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Contents

Foreword 5

Introduction 5

1 Scope 7

2 References 7

3 Definitions and abbreviations 11
3.1 Definitions 11
3.2 Abbreviations 12

4 RLL reference model and configurations 13
4.1 Definition 13
4.2 The DECT RLL reference model 13
4.2.1 DECT RLL reference model elements 14
4.2.2 DECT RLL reference model interfaces 14
4.3 Specific RLL configurations 15
4.3.1 RLL application 1: standard "fixed" service to socket 15
4.3.2 RLL application 2: delivery of service by radio - accessed via the customer's own CTA 15
4.3.3 RLL application 3: delivery of service by radio - accessed via the customer's own WRS and thence to portable or CTA 16
4.3.4 RLL application 4: mobility in the neighbourhood: service direct to portable. 16
4.3.5 RLL application 5: hybrid of applications 1 and 4 17
4.3.6 RLL application 6: hybrid of applications 2 and 3 17
4.4 Specific non-RLL configurations 18
4.4.1 Cordless telecommunication application 18
4.4.2 Interconnection of LE to the network 19

5 RLL services and facilities 19
5.1 Operational and functional requirements 19
5.1.1 Operational requirements 19
5.1.2 Functional requirements 20
5.1.3 Availability of services through the DECT RAP 20
5.2 Basic analogue RLL services 21
5.2.1 Analogue service categories 21
5.2.2 Power feed to the TE 22
5.2.3 Signalling from TE to LE 23
5.2.4 Signalling from LE to TE 25
5.2.5 End-to-end signal transport 26
5.2.6 Services made from combining basic services 27
5.3 Leased line service 28
5.3.1 Analogue leased lines 28
5.3.2 Digital leased lines 31
5.4 Normal digital (ISDN) RLL services 32
5.4.1 Services 32
5.4.2 Handling variable-service demands 32
5.4.3 Interfaces 33
5.4.4 Service support methods 33
5.5 New RLL services 34
5.5.1 Essential additional services 34
5.5.2 New service opportunities 34
5.5.2.1 New Service Implementations 34
5.5.2.2 New service presentations 35
5.5.2.3 New services 36
5.6 Service attributes, transmission characteristics and other impairments 36

5.6.1 Service attributes 36
5.6.2 Transmission attributes 38
5.6.3 Service attributes from ETR 139, subclause 6.2 39
5.6.4 Other attributes 39

6 Operation Administration and Maintenance (OA&M) 40
6.1 Introduction 40
6.2 Operations 40
6.3 Administration 41
6.4 Maintenance 41
6.4.1 Definitions 41
6.4.2 CTA 41
6.4.3 WRS 42
6.4.4 FP 43
6.4.5 Summary of RAP specific and other issues 44

7 Radio issues and traffic capacity requirements 45
7.1 The rural environment 46
7.1.1 DECT RLL in the rural environment - the question of range 46
7.2 The urban environment 46
7.2.1 DECT in the urban environment - the question of traffic capacity 47
7.3 Conclusions 48

8 Safety issues 48
8.1 Introduction 48
8.2 Exposure limits to electromagnetic radiation 48
8.3 Electrical safety 48
8.4 Acoustic shock issues 49
8.5 Lightning safety 49

9 Regulatory and licensing issues 49
9.1 Mobility issues 49
9.2 NTP issues 50
9.2.1 Physical, radio and virtual NTPs 50
9.2.2 Responsibility for maintenance of the radio path 51
9.2.3 Regulatory distinction between network equipment and TE 51
9.3 Data versus voice issues 51
9.4 Implications of additional concentration 52
9.5 Provision of emergency call service 52
9.6 Delay issues 52
9.7 Spectrum management Issues 53
9.8 Power supplies and power back up 53
9.9 Applicability of ONP requirements for leased line provision to RLL systems 53

10 Mobility in RLL 53
10.1 Introduction 53
10.2 Categories of mobility 54
10.3 Neighbourhood mobility 55
10.4 Single-cell mobility 55
10.5 Support of Universal Personal Telecommunication (UPT) 55

History 56

Foreword

This ETSI Technical Report (ETR) has been produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

This ETR has been produced in response to the requirement for an overview of the services, facilities and configurations to be offered by Digital Enhanced Cordless Telecommunications (DECT) Radio in the Local Loop (RLL) systems.

This ETR focuses on services and facilities, including Operation, Administration and Maintenance (OA&M) which should be supported by a DECT RLL Access Profile (RAP), and configurations for the DECT RLL access systems.

Introduction

The primary objective of a RLL technology is to deliver to end users, by radio means, the telecommunication services that are normally obtained through fixed cables from a telecommunications system.

RLL technologies present opportunities for telecommunications operators to serve new customers in developing countries and in other areas where provision of wired public telephony has been uneconomic or impractical, and to promote competition in the local loop in more developed markets. RLL operators are already licensed in a number of countries within and outside Europe and other licences are likely following deregulation of fixed access in the European Community in 1998.

The local loop (also known as the access network) is that part of a Public Telecommunications Operators (PTOs) network between the Local Exchange (LE) and a Network Termination Point (NTP) on the customers premises or at defined air interface with customers portable radio terminal. In this ETR RLL describes the situation where part or whole of the Local Loop is realized by radio means to deliver service either to the user’s premises or directly to the customer’s portable terminal. DECT RLL describes the situation where the radio component of an RLL system uses the DECT air interface standards

Characteristically, a RLL system has a network-side interface and a customer-side interface. Between these is at least one radio interface. Ideally, services are transported transparently and unimpaired between the end interfaces. In practice, using a normal radio link will almost always result in a system that is not completely transparent, and so specifications for RLL systems contain means to ensure transparency for those services that would otherwise not be properly carried by radio. Hence, this ETR defines the services, facilities and configurations to be supported by the DECT RLL service. It defines which services are mandatory and which are not. It also defines the maximum impairments to service that are permitted within the RLL system.

Because fixed cables are subject to failure, they are in most cases periodically tested for integrity using the OA&M procedures of the network operator. Clearly, a RLL system is subject to different failure mechanisms. In order to minimize the cost of locating and repairing faults in the RLL system, existing OA&M procedures need not only to be maintained, but they also need to be augmented to address the specific issues raised by RLL systems. These include dealing with uncertain radio coverage, power failures, backup batteries, subscriber registration and so on. This ETR addresses the essential OA&M requirements.

In common with other DECT applications, the DECT RLL access network comprises a Portable radio Termination (PT), a Fixed radio Termination (FT) and optionally one or more Wireless Relay Stations (WRSs). (In configurations where the DECT RLL is delivering service to the user's premises via a unmoveable PT into which standard Terminal Equipment (TE) may be connected the PT is known as Cordless Terminal Adapter (CTA) although this still complies with the general requirements of a PT.) It is for the RLL application attached to the DECT network to deal in the correct manner with the services specified and this ETR does not directly address the customer-side and network-side interfaces. It does, however, make a number of assumptions about these interfaces and lists those standard interfaces which are appropriate to the RLL service.

The RAP is the standard which implements the requirements contained within this ETR so far as it serves fixed users. RAP-compliant equipment from different manufacturers will inter-operate to provide customers and RLL system operators with a choice of equipment to use. This is achieved by basing the RAP standard on the DECT Generic Access Profile (GAP), ETS 300 444 [9]. The RAP only addresses the procedures and data structures on the DECT air interface and in the DECT network.

So far, it has been assumed that a RLL system provides the same services as a fixed telecommunications network. However, the use of radio provides the ability to offer new services that cannot be delivered over fixed cables. These new services include the use of direct radio communication from the fixed network to a portable telecommunications terminal, rather than providing a fixed socket. This provides limited mobility directly to the user in the same way as using a normal cordless telephone connected to a fixed socket. However, the RLL service defined in this ETR goes further, and extends this concept to provide the possibility of wider mobility within the access network. In this case the radio interface with the PT should comply with the GAP.

This ETR also highlights some difficulties raised by the RLL service concepts described here. These grey areas include the role and application of regulation, and the overlap of service provided by RLL systems with the service provided by other applications (e.g. telepoint).

The substantive clauses of this ETR are as follows:

Clause 4 develops the concept of DECT RLL and defines:

- a reference model which identifies the interfaces which are important for describing the DECT RLL and the services, facilities and OA&M needed to support it;

- identifies a number of configurations which are representative of RLL applications and a few similar configurations which are not considered RLL applications and explains why these are so classified.

Clause 5 lists and describes services and facilities which are relevant to DECT RLL and indicates which are mandatory service and which are optional. It also address those performance parameters (both attributes and impairments) which should be achieved by a DECT RLL system.

Clause 6 addresses over the air OA&M aspects, discusses those tests facilities and alarm events which should be supported by a DECT RLL system and looks at specific OA&M aspects affected by portable subscriber units.

Clause 7 addresses the radio related issues such as range, capacity and spectrum needs.

Clause 8 considers specific safety issues which become relevant specifically in RLL systems.

Clause 9 raises some regulatory issues which are relevant to RLL systems but does not attempt to indicate whether these are significant problems - not to propose solutions.

Clause 10 explores some of the issues of mobility in RLL systems.

1 Scope

This ETSI Technical Report (ETR) introduces the concept of Digital Enhanced Cordless Telecommunications (DECT) Radio in the Local Loop (RLL) and specifies the service requirements to be met by a DECT RLL network. It amplifies and refines the general service requirements for RLL systems contained in ETR 139 [10] and provides the specific technical detail needed to implement each service requirement through the use of the DECT RLL Access Profile (RAP), ETS 300 765, parts 1 and 2 [15] and [16].

Some of these requirements are specified in terms of the transparency to services and facilities which a DECT RLL system shall, or may, make available to support applications. Some requirements are already supported by existing procedures within the DECT standards, while others require new features to be specified. These issues all imply requirements on the various DECT network components, and on the air interface(s) between them. Hence they imply requirements on the DECT RAP. However, this ETR is not concerned with how these requirements are met.

Further requirements are described which are imposed upon a DECT RLL network to support essential OA&M facilities.

Various network configurations, which include DECT RLL networks are described, which need to be supported. Similar configurations incorporating DECT networks, but which are not considered DECT RLL applications, are also illustrated.

The ETR also identifies issues which might imply requirements and constraints on DECT RLL networks covering such aspects as safety, spectrum utilization and capacity as well as regulation issues which are not within ETSI domain to address in detail.

The ETR is aimed both at the general reader without detailed knowledge of DECT or of RLL and at those readers who wish to understand the standards applicable to RLL using DECT technology who will wish to use this ETR as an introduction to the DECT RAP.

2 References

For the purposes of this ETR, the following references apply:

[1] ETS 300 175-1: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 1: Overview".

[2] ETS 300 175-2: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 2: Physical Layer".

[3] ETS 300 175-3: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 3: Medium Access Control (MAC) layer".

[4] ETS 300 175-4: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 4: Data Link Control (DLC) layer".

[5] ETS 300 175-5: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 5: Network (NWK) layer".

[6] ETS 300 175-6: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 6: Identities and addressing".

[7] ETS 300 175-7: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 7: Security features".

[8] ETS 300 175-8: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 8: Speech coding and transmission".

[9] ETS 300 444: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Generic Access Profile (GAP)".

[10] ETR 139: "Radio Equipment and Systems (RES); Radio in the Local Loop (RLL)".

[11] ETS 300 659-1: "Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services; Part 1: On hook data transmission".

[12] ETS 300 659-2: "Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services; Part 2: Off hook data transmission".

[13] ETS 300 659-3: "Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services; Part 3: Server display and script services".

[14] ETR 310: "Radio Equipment and Systems (RES); Digital Enhanced Telecommunications (DECT); Traffic capacity and spectrum requirements for multi-system and multi-service applications co-existing in a common frequency band".

[15] ETS 300 765-1: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); DECT Radio local loop Access Profile (RAP); Part 1: Basic telephony services".

[16] ETS 300 765-2: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); DECT Radio local loop Access Profile (RAP); Part 2: Advanced telephony services".

[17] ETR 246: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Application of DECT Wireless Relay Stations (WRS)".

[18] ITU-R Recommendation 697: "Error performance objectives for the local-grade portion at each end of an ISDN connection utilizing digital radio-relay systems".

[19] 92/44/EEC: "Council Directive 92/44/EEC of 5 June 1992 on the application of open network provision to leased lines".

[20] ETS 300 450: "Business TeleCommunications (BTC); Ordinary and Special quality voice bandwidth; 2-wire analogue leased lines (A2O and A2S); Terminal equipment interface".

[21] TBR 15: "Business TeleCommunications (BTC); Ordinary and Special quality voice bandwidth 2-wire analogue leased lines (A2O and A2S); Attachment requirements for terminal equipment interface".

[22] ETS 300 453: "Business TeleCommunications (BTC); Ordinary and Special quality voice bandwidth 4-wire analogue leased lines (A4O and A4S); Terminal equipment interface".

[23] TBR 17: "Business TeleCommunications (BTC); Ordinary and Special quality voice bandwidth 4-wire analogue leased lines (A4O and A4S); Attachment requirements for terminal equipment interface".

[24] ETS 300 448: "Business TeleCommunications (BTC); Ordinary quality voice bandwidth 2-wire analogue leased line (A2O); Connection characteristics and network interface presentation".

[25] ETS 300 449: "Business TeleCommunications (BTC); Special quality voice bandwidth 2-wire analogue leased line (A2S); Connection characteristics and network interface presentation".

[26] ETS 300 451: "Business TeleCommunications (BTC); Ordinary quality voice bandwidth 4-wire analogue leased line (A4O); Connection characteristics and network interface presentation".

[27] ETS 300 288: "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U); Network interface presentation".

[28] ETS 300 289 with amendment A1: "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U); Connection characteristics".

[29] ETS 300 290 with amendment A1: "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U); Terminal equipment interface".

[30] TBR 14 with amendment A1: "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U); Attachment requirements for terminal equipment interface".

[31] ITU-T Recommendation G.113: "Transmission impairments".

[32] ITU-T Recommendation G.114: "One-way transmission time".

[33] ITU-T Recommendation G.173: "Transmission planning aspects of the speech service in digital public land mobile networks".

[34] ITU-T Recommendation G.821: "Error performance of an international digital connection forming part of an integrated services digital network".

[35] ETS 300 109: "Integrated Services Digital Network (ISDN); Circuit-mode 64 kbit/s 8 kHz structured bearer service category usable for speech information transfer; Service description".

[36] ITU-T Recommendation I.231: "Circuit-mode bearer service categories".

[37] ETS 300 110: "Integrated Services Digital Network (ISDN); Circuit-mode 64 kbit/s 8 kHz structured bearer service category usable for 3,1 kHz audio information transfer; Service description".

[38] ETS 300 001: "Attachments to Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface in the PSTN".

[39] 91/263/EEC: "Council Directive of 29 April 1991 on the approximation of the laws of the Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity".

[40] ETS 300 452: "Business TeleCommunications (BTC); Special quality voice bandwidth 4-wire analogue leased line (A4S); Connection characteristics and network interface presentation".

[41] ETS 300 324: "Signalling Protocols and Switching (SPS); V interfaces at the digital Local Exchange (LE); V5.1 interface for the support of Access Network (AN)".

[42] ETS 300 347: "Signalling Protocols and Switching (SPS); V interfaces at the digital Local Exchange (LE) V5.2 interface for the support of Access Network (AN)".

[43] TBR 6: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); General terminal attachment requirements".

[44] TBR 10: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) General terminal attachment requirements; Telephony applications".

[45] TBR 22: "Radio Equipment and Systems (RES); Attachment requirements for terminal equipment for Digital Enhanced Cordless Telecommunications (DECT) Generic Access Profile (GAP) applications".

[46] CCITT Recommendation V.23 (1988): "600/1200-baud modem standardized for use in the general switched telephone network".

[47] ITU-T Recommendation V.34: "A modem operating at data signalling rates of up to 28 800 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuits".

[48] IEC 1000-4-5 (1995): "Electromagnetic compatibility (EMC) Part a: Testing and measurement techniques, Section 5: Surge immunity test"

[49] CCITT Recommendation E.182 (1988): "Application of tones and recorded announcements in telephone services".

[50] ITU-R Recommendation 755: "Point-to-multipoint systems used in the fixed service".

[51] ITU-R Recommendation 756: "TEMA point-to-multipoint systems used as radio concentrators".

[52] ITU-R Recommendation 757: "Basic system requirements and performance objectives for cellular type mobile systems used as fixed systems".

[53] British Telecom Technology Journal Vol 7 No 2 (April 1989): "RG Blake: The role of radio for the fixed local access".

[54] ETS 300 049: "Integrated Services Digital Network (ISDN); ISDN Packet Mode Bearer Services (PMBS) ISDN Virtual Call (VC) and Permanent Virtual Call (PVC) bearer services provided by the D-channel of the user access - basic and primary rate".

[55] ITU-R Recommendation F.697: "Error performance and availability objectives for the local-grade portion at each end of an ISDN connection utilizing digital radio-relay systems".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETR, the following definitions apply:

authentication (user): The process whereby a DECT subscriber is positively verified to be a legitimate user of a particular Fixed Part (FP).

NOTE 1: Authentication is generally performed at call set-up, but may also be done at any other time (e.g. during a call).

call: All of the NWK layer processes involved in one network layer peer-to-peer association.

NOTE 2: Call may sometimes be used to refer to processes of all layers, since lower layer processes are implicitly required.

cell: The domain served by a single antenna(e) system (including a leaky feeder) of one FP.

NOTE 3: A cell may include more than one source of radiated Radio Frequency (RF) energy (i.e. more than one radio end point).

Cordless Terminal Adapter (CTA): Fixed physical grouping that contains a DECT PT and a line interface.

DECT Radio in the Local Loop (RLL): A RLL system where DECT air interface is used to connect Customer Premises Equipment (CPE) to the operator's equipment.

NOTE 4: The customer as well as the operator's equipment are determined by the position of the Network Termination Point (NTP).

DECT RLL Access Profile (RAP): The profile that ensures the air interface interoperability of DECT RAP CTAs and DECT RAP FPs and WRS, if applied.

Fixed Part (FP) (DECT FP): A physical grouping that contains all of the elements in the DECT network between the local network and the DECT air interface.

incoming call: A call received at a DECT Portable Part (PP) or CTA.

meter pulses: Are used for initiation of unit-based subscriber charging.

Network Termination Point (NTP): Is the point that defines the border between the equipment provided by the network operator and the CPE.

Portable Part (PP) (DECT PP): A physical grouping that contains all elements between the user and the DECT air interface. PP is a generic term that may describe one or several physical pieces.

Radio Fixed Part (RFP): One physical sub-group of a FP that contains all the radio end points (one or more) that are connected to a single system of antennas.

Radio in the Local Loop (RLL): Diversity of techniques & applications where connection of customers' TE to the LE is achieved by a configuration which includes an air interface (ETR 139 [10]).

register recall (Earth Loop register Recall / Time Break register Recall (ELR/TBR)): The ability of the CTA to request the initiation of the supplementary service "register recall" over the DECT interface and the ability of the DECT FP to transmit the request to the LE.

subscription registration: The infrequent process whereby a subscriber obtains access rights to one or more FPs.

NOTE 5: Subscription registration is usually required before a user can make or receive calls.

subscription load/modify: A procedure of loading subscription registration data in a PP or CTA in real-time over the air interface.

Wireless Relay Station (WRS): A physical grouping that combines elements of both PTs and FTs to relay information on a physical channel from one DECT termination to a physical channel to another DECT termination.

NOTE 6: The DECT termination can be a PT or an FT or another WRS.

WRS-CTA: A physical grouping comprising both the functions of a WRS for communication with a DECT PP, and a CTA with a port for connection of a (wired) terminal.

3.2 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

ADPCM	Adaptive Differential Pulse Code Modulation
B-ISDN	Broadband Integrated Services Digital Network
CLIP	Calling Line Identity Presentation
CPE	Customer Premises Equipment
CTA	Cordless Terminal Adapter
CTM	Cordless Terminal Mobility
DAS	DECT Access Site
DECT	Digital Enhanced Cordless Telecommunications
DTMF	Dual Tone Multi Frequency
DT-AS	Dual Tone Alerting Signal
ELR	Earth Loop register Recall
FP	Fixed Part
FT	Fixed radio Termination
FRU	Field Replaceable Unit
GAP	Generic Access Profile
GoS	Grade of Service
ISDN	Integrated Services Digital Network
LD	Loop Disconnect
LE	Local Exchange
NT1	ISDN Network Termination 1
NT2	ISDN Network Termination 2
NTP	Network Termination Point
OA&M	Operation, Administration and Maintenance
ONP	Open Network Provision
PBX	Private Branch Exchange
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
PP	Portable Part
PT	Portable radio Termination
PTO	Public Telecommunications Operator
QDU	Quantization Distortion Unit
RAP	RLL Access Profile
RFP	Radio Fixed Part
RLL	Radio in the Local Loop
RP-AS	Ringing Pulse Alerting Signal
TAS	Terminal Alerting Signal
TBR	Time Break register Recall
TE	Terminal Equipment
TE1	ISDN Terminal Equipment type 1
UPT	Universal Personal Telecommunication
WRS	Wireless Relay Station
WAM	Wide Area Mobility

4 RLL reference model and configurations

4.1 Definition

The **local loop** is that part of a Public Telecommunications Operators (PTOs) network between the LE (see subclause 4.2.1) and either a NTP at the customer's premises or a defined air interface to customers' portable TE.

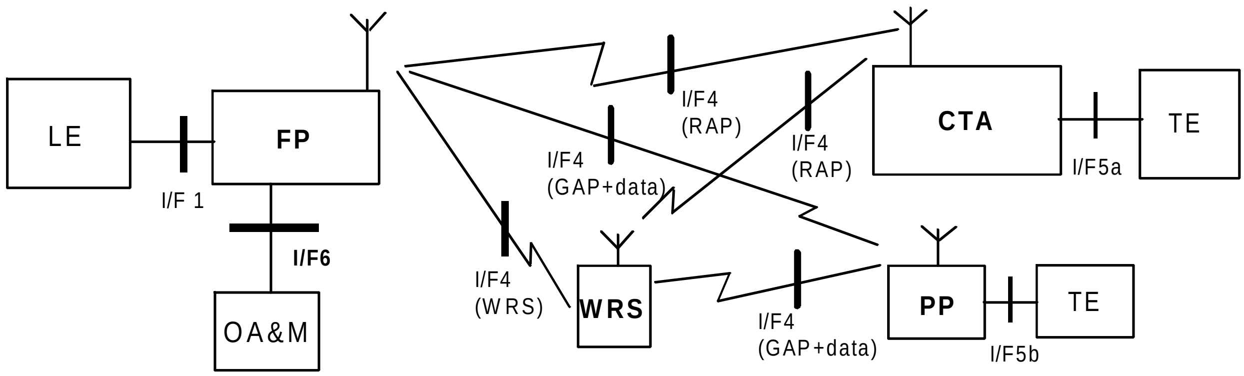
RLL describes the situation where the service is delivered to the customer's premises or to the customers portable TE by radio means. **DECT RLL** describes the situation where this radio interface complies with DECT Air Interface Standards.

Hence:

DECT RLL is the whole of that segment of a PTOs network between the LE and either a NTP on the customers premises or the customers portable terminal, provided that the service is delivered to the customer's premises or portable terminal by a radio interface compliant with the DECT air interface standards.

4.2 The DECT RLL reference model

A reference model for DECT RLL systems is presented in figure 1. This reference model originates from ETR 139 [10], but has been refined for the purpose of this ETR.



TE: Terminal Equipment
FP: Fixed Part
WRS: Wireless Relay Station
CTA: Cordless Terminal Adapter
PP: Portable Part

I/F1: LE to FP Interface
I/F4: DECT Air Interface
I/F5a: CTA to Terminal Interface
I/F5b: PP to Terminal Interface
I/F6: OA&M Interface

NOTE 1: In ETR 139 [10] reference model, two separate entities, i.e. the controller and the Radio FPs comprises what is called FP in the DECT RLL reference model. In this respect there is no reason to define an I/F3 interface.

NOTE 2: A single CTA can serve more than one TEs simultaneously.

Figure 1: DECT RLL reference model

The DECT RLL reference model differs from the one described in the ETR 139 [10], due to:

a) the presence of the WRS;

b) the presence of both CTA and PP.

Depending on whether the end-user uses a CTA or a PP, the IF/4 interface can be either RAP or GAP compliant. This ETR focuses on RAP and describes the services at IF/1 expected to be provided at IF/5a. The OA&M facilities defined in this ETR are only the ones that require information to be transported over the RAP air interface.

4.2.1 DECT RLL reference model elements

Local Exchange (LE): In this model "local exchange" is intended to represent a number of different elements of the fixed network, according to operator requirements. These may include the local switch, a network Point of Presence, and connections to the telephony network, the leased line network and the data network.

Fixed Part (FP): See subclause 3.1.

Cordless Terminal Adapter (CTA): See subclause 3.1.

Portable Part (PP): See subclause 3.1.

Terminal Equipment (TE): Includes Public Switched Telephone Network (PSTN), Integrated Services Digital Network (ISDN) and Broadband ISDN (B-ISDN) terminals. It may also include residential DECT systems, or in the case of a multiline CTA, wireline or wireless Private Branch Exchanges (PBXs).

Operation, Administration & Maintenance (OA&M): Information related to the configuration, monitoring, performance and fault management of RLL systems.

4.2.2 DECT RLL reference model interfaces

LE to FP interface (I/F1): this interface is used to connect the DECT RLL access network to the public fixed network. This interface is used to carry information between the controller and LE of the public network related to the services accessed by the RLL users. In this model the LE represents both the fixed PSTN/ISDN network and the private data network where appropriate. Examples of the interface between the possible interfaces used between the LE and the FP (I/F1) are:

- 2 Mbit/s;
- analog (2 wire);
- analog (4W + E&M);
- telex;
- digital data port;
- ISDN basic rate;
- V5.1, V5.2.

Radio interface (I/F4): DECT RAP or GAP compliant air interface used to connect a number of CTAs or PPs to FPs that may or may not include WRSs. The air interface is used to carry information related to call control, mobility management, and OA&M messages.

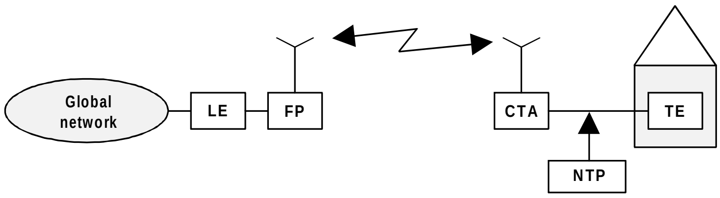
CTA to TE interface (I/F5): This interface is used to connect a TE to the CTA. This interface is used to carry information between the radio termination and a TE related to the services accessed by a user or an application.

OA&M interface (I/F6): This interface is used to connect the RLL system to the OA&M centre. This interface is used to carry between the OA&M centre and the FP information related to the configuration, performance and fault management of the RLL system.

4.3 Specific RLL configurations

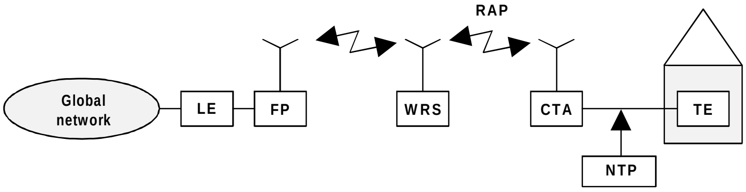
There will be regulatory issues associated with the reference configurations described below. It is not the purpose of this ETR to define regulatory issues but to highlight their existence.

4.3.1 RLL application 1: standard "fixed" service to socket



This is the most common RLL configuration. The final wired drop is replaced by a radio link to a CTA with network ending after the CTA but in the customers premises.

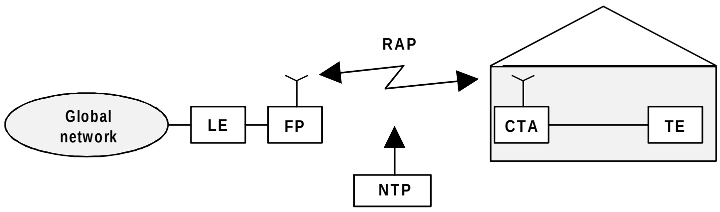
Figure 2



Similar to figure 2 but with a WRS see ETR 246 [16] in the access network under the control of the network operator.

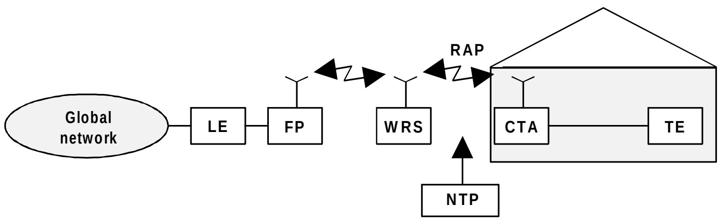
Figure 3

4.3.2 RLL application 2: delivery of service by radio - accessed via the customer's own CTA



In figure 4 another common configuration is shown. The CTA is owned in this case by the subscriber with the NTP located on the RAP compliant air interface.

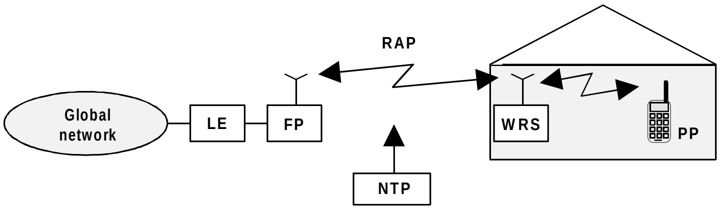
Figure 4



Similar to the configuration of figure 4 but with the WRS in the access network under the control of the network operator.

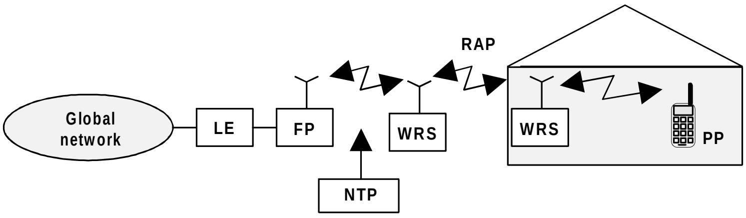
Figure 5

4.3.3 RLL application 3: delivery of service by radio - accessed via the customer's own WRS and thence to portable or CTA



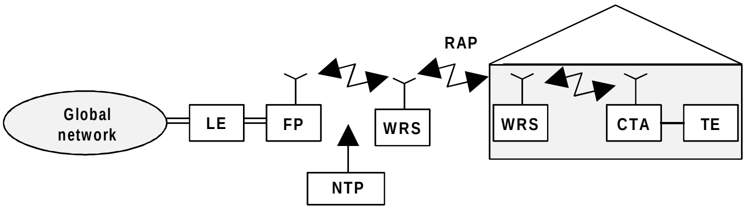
In the case of figure 6, the WRS is owned by the subscriber. There is no physical network termination as in the RLL Application 2. The network operator may need to know that the subscriber has attached a WRS.

Figure 6



Similar to the configuration of figure 6 but with two WRSs: one in the access network under the control of the network operator and another belonging to the subscriber. Problems rising due to the limited delay budget need to be considered.

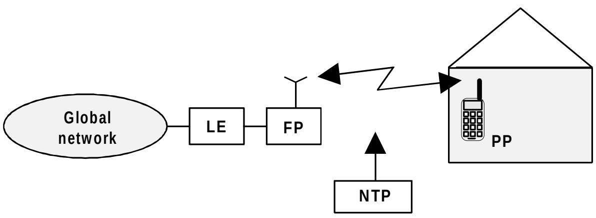
Figure 7



Similar to the configuration of figure 7, with the CTA and TE replacing the PP. Again delay problems may arise and need to be considered.

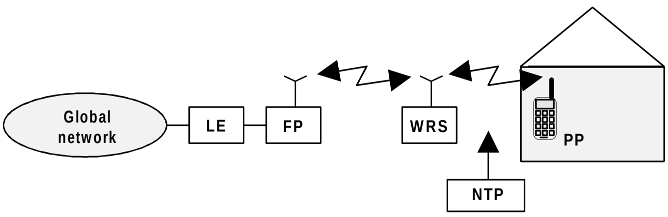
Figure 8

4.3.4 RLL application 4: mobility in the neighbourhood: service direct to portable



The configuration of figure 9 provides mobility to the RLL subscriber.

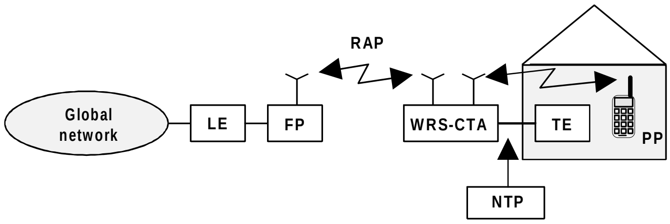
Figure 9



Similar to figure 9 but with a WRS in the access network under the control of the network operator.

Figure 10

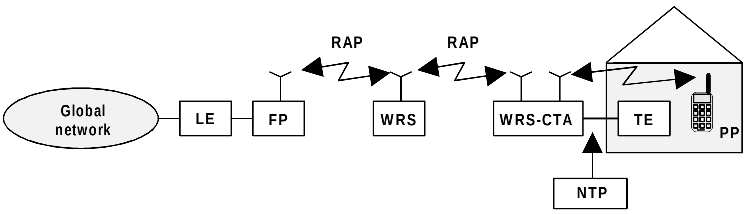
4.3.5 RLL application 5: hybrid of applications 1 and 4



Similar to figure 2 but with a hybrid WRS-CTA replacing the CTA. The WRS-CTA device allows the use of PP and TE simultaneously or alternatively. The NTP has now both wireline and wireless elements.

Depending upon the design of the WRS-CTA this configuration may support either only one call at a time to either a PP or to a fixed TE, or several simultaneous calls to multiple PPs or TE.

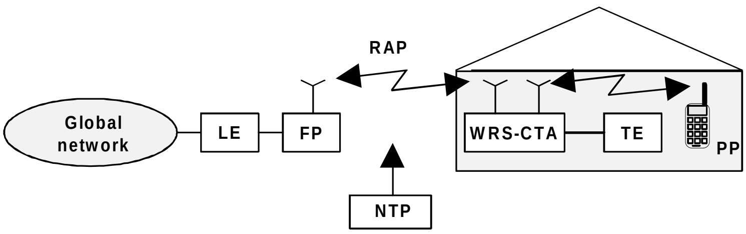
Figure 11



Similar to the configuration of figure 11, with a WRS in the access network under the control of the network operator.

Figure 12

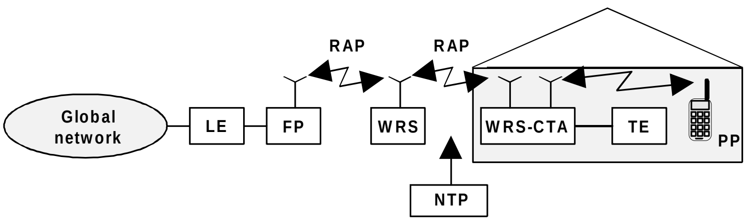
4.3.6 RLL application 6: hybrid of applications 2 and 3



Similar to figure 11 with the NTP positioned in the air interface between the FP and the WRS-CTA. The latter is owned by the subscriber.

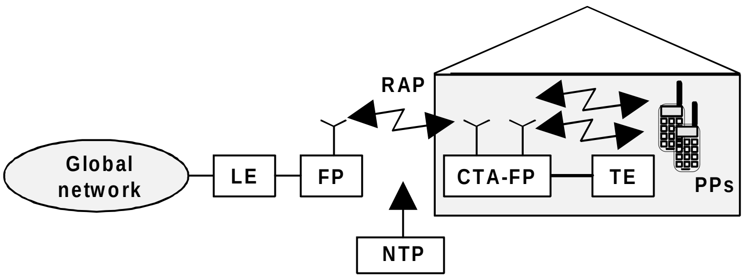
The WRS-CTA may provide an intercom function between two PPs and/or TEs.

Figure 13



Similar to the configuration of figure 13, with a radio relay in the access network under the control of the network operator.

Figure 14



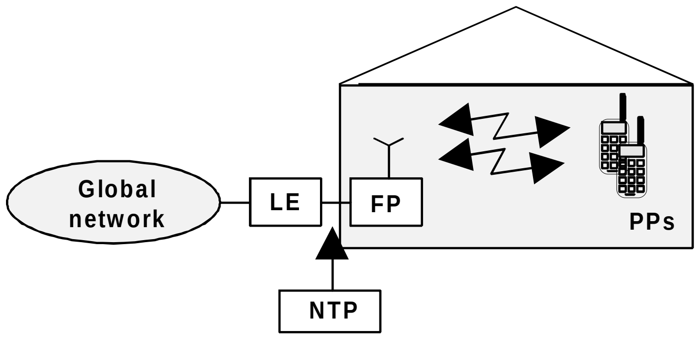
Similar to the configuration of figure 13, however the CTA-FP is a CTA, not a WRS from the viewpoint of the RLL FP, and acts as a residential FP to the PP, both for intercom calls between the PPs and for relayed external calls

Figure 15

4.4 Specific non-RLL configurations

The following configurations are included to illustrate some limits to the scope of the definition of DECT RLL - in both cases because the service is not delivered to the premises or directly by the operator to the customers terminal by a DECT radio interface.

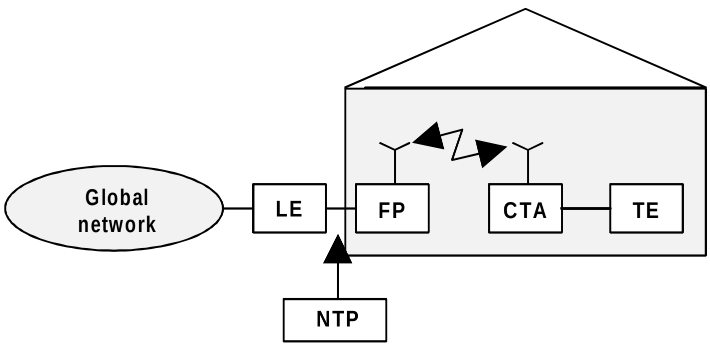
4.4.1 Cordless telecommunication application



The configuration of figure 16 is not RLL since the network operator is providing a wired service to the NTP. This is a classic residential DECT system configuration.

The FP may provide an intercom function between two PPs.

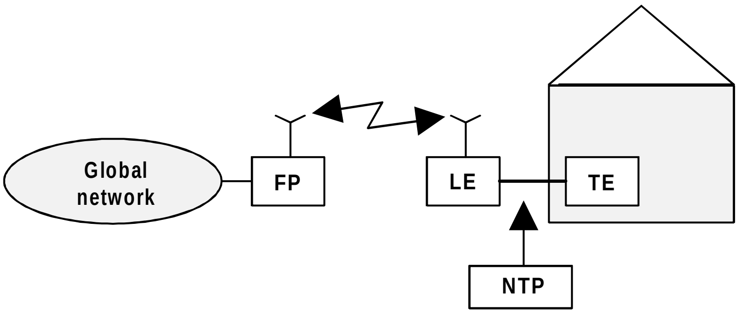
Figure 16



Similar to figure 16 but with the FP, CTA and TE are owned by the customer.

Figure 17

4.4.2 Interconnection of LE to the network



In the configurations of figures 18 and 19, the DECT radio interface is used for interconnection of a remote LE to network. It is not used to connect the LE and the user terminal.

Figure 18

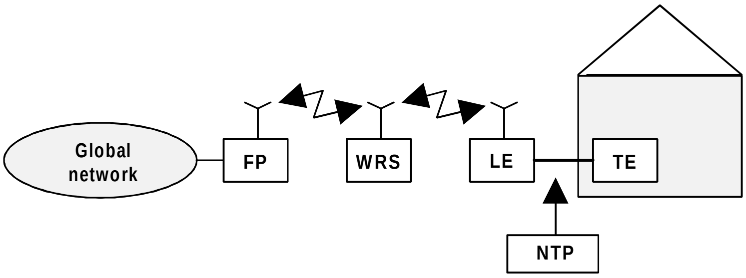


Figure 19

5 RLL services and facilities

The services listed and briefly described in this clause are not specific to DECT. Mostly, they are the normal services available today from a standard local loop connecting a customer's TE to a LE via a copper pair.

However, we also cover the special issues which arise from delivering local loop service over a radio connection. That is, through a fixed radio part (FP) connected to the LE and a CTA connected to the TE. Optionally a WRS may also be used.

Finally, the delivery of local loop services via radio creates the opportunity to define certain new services of which the user may take advantage. These are listed as well. Because these services are new, the definition of these services is expanded in other clauses of this ETR.

The operational and functional requirements for the DECT RLL service are covered in subclause 5.1. General issues relating to implementation are covered in subclauses 5.2 to 5.6. Specific issues for the DECT RAP are covered in subclause 5.7.

5.1 Operational and functional requirements

5.1.1 Operational requirements

From the point of view of a user (an actual user, a subscriber, a service provider, a network operator or a regulator), who looks at an RLL system from the outside, operational requirements for a DECT RLL service that are independent of the radio technology may be defined. These requirements mostly originate in clauses 6 and 7 of ETR 139 [10] and so are not duplicated here.

One special operational requirement, imposed by RES-03, is that the DECT RLL service shall support multi-vendor implementations. This is implemented by the DECT RAP (ETS 300 765, parts 1 and 2 [15] and [16]), which thereby creates the concept of service availability in a multi-vendor environment. This is classified in subclause 5.1.3. In all subsequent tables in clause 5, these defined categories are used to specify the availability of the service under the RAP.

NOTE: This ETR does not specify how the operational and functional requirements are provided. For this information, the RAP itself should be consulted.

5.1.2 Functional requirements

From the point of view of an implementor, the operational requirements above generate functional requirements that are radio-dependent but are implementation-independent. They are listed in table 1.

Table 1

Requirement	Details
The DECT RAP shall support multi-vendor implementation.	See subclause 5.1.3 for the levels of support available in multi-vendor systems.
The DECT RLL system shall provide the necessary functions to support basic telephony , the "Plain Old Telephone Service (POTS)" functionality in NET 4-compliant TE providing voice, fax and modem data services. The system shall provide transmission equivalent in many respects to wired connections.	Basic analogue local loop services are covered in subclause 5.2. Permitted service attributes, transmission characteristics and other impairments are covered in subclause 5.6.
The DECT RLL system shall be able to provide connection security.	Authentication functions are covered in subclause 5.5.1.
The DECT RLL system should be able to provide information confidentiality.	Encryption functions are covered in subclause 5.5.2.
The DECT RLL system shall support analogue and digital leased lines.	Analogue and digital leased lines are covered in subclause 5.3.
The DECT RLL system should be able to provide ISDN services with a quality that approaches the service quality of the fixed ISDN network.	ISDN local loop services are covered in subclause 5.4.
The DECT RLL system should implement all functions necessary for the support of mobility in portable (PP) and transportable (CTA) TE, within the domain of a single FP.	New services available as a result of RLL delivery are introduced in subclause 5.5.2 and further described in clause 10.

5.1.3 Availability of services through the DECT RAP

The DECT RAP designates, as with all DECT profiles, the services in each part of the DECT system as either mandatory (M), optional (O) or out-of-scope (I). In this context, mandatory means that a service shall be provided by the equipment and it shall be provided in the specified manner. Optional means that the service may be provided, or may not; however if it is provided it shall be provided in the specified manner. Out-of-scope means that the service is optional and no specification is provided for the service, so it may be implemented in any suitable proprietary manner.

The RAP designates M/O/I separately for the CTA, the WRS and the FP. In the case of the WRS, an additional category is T, indicating that the WRS is transparent to the service. Hence T may be considered as M, since the presence of a WRS will not interfere with delivery of the service.

Hence in designating the availability of a service from the LE, carried by a general RLL system, these three conditions may be defined:

- **U - Unconditional availability:** This means that there is no technical obstacle to the provision of the service. In this case, the service is listed in the RAP as mandatory for all of the equipment used to deliver it. Hence any combination of RAP equipment from any manufacturer will make the service available. Note that this does not mean that the service will be provided: that is a matter for commercial agreement between the TE's user, the RLL access system's operator and the network provider.

- **C - Conditional availability:** This means that the availability of the service is dependent only on whether or not it is implemented. In this case it is listed in the RAP as optional under at least one of the CTA/PP, WRS and FP. Hence the service will be available from any combination of RLL equipment from any manufacturer, but only where the feature is provided by all sub-systems.

- **P - Proprietary availability:** This normally means that the feature will only be available when equipment from a single manufacturer is used to deliver the service. In this case, at least one of the RLL sub-systems is permitted by the RAP to implement a service in a proprietary way (that is it is out of scope for the RAP). Hence the service will only be available if all of the relevant equipment implements the proprietary feature in a compatible way.

Tables 2 to 8 list in the "Status" column the current status of the availability of the specified service in the DECT RLL Access Profile, according to this classification.

5.2 Basic analogue RLL services

Basic analogue RLL services, introduced in subclause 6.1.1 of ETR 139 [10], means those handled by a terminal as defined in ETS 300 001 [38] (NET 4). The signals are presented across the A and B wires unless otherwise stated - an earth wire is not normally available on a PSTN LE interface, although it is present in some PBXs.

5.2.1 Analogue service categories

The basic services of the normal analogue local loop come under a number of categories:

- power feed to the TE;
- signalling from TE to LE;
- signalling from LE to TE;
- end-to-end signal transport.

There are also several services which are provided by combinations of the above basic services. In making the combination, a number of considerations may arise. These include such considerations as the matter of timing where there may be the need to preserve a strict timing relationship between the component services.

5.2.2 Power feed to the TE

Power feed to the TE is a basic local loop service, delivered by the LE through the copper pair. In the RLL service, this cannot be transported over a normal radio link, and so it needs to be delivered to the TE by the CTA instead.

Table 2

BASIC SERVICE	Status	Notes and RLL-specific issues
Loop voltage	**U** (note)	Loop voltage is provided by the CTA to the TE when it enters the on-hook state. The polarity of this voltage may occasionally be reversed for a certain period as a signal to the TE. A small amount of power is available from the loop when in the on-hook state. The CTA needs to be able to recognize when the TE enters the on-hook state, and deliver loop voltage to the TE.
Loop current	**U** (note)	Loop current is provided by the CTA to the TE when it enters the off-hook state. The CTA needs to be able to recognize when the TE enters the off-hook state and needs to deliver enough loop current to maintain the TE in this state. Loop current may be interrupted by Loop Disconnect (LD) dialling or a TBR. The polarity of the loop current may be reversed on some occasions, for example to indicate the start of charging to a pay-phone.
Line parking	**U** (note)	Line parking is a reduction of the loop current provided by the LE to the off-hook TE after a specified period without an end-to-end connection. The LE interface needs to retain the ability to detect an on-hook condition in the TE to release the line from the parked state. The service enables conservation of resource at the LE. The RLL equivalent is to cease usage of the radio spectrum. It is required to provide a transparent implementation. The FP needs to be able to detect that the line has been parked by the LE, signal the CTA to go into a parked state and release the RF link. The FP should then deliver busy indication back to the LE for all incoming calls until the CTA signals that the TE has gone back to the on-hook state. This assumes an analogue interface from FP to LE. The CTA needs to be able to recognize the TE going from the parked state to on-hook to signal this to the FP. The parked state indicator in the CTA should be preserved across a power interruption. If not, the CTA should always signal to the FP at power-up. Note that an independent implementation is possible, independent of whether it is provided by the LE. It is also possible to provide line parking as a CTA-only service, independent of the air interface. However, in these implementations some special features may be ineffective, such as the deliberate action of a PBX to busy-out a line in a hunt group.
NOTE: Mostly, power feed is not a matter concerning the radio interface and so the classification of the service may actually be considered "not applicable." In the case of line parking, however, there may be an impact on the radio interface which depends on how it is implemented.		

5.2.3 Signalling from TE to LE

These are the signals, both impedance and applied voltage/current, that a LE local loop interface will normally detect. If the radio transport cannot handle any signal directly, it needs to be detected by the CTA, transported over the radio interface and signalled to the LE by the RLL FP.

In the case of impedance changes, these signals are not usually transparently transported by the radio medium. They are normally acted on by either setting up or releasing the a radio link (e.g. off-hook, on hook) or by using an out-of-band digital signal (such as for register recall).

In the case of signalling voltages, they are usually transported over the radio transparently.

When signal transport is required when the radio link is not (yet) in place (for example if dialling is possible whilst the radio link is still in the process of being set up), signals may have to be detected at the CTA, stored and later transported as in-band or out-of-band digital signals.

Table 3

BASIC SERVICE	Status	Notes and RLL-specific issues
Go on-hook	**U** (note)	A TE impedance change intended to terminate a connection (hang up). The CTA needs to be able to recognize when the TE enters the on-hook state. Note that the release of the radio resource at both the calling end and at the called end is initiated in the first instance by the calling end hanging up.
Go off-hook	**U** (note)	A TE impedance change a) to start an outgoing call; or b) to answer an incoming call. The CTA needs to be able to recognize when the TE enters the off-hook state. If an incoming call is present, the CTA needs to complete the radio link set up and connect the call. If no incoming call is present, the CTA needs to set up the radio link for the outgoing call. If ringing signal is applied when the TE goes off-hook it should normally be removed within a specified period (ring trip).
Dialling		A short delay is normal between the TE going off-hook and the LE delivering dial tone and/or being able to accept dialling. RLL systems will introduce additional delay, which may need to be considered when designing them. The LE changes from the on-hook state to the dialling state on the first dialled digit and leaves the dialling state either on some time-out or if an other indication shows that dialling is complete. The LE removes dial tone when it enters the dialling state. It may be impossible for the CTA to recognize when the LE considers that dialling for the purpose of setting up an end-to-end connection is complete. The RLL system needs to be able to operate without this indication.
Option 1:	**U**	A user going off-hook to make a call needs to wait as long as necessary for the radio link to be set up and dial tone to be available from the LE. In some territories, the extra delay may cause the breach of a specified requirement.
Option 2:	**C**	A user going off-hook to make a call may dial within some specified period without waiting for the radio link to be set up and dial tone to be available from the LE. The CTA does not provide locally-generated dial tone.
Option 3:	**C**	As per option 2, but the CTA provides locally-generated dial tone.

(continued)

Table 3 (concluded)

BASIC SERVICE	Status	Notes and RLL-specific issues
Dual Tone Multi Frequency (DTMF) dialling	**U**	DTMF digits from the TE are dual-tone signal combinations generated in the off-hook state to set up an end-to-end connection. The DTMF alphabet comprizes 0 to 9, *, #, A, B, C, D. Of these the first twelve only are mandatory. Note that the FP and LE need to agree about the dialling type and the CTA and TE need also to agree. However it is entirely permissible for dialling by means of signalling out-of-band over the air interface to translate LD dialling from the TE to DTMF at the LE, and vice-versa. Note also that a mis-matched four-wire to two-wire hybrid at an FP using DTMF may cause the echo of DTMF digits at the TE, even if the TE uses LD dialling.
LD dialling	**C**	LD (or Decadic) digits from the TE are momentary impedance changes of defined length generated in the off-hook state to set up an end-to-end connection . The LD alphabet comprizes 0 to 9, of which all are normally mandatory if LD dialling provided.
TBR	**C**	TBR is a momentary TE impedance change of defined length detected in the off-hook state. The LE's action is not fully specified, but TBR is normally used to invoke a supplementary service. During the recall signal the TE is in the register recall state. Note that the FP and LE need to agree about recall type and the CTA and TE need also to agree. However it is entirely permissible for recall by means of signalling out-of-band over the air interface to translate ELR from the TE to TBR at the LE, and vice-versa.
ELR	**C**	ELR is the connection of the A or B wire to ground for a specified period. This is normally a PBX-only feature. It is detected in the off-hook state. The PBX's action is not fully specified, but ELR is normally used to invoke a supplementary service. During the recall signal the TE is in the register recall state.
Do not disturb	**C**	DND is a high impedance from the TE, somewhere between the on-hook and off-hook states, signalling the LE to not deliver incoming calls. Its use is discouraged as it may interfere with line testing. Network services should be used instead.
Disabling of echo control devices	**U**	Disabling of echo suppressers is performed when the TE is in the off-hook state and sends a nominally 2,100 Hz tone for a specified period. Network echo cancellers can also be disabled by reversing the phase of the signal for specified periods.
NOTE: On-hook and off-hook signals are detected by the CTA only and do not normally pass across the air interface. They do trigger air-interface-specific actions and are used as part of the incoming and outgoing call services of subclause 5.2.6.		

5.2.4 Signalling from LE to TE

The LE generates the following signals for the use of the TE. Therefore, where the RLL system is not transparent to these signals, they need to be detected by the RLL FP, transported by the RLL system and re-generated at the CTA.

Table 4

BASIC SERVICE	Status	Notes and RLL-specific issues
Ringing signal	**U**	Supplied in the on-hook state to signal the TE that an incoming call is available. In at least some territories it is required to reverse the polarity of the power feed for the duration of the ringing signal. If ringing signal is applied when the TE goes off-hook it is normally removed within a specified maximum period (ring trip). If a clear signal is received from the network while ringing signal is applied, it is removed within a specified period (ring clear). There may be a requirement for ringing signal to be applied by the CTA to the TE within a specified period after a call has arrived at the FP. Cadence replication at the CTA may be required for analogue ringing applied at the FP. In this case, truncated initial ring may occur as the link set-up is not instantaneous. Indication of incoming call at a digital FP interface may be accompanied by a specific ring cadence number which may determine the CTA's action.
Dial tone	**U**	Supplied in the off-hook state to indicate that a dialling register is available and dialling is possible. Removed following the first dialled digit. It may be reinstated after a register recall. Second dial tone may also be provided on gaining "external" or international access. Dial tone may be generated by the CTA or transported from the LE. See under Dialling in subclause 5.2.3. The issue of when to cut over from "fake" dial tone to real dial tone needs to be addressed, as well as the issue of whether to take an incoming call which arrives before LE dial tone is received.
Other supervisory tones	**U**	Those specified in ETS 300 001 [38] (NET 4) are Dial Tone (see above), Special Dial Tone, Busy Tone, Congestion Tone, Ringing Tone, and Special Information Tone. Others mentioned are Second Dial Tone, Number Unobtainable Tone, Acknowledgement tone, Intrusion Tone, Call Waiting Tone, Waiting Tone, Confirmation Tone, Special Confirmation Tone, Queue Tone, International Dial Tone, Paging Acceptance Tone, Positive Indication Tone, Negative Indication Tone, Warning Tone and Howler (Tone). See CCITT Recommendation E.182 [49]. If the radio transport is not transparent to any of these signals they need to be carried in out-of-band signalling and re-generated at the CTA.
Meter pulses	**C**	Supplied in the off-hook state and used to indicate unit-based subscriber charging. There are 50 Hz (longitudinal), 12 kHz and 16 kHz versions. If the radio transport is not transparent to any of these signals they need to be carried in out-of-band signalling and re-generated at the CTA. It is legally regulated in some territories that the meter in a customer's premises shall match the meter in the LE. It is therefore necessary for a CTA to acknowledge receipt of a meter pulse. See V5.1, ETS 300 324 [41] and V5.2, ETS 300 347 [42].
Line polarity reversal	**U**	Usually combined with other basic services to create more advanced services, such as Calling Line Identity Presentation (CLIP).
Terminal Alerting Signal (TAS)		The TAS is used for PSTN display services, such as CLIP. Its function is to alert a TE that data transmission is to be expected. There are three defined TASs (see ETS 300 659-1 [11]).

(continued)

Table 4 (concluded)

BASIC SERVICE	Status	Notes and RLL-specific issues
Dual Tone Alerting Signal (DT-AS):	**C**	A DT-AS. Start of data transmission is to be expected from 45 ms to 500 ms (exceptionally 5 s) after the end of the DT-AS. DT-AS duration is 100 ms ± 10 ms.
RP-AS:	**C**	A RP-AS. Start of data transmission is to be expected from 500 ms to 800 ms after the end of the RP-AS. RP-AS duration is between 200 ms and 300 ms.
Line reversal plus DT-AS:	**C**	A line polarity reversal followed by a DT-AS. The DT-AS shall start 100 ms or more after the line reversal. Start of data transmission shall start 45 ms or more after the DT-AS. Start of data transmission shall start no more than 700 ms after the line reversal.
PSTN display data	**C**	For the purposes of CLIP, etc., this data is sent by the LE to the TE as simplex asynchronous voice band data. The modem uses the 1 200 baud characteristics of ITU-T Recommendation V.23 [46].

5.2.5 End-to-end signal transport

After set-up of an end-to-end connection, including the RLL system, the following traffic signals need to be transported. Where the radio transport is not transparent, special means need to be provided to ensure the transport of normal signals.

Table 5

BASIC SERVICE	Status	Notes and RLL-specific issues
Voice	**U**	The RLL transport needs to be transparent, and introduce little impairment.
DTMF tones	**U**	In this context these are not used for connection set-up. The RLL transport needs to be transparent, and introduce little impairment. The frequently dialled combination "recall + DTMF digit" may cause timing problems if the recall is transmitted out-of-band with some delay, whilst the DTMF digit is sent immediately in-band.
Remote party tones	**U**	Answering Tone, Speech Signal (see above), Data Signal (see below), Remote Activation Tone. The RLL transport needs to be transparent, and introduce little impairment.
Modem and fax signals		Generally the RLL transport will be transparent to modem and fax signals up to a certain rate, but will not carry higher data rates (note).
Option 1:	**U**	Use normal RLL transport and support lower-rate connections only.
Option 2:	**C**	Detect the use of modem or fax signals and use a wider-bandwidth RLL transport to support all connections. For example, use 64 kbit/s transport to carry ITU-T Recommendation V.34 [47] (28,8 kbit/s) instead of 32 kbit/s.
Option 3:	**P**	Detect the use of modem or fax tones, use digital transport over the air with rate adaptation, and re-generate the tones at the destination.
NOTE: Adaptive Differential Pulse Code Modulation (ADPCM) 32 kbit/s codecs will transport voice signals well and network signals without excessive impairment. [According to ITU-T Recommendation G.173 [33]], they will transport up to 4 800 bit/s fax signals and up to 9 600 bit/s modem signals. Higher rate signals are not guaranteed to be properly transported.		

5.2.6 Services made from combining basic services

The following services are made up by combining basic services as defined in tables above. It should be noted that the combinations may introduce special requirements, such as maintaining specified timing relationships between the elements.

Table 6

SERVICE	Status	Notes and RLL-specific issues
Answering function	**U**	Incoming call: a call received by the CTA. Requires ringing and on-hook/off-hook detection.
Calling function	**U**	Outgoing call: a call initiated by the CTA. Requires dial tone, LD or DTMF dialling, and on-hook/off-hook detection.
Manual hold	**U**	Call termination controlled by LE, not the CTA. Certain circumstances such as emergency calls in some territories require that the network be in control of the ability to clear the connection.
Disconnect signal	**C**	On disconnection by the call originator, a short break is provided by the LE. This may be used for example to ensure that answering machines turn off at the end of a call.
Assignment of access priority	**C**	The line receives higher or lower priority access to limited resources. For example a doctor's line may be granted higher priority during emergency conditions. The use of a concentrating air interface provides additional blocking possibilities that may affect priority assignments under the RLL service.
PSTN display services	**C**	For example CLIP. See ETS 300 659-1 [11] for on-hook services; ETS 300 659-2 [12] for off-hook services; ETS 300 659-3 [13] for ADSI (screen-based interactive services). Uses a TAS and V.23 modem tones for display data. There are two options: transmission associated with ringing; or transmission not associated with ringing. For transmission associated with ringing there are two further options: data before ringing with a TAS, or data during ringing without a TAS (the TE is alerted by ringing itself).
Utility meter reading	**C**	A TAS followed by the transport of low-speed modem data to and from the TE. Used for reading residential utility meters (gas, electricity, water, etc.). The call is subsequently released. This proceeds without the subscriber's intervention.
Malicious call intercept	**C**	A Time-Break Recall received by the LE during an incoming call is used to trigger a call trace. This is a pre-arranged, not opportunistic service.
Direct Dialling In (DDI)	**C**	Indicates the dialled number of incoming call from LE to a PBX. There is no international standard for DDI on analogue local loops but all known local standards for DDI can be met by combinations of basic services such as line reversals and modem or DTMF tones

5.3 Leased line service

The Council Directive on the application of Open Network Provision (ONP) to leased lines (92/44/EEC [19]) provides for the harmonization of conditions for open and efficient access to, and use of leased lines provided over public telecommunications networks. It also provides for the availability throughout the community (EEC) of a minimum set of leased lines with harmonized technical characteristics.

These requirements may not apply to leased lines supplied via the RLL service. However the harmonized technical characteristics of the specified leased lines should be supported by their RLL-supplied equivalents.

The basic set of leased lines covered here includes the four types of harmonized analogue leased lines and the unrestricted 64 kbit/s digital leased line. The higher-rate digital leased lines are covered in subclause 5.5.2.

5.3.1 Analogue leased lines

Four types of analogue leased line are supported by ETSI under the ONP Directive:

- ordinary quality voice bandwidth two-wire analogue leased lines (type A2O);
- special quality voice bandwidth two-wire analogue leased lines (type A2S);
- ordinary quality voice bandwidth four-wire analogue leased lines (type A4O); and
- special quality voice bandwidth four-wire analogue leased lines (type A4S).

The requirements for two-wire terminals are contained within ETS 300 450 [20] and TBR 15 [20]. The requirements for four-wire terminals are contained within ETS 300 453 [22] and TBR 17 [23].

These analogue leased lines are characterized in the following way, with reference to the basic analogue RLL services in subclause 5.2:

- power shall not be fed to the TE. Hence subclause 5.2.2 is irrelevant in this context;
- there are no call set-up services: the line is permanently in place. Echo control devices shall not be present. Hence subclause 5.2.3 is irrelevant in this context;
- signals are not provided by the LE. Hence subclause 5.2.4 is irrelevant in this context; and
- there are no network-provided higher-level services made up by combinations of basic services. Hence subclause 5.2.6 is irrelevant in this context.

The only subclause that is relevant from those under basic analogue RLL services (subclause 5.2) is the subclause on signal transport (subclause 5.2.5). However, the subclause on special services (subclause 5.5.1) also applies for security reasons.

It should be noted that specific end-to-end requirements for analogue leased lines are contained in the relevant ETSs and are therefore not defined by this ETR. Since most of the requirements are end-to-end requirements, the entire leased line needs to be considered in specifying RLL transport at one end. Only the more important matters relating to RLL implementations are covered below.

Table 7

SERVICE	Status	Notes and RLL-specific issues
Ordinary quality voice bandwidth two-wire analogue leased line	**C**	Designated A2O: See ETS 300 448 [24] for the full transmission characteristics. In summary, however, this is a symmetrical, point-to-point, permanently connected (note 1) two-wire analogue leased line of "ordinary" voice quality. The key characteristics required include those for loss, signal levels, delay, noise, distortion, echo and stability. The delay for terrestrial connections shall be less than (15+0,01G) ms, where G is the geographical distance between the end-points in km (note 2). For satellite connections the delay shall not exceed 350 ms. Only one ADPCM transcoding is permitted within the entire end-to-end connection (note 3) and the quantizing distortion shall not exceed 7,5 Quantization Distortion Units (QDU).
Special quality voice bandwidth two-wire analogue leased line	**C**	Designated A2S: See ETS 300 449 [25] for the full transmission characteristics. In summary, however, this is a symmetrical, point-to-point, permanently connected (note 1) two-wire analogue leased line of "special" voice quality. Compared to those of the ordinary quality two-wire leased line, requirements are either the same or more stringent. There are several additional requirements that are not applied to A2O leased lines. Note that no ADPCM transcoding is permitted within the entire end-to-end connection (note 3) and the quantizing distortion shall not exceed 5 QDU.
Ordinary quality voice bandwidth four-wire analogue leased line	**C**	Designated A4O: See ETS 300 451 [26] for the full transmission characteristics. In summary, however, this is a symmetrical, point-to-point, permanently connected (note 1) four-wire analogue leased line of "ordinary" voice quality. The key characteristics required include those for loss, signal levels, delay, noise and distortion. The delay for terrestrial connections shall be less than (15+0,01G) ms, where G is the geographical distance between the end-points in km (note 2). For satellite connections the delay shall not exceed 350 ms. Only one ADPCM transcoding is permitted within the entire end-to-end connection (note 3) and the quantizing distortion shall not exceed 7,5 QDU.

(continued)

Table 7 (concluded)

SERVICE	Status	Notes and RLL-specific issues
Special quality voice bandwidth four-wire analogue leased line	**C**	Designated A4S: See ETS 300 452 [40] for the full transmission characteristics. In summary, however, this is a symmetrical, point-to-point, permanently connected (note 1) four-wire analogue leased line of "special" voice quality. Compared to those of the ordinary quality four-wire leased line, requirements are either the same or more stringent. There are several additional requirements that are not applied to A4O leased lines. Note that no ADPCM transcoding is permitted within the entire end-to-end connection (note 3) and the quantizing distortion shall not exceed 5 QDU.

NOTE 1: These are permanently connected analogue lines. They will therefore occupy the radio spectrum continuously unless a virtual leased line service is introduced (see subclause 5.5.2) to use the radio spectrum only when traffic flows.

NOTE 2: For digital RLL systems that have overall data framing delays of greater than 15 ms, the delay-time requirements cannot be met. This may also apply to systems where significant data buffering is required to allow the error rate to be improved.

NOTE 3: Since analogue leased lines for the normal quality service permit at most one ADPCM transcoding, only one end of a leased line may use a RLL system if it employs ADPCM transcoding. For the special quality service, no ADPCM transcoding is permitted. In this case a RLL system normally using ADPCM transport will have to convert to 64 kbit/s transport in order to meet this requirement.

5.3.2 Digital leased lines

This subclause covers only 64 kbit/s leased lines, designated D64U. There are other types of leased line specified by ETSI of these varieties: 2048 kbit/s (types D2048U and D2048S); 34 Mbit/s (types D34U and D34S); and 140 Mbit/s (types D140U and D140S). However although the higher rate digital leased lines may be carried over RLL systems of course (see subclause 5.5.2), they are outside the scope of this ETR because they are not normally delivered over a pair of copper wires.

For D64U digital leased lines, the requirements for network interface presentation are contained in ETS 300 288 [27]. The requirements for connection characteristics are contained in ETS 300 289 [28], and the requirements for TE interface are contained in ETS 300 290 [29]. The attachment requirements for TE interface are contained in TBR 14 [30].

Table 8

SERVICE	Status	Notes and RLL-specific issues
64 kbit/s digital unrestricted leased line with octet integrity	**C**	Designated D64U. See ETS 300 289 [28] for the full specification of its connection characteristics. In summary, however, this is a symmetrical, point-to-point, permanently connected (note 1), 64 kbit/s, unrestricted-data digital leased line with octet integrity (i.e. octet boundaries are preserved). The key characteristics required include those for delay, jitter, octet slip and error performance. The delay for terrestrial connections shall be less than (10+0,01G) ms, where G is the geographical distance between the end-points in km (note 2). For satellite connections the delay shall not exceed 350 ms. There shall be less than five octet slips per 24-hour period. It is required that for at least one of two consecutive 24 hour periods, the number of errored seconds shall be less than 5324, and the number of severely errored seconds shall be less than 105 (note 3). These values are derived from ITU-T Recommendation G.821 [34].
NOTE 1: This is a permanently connected leased line. It will therefore occupy the radio spectrum continuously unless a virtual leased line service is introduced (see subclause 5.5.2) to use the radio spectrum only when traffic flows. NOTE 2: For RLL systems that have overall data framing delays of greater than 10 ms, the delay-time requirements cannot be met. This may also apply to systems where significant data buffering is required to allow the error rate to be improved in order to meet the requirements of ETS 300 289 [28]. NOTE 3: These requirements apply to leased line connections extending over Europe (assumed length 9000 km). Error performance requirements (and also availability objectives) for the local-grade portion of connections may be taken from ITU-R Recommendation F.697 [54].		

5.4 Normal digital (ISDN) RLL services

This subclause covers the normal basic-rate ISDN services available on two-pair lines.

5.4.1 Services

Within the scope of this ETR, normal ISDN services means the following:

- ISDN circuit-mode 3,1 kHz audio (I.231.2 [36], ETS 300 109 [35]); and
- ISDN circuit-mode 64 kbit/s unrestricted digital information (I.231.3 [36], ETS 300 110 [37]);
- ISDN D-channel packet mode, see ETS 300 049 [54].

The first two are the minimum set of basic-rate ISDN services covered by the 1989 MoU for European Network Operators. There are other defined basic-rate services, including packet-mode data, that are not covered.

5.4.2 Handling variable-service demands

The key issue of ISDN basic-rate services in a RLL environment is that unlike normal analogue services, the user may select differing service levels requiring differing bandwidths to efficiently carry on the radio interface. For example, basic rate ISDN can carry one or two B-channels (for user traffic) sharing one D-channel (for signalling). For radio efficiency, voice channels may be normally carried at 32 kbit/s through ADPCM transcoding, rather than 64 kbit/s, to save on radio resources. However transparent digital communications mat not use ADPCM encoding. To illustrate the issue, some examples are shown below.

Table 9

Service example	Control	User	Total
One ordinary quality (ADPCM-encoded) voice channel.	1D at 16 kbit/s	1B at 32 kbit/s	48 kbit/s
Two separate special quality voice channels or a 128 kbit/s transparent data channel.	1D at 16 kbit/s	2B at 64 kbit/s each	144 kbit/s

Until the ISDN layer one and layer two protocols are terminated and the early layer three UI messages are seen, it is not known what service is required and hence what bandwidth is appropriate on a RLL air interface. In the radio spectrum, unlike wired connections, it is not desirable to occupy enough bandwidth to carry 144 kbit/s of traffic when only 48 kbit/s of traffic is really required.

This leads to the conclusion that for carrying ISDN over a RLL system (or any service that allows a user to demand a variable capacity) the protocols need to be terminated at a high enough layer of the protocol to determine the service required before the radio connection is set up. In the case of ISDN, termination should be provided at the CTA and at the FP up to and including layer two. The interworking unit should then recognize the service level demanded and cause the appropriate link to be set up on the RLL air interface.

5.4.3 Interfaces

Normally, the interface between the LE and the TE is the U interface, but this is not standardized. Hence ISDN RLL service should be provided at the user's premises to a ISDN Terminal Equipment type 1 (TE1) (e.g. a normal ISDN telephone set) at the S interface or at the combined S/T interface. It should also be provided where required to a ISDN Network Termination 2 (NT2) (PBX, multiplexer, etc.) through a T interface.

The RLL CTA therefore should do one of three things:

- emulate a ISDN Network Termination 1 (NT1) with a combined S/T interface (to support a terminal of type TE1); or
- emulate a NT1 with a T interface (to support a PBX/multiplexer of type NT2); or
- emulate a combined NT1 and NT2 with a S interface (to support a terminal of type TE1).

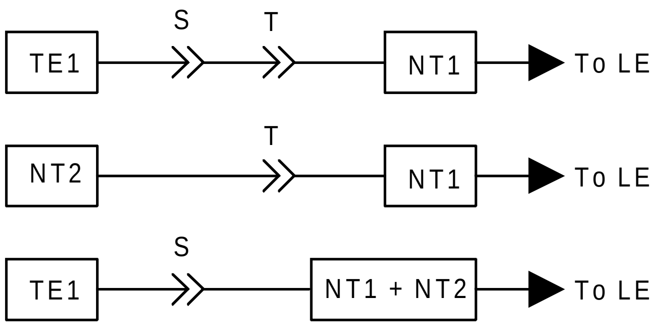


Figure 20 Supported ISDN configurations

TE1 is a standard ISDN terminal. NT2 is a PBX, multiplexer etc. and NT1 is a network terminator which terminates the U interface to the LE.

The FT may terminate a U interface (of whatever standard) or attach to the LE via a 2 Mbit/s interface or use any other appropriate digital LE interface.

5.4.4 Service support methods

A RLL system should provide for the various normal ISDN services as follows:

Table 10

SERVICE	Status	Notes and RLL-specific issues
Power feed	**C**	Power feed should be provided local to the CTA. Note that unlike analogue lines, ISDN power feed is independent of the state of the terminal and the LE.
ISDN circuit-mode 3,1 kHz audio	**C**	ISDN circuit-mode 3,1 kHz audio (I.231.2 [36], ETS 300 109 [35]) should be transcoded to 32 kbit/s ADPCM or better wherever possible. B-channels should only be allocated on demand to save spectrum.
ISDN circuit-mode 64 kbit/s unrestricted digital information	**C**	ISDN circuit-mode 64 kbit/s unrestricted digital information (I.231.3 [36], ETS 300 110 [37]) requires transparent 64 kbit/s transport. B-channels should only be allocated on demand to save spectrum.

5.5 New RLL services

5.5.1 Essential additional services

These are special services required because of the use of a RLL system to deliver telephony service. Primarily they result from "open access" to the radio spectrum in a RLL system and its impact on subscriber charging.

Table 11

SERVICE	Status	Notes and RLL-specific issues
Authentication of the CTA	**U**	Authentication is the process in which the CTA or PP is positively verified as a legitimate user of a particular FP. In most RLL cases it is a requirement for security reasons. The procedure is generally performed while a call is being set up, but may also be done during a call.
Authentication of the FP	**C**	This is the process by which the CTA verifies the identity of the FP. In most RLL cases it is required for security reasons if the FP modifies data at the CTA that affects access rights or charging.
Load/modify user subscription data		A procedure for loading or modifying the subscription and security data held in the CTA.
Option 1:	**U**	By direct electrical connection to the CTA.
Option 2:	**C**	Over the air.
Power failure handling	**U**	If the CTA provides the main telephony service, in certain territories this may imply the requirement to provide specified service in the event of power failure. The general requirement specified in ETR 139 [10] is that the CTA should provide at least 8 hours operation in standby (i.e. on-hook) mode. and 30 minutes off-hook talk time. The FP will provide alternative territory-specific service.

5.5.2 New service opportunities

The DECT RLL has certain inherent characteristics which are different and novel compared to twisted-pair copper access. It is therefore possible for operators to exploit these differences to implement existing services in new ways, or to present such services in new ways, or to offer entirely new services. These opportunities are considered in more detail in the following subclauses.

5.5.2.1 New Service Implementations

The characteristics of the DECT protocol make it advantageous to the operator to implement within the RLL network many of the traditional telecommunications services in novel ways, without the customer necessarily being made aware of this difference. The most obvious example is the use of ADPCM coding for the transport of telephony communications. As in this example, the advantages to be gained may be better spectrum economy, more efficient use of network infra-structure or better quality and reliability. At the same time, there may also be secondary effects upon the service characteristics, visible to the user, which the operator will take these into account in deciding whether to exploit these service implementations.

Non-voice services are those principally affected by these new opportunities. In particular, the DECT capability to transmit data using high-speed packet-oriented bearers creates new ways of transporting modem and fax information with better economy and efficiency.

The requirements on such implementations are:

- the use of spectrum and network resources in proportion to the volume of data transferred;

- support for user data transfer rates at least equal to, and possibly superior to those supported by the wired access network;

- support for a circuit- and connection-oriented user interaction model;

- latency and availability parameters consistent with the requirements of existing user applications, which are adapted to the characteristics of the fixed access network.

Different user services will require different ways of managing the RLL access link, and the transparent introduction of new service implementations will therefore require that the CTA shall be capable of differentiating between different user services without any local interaction with the user. This inevitably has an adverse effect upon the cost and complexity of a CTA.

5.5.2.2 New service presentations

The different implementations of services in the RLL imply different sets of cost and performance parameters for each service. Some operators consider it advantageous to expose these differences to the customer, by means of different ports on the CTA for each service.

The ports may be similar to those normally expected on a CTA, such as an RJ-11 connector; alternatively it may be more similar to the service-specific interfaces normally associated with TE. In particular, the ports may include:

- telephony: RJ-11 (voice);
- asynchronous modem: V.25;
- synchronous modem: V.35;
- frame relay: V.35;
- fax: RJ-11 (group 3).

The requirements to be met through such differentiation are:

- simultaneous support for different, non-overlapping services: for example, the possibility to conduct a telephone call and a modem connection simultaneously without the obligation to support two full subscriber lines;

- offer the customer full, simple visibility of the different service cost and performance parameters by the direct association between a CTA access port and a particular service;

- optimize the cost of the CTA by removing the requirement that it distinguish internally between the different services activated by the user.

5.5.2.3 New services

Apart from new ways of implementing or presenting traditional services, the characteristics of the DECT RLL make it possible to offer to the user entirely new services which go beyond those normally supported by a copper twisted-pair access network. Examples of such services are described in table 12.

Table 12

Service	Notes and RLL-specific issues
Mobility	See clause 10
Communication direct to PP	Delivery of service direct to the user's terminal, without a CTA. See clause 10.
Encryption of communication	Encryption of the transmission between the CTA and the FP. Based on the DECT encryption algorithm. Conditionally exportable.
Routed frame relay	DECT Native-mode packet-based routing and transmission of data frames. Access to CTA directly via Ethernet or ATM connector.
Enhanced fax services	DECT Native-mode message-based management of faxes, including store-and-forward and Internet inter-working. Based on the DECT Multi-media messaging (MMS) protocol.
Enhanced tariff and cost info	Provision to the subscriber of detailed tariff and cost data before, during and after a connection. Based on DECT cost information protocol.
Virtual analogue leased line	A virtual analogue leased line is one that sets up the radio transport only when there is analogue traffic to be carried, and releases the radio resource when not required. A protocol may be required to indicate when the channel is and is not required. This is not considered practical for most users, although provision may be technically possible (note).
Virtual digital leased line	A virtual digital leased line is one that sets up the radio transport only when there is digital traffic to be carried, and releases the radio resource when not required. A protocol may be required to indicate when the channel is and is not required (note).
NOTE: A leased line capability is possible over DECT but it is seen as a very poor use of spectrum. The concept of a "virtual" leased line has been proposed which shares the radio spectrum with other users. This however requires set-up signals from the terminals connected to the DECT system and as a result violates the present ONP directives. A new service needs to be defined to meet the requirements of radio systems.	

The details and phasing of the implementation of these services will depend upon operator judgement of market demand.

Wideband digital services at 2 Mbit/s and above are considered to be outside the scope of DECT RLL systems.

5.6 Service attributes, transmission characteristics and other impairments

This subclause details the service attributes perceived to be of importance to network providers, and which should be addressed when assessing potential radio technology solutions.

5.6.1 Service attributes

For the evaluation of attributes values, a duration of 150 ms has been taken as an assumption for the radio access network delay, split into 100 ms for radio link signalling establishment and 50 ms for radio connection establishment. This value affects the dial tone delay and the alerting sending delay.

Table 13

Attribute	Definition	Value (Target)
Traffic capacity	Estimated traffic peak rates per line at busy hour.	-Residential: 0,07 E -Small business / home-office: 0,15 E
Grade of service	Statistical availability of the communication channel for a particular customer's termination. It includes all the following delay parameters and blocking probability which impact service providing quality.	
Dial tone delay	Interval from the instant of off-hook and the beginning of the dial tone applied to the line.	Transparent mode: Normal load: up to 750 ms High load: up to 1,15 s Non-transparent mode: up to 400 ms (note 1)
Post-dialling delay	Time interval between the end of dialling by the subscriber and the reception by him of the appropriate tone or recorded announcement, or the abandon of the call without tone.	Transparent mode: analogue lines: Normal load: up to 950 ms High load: up to 1,65 s digital lines: Normal load: up to 450 ms High load: up to 750 ms Non-transparent mode: add 100 ms due to radio signalling link establishment delay (note 2)
Call clearing delay	Interval of time between the beginning of the sending of the clearing signal by the terminal and the appearance of the free circuit condition on the return line.	By the calling user: ? By the called user: ?
Access network delay	Delay introduced by the radio circuits in the local loop. The maximum delay includes the radio signalling link establishment followed by the connection establishment delay. In some cases both delays can be combined and the access network delay reduced.	up to 150 ms
Blocking probability on radio channels	Probability for a connection not to be established due to the occupancy of all radio resources.	Grade of Service (GoS) < 1 %
Error performance and availability	Availability of the system per subscriber considering propagation impairments and equipment failures, i.e. percentage of time during which the BER exceeds a threshold.	99,9 %

(continued)

Table 13 (concluded)

Attribute	Definition	Value (Target)
Service security	Covered by subclauses 5.5.1 and 5.5.2.	
Authentication	Covered by subclause 5.5.1.	
Mobility	Covered by clause 10.	
Service transparency	This includes all the transmission aspects that need to be equivalent or better to those of the fixed network See subclause 3.1. Additionally, service transparency means that all features available in fixed network need to be provided by the RLL system without shading: signalling, tones, delays, standard calling procedures. RLL systems need to be able to support fixed network modification like numbering plan.	
Emergency calls	Covered by Assignment of access priority in subclause 5.2.6 (note 3).	
NOTE 1: Delay for the CTA to send the dialling tone to the terminal. NOTE 2: Values given here are for outgoing calls. For incoming calls, an extra paging delay needs to be added for both transparent and non-transparent modes. NOTE 3: Two procedures need to be distinguished: - a user initiates an emergency call with a special dialling (e.g. fire department, police, ambulance, etc.). Then high priority is affected on a call per call basis only and submitted to recognition of the called number by the system. - in a emergency situation, the access service provider can decide to affect a high priority to all calls related to one user (a doctor for instance), for a limited duration. Here, the priority is affected to one person, regardless of called or calling numbers.		

5.6.2 Transmission attributes

All parameters mentioned in this subclause are dependent on the technology used. Therefore, the values given in table 14 should be taken as limits above which the system would not fit the fixed network requirements.

Table 14

Attribute	Definition	Value
Radio range supported	Radio range requested on a line of sight basis to fit RLL requirements regarding the different environments.	up to 5 km
CTA - TE max. distance supported		up to 1 km
CTA-power feed max. distance supported		up to 100 m
Battery stand-by	Minimum battery stand-by required by the RLL system to provide a minimum CTA autonomy.	30 min off-hook and 8 hours on-hook
Quantization distortion	Shading due to A/D-D/A conversions within the RLL system affecting in-band transmission.	3,5 QDU per access (note)
Unprotected Bit Error Ratio	Ratio of the number of bit errors to the total number of bits transmitted in a given time interval.	10^{-3}
NOTE: Except where precluded by leased line requirements.		

5.6.3 Service attributes from ETR 139, subclause 6.2

Table 15

ATTRIBUTE	VALUE
Traffic capacity (ETR 139 [10], subclause 6.2.1)	0,07 E (residential) 0,15 E (business).
Access network delay (ETR 139 [10], subclause 6.2.2)	Conform to ITU-T Recommendation G.114 [32] and meet ONP leased line requirements.
Grade of Service (ETR 139 [10], subclause 6.2.3)	< 1 % (derived from ITU-R Recommendation 757 [52]).
Error Performance and Availability (ETR 139 [10], subclause 6.2.4)	Conform to ITU-R Recommendations 697-1 [18] and 757 [52]. See also ITU-R Recommendations 755 [49] and 756 [51].
Service security (ETR 139 [10], subclause 6.2.5)	Covered by subclauses 5.5.1 and 5.5.2.
Authentication (ETR 139 [10], subclause 6.2.6)	Covered by subclause 5.5.1.
Mobility (ETR 139 [10], subclause 6.2.7)	Covered by clause 13.
Service Transparency (ETR 139 [10], subclause 6.2.8)	Transmission parameters: signal handling, frequency response, distortion, noise, loss, delay etc. See ITU-T Recommendation G.113 [31]. Much of this is covered within the main text. See also Other attributes, below.
Emergency Calls (ETR 139 [10], subclause 6.2.9)	Covered by Assignment of access priority in subclause 5.2.6.

5.6.4 Other attributes

Table 16

ATTRIBUTE	VALUE
Time to dial tone	150 ms (note 1).
Time to ring tone	500 ms.
Radio range supported	to 5 km.
CTA-TE max. distance supported	to 5 km.
Battery standby (ETR 139 [10], subclause 7.3)	30 min off hook and 8 hours on hook.
Quantization distortion	3,5 QDU per access (note 2).
NOTE 1: Total delay to dial tone, including RLL contribution. NOTE 2: Except where precluded by leased line requirements.	

6 Operation Administration and Maintenance (OA&M)

6.1 Introduction

OA&M is the term used to describe the way the access network is provided, administered and maintained by a network operator. Its purpose is to be able to provide a quick service to new customers economically and to manage and maintain the equipment in good working condition. RLL uses a mixture of copper and radio and therefore requires new procedures from the existing copper based network to manage and maintain the radio part of the access network.

The new procedures required are mainly concerned with new maintenance messages that need to be transported over the air interface between the radio PP and the CTA. This requires modification to the maintenance part of OA&M in order to provide specific alarms for essential equipment in the CTA and messages to convert the existing copper based test signals so that these signals can be replicated in the CTA.

A new procedure is required in the Administration part of OA&M for CTA subscription over the air. Messages will need to be defined for this in the ETS.

RAP specific issues are highlighted in the last part of this clause.

6.2 Operations

Operations include those activities that take place before service is provided to the user to maximize efficiency of the service both from the customers and the service providers viewpoints.

Planning the RLL network: this includes an estimate of the traffic generated, and the features, required by the subscribers. The radio connection will require new radio planning rules which will enable a prediction to be made of the optimum positioning of the base station to provide the best service coverage of the area and to minimize the interference to and from adjacent systems. Planning permission may be required before installation of the base station may proceed. The project management of the work in specifying what is to done and any contracts to be made with equipment providers and installers.

Installation: this includes the ordering of the equipment and all the site work involved in the installation, the field testing, and the acceptance testing and handover to the network operator.

Registration: the additional activity resulting from the radio link is the registration of the CTA's with the base station. This prevents unauthorized connection of a terminal via a CTA illegally introduced into the network. Registration may be completed over the air interface.

Future planning: in the post service period it is necessary to continue to monitor the traffic in the access network. It may increase sufficiently to reduce the grade of service offered to the customers to an unacceptable figure. Remedial action may be needed to restore it to the original level.

6.3 Administration

Administration is the centralization of the information on the RLL working conditions, including;

Configuration: it is necessary to keep an up to date record of the configuration of FP's, WRS's, CTA's within the operator’s network and any TE that is owned by the network operator.

Test management: the frequency and specification of tests need to be stored.

Performance management: it is necessary to obtain periodic results of performance tests particularly of the radio link. There can be a deterioration in the link performance due to the appearance of obstructions in the paths between the FP antenna and the antenna's associated with the CTA's. For instance buildings may be put up, trees may grow etc.. Other DECT systems not under the control of the RLL network operator may be installed giving rise to increased interference. The object of this approach is to be able to anticipate future problems before the customer has to complain.

Inventory of equipment: it is important to keep an up to date inventory of the equipment out in the field which includes the type and version number.

Subscription of CTA: this is a function that has to be associated with the nature of the radio system. The subscription data may be down loaded from the maintenance centre and will define the services to which the CTA is entitled. Certain information needs to be confidential.

6.4 Maintenance

Maintenance is the process of detecting faults or impairments in the access network and correcting the faults quickly, ideally before the customer has detected any fault.

Three parts of the wireless access system are discussed here, the FP, the WRS and the CTA.

6.4.1 Definitions

The Field Replaceable Unit (FRU) is defined as the lowest level of field replaceable equipment. Physical resources represent items of hardware which can be replaced in the field (FRUs) and also those which cannot, i.e. cables and racks. An FRU refers to separable physical components (or groups of components) which are capable of physical replacement as part of the network maintenance activities. A functional resource may be provided by one or more physical resources, or one or more functional resources may reside on one physical resource.

6.4.2 CTA

Physical resources of the CTA

The physical resources of the CTA are shown below:

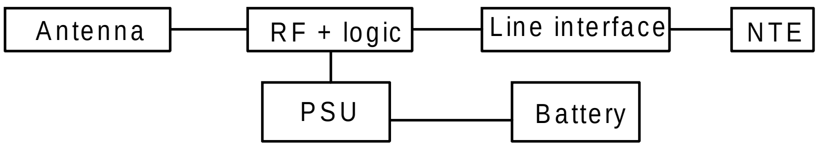


Figure 21: **CTA physical resources**

Physical resources within the CTA can be identified by the network management. The following minimum set of physical resources should be identified for the CTA:

- antenna;
- RF unit plus logic;
- line interface unit;
- power supply unit;
- backup battery;
- network terminating unit.

The messages transported over the air interface shall be able to distinguish between these physical resources.

Remote CTA tests

These tests enable the network management to request OA&M information from the CTA:

- detect network terminating unit;
- detect presence of telephone;
- check for leakage to earth;
- detect hazardous voltage;
- detect mains power at CTA;
- check for dial tone from exchange at CTA;
- link quality;
- RSSI;
- ring/ring trip;
- dialled digit test;
- number of failed remote call attempts made by CTA (statistics).

Air interface messages shall be defined that can be used by the FP to request the CTA for the above information and by the CTA to provide the above information to FP. This information is not provided automatically.

CTA alarm indications

These alarm indications shall be sent to a FP automatically to inform the network management that a significant system event has occurred or is about to occur which may seriously affect the system’s ability to function. A signal may be sent to indicate when the alarm condition has recovered. The following conditions are relevant:

- mains power failure;
- power supply unit failure;
- low battery voltage;
- opening of CTA enclosure;
- antenna failure.

Air interface messages shall be defined that can be used by the CTA to send alarms to the FP and by the FP to receive alarms from the CTA.

6.4.3 WRS

Physical Resources of the WRS

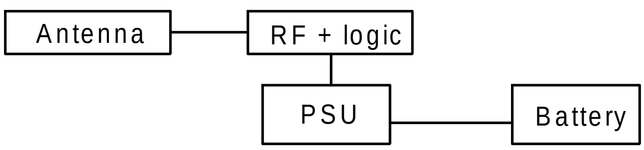


Figure 22: WRS physical resources

Physical resources within the WRS can be identified by the network management. The following minimum set of physical resources should be identified for the WRS:

- antenna;
- power supply unit;
- backup battery unit;
- radio unit plus logic.

Remote WRS tests

The network management should be able to activate specific tests in order to get OA&M information from the WRS. Here is a list of the most significant information that should be detected.

- detect mains power at WRS;
- check the serviceability of the WRS;
- check presence of WRS;
- link quality;
- RSSI.

Statistics

In order to estimate the performance and to discover potential problems, operational information should be collected by the WRS.

- number of failed call attempts to WRS;
- number of failed call attempts by WRS;
- number of call attempts per antenna;
- number of call attempts by WRS per frequency.

These statistics need to be accessed by the FP on request via the air interface.

WRS alarms

The following alarms or warnings shall be automatically provided to the network management. A signal may be sent to indicate when the condition has recovered:

- mains power failure;
- power supply unit failure;
- low battery voltage.

6.4.4 FP

Physical resources of the FP

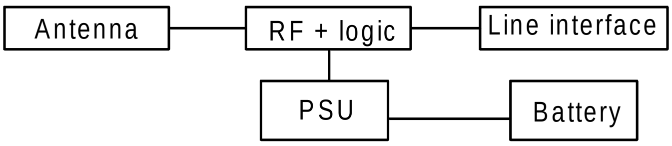


Figure 23: **FP physical resources**

Physical resources within the FP can be identified by the network management. The following minimum set of physical resources should be identified in the FP:

- antenna;
- RF unit plus logic;
- line interface unit (Copper, fibre or radio);
- power supply unit (either locally powered or line fed);
- backup battery.

FP alarms indications

These alarm indications shall be sent automatically to inform the network management that a significant system event has occurred or is about to occur which may seriously affect the system's ability to function. A signal also needs to be sent to indicate when the condition has recovered. The following events are relevant:

- RF failure;
- power supply unit failure;
- low battery voltage;
- opening of FP enclosure;
- antenna failure.

Remote FP tests

The FP can be connected to the LE by copper, fibre or radio, and the appropriate tests should be applied to check the connection between the LE and FP. The following tests are required to check the FP:

- RF power (monitor dummy bearer);
- electrical power to FP (either mains or battery feed from LE);
- DC power to FP.

6.4.5 Summary of RAP specific and other issues

The RAP specific issues cover the additional messages not detailed in the GAP. The majority of these issues concern the CTA.

Operations: planning of the RLL network requires radio planning rules for the positioning of the FP WRS's and the CTA's to be formulated so that the required grade of service can be achieved.

Administration: subscription/registration of the CTA is the new requirement for the Administration part of OA&M.

Maintenance Messages: new over the air messages need to be allocated in order to test the functions of the FP, WRS and CTA. Over the air messages are also required for alarms in the WRS and CTA.

FP: no over the air messages are required to test the functions of the FP.

WRS: new messages are required for the following test conditions to be sent from the LE:

- detection of mains power at WRS;
- checking the serviceability of the WRS;
- checking the presence of WRS.

New messages are required for the following alarms:

- mains power failure;
- power supply unit failure;
- low battery voltage.

Messages are also required for collecting the following statistics:

- number of failed call attempts to WRS;
- number of failed call attempts by WRS;
- number of call attempts per antenna;
- number of call attempts by WRS per frequency.

CTA: new messages are required for the following test conditions to be sent from the LE:

- detection of network terminating unit;
- detection of presence of telephone;
- checking for leakage to earth;
- detection of hazardous voltage;
- detection of mains power at CTA;
- checking for dial tone from exchange at CTA;
- checking Ring/ring trip;
- conducting dialled digit test;
- link quality;
- RSSI;
- collecting the number of failed remote call attempts made by CTA (statistics).

New messages are required for the following alarms:

- mains power failure;
- power supply unit failure;
- low battery voltage;
- opening of CTA enclosure.

7 Radio issues and traffic capacity requirements

Radio constraints and traffic requirements are the key considerations for designing any RLL system deployment. Possible configurations for RLL deployment vary greatly dependent upon many factors including: the propagation environment, the population density to be offered services and the distribution of that population, the expected penetration of the potential market, the range of services offered and the anticipated traffic per subscriber and the need to share radio frequency with other services. However, this clause illustrates the considerations in only two somewhat different scenarios - one representative of the rural, low density environment and one representative of the higher density urban environment and illustrates how DECT can address these scenarios.

It should be noted that effective radio ranges by using DECT in the RLL environment to serve subscribers through CTA rather than directly to portable DECT handsets are considerably greater than ranges expected in a DECT mobile mode because the signal path is more consistent, it can often be organized to be line of sight and the use of directional, antennae at the subscriber end of the link not only contributes antenna gain but also reduces the multi-path effects.

7.1 The rural environment

A rural environment may consist of a large area where few houses are spread out within a range of 10 km, sometimes grouped in small communities. The typical subscriber density within the area is 5 to 50 subscribers per km^2. The traffic per subscriber is estimated to 70 mE. Therefore, the traffic density is 0,35 E to 3,5 E per km^2.

The distribution of telephone subscribers in a typical rural community is far from uniform. For example, reference [53] indicates that in the UK, over 50 % of the subscribers reside within 1 km of the LE although a very small number lie between 10 and 15 km from the centre.

It is usual that the design of RLL systems to address such scenarios is more likely to be driven by the coverage range of the RLL system than by the traffic density.

7.1.1 DECT RLL in the rural environment - the question of range

With the DECT technology, in line of sight propagation conditions, ranges of up to 5 km are shown to be feasible using 12 dBi antennae at both ends of the link and with reasonable antenna heights, see ETR 310 [14]. A single hop WRS could extend this range by a further 5 km in a particular direction, therefore, bringing a very large proportion of the subscribers in the above scenario within range.

A DECT radio site will typically be supplied from the LE via one or two 2 Mbit/s links. These links will provide 30 to 60 trunks, which with 0,5 % blocking probability will support 19 E (271 subscribers) or 45 E (643 subscribers) average traffic per site. A small number of subscribers per radio site makes the total system cost per subscriber relatively expensive. Beyond a certain number of subscribers per site, the marginal system cost per additional subscriber will not further decrease much. It is estimated that this limit in many cases has been passed with 271 subscribers per DECT radio site, which makes such a site practical. ETR 310 [14] shows that with 19 E radio site, a range of 1 km will support 104 subscribers per km^2, and that a 5 km range will support 4 subscribers per km^2.

This indicates that DECT with suitable antenna site arrangements will support economic deployment of RLL systems for 5 - 50 subscribers per km^2, without need to stretch the 5 km range requirement.

Furthermore, advance timing of the CTAs, which allows up to 17 km range with maintained TDD guard space, has been introduced in the 2nd edition of ETS 300 175, parts 1 to 8 [1] to [8]. This feature was not available when ETR 139 [10] was published. Line of site ranges of 10 - 15 km are in principle possible to a CTA or to a pool of WRSs in a remote small village. This however requires higher antenna gain (larger antennas) and higher antenna installations. For example, traditional 2 GHz 2 Mbit/s radio links without equalizers provide reliable services over 15 - 20 km using typically 30 dBi antennas.

7.2 The urban environment

Urban scenarios can be even more varied . For example, the requirement might be the extension of an incumbent operators network to a new housing area or to a new town, or might be the for a new operator to offer service in an established town. The connection density typically ranges from 500 connections/km^2 in a villa area to 2 000 connections/km^2 in a residential area with 2 to 4 storey apartments. At 70 mE per connection this can give traffic densities of 35 - 140 E/km^2. In exceptional cases the highest residential traffic can reach 140 - 280 E/km^2 for 4 to 8 storey apartments. A business centre metropolitan area may have 10 000 employees per km^2. At 150 mE per employee, with some 60 % of that traffic being the market for a new telecommunications operator, the rest being internal PBX traffic. This could generate network traffic densities of 1 000 E/km^2 and assuming that some 10 % of this traffic would be carried by the new RLL operator, this implies some 100 - 150 E/km^2 should be supported by the RLL system. And this is only for voice traffic.

There is a world wide rapid growth of residential and office Internet subscriptions - 6 million in USA in 1995. It is foreseen that this growth will be such that data services will be a extensively used as speech within a few years. With new operators likely to focus on this new data traffic opportunity and with existing operators wired networks becoming fully loaded for today's speech traffic, we might expect to see a disproportionate amount of the new data traffic being carried by RLL based networks.

Therefore, we project that in the urban environment we may expect the following traffic per subscriber.

Table 17

Subscriber	Speech service only	Speech and emerging data service
Office worker	150 - 200 mE	300 - 400 mE
Resident	50 - 70 mE	100 - 400 mE

On this basis we predict that a RLL system could be called upon to address a traffic density of 200 - 300 E/km^2. In such environments, it would be expected that the design of the RLL system would be more likely to be driven by the traffic density requirements than by the range requirements - and this figure only represents about 10 % of the total telecommunications traffic in the urban area.

7.2.1 DECT in the urban environment - the question of traffic capacity

This traffic density represents a challenge to the system designer and simple single base stations are unlikely to meet the requirement effectively. ETR 310 [14] contains detailed information on the capacity for DECT RLL configurations with different sectorized and omni-directional antenna installations, and only a few of the conclusions from ETR 310 [14] are reproduced here. Economic deployment and efficient use of the spectrum often requires several RFPs to be concentrated at a single access site with multiple directional antennae, in a sectorized configuration. One practical implementation of such a DECT Access Site (DAS) is to have six sectors with one RFP per sector, each sector having about a 90 degree opening angle and 12 dBi antenna gain. The CTAs also have a 90 degree sector 12 dBi gain antenna.

One configuration considered within ETR 310 [14], is the regular arrangement of seven such DASs in a hexagonal pattern, synchronized, with cell sides (range) of 1 km, giving a linear separation between neighbouring DASs of 1,73 km and a service area per DAS of 2,6 km^2. The model assumes: roof top antennae and line of sight (or near line of sight) propagation conditions for 75 % of the CTAs and non line of site for 25 %, each subscriber's ability to see two RFP sectors (with reliability and trunking benefits), and with Poisson distributed traffic and multi-path Rayleigh fading. Typical DECT performance parameters are assumed of 24 dBm transmit power and -89 dBm receiver sensitivity are assumed. The total allocation of 20 MHz spectrum is assumed.

The simulation predicts a capacity per DAS of 40,2 E, at a Grade of Service of 1 %. This corresponds to a traffic density of 40,2/2,6 = 15,5 E/km^2. A development of the DAS which incorporates two RFPs per sector will increase the DASs capacity to 57,2 E, at the same Grade of Service, corresponding to a traffic density of 57,2/2,6 = 22 E/km^2. 57,2 E/DAS is the (interference limited) maximum sharable traffic in case of several RLL operators and 10 DECT carriers (20 MHz). 6 carriers (12 MHz) will support maximum 32 E/DAS and 12,3 E/km^2. Smaller site separation distances will increase the traffic densities. For example, with 500 m site separation (280 m range) and a local spectrum availability corresponding to 6 carriers, the traffic density will be about 150 E per km^2, as typically required in the urban environment.

NOTE: A 1 % Grade of Service has been assumed in these examples. ETR 310 [14] provides calculations for other GoS values.

The European initial DECT allocation 1 880 - 1 900 MHz provides 10 DECT carriers. The second edition of the DECT standard, ETS 300 175, parts 1 to 8 [1] to [8] have extended DECT carriers defined up to 1 937 MHz to insure interoperability also in extended DECT allocations, or in countries with other allocations than 1 880 - 1 900 MHz. Extension up to 1910 MHz will provide totally 16 carriers, and extension up to 1 920 MHz, 22 carriers.

In many countries and for many scenarios, depending on number of operators and other factors, the ETR 310 [14] indicates that the initial 1 880 - 1 900 MHz, will support reliable and economic deployment of DECT RLL systems effectively coexisting with other DECT applications.

It is recognized that there may be market conditions which favour extension of the spectrum available to DECT for public (RLL) services. Any justification for further spectrum allocation shall depend on the efficient use of the spectrum. Some dedicated RLL systems are typically allocated 10 - 30 MHz per operator. Compared with the allocation of two 20 MHz bands for two operators for RLL, ETR 310 [14] indicates that a shared allocation of 40 MHz for DECT could support at least four DECT RLL operators, a number of public street system operators and the traffic required by all DECT office and residential systems including anticipated emerging increase of data traffic.

ETR 310 [14] considers the interference potential between DECT RLL and the other DECT applications including residential, office, public Cordless Terminal Mobility (CTM) hot spots and street CTM. It concludes that the potential for interference from RLL to these services is low, that the interference on RLL from these services is low apart from public street CTM, which may interfere somewhat more. Mutual interference potential between two DECT RLL systems the same area is significant and these would benefit from synchronization.

7.3 Conclusions

There are many differing requirements for RLL system design. Two extreme examples have been discussed in this clause. For the rural situation, where the key design parameter is the coverage radio range of the radio link, most of the potential subscribers in rural communities can be can be addressed by DECT RLL. For the urban situation, the key design factor is the capacity of the DECT system and the allocated spectrum. Most of urban requirements can be served by DECT RLL without serious prejudice to other DECT services - but some scenarios might benefit from additional spectrum, for instance to serve anticipated emerging increase of data traffic. See ETR 310 [14] for further information.

8 Safety issues

8.1 Introduction

This clause highlights some of the safety issues which differ between the traditional use of DECT for in-building private systems and the use of DECT in RLL applications. It is stressed that safety matters do not fall within ETSI’s remit and for a full understanding of the safety matters associated with the RLL application, then standards published by bodies responsible for safety matters should be consulted, including those from CENELEC and national standardization organizations. Additionally, several ITU recommendations and the EC Directives address matters of safety of telephonic and other equipment.

8.2 Exposure limits to electromagnetic radiation

ETR 139 [10] gives references to an EC directive, CENELEC recommendations and to relevant national and European exposure limits defined in terms of average and local peak specific absorption rates. These references apply to both hand-held transmitters and to fixed transmitters and their antenna installations.

There are no different exposure considerations for the DECT handset when used for the RLL application from when it is used in traditional DECT applications and hence this is discussed no further in this ETR. In the FPs of a RLL network, to achieve the greater ranges and to take advantage of the fixed nature of the radio path, manufacturers and operators may make use of higher gain directional antennae, either on the exterior of the customers premises or at the other FPs of the network. The operator should ensure that customers, their own staff or members of the public in the vicinity of the system, especially near to the line of sight of directional antennae, are not subjected to radiation in excess of the CENELEC, EC or national limits. ETR 139 [10] indicates that even with transmitters of tens of watts, the required safety distance is typically less than 1 m to 2 m, and so, with the much lower power levels associated with DECT even when high gain antennae are employed, even shorter safety distances should be needed.

As the antennae within the FPs of the DECT RLL network are likely to be mounted well above ground level to avoid ground clutter and obstacles, and to deter tampering, it is suggested that these safety distances will be achieved in general without any special provisions.

8.3 Electrical safety

When a mains powered CTA is used in conjunction with a conventional wired terminal, consideration needs to be given to protecting the phone user from mains electrical hazard. However, it is felt that such safety issues are addressed by the EC Low Voltage directive. Within EU, compliance with this directive will be required of all equipment on customer premises or elsewhere where the operators staff will be working.

The operator should protect the wired parts of the network from mains voltages being applied under fault conditions. However, this issue is no different in the context of FPs being used for an RLL application from that used in other DECT applications.

8.4 Acoustic shock issues

Steps should be taken to avoid users being to subjected to acoustic shock when using the RLL system properly or improperly. Two specific potential hazards have been identified but the operator should ensure that any others are addressed either by network design or by specific equipment design.

The first issue concerns ringers in one piece telephones such as a DECT handset or fixed phones attached to a CTA, where the ringer function is provided through the telephone ear-piece. This is a particular hazard to children when pretending to make telephone calls holding the ear-piece closely acoustically coupled to their ear. DECT handsets have addressed the issues of acoustic shock, but the CTA needs to ensure that the hazard is adequately addressed when a fixed terminal of unknown type is attached. One particular issue is that the requirements of ring-trip (see subclause 5.2.4) are met under all conditions lest ringing continues after the handset has been lifted and placed to the ear.

The second issue concerns the high amplitude "howler tone" (see subclause 5.2.4) which is deliberately applied by the LE to alert customers that a handset has been left in the off-hook state. The CTA designer needs to ensure that any signal processing including ADPCM transcoding and muting will not result in acoustic shock when an improved telephone is attached.

8.5 Lightning safety

The equipment installer and the manufacturer will have to ensure that equipment intended for mounting on the exterior of customers premises or at other fixed sites within the RLL network is installed and designed so as not to present a hazard either to the user or to the operators own staff in the event of a lightning strike. ETR 139 [10] suggests that it is preferable if additional protection installation specific protection were not needed and suggests the use of safety barriers within the equipment. IEC 1000-4-5 [47] addresses the issue of lightning safety in the context of telephone networks.

9 Regulatory and licensing issues

It is the aim of this clause to identify those aspects of RLL systems which might be of concern to those International, European or National bodies responsible for regulatory matters. Most of the issues raised are not specific to DECT RLL systems as they also apply to other RLL technologies. Aspects both of telecommunications regulation and licensing and of spectrum management policy are highlighted. It is not suggested that every relevant regulatory issue is identified here - only those specific issues which derive from the use of RLL techniques. It is not intended to offer recommended solutions or approaches to the issues raised, as such matters are clearly beyond the competence of ETSI.

9.1 Mobility issues

According to ETR 139 [10], RLL systems provide only fixed service. However, the scope of the RLL systems considered by the current report is extended to include limited mobility services. In general, providers of mobile services have been subject to different regulatory and licensing regimes from providers of fixed services. It is apparent that some of the configurations discussed in clause 4 exhibit characteristics both of fixed services - where service is offered through a fixed CTA, for example - and mobile services - where service is offered directly to a portable handset.

Indeed many elements of the FPs of the RLL configuration pass traffic for fixed and mobile users indistinguishably. Regulatory bodies may wish to consider the need to reconcile the different regimes for fixed and mobile services in the context of RLL as part of a more general process of the convergence of fixed and mobile services. The case for Common Air Interfaces for supporting mobile services is well established and DECTs GAP profile would ensure that this was achieved for mobility in RLL applications. This is just an example of the convergence of fixed and mobile communications which is becoming known as "personal communications", and regulatory bodies are beginning to address such issues.

It is generally assumed in the current report and elsewhere that each CTA is installed in a fixed place and as such is clearly part of a fixed network, providing a fixed NTP on the customer’s premises. However, it is technically feasible for CTAs to be moved from location to location without any special action in the (fixed) network. Such moveability could offer advantages to operators but does challenge the accepted definition of fixed services. It is not inconceivable that CTAs could be designed which even more closely correspond to limited mobility system otherwise offered only to portable handsets.

9.2 NTP issues

The NTP delimits the responsibility of the Network Operator or service provider. The definition, interpretation and position of the NTP in the context of RLL may have widespread implications for regulators.

9.2.1 Physical, radio and virtual NTPs

With wireline networks the NTP is conventionally an tangible point typically an electrical connection. For services to domestic premises this is typically a telephone socket into which the customer may plug any approved TE; for multi-line services to business premises it usually takes the form of a junction box to which a PBX or Key-system is connected.

For many of the configurations illustrated in clause 4, the NTP corresponds directly to the conventional wired socket or junction box: this is a physical NTP. However, in other configurations the interface between the CPE and the network equipment is a common air interface similar in concept to that presented by mobile network operator. This is a radio NTP. In the view of some, the NTP can be a logical interface within a single equipment which is not capable of being accessed externally. This is a virtual NTP.

The rationale for recognizing a virtual NTP is illustrated by the configurations shown in figure 24.

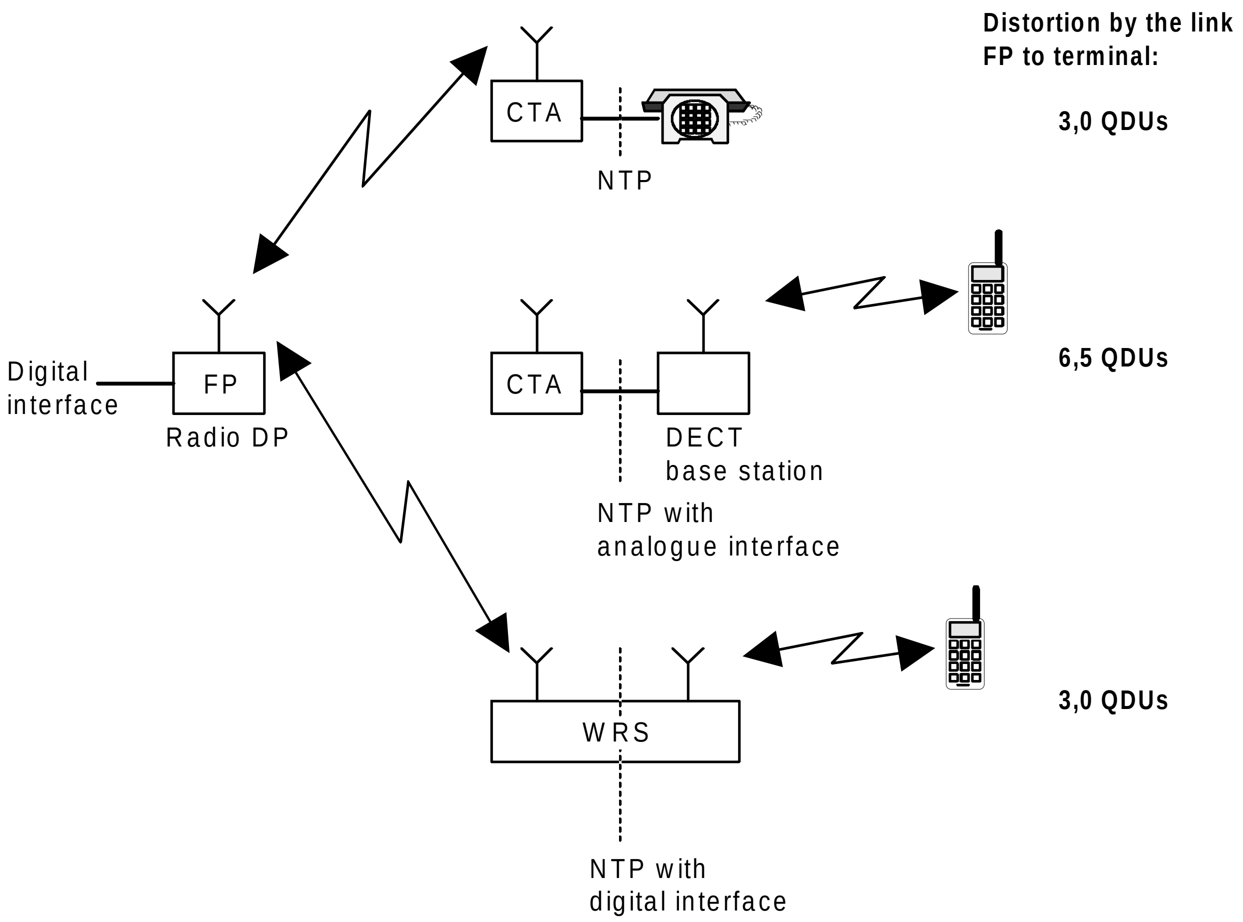


Figure 24: Virtual NTPs in RLL systems

In the top example, the customer is supplied with service at a conventional telephone socket. In the second example, the customer wishes to have some mobility in his home so he connects a DECT base station to that socket. In the bottom example, where the RLL service uses DECT air interface, the user obtains similar functionality as above, but enjoys substantially reduced quantization distortion by eliminating digital-analogue and analogue-digital conversions in tandem. In this case the two equipment's (CTA and DECT base station) are replaced by a single DECT radio implementation.

This is clearly a technically attractive configuration which could well offer some equipment economies, despite its regulatory complications. Some operators, who may be only permitted under their licences to offer fixed services, argue that, by analogy with the previous example, the NTP is conceptually within the WRS, as they accept responsibility for the radio link between the FP and the customer's premises but not for the radio link between the WRS and the customer's terminal. The concept of a inaccessible NTP within of a piece of equipment is novel. As the demarcation point between the responsibility of the operator and that of the customer, an inaccessible NTP within a piece of equipment provokes questions on responsibility for equipment fault diagnosis, maintenance and power supply. This configuration is beneficial to both operators and users by providing better speech quality than in the second example, but on the other hand it restricts the customer's choice of CPE.

9.2.2 Responsibility for maintenance of the radio path

The quality of the service enjoyed by the RLL customer will in all cases depend upon the robustness of the radio path. Where the NTP occurs on the customer side of the radio path, the responsibility for providing and sustaining the radio path as the environment changes is clearly the network operator's, but where the NTP is within the radio path or entirely on the Network side of the radio path, then the responsibility is unclear. The analogy with the responsibility of broadcast television suggests that the customer would have responsibility to ensure that he maintains good radio pathway, even when new buildings are constructed or trees grow to obstruct the path. A different analogy applies with cellular operators who are typically obliged to provide nominal signal strengths in outdoor locations within the coverage area - but have no obligation to provide adequate signals within the customers premises. It is not clear whether regulators will accept such a situation for essential telephony services.

9.2.3 Regulatory distinction between network equipment and TE

The role of the NTP, to partition a telephone system incorporating radio into its network parts and its terminal equipment parts may make a substantial difference to the regulations applicable to the system. This happens for at least two reasons: determining whether the system is within the scope of "RLL", and determining which EC Directives are to be applied.

RLL scope: comparing some of the diagrams in subclause 4.3 it can be seen that the determination of whether a configuration is considered RLL or not may well depend upon the position of the NTP. (For example, compare figure 2 with figure 17: only the former is classified as a RLL application. For a second example, compare figure 6 with figure 10: one could argue that the operator is offering a fixed service in the former but a mobile service in the latter.) The classification between these pairs of situations is not determined by the equipment involved which is the same. Clearly, the distinction is to do with the purpose for which the equipment is used and possibly the location where the equipment is installed. The issue is whether regulation is appropriate to distinguish between these situations, if so what regulation it is, and then how it is to be framed and applied.

Directives: in principle, the European Commission's telecommunications terminal equipment Directive 91/263/EEC [39] applies only to terminal equipment, and not to network equipment. Hence Common Technical Regulations, created under the TTE Directive, currently apply to terminal equipment parts of the RLL. However, in simple RLL applications, such as is shown in figure 2, the radio equipment is clearly part of the network and therefore not subject to the provisions of the Common Technical Regulations. However, it is understood that Regulators may wish to extend the scope of the CTRs to all radio aspects of DECT systems. In particular, this would mean that CTR 6 (radio) (derived from TBR 6 [43]), CTR 10 (telephony) (derived from TBR 10 [44]) and CTR 22 (GAP) (derived from TBR 22 [44] are not currently applicable to in these RLL cases and some action will be needed if the scope is to be extended.

The European Commission has elaborated a draft amendment of Directive 90/388/EEC on competition in the markets for telecommunications services. This draft Directive amendment defines DECT as an important alternative to the wired PSTN/ISDN network access. In addition, all Member States are to grant licences for public DECT systems. Furthermore any restrictions on the combination of DECT with other mobile technologies are to be withdrawn.

9.3 Data versus voice issues

An advanced RLL system using digital radio transmission can carry both voice and data traffic. In general, the regulation concerning data transmission is less stringent than the regulation concerning the carriage of voice. It is not clear whether these two regulatory regimes will unnecessarily restrict the field of applications in which RLL systems may be deployed.

9.4 Implications of additional concentration

Some implications of the additional concentration which inevitably occurs in an RLL network compared with a wired network have been discussed. Although the concentration groups can be small and although the point of concentration has been moved nearer to the customer than is the case with wired local loops, the network operator can make adequate compensation for this and can, in principle, achieve the desired GoS by including sufficient channels at each stage of the network - and radio access systems can offer a degree of path diversity not readily available in copper local loops.

The RLL operator has to plan his system installation so that the required Grade of Service is met. In case of DECT the spectrum will be totally or partly shared between public RLL operators and other DECT services. The shared spectrum has the advantage, due to the uneven local traffic share between operators, that in average the RLL operator has access to larger spectrum than if the available spectrum is split between operators. This leads in average to lower infrastructure cost and more efficient use of the spectrum. The concept of shared spectrum is rather new for public services. An RLL operator always has to monitor changes in the local traffic and GoS, in order to be able to meet emerging traffic increase by changing his infrastructure. When the spectrum is shared, this emerging traffic increase is not only due to his own traffic but may also be due to the traffic from other DECT systems. Enough spectrum has be allocated so that the gain in infrastructure cost due to shared spectrum is not lost due to increase in costs to solve local hot spot situations created by traffic from other systems. ETR 310 [14] shows the sharing conditions under which reliable and economic DECT RLL applications can be provided, depending mainly on total spectrum available and the number of operators.

Some RLL operators have proposed a lower overall Grade of Service than is normal for wired local loops, but continue to offer higher Grades of Service for certain lines (such as for doctors) or for certain call types (such as for emergency calls) by allocating resources on a priority basis during periods of congestion. This principle is unusual in wired telephony today, as there is little concentration before the LE but has parallels in history where domestic customers were often forced to use "party lines", for which lower tariffs applied. It is to be questioned to what extent such prioritization of access to the network is desirable.

9.5 Provision of emergency call service

There appear to be no requirements to make mandatory the provision of emergency calls or for giving emergency calls any priority over other traffic. No recommendation is made for changing this situation for DECT RLL.

9.6 Delay issues

For the local loop (as well as for the whole network), limits to transmission delays are normally set in order to ensure that, in a multioperator environment, performance is not affected by the introduction of excessive delays. DECT RLL introduces an extra 10 ms of frame delay (more when WRSs are employed). This may come into conflict with existing network regulation. Therefore, the implications of this extra delay need to be considered from a regulatory point of view. Today's CPE also have delay limits (5 ms in UK).

There are further delay considerations for some leased lines which are considered under subclause 9.9 below.

Consideration should be given to specifying a maximum number of WRSs that can be used in cascade but it is suggested that this might be left to the discretion of operators. It should be recognized that further WRSs could be used on customer’s premises within the TE and therefore, outside the control of the operator.

The current regulations on delay are based on the requirements of the wired local loop and do not consider the use of radio in the local loop. DECT contains mechanisms to compensate for the effect of the additional delays introduced by the radio link. The current delay regulations may need re-interpretation in the context of RLL.

9.7 Spectrum management Issues

There are several spectrum management issues, including, use of WRSs, the combination of services with different traffic characteristics and the sharing of spectrum between different DECT services. All rely for their co-existence on the DECT dynamic channel selection. The means and rules for reliable co-existence are covered in ETR 310 [14].

9.8 Power supplies and power back up

RLL services generally depend upon local mains electricity power supplies at several points in the network, but in particular in the customers home. Regulators concerned with the availability of the service, especially for emergency calls, will have to take account of the reliability of the local electricity power supplies and specify appropriate battery back-up arrangements to ensure adequate availability of the service.

A similar logic would require regulators to contemplate the requirement for minimum service durations of portable terminals where these are the principal means of delivering service to a customer’s premises, and perhaps of defining requirements to recharge this portable equipment during power outages perhaps by means of replacement batteries or through chargers with their own back-up supplies.

9.9 Applicability of ONP requirements for leased line provision to RLL systems

The ONP Directive, 92/44/EEC [19] requires leased line services with defined characteristics to be made available in each EU member state. The directive itself places no obligations on operators, but national authorities might require some or all operators to provide leased line services. As discussed in subclause 5.3, delay constraints for digital leased lines are incompatible with DECT timings and restrictions on the use of ADPCM in analogue leased lines cannot be complied with if DECT RLL is used at both ends of a leased line connection. Further, the only manner which other requirements for leased line connections can be provided is to leave one or more a radio channel permanently allocated for each leased line. Such an allocation is contrary to the spirit of DECT channel allocation.

Therefore, provision of leased lines would be almost impossible for operators wishing to offer service entirely via DECT RLL. It is for consideration of the regulators such operators might offer " virtual leased line" service (see subclause 5.5.2) instead. It is noted that special provisions have been made for satellite connections in some cases and perhaps the regulators could consider some relaxation in respect of services provided by RLL means.

10 Mobility in RLL

10.1 Introduction

The RLL system configurations presented in clause 4, include fixed subscriber units as well as portable subscriber units. In this clause we consider only the services provided by portable subscriber units.

In many cases there is interest for an operator to use the same DECT infrastructure for not only fixed but also mobile users in order to save costs. Based on this single infrastructure an operator can design its services, which may include different levels of mobility as described below, although some of them may not be considered as RLL.

Mobile communication systems can be divided with respect to mobility into two major categories:

- systems designed for high-tier mobility; and
- systems designed for low-tier mobility.

In the first category one could easily classify GSM, as this system has been designed with wide area coverage and the business nomadic user in mind who demands world-wide communication even at velocities in excess of 200 km/h. An example of low-tier mobility is the DECT system which has smaller cells and provides higher capacity but offers service over smaller areas to users who are not moving as fast.

The scope of this ETR excludes consideration of high-tier systems where they have their own integral networks.

Although it is not technically necessary, a common air interface is usually considered essential in a mobile service. This position is generally aligned with the views of operators and regulators.

10.2 Categories of mobility

Concentrating on low-tier mobility provision using DECT, we can further distinguish three cases:

- case 1: provision of Wide Area Mobility (WAM);
- case 2: provision of local mobility, or mobility in the neighbourhood; and
- case 3: provision of mobility restricted to a single radio cell.

This is illustrated in figure 25.

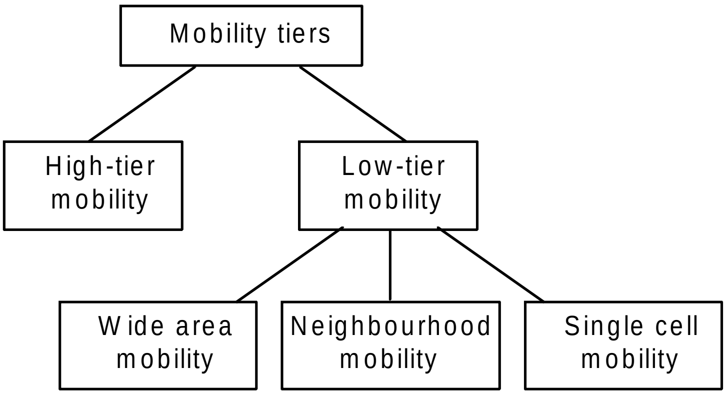


Figure 25: Classification of mobility

Case 1 refers to the two-way telepoint application and requires the collaboration of GSM Public Land Mobile Networks or Intelligent Networks (IN), such as CTM and the PSTN/ISDN, including the implementation of specific mobility functions in the core network with relevant signalling in the radio access network. It also requires the provision of full mobility management protocol in the RLL system. Users can move from town to town and still be able to make and receive calls.

In the case 2, the user is provided with service over a number of cells, but in a restricted geographical area covered by a single low-tier system, and in case 3 the user is provided with service only in one radio cell.

Case 1 is not a RLL application. Case 2 may be a RLL application. Case 3 always is.

10.3 Neighbourhood mobility

Neighbourhood mobility can be defined as the ability of a portable terminal to access telecommunication services while in a delimited area covering several cells (i.e. a cluster of cells covering a neighbourhood area). Neighbourhood mobility can therefore be considered as a terminal mobility service offered to RLL users equipped with hand portable units in the neighbourhood of a location (e.g. in the vicinity of the user's home) which can be pre-defined at service subscription.

Where a neighbourhood is defined by the technical construction of the local loop system, its boundaries might not coincide for all users with the boundaries which a service provider will wish to, or may be required to define.

Operators differ in their opinions on the market acceptability of Neighbourhood Mobility which is defined by technical construction and topology of the RLL network.

Some operators believe that the concept of mobility within a cluster of DECT cells can be made attractive. Such mobility requires no external mobility functions and falls within the scope of DECT RLL.

However, other operators believe that such a lack of homogeneity is not acceptable in their markets and insist that neighbourhood mobility needs to be implemented as a geographical restriction to an individual subscribers neighbourhood within a WAM system. Such operators note that amending the topology of the network for engineering or capacity reasons could impact the mobility area of customers and this too is felt to be unacceptable. Hence such operators assert that the definition of a neighbourhood as a cluster of cells in the DECT case is of limited use for local loop applications as the service offered to customers will appear different and falls outside the scope of this ETR. These operators argue that support of terminal mobility requires both implementation of specific mobility functions in the core network, relevant signalling across RLL/network interface (interface 1 in reference model) and provision of full mobility management protocols in the RLL system

10.4 Single-cell mobility

This is a service that provides a single-cell radio extension of the fixed access. This category of service requires no infrastructure support.

However, in this case, terminal relocation can also be provided as a service in the RLL system. This provides the user with the ability, from time to time, to re-locate and re-register with the system and obtain fixed services within a new cell. This service may be obtained if capabilities are provided to identify and address the appropriate terminal. This can be achieved with a DECT system by implementing at the FP some parts of the mobility management protocol of ETS 300 175-5 [5].

10.5 Support of Universal Personal Telecommunication (UPT)

UPT is a service which provides personal mobility, enabling a user to access telecommunication services without need to have a specific terminal. Otherwise stated, UPT is a service that offers a "universal" access to telecommunication networks. RLL systems, being specific access networks, should therefore provide capabilities to support UPT. In an RLL system connected to a network supporting personal mobility, the UPT user needs to be able to receive calls and be charged for the call he or she initiates.

History

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