Funding Models for AIN-Based Local Number Portability

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Abstract

Local Number Portability (LNP) is a *de facto* requirement in most countries that are encouraging a competitive infrastructure. This requirement, written into Sections 251 and 271 of the Telecommunications Act of 1996 in the US, has been studied by various agencies in the UK since the early to mid 1990s, and was part of the telecommunications reform legislation in Australia. In addition, the EU is proposing that LNP be required for major population centers by 2003. The technical solutions to implementing this vary by country, although all agree that the best long term approach uses the Advanced Intelligent Network (AIN) capabilities of the PSTN.

What has been emerging in the last six months has been cost recovery strategies, as upgrading the telephone network to support AIN is costly. We will examine the implementation strategies and cost recovery approaches in each of the countries and raise issues for the US as the rollout of LNP continues.

1   Introduction

Local number portability is a means for a customer to retain their telephone number when changing their location, service provider, or service. In today's telephone environment, the customer must obtain a new number for any of the following conditions; moving to a new location outside of the present switching area, choosing a new service provider (such as a competitive LEC), or choosing a new service, such as integrated digital services network (ISDN). A true LNP solution would provide for portability for all of these situations, and for integration into future architectures.

The introduction of LNP is intended to remove a barrier to entry for competitive local exchange carriers (CLECs) and thus promote competition in the local exchange. To ensure this competition,

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the competitive environment that LNP could produce must be assessed and the implementation must be designed to ensure that certain players are not given strategic advantage. This would include cost and structural concerns that could create barriers to entry for CLECs.

Regulators, inter-exchange carriers (IXCs), competitive access providers (CAPs), CLECs, and LECs have all taken the position that LNP is an necessary step to competitive local exchange service. There have been a number of surveys (see [5]) that show many subscribers (particularly business) are unwilling to change providers if this requires changing telephone numbers. A Gallup survey showed that 90% of business customers were unwilling to change their provider if it required a change in their phone number. These customers state that the impact in terms of cost of upgrading to the new number and the potential loss of customers would make this change prohibitive. These results are not reproduced universally, as reported by Cluny [4]: an OFTEL survey of British Telecom residential customers indicates that only 36% of the respondents indicated unwillingness to change numbers as a reason, and only 9% gave this as the most important reason for not switching from BT, although an OFTEL survey found that businesses were more deterred from switching than residential customers. Considering the surveys, the lack of portability is a potential barrier to competition. A barrier to competition can be thought of as a condition that imposes costs on an entrant that the incumbent do (or did) not have to bear [2]; number portability meets this definition in most commonly accepted interpretations.

2 Background

2.1 Telephone Numbering

At the heart of number assignments in any country is the numbering plan[1]. In the North America, this plan is called the North American Numbering Plan (NANP), which is a geographically-based plan that does not allow for portable number assignments. The NANP provides for the assignment of a geographic telephone number to describe a network address. This address defines a network location through which a call is routed and a customer is provided service[2]. The nature of this assignment is inherently non-portable.

The structure of the ten digit number is geographically and service provider limited. That is, the NPA is defined to a geographic area and the NXX is defined to a central office (a provider). A customer choosing to change providers will also be required to change their NXX. The NANP numbers are an integral aspect of routing and rating of a call as the present numbering system is defined. NPA codes are assigned to geographic regions and allow for routing and rating (assigning a charge) based on the known connection between geographic area and NPA. The NXX codes are assigned to LEC central offices (more specifically to a switch), as well as to the other providers (such as CAPs). This assignment allows the network to route calls to the correct switch on the basis of the NXX dialed.

The geographic specificity of the number also allows for proper rating of the call. The distance sensitive aspect of rating depends on evaluating this structure of the number. It should be noted that the proliferation of flat rate, distance insensitive calling plans in the US suggest that this may be becoming less of a critical issue for carriers.

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[1]The European Commission has been involved with numbering plans for the last several years, and Australia has recently released its new numbering plan. See, for instance http://www.eto.dk/numbering/reports.htm for Europe and http://www.austel.gov.au/number/index.htm.

[2]The NANP uses the format NPA-NXX-XXXX (N represents a digit from 1 to 9, X represents a digit from 0 to 9) to define a phone number in which the NPA defines a geographic area (often referred to as the area code), the NXX defines a central office in that area, and the XXXX defines the line number within that office.

Conceptually, then, number portability must transform a user's network address from a geographic, service provider specific to one that does not have those characteristics. In essence, this is what the technical approaches outlined below provide. This problem was first addressed in connection with the service provider portability of toll free "800" numbers in the US, so there is a strong temptation to study this experience for lessons that might apply to LNP.

2.2 "800" Number Portability

A number of papers have examined the economic and competitive impact of 800 portability [10, 14]. There is a general technical and regulatory similarity between 800 portability and LNP, and the 800 analogy indicates a number of policy and pricing dilemmas likely to arise during initial and later phases of LNP implementation.

Several of the guidelines suggested for LNP were first suggested for 800 portability. These are:

Equal Competition Opening 800 service was to provide competition in a long held monopoly, the inability to port 800 numbers represented a significant competitive disadvantage to the new entrants. The solution had to ensure an equal ability to compete. [3]

Customer Flexibility This guideline required a solution that would allow the customer the ability to freely move between providers. This ensured that competition would continue in the market and that switching to a new player would not represented a terminal move.

Customer Transparency This guideline represented a large number of issues including; connection delays, connection quality, and general functionality of the service. This turned out to be a technically difficult problem that controlled the implementation designs.

Minimize Infrastructure Changes This was a logical guideline that minimized cost, time, and effort.

Much of the same rhetoric used during the development of 800 portability is heard today with regard to LNP. Concerns regarding competition and equal access have been raised on one side, as well as rumors projecting the deterioration of service quality on the other. Much of this might well have been a result of those involved with the technical and policy aspects of implementing 800 portability service. 800 portability database proposals were made by the LECs, in much the same way that IXCs have proposed many of the LNP solutions. The similarities between LNP and 800 portability allow for the provision of a reference after which predictions can be modeled. Development of the association between these models must be undertaken in a prudent manner to avoid assuming aspects of one exist in the other when, in fact, they do not translate [10, 12].

Some of the results of conversion to 800 NP are:

- Delays in call setup time associated with the architectures are a major concern in implementing LNP; this same concern was expressed during the development of 800 portability. During that time, AT&T argued that the service would result in time delays of up to 20 seconds. Much of this delay was attributable to the lack of SS7 implementation in the local exchanges. Most of these predictions were unfounded; delays tended to increase, but not to the extent predicted. This delay could result in customer dissatisfaction and possibly customer loss.

- The introduction of 800 NP resulted in the deployment of SS-7 across the network. A similar increase in AIN capabilities can be expected from the introduction of LNP. An additional analogy can be drawn to the pricing requirements of the database queries.

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- During the initial phase of 800 portability, the IXCs accused the LECs of trying to inflate their 800 database access rates by including query costs that were excluded specifically under FCC docket 86-10. The rates proposed varied from 0.15 cents to 33 cents per query; the FCC reacted by initially fixing the rate to 0.15 cents/query. [15]

But the analogy between 800 portability and LNP grows tenuous when considering a number of fundamental issues.

1. "800" calls make up a small fraction of all calls, while future LNP usage is enormous in comparison. In 1996, there were approximately 4.5 million 800 service database dips (queries) daily, with the databases that handle this traffic operating at around 500 queries/second. This represents a reasonable database requirement. By contrast, general phone traffic, consists of over 1 billion calls per day. Even if only those numbers that are ported require additional handling, this still becomes a problem of much larger proportion. With this volume and rapidity of calls, it is clear that the 800 portability model only serves as a means for gross comparison; many of the analogies may not hold due to the difference in scale.

2. "800" numbers do not share the strong geographic aspect of the NANP. The NXX portion of an 800 number previously served to identify the carrier providing service, not an inherently geographical link to a location. With 800 portability, a database query is performed on the whole number and the routing information associated with the carrier and number are provided. With LNP, the same whole number query may be required, however the scale will be much greater, based on all 10 digits. The amount of infrastructure conversion is likewise much larger. By placing the translations into the SS7 network, upgrades will be required. Database size and access speed will need to match the demands of the traffic and performance specifications.

2.3 Technical Approaches

There are several different approaches to providing LNP functionality. Many of these have been discussed at length elsewhere (see, for example, [7, 13]). We briefly summarize the generic approaches that have some relevance today.

2.3.1 Call Forwarding Variants

Approaches to LNP that do not require large, up-front capital investments and can be used to provide LNP functionality quickly are based on call forwarding[3]. In call forwarding, a call to a number that has been switched to another service provider ("ported" from a "donor" service provider to a "recipient" provider) is simply forwarded at the destination switch. This means that a customer requesting LNP service after switching providers is assigned a new number at the switch (the new physical address) and keeps the old number (now a logical address). This has a number of disadvantages:

- These customers use two numbers from the numbering plan instead of one. If LNP increases to more than a small percentage of users, this can result in pressure on the numbering plan.

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[3]To be fair, many of the non-AIN approaches are a good bit more sophisticated and efficient than regular call forwarding.

- Calls use additional network resources, because they are routed to the original destination switch, and then away from it again (called "tromboning"). This makes the per call costs of this solution high. In addition, this results in longer call setup times.

- The original service provider (the "donor") will forever be involved with the customer, including if s/he switches service providers to a different recipient service provider in the future.

2.3.2 AIN Approaches

There is general agreement throughout the industry (and among regulators) that the best long term solution for LNP is based on the use of the AIN. Fundamentally, this requires the AIN to translate the telephone number into a physical address from a logical address. Thus, when a call is placed to such a logical address, the network must discover the associated physical address; this association is stored in a database. The typical approach is to implement this in the Signalling System 7 network using Advanced Intelligent Network software and features. There are several ways in which this can be accomplished; a more detailed discussion is outside of the scope of this paper.

This database must (logically) be a single database, although it may be physically partioned and replicated. The implementation details are important to the discussion institutional design, because for the system to operate as a whole, *all* components of the database must be synchronized. Failures to synchronize will result in call failures; this can be a powerful threat to an entrant if the database is owned by an incumbent. Using AIN-based solutions, the calls are routed much more efficiently and diverse customer-specific functionality can be retained without much difficulty. The significant disadvantage of this is the initial capital cost and lack of backward capability to older switches.

In the US, a method proposed by AT&T, Location Routing Number (LRN) was selected as the method of performing the database translation. [4] Further it was decided that the N-1 carrier would perform the database dip. Generally, this would be the originating carrier in a local call and the IXC in a long distance call. This approach requires any called number associated with a ported switch to be dipped, regardless of the number of actual ported numbers. The costs associated with this approach would represent a step function, unlike methods such as Query on Release (QoR). The UK has decided to implement LNP based on QoR. In this method, only numbers that have ported require a dip. This dip occurs after the original terminating switch, upon identifying that it no longer serves this number, releases the call setup back to a previous switch. This switch will then perform the dip and continue the call setup phase. The FCC views this approach undesirable because of the additional delay that is assymetrically incurred by ported numbers. Also, there exists a possible concern regarding the incentive of the original terminating carrier to cooperate in the process.

It is possible that carriers might elect a method that avoids unnecessary dipping, while not using QoR. We will refer to this approach as Query and Release (QaR). In this method, the carrier would allow the call to follow the default route to the original terminating switch. Here, the switch would determine that the number has ported and perform the dip. The switch would then pass this information along to complete the call. This approach avoids the need to query calls to non-ported numbers. The major drawbacks of this approach are that a slight additional delay may be experienced by ported numbers and that the calls to ported numbers are always dependent on the

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[4]The technical details of this implementation are outside the scope of this paper.

donor (usually incumbent) network[5]. Implementation of QaR could result in different cost recovery requirements than are discussed below.

2.3.3 Brief Technical Primer on AIN

Intelligence has been provided to the telephone network with the introduction of improved signaling systems and intelligent network architectures. This came in the form of common channel signaling (Signaling System 7) with Service Switching Points (SSPs), Signal Transfer Points (STPs) and Service Control Points (SCPs), the latter of which supports databases. SS-7 allows for the separation of the signaling from the voice channel, providing for a much more efficient use of the network and an ability to provide enhanced services.

The SSPs are integrated into or associated with stored-program control switches that are able to interface with the SS-7 signaling network. These devices contain limited service logic required to alter the handling of the call. The SSP differs from the ordinary switch in that it allows for the special handling conditions that IN services might require. More importantly, the SSP response can be controlled by a Service Control Point (SCP), not only by the local switch.

This routing to the SCP is facilitated by the SS-7 network, a connection generally routed through Signal Transfer Points (STPs). STPs are highly reliable, high speed packet switches that transport signaling messages between the network nodes. This is done through the use of large routing tables that provide routing to the proper SCP.

In order to manage the AIN platform, Service Management Systems (SMSs) contain the reference database for the SCPs. The SMS can supervise, perform remote maintenance, evaluate performance, and download software to the SCPs. This happens in a non-realtime environment, usually every few minutes or more. Service creation platforms interface with the SMS to allow network operators and customers to communicate with the SMS.

These components may be owned or outsourced by telephone companies, depending on their size and technical capabilities. In general, larger telephone companies may own their own SCPs, STPs, and SMSs, where smaller telephone companies may own only the SSPs and lease access to the STPs of another company. Similarly, services (such as database queries) might also be acquired from the SCPs and SMSs of other service providers.

3 Provision of LNP

Whatever the technical AIN approach, LNP is generally provided in the following way:

1. the SMS copies the relevant portions of the LNP database from a Local Number Portability Administrator (LNPA) on a regular (non-real-time) basis.

2. The SMS distributes this to the relevant SCPs.

3. When a query for a ported number arrives at an SCP, the routing instructions are returned to the querying SSP, and the call can be completed.

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[5]This could result in an untenable situation if the competition becomes particularly vicious and if the porting is substantially unilateral. Even if the donor network is cooperating in good faith, it will be difficult for the firm to credibly defend itself against charges of anticompetitive behavior, particularly in a public relations campaign where the standards of proof are often weak.

The query can either be to an "in house" SCP, or to one owned by another firm but that provides services under contract. In general, there appears to be competition in the US for the provision of SMS/SCP services, so economically efficient pricing can be expected.

The LNPA is one or more firms that maintain the "master" database for the country's (or region's) SMS systems. Provided cooperation and interconnection exists between LNPAs there is no technical reason why competitive provision of LNPA services is not possible. This element is particularly critical to the telecommunications infrastructure, so it is imperative that ownership and access be clarified and supervised. An opportunistic LNPA could hold the entire telecommunications infrastructure hostage, especially if the firm is a single provider.

3.1 Cost of AIN-Based LNP

In [1] and [11], the regulators in Australia and the UK (respectively) have broken the overall cost of LNP into these categories:

- One time capital costs

- Per call costs

- Administrative costs associated with transferring customers

These reports assert that, in the long run, the total costs will be lower using AIN approaches than call forwarding approaches, as the per call costs are much lower for AIN; this conclusion has also been drawn by Dunkely *et.al.* [7]. Thus, regulators in the US, UK, and Australia have all determined that LNP should by provided by an AIN-based approach in the long term. Australia and the UK will permit call-forwarding based solutions as interim measures. These countries will also allow for the QoR method so that infrastructure investments can be more incremental.

As we mentioned above, this approach requires the development of a large, logically unified, perhaps physically partitioned and replicated, real time database (as we discussed above), as well as upgrading all switches in the system to be AIN capable. These costs are not trivial. Studies have placed the cost of LNP to be between US\$5.50 [7] to US\$50 per line [13][6].

Since LNP is, generally speaking, a network feature required by regulators and not a feature that would voluntarily be offered by carriers, government agencies must be clear on approaches to funding these capital costs. In addition, it is important to be clear about preferred approaches to funding the ongoing operational costs of LNP. This is precisely what regulatory agencies have done in the last twelve months, albeit with different underlying assumptions

4 LNP Cost Allocation and Remuneration Issues

In this section, we examine the cost issues associated with LNP in the US, the UK, and Australia. Each of these countries have different market characteristics and the different histories, and the resulting LNP solutions reflect these differences.

4.1 LNP Policy in the US

Local Number Portability in the US was required by the Telecommunications Act of 1996 (section 251). The FCC approached this incrementally, with considerable support from the North American Numbering Council (NANC).

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[6]We have not yet fully analyzed the cause of this large difference in cost. The difference could be due to scale and scope, differing methods, or to the particular AIN implementation technology.

- On June 27, 1996, the FCC adopted the First Report and Order[7] regarding its implementation. In this R&O, the Commission did not select a particular technology, rather they required carriers to implement a solution that would satisfy certain performance criteria. The Commission adopted a phased implementation schedule for LNP in the top 100 Metropolitan Statistical Areas (MSA). Further, the Commission required LNP deployment in smaller MSAs within six months of a request by a carrier intending to serve that area.

- On March 11 1997, the FCC released the First Memorandum Opinion and Order on Reconsideration, regarding three issues: QoR, deadline extensions, and implementation schedules. Most relevant to this paper was the conclusion that QoR would not be acceptable as a long term solution.

- On August 18, 1997, the Commission adopted the Second Released and Order[8], regarding the selection and duties of the Local Number Portability Administrator (LNPA), as well as the location and technical specifications of the regional databases. Part of this Order was the acceptance of the N-1 querying protocol (discussed elsewhere). This R&O also ratified the organizational approach for LNP that was proposed by the NANC.

- On May 5, 1998, the Commission released the Third Report and Order[9], in which they adopted rules concerning the categorization of the capital costs and the database costs, and methods of allocating these costs. This paper will discuss issues focusing mostly on this last order. Unlike their counterparts in Australia and the UK, the Third Report and Order focuses only on system setup and operating costs and not on other costs, such as query costs and customer transfer costs.

We would like to digress for a moment to discuss the organizational backround for the LNP system. The NANC recommended that LNP be provided on a regional basis, with the regions being strictly[10] defined by the original seven Regional Bell Operating Company (RBOC) regions (without regard to mergers since divestiture). In each of these areas, a Limited Liability Corporation (LLC) was formed, whose membership iss open to any carrier[11]. The function of the LLC for a region was to select an impartial LNP Administrator (LNPA) for their region, to negotiate a contract with an NLPA, and to manage the LNPA. Originally, the two candidate firms were Lockheed-Martin IMS and Perot Systems. Since the Second R&O, Perot Systems is no longer a choice for the LLCs. The LNPA for a region maintains and operates the master database for the region under contract to the respective LLC. Terms and conditions for downloading databases to a carrier's SMS(s) were not available.

In the Third R&O (par. 61), the FCC identified three categories of cost:

Costs incurred by the industry as a whole These are shared costs that include the development, implementation, and operation of the database. The Third R&O (par. 105) that shared costs should be recovered based on an allocator based on end user revenues. The LNPA allocates its costs to *all* carriers in its region based on "each carrier's intrastate, interstate, and international end-user telecommunications revenues attributable to that region[12]."

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[7]Docket 95-116, 11 FCC Record 8352.

[8]CC Docket 95-116, FCC 97-289

[9]CC Docket 95-116, FCC 98-82

[10]A request by Cincinnati Bell, whose territory covers two of these regions, to be served by a single LNPA, was denied.

[11]The cost of membership was not apparent from the public documentation.

[12]It will be interesting to observe how Internet Service Providers will be treated in this regard.

Carrier-specific costs directly related to number portability This would include purchasing new switch generics to implement LNP and any dedicated SCPs and SMSs. In the Third R&O (par. 135), the FCC stated "[w]e will allow but not require incumbent LECs subject to rate of return or price cap regulation to recover [these costs] ... through a federal charge assessed on end users." Other carriers could recover these costs by any lawful means.

Carrier-specific costs not directly related to number portability These would include the costs of upgrading the SS7 network to handle the load of LNP; based on our earlier work [13], we expect this to be minimal, and part of general network development. The FCC (par. 8) concluded that these are not costs of number portability, so that they do not address these costs.

4.2   LNP Pricing Policy in the UK

LNP has been studied by OFTEL and the Monopolies and Mergers Commission (MMC) since 1993. In 1997, OFTEL modified the operating licenses of all carriers to require them to provide LNP, with an AIN-based solution as the long term approach [4, 11]. In their 1995 report, the MMC proposed the following (which were inserted into BT's operating license in July 1996):

- BT should bear the system setup costs

- BT should be permitted to pass on the per-line setup costs

- After October 1997, BT should bear the additional costs associated with a ported number (due largely to the inefficiencies of call forwarding based approaches)

To ensure reciprocity, OFTEL modified the licenses of all providers to ensure nationwide LNP. OFTEL based their cost allocation decisions on the following principles:

Cost Causation Actions causing costs should face prices that reflect those costs;

Cost Minimization Those who can affect costs should face incentives to minimize them;

Distribution of Benefits Benefits of LNP should be distributed to LNP users as well as all telecommunications users;

Effective Competition Portability will strengthen competition, which will benefit the industry;

Reciprocity and Symmetry Arrangements between operators must be reciprocal and symmetrical to promote effective competition;

Practicability The cost allocation scheme must be practical and relatively easy to implement.

OFTEL developed the following principle regarding costs and charges with respect to LNP:

"(a) charges shall be based on fully allocated costs of providing Portability or incremental costs (if that is what BT's costs are based on) unless the Donor and the Recipient operators shall have agreed [on] another cost basis ... ;
"(b) The Donor Operator shall make no charge in relation to its system setup costs;
"(c) Subject to (b) above, the Recipient operator shall pay charges based on the reasonable costs incurred by the Donor Operator in providing Portability with respect to each Number which, subject to (d) below may be paid by way of a specific charge relating to specified elements of the provision of the facility;

"(d) The Donor Operator shall make no specific charge based on Additional Conveyance Costs;

Even though OFTEL does not specify the nature of the database ownership, this approach seems to place the substantial capital cost burden on BT (the incumbent).

4.3 LNP Pricing Policy in Australia

The UK has an LNP enviroment that is similar to that in Australia in that both countries have a single dominant provider. Some major differences are that competition has been permitted for over 10 years, and there have been many forms of entry in the market for local telecommunications (*eg.* cable-based telephony).

The Australian local access market is dominated by Telstra, which has 99% of the connections, according to the ACCC report. Responsibility for LNP is split between the Australian Communications Authority (ACA), which is responsible for the technical aspects of LNP, and the ACCC, which is responsible for its economic aspects. It has been observed elsewhere [8], that the ACCC has taken a very "hands off" posture to the telecommunications markets in Australia, having a strong bias toward negotiated settlements of disputes (with no settlement deadline to initiate arbitration). Thus, the ACCC document is best read as a signal to the potential litigants that exposes the ACCC's likely rationale and likely position in a potential arbitration case. Other countries, including New Zealand, take even a more hands-off approach to regulation, allowing the threat of litigation to replace regulation.

The ACCC considered two cost recovery strategies in their report, which were:

1. Each carrier is responsible for its own costs; and

2. The "donor" carrier recovers costs from the "recipient" carrier[13].

These two were evaluated in terms of the economic incentives to the carriers and their ability to make appropriate economic signals to their customers. In this context, the ACCC concluded the following:

- "each CSP should be responsible for the system set-up and maintenance costs and any additional call conveyance costs incurred in their own network to meet their obligations under the Numbering Plan to provide limited and full local number portability; and

- "a recipient CSP should make a payment to the donor CSP based on the administrative costs incurred by the donor CSP when a customer ports their telephone number to the recipient CSP (customer transfer costs).

5 Discussion

The markets in the UK and Australia are both characterized (in part) by a single large carrier that provides local service to most of the respective country's telecommunications users. Perhaps by implication, then, the database would be owned by the dominant carrier with the queries charged on a call-by-call basis. Regulatory direction in these countries further support this arrangement, in that both the ACCC and OFTEL specify per-query and per-porting charges.

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[13]The donor carrier is the carrier *from* whom the number was ported, while the recipient is the carrier *to* whom the number was ported.

Local service provision in the US is better characterized by a (disjoint) set of dominant carriers that provide service to the majority of users in their region. These carriers could be competitors, although this out-of-region competition has not materialized in a significant way.

Regulatory cultures in these countries are all quite different, as summarized by Cowie and Mardsen [6, p. 19]. Australia, they point out, "replaced industry specific regulation with general competition law". While this puts all government oversight on a consistent basis, it tends to dilute industry specific expertise and can consequently result in a lack of action because of uncertainty. Cowie and Mardsen report that the Australian Telecommunications Users Group has been sharply critical of ACCC for this reason. In contrast to Australia, the UK has sector specific regulation that is bound by competition law (in the form of the Monopolies and Mergers Commission and the Office of Fair Trade). This system of dual regulation leads to some inefficiences and confusion, especially when the objectives of the agencies are at variance with each other. In the US, the involvement with competition law (via the Department of Justice) is sometimes *ad hoc*.

These postures are very evident in LNP regulation. OFTEL is very specific about the charges and regulations for LNP, and has taken a very clear posture promoting it. Indeed, the UK most likely has the greatest operational experience with LNP [4].

It is interesting to note that OFTEL seems to have placed an entry barrier on entrants by requiring the recipient carrier to pay one-time administrative costs of porting. Since it is likely that incumbents will more often be (entrant) recipient carriers, there would probably be a net revenue flow to the donor (BT), who already have numbers to begin with, and do not have to incur customer porting costs to win customers. It would seem that a more general policy on the costs of acquiring numbers would be appropriate in the near term.

These charges would seem to deter the use of LNP, as a rational entrant would seek to avoid these costs and would therefore be expected to seek out customers who are indifferent to losing their telephone number. Ideally, this would serve to deter porting of customers who do not value their telephone number sufficiently highly and restrict porting to those who value their number sufficiently highly.

The ACCC report mirrors much of the conclusions drawn in the UK. In fact, the conclusions we draw above apply also to Australia. We would like to make a few additional observations about the Australian approach (in light of [6]. The ACCC does not explicitly address the issue of common costs and ownership issues (*eg.* the database). ACCC conclusions are more a form of public analysis that reveal a current set of preferences; the emphasis remains on privately negotiated agreements. These conclusions are a form of implicit regulation because, although they do not prevent parties from concluding other agreements, they reveal the likely outcome of the end game.

The experience in the US stands in substantial contrast to the experience of these two countries. Due to the scale of the problem and the differences in structure, a similar approach does not apply. The US is clearly much more focussed on the structure and costs of the common infrastructure, which is an expected outcome of a multi-provider infrastructure, even if these firms are substantially monopolists [16].

Several issues arise out of the examination of LNP in the US:

1. The FCC has substantially "rubber stamped" the recommendations of the North American Numbering Committee. While encouraging industry to design preferred implementations of policies is appropriate, it strikes these researchers that the form of the recommendations follow the traditional form of the industry, which is centralization and focus on one market segment[14]. For example, there is no discussion in the official record of integrating the system

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[14]This is consistent with Horwitz's model of regulation [9].

with IP addresses, which may be a significant factor if Internet Telephony grows.

2. The LLC based structure was generally well conceived and implemented. Clearly, this structure can be manipulated via membership requirements and obligations (*eg.*, dues).

3. While the original plan required two numbering plan administrators, or LNPAs, (Lockheed Martin IMS and Perot Systems), only Lockheed Martin remains as an administrator. But even before this, there was no apparent attempt at creating competing LNPAs; instead, they were assigned to different regions, much in the way the local telephone market was divided into separate monopolies. Further, it is not clear who actually owns the master LNP database, this should be a resource available to competition.

4. By allowing LNPAs to recover costs from regional carriers, the FCC has created an environment in which the LNPA has no incentive to reduce costs, especially since there is no alternative candidate to provide LNPA service besides Lockheed Martin (LM). Further, LM is interested in providing the administrative function for number pooling through the same mechanism that is implemented for LNP. Will this result in a "gold plated" database[15]?

5. The technological approach that was chosen by NANC/FCC, the Local Routing Number (LRN) has two notable flaws. In the LRN method, if one number from an exchange is ported to another provider, *all* calls to that exchange require a database query. The first flaw with this approach is that the cost of LNP accelerates much more rapidly than with line-based approaches, such as Query on Release (in which only ported numbers require a query). Secondly, a rational strategy for a CLEC would be to increase the costs of their competitor, the ILEC, by requesting that a few numbers in many exchanges be ported. The ILEC would then be obligated to port the *entire* exchange.

6   Conclusions

Regulatory insight can be gained by studying the implementation and funding approach taken by each country. Although comparing the various funding models proves difficult, this exercise provides insight into different regulatory regimes in operation. Direct application of these frameworks from one contry to another is not feasible, as there are significant differences in the industry structures. Additionally, architectural differences further weaken comparisons.

One of the benefits of being an external observer in the process is the luxury of evaluating outcomes without having a stake in one development or another. From that vantage point, we conclude the following:

- An incremental method of initial LNP might have resulted in a more rapid introduction of competition, disregarding other difficulties such as local loop unbundling and other network elements. We presume that the US ILECs support of long-term LRN methods might well have had the intention of delaying competition. The UK, in permitting (and promoting) low cost interim approaches and the more gradual QoR long term approach, has successfully promoted local exchange competition.

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[15]It is arguable that a single provider creates economies of scope and scale, and that contract renewal should keep LM in check. We are not pursuaded by these arguments, as it is not clear that a viable alternative provider will emerge.

- The presumption of a single regional LNPA by the FCC (and NANC) and the cost-based method of remuneration has set up a situation that will require perpetual regulatory oversight. An alternative would be to presume (and encourage) multiple regional providers and to focus institutional structuring or rulemaking on their cooperation.

- That a single firm remains as the sole candidate for LNPA services is a troubling development, as it places a considerable degree of power over the telecommunications network in the hands of one firm.

- The LRN approach, while it does not assymetrically delay call setup, has some serious flaws, not the least of which is the potential for a competitor to assymetrically transfer costs onto the incumbent.

- By having competition in query provision (for carriers that do not build their own SMSs and SCPs), the FCC avoids price regulation for queries.

- The FCC has not specifically addressed the question of per-line costs of porting, unlike the ACCC and OFTEL. It may not be necessary, given the organizational structure in the US and the independent LNPA. In Australia and the UK, presumably Telstra and BT (respectively) will be the LNPA, although that was not explicitly stated in the documents. This would cause the questions of query and line transfer charges to be addressed in those countries and not in the US.

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