28.4%~14.47%, and packet latency increases by 6.44%~39.4% when traffic is reduced compared to corresponding baseline. BWP switching delay is not modelled.

On scheduling latency, no negative impact is observed.

=== end ===

**Agreement**

The following captures the results for dynamic /(semi)-static adaptation of bandwidth of active BWP.

* **Table 6.1.1-x: BS energy savings by BW adaptation within BWP**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **KPI** | **Baseline configuration/assumption** |
| **OPPO [R1-2211458]** | adaptation of bandwidth of active BWP of UEs | Cat 1 | low load(RU-10%) | 1.4% | UPT: 554.74Mbps(-46.8%); Access delay/latency: 9.35ms(+86.3%) | system BW of 100MHz, 64T: (M, N, P, Mg, Ng, MP, NP,) = (8, 8, 2, 1, 1, 4, 8) |
| low load(RU-0.2%) | 1.3% | UPT: 513.43Mbps(-52%); Access delay/latency: 1.78ms(+48.3%) |
| **Intel [R1-2212563]** | intra-carrier BWP adaptation | Low | -20.6% | UPT: Baseline (819.7Mbps), ES (346.8 Mbps); Avg EE (baseline): 5.10; Avg EE (ES): 1.87 | Baseline: Full BW ES: 50% BW |
| -75.4% | UPT: Baseline (819.7Mbps), ES (99.4 Mbps); Avg EE (baseline): 5.10; Avg EE (ES): 0.54 | Baseline: Full BW ES: 25% BW |
| Light | -45.9% | UPT: Baseline (611.5Mbps), ES (155.2Mbps); Avg EE (baseline): 2.66; Avg EE (ES): 0.69 | Baseline: Full BW ES: 50% BW |
| -61.8% | UPT: Baseline (611.5Mbps), ES (25.7Mbps); Avg EE (baseline): 2.66 Avg EE (ES): 0.26 | Baseline: Full BW ES: 25% BW |
| Medium | -27.6% | UPT: Baseline (457.9Mbps), ES (50.5Mbps); Avg EE (baseline): 1.50 Avg EE (ES): 0.44 | Baseline: Full BW ES: 50% BW |
| -13.5% | UPT: Baseline (457.9Mbps), ES (12.3Mbps); Avg EE (baseline): 1.50; Avg EE (ES): 0.44 | Baseline: Full BW ES: 25% BW |
| CEWiT {R1-xxxx} | Dynamic adaptation of bandwidth of active BWP of UEs with dynamic indication | Cat 1 | Medium | 1.75% |  | Baseline: Full BW of 100MHz, 32 ports ES: 50% BW |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category &Reference configuration** | **Load scenario** | **ES gain (%)** | **UPT/latency/UE power/ Other KPIs** | **Baseline configuration/assumption** | **Evaluation methodology/assumption details/traffic model** |
| **MTK**  **[R1-2212259]** | #TxRU\_32 | Cat 1, Set 1 | Light | 15.8% | UPT loss:4.54%;  latency increase:4.76%;  UE power increase:3.48% | BS #TxRU 64 | SLS; DRX (160, 8, 100); FTP3 traffic |
| Cat 2, Set 1 | 15.8% | UPT loss:4.54%;  latency increase:4.76%;  UE power increase:3.48% |
| #TxRU\_16 | Cat 1, Set 1 | 19.2% | UPT loss:16.92%;  latency increase:20.36%;  UE power increase:14.70% |
| Cat 2, Set 1 | 22.1% | UPT loss:16.92%;  latency increase:20.36%;  UE power increase:14.70% |
| #TxRU\_8 | Cat 1, Set 1 | 22.1% | UPT loss:47.48%;  latency increase:90.42%;  UE power increase:47.94% |
| Cat 2, Set 1 | 24.9% | UPT loss:47.48%;  latency increase:90.42%;  UE power increase:47.94% |
| #TxRU\_32 | Cat 1, Set 1 | Medium | 25.3% | UPT loss:6.39%;  latency increase:6.83%;  UE power increase:4.20% |
| Cat 2, Set 1 | 26.6% | UPT loss:6.39%;  latency increase:6.83%;  UE power increase:4.20% |
| #TxRU\_16 | Cat 1, Set 1 | 31.4% | UPT loss:44.78%;  latency increase:81.08%;  UE power increase:32.85% |
| Cat 2, Set 1 | 36.7% | UPT loss:44.78%;  latency increase:81.08%;  UE power increase:32.85% |
| #TxRU\_8 | Cat 1, Set 1 | 36.0% | UPT loss:87.08%;  latency increase:647.07%;  UE power increase:79.99% |
| Cat 2, Set 1 | 45.2% | UPT loss:87.08%;  latency increase:647.07%;  UE power increase:79.99% |
| #TxRU\_32\_PDSCH\_PowOffset\_-3dB | Cat 1, Set 1 | Light | 18.8% | UPT loss:9.06%;  latency increase:9.96%;  UE power increase:7.62% | BS #TxRU 64; PDSCH power offset 0 dB | SLS; DRX (160, 8, 100);  FTP3 traffic model;  Single value η (=1) |
| Cat 2, Set 1 | 19.7% | UPT loss:9.06%;  latency increase:9.96%;  UE power increase:7.62% |
| **OPPO**  **[R1-2211458]** | Dynamic adaptation of spatial elements. | Cat 1,Set 1 | low load(RU-10%) | 22.1% | UPT: 550Mbps(-47.2%);  latency: 12.41ms(+147%) | system BW of 100MHz, 64T: (M, N, P, Mg, Ng, MP, NP,) = (8, 8, 2, 1, 1, 4, 8) | SLS, 8T: (M, N, P, Mg, Ng, MP, NP,) = (4, 2, 2, 1, 1, 2, 2) is used for evaluation;  FTP3 traffic model;  A = 0.4 and η=1 |
| low load(RU-0.2%) | 13.7% | UPT: 782.56Mbps(-21.2%);  latency:1.79ms(+49.1%) | SLS, 8T: (M, N, P, Mg, Ng, MP, NP,) = (4, 2, 2, 1, 1, 2, 2) is used for ES evaluation,;  FTP3 IM traffic model;  A = 0.4 and η=1 |
| **Huawei,HiSilicon**  **[R1-2210858]** | Dynamic TRX adaption with Multiple CSIs | Cat 2,Set 1 | 10% load(low) | 7.7% | 0% UPT loss | Dynamic TRX adaption with Single 64T CSI; | NO C-DRX;  Subband based CSI-feedback in every 5 slots;  FTP3 IM traffic model;  A=0.4; η=1, 0.76 |
| 4.0% | 5% UPT loss |
| 3.4% | 10% UPT loss |
| 30% load(medium) | 13.0% | 0% UPT loss |
| 11.3% | 5% UPT loss |
| 9.6% | 10% UPT loss |
| 10% load(low) | 7.5% | 0% UPT loss | C-DRX with (cycle, on-duration, inactivity timer) = (320, 10, 80) ms;  Subband based CSI-feedback in every 5 slots;  FTP3 IM traffic model;  A=0.4; η=1, 0.76 |
| 30% load(medium) | 10.9% | 0% UPT loss |
| Cat 2,Set 2 | 10% load(low) | 7.5% | 0% UPT loss | NO C-DRX;  Subband based CSI-feedback in every 5 slots;  FTP3 IM traffic model;  A=0.4; η=1, 0.76) |
| 13.2% | 5% UPT loss |
| 10.2% | 10% UPT loss |
| 30% load(medium) | 10.3% | 0% UPT loss |
| 19.2% | 5% UPT loss |
| 14.8% | 10% UPT loss |
| **ZTE,Sanechips**  **[R1-2211903]** | TxRU reduction 48TxRU | Cat 2, Set 1 | Low load(RU=8.8%) | 7.8% | 1.5% UPT loss | Baseline: 64TxRU | FTP3: 20K packet size;η=1 |
| TxRU reduction 32TxRU | Low load(RU=8.8%) | 15.5% | 4.47% UPT loss |
| TxRU reduction 16TxRU | Low load(RU=8.8%) | 23.5% | 11.06% UPT loss |
| TxRU reduction 48TxRU | light load(RU=20%) | 10.8% | 1.5% UPT loss |
| TxRU reduction 32TxRU | light load(RU=20%) | 21.7% | 7.06% UPT loss |
| TxRU reduction 16TxRU | light load(RU=20%) | 33.7% | 15.31% UPT loss |
| TxRU reduction 48TxRU | medium load(RU=32%) | 12.5% | 3.34% UPT loss |
| TxRU reduction 32TxRU | medium load(RU=32%) | 24.6% | 10.44% UPT loss |
| Dynamic TxRUs adaptation via multi-CSI | Low load(RU=8.8%) | 27.1% | 0.9% UPT loss |
| light load(RU=20%) | 28.7% | 1.5% UPT loss |
| light load(RU=20%) | 31.3% | 7% UPT loss |
| medium load(RU=32%) | 23.8% | 1.17% UPT loss |
| TxRU reduction 48TxRU | Low load(RU=10%) | 5.6% | 6.89% UPT loss | FTP3: 0.1M packet size,η=1 |
| TxRU reduction 32TxRU | Low load(RU=10%) | 11.0% | 18.39% UPT loss |
| TxRU reduction 48TxRU | light load(RU=20%) | 9.1% | 6.32% UPT loss |
| TxRU reduction 32TxRU | light load(RU=20%) | 18.6% | 14.88% UPT loss |
| TxRU reduction 48TxRU | Medium load(RU=40%) | 11.8% | 8.01% UPT loss |
| TxRU reduction 32TxRU | Medium load(RU=40%) | 25.0% | 20.88% UPT loss |
| Dynamic TxRUs adaptation via multi-CSI | Low load(RU=10%) | 7.6% | 3.1% UPT loss |
| Low load(RU=10%) | 11.1% | 5.04% UPT loss |
| Low load(RU=10%) | 12.7% | 6.03% UPT loss |
| light load(RU=20%) | 13.8% | 2.52% UPT loss |
| light load(RU=20%) | 16.3% | 4.13% UPT loss |
| light load(RU=20%) | 18.7% | 5.15% UPT loss |
| light load(RU=20%) | 21.1% | 6.96% UPT loss |
| Medium load(RU=40%) | 15.7% | 2.89% UPT loss |
| Medium load(RU=40%) | 17.1% | 4.16% UPT loss |
| TxRU reduction 24TxRU | Cat 2, Set 2 | Low load(RU=5%) | 4.8% | 2.03% UPT loss | Baseline: 32TxRU | FTP3: 20K packet size,η=1 |
| TxRU reduction 16TxRU | Low load(RU=5%) | 9.6% | 5.61% UPT loss |
| TxRU reduction 8TxRU | Low load(RU=5%) | 14.8% | 12.5% UPT loss |
| TxRU reduction 24TxRU | Low load(RU=11%) | 8.0% | 3.07% UPT loss |
| TxRU reduction 16TxRU | Low load(RU=11%) | 15.9% | 9.75% UPT loss |
| TxRU reduction 8TxRU | Low load(RU=11%) | 25.3% | 19.36% UPT loss |
| TxRU reduction 24TxRU | light load(RU=20%) | 9.6% | 5.19% UPT loss |
| TxRU reduction 16TxRU | light load(RU=20%) | 19.7% | 12.87% UPT loss |
| TxRU reduction 8TxRU | light load(RU=20%) | 32.1% | 23.931% UPT loss |
| TxRU reduction 24TxRU | Low load(RU=5%) | 7.9% | 0.42% UPT loss | FTP3: 4K packet size, η=1 |
| TxRU reduction 16TxRU | Low load(RU=5%) | 15.8% | 1.72% UPT loss |
| TxRU reduction 8TxRU | Low load(RU=5%) | 24.3% | 3.54% UPT loss |
| TxRU reduction 24TxRU | Low load(RU=13%) | 11.2% | 0.67% UPT loss |
| TxRU reduction 16TxRU | Low load(RU=13%) | 22.7% | 1.5% UPT loss |
| TxRU reduction 8TxRU | Low load(RU=13%) | 35.0% | 3.84% UPT loss |
| TxRU reduction 24TxRU | light load(RU=28%) | 14.0% | 1.86% UPT loss |
| TxRU reduction 16TxRU | light load(RU=28%) | 27.8% | 6.16% UPT loss |
| TxRU reduction 8TxRU | light load(RU=28%) | 43.4% | 14.15% UPT loss |
| TxRU reduction 24TxRU | Medium load(RU=48%) | 14.3% | 5.07% UPT loss |
| TxRU reduction 16TxRU | Medium load(RU=48%) | 29.4% | 14.63% UPT loss |
| Dynamic TxRUs adaptation via multi-CSI | Low load(RU=5%) | 18.1% | 0.62% UPT loss |
| Low load(RU=13%) | 23.7% | 0.16% UPT loss |
| light load(RU=28%) | 19.4% | 0.74% UPT loss |
| Medium load(RU=48%) | 13.7% | 1.01% UPT loss |
| **Vivo**  **[R1-2211018 , R1-2212541]** | Dynamic antenna port adaptation (antenna ports are dynamically adapted (between 64 ports and 8 ports) according to the cell traffic load, in every slot) | Cat 1, Set 1 | 12.38% | 9.4% | UPT loss:0.36%;  latency increase: 0.08%;  UE power increase: 0.02% | Baseline: antenna ports are always 64 | SLS; No UE DRX; FTP3 traffic model,A=0.4, η=1 |
| 12.57% | 9.4% | UPT loss:1.98%;  latency increase: 2.20%;  UE power increase: 0.04% |
| 15.31% | 6.8% | UPT loss:12.26%;  latency increase: 14.20%;  UE power increase: 1.35% |
| Cat 2, Set 1 | 12.52% | 8.1% | UPT loss:2.12%;  latency increase: 2.35%;  UE power increase: 0.17% |
| 13.16% | 8.1% | UPT loss:6.48%;  latency increase:8.25%;  UE power increase:0.45% |
| 16.42% | 6.7% | UPT loss:18.50%;  latency increase:38.22%;  UE power increase:1.96% |
| Dynamic antenna port adaptation (between 64 ports and 8 ports) with multi-CSI | Cat 1, Set 1 | 15.33% | 12.8% | UPT loss:0.02%;  latency increase: 0.05%;  UE power increase: 0.01% | Baseline: antenna ports are always 64 | SLS; No UE DRX; FTP3 traffic model,A=0.4, η=1 |
| **NOKIA/NSB**  **[R1-2211097]** | Reduced number of TX to 32 | Cat 2, Set 1 | Low | 27.6% | UPT: 163,26 Mbps | Single cell operation as per SET1 (64 TRX). UEs are initially in RRC\_CONNECTED state | SLS+Post-processing; FTP3 traffic model; A=0,4; Single value η (=1) |
| Light | 28.5% | UPT: 117,64 Mbps |
| Medium | 29.5% | UPT: 75,47 Mbps |
| **Intel**  **[R1-2212563]** | Antenna port adaptation | Cat 1, Set 1 | Low | 19.1% | UPT Baseline: 819.7Mbps UPT ES: 731.1Mbps;  Avg EE (baseline): 5.11 Avg EE (ES): 5.46 | Baseline: 64Tx (fixed) ES: 32Tx (fixed) | SLS No C-DRX used for UEs; CSI feedback based on SRS; FTP3 traffic model; A = 0.4; η(s\_f,s\_p )=1 for any sf, sp; |
| 27.3% | UPT Baseline: 819.7Mbps UPT ES: 585.5Mbps;  Avg EE (baseline): 5.11 Avg EE (ES): 4.81 | Baseline: 64Tx (fixed) ES: 16Tx (fixed) |
| 4.5% | UPT Baseline: 819.7Mbps UPT ES: 801.8Mbps;  Avg EE (baseline): 5.11 Avg EE (ES): 5.07 | Baseline: 64Tx (fixed) ES: variable |
| Light | 25.7% | UPT Baseline: 611.5Mbps UPT ES: 539.8Mbps;  Avg EE (baseline): 2.67 Avg EE (ES): 3.11 | Baseline: 64Tx (fixed) ES: 32Tx (fixed) |
| 35.7% | UPT Baseline: 611.5Mbps UPT ES: 400.3Mbps;  Avg EE (baseline): 2.67 Avg EE (ES): 2.73 | Baseline: 64Tx (fixed) ES: 16Tx (fixed) |
| 1.9% | UPT Baseline: 611.5Mbps UPT ES: 606.7Mbps;  Avg EE (baseline): 2.67 Avg EE (ES): 2.71 | Baseline: 64Tx (fixed) ES: variable |
| Medium | 29.6% | UPT Baseline: 457.9Mbps UPT ES: 389.3Mbps;  Avg EE (baseline): 1.5 Avg EE (ES): 1.84 | Baseline: 64Tx (fixed) ES: 32Tx (fixed) |
| 41.8% | UPT Baseline: 457.9Mbps UPT ES: 243.9Mbps;  Avg EE (baseline): 1.5 Avg EE (ES): 1.67 | Baseline: 64Tx (fixed) ES: 16Tx (fixed) |
| 0.0% | UPT Baseline: 457.9Mbps UPT ES: 457.8Mbps;  Avg EE (baseline): 1.5 Avg EE (ES): 1.50 | Baseline: 64Tx (fixed) ES: variable |
| **CATT**  **[R1-2211210]** | Dynamic adaptation of spatial elements | Cat 1, Set 1 | Low load | 6.8% | UPT loss:0.32% | SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);SSB periodicity 20ms;CSI-RS/TRS 10ms;TxRU= 64. | SLS; (cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);  SSB periodicity 20ms;CSI-RS/TRS 10ms;dynamic spatial antenna adaptation:  gNB dynamic adaptation of the number of TxRU from 64TxRU to 32 TxRU;  FTP3 traffic model; A=0.4; η(s\_f, s\_p)=1. |
| Light load | 12.2% | UPT loss:0.62% |
| Medium load | 18.0% | UPT loss:3.8% |
| Low load | 6.9% | UPT loss:1.5% | SLS; SSB periodicity 20ms;CSI-RS/TRS 10ms;TxRU= 64. | SLS; No DRX;  SSB periodicity 20ms;CSI-RS/TRS 10ms;dynamic spatial antenna adaptation:  gNB dynamic adaptation of the number of TxRU from 64TxRU to 32 TxRU;  A=0.4; η(s\_f, s\_p)=1. |
| Light load | 12.3% | UPT loss:1.6% |
| Medium load | 19.6% | UPT loss:1.8% |
| **Fujitsu**  **[R1-2211085]** | Dynamic TxRU adaptation | Cat 2, Set 1 | low | 24.1% | 5.7% average UPT loss | BS #TxRU=64 | CSI feedback period = 20ms, feedback delay = 4ms,  immediate antenna adaptation delay gNB dynamically turns out half of the TxRUs if the DL data in the buffer is expected to be transmitted in the next slot;  FTP3 traffic model; A=0.4; Single value η (=1) |
| light | 18.6% | 4.1% average UPT loss |
| medium | 12.0% | 2.3% average UPT loss |
| Cat 2, Set 2 | low | 26.5% | 0.6% average UPT loss | BS #TxRU=32 |
| light | 20.0% | 0.5% average UPT loss |
| medium | 12.8% | 0.3% average UPT loss |
| **Ericsson**  **[R1-2212154]** | BS #TxRU 32 | Cat1, Set 1 | Low | 15.0% | UPT loss of 1% for 95-%,  UPT loss of 2% for 50-% UPT loss of 8% for 5-% | BS #TxRU 64 | 1 SSB Single value η (=1)  FTP3 traffic model  Dynamic switching applied, i.e. adapting number of antennas for energy efficiency in durations when only users in good channel condition are scheduled. Note separate evaluation performed for different number of antennas (i.e. no switching between these settings). |
| Light | 21.2% | UPT loss of 3% for 95-%,  UPT loss of 6% for 50-% UPT loss of 12% for 5-% |
| Medium | 22.4% | UPT loss of 3% for 95-%,  UPT loss of 14% for 50-% UPT loss of 22% for 5-% |
| BS #TxRU 16 | Low | 21.4% | UPT loss of 3% for 95-%,  UPT loss of 5% for 50-% UPT loss of 14% for 5-% |
| Light | 31.6% | UPT loss of 6% for 95-%,  UPT loss of 15% for 50-% UPT loss of 44% for 5-% |
| Medium | 36.6% | UPT loss of 8% for 95-%,  UPT loss of 25% for 50-% UPT loss of 33% for 5-% |
| **Qualcomm**  **[R1-2212128]** | #TxRU reduction (64 to 32) | Cat 1, Set 1 | Low | 29.4% | UPT loss at 50%tile: 31%; DL SINR loss at 5% tile: 4.5dB | BS #TxRU 64 | FTP3 traffic model |
| Light | 28.6% | UPT loss at 50%tile: 30%; DL SINR loss at 5% tile: 6.5dB |
| **Samsung**  **[R1-2212543]** | #TxRU reduction (64 to 32) | Cat 1, Set 1 | Medium | 28.82% | UPT loss: 12.97%; latency increase: 16.69%  Baseline traffic: 27.87 % RU Changed traffic: 32.28 % RU | BS #TxRU 64 | FR1, Port adaptation from 64 to 32 TxRU  FTP3 traffic model |
| Light | 25.3% | UPT loss: 14.70%; latency increase: 16.84%;  Baseline traffic: 14.21 % RU Changed traffic: 16.94 % RU |
| Low | 19.47% | UPT loss: 19.19%; latency increase: 17.46%  Baseline traffic: 3.48 % RU Changed traffic: 4.05 % RU |
| Low | 10.93% | UPT loss: 25.12%; latency increase: 16.66%  Baseline traffic: 1.29 % RU Changed traffic: 1.56 % RU |
| #TxRU reduction (32 to 16) | Cat 1, Set 3 | Medium | 31.9% | UPT loss: 10.37%; latency increase: 4.58%  Baseline traffic: 21.69 % RU Changed traffic: 22.56 % RU | BS #TxRU 32 | FR2, Port adaptation from 32 to 16 TxRU  FTP3 traffic model |
| Low | 26.8% | UPT loss: 13.42%; latency increase: 15.54%  Baseline traffic: 7.23 % RU Changed traffic: 7.5 % RU |
| #TxRU reduction (32 to 8) | Cat 1, Set 3 | Medium | 48.2% | UPT loss: 7.6%; latency increase: 12.47%  Baseline traffic: 21.69 % RU Changed traffic: 23.31 % RU | BS #TxRU 32 | FR2, Port adaptation from 32 to 8 TxRU  FTP3 traffic model |
| Low | 40.5% | UPT loss: 13.7%; latency increase: 26.4%  Baseline traffic: 7.23 % RU Changed traffic: 7.76 % RU |

3 sources show different observations. One source show small BW energy saving gain by 1.3%/1.4% at the expense of about 50% UPT loss and increased access delay/latency by 48.3%/86.3%. One source shows a BW energy saving gain of 1.7%. One source shows BS power consumption increases with BWP size reduction in a carrier and negative energy saving gain in the range -13.5%~ -75.4% is observed, together with significantly reduced UPT, and additionally reduced average EE.

=== end ===

**Agreement**

The following capture the results for dynamic adaptation of spatial elements.

* **Table 6.1.1-x: BS energy savings by adaptation of spatial elements**
* **Use table in section 6.3.1.2 of R1-2212935**

12 sources observed that BS energy savings can be achieved, at all loads for different sets of reference configurations with FTP3 for FTP3 IM traffic models, with or without UE C-DRX configuration. The gain depends on whether there is multiple CSI report assistance, the number of antenna ports that can be adapted, the load scenarios, and UPT loss. No performance analysis was provided for broadcast and common channels with dynamic antenna adaptation.

With dynamic/semi-static adaptation of spatial elements,

* One source shows that BS energy saving for UE specific PDSCH for FR1 can be achieved by 3.4%~19.2% with dynamic adaptation and multi-CSI, compared to dynamic adaptation of spatial elements with single CSI report. The UPT loss was observed by less than 10%.
* 2 source shows that the gain for UE specific PDSCH for FR1 can be 7.6%~31.3% with dynamic adaptation and multi-CSI, compared with no adaptation, with UPT loss of 0.02%~7%.
* 2 sources show that the gain can be 6.7%~26.5% with dynamic adaptation without multi-CSI, compared to no adaptation, with UPT loss of 0.3%~18.5%.
* 9 source show that the gain can be 4.8%~48.2% with static adaptation without multi-CSI, compared to no adaptation, with UPT loss of 0.02%~87.08%. One source observed that the downlink coverage is reduced by 4.5dB – 6.5dB when reducing the number of TxRUs from 64 to 32 in Set 1 FR1 configuration.
* One source shows that when dynamic antenna adaptation is variably changed, the gain is reduced to a range of 0~4.5% with 0.02%~2.18% UPT loss.
* One source shows BS energy saving can be 18.8%~19.7% that additional gain can be obtained when this scheme is combined with PDSCH power offset. The UPT loss is observed by 9.06%.
* More number of elements are reduced, more gain can be generally obtained.

On latency, there is negative impact observed in three sources and the increment becomes larger as the number of reduced antenna ports becomes larger.

On UE power consumption, 2 sources show that there is increase by up to 79.99% % (number of TX RU is reduced from 64 to 8).

Additionally, one result shows that the average EE can be generally increased except for the low load case where number of antenna is reduced from 64 to 16, and the case of antenna number variably changing.

=== end ===

**Agreement**

The following capture the results for TRP muting in multi-TRP operation.

* **Table 6.1.1-x: BS energy savings by TRP muting in multi-TRP operation**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **UPT/latency/UE power consumption/ Other KPIs** | **Baseline configuration/assumption** | **Evaluation methodology/assumption details** |
| **NOKIA/NSB**  **[R1-2211097]** | Semi-static reduced number of TRPs | Cat 2, Set 1 | Low | 38.8% | UPT loss: -14.49% | 2 TRPs are assumed. UEs are initially in RRC\_CONNECTED state. | SLS+Post-processing,  FTP3 traffic model; A=0,4; Single value η (=1).  70% of the P\_Static among TRPs |
| Light | 37.2% | UPT loss: -14.14% |
| Medium | 36.9% | UPT loss: -7.27% |
| **CATT**  **[R1-2211210]** | Dynamic TRP muting/adaptation in multi-TRP operation | Cat 1, Set 1 | Low load | 28.4% | UE power: 50.6;  UE ESG:12.7% | M-TRP configuration:  One cell is configured with 2TRPs;  Both of TRP are activated. | SLS; (DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);  SSB periodicity 20ms;  CSI-RS/TRS 10ms;  TRP OFF: 160ms SSB/CSI-RS transmission.  When TRP is activated, additional CSI-RS/TRS is transmitted before data scheduling. FTP3 traffic model; A=0.4; η(s\_f, s\_p)=1. |
| Light load | 28.7% | UE power: 50.6;  UE ESG:12.7% |
| Medium load | 19.7% | UE power: 51.6;  UE ESG:12.4% |
| **Qualcomm**  **[R1-2212128]** | Semi-static TRP reduction (2 to 1) | Cat 1, Set 1 | Low | 41.6% | UPT loss at 50%-tile: 16% | 2 TRPs, each with 64 TxRUs | FTP3 traffic model |
| Light | 39.0% | UPT loss at 50%-tile: 22% |

For two TRP configuration case at different loads,

* (2 sources) with semi-static TRP reduction, BS energy saving gain can be achieved by 36.9%~41.6% compared to no TRP reduction, with UPT loss of 7.27%~22%;
* (one source) with dynamic TRP reduction, compared to no TRP reduction, BS energy saving gain can be achieved by 19.7%~28.7%, without reported UPT impact. It assumes two TRP are always transmitting CSI-RS.

For the BS energy saving gain around 19.7%~28.7%, it is also observed from one source that UE power savings can be achieved by about 12%.

=== end ===

**Agreement**

The following capture the results for adaptation of transmission power of signals and channels.

* **Table 6.1.1-x: BS energy savings by dynamic transmission power adaptation**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **Baseline configuration/assumption** | **Other KPI** |
| **MTK**  **[R1-2212259]** | PDSCH\_PowOffset\_-3dB | Cat 1 | Light | 8.7% | Baseline：PDSCH power offset 0 dB  ES scheme：PDSCH power offset -3/-6/-9 dB  reference configuration：Set1  FTP3，DRX (160, 8, 100)，Single value η (=1) | UPT:2.03%,UE power comsumption:1.80%,ltency:2.07% |
| PDSCH\_PowOffset\_-6dB | 11.1% | UPT:5.66%,UE power comsumption:4.47%,latency:6.00% |
| PDSCH\_PowOffset\_-9dB | 9.0% | UPT:10.80%,UE power comsumption:9.17%,latency:12.11% |
| PDSCH\_PowOffset\_-3dB | Medium | 13.9% | UPT:3.28%,UE power comsumption:2.46%,latency:3.39% |
| PDSCH\_PowOffset\_-6dB | 18.7% | UPT:8.97%,UE power comsumption:6.80%,latency:9.85% |
| PDSCH\_PowOffset\_-9dB | 17.7% | UPT:19.49%,UE power comsumption:14.78%,latency:24.21% |
| PDSCH\_PowOffset\_-3dB | Cat 2 | Light | 8.7% | UPT:2.03%,UE power comsumption:1.80%,latency:2.07% |
| PDSCH\_PowOffset\_-6dB | 11.8% | UPT:5.66%,UE power comsumption:4.47%,.latency:6.00% |
| PDSCH\_PowOffset\_-9dB | 11.2% | UPT:10.80%,UE power comsumption:9.17%,latency:12.11% |
| PDSCH\_PowOffset\_-3dB | Medium | 14.7% | UPT:3.28%,UE power comsumption:2.46%,latency:3.39% |
| PDSCH\_PowOffset\_-6dB | 20.6% | UPT:8.97%,UE power comsumption:6.80%,latency:9.85% |
| PDSCH\_PowOffset\_-9dB | 21.0% | UPT:19.49%,UE power comsumption:14.78%,latency:24.21% |
| #TxRU\_32\_PDSCH\_PowOffset\_-3dB | Cat 1 | Light | 18.8% | Baseline：PDSCH power offset 0 dB,BS #TxRU 64  ES scheme：PDSCH power offset -3 dB, BS #TxRU 32  reference configuration：Set1  FTP3，DRX (160, 8, 100)，Single value η (=1) | UPT:9.06%,UE power comsumption:7.62%,latency:9.96% |
| Cat 2 | 19.7% | UPT:9.06%,UE power comsumption:7.62%,latency:9.96% |
| **Huawei，HiSilicon**  **[R1-2210858]** | Dynamic Power back-off with Multiple CSIs | Cat 2 | 30% load(medium) | 5.3% | baseline: Dynamic Power back-off with Single CSI  ES scheme: Dynamic Power back-off with Multiple CSIs  reference configuration: Set1  FTP3 IM, NO C-DRX; Subband based CSI-feedback in every 5 slots, slot level with time-domain scaling; A=0.4; η=1, 0.76(s\_f\*s\_p<0.5) | UPT: 0% loss |
| 7.3% | baseline: Dynamic Power back-off with Single CSI  ES scheme: Dynamic Power back-off with Multiple CSIs  reference configuration: Set1  VoIP, NO C-DRX; Subband based CSI-feedback in every 5 slots, slot level with time-domain scaling; A=0.4; η=1, 0.76(s\_f\*s\_p<0.5) |
| 6.9% | baseline: Dynamic Power back-off with Single CSI  ES scheme: Dynamic Power back-off with Multiple CSIs  reference configuration: Set2  VoIP, NO C-DRX; Subband based CSI-feedback in every 5 slots, slot level with time-domain scaling; A=0.4; η=1, 0.76(s\_f\*s\_p<0.5) |
| 11.5% | baseline: Dynamic Power back-off with Single CSI  ES scheme: Dynamic Power back-off with Multiple CSIs  reference configuration: Set2  VoIP, 4T for Set 2,NO C-DRX; Subband based CSI-feedback in every 5 slots, slot level with time-domain scaling; A=0.4; η=1, 0.76(s\_f\*s\_p<0.5) |
| 5.3% | baseline: Dynamic Power back-off with Single CSI  ES scheme: Dynamic Power back-off with Multiple CSIs  reference configuration: Set2  FTP3 IM, 4T for Set 2, NO C-DRX; Subband based CSI-feedback in every 5 slots, slot level with time-domain scaling; A=0.4; η=1, 0.76(s\_f\*s\_p<0.5) |
| **ZTE,Sanechips**  **[R1-2211903]** | PDSCH PSD reduction 53.75dBm | Cat 2 | Low load(RU=10%) | 2.3% | Baseline: 55dBm  reference configuration:Set 1: FR1 TDD, FTP3: 20K packet size, slot-level,Pstatic=P3, η=1 | 0.56% UPT loss |
| light load(RU=20%) | 4.4% | 1.82% UPT loss |
| Medium load(RU=31%) | 6.0% | 3.8% UPT loss |
| PDSCH PSD reduction 52dBm | Low load(RU=10%) | 6.4% | 1.26% UPT loss |
| light load(RU=20%) | 10.1% | 1.83% UPT loss |
| Medium load(RU=31%) | 12.9% | 2.38% UPT loss |
| Low load(RU=4.7%) | 3.9% | Baseline: 55dBm  reference configuration:Set 1: FR1 TDD, FTP3: 0.5M packet size, slot-level,Pstatic=P3, η=1 | 5.74% UPT loss |
| Low load(RU=9.6%) | 7.0% | 4.32% UPT loss |
| light load(RU=23.5%) | 12.2% | 5.48% UPT loss |
| Medium load(RU=38.4%) | 16.6% | 9.81% UPT loss |
| PDSCH PSD reduction 47.75dBm | Low load(RU=13%) | 5.9% | Baseline: 49dBm  reference configuration:Set 2: FR1 FDD, FTP3: 0.1M packet size, slot-level,Pstatic=P3, η=1 | 0.64% UPT loss |
| light load(RU=29%) | 8.6% | 0.05% UPT loss |
| PDSCH PSD reduction 46dBm | Low load(RU=13%) | 11.8% | 1.56% UPT loss |
| light load(RU=29%) | 17.0% | 0.75% UPT loss |
| Dynamic PDSCH PSD adaptation via multi-CSI | Low load(RU=10%) | 12.1% | Baseline: 55dBm  reference configuration:Set 1: FR1 TDD, FTP3: 20K packet size, slot-level,Pstatic=P3, η=1 | 0.38% UPT loss |
| light load(RU=20%) | 16.6% | 0.35% UPT loss |
| Medium load(RU=31%) | 23.8% | 1.17% UPT loss |
| Medium load(RU=31%) | 16.4% | 0.27% UPT loss |
| **NOKIA/NSB**  **[R1-2211097]** | Reduced DL transmit power by 3dB | Cat 2 | Low | 9.8% | Baseline: MaximumTx power of 49 dBm.UEs are initially in RRC\_CONNECTED state  reference configuration:Set 2, DL-FTP3, A=0,4; Single value η (=1)  SLS | UPT:144 Mbps |
| Reduced DL transmit power by 6dB | 12.2% | UPT:134 Mbps |
| Reduced DL transmit power by 9dB | 13.4% | UPT:119 Mbps |
| Reduced DL transmit power by 3dB | Light | 15.4% | UPT:104 Mbps |
| Reduced DL transmit power by 6dB | 19.7% | UPT:97 Mbps |
| Reduced DL transmit power by 9dB | 17.9% | UPT:88 Mbps |
| Reduced DL transmit power by 3dB | Medium | 16.2% | UPT:76 Mbps |
| Reduced DL transmit power by 6dB | 23.4% | UPT:70 Mbps |
| Reduced DL transmit power by 9dB | 24.7% | UPT:63 Mbps |
| **DCM**  **[R1-2211994]** | PDSCH\_PowOffset\_-6dB | Cat 1 | Light | 6.6% | Baseline:PDSCH power offset 0 dB  reference configuration:Set 1,FTP3, A=0.4, Single value η (=1) | 1.00% UPT loss |
| PDSCH\_PowOffset\_-12dB | 8.3% | 2.60% UPT loss |
| PDSCH\_PowOffset\_-18dB | 8.7% | 5.70% UPT loss |
| PDSCH\_PowOffset\_-6dB | Medium | 15.5% | 2.50% UPT loss |
| PDSCH\_PowOffset\_-12dB | 19.5% | 2.00% UPT loss |
| PDSCH\_PowOffset\_-18dB | 20.4% | 5.80% UPT loss |
| PDSCH\_PowOffset\_-6dB | High | 24.1% | -3.10% UPT loss |
| PDSCH\_PowOffset\_-12dB | 29.9% | -0.70% UPT loss |
| PDSCH\_PowOffset\_-18dB | 31.4% | 0% UPT loss |
| **Intel**  **[R1-2212563]** | Transmit Power Adaptation/ -12dB power | Cat1 | Low | 19.2% | Baseline: Full power  SLS; No C-DRX used for UEs;  CSI feedback based on SRS;  SIB1 BW: 48 PRB;  No paging overhead;  1 SSB beam;  SSB/PRACH periodicity: 20msec;  SIB1 periodicity: 40msec;  Slot level model  For scaling:  A = 0.4;  η(s\_f,s\_p )=1 for any sf, sp; | Baseline: 819.7 Mbps ES: 746 Mbps  Avg EE (Baseline): 5.10  Avg EE (ES) : 5.43 |
| Light | 28.2% | Baseline: 611.5 Mbps ES: 567.5 Mbps  Avg EE (Baseline): 2.66 Avg EE (ES) : 3.25 |
| Medium | 34.3% | Baseline: 457.9 Mbps ES: 415.1 Mbps  Avg EE (Baseline): 1.5 Avg EE (ES) : 2.03 |
| Transmit Power Adaptation/ -6dB power | Low | 17.6% | Baseline: 819.7 Mbps ES: 798.5 Mbps  Avg EE (Baseline): 5.10 Avg EE (ES) : 5.83 |
| Light | 25.4% | Baseline: 611.5 Mbps ES: 604.8 Mbps  Avg EE (Baseline): 2.66 Avg EE (ES) : 3.41 |
| Medium | 30.0% | Baseline: 457.9 Mbps ES: 450.7 Mbps  Avg EE (Baseline): 1.5 Avg EE (ES) : 2.06 |
| **CATT**  **[R1-2211210]** | Adaptation of transmission power of signals and channels | Cat 1 | Low load | 3.9% | Baseline:SSB periodicity 20ms;CSI-RS/TRS 10ms;Transmission power:55dBm;  reference configuration:Set 1, FTP3, inter-arrival time = 200ms, packet size = 0.5Mbytes;  A=0.4; η(s\_f, s\_p)=1. | UPTloss:1.6% |
| Light load | 7.7% | UPTloss:1.8% |
| Medium load | 9.1% | UPTloss:2.8% |
| Low load | 4.1% | Baseline: SSB periodicity 20ms;CSI-RS/TRS 10ms;(DRX-cycle, on duration timer, inactivity timer) = (160ms, 8ms, 100ms);Power domain adaptation;  reference configuration:Set 1, FTP3, inter-arrival time = 200ms, packet size = 0.5Mbytes;  A=0.4; η(s\_f, s\_p)=1. | UPTloss:1.9% |
| Light load | 7.7% | UPTloss:3.9% |
| Medium load | 11.2% | UPTloss:3.1% |
| **Ericsson**  **[R1-2212154]** | Tx power adaptation (reduction up to 12 dB) | Cat1 | Low | 20.9% | Baseline: BS Tx power 55 dBm  reference configuration:Set 1,FTP3  1 SSB  Single value η (=1).  For ES scheme: dynamic switching applied, i.e. adapting DL Tx power for energy efficiency in durations when only users in good channel condition are scheduled. Note separate evaluation performed for different power settings (i.e. no switching between these settings) | UPT loss of 1% for 95-% UE,  UPT loss of 3% for 50-% UE UPT loss of 22% for 5-% UE |
| Light | 40.5% | UPT loss of 1% for 95-% UE,  UPT loss of 8% for 50-% UE UPT loss of 36% for 5-% UE |
| Medium | 47.6% | UPT loss of 0% for 95-% UE,  UPT loss of 9% for 50-% UE UPT loss of 13% for 5-% UE |
| Tx power adaptation (reduction up to 6 dB) | Low | 17.7% | UPT loss of 1% for 95-% UE,  UPT loss of 1% for 50-% UE UPT loss of 2% for 5-% UE |
| Light | 33.0% | UPT loss of 0% for 95-% UE,  UPT loss of 4% for 50-% UE UPT loss of 7% for 5-% UE |
| Medium | 38.5% | UPT loss of 2% for 95-% UE,  UPT loss of 9% for 50-% UE UPT loss of 7% for 5-% UE |
| **Samsung**  **[R1-2212543]** | Transmission power adaptation | Cat 1 | Reference traffic:  7.5 % RU  Reduced traffic:  4.4 % RU | 51.5% | Baseline: BS Tx power 55 dBm  reference configuration:Set 1,FTP3  a static part of power for BS: P\_3 A: 0.4 For eta, If two values of η(s\_f,s\_p ) are used for evaluation,η(s\_f,s\_p ) = 0.76 if s\_f\*s\_p <0.5; otherwise, η(s\_f,s\_p )=1. 46.5 and 5.2 relative power per a SSB for Cat 1 and Cat 2 | UPT:10.40%, Packet latency: 24.7%  Scheduling latency: No increase |
| Cat 2 | 17.5% | UPT:10.40%, Packet latency: 24.7%  Scheduling latency: No increase |
| **Qualcomm**  **[R1-2212128]** | Tx power reduction (55dBm to 52dBm) | Cat 1 | Low | 13.1% | Baseline: BS BS #TxRU 64 with 55dBm Tx power  reference configuration:Set 1,FTP3 | UPT lsss at 50%-tile: 10%,  DL SINR loss at 5% tile: 4dB |
| Light | 6.6% | UPT loss at 50%-tile: 16%,  DL SINR loss at 5% tile: 3dB |

With transmission power reduction on PDSCH, 10 sources show that it can achieve BS energy savings gain at all load cases for both Set 1 FR1 TDD and Set 2 FR1 FDD including 4Tx BS antenna configuration, for both BS categories with FTP3 or FTP3 IM model, with or without UE C-DRX configuration.

With dynamic power reduction assisted by multi-CSI,

* For UE specific PDSCH in FR1, one source observed BS energy saving gain by 5.3%~11.5%, compared to dynamic power reduction without multi-CSI report; one source observed BS energy savings by 12.1%~23.8%, compared to no power reduction baseline;
* The gain generally increases when the traffic load increases;
* The UPT loss is less than 1.17%.
* No performance analysis was provided for broadcast and common channels with dynamic downlink transmission power adaptation.

With semi-static power reduction of 3~18dB in 6 sources and two other sources, compared to a baseline without power reduction, network energy saving can be achieved by 3.9%~51.6%.

* The gain can increase as the traffic load increases in most cases while one source observed a reduced gain, for BS category 1 with power reduction of 3 dB;
* The UPT loss is observed from 2.03%~19.49%.

One source observed that the latency can be increased by up to 24.21% when the power reduction level is up to 9 dB; one source observed that packet latency can be increased by 24.7% while scheduling delay is not increased.

On UE power consumption, one source shows that less than 10% increment is observed in most cases.

One source also observed that when combined with spatial element reduction, in the case of 3 dB power reduction, the network energy savings can be further increased by about 10%, while together with UPT loss/UE power consumption increase/latency increase of 9.06%/7.62%/9.96% respectively.

One source shows this scheme can increase the average EE. One source observed that the downlink SINR is reduced by 3dB – 4dB when reducing the downlink transmission power from 55dBm to 52dBm in Set 1 FR1 configuration.

=== end ===

**Agreement**

The following capture the results by Channel Aware Tone reservation.

* **Table 6.1.1-x: BS energy savings by Channel Aware Tone reservation**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **Baseline configuration/assumption** | **Other KPI** | **Note** |
| **Qualcomm**  **[R1-2212129]** | PA Backoff reduction of 1-3dB due to PAPR reduction from Channel Aware Tone reservation | Cat 1 |  | 9.5% | Set 3 | UPT:0.00%  latency: 0%  UE power consumption: 0% | Evaluation showing utilization of PAPR reduction, where the PAPR reduction is used to reduce the backoff PA attribute (Pmax) while maintaining the TX power and signal EVM  The Backoff also compensates for the tones used for the TR signal, thus no UPT loss occurs  Comparing Channel Aware Tone Reservation to Transparent Tone Reservation  Note: η was calculated corresponding to the backoff reduction as was provided by a formula (referencing Tdoc R1-220996) |
|  | 2.1% |
|  | 4.4% | Set 1 |
|  | 2.1% |

One source observed that channel aware tone reservation can achieve PA back-off reduction of 1-3 dB which leads to 2.1%~9.5% BS energy saving gains depending on configurations, compared with transparent tone reservation. Note PA scaling values used for this NW ES scheme are not covered by RAN1 power consumption scaling model.

On UPT/latency, no negative impact is observed.

No impact on UE power consumption.

=== end ===

**Agreement**

The following capture the results for UE post-distortion.

* **Table 6.1.1-x: BS energy savings by [UE post-distortion]**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **Baseline configuration/assumption** | **Other KPI** | **Note** |
| **Qualcomm**  **[R1-2212129]** | UE post-distortion | Cat 1 |  | 16.1% | Set 3 | UPT:0.00%  latency: 0% | Evaluation showing utilization of PAPR reduction, where the PAPR reduction is used to reduce the backoff PA attribute (Pmax) while maintaining the TX power and signal EVM  The Backoff also compensates for the tones used for the TR signal, thus no UPT loss occurs  Processing and power consumption of the UE depends on the UE receiver’s design for DPoD.  Note: η was calculated corresponding to the backoff reduction as was provided by a formula (referencing Tdoc R1-220996) |

One source observed that UE post-distortion can achieve BS energy saving by 16.1% for Set 3 reference configuration. Note PA scaling values used for this NW ES scheme are not covered by RAN1 power consumption scaling model.

On UPT or latency, there is no negative impact observed.

The impact on UE power consumption depends on UE receiver’s design for DPoD.

**Agreement**

The following capture the results by Over the air DPD.

* **Table 6.1.1-x: BS energy savings by Over the air DPD**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Company** | **ES scheme** | **BS Category** | **Load scenario** | **ES gain (%)** | **Baseline configuration/assumption** | **Other KPI** | **Note** |
| **Qualcomm**  **[R1-2212745]** | Over the air DPD (DPD-OTA) | Cat 1 |  | 8.9% | Set 3 | UPT:0.00%  latency: 0% | Evaluation showing utilization of PAPR reduction, where the PAPR reduction is used to reduce the backoff PA attribute (Pmax) while maintaining the TX power and signal EVM  Note: η was calculated corresponding to the backoff reduction as was provided by a formula (referencing Tdoc R1-220996) |

One source observed that DPD-OTA can achieve BS energy saving by 8.9% for Set 3 reference configuration. Note PA scaling values used for this NW ES scheme are not covered by RAN1 power consumption scaling model.On UPT/latency, no negative impact is observed.

Additional UE power consumption is considered to be negligible due to the low report periodicity expected.

=== end ===

***Network energy saving techniques***

**Agreement**

The following template is to be used for capturing potential network energy saving techniques into the TR.

**6.X.Y Technique A/B/C/D-{number}**

*[Moderator Note: Rapporteur will numerate the techniques in the TR]*

**6. X.Y.1 Description of technique**

*[Moderator Note: background information and general description of the technique are described here. This subsection to be discussed in AI 9.7.2]*

**6. X.Y.2 Analysis of NW energy saving and performance impact**

*[Moderator Note: Analysis/Observation of performance evaluations. This subsection to be discussed in AI 9.7.1]*

**6. X.Y.3 Legacy UE and RAN1 specification impacts**

*[Moderator Note: any observation of impact to legacy UEs from RAN1 perspective, and any RAN1 specification impact described here. The focus of the specification impact should be from RAN1 perspective. If the technique has sub-techniques that are analyzed in 6.X.Y.2, then legacy UE and RAN1 specification impact should be described for each sub-technique. This subsection to be discussed in AI 9.7.2]*

**Agreement**

* Agree to following text for inclusion into TR.

6.1.X Technique A-1

6.1.X.1 Description of technique

In Rel-15 NR, time-domain positions of transmitted SSBs within a half frame are semi-statically configured. Further, UE assumes a single periodicity for the transmitted SSBs. The transmission of common signal and channels or reception of random-access signals may limit the gNB ability to use (deeper) sleep modes to save energy. Currently, system information (SI) update mechanism can adapt the parameters in the cell, such as those associated with downlink common and broadcast signals, such as SSB/SI/paging/cell common PDCCH, and/or the periodicity/availability of uplink random access resources.

Technique A-1 adapts the transmission pattern (when applicable) of downlink common and broadcast signals, such as SSB/SI/paging/cell common PDCCH, and/or the transmission pattern/availability of uplink random access opportunities. Adaptation of the transmission pattern includes changes to periodicity, time resource locations, and omitting of specific signals/channels. The transmission pattern can be adapted semi-statically or dynamically.

6.1.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.1.X.3 Legacy UE and RAN1 specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

* The access latency of legacy UEs may be impacted

Specification impact of the technique may include:

For simplified version of SSB, such as only PSS or only PSS and SSS without PBCH, or PSS and SSS with partial PBCH:

- signaling mechanism to inform the UE about the use of simplified version of SSB, if needed,

- Changes to SSB may have impact on SI acquisition, initial access, RRM/RLM measurements, and mobility for legacy UEs and UEs that may not support the technique,

- Technique may be enabled for a carrier only when legacy UEs are not using the carrier.

For skipping of SSB/SIB1 transmission occasion:

- signaling mechanism to inform the UE about the skipping of SSB/SIB transmission occasions, if needed,

- Skipping of common signals and channels, such as SSB and SIB1, may have impact on initial access, RRM/RLM/BM measurements, and performance for legacy UEs and UEs that may not support the technique,

- Technique may be enabled for a carrier only when legacy UEs are not using the carrier.

For configuration/adaptation of longer periodicity of SSB/SIB1 and/or uplink random access opportunities:

- signaling mechanism to inform the UE about the configuration/adaptation,

- Adaption of common signals and channels may have impact on SI acquisition, initial access, RRM/RLM/BM measurements, and performance for legacy UEs and UEs that may not support the technique.

For the paging enhancement where paging resources are grouped in a compact manner, potential specification impact of the enhancements from paging transmission includes the following:

- paging reception procedure (RAN2), i.e., identification of POs and PFs for Rel-18 UEs

- UEs that do not support the technique are expected to follow legacy paging reception procedure in the cell.

For dynamically adapting PRACH periodicity and occasions:

- signaling mechanism to inform the UE about the RACH enhancement resources,

- preparation procedure time for dynamic PRACH adaptation,

- UEs that do not support the technique are expected to use legacy RACH resources in the cell.

For scheduling of SIB1 without PDCCH:

- signaling mechanism to inform the UE about the use of SIB1 without PDCCH, if needed,

- Changes to PDCCH of SIB1 may have impact on initial access, and system information acquisition for legacy UEs and UEs that may not support the technique,

- The specification impacts may include signalling mechanism to inform the UE about SIB1 transmissions, details of SI acquisition,

- Technique may be enabled for a carrier only when legacy UEs are not using the carrier.

**Agreement**

* Agree to following text for inclusion into TR.

6.1.X Technique A-2

6.1.X.1 Description of technique

The semi-static configured UE specific channels/signals may require the gNB to perform periodic transmission or reception if they are activated. Except for positioning RS (PRS), the configurations for the listed UE-specific signals/channels are BWP-specific. Current specification allows gNB to dynamically activate/deactivate CG-PUSCH/SPS/CSI-RS/CSI report/SRS using DCI (i.e., PDCCH transmission) in UE specific manner.

Technique A-2 aims to reduce or omit time occasions for the UE specific resources during low activity/non-active periods of the cell. The potential list of UE specific resources includes periodic/semi-static CSI-RS, group-common/UE-specific PDCCH, SPS PDSCH, PUCCH carrying SR, PUCCH/PUSCH carrying CSI reports, PUCCH carrying HARQ-ACK for SPS, CG-PUSCH, SRS, positioning RS (PRS).

UEs may assist the network with information related to the traffic (e.g., about which resources are necessary or unnecessary) so that the network can optimize its scheduling and achieve more sleep opportunities.

6.1.X.2 Analysis of performance and impacts

No evaluations of this technique are available.

6.1.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include at least:

- mechanisms to configure and/or inform UEs about the resource availability,

- UE behavior and procedures when configuration and/or information of the resource availability of cell is provided.

Reducing or omitting time occasions for the UE specific resources during low activity/non-active periods of the cell for the UEs that may not support the technique are not expected to impact UEs that do not support the technique.

**Agreement**:

* Agree to following text for inclusion into TR.

6.1.X Technique A-3

6.1.X.1 Description of technique

Technique A-3 enables the UE to send an uplink wake-up signal to request transitioning of a cell from no or reduced transmission/reception activity to active transmission or reception of a channel/signal. The technique can be applied to UEs in one or more RRC states. The UE wake up signal (WUS) may be used to trigger the SSB/SIB transmission. Technique A-3 can be used trigger SSB/SIB1 transmissions in A-6. Technique A-3 can be used to trigger gNB to wake up in A-4.

With the support of WUS, the gNB might be inactive (e.g., where it does not transmit nor receive signal/channel or where it only transmits and receives limited signals). A gNB can transition to become active for transmitting or receiving a channel/signal upon reception of an uplink signal from the UE.

6.1.X.2 Analysis of performance and impacts

6.1.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- design of uplink wakeup signal/channel,

- signaling details of wakeup signal/channel and if needed, downlink signal/channel design/procedure for carrying information regarding the wakeup configuration,

- conditions for triggering WUS,

- mechanisms for DL synchronization and UE measurements needed prior to WUS transmission,

- UE’s assistance information to aid wake up operations by gNB,

- UE behavior/procedure after transmitting WUS,

- mechanism on how the UE can be informed about cell activity or lack of activity.

Legacy UEs and UEs that do not support this technique cannot wake up a cell that is inactive. Legacy UEs and UEs that do not support this technique are not provided with expected transmission from the cell, they cannot be operate in the cell.

**Agreement**

* Agree to following text for inclusion into TR.

6.1.X Technique A-4

6.1.X.1 Description of technique

Currently, the gNB can use reduce downlink transmission/uplink reception activity without an explicit cell DTX/DRX pattern with restrictions due to UE DRX configurations and any configured transmission/reception, e.g., common channels/signals. Currently C-DRX is configured per UE. The alignment of the DRX cycles or offsets for different UEs can be done only via RRC. During UE DRX off period, the UE does not expect to monitor PDCCH, but it is allowed to initiate UL transmission according to the configured resources (e.g. using PUCCH, RACH, SR, or CG-PUSCH). Aligning/Omitting of DRX patterns across multiple UE’s can be achieved via gNB implementation.

Technique A-4 aims at providing mechanisms informing UE whether the cell stays inactive. This may include enhancements to UE DRX configuration, e.g., to align/omit DRX cycles or start offsets of DRX, for UEs in connected mode or idle/inactive mode, potentially allowing longer opportunities for cell inactivity. During a cell DTX/DRX, the cell may have no transmission/reception or only keep limited transmission/reception. For example, the cell does not need to transmit or receive some periodic signals/channels, such as common channels/signals or UE specific signals/channels.

6.1.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.1.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- design of cell DTX/DRX pattern/timers/parameters/procedure, if needed,

- configuration and indication of cell DTX/DRX information to UE, if needed and applicable,

- UE behaviors and procedures when cell DTX/DRX is in operation and/or when UE DRX is configured, if needed,

- potential channel/signal design and mechanism and uplink procedure (e.g., UE request or assistance feedback) related to cell DTX/DRX,

- enhancements to UE DRX configuration

- enhancements to UE DRX parameter adaptation.

For the cell DTX/DRX cases, depending on DTX/DRX occasions, legacy UEs and UEs that do not support the technique may not have impact to idle/inactive/connected mode operations. For example, if DTX/DRX are not applied to common signals and channel required for idle/inactive/connected modes or applied in UE specific manner, legacy UEs and UEs that do not support the technique may not be impacted.

**Agreement**

* Agree to following text for inclusion into TR.

6.2.X Technique B-2

6.2.X.1 Description of technique

In Rel-17, UE-specific BWP configuration and switching is supported. For SPS PDSCH reception, type-2 CG PUSCH transmission, and SP-CSI reporting on PUSCH, once BWP is switched, they should be reactivated by activation DCI.

Technique B-2 supports enhancements to enable UE group-common or cell-specific BWP configuration and/or switching. Also supports enhancements to enable SPS PDSCH reception/Type-2 CG PUSCH transmission/SP-CSI reporting on PUSCH without reactivation after the BWP switching.

6.2.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.2.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- signaling and procedure to support UE group-common or cell-specific BWP configuration and/or switching of BWP,

Legacy UEs and UEs that do not support the technique are not able to change the BWP using the enhanced signaling mechanisms.

**Agreement**

* Agree to following text for inclusion into TR.

6.2.X Technique B-3

6.2.X.1 Description of technique

Currently, a bandwidth of a BWP is semi-statically configured, and the bandwidth of the given BWP cannot be dynamically changed. The current BWP framework allows the UEs to be configured with a default BWP and switching to a default BWP based on timer. Reduction of the frequency resources within a BWP can be achieved via configuration and scheduling a the gNB.

Technique B-3 supports enhancements to enable group-common signaling to adapt the bandwidth of active BWP and continue operating in same BWP. Some frequency resources within the active BWP may be deactivated.

6.2.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.2.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- include behavior, procedure, and signaling related to enabling group-common adaptation of the bandwidth of active BWP,

-

**Agreement**:

* Agree to following text for inclusion into TR.

6.3.X Technique C-1

6.3.X.1 Description of technique

According to legacy MIMO procedures, the adaptation of spatial elements can be achieved by RRC (re-)configurations updating, such as CSI-RS (re-)configurations, in a semi-static manner. Moreover, the current framework allows UE to be configured with multiple CSI-RS resources, where these CSI-RS configurations may be with respect to different numbers of spatial antenna ports or antenna elements. With CSI reports respect to different number of spatial elements available, gNB is able to dynamically adjust the number of spatial elements for PDSCH transmission in current specification. CSI-RS and CSI reporting configurations are BWP-specific, and BWP adaptation framework can be utilized for the adaptation for a UE capable of multiple BWPs and dynamic BWP switching.

Indication for potential enhancements related to spatial element adaptation may help the UEs to adapt the already configured CSI-RS configuration such as dynamic/semi-persistent ON-OFF of CSI-RS or to reconfigure the CSI-RS configuration, with respect to adapted number of spatial elements/ports.

Technique C-1 aims to enhance dynamically adaptation of spatial elements such as the number of active transceiver chains or the number of active antenna panels at gNB in transmitting and/or receiving channels and signals.

6.3.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.3.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- mechanisms to indicate spatial element adaptation to the UE,

- signaling to update the active CSI-RS configurations

- enhancements on CSI-RS (re)configuration, CSI/RRM/RLM measurements, CSI reporting (e.g., multiple CSI reports), and beam management for gNB to switch between different spatial domain configurations,

-- associated UE behavior in case of spatial element adaptation occurs, if needed, e.g., measurements, CSI feedback, power control, PUSCH/PDSCH repetition, SRS transmission, TCI configuration, beam management, beam failure recovery, radio link monitoring, cell (re)selection, handover, initial access, etc.

There is no impact for legacy UEs if the spatial element adaptation is used on a UE-specific basis, i.e., applied only for UEs supporting the technique.

**Agreement**

* Agree to following text for inclusion into TR.

6.3.X Technique C-2

6.3.X.1 Description of technique

Technique C-2 aims to support TRP activation/deactivation that can be informed to the UE when a UE is configured with multiple TRPs. The technique aims to dynamically adapt the number of TRPs transmitting and/or receiving signals and channels.

6.3.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.3.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- UE-specific/group-level/cell common signaling for indicating adaptation of TRPs and TRP-related parameters (e.g. TRP index or CORESET pool index) in mTRP,

- enhancements to UE behaviors due to dynamic adaptation of TRPs, e.g., measurements, CSI feedback, power control, PDCCH/PUCCH/PUSCH/PDSCH repetition, single-DCI based scheduling, multi-DCI based scheduling, SRS transmission, TCI configuration, beam management, beam failure recovery, radio link monitoring, cell (re)selection, handover, initial access, etc,

There is no impact for legacy UEs if the spatial element adaptation is used on a UE-specific basis, i.e., applied only for UEs supporting the technique.

**Agreement**

* Agree to following text for inclusion into TR.

6.4.X Technique D-1

6.4.X.1 Description of technique

As per current specification, the SSB reference power, ss-PBCH-BlockPower is defined in SIB1. The powercontrolOffsetSS that is the power offset between (NZP)CSI-RS and SSB and the powerControlOffset that is the power offset of PDSCH and (NZP) CSI-RS are semi-statically configured via RRC signaling. The power offset configurations for PDSCH and CSI-RS are BWP-specific. Current specification allows gNB to adapt the PDSCH transmission power..

Technique D-1 aims at adapting the transmission power or PSD of downlink signals and channels dynamically, by enhancing the related configuration to the UE (e.g. considering power offsets that account for potential power adaptation) and/or enhancing the UE feedback (e.g. CSI report) to assist NW energy saving operation. The technique may be applicable to one or more of PDSCH, CSI-RS, DMRS, broadcast channels/signals (e.g., SSB/SI/paging). Enhancements for updating the power offset values between various signals and channels, e.g., CSI-RS to SSB, or PDSCH to CSI-RS using lower layer signaling.

6.4.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.4.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- signaling of modified power of SSB or power ratio between CSI-RS and PDSCH/SSB to provide adaptation of power ratio values, e.g. by utilizing UE-specific, group-level or cell common signaling,

- enhancements on RRM measurements, beam management, beam failure recovery, radio link monitoring, cell (re)selection and handover procedure

- enhancements to CSI measurements and reporting, e.g. multiple CSI reports in a single report

There is no impact for legacy UEs and UEs that do not support the technique if the signaling of modified power ratio between CSI-RS and PDSCH/SSB or between SSB and CSI-RS, enhancements on CSI measurement and reporting are used on a UE-specific basis, i.e., applied only for UEs supporting the enhancement.

**Agreement**

* Agree to following text for inclusion into TR.

6.4.X Technique D-2

6.4.X.1 Description of technique

gNB may implement digital pre-distortion (DPD) to compensate for the non-linear impairments of the transmitter in standard transparent manner.

Technique D-2 supports over the air digital pre-distortion at the gNB. In gNB digital pre-distortion over the air, the UEs assist the gNB in reducing nonlinear impairments introduced by the PA, by processing on training signals, and reporting the information needed for gNB digital pre-distortion.

6.4.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.4.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- signaling/configuration for supporting gNB digital pre-distortion,

- introduction of training signals/CSI-RS enhancements,

- signaling for reporting assistance information for gNB digital pre-distortion,

- indication to the UE of whether it needs to apply non-linear equalization for a transmission

Legacy UEs and UEs that do not support providing assistance information for gNB digital pre-distortion (DPD) may not be able to contribute to improvement of the DPD.

**Agreement**

* Agree to following text for inclusion into TR.

6.4.X Technique D-3

6.4.X.1 Description of technique

Technique D-3 supports tone reservation that decreases PAPR, potentially taking into account channel conditions and characteristics. Tone reservation (TR) exploits the channel nulls to carry TR tones, potentially taking into account channel conditions and characteristics. The UE must be notified of the sub-carriers carrying the TR signal for rate matching purposes only if UE performs transmission or reception of the resource including sub-carriers carrying the TR signal.

gNB may be able to implement PAPR reduction in including tone reservations via implementation with appropriate scheduling of signals and channels.

6.4.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.4.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- assistance information from the UE to help gNB determine tone reservation positions,

- mechanism to convey information about tone reservation positions to the UE,

- behaviors associated with handling of resources with tone reservation positions.

Legacy UEs and UEs that do not support the technique may not be aware of tone reservation positions.

**Agreement**

* Agree to following text for inclusion into TR.

6.4.X Technique D-4

6.4.X.1 Description of technique

In case of low load, the PA can adapt/reduce its backoff reducing thus the PA power consumption. PA backoff impacts unwanted in-band and out-of-band emissions. gNB may be able to implement PA backoff adaptation in a specification transparent manner.

Technique D-4 supports modification and/or reduction of the power amplifier (PA) backoff in cases of no or low load. This technique enables PA backoff adaptation for few msec and coordinate PA backoff adaptation among neighboring cells.

6.4.X.2 Analysis of performance and impacts

No evaluations of this technique are available.

6.4.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

* enhancements to UE measurements for assessing the impact from the PA backoff adaptation of neighbor cells

**Agreement**

* Agree to following text for inclusion into TR.

6.4.X Technique D-5

6.4.X.1 Description of technique

Technique D-5 supports the UE performing received signal post-distortion processing (e.g. non-linear equalization stage that will “invert” the non-linearity) to combat non-linear impairments from the transmitter. The technique also considers enhancements to transmission of reference signals or information to aid the UE to perform post-distortion processing.

6.4.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.4.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- mechanism and signalling to enable operation of UE post distortion,

- enhancements to reference signals to aid UE post distortion,

- signaling/configuration for supporting UE digital post-distortion,

- introduction of activation of UE post distortion, notification of selected power amplifier model, and possibly configuration of training reference signals,

- signaling for indicating to the UE of whether it needs to apply non-linear equalization for a downlink transmission.

Legacy UEs and UEs that do not support the technique are not able to compensate the received signal distortions based on this enhancement mechanism.

**Agreement**

* Agree to following text for inclusion into TR.

6.1.X Technique A-6

6.1.X.1 Description of technique

Current specification supports SSB/SIB1-less operation for intra-band CA, where UE retrieves system information from and can perform synchronization based on another intra-band cell that transmits SSB and SIB1. Current specification supports SSB periodicity configuration up to 160 msec.

For technique A-6, the UE may obtain system information from other associated carriers/cells and synchronize from other associated carriers/cells and/or synchronize from signal(s) transmitted on the cell.

Technique A-6 also supports on-demand SSBs/SIB1 transmissions and enable longer periods of cell inactivity to achieve network energy saving. SSB/SIB1 transmission at the serving cell can be triggered on-demand, e.g by the UE.

6.1.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.1.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

Specification impact of the technique may include:

- channel/signal design and behaviors and procedures of on-demand SSBs/SIB1 and any related signaling,

- random access related enhancement including procedures and configuration for UEs to access the SSB/SIB1-less carrier/cell,

- mobility support or paging for the cell that does not transmit SSB and/or SIB1,

- design for new signal/channel (if any) and related procedures,

For on-demand SSB, if no SSB or simplified SSB is transmitted and normal SSB transmission is triggered upon reception of UE WUS, legacy UEs and UEs that do not support this technique may not be able to operate in this cell.

- Technique may be enabled for a carrier only when legacy UEs are not using the carrier.

For on-demand SIB1, if no SIB1 is transmitted and normal SIB1 transmission is triggered upon reception of UE WUS, legacy UEs and UEs that do not support this technique may not be able to operate in this cell.

- Technique may be enabled for a carrier only when legacy UEs are not using the carrier.

For technique where UE may obtain system information from other associated carriers/cells, cell without a SSB cannot be used as Pcell/PScell/inter-band Scell for legacy UEs and UEs that do not support this technique.

For technique where UE may obtain system information from other associated carriers/cells, cell without a SIB1 cannot be used as Pcell for legacy UEs and UEs that do not support this technique.

**Agreement**

* Agree to following text for inclusion into TR.

6.2.X Technique B-1

6.2.X.1 Description of technique

Intra-band SSB-less Scell operation is supported by the current specification. Pcell switching is supported by handover command according to current specification.

Technique B-1 supports inter-band CA with SSB-less Scell. No SSB transmission in some inter-band SCell. The synchronization is acquired from other cell with SSB transmission or same cell with simplified signal transmission, also in order for fast activation and deactivation of SCell. Enabling of inter-band SSB-less Scell operation that may include mechanism for UE/gNB to trigger normal SSB transmission and/or reference signals, if needed, on a SCell for fast access, where the on-demand uplink triggering signal can be received either at inter-band SSB-less cell or another carrier/cell. RACH transmission opportunity may be supported in SSB-less Scell.

Technique B-1 supports dynamic Pcell switching in which a common primary cell may be dynamically indicated for a group of UEs.

6.2.X.2 Analysis of performance and impacts

*[Editor Note: Analysis/Observation of performance evaluations to be discussed in AI 9.7.1]*

6.2.X.3 Legacy UE and RAN1 Specification impacts

The list of UE and RAN1 specification impact described in this section is not an exhaustive list. RAN1 may identify additional impact and also determine that listed impact below may no longer apply to the described technique(s) as specification is further developed.

For SSB-less inter-band CA, Specification impact of the technique may include:

- RACH procedures in SSB-less SCell for inter-band CA,

- enhancement on SCell activation procedure,

- enhancements on SCell dormancy operation,

- design for new simplified signal/channel (if supported) and related procedures,

Legacy UEs or UEs that do not support this feature may not be able to operate inter-band CA with SSB-less Scells. A carrier without SSB cannot be operated as a PCell for legacy UEs. The carrier cannot be operated as an SCell for legacy UEs if another intra-band carrier with SSB is not present. At least the feasibility and/or potential requirements of acquiring synchronization/measurements (including AGC aspects) from other cell with SSB transmission in inter-band CA needs study.

For inter-band SSB-less technique, cell without a SSB cannot be used as Pcell/PScell/inter-band Scell for the legacy UEs and UEs that do not support this technique.

For UE-group Pcell switching, specification impact may include:

- mechanism to signal Pcell switching,

- UE behavior based on indicated signalling.

***Moderator summaries***

R1-2212564 Discussion Summary #1 for energy saving techniques of NW energy saving SI Moderator (Intel Corporation)

R1-2212565 Discussion Summary #2 for energy saving techniques of NW energy saving SI Moderator (Intel Corporation)

R1-2212702 FL summary#1 for NW Energy Savings Moderator (Huawei)

R1-2212703 FL summary#2 for NW Energy Savings Moderator (Huawei)

R1-2212779 Discussion Summary #3 for energy saving techniques of NW energy saving SI Moderator (Intel Corporation)

R1-2212780 Discussion Summary #4 for energy saving techniques of NW energy saving SI Moderator (Intel Corporation)

R1-2212935 FL summary#3 for NW Energy Savings Moderator (Huawei)

R1-2213013 Simulation results summary for NW Energy Savings Moderator (Huawei)

R1-2213014 Comments collection for updated draft TR 38.864 post RAN1#111 Moderator (Huawei)

#### 2.1.2 Remaining Open issues

None.

## 2.2 RAN2

#### 2.2.1 Agreements

##### 2.2.1.1 RAN2#119bis-e

**DTX/DRX:**

**Agreements**

=> Periodic DTX is assumed as a baseline. The gNB provides indication to UE about NW DTX mode/configuration via dedicated dynamic L1/L2 signaling.

=> Dynamic L1/L2 group signalling from NW to provide NW DTX mode/configuration is also considered in RAN2

=> It is beneficial to align UE DRX with network DTX and DRX alignment among multiple UEs. Details are FFS, including UE transmission/reception behavior during DTX. RAN2 to study the alignment.

**Cell selection/reselection and SSB/SIB-less:**

**Agreements:**

1. There is a need to allow NES cells to prevent legacy UEs from camping. FFS the definition of NES cells.
2. Whether to bar legacy UEs is configurable by NES cells in Idle/Inactive mode and the network should be able to allow NES-capable UEs to camp on the NES cell. Options to bar UEs to be considered are 1) UseIntra/InterFreqExcludedCellList (FFS on the exact mechanism and spec impact) and 2) use cellBarred or cell reservation fields in MIB/SIB.
3. The network should be able to configure NES capable UEs to (de)prioritize NES cells. mechanism such as can be considered for both frequency and cell levels cell selection/reselection (de)prioritization. FFS on whether the existing mechanism is sufficient.
4. For SSB/SIB-less solution, RAN2 starts with multi-carrier case
5. RAN2 assumes that the SSB-less solution for inter-band CA in connected mode we can consider to use the intra-band CA mechanism as a baseline/starting point. FFS whether there are other impacts for RAN2 according to other WGs discussion
6. For SIB-less/SSB-less, capture the solutions in more details over the email discussion and clarify the definition on anchor cell. (e.g. 1) non-anchor NES cell doesn’t transmit SSB and SI 2) non-anchor cell doesn’t transmit SIB) FFS for paging in both mechanisms.

**Endorsed TP:**

R2-2211067 TP on Cell DTX DRX to TR 38.864 Huawei, HiSilicon, Apple

##### 2.2.1.2 RAN2#120

**DTX/DRX:**

**Agreements**

1 Clarify previous agreement to: periodic cell DTX/DRX pattern is configured by UE-specific RRC. Periodic cell DTX/DRX can be activated/deactivated by L1/L2 signalling and UE-specific RRC signaling.

2 Capture in TR 38.864 that both UE specific and common L1/L2 signalling can be considered for at least activating/deactivating the cell DTX/DRX pattern, per the agreement in 119b-e.

3 Cell DTX and Cell DRX modes can be configured and operated separately (e.g. one RRC configuration set for DL and the other set for UL). Cell DTX/DRX can also be configured and operated together.

4 It is up to NW whether legacy UEs can access cells with Cell DTX/DRX

5 Cell DTX/DRX can be configured per serving cell and can be applicable for different cells in CA. No additional RAN2 impacts or enhancements are foreseen.

6 Whether to support multiple Cell DTX/DRX configurations can be discussed later in the normative phase.

7 At least the following parameters can be configured per cell DTX/DRX configuration: periodicity, start slot/offset, on duration. Details related to UE behaviour can be discussed during WI phase

8 From RAN2 perspective DTX/DRX is feasible

**SSB/SIB-less:**

**Agreements on SIB/SIBless:**

1 Anchor cell is a cell where UE assumes SSB, system information and paging are transmitted.

2 Non-anchor cell without SIB is a cell where NES-capable UEs do not assume system information is transmitted. The system information transmitted by anchor cell may also include the necessary information for NES-capable UEs to access a non-anchor cell.

3 Non-anchor cell without SIB and SSB is a cell where NES-capable UEs do not assume SSB or system information are transmitted. The system information transmitted by anchor cell may also include the necessary information for NES-capable UEs to access a non-anchor cell.

4 It is up to RAN1/RAN4 whether it is possible for the UE to synchronize with the non-anchor cell using anchor cell SSB and the conditions to do so

5 UE camps on the anchor cell, not SSB-less/SIB-less cell.

6 We will not support paging on a cell without SIB and/or a cell without SIB and SSB

7 Feasibility of this solution is in RAN1 scope

**Cell selection/reselection:**

**Agreements on cell reselection**

1. Keep the terminology of "NES cell" in the TR. The definition of NES cell will be discussed in normative phase. Remove the FFS on definition (rapporteur to update this).
2. For legacy UE barring mechanism, current TR is sufficient to conclude SI, and solution details should be discussed in normative phase. Remove the FFS on exact mechanism and spec impacts.
3. From RAN2 perspective legacy devices and new NES UEs can be handled via cell selection/reselection techniques

**Connected mode mobility:**

Agreements

1. Capture the solution on enhancing the CHO framework (for faster offloading/onloading during cell deactivation/activation) enabling a evaluation of CHO conditions depending on the NES state of the source/target cell. How to indicate to UE the triggering of the CHO evaluation is up to normative phase. Whenever mobility from source cell is triggered, one could also consider how UE would not select NES cell if any other cell is available when selecting the new cell. Corresponding TP for this is provided in the Annex
2. RAN2 does not consider at this point group HO (optimizing R15 HO procedure).
3. RAN2 does not consider at this point BWP adaptation with group signaling (no supporting papers in RAN2)
4. From RAN2 perspective, CHO enhancements are feasible

**Other:**

**Agreement**

=> If RAN1 agrees to support WUS then from RAN2 point of view it is feasible and details can be discussed in normative phase.

=> From RAN2 perspective, the feasibility of all other solutions is in RAN1 and/or RAN4 scope

=> From RAN2 perspective the study is considered complete

**Endorsed TP:**

R2-2213072 Latest TR 38.864 v0.4.0 for information Huawei, HiSilicon

R2-2213040 Post RAN2#120 TP for TR 38.864 Huawei

An LS will be sent to RAN1 in R2-2213041, informing RAN1 of the endorsed TPs.

#### 2.2.2 Remaining Open issues

None.

## 2.3 RAN3

#### 2.3.1 Agreements

**RAN3-117bis-e meeting**

Cell DTX/DRX:

* The inter-node exchange of the cell DTX/DRX (if defined by RAN1/RAN2) is considered necessary.

Cell NES states:

* WA: The inter-node exchange on the NES states or more granular cells status information if defined by RAN1/RAN2 is needed if the benefits are confirmed. The detailed NES state or more granular information is pending to other groups.

Enhanced cell on/off:

* RAN3 considers that inter-node beam activation is needed, i.e. to request a neighbouring NG-RAN node to switch on beam(s) which has been deactivated.

**RAN3-118 meeting**

About the editor note in TR related to RAN3, update it to Note.

Add “The following candidate techniques should be evaluated in terms of energy saving gain at the normative phase.” at the beginning of the TR related to RAN3 (i.e. 6.x Higher layer aspects for network energy savings).

No need to capture in TR about the cell DTX/DRX information and the joint or separate DTX and DRX configuration.

Agree the TP on beam level activation (take R3-226399 as basis, with the following contents)

* This mechanism allows an NG-RAN node to request a neighbouring NG-RAN node to switch on certain SSB beams which have been deactivated e.g., in the capacity layer. With this mechanism, the NG-RAN node in the coverage-layer can request the re-activation of SSB beams that are deactivated before.

On the exchange NES state over network interfaces, RAN3 can further work pending on other group decision at normative phase.

No consensus on the TP on the increased autonomy for gNB-DU. RAN3 can further work on the increased autonomy for gNB-DU pending on development of other NES techniques at normative phase

Agree a simple TP (take R3-226457 as basis) on the paging enhancement

No consensus on the TP on the handover enhancement.

No consensus on the TP on the other techniques.

From RAN3 perspective, the NES SI can be closed.

The pCRs in R3-226860 and R3-226861, and the LS to RAN1 in R3-226862 are agreed.

#### 2.3.2 Remaining Open issues

None

## 2.4 RAN4

#### 2.4.1 Agreements

#### 2.4.2 Remaining Open issues

## 2.5 RAN5

#### 2.5.1 Agreements

#### 2.5.2 Remaining Open issues

#### 2.5.3 Remaining Open issues with cross-WG dependencies

## 2.6 RAN6

#### 2.6.1 Agreements

#### 2.6.2 Remaining Open issues

## 3. Detailed progress in SA/CT WGs since last TSG meeting (for all involved WGs)

NOTE: This section only needs to be filled in for WI/SIs where there is a corresponding relevant WI/SI in SA/CT.

## 3.1 SAx/CTs

#### 3.1.1 Agreements with cross-TSG impacts

#### 3.1.2 Remaining Open issues with cross-TSG impacts

NOTE: This section should also flag any critical dependencies that need TSG attention.

## 4. References

NOTE: This can be e.g. a list of all related Tdocs in the affected WGs since last TSG, references to LSs, produced TRs/TSs, the work/study item description or status reports of previous TSGs.

**RAN1#110bis-e**

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| --- | --- | --- | --- |
| [1] | [**R1-2208381**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208381.zip) | BS Sleep States | FUTUREWEI |
| [2] | [**R1-2208382**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208382.zip) | Potential enhancements for network energy saving | FUTUREWEI |
| [3] | [**R1-2208424**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208424.zip) | Discussion on performance evaluation for network energy saving | Huawei, HiSilicon |
| [4] | [**R1-2208425**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208425.zip) | Discussion on network energy saving techniques | Huawei, HiSilicon |
| [5] | [**R1-2208518**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208518.zip) | NW energy savings performance evaluation | Nokia, Nokia Shanghai Bell |
| [6] | [**R1-2208519**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208519.zip) | Network energy saving techniques | Nokia, Nokia Shanghai Bell |
| [7] | [**R1-2208561**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208561.zip) | Discussion on performance evaluation of network energy savings | Spreadtrum Communications |
| [8] | [**R1-2208562**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208562.zip) | Discussion on network energy saving techniques | Spreadtrum Communications |
| [9] | [**R1-2208654**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208654.zip) | Discussion on NW energy savings performance evaluation | vivo |
| [10] | [**R1-2208655**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208655.zip) | Discussion on NW energy saving technique | vivo |
| [11] | [**R1-2208776**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208776.zip) | Discussion on network energy saving performance evaluation methods | China Telecom |
| [12] | [**R1-2208777**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208777.zip) | Discussion on potential network energy saving techniques | China Telecom |
| [13] | [**R1-2208832**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208832.zip) | Discussion on NW energy savings performance evaluation | OPPO |
| [14] | [**R1-2208833**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208833.zip) | Discussion on network energy saving techniques | OPPO |
| [15] | [**R1-2208987**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208987.zip) | Evaluation Methodology and Power Model for Network Energy Saving | CATT |
| [16] | [**R1-2208988**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208988.zip) | Network Energy Saving techniques in time, frequency, and spatial domain | CATT |
| [17] | [**R1-2209022**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209022.zip) | Discussion on NW energy savings performance evaluation | Fujitsu |
| [18] | [**R1-2209023**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209023.zip) | Discussion on network energy saving techniques | Fujitsu |
| [19] | [**R1-2209063**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209063.zip) | Discussion on Network energy saving performance evaluations | Intel Corporation |
| [20] | [**R1-2209064**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209064.zip) | Discussion on Network Energy Saving Techniques | Intel Corporation |
| [21] | [**R1-2209127**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209127.zip) | Network energy saving techniques | Lenovo |
| [22] | [**R1-2209195**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209195.zip) | Discussion on NW energy saving performance evaluation | ZTE, Sanechips |
| [23] | [**R1-2209196**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209196.zip) | Discussion on NW energy saving techniques | ZTE, Sanechips |
| [24] | [**R1-2209296**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209296.zip) | Discussions on techniques for network energy saving | xiaomi |
| [25] | [**R1-2209348**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209348.zip) | Discussion on network energy saving performance evaluation | CMCC |
| [26] | [**R1-2209349**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209349.zip) | Discussion on network energy saving techniques | CMCC |
| [27] | [**R1-2209425**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209425.zip) | Discussion on network energy saving techniques | NEC |
| [28] | [**R1-2209452**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209452.zip) | Discussion on performance evaluation for network energy savings | LG Electronics |
| [29] | [**R1-2209453**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209453.zip) | Discussion on physical layer techniques for network energy savings | LG Electronics |
| [30] | [**R1-2209500**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209500.zip) | Network Energy Savings Performance Evaluation | MediaTek Inc. |
| [31] | [**R1-2209501**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209501.zip) | On network energy savings techniques | MediaTek Inc. |
| [32] | [**R1-2209592**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209592.zip) | Discussion on network energy saving techniques | Apple |
| [33] | [**R1-2209612**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209612.zip) | On Network Energy Saving Techniques | Fraunhofer IIS, Fraunhofer HHI |
| [34] | [**R1-2209617**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209617.zip) | Discussion on network energy savings performance | Rakuten Symphony |
| [35] | [**R1-2209618**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209618.zip) | Discussion on network energy saving techniques | Rakuten Symphony |
| [36] | [**R1-2209633**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209633.zip) | Discussion on potential network energy saving techniques | Panasonic |
| [37] | [**R1-2209653**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209653.zip) | Performance evaluation for network energy saving | InterDigital, Inc. |
| [38] | [**R1-2209655**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209655.zip) | Potential techniques for network energy saving | InterDigital, Inc. |
| [39] | [**R1-2209679**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209679.zip) | TR 38.864 v0.2.0 for study on network energy savings for NR | Huawei |
| [40] | [**R1-2209742**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209742.zip) | NW energy savings performance evaluation | Samsung |
| [41] | [**R1-2209743**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209743.zip) | Network energy saving techniques | Samsung |
| [42] | [**R1-2209858**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209858.zip) | Network energy consumption modeling and evaluation | Ericsson |
| [43] | [**R1-2209859**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209859.zip) | Network energy savings techniques | Ericsson |
| [44] | [**R1-2209913**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209913.zip) | Discussion on NW energy savings performance evaluation | NTT DOCOMO, INC. |
| [45] | [**R1-2209914**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209914.zip) | Discussion on NW energy saving techniques | NTT DOCOMO, INC. |
| [46] | [**R1-2209996**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209996.zip) | NW energy savings performance evaluation | Qualcomm Incorporated |
| [47] | [**R1-2209997**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209997.zip) | Network energy saving techniques | Qualcomm Incorporated |
| [48] | [**R1-2210021**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210021.zip) | Performance evaluation for network energy saving | Lenovo |
| [49] | [**R1-2210031**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210031.zip) | Discussion on potential L1 network energy saving techniques for NR | ITRI |
| [50] | [**R1-2210113**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210113.zip) | Discussion on Network energy saving techniques | CEWiT |
| [51] | [**R1-2210239**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210239.zip) | Network Energy Savings Performance Evaluation | MediaTek Inc. |
| [52] | [**R1-2210257**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210257.zip) | Network Energy Savings Performance Evaluation | MediaTek Inc. |
| [53] | [**R1-2210301**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210301.zip) | FL summary#1 for R18 NW\_ES | Moderator (Huawei) |
| [54] | [**R1-2210302**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210302.zip) | FL summary#2 for R18 NW\_ES | Moderator (Huawei) |
| [55] | [**R1-2210303**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210303.zip) | FL summary#3 for R18 NW\_ES | Moderator (Huawei) |
| [56] | [**R1-2210348**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210348.zip) | Discussion Summary #1 for energy saving techniques of NW energy saving SI | Moderator (Intel Corporation) |
| [57] | [**R1-2210349**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210349.zip) | Discussion Summary #2 for energy saving techniques of NW energy saving SI | Moderator (Intel Corporation) |
| [58] | [**R1-2210592**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210592.zip) | FL summary#4 for R18 NW\_ES | Moderator (Huawei) |
| [59] | [**R1-2210593**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210593.zip) | Comment collection for draftTR 38.864 | Moderator (Huawei) |
| [60] | [**R1-2210619**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210619.zip) | Discussion Summary #3 for energy saving techniques of NW energy saving SI | Moderator (Intel Corporation) |
| [61] | [**R1-2210620**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210620.zip) | Discussion Summary #4 for energy saving techniques of NW energy saving SI | Moderator (Intel Corporation) |
| [62] | [**R1-2210744**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210744.zip) | Discussion Summary #5 for energy saving techniques of NW energy saving SI | Moderator (Intel Corporation) |
| [63] | [**R1-2210792**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210792.zip) | TR 38.864 v0.3.0 for study on network energy savings for NR | Huawei |
| [64] | [**R1-2210793**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210793.zip) | Post-meeting comment collection for draftTR 38.864 v0.3.0 | Moderator (Huawei) |

**RAN1#111**

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| [65] | [**R1-2210852**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2210852.zip) | Network Energy Saving Techniques | FUTUREWEI |
| [66] | [**R1-2210858**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2210858.zip) | Evaluation results and other performance aspects for network energy savings | Huawei, HiSilicon |
| [67] | [**R1-2210859**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2210859.zip) | On techniques aspects for network energy savings | Huawei, HiSilicon |
| [68] | [**R1-2211018**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211018.zip) | Discussions on NW energy savings performance evaluation | vivo |
| [69] | [**R1-2211019**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211019.zip) | Discussion on NW energy saving technique | vivo |
| [70] | [**R1-2211085**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211085.zip) | Discussion on NW energy saving performance evaluation | Fujitsu |
| [71] | [**R1-2211086**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211086.zip) | Discussion on network energy saving techniques | Fujitsu |
| [72] | [**R1-2211097**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211097.zip) | NW energy savings performance evaluation | Nokia, Nokia Shanghai Bell |
| [73] | [**R1-2211098**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211098.zip) | Network energy saving techniques | Nokia, Nokia Shanghai Bell |
| [74] | [**R1-2211209**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211209.zip) | Remaining Issues of Evaluation Methodology and Power Model for Network Energy Saving | CATT |
| [75] | [**R1-2211210**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211210.zip) | Network Energy Saving techniques in time, frequency, and spatial domain | CATT |
| [76] | [**R1-2211241**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211241.zip) | Discussion on performance evaluation of network energy savings | Spreadtrum Communications |
| [77] | [**R1-2211242**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211242.zip) | Discussion on network energy saving techniques | Spreadtrum Communications |
| [78] | [**R1-2211373**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211373.zip) | Discussions on techniques for network energy saving | xiaomi |
| [79] | [**R1-2211410**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211410.zip) | Discussion on Network energy saving performance evaluations | Intel Corporation |
| [80] | [**R1-2211411**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211411.zip) | Discussion on Network Energy Saving Techniques | Intel Corporation |
| [81] | [**R1-2211458**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211458.zip) | Discussion on NW energy savings performance evaluation | OPPO |
| [82] | [**R1-2211459**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211459.zip) | Discussion on network energy saving techniques | OPPO |
| [83] | [**R1-2211518**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211518.zip) | Discussion on on network energy saving techniques | Transsion Holdings |
| [84] | [**R1-2211532**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211532.zip) | Discussion on the network energy saving techniques | China Telecom |
| [85] | [**R1-2211598**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211598.zip) | Discussion on potential network energy saving techniques | Panasonic |
| [86] | [**R1-2211691**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211691.zip) | Discussion on network energy saving performance evaluation | CMCC |
| [87] | [**R1-2211692**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211692.zip) | Discussion on network energy saving techniques | CMCC |
| [88] | [**R1-2211751**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211751.zip) | Discussion on network energy saving techniques | NEC |
| [89] | [**R1-2211780**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211780.zip) | Network energy saving techniques | Lenovo |
| [90] | [**R1-2211821**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211821.zip) | Discussion on network energy saving techniques | Apple |
| [91] | [**R1-2211845**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211845.zip) | Performance evaluation for network energy saving | InterDigital, Inc. |
| [92] | [**R1-2211846**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211846.zip) | Potential techniques for network energy saving | InterDigital, Inc. |
| [93] | [**R1-2211903**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211903.zip) | Evaluation results of NW energy saving techniques | ZTE, Sanechips |
| [94] | [**R1-2211904**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211904.zip) | Discussion on NW energy saving techniques | ZTE, Sanechips |
| [95] | [**R1-2211938**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211938.zip) | Views on the scope for Rel. 18 network energy saving techniques | AT&T |
| [96] | [**R1-2211994**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211994.zip) | Discussion on NW energy saving performance evaluation | NTT DOCOMO, INC. |
| [97] | [**R1-2211995**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2211995.zip) | Discussion on NW energy saving techniques | NTT DOCOMO, INC. |
| [98] | [**R1-2212056**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212056.zip) | NW energy savings performance evaluation | Samsung |
| [99] | [**R1-2212057**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212057.zip) | Network energy saving techniques | Samsung |
| [100] | [**R1-2212128**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212128.zip) | NW energy savings performance evaluation | Qualcomm Incorporated |
| [101] | [**R1-2212129**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212129.zip) | Network energy saving techniques | Qualcomm Incorporated |
| [102] | [**R1-2212154**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212154.zip) | Evaluations for network energy savings techniques | Ericsson |
| [103] | [**R1-2212155**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212155.zip) | Network energy savings techniques | Ericsson |
| [104] | [**R1-2212259**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212259.zip) | NW energy savings performance evaluation | MediaTek Inc. |
| [105] | [**R1-2212260**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212260.zip) | Network energy saving techniques | MediaTek Inc. |
| [106] | [**R1-2212301**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212301.zip) | Discussion on performance evaluation for network energy savings | LG Electronics |
| [107] | [**R1-2212302**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212302.zip) | Discussion on physical layer techniques for network energy savings | LG Electronics |
| [108] | [**R1-2212315**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212315.zip) | Discussion on network energy saving techniques | Rakuten Symphony |
| [109] | [**R1-2212335**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212335.zip) | Discussion on potential L1 network energy saving techniques for NR | ITRI |
| [110] | [**R1-2212381**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212381.zip) | On Network Energy Saving Techniques | Fraunhofer IIS, Fraunhofer HHI |
| [111] | [**R1-2212429**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212429.zip) | Discussion on Network energy saving techniques | CEWiT |
| [112] | [**R1-2212483**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212483.zip) | TR 38.864 update for study on network energy savings for NR | Huawei |
| [113] | [**R1-2212541**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212541.zip) | Discussions on NW energy savings performance evaluation | vivo |
| [114] | [**R1-2212543**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212543.zip) | NW energy savings performance evaluation | Samsung |
| [115] | [**R1-2212563**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212563.zip) | Discussion on Network energy saving performance evaluations | Intel Corporation |
| [116] | [**R1-2212564**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212564.zip) | Discussion Summary #1 for energy saving techniques of NW energy saving SI | Moderator (Intel Corporation) |
| [117] | [**R1-2212565**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212565.zip) | Discussion Summary #2 for energy saving techniques of NW energy saving SI | Moderator (Intel Corporation) |
| [118] | [**R1-2212653**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212653.zip) | NW energy savings performance evaluation | Qualcomm Incorporated |
| [119] | [**R1-2212702**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212702.zip) | FL summary#1 for NW Energy Savings | Moderator (Huawei) |
| [120] | [**R1-2212703**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212703.zip) | FL summary#2 for NW Energy Savings | Moderator (Huawei) |
| [121] | R1-2212738 | Evaluation results of NW energy saving techniques | ZTE, Sanechips |
| [122] | [**R1-2212745**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212745.zip) | NW energy savings performance evaluation | Qualcomm Incorporated |
| [123] | [**R1-2212765**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212765.zip) | Discussion on Network energy saving techniques | CEWiT |
| [124] | [**R1-2212779**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212779.zip) | Discussion Summary #3 for energy saving techniques of NW energy saving SI | Moderator (Intel Corporation) |
| [125] | [**R1-2212780**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212780.zip) | Discussion Summary #4 for energy saving techniques of NW energy saving SI | Moderator (Intel Corporation) |
| [126] | [**R1-2212814**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212814.zip) | Discussion on Network energy saving techniques | CEWiT |
| [127] | [**R1-2212934**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212934.zip) | NW energy savings performance evaluation | Qualcomm Incorporated |
| [128] | [**R1-2212935**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2212935.zip) | FL summary#3 for NW Energy Savings | Moderator (Huawei) |
| [129] | [**R1-2213000**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_111/Docs/R1-2213000.zip) | NW energy savings performance evaluation | Qualcomm Incorporated |
| [130] | **R1-2213013** | Simulation results summary for NW Energy Savings | Moderator (Huawei) |
| [131] | **R1-2213014** | Comments collection for updated draft TR 38.864 post RAN1#111 | Moderator (Huawei) |
| [132] | **R1-2213007** | TR 38.864 update for study on network energy savings for NR | Huawei |
| [133] | **R1-2213006** | FL summary for Post-110-R18- NW\_ES2 | Moderator (Huawei) |

**RAN2#119bis-e**

1. R2-2209365 LS on skeleton of TR 38.864 for NR network energy savings (R3-225203; contact: Huawei) RAN3
2. R2-2209474 On solutions aiming at reducing periodic DL transmissions (1-4) CATT
3. R2-2209475 Autonomous SCell activation and gNB DTX/DRX CATT
4. R2-2209476 Assistance Information from the UE CATT
5. R2-2209735 Group signalling for network energy saving techniques Intel Corporation
6. R2-2209736 Assistance information from UE Intel Corporation
7. R2-2209757 Further discussion on NW DTX-DRX Apple
8. R2-2209758 Discussion on Network energy saving for CONNECTED UE - group CHO and BWP adaptation Apple
9. R2-2209759 Discussion on Network energy saving for IDLE and INACTIVE UE - cell (re)selection and SSB-less Apple
10. R2-2209809 Discussions on time domain techniques for network energy saving vivo
11. R2-2209810 cell (re)selection and handover considering network energy saving vivo
12. R2-2209811 Discussions on frequency domain techniques for network energy saving vivo
13. R2-2209886 Aspects on Network energy savings VODAFONE Group Plc
14. R2-2209964 Discussion on supporting of network energy savings for NR Lenovo
15. R2-2209965 NES impact to RRC\_CONNECTED UE Lenovo
16. R2-2210019 Discussion on network energy savings OPPO
17. R2-2210020 Discussion on the UE assistance information OPPO, Apple
18. R2-2210053 Energy saving for On-demand other SIBs Xiaomi
19. R2-2210105 Consideration on network energy saving Fujitsu
20. R2-2210128 Common Channel Updates for NES Nokia, Nokia Shanghai Bell
21. R2-2210129 Mobility and Access Control for NES Nokia, Nokia Shanghai Bell
22. R2-2210141 Discussion on time domain NES solutions CMCC
23. R2-2210142 Discussion on UE assistance information for NES CMCC
24. R2-2210143 Discussion on Mobility issues CMCC
25. R2-2210185 Details on time domain solutions for NES Nokia, Nokia Shanghai Bell
26. R2-2210225 Discussion on idle and inactive state UE grouping for NES gNB DTX Sony
27. R2-2210226 SIB-less and UE wake up request signal Sony
28. R2-2210227 Handover enhancement for NES Sony
29. R2-2210235 Aspects on Network Energy Saving Techniques Fraunhofer IIS, Fraunhofer HHI
30. R2-2210252 Energy Saving from RRC Idle Operation Lenovo
31. R2-2210253 Further aspects on NW DTX/DRX Ericsson
32. R2-2210254 Paging Enhancements for Beams Ericsson
33. R2-2210255 Handling of Legacy UEs on a NES Capable Cell Ericsson
34. R2-2210282 Time domain NES aspects InterDigital
35. R2-2210283 Frequency domain NES aspects InterDigital
36. R2-2210284 UE assistance information for NES InterDigital
37. R2-2210337 UE awareness by gNB and coexistence with legacy UEs for NES NEC Telecom MODUS Ltd.
38. R2-2210369 Network energy saving techniques Qualcomm Incorporated
39. R2-2210370 NES Proposed Common Signalling Techniques Assessment Qualcomm Incorporated
40. R2-2210383 NW DTX/DRX operation for NES ETRI
41. R2-2210415 Work plan for NR network energy savings Huawei, HiSilicon
42. R2-2210416 TR 38.864 skeleton for study on network energy savings for NR Huawei, HiSilicon
43. R2-2210417 Report of [POST119-e][313][NES] Details of solutions (Huawei) Huawei, HiSilicon
44. R2-2210418 Discussion on SSB-less and SIB1-less techniques for NES Huawei, HiSilicon
45. R2-2210419 Discussion on cell activation triggered by UL WUS Huawei, HiSilicon
46. R2-2210420 Discussion on network DTX Huawei, HiSilicon
47. R2-2210478 Discussion on network energy saving Sharp
48. R2-2210556 Considerations on Energy saving KDDI Corporation
49. R2-2210595 Discussion on resource adaptation for NES LG Electronics Inc.
50. R2-2210611 Assistance Information for NES Samsung
51. R2-2210612 Cell Prioritization for NES Samsung
52. R2-2210613 Resource Adaptation for NES Samsung
53. R2-2210653 SSB/SIB/Paging and Group HO LG Electronics Finland
54. R2-2210656 Considerations on Network Energy Saving techniques MediaTek Inc.
55. R2-2210665 Supporting access via NES cell ZTE corporation, Sanechips
56. R2-2210666 Techniques in various domains and UE assistance information for network energy saving ZTE corporation, Sanechips
57. R2-2210667 Supporting multiple power states ZTE corporation, Sanechips
58. R2-2210707 Discussion on Network Energy Saving in RAN2 study NTT DOCOMO INC.
59. R2-2210772 Considerations on Network Energy Saving techniques MediaTek Inc.
60. R2-2210792 Report of [POST119-e][313][NES] Details of solutions (Huawei) Huawei, HiSilicon
61. R2-2210995 Report of [Offline-302][NES] Cell Selection/Reseletion and SSB/SIB-less (Huawei Huawei
62. R2-2211066 Report of [POST119bis][303][NES] TP on NW DTX/DRX (Huawei/Apple) Huawei, HiSilicon, Apple
63. R2-2211067 TP on Cell DTX DRX to TR 38.864 Huawei, HiSilicon, Apple

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1. R2-2211159 LS on Cell DTX/DRX for NR network energy savings (R3-226002; contact: Huawei) RAN3
2. R2-2211427 TP on cell selection/reselection and SSB/SIB-less Huawei, HiSilicon
3. R2-2211428 Report of [POST119bis][304][NES] TP on cell selection/reselection and SSB/SIB-less (Huawei) Huawei, HiSilicon
4. R2-2211443 Remaining issues on Cell DTX/DRX CATT
5. R2-2211444 Further Considerations on NES Cell without SIB CATT
6. R2-2211445 Remaining Issues on Cell Selection/Reselection CATT
7. R2-2211446 Consideration on mobility enhancements CATT
8. R2-2211586 NES Network DTX and DRX Mechanism Qualcomm Incorporated
9. R2-2211589 NES SIB-less and SSB-less Techniques Qualcomm Incorporated
10. R2-2211591 Cell Selection and Reselection NES Techniques Qualcomm Incorporated
11. R2-2211602 NES Connected mode mobility Qualcomm Incorporated
12. R2-2211664 discussion on cell DTX/DRX vivo
13. R2-2211665 discussion on SSB/SIB-less/paging vivo
14. R2-2211666 discussion on cell selection/reselection vivo
15. R2-2211667 discussion on UE WUS and TP for TR vivo
16. R2-2211679 Further discussion on Cell DTX / DRX Apple
17. R2-2211680 Discussion and comparison of SSB-less and SIB-less solutions Apple
18. R2-2211681 Further discussion on cell (re)selection enhancement for Network energy saving Apple
19. R2-2211682 Further discussion on mobility enhancement for Network energy saving Apple
20. R2-2211774 Further details on Cell DTX/DRX Nokia, Nokia Shanghai Bell
21. R2-2211826 Discussions on common signal-less solutions for NES Fujitsu
22. R2-2211845 Discussions on common signal-less solutions for NES Fujitsu
23. R2-2211920 Discussion on idle and inactive state UE grouping for NES gNB DTX Sony
24. R2-2211921 Handover enhancement for NES Sony
25. R2-2211922 UE wake-up request signal Sony
26. R2-2211953 Discussion on DTX/DRX mechanism OPPO
27. R2-2211954 Discussion on SSB/SIB-less OPPO
28. R2-2211955 Discussion on cell selection/reselection OPPO
29. R2-2211956 Discussion on the UE assistance information OPPO, Apple
30. R2-2211966 SSB and Paging for NES Nokia, Nokia Shanghai Bell
31. R2-2211967 Cell reselection and access control for NES Nokia, Nokia Shanghai Bell
32. R2-2211968 Moiblity enhancements for NES Nokia, Nokia Shanghai Bell
33. R2-2212053 Cell selection/re-selection in NES Lenovo
34. R2-2212054 NES impact to UE mobility Lenovo
35. R2-2212055 Discussion on supporting of NES Lenovo
36. R2-2212058 Discussion on DTX/DRX for NES Samsung
37. R2-2212059 Discussion on SSB/SIB-less Solutions for NES Samsung
38. R2-2212060 Discussion on Cell Selection and Reselection for NES Samsung
39. R2-2212061 BWP Adaptation for NES Samsung
40. R2-2212110 Impacts of SSB/SIB1 adaptations and their mitigation Fraunhofer IIS
41. R2-2212113 Considerations of Cell DTX and DRX Intel Corporation
42. R2-2212114 Considerations of SIBless cell with or without SSB Intel Corporation
43. R2-2212115 Further considerations of group handover Intel Corporation
44. R2-2212116 Cell (re)selection for handling legacy UEs and NES capable Ues Intel Corporation
45. R2-2212181 Supporting access via NES cell ZTE Corporation, Sanechips
46. R2-2212182 Supporting multiple DTX configuration ZTE Corporation, Sanechips
47. R2-2212183 Consideration on cell selection and reselection related to NES for NR ZTE Corporation, Sanechips
48. R2-2212184 Techniques in various domains and UE assistance information for NES ZTE Corporation, Sanechips
49. R2-2212273 CHO improvements for Network Energy Savings Vodafone GmbH
50. R2-2212312 Discussion on SSB-less and SIB-less cell LG Electronics Inc.
51. R2-2212314 Further aspects on Cell DTX/DRX Ericsson
52. R2-2212315 Handling of NES capable and not capable UEs on EE Cell Ericsson
53. R2-2212324 Cell DTX/DRX InterDigital
54. R2-2212325 NES cell selection and resection aspects InterDigital
55. R2-2212326 NES mobility aspects InterDigital
56. R2-2212327 SSB/SIB-less cell operation InterDigital
57. R2-2212383 Discussion on Wake Up Signalling and paging-less NES cells NEC Telecom MODUS Ltd.
58. R2-2212387 SIB-less, SSB-less and paging enhancements Ericsson
59. R2-2212393 Group handover for NW energy savings Ericsson
60. R2-2212569 Cell DTX/DRX related issues ETRI
61. R2-2212634 Discussion on SSB/SIB1/Paging-less NES solution CMCC
62. R2-2212641 Consideration on group mobility for network energy saving Fujitsu Limited
63. R2-2212720 Considerations on SSB/SIB-less solutions for NW energy saving KDDI Corporation
64. R2-2212792 Assistance information for NW DTX/DRX NTT DOCOMO INC.
65. R2-2212796 Assistance information for cell reselection NTT DOCOMO INC.
66. R2-2212823 Connected mode mobility LG Electronics Finland
67. R2-2212825 Work plan for NR network energy savings Huawei, HiSilicon
68. R2-2212840 Recommendations for DTX/DRX mechanism MediaTek Inc.
69. R2-2212841 Recommendations for SSB/SIB1-less techniques MediaTek Inc.
70. R2-2212842 Recommendations for network energy saving techniques MediaTek Inc.
71. R2-2212851 Discussion on DTX/DRX mechanism LG Electronics Inc.
72. R2-2212867 Energy Saving from RRC Idle Operation Lenovo
73. R2-2212868 Latest TR 38.864 v0.4.0 for information Huawei, HiSilicon
74. R2-2212869 Discussion on cell DTX Huawei, HiSilicon
75. R2-2212870 Discussion on SIB-less techniques Huawei, HiSilicon
76. R2-2212871 Discussion on cell selection/reselection for NES Huawei, HiSilicon
77. R2-2212872 Discussion on connected mode mobility for NES Huawei, HiSilicon
78. R2-2212919 Access restriction and cell reselection LG Electronics
79. R2-2212930 Group Handover for NES Rakuten Mobile, Inc
80. R2-2212969 [PRE120][305][NES] Summary of Others – 8.3.6 (Huawei) Huawei, HiSilicon
81. R2-2212971 Summary of Cell (Re)selection – 8.3.4 (Apple) Apple
82. R2-2212973 Feature summary for 8.3.3 Ericsson
83. R2-2213040 Post RAN2#120 TP for TR 38.864 Huawei
84. R2-2213041 LS on RAN2 TP for Network energy savings for NR RAN2
85. R2-2213071 Report of [301][NES] Summary of DTX/DRX – 8.3.2 InterDigital
86. R2-2213072 Feature summary for 8.3.5 Ericsson
87. R2-2213074 Latest RAN2 TP for TR 38.864 v0.4.0 Huawei, HiSilicon
88. R2-2213075 Report of [301][NES] Summary of DTX/DRX – 8.3.2 InterDigital
89. R2-2213076 Latest RAN2 TP for TR 38.864 v0.4.0 Huawei, HiSilicon
90. R2-2213077 TP capturing agreements related to DTX/DRX InterDigital
91. R2-2213266 [Offline-302][NES] Summary of SSB-SIBless-Paging Ericsson
92. R2-2213703 [PRE120][304][NES] Summary of Connected Mode Mobility – 8.3.5 (Nokia) Nokia (Rapporteur)

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1. R3-225668 Work plan for NR network energy savings Huawei
2. R3-225669 TR 38.864 v0.1.0 for information Huawei
3. R3-22541 Information exchange over network interfaces for network energy savings Qualcomm Incorporated
4. R3-225565 Discussion on Network Energy Saving SI Ericsson
5. R3-225595 (TP for TR 38.864) Increased autonomy for cell switch-on/off in the gNB-DU Nokia, Nokia Shanghai Bell
6. R3-225670 (Rev in R3-226001) Network energy saving techniques Huawei
7. R3-225707 Discussion on network energy saving Samsung
8. R3-225723 TP for 38.864 on beam level activation/deactivation CATT
9. R3-225839 Discussion on NW Energy Saving and TP to TR38.864 ZTE
10. R3-226002 LS on Cell DTX/DRX for NR network energy savings RAN3

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1. R3-226397 Work plan for NR network energy savings Huawei
2. R3-226398 Latest draft TR 38.864 v0.4.0 for information Huawei
3. R3-226399 (Rev in R3-226860 Rev in R3-226897) Network energy saving techniques Huawei
4. R3-226457 (Rev in R3-226861) Discussion on Network Energy Saving SI Ericsson
5. R3-226525 Information exchange over network interfaces for network energy savings Qualcomm Incorporated
6. R3-226584 Discussion on network energy saving Samsung
7. R3-226359 TP for 38.864 on Network Energy Saving CATT
8. R3-226754 Discussion on NW ES and TP ZTE
9. R3-226669 Considerations on network energy savings Intel Corporation
10. R3-226532 (TP for TR 38.864) Increased autonomy for cell switch-on/off in the gNB-DU Nokia, Nokia Shanghai Bell
11. R3-226862 (Rev in R3-226898) LS to RAN1 on network energy saving techniques RAN3

27.10.2022 minor adaptations for RAN #98e

01.08.2022 minor adaptations for RAN #97e

21.05.2022 minor adaptations for RAN #96

10.01.2022 minor adaptations for RAN #95e

04.10.2021 minor adaptations for RAN #94e

08.08.2021 minor adaptations for RAN #93e

17.05.2021 minor adaptations for RAN #92e

28.01.2021 minor adaptations for RAN #91e

09.11.2020 minor adaptations for RAN #90e

31.08.2020 minor adaptations for RAN #89e

20.04.2020 minor adaptations for RAN #88e

18.02.2020 minor adaptations for RAN #87e

14.11.2019 minor adaptations for RAN #86

18.08.2019 minor adaptations for RAN #85

12.05.2019 minor adaptations for RAN #84

27.02.2019 minor adaptations for RAN #83

21.11.2018 completion levels with colours added (for RAN #82)

v04.81 31.07.2018 simplification of template and addition of cross-TSG aspects (for RAN #81)

v04.80 21.05.2018 minor adaptations for RAN #80

v04.79 26.02.2018 minor adaptations for RAN #79

v04.78 18.11.2017 minor adaptations for RAN #78

v04.77 06.08.2017 minor adaptations for RAN #77

v04.76 15.05.2017 minor adaptations for RAN #76

v04.75 31.01.2017 minor adaptations for RAN #75

v04.74 28.10.2016 minor adaptations for RAN #74

v04.73 01.09.2016 adaptations for RAN #73 (time units in extra Excel table, RAN6 reporting included)

v04.72 26.05.2016 adaptations for RAN #72 (introduction of NR & GERAN TUs)

v04.71 10.02.2016 minor adaptations for RAN #71

v04.70 30.10.2015 minor adaptations for RAN #70

v04.69 12.08.2015 minor adaptations for RAN #69

v04.68 21.05.2015 minor adaptations for RAN #68

v04.67 01.02.2015 minor adaptations for RAN #67

v04.66 16.11.2014 minor adaptations for RAN #66

v04.65 16.08.2014 minor adaptations for RAN #65

v04.64 22.05.2014 minor adaptations for RAN #64

v04.63 24.01.2014 restructuring for RAN #63 to cover Core & Perf. in one doc file

v03.62 11.11.2013 section 1.2.3 adapted for RAN #62

v03 11.08.2013 section 1.2.3 added on time budget

v02 07.05.2010 history added, some spelling corrections

v01 13.11.2009 First version of the template