NIPES Journal of Science and Technology Research 4(3) 2022 pp.71 - 79 pISSN-2682-5821, eISSN-2682-5821

NIPES

Journal of Science and Technology Research

Journal homepage: www.nipesjournals.org.ng

GSM Value Added Services (VAS) Provision from Intelligent Network (IN) Platform Through GSM-IN Integration

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Article Info

Keywords: GSM, Intelligent Network, Signaling System 7

Received 9 May 2022
Revised 3 July 2022
Accepted 22 July 2022
Available online 2 Sept 2022

https://doi.org/10.37933/nipes/4.3.2022.8

https://nipesjournals.org.ng

Abstract

This work presents a review and initiates a concept to provide Value Added Services (VAS) for Global System for Mobile Communication (GSM) from Intelligent Network (IN) platform through the integration of GSM and IN networks. Also, it is to enable service providers achieve service independence from the switch vendors and rapid service creation in the ever evolving mobile communication market. In this approach, the existing GSM and IN networks were reviewed and the findings show that both GSM and IN core Networks use Signaling System No. 7 (SS7) signaling for Mobile Application Part (MAP) and Intelligent Network Application Part (INAP) protocols respectively. Based on this, an integration of the two networks is suggested by absorbing MAP into INAP and VAS provision and management moved from the GSM to IN nodes. Then, the GSM mobility and VAS procedures transformed to fit into IN Service Independent Building Block (SIB) architecture. The result of this is that VAS could be provided as an IN service for GSM. This will promote true multi-vendor operation in a network.

1. Introduction

Mobile phones today have moved beyond their fundamental role of communication and have graduated to become an extension of the persona of the user. We are witnessing an era when users buy mobile phones not just to be in touch, but to express themselves, their attitude, feelings and interest [1]. Hence, customers continuously want more from their service provider. Providing mobility is the basic function of the GSM and as a result providing supplementary service (VAS) was not primarily a major function of the GSM architecture and structure and service providers were restricted to switch oriented functions. To add new features or services, it had to be carried out rightly at the switch systems. This made service introduction to be hardwired and very difficult to implement with lack of flexibility. As a way of solving this limitation, service nodes were provided into the telephone network. Nevertheless, calls were required to be channeled to these service nodes and routed back to the network. This was a serious disadvantage in the system that needed costly additional interfacing card. This saw the development of Intelligent Network (IN) as a way to overcome the observed shortcoming. IN allows some telecommunication company (telco) proprietary solutions. In catering for these supplementary services, the GSM network lacked the ability for the provisioning of a devoted medium for the creation and provisioning of supplementary services. As the need and use of supplementary services eventually became important, GSM operators evolved a process for the creation and provisioning of services in GSM networks known as Customized Application for Mobile Enhanced Logic (CAMEL) [2].

CAMEL was founded on the principles of IN, which helps call processing to be adjourned while asking for information from the home network on the completion of the call [3, 4]. CAMEL gives

GSM the capability to give telco definitive services relying on IN operations logic to a GSM customers even while roaming beyond the network. One of the shortcomings of CAMEL is the lack of mutual relation between INAP which is used for service provisioning and MAP which is used mainly for mobility management. The local processing of services is also not possible with CAMEL. CAMEL in the short run is a possible solution for service provision in both the home and roamed networks. Nevertheless, it is possibly not a long term and permanent solution that would truly integrate GSM and IN [5, 4]. This drawback will be a major challenge in the immediate future therefore, there is the necessity of actual integration of GSM and IN to optimize creation of Value-Added Services (VAS).

1.2 Intelligent Network (IN)

An intelligent Network (IN) is a telephone network framework where service logic that handles call is dissociated from the switching elements and placed in a different node. This permits services to be added or altered without redesigning the switching infrastructure [6, 7]. It is a concept that is expected to be applied to all telecommunication networks and aims to facilitate the introduction and management of new services. The IN allows building tailor-made services onto a stable telecommunication platform. This satisfies the needs of today's competitive market for speed, cost effectiveness and the demand for more Value Added Services.

The IN conceptual model (INCM) is not an architecture. It is a framework for the design and description of the IN architecture. Various "models" and "concepts" are used in the standardization of IN. The IN conceptual model represents a formal framework within which these concepts are identified, characterized and related.

To achieve this, the INCM consists of four "planes". Each plane represents a separate theoretical view of the capabilities offered by an IN- organized network. These views address: service aspects, global functionality, distributed functionality, and physical aspects of an IN [6]. These planes are the domains of services and service features, service independent building block (SIB), functional entities, information flow and physical nodes and protocol interfaces respectively. Figure. 1 shows the INCM.

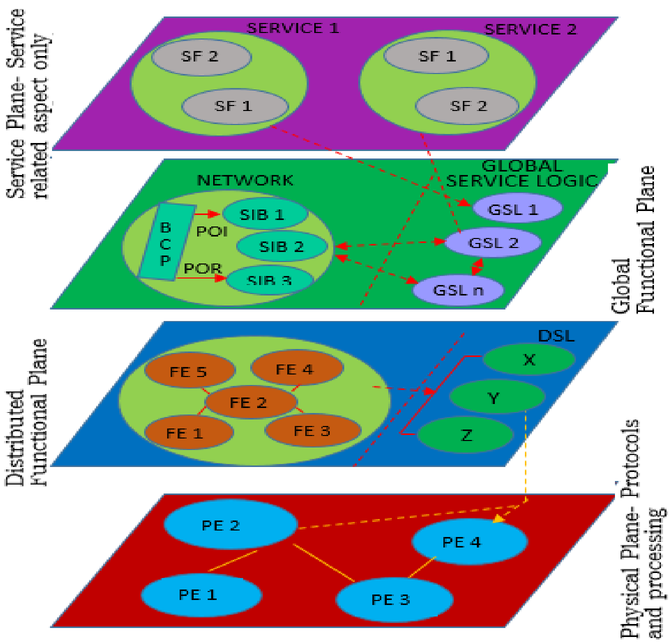


Figure. 1. IN Conceptual model

a. The Service Plane

The service plane offers a service function aligned view and defines services on grounds of service features. The service features are on their own defined with regards to global service logic. Every service feature is specified by a singular group of Global Service Logic (GSL). At the height of service plane, there is no purview of the inter-relation of the service feature and the physical network on which they are used [8].

b. The Global Functional Plane

The global functional plane patterns an IN structured network as a singular body. It prescribes globally possible SIBs. These SIBs are representations of the fundamental abilities of the basic operational network. One of the most important SIB is the Basic Call Process (BCP) which the rest SIBs relates with. Again, the Points Of Initiation (POI) and Point Of Return (POR) are specified in it and they offer the interaction between BCP and a range of different SIBs. The SIBs are modular building blocks that can be reused as often as possible and describes a complete unit of activity. They are used to set-up service by service creator. Majority of the services can be built from a library of subsisting SIBs, but if functionality is not available, functions that are required are included in the library as SIBs or a group of SIBs [4].

c. Distributed Functional Plane

The distributed functional plane patterns a distributed view of an IN structured network. This plane is the initial point where conventional network framework can be viewed with the network being described using functional entities. Every functional entity is capable of carrying out actions. These actions are termed functional entity actions (FEAs). It is the minute unit of action and is entirely subsumed inside a functional entity.

SIBs are achieved inside this plane as a chain of FEAs. Eventually, a number of SIBs needs information transit among functional entities to enable an SIB to be achieved. The flow of information results to INAP protocol in the physical plane [8].

d. The Physical Plane

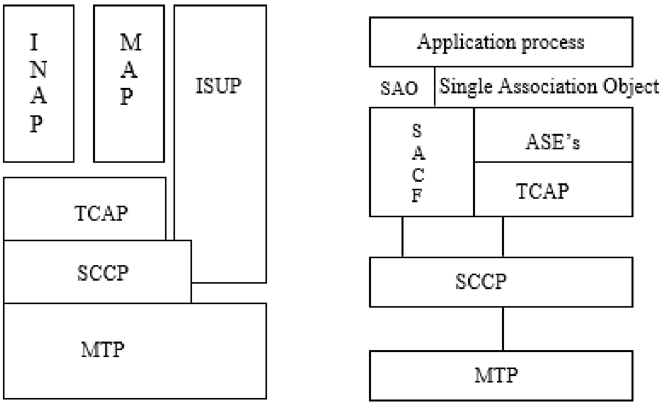
The physical plane maps the functional plane into a physical network and patterns the various physical entities and protocols that exist inside an IN structured network [8]

1.3 Intelligent Network Application Part Protocol (INAP)

Intelligent network makes use of SS7 Signaling capabilities just as GSM MAP does. INAP is aimed to be used among the following four functions: SSF, SCF, SDF and SRF [9]. Like MAP, intelligent network need to cater for both call-related, out-of-call signaling and require a signaling mechanism logically separated from the bearer channel. The intelligent network application protocol that carries out every IN signaling requirements uses SS7 transaction capabilities. Hence, majority of operations of INAP are much the same as GSM MAP. INAP introduction was after GSM MAP had been in operation and as a result more of MAP functionalities are included [4].

The INAP protocol framework is predicated on the OSI application layer structure as shown in Figure 2. A physical element has coordinated singular or multiple interactions with other physical element. The single association control function offers a co-ordination responsibility using application service elements (ASEs) which includes the governing of transactions supported by

ASE's (based on the order of primitive received). The Single Association Object (SAO) stands in for SACF plus a group of ASE's to be used over a sole interaction between a pair of physical entities.



(a) SS7 showing INAP **(b) INAP Protocol Architecture (Single Interaction)**

Figure 2. Block Diagram of INAP Protocol Architecture

1.4 Mobile Application Part (MAP) in GSM

MAP is a protocol specially designed to support GSM requirements and it is one of the most commonly used application protocols within the GSM network. It provides the necessary signaling procedures required for information exchange between network entities. MAP also provides the signaling control for handover (HO) [10]. Figure 3 and Table 1 show GSM MAP interfaces and SS7 protocol connections.

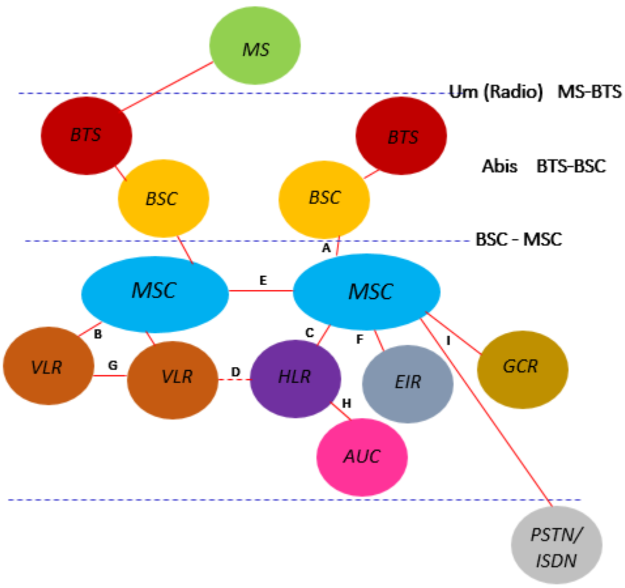


Figure 3. MAP Interfaces on GSM Network

2. Current Technology

Most recently, CAMEL was introduced to provide the GSM operators with the ability to offer operator specific based on IN services logic to a GSM subscriber even when roaming outside the network. In CAMEL, there is no true integration of the two networks and call processing is suspended in GSM while IN services are executed [4]. As a result, there exist two parallel protocols (MAP and CAMEL which is an IN derivative) in the core network of GSM. This consumes bandwidth and also does not perform same function absolutely as INAP does in the fixed network.

Today in Nigeria and other countries of the world, different versions of CAMEL by various VAS providers are available to suit their purpose. Some of them refer to it as CAMEL Application Part (CAP). The current technology architecture is as shown in Figure. 4.

Table 1. GSM MAP interfaces and SS7 protocol connection

Name	Interface	SS7 Element and Connection
Um (Radio)	MS ↔ BTS	LAPDm (None SS7)
A-bis	BTS↔BSC	LAPD (None SS7)
A (SS7)	BSC ↔ MSC	BSSMAP
B (SS7)	MSC ↔ VLR	MAP (Permanent Connection)
C (SS7)	MSC ↔ HLR	MAP (Permanent Connection)
D (SS7)	VLR ↔ HLR	MAP (Sporadic connection)
E (SS7)	MSC↔MSC	MAP (Sporadic connection)
F (SS7)	MSC↔EIR	MAP (Permanent connection)
G (SS7)	VLR↔VLR	MAP(Sporadic connection)
H (SS7)	HLR ↔AUC	MAP (Permanent connection)
I (SS7)	MSC ↔GCR	MAP (Permanent connection)
(SS7)	MSC↔PSTN MSC↔ISDN	SS7 basic + TUP or ISUP MSC-ISDN

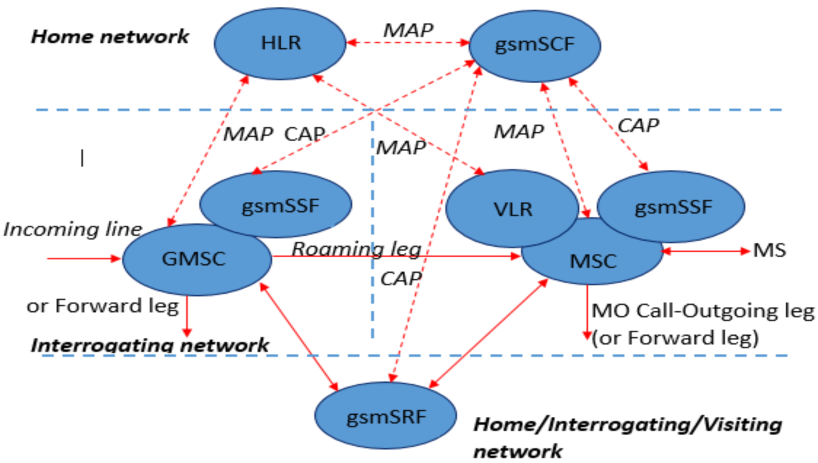


Figure 4. CAMEL Phase 2 Architecture

A review of the GSM and IN was undertaken as well as their existing signaling for interchanges. SS7 signaling was found to be common to the MAP for the core GSM network elements and the INAP Protocols and then the proposition for the absorption of MAP into INAP. This would help to avoid two parallel protocols existing side by side. This measure is adopted as MAP protocol had been defined before the development of INAP which is configurable by operator [4].

From the review, it has been observed that:

i. Both Mobile Application Part (MAP) and Intelligent Network Application Part (INAP) use SS7 signaling in the core networks.
ii. MAP predates INAP and it therefore does not possess more facility like INAP to enable flexible service creation.
iii. Both protocols use the same dialogue number in some instance. So allowing two of them to exist will create problem during communication between the two protocols. But INAP is

reconfigurable while MAP is not, as a result, it is suggested here that MAP be absorbed into INAP and INAP renumbered.

iv. The SSP functionality of IN can be moved to MSC to enable VAS to be detected as IN service and subscriber database can be moved to IN node.

A suggested model of integration of the two networks will be achieved by moving some IN Switching functionality namely the SSP to the switch (MSC) to form Mobile Service Switching Point (MSSP) and moving the database for service provisioning and mobility from the switch to IN functionalities to enable such services to be provided as IN service. This integration is postulated on the use of SIBs which are capable of repeated use as an IN building blocks. The advantage of SIB is the speed in usage and the ability to be stored for repeated use and that favoured the chosen approach. The exchanges including signaling for services and mobility for the suggested GSM-IN architecture were tailored to imitate the exchanges of GSM architecture; initiated and handled as IN services. There will be no change in the GSM access network in the suggested GSM-IN architecture. This will be so in order to permit the usage of the subsisting mobile stations and its mobility procedures to be rendered as IN services. Finally, the service creation process of the VAS from IN point of service creation was suggested to ensure rapid customer service creation and deployment.

3.1 GSM-IN Integrated Architecture

The concept for GSM-IN architecture here is only in the core element, affecting the switching and database elements since these are the point of mobility concern and VAS are processed in these areas. Here, the IN is dominant over the control (Core) network. The point of interaction between the radio access networks will remain to be the MSC. The MSC will include elements of both IN and GSM, and equipped with the functionality to recognize and manage IN service request and exchanges which thus far have not been so. The Service Switching Function (SSF) when integrated into the MSC will aid the MSC in performing this task.

The functionality of the MSC, VLR and HLR especially the mobility component would be made to reside in the Mobile Service Control Point (MSCP). Data for Services and mobility along with IN services and user data would be stored in the HLR in the GSM network and moved to Mobile Service Data Point (MSDP). Therefore, a service data point with mobility data would be called a Mobile Service Data Point. With these arrangements, the function of the HLR would have be comfortably taken care of and it would become obsolete.

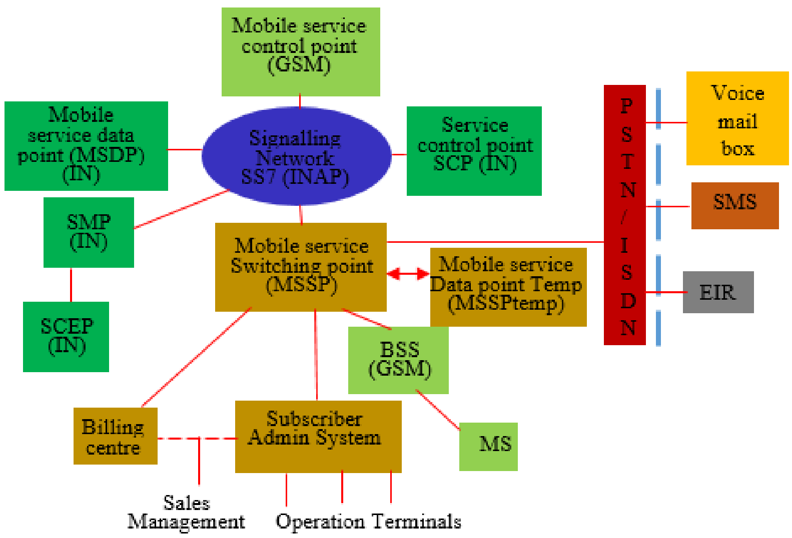


Figure 5. Block Diagram of GSM-IN integration Architecture

In the legacy GSM architecture, the VLR houses a copy of most data domiciled in the HLR and this is a temporary data which only exist as long as the subscriber is active in the coverage area of the VLR. In essence, the VLR contain a duplicate data of subscribers from the HLR. This is done to reduce frequent and time consuming referencing of the HLR and its attendant signaling [11, 4]. Caching user information on the VLR reduces the number of occasions on which it needs to be retrieved from the HLR, thereby reducing the total signaling traffic on the network. Once the information on the user is downloaded by the VLR, no further request for information from the HLR is necessary. Since the mobility control functions will be moved to the MSCP, the need and use of VLR will then serves only as a temporary database. Therefore, the suggested GSM – IN architecture will have the VLR temporary database connected to the MSCP and it will then contain both IN and GSM user data. It would then be called the $MSPD_{temp}$. Figure. 5 shows this new GSM-IN architecture as suggested.

a. Mobile Service Switching Point (MSSP)

In the suggested GSM-IN architecture the MSC will be converted into MSSP by the combination of certain functionalities of IN and distribute some of these functions to other nodes such as the Service Control Point (SCP). The Mobile Service Switching Point is made up of two major elements namely the service switching function and the call control function (CCF). The call control function provides the means for establishing and controlling bearer services on behalf of network users; the CCF refers to call and connection handling in classical sense and provides a trigger process for accessing IN functionalities and as well monitors the progress of calls. The logic required for IN services request and to control the signaling between CCF and SCF are managed by the service switching functionality. The Service SSF also regulates the switch at the request of the service control function.

The SSF is situated at the MSC for the reason that the MSC is the center for all services and mobility and the processing of all messages to and from the access network in the GSM network. It is also an ideal position for the detection and processing of messages from the *service control point* as the MSC already have mechanisms for detecting service request and a call state model. The incorporation of SSF into MSC to form MSSP will mean that all services and mobility procedures that were primary resident in some GSM nodes will be moved to the Service Control Point (SCP). For example HLR, MSC and VLR and the control procedures will be moved to MSCP leaving only inter-cell and inter-BSC handovers to be handled outside the control of MSCP. The Inter-MSC handover will be carried out as an IN-service under the management of the *service control point*. In this new arrangement, IN network will see the MSC and the radio network under it as a single unit. Therefore, from the perspective of IN, an inter-MSC handover would involve two entities. An inter-MSC handover had been outlined as a MAP protocol signaling and having suggested the absorption of MAP into INAP with its functionality and procedures transferred to INAP, conflict in the inter-MSC handover would be eliminated.

The service switching function does not control the call state models, rather it is controlled by the call control function. The existing IN service detection and triggering processes outside a call in the GSM will however be retained in the GSM-IN integrated network as IN network is not part of the functionality for detecting IN service request.

In this concept of GSM-IN integrated architecture, there need to be a function that will relate the functionality of the GSM to the IN and vice versa. Since the Mobile Service Switching Point is the major point of integration of these two network, the functionality that will enable this relation will be needed to be carried out here referred to as the ‘conversion function.’ This conversion function will be saddled with the responsibility of interpreting the signaling message between the GSM mobile terminal and the radio access network, and the IN control network. This will be done by transforming GSM message signaling pertaining the mobile terminal and the radio network into

INAP messages and vice versa. This functionality is restricted to converting signaling messages where the MSC acts as a go-in-between the mobile terminal and the Service Control Points since the messaging numbers by INAP and the radio access network will not exactly be identical. The conversion function is as shown in Figure 6.

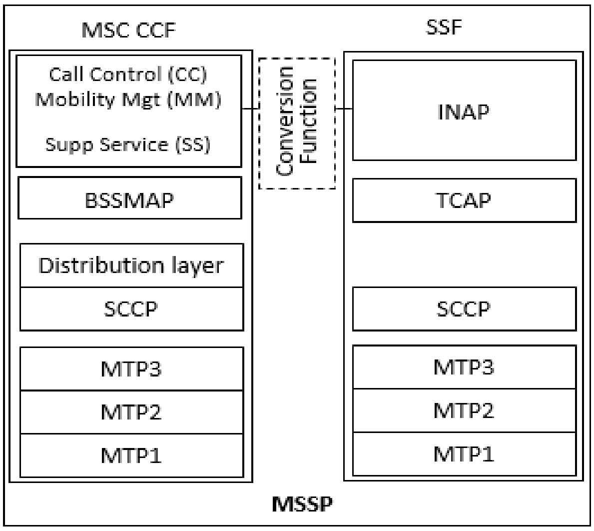


Figure 6. Signaling protocol stack for MSSP illustrating the interacting between the SSP and the MSC

b. Mobile Service Control Point (MSCP)

In this suggested architecture, Mobile Service Control Point (MSCP) will be used to show an SCP that possesses the capability for mobility services. Therefore, within the MSCP, *Mobile SIBs* (MSIBs) will exist and will be entirely devoted for mobility services. This characteristic feature is the singular distinguishing feature of an SCP and MSCP.

c. Mobile Service Data Point (MSDP)

A Mobile Service Data Point (MSDP) is a service data function, where subscriber's service data and mobility data are stored. A subscriber's 'Character Set' will contain user supplementary service data [4]. This will include VAS services subscribed to and mobility data such as the roamed MSC position location of MSC being roamed and the extent of allowed roamed services.

d. Mobile Service Data Point Temporary ($MSDP_{temp}$)

This is a temporary database of the MSCP. It contains some functionality data that are found in MSCP. This provisional database is used only when the subscriber is roaming an associated MSC. The service control point will use the MSC - mobile service data point temporary association to find the location of the mobile service data point temporary [4]. The function and usage of $MSDP_{temp}$ is the same as that of VLR in the GSM architecture.

3.2 GSM-IN Integrated Architecture Signaling

MAP and INAP already exist for GSM and IN networks respectively. One of the existing protocols cannot serve the purpose of the integrated architecture from the routing point of view; there are no conflicts between MAP and INAP from the MTP to SCCP level [8]. At the transmission capability layer, both protocols are incompatible especially during the dialogue. Value-Added Services are mostly associated with mobility service and if they are to be combined, (MAP for mobility and

INAP for value-added services) then, it will be important to combine communications from both protocols during exchanges.

The SS7 has a shortcoming as the application context (i.e. MAP or INAP) has to be initially agreed on before commencing any form of exchange or communication. In order to avoid conflict during communication, both protocol and operations should be changed in some parts to enable them to exist together [4]. To eliminate this conflict completely, it is suggested here that MAP should be absorb into INAP, eliminating MAP completely. Absorbing MAP into INAP will automatically enable INAP to use the mobility functionalities of MAP and its operation outlined as INAP operations with unique number. This will be in addition to the unique functionalities already defined for INAP. By so doing the conflicts will be entirely removed. Table 2 shows the various interfaces and the signaling protocol that exist between them.

Table 2. GSM INAP interfaces and SS7 connection

Name	Interface	SS7 Element and Connection
Um	MS ↔ BTS	
A-bis	BTS↔BSC	
B (SS7)	BSC ↔MSSP (MSC)	INAP with protocol translation
C (SS7)	MSSP↔ $MSDP_{temp}$	INAP
D (SS7)	Interface between all IN functionality	INAP

4. Conclusion

Value Added Service (VAS) in mobile network especially the GSM could be achieved through this concept of GSM VAS provisioning from IN platform through GSM-IN integration as this has open a new vista in rapid service creation particularly mobility based services by the moving of value-added service provisioning from the switch to IN nodes. VAS through this concept could be provided as an IN service for GSM. This cannot be without any change in the signaling arrangement of the architecture. To achieve this, it is suggested here that the Mobile Application Part (MAP) be absorbed into the Intelligent Network Application Part (INAP), an IN protocol to be used between the core elements of the new architecture. This would ensure the true interaction and integration of IN and GSM networks to achieve greater speed of service provisioning and independence. Though service independence on vendor equipment have been partially achieved through CAMEL, with this true integration approach, greater independence may be achieved and most importantly pave the way for service provisioning in the evolution of Universal Mobile Telecommunication System (UMTS).

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