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Short Range Devices;
Low Throughput Networks (LTN);
Protocols for radio interface A;
Part 2: TS-UNB protocol

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document is part 2 of a multi-part deliverable. Full details of the entire series can be found in part 1 [i.18].

The present document is the revision of clause 6 (i.e. TS-UNB protocol) of ETSI TS 103 357 (V1.1.1) [i.17]. It includes numerous improvements to the previous TS-UNB specifications, as follows:

- removal of flaws, inconsistencies, and typos in TS-UNB clause;
- inclusion of new functionalities: class B, class C end-points, higher symbol rates, timing flexibility, burst concatenation, guard symbols;
- inclusion of new control segments for test purpose;
- deprecation of single burst mode;
- informative annexes on TS-UNB protocol.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**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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1 Scope

The present document, which is part 2 of a multi-part document, specifies the TS-UNB protocol. It contains an implementable description of its physical and MAC/link protocol layers.

The present document is structured as follows:

- clause 2 provides references;
- clause 3 provides definitions of terms, symbols and abbreviation used;
- clause 4 specifies the TS-UNB protocol;
- informative annex A provides examples of radio profiles;
- informative annex B provides examples of MAC payload formats;
- informative annex C summarizes durations and layouts of DLB structure;
- informative annex D provides numerical examples.

TS-UNB is one of the three radio technologies specified for LTN systems, that are addressed in two overall documents:

- ETSI TR 103 249 [i.8], that describes LTN use cases and system characteristics.
- ETSI TS 103 358 [i.9], that specifies the architecture of LTN systems.

2 References

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2.1 Normative 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.

ETSI TS 103 357-2 V2.1.1 (2024-06)
https://standards.iteh.ai/catalog/standards/sist/2724999b-3179-4e33-9d47-353b6e70f6ed/etsi-ts-103-357-2-v2-1-1-2024-06

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

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 necessary for the application of the present document.

[1] IEEE™ Std 802.15.4-2011: "IEEE Standard for Local and metropolitan area networks--Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs)".

[2] NIST Publication 197 (2001): "Advanced Encryption Standard (AES)".

[3] NIST Special Publication 800-38B (2005): "Recommendation for Block Cipher Modes of Operation: "the CMAC Mode for Authentication".

[4] Void.

[5] Void.

[6] IEEE™ Guidelines for Use of Extended Unique Identifier (EUI), Organizationally Unique Identifier (OUI), and Company ID (CID).

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] ERC Recommendation 70-03 (Tromsø 1997 and subsequent amendments): "Relating to the use of short range devices (SRD)", Recommendation adopted by the Frequency Management, Regulatory Affairs and Spectrum Engineering Working Groups, Version of 21 October 2016.

[i.2] ETSI EN 300 220-1 (V2.4.1) (05-2012): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW; Part 1: Technical characteristics and test methods".

[i.3] CFR Title 47 Part 15 section 15.247: "Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz".

[i.4] ARIB STD-T108: "920 MHz-Band Telemeter, Telecontrol and data transmission radio equipment", Version 1.0 of February 14th 2012.

[i.5] Void.

[i.6] IETF RFC 4493 (2006): "The AES-CMAC Algorithm".

[i.7] EN 13757-7:2018: "Communication systems for meters - Part 7: Transport and security services" (produced by CEN).

[i.8] ETSI TR 103 249 (V1.1.1) (10-2017): "Low Throughput Network (LTN); Use Cases and System Characteristics".

[i.9] ETSI TS 103 358 (V1.1.1) (06-2018): "Short range devices; Low Throughput Networks (LTN) Architecture; LTN Architecture".

[i.10] EN 13757-3:2018: "Communication systems for meters - Part 3: Application protocols" (produced by CEN).

[i.11] Void.

[i.12] IO-Link Interface and System Specification, Version 1.1.3, 2019.

[i.13] EN 13757-8: 2023. "Communication systems for meters - Part 8: Adaptation layer" (produced by CEN).

[i.14] EN 13757-4:2019: "Communication systems for meters - Part 4: Wireless M-Bus communication" (produced by CEN).

[i.15] Open Metering System Specification (OMS-S), Volume 2, Annex Q, Issue 5.0.1, December 2023.

[i.16] Void.

[i.17] ETSI TS 103 357 (V1.1.1) (06-2018): "Short Range Devices; Low Throughput Networks (LTN); Protocols for radio interface A".

[i.18] ETSI TS 103 357-1: "Short Range Devices; Low Throughput Networks (LTN); Protocols for radio interface A; Part 1: Lfour and DD-UNB protocol families".

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3 Definitions of terms, symbols, and abbreviations

3.1 Terms

For the purposes of the present document, the following terms and definitions apply:

equivalent signal to noise ratio: signal to noise ratio (including interference) of the received message as if it was only distorted by additive noise

NOTE: The eqSNR-I is calculated based on a mutual information estimate of all radio-bursts. It is limited to +20 dB and the reception threshold is around -2 dB. For example, if in a short message with up to 10 Byte user data one radio-bursts is missed, the eqSNR decreases by app. 0,2 dB.

message signal to noise ratio: ratio of the estimated average power of the non-distorted radio-bursts over the estimated average noise power of the non-distorted radio-bursts

NOTE: Only the radio-bursts which are suspected to be free of interference, fading and which are not missed are used for the calculation.

radio-burst: radio transmission over the air which starts with a ramp up, finishes with a ramp down and which has a continuous centre frequency and constant transmission power (apart from modulation)

radio-burst signal to noise ratio: ratio of the estimated average power over the estimated average noise power

NOTE: Only the radio-bursts which are suspected to be free of interference, fading and which are not missed are used for the calculation.

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radio-burst received signal strength indicator: average of the estimated power of non-interfered radio-bursts of the received message

NOTE: For the calculation only the radio-bursts are used which are suspected free of interference, fading and which are not missing.

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radio-frame: area in time and frequency plane containing all radio-bursts belonging to one packet

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sub-packet: fragment of a packet after telegram splitting

TSMA pattern: time and frequency transmission scheme of a radio frame

3.2 Symbols

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

ΔT	actual symbol duration
ΔT_{dn}	Time interval between blocks of an extension frame
ΔT_{du}	maximum time window for a high priority uplink response
ΔT_{TSI}	Time interval between core frame and extension frame
ΔT_{ud}	Time interval between uplink frame and downlink frame
ΔT_{ULP}	standard symbol duration (i.e. duration of a symbol with ULP symbol rate)
B_c	Carrier spacing
B_{ch}	Channel bandwidth
C_{RB}	Radio-burst carrier number of TSMA pattern
C_{offset}	Carrier offset of radio frame
dB	decibel
$f_{0,DLB}$	lowest frequency available in a channel for DLB transmission
f_c	Channel centre frequency
f_{offset}	Additional pseudorandom radio frequency offset to the centre frequency
f_{RB}	Carrier frequency of a radio-burst
nb	Number of PSDU data bytes
n_{ts}	Timeslot offset of radio frame
p_{TSDL}	Downlink TSMA pattern number

r_{TDN}	look-up values for the time delay in an extension frame with flexibility
S_{TOTAL}	Total number of sub-packets in a radio frame
S_C	Number of sub-packets in core frame
S_E	Number of sub-packets in extension frame
S_{RF}	Timeslot offset of radio frame
T_0	Start time of the radio frame transmission
T_{PPDU}	PPDU duration in seconds
T_{RB}	Time difference between two consecutive radio-bursts in number of symbols
T_{SB}	Sync-burst time

3.3 Abbreviations

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

ACK	Acknowledge
ADSI	Application Data Size Indicator (used in fragmentation procedure)
AES	Advanced Encryption Standard
BC	Beacon Core
BDU	Block Data Unit
BE	Beacon Extension
BRxC	Beacon receive Cycle
BS	Base Station
BSSH	Base Station Specific Hopping
BT	Bandwidth-bit period product
CIV	CMAC initialization vector
CMAC	Cipher-based Message Authentication Code
CO	Carrier Offset
CRC	Cyclic Redundancy Check
DATA_A	Data field A of a radio-burst
DATA_B	Data field B of a radio-burst
DATA_C	Data field C of a radio-burst
DC	Duty Cycle
DE	Data Extension
DL	Downlink
DLA	Downlink Class A (a transmission mode)
DLAC	DLA Core (block)
DLB	Downlink Class B (a transmission mode)
DLC	Downlink Class C (a transmission mode)
DLCC	DLC Core (block)
DLRX	Downlink Receive (status)
DL-SB	Downlink Single Burst (deprecated)
DPG	Downlink (TSMA) Pattern Group
EFI	Extension Frame Indicator
EIV	Encryption Initialization Vector
EP	End-Point
eqSNR	Equivalent Signal to Noise Ratio
ER	Extended Reach (a symbol rate)
EUI	Extended Unique Identifier
FEC	Forward Error Correction
FFB	Frame Format B (one of the variable MAC mode type for M-Bus)
FPO	Fragmentation Payload Offset
FSCNT	Fragmentation Session CouNTer
FS-ID	Fragmentation Session Identifier
FTM	Flexible Timing Mode
GFSK	Gaussian Frequency Shift Keying
GMSK	Gaussian Minimum Shift Keying
HDR	High Data Rate (a burst structure)
IA	Implicit Addressing (a flag)
IEEE	Institute of Electrical and Electronics Engineers
IPv6	Internet Protocol version 6
LFSR	Linear Feedback Shift Register

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LPDE	Low Power Drain End-point Devices
LPDU	Link Layer Protocol Data Unit
LSB	Least Significant Bit
LTN	Low Throughput Network
MAC	Medium Access Control
MMODE	MAC MODE
MPAI	MAC Pres-Addressing Info
MPDU	MAC Protocol Data Unit
MPF	MAC Payload Format
MSB	Most Significant Bit
MSK	Minimum Shift Keying
PDU	Protocol Data Unit
PHR	PHY Header
PHY	Physical layer
PN9	Pseudo Noise sequence of length 9
PPDU	PHY Protocol Data Unit
PRB	Physical Resource Block
PS	Pilot Sequence
PS_A	Pilot Sequence A
PS_B	Pilot Sequence B
PS_DA	Pilot Sequence Down A (a BDU field in downlink)
PS_DB	Pilot Sequence Down B (a BDU field in downlink)
PS_DS	Pilot Sequence field of a DL Sync burst
PS_US	Pilot Sequence field of a UL Sync burst
PSDU	PHY Service Data Unit
PSI	Packet Size Indicator
RE	Resource Element
RFU	Reserved for Future Use
RSSI	Received Signal Strength Indicator
RX	Receiver
SBDU	Sync-Burst Data Unit
SBR	Single Burst Rate
SDU	Service Data Unit
SIGN	Signature field of TS burst
SNR	Signal to Noise Ratio
SRD	Short Range Device
Sync	Synchronization
TDN	Time dealy between block of a downlink extension frame
TDN_F	time delay extension frame with flexibility
THB	Time delay Half Block
TS	Telegram Splitting
TSI	Transmission Start-time Indicator
TSI_F	Transmission Start-time Indicator in case of timing flexibility
TSMA	Telegram Splitting Multiple Access
TS-UNB	Telegram Splitting Ultra Narrow Band
TX	Transmitter
UL	Uplink
ULP	Ultra Low Power (a symbol rate)
ULP2	Ultra Low Power 2 (a symbol rate)
ULP8	Ultra Low Power 8 (a symbol rate)
ULZ	Uplink class Z (a transmission mode)
U-MPDU	Uplink-MPDU
UNB	Ultra Narrowband
UPG	Uplink Pattern Group
WMBUS	Wireless M-BUS
XOR	eXclusive OR

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