

Mobile Internet and Rich Voice Plus: the Social Shaping of Convergence.

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1. Introduction

One of the debates in the shaping of wireless futures, and perhaps the most uncertain, is over what the technology actually offers end users. It is clear that there are two dominant value propositions for two markets: Rich Voice and Mobile Internet. However it is also clear that these services represent two contrasting regimes for understanding the market, the role of network operators within it, and the innovation environment for business and technical change. These regimes are those of the Internet and Telco world who are circling each other, drawn to the vision of Internet and mobile phone convergence.

There are a number of key issues that will shape the development of convergence, these include the licensing and allocation of radio spectrum, development of lower power devices, standardisation processes, and the control operators have over mobile devices. This paper investigates two issues: first, the idea of convergence, how it may occur, and whom it may benefit, then two emerging markets, Rich Voice, and Mobile Internet, which represent alternative views of the future of telecommunications convergence.

2. Convergence

The developments of new wireless access technologies has to be put in the context of the continuing 'convergence' phenomenon that started in the 1970s, but really came to the fore in the 1990s when interactive network multimedia based on the diffusion of the personal computer, and the technical and market success of the Internet model. All media and communications could flow down the same 'pipes', and could be created and accessed on common devices. This vision was partly successful, but has largely failed to integrate the dominant media and communications modes: radio and television broadcasting, and voice telephony. In parallel with the Internet came digital television and the mobile telephone explosion – the latter being arguably more pervasive and more successful (the former we shall discuss later). Despite using an all-digital system the mobile phone was firmly in the camp of voice telephony. However hidden in the dominant GSM standard was a simple messaging system whose unplanned uptake mirrored the success of email with the Internet (and messaging on most previous generations of communications systems, such as Teletel/Minitel). The short messaging service (SMS) introduced 'multimedia' to the mobile telephony world, and generated substantial profits. This confirmed the visions of

¹ This report is based on review of literature from telecommunication economics and policy, reports from IST projects, industry papers and commercial documents. A series of 24 interviews were conducted with members of firms operating in this area, including engineers, and senior managers with a range of different roles. Representatives of the telecommunications regulators were interviewed in Norway and Spain. We would like to thank them for their cooperation. Conversations we also held with academics working in the field of telecommunications policy in Spain and the UK. A large focus group study was conducted with 25 members of the EC funded project FLOWS, including engineers, academics and business managers, which contributed to the timeline development and understanding of technical development issues.
<http://www.flows-ist.org>.

communication engineers and investors from the mid 1990s that data transfer capabilities could be an important part of future mass market mobile telecommunications products. Peaking in its frenzy in 2001, this vision has attracted the attention of major IT companies, the cellular mobile telephone operators and telecommunications equipment designers and manufactures, not to mention a host of other firms sensing an opportunity or another bandwagon comparable to the Internet boom. The vision for IT firms is for the wireless networks to become an integrated extension of the data network world, and or from the mobile operators perspective, to make data and multimedia an integrated part of the wireless world. All of this is occurring in the context of the development of 'broadband'. We address later the interests and strategies of these firms with relation to these visions

2.1 Interoperability

Alongside, or part of the general convergence vision are a number of other overarching visions shaping innovation. The first is Total Network Interoperability to create a *seamless network*. The success of the Internet, and of the GSM standard has made it almost an article of faith that all networks and devices should be able to connect together, and operate as one. A device should be able to access services on the network whatever access method or terminal they use. This vision can be interpreted in a number of ways, firstly on the extension of the use of a few dominant standards and protocols, but more importantly, on developing rules and policies on *interoperability* of networks [2], so that multiple technologies and standards can continue to evolve, but in a way that is increasingly transparent to the users. This interoperability could include physical access, data and session routing, authentication, and billing, quality of service guarantees, and seamless switching between different network and access types. Interoperability also involves introducing a 'layer' model into network technology [3, 4]. This logically separates the physical, data, communication session, network service, service management and applications through the definition of protocols that theoretically allow communications to run transparently over different bears services and network types. Business services such as billing, authentication and security, as well as any user applications can therefore to operate across a range of networks. Since the telecommunications industry has changed from nationally bounded vertical businesses to a global horizontal organisation [5] [2] technology firms have emerged that have interests across a wide range of markets, and since the 1970s have been attempting to find synergies between IT, telecommunications including broadcasting and consumer electronics based on development of digital technology. Much of the development of interoperable technologies is conducted through a number of standards organisations that include a core of global technology players. Within existing standards grouping such as the 3GPP (3rd Generation Partnership Project, the European based standards and specification group for third generation mobile systems) interoperability is on the agenda. Behind this vision of interoperability is not only the desire to expand the market for electronic products, but to create universal devices where the technology is transparent to the end user.

However, as we shall discuss this vision is not accepted uncritically, and how important it will be:

"It's probably a little bit too early to say whether seamless handover between standards will become a critical factor. The question is will there be a battle to death for supremacy between standards, or will there be an enlightened self-interest at some point that says 'we can work together in all of our best interests', so they can co-exist? Some will have to co-exist, but there are other cases where there's a competitive feeling, and interoperability is something the industry will struggle to embrace. I'm always hopeful, because I think everyone gains from providing services in a seamless way. Customers don't want to think about those things, and they usually embrace the more ubiquitous technology, whether or not it's superior". Director, European cable broadband provider

2.2 Interconnection

Alongside the idea of interoperability is *Total Interconnection*. While interoperability implies that networks and devices can 'interwork', the actual interconnection is a commercial issue for the network operators. Do we want our networks to connect seamlessly and transparently to those of others, in whose interest is it to allow this? Again, the model of the Internet and GSM (and the POTS and postal service before them) serves this argument. Those who did not connect their network to the common network through common standards died, or at least remained under exploited, as the Europeans do not tire from telling Americans about their mobile telephony industry. Economists see the 'network externalities' of interconnection as providing overwhelming benefits to the operators as well as users, for general purpose communications networks: the more people reachable, and the more sources of information made available by connecting to other networks, the more successful all the network and content providers will be, however extensive the network or valuable the content of any individual firm. However, the actual operation of this is rather different in reality. In the Internet world, free Internet interconnection has been replaced by dominant global network operators, and expensive Internet exchanges, despite transparency for end users. International telephony and inter-network cellular connections still cost far more to the end user than internal connections. Ownership of the customer and end-to-end service provision over a wholly controlled network are the dominant themes in the business strategies of most major firms. It should certainly not be a forgone conclusion that interconnectivity will be the norm. Interoperability with its layer model, offers operators ways of managing many different network technologies and types of data within common control and business. It also offers the possibility to 'layer' industry. Just as operators were divided from equipment business, the layer model implies that each layer of technology corresponds to a different business. Interoperability allows content and service companies to deal with end users while the network operators apparently disappear. This is a highly undesirable position for mobile operators, who learned from the internet that the layer model can mean that much innovative service and profitable business can flow over their networks and which they do not benefit from, while they are squeezed in a highly competitive commodity carrier business. Vertical integration is still a strong strategy of operators who wish to maintain their gateway role.

2.3 Wireless World

There are two other visions that are important in shaping research and development and investment, first the Wireless World Vision. Championed by mobile telephony technology companies and operators, this vision is that all devices will communicate wirelessly, all last mile or last metre connections will be by radio and wires will be eliminated. A variety of radio access technologies can provide every type of interconnection in a much richer and more flexible way than wires ever could. Indeed wireless makes possible total interconnection, in structured or *ad hoc* ways. To make this happen interoperability needs to be solved at many levels of technology. One version of the wireless world vision is that proposed by the WWRF (Wireless World Research Forum) a consortium of telecommunications equipment firms formed to promote research on "wireless communications beyond 3G". They suggest a person-centred series of connectivity spheres ("Multisphere"), each one using a different set of technologies, e.g. Bluetooth for the personal area network (PAN), WLAN for the local area, mobile cellular for the 'global sphere' etc. [6, 7] [8]. However this model ignores the fact that these are not only complementary spheres, but also competing². Mobile cellular can provide personal area and local area connectivity well in many situations, requiring only one radio standard. The owners of these networks have an alternative vision of the wireless world where managed cellular networks provide wire replacement and networking at all levels. Promoters of WLAN technologies also suggest a wireless world vision based round locally managed and ubiquitous short-range radio connected to the Internet.

² Of course, the authors have developed much more sophisticated visions of the business relationships and developments need to make this work. S. Arbanowski, R. Pabst, Klaus Mößner, P. Pulli, X. Zheng, K. Raatikainen, M. Uusitalo, M. Lipka, K. Ott, and Andreas Schieder, "The WSI Reference Model, Wireless Strategic Initiative (WSI) Deliverable 09," IST-1999-12300 Wireless Strategic Initiative (WSI) 12/2002 2002.

2.4 Ubiquitous Computing

The other vision is of ubiquitous computing, of embedded computing and communications facilities in objects, buildings, vehicles and on or in people e.g. [10]. This vision comes heavily from the IT industry, and the consumer electronic industry. Early appearances are in mobile phones, handheld computers, RFID tags of various sorts, devices for the disabled in 'smart' homes etc. Of course this vision relies heavily on wireless technology too: the easiest way to connect many devices, especially when they are retro-fitted to the existing built environment, is to use radio. Interoperability is very important in the creation of ad hoc networks between 'smart' devices. Low power consumption is another key factor, as many of these devices are designed to be transparent to the end user, forgotten parts of the environment, unlike mobile phones and computers, which are highly personal, and attention demanding.

2.5 Personal devices

One of the major trends in electronic products and services has been the individualisation of ownership and use. For example, television and the telephone have changed from being largely communal technologies, to personal technologies. Personally owned and used devices with multiple functions and connectivity are the focus of strategies of several industries, from consumer electronics, computing and wireless telephony, through to television, finance and security. For mass producers, and service providers individualization of these products multiplies the potential market. However there is factor of control, as important as sheer numbers. The point of use is the market key, whether or not convergence occurs in the network, therefore it becomes extremely important to be able to specify, configure and control the devices in the pockets and vehicles of customers. Many would like to loosen the grip of mobile operators. The link between the personal device and the technological environment around - in private and public spaces - is a key challenge.

3. Industry Confrontations

As we know well 'convergence' is much more than co-mingled bits' or interoperable technology, it is about the convergence of industries, of government policy, of regulation, of means of communication and expression, and the remaking of all of these in the process. While there has been a certain amount of predation by one industry of an area previously seen as 'belonging' to another, it is more often the case that the emergence of a new market, a new technology or a new industry is the site of attempts to define and dominate it by a number of different players each with their set of core competences that could be used to shape it. For example, our current topic is the attempt to define the new wireless world as wireless Internet access or as multimedia enhanced telephony. Alternatively there have been convergence movements based on perceived 'synergies' that have been rather less successful, particularly between 'content' firms and network service operators.

In the field of the wireless world we can see important convergence movements, in the sense of definition of new markets and industries on a two dimensions, between voice-based telecommunications and the IT businesses [2], and between existing cellular business and various fixed network and new wireless businesses.

3.1 Telecommunications and the Voice Business

Voice telephony is the dominant part of the mass-market telecommunications industry. The product speech communication has particular demands on the network, and the business is based on connecting people rather than data transmission. The telecommunications industry with its core revenues in speech services and technology is powerful, but it has undergone a series of major changes over the last 20 years, from nationalistic, vertically integrated and regulated monopolies to today an increasingly globalised set of technology companies providing standardised products to national and global operators. These firms have the

technology and business models to authenticate and bill millions of people for payments of less than a penny. The telephony industry uses technology based on switched circuits, which despite the long establishment of packet switching is still important in the mentality of the industry. The main reason is to do with the demands of real-time real-life conversations – humans are very sensitive to disruption in speech, and used to good quality voice communication with no interruptions, delays etc. For telephony engineers Quality of Service (QoS) is an essential concept, and one that applies equally to other services that Telcos have often provided, such as voice conferencing, the distribution of television and radio broadcasting, and non-IP data networks. Digital telephony systems including cellular technologies, are designed with speech transmission first, and have rather different characteristics to network technology designed for data transmission. However the voice industry faces a number of challenges. One is digital trunk capacity where capacity is huge, and has become a commodity market which has slashed profits; regulators and competition have forced down fixed telephony prices, and the same is happening in mobile. There is also the challenge of voice over IP on the Internet, where the Telcos loses control of the use of the channel into the home, and the ability to charge per minute. Finally there is the challenge of increasing competition in the local loop. Therefore Telcos must find new markets and new technologies.

3.2 Non-voice – IT and Multimedia

The IT industry over the last 10 years has been rocked by the emergence of the Internet and large scale networked IT. The Internet boom years were an undoubted success for network, server and terminal technology firms and software providers, but rather less so for the infrastructure and network services businesses. Over-investment in fibre created spectacular bankruptcies. The roll out of broadband has been equally painful financially. Internet protocol made possible this massive explosion in non-voice, but in order to have the final convergence of voice, data and broadcasting, a new version of IP that deals with quality of service is needed and which exists unimplemented (IPv6). It is still not easy to make money from the Internet, and now the equipment manufacturers and software companies also need a way to sustain the expansion in networking, and IT use. Two themes dominate this: the networked ubiquitous computing vision, and the expansion of applications and services available on networks. To do this requires many new sorts of terminals, pervasive broadband and wireless networking, and the promotion of new uses of these technologies, from telemedicine to online gaming. But why do data network firms want to integrate voice: because it is still the dominant communication market. In particular, almost all new businesses looking at serving the local loop have to have a voice capability in order to get customers to even look at their product.

3.3 Wired business

The provision of wire-based telecommunications has been steadily moving from voice to data, and data dominated by the Internet. The providers of these services include traditional Telcos, Internet services providers, large infrastructure firms with global trunk networks, and cable television firms. Bandwidth in the wired trunk is very cheap now as mentioned earlier. The last mile (or local loop) is an expensive and difficult market, often dominated by incumbents. Although voice is still a growing area, the profits are less, and growth is seen in data services, hence the investment in local loop broadband. Bandwidth is not a premium in the wired businesses, who largely now sell unlimited access at flat rates, which in the early stages of broadband uptake can still generate a premium. The development of the Internet took the industry by complete surprise, and is the *de facto* way of accessing services and applications. This means that it is very difficult to make money out of anything except selling connection and bandwidth. However content and applications firms are not particularly happy with the Internet, the free exchange of data between users and the lack of a controlled and simple billing system is a big headache. The dominant terminals for the end user are the telephone, the PC, and increasingly important, the television decoder. The fixed wire industry is seeing an increasing amount of traffic move to mobile services, and wants to be able to harness some of the power of wireless technology for its own use.

3.4 Wireless Business

The wireless business is dominated by limited spectrum and the regulation and licensing of its use. Spectrum is allocated to a small number of firms who have met stringent service or financial requirements, be it in broadcasting or cellular telephony. The spectrum is dominated by broadcasters for historical reasons and is spectrum that governments and telecommunications firms would love to get their hands on. Cellular phone companies have very little spectrum, and often pay a great deal for it. They are therefore keen to defend their investment. Cellular technology enables them to reuse it very efficiently to provide last mile, fully mobile voice connections. Unlike the fixed line business, cell firms have a special relationship with their customers, they provide a personal terminal, and can access them anywhere. The cellular industry sees that mobile personal connection as vital in the move towards converged multimedia services, and have invested heavily in new technology and standards development, we have data-enabled GSM, a complex 3G standard, and future broadband, 4G standards are in development. One interesting feature of cellular networks is that the core networks are privately owned, and likely to switch over to using IPv6. Mobile data access is not defined by the Internet (yet), data services and content can be charged in many ways that Internet firms can only dream of. The operators control these payments. However there is more to wireless than cellular. Broadcasters who would like ways to leverage their spectrum in more valuable ways. There is also broadband 'fixed' wireless technology, of short range such as WLAN, or longer range wireless metropolitan areas networks or fixed wireless access, a competitor and complement to ADSL and cable modems. Fixed wireless technologies are also increasingly able to offer full mobility. Development of business using these technologies is open to all, fixed and mobile operators, new entrants, and even IT firms or city governments.

The preceding characterisation of these industries as separate is, of course, misleading; many Telcos or network operators are involved in a wide range of business, providing mobile telephony, global Internet backbones, local loop and broadcasting, an equipment vendors sell systems in the same to these operators. Within this array, a number of significant groups stand out. Most clear is the divide between firms such as Microsoft, Intel, Cisco, HP and IBM, Accenture and AOL etc in the IT technology and services industry, and Vodafone, AT&T, NTT, China Telecom, MCI, Deutsche Telekom, Telefónica, Ericsson, Motorola, Nokia, Siemens etc. primarily-based in telecommunications. There are also some other firms such as Sony in the consumer electronics sector who have a strong investment in the terminal and content businesses but are not part of core business IT industry, and Philips as an example of firm with a great deal of core technology as well as consumer electronics.

On the Wireless – wired axis, there is one major mobile telephony-only group, Vodafone, in a class of its own, and a few other wireless only firms. Many other cellular firms are parts of diversified telecommunications groups e.g. T-mobile and Deutsche Telekom, Orange and France Telecom, Telefónica Mviles and Telefónica, DoCoMo and NTT. But these firms are normally operationally separate, and often separated by regulation. There are also firms like British Telecom that in the context of the downturn in technology and telecommunications markets, has had to divest itself of its cellular telephone division.

3.5 Broadcasting and Audio-Visual– the Wireless Outsider

The preceding account, contrasting the Internet and IT world with the world of telecommunications by no means represents not the whole story. The largest users of spectrum are the broadcasters. They have their own digital technology and are very powerful players. Much of the innovation is funded, supported and standardised by public broadcasters, who still play an important role in broadcasting in most countries. The creation of digital television is a highly political process.

Innovation comes from equipment firms operating in markets largely shaped by the operators who in this case are the creators and mediator of content. This presents a sharp contrast with the telephony or even the IT world, which has always struggled to come to terms with the production, marketing and management of content. However, the equipment firms involved in broadcast technology include many of same firms that supply consumer electronics and

telecommunications domestic equipment. The broadcast industry has gone through its own upheavals in the last 10 years with direct digital broadcasting by satellite, digital cable networks and digital terrestrial television shaking up the organisation of the industry and choice available to the public, and introducing powerful new private players. The leading suite of standards and technology has been developed by the DVB consortium founded by public broadcaster. This now allows not only broadcasting, but also many interactive services, and opens new revenue streams. Broadcasters are some of the most active developers of Internet and cross-media content that puts them in a very powerful position in the convergence ring. They are also facing up to the challenge of Internet TV. It is thus legitimate to suggest that broadcast industry forms a third pole in the wired-wireless model.

4. Key Business Issues

In summary, the key issues are to do with interoperability and interconnection, and control of integration of the wireless space with the data and broadcasting world. First there is Interoperability at the physical and data level and at the service level. Service level interoperability especially the 3 As – Access, Accounting and Authentication are the basis of commercial issues of interconnection. However interconnection is only one method a firm can apply in trying to maximise profits and growth. End to end ownership and control of multiple networks with interoperability within the business, and ‘ownership’ or privileged access to the customer are key issues.

This raises the most important business issue of all, how to make money. There are three main ways to make money. Firstly, through the economies of scale and the associated efficiency improvements leading to market growth through (which the major operators have traditionally pursued). Secondly, through monopoly taxation of innovative technologies and services. Finally, by maximising coverage (and concentrating of the most profitable parts of the value chain). However the network externality considerations suggest that maximum benefit comes from interconnection and maximising end user access to other people, services and content, a model that undermines the logic of the previous business models. It is not at all clear which model will be most successful, between, for example, what we can call the Internet model and the private interconnected network model. The joker in the pack is certainly the Internet, whose success has had a profound effect on what the public expects, and what firms are able to deliver. It has also had an important effect on innovation processes. The Internet was a publicly funded innovation, further developed through a widespread bottom-up innovation process. Mobile telephony is highly centralised, involving closed standards at many levels, heavily regulated and private, as the industry needs access to large amounts of capital that only big business can secure.

Another issue is the contrasting innovation and operating regimes contrast networks, technology and content controlled by big business, and bottom up spread of the Internet model, with *ad-hoc* development, and open, but competing standards where big business is much less powerful (Table 1). These both offer strong cases for best way create systems for the market, but also compete. In the convergence world these two systems come up against each other.

From the INTERNET world	From the TELCO world
Bottom up development	Top down
Internet style business model (I.e. many, none convincing yet)	Vertically integrated
Heterogeneous supply	Centralised
Decentralised control	End-to-end control
Open innovation	Closed innovation

Network-Edge model	Highly regulated
Unlicensed spectrum	Licensed spectrum (not exclusively)
AAA still weak	AAA strong
Computer industry able to enter wireless equipment business	
Suits US mentality	

Table 1: Contrasting innovation and operating environments for Internet and Telco world see for example [11].

The Head of Standards and Policy, UK / European Mobile Network Operator explains one of the reasons this difference exists:

“There are different development models, historically, between the telecommunications and Internet worlds. The latter tends to develop lots of different solutions for the same problem and then let the market decide between one or more standards. The telecom world involves a more planned and orchestrated process; they are different, but there’s some convergence. Building infrastructure requires standards ... you can only make investment in network infrastructure with confidence that that technology is going to be successful.” Head of Standards and Policy, UK / European Mobile Network Operator

5. Critiques of convergence and interoperability

Convergence and interoperability appear to be so commonly mentioned, that to suggest an alternative scenario is almost a heresy. However some commentators dare to do this, and the strategies of many wireless and mobile firms in fact suggest that the continued divergence (or at least segmentation) of voice and non-voice markets, and of wired and wireless infrastructures will continue, and may in fact be beneficial to consumers and operators alike in many circumstances.

Here are a number of critiques of convergence and interoperability:

1. Voice and data are very different. Voice still dominates revenues, even if data traffic is larger in volume, and even that calculation depends on what is included in the sum. Although may be joined by video, and some stringent data services, it does not necessarily make sense to try and use one core network or radio access system to serve both markets [12]. Convergence terminals actually allow multiple core networks to be linked together, rather than insisting on a single core.
2. The price that bandwidth is sold at for various applications varies by up to 5 orders of magnitude at least [12] [13]. Convergence systems cannot sustain this level of difference, even accounting for various quality of service enhancement. Unless the entire system is tightly controlled then solutions will be found to undermine price differences, as we are seeing in constant attempts to run voice calling over the Internet.
3. An engineering focus on interoperability may be a considerable distraction from other development trajectories for wireless terminals, which firms focused on end users or specific applications may be able to exploit to the exclusion of interoperability focused firms.
4. Control over the terminal is crucial based on this argument. When the end user can buy or configure the terminal to take advantage of multiple standards and protocols this undermines the control of the network owners to offer separately priced services and to access controlled applications and content.

5. Interoperability at network levels may make economic sense in terms of deploying common standards and mass-produced equipment, but interconnection and interoperability at application and service levels inevitably means competition for the same customers and services. This will certainly constrain convergence at a commercial level.
6. The mobile telephone, used primarily for voice, with some messaging and data services, has been one of the most successful mass market electronic products for a variety of reasons, despite very poor interconnectivity, even with other mobile network operators. Firms that focus on improving the mobile telephone, may best be able to sustain their market position by reducing end-user costs, increasing battery life, reliability, coverage etc. Introducing the complexity of multiple radio access standards is by no means the most effective way of developing the mobile telephone, although MIMO could be important in increasing quality of service to users.
7. Complex applications need vertical integrated networks – not disintegration on the layer model. This is especially true at early stages of innovation when close coordination between content, application, service and network operators and equipment vendors is needed, generally with the network operator taking the lead as they have the largest investment.
8. Interoperability allows content and service companies to deal with end users while the network operators apparently disappear. This is a highly undesirable position for mobile operators, who learned from the internet that the layer model can mean that much innovative service and profitable business can flow over their networks and which they do not benefit from, while they are squeezed in a highly competitive commodity carrier business.
9. Single Standards Solutions. One family of standards can be used to provide all types of network access. This is an argument from the developers of 3G mobile standards and specifications. They propose a system that could effectively offer the full range of quality of service all through one set of standards, either within a single frequency band, or by integrating different modes. The deployment of TDD UTRAN to provide local area broadband data is one possibility. This has the advantage of keeping standards development within one established forum, with the same industry actors.
10. Another benefit of single standard solution, rather than radio convergence is that single standard solutions are simpler to manage, and may be just as cost effective in the long run. Telefónica Mobiles conducted studies that suggested that there was no clear cost benefit to developing a network of 802.11 or HiperLAN/2 base stations when the cost of ownership and management is taken into account.

Morganti [12] points out that most attempts at convergence have failed to produce returns. Engineers long ago decided not to try and integrate rail and road transport! Convergence is likely to be a messy business, and although multi-standard terminals will be in demand whatever scenario eventually develops, we need to use other perspectives to throw more light on likely outcomes.

6. Mobile Internet and Rich Voice

To understand the convergence process we have to consider the influence of two main markets: the domestic mass market and the business market. There are a few basic features of the market for telecommunications services. First, is that management of costs, especially in a downward direction, is one of the dominant themes for both individual and corporate users. This particularly so for firms in the wake of the economic slowdown associated with the telecoms bubble and dot-com crash and other economically significant events. It is therefore important to think how innovations in telecommunications technology and service will satisfy this key market criterion. Regulators, with an eye on competition and economic climate are also putting pressure on MNOs to reduce prices, particular in the area of interconnection between firms and internationally.

6.1 Corporate users – VPN connection

One key growth market mentioned by the interviewees that we surveyed is the growth in the provision of Virtual Private Networks (VPNs). These integrate the telecommunications – Internet or voice, of firms, and enable them to manage costs for each employee and for the firm as a whole. It is an example of how financial stringency stimulates new business and innovation. This in turned opens up the possibility of integrated mobile Virtual Private Networks (mVPNs) – the integration of voice and multimedia on common mobile and fixed platforms.

“The reality is we are in happy enough time where the capex of the corporates are being reduced for one and half year, two years, so the spending of corporates has been drastically reduced after the Internet hype so this is a reality. We are very successful providing corporate VPNs. When we talk about corporate VPN actually up to now what’s more or less voice ... but also the first, the big application is the Internet access and the mail access so we are delivering that. We are already delivering Internet access. Security is key for corporate. So when Internet is, the security mechanism that allow corporate employees to access their Internet and also the basic service that every single company has... . These are the two basic services we are already incorporating into the corporate portfolio. The current development is to have a voice plus data integrated author and this is why we are working right now.” Nunez, Telefónica Moviles, 2003

As a Nokia brochure points out:

While the corporate end user’s method and device used for connectivity may range from wired to true wireless, the content being accessed and the infrastructure where it resides are still very much wired and IP-based. [14].

This firmly puts wireless in the camp of the Internet and as an extension of the wired world. It also is a firm pointer towards convergence solutions that integrate private networks including WLAN and private MANs with broader public cellular and WLAN networks. All this has to be provided in an integrated package with strong accounting and security facilities, all strengths of the MNO that can integrate with a wired business, or of the MVNO with access to multiple networks.

6.2 Mass Consumer Market

The mass market is also being satisfied by new technology. The launch of Hutchinson’s ‘3’ UMTS service in the UK is drawing customers purely on the basis of a voice package that effectively gives complete control of costs by offering a high number of inclusive minutes. The voice plus strategy hypes new services, but talks ‘controlled’ cost. Based on a voice model, video calling, entertainment and information services are extra features to encourage users to occasionally spend more, though these are not presented as central to the use of the terminal.

There are certainly two markets, one which can be called the rich voice model, the other one the mobile internet. This division is recognised by the operators:

“It’s not so simple as doing something in the enterprise market to spin off into the consumer market. We’re looking at different markets, albeit perhaps the same end-user. There’s already a range of mobile applications in the enterprise market, either specialised services for a particular extended workforce, or simple things like email and corporate Intranet remote access.” Head of Standards and Policy, UK / European Mobile Network Operator

“Yes, mobile broadband, they’re buying into it. Yes, we see the market, especially for the mobile operators, in two spaces. The one space is the traditional area, is to say yes, do your STD networks that’s fine, provide your voice video, customised entertainment, ... data services, MMF, from your handset. You’ve got your standard voice type services, plus your value added services but as a package you want to ... offer mobile broadband ... incremental package that people will have. They’re not

going to get rid of the handset clearly, but likewise you can't get rid of the PC either. So we see these two things co-existing together." Ipwireless, 2003.

"Because I think there are two parallel line in the world. The Internet paradigm, content, delivery, access, those are the words that are key, and there are some wireless operators they are more or less replicating the Internet model into mobility and our concept is this is good and this is part of the service we are looking for. But first and formerly, we have to solve the person-to-person thing and we say, conceptualise our customer like a content provider. So in fact, if we have 18 million customers in Spain, or consumer customer, we have 18 million content providers. So the conceptualisation is if I call you it's because your content, your voice and your thinking is valuable for me. With this concept then you can elaborate much more the whole model that just put in. Connectivity service on one side and content delivery on the other side. So this is the other explanation of our... . We are elaborating services that help person-to-person communication to happen. So the first value added services for instant are basic ones." Nunez, Telefónica Moviles, 2003.

This last quote hints at the difference in the whole approach to the two markets: one based on the Internet, and another on building various value-added services on the back of the voice market.

A key part of the investment calculation for wireless networks is that they offer access to network applications and 'content' that can be sold at a premium. The layer model suggests that each business layer is run most efficiently by specialised firms. Content and applications companies should run their businesses, and network firms theirs. However to sell network services one needs to sell content and applications. Bell had to work hard to sell voice calling as an application of his telephone system. It was also used for point-to-point transmission of 'content' (and is still used for broadcasting today). Eventually the transmission of voice and the switched voice calling service were vertically integrated, along with commercialisation and customer support. The vertical model worked well for a 100 years. However the experience of the Internet, and interconnectivity project suggest disintegration of the business model again. This ignites a tension: it is very hard to sell new technology to end-users without clear uses including the content and applications in the case of telecommunications. This means it makes sense to maintain the vertical integration, so that end users services and new network technology can be launched and innovation managed in parallel. However firms that build and run large-scale network technologies are not always the best at flowing short-term content fashions, or able to focus on in depth business service development that integrates applications and network. Indeed MNOs were slow to recognise even the most simple messaging application SMS. This places MNOs in a difficult situation – they risk stifling innovation and competition by strong vertical integration, but unless they are very active in developing these applications market growth could be very slow. The path than most have chosen to take is being a strong and active intermediary between content and application firms and end users. This enables them to maintain strong control and branding over the whole wireless business market.

However the Internet offers a particular model of the relationship between end consumers, network operators and third party content products and application providers that many find threatening. Despite its staggering success the Internet has not made it easy for either network operators or content producers to make money. It has also created a communication and information environment that is powerful in its interconnectivity and for user innovation, but anarchic and confusing for many users.

Although it is to a certain extent a simplification there are clearly two models for what new wireless systems can provide, which will shape the emerge of convergence terminals and demand for bandwidth.

First, the wireless world as an extension of Internet: core networks are switching to all IP protocol, voice services, broadcast radio and television are being subsumed into the Internet. New radio technologies are just ways of making the Internet terminals wireless. All the content and applications that one could desire are available on the Internet, or will be shortly.

Internet technologies can provide security, authentication and billing. Anyone can become a content publisher on line. There is a critical mass of e-mail users content and application providers, why try and develop an alternative closed system for applications and content? This perspective is certainly that led by the IT industry. Wireless operators should provide the same sort of flat rate network access that Internet users are used to, and not get involved in developing applications and content. Potential customers now understand the Internet model, and expect to get access on similar terms to all the applications and content on line via wireless terminals. They will pay for access and, but, under this view, it is pointless trying to package up and sell individual services at premium levels, or try and pick the content that people may want to use.

The opposing view is the 'rich voice', model of wireless services and content provision. This states that new wireless services for the mass market will be based on the telephone handset, so will be primarily used for voice, with additional services. Messaging capabilities have proved successful at a considerable premium for operators, these can be extended to entertainment information, video communication and the like.

6.3 Billing

The billing engine is key to understanding the Telcos' strengths in the rich voice market and as providers of VPNs. One of the crucial applications that Telecoms and MNOs in particular have installed on their networks are billing systems. They are able to bill per second of voice or video call, per message or per kilobyte of data, or for any other transaction. Associated with billing are the security and authentication systems that make it secure and trustworthy. This can be offered as a service to subscribers and content companies.

"We have the capability to bill, invoice the customer, and it's up to a third party - we are not the creators of all the content, we understand that the clever people is outside and if they are clever enough and they want to be reached we have a billing machine, an access network that allow them to sell their product." Nunez, Telefónica Moviles, 2003.

MNOs also have the capacity to bill individual terminal users, rather than households or companies that have fixed lines.

"And I think the mobile operator has a big advantage over the fixed operator because now the world about ... and billing everywhere. Fixed operators normally bill a home or an enterprise, doesn't bill an employee or a person. We have the billing engine capable to bill senior persons." Nunez Telefónica Moviles, 2003.

Rather than having just one way of billing, this sophisticated billing system allows operators to package 'service products' to bill for any unit – a piece of information, a photograph, a phone call, irrespective of any actual costs to deliver, or relative the cost of another service product. Typically flat rate charging schemes are sold where the right to use a certain number of units of communication are sold for a fixed price. This makes it easy to find the market price for individual services, rather than relying on a one size fits all

"We have the capability to bill, invoice the customer, and it's up to a third party - we are not the creators of all the content, we understand that the clever people is outside and if they are clever enough and they want to be reached we have a billing machine, an access network that allow them to sell their product." Nunez, Telefónica Moviles, 2003.

Billing systems are important for convergence networks and for convergence terminals, because they potentially allow use of many different wireless access systems into one bill for the end user. Today, Nokia is promoting a system that allows firms to use the same billing system by using the subscriber's SIM as identification for both Voice and WiFi networks. T-mobile in the USA is offering an integrated billing system for their cellular and public WiFi hotspot customers.

6.4 Rich Voice – ‘making profits’

The mobile operators are able to charge in many different ways, and use this to extract the maximum payment they can from users. The core expertise of MNO is person-to-person communications, and the rich voice model is built on that. The case for rich voice and the mass market is explained with the words of a senior manager at Telefónica Moviles, Nuñez:

“It’s always adding value to the person to person communication that’s key for us.”
Nunez, Telefónica Moviles, 2003.

“There are basic services and of course for a telecom operator the basic service is voice and then you have value added services that can be either voice, data or machine to machine... So service means for us anything that can be offered and billed to the end customer.” Nunez, Telefónica Moviles 2003

“You can go all this in voice and you can imagine whatever, conference calls, automatic assisted information doing a calling conversation where you can imagine is the future we are looking for enriching the person to person voice communication. Then it comes the paradigm of writing, messaging and this is the most successful second key application for mobility right now and the position is very clear.” Nunez, Telefónica Moviles 2003.

It is also about gradual evolution, not throwing everyone in the deep end of mobile Internet and hoping they will find a useful service. The WAP fiasco illustrated the difficulty with this approach.

“[The industry] went into 3G in the early days thinking that there’d be a big generation step – it would implement 3G like it did 2G at the end of the 1990s – we’d all move over to the new technology and there’d be lots of new services. We’re now seeing more of an evolution; the delay in investment of 3G is giving 2G and 2.5G time to be used for developing initial services, so we’re no longer necessarily defining this as being either a 2G or a 3G – it’s more of an evolution.”
Head of Standards and Policy, UK / European Mobile Network Operator.

“We can design many things but we are trying to focus only on there are new services that are affordable and can be demanded by the market. So this is important because we are not just exploring whatever is possible but from the very beginning we are making parallel business analysis.” Nuñez Telefónica Moviles 2003.

Every innovation is about getting more income:

“We are looking for new values, new services that make the customer to spend more money.” Nuñez, Telefónica Moviles, 2003.

And getting to people to spend money without thinking, because on the spur of the moment they can be persuaded too.

“The same people that understand therefore are flat Internet access, they have to pay 30 Euros a month and have a free email. The same people will pay 1 Euro for an SMS or 0.5 Euro or whatever, so the human being is something sometimes irrational but well, this is all the business about.” Nuñez, Telefónica Moviles, 2003.

“It’s not just a single service, it’s a concept that is a very important differentiator at least from the work perspective, from the Internet paradigm. This is push capability. Because we have the terminal, the handsets in the pocket of the customer 24 hours a day. We are only able to send something by direct to them.... . On the Internet this is not possible because people are not looking.” Nuñez, Telefónica Moviles, 2003.

Ubiquitous on-the-move access is another key to rich voice concept on mobile technology that WLAN with its Internet model cannot deliver:

“I mean probably not quite, you won’t get the same sort of peak through puts that you get on wireless LAN but you have to say that 384 kilobits is not slow, it certainly

can compete with ADSL. And we do actually believe that them, which is why we paid 4 billion for the license to it, people's lifestyles will change and they will want to do everything on the move and 3G is the main enabler for doing that. Wireless LAN doesn't, because wireless LAN isn't ubiquitous, it's just hot spot. And probably always will be." Senior Engineer, Orange.

Many MNOs agree that the mass market on the move is the key because at the end of the day, however many business contracts there are:

"The real money-maker is the high volume consumer." Director, RF Technology Systems, Network Infrastructure Provider

It is often argued that mobile Internet business is relatively small – not many people carry laptops and want Internet connections. There are only a few nomadic workers and they just want basic e-mail access in their hotel, service station or airport lounge. It is important market to address, but most customers want simple, phone based, packaged services that they use impulsively.

The mobile operators thus have a clear view about how they would like to make money using their billing system and control over the terminal in their customer pocket, and will do everything they can to make sure they are allowed to continue operate this way. What they fear is the Internet model:

"You will hear me all the time talking about two worlds, the free world of the Internet and the business of the mobility. OK? They are different models and in the Internet, no one has a SIM card that can prepay already able to be invoiced by an operation and this is why Internet has value because nobody can pay. In mobility everyone, operator, has ability to extract from your pockets some cents or pennies, ... So this billing enabler makes the business to happen. Then, behind us there is a whole industry of contents that have to use this billing machine to make the business. So there are two approaches to this. The Internet world normally and ... all the stuff is just a battle for free, free, free. And freeness costs reduction, competition on bandwidth, flat rate, free access within the weekend, free access..." Nuñez, Telefónica Moviles, 2003.

6.5 Mobile Internet – 'destroying value', promoting innovation

The arrival of WLAN and its potential to threaten the 3G business model is spelled out by Nuñez:

"The real risk for Wi-Fi, sometime say well wireless operator are risky because Wi-Fi is for free, well the real risk is for the whole industry because Wi-Fi could bring the concept to the end user that everything can be paid by a single flat rate per month so you destroy the element values of the email, the SMS, the conversation, video conversation or meeting conversation, the push whatever. Now in the world zone we are making relevant every single product and putting in a price for it and we are ... to build by ..., by kilobyte, to come in by DSL operator selling by kilobyte they don't understand. They just without any billing say you are a user, I place a bill, the same bill every month. This is as complex as I can achieve. Now here in mobility we are making that bill that take into account the hour where you are calling from, where you are calling to, which are the interconnection, which are the events, the size of the SMS, the colours, we are so much enriched in value for creating the business of." Nuñez, Telefónica Moviles, 2003.

"But of course it's more simple you pay 30 Euros a month for a DSL, this is simpler. But again at the same time you are destroying all these rich full environment for selling every goal your team is scoring. We are, in our ..., selling every goal your team is scoring. You cannot do this it in ... service." Nuñez, Telefónica Moviles, 2003.

They are right to be scared, but are they right to think the mobile Internet is just a small share of potential business? To deny the promise of the mobile Internet would be folly, especially as

the Internet is starting to mature and incorporate more and more sophisticated technology, and is used by nearly 50% of the population of developed countries. There is a demand for wireless Internet connection, and the mobile network operators are not presently able to satisfy it, creating a business opportunity to invest in public wireless LAN infrastructure. Technically there are problems adding wireless to the Internet. Many Internet applications are unable to deal with the delays and lower bandwidths associated with wireless links. Adding wireless connection is not just an issue for the network layer, but affects applications considerably.

Building value added services in the rich voice world involves a degree of vertical integration, with portals such as Vodafone's Vizzavi, and business agreements with content developers to develop and promote location-based services, and entertainment and information services. It assumes that most customers need a guide to find the services and limited choice.

The Internet model suggests that most potential customers understand very well on line information and advanced communications. They want it easily, but are coming to expect ubiquitous access to content. Promoting the idea of the mobile Internet, and the inability of existing operators to deliver it is the marketing manager at IPWireless:

"Our view is that we don't want the walled garden, that the real growth in the market will be from giving unlimited, far cost effective access to the Internet." IPWireless.

"So our solution is able to deliver 1.5 megabits per second to every user, but it's able to do that with full mobility."

"We believe that people want access to the Internet, that the Internet has all the applications and services that people require and they want to access those applications and services from a laptop or a PDA using an interface, a user interface that they're comfortable and familiar with, and they want to access that in multiple locations. Laptop sales is a ...growing segment, really ... sales in Western Europe, USA, they're growing over 54% compound currently. Computer sales are flat to declining. So there's a clear demand for mobility." IPWireless.

"You know, you look at GPRS today as an example, the company all touted it as a the mobile Internet but A, it's very, very slow, far too slow for what people need, and secondarily, it's very, very expensive. We estimate that an average corporate user needs to download about a gigabyte of information a month, with a standard working practice. If you try to do that on GPRS it will cost you a fortune." IPWireless.

In conclusions there is a good argument for single standard mobile phone based business, and it is clear why the internet model that could come on the back of WLAN is not at all a favourite of the Mobile Operator. Content producers hated the Internet too as it was so hard to make any money from it, so despite reservations (Interview with Spanish newspaper and publishing companies confirm this), they are willing to work with the firms who can send out bills.

However the mobile Internet has a strong case. Operators are addressing it though mVPNs etc. It is a concept of access to content and applications that is being heavily promoted by firms such as Intel. The big question is whether convergence devices linking WLAN and cell phones will be laptops and PDAs for mobile internet access, or whether people will pay for 'rich voice' on various entertainment and networking devices, and the ubiquitous mobile phone?

6.6 Current Business Environment

The current business environment for investment in telecommunications is relatively difficult, although improving as demand for data services emerges, and finally 3G and WLAN hotspot networks come on line. The market and technology are uncertain and unstable. Standards are in place for 3G and some key standards in DVB and WLAN, but many others are still open. New types of business that could inject new money and vision into telecommunications, such as mobile virtual network operators, are closed out of many markets, and MNOs are ambivalent about whether they will help drive the market or

undermine their market position. One common factor in all market players is the need to save money. Equipment vendors are cutting investment and workforce, network operators need to cut cost and meet heavy investment obligations. Corporate customers want to control spiralling communication and networking costs, and so do mass market customers. Equipment vendors from telecommunications and IT industry all have their existing markets squeezed and need to develop new markets. To succeed they need to show how those products and service can save their customers money.

One crucial issue is the strength of the mobile operators to define and control the introduction of both new technologies and new services, in the fact of technology firms and application providers. They have difficult choices to make about what their business is, and where the maximum value is to be obtained – as bit pipe operators, wholesalers of radio access, value added service providers etc. Europe in particular has a mixed regime of smaller national operator and a few international groups, a reflection a change process that is still not complete. Greater consolidation across national boundaries is certain to occur, creating fewer more powerful groups capable of dictating technical change. It remains to be seen if the actual operation – ownership, building, maintenance of the physical networks remains integrated with the commercialisation of services and applications based on that network, or becomes a separate business layer, or even taken over by the technology vendors.

Despite some major differences of interest and future visions between industrial, their financial backers and governmental actors, many act in a highly reflexive manner, constantly reevaluating strategy, entering into alliances to take advantage emerging demand, or changing their market position. In particular, shareholders are able to command considerable influence forcing change, consolidation and business separation. However in some important cases these are governments, who have strong political agendas that reinforce particular structures.

7. Conclusions

This paper has studied the prospects for multi-standard terminals from two perspectives: the idea and reality of convergence, and the business model for providing services using telecommunications technology. There are strong forces trying to shape the meaning of the wireless world with two application models, rich voice and mobile internet that represent two completely different innovation and business models. This will have important implications for the way convergence develops and place of different actors in the value network.

Equipment makers are looking for synergies between product divisions. They want to expand overall market with more types of devices with more capabilities. They also want to provide solutions to network operators, private intermediate and end users. There are different markets, the small number of network operators who offer big business deals, but drive hard bargains, and the mass market that offers initial high returns but hard to satisfy as technology forms only part of the package that people buy.

Equipment vendors need to convince operators that convergence is important, and then offer solutions that enable them to take advantage of it and especially to control the development of the market, and able them to offer specific value added services etc.

However in the mass market they compete against the vision of the IT firms who propose an Internet-based vision of convergence, making wireless an extension of the wired Internet world. Fixed wire operators can also imagine convergence devices as a way to enter the wireless world.

Mobile Network Operators want to expand their business and generate income, WLAN seen as a rather open business opportunity and also a threat to 3G, so they need to need to find ways of control it. Convergence systems are clearly a business advantage as they give access to more radio spectrum to carry multimedia traffic, saving valuable space on 3G and 2.5G networks that can be used for higher value business. However supporting and promoting several new standards at one time could confuse the message to the mass market, though it will satisfy sophisticated customers.

Broadcasters also see the opportunity of reaching audience away from traditional spaces, and expanding the revenue opportunities of datacasting and interactive TV. Mobile convergence is one way to get a back-channel, and piggy backing on the marketing and platforms of the mobile operators, sharing costs and risks of developing mobile broadcasting.

Two key issues that emerge are the control of the end terminal, and through it the access to the network and the customer, and the changing regulation and access to spectrum that is occurring around licence free and new spectrum releases. These issues are investigated in depth by the author in other papers based on the report Cost and Benefit of Use Scenarios: The selection environment for MIMO-enabled multi-standard wireless devices including cost benefit analysis of various convergence technologies, Prepared are part of the FLOWS research on simultaneous use of standards in multi-standard devices [1].

7.1 In Summary

- Convergence devices will happen.
- But convergence will be controlled by the operators to a great degree.
- Smaller devices satisfied with 1 or 2 standards (e.g. rich voice phones).
- Customisable devices (PDA->laptop) – allow user configuration.
- Mass-market production of plug-in units and individual chipsets will allow important economies of scale necessary for success.
- More expensive integrated multi-standard units may be delayed by market?

- Need a firm or industry to champion convergence for it to occur.

7.2 Implications for Policy

- Convergence could reduce over-all competition, so it will be necessary to allow new types of operators – MVNOS and WLAN only operators as well as new 3G operators.
- Encourage convergence as a solution to the expected slow arrival of 3G systems.
- Allow multiple systems to be run by the same operators, convergence devices will integrate them.
- MNVOs will play a key role in convergence if supported.
- Allow major WLAN operators to be treated like mobile operators – roaming agreements will need to be made between WLAN and cellular business.
- Do not allow operators to restrict the type of device that connects to their networks – as long as it conforms to specifications.
- Convergence devices will enable one network connection to substitute for another when there are pricing and access restrictions: this should help force down prices in mobile systems.
- Releasing digital TV spectrum for data casting would be a strong incentive for convergence devices.
- Allow higher power WLAN and the operation of private MANs/WANs
- Allocate more spectrum for WLAN which will stimulate investment and innovation to include convergence technologies.
- Allow leasing of spectrum – this allow various systems to be tied together by MNOs

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