FEASIBILITY STUDY ON MOBILE NUMBER PORTABILITY IMPLEMENTATION IN SRI LANKA

Chamila Buddika Hatharaliyadda

(118458H)

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Department of Electronic and Telecommunication Engineering

University of Moratuwa

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ABSTRACT

Mobile telephone number is considered as a great asset to a mobile telephone user. Generally subscribers are reluctant to change their mobile telephone number as it requires him to communicate about his movement to each and every potential person that is trying to reach him via his mobile telephone. Mobile number portability is a network function that allows mobile subscriber to switch service provider while retaining the mobile telephone number. Many countries have implemented MNP services in their telecommunication network to date.

In this research study the necessity and subscriber willingness to accept MNP services implemented in Sri Lankan telecommunication market was tested through a mobile subscriber survey. In addition statistics on reasons for subscriber churn and some demographic aspects of subscribers those are willing to accept MNP services also analyzed through the responses collected on survey.

Different MNP implementation architectures were analyzed in detailed with call flows. Advantages and disadvantages of each implementation architectures was identified and compared. The list of modification required in mobile service provider's core network under each architecture was identified and feasibility of implementing each architecture was discussed with mobile telecom service providers in Sri Lanka.

Analysis and comparison of costs involved in each different MNP implementation architecture was performed. The recommendations on implementable MNP architecture was given based on the feasibility and cost analysis using the statistics prediction made through subscriber survey.

ACKNOWLEDGEMENTS

It is with great pleasure I take this opportunity to convey my sincere thanks to the Department of Electronic and Telecommunication Engineering, University of Moratuwa, Sri Lanka for giving me the opportunity to participate in the Master of telecommunications course.

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CHAPTER 1: INTRODUCTION

1.1. Overview of Sri Lankan telecommunication market

Sri Lankan telecommunication market is one of the fast growing in the world. There are three fixed network service providers. Sri Lanka Telecom (SLT) is the incumbent telecom operator in Sri Lanka privileged to own only the copper network available within the country. SLT provide fixed voice telephone services over copper wiring as well as over CDMA technology. Lankabell limited and Dialog broadband networks are the other two service providers offering fixed voice telephony service in Sri Lanka using CDMA technology.

The mobile telecommunication market is the most competitive in Sri Lanka and there are five services providers offering mobile telephony services in the country. The total number of mobile connections has crossed 24.7 million and the SIM penetration is around 115%. All five operators deliver the services over GSM technology. Dialog Axiata has the highest market share in mobile telecommunication and own nearly 39% of the total subscriber base. Both Sri Lanka Telecom Mobitel and Etisalat Lanka has nearly 6 million subscriber base leading to 23% of market share each. Hutchison Telecommunications Lanka and Airtel Sri Lanka, the last entrance to the market has nearly 2 million subscriber base in each network. In addition to GSM networks Dialog and Mobitel maintain LTE networks and offer 4G services to the subscribers.

Telecommunication regulatory commission of Sri Lanka (TRCSL) acts as the national regulatory agency for telecommunications in Sri Lanka. Issuance of telecommunication licenses and frequency allocations are also facilitated by the TRCSL.

Unlike most other countries the price of basic telecommunication services that is voice calls and short message service charges are regulated by a floor price. This indicates the level of competition prevailing in the telecommunication market in Sri Lanka.

1.2. Overview of Mobile number portability

Mobile number portability is a network function that allows mobile subscriber to switch services and or network service provider while retaining his/her mobile telephone number. Generally subscribers are reluctant to change their mobile telephone number as it requires him to communicate about his movement to each and every potential person that is trying to reach him via his mobile telephone. In case of premium and business users loss of important business calls, reprinting business cards, bill boards updating the web sites are more costly than the financial and other gains achieved by switching.

In telecommunication regulators point of view mobile number portability plays an important role in their effort in liberalizing telecommunication market by enhancing fair competition among service providers. Further MNP welcomes new entrance to the market and reduces competitive advantage observed by incumbent and larger operators to a certain extent. On the other hand availability of MNP puts more pressure on service providers in terms of customer retention and they are automatically forced to maintain and improves the quality of services including coverage and network reachability.

1.3. International experience with MNP

Number Portability (NP) has already been implemented in over 75 countries across the globe. In 1997 Singapore deployed the mobile number portability services becoming the earliest country to accommodate number portability. The MNP supported network count began to grow from their onwards.

This section summarizes the state of play with MNP in Singapore, Honk Kong and India.

1.3.1. Singapore

Telecommunications Authority of Singapore (TAS) the government body responsible for development of information technology and telecommunications within Singapore, requested mobile service providers of Singapore to deploy MNP services targeting to achieve effective competition and establishing a globally competitive telecoms sector with multiple players offering innovative, high quality and cost effective services while facilitating consumer benefit.

The Telecommunications Authority of Singapore (TAS) adopted a phased approach to the implementation of MNP. Three different MNP implementation options has been discussed namely call forwarding, Originating Re-route (proprietary standard) and the Intelligent Network (IN) solutions. Originated re-route option has been rejected considering the deviation of GSM standards and possible difficulties achieving international roaming. IN based solution has been omitted due to the prevailed technical immaturity of the solution at the time of implementation.

Call forwarding solutions utilizes two numbers from both networks and all terminating calls to a ported number would flow via donor network causing inefficient use of network resources. On the other hand the Caller line Identification (CLI) displayed on recipient handset for a call originated from a ported number be always the number allocated from new subscription network. Further there was an increased demand on supplementary services such as SMS from mobile telephone users in Singapore. However most of the supplementary services were not addressed in call forwarding method.

Therefore in 2002 TAS requested for a re-evaluation of the existing technical MNP solution. TAS published set of requirements and maintained technology neutral approach; therefore mobile operators were left to decide on the most appropriate and cost effective technical solution to implement MNP.

MNP services in Singapore introduced with a monthly subscription charge. However later in 2003 TAS recognized the monthly subscription fee as a barrier to consumers wishing to switch operators but retain his mobile number. Therefore monthly subscription fee charging was ceased in 2003 and operators were allowed only a one time charge.

Only around 4% of mobile subscribers has ported their mobile numbers under MNP since the introduction of service. Porting process may take up to 5 working days.

1.3.2. Hong Kong

The telecommunications market in Hong Kong is known as one of the most competitive in the world. Office of the Telecommunications Authority (OFTA) is the telecommunication regulatory body of Hong Kong. OFTA expressed their willingness to implement MNP services in Hong Kong in 1997. This initiative was forced by the introduction of 6 new Personal Communication Services (PCS) operators in the market.

Hong Kong regulator also selected a phased approached in deploying MNP in the country. Decisions were taken based on feasibility and cost benefit analysis performed on telecommunication market in Hong Kong.

Similar to Singapore the first interim solution of MNP implementation was based on call forwarding. Distributed database architecture was introduced in 2003 and database query by donor network for identifying the porting status of subscribers were accommodated.

MNP implementation in Hong Kong is considered as most success story in the world. The porting rate in Hong Kong has crossed the 100% that is the number of successful porting has exceeded the number of mobile subscriber connections in the country. Process takes maximum 2 days to complete the porting.

1.3.3. India

Indian telecommunication market is the second largest market in terms of number of connections. Further more India continues to be one of the fastest growing major telecom markets in the world. The country has been divided in to several regions called “telecom service areas” based on geographical location and the populations. License to provide telecom services are issued based on service areas and an operator licensed to one service area being restricted from providing services in another area unless otherwise the particular operator posses a license to offer service in that service area.

MNP services in India commenced in 2011. However as per Indian telecommunication regular (TRAI) recommendations portability was restricted only to telecom service area. Therefore subscribers allowed moving between service providers in the same service area.

Unlike in Hong Kong and Singapore India have not utilized interim solutions for technical realization of MNP. The implementation option selected for call routing was the “All Call query” where porting status of called party number is queried on all originated calls and route directly to the subscription network of ported number. Therefore donor network is not involved in call routing; hence network resource utilization is efficient. Now telecom regulator of India is considering the option of enabling country wide Mobile Number portability.

Porting process will happen after 7 days from the official request and involve around 2 hours of complete service unavailability on the number being ported.

1.4. Problem statement

Number portability has been adopted by many developed countries across the globe with matured telecom markets to date including several developed countries in Asia. In 1997 Singapore deployed MNP becoming the earliest country to accommodate number portability. The MNP supported network count began to grow from their onwards. MNP implementation in Pakistan took place in 2006 and became the first south Asian country to adopt mobile number portability.MNP deployment in India took place very recently.

Unlike in developed countries larger portion of mobile market of developing countries made up by low-end, non premium pre-paid users. Their basic aim is to communicate in the most inexpensive manner. Therefore the price of basic services becomes the governing factor of telecommunication market. It is common to observe subscribers adopting to several cost reduction strategies with their mobile connections. These subscribers easily switch in to a mobile service provider offering most cost effective tariff plan for the moment. Another strategy is the use of multiple mobile connections from different operators, in order to avail of on-net call tariffs and benefits and to experience the benefit of seasonal offers.

Compared with developed and matured telecom markets the service providers in south Asian countries gain lesser return on investment due to the behaviors explained above. Also most operators use budget network models and adhoc service implementations to accommodate lower call charges.

Success of MNP measured in terms of number of ported numbers. However higher number of porting can not be expected in Sri Lanka due to lesser population compared with other countries.

Considering above facts it is obvious that the conditions in developed telecom markets are very much different from Sri Lankan markets. Therefore it would not be effective to apply same techniques adopted by developed countries in implementing

MNP directly in Sri Lanka. Strategies and techniques should be cost effective and should justify both effort and cost of implementation.

1.5. Research Objectives

The main objective of having mobile number portability support is to facilitate mobile telephone subscriber movement from one service provider to another. Subscribers tend to change their service provider due to many reasons such as unsatisfactory service quality offered by current service provider, to gain access to additional supplementary services offered by other service providers, experience lower tariffs on services.

The price competition in Sri Lankan telecommunication market is controlled by the floor price introduced by TRCSL. Therefore all subscribers experience almost similar tariffs on services across all mobile service providers. A comparison of charges applicable on basic services is included in Annex-E However the subscribers may want to change the service provider due to other reasons. According to the GSMA intelligence statistics the SIM penetration in Sri Lanka has crossed 100%. That is 24.7 Million mobile connections are utilized by 21.4 Million population. This clearly shows that most subscribers are using more than one mobile connection. Therefore the demand on MNP services in Sri Lanka would be different from other countries.

During the research project an analysis on the level of satisfaction the subscribers has with current service providers, their willingness to switch service providers under MNP offering will be performed through an public opinion survey.

There are several technical implementation architectures which different countries have used in implementing number portability. However there is no analysis done on technical challenges and cost analysis on different architectures in Sri Lankan telecommunication market context. The main objective of this research project is to

develop technical implementation architecture for MNP in Sri Lanka based on the feasibility and cost analysis performed during the research.

1.6. Organization of the thesis

This thesis contains 9 chapters and 6 Annexes.

Introduction to Signaling System Number 7 (SS7) , protocols and signaling messages involved in basic call handling and MNP services are described in chapter2. Different MNP implementation architectures and their feasibility of implementing in Sri Lanka included in Chapter3.

Chapter 4 contains the details about the mobile subscriber survey including questionnaire designing, sample selection and survey outcome. Mobile Telecom service providers' feedback on MNP implementation in Sri Lanka is summarized in Chapeter5.

Various costs involved in MNP implementation are discussed in Chapter6.Comparison of different MNP routing schemes in terms of cost are given at the end of the chapter.

Chapter7 contains the recommendations made based on subscriber survey, Feasibility and costs analysis on various MNP implementation architectures. Modifications required in Service provider networks and centralized equipments to be used in implementing MNP are given in chapter 8.

Chapter 9 contains the conclusions made after the study of MNP implementation in Sri Lanka.

Annex-A includes the detailed call flows applicable on terminating voice calls under each MNP routing scheme. MNP porting rate forecast described in Annex-B. Annex-

C explains the calculation of cost of additional post dial delay caused by introduction of MNP. Annex-D is the high level Scope of Work (SoW) shared with telecom equipment suppliers to get cost and time estimations. A comparison of call charges applicable across mobile service providers included in Annex-E. Annex-F contains the questionnaire used in survey.

CHAPTER 2: OVERVIEW OF SIGNALING SYSTEM NUMBER 7 (SS7)

Equipments in a telecommunication network should communicate certain signaling information between each other to provide the desired services of them. Though the actual data being transmitted (ex: Voice call) is independent of the signaling being exchanged, without signaling whole communication would become meaningless.

SS7 is a widely used signaling system in both mobile and fixed telecommunication networks. SS7 uses Common Channel Signaling concept where signaling related to thousands of traffic circuits are transmitted in a common signaling channel. Transmission and transmission path of signaling channel is independent that of traffic circuits.

Similar to OSI reference model used in IP networking, SS7 protocol stack comprise several layers which are expected to perform certain functionalities specific to each layer. The figure 2.1 below describes the layered architecture of SS7 protocols that are being discussed in this document.

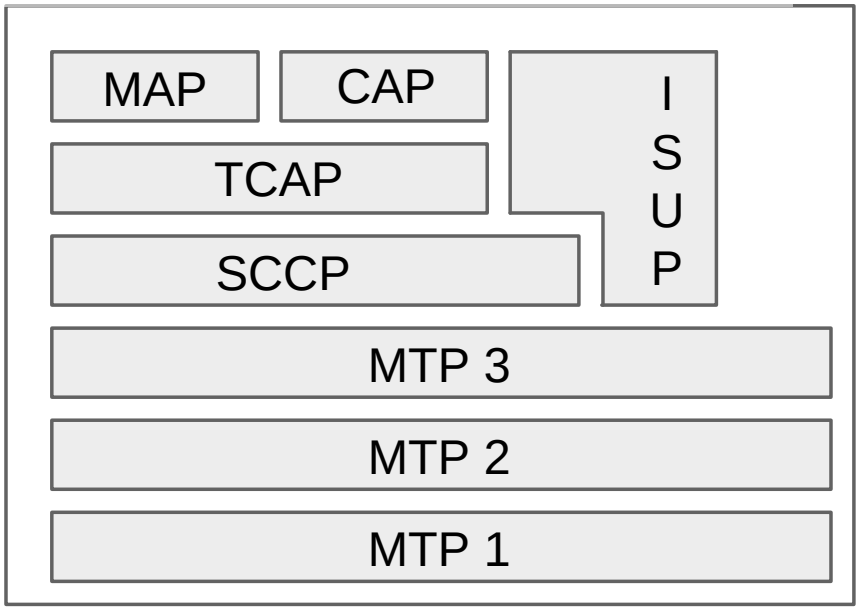


Figure 2. 1 : Layered architecture of SS7 protocol stack

MTP1 is the physical layer of SS7. It defines the requirement of both physical and electrical interfaces on signaling devices [19]. MTP1 allows bidirectional transmission therefore MTP1 specifies two data channels operating in opposite directions. MTP 2 layer facilitate the link alignment at the initialization of a signaling link between two nodes. Further MTP2 performs error detection and retransmissions where necessary.

MTP 3 is the network layer, and it implements routing functions. The information available in MTP3 layer such as point codes are used to route signaling messages in SS7 network. All three MTP layers together are called the Message Transfer Part (MTP) and is used as a primary means of packet transport in a SS7 network.

Under SIGTRAN implementations MTP layers are being replaced by three bottoms most layers of OSI reference model, namely Physical, Data link and Network. This allows transmission of signaling messages over a traditional Ethernet network leading to significant reduction on costs associated with traditional SS7 signaling network.

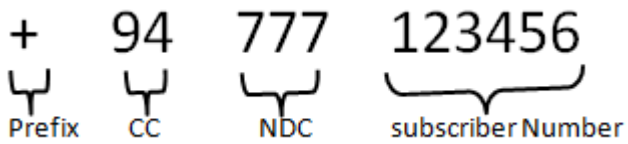
2.1.Subscriber identification numbers associated with MNP

2.1.1. MSISDN

MSISDN is a term used in telecommunication technical domain to specify the number which is known as the mobile telephone number in general public. It is acronym for “Mobile Subscriber ISDN Number”. The maximum allowable length of a MSISDN is 15 digits [ITU-T E.164 recommendation]. MSISDN is used only to fulfill the routing requirements within the core network. All other subscriber related activities (ex: Location update, Paging, Authentication) are done based on a number called IMSI. Neither mobile station nor SIM card aware of the MSISDN is being tagged with the subscriber.

MSISDN in ITU-T E.164 format comprises international prefix (+ or 00), country code, National destination code (Network code) and subscriber number. Country codes are issued as per the ITU-T recommendation E.164 are published periodically by Telecommunication Standardization Bureau[ITU-T E.164 recommendation].

Ex:



Since the NDCs are assigned to mobile telephone service providers, subscribers are not allowed to move between service providers while retaining the same MSISDN under normal conditions (i.e. Without Mobile Number portability).

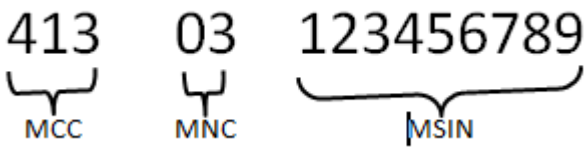
2.1.2. IMSI

IMSI is a unique number associated with each SIM (Subscriber Identity Module) card inserted into a GSM/ UMTS mobile telephone. IMSI stands for "International Mobile Subscriber Identity". IMSI is used to identify a particular mobile station uniquely within mobile telephone network. The maximum allowable length of an IMSI is 15 digits [ITU-T E.212 recommendation].Whenever a mobile subscriber switches mobile telephone service provider under mobile number portability; subscriber is allowed to take the MSISDN issued by donor network to him. However the recipient network of the ported number should issue a new IMSI from the range allocated for the recipient network. Mapping between MSISDN and IMSI is being made in Home Location Registry (HLR) of subscription network and transferred to relevant visitor location register (VLR) upon location update.

Three leftmost digits of an IMSI denotes the mobile country code (MCC),next 2 or 3 digits denotes the mobile network code (MNC) which identifies the mobile telephone service provider in a particular country. The length of MNC depends on

MCC. Rest of the digits denotes the Mobile subscription identification number (MSIN) assigned by the telephone service provider.

Ex:



2.1.3. Network routing Number

NRN stands for "Network routing Number". NRN is a number which is used to identify and route the signaling messages to a ported number specifically. The recipient network should be able to identify the called party number based on NRN. Therefore the NRN is composed by an adding a prefix to called party address. The prefix to be used can be agreed by service providers in the portability domain and should identify the each service provider separately.

2.2.ISUP

ISUP the acronym for "ISDN user part" is used to carry inter-exchange signaling related to voice calls. It is responsible for setting up and releasing voice trunks used for inter exchange calls. ISUP is faster compared to channel associated signaling. ISUP has higher bandwidth since it uses Common Channel Signaling therefore it can carry more signaling information than signaling protocol implemented over Channel associated signaling[ref: ss7 handbook]. ISUP messages being exchanged while setup and teardown of a voice call are mentioned below in figure 2.2.

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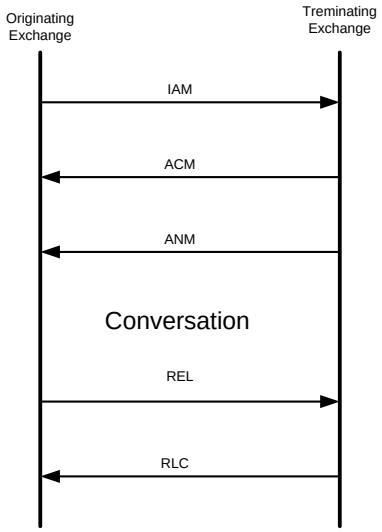

Figure 2. 2 ISUP messages being exchanged while setup and teardown of a voice call

IAM (Initial Address Message) is the very first message sent from originating exchange to the terminating exchange indicating the attempt to setup a call. This message contains the information required to establish call session such as Calling party number (A party), Called party number (B party) and physical circuit being (CIC) associated with the call.

ACM (Address Complete Message) is the subsequent message sent from terminating exchange to originating exchange to indicate the call to B party can be completed and B party is free.

Ones the B party answer the phone, ANM (Answer Message) is sent from terminating exchange to the originating exchange allowing conversation to start.

Either party may initiate tear down of the call by sending REL (Release Message) which should acknowledge by the far end exchange by sending RLC (Release Complete) message. After successful transmission of the RLC message both exchanges releases the circuits and other resources allocated for the call.

2.3.MAP

MAP stands for “Mobile Application Part”. Most application layer services utilize the MAP signaling for communications. Routing information sharing between Mobile switching centers and HLR, Transmission of Short messages (SMS) are completely relying on MAP messages.

MAP layer utilizes the services provided by TCAP (Transaction Capabilities Application Part) which resides immediately below the MAP layer. TCAP provides the session maintenance capability and match the responses against requests.

SCCP (Signaling Connection Control Part) runs on top of MTP layers and provide services to TCAP for message routing between nodes. Each SCCP message contains source and destination addresses which are named as calling and called addresses respectively. These addresses take the form of E.164 number, hence globally routable. Further SCCP is used to reach the desired application service of the far end if single node is running multiple services.

2.4. CAP

CAP an acronym for “CAMEL Application Part” resides on top of TCAP layer. CAP is used by one network node to start a procedure in a peer node. Response to a CAP request could also be a request to start another procedure in request originated node. Network equipments in telecommunication network (ex: MSC) are capable of invoking a CAP message towards specified peer node based on an occurrence of an event called Detection Point (DP). Examples could be, initiate charging procedures in an online charging system for all mobile originated calls. Response from online charging system may instruct MSC to release the call immediately if the charging was unsuccessful or to continue with call and inform subsequent events like tear down of the call, back to the charging system.

CAP messages involved in MNP solutions are described below.

2.4.1. InitialDP

If an IN based solution is involved in providing MNP solutions the MSC will trigger InitalDP message towards number portability database to query the porting status of the called party number. The InitialDP message contains all the information required to make decisions such as calling party number, called party number, Location information, forwarding information if call is a forwarded from another number.

2.4.2. Service key

Service key is a parameter contains in InitialDP message. It is used to identify the corresponding procedure to be executed upon receiving an InitialDP message, as single IN entity may host several services. It is InitialDP invoking entity's responsibility to insert correct service Key based on the triggering criteria. For an example, a number portability database query should contain correct service key associated with MNP services, Number portability database may not respond to InitialDP messages with Service keys that are not configured for MNP services.

2.4.3. Continue

CAP "continue" is one of the possible responses to a CAP InitialDP request. As name implies, the "Continue" message requests invoking entity to continue with the rest of the procedures associated with current transaction. For an example the number portability database will respond with "Continue" message for an InitialDP triggered to a non ported number, therefore the MSC handles the call under normal call handling procedures.

2.4.4. Connect

CAP "Connect" message is used to instruct MSC to route the call to an alternative destination number rather than the originally called number. "Connect" performs similar function as call forwarding. The number portability database will respond

with “connect” message for an InitialDP triggered to a ported number so that MSC routes the call towards subscription network of the ported number.

CHAPTER 3: IMPLEMENTATION ARCHITECTURES OF MOBILE NUMBER PORTABILITY

3.1.Impact of MNP on Mobile originated calls

Whenever a mobile station is switched on, it should be authenticated with the network. Network will let only the authenticated mobile stations to access and use the resources of the network. Further mobile station should keep informed the network, where it is roaming currently via a procedure called “location update” in GSM/UMTS network.

IMSI is used to identify a mobile station uniquely in both the above procedures, hence MSISDN is not required. Since the ported number is assigned with an IMSI from the recipient network both authentication and location update in recipient network will work as expected. Therefore mobile originated voice calls from a ported number should not be impacted by the availability of number portability.

HLR maintains the mapping between IMSI and MSISDN per each subscriber; this information is being downloaded to MSC whenever subscriber roams to that particular MSC. In case of mobile originated call, MSC will insert the associated MSISDN value of the call originator in “calling Party Number” parameter of the IAM. This parameter is used for charging, caller line identification (CLI), and Call detail recording purposes.

In order to facilitate a subscriber porting in to the network, HLR in that network should support paring a MSISDN other than from the range originally assigned to that network against an IMSI of own network that is assigned to ported in subscriber.

3.2.Impact of MNP on Mobile terminated calls

Routing methods used in GSM/UMTS core network under MNP unavailable scenarios are severely impacted by the mobile number portability as important

routing decisions are made based on the called party address in IAM or SCCP messages carrying MAP “Send Routing Information”.

Different alternative routing procedures are being used by different operators across the globe to address the concerns. Specifically four methods listed below are globally accepted [16].

1. Terminating call Query on Digit Analysis (TQoD)
2. Query on HLR Release (QoHR)
3. Originating call Query on Digit Analysis(OQoD)
4. Signaling Relay Function based solution. (SRF based)

Detailed call flows of each routing scheme are included in Appendix-A.

3.3.Terminating call Query on Digit Analysis (TQoD)

3.3.1. Introduction

In this routing scheme only the donor network and the subscription network maintains the information about the ported subscribers. Terminating call to a ported number originated from a national or from an international network is routed towards number range holder network (Donor network) using ordinary routing rules used to route calls under MNP unavailable scenario. Donor network suppose to perform number portability database lookup for all terminated calls from outside the network. If the number is identified to be ported, call will be routed towards the subscription network. Otherwise call will be handled according to the normal procedures.

Number portability database may reside outside the Donor network, if it is shared by all service providers in the porting domain and is centrally managed. Other option is to maintain number portability database by each service provider containing information about the subscription network of each of the ported out number.

3.3.2. Porting process

3.3.2.1. Number range holder network

- Remove the entry associated with the ported number from HLR
- Add an entry in number portability database along with NRN associated with the ported number
- If the number is already in number portability database , (Already ported number being switched from current service provider to another) modify the entry in number portability database and insert new NRN

3.3.2.2. Recipient network

- Add an entry in HLR associated with ported in number
- If the number is already in number portability database, remove the entry.

3.3.2.3. Other networks

- No modification is required

3.3.2.4. Terminating calls to a ported out number

Under TQoD, to handle the terminating call to a ported out number which is originated within the donor network there should be special arrangements, below routing models are fasible to utilize.

Implementing TQoD functionality in MSCs in addition to gateway MSCs may make the solution uniform across all scenarios. However once the TQoD implemented in MSCs , NPDB query would be made to all terminating calls regardless of whether the call was originated outside the network or insider the network, therefore all calls generated inside the country or outside the country would experience additional post dial delay.

3.3.2.5. Feasibility

Core networks of all telecom service providers are capable of handling CAMEL version 3, hence triggering of CAMEL InitialDP towards NPDB from GMSC, and MSCs on all terminated calls are feasible across all service providers.

Integration of number portability database to core network can be accommodated over Sigtran M3UA.

Either centralized or distributed database model can be used for number portability database.

3.3.2.6. Pros and Cons

Pros

- Uses standard GSM / UMTS call flows throughout the implementation.
- Modifications are required only at Gateway MSCs of Donor network and Recipient network
- Calls originated both within the portability domain and outside the portability domain are handled in the same manner

Cons

- Increased post dial delay observed for terminated calls to both ported and non ported numbers, as database quarry is performed for all terminating calls.
- Waste of trunks usage, as additional trunks between originating network and donor network is always required to establish a voice call to a ported number.
- Waste of resources as GMSC of donor network should always involve in call termination to a ported number.

3.3.3. Required modifications in core network

- Gateway MSCs involved in interworking between service providers within portability domain should be capable of triggering CAMEL InitialDP towards number portability database for all terminating calls towards the network.
- HLR should allow paring a MSISDN originally owned by other network against own network IMSI.
- To trigger number portability database in case of originated call within donor network to a ported out number any of the below implementations should be utilized.
    - CAMEL DCSI triggering
    - OQoD routing mechanism
    - QoHR routing mechanism

- Gateway MSC should identify the terminating calls to ported in number (i.e. Called party number contains an NRN) and should avoid quarrying number portability database.
- Gateway MSC should identify the terminating calls to ported in number (i.e. Called party number contains an NRN) and remove the prefix in NRN and trigger MAP Send routing info message towards HLR

3.4.Query on HLR Release (QoHR)

3.4.1. Introduction

Similar to Terminating Query on Digit analysis scheme only the donor network and the subscription network maintains the information about ported subscribers . Terminating call to a ported number originated from a national or from an international network is routed towards number range holder network (Donor network) using ordinary routing rules used to route calls under MNP unavailable

scenario. Unlike in TQoD scenario the Gateway MSC in Donor network queries HLR for all incoming calls towards numbers in its own number range. HLR will respond with MSRN for all non ported numbers and "Unknown Subscriber" error on all ported out numbers. Number portability database query is done only for the numbers for which HLR respond with "Unknown Subscriber". If the number is identified to be ported, call will be routed towards the subscription network. Otherwise call released.

Number portability database may reside outside the Donor network, if it is shared by all service providers in the porting a domain and is centrally managed. Other option is to maintain number portability database by each service provider containing information about the subscription network of each ported out number.

3.4.2. Porting process

3.4.2.1. Number range holder network

- Remove the entry associated with the ported number from HLR
- Add an entry in number portability database along with NRN associated with the ported number
- If the number is already in number portability database , (Already ported number being switched from current service provider to another) modify the entry in number portability database and insert new NRN

3.4.2.2. Recipient network

- Add an entry in HLR associated with ported in number
- If the number is already in number portability database, remove the entry.

3.4.2.3. Other networks

- No modification is required

3.4.3. Terminating calls to a ported out number

Calls originated within donor network to a ported out number can be treated in the same manner as originated calls outside the network by implementing the QoHR routing mechanism in MSCs in addition to gateway MSCs.

3.4.4. Feasibility

Core networks of all telecom service providers are capable of handling CAMEL version 3, hence triggering CAMEL InitialDP towards NPDB from GMSC and MSCs based on release cause from HLR for SRI requests is feasible across all service providers.

Integration of number portability database to core network can be accommodated over Sigtran M3UA.

Either centralized or distributed database model can be used for number portability database.

3.4.5. Pros and Cons

Pros

- Uses standard GSM / UMTS call flows throughout the implementation.
- Modifications are required only at Gateway MSCs of Donor network and Recipient network
- Calls originated both within the portability domain and outside the portability domain are handled in the same manner
- Increase in post dial delay is observed only for terminating calls to a ported number as number portability database query is performed only for undefined numbers in HLR.

Cons

- Waste of trunks usage, as additional trunks between originating network and donor network is always required to establish a voice call to a ported number.
- Waste of resources as GMSC of donor network should always involve in call termination to a ported number.

3.4.6. Required modifications in core network

- Gateway MSCs involved in interworking between service providers within portability domain should be capable of triggering CAMEL InitialDP towards number portability database if HLR returns "unknown subscriber" for MAP send routing information request.
- HLR should allow paring a MSISDN originally owned by other network against own network IMSI.
- MSCs should trigger number portability database if HLR returns "unknown subscriber" for MAP send routing information request in case of originated call within donor network to a ported out number.
- Gateway MSC should identify the terminating calls to ported in number (i.e. Called party number contains an NRN) and remove the prefix in NRN and trigger MAP Send routing info message towards HLR

3.5.Originating Query on Digit analysis (OQoD)

3.5.1. Introduction

Unlike in TQoD and QoHR schemes in OQoD originating network maintain the information of ported number. Call routing in OQoD is more efficient than both TQoD and QoHR as call is directly routed from Originating network to subscription network without going through donor network.

Number portability database is queried for all originated calls to identify whether the destination number is ported or not. Call to non ported numbers will follow normal call handling procedures where as calls to a ported number will be routed to the subscription network based on the response received from number portability databases.
However calls originated outside the portability domain should still be handled using either TQoD or QoHR.

Number portability database may reside outside the Donor network, if it is shared by all service providers in the porting a domain and is centrally managed. Other option is to maintain number portability database by each service provider containing information about the subscription network of each ported out number.

3.5.2. Porting process

3.5.2.1. Number range holder network

- Remove the entry associated with the ported number from HLR
- Add an entry in number portability database along with NRN associated with the ported number
- If the number is already in number portability database , (Already ported number being switched from current service provider to another) modify the entry in number portability database and insert new NRN

3.5.2.2. Recipient network

- Add an entry in HLR associated with ported in number
- Add an entry in number portability database along with NRN associated with the ported number
- If the number is already in number portability database, remove the entry.

3.5.2.3. Other networks in portability domain

- Add an entry in number portability database along with NRN associated with the ported number
- If the number is already in number portability database , (Already ported number being switched from current service provider to another) modify the entry in number portability database

3.5.3. Terminating calls to a ported out number

No modifications required.

3.5.4. Feasibility

Core networks of all telecom service providers are capable of handling CAMEL version 3, hence triggering CAMEL InitialDP towards NPDB from MSCs for all originated calls inside the network is feasible. Further GMSCs are capable of triggering initialDP on terminated calls originated outside the portability domain.

Integration of number portability database to the core network can be accommodated over Sigtran M3UA.

Either centralized or distributed database model can be used for number portability database.

3.5.5. Pros and Cons

Pros

- Efficient use of voice trunks as terminated calls to a ported number is directly routed towards subscription network without involvement of donor network.
- Uses standard GSM / UMTS call flows throughout the implementation.

Cons

- Modifications are required at MSCs of all networks in portability domain. All service providers should be ready to offer MNP services to launch the MNP in the country
- Increase in post dial delay is observed for all calls originated within portability domains as number portability database query is performed on all originated calls.
- Calls originated outside the portability domain are handled differently than the call originated within the portability domain

3.5.6. Required modifications in core network

- All MSCs in all service providers in portability domain should query number portability database on all originated calls
- HLR should allow paring a MSISDN originally owned by other network against own network IMSI.
- Gateway MSC should identify the terminating calls to ported in number (i.e. Called party number contains an NRN) and remove the prefix in NRN and trigger MAP Send routing info message towards HLR
- Donor network should implement either TQoD, QoHR to accommodate the calls originated outside the portability domain

3.6.Signaling Relay Function (SRF)

3.6.1. Introduction

In an environment supporting “Signaling Relay Function” call and non call related messages sent towards HLR which are affected by Mobile number portability are routed via Signaling Relay. The Signaling Relay function relays the signaling messages to an alternative HLRs based on the type of message (call-related, non-call-related or MNP information request) and on the porting status of the called

subscriber. Signaling Relay function implementations can co exists with IN based MNP solutions (TQoD, QoHR, OQoD) . Signaling relay function can be used to handle call related as well as non call related signaling messages in an MNP environment.

Mobile Number Portability solution over Signaling Relay Function can be implemented under two routing mechanisms called direct routing and indirect routing. If indirect routing is used, calls to a ported number is routed via donor network therefore donor network should maintain the information about ported numbers. Under direct routing scheme terminated calls to a ported number is directly routed to the subscription network.

3.6.2. Porting process – Direct routing

3.6.2.1. Number range holder network

- Remove the entry associated with ported number from HLR
- Add an entry in number portability database along with NRN associated with the ported number
- If the number is already in number portability database , (Already ported number being switched from current service provider to another) modify the entry in number portability database

3.6.2.2. Recipient network

- Add an entry in HLR associated with ported in number
- Add an entry in number portability database along with NRN associated with the ported number
- If the number is already in number portability database, modify the entry.

3.6.2.3. Other networks

- Add an entry in number portability database along with NRN associated with the ported number

3.6.3. Porting process –inDirect routing

3.6.3.1. Number range holder network

- Remove the entry associated with ported number from HLR
- Add an entry in number portability database along with NRN associated with the ported number
- If the number is already in number portability database , (Already ported number being switched from current service provider to another) modify the entry in number portability database
-

3.6.3.2. Recipient network

- Add an entry in HLR associated with ported in number
- Add an entry in number portability database along with NRN associated with the ported number
- If the number is already in number portability database, modify the entry.

3.6.3.3. Other networks

- No modifications required

3.6.4. Terminating calls to a ported out number

- No modifications required.

3.6.5. Feasibility

Signaling Transfer Point (STP) functionality is not available with one service provider in Sri Lanka. Therefore SCCP translation type modifications and signaling message routing based on SCCP translation type is not feasible in that network. Further the MSC s in that network also does not support SCCP translation type

modifications and routing. Introducing STP functionality in network would be major rearrangement of entire network.

Hence the implementation of Signaling Relay Function (SRF) within Sri Lanka is considered as not feasible option and will not be further evaluated in this study.

3.6.6. Pros and Cons

Pros

- Efficient use of voice trunks as terminated calls to a ported number is directly routed towards subscription network, if direct routing is used.
- Uses standard GSM / UMTS call flows throughout the implementation except database query , if indirect routing is used.
- Calls originated inside and outside the portability domain are handled in the same manner if indirect routing is used.

Cons

- Inefficient use of voice trunks as terminated calls to a ported number is always routed via number range holder network , if indirect routing is used.
- Increase in post dial delay is observed for all calls originated within portability domains as number portability database query is performed on all originated calls.
- Modifications are required at MSCs/STP to route MAP SRI Requests via Signaling relay function.
- Calls originated outside the portability domain are handled differently than the call originated within the portability domain if direct routing is used.
- MSCs will directly communicate with HLRs in other service provider networks for MAP violating standard GSM/UMTS call flow, if direct routing is used.

3.6.7. Required modifications in core network

- If direct routing to be used MAP SRI towards number ranges other than the number range owned by the network should directly be triggered towards the respective HLRs of the other network.
- Signaling Relay Function should be opened to accept and respond MAP SRI from other operator networks if direct routing is used.
- Network should be configured to route all MAP SRI requests via Signaling relay function.
- HLR should allow paring a MSISDN originally owned by other network against own network IMSI.
- Gateway MSC should identify the terminating calls to ported in number (i.e. Called party number contains an NRN) and remove the prefix in NRN and trigger MAP Send routing info message towards HLR

CHAPTER 4: MOBILE SUBSCRIBER SURVEY

This chapter contains the details about the mobile subscriber survey conducted for the study into subscriber expectation and willingness to accept MNP in Sri Lanka. Responses from total of 355 mobile telephone subscribers were collected. Sample was selected based on "Quota sampling" method. Survey was conducted using a printed questionnaire paper and included in as Annex-F.

4.1.Questionnaire designing

The survey questioner was designed to capture the information required to analyze the correlation between customer satisfaction level, loyalty, brand effect and multiple SIM ownership against the subscriber willingness to accept MNP. Table 4.1 contains the hypothesis, variables and associated questions used to capture the information against the variable.

Five demographic aspects were also tested and summarized in table 4.2

Customer willingness to pay for MNP services was tested via the question 7. The question was design under Double-Bounded Dichotomous Choice [13] method. First, survey responders were offered monthly rental of LKR 100.00 that is equal to one third of average revenue per user (ARPU) in Sri Lankan telecommunication market. If responder is not willing to pay LKR 100.00 then monthly fee of LKR 50.00 was offered as the second option, if he is willing to pay LKR 100 then it was tested to see whether he is willing to pay double of it.

Question4 was included in the questionnaire to identify the number of subscribers who are expecting to move in to a new service provider under MNP unavailable scenario. The results were used in calculating the costs involved in MNP implementation.

Question5 was included to test the subscriber willingness to accept MNP services. Percentage of subscribers remains attached to the current service provider considering the value of mobile telephone number was identified using the responses given on this question.

Question8 and question9 were included in the questionnaire to identify the necessity and the demand of MNP services in user point of view.

Question15 was included to test whether the responder is directly engaged with telecommunication services; such responses were excluded from the calculations to avoid the possible bias.

Table 4.1: Questions added to test the correlation

Hypothesis	Variables	Indicator	Measure	Question
Overall satisfaction level directly related with the subscriber churn	Quality of the service provided by service provider	Satisfaction level	Excellent, Good , Moderate, Bad, Extremely bad	Question 3) e Question 3) q
	Availability of network coverage	Coverage availability at frequently visited locations	Available, not available	Question 3) f Question 3) r
	Charges applicable on services	Charges relative to other telecom service providers	Too high, High, almost same, Low, Too Low	Question 3) g Question 3) s
	Availability of supplementary services	Supplementary services fulfill the requirements	Adequate, Not adequate	Question 3) h Question 3) t
Brand effect and loyalty refrain customer from churn	Long stay in the network	No of years stayed with service provider	No of years	Question 3) i Question 3) u
	Level of pride on the brand	Level of pride on the brand	Proud, Neutral , not proud	Question 3) j Question 3) v
Availability of Dual SIM facility of mobile phones and multiple SIM ownership has negative impact on MNP success	Multiple SIM ownership	Usage of more than one SIM	Use multiple SIMs, Use only one SIM	Question 2

Table 4.2: Demographic aspects

Hypothesis	Variables	Indicator	Measure	Question
Demographic aspects				
Younger generation adopt new technologies , services faster , hence MNP	Age	Age	Age years	Age:……
People with low income level values the telecommunications less, hence move easily	Monthly income	Income in LKR	Below Rs 30,000, Below Rs 50,000, Below Rs 100,000, Above Rs 100,000	Question 13
Educated people has more inertia to change their mobile number	Highest education level	Highest education level	GCE O/L, GCE A/L ,Diploma, Bachelor's degree, Post graduate	Question 14
Pre-paid users will move easily between service providers than post paid users	Mode of payment	Mode of payment	Pre paid, Post paid	Question 3) b Question 3) n
Enterprise or Business users has more inertia to move	Type of registration of the mobile connection	Who pays your mobile phone bill	Myself, Parents or guardian, My employer(Company)	Question 3) c Question 3) o

4.2.Sample size calculation

Number of active mobile telephone connections in the country (Approx. 24 million) has been taken as the target population.

Equation:

$$Sample\ size = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1+\left(\frac{z^2 \times p(1-p)}{Ne^2}\right)}$$

Where:

z = Z-score of the relevant confidence level
p = expected response distribution
e = percentage of margin error
N = Population size

z	1.65 (To achieve 90% confidence level)
p	0.5 (Assumed normal distribution)
e	5%
N	24 million
Sample size	271

To achieve confidence level 90% with +/- 5% error, minimum 271 responses are required for the analysis.

4.3.Response collection

Survey responders were selected according to the "Quota sampling" method. Calculated Sample size was split in to 5 sub groups each representing a mobile service provider. Number of response to be collected per each category (quota) was decided based on the market share of the each mobile telecom service provider.

A group consisting ten members of volunteer interviewers assisted in conducting the survey. Each member was asked to collect 36 survey responses according to the quota specified in the Table 4.3. In case of survey responder bearing multiple mobile telephone

connections, only the connection specified as the primary connection (SIM1) by responder was counted on quota.

Table 4.3: Survey response quota allocated per each operator

	Number of survey responses to collected by each interviewer
Dialog	14
Mobitel	8
Etisalat	8
Airtel	3
Hutch	3

4.4.Survey outcome

4.4.1. Assignment of numerical values for the ordinal and nominal data

Table 4.4 : Assignment of numerical values for the ordinal, nominal data

		Numerical value assigned					
		0	1	2	3	4	5
Ordinal, nominal data	Willingness to accept MNP	Not willing to accept MNP and will not move	Willing to accept MNP and will be moved				
	Satisfaction level on Service quality	-	Excellent	Good	Moderate	Bad	Extremely bad
	Charges on services	-	Too Low	Low	Almost same	High	Too High
	Coverage availability at frequently visited locations	-	Available	-	-	-	Not available

	Supplementary services provided by service provider	-	Adequate	-	-	-	Not adequate
	Pride on brand name	-	Proud	-	Neutral	-	Not proud
	Type of connection	-	Personal	-	-	-	Enterprise
	Mode of payment	-	Prepaid	-	-	-	Postpaid
	Multiple SIM ownership	-	Use only one SIM	-	-	-	Use multiple SIMs
	Education level	-	GCE O/L	GCE A/L	Diploma	Bachelor's Degree	Post graduate
	Monthly income (X in LKR)	-	X< 30,000	30,000 < X< 50,000	50,000 <X < 100,000	X > 100,000	-

4.4.2. Response distribution

The distribution of survey participants among mobile service providers nearly tally with the market share of each of the operators.

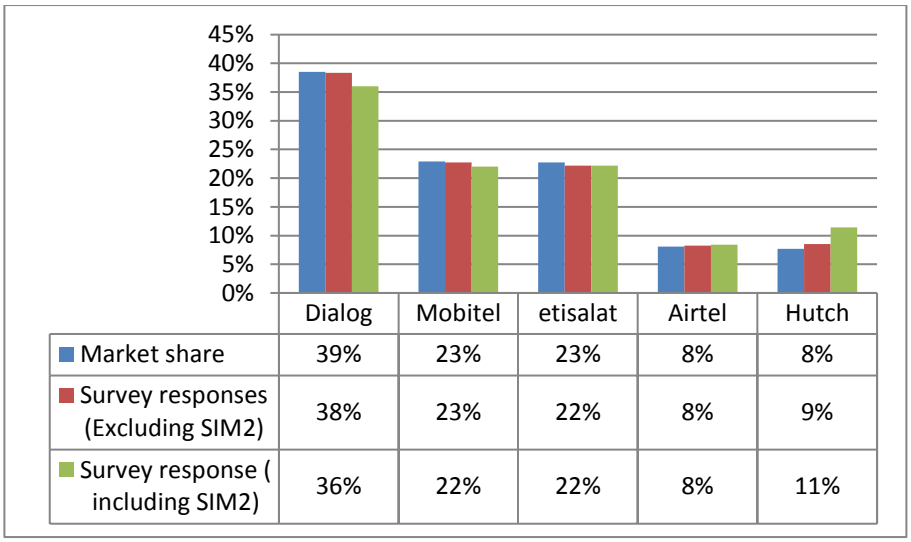

Figure 4. 1 : Distribution of survey response

4.4.3. Necessity of MNP

According to the survey results 41% of mobile subscribers say that MNP services are required in Sri Lankan telecommunication market.

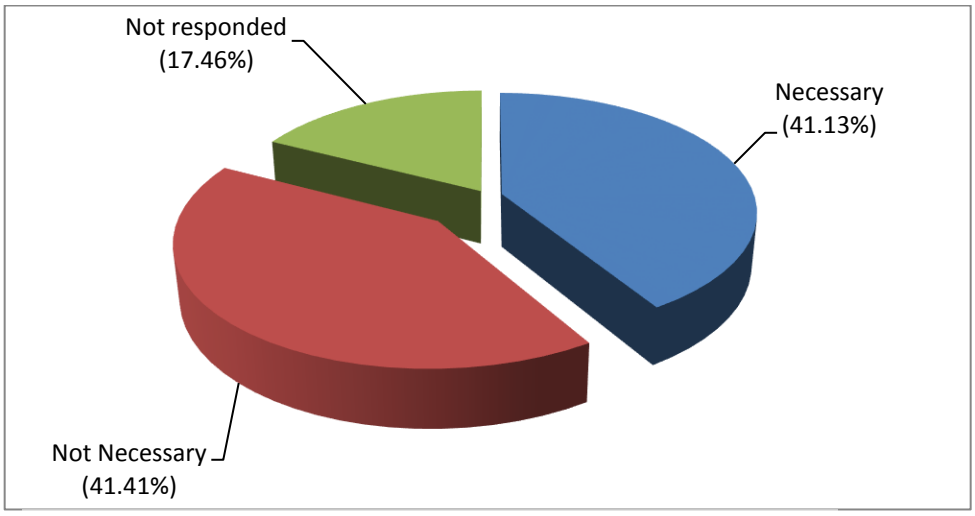

Figure 4. 2: Necessity of MNP

4.5.Subscriber churn

24% of the subscribers will disconnect the current mobile connect and move to a new service provider even if MNP is not available.

Table 4.5: Are you seriously considering moving to another mobile service provider?

	Number of responses	%
Yes	86	24
No	269	76

4.6.Willing to accept MNP

40% of subscribers will make use of MNP and move to a new service provider.

Table 4.6 : If you were given a chance to keep existing mobile number and move to another service provider, will you move?

	Number of responses	%
Yes	142	40
No	213	60

Subscriber churn will increase up to 40% from 24% under MNP available scenario. It is observed that value of mobile telephone number has restricted the movement of 16% mobile subscribers to another service provider.

4.7.Subscriber willingness to pay for MNP services

Majority of subscribers are willing to pay to for having the MNP services. Survey suggests that 22% of subscribers are willing to get MNP services even at a cost of LKR 200 per month

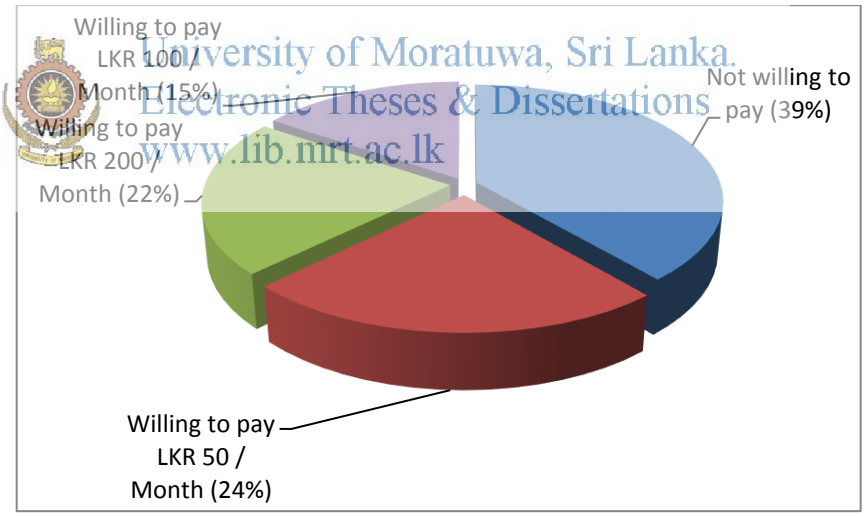

Figure 4.3 : Subscriber willingness to pay for MNP

4.8.How soon MNP services should be available

More than 70% of subscribers willing to accept MNP are expecting to have the MNP service implemented within 6 months.

Table 4.7 : How soon MNP services should be available?

	Number of responses	%
immediately	73	51%
within 6 months	32	23%
within 1 year	21	15%
within 2 years	5	4%
Not responded	11	8%

4.9.Correlation analysis

Somers' D_{XY} rank correlation method was used to analyze the correlation of variables. Somer's D_{XY} correlation coefficients are alternatives to Pearson's product-moment correlation coefficient and Spearman's rank-order correlation coefficient for ordinal data [20]. The coefficient shows how many more favorable than non-favorable pairs exist divided by the total number of pairs. The coefficient may vary in the range from -1 (all pairs disagree) to 1 (all pairs agree.)

4.9.1. Analysis on customer satisfaction level

Somers' D_{XY} rank correlation coefficient was computed to assess the relationship between the variables defining subscriber satisfaction level on the quality of services provided by the mobile telecom service provider, availability of network coverage at frequently visited locations, applicable call charges (as per subscriber point of view) and availability of adequate supplementary services to fulfill subscriber requirements against willingness to accept MNP and move in to a new service provider. Correlation coefficients are summarized in Table 4.8

Overall, there was a slight, positive correlation between specified variables and willingness to accept MNP. Higher dissatisfaction levels were correlated with increases user willingness to accept MNP and move in to a different mobile telecom service provider.

Table 4.8: Correlation analysis – satisfaction level vs. Willingness to accept MNP

	D_{XY}	C
Satisfaction level on quality of services	0.15	0.57
Call charges	0.14	0.57
Network coverage availability	0.12	0.56
Availability of supplementary services	0.16	0.58
Combination of all four factors	0.29	0.56

4.9.2. Loyalty and Brand effect

4.9.2.1. Network stay vs. willingness to accept MNP

Somers' D_{XY} rank correlation coefficient between variables network stay and willingness to accept MNP showed light negative correlation D_{XY} = -0.065, C=0.67.

Therefore it can conclude that number of years that subscriber has stayed in particular network does not have major impact on churn under MNP, however there is a little tendency that long stay subscriber not moving to another service provider.

4.9.2.2. Brand effect

Correlation coefficient of DXY= 0.15, C=0.57 observed between customer pride of the service provider against the willingness to accept MNP.

Therefore it can assume that marginal level of brand effect is there in Sri Lankan telecommunication market.

4.9.2.3. Impact of multiple SIM ownership

Somers' DXY rank correlation coefficient was computed to assess the relationship between the variables multiple SIM ownership and willingness to accept MNP. Results

shows exists slight positive correlation between the variables with coefficient D_{XY} =0.066 . C=0.53.

The hypothesis was that the existence of multiple SIM ownership causes negative impact on success of MNP. However as per the correlation analysis it is evident that the there is no such negative impact.

4.10. Demographic aspects

4.10.1. Age

There is no significant correlation between MNP acceptance and subscriber churn against the age.

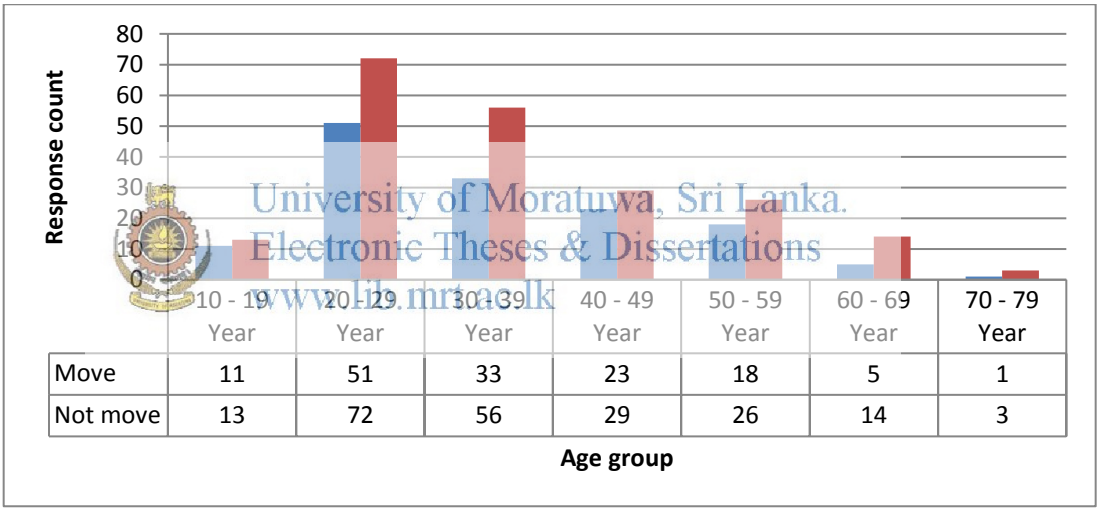

Figure 4.4: Age distribution

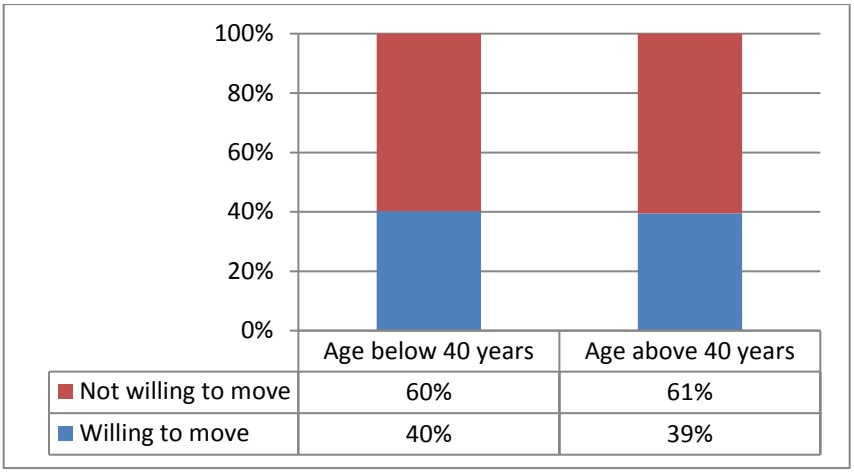

Figure 4.5 : Comparison age VS willingness to move under MNP

4.10.2. Monthly income

Subscribers with higher monthly income are more reluctant to change the mobile telecom service provider even while keeping mobile telephone number.

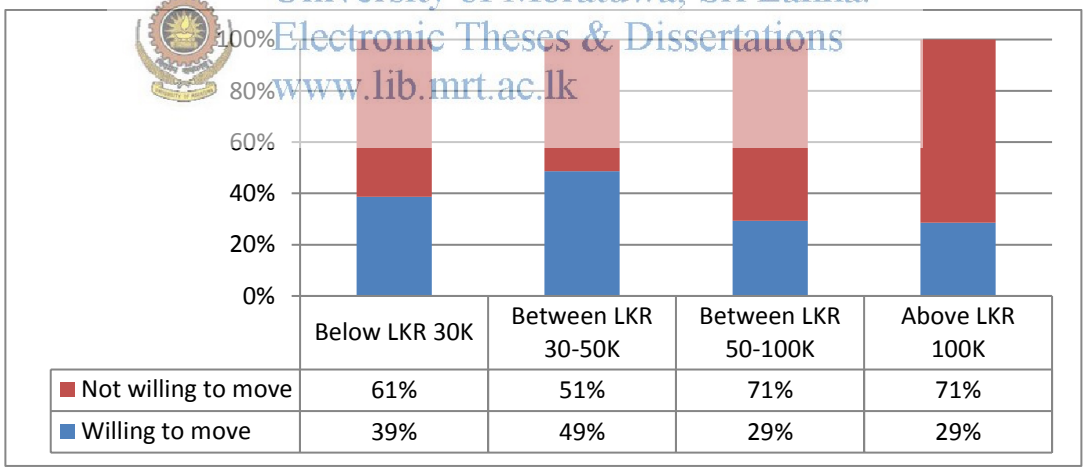

Figure 4.6: Monthly income VS willingness to move under MNP

4.10.3. Education level

Subscribers with higher education background have little less interest on accepting MNP and moving in to a new service provider.

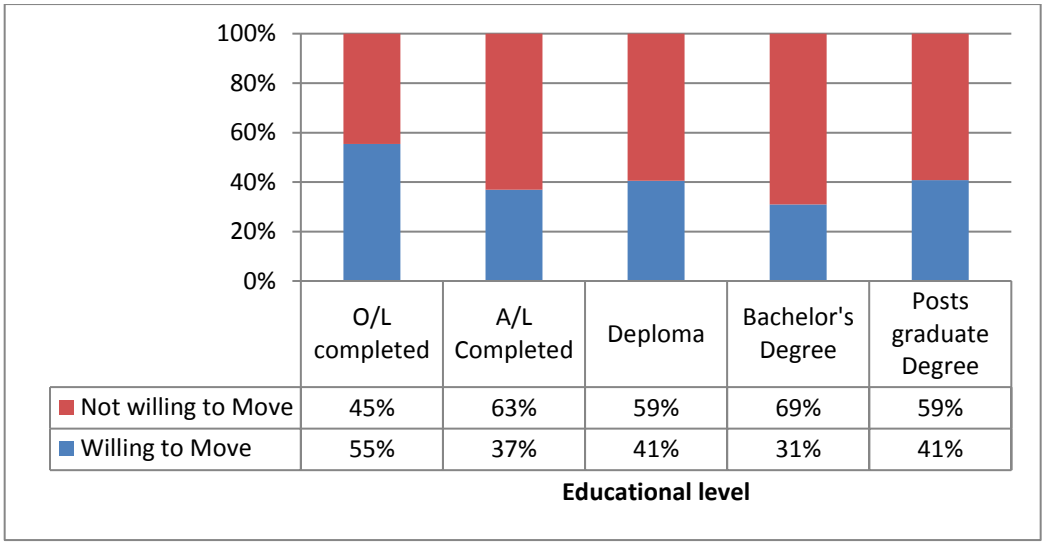

Figure 4.7 : Educational level VS willingness to move under MNP

4.10.4. Mode of payment

According to the survey results, the mode of payment used by subscribers for telecommunication services does not have direct impact on willingness to accept MNP services.

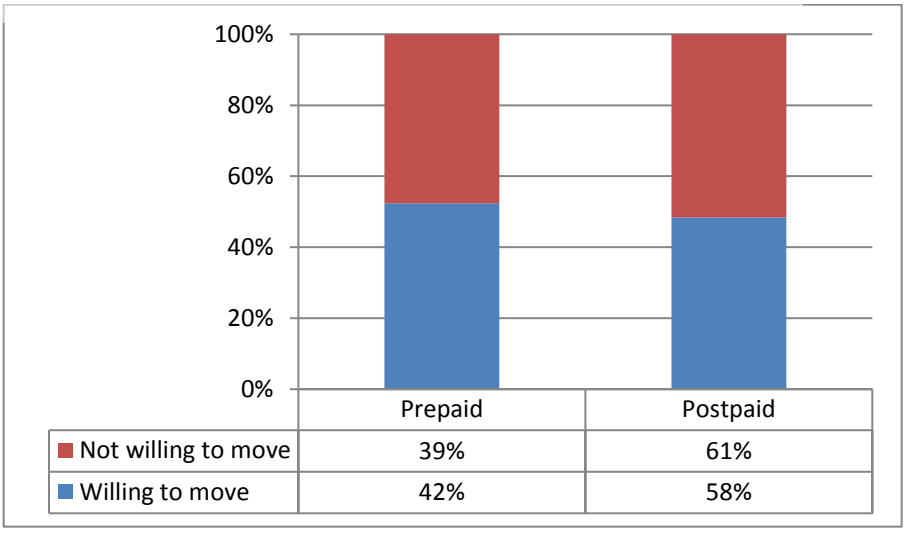

Figure 4.8: Education level VS willingness to move under MNP

4.10.5. Type of connection

Demand for MNP services from enterprise users are more compared to the other users.

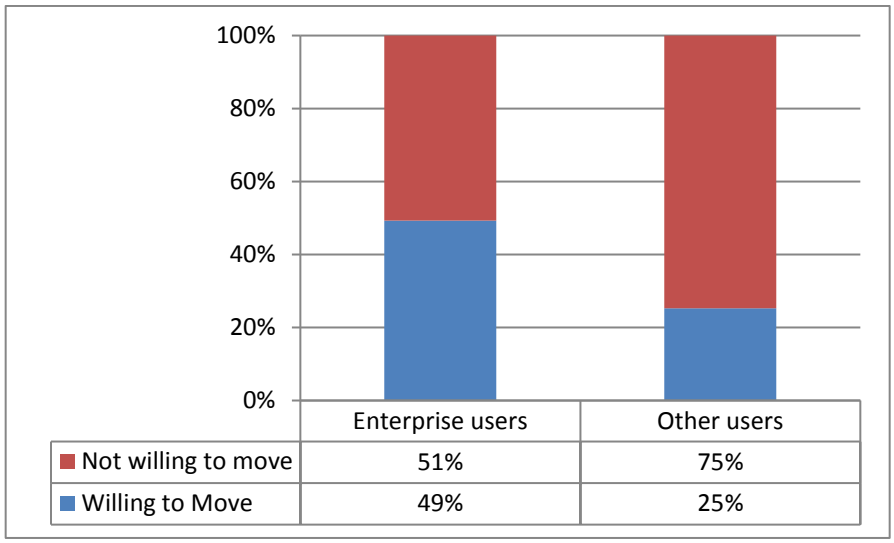

Figure 4.9 : Type of connection

4.11. Predictions and calculations

4.11.1. Number of originated calls per day by MNP accepted subscriber:

Table 4.9 : Number of originated calls per day by MNP accepted subscriber

	median	Number of survey responses	frequency
0-5 calls/ day	2.5	48	120
5-10 calls/ day	7.5	74	555
10-25 calls/ day	17.5	40	700
More than 25 calls/ day	25*	42	1,050
Sum			2,425

* Assume 25

Average number of terminated calls per day per subscriber = 7

4.11.2. Number of terminated calls per day by MNP accepted subscriber:

Table 4.10 : Number of terminated calls per day by MNP accepted subscriber

	median	Number of survey responses	frequency
0-5 calls/ day	2.5	47	117
5-10 calls/ day	7.5	64	480
10-25 calls/ day	17.5	48	840
More than 25 calls/ day	25*	45	1,125
Sum			2,562

* Assume 25

Average number of originated calls per day per subscriber = 7

4.11.3. Average monthly bill (Post paid Subscriber)

Table 4.11 : Number of terminated calls per day by MNP accepted subscriber

	median	Number of survey responses	Sum
LKR 0-300 / month	150	20	3,000
LKR 300-600 / month	450	62	27,900
Above LKR 600 /month*	600*	83	49,800
Sum			80,700

* Assume 600

Average monthly bill of a post paid subscriber = LKR 490

4.11.4. Average monthly bill (Pre paid Subscriber)

Table 4.12 : Number of terminated calls per day by MNP accepted subscriber

	median	Number of survey responses	Sum
LKR 0-300 / month	150	159	23,850
LKR 300-600 / month	450	105	47,250
Above LKR 600 /month*	600*	65	39,000

Sum	110,100

* Assume 600

Average monthly bill of a pre paid subscriber = LKR 335

CHAPTER 5: MOBILE TELECOM SERVICE PROVIDERS FEEDBACK ON IMPLEMENTATION OF MNP

In this chapter five mobile telecom service providers were segregated to two categories based on the market share. Service providers in one category have similar views on some aspects and there are some more aspects that all service providers share similar views. Service providers having more than 5 million subscriber base have been categorized as large operators and others categorized as small operators.

Table 5.1 : Segregation of telecom service providers

Large operators	Small operators
Dialog	Airtel
Mobitel	Hutch
Etisalat	

5.1. Overall view on the availability of MNP

All service providers are well aware of the benefits of MNP in terms of customer and regular point of view. Almost all operators have performed initial high level feasibility study in implementing MNP services in their networks and have a good understanding about the technical complexities that may arises due to the availability of MNP.

All operators informed that the implementations of proposed call flows are feasible in their core networks with software upgrades core network elements. Except the implementation of "Signaling Relay Function" in one operators network due to unavailability of functionality of signaling transfer point.

Service providers highlighted the requirement of having well established process to be followed while number ports and a clearing house to minimize the possible inconvenience that may be faced by subscriber are being ported. Further the large

operators raise a concern on scarcity of numbers to be issued on fresh subscriptions and stressed that the process should incorporate a mechanism to release the numbers back to the donor network if a connection of a ported subscriber was permanently disconnected due to any reason so that they can re-utilize the number.

5.2.Handling other barriers than call routing

Many value added services that are there in service provider's network relying on MSISDN for user authentications. Majority of service providers mentioned that the services are developed by several third parties where incorporating the changes that are requested by MNP would be a tedious task.

Also highlighted that the continues and closer corporation between service providers is required to collect necessary information to resolve customer complaints and answer queries related to ported numbers.

5.3. Direct call routing vs. routing via Donor network

Large operators prefer direct call routing where call originating network suppose to query the portability status of the called party number and route the call directly to the subscription network, whereas small operators preferred the other way round.

5.4.Centralized number portability database vs. Distributed database.

Two large operators and one small operator prefer to have distributed databases possibly with one centralized number portability database synchronizing the data to rest of the databases.

Other two operators prefer a centralized number portability database managed by a third party.

5.5. Regulator involvement

All service providers highlighted the requirement of huge involvement of regulator at every stage of the implementation of MNP to make it a success. Further they stressed that the process and service level agreement establishments should be coordinated by regulator and monitored regularly. Also service providers mentioned the requirement of having regulator involvement for smooth handling of information requests received via various parties that are associated with ported numbers.

5.6. Network sharing

Some service providers currently are in discussion with other service providers for enabling of radio access network sharing. If network sharing is enabled across the country across all service providers the network coverage issues observed by subscribers will be minimized. This will results in reduction of number of subscriber movements to be happened due to unsatisfactory caused by unavailability of the network coverage.

5.7. Timelines

All service providers mentioned that MNP implementation can be accommodated maximum within six months from the finalization of implementation strategy and negotiations with equipment providers, regulator and other service providers.

CHAPTER 6: TRCSL VIEW ON IMPLEMENTATION OF MNP

Telecommunication Regulatory Commission of Sri Lanka (TRCSL) is the national regulatory body for telecommunications in Sri Lanka. TRCSL was established under the Sri Lanka Telecommunication (Amendment) Act No. 27 of 1996.

TRCSL has conducted series of discussions and high level feasibility analysis on implementation of Mobile number portability services in Sri Lanka in 2010-2011 time period. Feedback of telecom service providers and relevant stake holders has been collected. There was a concern on mobile subscriber willingness to accept MNP services under the fact that higher percentage of pre-paid subscribers in the telecommunication market. Further the number of issued Mobile connections for subscribers surpasses the total population of Sri Lanka and number of inactive mobile telephone connections has increased considerably. Therefore it was assumed that the value of keeping the mobile number unchanged while moving to a new service provider is less in Sri Lankan telecommunication market compared to other countries. Considering the above facts and the feedback of the stake holders the more priority has been assigned to other regulatory initiatives than for Mobile Number portability.

TRCSL is open to re-start the discussions on implementation of MNP in Sri Lanka. Commission prefer establishing a steering committee consisting TRCSL officials, participants from all mobile telephone service providers and other stake holders to act in the planning, implementation and maintenance activities of MNP services in Sri Lanka. Further TRCSL believes that it is required to perform analysis on aspects of fixed mobile convergence and opening portability between fixed and mobile telephone connections in addition to mobile number portability.

6.1. MNP implementation architecture for Sri Lanka

TRCSL prefer defining implementation architecture of MNP for Sri Lanka based on the international standards available. MNP steering committee is expected to perform feasibility and costs analysis before proposing the finalized architecture. Once finalized all mobile telecom service providers should implement recommended architecture in their networks to fulfill the MNP requirements. Steering committee may consult relevant resource organizations, people whenever required.

6.2. Processes and procedures implementation

TRCSL also inline with the telecom service providers view on having proper procedures and processes to achieve the success in MNP implementation. The regulatory commission is willing to participate in defining and establishing the processes. Further they are willing to monitor the operator's performance on established procedures until the smooth operation of mobile number portability is achieved.

6.3. Handling information requests and customer queries

Telecommunication regulatory commission accepted that the current procedures and responsibilities of fulfilling information requests such as call detail recordings (CDR) and handling customer queries would be impacted by the implementation of MNP services. TRCSL is willing to establish a proper mechanism to handle the conflicts arising due to availability of MNP whenever required.

6.4. Cost recovery

TRCSL stated that there are several mechanisms to address cost recovery of implementation of MNP services including monthly rental charging from subscribers. Mechanism on cost recovery to be decided based on the government strategies and other governing factors.

6.5. Network sharing

TRCSL encourages implementation of radio network sharing between service providers to address the network coverage related issues. TRCSL believes that resolution of network coverage issues leads to decrease in subscriber churn.

CHAPTER 7: COSTS ANALYSIS

7.1. Introduction

This chapter discusses the methodology used to estimate the costs of three IN based implementation options of Mobile number portability and to compare the total costs involved under each implementation. Since the MNP SRF architecture is not feasible with one operator costs involved in implementing SRF is not considered in the costs analysis. Information gathered via interviews with five mobile telephone service providers in Sri Lanka, interviews with telecom software providers, Statistics published by GSMA Intelligence, previous international studies and knowledge of the telecommunications and the results extracted from the mobile telephone user survey, have been used in estimating the costs. Only the costs that are incurred as a direct result of the introduction of mobile number portability are considered in calculating the costs.

The modification required in Operations support systems (OSS) and business support systems (BSS) to accommodate the implementation of Mobile number portability is out of the scope of this study. Hence costs involved in OSS, BSS upgrades and procedural changes in subscriber provisioning has not been considers in cost calculations.

Section 5.2 of this chapter describes the various cost elements involved in implementing and maintenance of mobile number portability solutions. Solution development and deployment costs, Ongoing costs such as maintenance fees, per subscriber costs and per call related costs are discussion in separate sub sections.

Section 5.3 discusses the total cost of implementing and maintenance of three different MNP architectures namely OQoD, TQoD and QoHR for five years. A comparison of different MNP architectures under centralized MNP NPDB and distributed NPDB has been done.

7.2. Cost elements

7.2.1. MNP Solution development costs

7.2.1.1. MSC software upgrade

All three MNP implementation options TQoD, OQoD and QoHR involves CAMEL InitialDP triggering towards MNP number portability database. Database trigger is initiated from the MSC involved in call handling. Therefore it is mandatory to upgrade the Mobile switching center software to accommodate the requirement.

Based on the feedback received from mobile service providers and telecom equipment providers, it was predicted that the cost involved in MSC software upgrade is LKR 40,000,000.00 per MSC. Assuming each service provider need to upgrade three MSCs and one Gateway MSC to deploy MNP services, total switch software upgrade cost is LKR 800,000,000.00

7.2.1.2. Number portability database

All three database deployment options (centralized, distributed and both centralized and distributed) has been separately considered as per table 6.1

Table 6.1 : Costs per each database deployment option

	Software cost (LKR)	Hardware cost (LKR)	Sum (LKR)
Centralized DB	7,000,000	900,000	7,900,000
Distributed DB	12,500,000	3,750,000	16,250,000
Both centralized and distributed DB	19,500,000	4,650,000	24,150,000

7.2.1.3. Human resources cost

Human resources costs involved in developing and deployment of software provided by the telecom equipment providers are included in the solution development cost. Therefore only human resource costs that each service provider has to incur while deployment of the solution in the service provider network has been considered.

Table 6.2 : Human resources cost

	Man day effort	Cost per man day(LKR)	Total cost (LKR)
Engineer	30	8,000	240,000
Technical Officer	45	3,000	135,000
Project Manager	20	7,500	150,000
Manager	2	15,000	30,000
Sum			555,000
Total cost on 5 service providers(LKR)			2,775,000

7.2.2. Ongoing costs

7.2.2.1. Infrastructure cost

MSC software upgrade will be done on the existing hardware components and no additional infrastructure involved. For the deployment of number portability database standard 2U rack mounted servers are proposed. Considered LKR 50,000 cost per hardware server per month for Space, Electricity and Air Conditioning. Each database server will run with 1+1 redundancy.

Table 6.3 : Infrastructure cost per year

	Cost (LKR)
Centralized DB	1,200,000
Distributed DB	6,000,000
Both centralized and distributed DB	7,200,000

7.2.2.2. Software maintenance fee

MSC software upgrade performed on top of existing hardware and software, hence there is no additional maintenance feed added. 10% of annual maintenance fee from the procurement value will be charged by Number portability database software provider after the first year of service deployment. It is assumed centralized database (if involved) is fully managed by the software provider and daily maintenance tasks are performed by them at a cost of 20% of the procurement value. Maintenance charges are applicable only from the second year of service deployment.

Table 6.4 : Annual maintenance fee (NPDB)

	Cost (LKR)
Centralized DB	1,580,000
Distributed DB	1,700,000
Both centralized and distributed DB	3,280,000

7.2.2.3. Hardware maintenance fee

Hardware servers comes with 3 years warranty, hence maintenance charges are applicable only from 4th year of the service deployment

Table 6.5 : Annual maintenance fee (Server hardware)

	Cost (LKR)
Centralized DB	90,000
Distributed DB	450,000
Both centralized and distributed DB	540,000

7.2.3. Per subscriber porting cost

Forecast of the number of subscriber movement using MNP services is described in Annex-B. Subscription network service provider should issue a new SIM card for all the ported in subscribers. However as per the statistics extracted from the mobile subscriber

survey 60% of the subscribers who will move using MNP services will move the telecom service provide even if MNP services are not there. Therefore only 40% of total subscriber movement will be considered as an addition in cost calculations. Cost per SIM card assumed to be LKR 25.00.

Other costs involve in provisioning such as documentation, information transfer between donor network and subscription network are not considered on cost calculation as out of scope of this study.

Table 6.6 :Cost of SIM cards

	2016	2017	2018	2019	2020
Subscriber forecast 1	24,699,725	45,634,482	14,445,452	13,745,495	14,393,406
Subscriber forecast 2	17,678,660	16,437,110	15,449,070	14,819,910	14,488,180
Subscriber forecast 3	17,678,660	16,437,110	15,449,070	14,819,910	14,488,180

7.2.4. Per voice call cost

Terminating call to a ported number is routed via the donor network under routing schemes TQoD and QoHR. This involves additional voice trunk utilization between call originated networks and the donor network and additional resource utilization of the GMSC of the donor network. Further if OQoD routing scheme is deployed to cater MNP requirements, donor network should handle the terminating calls to a ported out number which is originated outside the portability domain. It was assumed that 10% of terminated calls are from outside the portability domain (i.e. Calls originated from fixed networks and international networks) and TQoD scheme is used to handle such calls. The costs associated with additional trunk utilization and GMSC resource utilization has been calculated assuming cost of LKR 0.10 per minute and summarized in Table 6.7.

Additional post dial delay is experienced on all voice calls if either OQoD or TQoD routing mechanisms are used and additional delay is observed on terminated calls to ported numbers if QoHR routing mechanism is used. Based on the mobile telephone subscriber survey and the information gathered from the telecom service providers, average terminated calls per subscriber per day is around 7.

Additional posts dial delay observed by subscribers across the country per day sum up to a considerable number of man days. Cost of post dial delay is therefore calculated based on per capita income [18]. Per capita income of the country has been divided by the total population and multiplied by the population in the age range of 20 years to 70 years. Assumed population outside the age range 20-70 years are not involved in production.

Assumed 20ms additional transmission delay if only a centralized database is used and shared by all service providers. Detailed calculation of cost addition by post dial delay is included in Annex-C

Table 6.7 : Cost of additional trunk utilization and GMSC resource utilization (LKR)

	2016	2017	2018	2019	2020
TQoD -sub forecast1	1,863,744	5,297,869	6,361,509	7,367,040	8,416,458
TQoD -sub forecast2	2,471,601	7,020,130	8,387,698	9,393,230	10,442,647
TQoD -sub forecast3	3,079,458	8,742,392	10,413,888	11,419,419	12,468,837
OQoD -sub forecast1	2,160,100	2,284,595	2,401,597	2,513,829	2,623,544
OQoD -sub forecast2	2,160,100	2,284,595	2,401,597	2,513,829	2,623,544
OQoD -sub forecast3	2,160,100	2,284,595	2,401,597	2,513,829	2,623,544
QoHR -sub forecast1	1,863,744	5,297,869	6,361,509	7,367,040	8,416,458
QoHR -sub forecast2	2,471,601	7,020,130	8,387,698	9,393,230	10,442,647
QoHR -sub forecast3	3,079,458	8,742,392	10,413,888	11,419,419	12,468,837

Table 6.8 : Cost of post dial delay – with Centralized NPDB

	2016	2017	2018	2019	2020
TQoD - sub forecast 1	234,579,415	272,406,098	292,146,141	310,973,556	329,864,293
TQoD - sub forecast 2	239,020,781	284,989,971	306,950,697	325,778,112	344,668,848

TQoD - sub forecast 3	243,462,148	297,573,843	321,755,253	340,582,667	359,473,404
OQoD - sub forecast 1	214,648,592	227,019,642	238,646,143	249,798,530	260,700,934
OQoD - sub forecast 2	214,648,592	227,019,642	238,646,143	249,798,530	260,700,934
OQoD - sub forecast 3	214,648,592	227,019,642	238,646,143	249,798,530	260,700,934
QoHR - sub forecast 1	59,917,567	170,321,397	204,516,375	236,843,243	270,581,011
QoHR - sub forecast 2	79,459,581	225,690,436	269,656,420	301,983,289	335,721,057
QoHR - sub forecast 3	99,001,595	281,059,475	334,796,466	367,123,335	400,861,103

Table 6.9 : Cost of post dial delay – with Distributed NPDBs

	2016	2017	2018	2019	2020
TQoD - sub forecast 1	203,013,445	239,020,857	257,051,120	274,238,478	291,525,920
TQoD - sub forecast 2	207,454,812	251,604,729	271,855,676	289,043,034	306,330,476
TQoD - sub forecast 3	211,896,179	264,188,602	286,660,232	303,847,589	321,135,032
OQoD - sub forecast 1	186,239,219	196,972,924	207,060,624	216,736,960	226,196,398
OQoD - sub forecast 2	186,239,219	196,972,924	207,060,624	216,736,960	226,196,398
OQoD - sub forecast 3	186,239,219	196,972,924	207,060,624	216,736,960	226,196,398
QoHR - sub forecast 1	57,194,041	162,579,515	195,220,176	226,077,641	258,281,874
QoHR - sub forecast 2	75,847,782	215,431,780	257,399,310	288,256,776	320,461,009
QoHR - sub forecast 3	94,501,522	268,284,044	319,578,445	350,435,910	382,640,143

7.3. Total cost

Total cost on MNP deployment and operation for 5 years from year starting 2016, based on 3 different subscriber forecasts under different MNP routing mechanisms is

mentioned in table 6.10. Assumed MNP implementation will be completed and be ready to deploy by the beginning of 2016.

Based on the cost comparison of each MNP implementation mechanism on different porting rates as depicted in figure 6.1 and Figure 6.2, under the utilization of distributed number portability database and centralized number portability database respectively , it is clear that the total cost of QoHR mechanism increases with the porting rate. Therefore QoHR mechanism is not cost effective unless porting rate remains below 34%. The Cost of additional trunk utilization and post dial delays of TQoD is higher than that of OQoD, therefore OQoD routing mechanism is the most cost effective.

Cost of deployment and maintenance of distributed databases are higher than the cost of centralized database utilization, however the higher post dial delay caused by additional transmission delay on utilization of centralized database sums up to a more higher cost. Therefore utilization of distributed number portability database is more cost effective. The cost comparison of centralized and distributed number portability database utilization under OQoD routing scheme is depicted in figure 6.3

Table 6.10 : Total cost for 5 years from 2016-2020 (LKR)

	MNPDB	Porting Rate 30%	Porting Rate 40%	Porting Rate -50%
TQoD	Centralized	2,405,369,681	2,502,490,678	2,599,611,674
OQoD	Centralized	2,138,891,065	2,166,164,468	2,193,437,871
QoHR	Centralized	1,907,579,772	2,213,593,052	2,519,606,331
TQoD	Distributed	2,264,549,999	2,361,670,995	2,458,791,992
OQoD	Distributed	2,015,583,351	2,042,856,754	2,070,130,157
QoHR	Distributed	1,899,053,427	2,192,778,925	2,486,504,423

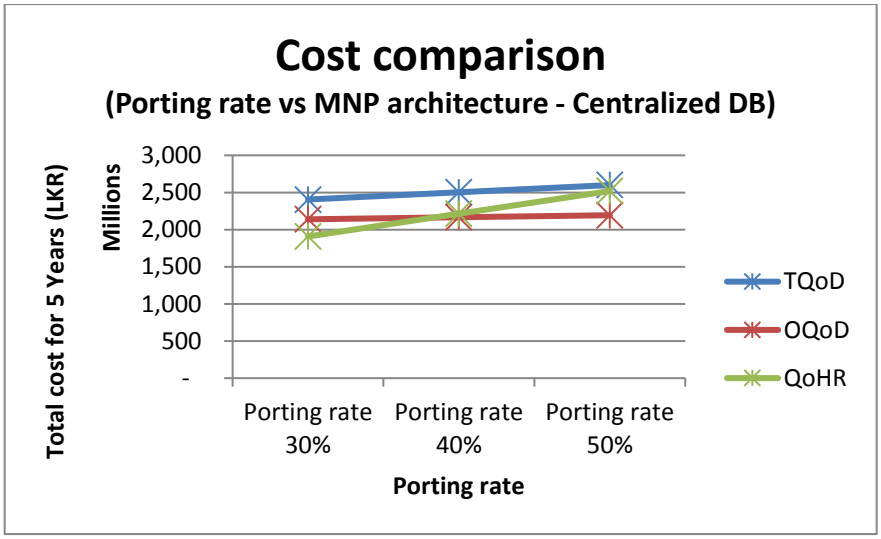

Figure 6.1 : Comparison of total cost for 5 years under different MNP implementations – centralized database

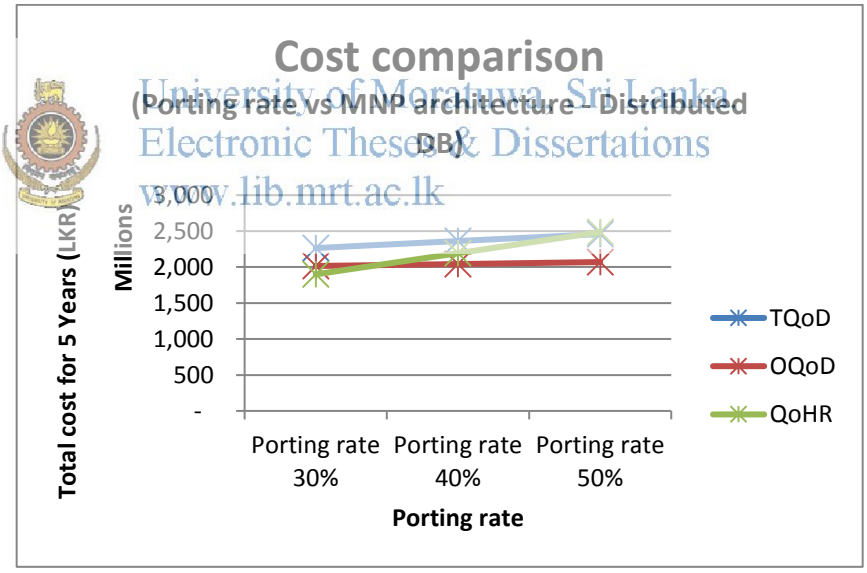

Figure 6.2 : Comparison of total cost for 5 years under different MNP implementations – Distributed database

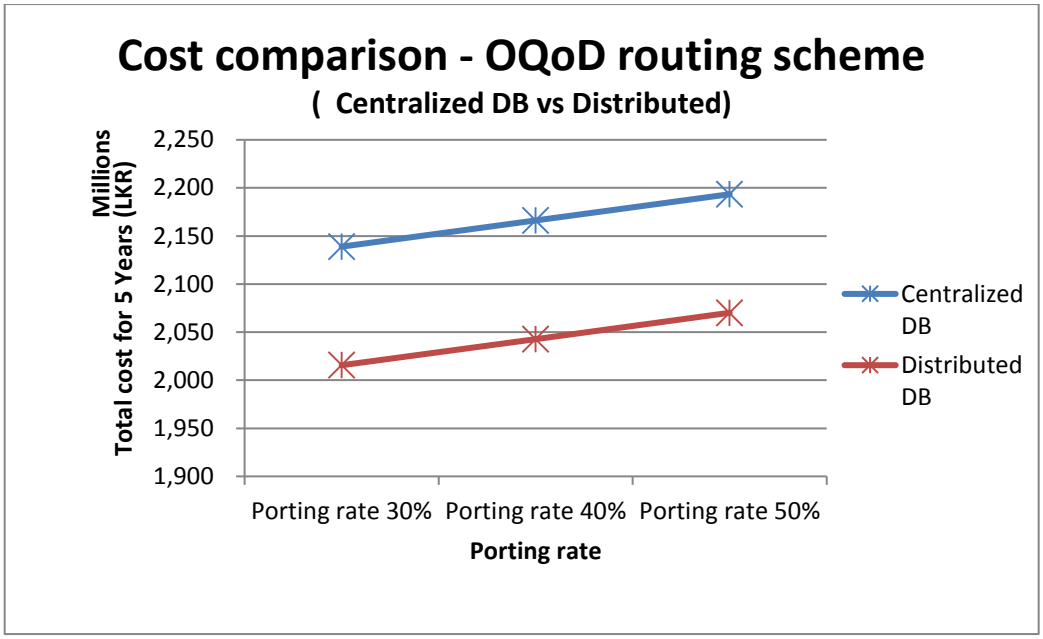

Figure 6.3 : Comparison of total cost for 5 years under OQoD – Distributed vs. Centralized NPDB

CHAPTER 8: RECOMMENDATIONS

8.1. MNP implementation architecture

Based on the analysis, the implementation of OQoD MNP architecture in Sri Lanka is more suitable in terms of both cost and feasibility. Unlike in QoHR architecture the OQoD incur an additional post dial delay on all voice calls. However the routing mechanism avoids the requirement of call routing via donor network. Therefore the donor network should not be bother about the capacity enhancements in GMSC and interconnection signaling links to cater terminated calls to a ported out number as number of porting increases.

Further the post dial delay introduced by OQoD is similar to that of TQoD as under both routing schemes an additional database query is required for all voice calls regardless of whether the destination number is ported or not. QoHR routing scheme bypasses the additional post dial delay on terminated calls to a ported number, however the cost of additional resource utilization due to calls being routed via donor network surpasses the gain of avoidance of post dial delay as number of porting increases, hence not suitable in long run.

TQoD capability in GMSC should be implemented to handle the calls originated outside the portability domain that is from fixed networks and international networks to a ported number as networks outside the portability domain always route the calls towards donor network based on network prefix.

8.2. Number portability database

The post dials delay introduced by transmission delay of signaling messages between MSCs and number portability database can be reduced by utilizing distributed database architecture. Further all mobile telecom service providers in Sri Lanka are more

comfortable having the full control in call handling within their network. Therefore distributed database architecture is more preferred by them too.

However it is more convenient to have centralized database as the information of ported numbers should be accessible by all service providers within the portability domain under OQoD routing scheme.

Considering the facts it is recommended to have a combination of both centralized and distributed number portability databases. The centralized number portability database should be integrated with provisioning systems of all service providers. It is responsibility of donor and or recipient network to update the information about the ported number at the time of porting. Centralize database is responsible for data synchronization to distributed databases in regular basis.

Service providers will always queries the number portability database residing inside the local network and number queries will not reach the centralized database in any case . Therefore it is not necessary to have a SS7 signaling capability at centralized database.

Centralized database can be managed by a third party governed by regulator.

CHAPTER 9: LIST OF MODIFICATIONS AND EQUIPMENTS REQUIRED TO IMPLEMENT MNP

9.1. Telecom service provider networks

- All MSCs in portability domain should query number portability database on all originated calls via CAMEL initialDP
- HLR should allow paring a MSISDN originally owned by other network against own network IMSI.
- Gateway MSCs should identify the terminating calls to ported in number (i.e. Called party number contains a NRN) and remove the prefix in NRN and trigger MAP Send routing info message towards HLR
- Donor network should implement TQoD to accommodate the calls originated outside the portability domain
- Deployment of number portability database inside the core network with the capability of handling CAMEL signaling over Sigtran M3UA.

9.2. List of centralized equipments

- Centralized number portability database integrated with provisioning systems of all service providers with the capability of data synchronization to slave databases residing inside service provider networks.

CHAPTER 10: CONCLUSION

Mobile telecom service subscribers in Sri Lanka feel that the availability of Mobile number portability services is necessary. Around 40% of mobile subscribers expected to move if MNP services are available over 24% of subscriber movement expected even if MNP services are not available. Therefore the availability of MNP will influence 16% more subscriber movement than under normal conditions.

Dissatisfaction on quality of services provide by service provider, unavailability of network coverage and the inadequate availability of supplementary services cause subscribers to move to a new service provider. However the applicable charges impacts slightly more on subscriber movement. Even under prevailing floor price regulation there is a little room for increasing the competition in the market by implementing MNP. A comparison of applicable charges on basic services across service providers is available in Annex-E. Since there is no floor price regulation on other services such as data usage and supplementary services, market competition can further be increased by introducing MNP services.

Availability of radio access network sharing is expected to address the network coverage unavailability issues to a certain extent. However to date no service provider is ready commercial deployment of network sharing. Out of five service providers two do not have any idea on implementing the network sharing option in their networks in near future.

All mobile telecom service providers in the country are ready to implement MNP services in their networks. The core networks elements of all service providers support implementation of proposed MNP architecture. However there is a necessity of regulator involvement at every stage of MNP implementation and operations until proper processes are in place to smooth operation of MNP services.

As per the survey outcome there exists brand effect in Sri Lankan telecommunication market to a little extent and necessary measures should be taken to overcome the brand effect to gain more success in MNP implementation.

It is mandatory to analyze the impact on provisioning systems and other platforms offering value added services in service provider networks caused by implementation of MNP services. Costs on such modifications and costs involved in establishment of MNP porting processes should be calculated and considered before starting the implementation of MNP services in Sri Lanka.

Majority of subscribers who are expecting MNP services are willing to pay a monthly rental for getting the MNP services. Hence there is a possibility of establishing a MNP cost recovery mechanism Sri Lanka.

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ANNEX-A: CALL FLOWS

A-1. TQoD

A-1.1. Terminating call to a non ported number

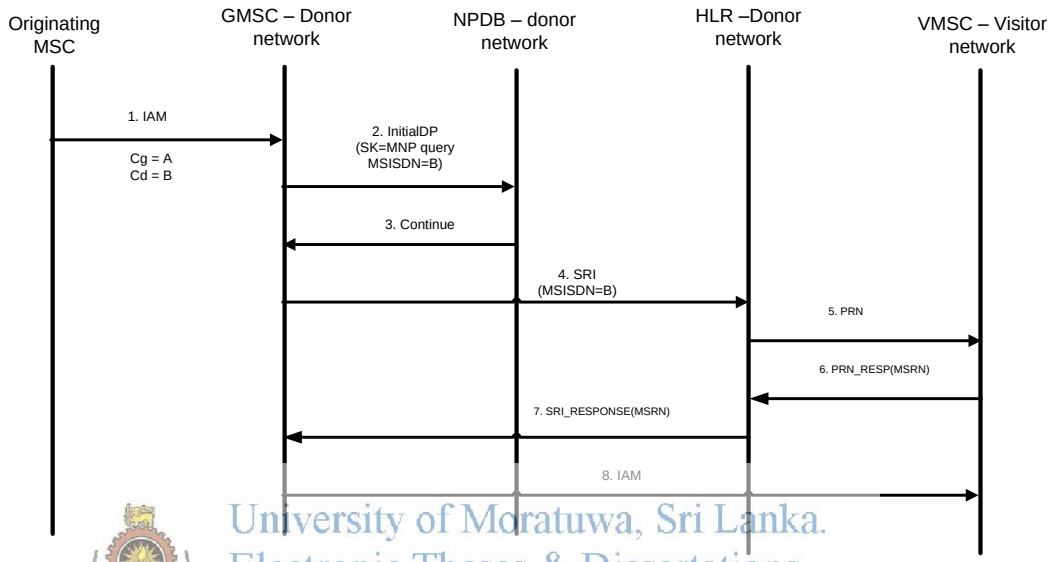


Figure A-1: Call flow – Terminating call to a non ported number (TQoD)

1. From originating MSC call is setup to MSISDN of "B" party, therefore ISUP "IAM" message routed towards number range holder (Donor) network.
2. GMSC of donor network is configured to trigger CAMEL "InitialDP" towards number portability database residing inside the network.
3. Number portability database identifies the number as non ported number and respond with CAMEL "Continue".
4. GSMC queries HLR by sending "SRI" to find the routing information for "B" party number.
5. HLR talks to visitor MSC and request MSRN by sending "PRN"
6. VMSC respond with MSRN

7. HLR returns the received MSRN in SRI_resp back to GMSC.
8. GMSC setup call with VMSC by dialing the MSRN.

A-1.2. Terminating call to a ported number

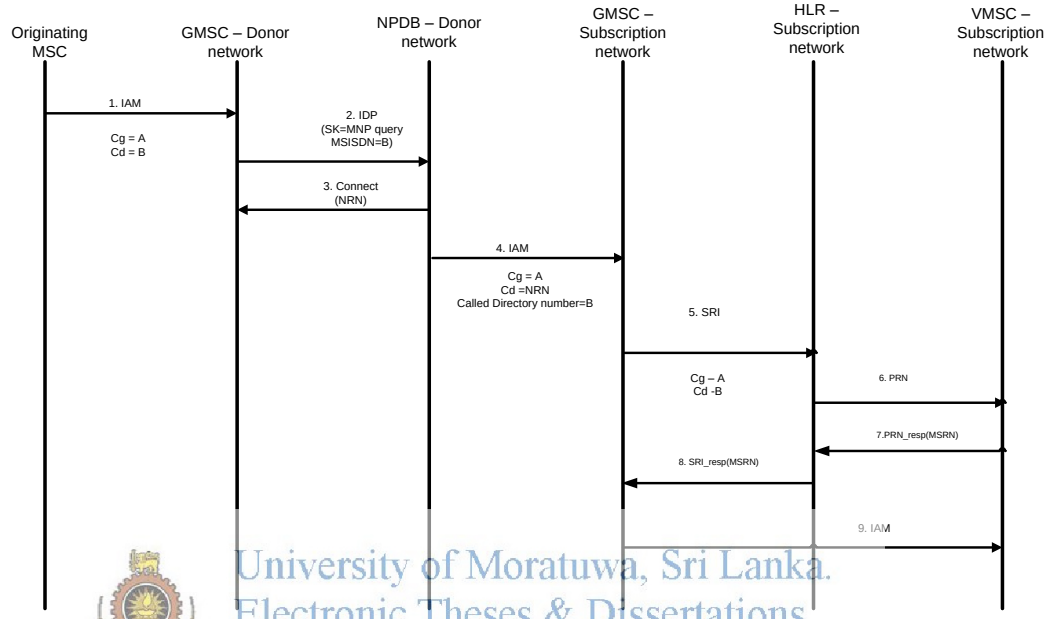


Figure A-2 : Call flow – Terminating call to a ported number (TQoD)

1. From originating MSC call is setup to MSISDN of "B" party, therefore ISUP "IAM" message routed towards donor network.
2. GMSC of donor network is configured to trigger CAMEL "InitialDP" towards number portability database residing inside the network.
3. Number portability database identifies the number as ported number and respond with CAMEL "connect". Here call is connected to the Network Routing Number so that call can be routed to subscription network.
4. GMSC setup the call towards NRN and call will be routed to GMSC of subscription network.

5. Since the call is terminated to a NRN, GSMC identify the number as ported in number and does not trigger number portability database, and directly queries HLR by sending "SRI" to find the routing information for "B" party number.
6. HLR talks to visitor MSC and request MSRN by sending "PRN"
7. VMSC respond with MSRN
8. HLR returns the received MSRN in SRI_resp back to GMSC.
9. GMSC setup call with VMSC by dialing the MSRN.

A-2. QoHR

A-2.1. Terminating call to a non ported number

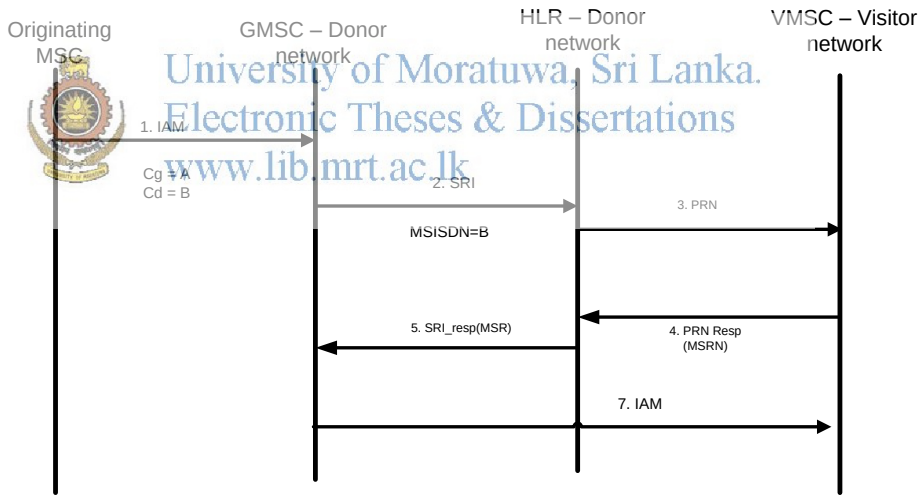


Figure A-3: Call flow – Terminating call to a non ported number (QoHR)

1. From originating MSC call is setup to MSISDN of "B" party, therefore ISUP "IAM" message routed towards donor network.
2. GMSC of Donor network will query HLR by sending "SRI" to find the routing information for B party number.

3. Since HLR contains an subscription entry for B number (i.e. Number is not ported)HLR talks to visitor MSC and request MSRN by sending “PRN”
4. VMSC respond with MSRN
5. HLR returns the received MSRN in SRI_resp back to GMSC.
6. GMSC setup call with VMSC by dialing the MSRN.

A-2.2. Terminating call to a ported number

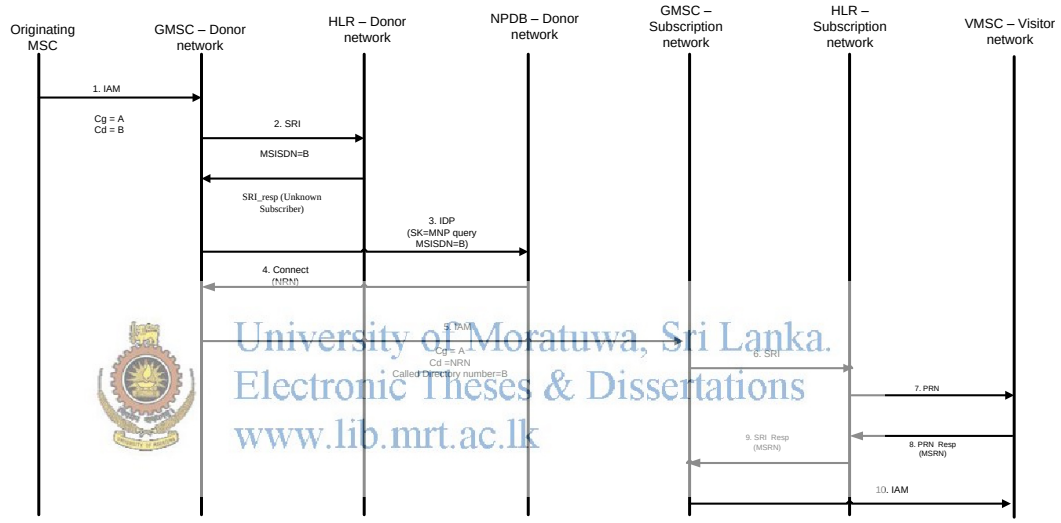


Figure A-4: Call flow – Terminating call to a non ported number (QoHR)

1. From originating MSC call is setup to MSISDN of “B” party, therefore ISUP “IAM” message routed towards donor network.
2. GMSC of Donor network will query HLR by sending “SRI” to find the routing information for B party number.
3. Since there is no entry in HLR associated with B number HLR will return the SRI response with error code Unknown subscriber.

4. GMSC of donor network is configured to trigger CAMEL "InitialDP" towards number portability database residing inside the network if a SRI response contains "Unknown subscriber" error code.
5. Number portability database identifies the number as ported number and respond with CAMEL "connect". Here call is connected to the Network Routing Number so that call can be routed to subscription network.
6. GMSC setup the call towards NRN and call will be routed to GMSC of subscription network.
7. Since the call is terminated to a NRN, GSMC identify the number as ported in number and does not trigger number portability database, and directly queries HLR by sending "SRI" to find the routing information for "B" party number.
8. HLR talks to visitor MSC and request MSRN by sending "PRN"
9. VMSC respond with MSRN
10. HLR returns the received MSRN in SRI_resp back to GMSC.
11. GMSC setup call with VMSC by dialing the MSRN.

A-3. OQoD

A-3.1. Terminating call to a non ported number

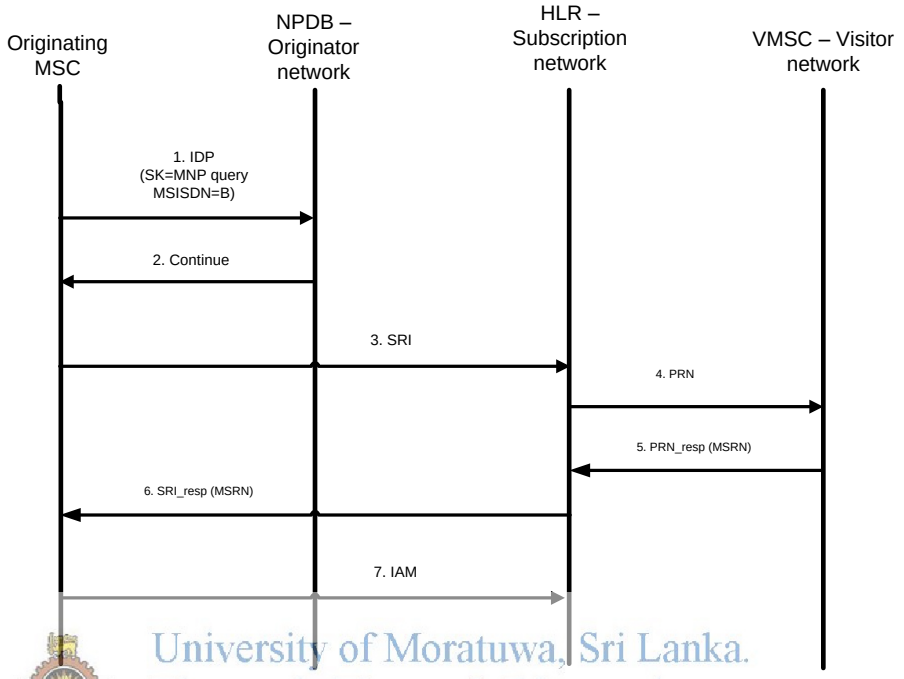


Figure A-5: Call flow – Terminating call to a non ported number (OQoD)

1. Originating MSC triggers CAMEL "InitialDP" towards number portability database residing inside the network .
2. Number portability database identifies the number as non ported number and respond with CAMEL "continue". Therefore call is handled in normal procedure afterwards.
3. Originating MSC queries HLR by sending "SRI" to find the routing information for "B" party number.
4. HLR talks to visitor MSC and request MSRN by sending "PRN"
5. VMSC respond with MSRN
6. HLR returns the received MSRN in SRI_resp back to Originating MSC.
7. Originating MSC setup call with VMSC by dialing the MSRN.

A-3.2. Terminating call to a ported number

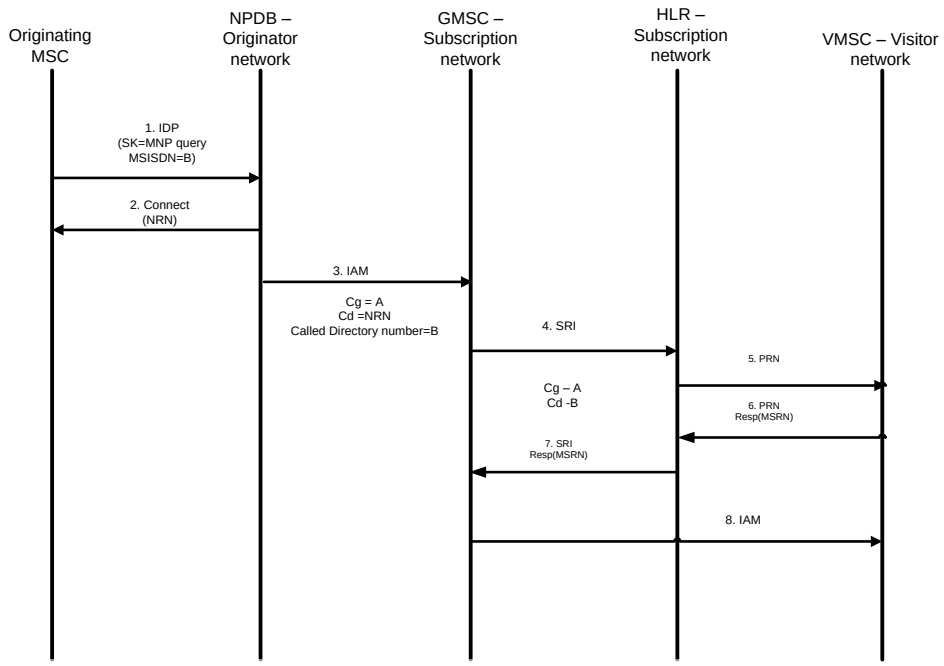


Figure A-6: Call flow – Terminating call to a ported number (OQoD)

1. Originating MSC triggers CAMEL "InitialDP" towards number portability database residing inside the network .
2. Number portability database identifies the number as non ported number and respond with CAMEL "continue". Therefore call is handled in normal procedure afterwards.
3. Number portability database identifies the number as ported number and respond with CAMEL "connect". Here call is connected to the Network Routing Number so that call can be routed to subscription network.
4. Originating MSC setup the call towards NRN and call will be routed to GMSC of subscription network.
5. GMSC of subscription network will query HLR by sending "SRI" to find the routing information for B party number.
6. HLR talks to visitor MSC and request MSRN by sending "PRN"
7. VMSC respond with MSRN

8. HLR returns the received MSRN in SRI_resp back to GMSC.
9. GMSC setup call with VMSC by dialing the MSRN.

A-4. Signaling Relay function

A-4.1. Terminated call to a non ported or ported in number (Direct/indirect routing)

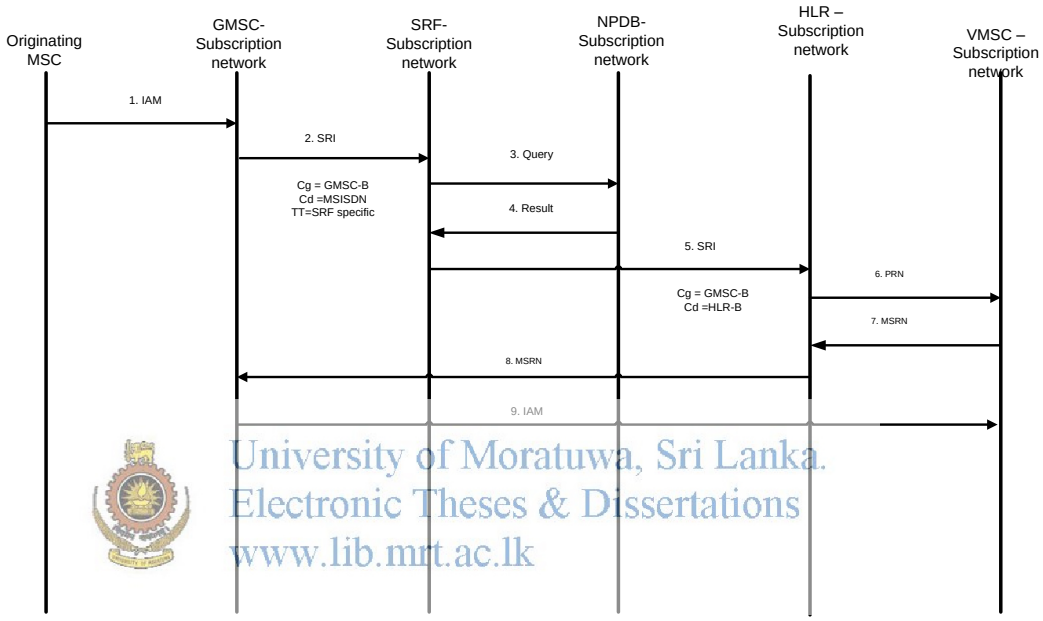


Figure A-7: Call flow – Terminating call to a non ported number (SRF)

1. From originating MSC call is setup to MSISDN of "B" party if B is non ported or to NRN if B is ported (After flow through SRF if direct routing is used), therefore ISUP "IAM" message routed towards donor network.
2. Gateway MSC will query HLR by sending "SRI" to find the routing information for B party number or NRN. Network nodes are configured to route the SRI request via Signaling Relay Function.
3. Signaling relay function queries the number portability database. The communication interface between Signaling relay function and Number portability interface is not standardized.

4. Number portability database identifies the number as non ported or ported in number and respond accordingly to the Signaling Relay Function.
5. Signaling Relay Function passes the SRI request to HLR without modifying the SCCP / TCAP parameters received in previous SRI from originating MSC.
6. HLR talks to visitor MSC and requests MSRN by sending "PRN"
7. VMSC respond with MSRN
8. HLR returns the received MSRN in SRI_resp back to originating MSC.
9. Originating MSC sets up the call with VMSC by dialing the MSRN.

A-4.2. Terminating Call to a ported number (Direct routing)

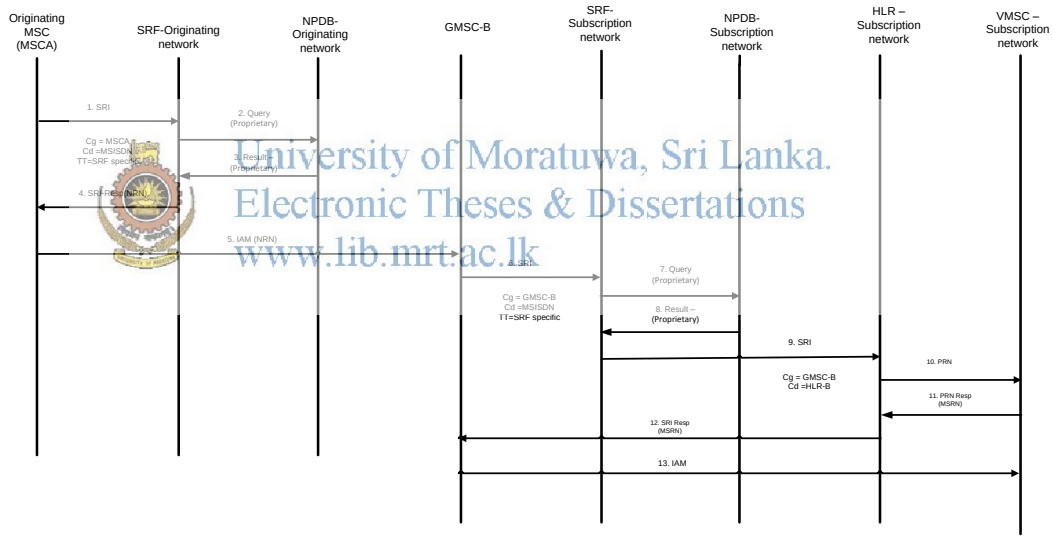


Figure A-8: Call flow – Terminating call to a ported number (SRF-Direct routing)

1. Originating MSC will query HLR by sending "SRI" to find the routing information for B party number. Network nodes are configured to route the SRI request via Signaling Relay function.
2. Signaling relay function queries the number portability database over a proprietary interface.

3. Number portability database identifies the number as ported number and respond with NRN to identify the subscription network.
4. Signaling Relay Function passes the SRI response containing NRN.
5. Originating MSC modify the called party address to NRN and initiate the call
6. GMSC will query HLR by sending "SRI" to find the routing information for B party number. Network nodes are configured to route the SRI request via Signaling Relay function.
7. Signaling relay function queries the number portability database over a proprietary interface.
8. Number portability database identifies the number as ported in number and respond accordingly.
9. Signaling relay function passes the SRI to own network HLR without modifying the SCCP/TCAP parameters.
10. HLR talks to visitor MSC and requests MSRN by sending "PRN"
11. VMSC respond with MSRN
12. HLR returns the received MSRN in SRI_resp back to originating MSC.
13. Originating MSC sets up the call with VMSC by dialing the MSRN.

A-4.3. Terminating Call to a ported number (Indirect routing)

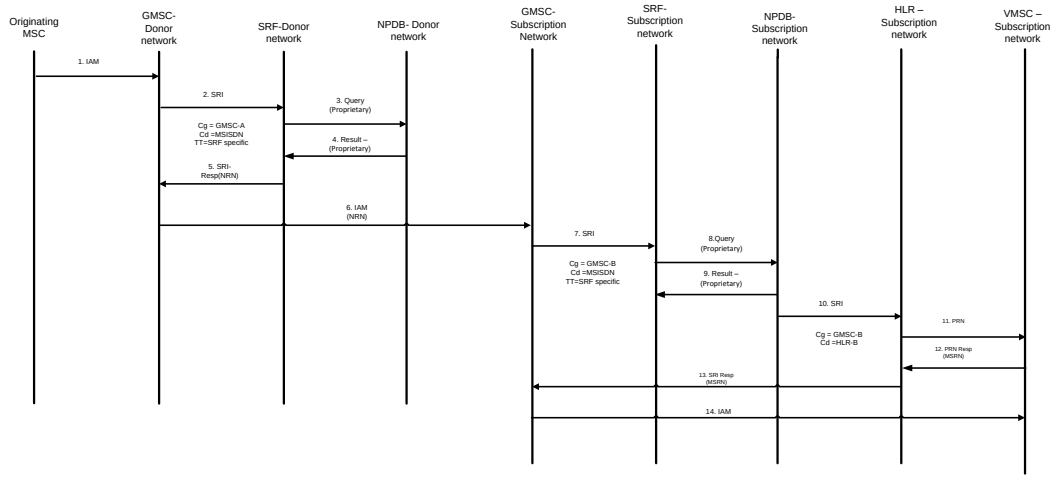


Figure A-9: Call flow – Terminating call to a ported number (SRF-indirect routing)

1. From originating MSC call is setup to MSISDN of "B" party, therefore ISUP "IAM" message routed towards donor network.
2. GMSC of donor network will query HLR by sending "SRI" to find the routing information for B party number. Network nodes are configured to route the SRI request via Signaling Relay function.
3. Signaling relay function queries the number portability database over a proprietary interface.
4. Number portability database identifies the number as ported number and respond with NRN to identify the subscription network.
5. Signaling Relay Function passes the SRI response containing NRN.
6. GMSC of donor network modifies the called party address to NRN and route the call towards subscription network.
7. GMSC of subscription network will query HLR by sending "SRI" to find the routing information for B party number. Network nodes are configured to route the SRI request via Signaling Relay function.
8. Signaling relay function queries the number portability database over a proprietary interface.
9. Number portability database identifies the number as ported in number and respond accordingly.
10. Signaling relay function passes the SRI to own network HLR without modifying the SCCP/TCAP parameters.
11. HLR talks to visitor MSC and requests MSRN by sending "PRN"
12. VMSC respond with MSRN
13. HLR returns the received MSRN in SRI_resp back to originating MSC.
14. Originating MSC sets up the call with VMSC by dialing the MSRN.

A-4.4. Terminating Call to a ported number (Indirect routing – related to subscription)

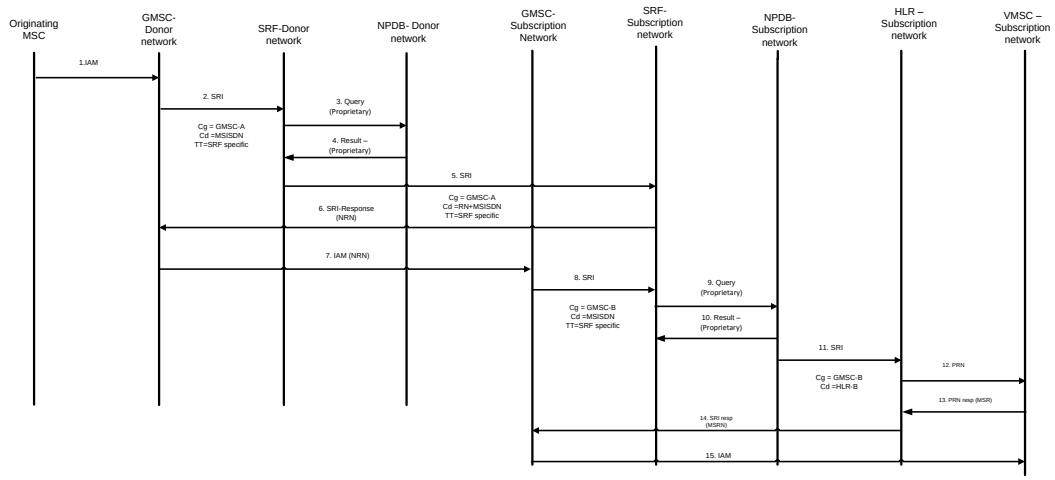


Figure A-10: Call flow – Terminating call to a ported number (SRF-indirect routing – related to subscription)

1. From originating MSC call is setup to MSISDN of "B" party, therefore ISUP "IAM" message routed towards donor network.
2. GMSC of donor network will query HLR by sending "SRI" to find the routing information for B party number. Network nodes are configured to route the SRI request via Signaling Relay function.
3. Signaling relay function queries the number portability database over a proprietary interface.
4. Number portability database identifies the number as ported number and respond accordingly to identify the subscription network.
5. Signaling Relay Function relay the SRI request to Signaling relay of subscription network without modifying SCCP parameters of previous SRI.
6. Signaling relay function of subscription network identifies the number as ported in number and respond with NRN.
7. GMSC of donor network modifies the called party address to NRN and route the call towards subscription network.

8. GMSC of subscription network will query HLR by sending “SRI” to find the routing information for B party number. Network nodes are configured to route the SRI request via Signaling Relay function.
9. Signaling relay function queries the number portability database over a proprietary interface.
10. Number portability database identifies the number as ported in number and respond accordingly.
11. Signaling relay function passes the SRI to own network HLR without modifying the SCCP/TCAP parameters.
12. HLR talks to visitor MSC and requests MSRN by sending “PRN”
13. VMSC respond with MSRN
14. HLR returns the received MSRN in SRI_resp back to originating MSC.
15. Originating MSC sets up the call with VMSC by dialing the MSRN.

ANNEX –B: FORECASTS OF PORTING RATE

According to the mobile telephone user survey 40% of subscribers are expecting MNP services and will moved to a new service provider. For calculation of costs both 30% and 50% porting rates included in addition to 40% porting rate considering the facts that sample was selected based on Quota Sampling method and it does not represent a true random sample and confidence level and confidence interval of the survey outcome based on sample size.

It was assumed only 30% of subscribers who are willing to accept MNP will move to new service provider in the first year of MNP implementation due to lack of awareness and confidence on the service. Remaining 70% of subscribers distributed in to next 2 years, 60% in second year of MNP implementation and 10% in third year.

From 4th year of MNP implementation only 4% of total subscriber base assumed to utilize MNP services considering the prevailing churn rate and the possible improvements in service provider networks in terms of coverage, quality of services ,tariffs and supplementary services due to the increased pressure arises on service providers after MNP implementation.

Further it was assumed only 3% of subscribers will churn using MNP within the first year of fresh subscription and 4% in the second year and 5% year after. Further it was assumed 0.5% of subscribes will switch mobile service providers more than once.

Table B-1: Total number of porting, based on 30% porting rate assumption

	2015	2016	2017	2018	2019	2020
Number of Mobile connections in Sri Lanka - forecast [Based on GSMA intelligence]	26,718,984	28,484,834	30,126,528	31,669,417	33,149,389	34,596,187
Number of Mobile connections Additions (compared to previous year)	-	1,765,850	1,641,694	1,542,889	1,479,972	1,446,798
Expected number of porting	-	2,457,684	4,528,517	1,402,601	1,325,976	1,383,847
Cumulative expected number of porting	-	2,457,684	6,986,201	8,388,802	9,714,778	11,098,625
Number of subscribers porting more than once		12,288	34,931	41,944	48,574	55,493
Total porting		2,469,972	7,021,132	8,430,746	9,763,352	11,154,119
Porting %		9%	23%	27%	29%	32%

	2015	2016	2017	2018	2019	2020
Number of Mobile connections in Sri Lanka - forecast [Based on GSMA intelligence]	26,718,984	28,484,834	30,126,528	31,669,417	33,149,389	34,596,187
Number of Mobile connections Additions (	-	1,765,850	1,641,694	1,542,889	1,479,972	1,446,798

compared to previous year)						
Expected number of porting	-	3,259,254	5,998,061	1,803,386	1,325,976	1,383,847
Cumulative expected number of porting	-	3,259,254	9,257,315	11,060,701	12,386,676	13,770,524
Number of subscribers porting more than once		16,296	46,287	55,304	61,933	68,853
Total porting		3,275,550	9,303,601	11,116,004	12,448,610	13,839,377
Porting %		11%	31%	35%	38%	40%

Table B-1 :Total number of porting, based on 40% porting rate assumption

Table B-3 : Total number of porting, based on 50% porting rate assumption

	2015	2016	2017	2018	2019	2020
Number of Mobile connections in Sri Lanka - forecast [Based on GSMA intelligence]	26,718,984	28,484,834	30,126,528	31,669,417	33,149,389	34,596,187
Number of Mobile connections Additions (compared to previous year)	-	1,765,850	1,641,694	1,542,889	1,479,972	1,446,798
Expected number of porting	-	4,060,823	7,467,605	2,204,171	1,325,976	1,383,847
Cumulative expected number of porting	-	4,060,823	11,528,429	13,732,599	15,058,575	16,442,422
Number of subscribers porting more than once		20,304	57,642	68,663	75,293	82,212
Total porting		4,081,127	11,586,071	13,801,262	15,133,868	16,524,634
Porting %		14%	38%	44%	46%	48%

ANNEX-C: CALCULATION OF COST OF POST DIAL DELAY

Assumptions:

1. After dialing the number, Call Originator waits for recipient to answer the call. During the waiting time call originator does not involve in any useful work.

2. Only age group between 20 years and 70 years considered as workforce and only the population in workforce contributes in country's income. Per capita income [ref: Central bank report 2013] multiplied by the total population divided by work force population gives the average monetary value of a man day of a work force.

3. Number portability database always runs in optimum performance hence database query delay assumed to be 80ms.

Parameters:

1. Number portability database response delay = 20 ms
2. HLR response and signaling transmission delays =200 ms
3. CAMEL InitialDP response and signaling transmission delays(Distributed DB) = 40 ms
4. CAMEL InitialDP response and signaling transmission delays(Centralized DB) = 60 ms
5. IAM transmission and processing delay = 100 ms

Table C-1: Extra signaling and trunk utilization under each MNP implementation architecture

	TQoD	OQoD	QoHR
SRI	No additional SRI	No additional SRI	one per terminated call to a ported number
IDP	For all terminated calls	For all originated calls to destination numbers in portability domain And One per terminated call, originated outside the portability domain	one per terminated call to a ported number
IAM	one per terminated call to a ported number	One per terminated call, originated outside the portability domain	one per terminated call to a ported number
DB queries	For all terminated calls	For all originated calls to destination numbers in portability domain And One per terminated call, originated outside the portability domain	one per terminated call to a ported number
Additional Trunk utilization	one per terminated call to a ported number	One per terminated call, originated outside the portability domain	one per terminated call to a ported number

Calculation of monetary value of a man day:

Per capita income(LKR) [CBSL report – 2013] = 423,467

Total Population [CBSL report – 2013] = 20,483,000

Work force population (Age 20-70 year)[CBSL report – 2013] = 12,683,000

Per day production of a work force person = Per capita income X (work force population / Total population)

Per day production of a work force person (LKR) = 1,873.89

Per hour production of a work force person (LKR) = 78.07

Table C-2: Total cost caused by additional post dial delay per day – Distributed database (LKR)

	2016	2017	2018	2019	2020
TQoD| porting rate 30%	556,201	654,852	704,250	751,338	798,701
TQoD| porting rate 40%	568,369	689,328	744,810	791,899	839,262
TQoD| porting rate 50%	580,537	723,804	785,370	832,459	879,822
OQoD| porting rate 30%	510,244	539,652	567,289	593,800	619,716
OQoD| porting rate 40%	510,244	539,652	567,289	593,800	619,716
OQoD| porting rate 50%	510,244	539,652	567,289	593,800	619,716
QoHR| porting rate 30%	156,696	445,423	534,850	619,391	707,622
QoHR |porting rate 40%	207,802	590,224	705,204	789,745	877,975
QoHR |porting rate 50%	258,908	735,025	875,557	960,098	1,048,329

Table C-3: Total cost caused by additional post dial delay per day – Centralized database (LKR)

	2016	2017	2018	2019	2020
TQoD| porting rate 30%	642,683	746,318	800,400	851,982	903,738
TQoD| porting rate 40%	654,851	780,794	840,961	892,543	944,298
TQoD| porting rate 50%	667,020	815,271	881,521	933,103	984,859
OQoD| porting rate 30%	588,078	621,972	653,825	684,380	714,249
OQoD| porting rate 40%	588,078	621,972	653,825	684,380	714,249
OQoD| porting rate 50%	588,078	621,972	653,825	684,380	714,249
QoHR| porting rate 30%	164,158	466,634	560,319	648,886	741,318
QoHR | porting rate 40%	217,697	618,330	738,785	827,351	919,784
QoHR | porting rate 50%	271,237	770,026	917,251	1,005,817	1,098,250

ANNEX -D: SCOPE OF WORK (MNPDB AND SRF)

Scope of Work

Implementation of Number portability database and MNP Signaling Relay function

1. Introduction

1.1. Purpose of the document

This document is intended to communicate the requirements of software solution to achieve implementation of Mobile number portability in Sri Lanka.

1.2. Definitions, Acronyms And Abbreviations

GSM- Global system for mobile communication
HLR – home Location register
IAM – Initial address message
M3UA – MTP3 user adaptation
MAP – Mobile Application Part
MNP – Mobile Number Portability
MSC – Mobile switching center
NPDB – Number portability database
NRN – Network Routing Number
SCCP – Signaling connection control part
SRF – Signaling relay function
STP – Signaling transfer point
TDM – Tie Division Multiplexing
UMTS - Universal Mobile Telecommunications System

1.3. overview

Mobile number portability is a network function that allows mobile subscriber to switch services and or network service provider while retaining his/her mobile telephone number. Portability of mobile telephone connections from prepaid to post paid or vice versa can be considered be part of service portability within the network. Facilitating mobile subscriber movement between mobile telephone service providers is the most challenging in terms of technical implementation.

Routing methods used in GSM/UMTS core network under MNP unavailable scenarios are severely impacted by mobile number portability as important routing decisions are made based on the called party address in IAM or SCCP messages carrying MAP “Send Routing Information”.

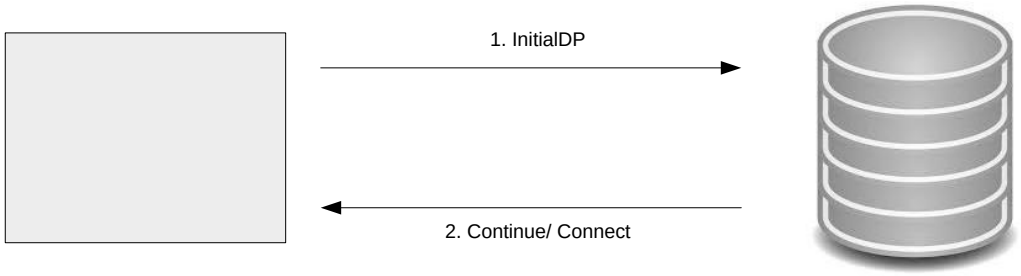
Different alternative routing procedures are being used by different operators across the globe to address the concerns. Specifically four methods listed below are globally accepted [3GPP TS 23.066].

5. Terminating call Query on Digit Analysis (TQoD)
6. Query on HLR Release (QoHR)
7. Originating call Query on Digit Analysis(OQoD)
8. Signaling Relay Function based solution. (SRF based)

2. Number portability database

2.1. Introduction

Figure D-1: Basic Message flow



2.1.1. Number portability database should maintain the associated network routing number (NRN) against MSISDN for ported number.

2.1.2. Two options to be considered

2.1.2.1. Centrally managed, Shared number portability database across all service providers

2.1.2.2. Individually managed number portability database per each operator.

2.1.3. Integrate with operator MSC or STP over

2.1.3.1. Sigtran M3UA

2.1.3.2. TDM E1

2.1.4. Accept CAMEL InitialDP messages triggered from MSC towards NPDB.

2.1.5. Should accept only the defined CAMEL Service keys for MNP services.

2.1.6. Should support configuring MNP associated services keys via Administrator web interface.

2.1.7. Database lookup should be performed based on called party address in InitialDP.

2.1.8. If called party number is identified to be non ported , InitalDP should be responded with CAMEL continue message so that MSC will continue normal call handling procedures

2.1.9. If called party number os identified to be ported InitalDP should be responded with CAMEL connect message so that MSC will route call towards subscription network of the ported number.

2.1.10. If CAMEL connect is used NRN associated with the ported MSISDN should be set as the called party number.

2.2. Number Provisioning

2.2.1. NPDB should provide an API to integrate 3rd party systems with NPDB for provisioning requirements

2.2.2. Addition, removal and modification of portability status of MSISDNs should be supported via provisioning interface.

2.2.3. Should be integrated with provisioning systems of all service providers

2.3. Number of records

2.3.1. Expected number of records to be supported in NPDB under each MNP implementation is mentioned below

	TQoD	QoHR	OQoD	MNP SRF - Direct routing	MNP SRF - indirect routing
Centralized NPDB	10,800,000	10,800,000	10,800,000	10,800,000	10,800,000
Individual NPDB					
Operator 1	4,000,000	4,000,000	10,800,000	10,800,000	5,700,000
Operator 2	2,400,000	2,400,000	10,800,000	10,800,000	4,500,000
Operator 3	2,400,000	2,400,000	10,800,000	10,800,000	4,500,000
Operator 4	1,000,000	1,000,000	10,800,000	10,800,000	3,450,000

Operator 5	1,000,000	1,000,000	10,800,000	10,800,000	3,450,000

2.3.2. System should be designed to handled 20% more number of entries without hardware or software modifications

2.3.3. System should be design in a scalable manner for easy capacity enhancements by adding hardware resources with no or minimum software changes.

2.4. Capacity

2.4.1. Expected number of queries per second to be supported in NPDB under each MNP implementation is mentioned below

	TQoD	QoHR	OQoD	MNP SRF - Direct routing	MNP SRF - indirect routing
Centralized NPDB	2,500	2,500	2,500	2,500	2,500
Individual NPDB					
Operator 1	1,000	1,000	2,500	2,500	1,250
Operator 2	650	650	2,500	2,500	1,000
Operator 3	650	650	2,500	2,500	1,000
Operator 4	250	250	2,500	2,500	1,000
Operator 5	250	250	2,500	2,500	1,000

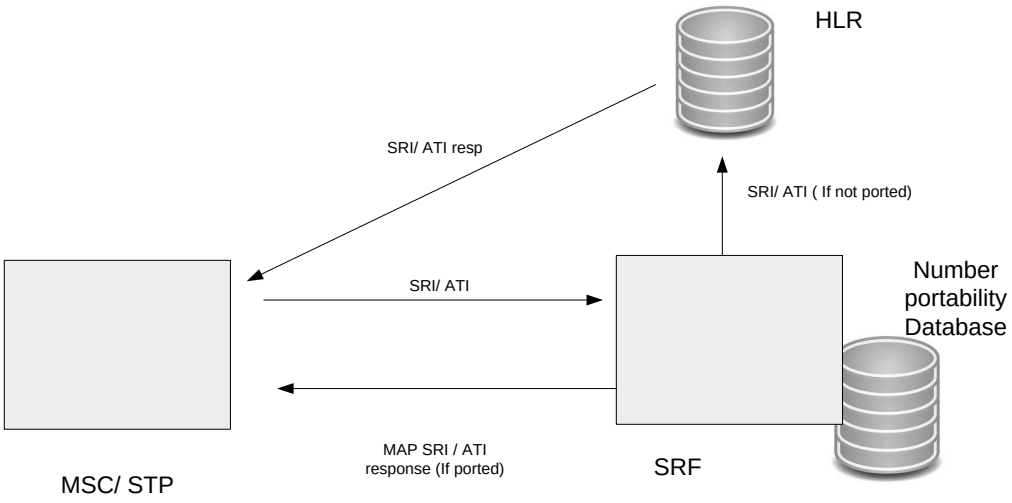
2.5. In case of MNP implementation using SRF vendor if free to use any communication interface between SRF and NPDB.

2.6. System should be designed to handled 20% more number of entries without hardware or software modifications

2.7. System should be design in a scalable manner for easy capacity enhancements by adding hardware resources with no or minimum software changes.

3. Signaling Relay function (SRF)

Figure D-2: SRF message flow



3.1. All MAP SRI and ATI messages will be routed via SRF.

3.2. Separate translation type (TT) will be used to route messages towards SRF from network nodes.

3.3. SRF should be capable of modifying the translation type when the messages are routed back to the network.

3.4. SRF should support routing messages to network nodes based on below parameters

3.4.1.Called party address

3.4.2.Translation type

3.4.3.MAP operation code

3.5. Routing rules defined inside SRF should support setting below parameters in signaling messages

3.5.1.OPC

3.5.2.DPC

3.5.3.Calling party address

3.5.4.Called party address

3.5.5.Translation type

3.6. For all receiving SRI messages SRF should query number portability database to identify whether the destination number is ported.

3.7. If the number is identified to be ported, SRF should respond to SRI so that call will be routed towards subscription network.

3.8. MAP ATI messages should be routed to the HLR of own network if number is identified to be non ported

3.9. MAP ATI should be routed to relevant HLR/ SRF of other network (Based on direct / indirect routing used) if number is identified to be ported.

3.10. Implementation should comply with 3GPP TS 23.066 specification.

4. Redundancy
   4.1. Proposed solution should address the redundancy in terms of hardware and software design.
   4.2. Geographical redundancy can be proposed as an option.

5. Admin interface
   5.1. Solution should include comprehensive web interface for system administrators
   5.2. All the configuration options should be available to perform via Admin interface.
   5.3. Should support role based login account creation
   5.4. Should support defining different user roles and create role based user accounts

6. Hardware requirements
   6.1. Should provide list of hardware required for deployment of solution
   6.2. Should mention hardware requirements separately for each of the below options.
      6.2.1.1. Centralized shared database among all operators
      6.2.1.2. Operator managed databases
         6.2.1.2.1. Operator1
         6.2.1.2.2. Operator2
         6.2.1.2.3. Operator3
         6.2.1.2.4. Operator 4
         6.2.1.2.5. Operator5
      6.2.1.3. MNP SRF

7. Pricing proposal
   7.1. Pricing (rough estimation) for below options should be provided separately per each option.
      7.1.1.Number portability database
         7.1.1.1. Centralized shared database among all operators
         7.1.1.2. Operator managed databases
            7.1.1.2.1. Operator1
            7.1.1.2.2. Operator2
            7.1.1.2.3. Operator3
            7.1.1.2.4. Operator 4
            7.1.1.2.5. Operator5
         7.1.1.3. MNP SRF

7.1.1.4. Annual maintenance fee

7.1.1.5. Annual maintenance fee for operating and managing shared , centralized database

7.2. Should indicate the annual maintenance fee per each option.

7.3. On centralized number portability database option, vendor may manage the entire service.

ANNEX-E: COMPARISON OF CALL CHARGES

According to the results of the survey average monthly bill of a post paid subscriber is around LKR 490 and the average bill of a pre paid subscriber is around LKR 335. After removing taxes usage charges per post paid subscriber per month is around LKR 380 and that of pre paid subscriber is around LKR 260 per month.

A comparison of usage charges applicable on an average post paid subscriber across mobile telephone service providers is mentioned in Table E-1.

Assumptions:

Service usage: Only Voice calls and SMS

Usage:

Voice calls (within the network) – 175 minutes / month

Voice calls (out side the network) – 85 minutes / month

SMS (within the network) – 50 / month

SMS (Outside the network) – 25 / month

Table E-1 : Comparison of usage charges – post paid

Service provider	Package name	Usage charge - LKR
Dialog	i250 Package	413.75
Mobitel	Value 50	373.75
Etisalat	Talk 100	363.75
Airtel	VIP150	406.25
Hutch	Post Paid Lite	363.75
Average		*384.25*
Standard deviation		*19.97*

As Table E-1 depicts there is a difference on total payable amount by average post paid service user between some service providers.

A comparison of usage charges applicable on an average pre paid subscriber across mobile telephone service providers is mentioned in Table E-2

Assumptions:

Service usage: Only Voice calls and SMS

Usage:

Voice calls (within the network) – 125 minutes / month

Voice calls (out side the network) – 60 minutes / month

SMS (within the network) – 50 / month

SMS (Outside the network) – 25 / month

Table E-2 : Comparison of usage charges – post paid

Service provider	Usage charge - LKR
Dialog	256.25
Mobitel	261.25
Etisalat	263.75
Airtel	258.75
Hutch	263.75
Average	260.75
Standard deviation	*2.59*

Unlike in post paid scenario the charges applicable across mobile service providers on pre paid services are more or less equal.

ANNEX –F: QUESTIONNAIRE

Name (Optional)…… Age : ……. (Years)

---

1. Does your mobile telephone supports dual SIM facility? ☐ Yes ☐ No
2. Do you use multiple SIMs? ☐ Yes ☐ No
3. Mobile telephone connection details

SIM1

a) Network Service provider ?

☐ Dialog ☐ Mobitel ☐ Etisalate ☐ Airtel ☐ Hutch

b) Mode of payment?

☐ Prepaid (Card connection) ☐ Post paid (Monthly bills)

c) Who pays your mobile phone bill?

☐ Myself, Parents or guardian ☐ My employer(Company)

d) How much you spend monthly on your mobile telephone bills (LKR)

☐ Below Rs.300.00 ☐ between Rs.300.00 - Rs.600.00 ☐ above Rs.600.00

e) How satisfied are you with quality of services offered by service provider?

☐ Excellent ☐ Good ☐ Moderate ☐ Bad ☐ Extremely bad

f) The Network coverage is available on almost all places I frequently visit?

☐ Yes ☐ No

g) Relative to other service providers the call charges are?

☐ Too high ☐ High ☐ almost same ☐ Low ☐ Too low

h) The supplementary services (ex: Mobile TV, Missed call alert)offered by service provider

☐ Adequate to full fill my requirements ☐ Not adequate to full fill my requirements

i) How many years have you been using this mobile telephone connection? …… (years)

j) Are you proud to be served by this service provider?

☐ Yes ☐ Neutral ☐ No

k) How frequently you make calls via this SIM? (per day)

☐ Below 5 ☐ Below 10 ☐ Below 25 ☐ More than 25

l) How frequently you receive calls to this SIM? (per day)

☐ Below 5 ☐ Below 10 ☐ Below 25 ☐ More than 25

SIM2

m) Network Service provider ?

☐ Dialog ☐ Mobitel ☐ Etisalate ☐ Airtel ☐ Hutch

n) Mode of payment?

☐ Prepaid (Card connection) ☐ Post paid (Monthly bills)

o) Who pays your mobile phone bill?

☐ Myself, Parents or guardian ☐ My employer(Company)

p) How much you spend monthly on your mobile telephone bills (LKR)

☐ Below Rs.300.00 ☐ between Rs.300.00 - Rs.600.00 ☐ above Rs.600.00

q) How satisfied are you with quality of services offered by service provider?

☐ Excellent ☐ Good ☐ Moderate ☐ Bad ☐ Extremely bad

r) The Network coverage is available on almost all places I frequently visit?

☐ Yes ☐ No

s) Relative to other service providers the call charges are?

☐ Too high ☐ High ☐ almost same ☐ Low ☐ Too low

t) The supplementary services (ex: Mobile TV, Missed call alert)offered by service provider

☐ Adequate to full fill my requirements ☐ Not adequate to full fill my requirements

u) How many years have you been using this mobile telephone connection? …… (years)

v) Are you proud to be served by this service provider?

☐ Yes ☐ Neutral ☐ No

w) How frequently you make calls via this SIM? (per day)

☐ Below 5 ☐ Below 10 ☐ Below 25 ☐ More than 25

x) How frequently you receive calls to this SIM? (per day)

☐ Below 5 ☐ Below 10 ☐ Below 25 ☐ More than 25

4. Are you seriously considering moving to another mobile service provider? ☐ Yes ☐ No
5. If you were given a chance to keep existing mobile number and move to another service provider, will you move? ☐ Yes ☐ No
6. If so which connection? ☐ SIM1 ☐ SIM2 ☐ Both
7. If so are you willing to pay Rs. 100.00 per month for that service? ☐ Yes ☐ No
    a. If answer for above question is "No", are you willing to pay Rs. 50.00 per month for that service? ☐ Yes ☐ No
    b. If answer for above question is "Yes", are you willing to pay Rs. 200.00 per month for that service? ☐ Yes ☐ No
8. What do you think about the necessity of introducing a service to keep mobile number with you while moving to another service provider?

    ☐ Extremely necessary ☐ Very necessary ☐ somewhat necessary ☐ Not at all necessary

9. When do you think that this service should be introduced in the mobile telecommunications market?

    ☐ Immediately ☐ Within 6 months ☐ Within 1 year ☐ Within 2 years ☐ After 2 years

10. Why did you select new service provider? (mark all applicable choices)

    ☐ Low call charges ☐ Better service ☐ Better coverage ☐ Offers and raffle draws

    ☐ Supplementary services ☐ other…….. (Please mention)

11. Do you have any experience of changing your mobile telephone number? ☐ Yes ☐ No
12. How many contacts are there in your address book?
    ☐ Below 100 ☐ below 200 ☐ below 500 ☐ More than 500
13. What is your monthly income level? (LKR)
    ☐ Below Rs 30,000 ☐ Below Rs 50,000 ☐ Below Rs 100,000 ☐ Above Rs 100,000
14. What is your highest education qualification?
    ☐ GCE O/L ☐ GCE A/L ☐ Diploma ☐ Bachelor's degree ☐ Post graduate
15. Is (or was) your job directly related to the telecommunication service? ☐ Yes ☐ No