EGPRS - Based Design Solution for Tariff Transparency Issue in Mobile Number Portability

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Abstract— **Mobile Number Portability is one of the major developments in the past twelve years of telecommunication industry. Introduction of this technology enabled consumer to switch from one service provider to other service provider without changing their mobile numbers. However, beside being successful implementation, mobile number portability has caused the loss of carrier identity which ultimately gives rise to tariff transparency issue. Since consumers will not be able to identify the called party network and hence they will be charged against their expectation which can become the cause of consumer's dissatisfaction towards their service provider. In this research we will address the prevailing issue of tariff transparency and carrier identification in mobile number portability. Then we will propose the implementation of an EGPRS based design solution to cater these issues from user end perspective**.

Keywords-component; Mobile Number Portability; Tariff Transparency;Enhanced General Packet Radio Service (EGPRS); Ported subscriber

I. INTRODUCTION

Mobile number portability refers to the service for mobile consumers to change their service provider according to their desire by keeping unique mobile number. Previously the change of mobile number on switching from one mobile operator to another operator had been considered as a hurdle in competition between cellular service providers. This major concern of changing phone number was defined to Network Interoperability Consultative Committee (NICC) by Oftel and passed to the Public Network Operator Interconnect Group (PNO-IG) in early 1994. The PNO-IG take up the issue and introduced a high level service description in order to meet the requirement of number portability[1].

Number Portability can be of various types like service provider number portability, location number portability and service portability [2]. Normally three types of approaches have been used to implement mobile number portability throughout the world which includes Centralized approach, Peer-to-peer approach and Hybrid approach. However among all of these, centralized approach for implementing MNP is most widely used in the world. Centralized database system has reduced the burden of managing ported subscribers from service providers.

Similarly, there are several ways for implementing call routing strategies in MNP, for instance, Onward Routing method and All Call Query (ACQ) method. ACQ is the most popular method for call routing which is being deployed in most of the countries [3].

Mobile Number Portability was first implemented in Singapore in 1997 followed by Hong Kong in 1999, Spain in 2000, Australia in 2001, Finland 2003, Pakistan 2006 etc [4]. Mobile Number Portability can be wireline as well as wireless. MNP has put forward a healthy competition between cellular operators to elevate their level of service in order to increase and retain their subscribers' growth [3]. On the other hand MNP has also worked as a very attractive approach and has produced encouragement for the end users to be having services of multiple mobile networks with unique mobile number and they can easily switch the mobile operator if they are not satisfied with the services of existing service provider. Number portability has reduced the switching costs of the customers while moving from one operator to another, this usually includes informing friends and family about the change of number, re-printing business cards, updating profile etc.

However, besides all the beneficial factors of MNP, it has induced a difficulty in realization of original network. In case of MNP, the customer may never know the called party network. Stefan Beuhler and Justus Haucap (2003) addressed this issue in their research and highlighted the fact that tariff transparency issue has largely been ignored while implementation of MNP. They claim that before MNP consumers can easily differentiate the mobile networks by the number prefix. But after launch of MNP, number prefix is no more beneficial in identification of mobile operator. Therefore, due to MNP full tariff transparency has been lost and it ultimately deteriorated consumer's price information [5].

Similar issue has been discussed by Arthur Goldstuck and Steven Ambrose (2006) from World Wide Worx in their

report. They declared that prefix confusion not only has an impact on the cellular user, but also on the least cost routing industry [6]. In 2005 a public enquiry paper on by Malaysian Communications and Multimedia Commissions has discussed the issue of tariff transparency and suggested solutions to this issue such as audible tones, Interactive Voice Response (IVR) and Short Message Service (SMS) [7]. Studies conducted in report (2008) by Hibbard Consulting declare that previously published studies did not take into account the loss of tariff transparency with MNP. Analysis and research have been shown that consumers are unhappy of being charged unexpectedly [8]. However to cater the issue of tariff transparency many countries have implemented different solutions such as audible tones, toll-free calls, toll-free SMS and announcements.

Yi Bing Lin (1999) augmented a voice announcement to know the customer about the billing rate before placing a call in his database method for number portability [2]. In contrast to announcement based solution for tariff transparency as per Irish report (2003) by Commission for Communications, the respondents from different mobile operators claims that after introduction of voice announcement facility to resolve issue of tariff transparency in MNP by one of the operator they observed large number of complaints from customers which clearly indicates that voice announcement is not an appropriate tool for Irish market [9]. Apart from this report, audible tones could be a good approach but it will be applicable only in case of calls not in case of SMS. Similarly toll-free SMS and toll-free calls could enable a customer to query the status of only one number at a time. Keeping in view all these factors a comprehensive and optimized solution should be proposed for tariff transparency and network realization in MNP.

This paper aims to focus on the issue of tariff transparency and its Enhanced General Packet Radio Service EGPRS based design solution. In first section we shall explain tariff transparency issue in mobile number portability. Then we shall discuss the background of EGPRS technology. Next, we provide a tutorial and show the implementation of EGPRS based design solution to cater tariff transparency issue. Finally we shall explore the benefits of the proposed design solution with respect to previous solutions followed by conclusions and future enhancements.

II. TARIFF TRANSPARENCY

Tariff transparency refers to the term of informing a mobile subscriber about the on-net, off-net and international call and SMS charges which are being charged by the service provider. When a subscriber gets port-in or port-out to or from any network the calling party subscriber do not know about the porting process of its called party subscriber. Let us consider a scenario in which calling party (A number) and called party (B number) belongs to the same mobile network say “U” mobile operator. In most of the cellular service providers the ON-NET charges are kept comparatively lower than their OFF-NET and International call and SMS rates. Therefore when subscriber A calls subscriber B, both using the services of same network, the calling party will be charged ON-NET call rates and it has already been known by calling party through the information provided by his current service provider. Now suppose called party (B number) wants to use the service of another network instead of his current network. Therefore called party (B number) port-out to other network say “W” cellular network. Since during the number portability administrative process there is no way included to inform the calling party numbers of the ported subscriber about the status of porting process, therefore when calling party (A number) calls his called party (B number), the calling party (A number) will be get charged through OFF-NET call rates instead of ON-NET call rates, since called party (B number) is now ported-out to other network “W” and this change in status of called party (B number) is not known by the calling party (A number) subscriber.

Due to unexpected call charging, a negative impact will be created on calling party (A number) subscriber since he has not been provided with the ported-out or ported-in details of called party (B number) and as per his assumption he would have been charged incorrectly for his call. This issue can lead a subscriber to lose his trust on the services provided by his current service provider. User may also prefer to change his network due to his wrong perception of incorrect charging which can ultimately cause a loss of customers to that mobile operator.

Electronic Communications Committee Report (2003) declares that problem of tariff transparency has been recognized by many countries where mobile number portability is implemented. Voice announcement services are implemented in Belgium, Finland, Hungary, Malta and Norway etc. SMS based services are implemented in Ireland, Slovenia and Switzerland. Toll-free call service implemented in Denmark, Estonia and Portugal. Audible warning for off-net calls service implemented in Austria, Croatia, Lithuania and Slovenia [10]. However it has been discussed earlier that voice announcement has been resulted in customer dissatisfaction, further to this voice announcement could be a costly option and it might also result in unnecessary trunk seizing which can be critical during busy call hours. On contrast SMS based solution and toll-free calls are quite good solutions but they are limited to the query of one or two ported numbers at a time. Audible tones, on the other hand could only inform about the off-net call, however carrier identification still not clear in this solution. Therefore, to fulfill the gap for the shortcomings of previous solutions we could aim to design a new solution based on EGPRS/EDGE technology.

III. ENHANCED GENERAL PACKET RADIO SERVICE

Enhanced General Packet Radio Service (EGPRS) or Enhanced Data Rate for GSM Evolution (EDGE) is the enhanced technology for 2G and 2.5 generation systems.

EGPRS can deliver three times faster bit rate ratio as compared to GPRS. GPRS can transfer data at rates of 115 kbps theoretically and up to 160 kbps on physical layer, where as EDGE/EGRPS can transfer up to 384 kbps on physical layer and 473.6 kbps theoretically. GPRS has only four coding schemes while EGPRS has nine modulation and coding schemes [11]. Hence EGPRS offers upto 200% increase in data bit rates [12]. Latest modulation and error tolerant transmission methodologies with help of mechanism of improved link adaption have made rates of EGPRS/EDGE possible. This has enabled improved spectrum efficiency and usability of modern applications like Wireless internet, emailing, file transferring and video calling.

EGPRS/EDGE technology has adaptability in existing cellular networks since it does not require new hardware or new systems to deploy it, therefore it appears to be a cost effective technology. So far EGPRS has proved to be a successful technology since it is also compatible with 3G technologies. Most of High Speed Packet Access (HSPA) network operators deploy GSM/EDGE for service continuity. Further to this, nearly all Wideband Code Division Multiple Access (WCDMA) handsets are also GSM handset, which enables WCDMA users to access GSM based services. Around 487 cellular operators have launched EGPRS in 190 countries throughout the world [13].

As we argued about the comprehensive solution for tariff transparency in mobile number portability to carry out the room for improvement in previous solutions. We could be able to achieve the desired enhancement by utilizing EGPRS technology. In the rest of discussion we introduce the architecture of EGPRS/EDGE based design solution and its message flow. Then we briefly explain the benefits of the proposed solution followed by conclusions and future enhancements.

IV. EGPRS BASED DESIGN SOLUTION

With EGPRS deployment mobile operators can easily provision value added services for their customers. We introduce an architecture based on EGPRS to accommodate the issue of tariff transparency and network identification which can be offered as a value added service for the customers by a cellular operator. In our case we propose that operator can offer this service by registration through SMS to a specific short code number dedicated for this service. After successful registration subscriber can be able to utilize this value added service. The service can be based on uploading a contact list in subscriber's handset through EGPRS to an application server (AS). (Application Server is a server that can provide the functions required to the host applications. It can maintain database as well as raise queries as per requirements) .This application server can be further integrated with Local Service Management System (LSMS). (LSMS is a computer system with database storage. It is responsible for collecting porting data and downloading it to local number portability database).
Application Server can communicate with LSMS through Simple Object Access Protocol (SOAP). (SOAP interface is a Remote Procedure Call based (RPC-based) service. It is a way for a program running in one kind of operating system such as Windows 2000 to communicate with a program in the same or another kind of an operating system such as Linux by using the World Wide Web's Hypertext Transfer Protocol HTTP and its Extensible Markup Language XML as the mechanism for information exchange). As soon as phone numbers uploaded via EGPRS service, AS shall store the phone numbers and communicate with LSMS for the current porting status of phone numbers. At the process completion between AS and LSMS, subscriber can receive SMS from AS to download phone numbers with their current network information. This way customer download phone numbers with their existing network identification.

V. THE ARCHITECHTURE OF EGPRS BASED DESIGN SOLUTION

The architecture is of EGPRS based design solution is shown in figure 1. In this architecture, the mobile switching centre (MSC) is the mobile switch which is responsible for routing voice calls and SMS. Home Location Register (HLR) is a central database contains detail of each mobile phone subscriber that is authorized to use GSM core network. Short Message Service Centre (SMSC) supports the sending and reception of text messages. The base station controller (BSC) is responsible for radio resource allocation to mobile station. Base transceiver station (BTS) contains the equipment for transmitting and receiving radio signals. Packet control unit support node (PCUSN) is a stand-alone node and responsible to complement the BSCs (2G and 3G) with PCU capability. Serving GPRS Support Node (SGSN) performs routing of packet data using internet protocol. It also performs function of mobility management, session management, state control and data packet routing on downlink including location tracking [14].

Gateway GPRS Support Node (GGSN) serves as the interconnect point between SGSN and external packet data network. Message Application Router (MAR) is a router used to route messages between SMSC and the outer world through Large accounts of targeted destinations. Large accounts (LA) are peer entities connected with MAR used to route the messages between MAR and outerworld. The Application Server (AS) and Local service management system (LSMS). The MSC, SMSC, MAR, LA and HLR will be involved during SMS subscription and SMS termination process. However uploading and downloading of phone numbers will involve BTS, BSC, PCUSN, SGSN, GGSN, AS and LSMS [14].

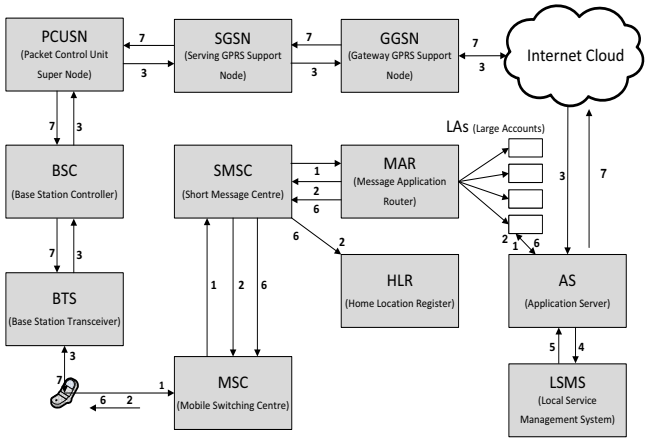

Figure 1. Architechture and Message Flow of EGPRS Based Design Solution

VI. MESSAGE FLOW FOR EGPRS BASED DESIGN SOLUTION

The message flow for EGPRS based design solution is illustrated in figure 1. In figure the numberings above arrows indicates the steps of message flow.

Step 1: Initially, mobile station sends SMS to a specific short code in order to register to avail the service. The MSC receive the message and send *Forward-short message request* to SMSC through Mobile Application Part MAP protocol. SMSC shall check the mapping of short code to its respective LA in its database and forward the message to MAR for onward routing through Short Message Peer-to-Peer Protocol. MAR shall route the message towards the AS through its respective LA.

Step 2: AS shall register the mobile station in its database and generate a message to MAR through its LA. The message generated by AS contains the contents of successful registration to the service and informing the mobile station that phone numbers can be uploaded now. After receiving acknowledgement from AS, MAR will route the message to SMSC for termination of SMS to the mobile station. SMSC raise *Send routing information request* message to HLR via MAP protocol to locate the current location of the mobile station. HLR sends *Send routing information acknowledgment* message to the SMSC containing the current location of mobile station. Then, SMSC sends *SMS_termination request* to the destination MSC to terminate SMS to the desired mobile station.

Step 3: After successful subscription to the service, mobile station can start uploading phone numbers in the handset to AS via EGPRS service. Packet data for access of EGPRS service shall be transferred by PCUSN to SGSN. SGSN then mark location update of mobile station in its database and transfer packet data to GGSN via GPRS tunnel Protocol (GTP) for onward routing. GGSN could search the web application of targeted AS via internet cloud and the phone shall be uploaded to AS.

Step 4: As soon as the phone numbers get uploaded AS can start raising query to LSMS via SOAP interface for the current porting status of uploaded phone numbers.

Step 5: LSMS then check its database and feedback to AS with porting status of required phone number via SOAP interface.

Step 6: On receiving response from LSMS, AS could update its database and append porting status with uploaded phone numbers. After completion of communication between AS and LSMS, AS will generate a message towards MAR through its respective LA which contains information about downloading the phone numbers with their current carriers. The message could be terminated through same path as explained earlier in Step 2.

Step 7: After receiving SMS from AS, mobile station should start downloading the uploaded phone numbers via same path described earlier in Step 3. The downloaded phone numbers might contain information about the current service providers with their call tariffs. (Information about Call tariffs can be optional).

VII. BENEFITS AND COMPARISON WITH PREVIOUS SOLUTIONS

As we have pointed out earlier the room for improvement for the solution of tariff transparency issue in mobile number portability, EGPRS based design solution could be more effective from voice announcement, SMS, toll-free call and audible tone solutions. This service shall be totally dependent on the desire of end user unlike in voice announcement service, where a customer hears announcement every time when placing a call for porting number. Since it has already studied that this solution resulted in negative feedback from customers. The SMS service and toll-free service are appropriate solutions but restricted to the query of one porting number at a time. On contrary to this, EGPRS solution provides the facility to query the porting status of more than one numbers at a time. Further to this audible tone solution does not provide information about the network name and call tariff rates. In EGPRS service current network name could be placed with the list of phone numbers. In addition, call tariff information might also be possible to append with porting status.

The proposed service can be implemented easily in current GSM deployed networks, since EGPRS does not require any new hardware integration and it is cost effective solution. Service provider could be required to integrate only one

application server within its existing architecture to deploy the suggested solution for tariff transparency.

VIII. CONCLUSIONS

In this research we have tried to describe the major issue of tariff transparency in mobile number portability and proposed an EGPRS based design solution to cater this issue. We show that EGPRS service can be used to implement a cost-effective and more beneficial solution for tariff transparency in mobile number portability. However, it might be a complex solution as compared with previous ones. But it can be implemented with some minor modifications as per practical GSM network requirements. The solution completely depends upon the customer's will of knowing the porting status or not. It can also provide a porting status of more than one number at a time. In contrast to this, count of uploaded phone numbers might be limited in proposed solution upto some threshold value which could be dependent upon the design and software specifications of application server deployed. We hope this research might be supportive to portray a new idea for mobile networks in different countries, and specifically for the countries where a proper solution for tariff transparency has not yet implemented.

IX. FUTURE SCOPE

Many challenges are still there to cater in implementation of mobile number portability. For instance, integration of mobile number portability in long term evolution (LTE) networks. Lots of work is in progress for enhancements in previous technologies to make them compatible with upcoming technologies. In EGPRS design solution, the limitation for the uploaded phone numbers can be enhanced by using Universal Subscriber Identity Module (USIM), use of Bearer Independent Protocol (BIP) at user end and capacity enhancement at Application Server (AS) end which can make it compatible with 3G and 4G networks [15]. The future research might be an extension of this research. For instance, a more detailed performance evaluation can be done of the same model.

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