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| Technical Report | |
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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

Y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**Should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**Can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**Will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The present document is intended to capture the output of the study item on XR Enhancements for NR [10], which aims at investigating power saving and capacity enhancements techniques tailored for XR services, as well as means to provide XR-awareness in RAN.

This study follows a series of earlier studies conducted in 3GPP by SA1 [2], SA4 [5] [6] [7] and RAN1 [8]. It is complemented by work in SA2 [12], SA4 [11] and SA6 [4].

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR [21.905](http://www.3gpp.org/ftp/Specs/html-info/21905.htm): "Vocabulary for 3GPP Specifications".

[2] 3GPP TR [22.842](http://www.3gpp.org/ftp/Specs/html-info/22842.htm): "Study on Network Controlled Interactive Service (NCIS) in the 5G System (5GS)".

[3] 3GPP TR [23.748](http://www.3gpp.org/ftp/Specs/html-info/23748.htm): "Study on enhancement of support for Edge Computing in 5G Core network(5GC)".

[4] 3GPP TR [23.758](http://www.3gpp.org/ftp/Specs/html-info/23758.htm): "Study on application architecture for enabling Edge Applications".

[5] 3GPP TR [26.918](http://www.3gpp.org/ftp/Specs/html-info/26918.htm): "Virtual Reality (VR) media services over 3GPP".

[6] 3GPP TR [26.926](http://www.3gpp.org/ftp/Specs/html-info/26926.htm): "Traffic Models and Quality Evaluation Methods for Media and XR Services in 5G Systems".

[7] 3GPP TR [26.928](http://www.3gpp.org/ftp/Specs/html-info/26928.htm): "Extended Reality (XR) in 5G".

[8] 3GPP TR [38.838](http://www.3gpp.org/ftp/Specs/html-info/38838.htm): "Study on XR (Extended Reality) evaluations for NR".

[9] 3GPP TR [23.700-60](https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=4007): "Study on architecture enhancement for XR and media services".

[10] [RP-220285](http://3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_95e/Docs/RP-220285.zip): "Study on XR Enhancements for NR".

[11] [SP-210043](http://3gpp.org/ftp/tsg_sa/TSG_SA/TSGs_91E_Electronic/Docs/SP-210043.zip): "Feasibility Study on Typical Traffic Characteristics for XR Services and other Media".

[12] [SP-220705](http://3gpp.org/ftp/tsg_sa/TSG_SA/TSGS_96_Budapest_2022_06/Docs/SP-220705.zip): "Study on XR (Extended Reality) and media services s".

[13] [S4-220505](http://3gpp.org/ftp/tsg_sa/WG4_CODEC/TSGS4_118-e/Docs/S4-220505.zip): "LS Reply on QoS support with PDU Set granularity".

[14] [S4aV220921](https://www.3gpp.org/ftp/tsg_sa/WG4_CODEC/3GPP_SA4_AHOC_MTGs/SA4_VIDEO/Docs/S4aV220921.zip): "Reply LS on further details on XR traffic".

[15] 3GPP TS [38.300](https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3191): "NR and NG-RAN Overall description; Stage-2".

[16] [S4-221626](http://3gpp.org/ftp/tsg_sa/WG4_CODEC/TSGS4_121_Toulouse/Docs/S4-221626.zip): "Reply LS on Pose Information".

[17] [S4aR230035](http://3gpp.org/ftp/tsg_sa/WG4_CODEC/3GPP_SA4_AHOC_MTGs/SA4_RTC/Docs/S4aR230035.zip): "Reply LS on PDU Set Handling"

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

**Field of view:** the angle of visible field expressed in degrees measured from the focal point.

**PDU Set**: A PDU Set is composed of one or more PDUs carrying the payload of one unit of information generated at the application level (e.g. a frame or video slice for XRM Services, as used in TR 26.926 [6]). In some implementations all PDUs in a PDU Set are needed by the application layer to use the corresponding unit of information. In other implementations, the application layer can still recover parts or all of the information unit, when some PDUs are missing.

**Multi-modal Data**: Multi-modal Data is defined to describe the input data from different kinds of devices/sensors or the output data to different kinds of destinations (e.g. one or more UEs) required for the same task or application. Multi-modal Data consists of more than one Single-modal Data, and there is strong dependency among each Single-modal Data. Single-modal Data can be seen as one type of data.

**Data Burst:** Data produced by the application in a short period of time, comprising PDUs from one or more PDU Sets.

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], TS 38.300 [15] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1] and in TS 38.300 [15].

3DoF Three Degrees of Freedom

6DoF Six Degrees of freedom

AR Augmented Reality

DASH Dynamic Adaptive Streaming over HTTP

FEC Forward Error Coding

FoV Field of view

FPS Frames Per Second

GBR Guaranteed Bit Rate

GFBR Guaranteed Flow Bit Rate

HEVC High-Efficiency Video Coding

HMD Head-Mounted Display

HUD Heads-Up Display

PDB Packet Delay Budget

PDU Protocol Data Unit

PER Packet Error Rate

PSDB PDU-Set Delay Budget

PSER PDU-Set Error Rate

PSI PDU-Set Importance

PSIHI PDU-Set Integrated Handling Indication

QCI QoS Class Identifier

QFI QoS Flow ID

QoE Quality of Experience

QoS Quality of Service

VR Virtual Reality

XR Extended reality

# 4 Introduction to Extended Reality

## 4.1 Extended Reality Types

Extended Reality (**XR**) refers to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. XR is an umbrella term for different types of realities (see TR 26.918 [5] and TR 26.928 [7]):

- Virtual reality (**VR**) is a rendered version of a delivered visual and audio scene. The rendering is designed to mimic the visual and audio sensory stimuli of the real world as naturally as possible to an observer or user as they move within the limits defined by the application. Virtual reality usually, but not necessarily, requires a user to wear a head mounted display (HMD), to completely replace the user's field of view with a simulated visual component, and to wear headphones, to provide the user with the accompanying audio. Some form of head and motion tracking of the user in VR is usually also necessary to allow the simulated visual and audio components to be updated in order to ensure that, from the user's perspective, items and sound sources remain consistent with the user's movements.

- Augmented reality (**AR**) is when a user is provided with additional information or artificially generated items or content overlaid upon their current environment. Such additional information or content will usually be visual and/or audible and their observation of their current environment may be direct, with no intermediate sensing, processing and rendering, or indirect, where their perception of their environment is relayed via sensors and may be enhanced or processed.

- Mixed reality (**MR**) is an advanced form of AR where some virtual elements are inserted into the physical scene with the intent to provide the illusion that these elements are part of the real scene.

Other terms used in the context of XR are Immersion as the sense of being surrounded by the virtual environment as well as Presence providing the feeling of being physically and spatially located in the virtual environment. The sense of presence provides significant minimum performance requirements for different technologies such as tracking, latency, persistency, resolution and optics.

This document uses the acronym XR throughout to refer to equipment, applications and functions used for VR, AR and MR. Examples include, but are not limited to HMDs for VR, optical see-through glasses and camera see-through HMDs for AR and MR and mobile devices with positional tracking and camera. They all offer some degree of spatial tracking and the spatial tracking results in an interaction to view some form of virtual content.

## 4.2 Human Perception and Tracking

For providing XR experiences that make the user feel *immersed* and *present*, several relevant quality of experience factors have been collected (see TR 26.926 [7]). Presence is the feeling of being physically and spatially located in an environment. Presence is divided into 2 types: Cognitive Presence and Perceptive Presence. Cognitive Presence is the presence of one's mind. It can be achieved by watching a compelling film or reading an engaging book. Cognitive Presence is important for an immersive experience of any kind. Perceptive Presence is the presence of one's senses. To accomplish perceptive presence, one's senses, sights, sound, touch and smell, have to be tricked. To create perceptive presence, the XR Device has to fool the user's senses, most notably the audio-visual system. XR Devices achieve this through positional tracking based on the movement. The goal of the system is to maintain your sense of presence and avoid breaking it. Perceptive Presence is the objective to be achieved by XR applications.

The Human field of view (**FoV**) is defined as the area of vision at a given moment (with a fixed head). It is the angle of visible field expressed in degrees measured from the focal point. The monocular FoV is the angle of the visible field of one eye whereas the binocular FoV is the combination of the two eyes fields (see TR 26.918 [5]). The binocular horizontal FoV is around 200-220°, while the vertical one around 135°. The central vision, which is about 60°, is also called the comfort zone where sensibility to details is the most important. Although less sensitive to definition, the peripheral vision is more receptive to movements.

In XR, actions and interactions involve movements and gestures. Thereby, the Degrees of Freedom (**DoF**) describe the number of independent parameters used to define movement in the 3D space (see TR 26.928 [7]):

- 3DoF: three rotational and un-limited movements around the X, Y and Z axes (respectively pitch, yaw and roll). A typical use case is a user sitting in a chair looking at 3D 360 VR content on an HMD.



Figure 4.2-1: 3DoF

- 6DoF: 3DoF with full translational movements along X, Y and Z axes. Beyond the 3DoF experience, it adds (i) moving up and down (elevating/heaving); (ii) moving left and right (strafing/swaying); and (iii) moving forward and backward (walking/surging). A typical use case is a user freely walking through 3D 360 VR content (physically or via dedicated user input means) displayed on an HMD.



Figure 4.2-2: 6DoF

An **XR View** describes a single view into an XR scene for a given time. Each view corresponds to a display or portion of a display used by an XR device to present the portion of the scene to the user.

An **XR Viewport** describes a viewport, or a rectangular region, of a graphics surface. The XR viewport corresponds to the projection of the XR View onto a target display. An XR viewport is predominantly defined by the width and height of the rectangular dimensions of the viewport.

An **XR Pose** describes a *position* and *orientation* in space relative to an XR Space. An essential element of XR is the spatial tracking of the viewer pose.

## 4.3 Capture, Encoding and Delivery

### 4.3.1 Video

XR content may be represented in different formats, e.g. panoramas or spheres depending on the capabilities of the capture systems. Since modern video coding standards are not designed to handle spherical content. Projection is used for conversion of a spherical (or 360°) video into a two-dimensional rectangular video before the encoding stage. After projection, the obtained two-dimensional rectangular image can be partitioned into regions (e.g. front, right, left, back, top, bottom) that can be rearranged to generate "packed" frames to increase coding efficiency or viewport dependent stream arrangement.

There are mainly three approaches that can be considered for 360 video delivery (see TR 26.918 [5]):

- Single stream approach: the single stream approach consists in providing the full 360 video and showing the interesting part only. Solutions that lie within this group have the drawback that either they may not be scalable or they may impose a big challenge in terms of required network resources (high bitrate of high resolution video) and required processing at the client side (decode a very high resolution video).

- Multi-stream approach: the multi-stream approach consists of encoding several streams, each of them emphasizing a given viewport and making them available for the receiver, so that the receiver decides which stream is delivered at each time instance.

- Tiled stream approach: the tiled stream approach consists in emphasizing the current user viewport through transmitting non-viewport samples with decreased resolution. The tiles can be provided as one common bitstream (using motion-constrained HEVC tiles) or as separate video streams.

In modern video codecs (see S4-220505 [13]):

- Complex prediction structures are used that take into account application constraints, encoding complexity, latency and dynamic decisions in the encoding. This may result in irregularities, for example based on sequence properties. In particular for low-latency delivery with error resiliency, different flavours of encoding operations are in use, and the concept of I, P and B pictures is not generally applicable.

- All PDUs in a PDU Set are needed by the application layer to use the corresponding unit of information in some implementations; while in some others, receivers may use the data up to the first lost fragmentation unit to recover at least parts of the video data and apply error concealment afterward.

- Furthermore, in motion-compensated predicted video decoding, some frames refer to other frames based on the video encoding configuration but also based on dynamic operational decisions. As a consequence, a PDU Set may “depend” on previously received PDU Sets. However, such dependencies do not necessarily result in discarding dependent information units.

### 4.3.2 Audio

For Audio, we can distinguish channel-based and object-based representations (see TR 26.918 [5]):

- Channel-based representation using multiple microphones to capture sounds from different directions and post-processing techniques are well known in the industry, as they have been the standard for decades.

- Object-based representations represent a complex auditory scene as a collection of single audio elements, each comprising an audio waveform and a set of associated parameters or metadata. The metadata embody the artistic intent by specifying the transformation of each of the audio elements to playback by the final reproduction system. Sound objects generally use monophonic audio tracks that have been recorded or synthesized through a process of sound design. These sound elements can be further manipulated, so as to be positioned in a horizontal plane around the listener, or in full three-dimensional space using positional metadata.

## 4.4 XR Engines and Rendering

XR engines provide a middleware that abstracts hardware and software functionalities for developers of XR applications (see TR 26.928 [7]). Typical components include a rendering engine for graphics, an audio engine for sound, and a physics engine for emulating the laws of physics. In the remainder of this Technical Report, the term *XR engine* is used to provide any type of typical XR functionalities as mentioned above.

The processing of an XR engine is not exclusively carried out in the device GPU. In power and resource constrained devices, it can be assisted or split across the network through edge computing (see TR 22.842 [2]): the UE sends the sensor data in uplink direction to the cloud side in a real time manner and when the cloud side receives the sensor data, it performs rendering computing and produces the multimedia data and then sends back to the user devices for display. This is where NR can play an essential role.

## 4.5 Characteristics and Requirements

### 4.5.1 General

In general, the RTP layer can handle (and potentially exploit) out-of-sequence reception of RTP packets, and some codecs even require it for good operations. Thus, a mode of operation where the lower-layers on the receiver side do not enforce in-sequence delivery is preferred (see S4aR230035 [17]).

Other than that, it is difficult to identify characteristics common for different XR applications since they heavily depend on the application choices, such as the application itself, the codec in use, the data formats and the encoding operation (see S4-220505 [13]). In particular, low-latency XR and cloud gaming video services such as Split-Rendering or Cloud Gaming typically would not use the traditional coding structure with a fixed Group of-Picture (GOP). In addition, the field of low-latency video delivery is undergoing heavy innovation and new coding methods may be established frequently. Thus, the traffic characteristics and requirements derived from the work done in SA4 (TR 26.926 [6] and TR 26.928 [7]) and listed below, can only be used as a baseline when specific examples for XR traffic characteristics are needed – bearing in mind that they are not universally applicable for all XR applications.

### 4.5.2 Video

The **frame rate** for XR video varies from 15 frames per second up to 90 or even 120 frames per second, with a typical minimum of 60 for VR (see TR 26.918 [5] and TR 26.926 [6]).

According to TR 26.918 [5], the **latency** of action of the angular or rotational vestibulo-ocular reflex is known to be of the order of 10 ms or in a range from 7-15 milliseconds and it seems reasonable that this should represent a performance goal for XR systems. This results in a motion-to-photon latency of less than 20 milliseconds, with 10ms being given as a goal.

Regarding the **bit rates**, between 10 and 200Mbps can be expected for XR depending on frame rate, resolution and codec efficiency (see TR 26.926 [6] and TR 26.928 [7]).

### 4.5.3 Audio

According to TR 26.918 [5], due to the relatively slower speed of sound compared to that of light, it is natural that users are more accustomed to, and therefore tolerant of, sound being relatively delayed with respect to the video component than sound being relatively in advance of the video component. Recent studies have led to recommendations of an accuracy of between 15 ms (audio delayed) and 5 ms (audio advanced) for the **synchronization**, with recommended absolute limits of 60 ms (audio delayed) and 40 ms (audio advanced) for broadcast video.

### 4.5.4 Pose Information

To maintain a reliable registration of the virtual world with the real world, as well as to ensure accurate tracking of the XR Viewer pose, XR applications require highly accurate, low-latency tracking of the device at about 1kHz sampling frequency. The size of a XR Viewer Pose associated to time, typically results in packets of size in the range of 30-100 bytes, such that the generated data is around several hundred kbit/s if delivered over the network (see TR 26.928 [7]).

Repeatedly providing the XR Viewer Pose for the same display time may not necessarily return the same result (the prediction gets increasingly accurate as the information is closer to the time when a prediction is made) and there is a trade-off between providing several XR Viewer Pose for a display time and using the same XR Viewer Pose for several consecutive display times. However, it can be assumed that sending one XR Viewer Pose aligned with the frame rate of the rendered video may be sufficient, for example at 60fps (see S4-221626 [16]).

Pose information has to be delivered with ultra-high reliability, therefore, similar performance as URLLC is expected i.e. packet loss rate should be lower than 10E-3 for uplink sensor data – see S4-221626 [16].

# 5 XR Enhancements for NR

## 5.1 XR Awareness

### 5.1.1 General

In both uplink and downlink, XR-Awareness contributes to optimizations of gNB radio resource scheduling and relies at least on the notions of PDU Set and Data Burst (see TR 23.700-60 [9]): a PDU Set is composed of one or more PDUs carrying the payload of one unit of information generated at the application level (e.g. a frame or video slice), while a Data Burst is a set of data PDUs generated and sent by the application in a short period of time.

NOTE: A Data Burst can be composed of multiple PDUs belonging to one or multiple PDU Sets. During a Data Burst, periods of data transmission inactivity should not be assumed. Although the duration of Data Bursts may vary, it can be assumed that it stays within the same order of magnitude. Also, the arrival time of the first packet of a data burst cannot be provided by 5GC.

The following information may be provided to RAN per QoS flow (see TR 23.700-60 [9]):

- Semi-static information for both UL and DL::

- Periodicity for UL and DL traffic of the QoS Flow provided via TSCAI/TSCAC;

- Traffic jitter information (e.g. jitter range) associated with each periodicity of the QoS flow provided via TSCAI/TSCAC;

- PDU Set QoS parameters of the QoS flow (i.e. applicable to all PDU sets of the QoS flow) provided by the SMF via NGAP:

- PDU Set Error Rate (PSER): defines an upper bound for a rate of non-congestion related PDU Set losses (see TR 23.700-60 [9]).

NOTE: In this release, a PDU set is considered as successfully delivered when all PDUs of a PDU Set are delivered successfully, and if the PSER is available, the usage of PSER supersedes the usage of PER.

- PDU Set Delay Budget (PSDB): time between reception of the first PDU and the successful delivery of the last arrived PDU of a PDU Set (see TR 23.700-60 [9]). PSDB is an optional parameter.

- PDU Set Integrated Handling Indication (PSIHI): indicates whether all PDUs of the PDU Set are needed for the usage of PDU Set by application layer.

- PDU Set Information and Identification (dynamic information for DL provided by user plane in GTP-U header):

- PDU Set Sequence Number within a PDU Set;

- PDU Set Size in bytes (FFS);

- PDU SN within a PDU Set;

- Indication of End PDU of the PDU Set;

- PDU Set Importance (PSI): identifies the relative importance of a PDU Set compared to other PDU Sets within a QoS Flow. RAN may use it for PDU Set level packet discarding in presence of congestion;

- End of Data Burst indication in the header of the last PDU of the Data Burst (optional).

For the uplink XR traffic, the UE needs to be able to identify PDU Set and Data Bursts dynamically, including PSI, but in-band marking over Uu of PDUs is not needed.

When the PSIHI is set for a PDU set, as soon as one PDU is known to be lost, the remaining PDUs of that PDU Set can be considered as no longer needed by the application and may be subject to discard operation (see subclause 5.3.2).

NOTE 1: This depends on the application and it cannot always be assumed that the remaining PDUs are not useful and can safely be discarded.

NOTE 2: In case of Forward Error Coding (FEC), active discarding of PDUs when assuming that a large enough number of packets have already been transmitted for FEC to recover without the remaining PDUs is not recommended as it might trigger an increase of FEC packets (see S4aV220921 [14]).

### 5.1.2 Layer 2 Structure

Depending on how the mapping of PDU Sets onto QoS flows is done in the NAS and how QoS flows are mapped onto DRBs in the AS, we can distinguish the following alternatives (as depicted on Figure 5.1.2-1 below):

- 111: one-to-one mapping between types of PDU Sets and QoS flows in the NAS and one-to-one mapping between QoS flows and DRBs in the AS. From a Layer 2 structure viewpoint, this alternative is already possible and requires as many DRBs as types of PDU Sets. Providing different QoS for the types of PDU Sets sent in different DRBs is already possible.

- NN1: one-to-one mapping between types of PDU Sets and QoS flows in the NAS and possible multiplexing of QoS flows in one DRB in the AS. From a Layer 2 structure viewpoint, this alternative is already possible but gives each QoS flows multiplexed in a DRB the same QoS. Providing different QoS for the types of PDU Sets (i.e. QoS flows) multiplexed in a single DRB is currently not possible.

- N11: possible multiplexing of types of PDU Sets in one QoS flow in the NAS and one-to-one mapping between QoS flows and DRBs in the AS. From a Layer 2 structure viewpoint, this alternative is already possible but gives each QoS flow/DRB one QoS. Providing different QoS for the types of PDU Sets multiplexed in a single QoS flow/DRB is currently not possible.

- N1N: possible multiplexing of types of PDU Sets in one QoS flow in the NAS and demultiplexing of types of PDU Sets from one QoS flow on multiple DRBs in the AS. From a Layer 2 structure viewpoint, demultiplexing of types of PDU Sets from one QoS flow onto multiple DRBs is currently not possible.



Figure 5.1.2-1: Mapping Alternatives

When comparing these alternatives, it was agreed that a QoS flow cannot be mapped onto multiple DRBs in the uplink, thereby excluding alternative N1N. For the other alternatives, it was also agreed that providing different QoS by splitting PDU sets of one DRB to different RLC bearers will not be possible i.e. that splitting a DRB onto multiple RLC entities will remain limited to existing cases (e.g. duplication).

In addition, the notion of PDU Set does not impact the granularity of:

- SDAP SDU handling: SDAP still maps every incoming SDU to a single PDU for a single PDCP entity;

- Retransmissions: HARQ still relies on MAC PDUs and ARQ on RLC PDUs.

In terms of logical channel prioritisation in uplink, changes due to PDU prioritisation will not be introduced, e.g. delay criteria was considered but agreed not to be pursued further unless fundamental issues are identified.

## 5.2 Power Saving Techniques

### 5.2.1 Physical Layer Enhancements

The evaluation results for proposed and studied power saving enhancement schemes are available in Annex B.2.

### 5.2.2 Layer 2 Enhancements

Most XR frame rates (15, 30, 45, 60, 72, 90 and 120fps) correspond to periodicities which are not an integer (66.66, 33.33, 22.22, 16.66, 13.88, 11.11 and 8.33ms respectively). The corresponding support by DRX will be dealt with in a semi-static manner at least (e.g. via RRC signalling).

In addition, RRC pre-configuration and switching of configurations of DRX can be considered for enhancements of XR power saving.

## 5.3 Capacity Improvements Techniques

### 5.3.1 Physical Layer Enhancements

The following enhancements for configured grant-based transmission are recommended:

- Multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration;

- Dynamic indication of unused CG PUSCH occasion(s) based on UCI (e.g., CG-UCI or a new UCI) by the UE.

The corresponding capacity performance evaluation results are available in Annex B.1.6.

The evaluation results for other proposed and studied capacity enhancement schemes are available in Annex B.1.

### 5.3.2 Layer 2 Enhancements

In order to enhance the scheduling of uplink resources for XR, the following improvements are envisioned:

- One or more additional BS table(s) to reduce the quantisation errors in BSR reporting (e.g. for high bit rates);

- Delay knowledge of buffered data, consisting of e.g. remaining time, and distinguishing how much data is buffered for which delay. It is to be determined whether the delay information is reported as part of BSR or as a new MAC CE. Also, how the delay information can be up to date considering e.g. scheduling and transmission delays needs to be investigated further.

- Additional BSR triggering conditions to allow timely availability of buffer status information can be investigated further.

- Delivery of some assistance information (e.g. periodicity) reusing TSCAI as a baseline. Whether additional mechanism is required can be further considered with an assumption that all information may not be always available at UE application.

- Signalling of UL traffic arrival information from the UE to the gNB to cope with tethering use cases (FFS).

For PDCP discard operation in uplink, the timer-based discard operation (when configured) should apply to all SDUs/PDUs belonging to the same PDU Set. Furthermore, when, for a PDU Set for which the PSIHI is set, one PDU is known to either be lost or associated to a discarded SDU (see subclause 5.1.1), all remaining PDUs of that PDU Set could be discarded at the transmitter to free up radio resources.

NOTE: This means that the granularity of the discard operation at PDCP in the transmitter should be the PDU Set when the PSIHI is set.

In case of congestion, the PSI may be used to discard packets (see subclause 5.1.1). In uplink, the corresponding mechanism will be introduced.

In uplink, the usage of Configured Grant brings potential benefits for XR services with the enhancements recommended in subclause 5.3.1, while in downlink, the usage of Semi-Persistent scheduling is not foreseen to bring any benefits.

NOTE: the layer 2 components of the mechanisms recommended in subclause 5.3.1 will be specified.

# 6 Conclusions

In conclusion of the study, the following enhancements for XR services are recommended:

- For XR Awareness:

- Provisioning of PDU Set QoS parameters and PDU Set Information and Identification to RAN as per TR 23.700-60 [9].

- For Power Saving:

- DRX support of XR frame rates corresponding to non-integer periodicities (through at least semi-static mechanisms e.g. RRC signalling).

- For Capacity Enhancements:

- Multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration;

- Dynamic indication of unused CG PUSCH occasion(s) based on UCI by the UE;

- BSR enhancements including at least new BS Table(s);

- Delay reporting of buffered data in uplink;

- Provision of XR traffic assistance information for DL and UL (e.g. periodicity);

- Discard operation of PDU Sets.

Annex A:  
Evaluation Methodology

Rel-17 evaluation methodology for XR power saving and capacity enhancements (see TR 38.838 [8]) is used as the baseline evaluation methodology for UE power saving and capacity evaluation of Rel-18 XR.

System capacity is identified as KPI for capacity study, which is defined as the maximum number of users per cell with at least Y % of UEs being satisfied. A UE is declared as a satisfied UE if all considered streams meet their own packet error rate (PER) and PDB requirements, i.e., more than X% of packets are successfully transmitted within a given air interface PDB. From Rel-17 XR evaluation methodology, baseline parameters are Y= 90% and X = 99%.

For power saving evaluation, power saving gain and capacity gain are calculated with respect to the AlwaysOn baseline unless otherwise noted. Jitter in DL is assumed on unless otherwise noted.

In addition to the values for jitter in DL in Table 5.1-2 in TR 38.838 [8], the following statistical parameters can also be optionally evaluated in Rel-18 XR SI.

NOTE: This optional assumption is not applicable to the evaluation of 90 FPS and above.

|  |  |  |
| --- | --- | --- |
| Parameter | unit | Optional value for evaluation |
| Mean | ms | 0 |
| STD | ms | 5 |
| Truncation range | ms | [-8, 8] |

Annex B:  
Evaluation Studies

## B.1 Capacity performance evaluation results

### B.1.1 Multi-PDSCH scheduling by a single DCI

This clause captures the capacity performance evaluation results for dynamic scheduling when multi-PDSCH is scheduled by a single DCI. Due to large XR video frame as per 38.838, resources in a single slot may be not enough to convey all the data of a frame, resulting in resource allocation spanning more than one slot. Thereby, in this clause, multi-PDSCH scheduling by a single DCI is evaluated to transmit XR video frame over multiple slots.

The performance of single-PDSCH scheduling, where X symbol(s) are always reserved for PDCCH transmission in each slot (scheme 1.1 in Tables B.1.1-1,2,3) has been compared against various schemes for multi-PDSCH scheduling. Particularly, the following schemes, where multi-PDSCH is scheduled by a single DCI, have been evaluated:

- Scheme 1.2: Multi-PDSCH scheduling, where unoccupied CORESET in a slot can be re-used for PDSCH transmission.

- Scheme 1.3: Multi-PDSCH scheduling, where X symbol(s) are always reserved for PDCCH transmission in each slot.

- Scheme 1.4: Multi-PDSCH scheduling with FDRA enhancement - more than one FDRA indication is contained in the scheduling DCI, each of which is applied to one or more scheduled PDSCH.

- Scheme 1.5: Multi-PDSCH scheduling enhancement with early HARQ-ACK feedback - multiple PUCCHs may be considered where HARQ-ACK for the earlier PDSCH(s) can be reported earlier than the later PDSCH(s) scheduled by the same DCI, to reduce latency of HARQ-ACK feedback.

- Scheme 1.6: Multi-PDSCH scheduling where single PDCCH schedules up to 4 PDSCHs and full flexibility in terms of resource (RB allocation) as well as MCS for each of the 4 PDSCHs.

- Scheme 1.7: Multi-PDSCH scheduling, where X symbols per slot are used for PDCCH if there is at least one UE that needs to be scheduled with first TB out of multiple TBs and 0 symbols per slot are used for PDCCH if no UE with the first TB out of multiple TBs needs to be scheduled.

The performance results of the above schemes are reported in Table B.1.1-1, Table B.1.1-2, Table B.1.1-3 in terms of the ratio of satisfied users.

TableB.1.1-1: FR1, DL, InH, VR/AR and Cloud Gaming at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [vivo] | R1-2208661 | 1.1\* | DDDSU | SU-MIMO | 30 | 10 | 9.8 | 9 | 96.61% | Note 1,3 |
| 45 | 6.08 | 6 | 91.67% |
| Source [vivo] | R1-2208661 | 1.1\*\* | DDDSU | SU-MIMO | 30 | 10 | 8.16 | 8 | 91.07% | Note 1,3 |
| 45 | 4.66 | 4 | 97.22% |
| Source [vivo] | R1-2208661 | 1.1\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 10.25 | 10 | 93.06% | Note 1,3 |
| Source [vivo] | R1-2208661 | 1.2\* | DDDSU | SU-MIMO | 30 | 10 | 10.37 | 10 | 95% | Note 1, 2,3 |
| 45 | 6.27 | 6 | 94.91% |
| Source [vivo] | R1-2208661 | 1.2\*\* | DDDSU | SU-MIMO | 30 | 10 | 9.58 | 9 | 95.14% | Note 1, 2,3 |
| 45 | 5.57 | 5 | 96.67% |
| Source [vivo] | R1-2208661 | 1.2\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 10.1 | 10 | 91.28% | Note 1, 2,3 |
| Source [vivo] | R1-2208661 | 1.3\* | DDDSU | SU-MIMO | 30 | 10 | 8.81 | 8 | 93.89% | Note 1,3 |
| Source [vivo] | R1-2208661 | 1.3\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.25 | 7 | 92.02% | Note 1,3 |
| Source [vivo] | R1-2208661 | 1.3\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 9.68 | 9 | 98.37% | Note 1,3 |
| Source [vivo] | R1-2208661 | 1.4\* | DDDSU | SU-MIMO | 30 | 10 | 11.09 | 11 | 90.8% | Note 1,2 |
| Source [vivo] | R1-2208661 | 1.5\* | DDDSU | SU-MIMO | 30 | 10 | 10.59 | 10 | 95.72% | Note 1,2 |
| Source [InterDigital] | R1-2209658 | 1.1\*\* | DDDSU | SU-MIMO | 30 | 10 | 5.3 | 5 | 94% | Note 1 |
| 45 | 3.1 | 3 | 91.5% |
| Source [InterDigital] | R1-2209658 | 1.1\*\* | DDDSU | SU-MIMO | 30 | 15 | 7.2 | 7 | 94.5% | Note 1 |
| Source [InterDigital] | R1-2209658 | 1.6\*\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.8 | 7 | 97% | Note 1,2 |
| 45 | 4.1 | 4 | 91% |
| Source [InterDigital] | R1-2209658 | 1.6\*\*\*\* | DDDSU | SU-MIMO | 30 | 15 | 10 | 10 | 100% | Note 1,2 |
| Source [ZTE] | R1-2209198 | 1.1\*\* | DDDSU | SU-MIMO | 30 | 10 | 9.1 | 9 | 91% | Note 1 |
| 60 | 3.4 | 3 | 97% |
| Source [ZTE] | R1-2209198 | 1.7\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.9 | 7 | 96% | Note 1,2,4 |
| 60 | 3.7 | 3 | 99% |
| Note 1: BS antenna parameters: 32TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1,4,4)  Note 2: No symbol for PDCCH is reserved in the slot where no scheduling DCI is transmitted  Note 3: Results does not consider any other PDCCH that may occupy the CORESET(s) than scheduling DCI, e.g. broadcast PDCCH  Note 4: Results consider 2 symbols are used for PDCCH, if at least one UE needs to be scheduled with the first TB out of multiple TBs  \* Number of PDCCH symbols per slot = 1  \*\* Number of PDCCH symbols per slot = 2  \*\*\* Number of PDCCH symbols per slot = 0.5  \*\*\*\* Number of PDCCH symbols per slot = 4 | | | | | | | | | | |

TableB.1.1-2: FR1, DL, DU, VR/AR and Cloud Gaming at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [InterDigital] | R1-2209658 | 1.1\*\* | DDDSU | SU-MIMO | 30 | 10 | 5.5 | 5 | 95% | Note 1 |
| 45 | 3.7 | 3 | 100% |
| Source [InterDigital] | R1-2209658 | 1.1\*\* | DDDSU | SU-MIMO | 30 | 15 | 7.5 | 7 | 95% | Note 1 |
| Source [InterDigital] | R1-2209658 | 1.6\*\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 8.4 | 8 | 94.5% | Note 1 |
| 45 | 5.1 | 5 | 91.5% |
| Source [InterDigital] | R1-2209658 | 1.6\*\*\*\* | DDDSU | SU-MIMO | 30 | 15 | 9.1 | 9 | 91% | Note 1 |
| Note 1: BS antenna parameters: 32TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,2,2,1,1:8,2)  \* Number of PDCCH symbols per slot = 1  \*\* Number of PDCCH symbols per slot = 2  \*\*\* Number of PDCCH symbols per slot = 0.5  \*\*\*\* Number of PDCCH symbols per slot = 4 | | | | | | | | | | |

TableB.1.1-3: FR1, DL, UMa, VR/AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [ZTE] | R1-2209198 | 1.1\*\* | DDDSU | SU-MIMO | 30 | 10 | 8.8 | 8 | 97% | Note 1 |
| Source [ZTE] | R1-2209198 | 1.7\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.6 | 7 | 96% | Note 1,2,4 |
| Note 1: BS antenna parameters: 64TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1:4,8)  Note 2: No symbol for PDCCH is reserved in the slot where no scheduling DCI is transmitted  Note 3: Results did not consider any other PDCCH that may occupy the CORESET(s) than scheduling DCI, e.g. broadcast PDCCH  Note 4: Results consider 2 symbols are used for PDCCH, if the slot is not the first slot of multiple TB scheduling for one UE but is the first slot of multiple TBs scheduling or the slot of single TB scheduling for another UE  \* Number of PDCCH symbols per slot = 1  \*\* Number of PDCCH symbols per slot = 2  \*\*\* Number of PDCCH symbols per slot = 0.5  \*\*\*\* Number of PDCCH symbols per slot = 4 | | | | | | | | | | |

Based on the evaluation results in Table B.1.1-1 and Table B.1.1-3, the following observations regarding multi-PDSCH scheduling by a single DCI as compared to single PDSCH scheduling can be made:

- For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [vivo] that the capacity is decreased from 9.8 UEs per cell with single-PDSCH scheduling to 8.81 UEs per cell with multi-PDSCH scheduling, where 1 symbol is always reserved for PDCCH transmission in each slot (capacity drop is -10%). Similar trend is observed when number of PDCCH symbols per slot is equal to 0.5 or 2 symbols.

- For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [vivo] that the capacity is increased from 9.8 UEs per cell with single-PDSCH scheduling to 10.37 UEs per cell with multi-PDSCH scheduling, where unoccupied CORESET in a slot can be re-used for PDSCH transmission (1 symbol for PDCCH transmission in each slot) (capacity gain is 6%). For VR/AR single-stream traffic model, 45Mbps, 10ms PDB, the results show similar trend.

- For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [vivo] that the capacity is decreased from 10.25 UEs per cell with single-PDSCH scheduling to 10.1 UEs per cell with multi-PDSCH scheduling, where unoccupied CORESET in a slot can be re-used for PDSCH transmission (0.5 for PDCCH transmission in each slot) (capacity drop is -1.46%).

- For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [ZTE] that the capacity is decreased from 9.1 UEs per cell with single-PDSCH scheduling to 7.9 UEs per cell with multi-PDSCH scheduling, where 2 symbols per slot are used for PDCCH if there is at least one UE that needs to be scheduled with first TB out of multiple TBs (capacity drop is -13%). For FR1, UMa scenario, the results show similar trend.

- For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 60Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [ZTE] that the capacity is increased from 3.4 UEs per cell with single-PDSCH scheduling to 3.7 UEs per cell with multi-PDSCH scheduling, where 2 symbols per slot are used for PDCCH if there is at least one UE that needs to be scheduled with first TB out of multiple TBs (capacity gain is 8%).

Based on the evaluation results in Table B.1.1-1 and Table B.1.1-2, the following observations regarding enhanced multi-PDSCH scheduling by a single DCI can be made:

- For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [vivo] that the capacity is increased from 10.37 UEs per cell with multi-PDSCH scheduling to 10.59 UEs per cell with multi-PDSCH scheduling enhancement of early HARQ-ACK feedback (unoccupied CORESET in a slot can be re-used for PDSCH transmission, 1 symbol for PDCCH transmission in each slot) (capacity gain is 2.12%).

- For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [vivo] that the capacity is increased from 10.37 UEs per cell with multi-PDSCH scheduling to 11.09 UEs per cell with multi-PDSCH scheduling FDRA enhancement (unoccupied CORESET in a slot can be re-used for PDSCH transmission, 1 symbol for PDCCH transmission in each slot) (capacity gain is 7%).

- For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [InterDigital] that the capacity is increased from 5.3 UEs per cell with single-PDSCH scheduling to 7.2 UEs per cell with multi-PDSCH scheduling, where single PDCCH schedules up to 4 PDSCHs/PUSCHs and full flexibility in terms of resource (RB allocation) as well as MCS for each of the 4 PDSCHs/PUSCHs (capacity gain is 36%). For VR/AR single-stream traffic model, 45Mbps, 10ms PDB and for CG single-stream traffic model, 15ms PDB, the results show similar trend.

- For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [InterDigital] that the capacity is increased from 5.5 UEs per cell with single-PDSCH scheduling to 8.4 UEs per cell with multi-PDSCH scheduling, where single PDCCH schedules up to 4 PDSCHs/PUSCHs and full flexibility in terms of resource (RB allocation) as well as MCS for each of the 4 PDSCHs/PUSCHs (capacity gain is 53%). For VR/AR single-stream traffic model, 45Mbps, 10ms PDB and for CG single-stream traffic model, 15ms PDB, the results show similar trend.

### B.1.2 Cooperative MIMO via DL interference probing based on SRS enhancement

This clause captures the capacity performance evaluation results for cooperative MIMO in TDD with downlink interference probing via SRS and precoding via bi-directional training (BiT). In TDD system, channel UL-DL reciprocity is utilized to obtain DL channel state information for improved performance of single-cell (non-cooperative) MU-MIMO. However, inter-cell interference is still the bottleneck that limits further capacity improvement.

The performance of MU-MIMO with zero forcing precoding (scheme 2.1 in Tables B.1.2-1,2) has been compared against Cooperative MIMO with DL interference probing (scheme 2.2 in Tables B.1.2-1,2).

Scheme 2.2: Cooperative MIMO with DL interference probing via SRS and precoding via bi-directional training (BiT), is the scheme where SRS triggering and transmission are enhanced to directly reflect DL interference spatial information (utilizing UL-DL reciprocity). Each gNB performs its own (MU) scheduling and instructs the scheduled UEs to sound on the scheduled PRBs. Then by TDD reciprocity, a gNB seeing strong UL interference from a certain spatial direction on the SRS resources (for example, via estimating the UL spatial covariance matrix of interference signals) implies that in DL transmission the gNB will cause strong interference to UE(s) in that direction. The gNB can then adjust the precoding for DL interference avoidance during the PDSCH transmissions. Each gNB measures the corresponding UL SRS resources and adjusts its DL precoding accordingly to achieve multi-cell DL interference coordination/avoidance in a distributed way, and hence the so-called ‘Bi-directional Training’ (BiT).

The performance results are reported in B.1.2-1 and B.1.2-2 in terms of the ratio of satisfied users.

TableB.1.2-1: FR1, DL, DU, VR/AR and Cloud Gaming at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Futurewei] | R1-2208377 | 2.1 | DDDSU | MU-MIMO | 45 | 10 | 12.2 | 12 | 90% | Note 1 |
| 15 | 17.4 | 17 | 94% |
| Source [Futurewei] | R1-2208377 | 2.2 | DDDSU | MU-MIMO | 45 | 10 | 16.9 | 16 | 91% | Note 1 |
| 15 | 21.7 | 21 | 92% |
| Source [Futurewei] | R1-2208377 | 2.1 | DDDSU | MU-MIMO | 30 | 10 | 21.7 | 21 | 91% | Note 1 |
| 15 | 27.1 | 27 | 91% |
| Source [Futurewei] | R1-2208377 | 2.2 | DDDSU | MU-MIMO | 30 | 10 | 25.8 | 25 | 91% | Note 1 |
| 15 | 30.1 | 30 | 91% |
| Source [Futurewei] | R1-2208377 | 2.1 | DDDUU | MU-MIMO | 45 | 10 | 8 | 8 | 90% | Note 1 |
| 15 | 12.7 | 12 | 96% |
| Source [Futurewei] | R1-2208377 | 2.2 | DDDUU | MU-MIMO | 45 | 10 | 13.1 | 13 | 90% | Note 1 |
| 15 | 16.9 | 16 | 95% |
| Source [Futurewei] | R1-2208377 | 2.1 | DDDUU | MU-MIMO | 30 | 10 | 13.7 | 13 | 92% | Note 1 |
| 15 | 21.5 | 21 | 93% |
| Source [Futurewei] | R1-2208377 | 2.2 | DDDUU | MU-MIMO | 30 | 10 | 19.9 | 19 | 93% | Note 1 |
| 15 | 25.6 | 25 | 93% |
| Note 1: BS antenna parameters: 64TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1:4,8) | | | | | | | | | | |

TableB.1.2-2: FR1, DL, UMa, VR/AR and Cloud Gaming at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Futurewei] | R1-2208377 | 2.1 | DDDSU | MU-MIMO | 45 | 10 | 7 | 7 | 90% | Note 1 |
| 15 | 9.7 | 9 | 93% |
| Source [Futurewei] | R1-2208377 | 2.2 | DDDSU | MU-MIMO | 45 | 10 | 9 | 9 | 90% | Note 1 |
| 15 | 11.6 | 11 | 92% |
| Source [Futurewei] | R1-2208377 | 2.1 | DDDSU | MU-MIMO | 30 | 10 | 11.4 | 11 | 94% | Note 1 |
| 15 | 14.2 | 14 | 91% |
| Source [Futurewei] | R1-2208377 | 2.2 | DDDSU | MU-MIMO | 30 | 10 | 13.2 | 13 | 92% | Note 1 |
| 15 | 16 | 16 | 90% |
| Source [Futurewei] | R1-2208377 | 2.1 | DDDUU | MU-MIMO | 45 | 10 | 5.2 | 5 | 90% | Note 1 |
| 15 | 6.8 | 6 | 94% |
| Source [Futurewei] | R1-2208377 | 2.2 | DDDUU | MU-MIMO | 45 | 10 | 6.6 | 6 | 93% | Note 1 |
| 15 | 9.4 | 9 | 91% |
| Source [Futurewei] | R1-2208377 | 2.1 | DDDUU | MU-MIMO | 30 | 10 | 8.8 | 8 | 90% | Note 1 |
| 15 | 11.4 | 11 | 94% |
| Source [Futurewei] | R1-2208377 | 2.2 | DDDUU | MU-MIMO | 30 | 10 | 10.4 | 10 | 92% | Note 1 |
| 15 | 13.3 | 13 | 93% |
| Note 1: BS antenna parameters: 64TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1:4,8) | | | | | | | | | | |

Based on the evaluation results in Table B.1.2-1 and Table B.1.2-2, the following observations can be made:

* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with MU-MIMO, 64TxRU and DDDSU, it is observed from Source [Futurewei] that the capacity is increased from 21.7 UEs per cell with MU-MIMO and zero forcing precoding to 25.8 UEs per cell with Cooperative MIMO via SRS enhancements (capacity gain is 19%). For 15ms PDB, the capacity gain is 11%. For UMa scenario, the results show similar trend.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 45Mbps, 10ms PDB, 60 FPS, with MU-MIMO, 64TxRU and DDDSU, it is observed from Source [Futurewei] that the capacity is increased from 12.2 UEs per cell with MU-MIMO and zero forcing precoding to 16.9 UEs per cell with Cooperative MIMO via SRS enhancements (capacity gain is 39%). For 15ms PDB, the capacity gain is 24%. For UMa scenario, the results show similar trend.
* For FR1, UMa, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 45Mbps, 10ms PDB, 60 FPS, with MU-MIMO, 64TxRU and DDDSU, it is observed from Source [Futurewei] that the capacity is increased from 7 UEs per cell with MU-MIMO and zero forcing precoding to 9 UEs per cell with Cooperative MIMO via SRS enhancements (capacity gain is 28%). For 15ms PDB, the capacity gain is 19%.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with MU-MIMO, 64TxRU and DDDUU, it is observed from Source [Futurewei] that the capacity is increased from 13.7 UEs per cell with MU-MIMO and zero forcing precoding to 19.9 UEs per cell with Cooperative MIMO via SRS enhancements (capacity gain is 45%). For 15ms PDB, the capacity gain is 19%.
* For FR1, UMa, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with MU-MIMO, 64TxRU and DDDUU, it is observed from Source [Futurewei] that the capacity is increased from 8.8 UEs per cell with MU-MIMO and zero forcing precoding to 10.4 UEs per cell with Cooperative MIMO via SRS enhancements (capacity gain is 18%). For 15ms PDB, the capacity gain is 16%.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 45Mbps, 10ms PDB, 60 FPS, with MU-MIMO, 64TxRU and DDDUU, it is observed from Source [Futurewei] that the capacity is increased from 8 UEs per cell with MU-MIMO and zero forcing precoding to 13.1 UEs per cell with Cooperative MIMO via SRS enhancements (capacity gain is 64%). For 15ms PDB, the capacity gain is 33%.
* For FR1, UMa, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 45Mbps, 10ms PDB, 60 FPS, with MU-MIMO, 64TxRU and DDDUU, it is observed from Source [Futurewei] that the capacity is increased from 5.2 UEs per cell with MU-MIMO and zero forcing precoding to 6.6 UEs per cell with Cooperative MIMO via SRS enhancements (capacity gain is 27%). For 15ms PDB, the capacity gain is 38%.

### B.1.3 Enhanced CQI for CBG-based transmissions

This clause captures the capacity performance evaluation results of enhanced CQI (eCQI) for code block group (CBG)-based transmissions. The use of CBG-based transmissions allows avoiding a re-transmission of the full transport block in case the receiver fails to correctly decode the full TB. A large size of one video frame as per TR 38.838, results in a large TB(s) size to convey a video frame.

The performance of the current legacy link adaptation with TB-based transmission legacy CQI reporting (scheme 3.1 in Table B.1.3-1) has been compared against CBG-based transmission with eCQI (scheme 3.2 in Table B.1.3-1). The legacy CQI corresponds to the highest supported MCS while not exceeding a 10% BLER target for the TBs.

Scheme 3.2: eCQI is the scheme where UE estimates the highest supported MCS (expressed via a CQI index), assuming that downlink transmissions occupy a set of downlink physical resource blocks termed the CSI reference resource with M code block groups, while the error probability of at most N failed code block groups does not exceed P. Parameters M, N, and P may be configured by the network, or fixed to values that are attractive for XR services. The configuration of the UE to use eCQI may be conducted with RRC signaling (note that configuration of current CQI schemes for a UE to use is also via RRC). The reporting of the eCQI can be in the form of an eCQI index (from current CQI tables [TS38.214 - Tables in 5.2.2.1] or enhanced CQI tables) that will guide the gNB to choose the supported modulation scheme, effective code rate, and overall efficiency that for its PDSCH transmissions. For the CBG-based transmission with eCQI, results are shown for parameter settings M=8 assuming either N=2 or N=4 and P= 50%.

The performance results are reported in Table B.1.3-1 in terms of the ratio of satisfied users.

TableB.1.3-1: FR1, DL, InH, VR/AR and Cloud Gaming at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Nokia] | R1-2209536 | 3.2\* | DDDSU | SU-MIMO | 30 | 10 | 6.35 | 6 | 99% | Note 1,2 |
| 15 | 7.31 | 7 | 99% |
| Source [Nokia] | R1-2209536 | 3.2\* | DDDSU | SU-MIMO | 45 | 10 | 4.15 | 4 | 95% | Note 1,2 |
| 15 | 5.12 | 5 | 95% |
| Source [Nokia] | R1-2209536 | 3.2\*\* | DDDSU | SU-MIMO | 30 | 10 | 6.22 | 6 | 97% | Note 1,2 |
| 15 | 7.31 | 7 | 99% |
| Source [Nokia] | R1-2209536 | 3.2\*\* | DDDSU | SU-MIMO | 45 | 10 | 4.10 | 4 | 93% | Note 1,2 |
| 15 | 4.83 | 4 | 100% |
| Source [Nokia] | R1-2209536 | 3.1 | DDDSU | SU-MIMO | 30 | 10 | 5.45 | 5 | 95% | Note 1 |
| 15 | 6.31 | 6 | 98% |
| Source [Nokia] | R1-2209536 | 3.1 | DDDSU | SU-MIMO | 45 | 10 | 3.35 | 3 | 99% | Note 1 |
| 15 | 4.18 | 4 | 94% |
| Note 1: BS antenna parameters: 32TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1,4,4)  Note 2: non-iid CBG errors in a TB are assumed  \* At most N failed code block groups, N= 4  \*\* At most N failed code block groups, N= 2 | | | | | | | | | | |

Based on the evaluation results in Table B.1.3-1, the following observations can be made:

* For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [Nokia] that the capacity is increased from 5.45 UEs per cell with legacy CQI to 6.35 UEs per cell with eCQI, where the error probability of at most N=4 failed code block groups out of 8 CBGs does not exceed P = 50% (capacity gain is 17%). For N=2, the results show similar trend.
* For FR1, InH, DL, with 100MHz bandwidth for Cloud Gaming single-stream traffic model, 30Mbps, 15ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [Nokia] that the capacity is increased from 6.31 UEs per cell with legacy CQI to 7.31 users per cell with eCQI, where the error probability of at most N=4 failed code block groups out of 8 CBGs does not exceed P = 50% (capacity gain is 16%). For N=2, the results show similar trend.
* For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 45Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [Nokia] that the capacity is increased from 3.35 UEs per cell with legacy CQI to 4.15 UEs per cell with eCQI, where the error probability of at most N=4 failed code block groups out of 8 CBGs does not exceed P = 50% (capacity gain is 24%). For N=2, the results show similar trend.
* For FR1, InH, DL, with 100MHz bandwidth for Cloud Gaming single-stream traffic model, 45Mbps, 15ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [Nokia] that the capacity is increased from 4.18 UEs per cell with legacy CQ to 5.12 UEs per cell with eCQI, where the error probability of at most N=4 failed code block groups out of 8 CBGs does not exceed P = 50% (capacity gain is 22%). For N=2, the results show similar trend.

### B.1.4 Enhanced CQI based on DMRS

This clause captures the capacity performance evaluation results of DMRS-based enhanced CQI reporting where the initial transmission is based on legacy CQI reporting, while the retransmission is DMRS based CQI reporting.

The performance of the current TB-based transmission with legacy CQI reporting (scheme 4.1 in Tables B.1.4) has been compared against CBG-based transmission (scheme 4.2 in Tables B.1.4) as well as TB-based re-transmission and DMRS-based CQI (scheme 4.3 in Tables B.1.4):

- Scheme 4.1: TB-based re-transmission (baseline scheme). In this scheme, TB-based retransmission is applied with legacy CSI reporting. Different outer-loop link adaptation configurations are used.

- Scheme 4.2: CBG-based re-transmission. In this scheme, CBG-based retransmission is applied with legacy CSI reporting. Different outer-loop link adaptation configurations are used. The number of CBGs per TB is equal to 8.

- Scheme 4.3: TB-based re-transmission with DMRS-based CQI. In this scheme, TB-based transmission/retransmission is applied where for the initial TB transmission legacy CQI reporting is used, while for the retransmission DMRS-based CQI reporting is used.

The performance results are reported in Table B.1.4-1 and Table B.1.4-2 in terms of the ratio of satisfied users.

TableB.1.4-1: FR1, DL, InH, VR/AR and Cloud Gaming at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Ericsson] | R1-2208402 | 4.1\* | DDDSU | SU-MIMO | 30 | 10 | 8.03 | 8 | 90% | Note 1,2 |
| 15 | 10.22 | 10 | 92% |
| Source [Ericsson] | R1-2208402 | 4.2\* | DDDSU | SU-MIMO | 30 | 10 | 8.08 | 8 | 91% | Note 1,2,3 |
| 15 | 10.34 | 10 | 93% |
| Source [Ericsson] | R1-2208402 | 4.3\* | DDDSU | SU-MIMO | 30 | 10 | 8.52 | 8 | 93% | Note 1,2 |
| 15 | 11.37 | 11 | 94% |
| Source [Ericsson] | R1-2208402 | 4.1\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.21 | 7 | 92% | Note 1,2 |
| 15 | 8.29 | 8 | 93% |
| Source [Ericsson] | R1-2208402 | 4.2\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.25 | 7 | 93% | Note 1,2,3 |
| 15 | 8.33 | 8 | 93% |
| Source [Ericsson] | R1-2208402 | 4.3\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.49 | 7 | 94% | Note 1,2 |
| 15 | 8.66 | 8 | 94% |
| Source [Ericsson] | R1-2208402 | 4.1\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.89 | 7 | 96% | Note 1,2 |
| 15 | 9.48 | 9 | 94% |
| Source [Ericsson] | R1-2208402 | 4.2\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 8.01 | 8 | 90% | Note 1,2,3 |
| 15 | 9.59 | 9 | 95% |
| Source [Ericsson] | R1-2208402 | 4.3\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 8.53 | 8 | 94% | Note 1,2 |
| 15 | 10.31 | 10 | 93% |
| Note 1: BS antenna parameters: 32TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1,4,4)  Note 2: Interleaved VRB-to-PRB mapping is applied  Note 3: iid CBG errors in a TB are assumed  \* without outer loop, BLER = 10%  \*\* with outer loop, BLER = 10%  \*\*\* with outer loop, BLER = 22% | | | | | | | | | | |

TableB.1.4-2: FR1, DL, UMa, VR/AR and Cloud Gaming at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Ericsson] | R1-2208402 | 4.1\* | DDDSU | SU-MIMO | 30 | 10 | 5.59 | 5 | 94% | Note 1,2 |
| 15 | 9.0 | 9 | 90% |
| Source [Ericsson] | R1-2208402 | 4.2\* | DDDSU | SU-MIMO | 30 | 10 | 5.80 | 5 | 95% | Note 1,2,3 |
| 15 | 9.15 | 9 | 91% |
| Source [Ericsson] | R1-2208402 | 4.3\* | DDDSU | SU-MIMO | 30 | 10 | 6.79 | 6 | 94% | Note 1,2 |
| 15 | 10.28 | 10 | 93% |
| Source [Ericsson] | R1-2208402 | 4.1\*\* | DDDSU | SU-MIMO | 30 | 10 | 5.88 | 5 | 96% | Note 1,2 |
| 15 | 7.26 | 7 | 92% |
| Source [Ericsson] | R1-2208402 | 4.2\*\* | DDDSU | SU-MIMO | 30 | 10 | 5.9 | 5 | 97% | Note 1,2,3 |
| 15 | 7.29 | 7 | 93% |
| Source [Ericsson] | R1-2208402 | 4.3\*\* | DDDSU | SU-MIMO | 30 | 10 | 6.13 | 6 | 91% | Note 1,2 |
| 15 | 7.40 | 7 | 93% |
| Source [Ericsson] | R1-2208402 | 4.1\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 6.40 | 6 | 93% | Note 1,2 |
| 15 | 8.24 | 8 | 92% |
| Source [Ericsson] | R1-2208402 | 4.2\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 6.46 | 6 | 93% | Note 1,2,3 |
| 15 | 8.32 | 8 | 93% |
| Source [Ericsson] | R1-2208402 | 4.3\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 7 | 7 | 90.0% | Note 1,2 |
| 15 | 8.84 | 8 | 96% |
| Note 1: BS antenna parameters: 64TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1:4,8)  Note 2: Interleaved VRB-to-PRB mapping is applied  Note 3: iid CBG errors in a TB are assumed  \* without outer loop, BLER = 10%  \*\* with outer loop, BLER = 10%  \*\*\* with outer loop, BLER = 22% | | | | | | | | | | |

Based on the evaluation results in Table B.1.4-1 and Table B.1.4-2, the following observations can be made:

* For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [Ericsson] that the capacity is increased by 6%, 4% and 8% when DMRS-based CQI is used as compared to legacy CQI for outer-loop link adaptation configurations of ‘disabled’, BLER=10% and BLER=22%, respectively.
* For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 15ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [Ericsson] that the capacity is increased by 11%, 4% and 9% when DMRS-based CQI is used as compared to legacy CQI for outer-loop link adaptation configurations of ‘disabled’, BLER=10% and BLER=22%, respectively.
* For FR1, UMa, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is increased by 21%, 4% and 9% when DMRS-based CQI is used as compared to legacy CQI for outer-loop link adaptation configurations of ‘disabled’, BLER=10% and BLER=22%, respectively.
* For FR1, UMa, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 15ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is increased by 14%, 2% and 7% when DMRS-based CQI is used as compared to legacy CQI for outer-loop link adaptation configurations of ‘disabled’, BLER=10% and BLER=22%, respectively.

### B.1.5 Soft HARQ-ACK enhancements

This clause captures the capacity performance evaluation results of soft HARQ-ACK enhancements. HARQ allows to recover transport blocks that are not successfully decoded by means of retransmissions. It can be leveraged to use MCS close to what the radio channel can support while maintaining high reliability. The gNB chooses the MCS for a transmission based on its knowledge of the channel conditions, but it cannot always precisely predict how they evolve.

The performance of Baseline HARQ-ACK (scheme 5.1 in Tables B.1.5-1,2,3) has been compared against different schemes with soft HARQ-ACK. Particularly, the following schemes, with soft HARQ-ACK, have been evaluated:

- Scheme 5.2: Soft HARQ-ACK indicating delta MCS: UE provides enhanced HARQ-ACK feedback beyond the single bit ACK/NACK status in the form of a Delta MCS based on PDSCH decoding. The soft HARQ-ACK feedback uses SINR measurements done on each TB and link curves obtained from link level simulations. Then the information the UE feeds back to the gNB is an estimation of how far the experienced SINR is from the SINR that would allow a reliable decoding of the TB.

- Scheme 5.3: Soft HARQ-ACK indicating number of redundant transmissions: 2-bit soft-HARQ feedback is reported by the UE and used by the gNB scheduler. The 2-bit soft-HARQ feedback represents 4 states: ACK, and NACK with n=1, 2, or 3, where “n” indicates how many redundant transmissions are requested by the UE.

The performance results are reported in Table B.1.5-1, Table B.1.5-2, Table B.1.5-3 in terms of the ratio of satisfied users.

TableB.1.5-1: FR1, DL, InH, VR/AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Qualcomm] | R1-2210003 | 5.2\* | DDDSU | MU-MIMO | 60 | 10 | 2.93 | 2 | 97.7% | Note 1 |
| 45 | 5.4 | 5 | 92.3% |
| 30 | 8.96 | 8 | 95% |
| Source [Qualcomm] | R1-2210003 | 5.1\* | DDDSU | MU-MIMO | 60 | 10 | 0 | 0 | N.A. | Note 1 |
| 45 | 4.5 | 4 | 93.1% |
| 30 | 8.5 | 8 | 92.9% |
| Source [Qualcomm] | R1-2210003 | 5.2\*\* | DDDSU | MU-MIMO | 60 | 10 | 2.1 | 2 | 91.25% | Note 1 |
| 45 | 4.1 | 4 | 91%% |
| 30 | 7.8 | 7 | 93.5% |
| Source [Qualcomm] | R1-2210003 | 5.1\*\* | DDDSU | MU-MIMO | 60 | 10 | 0 | 0 | N.A. | Note 1 |
| 45 | 0 | 0 | N.A. |
| 30 | 0 | 0 | N.A. |
| Source [Qualcomm] | R1-2210003 | 5.2\*\*\* | DDDSU | MU-MIMO | 60 | 10 | 1.17 | 1 | 91.25% | Note 1 |
| Source [Qualcomm] | R1-2210003 | 5.1\*\*\* | DDDSU | MU-MIMO | 60 | 10 | 0 | 0 | N.A. | Note 1 |
| Source [ZTE] | R1-2203607 | 5.2\*\*\* | DDDSU | MU-MIMO | 60 | 10 | 3.3 | 3 | 93% | Note 1 |
| Source [ZTE] | R1-2203607 | 5.1\*\*\* | DDDSU | MU-MIMO | 60 | 10 | 0 | 0 | N.A. | Note 1 |
| Note 1: BS antenna parameters: 32TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1:4,4)  \* gNB processing delay k3 (from HARQ feedback to retransmission) = 4 slots  \*\* gNB processing delay k3 (from HARQ feedback to retransmission) = 6 slots  \*\*\* gNB processing delay k3 (from HARQ feedback to retransmission) = 8 slots | | | | | | | | | | |

TableB.1.5-2: FR1, DL, DU, VR/AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Qualcomm] | R1-2210003 | 5.2\* | DDDSU | MU-MIMO | 60 | 10 | 4.6 | 4 | 94.5% | Note 1 |
| 45 | 7.5 | 7 | 93% |
| 30 | 11.9 | 11 | 94.1% |
| Source [Qualcomm] | R1-2210003 | 5.1\* | DDDSU | MU-MIMO | 60 | 10 | 0 | 0 | N.A. | Note 1 |
| 45 | 6.6 | 6 | 92.2% |
| 30 | 11.3 | 11 | 91.3% |
| Source [Qualcomm] | R1-2210003 | 5.2\*\* | DDDSU | MU-MIMO | 60 | 10 | 2.8 | 2 | 92.9% | Note 1 |
| 45 | 5.5 | 5 | 92.4% |
| 30 | 10.4 | 10 | 92% |
| Source [Qualcomm] | R1-2210003 | 5.1\*\* | DDDSU | MU-MIMO | 60 | 10 | 0 | 0 | N.A. | Note 1 |
| 45 | 0 | 0 | N.A. |
| 30 | 0 | 0 | N.A. |
| Source [Qualcomm] | R1-2210003 | 5.2\*\*\* | DDDSU | MU-MIMO | 60 | 10 | 2 | 2 | 90.1% | Note 1 |
| Source [Qualcomm] | R1-2210003 | 5.1\*\*\* | DDDSU | MU-MIMO | 60 | 10 | 0 | 0 | N.A. | Note 1 |
| Source [Futurewei] | R1-2208377 | 5.1\*\*\*\* | DDDUU | MU-MIMO | 45 | 10 | 8.4 | 8 | 91% | Note 1 |
| Source [Futurewei] | R1-2208377 | 5.3\*\*\*\* | DDDUU | MU-MIMO | 45 | 10 | 7.9 | 7 | 90% | Note 1 |
| Note 1: BS antenna parameters: 64TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1:4,8)  \* gNB processing delay k3 (from HARQ feedback to retransmission) = 4 slots  \*\* gNB processing delay k3 (from HARQ feedback to retransmission) = 6 slots  \*\*\* gNB processing delay k3 (from HARQ feedback to retransmission) = 8 slots  \*\*\*\* UE processing delay and gNB processing delay = 10 slots | | | | | | | | | | |

TableB.1.5-3: FR1, DL, UMa, VR/AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Futurewei] | R1-2208377 | 5.1\*\*\*\* | DDDUU | MU-MIMO | 45 | 10 | 6.2 | 6 | 90.3% | Note 1 |
| Source [Futurewei] | R1-2208377 | 5.3\*\*\*\* | DDDUU | MU-MIMO | 45 | 10 | 6.1 | 6 | 91.3% | Note 1 |
| Note 1: BS antenna parameters: 64TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1:4,8)  \*\*\*\* UE processing delay and gNB processing delay = 10 slots | | | | | | | | | | |

Based on the evaluation results in Table B.1.5-1, Table B.1.5-2, Table B.1.5-3 the following observations can be made.

* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Qualcomm] that the capacity is increased from 11.3 UEs per cell with baseline HARQ-ACK to 11.9 UEs per cell with soft HARQ-ACK indicating delta MCS based on PDSCH decoding and k3=4 slots (capacity gain is 5%). For InH scenario, the results show similar trend.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 45Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Qualcomm] that the capacity is increased from 6.6 UEs per cell with baseline HARQ-ACK to 7.5 UEs per cell with soft HARQ-ACK indicating delta MCS based on PDSCH decoding and k3=4 slots (capacity gain is 14%). For InH scenario, the results show similar trend.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 60Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Qualcomm] that the capacity is increased from 0 UEs per cell with baseline HARQ-ACK to 4.6 UEs per cell with soft HARQ-ACK indicating delta MCS based on PDSCH decoding and k3=4 slots. For InH scenario, the results show similar trend.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Qualcomm] that the capacity is increased from 0 UEs per cell with baseline HARQ-ACK to 10.4 UEs per cell with soft HARQ-ACK indicating delta MCS based on PDSCH decoding and k3=6 slots. For InH scenario, the results show similar trend.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 45Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Qualcomm] that the capacity is increased from 0 UEs per cell with baseline HARQ-ACK to 5.5 UEs per cell with soft HARQ-ACK indicating delta MCS based on PDSCH decoding and k3=6 slots. For InH scenario, the results show similar trend.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 60Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Qualcomm] that the capacity is increased from 0 UEs per cell with baseline HARQ-ACK to 2.8 UEs per cell with soft HARQ-ACK indicating delta MCS based on PDSCH decoding and k3=6 slots. For InH scenario, the results show similar trend.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 60Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Qualcomm] that the capacity is increased from 0 UEs per cell with baseline HARQ-ACK to 2 UEs per cell with soft HARQ-ACK indicating delta MCS based on PDSCH decoding and k3=8 slots. For InH scenario, the results show similar trend.
* For FR1, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 60Mbps, 10ms PDB, 60 FPS, with MU-MIMO, it is observed from Source [ZTE] that the capacity is increased from 0 UEs per cell with baseline HARQ-ACK to 3.3 UEs per cell with soft HARQ-ACK indicating delta MCS based on PDSCH decoding and k3=8 slots.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 45Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Futurewei] that the capacity is decreased from 8.4 UEs per cell with baseline HARQ-ACK to 7.9 UEs per cell with soft HARQ-ACK indicating how many redundant transmissions are requested by the UE (capacity drop is -6%).
* For FR1, UMa, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 45Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Futurewei] that the capacity is decreased from 6.2 UEs per cell with baseline HARQ-ACK to 6.1 UEs per cell with soft HARQ-ACK indicating how many redundant transmissions are requested by the UE (capacity drop is -2%).

### B.1.6 Configured grant scheduling

This clause captures the capacity performance evaluation results for configured grant scheduling. A UE can transmit UL data using CG resources after configuration (of a CG Config Type 1) or activation (of a CG Config Type 2), without the need of receiving UL grant from the gNB.

The performance of dynamic grant (DG) scheduling has been compared against configured grant (CG) scheduling. Particularly, the following schemes have been evaluated:

- Scheme 6.1.1: DG scheduling with SR followed by UL grant with BSR and data. It is assumed that an SR is triggered upon arrival of a new XR packet in the UE buffer. An UL resource is then granted to the UE to transmit BSR and a number of UL data. A periodicity of SR and a size of initial UL grant may vary and are indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.1.2: DG scheduling with SR followed by UL grant with BSR only. A periodicity of SR may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.2: Pre-scheduling dynamic grant: The scheduling is based on dynamic grants where it is assumed that the network is provided with XR traffic periodicity. An initial grant to the UE when its traffic is expected is transmitted (implementation-based learning) without using SR. A size of initial UL grant may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.3: Dynamic scheduling with genie BSR (DG with genie BSR): The scheduling is based on dynamic grants where it is assumed BSR is available with zero delay at the scheduler when a new XR packet arrives in the UE buffer, to be used for indicating UL grants to the UE. Hence, in this case, no SR or BSR delay is assumed.

- Scheme 6.4: Single CG configuration, where single PUSCH occasion per CG period is pre-configured with certain periodicity without relying on SR. In this scheme no scheduling delay is assumed. CG periodicity may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.5.1: Multiple CG configurations, where multiple PUSCH occasions per CG period are pre-configured with certain periodicity without relying on SR. In this scheme no scheduling delay is assumed. CG periodicity may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.5.2: Multiple CG configurations, where multiple PUSCH occasions per CG period are pre-configured with certain periodicity without relying on SR. In this scheme scheduling delay for scheduling more packets with DG is assumed as 2.5 ms. CG periodicity may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.6.1: Hybrid CG+DG scheduling – the scheduling is based on a combined use of configured and dynamic grants. SR resources are not used. Instead, CG resources are configured with a certain size in UL slot in order to transmit BSR and data when a new XR packet arrives. Whenever a new XR packet arrives in the UE buffer, the UE uses the nearest possible CG PUSCH occasion for BSR transmission and possibly some amount of data. The network can thus use the BSR to provide dynamic grants for the following data transmission. CG periodicity and size of CG grant may vary and are indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.6.2: Hybrid CG+DG scheduling – the scheduling is based on a combined use of configured and dynamic grants. SR resources are not used. Instead, CG resources are configured with a certain size in order to transmit BSR only when a new XR packet arrives. It is assumed that one PUSCH occasion per CG period is pre-configured with certain periodicity to align PUSCH occasions with XR packets. Whenever a new XR packet arrives in the UE buffer, the UE uses the nearest possible CG PUSCH occasion for BSR transmission. The network can thus use the BSR to provide dynamic grants for the corresponding data scheduling. CG periodicity and size of CG grant may vary and are indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.6.3: Hybrid CG+DG scheduling – the scheduling is based on a combined use of configured and dynamic grants. SR resources are not used. Instead, CG resources are configured with a certain size in UL slot in order to transmit BSR and data when a new XR packet arrives. Whenever a new XR packet arrives in the UE’s buffer, the UE uses the nearest possible CG PUSCH occasion for BSR transmission and possibly some amount of data. The network can thus use the BSR to provide dynamic grants for the following data transmission. The PDCCH monitoring window for the dynamic grant is pre-configured and associated with the CG PUSCH occasion in each CG period. The enhanced BSR that the BSR report will be triggered at the first used CG PUSCH occasion in each CG period to indicate to the gNB the remaining packet size is assumed. If the BSR is reported by the UE with the status “not empty”, the UE would monitor PDCCH in the subsequent slots for dynamic grant after XR packet transmission with the CG resource, in which the dynamic grant is used to schedule the remaining data of XR packet. If the BSR is reported by the UE with the status “empty”, the UE would not monitor PDCCH in the subsequent slots of the PDCCH monitoring window for XR packet transmission. Furthermore, if the XR packets are completely transmitted during the monitoring window, the UE can be indicated to go to sleep. If the XR packets arrive during the monitoring window, the UE can be indicated to skip the PDCCH monitoring until the packets arrive. CG periodicity and size of CG grant may vary and are indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.7: Enhanced CG with flexible resource allocation, where at least one PUSCH occasion per CG period is pre-configured with certain periodicity without relying on SR. In this scheme, it is assumed the UE can indicate to gNB unused CG PUSCH resources via CG-UCI. CG periodicity may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.8: Enhanced CG with dynamic adaptation of CG parameters and indication of unused/used CG PUSCH occasion(s). In this scheme, the UE adjusts CG parameters dynamically: MCS, number of PRBs, number of layers within the CG resource. The UE indicates these scheduling parameters to the gNB via UCI transmitted separately in the same CG resource, and whether the subsequent CG PUSCH occasions will be used/unused until next XR packet arrival. It is assumed that at least one PUSCH occasion per CG period is pre-configured with certain periodicity without relying on SR. CG periodicity may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.9: Enhanced CG with indication of unused/used CG PUSCH occasion(s), where the UE only indicates if the subsequent CG PUSCH occasions will be used/unused until next XR packet arrival. It is assumed that at least one PUSCH occasion per CG period is pre-configured with certain periodicity without relying on SR. CG periodicity may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.10: Enhanced CG with MAC CE based dynamic resource adjustment indication. In this scheme, CG resource is used to carry MAC CE based dynamic resource adjustment indication and video data, and resource adjustment indication delay based on MAC CE is 2.5ms. It is assumed that at least one PUSCH occasion per CG period is pre-configured with certain periodicity to align PUSCH occasions with XR packets without relying on SR. CG periodicity may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.11: Enhanced CG with UCI based dynamic resource adjustment indication. In this scheme, CG resource is used to carry UCI based dynamic resource adjustment indication and video data, and resource adjustment indication delay based on UCI is 0.5ms. It is assumed that at least one PUSCH occasion per CG period is pre-configured with certain periodicity to align PUSCH occasions with XR packets without relying on SR. CG periodicity may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

- Scheme 6.12: Enhanced CG with UCI based dynamic resource adjustment indication. In this scheme, CG resource is used to carry UCI based dynamic resource adjustment indication only, and the dynamic resource adjustment indication is used to inform the gNB data volume of an XR packet or required resources to transmit the XR packet. Resource adjustment indication delay based on UCI is 0.5ms. It is assumed that one PUSCH occasion per CG period is pre-configured with certain periodicity to align PUSCH occasions with XR packets without relying on SR. CG periodicity may vary and is indicated separately in Table B.1.6-1, Table B.1.6-2, Table B.1.6-3.

TableB.1.6-1: FR1, UL, InH, AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [CATT] | R1-2211175 | 6.1.1 | DDDUU | SU-MIMO | 10 | 30 | 5.4 | 5 | 90% | Note 1,2,14 |
| Source [CATT] | R1-2211175 | 6.4\* | DDDUU | SU-MIMO | 10 | 30 | <1 | 0 | N.A. | Note 1 |
| Source [CATT] | R1-2211175 | 6.6.3\* | DDDUU | SU-MIMO | 10 | 30 | 7.3 | 7 | 91% | Note 1,9,16 |
| Source [CATT] | R1-2211175 | 6.2\* | DDDUU | SU-MIMO | 10 | 30 | 7.2 | 7 | 90% | Note 1,12,15 |
| Source [InterDigital] | R1-2211843 | 6.1.1 | DDDSU | SU-MIMO | 10 | 30 | 7.1 | 7 | 91% | Note 1,2,11,17 |
| 10 | 2 | 2 | 100% |
| Source [InterDigital] | R1-2211843 | 6.4\*\* | DDDSU | SU-MIMO | 10 | 30 | 6 | 6 | 100% | Note 1 |
| 10 | 4.7 | 4 | 98% |
| Source [InterDigital] | R1-2211843 | 6.7\*\* | DDDSU | SU-MIMO | 10 | 30 | 7.5 | 7 | 100% | Note 1 |
| 10 | 5.2 | 5 | 99% |
| Source [vivo] | R1-2212595 | 6.5.2\*\*\* | DDDSU | SU-MIMO | 10 | 30 | 11.3 | 11 | 92.42% | Note 1,5,13 |
| 10 | 6.22 | 6 | 93.26% |
| Source [vivo] | R1-2212595 | 6.10\*\*\* | DDDSU | SU-MIMO | 10 | 30 | 11.85 | 11 | 93.46% | Note 1,5 |
| 10 | 6.42 | 6 | 94.44% |
| Source [vivo] | R1-2212595 | 6.11\*\*\* | DDDSU | SU-MIMO | 10 | 30 | 12.87 | 12 | 95.18% | Note 1,5 |
| 10 | 7.81 | 7 | 96.23% |
| Source [vivo] | R1-2212595 | 6.6.2\*\*\* | DDDSU | SU-MIMO | 10 | 30 | 13.96 | 13 | 94.08% | Note 1,6,13 |
| 10 | 6.12 | 6 | 92.13% |
| Source [vivo] | R1-2212595 | 6.12\*\*\* | DDDSU | SU-MIMO | 10 | 10 | 8.79 | 8 | 93.52% | Note 1,6 |
| Source [vivo] | R1-2212595 | 6.5.2\*\*\* | DDDSU | SU-MIMO | 10 | 10 | 7.53 | 7 | 94.41% | Note 1,7,13 |
| Source [vivo] | R1-2212595 | 6.11\*\*\* | DDDSU | SU-MIMO | 10 | 10 | 8.83 | 8 | 93.92% | Note 1,7 |
| Source [vivo] | R1-2212595 | 6.1.1\*\*\* | DDDSU | SU-MIMO | 10 | 30 | 13.94 | 13 | 93.96% | Note 1,3,3.1,10,13 |
| 10 | 2.33 | 2 | 95.69% |
| Source [vivo] | R1-2212595 | 6.1.1\*\*\* | DDDSU | SU-MIMO | 10 | 30 | 13.82 | 13 | 93.5% | Note 1,4,4.1,10,13 |
| 10 | 0 | 0 | N.A. |
| Source [vivo] | R1-2212595 | 6.5.2\*\*\* | DDDUU | SU-MIMO | 10 | 30 | 13.41 | 13 | 91.67% | Note 1,5,13 |
| 10 | 10.13 | 10 | 94.18% |
| Source [vivo] | R1-2212595 | 6.10\*\*\* | DDDUU | SU-MIMO | 10 | 30 | 13.85 | 13 | 92.72% | Note 1,5 |
| 10 | 10.76 | 10 | 94.61% |
| Source [vivo] | R1-2212595 | 6.11\*\*\* | DDDUU | SU-MIMO | 10 | 30 | 14.94 | 14 | 92.45% | Note 1,5 |
| 10 | 14.54 | 14 | 93.07% |
| Source [vivo] | R1-2212595 | 6.6.2\*\*\* | DDDUU | SU-MIMO | 10 | 30 | 16.73 | 16 | 92.26% | Note 1,6,13 |
| 10 | 6.57 | 6 | 95.15% |
| Source [vivo] | R1-2212595 | 6.1.1\*\*\* | DDDUU | SU-MIMO | 10 | 30 | 15.56 | 15 | 93.42% | Note 1,3,3.1,10,13 |
| 10 | 3.51 | 3 | 93.24% |
| Source [vivo] | R1-2212595 | 6.1.1\*\*\* | DDDUU | SU-MIMO | 10 | 30 | 15.2 | 15 | 92.8% | Note 1,4,4.1,10,13 |
| 10 | 0 | 0 | N.A. |
| Source [vivo] | R1-2212595 | 6.12\*\*\* | DDDUU | SU-MIMO | 10 | 10 | 10.32 | 10 | 94.17% | Note 1,6 |
| Source [vivo] | R1-2212595 | 6.5.2\*\*\* | DDDUU | SU-MIMO | 10 | 10 | 13.63 | 13 | 92.46% | Note 1,7,13 |
| Source [vivo] | R1-2212595 | 6.11\*\*\* | DDDUU | SU-MIMO | 10 | 10 | 15.15 | 15 | 92.21% | Note 1,7 |
| Note 1: BS antenna parameters: 32TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1:4,4)  Note 2: SR periodicity = 5 ms  Note 3: SR delay = 3 ms  Note 3.1: SR delay contains at least: delay for aligning to the nearest SR transmission occasion when an XR packet arrives, gNB processing delay for the reported SR.  Note 4: SR delay = 5 ms  Note 4.1: SR delay contains at least: delay for aligning to the nearest SR transmission occasion when an XR packet arrives, gNB processing delay for the reported SR.  Note 5: Size of configured grant = 166.7 kbit, and the number of PUSCH occasions depends on some factors such as channel quality of the UE, and available resource, etc.  Note 6: Size of configured grant = 80 bit  Note 7: Size of configured grant = 83.4 kbit, and the number of PUSCH occasions depends on some factors such as channel quality of the UE, and available resource, etc.  Note 8: Size of configured grant = 100 kbit  Note 9: Size of configured grant = 12096 bytes (128 PRBs with MCS 24)  Note 10: Size of initial UL grant = 83.4 kbit  Note 11: Size of initial UL grant = 400 kbits  Note 12: Size of initial UL grant = 128 PRBs with dynamic MCS selection  Note 13: BSR delay = 2.5 ms  Note 14: Scheduling delay is 5 ms-15 ms  Note 15: Scheduling delay is 0 ms-15 ms  Note 16: Scheduling delay is 2 ms-15 ms  Note 17: Scheduling delay = 5ms  \* CG periodicity = 16 ms  \*\* CG periodicity = 10 ms  \*\*\* CG periodicity pattern = (17,17,16) ms to align each CG occasion with a corresponding XR packet | | | | | | | | | | |

TableB.1.6-2: FR1, UL, DU, AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Ericsson] | R1-2210923 | 6.1.1 | DDDSU | SU-MIMO | 10 | 30 | 6.42 | 6 | 92% | Note 1,2,13,22 |
| 15 | 0.68 | 0 | N.A. |
| Source [Ericsson] | R1-2210923 | 6.1.1 | DDDSU | SU-MIMO | 10 | 30 | 6.8 | 6 | 95% | Note 1,2,14,18,22 |
| 15 | 2.06 | 2 | 90% |
| Source [Ericsson] | R1-2210923 | 6.2 | DDDSU | SU-MIMO | 10 | 30 | 6.86 | 6 | 95% | Note 1,2,14,22 |
| 15 | 4.54 | 4 | 93% |
| Source [Ericsson] | R1-2210923 | 6.4\* | DDDSU | SU-MIMO | 10 | 30 | 6.35 | 6 | 93% | Note 1,2,10,19 |
| 6.4\*\* | 15 | 2.75 | 2 | 92% |
| Source [Ericsson] | R1-2210923 | 6.6.1\* | DDDSU | SU-MIMO | 10 | 30 | 6.97 | 6 | 95% | Note 1,2,10,18,22 |
| 6.6.1\*\* | 15 | 4.97 | 4 | 94% |
| Source [Ericsson] | R1-2210923 | 6.3 | DDDSU | SU-MIMO | 10 | 30 | 7.1 | 7 | 91% | Note 1,2 |
| 15 | 5.02 | 5 | 90% |
| Source [Huawei] | R1-2212650 | 6.1.1 | DDDSU | MU-MIMO | 10 | 10 | 0 | 0 | N.A. | Note 1,3,15,18,24 |
| Source [Huawei] | R1-2212650 | 6.1.1 | DDDSU | MU-MIMO | 10 | 10 | 0 | 0 | N.A. | Note 1,3,16,18,24 |
| Source [Huawei] | R1-2212650 | 6.2 | DDDSU | MU-MIMO | 10 | 10 | 1.7 | 1 | 94.29% | Note 1,15,16,19,24 |
| Source [Huawei] | R1-2212650 | 6.4\*\*\* | DDDSU | MU-MIMO | 10 | 10 | 1 | 1 | 90.95% | Note 1,12 |
| Source [Huawei] | R1-2212650 | 6.1.1 | DDDSU | MU-MIMO | 10 | 15 | 0 | 0 | N.A. | Note 1,3,15,18,24 |
| Source [Huawei] | R1-2212650 | 6.1.1 | DDDSU | MU-MIMO | 10 | 15 | 0 | 0 | N.A. | Note 1,3,16,18,20 |
| Source [Huawei] | R1-2212650 | 6.2 | DDDSU | MU-MIMO | 10 | 15 | >3 | 3 | 96% | Note 1,16,19,24 |
| Source [Huawei] | R1-2212650 | 6.6.1\*\*\* | DDDSU | MU-MIMO | 10 | 15 | 0 | 0 | N.A. | Note 1,12,22 |
| Source [Huawei] | R1-2212650 | 6.5.2\*\*\* | DDDSU | MU-MIMO | 10 | 15 | 1.4 | 1 | 97.14% | Note 1,9,12,22 |
| Source [Huawei] | R1-2212650 | 6.9\*\*\* | DDDSU | MU-MIMO | 10 | 15 | 1.7 | 1 | 98.57% | Note 1,12,21,22 |
| Source [Sony] | R1-2211625 | 6.1.1 | DDDSU | SU-MIMO | 10 | 10 | 0 | 0 | N.A. | Note 1,3,14,23 |
| 15 | 3 | 3 | 90% |
| 30 | 6.35 | 6 | 91% |
| Source [Sony] | R1-2211625 | 6.4\*\* | DDDSU | SU-MIMO | 10 | 10 | 0 | 0 | N.A. | Note 1 |
| Source [Sony] | R1-2211625 | 6.8\*\* | DDDSU | SU-MIMO | 10 | 10 | 4 | 4 | 90% | Note 1,10,21 |
| 6.8\*\* | 15 | 4.4 | 4 | 92.5% | Note 1,10,21 |
| 6.8\* | 30 | 6.4 | 6 | 96.5% | Note 1,11,21 |
| Source [Sony] | R1-2211625 | 6.9\*\* | DDDSU | SU-MIMO | 10 | 10 | 1.6 | 1 | 96% | Note 1,10,21 |
| 6.9\*\* | 15 | 3.25 | 3 | 92.5% | Note 1,10,21 |
| 6.9\* | 30 | 6 | 6 | 90% | Note 1,11,21 |
| Source [ZTE] | R1-2211906 | 6.5.1\*\*\*\* | DDDSU | SU-MIMO | 20 | 30 | <1 | 0 | N.A. | Note 1,4 |
| 15 | <1 | 0 | N.A. |
| 10 | <1 | 0 | N.A. |
| Source [ZTE] | R1-2211906 | 6.1.2 | DDDSU | SU-MIMO | 20 | 30 | 3.5 | 3 | 94% | Note 1,3,23 |
| 15 | <1 | 0 | N.A. |
| 10 | <1 | 0 | N.A. |
| Source [ZTE] | R1-2211906 | 6.1.1 | DDDSU | SU-MIMO | 20 | 30 | 3.6 | 3 | 95% | Note 1,3,17,22 |
| 15 | 2.1 | 2 | 91% |
| 10 | <1 | 0 | N.A. |
| Source [ZTE] | R1-2211906 | 6.9\*\*\*\* | DDDSU | SU-MIMO | 20 | 30 | 3.9 | 3 | 96% | Note 1,5 |
| 15 | 3.5 | 3 | 93% |
| 10 | 2.6 | 2 | 95% |
| Source [ZTE] | R1-2211906 | 6.6.1\*\*\*\* | DDDSU | SU-MIMO | 20 | 30 | 3.7 | 3 | 95% | Note 1, 8, 11,22,25 |
| 15 | 2.1 | 2 | 91% |
|  | 10 | <1 | 0 | N.A. |
| Source [ZTE] | R1-2211906 | 6.1.1 | DDDSU | SU-MIMO | 20 | 30 | 3.4 | 3 | 93% | Note 1,3,20,22 |
| 15 | <1 | 0 | N.A. |
| Source [ZTE] | R1-2211906 | 6.6.1\*\*\*\* | DDDSU | SU-MIMO | 20 | 30 | 3.5 | 3 | 93% | Note 1,8,20,22,25 |
| 15 | <1 | 0 | N.A. |
| Source [ZTE] | R1-2211906 | 6.5.1\*\*\*\* | DDDSU | SU-MIMO | 10 | 15 | <1 | 0 | N.A. | Note 1,6 |
| 10 | <1 | 0 | N.A. |
| Source [ZTE] | R1-2211906 | 6.1.2 | DDDSU | SU-MIMO | 10 | 15 | 4 | 4 | 90% | Note 1,3,23 |
| 10 | <1 | 0 | N.A. |
| Source [ZTE] | R1-2211906 | 6.1.1 | DDDSU | SU-MIMO | 10 | 15 | 7 | 7 | 90% | Note 1,3,17,22 |
| 10 | <1 | 0 | N.A. |
| Source [ZTE] | R1-2211906 | 6.9\*\*\*\* | DDDSU | SU-MIMO | 10 | 15 | 8.2 | 8 | 91% | Note 1,7 |
| 10 | 5.4 | 5 | 91% |
| Source [ZTE] | R1-2211906 | 6.6.1\*\*\*\* | DDDSU | SU-MIMO | 10 | 15 | 7.1 | 7 | 91% | Note 1,8, 11,22,25 |
| Note 1: 64TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1:4,8)  Note 2: SR periodicity = 5ms  Note 3: SR periodicity = 2.5 ms  Note 4: 10 CG configurations with single CG PUSCH in a period in each CG configuration  Note 5: 10 CG PUSCH in a period  Note 6: 8 CG configurations with single CG PUSCH in a period in each CG configuration  Note 7: 8 CG PUSCH in a period  Note 8: Single CG PUSCH in a period  Note 9: At least one PUSCH per CG occasion is pre-configured.  Note 10: Size of configured grant = 60 kbit  Note 11: Size of configured grant = 100 kbit  Note 12: Size of configured grant is different for different UEs and it is up to configured resources and MCS  Note 13: Size of initial UL grant = 288 bits  Note 14: Size of initial UL grant = 117 kbit  Note 15: Size of initial UL grant = 400 bits  Note 16: Size of initial UL grant = 83.3 kbit  Note 17: Size of initial UL grant is ideal at scheduler  Note 18: No knowledge of XR traffic periodicity is assumed  Note 19: It is assumed that the XR periodicity, frame size range and arrivals related information is known by gNB  Note 20: BSR error probability is 10%  Note 21: The indication of unused occasions was conveyed via new separate UCI  Note 22: Scheduling delay is 2.5 ms  Note 23: Scheduling delay is 5 ms  Note 24: Scheduling delay is 2 slots  Note 25: If CG occasion collides with DL slot due to CG periodicity equal to 16.5 ms, that particular CG occasion is not used.  \* CG periodicity = 5 ms  \*\* CG periodicity = 2.5 ms  \*\*\* CG periodicity pattern = (17,17,16) ms, the periodicities of packet arrival and CG PUSCH have been aligned  \*\*\*\* CG periodicity = 16.5 ms, the periodicities of packet arrival and the first CG PUSCH in each period have been aligned | | | | | | | | | | |

TableB.1.6-3: FR1, UL, InH, AR pose/control at 250 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [vivo] | R1-2212595 | 6.1.1 | DDDSU | SU-MIMO | 0.2 | 10 | >30 |  |  | Note 1,2,4 |
| Source [vivo] | R1-2212595 | 6.1.1 | DDDSU | SU-MIMO | 0.2 | 10 | >30 |  |  | Note 1,3,4 |
| Source [vivo] | R1-2212595 | 6.4\* | DDDSU | SU-MIMO | 0.2 | 10 | >30 |  |  | Note 1 |
| Note 1: BS antenna parameters: 32TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1:4,4)  Note 2: SR delay = 3 ms  Note 3: SR delay = 5 ms  Note 4: Size of initial UL grant = 100 bytes  \* CG periodicity = 5 ms | | | | | | | | | | |

Based on the evaluation results in Table B.1.6-1, Table B.1.6-2 the following observations can be made:

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is increased from 6.42 UEs per cell with DG scheduling with SR followed by small initial UL grant (288 bits) with BSR and data (scheme 6.1.1) to 6.86 UEs per cell with pre-scheduling dynamic grant (scheme 6.2) (capacity gain is 7%). The capacity gain for 15ms PDB is 567%.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is increased from 6.8 UEs per cell with DG scheduling with SR followed by large initial UL grant (117 kbit) with BSR and data (scheme 6.1.1) to 6.86 UEs per cell with pre-scheduling dynamic grant (scheme 6.2) (capacity gain is 1%). The capacity gain for 15ms PDB is 120%.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is decreased from 6.42 UEs per cell with DG scheduling with SR followed by small initial UL grant (288 bits) with BSR and data (scheme 6.1.1) to 6.35 UEs per cell with single CG configuration (scheme 6.4) (capacity drop is -1%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is decreased from 6.8 UEs per cell with DG scheduling with SR followed by large initial UL grant (117 kbit) with BSR and data (scheme 6.1.1) to 6.35 UEs per cell with single CG configuration (scheme 6.4) (capacity drop is -7%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is increased from 0.68 UEs per cell with DG scheduling with SR followed by small initial UL grant (288 bits) with BSR and data (scheme 6.1.1) to 2.75 UEs per cell with single CG configuration (scheme 6.4) (capacity gain is 304%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is increased from 2.06 UEs per cell with DG scheduling with SR followed by large initial UL grant (117 kbit) with BSR and data (scheme 6.1.1) to 2.75 UEs per cell with single CG configuration (scheme 6.4) (capacity gain is 33%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is increased from 6.35 UEs per cell with single CG configuration (scheme 6.4) to 6.86 UEs per cell with pre-scheduling dynamic grant (scheme 6.2) (capacity gain is 8%). The capacity gain for 15ms PDB is 65%.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is increased from 6.35 UEs per cell with single CG configuration (scheme 6.4) to 6.97 UEs per cell with hybrid scheduling CG+DG, where CG resources are configured with a certain size in every UL slot in order to transmit BSR and data when new data arrives (scheme 6.6.1) (capacity gain is 10%). The capacity gain for 15ms PDB is 81%.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is increased from 6.86 UEs per cell with pre-scheduling dynamic grant (scheme 6.2) to 6.97 UEs per cell with hybrid scheduling CG+DG, where CG resources are configured with a certain size in every UL slot in order to transmit BSR and data when new data arrives (scheme 6.6.1) (capacity gain is 2%). The capacity gain for 15ms PDB is 9%.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Ericsson] that the capacity is increased from 6.97 UEs per cell with hybrid scheduling CG+DG, where CG resources are configured with a certain size in every UL slot in order to transmit BSR and data when new data arrives (scheme 6.6.1) to 7.1 UEs per cell with dynamic scheduling with genie BSR (scheme 6.3) (capacity gain is 2%). The capacity gain for 15ms PDB is 1%.

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [InterDigital] that the capacity is decreased from 7.1 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 6 UEs per cell with single CG configuration (scheme 6.4) (capacity drop is -15%).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [InterDigital] that the capacity is increased from 2 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 4.7 UEs per cell with single CG configuration (scheme 6.4) (capacity gain is 135%).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [InterDigital] that the capacity is increased from 7.1 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 7.5 UEs per cell with enhanced CG with flexible resource allocation (scheme 6.7) (capacity gain is 6%).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [InterDigital] that the capacity is increased from 2 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 5.2 UEs per cell with enhanced CG with flexible resource allocation (scheme 6.7) (capacity gain is 160%).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [CATT] that the capacity is decreased from 5.4 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 0 UEs per cell with single CG configuration (scheme 6.4).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [CATT] that the capacity is increased from 5.4 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 7.3 UEs per cell with hybrid CG+DG scheduling (scheme 6.6.3) (capacity gain is 35%).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [CATT] that the capacity is increased from 5.4 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 7.2 UEs per cell with pre-scheduling dynamic grant (scheme 6.2) (capacity gain is 33%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Sony] that the capacity is decreased from 6.35 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 5.6 UEs per cell with single CG configuration (scheme 6.4) (capacity drop is -11%). The capacity drop for 15ms PDB is 17%.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Sony] that the capacity is increased from 6.35 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 6.4 UEs per cell with enhanced CG with dynamic adaptation of CG parameters and indication of unused/used CG PUSCH occasion(s) (scheme 6.8) (capacity gain is 1%). The capacity gain for 15ms PDB is 44%.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Sony] that the capacity is decreased from 6.35 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 6 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9) (capacity drop is -6%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [Sony] that the capacity is increased from 3 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 3.25 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9) (capacity gain is 8%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 20Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is increased from 3.5 UEs per cell with DG scheduling with SR followed by UL grant with BSR only (scheme 6.1.2) to 3.6 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) (capacity gain is 3%). The trend is similar for PDB=10 ms and 15 ms as well as for 10Mbps scenario.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 20Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is decreased from 3.6 UEs per cell with DG scheduling with SR followed by UL grant with BSR and data (scheme 6.1.1) to 0 UEs per cell with multiple CG configurations (scheme 6.5.1). The trend is similar for PDB=10 ms and 15 ms as well as for 10Mbps scenario.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 20Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is increased from 3.6 UEs per cell with DG scheduling with SR followed by UL grant with BSR and data (scheme 6.1.1) to 3.9 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9) (capacity gain is 8%). The trend is similar if compare (scheme 6.1.2) with (scheme 6.9).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 20Mbps, 15ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is increased from 2.1 UEs per cell (scheme 6.1.1) to 3.5 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9) (capacity gain is 66.7%). The trend is similar if compare (scheme 6.9) with (scheme 6.1.2) or (scheme 6.6.1) for PDB=15 ms and for 20Mbps scenario.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is increased from 7 UEs per cell (scheme 6.1.1) to 8.2 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9) (capacity gain is 17%). The trend is similar if compare (scheme 6.9) with (scheme 6.6.1) for PDB=15 ms and for 10Mbps scenario.

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 20Mbps, 10ms PDB, 60FPS, with SU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is increased from 0 UE per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 1.1) to 2.6 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 9). The trend is similar if compare (scheme 1.2) with (scheme 9).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 20Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is increased from 3.7 UEs per cell with hybrid CG+DG scheduling (scheme 6.6.1) to 3.9 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9) (capacity gain is 5%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is increased from 4 UEs per cell (scheme 6.1.2) to 8.2 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9) (capacity gain is 95.2%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 20Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is increased from 3.5 UEs per cell (scheme 6.6.1) assuming 10% BSR error probability to 3.9 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9) (capacity gain is 11.4%).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [vivo] that the capacity is increased from 2.33 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 6.22 UEs per cell with multiple CG configurations (scheme 6.5.2) (capacity gain is 167%).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [vivo] that the capacity is increased from 2.33 UEs per cell with DG scheduling with SR followed by initial UL grant with BSR and data (scheme 6.1.1) to 6.12 UEs per cell with hybrid CG+DG scheduling (scheme 6.6.2) (capacity gain is 163%).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [vivo] that the capacity is increased from 6.12 UEs per cell with hybrid CG+DG scheduling (scheme 6.6.2) to 6.42 UEs per cell with enhanced CG with MAC CE based dynamic resource adjustment indication (scheme 6.10) (capacity gain is 5%).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [vivo] that the capacity is increased from 6.12 UEs per cell with hybrid CG+DG scheduling (scheme 6.6.2) to 7.81 UEs per cell with enhanced CG with UCI based dynamic resource adjustment indication (scheme 6.11) (capacity gain is 28%).

- For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [vivo] that the capacity is increased from 6.12 UEs per cell with hybrid CG+DG scheduling (scheme 6.6.2) to 8.79 UEs per cell with enhanced CG with UCI based dynamic resource adjustment indication (scheme 6.12) (capacity gain is 44%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Huawei] that the capacity is increased from 0 UEs per cell with DG scheduling with SR followed by small initial UL grant (400 bits) with BSR and data (scheme 6.1.1) to 1 UE per cell with single CG configuration (scheme 6.4).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Huawei] that the capacity is increased from 0 UEs per cell with DG scheduling with SR followed by large initial UL grant (83.3 kbit) with BSR and data (scheme 6.1.1) to 1 UE per cell with single CG configuration (scheme 6.4).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Huawei] that the capacity is increased from 1 UE per cell with cell with single CG configuration (scheme 6.4) to 1.7 UEs per cell with pre-scheduling dynamic grant (scheme 6.2) (capacity gain is 70%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Huawei] that the capacity is increased from 0 UEs per cell with DG scheduling with SR followed by small initial UL grant (400 bits) with BSR and data (scheme 6.1.1) to 1.7 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Huawei] that the capacity is increased from 0 UEs per cell with DG scheduling with SR followed by large initial UL grant (83.3 kbit) with BSR and data (scheme 6.1.1) to 1.7 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Huawei] that the capacity is increased from 1.4 UEs per cell with multiple CG configuration (scheme 6.5.2) to 1.7 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9) (capacity gain is 21%).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Huawei] that the capacity is increased from 0 UEs per cell with hybrid CG+DG scheduling (scheme 6.6.1) to 1.7 UEs per cell with enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9).

- For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Huawei] that the capacity is decreased from 3 UEs per cell with cell with pre-scheduling dynamic grant (scheme 6.2) to 1.7 UEs per cell with Enhanced CG with indication of unused/used CG PUSCH occasion(s) (scheme 6.9) (capacity drop is -43%).

### B.1.7 Scheduling restrictions due to RRM measurements

This clause captures the capacity performance evaluation results with and without intra- and inter frequency RRM measurement restrictions. Scheduling restrictions apply for the UEs during time-intervals where it is performing intra-frequency RRM measurements at FR2, or gap assisted inter-frequency RRM measurements. Such scheduling restrictions does not allow to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/CSI-RS. When XR frame arrival collides with RRM measurements, the XR frame will be delayed for the duration of SMTC window or measurement gap (MG).

The performance with SMTC/MG scheduling restrictions (scheme 7.2 and 7.4 in Table B.1.7-1 and Table B.1.7-2) has been compared against no SMTC/MG scheduling restrictions as well as with adaptation of MG period. Particularly, the following schemes have been evaluated:

- Scheme 7.1: Without SMTC scheduling restrictions. In this scheme, no scheduling restrictions for FR2 intra-frequency measurements were assumed. This can be realized via gNB-2-UE signalling to configure the UE with time-mask where it shall always prioritize PDCCH/PDSCH decoding and/or PUSCH transmission in line with XR traffic, even if colliding with SMTC windows. Alternatively, the UE-to-gNB signalling to make the gNB scheduler aware of when *s-MeasureConfig* induced scheduling restrictions apply could be applied.

- Scheme 7.2: With SMTC scheduling restrictions. In this scheme, scheduling restrictions every 20 ms time period for an SMTC window of 5 ms for FR2 intra-frequency measurements were assumed. In case the SMTC windows with scheduling restrictions collide with time periods where the gNB would need to schedule the XR transmission, XR frame transmission will be delayed.

- Scheme 7.3: No scheduling restrictions during measurement gap. In this scheme, no scheduling restrictions during measurement gap for inter-frequency measurements were assumed.

- Scheme 7.4: With scheduling restrictions during measurement gap. In this scheme, scheduling restrictions for the duration of measurement gap length of 6 ms are applied. Measurement gaps (MG) are configured to allow UE to do inter-frequency neighbour cell measurement and the corresponding RF tuning for RRM purposes (e.g. mobility, load balancing, CA set-up). In case the MG with scheduling restrictions collide with time periods where the gNB would need to schedule the XR transmission, XR frame transmission will be delayed.

- Scheme 7.5.1: Adaptation of MG period. The MG period is adapted to be 2 times when PCell RSRP is 2dB better than the best neighbour cell and 4 times when PCell RSRP is 4dB better than the best neighbour cell. The UE speed is 30km/h.

- Scheme 7.5.2 Adaptation of MG period. The MG period is adapted to be 4 times when PCell RSRP is 2dB better than the best neighbour cell and 8 times when PCell RSRP is 4dB better than the best neighbour cell. The UE speed is 30km/h.

TableB.1.7-1: FR2, DL, InH, VR/AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Nokia] | R1-2211552 | 7.1 | DDDSU | SU-MIMO | 30 | 10 | 7 | 7 | 90% | Note 1 |
| Source [Nokia] | R1-2211552 | 7.2 | DDDSU | SU-MIMO | 30 | 10 | 3.1 | 3 | 92% | Note 1 |
| Source [Nokia] | R1-2211552 | 7.1 | DDDSU | SU-MIMO | 30 | 15 | 9 | 9 | 91% | Note 1 |
| Source [Nokia] | R1-2211552 | 7.2 | DDDSU | SU-MIMO | 30 | 15 | 6.25 | 6 | 93% | Note 1 |
| Note 1: BS antenna parameters: 2TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (4,8,2,2,2;1,1) | | | | | | | | | | |

TableB.1.7-2: FR1, DL, DU, VR/AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [MediaTek] | R1-2212254 | 7.3 | DDDSU | SU-MIMO | 30 | 10 | 10.6 | 10 | 90.67% | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.4\* | DDDSU | SU-MIMO | 30 | 10 | 0 | 0 | N.A. | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.4\*\* | DDDSU | SU-MIMO | 30 | 10 | 2 | 2 | 88.1% | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.5.1\* | DDDSU | SU-MIMO | 30 | 10 | 0.5 | 0 | N.A. | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.5.1\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.2 | 7 | 90.48% | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.5.2\* | DDDSU | SU-MIMO | 30 | 10 | 0.8 | 0 | N.A. | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.5.2\*\* | DDDSU | SU-MIMO | 30 | 10 | 8.7 | 8 | 92.62% | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.4\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 0 | 0 | N.A. | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.4\*\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.2 | 7 | 90.48% | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.5.1\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 0.9 | 0 | N.A. | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.5.1\*\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 8.7 | 8 | 92.62% | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.5.2\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 5.5 | 5 | 90.32% | Note 1 |
| Source [MediaTek] | R1-2212254 | 7.5.2\*\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 9.2 | 9 | 90.66% | Note 1 |
| Note 1: BS antenna parameters: 64TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1:4,8)  \* MG configuration 40 ms, all UE  \*\* MG configuration 40 ms, cell-edge 20% UE  \*\*\* MG configuration 80 ms, all UE  \*\*\*\* MG configuration 80 ms, cell-edge 20% UE | | | | | | | | | | |

Based on the evaluation results in Table B.1.7-1 and Table B.1.7-2 the following observations can be made:

* For FR2, InH, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 2TxRU, it is observed from Source [Nokia] that the capacity is increased from 3.1 UEs per cell with SMTC scheduling restrictions for FR2 intra-frequency measurements (5 ms SMTC window every 20 ms) to 7 UEs per cell without SMTC scheduling restrictions for FR2 intra-frequency measurements (capacity gain is 126%). For 15ms PDB the capacity gain is 44%.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [MediaTek] that the capacity is increased from 0 UEs per cell with MG scheduling restrictions for inter-frequency measurements for all UEs (6 ms MG length every 40 ms) to 10.6 UEs per cell without MG scheduling restrictions for inter-frequency measurements. Similar trend is observed for MG configuration 80 ms.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [MediaTek] that the capacity is increased from 2 UEs per cell with MG scheduling restrictions for inter-frequency measurements for all 20% UEs (6 ms MG length every 40 ms) to 10.6 UEs per cell without MG scheduling restrictions for inter-frequency measurements (capacity gain is 400%). Similar trend is observed for MG configuration 80 ms.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [MediaTek] that the capacity is increased from 0 UEs per cell with MG scheduling restrictions for inter-frequency measurements for all UEs (6 ms MG length every 40 ms) to 0.5 UEs per cell with adaptation of MG period for inter-frequency measurements, where MG period is adapted to be 2 times when PCell RSRP is 2dB better than the best neighbour cell and 4 times when PCell RSRP is 4dB better than the best neighbour cell. Similar trend is observed for MG configuration 80 ms.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [MediaTek] that the capacity is increased from 2 UEs per cell with MG scheduling restrictions for inter-frequency measurements for all 20% UEs (6 ms MG length every 40 ms) to 7.2 UEs per cell with adaptation of MG period restrictions for inter-frequency measurements, where MG period is adapted to be 2 times when PCell RSRP is 2dB better than the best neighbour cell and 4 times when PCell RSRP is 4dB better than the best neighbour cell (capacity gain is 250%). Similar trend is observed for MG configuration 80 ms.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [MediaTek] that the capacity is increased from 0 UEs per cell with MG scheduling restrictions for inter-frequency measurements for all UEs (6 ms MG length every 40 ms) to 0.8 UEs per cell with adaptation of MG period for inter-frequency measurements, where MG period is adapted to be 2 times when PCell RSRP is 2dB better than the best neighbour cell and 4 times when PCell RSRP is 4dB better than the best neighbour cell. Similar trend is observed for MG configuration 80 ms.
* For FR1, DU, DL, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 64TxRU, it is observed from Source [MediaTek] that the capacity is increased from 2 UEs per cell with MG scheduling restrictions for inter-frequency measurements for all 20% UEs (6 ms MG length every 40 ms) to 8.7 UEs per cell with adaptation of MG period restrictions for inter-frequency measurements, where MG period is adapted to be 2 times when PCell RSRP is 2dB better than the best neighbour cell and 4 times when PCell RSRP is 4dB better than the best neighbour cell (capacity gain is 335%). Similar trend is observed for MG configuration 80 ms.

### B.1.8 Buffer status report

This clause captures the capacity performance evaluation results of enhancements related to buffer status report (BSR).

The performance of legacy BSR (scheme 8.1 in Table B.1.8-1 and Table B.1.8-2) has been compared against enhanced BSR schemes. Particularly, the following schemes have been evaluated:

- Scheme 8.1: Legacy dynamic scheduling with legacy BSR.

- Scheme 8.2: BSR with precise buffer size, where new buffer status (BS) table(s) with finer granularity is designed.

- Scheme 8.3: XR-specific triggering mechanism of BSR report. In this scheme, the pre-scheduling dynamic grant based on the XR awareness is considered and XR specific PDCCH monitoring is aligned with the periodicity of XR packet generation. The BSR is also enhanced to have XR-specific triggering mechanism of BSR report to minimize the scheduling delay. The XR-specific BSR report triggering mechanism is that the BSR report will be triggered at the 1st PUSCH of each XR packet at each cycle to inform gNB the remaining packet size to be transmitted after the 1st PUSCH transmission of the XR traffic. When gNB receive the BSR, gNB would schedule UE the UL PUSCH transmission until the completion of XR packet delivery in this cycle.

TableB.1.8-1: FR1, UL, InH, AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [CATT] | R1-2211175 | 8.1 | DDDUU | SU-MIMO | 10 | 30 | 5.4 | 5 | 90 | Note 1,2 |
| Source [CATT] | R1-2211175 | 8.3 | DDDUU | SU-MIMO | 10 | 30 | 7.2 | 7 | 90 | Note 1,2 |
| Note 1: BS antenna parameters: 32TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1:4,4)  Note 2: SR/BSR periodicity = 5 ms | | | | | | | | | | |

TableB.1.8-2: FR1, UL, DU, AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [ZTE] | R1-2211906 | 8.1\* | DDDSU | MU-MIMO | 10 | 30 | 9.5 | 9 | 95 | Note 1,2 |
| 20 | 3.4 | 3 | 91 |
| Source [ZTE] | R1-2211906 | 8.2 | DDDSU | MU-MIMO | 10 | 30 | 10.9 | 10 | 94 | Note 1,2 |
| 20 | 5.1 | 5 | 90 |
| Note 1: BS antenna parameters: 64TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1:4,8)  Note 2: SR periodicity = 2.5 ms  \* The length of the field for the Short BSR format and the Short Truncated BSR format is 5 bits | | | | | | | | | | |

Based on the evaluation results in Table B.1.8-1 and Table B.1.8-2 the following observations can be made:

* For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is increased from 9.5 UEs per cell with Legacy BSR to 10.9 UEs per cell with BSR with precise buffer size (capacity gain is 15%).
* For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 20Mbps, 30ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [ZTE] that the capacity is increased from 3.4 UEs per cell with Legacy BSR to 5.1 UEs per cell with BSR with precise buffer size (capacity gain is 50%).
* For FR1, InH, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 30ms PDB, 60 FPS, with SU-MIMO and 32TxRU, it is observed from Source [CATT] that the capacity is increased from 5.4 UEs per cell with dynamic grant scheduling to 7.2 UEs per cell with XR-specific triggering mechanism of BSR report (capacity gain is 33%).

### B.1.9 UL delay-aware scheduling

This clause captures the capacity performance evaluation results of enhancements related to UL delay aware scheduling.

The performance proportional fair scheduling (scheme 9.1 in Table B.1.9-1) has been compared against delay-aware scheduling. Particularly, the following schemes have been evaluated:

- Scheme 9.1: Proportional fair (PF) scheduling, where gNB uses PF scheduling, i.e., the scheduling priority of each user is calculated as the ratio of the instantaneous data rate over the historical data rate. The gNB does not consider delay during scheduling.

- Scheme 9.2: Delay-aware scheduling, where gNB is not aware of the exact UL data arrival time and can only apply SR or BSR reception time for delay-aware scheduling.

- Scheme 9.3: Delay-aware scheduling, where gNB is aware of the exact data arrival time and uses the exact data arrival time for delay-aware scheduling.

TableB.1.9-1: FR1, UL, DU, AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [Huawei] | R1-2210907 | 9.1 | DDDSU | MU-MIMO | 10 | 15 | 3 | 3 | 90 | Note 1, 2 |
| Source [Huawei] | R1-2210907 | 9.2 | DDDSU | MU-MIMO | 10 | 15 | 3.2 | 3 | 90.5 | Note 1, 2 |
| Source [Huawei] | R1-2210907 | 9.3 | DDDSU | MU-MIMO | 10 | 15 | 3.8 | 3 | 91.5 | Note 1, 2 |
| Note 1: BS antenna parameters: 64TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1:4,8)  Note 2: SR/BSR periodicity = 5 ms | | | | | | | | | | |

Based on the evaluation results in Table B.1.9-1 the following observations can be made.

* For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Huawei] that the capacity is increased from 3 UEs per cell with proportional fair scheduling to 3.2 UEs per cell with delay-aware scheduling, where gNB is not aware of the exact data arrival time (capacity gain is 7%).
* For FR1, DU, UL, with 100MHz bandwidth for AR single-stream traffic model, 10Mbps, 15ms PDB, 60 FPS, with MU-MIMO and 64TxRU, it is observed from Source [Huawei] that the capacity is increased from 3.2 UEs per cell with delay-aware scheduling, where gNB is not aware of the exact data arrival time to 3.8 UEs per cell with delay-aware scheduling, where gNB is aware of the exact data arrival time (capacity gain is 19%).

### B.1.10 XR-specific *playoutDelayForMediaStartup* for gNB scheduling awareness

This clause captures the capacity performance evaluation results of enhancements related to gNB awareness about playoutDelayForMediaStartup and appLayerBufferLevel, where the former is the waiting time that the user experiences for media start-up and the latter is buffer level, which indicates the playout duration for which media data of all active media components is available starting from the current playout time, where.

The performance dynamic grant scheduling (scheme 10.1 in Table B.1.10-1) has been compared against the scheme with playoutDelayForMediaStartup and appLayerBufferLevel awareness. Particularly, the following schemes have been evaluated:

- Scheme 10.1: Dynamic grant scheduling.

- Scheme 10.2: XR-specific *playoutDelayForMediaStartup* scheme. In this scheme, the *playoutDelayForMediaStartup* and *appLayerBufferLevel* is shared by the UE with the gNB. The scheme assumes, the feedback of XR-specific *playoutDelayForMediaStartup* and *appLayerBufferLevel* from UE would give the gNB scheduler additional delay budget in scheduling the XR data transmission to achieve additional link adaptation gain. For example, when the reported *appLayerBufferLevel* is 3 frames, gNB scheduler extends PDB for scheduling the XR packet on PDSCH for additional 50 ms. gNB prioritizes the UE scheduling based on the extended delay budged from the reported playout delay size and buffer level, in which a group UEs in the same priority queue are with the same length of playout delay.

TableB.1.10-1: FR1, DL, InH, VR/AR at 60 FPS

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source | Tdoc Source | Scheme | TDD format | SU/MU-MIMO | Data rate (Mbps) | PDB (ms) | Capacity (UEs/cell) | C1=floor (Capacity) | % of satisfied UEs when #UEs/cell =C1 | Notes |
| Source [CATT] | R1-2211175 | 10.1 | DDDSU | MU-MIMO | 30 | 10 | 10.9 | 10 | 90.97% | Note 1,2 |
| Source [CATT] | R1-2211175 | 10.1 | DDDSU | SU-MIMO | 30 | 10 | 3.7 | 3 | 92.5% | Note 1,2 |
| Source [CATT] | R1-2211175 | 10.1 | DDDSU | MU-MIMO | 30 | 10 | 11.5 | 11 | 95.83% | Note 1,3 |
| Source [CATT] | R1-2211175 | 10.1 | DDDSU | SU-MIMO | 30 | 10 | 5.8 | 5 | 96.7% | Note 1,3 |
| Source [CATT] | R1-2211175 | 10.2\* | DDDSU | MU-MIMO | 30 | 10 | 16 | 16 | 95% | Note 1 |
| Source [CATT] | R1-2211175 | 10.2\*\* | DDDSU | MU-MIMO | 30 | 10 | 20 | 20 | 92% | Note 1 |
| Source [CATT] | R1-2211175 | 10.2\*\*\* | DDDSU | MU-MIMO | 30 | 10 | 20 | 20 | 91% | Note 1 |
| Source [CATT] | R1-2211175 | 10.2\*\* | DDDSU | SU-MIMO | 30 | 10 | 7.3 | 7 | 91.3% | Note 1 |
| Source [CATT] | R1-2211175 | 10.2\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 11.8 | 11 | 98.3% | Note 1 |
| Source [CATT] | R1-2211175 | 10.2\*\*\*\* | DDDSU | SU-MIMO | 30 | 10 | 11.3 | 11 | 94.4% | Note 1 |
| Note 1: BS antenna parameters: 32TxRUs, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1:4,4)  Note 2: C-DRX configuration (16,12,4)  Note 3: UE always on  \* 2 frames playout delay  \*\* 3 frames playout delay  \*\*\* 4 frames playout delay  \*\*\*\* mixed playout delay {3, 4} | | | | | | | | | | |

Based on the evaluation results in Table B.1.10-1 the following observations can be made.

* For FR1, DL, InH, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 32TxRU, C-DRX configuration (16,12,4), it is observed from Source [CATT] that the capacity is increased from 10.9 UEs per cell with grant scheduling to 16/20/20 UEs per cell with XR-specific *playoutDelayForMediaStartup* scheme with 2/3/4 frames playout delay, respectively (capacity gains are 47%/83%/83%).
* For FR1, DL, InH, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with MU-MIMO and 32TxRU, UE always on, it is observed from Source [CATT] that the capacity is increased from 11.5 UEs per cell with grant scheduling to 16/20/20 UEs per cell with XR-specific *playoutDelayForMediaStartup* scheme with 2/3/4 frames playout delay, respectively (capacity gains are 39%/74%/74%).
* For FR1, DL, InH, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, C-DRX configuration (16,12,4), it is observed from Source [CATT] that the capacity is increased from 3.7 UEs per cell with grant scheduling to 7.3/11.8/11.3 UEs per cell with XR-specific *playoutDelayForMediaStartup* scheme with 3/4 and mixed {3,4} frames playout delay, respectively (capacity gains are 97%/219%/205%).
* For FR1, DL, InH, with 100MHz bandwidth for VR/AR single-stream traffic model, 30Mbps, 10ms PDB, 60 FPS, with SU-MIMO and 32TxRU, UE always on, it is observed from Source [CATT] that the capacity is increased from 5.8 UEs per cell with grant scheduling to 7.3/11.8/11.3 UEs per cell with XR-specific *playoutDelayForMediaStartup* scheme with 3/4 and mixed {3,4} frames playout delay, respectively (capacity gains are 26%/103%/95%).

## B.2 Power saving performance evaluation results

### B.2.1 Enhanced CDRX for semi-static periodicity alignment

This clause captures evaluation results for enhanced CDRX based on semi-static periodicity alignment between CDRX and XR traffic. The following evaluations were provided by companies:

- Ericsson and Intel evaluated configuring shifts for the start offset of CDRX On Duration and a number of DRX cycles after which the shifts should be added.

- Huawei evaluated configuring multiple start offsets for multiple On Durations within each CDRX cycle to align with multiple XR data arrivals.

- vivo evaluated multiple DRX configurations with different drx-StartOffset values.

- vivo evaluated one DRX cycle can contain multiple DRX On Durations based on single DRX configuration.

- Ericsson, vivo, OPPO, CATT, Intel, ZTE and Nokia evaluated the CDRX cycle pattern with multiple cycle values (e.g., {16ms, 17ms, 17ms} for 60fps XR video).

- ZTE, MediaTek and Qualcomm evaluated uniform non-integer number CDRX cycles with quantization operations in DRX formulas.

- ZTE evaluated multiple CDRX configurations with staggered offsets to align with multiple XR data arrivals.

NOTE: For enhanced CDRX with semi-static periodicity alignment, different companies used different notations (e.g., “Matched CDRX”, “eCDRX”, “Enhanced C-DRX”) to refer to their specific method to achieve periodicity alignment. There was no attempt to align notation.

Table B.2.1-1: FR1, DL+UL, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Ericsson | 35 | R1-2210922 | Always On | - | - | - | H | 8 | 8 | - | - | 90.1% | 0% | 0.0% | 0.0% | Note1 |
| Ericsson | 36 | R1-2210922 | R15/16 DRX (Long DRX) | 10 | 8 | 4 | H | 8 | 8 | - | - | 86.9% | -3.6% | 2.6% | 2.7% | Note1 |
| Ericsson | 37 | R1-2210922 | R15/16 DRX (Short DRX) | 4 | 2 | 4 | H | 8 | 8 | - | - | 80.2% | -11.0% | 6.1% | 6.1% | Note1 |
| Ericsson | 38 | R1-2210922 | Matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 85.5% | -5.1% | 7.2% | 7.1% | Note 1,2 |
| Ericsson | 39 | R1-2210922 | Matched CDRX | 17/17/16 | 10 | 4 | H | 8 | 8 | - | - | 86.4% | -4.1% | 7.6% | 7.5% | Note1 |
| Note 1: the DL traffic has a second flow for audio with 30ms PDB  Note 2: Matched CDRX has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms) | | | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.1-1, the following observations can be made.

- For FR1, DL + UL joint evaluation, DU, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Ericsson that

- Semi-static alignment provides

- mean power saving gain of 7.4% in the range of 7.2% to 7.6% for all UEs

- mean capacity gain of -4.6% in the range of -5.1% to -4.1%%

- R15/16 CDRX as the performance reference provides

- mean power saving gain of 4.35% in the range of 2.6% to 6.1% for all UEs

- mean capacity gain of -7.30% in the range of -11% to -3.6%

Table B.2.1-2: FR1, DL+UL, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 8 | R1-2211905 | Always On | - | - | - | H | 11 | 11 | 93.18% | 100% | 93.18% | 0% | - | - |  |
| ZTE | 9 | R1-2211905 | R15 CDRX | 10 | 8 | 4 | H | 11 | 11 | 90.15% | 100% | 90.15% | -3.3% | 6.65% | - |  |
| ZTE | 10 | R1-2211905 | R15 CDRX | 16 | 10 | 5 | H | 11 | 11 | 81.82% | 100% | 81.82% | -12.2% | 13.9% | - |  |
| ZTE | 12 | R1-2211905 | Non-uniform CDRX cycle | (17,17,16) | 6 | 4 | H | 11 | 11 | 90.15% | 100% | 90.15% | -3.3% | 23.86% | - |  |
| ZTE | 13 | R1-2211905 | Uniform non-integer CDRX cycle | (1000/60) | 6 | 4 | H | 11 | 11 | 90.15% | 100% | 90.15% | -3.3% | 23.85% | - |  |
| ZTE | 14 | R1-2211905 | Enhanced multiple CDRX (3 CDRX configurations) | 50ms DRX cycle | 6 | 4 | H | 11 | 11 | 90.11% | 100% | 90.11% | -3.3% | 24% | - |  |

Based on the evaluation results in Table B.2.1-2, the following observations can be made.

- For FR1, DL + UL joint evaluation, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from ZTE that

- Semi-static alignment provides

- mean power saving gain of 23.8% in the range of 24% to 23.90% for all UEs

- mean capacity gain of -3.33% in the range of -3.33% to -3.33%

- R15 CDRX as the performance reference provides

- mean power saving gain of 10.28% in the range of 6.65% to 13.9% for all UEs

- mean capacity gain of -7.75% in the range of -12.2% to -3.33%

Table B.2.1-3: FR1, DL-only, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| OPPO | 1 | R1-2211490 | Always On | - | - | - | H | 5 | 5 | 90.18% | 0.0% | 0.0% | 0.0% |  |
| OPPO | 2 | R1-2211490 | R15/16 CDRX | 16 | 14 | 2 | H | 5 | 5 | 88.77% | -1.6% | 5.11% | 5.55% |  |
| OPPO | 3 | R1-2211490 | Non-uniform CDRX cycle pattern | {17,17,16} | 10 | 2 | H | 5 | 5 | 88.77% | -1.6% | 18.72% | 19.43% |  |
| Huawei | 1 | R1-2210906 | Always On | - | - | - | H | 11 | 11 | 93.42% | 0.0% | 0.0% | - |  |
| Huawei | 2 | R1-2210906 | Legacy C-DRX | 16 | 12 | 4 | H | 11 | 11 | 83.20% | -10.9% | 5.57% | - |  |
| Huawei | 3 | R1-2210906 | Enhanced C-DRX | 50 {0, 16, 33} | 12 | 4 | H | 11 | 11 | 91.43% | -2.1% | 7.64% | - |  |
| QC | 4 | R1-2212134 | Always On | - | - | - | H | 13 | 12 | 89.3% | 0.0% | 0% | - |  |
| QC | 5 | R1-2212134 | Rel15/16 CDRX | 16 | 12 | 8 | H | 13 | 12 | 78.8% | -11.8% | 6.04% | - |  |
| QC | 6 | R1-2212134 | eCDRX | 16/17/17 | 12 | 8 | H | 13 | 12 | 90.0% | 0.8% | 3.92% | - |  |
| QC | 7 | R1-2212134 | Rel15/16 CDRX + PDCCH skipping | 16 | 12 | 8 | H | 13 | 12 | 38.3% | -57.1% | 25.7% | - |  |
| QC | 8 | R1-2212134 | eCDRX + PDCCH skipping | 16/17/17 | 12 | 8 | H | 13 | 12 | 87.5% | -2.0% | 24.5% | - |  |
| QC | 9 | R1-2212134 | Rel15/16 CDRX + PDCCH skipping + SSSG switching | 16 | 12 | 8 | H | 13 | 12 | 13.6% | -84.8% | 29.7% | - |  |
| QC | 10 | R1-2212134 | eCDRX + PDCCH skipping + SSSG switching | 16/17/17 | 12 | 8 | H | 13 | 12 | 82.5% | -7.6% | 28.8% | - |  |
| QC | 52 | R1-2212134 | Always On | - | - | - | H | 12 | 12 | 94.6% | 0.0% | 0% | - |  |
| QC | 53 | R1-2212134 | Rel15/16 CDRX | 16 | 12 | 8 | H | 12 | 12 | 86.5% | -8.6% | 6.17% | - |  |
| QC | 54 | R1-2212134 | eCDRX | 16/17/17 | 12 | 8 | H | 12 | 12 | 94.6% | 0.0% | 4.26% | - |  |
| QC | 55 | R1-2212134 | Rel15/16 CDRX + PDCCH skipping | 16 | 12 | 8 | H | 12 | 12 | 47.6% | -49.7% | 26.4% | - |  |
| QC | 56 | R1-2212134 | eCDRX + PDCCH skipping | 16/17/17 | 12 | 8 | H | 12 | 12 | 92.7% | -2.0% | 25.7% | - |  |
| QC | 57 | R1-2212134 | Rel15/16 CDRX + PDCCH skipping + SSSG switching | 16 | 12 | 8 | H | 12 | 12 | 19.8% | -79.1% | 30.6% | - |  |
| QC | 58 | R1-2212134 | eCDRX + PDCCH skipping + SSSG switching | 16/17/17 | 12 | 8 | H | 12 | 12 | 90.4% | -4.4% | 30.1% | - |  |
| Ericsson | 1 | R1-2210922 | Always On | - | - | - | H | 8 | 8 | 91.7% | 0.0% | 0% | 0% |  |
| Ericsson | 2 | R1-2210922 | R15/16 DRX (Long DRX) | 10 | 8 | 4 | H | 8 | 8 | 86.9% | -5.2% | 4.3% | 4.9% |  |
| Ericsson | 3 | R1-2210922 | R15/16 DRX (Short DRX) | 4 | 2 | 4 | H | 8 | 8 | 78.2% | -14.7% | 10.4% | 11.0% |  |
| Ericsson | 4 | R1-2210922 | Matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 87.2% | -4.9% | 10.5% | 11.4% | Note 1 |
| Ericsson | 5 | R1-2210922 | Matched CDRX | 17/17/16 | 10 | 4 | H | 8 | 8 | 87.0% | -5.1% | 10.1% | 10.5% |  |
| Ericsson | 1 | R1-2210922 | Always On | - | - | - | L | 2 | 8 | 100% | 0.0% | 0% | 0% |  |
| Ericsson | 2 | R1-2210922 | R15/16 DRX (Long DRX) | 10 | 8 | 4 | L | 2 | 8 | 100% | 0.0% | 4.8% | 4.8% |  |
| Ericsson | 3 | R1-2210922 | R15/16 DRX (Short DRX) | 4 | 2 | 4 | L | 2 | 8 | 100% | 0.0% | 12.4% | 12.4% |  |
| Ericsson | 4 | R1-2210922 | Matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 12.8% | 12.8% | Note 1 |
| Ericsson | 5 | R1-2210922 | Matched CDRX | 17/17/16 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 12.5% | 12.5% |  |
| Intel | 1 | R1-2211389 | AlwaysOn - baseline | - | - | - | H | 4 | 4 | 99.25% | 0.0% | 0.00% | - | Note2 |
| Intel | 2 | R1-2211389 | R15/16CDRX | 8 | 6 | 6 | H | 4 | 4 | 95.00% | -4.3% | 4.79% | - | Note2 |
| Intel | 3 | R1-2211389 | Enhanced CDRX | 8 | 6 | 6 | H | 4 | 4 | 99.25% | 0.0% | 10.54% | - | Note2,3 |
| Intel | 4 | R1-2211389 | R15/16CDRX | 16 | 14 | 4 | H | 4 | 4 | 96.00% | -3.3% | 3.13% | - | Note2 |
| Intel | 5 | R1-2211389 | Enhanced CDRX | 16 | 14 | 4 | H | 4 | 4 | 99.25% | 0.0% | 8.37% | - | Note2,4 |
| Intel | 11 | R1-2211389 | AlwaysOn - baseline | - | - | - | H | 4 | 4 | 98.25% | 0.0% | 0.00% | - |  |
| Intel | 12 | R1-2211389 | R15/16CDRX | 8 | 6 | 6 | H | 4 | 4 | 93.00% | -5.3% | 4.62% | - |  |
| Intel | 13 | R1-2211389 | Enhanced CDRX | 8 | 6 | 6 | H | 4 | 4 | 95.75% | -2.5% | 7.19% | - | Note3 |
| Intel | 14 | R1-2211389 | R15/16CDRX | 16 | 14 | 4 | H | 4 | 4 | 95.50% | -2.8% | 3.23% | - |  |
| Intel | 15 | R1-2211389 | Enhanced CDRX | 16 | 14 | 4 | H | 4 | 4 | 97.25% | -1.0% | 4.56% | - | Note4 |
| Note 1: Matched CDRX has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms)  Note 2: jitter is off  Note 3: start offset adjusted every 6 cycles  Note 4: start offset adjusted every 3 cycles | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.1-3, the following observations can be made.

- For FR1, DL only evaluation, DU, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from OPPO, Huawei, Qualcomm, Ericsson and Intel that

- semi-static alignment provides

- mean power saving gain of 8.36% in the range of 3.92% to 18.72% for all UEs

- mean capacity gain of -2.05% in the range of -5.10% to 0.80%

- R15/16 CDRX as the performance reference provides

- mean power saving gain of 5.68% in the range of 3.23% to 10.4% for all UEs

- mean capacity gain of -7.61% in the range of -14.70% to -1.60%

- For FR1, DL only evaluation, DU, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Qualcomm that

- semi-static alignment + R17 PDCCH monitoring adaptation provides

- mean power saving gain of 27.28% in the range of 24.5% to 30.1% for all UEs

- mean capacity gain of -4.00% in the range of -7.60% to -2.00%

- R15/16 CDRX + R17 PDCCH monitoring adaptation as the performance reference provides

- mean power saving gain of 28.1% in the range of 25.7% to 30.6% for all UEs

- mean capacity gain of -67.68% in the range of -84.80% to -49.70%

- For FR1, DL only evaluation, DU, low load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Ericsson that

- semi-static alignment provides

- mean power saving gain of 12.65% in the range of 12.50% to 12.80% for all UEs

- capacity gain of 0%

- R15/16 CDRX as the performance reference provides

- mean power saving gain of 8.60% in the range of 4.80% to 12.40% for all UEs

- capacity gain of 0%

- For FR1, DL only evaluation, DU, high load, jitter off, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Intel that

- semi-static alignment provides

- mean power saving gain of 9.46% in the range of 8.37% to 10.54% for all UEs

- capacity gain of 0.0%

- R15/16 CDRX as the performance reference provides

- mean power saving gain of 3.96% in the range of 3.13% to 4.79% for all UEs

- mean capacity gain of -3.8% in the range of -3.3% to -4.3%

Table B.2.1-4: FR1, DL-only, DU, CG30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| MTK | 22 | R1-2207008 | AlwaysOn - baseline | - | - | - | H | 12 | 12 | 94.6% | 0.0% | 0% | - |  |
| MTK | 23 | R1-2207008 | R17 CDRX | 16 | 12 | 8 | H | 12 | 12 | 92.7% | -2.0% | 5.4% | - |  |
| MTK | 24 | R1-2207008 | eCDRX (rational DRX cycle) | 50/3 | 12 | 8 | H | 12 | 12 | 94.3% | -0.3% | 9.9% | - |  |
| Intel | 6 | R1-2211389 | AlwaysOn - baseline | - | - | - | H | 4 | 4 | 99.75% | 0.0% | 0.00% | - | Note1 |
| Intel | 7 | R1-2211389 | R15/16CDRX | 8 | 6 | 6 | H | 4 | 4 | 97.25% | -2.5% | 4.79% | - | Note1 |
| Intel | 8 | R1-2211389 | Enhanced CDRX | 8 | 6 | 6 | H | 4 | 4 | 99.75% | 0.0% | 10.54% | - | Note1,2 |
| Intel | 9 | R1-2211389 | R15/16CDRX | 16 | 14 | 4 | H | 4 | 4 | 98.25% | -1.5% | 3.13% | - | Note1 |
| Intel | 10 | R1-2211389 | Enhanced CDRX | 16 | 14 | 4 | H | 4 | 4 | 99.75% | 0.0% | 8.37% | - | Note1,3 |
| Intel | 16 | R1-2211389 | AlwaysOn - baseline | - | - | - | H | 4 | 4 | 98.75% | 0.0% | 0.00% | - |  |
| Intel | 17 | R1-2211389 | R15/16CDRX | 8 | 6 | 6 | H | 4 | 4 | 95.25% | -3.5% | 4.62% | - |  |
| Intel | 18 | R1-2211389 | Enhanced CDRX | 8 | 6 | 6 | H | 4 | 4 | 97.50% | -1.3% | 7.19% | - | Note2 |
| Intel | 19 | R1-2211389 | R15/16CDRX | 16 | 14 | 4 | H | 4 | 4 | 97.25% | -1.5% | 3.23% | - |  |
| Intel | 20 | R1-2211389 | Enhanced CDRX | 16 | 14 | 4 | H | 4 | 4 | 98.25% | -0.5% | 4.56% | - | Note3 |
| Note 1: jitter is off  Note 2: start offset adjusted every 6 cycles  Note 3: start offset adjusted every 3 cycles | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.1-4, the following observations can be made.

- For FR1, DL only evaluation, DU, high load, CG 30Mbps traffic at 60fps and 15ms PDB, it is observed from MediaTek and Intel that

- semi-static alignment provides

- mean power saving gain of 7.22% in the range of 4.56% to 9.90% for all UEs

- mean capacity gain of -0.70% in the range of -1.30% to -0.3%

- R15/16 CDRX as the performance reference provides

- mean power saving gain of 4.42% in the range of 3.23% to 5.40% for all UEs

- mean capacity gain of -2.33% in the range of -3.5% to -1.5%

- For FR1, DL only evaluation, DU, high load, jitter off, CG 30Mbps traffic at 60fps and 15ms PDB, it is observed from Intel that

- semi-static alignment provides

- mean power saving gain of 9.46% in the range of 8.37% to 10.54% for all UEs

- capacity gain of 0%

- R15/16 CDRX as the performance reference provides

- mean power saving gain of 3.96% in the range of 3.13% to 4.79% for all UEs

- mean capacity gain of -2.0% in the range of -1.5% to -2.5%

Table B.2.1-5: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 1 | R1-2211905 | Always On | - | - | - | H | 11 | 11 | 93.18% | 0.0% | 0.0% | - |  |
| ZTE | 2 | R1-2211905 | R15 CDRX | 10 | 8 | 4 | H | 11 | 11 | 90.15% | -3.3% | 7% | - |  |
| ZTE | 3 | R1-2211905 | R15 CDRX | 16 | 10 | 5 | H | 11 | 11 | 81.82% | -12.2% | 18.47% | - |  |
| ZTE | 5 | R1-2211905 | Non-uniform CDRX cycle | (17,17,16) | 6 | 4 | H | 11 | 11 | 90.15% | -3.3% | 33.9% | - |  |
| ZTE | 6 | R1-2211905 | Uniform non-integer CDRX cycle | (1000/60) | 6 | 4 | H | 11 | 11 | 90.18% | -3.2% | 33.8% | - |  |
| ZTE | 7 | R1-2211905 | Enhanced multiple CDRX (3 CDRX configurations) | 50ms DRX cycle | 6 | 4 | H | 11 | 11 | 90.1% | -3.3% | 34% | - |  |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 5 | 10 | 100% | 0.0% | 0.0% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 16 | 14 | 4 | L | 5 | 10 | 100% | 0.0% | 3.67% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 10 | 8 | 4 | L | 5 | 10 | 100% | 0.0% | 5.72% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 4 | 3 | 1 | L | 5 | 10 | 100% | 0.0% | 4.63% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 16 | 8 | 4 | L | 5 | 10 | 11.67% | -88.3% | 19.71% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 10 | 5 | 2 | L | 5 | 10 | 78.33% | -21.7% | 15.41% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 10 | 4 | 2 | L | 5 | 10 | 52.22% | -47.8% | 22.17% | - |  |
| vivo |  | R1-2211024 | Enhanced DRX | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0.0% | 13.05% | - |  |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 92.50% | 0.0% | 0.0% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 16 | 14 | 4 | H | 10 | 10 | 91.81% | -0.7% | 3.46% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 10 | 8 | 4 | H | 10 | 10 | 91.25% | -1.4% | 5.10% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 4 | 3 | 1 | H | 10 | 10 | 91.68% | -0.9% | 4.03% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 16 | 8 | 4 | H | 10 | 10 | 2.78% | -97.0% | 18.21% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 10 | 5 | 2 | H | 10 | 10 | 45.00% | -51.4% | 13.10% | - |  |
| vivo |  | R1-2211024 | R15/16 DRX | 10 | 4 | 2 | H | 10 | 10 | 22.50% | -75.7% | 18.70% | - |  |
| vivo |  | R1-2211024 | Enhanced DRX | 16.67 | 8 | 4 | H | 10 | 10 | 91.94% | -0.6% | 10.08% | - |  |
| CATT | 1 | R1-2211174 | Baseline: DG scheduling and UE always-on | - | - | - | H | 12 | 12 | 95.8% | 0.0% | 0.0% | - |  |
| CATT | 2 | R1-2211174 | DG scheduling with C-DRX | 16 | 12 | 4 | H | 12 | 12 | 90.0% | -6.1% | 8.0% | - |  |
| CATT | 3 | R1-2211174 | Enhanced C-DRX | 17/17/16 | 8 | 4 | H | 12 | 12 | 0.0% | -100.0% | 25.5% | - |  |
| CATT | 3 | R1-2211174 | Enhanced C-DRX | 17/17/16 | 8 | 4 | H | 12 | 12 | 0.0% | -100.0% | 19.0% | - | Note1 |
| CATT | 4 | R1-2211174 | Enhanced C-DRX | 17/17/16 | 10 | 4 | H | 12 | 12 | 21.7% | -77.3% | 14.8% | - |  |
| CATT | 4 | R1-2211174 | Enhanced C-DRX | 17/17/16 | 10 | 4 | H | 12 | 12 | 21.7% | -77.3% | 7.4% | - | Note1 |
| CATT | 5 | R1-2211174 | Enhanced C-DRX | 17/17/16 | 12 | 4 | H | 12 | 12 | 84.2% | -12.1% | 9.3% | - |  |
| CATT | 5 | R1-2211174 | Enhanced C-DRX | 17/17/16 | 12 | 4 | H | 12 | 12 | 84.2% | -12.1% | 1.4% | - | Note1 |
| Nokia |  | R1-2211551 | Always On Baseline | - | - | - | H | 5 | 5 | 95% | 0.0% | 0.0% | - |  |
| Nokia | 7 | R1-2211551 | CDRX | 16 | 8 | 8 | H | 5 | 5 | 0% | -100.0% | - | - |  |
| Nokia | 8 | R1-2211551 | Cyclic DRX pattern | {16,17,17} | 8 | 8 | H | 5 | 5 | 0% | -100.0% | - | - |  |
| Note 1: PSG is calculated w.r.t. DG scheduling with C-DRX | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.1-5, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from ZTE, vivo, CATT and Nokia that

- semi-static alignment provides

- mean power saving gain of 23.05% in the range of 9.30% to 34% for all UEs with

- mean capacity gain of -28.54% in the range of -100% to -0.60%

- R15/16 CDRX as the performance reference provides

- mean power saving gain of 10.67% in the range of 3.46% to 18.70% for all UEs with

- mean capacity gain of -27.63% in the range of -100% to -0.70%

- For FR1, DL only evaluation, InH, low load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from vivo that

- semi-static alignment provides

- power saving gain of 13.05% for all UEs with

- capacity gain of 0%

- R15/16 CDRX as the performance reference provides

- mean power saving gain of 11.89% in the range of 3.67% to 22.17% for all UEs with

- mean capacity gain of -26.30% in the range of -88.3% to 0%

Table B.2.1-6: FR2, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| QC | 13 | R1-2212134 | Always On | - | - | - | H | 7 | 7 | 90% | 0.0% | 0% | - | Note 1 |
| QC | 14 | R1-2212134 | Rel15/16 CDRX | 16 | 4 | 4 | H | 7 | 7 | 0% | -100.0% | 28.60% | - | Note 1 |
| QC | 15 | R1-2212134 | Rel15/16 CDRX | 16 | 8 | 8 | H | 7 | 7 | 42% | -53.3% | 8.70% | - | Note 1 |
| QC | 16 | R1-2212134 | Rel15/16 CDRX | 16 | 8 | 16 | H | 7 | 7 | 90% | 0.0% | 0.29% | - | Note 1 |
| QC | 17 | R1-2212134 | eCDRX | 16/17/17 | 4 | 4 | H | 7 | 7 | 90% | 0.0% | 18.93% | - | Note 1 |
| QC | 18 | R1-2212134 | eCDRX | 16/17/17 | 8 | 8 | H | 7 | 7 | 90% | 0.0% | 7.71% | - | Note 1 |
| QC | 19 | R1-2212134 | eCDRX | 16/17/17 | 8 | 16 | H | 7 | 7 | 90% | 0.0% | 0.30% | - | Note 1 |
| QC | 20 | R1-2212134 | Always On | - | - | - | H | 7 | 7 | 90% | 0.0% | 0% | - |  |
| QC | 21 | R1-2212134 | Rel15/16 CDRX | 16 | 4 | 4 | H | 7 | 7 | 0% | -100.0% | 28.44% | - |  |
| QC | 22 | R1-2212134 | Rel15/16 CDRX | 16 | 8 | 8 | H | 7 | 7 | 50% | -44.4% | 9.64% | - |  |
| QC | 23 | R1-2212134 | Rel15/16 CDRX | 16 | 8 | 16 | H | 7 | 7 | 65% | -27.8% | 4.10% | - |  |
| QC | 24 | R1-2212134 | eCDRX | 16/17/17 | 4 | 4 | H | 7 | 7 | 27% | -70.0% | 25.10% | - |  |
| QC | 25 | R1-2212134 | eCDRX | 16/17/17 | 8 | 8 | H | 7 | 7 | 84% | -6.7% | 8.28% | - |  |
| QC | 26 | R1-2212134 | eCDRX | 16/17/17 | 8 | 16 | H | 7 | 7 | 88% | -2.2% | 2.43% | - |  |
| Note 1: jitter is off. | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.1-6, the following observations can be made

- For FR2, DL only evaluation, InH, high load, jitter off, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Qualcomm that

- semi-static alignment provides

- mean power saving gain of 8.98% in the range of 0.30% to 18.93% for all UEs

- capacity gain of 0%

- R15/16 CDRX as the performance reference provides

- mean power saving gain of 12.53% in the range of 0.29% to 28.60% for all UEs

- mean capacity gain of -51.10% in the range of -100% to 0%

- For FR2, DL only evaluation, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Qualcomm that

- semi-static alignment provides

- mean power saving gain of 11.94% in the range of 2.43% to 25.10% for all UEs

- mean capacity gain of -26.30% in the range of -70.00% to -2.2%

- R15/16 CDRX as the performance reference provides

- mean power saving gain of 14.06% in the range of 4.10% to 28.44% for all UEs

- mean capacity gain of -57.4% in the range of -100% to -27.8%

Table B.2.1-7: FR1, DL-only, InH, CG30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Nokia |  | R1-2211551 | Always On Baseline | - | - | - | H | 6 | 6 | 90% | 0.0% | 0.0% | - |  |
| Nokia | 1 | R1-2211551 | CDRX | 16 | 8 | 8 | H | 6 | 6 | 60% | -33.3% | 13.30% | - |  |
| Nokia | 2 | R1-2211551 | Cyclic DRX pattern | {16,17,17} | 8 | 8 | H | 6 | 6 | 40% | -55.6% | 16.00% | - |  |

Based on the evaluation results in Table B.2.1-7, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, CG 30Mbps traffic at 60fps and 15ms PDB, it is observed from Nokia that

- semi-static CDRX periodicity alignment provides

- power saving of 16.00%

- capacity gain of -55.6%

- R15/16 CDRX provides

- mean power saving gain of 13.30% for all UEs

- capacity gain of -33.3%

### B.2.2 Dynamic CDRX alignment

This clause captures evaluation results for enhanced CDRX based on dynamic alignment between CDRX and XR traffic. The following evaluations were provided by companies:

- Nokia evaluated dynamic adaptation of DRX parameters based on auxiliary L1/L2 signalling in addition to semi-static solution to align XR traffic and CDRX operation.

- ZTE and Qualcomm evaluated dynamic CDRX enhancement to adjust the CDRX start offset.

Table B.2.2-1: FR1, DL+UL pose/control, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 8 | R1-2211905 | Always on | - | - | - | H | 11 | 11 | 93.18% | 100%- | 93.18% | 0.00% | 0% | - |  |
| ZTE | 11 | R1-2211905 | Dynamic indication | 50 | 6 | 4 | H | 11 | 11 | 90.1% | 100% | 90.1% | -3.31% | 23% | - |  |
| ZTE | 12 | R1-2211905 | Non-uniform CDRX cycle | 17-17-16 | 6 | 4 | H | 11 | 11 | 90.15% | 100% | 90.15% | -3.25% | 23.86% | - |  |
| ZTE | 13 | R1-2211905 | Uniform non-integer CDRX cycle | (1000/60) | 6 | 4 | H | 11 | 11 | 90.15% | 100% | 90.15% | -3.25% | 23.85% | - |  |
| ZTE | 14 | R1-2211905 | Multiple CDRX (3 CDRX configurations) | 50ms DRX cycle | 6 | 4 | H | 11 | 11 | 90.11% | 100% | 90.11% | -3.29% | 24% | - |  |

Based on the evaluation results in Table B.2.2-1, the following observations can be made.

- For FR1, DL + UL joint evaluation, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from ZTE that

- dynamic alignment provides

- power saving gain of 23% for all UEs

- capacity gain of -3.31%

- semi-static alignment as the performance reference provides

- mean power saving gain of 23.90% in the range of 23.85% to 24% for all UEs

- mean capacity gain of -3.26% in the range of -3.29% to -3.25%.

Table B.2.2-2: FR1, DL-only, InH, CG30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Nokia |  | R1-2211551 | Always On Baseline | - | - | - | H | 6 | 6 | 90% | 0.0% | 0.0% | - |  |
| Nokia | 1 | R1-2211551 | CDRX | 16 | 8 | 8 | H | 6 | 6 | 60% | -33.3% | 13.30% | - |  |
| Nokia | 2 | R1-2211551 | Cyclic DRX pattern | {16,17,17} | 8 | 8 | H | 6 | 6 | 40% | -55.6% | 16.00% | - |  |
| Nokia | 3 | R1-2211551 | Adaptive DRX | 16 | 8 | 8 | H | 6 | 6 | 62% | -31.1% | 15.00% | - | Note1 |
| Nokia | 4 | R1-2211551 | Adaptive DRX | {16, 17, 17} | 8 | 8 | H | 6 | 6 | 62% | -31.1% | 15.00% | - | Note1 |
| Nokia | 5 | R1-2211551 | Adaptive DRX | 16 | 8 | 8 | H | 6 | 6 | 75% | -16.7% | 19.00% | - | Note2 |
| Note 1: startOffset = ExpectedArrival - FixedTimeShift  Note 2: scalingFactor X={1/2,1/4} | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.2-2, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, CG 30Mbps traffic at 60fps and 15ms PDB, it is observed from Nokia that

- adaptive DRX provides

- mean power saving gain of 16.33% in the range of 15.00% to 19.00% for all UEs

- mean capacity gain of -26.3% in the range of -31.1% to -16.7%

- semi-static CDRX periodicity alignment provides

- power saving of 16.00%

- capacity gain of -55.6%

- R15/16 CDRX provides

- mean power saving gain of 13.30% for all UEs

- capacity gain of -33.3%

Table B.2.2-3: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Nokia |  | R1-2211551 | Always On Baseline | - | - | - | H | 5 | 5 | 95% | 0.0% | 0.0% | - |  |
| Nokia | 7 | R1-2211551 | CDRX | 16 | 8 | 8 | H | 5 | 5 | 0% | -100.0% | - | - |  |
| Nokia | 8 | R1-2211551 | Cyclic DRX pattern | {16,17,17} | 8 | 8 | H | 5 | 5 | 0% | -100.0% | - | - |  |
| Nokia | 9 | R1-2211551 | Adaptive DRX | 16 | 8 | 8 | H | 5 | 5 | 25% | -73.7% | 15.00% | - | Note1 |
| Nokia | 10 | R1-2211551 | Adaptive DRX | {16, 17, 17} | 8 | 8 | H | 5 | 5 | 25% | -73.7% | 15.00% | - | Note1 |
| Nokia | 11 | R1-2211551 | Adaptive DRX | 16 | 8 | 8 | H | 5 | 5 | 70% | -26.3% | 19.00% | - | Note2 |
| ZTE | 1 | R1-2211905 | Always on | - | - | - | H | 11 | 11 | 93.18% | 0.00% | 0% | - |  |
| ZTE | 4 | R1-2211905 | Dynamic indication | 50 | 6 | 4 | H | 11 | 11 | 90.1% | -3.31% | 33% | - |  |
| ZTE | 5 | R1-2211905 | Non-uniform CDRX cycle | 17-17-16 | 6 | 4 | H | 11 | 11 | 90.15% | -3.25% | 33.9% | - |  |
| ZTE | 6 | R1-2211905 | Uniform non-integer CDRX cycle | (1000/60) | 6 | 4 | H | 11 | 11 | 90.18% | -3.22% | 33.8% | - |  |
| ZTE | 7 | R1-2211905 | Multiple CDRX (3 CDRX configurations) | 50ms DRX cycle | 6 | 4 | H | 11 | 11 | 90.1% | -3.31% | 34% | - |  |
| Note 1: startOffset = ExpectedArrival - FixedTimeShift  Note 2: scalingFactor X={1/2,1/4} | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.2-3, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Nokia that

- adaptive DRX provides

- mean power saving gain of 16.33% in the range of 15.00% to 19.00% for all UEs

- mean capacity gain of -57.90% in the range of -73.7% to -26.3%

- semi-static CDRX periodicity alignment and R15/16 CDRX provides

- capacity gain of -100%

- For FR1, DL only evaluation, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from ZTE that

- dynamic alignment provides power

- saving gain of 33% for all UEs

- capacity gain of -3.31%.

- semi-static alignment as the performance reference provides

- mean power saving gain of 33.90% in the range of 33.80% to 34% for all UEs

- mean capacity gain of -3.26% in the range of-3.22% to -3.31%.

Table B.2.2-4: FR2, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Additional Assumptions |
| QC | 39 | R1-2212134 | Always On | - | - | - | H | 7 | 7 | 90% | 0.0% | 0% |  |
| QC | 40 | R1-2212134 | eCDRX + PDCCH skipping | 16 | 4 | 4 | H | 7 | 7 | 27% | -70.0% | 31.5% | Note 1 |
| QC | 41 | R1-2212134 | eCDRX + PDCCH skipping | 16 | 8 | 8 | H | 7 | 7 | 84% | -6.7% | 17.4% | Note 1 |
| QC | 42 | R1-2212134 | eCDRX + PDCCH skipping | 16 | 8 | 16 | H | 7 | 7 | 88% | -2.2% | 12.7% | Note 1 |
| QC | 43 | R1-2212134 | Enhancement:  eCDRX + PDCCH skipping + Adaptive ON Start | 16 | 4 | 4 | H | 7 | 7 | 27% | -70.0% | 60.5% | Note 1 |
| QC | 44 | R1-2212134 | Enhancement:  eCDRX + PDCCH skipping + Adaptive ON Start | 16 | 8 | 8 | H | 7 | 7 | 84% | -6.7% | 48.9% | Note 1 |
| QC | 45 | R1-2212134 | Enhancement:  eCDRX + PDCCH skipping + Adaptive ON Start | 16 | 8 | 16 | H | 7 | 7 | 88% | -2.2% | 42.7% | Note 1 |
| QC | 46 | R1-2212134 | eCDRX + PDCCH skipping | 16 | 4 | 4 | H | 7 | 7 | 27% | -70.0% | 45.5% | Note 2 |
| QC | 47 | R1-2212134 | eCDRX + PDCCH skipping | 16 | 8 | 8 | H | 7 | 7 | 84% | -6.7% | 43.1% | Note 2 |
| QC | 48 | R1-2212134 | eCDRX + PDCCH skipping | 16 | 8 | 16 | H | 7 | 7 | 88% | -2.2% | 43.7% | Note 2 |
| QC | 49 | R1-2212134 | Enhancement:  eCDRX + PDCCH skipping + Adaptive ON Start | 16 | 4 | 4 | H | 7 | 7 | 27% | -70.0% | 74.5% | Note 2 |
| QC | 50 | R1-2212134 | Enhancement:  eCDRX + PDCCH skipping + Adaptive ON Start | 16 | 8 | 8 | H | 7 | 7 | 84% | -6.7% | 74.6% | Note 2 |
| QC | 51 | R1-2212134 | Enhancement:  eCDRX + PDCCH skipping + Adaptive ON Start | 16 | 8 | 16 | H | 7 | 7 | 88% | -2.2% | 73.7% | Note 2 |
| Note 1: PDCCH skipping inside ON duration only  Note 2: PDCCH skipping inside ON duration and for IAT (early IAT termination) | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.2-4, the following observations can be made.

- For FR2, DL only evaluation, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Qualcomm that

- adaptative On Start (on top of semi-static alignment and PDCCH skipping) provides

- mean power saving gain of 62.48% in the range of 42.70% and 74.60% for all UEs

- mean capacity gain of -26.30% in the range of -70.0% to -2.2%

- semi-static alignment and PDCCH skipping as the performance reference provides

- mean power saving gain of 32.32% in the range of 12.70% to 45.50% for all UEs

- mean capacity gain of -26.30% in the range of -70.0% to -2.2%

Table B.2.2-5: FR1, DL-only, DU, CG30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Nokia |  | R1-2206225 | Always On Baseline | - | - | - | H | 8 | 8 | 96% |  | 0.0% | - |  |
| Nokia | 1 | R1-2206225 | CDRX | 16 | 8 | 8 | H | 8 | 6 | 50% | -48% | 13.30% | - |  |
| Nokia | 2 | R1-2206225 | Adaptive DRX | 16 | [1,16] | 0 | H | 8 | 6 | 69% | -28% | 12.00% | - | Note 1 |
| Nokia | 3 | R1-2206225 | Adaptive DRX | 16 | [8,16] | 0 | H | 8 | 7 | 76% | -20% | 9.00% | - | Note 2 |
| Nokia | 4 | R1-2206225 | Adaptive DRX | 16 | [4,12] | 0 | H | 8 | 3 | 5% | -94% | 22.00% | - | Note 3 |
| Note 1: Onduration can be adapted in the range indicated in ODT column.  Note 2: Onduration can be adapted in the range indicated in ODT column. Range for startOffset adaptation was [0,2]ms  Note 2: Onduration can be adapted in the range indicated in ODT column. Range for startOffset adaptation was [0,4]ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.2-5, the following observations can be made.

- For FR1, DL only evaluation, DU, high load, CG 30Mbps traffic at 60fps and 15ms PDB, it is observed from Nokia that

- adaptive DRX provides

- mean power saving gain of 13.33% in the range of 9.00% to 22.00% for all UEs

- mean capacity gain of -47.33xx% in the range of -20% to X-94%%

- R15/16 CDRX provides

- mean power saving gain of 13.30% for all UEs

- capacity gain of -48%

Table B.2.2-6: FR1, DL-only, DU, AR/VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Nokia |  | R1-2206225 | Always On Baseline | - | - | - | H | 6 | 6 | 96% |  | 0.0% | - |  |
| Nokia | 1 | R1-2206225 | CDRX | 16 | 8 | 8 | H | 6 | 0 | 0% | -100% | 0.0% | - |  |
| Nokia | 2 | R1-2206225 | Adaptive DRX | 16 | [1,16] | 0 | H | 6 | 4 | 25% | -73% | 9.3% | - | Note 1 |
| Nokia | 3 | R1-2206225 | Adaptive DRX | 16 | [8,16] | 0 | H | 6 | 5 | 71% | -26% | 13% | - | Note 2 |
| Nokia | 4 | R1-2206225 | Adaptive DRX | 16 | [4,12] | 0 | H | 6 | 2 | 5% | -69% | 18.2% | - | Note 3 |
| Note 1: Onduration can be adapted in the range indicated in ODT column.  Note 2: Onduration can be adapted in the range indicated in ODT column. Range for startOffset adaptation was [0,2]ms  Note 3: Onduration can be adapted in the range indicated in ODT column. Range for startOffset adaptation was [0,3]ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.2-6, the following observations can be made.

- For FR1, DL only evaluation, DU, high load, AR/VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Nokia that

- adaptive DRX provides

- mean power saving gain of 13.5% in the range of 9.3% to 18.2% for all UEs

- mean capacity gain of -56% in the range of -26% to -73%

- R15/16 CDRX provides

- mean power saving gain of 0% for all UEs

- capacity gain of -100%

### B.2.3 Non-uniform PMOs within CDRX On Duration

This clause captures evaluation results for non-uniform PDCCH monitoring occasions (PMOs) within CDRX On Duration:

- Huawei evaluated configuring non-uniform PDCCH monitoring occasions within C-DRX On Duration based on bitmap to match with jitter distribution.

Table B.2.3-1: FR1, DL-only, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Huawei | 4 | R1-2210906 | Always On | - | 12 | 4 | H | 11 | 11 | 93.42% | 0.0% | 0.0% | - |  |
| Huawei | 5 | R1-2210906 | Legacy C-DRX | 16 | 12 | 4 | H | 11 | 11 | 83.20% | -10.9% | 5.57% | - |  |
| Huawei | 6 | R1-2210906 | Aligned CDRX | 50 {0, 16, 33} | 12 | 4 | H | 11 | 11 | 91.43% | -2.1% | 7.64% | - | Note 1 |
| Huawei | 7 | R1-2210906 | Aligned CDRX | 50 {0, 16, 33} | 12 | 4 | H | 11 | 11 | 85.89% | -8.1% | 15.81% | - | Note 2 |
| Huawei | 8 | R1-2210906 | Aligned CDRX + Non-uniform PMOs | 50 {0, 16, 33} | 12 | 4 | H | 11 | 11 | 89.70% | -4.0% | 16.23% | - | Note 3 |
| Huawei | 9 | R1-2210906 | Aligned CDRX + Non-uniform PMOs | 50 {0, 16, 33} | 12 | 4 | H | 11 | 11 | 85.71% | -8.3% | 20.75% | - | Note 4 |
| Note 1: PDCCH monitoring pattern within DRX On Duration is [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]  Note 2: PDCCH monitoring pattern within DRX On Duration is [0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 1, 1]  Note 3: PDCCH monitoring pattern within DRX On Duration is [0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 0, 1]  Note 4: PDCCH monitoring pattern within DRX On Duration is [0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0]  In the PDCCH monitoring pattern, 1 indicates a slot with PDCCH monitoring and 0 indicates a slot without PDCCH monitoring | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.3-1, the following observations can be made.

- For FR1, DL only evaluation, DU, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Huawei that

- non-uniform PMOs within On Duration provides

- mean power saving gain of 18.49% in the range of 16.23% and 20.75% for all UEs

- mean capacity gain of -6.15% in the range of -8.3% to -4.0%

- sparse PDCCH monitoring as the performance reference provides

- mean power saving gain of 11.73% in the range of 7.64% to 15.81% for all UEs

- mean capacity gain of -5.10% in the range of -8.1% to -2.1%

### B.2.4 Two-stage CDRX On Duration

This clause captures evaluation results for two-stage CDRX On Duration

- Ericsson evaluated the two-stage DRX solution with multiple inner On Durations within the outer On Duration and compared its performance with that of R17 PDCCH monitoring adaptation.

- vivo compared R17 PDCCH monitoring adaptation and the two-stage On-Duration by performance evaluations.

Table B.2.4-1: FR1, DL+UL, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Ericsson | 35 | R1-2210922 | Always On | - | - | - | H | 8 | 8 | - | - | 90.1% | 0.0% | - | - | Note1 |
| Ericsson | 38 | R1-2210922 | Matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 85.5% | -5.1% | 7.2% | 7.1% | Note1,2 |
| Ericsson | 40 | R1-2210922 | PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 84.7% | -6.0% | 7.6% | 7.6% | Note1,2 |
| Ericsson | 41 | R1-2210922 | R17 SSSG switching (sparse SSSG:2 ms on / 2 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 66.0% | -26.7% | 10.3% | 10.3% | Note1,2 |
| Ericsson | 42 | R1-2210922 | R17 SSSG switching (sparse SSSG:1 ms on / 1 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 79.8% | -11.4% | 10.7% | 10.7% | Note1,2 |
| Ericsson | 43 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 79.9% | -11.3% | 11.3% | 11.2% | Note1,2 |
| Ericsson | 44 | R1-2210922 | Two-stage DRX & matched CDRX | outer DRX: 16.6;  inner DRX: 4 | outer ODT: 10; inner ODT: 2 | 4 | H | 8 | 8 | - | - | 80.2% | -11.0% | 9.1% | 9.1% | Note1,3 |
| Ericsson | 45 | R1-2210922 | Two-stage DRX & matched CDRX | outer DRX: 16.6;  inner DRX: 2 | outer ODT: 10; inner ODT: 1 | 4 | H | 8 | 8 | - | - | 81.5% | -9.5% | 10.7% | 10.7% | Note1,3 |
| Ericsson | 46 | R1-2210922 | Two-stage DRX & PDCCH skipping & matched CDRX | outer DRX: 16.6;  inner DRX: 4 | outer ODT: 10; inner ODT: 2 | 4 | H | 8 | 8 | - | - | 79.8% | -11.4% | 9.5% | 9.5% | Note1,3 |
| Ericsson | 47 | R1-2210922 | Two-stage DRX & PDCCH skipping & matched CDRX | outer DRX: 16.6;  inner DRX: 2 | outer ODT: 10; inner ODT: 1 | 4 | H | 8 | 8 | - | - | 80.7% | -10.4% | 11.5% | 11.5% | Note1,3 |
| Note 1: the DL traffic has a second flow for audio with 30ms PDB  Note 2: Matched CDRX cycle has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms)  Note 3: Outer CDRX cycle has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms) | | | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.4-1, the following observations can be made.

- For FR1, DL + UL joint evaluation, DU, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Ericsson that

- two-stage CDRX On Duration provides

- mean power saving gain of 10.20% in the range of 9.10% to 11.50% for all UEs

- mean capacity gain of -10.58% in the range of -11.4% to -9.5%

- sparse PDDCH monitoring followed by SSSG switching as the performance reference provides

- mean power saving gain of 10.77% in the range of 10.30% to 11.30% for all UEs

- mean capacity gain of -16.47% in the range of -26.7% to -11.3%

Table B.2.4-2: FR1, DL-only, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Ericsson | 1 | R1-2210922 | Always On | - | - | - | H | 8 | 8 | 91.7% | 0.0% | 0.0% | 0.0% |  |
| Ericsson | 4 | R1-2210922 | Matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 87.2% | -4.9% | 10.5% | 11.4% | Note 1 |
| Ericsson | 6 | R1-2210922 | PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 87.3% | -4.8% | 15.8% | 16.0% | Note 1 |
| Ericsson | 7 | R1-2210922 | R17 SSSG switching (sparse SSSG: 2 ms on / 2 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 53.9% | -41.2% | 15.5% | 16.0% | Note 1 |
| Ericsson | 8 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 78.4% | -14.5% | 16.4% | 16.5% | Note 1 |
| Ericsson | 9 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 78.9% | -14.0% | 20.2% | 20.4% | Note 1 |
| Ericsson | 10 | R1-2210922 | Two-stage DRX & matched CDRX | outer DRX: 16.6;  inner DRX: 4 | outer ODT: 10; inner ODT: 2 | 4 | H | 8 | 8 | 79.2% | -13.6% | 14.8% | 15.1% | Note 2 |
| Ericsson | 11 | R1-2210922 | Two-stage DRX & matched CDRX | outer DRX: 16.6;  inner DRX: 2 | outer ODT: 10; inner ODT: 1 | 4 | H | 8 | 8 | 80.2% | -12.5% | 16.2% | 16.6% | Note 2 |
| Ericsson | 12 | R1-2210922 | Two-stage DRX & PDCCH skipping & matched CDRX | outer DRX: 16.6;  inner DRX: 4 | outer ODT: 10; inner ODT: 2 | 4 | H | 8 | 8 | 78.6% | -14.3% | 19.2% | 19.4% | Note 2 |
| Ericsson | 13 | R1-2210922 | Two-stage DRX & PDCCH skipping & matched CDRX | outer DRX: 16.6;  inner DRX: 2 | outer ODT: 10; inner ODT: 1 | 4 | H | 8 | 8 | 80.4% | -12.3% | 20.4% | 20.6% | Note 2 |
| Ericsson | 18 | R1-2210922 | Always On | - | - | - | L | 2 | 8 | 100% | 0.0% | 0.0% | 0.0% |  |
| Ericsson | 20 | R1-2210922 | Matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 12.8% | 12.8% | Note 1 |
| Ericsson | 23 | R1-2210922 | PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 22.5% | 22.5% | Note 1 |
| Ericsson | 24 | R1-2210922 | R17 SSSG switching (sparse SSSG: 2 ms on / 2 ms off) & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 82.9% | -17.1% | 18.2% | 18.2% | Note 1 |
| Ericsson | 25 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 19.2% | 19.2% | Note 1 |
| Ericsson | 26 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 26.6% | 26.6% | Note 1 |
| Ericsson | 27 | R1-2210922 | Two-stage DRX & matched CDRX | outer DRX: 16.6;  inner DRX: 4 | outer ODT: 10; inner ODT: 2 | 4 | L | 2 | 8 | 100% | 0.0% | 16.7% | 16.7% | Note 2 |
| Ericsson | 28 | R1-2210922 | Two-stage DRX & matched CDRX | outer DRX: 16.6;  inner DRX: 2 | outer ODT: 10; inner ODT: 1 | 4 | L | 2 | 8 | 100% | 0.0% | 19.0% | 19.0% | Note 2 |
| Ericsson | 29 | R1-2210922 | Two-stage DRX & PDCCH skipping & matched CDRX | outer DRX: 16.6;  inner DRX: 4 | outer ODT: 10; inner ODT: 2 | 4 | L | 2 | 8 | 100% | 0.0% | 25.9% | 25.9% | Note 2 |
| Ericsson | 30 | R1-2210922 | Two-stage DRX & PDCCH skipping & matched CDRX | outer DRX: 16.6;  inner DRX: 2 | outer ODT: 10; inner ODT: 1 | 4 | L | 2 | 8 | 100% | 0.0% | 27.0% | 27.0% | Note 2 |
| Note 1: Matched CDRX cycle has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms)  Note 2: Outer CDRX cycle has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms) | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.4-2, the following observations can be made.

- For FR1, DL only, DU, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Ericsson that

- two-stage CDRX On Duration provides

- mean power saving gain of 17.65% in the range of 4.80% to 20.40% for all UEs

- mean capacity gain of -13.18% in the range of -14.30% to -12.30%

- sparse PDDCH monitoring followed by SSSG switching as the performance reference provides

- mean power saving gain of 17.37% in the range of 15.50% to 20.20% for all UEs

- mean capacity gain of -23.23% in the range of -41.20% to -14.00%

- For FR1, DL only, DU, low load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Ericsson that

- two-stage CDRX On Duration provides

- mean power saving gain of 22.15% in the range of 6.70% to 27.00% for all UEs

- mean capacity gain of 0%

- sparse PDDCH monitoring followed by SSSG switching as the performance reference provides

- mean power saving gain of 21.33% in the range of 18.20% to 26.60% for all UEs

- mean capacity gain of -5.70% in the range of 0.00% to -17.10%

Table B.2.4-3: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 5 | 10 | 100% | 0.0% | 0.0% | - |  |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0.0% | 23.36% | - | Note1,2 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0.0% | 25.39% | - | Note1,3 |
| vivo |  | R1-2211024 | Two-stage CDRX | Outer CDRX: 16.67  Inner CDRX: 4 | Outer CDRX: 10  Inner CDRX: 2 | Outer CDRX: 4  Inner CDRX: 4 | L | 5 | 10 | 100% | 0.0% | 21.52% | - | Note4 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 92.50% | 0.0% | 0.0% | - |  |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 92.22% | -0.3% | 19.28% | - | Note1,2 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 88.52% | -4.3% | 21.84% | - | Note1,3 |
| vivo |  | R1-2211024 | Two-stage CDRX | Outer CDRX: 16.67  Inner CDRX: 4 | Outer CDRX: 10  Inner CDRX: 2 | Outer CDRX: 4  Inner CDRX: 4 | H | 10 | 10 | 86.89% | -6.1% | 16.36% | - | Note4 |
| Note 1: PDCCH skipping is indicated in the DCI that schedules a dummy PDSCH after all the HARQ-ACK processes of transmissions have been completed  Note 2: applying R17 sparse SSSG with PDCCH monitoring every 2 slots when DRX Onduration starts and switch to dense SSSG with PDCCH monitoring every 1 slot after detecting DCI scheduling XR traffic burst  Note 3: applying R17 sparse SSSG with PDCCH monitoring every 4 slots when DRX Onduration starts and switch to dense SSSG with PDCCH monitoring every 1 slot after detecting DCI scheduling XR traffic burst  Note 4: 4ms CDRX cycle and 2ms ODT for inner CDRX | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.4-3, the following observations can be made.

- For FR1, DL only, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from vivo that

- two-stage CDRX On Duration provides

- power saving gain of 16.36% for all UEs

- capacity gain of -6.1%

- sparse PDDCH monitoring followed by SSSG switching as the performance reference provides

- mean power saving gain of 20.56% in the range of 19.28% to 21.84% for all UEs

- mean capacity gain of -2.3% in the range of -4.3% to -0.3%

- For FR1, DL only, InH, low load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from vivo that

- two-stage CDRX On Duration provides

- power saving gain of 21.52% for all UEs

- mean capacity gain of 0.0%

- sparse PDDCH monitoring followed by SSSG switching as the performance reference provides

- mean power saving gain of 24.38% in the range of 23.36% to 25.39% for all UEs

- mean capacity gain of 0.0%

### B.2.5 Jitter handling by LP-WUS

This clause captures evaluation results for LP-WUS based jitter handling

- vivo and Xiaomi evaluated LP-WUS based wakeup mechanism for XR traffic in presence of jitter, i.e., UE wakes up after a LP-WUS is detected. LP-WUS evaluation methodologies such as power modelling of WUS detection and gap between detected LP-WUS and UE wakeup are based on their own assumptions.

Table FR1 B.2.5-1, DL-only, DU, VR45

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Xiaomi | 1 | R1-2211341 | Always On | - | - | - | H | 3 | 3 | 96.61% | 0.0% | - | 0.0% |  |
| Xiaomi | 2 | R1-2211341 | Rel-17 PDCCH skipping | - | - | - | H | 3 | 3 | 95% | -1.7% | - | 41.74% | Note 1 |
| Xiaomi | 4 | R1-2211341 | LP-WUS | - | - | - | H | 3 | 3 | 95% | -1.7% | - | 54.92% | Note 1, 2, 3 |
| Note 1: PDCCH skipping with 2 candidate durations(8/10ms)  Note 2: the relative power of LP WUS monitoring is assumed to be 1  Note 3:  the resource overhead for LP WUS is not considered | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.5-1, the following observations can be made.

- For FR1, DL only, DU, high load, VR 45Mbps traffic at 60fps and 10ms PDB, it is observed from Xiaomi that

- LP-WUS based jitter handling provides

- power saving gain of 54.92% for satisfied UEs

- mean capacity gain of -1.7%

Table B.2.5-2: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 5 | 10 | 100% | 0.0% | - | - | Note1 |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 5 | 10 | 100% | 0.0% | - | - | Note2 |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 5 | 10 | 100% | 0.0% | - | - | Note3 |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 5 | 10 | 100% | 0.0% | - | - | Note4 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0.0% | 23.36% | - | Note1,5,6 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 12 | 4 | L | 5 | 10 | 100% | 0.0% | 18.73% | - | Note2,5,6 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 16 | 4 | L | 5 | 10 | 100% | 0.0% | 15.79% | - | Note3,5,6 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 16 | 4 | L | 5 | 10 | 100% | 0.0% | 13.91% | - | Note4,5,6 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0.0% | 29.71% | - | Note1,5,7,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 12 | 4 | L | 5 | 10 | 100% | 0.0% | 28.26% | - | Note2,5,7,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 16 | 4 | L | 5 | 10 | 100% | 0.0% | 29.36% | - | Note3,5,7,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 16 | 4 | L | 5 | 10 | 100% | 0.0% | 29.28% | - | Note4,5,7,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 8 | 4 | L | 5 | 10 | 89.44% | -10.6% | 34.10% | - | Note1,5,8,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 12 | 4 | L | 5 | 10 | 87.22% | -12.8% | 34.83% | - | Note2,5,8,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 16 | 4 | L | 5 | 10 | 87.60% | -12.4% | 37.87% | - | Note3,5,8,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 8 | 4 | L | 5 | 10 | 99.44% | -0.6% | 34.10% | - | Note1,5,8,9,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 12 | 4 | L | 5 | 10 | 99.44% | -0.6% | 34.83% | - | Note2,5,8,9,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 16 | 4 | L | 5 | 10 | 99.33% | -0.7% | 37.87% | - | Note3,5,8,9,10 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 92.50% | 0.0% | - | - | Note1 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 92.33% | 0.0% | - | - | Note2 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 91.83% | 0.0% | - | - | Note3 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 90.94% | 0.0% | - | - | Note4 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 92.22% | -0.3% | 19.28% | - | Note1,5,6 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 12 | 4 | H | 10 | 10 | 92.16% | -0.2% | 14.96% | - | Note2,5,6 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 16 | 4 | H | 10 | 10 | 91.05% | -0.8% | 12.26% | - | Note3,5,6 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 16 | 4 | H | 10 | 10 | 91.01% | 0.1% | 11.17% | - | Note4,5,6 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 8 | 4 | H | 10 | 10 | 92.22% | -0.3% | 25.10% | - | Note1,5,7,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 12 | 4 | H | 10 | 10 | 92.20% | -0.1% | 24.08% | - | Note2,5,7,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 16 | 4 | H | 10 | 10 | 91.08% | -0.8% | 24.68% | - | Note3,5,7,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 16 | 4 | H | 10 | 10 | 91.11% | 0.2% | 25.90% | - | Note4,5,7,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 8 | 4 | H | 10 | 10 | 54.17% | -41.4% | 29.22% | - | Note1,5,8,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 12 | 4 | H | 10 | 10 | 53.61% | -41.9% | 30.26% | - | Note2,5,8,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 16 | 4 | H | 10 | 10 | 54.86% | -40.3% | 33.18% | - | Note3,5,8,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 8 | 4 | H | 10 | 10 | 82.78% | -10.5% | 29.22% | - | Note1,5,8,9,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 12 | 4 | H | 10 | 10 | 82.25% | -10.9% | 30.26% | - | Note2,5,8,9,10 |
| vivo |  | R1-2211024 | LP-WUS scheme | 16.67 | 16 | 4 | H | 10 | 10 | 82.51% | -10.1% | 33.18% | - | Note3,5,8,9,10 |
| Note 1: jitter range = [-4, +4]ms, STD=2ms  Note 2: jitter range = [-6, +6]ms, STD=2ms  Note 3: jitter range = [-8, +8]ms, STD=5ms  Note 4: jitter range = [-10, +10]ms, STD=5ms  Note 5: PDCCH skipping is indicated in the DCI that schedules a dummy PDSCH after all the HARQ-ACK processes of transmissions have been completed  Note 6: applying R17 sparse SSSG with PDCCH monitoring every 2 slots when DRX Onduration starts and switch to dense SSSG with PDCCH monitoring every 1 slot after detecting DCI scheduling XR traffic burst  Note 7: the total relative power (including the power of both LP-WUR and main radio) for LP-WUS monitoring is 45 units with no wake-up latency  Note 8: the total relative power (including the power of both LP-WUR and main radio) for LP-WUS monitoring is 20 units with 3ms wake-up latency  Note 9: UE satisfaction metric as 95% packet successful rate  Note 10: the resource overhead for LP WUS is not considered | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.5-2, the following observations can be made.

- For FR1, DL only, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from vivo that

- LP-WUS jitter handling provides

- mean power saving gain of 28.51% in the range of 24.08% to 33.18% for all UEs

- mean capacity gain of -15.61% in the range of -41.90% to -0.10%

- sparse PDDCH monitoring followed by SSSG switching to dense PDCCH monitoring as the performance reference provides

- mean power saving gain of 14.42% in the range of 11.17% to 19.28% for all UEs

- mean capacity gain of -0.30% in the range of -0.80% to -0.10%%%

- For FR1, DL only, InH, low load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from vivo that

- LP-WUS jitter handling provides

- mean power saving gain of 33.02% in the range of 29.71% to 37.87% for all UEs

- mean capacity gain of -3.77% in the range of -12.80% to 0.0%

- sparse PDDCH monitoring followed by SSSG switching to dense PDCCH monitoring as the performance reference provides

- mean power saving gain of 17.95% in the range of 13.91% to 23.36% for all UEs

- mean capacity gain of 0%

### B.2.6 Early stopping of On Duration Timer

This clause captures evaluation results for early stopping of DRX On Duration Timer based on the expiration of InactivityTimer or a configured time window:

- Huawei, Xiaomi and MediaTek evaluated early stopping of the On Duration Timer after the InactivityTimer or a configured time window expires to stop PDCCH monitoring.

Table B.2.6-1: FR1, DL-only, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Huawei | 11 | R1-2210906 | Always On | - | 12 | 4 | H | 11 | 11 | 93.42% | 0.0% | 0.0% | - |  |
| Huawei | 12 | R1-2210906 | Aligned CDRX | 50 {0, 16, 33} | 12 | 4 | H | 11 | 11 | 91.43% | -2.1% | 7.64% | - |  |
| Huawei | 13 | R1-2210906 | Aligned CDRX + early stopping of ODT | 50 {0, 16, 33} | 12 | 4 | H | 11 | 11 | 88.23% | -5.6% | 10.22% | - |  |

Based on the evaluation results in Table B.2.6-1, the following observations can be made.

- For FR1, DL only, DU, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from Huawei that

- on top of eCDRX, the early stopping of ODT provides

- power saving gain of 10.22% for all UEs

- capacity gain of -5.6%

- eCDRX as the performance reference provides

- power saving gain of 7.64% for all UEs

- capacity gain of -2.1%

Table B.2.6-2: FR1, DL-only, DU, CG30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| MTK | 22 | R1-2212253 | AlwaysOn - baseline | 0 | 0 | 0 | H | 12 | 12 | 94.6% | 0.0% | 0% | - |  |
| MTK | 23 | R1-2212253 | R15/16CDRX | 16 | 12 | 8 | H | 12 | 12 | 92.7% | -2.0% | 5.4% | - |  |
| MTK | 24 | R1-2212253 | eCDRX (rational DRX cycle) | (50/3) | 12 | 8 | H | 12 | 12 | 94.3% | -0.3% | 9.9% | - |  |
| MTK | 25 | R1-2212253 | eCDRX + stop ODT early | (50/3) | 12 | 8 | H | 12 | 12 | 92.4% | -2.3% | 16.6% | - |  |

Based on the evaluation results in Table B.2.6-2, the following observations can be made.

- For FR1, DL only, DU, high load, CG 30Mbps traffic at 60fps and 15ms PDB, it is observed from MediaTek that

- with eCDRX, the early stopping of ODT provides

- power saving gain of 16.6% for all UEs

- capacity gain of -2.3%

- eCDRX as the performance reference provides

- power saving gain of 9.9% for all UEs

- capacity gain of -0.3%

Table B.2.6-3: FR1, DL-only, DU, VR45

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Xiaomi | 1 | R1-2211341 | AlwaysOn | - | - | - | H | 3 | 3 | 100% | 0.0% | - | 0.0% |  |
| Xiaomi | 6 | R1-2211341 | CDRX | 16/17/17 | 12 | 4 | H | 3 | 3 | 98.41% | -1.59% | - | 11.39% |  |
| Xiaomi | 5 | R1-2211341 | CDRX+On duration early termination | 16/17/17 | 12 | 4 | H | 3 | 3 | 94.92% | -5.08% | - | 43.18% |  |

Based on the evaluation results in Table B.2.6-3, the following observations can be made.

- For FR1, DL only, DU, high load, VR 45Mbps traffic at 60fps and 10ms PDB, it is observed from Xiaomi that

- with eCDRX, the early stopping of ODT provides

- power saving gain of 43.18% for satisfied UEs

- capacity gain of -5.08%

- eCDRX as the performance reference provides

- power saving gain of 11.39% for all UEs

- capacity gain of -1.59%

### B.2.7 Additional DRX active time

This clause captures evaluation results for additional DRX active time.

- ZTE evaluated the extension for additional active time if UE does not receive UE specific data scheduled by a PDCCH CRC scrambled by the XR-specific RNTI within current active time.

- OPPO evaluated additional On Duration triggered by dynamic signaling such as a DCI to receive data that arrives after the On Duration expires.

- Nokia evaluated the Extension of Active Time (EAT) to extend DRX active time if XR frame does not arrive before the On Duration timer expires.

- vivo compared the additional DRX active time and R17 PDCCH monitoring adaptation scheme.

Table B.2.7-1: FR1, DL+UL, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 52 | R1-2212596 | Always on | - | - | - | H | 11 | 11 | - | - | 90.15% | 0.00% | 0% | - | Note 1 |
| ZTE | 15 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 12 | 4 | H | 11 | 11 | 88.36% | 100% | 88.36% | -1.99% | 7.5% | - | Note 1 |
| ZTE | 16 | R1-2212596 | Additional active time + aligned CDRX | Aligned every 50ms | 5 | 4 | H | 11 | 11 | 90% | 100% | 90% | -0.17% | 14.18% | - | Note 1,2 |
| Note 1: Jitter range = [-8,8]ms  Note 2: additional active time = original DRX On duration | | | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.7-1, the following observations can be made.

- For FR1, DL and UL joint evaluation, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from ZTE that

- on top of eCDRX, additional active time provides

- power saving gain of 14.18% for all UEs

- capacity gain of -0.17%.

- eCDRX as the performance reference provides

- power saving gain of 7.5% for all UEs

- capacity gain of -1.99%.

Table B.2.7-2: FR1, DL+UL, InH, VR45

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 54 | R1-2212596 | Always on | - | - | - | H | 7 | 7 | - | - | 90.48% | 0.00% | - | - | Note 1 |
| ZTE | 19 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 12 | 5 | H | 7 | 7 | 90% | 100% | 90% | -0.53% | 7.5% | - | Note 1 |
| ZTE | 20 | R1-2212596 | Additional active time + aligned CDRX | Aligned every 50ms | 6 | 5 | H | 7 | 7 | 88.1% | 100% | 88.1% | -2.63% | 15.16% | - | Note 1,2 |
| Note 1: Jitter range = [-8,8]ms  Note 2: additional active time = original DRX On duration | | | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.7-2, the following observations can be made.

- For FR1, DL and UL joint evaluation, InH, high load, VR 45Mbps traffic at 60fps and 10ms PDB, it is observed from ZTE that

- on top of eCDRX, additional active time provides

- power saving gain of 15.16% for all UEs

- capacity gain of -2.63%.

- eCDRX as the performance reference provides

- power saving gain of 7.5% for all UEs

- capacity gain of -0.53%.

Table B.2.7-3: FR1, DL+UL, InH, CG30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 56 | R1-2212596 | Always on | - | - | - | H | 12 | 12 | 96.53% | 100% | 96.53% | 0.00% | 0% | - |  |
| ZTE | 23 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 6 | 4 | H | 12 | 12 | 84% | 100% | 84% | -12.98% | 21.2% | - |  |
| ZTE | 24 | R1-2212596 | Additional active time + aligned CDRX | Aligned every 50ms | 6 | 4 | H | 12 | 12 | 88.19% | 100% | 88.19% | -8.64% | 21.3% | - | Note 1 |
| Note 1: additional active time = original DRX On duration | | | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.7-3, the following observations can be made.

- For FR1, DL and UL joint evaluation, InH, high load, CG 30Mbps traffic at 60fps and 15ms PDB, it is observed from ZTE that

- on top of eCDRX, additional active time provides

- power saving gain of 21.3% for all UEs

- capacity gain of -8.64%.

- eCDRX as the performance reference provides

- power saving gain of 21.2% for all UEs

- capacity gain of -12.98%.

Table B.2.7-4: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 53 | R1-2212596 | Always on | - | - | - | H | 11 | 11 | 90.15% | 0.00% | 0% | - | Note 1 |
| ZTE | 17 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 12 | 4 | H | 11 | 11 | 88.36% | -1.99% | 10.4% | - | Note 1 |
| ZTE | 18 | R1-2212596 | Additional active time + aligned CDRX | Aligned every 50ms | 5 | 4 | H | 11 | 11 | 90% | -0.17% | 30% | - | Note 1,2 |
| vivo |  | R1-2208660 | Always On | - | - | - | L | 5 | 10 | 100% | 0% | 0% | - |  |
| vivo |  | R1-2208660 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0% | 23.36% | - | Note 3,4 |
| vivo |  | R1-2208660 | Additional On-Duration | 16.67 | 4 | 4 | L | 5 | 10 | 100% | 0% | 18.73% | - | Note 5 |
| vivo |  | R1-2208660 | Always On | - | - | - | H | 10 | 10 | 92.50% | 0.0% | 0% | - |  |
| vivo |  | R1-2208660 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 92.22% | -0.3% | 19.28% | - | Note 3,4 |
| vivo |  | R1-2208660 | Additional On-Duration | 16.67 | 4 | 4 | H | 10 | 10 | 91.49% | -1.1% | 14.68% | - | Note 5 |
| Note 1: Jitter range = [-8,8]ms  Note 2: additional active time = original DRX On duration  Note 3: PDCCH skipping is indicated in the DCI that schedules a dummy PDSCH after all the HARQ-ACK processes of transmissions have been completed  Note 4: applying R17 sparse SSSG with PDCCH monitoring every 2 slots when DRX Onduration starts and switch to dense SSSG with PDCCH monitoring every 1 slot after detecting DCI scheduling XR traffic burst  Note 5: additional DRX onduration length is 4ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.7-4, the following observations can be made.

- For FR1, DL only, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from ZTE that

- with eCDRX, additional active time provides

- power saving gain of 30% for all UEs

- capacity gain of -0.17%.

- eCDRX as the performance reference provides power

- saving gain of 10.4% for all UEs

- capacity gain of -1.99%.

- For FR1, DL only, InH, low load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from vivo that

- on top of eCDRX, additional active time provides

- power saving gain of 18.73% for all UEs

- capacity gain of 0%

- eCDRX with R17 PDCCH monitoring adaptation as the performance reference provides

- power saving gain of 23.36% for all UEs

- capacity gain of 0%

- For FR1, DL only, InH, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from vivo that

- with eCDRX, additional active time provides

- power saving gain of 14.68% for all UEs

- capacity gain of -1.1%

- eCDRX with R17 PDCCH monitoring adaptation as the performance reference provides

- power saving gain of 19.28% for all UEs

- capacity gain of -0.3%

Table B.2.7-5: FR1, DL-only, InH, CG30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 57 | R1-2212596 | Always On | - | - | - | H | 12 | 12 | 96.53% | 0.00% | 0% | - |  |
| ZTE | 25 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 6 | 4 | H | 12 | 12 | 84% | -12.98% | 30.9% | - |  |
| ZTE | 26 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 8 | 6 | H | 12 | 12 | 88.89% | -7.91% | 20.6% | - |  |
| ZTE | 27 | R1-2212596 | Additional active time + aligned CDRX | Aligned every 50ms | 6 | 4 | H | 12 | 12 | 88.19% | -8.64% | 32.4% | - | Note 1 |
| Nokia |  | R1-2209535 | Always On Baseline | - | - | - | H | 6 | 6 | 90.00 % | 0.00% | 0.0% | - | - |
| Nokia | 1 | R1-2209535 | C-DRX with EAT | 16 | 8 | 0 | H | 6 | 6 | 51.38 % | -42.91% | 30.33 % | - | Note 2 |
| Nokia | 2 | R1-2209535 | C-DRX with EAT | 16 | 6 | 0 | H | 6 | 6 | 49.86 % | -44.60% | 30.40 % | - | Note 2 |
| Nokia | 3 | R1-2209535 | C-DRX with EAT | 16 | 4 | 0 | H | 6 | 6 | 51.80 % | -42.44% | 30.43 % | - | Note 2 |
| Nokia | 4 | R1-2209535 | C-DRX with EAT | 16 | 2 | 0 | H | 6 | 6 | 51.80 % | -42.44% | 30.43 % | - | Note 2 |
| Note1: additional active time = original DRX On duration  Note2:  Extension timer = 1ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.7-5, the following observations can be made.

- For FR1, DL only, InH, high load, CG 30Mbps traffic at 60fps and 15ms PDB, it is observed from ZTE that

- on top of eCDRX, additional active time provides

- power saving gain of 32.4% for all UEs

- capacity gain of -8.64%.

- eCDRX as the performance reference provides

- mean power saving gain of 25.75% in the range of 20.6% to 30.9% for all UEs

- mean capacity gain of -10.45% in the range of -12.985 to -7.91%.

- For FR1, DL only, InH, high load, CG 30Mbps traffic at 60fps and 15ms PDB, it is observed from Nokia that

- Extension of active time provides

- mean power saving gain of 30.40% for all UEs in the range of 30.33% to 30.43%

- mean capacity gain of -43.10% for all UEs in the range of -44.60% to -42.44%

Table B.2.7-6: FR1, DL-only, InH, VR45

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 55 | R1-2212596 | Always on | - | - | - | H | 7 | 7 | 90.48% | 0.00% | 0.00% | - | Note 1 |
| ZTE | 21 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 12 | 5 | H | 7 | 7 | 90% | -0.53% | 8.47% | - | Note 1 |
| ZTE | 22 | R1-2212596 | Additional active time + aligned CDRX | Aligned every 50ms | 6 | 5 | H | 7 | 7 | 88.1% | -2.63% | 20% | - | Note 1,3 |
| ZTE | 39 | R1-2212596 | Always on | - | - | - | H | 7 | 7 | 90% | 0.00% | 0.00% | - | Note 2 |
| ZTE | 41 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 88.10% | -2.11% | 4.60% | - | Note2 |
| ZTE | 40 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 12 | 5 | H | 7 | 7 | 80% | -11.11% | 9.46% | - | Note2 |
| ZTE | 42 | R1-2212596 | Additional active time + aligned CDRX | Aligned every 50ms | 2 | 4 | H | 7 | 7 | 89.48% | -0.58% | 19% | - | Note2,3 |
| ZTE | 44 | R1-2212596 | PDCCH Skipping  (duration = 2ms,4ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 72.62% | -19.31% | 10.84% | - | Note2 |
| ZTE | 43 | R1-2212596 | PDCCH skipping with dummy grant  (duration = 4ms,8ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 80.95% | -10.1% | 13.03% | - | Note2 |
| Note 1: Jitter range = [-8,8]ms, STD = 2.9ms  Note 2: Jitter range = [-8,8]ms, STD = 5ms  Note 3: additional active time = original DRX On duration | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.7-6, the following observations can be made.

- For FR1, DL only, InH, high load, VR 45Mbps traffic at 60fps and 10ms PDB, it is observed from ZTE that

- on top of eCDRX, additional active time provides mean

- power saving gain of 19.5% in the range of 19% to 20% for all UEs

- mean capacity gain of -1.61% in the range of -2.63% to -0.58%.

- eCDRX performance reference provides

- mean power saving gain of 7.51% in the range of 4.60% to 9.46% for all UEs

- mean capacity gain of -4.58% in the range of -11.11% to -0.53%.

- eCDRX + PDCCH skipping performance reference provides

- mean power saving gain of 11.94% in the range of 10.84% to 13.03% for all UEs

- mean capacity gain of -14.71% in the range of -19.31% to -10.1%.

Table B.2.7-7: FR1, DL-only, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| OPPO | 1 | R1-2211490 | Always On | - | - | - | H | 5 | 5 | 90.18% | 0.0% | 0.0% | 0.0% |  |
| OPPO | 3 | R1-2211490 | Non-uniform CDRX cycle pattern | {17,17,16} | 10 | 2 | H | 5 | 5 | 88.77% | -1.6% | 18.72% | 19.43% |  |
| OPPO | 4 | R1-2211490 | Non-uniform CDRX cycle pattern with dynamic additional ODT | {17,17,16} | 4 | 2 | H | 5 | 5 | 90.18% | 0.0% | 30.86% | 32.33% | Note1 |
| Note 1: another DRX On Duration time indicated by DCI is 4ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.7-7, the following observations can be made.

- For FR1, DL only, DU, high load, VR 30Mbps traffic at 60fps and 10ms PDB, it is observed from OPPO that

- on top of eCDRX, additional active time provides

- power saving gain of 30.86% for all UEs

- capacity gain of 0.0%

- eCDRX as the performance reference provides

- power saving gain of 18.72% for all UEs

- capacity gain of -1.6%

Table B.2.7-8: FR1, DL-only, DU, VR45

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 58 | R1-2212596 | Always on | - | - | - | H | 7 | 7 | 91.16% | 0.00% | 0% | - | Note 1 |
| ZTE | 34 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 87% | -4.56% | 4.86% | - | Note 1 |
| ZTE | 35 | R1-2212596 | Additional active time + aligned CDRX | Aligned every 50ms | 2 | 5 | H | 7 | 7 | 90.48% | -0.75% | 20.53% | - | Note 1,2 |
| ZTE | 36 | R1-2212596 | PDCCH skipping (duration = 2ms, 4ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 82% | -10.05% | 9.2% | - | Note 1 |
| ZTE | 28 | R1-2212596 | Always On | - | - | - | H | 7 | 7 | 91.16% | 0.00% | 0.0% | - |  |
| ZTE | 29 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 8 | 5 | H | 7 | 7 | 89.8% | -1.49% | 23% | - |  |
| ZTE | 30 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 10 | 5 | H | 7 | 7 | 90.48% | -0.75% | 16% | - |  |
| ZTE | 31 | R1-2212596 | Additional active time + aligned CDRX | Aligned every 50ms | 2 | 5 | H | 7 | 7 | 91.84% | 0.75% | 26.24% | - | Note 2 |
| ZTE | 32 | R1-2212596 | Additional active time + aligned CDRX + PDCCH skipping (duration = 2ms) | Aligned every 50ms | 2 | 5 | H | 7 | 7 | 91.16% | 0.00% | 33.5% | - |  |
| ZTE | 33 | R1-2212596 | PDCCH skipping (duration = 2ms, 4ms) | Aligned every 50ms | 10 | 5 | H | 7 | 7 | 84% | -7.9% | 24% | - | Note2 |
| ZTE | 46 | R1-2212596 | Always on | - | - | - | H | 7 | 7 | 90% | 0.00% | 0% | - | Note3 |
| ZTE | 47 | R1-2212596 | Aligned CDRX | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 85% | -5.56% | 4.50% | - | Note3 |
| ZTE | 48 | R1-2212596 | Additional active time + aligned CDRX | Aligned every 50ms | 2 | 4 | H | 7 | 7 | 84% | -6.67% | 18% | - | Note3 |
| ZTE | 49 | R1-2212596 | PDCCH Skipping  (duration = 2ms,4ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 74% | -17.78% | 9.6% | - | Note3 |
| ZTE | 50 | R1-2212596 | PDCCH skipping with dummy grant  (duration = 4ms,8ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 80% | -11.11% | 12% | - | Note3 |
| Note 1: Jitter range = [-8,8]ms, STD = 2.9ms  Note 2: additional active time = original DRX On duration  Note 3: Jitter range = [-8,8]ms, STD = 5ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.7-8, the following observations can be made.

- For FR1, DL only, DU, high load, VR 45Mbps traffic at 60fps and 10ms PDB, it is observed from ZTE that

- with eCDRX, additional active time provides

- mean power saving gain of 24.57% in the range of 18% to 33.50% for all UEs

- mean capacity gain of -1.67% in the range of -6.67% to 0.75%

- eCDRX performance reference provides

- mean power saving gain of 12.09% in the range of 4.50% to 23% for all UEs

- mean capacity gain of -3.09% in the range of -5.56% to -0.75%

- eCDRX + PDCCH skipping performance reference provides

- mean power saving gain of 13.70% in the range of 9.20% to 24% for all UEs

- mean capacity gain of -11.71% in the range of -17.78% to -7.90%

### B.2.8 Multiple active CDRX configurations

This clause captures evaluation results for multiple active CDRX configurations for multiple XR traffic flows.

- Ericsson and InterDigital evaluated the multiple active CDRX configurations separately for XR video and the other traffics.

- vivo compared multiple active CDRX configurations and a single active CDRX configuration with SPS or a single active CDRX configuration only.

Table B.2.8-1: FR1, DL+UL, DU, VR30 at 30fps + DL Audio

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Ericsson |  | R1-2210922 | Always On | - | - | - | H | 5 | 5 | - | - | 94.0% | 0.0% | 0% | 0% |  |
| Ericsson |  | R1-2210922 | R15/16 DRX (Long DRX) | 10 | 8 | 4 | H | 5 | 5 | - | - | 90.7% | -3.5% | 3.0% | 3.3% |  |
| Ericsson |  | R1-2210922 | R15/16 DRX (Short DRX) | 4 | 2 | 4 | H | 5 | 5 | - | - | 85.9% | -8.6% | 6.9% | 7.2% |  |
| Ericsson |  | R1-2210922 | Matched CDRX | 33.3 | 10 | 4 | H | 5 | 5 | - | - | 0% | -100.0% | 18.4% | - | Note 2 |
| Ericsson |  | R1-2210922 | Multi-flow DRX & Matched CDRX | 33.3 | 10 | 4 | H | 5 | 5 | - | - | 88.4% | -6.0% | 13.4% | 13.6% | Note1,2 |
| Ericsson |  | R1-2210922 | Multi-flow DRX & two-stage DRX & Matched CDRX | outer DRX: 33.3;  inner DRX: 4 | outer ODT: 10; inner ODT: 2 | 4 | H | 5 | 5 | - | - | 81.8% | -13.0% | 16.9% | 17.2% | Note2,3 |
| Note 1: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 0ms.  Note 2: Matched CDRX has (drx\_offset=3, traffic\_time\_offset=1 ms, drx-LongCycle=33 ms)  Note 3: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 4ms. | | | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.8-1, the following observations can be made.

- For FR1, DL + UL joint evaluation, DU, high load, VR 30Mbps traffic at 30fps with 10ms PDB and DL audio with 10ms PDB, it is observed from Ericsson that

- eCDRX with a single CDRX configuration provides

- power saving gain of 18.4% for all UEs

- capacity gain of -100%

- Multiple CDRX configurations + eCDRX provides

- power saving gain of 13.4%

- capacity gain of -6.0%

- Multiple CDRX configurations + eCDRX + two-stage DRX provides

- power saving gain of 17.2%

- capacity gain of -13.0%

Table B.2.8-2: FR1, DL+UL, DU, VR30 at 45fps + DL Audio

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Ericsson |  | R1-2210922 | Always On | - | - | - | H | 7 | 7 | - | - | 90.1% | 0.0% | - | - |  |
| Ericsson |  | R1-2210922 | R15/16 DRX (Long DRX) | 10 | 8 | 4 | H | 7 | 7 | - | - | 86.3% | -4.2% | 2.7% | 2.6% |  |
| Ericsson |  | R1-2210922 | R15/16 DRX (Short DRX) | 4 | 2 | 4 | H | 7 | 7 | - | - | 78.7% | -12.7% | 6.4% | 6.4% |  |
| Ericsson |  | R1-2210922 | Matched CDRX | 22.2 | 10 | 4 | H | 7 | 7 | - | - | 0% | -100.0% | 12.3% | - | Note 2 |
| Ericsson |  | R1-2210922 | Multi-flow DRX & Matched CDRX | 22.2 | 10 | 4 | H | 7 | 7 | - | - | 85.9% | -4.7% | 10.1% | 10.0% | Note1,2 |
| Ericsson |  | R1-2210922 | Multi-flow DRX & two-stage DRX & Matched CDRX | outer DRX: 22.2;  inner DRX: 4 | outer ODT: 10; inner ODT: 2 | 4 | H | 7 | 7 | - | - | 71.3% | -20.9% | 13.1% | 12.8% | Note1,2 |
| Note 1: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 0ms.  Note 2: Matched CDRX has (drx\_offset=9, traffic\_time\_offset=2 ms, drx-LongCycle=22 ms) | | | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.8-2, the following observations can be made.

- For FR1, DL + UL joint evaluation, DU, high load, VR 45Mbps traffic at 30fps with 10ms PDB and DL audio with 10ms PDB, it is observed from Ericsson that

- eCDRX with a single CDRX configuration provides

- power saving gain of 12.3% for all UEs

- capacity gain of -100%

- Multiple CDRX configurations + eCDRX provides

- power saving gain of 10.1%

- capacity gain of -4.7%

- Multiple CDRX configurations + eCDRX + two-stage DRX provides

- power saving gain of 13.1%

- capacity gain of -20.9%

Table B.2.8-3: FR1, DL-only, InH, VR30 at 60fps + DL Audio

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 5 | 10 | 100% | 0% | - | - |  |
| vivo |  | R1-2211024 | One active CDRX for video | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0% | 11.70% | - |  |
| vivo |  | R1-2211024 | One active CDRX for video and SPS for audio | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0% | 9.81% | - |  |
| vivo |  | R1-2211024 | Multiple CDRXs | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0% | 9.72% | - | Note1 |
| vivo |  | R1-2211024 | Multiple CDRXs | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0% | 9.52% | - | Note2 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 92.09% | 0.0% | - | - |  |
| vivo |  | R1-2211024 | One active CDRX for video | 16.67 | 8 | 4 | H | 10 | 10 | 91.07% | -1.1% | 9.23% | - |  |
| vivo |  | R1-2211024 | One active CDRX for video and SPS for audio | 16.67 | 8 | 4 | H | 10 | 10 | 91.66% | -0.5% | 8.14% | - |  |
| vivo |  | R1-2211024 | Multiple CDRXs | 16.67 | 8 | 4 | H | 10 | 10 | 91.02% | -1.2% | 8.04% | - | Note1 |
| vivo |  | R1-2211024 | Multiple CDRXs | 16.67 | 8 | 4 | H | 10 | 10 | 91.46% | -0.7% | 6.95% | - | Note2 |
| Note 1: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 0ms.  Note 2: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 2ms. | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.8-3, the following observations can be made.

- For FR1, DL-only evaluation, InH, high load, VR 30Mbps traffic at 60fps with 10ms PDB and DL audio, it is observed from vivo that

- multiple CDRX configurations with eCDRX provides

- mean power saving gain of 7.50% in the range of 6.95% to 8.04%

- mean capacity gain of -0.95% in the range of -1.2% to -0.7%

- single eCDRX + SPS performance reference provides

- power saving gain of 8.14%

- capacity gain of -0.5%

- single eCDRX performance reference provides

- power saving gain of 9.23%

- capacity gain of -1.1%

- For FR1, DL-only evaluation, InH, low load, VR 30Mbps traffic at 60fps with 10ms PDB and DL audio, it is observed from vivo that

- multiple CDRX configurations with eCDRX provides

- mean power saving gain of 9.62% in the range of 9.52% to 9.72%

- mean capacity gain of 0%

- single eCDRX + SPS performance reference provides

- power saving gain of 9.81%

- mean capacity gain of 0%

- single eCDRX performance reference provides

- power saving gain of 11.70%

- capacity gain of 0%

Table B.2.8-4: FR1, DL-only, InH, VR30 at 30fps + DL Audio

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| InterDigital | 5 | R1-2211842 | Always On | - | - | - | H | 3 | 3 | 91.70% | 0.0% | 0.0% | - |  |
| InterDigital | 6 | R1-2211842 | Single CDRX Config | 10 | 8 | 2 | H | 3 | 3 | 83.30% | -9.2% | 6.22% | - |  |
| InterDigital | 7 | R1-2211842 | Multi-CDRX Config Set 1 | 33 | 10 | 6 | H | 3 | 3 | 72.20% | -21.3% | 12.82% | - | Note1 |
| InterDigital | 7 | R1-2211842 | Multi-CDRX Config Set 1 | 33 | 10 | 6 | H | 3 | 3 | 72.20% | -21.3% | 6.97% | - | Note1,6 |
| InterDigital | 8 | R1-2211842 | Multi-CDRX Config Set 2 | 33 | 12 | 4 | H | 3 | 3 | 72.20% | -21.3% | 18.09% | - | Note2 |
| InterDigital | 8 | R1-2211842 | Multi-CDRX Config Set 2 | 33 | 12 | 4 | H | 3 | 3 | 72.20% | -21.3% | 12.54% | - | Note2,6 |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 3 | 6 | 100% | 0.0% | 0.0% | - | Note5 |
| vivo |  | R1-2211024 | One active CDRX for video | 33.33 | 8 | 4 | L | 3 | 6 | 0.00% | -100.0% | 41.06% | - | Note5 |
| vivo |  | R1-2211024 | One active CDRX for video and SPS for audio | 33.33 | 8 | 4 | L | 3 | 6 | 100% | 0.0% | 20.70% | - | Note5 |
| vivo |  | R1-2211024 | Multiple CDRXs | 33.33 | 8 | 4 | L | 3 | 6 | 100% | 0.0% | 19.84% | - | Note3,5 |
| vivo |  | R1-2211024 | Multiple CDRXs | 33.33 | 8 | 4 | L | 3 | 6 | 100% | 0.0% | 18.81% | - | Note4,5 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 6 | 6 | 94.91% | 0.0% | 0.0% | - | Note5 |
| vivo |  | R1-2211024 | One active CDRX for video | 33.33 | 8 | 4 | H | 6 | 6 | 0.00% | -100.0% | 37.32% | - | Note5 |
| vivo |  | R1-2211024 | One active CDRX for video and SPS for audio | 33.33 | 8 | 4 | H | 6 | 6 | 94.44% | -0.5% | 19.02% | - | Note5 |
| vivo |  | R1-2211024 | Multiple CDRXs | 33.33 | 8 | 4 | H | 6 | 6 | 93.98% | -1.0% | 18.34% | - | Note3,5 |
| vivo |  | R1-2211024 | Multiple CDRXs | 33.33 | 8 | 4 | H | 6 | 6 | 94.44% | -0.5% | 16.85% | - | Note4,5 |
| Note 1: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 6ms.  Note 2: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 4ms.  Note 3: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 0ms.  Note 4: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 2ms.  Note 5: DL audio has 10ms PDB  Note 6: PSG is calculated w.r.t. single CDRX scheme | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.8-4, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, AR 30Mbps traffic at 30fps with 10ms PDB and DL audio, it is observed from InterDigital that

- Multiple CDRX configurations provides

- mean power saving gain of 15.54% in the range of 12.82% to 18.09%

- mean capacity gain of -21.3%

- performance reference a single CDRX configuration provides

- power saving gain of 6.22% for all UEs

- capacity gain of -9.2%

- For FR1, DL-only evaluation, InH, high load, VR 30Mbps traffic at 30fps with 10ms PDB and DL audio with 10ms PDB, it is observed from vivo that

- multiple CDRX configurations with eCDRX provides

- mean power saving gain of 17.60% in the range of 16.85% to 18.34%

- mean capacity gain of -0.75% in the range of -1.0% to -0.5%

- performance reference single eCDRX + SPS provides

- power saving gain of 19.02%

- capacity gain of -0.5%

- performance reference single eCDRX provides

- power saving gain of 37.32%

- capacity gain of -100%

- For FR1, DL-only evaluation, InH, low load, VR 30Mbps traffic at 30fps with 10ms PDB and DL audio with 10ms PDB, it is observed from vivo that

- multiple CDRX configurations with eCDRX provides

- mean power saving gain of 19.33% in the range of 18.81% to 19.84%

- capacity gain of 0%

- performance reference single eCDRX + SPS provides

- power saving gain of 20.70%

- capacity gain of 0%

- performance reference single eCDRX provides

- power saving gain of 41.06%

- capacity gain of -100%

Table B.2.8-5: FR1, DL-only, CG, VR30 at 30fps + DL Audio

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| InterDigital | 1 | R1-2211842 | Always On | - | - | - | H | 3 | 3 | 100% | 0.0% | 0.0% | - |  |
| InterDigital | 2 | R1-2211842 | Single CDRX Config | 10 | 8 | 2 | H | 3 | 3 | 100% | 0.0% | 7.647% | - |  |
| InterDigital | 3 | R1-2211842 | Multi-CDRX Config Set 1 | 33 | 10 | 6 | H | 3 | 3 | 94.40% | -5.6% | 12.082% | - | Note1 |
| InterDigital | 3 | R1-2211842 | Multi-CDRX Config Set 1 | 33 | 10 | 6 | H | 3 | 3 | 94.40% | -5.6% | 4.73% | - | Note1,3 |
| InterDigital | 4 | R1-2211842 | Multi-CDRX Config Set 2 | 33 | 12 | 4 | H | 3 | 3 | 91.70% | -8.3% | 17.16% | - | Note2 |
| InterDigital | 4 | R1-2211842 | Multi-CDRX Config Set 2 | 33 | 12 | 4 | H | 3 | 3 | 91.70% | -8.3% | 10.23% | - | Note2,3 |
| Note 1: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 6ms.  Note 2: for the second CDRX, CDRX cycle = 10ms, ODT = 2ms, IAT = 4ms.  Note 3: PSG is calculated w.r.t. single CDRX scheme | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.8-5, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, CG 30Mbps traffic at 30fps with 15ms PDB and DL audio, it is observed from InterDigital that

- single CDRX configuration provides

- power saving gain of 7.647% for all UEs

- capacity gain of 0%

- Multiple CDRX configurations provides

- mean power saving gain of 14.62% in the range of 12.08% to 17.16%

- mean capacity gain of -6.95% in the range of -8.3% to -5.6%

### B.2.9 Dynamic grant enhancement with XR-specific pre-scheduling

This clause captures evaluation results for dynamic grant enhancement with XR-specific pre-scheduling

- CATT evaluated the pre-configured XR-specific PDCCH monitoring cycle and monitoring window disassociated with C-DRX which is aligned with the periodic XR packet generation cycle. UE is allowed to monitor PDCCH for XR-specific PDCCH monitoring cycle at both DRX ON and OFF. CATT also evaluated multicarrier solutions with one carrier for XR service and the second carrier for eMBB service.

Table B.2.9-1: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| CATT | 1 | R1-2211174 | Baseline: DG scheduling and UE always-on | - | - | - | H | 12 | 12 | 95.8% | 0.0% | 0.0% | - |  |
| CATT | 2 | R1-2211174 | DG scheduling with C-DRX | 16 | 12 | 4 | H | 12 | 12 | 90.0% | -6.1% | 8.0% | - |  |
| CATT | 3 | R1-2211174 | Semi-static C-DRX enhancement | 17/17/16 | 8 | 4 | H | 12 | 12 | 0.0% | -100.0% | 25.5% | - |  |
| CATT | 3 | R1-2211174 | Semi-static C-DRX enhancement | 17/17/16 | 8 | 4 | H | 12 | 12 | 0.0% | -100.0% | 19.0% | - | Note1 |
| CATT | 9 | R1-2211174 | Dynamic grant enhancement with XR-specific pre-scheduling scheme 1: Pre-scheduling DG window (16, 12) | 16 | 12 | 0 | H | 12 | 12 | 90.0% | -6.1% | 11.7% | - |  |
| CATT | 9 | R1-2211174 | Dynamic grant enhancement with XR-specific pre-scheduling scheme 1: Pre-scheduling DG window (16, 12) | 16 | 12 | 0 | H | 12 | 12 | 90.0% | -0.0% | 3.8% | - | Note1 |
| CATT | 10 | R1-2211174 | Dynamic grant enhancement with XR-specific pre-scheduling scheme 2: Dynamic grant enhancement with XR-specific pre-scheduling with non-scheduling PDCCH skipping indication | 16 | 12 | 0 | H | 12 | 12 | 89.7% | -7.0% | 22.4% | - |  |
| CATT | 10 | R1-2211174 | Dynamic grant enhancement with XR-specific pre-scheduling scheme 2: Dynamic grant enhancement with XR-specific pre-scheduling with non-scheduling PDCCH skipping indication | 16 | 12 | 0 | H | 12 | 12 | 89.7% | -0.9% | 15.7% | - | Note1 |
| CATT | 11 | R1-2211174 | Dynamic grant enhancement with XR-specific pre-scheduling scheme 3: Pre-scheduling DG window (16, 12) with go-to-sleep | 16 | 12 | 0 | H | 12 | 12 | 90.0% | -6.1% | 24.0% | - |  |
| CATT | 11 | R1-2211174 | Dynamic grant enhancement with XR-specific pre-scheduling scheme 3: Pre-scheduling DG window (16, 12) with go-to-sleep | 16 | 12 | 0 | H | 12 | 12 | 90.0% | -0.0% | 17.4% | - | Note1 |
| CATT | 12 | R1-2211174 | Dynamic grant enhancement with XR-specific pre-scheduling scheme 4: Pre-scheduling DG window (16, 12) with PDCCH skipping and go-to-sleep | 16 | 12 | 0 | H | 12 | 12 | 89.7% | -7.0% | 29.4% | - |  |
| CATT | 12 | R1-2211174 | Dynamic grant enhancement with XR-specific pre-scheduling scheme 4: Pre-scheduling DG window (16, 12) with PDCCH skipping and go-to-sleep | 16 | 12 | 0 | H | 12 | 12 | 89.7% | -0.9% | 23.3% | - | Note1 |
| Note 1: PSG is calculated w.r.t. DG scheduling with C-DRX | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.9-1, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from CATT that

- dynamic grant enhancement with XR-specific pre-scheduling scheme could obtain

- mean power saving gain of 21.88% in the range of 11.7% to 29.40%

- mean capacity gain of -6.55% in the range of -7.00% to -6.10%

- semi-static C-DRX enhancement scheme with (17/17/16, 8, 4) as the performance reference obtains

- mean power saving gain of 22.50% in the range of 19.00% to 25.50%

- mean capacity gain of -100%

- DG scheduling with C-DRX as the performance reference obtains

- mean power saving gain of 15.05% in the range of 3.8% to 23.3%

- mean capacity gain of -0.45%

Table B.2.9-2: FR1, DL-only, multi-carrier, InH, VR30 + IM

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Additional Assumptions |
| CATT | 1 | R1-2211174 | Baseline: DG scheduling and UE always-on | - | - | - | H | 12 | 12 | 95.8% | 0.00% | 0.0% |  |
| CATT | 3 | R1-2211174 | Enhanced C-DRX | 16/17/17 | 8 | 4 | H | 12 | 12 | 0.0% | -100.00% | 19.0% | Note1,3 |
| 27 | R1-2211174 | Enhanced C-DRX | 16/17/17 | 8 | 4 | H | 12 | 12 | - | - | 27.4% | Note2,3 |
| CATT | 12 | R1-2211174 | Dynamic grant enhancement with XR-specific pre-scheduling window (16, 12) with PDCCH skipping and go-to-sleep | - | - | - | H | 12 | 12 | 89.2% | -0.45% | 23.3% | Note1,3 |
| 26 | R1-2211174 | C-DRX for IM | 320 | 10 | 80 | H | 12 | 12 | - | - | 87.2% | Note2,3 |
| Note 1: first carrier for XR service  Note 2: second carrier for eMBB service  Note 3: baseline is DG scheduling with C-DRX(16, 12, 4) and Rel-17 PDCCH skipping scheme | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.9-2, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, multi-carrier, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from CATT that

- Dynamic grant enhancement with XR-specific pre-scheduling scheme for XR traffic carrier and IM traffic carrier provides

- mean power saving gain of 23.3% for the XR traffic carrier

- mean power saving gain of 87.2% for the IM traffic carrier

- mean capacity gain of -0.45% for the XR traffic carrier

- enhanced C-DRX (16/17/17, 8, 4) as performance reference provides

- mean power saving gain of 19.0% for the XR traffic carrier

- mean power saving gain of 27.4% for the IM traffic carrier

- mean capacity gain of -100% for the XR traffic carrier

When XR and IM traffic transmitted in different carriers, the semi-static C-DRX enhancement scheme with (16/17/17, 8, 4) degrade 59.8% PSG of carrier with IM traffic compared with that of dynamic grant enhancement with XR-specific pre-scheduling scheme.

### B.2.10 SPS+DG with UE power saving scheme

This clause captures evaluation results for the UE power saving scheme of SPS enhancement with dynamic grant (DG)

- CATT evaluated the periodic SPS occasion which provides wake-up timing for XR UE during DRX OFF and subsequent dynamic grant window for the transmission of XR packets. When XR packet arrives after the SPS occasion, gNB could indicate UE to perform PDCCH skipping until XR packet arrival and to transform to sleep state after XR packet transmission finishes.

Table B.2.10-1: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| CATT | 1 | R1-2211174 | Baseline: DG scheduling and UE always-on | - | - | - | H | 12 | 12 | 95.8% | 0.0% | 0.0% | 0.0% |  |
| CATT | 2 | R1-2211174 | DG scheduling with C-DRX | 16 | 12 | 4 | H | 12 | 12 | 90.0% | -6.1% | 8.0% | 8.0% |  |
| CATT | 21 | R1-2211174 | SPS enhancement | - | - | - | H | 12 | 12 | 90.0% | -6.1% | 12.5% | 12.6% |  |
| CATT | 21 | R1-2211174 | SPS enhancement | - | - | - | H | 12 | 12 | 90.0% | -0.0% | 9.8% | 9.9% | Note1 |
| CATT | 22 | R1-2211174 | Multiple SPS configurations | - | - | - | H | 12 | 12 | 0.0% | -100.0% | 47.4% | - |  |
| CATT | 22 | R1-2211174 | Multiple SPS configurations | - | - | - | H | 12 | 12 | 0.0% | -100.0% | 46.1% | - | Note1 |
| CATT | 23 | R1-2211174 | SPS enhancement with go-to-sleep | - | - | - | H | 12 | 12 | 88.33% | -7.8% | 39.8% | 39.9% |  |
| CATT | 23 | R1-2211174 | SPS enhancement with go-to-sleep | - | - | - | H | 12 | 12 | 88.33% | -1.9% | 38.0% | 38.1% | Note1 |
| Note 1: PSG is calculated w.r.t. DG scheduling with C-DRX | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.10-1, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from CATT that

- SPS +DG with power saving schemes provides

- mean power saving gain of 25.03% in the range of 9.80% to 39.8%

- mean capacity gain of -3.9% in the range of -0.0% to -7.8%

- DG scheduling with C-DRX(16, 12, 4) as the performance reference provides

- mean power saving gain of 8.0%

- mean capacity gain of -6.1%

- multiple SPS configurations as the performance reference provides

- mean power saving gain of 46.75% in the range of 46.10% to 47.40%

- mean capacity gain of -100%

### B.2.11 PDCCH skipping and interaction with HARQ retransmission

This clause captures evaluation results for PDCCH skipping and interaction with HARQ retransmission:

- Ericsson, vivo, MediaTek and ZTE evaluated the scheme that UE can resume PDCCH monitoring during the time when DRX retransmission timer is running if NACK is transmitted after PDCCH skipping has started.

Table B.2.11-1: FR1, DL+UL, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Ericsson | 35 | R1-2210922 | Always On | - | - | - | H | 8 | 8 |  |  | 90.1% | 0.0% | 0.0% | 0.0% | Note 1 |
| Ericsson | 36 | R1-2210922 | R15/16 DRX (Long DRX) | 10 | 8 | 4 | H | 8 | 8 |  |  | 86.9% | -3.6% | 2.6% | 2.7% | Note 1 |
| Ericsson | 37 | R1-2210922 | R15/16 DRX (Short DRX) | 4 | 2 | 4 | H | 8 | 8 |  |  | 80.2% | -11.0% | 6.1% | 6.1% | Note 1 |
| Ericsson | 38 | R1-2210922 | Matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 |  |  | 85.5% | -5.1% | 7.2% | 7.1% | Note 1,2 |
| Ericsson | 39 | R1-2210922 | Matched CDRX | 17/17/16 | 10 | 4 | H | 8 | 8 |  |  | 86.4% | -4.1% | 7.6% | 7.5% | Note 1 |
| Ericsson | 40 | R1-2210922 | PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 |  |  | 84.7% | -6.0% | 7.6% | 7.6% | Note1,2 |
| MTK | 18 | R1-2212253 | AlwaysOn - baseline | - | - | - | H | 8 | 8 |  |  | 92.14% | 0.0% | 0.0% |  |  |
| MTK | 19 | R1-2212253 | R17 PDCCH skipping | - | - | - | H | 8 | 8 |  |  | 62% | -32.7% | 3.96% |  | Note3 |
| MTK | 20 | R1-2212253 | R17 PDCCH skipping | - | - | - | H | 8 | 8 |  |  | 85.62% | -7.1% | 6.39% |  | Note4 |
| MTK | 21 | R1-2212253 | Enh: PDCCH skipping | - | - | - | H | 8 | 8 |  |  | 89.05% | -3.4% | 17.66% |  | Note5 |
| Note 1: the DL traffic has a second flow for audio with 30ms PDB  Note 2: Matched CDRX has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms)  Note 3: PDCCH skipping duration is 3ms  Note 4: PDCCH skipping duration is 2ms  Note 5: PDCCH skipping duration is 12ms, UE resumes PDCCH monitoring if UE transmits NACK | | | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.11-1, the following observations can be made.

- For FR1, DL + UL joint evaluation, DU, high load, VR 30Mbps traffic at 60fps with 10ms PDB and DL audio, it is observed from Ericsson that

- eCDRX as performance reference provides

- mean power saving gain of 7.4% in the range of 7.2% to 7.6% for all UEs

- mean capacity gain of -4.60% in the range of -5.1% to -4.1%

- PDCCH skipping enhancement with eCDRX provides

- power saving gain of 7.6% for all UEs

- capacity gain of -6.0%

- For FR1, DL + UL joint evaluation, DU, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from MediaTek that

- R17 PDCCH skipping performance reference provides

- mean power saving gain of 5.18% in the range of 3.96% to 6.39% for all UEs

- mean capacity gain of -19.90% in the range of -32.7% to -7.1%

- enhanced PDCCH skipping provides

- power saving gain of 17.66%

- capacity gain of -3.4%

Table B.2.11-2: FR1, DL-only, DU, CG30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| MTK | 1 | R1-2209517 | Always On | - | - | - | H | 12 | 12 | 92.54% | 0.0% | 0% |  |  |
| MTK | 2 | R1-2209517 | Rel-17 PDCCH skipping 5ms | - | - | - | H | 12 | 12 | 62.94% | -32.0% | 14.11% |  | Note 1 |
| MTK | 3 | R1-2209517 | Rel-17 PDCCH skipping | - | - | - | H | 12 | 12 | 83.10% | -10.2% | 11.13% |  | Note 2 |
| MTK | 4 | R1-2209517 | Rel-17 PDCCH skipping | - | - | - | H | 12 | 12 | 87.78% | -5.1% | 8.64% |  | Note 3 |
| MTK | 5 | R1-2209517 | PDCCH skipping enhancement | - | - | - | H | 12 | 12 | 84.37% | -8.8% | 29.60% |  | Note 4 |
| MTK | 5 | R1-2209517 | PDCCH skipping enhancement | - | - | - | H | 12 | 12 | 84.37% | -8.8% | 20.78% |  | Note 4, 5 |
| Note 1: PDCCH skipping duration is 5ms  Note 2: PDCCH skipping duration is 4ms  Note 3: PDCCH skipping duration is 3ms  Note 4: PDCCH skipping duration is 12ms, UE resumes PDCCH monitoring if UE transmits NACK  Note 5: PSG is calculated w.r.t. Rel-17 PDCCH skipping with duration equal to 3ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.11-2, the following observations can be made.

- For FR1, DL + UL joint evaluation, DU, high load, CG 30Mbps traffic at 60fps with 15ms PDB, it is observed from MediaTek that

- Rel-17 PDCCH skipping performance reference provides

- mean power saving gain of 11.29% in the range of 8.64% to 14.11% for all UEs

- mean capacity gain of -15.77% in the range of -32.0% to -5.1%

- enhanced PDCCH skipping provides

- mean power saving gain of 25.19% in the range of 20.78% to 29.60% for all UEs

- capacity gain of -8.8%

Table B.2.11-3: FR1, DL-only, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| MTK | 6 | R1-2209517 | Always On | - | - | - | H | 8 | 8 | 97.02% | 0.0% | 0% | - |  |
| MTK | 7 | R1-2209517 | Rel-17 PDCCH skipping 5ms | - | - | - | H | 8 | 8 | 72.38% | -25.4% | 8.62% | - | Note 1 |
| MTK | 8 | R1-2209517 | Rel-17 PDCCH skipping | - | - | - | H | 8 | 8 | 93.10% | -4.0% | 5.27% | - | Note 2 |
| MTK | 9 | R1-2209517 | PDCCH skipping enhancement | - | - | - | H | 8 | 8 | 96.08% | -1.0% | 31.77% | - | Note 3 |
| MTK | 9 | R1-2209517 | PDCCH skipping enhancement | - | - | - | H | 8 | 8 | 96.08% | -1.0% | 27.97% | - | Note 3, 4 |
| MTK | 14 | R1-2209517 | CDRX baseline | 16 | 10 | 5 | H | 8 | 8 | 33.10% | -65.9% | 0.0% | - |  |
| MTK | 15 | R1-2209517 | Rel-17 PDCCH skipping | 16 | 10 | 5 | H | 8 | 8 | 16.50% | -83.0% | 6.04% | - | Note 1 |
| MTK | 16 | R1-2209517 | Rel-17 PDCCH skipping | 16 | 10 | 5 | H | 8 | 8 | 3.30% | -96.6% | 9.41% | - | Note 2 |
| MTK | 17 | R1-2209517 | PDCCH skipping enhancement | 16 | 10 | 5 | H | 8 | 8 | 21.70% | -77.6% | 23.27% | - | Note 3 |
| Ericsson | 1 | R1-2210922 | Always On | - | - | - | H | 8 | 8 | 91.7% | 0.0% | 0% | 0% |  |
| Ericsson | 2 | R1-2210922 | R15/16 DRX (Long DRX) | 10 | 8 | 4 | H | 8 | 8 | 86.9% | -5.2% | 4.3% | 4.9% |  |
| Ericsson | 3 | R1-2210922 | R15/16 DRX (Short DRX) | 4 | 2 | 4 | H | 8 | 8 | 78.2% | -14.7% | 10.4% | 11.0% |  |
| Ericsson | 4 | R1-2210922 | Matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 87.2% | -4.9% | 10.5% | 11.4% | Note 5 |
| Ericsson | 5 | R1-2210922 | Matched CDRX | 17/17/16 | 10 | 4 | H | 8 | 8 | 87.0% | -5.1% | 10.1% | 10.5% |  |
| Ericsson | 6 | R1-2210922 | PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 87.3% | -4.8% | 15.8% | 16.0% | Note 5 |
| Ericsson | 1 | R1-2210922 | Always On | - | - | - | L | 2 | 8 | 100% | 0.0% | 0% | 0% |  |
| Ericsson | 2 | R1-2210922 | R15/16 DRX (Long DRX) | 10 | 8 | 4 | L | 2 | 8 | 100% | 0.0% | 4.8% | 4.8% |  |
| Ericsson | 3 | R1-2210922 | R15/16 DRX (Short DRX) | 4 | 2 | 4 | L | 2 | 8 | 100% | 0.0% | 12.4% | 12.4% |  |
| Ericsson | 4 | R1-2210922 | Matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 12.8% | 12.8% | Note 5 |
| Ericsson | 5 | R1-2210922 | Matched CDRX | 17/17/16 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 12.5% | 12.5% |  |
| Ericsson | 6 | R1-2210922 | PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 22.5% | 22.5% | Note 5 |
| Note 1: PDCCH skipping duration is 3ms  Note 2: PDCCH skipping duration is 2ms  Note 3: PDCCH skipping duration is 12ms, UE resumes PDCCH monitoring if UE transmits NACK  Note 4: PSG is calculated w.r.t. Rel-17 PDCCH skipping with duration equal to 2ms  Note 5: Matched CDRX has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms) | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.11-3, the following observations can be made.

- For FR1, DL only evaluation, DU, high load, DRX not configured, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from MediaTek that

- R17 PDCCH skipping as performance reference provides

- mean power saving gain of 6.95% in the range of 5.27% to 8.62% for all UEs

- mean capacity gain of -14.70% in the range of -25.4% to -4.0%

- enhanced PDCCH skipping provides

- mean power saving gain of 29.87% in the range of 27.97% to 31.77% for all UEs

- capacity gain of -1.0%

- For FR1, DL only evaluation, DU, high load, DRX configured, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from MediaTek that

- R17 PDCCH skipping as performance reference provides

- mean power saving gain of 7.73% in the range of 6.04% to 9.41% for all UEs

- mean capacity gain of -89.80% in the range of -96.6% to -83.0%

- enhanced PDCCH skipping provides

- power saving gain of 23.27%

- capacity gain of -77.6%

- For FR1, DL only evaluation, DU, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from Ericsson that

- eCDRX as performance reference provides

- mean power saving gain of 10.3% in the range of 10.1% to 10.5% for all UEs

- mean capacity gain of -5.0% in the range of -5.1% to -4.9%

- PDCCH skipping enhancement with eCDRX provides

- power saving gain of 15.8% for all UEs

- capacity gain of -4.8%

- For FR1, DL only evaluation, DU, low load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from Ericsson that

- eCDRX as performance reference provides

- mean power saving gain of 12.65% in the range of 12.5% to 12.8% for all UEs

- capacity gain of 0%

- PDCCH skipping enhancement with eCDRX provides

- power saving gain of 22.5% for all UEs

- capacity gain of 0%

Table B.2.11-4: FR1, DL-only, DU, VR45

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 46 | R1-2211905 | Always on | - | - | - | H | 7 | 7 | 90% | 0.00% | 0% | - | Note1 |
| ZTE | 47 | R1-2211905 | Aligned CDRX | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 85% | -5.56% | 4.50% | - | Note1 |
| ZTE | 49 | R1-2211905 | PDCCH Skipping  (duration = 2ms,4ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 74% | -17.78% | 9.6% | - | Note1 |
| ZTE | 50 | R1-2211905 | PDCCH skipping with dummy grant  (duration = 4ms,8ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 80% | -11.11% | 12% | - | Note1 |
| ZTE | 51 | R1-2211905 | PDCCH Skipping with retransmission  (duration = 3ms,7ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 84% | -6.67% | 16% | - | Note1 |
| MTK | 10 | R1-2209517 | Always On | - | - | - | H | 4 | 4 | 95.71% | 0.0% | 0% | - |  |
| MTK | 11 | R1-2209517 | Rel-17 PDCCH skipping | - | - | - | H | 4 | 4 | 67.38% | -29.6% | 7.97% | - | Note2 |
| MTK | 12 | R1-2209517 | Rel-17 PDCCH skipping | - | - | - | H | 4 | 4 | 89.52% | -6.5% | 4.90% | - | Note3 |
| MTK | 13 | R1-2209517 | PDCCH skipping enhancement | - | - | - | H | 4 | 4 | 93.10% | -2.7% | 29.31% | - | Note4 |
| MTK | 13 | R1-2209517 | PDCCH skipping enhancement | - | - | - | H | 4 | 4 | 93.10% | -2.7% | 25.68% | - | Note4,5 |
| Note 1: Jitter range = [-8,8]ms, STD = 5ms  Note 2: PDCCH skipping duration is 3ms  Note 3: PDCCH skipping duration is 2ms  Note 4: PDCCH skipping duration is 12ms, UE resumes PDCCH monitoring 5ms if UE transmits NACK  Note 5: PSG is calculated w.r.t. Rel-17 PDCCH skipping with duration equal to 2ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.11-4, the following observations can be made.

- For FR1, DL only evaluation, DU, high load, VR 45Mbps traffic at 60fps with 10ms PDB, it is observed from ZTE that

- R17 PDCCH skipping + eCDRX as performance reference provides

- mean power saving gain of 10.80% in the range of 9.6% to 12% for all UEs

- mean capacity gain of -14.45% in the range of -17.78% to -11.11%

- PDCCH skipping with retransmission enhancement + eCDRX provides

- power saving gain of 16% for all UEs with

- capacity gain of -6.67%

- For FR1, DL only evaluation, DU, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from MediaTek

- R17 PDCCH skipping as performance reference provides

- mean power saving gain of 6.44% in the range of 4.90% to 7.97% for all UEs

- mean capacity gain of -18.05% in the range of -29.6% to -6.5%

- enhanced PDCCH skipping without DRX provides

- mean power saving gain of 27.50% in the range of 25.68% to 29.31% for all UEs

- capacity gain of -2.70%

Table B.2.11-5: FR1, DL-only, InH, VR45

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| ZTE | 39 | R1-2211905 | Always on | - | - | - | H | 7 | 7 | 90% | 0.00% | 0.00% | - | Note1 |
| ZTE | 41 | R1-2211905 | Aligned CDRX | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 88.10% | -2.11% | 4.60% | - | Note1 |
| ZTE | 40 | R1-2211905 | Aligned CDRX | Aligned every 50ms | 12 | 5 | H | 7 | 7 | 80% | -11.11% | 9.46% | - | Note1 |
| ZTE | 44 | R1-2211905 | PDCCH Skipping  (duration = 2ms,4ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 72.62% | -19.31% | 10.84% | - | Note1 |
| ZTE | 43 | R1-2211905 | PDCCH skipping with dummy grant  (duration = 4ms,8ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 80.95% | -10.06% | 13.03% | - | Note1 |
| ZTE | 45 | R1-2211905 | PDCCH Skipping with retransmission  (duration = 3ms,7ms) | Aligned every 50ms | 14 | 5 | H | 7 | 7 | 84.52% | -6.1% | 16.31% | - | Note1 |
| Note 1: Jitter range = [-8,8]ms, STD = 5ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.11-5, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, VR 45Mbps traffic at 60fps with 10ms PDB, it is observed from ZTE that

- R17 PDCCH skipping + eCDRX performance reference provides

- mean power saving gain of 11.94% in the range of 10.84% to 13.03% for all UEs

- mean capacity gain of -14.69% in the range of -19.31% to -10.06%.

- PDCCH skipping with retransmission enhancement + eCDRX provides

- power saving gain of 16.31% for all UEs

- capacity gain of -6.1%.

Table B.2.11-6: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 5 | 10 | 100% | 0.0% | 0.0% | - | Note1 |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 5 | 10 | 100% | 0.0% | 0.0% | - | Note2 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0.0% | 23.36% | - | Note1, 4,5, 9 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 16 | 4 | L | 5 | 10 | 100% | 0.0% | 15.79% | - | Note2, 4,5, 9 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping with HARQ interaction | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0.0% | 37.13% | - | Note1, 3,5, 9 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping with HARQ interaction | 16.67 | 16 | 4 | L | 5 | 10 | 100% | 0.0% | 27.77% | - | Note2, 3,5, 9 |
| vivo |  | R1-2211024 | LP-WUS scheme and enhanced PDCCH skipping with HARQ interaction | 16.67 | 8 | 4 | L | 5 | 10 | 100% | 0.0% | 43.84% | - | Note1, 3,8, 9 |
| vivo |  | R1-2211024 | LP-WUS scheme and enhanced PDCCH skipping with HARQ interaction | 16.67 | 16 | 4 | L | 5 | 10 | 100% | 0.0% | 41.90% | - | Note2, 3,8, 9 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 92.50% | 0.0% | - | - | Note1 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 1.11% | -98.80% | 35.21% | - | Note1,3,5, 9 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 92.22% | -0.30% | 19.28% | - | Note1,4,5, 9 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping with HARQ interaction | 16.67 | 8 | 4 | H | 10 | 10 | 92.22% | -0.30% | 32.18% | - | Note1, 3,5, 9 |
| vivo |  | R1-2211024 | LP-WUS scheme and enhanced PDCCH skipping with HARQ interaction | 16.67 | 8 | 4 | H | 10 | 10 | 92.22% | -0.30% | 38.47% | - | Note1, 3,8, 9 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 97.45% | 0.0% | - | - | Note1,7 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 2.22% | -97.72% | 35.21% | - | Note1,3,5,7, 9 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 97.45% | 0% | 19.28% | - | Note1,4,5,7, 9 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping with HARQ interaction | 16.67 | 8 | 4 | H | 10 | 10 | 97.45% | 0% | 32.18% | - | Note1, 3,5,7, 9 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 93.12% | 0.0% | - | - | Note1,6 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 2.08% | -97.77% | 32.77% | - | Note1,3,5,6, 9 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 92.78% | -0.37% | 19.48% | - | Note1,4,5,6, 9 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping with HARQ interaction | 16.67 | 8 | 4 | H | 10 | 10 | 92.78% | -0.37% | 32.49% | - | Note1, 3,5,6, 9 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 97.45% | 0.0% | - | - | Note1,6,7 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 94.91% | -2.61% | 32.77% | - | Note1,3,5,6,7, 9 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 8 | 4 | H | 10 | 10 | 97.45% | 0% | 19.48% | - | Note1,4,5,6,7, 9 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping with HARQ interaction | 16.67 | 8 | 4 | H | 10 | 10 | 97.45% | 0% | 32.49% | - | Note1, 3,5,6,7, 9 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 91.83% | 0.0% | - | - | Note2 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | 16.67 | 16 | 4 | H | 10 | 10 | 91.05% | -0.90% | 12.26% | - | Note2,4,5, 9 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping with HARQ interaction | 16.67 | 16 | 4 | H | 10 | 10 | 91.20% | -0.69% | 23.67% | - | Note2, 3,5, 9 |
| vivo |  | R1-2211024 | LP-WUS scheme and enhanced PDCCH skipping with HARQ interaction | 16.67 | 16 | 4 | H | 10 | 10 | 91.20% | -0.69% | 37.20% | - | Note2, 3,8, 9 |
| Note 1: jitter range = [-4, +4]ms, STD = 2ms  Note 2: jitter range = [-8, +8]ms, STD = 5ms  Note 3: the network indicates PDCCH skipping in the DCI that schedules the initial PDSCH transmission of the last DL packet of an XR traffic burst  Note 4: PDCCH skipping is indicated in the DCI that schedules a dummy PDSCH after all the HARQ-ACK processes of transmissions have been completed  Note 5: applying R17 sparse SSSG with PDCCH monitoring every 2 slots when DRX Onduration starts and switch to dense SSSG with PDCCH monitoring every 1 slot after detecting DCI scheduling XR traffic burst  Note 6: initial BLER is reduced from 10% to 1%  Note 7: satisfaction metric as 95% packet successful rate  Note 8: the total relative power (including the power of both LP-WUR and main radio) for LP-WUS monitoring is 45 with no wake-up latency. The resource overhead for LP WUS is not considered.  Note 9: PDCCH skipping durations include 10 ms, 16 ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.11-6, the following observations can be made.

- For FR1, DL only evaluation, InH, low load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from vivo that

- R17 PDCCH skipping + eCDRX performance reference provides

- mean power saving gain of 19.58% in the range of 15.79% to 23.36% for all UEs

- capacity gain of 0%

- Enhanced PDCCH skipping + eCDRX provides

- mean power saving gain of 32.45% in the range of 27.77% to 37.13% for all UEs

- capacity gain of 0%

- When LP-WUS is adopted, enhanced PDCCH skipping + eCDRX + LP-WUS provides

- mean power saving gain of 42.87% in the range of 41.90% to 43.84% for all UEs

- capacity gain of 0%

- For FR1, DL only evaluation, InH, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from vivo that

- R17 PDCCH skipping + eCDRX performance reference provides

- mean power saving gain of 25.08% in the range of 12.26% to 35.21% for all UEs

- mean capacity gain of -33.16% in the range of -98.80% to 0.0%.

- Enhanced PDCCH skipping + eCDRX provides

- mean power saving gain of 30.60% in the range of 23.67% to 32.49% for all UEs

- mean capacity gain of -0.05% in the range of -0.37% to 0.0%.

- When LP-WUS is adopted, enhanced PDCCH skipping + eCDRX provides

- mean power saving gain of 37.84% in the range of 37.20% to 38.47% for all UEs

- mean capacity gain of -0.50% in the range of -0.69% to -0.30%.

### B.2.12 Enhancements to PDCCH skipping indication

This clause captures evaluation results for various enhancements for the PDCCH skipping indications

- Huawei and vivo evaluated the adaptive PDCCH skipping duration until the earliest possible arrival time of the next frame, i.e., the next jitter boundary position.

- Xiaomi evaluated PDCCH skipping with four skipping durations.

- CATT evaluated PDCCH skipping by introducing the go-to-sleep indication for UE transition to the sleep state immediately.

- Ericsson compared two cases by evaluations when CDRX is configured with: i) Rel-17 PDCCH skipping with two durations only; ii) or enhanced PDCCH skipping with arbitrary skipping duration covering the remaining DRX active time.

Table B.2.12-1: FR1, DL+UL, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Ericsson | 1 | R1-2208401 | Always On | - | - | - | H | 8 | 8 | - | - | 90.1% | 0.0% | 0.0% | 0.0% | Note1 |
| Ericsson | 7 | R1-2208401 | R17 PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 |  |  | 72.2% | -19.9% | 10.5% | 10.4% | Note1,2,4 |
| Ericsson | 8 | R1-2208401 | Enhanced PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 |  |  | 72.4% | -19.6% | 10.5% | 10.5% | Note1, 3,4 |
| Ericsson |  | R1-2208401 | Always On | - | - | - | L | 2 | 8 | - | - | 99.5% | 0.0% | 0.0% | 0.0% | Note1 |
| Ericsson | 15 | R1-2208401 | R17 PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 |  |  | 96.6% | -2.9% | 11.2% | 11.9% | Note1,2,4 |
| Ericsson | 16 | R1-2208401 | Enhanced PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 |  |  | 97.3% | -2.2% | 11.2% | 12.0% | Note1, 3,4 |
| Note 1: the DL traffic has a second flow for audio with 30ms PDB  Note 2: two possible PDCCH skipping periods 5 & 10ms  Note 3: UE skips the remaining DRX active time  Note 4: Matched CDRX has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms) | | | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.12-1, the following observations can be made.

- For FR1, DL + UL joint evaluation, DU, DRX configured, VR 30Mbps traffic at 60fps with 10ms PDB and DL audio, it is observed from Ericsson that

- Rel-17 PDCCH skipping with two durations as performance reference provides

- For high load, power saving gain of 10.4% and capacity gain of -19.9%

- For low load, power saving gain of 11.2% and capacity gain of -2.9%

- enhanced PDCCH skipping with arbitrary skipping duration covering the remaining DRX active time provides

- For high load, power saving gain of 10.5% and capacity gain of -19.6%

- For low load, power saving gain of 11.2% and capacity gain of -2.2%

Table B.2.12-2: FR1, DL-only, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Huawei | 1 | R1-2210906 | Always On | - | - | - | H | 11 | 11 | 93.42% | 0.0% | 0.0% | - |  |
| Huawei | 10 | R1-2210906 | Rel-17 PDCCH Skipping | - | - | - | H | 11 | 11 | 93.42% | 0.0% | 12.12% | - | Note 1 |
| Huawei | 11 | R1-2210906 | Rel-17 PDCCH Skipping | - | - | - | H | 11 | 11 | 93.42% | 0.0% | 11.15% | - | Note 2 |
| Huawei | 12 | R1-2210906 | PDCCH skipping with adaptive duration | - | - | - | H | 11 | 11 | 93.42% | 0.0% | 18.35% | - | Note 3 |
| Note 1: Set of PDCCH skipping duration is {5, 10, 15}ms  Note 2: Set of PDCCH skipping duration is {4, 16, 29}ms  Note 3: UE skips PDCCH monitoring until the earliest possible arrival time of next frame | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.12-2, the following observations can be made.

- For FR1, DL-only evaluation, DU, DRX not configured, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from Huawei that

- PDCCH skipping with adaptive duration provides

- power saving gain of 18.35%

- capacity gain of 0.00%

- R17 PDCCH skipping performance reference provides

- mean power saving gain of 11.64% in the range of 11.15% to 12.12% and

- capacity gain of 0.00%

Table B.2.12-3: FR1, DL-only, DU, VR45

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Xiaomi | 1 | R1-2211341 | AlwaysOn | - | - | - | H | 3 | 3 | 97% | 0.0% | - | 0.0% |  |
| Xiaomi | 2 | R1-2211341 | Rel-17 PDCCH skipping | - | - | - | H | 3 | 3 | 95% | -2.1% | - | 41.74% | Note 1 |
| Xiaomi | 3 | R1-2211341 | PDCCH skipping enhancement | - | - | - | H | 3 | 3 | 96% | -1.0% | - | 47.40% | Note 2 |
| Note 1: PDCCH skipping with 2 candidate durations(8/10ms)  Note 2: PDCCH skipping with 4 candidate durations(6/8/10/12ms) | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.12-3, the following observations can be made.

- For FR1, DL-only evaluation, DU, DRX not configured, high load, VR 45Mbps traffic at 60fps with 10ms PDB, it is observed from Xiaomi that

- Rel-17 PDCCH skipping with 2 candidate durations as performance reference provides

- power saving gain of 41.74%

- capacity gain of -2.1%

- PDCCH skipping enhancement with 4 candidate durations provides

- power saving gain of 47.40% for all UEs

- capacity gain of -1.0%

Table B.2.12-4: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| CATT | 1 | R1-2211174 | Baseline: DG scheduling and UE always-on | - | - | - | H | 12 | 12 | 95.8% | 0.0% | 0.0% | 0.0% |  |
| CATT | 2 | R1-2211174 | DG scheduling with C-DRX | 16 | 12 | 4 | H | 12 | 12 | 90.0% | -6.1% | 8.0% | 8.0% |  |
| CATT | 7 | R1-2211174 | PDCCH skipping enhancement (Go-to-sleep) | 16 | 12 | 4 | H | 12 | 12 | 90.00% | -6.1% | 24.0% | 24.4% |  |
| CATT | 7 | R1-2211174 | PDCCH skipping enhancement (Go-to-sleep) | 16 | 12 | 4 | H | 12 | 12 | 90.00% | -6.1% | 17.4% | 17.8% | Note1 |
| vivo |  | R1-2211024 | Always On | - | - | - | L | 5 | 10 | 100% | 0.0% | 0.0% | - |  |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | - | - | - | L | 5 | 10 | 100% | 0.0% | 6.93% | - | Note2,4 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | - | - | - | L | 5 | 10 | 100% | 0.0% | 18.18% | - | Note2,3,4 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping | - | - | - | L | 5 | 10 | 100% | 0.0% | 12.06% | - | Note2,5 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping | - | - | - | L | 5 | 10 | 100% | 0.0% | 23.36% | - | Note2,3,5 |
| vivo |  | R1-2211024 | Always On | - | - | - | H | 10 | 10 | 92.50% | 0.0% | 0.0% | - |  |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | - | - | - | H | 10 | 10 | 92.28% | -0.2% | 5.66% | - | Note2,4 |
| vivo |  | R1-2211024 | R17 PDCCH monitoring adaptation | - | - | - | H | 10 | 10 | 92.22% | -0.3% | 14.25% | - | Note2,3,4 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping | - | - | - | H | 10 | 10 | 92.30% | -0.2% | 10.46% | - | Note2,5 |
| vivo |  | R1-2211024 | Enhanced PDCCH skipping | - | - | - | H | 10 | 10 | 92.22% | -0.3% | 19.28% | - | Note2,3,5 |
| Note 1: PSG is calculated w.r.t. DG scheduling with C-DRX  Note 2: PDCCH skipping is indicated in the DCI that schedules a dummy PDSCH after all the HARQ-ACK processes of transmissions have been completed  Note 3: applying R17 sparse SSSG with PDCCH monitoring every 2 slots before XR traffic burst arrives and switch to dense SSSG with PDCCH monitoring every 1 slot after detecting DCI scheduling XR traffic burst  Note 4: with [6ms, 4ms, 2ms] candidate skipping durations  Note 5: one-shot skipping to the next jitter boundary position | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.12-4, the following observations can be made.

- For FR1, DL-only evaluation, InH, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from CATT that

- go-to-sleep based on PDCCH skipping enhancement provides

- power saving gain of 24.0% for all UEs

- capacity gain of -6.1%

- DG scheduling with C-DRX which provides

- power saving gain of 8.0%

- capacity gain of -6.1%

- For FR1, DL-only evaluation, InH, low load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from vivo that

- enhanced PDCCH skipping provides

- mean power saving gain of 17.71% in the range of 12.06% to 23.36%

- mean capacity gain of 0.00%

- R17 PDCCH monitoring provides

- mean power saving gain of 12.56% in the range of 6.93% to 18.18%

- mean capacity gain of 0.00%

- For FR1, DL-only evaluation, InH, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from vivo that

- enhanced PDCCH skipping provides

- mean power saving gain of 14.87% in the range of 10.46% to 19.28%

- mean capacity gain of -0.25% in the range of -0.3% to -0.2%

- R17 PDCCH monitoring provides

- mean power saving gain of 9.96% in the range of 5.66% to 14.25%

- mean capacity gain of -0.25% in the range of -0.3% to -0.2%

### B.2.13 Non-scheduling DCI based PDCCH skipping and continuous PDCCH skipping

This clause captures evaluation results for non-scheduling DCI based PDCCH skipping and UE continuous PDCCH skipping.

- CATT evaluated non-scheduling DCI based PDCCH skipping indication to reduce unnecessary PDCCH monitoring when no XR data is scheduled for transmission. On top of this, gNB configures a short PDCCH skipping duration and UE continuously skips the PMOs until the DCI is successfully decoded at the time of packet arrival.

Table B.2.13-1: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| CATT | 1 | R1-2211174 | Baseline: DG scheduling and UE always-on | - | - | - | H | 12 | 12 | 95.8% | 0.0% | 0.0% | 0.0% |  |
| CATT | 2 | R1-2211174 | DG scheduling with C-DRX | 16 | 12 | 4 | H | 12 | 12 | 90.0% | -6.1% | 8.0% | 8.0% | Note1 |
| CATT | 6 | R1-2211174 | PDCCH skipping enhancement (non-scheduling and scheduling DCI with persistent skipping indication) | 16 | 12 | 4 | H | 12 | 12 | 89.70% | -6.4% | 22.4% | 22.4% | Note1 |
| CATT | 6 | R1-2211174 | PDCCH skipping enhancement (non-scheduling and scheduling DCI with persistent skipping indication) | 16 | 12 | 4 | H | 12 | 12 | 89.70% | -0.33% | 15.7% | 15.7% | Note2 |
| CATT | 7 | R1-2211174 | PDCCH skipping enhancement (Go-to-sleep) | 16 | 12 | 4 | H | 12 | 12 | 90.00% | -6.1% | 24.0% | 24.4% | Note1 |
| CATT | 7 | R1-2211174 | PDCCH skipping enhancement (Go-to-sleep) | 16 | 12 | 4 | H | 12 | 12 | 90.00% | 0% | 17.4% | 17.8% | Note2 |
| CATT | 8 | R1-2211174 | PDCCH skipping enhancement (non-scheduling and scheduling DCI with continuous PDCCH skipping and dynamic go-to-sleep indication) | 16 | 12 | 4 | H | 12 | 12 | 89.70% | -6.4% | 29.4% | 29.9% | Note1 |
| CATT | 8 | R1-2211174 | PDCCH skipping enhancement (non-scheduling and scheduling DCI with continuous PDCCH skipping and dynamic go-to-sleep indication) | 16 | 12 | 4 | H | 12 | 12 | 89.70% | -0.33% | 23.3% | 23.8% | Note2 |
| Note 1: power saving gain and capacity gain are calculated w.r.t. Always-On  Note 2: power saving gain and capacity gain are calculated w.r.t. DG scheduling with C-DRX | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.13-1, the following observations can be made.

- For FR1, DL-only evaluation, InH, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from CATT that the

- non-scheduling DCI based PDCCH skipping with persistent skipping indication provides

- mean power saving gain of 22.4% w.r.t. Always-On

- mean capacity gain of -6.4% w.r.t. Always-On

- mean power saving gain of 15.7% w.r.t. DG scheduling with C-DRX(16, 12, 4)

- mean capacity gain of -0.33% w.r.t. DG scheduling with C-DRX(16, 12, 4)

- go-to-sleep indication scheme with C-DRX(16, 12, 4) provides

- mean power saving gain of 24.0% to 24.4% w.r.t. Always-On

- mean capacity gain of -6.1% w.r.t. Always-On

- mean power saving gain of 17.4% to 17.8% w.r.t. DG scheduling with C-DRX(16, 12, 4)

- mean capacity gain of 0% w.r.t. DG scheduling with C-DRX(16, 12, 4)

- non-scheduling and scheduling DCI with continuous PDCCH skipping and dynamic go-to-sleep indication provides

- mean power saving gain of 29.4% to 29.9% w.r.t. Always-On

- mean capacity gain of -6.4% w.r.t. Always-On

- mean power saving gain of 23.3% to 23.8% w.r.t. DG scheduling with C-DRX(16, 12, 4)

- mean capacity gain of -0.33% w.r.t. DG scheduling with C-DRX(16, 12, 4)

- DG scheduling with C-DRX(16, 12, 4) as the performance reference provides

- mean power saving gain of 8% w.r.t. Always-On

- mean capacity gain of -6.1% w.r.t. Always-On

### B.2.14 SSSG switching enhancements

This clause captures evaluation results for enhancements to SSSG switching.

- Ericsson evaluated enhanced SSSG switching based on (a) an implicit SSSG with sparse PDCCH monitoring applies at the start of drx-OnDuration and another SSSG with dense PDCCH monitoring in every time slot applies when a PDCCH for data traffic is received, (b) align the search space set monitoring pattern w.r.t. the DRX cycle.

Table B.2.14-1: FR1, DL+UL, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of DL satisfied UE | % of UL satisfied UE | % of DL + UL satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Ericsson | 35 | R1-2210922 | Always On | - | - | - | H | 8 | 8 | - | - | 90.1% | 0.0% | 0.0% | 0.0% | Note 1 |
| Ericsson | 41 | R1-2210922 | R17 SSSG switching (sparse SSSG: 2 ms on / 2 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 66.0% | -26.7% | 10.3% | 10.3% | Note 1,2 |
| Ericsson | 42 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 79.8% | -11.4% | 10.7% | 10.7% | Note 1,2 |
| Ericsson | 43 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 79.9% | -11.3% | 11.3% | 11.2% | Note 1,2 |
| Ericsson | 48 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 2 ms on / 2 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 80.0% | -11.2% | 9.7% | 9.7% | Note 1,2 |
| Ericsson | 49 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 79.5% | -11.8% | 11.5% | 11.5% | Note 1,2 |
| Ericsson | 50 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | - | - | 78.7% | -12.7% | 12.2% | 12.1% | Note 1,2 |
| Note 1: the DL traffic has a second flow for audio with 30ms PDB  Note 2: Matched CDRX has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms) | | | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.14-1, the following observations can be made.

- For FR1, DL + UL joint evaluation, DU, VR 30Mbps traffic at 60fps with 10ms PDB and DL audio, it is observed from Ericsson that

- R17 SSSG switching performance reference provides

- mean power saving gain of 10.50% in the range of 10.3% to 10.7%

- mean capacity gain of -19.05% in the range of -26.7% to -11.4%

- enhanced SSSG switching provides

- mean power saving gain of 10.60% in the range of 9.7% to 11.5% for all UEs

- mean capacity gain of -11.5% in the range of -11.8% to -11.2%

- R17 SSSG switching + PDCCH skipping performance reference provides

- power saving gain of 11.3%

- capacity gain of -11.3%

- enhanced SSSG switching + PDCCH skipping provides

- mean power saving gain of 12.2%

- capacity gain of -12.7%

Table B.2.14-2: FR1, DL-only, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Ericsson | 1 | R1-2210922 | Always On | - | - | - | H | 8 | 8 | 91.7% | 0.0% | 0.0% | 0.0% |  |
| Ericsson | 7 | R1-2210922 | R17 SSSG switching (sparse SSSG: 2 ms on / 2 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 53.9% | -41.2% | 15.5% | 16.0% | Note 1 |
| Ericsson | 8 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 78.4% | -14.5% | 16.4% | 16.5% | Note 1 |
| Ericsson | 9 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 78.9% | -14.0% | 20.2% | 20.4% | Note 1 |
| Ericsson | 14 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 2 ms on / 2 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 77.8% | -15.2% | 15.2% | 15.5% | Note 1 |
| Ericsson | 15 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 77.8% | -15.2% | 17.1% | 17.2% | Note 1 |
| Ericsson | 16 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 2 ms on / 2 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 78.7% | -14.2% | 18.0% | 18.2% | Note 1 |
| Ericsson | 17 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | H | 8 | 8 | 78.1% | -14.8% | 20.7% | 20.9% | Note 1 |
| Ericsson | 18 | R1-2210922 | Always On | - | - | - | L | 2 | 8 | 100% | 0.0% | 0% | 0% |  |
| Ericsson | 24 | R1-2210922 | R17 SSSG switching (sparse SSSG: 2 ms on / 2 ms off) & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 82.9% | -17.1% | 18.2% | 18.2% | Note 1 |
| Ericsson | 25 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 19.2% | 19.2% | Note 1 |
| Ericsson | 23 | R1-2210922 | R17 SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 26.6% | 26.6% | Note 1 |
| Ericsson | 31 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 2 ms on / 2 ms off) & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 17.3% | 17.3% | Note 1 |
| Ericsson | 32 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 19.3% | 19.3% | Note 1 |
| Ericsson | 33 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 2 ms on / 2 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 23.5% | 23.5% | Note 1 |
| Ericsson | 34 | R1-2210922 | Enhanced SSSG switching (sparse SSSG: 1 ms on / 1 ms off) & PDCCH skipping & matched CDRX | 16.6 | 10 | 4 | L | 2 | 8 | 100% | 0.0% | 27.1% | 27.1% | Note 1 |
| Note 1: Matched CDRX has (drx\_offset=3, traffic\_time\_offset=2 ms, drx-LongCycle=16 ms) | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.14-2, the following observations can be made.

- For FR1, DL only evaluation, DU, high load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from Ericsson that

- enhanced SSSG switching provides

- mean power saving gain of 16.15% in the range of 15.2% to 17.1% for all UEs

- capacity gain of -15.2%

- R17 SSSG switching performance reference provides

- mean power saving gain of 15.95% in the range of 15.5% to 16.4%

- mean capacity gain of -27.85% in the range of -41.2% to -14.5%

- enhanced SSSG switching + PDCCH skipping provides

- mean power saving gain of 19.35% in the range of 18.0% to 20.7%

- mean capacity gain of -14.5% in the range of -14.8% to -14.2%

- R17 SSSG switching + PDCCH skipping performance reference provides

- power saving gain of 20.2%

- capacity gain of -14.0%

- For FR1, DL only evaluation, DU, low load, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from Ericsson that

- enhanced SSSG switching provides

- mean power saving gain of 18.30% in the range of 17.3% to 19.3% for all UEs

- capacity gain of 0%

- R17 SSSG switching performance reference provides

- mean power saving gain of 18.7% in the range of 18.2% to 19.2%

- mean capacity gain of -8.6% in the range of -17.1% to 0%

- enhanced SSSG switching + PDCCH skipping provides

- mean power saving gain of 25.30% in the range of 23.50% to 27.10%

- capacity gain of 0%

- R17 SSSG switching + PDCCH skipping performance reference provides

- power saving gain of 26.6%

- capacity gain of 0%

### B.2.15 DCP indicated SSSG switching

- Nokia evaluated using DCI 2\_6 outside the CDRX active time to trigger SSSG switching for PDCCH monitoring adaptation.

Table B.2.15-1: 2 FR1, DL-only, InH, CG30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| Nokia |  | R1-2209535 | Always On Baseline | - | - | - | H | 6 | 6 | 90.00 % | 0.00% | - | - | - |
| Nokia | 1 | R1-2209535 | C-DRX + SSSG switching without DCI 2\_6 | 16 | 8 | 8 | H | 6 | 6 | 6.25 % | -93.06% | 38.27 % | - | Note 1 |
| Nokia | 2 | R1-2209535 | C-DRX + SSSG switching with DCI 2\_6 | 16 | 8 | 8 | H | 6 | 6 | 13.47 % | -85.03% | 34.11 % | - | Note 1 |
| Nokia | 3 | R1-2209535 | C-DRX + SSSG switching without DCI 2\_6 | 16 | 8 | 8 | H | 6 | 6 | 0.00 % | -100.00% | 47.60 % | - | Note 2 |
| Nokia | 4 | R1-2209535 | C-DRX + SSSG switching with DCI 2\_6 | 16 | 8 | 8 | H | 6 | 6 | 0.90 % | -99.00% | 35.97 % | - | Note 2 |
| Note 1: SSSG0 ks = 2, SSSG1 ks = 1, searchSpaceSwitchTimer = 8 ms  Note 2: SSSG0 ks = 4, SSSG1 ks = 1, searchSpaceSwitchTimer = 8 ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.15-1, the following observations can be made.

- For FR1, DL only evaluation, InH, high load, CG 30Mbps traffic at 60fps with 15ms PDB, it is observed from Nokia that

- DCP indicated SSSG switching provides

- mean power saving gain of 35.04% in the range of 34.11% to 35.97%

- mean capacity gain of -92.02% in the range of -99.00% to -85.03%

- R17 SSSG switching performance reference provides

- mean power saving gain of 42.94% in the range of 38.27% to 47.60%

- mean capacity gain of -96.53% in the range of -93.06% to -100.00%

### B.2.16 Retransmission-less CG for UL pose transmission

This clause captures evaluation results for retransmission-less CG for UL pose transmission.

- Qualcomm evaluated disabling the retransmission for CG for UL pose information so that UE does not monitor related UL retransmission scheduling DCI. Conservative MCS is configured for successful transmission of the UL pose by the first transmission.

Table B.2.16-1: FR1, DL+UL, DU, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| QC | 1 | R1-2212134 | Always On | - | - | - | H | 10 | 10 | 94.603% | 0.0% | 0% |  |  |
| QC | 2 | R1-2212134 | Aligned CDRX + CG with UL retransmission | 16/17/17 | 4 | 4 | H | 10 | 10 | 92.698% | -2.0% | 1.8% |  | Note 1 |
| QC | 3 | R1-2212134 | Aligned CDRX + CG without UL retransmission | 16/17/17 | 4 | 4 | H | 10 | 10 | 92.619% | -2.1% | 20.0% |  |  |
| Note 1: retransmission timer is set to 4ms | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.16-1, the following observations can be made.

- For FR1, DL + UL joint evaluation, DU, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from Qualcomm that

- retransmission-less CG for UL pose provides

- power saving gain of 20.0% for all UEs

- capacity gain of -2.1%

- performance reference CG with UL retransmission provides

- power saving gain of 1.8%

- capacity gain of -2.0%

### B.2.17 XR-specific playoutDelayForMediaStartup for XR UE power saving enhancement

This clause captures evaluation results for XR-specific playoutDelayForMediaStartup for XR UE power saving enhancement.

- CATT evaluated XR-specific playoutDelayForMediaStartup for XR UE power saving enhancement. When the size of the playout buffer is fed back to the gNB scheduler, gNB could have additional PDB for resource allocation of XR packet.

Table B.2.17-1: FR1, DL-only, InH, VR30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity performance gain | Mean PSG of all UEs (%) | Mean PSG of satisfied UEs (%) | Additional Assumptions |
| CATT | 1 | R1-2211174 | Baselin: DG scheduling with UE always on | - | - | - | H | 12 | 12 | 95.83% | 0.0% | 0.0% | - |  |
| CATT | 24 | R1-2211174 | XR-specific playoutDelayForMediaStartup scheme with go-to-sleep | 16 | 8 | 4 | H | 20 | 20 | 94.17% | 67% | 26.43% | - | Note1,2 |
| CATT | 25 | R1-2211174 | XR-specific playoutDelayForMediaStartup scheme with PDCCH skipping and go-to-sleep | 16 | 8 | 4 | H | 20 | 20 | 93.3% | 67% | 28.51% | - | Note1,2 |
| Note 1: The power saving gain is based on the same capacity as that of the baseline scheme (DG scheduling with UE always on).  Note 2: 3 frames playout buffer for all UEs | | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.17-1, the following observations can be made.

- For FR1, DL only, InH, VR 30Mbps traffic at 60fps with 10ms PDB, it is observed from CATT that with the awareness of UE XR-specific playoutDelayForMediaStartup, UE can achieve

- mean power saving gain of 26.43% to 28.51%

- mean capacity gain of 67%

### B.2.18 Partial UL transmission

This clause captures evaluation results for partial UL transmission.

- Qualcomm evaluated the scheme for UE to transmit over a resource among the allocated resource that is just enough to transmit the UL data with a new UCI indicating to gNB the resources utilized/skipped in the PUSCH or the MCS selected by the UE.

Table B.2.18-1: FR1, UL-only, UMa, UL Pose/Control

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| source | data row index | Tdoc source | Power saving scheme | CDRX cycle (ms) | ODT (ms) | IAT (ms) | Load H/L | #UE /cell | floor (Capacity) | % of satisfied UE | Capacity gain (%) | Mean PSG of all UEs (%) | Additional Assumptions |
| QC | 11 | R1-2212134 | Baseline: Wideband UL Scheduler Baseline | - | - | - | H | 4 | 4 | 95% | 0% | 0.00% |  |
| QC | 12 | R1-2212134 | Partial Uplink Transmission | - | - | - | H | 4 | 4 | 95% | 0% | 12.73% | Note1 |
| Note 1: power saving is calculated w.r.t. wideband UL transmission | | | | | | | | | | | | | |

Based on the evaluation results in Table B.2.18-1, the following observations can be made.

- For FR1, UL only evaluation, UMa, UL pose/control, it is observed from Qualcomm that with respect to the wideband UL transmission, the partial UL transmission provides

- power saving gain of 12.73%

- capacity gain of 0%

Annex C (informative):  
RAN2 Study Item Agreements

# C.1 RAN2#119-e

Agreements from RAN2#119-e meeting:

- RAN2 does not intend to ask RAN1 to change their simulation assumptions;

- RAN2 should take SA2/SA4 work into account.

- RAN2 assumes that PDU Set based parameters and PDU Set related information may be used for better support of XR services. RAN2 can consider both UL and DL directions.

- RAN2 will study PDU Set based parameters and PDU Set related information handling in Network and UE.

- RAN2 to adopt the current SA2 definition of PDU Set as an application media unit as working assumption, subjected to further guidance from SA2 and SA4.

- XR awareness discussion in RAN2 should consider PDU set characteristics and how to use the information available on those (for UL and/or DL). Can also consider how to handle data bursts.

- RAN2 can study e.g. periodicity, arrival time, jitter and frame-size variations for XR awareness to enable power savings and capacity enhancements. Can study also how often such parameters change (i.e. how dynamic they are).

- RAN2 can consider how PDU sets can be mapped to DRBs (FFS if SA2 discussion on PDU set mapping to QoS (sub-)flows impacts this).

- RAN2 to focus on the following issues for power saving, as well necessary parameters XR-awareness to support such enhancements, i.e.:

- DRX enhancements to address the issues of DRX cycle mismatch and jitter;

- Identify necessary parameters from CN for XR-awareness for power saving.

- Enhancements to Rel-17 PDCCH adaptation can be discussed based on RAN1 feedback, if they have any RAN2 impact.

- RAN2-specific aspects can be studied based on contributions (e.g. multiple XR traffic flows with different periodicities, SFN wrap-around, RAN2-specific CDRX aspects, …).

- As starting point, RAN2 can further discuss the solutions in TR 38.838 that can impact on L2 operation (e.g., BSR, LCP, assistance information for scheduling, packet discarding, prioritization) for XR-specific capacity improvement. RAN2-specific solutions are not precluded (even if RAN1 hasn’t discussed them before).

- Enhancement to SPS/CG should be justified for XR scheduling and should be evaluated against dynamic grant (DG) scheduling which should be considered as baseline. Should justify why enhancements are needed.

- RAN2 considers SPS enhancements may not be needed in Rel-18 XR since PDCCH capacity is not assumed to be a problem for XR. FFS if SPS has some power consumption benefits.

# C.2 RAN2#119bis-e

Agreements from RAN2#119bis-e meeting:

- From RAN2 viewpoint, the following information would be useful for PDU set handling in UL and DL:

- Semi-static information (from CN to RAN): At least PSER and PSDB;

- Dynamic information: At least identifying which PDU belongs to which data burst/PDU set is also needed, including means to determine at least PDU set boundaries.

- Capture the models 1a/b, 2a/b (from [R2-2209777](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209777.zip)) in TR and indicate what is possible in current specifications and how. FFS how LCH options work in each case

- SDAP maps each data packet in a PDU set to a single PDCP SDU, as in legacy (i.e. each PDU is only mapped to a single SDU).

- HARQ and RLC re-/transmissions for XR traffic are done as in legacy (i.e. they are not based on XR PDU sets).

- For UE transmitter, the PDCP discard should be performed per PDU set basis.

- For UE transmitter, the PDCP discard is managed per SDU for PDU set, the PDCP entity discards all PDCP SDUs associated with the PDU set.

- At least RRC pre-configuration and switching of configurations of DRX could be considered for enhancements of XR power saving. Other solutions are not precluded and can be further discussed.

- Introduce new BS table(s) to reduce the quantisation errors (e.g. for high bit rates). FFS how new BSR tables are created and how they impact BSR formats (can be discussed in WI phase).

- Delay information consists of at least “remaining time”.

- RAN2 considers a delay information is useful for XR. FFS if dynamic reporting from UE to network (e.g. via BSR) is needed, or whether PSDB is sufficient. If we have delay information, it needs to distinguish how much data is buffered for which delay value. Stage-3 details (e.g. what’s contained, how the triggering is done) can be discussed in the WI phase.

- If we have delay information reporting, RAN2 aims to define how the UE determines the “remaining time” in the delay information.

- Current CG configurations can be reused for UL XR traffic. FFS if enhancements are needed (RAN1 is already discussing something). RAN2 can discuss this in the next meeting.

- RAN2 can discuss potential enhancement to provide some assistant information on UL XR traffic for CG configurations at the gNB. FFS whether TSCAI can already provide all necessary information.

- RAN2 discuss whether additional traffic or QoS related information on downlink traffic beyond what has been agreed by SA2 needs to be provided to RAN for UE power savings.

- RAN2 study what traffic and QoS related information on uplink traffic (e.g. counterpart of what has been agreed by SA2) should be provided to RAN for UE power savings and how the information may be provided to RAN.

- Capture in TR that traffic parameters and Jitter are semi-static info.

- Can capture also SA2 agreements related to how they impact RAN2.

# C.3 RAN2#120

Agreements from RAN2#120 meeting:

- N1N excluded.

- Splitting DRB into multiple LCH (DC like) FFS.

- Should try to understand why we would need to treat PDU sets differently over the radio and why different PDU sets are muxed over same flows. Also need to understand need for reordering. LS to SA2/SA4 sent in R2-2213351.

- Agree that UE identifies PDU Sets / Bursts.

- In-band marking not needed. Further information considered if BSR is not enough.

- Handling of discard FFS.

- Regarding making LCP delay aware:

- If delay-aware LCP is introduced, need the ability to turn it off;

- SRBs not impacted.

- Not considered further unless fundamental issues are identified.

- RAN2 to support timer-based discarding of UL transmit side of PDCP PDU/SDUs of a PDU set. FFS how this is modelled in PDCP specification, can be discussed in WI phase.

- RAN2 aims to allow XR frame rates that correspond to non-integer periodicities in at least semi-static manner (e.g. RRC). Details can be left to WI phase.

- RAN2 thinks we need one or more additional BSR table(s) for XR. FFS whether these are static (=specified) or dynamic (e.g. generated, differs according to some RRC parameter), can be discussed in WI phase.

- RAN2 will introduce data volume information associated with delay information (e.g. remaining time) in a MAC CE. FFS if this is extension of BSR or new format. FFS how to do that (e.g. what exactly is reported) and how to ensure this information is up-to-date e.g. considering UL scheduling delay.

- RAN2 needs to discuss additional BSR triggering conditions to allow timely availability of buffer status information at gNB. This can be discussed in WI phase.

- RAN2 sees some benefit from CG to XR services. RAN2 will address enhancements triggered by RAN1 work.

- RAN2 agrees some assistance information can be beneficial (e.g. periodicity, packet size). RAN2 assumes baseline could be TSCAI (pending SA2 conclusions), can discuss during WI phase whether something additional is needed on top of that. If any assistance information is needed, its definition should be standardized.

- RAN2 thinks all information may not be always available at UE application.

# C.4 RAN2#121

Agreements from RAN2#121 meeting:

- RAN2 thinks that how PSER is enforced is up to network implementation.

- Introduce UL PDU Set Importance. How UE derives this will be handled in UE implementation.

- Can indicate that in RAN2 considers PDU set concept applicable to both UL and DL in LS to SA2.

- RAN2 thinks UL jitter may be present for XR (e.g. for tethering use cases). It is unclear how network would use UL jitter information (depends on what would be signalled and would anyway be up to network implementation).

- RAN2 intends to support tethering use case for XR. This may require signalling of some UL traffic arrival information from UE to network.

- Since we already agreed to not support delay-aware LCP, RAN2 aims not to introduce changes to LCP due to PDU prioritization.

- RAN2 thinks PSI can be useful for PDU set-based discard. RAN2 aims to introduce a mechanism to allow UE to handle discarding of packets with different PSI in case of congestion. FFS for other cases.

- Support of RLC bearer splitting should be limited to existing cases (e.g. PDCP duplication), no new XR-specific functionality.

Annex Z (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Change history | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2022-04 | RAN1#109 | R1-2204673 |  |  |  | Initial Skeleton | 0.0.1 |
| 2022-08 | RAN2#119 | R2-2207373 |  |  |  | Initial Skeleton | 0.0.1 |
| 2022-08 | RAN2#119 | R2-2207374 |  |  |  | Updated Structure | 0.0.2 |
| 2022-08 | RAN2#119 | R2-2208748 |  |  |  | First Endorsed Baseline | 0.1.0 |
| 2022-08 | RAN2#119 | R2-2208749 |  |  |  | Table of Content updated | 0.1.1 |
| 2022-09 | RAN2#119 | R2-2209220 |  |  |  | Overview and first RAN2 agreements included | 0.2.0 |
| 2022-10 | RAN2#119bis | R2-2210814 |  |  |  | Relevant definitions from 23.700-60 included  Useful pieces of information from SA4 LS added (S4-220505 and S4aV220921)  RAN2 agreements on PDU Set handling, discard, L2 structure captured, BS tables and delay reporting added. | 0.3.0 |
| 2022-11 | RAN2#120 | R2-2212908 |  |  |  | Minor editorial corrections | 0.3.1 |
| 2022-12 | RAN2#120 | R2-2213229 |  |  |  | RAN2 agreements on PDU Set handling, L2 architecture, BSR, discard and assistance information captured.  SA2 agreements on KI#4,5 (S2-2211440) and KI#8 (S2-2211404) captured.  RAN1 agreements (R1-2213015). | 0.4.0 |
| 2022-12 | RAN#98 | RP-223187 |  |  |  | Clean version for information. | 1.0.0 |
| 2023-02 | RAN2#121 | R2-2300152 |  |  |  | Update reflecting latest agreements from SA2 and SA4 | 1.0.1 |
| 2023-03 | RAN2#121 | R2-23xxxxx |  |  |  | RAN2 agreements on radio protocols impacts. | 1.0.2 |