MOBILITY AT EVER HIGHER SPEED?

Coverage vs. Capacity- an Innovator´s Dilemma

1.Introduction

Among the wide variety of the phenomena of industrial life to which the industrial networks approach has been applied, processes of technological development has a special position. In a large number of studies, the importance of industrial networks in invention and innovation processes has been demonstrated (e.g. Håkansson 1987; Lundgren 1991). Lundgren (1991), for example, showed how firms in formerly fairly unrelated industrial sectors were connected in such innovation processes, linking different technologies.

During the 1980s and 90s, a popular view of such linking of different technologies and different industrial sectors emerged with the emergence of the concept of ”convergence”. In focus were mainly three industrial areas: IT, telecom, and media, sometimes comple - lemented with the area of household appliances. It was widely assumed that the future would see the thre/four sectors coming together into one, changing the patterns of competition and cooperation, and leading to new technological innovations, new markets, and new demands for products and services. There would be a confluence of hitherto separated markets, requiring new forms of co-ordination and co-operation between firms in different industries.

The idea of converging industries and technologies also connect to tthe notion of overlapping networks. i.e the dynamic process when firms take strategic actions which change the interconnections and interdependencies between two or more networks of firms. Mattsson (1998) argues, for example, that such network openness has a dynamic effect. Overlaps stimulate strategic actions and strategic actions affect overlapping. Hence, inter-organisational systems overlap and organisations play in more than one arena of action at a time.

Convergence and overlapping of industrial networks is clearly visible as an empirical phenomenon in many industries. One of the best examples is the socalled ICT industries (information and communication industries). This, mainly empirical article, gives an

example of the dynamics of this industri, focusing on the efforts of the mobile industry to catch up in speed compared to what is already delivered over fixed networks. The vision has been to use the radio-waves not only telephony but also for the delivery of content like music and video on an Anywhere/ Anytime basis. ”Internet in the Pocket” for short. However , also other industries are also aiming for convergence but from quite different starting points. The computer industry has ambitions to add voice telephony to their data communications offerings, drawing on the large cost savings enabled by the Internet (TCP/IP) technology. As opposed to the mobile industry country-wide and anywhere coverage is not high on their agenda. The priority is rather to provide high capacity and speed at the low cost achieved by more localized investments in traffic-dense areas only. The content industry looks to be even more pragmatic. The different technologies and infrastructures considered to be merely a matter of alternate distribution channels. The very same (digitized) content can be fairly easily be repackaged for delivery over any combination of networks to any kind of digital device.

Given these clashes of agendas in between the industries, which are the chances for the mobile industry to fulfill its oriigal visions from the days before the collapse of the IT-bubble? Back then, mobile operators in

Europe paid a staggering 100+ Billiion Euro for the very license to build and run a 3 G (Third Generation Mobile) Network. In spite of the need to invest another 200 Biillion Euros into actually building the physical networks and to market (subsidize) the brandnew, and hence costly, handsets required.

At least in retrospect, this looks like a “ Mission Impossible” and a number of players have already withdrawn. As can be expecte

Intro

We have been spoiled by the ever-faster data communication speeds available over the fixed network. It is now possible to download music or a heavy ppt-file as speedily as a single text-page some years ago. To view television over the Internet is yet another option. There are good reasons to speak of a revolution, enabled by ongoing techno-logical progress.

No wonder therefore, that the mobile industry has spent considerable resources to reach similar speed increases, enabling the delivery of more advanced services. The mobile phone could be more than just a phone, but rather a more generic " digital device" by which all kind of services are available on an any-where/ anytime basis. There has been some progress in this direction as it is now possible to receive send e-mail as well as (still) pictures from about everywhere, even onboard fast-moving trains. However, this is still a far cry from the once popular visions of a fulfilled and happy marriage between mobiles and the Internet. That everything you could do from your office or your home should also be possible on the move remains an unfulfilled vision.

Just a temporary setback due to unavoidable teething problems? Or are also more basic issues at play, like the inescapable trade-off between coverage vs. capacity? These are the questions to be addressed in this paper with reference to Christensen (1997 and 2002) writings on the phenomena of disintegration and disruptive technologies

Background

Some years ago the success of I-Mode in Japan, Blackberry in the US and SMS (Short Message Services) in Europe aroused interest among investors worldwide. The reasoning seemed to be that if slow-speed services were so much in demand, then increasing the speed and capacity in order to provide even richer content would uncover

new demand and new revenues to be shared among operators, content providers and other vendors.

As indicated above, the proven success stories like I-Mode in Japan, SMS in Europe and Blackberry in the US are working at low transmission speeds. Even sending and receiving digitized photos directly through a cell-phone or a PDA does not require more bandwidth compared to what is now used for voice over mobile networks. Thus also MMS (Multi-media Message Services), which is supposed to supersede simple SMS messaging, can well be handled even at present speed levels of, especially if supported by Java and other means to minimize the need for more transmission capacity. However, they are offering other qualities that might be of greater importance to customers, like reliable nationwide coverage and low cost for each transaction, not to speak of the importance of "Always On", an inherent feature of packet switching as opposed to traditional circuit switching. Getting a laptop up to work is still a matter of minutes rather than seconds. Any device and service that can provide instant access is a winner for those on the move. This might well be one of the reasons behind the success of I-Mode in Japan as opposed to the failure of WAP in Europe that was launched prematurely, before the availability of packet switched services.

Given these mixed customer reactions it is a bit surprising that mobile operators have been so obsessed by the increase of sheer transmission speeds rather than other qualities where they can still claim a unique advantage. By contrast any migration to higher speeds in a mobile network is bound to provide less revenue per MHz or Mbyte compared to plain voice or other not so capacity-hungry non-voice services, like SMS and transmission of still pictures. Any downloading of hi-fi music, not to speak of movies is simply not realistic unless the price per Mbyte is drastically lowered to a level encouraging arbitraged delivery of more basic services Other options like Wireless LANs (WLANs) can offer radically lower costs for higher speeds at a rapidly increasing number of Hot Spots. However they are by definition local and any nationwide coverage and roaming is still far off. By contrast conventional cell networks (2 G/ 3G etc.) can offer superior geographical coverage, but not high-speed access without a heavy cost and price penalty. There is an inescapable trade-off between coverage vs. capacity, which can be seen as an example of the Innovator’s Dilemma. (Christensen 1997). Both

qualities can’t be increased in the very same network without a consequential price tag chilling off even the otherwise most enthusiastic potential customer.

There is some similarity to the airline industry. Newcomers can choose to be more “ localized” and to offer frequent and cheap connections on an A to B basis between major nodes. Conventional airlines can’t respond price-wise without quite drastic measures, uprooting their historical mission and heritage. Cf. also with Kaplan (2002) on the strategies available to Dell vs. Compaq

Any successful broadband service has to attract the interest also of third parties, such as the providers of content. They are not bound to use any specific kind of network as their distribution channel. Digital content can readily be re-packaged for access through a plethora of different networks and devices. In order to attract content, and hence endusers, mobile operators have to engage in some scheme for revenue sharing. However, there are simply lower margins to be shared for capacity-hungry content compared to content in less demand of any higher speed. (like poly-phonic ring signals, maps and still pictures .A possible way out from what looks like a Catch 22 for content providers and mobile operators alike could be a multi-channel approach. Operators of " 3G" networks could survive by providing anywhere/anytime instant access, coverage and position-based services, but also by referrals to locations where more content-rich services, provided by e.g. WLANs can be accessed and downloaded Some of this might actually come true for the operators of Wireless LANs (also known as WLANs, Wi-Fi, or 802.11) now rapidly being deployed at airports, railway stations, hotels, restaurants and even be made available inside aircraft and trains. As these services can provide speeds up to 54 Mbps they have a claim for the much-touted marriage between Wireless and the Wire bound Internet. However, the very merit of providing "true broadband" takes away a bit of the newness seen from the perspective of the content providers. Pricing and other aspects of the business model might look pretty much like those that apply to fixed broadband and other flat-rate services. Some possible exceptions to this simple observation will be discussed later after new mobile services such as "3G" and "2.5G" have been brought into the picture.

Cell phone operators have settled into a “generation” mindset, where “1G” analogue voice-only networks were replaced by “2G” digital voice-only networks, which in turn were to be replaced by “3G” voice and data networks. The movement from “1G” to “2G” went well, but the jump to “3G” has not. The original concept of UMTS (3G) was laudable especially since users were assumed to be able to use the same device in Europe, the US and in Asia. That vision has foundered on the rocks of lack of coordinated spectrum between the US and the rest of the world, spectrum scarcity most everywhere, resultant high prices for the spectrum available, hardware and software development problems, and perhaps most importantly, customer disinterest. The solution has been a mid-generation or “2.5G” solution (also known as GPRS), offering low-speed data and digital voice in the existing “2G” bands. It is in this generation I-Mode, SMS, Blackberry, and most other cellular data services currently are available

The outlook for mobile operators geared to provide true "3G" services looks less promising, even in the longer term. The reason is that higher speeds over a 3G conventional implies not only higher costs, but also less revenue per MHz compared to using the available and scarce spectrum for less "capacity-hungry" applications such as voice, SMS (Short Message Services) and email. Consider the following. Each 3G operator has a finite number of channels to offer customers per serving point and, although the channel may be used for either voice or data under 3G, it cannot be used for both at the same time. Therefore, any high-speed data channel in use takes away voice channels. Since the 3G model calls for data service to always be available the ability to deliver voice calls will be reduced. Costs increase in proportion to speed, whereas revenues per used capacity unit are bound to decrease. Now consider the pricing model for data use throughout most of the world. Users expect to pay for packets or for flat-rate access, not for time of connection, and neither volume nor flat rate pricing is likely to replace lost revenue form voice or SMS-type usage..

In any case mobile operators look bound to charge for capacity used, whether measured by minutes or Mbytes, given the scarcity of frequencies.[1] By contrast, most providers of public WLANs look bound to provide flat-rate services, even if access can be conditioned by permitting use only per day or per hour. Others, like airlines or hotel chains, might find it of interest to provide more or less free access in order to attract new customers. Cell phone operators might well use flat rate also in the introductory stage. At least in the short-term, operators might also be inclined (or even " forced") to give away handsets as well as content for " free", in order to boost the usage of idle capacity. Some money is better than no money, and the building of a customer base can be seen as necessary investment This is however not a sustainable strategy, not only because of any possible failure to attract large enough numbers to foot the bills to be paid to handset and content providers. Also a possible success poses a problem as operators then looks bound to fairly drastic price hikes to discourage "over-use" of high-speed access draining their capacity to deliver slow-speed (but higher-margin) basic services.

Perhaps a bit more discussion of "value-based pricing" is in order. "Value-based pricing" is already in full use when it comes to basic SMS. A fixed price is natural because the content size is also fixed (to 160 characters, total). When it comes to premium SMS with logos, ring tones etc. pricing based on "perceived value" is also natural as a basis for the revenue-sharing between a content provider and an operator. Fixed pricing is also logical when it comes to sending MMS-messages such as still pictures from camera phones. as it again is a matter of only a fraction of the capacity needed for voice calls. There is however a limit to how far a fixed price (for a given content) can be scaled up, as the users have other options rather than to send and receive content using mobile handsets as the only tool. As a case in point: Pictures taken by a camera-phone can also be uploaded to a home computer to be forwarded as plain e-mail attachments to a number of recipients. These other options might be even more attractive when it comes to applications actually requiring higher speeds, like downloading of music or films. The sheer capacity cost increases in proportion; taking up more and more of the total "perceived value" and leaving less and less room for a content

provider to get its share. Not to speak of the battery drain, and the need for more memory and processing power without undue increase in size, weight and cost for the handset. A more realistic scenario is that reception of music to a handset has to be limited to far less speed- thirsty streaming, whereas video has to limited to a 15 seconds clip as a preview. Any serious downloading can often await access to far less costly options, such as Internet access via a computer directly linked to the fixed network or via a WLAN Hotspot.

That said, the market for wireless non-voice services is not only a matter of deliveries from content providers, even if they clearly have a more crucial role for the take-up of non-voice services, as opposed to traditional voice telephony service where the users were their own (and hence unpaid) providers of content on a real-time basis.

Also in the forthcoming non-voice era the end-users and customers themselves might simply produce quite a large share of the content, not only by email but also by photos of the kids sent to grandparents and photos from tourists from their own camera (phone) rather than postcards. Within the business sector, access to the company Intranet (more or less internally produced) might be the driving force. The human urge to communicate is fact of life, which even Graham Bell failed to recognize as he assumed that the invention of the telephone was to be used for one-way access to concert halls, instead for direct communication between people. (Now labelled " peer-to-peer communication").

The very difference between the historical worlds of voice-telephony vs. the present menu of non-voice services is about timing. A telephone conversation has (by definition) to take place in real time and involve at least two actors. Whereas non-voice communication over the Internet is less bound by the condition of any real-time presence of more than one user. Even if two or more persons are involved, also the liveliest "conversations" can well stretch over a number of days, and hence be independent of any real time or time zones. This is bound to have deep-going consequences especially to the wireless segment of the tele-com industry, for which immediate access anywhere/ anytime has (rightfully) been seen as its quite unique selling point. As soon as users consider the content less crucial with respect to timing and geography, they have a number of

less costly options. Which at the end of the day might well be welcomed news (a " relief") also for the cell net operators.

Madness vs. Smartness

Against this quite dark picture, how come those operators in many European countries back in 99/00 actually paid such staggering amounts (more than100 G Euro) for their 3 G licenses? As shown by a number of studies from Chalmers University e.g. Bohlin et al (2003) the financial outcome brought even the largest operators close to bankruptcy. A non-surprising outcome even without the benefit of hindsight, as also ex ante calculations showed the prospect for any payback to be highly uncertain.

A number of possible interpretations of this paradox have been offered. The most common refers to the overheated conditions at the peak of the "IT-hype", where the sky was the limit. Many of the operators rather prefer to see themselves as victims of what they considered " blackmailing". They simply needed more frequency bands representing the "raw material" crucially needed for any future presence on the market. According this version it was not a matter of any over-heated minds or enthusiasm over 3 G- services, but rather a chilly matter of survival. There was no choice but to accept any terms and to pay any license fee, however bleak the prospect to get any payback out of investments in infrastructure for 3 G services. As one of the UK operators put it "No license is bound to be the death-knoll on the stock market as a company without any future. By paying otherwise impossible amounts of (borrowed) money the company and it shares will at least not be declared dead already by tomorrow".

There are observations in support of both versions. Examples such as Sonera and Telefonica paying 5 G Euro for one of the licenses in Germany (to later be deserted) cant possibly be described as a case of blackmailing, but rather of overheated minds. If they were to actually consummate their license it should have required a further 100 G Euro in investments, which neither the banks or the stock market considered any realistic option compared to simply write off the 5 G Euro as a loss. On the other hand, the obvious dragging of

feet also by the incumbent operators in UK and Germany supports the point that they have paid dearly for " the right NOT to invest" prematurely. The concept of " sunk costs" (in this case for the license) is often used as an argument for an urgent follow up, in order to recoup money already spent. It could however be interpreted the other way round, rather as a (necessary) high price for the privilege of flexibility avoiding " the Winner's Curse" and hence any First Mover (Dis) Advantage. With a market in waiting mode, why not let others act as snowploughs. (" In case they fail, it will spare our company any further needless investments. In case they are successful we have already bought the right to move in, taking full advantage of a more mature and cheaper technology with far less of any teething problems")

However, there are still other possible interpretations of the paradox (apart from the extremes of madness vs. smartness) to be discussed later in the text. In order to set the back- ground needed there is a need to briefly review the experiences also from markets outside Europe, as well as to look into what can be learnt from previous shifts of generations, such as the transition from 1G (NMT) to 2G (GSM) back in the early 90-ies.

Possible comparisons with other countries

What is there to be "imported" (or not) from the experiences in other countries? Among the candidate countries are Hong-Kong, Australia, UK, Germany and the US.

One possible comparison is Hong-Kong with respect to its policy of sequential (step-by-step) access of frequencies for 2G. In a first round only limited capacity was granted and only for a two year-period. In the second round only those who had actually invested and won customers were granted more frequencies etc. By this kind of qualification process sheer speculators were discouraged. HK did also pursue a version of its own for the 3G licensing, as the auction was not about paying any large lump sum upfront as in parts of Europe, but instead focused on the highest bid on the percentage of (actual) revenue to be paid to the Government over time. Also in this case hoarding was discouraged and barriers to entry (by any need to pay lump sums in advance) minimized.

-UK and Germany are often cited as warning examples with reference to the staggering amount of money paid for the licenses. The popular interpretation of “sunk cost” is that those having already paid dearly are supposed to be in a rush to invest rapidly and heavily in order to recover their money. However, even in theory quite the opposite might be rational from a “ cynical” business perspective. There is no “ First Mover Advantage” to get into 3 G from 2 G, but rather the opposite. The more of a delay the better. In the meantime the technology will be more stable and cheaper, and the need to pay for any extra subsidies of 3 G handsets vanish. In brief, those paying hefty sums for their licenses actually paid for their privilege NOT to invest “ “prematurely”.

In the longer term all operators might actually need also the new frequencies allocated for 3 G in Europe, but a consequence of the hoarding is that large chunks of spectrum might be left unused for quite a few years.

-The US is bound to be an even more relevant reference case as it has chosen much more pragmatic policies compared to Europe. Partly because out of necessity as the frequencies originally intended for UMTS worldwide were not available. Back in history the concept of UMTS (Universal Mobile Telecom Services) was born in the era of Voice Telephony. Everyone should be able to use the same handset whether in Europe, Asia or the US working on the very same frequency. Later on multiband handsets became available, but also the perceived need to add also non-voice services under the generic label of “3G”. Anyhow some operators in US, like AT&T, have (somewhat ironically) chosen to follow the supposedly “European” migration path from GSM to GRPS to EDGE. Others have based their offerings on another technical platform (CDMA) but are likewise only gradually moving from 2G to “near 3G”, to full 3 G. From a marketing perspective this gradual (organic) migration path has proved to be successful also in Japan where KDDI has got ~~far~~ more customers to its “near 3G” in comparison to the dominant operator, DoCoMo which “jumpstarted” into fully fledged 3 G from its successful i-mode (2.5 G) service. In fairness, DoCoMo had actually no choice but to jump, as they didn’t have the option of backwards comp ability with its ongoing i-mode services. They were hence bound to be a case in point of what can be labeled as “ the tragedy of non-organic migration“-

.DoCoMo´s previous success with i-mode has became its worst competitor of its own making .Too few of their customers have proved willing to give up what they already have, at least not unless the price tag is lowered drastically enough to compensate for the unavoidable teething problems stemming from clumsy and battery-hungry handsets, more spotty coverage etc.

European operators are luckily facing less of a drastic situation, compared to DoCoMo in Japan, as 3G handsets are backward compatible to the existing GSM networks, offering nationwide coverage in more than 100 countries. That said, the European economy at large looks bound to lose the competitive edge previously achieved by the successful deployment of GSM Asian and American companies have already taken full advantage of more pragmatic regimes, enabling more customer-oriented and organic growth.

Possible comparisons with previous "generations"

Going back to very early developments the NMT-system (now labeled 1G) can be seen as almost handmade, developed and launched under the tight control of the then Televerket and its Nordic counterparts, which made sure that all the pieces fitted together. However, the architecture was sufficiently open to make a Go. Handsets of all make and nationalities could be used, and several independent retailers sold them. (This might sound self-evident, but it is sometimes forgotten that NTT in Japan also were early out. They achieved little due to the overly closed and monopolistic policies of the NTT. On another continent AT&T and its Bell Labs had of course the technology, but anti-trust laws blocked it. The first cell networks come not in use in US until four years after Scandinavia and Japan. Perhaps the cake was divided in too small pieces before it was even fully baked? Anyhow, Comviq was able to launch a US-based solution in Sweden at the same time as the NMT-network.

The GSM-system (now labeled 2G) was also tightly designed once again by Televerket and its counterparts in Europe. However GSM provided a further degree of openness thru the introduction of the SIM-card. In the area of wireless communication GSM is often quoted as a success story due to its (relatively) open architecture, enabling

interaction between a great numbers of actors over national borders, also outside Europe. (Even if we tend to forget that it actually took a number of years to fully overcome a number of teething problems). In its more mature stages the industry resembled the PC- industry where open interfaces enable a high degree of cost-effective specialization and outsourcing. The classical value chain where each and every link in the whole process was closely monitored (and often produced in-house) by a few monoliths was replaced with more dynamic web "value constellations" with more free and dynamic interaction between a host of actors. No need for each and everyone to fully comprehend the full and complex process at large. All any new actor needed to focus on was to achieve the best possible solution in between clearly defined interfaces for input vs. output. This process where success feeds further success could well have continued for yet a number of years with successive and organic deployment of upgrades like GPRS and EDGE in pace with the users demand for new services and the adjacent industries ability to deliver the new software and content required. It is a bit of irony that it has been some operators in US (rather than in Europe) that has adopted this organic step-by-step enhancement of GSM making sure that the full constellations of actors can move in concert to the tunes of actual customer demand. Other operators in US are based on another (CDMA) technology base, like the successful KDDI in Japan. The common feature, irrespective of technology base, is the careful timing of demand and supply taking all actors and contributors into account. No network upgrade until there is a secured supply of cheap enough handsets and attractive content which can motivate the customers for the next upgrade. An outside-in approach and “organic” architecture as opposed to an inside-out strategy.

It is often tempting to repeat a previous success move, so Europe choose to jump-start 3G as "a new generation" rather than consider UMTS as just and upgrade and booster to 2G like GPRS and EDGE. The previous transition to 2G from 1G went rather smoothly, so why not also the transition to 3G from 2G? There are several fundamental reasons to why the two processes are not comparable.

To start from the user’s perspective. The transition to 2G from 1G was far easier for the simple reason that only a few actually had to switch. For a clear majority of GSM-users this was their very first mobile phone, enabling a new degree of freedom compared to the

fixed phone line. The difference between having a mobile vs. no mobile was pretty dramatic and positive. Also for those which actually had to switch from NMT to GSM it was pretty straightforward and only a matter of one well-known service, voice telephony. Over time GSM-services were extended to provide roaming also in countries outside Europe, and improved by gradually upgraded data communications capabilities. New features could be added, without any need to sacrifice what was already available. In brief, it was a smooth ride.

By contrast, the transition to 3 G from 2 G is bound to be an uphill battle. Many of the new features are unknown to most users, and necessitate a number of non-trivial settings and acceptance of equally unknown billing methods. (Mbytes rather than plain minutes etc). A perhaps even more crucial obstacle is that the users, at least in the short term, have to give up some advantages they already taken for granted, like convenient size and weight of the handsets, long battery life etc. Even if these obstacles might be resolved over time, the supply side does not look well prepared for any speedy solution.

From the perspective of the suppliers, they are facing a far more complex situation compared to the previous migration from 1 G to 2 G, not only because of the large number of different services to cater for. The successful breaking up of the vertical value chains requires new rounds of coordination of a highly scattered number of potential contributors, including handset and content providers etc. In the absence of any clear “channel captain” (and clear interfaces) this means time-consuming negotiations between potential partners. Who is to pay whom for what? Most of the operators are also badly equipped to handle the unavoidable outburst of questions and complaints from the users. It will no longer be a matter of providing a single and homogenous voice telephony service, where “Same Size Fits All”. The market is bound to be much more differentiated.

Professional users would ask for customized solutions to enable secure access to corporate Intra-nets. Private consumers would be more interested in the lowest possible price, and hence willing to accept “best effort”. The very concept of (any homogeneous level of) QoS is bound to be challenged, and replaced by a more pragmatic set of different trade-offs between price and performance.

Wide geographical coverage has been one of the success factors for GSM, now available in more than 150 countries, as opposed to the long splintered coverage in the US. On the other end of the scale there is also the viral spread of highly localized WiFi hotspots providing quite higher capacities at a lower price per MB. Yet another contrast is the survival of the low-speed Mobitex 20 years after the Televerket launched it. Still preferred by some users as it provides better coverage of the whole country than even the classical NMT. Mobitex did also serve as the launching pad for the Blackberry service in the US, as low speed was considered less of a problem compared to coverage and ease of use. There is clearly a trade-off between coverage vs. capacity, which looks bound to be of increasing importance over time, as still other technological options become available (WiMAX, UWB etc).

Summing up

Some years ago the mobile industry had high hopes on the eventual marriage between the successful Internet industry and the equally successful mobile industry. Every service that could be delivered over the fixed network could as well be delivered over a wireless network providing new degrees of freedom It looked pretty much of an almost unavoidable success story.

Some progress in this direction has been achieved insofar that it has proved technically feasible to deliver wireless access to high-speed two-way broadband services to local areas, often labelled “ hot spots”. However, extending the cover-age to “ anywhere” comes with an exponentially increasing price tag. Another basic obstacle is that customers can’t be expected to pay more in proportion to any speed increase, but rather less per Mbyte transferred. As opposed to the conditions in the fixed network where large-scale economies provided by optical fibre can compensate for lower margins, whereas wireless capacity is limited by frequencies as a scarce resource.

To return to the initial questions. Yes, there are of course unavoidable teething problems, not only those of a technical nature. Classical voice services were highly uniform and could be delivered on the format “ same size fits all”. By contrast the new non-voice services have to be much more adapted, not to say tailored to the actual requirements and needs of individual users given the number of

trade-offs discussed above. This implies a quite long learning process in dialogue between vendors and users. To eventually by successful such a learning process has to take also the second question on even more basic issues into account. The inescapable tradeoffs between coverage vs. capacity like the ongoing processes of disruption and disintegration are bound to highly affect the outcome.

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