



# A Hybrid Call Routing Framework for Mobile Number Portability in Nigeria

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**Abstract** - The essence of Mobile Number Portability (MNP) is to improve quality of service by deepening competition among service providers. This technology was launched in Nigeria in 2013 by the Nigerian Communication Commission (NCC) but the introduction of MNP in Nigeria has neither improved the quality of service offered by the service providers nor provided an open platform for fair competition for smaller telecommunication operators. Subscribers not being satisfied with the operators' services and the frequent network derailment have become more challenging. This has not only led to untold inconveniences to subscribers since the service providers have capitalized on this lapse to exploit the subscribers by imposing unreasonable charges to subscribers. Efficient MNP involves adopting an efficient call routing framework. This research therefore became imperative as it aims at analyzing the MNP call routing framework in Nigeria together with other existing frameworks with a view to coming up with a hybrid call routing framework for the enhancement of MNP in Nigeria. The system was designed using Object Oriented Analysis and Design Methodology (OOADM), Visual Basic.NET for the program codes and Microsoft Access as the Database system. The results indeed show that a hybrid between All Call Query (ACQ) frameworks already existing in Nigeria with call Drop back framework ensures reduction in network congestion and hence improved quality of service.

**Keywords:** MNP, Network, Service Provider, Framework, Call routing.

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## I. INTRODUCTION

Mobile Number portability (MNP) is a platform that enables subscribers to seamlessly switch mobile telecommunications service providers without changing their phone numbers. MNP gives the subscribers the privilege to easily change from networks that are not serving them well and also return when the network improves ensuring greater flexibility and mobility across networks. Mobile Number Portability (MNP) is equally the ability of subscribers to retain their phone numbers when changing from one mobile service provider to another [8]. It allows customers who wish to switch mobile operator to keep their mobile numbers, avoiding the costs of switching to new numbers [4]. Number portability is not a new concept and according to NCC, Nigeria is the 64<sup>th</sup> country in the world to have implemented it. The main objective according to the Nigerian Communications Commission (NCC) for implementing the service is to increase the level of competition in the mobile telecommunication market and so that quality of service can increase.

However, contrary to expectations, GSM service providers in Nigeria have latched on to the MNP scheme just to broaden the scope of their promos and advertisements rather than improve services as earlier envisaged [1]. From observations thus far, little has changed in terms of network coverage and the volume of dropped calls and intermittent service seizures, and other quality of service concerns. Thus the expectations raised by the MNP scheme are not being fulfilled and Nigerians again are looking to the NCC to rein on the GSM operators who have merely capitalized on the scheme to indulge in a wild medley of promos without improving their services. Indeed, MNP seems not to be recording expected success in Nigeria with only a handful of subscribers that switched networks within two months of its launch [1]. Hence, it is pertinent to state that up till date the launch of MNP in Nigeria seemed not to have recorded expected success. The scheme is expected to improve quality of service and enhance billing integrity, since operators would not want to lose customers who may be willing to shift to another network if they feel short-changed by their current networks.



It has been established that for porting to be efficient and successful, there are two technical issues that must be streamlined. These issues are (a) the type of database maintained which can be either centralized or distributed; (b) the calls made to the ported number must be re-routed. In the Nigerian context, NCC has already approved Central database system to enable them oversee the operations of the different operators. Then the second technical issue of re-routing of calls which is the actual porting process. This re-routing implies that an incoming call must find its way to the new service provider. Ordinarily the routing information used in routing the call prior to porting would route the call to the old service provider. Call routing is the method used for routing of calls from an originating network to the mobile network associated with a given mobile number whenever a call is made. This research is set to examine the various flavors to routing of calls and then come up with a more efficient one that can be adopted so that MNP can become a success in Nigeria.

## II LITERATURE REVIEW

The history of MNP started in 1990s with Singapore implementing a limited version of this functionality in 1997, Hongkong implemented in 1999, Spain in 2000, and Australia in 2001 and so on and so forth that as at September 2008, a total of 48 countries around the world had launched MNP [5]. The number of countries implementing MNP continued to increase rapidly that by 2011 also there were 63 countries that had implemented MNP, [6]. This wind of the MNP, which was only blowing in Europe and America over a decade ago has even cut across the African continent and Nigeria in order not to be left behind the wheel joined in April 22<sup>nd</sup>, 2013 to become the 64<sup>th</sup> country of the world to embrace the MNP scheme,[1]. Mobile Number Portability (MNP) can be defined as the ability of subscribers to retain their phone numbers when changing from one mobile service provider to another [8]. It allows customers who wish to switch mobile operator to keep their mobile numbers, avoiding the costs of switching to new numbers [4]. MNP entails a lot of processes such as porting processes, code of conduct between Donor Operator and Recipient Operator, technology used for porting, competition, and customer standards to determine the success or failure of MNP depending on how they are implemented by mobile operators. Mobile number portability is simply keeping mobile phone number when moving from the existing service provider to a new service provider [3].

### A. MOBILE NUMBER PORTABILITY IN NIGERIA

The Nigeria Communications Commission (NCC) on April, 22<sup>nd</sup> 2013 launched the take-off of the Mobile Number Portability (MNP) scheme [1]. This is the most collaborative programme embarked upon by both the NCC and GSM service providers. The scheme is meant to deepen competition among telecoms companies and challenge them to offer improved and affordable services. The GSM companies bristled with excitement and Nigerians were full of expectations. The policy took off three years after the initial target set in 2009.

MNP considered a revolutionary step in the development of telecommunications services in Nigeria, the policy in a nutshell, enables phone subscribers in a multi-network environment to change from one network to the other without changing their telephone numbers, following the granting of a porting request. It was meant to make GSM companies sit up and raise their standards, failure of which they risk losing their customers. So far, however, the porting game is yet to spiral into a full-scale competitive storm. The excitement and expectation which trailed the launch of the scheme has all but died out. On their part, GSM service providers have merely used the MNP scheme to broaden the scope of their promos and advertisements, changed in terms network coverage and the volume of dropped calls and intermittent service seizures, and other quality of service concerns. But the importance of MNP cannot be over emphasized in the development of effective competition in telecommunication sector. [10] stressed that the importance of MNP is very paramount, if any country's telecommunication must grow. On Evaluation of Subscriber Attitude to Mobile Number Portability Implementation in Nigeria, [9] assessed the attitude of mobile telephone subscribers to the implementation of mobile number portability (MNP) in Nigeria. Findings revealed that while most subscribers supported the implementation of MNP in Nigeria, a significant proportion believed that tariffs would not drop as long as the power problem continued. Furthermore, it was found that of the demographic variables, age had the strongest influence on subscriber attitudes and this was identified as a strategic focus for network operators and the regulatory authority. Based on the above findings and conclusions, they recommended that future work should determine empirically the knowledge of MNP of the subscribers in Nigeria and capture the respondents' intention to port.

In another research, [7] developed a conceptual framework on user perspective on factors of quality of service for Mobile SIM networks using 3D fuzzy logic approach as a means of enhancing the MNP scheme in Nigeria. They presented a chronological procedure for the implementation for both the network integration and the customer perspective on quality of service. The work was designed as an initial exploration to demonstrate the feasibility of a flexible trusted platform.



However, the study did not explore or empirically determine extent of improvement. Another limitation is that the study did not capture the Key Performance Indices (KPIs) of the network regulators for switching as a result of mobile Number Portability availability. And as such they suggested that these shortcomings could be examined in further studies.

### III. SIGNIFICANCE OF THIS RESEARCH

The importance and the inevitability of this research are very obvious. There is a growing disillusionment by Nigerians on MNP because of the prevailing poor quality of service, network failure, increment in call tariffs etc and the inability of MNP to help resolve these issues which is affecting business transactions that are dependent on communication. And as such many subscribers and operators have kicked against MNP in different ways. For instance some subscribers believe that instead of waiting for 48hrs to port their numbers, they would rather purchase a new SIM and start using almost immediately. They have forgotten that a new SIM implies a new identity and cost of informing friends and business associates about a new number change will at the end of the day be more than the cost of porting a number. Operators on the other hand have claimed that Mobile Number Portability is unnecessary and that it is an unwarranted expense, using assertions that the sector is already highly competitive and have suggested alternatives such as personal numbering and Universal Personal Telephony (UPT). But, these are not substitutes to MNP, but are rather expensive, value-added services. The sector may be competitive as they claim but with Mobile Number Portability in place, the remaining barriers to competition between operators would be removed thus paving way for a more dynamic and fully competitive market. Mobile Number Portability has a lot of advantages to offer. If not, why would both the developed and developing economies of the world embrace it? Embracing the MNP will position Nigeria to catch up with other developing economies like Ghana already investing in the scheme. And since other countries of the world are trying to keep pace with ever growing technological innovations, Nigeria should not be left behind.

MNP implementation in Nigeria will serve as a telecommunication gateway project for ICT in Nigeria by enabling the Ministry of Communication Technology to facilitate the installation of a consolidated national gateway monitoring system to help the sector accelerate the development of mobile telephony in Nigeria. The MNP infrastructure will as matter of necessity create the enabling environment for a competitive terrain that will enhance the delivery of affordable ICT services such as provision of universal access to telephony and services to underserved and un-served areas of the country, thereby bridging the digital divide between the urban and rural areas. The MNP framework will equally promote transparency in the communication industry and enforce the verification of the number of international telephones calls to Nigeria for the purpose of enhancing revenue generation for national development.

### IV. EXISTING MNP CALL ROUTING FRAMEWORKS

There are many variations to routing of incoming calls in a ported network and they are categorized into four and they include: Onward Routing (OR), Query on Release (QoR), Call dropback and All Call Query (ACQ). These call routing frameworks are analyzed as follows:

#### A. THE ALL CALL QUERY FRAMEWORK (ACQ).

In this framework responsibility is placed on the originating network to detect any calls to ported mobile numbers, so as to retrieve routing information for those calls, and to reroute them. The donor GSM network is not involved in call handling, and therefore has no responsibilities in this respect. The recipient GSM network has the responsibility to detect that calls are addressed to ported numbers (the recipient network would otherwise route those calls to the donor GSM network). The recipient GSM network shall also complete the calls, which involves retrieval of information from the location register of the central number portability database. In summary, in the ACQ model the originating network upon receiving a call, the originating network sends a query to a centrally administered NPDB which returns a Routing Number (RN) associated with the dialed number. The RN number is used by the originating network to route the call to the recipient network. This is also called direct routing. Examples of countries that adopt this framework are Nigeria, India, Italy, Poland, Austria, Germany etc. The names of other countries that adopt ACQ are shown in appendix F of this thesis. The framework is shown in figure 1 below. The framework is further explained using the procedural flow diagram figure 1 below.

#### B. CALL DROPBACK FRAMEWORK

In this Framework, the originating network first routes the call to the donor GSM network. The donor GSM network detects that number portability has been applied, consults the NP database, and retrieves routing information for the call. The donor GSM network then releases the call back to the originating network with the routing information. On reception of the release message with the routing information the originating network reroutes the call to the recipient GSM network. In a nutshell the call drop back implies that the originating network sends the call to the donor network.

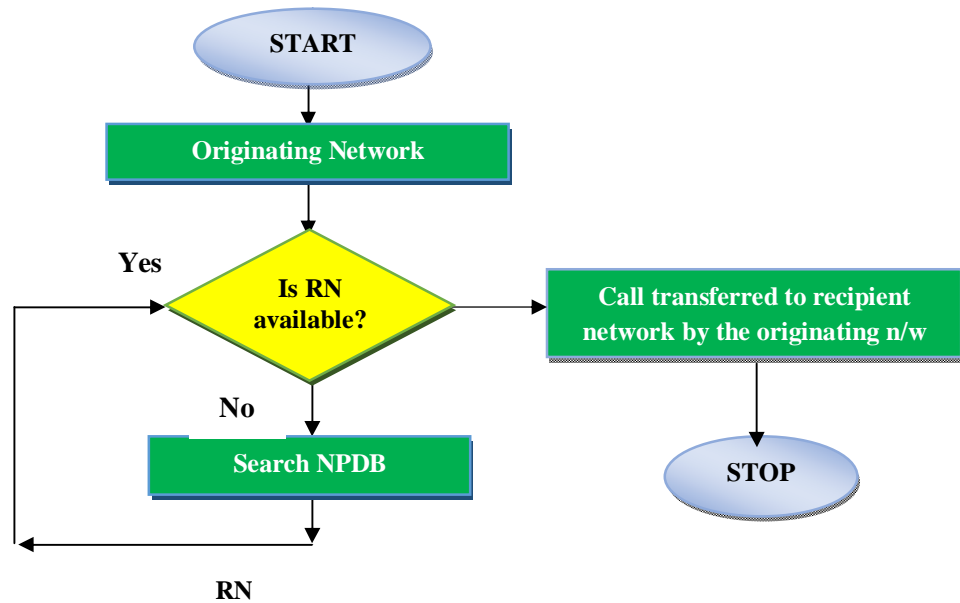


Fig 1. Flow diagram of All Call Query Routing Framework

The donor network checks its internal database. And if the routing number is not available in its local database, the donor network makes a query to NPDB and finds the routing number associated with the dialed number. After which it returns the routing number to the originating network. The originating network then routes the call to the new servicing network using the routing number. This framework has the advantage that both the donor network and recipient networks are involved in the re-routing of calls. It is illustrated in figure below. The framework is also further explained using the flow diagram figure 2 below.

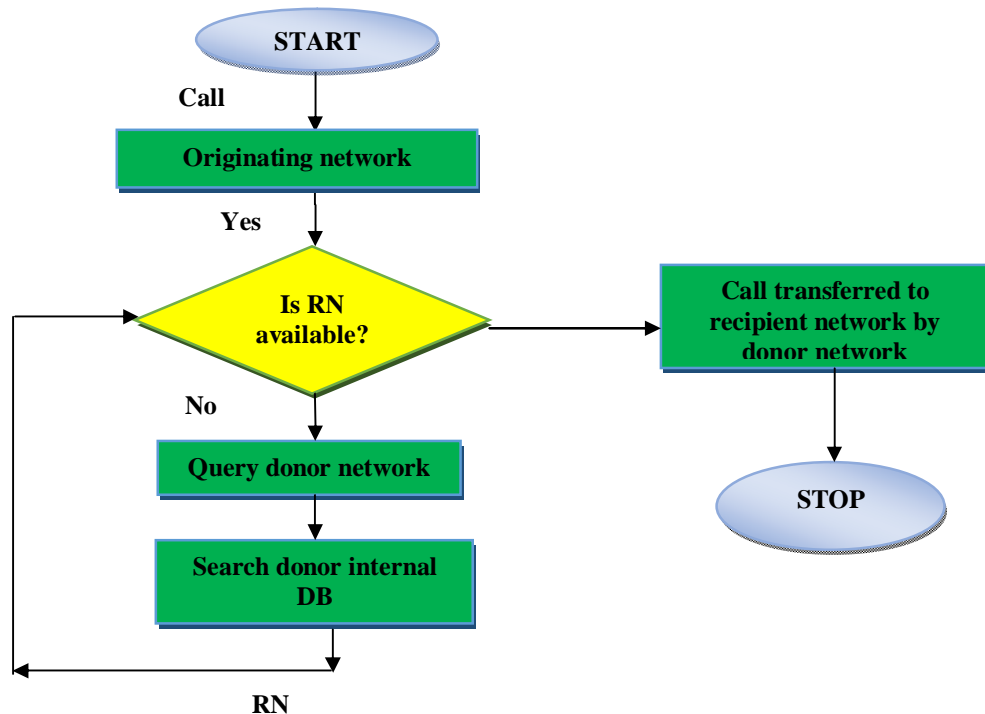


Fig2 Flow Diagram of Call Dropback Routing Framework.

### C. ONWARD ROUTING FRAMEWORK

In this framework, the originating network sends the call to the donor network. The donor network checks the Number Portability Database (NPDB) and finds that the number has moved out of donor switch. The donor network makes a query to NPDB. NPDB returns the routing number associated with the dialed number. The donor network uses the routing number to forward the call to new network. The routing of the call via the donor GSM network and require a corresponding high-level network models. Some of the countries that adopt this framework are United Kingdom, Switzerland, and Spain etc. This framework is also called call forwarding and is as shown in figure 3 below.

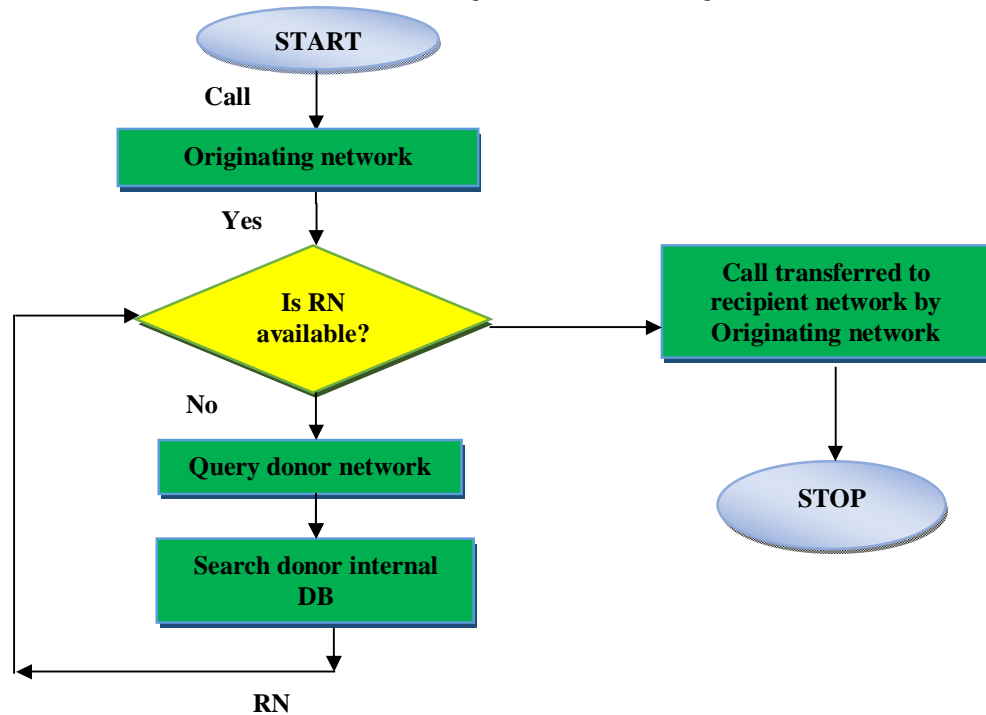


Fig 3. Flow diagram for Onward Routing Framework.

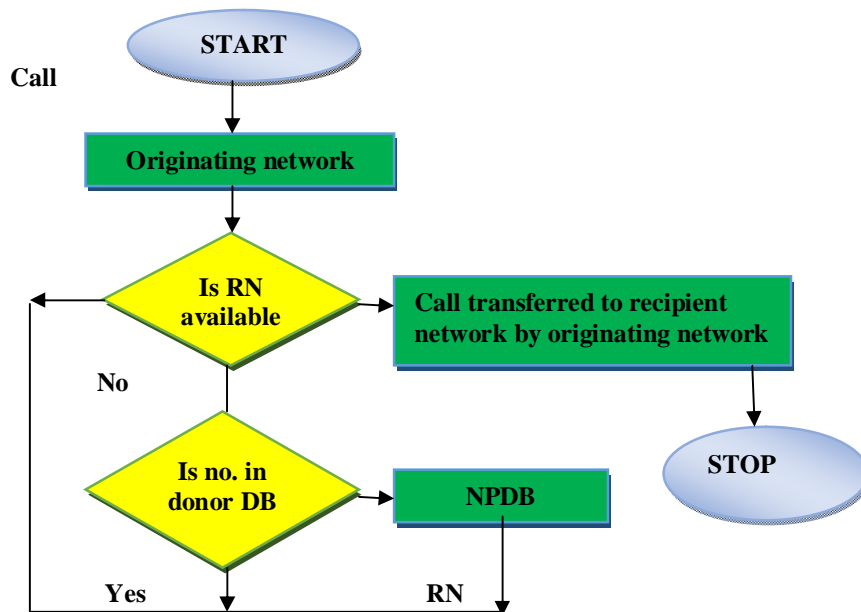


Fig 4. Flow diagram for Query on Release Framework.

#### D. QUERY ON RELEASE ROUTING FRAMEWORK

The originating network in this framework sends the call to the donor network. It then detects that the called number has been ported out to another network. It thereafter releases the call with a special indication telling that called number is ported out. The originating network then sends a query to its own Number Portability Database (NPDB). The NPDB returns the routing number (RN) associated with the dialed number. The originating number then routes the call to the new servicing network. The framework is as shown in figure 4 below.

#### V. COMPARING THE EXISTING CALL ROUTING FRAMEWORKS.

The four routing frameworks have their different strengths and weaknesses and these strengths and weaknesses can be compared using the following parameters:

- i) *Call routing cost*
- ii) *Type of database accepted*
- iii) *Number portability database searched.*
- iv) *Network congestion.*
- v) *Efficiency in searching of routing number.*
- vi) *Efficiency in terms of network resources used.*
- vii) *Need for a dedicated circuit between the originating network and donor network.*
- viii) *Maintenance of Local NPDB by the donor networks.*

TABLE 1 BELOW SUMMARIZES THE COMPARISON OF DIFFERENT CALL ROUTING FRAMEWORKS.  
TABLE: COMPARISONS OF EXISTING CALL ROUTING FRAMEWORKS.

PARAMETERS	ACQ FRAMEWORK	CALL DROPBACK FRAMEWORK	ONWARD ROUTING FRAMEWORK	QUERY ON RELEASE FRAMEWORK	REMARKS
CALL ROUTING COST	High routing cost	Moderate routing cost	Low cost	Moderate routing cost	High routing cost is due to maintaining only a centralized DB for all the operators. .
TYPE OF DB ACCEPTED	Centralized DB	Distributed DB	Distributed	Centralized	For efficient porting both centralized & distributed DB can be maintained.
NPDB SEARCHED	Searches centralized NPDB	Searches donor network local NPDB	Searches donor network local NPDB	Searches centralized NPDB	Searching of donor network local DB can reduced time during porting
EFFICIENCY IN SEARCHING	Less complex, direct search to NPDB	Very efficient since donor n/w only queries its internal DB	Efficient also & less complex only donor n/w DB is searched	Not efficient because searches donor n/w before NPDB for RN	With efficient RN retrieval, porting will be very efficient.
NETWORK CONGESTION	Moderate n/w congestion per call	Less n/w congestion per call because of involvement of donor n/w	Moderate congestion per call.	High n/w congest per call	Improved quality of service can only be achieved with less n/w congestion
EFFICIENCY IN TERMS OF N/W RESOURCES USED	Very efficient. Does not involve donor n/w to route the call	Efficient. Donor n/w send RN to originating n/which then routes the call to recipient n/w	Efficient. Donor network routes the call to the recipient n/w	Not efficient involves the donor n/w & use of NPDB	Efficiency in terms of network resources is seen in routing of calls.

NEED FOR DEDICATED CIRCUIT	No circuit needed between originating and donor n/w	Dedicated circuit is needed for the donor network to communicate with the originating n/w	No circuit is needed	Dedicated circuit is needed between the originating n/w and the donor n/w	The need for dedicated circuit is very important for efficient porting (routing of calls)
MAINTENANCE OF LOCAL NPDB BY THE DONOR N/W	Does not need donor n/w local DB	Donor local NPDB is maintained	Donor local DB is maintained	Does not require donor n/w to maintain local DB	Maintenance of both centralized NPDB and local NPDB by the network is still advisable

### VI. SUMMARY OF FINDINGS

From the table above, it is seen that originating network derives the Routing Number (RN) from the Number Portability Database (NPDB) and then routes the call directly to the recipient network in ACQ framework, whereas all other routing frameworks require the donor network to supply the routing number. Therefore, there is the involvement of donor network in Query on Release, Call Dropback and Onward routing frameworks. A dedicated signaled circuit is equally required between originating network and donor network in Query on Release and Call Dropback frameworks as call is made. The movement of routing number to and fro the network increases network traffic per call in case of Query on Release and Call Dropback frameworks. Onward routing is often regarded as the simplest routing method to implement and the All Call Query method as the most complex, with the other methods lying between these two extremes. This is also reflected in the costs of establishment, with onward routing regarded as cheaper to establish than the all call query method. However, a country must adopt any of these routing frameworks or a combination of them for efficient porting experience. For example, presently Nigeria opted for All Call Query framework.

### VII. PROPOSED HYBRID CALL ROUTING FRAMEWORK FOR MNP IN NIGERIA.

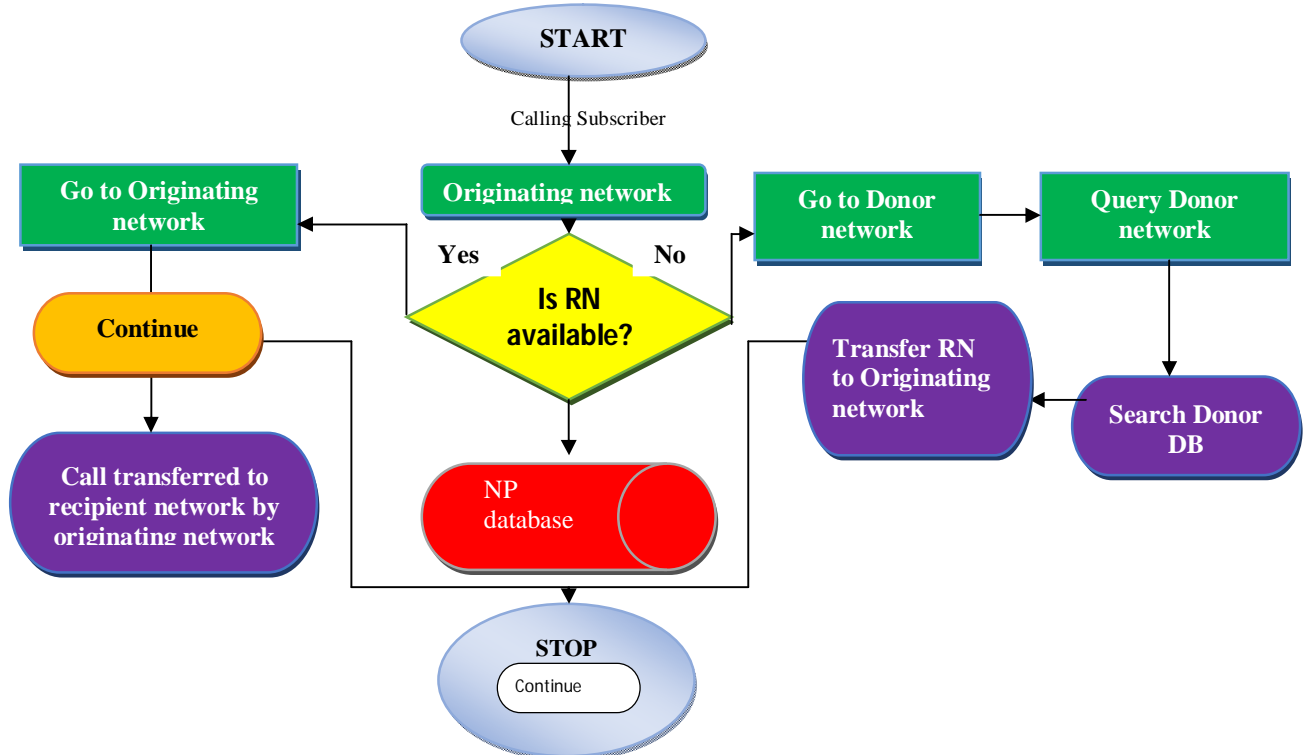


Figure5. The hybrid Call Routing Framework.

## VIII. ANALYSIS OF THE HYBRID CALL ROUTING FRAMEWORK

Given the loopholes in the existing call routing framework, it becomes paramount to introduce a model that can combine the advantages of two frameworks to produce an enhanced call routing framework for Nigeria. Hence in this research, a hybrid model architecture between All Call Query and Call Drop Back frameworks has been developed. In the hybrid framework, each network operator keeps and maintains its own local number portability database alongside the central number portability database. When a call is made to a number, the originating network now has the option to either query the central database or liaise with the donor network to query its local database in order to retrieve the routing number with which to route the call. The hybrid model combines the functionality of ACQ and Call Dropback models. This hybrid routing model ensures less search complexity which in turn ensures faster porting, less network seizures and less volume of dropped calls which are being experienced today even with the MNP in place.

## IX. MERITS OF THE HYBRID FRAMEWORK

The merits of the proposed hybrid model are discussed below.

- a) *The utilization of the two databases in proposed hybrid model makes the model more efficient by reducing the time required to retrieve the routing number with which to route a call to a number.*
- b) *This routing model combines the efficiencies of the All Call Query and Call Dropback models and offers less search complexity, moderate cost of implementation, flexibility of network resources and reduced network traffic.*
- c) *The hybrid model becomes more cost effective as porting becomes more common or prevalent.*

## X. JUSTIFICATION OF THE HYBRID MODEL

Mobile number portability is one of the revolutionary steps in the development of telecommunication services in Nigeria. But in Nigeria today, it is very obvious that the porting game is yet to spiral into a full-scale competitive storm. This can largely be attributed to the fact most subscribers have remained circumspect, opting to remain with their old service providers rather than dare uncharted waters. The excitement and expectation which trailed the launch of the scheme has all but died out. It is also clear that little has changed in terms of network coverage and the volume of dropped calls and intermittent service seizures, and other quality of service concerns. The much-awaited value-laden services promised by the operators of the various networks remain a mirage. There is as yet little accountability (to the subscriber), billing integrity, as well as any significant difference in the quality of services offered. Subscribers continue to be disturbed by unsolicited SMS wired to their phones for unsubscribed services and promos run by service providers.

But since Nigerians would not carry placards to compel these operators to render services that would encourage porting, they are anxiously relying on the Nigerian Communications Commission to protect them from the obvious complacency and lack of initiative of the service providers. The truth is that many more people really want to port and are waiting to be encouraged.

The implementation of this work therefore becomes inevitable since the research did not only assess the viability of MNP in Nigeria, it also evaluated the different call routing frameworks as adopted in Nigeria and other porting Nations and identified strengths and weaknesses of each and every one of them. The hybrid model developed in this research will be of immense assistance should Nigerian Communication Commission decide to revisit the mobile number portability as earlier on promised from the available literatures.

Also the hybrid call routing model developed combines the following features of the ACQ and Call Dropback models:

- a) *Cost effectiveness of the ACQ model*
- b) *Less search complexity feature of both the ACQ and call dropback models.*
- c) *Efficiency of Call dropback model in terms of the network resources used.*
- d) *In the hybrid model there a low network traffic per call and is therefore cheaper, faster and records a low number of dropped calls which are the ingredients of good quality of services that porting is meant to offer.*

## XI. CONCLUSION

As challenging as this research problem is, efforts were made to evaluate the various existing call routing frameworks as obtainable in Nigeria and other countries as a tool for checking the viability of MNP enhancement such that quality of service can improve in Nigeria. This research work has thus led credence to the core underlying issues surrounding the success of MNP in Nigeria. It also represented a concise domain independent practical model to address the Nigerian portability problem. The work clearly highlighted the type of call routing framework as a key factor in the resolution of the present MNP issues.





The simulation of the hybrid framework demonstrated that if government allows the current All Call Query model for MNP to remain, quality of service would not improve. Hence the adoption of the Hybrid Call Routing framework would make MNP feasible and viable in Nigeria.

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