

## IP-based NGNs and interconnection. The Debate in Europe

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**Abstract:** Historically, interconnection in the world of the Internet has been approached significantly differently from interconnection in the fixed Public Switched Telephone Network (PSTN) and the mobile Public Land Mobile Network (PLMN). As fixed and mobile networks evolve to Next Generation Networks (NGNs) based on the Internet Protocol (IP), it becomes increasingly necessary to merge these perspectives in order to achieve a unified and integrated approach to network interconnection. There is a rich history of economic analysis of IP-based and of conventional switched networks that began to converge early in this decade. In 2008, this issue is coming to a boil, as regulators seek to provide regulatory certainty for the build-out of NGNs, even in the face of substantial uncertainties, and even though practical experience with NGNs is still in a very preliminary state. What can we learn from the historical evolution of the theory of interconnection for Internet, NGN, PSTN and PLMN? What issues are "in play" today? What is the appropriate destination in the long term? What nearer term measures are appropriate?

**Key words:** interconnection, NGN, Internet Protocol (IP), bill and keep, Calling Party's Network Pays (CPNP), peering, transit.

Historically, interconnection in the world of the Internet has been approached significantly differently from interconnection in the fixed Public Switched Telephone Network (PSTN) and the mobile Public Land Mobile Network (PLMN). As fixed and mobile networks evolve to Next Generation Networks (NGNs) based on the Internet Protocol (IP), it becomes increasingly necessary to merge these perspectives in order to achieve a unified and integrated approach to network interconnection.

We note at the outset that our topic in this paper is *interconnection*, which enables the respective customers of two different network operators to communicate with one another. Interconnection is related to, but distinct from, network *access*, where one network operator procures services from another in order to serve its own customers.

Throughout the world, the predominant commercial arrangements for interconnection of the *Public Switched Telephone Network (PSTN)* and its

mobile counterpart are based on *Calling Party's Network Pays (CPNP)*. CPNP is a system for interconnection of voice networks. The network of the party that places a voice call (the *originating network*) makes a wholesale payment to the network of the party that receives the call (the *terminating network*).

Why is there a wholesale payment? CPNP is based on a range of assumptions, many of which were dubious in the first instance; however, the system worked well enough in the past. The assumptions that undergird CPNP wholesale arrangements are:

- The network exists to support voice services; the majority of cost associated with network operation is attributable to voice services.
- All of the costs are properly attributable to the party that places the call, none to the party that receives the call.
- Only the calling party makes a retail payment to its service provider; thus, if there were no wholesale CPNP payment, the terminating network would receive no revenue at all.
- The voice service is indistinguishable and inseparable from the underlying network.

While these assumptions may have been questionable for the PSTN in the past, they were at least good enough to be workable. The migration to IP-based NGNs going forward calls every one of these assumptions into question, to the point where the traditional CPNP system as we have known it is not sustainable going forward. Considering the assumptions in turn:

- NGNs do not exist solely to support voice – they also support data and video. The vast majority of traffic carried by most NGNs will be for data and video. Voice is a low-bandwidth application that is likely responsible for only a very small fraction of the traffic of the network (in most cases), and thus only a small fraction of the overall cost.
- For services other than traditional voice, there is no single model that is obviously or inherently appropriate for apportioning cost among the participants to an application layer interaction over an IP-based network. Even in today's network, it was never correct to attribute all cost to the party that initiates the call – if the party receiving the call did not receive value, he or she would simply hang up (JEON, LAFFONT & TIROLE, 2000; DE GRABA, 2000).
- The assumption that retail arrangements are invariably Calling Party Pays (CPP), with no retail payment by the party that receives the call, is

clearly irrelevant to other IP-based services. Even in today's network, these traditional arrangements are not the ones that most consumers would prefer; rather consumers would prefer *true* flat rate plans like those that exist in North America and in other countries that have low CPNP rates.<sup>1</sup>

- The assumption that the network and the service are indistinguishable is clearly inappropriate. IP-based NGNs are entirely capable of supporting third party independent service providers for voice, video and data. These services are likely to flourish unless network operators are permitted to suppress them through anticompetitive acts.

Regulators have known for some time that a collision was coming. IP-based interconnection has been studied by a number of National Regulatory Authorities (NRAs), including the Bundesnetzagentur or BNetzA (Germany) (BNETZA, 2006; MARCUS, 2006a; VOGELSANG, 2006), Ofcom (UK) (see for instance OFCOM, 2005), and the NHH (Hungary) (WIK, 2007). The issue has been studied by the OECD (PALTRIDGE, 2006). It has been reviewed at least twice by the International Telecommunications Union (ITU) (MARCUS, 2006b; MARCUS 2007).

In 2008, this issue is coming to a boil, as regulators seek to provide regulatory certainty for the build-out of NGNs, even in the face of substantial uncertainties, and even though practical experience with NGNs is still in a very preliminary state. The issue has come to a head as a result of two consultations by the European Regulators' Group (ERG) (ERG, 2007; ERG, 2008); a substantial report for the European Commission (WIK, 2008); and now a public consultation by the European Commission (EUROPEAN COMMISSION, 2008a).

The next section of this article reviews the rich history of economic analysis of IP-based and of conventional switched networks – a literature that began to converge early in this decade.

The subsequent sections of this paper review the major developments of 2008, including the ERG consultation, the WIK report (of which this author was a principal contributor), and the Commission's consultation. We seek to explain the findings. We then close by comparing and contrasting the similar but not identical conclusions.

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<sup>1</sup> Flat rate plans in the US and in countries with low or zero CPNP payments usually include all domestic calls. Flat rate plans in Europe either exclude calls with high CPNP payments (e.g. calls to off-net mobile users), or else are ridiculously expensive.

## ■ The literature of IP-based interconnection

This section of the paper seeks to provide a brief historical overview of the literature on interconnection. For a more comprehensive annotated bibliography, the reader may wish to refer to WIK 2008.

A purely theoretical literature on IP-based interconnection had already emerged by the early 1990s, concentrating primarily on abstract notions of congestion pricing. Unfortunately, this literature was extensively self-referential, and largely disconnected from real world interests, real world concerns, and the real workings of the Internet.

Serious economic analysis of the economics of the Internet could be said to have originated in the late 1990s with the mathematician Andrew Odlyzko, who published (and continues to publish) a range of thoughtful papers with solid empirical grounding (see, for instance, ODLYZKO, 2001). Topics included the rate of growth of the Internet; economic incentives (or lack of incentives) to implement differentiated quality of service; pricing structures and consumer preference (arguing that consumers greatly prefer flat rate arrangements, and are willing to pay a premium for them); and the relative value of content versus transmission in the Internet.

Analysis of Internet interconnection took off in earnest starting in 1997. A series of high profile mergers (WorldCom/MCI and WorldCom/Sprint) could be said to have done for the literature of IP interconnection what two world wars did for the technology of aviation: the mergers created interest, commercial need, and funding, and thus spurred development of the state of the art in a way that would not have been possible in "peacetime". Potential anticompetitive effects in regard to Internet backbone peering featured prominently in both cases.

Particularly noteworthy is the "CRT" paper (CRÉMER, 2000), which sought to explain the incentives to interconnect IP backbones, drawing on work by KATZ & SHAPIRO (1985) and FARRELL & SALONER (1985) regarding standards compliance in the presence of network externalities. The model incorporated basic elements of mathematical queueing theory to assess the likelihood that a firm that controlled access to a large enough fraction of the global user base might selectively degrade the quality of interconnection (or equivalently fail to upgrade capacity when required by growth) so as to disadvantage competitive rivals.

These same merger cases inspired a number of other papers by senior economists, including MILGROM *et al.* (2000).

In parallel with these developments, a real literature on PSTN interconnection was taking shape, as exemplified by the "LRT" papers from a group at the IDEI in Toulouse (LAFFONT *et al.*, 1998a, 1998b), and a comparably groundbreaking paper by Mark Armstrong (ARMSTRONG, 1998).

A number of the veterans of the WorldCom merger cases continued to be interested in these issues. Several of us came together to attempt a comprehensive economic assessment of Internet backbone peering in the "LMRT" paper, LAFFONT *et al.* (2003). The paper analyses peering incentives and economics using a model of differentiated service quality based on HOTELLING (1929). The analysis distinguishes between Internet content providers versus Internet users ("eyeballs"), thus anticipating the later seminal Toulouse work on two-sided markets (notably TIROLE & ROCHET, 2004)). Zero or non-zero access payments could readily be modeled.<sup>2</sup> The paper arrived at a number of important results and conclusions:

- The paper includes a brief discussion of the use of different access payments in exchange for the provision of different levels of Quality of Service (QoS).<sup>3</sup>
- The paper established a key bridge between the economic theory of Internet interconnection and that of PSTN interconnection. If one corrects for the "missing price" in PSTN voice arrangements – the fact that the recipient of a call generally does not pay for it – then the models turn out to be equivalent.

In traditional switched networks, the literature has been increasingly concerned with inefficiently high call termination rates under CPNP. These

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<sup>2</sup> Many articles wrongly assume that all peering is free of charge, or even assume that any interconnection that is free of charge constitutes peering (and vice versa). This is incorrect. The distinction between peering versus other forms of Internet interconnection (e.g. transit) is that peers are obliged to carry traffic only to their respective customers (and thus to customers of their customers), but not to third parties. (See NRIC, 2001). This is a *technical* distinction, reflected in the construction of the Internet routing table. It has economic ramifications, but it is not primarily an economic distinction. Peering is often, but not always, implemented without cost to either network. When I was in industry, about 10% of my company's peering relationships involved payment.

<sup>3</sup> This is an important result, but the discussion in the paper is brief to the point of being easily missed. The economics turned out to be straightforward. That is an important result in itself.

high rates distort economic incentives, inflate retail prices, and thus artificially depress the number of calls placed to mobile phones (thus depressing *usage* at the same time that they provide a spur to *adoption*). CAVE *et al.* (2003) argued that inefficiently high termination rates were causing huge economic transfers from fixed customers to mobile network operators, thus distorting the economics of both fixed and mobile networks. LITTLECHILD (2006) argues that the best remedy would be for Europe as a whole to adopt a US-based model of interconnection.

The United States (along with Hong Kong, Singapore, Canada, and France prior to 2004) uses a different system that is often referred to as Bill and Keep. In the US, the local termination fees of dominant (SMP) fixed operators are limited to cost-based rates, but those of mobile and nondominant fixed are unrestricted, and subject to negotiation. Mobile-to-Mobile (M2M) rates are often voluntarily set to zero (i.e. Bill and Keep). Many Americans incorrectly assume that this result is attributable solely to the use of voluntary negotiation; however, European experience prior to 2002 directly contradicts that claim. The result is better understood as a result of the obligation that charges be reciprocal, i.e. equal in both directions (even between fixed and mobile operators), thus effectively preventing subsidies from the fixed market to the mobile, in conjunction with obligations to interconnect and to voluntarily negotiate rates or else have them imposed (DE GRABA, 2000; ATKINSON & BARNEKOV, 2000; MARCUS, 2004).

The ITU has examined IP-based interconnection, with a focus on the migration to NGN, at least twice in recent years, first in (MARCUS, 2006) and more recently and expansively as a chapter in their annual *Trends* guide for 2007 (MARCUS, 2007). The latter paper is particularly concerned with the continued distorting effects of high termination rates as networks evolve to IP-based NGNs; however, its focus is on developing countries rather than on the developed world. With that in mind, MARCUS (2007) advocates that developing countries adopt mobile termination rates much lower than those that are common today – for example, India has achieved excellent results with fixed and mobile termination rates of about \$0.005 per minute.

The literature of interconnection has continued to evolve. ARMSTRONG & WRIGHT (2008) provides separate analyses of incentives for fixed operators versus mobile. In reality, the analysis is of operators whose termination rates are comparatively low, and capped, versus those whose rates are higher, and possibly not capped. The paper represents an important extension to existing theory.

Tomasso Valletti has written several relevant and noteworthy papers (with various co-authors). One (VALLETTI & HOUPIS, 2005) argues that there is no "silver bullet" as regards the termination rate – that there are many different factors that could be considered, and no uniquely correct way to set the rate (see also LITTLECHILD, 2006). Another (VALLETTI & GENAKOS, 2008) seeks to empirically estimate the magnitude of the so-called "waterbed effect", which is the tendency for reductions in the termination fee to be partially offset by increases in the retail price (typically, increases in the monthly fee or reductions in handset subsidies).

## ■ Recent developments: The WIK report (2008)

WIK's 2008 report on "The Future of IP Interconnection" (WIK, 2008) was not commissioned with the expectation that it would be part of an impending debate over termination rates; nonetheless, it has had a significant bearing on that debate. IP interconnection is increasingly intertwined with conventional fixed and mobile termination as these networks evolve to IP-based NGNs. As it turns out, many of the findings of the report are relevant not only to future NGNs, but also to current switched networks.<sup>4</sup>

Interconnection arrangements in the Internet have been relatively unproblematic, and regulation of Internet interconnection has rarely been felt to be necessary. Regulation of the voice service in traditional switched and mobile networks, by contrast, has usually been necessary in order to address the *call termination monopoly*. For newer networks that support both voice and data, the voice is likely for the foreseeable future to continue to represent the majority of the revenue (albeit a small fraction of the traffic, and thus of the cost). A threshold question for the study was to evaluate the degree to which the termination monopoly would be relevant to future NGNs.

Our conclusion was that service providers that possessed terminating monopoly power today would still possess it in an IP-based world. As long as no other service provider could complete calls to their customers, the migration to IP would not in and of itself change their market power in regard

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<sup>4</sup> This author had the honour and good fortune to work with some exceptionally knowledgeable and talented colleagues on the project, many of whom had been studying these issues for many years.

to their *voice* services. This finding played a large role in our recommendations.

We also found a number of concrete indications that both fixed and mobile operators were already taking whatever measures they could to preserve their existing call termination arrangements, as nearly as possible, as their networks evolved to IP-based NGNs.

We felt that current termination arrangements generate significant inefficiencies and economic distortions in Europe today. They tend to inflate retail per-minute mobile prices, and thus to depress calls to mobile telephones. The transfers from fixed users to mobile operators continue to distort the evolution of both networks. The migration to NGN would not fix these problems; on the contrary, it might exacerbate them, as the termination fees would be associated with a voice service that was relevant to only a small and declining fraction of the cost of the network.

We also felt, upon reflection, that it might be counterproductive to wait for the migration to IP-based interconnection to make changes. Many network operators benefit from high termination fees today, both directly and indirectly (for example, through their tendency to inflate retail prices); those operators would have no reason to voluntarily give up high termination rates. Thus, conditioning a change in the interconnection regime on the migration to IP-based interconnection might simply accentuate disincentives to migrate to IP-based interconnection in the first place.

With all of this in mind, we argued that mobile termination rates should be moved in some way to much lower levels than are typical in Europe today (currently, they are 9.67 euro cents per minute - EUROPEAN COMMISSION, 2008b). We recommended an accelerated glide path of somewhere between three and five years.

We did not identify a specific level of rates at the end of that period. As noted earlier, there are a great many factors that could be reflected in determining an optimal termination rate. There are many advantages that would flow from the use of a maximum rate of zero (which is equivalent to mandating the use of Bill and Keep arrangements); however, we do not exclude the possibility that a low but non-zero rate might have advantages of its own. India seems to have achieved good results (in terms of retail prices, mobile phone usage, and rapidity of mobile penetration) with termination rates of about half a cent per minute for both fixed and mobile (MARCUS, 2007).



We did not see the need for other remedies for IP-based interconnection. There are risks of new competitive bottlenecks, for example as a result of the introduction of NGN/IMS, but we felt that it would be premature to impose prophylactic regulation. We did not identify concrete, immediate problems with IP-based applications other than voice.

We also considered the network neutrality debate that continues to rage in the United States. The migration to IP introduces the risk that network operators that possess some form of market power might choose to impose subtle anticompetitive degradations to the Quality of Service (QoS) over the interconnection in order to weaken competitors, or to favour affiliated services over unaffiliated ones (CRÉMER, REY & TIROLE, 2000). The issue is very real, but we felt that it was not a significant concern for Europe. First, the threat of anticompetitive behaviour is much less in Europe because our broadband markets are more robustly competitive than those of the US – effective competition inhibits this kind of behaviour. Second, the European regulatory framework already provides tools to deal with any problems that might emerge here (see also CAVE & CROCIONI, 2008; MARCUS, 2008). The Commission's modest proposed enhancements to the regulatory framework to facilitate informed consumer choice, and to reduce switching costs, seem to be more than adequate at this time.

It is important to note what we did *not* recommend. First, we did not recommend any regulatory controls at the *retail* level – neither in regard to charging principles, nor as regards the level of charges.<sup>5</sup> One could debate endlessly whether consumers are better served by Calling Party Pays (CPP),<sup>6</sup> Receiving Party Pays (RPP), or flat rates at the retail level. We think that this is first and foremost a choice for the market, not for the regulator. Other things being equal, the regulator might wish to choose wholesale remedies that place as few constraints as possible on retail arrangements; otherwise, we see no reason to treat this as a regulatory matter at all.<sup>7</sup>

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<sup>5</sup> The WIK 2008 report did not address roaming. Roaming poses special challenges, not only at the wholesale level but also at the retail level. This author thinks that the Commission's initiative to regulate retail prices for voice mobile roaming in 2007 was appropriate.

<sup>6</sup> CPP at the retail level should not be confused with Calling Party's Network Pays (CPNP) at the wholesale level. They are often found together, but they are not the same thing.

<sup>7</sup> We note that a number of trade press articles incorrectly cited WIK (2008) as advocating the use of RPP at the retail level.

Second, even though a number of the authors of WIK (2008) see great merit in the system used in the US, we did not literally recommend its adoption in Europe. One of the great attractions of the US system is that it achieves termination rates in many cases (not all) through negotiation between the parties, rather than by regulatory rate-setting. This leads to low rates, as previously noted, due to obligations of reciprocity of rates, and because fixed incumbents with market power are limited to cost-based rates.

We see no obvious way to gradually phase in a system based on the exact US model, and we have concerns that neither consumers nor service providers could react overnight to the implementation of such a system. Service providers would likely choose to shift their retail pricing models under such an arrangement by (1) lowering usage charges, (2) reducing handset subsidies, and (3) increasing monthly fixed fees. We think that all of this would need time to settle in; consequently, we did not advocate an approach that would imply a "flag day" all-or-nothing transition.

If a US-like system were desired, the fast glide path would still be an appropriate way to get there. By setting the maximum end rate to zero, rather than a low but non-zero value, Europe could end up with arrangements that are economically roughly equivalent to those of the US but with a gradual phase-in (and also without the need for the kind of messy fine-tuning of the system that was required in the United States - see MARCUS, 2004).

## ■ Recent developments: The ERG Consultation (2008)

The European Regulators' Group (ERG) developed a second public consultation on IP-based interconnection in 2007 (ERG, 2007, 2008).

The ERG (2008) report reviews the differences between the switched network and the emerging NGN, and considers the drivers for change. It reflects on the differences between switched networks and NGN, in terms of the separation of network from service; the inherent cost structure; and the number of points of interconnection.

With that basis of analysis established, the ERG offers a range of conclusions and recommendations. Significantly, they conclude that "[...] the move to NGNs does not provide an opportunity to roll back regulation on existing services if the competitive conditions have not changed."

The ERG sees a possible need to ensure (perhaps through the application of Article 5 of the *Access and Interconnection Directive*) full end to end connectivity and interoperability at an appropriate level of Quality of Service. This implies the need for operators to use standard protocols and interfaces, and to provide information on their use.

The document assesses the relative merits of CPNP versus US-style Bill and Keep arrangements at length; however, it appears to stop short of definitively advocating one system versus the other. One might reasonably infer that the national regulators who comprise ERG did not reach full consensus on this point.

Finally, ERG (2008) contains a useful discussion of regulatory concerns during the transition period, when switched networks and IP-based NGNs operate in parallel.

## ■ Recent developments:

### **The European Commission's consultation (2008)**

The Commission's consultation document (EUROPEAN COMMISSION, 2008a) is much less philosophical than the ERG document; instead, it is much more concrete and applied. The Commission was apparently concerned primarily with the wide disparity among termination rates among Member States, and secondarily with the high levels of those rates. The Commission document considers only briefly a possible change of wholesale charging mechanism to anything other than cost-based CPNP; their focus is instead on the level of rates, and on the means by which those rates are determined.

The consultation document would require Member State NRAs to compute costs pursuant to the following principles by the end of 2011:

- Costs should be computed for an efficient operator using modern technology, based on bottom-up modeling of *long-run incremental costs (LRIC)*. Current or legacy costs are not relevant. For mobile operators, the access should be assumed to reflect a mix of 2G and 3G, while for both fixed and mobile operators the network core should be assumed to be NGN.
- The cost computation should reflect only *avoidable* costs associated with the voice service. Costs associated with other services are excluded, as are costs that are non-traffic-related.

- The Commission acknowledged that there are benefits to both calling and called parties; nonetheless, they supported recovery of the full avoidable costs of terminating the call in the wholesale charge.
- In the absence of an objective cost difference outside of the control of the operators, each Member State should have only one rate for fixed operators, and another for mobile operators (i.e. they should be *symmetric* between mobile operators, and also between fixed operators). The only valid cost difference that the Commission has identified flows from the differences between 900 MHz versus 1800 MHz spectrum.

These changes would collectively imply a migration to much lower fixed and mobile termination rates than those that pertain today. Where the current European average mobile termination rate is €0.967 per minute (EUROPEAN COMMISSION, 2008a), these changes might imply a reduction to something like € 0.02 or € 0.03.

## ■ Concluding observations

An important unifying thread among all three documents is the apparent desire to substantially reduce mobile termination rates over the next few years. The WIK 2008 report advocated reduction to a low rate, possibly but not necessarily zero, over the next three to five years. The ERG 2008 report seems to lean in the direction of adopting Bill and Keep, effectively reducing the rate to zero. The European Commission consultation would use a different mechanism to reduce the rate to perhaps €0.02 or €0.03 per minute by the end of 2011.

The ERG and Commission approaches should be similar in effect, but they also differ in important ways. The adoption of a zero rate potentially simplifies the regulator's job substantially, once it is firmly in place. The regulator could perhaps escape the burdensome cycle of constantly arguing whether the rate should be half a euro cent higher or lower. Zero is clear and unambiguous.

On the other hand, it may be easier to sustain the Commission's approach against legal challenge, since it is firmly grounded in established concepts of cost-orientation of call termination prices and in the Commission's authority under the Framework Directive to coordinate implementation of the

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regulatory framework. It may be easier to argue that the Commission's approach is proportionate (i.e. no more intrusive than necessary).

A substantial reduction in termination rates, however achieved, should result in substantial benefits for the great majority of Europeans – greater ability and willingness to use their mobile services, and more cost-effective retail arrangements. Significantly, the reduction in overall economic distortion to fixed and mobile services helps to establish necessary preconditions for a smooth migration to IP-based services.

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