



An Improved Call Routing Framework for Mobile Number Portability in Nigeria

Nnochiri Ifeoma U¹, Iroegbu Chibuisi^{*2}

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Abstract

Call routing is a call management feature where each incoming call is placed in a queue and is then routed to a specific person or group of people based on pre-established rules and criteria. Call routing issues occurs when incoming calls do not reach the appropriate agent because of technical or configuration issues. This work aims at improving call routing framework for mobile number portability in Nigeria. A mobile number portability mathematical predictive model was developed to determine the routing of both originating and received calls. The model was used to create figures of the donor network and Recipient network during mobile number portability (MNP) in MATLAB using number of nodes $n = 20$. The performance of the model was evaluated through the result of the analysis. The result shows how a mobile user A with Mobile Station International Subscriber Directory Numbers (MSISDN) 08130721624 operating on a donor network ported to a recipient network B. The research succeeded in solving the setbacks of poor quality of service common in our networks due to incompetent techniques of routing calls to called numbers. This has thus opened other research questions or perspective in academic environments and other research fields.

✉ Iroegbu Chibuisi: iroegbu.chibuisi@mouau.edu.ng

¹ Department of Computer Engineering, Michael Okpara University of Agriculture, Umudike

² Department of Electrical/Electronic Engineering, Michael Okpara University of Agriculture, Umudike

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1.0 Introduction

Mobile number portability is a mechanism that enables knowledgeable mobile network users in the general domain to switch from one service provider to another with the intention of experiencing superior services, all the while keeping their initial mobile phone numbers intact. This process operates within a formal context, providing users with the opportunity to enhance their mobile services without the hassle of changing phone numbers (Otoo, 2017).

Since the introduction of MNP by Nigerian Communications Commission (NCC) on April 22, 2013, MNP has gained wide acceptability. The platform, as noted by Nigerian Communications Commission (NCC), is capable of empowering customers, arousing healthy competition among the foremost network providers and helping in the realization of better quality services in Nigeria. Statistical results show a stable rise in figures for MNP migration requests. For instance, in 2013, 2014 and 2015, there were 225, 405 and 592 regular day today migrations completed, respectively (Aydin, 2005).

Although much research has been done on mobile number portability, concentrating on the perspective of competition at the business stage, little consideration has been given to the implementation of the system. Mobile Number Portability (MNP) permits users to vary network providers while maintaining their current phone numbers. It gives network users flexibility to toggle among network providers without incurring the related expenses of altering their phone numbers. It equally encourages healthy, useful competition among the service providers (Siwach, 2019).

In 1997, Singapore implemented MNP, making it the first country to implement MNP in the world.

At present, more than 73 countries, including France, the USA, Japan, India, the UK, Russia, Canada, and Germany, have successfully installed MNP (Boateng and Owusu, 2018). African countries with the MNP plan include Senegal, Ghana, South Africa, Kenya and Egypt. In Nigeria, MNP was initiated on April 22, 2013. It aims at allowing Mobile users to liberally and easily toggle among network providers.

In order to implement and deploy MNP effectively, the Nigerian Communications Commission (NCC) regulator must start, compel and control the process. They are responsible for issuing the regulatory structure for the procedure of mobile number portability in the country. The NCC is tasked with ensuring an efficient and competent migration system, fortifying the interaction among network Providers, protecting user's privileges and guaranteeing users' contentment. The NCC specifies punishments required for non-cooperation with the provisions of these policies (NCC, 2013).

MNP makes use of the Mobile Station International Subscriber Directory Numbers (MSISDN) in lieu of the International Subscriber Mobile Identity (IMSI); therefore, it can influence all MSISDN support services like SMS and MMS, leaving and arriving calls, etc.

The authors of Olatokun and Nwonne, (2012) looked at how important it is to consider factors like price, brand image, availability, quality, and promotion when choosing a mobile telecommunications provider. The factors influencing customer loyalty among GSM subscribers in north-western Nigeria were determined by the authors in Hashim, (2014). In the Nigerian mobile phone market, switching costs and customer loyalty have been studied by Oyeniyi and Joachim, (2008). According to the study, switching costs have a major impact on customer retention and customer satisfaction has

a positive relationship with retention.

In Adegoke *et al.* (2008), authors evaluated the performance of GSM operators in Nigeria and found that, despite GSM's apparent revolutionary nature, the industry has numerous issues. The issues found included power supply instability, infrastructure security, the threat posed by social miscreants in host communities, a variety of taxes and regulations, and inter-network connectivity. They claimed that each of these elements influences the quality of services provided by GSM providers in Nigeria in one way or another.

None of these studies addressed the performance of GSM service providers and customer satisfaction. Some of the few studies that have made attempts in the direction of this study were the works of Adeiza (2010) and Jibrin and Ahmad (2014). These works had methodological problems: some concentrated on only one state or institution, while others dealt with isolated variable indicators. They also used small sample sizes selected from narrowly defined populations and, moreover, they failed to integrate the various independent variable sets. As a result, the findings and conclusions of the studies have limited relevance for broad generalizations. Therefore, this work is designed to overcome deficiencies found in previous studies within the Nigerian context. In this research, an improved call routing framework for mobile number portability in Nigeria is presented.

2.0 Nigerian Porting Concept

In Nigeria, the process of porting a number begins when a subscriber expresses interest in doing so and notifies his or her preferred network (now the recipient operator). Visiting the recipient network in person with a legitimate identity card accomplishes this. We refer to this technique as recipient-led porting. The subscriber

is required to fill out a form with all of their personal information. They will also be told to send the message "PORT" to the Number Portability Clearing House by short code 3232. When this is finished, the clearing house notifies the donor network via message that a subscriber has decided to port out of its network. Following approval from both networks, the user receives a new SIM card from the recipient operator (or new network provider). After 48 hours, the subscriber is expected to switch out their old SIM card for the new one and start making and receiving calls. This is summarized in the following steps for clarity:

- (a) The subscriber visits any of the outlets of the service provider he or she intends to switch to.
- (b) The subscriber completes the necessary forms.
- (c) The new operator verifies and forwards the request to number portability clearing house.
- (d) If the request is approved, the subscriber is directed to send an SMS; "PORT" to 3232.
- (e) After processing, the donor operator is informed that this particular subscriber has ported out of its network and a new SIM card will be issued to the subscriber still bearing the old number.
- (f) The number portability clearing House Admin makes this information available to both the donor and the recipient network and the number is disconnected from the donor network and provisioned in the recipient operator's network.
- (g) The location routing number of the recipient operator is defined against the ported-in subscriber.
- (h) A new location routing number is relayed and updated by all operators.
- (i) The subscriber is expected to wait for some time (between 24 – 48hrs) before he or she gets an SMS to commence using the ported number.

(j) A subscriber is also expected by regulation to stay for a minimum of 90days on the new network before any other migration.

3.0 Methodology

It is assumed in this study that subscribers porting to a network service provider facility via a centralized database at a predetermined time (t) adhere to a dynamic arrival procedure, meaning that the service facility (Sf) controls the process even for the subscribers. In order to match the service intensity S_i , the service facility Sf must modify its capacity.

It was now thought that the arrival time distribution for the subscribers is roughly represented by a Poisson distribution (Pd). This discrete probability distribution gives estimates of how many subscribers' calls might be received during each given time interval (t). There is a fixed-line telephone market of size $k > 0$, and there are two mobile networks, $i = A, B$. Assuming that mobile and fixed phone services represent two distinct markets, we rule out intermodal competition between mobile and fixed phone providers. It is believed that the mobile networks are distinguished by a hotelling line of length 1, where network B is situated at 1 and network A is placed at 0. Assume that company B is a recent entry and company A is the current mobile operator. Customers who switch from A to B have a switching cost of $K \geq 0$ in the absence of MNP. As a result, K represents how much customer's value retaining their phone number. Furthermore, assume that the distribution of consumers is uniform between 0 and 1. Lastly, suppose that a customer at d obtains utilities V_A and V_B upon joining network A or B, respectively, with a specified income of z .

$$V_A = z + t_0 - \gamma d + v(r) \quad (1)$$

$$V_B = z + t_0 - K - \gamma(1 - d) + v(r) \quad (2)$$

where K represents how much customer's value retaining their phone number, V_A represents utility A, V_B represents utility B, z represents income, $v(r)$ represents value that consumers derive from making calls, t_0 represents the intrinsic value, Γ represents network differentiation. In this case, the degree of network differentiation is indicated by γ , and t_0 represents the intrinsic value that a consumer derives from being connected to a mobile phone network. The variable $v(r)$ represents the value that consumers derive from making calls.

We consider the scenario where mobile operators $i = A, B$ compete in non-linear prices, i.e., they select two-part tariffs consisting of a fixed subscription fee F_i and variable service charges p_{ij} for mobile services (such as calls, SMS, etc.) indexed by $j = 1, \dots, n$. As a result, mobile operator i offers a tariff function:

$$W_i(r_{i1}, \dots, r_{in}) = F_i + \sum_{j=1}^n p_{ij} r_{ij}, \quad i = A, B \quad (3)$$

Assume that n subscriber calls come in between 0 and t . The expected number of arrivals within a time period t will be t if τ is the expected or average number of call arrivals per unit time for porting. Given is the Poisson probability distribution function.

$$P(x = n | P_n = \tau t) = \frac{(\tau t)^n e^{-\tau t}}{n!}, \quad n = 0, 1, 2, \dots \quad (4)$$

The probability that no call will arrive within the interval 0 to t can be obtained from equation 1 as follows:

$$P(x = 0 | P_n = \tau t) = \frac{(\tau t)^0 e^{-\tau t}}{0!} = e^{-\tau t} \quad (5)$$

Since a subscriber's calls can arrive at any moment, T , which represents the interval between consecutive call arrivals, it must be a continuous random variable. The likelihood that T exceeds t is equal to the probability that there would not be a call arrival during the interval

from 0 to t . Thus,

$$P(T > t) = (x = 0 | P_n = \tau t) = e^{-\tau t} \quad (6)$$

Given two consecutive call arrivals, the cumulative chance that the T between them is t or less is given by:

$$P(T \leq t) = 1 - P(T > t) = 1 - e^{-\tau t}, t \geq 0 \quad (7)$$

The length of the wireless network is given as

$$w = 2 * n \quad (8)$$

where n represents number of nodes. The width of the network is given as:

$$h = 2 * n \quad (9)$$

While the radio range in meters is given as:

$$R = n/1.3 \quad (10)$$

The above model is used to create figures of the donor network and recipient network during MNP in MATLAB using $n = 20$. Figure 1 shows the Call Routing Framework of the proposed system

4.0 Results and Discussion

Figure 2 shows the MNP process of mobile [A] over a wireless network coverage. From Figure 2, the various mobile users in a given network region operated by networks A and B are shown. The blue lines showed a link among network users M , the base transceiver station BTS , and the mobile switching centre MSC .

Mobile user A with MSISDN 08130721624 operating on a donor network and wants to port

to the recipient network follows steps 1-3 with green arrows to inform the recipient network of his intentions to port. The recipient network in turn informs the user donor network of the user with MSISDN intentions of porting, as shown by the purple arrows. If this request is accepted, then the donor network issues a new international mobile subscriber identity IMSI to the porting number but still retains the MSISDN number of the user and also clears its record from the visitor location register (VLR) and home location register (HLR) of the donor network. This will be added to the visitor location register (VLR) and home location register (HLR) of the recipient network.

Figure 3 describes the result after the porting of mobile user A. After the porting process completes, as seen in Figure 3, if Mobile B calls the same MSISDN to contact Mobile A, the call goes to the donor network. But when checking in the VLR and HLR, it will give an error and then search in the NPDB. NPDB will give the new information about this number in the recipient network, so that MSC Operator 1 will route the call to the MSC of the recipient network. The recipient network then connects mobile A to mobile B.

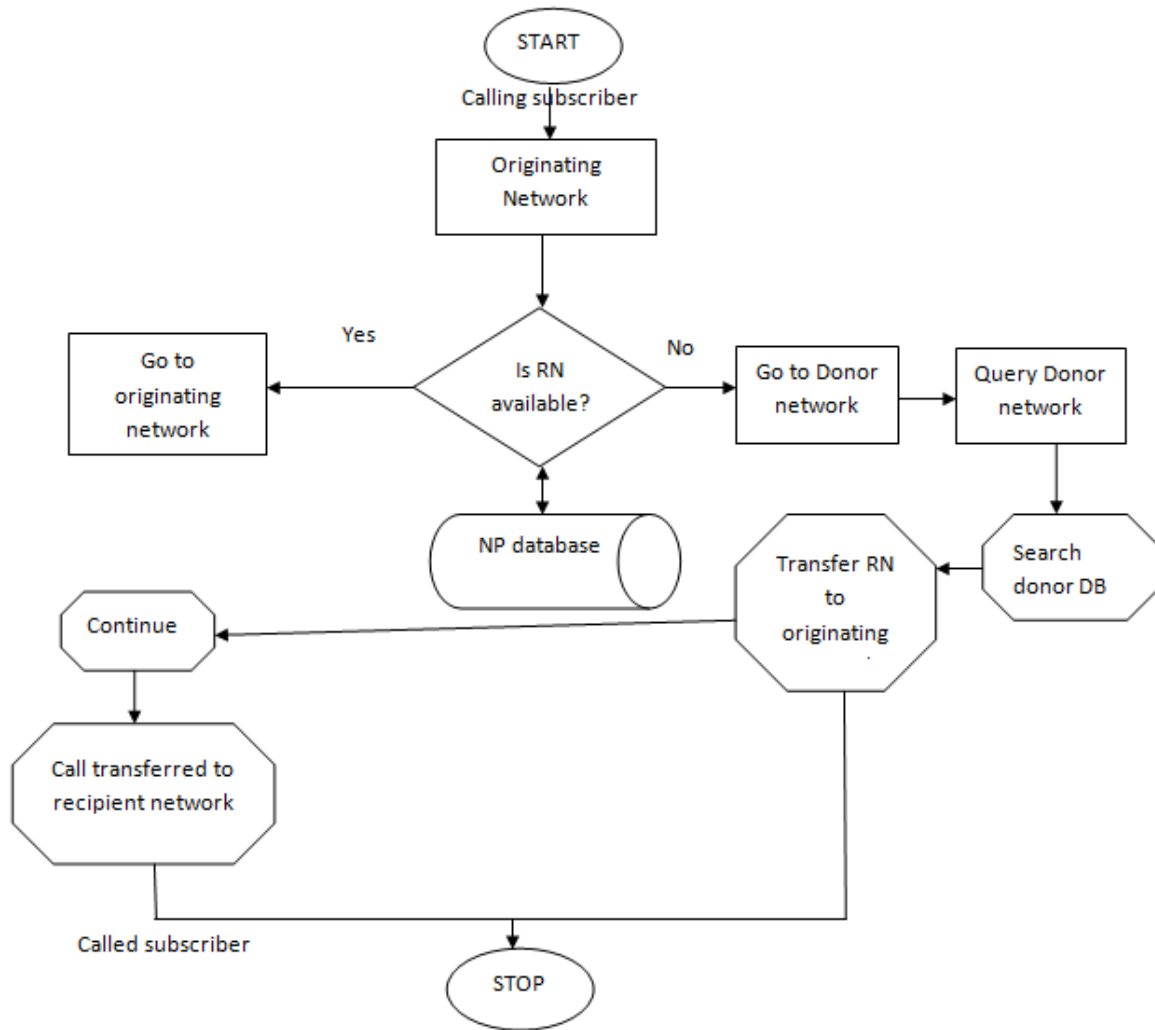


Figure 1: The Proposed Call Routing Framework

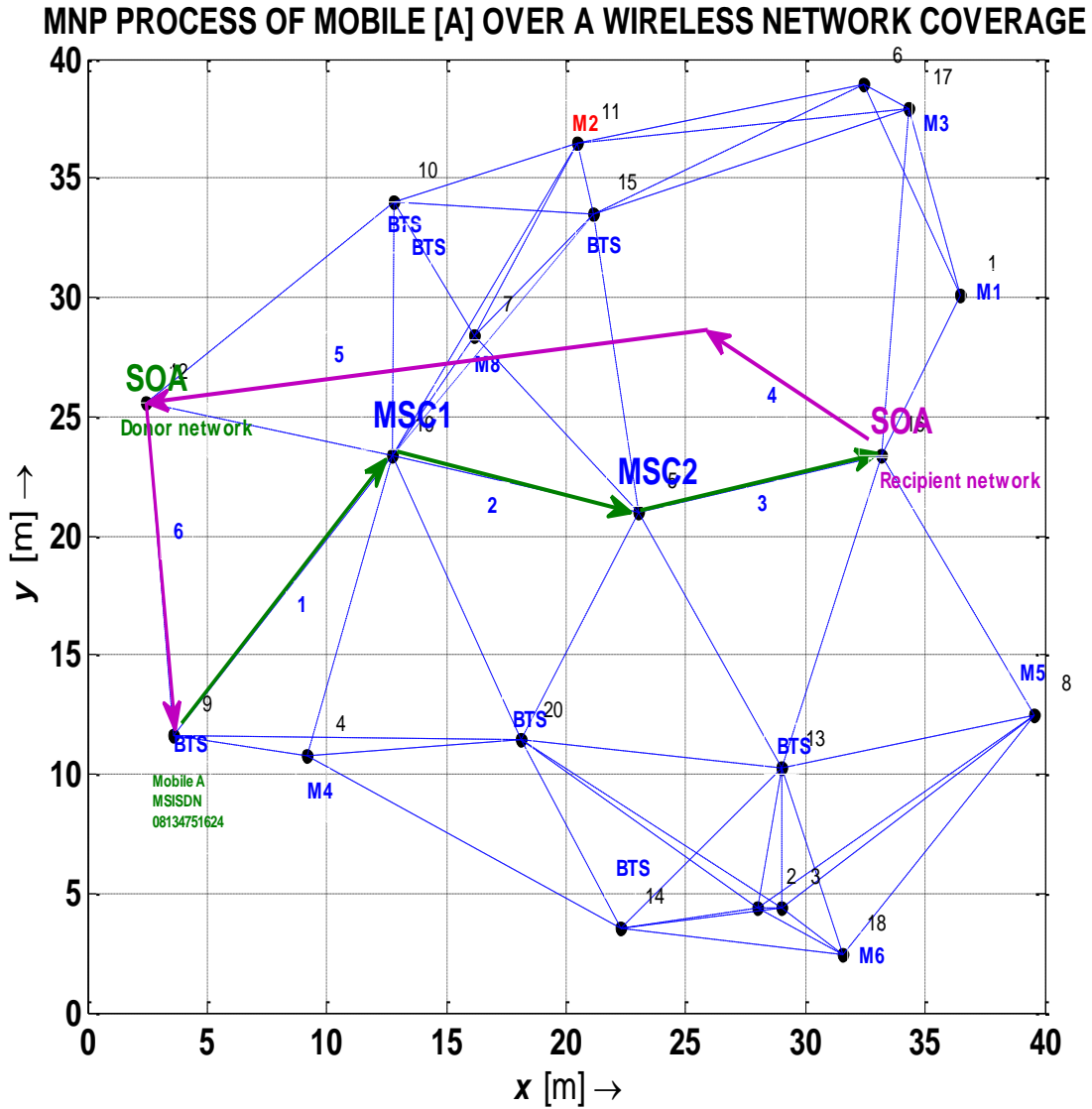


Figure 2: The MNP process of mobile [A] over a wireless network coverage. Mobile Switching Center (MSC), Base Transceiver Station (BTS), Service Oriented Architecture (SOA), Mobile (M)

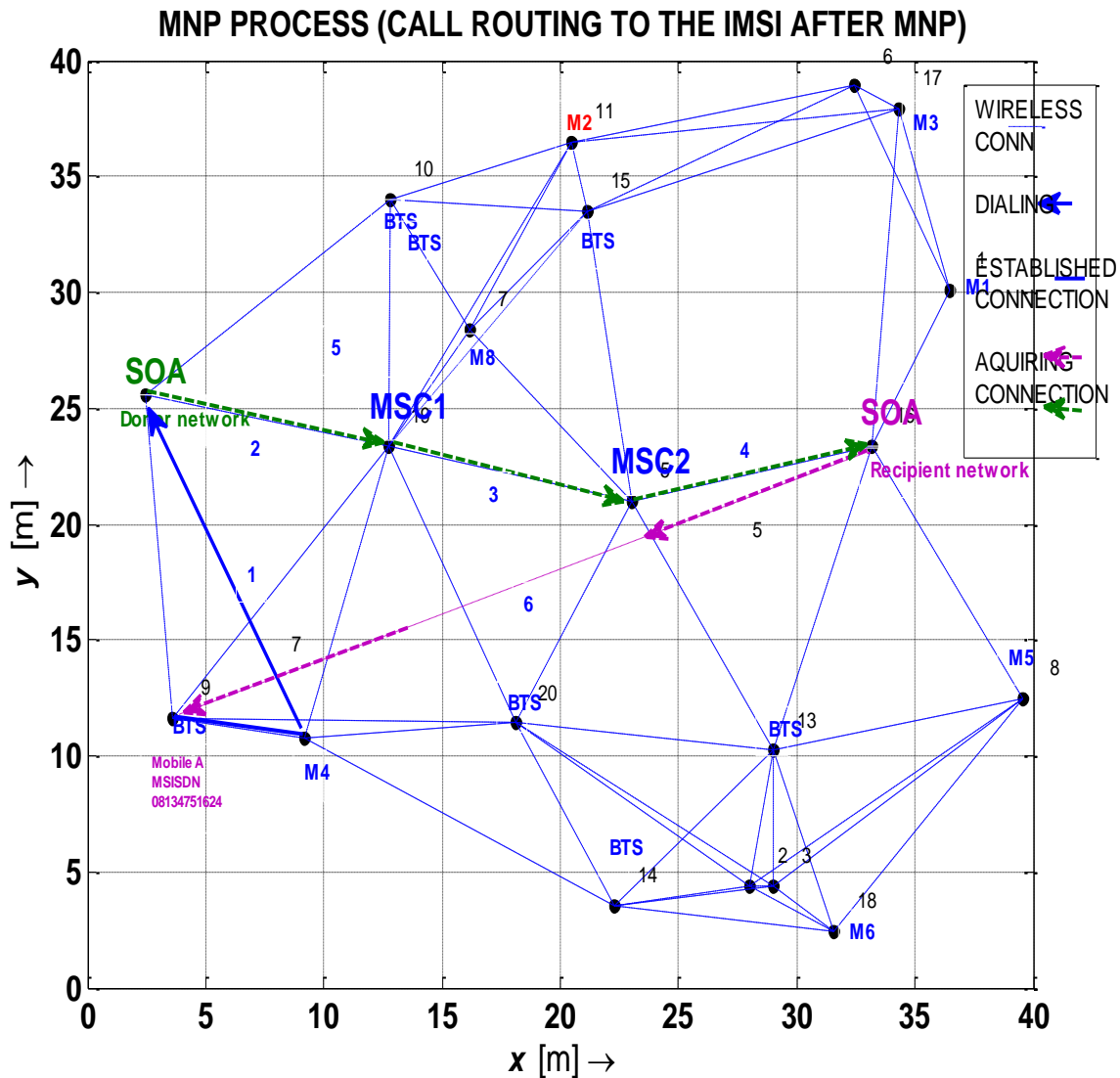


Figure 3: The result after porting of mobile user A

5.0 Conclusion

One of the groundbreaking developments in Nigerian telecommunications services is mobile number portability. However, it is clear that the porting game in Nigeria right now has not picked up enough steam to become a major competitive storm. This is mostly due to the fact that the majority of users have stayed cautious and have chosen to stick with their current service providers rather than venture into unfamiliar territory. In this research, an improved call routing framework for MNP in Nigeria was implemented. A MNP call routing framework was developed in this research to solve the setbacks of poor quality of service common in our

networks due to incompetent techniques of routing calls to called numbers and the result is as shown in the sample output of this work. This has opened other research questions or perspectives in academic environments and other research fields.

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List of Symbols and Abbreviations

| | |
|--------|---|
| RN | Routing Number |
| NPDB | Number Portability Database |
| IMSI | International Mobile Subscriber Identity |
| VLR | Visitor Location Register |
| HLR | Home Location Register |
| MSISDN | Mobile Station International Subscriber Directory Numbers |
| MSC | Mobile Switching Center |
| SIM | Subscriber Identity Module |
| RN | Routing Number |
| NP | Number Portability |