



Low Throughput Network (LTN); Use Cases and System Characteristics

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Foreword

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

The present document contains use cases and system requirements to support the development of an LTN standard.

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

Low Throughput Network (LTN) is a wide area wireless network technology with specific characteristics compared to existing radio networks. Deployments of LTN Systems include Base Stations and End Points which communicate over an air interface. End Points (typically a large number) are arranged predominantly in a star configuration around each base station, each base station is connected to the core network. In a small minority of cases (e.g. to provide connectivity in a hard-to-reach location) relays are used.

LTN enables long range data transportation (distances up to 40 km in open field) whilst being suited for mains or battery powered End Point operation. Typical Use Cases include communicating with underground equipment where high radio path losses and extremely long operating life from batteries are required, as well as street lighting control where high densities of End Points are required. LTN systems connect indoor and outdoor End Points, in urban and rural environments. Furthermore, the low throughput transmission combined with advanced signal processing provides effective protection against interference. As a consequence, LTN is particularly well adapted for low throughput reliable machine to machine (M2M) communication.

LTN can be applied to autonomous battery operated M2M devices that sends only a few bytes per day, week or month.

The elements provided in the document are intended to identify Use Cases and System Requirements for LTN Systems.

Clause 4 provides an overview of the main applications foreseen for LTN networks and estimates the numbers of LTN devices that applications may give rise to.

Clause 5 lists typical Use Cases with their individual characteristics and associated constraints and goes into some use cases in more detail than Clause 4.

Clause 6 summarizes the key attributes that LTN technology should exhibit to allow the above Use Cases to be realized.

Clause 7 describes characteristics of LTN systems, mainly arising from the use cases analysis.

These LTN system characteristics are expected to be used in the development of the architecture and protocols specifications of LTN.

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1 Scope

The present document provides illustrative use cases for LTN Systems and key characteristics of such systems to support the development of the LTN Standard.

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] ETSI GS LTN 001 (V1.1.1): "Low Throughput Networks (LTN); Use Cases for Low Throughput Networks".

[i.2] TALQ: "TALQ Specification Overview".

NOTE: Available at <http://www.talq-consortium.org/data/downloadables/2/4/20150318-talq-specification-overview-white-paper.pdf>.

[i.3] Analysis Mason: "Low-powered wireless solutions have the potential to increase the M2M market by over 3 billion connections".

NOTE: Available at <http://www.analysismason.com/Research/Content/Reports/Low-powered-wireless-solutions-have-the-potential-to-increase-the-M2M-market-by-over-3-billion-connections/White-paper-PDF/>.

[i.4] Energy Saving Trust: "A Guide to Telematics".

NOTE: Available at http://www.energysavingtrust.org.uk/businesses/sites/default/files/Telematics%2Bguide_WEB%2BONLINE.pdf.

[i.5] Department of Transport (UK) FBP1042: "Telematics for Efficient Road Freight Operations".

NOTE: Available at http://webarchive.nationalarchives.gov.uk/20110615041210/http://www.freightbestpractice.org.uk/categories/3505_551_publications.aspx?filter=69_Guide.

[i.6] IPPR: "Implementing Pay-As-You-Drive Vehicle Insurance".

NOTE: Available at <http://www.ippr.org/files/uploadedFiles/events/ToddLitman.pdf?noredirect=1>.

[i.7] National Bureau of Economic Research: "Measuring Positive Externalities from Unobservable Victim Precaution: An Empirical Analysis of Lojack".

NOTE: Available at <http://www.nber.org/papers/w5928>.

[i.8] Insurance Europe aisbl: "European Motor Insurance Markets Nov 2015".

NOTE: Available at <https://www.insuranceeurope.eu/european-motor-insurance-markets>.

[i.9] ERC Recommendation 70-03 (Annex 1 h1.6): "Relating to the use of Short Range Devices (SRD)".

NOTE: Available at <http://www.erodocdb.dk/docs/doc98/official/pdf/rec7003e.pdf>.

[i.10] ETSI EN 300 220: "Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz".

[i.11] FCC CFR Part 15.247: "Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz".

[i.12] ARIB STD/T108: "920MHz-Band Telemeter, Telecontrol and Data Transmission Radio Equipment".

[i.13] FIPS PUB 197: "National Institute of Standards and Technology Federal Information Processing Standard Advanced Encryption Standard (AES)".

3 Definitions and abbreviations

3.1 Definitions

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

1-way: user data transmission to/from a specific End Point in either uplink or downlink direction, not both

NOTE: No acknowledgement of message receipt is possible.

1,5-way: user data transmission to/from a specific End Point in either uplink or downlink direction, not both, but where limited return channel capacity is available for acknowledgement messages to be sent

2-way: user data transmission between a specific End Point and Base Station in both uplink and downlink directions

NOTE: Acknowledgement of message receipt is possible.

Base Station (BS): radio hub of an LTN system

core network: one or more servers connecting base stations to network applications

downlink: wireless link from the Base Station towards the End Point

end point: leaf node of an LTN system

link budget: maximum tolerable path loss from the transmitter antenna connector to that at the receiver for acceptable link performance on a static channel

LTN family: instantiation of the LTN standard with tailored technical parameters

LTN standard: technical specifications developed by ETSI which describe the architecture and protocols of LTN systems

LTN system: high capacity star-based network, with high rejection of interference and noise, dedicated for low power IoT connectivity over shared spectrum

NOTE 1: The geographical deployment of an LTN system may vary on scale between local and global, including discontinuous coverage.

NOTE 2: See clause 6.2.1 for the categorization of deployment areas used in the present document.

multicast: downlink communication from a Base Station to multiple End Points

relay point: radio node that relays radio packets for a small number of end points

static channel: radio channel with no impairments other than attenuation

EXAMPLE: Channel with no time variance, fading or multipath.

unicast: 1-way, 1,5-way or 2-way communication between a Base Station and a specific End Point

uplink: wireless link from the End Point towards the Base Station

3.2 Abbreviations

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

3G	3 rd Generation Cellular
BS	Base Station
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
DC	Duty Cycle
DL	Downlink
DR	Demand Response
ECG	ElectroCardioGram
EP	End Point
EPC	Electronic Product Code
ERC	European Radio communication Committee
ERP	Effective Radiated Power
FCC	Federal Communication Commission
FPI	Fault Passage Indicator
GDP	Gross Domestic Product
GPS	Global Positioning System
IHD	In Home Display
LPG	Liquified Petroleum Gas
LPWA	Low Power Wide Area
LTN	Low Throughput Network
LV	Low Voltage
M2M	Machine to Machine
MCL	Minimum Coupling Loss
MV	Medium Voltage
OTA	Over The Air
RFID	Radio Frequency Identification
RTC	Real Time Clock
RTLS	Real Time Location System
SLA	Service Level Agreement
UK	United Kingdom
UL	Uplink
UNB	Ultra-Narrow Band
VOC	Volatile Organic Compounds

4 Application Domains

A large and varied range of applications is envisaged for LPWA systems, and LTN systems are a subset of LPWA systems. Analysts see the LPWA market as largely additive to cellular technology [i.3]. This clause provides an overview of the main applications foreseen and estimates the numbers of LPWA devices to which these applications may give rise.

Table 1 sets out some of the application domains in which LTN can be used.

Table 1: Domains of application and use cases

Domain	Sub-domain	Use case
Metering	Water & Gas distribution	Collect data 3-4 times daily water and gas usage data
	Electricity distribution	Collect data daily or hourly electricity usage data
Infrastructure networks	Water & Gas transportation	Water and Gas infrastructure network surveillance (alarm, metering parameters)
	Electricity transportation	Electricity transport status monitoring and command/control
	Road/traffic management	Traffic light control, traffic level monitoring, emergency gate status control, digital signage status and updates
	Pipelines	Collect data on Metrics (temperature, pressure), alarms, leakage, vibration
	Drains	Collect data on Levels, turbidity ratio
Environment/Smart City	Waste management	Collect data on Levels, location
	Air pollution monitoring and alerting	Collect data on Humidity, temperature, VOC, CO ₂ , CO, etc.
	Acoustic noise monitoring	Noise level monitoring
	Street Lighting	Control of on/off times and dimming profile; monitoring of electricity usage; support of asset management locations
	Parking Management	Availability monitoring; support for enforcement and payment systems
	Self Service bike rental	Bike & rack availability, status monitoring, location
	Digital board monitoring	Status, screen display rotation/timeslot control
	Water pipe leakage monitoring	Leakage monitoring
Environment/Country side	Soil quality monitoring	Acidity, humidity, nitrogen, landslide prevention
	Livestock surveillance	Geolocation, health status, wolf prevention (accelerometer), geofencing, teleguidance
	Cattle & pet monitoring	Geolocation
	Climate	Rain, wind, temperature, humidity (pressure)
	Irrigation	Leakage
	Run off monitoring	Landfill liquor, nitrates, phosphates monitoring
Remote monitoring (telesurveillance)	House	Fire detection, smoke, CO, flood, leakage, intrusion, temperature, home automation (blinds, etc.)
	Building	Fire detection, smoke, CO, flood, leakage, intrusion, temperature, building automation (blinds, heating, air conditioning, etc.), telesurveillance
Industrial	Water tank management	Water level, leakage, refill management
	Asset tracking	Location, anti-theft
	Industrial plant condition monitoring	Generators, compressors, pumps: bearing temperatures, oil levels, vibration
Automotive	Vehicle tracking	Location, anti-theft
	Impact detection	Send message when vehicle is stopped abruptly
	"Pay As You Drive"	Send message to the driver about the driving behaviour Collect data about driving behaviour
	Assistance request, Break down call, Comfort Call	Send a localization message to request support
	Fault, service interval reporting	Send condition and mileage parameters periodically or on fault
Logistics	Goods tracking	Localization of goods
	Off grid fuel delivery	LPG, Oil, Biomass, Coal automatic re-supply
	Refrigerated container monitoring	Set, control, monitor containers for temperature, low fuel, load integrity
	Conservation parameters	Send message alarms related to temperature/shock for sensitive products
Healthcare	Patient monitoring	Fall down detection, out of area detection, ECG monitoring, activity monitoring, Alert
	Home Medical Equipment status and usage	Control of correct usage of medical equipment and status
	Attendance tracking	Care staff SLA's, compliance and billing data
Conventional Cellular Cooperation	Alarm sending	Send alarm message and activation of 3G for sending data (video, etc.)

Domain	Sub-domain	Use case
House appliances	Pet tracking	Localize pets
	White goods	Usage identification Preventive maintenance
	Personal asset	Location of luggage, clothes, satchel, phone (when battery down), etc.
Truck	Tyre monitoring	Check pressure and tyre usage
Identification	Authentication	Additional level of security for exchange Identification/authentication data

Analysts predict that the total addressable market for LPWA devices will exceed 12 bn devices by 2020 with predictions of 1 bn connections by that time. Table 2 shows a forecast of accumulated connectivity revenue [i.3].

Table 2: Forecast connectivity revenues (US\$ bns)

2016	2017	2018	2019	2020	2021	2022	2023
0,1	0,6	1,3	2,5	3,4	6	8,3	10,7

The estimated number of End Points per 100 M inhabitants for different application domains is shown in Table 3 [i.3].

Table 3: Number of End Points per 100 M inhabitants by application domain

Application Domain	100 M inhabitants basis (see notes)
Water smart meter	30 M
Gas smart meter	16 M
Electricity smart meter	57 M
Waste management	25 M
Air Pollution	200 k
Acoustic Noise	200 k
Public Lighting	1 M
Parking management	4 M
Self Service Bike rental	200 k
Automotive	60 M
Paper Advertising Board monitoring	50 k
Patient Monitoring	1 M
TOTAL number of EPs	185 M (around 2 per inhabitants)
NOTE 1: The above numbers are based on a population of 100 M inhabitants and estimate the number of EPs per different use case.	
NOTE 2: 100 M inhabitants, 55 % individual houses/45 % apartment buildings [i.1].	
NOTE 3: 41 M households with an average of 2,4 people/households [i.1], 23 M residential house, 18 M apartment buildings, dustbin: 10 % of apartment buildings, 50 000 cities.	
NOTE 4: Parking excludes: indoor parking (use wire line connectivity), private parking.	
NOTE 5: Self Service Bike Rental: based in France [i.1], Automobile: based in France [i.1].	

5 Example applications and use cases

5.1 Smart Metering

5.1.0 General

'Metering' is a broad domain that covers multiple areas including those listed below.

Water and gas metering normally require battery operated End Points while Electricity metering can normally employ End Points with external power.