ETSI work on IoT connectivity: LTN, CSS, Mesh and Others

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Outline

ETSI produces a very large number of standards covering the entire domain of telecommunications and related services. Here we can only look a tiny portion of that work and we limit our view to some ETSI work for licence exempt spectrum below 1GHz

- ETSI Deliverables
- Some sub-GHz approaches to IoT connectivity
  - LTN
  - LPWAN-CSS
  - Mesh networks
- Summary

ETSI Deliverables

- ETSI produces a wide range of standards and technical reports related to IoT connectivity, including:
  - System Reference Documents (SRdoc)
  - Technical Specifications (TS)
  - Harmonised Standards (EN)
- SRdocs support the European regulatory process by describing technologies, applications and markets as input to CEPT spectrum management processes
  - Some SRDoc examples from the work of ERM TG28 include:
    - TR 102 886: SRdoc - Smart Metering
    - TR 103 245: SRdoc - Wideband SRDs
    - TR 103 435: SRdoc - UNB SRDs below 1 GHz
    - TR 103 526: SRdoc - ERMTG28 - LPWAN-CSS

ETSI Deliverables (2)

- Harmonized Standards provide the means for manufacturers to bring products to European Markets through presumption of conformity (when cited in the Official Journal of the EU)
  - Key examples for sub-GHz licence exempt spectrum from TG28 include:
    - EN 300 220: 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;
    - EN 303 204: Network Based Short Range Devices (SRD); Radio equipment to be used in the 870 MHz to 876 MHz frequency range with power levels ranging up to 500 mW
- Technical Specifications describe radio and protocol operation for specific products:
  - Examples include:
    - Several ETSI TS within 3GPP specifying LTE, NB-IOT, etc.
    - TS 102 887: Short Range Devices (SRD); Smart Metering Wireless Access Protocol
    - TSs on Architecture and protocols under development for LTN
    - Plus of course many, many more…

IoT Connectivity

- ETSI standards support many sub-GHz approaches to IoT connectivity including:
  - Cellular IoT Technologies like NB-IOT and LTE-M, which are covered by 3GPP standardization work
  - Low Throughput Networks (LTN) based on several radio technologies[1]
  - LPWAN-CSS (Chirp Spread Spectrum)[1]
  - Mesh networks
  - Many others…

ERM TG28

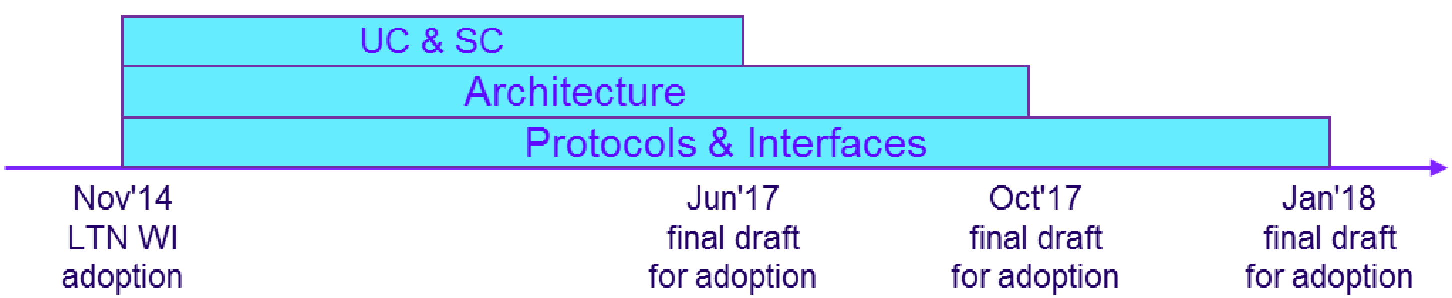
[1]Star networks with long range (achieved by operating at low data rate) and low power consumption in the IOT device

Wide Area Coverage

- Wide Area coverage can be obtained by trading link performance for range
  - CEPT regulations for non-specific SRDs (ERC/REC 70-03 Annex 1) and Data Collection SRDs (ERC/REC 70-03 Annex 2) allow up to 500mW Tx power in certain frequency ranges
    - EN 300 220 restricts Tx power in many SRD sub-bands to ≤25mW with a few ≤500mW. Duty Cycle limits also vary, from .1% to 2.5% to 10%, depending on the sub-band and other spectrum access conditions
    - EN 303 204 provides ≤500mW Tx power conditional on APC (≤ 5mW in strong link) and advanced short term Duty Cycle behaviour (≤ 400ms maximum emission duration). Duty cycle limits are ≤2.5% and under certain conditions ≤10% for NRP (access points)
  - Using the same Tx power limits:
    - LPWAN approaches using UNB or CSS extend range to multiple km at low data rates
      - E.g. 100-2500 Hz Channels with data rates up to 500bps, 125 kHz Channels with data rates from 250bps - 4.5kbps
    - Multihop communications extends range via re-transmissions retaining short range link performance
      - E.g. 200kHz Channels with data rates ~200kbps over 10s/100s metres

Structure of the LTN Standard

- LTN Rapporteur Groups of ERM TG28 are preparing three documents:
  - TR103249: LTN Use Cases and System Characteristics
  - TS103358: LTN Architecture
  - TS103357: Protocols for LTN interfaces A, B and C

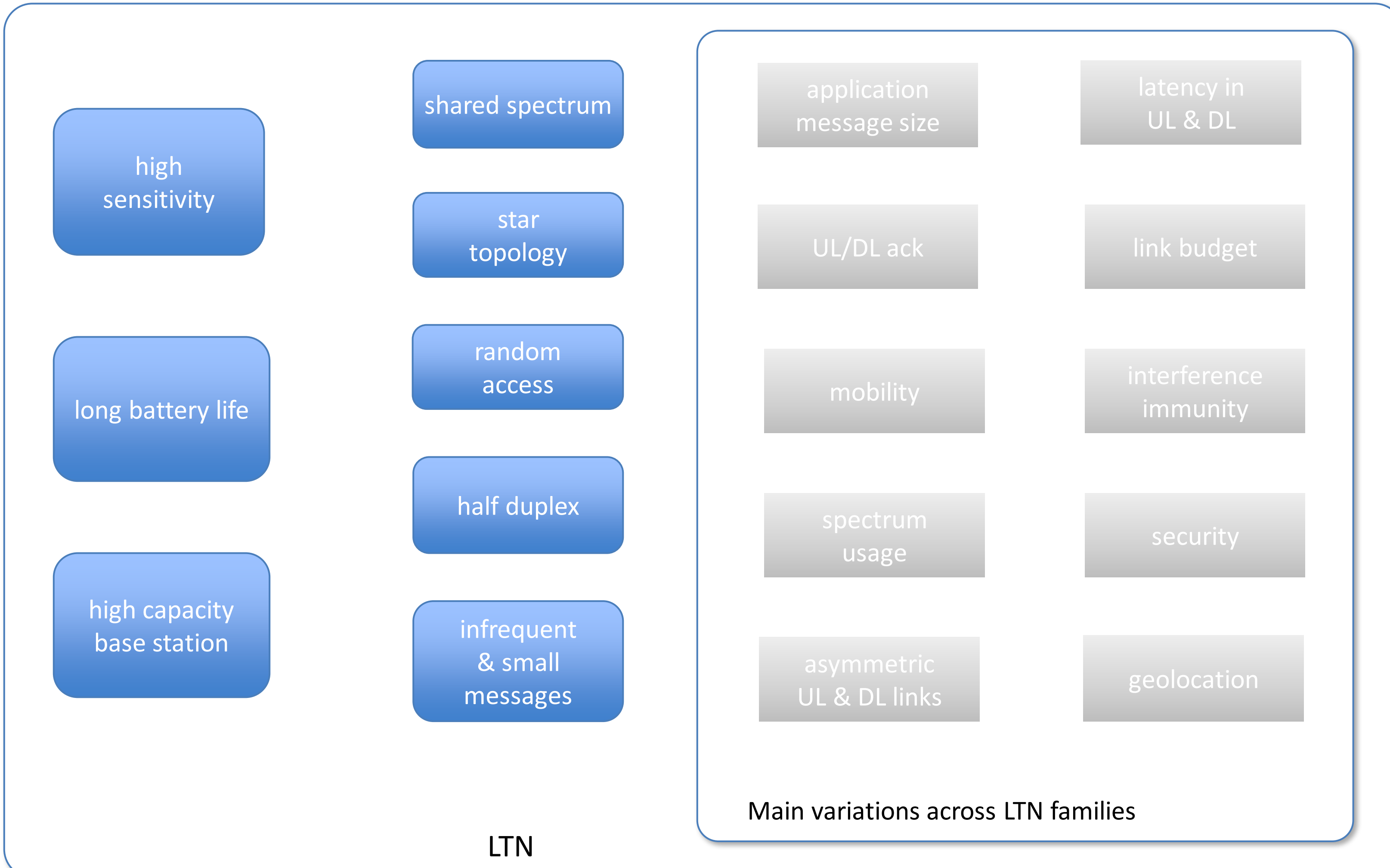


LTN Use Cases

LTN characteristics derived from various Use Cases, e.g.:

- Smart metering / water and gas
  - Mainly battery operated, small data size, low update rate, indoor penetration
- Environment monitoring / smart agriculture
  - Mainly battery operated, high coverage range, no latency restrictions
- Logistics
  - Small data size, harmonised license-free frequency bands
- Smart cities / street lighting
  - Controlled latency, bidirectional communication

LTN Characteristics



LTN Families - Overview

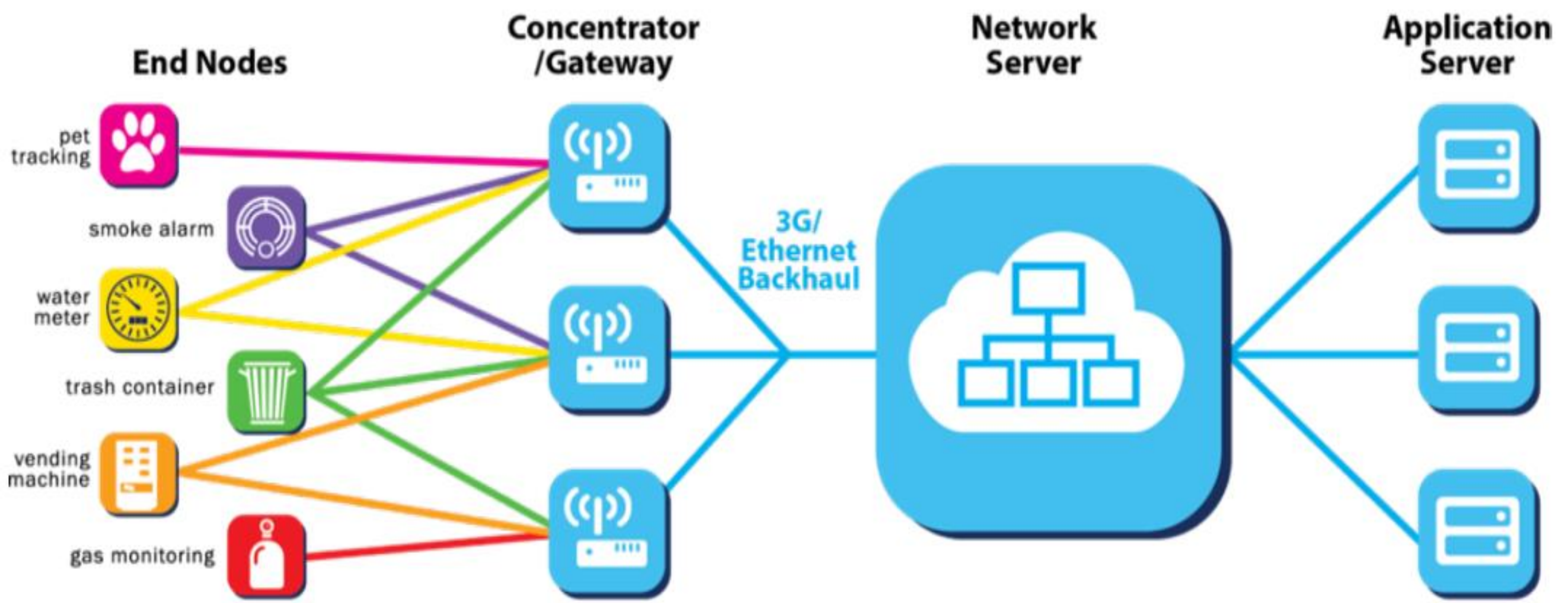
- LTN families:
  - Four different technical approaches for air interface to address different application needs

Parameter	3D-UNB	TS-UNB	DD-UNB	Lfour
Channel Access	Random Channel Access in frequency and time		Random Channel Access in frequency and slotted in time	
Transmission Timing	Endpoint Triggered		Beacon Time	GPS Time[1]
Specificity	Cooperative reception	Power optimized	Low downlink latency	High speed mobility

Note 1: One implementation example; other synchronization methods may be used

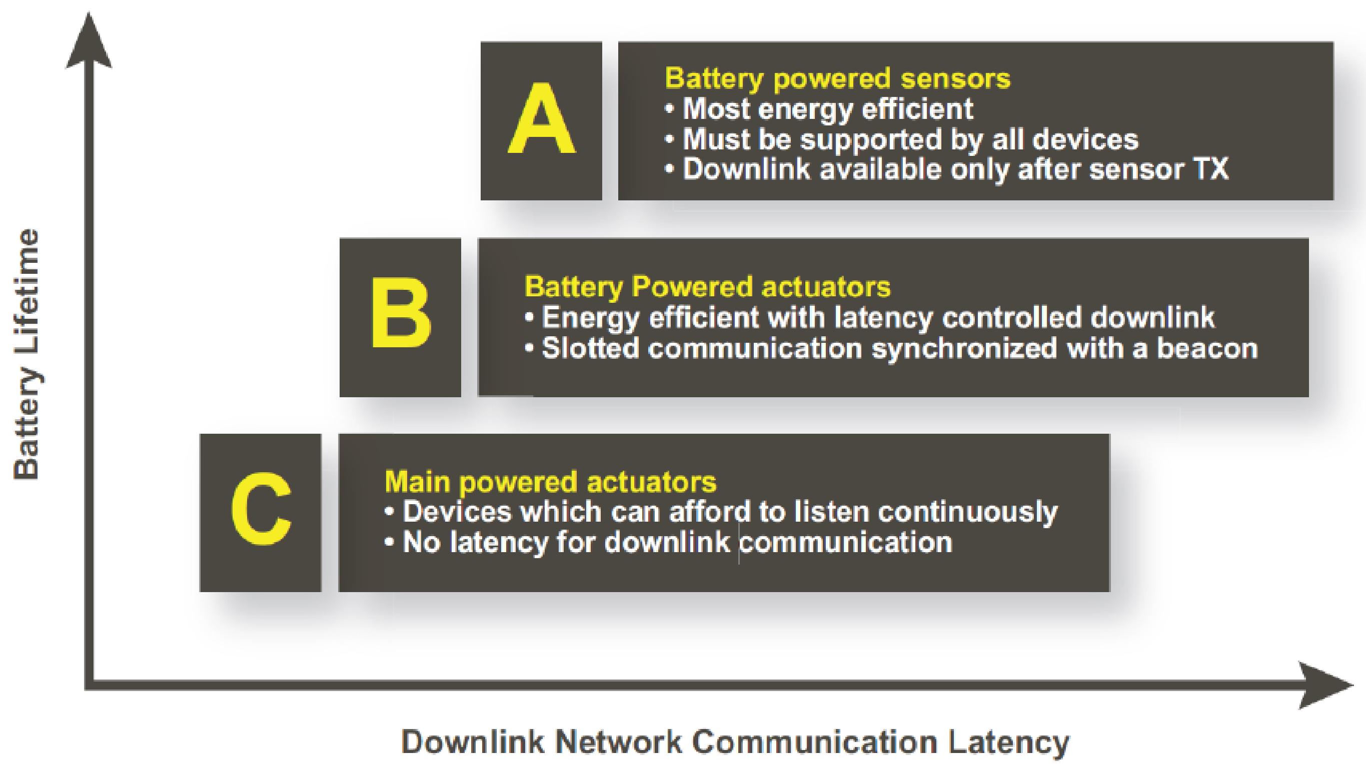
SRdoc LPWAN-CSS (1)

- Deals with a star of star network providing low-data rate connectivity for long range. The architecture is shown in the picture below.



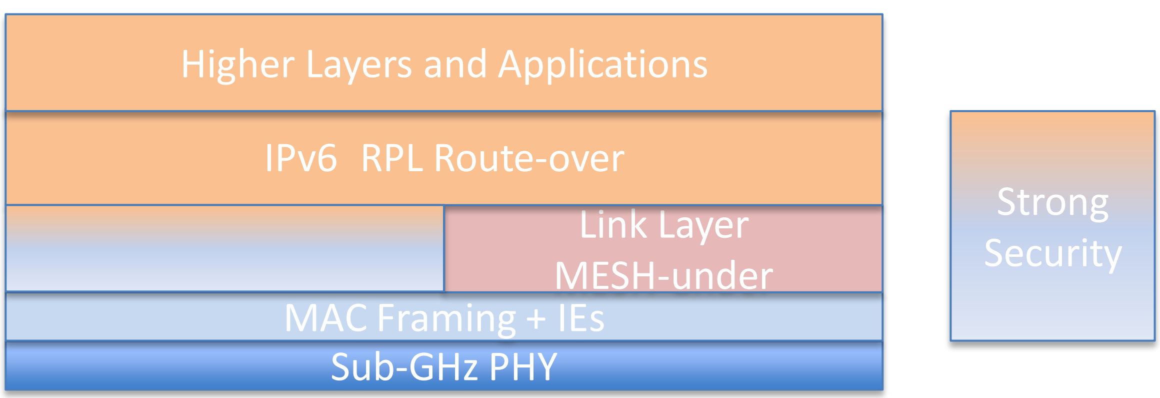
SRdoc LPWAN-CSS (2)

- Different classes of device to enable ultra low power consumption



Sub-GHz Mesh Networks (1)

- Examples include Field Area Networks for Utility applications
  - Major trend towards IPv6 standardization
  - RPL Network Layer routing for harsh deployment environments
  - MAC sub-layer MESH for high performance, latency-critical applications
  - Synchronised or Pseudo-random channel hopping mitigating interference limited shared spectrum operation
  - Large Scale Networks – millions of nodes



Characteristics of Mesh Networks

- Substantial capacity increase via spatial re-use of limited spectrum
- Dynamic routing to overcome time-varying propagation impairments
- High diversity via many neighbour links for robust network connectivity
- Wide range of dynamic device operation
  - Adaptive Power Control (APC)
  - Adaptive data rates and modulation
  - Dynamic frequency use per transmission
- Addresses real network use case requirements with capacity for expansion and future growth
- Proven very large scale deployments in AMI applications
  - Growing installed base in Smart City applications & other IoT domains
- Support simple battery operated devices in mixed network deployments with minimum device complexity

Summary

- ETSI standards support a wide range of Use Cases for IoT communications in sub-GHz licence exempt frequency bands
- Network architectures supported include:
  - LTN for low power infrequent communications by predominantly battery operated devices
  - LPWAN-CSS for similar use cases to LTN
  - Mesh networks for high capacity and low latency applications

Visit the ETSI Web site for more information on the wide range of ETSI IoT related work (www.etsi.org)

thank you.

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Welcome to the World of Standards

ETSI

World Class Standards

Further supporting slides for LTN families

3D-UNB

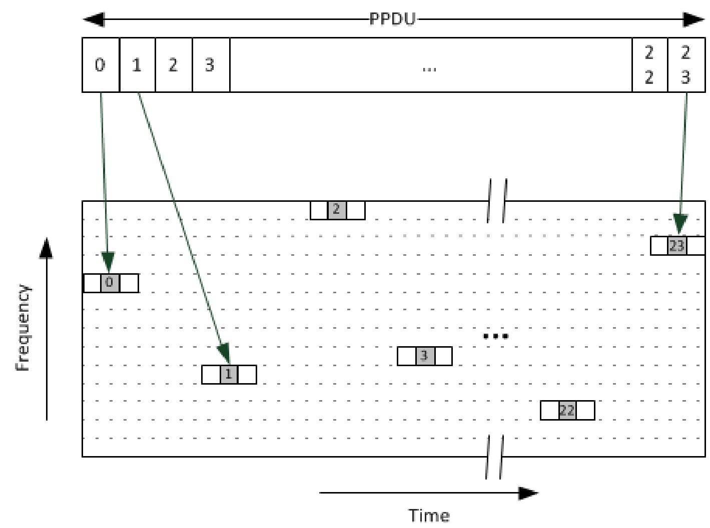
- Triple diversity ultra-narrow band
  - Diversity in time: aloha random access in uplink
  - Diversity in frequency: no channelization; Tx freq. randomly selected by device within operation band
  - Diversity in space: UL transmission received by all surrounding base stations
- Modulation: DBPSK 100 baud in UL ; GFSK 600 baud in DL
- Message size: 0-12 bytes in UL ; 8 bytes in DL
- DL: triggered by device
- Security: 128b auth. key & 128b encrypt. key
- Worldwide deployment

DD-UNB

- Ultra-Narrow Band system widely deployed for ‘smart city’ applications
- Bi-directional communications for sensing and control applications
- Flexible support of relays for hard-to-reach nodes
- Optional acknowledgement
- Unicast, multicast supported
- Adaptive coding and UL power control
- AES-256 encryption / authentication supported
- Slotted ALOHA in MAC procedure
- Worldwide deployment

TS-UNB

- Telegram Splitting Multiple Access (TSMA) based UNB:
  - Random channel access scheme with time-sliced radio transmission of PPDU
- GMSK modulation with 2380 baud and channel coding to shorten transmission time:
  - Low duty cycle (0,1%) band operation
  - Ultra low power (< 20µWh/message)
- Bi-directional communication
- Variable message size up to 245 bytes
- Security: AES128 encryption and authentication
- Pilot installations



LFour

- UL only protocol designed for multi-region operation e.g. Japan, Europe, USA
- Three PHY modes based on chirp spreading and π/2 shift BPSK modulation
- LDPC based error-correction and optional retransmissions
- Polite channel access by duty-cycle as well as listen before talk
- Precise GPS timing for synchronization
- Options of AES128 or ISO/IEC29192-2 CLEFIA based encryption