Part 2-1

Description template of the proposed candidate technology for IMT-2020

#### 5.2.3.1 Description template background

This description template is a template for the description of the characteristics of the proposed RIT. It is to describe our proposal for a radio interface for IMT‑2020 to a level of detail that will facilitate a sufficient understanding of the proposed technology in order to enable an independent technical assessment of compliance with the IMT‑2020 requirements as specified in the Report ITU-R M.2410.

The proposed RIT refers to the latest 3GPP New Radio Technical Specifications. In order to satisfy all the requirements of IMT-2020, the RIT will be updated to include more features necessary.

#### 5.2.3.2 Description template – characteristics template

| Item | Item to be described |
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| **5.2.3.2.1** | **Test environment(s)** |
| 5.2.3.2.1.1 | What test environments (described in Report ITU-R M.2412-0) does this technology description template address?  *This proposal targets to addresses all the five test environments across the three usage scenarios (eMBB, mMTC, and URLLC) as described in Report ITU-R M.2412-0.* |
| **5.2.3.2.2** | **Radio interface functional aspects** |
| 5.2.3.2.2.1 | *Multiple access schemes*  Which access scheme(s) does the proposal use? Describe in detail the multiple access schemes employed with their main parameters.  *Multiple access based on a combination of*   * *OFDMA: Transmission to/from different UEs using mutually orthogonal frequency assignments. Multiple OFDM numerologies are supported.. Granularity in frequency assignment: One resource block consisting of twelve subcarriers over one OFDM symbol. DFT-spread OFDM is also used in uplink.* * *TDMA: Transmission to/from different UEs with separation in time. Granularity: 14-symbol duration for slot-based operation, less than slot duration with 2, 4, 7 symbol-duration granularities for non-slot based operation, regardless of OFDM numerology.* * *CDMA: Inter-cell interference suppressed by processing gain of channel coding and/or spreading allowing for a frequency reuse of one.* * *SDMA: Possibility to transmit to/from multiple users using the same time/frequency resource (SDMA or multi-user MIMO) as part of the advanced-antenna capabilities.* |
| 5.2.3.2.2.2 | *Modulation scheme* |
| 5.2.3.2.2.2.1 | What is the baseband modulation scheme? If both data modulation and spreading modulation are required, describe in detail.  Describe the modulation scheme employed for data and control information.  What is the symbol rate after modulation?  *Data and higher-layer control: -BPSK (uplink only when transform precoding enabled), QPSK, 16QAM, 64QAM, 256QAM*  *L1/L2 control: -BPSK, BPSK and QPSK for uplink control channel (PUCCH), QPSK for downlink control channel (PDCCH)*  *Symbol rate: 168 and 144 symbols per resource block per slot for normal and extended CP, respectively. Symbol rate per resource block per slot depends on sub-carrier spacing.*   * *For 15 kHz sub-carrier spacing and normal CP: 168 × 103 symbols per second* * *For 30 kHz sub-carrier spacing and normal CP: 336 × 103 symbols per second* * *For 60 kHz sub-carrier spacing and normal CP: 672 × 103 symbols per second* * *For 120 kHz sub-carrier spacing and normal CP: 1344 × 103 symbols per second* * *For 240 kHz sub-carrier spacing and normal CP: 2688 × 103 symbols per second* |
| 5.2.3.2.2.2.2 | *PAPR*  What is the RF peak to average power ratio after baseband filtering (dB)? Describe the PAPR (peak-to-average power ratio) reduction algorithms if they are used in the proposed RIT/SRIT.  *Uplink and downlink when OFDMA is used: PAPR = 8.4 dB (99.9 %)*  *Uplink when DFT-s-OFDM is used: Peak-to-Average Power Ratio (PAPR) and Cubic Metric (CM) depends on modulation scheme and number of component carrier. The CM is a method of predicting the power de-rating from signal modulation characteristics and is found to be more useful than other metrics such as PAPR*   * *-BPSK: PAPR = 4.5 dB (99.9 %), CM = 0.3 dB* * *QPSK: PAPR = 5.8 dB (99.9 %), CM = 1.2 dB* * *16QAM: PAPR = 6.5 dB (99.9 %), CM = 2.1 dB* * *64QAM: PAPR = 6.6 dB (99.9 %), CM = 2.3 dB* * *256QAM: PAPR = 6.7 dB (99.9 %), CM = 2.4 dB*   *Any PAPR-reduction algorithm is transmitter-implementation specific for uplink and downlink.* |
| 5.2.3.2.2.3 | *Error control coding scheme and interleaving* |
| 5.2.3.2.2.3.1 | Provide details of error control coding scheme for both downlink and uplink.  For example,  – FEC or other schemes?  The proponents can provide additional information on the decoding schemes.  *Error control coding is performed on the transport channels and control information.*   * *For uplink and downlink data except PBCH: LDPC* * *For downlink PBCH: Polar* * *For downlink control (DCI): Polar* * *For uplink control (UCI with payload size ≥ 12): Polar* * *For uplink control (UCI with 3 ≤ payload size ≤ 11): Reed-Muller* * *For uplink control (UCI with payload size 2): Simplex code* * *For uplink control (UCI with payload size 1): Repetition*   *For more details, see TTAT.3G-38.212.*  *Decoding mechanism is implementation specific.* |
| 5.2.3.2.2.3.2 | Describe the bit interleaving scheme for both uplink and downlink.  *According to the section 5.4.2 of TS 38.212 (Rate matching for LDPC code), bit interleaving is performed after LDPC encoding for both uplink and downlink.*  *According to the section 5.4.1 of TS 38.212 (Rate matching for Polar code), rate matching for Polar code consists of sub-block interleaving, bit collection, and bit interleaving.*  *For more details, see TTAT.3G-38.212 clause 5.4.* |
| **5.2.3.2.3** | **Describe channel tracking capabilities (e.g. channel tracking algorithm, pilot symbol configuration, etc.) to accommodate rapidly changing delay spread profile.**  *To support channel tracking, different types of reference signals can be transmitted on downlink and uplink respectively.*  ***Downlink:***   * ***Synchronization signals (SS)*** *consist of primary SS (PSS) and secondary SS (SSS) and can be used for the initial access. PSS and SSS forms a SS block together with physical broadcast channel (PBCH). Each SS block is repeated with a certain periodicity and may correspond to each beam when analog/digital/hybrid beamforming is used.* * ***Channel-state information RS (CSI-RS)*** *can be used for estimation of channel-state information (CSI) to further prepare feedback reporting to base station (CQI for link adaptation, precoder-matrix/vector selection, etc.) to assist beamforming and scheduling. Also, CSI-RS can be used for tracking time/frequency. In this case, UE assumes that CSI-RS burst is quasi co-located with respect to delay spread, average delay, Doppler shift, and Doppler spread with the PDSCH DM-RS. CSI-RS is UE-specifically configurable. CSI-RS can also be used for the measurement for mobility support. For the detailed structure of CSI-RS, see TTAT.3G-38.211 sub-clause 7.4.1.5* * ***Demodulation RS (DM-RS)*** *can be used for downlink channel estimation for coherent demodulation of Physical Downlink Shared Channel (PDSCH) and PDCCH. At least DM-RS is mapped over 1 or 2 adjacent OFDM symbols which are front-loaded, and the additional DMRS is always present in the prefixed location. DM-RS supports up to 12 ports. For the detailed structure of DM-RS, see TTAT.3G-38.211 sub-clauses 7.4.1.1 and 7.4.1.3.* * ***Phase-tracking RS (PT-RS)*** *is present only in the resource blocks used for the PDSCH, and only if the higher-layer parameter indicates PT-RS being used. For the detailed structure of PT-RS, see TTAT.3G 38.211 sub-clause 7.4.1.2.*   ***Uplink:***   * ***Sounding RS (SRS)*** *can be used for estimation of uplink CSI to assist uplink scheduling and uplink power control. The transmission of SRS is configurable. For the detailed structure of uplink SRS, see TTAT.3G-38.211 sub-clause 6.4.1.4.* * ***Demodulation RS (DM-RS)*** *can be used for channel estimation for coherent demodulation of the Physical Uplink Shared Channel (PUSCH) and the PUCCH. Uplink DM-RS is mapped to physical resources according to the type given by higher-layer parameter. For the detailed structure of uplink DM-RS for PUSCH and PUCCH, see TTAT.3G-38.211 sub-clauses 6.4.1.1 and 6.4.1.3, respectively.* * ***Phase-tracking RS (PT-RS)*** *is present only in the resource blocks used for the PUSCH, and only if the higher-layer parameter indicates PT-RS being used. For the detailed structure of PT-RS, see TTAT.3G-38.211 sub-clause 6.4.1.2.*   *Channel-tracking/estimation algorithms are receiver-implementation specific.* |

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| **5.2.3.2.4** | **Physical channel structure and multiplexing** |
| 5.2.3.2.4.1 | What is the physical channel bit rate (M or Gbit/s) for supported bandwidths?  i.e., the product of the modulation symbol rate (in symbols per second), bits per modulation symbol, and the number of streams supported by the antenna system.  *The physical channel bit rate depends on the modulation scheme, subcarrier spacing, number of resource blocks, and number of spatial-multiplexing layers.* |
| 5.2.3.2.4.2 | *Layer 1 and Layer 2 overhead estimation.*  Describe how the RIT/SRIT accounts for all layer 1 (PHY) and layer 2 (MAC) overhead and provide an accurate estimate that includes static and dynamic overheads.  *L1 overhead for downlink considers DMRS, CSI-RS, TRS, PTRS, SSB, and PDCCH. L1 overhead for uplink considers DMRS, SRS, PTRS, RACH, PUCCH, and control signalings on PUSCH. The overhead is set dynamically according to the carrier frequency, subcarrier spacing, bandwidth, and multiplexing, etc.*  *Headers of SADP, PDCP, RLC, and MAC PDUs are also considered as L2 overhead. One MAC PDU may contain one or multiple headers. The sizes of different PDU headers are as follows:*   * *MAC subheader: 2 ~ 3 bytes* * *RLC subheader: 2 ~ 3 bytes* * *PDCP subheader: 2 ~ 3 bytes* * *SDAP subheader: 1 byte*   *L2 overhead would be 7 ~ 10 bytes per transport block assuming one subheader per sublayer. The overhead is increased when the transport block conveys multiple packets or segmented packets.* |
| 5.2.3.2.4.3 | *Variable bit rate capabilities:*  Describe how the proposal supports different applications and services with various bit rate requirements.  *For a given combination of subcarrier spacing, modulation scheme, code rate, and number of spatial-multiplexing layers, the data rate available to a user can be controlled by the scheduler by assigning different number of resource blocks for the transmission. In case of multiple services, the available/assigned resource, and thus the available data rate, is shared between the services.* |
| 5.2.3.2.4.4 | *Variable payload capabilities:*  Describe how the RIT/SRIT supports IP-based application layer protocols/services (e.g., VoIP, video-streaming, interactive gaming, etc.) with variable-size payloads.  *The RIT is designed primarily for IP based services. The variable transport-block size is supported.*  *See TTAT.3G-38.214 sub-clause 5.1.3.2 for details.* |
| 5.2.3.2.4.5 | *Signalling transmission scheme:*  Describe how transmission schemes are different for signalling/control from that of user data.  ***Uplink***  *The physical uplink control channel (PUCCH) supports multiple formats as shown in Table 5.2.3.2.4.5-1.*  *Table 5.2.3.2.4.5-1: PUCCH formats*   |  |  |  | | --- | --- | --- | | *PUCCH format* | *Length in OFDM symbols* | *Number of bits* | | *0* | *1 – 2* | *≤2* | | *1* | *4 – 14* | *≤2* | | *2* | *1 – 2* | *>2* | | *3* | *4 – 14* | *>2* | | *4* | *4 – 14* | *>2* |   *Control signalling is limited to π/2-BPSK , BPSK and QPSK modulation. Repetition, simplex, Reed-Muller, and polar coding schemes are supported according to control information.*  ***Downlink***  *A control-resource set (CORESET) consists of resource blocks in the frequency domain, and symbols in the time domain. A control-channel element (CCE) consists of 6 resource-element groups (REGs) where a REG equals one resource block during one OFDM symbol, which is 12 subcarriers. A physical downlink control channel (PDCCH) consists of one or more CCEs.*  *Control signalling is limited to QPSK modulation and relies on polar coding.*  *Besides PUCCH and PDCCH, higher-layers signalling is carried within transport blocks.* |
| 5.2.3.2.4.6 | *Small signalling overhead*  Signalling overhead refers to the radio resource that is required by the signalling divided by the total radio resource which is used to complete a transmission of a packet. The signalling includes necessary messages exchanged in DL and UL directions during a signalling mechanism, and Layer 2 protocol header for the data packet.  Describe how the RIT/SRIT supports efficient mechanism to provide small signalling overhead in case of small packet transmissions.  *According to the length of PDU, layer 2 protocol header size can be variable as follows:*   * *MAC subheader: 2 ~ 3 bytes* * *RLC subheader: 2 ~ 3 bytes* * *PDCP subheader: 2 ~ 3 bytes* * *SDAP subheader: 1 byte*   *Even though a number of RLC PDUs are multiplexed into a MAC PDU, PDU header size keeps between 2 and 3 bytes due to MAC subheaders’ being distributed across the entire MAC PDU. To efficiently transmit small packet, layer 2 overhead can be reduced by using small sized header. See TTAT.3G-38.300 sub-clause 6.6 for details.*  *Further information will be provided later in accordance with 3GPP NR specifications.* |
| **5.2.3.2.5** | **Mobility management (Handover)** |
| 5.2.3.2.5.1 | Describe the handover mechanisms and procedures which are associated with  – Inter-System handover including the ability to support mobility between the RIT/SRIT and at least one other IMT system  – Intra-System handover  1 Intra-frequency and Inter-frequency  2 Within the RIT or between component RITs within one SRIT (if applicable)  Characterize the type of handover strategy or strategies (for example, UE or base station assisted handover, type of handover measurements).  What other IMT system (other than IMT-2020) could be supported by the handover mechanism?  *Network controlled handover mechanism is used for connected mode UEs when performing Inter-System and Intra-System handover. Source base station initiates handover and target base station performs admission control. UE receives a handover command which is provided by source base station and moves to the target base station.*  *Handover mechanism uses intra-frequency, inter-frequency, and inter-RAT measurements which are performed by UEs. UE measures reference signal strength and quality and reports them to base station for handover decision. Time gap for measurements is needed for inter-frequency measurements.*  *For more details, refer to TTAT.3G-38.300 sub-clauses 9.2.3 & 9.3.* |
| 5.2.3.2.5.2 | Describe the handover mechanisms and procedures to meet the simultaneous handover requirements of a large number of users in high speed scenarios (up to 500km/h moving speed) with high handover success rate.  *This RIT supports various patterns of reference signals (DMRS, SRS, etc.) to support various mobilities of up to 500 km/h.*  *Further information will be provided later in accordance with 3GPP NR specifications.* |
| **5.2.3.2.6** | **Radio resource management** |
| 5.2.3.2.6.1 | Describe the radio resource management, for example support of:  – centralised and/or distributed RRM  – dynamic and flexible radio resource management  – efficient load balancing.  *RRM functions are located in base station and perform distributed RRM mechanism. The functions include radio bearer control, radio admission control, and radio resource allocation.*  *RRM performs packet scheduling to dynamically allocate radio resources to UEs. The scheduling is based on QoS and channel quality information, and the periodicity of scheduling is one or multiple slots for slot-based scheduling and less than one slot for non-slot based scheduling. In addition, RRM functions can flexibly configure/modify/release radio bearers and resources to support various service scenarios.*  *RRM provides load balancing between cells with handover, cell reselection mechanisms to efficiently distribute UEs and traffic among cells.* |
| 5.2.3.2.6.2 | *Inter-RIT interworking*  Describe the functional blocks and mechanisms for interworking (such as a network architecture model) between component RITs within a SRIT, if supported.  *The RIT supports interworking with other RAT (e.g. LTE) by providing multi-connectivity and handover mechanisms. Using multi-connectivity, a UE can establish radio connections with multiple base stations. Additionally, handover mechanism supports UE’s mobility among different RATs* |
| 5.2.3.2.6.3 | *Connection/session management*  The mechanisms for connection/session management over the air-interface should be described. For example:  – The support of multiple protocol states with fast and dynamic transitions.  – The signalling schemes for allocating and releasing resources.  *Connection management is performed from base station and session management is performed from network node (SMF: Session Management Function) by using RRC protocol and NAS protocol.*  *The RRC protocol is composed of three states, RRC\_CONNECTED, RRC\_INACTIVE, and RRC\_IDLE. The RRC\_INACTIVE state supports fast transition to RRC\_CONNECTED state by maintaining connection between UE and base station.*  *RRC messages are used to establish, reconfigure, release of dedicated radio resources between UE and base station.* |
| **5.2.3.2.7** | **Frame structure** |
| 5.2.3.2.7.1 | Describe the frame structure for downlink and uplink by providing sufficient information such as:  – frame length,  – the number of time slots per frame,  – the number and position of switch points per frame for TDD  – guard time or the number of guard bits,  – user payload information per time slot,  – sub-carrier spacing  – control channel structure and multiplexing,  – power control bit rate.  *Subcarrier spacings of 15, 30, 60, 120, and 240 kHz are supported. For synchronization signals, 15 and 30 kHz are supported for frequency range 1 (450 MHz ~ 6 GHz), and 120 and 240 kHz are supported for frequency range 2 (24.25 GHz ~ 52.6 GHz). For control and data channels, 15, 30, and 60 kHz are supported for frequency range 1, and 120 kHz are supported for frequency range 2.*  *One radio frame of length 10 ms consists of 10 subframes, each of length 1 ms. Each subframe consists of 1, 2, 4, 8, and 16 slots for subcarrier spacing of 15, 30, 60, 120, and 240 kHz, respectively. Each slot consists of 14 OFDM symbols in case of normal cyclic prefix and 12 OFDM symbols in case of extended cyclic prefix.*  *In TDD, per each slot, up to 2 DL-to-UL switching points are allowed. One or more OFDM symbols serve as a guard time between DL and UL.*  *Downlink control channel region is flexibly allocated in time and frequency. A downlink control region spans 1~3 OFDM symbols in time, and is localized or distributed in frequency. A downlink control channel can be time and/or frequency multiplexed with a downlink data channel on a slot or mini-slot basis.*  *Uplink control channel region is flexibly allocated in time and frequency. An uplink control region spans 4~14 OFDM symbols for long duration formats and 1~2 OFDM symbols for short duration formats, and is localized in frequency. Intra-slot or inter-slot frequency hopping is supported. An uplink control channel can be time and/or frequency multiplexed with an uplink data channel on a slot or mini-slot basis. Uplink control information can be piggy-backed with data, i.e. transmitted with data on PUSCH when UE has uplink data to be transmitted.*  *Up to one or multiple power control commands per slot are supported. The power control rate depends on the slot duration and the maximum allowed number of power control commands per slot.* |
| **5.2.3.2.8** | **Spectrum capabilities and duplex technologies**  NOTE 1 – Parameters for both downlink and uplink should be described separately, if necessary. |
| 5.2.3.2.8.1 | *Spectrum sharing and flexible spectrum use*  Does the RIT/SRIT support flexible spectrum use and/or spectrum sharing? Provide the detail.  Description such as capability to flexibly allocate the spectrum resources in an adaptive manner for paired and un-paired spectrum to address the uplink and downlink traffic asymmetry.  *Flexible spectrum use is supported by using one or multiple component carriers. One component carrier supports a scalable bandwidth with a single PRB granularity by means of bandwidth part configuration/adaptation. Multiple component carriers can be aggregated to achieve up to at least several GHz of transmission bandwidth. The aggregated component carriers can be either contiguous or non-contiguous in the same or different frequency band. For unpaired spectrum, resources can be flexibly allocated as UL or DL in a dynamic or semi-static manner.*  *Inter-RAT and inter-operator spectrum sharing is supported for efficient use of spectrum. For example, the RIT supports spectrum sharing with LTE. A carrier of the RIT can share the spectrum with a LTE carrier by FDM (frequency division multiplexing) or TDM (time division multiplexing) manner. To enable efficient multiplexing, OFDM symbols and subcarriers can be aligned in time and frequency, respectively, between the RIT and LTE. In addition, LTE CRS (cell-specific reference signal) can be protected by rate matching the signals and channels of the RIT around the LTE CRS.* |
| 5.2.3.2.8.2 | *Channel bandwidth scalability*  Describe how the proposed RIT/SRIT supports channel bandwidth scalability, including the supported bandwidths.  Describe whether the proposed RIT/SRIT supports extensions for scalable bandwidths wider than 100 MHz.  Describe whether the proposed RIT/SRIT supports extensions for scalable bandwidths wider than 1 GHz, e.g., when operated in higher frequency bands noted in § 5.2.4.2.  Consider, for example:  – The scalability of operating bandwidths.  – The scalability using single and/or multiple RF carriers.  Describe multiple contiguous (or non-contiguous) band aggregation capabilities, if any. Consider for example the aggregation of multiple channels to support higher user bit rates.  *One component carrier supports a scalable bandwidth with a single PRB granularity. The minimum channel bandwidth is 5 or 10 MHz depending on the frequency band for frequency range 1 and 50 MHz for frequency range 2. The maximum channel bandwidth is 100 MHz for frequency range 1 and 400 MHz for frequency range 2.*  *By aggregating up to 16 component carriers, transmission bandwidths up to at least 1.6 GHz and 6.4 GHz are respectively supported for frequency range 1 and frequency range 2 to provide high peak data rates. Component carriers can be either contiguous or non-contiguous in the same or different frequency band.*  *Each component carrier except the primary component carrier can be activated and deactivated in a dynamic manner depending on traffic situation.* |
| 5.2.3.2.8.3 | What are the frequency bands supported by the RIT/SRIT? Please list.  *The RIT will be capable to support IMT identified bands including following frequency bands of 3GPP. Further considerations may be expected in defined bands for 3GPP NR. Introduction of other IMT identified bands are also not precluded in the future.*  *Frequency range 2 (24.25 GHz ~ 52.6 GHz):*   |  |  |  | | --- | --- | --- | | *NR operating band* | *Uplink (UL) operating band*  *BS receive / UE transmit*  FUL\_low *–* FUL\_high | *Downlink (DL) operating band*  *BS transmit / UE receive*  FDL\_low *–* FDL\_high | | *n257* | *26.5 GHz – 29.5 GHz* | *26.5 GHz – 29.5 GHz* | | *n258* | *24.25 GHz – 27.5 GHz* | *24.25 GHz – 27.5 GHz* |   *Frequency range 1 (450 MHz ~ 6 GHz):*   |  |  |  | | --- | --- | --- | | *NR operating band* | *Uplink (UL) operating band*  *BS receive / UE transmit*  FUL\_low *–* FUL\_high | *Downlink (DL) operating band*  *BS transmit / UE receive*  FDL\_low *–* FDL\_high | | *n78* | *3300 MHz – 3800 MHz* | *3300 MHz – 3800 MHz* | |
| 5.2.3.2.8.4 | What is the minimum amount of spectrum required to deploy a contiguous network, including guardbands (MHz)?  ***FDD:***  *The minimum amount of spectrum to support contiguous carrier aggregation is 10 (2\*5) MHz for frequency range 1 and 100 (2\*50) MHz for frequency range 2.*  ***TDD:***  *The minimum amount of spectrum to support contiguous carrier aggregation is 5 MHz for frequency range 1 and 50 MHz for frequency range 2.*  *Guard band between two component carriers is not necessarily required.* |
| 5.2.3.2.8.5 | What are the minimum and maximum transmission bandwidth (MHz) measured at the 3 dB down points?  *Assuming the 3 dB bandwidth roughly equals the 99% channel bandwidth occupied by a single component carrier, the minimum 3 dB bandwidth is roughly 5 or 10 MHz depending on the frequency band for frequency range 1 and 50 MHz for frequency range 2, and the maximum 3 dB bandwidth is roughly 100 MHz for frequency range 1 and 400 MHz for frequency range 2.* |
| 5.2.3.2.8.6 | What duplexing scheme(s) is (are) described in this template?  (e.g. TDD, FDD or half-duplex FDD).  Provide the description such as:  – What duplexing scheme(s) can be applied to paired spectrum? Provide the details (see below as some examples).  – What duplexing scheme(s) can be applied to un-paired spectrum? Provide the details (see below as some examples).  Describe details such as:  – What is the minimum (up/down) frequency separation in case  of full- and half-duplex FDD?  – What is the requirement of transmit/receive isolation in case  of full- an half-duplex FDD? Does the RIT require a duplexer  in either the UE or base station?  – What is the minimum (up/down) time separation in case of TDD?  – Whether the DL/UL ratio variable for TDD? What is the DL/UL ratio supported? If the DL/UL ratio for TDD is variable, what would be the coexistence criteria for adjacent cells?  *The RIT supports full-duplex/half-duplex FDD, which operate on a paired spectrum. For the base station, a duplexer is needed for half-duplex/full-duplex FDD. For the terminal, a duplexer is needed for full-duplex FDD only. The RIT also supports TDD which operates on an unpaired spectrum. For both the base station and the terminal, a RF switch is needed for TDD.*  *For TDD, dynamic and semi-static DL/UL ratio adaptation with various symbol-level and slot-level DL/UL ratios is supported. Cross-link interference mitigation schemes are supported to enable different DL/UL configurations among adjacent cells.* |

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| **5.2.3.2.9** | **Support of Advanced antenna capabilities** |
| 5.2.3.2.9.1 | Fully describe the multi-antenna systems (e.g. massive MIMO) supported in the UE, base station, or both that can be used and/or must be used; characterize their impacts on systems performance; e.g., does the RIT have the capability for the use of:  – spatial multiplexing techniques,  – spatial transmit diversity techniques,  – beam-forming techniques (e.g., analog, digital, hybrid).  *Two transmission schemes are supported: codebook based transmission and non-codebook based transmission. Semi-open loop, closed loop, and diversity schemes transparent to specification**are supported. Hybrid beamforming with analog and digital beamforming is supported.* |
| 5.2.3.2.9.2 | How many antenna elements are supported by the base station and UE for transmission and reception? What is the antenna spacing (in wavelengths)?  *The number of transmit/receive antenna elements is implementation specific and depends on the number of antenna ports.*  *The antenna configuration (correlated/uncorrelated antennas, co-polar/cross-polar configuration, etc.) is implementation specific.*  *Up to 32 antenna ports are supported in the downlink. Up to 4 antenna ports are supported in the uplink.* |
| 5.2.3.2.9.3 | Provide details on the antenna configuration that is used in the self-evaluation.  *Related description is provided with the self-evaluation report.* |
| 5.2.3.2.9.4 | If spatial multiplexing (MIMO) is supported, does the proposal support (provide details if supported)  – Single-codeword (SCW) and/or multi-codeword (MCW)  – Open and/or closed loop MIMO  – Cooperative MIMO  – Single-user MIMO and/or multi-user MIMO.  *Multi-codeword (up to two codewords) is supported for DL. Single codeword is supported for UL.*  *Closed loop MIMO is supported.*  *It supports coordinated multipoint transmission/reception. It can mitigate interference between base stations and improve system performance, which could be used to implement different forms of cooperative multi-antenna (MIMO) transmission schemes.*  *Both single-user MIMO and multi-user MIMO are supported.* |
| 5.2.3.2.9.5 | Other antenna technologies  Does the RIT/SRIT support other antenna technologies, for example:  – remote antennas,  – distributed antennas.  If so, please describe.  *The use of remote antennas and distributed antennas is supported by NR.* |
| 5.2.3.2.9.6 | Provide the antenna tilt angle used in the self-evaluation.  *Related description is provided with the self-evaluation report.* |

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| **5.2.3.2.10** | **Link adaptation and power control** |
| 5.2.3.2.10.1 | Describe link adaptation techniques employed by RIT/SRIT, including:  – the supported modulation and coding schemes,  – the supporting channel quality measurements, the reporting of these measurements, their frequency and granularity.  Provide details of any adaptive modulation and coding schemes, including:  – Hybrid ARQ or other retransmission mechanisms?  – Algorithms for adaptive modulation and coding, which are used in the self-evaluation.  – Other schemes?  *For data, the RIT supports the modulation schemes π/2-BPSK (for uplink only), QPSK, 16 QAM, 64 QAM and 256 QAM, and distinct coding schemes for either data or control. LDPC coding is applied for both downlink data and uplink data.*  *In both downlink and uplink, link adaptation (selection of modulation scheme and code rate) is controlled by the base station. In the downlink the network selection of modulation-scheme/code-rate combination can e.g. be based on Channel Quality Indicators (CQIs) reported by the terminals. Several different CQI modes exist, including normal resolution and high resolution modes, frequency-selective and wideband modes, periodic, semi-persistent and aperiodic modes. The CQI mode is controlled by the base station. In the uplink, the base station may measure either the traffic channel or sounding reference signals and use this as input to link adaptation.*  *On the MAC layer, hybrid ARQ with soft-combining between transmissions is supported. Different redundancy versions are used for different transmissions. The modulation scheme may be changed for retransmissions. To increase resource efficiency for both downlink and uplink, the retransmission can be based on one transport block or a group of smaller pieces of code blocks depending on the base station’s decision. In order to minimize delay and feedback, a set of parallel stop-and-wait protocols are used. The residual errors can be handled by MAC ARQ on the RLC layer.*  *For more details, refer to TTAT.3G-38.214, 38.321 and 38.322.* |
| 5.2.3.2.10.2 | Provide details of any power control scheme included in the proposal, for example:  – Power control step size (dB)  – Power control cycles per second  – Power control dynamic range (dB)  – Minimum transmit power level with power control  – Associated signalling and control messages.  *The RIT uplink power control is based on both signal-strength measurements done by the terminal itself (open-loop power control), as well as measurements by the base station. The later measurements are used to generate power-control commands that are subsequently fed back to the terminals as part of the downlink control signalling (closed-loop power control) and can be multiple commands to support the multipoint reception and/or beam-based transmission/reception. Both absolute and relative power-control commands are supported, and each step size is chosen in {-1, 0, 1, 3} for relative control and {-4, -1, 1, 4} for absolute control. The power control command is included in the downlink control message and can be broadcasted to relevant terminals for each slot, i.e., 1 ms or less depending on the numerology.*  *Downlink power control is network-implementation specific and thus outside the scope of the specification.*  *For more details, refer to TTAT.3G-38.213.* |

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| **5.2.3.2.11** | **Power classes** |
| 5.2.3.2.11.1 | *UE emitted power* |
| 5.2.3.2.11.1.1 | What is the radiated antenna power measured at the antenna (dBm)?  *The output power is defined separately for different frequency ranges (FRs). For FR1, the maximum output power is measured as the sum of the maximum output power at each UE antenna connector. The maximum output power is defined by UE power class as following table.*  <UE maximum output power for FR 1>   |  |  |  |  |  | | --- | --- | --- | --- | --- | | FR1 band | Class 2 (dBm) | Tolerance (dB) | Class 3 (dBm) | Tolerance (dB) | | n78 | 26 | +2/-3 | 23 | +2/-3 | | NOTE 1: PPowerClass is the maximum UE power specified without taking into account the tolerance  NOTE 2: Powerclass 3 is default power class unless otherwise stated  NOTE 3: Refers to the transmission bandwidths (Figure 5.3.3-1) confined within FUL\_low and FUL\_low + 4 MHz or FUL\_high – 4 MHz and FUL\_high, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB | | | | |   *For FR 2, the maximum output power radiated by the UE for any transmission bandwidth of NR carrier is defined as TRP (Total Radiated Power) and EIRP(Equivalent Isotropically Radiated Power). In each power class in FR2, a UE minimum peak EIRP and UE maximum output power limits (maximum TRP and maximum EIRP) are specified as following table.*  < UE maximum output power for FR 2>   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | FR2 band | Power class 1 | | | Power class 2 | | | Power class 3 | | | Power class 4 | | | |  | Min Peak EIRP  (dBm) | Max TRP (dBm) | Max EIRP  (dBm) | Min Peak EIRP  (dBm) | Max TRP (dBm) | Max EIRP  (dBm) | Min Peak EIRP  (dBm) | Max TRP (dBm) | Max EIRP  (dBm) | Min Peak EIRP  (dBm) | Max TRP (dBm) | Max EIRP  (dBm) | | n257 | 40.0 | 35 | 55 | 29 | 23 | 43 | 22.4 | 23 | 43 | 34 | 23 | 43 | | n258 | 40.0 | 35 | 55 | 29 | 23 | 43 | 22.4 | 23 | 43 | 34 | 23 | 43 | | NOTE 1: Minimum peak EIRP is defined as the lower limit without tolerance  NOTE 2: Power class 1 UE is used for fixed wireless access (FWA). | | | | | | | | | | | | |   *For more details, refer to TTAT.3G-38.101.* |
| 5.2.3.2.11.1.2 | What is the maximum peak power transmitted while in active or busy state?  *The maximum output power for transmission bandwidth within the channel bandwidth of carrier is defined according to the UE power class and the frequency range (See 5.2.3.2.11.1.1).* |
| 5.2.3.2.11.1.3 | What is the time averaged power transmitted while in active or busy state? Provide a detailed explanation used to calculate this time average power.  *The time averaged power transmitted in active state may be affected by various factors such as UE channel conditions and allocated bandwidth. One method calculating the averaged transmit power is to take median of minimum UE output power and maximum UE output power, where the maximum UE output power is defined in 5.2.3.2.11.1.1 and 5.2.3.2.11.1.2, and the minimum output power of NR UE is defined as the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks) as shown in the following tables. For FR2, the minimum output power of power class 1 is specified differently from that of power class 2, 3 and 4.*  <Minimum UE output power for FR1>   |  |  |  |  | | --- | --- | --- | --- | | FR1 band | Channel bandwidth  (MHz) | Minimum output power  (dBm) | Measurement bandwidth  (MHz) | | n78 | 5 | -40 | 4.515 | | 10 | -40 | 9.375 | | 15 | -40 | 14.235 | | 20 | -40 | 19.095 | | 25 | -39 | 23.955 | | 30 | -38.2 | 28.815 | | 40 | -37 | 38.895 | | 50 | -36 | 48.615 | | 60 | -35.2 | 58.35 | | 80 | -34 | 78.15 | | 90 | -33.5 | 88.23 | | 100 | -33 | 98.31 |   <Minimum UE output power for FR2>   |  |  |  |  |  | | --- | --- | --- | --- | --- | | FR2 band | UE power class | Channel bandwidth  (MHz) | Minimum  output power  (dBm) | Measurement  bandwidth  (MHz) | | n257,  n258 | Power class 1 | 50 | 4 | 47.52 | | 100 | 4 | 95.04 | | 200 | 4 | 190.08 | | 400 | 4 | 380.16 | | Power class 2, 3, 4 | 50 | -13 | 47.52 | | 100 | -13 | 95.04 | | 200 | -13 | 190.08 | | 400 | -13 | 380.16 |   *For more details, refer to TTAT.3G-38.101.* |
| 5.2.3.2.11.2 | *Base station emitted power* |
| 5.2.3.2.11.2.1 | What is the base station transmit power per RF carrier?  *The base station is declared to support one or more beams. The base station transmit power is defined as the EIRP level for a declared beam at a specific beam peak direction.*  *For more details, refer to TTAT.3G-38.104.* |
| 5.2.3.2.11.2.2 | What is the maximum peak transmitted power per RF carrier radiated from antenna?  *The base station maximum carrier output power is mean power level measured per carrier at the indicted interface, during the transmitter ON period in a specified reference condition.*  *Despite the general requirements for the BS output power described in TTAT.3G- 38.104, additional regional requirements might be applicable.*  *There may exist regional regulatory requirements which limit the maximum radiated transmit power.*  *For more details, refer to TTAT.3G-38.101 and 38.104.* |
| 5.2.3.2.11.2.3 | What is the average transmitted power per RF carrier radiated from antenna?  *The time averaged power transmitted in active state may be affected by various factors such as UE channel conditions and allocated bandwidth. The base station maximum carrier output power is mean power level measured per carrier at the indicted interface, during the transmitter ON period in a specified reference condition.* |

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| **5.2.3.2.12** | **Scheduler, QoS support and management, data services** |
| 5.2.3.2.12.1 | QoS support  – What QoS classes are supported?  – How QoS classes associated with each service flow can be negotiated.  – QoS attributes, for example:  • data rate (ranging from the lowest supported data rate to maximum data rate supported by the MAC/PHY);  • control plane and user plane latency (delivery delay);  • packet error ratio (after all corrections provided by the MAC/PHY layers), and delay variation (jitter).  – Is QoS supported when handing off between radio access networks? If so, describe the corresponding procedures.  – How users may utilize several applications with differing QoS requirements at the same time.  *QoS flow is the finest granularity of QoS differentiation in a PDU session and it is identified by an QoS Flow ID (QFI) in a packet header.*  *A QoS Flow either be 'Non-GBR (Guaranteed Bit Rate)' or 'GBR' depending on its QoS profile. The QoS profile of a Non-GBR QoS flow contains 5G QoS Identifier (5QI), Allocation and Retention Priority (ARP), and optionally Reflective QoS Attribute (RQA). In case of a GBR QoS flow, the QoS profile contains 5QI, ARP, Guaranteed Flow Bit Rate (GFBR), Maximum Flow Bit Rate (MFBR), and notification control. 7 values of 5QI for GBR and 8 values of 5QI for non-GBR are standardised.*  *The SMF of CN provides the QFI together with the QoS profile to the (R)AN when a QoS flow is established or modified.*  *Data radio bearer is used to convey packets via radio access and QoS flow to DRB association is performed at both NAS (Non-Access Stratum) and AS (Access Stratum).*  *QoS characteristics which are indicated through the 5QI value are resource type (GBR/Non-GBR: Guaranteed Bit Rate), priority level, packet delay budget, packet error rate, averaging window.*  *The QoS profile could be used to determine which QoS flows to prioritize at handover.*  *By using multiple QoS flows having different QoS profile, multiple application flows with different QoS requirements could be accommodated at the same time. Network configures multiple DRBs with different QoS profile to one UE and schedules multiple DRBs at the same time.* |
| 5.2.3.2.12.2 | *Scheduling mechanisms*  – Exemplify scheduling algorithm(s) that may be used for full buffer and non-full buffer traffic in the technology proposal for evaluation purposes.  Describe any measurements and/or reporting required for scheduling.  *Scheduler which is located in base station assigns radio resources in a unit of TTI (e.g. non-slot, slot, multiple-slots) taking into account UE buffer status on downlink and uplink. The scheduler also considers channel status information and numerologies.*  *Measurement report and uplink buffer status report are required to perform scheduling in base station.*  *Further information will be provided later in accordance with 3GPP specifications.* |

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| **5.2.3.2.13** | **Radio interface architecture and protocol stack** |
| 5.2.3.2.13.1 | Describe details of the radio interface architecture and protocol stack such as:  – Logical channels  – Control channels  – Traffic channels  Transport channels and/or physical channels.  *The control plane consists of the NAS, RRC, PDCP, RLC, MAC and PHY layers.*    *control plane protocol stack*   * *NAS: Protocol between the UE and CN, and performs e.g., authentication, context activation/ deactivation and location registration management.* * *RRC: Protocol between the UE and RAN, and performs e.g., system information delivery, connection establishment/release and mobility control.* * *PDCP: Performs header compression, integrity protection and ciphering.* * *RLC: Performs segmentation/concatenation of packets and ARQ.* * *MAC: Performs HARQ and scheduling.*   *The user plane consists of the SDAP, PDCP, RLC, MAC and PHY layers.*    *user plane protocol stack*  *The functions of PDCP, RLC and MAC are the same as for C-plane.*   * *SDAP: SDAP (Service Data Adaptation Protocol) performs mapping between a QoS flow and a data radio bearer.*   *Logical channels are classified to BCCH, PCCH, CCCH, DCCH, and DTCH. Transport channels are composed of BCH, PCH, RACH, DL-SCH, and UL-SCH. Physical channels are composed of PBCH, PRACH, PDCCH, PUCCH, PDSCH, and PUSCH.*  *For more details, refer to: TTAT.3G 38.300, 38.401, 38.201 and 37.340.* |
| 5.2.3.2.13.2 | What is the bit rate required for transmitting feedback information?  *Assuming that an RLC AM Status report is sent once every 50 ms and that comprises on average less than one negative acknowledgement, its size including RLC/MAC header overhead is then on average 3+1=4 octets. Consequently, the overhead this causes is 32/0.05= 640 bit/s. This corresponds to 0.06, 0.006 and 0.0006% overhead for link speeds of 1, 10 and 100 Mbit/s.* |
| 5.2.3.2.13.3 | *Channel access:*  Describe in details how RIT/SRIT accomplishes initial channel access, (e.g. contention or non-contention based).  *The UE gets access to a cell via the contention-based random access procedure at initial connection from idle mode. With this procedure the UE transmits a random access preamble by choosing one from a maximum of 64 possible candidates on a PRACH which are configured by the network and signalled to the UE via broadcast signalling. If the base station detects a random access preamble, the base station sends a response allocating a temporary UE identity and radio resources for the uplink transmission of the initial RRC message. The UE further transmits the initial RRC message to the base station, using the allocated resources. If the base station successfully receives this initial RRC message, the base station echoes the message back to the UE in order to resolve possible contention. The UE could perform multiple attempts until it is successful in accessing the cell or until a timer supervising the procedure has elapsed. Multiple PRACHs can be configured, in order to reduce the probability of contention and to increase the PRACH capacity.*  *For UEs who have gained access to a cell (i.e. has RRC connection), non-contention based channel access request is supported (e.g., during Handover to a new cell) by means of:*   * *Scheduling Request (SR) on PUCCH, in which a dedicated resource on PUCCH for SR is semi-statically assigned by the base station to a UE, and* * *Dedicated random access resource assignment, in which a dedicated random access preamble on specific PRACH(s) is dynamically assigned by the base station to a UE via dedicated signalling, thereby making it possible to skip the contention resolution procedure.*   *For more details, refer to TTAT.3G-38.300, 38.321 and 38.213.* |
| **5.2.3.2.14** | **Cell selection** |
| 5.2.3.2.14.1 | Describe in detail how the RIT/SRIT accomplishes cell selection to determine the serving cell for the users.  *The UE performs cell search with aid of synchronisation signals (SSs) which are transmitted using 15, 30 or 60 kHz for frequency range 1, and 120 or 240 kHz for frequency range 2 on the downlink.*  *If multiple SSs are detected, the UE selects the best SS in terms of the received reference-signal power to ensure efficient spectrum usage.*  *If a cell is detected, the UE checks the suitability of the cell, i.e., the UE checks that the received reference-signal power is above the minimum required value and checks the PLMN identity, as well as other parameters restricting camping on the cell (e.g., cell barring status), on system information.*  *If multiple cells are found as suitable, the UE selects the best cell in terms of the received reference-signal power to ensure efficient spectrum usage.*  *For inter-frequency and inter-RAT cell reselection, absolute priorities could be configured so that certain frequency/RAT would be prioritized for camping. The priorities could be signalled by system information broadcast or by dedicated signalling.*  *For more details, refer to TTAT.3G-38.300 and 38.304.* |

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| **5.2.3.2.15** | **Location determination mechanisms** |
| 5.2.3.2.15.1 | Describe any location determination mechanisms that may be used, e.g., to support location based services.  *To facilitate location based services, network supports a range of complementary positioning technologies. Cell ID method utilizes cellular system knowledge about the serving cell of a specific user. Network-assisted GNSS method, WLAN positioning, and observed time difference of arrival (OTDOA) positioning are also supported.*  *Further information will be provided later in accordance with 3GPP specifications.* |
| **5.2.3.2.16** | **Priority access mechanisms** |
| 5.2.3.2.16.1 | Describe techniques employed to support prioritization of access to radio or network resources for specific services or specific users (e.g., to allow access by emergency services).  *Base station supports overload and access control functionality by using RRC connection reject, RRC connection release, and UE based access barring mechanisms.*  *Unified access barring mechanism for UEs is supported to all use cases and scenarios which include emergency services.*  *Further information will be provided later in accordance with 3GPP specifications.* |
| **5.2.3.2.17** | **Unicast, multicast and broadcast** |
| 5.2.3.2.17.1 | Describe how the RIT/SRIT enables:  – broadcast capabilities,  – multicast capabilities,  – unicast capabilities,  using both dedicated carriers and/or shared carriers. Please describe how all three capabilities can exist simultaneously.  *The RIT is envisioned to support broadcast, multicast and unicast services. Most of the downlink and uplink transmissions are unicast. Broadcast is supported to transfer some kind of the system information.* |
| 5.2.3.2.17.2 | Describe whether the proposal is capable of providing multiple user services simultaneously to any user with appropriate channel capacity assignments?  *Multiple services per user can be supported by setting up multiple bearers per user. Each bearer is characterized by an individual QoS profile, including the attributes guaranteed bitrate, maximum bitrate, and allocation and retention priority.* |
| 5.2.3.2.17.3 | Provide details of the codec used.  Does the RIT/SRIT support multiple voice and/or video codecs? Provide the detail.  *The RIT supports the AMR-WB voice codec and could support various other voice and video codec as desired. The RIT is agnostic of the codec used and is capable of accommodating diverse range of codec that are commonly used today as well as those defined in future.* |
| **5.2.3.2.18** | **Privacy, authorization, encryption, authentication and legal intercept schemes** |
| 5.2.3.2.18.1 | Any privacy, authorization, encryption, authentication and legal intercept schemes that are enabled in the radio interface technology should be described. Describe whether any synchronisation is needed for privacy and encryptions mechanisms used in the RIT/SRIT.  Describe how the RIT/SRIT addresses the radio access security, with a particular focus on the following security items:  – system signalling integrity and confidentiality,  – user equipment identity authentication and confidentiality,  – subscriber identity authentication and confidentiality,  – user data integrity and confidentiality  Describe how the RIT/SRIT may be protected against attacks, for example:  – passive,  – man in the middle,  – replay,  – denial of service.  *In order to provide enhanced privacy, the concealment of subscription permanent identifier over-the-air, regular refreshment of subscription temporary identifier, and device-assisted network-based framework for false base station detection are provided.*  *In addition to authentication and authorization which are already existed in LTE-Advanced, more improved flexible authentication for both the 3GPP and external network has been introduced in the RIT.*  *The RIT includes protection against active, passive, denial of service, and replay attacks.*  *Further information will be provided later in accordance with 3GPP specifications.* |
| **5.2.3.2.19** | **Frequency planning** |
| 5.2.3.2.19.1 | How does the RIT/SRIT support adding new cells or new RF carriers? Provide details.  *1008 physical cell IDs are supported. Therefore 1008 cell reuse is realized theoretically. New RF carriers can be allocated on desired frequency location with the same or different physical cell IDs. Actual cell and carrier deployment is operation specific.*  *From a user terminal perspective, adding new cells or carriers is supported by carrier aggregation and dual connectivity. Dynamic activation and deactivation of cells or carriers depending on traffic load is supported.* |
| **5.2.3.2.20** | **Interference mitigation within radio interface** |
| 5.2.3.2.20.1 | Does the proposal support Interference mitigation? If so, describe the corresponding mechanism.  *Static inter-cell interference mitigation is supported by means of e.g. frequency reuse, soft frequency reuse, and reuse partitioning. The dynamic inter-cell interference is supported by means of joint scheduling or beamforming. In the case of dynamic TDD operation where the direction of a slot can be changed in each slot, the terminal measures the channel between terminals as well as the channel between neighboring base station and the terminal, and reports to the base station in order to reduce inter-cell interferences.*  *Inter-cell interference mitigation is supported by means of exchanging interference measurements and scheduling decisions between base stations.*  *The base station cooperation is another approach supported by the RIT to mitigate interference dynamically between base stations and improve system performance. The coordinated base stations could either correspond to cells of the same base station or different base station.*  *Furthermore, the inter-RAT coexistence is also considered in both FDD and TDD. The downlink rate matching for signals from neighboring base stations of same RAT or other RAT (e.g., LTE) is supported.*  *Further information will be provided later in accordance with 3GPP specifications.* |
| 5.2.3.2.20.2 | What is the signalling, if any, which can be used for intercell interference mitigation?  *To reduce inter-cell interference, the RIT can configure different sequence resource for downlink and uplink. For example, CP-OFDM based transmission for both downlink and uplink, the different scrambling initialization is supported. The base station can configure the scrambling sequence to the terminal to distinguish different transmission points, e.g., base stations or terminals. For uplink transmission based on DFT-s-OFDM, the different sequence is assigned the orthogonal sequences to each terminal. To further orthogonalize the inter-cell interference for uplink, a sequence can be configured to switch to another sequence.*  *Further information will be provided later in accordance with 3GPP specifications.* |
| 5.2.3.2.20.3 | *Link level interference mitigation*  Describe the feature or features used to mitigate intersymbol interference.  *The RIT adopts OFDM modulation to mitigate inter-symbol interference for both uplink and downlink. The cyclic prefix effectively eliminates the inter-symbol interference.*  *The OFDMA is also supported, and to align the received timing at uplink, the base station controls the transmission timing of each terminal. The initial transmission timing is known to the terminal via the random access procedure.* |
| 5.2.3.2.20.4 | Describe the approach taken to cope with multipath propagation effects (e.g. via equalizer, rake receiver, cyclic prefix, etc.).  *The use of CP-OFDM with a feasible cyclic prefix provides robustness to time-dispersion/frequency-selectivity on the radio channel. This can apply to both downlink and uplink.*  *According to the configuration for uplink, the DFT-s-OFDM can also be used. Time-dispersion/frequency-selectivity on the radio channel can be handled by receiver-side equalization. The detailed equalization approach is implementation dependent. Examples of equalization approaches include frequency-domain linear equalization and Turbo equalization. The use of cyclic prefix also for the uplink may simplify the equalizer implementation.* |
| 5.2.3.2.20.5 | *Diversity techniques*  Describe the diversity techniques supported in the user equipment and at the base station, including micro diversity and macro diversity, characterizing the type of diversity used, for example:  – Time diversity: repetition, Rake-receiver, etc.  – Space diversity: multiple sectors, etc.  – Frequency diversity: frequency hopping (FH), wideband transmission, etc.  – Code diversity: multiple PN codes, multiple FH code, etc.  – Multi-user diversity: proportional fairness (PF), etc.  – Other schemes.  Characterize the diversity combining algorithm, for example, switched diversity, maximal ratio combining, equal gain combining.  Provide information on the receiver/transmitter RF configurations, for example:  – number of RF receivers  – number of RF transmitters.  *The various diversity techniques are supported. For the space domain, the base station cooperation is supported as a macro diversity. The micro diversity is supported implicitly. The antenna selection at a terminal is supported for uplink data transmission. For the frequency domain, the DFT-s-OFDM for uplink transforms among subcarriers to achieve the diversity. The CP-OFDM for both downlink and uplink supports the wideband transmission bandwidth with channel coding, which gains the diversity. For the time diversity, the retransmission based on HARQ-ACK is supported that the retransmission occurs after the coherence time. The multi-user diversity is supported by means of the base station scheduling for both downlink and uplink.*  *The diversity combining algorithm is implementation dependent.*  *The number of RF configurations are implementation dependent and the number of antenna ports can be configured, but it is subject to UE capability. As an example, for single user MIMO operation in a single cell operation, the terminal may have 4 transmitters and 8 receivers.* |
| **5.2.3.2.21** | **Synchronization requirements** |
| 5.2.3.2.21.1 | Describe RIT’s/SRIT’s timing requirements, e.g.  – Is base station-to-base station synchronization required? Provide precise information, the type of synchronization, i.e., synchronization of carrier frequency, bit clock, spreading code or frame, and their accuracy.  – Is base station-to-network synchronization required?  State short-term frequency and timing accuracy of base station transmit signal.  *Tight BS-to-BS synchronization is not required. However, in some scenarios, system performance may have gains from tight BS-to-BS synchronization.*  *As an example, assuming coordinated transmission/reception based on joint processing (joint transmission in the downlink direction, joint reception in the uplink direction) between multiple base stations, tight synchronization and time alignment between the base stations involved in the joint processing would be required. For proper operation, the synchronization should be aligned within the cyclic prefix.*  *Tight BS-to-network synchronization is not required.*  *Frequency accuracy of base station transmit signal is within ±0.05 ppm observed over a period of one slot.*  *Timing accuracy of base station transmit signal is within 65 ns for single carrier (MIMO or TX div), 260 ns for intra-band contiguous carrier aggregation, 3µs for intra-band non-contiguous and inter-band CA.*  *For more information, please refer to TTAT.3G-38.401, 38.133 and 38.104.* |
| 5.2.3.2.21.2 | Describe the synchronization mechanisms used in the proposal, including synchronization between a user terminal and a base station.  *The RIT may support different kind of methods and techniques to satisfy the synchronization requirements. A UE acquires time and frequency synchronization with a cell using the primary synchronization signals (PSS) and secondary synchronization signals (SSS). PSS and SSS together used for cell ID detection.*  *For more details, refer to TTAT.3G-38.213 and 38.211.* |
| **5.2.3.2.22** | Link budget template  Proponents should complete the link budget template in § 5.2.3.3 to this description template for the environments supported in the RIT.  *The information is provided with link budget template.* |
| **5.2.3.2.23** | **Support for wide range of services** |
| 5.2.3.2.23.1 | Describe what kind of services/applications can be supported in each usage scenarios in Recommendation ITU-R M.2083 (eMBB, URLLC, and mMTC).  *Mobile Broadband addresses the human-centric use cases for access to multi-media content, services and data. The demand for mobile broadband will continue to increase, leading to enhanced Mobile Broadband. The enhanced Mobile Broadband usage scenario will come with new application areas and requirements in addition to existing Mobile Broadband applications for improved performance and an increasingly seamless user experience. This usage scenario covers a range of cases, including wide-area coverage and hotspot, which have different requirements. For the hotspot case, i.e. for an area with high user density, very high traffic capacity is needed, while the requirement for mobility is low and user data rate is higher than that of wide area coverage. For the wide area coverage case, seamless coverage and medium to high mobility are desired, with much improved user data rate compared to existing data rates. However the data rate requirement may be relaxed compared to hotspot.*  *eMBB enables Gigabytes transmission in a second, therefore, facilitates such services as 3D video, UHD screens, work and play in the cloud, and augmented reality.*  *Ultra-reliable and low latency communications have stringent requirements for capabilities such as throughput, latency and availability. Wireless control of industrial manufacturing or production processes, remote medical surgery, distribution automation in a smart grid, transportation safety can be supported with the proposed technology.*  *Massive machine type communications is characterized by a very large number of connected devices typically transmitting a relatively low volume of non-delay-sensitive data. Devices are required to be low cost, and have a very long battery life. Smart city is one of the mMTC applications.*  *For more details, refer to ITU-R M.2083-0.* |
| 5.2.3.2.23.2 | Describe any capabilities/features to flexibly deploy a range of services across different usage scenarios (eMBB, URLLC, and mMTC) in an efficient manner, (e.g., a proposed RIT/SRIT is designed to use a single continuous or multiple block(s) of spectrum).  *Different sub-carrier spacings multiplexed into one RF carrier supports wide range of services across the above three usage scenarios co-existed on the same spectrum.*  *For eMBB services, the RIT supports:*   * *Higher frequency bands (frequency range 2) as well as lower frequency bands (frequency range 2)* * *Maximum channel bandwidth of 100 MHz for frequency range 1 and 400 MHz for frequency range 2* * *Aggregation of multiple component carriers to provide up to 6.4 GHz transmission bandwidth* * *Up to 8 layers in DL, and up to 4 layers in UL*   *For URLLC services, the RIT supports:*   * *Short scheduling intervals using larger subcarriers spacings (30, 60, 120 kHz)* * *Front loaded DMRS* * *Pre-emption and UL transmission without grant*   *For mMTC services, the RIT supports:*   * *DFT-s-OFDM, extended DRX cycle for RRC active state to improve battery life* * *Slot aggregation for both control and data, high aggregation level for downlink control channel to extend coverage*   *Further information will be provided later in accordance with 3GPP specifications.* |
| **5.2.3.2.24** | **Global circulation of terminals**  Describe technical basis for global circulation of terminals not causing harmful interference in any country where they circulate, including a case when terminals have capability of device-to-device direct communication mode.  *The RIT will use defined NR frequency bands by 3GPP and each frequency band complies to the regulatory requirements of a given region. For more details on the normative spectrum emission mask and additional spectrum mask, refer to TTAT.3G-38.101.*  *This RIT does not support device-to-device communication mode at this stage.* |
| **5.2.3.2.25** | **Energy efficiency**  Describe how the RIT/SRIT supports a high sleep ratio and long sleep duration.  Describe other mechanisms of the RIT/SRIT that improve the support of energy efficiency operation for both network and device.  *When no data transfer takes place, NR network will keep periodical transmission of SS/PBCH blocks and RMSI (remaining minimum system information), as well as paging signal in order for UEs to detect and access the radio network. For the initial network access, UE may assume 20 ms periodicity of SS/PBCH block transmission. In order to improve energy efficiency, the periodicity of SS/PBCH block transmission can be configured. The sleep ratio for SS/PBCH block, RMSI, and paging are evaluated in TR37.910.*  *Also the RIT supports two different types of SIB transmission. One is being transmitted periodically, the other is being transmitted only when there is the request from UE.*  *The RIT supports DRX mode operation in RRC\_CONNECTED, RRC\_INACTIVE and RRC\_IDLE modes. DRX cycle consists of on-duration followed by a possible period of inactivity in order for UEs to save battery power during the inactivity period.*  *In addition, a UE configured for operation in bandwidth parts (BWPs) of a serving cell, is configured by higher layers for the serving cell with a set of at most four bandwidth parts for receptions by the UE (DL BWP set) in a DL bandwidth by parameter DL-BWP-index and a set of at most four BWPs for transmissions by the UE (UL BWP set) in an UL bandwidth by parameter UL-BWP-index for the serving cell. For unpaired spectrum operation, a DL BWP from the set of configured DL BWPs is linked to an UL BWP from the set of configured UL BWPs. For unpaired spectrum operation, a UE can expect that the center frequency for a DL BWP is same as the center frequency for a UL BWP. When configured to operate on a narrower bandwidth, much lower clock rate at UE side contribute to energy efficiency.*  *The RIT supports RRC\_INACTIVE state. In RRC\_INACTIVE, an UE remains RRC connection while maintaining battery saving advantages from Idle mode. Also, transition to connected state for data transfer is fast. No core network signalling is needed. The RRC context is already in place in the network.*  *Further information will be provided later in accordance with 3GPP specifications.* |
| **5.2.3.2.26** | **Other items** |
| 5.2.3.2.26.1 | *Coverage extension schemes*  Describe the capability to support/ coverage extension schemes, such as relays or repeaters.  *The RIT provides SUL (Supplementary Uplink) scheme for UL coverage extension. With SUL, the UE is configured with 2 UL carriers and uses the SUL carrier when the channel quality is lower than configured threshold.*  *Further information will be provided later in accordance with 3GPP specifications.* |
| 5.2.3.2.26.2 | *Self-organisation*  Describe any self-organizing aspects that are enabled by the RIT/SRIT.  *The RIT provides self-organisation aspect by self-configuration, ANR (Automatic Neighbour Relation) mechanism. With self-organisation aspect, network automatically configures newly deployed base stations and manages neighbour cell lists in a base station by using UE measurement report.*  *For more detail, refer to TTAT.3G-38.300, 38.413, 38.423 and 38.331.* |
| 5.2.3.2.26.3 | Describe the frequency reuse schemes (including reuse factor and pattern) for the assessment of average spectral efficiency and 5th percentile user spectral efficiency.  *The RIT can access the full frequency dynamically, and no frequency reuse is assumed semi-statically for interference coordination.*  *However, depending on the deployment scenario, an implementation can apply a specific frequency reuse scheme and, in this case, the average/5th user spectral efficiency should be taken care of.* |
| 5.2.3.2.26.4 | Is the RIT/component RIT an evolution of an existing IMT technology? Provide the detail.  *This RIT is new radio developed as 3GPP NR, and will be evolving.* |
| 5.2.3.2.26.5 | Does the proposal satisfy a specific spectrum mask? Provide the detail. (This information is not intended to be used for sharing studies.)  *Yes.*  *For both UE and Base Station side, the spectrum masks are specified in TTAT.3G-38.101 and 38.104, respectively.* |
| 5.2.3.2.26.6 | Describe any UE power saving mechanisms used in the RIT/SRIT.  *DRX in connected, inactive, and idle modes is supported.*  *Inactive state, RF bandwidth adaptation, and pipelining frame structure are newly introduced features to further improve UE power saving.* |
| 5.2.3.2.26.7 | *Simulation process issues*  Describe the methodology used in the analytical approach.  Proponent should provide information on the width of confidence intervals of user and system performance metrics of corresponding mean values, and evaluation groups are encouraged to provide this information as requested in § 7.1 of Report ITU-R M.2412-0.  *Related description is provided with the self-evaluation report in accordance with Report ITU-R M.2412-0.* |
| 5.2.3.2.26.8 | *Operational life time*  Describe the mechanisms to provide long operational life time for devices without recharge for at least massive machine type communications  *In order to lengthen battery life, DFT-s-OFDM, uplink power control, DRX in connected mode, configurable bandwidth for transmission/reception are provided.* |
| 5.2.3.2.26.9 | *Latency for infrequent small packet*  Describe the mechanisms to reduce the latency for infrequent small packet, which is, in a transfer of infrequent application layer small packets/messages, the time it takes to successfully deliver an application layer packet/message from the radio protocol layer 2/3 SDU ingress point at the UE to the radio protocol layer 2/3 SDU egress point in the base station, when the UE starts from its most "battery efficient" state.  *The RIT supports the inactive state as a “battery efficient” state and a UE can maintain connections with base station in the state. So, the UE can transmit infrequent small packets without performing signalling for connection setup.* |
| 5.2.3.2.26.10 | *Control plane latency*  Provide additional information whether the RIT/SRIT can support a lower control plane latency (refer to § 4.7.2 in Report ITU-R M.2410-0).  *The information will be provided in later update.* |
| 5.2.3.2.26.11 | *Reliability*  Provide additional information whether the RIT/RSIT can support reliability for larger packet sizes (refer to § 4.10 in Report ITU-R M.2410-0).  *Following features can contribute to high reliability:*   * *Capacity achieving error-correction codes such as LDPC and Polar* * *Soft combining by Hybrid ARQ or repetition transmission* * *Diversity combining by multi-antenna transmission and reception*   *Further information will be provided later in accordance with 3GPP specifications.* |
| 5.2.3.2.26.12 | *Mobility*  Provide additional information for the downlink mobility performance of the RIT/SRIT (refer to § 4.11 in Report ITU-R M.2410-0).  *The intention of DMRS is for channel estimation. In order to support different downlink mobility environments, DM-RS occasions in a slot can be differently configured. In the case of low mobility conditions, front-loaded one DM-RS configuration per slot is beneficial. To combat rapid channel, up to four DM-RS occasions per slot can be configured. Also, TRS and PT-RS are supported for frequency tracking and phase noise compensation, respectively.* |
| **5.2.3.2.27** | **Other information**  Please provide any additional information that the proponent believes may be useful to the evaluation process.  *We would like to continue to provide additional information which is useful to the evaluation, if any.* |

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