# A Personal Telecommunications System

## Field of the Invention

The invention relates to a personal telecommunications system (PCS) based on a fixed telecommunications network, such as a Public Switched Telephone Network, having a mobile communications system as an access network, connected to a local exchange.

## Background of the Invention

Various cellular radio systems enabling personal wireless data transmission have been in use for long. An example of the mobile communication systems is the European digital mobile communication system GSM (Global System for Mobile Communications). In addition, a new generation of radio systems is being developed, which are expected to further expand the possibilities of personal wireless communication. One of these systems under standardization is the Personal Communication System (PCS) in the United States. In accordance with the present expectations, there will be two types of PCS networks, namely traditional overlay type networks, and fixed ISDN and PSTN networks. There will be a number of alternatives for the radio interface, one of which is the GSM based PCS1900 (a GSM system operating within the frequency range of 1900 MHz).

Modification of an existing mobile communication standard (such as GSM or DCS1800) to a PCS-overlay network is a relatively straightforward process. Instead, more problems will be caused by PCS networks similar to the fixed ISDN and PSTN networks, employing a standard local exchange (LE) of the fixed network instead of a mobile services switching centre, such as an ISDN/PSTN based network is not directly

compatible with the GSM network architecture. The mobile services switching centre is the central entity of the network in a GSM based overlay network. In an ISDN/PSTN based network, however, the local exchange LE does not have any functions supporting the mobile communication network. In the future, the local exchange LE may be assumed to include a small set of general functions that support switching of mobile communication networks (non-call related signalling, handover switching support of some kind), but they are not necessarily very useful for meeting the requirements of the PCS1900 system, for instance.

A solution to this problem is disclosed in "Switching and signalling generic requirements for network access services to personal communication services (PCS) provider", GR-2801-CORE, Issue 1, December 1993, Bellcore, Bell Communications Research, particularly chapter 1, pp. 1 to 10, chapter 2, pp. 1 to 26, and chapter 3, pp. 133 to 137. In a Bellcore network disclosed in the above document, the radio interface is a wireless access communication system WACS (Bellcore TR INS-001313), which is connected to the local exchange of a fixed network. An intelligent network is connected to the local exchange, providing the local exchange with the service logic, the databases and the operations required for the mobility management of the access network. In other words, an AIN network (Advanced Intelligent Network) provides the subscriber database services, location management, authentication, access control etc. in an integrated manner. The basic features of call control are located in an ISDN local exchange, from which call control can initiate intelligent network operations in accordance with predetermined triggers via a standard AIN interface. The Bellcore system also supports handover,

which is referred by Bellcore to as "Automatic Link Transfer" (ALT). The aim of ALT is to ensure the continuity of a service to the user when the signal strength varies during an answered call. The signal strength may vary e.g. if a PCS user is moving, or if the conditions of the radio environment change. The aim of ALT is to enable the continuity of an answered ongoing call without interruption, and without the user taking any measures for performing an ALT or being aware of the fact the ALT has taken place. Chapter 3, pp. 133 to 138 of the above-mentioned document discloses an ALT procedure in which a local exchange operates as the "anchor point" of handover. In other words, when an ALT is carried out from an old base station system (IPS/RPCU) to a new base station system (IPS/RPCU), the connection to the old base station system is released in the exchange, and a new connection is established to the new base station system. In such a case, the local exchange for the fixed network is the anchor point of switching and signalling. The handover employing the local exchange as the anchor point may be carried out in new national ISDN exchanges having the required features. This handover concept, however, cannot be considered as an appropriate way of proceeding, particularly at the initial stage of the PCS systems, because most of the existing exchanges of the fixed network represent the older type, and it is not possible to guarantee the availability of exchanges that have the required features. Furthermore, problems are caused by the fact that a network element incompatible with the access network standard, such as the GSM, is used as the anchor point of handover connections.

**Disclosure of the Invention**

The object of the present invention is a

telecommunications system in which the control of the radio network access network is as independent of the features of the fixed local exchange as possible.

This is achieved with a telecommunications system comprising a local exchange of a fixed network, mobile stations, base station systems providing the mobile stations a wireless access network to the local exchange, each base station system comprising a base station controller and a plurality of base stations. The method is characterized in that

location management, radio resources management and/or handover control are concentrated in a group of two or more base station systems in one master base station controller, which controls the other base station controllers of the group.

In accordance with the invention, the highest level network element controlling the radio path is the base station controller. In several applications, the base station controller may be, however, too small a unit for location management, radio resources control, and/or handover control, for instance. According to the invention, these features are concentrated in a group of base station controllers in one master base station controller, which controls the other base station controllers of the group, lacking the above-mentioned features.

Alternative ways of implementing the invention would have been e.g. constructing a separate device for controlling the base stations, or performing the functions related to the radio path management in the service control point of the intelligent network. The above-mentioned alternative is attended by the drawback that the functions to be performed are highly radio path-specific, whereby it is not sensible to perform them in a public intelligent network, but it is more

natural that a manufacturer of the base station controllers also manufactures a unit for controlling them. As compared with a separate device for controlling the base station controllers, the invention allows lower manufacturing costs and signalling costs, since one base station controller controls itself. The invention also enables modification of "slave" base station controllers to independent base station controllers at a later stage if required due to their traffic load.

**Brief Description of the Drawings**

In the following, the invention will be described in more detail by means of preferred embodiments with reference to the attached drawings, in which

Figure 1 is a block diagram illustrating an ISDN-based PCS network in accordance with the invention,

Figure 2 is a block diagram illustrating dividing the functions of a mobile services switching centre into functional units, and allocating them to different network elements.

**The Preferred Embodiments of the Invention**

The basic principles of the invention may be applied to connecting any wireless access network to an intelligent network and to a local exchange of a fixed network. In the preferred embodiments of the invention, the access network is a radio system based on the GSM system, such as PCS1900. In other words, the access network is modified from the GSM mobile communications system or its 1800-MHz version DCS1800. As to the details of the GSM system, reference is made to the GSM recommendations and the book "The GSM System for Mobile Communications", M. Mouly & M. Pautet, Palaiseau, France, 1992, ISBN:2-9507190-0-0-7.

The block diagram of Figure 1 illustrates the network elements of the access network PCS1900 connected to the fixed network. The access network PCS1900 comprises base station systems BSS each comprising one base station controller BSC, and a plurality of base stations BTS. Base stations BTS communicate over the radio interface with personal stations PS (mobile stations). The radio interface between a personal station PS and a base station BTS, as well as the interface between the base station BTS and the base station controller BSC are similar to those in a conventional overlay PCS1900 system, and they are not paid closer attention to herein. Unlike in a conventional GSM-based network, however, base station controllers BSC are not connected to the mobile services switching centre MSC, but to the local exchange LE of a fixed network, such as ISDN or PSTN. In the preferred embodiments of the invention, the local exchange is an ISDN exchange. The local exchange LE, in turn, is connected to a service control point SCP of the advanced intelligent network AIN through a standard intelligent network connection. In some cases, the intelligent network is not required. In such a case, the local exchange itself may contain more intelligent functions. Further, the local exchange LE may be connected to the other local exchanges LE or trunk exchanges TX of the ISDN network, as normally.

A PCS network based on a fixed network is thus not directly compatible with the GSM architecture, as there is no mobile services switching centre MSC. In a conventional overlay mobile communications network, the mobile services switching centre MSC is the central unit of the network, but the local exchange of a fixed network does not support all of the MSC functionality. Therefore, in the present invention, the functions of

the mobile communications switching centre are divided into functional units, which are located in the base station controller BSC, except for the call control. In addition, by means of the intelligent network AIN, a function corresponding to the home location register HLR of the GSM system is provided, as well as part of a function corresponding to the visitor location register.

In the following, an example of dividing the original functions of the mobile communications system into functional units is described with reference to Figure 2, said functions being then re-allocated to physical network elements of an ISDN based PCS network. Functionally, the names of the units all end with letter F (function) in order to make a distinction between functional units, and physical network elements (BSC, SCP, LE,...) in which they may be located. In the following, each functional unit will be described briefly.

BSCF (Base Station Controller Function) corresponds to the normal BSC functionality in the GSM network.

BSCF+ (Base Station Controller Function Additions):

- divides the A-interface from the BSCF so that call control is assigned to LEF and other signalling to RSCF,
- carries out the switching operations related to handover (HO) acting as the anchor point for the switching operations,
- converts GSM based call control into ISDN call control,
- includes different possible interworking functions.

LEF (local exchange function) includes the standard functions of an ISDN local exchange LE

(National ISDN3 as a default). LEF may also support non-call related (NCA) signalling from the base station system BSS to the service control point SCP. In the preferred embodiment of the invention, no modifications are suggested to the standard LEF function because an ISDN based PCS1900 system should be able to operate under the ISDN local exchange LE of any standard fixed network.

RSCF (radio system control function) performs several tasks of the mobile services switching centre MSC. It controls radio resources (i.e. it generates e.g. assignment and handover commands, and controls the handover between base station controllers BSC or local exchanges LE). In addition, RSCF is also an interface unit between the A-interface protocols and MAP protocols.

HOF (handover decision function). This unit is separated from the RSCF in order to enable control of the handover process from an even higher level. However, the high-level decisions only, such as overload control, are made by the HOF. The actual handover is carried out by the BSCF+, and it is controlled by the RSCF.

VLRF (visitor location register function) is a traditional VLR divided into two parts: VLR1F and VLR2F. The upper part VLR2F of the VLR is located in the service control point SCP of the intelligent network, and the lower part VLR1F in the access network, more precisely in the base station controller. In accordance to the division that presently seems most preferable, the lower VLR1F handles authentication, location management, temporary identification, etc., whereas the upper VLR2F handles service control and other matters related to the user's profile.

SCF (service control function) is a standard

service control function SCF of the fixed network, providing the standard intelligent network services (AIN). Moreover, it has an ability to carry out location interrogations to the HLRF (corresponding to the gateway-MSC situation), and local location interrogations to the VLRF, as well as to co-operate with the VLRF for responding to AIN interrogations, etc.

The HLRF (home location register function) is a home location register in accordance with the GSM. In addition, the intelligent network comprises an EIRF (equipment identification register function), and possibly an SMS-GIWF (short message service gateway - interworking function), which are not paid closer attention to herein.

In accordance with the basic principle of the invention, an effort is made to concentrate location management, radio resources management, and handover control, for instance, in one base station controller, BSC, which controls one or more other base station controllers, so-called slaves. Figure 2 shows three BSC's, BSC1 operating as the master BSC, and BSC2 and BSC3 as the slave-BSC's.

It must be noted that functional units BSCF, BSCF+, and LEF only are used for handling the actual speech/data connections. These functional units located in the lower part of the functional model are bound to route connections (connection chain: BSCF, BSCF+, LEF). Therefore, each BSC must contain a BSCF and a BCSF+ unit. Call control, that is, an LEF unit must be included in the local exchange LE.

The other functional units handle signalling only, and they may therefore be allocated more freely.

In the preferred embodiment of the invention, the other functional units are distributed to the

network element in accordance with Figure 2: SCP contains units SCF and VLR2F; the master base station controller BSC1 contains an access manager AM containing units HOF and VLR1F. Alternatively, the entire VLRF may be located in the BSC or in the SCP. Base station controllers BSC2 and BSC3 are also through signalling connections 11 under control of the access manager AM of the master base station controller BSC1.

The preferred embodiment of the invention further comprises a new, alternative signalling route 10, which bypasses the local exchange LE between the base station controller BSC and the service control point SCP. This makes signalling between the BSC and the HLR simpler. The signalling interfaces LE-BSC and SCP-BSC are termed as C-interfaces. Signalling of a C-interface may use non-call related signalling of the ISDN network, or, alternatively, the network of a Signalling System Nr 7 (SS7) for the PCS-related signalling between the base station controller BSC and the intelligent network AIN.

The attached figures and the explanation associated therewith are only intended to illustrate the present invention. Although the invention has been disclosed with reference to certain embodiments, it is to be understood that the explanation is made by way of example only, and alterations and modifications are possible without deviating from the scope and the spirit of the attached claims.

Claims:

1. A telecommunications system comprising a local exchange (LE) of a fixed network, mobile stations (PS), base station systems (BCS,BTS), providing for the mobile stations a wireless access network to the local exchange, each base station system comprising a base station controller and a plurality of base stations, c h a r a c t e r i z e d in that location management, radio resources management and/or handover control (VLR1F, RSCF, HOF) are concentrated in a group of two or more base station systems in a master base station controller (BSC1), which controls the other base station controllers (BSC2, BSC3) of the group.

2. A telecommunications system as claimed in claim 1, c h a r a c t e r i z e d in that all the functionality of a GSM based visitor location register is located in the master base station controller.

3. A telecommunications system as claimed in claim 1, c h a r a c t e r i z e d by an intelligent network (AIN, SCP) having an intelligent network interface to the local exchange, and in that the functionality of the GSM based visitor location register is partly (VLR1F) located in the master base station controller (BSC1), and partly (VLR2F) in the intelligent network (SCP).

4. A telecommunications system as claimed in claim 1, c h a r a c t e r i z e d in that the local exchange is an ISDN exchange.