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Low Throughput Networks (LTN); Functional Architecture

Disclaimer

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Contents

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Low Throughput Networks (LTN).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**may not**", "**need**", "**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 technology of wide area wireless network with specific characteristics compared to existing radio networks.

LTN enables long range data transportation (distances up to 40 km in open field) and has the capacity to communicate with underground equipment, using minimal power consumption.

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 machine to machine (M2M) traffic where latency may be low.

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

LTN networks can cooperate with cellular networks addressing use cases where redundancy, complementary or alternative connectivity is suitable.

The elements provided in the present document are intended to identify potential areas of standardization to ensure interoperability and provide guidelines for device, modem and software solutions for vendors, integrators and operators.

The present document is intended for an audience with a technical perspective, whereas the use case document GS LTN 001 [1] addresses a business-oriented view on LTN.

Clause 5 describes the LTN architecture.

Clause 6 deals with uplink and downlink data flows.

Clause 7 describes the overall system requirements.

Clause 8 describes the various LTN interfaces.

Clause 9 deals with interoperability in LTN.

1 Scope

The present document aims to:

- describe the characteristics of the architecture of a Low Throughput Network;
- illustrate the applicability of LTN in industrial communication;
- highlight the specificity of LTN deployment.

2 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.

Referenced documents which are not found to be publicly available in the expected location might be found at http://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.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

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

2.2 Informative references

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] Recommendation ITU-T I.113: "Vocabulary of terms for broadband aspects of ISDN".

[i.2] ETSI TS 127 007 (V11.8.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; AT command set for User Equipment (UE) (3GPP TS 27.007 version 11.8.0 Release 11)".

[i.3] ETSI TS 102 921: "Machine-to-Machine communications (M2M); mIa, dIa and mId interfaces".

[i.4] TIA-232-F: "Interface Between Data Terminal Equipment and Data Circuit- Terminating Equipment Employing Serial Binary Data Interchange".

[i.5] NXP : UM102014: "I²C bus Specification and user manual".

3 Definitions and abbreviations

3.1 Definitions

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

average daily throughput: average daily data volume per LTN Object

backend systems: information system that runs applications and back-office features

bearers: information transmission path of defined capacity, delay and bit error rate

collaborative reception: ability to receive the signal of an LTN object by multiple antennas and LAP located on different locations

collected data: data coming from the application (e.g. index value) and coming from the LEP modem itself (battery level, T°C, etc.)

instantaneous throughput: raw data rate per frame per LEP

interface specification: document that defines the requirements for interoperability between architecture blocks

payload: part of a data stream representing the user information

throughput: parameter describing service speed

NOTE: The number of data bits successfully transferred in one direction between specified reference points per unit time (see [i.1]).

3.2 Abbreviations

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

ADSL	Asymetric Digital Subscriber Line
API	Application Programming Interface
AT	Attention
BSS	Business Support System
CRA	Central Registration Authority
CRC	Cyclic Redundancy Check
GSM	Global Mobile System
IP	Internet Protocol
IS	Information System
LAP	LTN Access Point
LEP	LTN End Point
LTN	Low Throughput Network
NID	UNB Node Identifier
NM	Network Management
OSS	Operation Support System
OSSS	Orthogonal Sequence Spread Spectrum
PAC	Porting Authorization Code
SAS	Service As Software
SIM	Subscriber Identity Module
SPI	Serial Physical Interface
UNB	Ultra Narrow Band
WAN	Wide Area Network

4 Low Throughput Networks

Wireless machine to machine (M2M) is currently using either GSM networks or proprietary radio networks. A number of M2M use cases require long battery life and long range coverage while using small payload and limited throughput. LTN overcomes classical radio network limitation and complexity by optimizing the power consumption and the link budget.

This kind of networks is mainly dedicated for user data collection but can also provide bidirectional features such as acknowledge mechanism and Geo-localization.

The LTN has an optimized link budget and connexion less access scheme, suitable for battery-operated LEP. The LTN high link budget allows also extended coverage range.

Initial manufacturing embeds LEP's credentials that enable plug and play implementation for the end users.

LTN typical properties are:

- A throughput around 200 Bytes per day (typical) to 5 kBytes per day (maximum).
- A Payload size of 12 Bytes (maximum 255 Bytes).
- Instantaneous Throughput: 10-1 000 bit/s (50 kbit/s maximum) peak with technology that allow an adaptive throughput correlate to the link budget.
- Ability to handle up to 10 connected objects per inhabitant.
- Ability to provide security functions between the LTN Object and application provider platform: e.g. spoofing anti theft, tempering, rolling code, etc.

Figure 1 illustrates a comparison between classical radio technologies and LTN in terms of range, throughput and radiated power.

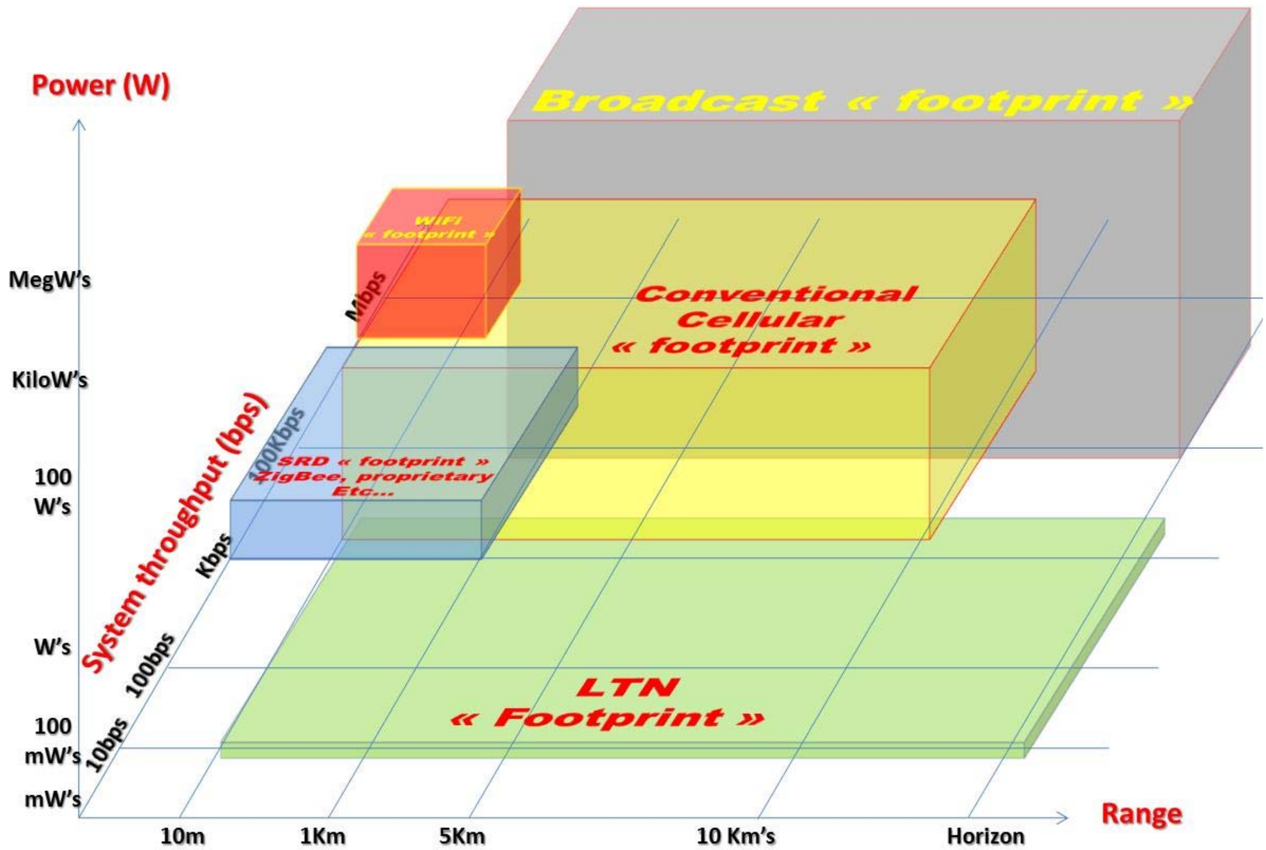

Figure 1: Energy & throughput range comparison

5 Architecture

A LTN Network is composed of:

- An object with LTN modem running LTN radio protocol
- Radio base stations (LAP) for reception and transmission of LTN radio packets
- LTN Server to:
  - store and forward application data
  - manage the network

- CRA server for safe managing identification codes of devices and base stations
- An OSS/BSS or application server in order to manage network and user messages

LTN network deployment shall be done with overlapping LAP coverage on the same frequency band in order to have cooperative reception of LEP messages.

The interfaces will be described below, and except for interface A, all interfaces are based on IP protocols with various physical bearers (see figure 2).

LTN entities implement functionalities that are LTN specific or common in cellular radio networks (see figure 3).

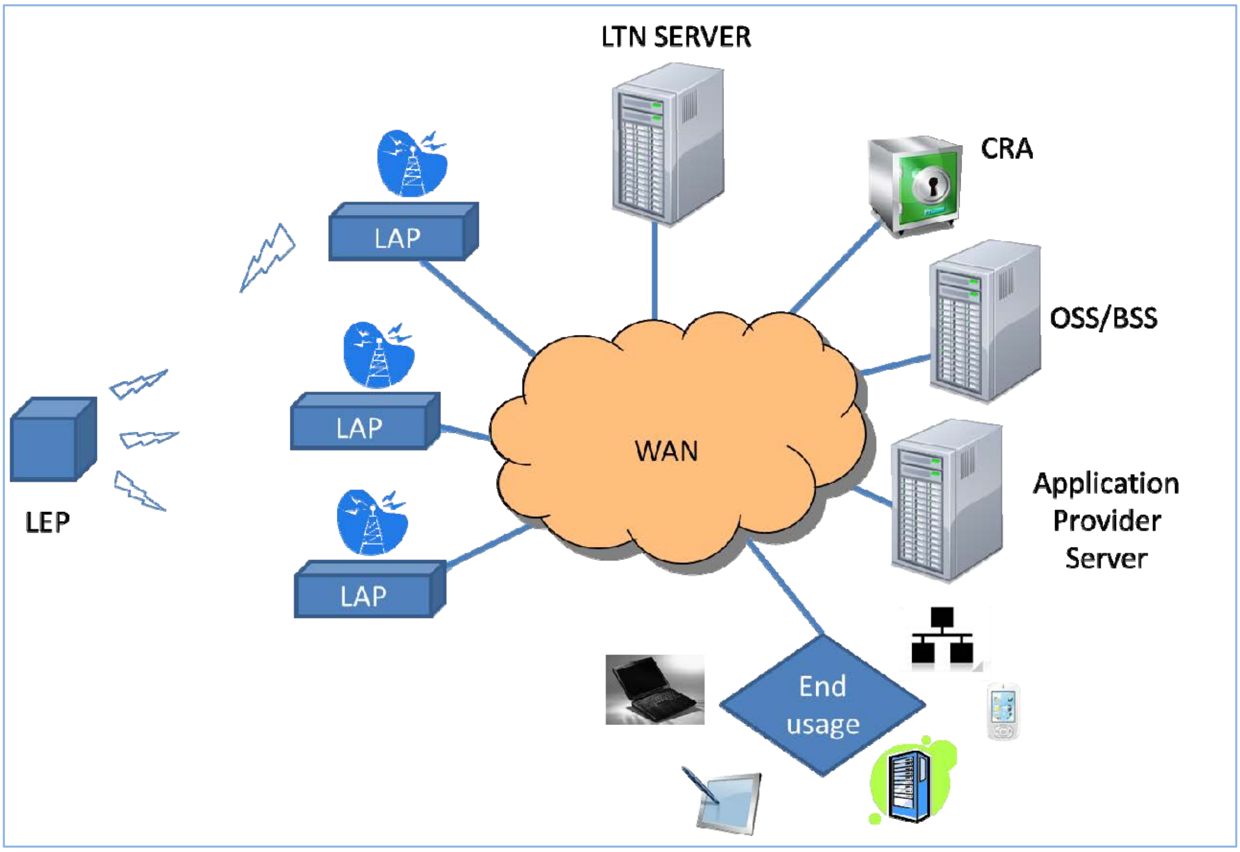

Figure 2: Overall architecture of LTN

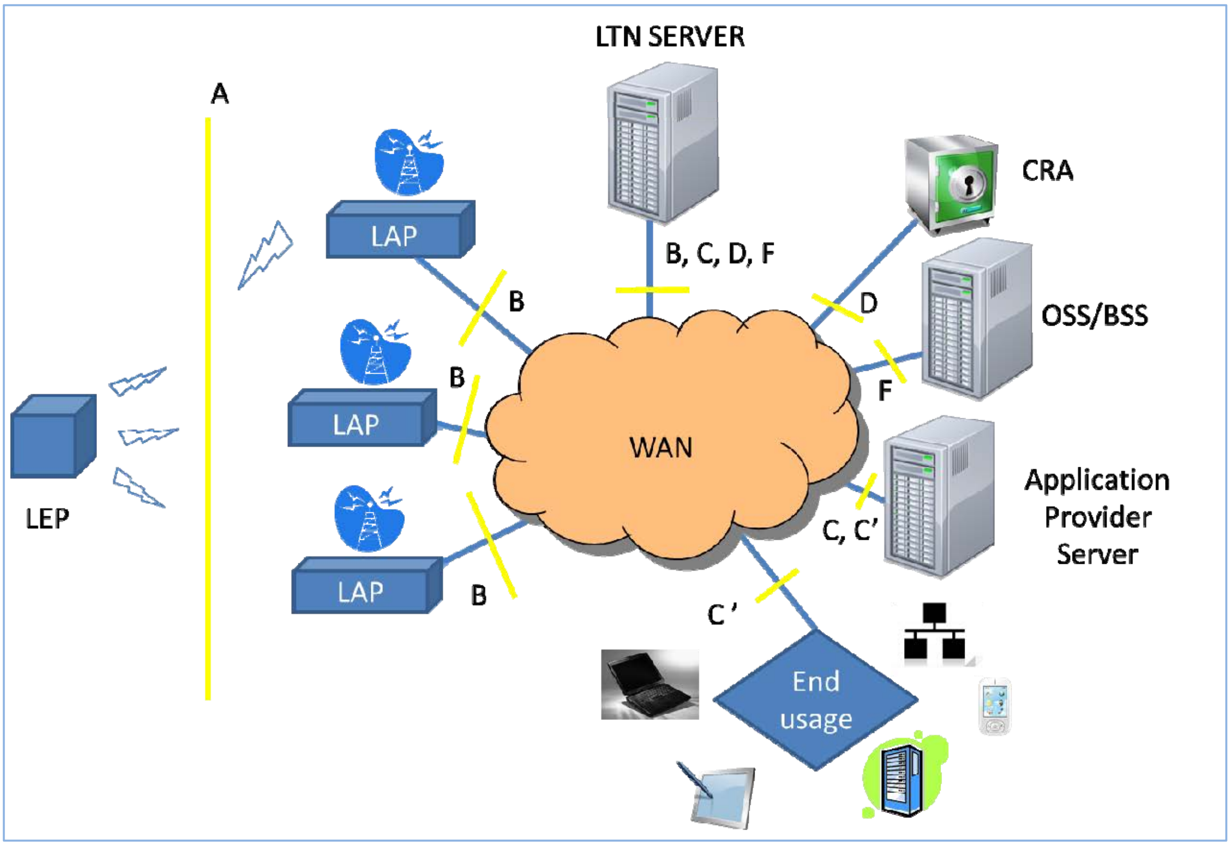

Figure 3: Main interfaces in LTN

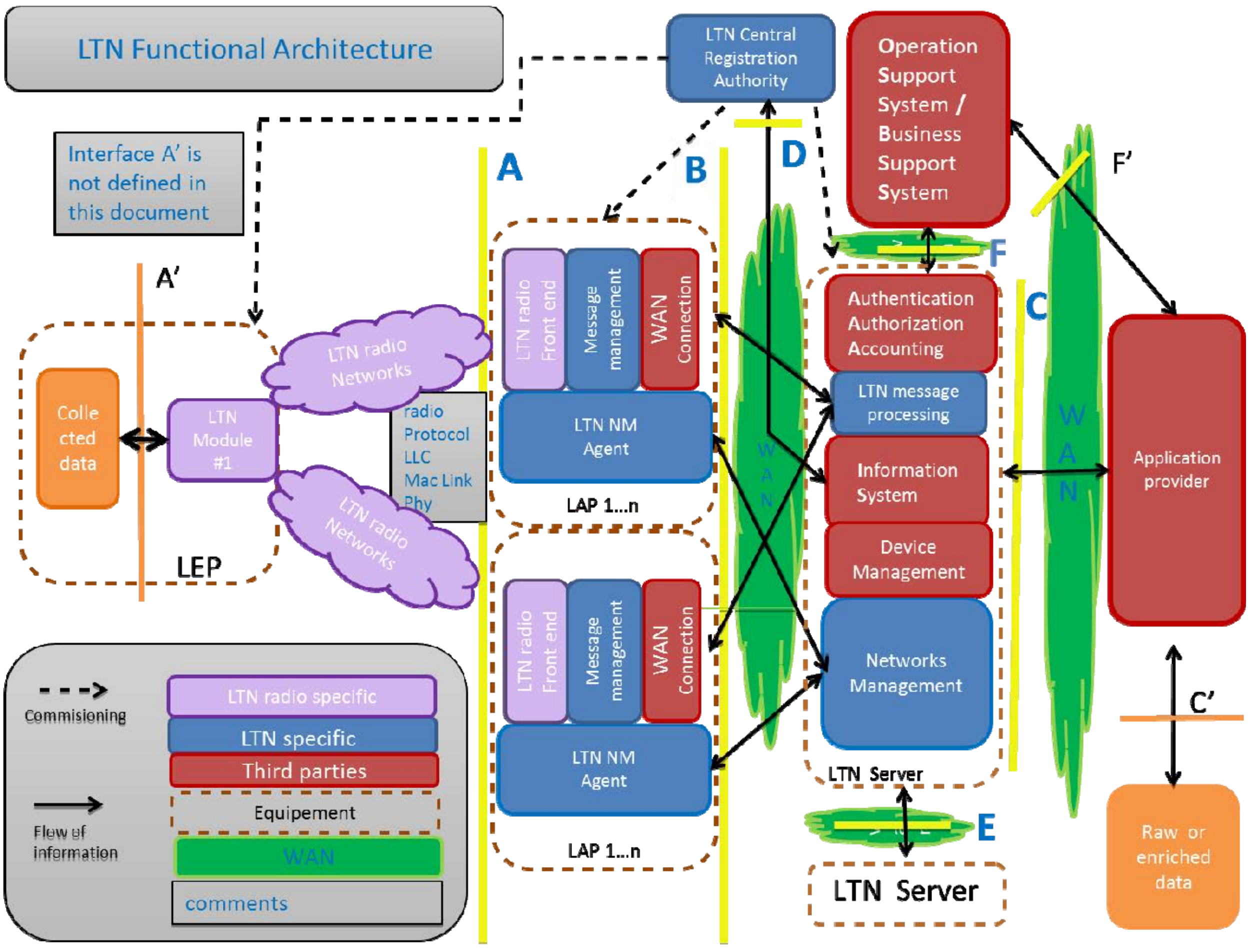

Figure 4: LTN functional architecture

6 LTN data flow

6.1 Uplink data flow

A LEP with or without prior synchronization sends radio packets that shall be received by one or several LAPs.

Each LAP receiving the radio packet, verifies the message consistency and forwards it through a secured IP link to a LTN server.

The server will deduplicate messages coming from several base stations, check authentication authorization and accounting and make it available to the application provider server.

The messages can be pushed or pulled to the application sever through standard API (see figure 5).

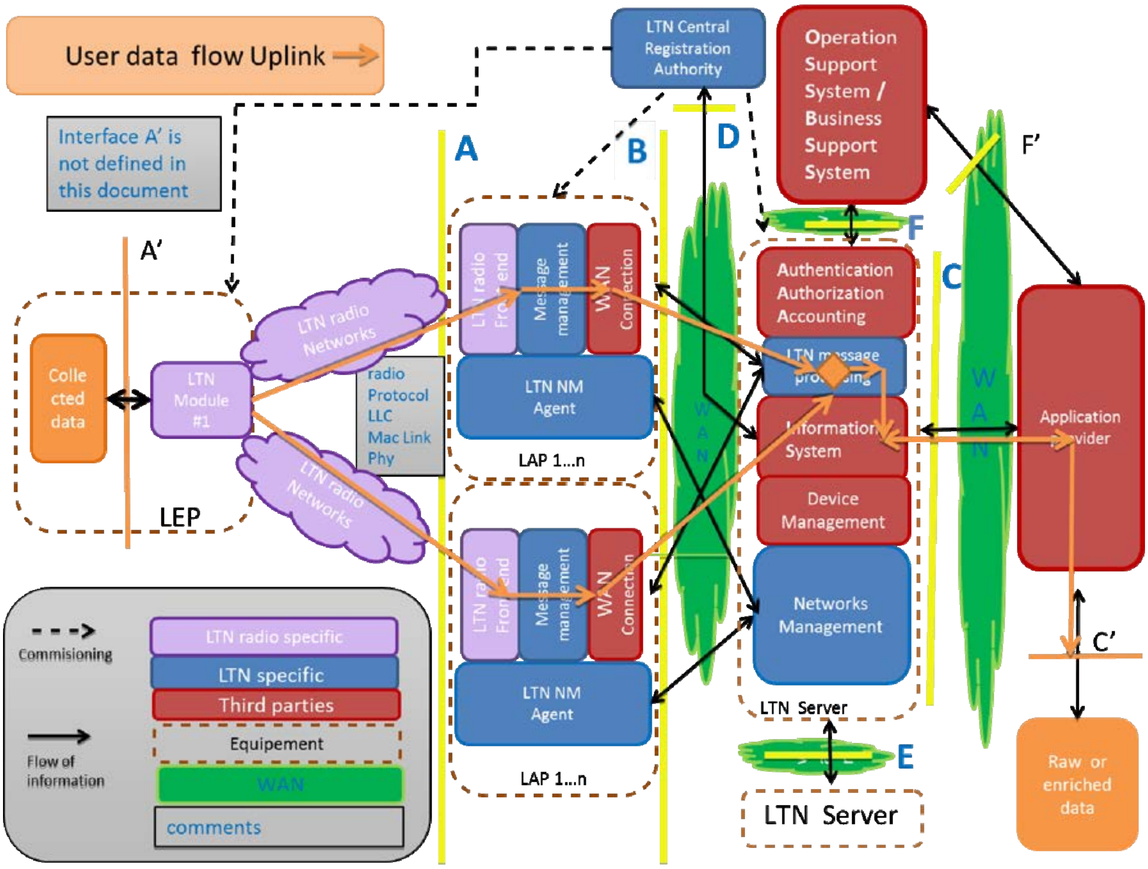

Figure 5: Uplink data flow

6.2 Downlink data flow

Downlink transmissions are available in LTN systems, even if LTN is designed mainly for uplink transmissions as stated in use cases document (GS LTN 001 [1]).

When a downlink message is requested, the application server sends a downlink message request to the LTN server. The LTN server forwards the downlink message to the most appropriate LAP which transmits it to the LEP (see figure 6).

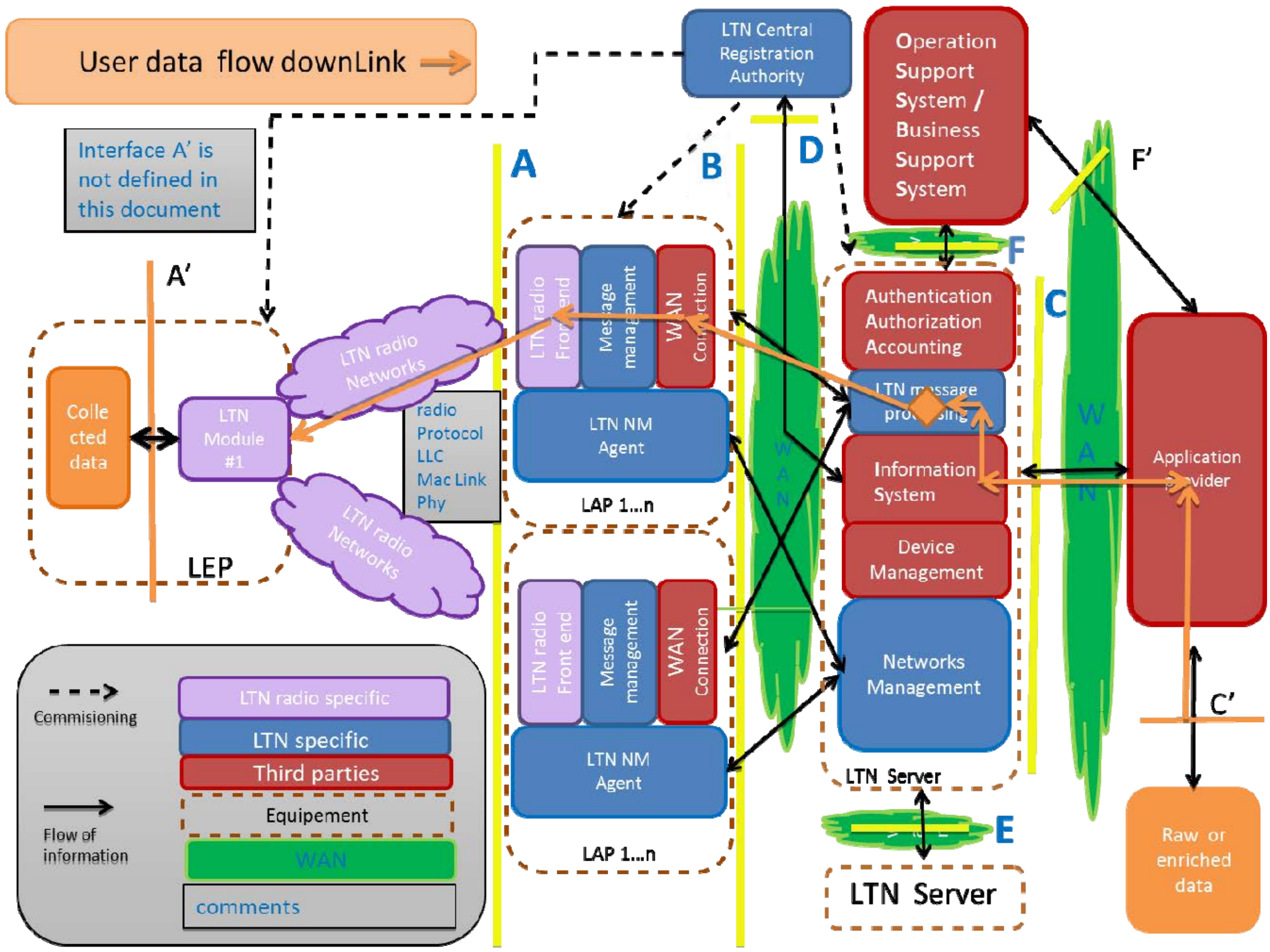

Figure 6: Downlink data flow

7 Overall system requirements

7.1 LEP

The device is made of two functional parts, a data collector and a LTN module. The interface between these two modules is out of scope of the present document but it is recommended to be compatible with the AT Command standard [i.2] other serial link such as SPI bus RS232 [i.4], I2C [i.5] or equivalent.

7.1.1 LTN module characteristics

This module collects data from the data collector and implements the radio interface. Its key characteristics are:

- UNB and OSSS (radio technologies described in the following clauses).
- LTN modem is only commissioned during the manufacturing process.
- No other operation is required to operate the modem (e.g. SIM card introduction).
- Each modem has a unique identifier.
- The LTN module can work without any preliminary network synchronization allowing very low power consumption.
- The LTN module can send and receive information.

- In some implementations, encryption keys, and radio parameters can be dynamically changed.

7.2 LTN Radio Networks

Two technologies are available based on UNB and OSSS modulation. Each emitted signal is supposed to be received by several LAPs (cooperative reception). This feature improves significantly reception quality even though modules are not synchronized.(see figure 7).

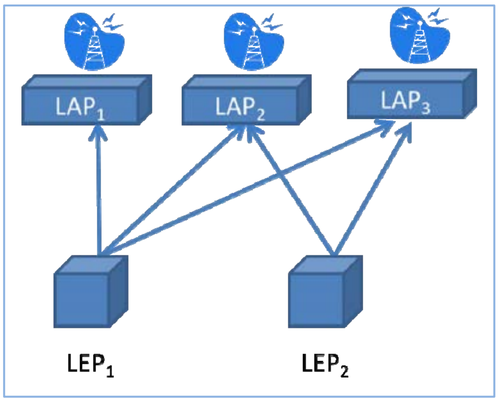

Figure 7: Principle of cooperative reception

7.3 LAP

7.3.1 LTN radio front end

The radio front end monitors a defined spectrum which detects and demodulates one or more simultaneous messages. Messages integrity is checked by adequate means (CRC, Hash) and transfers the decapsulated messages (plus indicators) to the LTN message management.

As far as down-link is concerned, the radio front end comprises a transmitter (duplexed or not) which can handle transmission of one or multiple messages.

7.3.2 LTN messages management

The LTN messages management checks: format, integrity, timestamps, stores (if required) received messages, and forwards them to the WAN connection.

Downlinks slot times are calculated within the LTN server and the actual time synchronization is implemented by this functional block.

Periodic beacon or broadcast transmission are implemented by this block.

7.3.3 LTN Network Management agent

The network management agent implements the monitoring and configuration function of the LAP such as spectrum monitoring, radio configuration, hardware and software status, remote software upgrade, and all services running on the LAP.

7.3.4 LTN Server

7.3.4.1 LTN Message processing

This functional block performs the following features:

- Message deduplication for cooperative reception (see clause 7.2)
- Message Authentication, Authorization and Accounting
- Message forwarding (once authenticated) to the Information System
- Manages and stores the LEP traffic history database
- Computes localization of LEP

Optionally:

- Manages end device radio configuration (e.g. data rate, transmit power, channel allocation)
- Generates end device acknowledgement if required (end device to LTN server message delivery confirmation)
- Updates downlink route and schedule downlink multicast
- Collects data for network management

7.3.4.2 Networks management

This functional block implements the following features:

- LAP authentication
- Manage and monitor LAP connectivity over WAN
- Monitor the radio spectrum
- LAP components status monitoring
- Manage software upload

All data are sent to the OSS system for display, command and control of the network.

7.4 CRA (for UNB implementation only)

The main feature of the Central Registration Authority (CRA) block is to ensure the unique identifier for each LTN module and to provide secret keys to manufacturers.

Secondary features are:

- Allocate and maintain the range of NID for LEP manufacturers
- Generate secrete keys
- Generate PAC
- Check PAC validity upon OSS/BSS request

8 Interface description

Except for interface A which is an air interface, all interfaces use the Internet Protocol Standards, therefore WAN connections should use secure links.

8.1 Interface A

Interface A is the air interface of LTN using two radio technologies UNB and OSSS. A detailed description is available in the document "LTN Protocols and Interfaces" [1].

8.2 Interface B

Interface B is the interface between the LAPs and the LTN servers. This interface uses common IP based WAN such as ADSL, optical fiber, terrestrial microwaves links or satellite.

8.3 Interface C

Interface C is between the LTN server and the application provider, it is based on Internet Protocols Standards.

It is similar to dIa interface defined in smart M2M architecture [i.3].

8.4 Interface D

Interface D is between the LTN Central Registration Authority and the LTN servers, it is based on the Internet Protocol Standards.

8.5 Interface E

Interface E is between several LTN servers, based also on Internet Protocol standards and allow data exchange between several LTN servers in case of roaming.

8.6 Interface F

Interface F is between the LTN servers and the OSS/BSS servers. Based on Internet Protocols standards, it allows exchange of data related to registration and or network status.

8.7 Interface A'

The definition of this interface is out of scope of the present document. It is the interface inside the LEP between the data collection system and the LTN Module. Interface A' should be implemented with AT commands over a serial link.

8.8 Interface C'

The definition of this interface is out of scope of the present document. It is the end user interface provided by the application provider.

8.9 Interface F'

The definition of this interface is out of scope of the present document. It is the interface between the application provider and the OSS/BSS Server dedicated to the management of the LEP registration and/or the Networks status. It is based on Internet Protocol standards.

9 Interoperability scenario and deployment

Three levels of interoperability are already defined:

- Interoperability A1: A LEP can embed two LTN modules (UNB, OSSS) it allows to communicate with all LTN access available

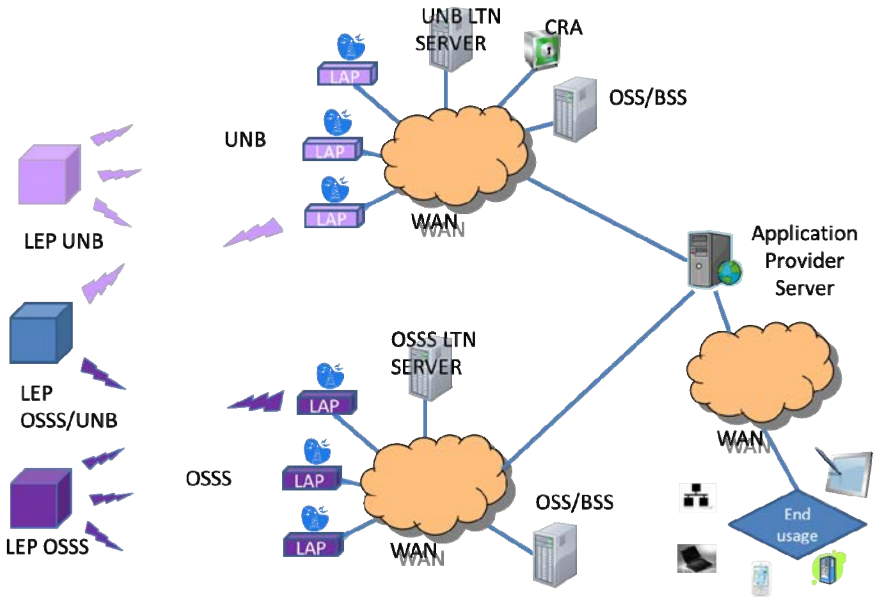

Figure 8: A1 interoperability

- Interoperability A2: A LAP can embed two LTN radio front ends (UNB, OSSS). This LAP can receive and transmit the messages coming from two LTN technologies

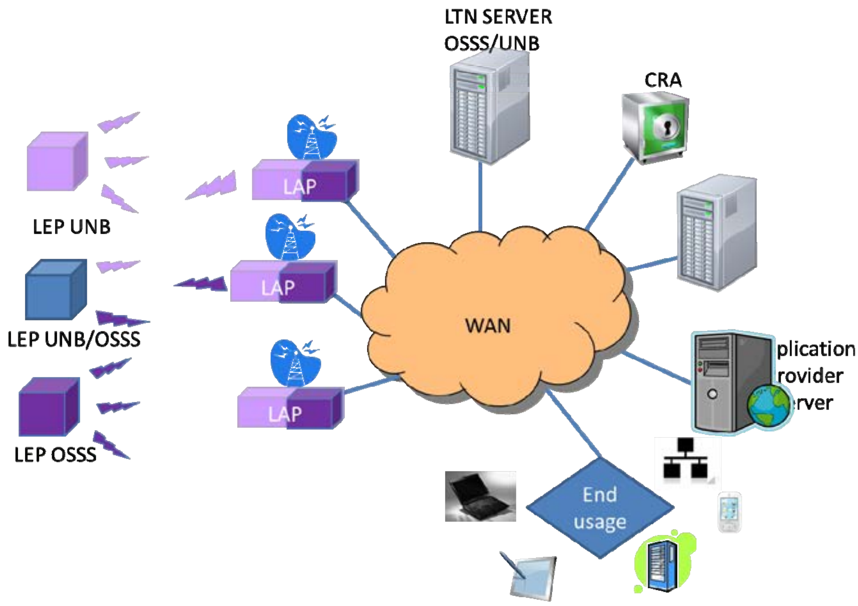

Figure 9: A2 interoperability

- Interoperability B1: Allows connection of a LAP using UNB and a LAP using OSSS to the same LTN server

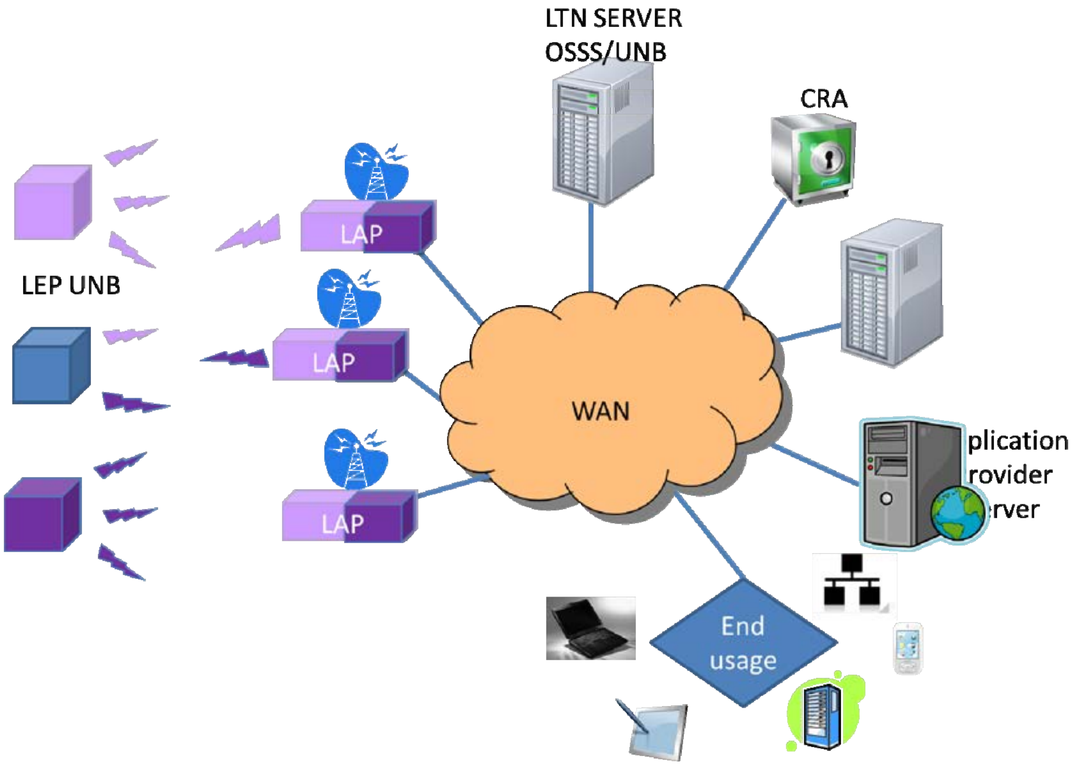

Figure 10: B1 interoperability

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Annex B (informative): Bibliography

ETSI TS 102 689: "Machine-to-Machine communications (M2M); M2M service requirements".

ETSI TS 102 690: "Machine-to-Machine communications (M2M); Functional architecture".

ETSI EN 300 220: "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".

ETSI EN 300 113-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 1: Technical characteristics and methods of measurement".

ETSI EN 300 113-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

FCC CFR 47 Part 15: "Telecommunication: Radio Frequency Devices".

ETSI EN 300 328: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

OMA-AD-LightweightM2M-V1_0-20130607-D.

ETSI GS LTN 003: "Low Throughput Networks (LTN); Protocols and Interfaces".

History

Document history		
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