Performance Impacts Due to Number Portability under Various Routing Schemes

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***Abstract*—Number portability provides users the capability to keep their telephone numbers as they moves to another provider. Number portability technology involves complicated architecture between different providers. From a routing perspective, and in order to simplify the model, we consider that the traversal of a call to a ported number may involve three different networks: the Originating Network, the Donor Network, and the Recipient Network. In this work, we consider four routing schemes, Onward Routing (OR), Query on Release (QoR), Call Dropback/Return to Pivot (CD/RtP), and All Call Query (ACQ) for number portability. We present preliminary results on their performances under various scenarios from a connection setup delay point of view when the rate of portability changes.**

I. Introduction

Number portability means the ability that subscribers keep their telephone numbers while transferring to another service provider. In order to setup a call to support number portability, three different network providers may be involved. The Originating Network (ON)[3], the Donor Network (DN)[3] and the Recipient Network (RN)[3]. A number that moves from DN to RN is known as the ported number. For a call to a ported number, there are four basic routing schemes[4] possible: Onward Routing (OR), Query on Release (QoR), Call Dropback/Return to Pivot (CD/RtP), and All Call Query (ACQ).

There has been little study on the performance of the four schemes as far as impact is concerned when the number of ported numbers is significant. In particular, we are interested in the connection setup delay (also known as the post-dial delay) performance as setup messages pass through these three networks. We have built a simulation model that takes into account various entities in these three networks for each scheme. In our work, we consider the following: (1) Understanding how message traffic is routed in the signalling network and how the signalling network is involved in these four schemes, (2) Identifying proper parameters to pick that would impact the routing performance, (3) Designing a series of simulation scenarios to compare the performance between four routing schemes.

II. Number Portability Routing Schemes: Overview

Four basic routing schemes have been developed and deployed to ensure effectively delivering calls to ported numbers based on different cases. Five basic components[4] are included in this discussion: the Donor Network, the Originating Network, the Recipient Network and two forms of Number Portability Databases (internal NPDB and centralized NPDB).

Various discussions about the four number portability routing schemes can be found in [3], [2], [4], [5]. As shown in Fig. 1, the *Onward Routing (OR)* scheme requires to set up two call segments that are from the ON to the DN and from the DN to the RN; an internal NPDB is used for the DN to query ported number routing information. The *Query on Release (QoR)* scheme does not require this, and the DN will release the circuit after it sends the call back to the ON; the ON will then check the centralized NPDB to find out the destination network of the called ported number. The *Call Dropback (CD/RtP)* scheme is sort of a combination of the OR and the QoR: the DN does not need to hold the circuit from the ON all the time, and an internal NPDB is used. The incoming calls to the *All Call Query scheme (ACQ)* does not go to the DN but all queries go to the centralized NPDB first, then the calls to the ported number will be forwarded to the RN from the ON.

Currently, most comparisons of the four routing schemes are at a high level of qualitative assessment such as facility cost. However, the performance impact is an important consideration from a routing point of view. Therefore, in our work, we take packet delay as the main factor, and the queueing delay is the dominant impact. The inter-arrival rate of calls and processing rates at the facilities will directly affect the queueing delay, and the ratio of choosing number portability is another important factor to impact the performance of each scheme. Thus, we developed a simulation model for each routing scheme and simulated the traffic flow under multiple situations, in order to determine the most stable and efficient routing scheme.

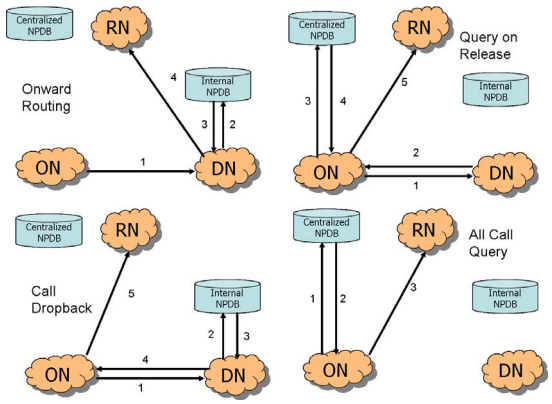

Fig. 1. Number Portability Routing Schemes

978-0-9836283-0-9

This paper was peer reviewed by subject matter experts for publication in the Proceedings of ITC 2011

III. Modeling

From the routing scheme diagrams[4], we observe that the traffic flow within each scheme involves various facilities and links, which we can model as a queueing network. In our simulation, we assume the call arrival to be a Poisson process and the service time at each facility to be exponentially distributed. Our goal is to find out the performance impact on the call set-up delay due to number portability under different routing schemes, which requires estimation of time in a system. The entire model is built in the CSIM simulation environment.

IV. Simulation and Results

Our performance study on post-dial call setup delay was conducted by considering the impact due to the percentage of numbers ported. We varied this rate from 5% to 95%. While in a realistic environment, it is unlikely that this rate would go beyond 25% to 30%, we were interested in understanding the pattern of behavior if the portability rate became very high. For each situation, we ran the simulation model with five different seeds, and in the graphs, we plotted the 95% confidence interval based on the Student-t distribution. As it may be noted, in some cases, the width of the interval was small while for others it was large; this was dictated by the actual number of samples that affected a particular situation when the total calls generated was fixed. In our study, we considered two scenarios:

- *Scenario I: Adjusting Service Rate*: In this case, the arrival rate is kept fixed, while the service rate in each network and the NPDB transaction rate varied. Within this scenario, there are two sub-scenarios: one where the service rate is fixed while the NPDB transaction rate was fixed while in the other, the NPDB transaction rate is fixed while the service rate in one specific network varied.
- *Scenario II: Adjusting the Inter-arrival Rate*: If all service rates are kept fixed, including both NPDBs and network providers, then the inter-arrival rate of incoming calls is the factor to consider in regard to post-dial delay.

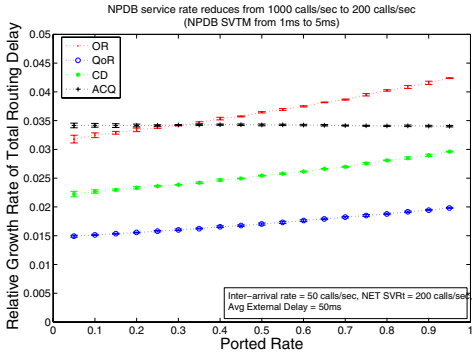

Fig. 2. Scenario I – Relative Growth Rate of Total Routing Delay

Due to the limited page, we show one figure result for each scenario as shown in Fig. 2 and Fig. 3. The results show that:

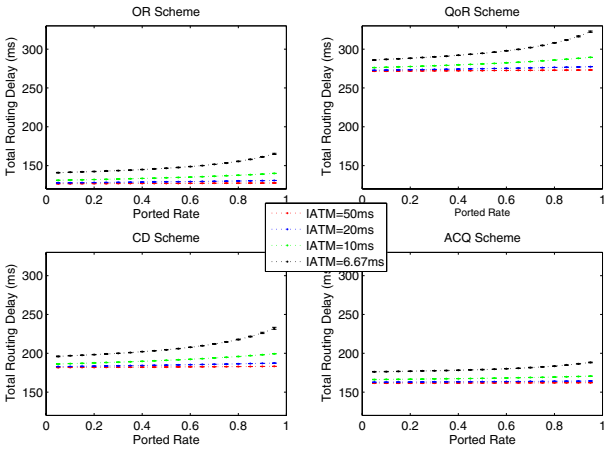

Fig. 3. Scenario II: Delay Pattern when Reducing Inter-arrival Rate of Incoming Calls

- From the total routing delay's perspective, the OR scheme shows better performance, particularly when the ported rate is low.
- The ACQ scheme shows more stable performance to the ported rate, and its performance is not greatly affected by the system load.
- When the ported rate is low, the QoR scheme is less relatively affected by its components' service rate.

In addition, we are conducting further studies on the total routing delay of four schemes and their relative growth by varying the service rate at a particular network provider (Originating Network, Donor Network or Recipient Network), respectively.

V. Summary and Future Work

Our current work focuses on a simulation study using simple models for the four number portability routing schemes. We found that the ACQ scheme shows more stable performance under a high ported-rate situation as well as the heavy loaded traffic. However, if the ported rate is low, the OR scheme shows better performance from a routing set up delay point of view. Our preliminary results do not consider background traffic. Furthermore, we wish to consider non-Poissonian arrival traffic and service time distributions to understand how the impact could differ.

References

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