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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 application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or I-ETS.

This ETR aims to provide an overall description of the Digital European Cordless Telecommunications (DECT) system in terms of interfacing to other networks.

The Annexes A - F are the chapters of the original document.

NOTE: This version of ETR 056 has been produced in electronic format from the originally published paper version. In case of discrepancies between this version and the original, the original approved version (available from the ETSI secretariat) takes precedence.

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1 Scope

This ETR describes DECT from a systems point of view and examines some of the issues associated with the interworking of DECT with a host network.

This ETR was drafted to provide assistance for those persons who want a better understanding of the DECT system and its architecture.

Emphasis has been placed on the special features of the DECT system, for example, the identity structures, the mobility management and supplementary services, along with recommendations for efficient interworking between DECT and PSTN, ISDN and GSM.

2 Definitions and abbreviations

2.1 Definitions

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

Antenna diversity: antenna diversity implies that the RFP for each bearer independently can select different antenna properties such as gain, polarisation, coverage patterns, and other features that may effect the practical coverage. A typical example is space diversity, provided by two vertically polarized antennas separated by 10 - 20 cm.

Attach: the process whereby a portable part within the coverage area of a fixed part to which it has access rights, notifies this fixed part that it is operative. The reverse process is detach, which reports the portable part as inoperative.

NOTE 1: An operative portable part is assumed to be ready to receive calls.

Authentication (of a subscriber): the process whereby a DECT subscriber is positively verified to be a legitimate user of a particular fixed part.

NOTE 2: Authentication is generally performed at call setup, but may also be done at any other time (e.g. during a call).

Bearer: see MAC Bearer or Bearer service.

Bearer Handover: the internal handover process provided by the MAC layer, whereby one MAC connection can modify its underlying bearers while maintaining the service provided to the DLC layer.

NOTE 3: Bearer handover is slot based.

Bearer Service: a type of telecommunication service that provides a defined capability for the transmission of signals between user-network interfaces.

NOTE 4: The DECT user-network interface corresponds to the top of the DECT Network layer (layer 3).

Broadcast: a simplex point-to-multipoint mode of transmission.

NOTE 5: The transmitter may disregard the presence or absence of receivers.

C-plane: the control plane of the DECT protocol stacks, which contains all of the internal DECT protocol control, but may also include some external user information.

NOTE 6: The C-plane stack always contains protocol entities up to and including the network layer.

Call: all of the NWK layer processes involved in one network layer peer-to-peer association.

NOTE 7: 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 feader) of one fixed part.

NOTE 8: A cell may include more than one source of radiated RF energy (i.e. more than one radio end point).

Central Control Fixed Part (CCFP): a physical grouping that contains the central elements of a fixed part. A fixed part contains a maximum of one CCFP.

NOTE 9: A CCFP controls one or more RFPs.

Centrex: an implementation of a private telecommunication network exchange that is not located on the premises of the private network operator. It may be co-located with, or physically a part of a public exchange.

Channel: see physical channel.

Cluster: a logical grouping of one or more cells between which bearer handover is possible. A Cluster Control Function (CCF) controls one cluster.

NOTE 10: Internal handover to a cell which is not part of the same cluster can only be done by connection handover.

Connection: see "MAC connection".

Connection Handover: the internal handover process provided by the DLC layer, whereby one set of DLC entities (C-plane and U-plane) can reroute data from one MAC connection to a second new MAC connection, while maintaining the service provided to the network layer.

NOTE 11: Connection handover is DLC frame based.

Connectionless Mode (C/L): a transmission mode that transfers one packet (one self contained unit) of data from one source point to one (or more) destination points in a single phase.

NOTE 12: Connectionless transmissions require the peer-to-peer associations to be prearranged, and the transmission is unacknowledged at that layer.

Connection Oriented Mode (C/O): a transmission mode that transfers data from one source point to one or more destination points using a protocol based on three phases: "Setup", "Data transfer" and "Release".

NOTE 13: Connection oriented mode requires no prearranged associations between peer entities (unlike C/L mode).

Coverage Area: the area over which reliable communication can be established and maintained.

DECT NetWork (DNW): a network that uses the DECT air interface to interconnect a local network to one or more portable applications. The logical boundaries of the DECT network are defined to be at the top of the DECT network layer.

NOTE 14: A DECT NetWork (DNW) is a logical grouping that contains one or more fixed radio terminations plus their associated portable radio termination. The boundaries of the DECT network are not physical boundaries.

DLC Broadcast: a simplex "connectionless" mode of transmission from the DLC broadcast entity of one fixed radio termination to the DLC broadcast entities in one or more portable radio terminations.

NOTE 15: The transmitter may disregard the presence or absence of receivers.

DLC Data Link (DLC LINK): an association between two DLC layer entities. This can either be one C-plane association or one U-plane association.

NOTE 16: This is not the same as a MAC connection.

DLC Frame: the format used to structure all messages that are exchanged between DLC layer peer entities.

NOTE 17: Different DLC frames are used in the C-plane and the U-plane, and there is more than one format of DLC frame in each plane.

Double-simplex bearer: the use of two simplex bearers operating in the same direction on two physical channels. These pairs of channels always use the same RF carrier and always use evenly spaced slots (i.e. separated by 0,5 TDMA frame).

A double-simplex bearer only exists as part of a multibearer MAC connection.

Down-link: transmission in the direction FT to PT.

Duplex Bearer: the use of two simplex bearers operating in opposite directions on two physical channels. These pairs of channels always use the same RF carrier and always use evenly spaced slots (i.e. separated by 0,5 TDMA frame).

End System (ES): a logical grouping that contains application processes and supports telecommunication services.

NOTE 18: From the OSI point of view, end systems are considered as sources and sinks of information.

External Handover: the process of switching a call in progress from one fixed radio termination to another fixed radio termination.

Field: a continuous region of data (i.e. adjacent bits) that jointly convey information. Typically, a message will contain several fields. If data is not continuous then it is defined as two (or more) fields.

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

NOTE 19: A DECT fixed part contains the logical elements of at least one fixed radio termination, plus additional implementation specific elements.

Fixed Radio Termination (FT): a logical group of functions that contains all of the DECT processes and procedures on the fixed side of the DECT air interface.

NOTE 20: A fixed radio termination only includes elements that are defined in ETS 300 175. This includes radio transmission elements (layer 1) together with a selection of layer 2 and layer 3 elements.

Flow Control: the mechanism that is used to regulate the flow of data between two peer entities.

Fragment: one of the service data units that is produced by the process of fragmentation.

NOTE 21: This is not the same as a segment.

Fragmentation: the process of dividing a protocol data unit into more than one service data unit for delivery to a lower layer. The reverse process is recombination.

NOTE 22: This is not the same as segmentation.

Frame: see TDMA frame or DLC frame.

Full Slot (Slot): one 24th of a TDMA frame which is used to support one physical channel.

Generic: a generalised set or general purpose set, often in the sense of basic or ordinary.

Geographically unique: this term relates to fixed part identities, PARIs and RFPIs. It indicates that two fixed parts with the same PARI, or respectively two RFPs with the same RFPI, can not be reached or listened to at the same geographical position.

NOTE 23: PARI stands for Primary Access Rights Identifier, RFPI stands for Radio Fixed Part Identifier.

Global NetWork (GNW): a telecommunication network capable of offering a long distance telecommunication service.

NOTE 24: The term does not include legal or regulatory aspects, nor does it indicate if the network is a public or a private network.

Globally unique identity: the identity is unique within DECT (without geographical or other restrictions).

Guard space: the nominal interval between the end of a radio transmission in a given slot, and the start of a radio transmission in the next successive slot.

NOTE 25: This interval is included at the end of every slot, in order to prevent adjacent transmissions from overlapping even when they originate with slightly different timing references (e.g. from different radio end points).

Half slot: one 48th of a TDMA frame which is used to support one physical channel.

Handover: the process of switching a call in progress from one physical channel to another physical channel. These processes can be internal (see internal handover) or external (see external handover).

NOTE 26: There are two physical forms of handover, intra-cell handover and inter-cell handover. Intra-cell handover is always internal, inter-cell handover can be internal or external.

Incoming call: a call received at a portable part.

Inter-cell handover: the switching of a call in progress from one cell to another cell.

Internal handover: handover processes that are completely internal to one fixed radio termination. Internal handover reconnects the call at the lower layers, while maintaining the call at the NWK layer.

NOTE 27: The lower layer reconnection can either be at the DLC layer (see connection handover) or at the MAC layer (see bearer handover).

Interoperability: the capability of fixed parts and portable parts, that enable a portable part to obtain access to teleservices in more than one location area and/or from more than one operator (more than one service provider).

Interoperator roaming: roaming between fixed part coverage areas of different operators (different service providers).

InterWorking Unit (IWU): a unit that is used to interconnect subnetworks.

NOTE 28: The IWU should contain the InterWorking Functions (IWF) necessary to support the required subnetwork interworking.

Intra-cell handover: the switching of a call in progress from one physical channel of one cell to another physical channel of the same cell.

Intraoperator roaming: roaming between different fixed part coverage areas of the same operator (same service provider).

Link: see DLC data link.

Local NetWork (LNW): a telecommunication network capable of offering local telecommunication services.

NOTE 29: The term does not include legal or regulatory aspects, nor does it indicate if the network is a public network or a private network.

Locally unique identity: the identity is unique within one FP or location area, depending on application.

Location area: the domain in which a portable part may receive (and/or make) calls as a result of a single location registration.

Location registration: the process whereby the position of a DECT portable termination is determined to the level of one location area, and this position is updated in one or more databases.

NOTE 30: These databases are not included within the DECT fixed radio termination.

Logical channel: a generic term for any distinct data path. Logical channels can be considered to operate between logical end points.

Lower Layer Management Entity (LLME): a management entity that spans a number of lower layers, and is used to describe all control activities which do not follow the rules of layering.

NOTE 31: The DECT LLME spans the network layer, the DLC layer, the MAC layer and the physical layer.

MAC Bearer (Bearer): MAC bearers are the service elements that are provided by each Cell Site Function (CSF). Each MAC bearer corresponds to a single service instance to the physical layer. See also simplex bearer, duplex bearer and double simplex bearer.

MAC connection (connection): an association between one source MAC multi-bearer control (MBC) entity and one destination MAC MBC entity. This provides a set of related MAC services (a set of logical channels), and it can involve one or more underlying MAC bearers.

Multiframe: a repeating sequence of 16 successive TDMA frames, that allows low rate or sporadic information to be multiplexed (e.g. basic system information or paging).

Network (telecommunication network): all the means of providing telecommunication services between a number of locations where the services are accessed via equipment attached to the network.

Node: a point at which switching occurs.

Operator (DECT operator): the individual or entity who or which is responsible for operation of one or more DECT fixed parts.

NOTE 32: The term does not imply any legal or regulatory conditions, nor does it imply any aspects of ownership.

Outgoing call: a call originating from a portable part.

Paging: the process of broadcasting a message from a DECT fixed part to one or more DECT portable parts.

NOTE 33: Different types of paging message are possible. For example, the {Request paging} message orders the recipient to respond with a call setup attempt.

Paging area: the domain in which the portable part will be paged as a part of incoming call establishment.

NOTE 34: In general, the paging area will be equal to the TPUI domain, since the TPUI is used for paging.

Phase: one discrete part of a procedure, where the start and end of the part can be clearly identified (e.g. by the arrival or dispatch of a primitive).

Physical channel (channel): the simplex channel that is created by transmitting in one particular slot on one particular RF channel in successive TDMA frames. See also simplex bearer.

NOTE 35: One physical channel provides a simplex service. Two physical channels are required to provide a duplex service.

Portable Application (PA): a logical grouping that contains all the elements that lie beyond the DECT network boundary on the portable side.

NOTE 36: The functions contained in the portable application may be physically distributed, but any such distribution is invisible to the DECT network.

Portable HandSet (PHS): a single physical grouping that contains all of the portable elements that are needed to provide a teleservice to the user.

NOTE 37: PHS is a subset of all possible portable parts. This subset includes all physical groupings that combine one portable radio termination plus at least one portable application in a single physical box.

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

NOTE 38: A DECT portable part is logically divided into one portable termination plus one or more portable applications.

Portable radio Termination (PT): a logical group of functions that contains all of the DECT processes and procedures on the portable side of the DECT air interface.

NOTE 39: A portable radio termination only includes elements that are defined in ETS 300 175. This includes radio transmission elements (layer 1) together with a selection of layer 2 and layer 3 elements.

Primitive: a distinct (but abstract) data element that is passed between adjacent protocol layers.

NOTE 40: A service primitive contains one SDU.

Private: an attribute indicating that the application of the so qualified term, e.g. a network, an equipment, a service, is offered to, or is in the interest, of a determined set of users.

NOTE 41: The term does not include any legal or regulatory aspects, nor does it indicate any aspects of ownership.

Public: an attribute indicating that the application of the so qualified term, e.g. a network, an equipment, a service, is offered to, or is in the interest of, the general public.

NOTE 42: The term does not include any legal or regulatory aspects, nor does it indicate any aspects of ownership.

Public Access Profile (PAP): a defined part of ETS 300 175 that ensures interoperability between FPs and PPs for public access services.

Public access service: a service that provides access to a public network for the general public.

NOTE 43: The term does not imply any legal or regulatory aspect, nor does it imply any aspects of ownership.

Radio channel: no defined meaning. See RF channel or physical channel.

Radio End Point (REP): a physical grouping that contains one radio transceiver (transmitter/receiver), fixed or portable.

NOTE 44: A REP may operate only as a receiver or only as a transmitter.

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

Registration: an ambiguous term, that should always be qualified. See either location registration or subscription registration.

RF carrier (carrier): the centre frequency occupied by one DECT transmission.

RF channel: the nominal range of frequencies (RF spectrum) allocated to the DECT transmissions of a single RF carrier.

Roaming: the movement of a portable part from one fixed part coverage area to another fixed part coverage area, where the capabilities of the fixed parts enable the portable part to make or receive calls in both areas.

NOTE 45: Roaming requires the relevant FPs and PPs to be interoperable.

Roaming service: a service which can be used in more than one fixed part coverage area.

Segment: one of the pieces of data that is produced by the process of segmentation.

NOTE 46: In general, one segment only represents a portion of a complete message.

Segmentation: the process of partitioning one Service Data Unit (SDU) from a higher layer into more than one Protocol Data Unit (PDU). The reverse process is assembly.

Service provider (telecommunications service provider): the individual or entity who or which interfaces to the customer in providing telecommunications service.

NOTE 47: The term does not imply any legal or regulatory conditions, nor does it indicate whether public service or private service is provided.

NOTE 48: The term service provider is also used with a different meaning in the ISO/OSI layered model.

Sequencing (Sequence Numbering): the process of adding a sequence number to a set of data packets so that the packets can be reassembled in the correct order, regardless of the order they are received. See also segmentation.

Simplex bearer: a simplex bearer is the MAC layer service that is created using one physical channel. See also duplex bearer and double simplex bearer.

Single Radio Fixed Part (SRFP): a radio fixed part that contains only one REP.

NOTE 49: The SRFP is defined for DECT system analysis. Unless otherwise stated, a SRFP is assumed to support multiple calls, and is limited only by the capacity of its single radio end point.

Subscriber (customer): the natural person or the juristic person who has subscribed to telecommunication services, and is therefore responsible for payment.

Subscription registration: the infrequent process whereby a subscriber obtains access rights to one or more fixed parts.

NOTE 50: Subscription registration is usually required before a user can make or receive calls.

Supplementary service: a service that modifies or supplements a basic telecommunication service.

NOTE 51: Three functional groups of supplementary services are defined for DECT:

1) DECT TRANSPARENT supplementary services

   - the service elements are unspecified within the DECT standard;

2) DECT STANDARD supplementary services

   - the service elements are specified within the DECT standard, by reference to other standards;

3) DECT SPECIFIC supplementary services

   - the service elements are fully specified within the DECT standard.

Switching: the process of interconnecting functional units, transmission channels or telecommunication circuits for as long as required to convey signals.

TDMA frame: a time-division multiplex of 10 msec duration, containing 24 successive full slots. A TDMA frame starts with the first bit period of full slot 0 and ends with the last bit period of full slot 23.

Telecommunication: any transmission and/or emission and/or reception of signals representing signs, writing, images, and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems.

Teleservice: a type of telecommunication service that provides the complete capability, including terminal equipment functions, for communication between users, according to protocols that are established by agreement.

TPUI domain: the domain over which every TPUI is (locally) unique.

NOTE 52: In general, the TPUI domain will be equal to the paging area and thereby equal to the location area.

U-plane: the user plane of the DECT protocol stacks. This plane contains most of the end-to-end (external) user information and user control.

NOTE 53: The U-plane protocols do not include any internal DECT protocol control, and it may be null at the Network layer and at the DLC layers for some services.

Up link: transmission in the direction PT to FT.

User (of a telecommunication network): a person or machine delegated by a subscriber (by a customer) to use the services and/or facilities of a telecommunication network.

2.2 Abbreviations

For the purposes of this ETR the following abbreviations apply.

AC	Authentication Code
ACP	Adjacent Channel Power. The transmitted power that spills over into an adjacent RF channel
ACK	ACKnowledgement
ADPCM	Adaptive Differential Pulse Code Modulation
ARC	Access Rights Class, shows the type of access to a DECT network, such as public, residential or private
ARD	Access Rights Details, is a unique number within one ARC
ARI	Access Rights Identity is, to a service provider, a globally unique identity that shows the access rights related to that service provider. The ARI consists of an ARC and an ARD. There are three categories of ARIs: - PARI (Primary ARI); - SARI (Secondary ARI); - TARI (Tertiary ARI).
ARQ	Automatic Repeat ReQuest. The process of automatically requesting a retransmission of data that is received in error
BCD	Binary Coded Decimal
BMC	Broadcast Message Control. A MAC layer functional grouping
CBC	Connectionless Bearer Control. A MAC layer functional grouping
CC	Call Control. A NWK layer functional grouping
CCF	Cluster Control Function. A MAC layer functional grouping
CCFP	Central Control Fixed Part. See definitions
CCITT	(The) International Telegraph and Telephone Consultative Committee
CEP	Connection End Point. A logical reference point between peers
CEPT	Conference of European Posts and Telecommunications
CI	Common Interface (standard)
CK	Cipher Key
CODEC	COder-DECoder
CLMS	ConnectionLess Message Service. A NWK layer functional grouping
CMC	Connectionless Message Control. A MAC layer functional grouping
COMS	Connection Oriented Message Service. A NWK layer functional grouping
CRC	Cyclic Redundancy Check. A cyclically generated field of parity bits
CSF	Cell Site Function. A MAC layer functional grouping
CSPDN	Circuit Switched Public Data Network
CX	Co-eXistence standard
C-PLANE	Control PLANE. See definitions
C/L	ConnectionLess mode. See definitions
C/O	Connection Orientated mode. See definitions
DAM	DECT Authentication Module
DBC	Dummy Bearer Control. A MAC layer functional grouping
dBc	dB relative to the peak power of an unmodulated carrier
dBm	dB relative to 1 milliwatt
DCK	Derived Cipher Key
DECT	Digital European Cordless Telecommunications
DLC	Data Link Control. Layer 2b of the DECT protocol stack
DLEI	Data Link Endpoint Identifier (DLC layer)
DLI	Data Link identifier (DLC layer)
DNW	DECT NetWork. See definitions
DSAA	DECT Standard Authentication Algorithm
DSC	DECT Standard Cipher
ERP	Effective Radiated Power
ES	End System
FMID	Fixed Part MAC Identity. (MAC layer)
FP	Fixed Part. See definitions

FT	Fixed radio Termination. See definitions
GFSK	Gaussian Frequency Shift Keying
GNW	Global NetWork. See definitions
HDB	Home Data Base
IA5	International Alphabet No.5 (defined by CCITT)
IFEI	International Fixed Equipment Identity
IPEI	International Portable Equipment Identity
IPUI	International Portable User Identity. The IPUI is an identity that uniquely defines one user within the domain defined by his Access Rights as related to this IPUI. The IPUI consists of a PUT and a PUN. The IPUI may be locally unique or globally unique depending on type of PUT
IRC	Idle Receiver Control. A MAC layer functional grouping
ISDN	Integrated Services Digital Network
IWF	InterWorking Functions
IWU	InterWorking Unit. See definitions
K	authentication Key
KS	PP authentication Session Key
KS'	FP authentication Session Key
KSG	Key Stream Generator
KSS	Key Stream Segment
LAPC	a DLC layer C-plane protocol entity
LAN	Local Area Network
LBN	Logical Bearer Number. (MAC layer)
LCE	Link Control Entity. A NWK layer functional grouping
LCN	Logical Connection Number. (DLC/MAC layer)
LLME	Lower Layer Management Entity. See definitions
LLN	Logical Link Number. (DLC layer)
LNW	Local NetWork. See definitions
MAC	Medium Access Control. Layer 2a of the DECT protocol stack
MBC	Multiple Bearer Control. A MAC layer functional grouping
MCEI	MAC Connection Endpoint Identification
MM	Mobility Management. A NWK layer functional grouping
MUX	time MUltipleXor
NWK	NetWorK. Layer 3 of the DECT protocol stack
OSI	Open Systems Interconnection
PA	Portable Application. See definitions
PARI	Primary Access Rights Identity. The PARI is the most frequently transmitted ARI. Every DECT RFP must transmit a PARI
PARK	Portable Access Rights Key, states the access rights for a PP
PARK{y}	PARK with value y for it's Park length indicator
PBX(PABX)	Private Automatic Branch Exchange
PCI	Protocol Control Information
PDU	Protocol Data Unit
PHL	PHysical; Layer 1 of the DECT protocol stack
PHS	Portable HandSet. See definitions
PLI	Park Length Indicator. The PLI associates a group of FP ARIs to the PARK, by indicating how many of the first ARC + ARD bits are relevant. The remaining bits have don't care status. The PLI is programmed into a PP as part of the subscription process
PMID	Portable part MAC IDentity. (MAC layer)
POT(S)	Plain Old Telephone (Service). The basic analogue telephony teleservice
PP	Portable Part. See definitions
PSPDN	Packet Switched Public Data Network
PSTN	Public Switched Telephone Network
PT	Portable radio Termination. See definitions
PTN	Private Telecommunication Network
PUN	Portable User Number. The PUN is a globally or locally unique number within one PUT
PUT	Portable User Type. The PUT shows the numbering plan structure of a PUN
RAND_F	a RANDom challenge issued by a FT
RAND_P	a RANDom challenge issued by a PT
REP	Radio End Point. See definitions
RES1	a RESponse calculated by a PT

RES2	a RESponse calculated by an FT
RF	Radio Frequency
RFP	Radio Fixed Part. See definitions
RFPI	Radio Fixed Part Identity. Every RFP frequently transmits this identity, that is geographically unique. The RFPI shows: - PARI; - the RFPs local identity within that fixed part; - domains for handover and location areas.
RPN	Radio fixed Part Number
RS	A value used to establish authentication session keys
RSSI	Radio Signal Strength Indicator. A quantitative measure of the RF signal strength of one RF channel
SAP	Service Access Point. A logical reference point between layers
SARI	Secondary Access Rights Identity. The SARI is less frequently broadcast than the PARI
SCK	Static Cipher Key
SDU	Service Data Unit
SS	Supplementary Services. A NWK layer functional grouping
TARI	Tertiary Access Rights Identity. The TARI is not broadcast at all and is only available as a yes/no answer upon a request that includes the wanted ARI
TBC	Traffic Bearer Control. A MAC layer functional grouping
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TI	Transaction Identifier. (NWK layer)
TPUI	Temporary Portable User Identity
UAK	User Authentication Key
UPI	User Personal Identification
U-PLANE	User PLANE. See definitions
VDB	Visitors Data Base
XRES1	an eXpected RESponse calculated by a FT
XRES2	an eXpected RESponse calculated by a PT

Annex A: DECT reference model

This Annex contains Chapter 3 of the DECT System description document, and consists of pages numbered 3.1 to 3.17 (i.e. 17 pages).

Chapter 3

DECT Reference Model

3.0 Version History

Version 00.00 1990-01-15 First release to RES-3N

Version 01.00 1990-02-26 Second release to RES-3N, first release to RES-3

General Reference Model changed to Reference Model
Target Network Reference Models changed to Target Network Reference Configurations
End/Intermediate System changed to End System
Reference points alpha, beta, gamma and delta changed to D1, D2, D3 and D4
No Interworking Units in Reference Model
Protocol Stacks moved to Protocol Architecture chapter
The Reference Point Matrices removed

Version 02.00 1990-03-22 Third release to RES-3N,

GSM defined as a Extended Services network instead of a Global network
Addition of Open Access Service Reference Model

Version 03.00 1990-04-25 Fourth release to RES-3N

DECT Cordless System renamed DECT Portable Termination
Examples enclosed in Reference Configurations
Cordless S-bus Reference Configuration
X.25 PAD Reference Configuration
LAN Station Reference Configuration changed to a LAN Bridge

Version 04.00 1990-05-03 Second release to RES-3

Open Access Service Reference Model revised

Version 05.00 1990-09-27 Third release to RES-3

Restructuring of contents
New definitions introduced
Open Access Service Reference Model replaced with Telepoint Reference Configurations

Version 05.01 1991-03-11 Fifth release to RES-3N, fourth release to RES-3

Increased explanatory text to and renumbering of the target network reference configurations
X.25 reference configurations slightly changed.

Version 05.02 1991-04-18 Sixth release to RES-3N

Minor editorial changes

Version 06.00 1991-05-28 Fifth release to RES-3

Alignment to chapter 4 and 7 of DECT System Description Document
End System changed to Portable Application
Alignment of the reference points to physical boundaries deleted, and reference configuration figures changed accordingly
Telepoint reference configuration deleted

Version 06.01 1991-09-25 Seventh release to RES-3N

Adjustment of reference points/interfaces in reference configuration figures 3.6 - 3.16

3.1 The Reference Model

The DECT Reference Model defines the relations and reference points within the DECT Network and with attached networks. The Reference Model describes these networks in both a logical and a physical domain.

The logical and physical groupings in the reference model are defined in chapter 2 of the DECT System Description Document. In this chapter they are further described and exemplified.

Each logical grouping in the DECT Reference Model is divided by reference points, as described in figure 3.1. Reference point D3 always corresponds to a physical boundary. Reference points D2 and D4 can never align to physical boundaries, they have been defined to clearly indicate the logical boundaries of the DECT Network. Reference point D1 may correspond to a physical boundary.

The reference model describes the whole network architecture, in which the DECT Network exists, as a tree structure. This is to show that each logically higher grouping can communicate with a multiple of logically lower groupings, and that groupings on the same logical level cannot communicate directly, but only via a logically higher grouping.

In the reference configurations this multiple relation is not shown. For simplicity reasons only one branch of the reference model tree is described. In each reference configuration an example of a possible implementation is included.

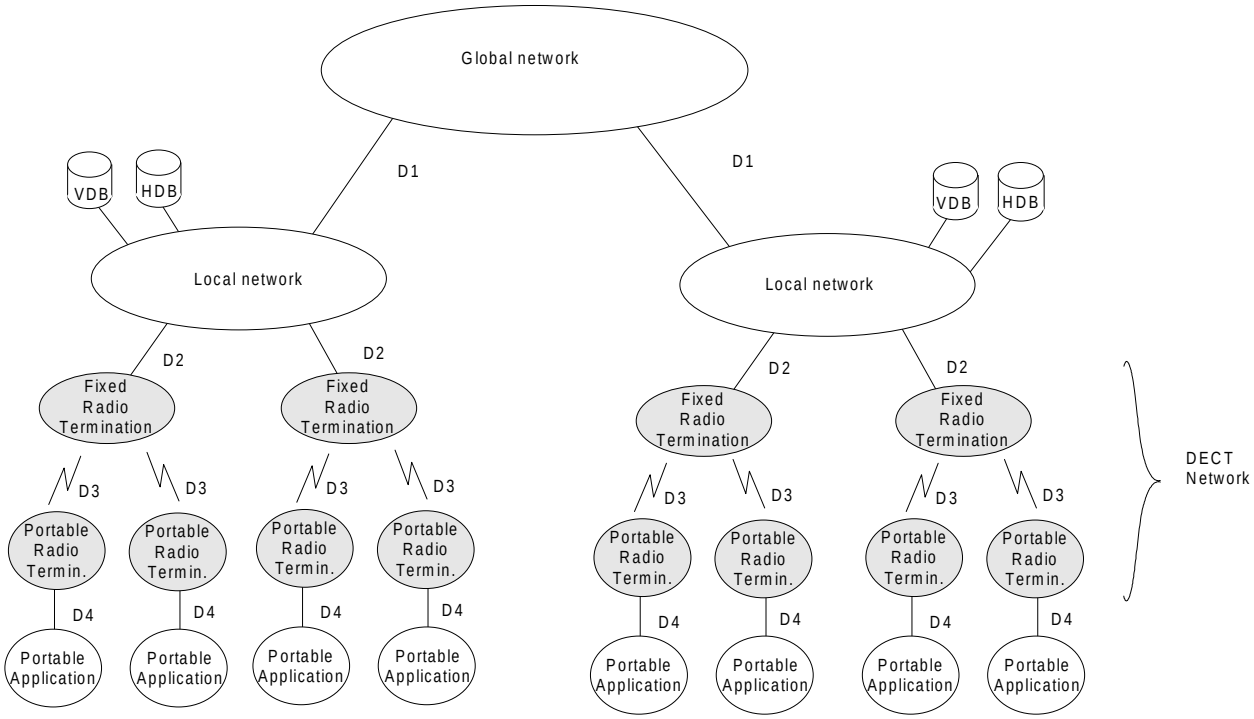

Figure 3.1 DECT Reference Model; Logical groupings

3.2 Logical Groupings

3.2.1 Global Network

The Global Network (GNW) is a logical grouping that supports a long distance telecommunication service as well as address translation, routing and relaying between connected Local Networks. It has typically national or international extent.

The primary target Global Networks are

I) PSTN,
ii) ISDN,
iii) X.25 PSPDN and
iv) GSM PLMN

3.2.2 Local Network

The Local Network (LNW) supports a local telecommunication service. Typically, such a network is local in extent.

The characteristics of the Local Network may, depending on its actual implementation, vary from eg a multiplexer to highly sophisticated networks like a PTN (Private Telecommunication Network).

Since the DECT Fixed Radio Termination does not include switching (see 3.2.3) such functions must be located in the Local Network. It is in this context important to remember that both these groupings are defined in the logical domain.

Services supported by the Global Network and the Local Network may differ in range and performance.

The Local Network is responsible for the translation of Global Network identities (eg PSTN and ISDN numbers) to DECT-specific identities (eg IPUIs and TPUIs).

Two Local Networks are separate if address translation is required to allow communication between them.

The primary target Local Networks are

I) analogue and digital PBXs,
ii) ISPBXs and
iii) IEEE 802 LANs.

3.2.3 Databases

All network mobility functional entities must be external to DECT, either in the Local Network or in the Global Network. Two logical groupings that are needed in inter-DECT Network mobility are the Home Data Base (HDB) and the Visitor Data Base (VDB). They are also described in chapter six of the DECT System Description Document (Mobility Functions).

The Home Data Base is a logical grouping in charge of the management of subscribers. Two kinds of information is stored there, namely

- subscription information for charging and billing purposes and other subscriber parameters like service profile etc, and
- location information, which enables the routing of calls from the home Local Network to the visited Local Network.

The relation between identities of the DECT user or PP is also stored in the HDB. The identity structure in DECT is described in chapter five of the DECT System Description Document (Identities and Addressing).

The Visitor Data Base manages visiting subscribers or PPs. When a "visitor" enters a Local Network a registration- and location updating process may be initiated, which enables the VDB to offer services according to the visitor's service profile, and the HDB to rout incoming calls to the right Local Network.

Note These definitions are intended for general guidance. Particular applications (eg GSM) may differ in the partitioning of these functions.

3.2.4 DECT Network

The DECT Network interconnects the Local Network and the Portable Application. It can be considered as a cordless intervention between these attached networks. It contains by definition no application processes. One DECT Network has only one network address for each user or equipment.

The DECT Network contains (in the logical domain) one or more Fixed Radio Terminations (FT) and their associated Portable Radio Terminations (PT).

3.2.5 Fixed Radio Termination

The Fixed Radio Termination (FT) is a logical grouping that contains all functions and procedures on the fixed side of the DECT air interface, which are defined in the CI specification. FT is responsible for handling eg

I) layer three protocol handling in the C-(Control) plane, (except mobility),
ii) layer two protocol handling in the U-(User) plane,
iii) layer two routing and relaying within the DECT network

The Fixed Radio Termination contains no switching functional entities, except those required for handover and multiple calls. Multiple instances of calls can exist, but can't be connected together. This means that it will not be able to handle a connection between two Portable Radio Terminations (eg handsets) within the DECT Network. All switching functions must be performed outside the logical boundaries of the Fixed Radio Termination. Figure 3.2 shows one Fixed Radio Termination handling two instances of calls. The logical groupings beyond the D2 reference point are not shown.

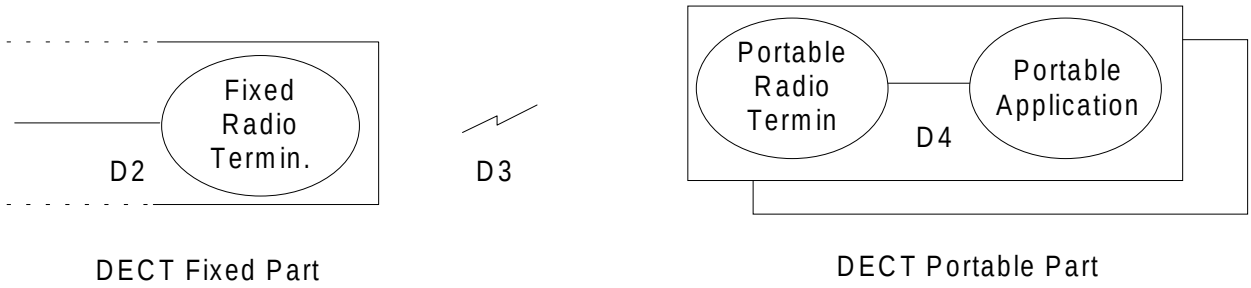

Figure 3.2 Logical groupings in the DECT Portable Part and in the DECT Fixed Part

3.2.6 Portable Radio Termination

The Portable Radio Termination is the portable radio transmission termination, ie the portable part of the DECT Network in the logical domain. It includes all protocol elements that are defined for OSI layers 1, 2 and 3 of the CI specification.

3.2.7 Portable Application

The Portable Application (PA) is a logical grouping that contains everything beyond the DECT Network boundary on the portable side.

Note The functions contained in the Portable Application may be physically distributed, but any such distribution is invisible to DECT.

3.2.8 DECT Interworking

The connection of the DECT Network and the Local Network on the fixed side and the Portable Application on the portable side will in general require some kind of interworking. The CI specification will specify messages and procedures which support this interworking. It will not specify the Interworking Units that include these functions, or even the location of such entities. Both the units and their location will be matters for implementations and specific system requirements.

The interworking functions will logically take place on the boundaries of the DECT Network, at the D2 and D4 reference points. The interworking functions are described in the DECT Reference Model as in figure 3.3. This model does not attempt to describe the position of these functions more precisely.

DECT interworking is further described in chapter 7 of the DECT System Description Document.

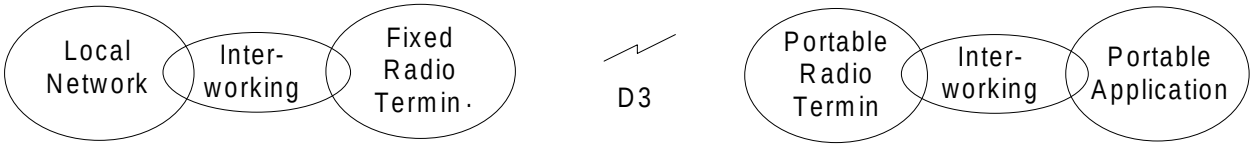

Figure 3.3 DECT Interworking

3.3 Physical Groupings

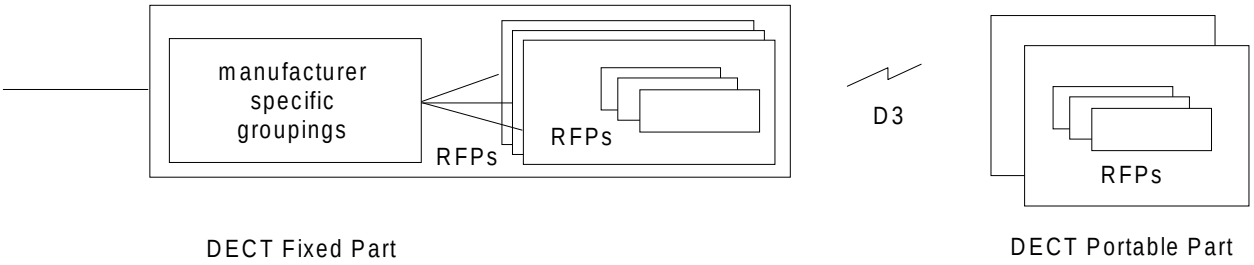

Figure 3.4 Physical groupings in the DECT Portable Parts and in the DECT Fixed Part

3.3.1 DECT Fixed Part

DECT is physically divided into two parts; a DECT Fixed Part (FP) and a DECT Portable Part (PP).

The only logical grouping in the DECT Fixed Part , relevant to the CI specification, is the Fixed Radio Termination, as described in paragraph 3.2.3. The DECT Fixed Part may include more than one Fixed Radio Termination.

The DECT Fixed Part contains two types of physical groupings: Radio Fixed Part (RFP) and Radio End Point (REP). A Fixed Part may include more than one Radio Fixed Part, and each Radio Fixed Part includes all the Radio End Points connected to one single antennae system.

Each Radio Fixed Part corresponds to one cell site, and each Radio End Point corresponds to one radio transceiver.

3.3.2 DECT Portable Part

The DECT Portable Part is a physical grouping that contains both DECT logical groupings (Portable Radio Termination) and non-DECT groupings (Portable Application), ie all elements between the DECT air interface and the user.

In the physical domain the DECT Portable Part includes typically one Radio End Point, but multiple Radio End Points are allowed.

The DECT Portable Part can be realised as one single physical entity, able to offer a teleservice to the user: a Portable Handset (PHS).

3.4 Reference Configurations

A number of DECT primary target networks have been identified. These are networks, to which the DECT Network primarily is specified to be connected. In paragraph 3.4 a number of reference configurations for these target networks are described. The reference configurations are conceptual configurations, used to identify and describe different access arrangements of the DECT Network to the target networks (PSTN, ISDN, X.25, IEEE 802 LAN and GSM).

The reference configurations serve to describe how the DECT Reference Model is related to the reference model of each network. Each configuration consists of three box-chains. The uppermost box-chain describes the reference model of the target network. Below is a box-chain which describes the DECT reference model. The mapping of these box-chains is based on the reference points. Since the reference points define the boundaries of the functional groupings, the groupings of DECT will have a well-defined relation to the groupings of the target network in each configuration. However, the target network reference points may only be subsets of the mapped DECT reference points, ie apart from the services defined for the target network reference points, other services and information may also be transferred over the DECT reference points.

DECT can be configured in one target network in a number of ways, ie the reference points of the target network can be offered at different reference points of DECT. This means that for different configurations in one target network, the DECT groupings will have different relations to the groupings of the target network.

The lowest box-chain is an example of how a physical DECT equipment can be connected to an interface of the target network, and sometimes offers an interface of the target network in the portable part.

Note: Some target networks does not have a reference model with logical reference points. In these networks only physical interfaces are defined.

3.4.1 PSTN Reference Configurations

PSTN can be described as a number of hierarchical physical groupings, such as the transport network with trunc exchanges, the local loop with local exchanges, PBX (-networks) and POTs. When PSTN is described below as one PSTN-box, this includes both the transport network and the local loop.

In PSTN DECT has been foreseen to be configured in three ways; as a POT connected directly to the local loop (3.4.1.1) or to a PBX (3.4.1.2), as a logical part of a PBX (3.4.1.2), and as a fixed wire substitute in the local loop (3.4.1.3).

3.4.1.1 Domestic Telephone

The most simple DECT configuration is the domestic telephone. The DECT Network is connected to the PSTN at the subscriber interface (telephone socket) as a POT (Plain Old Telephone). In this configuration DECT has in principle the same functionality as earlier generations of cordless telephones. The example shows a domestic telephone, consisting of a FP and a handset.

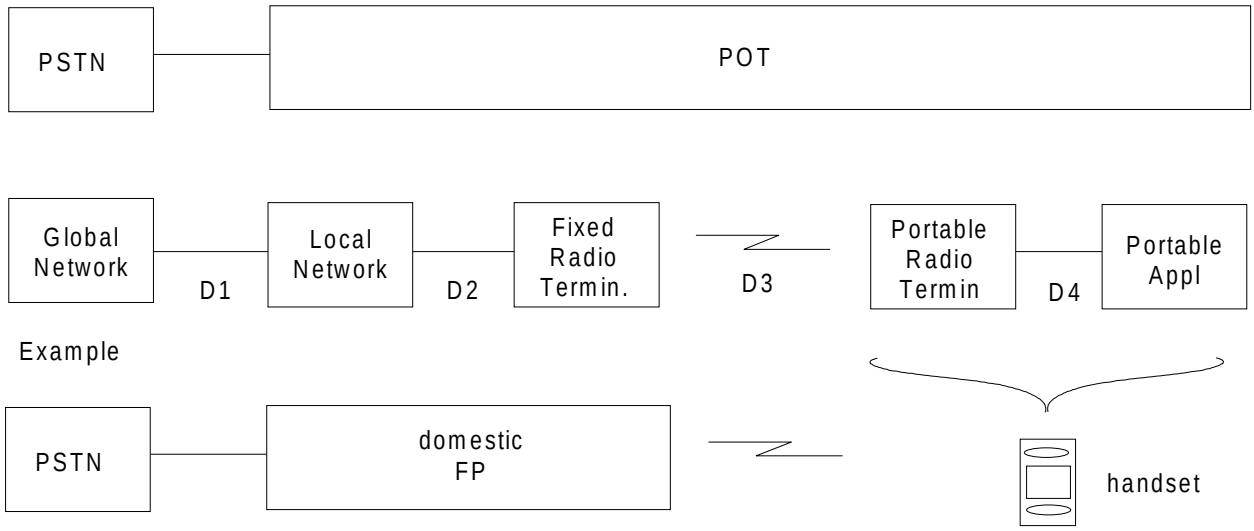

Figure 3.5

3.4.1.2 PBX

The DECT Network can be connected to an existing PBX as i) a cordless POT extension, or ii) as a logical part of the PBX.

In case i) the Fixed Radio Termination, the Portable Radio Termination and the Portable Application will be a part of the POT, and the Local Network will be the PBX. This is equal to 3.4.1.1, with the exception that the Fixed Part is connected to a PBX extension line instead of directly to the local loop. This is shown and exemplified in figure 3.6a.

In case ii) the Portable Radio Termination and Portable Application can be considered as the POT. The Fixed Radio Termination may perform internal layer two-switching (hand-over) etc, and can therefore be considered as a logical part of the PBX.

Case ii) is described in figure 3.6b with two examples. Example a) describes a fixed DECT infrastructure with one common control entity and a number of RFPs. The common control entity is a physically separate adjunct to the PBX. It may include DECT-external functionality, and the D2 reference point may therefore be an internal interface in the common control entity. In example b) the DECT-specific functional entities are physically integrated in the PBX as a module for cordless access.

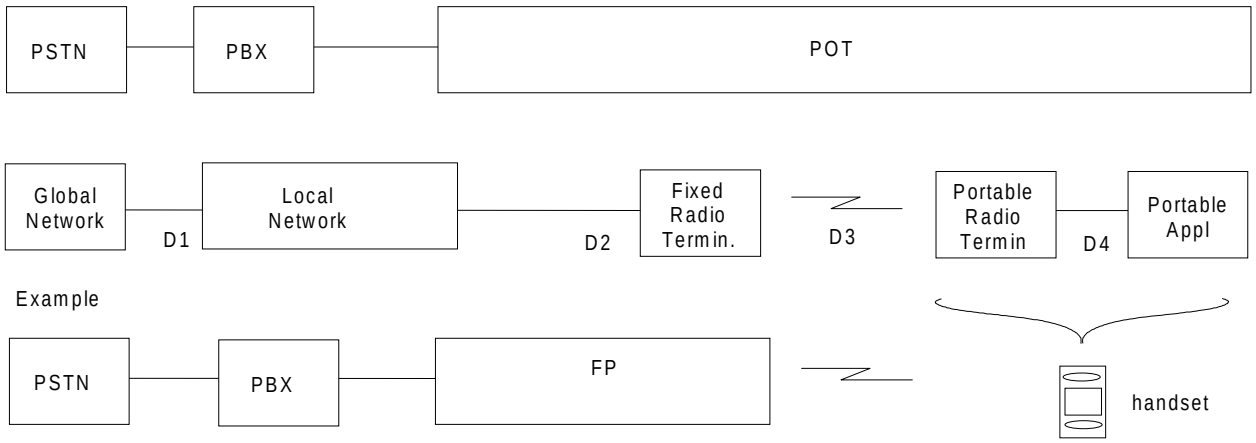

Figure 3.6a.

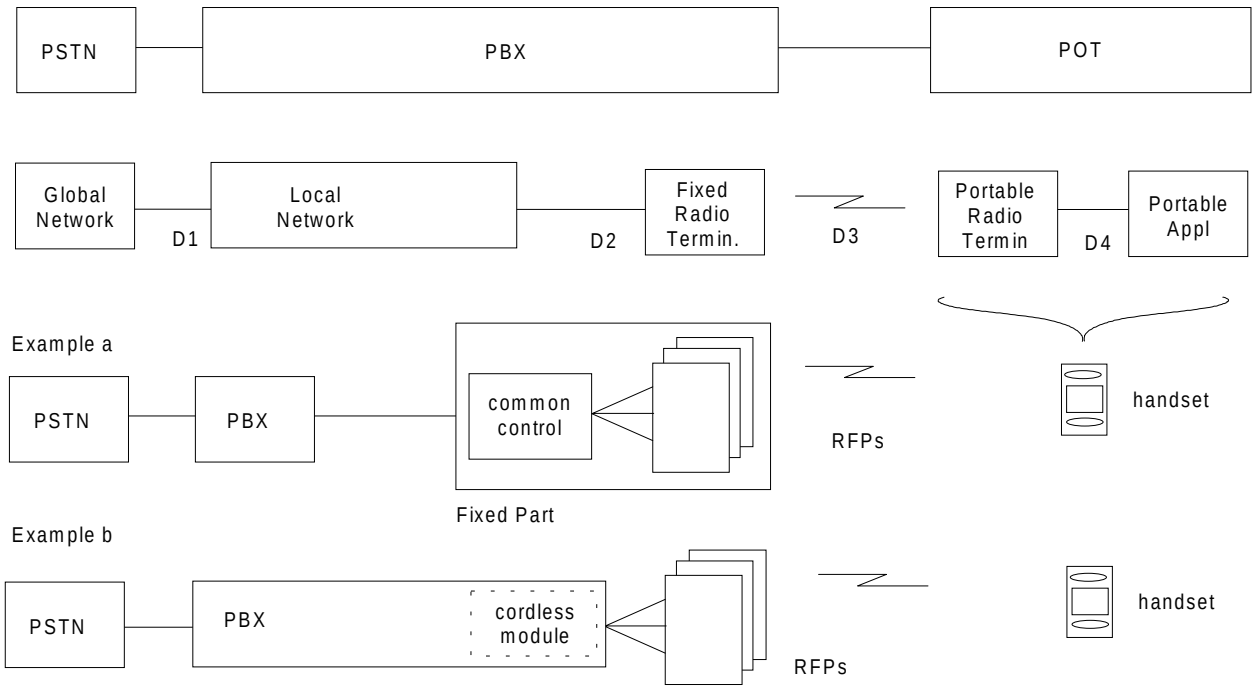

Figure 3.6b.

3.4.1.3 Local Loop

The DECT Network can be integrated in the PSTN as a local loop replacement. The PSTN operator provides the Portable Radio Termination as a terminal adaptor, to which the customer plugs the wired or cordless terminal (the Portable Application). Since both the Fixed and the Portable Radio Termination is included in the local loop, and is in principle "invisible" to the end user, the entire DECT Network is a part of the PSTN.

The example shows a fixed DECT infrastructure, connected to the local exchange, and a "portable" equipment attached eg to the outer wall of the subscriber's house. This "portable" equipment is an adaptor between the DECT radio interface and the interface at the customer's telephone plug. The Portable Application is exemplified with an ordinary telephone.

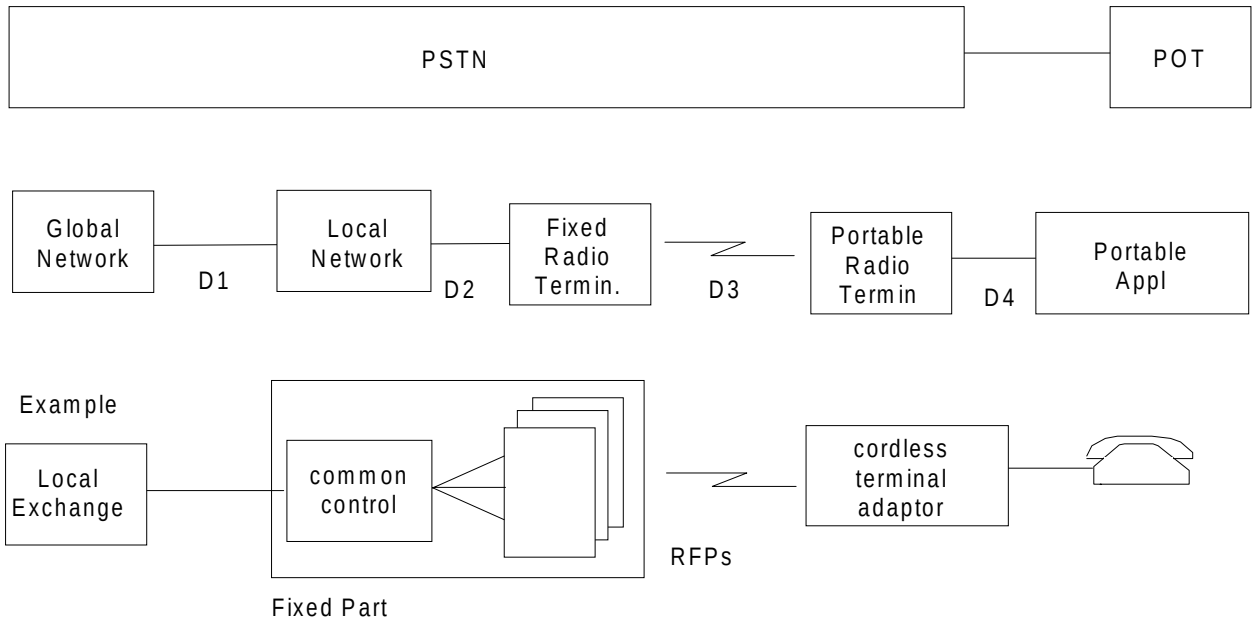

Figure 3.7

3.4.2 ISDN Reference Configurations

Based on to which ISDN reference point the DECT Network will be connected or what ISDN reference point should be offered at the portable side, the DECT logical groupings will perform the functions of different ISDN logical groupings.

DECT is foreseen to be configured in ISDN almost the same way as in PSTN, ie as a TE1 or TE2 to the S- or R-reference points respectively, directly to the local loop or to an ISPBX (3.4.2.1), as a logical part of the NT2 (3.4.2.2) or as a fixed wire replacement in the Local Loop (3.4.2.3).

Note: DECT will not be specified to support a configuration where some of the eight TEs are connected to a fixed part of the S-bus, and some are connected to a cordless part of the S-bus.

3.4.2.1 Terminal Equipment

The DECT Network can be connected to the ISDN S-bus as a TE1 (figure 3.8a), or to the R reference point as a TE2 (3.8b). It should also be possible to configure a DECT Network with only a part of the TE1 functionality in ISDN (3.8c). The Local Network in the DECT reference model will be the NT2. If the NT2 does not exist (ie the TE1 or TA is directly connected to the NT1 and the T- and S-reference points will coincide) the Local Network will be minimal. The Global Network in the DECT reference model can be considered as including also the NT1. This also implies that the D1 reference point will be the ISDN T reference point.

If the DECT Network shall perform the functions of TE1, and the Local Network in the general case is the NT2, the D2 reference point will appear after the ISDN S reference point. The example shows the NT2/Local Network as an ISPBX. The DECT Fixed Part together with the Portable Radio Termination and Portable Application integrated in one handset, will for the ISPBX look like a TE1.

If the DECT Network shall perform the functions of TE2, D2 will appear after the R reference point. Since the Fixed Radio Termination is connected to the Local Network and the TE2 is connected to the TA, the Local Network must in this configuration also include the TA. In the example the Fixed Radio Termination is a DECT Fixed Part of some sort, the Portable Radio Termination is contained in a cordless terminal adaptor and the Portable Application includes a X- or V-series terminal. This DECT Network and Portable Application is the TE2, connected to the ISPBX via a TA.

In the third case the Local Network will include some TE1 functionality. In the example the DECT Fixed Part, connected to the S-bus, includes both DECT specific functionality (Fixed Radio Termination) and TE1 functionality, so that the ISPBX sees a true TE1.

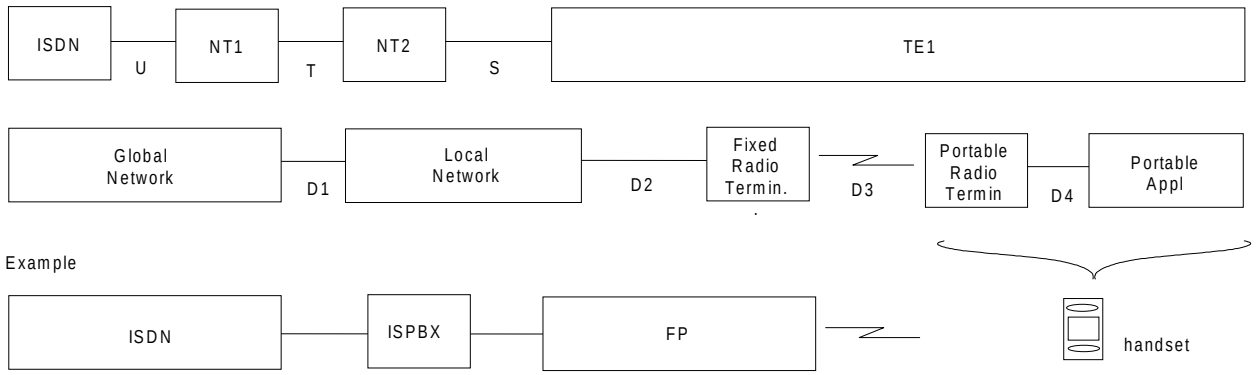

Figure 3.8a

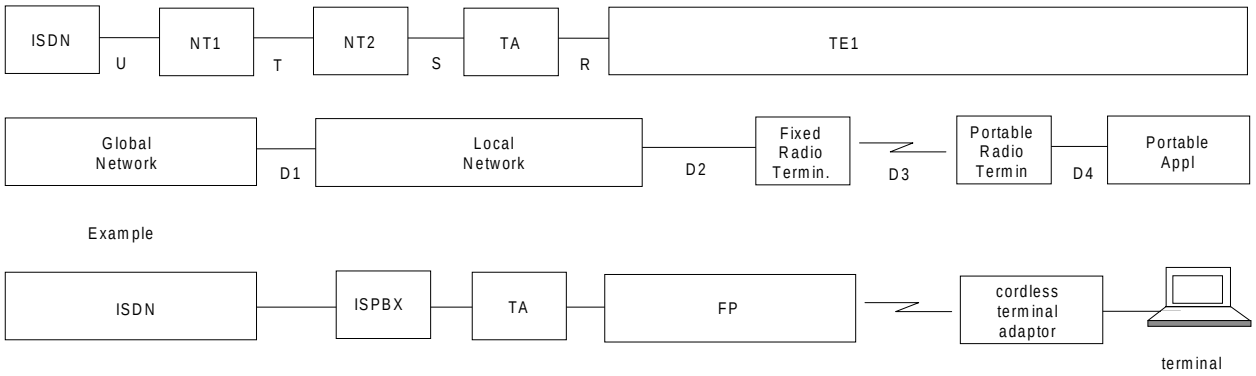

Figure 3.8b

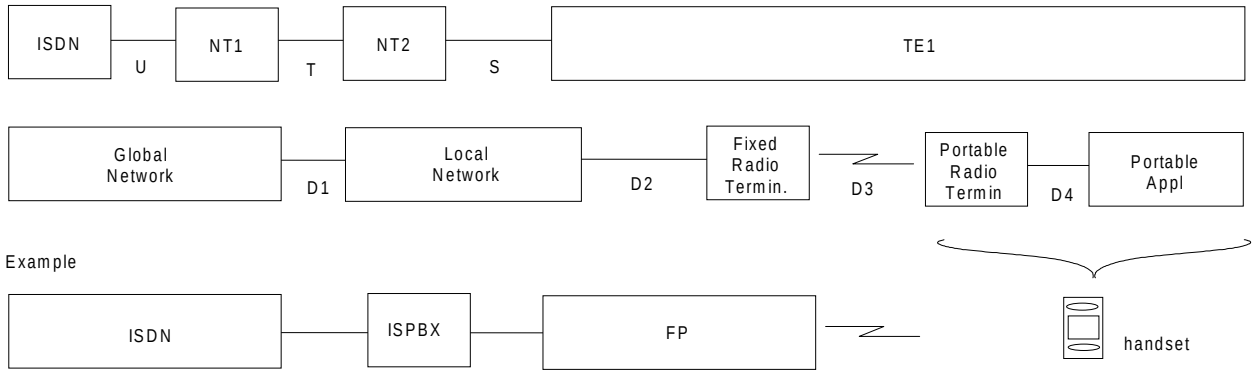

Figure 3.8c

3.4.2.2 Network Termination 2

In the previous paragraph the S reference point was on the fixed side of the air interface and the DECT Network was the TE2, TE1 or part thereof. In this configuration the S reference point shall be offered on the portable side of the air interface. The S reference point is the boundary of the TE1 (or TA) on one side and the NT2 on the other side. Since D4 separates the Portable Application from the Portable Radio Termination, the DECT Network must be a part of the NT2 and the Portable Application includes the TE1 (or TA and TE2). As in 3.4.2.1, the Local Network is (a part of) NT2, and the Global Network includes NT1, which means that D1 corresponds to the T reference point in this configuration also.

In the example the common control entity includes both the Fixed Radio Termination and some of the Local Network functionality. D2 can not be mapped onto an ISDN reference point, but will be internal in the NT2, as well as in the physical common control entity.

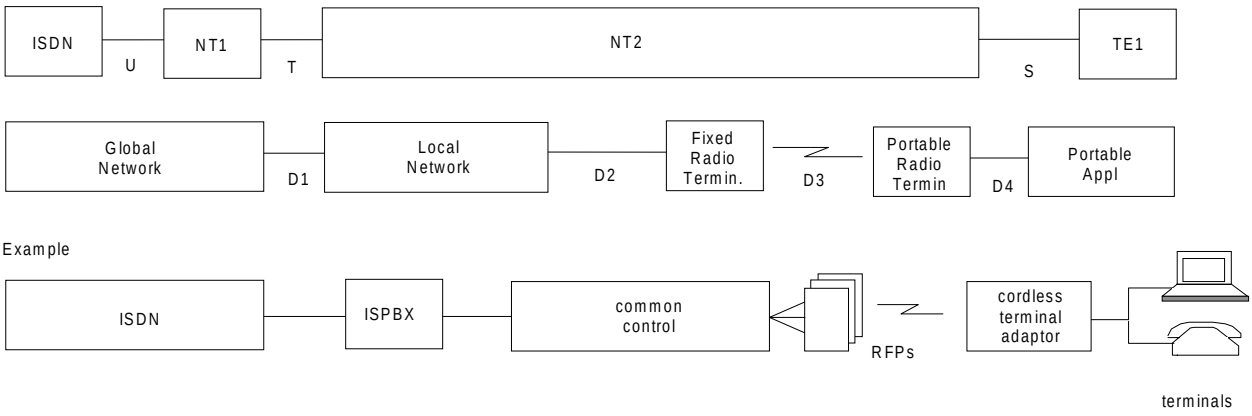

Figure 3.9

3.4.2.3 Local Loop

In 3.4.2.1 the S reference point was on the fixed side of the radio interface and in 3.4.2.2 the S reference point was on the portable side, but the T reference point was still fixed. In this configuration T shall be offered on the portable side.

In the example, the ISDN operator connects the ISDN Local Exchange to the NT1 by means of the DECT Network. The NT1, implemented as a cordless terminal adaptor, allows the user to connect the equipment (NT2, TE1, TA, and/or TE2) to the S_0 or S_2 interface; DECT is a local loop replacement. It is out of the scope of this reference configuration to define whether the DECT air interface can carry the Primary Rate Interface or not.

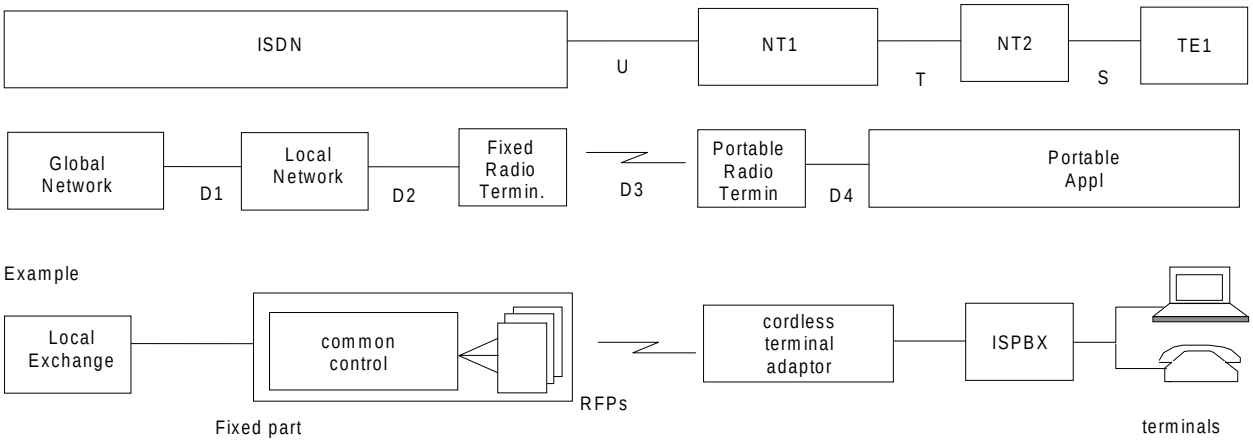

Figure 3.10

3.4.3 X.25 Reference Configuration

3.4.3.1 Data Terminal Equipment

The DECT Network attached to a X.25 PSPDN is described in figure 3.11. X.25 is only a user access protocol, and only two functional groupings are defined in the X.25 "reference model"; DTE and DCE An undefined network connects the DCEs/DTEs. From the DECT Reference Model point-of-view, the undefined network is the Global Network. The DCE offers a cordless X.25 interface, which means that the entire DECT Network (and if the DCE has switching capabilities, also the Local Network) must be included in the DCE.

In the example a terminal (part of the Portable Application) is connected to a cordless terminal adaptor (the Portable Radio Termination) at the X.25 interface. The cordless terminal adaptor includes a Portable Radio Termination to access the air interface.

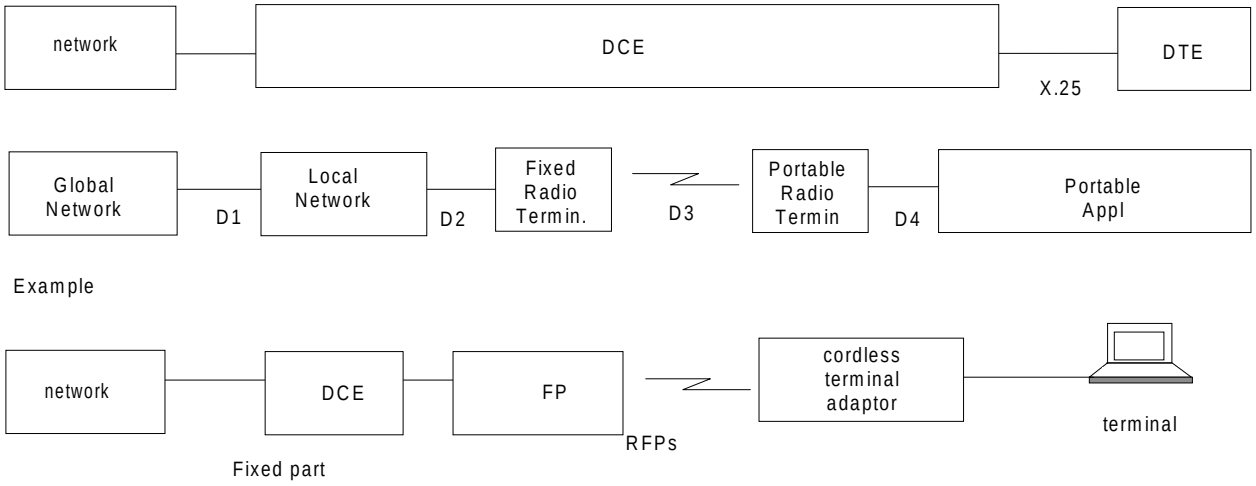

Figure 3.11

3.4.3.2 PAD Equipment

If the terminal cannot handle X.25 protocol, it must be connected to the DCE via a PAD (Packet Assembler-Disassembler), which, to the DCE, makes it look like a DTE. The Local Network will contain the DCE and the DECT Network will be part of the PAD.

The example shows an implementation, where the PAD is a base station and a cordless terminal adaptor, offering X.25 interface on the fixed side and the interface requested by the terminal on the portable side.

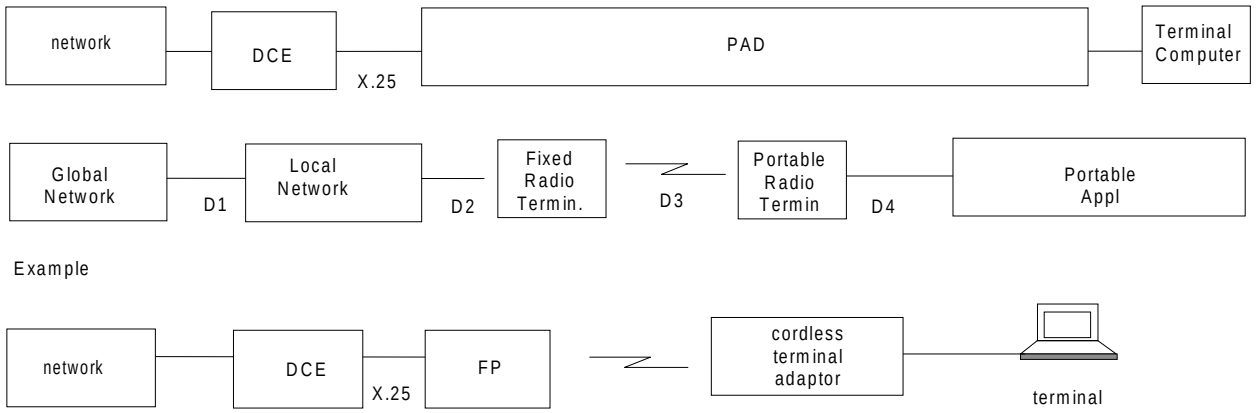

Figure 3.12

3.4.4 GSM Reference Configurations

3.4.4.1 Base Station Subsystem

In a GSM Network DECT can act as a BSS (Base Station Subsystem). Since the BSC includes functionality which in the DECT Reference Model is located in the Local Network, both the Local Network and the Fixed Radio Termination corresponds to the BSS of GSM. This implies that the Global Network is the MSC (and the rest of the GSM-network and PSTN/ISDN) and the D1 reference point is the GSM A-reference point. The MS of GSM equals the Portable Radio Termination and Portable Application. The D2 reference point is an undefined reference point in the BSS, and D4 is internal to the MS.

Notice that the protocols across the D3 reference point (DECT CI air interface) are not equal to the protocols across the Um reference point (GSM air interface).

In the example, the BSS consists of a common control and a number of base stations, and the MS (Portable Radio Termination and Portable Application, integrated) is a DECT handset.

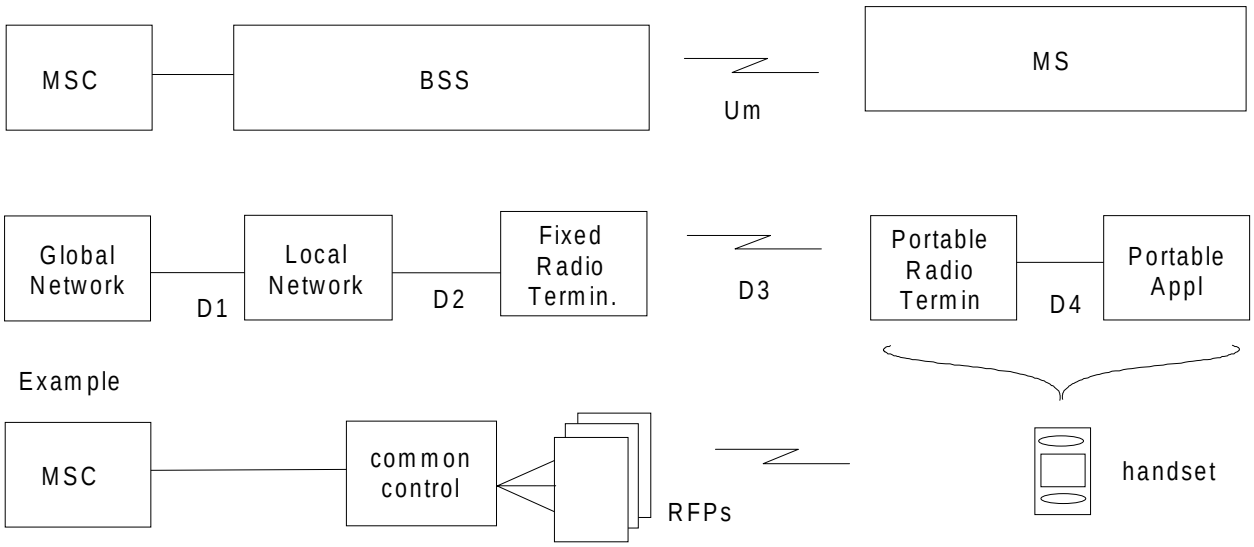

Figure 3.13

3.4.4.2 Mobile Station

The GSM and DECT Network can be connected in tandem after the GSM air interface. Both the Portable Application, the Portable Radio Termination, the Fixed Radio Termination and, if switching capabilities are included, the Local Network are located on the mobile side of the GSM air interface. In the GSM reference Model, three groupings can be found on the mobile side; an MT, a TA and a TE. In the reference configuration the D1 reference point is the GSM R reference point. However, D1 could also correspond to S or Um, since the DECT Reference Model is vague regarding the functionality of the Local Network.

In the example the GSM BSS "sees" a true GSM mobile station. A DECT/GSM converter acts as an interworking unit between the GSM and the DECT air interfaces. Here no switching is included in he converter. However, the Local Network-part of the converter could also be a PBX, allowing many DECT PPs to communicate with the GSM network.

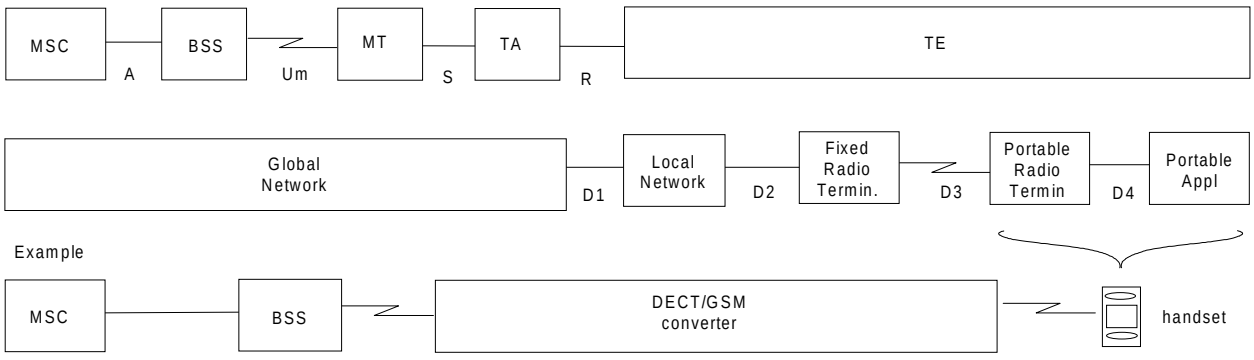

Figure 3.14

3.4.5 IEEE 802 Reference Configurations

3.4.5.1 Bridge

To allow for terminals to communicate with a LAN via the DECT air interface, the DECT Network can interconnect them as a LAN bridge. The bridge consists of the Fixed Radio Termination and the Portable Radio Termination. In the configuration in figure 3.15, the LAN has a star topology, but it can of course be of any type, eg a ring.

The example shows how the bridge is realised as a base station and a cordless terminal adaptor, handling the communication between the terminal and the LAN.

3.4.5.2 Gateway

The DECT Network can be configured as a cordless gateway between two LANs as in figure 3.18. The Fixed Radio Termination and the Portable Radio Termination are the gateway, and, according to the DECT Reference Model, one Local Network is one LAN and the Portable Application is the other LAN.

In the example a Fixed Part and a cordless terminal adaptor together forms the gateway. They will of course in reality look very similar.

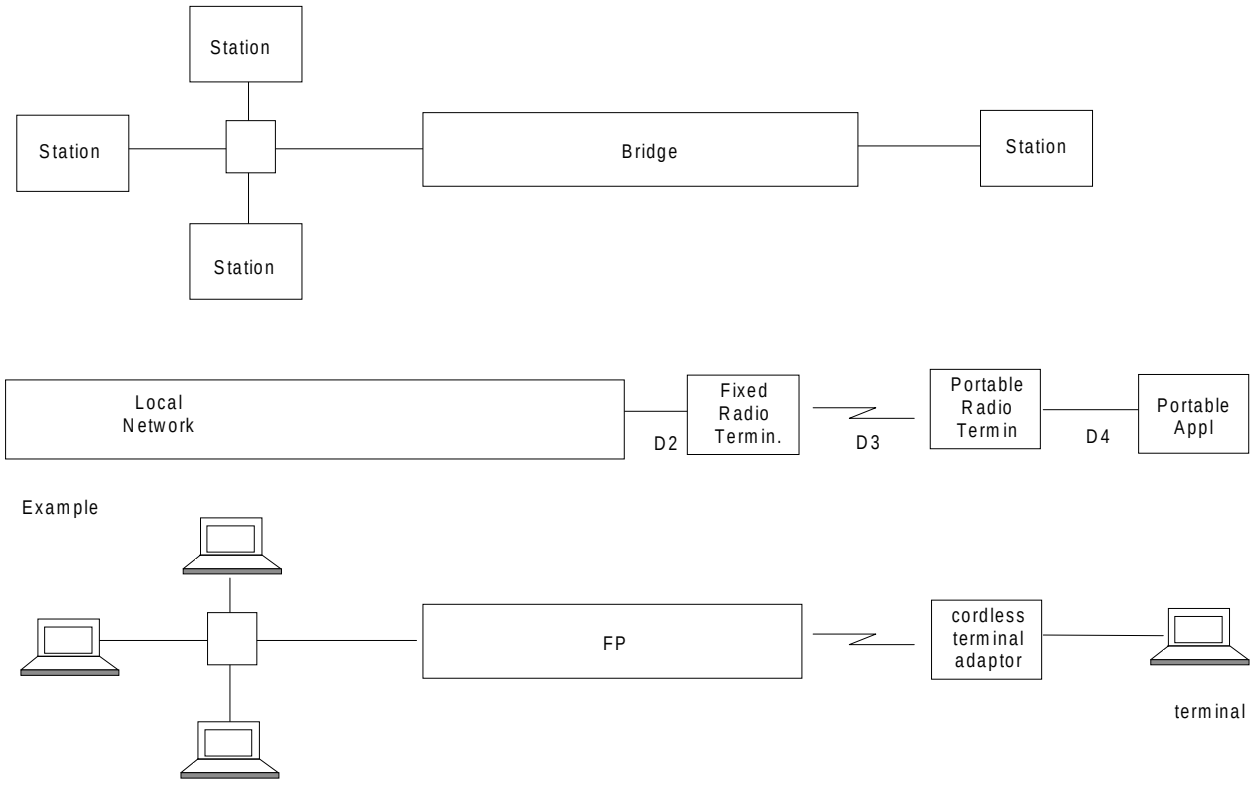

Figure 3.15

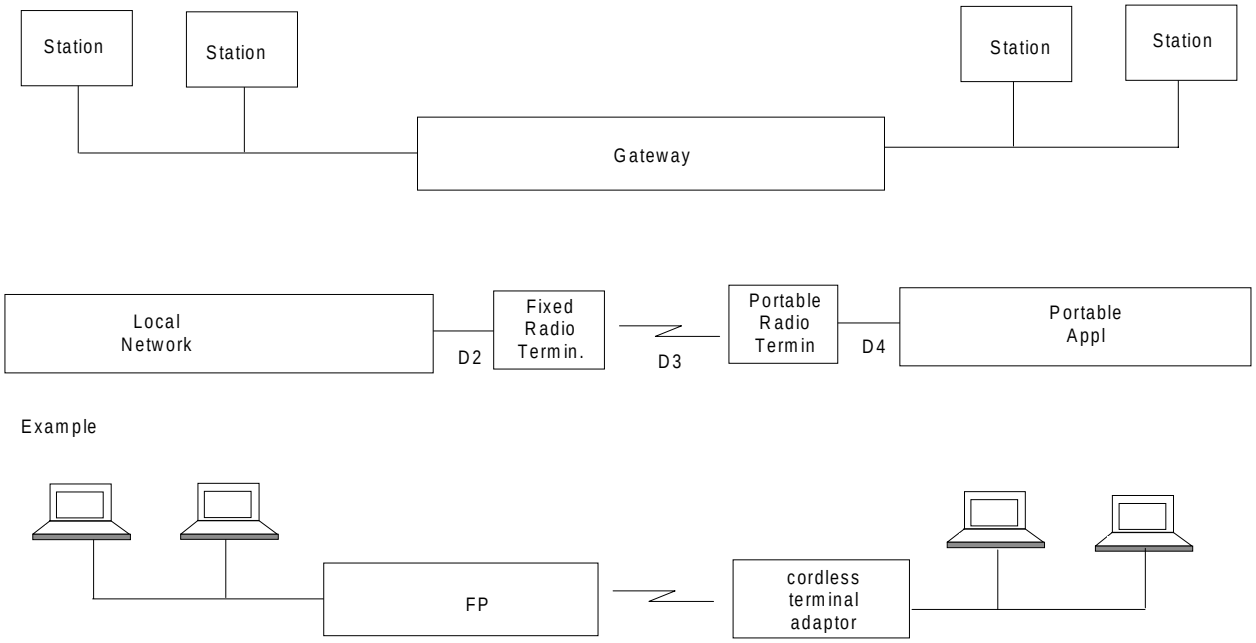

Figure 3.16

3.5 Source documents

CCITT	Red Book ISDN recommendation (Fascicle III.5)
CCITT	Red Book Q.65 recommendation
ECMA TR/44	An architectural framework for private networks
RES-3(89)42	DECT reference document
RES-3(89)7	Signalling capacity required for supporting an ISDN basic service
RES-3(89)81	DECT scenarios
RES-3N(89)6	Signalling protocol architecture in DECT
RES-3N(89)42	Proposal for a formal protocol methodology
RES-3N(90)18	Telepoint environments in DECT
TCS/R TD05	DECT reference model

Annex B: System protocol architecture

This Annex contains Chapter 4 of the DECT System description document, and consists of pages numbered 4.1 to 4.28 (i.e. 28 pages).

Chapter 4

System Protocol Architecture

Contents

Version History

Version 00.00	Issued at RES3-N meeting in London 16/17.1.90
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Version 02.00	Issued at RES3-N meeting in Paris 25/26/27.4.90
Version 03.00	Sent to PT10 for consistency inspection 4.5.90
Version 03.01	Issued at RES3 meeting in Bern May 90
Version 04.00	Issued at RES3-N meeting in The Hague July 1990
Version 05.00	Issued at RES3 meeting in Helsinki October 1990
Version 05.01	Issued in parts at RES3-N meeting in London December 1990
Version 06.00	Issued at RES3 meeting in München December 1990
Version 07.00	Issued at RES3-N meeting in Aarhus April 1991
Version 07.01	Faxed in parts to PT10 for consistency inspection 30.5.91
Version 07.02	Sent to PT10 for last agreement 3.6.91
Version 08.00	Issued at RES3 meeting in Guernsey June 1991

Revision Marks
No revision marking mechanism is used in this version.

4.0. Scope

This document is part of the framework of RES3-N for the DECT Data Link and Network Layer specifications. System protocol architecture is shown by using an overall protocol architecture model for single- and a multi-cell systesms and the unconstrained network service provider model and the sublayer model. A classification of the DECT network and the functional description are made by using the sublayer model whilst the description of protocol elements, primitives, services and procedures are included in the DECT C/I specification chapters.

4.1. References

4.1.1. Relevant Input Papers, Specifications

The following input papers and specifications from RES3, RES3-N, RES3-R and PT10 members are relevant for this framework:

(1) ETSI DE/RES 3001-2	DECT C/I Specification: Physical Layer (PHL)
(2) ETSI DE/RES 3001-3	DECT C/I Specification: Medium Access Layer (MAC)
(20) ETSI DE/RES 3001-1	DECT C/I Specification: Overview
(21) RES3-N(90)10	DECT Reference Model
(22) ETSI DE/RES 3001-6	DECT C/I specification. Identities and Addressing
(23) RES3-N(90)31	Mobility Functions
(24) ETSI DE/RES 3001-4	DECT C/I specification. Data Link Control Layer (DLC)
(25) ETSI DE/RES 3001-5	DECT C/I specification. Network Layer (NWL)
(26) RES3-N(90)164	DECT NWL Functional Requirements
(27) RES3-N(90)168	Interworking
(28) ETSI DE/RES 3001-8	DECT C/I Specification: Speech Coding and Transmission

Tab 4-1 Relevant Input Papers and Specifications

4.1.2. Relevant Documents

The following international standards and recommendations are relevant for this framework:

(50) ECMA TR/44	An Architectural Framework for Private Networks
(51) ISO DP10028	Telecommunications and Information Exchange between Systems.
(52) GSM 04.06	MS-BSS Interface: Data Link Layer Specifications
(53) GSM 04.07	Mobile Radio Interface Signalling Layer 3 - General Aspects.
(54) GSM 04.08	Mobile Radio Interface Layer 3 Specifications
(55) I.320	ISDN Protocol Reference Model
(56) I.324	ISDN Network Architecture

(57) I.440	ISDN User-Network Interface Data Link Layer - General Aspects
(58) I.441	ISDN User-Network Interface Data Link Layer Specifications
(59) I.450	ISDN User-Network Interface Layer 3 - General Aspects
(60) I.451	ISDN User-Network Interface Layer 3 Specification for Basic Call Control
(61) I.452	Generic Procedures for the Control of ISDN Supplementary Services.
(62) I.510	Definitions and General Principles for ISDN Interworking
(63) G.711	Pulse Code Modulation of Voice Frequencies
(64) G.721	32kbit/s Adaptive Differential Pulse Code Modulation
(65) I.122	Framework for Providing Additional Packet Mode Bearer Services
(66) V.110/I.463	ISDN Rate Adaption

Tab 4-2 Relevant Documents

4.2. Unconstrained Network Service Provider Model (UNSPM)

This model shows the service boundary of the DECT network to the attached networks and end systems. It shows where the DECT network services are provided to the attached networks or end systems. The DECT network services provision will be defined by services accessable at so called service access points (SAPs) in the Interworking Units (IWUs) or end systems.

According to the definitions in (50) the DECT network can be considered as a subnetwork (the ether) plus two interworking units between two attached networks. The DECT network itself does not contain any application process.

4.2.1. UNSPM for the C-Plane

The following figure shows the model for the signalling part (C plane).

Note that the interaction level (OSI layer) of the attached networks can be at any layer in their protocol stacks (but is typically also at layer 3 as drawn in the following picture). However for the DECT network the intervention level for signalling is always at OSI layer 3.

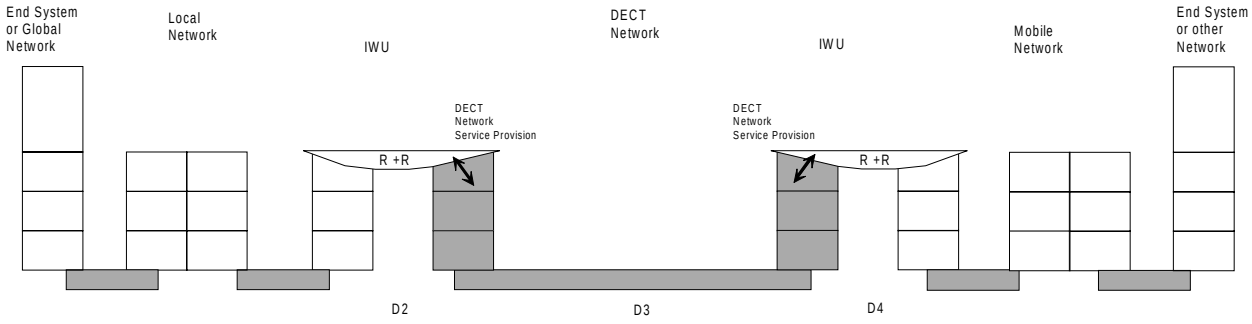


Fig 4-1 Unconstrained Network Service Provider Model (C-plane)

The figure above shows that the reference points D2 and D4 are located in the IWU to both attached networks. It is assumed that these reference points coincide with the network service provision boundaries.

4.2.2. UNSPM for the U-Plane

The following figure shows the model for the data traffic part (U plane). As an example the approach for telephony information conveyed through a DECT system is shown. It is assumed that the information (speech) is converted at the presentation layer (ADPCM/PCM or ADPCM/RPE-LTP or ADPCM to analogue) in the interworking units but belongs still to the attached network. ADPCM to TDMA coding conversion takes place at layer 2 (MAC) in the DECT network.

Note that the interaction level (OSI layer) of the attached networks can be at any layer in their protocol stacks depending on the type of network attached to the DECT network and the connection type of the data (but is typically at the same layer as the DECT network). The transcoding of ADPCM to another coding algorithm is completely outside the DECT network. For the time being it is assumed that the DECT network does not provide any functions above the network layer (layer 3) even for the user plane. Therefore the transcoding in this example belongs to the local network and the mobile network respectively. The drawing convention for a transcoder is in such a way that each coding algorithm is shown in the left and right protocol stack separately.

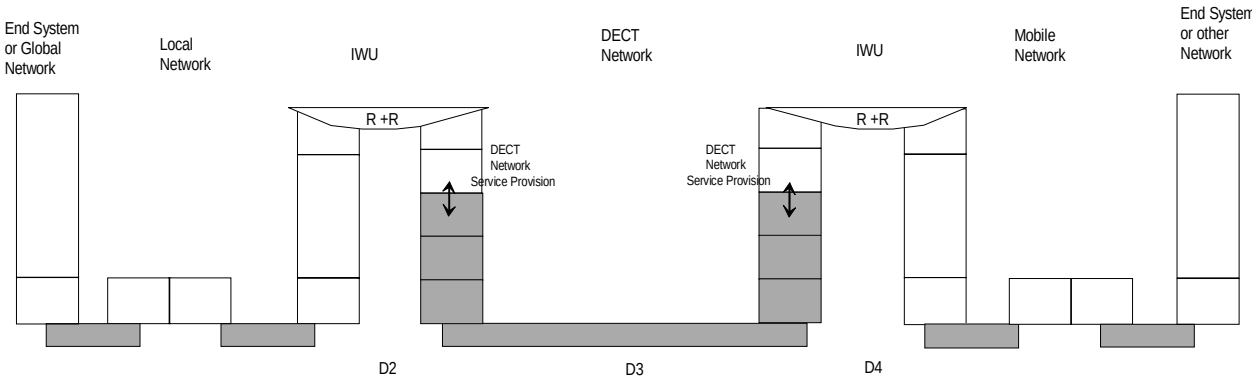


Fig 4-2 Unconstrained Network Service Provider Model (eg. U Plane for Telephony)

Note that the network service provision of the DECT network for the user plane in this example does not coincide with the boundary to the routing and relay function in the interworking units. This approach enables the service providers to convey protocol data units belonging to layers above layer 3 in the attached networks transparently in the DECT network (in this example G.721 presentation of speech is conveyed transparently). Other examples may show that the DECT network service provision coincide with the boundary to the routing and relay function.

Again for the user plane the reference points D2 and D4 are located in the IWU of the attached networks. It is also assumed that these reference points coincide with the network service provision boundaries.

4.3. Overall Protocol Architecture Model

The overall protocol architecture models are more implementator-oriented than the unconstrained network service provider models.

The overall protocol architecture models give a detailed overview of the DECT network in the case of a single- or multi-cell system. These models may show the repartition of layer elements in both cases and they are drawn showing the control plane (C) and the user plane (U) separately (55).

It is assumed in the following two examples that the attached network is a public or private ISDN and the end systems have the functionality of an ISDN terminal. These two examples use the same protocol architecture model in the C plane.

The next two examples show the situation when the attached networks are a LAN and a GSM.

For all examples it is shown that an end system may be built physically together with the cordless terminal adaptor (CTA) or separately by using the cordless terminal adaptor (CTA) as an interworking unit (IWU).

4.3.1. Single Cell Systems

In a DECT single cell system all functions of the FT are usually in the same equipment. Layer 2 of the DECT network on the fixed side therefore resides completely in the same equipment. Inter-cell handover does not exist but all other types of handovers may occur.

4.3.1.1. Telephony Teleservice by Attachment to an ISDN

4.3.1.1.1. Control Plane (C)

The following figure shows the protocol reference model in the control plane (C) of a single cell system for an ISDN Telephony service. For simplicity reasons the global network attached to the local network and the remote end system are not shown. Only the reference points locating on a visible interface are indicated. The Kx-reference points (62) denoting the interworking between the DECT network and the ISDN are located inside the Interworking Units in the Routing and Relay Function (R+R) and therefore not visible on an interface.

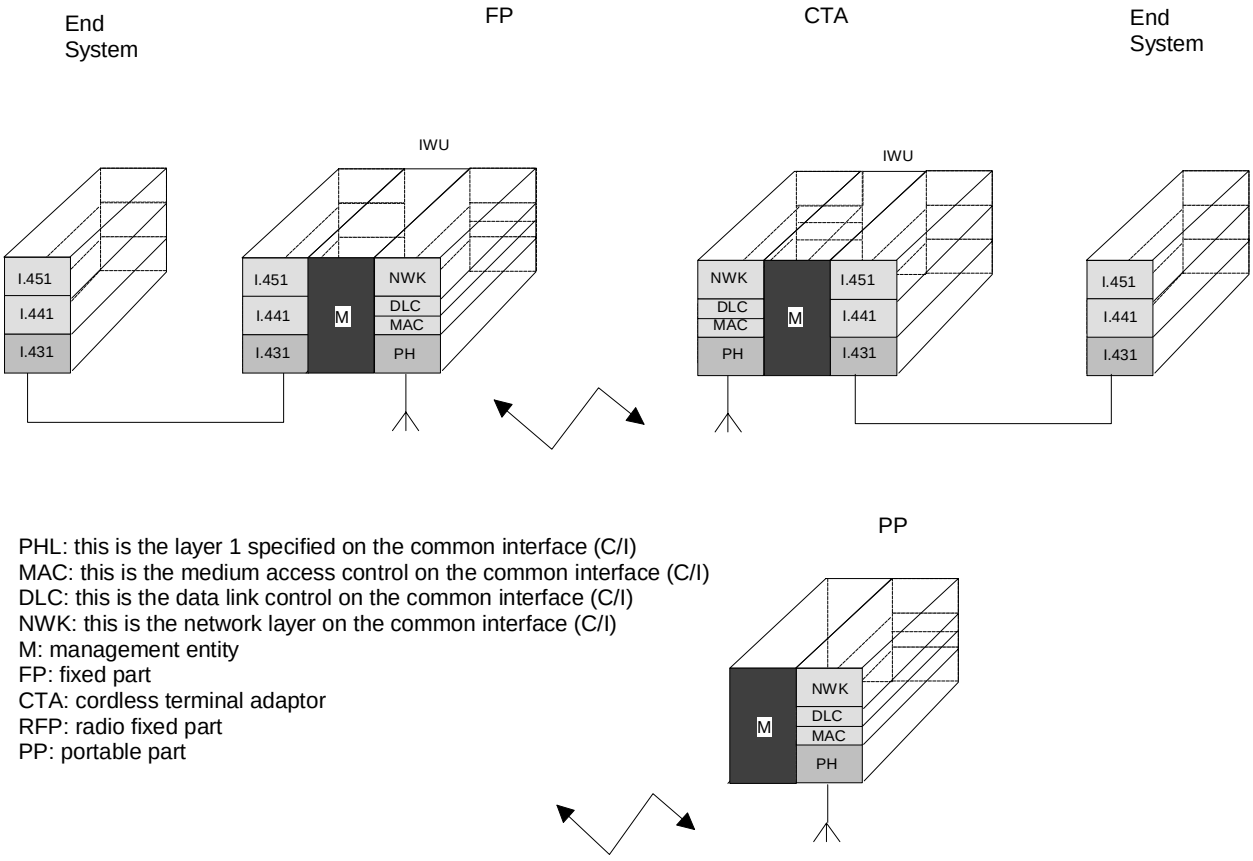
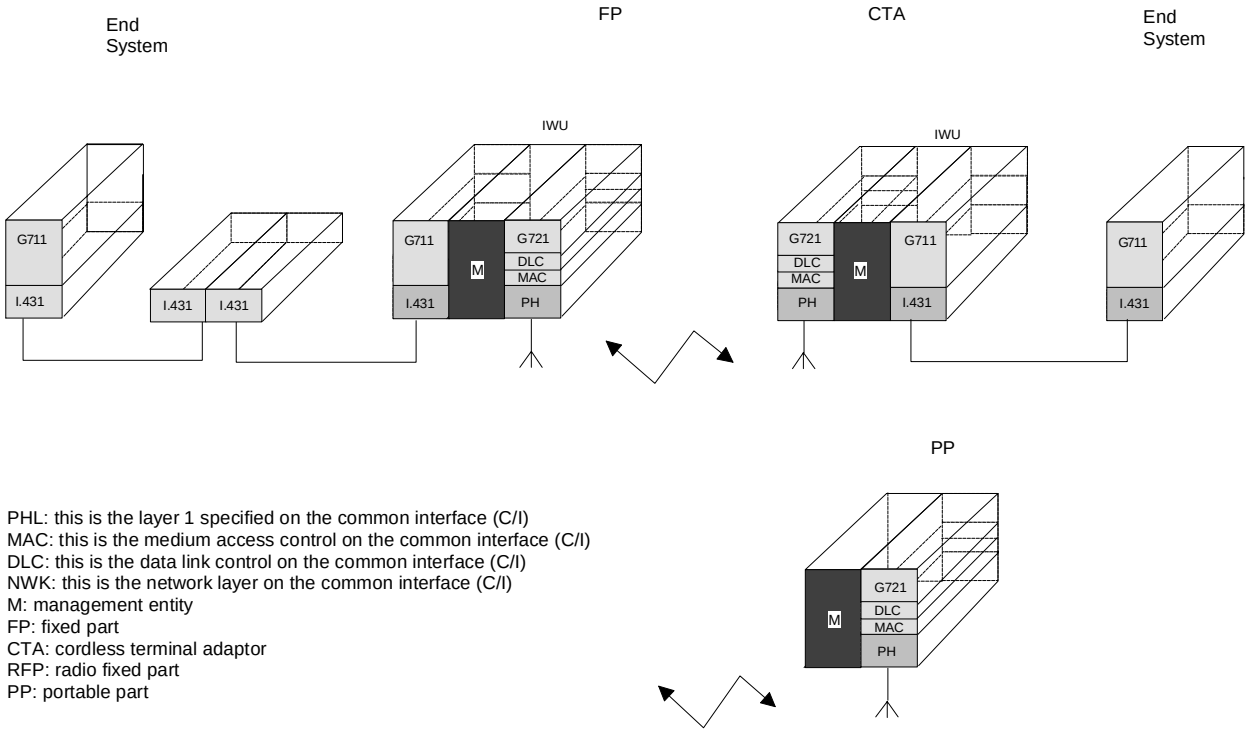


Fig 4-3 Protocol Architecture Model of the C plane in a DECT Single Cell System by Attachment to an ISDN

4.3.1.1.2. User Plane (U)

The example shows the situation for the telephony teleservice using a single cell DECT network attached to a public ISDN. The model shows the transcoding of the speech according to (64) and (63) (layer 6) in the FP and PP in layer 6 which is not part of the DECT network. This is a possibility which allows the communication with wired ISDN terminals but is not the only solution. The data link control sublayer (DLC) is shown in its function as transparent unprotected service (TRUP) which uses the lower FBn frame buffering function. The FBn frame buffering function itself has access to the MAC layer by using an In-channel which provides unprotected data transfer.



PHL: this is the layer 1 specified on the common interface (C/I)
MAC: this is the medium access control on the common interface (C/I)
DLC: this is the data link control on the common interface (C/I)
NWK: this is the network layer on the common interface (C/I)
M: management entity
FP: fixed part
CTA: cordless terminal adaptor
RFP: radio fixed part
PP: portable part

Fig 4-4 Protocol Architecture Model of the U plane in a DECT Single Cell System for Telephony by Attachment to an ISDN

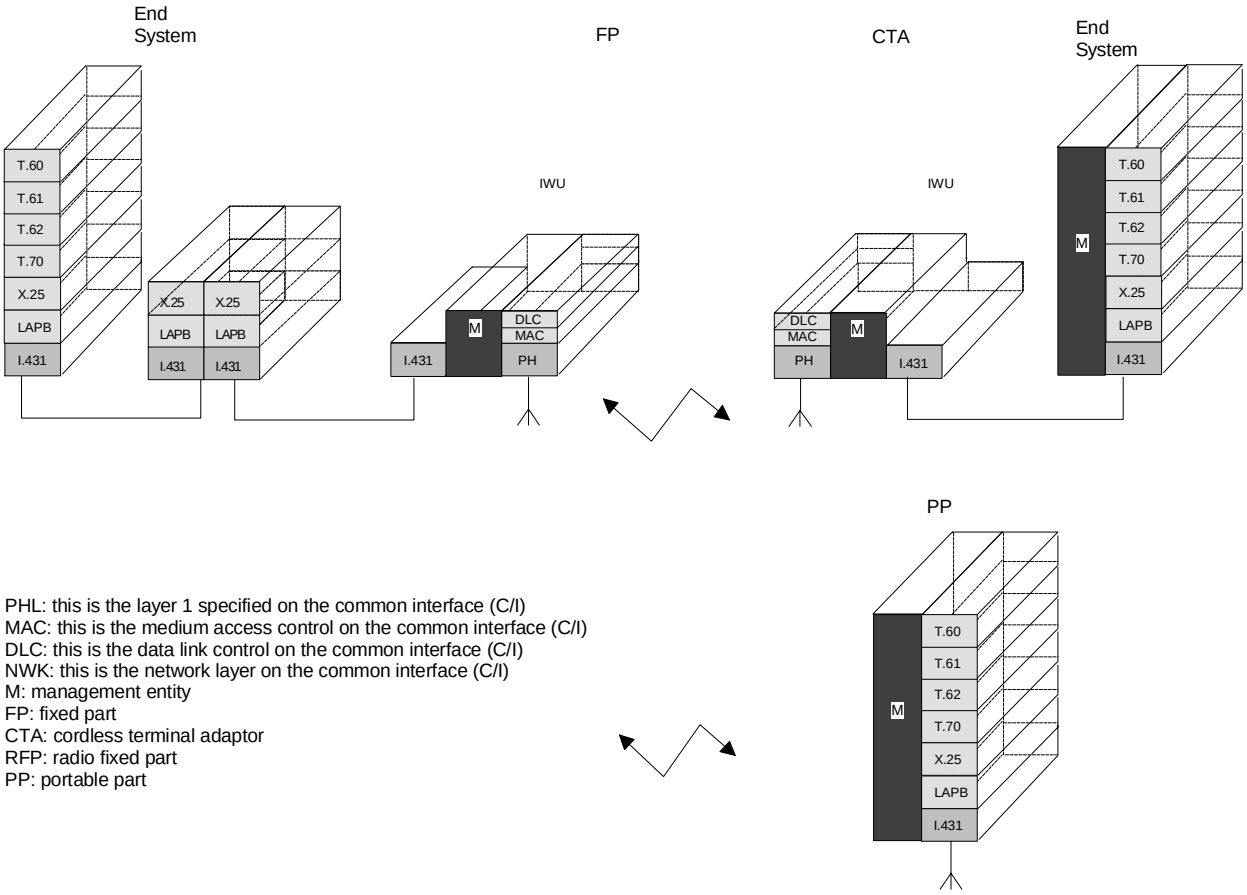
4.3.1.2. Packet Data Communication Service by Attachment to an ISDN

4.3.1.2.1. Control Plane (C)

The same protocol architecture model applies for the C plane for the packet data communication service as for the telephony service.

4.3.1.2.2. User Plane (U)

The example shows the situation for a packet data communication teleservice using a single cell DECT system attached to an ISDN. The data link control sublayer (DLC) is shown as a function which provides frame relaying service (FREL) by using the protected data transfer service from the medium access sublayer (MAC). An ISDN Teletex service is shown using a packet handling function with a virtual packet mode bearer inside the ISDN. It must be noted that the X.25 layer 2 (LAPB) is not affected inside the DECT network user plane but some functions like HDLC flag removal and zero-bit insertion/deletion can be provided in both interworking units.



PHL: this is the layer 1 specified on the common interface (C/I)
MAC: this is the medium access control on the common interface (C/I)
DLC: this is the data link control on the common interface (C/I)
NWK: this is the network layer on the common interface (C/I)
M: management entity
FP: fixed part
CTA: cordless terminal adaptor
RFP: radio fixed part
PP: portable part

Fig 4-5 Protocol Architecture Model of the U plane in a DECT Single Cell System for Packet Data Communication by Attachment to an ISDN (eg. Teletex)

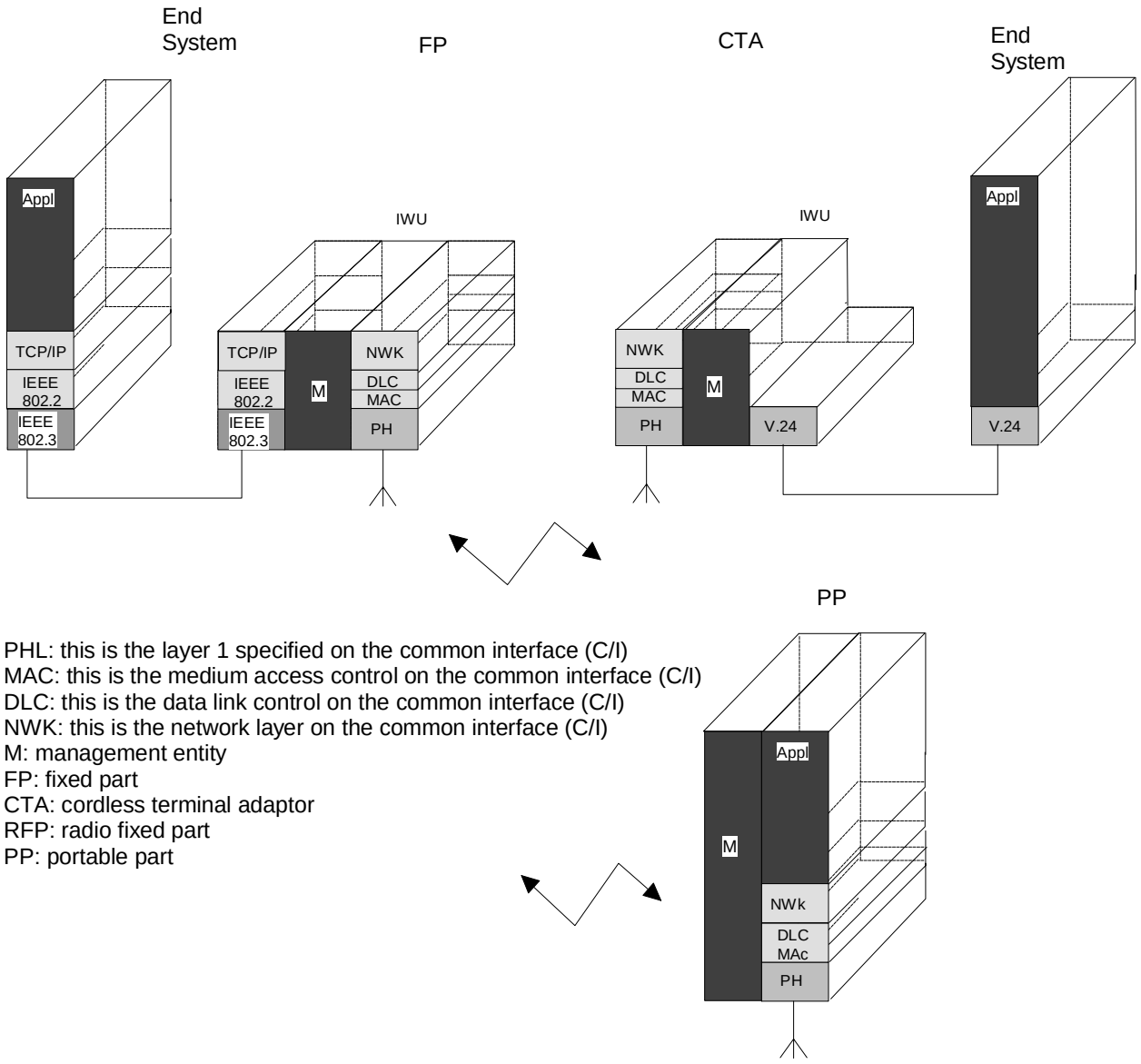
4.3.1.3. Packet Data Communication Service by Attachment to a LAN

The following figures show the protocol reference model for a DECT Cordless LAN Station. It is assumed that the DECT Fixed Network provided by a single RFP (which includes the complete FT functions) is attached to an Ethernet LAN using the IEEE 802 series protocols and a TCP/IP network and transport protocol which ends at the DECT/LAN-Gateway (LAN - IWU- FP). The figure shows the situation where a wired data terminal equipment is running only a simple asynchronous start/stop layer 1 protocol without further network functions and connected to a DECT Cordless Terminal Adapter (with antenna) and the same situation where the data terminal equipment is dedicated to a DECT network and therefore has a built-in radio. The remote end system attached to the wired LAN is intended to be a host computer running TCP/IP with various applications on higher layer protocols (Layer 5-7).

Note that this approach is only one of many possibilities of attaching a DECT network to a LAN. The transportation of the data information can be provided by using the transparent unprotected service (TRUP), the frame relaying (FREL) or the frame switching service (FSWI) or one of the rate adaption services (BRAT or SRAT) and the higher layer information like the transport control protocol (TCP) need not end in the DECT/LAN-Gateway when the cordless terminal has the ability to handle higher layer protocols like TCP, NFS, etc.

4.3.1.3.1. Control Plane (C)

In the control plane the FP is shown as a built-in function of a gateway for the TCP/IP protocol running on the wired LAN and the DECT network layer protocol running on the DECT common air interface.



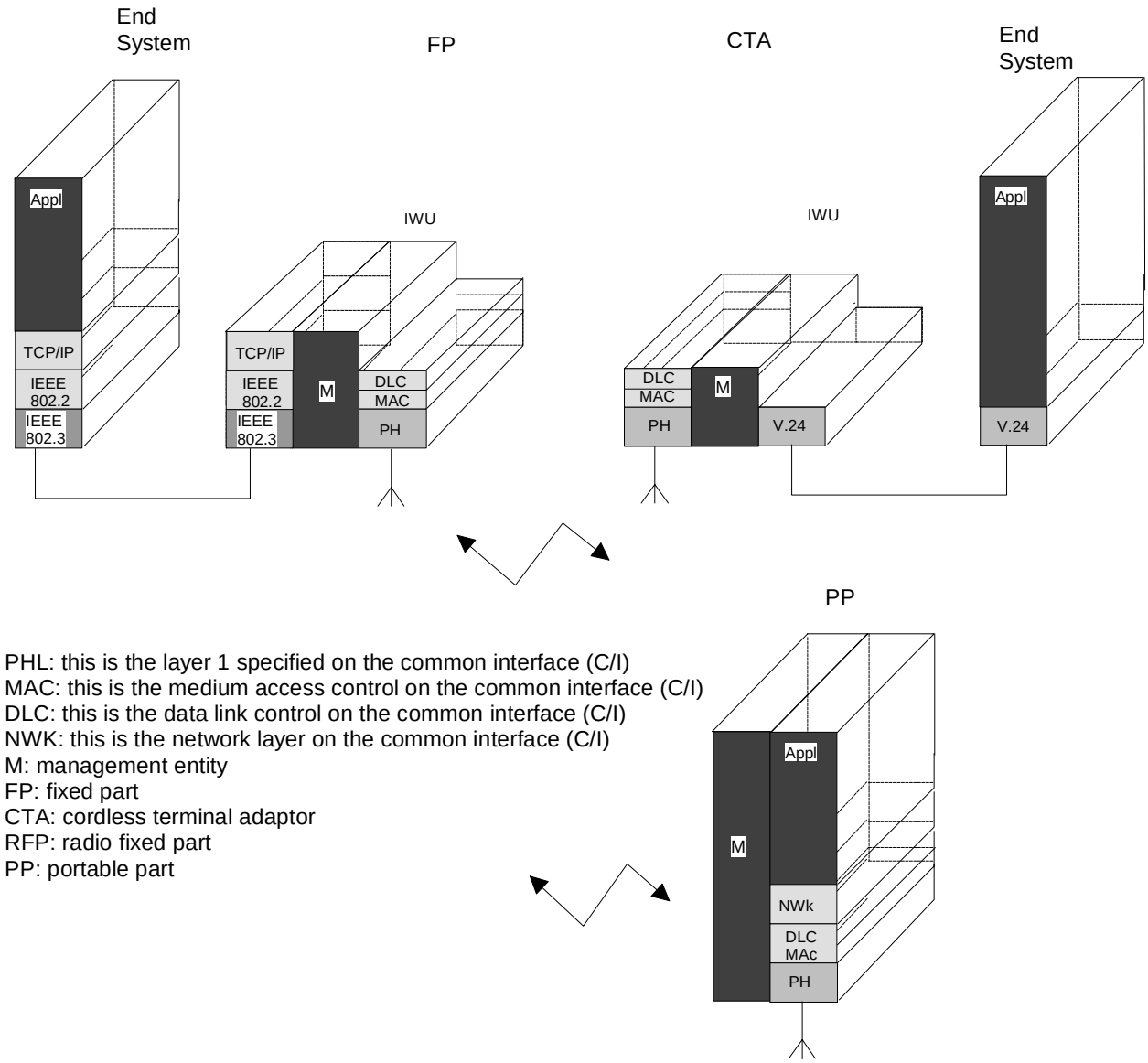
PHL: this is the layer 1 specified on the common interface (C/I)
MAC: this is the medium access control on the common interface (C/I)
DLC: this is the data link control on the common interface (C/I)
NWK: this is the network layer on the common interface (C/I)
M: management entity
FP: fixed part
CTA: cordless terminal adaptor
RFP: radio fixed part
PP: portable part

Fig 4-6 Protocol Architecture Model of the C plane in a DECT Single Cell System for Packet Data Communication by Attachment to a LAN

4.3.1.3.2. User Plane (U)

In the user plane the FP is shown as a built-in function of a gateway beetween the TCP/IP protocol (either connectionless or connection-oriented) running on the wired LAN and the DECT frame switching service (connection-oriented) on the DECT common air interface. Note that this approach is not the only possibility to provide a gateway for the traffic data since TCP/IP includes also higher layer information (transport layer) which could be transparently conveyed through the DECT network. Note also that for the time being the connection-oriented frame switching service is used in DECT but we could also figure to have a more convenient connectionless service in DECT (which is not yet defined).

Since it is assumed in this example that the end system at the DECT mobile network side has no functionality above layer 1 both CTA/PP and FP have to use the DLC frame switching service (FSWI) and the MAC protected data service (Ip).



PHL: this is the layer 1 specified on the common interface (C/I)
MAC: this is the medium access control on the common interface (C/I)
DLC: this is the data link control on the common interface (C/I)
NWK: this is the network layer on the common interface (C/I)
M: management entity
FP: fixed part
CTA: cordless terminal adaptor
RFP: radio fixed part
PP: portable part

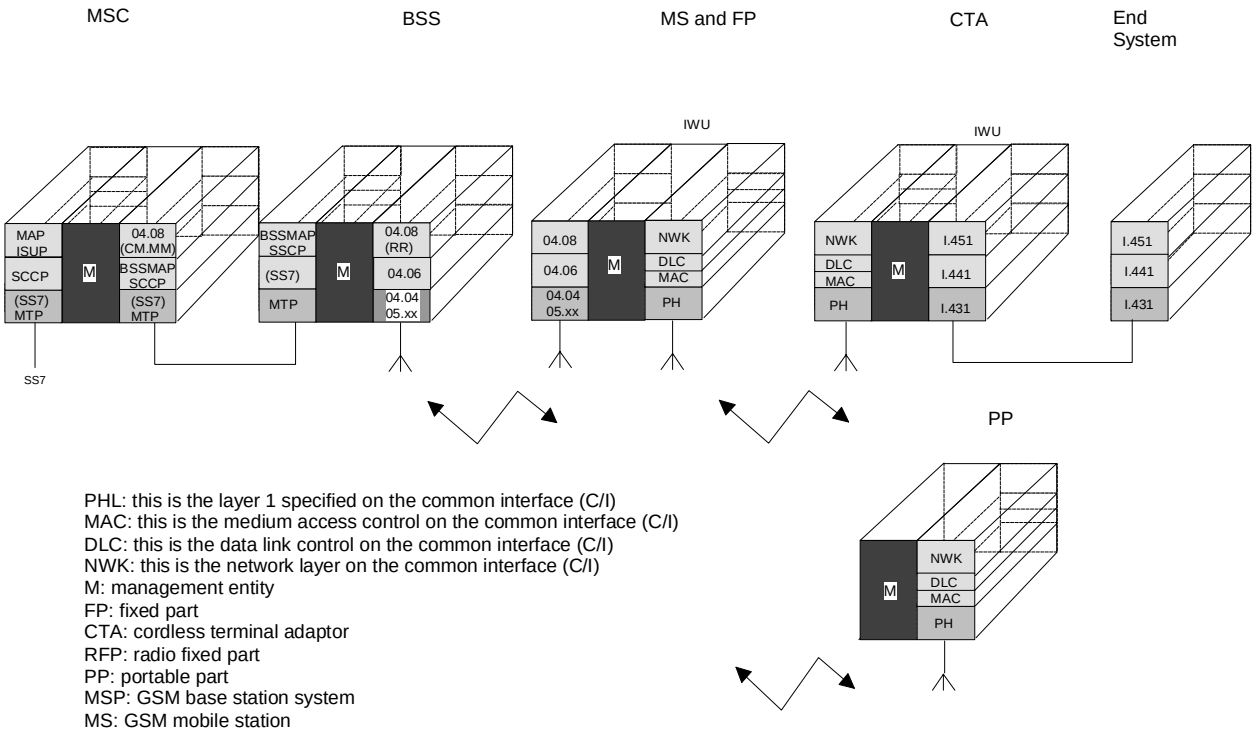
Fig 4-7 Protocol Architecture Model of the U plane in a DECT Single Cell System for Packet Data Communication by Attachment to a LAN

4.3.1.4. Mobile Public Access Service by Attachment to GSM

The following figure shows the situation of a DECT mobile public access service for telephony provided by a single cell system using the GSM network. For simplicity reasons the possible repartition of the GSM Base Station System into Base Station Controller and Base Station Transceiver is not done. Furthermore it is assumed that the GSM Mobile Station and the DECT FP are in the same unit (providing there the interworking function between DECT and GSM system). Not all the valuable recommendations can be shown in the protocol stacks since in GSM often more than one recommendation is applicable to a single layer.

4.3.1.4.1. Control Plane (C)

The following figure shows the mobile public access service on the control plane. It must be noted that in the GSM network various signalling system 7 functions are located above the OSI network layer 3 but some GSM 04.08 functions (connection management, mobility management) which are located in layer 3 on the GSM radio interface are using these SS7 functions in the local SS7 network between MSC and BSS. Therefore alle function of layer 3 and above in the GSM network are drawn in the following figure in layer 3.

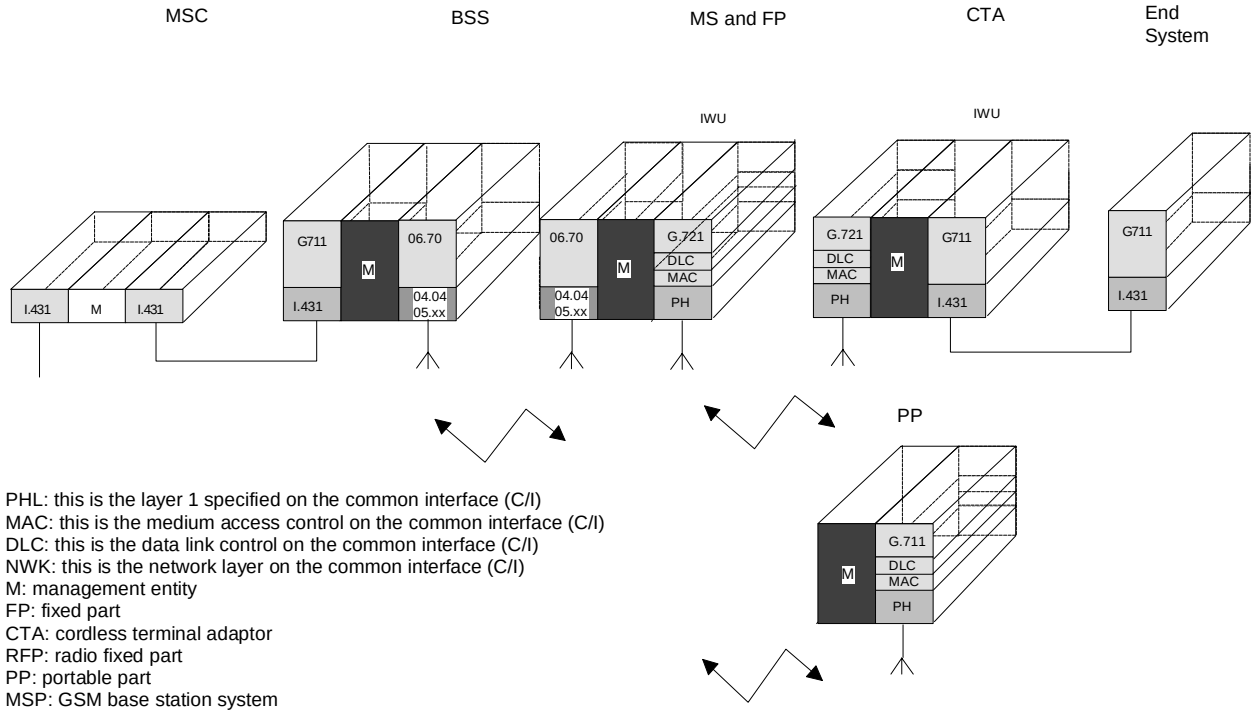


PHL: this is the layer 1 specified on the common interface (C/I)
MAC: this is the medium access control on the common interface (C/I)
DLC: this is the data link control on the common interface (C/I)
NWK: this is the network layer on the common interface (C/I)
M: management entity
FP: fixed part
CTA: cordless terminal adaptor
RFP: radio fixed part
PP: portable part
MSP: GSM base station system
MS: GSM mobile station

Fig 4-8 Protocol Architecture Model of the C plane in a DECT Single Cell System for a Mobile Public Access Telephony Service by Attachment to a GSM

4.3.1.4.2. User Plane (U)

It is assumed that the transcoding of the speech which is in the GSM radio path RPE-LTP according to the 06.xx series recommendations is done in the Base Station System of the local GSM network. The further transportation of the speech from the GSM Base Stations to the Mobile Switching Center and into the public network is performed by ISDN based interfaces according to the I-series recommendations using the G.711 coding.



PHL: this is the layer 1 specified on the common interface (C/I)
MAC: this is the medium access control on the common interface (C/I)
DLC: this is the data link control on the common interface (C/I)
NWK: this is the network layer on the common interface (C/I)
M: management entity
FP: fixed part
CTA: cordless terminal adaptor
RFP: radio fixed part
PP: portable part
MSP: GSM base station system
MS: GSM mobile station

Fig 4-9 Protocol Architecture Model of the U plane in a DECT Single Cell System for a Mobile Telepoint Telephony Service by Attachment to a GSM

4.3.2. Multi Cell Systems

In a DECT multi cell system the FP has physically distributed subgroups of functions which are located in so-called Radio Fixed Parts (RFP). Most of the logical functions however remains in a more or less centralised equipment which is typically built together with the Interworking Unit (IWU) which provides the gateway to the Local Network. Layer 2 of the DECT network on the fixed side therefore is in the most general case where only one cluster is designed physically splitted in the MAC sublayer (between MBC and TBC) between the centralised equipment and several RFPs. However there is no implication by the DECT C/I specifications at which function inside the DLC or inside the MAC or below the MAC or between the sublayers of layer 2 the repartition is to be done since it is still open to the manufacturers to cluster the FP in such a way that bearer handover can only be performed inside clusters (one or a group of RFPs).

Inter-cell handover may occur and can be handled by the DLC sublayer (connection handover) in the centralised equipment and PT or by the MAC sublayer (bearer handover) in the Common Control Function (CCF) and PT. The interface between the centralised equipment and the RFPs is manufacturer specific and is not of interest for the C/I specifications. The transportation of the messages on the physical media between the centralised equipment and the RFPs again is manufacturer specific and the management functions (LLME and System Management) which are spread over all lower layers have to communicate together by manufacturer specific messages.

Since the protocol stacks do not differ essentially from those drawn for the single cell systems except those which are manufacturer specific in its physical separation between RFP and a centralised equipment only the general approach for building multi-cell system is shown in the following picture.

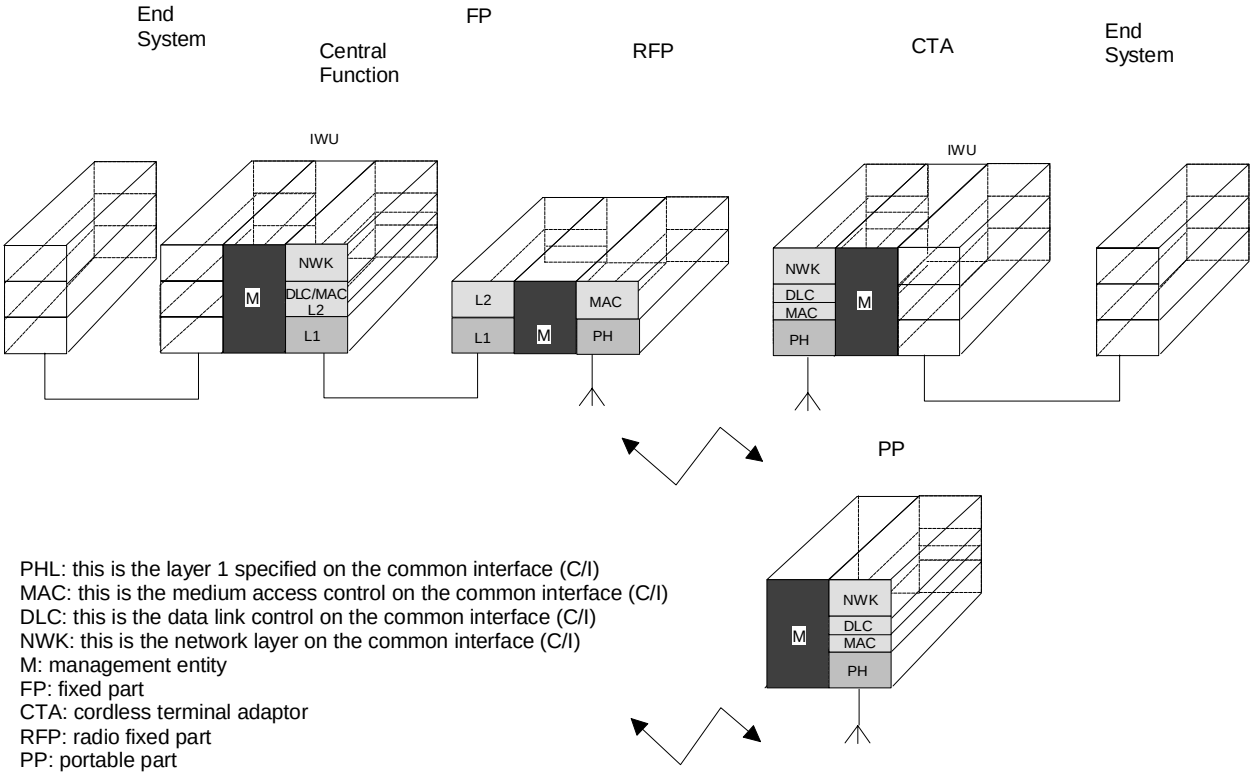


Fig. 4-10 General Protocol Architecture Model for DECT Multi Cell Systems

4.4. Sublayer Model

This chapter shows the sublayer model of the DECT network depicting the situation on the common air interface (C/I). Note that this situation shows the most general case in the common air interface with all possible options and is therefore more suitable to the DECT fixed part. It is used to classify the DECT network in a way like done in (50).

4.4.1. Graphical Presentation

This chapter describes the DECT network in a sublayer model which is repartitioned into U-plane and C-plane functions. It shows the location of each function belonging to layers, sublayers and entities. Furthermore the service access points for the attached local network and end system or interworking units are visible. Derivable from this model a classification of the network and the functions, procedures, primitives, services and procedures may be defined.

The following symbols are used in the graphical presentation of the sublayer model.

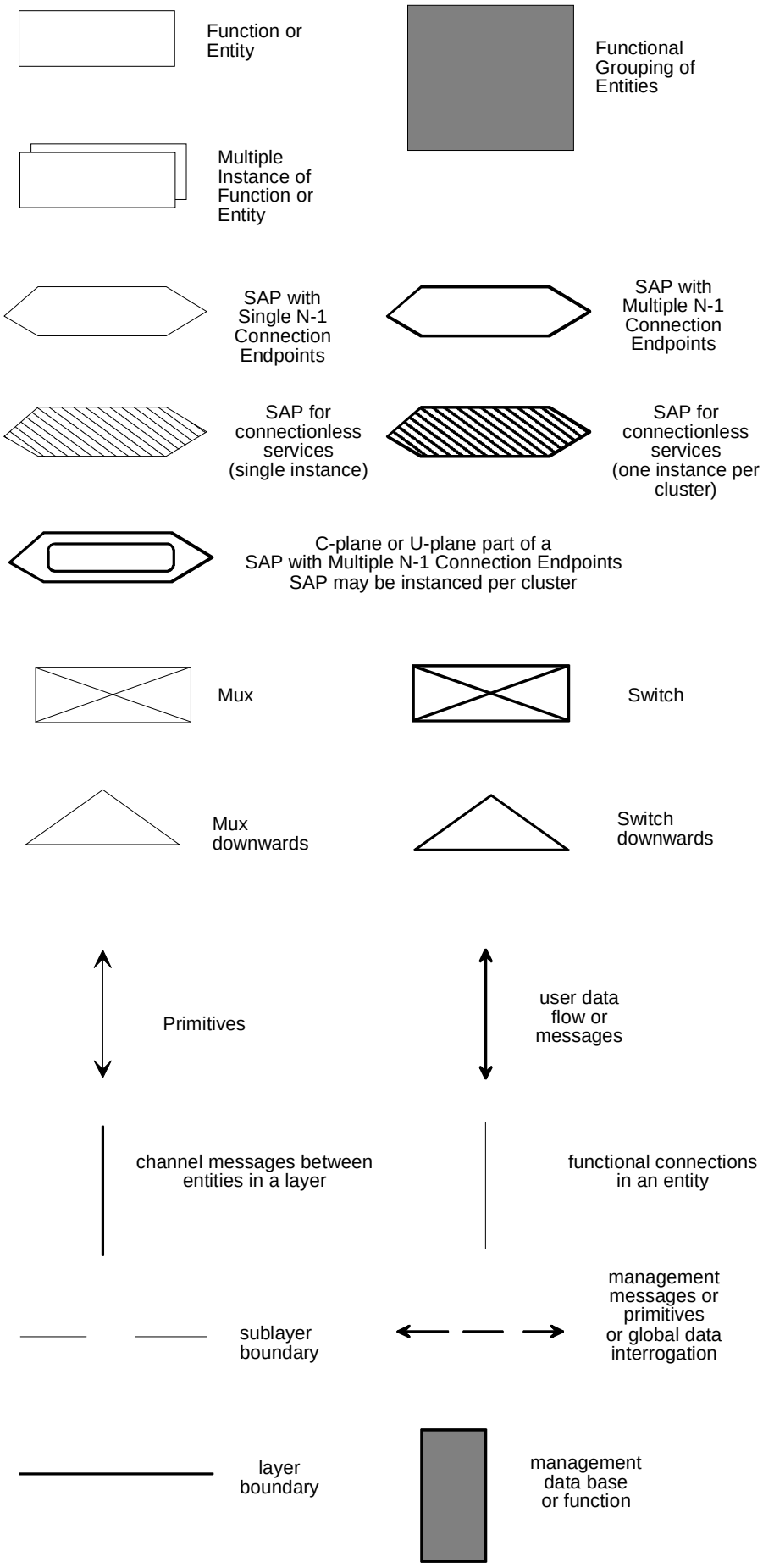


Fig. 4-11 Symbols for Sublayer Model Presentation

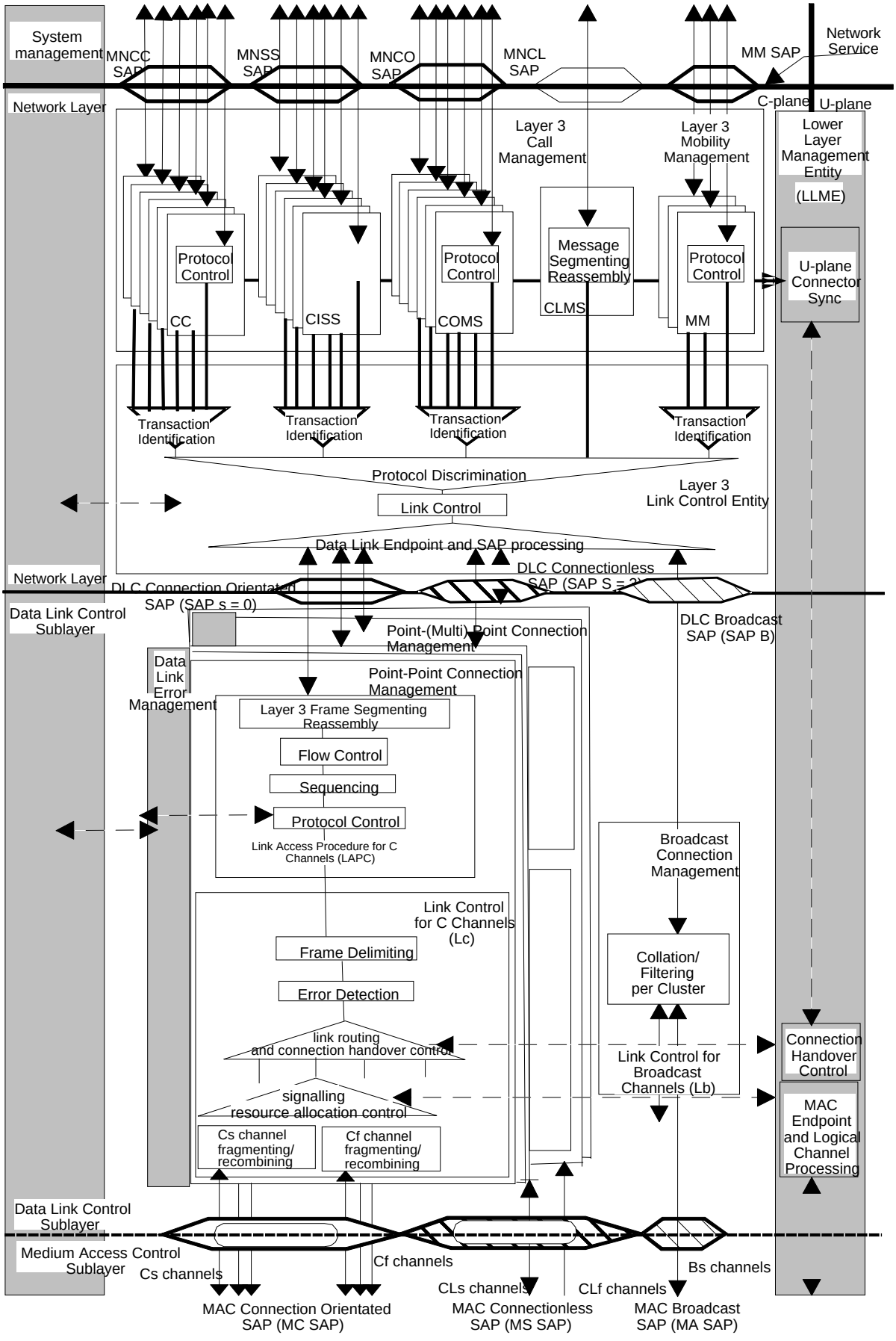


Fig. 4-12 Sublayer Model of a DECT Network (C-plane, NWK and DLC only)

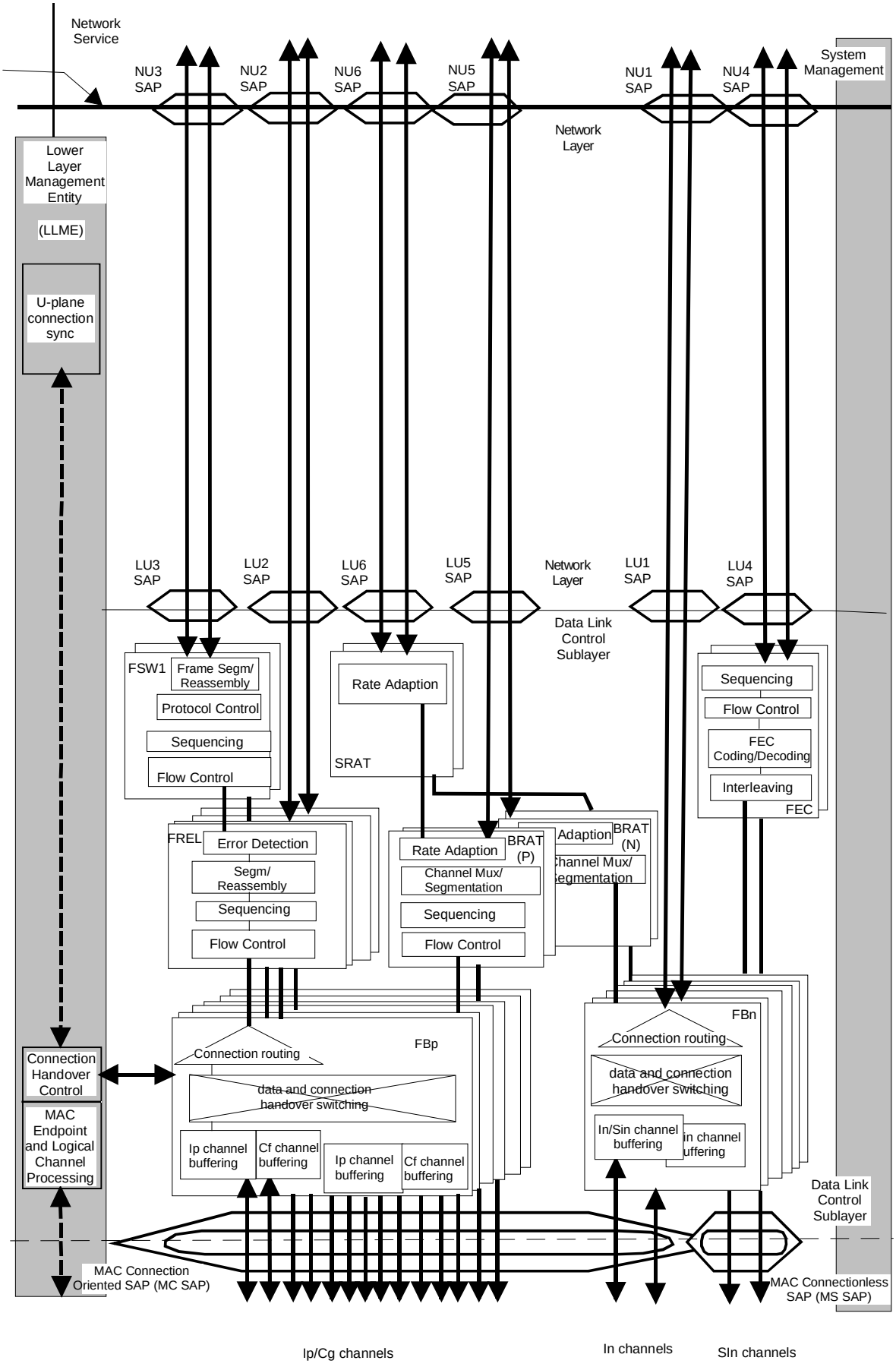


Fig. 4-13 Sublayer Model of a DECT Network (U-plane, NWK and DLC only)

4.4.2. Classification

This chapter describes the classification of the DECT network for signalling and data transfer for each sublayer according to (50).

Some of the functions in the DECT network do not fit into the classification scheme according to (50). These functions belong either to the mobile behaviour of the DECT subscribers (link routing and connection handover control) or to the special SAP based performance (signalling resource allocation control) or the fragmenting of signalling and traffic information (logical channel dependend fragmenting and recombining). These functions are not included in the following tables but are listed below the tables.

4.4.2.1. LU1 Transparent Unprotected Service (TRUP) in the User Plane (U)

This user plane service is intended to be used for the DECT telephony service and other speech services. It might be also used for transparent data services not supported by DECT. It is assumed that any data rate adaption or speech transcoding is done in the interworking units at the network service boundary and that the data at the LU1 SAP appears in a structured 32kbit/s (with 4kHz integrity) data stream. This service uses only the lower FBn entities in the DLC user plane. The PDU delimiting is set by the fixed length structure for FU1 frames.

Sublayer		DLC (LU1)	Layer 3	Combined
Segmenting/reassembly	c5	-	-	-
Sequencing	c4	-	-	-
Splitting	c3	-	-	-
Flow control	c2	-	-	-
Error control	c1	-	-	-
Connection qualification	b3	-	-	-
Remote SAP processing	b2	-	-	-
Local SAP processing	b1	-	-	-
Protocol version identificat.	a5	-	-	-
CC/DT/CL discrimination	a4	-	-	-
Error detection	-	-	-	
PDU delimiting	a2	fixed	-	fixed
Protocol identification	a1	-	-	-

Tab 4-3 Generic Layer Architecture Model (GLA) for the LU1 Transparent Unprotected Service (TRUP) in the User Plane (U)

This service includes the non-classified connection routing, data and connection handover switching and the In/SIn-channel buffering functions.

4.4.2.2. LU2 Frame Relay Service (FREL) in the User Plane (U)

This user plane service is intended to be used for the DECT data services for attached networks providing data services with LAPD/LAPB/LAPDm/LLC procedures at the data link level and controlling these data links end-to-end in the attached local network and the end system respectively. The functions provided in this service are similar to the described frame relaying service in (65) but does not contain the so-called "core" functions.

The service adds a checksum to the SDU, segments and provides error correction by using several transmission classes and frame types. It must be noted that the end-to-end frames which are flow controlled by the attached networks are not affected inside the service. If the frames contain zero insertion and flag delimiting, it is assumed that all flags and zero insertions are removed by the interworking unit at the sending side before the (stripped) frames are submitted to the DECT network. The flags and zero insertions may be restored by the interworking unit at the receive side if necessary. All of these procedures are outside the DECT network service provision boundary.

It must also be noted that in this service a non-classified sort of error detection (checksum) occurs at the top level of the sublayer classification, called "reassembly checking". A further error detection of the service is provided in the MAC sublayer and does not occur in this classification table.

This service uses only the FBp entities in the lower DLC user plane.

Sublayer		DLC (LU2)	Layer 3	Combined
Reassembly checking		o		o
Segmenting/reassembly	c5	o	-	o
Sequencing	c4	o	-	o
Splitting	c3	-	-	-
Flow control	c2	o	-	o
Error control	c1	o	-	o
Connection qualification	b3	o	-	o
Remote SAP processing	b2	o	-	o
Local SAP processing	b1	o	-	o
Protocol version identificat.	a5	-	-	-
CC/DT/CL discrimination	a4	-	-	-
Error detection	a3	-	-	-
PDU delimiting	a2	fixed	-	fixed
Protocol identification	a1	-	-	-

Tab 4-4 Generic Layer Architecture (GLA) Model for the LU2 Frame Relaying Service (FREL) in the User Plane (U)

This service includes the non-classified connection routing, data and connection handover switching, the Ip- and Gf-channel buffering functions.

4.4.2.3. LU3 Frame Switching Service (FSWI) in the User Plane (U)

This user plane service is intended to be used for the DECT data services for attached networks providing any data services not belonging to the class of LAPD/LAPB/LAPDm/LLC procedures or attached networks using these procedures but which are not able to adapt the timing requirements or congestion problems to the delayed air environment (and other reasons like throughput).

This service uses the upper FSWI entities which themself use the lower FREL and FBp entities in the DLC user plane.

It must be noted that this service has two serial stages of classification tables in the DLC user-plane since the FSWI service uses the FREL service which means that some sublayer functions like sequencing occur twice.

Sublayer		DLC (LU3)	Layer 3	Combined
Segmenting/reassembly	c5	o	-	o
Sequencing	c4	o	-	o
Splitting	c3	-	-	-
Flow control	c2	o	-	o
Error control	c1	o	-	o
Connection qualification	b3	-	-	-
Remote SAP processing	b2	-	-	-
Local SAP processing	b1	-	-	-
Protocol version identificat.	a5	-	-	-
CC/DT/CL discrimination	a4	-	-	-
Error detection	a3	o	-	o
PDU delimiting	a2	-	-	-
Protocol identification	a1	-	-	-

Sublayer		DLC (LU2	DLC (LU2 + LU3)
Reassembly checking		o	o
Segmenting/reassembly	c5	o	oo
Sequencing	c4	o	oo
Splitting	c3		-
Flow control	c2	o	oo
Error control	c1	o	oo
Connection qualification	b3	o	o
Remote SAP processing	b2	o	o
Local SAP processing	b1	o	o
Protocol version identificat.	a5	-	-
CC/DT/CL discrimination	a4	-	-
Error detection	a3	-	o
PDU delimiting	a2		fixed
Protocol identification	a1		-

Tab 4-5 Generic Layer Architecture (GLA) Model for the LU3 Frame Switching Service (FSWI) in the User Plane (U)

This service includes the non-classified connection routing, data and connection handover switching, the Ip- and Gf-channel buffering functions.

4.4.2.4. LU4 Forward Error Correction Service (FEC) in the User Plane (U)

This standard DECT user plane service is intended to be used for ISDN services like videphony which need a guaranteed throughput at the network service provision boundary. Further study is required to define the detailed functions of this user-plane service. The following table shows a first assumption of possible functions performed in this service.

This service uses the higher FEC entities which themself use the lower FBn entities in the DLC user plane.

Note that other FEC services which can not be provided by using the service at LU4 can be performed by another entity outside the DECT service provision boundary (in any layer above layer 3) and by using the DECT service provided at SAP LU1 (non-DECT FEC services) directly.

Sublayer		DLC (LU4)	Layer 3	Combined
Segmenting/reassembly	c5	o	-	o
Sequencing	c4	o	-	o
Splitting	c3	-	-	-
Flow control	c2	o	-	o
Error control	c1	o	-	o
Connection qualification	b3	o	-	o
Remote SAP processing	b2	o	-	o
Local SAP processing	b1	o	-	o
Protocol version identificat.	a5	-	-	-
CC/DT/CL discrimination	a4	-	-	-
Error detection	a3	o	-	o
PDU delimiting	a2	fixed	-	fixed
Protocol identification	a1	-	-	-

Tab 4-6 Generic Layer Architecture (GLA) Model for the LU4 Forward Error Correction Service (FEC) in the User Plane (U)

This service includes the non-classified connection routing, data and connection handover switching and the In/SIn-channel fragmenting and recombining functions.

4.4.2.5. LU5 Basic Rate Adaption Service (BRAT) in the User Plane (U)

This user plane service is intended to be used for data services of attached ISDN networks using the V.110 intermediate or ISDN standard data rates (8, 16, 32, 64). Higher data rates or multiple channels can be achieved by using several instances of the LU5 service. This service uses the higher BRAT entities which themself use the lower FBp (protected) or FBn (unprotected) entities in the DLC user plane.

The distinction between protected and unprotected service is defined by two transmission classes, class N for unprotected service, class P for protected service. Functions which are only provided in transmission class P are therefore shown in the following table.

The service gurarantees a constant throughput.

Sublayer		DLC (LU5)	Layer 3	Combined
Segmenting/reassembly	c5	-	-	-
Sequencing	c4	class P only	-	class P only
Splitting	c3	-	-	-
Flow control	c2	class P only	-	class P only
Error control	c1	-	-	-
Connection qualification	b3	o	-	o
Remote SAP processing	b2	o	-	o
Local SAP processing	b1	o	-	o
Protocol version identificat.	a5	-	-	-
CC/DT/CL discrimination	a4	-	-	-
Error detection	a3	-	-	-
PDU delimiting	a2	fixed	-	fixed
Protocol identification	a1	-	-	-

Tab 4-7 Generic Layer Architecture (GLA) Model for the LU5 Basic Rate Adaption Service (BRAT) in the User Plane (U)

This service includes the non-classified connection routing, data and connection handover switching, the Ip- and Gf-channel buffering functions for class P transmission and In channel buffering for class N transmission.

4.4.2.6. LU6 Secondary Rate Adaption Service (SRAT) Service in the User Plane (U)

This user plane service is intended to be used for data services of attached networks using data rates not associated with standard ISDN intermediate or full ISDN data rates. This service uses the higher SRAT entities which themself use the lower BRAT and FBp entities in the DLC user plane.

It must be noted that this service has two stages of classification in the DLC user-plane since the SRAT service uses the BRAT service which means that some sublayer functions may occur twice.

Since the LU6 service is for further standardisation, no detailed functions can be classified in the first of the following tables.

Sublayer		DLC (LU6)	Layer 3	Combined
Segmenting/reassembly	c5	-	-	-
Sequencing	c4	-	-	-
Splitting	c3	-	-	-
Flow control	c2	-	-	-
Error control	c1	-	-	-
Connection qualification	b3	-	-	-
Remote SAP processing	b2	-	-	-
Local SAP processing	b1	-	-	-
Protocol version identificat.	a5	-	-	-
CC/DT/CL discrimination	a4	-	-	-
Error detection	a3	-	-	-
PDU delimiting	a2	-	-	-
Protocol identification	a1	-	-	-

Sublayer		DLC (LU5)	DLC (LU5 + LU6)
Segmenting/reassembly	c5	-	-
Sequencing	c4	class P only	class P only
Splitting	c3	-	-
Flow control	c2	class P only	class P only
Error control	c1	-	-
Connection qualification	b3	o	o
Remote SAP processing	b2	o	o
Local SAP processing	b1	o	o
Protocol version identificat.	a5	-	-
CC/DT/CL discrimination	a4	-	-
Error detection	a3	-	-
PDU delimiting	a2	fixed	fixed
Protocol identification	a1	-	-

Tab 4-7 Generic Layer Architecture (GLA) Model for the LU6 Service in the User Plane (U)

This service includes the non-classified connection routing, data and connection handover switching, the Ip- and Gf-channel buffering functions for class P transmission and In channel buffering for class N transmission.

4.4.2.7. Point-(Multi-)Point Connection Management in the Control Plane (C)

The point-point and point-multipoint connection management in the control plane is intended to transport safely the upper layer signalling information for point-to-point connections and upper layer connectionless signalling and data information for point-multipoint configurations.

Sublayer		DLC LAPC	DLC Lc	DLC Combined	Layer 3
Segmenting/reassembly	c5	o	-	o	-
Sequencing	c4	o	-	o	-
Splitting	c3	-	-	-	-
Flow control	c2	o	-	o	-
Error control	c1	o	-	o	-
Connection qualification	b3	-	o	o	o
Remote SAP processing	b2	-	o	o	o
Local SAP processing	b1	-	o	o	o
Protocol version identificat.	a5	-	-	-	-
CC/DT/CL discrimination	a4	-	-	-	o
Error detection	a3	-	o	o	-
PDU delimiting	a2	-	o	o	o
Protocol identification	a1	-	-	-	o

Tab 4-7 Generic Layer Architecture Model (GLA) for the Point-(Multi-)Point Connection Management in the Control Plane (C)

This service includes the non-classified signalling and connection handover control , the signalling resource allocation control and the Cs- or Cf-channel fragmenting and recombining functions.

4.4.2.8. Broadcast Connection Management in the Control Plane (C)

The broadcast connection management in the control plane is intended to broadcast any upper layer information.

This service is unidirectional from the FT to the PTs only and uses unacknowledged information transfer (class U).

Sublayer		DLC Lb	Layer 3
Segmenting/reassembly	c5	-	-
Sequencing	c4	-	-
Splitting	c3	-	o
Flow control	c2	-	-
Error control	c1	-	o
Connection qualification	b3	-	o
Remote SAP processing	b2	o	o
Local SAP processing	b1	o	o
Protocol version identificat.	a5	-	-
CC/DT/CL discrimination	a4	-	o
Error detection	a3	-	-
PDU delimiting	a2	-	o
Protocol identification	a1	-	o

Tab 4-8 Generic Layer Architecture Model (GLA) for the Broadcast Connection Management in the Control Plane (C)

4.4.3. Functions

This chapter describes the function of each entity of the sublayer model.

4.4.3.1. Functions of the DLC Entities

4.4.3.1.1. Functions of the Point-(Multi-)Point Connection Management Entities (C-plane)

It must be noted that a DLC sublayer entity in the C-plane may have several point-point data link control entities at a time (multiple instance entities) and typically one point-multipoint data link control entity. The instancing of data link endpoints inside the S SAP between the network layer and a LAPC entity is done by using the Data Link Endpoint Identifier (DLEI) which is a combination of SAPI, LLN and MCEI.

4.4.3.1.1.1. Functions of the Link Access Procedure for the C Channels (LAPC)

A LAPC entity may handle acknowledged and unacknowledged information transport for signalling requested and indicated at the service access points S. The link access procedure LAPC can operate in three modes: class U (unacknowledged service), class A (single frame acknowledged service) or class B (multiple frame acknowledged service). Typically one instance of a LAPC entity works together with one instance of a Lc entity. This is not valid in connection handover situations (where temporarily two Lc instances exist) or when a LAPC entity in operation class A or B and a LAPC entity in operation class U use together one MAC connection.

4.4.3.1.1.1.1. Layer 3 Frame Segmenting and Reassembly

This functions provides means to segment and reassembly layer 3 frames exceeding the maximum length allowed. The maximum length should be unique (63 octets) for all frames independently of the service used at the MAC sublayer. A more data bit will be used to indicate portions of segmented layer 3 signalling information.

4.4.3.1.1.1.2. Flow Control

This function provides means to control the flow of frames. An acknowleged information transfer is applicable (multiple frame operation in class B and single frame operation in class A) and retransmission of unacknowledged frames will be undertaken. Modulo 8 operation by using a window size of 3 will be applicable for class B operation and a modulo 2 operation by using window size 1 for class A operation. Suspension and resumption of data flow during handover can be provided by use of a special bit (NLF-bit) in any LAPC frame but only in the case of class B operation.

This function can be switched off for class U unacknowledged information transport on DLC level. This unacknowledged service will be indicated by the network layer and reported to the network layer using different primitives at service access point S.

4.4.3.1.1.1.3. Sequence Control

This function provide means to control the correct sequence of the frames. It maintains the sequential order of frames across a data link connection.

This function can be switched off for class U unacknowledged information transport on DLC level. This unacknowledged service will be indicated by the network layer and reported to the network layer using different primitives at service access point S.

4.4.3.1.1.1.4. Protocol Control

This function controls the data link protocol for multiple frame operation in class B and single frame operation in class A. It establishes and releases the data link connection requested by the network layer according to the protocol rules of the specified class A or B and detects formats and operational errors on the data link. It initialises recovery procedures on the detected errors and notifies the corresponding error management entity in case of non-recoverable errors. This protocol control includes means to free and assess instances of protocol control procedures requested by a system management entity to allow the dynamical behaviour of users in a DECT system. A HDLC protocol like (52) is used with additional means

to allow temporary suspension of data links (indicated by specific primitives from the network layer) which enables the DLC entity to free the associated MBC functions in the MAC layer and therefore the radio resources used for signalling and information transport (class B only).

This function is different when class U unacknowledged information transport service is required. Only queuing of messages would be provided by LAPC in this case and the establishment and release of the radio resources when no message is in the queue is not foreseen.

4.4.3.1.1.2. Functions of the Link Control for the C Channels (Lc)

A Lc entity has a one-to-one relationship with the MACs MBC or CMC entity carrying signalling information at the MC or MB SAPs. The Lc for point-point connections and its corresponding MBC entity use the MAC connection identifier (MCEI) to address each other through the cluster-specific MC SAP. The logical channels Cs and Cf (SAP MC) are used for this kind of layer-to-layer communication. The Lc for connectionless connections and its corresponding CMC entity do not need a connection qualification since only one endpoint is allowed. The logical channel CLs or CLf (SAP MB) are used for this kind of layer-to-layer communication.

Typically one instance of a LAPC entity works together with one instance of a Lc entity. In connection handover situations where temporarily two MBC connections coexist for one signalling data link the two instanced Lc entities (one per MBC) coordinate together with the LLME the information flow of the signalling information to the LAPCs.

4.4.3.1.1.2.1. Frame Delimiting

This function provides means to recognize the length of a LAPC frame. The function will be performed by using a length indicator like (52) instead of zero-bit insertion/deletion like in (58) and the checksum field which allows to resynchronise. The length is a multiple of the logical channel based fragmenting scheme and the non-used octets are filled with fill fields.

4.4.3.1.1.2.2. Error Detection

This function provides means to recognize transmission errors over a complete LAPC frame. Frames will be ignored when such an error occurs. A simple checksum field of 2 octets to recognize possible slot thefts in the MAC sublayer will be used.

4.4.3.1.1.2.3. Link Routing and Connection Handover Control

This function performs the physical routing of signalling frames to the different RFPs or Clusters in the DECT fixed part when performing connection handover. In case of connection handover it updates the data base of routing of data link connections and physical routings of data links in multi-cell systems to different MBC functions and serves as temporary multiplexor during connection handover for one LAPC entity. This function performs the connection qualification of the Lc entity which is provided by the Logical Link Number (LLN) in the DLC header field. The dynamical allocation of the Logical Link Number during link establishment will allow future multi-links per PT in the C-plane and determines additionally the class of operation of the LAPC entities. The dynamical allocation of the LLN is very simple when only one LAPC entity and class A operation is required. The LLN is automatically freed when the LAPC entity is released. This function also administrates an internal addressing to the MAC sublayer (MCEI) in order to allow the addressing of the various instances of MAC connection endpoints in the MAC connection orientated SAP (MC SAP) to the MAC sublayers MBC function. The Data Link Endpoint Identifier (DLEI) will provide a unique identification for each signalling data link existing in the FT.

The Link Routing and Connection Handover Control works closely together with the Connection Handover Control entity in the LLME which synchronises the connection handover for C-plane and U-plane.

4.4.3.1.1.2.4. Signalling Resource Allocation Control

This function allocates and deallocates signalling resources in the MAC sublayer by using the appropriate primitive services. It performs the local and remote SAP processing of the Lc entity by reading and writing to the correct MAC logical channel (either Cs or Cf) inside the MAC connection orientated SAP (MC SAP). The allocation is based on primitive parameters acquired by layer 3 entities which define the needed signalling resources. This function is also responsable to control the user data flow through the different user data channels inside the MAC connection orientated SAP to the MAC sublayer by management functions in the LLME since user data and signalling may compete for the same MAC channel resources. It can provide information by means of protocol elements to its peer entity indicating the use of the services in the MAC sublayer and negotiate a changement of a MAC service use during the life of a data link (i.e. in the established phase). It must be able to treat changements of channel requirements during a data link connection. The changements are indicated by parameterised primitives from the network layer and have also influence to the LLME which controls the user data flow. If a call (in the meaning of layer 3) uses several MAC traffic bearers (multi-channel connection) then this function has to decide about the allocation of the signalling data link frames onto which of all MBC functions (which itself may allocate several traffic beareres) used in the MAC sublayer. Note that a Lc entity is only allowed to use one MAC MBC function for the transportation of all the signalling data but the Lc entity may use a separate (separate from the U-plane) MBC entity only for the transportation of signalling (by using Cf channel only). Note also that one Lc instance always process one MAC connection endpoint (MCE) and one pair of Cs/Cf channels.

The Signalling Resource Allocation Control works closely together with the MAC Endpoint and Logical Channel Processing entity in the LLME since only the LLME can supervise one MAC connection which serves the C-plane and U-plane information provided by Lc and FUx entities.

4.4.3.1.1.2.5. Cf/Cs-channels fragmenting/recombining

These functions allow to fragment and recombine the complete LAPC frames into portions according to the performance of the used logical channels (Cs or Cf) at the MAC sublayer boundary (MA SAP).

4.4.3.1.1.2.6. CLf/CLs-channels fragmenting/recombining

These functions allow to fragment and recombine the complete LAPC frames into portions according to the performance of the used logical channels (CLs or CLf) at the MAC sublayer boundary (MB SAP).

4.4.3.1.2. Functions of the Broadcast Connection Management Entities

The Broadcast Connection Management (Lb) is intended to carry mainly paging information from/to the LCE by using the MACs Bs logical channel (MA SAP) but may also be used for other broadcasted messages which only need a slow broadcast channel.

4.4.3.1.3. Functions of the Frame Relay (FREL) entity

These functions are intended to be used as upper or medium DLC user plane functions for the DECT standard Frame Relay Service (FREL) which is accessable directly at the LU2 service access point. These functions can also be accessed by an upper Frame Switching (FSWI) entity. The complete Frame Relay Service is only performed together with the lower DLC user plane FBp entity which produces frames of the FU4, FU5 and FU6 scheme and several transmission classes.

4.4.3.1.3.1. Error Detection

This function provides means detect errors of the complete Service Data Unit (SDU). A checksum will be added to the SDU in order to provide this function.

4.4.3.1.3.2. Segmenting and Reassembly

This function provides means to segment and reassembly the SDU plus checksum exceeding the maximum length of one PDU (32 octets) supplied to the MAC.

4.4.3.1.3.3. Flow Control

This function provides means to control the flow of one frame which is set to one Protocol Data Unit (PDU).

4.4.3.1.3.4. Sequence Control

This function provide means to control the correct sequence of the frames. It maintains the sequential order of frames across the user plane data link connection.

4.4.3.1.4. Functions of the Frame Switching (FSWI) entity

These functions are intended to be used as upper DLC user plane functions for the DECT standard Frame Switching Service (FSWI) which is accessable at the LU3 service access point. The complete Frame Switching Service is only performed together with the lower DLC user plane FREL and FBp entity. This kind of HDLC protocol is called LAPU.

4.4.3.1.4.1. Frame Segmenting and Reassembly

This function provides means to segment and reassembly higher layer frames exceeding the maximum length allowed for LAPU frames

4.4.3.1.4.2. Flow Control

This function provides means to control the flow of LAPU frames. Probably the same control mechanism as for LAPC frames will be applicable.

4.4.3.1.4.3. Sequence Control

This function provide means to control the correct sequence of the LAPU frames. It maintains the sequential order of frames across the user plane data link connection.

4.4.3.1.4.4. Protocol Control

This function controls the data link protocol for LAPU acknowledged operation. It establishes and releases the data link connection when the MAC sublayer has been established or released by C plane signalling procedures and the LLME indicates the start or stop of operation.

4.4.3.1.5. Functions of the Forward Error Correction (FEC) entity

These functions are intended to be used as upper DLC user plane functions for the DECT standard Forward Error Correction Service (FEC) which is accessable at the LU4 service access point. The complete Forward Error Correction Service is only performed together with the lower DLC user plane FBn entity.

4.4.3.1.5.1. Sequence Control

FEC sevices are for further standardisation.

4.4.3.1.5.2. Flow Control

FEC sevices are for further standardisation.

4.4.3.1.5.3. FEC coding/decoding

FEC sevices are for further standardisation.

4.4.3.1.5.4. Interleaving

FEC sevices are for further standardisation.

4.4.3.1.6. Functions of the Basic Rate Adaption (BRAT) entity

These functions are intended to be used as upper DLC user plane function for the DECT Basic Rate Adaption Service (BRAT) which is accessable at the LU5 service access point. The complete Rate Adaption Service is only performed together with the lower DLC user plane FBp or FBn entity.

4.4.3.1.6.1. Rate Adaption

This function performs the rate adaption of data information arriving at the network service provision boundaries from networks using the rate adaption mechanism [66] in an ISDN circuit-switched environment and those used in a GSM PLMN as described in [39]. Only the DECT standard intermediate rate will be performed at this level. Other data rates can be performed by using first the Secondary Rate Adaption entity.

4.4.3.1.6.2. Channel Multiplexing and Segmenting

This function provides means to multiplex individual channels into multi-channel sets (MCS) and to segment these multi-channel sets into frames (FU5 frames for class P, protected operation, and FU1 frames for class N, unprotected operation).

4.4.3.1.6.3. Sequencing

This function is only performed in case of class P operation. The required transmission class for FU5 frames determines the way of operation.

4.4.3.1.6.4. Flow Control

This function is only performed in case of class P operation. The function provides means to control the flow of the FU5 frames.

4.4.3.1.7. Functions of the Secondary Rate Adaption (SRAT) entity

These functions are intended to be used as upper DLC user plane function for the DECT Secondary Rate Adaption Service (SRAT) which is accessable at the LU6 service access point. The complete Rate Adaption Service is only performed together with the BRAT and the lower DLC user plane FBp or FBn entity.

4.4.3.1.7.1. Rate Adaption

This function performs the rate adaption of data information arriving at the network service provision boundaries from networks using non-ISDN intermediate or full data rates. The function here provides rate adaption to one of the intermediate rates supported by the BRAT service.

4.4.3.1.8. Functions of the Frame Buffering Entity for the In/SIn Channels (FBn)

4.4.3.1.8.1. Connection Routing

This function is used to route and multiplex the data flow of the upper DLC U-plane entities to the correct logical channels (MAC bearers) in the case of multi-bearer connections.

4.4.3.1.8.1.1. Data and Connection Handover Switching

This function is used to switch the data flow of the upper DLC U-plane entities to the correct RFPs as well as to the correct bearers in connection handover situations. The function is also responsable for the connection qualification. In case of connection handover the function must perform the rerouting of the data flow controlled by the Connection Handover Control entity in the LLME.

4.4.3.1.8.1.2. In/SIn-channel buffering

This function buffers the data flow according to the fragmentation rules given by the logical channel within the layer-to-layer communication to the MAC.

4.4.3.1.9. Functions of the Frame Buffering Entity for the Ip/Gf Channels (FBp)

4.4.3.1.9.1. Connection Routing

This function is used to route and multiplex the data flow of the upper DLC U-plane entities to the correct logical channels (MAC bearers) in the case of multi-bearer connections.

4.4.3.1.9.1.1. Data and Connection Handover Switching

This function is used to switch the data flow of the upper DLC U-plane entities to the correct RFPs as well as to the correct bearers in connection handover situations. The function is also responsable for the connection qualification. In case of connection handover the function must perform the rerouting of the data flow controlled by the Connection Handover Control entity in the LLME.

4.4.3.1.9.1.2. Ip/Gf-channel buffering

This function buffers the data flow according to the fragmentation rules given by the logical channel within the layer-to-layer communication to the MAC.

4.4.3.2. Functions of the NWK Entities

4.4.3.2.1. Functions of the Call Management Entities (C-plane)

4.4.3.2.1.1. Call Control (CC)

It must be noted that this function is multiplied per instance of call control procedure and they are independent from each other (parallel transactions).

4.4.3.2.1.1.1. Protocol Control

The function of the protocol control is to establish, maintain and release a circuit-switched connection for circuit switched communication. It also contains the procedures to perform call-related supplementary services of all type of terminals and call independent supplementary services of stimulus type terminals. A protocol similar to (54, 59 and 60) is used. A call control entity uses the connection-orientated data link layer service at service access points S (multiple or single frame operation and unacknowledged information). The type of operation requested depends on the protocol used in the CC protocol control itself and on the grade of service needed for the signalling of the teleservice which is processed by one CC entity. Note all services of the DLC will use a connection-orientated and acknowledged information transport in the MAC sublayer.

4.4.3.2.1.2. Call Independent Supplementary Services Control (CISS)

It must be noted that this function is multiplied per instance of call control procedure and they are independent from each other (parallel transactions).

4.4.3.2.1.2.1. Protocol Control

The function of the protocol control is to establish, maintain and release a communication outside the context of a call. It serves to administrate call independent supplementary services like call forwarding between the network provider and the users. A protocol control like used in (53) would be applicable. A CISS entity may use the connection-orientated data link layer service at service access points S (multiple or single frame operation or unacknowledged information). The type of operation depends on the protocol used in the CISS protocol control itself and on the grade of service needed for signalling of CISS services between user and network. Note that all services of the DLC will use a connection-orientated and acknowledged information transport in the MAC sublayer.

4.4.3.2.1.3. Connection Orientated Message Service (COMS)

It must be noted that this function is multiplied per instance of connection orientated message service procedure and they are independent from each other (parallel transactions).

One application of the COMS is the use of the DECT signalling path for terminals operating in a very bursty mode. These terminals may establish a network layer call and a data link by not using all the time the radio resources (MAC establish/release during the call and data link suspension/resumption). In this case the COMS would allow to convey data through the DECT signalling path (C-plane) by using a connection-orientated DLC service. A COMS entity has never an associated data link in the user plane.

4.4.3.2.1.3.1. Protocol Control

The function of the protocol control is to establish and release a connection orientated message service connection.

4.4.3.2.1.4. Connectionless Message Service (CLMS)

It must be noted that this function is not instanced since it is a single connectionless network layer service and is unidirectional in the FT to PT direction. Therefore no transaction identifier is needed.

One possible application of this entity is the use of the DECT signalling path of FP which are used to broadcast network layer system information or interworking unit information to all or a part of their PP. A typical application is located in key telephone systems which normally supply their subscribers with system-wide information (e.g. busy subscribers, time, etc.). This service would typically use a connectionless (multicast/broadcast) service of the DLC by using the service access point B or S (SAPI=3).

4.4.3.2.1.4.1. Message Segmenting/Reassembly

The function of the message segmenting/reassembly is to send and receive messages in a connectionless way and to segment/reassembly them according to the frame lengths defined at SAP B or SAP S=3 respectively.

4.4.3.2.2. Functions of the Mobility Management Entities (C-plane)

4.4.3.2.2.1. Mobility Management (MM)

It must be noted that this function is multiplied per instance of mobility management procedure and they are independent from each other (parallel transactions). It is possible that a restriction to one or two instances of mobility management procedures per PT will be defined.The function of the mobility control in the mobility management is to support the mobility of the user terminals, such as informing the network of its present location and providing user identity confidentiality. Authentication procedures and the security algorithms will be performed in this control entity and the exchange of data to the HDB and VDB located in the local network will be enabled by using the MM SAP.

4.4.3.2.2.1.1. Protocol Control

The function of the protocol control is to send and receive mobility management messages according to the rules of the mobility management protocol.

4.4.3.2.3. Function of the Link Control Entity LCE (C-plane)

This entity forms the very lowest part of the network layer in the C-plane. The LCE does not perform any peer-to-peer protocol except for paging procedures.

4.4.3.2.3.1. Transaction Identification

This function multiplexes the various transactions in each network layer protocol type to the connection management. It uses a transaction identifier (TI) which distinguishes between the different instances (54). This function should be able to dynamically allocate new instances of protocol control entities when new transactions have been recognized.

4.4.3.2.3.2. Protocol Discrimination

This multiplexing function provides the separation of the protocol message flow to the different protocol types and entities by using a protocol discriminator (PD) (54).

4.4.3.2.3.3. Link Control

This function handles paging messages when no appropriate connection-orientated data link is available for a new PT at the S SAP. It also allows to relate new established data links with proviously broadcasted paging messages and can buffer network layer messages during the paging procedure. The link control uses the B SAP for the first paging request message.

4.4.3.2.3.4. Data Link Endpoint and SAP Processing

This function selects the correct primitive service to the data link layer and establishes and releases point-point data link connections for the S SAP to the DLC. It administrates an internal addressing (DLEI) to allow addressing of different data link endpoints inside the S SAPs to the point-point data link connection management.

4.4.3.3. Functions of the Low Layer Management Entity (LLME)

The functions of this entity is to handle the data base for the different sublayers and to serve as interactor of the functions in the control and user plane.

4.4.3.3.1. Connection Handover Control

The function of Low Layer Management Entity for the Link Control Entities (Lc,FBx) is to administrate the relationship of the different entities in the C and U plane. In the simplest cases (e.g. telephony service) the LLME serves as driver for the data and connection handover function in the FBn entity. In more complicated applications like the frame relaying service for a data call it handles the start and stop of the data traffic in the U plane by indication of the C plane entity and administrates the relationship of the diffenent instances of Link Control Entities in both planes. In the case of connection handover the LLME must perform a synchronous switching of U and C planes for traffic data and signalling and rearrange the relationship of entities in both planes after the completion of the connection handover process.

4.4.3.3.2. MAC Endpoint and Logical Channel Processing

This entity administrates the MAC endpoints for both C-plane and U-plane MAC connections. It uses supervisory states (open, close, etc.) for these MAC connections and decides about the allocation of MAC connection types and used logical channels for an identified network layer call. It works closely together with the network layer based U-plane Connection Synchronisation entity in the LLME.

4.4.3.3.3. U-plane Connection Synchronisation

This entity informes the DLC based MAC Endpoint and Logical Channel Processing entity about the needed resources in the U-plane for a specific network layer call. It also switches the NUx SAPs U-plane data flow according to the C-plane based procedures in the network layer connection management.

Annex C: Identities and addressing

This Annex contains Chapter 5 of the DECT System description document, and consists of pages numbered 5.1 to 5.21 (i.e. 21 pages).

Chapter 5

Identities and adressing

5 Identities and addressing

5.1 Version history

Version 05.01 revised after the RES3-N meeting in London 4-5/12 -91
- Introduced internal and external handover.

Version 06.00 released at the RES3 meeting 10-14/6 -91 in Guernsey
This version of Chapter 5 has gone through a major cut down of the content, due to the creation of CI Part 6 "Identities and addressing". All detailed information that earlier was in this Chapter has been moved into CI 6. The aim of Chapter 5 is to be an introduction to the DECT identities.

Version 06.01
Only minor editorial changes.

5.2 Introduction

This chapter briefly describes the identity structure of DECT and mainly the following identities:

- Fixed Part (FP) Identities
- Portable Part (PP) Identities

Fixed Part Identities and **Portable Part Identities**
are used for:

- Access information from Fixed Parts to Portable Parts.
- Access requests from Portable Parts
- Identification of Portable Parts.
- Identification of Fixed Parts and Radio Fixed Parts.
- Paging
- Billing

These identities support:

- Different environments, such as residential, public or private.
- Supply to Manufacturers, Installers and Operators of globally unique identity elements with a minimum of central administration.
- Multi access rights for the same portable.
- Large freedom for Manufacturers, Installers and Operators to structure the FP identities, e.g. to facilitate provision of access rights to groups of DECT systems.
- Roaming agreements between DECT Networks run by the same or different owners/operators.
- Indication of handover domains.
- Indication of location areas, i.e paging areas.
- Indication of subscription areas of a public service.

These identities are **not** used for:

- User authentication

5.3 Definitions

This section gives a short definition of all the major identities. More details can be found in the sections indicated below.

ARC: Access Rights Class, shows the type of access to a DECT Network, such as public, residential or private.

ARD: Access Rights Details, is a unique number within one ARC.

ARI: Access Rights Identity (section 5.5), is, to a service provider, a globally unique identity that shows the access rights related to that service provider. The ARI consists of an ARC and an ARD. There are three categories of ARI:s;

- PARI, Primary ARI
- SARI, Secondary ARI
- TARI, Tertiary ARI

Several Fixed Parts may apply the same ARI. However, as PARI it has to be geographically unique.

PARI: Primary Access Rights Identity, is the most frequently transmitted ARI. Every DECT RFP must transmit a PARI.

SARI: Secondary Access Rights Identity, is less frequently broadcast than the PARI.

TARI: Tertiary Access Rights Identity, is not broadcast at all and is only available as a Yes/No answer upon a request including the wanted ARI.

RFPI: Radio Fixed Part Identity (section 5.5), every RFP frequently transmits this identity, that is geographically unique. The RFPI shows:

- Primary Access Rights Identity, PARI
- The RFP:s local identity within that Fixed Part.
- Domains for handover and location areas.

PARK: Portable Access Rights Key (section 5.6), states the access rights for a PP.

PLI: Park Length Indicator, associates a group of FP ARI:s to the PARK, by indicating how many of the first ARC+ARD bits that are relevant. The rest have don't care status. Note: The PLI is programmed into a PP as a part of the subscription process.

PUT: Portable User Type, shows the numbering plan structure of a PUN.

PUN: Portable User Number, is a globally or locally unique number within one PUT.

IPUI: International Portable User Identity (section 5.6), is an identity that uniquely defines one user within the domain defined by his Access Rights. The IPUI consists of a PUT and a PUN. The IPUI may be locally unique or globally unique depending on the type of PUT.

TPUI: Temporary Portable User Identity (section 5.6), is a temporary and short identity only valid within the domain of one Location Area, see Chapter 6. The purpose of this is to have an identity short enough to enable paging and also to avoid fraudulent usage of the IPUI.

Geographically unique, This term relates to Fixed Part Identities, PARI:s and RFPI:s. It indicates that two systems with the same PARI, or respectively two RFPI:s with the same RFPI, cannot be reached or listened to at the same geographical position.

Globally Unique (Identity), The identity is unique within DECT (without geographical or other restrictions).

Locally Unique (Identity), The identity is unique within one Location Area, depending on application.

5.4 General description of Fp and PP identities

General principles;

Every Radio Fixed Part, broadcasts for its purpose a unique identity which contains a globally unique (to a service provider) Access Rights Identity, ARI. Every Portable Part, PP, has both a Portable Access Rights Key, PARK, and an International Portable User Identity, PUI. A PP is allowed to access any RFP which broadcasts an ARI that can be identified by any of the PARK:s of that PP. The IPUI is used to identify the portable in the domain defined by its related ARI. This IPUI can either be locally unique or globally unique. The following figure illustrates the identity structure:

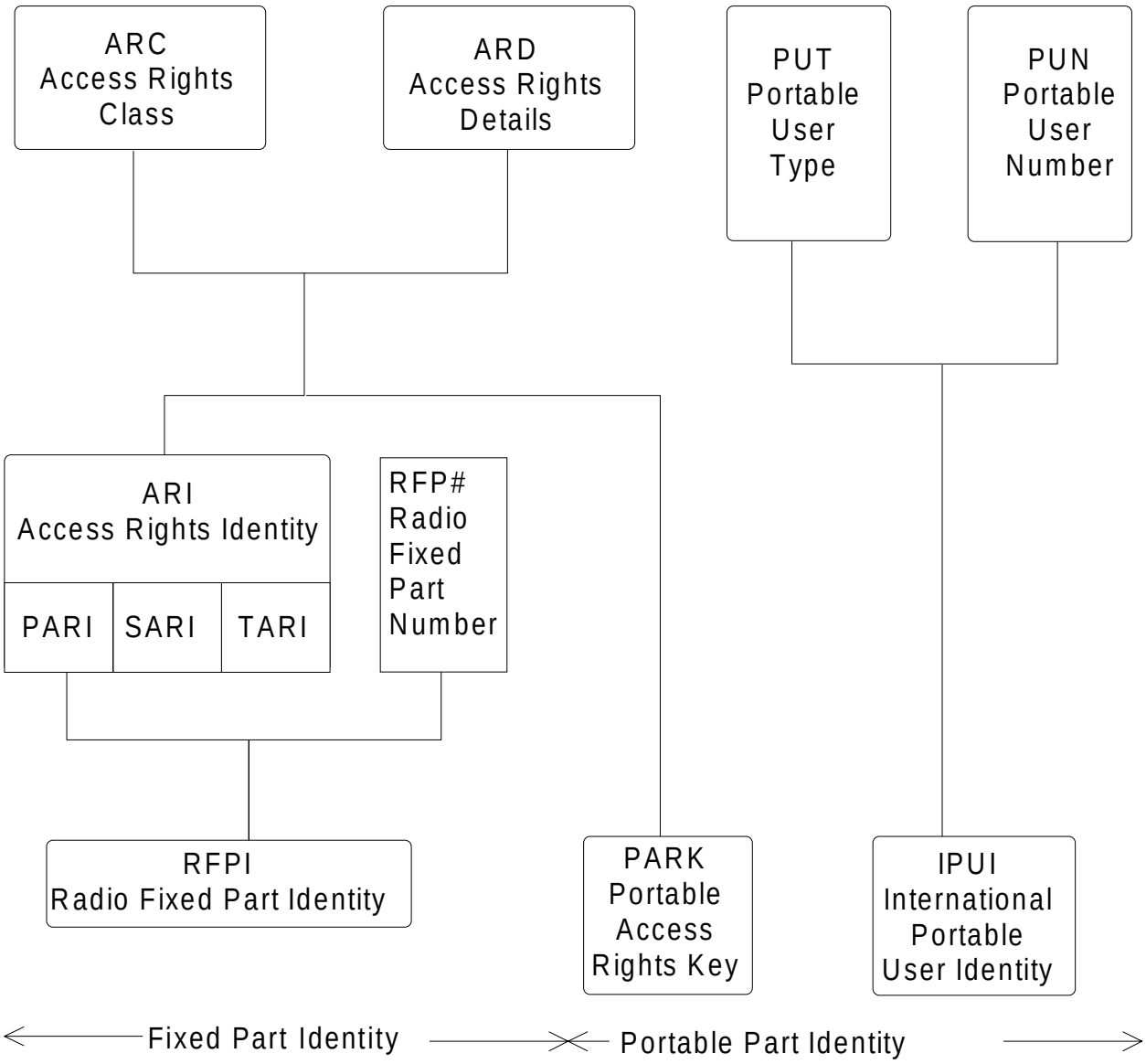


Figure 5.1.

The common base for the DECT identity structure is the ARC and ARD. These must be known by both the fixed and portable parts. In the fixed part the ARC and ARD are called ARI and in the portable they are called PARK. The distinction between PARK and ARI is that each PARK can have a group of ARD:s allocated, which is done by defining a Park Length Indicator, PLI, at subscription.

If the ARI is a primary ARI i.e PARI, it will together with a RFP number form the broadcast identity RFPI. ARI:s can also be less frequently broadcast as SARI:s or available upon request as TARI:s.

The PUT and PUN form the portable user's identity IPUI. This identity can either be globally unique or locally unique. IPUI:s can be replaced by temporary and shorter identities, TPUI:s. These TPUI:s are only locally unique.

A portable is only allowed to access a fixed part if its PARK includes one of the ARI:s of the FP, i.e PARI, SARI or TARI.

5.5 Fixed Part Identities

Fixed Part Identities are used to inform portables about the identity of a DECT Network and the access rights to that DECT Network and thereby reduce the number of access attempts from unauthorised portables. These identities also carry information about domains for handover and location areas.

A DECT FP broadcasts this information on the NT-channel via all its radio fixed parts at least once per multiframe. A portable must be able to interpret necessary parts of this broadcast information to detect the access rights to a system or even access rights agreements between system operators, i.e operator A and B has a bilateral agreement permitting their users to roam between their systems. These agreements can change and can therefore not be stored in portables without updating them frequently. Therefore the FP handles access rights information that is embedded in the identity structure.

The DECT identity structure provides solutions for residential, public and private environments. This can also be extended to combinations between these environments, e.g private (closed) groups of users within a public DECT Network, and e.g public users access to private DECT Networks.

The base for the identity structure is formed by the **Access Rights Classes**, **ARC** and the **Access Rights Details**, **ARD**.

ARC; Shows the type of access to a DECT Network, such as public private or residential.

ARD; This is a unique number with an infrastructure depending on the ARC.

The ARC and ARD together forms the basic identity, the **Access Rights Identity**, **ARI**.

ARI; This identity is **globally unique** to a service provider and shows the access rights related to one service provider. This identity may be applied to any number of Fixed Part installations. There are three categories of ARI:s;

- **PARI**, Primary **ARI** must be broadcast. This is also the most frequently broadcast ARI in order to give a higher grade of service to users with these access rights. The PARI is broadcast over the NT-channel.

- **SARI**, Secondary **ARI**. The **SARI** is less frequently broadcast than the **PARI**, used channel is the QT-channel.

- **TARI**, Tertiary **ARI**. The **TARI** is not broadcast at all and is only available as a Yes/No answer to a request included the wanted **ARI**.

Several Fixed Parts may apply the same ARI. However, as PARI, it has to be geographically unique.

The classification of primary, secondary and tertiary access rights gives the possibility for operators or system owners to offer their subscribers/users an almost unlimited list of roaming agreements. This classification can be seen as an iceberg with the PARI visible on the top followed by a less visible SARI list and in the depth the invisible TARI:s. Presence of SARI(s) is broadcast together with the PARI, i.e to inform portables that there are more access possibilities beside the primary ARI. The same technique is used to indicate presence of TARI(s) in the SARI broadcast message. The SARI message structure and how a PP shall handle this information is described in CI part 6.

Structure of ARI, figure below;

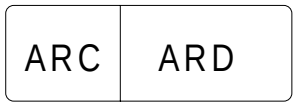


Figure 5.2. Structure of ARI.

ARC, Access Right Classes, 8 available classes named A-H.

ARD, Details, depends on the ARC.

One ARI together with a Radio Fixed Part number forms a broadcast identity **Radio Fixed Part Identity**, **RFPI**. The ARI embedded in the RFPI is the **PARI**. The RFPI has three purposes;

- To carry the PARI
- To geographically uniquely identify RFP:s
- To show domains for handover and location areas.

The RFPI is frequently transmitted as MAC A-field data and has there-fore a limitation of 40 bits.

Figure 5.3 Structure of RFPI

E. This field indicates if there are any SARI:s available. Value yes or no.
PARI, Primary Access Rights Identity.
NO, Radio Fixed Part number.

For multi-cell installations the RFPI carries information about Location Areas and handover domains, see also chapter 6 of SDD.

Location Area (LA)

A default Location Area is defined as the ARI part of the RFPI, as soon as this part changes the PP has entered into a new LocationArea and has to do a location updating. It is possible to define Location Areas that differ from the default one by informing how many bits of the RFPI that should be used as a Location Area. This is done with a Location Area Level (LAL) indicator that is submitted as a result of a successful location updating. See figures below.

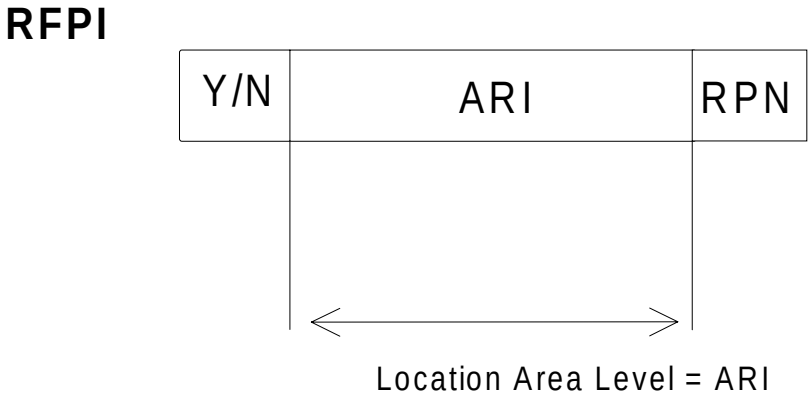


Figure 5.4. Default Location Area

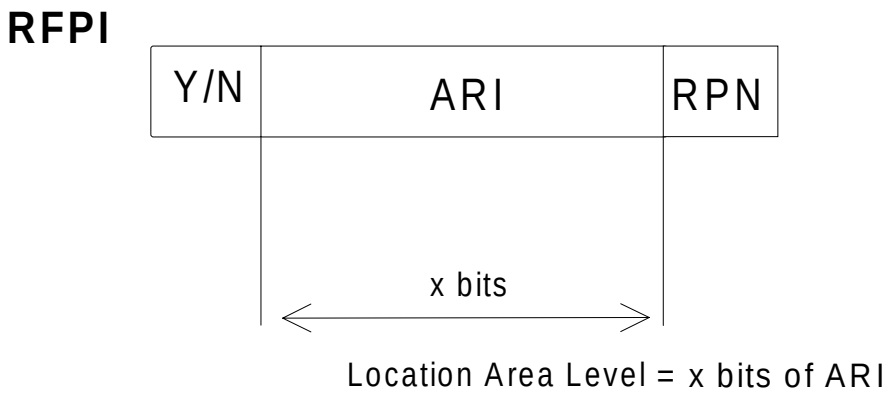
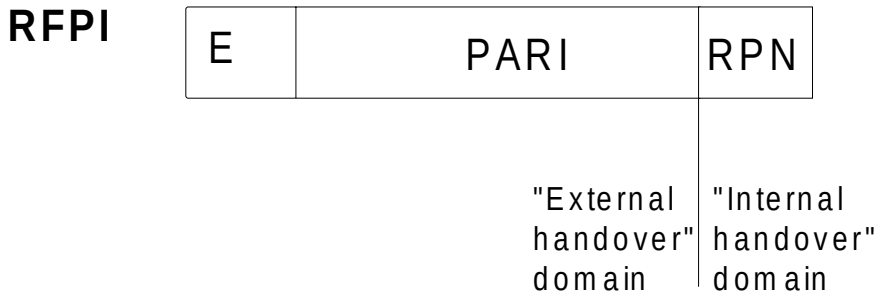


Figure 5.5. Define Location Area

Handover

The internal handover procedures in DECT are defined as bearer handover and connection handover. A bearer handover is the process where a MAC MBC can modify its underlying bearers and a connection handover is the process where a DLC (C-plane and U-plane) re-routes from one MAC connection to a new MAC connection. The internal handover procedures (bearer and connection handover) operate completely within one DECT Fixed Part. DECT also provide messages that support handover between different Fixed Parts. This is called external handover. The maximum domain of internal handover can be distinguished by the broadcast RFPI. RFPIs that only differ in the RPN field are part of the same Fixed Part and therefore can be expected to support internal handover, see figure below:



Four different classes of Access Rights Identities have been defined, these are briefly described in the following sections.

5.5.1 Access Right Identity A

This class is intended to be used for small single cell systems and small multi cell systems, i.e a maximum of 7 base stations. Typical usage will be as residential systems and small PBX systems. Equipment belonging to this class will probably be sold by non-expert retailers. Therefore the allocation process of class details must be delegated to manufacturers by a common administration.

This class is a compromise between having enough space for allocation of fixed part numbers for single cell systems and to have enough with space for allocation of radio fixed part numbers for small multi cell systems. This results in a longer ARI than for the other access classes and this ARI is therefore restricted only to be used as a PARI.

Structures and codes, see CI part 6.

5.5.2 Access Right Identity B

This Access Rights Class is reserved for more complex private installations such as LAN:s and various types of multi-cell PABX:s, with a maximum of 255 base stations/Fixed Part.

In these environments it is necessary to be able to install new or replace old equipment without changing ARI:s or RFPI:s. This indicates that ARI B is mainly an identity that follows a system and not specific equipment.

The RFPI:s could be allocated directly by the manufacturer or by dealers or installers authorised by the manufacturer.

The manufacturer is responsible of distributing ARI:s to authorised dealers/installers. Structures and codes, see CI part 6.

5.5.3 Access Right Identity C

This Access Right Class is reserved for public access such as Telepoints with a maximum of 255 base stations/Fixed Part. Structure and coding, see CI part 6.

5.5.4 Access Right Identity D

This class is reserved for public usage where the DECT Network is attached to a GSM Network and run by the GSM operator. The purpose of this class is to enable DECT users with GSM subscriptions to access their GSM Network via DECT. PARI:s in this class may only be used in DECT networks owned by a GSM operator. Structure and coding, see CI part 6.

5.6 Portable Part Identities

Portable Part Identities have two main purposes, first to enable a portable to select a permitted DECT Network and second to uniquely identify the portable within that DECT Network. For these purposes there are two identities defined.

These are named **Portable Access Rights Key**, **PARK**, and **International Portable User Identity**, **IPUI**. A portable must have at least one pair of a **PARK** and an **IPUI**.

PARK; The PARK defines the access rights for a portable part.

IPUI; The IPUI is an identity that uniquely defines one user within the domain defined by his Access Rights. The IPUI may be locally unique or globally unique.

The portable compares its PARK with ARI:s, if the PARK is identical with one ARI, the portable is allowed to access that DECT Network. A portable is fully identified by its PARK and IPUI in that DECT Network.

A **locally unique IPUI** has a validity domain restricted to one particular DECT Network, such as a PABX or a LAN. These identities are therefore restricted to be used only in that Network. These identities are normally not connected to a subscription.

A **globally unique IPUI** has no restricted domain by itself. Any restrictions for usage of this identity has to do with the access rights (PARK) that is related to the identity. A globally IPUI is normally connected to one or more subscriptions.

The structure of the PARK and IPUI:

Figure 5.6. Structure of PARK

ARC, Access Rights Classes, 8 available classes named A-H.

ARD, Details, depends on the ARC.
See also chapter 5.5

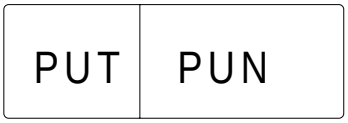


Figure 5.7. Structure of IPUI

PUT, Portable User Type, defines the numbering plan PUN. There are 8 available types named N-U.

PUN, Portable User Number, is a locally or globally unique number within one PUT.

Beside the IPUI it is possible to assign temporary identities to portables, **Temporary Portable User Identity**, **TPUI**.

TPUI; This is a temporary and short identity only valid within the domain of one Location Area, see SDD Chapter 6. The purpose of this is to have an identity short enough to enable efficient paging.

Portable Access Rights Keys and locally and globally unique IPUI:s are described in the following sections.

5.6.1 Portable Access Right Key, PARK

The PARK is similar to the ARI. The difference is that an ARI is uniquely specified by the values of its the subfields but a PARK can have "wild card" options for some of the subfields. This is done by defining a Park Length Indicator, PLI, at subscription. This PLI defines how many (y) bits of a PARK that shall fit with a broadcast ARI, see below:

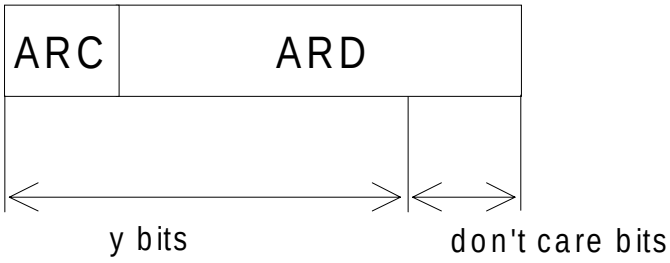


Figure 5.8. Park Length Indicator, PLI

The number of PARK:s is the same as the number of ARI:s, i.e each ARI has got a corresponding PARK.

PARK A - ARI A
PARK B - ARI B
PARK C - ARI C
PARK D - ARI D

5.6.2 International Portable User's Identity, IPUI

At the present there are 7 types of IPUI:s. The IPUI plus the PARK is the complete identity for a portable.

Combination of PARK:s, IPUI:s and ARI:s are shown in chapter 5.7. A short description of IPUI:s follow, detailed information is found in CI part 6.

5.6.2.1 Portable User Identity Type N [residential/default

This identity is **globally unique** and is also the default one for a portable. This identity is based on the portable's equipment identity, which is embedded by the manufacturer.

This identity is intended to be used for simple systems (see ARI A)and also for emergency calls and for checking of stolen equipment. Numbering, see CI part 6.

5.6.2.2 Portable User Identity Type O [Private/Closed]

This is a **locally unique** identity, i.e it is specified by the operator/owner of a DECT Network and is only valid within that Network. Intended to be used for PABX:s and LAN:s. Numbering, see CI part 6.

5.6.2.3 Portable User Identity Type P [Public/Telepoint]

This identity is **globally unique** and intended to be used in public environments such as Telepoints. In these environments the identity is related to a subscription. A user with this identity will be charged via a Telepoint account structure. The size of the account number supports usage of existing Telepoint account structures. Numbering, see CI part 6.

5.6.2.4 Portable User Identity Type Q [Public/General]

This identity is **globally unique** and similar to IPUI P, except that subscribers will be charged via their bank accounts. Numbering, see CI part 6.

5.6.2.5 Portable User Identity Type R [Public/GSM]

This identity is **globally unique** and similar to IPUI P and IPUI Q, except for that subscribers with this identity type already have GSM subscriptions. DECT and GSM charging can therefore be on the same bill. Numbering, see CI part 6.

5.6.2.6 Portable User Identity Type S [PSTN/ISDN]

This is a **global unique** identity, which can be used in all environments. Numbering, see CI part 6.

5.6.2.7 Portable User Identity Type T [Private extended]

This identity is intended to support roaming between private DECT Networks run by the same owner e.g bigger companies with IPUI O users can support roaming of there portables between different sites in different countries by adding a IPUI T. Numbering, see CI part 6.

5.7 Combinations of ARI:s, PARK:s and IPUI:s

The following table illustrates the default combinations of identities, of course it is possible to combine them in other ways.

ARI	ENVIRONMENT	SARI/ TARI	PARK	IPUI
A	Residential and private PDX single- and small multiple-cell systems	NO	A	N, S
B	Private multiple-cell PABX:s	YES	B	O, S, T
C	Public single- and multiple-cell systems	YES	C	P, Q, R, S
D	Public DECT access to GSM operator network	YES	D	R

5.8 General rules for the usage of FP and PP identities

The general principles for usage of DECT identities are:

1. A FP must broadcast ARI as a part of the RFPI. This ARI is the PARI (Primary ARI). Used channel is the NT-channel.

2. A FP can broadcast more than one ARI, these ARI:s are called SARI:s. Presence of SARI:s are indicated in the RFPI. SARI:s are broadcast in a separate message at the QT-channel.

3. A FP can have a set of stored non-broadcast ARI:s, these are called TARI:s. Presence of TARI:s is indicated in the broadcast message for SARI:s.

4. A portable must have at least one pair of PARK and IPUI.

5. A portable is only allowed to access a FP if its PARK is equal to the PARI.

6. A portable is only allowed to access a FP if its PARK is equal to the SARI, and not on the black list.

   Note: It's possible to stop unwanted portables from trying to access by requesting for TARIs. This is done by black marking of these portables ARIs in the SARI-list message. See CI part 6.

7. If a FP has a TARI list it is permitted for a portable to request permission to access by submitting its PARK to the FP, as long as its PARK not is equal to a black SARI.

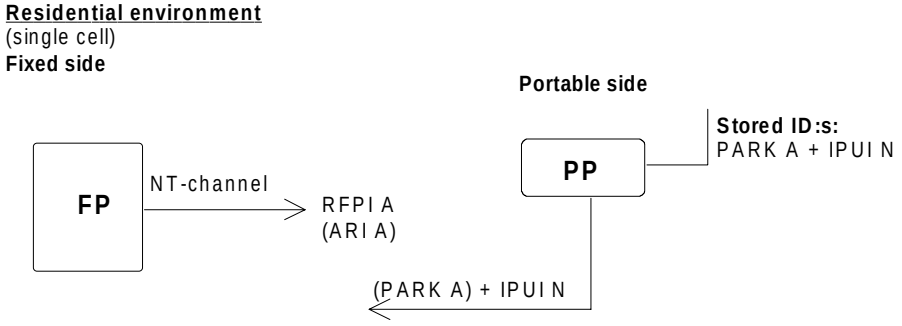
8. A user of a portable is uniquely identified by his PARK and IPUI.

5.9 Examples of usage of FP- and PP- identities

In this section the flexibility of the identity structure is illustrated by a number of examples. This is done by starting with a simple residential PP and extend permitted environments for this PP by adding a necessary pair of identities. This also illustrates that it is possible to use the same PP in a number of networks run by different operators as long as there are agreements between these operators.

5.9.1 Residential ID usage

The fixed part in a residential environment can only broadcast one ARI as a part of the RFPI and the PP has one PARK stored together with the IPUI. The PP is fully identified by sending its PARK + IPUI.



Note: Identification in a residential environment, it is possible for the portable to omit the PARK.

Figure 5.9. Residential ID usage

5.9.2 Public ID usage

5.9.2.1 Primary

Starting with the simplest public case, a telepoint where the operator has no agreements with other operators. The fixed part then only broadcasts one ARI as a part of the RFPI. The PP has one PARK stored together with the IPUI. The PP is fully identified by sending its PARK + IPUI.

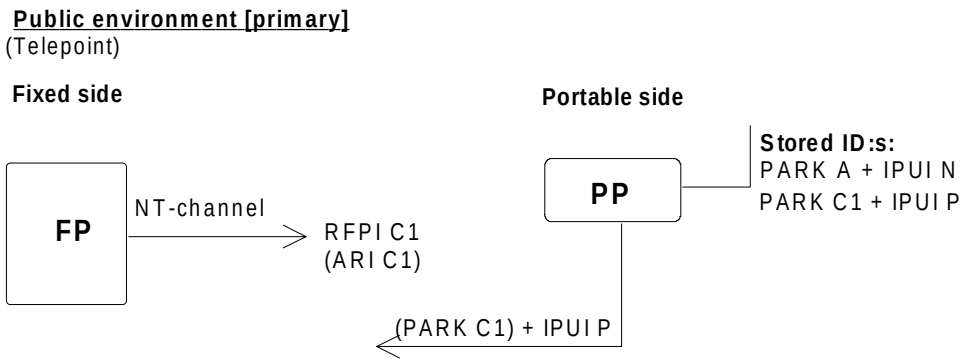


Figure 5.10. Public ID usage (primary)

5.9.2.2 Secondary

If a telepoint operator has agreements with other operators, their ARI:s will be broadcasted on the QT-channel as SARI:s. A visiting permitted PP will find a SARI that is equal to its PARK. This PP will be fully identified by its PARK + IPUI.

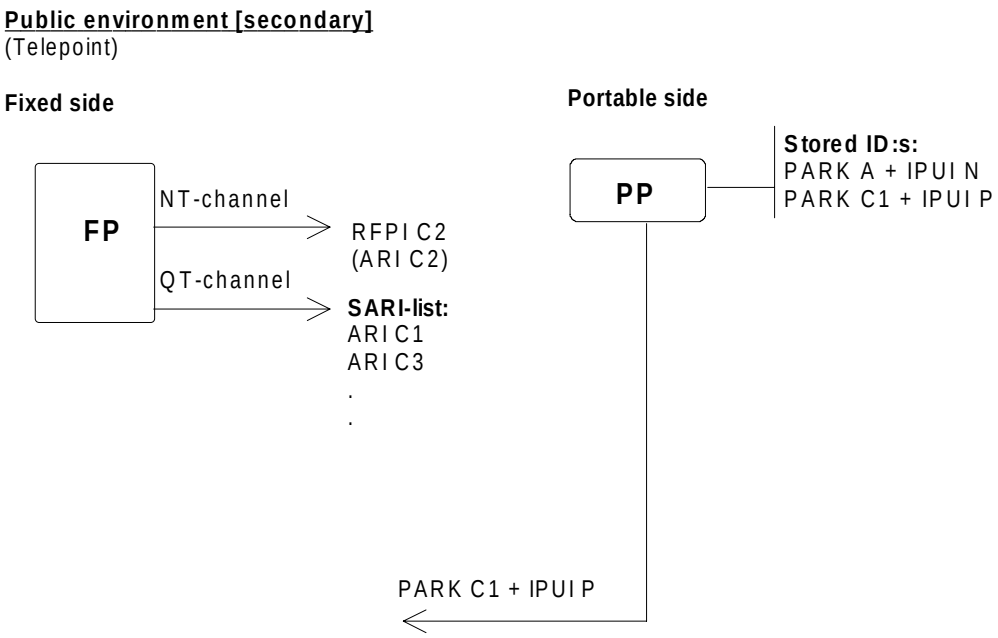


Figure 5.11. Public ID usage (secondary)

5.9.2.3 Tertiary

When the number of SARI:s exceeds the limit of capability of the QT-channel, non frequently used ARI:s can be stored in a TARI list. A PP with a PARK that doesn't match to the PARI or SARI can request permission to access by sending the wanted ARI to the FP, a TARI-request. The presence of TARIs are indicated in the SARI messages. The PP is fully identified by it's PARK + IPUI.

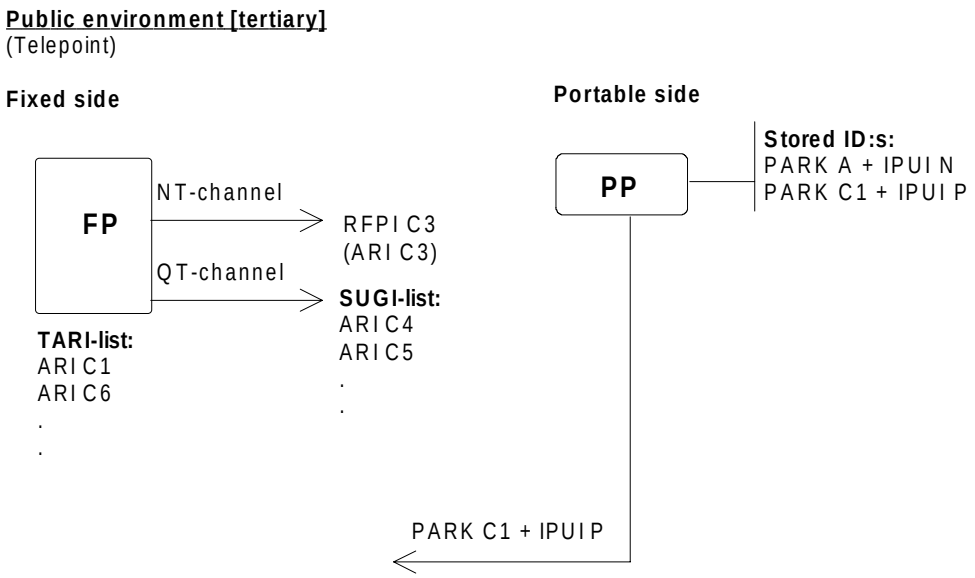


Figure 5.12. Public ID usage (tertiary)

5.9.3 Private ID usage

5.9.3.1 Primary

An ordinary business system will have a PARI transmitted as a part of the RFPI and the PP has a PARK and an IPUI stored. The PP is fully identified by the PARK + IPUI.

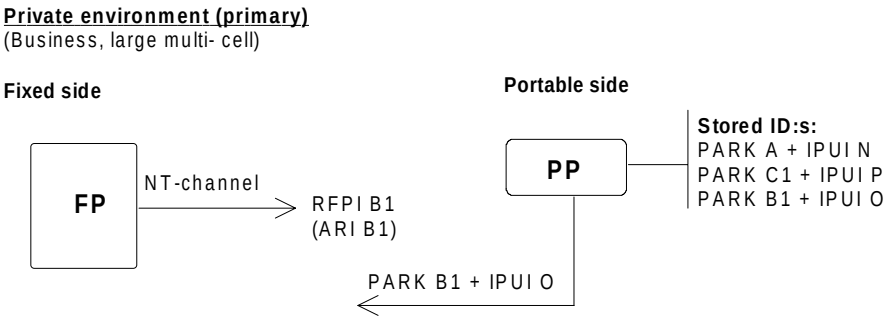


Figure 5.13 Private ID usage (primary)

5.9.3.2 Secondary

Even in this environment it will be possible to have agreements with other operators. A visiting permitted PP will recognize a SARI that is equal to the PP's PARK. The PP will be identified by its PARK and IPUI.

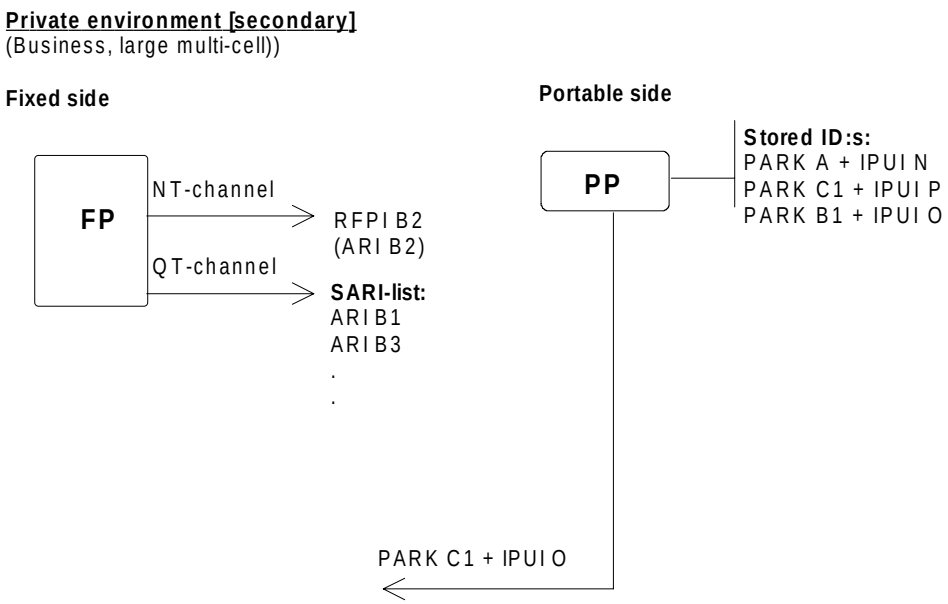


Figure 5.14. Private ID usage (secondary)

5.9.4 Mixed private and Public usage

5.9.4.1 Public in private environments

In areas where private and public environments intercept each other it could be possible to let public users have access to a private environment. Users within the private environment don't need to read there ARI so often therefore this ARI could be broadcast as a SARI. This will enable private systems to send a public system's ARI as a PARI and by that give public users a high grade of service.

5.10 Source documents

RES-3N (90) 10 SDD Chapter 3. DECT reference model Rev 05.02
RES-3N (90) 31 SDD Chapter 6. Mobility functions Rev 3
CI SPEC PART 3 Ver 08.00
CI SPEC PART 5 Ver 08.00
CI SPEC PART 6 Ver 3.03

Annex D: Mobility functions

This Annex contains Chapter 6 of the DECT System description document, and consists of pages numbered 6.1 to 6.24 (i.e. 24 pages)

Chapter 6

Mobility functions

Contents

6.1 Version History

Version 1.0 1990-03-22 First release to RES3-N

Version 2.0 1990-04-25 Second release to RES3-N

Version 2.1 1990-05-02 Revised after the 8th RES3-N meeting
Paris, April 25-27
First release to RES3 (1990-05-07)

Version 2.2 1990-07-06 Revised after the 9th RES3-N meeting
Malmö, June 18-19.

Version 2.3 1990-08-27 Revised after the 10th RES3-N meeting
The Hague, July 17-18.
Some rephrasing in sect. 6.4.3 and 6.5.3.

Version 2.4 1990-09-27 Revised after the 12th RES3-N meeting
Berlin, September 24-26
Change in terminology,
in line with functional requirements.

Version 2.5 1990-11-13 Revised after the 13th RES3-N meeting
Madrid, October 24-25.
System Reference Document (SRD) changed into
System Description Document (SDD).

Version 2.6 1990-12-06 Revised after the 14th RES3-N meeting
London, December 4-5.
Some changes in terminology, some rephrasing,
Update of pictures, extra section 6.5.3.3 on
DECT specific procedures for PBXes.

Version 3.0 1991-02-01 Revised after the 16th RES3-N meeting
Cambridge, January 14-15.
Overall revision to align with CI spec.

Version 3.1 1991-05-29 Revised after the 20th RES3-N meeting
Ivrea, May 22-24.
'For further study' remarks removed/replaced,
SDD and CI cross references corrected

6.2 Introduction

The aim of this chapter is to list mobility functions for DECT supporting the mobility of DECT portable parts, for instance by informing the network of the present location of the subscriber and providing identity confidentiality. In order to support these mobility functions, procedures for mobility management will have to be described for use on the DECT radio interface.

If DECT networks would be no more than just a network termination (offering mobility that is restricted to that particular DECT coverage area), the mobility of DECT portable parts would be independent of the functionality of networks external to DECT. However, a wider mobility of DECT portable parts depends on mobility functions offered by external networks. These external mobility functions are outside the scope of DECT, meaning that in RES3 no effort is spent on mobility functionalities and procedures that need to be specified in networks external to DECT.

In section 6.3 of this chapter, DECT mobility functions are described on a high abstraction level.

DECT mobility features for the different application areas of DECT (residential use, telepoint access and business system use) are discussed in section 6.4, taking into account the existence of mobility supporting functions external of the DECT system.

Mobility functions will finally result in *signalling procedures* which could involve networks external to DECT as well as the DECT radio interface. These signalling procedures are worked out in section 6.5 as far as telepoints and Private Telecommunications Networks are concerned.

For a more detailed description of procedures and information flow over the DECT radio interface, the reader is advised to consult the DECT Common Interface specification (the MM-sections of CI part 5 in particular).

6.3 Mobility functions

In this section all functions required for DECT mobility support for all application areas will be discussed.

6.3.1 Identification related functions

Different types of identification are envisaged: the identification of the user, the user's equipment (which could be the same as user identification, see chapter 5), the identification of a DECT fixed part and the identification of access rights. In this section, identification types will be split into two groups: portable part identification and fixed part identification.

6.3.1.1 Portable part identification

If a user requests a DECT service, or if the DECT network requests the user's (equipment) identity, this user will have to supply an identity (IPUI, TPUI or IPEI, refer to chapter 5) which enables the DECT fixed part:

- to identify the user or the user's equipment, and
- to decide whether or not this user/equipment could possibly be allowed access in this environment for a particular application. A final decision can depend on the outcome of an authentication procedure.

For efficiency purposes temporary user identities (TPUIs) can be assigned. These identities are unique in an area referred to as a TPUI domain and are shorter than the IPUIs. They are used for paging and security purposes (the IPUI does not have to be frequently transferred over the radio interface anymore). Functions for the handling and the assignment of these temporary user identities are required.

Typically in residential environments the equipment identity (IPEI, refer to chapter 5) and the residential IPUI are the same. In general IPUI and IPEI are not the same, enabling prevention of the use of stolen equipment.

6.3.1.2 Fixed part identification

A DECT fixed part will have to provide an identity (RFPI, refer to chapter 5) over the radio interface in order to allow the user:

- to determine whether or not the DECT fixed part belongs to the environment the user wishes to access
- to determine whether or not that *particular* DECT fixed part is the one the user wishes to access.

The portable monitors the RFPI in order to determine the access rights. Not all access rights are broadcast via the RFPI: secondary access rights and tertiary access rights may exist, the latter not being broadcast but stored in the fixed part. Functions for broadcasting the RFPI and Access Rights Identifiers (ARIs) are required, refer to chapter 5 (PARI, SARI, TARI use). Part of the RFPI may also define the Location Area (LA), refer to section 6.3.5.3.

6.3.2 Security related functions

Security can be interpreted as follows: identity confidentiality and protection of transferred information on the radio link. For these two security aspects two techniques have been defined: authentication and cryptographic techniques.

6.3.2.1 Authentication related functions

- **User authentication**

  User authentication is the process whereby a DECT user is positively verified to be a legitimate user of a particular DECT fixed part. Authentication is generally performed at call setup, but may also be done at any other time (e.g. during a call). It is mandatory that every portable part has the `DECT Standard Authentication Algorithm' built in (usage optional). If the user has to be authenticated in a DECT network other than his home DECT network, the user specific authentication parameters will generally not be available in this `visited' DECT network. Therefore, the authentication procedure could raise the need for:

  - Functions for the retrieval of authentication parameters

  Authentication parameters will probably have to be obtained from a Home DataBase (HDB). Once obtained, these parameters may be stored locally to avoid future parameter retrieval traffic (temporary installation of user's parameters). Some networks will require the use of a derived key which enables the visited DECT network to execute a challenge signed response authentication procedure with the handset. However the secret key itself is not necessarily revealed to the visited DECT network.

  As mentioned before, parameter retrieval functions in networks external to DECT are outside the RES3 mandate.

- **DECT fixed part authentication**

  Fixed part authentication provides a means to the user to check the fixed part identity. This prevents a fixed part, like a base station, from being impersonated. This way the user can not be tricked by a phoney fixed part.

- **Mutual authentication**

  A process by which both the user and the fixed part are authenticated. This will be performed by doing user authentication and fixed part authentication (or the other way around) right after another.

- **Proprietary authentication functions**

  The possibility to implement proprietary authentication algorithms will be left open.

6.3.2.2 Functions for encryption

A standardised encryption algorithm has been specified for DECT handsets. The following functions have been envisaged:

- **Encryption of user information**

  The process carried out on user information to be transferred over the radiolink prior to transmission over the DECT radio carrier to protect against unwanted recovery of this information.

- **Encryption of signalling information**

  The process carried out on signalling information prior to transmission over the DECT radiolink to protect against unwanted recovery of signalling information.

- **Proprietary encryption algorithms**

  The possibility to implement proprietary encryption algorithms for higher protection levels, will be left open.

The cipher key could have resulted from an authentication procedure. Encryption functions will probably require cipher mode setting.

6.3.3 Charging and billing related functions

Functions for the support of charging and billing are described in more detail in chapter 8 of this System Description Document. In this section a distinction is made between call related and non-call related charging.

6.3.3.1 Call related charging

In some DECT environments (e.g. residential use), charging and billing can be related to the connection of the DECT fixed part to the public network. In this case, the call related charging functions of the public network will be sufficient (point-of-attachment charging).

However, things turn out to be more difficult in the public environment (e.g. for telepoint applications). Charging and billing will now have to be related to the subscriber: Subscriber related charging.

Subscriber related charging could for example be supported as follows: A telepoint stores call associated information (charging information and user identification) in its local telepoint database (TDB). Periodically this TDB can be consulted and cleared by a Billing Centre (BC) in order to calculate DECT bills for DECT subscribers[1]. Subscriber related charging will require a secure authentication procedure.

Incoming calls in a DECT network other than the home DECT network could cause the principles of charging to deviate from usual charging procedures (e.g. as for GSM, the calling party is charged for the connection to the home location of the called party. The called party may be charged for the connection from the home location to the visited location).

6.3.3.2 Non call related charging

Non call related charging applies to actions the network has to perform not being part of the call establishment, call maintain or call release phase. Examples are:

- charging for location registration (see sect. 6.3.5.3)
- charging for the activation of supplementary services (e.g. user's modification of call forwarding parameters)

6.3.4 Hand-over related functions

Once a call has been established, there is still a need to enable a change of physical channels without release of the call. This can involve a change of frequency band or timeslot due to quality loss and interference, or a change of base station due to the mobility of a user in a multi-cell environment (e.g. large business systems). This capability to change physical channels *during a call* is referred to as a hand-over function. Several types of hand-over can be distinguished, within a cell (intra-cell), between cells belonging to the same DECT fixed part (inter-cell, internal) and between cells belonging to different fixed parts (inter-cell, external).

6.3.4.1 Intra-cell hand-over (internal hand-over)

Intra-cell hand-over involves a change of physical channels within a cell during a call. This can involve a change of frequency band or timeslot. This type of hand-over will be handled by the DECT network. This type of hand-over involves a bearer hand-over.

6.3.4.2 Inter-cell hand-over (internal)

A change of base stations belonging to the same DECT fixed part, this type of handover will be handled by the DECT network. Logically seen it is a change of physical channels as with Inter-cell Hand-over. It can involve a bearer or a connection hand-over.

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[1] The DECT user may not necessarily be the DECT subscriber, e.g. in business environments the company will be charged and billed, not the actual user.

6.3.4.3 Inter-cell hand-over (external)

A change of base stations belonging to different DECT fixed parts. This type of hand-over needs Network layer specific functions (e.g. rerouting) and as such can only be handled by a DECT local network. It is only feasible if two DECT systems are connected to a common management facility. This common management entity could be the GSM PLMN.

6.3.5 Registration related functions

Limited by agreements concerning the provision of services to a particular user, the DECT user at a certain time may wish to register to specific services. In this section we only distinguish between registration for services requiring location registration (e.g. receiving incoming calls) and services not requiring location registration (e.g. making outgoing calls). This in contrast to GSM, where registration for outgoing calls can not be separated from registration for incoming calls.

An overview of registration related functions is given in figure 6.1.

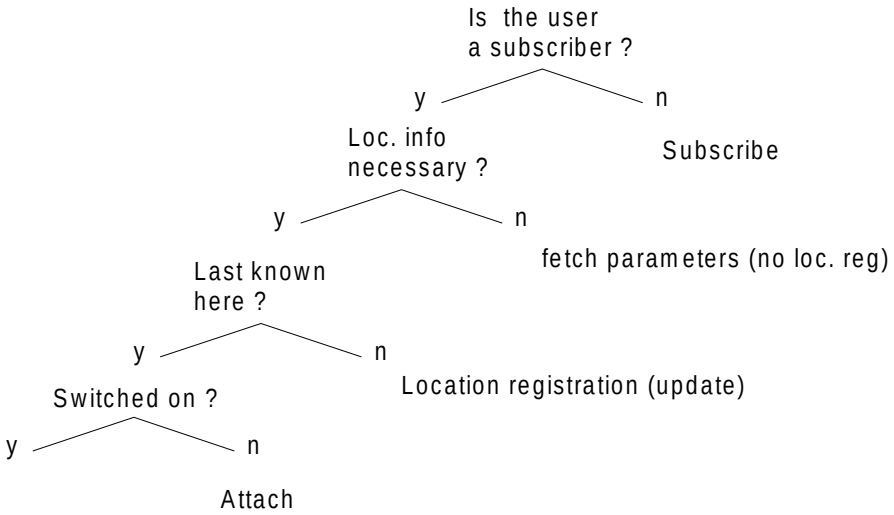


Figure 6.1: Registration related functions

6.3.5.1 Subscription related functions

Subscription related procedures involve both a DECT operator and a user. The goal of these procedures is to make (revise) an agreement concerning the provision of services to the user (subscriber). Normally these procedures are handled administratively due to the insecurity of subscription over the air (on-air subscription). However, in certain environments on-air subscription could be implemented (residential or business).

6.3.5.2 Registration for services without location registration

The purpose of this registration at a DECT fixed part is to enable the parameters of a user to be conveyed to that particular DECT fixed part. Thus allowing the user to be authenticated and to be served. An example of a service not needing location registration is making outgoing calls. In some cases location registration functions may be included, however, this is not necessary for outgoing call provision.

6.3.5.3 Location registration

For some services, location information is needed in the network to perform certain actions. One example is the ability to receive incoming calls in a DECT network other than the user's home network (in a visited DECT network).

Location registration could be used in order to support these incoming calls. The position of the handset will be registered up to the level of Location Areas (LAs). The size of these LAs may vary from a single cell to several DECT fixed parts, depending on efficiency and capacity requirements (or service requirements: e.g. fast call setup requires the LA to be one cell). DECT LAs are identified by means of a defined part of the broadcast RFPI. Therefore the maximum size of a location area depends on the structure of the RFPI.

Depending on location information already stored in the local Visited Database (VDB) or the Home Database (HDB), the registration can be regarded as a new registration or an update. Depending on previously stored information either the VDB, HDB or both will be updated.

Two forms of location registration procedures can be thought of:

- user initiated location updating

  The *user* decides whether he wants to receive incoming calls in a DECT system he is visiting. If so, he will initiate a location registration procedure (e.g. by pushing a special button).

- automatic location updating

  The *portable part* starts a location registration procedure as soon as it detects having entered another location area (new LA does not equal old LA), just like in GSM. If location areas are geographically defined areas overlaying several DECT fixed parts, it seems logical to choose for automatic location registration. If a border is crossed during a call, the location registration will be performed after release of the call.

The following functions will probably be associated with location registration:

- authentication
- updating of the VDB and/or HDB
- identity confidentiality

  In order to protect the privacy of the user, the access to location information must be restricted to specific applications authorized by the customer and the administration concerned.

Mobile DECT systems (mobile telepoint) enabled by GSM, are a special case. Here, the location registration functions of the GSM network can be used. If GSM is used transparently, the DECT HDB only has to provide the appropriate GSM identity (MS-ISDN number) by means of which the DECT user can be reached.

6.3.5.4 Location information erasure (delocation)

If a DECT user has performed a location registration in a different location area than he was registered in before, the network may take actions to erase user's parameters and location information stored in the old VDB. Delocation procedures require no interaction with the portable part, hence they are not part of the DECT CI specification.

6.3.5.5 Functions for the support of attach/detach procedures

These functions offer the possibility to mark the relevant IPUI of the DECT portable part as active or inactive. This way the user signals the network whether he is ready or not to receive incoming calls. The attachment process has been made implicit in the location registration procedures, whilst the user may explicitly detach. Depending on the information already available in VDB or HDB this function involves the update of status or location information in VDB or HDB. This way the routing process can be made as efficiently as possible.

6.3.6 Locating and Routing related functions

6.3.6.1 Location Information Retrieval

As mentioned before, location information concerning a subscriber will probably be stored in the subscriber's HDB. The routing process of an incoming call needs this location information (typically the routing address of a location area). Therefore, routing should preferably be preceded by interrogation of the called party's HDB in order to be efficient. If routing cannot be preceded by an interrogation process, an incoming call could be rerouted from the HDB.

In some environments the locating and routing functions require other information than the Location Area Identifier. In a mobile DECT network (mobile telepoint) where GSM enables the DECT network to be mobile (transparent use of GSM), the HDB will have to provide a GSM identity (MS-ISDN number), in order to invoke the GSM routing functions. The MS-ISDN could be used to route the call to a GSM gateway. GSM will perform further locating and routing to a particular GSM Mobile Station. In order to reach the correct DECT subscriber, an association has to be made between IMSI and IPUI. A DECT subscriber could for instance also be a GSM subscriber for the mobile telepoint application.

6.3.6.2 Paging

Within the location area a paging function will be necessary to see if the called party is present and to enable further routing to the exact cell. As such the entire location area will have to be paged. Therefore the Paging Area (PA) is the location area. However, network implementors may decide to page in parts of the location area at a time in a specific order.

If a TPUI has been assigned this TPUI will be used in the paging process, if not a short form of IPUI will be used.

Once the called party (authenticated, if applicable) has responded to a paging message, in which case the exact cell he is in is known, the call can be routed further to that particular base station and finally reach the called party.

6.4 Mobility and DECT application areas

Within DECT, several areas of application are envisaged: residential, public (telepoint) and business applications. Considering the current status of national networks DECT has to be attached to, subscriber mobility for all applications in all environments (e.g. handover between environments) can not be provided in the short term. Solutions can be found for mobility *within* environments, for instance inter-PABX mobility, in a relatively short term. In the long term overall subscriber mobility could be provided by the future Personal Telecommunication Service (PTS).

For the time being the DECT environments will be considered to be stand-alone environments. This means that a subscriber is assumed to have different ISDN/PSTN numbers for each environment and mobility is limited to the present environment. In the long term PTS will be used to provide the DECT-PT subscriber with a single personal number.

In the following subsections mobility in the different application areas will be discussed.

6.4.1 Residential use

The residential DECT network can be considered as just an extension of the global public network. The system can be seen as a radiolink replacement of a fixed line. Subscriber mobility is restricted to this DECT network, and as such this type of mobility does not put any requirement upon the external network as far as mobility support is concerned. Charging will probably be point-of-attachment related.

6.4.2 Public (telepoint) access

The basic service assumption for the telepoint application implies that

- the subscriber is able to make outgoing calls in telepoint systems he is allowed to access
- there is the possibility to receive incoming calls in specific telepoint systems (areas) the subscriber is registered in (location information is known to the routing process).

Also, handover between different DECT telepoints could be allowed for (if a common management facility is available, e.g. the GSM-PLMN).

As a consequence of subscriber mobility in this environment, requirements will be put upon the network external to the telepoints. A background network allowing for subscriber mobility (a `telepoint network') will be needed. This telepoint network will have to support certain application procedures; a first outline for application procedures for the support of telepoint services has been described in section 6.5.

6.4.3 Business system use

As mentioned above, the Personal Telecommunications service is considered to be a future capability of the global public network. However, in order to allow for subscriber mobility in and inter PABXs at short notice, a short term scenario has been envisaged which comprises:

- the use of existing PABX mobility functions
- extension of existing functions

Some mobility functions are available in PABXs. A short term scenario may consist of implementing inter-PABX functions and services. As such subscriber mobility in the business environment influences the external network. On the long term these solutions may coexist at first with solutions offered by the Personal Telecommunications service.

In the following section application procedures are shown considering Private Telecommunication Networks as well.

6.5 DECT application procedures

This section reflects the results of a first study on application procedures needed to support mobility management for DECT subscribers in the telepoint environment and in the business environment. All DECT external network functionalities are essentially out of the scope of RES3, however, in order to show the similarity with existing ideas on this subject in other ETSI working groups this section has been included.

6.5.1 DECT telepoint application procedures

Many ideas of the procedures as defined in Recommendation GSM 04.08 `Mobile Radio Interface Layer 3 Specification' could be reconsidered for the support of the DECT telepoint mobility functions. Also, many ideas of the application procedures as defined in Recommendation GSM 09.02 `CCITT Signalling System No.7, Mobile Application Part' could be reconsidered for the support of the DECT telepoint mobility functions. Therefore, a first outline of DECT telepoint application procedures, which is given below, has been based on MAP. However, in some respects MAP procedures cannot simply be adopted for DECT purposes, for instance handover is being treated differently.

6.5.1.1 Telepoint network entities

The telepoint network entities which have been used for the description of DECT telepoint application procedures, are represented in figure 6.2.

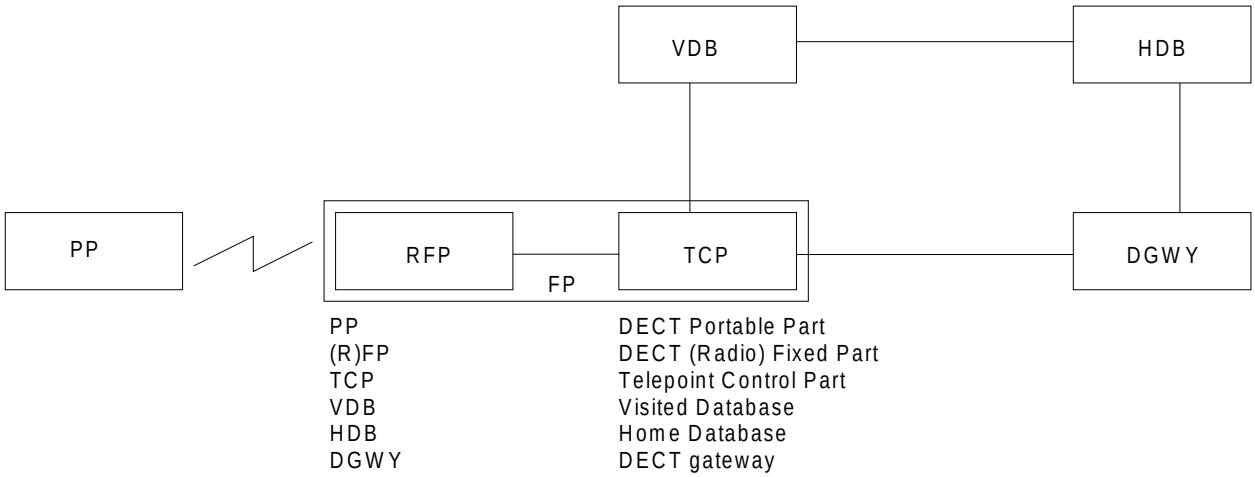


Figure 6.2 Telepoint network entities

6.5.1.2 Retrieval of subscriber parameters

- Information retrieval from VDB

  for incoming and outgoing call set-up, used when the VDB can provide all the information that is requested by the TCP.

- Indirect information retrieval

  if the subscriber is not known to the VDB, or if the subscriber is known to the VDB, but the VDB cannot provide all requested information, the HDB is consulted via the VDB

- Procedure for obtaining routing data

  used for incoming call set-up by a DECT gateway, for obtaining the routing information (position) of a specific subscriber, either directly from the HDB or else via the VDB from the HDB.

6.5.1.3 Subscriber management

In order to allow a DECT cordless system to receive incoming calls in a system other than a home DECT system, The following MAP procedures could be considered:

Location information management

- subscriber parameter request procedure

  used by the VDB to request the HDB to provide subscriber parameters for a specified subscriber.

- location information retrieval procedure

  used by the HDB to obtain information concerning subscribers temporarily registered in a VDB.

Updating of subscriber data in a VDB

- insert subscriber data procedure

  used when subscriber data shall be inserted in VDB

- delete subscriber data procedure

  used when subscriber data shall be removed in VDB

6.5.1.4 Location registration related

Location registration

- Updating involving only HDB

- Updating involving only the VDB

  if a subscriber enters a new location area related to the same VDB

- Updating involving both VDB and HDB

  if the new location area is related to a new VDB, the HDB must be informed of the new position of the DECT cordless system

- Updating involving new VDB, old VDB and HDB

  in the same case as for the above procedure, if the DECT cordless system identifies itself using the TPUI allocated to it in the previous VLR, also that register must be involved.

- Updating initiated by VDB

  as a consequence of an IPUI attach message, the VDB can initiate a location update if the subscriber was not present before.

Location information erasure (delocation)

The delocation procedure is initiated by the HDB when a subscriber enters a new location area served by a different VDB in order to erase the information stored in the old VDB.

IPUI attach/detach

The purpose of the IPUI detach procedure is to enable a Portable Terminal to indicate that it is about to enter an inactive state. The information is used to reject calls to the portable part without sending a paging message on the radio path. The IPUI detached information could either be stored in the VDB and no information being passed to the HDB, or optionally, the HDB may be informed and the IPUI detached flag is then set in the HDB.

IPUI attach will be used after IPUI detach to indicate that the portable part is ready to receive incoming calls again. IPUI attach messages are implicitly incorporated into location registration messages.

6.5.1.5 Handover between DECT fixed parts

Considerable deviations from the existing MAP handover procedures are foreseen, since in GSM the handover procedure is centralized, driven by the network and relies upon `backward' handover methods. In DECT, it is decentralized, driven by the portable and relies on `forward' handover.

However, a short term scenario can be used in which GSM-PLMN is being used for this type of handover. In that case the GSM-MAP is used. DECT supports the option of backward handover in its external handover procedures.

6.5.1.6 Operation and maintenance

Outside the scope of this document, outside the mandate of RES3.

6.5.1.7 Fault recovery of location registers

Outside the scope of this document, outside the mandate of RES3.

6.5.1.8 Management of International Portable Equipment Identities

IPEIs could be stored in a DECT Equipment Register (DEIR) which could then be consulted in order to check the validity of the IPEI, to protect against stolen portables or to trace the equipment manufacturer.

6.5.1.9 Authentication

A DECT Standard Authentication Algorithm (DSAA) will be provision mandatory in all handsets, its usage, however, is optional. It is envisaged that all portables in the telepoint environment will be authenticated prior to or during service provision.

6.5.1.10 Management of security related functions

Outside the scope of this document.

6.5.1.11 Identity management

- Identity request procedure

  when the VDB receives a TPUI which is not assigned to any subscriber, the DECT fixed part requests open identification (using IPUI) from the subscriber. The fixed part may also request the IPEI.

- Reassignment of TPUI

  used by VDB to reallocate the TPUI during an ongoing transaction

6.5.1.12 Access management procedures

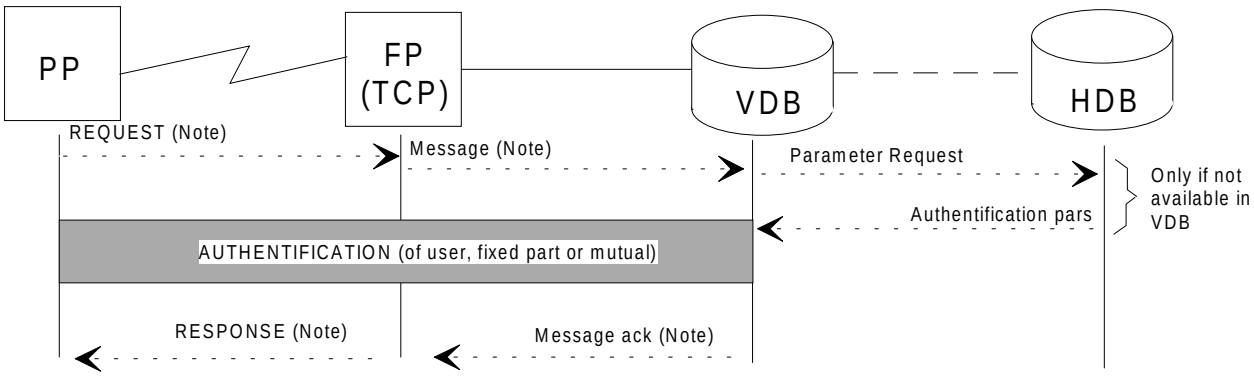
A procedure for initiating and terminating the access phase which comprises identification, authentication and ciphering mode setting. More details can be found in chapter 5.

6.5.1.13 Search and paging procedures

Used by VDB to verify the presence in a location area of a called user for an incoming call.

6.5.2 Telepoint information flow diagrams

Examples of possible information flow diagrams for DECT telepoint environment are given in the figures 6.3 up to 6.6. Call control and mobility management processes can be operated independent of each other in DECT. Therefore the network operator defines their relationship.



Note: REQUEST, RESPONSE, Message and Message Ack indicate a message associated with a call set-up, location registration, operation of a supplementary service or any other event requiring authentification

Figure 6.3: Authentication procedure

As for location registration and the routing of incoming calls, these procedures do only give a general description leaving several possibilities open.

With the information obtained from the HDB it is possible to route the call up to the fixed part of the telepoint. This part could be in charge of different smaller DECT fixed parts. The details of how routing up to the proper user is performed can vary according to the size of the location area. If a location area does only contain one DECT fixed system the call can be routed up to DECT fixed system before the paging procedure. As an alternative, a location area could comprise several telepoint DECT fixed parts (like for example all telepoint DECT fixed parts within a city). In this case, a paging procedure involving all DECT fixed parts within the location area, will have to be initiated by a common control. Only if this paging procedure ends up successfully, the call can be routed up to the proper DECT fixed system.

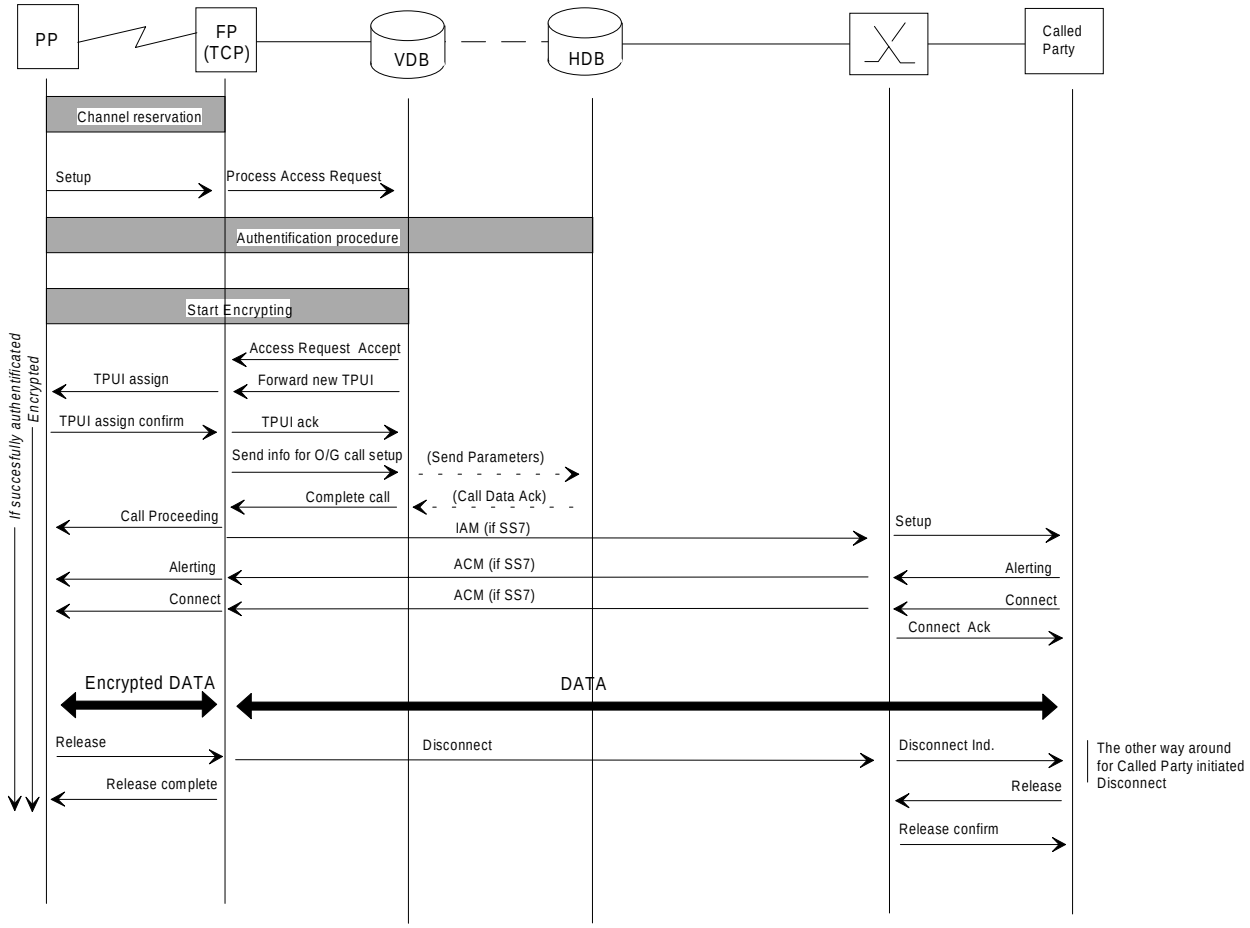


Figure 6.4: Example of Outgoing call set-up

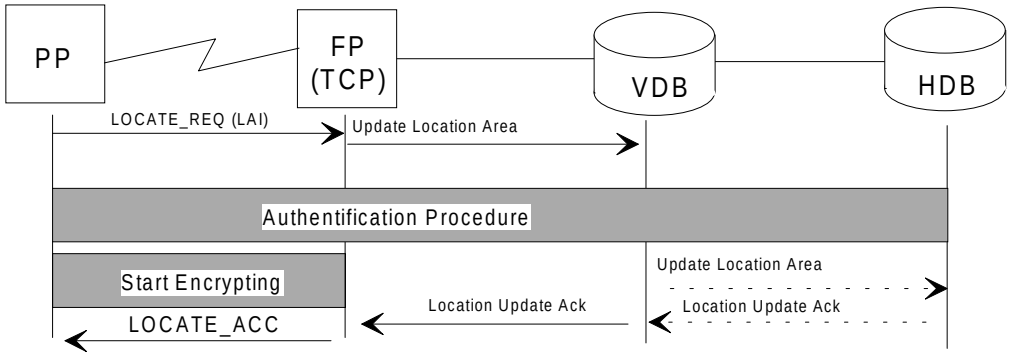


Figure 6.5: Example of location updating procedure

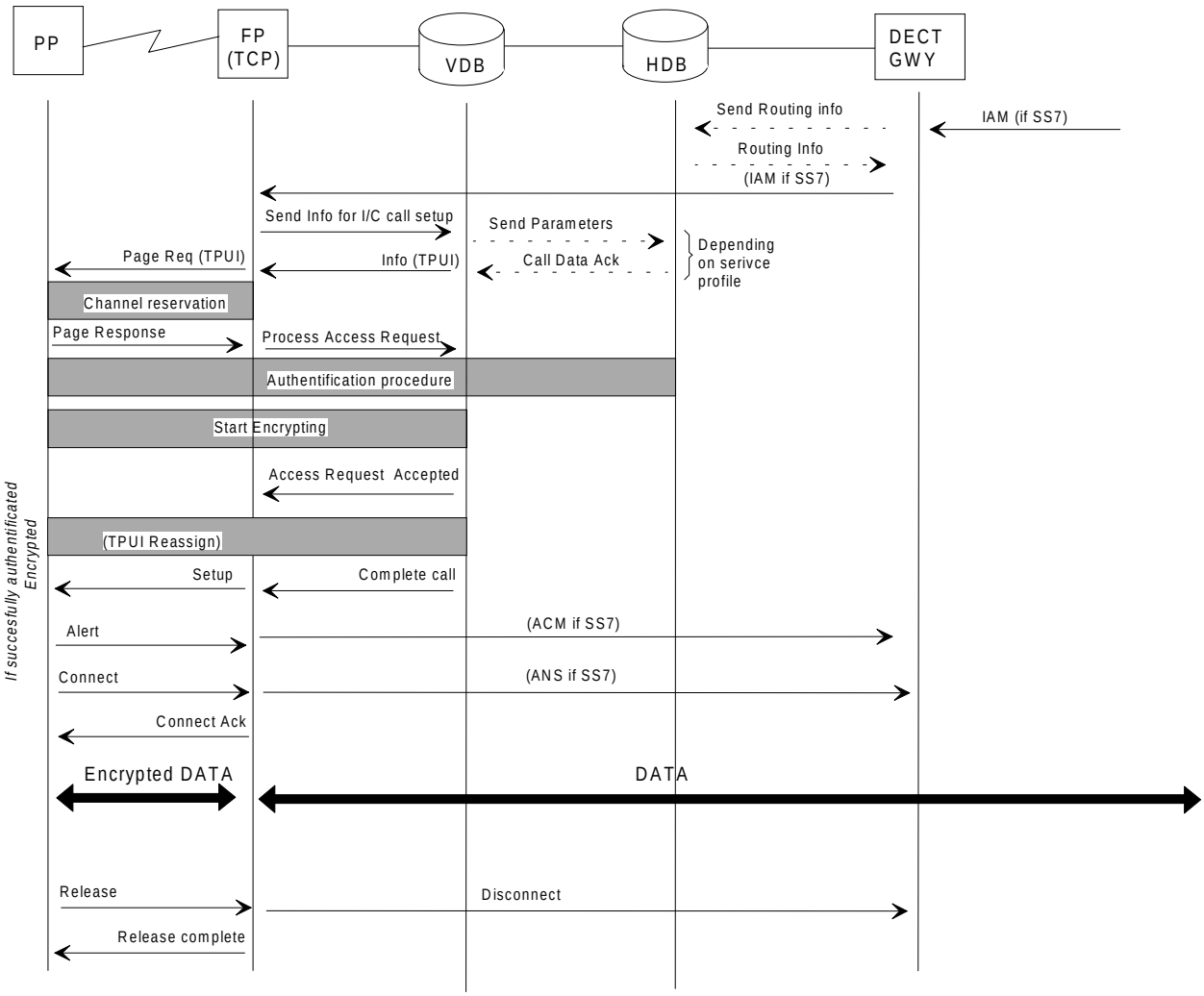


Figure 6.6: Example of incoming call set-up

6.5.3 Mobility management for Private Telecommunication Networks

As mentioned before, it is likely that in the future mobility services for PBXs will be offered by the public network (refer to CCITT and ETSI work on personal telecommunications).In the short term, however, the mobility functionalities in PBXs could be used. This way a short term scenario for offering DECT mobility by PBX services could comprise:

- the use of existing PBX mobility functions
- extension of existing functions

The extension/adaptation of PBX mobility functions implies a needed standardisation work on inter and intra-PBX functions and services. In order to support mobility management, PBXs could be equipped with HDBs and VDBs. In the long term these solutions may coexist with solutions offered by the Personal Telecommunications service.

In the examples given below it is described how existing PBX supplementary services (call forwarding and call transfer) could possibly be adjusted for the provision of DECT mobility in PBXs. It is intended that the DECT external handover procedures may be interworked with these PBX services in order to extend the performance available to the DECT user.

6.5.3.1 DECT using call forwarding (remotely activated)

In the following example, it is described how DECT could use a PBX follow-me or call forwarding function which has been extended in such a way that it can be remotely activated.

The subscriber activates the portable part (PP) in a DECT system which is not the subscriber's home DECT system. After a DECT internal identification and authentication procedure (the supporting parameters have to be obtainable !), the PP requests a follow-me from the new DECT system. The PP's home PBX now reroutes all incoming calls to the new DECT system, possibly connected to a different PBX (refer to figure 6.7).

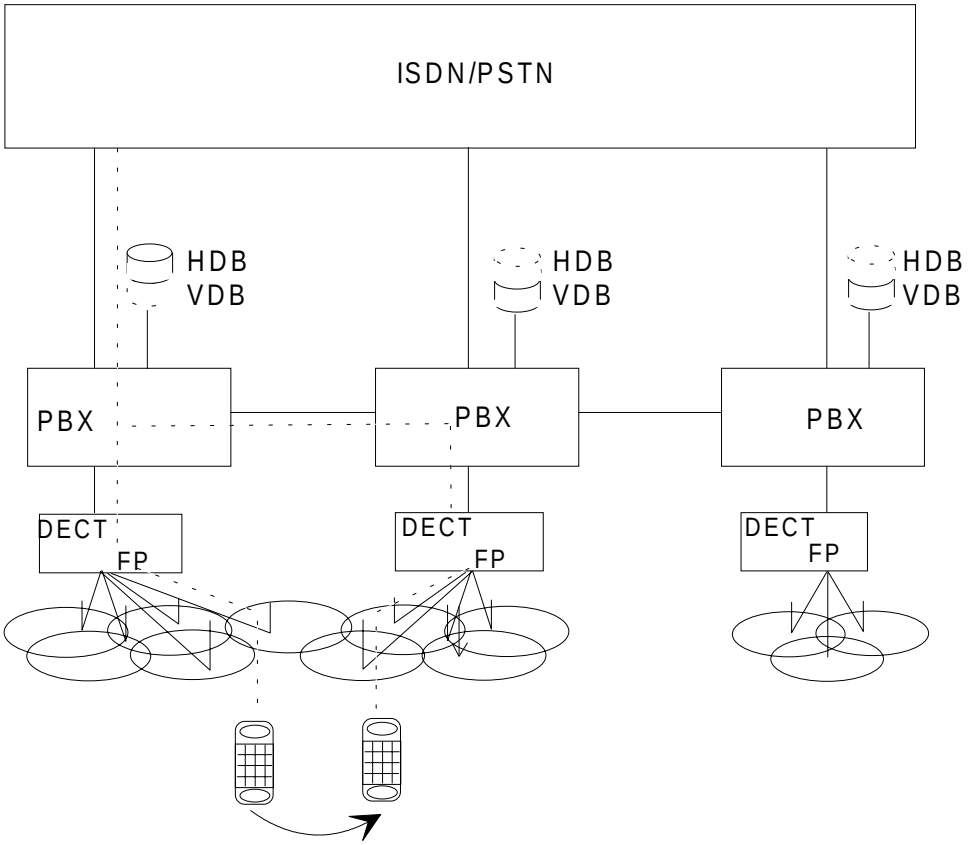


Figure 6.7: Follow-me remotely activated

6.5.3.2 DECT using Call transfer ordered from third extension

By now, call transfer to a new extension can only be ordered by one of the two communicating parties. However, in order to facilitate handover between independent DECT systems connected to one or two different PBXes, this call transfer function could be extended in such a way that it would allow the call transfer to be ordered from a third extension.

When a PP during a call detects the need for a handover to a cell belonging to a new DECT system, it requests a call setup on the new basestation thereby referring to the ongoing call (using a call reference, unique for the associated PBXes). The new DECT system can request a call transfer to the extension it has allocated for the PP. The call is rerouted to the new DECT system, possibly connected to a new PBX, as well (refer to figure 6.8).

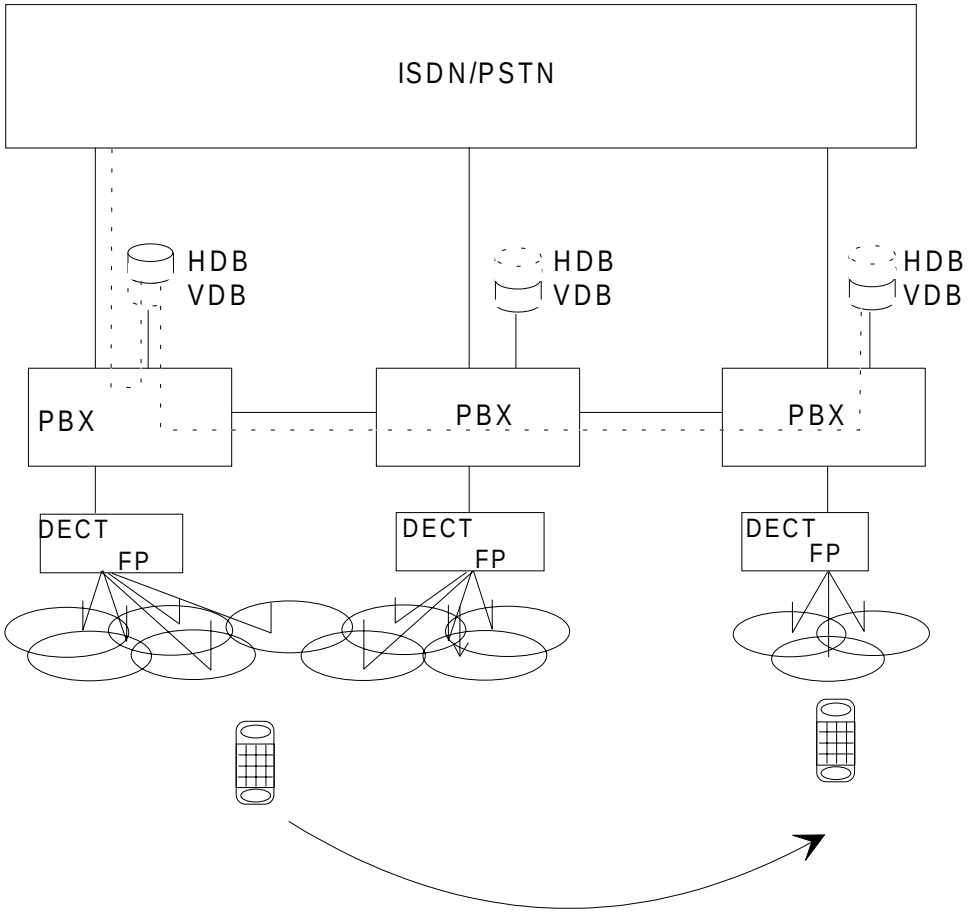


Figure 6.8: Call transfer from a third extension

6.5.3.3 DECT specific processes

Details on the DECT specific processes concerning intra and inter-PBX mobility support can be found in chapter 7.

6.6 Source documents

RES3N(90)197	System Description Document chapters 2, 3, 5, 7, and 8.
RES3N(90)105	Common Interface Specification, part 5 : NWK Layer.
RES3N(90)101	Security Features for DECT (ETSI RES3-S EG-1).
RES3N(90)164	Network layer functional requirements list.

GSM Rec. 04.08 Mobile Radio Interface Layer 3 Specification
GSM Rec. 09.02 Mobile Application Part
DECT Services and Facilities document.

Annex E: Interworking

This Annex contains Chapter 7 of the DECT System description document, and consists of pages numbered 7.1 to 7.139 (i.e. 139 pages)

Chapter 7

INTERWORKING

CONTENTS

7.0 VERSION HISTORY

Version 1.0 11.09.90
Issued at RES-3N Berlin, 24-26 September 1990.
First issue based on papers previously submitted to RES-3N, revised and supplemented.
Includes a limited set of Interworking Profiles.[210] [212] [214] [216]

Version 1.01 28.09.90
Minor revisions following Berlin.

Version 2.0 19.10.90
Definitions updated.
Supplementary Service Agreement process added.
IWP(1) - Draft added
IWP(6) - architecture and configuration info added, frame relaying clarified.

Version 2.1 19.11.90
Issued at RES-3N Sophia Antipolis 21-23 November 1990
Update to reflect changes in other chapters.
Interworking Processes substantially re-written.
- IWF Selection - new
- Interworking Authentication - new
- Call Negotiation - incorporated into IWF selection
- End-to-end compatibility - revised and more detail
- Call Information, Subscription Agreement - both deleted
- Interworking Indication - incorporated into IWF Selection

IWP(1) - C-plane procedures added.

Version 3.0 10.01.91
Issued at RES-3N Cambridge 14-15 January 1991
Minor corrections throughout.
Updated to reflect changes in CI Part 5
Revised sections: 7.4.2, 7.7.4 (SS updated for CI5 & Ch 8)
New sections: 7.7.6 (transparent protocol interworking), 7.7.7 (routing), 7.7.8 (relaying)

Version 4.0 19.04.91
Issued at RES-3N Åarhus 22-24 April 1991
Updated for CI4 v8.00, CI5 v6.00
Revised and extended definitions
7.4.9 renamed and revised
7.5 Model revised
7.7.1 revised for Call Negotiation
7.7.4 SS revised
IWP(1) revised to make use of CC-CONNECT clearer and add register recall
IWP(3) partial draft added
IWP(4) draft added
IWP(9) draft added
IWP(12) draft added

Version 4.1 20.05.91
Issued (part only) at RES-3N Ivrea 22-24 May 1991
IWP(1) revised to include SS activation
IWP(2) draft added
IWP(3) revised to include SS activation
IWP(10) added
C-Plane models in IWP(3) amended
7.7.1.1 Call Negotiation revised

Version 4.2 08.06.91
Issued at RES-3 Guernsey 10-14 June 1991
Changes discussed at Ivrea on ISDN I/Wing incorporated
IWP(3) C-plane procedures and message sequence diagrams added
IWP(9) updated

Version 4.2.1 25.06.91
Comments removed from text ready for circulation.

Version 4.2.2 28.06.91
Edited to align with versions of CI Parts 4 and 5 to be issued for public comment.

7.1 SCOPE

This chapter of the DECT System Description Document specifies the principles to be adopted when interworking DECT with other subnetworks. Recommendations for interworking with specific subnetworks are included. It should be read in conjunction with the DECT CI specification, Part 5, Network Layer.

7.2 INTRODUCTION

Real systems which incorporate DECT will, in general, require interworking with other local or wide area networks to provide useful communications. DECT specifies air interface protocols and system requirements necessary to ensure common usage of the air interface. This chapter presents general principles for interworking, processes and profiles for connection to a number of specific networks. It does not constrain the features or services provided by either real systems or interworking units.

All information required for interworking from the DECT system is transferred in messages in the DECT network protocol. A number of processes are required to support interworking and these are described in section 7.7. Each description includes the requirements of the DECT Network Protocol to support it. There are a number of interactions required between the DECT subnetwork and the interworking unit. These are controlled by interworking functions within the interworking unit. These interactions may be loosely grouped together as:-

- Selection
- Authentication
- Negotiation
- Progress

The Network Protocol provides messages and procedures which support these processes but not the specification of the processes themselves. It is important to distinguish between the processes required in interworking units and DECT components for specific interworking and the elements of the Network Protocol to support them. As an example selection of the interworking function is a process necessary within the interworking unit. In some cases this may be trivial, for example a simple system offering only voice connection to a single ISDN B channel. In other cases the process may need to choose between alternative attached subnetworks or options. The specification of this process depends on the interworking supported and the level of service offered and is therefore a matter for individual implementation.

Note that several of the processes may be supported by a common Network Protocol message exchange.

The interworking profiles provide detailed descriptions of C- and U-plane procedures in the DECT subnetwork, corresponding procedures in the attached network, application of the interworking processes described earlier and a mapping onto network layer messages and information elements.

7.3 DEFINITIONS

Abbreviations:

CP	Convergence Protocol
CSPDN	Circuit Switched Public Data Network
DCE	Data Circuit Terminating Equipment
DTE	Data Terminal Equipment
GSM	(GSM)
ISDN	Integrated Services Digital Network
IWF	Interworking Function
IWP	Interworking Profile
IWU	Interworking Unit
LAN	Local Area Network
PBX	Private Branch Exchange
PSPDN	Packet Switched Public Data Network
PSTN	Public Switched Telephone Network

DECT specific abbreviations and terms used in this chapter can be found in 'DECT Terminology: Definitions and Glossary'.[203]

The following definitions have, where possible, been adapted from other international standards for usage in DECT. Definitions have been ordered logically to avoid forward referencing.

End System

A system which contains application processes, which from an OSI point of view are considered as sources and sinks of information. Communication protocols are expected to support the needs of these applications processes.[121]

Intermediate System

A system which does not contain application processes, and is used only to enable interconnection of other systems through relaying mechanisms at or below the Network Service boundary. [121]

Subnetwork

A physical medium (media), or a collection of both equipment and physical media, which form(s) an autonomous whole and which can be used to interconnect systems for the purpose of communications.

If the subnetwork consists of a collection of both equipment and physical media, then it may be represented as an intermediate system.[121]

DECT Subnetwork

The collection of DECT Fixed Radio Termination, Portable Radio Termination and radio medium with subnetwork service provision at the DECT network user boundary.

Attached Subnetwork

A subnetwork to which a DECT Subnetwork is attached at its Fixed Radio Termination for the purpose of communication to either an end system or another subnetwork.

Mobile Subnetwork

A subnetwork to which a DECT subnetwork is attached at its Portable Radio Termination for the purpose of communication to either an end system or another subnetwork.

Interworking

The term interworking is used to express interactions between networks, between end systems, or between parts thereof, with the aim of providing a functional entity capable of supporting end-to-end communication.[102]

Interworking Function (IWF)

The interactions referred to in the Interworking definition rely on Interworking Functions and on the means to select these functions. These include the conversion of physical and electrical states and the mapping of protocols. An IWF may be implemented in the DECT Network, Local Network or Global Network, or some combination of these.[102]

In the case of the DECT Network, the IWF may be implemented at the service boundary of the DECT Subnetwork and either the Attached Subnetwork or Mobile Subnetwork.

Interworking Unit (IWU)

An intermediate system used to interconnect subnetworks. The IWU will contain the IWF's necessary to support the required network interworking between the subnetworks.[121]

The terms F-IWU and P-IWU are used to distinguish between IWUs in the Fixed Part and Portable Part respectively. Where the term IWU is used without qualification this can be taken to mean an IWU at the FP (the normal case).

Interworking Profile (IWP)

A set of procedures, functions and restrictions necessary to provide interworking between a DECT subnetwork and some other specific subnetwork for the purpose of supporting specified network interworking capabilities.

Routing and Relaying (R + R)

Routing is the capability of the IWU to derive from the destination address and if necessary other information the correct outgoing media and source and destination points of attachment to the outgoing media.

Relaying is the capability of the IWU to perform the actual forwarding of information form an attached system via the subnetwork access protocol.

It is normal to group these two functions together as R + R.[121]

Interworking Processes

Interworking processes are required within the IWU to ensure proper operation of the IWF(s) and routing and relaying functions.

Convergence Protocol (CP)

A protocol used on top of the (DECT) subnetwork service, which creates a new service boundary that is used as the basis for interconnection with the attached subnetwork.[121]

Internetwork Protocol

A subnetwork independent convergence protocol combined with R + R functions.[120]

Service Mapping

A list of services which can be supported in both the subnetworks attached to the IWU and can therefore be interworked. Note that only services up to the protocol intervention layer within the IWU are relevant to the service mapping. Services carried in the subnetworks at a higher layer will be transparent to the IWU.

Conventions:

Throughout this chapter the following conventions are used:-

Outgoing Call	A call originated in the DECT subnetwork
Incoming Call	A call originated in the attached subnetwork

DECT Layer 3 messages and Information Elements
eg {SETUP} “Called Party Number”

Other protocol Layer 3 messages and Information Elements
eg SETUP “Called Party Number” (Q.931)

Other signalling conditions
eg (PSTN) on-hook

Note that information elements shown on the message sequence diagram examples are for illustration only and only those relevant to interworking are included.

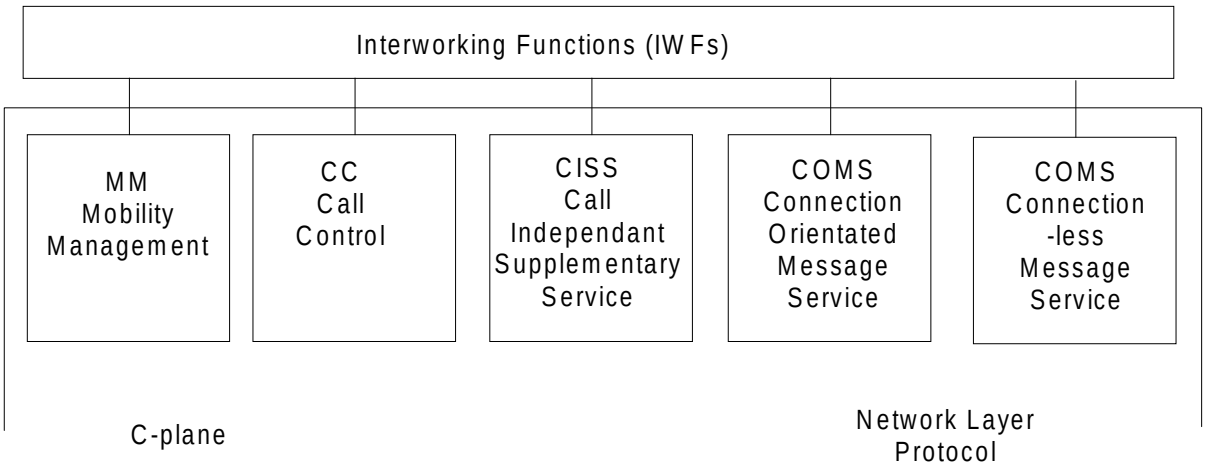
7.4 GENERAL PRINCIPLES

7.4.1 Model

The model to be used for interworking is the Unconstrained Network Service Provider model described in ECMA TR/44. [121]

7.4.2 Relationships with other Functions

Interworking functions provide the linkages between the Network Protocol entities in the C-plane, figure 7.4.1. No such linkages are required in the U-plane.



Relationship with Network Layer Entities
Figure 7.4.1

CLMS can only be used in the direction fixed to portable.

7.4.3 Implementation of Interworking Functions (IWF's)

This chapter of the DECT System Description Document specifies interworking models, protocol architectures and Interworking Profiles (IWP). IWPs are recommendations for interworking. They serve to describe how, given the DECT Network and lower layer protocols, it is recommended that interworking with specific subnetworks should be achieved. The Network Protocol provides the underlying communications to achieve interworking. [202]

7.4.4 Implementation of Interworking Units (IWU's)

The CI specification Part 5 includes Layer 3 messages and information elements. Interworking processes and procedures will be included in the CI specification only in so far as they are a necessary part of the Network Protocol. The IWU itself will not be specified. The architecture allows a wide variety of IWU's to be realised, including interworking to networks for which specific models are not provided. Specific implementations also recognise different national requirements for interworking with public networks. [202]

7.4.5 Location of IWU

Location of the IWU is a matter for specific system requirements.

7.4.6 Lower Layer Services

Some interworking requirements explicitly assume the existence of DLC U-plane interworking services. [201]

Those identified by IWPs in this chapter are:

- LU1 Transparent Unprotected Data Service
- LU2 Frame Relay Service

- LU3 Frame Switching Service
- LU5 Basic Rate Adaptation Service
- LU6 Secondary Rate Adaptation Service

7.4.7 Profiles

Profiles are included as a part of this interworking chapter. These profiles are specific to an interworking scenario and include:

- C-plane procedures
- U-plane procedures
- Applicability of interworking processes (selection, negotiation etc.)
- Message sequences
- Mapping onto Layer 3 messages and information elements
- Requirements for Bearer Services
- Service Mappings
- Requirements for any convergence protocol
- restrictions on DECT specific functions such as mobility.

Profiles do not constrain interworking possibilities but provide minimum requirements for interoperability between systems.

7.4.8 Convergence Protocols

Convergence protocols above the DECT subnetwork (Layer 3) will not be specified. [121]

7.4.9 Interworking Functional Requirements

a) Service Mapping

Interworking requires a service mapping between DECT and the attached subnetwork so that end systems can satisfactorily communicate. The interworking processes (see 7.7) are general descriptions of the means of doing this. The interworking profiles (IWPs) are specific descriptions for a number of different attached subnetworks and interworking scenarios. When describing the processes and profiles it is useful to consider the network related characteristics which have an impact on the service mapping at the point of interworking (i.e. the IWU). For example, [102] :

i Connection Related: Connection type, bearer capability, interface characteristics, addressing, routing etc.

ii Network-to Network Protocols: for signalling in the C-plane for connection control or user data in the U-plane.

iii Supplementary Services:

iv In-band Protocol Conversion: Rate Adaptation, modem selection, voice encoding etc.

v Network Control Related: Billing, subscription etc.

b) Information Handling

Each interworking function within the IWU may be considered in terms of its intervention at the subnetwork service provision boundary. Information is handled in one of the following ways: [104]

i Information is terminated at the IWU.

ii Information is interpreted at the IWU and transferred to the subnetwork.

iii The IWU is transparent

iv Information is generated at the IWU and passed to one or both subnetworks.

c) Categories of IWF

IWFs may be considered to be in one of two categories.[102]

i) Connection Dependent

Those functions needed to interconnect DECT to other networks,

ii) Communication Dependent

Those functions in addition to connection dependent functions needed in order to establish specific end-to-end communication and which may differ from application to application.

As an example interworking a circuit switched data call with the PSTN might require the selection of the following IWFs:

Connection Dependent	PSTN Interworking
Communication Dependent	Selection of modem type
	End-to-end compatibility exchange

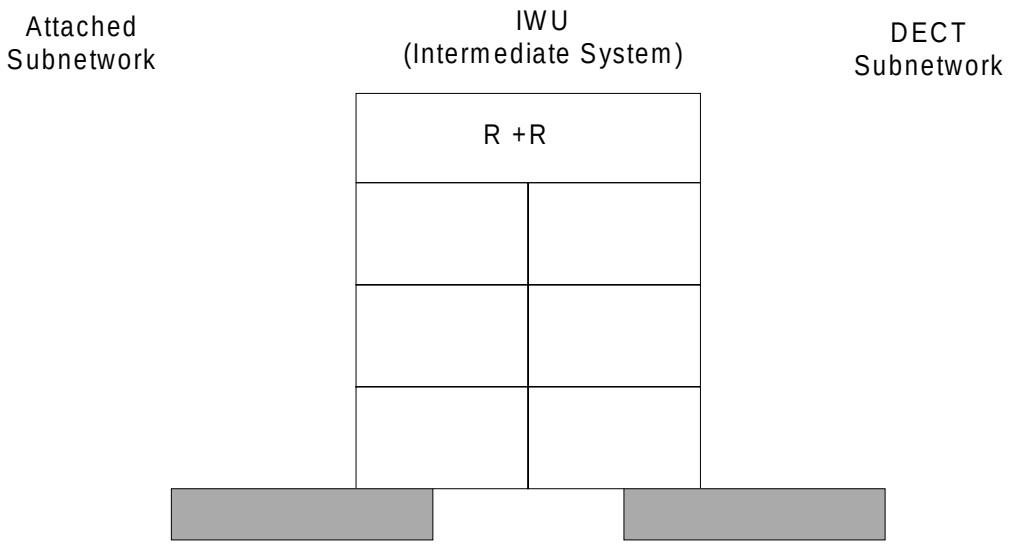
The individual interworking profiles (IWPs) presented later in this chapter list the IWFs required for each case.

7.5 INTERWORKING MODEL

7.5.1 Unconstrained Network Service Provider Model for the IWU

The following model is based on the concepts developed in TR/44. [121]. For clarity and simplicity however the DECT subnetwork is not considered as an intermediate system. This is because it contains no equipments and is merely represented by a defined set of access protocols, the 'air interface'.

An Interworking Unit (IWU) connects a DECT subnetwork to some other subnetwork, figure 7.5.1. The IWU is an intermediate system, that is, it contains no applications processes and can only be used for the interconnection of networks for the purpose of communications. The protocol intervention level of the IWU is the highest layer in the subnetwork access protocol. The intervention level on the DECT side of the IWU in the C-plane is at the Layer 3 service boundary, and in the U-plane at the Layer 2 service boundary.



IWU Model

Figure 7.5.1

A convergence protocol is required when interworking between an end system and an attached subnetwork requires some higher level interaction within the IWU. IWPs included in this chapter identify

requirements for convergence protocols but as by definition they exist above the network service boundary they are not specified.

The IWU includes a "Routing and Relaying" function (R+R) above the subnetwork access protocols.

Note that the IWU can only support services which are common in both subnetworks. (This is known as "service mapping".) [103]

In the DECT subnetwork all information needed by the R+R function will be conveyed by a parameter exchange at the subnetwork service boundary in the C-plane (Layer 3).

7.5.2 Signalling Part Model

Figures 7.5.2 and 7.5.3 show models relating to interworking for the signalling part (C-plane in the DECT subnetwork). The protocol intervention level is at the Network Layer (layer 3) at the boundaries of the DECT subnetwork but could be at other layers in the attached subnetwork.

In figure 7.5.2 the DECT subnetwork is terminated by an end system, for example a portable handset. The subnetwork access protocols in this end system form part of the PT and those in the IWU (fixed) form part of the FT. No assumptions are made about the physical realisation of the IWU.

In figure 7.5.3 the concept of a terminal adaptor is introduced. This is a further IWU providing interconnection between the DECT subnetwork and the Mobile subnetwork. The Mobile subnetwork may be either a medium or an intermediate system. End systems are not shown in this figure. The terminal adaptor may be used for either,

i) supporting end systems which do not contain a PT

or

ii) providing a gateway function to subnetworks not supporting the DECT protocols.

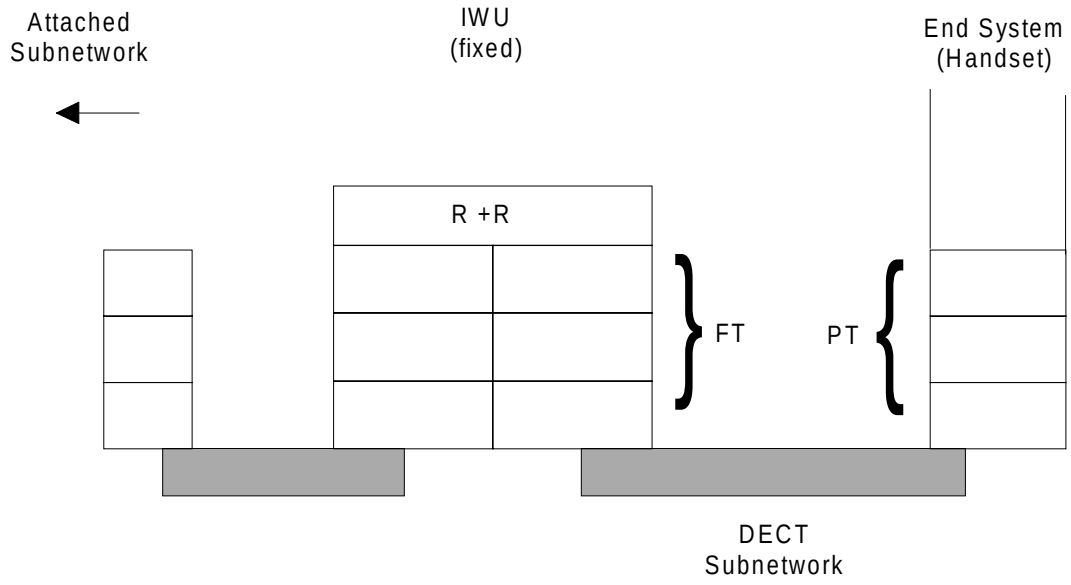
See also [205].

7.5.3 User Part Model

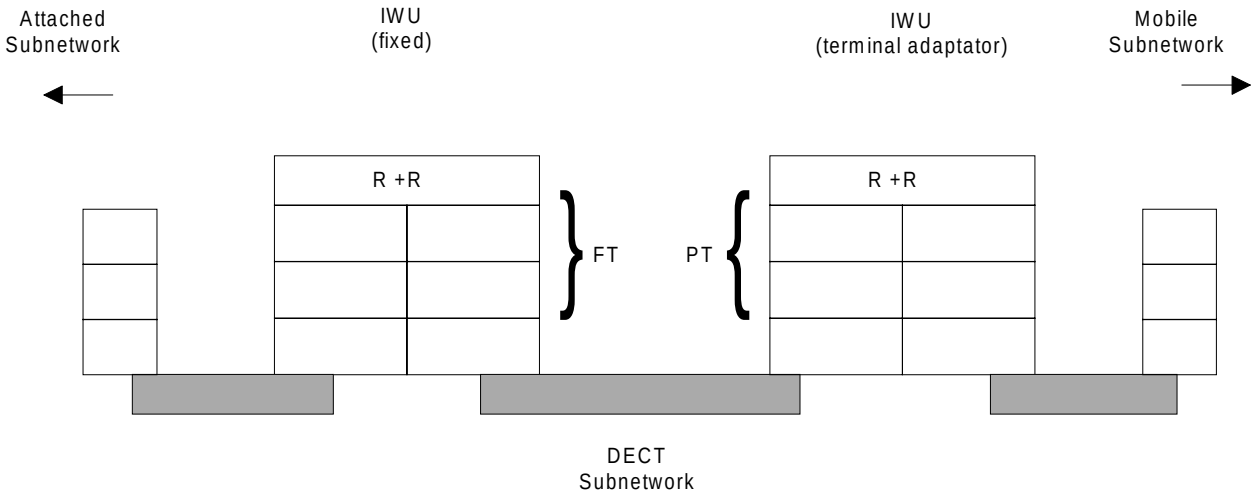
Figures 7.5.4 and 7.5.5 show models relating to interworking of the user data part (U-plane in the DECT subnetwork). These particular examples illustrate interworking to analogue telephony networks. Speech coding is considered here as a presentation layer function. The IWU therefore contains a transcoding function and there is a convergence protocol between the speech coders.

Figure 7.5.4 applies when the DECT subnetwork is terminated by an end system, in this case a portable handset. Figure 7.5.5 extends the terminal adaptor to the U-plane.

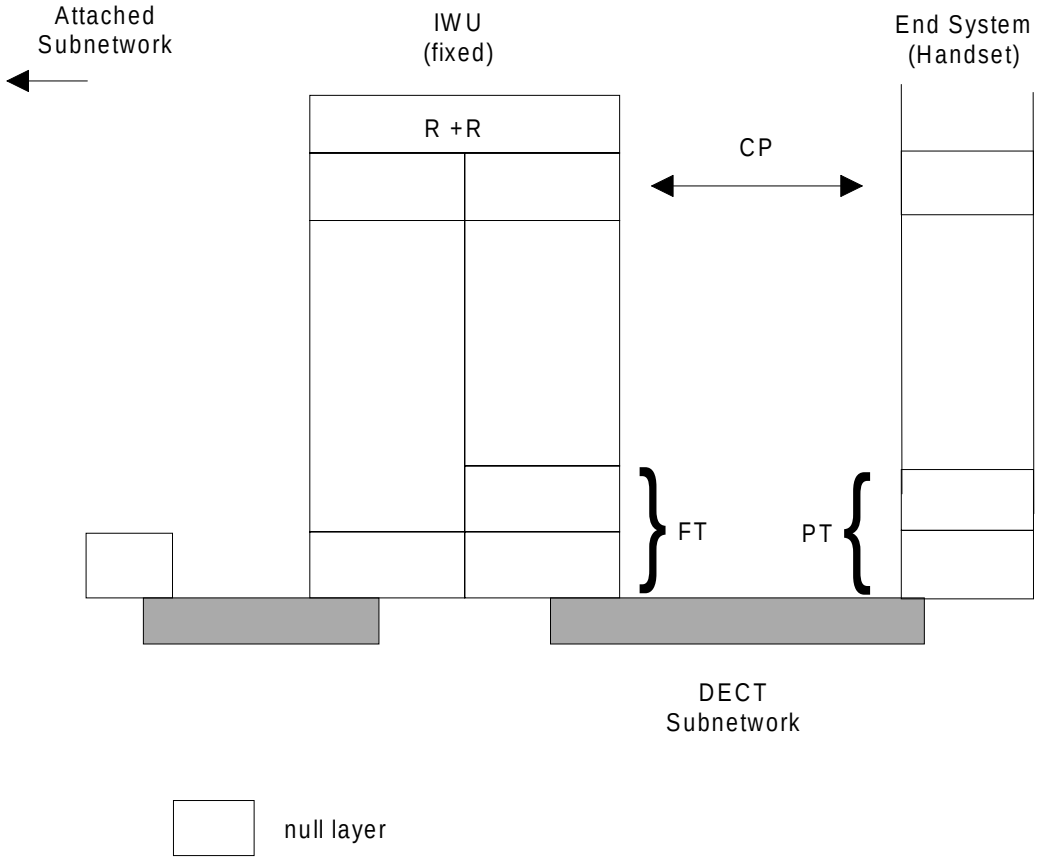
See also [205].



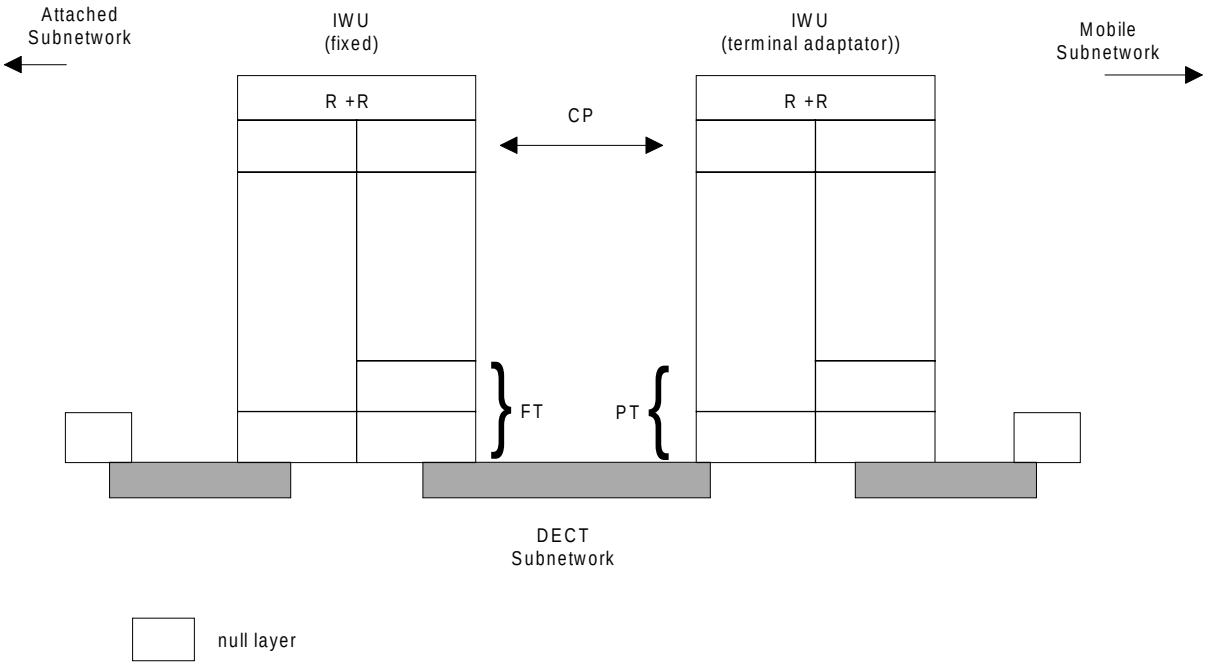
Signalling Part Model
(End System)
Figure 7.5.2



Signalling Part Model
(Terminal Adaptor)
Figure 7.5.3



User Part Model
(End System)
Figure 7.5.4



User Part Model
(Terminal Adaptor)
Figure 7.5.5

7.6 NETWORK SUPPORT

Table 7.6.1 gives the DECT interworking configurations. Other teleservices may be considered as specific examples of data transmission (analogue or digital attached subnetworks). However for the relevant interworking profile to be applicable it must be shown that a service mapping is possible. Circuit Switched Public Data Networks (CSPDN) are not specifically supported. The table includes four public network types and one private network (IS 8802 LAN). Interworking with other private networks (eg PBX) is based on similar public networks.

Table 7.6.1

	DECT Interworked with				
Telecommunications Service Supported	ISDN	PSTN	PSPDN	GSM	IS 8802 LAn
Telephony	X	X		X	
Data Transmision-					
Circuit Switched	X	X	X	X	
packet Switched	X				X
Gp 3 Facsimile	X	X			
Gp 4 Facsimile	X				

Notes:

i) Interworking with other LANS will use the profile for IS8802 for guidance.

ii) Other dedicated networks may be interworked using an ISDN as a transit network.

7.7 INTERWORKING PROCESSES

The following are processes within an IWU to ensure correct operation of the interworking functions between the subnetworks. These rely on procedures in the network layer peer protocol to provide information between the DECT portable radio termination (PT) and the IWU and on signalling information from or signalling conditions on the attached subnetwork.

7.7.1 IWF Selection

7.7.1.1 Call Negotiation

IWFs are invoked in the IWU as a result of service requirements for interworking. During call establishment it is possible for the IWU and DECT PT to negotiate aspects of the service mapping. Depending on the requirements and capabilities of the attached subnetwork there may be a similar negotiation between it and the IWU. A complete service mapping requires consideration of the capabilities and requirements of the DECT subnetwork, the attached subnetwork and the IWU itself. The process of establishing the service mapping is known as Call Negotiation and results in the selection of a suitable IWF (or IWFs) if possible.

The remainder of this section refers only to the Call Negotiation in the DECT subnetwork.

A successful service mapping can only make use of capabilities common to both subnetworks. Information is supplied by the (DECT) call originator during the call establishment phase (typically in a {CC-SETUP} message). Negotiation at the call terminating end is limited to either accepting the call and providing a service mapping or rejecting the call with (optionally) details of an alternative service mapping provided the call originator supports negotiation. The calling end is then at liberty to attempt a new call establishment with revised interworking requirements.

The call originator specifies information relevant to establishing a service mapping in the “IWU-Attributes” element of the {CC-SETUP} message.

The negotiation indicator (part of the “IWu-Attributes” element) is used as follows:

Negotiation Indicator
Value

Negotiation not possible:
If a service mapping is not possible the terminating end will reject the call.

Exchanged Parameters:
If a service mapping is not possible the terminating end will reject the call and may provide an alternative service mapping. Call originator may then attempt a new setup with revised interworking requirements.

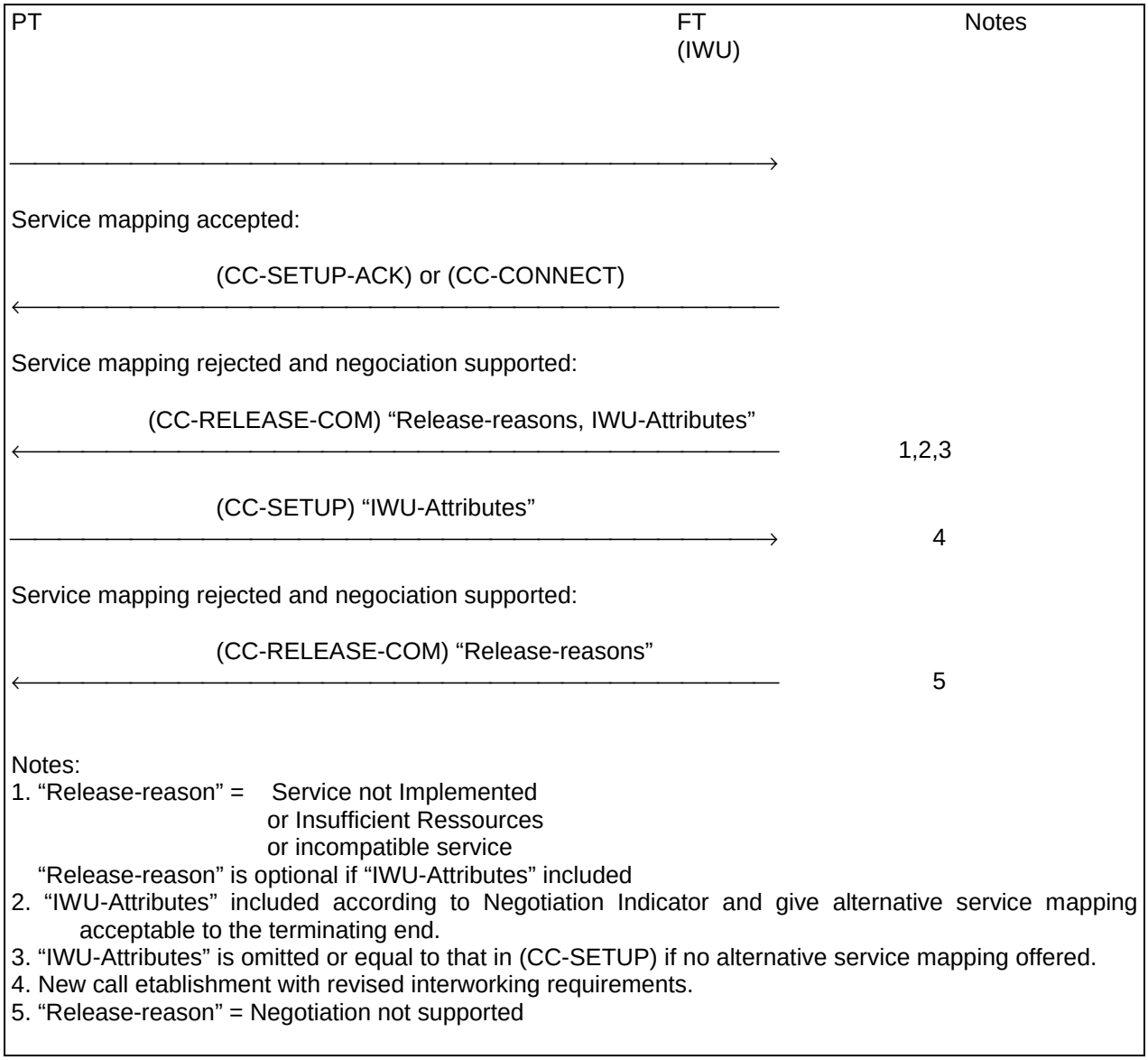
The following are possible outcomes of the Call Negotiation:

i A service mapping is possible and is accepted by the end terminating the call.
The negotiation is accepted by continuing with call establishment in the normal way.

ii A service mapping is possible but is rejected by the end terminating the call.
This is an exceptional condition and a reject reason must be given.

iii A service mapping is not possible.
The negotiation is rejected by the terminating end rejecting the call setup.

Figure 7.7.1 illustrates typical message sequences for a PT originated call. An IWU originated call would be similar.



Call Negotiation
Figure 7.7.1

Call Negotiation may be pre-determined in part or on a call-by-call basis. If pre-determined then normally at least sufficient information must be supplied to agree on the connection dependent IWFs if possible. Other IWFs may then be pre-determined. The agreement between the IWU and attached subnetwork may similarly be on a pre-determined basis.

7.7.1.2 Outgoing Access

FUNCTIONAL REQUIREMENTS:

The service requirements are inferred by information supplied to the IWU from the network protocol during the call establishment phase.

The user need not have specific knowledge of the attached subnetworks. For example a user requiring a speech call need not be concerned whether interworking is to be provided to a PSTN or ISDN. Similarly, an X.25 call could be interworked by providing direct access to the PSPDN, via ISDN circuit mode or via ISDN packet mode. In all cases, however, the choices left open to the IWU may be constrained by supplying more specific information for the selection of IWFs.

INFORMATION EXCHANGED

TYPE	CODED OPTIONS	NOTES
Negotiation Indicator	Negotiation not possible Exchanged Parameters	1
Transfer Capability	speech unrestricted digital information restricted digital information 3.1 kHz audio 7kHz audio fax video	
Transfer Mode	circuit mode packet mode	 2
Attached Subnetwork Connection Type	connection orientated virtual circuit connectionless not applicable	 3
Bearer Symmetry	Symmetrical Asymmetrical	4
Urgency	Normal Service Emergency Service External handover	
User Information Bearer Rate	nil 16kbps n*16kbps 32kbps n*32kbps 64kbps n*64kbps 384kbps unspecified packet rate	5 6 7
Structure	8kHz integrity SDU integrity Unstructured default	

TYPE	CODED OPTIONS	NOTES
User Information Protocol	G.721 ADPCM G.711 μ-law PCM G.711 A-law PCM G.722/G.725 7kHz audio H.261 384kbps video V.110 rate adaptation non standard rate adaptation Gp3 Fax Gp4 Fax X.28/X.29 user specific	
L3 Protocol ID	Q.931 X.25, packet layer GSM 04.08 IS 8348 (OSI connection orientated) IS 8208 (X.25 pkt layer for DTE) IS 8473 (OSI connectionless) user specific	 8
L2 Protocol ID	IS 8802/LLC LAPB (X.25 link layer) LAPB extended (X.25 Multilink) MLP (X.25 link layer) LAPD (Q.921) LAPM (V.42) $LAPD_m$ (GSM 04.06) Basic Mode IS 1745 user specific	8 9
V.110 Rate Adaptation Parameters	TBD	10
Modem Type	V.21 V.22 bis V.23 V.26, bis, ter V.27, bis, ter V.29 V.32 V.33 V.35	11, 12 V.22

Notes:

1 Used to determine capabilities of Call Negotiation

2 Transfer mode should be maintained across the interworking.

3 If 'not applicable' then connection type does not need to be maintained across interworking.

4 Refers to U-plane bearer capacity.

5 nil is specified when user information is not to be interworked.

6 'Unspecified' is used for connection or virtual circuit types where rate is not relevant, eg interworking to analogue networks.

7 'Packet rate' is used for connectionless interworking only when the IWU must ensure sufficient capacity available on subnetworks to meet packet demands.

8 U-plane transparent

9 'User specific' if frame structure irrelevant to interworking

10 Only if indicated by User Information Protocol.

11 Only if 3.1kHz audio transfer capability.

12 Modem Type is also used for end-to-end compatibility.

LAYER 3 PROCEDURES:

All information relevant to selection of the IWF is passed during the call establishment phase. The following Layer 3 procedures are relevant:

Call Control Entity:
- Call Setup
- Call Connect
- Call Release
- Suspend and Resume

Call Setup: The {CC-SETUP} message contains information relevant to the interworking service mapping. The IWU performs a service mapping, possibly after a negotiation, and selects the required IWFs. Different IWFs may be provided for normal and emergency call services.

Call Connect: The Call Connect procedures are used to indicate to the IWU and peer Layer 3 entities that user data can now be passed. The IWU must connect the user data paths of the two subnetworks, remove any temporary conditions such as muting and instigate any other required relaying functions.

Call Release: The Call Release procedures cause the IWU to:
- cease its relaying function
- de-select IWFs
- release any on-demand call on the attached subnetwork.

Suspend and Resume:
These are optional procedures which allow the underlying DECT resources to be temporarily released. The IWU need not be aware of these procedures in many cases, however in other cases suspension of the DECT link may need to result in release of IWU and attached subnetwork resources. Similarly inactivity on the attached subnetwork may need to be interworked to DECT link suspension.

COMS Entity:
- COMS Setup
- COMS Connect
- COMS Release
- Suspend and Resume

Selection of the IWFs in a COMS call is similar to the above with the following exceptions:

i) The setup message cannot carry certain information elements thus restricting IWFs which may be selected.

ii) Emergency calls are not available.

iii) Negotiation of the service mapping is not allowed.

LAYER 3 MESSAGES AND INFORMATION ELEMENTS

Message	Relevant Information Elements
{CC-SETUP}	IWU Attributes, Basic Service End-to-End Compatibility
{CC-SETUP-ACK}	Progress Indicator
{CC-CALL-PROC}	Progress Indicator
{CC-ALERTING}	
{CC-CONNECT}	IWU Attributes, Progress Indicator
{CC-RELEASE}	Release Reasons
{CC-RELEASE-COM}	IWU Attributes, Release Reasons

Message	Relevant Information Elements
{COMS-SETUP}	IWU Attributes
{COMS-CONNECT}	
{COMS-RELEASE}	Release Reasons
{COMS-RELEASE-COM}	Release Reasons

The information required to select the IWF is carried in Information Elements as follows:-

Information Element	Information Exchanged
IWU Attributes	Negotiation Indicator Transfer Capability Transfer Mode Attached subnetwork connection type Bearer Symmetry User Information Bearer Rate Structure User Information Protocol L3 Protocol ID L2 Protocol ID
Basic Service	Urgency
End-to-End Compatibility	V.110 Rate Adaptation Parameters Modem Type

7.7.1.3 Incoming Access

FUNCTIONAL REQUIREMENTS:

The method of selecting IWFs for incoming calls will vary depending on the attached subnetwork. The IWU will assess the interworking requirements based on either in-band or out-band signalling from the attached subnetwork. Depending on the network these may be either explicit or involve a call negotiation phase. The IWU needs to perform a service mapping between the service requested by the incoming call and the capability of the DECT subnetwork and end system. Unless pre-determined this may involve the IWU in two simultaneous call negotiations, one to each subnetwork.

The IWU informs the Network Layer of the requirements for the DECT subnetwork. DLC and MAC specific requirements will be assessed. The IWU will attempt to send as much information as possible in the {CC-SETUP} or {COMS-SETUP} messages but this may be limited by the information available from the attached subnetwork. If the Portable Part includes the end system then it checks compatibility of the service requested with what it can offer and replies accordingly. If, however, the Portable Part includes an IWU to the Mobile subnetwork then a further call negotiation is required before complete agreement on service mapping, Attached Subnetwork-DECT-Mobile Subnetwork can be concluded.

Refer also to general descriptions in 7.7.1.2.

INFORMATION EXCHANGED

Refer to 7.7.1.2

LAYER 3 PROCEDURES

Refer to 7.7.1.2

LAYER 3 MESSAGES AND INFORMATION ELEMENTS

Message	Relevant Information Elements
{CC-SETUP}	IWU Attributes, End-to-End Compatibility
{CC-ALERTING}	
{CC-CONNECT}	Progress Indicator
{CC-CONNECT-ACK}	
{CC-RELEASE}	Release Reasons
{CC-RELEASE-COM}	IWU Attributes, Release Reasons

Message	Relevant Information Elements
{COMS-SETUP}	IWU Attributes
{COMS-CONNECT}	
{COMS-RELEASE}	Release Reasons
{COMS-RELEASE-COM}	Release Reasons

7.7.2 Interworking Authentication Exchange

FUNCTIONAL REQUIREMENTS

The IWU may be involved in the following two aspects of authentication.

1 Meeting the authentication requirements (if any) for the attachment of the FP to the attached subnetwork.

2 Interworking the DECT authentication procedures with the attached subnetwork authentication procedures (if required). [Note this is only required if the procedures are not independent.]

In some cases any authentication required on the attached subnetwork will be independent of DECT authentication. However, in other cases the IWU will need to interwork the authentication procedures. For example when connected to GSM the network will send an authentication request to the FT according to GSM 04.08. The IWU will relay this to the PT in a DECT {AUTH-REQUEST} message with = 'GSM'. The PT will calculate the response, SRES, according to the GSM algorithm and forward this to the FT in a {AUTH-REPLY} message. The IWU will relay this response to the GSM network in an 04.08 AUTHENTICATION RESPONSE message. Note that for any exchange at all to be possible across the DECT subnetwork, first the DECT authentication procedures must have been completed.

INFORMATION EXCHANGED

TYPE	CODED OPTIONS	NOTES
Authentication Type	GSM other	 1
Authentication Parameters	Challenging Random Number Cipher Key	2,3
Authentication Response	Calculated response	4,5
Reject Reason	unknown authentication type authentication failed missing parameter unknown parameter	6

Notes

1 'Other' is used for unspecified proprietary algorithms. Note DECT standard authentication is not part of interworking.

2 Refer to specific IWP

3 Direction FT to PT

4 Algorithm dependent on authentication type.

5 Direction PT to FT

6 Reject reason codes to be interworked to attached subnetwork. IWP will provide mapping.

LAYER 3 PROCEDURES:

The following Layer 3 procedures are relevant when interworking DECT authentication procedures with those of the attached subnetwork:

Mobility Management Entity: Authentication

Only the procedures for authentication of the PT or the user are relevant to interworking. In each case the element “AUTH-TYPE” indicates the algorithm to be used (eg GSM).

LAYER 3 MESSAGES AND INFORMATION ELEMENTS:

Message	Relevant Information Elements
AUTH-REJECT	Reject Reason, Auth-Type
AUTH-REPLY	RS RES
AUTH-REQUEST	AUTH-TYPE, RES, RAND, RS

7.7.3 End-to-End Compatibility

FUNCTIONAL REQUIREMENTS:

Information is exchanged to determine user-to-user or terminal equipment compatibility. This may be either interpreted by the IWU or interworked to the attached subnetwork. This information ensures transfer compatibility and compatibility of the DTE/DCE interface.

This process deals with the communication dependent IWFs. The information is exchanged during call establishment, either on first request or subsequently. No negotiation is permitted on characteristics specified, however, all elements are optional for inclusion in the message.

INFORMATION EXCHANGED:

Type	Encoded Options		Notes
Forward User Rate	75 bps 300 bps 600 bps 1200 bps 2400 bps 4800 bps 7200 bps 9600 bps 19200 bps	8 kbps 16 kbps 32 kbps 48 kbps 64 kbps n*64 kbps	1, 3
Backward User Rate	75 bps 300 bps 600 bps 1200 bps 2400 bps 4800 bps 7200 bps 9600 bps 19200 bps	8 kbps 16 kbps 32 kbps 48 kbps 64 kbps n*64 kbps	2, 3
Modem Type			4,5
Synchronization	Async Sync		
Parity	odd even none BIN 0 BIN 1		

Type	Encoded Options	Notes
Transmission Mode	half duplex duplex	
Start/stop bits	none 1 1.5 2	
Clock source	network dependent network independent	6

Notes:

1 Forward direction is from call originator

2 Backward direction is to call originator

3 User rates must be compatible with U-plane bearer rate and Rate Adaptation parameters in IWF selection.

4 This information is also required for IWF selection - see section 7.7.1.1

5 Modem type need not be specified if modem is to selected by the IWU but if it is then it must be compatible with user rate selected.

6 Clock may be sourced by DTE or network.

LAYER 3 PROCEDURES:

All information relevant to end-to-end compatibility is passed during the call establishment phase. The following Layer 3 procedures are relevant:

Call Control Entity:	Call Setup
	Call Information
	Call Release

Call Setup For outgoing calls interworked to PSTN (directly or via an ISDN) user rate, modem type and synchronisation are used to select a modem at the IWU or within the attached subnetwork. If a suitable modem is not available the call request will be rejected. For non-PSTN interworked calls modem type is ignored and user rate is passed end-to-end. Other parameters are interworked to the attached sub-network or passed end-to-end.

For incoming calls all parameters may be passed to the PP for compatibility checking. If a mapping is not possible the call request will be rejected. All parameters are optional. Modem type is ignored unless a 3.1 kHz bearer has been selected in which case user rate, modem type and synchronisation are used to select a suitable modem at the PP.

Call Release: All IWFs including modems are released.

LAYER 3 MESSAGES and INFORMATION ELEMENTS:

Message	Relevant Information Elements
{CC-SETUP} {CC-RELEASE}	End-to-End Compatibility

7.7.4 Supplementary Service Interworking

FUNCTIONAL REQUIREMENTS:

The IWU provides, where necessary, interworking of supplementary services. From the point of view of a DECT portable part a supplementary service may be provided by any of :-

- the attached subnetwork
- a service provider accessed via the attached subnetwork
- a further subnetwork where the attached subnetwork is used as a transit network
- the IWU itself

Supplementary service interworking needs to consider:

i interworking of the control protocol
ii interworking of call related supplementary services
iii interworking of call independent supplementary services
iv interworking of DECT specific supplementary services

In the DECT subnetwork three protocols are defined for control of supplementary services. Keypad and Feature Key protocols are of the stimulus type. There is also a Functional protocol. This approach closely follows that defined for ISDN. Interworking to an ISDN or some other network using similar supplementary service protocol structures involves a mapping of keypad codes, Feature Key identity codes or Functional Protocols. Interworking to other types of network may require a different approach. Individual IWPs provide further information on the interworking of supplementary services.

It is assumed here that DECT FTs and PTs may support any combination of the three protocols. Where there is a choice of protocol between the FT and PT or on the attached subnetwork the IWU will where possible ensure the use of protocols which provide the greatest interworking of supplementary services.

[208].

Supplementary services may be either call related (CRSS) or call independent (CISS). CRSS are associated with a specific instance of a CC entity. CISS apply to all calls or to services unrelated to any call instances. In addition there are a number of DECT specific supplementary services all of which are call related.

Interworking of Keypad Protocol

This section considers the use of the keypad protocol in the DECT subnetwork which are used for CRSS.

Supplementary services are invoked by transferring a service code from the PT to the service provider. Service codes may be input from the keypad at the portable. In some cases all of the information required by the service provider can be transferred in the setup message and in others additional information will need to be sent in a message during the call. Service codes are a string of IA5 characters sent in an information element within a Layer 3 message. The IWU may provide interworking of codesets. IA5 characters may be sent from the FT to PT in “Display” information elements.

DECT does not specify the keypad codes to be used for the invocation of CRSS. These must be agreed in advance and may be either a standardised service code set (eg SF2) or may be network dependent. The IWU will either interwork the service codes transparently or, in the case of a standardised code set, provide translation to the codeset supported on the attached subnetwork.

The mapping of supplementary service requests from the DECT subnetwork using the keypad protocol onto some dissimilar protocol on the attached subnetwork may provide only limited interworking, if any. When the IWU cannot map a service request then it will be ignored.

Interworking of Feature Key Protocol

This section considers the use of the feature key management protocol in the DECT subnetwork.

This protocol relies on the transfer of a Feature Indicator. This is network dependent and must be coordinated between user and service provider (in some cases at subscription time). There is no negotiation of interworking of feature identifiers as there is with keypad codesets.

The interworking of the feature key protocol is dependent on the capabilities of the attached subnetwork and implementation of the IWU. IWPs provide further information.

Where the attached subnetwork does not offer a suitable protocol then interworking may be restricted or not possible. If the IWU cannot map a service request then it will be ignored.

Interworking of Functional Protocol

This section considers the use of the functional protocol in the DECT subnetwork.

If the attached subnetwork uses the same functional protocol then interworking is accomplished by a straightforward mapping of the messages. In other cases or where the attached subnetwork does not support a functional protocol interworking may be restricted or not possible. The degree of interworking will be dependent on the capabilities of the attached subnetwork and the implementation of the IWU. IWPs provide further information.

When the IWU cannot map a functional protocol then either the service request will be rejected, whilst always ensuring correct and consistent operation of the protocol, or the call will be released.

Interworking of CRSS

Unless the service is offered by the DECT FP or by the IWU the CRSS will require interworking to the attached subnetwork. The IWU performs the mapping of the control protocol. DECT standard features are based on those of the ISDN.

The functional protocol also defines a number of separate message supplementary services concerned with the {HOLD} and {RETRIEVE} functions. Interworking of these messages to networks other than ISDN is for further study.

Interworking of CISS

There is no general method of interworking CISS. Appropriate IWPs identify specific interworking requirements.

Interworking of DECT Specific Features

DECT specific feature use the feature key management protocol. All of these require interworking to the attached subnetwork if possible. The element “FEATURE ACTIVATE” is used to select a feature and “FEATURE ACTIVATE” to indicate its status to the PT. These features generally interwork to signalling conditions on the attached subnetwork, for example 'goto DTMF'. Where interworking is possible IWPs identify specific requirements.

INFORMATION EXCHANGED

Type	Encoded Options	Notes
Class	Service access codes	
Feature Indicator		1
CISS		1

Notes:

1 Network dependent.

LAYER 3 PROCEDURES

This process is only invoked when access to supplementary services may be required during a call. It should be used for all speech calls and optionally for circuit switched access data calls.

The following Layer 3 procedures are relevant:

Call Control Entity : Call Setup
Call Information
Call Release

CISS Entity : Keypad Protocol
Feature Key Management Protocol
Functional Protocol

Call Setup: During call setup elements for the Keypad, Feature Key or Functional Protocols may be sent.

Call Information: Supplementary services may be accessed during a call using the call information procedures.

Call Release: Any interworking of call related supplementary services is released when the call is released from either end. Any interworking of call independent supplementary services will be released only if either the interworking is complete or cannot be continued without the existence of a call to the PT.

Keypad Protocol: see Functional Requirements in this section

Feature Key Management Protocol: see Functional Requirements in this section

Functional Protocol: see Functional Requirements in this section

LAYER 3 MESSAGES AND INFORMATION ELEMENTS

Message	Relevant Information Elements
	Keypad, display, Facility, Feature Activate, Feature Indicate

Most CC or CISS messages may contain supplementary service elements which will be interworked.

7.7.5 Queue Control

FUNCTIONAL REQUIREMENTS:

Queue Control controls access to an IWF if either:

1) the IWF is busy
2) the subnetwork service agreed in service agreement is busy

7.7.6 Transparent Protocol Interworking

FUNCTIONAL REQUIREMENTS:

In some instances it is necessary to carry signalling information between the subnetwork and PP which has no significance to the DECT air interface and cannot be interworked with the DECT network protocol. Such information is carried transparently across the DECT subnetwork (in either direction) between IWU and PP at the network service boundary in the C-plane. A protocol identifier enables the IWU (or PP) to interwork the information. The same method may be used to carry information to and from the IWU for control purposes.

Using this technique a non-DECT network protocol could be carried transparently across the DECT subnetwork. As an example an ISDN terminal supporting the DECT air interface could continue to send and receive Q.931 messages to an attached ISDN. The technique may also be used to carry higher layer information.

INFORMATION EXCHANGED

Type	Encoded Options	Notes
Protocol ID	Q.931	1
	GSM 04.08	1
	X.244/X.224	2
	IA5 characters	
	V.120	
	IS 8208	
	IS 8473	
	Higher Layer	3
	IWU control	4
	other	
User Info	-	5

Notes:

1 Protocol ID allows for messages or information elements.

2 X.25 protocol identification and ISO transport protocol.

3 ie above Network service boundary.

4 Information carried transparently to/from IWU for control and not for interworking to the attached subnetwork.

5 Maximum length only restricted by DECT network protocol.

LAYER 3 PROCEDURES

The information is exchanged between network service boundaries using the CC entity independent of the layer 3 procedures.

LAYER 3 MESSAGES AND INFORMATION ELEMENTS

Message	Relevant Information Elements
{CC-SETUP}	IWU-TO-IWU, IWU-Packet
{CC-INFO}	IWU-TO-IWU, IWU-Packet
{CC-SETUP-ACK}	IWU-TO-IWU, IWU-Packet
{CC-CALL-PROC}	IWU-TO-IWU, IWU-Packet
{CC-ALERT}	IWU-TO-IWU, IWU-Packet
{CC-CONNECT}	IWU-TO-IWU, IWU-Packet
{CC-CONNECT-ACK}	IWU-TO-IWU, IWU-Packet
{CC-RELEASE}	IWU-TO-IWU, IWU-Packet
{CC-RELEASE-COM}	IWU-TO-IWU, IWU-Packet
{IWU-INFO}	IWU-TO-IWU, IWU-Packet

Note that the IWU-INFO message is used with the CC entity to carry the transparent protocol information if no other suitable message is available.

Message	Relevant Information Elements
{COMS-SETUP}	IWU-TO-IWU, IWU-Packet
{COMS-INFO}	IWU-TO-IWU, IWU-Packet
{COMS-CONNECT}	IWU-TO-IWU, IWU-Packet
{COMS-RELEASE}	IWU-TO-IWU, IWU-Packet
{COMS-RELEASE	IWU-TO-IWU, IWU-Packet-COM}

7.7.7 Routing

7.7.7.1 Outgoing Access

FUNCTIONAL REQUIREMENTS:

The routing process in the IWU determines the correct outgoing media and source and destination points of attachment to the outgoing media. (Address mapping.)

Selection of the media will in most cases be determined by the IWF selection (see 7.7.1.1). In some cases the routing process may need to perform part of the selection (for example choice of B channel for ISDN interworking) based on additional information. In general this is a matter for individual implementations of the IWU.

Derivation of the source and destination addresses are a function of the requirements of the attached subnetwork. The source address, if required, may be either the address of the IWU or (if possible) that of the PT. The destination address is derived from information supplied during call establishment by the PT. The IWU may perform any type of address translation in order to obtain the correct outgoing destination address.

INFORMATION EXCHANGED

Type	Encoded Options	Notes
Destination Address	Called Party No. Abbreviated Address	1
Number Type	International National Local significance Abbreviation other	
Numbering Plan	PSTN ISDN Data Private National Standard	
Source Address	-	2
Outgoing Media	-	3

Notes:

1 May include subaddress information.

2 The source address, if required, may be derived either locally by the IWU or from the portable identity.

3 see 7.7.1.1, IWF Selection.

LAYER 3 PROCEDURES

Information to determine the routing of the outgoing call is passed during the call establishment phase. This section describes that which is in addition to IWF selection. The following Layer 3 procedures are relevant :-

Call Control Entity: Call Setup

COMS Entity: COMS Setup

Call Setup: Information to determine the destination address is sent by the PT in either a {CC-SETUP} message or subsequent {CC-INFO} messages. Either en-bloc or piecewise sending may be used. The portable ID may be used to derive the source address if required.

COMS Setup: Similar to the above except that there is no equivalent of the {CC-SETUP} message.

LAYER 3 MESSAGES AND INFORMATION ELEMENTS

Message	Relevant Information Elements
CC-SETUP	Called Party Number, Called Party Subaddress, Identity
CC-INFO	Called Party Number, Called Party Subaddress, Keypad

Message	Relevant Information Elements
COMS-SETUP	Called Party Number, Called Party Subaddress, Identity

7.7.7.2 Incoming Access

FUNCTIONAL REQUIREMENTS

The routing process determines a point of attachment (ie destination address) on the DECT subnetwork based on information supplied from the attached subnetwork. The interworking depends on the capability of the attached subnetwork to provide complete address information.

The incoming call may be :

i offered to any PT which can communicate with the FT attached to the IWU

ii offered to a subset of i)

or

iii routed to a specific PT

This process is not relevant to the DECT network protocol.

7.7.8 Relaying

FUNCTIONAL REQUIREMENTS

The relaying process forwards information between the DECT U-plane and the attached subnetwork. The information may be interworked either transparently or not. For example relaying of X.25 frames may be transparent but encoded voice signal to or from an ISDN require a transcoding function.

This process is not relevant to the DECT network protocol.

7.8 NETWORK PROTOCOL ELEMENTS

For further study

7.9 INTERWORKING PROFILES

7.9.1 PSTN Telephony
7.9.2 PSTN Circuit Switched Data
7.9.3 ISDN Telephony
7.9.4 ISDN Circuit Switched Data
7.9.5 ISDN Packet Switched Data
7.9.6 PSPDN Data Access via ISDN
7.9.7 PSPDN Data
7.9.8 PSPDN Data with PAD Access
7.9.9 GSM Telephony A I/F
7.9.10 GSM Telephony Um I/F
7.9.11 GSM Circuit Switched Data
7.9.12 ISO IS8802 LAN
7.9.13 Group 3 Fax
7.9.14 Keysystems
7.9.15 PBX

7.9.1 PSTN TELEPHONY

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Contents

1 General

This IWP explains how a DECT subnetwork interworks with a PSTN and other networks having speech-band analogue user network access. It only covers the application of these network interfaces to telephony (ie speech). Where the term 'PSTN' is used this can also be taken to be applicable to any network or subnetwork with suitable analogue interfaces, be it a PSTN local loop or PBX user interface.

Applicability of this IWP:

- Attached subnetwork = PSTN
- Attached subnetwork access by analogue bearer with speech capability
- Attachment may be direct to PSTN local loop or to PBX user interface
- Interworking Functions may be supported by some combination of DECT IWU and PBX (or equivalent)
- Secondary interworking may be provided by a PBX (eg interworking to an ISDN)
- Telephony (speech) applications
- User attached network interface may support LD or MF signalling
- DECT Single Cell Systems

The IWU needs to support the following processes:-

- WF Selection
- Supplementary Service Interworking
- Queue control (optional)
- Routing
- Relaying

and the following functions (IWFs):

- PSTN/Telephony
- U-plane relaying and signal conversion.

Attachment to a PSTN requires interworking of signalling conditions and of speech. Signalling is carried digitally across the DECT subnetwork in the C-plane but by a combination of in-band tones, loop disconnect pulses (LD) and DC signalling conditions at the PSTN user interface. PSTN user interfaces vary in detail from network to network, but by giving typical examples this IWP serves to illustrate the general principles of PSTN interworking. Speech requires a signal conversion function within the IWU. It is carried digitally encoded in the DECT U-plane and converted to or from an analogue signal at the PSTN user interface by the IWU. The IWU will apply appropriate signal conditioning to the analogue signal to meet the requirements of the attached PSTN.

The following PSTN related signalling functions are interworked:

Basic Functions [223]
- bell on/off
- on/off-hook
- dialled digits (LD and MF)
- register recall
- goto MF
- pause

Additional Functions
- metering pulses

PBX Related Functions [223]
- selection of outside line
- selection of internal line
- specific line selection
- authentication

Table 1.1/IWP(1) lists the key DECT and PSTN characteristics relevant to interworking telephony.

	DECT	**PSTN**	**Interworking functions**
Subscriber interface User network signalling Terminal equipment Transmission Information transfer mode(s) Information transfer capability	Digital Out-band Digital Digital CO/CL Speech, unrestricted digital, 3.1 kHz audio video etc.	Analogue In-band or Out-band Analogue Digital/Analogue CO 3.1 kHz audio	

Table 1.1/IWP(1)

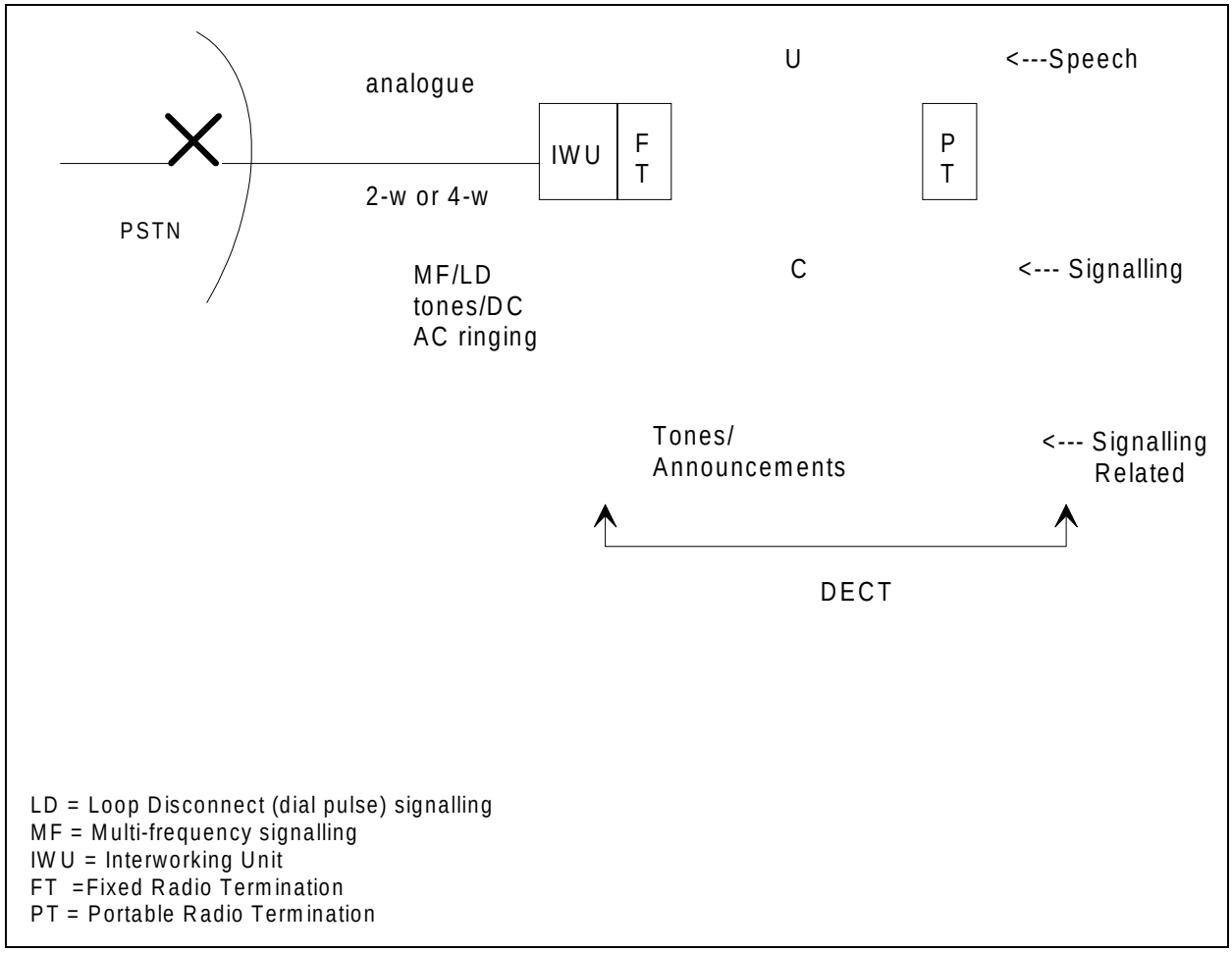
The interworking functions may be implemented in either the DECT IWU or a PBX or some combination of the two. The minimum requirement for the DECT IWU is that it implements basic interworking to an analogue line.

Figures 1.1a/IWP(1) and 1.1b/IWP(1) show typical configurations. Note that a PBX might provide secondary interworking such as to an ISDN or inter-PBX network. Such secondary interworking is transparent to DECT.

Tones and announcements originating from the fixed network will, in general, be interworked to the DECT U-plane. In specific cases signalling tones will need to be interworked to the C-plane by the use of tone detectors in the IWU.

Protocol architecture models can be found elsewhere in the DECT System Description Document:

		Refer to:
Single Cell	Signalling Model User Data Model	[to be added] [to be added]
Multi Cell	Signalling Model User Data Model	[to be added] [to be added]



Typical PSTN Interworking Configuration
Figure 1.1a/IWP(1)

The PSTN subnetwork may support any of the following connection types:-

i Demand access. Connection is established on demand in response to an off-hook signal. Dialled digits indicate the destination address on the attached subnetwork.

ii Semi-permanent connection. Connection is established in response to an off-hook signal. The destination address is fixed and no dialling is required.

iii Permanent connection. Permanent physical connection via the PSTN to the destination. No signalling is required.

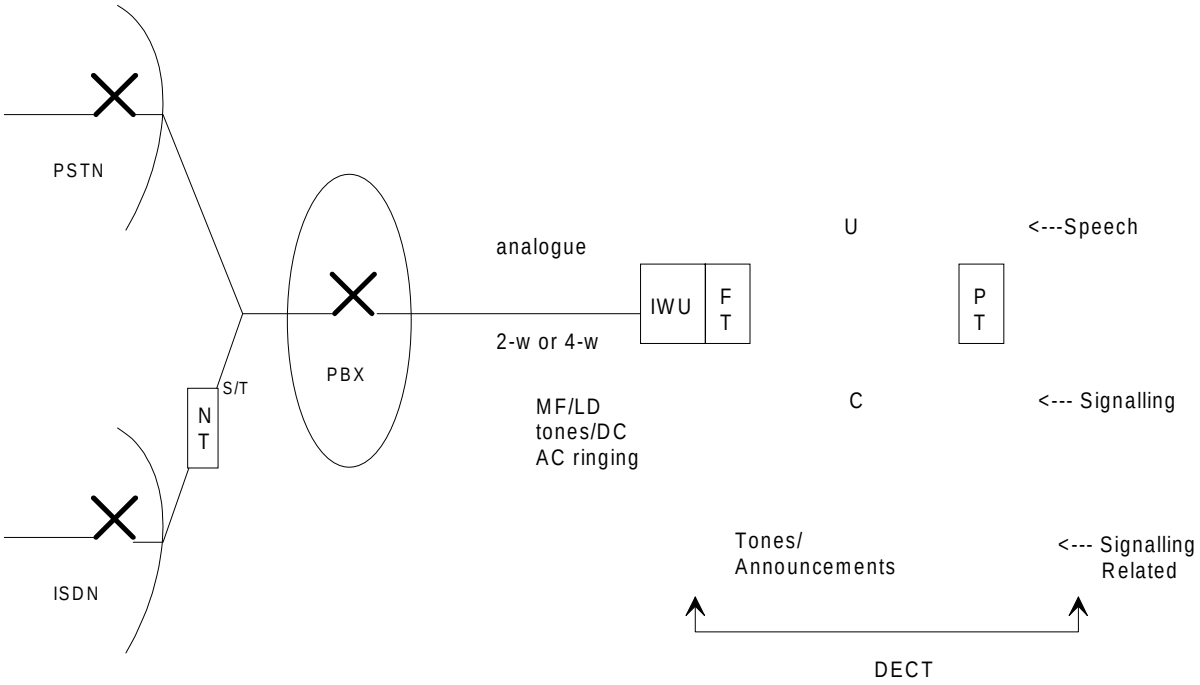
On each type of PSTN connection there must be some signalling indication of an incoming call. With demand access this will be an AC ringing signal. In other cases different PSTNs may offer this signalling condition in different ways, eg AC ringing, battery reversal or other DC conditions. The IWU must have an IWF suitable for interworking the incoming call indication appropriate to its application.

The DECT subnetwork has the ability to provide a connection:-

i On demand.

ii When a LAPC connection already exists.

The PSTN/telephony IWF may support any combination of the above according to its application.



LD = Loop Disconnect (dial pulse) signalling
MF = Multi-frequency signalling
IWU = Interworking Unit
NT = Network Termination 2 and/or 1
FT =Fixed Radio Termination
PT = Portable Radio Termination

Notes:

1) PSTN may be accessed from PBX via a variety of trunk user interface. PBX provides any secondary interworking transparently to the DECT subnetwork

2) ISDN Basic or ¨Primary Rate access. PBX provides secondary interworking transparently to the DECT subnetwork.

Typical PSTN/PBX Interworking Configuration
Figure 1.1b/IWP(1)

2 C-Plane Procedures

2.1 Outgoing Access

2.1.1 Demand Access

The PT establishes a LAPC connection (if one does not already exist) across the DECT subnetwork to the IWU. During the call establishment phase which follows the PT provides the IWU with sufficient information to select the IWFs and enable interworking of the call setup to the PSTN.

The IWU-FT receives a {CC-SETUP} message from the PT. PSTN interworking will be inferred from the IWU attributes. Provided the {CC-SETUP} message contains sufficient information for the IWFs to be selected, the IWU applies an off-hook condition to the PSTN line interface. At the same time either a timer is started or a dial tone detector enabled.

The destination address is supplied by the PT. This is in the form of either

a) a PSTN subscriber number (or PBX extension number)

or

b) a short code understood by the network (or PBX)

or

c) a short code understood by the IWU.

Cases (a) and (b) are transparent to the IWU and may only contain valid PSTN digits. Case (c) is a non-standardised option and may contain any IA5 characters.

If case (c) is not supported by the IWU or is restricted to PSTN digits then any setup message containing invalid PSTN digits will be rejected.

Both piecewise and en-bloc sending from the PT are supported. With piecewise sending the destination address is sent during the call information phase in keypad elements of a {CC-INFO} message. Keypad elements may be sent singularly or in groups until the complete destination address has been sent. Note that there is no information as to the length of the address. The IWU translates all keypad elements received into dialled digits. The call information phase starts once the PT has received either a {CC-SETUP-ACK} or {CC-CONNECT} message and continues as along as there are keypad elements to send. Keypad elements may be sent at any stage during this phase.

If en-bloc sending is used from the PT then the complete destination address is sent with the {CC-SETUP} message.

PTs may support either or both piecewise and en-bloc sending . IWUs will support both without distinction.

The protocol allows the IWU-FT to reply to {CC-SETUP} with either {CC-SETUP-ACK} or {CC-CONNECT}. If {CC-SETUP-ACK} is used then the PT retains some control over when to connect the U-plane. If {CC-CONNECT} is received at the PT then the U-plane is connected through immediately and the PP will rely on network generated tones. The normal method of interworking to PSTN will be to return {CC-CONNECT} to a {CC-SETUP}.

The PT may support either manual or automatic dialling. If manual dialling then some suitable indication must be given to the user that number entry may start. This may be either locally generated (ie within the PT) or dial tone generated by the PSTN. If locally generated then there is no restriction on when this may be provided. Suitable locally generated indications include:

i dial tone generated when the PT receives {CC-SETUP-ACK} if piecewise sending is to be used.

ii dial tone whenever service is potentially available if en-bloc sending is to be used.

iii some other audible or visual indication in place of dial tone in (i) and (ii)

(Note that compatibility across a range of networks, PSTN, ISDN or other mobile, may require the PT to provide a locally generated indication. Unless the IWU-FT supports {CC-SETUP-ACK} then the user will always receive network generated dial tone when connected to the PSTN.)

The IWU buffers all address information received until either the timer expires or dial tone is detected. After this time all digits buffered and all those subsequently received are sent as dialled digits on the PSTN. Dialled digits must meet the requirements of the PSTN attached to. The IWU may support either loop disconnect (LD or dial pulse) or MF4 dialling, or both. If both are supported then selection may be either

i 'hard wired'

or

ii LD with a 'goto MF' function controlled by the PT. In this case dialling is initially assumed to be LD with each new call.

Ring tone will be received from the PSTN some time after the destination has been alerted. The IWU will pass this transparently through to the PT.

Finally the IWU-FT sends {CC-CONNECT} to the PT to indicate to the PT to connect through the U-plane. This may be either when the IWU has determined that call establishment is complete or earlier. It is not specified how the IWU determines that the call has been answered. The following may be suitable depending on the requirements and capabilities of the attached PSTN

i detect the end of ring tone. (Note on many PSTNs this is not a reliable method.)

ii detect call answered signal from the PSTN. (Note this is not an option commonly available).

iii a timeout after completing dialling the last digit. This timer is reset each time a new CC-INFO message containing a keypad element is received.

Normally the IWU-FT will return {CC-CONNECT} in reply to {CC-SETUP}.

Subsequent {CC-INFO} messages with keypad elements will be dialled in the normal way.

2.1.2 Semi-Permanent Access

With this type of PSTN access only an off-hook signal is required to get routed to the destination. No dialling is required. Ring tone may or may not be provided.

If the IWU is aware that this is a semi-permanent connection then {CC-CONNECT} will always be returned after applying the off-hook signal. A destination address supplied in {CC-SETUP} will be ignored but subsequent {CC-INFO} messages with keypad elements will be dialled in the normal way.

2.1.3 Permanent Access

In this case not even an off-hook signal is required. Otherwise this is the same as semi-permanent access with the exception that ring tone is never provided.

Note that if the IWU cannot distinguish between types of PSTN access (eg by 'hard wiring') then it is unlikely that satisfactory operation can be obtained.

2.2 Incoming Access

The IWU detects an incoming PSTN call by detecting the presence of ringing. The IWU ringing detector must detect all ringing conditions on the PSTN line and meet attachment requirements for the particular PSTN. When a valid ringing condition has been detected the IWU-FT establishes MAC and DLC connections to the PT if not already existing. The network connection is then established with a {CC-SETUP} message and acknowledged with {CC-ALERTING}. The PT generates a local ringing indication. This may be in sympathy with the PSTN ringing cadence using bell elements in {CC-INFO} messages from the IWU or some locally generated cadence or other indication. When the PT answers the incoming call a {CC-CONNECT} message is sent to the IWU which then applies an off-hook condition to the PSTN. {CC-CONNECT-ACK} to the PT indicates the call has been answered and the U-plane connected through at the IWU.

Keypad information sent from the PT during the call will be dialled as digits on the PSTN by the IWU in the normal way.

2.3 Release

If the PT releases the call as the result of some user action then the IWU will apply an on-hook condition to the PSTN line in response to {CC-RELEASE} and reply to the PT with {CC-RELEASE-COM}.

If a backward clear signal is available on the PSTN then the IWU should detect this, apply an on-hook signal and signal call release to the PT by sending {CC-RELEASE}. (Note backward clear signals are not normally available.)

The LAPC connection between PT and IWU will also be released if there are no other active components.

2.4 Access Collision

[For further study]

2.5 Supplementary Service Activation

2.5.1 Register Recall

Register recall is required on analogue networks offering supplementary services. It is used to regain access to a signalling register for further dialled digits. The sequence of events will typically be:

- establish call
- operate register recall
- call placed on hold
- dial tone returned to caller
- caller accesses supplementary service by dialling access code (this could be a third party enquiry call)
- caller returned to held call

Register recall normally uses one of two methods:

- earth recall

  A local earth is applied to one leg of the 2-wire line whilst maintaining the holding loop. (off hook)

- timed break

  The holding loop is removed for a defined period of time. This is longer than a break in a dialled digit.

2.5.2 Interworking Requirements

To interwork easily with analogue networks a DECT PP should have some means of operating register recall directly, for example a button. The network protocol provides a means ('Feature Activation') of conveying this between PT and FT. However, because this is not a requirement when connected to a digital network, handsets will also be produced without this facility.

We therefore have the following interworking scenarios:

	Attached Subnetwork	
	Analogue without RR	Analogue with RR
PP with R button	Case 1	Case 2
PP without R button	-	Case 3

R button = button or some other means of operating register recall.

Case 1

The FP must be set to ignore register recall.
The PT sends “Feature Activate” (RR = set) at any time during the active phase of a call in response to operation of the R button.
Register recall suppressed at the IWU.
FT replies with “Feature Indicate” (RR = 'not supported')

Case 2

The PT sends “Feature Activate” (RR = set) at any time during the active phase of a call in response to operation of the R button. The IWU applies the appropriate register recall condition to meet the requirements of the attached subnetwork. The FT replies with “Feature Indicate” (RR = set). The network will normally send dial tone or some recorded message to the handset and this will be passed through transparently with no further action. The PT continues with the DECT SS protocol which is interworked to the analogue network.

Case 3

The PP does not have an R button.
With either of the stimulus protocols (keypad or feature key) neither the PP nor IWU has any real knowledge of the supplementary service. To provide interworking the IWU would need to recognise the start of the supplementary service access, generate register recall locally and be able to translate access codes or feature codes into dialled digits after a suitable delay. If the PT implements the functional protocol then this cannot anyway be interworked to an analogue network.

The conclusion is then that in this case it is very difficult for the PP to obtain access to supplementary services.

2.6 - 2.8

[For further study]

3 U-Plane Procedures

[For further study]

4 PBX Related Procedures

[For further study]

5 Emergency Call Interworking

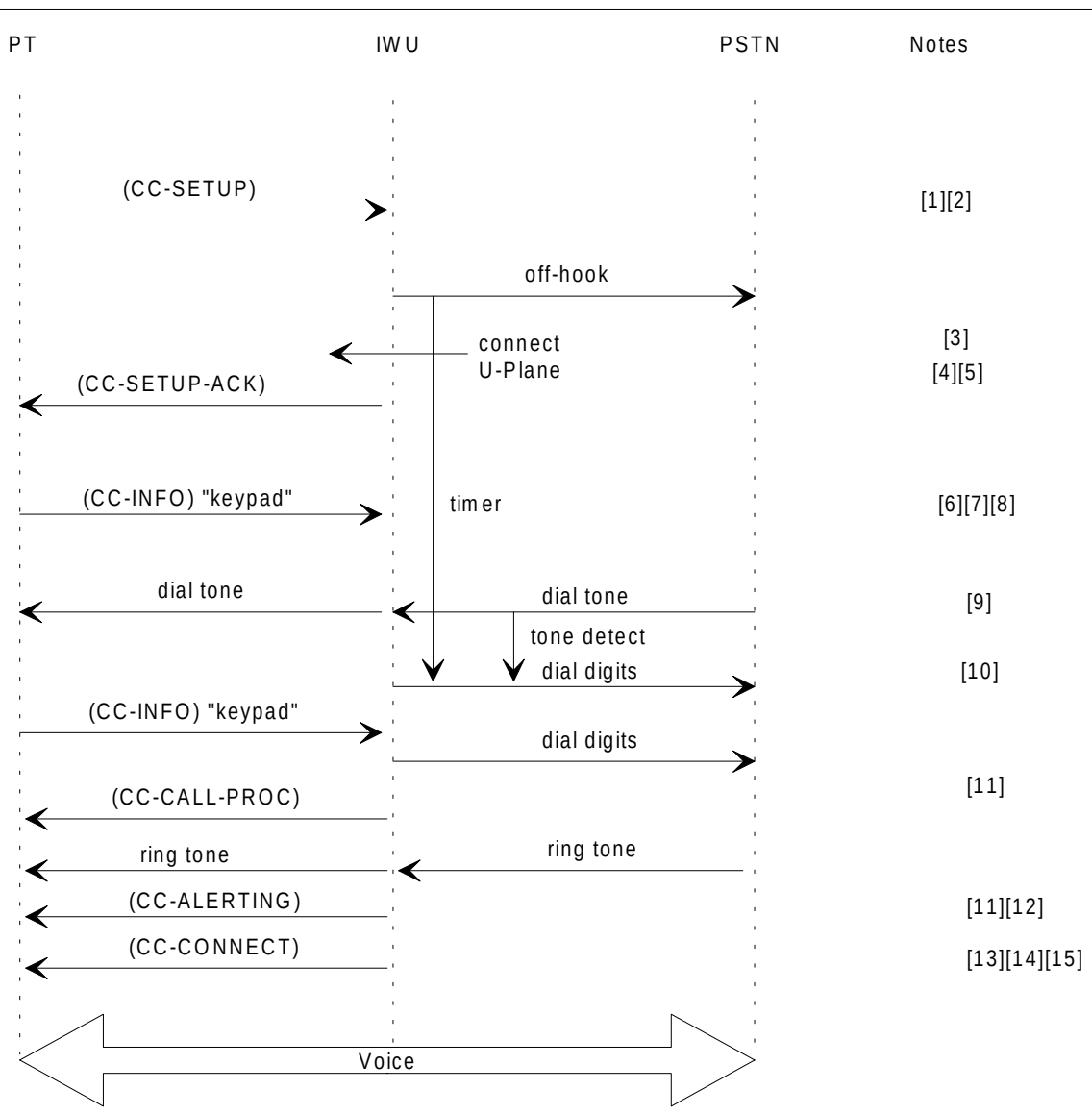
[For further study]

6 Process Applicability

[For further study]

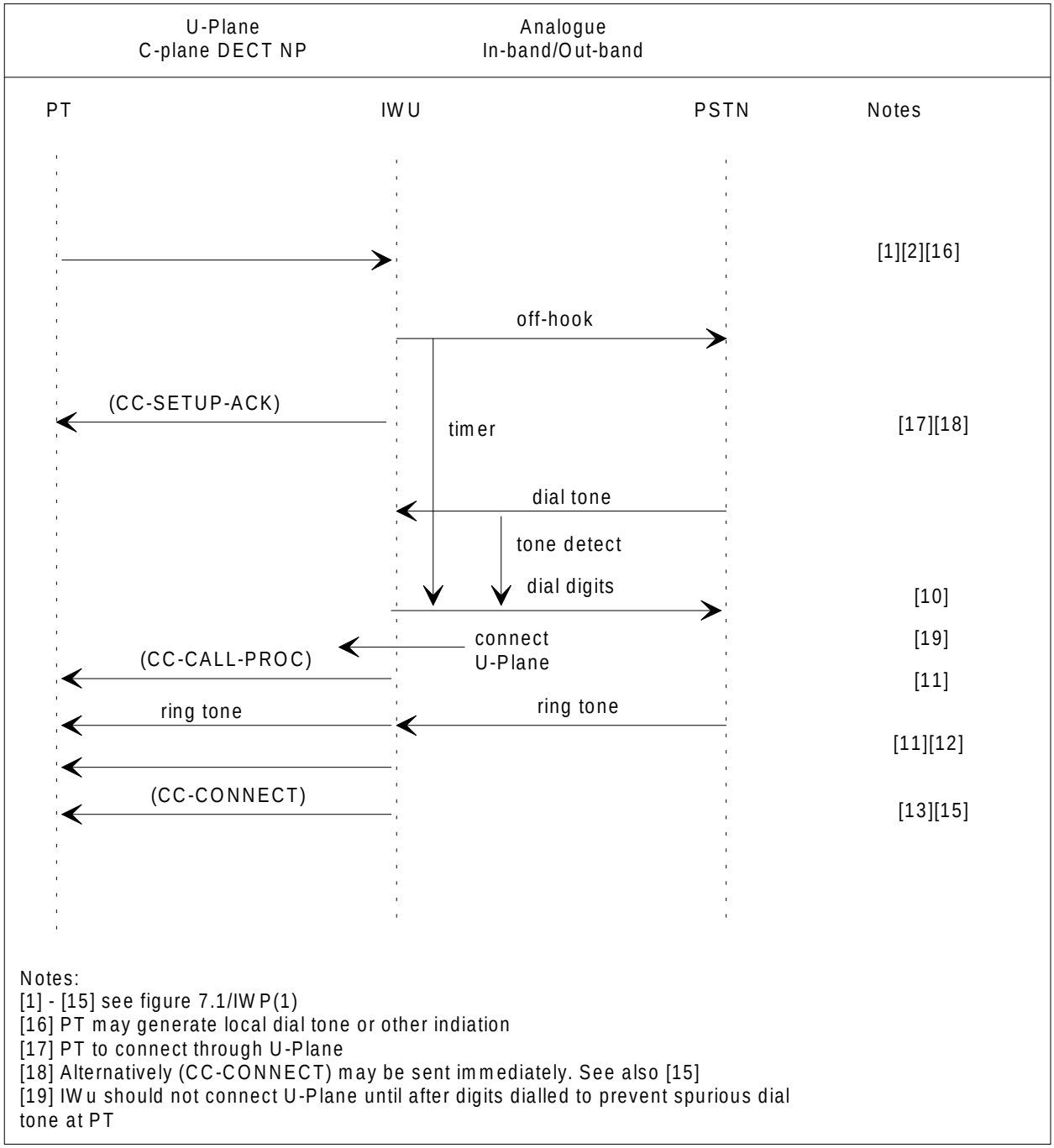
7 Message Sequence Examples

- PT Originated Call, Piecewise Sending, Figure 7.1/IWP(1)
- PT Originated Call, En-Bloc Sending, Figure 7.2/IWP(1)
- PT Terminated Call, Figure 7.3/IWP(1)
- PT Cleared Call, Figure 7.4/IWP(1)



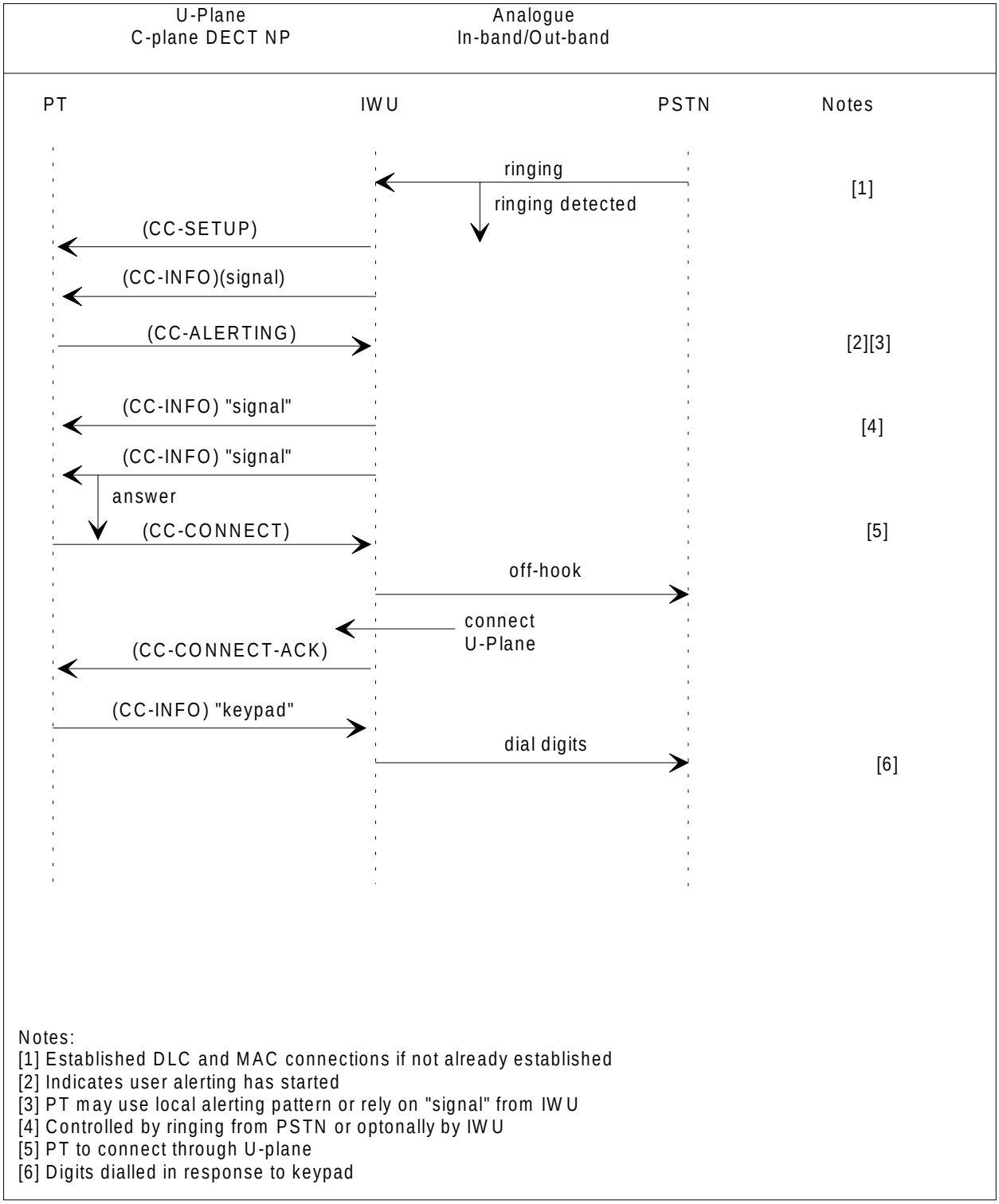
Notes:
[1] LAPC connection in place
[2] Parameters include Supplementary Service Negotiation
[3] Recommended that U-Plane connected through IWU at earliest opportunity but not later than dial tone detector or timer
[4] PT may either connect through U-Plane or PP generate local dial tone
[5] Alternatively (CC-CONNECT) may be sent immediately in which case PT must connect U-Plane. see also [15].
[6] Keyboard information can be sent at any time after (CC-SETUP-ACK) even before dial tone
[7] Digits buffered at IWU
[8] PP generated dial tone stopped after first digit
[9] U-Plane may not be connected at PT, see note [4]
[10] Timer and dial tone detector are optional but it's recommended that as a minimum timer of minimum value recommended for the PSTN is used
[11] Optional
[12] Only if U-PLane installed at IWU
[13] IWU may use any appropriate means to detect the call answered condition (eg cessation of tone or timer) or send (CC-CONECt) in place of (CC-SETUP-ACK).
[14] PT must fully connect U-Plane if not already done so
[15] (CC-CONNECT) is always the last message from IWU

PT Originated Call
Piecewise Sending
Figure 7.1/IWP(1)



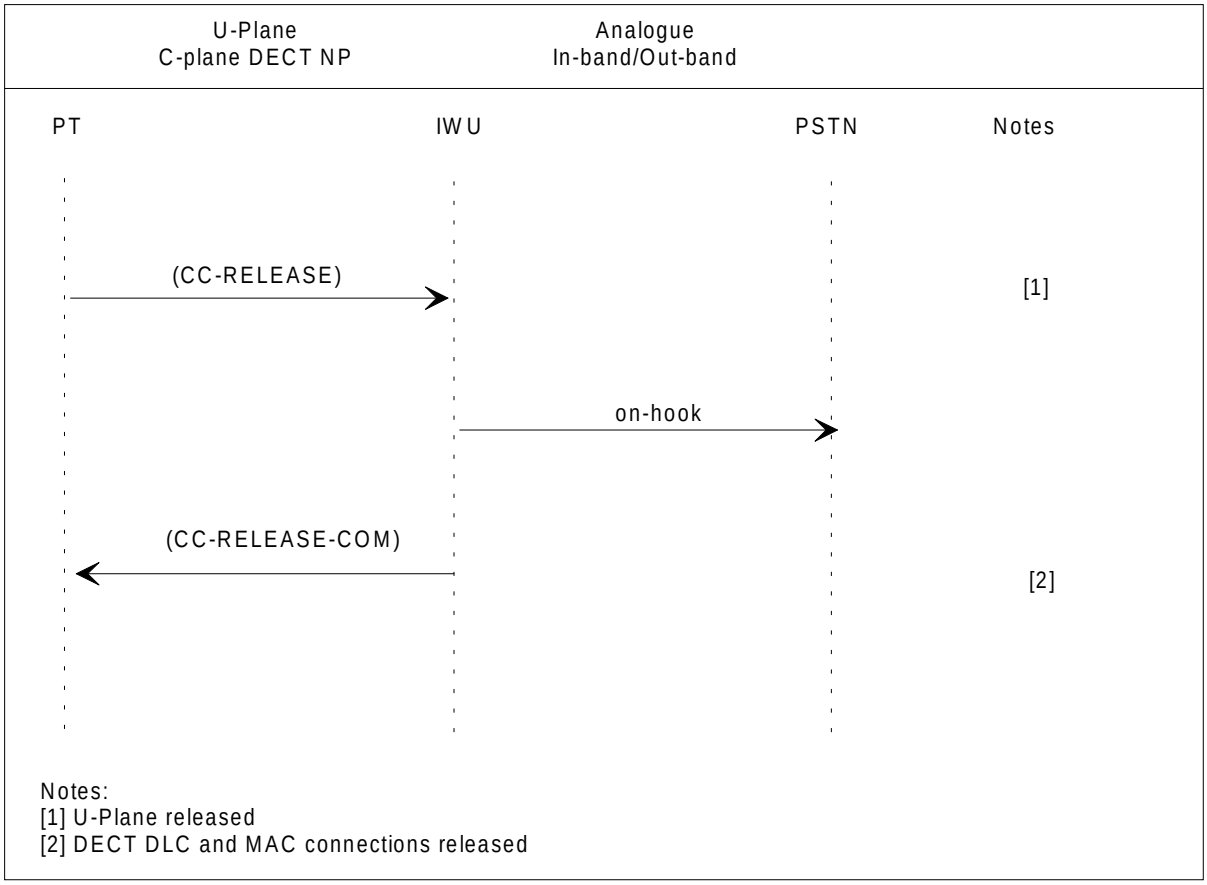
Notes:
[1] - [15] see figure 7.1/IWP(1)
[16] PT may generate local dial tone or other indiation
[17] PT to connect through U-Plane
[18] Alternatively (CC-CONNECT) may be sent immediately. See also [15]
[19] IWu should not connect U-Plane until after digits dialled to prevent spurious dial tone at PT

PT Originated Call
En-Bloc Sending
Figure 7.2/IWP(1)



Notes:
[1] Established DLC and MAC connections if not already established
[2] Indicates user alerting has started
[3] PT may use local alerting pattern or rely on "signal" from IWU
[4] Controlled by ringing from PSTN or optonally by IWU
[5] PT to connect through U-plane
[6] Digits dialled in response to keypad

PT Terminated Call
Figure 7.3/IWP(1)



PT Cleared Call
Figure 7.4/IWP(1)

7.9.2 PSTN CIRCUIT SWITCHED DATA

[220]

Contents

1 GENERAL

This IWP explains how a DECT subnetwork interworks with a PSTN for the purpose of supporting circuit switched data communications. Figure 1.1/IWP(2) shows the general configuration.

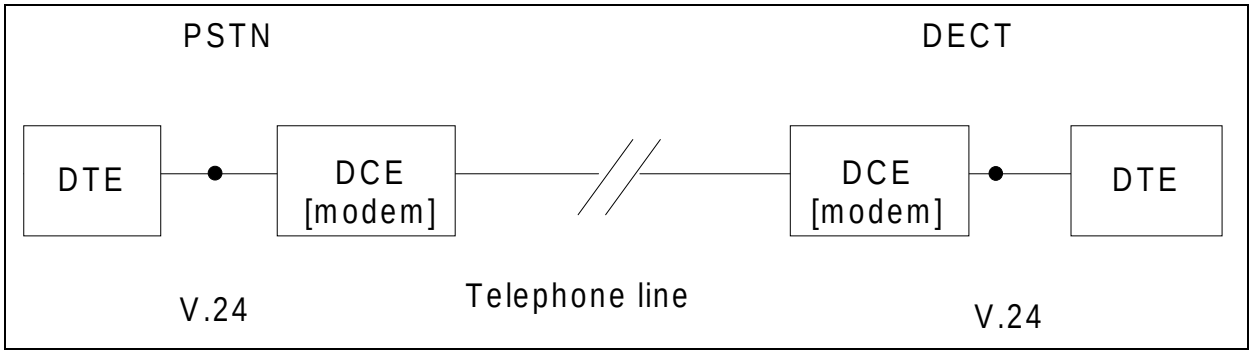


Figure 1.1/IWP(2)
Connection of 2 DTEs via Modems

If both DTE's are connected to compatible modems (for example CCITT V series) then the call could be routed as a normal telephony call and the subnetworks need not be aware that data communication is taking place. This might include Telefax services.

If only one of the DTE's is connected to a modem, it is necessary for another compatible modem to be connected in the route of the call.

The simplest solution is for all DECT subscribers to take care of the problem by always having a V series modem connected to their DTE regardless of whether the data call will be interworked to the PSTN or ISDN. This would allow a maximum user data rate of (depending on local regulations) of 9600 bps. Figure 1.2/IWP(2).

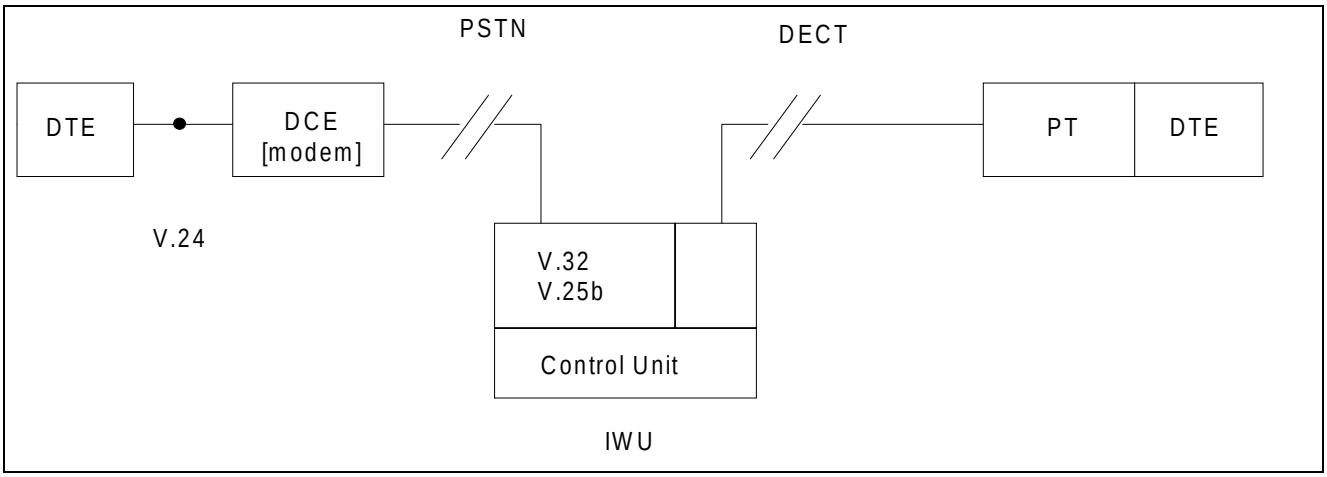


Figure 1.2/IWP(2)
Modem Pool

An alternative is to establish IWU's in one or more places in the network where a pool of modems can be used to service a number of calls. If there is no PSTN/ISDN IWU at the boundary of the DECT subnetwork then another IWF could be used to transport the data to an IWU at the boundary of the PSTN. The resultant model would then be:-

DTE - IWF - DECT - IWF - ISDN - IWF - PSTN - DTE
(I.516)

The modem pool should interwork from the PSTN (with modem) to/from DECT (without modem).

The modem pool should have numbers for:

- PSTN Synchronous
- PSTN Asynchronous
- DECT Synchronous
- DECT Asynchronous

The configuration can then be made in different ways:

- Each number specifies one rate and/or setup
- Group of numbers with adaptive modems and/or a specific setup
- Setup message includes user rate and other information and the IWU makes the selection.

In the modem pool there could be a selection of different modems according to the following table:

	bps
V.21	300
V.22	1200
V.23	600/1200
V.22bis	2400
V.26bis	1200/2400
V.26ter	2400
V.27ter	2400/4800
V.32	9600/4800/2400
V.33	14400/12000

The modems in the modem pool could be multistandard modems according to V.32, V.22bis or V.22. The modem control protocol could be V.25bis, Hayes-AT or other allowed according to national regulations.

V.25bis allows:

asynchronous operation (off, message, cr, lf)
synchronous character orientated operation, IS 1745
(SYN, SYN, STX, message, ETX)
synchronous bit orientated operation, using HDLC
(F, A, C, message, FCS, F)

V.25bis Automatic call/answering
V.41 Code independent error control system
V.42 Error correcting procedures for DCE's using async/sync conversion.

2 C-Plane and Control Procedures

2.1 Calls to and from the Modem Pool

One step.
In call setup you input the call's data which includes the number to the modem pool, the B subscriber and the necessary information for the setup of the modem connection.

Two steps.
You first establish a connection to a suitable modem pool. When you have that connection you input the B subscribers number and the necessary information for the call setup of the modem connection.

2.2 Modem Pool Functions

Rate adaptation and signal conversion.
Automatic call and answering/signalling (CCITT V.25bis or Hayes-AT)
Variable character length (asynchronous services)
Interactive communication (PSTN modem user/DECT PT)
Flowcontrol (XON/XOFF or CTS/DTR)
User ID
Clearing functions

Select a modem to ensure compatibility across networks.
Negotiate the required data signalling rate (modem rate)

2.3 Incoming Calls

The PSTN subscriber makes a telephone call, either via the telephone or via a dial-up modem, to a number in the IWU which is equiped with a suitable modem. After connection, synchronisation and V.100/V.32 rate selection starts up between the a-subscriber and the modem in the modem pool. When this done the line will be through connected to the control unit in the IWU. An interactive mode starts up between A-DTE and the IWU control unit under which the real B-number (ie the DECT subscriber) is transferred. The IWU control unit generates a setup message allowing the IWU to establish the appropriate connection to the PT.

2.4 Outgoing Calls

The PT establishes a connection across the DECT subnetwork to the IWU. Information transferred enables an appropriate IWF, bearer and PSTN access unit to be selected. The DECT subnetwork dynamically allocates U-plane bandwidth to meet the demands to and from the IWU. Information about B-number is transferred to the control unit which via either V.25bis or Hayes commands the modem pool to establish a connection to the B-subscriber. Pulse or DTMF dialling may be used on the PSTN.

After connection, synchronisation and rate selection between the modem pool and the B-subscriber's modem starts up and data transfer can begin.

2.5 Release

When the IWU receives {CC-RELEASE} from the PT the control unit, via V.25bis or Hayes-AT, commands the modem pool to go on-hook at the PSTN line. A clearing condition from the PSTN results in a clearing message from the modem pool to the control unit which in turn releases the connection to the PT.

2.6 Error Handling

Synchronisation errors are handled according to V.32 for modem/PSTN side and DLC/MAC for DECT.

3 U-Plane Procedures

3.1 General

Data are transferred between the PT and IWU in the U-plane. Depending on the chosen LU different actions should be taken in th IWU.

4 PBX Modem Pool Functions

[for further study]

5 Process Applicability

[for further study]

6 Message Sequence Examples

[for further study]

7 Mapping

[for further study]

7.9.3 ISDN TELEPHONY

[215] [219] [224] [225]

Contents

1 General

This IWP explains how a DECT subnetwork interworks with an ISDN at the S/T reference point. It only covers the application of this network interface to telephony (ie speech). Where the term 'ISDN' is used this can also be taken to be applicable to any interface conforming to the ISDN access protocols at the S/T reference point.

Applicability of this IWP:

- Attached subnetwork = ISDN
- Attached subnetwork access at the S/T reference point
- Attached network access protocols Q.921 and Q.931 (or derivatives)
- Attachment may be direct to PSTN local loop or to PBX user interface
- Interworking Functions may be supported by some combination of DECT IWU and ISPBX (or equivalent)
- Secondary interworking may be provided by a PBX (eg interworking to a PSTN)
- Telephony (speech) applications
- DECT Single Cell Systems

The IWU needs to support the following processes:-

- IWF Selection
- Supplementary Service Interworking
- Queue control (optional)
- Transparent protocol interworking
- Routing
- Relaying

and the following functions (IWFs):-

- ISDN/Telephony
- U-plane relaying

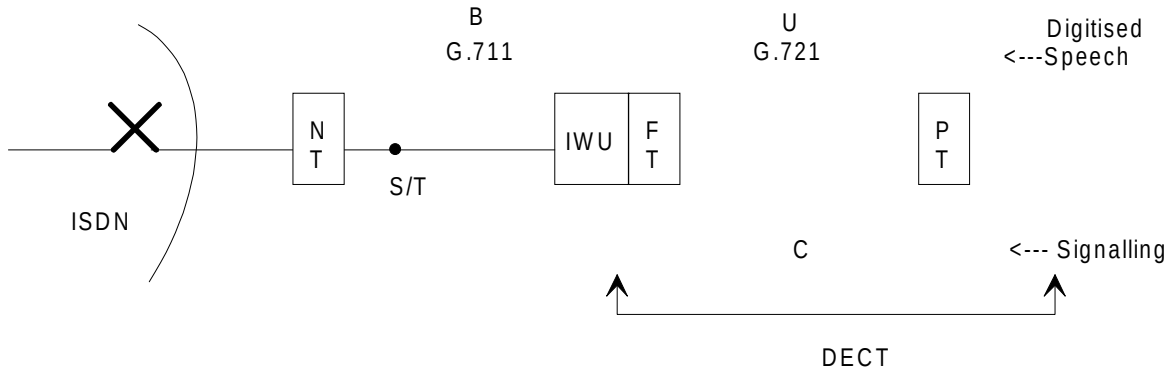
Attachment to an ISDN requires interworking of signalling conditions and of speech. Signalling is carried in the DECT C-plane using DECT protocols and on the ISDN D channel using LAP.D (Q.921) and Q.931 (or a derivative) at Layer 3. The DECT protocols are fully terminated at the FT and PT whereas the ISDN protocol may be fully terminated at the IWU, partially terminated or relayed. If partially terminated then parts of the ISDN network protocol are carried transparently across DECT and if relayed then LAPD frames are carried transparently across the DECT subnetwork. ISDNs vary in detail and differences need to be taken into account in the implementation of the IWU. This IWP is based, where applicable, on draft ETSI standards for connection to public ISDNs at the S/T reference point. [145] [146] [300]. In general reference to ETSI 300 102 can also be taken as refering to CCITT Q.931.

Speech and in-band tones require a transcoding function within the IWU between G.721 ADPCM and G.711 PCM.

The interworking functions may be implemented in either the DECT IWU or an ISPBX or some combination of the two. The minimum requirement for the DECT IWU is that it implements basic interworking to an ISDN S/T reference point according to [145].

Figures 1.1a/IWP(3) and 1.1b/IWP(3) show typical configurations. Note that an ISPBX might provide secondary interworking such as to a PSTN or inter-PBX network (analogue or digital). Such secondary interworking is transparent to DECT.

Tones and announcements originating from the fixed network will be interworked between ISDN B channels and the DECT U-plane.



NT = Network termiantion 2 and/ or 1
IWU = Interworking Unit
FT= Fixed Radio Termination
PT = Portable Radio Termination

Notes:

1) Single cell only illustrated (on any B channel)
2) ISDN Basic or Primary Rate access

Typical ISDN Interworking Configuration
Figure 1.1a/IWP(3)

The ISDN subnetwork may support any of the following connection types:-

i Demand access. Connection is established on demand in response to the appropriate signalling conditions at the S/T interface. The destination address is interworked between DECT and ISDN SETUP messages.

ii Semi-permanent connection. Connection is established in response to an off-hook signal. The destination address is fixed and no dialling is required. This is available as a subscription time option on some ISDNs.

iii When a LAPD connection already exists

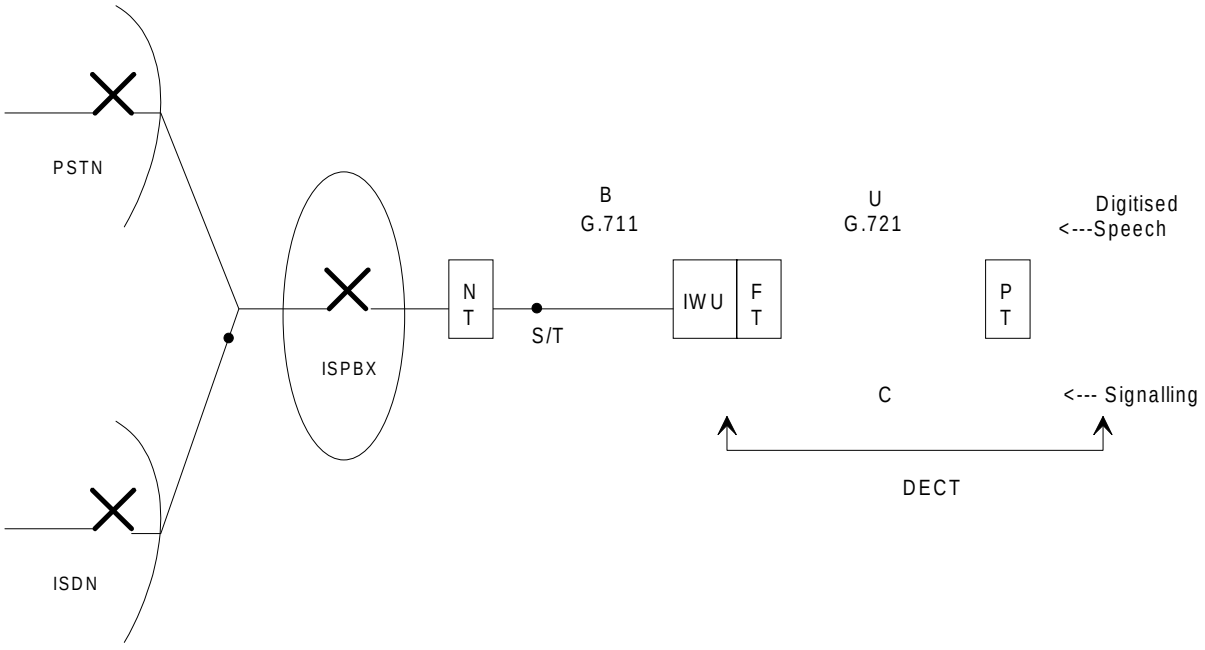
The IWU (or ISDN) will control the selection of the B channel.

The DECT subnetwork has the ability to provide a connection:-

i On demand.

ii When a LAPC connection already exists.

The ISDN/telephony IWF may support any combination of the above according to its application.



ISPBX = Integrated Services PBX
NT = Network termination 2 and/ or 1
IWU = Interworking Unit
FT= Fixed Radio Termination
PT = Portable Radio Termination

Notes:

1) PSTN may be accessed from ISPBX via a variety of trunk user interface. ISPBX provides any secondary interworking transparently to the DECT subnetwork

2) ISDN Basic or ¨Primary Rate access. ISPBX provides secondary interworking transparently to the DECT subnetwork.

Typical ISDN/ISPBX Interworking Configuration
Figure 1.1b/IWP(3)

2 Protocol Architecture Models

2.1 C-Plane Models

There a number of ways in which DECT and ISDN may be interworked. The following are considered in this IWP:-

Case 1: The ISDN protocol is fully terminated at the F-IWU.
Figure 2.1/IWP(3).

Case 2: The ISDN protocol is partially terminated at the F-IWU.
Figures 2.2 and 2.3/IWP(3).
In these cases some messages and elements of the ISDN layer 3 protocol (ETS 300 102 or Q.931) are transferred transparently across the DECT subnetwork. Other messages are terminated at the F-IWU.

Case 3: The ISDN protocol is relayed by the F-IWU either in the DECT C-plane or U-plane.
Figures 2.4 and 2.5/IWP(3)

2.2 Terminated Protocol

In Case 1 the ISDN subnetwork is fully terminated at the F-IWU. The F-IWU performs a routing and relaying function for signalling information between the two subnetworks. Signalling information is either fully interworked between the subnetworks or is lost.

2.3 Partially Terminated Protocol

The DECT network layer has a similar construction to the ISDN network layer. Many ISDN messages have a corresponding DECT message (eg {CC-SETUP}). Similarly many ISDN information elements have a corresponding DECT information element. The detailed contents of messages or elements may differ between DECT and ISDN. In some cases there are no DECT equivalents and for these the DECT network protocol provides a transparent relay mechanism in the C-plane, the IWU-to-IWU information element. This may be used to encapsulate either a network protocol message or information element. The contents of the IWU-to-IWU information element have no effect on the DECT network protocol and are simply transferred between service boundaries in FP and PP.

The F-IWU must interpret the ISDN protocol for the purposes of routing and relaying and controlling the DECT subnetwork. Those elements of the ISDN protocol which cannot be adequately interworked into the DECT protocol but are required for correct operation of the end system are relayed in the DECT C-plane using this mechanism. Information flow from end system to ISDN may be considered in a similar way.

This is known as a partially terminated protocol. In Case 2.1 both the ISDN and mobile subnetworks see a complete ISDN network protocol. Messages originating in the ISDN (for example) however need not appear with exactly the same contents at the S/T reference point in the mobile subnetwork. The rule is that interworking must maintain the integrity of the protocol and transfer sufficient information across the DECT subnetwork to ensure correct operation of both network and end system. In Case 2.2 those ISDN messages and information elements which cannot be interworked to DECT are relayed transparently across the DECT subnetwork. These appear at the DECT service boundary and are handled by higher layer processes in the end system.

In both these cases ISDN messages are interworked to DECT messages if possible and the transparent relaying mechanism only used otherwise.

The F-IWU may interwork an ISDN message in any of the following ways:-

i Completely interworked to a DECT message without loss of information.

ii Completely interworked to a DECT message with some information elements transferred in . Again this is without loss of information.

iii Partially interworked to a DECT message with loss of some information but maintaining the integrity of the protocol and correct operation. element may be used to carry elements which have no DECT equivalents.

iv Not interworked but transferred intact in an element across the DECT subnetwork (for example in a {CC-INFO} message).

2.4 Relayed Protocol

It is also possible to interwork to an ISDN by relayimg the ISDN protocol in its entirity across the DECT subnetwork. The F-IWU must still interpret the ISDN layer 3 protocol for the purpose of controlling the DECT subnetwork. The end system runs both DECT and ISDN protocols.

The F-IWU will handle protocol elements in one of the following ways :-

i Interpret the ISDN protocol for the purpose of controlling the DECT subnetwork (for example an ISDN SETUP will normally result in a {CC-SETUP}) and relay the ISDN protocol transparently,

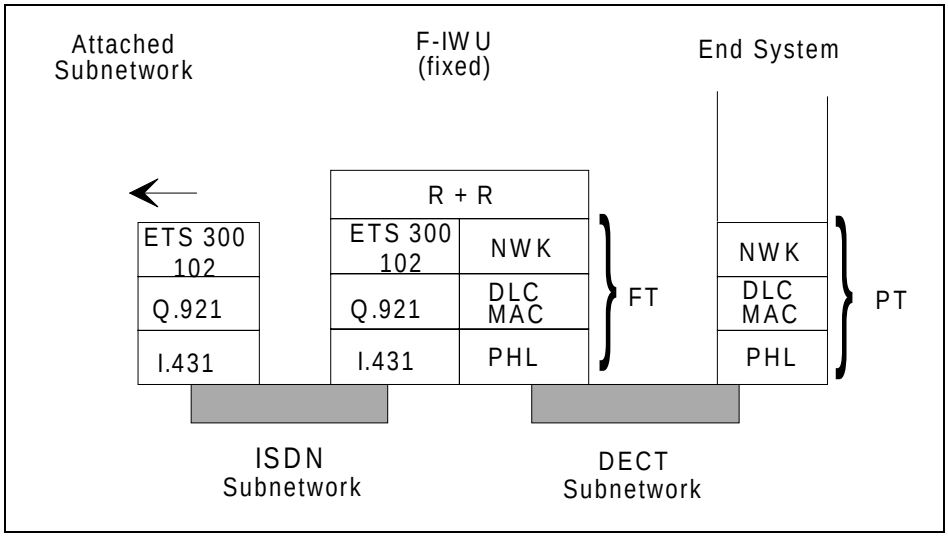
or

ii Just relay the ISDN protocol transparently if no equivalent DECT state or process exists.

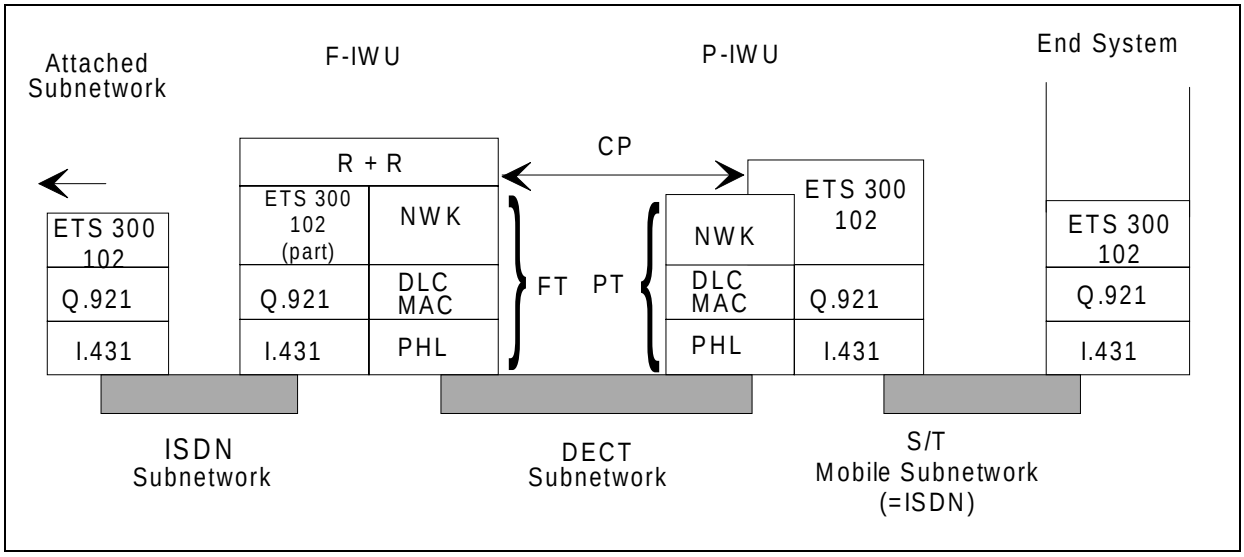
Similar considerations apply for information flowing from DECT to ISDN.

In Case 3.1 the IWU intervention level is at the layer 2 service boundary in the ISDN. The ISDN layer 2 protocol is fully terminated at the F-IWU and the layer 3 protocol is relayed in the DECT C-plane using the information element. This differs from Case 2.2 in that the end system runs a complete ISDN layer 3 protocol rather than just interpreting those messages and elements which cannot be interworked to DECT. It also differs from Case 2.1 in that all layer 3 messages are relayed.

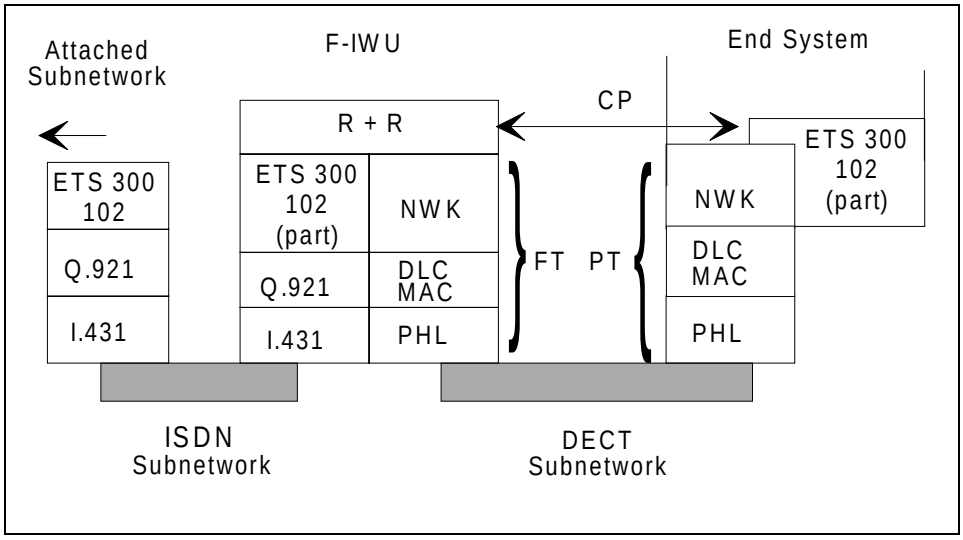
In Case 3.2 the IWU intervention level is at the layer 1 service boundary in the ISDN. ISDN LAPD frames are relayed in the DECT U-plane using the Basic Rate Adaption and frame relay services or in the DECT C-plane using the “IWU-PACKET” information element.



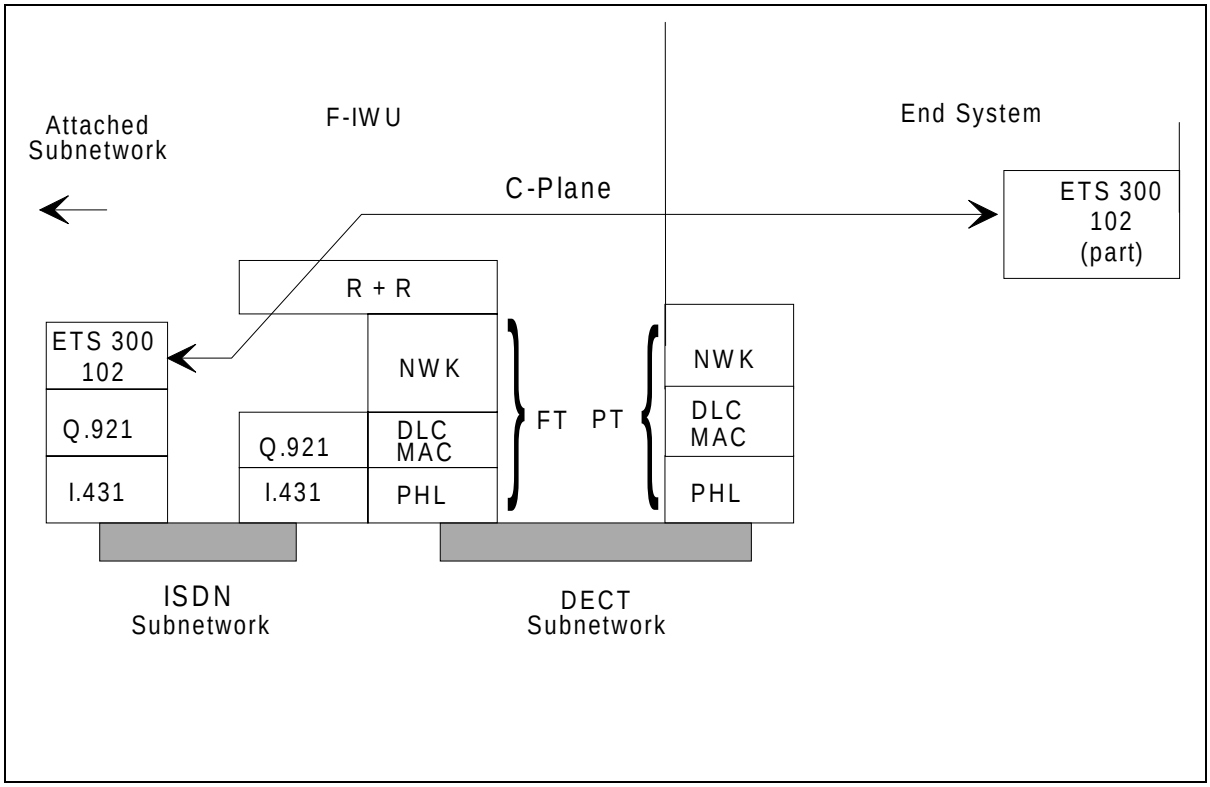
Case 1: Terminated Protocol
Figure 2.1/IWP(3)



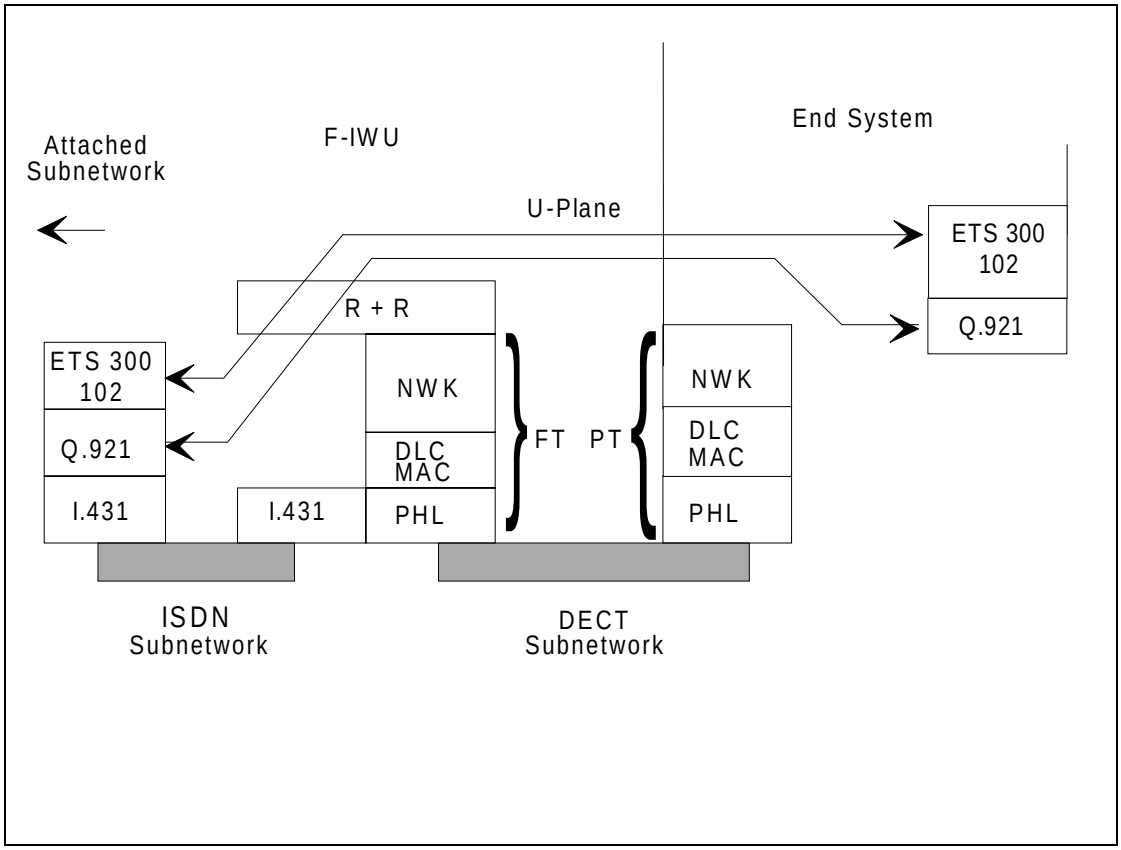
Case 2.1: Partially Terminated Protocol
S/T Reference Point at Mobile Subnetwork
Figure 2.2/IWP(3)



Case 2.2: Partially Terminated Protocol
Figure 2.3/IWP(3)



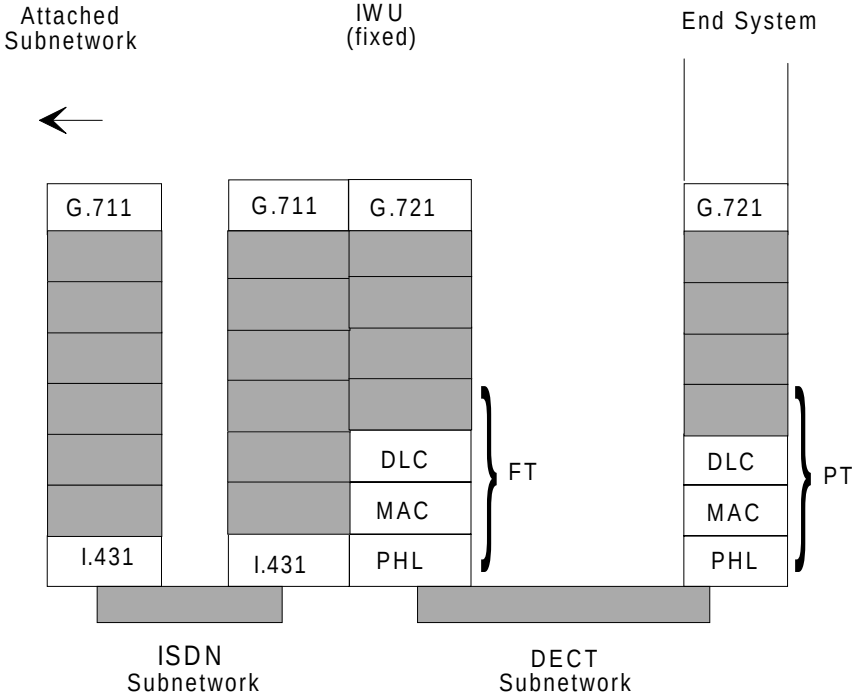
Case 3.1: Relayed Protocol - Layer 3
Figure 2.4/IWP(3)



Case 3.2: Relayed Protocol - Layers 2 and 3
Figure 2.5/IWP(3)

2.5 U-Plane Model

Figure 2.6/IWP(3) shows an example U-plane model where the IWU provides a transcoding function between 32kbps ADPCM and 64kbps PCM.



Example U-Plane Model
Figure 2.6/IWP(3)

3 C-Plane Procedures

3.1 Outgoing Access

3.1.1 General

The following apply to outgoing access for all of the interworking cases described in 2.1 - 2.4.

The IWU may support any or all of the ISDN interworking cases however as there is no selection process and no mandatory requirements on PTs as regards ISDN interworking it is advisable for IWU implementations to support as many as possible.

In response to an off-hook condition in the end system the PT establishes a LAPC connection (if one does not already exist) across the DECT subnetwork to the IWU. During the call establishment phase which follows the PT provides the IWU with sufficient information to select the IWFs and enable interworking of the call setup to the ISDN.

Whichever interworking case is implemented there must next be a call setup across the DECT subnetwork using the CC. The IWU-FT receives a {CC-SETUP} message from the PT. ISDN interworking will be inferred from the IWU attributes. Provided the {CC-SETUP} message contains sufficient information for the IWFs to be selected, the IWU starts the ISDN call establishment procedure at the S/T interface. If interworking is not possible the call is rejected by the IWU.

The destination address is supplied by the PT. This is in the form of either

a) an ISDN subscriber number or network specific number (or ISPBX extension number)

or

b) a short code understood by the network (or ISPBX)

or

c) a short code understood by the IWU.

Cases (a) and (b) are transparent to the IWU and may contain any IA5 characters. Case (c) is a non-standardised option and may also contain any IA5 characters. The short code will be translated by the IWU into a valid ISDN number.

If case (c) is not supported by the IWU then the destination address will be treated as a network specific number.

Both piecewise and en-bloc sending from the PT are supported. With piecewise sending the destination address is sent during the call information phase in keypad elements of a {CC-INFO} message. If en-bloc sending is used from the PT then the complete destination address is sent with the {CC-SETUP} message in a “Called Party Number” information element.

PTs may support either or both piecewise and en-bloc sending . IWUs should support both without distinction.

The PT may support either manual or automatic dialling. If manual dialling then some suitable indication must be given to the user that number entry may start. This may be either locally generated (ie within the PT) or received from the network. If locally generated then there is no restriction on when this may be provided. Suitable locally generated indications include:

i dial tone generated when the PT receives {CC-SETUP-ACK} if piecewise sending is to be used.

ii dial tone whenever service is potentially available if en-bloc sending is to be used.

iii some other audible or visual indication in place of dial tone in (i) and (ii)

The ISDN indicates when network generated in-band tones are potentially available and this information is relayed across the DECT subnetwork to the PT.

The following sections describe in more detail the interworking of outgoing access in each of the interworking cases.

3.1.2 Case 1

En-bloc Sending:
In response to an off-hook indication in the end system and after establishing a LAPC connection the PT sends a {CC-SETUP} message to the FT which includes the complete dialled number in the “Called Party Number” element. If the IWU determines that a service mapping is possible it establishes a LAPB connection on the ISDN (if one does not already exist) and sends a SETUP message containing the called party number either unaltered or translated if the IWU is providing short code translation. Note that the DECT and ISDN messages will normally contain identical “Called Party Number” elements although the IWU may translate number type and number plan codings if appropriate. Other elements in the ISDN SETUP message (eg BC and LLC) will be derived by the IWU either from DECT setup elements (eg “CALL ATTRIBUTES” and “IWU ATTRIBUTES” or generated locally.

If the attached subnetwork accepts the call setup then CALL PROCEEDING will be received by the IWU from the ISDN and {CC-CALL-PROC} will be sent to the PT. If however the ISDN determines that the called party number is incomplete or if it cannot determine whether it is complete or not then SETUP ACKNOWLEDGE will be returned and the IWU will then send {CC-SETUP-ACK} to the PT forcing it into the overlap sending state. Further dialling information will then be sent from the PT in {CC-INFO} messages.

Piecewise Sending:
In response to an off-hook indication in the end system and after establishing a LAPC connection the PT sends a {CC-SETUP} message to the FT which does not include a “Called Party Number” element. If the IWU determines that a service mapping is possible it establishes a LAPB connection on the ISDN (if one does not already exist) and sends a SETUP message. Elements in the ISDN SETUP message (eg BC and LLC) will be derived by the IWU either from DECT setup elements (eg “CALL ATTRIBUTES” and “IWU ATTRIBUTES” or generated locally. The ISDN will return SETUP ACKNOWLEDGE and the IWU will then send {CC-SETUP-ACK} to the PT forcing it into the overlap sending state. If the “Progress indicator” element indicates that in-band tones are available then the PT should connect the U-plane at this point. Note that the “Progress indicator” need not be interworked from the network if the IWU generates tones (eg dial tone) and call announcements. The called party number is sent from the PT in {CC-INFO} messages using either “single keypad” or “multi-keypad” elements. These may be buffered at the IWU and are sent to the ISDN in Called Party Number elements in INFO messages. (Note: This is according to ETS 300 102. Q.931 also allows the use of keypad elements for the called party number.)

Once the attached subnetwork has determined that the called party number is complete then CALL PROCEEDING will be returned to the IWU and {CC-CALL-PROC} will be sent to the PT.

In both en-bloc and piecewise cases the call now proceeds as follows. ALERTING is received from the ISDN to indicate that user alerting has started. This is interworked to {CC-ALERTING} to the PT. When the called party answers the call CONNECT is received from the ISDN and is interworked to {CC-CONNECT}. The PT will connect the U-plane at this point if it has not alredy done so due to a “Progress indicator” element. {CC-CONNECT-ACK} is sent from the PT to indicate the completion of call establishment. The IWU interworks this to CONNECT ACKNOWLEDGE on the ISDN.

3.1.3 Case 2.1

In this case the end system (called "terminal" from now on) is connected to an S-interface at the DECT mobile subnetwork.

In response to an off-hook condition the terminal sends a SETUP message to the P-IWU. This is interworked across the DECT subnetwork using . Elements in the SETUP message which cannot be interworked to DECT elements are sent transparently in an element in the message. At the IWU the original setup message can be reconstructed from a combination of DECT elements and the contents of the “IWU-to-IWU”.

In a similar way elements received in messages from the ISDN are interworked either into DECT elements or “IWU-to-IWU”.

In some cases the messages on the ISDN may not have identical contents to those sent by or received at the terminal. This is acceptable provided that correct operation and the integrity of the protocol is maintained.

Call establishment proceeds in a similar way to Case 1.

3.1.4 Case 2.2

In this case the PP is able to generate and receive certain ISDN information elements to supplement those which can be interworked directly to DECT elements. Only the en-bloc case will be described here.

In response to an off-hook indication in the end system and after establishing a LAPC connection the PT sends a {CC-SETUP} message to the FT which includes the complete dialled number in the “Called Party Number” element. Further information may be supplied by the PT in the form of ISDN information elements which are carried transparently across DECT in an element. If the IWU determines that a service mapping is possible it establishes a LAPB connection on the ISDN (if one does not already exist) and sends a SETUP message containing the called party number and the contents of any element. Note that the DECT and ISDN messages will normally contain identical “Called Party Number” elements although the IWU may translate number type and number plan codings if appropriate. If the IWU is able to generate an ISDN element from DECT element(s) but also receives it in the element then the later will be used.

If the attached subnetwork accepts the call setup then CALL PROCEEDING will be received by the IWU from the ISDN and {CC-CALL-PROC} will be sent to the PT. If however the ISDN determines that the called party number is incomplete or if it cannot determine whether it is complete or not then SETUP ACKNOWLEDGE will be returned and the IWU will then send {CC-SETUP-ACK} to the PT forcing it into the overlap sending state. Further dialling information will then be sent from the PT in {CC-INFO} messages.

If the IWU receives any elements in ISDN messages which cannot be completely interworked into DECT elements then these will be relayed transparently to the PT in elements in the appropriate messages.

Otherwise call setup is similar to Case 1.

3.1.5 Case 3.1

In this case the PP handles the ISDN protocol. Only the en-bloc case will be described here.

In response to an off-hook indication in the end system and after establishing a LAPC connection the PT sends a {CC-SETUP} message to the FT which, optionally, includes the complete dialled number in the “Called Party Number” element. A complete ISDN setup message generated in the end system is carried transparently across DECT in an element. If the IWU determines that a service mapping is possible it establishes a LAPB connection on the ISDN (if one does not already exist) and sends the SETUP message contained in the element. If the IWU is able to generate an ISDN message from a DECT message but also receives a similar message in the element then the later will be used.

If the attached subnetwork accepts the call setup then CALL PROCEEDING will be received by the IWU from the ISDN and {CC-CALL-PROC} will be sent to the PT. The entire CALL PROCEEDING message is also relayed to the PP in an element. If however the ISDN determines that the called party number is incomplete or if it cannot determine whether it is complete or not then SETUP ACKNOWLEDGE will be returned and the IWU will then send {CC-SETUP-ACK} to the PT forcing it into the overlap sending state. Again the entire ISDN message is relayed to the PP in an element. Further dialling information will then be sent from the PT in {CC-INFO} messages.

If the IWU receives ISDN messages which cannot be interworked into DECT messages during the call information phase then these will be relayed transparently to the PP in elements in a{CC-INFO} message. Similarly for messages originated by the end system.

Otherwise call setup is similar to Case 1.

3.1.6 Case 3.2

This is similar to case 1 except that LAPB frames are relayed transparently across the DECT subnetwork.

3.2 Incoming Access

This is described for Case 1 but others are similar.

An incoming call is indicated by a SETUP message being received at the IWU from the ISDN. The FT establishes MAC and DLC connections to the PT (if not already existing) after paging. The SETUP message is then interworked to a {CC-SETUP} message and the “signal” element indicates the user alerting pattern to be used. {CC-INFO} may also be sent from the FT to change the alerting pattern. {CC-ALERTING} is returned from the PT to indicate that user alerting has started. This is interworked to an ISDN ALERTING message. When the PP answers the incoming call a {CC-CONNECT} message is sent to the IWU which then interworks it to an ISDN CONNECT. CONNECT ACKNOWLEDGE returned from the ISDN confirms the B channel identification. At this point the U-plane must be connected. {CC-CONNECT-ACK} is sent to the PT.

3.3 Release

This is described for Case 1 but others are similar.

If the PT releases the call as a result of some user action then the IWU will send a DISCONNECT message to the ISDN in response to receiving a {CC-RELEASE}. When the network confirms the release of the B channel by sending RELEASE the IWU sends a {CC-RELEASE-COM} to the PT and a RELEASE COM to the ISDN.

If the call is released from the network then this is indicated by the receipt of a DISCONNECT message.

3.4 Access Collision

[For further study]

3.5 Supplementary Service Access

3.5.1 Supplementary Service Access in Digital Networks

Supplementary services provided by digital networks are accessed by sending codes within messages in the network protocol. DECT is in this respect modelled on ISDN (Q.932). Three types of protocol may be used:

- keypad
- feature key
- functional protocols

DECT supplementary service procedures may be interworked in a straightforward way to digital networks provided a similar protocol is used on both networks.

3.5.2 Interworking Requirements

To interwork easily with analogue networks a DECT PP should have some means of operating the register recall function directly, for example a button. The network protocol provides a means ('Feature Activation') of conveying this between PT and FT. However, because this is not a requirement when connected to a digital network, handsets will also be produced without this facility.

We therefore have the following interworking scenarios:

	Attached Subnetwork:
	Digital
PP with R button	Case 1
PP without R button	Case 2

R button = button or some other means of operating register recall when interworking to analogue networks.

Case 1

Register recall has no meaning on the digital network and is therefore not interworked. To maintain compatibility with access to analogue networks the user will expect either dial tone or some other MMI indication in response to operating the R button. This then indicates that access to a supplementary service may proceed. Note that correct operation of the protocol does not require the foregoing. The dial tone is not mandatory but clearly provides a better interface to the user. It could be generated in the IWU or PP.

The procedure then is as follows:
During the active phase of a call the user operates the R button. The PT sends “Feature Activate” (RR = set). The IWU replies with “Feature Indicator” (RR = not interworked). The IWU should also connect a dial tone generator (if provided) to the U-plane until further SS messages are received or a timeout operates. Alternatively on receiving 'RR = not interworked' the PP could generate an appropriate indication to the user.

Case 2

If similar protocols are used in both digital networks then the supplementary services may be interworked directly. In other cases interworking may be more difficult or even impossible. Refer to the section on supplementary service interworking, 7.7.4.

3.6 Call Offering

[For further study]

3.7 Hold and Retrieve

[For further study]

3.8 User-to-User Signalling

[For further study]

3.9 Address Mapping

[For further study]

4 - 7

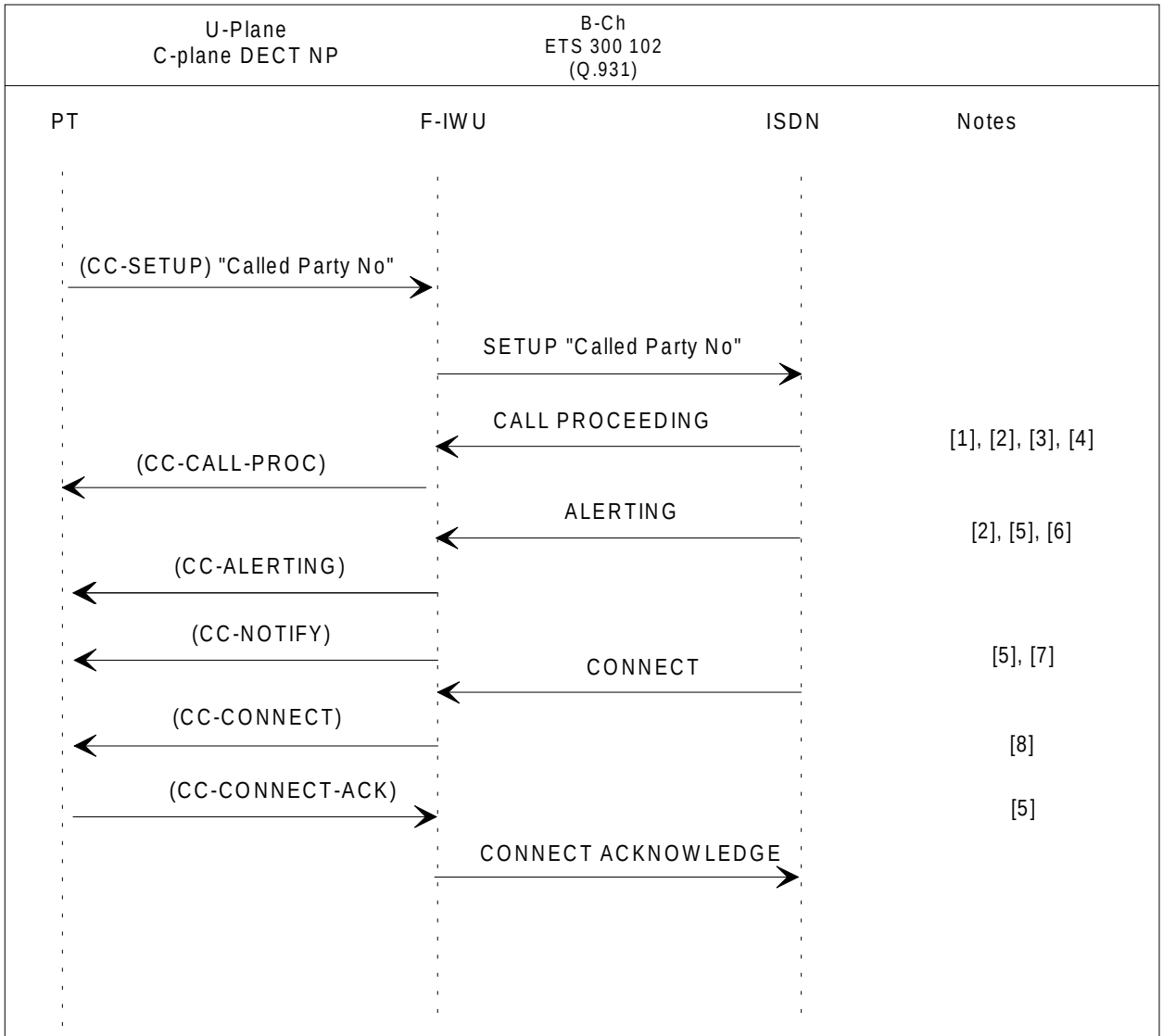
[For further study]

[Further C-plane and U-plane procedures exist in a number of RES-3N input papers. [215] [224] [225].]

8 Message Sequence Examples

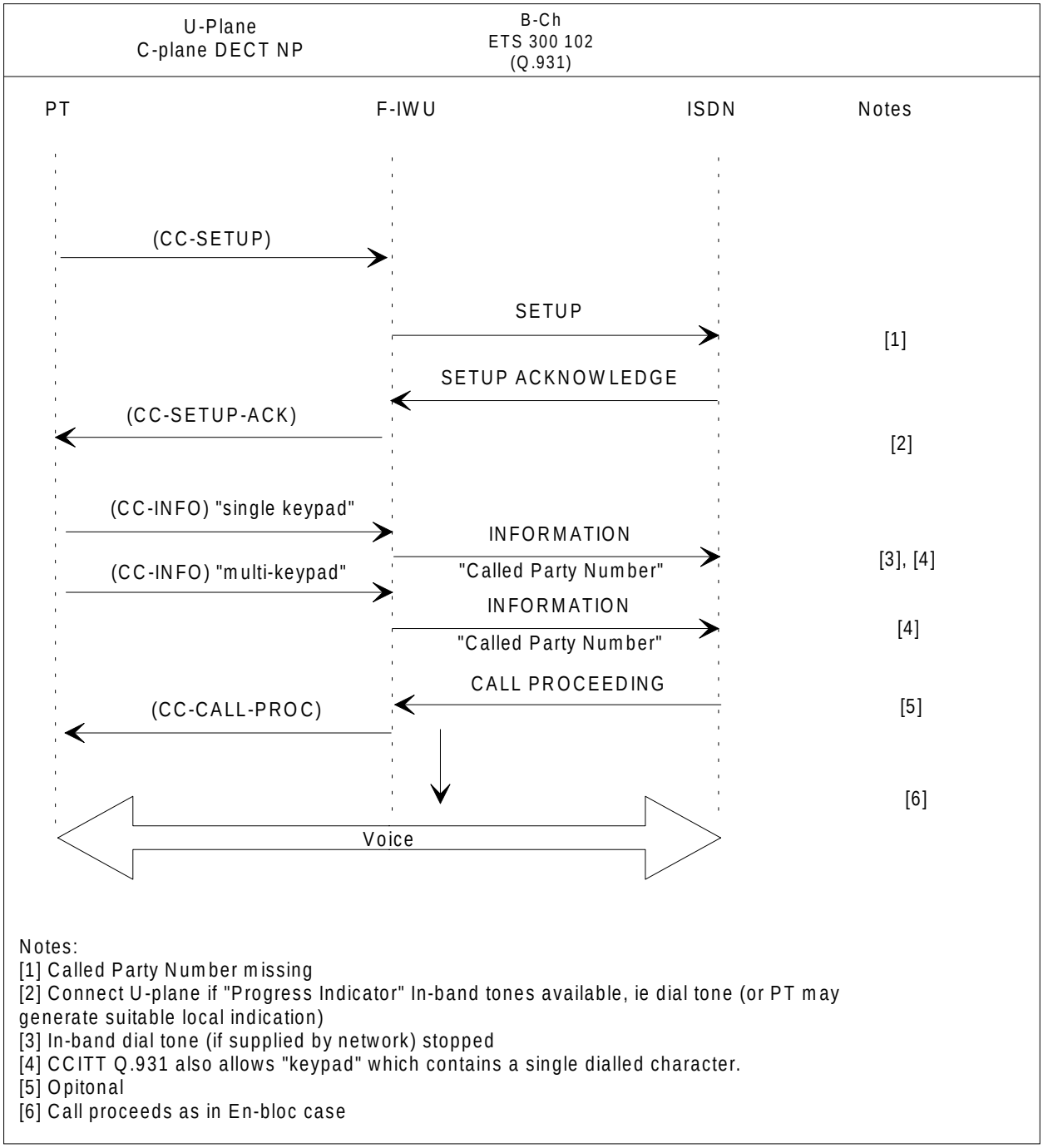
- Outgoing Access, En-bloc Sending, Case 1 fig 8.1/IWP(3)
- Outgoing Access, Piece wise Sending, Case 1 fig 8.2/IWP(3)
- Outgoing Access, Piecewise Sending, Case 2.1 fig 8.3/IWP(3)
- Outgoing Access, En-bloc Sending, Case 2.2 fig 8.4/IWP(3)

- Outgoing Access, En-bloc Sending, Case 3.1 fig 8.5/IWP(3)
- Outgoing Access, En-bloc Sending, Case 3.2 fig 8.6/IWP(3)
- Incoming Access, Case 1 fig 8.7/IWP(1)
- PT Release fig 8.8/IWP(3)
- Network Release fig 8.9/IWP(3)



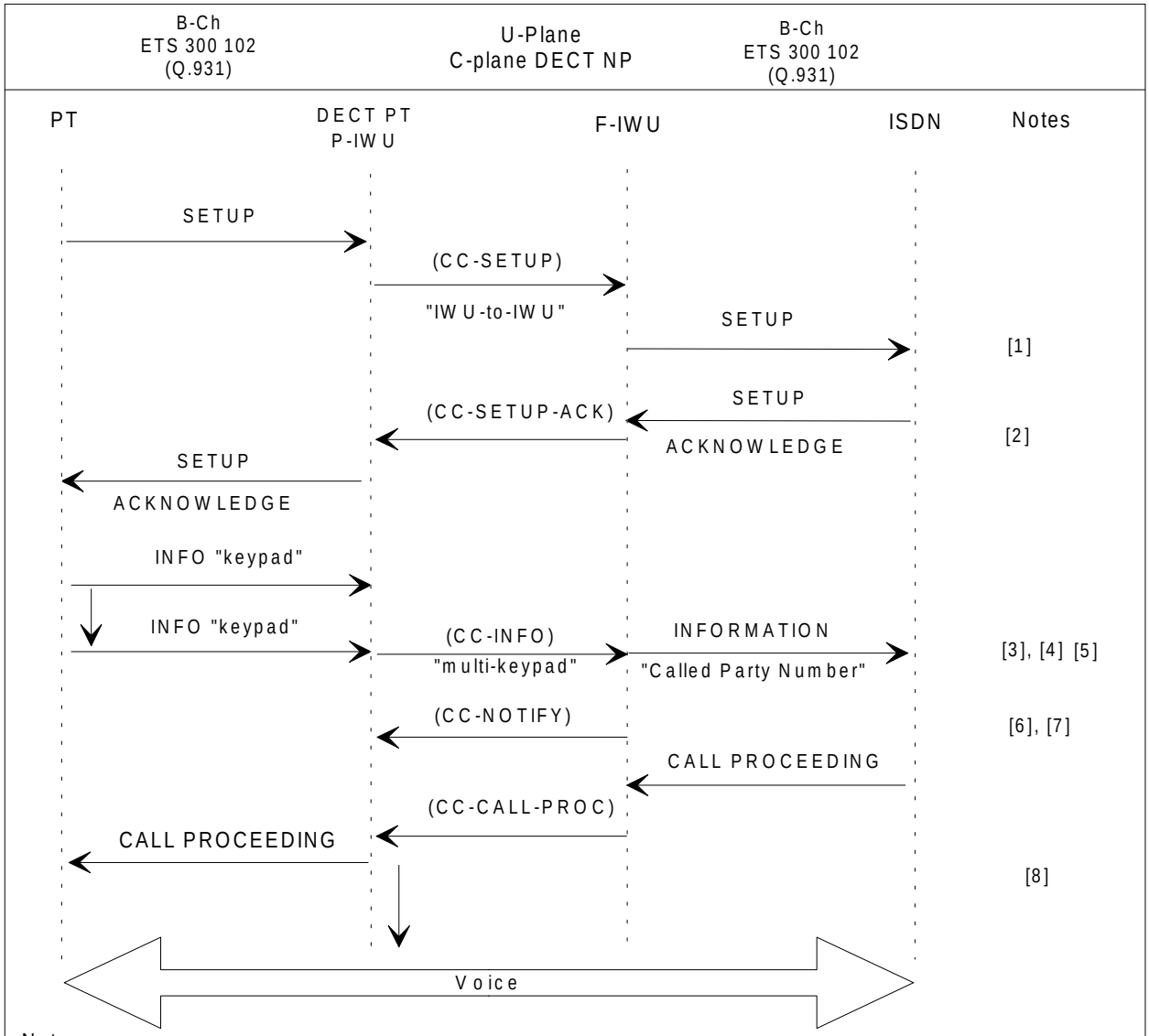
Notes:
[1] Call accepted by attached subnetwork
[2] U-Plane to be connected if "Progress indicator" In-Band tones available (or some other locally generated indication at PT)
[3] B channel assigned
[4] SETUP ACKNOWLEDGE will be returned from network if call setup information is incomplete. FT then sends (CC-SETUP-ACK) to PT which enters overlap sending state.
[5] Optional
[6] Indicates called party being alerted (ringing)
[7] May be sent at any time by FT to restart CC Completion timer
[8] U-Plane to be connected if not already done so

Outgoing Access, En-bloc Sending, Case 1
fig 8.1/IWP(3)



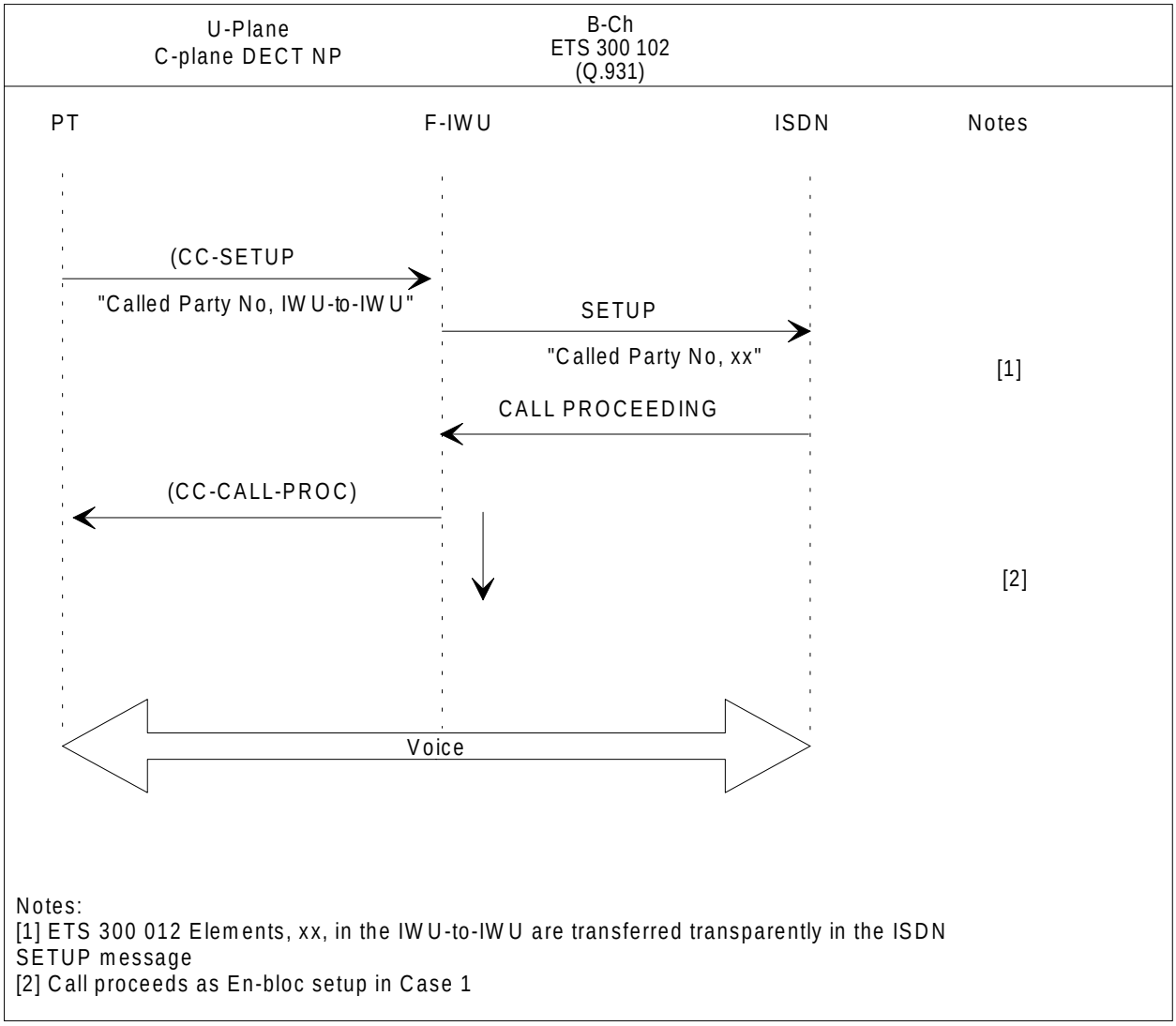
Notes:
[1] Called Party Number missing
[2] Connect U-plane if "Progress Indicator" In-band tones available, ie dial tone (or PT may generate suitable local indication)
[3] In-band dial tone (if supplied by network) stopped
[4] CCITT Q.931 also allows "keypad" which contains a single dialled character.
[5] Opitonal
[6] Call proceeds as in En-bloc case

Outgoing Access, Piece wise Sending, Case 1
fig 8.2/IWP(3)



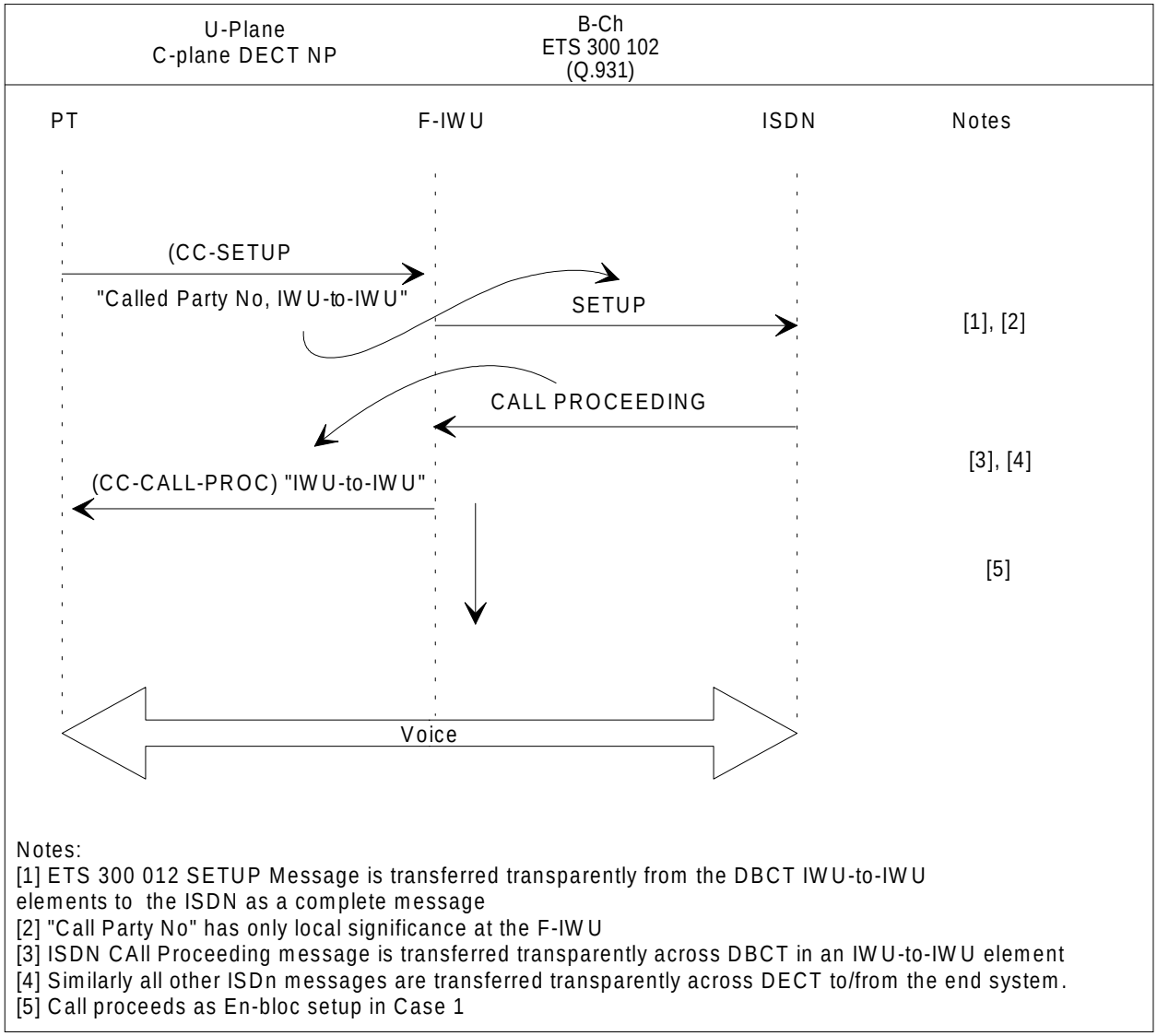
Notes:
[1] "IWU-to-IWU" carries information elements not interworked.
[2] Connect U-plane if "Progress Indicator" In-band tones available, ie dial tone (or PT may generate suitable local indication)
[3] Dial digits may be buffered over DECT and sent in a"multi-keypad" element. There may also be anumber of INFORMATION messages
[4] Careful consideration of timers may be required.
[5] CCITT Q.931 also allows "keypad" which contains a single dialled character.
[6] Opitonal.
[7] May be sent at any time by Ft to restart CC Completion timer
[8] Call proceeds in a similar way to Case 1

Outgoing Access, Piecewise Sending, Case 2.1
fig 8.3/IWP(3)



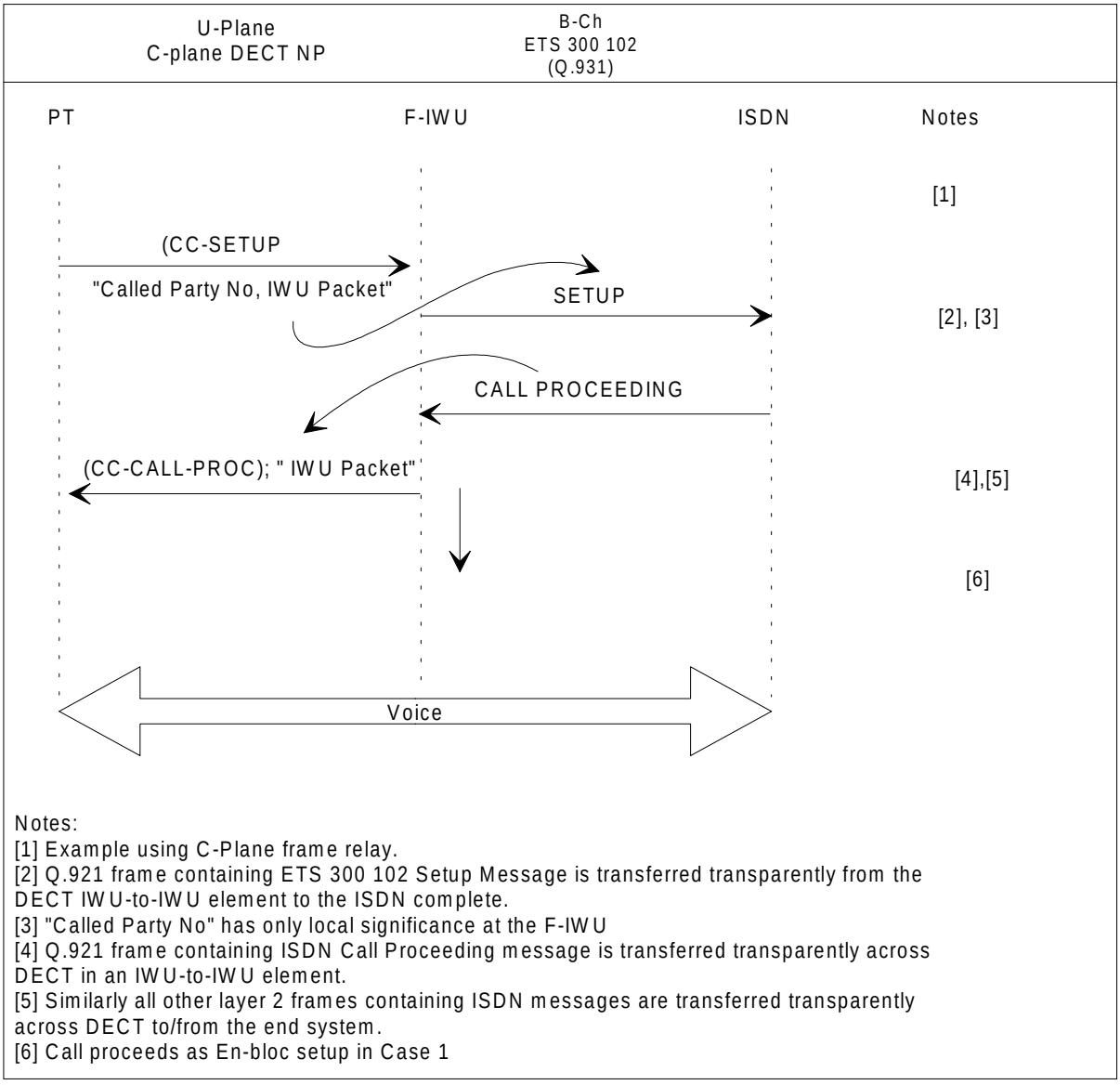
Notes:
[1] ETS 300 012 Elements, xx, in the IWU-to-IWU are transferred transparently in the ISDN SETUP message
[2] Call proceeds as En-bloc setup in Case 1

Outgoing Access, En-bloc Sending, Case 2.2
fig 8.4/IWP(3)



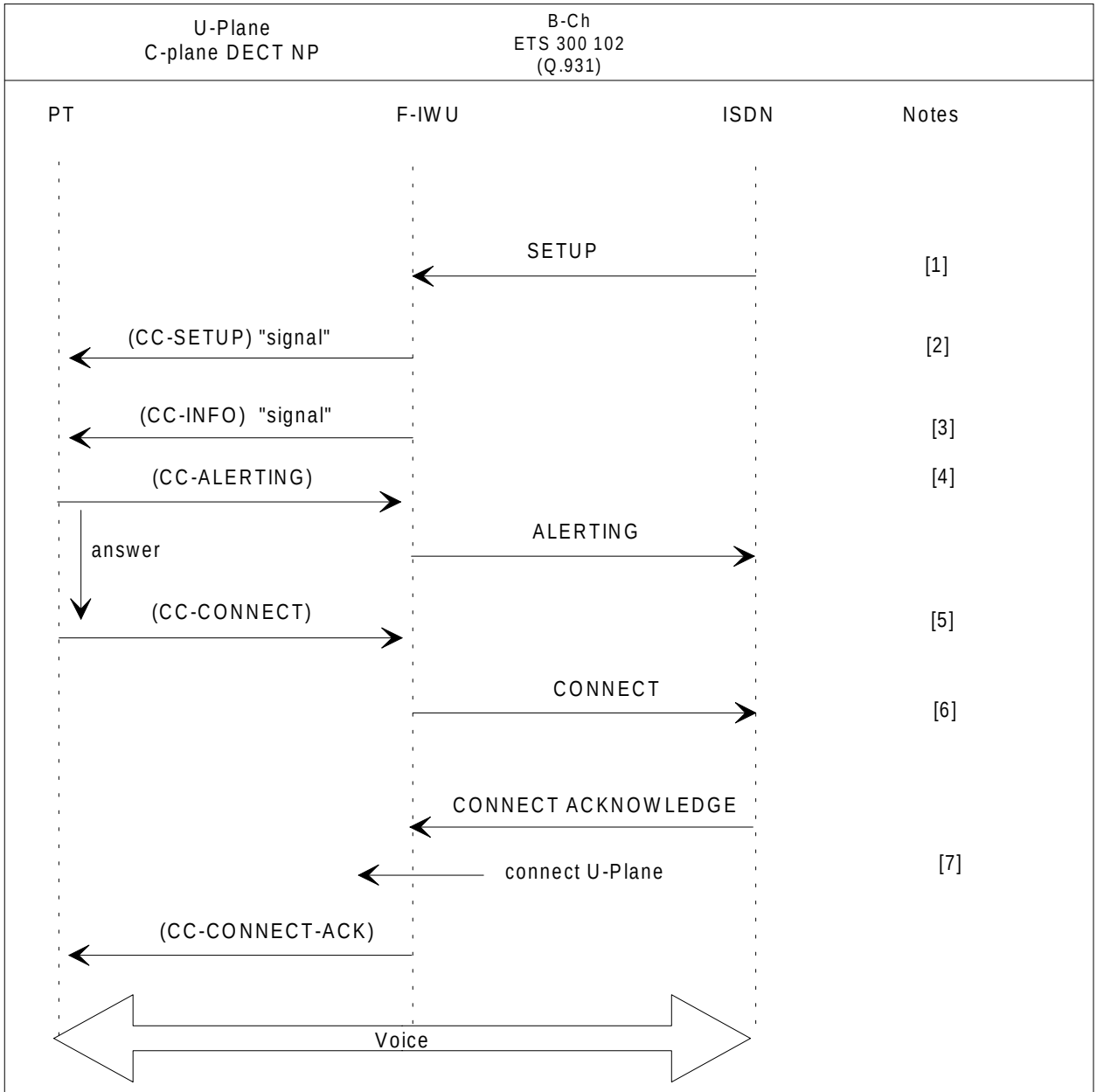
Notes:
[1] ETS 300 012 SETUP Message is transferred transparently from the DBCT IWU-to-IWU elements to the ISDN as a complete message
[2] "Call Party No" has only local significance at the F-IWU
[3] ISDN CAll Proceeding message is transferred transparently across DBCT in an IWU-to-IWU element
[4] Similarly all other ISDn messages are transferred transparently across DECT to/from the end system.
[5] Call proceeds as En-bloc setup in Case 1

Outgoing Access, En-bloc Sending, Case 3.1
fig 8.5/IWP(3)



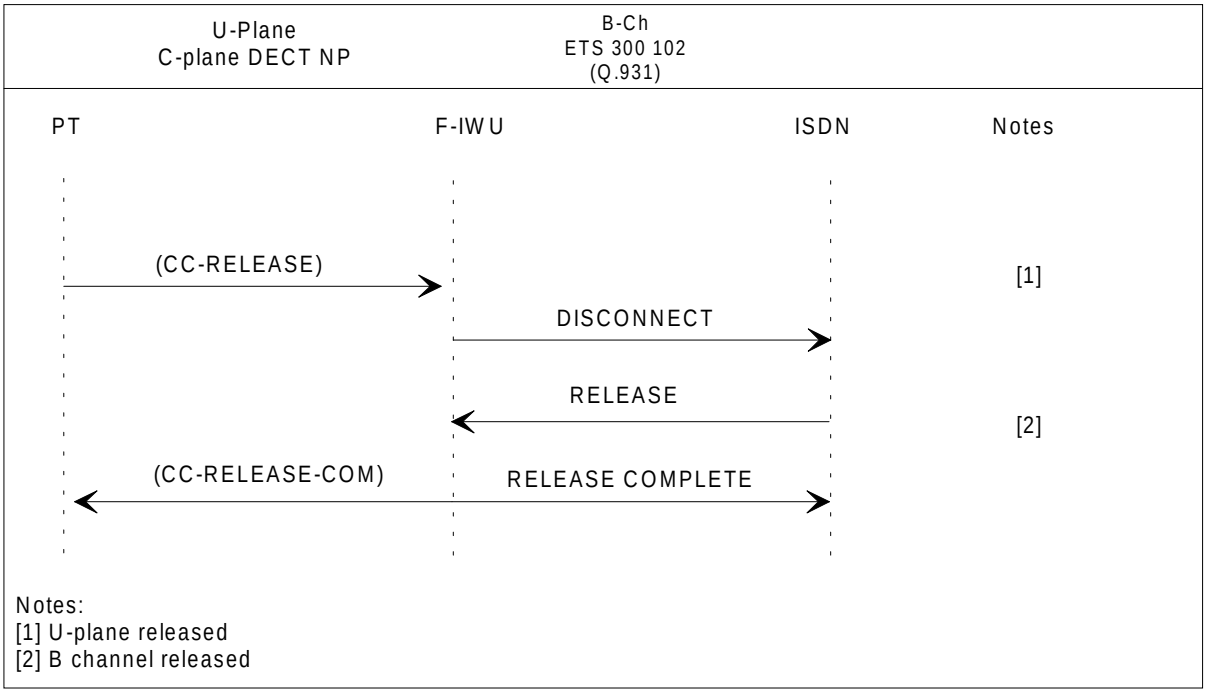
Notes:
[1] Example using C-Plane frame relay.
[2] Q.921 frame containing ETS 300 102 Setup Message is transferred transparently from the DECT IWU-to-IWU element to the ISDN complete.
[3] "Called Party No" has only local significance at the F-IWU
[4] Q.921 frame containing ISDN Call Proceeding message is transferred transparently across DECT in an IWU-to-IWU element.
[5] Similarly all other layer 2 frames containing ISDN messages are transferred transparently across DECT to/from the end system.
[6] Call proceeds as En-bloc setup in Case 1

Outgoing Access, En-bloc Sending, Case 3.2
fig 8.6/IWP(3)

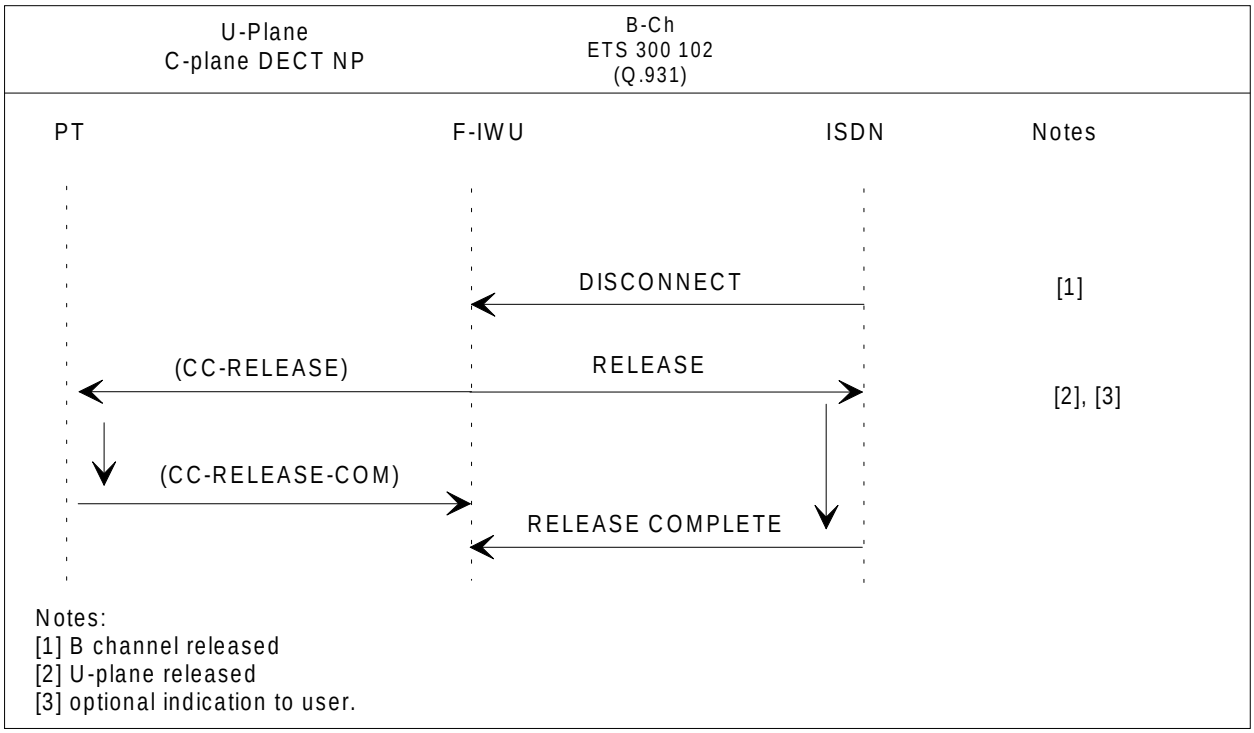


Notes:
[1] Establish DLC and MAC connections if not already existing.
[2] Signal indicates alerting pattern - optional
[3] Signal indicates alerting pattern if not in SETUP message.
[4] User alerting started.
[5] PT should connect U-Plane to receive in-band call announcements.
[6] Contains B-Channel identification.
[7] Latest point at which U-Plane can be connected

Incoming Access, Case 1
fig 8.7/IWP(1)



PT Release
fig 8.8/IWP(3)



Network Release
fig 8.9/IWP(3)

7.9.4 ISDN CIRCUIT SWITCHED DATA

Contents

1 General

This IWP explains how a DECT subnetwork interworks with an ISDN for the purpose of supporting circuit switched data communication with circuit switched access.

Applicability of this IWP:

- Attached subnetwork = ISDN
- Dedicated PP with DECT rate adaption capability (Case B)
- Dedicated PP with ISDN rate adaption capability (Case A)
- Circuit switched access to ISDN terminals using V.110 rate adaptation
- DECT single cell systems
- SDN basic or primary rate access

The IWU needs to support the following processes:

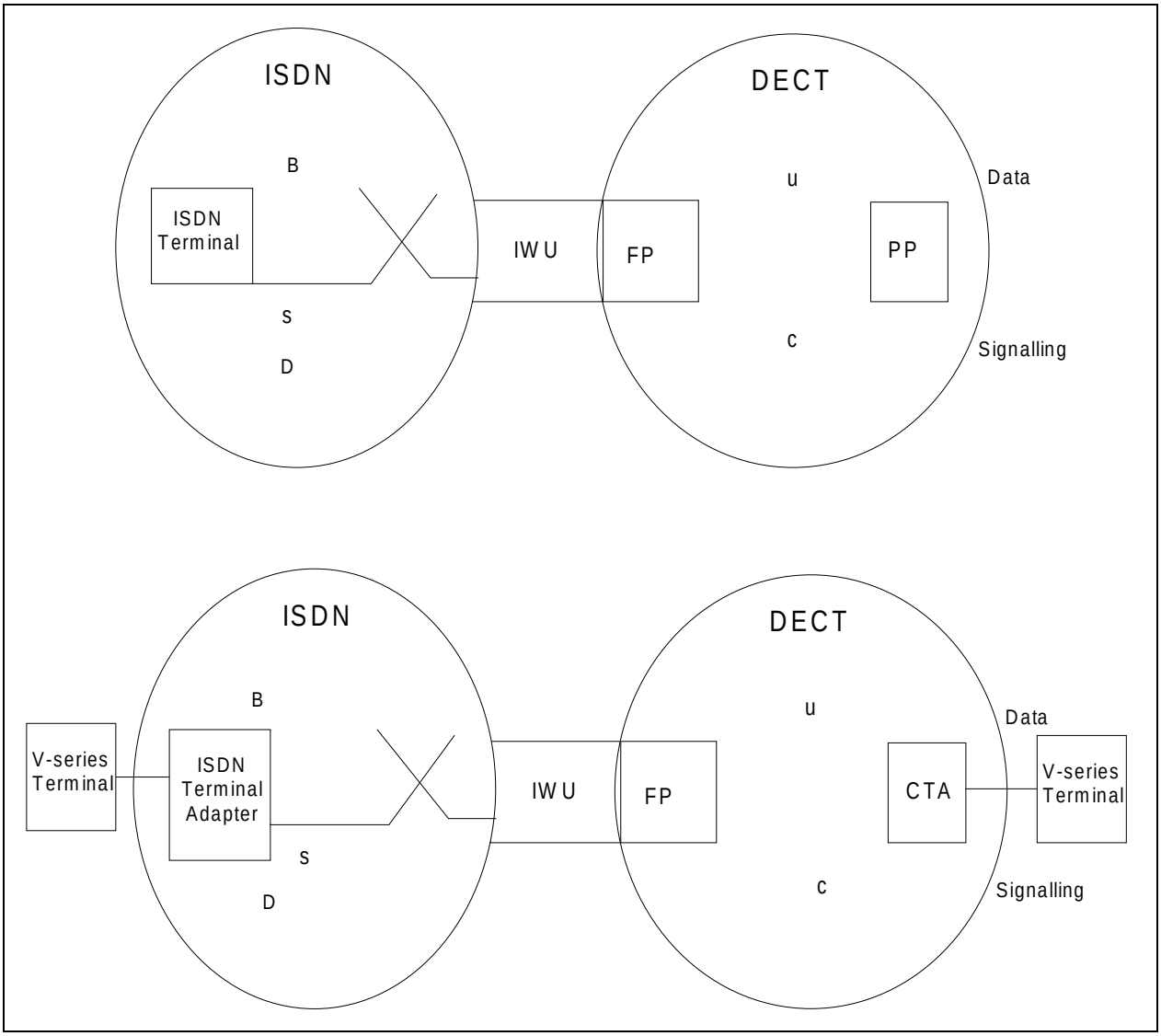
- IWF selection
- Call negotiation
- Call information
- Interworking indication
- Queue control (optional)

Access to the ISDN terminal is accomplished by establishing a transparent circuit-switched connection through the ISDN. User data is carried in the DECT U-plane using the DECT rate adaptation service (maximum integration scenario, Case B) or a protected, transparent ISDN service (minimum integration scenario, Case A) and a full ISDN B-channel or B-subchannel in the ISDN.

Signalling information is carried on the DECT subnetwork in the C-plane (Case B) or in the C- and U-plane (Case A) and on the ISDN subnetwork in a D-channel. Some end-to-end flow control signalling information and status information may be carried in the user data frame.

Protocol architecture models can be found elsewhere in the DECT system description document:

	Refer to:
Single Cell	
Signalling Model	4.3.1
User Data Model	4.3.1
Multi Cell	
Signalling Model	4.3.2
User Data Model	4.3.2



Typical Configurations
Fig. 1.1/IWP(4)

The ISDN subnetwork may support any of the following connection types on B-channels:

i Demand access. Physical, data link and network connections established on demand between the IWU and ISDN terminal.
ii Semi-permanent connection. Physical layer remains activated and a physical path is connected semi-permanently through the ISDN:

The DECT subnetwork has the ability to provide a connection:

i On demand.
ii With fixed bandwith allocation

The IWF called for in this profile may support any combination of the above according to its application. The DECT subnetwork will not change the type of service in the U-plane during the active phase of a call.

2 C-plane Procedures

2.1 Outgoing Access

The PP or the CTA establishes a LAPC connection (if not already active) and network connections across the DECT subnetwork to the IWU. The CTA initiates this action after a local signalisation from the V-series terminal using V.25bis, Hayes or manufacturer specific menu commands. Information transferred enables an appropriate IWF, bearer and ISDN terminal or ISDN terminal adapter to be selected.

The DECT subnetwork allocates a fixed U-plane bandwith according to the mapping scheme of V.110 rates used with the U-plane rate adaption service (RATE) in Case B. For Case A the DECT subnetwork allocates a fixed U-plane bandwith according to the mapping scheme of V.110 rates for data and possibly U-plane bandwith for the ISDN D-channel, which can be conveyed transparently after call setup. The minimum integration scenario will use a new protected, fixed throughput, transparent ISDN service.

After establishment of the U-plane connection, further end-to-end signalling information is possible by using in-band channels supported by V.110 and possibly also by the DECT rate adaption service (Case B).

The IWU will be informed by the ISDN network which B-channel or B-subchannel is selected for the communication in the ISDN.

2.2. Incoming Access

The ISDN signals the establishment of the circuit-switched connection to the IWU using standard ISDN procedures. These procedures are described in general in Q.931 and V.110. Information provided in the SETUP message allows the IWU to establish appropriate connection via the FP to the PP or CTA/V-series terminal and to specify if Case A or Case B interworking profiles are needed.

The incoming call is presented to the V-series terminal by the CTA by using V.25bis, Hayes or other manufacturer-specific menu commands (e.g. automatic call accept).

2.3 Release

When the IWU receives a {CC-RELEASE} message from the PP via the FP the circuit switched connection will be also released in the ISDN subnetwork by using the appropriate ISDN procedures. The U-plane connection as well as the B-(sub)channel connection may be released without further synchronisation to the C-plane procedures.

Clearing from the ISDN is handled in the same way.

2.4 Error Handling and Cause Codes

[For further study]

2.5 Access Collision

[For further study]

3 U-plane Procedures

3.1 U-plane Connection

Data information is transferred in the DECT subnetwork between FP and PP or CTA in the U-plane. The data information may be only transferred end-to-end when the physical layer in the ISDN subnetwork is established.The ISDN subnetwork uses a full B-channel or a B-subchannel (8, 16 or 32kbit/s) according to V.460. The connection in the ISDN is fully circuit switched and has an end-to-end connection (no virtual calls). The IWU may have the ability to switch the data from more than one connection in the DECT subnetwork into several B-subchannels (multiplexed B-channels) in the ISDN network.

The data information is carried transparently in the ISDN B-(sub)channels but a rate adaption service exists in the ISDN terminal or ISDN terminal adaptor and in the IWU equipment (Case B). The data information is carried in the DECT subnetwork by using the standard DECT rate adaption service (RATE) which can be accessed by LU5 in the DLC Layer (U-plane).

For Case A the information is carried transparently in the ISDN B-(sub)channels as well as in the DECT U-plane connection by using the new protected, fixed throughput ISDN service. A rate adaption mechanism for Case A exists only in the DECT PP and in the ISDN terminal and the FP needs only to reconfigure the channels in the DLC U-plane.

3.2 U-plane Service in the ISDN

The data information transport in the ISDN subnetwork is described in I.460 (multiplexing, rate adaption and support of existing interfaces) and V.110/V.463 (support of DTEs with V-series type interfaces by an ISDN).

3.3 U-plane Service in the DECT

The data information transport in the DECT subnetwork will be described in the DLC LU5 service specification for Case B.

For Case A the data information transport in the DECT subnetwork will be described in the new DLC ISDN transparent service.

4 ISPBX Related Procedures

[For further study]

5 Process Applicability

[For further study]

6 Message Sequence Examples

[For further study]

7 Mapping

[For further study]

7.9.5 ISDN PACKET SWITCHED DATA

For further study

7.9.6 CIRCUIT-SWITCHED ACCESS TO PSPDN VIA AN ISDN

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Contents

1 General

This IWP explains how a DECT subnetwork interworks with an ISDN for the purpose of supporting packet communications with circuit switched access.

Applicability of this IWP:

- Attached Subnetwork = ISDN
- Dedicated PP with X.25 capability
- Circuit-switched access to PSPDN services (X.31 Case A [109],[105])
- DECT Single Cell Systems
- ISDN Basic or Primary Rate Access

The IWU needs to support the following processes:-

- IWF Selection
- Call Negotiation
- Call Information
- Interworking Indication
- Queue control (optional)

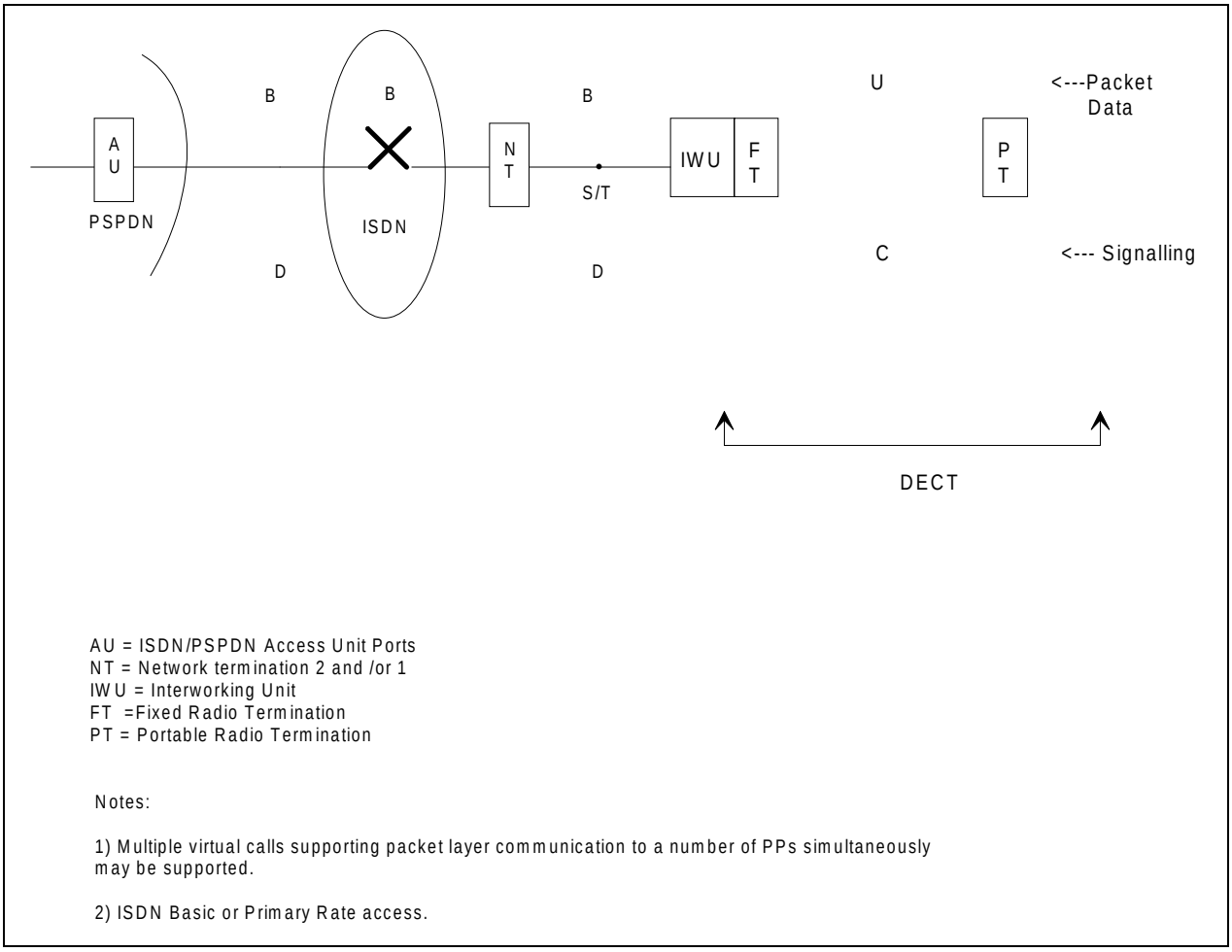
and the following function (IWF):-

- ISDN/PSPDN

Access to a PSPDN is accomplished by establishing a transparent circuit-switched connection through the ISDN to an access unit on the PSPDN. User packet data is carried in the DECT U-plane using a frame relaying service and transparently in an ISDN B-channel. Signalling information is carried on the DECT subnetwork in the C-plane and on the ISDN subnetwork in a D-channel. The connection may be initiated by either the user or PSPDN access unit. Figure 1.1/IWP(6) shows a typical configuration.

Protocol architecture models can be found elsewhere in the DECT System Description Document:

		Refer to:
Single Cell	Signalling Model User Data Model	4.3.1.1.1 4.3.1.2.1
Multi Cell	Signalling Model User Data Model	4.3.2 4.3.2



Typical Configuration
Figure 1.1/IWP(6)

The ISDN subnetwork may support any of the following connection types on B- and D-channels:-

i Demand Access. Physical, data link and network connections established on demand between the IWU and PSPDN access unit.

ii Type 1 semi-permanent connection. Physical layer remains activated and a physical path is connected semi-permanently through the ISDN.

iii Type 2 semi-permanent connection. Physical and data link layers remain semi-permanently connected through the ISDN.

The DECT subnetwork has the ability to provide a connection:-

i) On demand

ii) When a LAPC connection already exists

iii) with dynamic bandwidth allocation

The IWF called for in this profile may support any combination of the above according to its application. Note that the DECT subnetwork also has the ability to change the type of service in the U-plane during the active phase of a call.

If the IWU is connected to the ISDN at the S-reference point, other IWU's or terminal equipments may be connected to the same point. Whether call offering can be supported at either the ISDN interface or DECT subnetwork is for further study.

2 C-Plane Procedures

C-plane procedures are used to select the appropriate IWF and to establish and control a connection between the PT and FT.

2.1 Outgoing Access

The PT establishes a LAPC connection (if not already active) and network connection across the DECT subnetwork to the IWU. Information transferred enables an appropriate IWF, bearer and PSPDN access unit to be selected. Information on the PSPDN access unit is only required where interworking is provided to a number of networks. The DECT subnetwork may dynamically allocate U-plane bandwidth to meet the demands of packet transfer to and from the IWU.

The IWU establishes and controls connections across the ISDN to the PSPDN access port. There are three phases to this.

- Establishment of physical circuit to the access unit if not already established. This may be on demand of semi-permanent.
- Establishment of data link layer (LAPB) if not already established. This again may be on demand or semi-permanent.
- Establishment of packet layer virtual call (X.25)

The IWU may be multiplexing packets from a number of PTs into different virtual calls. In all cases the IWU remains responsible for establishing and releasing ISDN connections at all layers based on information provided by the PT (or PTs) at set-up and during the call. Note that connections at all three layers on the ISDN are maintained independently of connections on the DECT subnetwork to meet the demands of packet transfer in both directions.

The IWU will select which B-channel to use.

2.2 Incoming Access

The ISDN signals the establishment of the circuit-switched connection to the IWU using standard ISDN procedures. These procedures are described in general in X.32 [110] (as applied to the ISDN) and in Q.931 [105]. Information provided in the SETUP message allows the IWU to establish appropriate connections to the PT.

There is again a degree of independence between connections on the two subnetworks. The IWU must ensure that appropriate connections are maintained to meet the demands of packet transfer in both directions.

2.3 Release

When the IWU receives a {CC-RELEASE} message from the PT the X.25 virtual call will be released (cleared) but note that it does not necessarily follow that the LAPB and physical connections will also be cleared. The IWU will release the ISDN data link and physical connections (unless semi-permanent) once all PTs accessing packet services have released.

Clearing from the ISDN depends on whether the packet level , LAPB or physical connection is cleared. If a virtual call is cleared at the packet level then only the DECT connection to the relevant PT will be released. The LAPC connection will also be released if there are no other active connections. If either the LAPB or physical connections are released then all connections between IWU and PTs will be released.

2.4 Error Handling and Cause Codes

[For further study]

2.5 Access Collision

The ISDN will give priority to an incoming call should this occur at the interface simultaneously with an outgoing request. The IWU may accept or reject the incoming call. Similarly the IWU will give priority to an incoming call at its interface with the DECT subnetwork. In this case the PT may accept or reject the incoming call in favour of its own outgoing request.

3 U-Plane Procedures

3.1 U-Plane Connection

Data packets are transferred between PT and FT in the U-plane. Packets may be transferred from PT to FT only once a link layer and physical connection have been established between IWU and PSPDN access unit across the ISDN. However, a packet layer virtual call need not exist. Similarly incoming packets from the ISDN will only be accepted by the IWU if a LAPC connection has been established to the PT. A B-channel is used for transmission of packets to and from the access unit.

Data packets are carried transparently in the ISDN B-channel but a frame relaying service is used in the DECT U-plane. The frame relaying function serves the following purposes:

- conversion to the bit orientated HDLC LAPB frames to octet aligned frames suitable for transmission over the DECT lower layers.

- removal of redundant information to maximise usage of the radio medium.

The frame relay service is provided by LU_2 in the DLC layer.

3.2 LAPB Frames

3.2.1 Outgoing Frames

The PP will construct an X.25 packet of length no greater than the maximum permissible on the PSPDN to be connected to. This will be inserted into a properly formatted LAPB frame and passed by the IWF across the DECT network service boundary to the LU_2 entity. LU_2 leaves the LAPB address and control fields intact, strips delimiting flags, inserted zeros and frame check sequence (FCS). The frame is aligned to octet boundaries and the resultant protocol data unit is transmitted to the IWU (after segmentation and retransmissions if necessary). Idle (or fill) flags are not passed by the IWF to LU_2. The LU_2 entity in the IWU reconstructs the LAPB frame by calculating the Frame Check Sequence (FCS) field, inserting zeros and adding flags at each end of the frame. Flags will be inserted on the data link connection when no packets are available for transmission.

3.2.2 Incoming Frames

Similarly the LU_2 entity in the IWU strips flags and inserted zeros from the received LAPB frame and checks then strips the FCS. The frame is rejected if the FCS fails. The IWU may optionally check the address field but the control field is always passed transparently to the PT. The resultant protocol data unit is transmitted to the PT (after segmentation and retransmissions of necessary). The receiving LU_2 entity in the PT will reconstruct the LAPB frame before passing to the IWF.

4 Process Applicability

[For further study]

5 Message Sequence Examples

- PT Originated Call Figure 5.1/IWP(6)
- PT Terminated Call Figure 5.2/IWP(6)
- PT Cleared Call Figure 5.3/IWP(6)

6 Mapping

6.1 Information Elements

[For further study]

6.2 Error Handling and Cause Codes

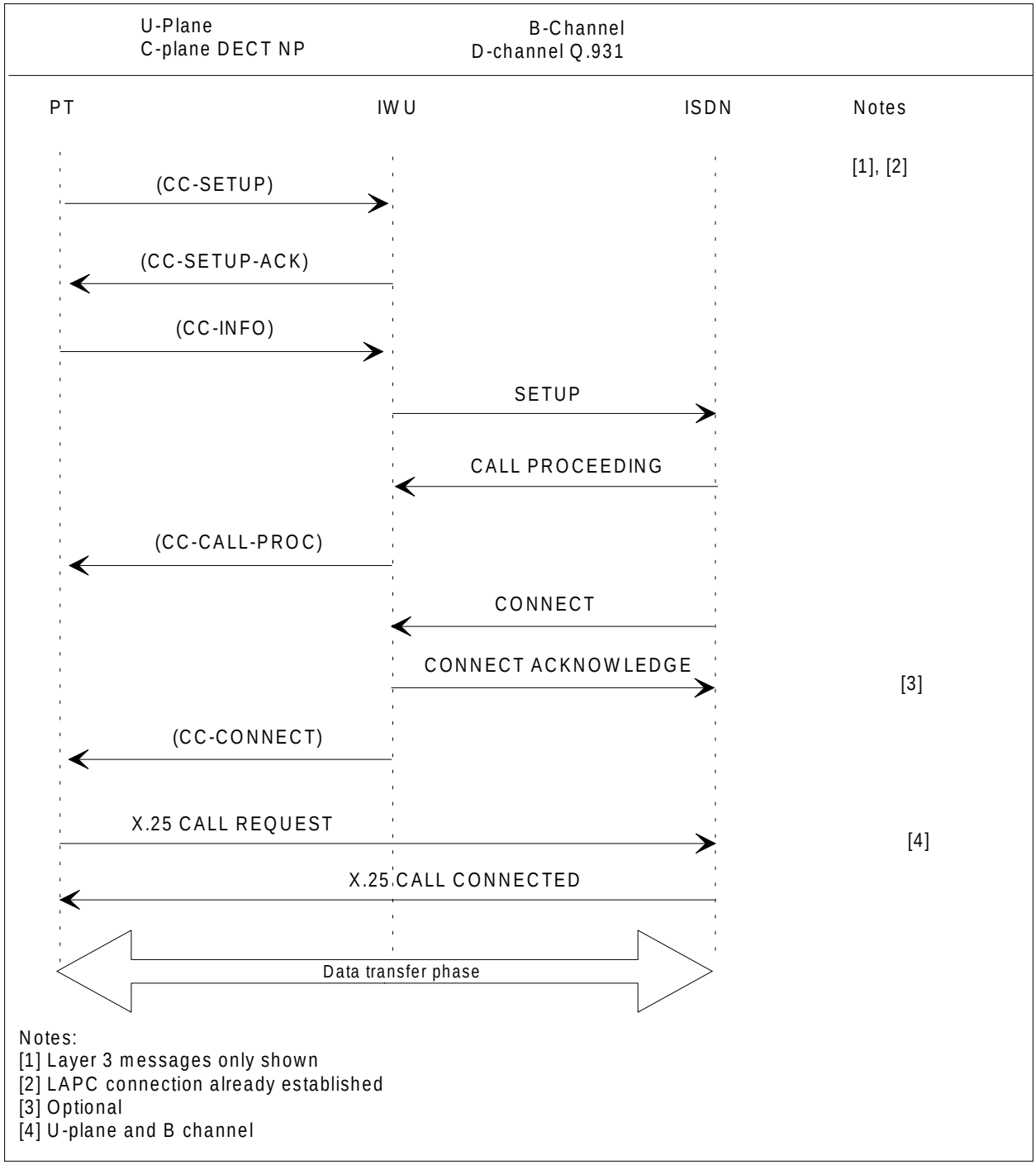
[For further study]

6.3 Bearer Services

[For further study]

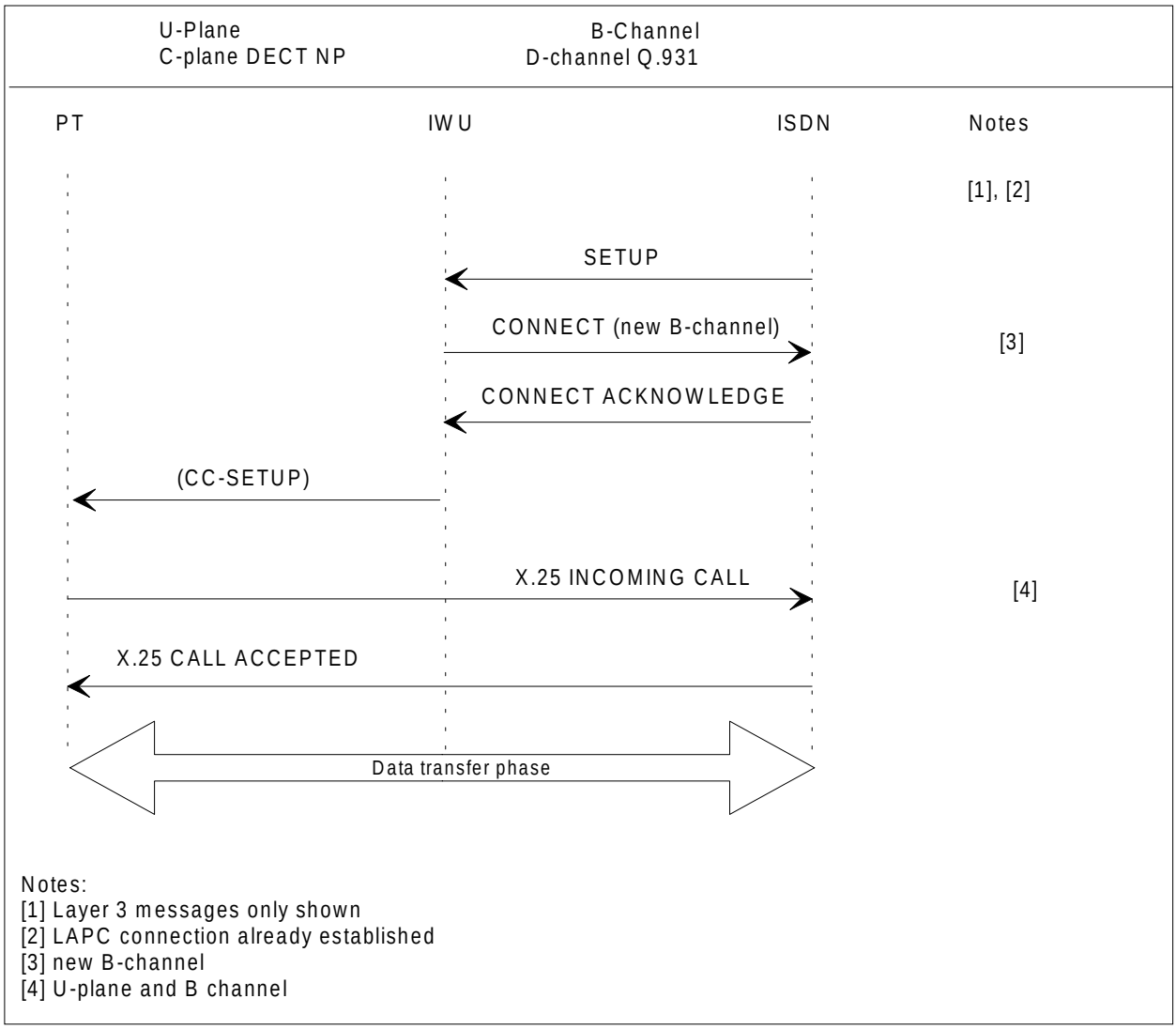
6.4 Service Mappings

[For further study]



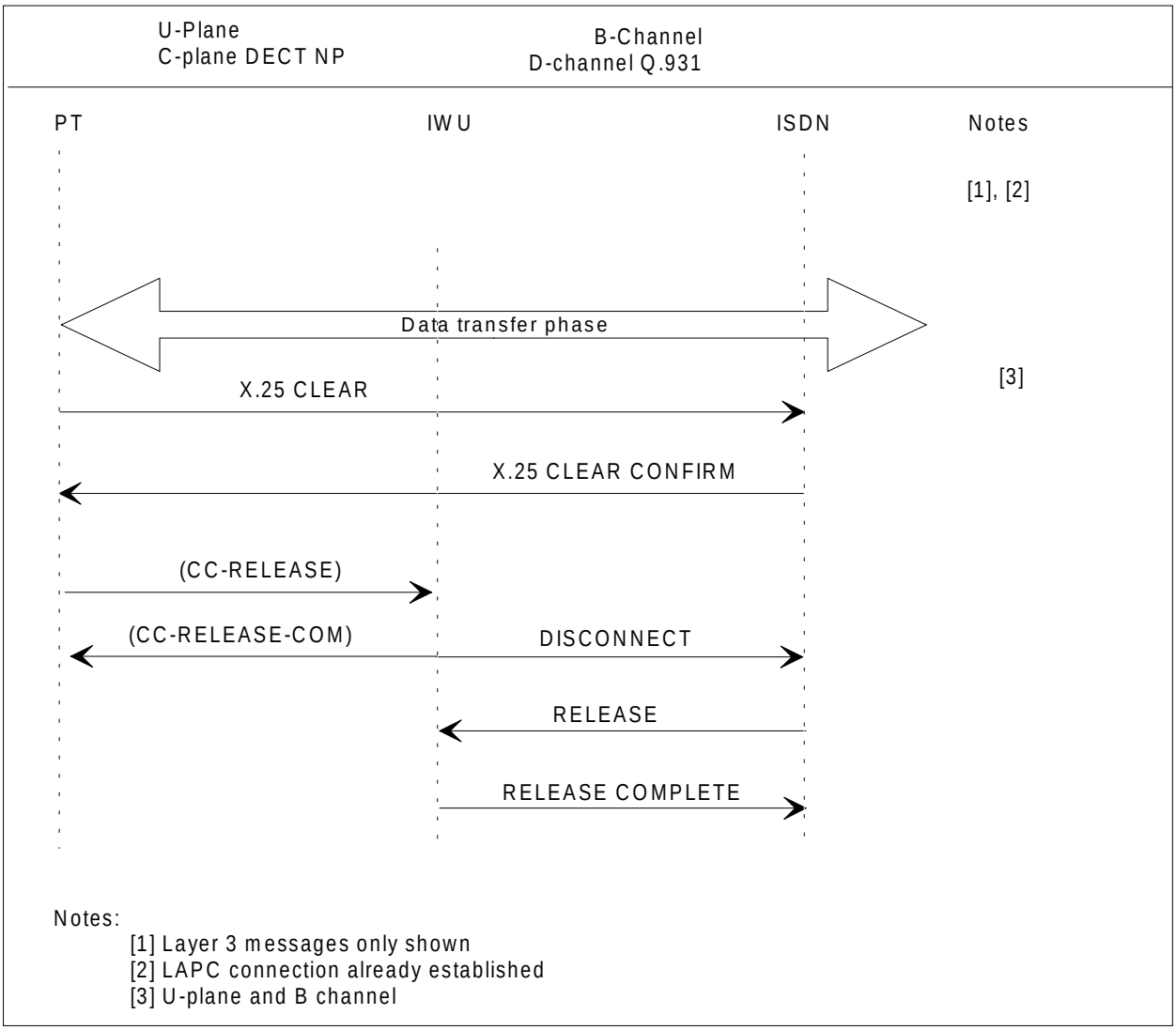
PT Originated Call
ISDN/PSPDN Interworking, Circuit-Switched B-Channel Access

Figure 5.1/IWP(6)



PT Terminated Call
ISDN/PSPDN Interworking, Circuit-Switched B-Channel Access

Figure 5.2/IWP(6)



PT Cleared Call
ISDN/PSPDN Interworking, Circuit- Switched B-Channel Access
last virtual call cleared in this channel

Figure 5.3/IWP(6)

7.9.7 PSPDN DATA

For further study

7.9.8 PSPDN DATA WITH PAD ACCESS

For further study

7.9.9 GSM PLMN (A INTERFACE) - TELEPHONY

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Contents

1 General

1.1 Scope

The scope of this document is to give guidance with regard to interworking between GSM PLMN and the DECT air interface specification as the point-of-attachment of the DECT fixed network (reference point D1 in the DECT reference model) as the standard GSM A-interface.

In a GSM PLMN/DECT environment the GSM BSS is replaced by a DECT fixed system which emulates the functionality of the BSS.

1.2 Applicability of this IWP

- Attached subnetwork: GSM (A-interface)
- Dedicated PAP (Public Access Profile) Portable Part for incoming calls which has a GSM IMSI and which can calculate a response to a GSM authentication challenge with the standard GSM authentication algorithm and derive the DECT ciphering key from the calculated GSM key.
- DECT environment with access rights type D (GSM Public Access) and/or system with broadcast attributes coding 'SIM Services Available'.
- Circuit-switched access to GSM services - telephony

Refer to the relevant GSM specifications, [142], [143], [144] throughout this IWP.

1.2 Assumptions

From the GSM fixed network point-of-view, the DECT subscriber is a GSM subscriber ie the data structures and functionality in the GSM network are standard GSM (eg IMSI's), but instead of using the GSM air interface (Um) as an access method to the GSM PLMN, DECT CI is used instead.

In this scenario the subscriber has a GSM SIM (ie functionality of a SIM as a detachable module or as hardware in the portable) which normally is used in a GSM portable. When using the DECT air interface as an access method, the same SIM can be inserted into a DECT handset and used there as an authentication module.

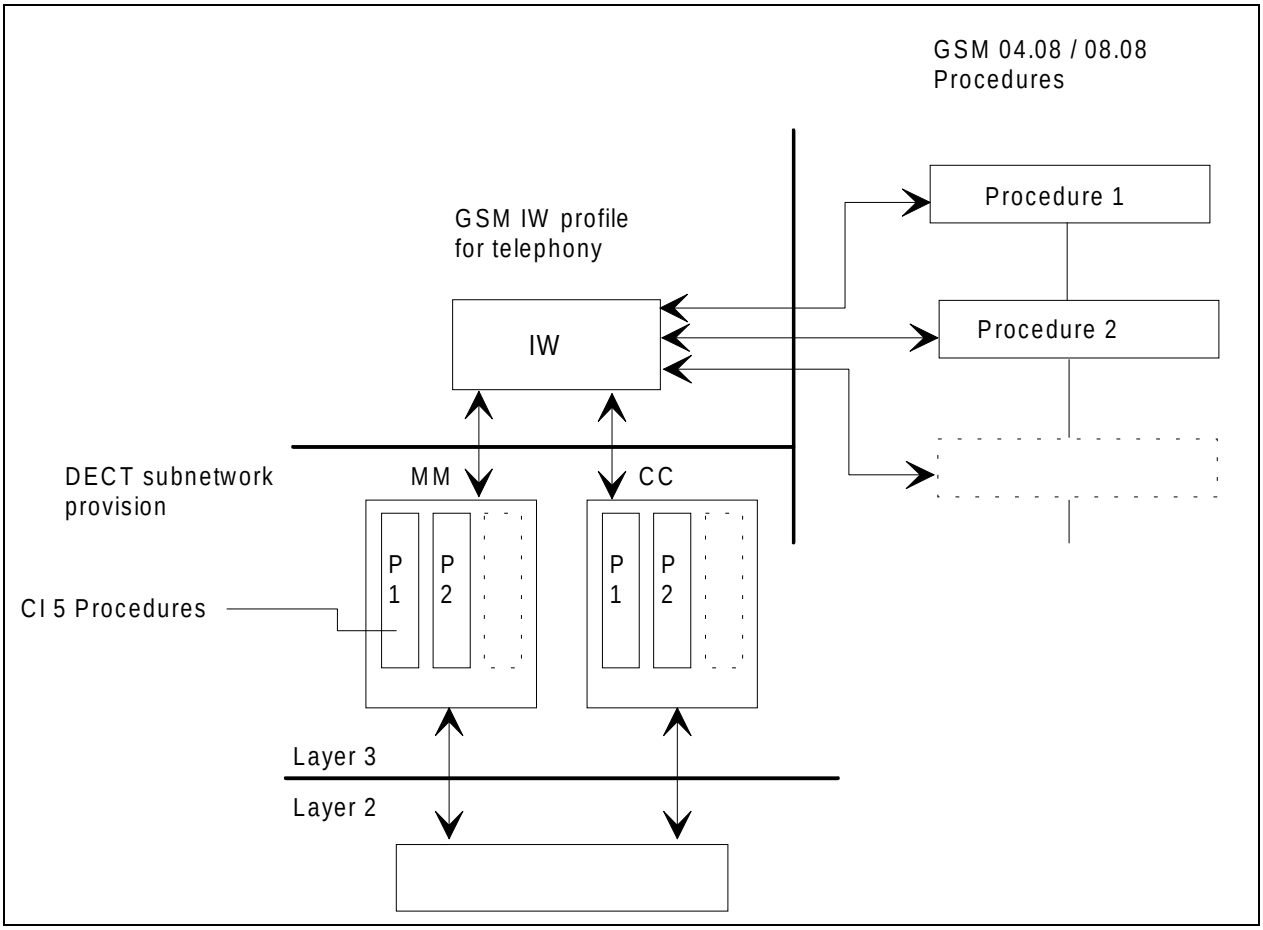
2 C-Plane procedures

2.1 General

All the procedures described in the following chapters are standard DECT procedures which are driven and controlled by the Interworking Unit. The only extra requirement for a portable part compared to the standard DECT Public Access Profile portable for incoming calls is the ability to calculate the response to an authentcation challengewith the standard GSM algorithm and derive the DECT ciphering key from the calculated GSM key with the standard DECT algorithm.

All information elements used are standard DECT. Only the mapping of relevant GSM procedures and GSM specific data to standard DECT procedures and information elements is being presented. Non-relevant GSM procedures (mostly relating to GSM radio resource management) are not described and are considered to be mostly ignored by the IWU.

Note: The use of the GSM IMSI during the call setup, location updating etc implies the use of GSM-specific information elements described in the following.



Mapping of GSM procedures to DECT.
Figure 2.1/IWP(9)

2.2 Call Control interworking procedures

2.2.1 Call establishment procedures

PT initiated call establishment

At this point it is assumed that the location updating procedure has taken place and the GSM specific temporary identity has been allocated to the PT.

Information elements to be inserted in the {CC-SETUP} message by the IW layer 3 entity:

- "PORTABLE IDENTITY" with identity value coding: IPUI-R. GSM IMSI associated to the "NETWORK ASSIGNED IDENTITY" with type coding: TMSI received and stored by the portable at the latest TPUI assignment procedure or location updating procedure in the current DECT location area.

- Optionally with the latest "CIPHER-INFO" stored by the portable due to an earlier transaction.

If {CC-INFO} is being used to convey the called party address, element "sending complete" is interpreted by the IWU that the called party address is complete and can be sent en-bloc to the PLMN.

Relevant information elements are mapped to CM-SERVICE REQUEST and SETUP messages in the A-interface.

FT initiated call establishment

When a GSM specific identity is being received by the PT in a PAGING message from the PLMN, the FT shall initiate a DECT paging procedure using the associated DECT identities due to earlier transactions. The following {CC-SETUP} message sent by the FT to the PT must include the IMSI associated to the identity in the PAGING mesaage (TMSI or IMSI).

2.2.2 Call Release Procedures

Call Release Initiated by FT

On reception of a DISCONNECT message from the PLMN the FT initiates the normal DECT release procedure by sending a {CC-RELEASE} message to the portable. After receiving {CC-RELEASE-COM} the FT responds to the network with a RELEASE COMPLETE message.

Call Release Initiated by PT

On reception of a {CC-RELEASE} message from the PT the FT initiates the GSM call clearing procedure by sending a DISCONNECT message to the network. After receiving RELEASE message from the network as a response to the DISCONNECT message the FT responds to the PT with a {CC-RELEASE-COM} message and sends a RELEASE COMPLETE message to the network.

2.3 Mobility Management interworking procedures

2.3.1 Identity procedures

Procedure for GSM TMSI assignment

In addition to possible other temporary identity allocations for the portable, the FT must always perform a temporary identity assignment procedure after receiving a GSM TMSI (in a TMSI allocation procedure taking place in the A-interface) by sending the TMSI transparently in the “Network Assigned Identity” element with Identity Value coding TMSI to the portable in the {TEMPORARY IDENTITY ASSIGN} message.

When the PT receives the corresponding “Identity” the portable has to store and use it the way the PAP defines.

Procedure for identification of PT

After receiving an identity request message from the MSC the FT must perform the corresponding identity request procedure with the respective “Identity Type” group coding using:

i) Portable Identity of type IMSI
ii) Network Assigned Identity for the TMSI
iii) Portable Identity of type IPEI for the IMEI

Note: IPEI to IMEI mapping has to be done in the IWU due to the differing number structures.

The corresponding identity must be sent by the portable in the {IDENTITY REPLY} message as defined in CI5.

2.3.2 Authentication Procedures

Authentication of a PT

Upon receipt of an authentication request from the MSC the FT sends a {AUTHENTICATION-REQUEST} message to the PT including.

- "Cipher-Info" corresponding to the GSM parameters

- "AUTH-TYPE" ='GSM', information element must be included in both: {AUTHENTICATION-REQUEST} and {AUTHENTICATION-REPLY} messages.

Upon receipt of an {AUTHENTICATION-REQUEST} message with information element "AUTH-TYPE" ='GSM' included, the PT must calculate the response "RES" with standard GSM authentication algorithms.

A GSM specific ciphering key Kc is calculated as a result of the GSM-authentication to be used by the DECT ciphering machine. The DECT ciphering key is derived from the Kc with a standard algorithm.

2.3.3 Location procedures

As a result of reception of a {LOCATE-REQUEST} message from the PT which includes:

- "Network Assigned Identity" (GSM specific) which the handset was using in the previous DECT system which is attached to the GSM network.

- LOCATION AREA IDENTIFICATION (defined by GSM 04.08) which was received from the previous DECT system which is attached to the GSM network is mapped transparently to "Location Area" in the EXTENDED LOCATION INFORMATION field.

- "Ciphering-Info" with the last stored GSM cipher key sequence number.

FT responds with a {LOCATE ACCEPT} message including:

- Current LOCATION AREA IDENTIFICATION (defined by GSM 04.08) mapped to "Location Area" element which is stored by the portable.

It is also possible to perform a TMSI assignment procedure during location updating procedure by inserting the same information elements in the {LOCATE ACCEPT} message as used in the temporary identity assignment procedure

3 U-Plane procedures

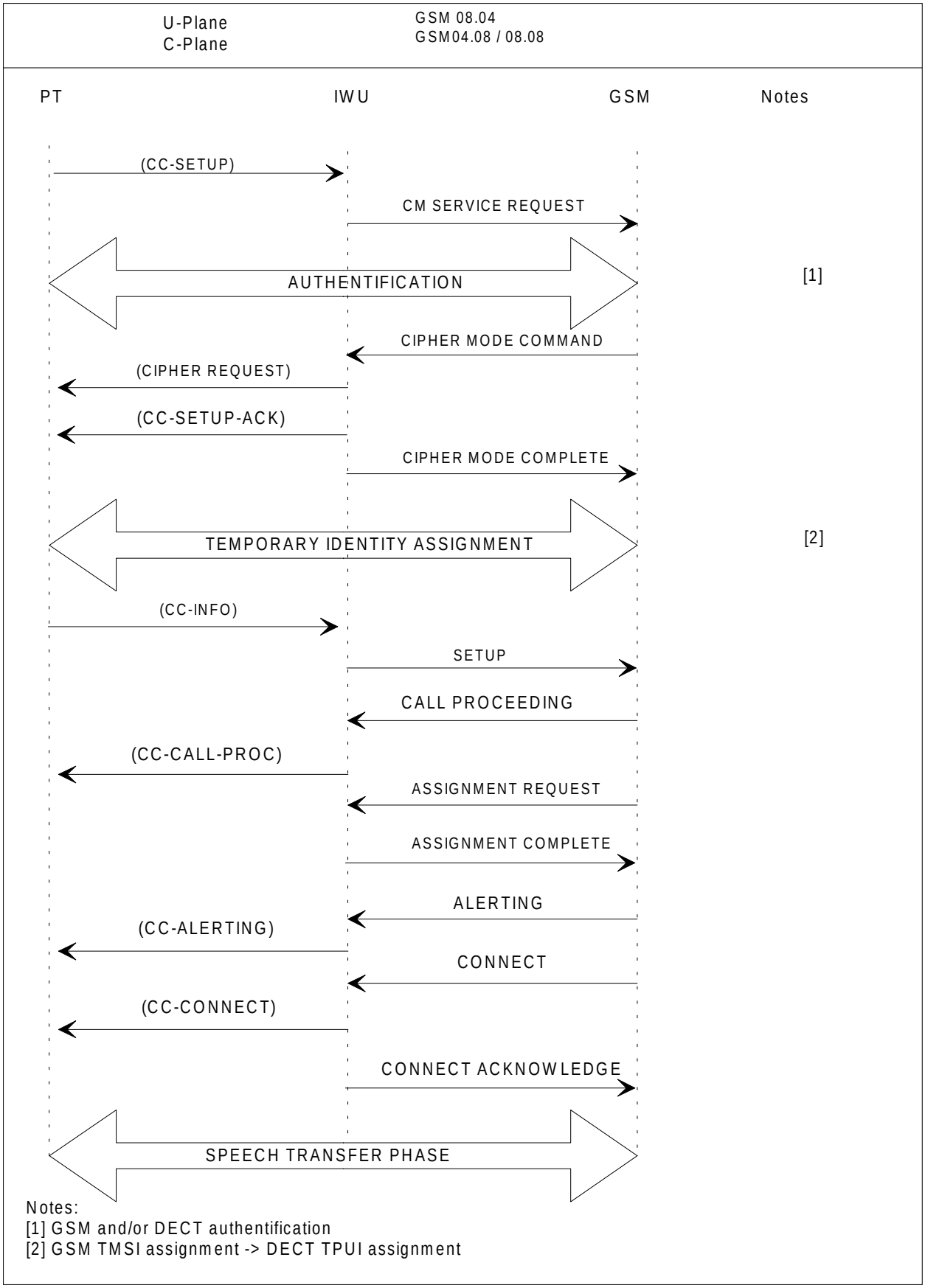
The LU1 service is used by DECT. The U-plane is established according to normal DECT CC procedures defined for LU1.

4 Process Applicability

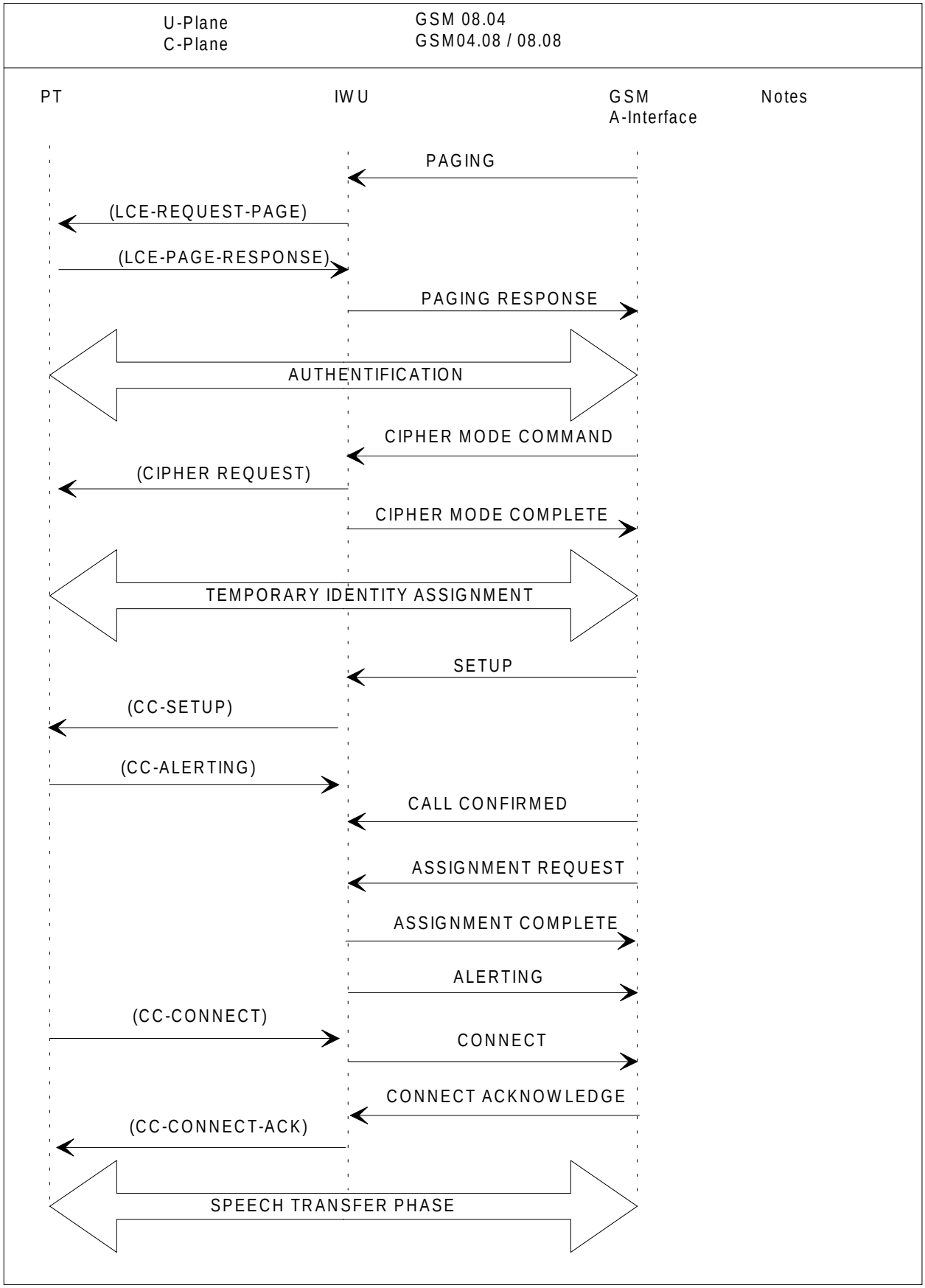
[For further study]

5 Message Sequence Examples

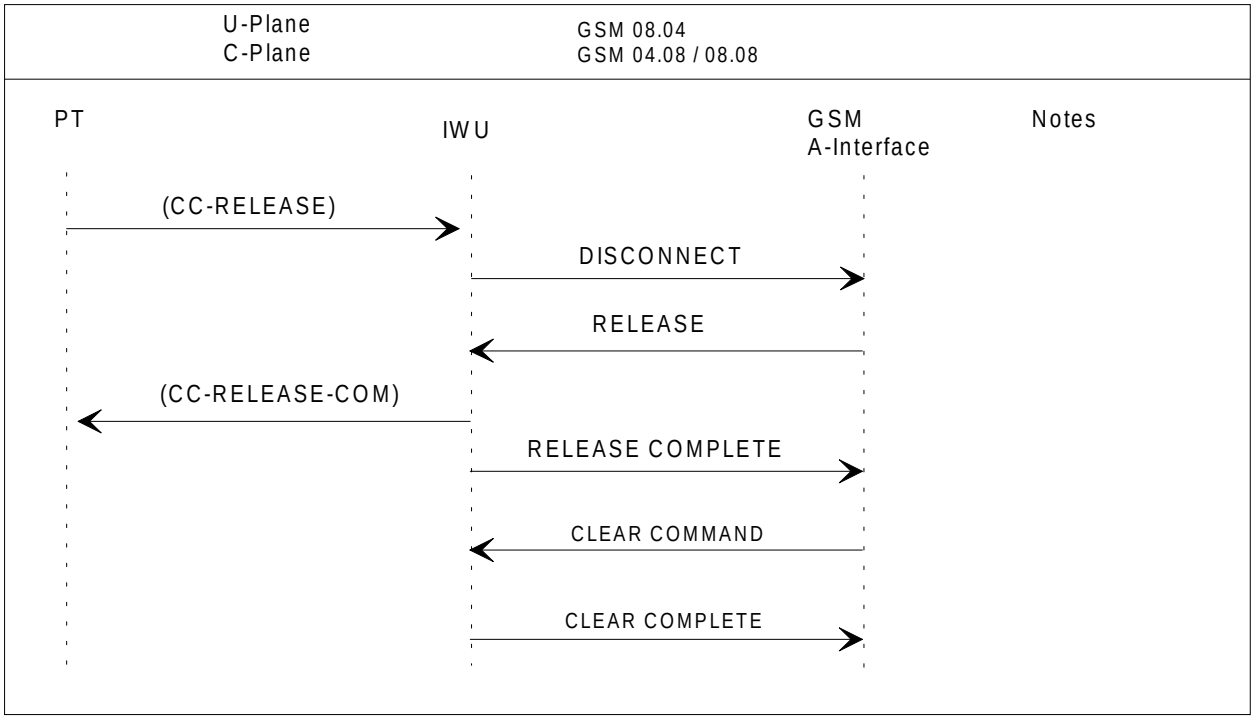
Figure 5.1/IWP(9)	PT Originated Call
Figure 5.2/IWP(9)	PT Terminated Call
Figure 5.3a)/IWP(9)	Call Release, PT Clears
Figure 5.3b)/IWP(9)	Call Release, FT Clears
Figure 5.4/IWP(9)	Location Registration



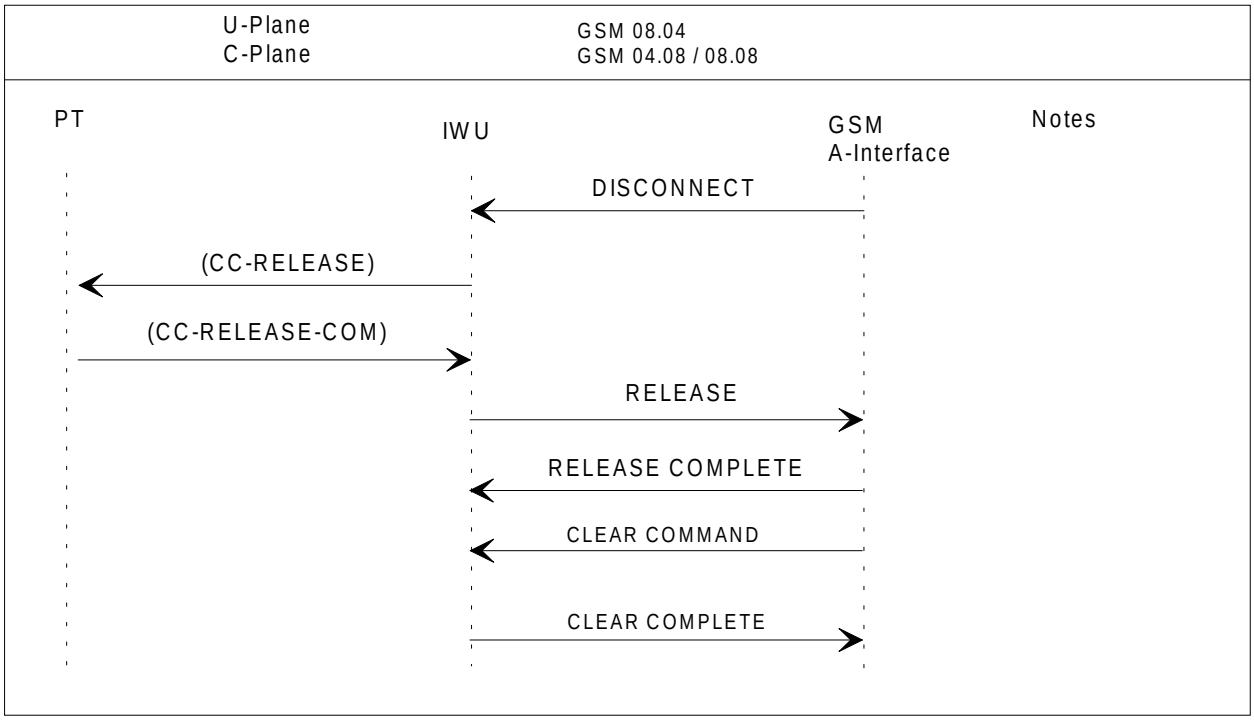
PT originated call
Figure 5.1/IWP(9)



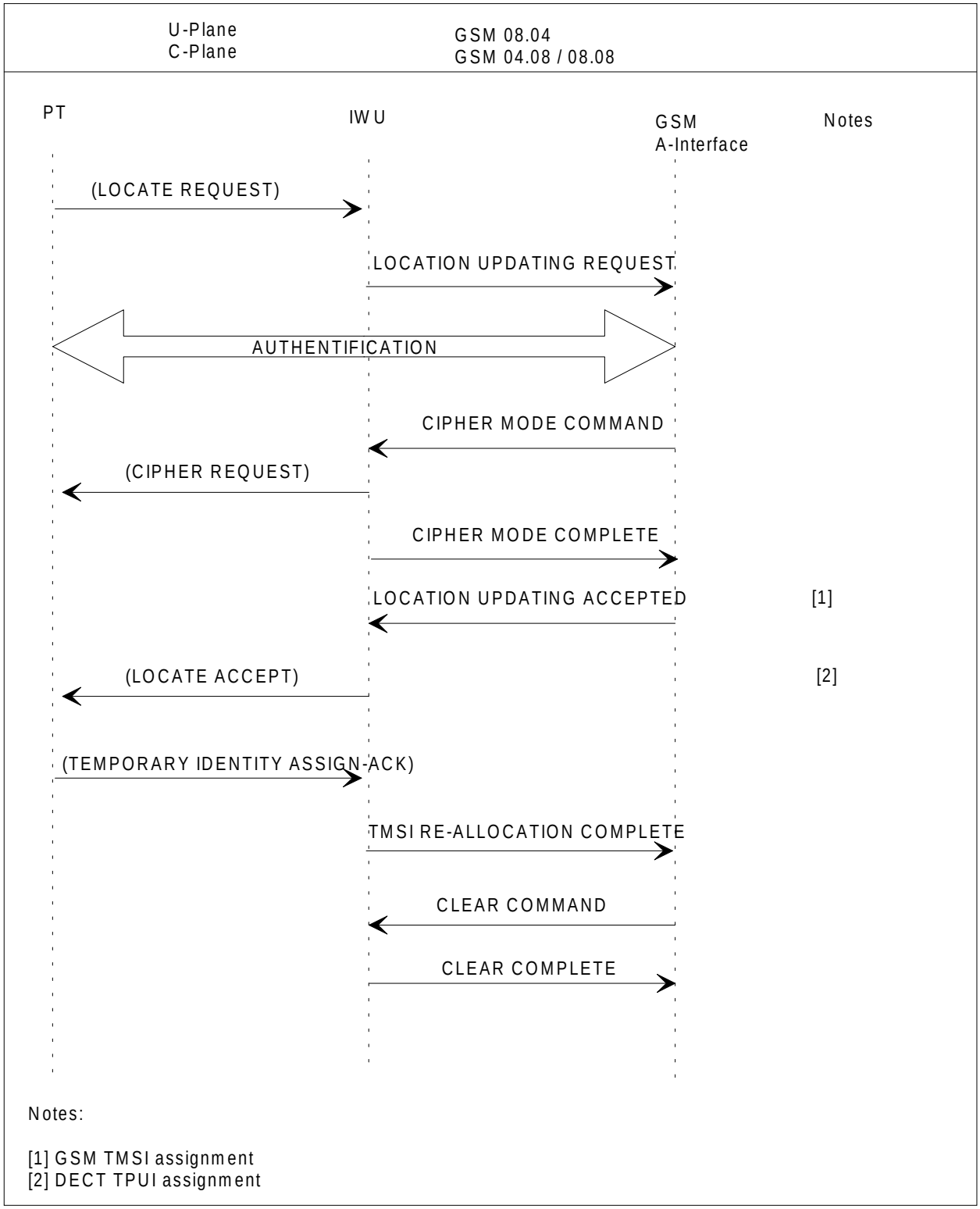
PT terminated call
Figure 5.2/IWP(9)



a) PT clears



b) FT clears
Call Release
Figure 5.3/IWP(9)



Location Registration
Figure 5.4/IWP(9)

6 Mapping

6.1 Information elements

GSM LOCATION AREA IDENTIFICATION ([LAI] defined by GSM 04.08)

-> “Location request”, EXTENDED LOCATION AREA INFORMATION field
-> {LOCATION-REQUEST}, {LOCATION-ACCEPT}

GSM MOBILE IDENTITY (defined by GSM 04.08)

i) IMSI: “Portable Identity” with value coding for the IMSI
-> {CC SETUP}, {LOCATE ACCEPT}, {IDENTITY REPLY}

ii) TMSI: “Network Assigned Identity” with type coding for the TMSI
-> {TPUI ASSIGN}, {LOCATE ACCEPT}, {IDENTITY REPLY}

iii) IMEI: “Portable Identity” with value coding for the IPEI
{IDENTITY REPLY}

GSM CIPHER KEY SEQUENCE NUMBER
-> “Ciphering-Info” cipher key type coding: static
cipher key sequence number: equivalent to GSM
DECT ciphering key is a derivative of GSM ciphering key Kc.

6.2 Error handling and cause codes

[For further study]

7.9.10 GSM TELEPHONY - Um Interface

[213]

Contents

1 General

One of DECT's basic capabilities in the public environment is tandem use with other mobile systems. In other words DECT *mobile* base stations have to be specified. This capability can be offered if interworking with the GSM air interface is made possible. GSM can offer mobility features to the DECT base station necessary for (limited) DECT service provision in trains and other mobile environments. In this document it will be described how this type of interworking can be accomplished.

Applicability of this IWP:

- Attached subnetwork = GSM
- Attachment at Um interface
- Telephony and low speed data applications
- DECT single cell systems

The IWU needs to support the following processes:

- IWF Selection
- Interworking Authentication Exchange
- End-to-End Compatibility
- Supplementary Service Interworking
- Queue Control (optional)
- Routing
- Relaying

and the following functions (IWFs):

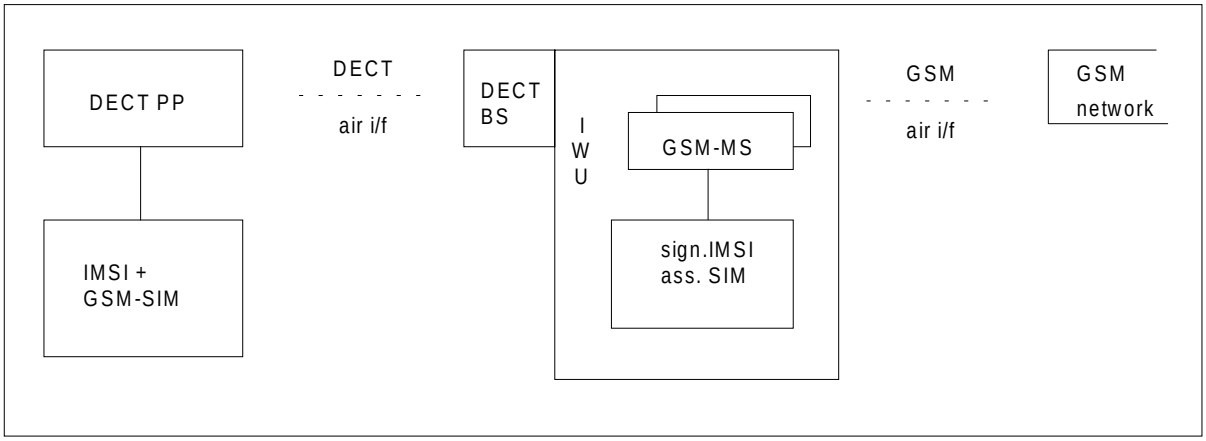
- GSM/Telephony
- U-plane Relaying

The interworking unit (IWU) is located in the mobile base station. From the point of view of DECT, it is a special base station, from the point of view of GSM, it is a GSM mobile station. The IWU will establish calls on the GSM radio interface based on the service requirements requested by the DECT user. Three separate cases are distinguished here:

- Bidirectional mobile `telepoint' (multi-access)
- Unidirectional mobile `telepoint' (multi-access)
- Bidirectional private mobile base station (single-access, e.g. DECT access to GSM mobile station in a car).

1.1 Case 1: Bidirectional mobile `telepoint'

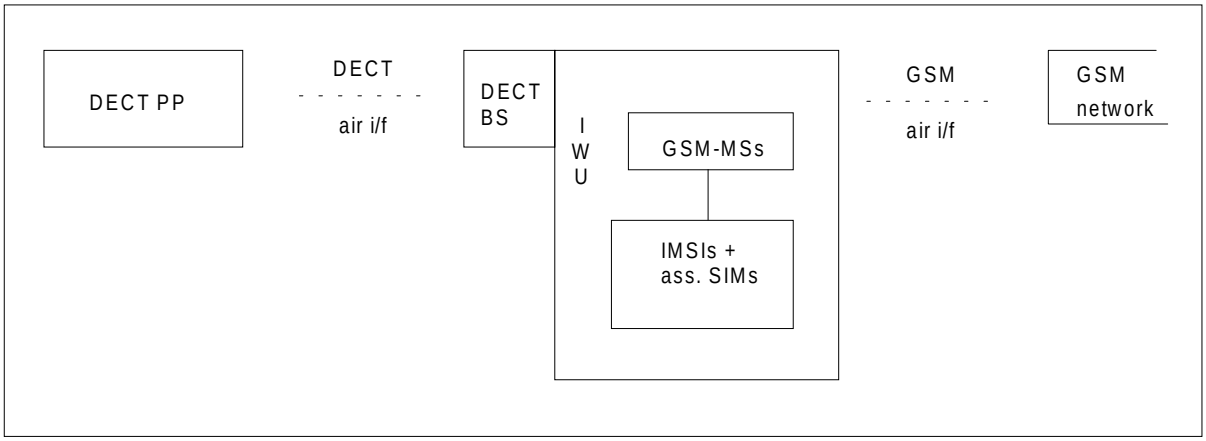
- The DECT subscriber is known as a GSM subscriber (the subscriber has an IMSI).
- The DECT subscriber is in possession of a GSM-SIM.
- Authentication will be performed by GSM.
- The calculated ciphering key will be used on the GSM air interface.
- Optional DECT security processes require that DECT parameters are available in or obtainable by the IWU (by using a special signalling IMSI + SIM).
- A DECT ciphering key will be used on the DECT air interface.
- Both ciphering keys have to be known by the IWU in the mobile base station.
- Incoming and outgoing calls are possible.



Model of case 1 interworking
Figure 1.1/IWP(10)

1.2 Case 2: Unidirectional mobile `telepoint'

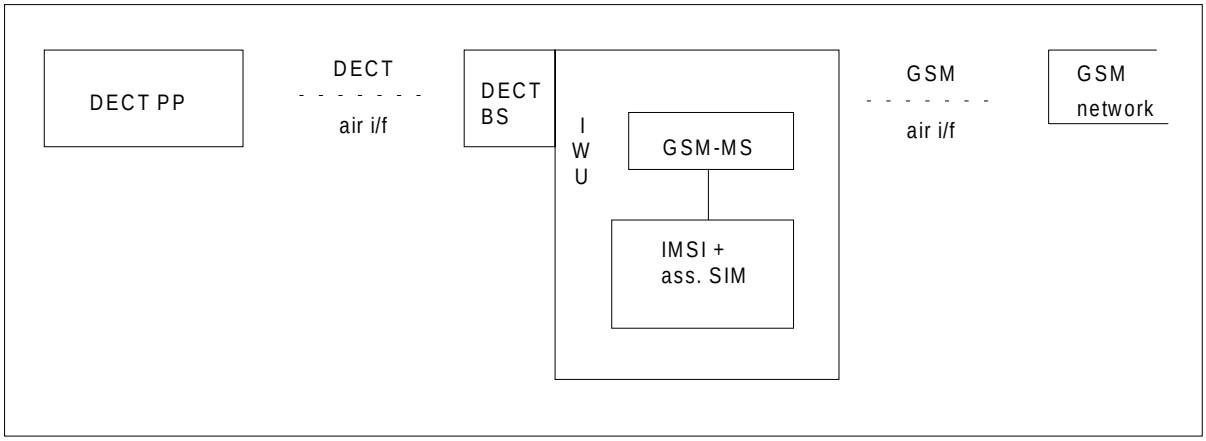
- The DECT subscriber is not a GSM subscriber.
- IMSIs will be assigned on demand from an IMSI pool by the IWU in the mobile base station.
- DECT parameters are available in or obtainable by the IWU in the mobile base station for DECT air interface protection.
- Only outgoing calls are possible.



Model for case 2 interworking
Figure 1.2/IWP(10)

1.3 Case 3: Bidirectional private mobile base station

- Logically: a mobile residential base station
- The DECT mobile base station is a GSM mobile station with one IMSI.
- Only the DECT subscriber whose parameters are stored at the GSM mobile station site can have access to the mobile station.
- Incoming and outgoing calls to the GSM mobile station and subsequently to the DECT portable are possible since relation IPUI-IMSI is static.



Model for case 3 interworking
Figure 1.3/IWP(10)

2 C-Plane Procedures

C-plane procedures are used to select the appropriate IWFs (InterWorking Functions) and to establish and control a connection between the PP and the IWU. The IWFs are chosen based on the attributes of the requested service (e.g. speech, data up to 9600 bps).

2.1 Outgoing Calls

Upon monitoring the broadcast information from the mobile base station, the PP establishes a LAPC connection with the IWU and sends a {CC-SETUP}-message plus IPUI. If the setup message does not contain any address information, a {CC-SETUP-ACK}-message will be returned and address information transferred by the PP to the IWU (in piecewise-sending-mode) will have to be buffered in order to send it en-block over the GSM air interface. If the DECT parameters for the submitted IPUI are not available, the IWU will setup a communication link (using a special IMSI for this purpose) through the GSM network to a DECT database for parameter retrieval purposes (only in case 1 and 2).

Upon retrieval of the DECT parameters, the DECT authentication process starts in order to authenticate the IPUI and to initiate the encryption of the DECT radio link.

2.1.1 Case 1:

Depending on the status of the Mobility Management state machine for the IMSI extracted from the IPUI (this status is known by the IWU), the IWU will initiate the GSM location updating procedure for this IMSI prior to sending a {CC-SETUP}-message to GSM.

The GSM authentication starts. The messages associated with this authentication process will be relayed to the DECT portable part. This PP uses these messages and the GSM-SIM to respond and to calculate a GSM ciphering key. The authentication result will be relayed back to GSM. GSM sends a CIPHER MODE COMMAND message in order to start the encryption process. The IWU will translate this command into a request for the calculated GSM ciphering key. However, in order to ensure that the CIPHER MODE ACKNOWLEDGE message reaches GSM in time (the associated GSM timer may not expire), this key may be requested right after the authentication response has been relayed. The PP will send the session key (calculated in the GSM authentication process) to the IWU via the protected DECT radio link. The IWU sends a {cipher mode acknowledge}-message to GSM.

To decrease the call setup delay, the GSM location updating procedure may be initiated during the DECT parameter retrieval process, however, we have to ensure that if the CIPHER MODE COMMAND message arrives, the IWU will be able to send an acknowledgement within expiry of the associated GSM counter. This means that (DECT authentication,) DECT encryption, GSM authentication and GSM session key transfer and cipher mode acknowledgement have to be completed before timer expiry.

2.1.2 Case 2:

Upon successful authentication, the IWU will select an IMSI from an IMSI pool that has been assigned previously to the IWU site, and uses this IMSI to request a GSM service (after location updating or IMSI attach). GSM will authenticate this IMSI and GSM encryption starts. The IWU will need to have the SIM associated with the IMSI.

2.1.3 Case 3:

The DECT parameters are already at the mobile (base) station site, no signalling IMSI is needed for parameter retrieval. The DECT radio link can be setup in the same manner as for residential environments. The IWU has only one IMSI to choose from, so this one will be used on the GSM air interface. Normal GSM procedures can start from here.

At this point GSM may decide to reallocate a TMSI. The IWU translates this TMSI into a TPUI. Now the portable is ready to make an outgoing call.

2.2 Incoming calls

Incoming calls only apply to case 1 and 3 if a location registration procedure has been performed and the IMSI is still attached. The IWU can initiate automatically GSM location updates, the PP does not have to get involved. The PP will only notice in case 1 that for each location update it is requested to authenticate itself.

If a call arrives for a particular IPUI/IMSI, a PAGING message (with TMSI) arrives in the IWU from the GSM network. The IWU translates this message into a {LCE-request-page}-message (with TPUI). The PP responds and the IWU will translate this DECT response into a GSM response, after a DECT authentication procedure, and the GSM authentication process starts.

In case 1 the IWU will relay the associated messages and, upon receipt of a {cipher mode command}-message, will request the GSM ciphering key from the PP.

Once both radio links are protected, the call can be routed to the portable.

2.3 Release

2.3.1 Case 1 / 3:

If the IWU receives a {CC-RELEASE} message from the PP, this request will be relayed to GSM. If no incoming calls are queued, GSM will release the link. After that the IWU will release the link with the PP.

If the PP does not want to receive incoming calls (his service request did not consist of a {LOCATE REQUEST} message), he can either perform a detach himself or this detach could be performed automatically by the IWU. These actions are required since GSM makes no distinction between registration for outgoing calls and registration for incoming calls.

2.3.2 Case 2:

If the IWU receives a {CC-RELEASE} message from the PP, it will relay this request (after sending a {DETACH} message} to GSM provided that no other PPs require capacity on the GSM radio interface. Otherwise the IMSI will be allocated to a different IPUI, and the GSM MM-link can be maintained. In any case, the IWU will release the link to the original PP.

3 U-plane procedures

In all cases the U-plane will be established according to the call setup attributes that can be provided by a GSM link: one telephone channel or data up to 9600 bit/s.

The 32 kbps ADPCM voice channel has to be translated into the 13 kbps RPE-LTP (Regular Pulse Excited - Long Term Prediction) channel.

The DECT framing structure will have to be mapped onto the GSM framing structure as far as user data is concerned.

4 Process applicability

4.1 IWF Selection

The PP is aware of the fact that only GSM services can be offered (from monitoring the RFPI: ARC D). Depending on the service requested (speech, or data) the right interworking functions will be selected by the IWU. So the IWU chooses the IWFs according to the service requested. Requests for services exceeding the GSM-capabilities can be rejected by the application process in the PP or the IWU in the mobile base station.

Since the tandem use of GSM can result in additional call setup delay it is advisable to inform the handset of call progress. For instance the portable could be informed about the parameter retrieval process.

4.2 Interworking Authentication Exchange

The following only applies to case 1, in case 2 and 3 the GSM authentication procedure does not require the PP to be involved:

The GSM authentication procedure will be performed transparently through the IWU. However, the IWU may need to do some reformatting. Since the portable has an IMSI with associated SIM with it, requests (RAND) will be directed right to the portable . The portable will calculate a session key and a response (SRES). The SRES will be sent to the GSM network.

The GSM network will then respond with a CIPHER MODE COMMAND message. This triggers the IWU to send a {send GSM key}-message, or equivalent, to the portable. The portable will send the session key.

4.3 End-to-End Compatibility

In GSM (hence also in the IWU) three different processes of compatibility checking shall be performed:

- at the user-to-network interface on the calling side (this includes CM SERVICE REQUEST checking as far as subscription is concerned, and SETUP checking based on the service request).
- at the network-to-user interface on the called side (this includes examination of address information and whether bearer capabilities are matching).
- user-to-user compatibility checking (based on information contained in the `High layer compatibility' and `Low layer compatibility' information elements in the {setup} message).

4.4 Supplementary Service Agreement

GSM can only support DECT supplementary services as far as they are also available in GSM. The IWU will translate stimulus or functional messages for the activation of supplementary services into GSM SS-activation messages.

4.5 Queue Control

Since it can be envisaged that only a number of interworking units are available in case 1 and 2, some form of queue control could be implemented. If a call is queued, the parameter fetching process may already start.

This queue control could for instance consist of `automatic call back' procedures.

In case 2 upon releasing an IMSI for a specific PP, the GSM MM-connection could be maintained for queued requests from other PPs.

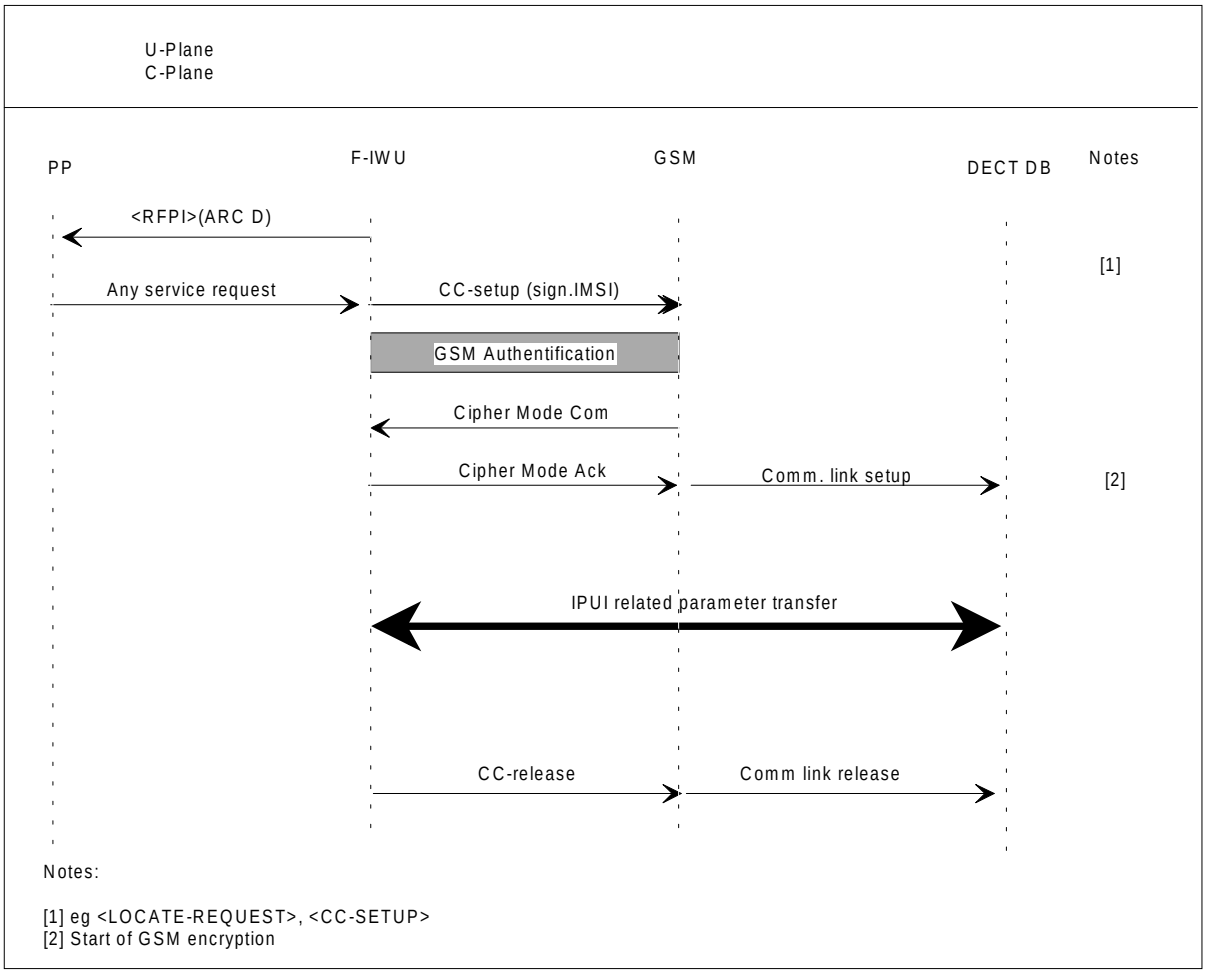
4.6 Routing

[For further study]

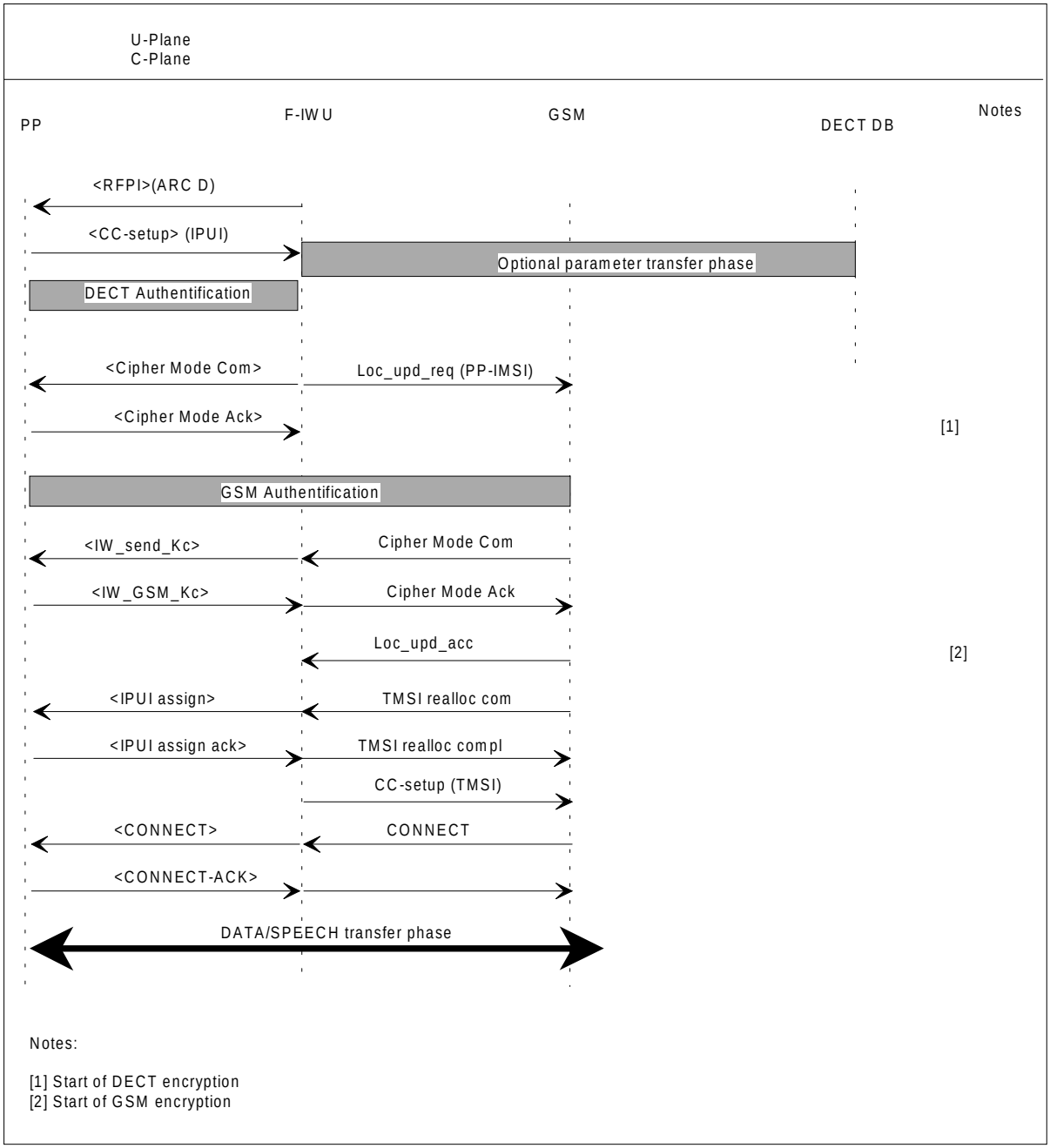
4.7 Relaying

[For further study]

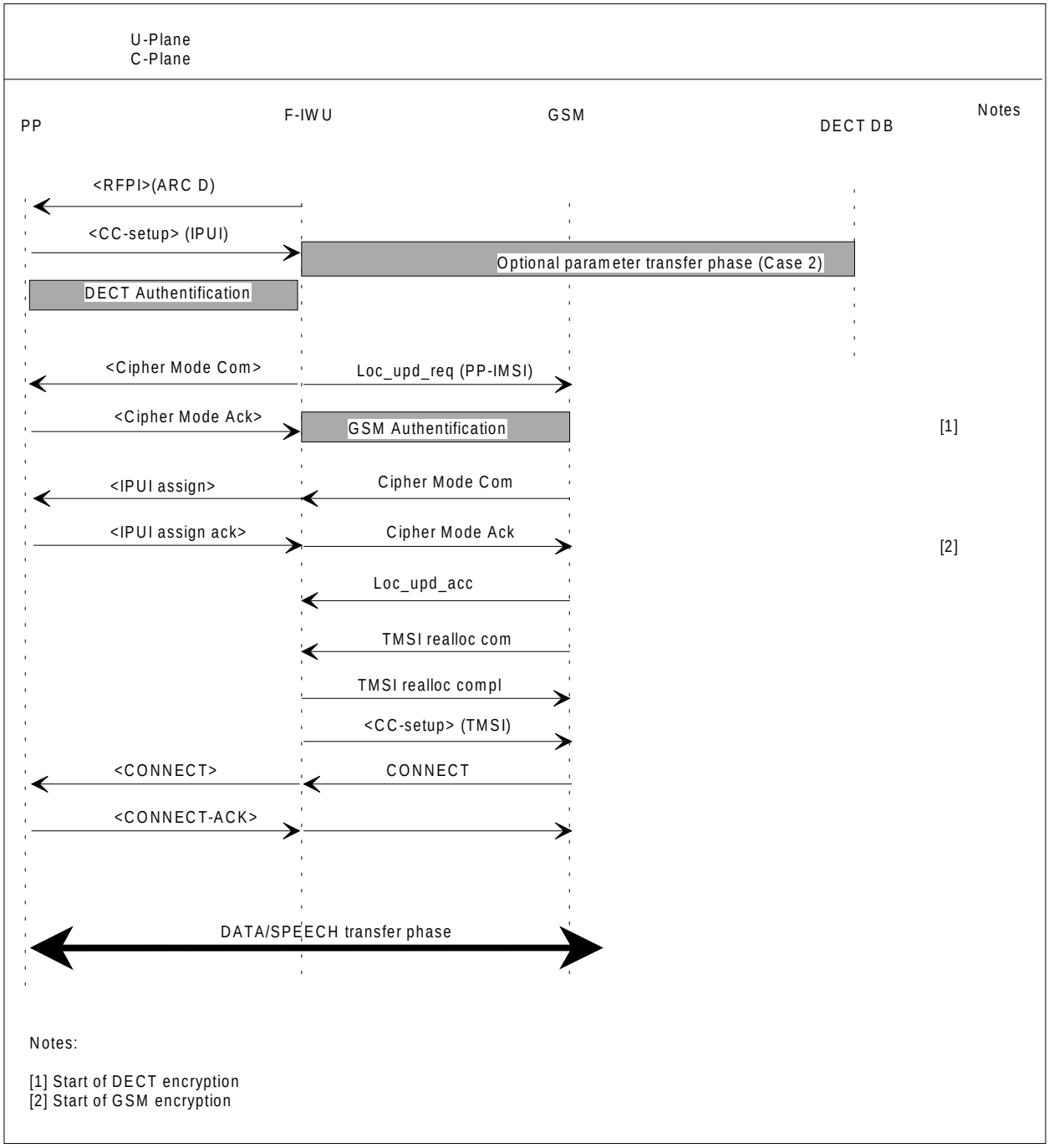
5 Message sequences



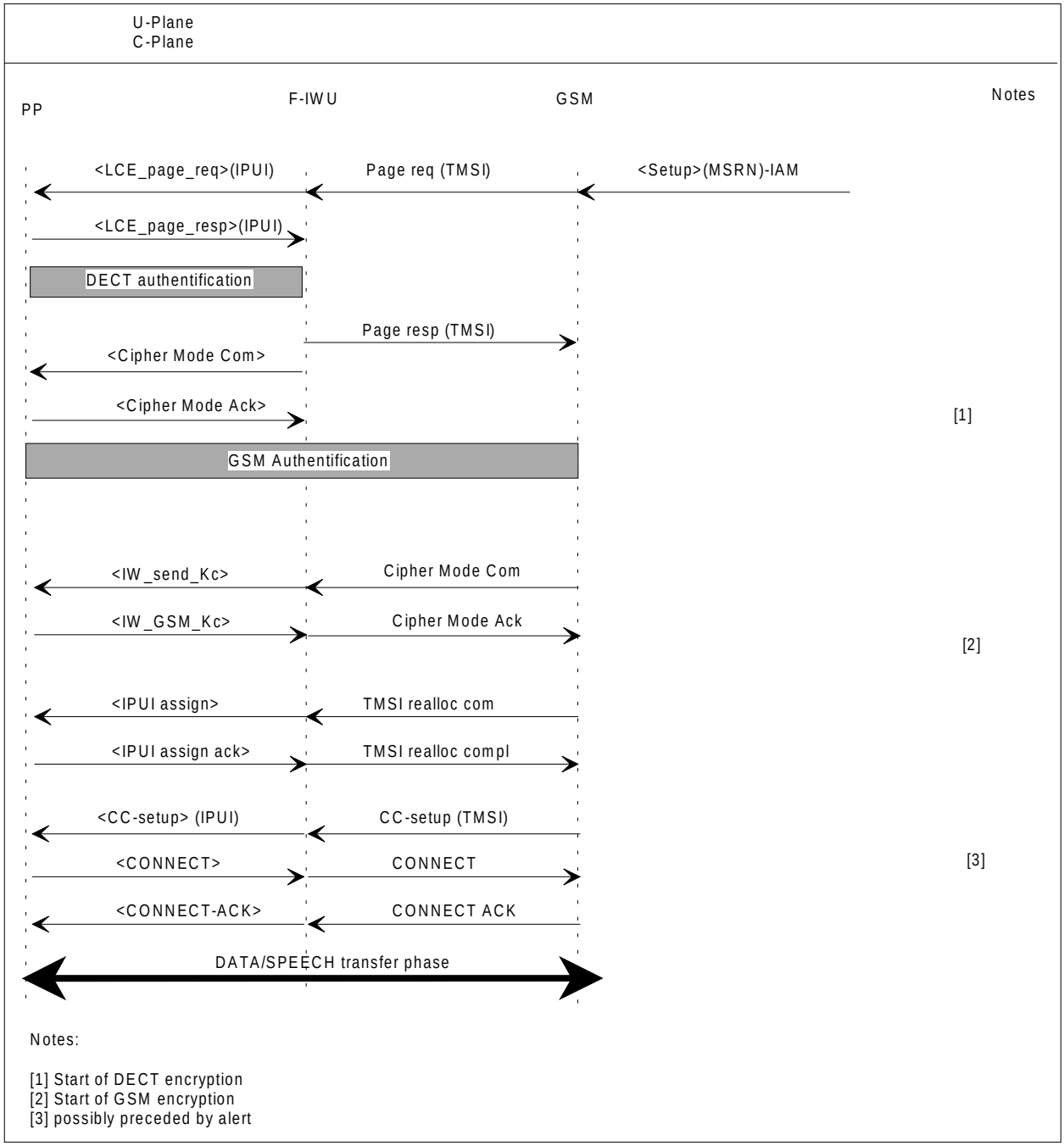
DECT Parameter Transfer in Cases 1 and 2
Figure 5.1/IWP(10)



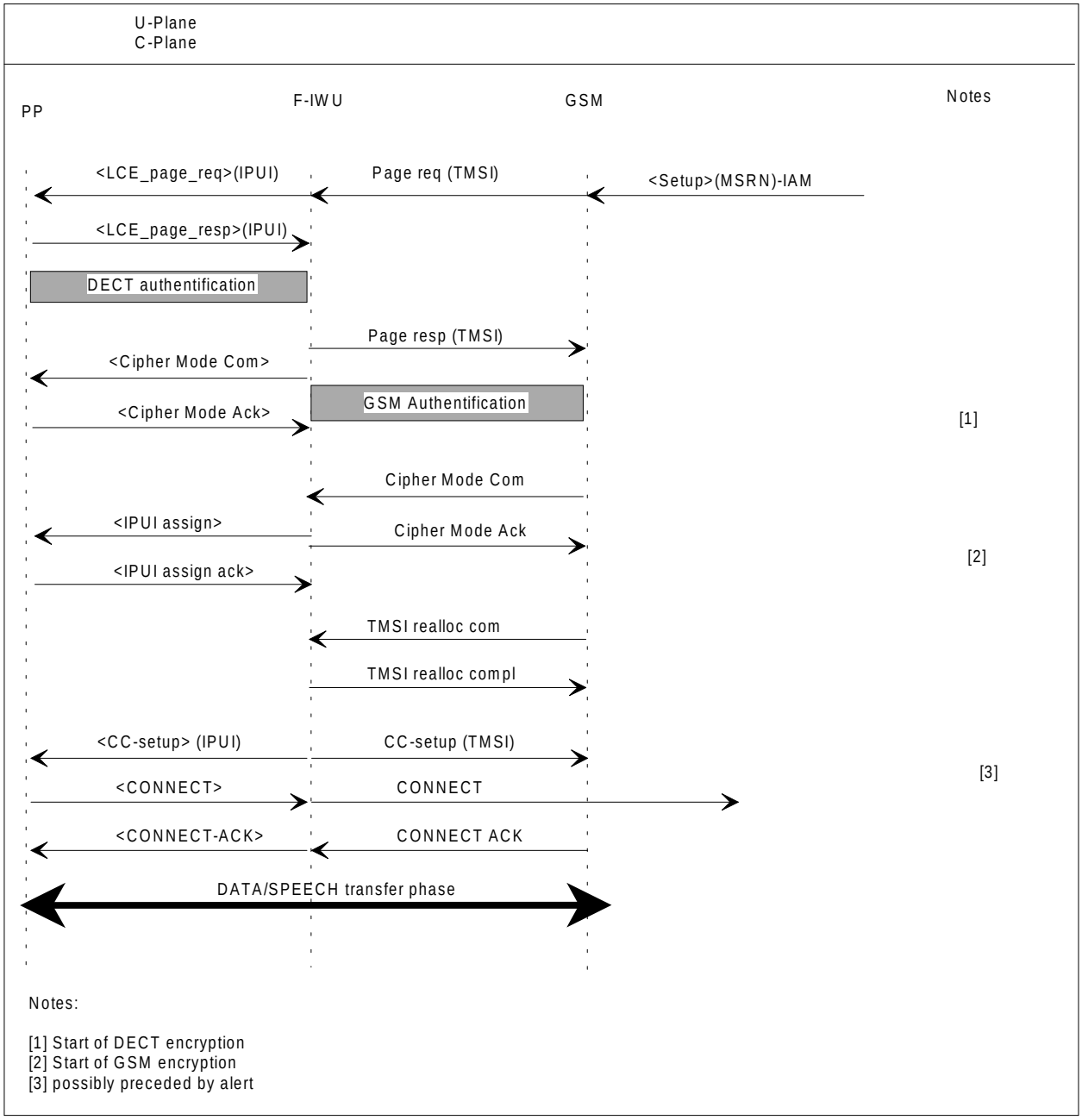
Outgoing Call Setup in Case 1
Figure 5.2/IWP(10)



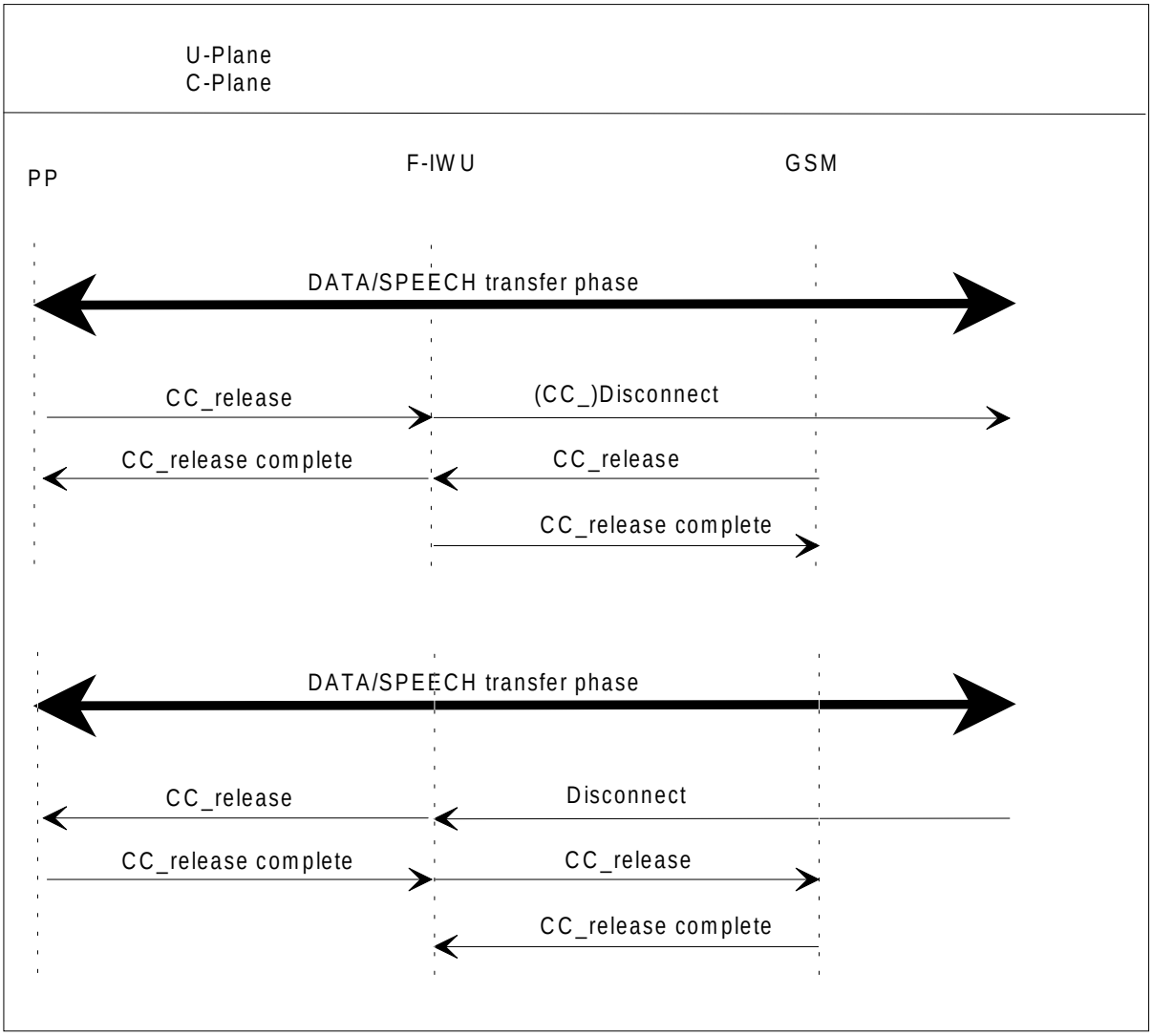
Outgoing Call Setup in Cases 2 and 3
Figure 5.3/IWP(3)



Incoming Call Setup in Case 1
Figure5.4/IWP(10)



Incoming Call Setup in Case 3
Figure 5.5/IWP(10)



Release Procedures: PT and FT Initiated
Figure 5.6/IWP(10)

6 Mapping of NWL messages

Case 1 only is marked with `*'. Only the information elements of messages that need to be interworked are shown.

6.1 Mapping of GSM RR-messages

DECT PP **DECT BS-IWU-GSM MS** **GSM network**

<-- **RR-additional assignment**
<-- **RR-immediate assignment**
<-- **RR-immediate assignment extended**
<-- **RR-immediate assignment reject**
<-- **RR-ciphering mode command** (cipher mode setting)
* <-- **MM-cipher request** (cipher info, conn.id., IWU-to-IWU)
* --> **A MAC cipher related message** --> **RR-ciphering mode complete**
<-- **RR-assignment command**
--> **RR-assignment complete**
--> **RR-assignment failure**
<-- **RR-handover access**
<-- **RR-handover command**
--> **RR-handover complete**
--> **RR-handover failure**
<-- **RR-physical information**
<-- **RR-channel release**
<-- **RR-partial release**
--> **RR-partial release complete**
<-- **RR-paging request type 1-3 (TMSIs, mobile identities)**
<-- **LCE-request page** (long address, short address)
--> **LCE-page response** (idents, cipher info)
--> **RR-paging response** (ciph. key seq. nr., MS classm. 2, mob.ident.)
<-- **RR-system information type 1,2,4,5**
<-- **On NT /QT broadcast channel** <-- **RR-system information type 3,6** (cell id., LAI, control ch.descr., cell options, cell select.pars, RACH control pars, PLMN permitted)

<-- **RR-channel mode modify**
--> **RR-channel mode modify acknowledge**
--> **RR-channel request**
--> **RR-classmark change**
<-- **RR-frequency redefinition**
--> **RR-measurement report**
<-- **RR-synchronization channel info.**
<-> **RR-RR-status**

6.2 Authentication procedures

<-- **MM-authentication request** (ciphering key seq nr.,RAND)
* <-- **MM-auth. req.** (type,RAND,ciph.info,[IWU-to-IWU])
* --> **MM-auth. reply** (RES,key,[IWU-to-IWU])
--> MM-authentication response (SRES)
possible answer:
<-- MM-authentication reject
* <-- **MM-auth. reject** (type, reject reason)

6.3 Identification procedures

<-- **MM-identity request** (ID_type)
* <-- **MM-identity request** (identity type:GSM)
* --> **MM-identity reply** (GSM-identity)
--> **MM-identity response** (mob.ident.)

<-- **MM-TMSI reallocation command** (LAI, mobile id.)
<-- **MM-TPUI assign** (identity,GSM ident., more data)
--> **MM-TPUI assign ackn**
--> **MM-TMSI reallocation complete**
<-> **MM-MM-status** (reject cause, control state)

6.4 Location registration related

* --> **MM-locate request** (idents,more data,LA,ciph.inf.)

--> **MM-location updating request** (loc.upd.type, LAI,MS classm.1,mob.id.)
<- Authentication procedure ->
<- TMSI-reallocation procedure or implicit in: ->
<-- **MM-location updating accept** (LAI, TMSI/IMSI)
* <-- **MM-locate accept** (LA, idents,more data)
other answer:

<-- **MM-location updating reject** (reject cause)
* <-- **MM-locate reject** (reject reason)
* --> **MM-detach** (identity) --> **MM-IMSI detach indication** (MS classm. 1, mob.ident.)

- automatic location update generated by IWU: -
--> **MM-location updating request** (loc.upd.type, LAI,MS classm.1,mob.id.)
* <-> - involvement of PP - <-> Authentication procedure
<-> TMSI-reallocation procedure or implicit in:
<-- **MM-location updating accept** (LAI, TMSI/IMSI)
* <-- **MM-TPUI assign** (ident -NWK assigned-,more data - GSM LA ?-)
* --> **MM-TPUI assign ackn**

6.5 DECT Terminated Call Establishment (Cases1 and 3)

<-- **CC-setup** (repeat ind., bearer cap., facility, progr.ind., signal, calling party BCD addr., calling party subaddr., called party BCD number, called p.subaddr., repeat ind.,low layer comp., rep.ind., high layer comp., user-user)
<-- **CC-setup** (repeat ind.,IWU attr.,call attr.,ident., more data, called p.nr., called p.subaddr., sending complete, ciph.inf., feature ind., facility, IWU-to-IWU)
possible answers:
--> **CC-release complete** (release reasons, IWU-to-IWU)
--> **CC-release complete** (cause, facility, user-user)
--> **CC-setup ackn** (IWU attr.,call attr.) **MANDATORY answer before T303 (GSM-timer) expiry:**
--> **CC-call confirmed** (rep.ind., bearer cap., cause)
--> **CC-alerting** (conn.id.)
--> **CC-alerting**
--> **CC-connect** (conn.id.,IWU-to-IWU)
--> **CC-connect**
<-- **CC-connect acknowledge**
<-- **CC-connect ackn** (conn.id.,displ.,IWU-to-IWU)

6.6 DECT initiated call control procedures

--> **CC-setup** (repeat ind.,IWU attr.,call attr.,idents., more data, term.cap., called p.nr., called p.subaddr.,sending complete,ciph.inf.,feature act.,facility, IWU-to-IWU)

(<-- **CC-setup ack / notify**) Possible DECT-parameter retrieval using signalling IMSI in case 1 and 2. In case 3
(--> **CC-info** for overl. sending) the DECT-parameters are already available. Optionally followed by DECT security procedures.

establishing the GSM MM-connection:
--> **MM-CM service req** (CM serv.type, ciph.key seq.nr., MS classm.2,mob.id)
<-- **MM-CM service accept / reject** (cause)
--> **CC-(emergency) setup** (repeat ind., bearer cap., mob.id., facility, calling party
(<-- **CC-call proceed.**) subaddr.,called party BCD number,called p. subaddr., repeat ind.,low layer comp., rep.ind.,high layer comp., user-user)

possible answers:
<-- **CC-call proceeding** (rep.ind.,bearer cap., progress ind.)
<-- **CC-call proceed.** (progress ind.,conn.id.,displ.,signal,feature ind.,facility, IWU-to-IWU)

<-- **CC-alerting** (facility,progress ind.,user-user)
<-- **CC-alerting** (conn.id.,displ.,signal,feature ind.,facility,IWU-to-IWU)

<-- **CC-connect** (facility, progress ind.,user-user)
<-- **CC-connect** (progress ind.,conn.id.,displ.,signal,feature ind.,facility,IWU-to-IWU)
MANDATORY answer before T313 expiry:
--> **CC-connect acknowledge**
<-- **CC-progress** (progress ind., user-to-user)
<-- **CC-call proceeding/info** (progress ind., IWU-to-IWU)

6.7 Call clearing procedures

[For further study]

<-- **CC-disconnect** (cause, facility, progress ind., user-user)
--> **CC-release** (cause, facility, user-user)
<-- **CC-release complete** (cause, facility, user-user)
--> **CC-disconnect** (cause, facility, user-user)
<-- **CC-release** (cause, facility, user-user)
--> **CC-release complete** (cause, facility, user-user)

--> **CC-release complete** (release reasons, IWU-to-IWU)
--> **CC-release** (release reasons, IWU-to-IWU)
<-- **CC-release** (release reasons, display, feature ind., facility, IWU-to-IWU)
<-- **CC-release complete** (release reasons, display, feature ind., facility, IWU-to-IWU)

6.8 Miscellaneous CC

<-> **CC-service change** <-> **CC-modify** (bearer cap.,low layer comp., high layer comp.)
<-> **CC-service accept** <-> **CC-modify complete** (bear. cap.,low layer comp., high layer comp.)
<-> **CC-service reject** <-> **CC-modify reject** (bear. cap.,cause,ll comp., hl comp.)
or **IWU-info** <-> **CC-user information** (user-user, more data)
<-> **CC-congestion control** (congestion level, cause)
<-> **CC-notify** (notif. ind.?) <-> **CC-notify** (notification ind.)
<-> **CC-status** (cause, call state)
<-> **CC-status enquiry**

7.9.11 GSM CIRCUIT SWITCHED DATA

For further study

7.9.12 ISO/IEC 8802 LAN

Contents

Figures

1 General

This IWP explains how a DECT subnetwork interworks with a LAN conforming to one of the ISO/IEC 8802 standards for the purpose of supporting packet data communications. Interworking with other LANs should use this profile for guidance. Possible configurations range from simple single cordless drops (figure 1.1/IWP(12)), to multi-terminal attachments and cordless gateways between cabled LANs.

Applicability of this IWP

- Attached subnetwork = ISO/IEC 8802 LAN
- Dedicated PP with ISO/IEC 8802 LAN capability
- DECT single cell systems

The IWU needs to support the following processes:

- IWF Selection
- Routing
- Relaying

This profile describes interworking to the MAC layer of a data only ISO 8802 LAN (8802.3, 8802.4, 8802.5). Interworking to this boundary has the advantage that the processes required are independent of higher layer LAN protocols. In addition, the efficiency of the interworking function will depend on the amount of processing required to convey information. It is therefore preferable to provide a fairly simple interworking function at a lower protocol layer.

Interworking between 8802 LAN protocols at the MAC layer is termed MAC bridging and is described in IEEE 802.1d[1] [ref].

LAN communication at the MAC layer is not dependent on the prior establishment of a call, or connection. In interworking LAN data over DECT, the IWU is required to provide the necessary connection control and signalling in the C-plane in order to set up and maintain a virtual connection to support packet communication. User data is carried in the U-plane using the DECT frame relay (FREL) service.

The LAN subnetwork may be thought of as supporting a permanent physical connection over which data for multiple destinations (and from multiple sources) is multiplexed.

The DECT subnetwork has the ability to provide a connection:

i On demand
ii When a LAPC connection already exists
iii With dynamic bandwidth allocation

Protocol architecture models are illustrated in figures 2.1/IWP(12) and 2.2/IWP(12).

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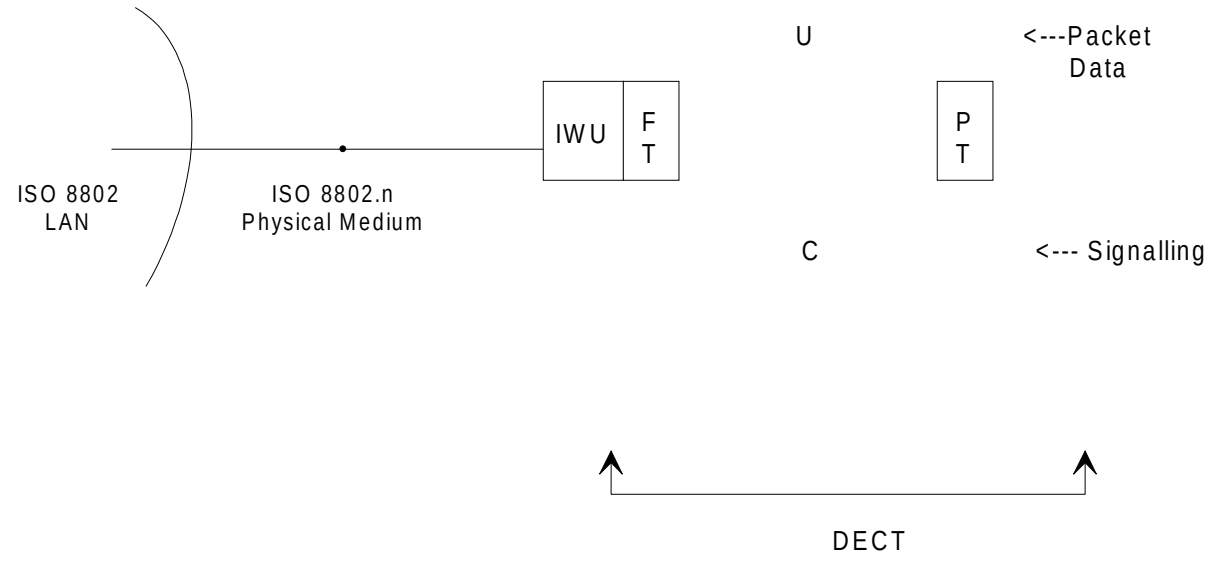
[1] IEEE 802.1d MAC Bridging has not yet been issued as an ISO standard



LAN = Local Area Network
IWU = Interworking Unit
FT =Fixed Radio Termination
PT = Portable Radio Termination

Notes:

2) A small amount of packet data may be conveyed in the C-plane using the CLMS connectionless service

1) Multiple virtual calls supporting packet communication to a number of PPs simultaneously may be supported.

Simple LAN Interworking Configuration
Figure 1.1/IWP(12)

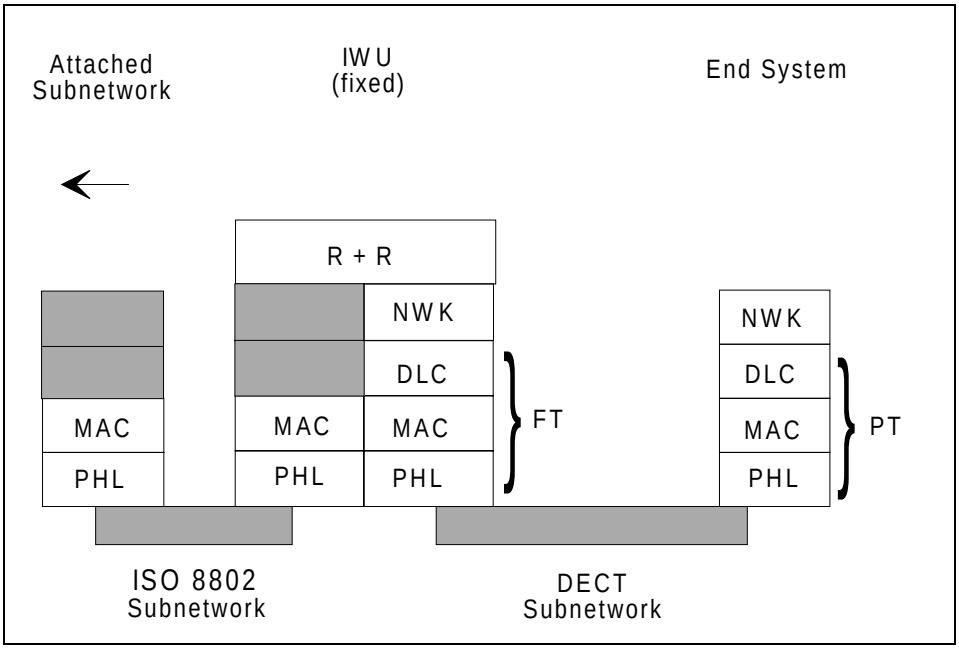
2 C-Plane Procedures

C-plane procedures are used to select the appropriate IWF and to establish and maintain a connection between the FT and PT.

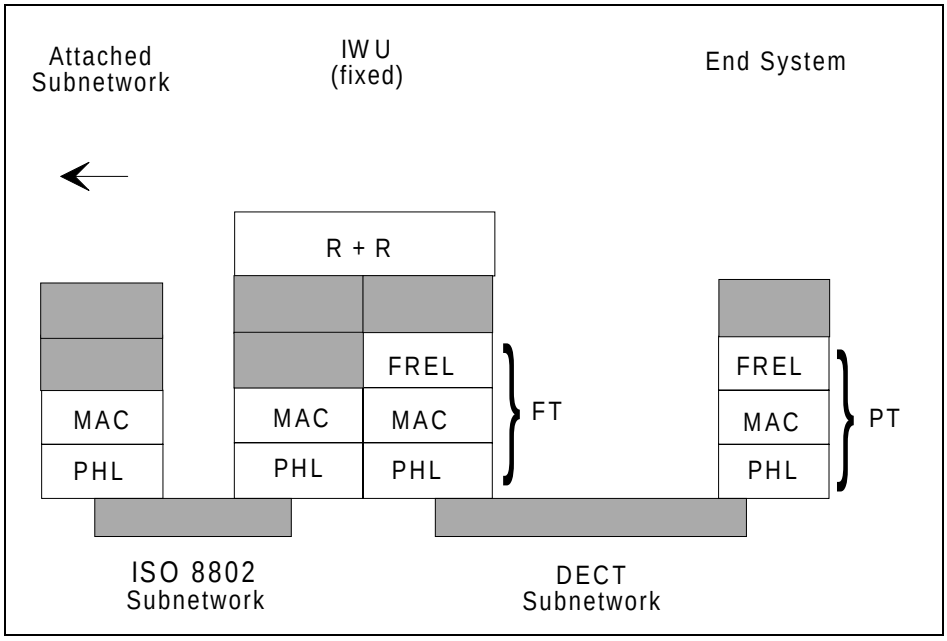
2.1 Outgoing Access

If the PT has packet data to send, it must first establish a LAPC connection across the DECT subnetwork to the IWU (assuming that an suitable active, or suspended connection does not already exist). During the call establishment phase the PT provides the IWU with sufficient information to select the IWFs. There is no corresponding call setup procedure to be interworked to the LAN subnetwork.

The CC entity and a corresponding U-plane connection are used in most cases. However, if a short packet is to be sent (routing information for example) then this might be conveyed in the C-plane using the COMS or CLMS entities, or even without a C-plane connection using CLMS. However, it should be noted that the connectionless CLMS service PT-FT is of limited use.



C-Plane Protocol Model (End System)
Figure 2.1/IWP(12)



U-Plane Protocol Model (End System)
Figure 2.2/IWP(12)

The IWU-FT will receive a {CC-SETUP} message from the PT, in which LAN interworking will be inferred from the IWU attributes. If the PT address is not already known to the IWU from the synchronisation process, then this should be entered in the routing table. The PT will use an ISO 8802 compatible locally administered 48 bit address, either using the default IPUI (type N), or private identity (type O). Locally administered addresses may be interworked with the 48 bit global LAN addresses likely to be in use on the LAN subnetwork. The routing table enables packets arriving from the LAN subnetwork to be selected for routing across the DECT subnetwork. If there is insufficient space in the routing table, then the oldest entry is removed and any associated connection released. If a PT location changes such that its identity is removed from the LCE location table, then this entry should be amended or removed from the routing table. Routing table entries will automatically be removed and connections released after a certain maximum time without active communication.

Since the single connection between PT and FT will be used to convey packets to multiple destination addresses, no destination address is supplied by the PT. The exception to this might be to send a short code understood by the IWU.

The protocol allows the IWU-FT to reply to the {CC-SETUP} request with either a {CC-SETUP-ACK}, or {CC-CONNECT}. If the {CC-CONNECT} is received at the PT then the U-plane is connected through immediately. The DECT subnetwork may dynamically allocate U-plane bandwidth to meet the demands of packet transfer to and from the IWU. Packets consist of ISO 8802 MAC SDUs and are transported using the U-plane frame relay service (FREL).

2.2 Link Suspend & Resume

If a period expires between user data packets, the connection is suspended to free resources for other DECT users. The dormant connection remains while the PT is still active and within the service area. This allows the connection setup delay to be reduced in further packet communication.

Suspend and resume are expected to maintain U-plane data integrity. Thus if a connection is suspended, all outstanding data is delivered before the MAC resources are released. User data received following a link suspend is queued pending a link resume. The link may be resumed immediately following successful suspension if data is queued during the link suspend process.

2.3 Incoming Access

Several different scenarios can exist in the FT when an incoming packet is received from the LAN subnetwork. The IWU LAN subnetwork port listens to all LAN traffic.

i An entry for the addressed PT exists in the IWU routing table and a suitable connection is established to this PT which may be in the active or suspended state.

ii An entry for the addressed PT exists in the IWU routing table and no suitable connection is established. Note that a connection may exist that is not suitable to carry the new data.

iii No entry exists for the addressed PT in the IWU routing table and no suitable connection is established.

iv The incoming packet is a LAN broadcast packet.

If no suitable connection exists then a connection is established to the PT to convey the packet data. If the incoming packet is a broadcast packet then this may be conveyed without C-plane connection establishment in a CLMS message. Note that a connection may already exist between PT and FT that is not suitable to transport the incoming data (an asymmetric connection for example).

If packets arrive addressed to an unknown PT, then these are discarded.

Note that the IWU will not be passed the incoming packet from the LAN subnetwork until reception has been completed. The packet will be discarded by the LAN MAC layer if the CRC does not check.

2.4 Release

If the PT releases the connection as the result of user action, then the PT will send a {CC-RELEASE} to the FT-IWU, which responds with a {CC-RELEASE-COM}. Suspended connections may be released without the need to resume the connection. In this case there are no MAC resources to release and the release involves clearing all connection references.

The FT-IWU may release the link if the connection reaches a predetermined age without active communication, or if the PT address is marked as old and removed from the routing table to make room for a new entry.

3 U-Plane Procedures

Most LAN data packets are transported in the U-plane and are transferred once a C-plane connection has been established. The exception to this may be for small, or broadcast packets which may be transported in the C-plane.

LAN MAC SDU packets are transported using the DECT frame relay service (FREL) provided by LU_2 in the DLC layer. This provides:

- Error detection capabilities beyond that available from the MAC Ip service
- SDU segmenting and reassembly

4. Process Applicability

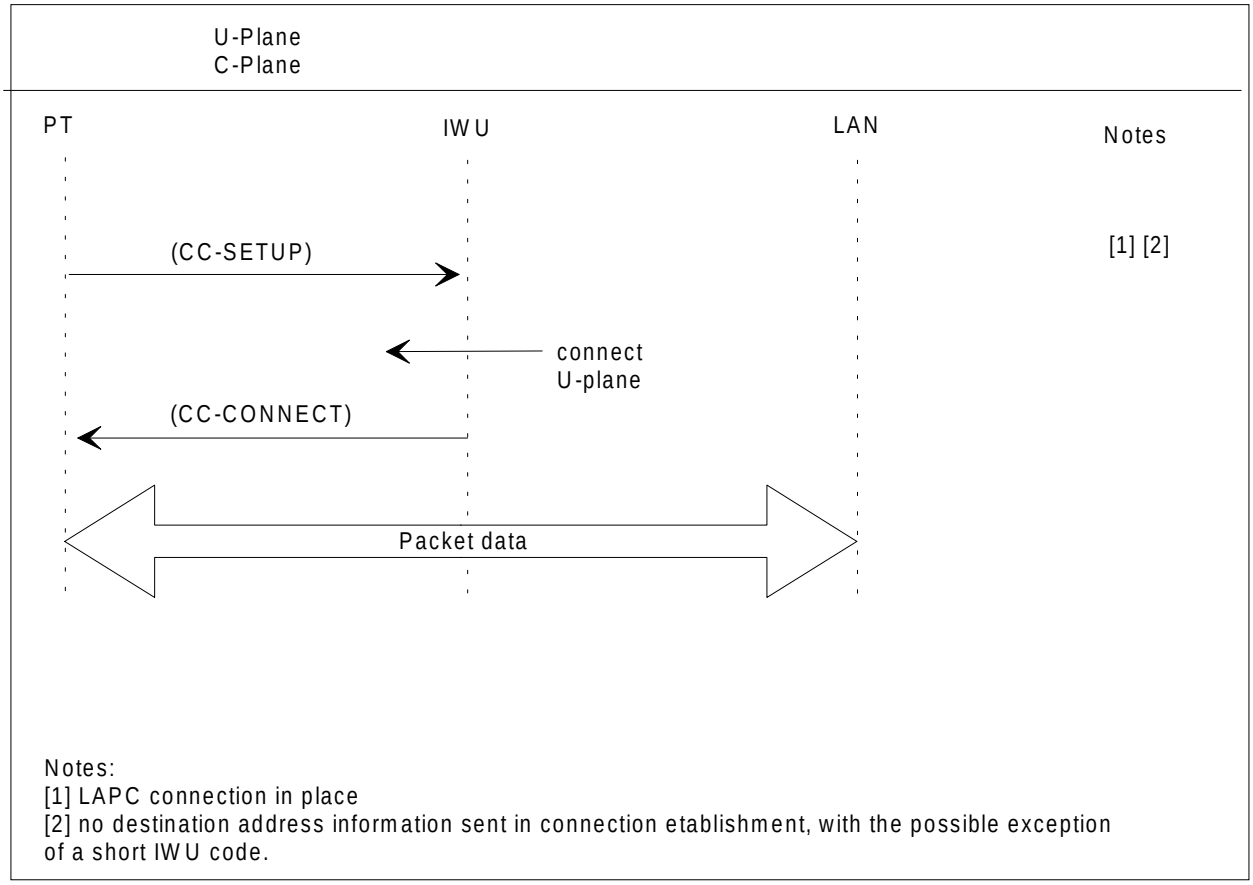
[For further study]

5. Message Sequence Examples

PT Originated Connection	Figure 5.1/IWP(12)/IWP(12)
PT Terminated Connection	Figure 5.2/IWP(12)/IWP(12)
PT Cleared Connection	Figure 5.3/IWP(12)/IWP(12)

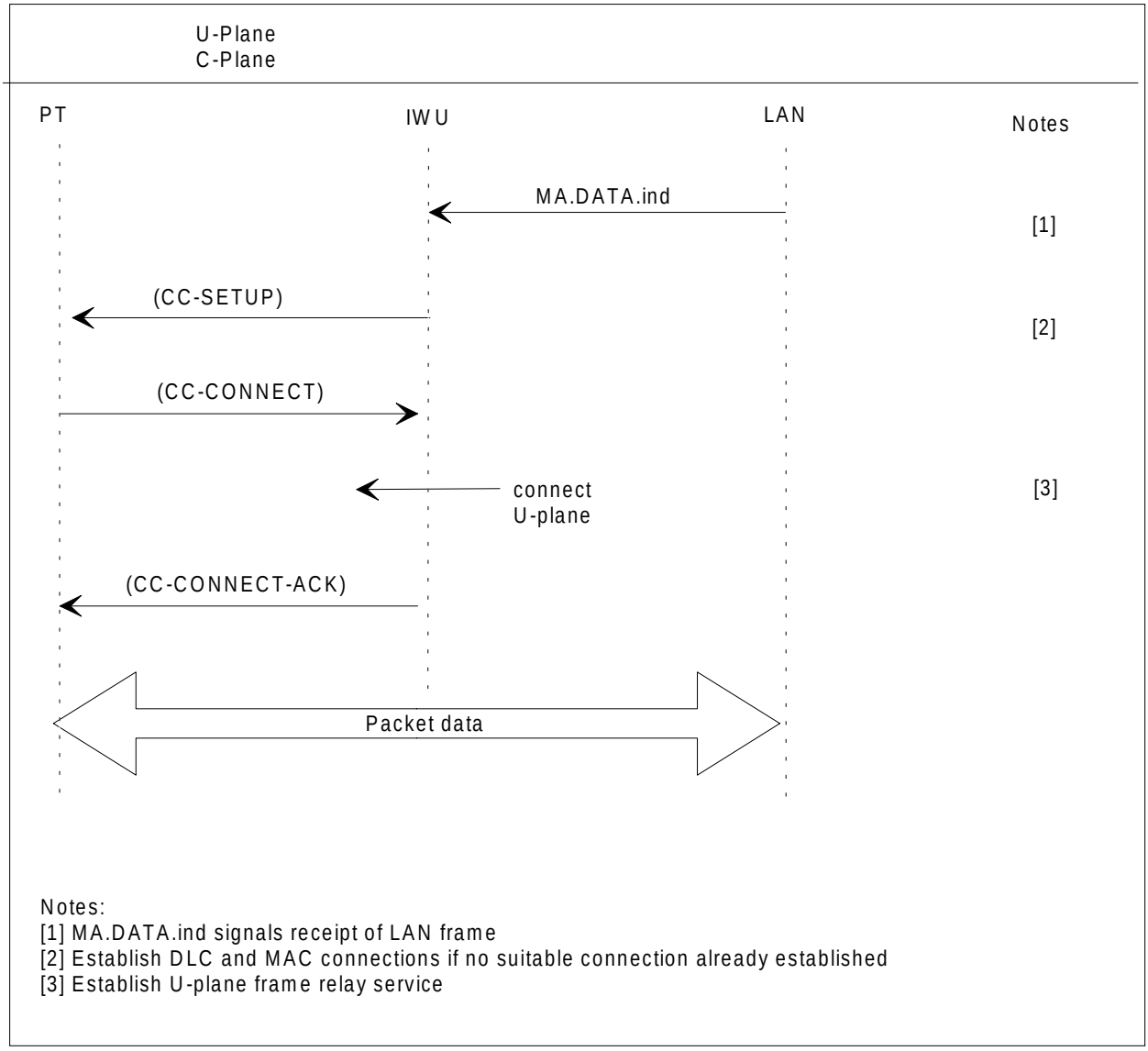
6. Mapping

[For further study]



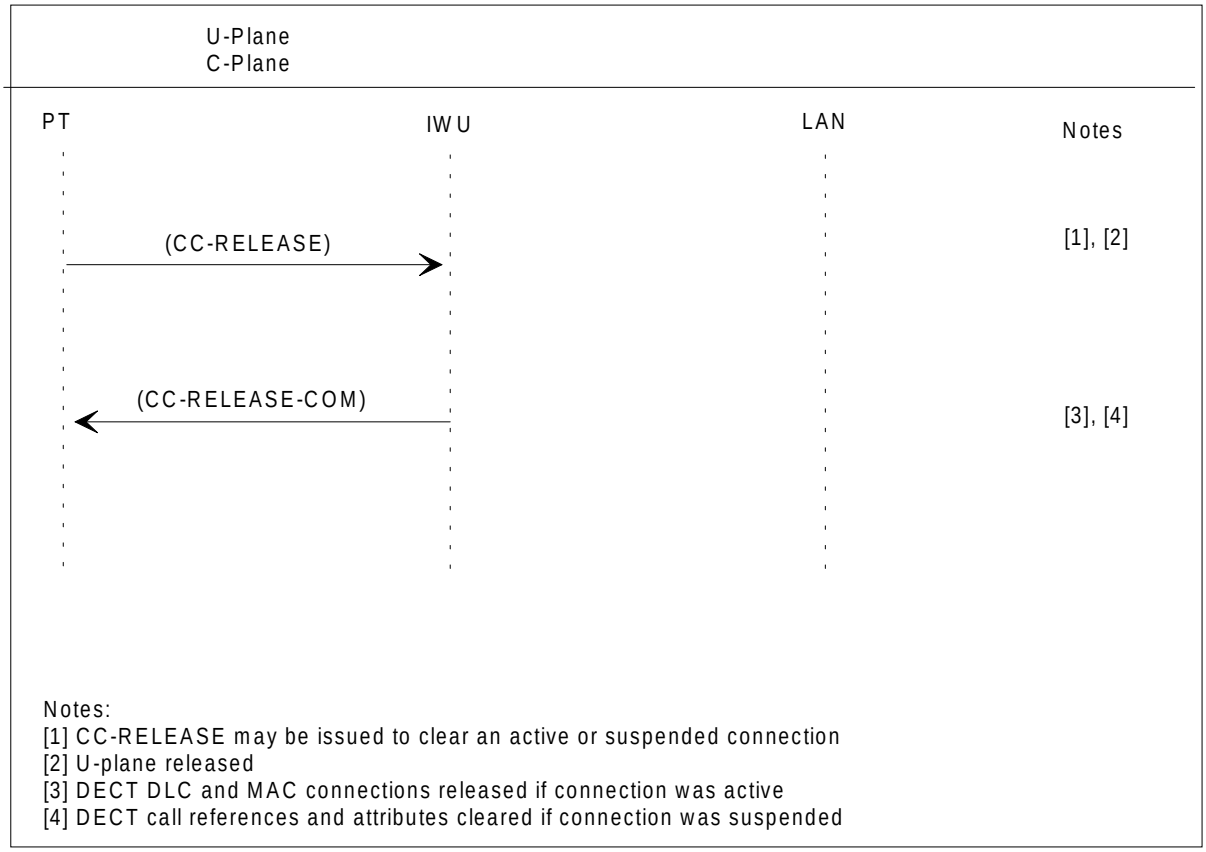
PT Originated Connection
ISO/IEC 8802 LAN Interworking

Figure 5.1/IWP(12)



PT Terminated Connection
ISO/IEC 8802 LAN Interworking

Figure 5.2/IWP(12)



PT Cleared Connection
ISO/IEC 8802 LAN Interworking

Figure 5.3/IWP(12)

7.9.13 GROUP 3 FAX

For further study

7.9.14 KEYSYSTEMS

For further study

7.9.15 PBX

For further study

7.9.16 ISPBX

For further study
See [224] for draft.

7.10 MOBILITY MANAGEMENT INTERWORKING

[For further study]

7.11 REFERENCES

7.11.1 International Standards and Recommendations

[101]	I.500	CCITT	Blue Book
[102]	I.510	CCITT	Blue Book
[103]	I.515	CCITT	Blue Book
[104]	I.520	CCITT	Blue Book
[105]	Q.931	CCITT	Blue Book
[106]	V.110	CCITT	Blue Book
[107]	V.120	CCITT	Blue Book
[108]	X.25	CCITT	Blue Book
[109]	X.31	CCITT	Blue Book
[110]	X.32	CCITT	Blue Book
[120]	TR/25	ECMA	March 85
[121]	TR/44	ECMA	2nd Edition December 1989
[141]	IS 8802-2	ISO	31.12.89
[142]	GSM 04.08	ETSI	V 3.8.0
[143]	GSM 08.08	ETSI	V 3.9.2
[144]	GSM 09.09	ETSI	V 3.0.0
[145]	prETS 300 102-1	ETSI	Aug 90
[146]	prETS 300 102-2	ETSI	Aug 90

7.11.2 DECT CI Specification and System Description Document

[201]	CI Part 4, DLC Layer	Ver 10.01
[202]	CI Part 5, Network Layer	Ver 9.00
[203]	System Description Document, Chapter 2, Terminology	Ver 6.03
[204]	System Description Document, Chapter 3, Reference Model	Ver 4.00
[205]	System Description Document, Chapter 4, System Protocol Architecture	Ver 4.00
[206]	System Description Document, Chapter 5, Identities and Addressing	Ver 3.00
[207]	System Description Document, Chapter 6, Mobility Functions	Ver 2.03
[208]	System Description Document, Chapter 8, Supplementary Services	-

7.11.3 RES-3N Input Papers

[210]	RES-3N (90)97	Network Layer Requirements - Interworking	Ver 2.0
[211]	RES-3N (90)110	Interworking Principles of GSM/ISDN	Ver 1.0
[212]	RES-3N (90)125	DECT Interworking Functions - Principles and Assumptions	Ver 2.0
[213]	RES-3N (90)133	Signalling Interworking Between DECT and GSM A I/F	Ver 2.03
[214]	RES-3N (90)142	DECT Interworking Definition of Terms	Ver 1.0
[215]	RES-3N (90)143	IWU Requirements (PSTN/ISDN)	Ver 1.0
[216]	RES-3N(90)144	Interworking Profiles - PSPDN	Ver 1.0
[217]	RES-3N(90)152	Call Attributes	Ver 3.01
[218]	RES-3N(90)154	Mobile Telepoints - DECT and GSM?	Ver 1.0
[219]	RES-3N(90)155	Comments on Call Control/IWU Requirements	Ver 1.0
[220]	RES-3N(90)157	IWP-PSTN Circuit Switched Data	Ver 1.04
[221]	RES-3N(90)158	Access to Supplementary Services	Ver 1.0
[223]	RES-3N(90)162	Services and Facilities Requirements Specification (RES-3S)	Ver 7
[224]	RES-3N(91)49	IWP DECT - ISPBX (Telephony)	Ver 1.0
[225]	RES-3N(91)...	ISDN - DECT Interworking (SELTA)	

7.11.4 Other Technical Reports and Documents

[300]	ETR T/S 46-39	Application of the BC, HLC and LLC Information Elements by Terminals Supporting ISDN Services

Annex F: Supplementary services

This Annex contains Chapter 8 of the DECT System description document, and consists of pages numbered 8.1 to 8.15 (i.e. 15 pages)

Chapter 8

Supplementary Services

8.0 Version History

Version 00.00 1990-10-24 First release to RES-3N
Version 01.00 1990-11-21 Second release to RES-3N
Text on Call Related and Call Independent Supplementary Services added. Figures added showing Facility Information Element format and Component format.
Version 02.00 1990-12-03 Third release to RES-3N
List of Source Documents added. Various clarifications and editorial changes.
Version 04.00 1991-04-20 Fourth release to RES-3N
Text on DECT Specific Supplementary Services added.
Version 04.01 1991-09-25 Fifth release to RES-3N
Various clarifications and editorial changes.
Version 04.02 1992-04-28 Sixth release to RES-3N
Minor editorial changes.

8.1 Scope

This chapter is concerned with the ways in which DECT systems may support Supplementary Services offered by the local networks to which DECT systems may be attached.

8.2 Introduction

DECT users will require access to the Supplementary Services provided by both the DECT system itself and by the network to which the DECT system is attached.

8.3 General

The CCITT do not offer a definition of the term Supplementary Service but its meaning is generally taken to be that contained in CCITT recommendation I.210 section 2.4 which states that a Supplementary Service modifies or supplements a basic telecommunication service. Basic telecommunication services are divided into bearer services and teleservices.

A bearer service defines the capability to transfer information between user-network interfaces. There are two possible user-network interfaces that could be considered here. Firstly there is the air-interface between the portable part and the fixed part. Secondly there is the interface between the fixed part and the local network. This second interface is outside the scope of the DECT specifications which are primarily concerned with the air interface. Therefore it is assumed in this chapter that the user-network interface is that between the portable part and the fixed part, i.e. the air interface as specified by the CI.

A teleservice defines the capability for communication between terminals or users and includes the terminal functions as well as network capabilities. For the purposes of this chapter the terminal equipment is taken to be the portable part.

A single Supplementary Service may modify both the bearer service and the teleservice, hence it is not possible to categorize Supplementary Services into those only affecting teleservices.

8.4 Supplementary Service Procedures

Two kinds of operational procedures are possible at the user-network interface: these are referred to as stimulus and functional procedures. The operation of these procedures reflect the capabilities of the user's terminal. However it should be noted that a terminal may use stimulus procedures for some Supplementary Services and functional procedures for others.

8.4.1 Stimulus Procedures

Stimulus procedures require no specific intelligence in the terminal for the Supplementary Service concerned. In general the user actions are passed onto the network for interpretation and network responses are in the form of simple commands to the terminal to give indications to the user, the nature of the indication, audible, visual, or whatever, is determined by the network not the terminal.

Stimulus procedures allow the terminal to be relatively simple because it need have no knowledge of call states. A terminal using such procedures is said to be operating in stimulus mode. Note that though the terminal may be described as simple in the current context, it may be a sophisticated device in other ways, e.g. a PC with an ISDN communications card.

A user with a terminal operating in stimulus mode can access any Supplementary Service which the network chooses to provide in a stimulus fashion. Therefore as the network evolves and offers new services the user does not have to exchange or upgrade the terminal.

A disadvantage of terminals operating in stimulus mode is that because they provide no support for Supplementary Services, the full functionality of the service may not be available and the users interface may not always be satisfactory.

Another consideration is that the specific details of the stimulus procedures for each Supplementary Services have not been standardized. Therefore the user interface will vary across networks even using the same terminal.

8.4.2 Functional Procedures

Functional procedures are so called because the terminal requires specific intelligence concerning the Supplementary Service involved. User actions are interpreted by the terminal and their meaning is passed onto the network. Network responses are specific to the Supplementary Service concerned and are primarily intended for the terminal. It is the responsibility of the terminal to use those responses to determine the nature and type of indications to present to the user.

Because the terminal and the network cooperate in providing the service, the full functionality of that service is available to the user and the user interface is specific to that service.

The functional procedures and protocols for ISDN Supplementary Services are currently being standardized within ETSI. Therefore a functional terminal will work in a consistent way when it is used to access different ISDN networks offering the standardized Supplementary Services; the user will press the same keys and receive the same sorts of indication.

These benefits come at a cost. Functional terminals are more complex than stimulus terminals and so tend to be more expensive. For portable parts the increased power consumption and consequent reduction in battery life may be an important consideration.

Another aspect of functional terminals is that the services they support are based on those offered by the networks at the time the terminal was designed. However networks are not static and Supplementary Services introduced after the terminal is designed cannot be accessed in a functional manner by the terminal. This means that unless the terminal can be upgraded, it becomes necessary to operate the terminal in stimulus mode to use such Supplementary Services.

8.4.3 Interworking of Functional and Stimulus Procedures

Though interworking is the subject of a separate chapter, the use of functional and stimulus procedures by the local network has some consequences for the CI.

The diagram in figure 8.1 shows the four possible interworking situations between the portable part and the local network for Supplementary Services.

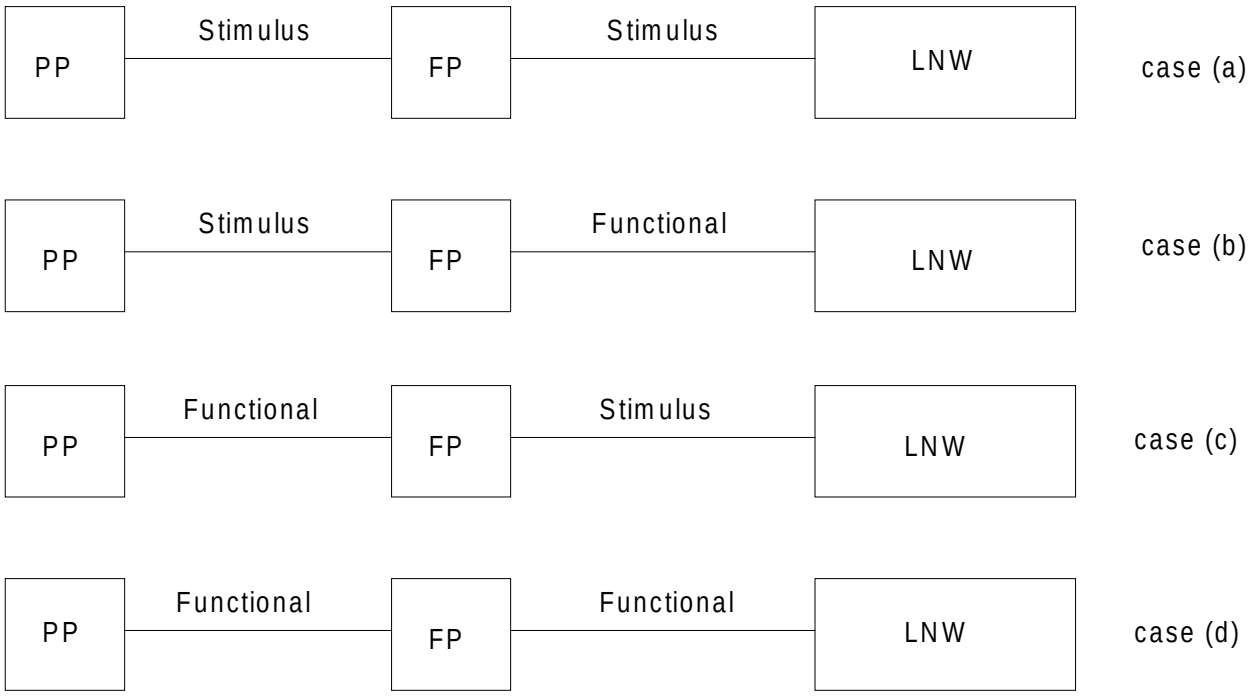


Figure 8.1 The four possible interworking situations between the portable part and the Local Network

8.4.3.1 Case (a)

This case arises when both the portable part and the local network uses stimulus procedures.

The fixed part has to perform protocol mappings in two directions. From user to network it has to map a code set used by the user onto that used by the local network; from network to user it has to map indications intended for the user (sent by the local network) onto those which the user will understand.

If the stimulus protocol used by the portable part and by the local network are the same, this mapping can become very complex.

Therefore in this case the only practical situation is where both stimulus protocols are the same and the fixed part is transparent as far as the stimulus protocol is concerned.

8.4.3.2 Case (b)

This case arises when the local network only offers a service using functional procedures but the portable part only is capable of using stimulus procedures.

The fixed part has to map the codeset used by the user to functional messages understood by the network. This requires the fixed part to understand the meaning of the user's codeset. This is possible though the complexity this introduces would depend very much on the nature of the codeset.

From network to user, the fixed part has to map functional messages intended for the terminal onto indications intended for the user. This is also possible.

If it can be assumed that any local network which provides Supplementary Services using functional procedures will also provide those service by stimulus procedures, then this case does not have much practical significance. However if this cannot be assumed, then there are significant questions for the implementation of the fixed part.

8.4.3.3 Case (c)

This case occurs when the portable uses functional procedures but the local network only supports stimulus procedures.

In the user to network direction the fixed part maps functional messages caused by user actions onto the codeset used by the local network. This is feasible but is not very practical. In the network to user direction, the fixed part has to map indications intended for the user onto functional messages understandable by the portable part. This would be very difficult for some types of indication, e.g. text for display. Therefore this is not a practical situation.

Because this case is not really workable it has no significance for DECT. These comments only apply where the Supplementary Service is provided by the local network. If the fixed part provides DECT specific Supplementary Services then different considerations apply.

8.4.3.4 Case (d)

This case arises when both the portable part and the local network use functional procedures.

The fixed part has to map between functional signals for both directions of transmission. If both functional protocols are the same this is relatively simple. If they were to be different, the mapping could be very complex depending of the differences in the procedures.

In practice the functional protocol used by the local network is likely to be based on the ETSI standards for Supplementary Services. This implies that if the DECT CI is to provide a functional protocol then the requirements for the protocol should be derived from the ETSI standards for Supplementary Services, particularly the stage 2 and stage 3 descriptions.

An example of this case is DECT interworking with GSM.

8.4.4 User Interface Aspects

One of the benefits of a functional implementation of a Supplementary Service is that the user interface should be better than if the implementation were stimulus. While this may usually be the case it is not always so. Where the terminal is used with a specific known network, a stimulus implementation can provide a user interface which compares with that given by a functional implementation.

A simple example of a terminal with a display will illustrate this. The use of a visual display poses some problems when stimulus procedures are used. The length of the display needs to be aligned with the maximum length of text which the network sends. The terminal needs to know which control codes, if any, that the network will use to control the display. If there are no display control codes, the terminal needs to know when to clear the display and when to retain it.

If the terminal is to work with a number of different networks then these issues become complex and lead to design compromises. However if only one network is involved then no such compromises have to be made. In some situations it may be possible for the network to give specific support for the terminal.

For portable parts which are not intended for use in multiple networks, e.g. desktop terminals, the stimulus approach may be quite adequate and therefore should be allowed by the CI.

8.5 Supplementary Service Protocols

Stimulus and functional procedures require different types of protocol at the user network interface, these are referred to as stimulus and functional protocols. A particular network may use either or both kinds of protocol. For example the PSTN will only offer a stimulus protocol whereas an ISDN network may offer both stimulus and functional protocols.

8.5.1 Stimulus Protocols

For the ISDN environment two variants of stimulus protocols have been defined; these are the keypad protocol and the feature key management protocol. These along with a functional protocol, are described in CCITT recommendation Q.932 (1988). The keypad protocol has been adopted by ETSI and is specified in ETS 300 122 (formerly referenced ETS T/S 46-32A).

The keypad protocol is based on the Keypad Facility information element and the display information element. Q.932 implies that this protocol may only be used in association with a call. The Keypad facility information element may be included in the Setup and Information messages. The Display information element may be included in any message sent by the network to the user.

The feature key management protocol is based on the Feature Activation and the Feature Indicate information elements. This protocol can be used for both call related and non- call related Supplementary Services.

These protocols only provide the framework for Supplementary Service control. For example the actual contents of the Keypad facility information element will depend on the codeset in use. The DECT CI should adopt the same approach, i.e. it should provide the mechanisms for stimulus procedures, in line with those mechanisms defined in Q.932, but leave the details of the codesets to be used as an implementation option.

Q.932 defines the following additional information elements for Supplementary Service Control; information request, service profile identification, and endpoint identifier. The need for the CI to carry these information elements is still to be investigated.

8.5.2 Functional Protocols

The functional protocol defined in Q.932 uses the Facility information element which has been defined for this purpose. This information element conveys application layer protocol based on the remote operations protocols defined in CCITT recommendation X.229. Thus each Supplementary Service is modelled as a remote operation.

The remote operations protocol, ROSE, requires each operation to be identified by a unique identifier. Object identifiers are defined in the CCITT Recommendation X.208 (Abstract Syntax Notation number 1, or ASN.1).

In addition to the Facility information element, Q.932 defines specific messages for use in the functional protocol. These are Hold, Hold Acknowledge, Hold Reject, Retrieve, Retrieve Acknowledge and Retrieve Reject.

8.6 Modelling of Supplementary Services in DECT.

(Subclause 6.3.3 of part 5 of the DECT CI standard [5].)

8.7 Call Related Supplementary Services

A Supplementary Service is call related if it is invoked within the context of a call and if it modifies that call in some way. Such Supplementary Services my be invoked during the establishment of a call, during its active phase, or during call clearing.

The Supplementary Service control information is transported by layer three messages on the data link for the active call. Therefore a data link does not need to be established.

The procedures used for the control of the Supplementary Services may be either functional or stimulus.

8.7.1 Functional Procedures

The functional protocol uses the Facility information element to carry Supplementary Service control information. This information element may be sent in a call control message if one is to be sent, otherwise it may be sent in a Facility message. For example, if the Supplementary Service is invoked on establishment, the Facility information element would be sent in a Setup message. If a Facility message has to be used, the value of the call reference must be the same as that of the related call.

8.7.2 Stimulus procedures

Both the Keypad protocol and the Feature Key Management protocol may be used.

8.8 Call Independent Supplementary Services

A Supplementary Service is call independent if it is invoked outside the context of a call. Such a service may be invoked when there is no active call. It may also be invoked when there is an active call, however it does not modify that call.

Before Supplementary Service control information can be sent, the sender must ensure that a data link exists. If a data link does not exist then one must be established using the appropriate procedure of the CI.

The procedures used for the control of the Supplementary Service may either be functional or stimulus.

8.8.1 Functional Procedures

When the data link is established, a signalling connection at layer three must be established. Either the fixed part of the portable does this by sending a CISS-Register message across the air interface. The signalling connection is identified by the call reference in the CISS-Register message. Usually the CISS-Register message will also contain Supplementary Service information in a Facility information element. Further Supplementary Service control information may be exchanged by the use of the Facility messages. The signalling connection is cleared by the clearing part sending a CC-Release-Complete message.

8.8.2 Stimulus Procedures

The feature key management protocol may be used for call independent Supplementary Services. When the data link is established, a Supplementary Service is invoked by sending an Information message containing a Feature Activation information element. The response may be another Information element containing a Feature indication information element.

8.9 Supplementary Services Specific to DECT

The DECT system itself may provide Supplementary Services independently of the local network. DECT defined Supplementary Services must be distinguished from those defined by CCITT and possibly other standard bodies. Furthermore, the DECT system must be able to distinguish between those Supplementary Services which is intended to process from tho se which are intended from the local network.

DECT Specific Supplementary Services are distinguished by the use of the Feature Key Management Protocol.

8.9.1 Queue Management

8.9.1.1 Overview

The DECT specific Supplementary Service Queue Management is used when all external lines are busy. The CC instance of the call is put in a queue for external lines, and is alerted when it is first in line. This Supplementary Services enables separate queues for different kinds of external networks.

8.9.1.2 Procedures

The PT may invoke the Queue Management Supplementary Service during Call Setup upon receipt of a CC-Service-Reject indicating that no external lines are available. The procedure is initiated by sending a Queue Entry Request included in a Feature Activate information element. The FT puts the Call Control Entity corresponding to the specific call in a queue for external lines and responds to the PT with an acknowledge of that the service has been accepted and the status of the queue. The FT thereafter sends indications of the status of the queue in Feature Indicate information elements after any change in the queue. The queuing information may be included in a CC-INFO message or in any CC or CISS message where the Feature Indicate and Feature Activate information elements are allowed. When an external line is free, the FT continues with the Call Setup by sending e.g. a CC-Call-Proc, a CC-Alerting or a CC-Connect depending of the status of the call. The queue is left by making a Call Release.

8.9.2 Indication of Subscriber Number

8.9.2.1 Overview

The DECT specific Supplementary Service Indication of subscriber number is used to obtain the current extension number. This feature can e.g. be useful for a visitor who gets a temporary subscription and wants to know his temporary subscriber number.

8.9.2.2 Procedures

For this Supplementary Service the Feature Key Management Protocol is used. To request the service a Feature Activate information element with the feature coding Indication of Subscriber Number is sent. If this service is supported by the network, the subscriber number is transmitted using a Feature Indicate information element.

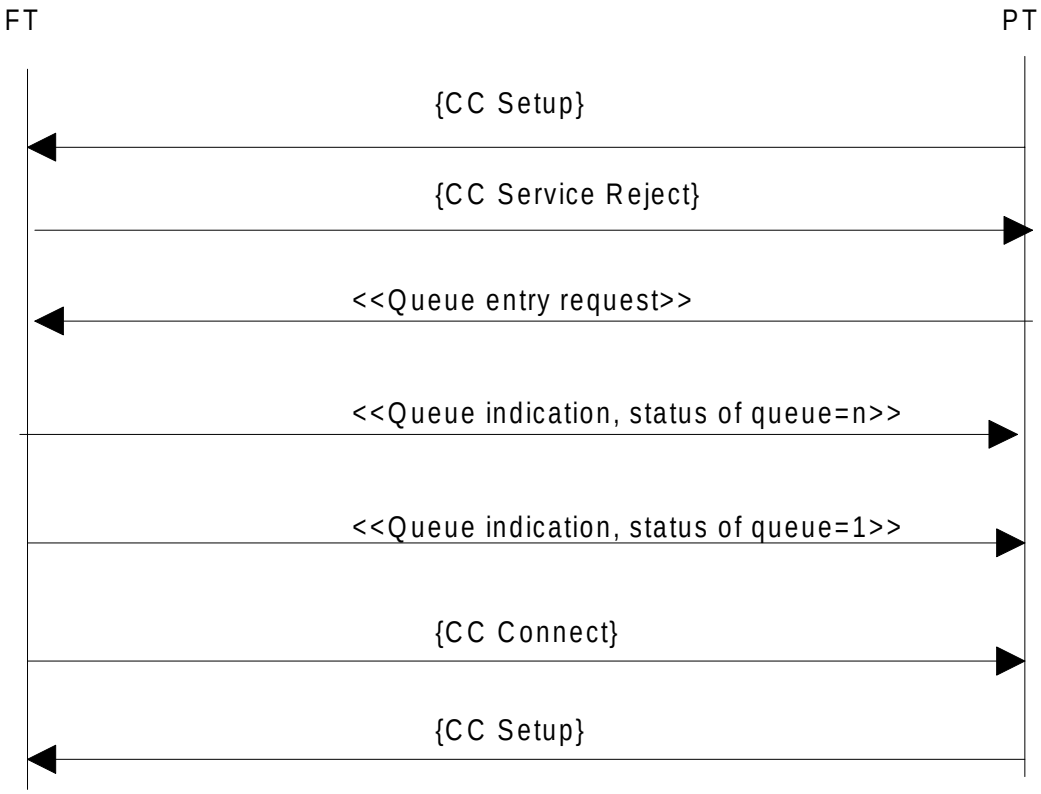


Figure 8.2 Queue Management procedures

8.9.3 Control of Echo Control Functions

8.9.3.1 Overview

DECT defines echo control functions in the Fixed Part (FP) that control both the echo perceived by the DECT user and the echo perceived by the far end talker. In total, four functions are defined.

8.9.3.1.1 Control of Echo perceived by DECT user

Requirement 1 and Requirement 2:
(subclause 7.10 of part 8 of the DECT CI standard [8].)

Requirement 1 is primarily designed to control the echo from the DECT hybrid in the case of a 2-wire connection.

Requirement 2 is primarily designed to control the echo from the far end hybrids.

8.9.3.1.2 Control of Echo perceived by far end talker

Option (a) and Option (b):
(subclause 7.4.1.2 of part 8 of the DECT CI standard [8].)

Option (a) is primarily designed to ensure that echo cancellers at the international switching centre are activated. Option (a) should always be used when connecting to a PSTN or ISDN.

Option (b) is primarily designed for specific Local Networks (in particular, connection to the GSM mobile or fixed network) to ensure that the effective TCL from the DECT network is always in excess of 46 dB.

8.9.3.1.3 Use of Echo control functions

The exact function(s) to be used depends upon the type of interface and the type of networks to which DECT is connected. These echo control functions should be disconnected when not needed to optimize the speech quality. The connect/disconnect decision (for each function) depends upon the installation and/or routing information (on a per call basis). It may also depend on the service provided: data services may not require echo control functions.

Where possible, all echo control functions should be fully controlled by the Fixed Part and in many cases be preset at installation. For particular cases (eg disconnection of requirement 2 for internal PBX calls) a supplementary service is defined that allows the Portable Part (PP) to override this FP control.

NOTE: All possible PP control options are provided to allow for future development, but most of these should not be required.

Control of echo functions on a per call basis is expected to use the call routing information and/or the service type. This can be provided by number analysis in the PP or FP. When this analysis is provided in the PP, the messages defined in part 5 of this standard [5] subclause 7.7.16 shall be used to transfer this information to the FP.

NOTE: Connect/disconnect information could also be provided by a PABX or the PSTN/ISDN via the FP Interworking Unit, IWU.

8.9.3.2 Examples of operation

8.9.3.2.1 Requirement 1 operation

FP operation (normal case)
The use of requirement 1 is normally installation dependent and shall be connected only if the FP is connected to a 2-wire interface.

PP operation
Not recommended.

8.9.3.2.2 Requirement 2 operation

FP operation (normal case)
This shall be disconnected if the is FP connected to a mobile or fixed GSM network. It shall be connected when the FP is connected to the PSTN/ISDN also via a PABX. It may be disconnected or may provide a reduced echo loss depending on available routing information.

PP operation
Example 1: Disconnect for internal PBX calls (processing of routing information by PP - key systems).

Example 2: Disconnect when using 4-wire connection to ISDN terminal.

8.9.3.2.3 Option (a) operation

FP operation (normal case)
This should be connected when the FP is connected to the PSTN/ISDN, including the case of connection via a PABX. It may be disconnected depending on available routing information.

NOTE: Either option (a) or option (b) shall always be used in this case. Option (a) is in tended for this case.

PP operation
Normally not used.

8.9.3.2.4 Option (b) operation

FP operation (normal case)

This shall be connected if the FP is connected to a mobile or fixed GSM network. In case of a mobile network, it shall be disconnected for Discontinuous Transmission connections. See part 8 of this standard [8] subclause 8.2.1.2.2.

NOTE: The functions defined by options (a) and (b) above are alternative functions. They shall both be disconnected if the Terminal Capability message indicate 'Full TCL' meaning TCLw > 46 dB. See part 8 of this standard [8] subclause 7.4.1.1.

PP operation
Normally not used.

8.9.4 Cost Information

8.9.4.1 Overview

The DECT Specific Supplementary Service Cost Information provides the user with cost information either concerning the end to end connection or the DECT link.

8.9.4.2 Cost Information types

The user may be provided with the following types of cost information: Advice of Tariff, Advice of Charge and Charging Pulses. The support of this feature does not compel any specific tariffing principles for the public access service.

Advice of Tariff is a service which nevertheless can provide the user with cost information in separate, well defined, segments. This feature can give the user an indication of the cost level of a call and enables the user itself to estimate the cost. Information can be sent after any tariff change during the call. The service Advice of Charge provides the user with a calculated charge at the end of the call. The Charging Pulses service continuously provides the user with ticks during a call.

8.9.4.3 Cost Information Elements

The Cost Information supplementary service uses the Feature Key Management Protocol, i.e. the information elements used are the Feature Activate and the Feature Indicate information elements.

The Feature Activate information element should contain information about the the type of cost information. This information should indicate whether the user requests for DECT internal cost information or end to end cost information, and if the user requests for Advice of Tariff, Calculated Cost Info or Charging Pulses.

The information field in the Feature Indicate information element contains cost information. c1-c15 are well defined charging components, which can enable the user to receive and estimate cost information in any DECT network which supports the service. The components c16 - c22 are left for the Local Network operator to define.

Component:	**Description:**
c1	Units per interval
c2	Seconds/time interval
c3	Scaling factor
c4	Unit increment

c5	Units per data interval
c6	Segments per data interval
c7	Initial seconds/time interval
c8	reserved
c9	reserved
c10	Fixed cost for access to a specific network
c11	Calculated charged amount
c12	Fixed Supplementary Service cost
c13	Supplementary Service cost per time interval
c14	Pulse
c16-c23	Network proprietary components

All other values reserved

Component c1:
This component defines the number of unit increments per interval.It is set in terms of Visited Location Area units/interval.

Component c2:
This component defines the time interval for unitization, and is specified in seconds.

Component c3:
This component defines the scaling factor to convert from Visited Location Area units to Home Location Area units. The derivation ofthis scaling factor is described. It is a dimensionless multiplier.

Component c4:
This component defines the number of units increments on receipt of the message containing the charging components. It is specified in units of the Visited Location Area.

Component c5:
This component defines the number of unit increments per data interval. It is set in terms of Visited Location Area units/interval.

Component c6:
This component defines the data usage interval for unitization.

Component c7:
This component defines the initial time interval for unitization.

Component c10:
This component defines a fixed cost for access to a specific network.

Component c11:
This component defines the calculated cost in either the currencyof the Home Location Area or the Visited Location Area.

Component c12:
This component defines a fixed cost for a specific Supplementary Service.

Component c13:
This component defines the cost per time unit for a specific Supplementary Service.

Component c14:
This component represents one pulse possibly also the cost per pulse.

8.9.4.4 Cost Information Procedures

The Cost Information procedure may be initiated during Call Setup,by sending a Feature Activate information element in e.g. a CC-Setup message. Additional information in any direction could be transmitted in the CC-Info message or in any other of the CC messages where the Feature Activate and Feature Indicate information elements are allowed.

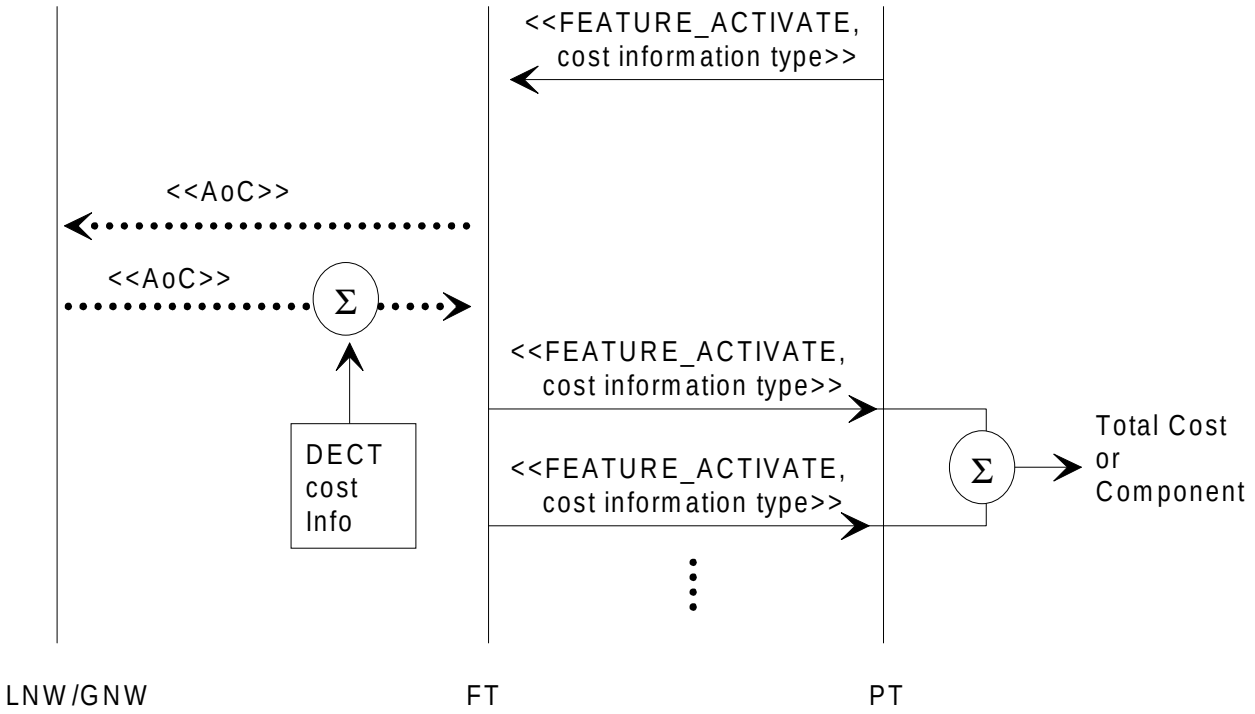


Figure 8.3 Cost information procedure

Figure 8.4 describes the procedures in more detail. The FT invokesthe procedure by requesting for end to end or internal cost information and the requested cost information type. If end to end informationis requested, the FT requests for an external Advice of Charge, after reception of the invoking Feature Activation information element. After any change in either the external network or the DECT network the FT collects the updated information, puts the information, either some or all of the charging components, in the cost information component of a Feature Indication information element and sends this to the PT.

In the case when the pulse feature is requested by the PT, the FTimmediately starts to continuously send the pulse charging component in intervals defined by the operator.

8.10 Source Documents

8.10.1 International Standards and Recommendations

CCITT Recommendation I.210 (1988)
CCITT Recommendation Q.931 (1988)
CCITT Recommendation Q.932 (1988)

8.10.2 RES-3N Input Documents

RES-3N (90/94) ISDN Supplementary Services
RES-3N (90/115) Services and Facilities
RES-3N (90/116) On Service(Access)Codes and Function Keys
RES-3N (90/140) DECT Supplementary Services
RES-3N (90/158) Access to Supplementary Services
RES-3N (90/164) Note on Bill Checking to RES-3S
RES-3N (90/167) DECT Charging Supplementary Services
RES-3N (90/196) Address Digit Distinction From PSTN-SS codes
RES-3N (90/200) DECT Specific Supplementary Services

Annex G: Bibliography

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

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

[3] ETS 300 175-3: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Common Interface Part 3: Medium access control layer".

[4] ETS 300 175-4: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Common Interface Part 4: Data link control layer".

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

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

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

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

[9] ETS 300 175-9: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Common Interface Part 9: Public access profile".

[10] I-ETS 300 176: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Approval test specification".

[11] ETR 15: "Digital European Cordless Telecommunications Reference document".

[12] ETR 42: "Radio Equipment and Systems; Digital European Cordless Telecommunications (DECT) A guide to the DECT features that influence the traffic capacity and the maintenance of high radio link transmission quality, including the results of simulations".

[13] ETR 43: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Common interface Services and facilities requirements specification".

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