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TECHNICAL REPORT

**ETSI Evaluation Group;
Final Evaluation Report on DECT-2020 NR**

Reference

DTR/MSG-EVAL-001

Keywords

DECT-2020, IMT-2020, radio

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Mobile Standards Group (MSG).

ETSI EG is a registered Independent Evaluation Group (IEG) of ITU-R for the purpose of evaluation of IMT-2020 candidate technologies: https://www.itu.int/oth/R0A0600007B/en.

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The present document is a documentation of the IMT-2020 evaluation results contributed by the ETSI Evaluation Group (EG) to the IMT-2020 process.

The ETSI EG focussed on evaluating the DECT-2020 NR component Radio Interface Technology (RIT) of the Set of Radio Interface Technologies (SRIT) proposed by ETSI TC DECT and DECT Forum.

The proposed SRIT consists of:

- "DECT-2020 NR" component RIT; and

- "3GPP 5G NR" component RIT.

According to the submission by ETSI, the proposed candidate RIT DECT-2020 NR focuses on the usage scenarios URLLC and mMTC, while the 3GPP 5G NR delivers the required support of eMBB.

It is to be noted that the requirements, evaluation criteria, scenarios and guidelines in Reports ITU-R M.2410-0 [i.1], ITU-R M.2411-0 [i.2] and ITU-R M.2412-0 [i.3] define scenario benchmarks to be fulfilled by the candidate technologies. These scenarios might not reflect practical deployments and might limit the performance reachable under practical deployment considerations of the technology.

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1 Scope

The present document presents the ITU-R IMT-2020 evaluation results of the ETSI Evaluation Group (EG) as provided to ITU-R WP 5D [i.14].

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1]   Report ITU-R M.2410-0: "Minimum requirements related to technical performance for IMT-2020 radio interface(s)".

[i.2]   Report ITU-R M.2411-0: "Requirements, evaluation criteria and submission templates for the development of IMT-2020".

[i.3]   Report ITU-R M.2412-0: "Guidelines for evaluation of radio interface technologies for IMT-2020".

[i.4]   Report ITU-R M.2135-1: "Guidelines for evaluation of radio interface technologies for IMT-Advanced".

[i.5]   Recommendation ITU-R M.1036-6: "Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations".

[i.6]   ETSI TS 103 636-1 (V1.1.1): "DECT-2020 New Radio (NR); Part 1: Overview; Release 1".

[i.7]   ETSI TS 103 636-2 (V1.1.1): "DECT-2020 New Radio (NR); Part 2: Radio reception and transmission requirements; Release 1".

[i.8]   ETSI TS 103 636-3 (V1.1.1): "DECT-2020 New Radio (NR); Part 3: Physical layer; Release 1".

[i.9]   ETSI TS 103 636-4 (V1.1.1): "DECT-2020 New Radio (NR); Part 4: MAC layer; Release 1".

[i.10]   3GPP TR 36.843 (V12.0.1): "Study on LTE device to device proximity services; Radio aspects".

[i.11]   ETSI TR 138 901 (V16.1.0): "5G; Study on channel model for frequencies from 0.5 to 100 GHz (3GPP TR 38.901 version 16.1.0 Release 16)".

[i.12]   ETSI TR 137 910 (V16.1.0): "5G; Study on self evaluation towards IMT-2020 submission (3GPP TR 37.910 version 16.1.0 Release 16)".

[i.13]   ITU Radio Regulations.

[i.14]   ITU-R WP5D Contribution 5D/1299: "Candidate submission for inclusion in IMT-2020".

NOTE   Available at https://www.itu.int/md/R15-WP5D-C-1299/en.

[i.15]   ITU-R IMT.2020 Contribution IMT-2020/17 (Rev. 1): "Acknowledgement of candidate SRIT
             submission from ETSI (TC DECT) and DECT Forum under step 3 of the IMT-2020 process".

NOTE: Available at https://www.itu.int/md/R15-IMT.2020-C-0017/en.

[i.16]   ITU-R WP5D Contribution 5D/222: "Report on the thirty-fifth meeting of Working Party 5D
             (e-meeting, 23 June - 9 July 2020)".

NOTE: Available at https://www.itu.int/md/R19-WP5D-C-0222/en.

[i.17]   ITU-R WP5D Contribution 5D/360: "Report on the thirty-sixth meeting of Working Party 5D
             (e-meeting, 5-16 October 2020)".

3   Definition of terms, symbols and abbreviations

3.1   Terms

Void.

3.2   Symbols

For the purposes of the present document, the following symbols apply:

N_{FT}	Number of FT
N_{RD}	Number of RD
N_S	Number of Sites

3.3   Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	3rd Generation Partnership Project
ACK	Acknowledge
BS	Base Station
CFO	Carrier Frequency Offset
CP	Control Plane
CW	Contention Window
D2D	Device to Device
DECT	Digital Enhanced Cordless Telecommunications
DL	Downlink
EG	Evaluation Group
eMBB	enhanced Mobile Broad Band
FDMA	Frequency Division Multiple Access
FFT	Fast Fourier Transform
FT	Fixed Termination point
GI	Guard Interval
HARQ	Hybrid Automatic Repeat request
ID	IDentifier
IE	Information Element
IEG	Independent Evaluation Group
I-I	Indoor to Indoor
IMT	International Mobile Telecommunications
InH	In House
ISD	Inter Site Distance
ITU-R	International Telecommunication Union - Radiocommunication sector

LBT   Listen Before Talk
LOS   Line Of Sight
MAC   Medium Access Control
MCS   Modulation Coding Scheme
MIC   Message Integrity Code
mMTC   massive Machine Type Communications
MRC   Maximum Ratio Combining
MUX   Multiplex
NACK   Non Acknowledge
NLOS   Non Line Of Sight
NR   New Radio
O-I   Outdoor to Indoor
O-O   Outdoor to Outdoor
PCC   Physical Control Channel
PDC   Physical Data Channel
PDU   Protocol Data Unit
PER   Packet Error Rate
PHY   Physical Layer
POR   Packet Outage Rate
PT   Portable Termination point
QoS   Quality of Service
QPSK   Quadrature Phase-Shift Keying
RACH   Random Access Channel
RD   Radio Device
RD-F   Radio Device operating as Forwarder
RD-FT   Radio Device operating as FT
RD-P   Radio Device which is Portable
RD-RD   RD to RD
RF   Radio Frequency
RIT   Radio Interface Technology
RSSI   Receive Signal Strength Indication
RX   Receiver
SCS   Sub-Carrier Spacing
SDU   Service Data Unit
SINR   Signal to Interference plus Noise Ratio
SISO   Single Input Single Output
SNR   Signal to Noise Ratio
SRIT   Set of Radio Interface Technologies
STF   Synchronization Training Field
TBS   Transport Block Size
TC   Technical Committee
TDD   Time Division Duplex
TDL   Tapped Delay Line
TDMA   Time Division Multiple Access
TRxP   Transmission Reception Point
TX   Transmitter
UE   User Equipment
UMi   Urban Micro
UP   User Plane
URLLC   Ultra Reliable Low Latency Communications
WP   Working Party
ZF   Zero Forcing

4 Technologies evaluated by the ETSI Evaluation Group

The ETSI EG focus on evaluating the DECT-2020 NR component RIT of the SRIT proposed by ETSI TC DECT and DECT Forum in the submission in Contribution IMT-2020/17 (Rev. 1) [i.15].

The ETSI EG and its members have utilized the ITU-R evaluation guidelines in Report ITU-R M.2412-0 [i.3].

The following additional evaluation methodologies to complement the evaluation guidelines have been used:

a) Connection density evaluation of Mesh networking technology requires:

- to select a D2D channel model;

- to define a cost function for the next-hop selection;

- to handle simulation complexity, it is noted that it is hard to drive the technology to an outage rate of 1 % just by increasing device numbers.

b) The following recommendations by ETSI TC DECT are considered:

- D2D channel models of 3GPP are adopted: 3GPP TR 36.843 [i.10] (p. 39), ETSI TR 138 901 [i.11], Report ITU-R M.2135-1 [i.4], Table 8-7 (p. 17).

- Cost function is solely the number of hops required to reach RD, FT (BS).

- The evaluation procedure in section 7.1.3 in Report ITU-R M.2412-0 [i.3] aims at finding N' (devices per TRxP) satisfying a packet outage rate of 1 %. The essence of the criteria is evaluated which is the connection density of 1 000 000 devices/km^2 with a maximum 1 % outage rate. This ensures that simulation complexity can be handled.

c) Further, increasing traffic rates as encouraged by Report ITU-R M.2412-0 [i.3] is investigated.

Table 1: ETSI Evaluation Groups' intention to evaluate submissions or parts thereof

	ETSI-DECT IMT-2020/17 (Rev. 1) [i.15] Partial evaluation (only the DECT component RIT)
Parameters via Inspection	
• Bandwidth	●
• Energy Efficiency	N/A
• Spectrum	●
• Services	●
Parameters via Analysis	
• Peak data rate	N/A
• Peak spectral efficiency	N/A
• User experienced data rate	N/A
• Area traffic capacity	N/A
• Latency (UP and CP)	●
• Mobility interruption time	●
Parameters via Simulation	
• Average spectral efficiency	N/A
• 5 % spectral efficiency	N/A
• Mobility	N/A
• Reliability	●
• Connection density	●

5 Compliance templates

5.1 Compliance templates for ETSI/DECT (DECT-2020 "NR" component RIT only)

5.1.1 Services

Compliance template for services

Report ITU-R M.2411-0 [i.2] requirement section	Service capability requirements	Evaluator's comments
5.2.4.1.1	**Support for wide range of services** Is the proposal able to support a range of services across different usage scenarios (eMBB, URLLC, and mMTC)? ☑ YES / ☐ NO Specify which usage scenarios (eMBB, URLLC, and mMTC) the candidate RIT or candidate SRIT can support. See note.	The support of a wide range of services is verified by inspection of the candidate RITs/SRITs ability to meet the minimum technical performance requirements for various usage scenarios and their associated test environments. The proposed SRIT consists of: • "DECT-2020 NR" component RIT; and • "3GPP 5G NR" component RIT. Each component RIT of an SRIT needs to support at least two different usage scenarios. The candidate RIT 3GPP 5G NR is identical to the submission by 3GPP, which was concluded by ITU-R WP 5D to support eMBB, URLLC, and mMTC. The proposed RIT DECT-2020 NR supports according to the submission in Contribution IMT-2020/17 (Rev. 1) [i.15] the usage scenarios URLLC and mMTC. The ETSI EG concluded that DECT-2020 NR is able to support URLLC and mMTC. In conclusion, the proposal is able to support a range of services across different usage scenarios. Each component RIT of the proposed SRIT is able to support at least two different usage scenarios.
NOTE:	Refer to the process requirements in IMT-2020/2.	

5.1.2 Spectrum

Compliance template for spectrum

Report ITU-R M.2411-0 [i.2] requirement section	Spectrum capability requirements		
5.2.4.2.1	**Frequency bands identified for IMT** Is the proposal able to utilize at least one frequency band identified for IMT in the ITU Radio Regulations [i.13]? ☑ YES / ☐ NO Specify in which band(s) the candidate RIT or candidate SRIT can be deployed. According to information provided in Contribution 5D/1299 [i.14] (characteristic template under clauses 5.2.3.2.8.3 and 5.2.4.1.1 of self-evaluation), the DECT-2020 NR component aims to operate in: • 1 880 MHz to 1 900 MHz • 1 900 MHz to 1 980 MHz and 2 010 MHz to 2 025 MHz (IMT-2000 FT bands) • Any other frequency band including above 24,25 GHz Further frequencies at the 5 GHz band have been considered as possible. According to published ETSI technical specifications, the following bands are supported by release 1 of DECT-2020 NR:		
	Band number	**Receiving band (MHz)**	**Transmitting band (MHz)**
	1	1 880 to 1 900	1 880 to 1 900
	2	1 900 to 1 920	1 900 to 1 920
	3	2 400 to 2 483,5	2 400 to 2 483,5
	4	902 to 928	902 to 928
	5	450 to 470	450 to 470
	6	698 to 806	698 to 806
	7	716 to 728	716 to 728
	8	1 432 to 1 517	1 432 to 1 517
	9	1 910 to 1 930	1 910 to 1 930
	10	2 010 to 2 025	2 010 to 2 025
	11	2 300 to 2 400	2 300 to 2 400
	12	2 500 to 2 620	2 500 to 2 620
	13	3 300 to 3 400	3 300 to 3 400
	14	3 400 to 3 600	3 400 to 3 600
	15	3 600 to 3 700	3 600 to 3 700
	16	4 800 to 4 990	4 800 to 4 990
	17	5 725 to 5 875	5 725 to 5 875
	Some of these bands have been identified for IMT (see Recommendation ITU-R M.1036-6 [i.5]). The proposed SRIT can support additional IMT frequency ranges due to the component RIT 3GPP 5G NR. In conclusion, each RIT of the proposal is able to utilize at least one frequency band identified for IMT in the ITU Radio Regulations [i.13].		
5.2.4.2.2	**Higher Frequency range/band(s)** Is the proposal able to utilize the higher frequency range/band(s) above 24,25 GHz? ☑ YES / ☐ NO Specify in which band(s) the candidate RIT or candidate SRIT can be deployed. See note. According to information provided in Contribution 5D/1299 [i.14] (characteristic template under clauses 5.2.3.2.8.3 and 5.2.4.1.1 of self-evaluation), it is envisioned by the proponent that frequency ranges above 24,25 GHz are supported. According to published ETSI TS 103 636-2 [i.7], the support of frequency ranges above 24,25 GHz is not yet implemented. Therefore, the component RIT DECT-2020 NR is currently not utilizing the higher frequency range/band(s) above 24,25 GHz. The component RIT 3GPP 5G NR is concluded by Contribution 5D/1299 [i.14] to be able to utilize the higher frequency range/band(s) above 24,25 GHz. In conclusion, the candidate SRIT fulfils the condition that at least one of the component RITs needs to fulfil this requirement.		
NOTE: In the case of the candidate SRIT, at least one of the component RITs need to fulfil this requirement.			

5.1.3 Technical Performance

Note that the ETSI EG focuses on the evaluation of the DECT-2020 NR component RIT by inspection, analysis, and simulation.

The proponent had confirmed in Contribution IMT-2020/17 (Rev. 1) [i.15] that this component could only be applied to the UMa-mMTC and UMa-URLLC test environments.

Compliance template for technical performance

Minimum technical performance requirements item (section 5.2.4.3.x in Report ITU-R M.2411-0 [i.2]), units, and Report ITU-R M.2410-0 [i.1], section reference see note 1	Category			Required value	Value, see note 2	Requirement met?	Comments, see note 3
	Usage scenario	Test environment	Downlink or uplink				
5.2.4.3.1 Peak data rate (Gbit/s) (4.1)	eMBB	Not applicable	Downlink	20	N/A	☐ Yes ☐ No	
			Uplink	10	N/A	☐ Yes ☐ No	
5.2.4.3.2 Peak spectral efficiency (bit/s/Hz) (4.2)	eMBB	Not applicable	Downlink	30	N/A	☐ Yes ☐ No	
			Uplink	15	N/A	☐ Yes ☐ No	
5.2.4.3.3 User experienced data rate (Mbit/s) (4.3)	eMBB	Dense Urban - eMBB	Downlink	100	N/A	☐ Yes ☐ No	
			Uplink	50	N/A	☐ Yes ☐ No	
5.2.4.3.4 5th percentile user spectral efficiency (bit/s/Hz) (4.4)	eMBB	Indoor Hotspot - eMBB	Downlink	0,3	N/A	☐ Yes ☐ No	
			Uplink	0,21	N/A	☐ Yes ☐ No	
	eMBB	Dense Urban - eMBB	Downlink	0,225	N/A	☐ Yes ☐ No	
			Uplink	0,15	N/A	☐ Yes ☐ No	
	eMBB	Rural - eMBB	Downlink	0,12	N/A	☐ Yes ☐ No	
			Uplink	0,045	N/A	☐ Yes ☐ No	
5.2.4.3.5 Average spectral efficiency (bit/s/Hz/ TRxP) (4.5)	eMBB	Indoor Hotspot - eMBB	Downlink	9	N/A	☐ Yes ☐ No	
			Uplink	6,75	N/A	☐ Yes ☐ No	
	eMBB	Dense Urban - eMBB	Downlink	7,8	N/A	☐ Yes ☐ No	
			Uplink	5,4	N/A	☐ Yes ☐ No	
	eMBB	Rural - eMBB	Downlink	3,3	N/A	☐ Yes ☐ No	
					N/A	☐ Yes ☐ No	
			Uplink	1,6	N/A	☐ Yes ☐ No	
					N/A	☐ Yes ☐ No	

Minimum technical performance requirements item (section 5.2.4.3.x in Report ITU-R M.2411-0 [i.2]), units, and Report ITU-R M.2410-0 [i.1], section reference see note 1	Category			Required value	Value, see note 2	Requirement met?	Comments, see note 3
	Usage scenario	Test environment	Downlink or uplink				
5.2.4.3.6 Area traffic capacity (Mbit/s/m^2) (4.6)	eMBB	Indoor-Hotspot - eMBB	Downlink	10	N/A	☐ Yes ☐ No	
5.2.4.3.7 User plane latency (ms) (4.7.1)	eMBB	Not applicable	Uplink and Downlink	4	N/A	☐ Yes ☐ No	
	URLLC	Not applicable	Uplink and Downlink	1	0,11 ms to 0,96 ms	☑ Yes ☐ No	For identified configurations fulfilling the requirement.
5.2.4.3.8 Control plane latency (ms) (4.7.2)	eMBB	Not applicable	Not applicable	20	N/A	☐ Yes ☐ No	
	URLLC	Not applicable	Not applicable	20	2,10 ms to 16,83 ms	☑ Yes ☐ No	For all analysed configurations.
5.2.4.3.9 Connection density (devices/km^2) (4.8)	mMTC	Urban Macro - mMTC	Uplink	1 000 000	Above 1 000 000	☑ Yes ☐ No	Based on 3 independent system simulations. Higher traffic densities demonstrated.
5.2.4.3.10 Energy efficiency (4.9)	eMBB	Not applicable	Not applicable	Capability to support a high sleep ratio and long sleep duration	N/A	☐ Yes ☐ No	
5.2.4.3.11 Reliability (4.10)	URLLC	Urban Macro - URLLC	Uplink or Downlink	1-10^{-5} success probability of transmitting a layer 2 PDU (protocol data unit) of size 32 bytes within 1 ms in channel quality of coverage edge	Better than 1-10^{-5}	☑ Yes ☐ No	For identified configurations fulfilling the requirement.

Minimum technical performance requirements item (section 5.2.4.3.x in Report ITU-R M.2411-0 [i.2]), units, and Report ITU-R M.2410-0 [i.1], section reference see note 1	Category			Required value	Value, see note 2	Requirement met?	Comments, see note 3
	Usage scenario	Test environment	Downlink or uplink				
5.2.4.3.12 Mobility classes (4.11)	eMBB	Indoor Hotspot - eMBB	Uplink	Stationary, Pedestrian	N/A	☐ Yes ☐ No	
	eMBB	Dense Urban - eMBB	Uplink	Stationary, Pedestrian, Vehicular (up to 30 km/h)	N/A	☐ Yes ☐ No	
	eMBB	Rural - eMBB	Uplink	Pedestrian, Vehicular, High speed vehicular	N/A	☐ Yes ☐ No	
5.2.4.3.13 Mobility Traffic channel link data rates (bit/s/Hz) (4.11)	eMBB	Indoor Hotspot - eMBB	Uplink	1,5 (10 km/h)	N/A	☐ Yes ☐ No	
	eMBB	Dense Urban - eMBB	Uplink	1,12 (30 km/h)	N/A	☐ Yes ☐ No	
	eMBB	Rural - eMBB	Uplink	0,8 (120 km/h)		☐ Yes ☐ No	
				0,45 (500 km/h)	N/A	☐ Yes ☐ No	
5.2.4.3.14 Mobility interruption time (ms) (4.12)	eMBB and URLLC	Not applicable	Not applicable	0 ms	0 ms	☑ Yes ☐ No	"Make before Break" principle.
5.2.4.3.15 Bandwidth and Scalability (4.13)	Not applicable	Not applicable	Not applicable	At least 100 MHz	221,184 MHz	☑ Yes ☐ No	
				Up to 1 GHz	Via multiple RF carrier	☑ Yes ☐ No	
				Support of multiple different bandwidth values see note 4	1,728 MHz to 221,184 MHz	☑ Yes ☐ No	
NOTE 1: As defined in Report ITU-R M.2410-0 [i.1].							
NOTE 2: According to the evaluation methodology specified in Report ITU-R M.2412-0 [i.3].							
NOTE 3: Proponents should report their selected evaluation methodology of the Connection density, the channel model variant used, and evaluation configuration(s) with their exact values (e.g. antenna element number, bandwidth, etc.) per test environment, and could provide other relevant information as well. For details, refer to Report ITU-R M.2412-0 [i.3], in particular, section 7.1.3 for the evaluation methodologies, section 8.4 for the evaluation configurations per each test environment, and Annex A on the channel model variants.							
NOTE 4: Refer to section 7.3.1 of Report ITU-R M.2412-0 [i.3].							