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This document (revision of Tdoc TSGR#2(99)053) provides baseband and RF values for UTRA agreed by 3GPP TSG RAN WG1 and WG4 and subsequently discussed in TSG RAN for inclusion in the Key Characteristics of the IMT-2000 Radio Interface(s) being developed by ITU-R TG 8/1. The attached contribution is meant to be submitted to the next meeting of ITU-R TG 8/1 (Fortaleza, Brazil, 8-19 March 1999) by Individual Member.

[NATIONAL ADMINISTRATION OR ITU MEMBER][1]

UTRA BASEBAND AND RF KEY CHARACTERISTICS

1 INTRODUCTION

The formation of the Third Generation Partnership Project (3GPP) was reported to the last meeting of ITU-R TG 8/1 WG5 (Doc 8-1/WG5-028). This collaborative project is now fully operational. So far, five Organisational Partners have signed the Third Generation Partnership Project Agreement, namely: ARIB, ETSI, T1, TTA, TTC.

This document provides baseband and RF values for UTRA based on the current activity within 3GPP TSG RAN (which is the Radio Access Network Technical Specification Group whithin 3GPP responsible for the elaboration of the Specifications for the UTRA - Universal Terrestrial Radio Access).

[1] This contribution was developed in 3GPP TSG RAN

2 BASEBAND KEY CHARACTERISTICS

TABLE 2

Baseband Key Characteristics

#	Names of the Key Characteristics	Definitions	Values
1	**Multiple access technique**	The multiple access technique allows multiple users to share transmission media without creating uncontrollable interference to each other. The multiple access techniques can be used individually or in a hybrid mode, for example, time, code and space multiplexing (TD/CD/SDMA). Note: Different multiple access schemes usually employ different radio techniques. For example, CDMA commonly uses fast power control; and TD/CDMA typically uses joint detection. Similarly, SDMA generally employs adaptive beamforming.	FDD: DS-CDMA TDD: DS-CDMA/TDMA
2	**Chip rate**	The rate at which information data is spread by pseudo random code modulation elements in a direct sequence CDMA system. Notes: The transmitted signal bandwidth is a function of the chip rate. It has key impact on multipath signal delay resolution capability and the processing gain of DS-CDMA systems.	1.024, 4.096, 8.192, 16.384 Mcps Primary value: 4096 Mcps
3	**Frame structure**	Frame Structure is a specified portion of time slots. Frame structure has two important aspects, one of which is number of time slots in a frame and another one is frame length. • Number of time slots in a frame • Frame Length Note: The frame structure is a key characteristic of baseband system, since it may be affected by parameters such as multiple access scheme,	Number of time slots in a frame: 16 Note: In FDD, a user normally transmits/receives on all 16 time slots. Frame length: 10 ms

		duplexing scheme, power control, interleaver size and vocoder scheme.	
4	**Variable length spreading factor**	A modification of a direct sequence spreading code that creates a family of orthogonal codes of variable length to support variable data rates in a DS-CDMA system. Notes: The use of orthogonal variable spreading codes enables implementation of data rates greater than 8-16 kbps with minimal complexity & performance impact.	FDD: UL 4-256, DL 4-512 TDD: 1-16 (Answers given for the 4.096 Mcps chip rate)
5	**Inter base station asynchronous/ synchronous operation**	System base stations whose relative time difference is determined and maintained to a very tight tolerance e.g., a chip period, by utilization of a common clock or timing source, are said to be synchronized. Asynchronous base stations may use a common timing source mainly for frequency stability purposes, but there is no requirement on the relative time difference between them. Notes: Synchronous systems are desirable for 2G/3G roaming within the same frequency band for existing 2G synchronized systems. Asynchronous systems facilitate multi-environment user roaming without accurate base station synchronization.	FDD: asynchronous or synchronous TDD: synchronous (at symbol level with respect to highest spreading factor), asynchronous possible
6	**Inter-user synchronization**	A method used to synchronize all DS-CDMA user transmissions in a sector or cell at the base station receiver. Notes: This can simplify many advanced DSP implementation requirements such as joint detection, beam-forming and software radio design. It can also decrease fast power control requirements and inter users interference with orthogonal codes. Inter-user synchronization is used only for CDMA.	Optional uplink synchronization
7	**Handover**	In general, handover is the process of transferring the mobile station's communication from one radio channel to another when the mobile is moving between sectors or between cells. Note: Handover is an essential element of a mobile telecommunications system as it permits mobility through the coverage area of the network. There are two types of handover - hard and soft, depending upon whether there are simultaneous connections to more than one base	The following types of handover are supported: - Intra-system/intra-frequency handover: - Soft/softer handover - Hard handover - Intra-system/inter-frequency handover: - Hard handover - Inter-system handover:

		station during the handover process. . Soft handover has the benefit of allowing diversity combining of signals to enhance performance. Of particular importance when defining the handover mechanism are • the measurement method that triggers the handover, • whether the mobile station assists in the handover process by performing measurements, or initiates the handover, and the messaging between the mobile station and base station during the course of the handover.	- Hard handover
8	**Channel coding and interleaving**	**Channel coding and decoding** is the process to introduce some redundancy in the information sequence in a controlled manner such that the redundancy can be used at the receiver to overcome the effects of noise and interference encountered in the transmission channel, thus increasing the reliability of the received data. Note: Channel coding techniques (e.g., convolutional codes, block codes, turbo codes) are essential in achieving low bit error ratios and/or coding gain. Turbo codes have recently been shown to improve system capacity and QoS for high data rate services. The components of a Turbo coder consist of recursive systematic coders and an interlever. The improvements resulting from Turbo codes are dependent on the design (generator polynomial) of the recursive systematic coders and interleaver matrix. **Interleaving and de-interleaving** is the process to permute the transmission sequences of coded bit stream prior to modulation and to reverse this operation following demodulation. It is used to separate and redistribute bursty errors over several codewords or constraint lengths for higher probability of correct decoding by codes designed to correct random errors. Note: Interleaving helps in randomizing error patters. The effectiveness of interleavers generally improves with size, representing a design trade-off with signal delay. The interleaver depth, to be effective, must be large compared with the mean duration of channel fades.	**Coding:** Convolutional code with K=9, R=1/2, or 1/3 Turbo code with K=4 or K=3 **Interleaving:** Inter-frame interleaving (20/40/80 ms) Intra-frame interleaving (10 ms)
9	**Random access**	Random Access is the technique for multiple mobile stations to access	FDD: Acquisition indication based random-access mechanism with power ramping on preamble

		radio channels without prior scheduling. Note: Because of the lack of pre-arrangement, collisions of the transmissions from different stations occur, at an average rate that depends on the traffic and re-transmission rules. An optimized random access design minimizes collisions among mobile stations, thereby throughput and reducing delay and interference.	followed by message TDD: Slotted ALOHA, 1 slot RACH (0.625 ms)
10	**Modulation (up-link and down-link)**	The process of varying certain parameters of a digital code signal (carrier), through digital signal processing, in accordance with a digital message signal, to allow transmission of the message signal through IF and RF channels, followed by its possible detection. Notes: Modulation is important because variation of the code signal parameters can impact QoS or lead to significant variations in system complexity.	FDD: Data modulation: UL dual channel QPSK, DL QPSK Spreading modulation: UL HPSK[2], DL QPSK TDD: Data modulation: QPSK Spreading modulation: QPSK
11	**Channelization code (up-link and down-link)**	Channelization codes are set of orthogonal codes used for spreading and identification of any other channels. Note: It is important in CDMA systems to minimize the interference between users and between channels in the cell in down-link and between channels of a user in up-link	Real OVSF (Orthogonal Variable Spreading Factor) codes
12	**Scrambling code** **(up-link and down-link)**	Scrambling code is used in DS-CDMA systems to identify BTS or sector in down-link, and MS in up- link. Note: It is important for multiple access system to correctly identify users.	FDD: DL: Complex code, 40960 chips (10 ms) segments from Gold codes. UL: Complex code, 40960 chips (10 ms) segments from Gold codes (long codes) or 256 chips extended S(2) codes (short codes). TDD: Complex codes, 16 chips long with phase-transition restrictions. (Answers given for the 4.096 Mcps chip rate)

[2] In 3GPP Specifications HPSK is described as part of the scrambling.

13	**Pilot structure**	The system pilot is used for channel searching, estimation, acquisition, demodulation and can also be used to assist soft handover. It can also be used to implement fast power control and adaptive antenna technologies. The pilot can be continuous and code multiplexed, or periodic and time multiplexed. Notes: A pilot channel or pilot symbols provide a phase reference for coherent detection. It also provides a means for signal strength comparison between the base stations. This makes soft handover possible. The downlink pilot can either be common to all users in a cell or a sector, or dedicated to each traffic channel. The pilot channel structure can impact overall system capacity and performance.	FDD: Time-multiplexed dedicated pilot symbols, and time-multiplexed common pilot symbols on common control physical channel TDD: Time-multiplexed dedicated pilot sequence
14	**Detection** **(up-link and down-link)**	The process performed by the receiver to recover the original signal in the presence of channel degradation and to transform the detected signal back to a digital signal. Notes: There are two common methods of detection. Coherent detection requires a reference waveform to be generated at the receiver that is matched in frequency and phase to the transmitted signal. When a phase reference can not be maintained, noncoherent detection is used. Most radio transmission technologies use coherent detection for both forward link and reverse link, which significantly increases the capacity for these systems and differentiates them from 2G systems. **Joint detection** is used to coherently detect the data in CDMA and TDMA time slots that are spread with a limited number of CDMA codes to cope with multipath propagation effects at the MS and BS and improve overall performance. **Multi-user detection** involves the joint detection of all users in a cell. This technique significantly helps in reducing intracell interference and thereby increases the capacity of the reverse link. The implementation of multiuser detection will have an impact on the base station receiver complexity and architecture.	Coherent detection Joint-detection/Multi-user-detection supported
15	**Power control** **(up-link and down-link)**	The adjustment of the transmitted power in order to keep the received power from each station in a multiple-access communication system at the minimum power required to maintain a given QoS.	FDD: Closed loop power control on dedicated channels Open loop and optional closed loop power control for

		Note: Such a strategy maximizes overall system capacity.	random-access channels TDD: Open or closed loop power control on dedicated channels Open loop power control for random-access channel
16	**Variable data rate (up-link and down-link)**	A feature that adapts the instantaneous transmission rate on a specific traffic channel to the instantaneous amount of data to be transmitted in accordance with the demands of a data source or the propagation conditions. **Symmetric/asymmetric data rate** The capability of a system to operate with equal (symmetric) or different (asymmetric) data rate on the downlink and uplink in order to support symmetric or asymmetric uplink/downlink traffic. Note: The efficient support of asymmetric rate allows for optimal usage of the radio resources, resulting in higher overall system capacity when the users' traffic is mixed, i.e., both symmetric and asymmetric.	-Different data rates supported with: - Variable spreading factor - Multi-code - Multi-slot (TDD only) - Code puncturing - Unequal repetition - DTX (FDD DL and TDD DL & UL) - Rate can change on frame-by-frame basis - UL/DL data-rate asymmetry supported - Overall UL/DL asymmetry supported with TDD
17	**Diversity**	Diversity is the process by which several replicas of the same information-bearing signal are transmitted and received over multiple channels that exhibit independent fading. Note: There is a good likelihood that at least one or more of the received signals will not be in a fade at any given instance in time, thus providing adequate signal level to the receiver with reasonable transmitted power. Diversity techniques seek to generate and exploit multiple branches over which the signal shows low fade correlation. To obtain the best diversity performance, the multiple access scheme, modulation, coding and antenna design must all be carefully chosen so as to provide a rich and reliable level of well-balanced, low correlation diversity branches in the propagation environment. Successful exploitation of diversity leads to:	– Time diversity – Frequency diversity – Multi-path diversity – Antenna diversity – Transmit diversity, both open loop and closed loop, for FDD mode – Selective transmit diversity for TDD mode - Relaying diversity (ODMA in TDD) - Macro-diversity

		reduced power requirements increased coverage improved battery life improved voice quality and handover performance.	
18	**Adaptive equalizer**	Time varying channel dispersion due to multipath propagation can cause inter-symbol interference, resulting in increased Bit Error Ratio (BER) or dropped calls on wireless communication systems. Active equalization is the process of reducing inter-symbol interference in a communication system by real-time adjustment of a filter that compensates for a time-varying multipath channel. Note: Adaptive equalization is essential for Time Division Multiple Access (TDMA) communication systems to meet the high data rate service requirements of IMT-2000, such as high spectral efficiency and reasonable costs for outdoor macrocellular environments. Adaptive equalization can also be utilized to increase TDMA system capacity. The effectiveness of adaptive equalization depends on the time-rate of change of the channel characteristics in comparison to the signal characteristics.	Not needed
19	**Dynamic Channel Allocation**	DCA is the assignment of channels in real-time, in accordance with observed traffic/interference conditions, as opposed to a prearranged channel assignment. DCA avoids planning of the radio channels and is required for uncoordinated systems sharing the same frequency band.	FDD: Supported (dynamic assignment to carriers) TDD: - Supported (dynamic assignment to carriers/time-slots) - ODMA (Opportunity Driven Multiple Access)
20	**Duplexing Scheme**	The duplexing scheme is the method by which the transmitter and the receiver share the limited sources, such as time and frequency. This can be achieved through the use of frequency (Frequency Division Duplexing – FDD) and time (Time Division Duplexing – TDD).	FDD or TDD

21	**Multicarrier**	Muticarrier is a method to allow one transceiver to receive or transmit several carriers simultaneously. Note: Muticarrier can give flexibility of system planning and give backward compatibility, it also can help to easily use many new technologies.	Multi-carrier is not used

3. RF KEY CHARACTERISTICS

TABLE 1
RF Key Characteristics

	Name of Key Characteristic	Definition[3]	remarks [4]	List of proposed values [5]	
				Mobile Station Value	Base Station Value
	Transmitter characteristics	The transmitter characteristics are specified at the antenna connector of the equipment. If there is no antenna connector, appropriate measuring mechanism should be defined. For example antenna emission power can be measured at the test site or at the RFCD (Radio-Frequency Coupling Device) calibrated at the test site.	Modified definition		

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[3] Editor's note: The columns 'Name of Key Characteristic' and 'Definition' are quite stable and are to be frozen.

[4] Editor's note: This column is for information purpose only and will be deleted at 16th TG8/1 meeting.

[5] Editor's note: The column 'List of proposed values' is a compilation of input contributions at WG-5 meeting in Malaysia. Some of the definition of 'RF key characteristics' were changed during the meeting. The listed values in these columns were proposed based on the definitions in Doc. 8-1/TEMP/126. Therefore, the listed values in this column may not be consistent to the revised definition of the 'RF key characteristics.'

	Transmit power				
1.1	Power classes (A1.2.16)[6]	The power classes define the maximum average output transmitter power level, measured over a unit time. The power classes together with the service type (bit rate, QoS etc.) define the coverage. An operator can use this for planning its network. For multi-standard terminals the highest power class level that needs to be supported will set the power amplifier requirements. The accuracy of the power may depend on appropriate regional regulations.	New definition	Power classes are being discussed in the range 0-33 dBm. One class of 21 dBm is identified.	<= 43 dBm
1.2	Dynamic range (A1.2.22.3)	The output power dynamic range is the difference between the maximum and the minimum transmitted power for a specified reference condition.	No change	the minimum specified transmit power is -44dBm/ 4.096 MHz	for FDD: >= 18 dB for TDD: >= 30 dB
1.3	Power Control Steps (A1.2.22.1)	The power control step is the minimum step change in the transmitter output power in response to a power control command.	No change	for FDD: 1 dB for TDD: 1-3 dB	for FDD: 1 dB for TDD: 1-3 dB
1.4	Frequency stability (A1.4.1)	The ability of mobile and base station to maintain the transmission frequency at the assigned carrier frequencies.	New definition	+/- 0.1 ppm (locked to the system)	+/- 0.05 ppm

[6] Editor's note: Notation (A1.X.Y.Z) indicates reference attribute of Annex-1 of Recommendation ITU-R M.1225. The reference would be deleted when draft new recommendation IMT.RKEY is finalized.

	Output RF spectrum emissions				
1.5	3 dB Bandwidth (A1.2.5)	Bandwidth is the frequency range of the transmitter power per RF channel measured at the 3 dB down points.	Modified definition	Exactly equal to chip rate: 4.096 MHz (8.192 MHz and 16.384 MHz for the higher chip rates)	Exactly equal to chip rate: 4.096 MHz (8.192 MHz and 16.384 MHz for the higher chip rates)
	Out of band emissions (A1.4.2)		Merged into item 1.7		
1.6	Adjacent Channel Leakage power ratio *[Editor's Note: Prior name was Adjacent Power Protection.]*	Adjacent channel leakage power is the interference power at adjacent channels that are outside the assigned channel and is defined as the power that is radiated within a specified bandwidth. Adjacent channel leakage power ratio is the ratio of the leakage power and total radiation power. Note: The modulation and power level switching spectra can produce significant interference in the adjacent channel bands. The effects on the spectrum due to continuous modulation spectrum and due to the switching transient spectrum do not occur at the same time.	New name New definition	ACLR= 30-40dBc (5MHz offset) Next ACLR=40-50dBc (10 MHz offset) (considering the 3dB bandwidth) (work is continuing to define a single value)	ACLR= 45-55 dBc (5MHz offset) Next ACLR= 55-65 dBc (10MHz offset) (considering the 3dB bandwidth) (work is continuing to define a single value)

1.7	Out of band and Spurious emissions (A1.4.2)	Out of band and Spurious emissions are the emissions at frequencies that are outside the assigned channel, as a function of frequency offset.	Merged item Modified definition[7]	Requirements will be based on applicable tables from Recommendation ITU-R SM.329. Local radio regulatory agencies would also establish emission limits (e.g. FCC in the U.S., ERC in Europe, Japanese regulatory Body)	Requirements will be based on applicable tables from Recommendation ITU-R SM.329. Local radio regulatory agencies would also establish emission limits (e.g. FCC in the U.S., ERC in Europe, Japanese regulatory Body)
1.8	Transmit linearity requirements (A1.4.10)	Transmit linearity characterizes the linear and broadband transmitter power amplifier requirements to meet spurious and out of band emissions. This is primarily characterized by peak to average power ratio (A1.2.11) which dictates the power amplifier backoff from the saturation point.	Modified definition	Characterized by ACLR (see 1.6 above)	Characterized by ACLR (see 1.6 above)
1.9	Standby RF output power	Standby RF output power is the nominal Mobile Station RF power output while in idle state.	New item[8]	Emission limits established by local radio regulatory agencies generally apply (e.g. FCC in the U.S., ERC in Europe, Japanese regulatory Body)	N/A
	Receiver characteristics				

[7] Editor's note: It should be noted that the draft new Rec. IMT.TERM would define this characteristic for mobile stations. In order to keep consistency among ITU Recommendations, the next TG 8/1 meeting should check this observation.

[8] Editor's note: Keep this item to invite contributions for next TG 8/1 meeting.

2.1	Reference sensitivity	The RF sensitivity is the minimum receiver power measured at the antenna port at which the FER/BER does not exceed the specified values. The parameter will therefore depend on the bit rate and QoS requirement, but also implementation factors such as Noise Figure (NF) according to the following equation: $P_{Rx\ Sens} = kT \cdot NF \cdot \frac{E_b}{N_0} \cdot R_b$ where kT is the thermal noise density –174 dBm/Hz, NF is the receiver noise figure, Eb/N0 is the receiver information bit energy to noise density threshold (at the given QoS) and Rb is the information bit rate. Since Eb/N0 and Rb (andf hence PRx Sens) will vary with the service, it is only NF that can be considered a key RF parameter. PRx Sens will set the coverage for an unloaded traffic case. If different noise figures are used in different radio interfaces, then the lowest noise figure applies for a multi-mode terminal implementation.	Modified name and definition	-117dBm for 12.2kbps measurement channel	Based on NF <= 5 dB (nominal) for normal BTS, higher NF for micro and pico BTS
2.2	Receiver dynamic range (A1.4.12)	The difference, in decibels, between the overload level and the minimum acceptable signal level in a transmission system.	Modified name and definition	Maximum level: –25 dBm	>= 30dB

2.3	Intermodulation sensitivity (A1.4.11)	The intermodulation sensitivity is the receiver's ability to receive a signal on its assigned channel frequency in the presence of two interfering RF signals. These RF signals are separated from the assigned channel frequency and from each other such that the third order mixing of the two interfering RF signals can occur in the non-linear elements of the receiver, producing an interfering signal in the band of the desired signal. The receiver performance is measured by the frame error rate or bit error rate. *[clarification to the definition: this applies to in-band interference signal]*	Modified name and definition was changed.	The level of the interfering signal : -46dBm	The exact specifications are yet to be defined.

2.4	Spurious response and Blocking	The spurious response and receiver blocking level are the signal level that causes the receiver to mute due to interferering RF signals. Receiver blocking level is generally not sensitive to frequency differences between the out of band signal and the receive center frequency.	Modified name and definition	In-band blocking: -44dBm (over 15MHz offset) (the coexistance with other systems should be considered)	(the coexistance with other systems should be considered)
2.5	Adjacent channel selectivity	Adjacent channel selectivity is the receiver ability to receive a desired signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the center frequency of the assigned channel. Receiver selectivity performance is measured at a specific frame error rate or bit error rate.	Modified definition [9]	>= 48dB for 12.2kbps measurement channel (the optimum value is currently under investigation)	>= 48 dB for 12.2kbps measurement channel (the optimum value is currently under investigation)
	Other characteristics				
3.1	Diversity techniques (A1.2.23)	[Diversity, as applied to the RF front-end, would imply combining or transmitting independent replicas of the same signal in space or time.] Note: IMT-2000 should not preclude the use of diversity schemes.	Modified definition	Time diversity Space diversity (optional) Frequency diversity ODMA can provide path diversity in TDD mode	Time diversity Space diversity Frequency diversity Macro diversity Transmitter diversity (optional) ODMA can provide path diversity in TDD mode

[9] Editor's note: Keep this item to invite contributions for next TG 8/1 meeting.

3.2	Smart antennas (A1.3.6)	[Smart antenna is an advanced antenna technology composed by an antenna array and beamformed in baseband data processing.] Note: IMT-2000 should not preclude the use of smart antennas. [Smart antenna is one of main features to enhance QoS and to reduce complexity.]	Modified definition	Supported both in the up- and down link through dedicated pilots (optional).	Supported both in the up- and down link through dedicated pilots (optional).
3.3	Minimum operating bandwidth (A1.2.1 & A1.2.4)	Minimum operating bandwidth is characterised by RF channel spacing (A1.2.4) and the minimum bandwidth for deployment (A1.2.1).	Modified name and definition	FDD: Uplink 1920-1980 MHz, Downlink 2110-2170 MHz TDD: 1900-1920, 2010-2025 MHz. Deployment of TDD in the 1920-1980 MHz band is an open item. Operation in other bands is not precluded. Operating bandwidth: FDD 2x5 MHz or more, TDD 1x5 MHz or more.	FDD: Uplink 1920-1980 MHz, Downlink 2110-2170 MHz TDD: 1900-1920, 2010-2025 MHz. Deployment of TDD in the 1920-1980 MHz band is an open item. Operation in other bands is not precluded. Operating bandwidth: FDD 2x5 MHz or more, TDD 1x5 MHz or more.