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SHARED NETWORKS: MAKING WIRELESS COMMUNICATION AFFORDABLE

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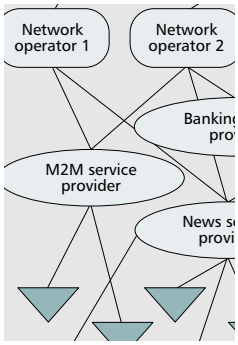

The authors believe that the generic product life-cycle model provides insights that indicate network sharing, in an appropriately constructed regulatory framework, is not a threat to vigorous competition in the 3G industry, and in fact, is one of the keys to stimulating the development of advanced, affordable services.

ABSTRACT

In the wake of the substantial financial commitments incurred by European and other UMTS network operators in the form of licence fees, licensees have turned to network sharing as a means of reducing the capital requirements needed to bring 3G services to market. The reception from European regulators has been mixed, due to concerns that this will inhibit competition, slow buildout, or otherwise result in reduced consumer benefits. The authors believe that the generic product life cycle model provides insights that indicate that network sharing, within an appropriately constructed regulatory framework, is not a threat to vigorous competition in the 3G industry, and in fact is one of the keys to stimulating the development of advanced, ubiquitous, affordable services.

INTRODUCTION

"Network sharing" for second- and third-generation (2G, 3G) mobile communications networks has been the focus of increasing attention in certain parts of the industry for some time now. Industry has viewed it primarily as a capital expenditure (capex) reduction tool: following the implosion of their inflated valuations and the reduction in their credit ratings, 3G licensees began scrambling to find means to shore up their business cases. In some cases, this was achieved by simply handling licenses back to the regulator (Germany, Norway); more often, operators chose either to lobby for reduced or delayed service and coverage requirements, or to turn to network sharing as a means of reducing costs [1].

Although initially reluctant, economic realities have forced regulators to accept varying degrees of network sharing. In most markets, this acceptance has been accompanied by a range of conditions, constraints, and requirements, reflecting regulatory fears that sharing will inhibit competition or slow rollout [1].

A similar dynamic is evident in 2G networks as well, although it is less evident simply because 2G network operators have generally not been subject to the same level of financial constraint as 3G ones. One notable exception is in America, where intense competition among 300+ local and regional and six national carriers has squeezed gross margins to a fraction of those earned elsewhere. As a result, network sharing is more prevalent in America than anywhere else in the world, with coverage in many areas being providing by "neutral hosts," third parties who own and operate network infrastructure and provide coverage on behalf of two or more operators.

We do not dispute the importance of capex savings as *one* of the main benefits of network sharing, but we believe that operators and regulators alike have overlooked the issue's more fundamental implications for the industry. Network sharing allows the value chain to be disaggregated into network operators, neutral hosts, mobile virtual network operators (MVNOs), service providers, and other entities, which in turn will facilitate the emergence and development of the advanced services that ultimately will contribute far more to the 3G business case than simple cost reductions.

NETWORK SHARING DEFINED

The term *shared network* does not precisely define a specific architecture for Global System for Mobile Communications (GSM), Universal Mobile Telecommunications System (UMTS), or any other wireless communications network used by two or more operators. Rather, there are many variations, and several of these variations have two or more levels of shared infrastructure [1–3].

SHARED NETWORK ARCHITECTURE

The different options available to operators for sharing network infrastructure can be as limited as simply sharing civil works such as towers, rack space, and power supplies, or nearly complete sharing of the network, as is the case with an MVNO, which has little of its own infrastructure beyond a home location register (HLR) and a billing system (Fig. 1).

Vendors typically describe the different alternatives for network sharing as [2, 3]:

- Site and passive radio access network (RAN) sharing
- Shared RAN
- Shared core network
- Full network sharing
- Geographical split

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For regulatory purposes, the EU Competition Directorate has also defined five levels of sharing, but these are not entirely identical to those used by industry [1].

It is not our intent to advocate a particular architecture or approach; the optimum varies from one market to another, and very often migration from one method to another is called for as conditions evolve. The essential thing is to have a technical and financial architecture that permits network operators to cooperate, consolidate, or otherwise share resources while the wholly independent service providers are free to engage in uninhibited competition.

The Benefits of Network Sharing

As described above, the capacities for network sharing to deliver reductions in network capex requirements are well known and generally accepted within the industry. White papers by companies such as Ericsson and Nokia [2, 3] have made a reasonable effort to quantify these benefits, as shown in Fig. 2. This chart shows typical capex requirements for each of the three main components of infrastructure investment (core network, active RAN, and passive RAN) under a "geographical split" shared network relative to the cost of building a separate network.

Similarly, Nokia claims 20–30 percent savings from site sharing, and 30–40 percent sharing from site and RAN sharing.

Swedish Case Study

A case study conducted by Björkdahl and Bohlin for Post och Telestyrelsen(PTS), the Swedish regulatory agency, provides a more detailed analysis of the cost savings potential of network sharing [4]. The authors of this study began by estimating the number of sites the operators sharing the 3GIS network (Vodafone, Tre, and Orange) and the Svenska UMTS Nät (Telia and Tele2) will need to build in order to meet the minimum coverage conditions specified in their licenses, and then calculated the total investment at 24.4 million SEK. With no network sharing (e.g., each operator would build its own completely independent infrastructure), the required capital investment needed to meet the PTS mandated minimum coverage requirements could be as high as 38 billion SEK, reflecting a potential savings of 42 percent. Björkdahl and Bohlin also made an estimate of the savings that could be achieved were all four network operators to share a single network in rural areas. In this case, the authors estimate the capex requirements would decline further, to 19 billion SEK (Fig. 2) [4].

Key Benefits of Network Sharing

These analyses are summarized here not because we challenge these conclusions, but in support of our view that the mobile communications industry generally — operators, regulators, vendors, and academics alike — has inappropriately focused exclusively on these capex-related benefits while overlooking the far more important strategic benefits that such sharing can potentially deliver. The product life cycle model, as described by Philip Kotler and others [5], is the key to understanding the consumer, financial, and cultural benefits that can be derived from network sharing given an appropriate regulatory posture and understanding on the part of various market players.

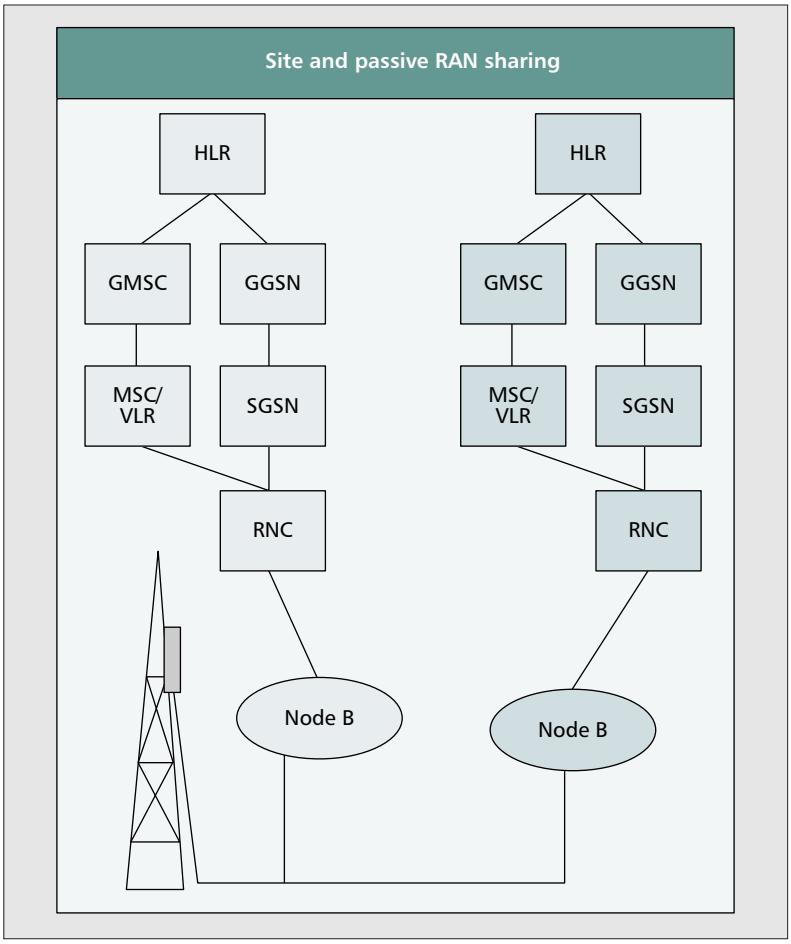

Figure 1. *A schematic illustration of the basic level of network sharing, sharing of site and passive radio access network (antennas and cables). Together with the node Bs (base stations) and radio network controller (RNC), they make up the complete radio access network (RAN). SGSN: serving GPRS support node.*

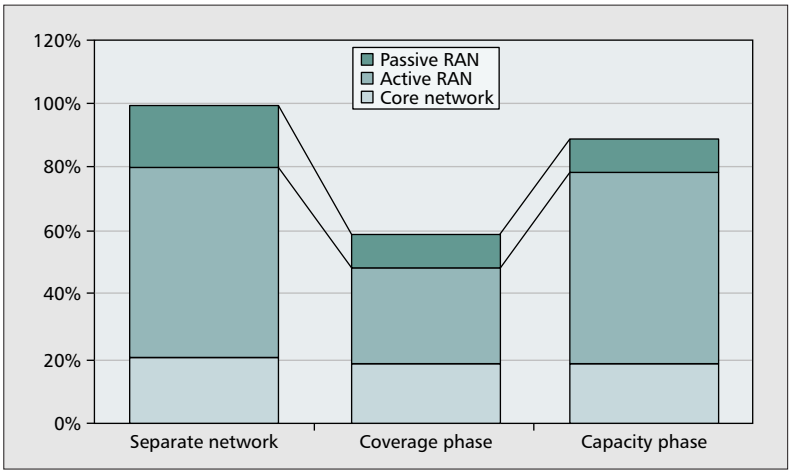

Figure 2. *Potential capex savings from geographical split network sharing during the different rollout phases of a 3G network [2].*

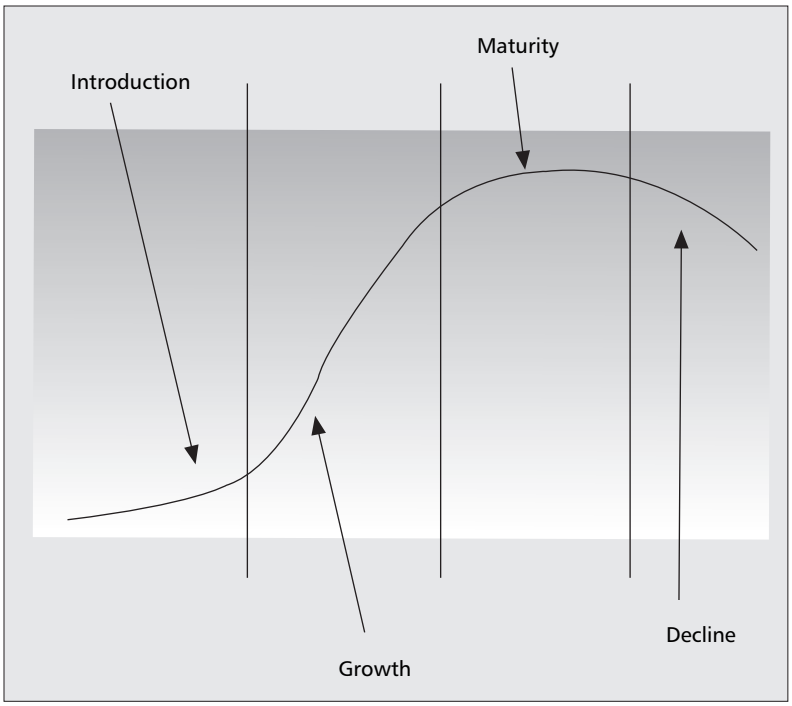

Figure 3. *The generic product life cycle model [6].*

The Generic Product Life Cycle Model Reviewed

The product life cycle model divides the life of a new product into four distinct phases: *introduction*, *growth*, *maturity*, and *decline* (also sometimes referred to as the *harvest* phase) (Fig. 3).

- The introduction phase begins when a new technology or product first appears on the market.
- The growth phase begins when sales start to develop and typically reach double-digit growth rates.
- The maturity phase begins when this growth tapers off and a majority of the potential market has been saturated.
- The decline phase begins once annual sales pass their peak.

Implications for the 3G Industry

The product life cycle model has been used to show that as a new product progresses through these four phases, it shares a number of characteristics with other products in the same phase, even when these products differ extensively in any number of dimensions: mass market vs. specialist, complex vs. simple, and so on. Two of these common characteristics are particularly relevant to this analysis of the potential benefits of network sharing.

Increasing specialization: The model predicts that as a product category matures, one can expect to see the emergence of products with increasingly specialized designs for an increasingly segmented marketplace. Each of these segments, however, becomes increasingly homogenous. In the mobile communications industry, this characteristic is manifested by the emergence of MVNOs that offer more and more targeted offers for very specific classes of users: students, road warriors, tradespeople, executives, and so on.

Disaggregation of the value chain: Extensive vertical integration is a characteristic of an immature product. As the product increases in complexity, it is no longer possible for a single organization to providr an end-to-end solution. Until recently, mobile network operators (MNOs) managed service development and launch, distribution, sales, repairs and after-sales services, branding, service platforms, retail networks, and so on. Many of these activities are already being outsourced, but the industry can only reach its full potential if this process can continue. Network operation and maintenance and service creation and development are quite obviously very different businesses, and network sharing provides an efficient, manageable means for them to operate with greater independence of each other.

In order to properly understand the insights this model can provide, it is necessary to recognize that although UMTS is definitely a technology just now entering the growth phase, UMTS is a subset of a broader product category, mobile communications, that reached maturity in the late 1990s. Although the product continues to evolve and be enhanced with things like multimedia messaging service (MMS) and streaming video, the fundamental design — a screen, a keyboard, a network that is both ubiquitous and affordable to the mass market — is basically stable. Industry consolidation is clearly already evident, and it is likely a handful of global players will soon control the majority of subscribers. Specialization is also already clearly evident, not only in handset designs, but in the emergence of specialized niche brands such as Virgin Mobile and Djuice on the service side. But it is the issues and implications around the disaggregation of the value chain that are relevant to the question of network sharing, and we believe it is important for the regulators to recognize these implications and construct a regulatory framework that keeps them in mind.

The Future Industry Structure

Given a regulatory environment that permits the financial and operational separation of the network and service layers, these two parts of the mobile communications industry will evolve naturally into entities that reflect their differing characteristics. The network operators will consolidate, stabilize, and focus less on innovation than on reducing cost. The service providers will experience the healthy turmoil typical of industries in the introduction/early growth phases, as startups grow or go bankrupt, business models are tried and discarded, and various service, sales channel, and other concepts are tested and developed in the marketplace.

That this structural disintegration is both natural and value enhancing is illustrated by the experiences of other industries as described, for example, by John Hagel and Marc Singer in their 1999 article, "Unbundling the Corporation," which notes the role of the information technologies in the appearance of market actors focused on very specific parts of the value chain [6]. While we disagree that this phenomenon is a

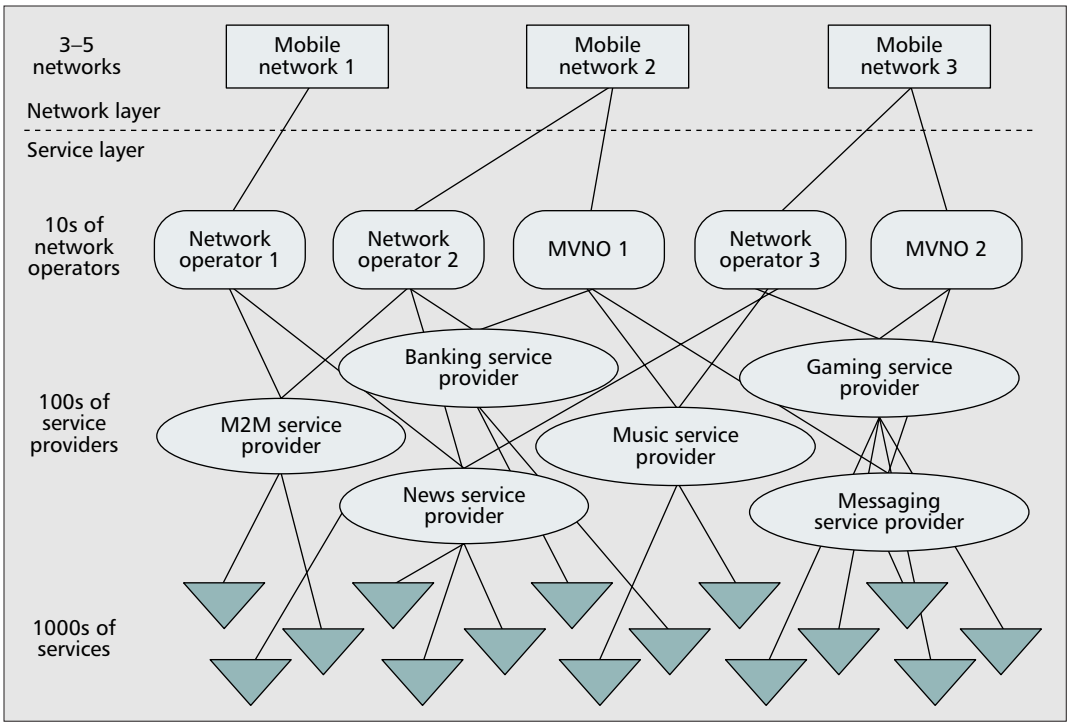

Figure 4. *Future wireless communications industry structure.*

new one, the examples they cite (Yahoo!, Amazon.com) illustrate clearly the natural trends that can be expected to emerge if and when artificial regulator-imposed barriers to their development are removed.

Recall that one of the characteristics of a maturing industry is increasing specialization into niche products, and a single entity is no longer capable of meeting the diverging needs of the various markets for services that are emerging. This was possible in the era when voice/voice mail/short message service (SMS) and ring tones constituted the entire product range, but the product market needs to fragment into numerous specialized providers, while the underlying network industry needs to consolidate into a more efficient, more stable structure. This stability in turn will be more suited to the creation of the rather stringent regulatory controls that will be required to prevent the emergence of monopolistic or other undesirable behaviors, and the separation from the service layer means that these controls will not inadvertently be applied to the wireless service industry, where they would be inappropriate. This industry needs maximum freedom to experiment and continuously reinvent itself through creative destruction.

Characteristics of the Future Wireless Industry

The two parts of the industry will diverge in many other ways as well. Consider:

Capital markets: The orientation of investors in these two layers is also diverging, and bundling the two different business propositions they represent into a single market instrument (shares, options, derivatives, etc. based on vertically integrated MNOs) will appeal to neither long-term, growth-oriented, risk-tolerant investors who seek the potential of startups and disruptive business models, nor to short-term, income-oriented investors who are interested in the safe steady returns a pure network company might be able to offer.

Cultural issues: What sort of employee is going to be satisfied in such a hybrid organization? What should its focus be? How will management be incentivized? To reduce costs, or to enhance innovation? A vertically integrated organization will always have employees with conflicting objectives.

Service issues: Networks must be stable, reliable, and standardized. Customers will be far more tolerant of flaws in emerging new services, which must have the freedom to experiment with approaches and configurations before a solution is finalized.

Network Architecture

Although we have been critical of the overemphasis on capex savings, we also note there may be further opportunities for capex reductions beyond those already enumerated and generally acknowledged within the industry. As noted above, the product life cycle model indicates that we can expect providers to become increasingly specialized, serving the needs of specific market and service niches. This implies that their respective customer bases will become increasingly homogenous as well, with homogenous needs and usage patterns. In turn, this homogeneity implies, for example, that a teen-oriented network's customers will have very little demand during the day, but very intense demand peaking in the hour "off-peak" rates first go into effect. Another provider targeting the small to medium enterprise (SME) market might have intense demand during the day, but much less in the evening. As the market continues to evolve,

Networks must be stable, reliable, and standardised. Customers will be far more tolerant of flaws in emerging new services, which must have the freedom to experiment with approaches and configurations before a solution is finalized.

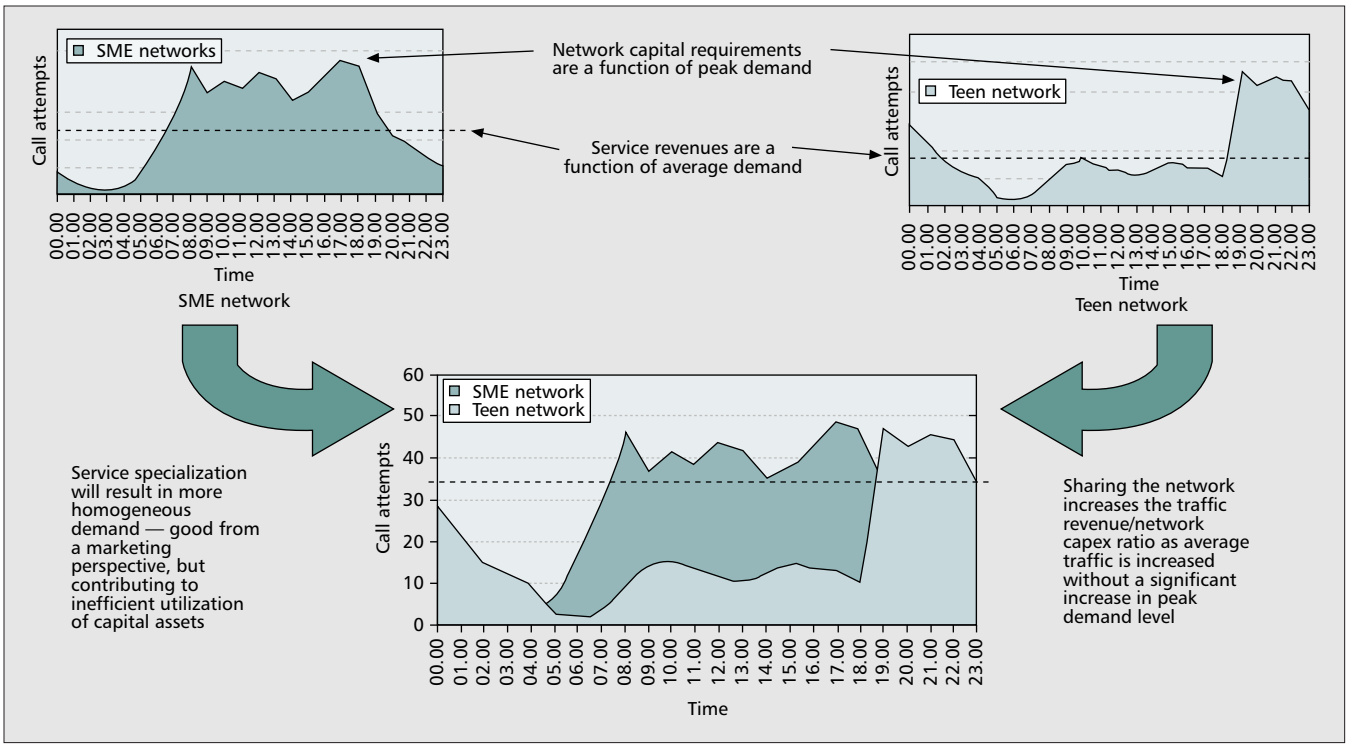

Figure 5. *Capex implications of market maturation.*

this homogeneity is going to become increasingly pronounced as providers develop more and more targeted offers (Fig. 5).

Such developments have significant network implications because network capex requirements are a function of *peak* demand (capacity), whereas revenues are a function of *average* demand. Therefore, the ideal customer base for a network operator is as diverse as possible, whereas a marketing organization can most efficiently serve a homogenous customer base. The only way to deliver both requirements is through separating the network provisioning and service provisioning functions.

Special Environments

The final argument for the need for network sharing concerns special environments such as tunnels, underground stations, rural highways, airports, and shopping malls. Two unique characteristics of these environments make shared networks almost necessary and effective regulation desirable.

They are under the control of a state or quasi-public monopoly such as a mass transit provider, highway authority, or private landlord. These landlords do not want the disruption caused by multiple installations of network infrastructure, and often are tempted to use their monopoly over access to demand a share of the usage revenues. This may be good for their shareholders, but not society as a whole, which does not benefit from such monopolistic behaviors. In Boston, Massachusetts, the independent authority that is responsible for the construction and operation of a new multibillion-dollar 10 km motorway tunnel under the city is attempting to use its monopoly over access to the tunnel to demand concessionary payments from network operators. Allowing the tunnel authority to do so would make it appear they are better serving their public owners by reducing the tunnel's net operating cost; however, this improved net result is delivered by increasing revenues that come initially from the MNOs, but ultimately from the taxpayers who are also subscribers to the network. The net gain to the treasury is zero (as access revenues are offset by reduced tax receipts), and while the negotiations between the authority and the operators drag on over how to divide the pie, the pie itself remains diminished in size as the broader economy is denied the productivity gains that would result from tunnel users having access to the network [7].

The demand levels in such environments are frequently inadequate to economically support the capital and maintenance costs required for two, three, or more separate networks. The number of such environments for which a viable network coverage business case exists is therefore significantly expanded if infrastructure is shared.

Distributed Antenna Systems

An alternative approach to sharing the RAN is to distribute the radio frequency (RF) power from the operators' respective base stations via a common shared distributed antenna system (DAS) [8, 9]. This is a technology that has the potential to reduce capex requirements even further, but whose potential is severely limited in the absence of network sharing. Additionally, the specialized nature of the technology makes it sensible for installations of such systems to be carried out by independent neutral hosts rather than network operators. Such a system typically consists of analog broadband radio repeaters and optical fibers. They are often used for spe-

cial environments such as airports, underground stations, or indoor coverage in skyscrapers or shopping malls (Fig. 6).

This type of architecture can also be used to share infrastructure between operators using two or more technologies, such as UMTS, GSM, IS-95, and 802.11b/a. Furthermore, such a centralized radio installation also provides greater trunking efficiency; hence, it is a much more cost-efficient alternative for operators to provide capacity in office and other high-user-density environments than a traditional micro-base station or picocell deployment.

Neutral Hosts

Neutral hosts are independent companies that install, operate, and maintain network infrastructure for the benefit of two or more operators. In addition to more familiar entities such as MVNOs and service providers, these companies represent another manifestation of the ongoing breakup of the value chain into specialist players. Again, conventional wisdom in the industry views them primarily as a source of capex savings, but when they are considered together with DAS and the unique requirements of providing coverage in special environments as described above, it becomes clear that capex savings are only one of the benefits they provide.

From a technology standpoint, both DAS and the special environments described above require specialized hardware requiring specialized know-how for its installation and optimization. This suggests that such work is best carried out by independent firms with very deep but narrow technical skills.

More important from the consumer's perspective is the fact that unlike operators, they are by definition "neutral"; that is, they have no network license and no retail customers of their own, so their objective is to distribute the fixed costs of each installation over as many operators as possible, in contrast to MNOs, whose optimal strategy is to seek competitive advantage through exclusionary tactics and then use this advantage to demand prices that more than offset their higher costs.

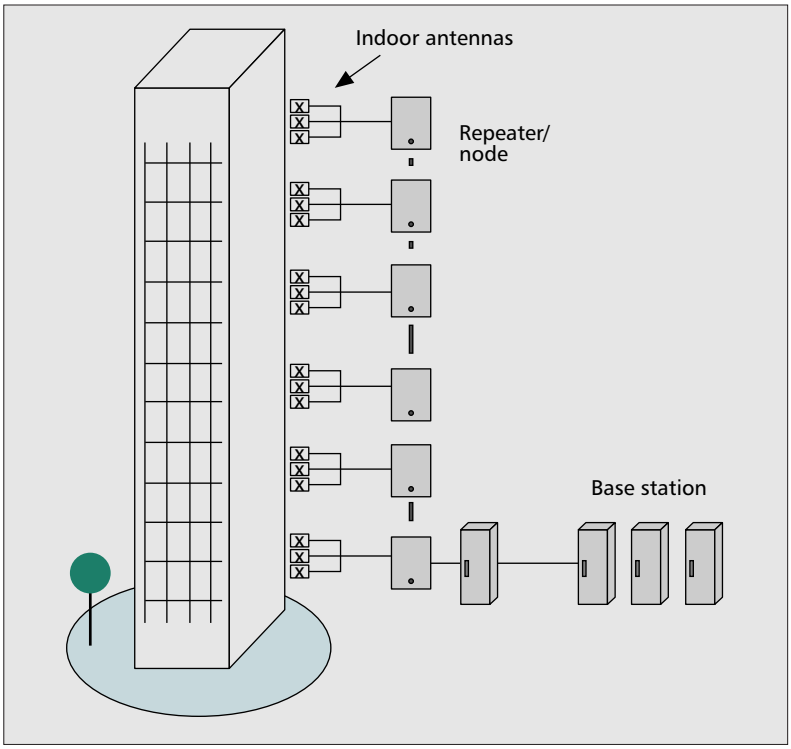

Figure 6. *A schematic illustration of a distributed antenna system based on radio repeaters fed by a pooled base.*

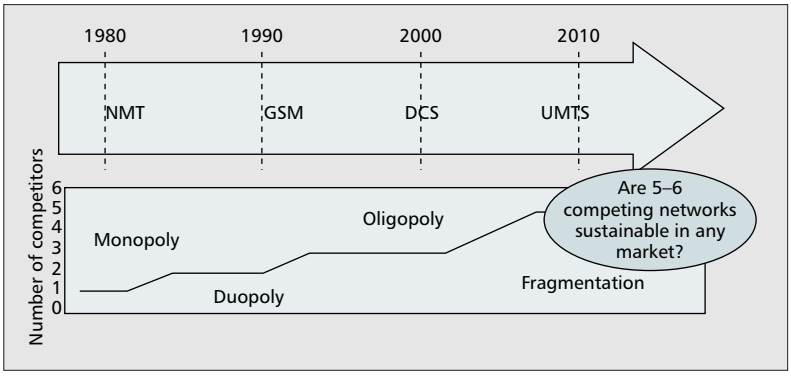

Figure 7. *Evolution of competition in the European wireless industry.*

Implications for Regulators

Simply put, the objective of the regulator is to ensure that a scare resource (spectrum) is allocated to the private sector in such a way that it is incentivized to provide the maximum possible public benefit (e.g., to get the most services available to the most people in the shortest time period at the lowest price possible). One of the chief potential obstacles to achieving this objective has been perceived to be monopolistic tendencies, and this belief has been reinforced by historical experiences, in which national regulators have witnessed a steady increase in competitive behaviors, and steady declines in end-user pricing as they developed the market from a monopoly or duopoly under Nordic Mobile Telephone (NMT) in the 1980s, then to two or three competitors with the introduction of GSM, and then to three or four with so-called digital cellular system (DCS, GSM 1800) licenses. This seemingly political-cost-free way of delivering consumer benefits and bringing new revenues to national treasuries is no doubt in part behind the decision to license five or even six carriers with the issuance of UMTS licenses in recent years.

The financial difficulties experienced by the licensees have finally demonstrated that spectrum auctions are not a license to print money, and there is a diminishing rate of return to be yielded from increasing competition (Fig. 7).

More important, the issue overlooked by those who expect competition alone to lower prices and stimulate service development is the fact that no amount of competition can push pricing below cost in the long run, and increasing competition lowers the number of subscribers over which fixed costs can be spread. As the product life cycle model indicates, one of the mechanisms through which consumers benefit from the maturation of a product category is

Historically, competition has been on the network layer, but as services offered over these networks become increasingly sophisticated and specialized, and hence less commoditized, competition will move to the service layer.

	Network layer	Service layer
Product life cycle	Maturity	Growth
Competition	Consolidating	Fragmenting
Key success factors	• High reliability • Low cost • Stability • Increasing standardization	• Time to market • Freedom to experiment • Continuous innovation • Increasing specialization
Investor profile	• Income oriented • Risk averse	• Growth oriented • Risk tolerant
Regulatory requirements	• Tightly regulated oligopoly • Cost-based interconnect and collocation fees • Mandatory standards and protocols	• Encourage/reward risk taking • Basic regulation of fundamental business practices such as marketing claims

Table 1. *Key strategic and environmental differences between the network and service layers.*

industry consolidation and economies of scale (this is not to deny that other factors such as learning curve effects also work to lower cost bases). In the U.S. market, where six national and more than 300 local and regional carriers battle for market share, intense competition has yielded low prices, but revenues that could have been spent on service development and coverage extension have instead been diverted to handset subsidies and marketing campaigns (although it is acknowledged that incompatible network technologies in the United States are also a barrier to the consolidation that might otherwise increase investment efficiency). Hence, the U.S. market is characterized by very low prices, but also by spotty coverage, network congestion, and lagging service development. For optimal consumer benefit, revenues and margins must be robust enough to support investments in infrastructure and services.

The Role of the Regulator

The key question for the regulator should be how to deliver the benefits of scale economies and consolidation without causing a concomitant and market-inhibiting decline in competition.

Regulatory postures must change as industries mature and evolve, and the fact that the mobile communications industry is mature, but the products and services collectively referred to as 3G delivered on this platform are either still in introduction or just entering the growth stage, implies that a "one-size-fits-all" regulatory approach is no longer appropriate. This contrasts with the situation 10 years ago, when the entire industry was new, and a singular regulatory framework could be applied to all the industry players. As described, allowing (or even encouraging) the network and service layers of the industry to separate from each other is in accordance with the natural evolution seen previously in other industries and, as will be shown, will deliver numerous other benefits as well.

Historically, competition has been on the network layer, but as services offered over these networks become increasingly sophisticated and specialized, and hence less commoditized, competition will move to the service layer, leaving the supporting networks as stable, standardized commodities that require a relatively active level of regulation. The objectives of regulators should be to:

- Create a stable, predictable business environment in which network providers can consolidate and reduce operating costs
- Encourage, or mandate where necessary, the development of standardized open interfaces and protocols as a platform for service creation
- Ensure that all existing, new, and potential mobile service providers have access to the network and its supporting service platforms on a cost-based nondiscriminatory basis
- Implement regulations and policies that encourage or mandate cost-based access to monopoly-controlled environments such as rail and underground stations, highway tunnels, and airports
- Use tax, fiscal, and other policy levers to counter free-rider effects and other obstacles to coverage and capacity investments

Some value-chain issues are generally not the concern of telecom regulators; already there is a trend in the industry to rely less on operator-owned retail channels, and functions such as IT, billing, and customer care have been successfully outsourced in many markets without any undue government interference. But public discussions about network sharing often do not properly take these life cycle implications into account.

Obstacles to Effective Network Sharing

The potential for some monopolistic issues to emerge in a shared network environment was suggested above, and there are some such problems. However, the authors believe that given an appropriate regulatory framework, the benefits far outweigh these issues.

Loss of Competitiveness

As almost any market research or customer satisfaction survey in almost any wireless market will show, *coverage* is by far the single most important issue to customers and by far the most important dimension on which operators compete. People also consider things like brand name, customer service, service availability, handsets, and entry barriers, but if the provider does not offer coverage in the area or areas in which they spend their time, nearly all other issues become irrelevant. Customers also complain about other things: exorbitant roaming charges, confusing invoices, and rude service reps, but poor coverage and dropped calls are far more likely to get them to switch. If, however, all operators offer the same network and more or less identical coverage, customers have nowhere to switch to, and operators lose most financial incentive to address the problem.

"Free Rider" Effects

In any market where two service providers share a network, and that network reaches capacity, it will always be because one of the two has significantly more customers than the other. Therefore, the market laggard has no reason to contribute to network expansion, leaving the market leader with two unattractive options:

- Expand at its own expense, giving the laggard a free ride.
- Refuse to expand, hurting its own customers more than the laggard's.

In essence, mediocrity is rewarded.

Regulators need to consider using policies like investment credits, asset depreciation schedules, and penalties to discentivize and manage these sorts of anti-competitive behaviors.

Fundamentally, the regulatory authorities need to develop a mentality that recognizes the emerging differences between the network and service layers, and implement policies reflecting these differences (Table 1).

Conclusions

We believe the organizational and financial separation of the network and service layers is the best means of enhancing — if not salvaging — the 3G business case. Sharing of the passive RAN will significantly extend the reach of coverage into office spaces and other indoor areas, and sharing of the RAN and core networks will allow outdoor coverage to be economically extended. Specialized MVNOs will enable the emergence of new classes of applications that utilize these networks, such as M2M operators.

Although they will ultimately be the primary beneficiaries, operators are also likely to be the main focus of resistance to this transformation in the short run, as they will adopt this approach only in the presence of strong regulatory support.

The burden of leadership, therefore, lies primarily with the regulators, who must convince a skeptical industry of its commitment to spurring restructuring and ensuring equal, cost-based, and nondiscriminatory access to the network for all existing, new, and potential market entrants.

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Additional Reading

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Biographies

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The burden of leadership lies primarily with the regulators, who must convince a skeptical industry of its commitment to spurring restructuring and ensuring equal, cost-based and non-discriminatory access to the network.