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Foreword

This ETSI Technical Report (ETR) was produced by the Business TeleCommunications (BTC) Technical Committee of the European Telecommunications Standards Institute (ETSI).

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

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1 Scope

This ETR shows the impact that introduction of private Cordless Terminal Mobility (CTM) has on a Private Telecommunication Network (PTN). The report only deals with the support of CTM within a single PTN and covers the following aspects:

- basic services as defined in ETS 300 171 [1];

- supplementary services: implementation considerations are included as well as the inter-relationships between the various CTM supplementary services;

- network management services: only those management services which are likely to have a significant impact on PTN mobility are considered. Also included in this subclause are the specific network management requirements for the support of PTN mobility services;

- signalling capabilities: consideration is given to the signalling which is needed to support radio equipment connected to a PTN in terms of existing capabilities and proposals for possible future enhancements;

- addressing capabilities: consideration is given to the addressing methods that is needed to support Cordless Terminals (CT) through radio equipment connected to a PTN in terms of existing capabilities and proposals for possible future enhancements.

2 References

This ETR incorporates by dated and undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETR only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETS 300 171 (1992): "Private Telecommunication Network (PTN); Specification, functional models and information flows; Control aspects of circuit mode basic services".

[2] ETS 300 189 (1992): "Private Telecommunication Network (PTN); Addressing; ECMA-PTNA".

[3] ETS 300 415 (1994): "Private Telecommunication Networks (PTN); Terms and Definitions".

[4] CCITT Recommendation I.210 (1988): "Principles of telecommunication services supported by an ISDN and the means to describe them".

[5] ECMA TR/Compendium (1994): "Compendium of PTN Management Services".

[6] ETR 048 (1992): "Network Aspects (NA); Telecommunications Management Network (TMN); Management services prose descriptions".

[7] CCITT Recommendation E.212 (1989): "Identification plan for land mobile stations".

[8] CCITT Recommendation E.164 (1989): "Numbering plan for the ISDN era".

[9] ISO/IEC 11579-1 (1994): "Information technology - Telecomunications and information exchange between systems - Private integrated services network- Part 1 - Reference configuration for PISN Exchanges (PINX)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETR the following definitions apply:

Additional Network Feature (ANF): A set of functions supporting services above those required for a basic call. The customer for these services can be any entity within the network, i.e. any entity other than a user (see ETS 300 415 [3]).

call (basic call): The instance of the use of a service (see ETS 300 171 [1]).

P reference point: The P reference point defines the boundary between the private termination type 1 and the private termination type 2 functional groupings (based on ISO/IEC 11579-1[9]).

Private Telecommunication Network (PTN): A network serving a pre-determined set of users (different from a public network which provides services to the general public). The attribute "private" does not indicate any aspects of ownership (based on ETS 300 415 [3]).

Private Telecommunication Network eXchange (PTNX): A PTN nodal entity that provides automatic switching and call handling functions used for the provision of telecommunication services. The nodal entity can be implemented by one or more pieces of equipment located on the premises of the private network administrator or by equipment co-located with, or physically part of, a public network (based on ETS 300 415 [3]).

PTN address: Formalized information used to indicate unambiguously an identifiable entity. Within the context of this ETR, identifiable entities are those which use telecommunication services (based on ETS 300 189 [2]).

PTN number: A number of the domain covered by a PTN Numbering Plan (see ETS 300 189 [2]).

supplementary service: A service which modifies or supplements a basic telecommunication service. Consequently, it cannot be offered to a customer as a stand alone service. It should be offered together with or in association with a basic telecommunication service. The same supplementary service may be common to a number of telecommunication services (based on CCITT Recommendation I.210 [4]).

Cordless Terminal Mobility (CTM): The ability of a CT to be in continuous motion whilst accessing and using the telecommunication services offered by the PTN, as well as the capability of the network to keep track of the CT's location throughout the network.

CTM user: Primarily the human operator of a CT, but also including those entities within both the CT and the Fixed Part (FP) which act on behalf of the user to provide protocol translation and autonomous actions such as location registration requests and responses to authentication requests.

Fixed Part (FP): A physical grouping of some or all of the fixed component parts of mobile radio system. These would include one or more radio equipments attached to an antenna system. It could also include common control functions and interfaces to the PTNX.

NOTE: The use of FP in this ETR does not preclude the integration of this physical grouping within a PTNX.

Home Data Base (HDB): The data base in which the current location and all associated parameters of a CT is stored.

home PTNX: The PTNX which has direct access to the HDB for a particular CTM user.

Q interface SIGnalling protocol (QSIG): The generic term describing the signalling information flows (i.e., not a specific protocol) within a DQ- channel.

Signalling over the S reference point (SSIG): The generic term describing the signalling information flows (i.e., not a specific protocol) within a D_S- channel.

visited area: The coverage area controlled by the Visitor Data Base(VDB).

Visitor Data Base (VDB): The database in which all relevant parameters concerning a CT are stored as long as they are in an area controlled by this database.

visitor PTNX: The PTNX which has direct access to the VDB currently associated with a particular CTM user.

3.2 Abbreviations

For the purposes of this ETR the following abbreviations apply:

ANF	Additional Network Feature
ANF-CTMI, CTMI	Incoming CTM call handling Additional Network Feature
ANF-CTMO, CTMO	Outgoing CTM call handling Additional Network Feature
ANF-CTSP, CTSP	Transfer of Service Profile Additional Network Feature
CC	Call Control
CCA	Call Control Agent
CIPCL	Call Intrusion Protection and Capability Levels
CT	Cordless Terminal, generic term
CT2	Second generation Cordless Terminal
CTM	Cordless Terminal Mobility
DECT	Digital European Cordless Telecommunications
FP	Fixed Part
HDB	Home Data Base
IMSI	International Mobile Station Identifier
IPUI	International Portable User Identity
LID	Link IDentification code
PARK	Portable Access Right Key
PTN	Private Telecommunication Network
PTNX	Private Telecommunication Network Exchange
QSIG	SIGnalling over the Q-reference point
SS	Supplementary Service
SS-CTAT, CTAT	Supplementary Service Authentication of a CTM user
SS-CTAN, CTAN	Supplementary Service Authentication of a PTN
SS-CTLR, CTLR	Supplementary Service Cordless Terminal Location registration
SS-DND	Supplementary Service Do-Not-Disturb
SSIG	Signalling over the S reference point
VDB	Visitor Data Base

4 Introduction to CTM

4.1 Overview

The purpose of CTM is to enable users of CTs to make and receive calls from any location within the PTN where coverage is provided. It is intended that it should be possible to add CTM functionality to those parts of a PTN where it is required without modification to any other part of the network.

Mobility functions are confined to two places in the PTN for a given CT:

- the home area: which consists of the home PTNX and the Home Data Base (HDB);

- the currently visited area: which includes the visitor PTNX, the Visitor Data Base (VDB), and part of the radio system (i.e., a scenario dependent part of the Fixed Part (FP)).

It is assumed that no changes are necessary to any entity of the PTN not involved in the provision of mobility.

4.2 Model

The following model shows how CTM related entities are integrated into the PTN. It is intended to show the basic concepts of CTM and should not be interpreted as a formal architecture model.

The model is based on the concept of HDB and VDB, which store all the mobility relevant data for each CTM user.

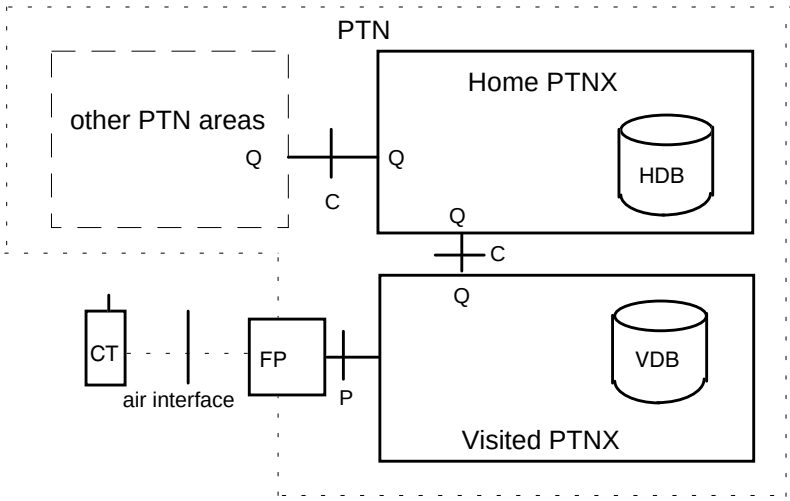

Figure 1: Overall block diagram of a PTN supporting CTM

The reference points shown in the model above (see Figure 1) refers to logical divisions between functional groupings and need not be associated with any physical interface.

A roaming CT is temporarily associated with an access at the PTNX currently visited, while it is registered there. Knowledge of the visited area is stored in the CT's HDB at the time of location registration. The access to be used is stored in the VDB at the visited area and is updated locally when the access changes (roaming within the visited area).

4.3 Identification of CTs

Each CT is permanently associated with its home PTNX as if it were a terminal attached to that PTNX. Thus the CT can be made an addressable entity by assigning a PTN number from the number range of the home PTNX to it, which allows every other PTNX to route calls to that CT.

To accommodate certain implementation scenarios it is possible to assign to a terminal an identifier which is permanent but which is not a PTN number. Such a facility would be used with CTs which are unable to support user-assigned identifiers or in situations where interworking with other (public) networks is a requirement. This identifier is used to determine the CTM user's entry in the HDB and has a one-to-one relationship with the PTN number which is used for routeing purposes.

NOTE: This does not prevent scenarios where the same number can be assigned to a user's CT and fixed terminal at the same time. The home PTNX can take a local decision which of the two is to receive an incoming call or it can decide to ring at both terminals in parallel.

5 Basic service considerations

5.1 Provision of basic services

For the purpose of this ETR, basic services are the telecommunication services defined in ETS 300 171 [1]:

- circuit-mode 64 kbit/s unrestricted, circuit-mode 3,1 kHz audio and circuit-mode speech;

- telephony 3,1 kHz, telefax group 4, and circuit-mode syntax-based videotext, based on these bearer services.

Introducing CTM in a PTN should not force the PTN to provide any other services than these basic ones.

If the capabilities of the radio system differ from the basic services provided by the PTN, the necessary interworking functions ought to be located in the FP of the radio system.

5.2 Basic call procedures for CTM

The basic call procedures can be re-used for CTM calls without changes if the extra functionality needed is added in the following form:

- standardised supplementary services and Additional Network Features (ANFs); and

- implementation specific local procedures.

This approach is a well established principle for enhancing the services offered by PTNs.

6 Supplementary service considerations

6.1 Overview of CTM Roaming supplementary services and ANFs

CTM is facilitated by several supplementary services and ANFs, which together with basic Call Control (CC), support the functions of CTM roaming:

- CTM call handling;

- location handling;

- authentication.

6.1.1 CTM call handling

CTM call handling comprises two ANFs: Incoming CTM Call Handling (CTMI) for calls destined for a CTM user, and Outgoing CTM Call Handling (CTMO) for calls originated by a CTM user:

- ANF-CTMI performs the necessary actions to route a call to a roaming CTM user's current location (also referred to as visited location), such as looking up data bases and redirecting the call;

- ANF-CTMO assists calls made by a CTM user, by verifying the identity supplied by the CTM user at the visited location and providing its service profile or redirecting the call to the user's home PTNX for processing.

6.1.2 Location handling

Location handling consists of the supplementary service Cordless Terminal Location Registration (CTLR) and the ANF Transfer of Service Profile (CTSP):

- SS-CTLR updates the location information in the HDB and VDB if the CTM user registers at a new location area or deregisters from the network;

- ANF-CTSP enables transfer of service profile information between the HDB and VDB.

6.1.3 Authentication

Authentication comprises the supplementary services: authentication of a CTM user (CTAT) and Authentication of a PTN (CTAN) for authenticating the CT and the network:

- SS-CTAT enables the network to validate the identity provided by the CTM user;

- SS-CTAN enables the CTM user to validate the identity of the network.

6.1.4 Relationships between CTM supplementary services and ANFs

Figures 2 and 3 show possible relationships among the services listed above. Input and output signals represent stimuli as seen from the PTN. Arrows represent control flows. Shaded boxes represent optional services, i.e., the service may or may not be invoked at that point.

In the figures below CTM Idle represents a state where the CTM user's location is not known and CTM Registered represents the state when the CTM user's location is known.

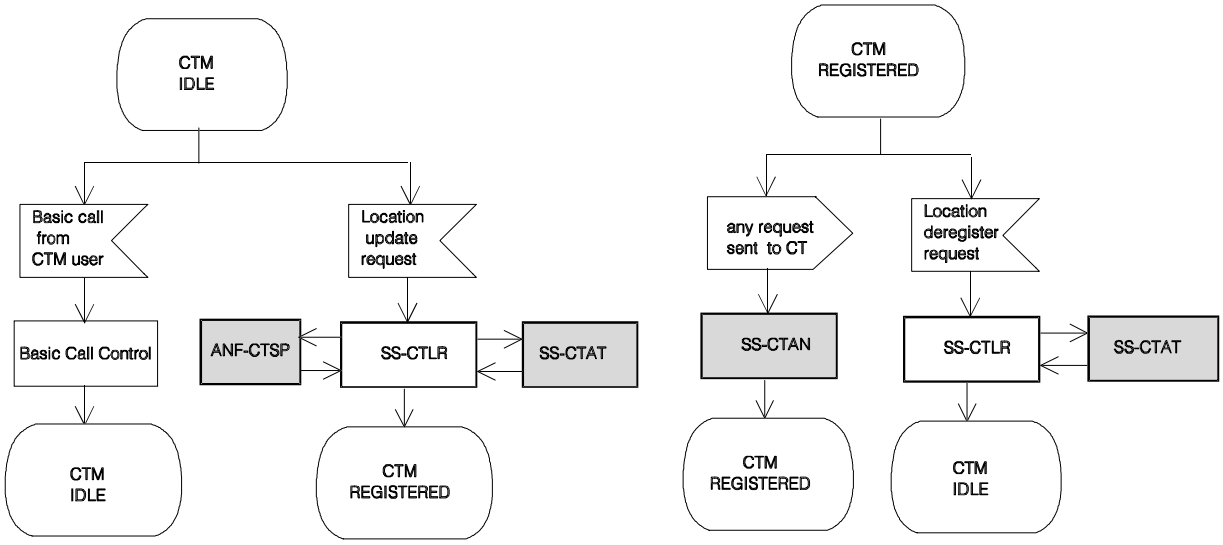

Figure 2: Relationship of CTM services

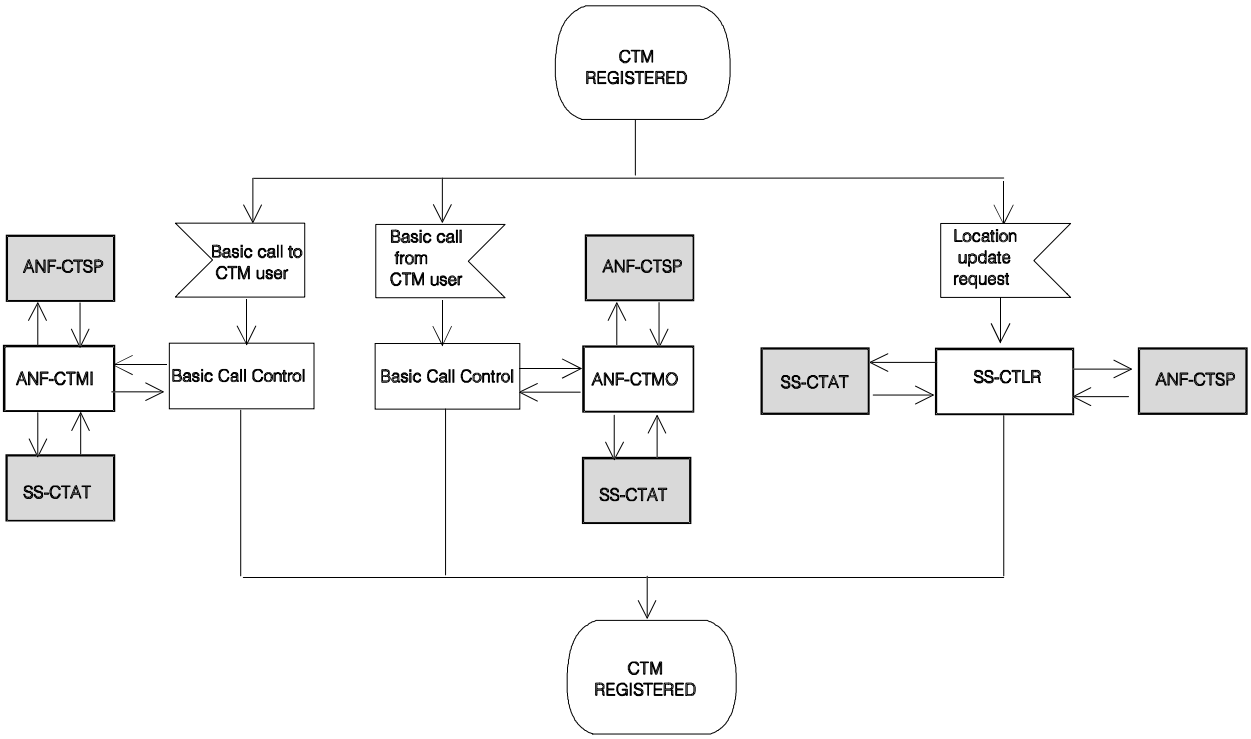

Figure 3: Relationship of CTM services (concluded)

6.2 Interactions considered in CTM Stage 1 standards

Although a wide range of existing and planned supplementary services are considered in this ETR, only a limited set was used as a basis for the interactions defined in the stage 1 standards for CTM call handling, location handling and authentication. This set, shown in table 1, included only those supplementary services and ANFs that were already published as ETSI or ECMA standards.

Table 1: Summary of status of PTN supplementary service and ANF standards

Name Date: February 1994	Acronym	Standard
Calling Line Identification Presentation	SS-CLIP	ETS 300 173
Connected Line Identification Presentation	SS-COLP	ETS 300 173
Calling Line Identification Restriction	SS-CLIR	ETS 300 173
Connected Line Identification Restriction	SS-COLR	ETS 300 173
Calling Name Identification Presentation	SS-CNIP	ETS 300 237
Connected Name Identification Presentation	SS-CONP	ETS 300 237
Calling/Connected Name Identification Restriction	SS-CNIR	ETS 300 237
Call Forwarding Unconditional	SS-CFU	ETS 300 256
Call Forwarding on Busy	SS-CFB	ETS 300 256
Call Forwarding on No Reply	SS-CFNR	ETS 300 256
Call Transfer	SS-CT	ETS 300 260
Path Replacement	ANF-PR	ETS 300 258
Call Completion to a Busy Subscriber	SS-CCBS	ETS 300 365
Call Completion on No Reply	SS-CCNR	ETS 300 365
Call Offer	SS-CO	ETS 300 361
Do-Not-Disturb	SS-DND	ETS 300 363
Do-Not-Disturb Override	SS-DNDO	ETS 300 363
Call Intrusion	SS-CI	ECMA 202
Advice Of Charge	SS-AOC	
Recall	SS-RE	
Call Interception	ANF-CINT	
Route Restriction	ANF-RR	
Night Service	SS-NS	
Call Distribution to the Attendant	SS-CDA	
Conference Call Add-On	SS-CONF	ETS 300 365
User-to-User Signalling	SS-UUS	
Controlled Diversion	SS-CDIV	ETS 300 256
Controlled Diversion Consult	SS-CDIVC	ETS 300 256
Call Deflection	SS-CD	
	-	
Common Information	ANF-?	
Supervisory Information Presentation	SS-SIP	
Alternative Routeing Indication	ANF-ARI	
Routeing	ANF-?	
Serial Call	SS-SC	
In-call Modification	SS-IM	
Source Routeing	ANF-SR	

NOTE: Route Restriction and Call Barring are currently ill-defined and may, in fact be local procedures. Their data structures will, however, form an important part of the service profiles that will be needed to be moved from PTNX to PTNX to support CTM.
Multiple Subscriber Number procedures have been incorporated into QSIG basic call.
Call Hold, Call Waiting and Terminal Portability are considered to be local procedures in a PTN not requiring standardisation. However, if CTM is implemented, the Call Hold and Call Waiting supplementary services may be required to be standardised at the P reference point.

6.3 General issues

The provision of standardised supplementary services, where one or more of the involved users is a CTM user, can present a number of problems in their implementation. This subclause identifies some of the general issues which should be considered and then looks at certain specific services which put forward particular difficulties when CTM users are involved.

6.3.1 Access to supplementary services

One of the most obvious problems likely to be encountered by CTM users, as they roam from one PTNX to another, is the difference in supplementary service access methods implemented by the various manufacturers.

Careful network planning and management can, in many cases, be used to provide unified user procedures throughout the network but this is likely to be more difficult where:

- CTM is introduced to an established PTN of fixed users as the co-ordination of user procedures is of considerably less importance when all user terminals are static. Also, there may be some resistance to change among the existing users;

- some terminals or PTNXs within the network implement fixed user procedures set by the manufacturer and are not available for customisation.

The rationalisation of user procedures is, however, a difficult problem to deal with. While complying with the QSIG standards for supplementary service signalling between PTNXs, each manufacturer is likely to offer access to the services in slightly different ways. The reason is:

- firstly, there are three generic procedures for network access protocols (i.e., the protocol between network and terminal equipment): functional procedures, the keypad stimulus protocol and the feature key management stimulus protocol; and

- secondly, even if the same generic method is used, there is still scope for differences, since in the stimulus protocol case no specific procedures are standardised for individual supplementary services, and standardised functional procedures are so far defined for public Integrated Services Digital Network (ISDN) terminals only and for very few services.

This could cause confusion to roaming CTM users as they try to invoke supplementary services at different points within the PTN.

One way to overcome this problem is to create a homogeneous environment for roaming CTM users, e.g., by ensuring that all PTNXs supporting CTM in a network, all fixed radio equipment and, all CTs are from a single manufacturer and of a similar mark (in many instances this will not be considered as a practical solution), or by specifying standards for the access procedures (which is a long term goal rather than a practical alternative for the near future).

Another option is to ensure that the CTM user's home PTNX is always accessed to provide supplementary services. For many services this would be quite acceptable and a very practical solution, but for others, the processing and signalling overheads necessary for maintaining user status at the home PTNX would be intolerable. Subclause 6.4 discusses in more detail some specific problems.

A further option is to make use of the functional protocols defined for the public ISDN. CTs would have to support these protocols and there would need to be a mapping between functional and stimulus signalling at the P reference point. Such mapping is not standardised and, as mentioned above, only a few supplementary service protocols have been published in standards. CTs and FPs would need to be upgraded whenever the functional protocols for a new service are published. The cost of keeping these up-to-date could be too high, unless or until a method of downloading a CT on-line can be devised.

6.3.2 Service options

PTN standards specify in many cases the mandatory core of a supplementary service and optional features, which an implementation may support in addition to the basic core. A manufacturer may provide further proprietary enhancements of the supplementary service. For instance, the core of Call Forwarding Unconditional (CFU) is that all calls or all calls associated with a specific basic service are diverted to

another PTN address. Standard options are the provision of notifications, interrogation procedures, etc. A manufacturer may further offer the non-standardised possibility to specify different diverted-to numbers based on certain call criteria, e.g., external versus internal calls, while still complying with the basic core of CFU.

The consistent provision of standard and proprietary service options for roaming CTM users faces similar difficulties as discussed in subclause 6.3.1. Invoking the supplementary service at the home PTNX, regardless of the CTM user's actual location, again seems a good solution in some cases. For more details see subclause 6.4.

6.3.3 Dynamic registration and service related data

Some existing supplementary services allow the served user to register data that are then used in the invocation of the service. An example is the diverted-to user's address in the Call Diversion services. Once registered, this information should continue to be associated with the CTM user regardless of the user's movements within the PTN.

Other supplementary services rely on data stored in association with a specific service invocation, which also should "follow" the CTM user when changing location. An example is the queue of outstanding call completion requests.

In both cases this may prove to be difficult in a multi-vendor environment where such data may be stored and processed in quite different ways. There seems to be no simple solution to this problem other than imposing constraints on the use of such services by CTM users.

6.3.4 Destination PTNX: home PTNX versus visitor PTNX

Many supplementary services require actions from the destination PTNX of a call. In the CTM case it is not so obvious what should be regarded the destination PTNX, since the CTM user "exists" twice in the PTN. In a logical sense it would be the home PTNX, as it holds the CTM user's permanent "image". From a call termination point of view it would be the visitor PTNX, as this is the CTM user's current physical location. The determination of which interpretation is more suitable should be made on a case-by-case basis.

If the visitor PTNX is chosen, the following considerations are worthy of note in almost all cases:

- the service may not be available to a served CTM user at all locations;

- the subscribed options by the served CTM user may not be offered at all visitor PTNXs;

- user procedures may differ from PTNX to PTNX.

6.4 Specific supplementary service considerations

The following subclause deals with possible problems and other considerations to be taken into account when implementing existing PTN supplementary services and ANFs in a CTM environment.

6.4.1 Call diversion services

The call diversion services already provide for remote activation and deactivation but the problems associated with varying user procedures and service options as described in subclauses 6.3.1 and 6.3.2 still apply.

It is worth considering the three call forwarding services separately as their requirements for operating with CTM users are different.

6.4.1.1 Call Forward Unconditional (SS-CFU)

NOTE: In the context of mobility, activation and deactivation can also be performed remotely by the served user at a location other than the home location.

6.4.1.1.1 Service description

Once CFU has been activated, all incoming calls to the served user or just those relating to a specific basic service, are diverted to another destination defined by a PTN number and, optionally, a subaddress, specified at the time of activation of the service. Incoming calls are diverted immediately, independently of whether the served user is busy or free. A diversion according to SS-CFU may be concatenated with one or more other diversions.

Activation and deactivation of this service can be performed by the served user (locally) or by another authorised user (remotely).

Diversion can be achieved by forward switching (routeing onwards from the served user's PTNX) or by re-routeing from the originating PTNX.

6.4.1.1.2 Interactions

SS-CFU is the simplest of the three services to consider. A call arriving at the CTM user's home PTNX, when the CTM user has activated SS-CFU, can be detected and diverted without any attempt to reach the current visitor PTNX, i.e., SS-CFU is invoked at the home PTNX.

6.4.1.2 Call Forward on Busy (SS-CFB)

6.4.1.2.1 Service description

If the served user is busy and SS-CFB has been activated, all incoming calls to the served user or just those relating to a specific basic service, are diverted to another destination defined by a PTN number, and optionally a subaddress, specified at the time of activation of the service. A diversion according to SS-CFB may be concatenated with one or more other diversions.

Activation and deactivation of this service can be performed by the served user (locally) or by another authorised user (remotely).

Diversion can be achieved by forward switching or by re-routeing from the originating PTNX.

6.4.1.2.2 Interactions

It is almost impossible for the home PTNX to be kept informed of the busy/free status of a roaming CTM user such that SS-CFB could be invoked prior to routeing to the visitor PTNX. This leaves a number of options for the provision of this service, all of which involve co-operation between the home and the visitor PTNXs:

a) **SS-CFB is always invoked at the visitor PTNX.** The home PTNX should ensure that the diverted-to number and the user's options for diversion are transferred to the new visitor PTNX before or at the time of the first incoming call to the CTM user, effectively deactivating SS-CFB at the old location and activating it at the new location.

NOTE: Activation of SS-CFB by the CTM user may be performed locally at a visitor PTNX, but in order to transfer the activation to a new location later on, the home PTNX should be made aware of it, e.g., by means of a procedure similar to remote SS-CFB activation or by invoking ANF-CTSP.

Assuming that the CTM user subscribes to a standard form of SS-CFB at the home PTNX, the following variations could be encountered at visitor PTNXs as the user roams within the PTN:

- PTNXs offering standard SS-CFB;

  Feature activation/deactivation procedures may differ but operation of the service should be identical.

- PTNXs offering a non-standard SS-CFB;

Feature activation/deactivation procedures are more likely to differ and the operation of the service may be similar but could be enhanced or simplified compared with the standard SS-CFB.

- PTNXs offering no SS-CFB service at all.

  In this case, of course, the CTM user's calls are not redirected if the user is busy.

b) **SS-CFB is activated at the home PTNX but invoked as part of the CTMI service at the visitor PTNX.** The home PTNX maintains all of the registration data and user options relating to SS-CFB and passes this information to the visitor PTNX with each incoming call as part of the CTMI information flows. If the CTM user is then determined to be busy, the CTMI service diverts the call from the visitor PTNX to the identified diverted-To user. This method of operation would require extensive modification to the proposed CTMI service and there would have to be a consistent means of accessing the home PTNX to activate and deactivate SS-CFB. However, the signalling and processing overheads are likely to be minimal and the CTM user can be guaranteed getting the same service at any point in the PTN if the service is available.

c) **calls to busy CTM users are re-directed back to the home PTNX for the invocation of SS-CFB.** Once again, the home PTNX maintains all of the registration data and user options relating to SS-CFB but only passes an indication that SS-CFB is available in the CTMI information flows. If the visitor PTNX determines that the CTM user is busy, it passes the call back to the home PTNX where SS-CFB can be invoked.

   If the PTN is configured such that, for a call where SS-CFB would be applicable, CTMI routes the call from the home PTNX by forward switching, this method is very simple to implement. A call to a busy user would normally be rejected with an appropriate indication and this can be detected by the home PTNX thereby causing SS-CFB to be invoked. In this case there is not even a need for CTMI to inform the visitor PTNX that SS-CFB is available.

   If, however, the call from the home PTNX was originally routed to the visitor PTNX by the re-routeing method, there is no certainty that the home PTNX will still be involved in the call at the time that the CTM user is determined to be busy. In this case, the visitor PTNX should use the CTM user's PTN address to direct the call back to the home PTNX with a suitable indication that SS-CFB is to be invoked.

d) **the visitor PTNX redirects a call to a busy CTM user following a dialogue with the home PTNX.** As with the previous two options, the home PTNX maintains all of the registration data and user options relating to SS-CFB. On encountering a busy CTM user, the visitor PTNX requests the SS-CFB options, diverted-to address and other related information from the home PTNX. It is then able to redirect the call itself even though control of the SS-CFB operation remains at the home PTNX.

6.4.1.3 Call Forward on No Reply (SS-CFNR)

6.4.1.3.1 Service description

If the served user fails to answer an incoming call within a predefined period and SS-CFNR has been activated, the call will be diverted to another destination defined by a PTN number, and optionally a subaddress, specified at the time of activation of the service. This conditional diversion may apply to all calls to the served user or just those relating to a specific basic service. A diversion according to SS-CFNR may be concatenated with one or more other diversions.

Activation and deactivation of this service can be performed by the served user (locally) or by another authorised user (remotely).

Diversion can be achieved by forward switching or by re-routeing from the originating PTNX.

6.4.1.3.2 Interactions

SS-CFNR presents similar operational difficulties to those seen in SS-CFB when the original called party is a CTM user.

The options considered are basically the same as those for SS-CFB:

- SS-CFNR is always invoked at the visitor PTNX. Same comments as for SS-CFB;

- SS-CFNR is activated at the home PTNX but invoked as part of the CTMI service at the visitor PTNX. Same comments as for SS-CFB;

- responsibility for processing unanswered CTM calls reverts to the home PTNX for the invocation of SS-CFNR after a suitable time-out. Using this method would imply that almost all calls to CTM users would need to be directed from the home PTNX by forward switching and this could be seen as very wasteful of resources;

- the visitor PTNX redirects an unanswered call to a CTM user following a dialogue with the home PTNX. Same comments as for SS-CFB.

6.4.2 Call Transfer (SS-CT)

6.4.2.1 Service description

SS-CT enables a PTN user who has two calls of the same basic service to connect the two other users together as a new call. One of the calls should be in the active state but the other call can be either active or alerting.

Transfer can be by means of "join", where the two connections are simply joined together at the served user's PTNX, or by rerouteing. In the latter case a new connection path is established between the PTNXs of the two users to be transferred and the original connection paths are released.

6.4.2.2 Interactions

There are no obvious operational difficulties involved in the use of SS-CT by CTM users. It is likely that the service would have to be executed at the visitor PTNX as route optimisation procedures may have removed the home PTNX from the call path by the time that SS-CT is invoked. Additionally, even if a path was to be found such that SS-CT could be invoked at the home PTNX, a "transfer by join" might leave a very complex overall call path. For such a simple service (from the user's point of view) with only limited options for variation in access methods, it is probably unnecessary to implement elaborate procedures to ensure that it is always invoked at the CTM user's home PTNX. However, this does not imply that careful implementation planning would not be necessary to ensure that a unified procedure is employed throughout a network.

6.4.3 Path Replacement (ANF-PR)

6.4.3.1 Service description

ANF-PR permits an active call's connection through the PTN to be replaced by a new connection in order to find a more efficient route. It is applicable to basic services where a temporary discontinuity in the transfer of user information can be tolerated, for example, speech and video. If unsuccessful, repeat attempts can be made at intervals as long as the call remains active.

6.4.3.2 Interactions

No significant interactions or considerations.

6.4.4 Call completion services

6.4.4.1 Service description

Call Completion enables a calling user (user A), whose call to user B met a busy condition (Call Completion to Busy Subscriber, SS-CCBS) or was not answered (Call Completion on No Reply, SS-CCNR), to be informed when user B becomes available and to have the original call established. Although several options exist for the operation of this service in a PTN, it is always an end-to-end service between originating and terminating PTNX. One way of operating, which is the only method used in the public ISDN, requires that a signalling connection is maintained between both PTNXs until the service

completes. Regardless of the method used, both end PTNXs have to store information relating to the call completion request, possibly in a queue of similar requests invoked by or against that particular user. The terminating PTNX has to monitor the status of user B, while the originating PTNX runs a service duration timer and cancels the request upon expiry of the timer. All these tasks are implementation specific and also involve local interaction with the terminals concerned.

The network signalling protocol has to be able to convey requests for monitoring a destination, requests to cancel monitoring, and indications that the destination is no longer busy or has been used and is free again. The protocol also has to be able to support reservation of the path for the call and the completion of the call when the calling user has responded to the recall.

6.4.4.2 Interactions

This brief outline already shows the difficulties that arise if one of the users is a CTM user, in which case the end PTNX (originating or terminating) would be the visitor PTNX. If the CTM user roams to a new location and the call completion service is to continue, the new visitor PTNX would have to carry on the tasks that were started in an implementation dependent way at the previous location, and also interact with the terminal consistently. If a signalling connection is maintained this connection would have to be handed over (transferred) to the new visitor PTNX (such a handover or transfer capability is currently not defined).

A simple solution would be to cancel the call completion request if the CTM user roamed to a new visitor PTNX before the CC recall occurs (call completion could be cancelled for other reasons, too, e.g., if the called user invoked SS-DND). This limitation might be unacceptable where CTM users frequently move from one Visited Area to another but in most cases it would be satisfactory.

In order to overcome the problem of cancelling a large proportion of call completion requests for very mobile users, two approaches can be considered:

a) **invoking call completion at the CTM user's home PTNX.** This turns out not to be a practical option for two main reasons:

   - it would be very difficult for the home PTNX to monitor the status of a called CTM user on whom SS-CCBS or SS-CCNR had been invoked;

   - existing call completion procedures do not provide for actions separated from the local end PTNXs.

b) **transferring a call completion request or indication between visitor PTNXs with each location registration.** Unless it can be guaranteed that each visitor PTNX is from a single manufacturer and of a similar mark, this, too, is an impractical approach as implementations of call completion services are likely to differ considerably between manufacturers.

6.4.4.2.1 Call Completion to a Busy Subscriber (SS-CCBS)

The options which exist for SS-CCBS are as follows:

- accept the limitation that SS-CCBS is cancelled when the CTM user roams to a new visited area;

- where the CTM user is the served user, use the call offer service instead of SS-CCBS;

- where the CTM user is the served user or the called user, use a non-standard service such as message waiting or mail-box.

6.4.4.2.2 Call Completion on No Reply (SS-CCNR)

In order to offer some level of SS-CCNR service to a roaming CTM user, there are also a number of similar options that may be considered:

- accept the limitation that SS-CCNR is cancelled when the CTM user roams to a new visited area;

- where the CTM user is the served user or the called user, use a non-standard service such as message waiting or mail-box.

6.4.5 Call Offer (SS-CO)

6.4.5.1 Service description

SS-CO permits a calling user to request that the call be offered to the user at the busy destination and that the called user be given the choice of accepting, rejecting or ignoring the offered call.

A PTNX can offer its users one or more of four different ways of invoking SS-CO:

- automatically and instantly on every call meeting busy;
- automatically after a timeout if a call met busy;
- instantly on a call meeting busy if the calling user included a SS-CO request in the SETUP message;
- after consulting the calling user when meeting busy.

These different ways can be regarded as service options which the served user of SS-CO (the calling user) can subscribe to.

6.4.5.2 Interactions

There are no significant interactions between the SS-CO and the CTM services regardless of whether the CTM user is the calling user or the called user. The only consideration worthy of note is that, SS-CO can only be invoked at the visitor PTNX.

Repeated SS-CO requests against the same called CTM user will sometimes succeed and sometimes fail, depending on whether the current visitor PTNX supports SS-CO or not.

6.4.6 Do-Not-Disturb services

6.4.6.1 Do-Not-Disturb (SS-DND)

6.4.6.1.1 Service description

SS-DND allows the served (called) user to have all calls or just those relating to a specific basic service rejected by the PTN. The calling user is given an appropriate indication.

SS-DND may be overridden by means of SS-DNDO (see below), if the calling user has a sufficient capability level. The served user of SS-DND may be given different levels of protection against override of SS-DND by SS-DNDO.

Activation and deactivation of this service can be performed by the served user (locally) or by another authorised user (remotely).

6.4.6.1.2 Interactions

If the calling user is a CTM user no special considerations apply, other than the ones raised about consistent service appearance, in this case with regard to the visitor PTNX providing notifications and/or tones or announcements.

If the called user is a CTM user, the Do-Not-Disturb service could be invoked at either the home PTNX or the visitor PTNX.

a) **SS-DND invoked at home PTNX.** In this case, the existing procedures for remote activation or deactivation would be used, Operation of the service would be quite effective and easy to implement for the following reasons:

   - once activated, no further signalling is required between home PTNX and any visitor PTNX, not even in the case of location changes, until the service is deactivated;

- incoming calls could be rejected at the home PTNX before being routed through the network to the visitor PTNX;

- the user interface and the operation of the service would be consistent as it would always run at the same PTNX;

- the service would always be available to a subscribing user regardless of the capabilities of the visitor PTNX.

b) **SS-DND invoked at the visitor PTNX.** Assuming that the service is available at the visitor PTNX, activation or deactivation is a local procedure. However, network signalling is usually still required in order to make the home PTNX aware of the activation and deactivation; either SS-DND remote procedures or ANF-CTSP could be used for that purpose. Operation of the service in this way has the following drawbacks:

   - with every location change, SS-DND will have to be activated again at the new visitor PTNX, e.g., as part of the location update procedures;

   - calls to the CTM user would have to be routed as far as the visitor PTNX before being rejected as a result of SS-DND;

   - as with all services, the user interface might not be consistent between PTNXs;

   - a visitor PTNX may not support SS-DND;

   - support of subscription options, e.g., override protection levels (DNDPL), may not be compatible. The SS-DND standard requires only that DNDPL 0 and 3 shall be supported. A CTM user assigned a protection level of 1 or 2 at the home PTNX may have to accept a different level of protection at a visitor PTNX which supports only the mandatory values.

6.4.6.2 Do-Not-Disturb Override (SS-DNDO)

6.4.6.2.1 Service description

SS-DNDO enables a served (calling) user to override the SS-DND condition and cause the call to continue as if SS-DND had not been encountered. Various levels of override capability can be given to served users allowing the override of different levels of protection associated with users of SS-DND.

A PTNX can offer its users one or more of three different ways of invoking SS-DNDO:

- automatically on a call meeting SS-DND at the called user;

- instantly if the calling user included a SS-DNDO request in the SETUP;

- after consulting the calling user when a call met SS-DND at the called user.

These different ways can be regarded as service options which the served users of SS-DNDO can subscribe to.

For the actual operation of SS-DNDO the PTNX can implement the service with or without the path retention method. In the first case the call is retained after meeting SS-DND and used for the invocation of SS-DNDO, in the second case it is released, with the SS-DNDO invocation using a new call.

6.4.6.2.2 Interactions

Invocation of SS-DNDO by a calling CTM user is similar to invoking SS-CO. Therefore, the considerations of subclause 6.4.5 apply here accordingly.

In the case that SS-DNDO is invoked on a CTM user having SS-DND active, the service ought to operate at the same PTNX as SS-DND (see subclause 6.4.6.1):

- if this is the home PTNX and SS-DNDO is allowed (i.e., the CTM user's SS-DND protection level is lower than the SS-DNDO capability level of the calling user) the call should be routed to the visitor PTNX as if SS-DND were not active. Using the path retention method in this case means that the path is retained only between the originating PTNX and the home PTNX. If the path is also to be retained for SS-CO or SS-CI, the appropriate request should be included in the SETUP to the visitor PTNX after SS-DNDO has been invoked successfully;

- If SS-DND operates at the visitor PTNX, SS-DNDO does not seem to cause any additional complications.

6.4.7 Call Intrusion (SS-CI)

6.4.7.1 Service description

SS-CI permits a calling user to request immediate connection to a busy destination. This may involve joining the new call in conference with the existing call or, alternatively, may cause the existing call to be placed on hold. The original call is restored on withdrawal of the served user.

Once intrusion has occurred, the calling user may, optionally, have the authority to request that the unwanted user is released from the call.

Served users can be given different intrusion capability levels and other users may be given protection against their calls being intruded upon. Different levels of intrusion protection can protect against different levels of authority to intrude as indicated in table 2.

Table 2: Relationship between Call Intrusion Protection and Capability Levels (CIPCL)

		Capability level		
		1	2	3
Protection Level	0	✓	✓	✓
	1	×	✓	✓
	2	×	×	✓
	3	×	×	×
✓ Intrusion possible × Intrusion not possible				

The network can offer the served (calling) user two different ways to invoke SS-CI; immediately with the call setup, if the call meets busy, or after consultation when the call meets busy.

Support of subscription options, e.g., override protection levels (CIPCL), may not be compatible. The SS-CI standard requires only that CIPCL levels 0 and 3 shall be supported. A CTM user assigned a protection level of 1 or 2 at the home PTNX may have to accept a different level of protection at a visitor PTNX which supports only the mandatory values.

6.4.7.2 Interactions

There are no significant interactions between the SS-CI and the CTM services regardless of whether the CTM user is intruding or being intruded upon. As SS-CI can only be invoked at the visitor PTNX for a CTM user, it is worth noting the following important considerations:

- the service may not be available to a calling CTM user at all locations;

- the subscribed options by the calling CTM user (e.g., immediate invocation on busy) may not be offered at all visitor PTNXs;

- the procedures for manual invocation by the calling CTM user may differ from PTNX to PTNX;

- a visitor PTNX may not support the particular capability level (CICL) the calling user has at his home PTNX;

- at any visited location which supports SS-CI the CTM user should be provided with an intrusion protection level (CIPL) at least as high as the user subscribes to at the home PTNX;

- if the CTM user is the unwanted party in an intrusion attempt and the visitor PTNX does not support SS-CI, the CTM user would have no protection against intrusion. In this case the protection level could be provided from the home PTNX, acting as the unwanted-user-PTNX of SS-CI. However, with the existing SS-CI procedures this is only possible if the home PTNX is on the call path of the unwanted call, which cannot be assumed to be generally the case.

6.4.8 Advice Of Charge (SS-AOC)

NOTE: The definition of this service for PTNs is not yet stable so this subclause should be considered as speculative.

6.4.8.1 Service description

SS-AOC allows the served user to receive information concerning charges for a call. Three versions of the service provide information on:

- charging rates at call establishment time and changes to the charging rates during a call;

- cumulative charge information automatically or on request during a call;

- final charge information when the call is released.

The main interest in this service is the provision of information on charges incurred in the public network on a call-by-call basis.

6.4.8.2 Interactions

No significant interactions or considerations.

6.4.9 Recall (SS-RE)

6.4.9.1 Service description

SS-RE is used to redirect a transferred call back to the served user if the call is unanswered within a predetermined period.

In this service the following notation is used:

- User A: The served user of both SS-RE and SS-CT;

- User B: The user having a call with User A in active state prior to transfer;

- User C: The transferred-to user, being alerted or busy.

6.4.9.2 Interactions

There are no significant interactions to be considered when User B or User C in the SS-RE are CTM users.

SS-RE allows two options for processing a recall to the transferring user:

- the first option is to send a new SETUP message from User B to the served user (User A) to effect the recall. If this method is used, there would be no interactions to be considered when User A is also a CTM user. The recall SETUP message would be directed towards the home PTNX and would be processed as a normal incoming call regardless of the CTM user's present location;

- the second option is to signal to User A from the local PTNX if User C fails to respond. In most cases, the recall timers will be 30 s or less and it would, therefore, be unlikely that User A would

roam to a new visitor area in this time. If, however, this were to occur, it would be reasonable to allow the recall to fail or to invoke some other implementation specific exceptional procedure.

6.4.10 Call Intercept (ANF-CINT)

6.4.10.1 Service description

ANF-CINT is particularly applicable to attendants. Certain types of call which encounter certain types of failure condition in the PTN are diverted to a designated user. The purpose of this is to provide further assistance to the calling user. The type of call to which the service applies are defined by the basic service(s) and the source of the call (e.g., intra-PTN, incoming calls from a public network). The particular failure conditions that lead to the invocation of this ANF are network and implementation dependent, but examples include:

- destination number unobtainable;
- no reply;
- call rejection.

Diversion can be achieved by forward switching from the PTNX that detects the failure condition or by re-routeing from the originating PTNX.

6.4.10.2 Interactions

No significant interactions or considerations.

NOTE: It would be very useful to have "CTM user out of range" added to the list of interception causes in the SS-CINT standards.

6.4.11 Night Service

NOTE: The definition of this service is not yet stable, so this subclause should be considered as speculative.

6.4.11.1 Attendant Night Mode (SS-NMA)

6.4.11.1.1 Service description

SS-NMA enables a user designated as an attendant to indicate to the PTN that he or she is either available or not available for handling attendant calls. When not available (SS-NMA), calls can be redirected to an alternative answering position. This service provides an equivalent to "Log-on" and "Log-off" procedures.

6.4.11.1.2 Interactions

Attendant night mode is a direct derivative of SS-CFU and, therefore, the same considerations described in subclause **Error! Bookmark not defined.** apply when a CTM user is acting as the attendant.

6.4.12 Call distribution to the attendant (SS-CDA)

NOTE: The definition of this service is not yet stable so this subclause should be considered as speculative.

6.4.12.1 Service description

SS-CDA provides for calls to attendants to be distributed between selected attendants and provides for the handling of calls when all eligible attendants are busy. A queue may be handled by a number of attendants (common queue) or by a single attendant (specific queue). Attendants can be linked together in attendant groups where each member of the group has equal responsibility for the calls queuing for the group.

Each call to an attendant is allocated to an appropriate call queue and, when one or more eligible attendants are available, presented to either a specific attendant or to a group of attendants.

There is no constraint on the geographical location of the members of an attendant group.

The relationship of "queues to attendant groups" and "attendant groups to attendants" can be as follows:

- limited attendant grouping: each attendant is a member of only one attendant group but each common queue can be serviced by one or more attendant groups;

- **l**imited queue association: an attendant may be a member of more than one attendant group but each queue is associated with only one attendant group.

6.4.12.2 Interactions

No significant interactions or considerations.

7 Management service consideration

A number of services providing management functions within a PTN have been identified in ECMA TR/Compendium [5] and ETR 048 [6]. The descriptions of these services are brief and no detailed standards have been published. This subclause, therefore, considers, in very general terms only, a selection of management services where the impact of CTM might be significant.

The management services considered are:

a) user aspects administration;

   - management and administration of services;

b) routeing administration;

   - dynamic management of routeing information;

c) tariff and charging administration;

   - management and administration tariff schemes and call charging data;

d) traffic management;

   - optimisation of traffic flows within a PTN;

e) management of PTN user access;

   - configuration, performance management and fault processing at the access termination points of a PTNX;

f) restoration and recovery;

   - returning PTN equipment to service following a fault condition or maintenance activity;

g) management of PTN network services;

   - configuration, performance management and fault processing of basic telecommunications services;

h) management of dialling/numbering plans;

- establishment of PTN numbering plans and the allocation of numbers to addressable entities;

i) management of mobility;

- management and administration of functions and information specific to CTM;

j) configuration of PTN supplementary services;

- configuration, performance management and fault processing of supplementary services and ANFs.

These services are considered individually in the following subclauses.

7.1 User aspects administration

The purpose of this management service is to allocate and administer telecommunications services (basic and supplementary services) to PTN users. Considerations related to CTM are:

- the ability to provide a flexible allocation of basic services between a CTM user's mobile terminal and a fixed access. As an example, voice may be allocated to the mobile terminal while G4 Fax is allocated to a fixed access;

- the ability to register a CTM user as a valid PTN user by creating a new entry in the appropriate HDB;

- "black listing"; i.e., the maintaining of a list of CTM users to whom no service whatsoever is to be provided;

- the ability to limit, for some users, the provision of mobility service to certain visitor PTNXs (a subset of the full range of visitor PTNXs);

- the ability to "ZAP", i.e., to remotely disable, a CT which the PTN determines should not be receiving service (possibly as a result of security, identity or access rights violations).

7.2 Routeing administration

This service enables a PTN manager to modify network routeing plans dynamically based on a variety of parameters such as time-of-day and traffic flows. The implementation of CTM has no significant impact on this management service although it is likely that there will be a greater proportion of inter-PTNX calls generated as a result of the routeing of CTM calls between the home PTNX and the visitor PTNX. This may require nothing more than careful planning of routeing tables.

7.3 Tariff and charging administration

This service manages the collection, aggregation and analysis of charging information received as a result of calls made through other networks (primarily, public networks). It is essential that charging information is allocated correctly to the accounting records of a CTM user regardless of where the user roams within the PTN.

7.4 Traffic management

The purpose of this service is to optimise the use of PTN resources to maximise traffic capacity under varying user demand conditions. With CTM implemented in a network, not only is the demand for traffic capacity variable, the relationship between users and PTNXs is also variable. This means that user densities at a given PTNX can change throughout the day, often quite dramatically. An example of this is a works cafeteria where the concentration of users is very high for one or two hours each day during meal breaks but almost negligible at other times.

The traffic management service should take into account these possible fluctuations in user densities caused by the implementation of CTM.

7.5 Management of PTN user access

This service provides a management function to a physical user access, independent of any specific user on the access. The functions provided include performance monitoring, configuration, alarm surveillance and fault supervision. In a CTM environment, the physical access between the PTNX and the FP would be managed by this service. Consideration needs to be given to the fact that the number of users making and receiving calls at an FP access is liable to continual change.

Alarm surveillance and failure supervision will have an added layer of complication as they will need to differentiate between alarm conditions and failures occurring in the FP and those which originate in the CT.

In PTNs where the FPs are more complex devices, configuration procedures may include the establishment of the initial conditions in any mapping or translation tables.

7.6 Restoration and recovery

This service is primarily concerned with bringing routes or other physical parts of a PTN back into service following a fault or maintenance activity. One of the aspects of restoration and recovery which should be considered for the case where CTM is implemented is the rebuilding of HDBs and VDBs to reflect either the last known locations of the CTM users or their current locations.

7.7 Management of PTN network services

Network services are those aspects of a PTN which are essential to its overall operation but which are not specifically call related. They include such things as operating systems and hot-standby monitoring and switching. Within a PTN offering CTM, it is reasonable to suppose that the access and maintenance mechanisms associated with the HDBs and VDBs would also fall into this category.

7.8 Management of numbering/dialling plans

This management service provides facilities for establishing network-wide numbering plans and for allocating individual numbers from within the overall plan to addressable entities. In a PTN offering CTM, the service will have to support the following procedures:

- the allocation of the same PTN number to a CTM user and to the associated HDB entry. This may involve interworking with other mobility management services to transmit the assigned PTN number to a user's CT;

- the allocation of a PTN number to each VDB as this is needed for the routeing of calls from the home PTNX through to the visitor PTNX and also for location registrations where the CT provides an alternative temporary identifier;

- the mapping of external CT identifiers such as the International Mobile Station Identifier (IMSI), International Portable User Identity (IPUI) of Digital European Cordless Telecommunications (DECT) or the Second generation Cordless Terminal (CT2) PID to PTN numbers within the PTN numbering plan.

It is important that this management service does not prevent the use of either a totally integrated numbering system for CTM users, thereby allowing a fixed user to keep the same PTN number when becoming a CTM user, or a scheme where CTM users are assigned to an exclusive numbering range using, for example, a specific prefix for all CTM users' PTN numbers.

7.9 Management of mobility

As a management service, the management of mobility exists only as a name with no definition of its capabilities listed yet (see ECMA TR/Compendium [5]).

The following function should be considered for inclusion in this service: communication with a CT at the time of initial registration within a PTN to establish the PTN number or other identifier to be used on the air interface in calls to and from the CTM user. DECT and CT2 have slightly different requirements, as shown below.

7.9.1 DECT

When registering in a network for the first time, a DECT terminal can request access rights from the FP. The request will include a default identifier and, optionally, cipher and authentication parameters, terminal capabilities and other non-specific user information.

The response from the network contains the identifier that the terminal should use until further notice (the IPUI) and at least one Portable Access Right Key (PARK) which defines the range of base stations accessible to the CT. Additional information may also be sent to the CT and this can include authentication and encryption parameters, class of service and other network-specific data.

7.9.2 CT2

When a CT2 terminal is registered on a system, it is necessary for the system to assign a CT2 specific identity called a Link IDentification code (LID) and for this identifier to be stored in the terminal.

Further information may also be stored in the terminal at registration time. This optional information includes parameters for authentication, class of service and network specific information of a non-standardised nature:

- the allocation of security keys to CTs and to HDBs for the purposes of encryption and authentication;

- the management of HDBs and VDBs in order to maintain the necessary formats and the appropriate structures. This would also include inserting initial data conditions as required.

7.10 Configuration of PTN supplementary services

The purpose of this service is to establish network-wide configuration options and default access procedures for all supplementary services implemented. In a CTM environment this could include:

- default service profiles to be used for roaming CTM users;

- the conditions under which outgoing calls from a CTM user should be routed towards the home PTNX;

- whether the use of temporary identifiers is enabled or not;

- in cases where the operation of certain supplementary services is restricted or inadvisable for CTM users (as described in subclause 6.4), the alternative services to be used or the extent of the restriction to CTM users.

8 Signalling considerations

The provision of CTM in a PTN can introduce some additional signalling requirements, depending on the distribution of CTM functions among physical entities. The following cases can be distinguished.

8.1 Signalling between PTNXs

This type of information exchange is part of the signalling system QSIG.

8.1.1 Location update (SS-CTLR, ANF-CTSP) and authentication (SS-CTAN, SS-CTAT)

The logical PTN entities involved in location update and authentication are HDB, VDB(s), and possibly some additional ones , e.g., for security parameter provision or identity translation. All these entities are located in - or accessible via - one or more PTNXs.

A QSIG protocol is only required if any two of the logical entities need to communicate with each other and are located in separate PTNXs. All information exchanges for location update and authentication are call independent (i.e., not directly related to any existing basic call). Therefore the protocols for SS-CTLR, ANF-CTSP, SS-CTAN and SS-CTAT will be based on the call independent connection oriented transport mechanism of QSIG generic procedures.

8.1.2 Incoming and outgoing CTM calls (ANF-CTMI, ANF-CTMO)

8.1.2.1 ANF-CTMI

Calls to a roaming CTM user may require the transport between PTNXs of the user's identity, as well as the address where the user is currently reachable. This additional signalling will be based on the call related transport mechanisms of QSIG generic procedures.

8.1.2.2 ANF-CTMO

Calls from a CTM user may be redirected to the user's home PTNX for processing. This procedure will also be based on call related signalling mechanisms of QSIG.

Some processing steps of ANF-CTMI and ANF-CTMO may involve an enquiry to the HDB from a PTNX separate from the home PTNX. This enquiry is independent of the CTM call itself, and the related signalling will be based on call independent transport mechanisms of QSIG generic procedures.

8.1.3 Supplementary service control

QSIG generic procedures are sufficient as a basis for all signalling in association with supplementary services involving a CTM user. As discussed in clause 6, the location of functional entities (i.e., the role of individual PTNXs in providing a supplementary service) may be different from the wired case, but the protocols themselves should not be affected.

8.2 Signalling between the PTN and the FP

If the FP is a physical equipment separated from a PTNX, a protocol is required across the P reference point. Three implementation options are considered in the following paragraphs:

- a reference point based upon symmetrical protocols;

- a reference point based upon non-symmetrical protocols;

- a non-PTN reference point.

8.2.1 Symmetrical protocol reference point

The P reference point could be based on an existing symmetrical reference point such as Q. It would not be required to support supplementary services and ANFs with the FP acting as an end PTNX, but additional functions specific to CTM would be necessary. The basic call would be based on QSIG.

Advantages:

- a full range of standards already exists for QSIG;

- functional generic procedures for the control of supplementary services already exist for QSIG.

Disadvantages:

- the existing PTN basic call model does not include an entity between the terminating PTNX (CC) and the user (Call Control Agent (CCA)). If the CCA function is considered to be in the CT then the existing model would expect the end CC to reside in the FP. This would imply that the FP should support all QSIG supplementary services as if it were an end PTNX unless a new type of functional entity specifically for FPs can be defined.

8.2.2 Non-symmetrical protocol reference point

As an alternative, the P reference point could be modelled on a non-symmetrical reference point such as S reference point at the coincident S and T reference point. Such an implementation would require that the S reference point is extended across the air interface from the terminating PTNX to the CT. Basic call would be based on Signalling over S reference point (SSIG) and additional functions specific to CTM would be necessary.

Advantages:

- standards already exist for SSIG basic call;

- this implementation is suitable for modelling the simple case where the CT does not have an S-bus extending from it (the DECT "End" case).

Disadvantages:

- SSIG standards are not available for most supplementary service functions;

- several generic procedures exist for S and S/T signalling (two stimulus protocols and one functional protocol) and it would be difficult to ensure that, within a PTN, all CTs, FPs and PTNXs complied with the same single protocol;

- this implementation would be unsuitable for modelling the more complex case where the CT has an S-bus extending from it (the DECT "Intermediate" case).

8.2.3 Non-PTN reference point (gateway)

If the visitor PTNX is considered as a gateway PTNX, the P reference point can then be defined as a non-PTN or non-ISDN reference point. The signalling protocols could be based on the specific technology used in the FP and CT.

Advantages:

- this implementation is suited to the existing interworking scenarios of supplementary services where the gateway PTNX acts as a control point;

- this implementation is suitable for modelling the more complex case where the CT has an S-bus extending from it (the DECT "Intermediate" case);

- standards exist within the current air-interface technologies for mobility related functions such as location registration and authentication;

- physical implementations of the FP could be very simple and would facilitate easy integration within the visitor PTNX.

Disadvantage:

- a signalling protocol would be required for each different air interface.

9 Numbering considerations

9.1 Addressable entities

When a PTN provides CTM, the following entities should be addressable by means of a PTN number (see ETS 300 189 [2]):

- individual CTM users and their HDB entries; usually the same number will be used to address a CTM user and the corresponding HDB entry;

- optionally, an HDB as a whole, e.g., if the CT identities used for location registration are IMSI-like;

- each VDB as a whole;

- optionally, a specific service such as identity translation, if located in a separate PTNX;

- optionally, each FP if required by an implementation.

Additional addressing requirements, e.g., for the support of temporary roaming numbers; are outside the scope of current PTN standardisation.

9.2 Number formats

The numbers used for addressing the entities listed in subclause 9.1 should be part of the numbering plan used for the PTN. This could be CCITT Recommendation E.164 [8] or a private numbering plan. The numbers can be used in explicit or implicit form.

In any case the numbers should be significant in the domain where CTM users are allowed to roam.

Example: Suppose a CTM user's home PTNX is PTNX A, which is part of a PTN with a 3-level explicit private numbering plan (see figure 4).

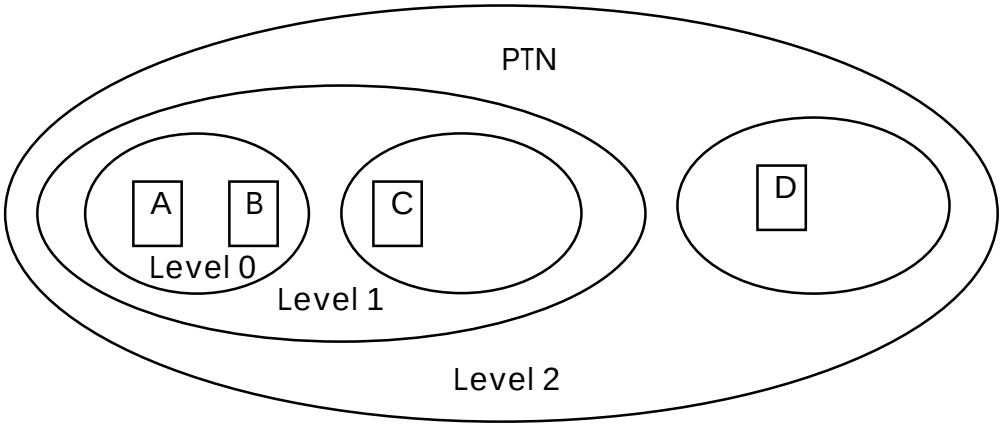

Figure 4: Example of a PTN numbering scheme

If roaming is only possible between PTNXs A and B sharing the same number domain, a local number (level 0) is sufficient for the CTM user. If the user may also roam to PTNX C, a level 1 regional number will be sufficient. If the user can roam to PTNX D as well, a complete (level 2) PTN number is needed.

If an implicit numbering plan is used in a PTN the numbers used for CTM users should include prefixes which are sufficient to identify the home PTNX unambiguously from every PTNX where the user may register.

9.3 Alternative identifiers

Additionally to PTN numbers other identities may be used to identify a CTM user when registering at a visitor PTNX. These identities have a one-to-one relationship to the CTM user's PTN number and should allow the visitor PTNX to determine the home PTNX, the previous visitor PTNX or a directory service where the identity can be translated into the PTN number. Alternative identifiers could include the following:

- IMSI as defined in CCITT Recommendation E.212 [7];

- a temporary identifier assigned by the PTN during a previous location registration;

- a technology dependent equipment identifier permanently assigned to the CT.

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