Capgemini
CONSULTING.TECHNOLOGY.OUTSOURCING

Telecom, Media & Entertainment | the way we see it

Telecom & Media Insights Journal 2005

Broadband Takes Flight

Table of Contents

Foreword

In an industry characterized by turbulence and uncertainty, with a constant flow of technological innovation, consumer demand and financial outcomes are more and more difficult to predict. This has certainly been true in 2005. The rapid growth in broadband; the stuttered adoption of 3G; the challenge of VoIP; the increasing competition and corresponding decline in prices; the search for new services that will drive ARPU growth—the industry is evolving rapidly. Managing this level of uncertainty, the corresponding risk profile and the number of investment decisions is becoming more and more complex.

To navigate these turbulent skies requires the foresight to know not only what challenges and opportunities are emerging, but also what action to take. For over 30 years, Telecom, Media & Entertainment (TME), a global sector organization of Capgemini, has been helping the telecommunications and media & entertainment industries turn their goals and aspirations into reality. Our clients include over 80% of the top telecom, media & entertainment leaders worldwide and we have successfully delivered over 1,000 engagements in some 50 countries around the world.

Our commitment to research and analysis plays a fundamental role in our ability to deliver real value to our clients. Now in its 12th year of operations, the TME Strategy Lab is a global network of strategy consultants dedicated to generating content-rich insights into the telecom and media industries based on in-depth analytical research and our willingness to take a position on some of the most complex issues facing our industries. We would like to thank the numerous clients, colleagues, research organisations and academics who have worked with us this year and have helped us advance the thinking on key industry topics.

This Journal brings together an edited collection of the "Insight" papers published by the TME Lab over the past year. I hope you find these perspectives insightful and thought provoking.

Didier Bonnet

Managing Director
Telecom, Media & Entertainment

Preface

More than any other year, 2005 bears testimony to the fact that the telecom and media sector is a rapidly evolving industry and a turbulent world.

We start this Journal with looking at the broadband market, which grew tremendously this year with more than 24 million new subscribers worldwide in the first 6 months alone. As we highlight in the first chapter, local loop unbundlers have been instrumental in driving broadband penetration through aggressive price cuts. As the broadband access market matures and prices decline rapidly, operators are looking for new sources of revenue. In chapter 2, we highlight that home gateways, launched by an increasing number of DSL players in Western Europe, will be a strategic tool for operators to drive uptake of additional services, such as VoIP and TVoDSL.

The rise in broadband penetration has fuelled usage of Voice over IP services posing a big threat to incumbents' PSTN revenues to the order of €5bn by 2008. In chapter 3, we explore whether the mobile segment is the next frontier for VoIP by assessing the voice quality, costs savings and the user experience of making a mobile call over IP. We also quantify the near-term threat to operators' mobile voice revenues.

Mesh networks is another technology that could disrupt the current telecom set up. In chapter 4, we show that mesh networks have a strong user value proposition and could have a significant impact on operators' revenues in the next 3 to 5 years.

2005 has also been the year of mobile broadband. More than 30 players launched 3G while 45 operators deployed EDGE networks. As 3G is starting to gain subscribers, alternative wireless technologies like TD-CDMA and Flash-OFDM are emerging, promising a better experience to mobile users. In chapter 5, we assess whether 3G is under threat from these alternative wireless technologies and discuss strategic options for mobile operators.

3G operators are keen to launch new services that will drive ARPU up and deliver the return on operators' massive investments. In the final issue of this year, we discuss which mobile data services have the best chance of succeeding and what operators need to do to realise the prospects. We argue that mobile TV could emerge as the star performer in the data market.

2006 will be another year of major changes in the telecom and media sector as fixed incumbents start to deploy next generation networks and face increasing competition from a wide range of new entrants and stronger alternative operators. We also expect Internet players, such as Google and Yahoo! to continue their forays into the telecom and media space potentially disrupting the current set up with innovative business models. The exciting marketplace that Telecom & Media represents is set to remain so for some time to come.

Jawad Shaikh & Jerome Buvat
TME Strategy Lab

1 The Changing Face of DSL Provision in Western Europe

First published: October 2004

Objective of Study

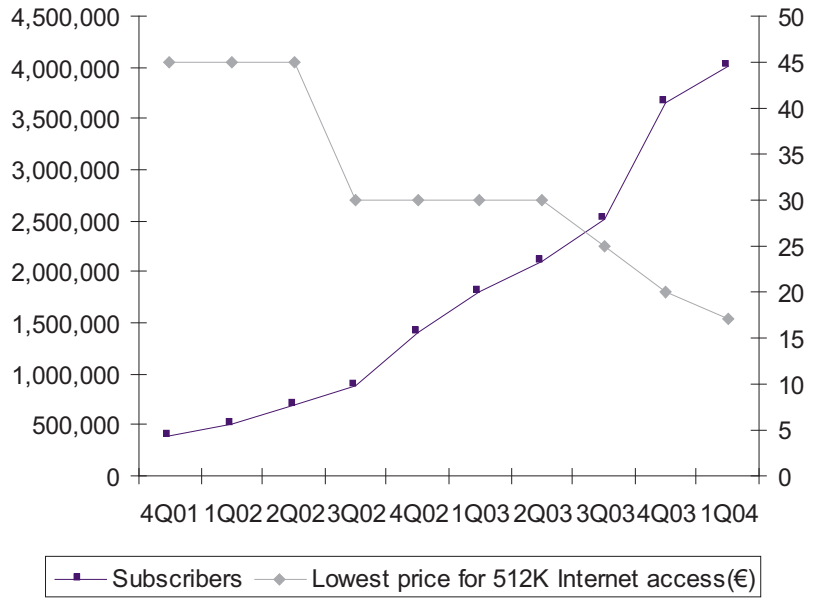
The increasing popularity of DSL creates both challenges and opportunities; Capgemini assessed the implications of the rise of the DSL Service Provider.

The rise of DSL as a preferred Internet access technology is creating new challenges and opportunities for telecom operators and ISPs alike. DSL represents a significant source of additional revenue for incumbents and ISPs, but at the same time their traditional business is threatened by the rise of DSL Service Providers (DSPs) offering both Internet access and Voice over IP at very attractive prices. Capgemini's TME Strategy Lab explores the implications of the rise of DSPs for incumbents and alternative players, and for the market as a whole.

The DSL market is that rarity: a telecom sector whose growth has been significantly underestimated by analysts. Three years ago, experts forecasted around 6m DSL connections in Western Europe for 2003,[1] but by the end of the year the actual figure was more than 17m. Much of this growth has come in the past year, with 10 million new subscribers in Western Europe from March 2003 to March 2004.[2]

In some countries, the growth has been even greater: in France, for example, the DSL subscriber market grew by 124% in 2003[3] vs. 90% in Western Europe, adding more than 2.2m new lines. France now has one of the highest DSL penetration rates in Western Europe (16% vs. 13% on average) and has around 75% (or 1.7m) more DSL lines than the UK, with the same population. We analyzed the DSP market, focusing on France as one of the leading DSL countries in Europe.

Figure 1.1 Number of DSL Subscribers and Entry-Level 512K DSL Price in France (€/Month)



Source: ECTA DSL Scorecard, 2001, 2002, 2003 and 2004; Capgemini analysis.

The Rise of the DSP

A major driver behind the dramatic growth of the French DSL market has been a rapid decline in prices (see Figure 1.1). Entry-level DSL prices were cut by 55% in 2 years.[4] The price decline even accelerated in the first quarter of 2004 with a reduction of 15% vs. 10% on average since 2001.

One of the key factors that led to this dramatic price decline in France has been the rise of a new type of player: DSL Service Providers (DSPs). DSPs lie at the convergence of telecom network operator and Internet Service Provider (ISP) business models. They provide DSL-based Internet access and additional services that ISPs reselling incumbents' products do not offer, such as Voice over IP and/or television/video on demand.

To offer these services, DSPs usually operate GigaEthernet (GE) networks, which support very high bandwidth

1 Gartner, "Residential Broadband: Western Europe, 2000-2005", July 2001; Forrester, quoted by Goldman Sachs, "Technology: Internet-New Media", 13 June 2001. 2 ECTA DSL Scorecard, March 2003 and 2004. 3 March 2003 to March 2004. 4 From 4Q01 to 4Q03.

requirements, and unbundle the local loop. When unbundling the local loop, DSPs have the choice between two options: shared vs. full unbundling. In the first option, DSPs can only provide data services, be they broadband Internet or VoIP. When opting for full unbundling, DSPs are also able to offer traditional PSTN voice in addition to data services; in this option they will also collect the basic land-line subscription that the incumbent normally receives.

DSPs Have the Cost Advantage

Local-loop unbundling gives DSPs a significant cost advantage against ISPs reselling incumbents' products, regardless of whether the latter use a "resale" or "bitstream" sourcing model (see Figure 1.2).

The "resale" model, which is only available in a few European countries, such as France and the UK, enables ISPs to buy end-to-end DSL access from network operators. ISPs adopting this model can offer DSL access with minimal capital expenditure but do not have any possibility to differentiate their services, apart from lowering prices. In France and the UK, those players post very weak gross margins: between 5 and 10%.

"Bitstream" sourcing is accessible to all European ISPs, except in Switzerland. It enables Internet providers to collect traffic at regional points and use their own network for core transport, which gives them slightly superior margins than ISPs opting for the resale option.

Whatever the sourcing model, ISPs reselling incumbents' products have a significant cost disadvantage compared to DSPs, as most of their operational expenditure depends on incumbents' own costs and prices.

Incumbents are also disadvantaged relative to DSPs. In their home markets, incumbents operate legacy ATM networks that are expensive to run and maintain, while most DSPs use a GE infrastructure. GE technology enables DSPs to cut network operational costs by managing an end-to-end Quality of Service (QoS) while incumbents, operating both legacy ATM networks and national IP infrastructure, have to handle two types of QoS (i.e. ATM and IP).

As a result, DSPs typically enjoy a strong cost advantage not only over ISPs but also incumbents, which enables them to offer very attractive prices for both DSL access and voice.

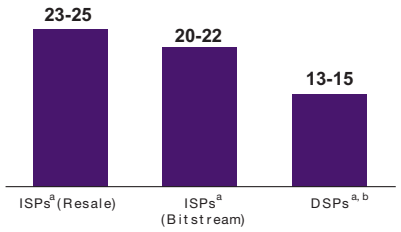
DSPs Have the Services Advantage

DSPs' most attractive value proposition consists of very high bandwidth DSL access (up to 4–5Mb/s) combined with unlimited domestic fixed-line calls. Some players, such as Free, the largest DSP in France, also offer TV services over DSL. Free now provides a 5Mb/s DSL connection with fixed-line local and national calls at no charge and TV services for €29.99 a month. Free's TV services comprise fifty-seven free channels, covering news, music, games, sport, and content for ethnic minorities.

In the French market, double and triple plays are rapidly becoming the standard DSP offering and are now priced at the same level or even below single plays from Wanadoo (France Telecom's ISP) and ISPs reselling FT's wholesale DSL access (see Figure 1.3).

To make matters worse, both national operators and ISPs reselling the incumbent's products are unable to match DSPs' services. Compared to DSPs' GE infrastructure, incumbents' legacy ATM backhaul networks are less scalable and costlier to run, making it difficult and more expensive to offer TV over DSL or 4–5Mb/s Internet access. Even ISPs using the "bitstream" sourcing model are not able to provide very high speed Internet access as the parameters of the service (downstream and upstream bandwidth) are set by incumbents. In addition, voice and TV over DSL require high-quality service, something that incumbents do not guarantee, making it almost impossible for resellers to offer reliable VoIP and TV over DSL services.

Figure 1.2 DSL Monthly Access and Traffic Costs per Line in France, 2004, €



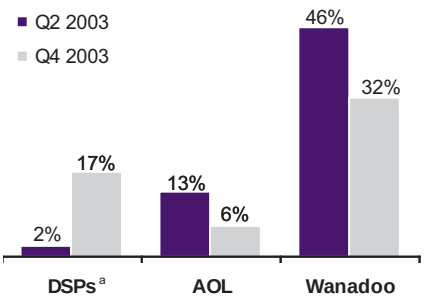
Source: Capgemini analysis. a. Including back-haul costs. b. In unbundled areas

Figure 1.3 Comparison of Offering Tariffs in France

Provider	Internet Access (2MB)	Un-limited Calls[a]	TV Services	Pricing (€)
DSPs				
Free	✓[b]	✓	✓	29.9
Neuf	✓	✓		29.9
ISP				
Club Internet	✓			34.9
Incumbent				
Wanadoo	✓			44.9

Source: Companies' websites; Tariffs valid on 23 June 2004. a. Calls to domestic fixed-lines b. 5Mb/s

Figure 1.4 Share of Net DSL Additions, Q2 2003—Q4 2003



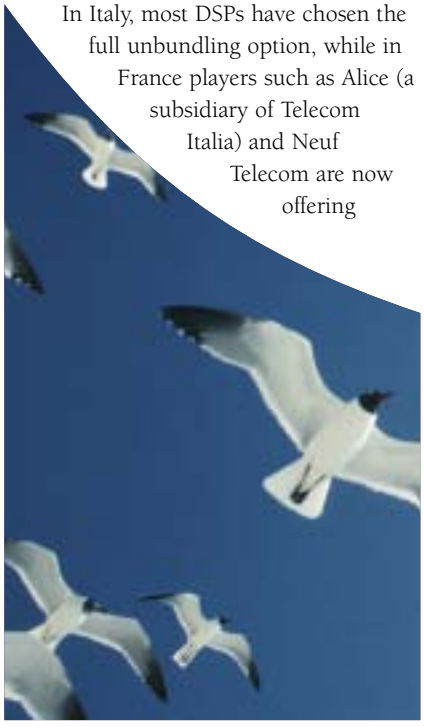
Source: Goldman Sachs, "Voice over Broadband", 29 April 2004. a. In unbundled areas only.

Result: Incumbents and ISPs Are Losing Out

Unsurprisingly, with these advantages DSPs are rapidly gaining market share in France at the expense of both incumbents and ISPs reselling incumbents' products (see Figure 1.4).

The development of DSPs in the market represents an increasing threat for incumbents' voice traffic and access revenues. Voice, which has been at the core of traditional operators' business models for as long as they have existed, becomes just another application when it is a data service over DSL broadband technology and thus can be offered at very attractive prices. In France, most DSPs now include free unlimited calls to domestic fixed lines in their packages and this is likely to be the model that most DSPs will adopt in Europe.

The increasing popularity of full unbundling among DSPs is also likely to put incumbents' voice access revenues under pressure. Indeed, full unbundling enables DSPs to supply both DSL connection and PSTN voice, which means they can collect the monthly subscription fee that incumbents normally receive. In Italy, most DSPs have chosen the full unbundling option, while in France players such as Alice (a subsidiary of Telecom Italia) and Neuf Telecom are now offering customers the possibility to drop France Telecom's line. Alice prices its 1Mb/s DSL access at €10.48 a month when customers choose packages that include the basic land-line subscription. In this package, customers also benefit from cheap voice tariffs.



This suggests that incumbents, such as Eircom and BT who rely on voice for respectively 73% and 44% of their revenues,[5] are the most likely to suffer from the rise of DSPs.

Incumbents Are Adopting the DSP Model

With their voice businesses in decline and DSL revenues under pressure in their home market, incumbents too are exploring the DSP model in new geographies.

France Telecom (FT), one of the incumbents that has suffered most from the arrival of DSPs on its home turf, is developing an aggressive European DSP strategy. Wanadoo, FT's broadband arm, recently announced that it planned to increase its ADSL market share to 20% in Spain, UK, the Netherlands, Belgium, and Switzerland, mostly by unbundling the local loop.[6]

In Spain Wanadoo aims to cover 30 to 40% of the population by the end of 2004 via local loop unbundling. It will provide VoIP services and TV over DSL, leveraging a partnership with Spanish public broadcaster TVE. And in the UK, Wanadoo intends to offer voice over IP and then video on demand through its new gateway, called Livebox, next year.

Likewise, last year Telecom Italia announced an investment of around €250m in France to set up DSP operations,[7] and recently the company acquired German broadband provider Hansenet.

It is very likely that more incumbents will follow the same path to benefit from DSL opportunities in new geographies and try to offset the losses they are likely to face in their home markets.

A War between Incumbents?

Deep-pocketed incumbents pursuing a DSP strategy outside of their home markets are likely to be successful. They can absorb initial losses and also enjoy a cost and operational advantage over non-incumbent rivals, as they benefit from scale and expertise in their processes and technologies.

In developing European DSP strategies, incumbents will force other incumbents into a battle for their core business. In the next few years, the European DSL market could become a battleground for large incumbent operators fighting to protect their home market while attacking other national operators' geographies to increase their revenues.

France Telecom and Telecom Italia have already started, but Deutsche Telekom (DT) and British Telecom's future strategies in Europe are uncertain. FT and DT recently signed a co-operation agreement to carry out joint R&D initiatives, so it is not clear whether DT would launch a direct attack against France Telecom on its home turf. However, DT might want to leverage T-Mobile's strong customer base in the UK to enter the emerging British DSP market.

Challenges Lying Ahead for DSPs

In order to develop a workable DSP business model, there are many challenges that incumbents and ISPs need to tackle.

First, DSPs will need to find the necessary funds to invest in the unbundling of the local loop: between €150m and €300m to cover 60 to 80% of residential customers, according to the country's population density. In France, Neuf Telecom's management estimates its total investment in local-loop unbundling to be €300m by end of 2004 to cover 75% of the population. Cegetel spent €150m on unbundling in 2003 in order to cover around 60% of households and 75% of business customers.

While it represents only 5 to 10% of incumbents' yearly fixed-line capex,

5 Goldman Sachs, "Voice over Broadband", 29 April 2004. 6 Screen Digest, Newsletter, June 2004. 7 Enders Analysis, "Local Loop Unbundling in France", November 2003.

€150m is a very significant investment for ISPs with revenues of less than €1bn and who typically spend €50m–100m on capex in total. Those ISPs will need to find ways to participate in the DSP world without having to invest large sums of cash; one solution could be to partner with DSPs that have unbundled the local loop and offer wholesale services.

Second, DSPs wishing to offer TV over DSL will have to strike deals with content providers. This might prove difficult in countries where the largest content providers are also dominant broadcasters. DSPs in the UK, for example, will have to negotiate rights with Sky and get content at an attractive rate-something cable operators have been negotiating for years without any significant success. It is unclear whether the UK regulator Ofcom will intervene in this new TV over DSL market. In France, DSPs also face significant difficulties: Free did not manage to strike a deal with TF1, the largest free-to-air broadcaster, and thus does not offer the channel in its package.

Third, DSPs will have to deal with a different regulatory environment in each country. French DSPs have benefited from very attractive local-loop unbundling prices, 30–60% cheaper than in the UK,[8] for example, which partially explains their rapid success. In Italy, it is no surprise that 99% of unbundled lines are fully unbundled, given that prices for this option are the lowest in Europe.

Before launching operations, DSPs need to make sure that the economics look attractive and that the regulatory environment is conducive to their development. They will also have to put strong pressure on regulators to be able to strike equitable deals with content providers.

Conclusions

The arrival of DSPs in Europe will likely lead to a significant shake-out of the DSL market over the next 3 years. It is likely that only three or four players will survive in each country.

Only a few ISPs will have enough financial muscle to convert into DSPs and compete on a national scale. Smaller ISPs will most probably be forced out of the market as they will not be able to compete on prices and services.

Incumbents pursuing a DSP strategy will play strong away from home. They benefit from the deeper financial resources of their parent companies, and because their scale may be more attractive for content partners. They are also more likely to survive the inevitable shakeouts that may swallow their competitors.

On their home turf, incumbents are likely to continue to lose market share. They will suffer from the competition of foreign incumbents and large local DSPs with significant cost advantages.

In the next few years, the European DSL market could become a battleground for large incumbent operators fighting to protect their home market while attacking other national operators' geographies to increase their revenues.

8 57% difference for shared local-loop unbundling (LLU) and 31% for full LLU before BT's price cut announcement in June 2004.

2 Home Gateways: A Business Imperative in a Box

First published: June 2005

Objective of Study

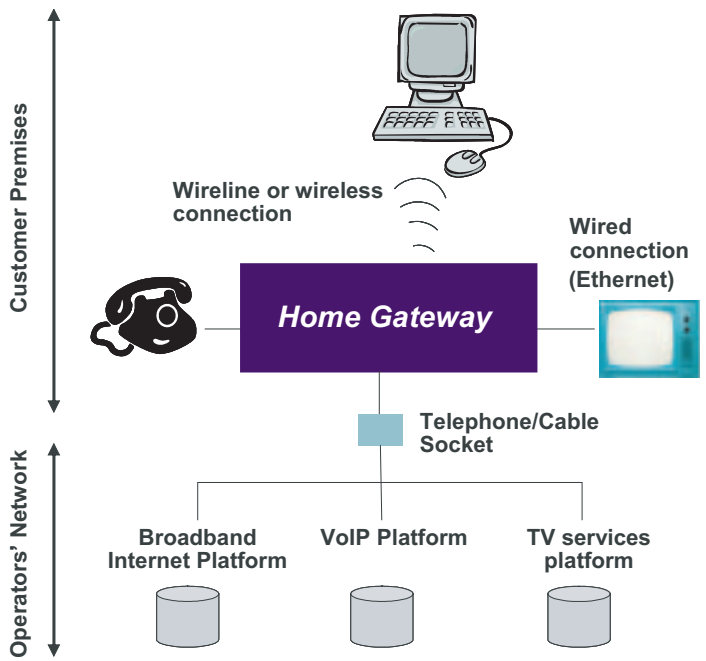
The home gateway is the latest device that promises to realize the dream of a fully connected home. We explored the home gateways market, assessing its drivers and the options for operators.

Home Gateways: Now a Reality in Europe and Asia

For years, realizing the "connected" home concept has been an important objective for telecom and media players. The connected home was envisioned to link all telecom and multimedia devices that existed in the home and connect them to external networks via high-speed Internet.

Today, the connected home is getting closer to reality. Over the past few months, numerous operators, such as France Telecom and Korea Telecom, have launched home gateways that propose to link telecom and some multimedia devices. And indeed, all five of the major DSL operators[1] in France now offer home gateways.

Figure 2.1 The Home Gateway



Moreover, telecom operators are not the only players to be active in this emerging market. Consumer electronics companies, such as Sony, LG and Samsung are manufacturing home gateways and selling them directly to consumers, competing head-on with network operators and ISPs. Software/PC manufacturers are also entering the home gateways space.

Should operators launch home gateways, and if so, what are the optimal strategies they should pursue? In this report, Capgemini's TME Strategy Lab explores answers to these questions and investigates the likely challenges that operators launching home gateways will face.

What is a Home Gateway?

The home gateway is a "box", connected to a cable or telephone network, that supports VoIP and Broadband Internet (double-play) or VoIP, Broadband Internet and TV services (triple-play), as Figure 2.1 shows. Some home gateways also enable other advanced services such as home networking and monitoring, i.e. going further into the "connected home" concept.

There are two major types of home gateways: "integrated" home gateways or "two terminal" gateways. Integrated gateways include a TV set-top box, while for "two terminal" gateways, the TV set-top box is a separate device. Typically, an integrated gateway costs around €150 to produce vs. around €100 for a "two terminal" gateway.[2] However, costs are expected to decline rapidly from €150 to €80 for an integrated box as manufacturers generate economies of scale.

Home Gateway Launches

Local loop unbundlers were the first to commercialize home gateways, with

1 Free, Tiscali, Wanadoo, Neuf Telecom and Cegetel. 2 CDC IXIS Securities, "Iliad", July 2004 and Capgemini analysis.

Figure 2.2 Timeline of Key Home Gateway Launches

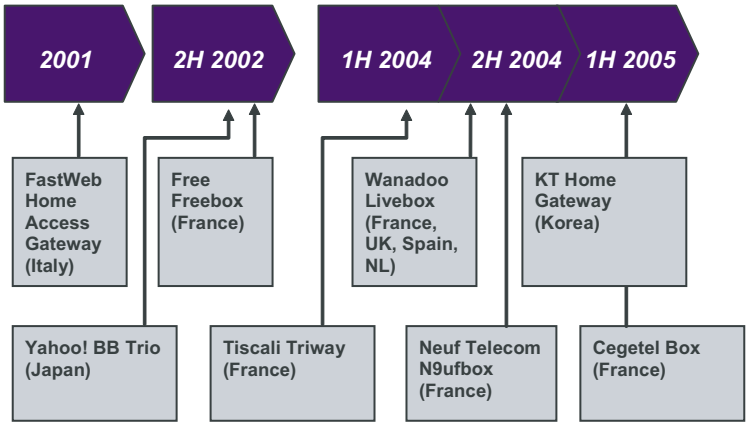


Figure 2.3 Services Offered by Home Gateway Players

Operator	Home Gateway	TV Services				Internet Services		Communication Services			WiFi Capa-bility
		TV	HDTV[d]	PVR[d]	VoD[d]	Internet Access	ADSL2	PSTN	VoIP	Video Telephony	
Wanadoo (France)	Livebox	✓b, c			✓ b, c	✓	✓	✓	✓	✓a	✓a
Free (France)	Freebox	✓	Trial	✓a		✓	✓	✓	✓		✓a
Korea Telecom (Korea)	Samsung SMT-7000S	✓ (DTH + IPTV)[d]		✓a	✓	✓	n/a		✓	✓c	✓
FastWeb (Italy)	Home Access Gateway	✓b		✓	✓	✓			✓	✓	✓a
Tiscali (France)	Triway	✓b, c (DTT + IPTV)[d]			✓c	✓	✓	✓	✓		✓a
Neuf Telecom (France)	N9ufbox	✓b				✓	✓	✓	✓		✓a
Yahoo BB (Japan)	Trio	✓b			✓	✓			✓		✓ a

Source: Operators' websites. Note: a. Requires physical add-on. b. TV only enabled through separate set-top-box. c. Service to be launched in 2005. d. HDTV: High Definition TV; PVR: Personal Video Recorder

FastWeb in Italy and Free in France launching in 2001 and 2002 respectively. The home gateway enabled unbundlers, such as Free and Fastweb to be the first to offer double and triple-play services in their respective markets.

As a result of this double/triple-play strategy and through very attractive DSL access prices, local loop unbundlers managed to capture a significant share in the market. Free in France, for example, succeeded in achieving 17% market share in the residential DSL sector at the end of 2004, with more than 50% of their subscribers having installed a home gateway.

The success story of Free triggered fellow local loop unbundlers Tiscali, Neuf Telecom and Cegetel to develop similar plans in France. Wanadoo, France Telecom's Internet division, also launched its home gateway, the Livebox, in France and the UK last summer, followed by Spain and the Netherlands in October 2004. Wanadoo experienced significant demand for its Livebox, shipping 194,000 terminals in France in Q4 2004, compared to 40,000 in the previous quarter.

Other incumbents are likely to follow Wanadoo's example and launch home gateways to pre-empt or respond to the rising penetration of local loop unbundlers. In March 2005, nine large incumbents[3] created the Home Gateway Initiative to discuss standards and technical issues. It is very likely that some of these players will introduce home gateways in the near future.

Services Enabled by the Home Gateway

Home gateways enable operators to offer a wide range of Internet, voice and TV services as Figure 2.3 shows. Most newer gateways are also compatible with Wi-Fi, which enable operators to provide wireless broadband and shared Internet connections. One of the most advanced gateways available in the market is the one launched by Korea Telecom (KT) in June 2004. The gateway has a flexible network interface, supporting both satellite TV and IPTV, and has numerous innovative service features. For example, KT's gateway enables customers to send SMS from their TV set to mobile phones as well as view images of their household through a camera. KT's marketing plan shows the range of potential services operators can offer via a home gateway. In 2005, KT's home gateway will enable the remote control of household features, like door locks, lighting and heating, through mobile handsets. In addition, the operator plans to integrate video calling services through the home gateway, where consumers can view the other party on TV whilst talking on the phone.

3 Belgacom, BT, Deutsche Telekom, France Telecom, KPN, TeliaSonera, NTT, Telefonica and Telecom Italia.

Similarly other players, such as Wanadoo, plan to launch photo and music management services as well as access management, where Internet access as well as IPTV can be restricted with regards to time and content.

The increasing number of services that operators are offering through home gateways will likely make these intelligent boxes a critical part of households' equipment in the next few years. And increasing customers' stickiness as well as getting an increasing share of customers' wallets are precisely what operators aim to achieve.

Rationale for Launching Home Gateways

By launching home gateways, operators can address two key objectives: increase upselling and decrease churn.

Increase Upselling

Broadband access was network operators' growth engine in 2004, accounting for 34% of revenue growth for British Telecom in H1 2004 and 13% of France Telecom's revenue growth during 2004. However, increasing broadband market maturity and sharply declining prices have caused this growth engine to slow down.

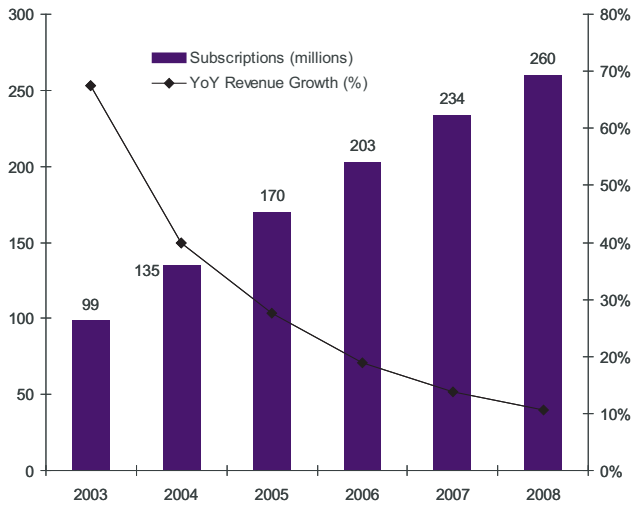
As Figure 2.4 highlights, the worldwide broadband access revenue YOY growth rate is forecasted to fall by half, from 40% in 2004 to 19% by 2006. And it might fall further if prices continue to decline. In the Netherlands and France, broadband prices already declined sharply by 54% and 50% respectively in 2003.

With the slow down in broadband access revenue growth, operators are searching for new sources of revenue. This is where the home gateway comes into play. By enabling services such as VoIP, IPTV and home security, home gateways will help operators broaden their service portfolio and achieve their revenue growth objectives.

Moreover, home gateways are designed to simplify the upselling of new services to customers. To activate these new services, customers need make no additional investments because the necessary hardware is already in the home. The gateway communicates remotely with a central server to upgrade its middleware, install new services, fix program errors, and monitor and perform maintenance. This remote upgrade process is undertaken by the operator and customers only need to acknowledge service activation.

Operators are already experiencing some success with their home gateway strategy. In France, 75% of Wanadoo's Livebox customers took up the VoIP service in Q3 2004. In Italy, FastWeb has seen its annualized video services Average Revenue per User (ARPU) increase from €21 in Q2 2003 to €102 in Q1 2004, a steep increase of almost 400%. The ARPU of its basic telecoms services, on the other hand, has only registered a growth rate of around 1.5% over the same period, to reach €806.

Figure 2.4 Global Broadband Subscribers (m) & Revenue Growth (%)



Source: IDC, "Worldwide Broadband Access Services 2004-2008 Forecast Update", July 2004

Decrease Churn

Characteristically for any maturing, competitive market, DSL churn has also become a major source of concern for operators. For example, in Q3 2004, Wanadoo's churn increased to 22% compared to 10% in 2002.

To reduce churn, operators aim to transform the home gateway into an indispensable piece of equipment for the home. By enabling a wide range of services including double or triple play, home gateways will become a core element among household appliances. There are some signs that this strategy is starting to work: in France, for example, Free enjoyed about 30–50% lower churn rates than players who had not deployed home gateways.

Innovative services such as home automation or the management of multimedia content like photos, music and videos will also increase the perceived value of the fixed line, making home gateways a valuable defensive tool to help limit fixed-mobile substitution.

The proprietary nature of the box contributes to operators' retention efforts. As no international standards have been agreed, home gateways only work with services launched by the same operator, which makes switching to another operator more difficult because a new home gateway has to be ordered and set up.

Home gateways also enable operators to have a physical representation of their service offering in the home as most of the boxes are branded. Tied up to that is the design of the gateway that may play a role in attracting customers and increasing loyalty. Some home gateways come in attractive, futuristic designs, further

enhancing their differentiation in the market. This increasing visibility of operators' services might, in turn, positively impact customers' brand awareness and loyalty.

Given the significant benefits, we believe that operators should launch home gateways. Incumbents in particular can pre-empt the arrival of new entrants and/or respond to unbundlers' increasing market share through this strategy.

What Gateway Strategies Should Operators Follow?

To remain competitive in the market, providing customers with a home gateway is becoming an imperative for many operators. However, launching a gateway is a complex project requiring significant investment and involving multiple functions across the organization as well as external providers, such as manufacturers or middleware suppliers. Above all, it will require a clear strategy and a long-term roadmap of services.

When launching home gateways, operators will have to make four key decisions. Operators need to determine the range of services the gateway will enable, choose the type of home gateway they want to launch, develop a middleware strategy and define the distribution strategy.

Services Roadmap

Operators need to develop a long-term services roadmap to have clear visibility of new services over the next 3–5 years—the expected lifetime of a home gateway.

Figure 2.5 Wanadoo's "Livebox Fashion"

Long-term planning will help operators avoid costly hardware replacement and complex migration issues. Organizationally, we recommend operators set up a centralized planning team to determine the long-term needs and resource allocation issues across the various business and product divisions. This is especially true for operators active in several markets or countries with inherently different local regulatory requirements and market conditions, and operators wishing to launch fixed-mobile services.

Home gateways should at a minimum enable triple-play services to be an effective revenue lever. As already highlighted, Korea Telecom's services roadmap is a good illustration of the type of services operators can consider, stretching from telephony and television services, through remote appliance control, to innovative medical care and monitoring.

Product Design

There are two important issues to consider when designing the home gateway: how to make it look aesthetically pleasing and whether it should be designed as an integrated one-piece or a two-terminal home gateway.

The first issue is straightforward. Design has become increasingly important in the world of technology products, as evident in the success of Apple's iPod. The design of the home gateway should reflect its multiple functionality and appeal to customers. We believe that home gateways should not have the same design as traditional single-functionality DSL modems.

Sleek, attractive boxes such as Wanadoo's Livebox mean the home gateway is more likely to be a talking point in the home, increasing its chances of becoming a must-have item. Wanadoo have gone so far as to introduce "Livebox Fashion" (see Figure 2.5)—a limited series of Livebox terminals in pink aimed at "introducing some fun in the home."

The second issue is more difficult and depends on operator-specific constraints. We consider offering an integrated, one-terminal home gateway as the optimal strategy. It makes upselling TV services much easier as it does not require the customer to purchase or rent any additional hardware as the home gateway can be upgraded remotely and automatically via middleware. Most importantly for operators, a one-box approach reduces the cost and complexity of the logistics and distribution process.

Under certain conditions, however, some operators may prefer to offer a "two-terminal" home gateway. First, if they are not ready to launch a one-box gateway and are under strong pressure to commercialize a box as soon as possible to avoid further market share loss to unbundlers. Second, if they do not have enough capex headroom to afford the 50% increase in production costs that the integrated gateway typically requires.

Middleware Strategy

Middleware enables the different internal components of the home gateway to communicate with each other. It also enables communication between the home gateway and the operator's service platforms. Operators can choose to develop their middleware either externally through outsourcing or internally through product development.

We believe that operators should develop their middleware internally. Ownership of the middleware is critical in creating a unique set of services. Internal middleware development will also enable greater flexibility in the prioritization and allocation of resources, leading to better control and influence over the strategic timing of product launches. Some operators are already looking towards acquisitions or joint ventures to have middleware capabilities. For example, US-based SBC recently formed a joint-venture with middleware company 2Wire, while Comcast acquired middleware company Liberate, in early 2005. We anticipate that an increasing number of operators will build middleware capabilities either organically or through acquisitions.

On the other hand, a lack of in-house middleware expertise or funding in many operators will drive the middleware

outsourcing market. Although operators that outsource enjoy the flexibility of being able to select the best resources in the market, they are fully dependent on these middleware firms in terms of product launch timings and middleware upgrades. In addition, since all operators enjoy equal access to middleware firms, it implies that similar middleware will be sold to several operators, commoditizing its functionality.

Distribution Strategy
Developing a distribution strategy involves assessing both external market conditions as well as operator-specific factors. These include closely examining competitor activities, market maturity of technology advancements, and operators' financial and resource capacity.

Operators typically have three choices in terms of distribution:

- Distribute to new customers only.
- Distribute to all new customers and selected existing customers.
- Distribute to all new and existing customers.

We believe the second option is the best strategy in most markets. Selective distribution is key if an operator has a large established base of existing customers and does not have the financial capacity to provide every customer with a home gateway, or if certain customer segments are unlikely to take up new services. Selective distribution also makes sense if new subscribers generate most of the growth in the DSL access market. When the market matures and home gateways become standard offerings, operators will have to change their strategy and distribute gateways to all customers to avoid an increase in churn.

Restricting distribution to only new customers can prove to be a risky strategy. Subjected to "distribution discrimination", frustrated existing customers may churn to competitors. Distributing to all customers makes sense for some operators, especially new entrants, who do not have a large, established base of customers, or deep pocketed incumbents.

However, getting the strategy right is not all that needs to be in place. Operators need to anticipate implementation challenges that they will likely face.

Challenges Facing Operators in Launching Home Gateways

Home gateways present significant opportunities for operators to rejuvenate revenues and achieve growth through new services. But jumping onto the bandwagon without consideration for implementation challenges could be a recipe for disaster and market embarrassment. We see challenges in three areas in particular that players must be wary of and plan for: provisioning, service activation and customer service.

Provisioning Issues
Provisioning is one of the key challenges that operators face when launching home gateways. Some French operators faced severe provisioning delays driven in part by home gateway manufacturers who could not ramp up production quickly enough to meet the surge in demand. Because of this, some customers in France had to wait up to 2 months to get their home gateways, compared to an official delivery time of 3 to 4 days. One of the largest French operators received between 2,000 and 3,000 orders a day, a significant discrepancy from its internal forecast of 1,000 daily orders.

Free, one of the largest unbundlers in France, is also facing provisioning issues. Free chose to focus on new customers in order to limit production costs-probably because of financial constraints. It capped distribution to a maximum of 5,000 Freebox terminals per month for existing customers, making it very difficult for existing customers to get a Freebox and benefit from Free's triple-play services. At current replacement levels, providing the current customer base with a terminal would take around 7 years. A consequence of this strategy is likely to be an increase in churn in the medium term as existing customers face difficulties in accessing new services without the home gateway.

Before launching gateways, operators need to anticipate demand in line with market reality. They also have to ensure that their suppliers have enough production capacity to meet the demand and can ramp up production rapidly.

Financial constraints and production capacity limits are common root causes of provisioning problems. Operators with such constraints face a critical challenge of managing the existing customer base, since marginalizing existing customers in new product launches will inevitably destroy customer loyalty.

Service Activation Challenges
Home Gateways' identification tagging system adds an additional, undesirable variable in the customer experience chain for some operators. Most home gateways have to be tagged with a unique MAC[4] address in order to coordinate the billing, tracking and disconnection processes along the supply chain.

Activation of some home gateways in France required customers to key in two codes, including the MAC address, of up to 12 digits each, without which the services would not work. Since service activation was manual, many customers mistyped the codes and chalked up PSTN telephony bills of as much as €400 under the mistaken assumption that they were making VoIP calls through the home gateway. Customer confusion and technical problems led in turn to a significant increase in customer service calls.

By contrast, an operator in the Netherlands adopted a different approach. It pre-registered the home gateway codes before shipping them out, making service activation automatic for the customer. Judging from the lower number of customer complaints received at its Dutch call centers, the result was greater customer satisfaction.

4 MAC = Media Access Control

To avoid the issues that some French players faced, we believe that operators should make sure that critical service activation processes are automated.

Customer Service Challenges
Customer services represent another key challenge for operators. In France, for example, players faced a significant surge in the number of calls received following the launch of home gateways. It appears that most operators had not anticipated this increase in calls, which explains why some customers had to wait up to 30 minutes in call queues vs. an industry average of around 5 minutes before the launch of gateways. In addition, the 1- to 2-day training that most operators provided to Customer Service Representatives (CSRs) proved insufficient, as customer service teams were unable to answer many technical questions. Long call queues and CSRs' difficulties to answer questions saw some customers paying bills of up to €50 for customer service calls.

When launching home gateways, operators will have to train CSRs on the new services and functionalities enabled by the home gateway. This training should encompass a review of the most likely technical issues that customers will face. To address complex questions, we believe that operators should consider creating a dedicated technical hot-line. Operators will also have to revise the size of their call centers according to the anticipated demand for home gateways and the fact that most new customers will call the help desk in the first 3 months. Free, for example, was forced to increase the size of its customer service team by 40% in order to cope with Freebox-related calls. To reduce the number of potential calls, operators also need to make sure that the home gateway user manual is written in non-technical language understandable to any customer.

To address the above challenges and anticipate other potential issues, operators need to assess the impacts of launching a home gateway on their operations. However, in the rush to gain market share most operators did not spend enough time understanding the full implications. As a result, many players have struggled to deliver home gateway services as promised.

Conclusion

Home gateways have proven to be a strategic tool for local loop unbundlers to rapidly gain market share in Europe and Japan. As the broadband access market is maturing and prices rapidly declining, we believe home gateways will be instrumental in helping incumbents offer new services and increase revenues. Gateways will also enable incumbents to respond to the rise of local loop unbundlers and reduce churn.

Operators should also not wait too long to launch home gateways. Today, gateways give most operators a competitive advantage, but in many maturing DSL markets, they are becoming a competitive necessity. In France, for example, all large DSL players have launched or are planning to launch a home gateway. We expect this competitive environment will be replicated in many other European countries and that home gateways will likely become mainstream across Europe in the next couple of years. In 2006/2007, we anticipate that 70–80% of new DSL subscribers in France will opt for or be given a home gateway. In countries such as the UK, Spain and the Netherlands, Wanadoo's rollout of the Livebox will likely lead other players, including incumbents, to follow suit, which will drive mass market availability of gateways. The decreasing cost of the boxes will also encourage operators to jump onto the bandwagon.

Before launch, operators will have to make key decisions on the design and distribution of the gateways as well as the range of services they will offer. We recommend operators create one-box terminals enabling triple-play services, develop their middleware internally, and distribute gateways to all new and selected existing customers. Operators will also need to carefully assess how gateways will affect their internal processes. Evaluating the impact on customer services is critical to avoid the difficulties that French operators faced. Operators need to recognize that home gateways will dramatically impact their organizations, from provisioning and logistics to customer services and billing. Having the right strategy and supporting processes in place will be critical in making the launch of a home gateway successful.

3 Mobile VoIP: Knocking at the Gates?

First published: March 2005

Objective of the study

The prospect of using VoIP for calls over mobile and other wireless data networks can hold significant implications for mobile operators' revenues. Capgemini's TME Strategy Lab analyzed the latest market developments and assessed the magnitude of the potential impact.

Over the past few years Voice over IP (VoIP) has emerged from its PC-to-PC based roots beset with static and glitches, to become a credible threat to traditional telephony revenues.

In Europe alone, VoIP is expected to contribute over 13% to telephony revenues by 2008, and fixed-line incumbents could potentially lose over €6.4 billion of revenues over the period 2004–2008[1]. In response, fixed- line operators have realized that they can no longer ignore this trend and have started offering VoIP bundled with their broadband services.

So far this growth has been concentrated on VoIP calling over wired links; the question now is whether this trend will be repeated in the wireless world. In this report, Capgemini's TME Strategy Lab explores the prospects of VoIP over wireless networks. We consider the feasibility of carrying a voice call over IP-based wireless networks and the attractiveness of mobile VoIP services to consumers, to assess the threat it poses to traditional mobile voice revenues.

What is mobile VoIP?
Mobile VoIP refers to a voice call that is transported as IP packets over both the radio and core network of the service provider. The key difference from a traditional circuit-switched mobile voice call is the use of IP protocol and the packet switched data network of the mobile operators.

Additionally, to qualify as mobile VoIP, the call must be made using a wireless handset and should remain connected even while the user is in motion. Calls using data devices such as PDAs and laptops are not considered in this discussion.

With the recent developments in Wi-Fi enablement of mobile handsets and the possibility of seamless roaming across cellular and Wi-Fi networks, voice over Wi-Fi networks (VoWi-Fi) is also covered in our discussion as a possible threat to mobile revenues.

Key requirements for VoIP
Fixed-line VoIP has successfully evolved from a "best-effort" quality service accessible through computer software to one that is no longer tied to a PC and is readily available and affordable for customers with broadband access.

Acceptable quality, ease of use, and cost advantages are the key factors working in favor of fixed-line VoIP and are also pre-requisites for the success of mobile VoIP.

Acceptable voice quality
The key measure for quality of service (QoS) is latency, which accounts for the delay between the dispatch and receipt at the destination of voice packets. For mobile VoIP to be of the same quality as a standard mobile call, latency should be no greater than 150 milliseconds.

In a standard circuit-switched mobile call, all packets use a single path and are transported to the receiver in an orderly fashion. With packet switching, delays can ensue as routers determine a path for each packet, such that they may reach the destination at different times and would have to be re-assembled on arrival. The network, therefore, would need to be designed to identify and prioritize voice packets over other applications that are less latency-sensitive.

Compelling cost advantages
VoIP over wireline has gained in

1 Analysys, "Voice Communications: From Public Service to Private Application", November 2004.

popularity due to the significant cost saving it brings to users. Customers with broadband Internet connections can make unlimited calls within the country and international calls at a fraction of the regular cost. Customers in the US, for example, have indicated savings of more than 50% on their monthly bill through the use of VoIP services from providers like Vonage.[2] For VoIP to be attractive to mobile users, it must similarly offer significant cost savings. The opportunity for cost savings presented by VoIP could be even greater given the more expensive rates and exorbitant roaming charges for mobile calls.

Ease of use
The user experience of making a VoIP call over wireline networks today is no different from a traditional call made over PSTN. A simple VoIP adaptor allows existing PSTN telephone sets to be used in exactly the same way as before.

Similarly in the mobile world, it is imperative for a VoIP service over wireless to be intuitive and as simple as dialing a regular mobile call. Any complications around requirements to download software, set up a data session, and follow a multitude of other steps will only drive interested users away and deter widespread adoption.

In the following sections, we examine how VoIP over wireless networks measures up against these three critical requirements of providing adequate quality, cost saving, and ease of use. We assess the prospects of mobile VoIP over cellular data as well as other wireless networks-including Wi-Fi.

Assessment of VoIP over Cellular Data Networks

Some operators have already been backhauling voice as IP packets on their core networks and realizing the corresponding benefits of scalability and flexibility. This section explores the prospect of using IP for end-to-end transport of voice packets over cellular networks-encompassing the current 3G deployments as well as future technologies.

Evaluating VoIP over cellular against key requirements
As discussed in the previous section, acceptable quality, cost savings and a positive user experience are critical to the success of VoIP. We take each factor in turn and assess how well cellular networks address it.

Voice quality
The quality of VoIP calls over a cellular network is constrained by the availability of adequate bandwidth, the network processing time, and the ability to differentiate and prioritize voice traffic over other data.

Current 3G networks have higher data access download speeds of 384Kbps, but uplink speed remains constrained at 64Kbps, which is likely to be insufficient as more users log on within the same cell site.

Moreover, while the air interface is optimized to correct errors for standard mobile calls, it is not designed to account for packet loss that is possible on data connections. Ideally, the network should be able to detect corrupt packets and retransmit quickly, but retransmission in the current 3G deployments takes considerable time leading to latency.

Combine these limitations with restricted radio channel availability during peak traffic and an error-prone radio link, and the need for mechanisms ensuring identification and prioritization of VoIP traffic over other data becomes self evident. However, such means are not yet in place, implying that VoIP will be undifferentiated from other data traffic-likely resulting in quality degradation.

In concert, the various limitations of existing cellular networks can result in overall latency to be over 400msec—substantially above the 150msec threshold for acceptable voice quality.

Cost advantage
In addition to the QoS concerns, the economics of switching to VoIP over cellular data network are not so clear cut. Even after the deployment of 3G, data access tariffs remain expensive, such that consumers are unlikely to see any benefit in switching from standard mobile telephony to VoIP.

We estimate that a 5-minute VoIP call utilizes approximately 1MB of data. For 300 minutes of calling, equivalent to 60MB, a typical plan will charge £23.50 for the data traffic and an additional £10 per month for subscription to a VoIP service. Compare this to the standard 300 minutes at around £30, as offered by Orange UK for example, and the prospect of any cost saving stands essentially wiped out.

Figure 3.1 indicates the equivalent cost per minute of making a VoIP call for entry level to high-end data packages compared with the cost of making a standard mobile call (using Orange UK's £30 monthly voice plan with 300 inclusive minutes).

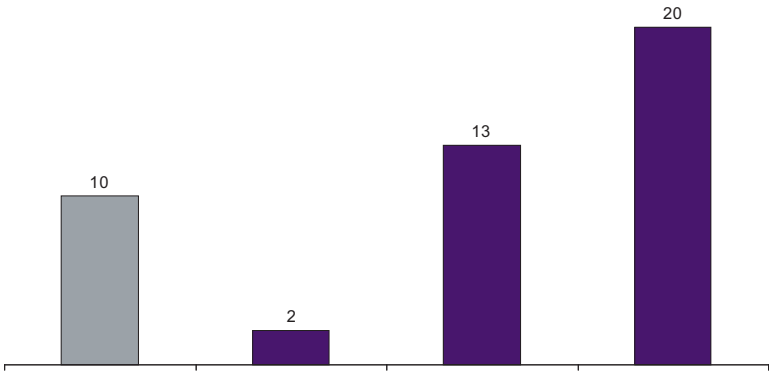
While it can be argued that the higher end plans are more cost effective on per MB pricing, they also come at a high monthly cost that renders them unaffordable for most consumers.

Moreover, standard voice tariffs are on the decline as operators are launching a slew of promotions and discounts, which from a consumer standpoint will further negate the case for using VoIP for calls over mobile networks.

Ease of use
Making a VoIP call over mobile networks does not score high on the ease of use factor either. First, users need to procure a device capable of running VoIP client software, which narrows the market to high-end smart phones running on a Pocket-PC/Win-CE/Palm operating system. Next, downloading and installing VoIP software on the phone requires some technical know-how, which is a potential inhibitor for adoption. Once the software is installed, to make a call users will need to initiate an Internet data session that typically takes a few seconds. After the data call has been established, users will have to access the VoIP client to dial the

2 Compared to the cost of unlimited domestic calling packages offered by US fixed line service providers.

Figure 3.1 Cost of VoIP Call Over Various Data Packages
Example: Orange UK (1p/minute)



Monthly Data Plan Charges	£88	£41	£16
Inclusive MBs/ Equivalent VoIP Minutes	1000 MB 5,000 mins	80MB 400 mins	25MB 125 mins
VoIP Subscription Charges	£10		
Total Monthly Charges	£98	£51	£26

Figure 3.2 QoS–Related Issues for Mobile VoIP

Factors Impacting QoS	Issues with Current 3G Deployments	Anticipated Evolution
Bandwidth Availability	• Currently 3G supports average throughput of 200–300Kbps, but only 4–5 users/sector are supported simultaneously and performance deteriorates with more users • Voice requires both sufficient bandwidth availability for both uplink and downlink, but uplink is currently constrained to 64Kbps	• HSDPA, the next evolution of WCDMA, will support up to 1Mbps average throughput, however uplink will remain constrained • Evolution to HSUPA will enable higher average uplink speeds of 600 Kbps, which will improve VoIP experience
Network Processing Time	• The network should be able to detect corrupt data and retransmit quickly, but current WCDMA networks can take 30ms or longer to receive the resent data packet [5]	• In HSDPA, intelligence lies closer to air interface and a TTI of 2ms ensures that the radio link quality is monitored more frequently reducing delay in retransmission of data packets
Traffic Prioritization	• Current 3G networks do not have any mechanism for prioritizing VoIP traffic in the network	• QoS-aware radio networks are part of HSDPA release, which will enable prioritization of VoIP traffic for improved quality
	Currently, the total latency is up to 400 msec, compared to the desirable level of <150ms	*Upcoming developments promise to reduce the network latency to less than 100 msec*

call and then wait again for the call to go through. Currently, it is also not possible to integrate various handset related features and facilities such as phonebook and direct dial from contact list to VoIP calling.

This drawn-out process that a customer will have to go through to make a VoIP call compares unfavorably with the convenience of quickly browsing through the stored contacts in the phone book of an average phone and making a regular mobile call.

Given these challenges of inadequate quality, the non-existent cost savings, and the rather cumbersome user experience, the case for mobile VoIP over today's mobile networks is not very compelling.

Future of VoIP with 3G Evolution

The evolution path of 3G networks technology, however, holds some promise for VoIP, but not in the near term. HSDPA[3], the next step in the evolution of WCDMA[4], promises greater downlink bandwidth, but the problematic uplink will remain unaddressed. The subsequent release of HSUPA will enable higher average uplink speeds of 600Kbps, making acceptable quality VoIP over cellular data networks a possibility. In the meantime, specifications are also being laid down for the identification and prioritization of different types of data traffic to enable better QoS support.

However, large-scale commercial availability of these upgrades is still a few years in the future. The HSDPA network upgrade is not expected before 2006 and the HSUPA upgrades to WCDMA networks are not expected to start before 2007. In addition to network upgrades, availability of affordable consumer handsets using these technologies is also an issue.

Figure 3.2 highlights the key QoS-related issues for mobile VoIP and the anticipated developments that may help address them.

3 HSDPA: High Speed Downlink Packet Access. 4 HSUPA: High Speed Uplink Packet Access, It is the next upgrade to HSDPA. 5 WCDMA has a Transmission Time Interval (TTI) of 10ms, which means that it can take 30ms or longer to receive the resent data packet.

Potential impact of VoIP over cellular networks

VoIP over cellular data networks today faces significant barriers to mass consumer adoption driven by inadequate quality, insufficient cost saving, and an unconvincing user experience. Third-party players may enter the market targeting early adopters with VoIP services over the operators' Internet data access, but mobile operators are in a position to stifle such moves. For example, mobile operators can prioritize their own supported services and relegate the rest of the traffic to a lower priority, thus forcing the latency on the "unauthorized" VoIP calls to climb above permissible limits-discouraging potential users.

The emergence of VoIP over cellular data networks as a credible alternative to traditional mobile voice calling will have to wait for operators to roll out HSUPA, lower data access tariffs, and for low-cost mass market handsets with pre-loaded VoIP clients to be widely available.

VoIP over Other Wireless Technologies

The most prominent "other" wireless technology today that could encourage VoIP adoption is Wi-Fi. Compared to making VoIP over cellular, voice over Wi-Fi networks (VoWi-Fi) is already gathering momentum, aided by the declining costs of equipment and the rapid growth in broadband penetration.

We will first evaluate developments in VoWi-Fi and its impact on mobile operators' revenues and then explore selected other wireless technologies that are appearing on the horizon.

Assessment of VoIP over Wi-Fi networks

VoWi-Fi has started to emerge in the market with the launch of Wi-Fi phones–113,000 were sold worldwide in 2004. Vonage and Net2Phone, both VoIP pure plays, are among the players to have launched Wi-Fi handsets, while Skype, another VoIP service provider in the US, is working on having its software preloaded on a range of Wi-Fi enabled mobile smart phones. Most major mobile device vendors have also launched or are close to launching phones with Wi-Fi functionality. While the models available in the market currently are expensive and targeted more to the corporate market, the trend to integrate Wi-Fi into more and more handsets will continue.

Compared to cellular, VoWi-Fi enjoys clear advantages of greater bandwidth availability and lower costs. However, it still faces certain key challenges that will inhibit its growth prospects. To assess its commercial attractiveness, we evaluated the performance of VoIP over Wi-Fi networks on the key considerations of voice quality, affordability and user experience.

Voice quality

The key challenge facing VoWi-Fi is the limited range of coverage of Wi-Fi networks. Even within enterprise deployments where multiple access points can be set up to increase coverage across the campus, issues of radio dead spots and quality deterioration can crop up. Some packet loss is likely as users move between access points, which may not only add to latency but also lead to the call being dropped altogether. For example, if a caller moves between different access points, most PDAs, laptops and Wi-Fi phones will perform a network scan, which can result in latency of around 400 to 600 milliseconds.

However, complex corporate deployments can plan the network to ensure that the connection can be maintained in most cases while moving between access points. Enterprises can also implement prioritization of VoIP traffic over other data traffic to reduce QoS issues. All in all, it is possible to hold an acceptable quality VoIP call over Wi-Fi networks in well-planned limited area implementations.

Cost advantage

VoWi-Fi presents a sizable cost saving potential for users, especially with the trend of increasing Wi-Fi enablement of homes and offices. An analysis of mobile calls by location shows that, on average, 21% of mobile calls originate from home and 23% at the office, while another 30% are made from other indoor locations. The use of VoIP over Wi-Fi at home and the office and some of the other indoor locations could cut the consumer charges for these calls by 50% or more.

Our calculations show that users can save up to 24% on their total mobile bills by switching to VoIP in locations covered by Wi-Fi (after accounting for the additional cost of VoIP subscription).

The enterprise segment is likely to take the first leap. They have already started deploying VoIP over fixed line in their offices and with Wi-Fi on the priority list of most corporates, VoWi-Fi is the next logical step of migration.

User experience

While VoWi-Fi stands up to the cost savings challenge, its inherent nature of being a short-range technology leads to coverage limitations, spelling inconvenience for users. A VoIP call will drop as soon as users move out of range of a Wi-Fi network. Moreover, making VoWi-Fi calls in public areas requires subscription to the hotspot service of an operator. Since roaming between various service providers is still in its nascent stages, most users will likely not opt for a monthly subscription. Users will therefore need to get an hourly or pay-as-you-go pass each time they access an available hotspot, which can be cumbersome.

Furthermore, availability-of easy-to-use devices at an affordable price is currently an issue. Wi-Fi–only phones cost $150–200 and are comparatively bulkier and have a shorter battery life. The likelihood that a large number of users would carry two phones—one mobile and one Wi-Fi—is rather low.

Some of these concerns will get addressed with the arrival of dual-mode devices, which can roam across Wi-Fi and cellular networks. These devices promise seamless switching of calls from a Wi-Fi to a mobile network, when the caller moves out of the range of a hotspot. However, early versions of these handsets have not been able to seamlessly switch between the networks and have suffered battery-life

issues. New and improved versions are expected to be launched this year, but will likely be very expensive (~$500) initially. While these may find takers in the business segment, we expect wide-scale adoption only when the prices fall significantly.

So in aggregate, we see the case for VoWi-Fi starting to become compelling for corporate users, but is still some ways away for consumers.

VoIP over Other Broadband Wireless Technologies

Unrelated to 3G evolution, other technologies that promise a wider coverage range and greater support for mobility and QoS for applications such as VoIP are also emerging. The key ones deserving consideration are TDD-CDMA[6], Flash-OFDM[7], and WiMAX/Mobile-Fi[8]. These technologies are in fact already being trialed and deployed by competitive players to take on the fixed line incumbents for city-wide fixed-wireless access.

PCCW in the UK, Woosh in Australia, and Clix in Portugal are some examples of competitive broadband players deploying TDD-CDMA. PCCW plans to offer broadband wireless service over TDD-CDMA for up to 75% of the UK population within 2 years. They intend to install over 2,200 sites across the UK that can support anywhere between 7,000 to 9,000 households per site. It has also announced plans to offer VoIP.

Flash-OFDM and WiMax are similarly being trialed by several operators for fixed wireless access and backhaul applications. Telabria, a UK-based start-up, has started construction of a WiMax network and expects to launch later this year. It aims to use WiMax for both backhauling traffic and to offer commercial services to its enterprise customers with support for VoIP from the outset. With its promised latency of <50ms, Flash-OFDM can support delay-sensitive applications such as VoIP and is being trialed by Vodafone in Japan, T-Mobile in Europe, and Nextel in the US.

What should be of concern for mobile operators is that these emerging technologies can offer a high range of coverage and claim to support mobility and QoS for applications such as VoIP, thus overcoming the challenges faced by VoIP for deployments over cellular or Wi-Fi networks. If these technologies start gaining ground and encompass city-wide deployments, they will present a definitive threat to mobile operators.

But to date, these technologies have not gained the backing of any large operator and are still in the trial phase. They also face issues of availability of handsets on a commercial scale and regulatory constraints on offering mobility under fixed wireless access licenses. Though we do not expect these technologies to become mass-market in medium term, they do present a long-term strategic threat and mobile operators need to carefully track their development.

Potential impact of VoIP over Wi-Fi and other wireless broadband networks

While other broadband wireless technologies are struggling to gain a foothold, the emergence of VoWi-Fi is the first step towards availability of mobile VoIP. Quality issues in limited area implementations such as enterprise deployments are addressable through careful network design to ensure overlapping coverage and faster hand-offs when the user is mobile between access points. The potential savings can be compelling for users, especially with broadband penetration and Wi-Fi deployment in homes, offices, and public places set to increase.

However, wide-scale adoption will await availability of affordable, dual-mode devices, which can seamlessly switch calls between Wi-Fi and cellular networks. Though these devices are starting to appear, issues of battery power and switching between the two networks are still to be ironed out. Most significantly, the expensive pricing of these early devices will likely keep them out of mass-market segment reach.

Airdata-Germany

Airdata offers TDD-CDMA-based broadband and has rolled out a VoIP service as well.

The VoIP service is available for €8 per month; customers get free on-net and 100 minutes of domestic calls while a comparable package (100 minutes of on-net and fixed-line calls) from T-Mobile

Implications for Mobile Operators

After assessing the development of VoIP over various wireless technologies, we believe that the only significant impact to traditional mobile revenues in the 2–3 years will come from the emergence of VoIP over Wi-Fi. VoIP over cellular networks will continue to face QoS issues till the rollout of HSUPA and better QoS support around 2008. Meanwhile the new broadband wireless technologies like TDD-CDMA, Wi-Max, and Flash OFDM will need to combat mobility constraints imposed by license conditions and also look for big operator backing to be of any significant consequence.

Impact of VoIP on mobile operators' revenues

As noted above, we consider VoWi-Fi to be the only viable threat to mobile operator revenues in the near-term. VoWi-Fi will primarily emerge in the enterprise segment over the next 2–3 years and will gain momentum in the consumer segment only post-2008.

A key constraint to consumer adoption is the availability of dual-mode devices. While these devices are likely to be launched this year, the heavy price tag will limit adoption mainly to the business user segment. Consumers will likely wait for mass-market availability of these phones at more affordable prices. Current forecasts indicate that 100 million Wi-Fi—enabled mobile phones will be sold in 2008, which will account for nearly 5% of the expected 2 billion mobile subscriber base. By then, Wi-Fi penetration is also expected to have reached 35–40% of broadband homes, allowing personal users

6 TDD is part of 3GPP specification and most UMTS licensees have some TDD spectrum. It offers 600-700Kbps average speeds. 7 Proprietary technology from Flarion in the US offering end-to-end VoIP support with low latency (<50ms). 8 These are the emerging IEEE wireless WAN standards.

to save costs by switching mobile calls made while at home to the Wi-Fi network.

We estimate that VoWi-Fi will account for roughly 7% of mobile revenue loss by 2008 in Western Europe. The business segment will contribute to €4.5 billion of mobile revenue loss while the consumer segment will account for nearly €1.3 billion. Any acceleration in broadband uptake and device availability will expedite and increase the impact on revenues further.

Strategic options for mobile operators

Though the near-term financial impact of VoIP over wireless networks may not be significant, mobile operators cannot ignore these developments. Three types of players are knocking on the gates to threaten mobile operator hegemony: VoIP pure plays, broadband players offering fixed-wireless access, and aggressive fixed-line incumbents looking at ways to stem fixed-to-mobile substitution. In fact, some fixed-line incumbents have already announced VoWi-Fi initiatives. BT's Bluephone, for example, will enable calls to be switched to the broadband connection through Bluetooth or Wi-Fi when at home or the office. Korea Telecom launched a similar service called Du in August 2004 that proclaims to help users save 20% on their mobile phone bills.

So how will/should mobile operators respond? We see two main approaches prevailing in the market.

Defend the turf

The first level of response from mobile operators is likely to be a reduction in mobile tariffs to reduce the potential arbitrage benefit from using VoWi-Fi. The increased voice capacity of mobile networks with 3G deployment is giving operators more room to maneuver voice tariffs. Many operators have already introduced lower charges after the launch of 3G networks and future upgrades to HSDPA and HSUPA will make it possible to drop prices even further.

Operators are also likely to block competitive broadband players deploying new wireless technologies from offering mobile VoIP. For example, cellular operators are lobbying against PCCW in the UK from offering any form of portability even though the technology supports mobility and hand offs. Mobile operators argue that allowing customers to link to multiple base stations amounts to portability and breaks the license terms, an issue that regulator Ofcom will have to clarify once PCCW goes live with voice services.

Regulators are also coming under increasing pressure from wireline players to tax VoIP on the same terms as PSTN services. Wireless players can join forces with incumbents to slow down VoIP progress, if not stop it altogether.

In addition to the blocking tactics, operators should continue to press with value-added services—particularly aimed at business users—to differentiate from the less "robust" competitor propositions. Mobile operators are already offering facilities such as closed-user groups, ability to share inclusive minutes, usage capping and many more. Moreover, services such as Virtual PBX, which enables business users to enjoy PBX-like features on a mobile phone without investing in a PBX infrastructure, will also help counter the VoWi-Fi threat.

Expand the turf

While defensive measures can help operators limit the impact of VoIP in the near term (~2 years), the approach is not a sustainable one. 3G evolution will undoubtedly offer more bandwidth and speed, but operators will need to be realistic about their ability to effectively compete with other broadband wireless technologies. As these broadband wireless options become more viable, operators must ensure that they are not left sidelined

and unable to participate in any growth stemming from these alternative technologies.

Most mobile operators in Europe, for example, already have some unpaired TDD spectrum as part of their 3G license and can evaluate the prospect of using TDD-CDMA to offer data access services. This will allow operators to benefit from lower costs, as they will be able to use their existing infrastructure to co-locate base stations and share cell site equipment, including antennae. In addition, as 3G technologies are optimized for outdoor coverage, providing in-building coverage using 3G spectrum is likely to be more expensive than using the alternative wireless technologies like Wi-Fi or TDD-CDMA. Mobile operators can also push for dual-mode devices to accelerate fixed-to-mobile substitution. As cost and coverage are the key concerns voiced by consumers in using the mobile as the main phone, mobile operators can seize the opportunity afforded by cellular/Wi-Fi integration to encourage a complete replacement of the fixed-line phone.

Conclusions

In conclusion, mobile VoIP is still in its nascent stages and we consider the near-term threat to operators' traditional mobile voice business to be minor. Over cellular networks, the VoIP proposition today is not compelling, driven by a combination of quality issues, poor user experience, and insignificant cost savings potential. VoIP over Wi-Fi networks, on the other hand, can provide acceptable voice quality with careful network design and the opportunity for significant cost saving. However, widespread adoption of VoWi-Fi will depend on the availability of affordable dual-mode cellular/Wi-Fi devices. We see VoWi-Fi starting to take a significant toll on mobile operator revenues from 2008.

In the meantime, mobile operators should not ignore the march of newer wireless technologies, which are lowering the entry barriers for fixed-line, competitive broadband, and VoIP pure plays to offer wireless VoIP. While mobile operators can defend their turf to counter the threat from alternative technologies in the short range, the strategy is not sustainable over the long term. The threat from wireless broadband players will grow and operators risk being cannibalized if they do not actively position themselves to ride the crest of any potential growth wave emanating from one of the alternative technologies.

We believe mobile VoIP poses little threat to operators' traditional mobile voice business in the short term, but operators should position themselves to ride the crest of any potential growth wave emanating from one of the alternative technologies.

4 Charge of the Mesh Brigade: Hype or Disruption in Progress?

First published: February 2005

Objective of Study

The latest disruptive technology to arrive in the telecoms market is the mesh network; we analyzed what makes them disruptive and assessed the likely impact on the incumbents.

Wireless Mesh Networks

Mesh networks are peer-to-peer communication networks that allow two user devices to communicate directly, instead of being routed through a central switch.

The Semi-Mesh

Most vendors are offering a semi-mesh architecture because their routing algorithms do not support the huge signaling overheads associated with a large-scale true mesh deployment.

What Are Wireless Mesh Networks?

Throughout its history, the telecommunications sector has seen new technologies evolve and offer better value propositions to the user, replacing older technologies on the way. Events like the telephone replacing the telegraph, wireless surpassing fixed line, and VoIP evolving to replace circuit-switched technology, bear testimony to the fact that telecommunications is a breeding ground for "disruptive technologies."

Disruptive technologies, as described by Clayton Christensen in his 1997 book *The Innovator's Dilemma*, are products or processes, often with performance issues, that establish themselves within a less demanding niche segment of an existing market. Through performance improvements these innovations spread into mass segments, ultimately displacing the incumbents.

Keeping true to the historical trend, a new technology is knocking on the doors of the telecommunications industry: the wireless mesh network. Like many of its predecessors, it has significant potential to disrupt the current telecom setup.

In this report, Capgemini's TME Strategy Lab analyzes what makes mesh networks disruptive, exploring what impact this technology is likely to have on the incumbents, and how the incumbents can face up to the challenge.

What is a mesh network?

Wireless mesh networks are peer-to-peer wireless communication systems that allow two user devices to communicate directly, instead of being routed through a central switch.

A mesh network differs from a conventional network in many ways. Unlike in a conventional network, end user devices in a mesh network in addition to sending their own data, act as router or repeater, relaying signals for other devices. The routing information of a conventional network resides in the central switch, whereas this intelligence is distributed among the mesh entities, giving it a decentralized nature. This in turn allows each meshed transmitter node to relay signals to several other nodes, as opposed to conventional transmitter nodes, which talk to each other through the central switch.

Additionally, backhaul communication of mesh networks is also over the air interface, requiring substantially less wiring than a conventional network to connect the transmitter nodes back to the central switch.

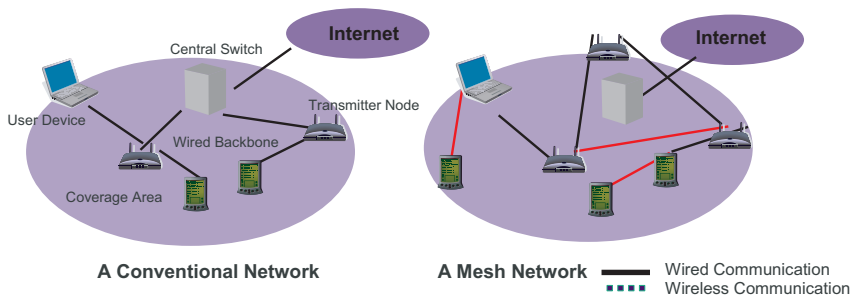
Mesh network architecture

Vendors are offering mesh solutions under two basic architectures, trying to balance network scalability with its throughput.

The network mesh creates a wireless mesh only among the transmitter nodes. In such networks the client devices do not relay data for other devices. This semi-mesh, by virtue of dumb user devices, restricts the number of transmitters, allowing low routing signal overheads. Most vendors support this architecture as their routing algorithms are not robust enough to handle large-scale signaling overheads.

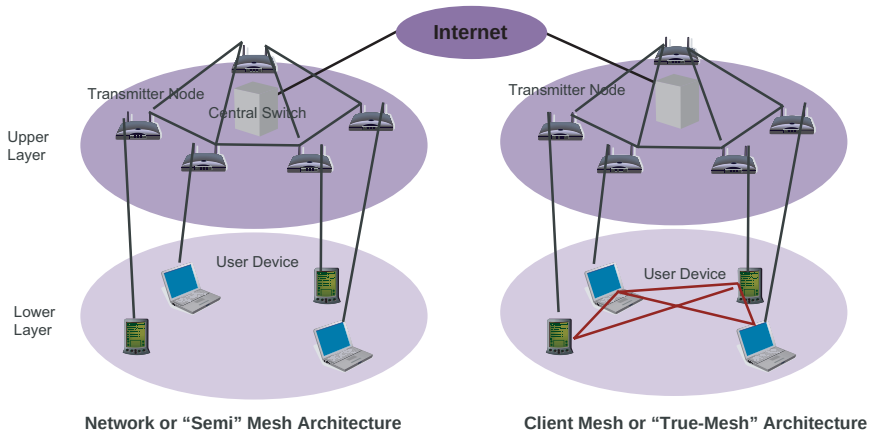
The client mesh, on the other hand, in addition to the transmitter nodes, enables a wireless mesh among the client devices, allowing them to relay data for other devices. The true mesh allows peer-to-peer networks, improving the coverage and robustness of the network. A small number of vendors are pushing this architecture, backed by proprietary

Figure 4.1 Mesh network as compared to a conventional network



Source: Capgemini TME Strategy Lab.

Figure 4.2 Mesh Network Architecture



routing algorithms. Motorola is one such vendor offering client mesh architecture via its wireless PCMCIA cards.

Wi-Fi finds favour with mesh network vendors

Mesh protocols are frequency agnostic and can be used with technologies like Wi-Fi, Bluetooth, Zigbee, and Ultra-wide band (UWB). But, with the growing customer uptake of 802.11 Wi-Fi, vendors are increasingly using these standards for implementing mesh networks. Wi-Fi-based mesh networks enable customers to continue with their existing Wi-Fi devices, without any hardware or software upgrade. The increasing availability of Wi-Fi devices is likely to boost the deployment of Wi-Fi-based mesh networks.

What Makes Meshes Potentially So Disruptive?

The strong value proposition mesh networks bring for the user and substantially lowered entry barriers for greenfield operators have prompted the uptake of this technology as an alternate broadband solution. This is what makes it potentially so disruptive to incumbent operators.

Strong value proposition to the user

On the demand side, mesh networks offer substantial benefits to the users in terms of better features, lowered costs, and enhanced experience:

Private Networks: The peer-to-peer nature of mesh networks encourages users to set up their own networks, with each participant in the network owning and maintaining its own hardware. This could allow some customers to bypass operators for local communications.

High Speeds: Users get download speeds of 3x-6x cable/DSL, and about 12x-15x data speeds compared to a conventional 3G network. Mesh networks based on UWB are slated to provide data speeds of up to 400Mbps.

Low Price Points: Mesh wireless broadband offerings are available at nearly a fifth of cellular data prices, one third of DSL/cable price points, and at nearly half the price of Wi-Fi offerings. Customers can benefit from faster installation at lower cost due to the reduced cabling requirements.

Seamless Mobility: With mesh networks, users need not search for hotspots as they get a city-wide, fully mobile, broadband connection.

Improved Service Quality: Mesh network customers get to experience a higher quality service as high network redundancy prevents link drops and outages, common in other wireless networks.

Lowered entry barriers

On the supply side, mesh networks lower entry barriers, driving greenfield operators to launch turnkey operations:

Reduced Regulatory Barriers: Mesh networks enable operators to shorten service-launch timelines by overcoming regulatory barriers. With their frequency-agnostic properties, mesh networks can be launched on license-free technologies like Wi-Fi. This enables operators to bypass prolonged processes associated with spectrum allocations for commercial use.

Substantial Cost Benefits: Unlicensed spectrum and the absence of an expensive wired backbone enable operators to set up mesh networks with much lower capital expenditure than networks based on other technologies. Automatic configuration and topology selection enable low maintenance and operational costs. In addition, because of the shorter transmission distances involved, mesh transmitters consume less power compared to other wireless technologies (see Figure 4.3).

Enhanced Network Robustness: Dynamic routing and no central point of failure

enable the networks to operate even if nodes are removed or damaged.

Ease of Installation: Mesh systems use dynamic node discovery and automatic selection of topology to install and integrate the nodes with itself, without further configuration requirements.

Mesh Networks Are Already Here But Can They Become Mainstream?

New entrants are already deploying city-wide mesh networks

The past few months have seen increased deployment of mesh networks around the world. Like a true disruptive technology, mesh networks are largely being deployed by new entrants like greenfield operators and community-based network players.

Greenfield Operators: Taking advantage of low set-up costs and reduced timelines, many start-ups have recently launched mesh-network-based broadband services. Qware Systems, for example, is deploying a Wi-Fi-based, $70 million, city-wide wireless-network mesh in Taipei. The network will have 10,000 wireless access points in service by year-end 2005 and serve 90% of Taipei's 2.65 million population in an area of 272 square kilometers. Qware plans to charge a basic monthly fee of $4.50–12, compared to $24–30 charged by fixed-line broadband providers.

HotSpot Amsterdam, a start-up, deployed a city-wide Wi-Fi (802.11)-based network mesh in Amsterdam in August 2004, to provide commercial broadband services.

Community-based Network Players: With their low operating costs and easy manageability, mesh networks are enabling city councils and campuses to launch their own private community networks. In mid-2003, authorities in Medford, Oregon in the US selected a client mesh solution over GPRS for town-wide, public services data communications. The client mesh enables city officials to form ad-hoc mesh networks with their access devices.

In September 2004, the city of Philadelphia announced plans to invest in a network mesh based on the 802.11b standard. Once complete, the mesh network will deliver free broadband Internet to city residents.

According to industry estimates, around 100 municipalities around the world are using mesh-based networks in one form or the other.[2] The level of threat from municipal-run businesses to incumbent operators can be gauged from the fact that the US incumbents have lobbied aggressively to prevent communities launching non-commercial broadband services. And they have managed to get favorable legislation passed in fourteen US states preventing municipalities from launching such services.

Path to Mainstream: The Mesh Scorecard

The significant increase in the number of deployments and the move towards large-scale city-wide networks across the world suggest that mesh networks may soon be a mainstream phenomenon.

But not all innovations identified as disruptive have become mainstream. Disruptive technologies have had their own fair share of successes and failures. While VoIP, ADSL, and digital cameras are some of the much publicized successful disruptions, stories like betamax vs. VHS and laserdisks vs. DVDs are some classic failures of disruptive technologies.

Historically, successful disruptive innovations have carried a proven user appeal. These technologies have established an efficient partner ecosystem and overcome performance issues early on. Regulatory support and technology standardization have also helped these innovations go mainstream.

If we analyze mesh networks against these parameters, we find that:

User Appeal: Mesh networks have an established primary target audience in large geographical pockets still waiting to go broadband live. It has already generated successful references for commercial deployments in niche segments and is now moving towards large-scale city-wide deployments.

Partner Ecosystem: For mesh networks to become mainstream, an ecosystem of equipment vendors, application providers, CPE manufacturers, and operators has to

Figure 4.3 Cost Performance Comparison of Mesh to Other Technologies

Technology	Throughput	Number of Cells	Cost[a] (Million $)
DSL[b]	1000-1500 Kbps (Downlink) 200-385 Kbps (Uplink)	-	~ 1,500-2,000
Wi-Fi[c]	1000-4000 Kbps (Symmetric)	600	~ 9
3G[d] (CDMA: EVDO)	300-500 Kbps (Downlink) ~ 50 Kbps (Uplink)	64	~ 8
Mesh Networks[e]	500-2000 Kbps (Symmetric)	600	~ 2

a. Network deployment costs in Manhattan (34 square miles). b. Estimates for rebuilding the Verizon fixed network in Manhattan post 9/11. c. Airvana estimates for a Wi-Fi network @ $15000/ Wi-Fi node purchase and installation cost. d. Airvana estimates for an overlay EVDO network @ $125000/ per radio node purchase and installation costs. e. Wi-Fi-based mesh networks; Tropos Networks data. Note: In the case of a WiMAX-based network, deployment costs would amount to around $135,000 for a similar 30-mile area.[1] Just as mesh over Wi-Fi is more cost effective than Wi-Fi, the capital expenditure necessary for mesh over WiMax will be lower than for WiMAX.

1 California Performance Review, "Wireless Metropolitan Area Networks Provide Improved Broadband Access", August 2004. 2 Ron Sege, president of Tropos Networks, in the *International Herald Tribune* article "A Turf War over Wi-Fi Wireless", 10 January 2005.

evolve to establish a robust value chain. It's imperative that R&D support is maintained upon current performance levels.

Today mesh network vendors are dominated by very small technology start-ups, concentrating on niche segments of public safety and educational campuses. The long-term capability of these vendors to sell a new technology and to provide a sustained support backbone remains to be seen. But the mesh phenomenon has started to gather steam and big players like Motorola and Nortel have joined the mesh platform in the past few months. Large Wi-Fi operators like Boingo have also started tying up with mesh-based service providers.

Standards and Regulations: All present mesh offerings are based on proprietary protocols and are not interoperable with each other. This may hinder faster uptake of the technology as the incompatibilities between proprietary networks will prevent groups of mesh users from communicating with each other directly. But progress has been made towards standardization by setting up a new IEEE[3] task group in July 2004. This group is working on wireless mesh standards known as IEEE 802.11s. Publication of these standards is estimated to be at least 3 years away.

When used with Wi-Fi standards, mesh networks do not face any regulatory challenges, as the 2.4Ghz band is globally license free. With regards to the 5Ghz frequency band, although it is an unlicensed band in Europe, some countries do not allow outdoor use of this band.

Security Issues: As most current implementations of mesh networks are based on Wi-Fi, questions on the security aspect are bound to arise. To counter this, mesh vendors claim to have developed protocols providing built-in security mechanisms, like advanced encryption on the backbone link and user authentication. Additionally, work is already in progress to incorporate the IEEE 802.11i security standards into Wi-Fi mesh products.

Technology Stability: The true scalability potential of mesh networks, while maintaining the bandwidth, is still under the scanner. A large city-wide mesh network may have its bandwidth choked by too many routing information updates. Similarly, the capability to maintain low latencies over multiple hops is an area of concern. Sustained bandwidth availability with low latencies is a must for providing services like Video on Demand (VoD) and Voice over IP (VoIP).

Vendors have come up with innovative solutions to overcome these issues. On offer are multi-radio solutions to provide sustained bandwidth and software suites to create QoS solutions for applications like VoD and VoIP. But to date there is no installation large enough to substantiate the claims.

Additionally, in the case of client meshes, due to the increased amount of processing involved in user devices, they tend to drain device batteries at a faster rate.

But disruptive innovations often initially have performance issues. The small off-road motorcycles introduced by Honda in the 1960s, Apple's first personal computer, and mobile communication itself all initially underperformed the mainstream offerings. Only once simple and less demanding setups have been introduced do these innovations improve enough to relegate existing dominant firms to the sidelines.

Mesh networks are likely to become a reality in the next couple of years

Mesh technology possesses most of the necessary success drivers and work is continuing on the remaining few glitches. As the barriers are removed over the next few years, and as the technology evolves, ironing out its performance issues, the disruptive potential of mesh networks will grow in scale and scope.

It is possible that 2005 will see niche segment mesh implementations give way to increased deployments of large-scale, city-wide broadband networks. And by 2006, based on the performance results of broadband deployments in cities like Taipei and Philadelphia, we can expect the number of greenfield operators to mushroom globally, trying to replicate the success.

A major boost to mesh networks may come from the successful evolution of user devices equipped with Wi-Fi/cellular interoperability by 2006, as this would lead to increased Wi-Fi–based mesh network usage.

But the biggest trigger for mass deployment of large scale mesh networks will be the availability of the 802.11s standardization in 2007, which will bring the true disruptive potential of these networks to fruition.

Potential Impact on Incumbents

In the next 2 to 3 years…

Until recently mesh technology was not considered ripe enough to challenge the incumbents. But over the past few months, this view has begun to change as mesh networks start to make their first forays into city-wide deployments. Today it is clear that mesh networks have the potential to severely impact the business of Wi-Fi, DSL, cable, and cellular service providers in the medium term.

Wi-Fi Operators

Users no longer need to search for a hotspot for broadband access as mesh networks provide wide area, ubiquitous access to broadband services. Wi-Fi operators will have to compete with a truly mobile, low-cost alternative.

The Wi-Fi model can be compared to that of payphones, wherein a user has to go to a particular place to access the service. The emergence of mobile phones has made payphones redundant. Similarly, mesh networks with their potential for city-wide coverage render standalone Wi-Fi networks outmoded.

In addition, unlike with Wi-Fi services, users will not face access point congestion issues in mesh networks. Users also get to enjoy seamless roaming on mesh

3 Institute of Electrical and Electronics Engineers.

networks. And they can start using the service almost immediately as installation cabling requirements are minimal.

DSL/Cable Operators
Substantial network capex and opex savings over fixed-line networks will make it possible for mesh networks to offer lower service price points. This may lead to fixed-line players facing intensive price-based competition from wireless mesh operators.

Similar speeds at substantially lower costs will impact broadband revenues by driving customer churn.

Users will also get the advantage of seamless mobility. But the mobility factor will be of limited impact as people use broadband in the home for different reasons to outdoor/in-transit use. The value proposition instead lies in the fact that a single connection will fulfill both needs.

Mobile Operators
Mesh networks have the potential to threaten both the data and voice revenues of cellular operators—the same operators that are looking to data to be the next growth driver.

In Europe, data revenues made up 16% of operator revenues in 2004 and are estimated to increase to 22% by 2007.[4] Mesh networks hold the potential to steamroll the data plans of mobile operators, as they offer a better user experience with no connection dropout and congestion issues. Users can experience 10x data speeds symmetrically for both uplink and downlink, unlike cellular services.

A license-free spectrum gives mesh networks substantial cost benefits over a cellular network. Mesh operators can pass on the cost benefits to the customer. With the advent of Wi-Fi-compatible mobile phones by the end of 2005/early 2006, Wi-Fi mesh networks are slated to provide a better, more cost-effective alternative to customers' data needs.

Going forward, mesh networks even pose a challenge to the voice revenues of mobile operators. Currently, the non-ubiquitous nature of Wi-Fi networks is detrimental to the spread of VoIP over Wi-Fi, as the prospect of going to a hotspot to make or receive a call defeats the purpose of mobile VoIP. But meshes, with their wide area coverage, will drive mobile VoIP.

5 to 7 years from now…
After municipalities, it will be the corporate and enterprise users who will move away from operator services and see substantial cost savings to mesh-based communication networks. This can have a major impact on overall operators' margins as corporates form the biggest proportion of high-margin customers.

In the longer term, even consumers may set up their own mesh networks, however, standardization of mesh protocols is essential to making this a reality.

Current proprietary solutions enable mesh-based micro networks to link up directly, only if all such networks are from the same vendor. With suitable firewall permissions, the user device will dynamically link up with the neighbouring mesh. With evolving technology, the routing overheads may come down further to enable intercity mesh linkups. Standardization and proliferation of client meshes will further drive cross-city linkups. Although not conceivable at current technology levels, a global mega network of linked-up local mesh networks cannot be completely ruled out.

As users move away from operator networks, revenues from network usage would be drastically hit. The take up of VoIP over mesh networks will impact the voice revenues of incumbents. Operators' control of mobile content distribution may be lost. And operator data revenues will take a plunge as distribution gets fragmented across micro private networks.

Incumbent Response Strategies

The majority of incumbents facing disruption end up focusing on the potential losses caused by disruption. They find it difficult to adopt the innovation during the early stages of its technology lifecycle, because of the significant capital sunk in the older technology. Additionally, the prospect of the cannibalization of established revenue-generating products and unprofitability of under-sized initial target segments keep the incumbents from accepting the change.

But when a disruption of the scale of mesh technology knocks on the door, it is imperative that the threat is recognized and acknowledged at an early stage. Once the risks are identified, the incumbents need to either carry out a preemptive or retaliatory move.

When faced with disruptions, historically incumbents generally resort to one of the following strategies:

Side-step
One option for the operators is to ignore the threat from the new entrants because initially their offerings address only those segments that are either unserved or are loss inducing/low profit for the incumbents. Incumbents will undoubtedly find it convenient to ignore or exit these segments to concentrate on higher margin ones.

However, this strategy invariably leads to new entrants following the incumbents into these lucrative categories on the back of performance improvements. Mesh networks are already graduating from low-interest niche segments to lucrative city-wide deployments and side-stepping will not be the right choice for incumbents.

Confront
Another option for the incumbents is to take on the challenger and apply various tactics to confront the new entrants. To compete with disruptive innovations, the incumbents could:

Set Up Regulatory Roadblocks: However, this has proven to be more of a delaying tactic rather than a blocking one and even then with only limited success. Moreover, mesh networks provide limited

4 Smith Barney, "European Mobile Returns", September 2004.

maneuverability in this context. In the case of the US regulations against municipalities, many groups including large companies like Intel have already joined forces to challenge the legislation.

Undercut New Entrants: With their deep pockets incumbents may resort to undercutting the new entrants to drive them out of the business. But with the price advantage that mesh networks offer, incumbents would be hard pressed to compete on prices. Existing wafer-thin margins also play against this strategy.

Differentiate Offerings: This strategy is best suited for incumbents as it will give them the opportunity of utilizing their strengths while hitting on the weak spots of the mesh operators.

While the competition will drive bandwidth towards commoditization, it will be content deals that will differentiate one service provider from another. The incumbents can use exclusive content deals to differentiate themselves from plain vanilla ISP offerings of the mesh operators. Also, with the scalability and latency issues currently faced by mesh networks, they would be hard pressed to offer services like VoIP and VoD in the near term. Incumbents need to market VoIP and VoD aggressively in the form of value-for-money bundles and accelerate their triple-play strategy.

Integrate

While the differentiation strategy does give a competitive edge to the incumbents, it will not be a sustainable advantage in the long term. Competition will hasten performance improvements in mesh networks and the new players will hone their skills in the market. Once this happens, the balance will start shifting towards the new players.

To circumvent this, incumbents should consider incorporating mesh technology into their own plans for the long term. Instead of seeing mesh networks as a competitive threat, Wi-Fi, DSL and cable players can incorporate mesh networks into their network strategy for faster roll outs and greater coverage.

Wi-Fi operators can dramatically enhance the value proposition of their offerings by providing city-wide mesh network coverage instead of restricting their users to selective hotspots. With their ubiquitous coverage, mesh networks can also be a key driver for the VoIP over Wi-Fi plans of these operators.

In the case of DSL and cable players, meshed Wi-Fi networks provide a perfect extension to spread out their networks to remote areas that would otherwise have been financially unviable for a wired network. These operators need no longer wait for a critical customer mass to build up and can launch mesh services within the shortest possible time and at substantially lower costs.

With many of them already running commercial Wi-Fi services, mobile players should also give serious consideration to Wi-Fi mesh networks. Mesh networks can satisfy the demands of high bandwidth data applications, and with Wi-Fi-compatible mobile phones making their first appearances in the market, a cellular/Wi-Fi combination network can work out to be a lucrative option. To start with, operators can use mesh networks as a data delivery network for high data usage areas, such as central business districts.

Conclusion

Disruptive technologies normally have a long gestation period. Launched in 1967, minicomputers took nearly 2 decades to surpass mainframe dollar sales in the late 1980s. And even after that mainframe dollar sales did not show double-year declines until the early 1990s. Thus, both markets continued to grow for some time after the initial emergence of the disruptive technology. According to Clark Gilbert, assistant professor at the Harvard Business School, disruption always creates new net growth because it expands the total reach of products and services.[5] Incumbents need to recognize this opportunity and adapt to capture the value generated by mesh networks.

We see more large city-wide mesh network deployments emerging in the next 2 to 3 years, driven both by greenfield operators as well as municipalities. At the same time, enterprises will also start to trial and deploy the technology for their internal communication and connectivity needs. In 5 to 7 years, we envision greater standardization of protocols enabling wider adoption of mesh technology, encouraging communities of consumers to set up their own networks.

While mesh networks do represent a substantial threat, they also provide a significant opportunity for incumbents to offer a high-quality user experience in a cost-effective manner. For incumbents, the choice is between adopting and enjoying the benefits of a better technology or fighting against opponents becoming stronger by the day. We recommend the former.

5 Harvard Business School, HBS Working Knowledge, "Read All About It! Newspapers Lose Web War", January 2002

5 The Future of 3G: Assessing the Threat of Alternative Wireless Technologies

First published: September 2005

Objective of the study

Various wireless technologies are emerging that are set to compete with 3G in a fight for wireless data revenues. Capgemini analyzed the latest market developments to assess whether 3G is under threat from these alternative wireless technologies.

With mobile penetration approaching saturation in many European countries, operators are relying on data services to generate growth. To enable access to advanced data services at faster speeds and more affordable prices, mobile operators around the world are upgrading their second-generation (2G) GSM networks to third-generation (3G) networks. Europe alone saw 48 3G network launches in 2004, based on Wideband CDMA (WCDMA), which has emerged as the 3G technology of choice for GSM network evolution worldwide.

However, WCDMA networks are not adequately living up to expectations for delivering high data speeds and supporting bandwidth-intensive applications. User experience indicates that high-speed data access (200–300Kbps throughput) is usually available to no more than 5–8 simultaneous users in a cell, with performance deteriorating as more mobile data subscribers log in. The performance challenges have prompted operators to start planning for and investing to upgrade their WCDMA networks—barely a year after the launch.

At the same time, other high-speed wireless technologies are also emerging, promising a broadband-like experience to mobile users. These technologies have the potential to cannibalise the very data revenues that mobile operators are banking on to justify their 3G investments.

In this report, Capgemini's TME Strategy Lab explores whether WCDMA will survive the onslaught of these emerging wireless technologies. We evaluate how WCDMA networks are evolving towards higher speeds and greater efficiency and whether the alternative wireless technologies will match up to this mainstream evolution to become commercially successful on a large scale.

The Emergence of Alternative Technologies

A host of broadband wireless technologies are emerging that offer consumers much higher data speeds compared to WCDMA, support VoIP, and in some cases, also provide mobile services. In this section, we profile the key emerging wireless broadband technologies, with the potential to challenge WCDMA.

TD-CDMA

Time Division Code Division Multiple Access, or TD-CDMA, is an approved 3G technology with mobile capabilities that offers better spectrum efficiency and higher data speeds compared to WCDMA. It can provide peak data rates of 5Mbps using 5MHz spectrum as compared to only 2Mbps available with WCDMA on 2X5MHz spectrum.[1]

Most European regulators awarded 5MHz spectrum for TD-CDMA bundled with the WCDMA spectrum in the 3G licences. However, mobile operators have thus far concentrated their investments on the mainstream WCDMA implementation, by and large ignoring TD-CDMA.

TD-CDMA has started attracting attention recently after deployments by fixed players for wireless broadband data access. For example, PCCW, a competitive broadband operator in the UK, has won 40MHz of spectrum on the 3.5GHz band and is rolling out its fixed wireless broadband offering using TD-CDMA, with plans to

1 TD-CDMA uses the same 5MHz carrier for both uplink and downlink. WCDMA, however, uses separate 5MHz carriers for uplink and downlink and hence, is represented as 2X5MHz (or 2Xmultiples of 5MHz).

reach 75% population coverage in the country. PCCW is offering portable wireless services at DSL speeds and rates, and has plans to launch VoIP as well.

Mobile operators such as Orange France and T-Mobile in Czech Republic have also started evaluating TD-CDMA and have recently announced trials, which may help the technology gain traction within the mobile community.

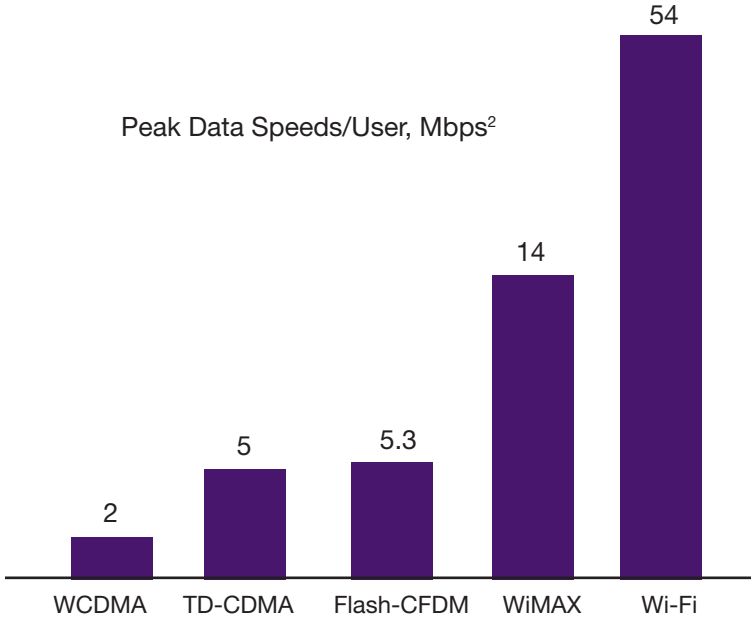
Flash-OFDM
Orthogonal Frequency Division Multiplexing (OFDM) is a radio technology that exhibits distinct advantages over CDMA in terms of efficiency and increasing capacity. Flarion Technologies Inc. in the US offers a proprietary OFDM-based mobile technology, Flash-OFDM, which is an end-to-end IP network. The technology has distinct performance advantages such as peak data rates of 5.3Mbps using lesser frequency spectrum than WCDMA and a round-trip delay of <50ms (compared to 300ms on WCDMA).

Flash-OFDM is at various stages of trial with operators such as T-Mobile in Germany and Nextel in the US. The Government of Finland has awarded a licence to build a nationwide mobile broadband network using Flash-OFDM, which will offer high-speed Internet as well as VoIP.

Standards bodies are considering integrating OFDM with WCDMA for the next phase of 3G evolution with likely deployments by 2010. Qualcomm, which owns the IPR of CDMA technology, recently acquired Flarion, with the possible intention of using the latter's expertise to develop an OFDM/CDMA hybrid technology. In light of this development, it is likely that Flash-OFDM will be subsumed in the WCDMA evolution rather than pose a threat to the mainstream 3G technologies.

WiMAX
WiMAX promises to deliver wireless broadband within a coverage area of up to 50km at peak data rates of up to 70Mbps. Though it will require licensed spectrum for wide-scale deployment, the cost of hardware for setting up a citywide WiMAX network will be much less than WCDMA. Current versions of the technology do not offer mobility but a mobile WiMAX standard (802.16e) is under development and is expected to be available by 2007.

Figure 5.1 Users can expect much higher peak data speeds with alternative technology options than WCDMA



Many competitive players have already started launching fixed wireless broadband services using WiMAX. For example, Libera, a UK broadband wireless start up, is providing pre-standard WiMAX-based services in Bristol and has plans to cover 75% of UK businesses in the next two years. Tower Stream in the US has the largest pre-standard WiMAX deployment, offering fixed wireless broadband access to the business segment across New York, Los Angeles, Chicago, and San Francisco with aggressive plans to extend the coverage throughout the rest of the country.

WiMAX is backed by the IEEE consortium with more than 220 members encompassing an entire ecosystem of equipment manufacturers, operators, application providers, etc. Intel is at the forefront of promoting this technology and if successful, one can envisage a scenario where all laptops and PDAs are WiMAX-ready. In the event that regulatory conditions also co-operate and move towards a technology-neutral approach, mobile WiMAX deployments may start posing a real threat to mobile operators' data revenues.

Wi-Fi
Wi-Fi provides wireless connectivity for broadband users within a limited area or hotspot (typically a radius of 20–25m). Wi-Fi can support a peak data rate of 54Mbps, which is shared amongst simultaneous users. It has rapidly gained popularity in light of its easy installation and affordable equipment.

In contrast to WCDMA, Wi-Fi is deployed over unlicensed radio spectrum, which further lowers cost of deployment. This has led to many public hotspots springing up, run by private businesses at hotels, restaurants, airports, etc. Even mobile and fixed-line operators are investing in public

2 WCDMA uses 2X5MHz spectrum to deliver the indicated theoretical peak data rates which are available to a single user. Peak data speed on TD-CDMA is indicated as available on 5MHz, Flash-OFDM on 2X1.25MHz, WiMax on 2X5MHz. Wi-Fi uses unlicensed radio channels and hence, carrier bandwidth are not relevant.

hotspots and striking alliances with other operators to offer as large a footprint as possible. Chaska.net, a wireless ISP in the city of Chaska, Minnesota has gone live with its Wi-Fi network, which covers 16 square miles, and 20% of the city's households have taken up the subscription in the 4 months since launch.

Wi-Fi does not directly compare with 3G deployments in terms of true mobility, but a growing network of hotspots leading to city-wide deployment offers users an alternate mechanism to access data services than 3G.

The WCDMA Evolution

With the current speeds that are available on WCDMA proving inadequate, operators are looking to upgrade their 3G networks—barely a year after launch. The first step in the upgrade path is High Speed Downlink Packet Access (HSDPA), followed by High Speed Uplink Packet Access (HSUPA). Beyond HSUPA, a "Super 3G" upgrade is being considered, to counter the threat of future "4G" technologies.

We will now profile the upcoming WCDMA upgrades and assess the performance enhancement potential of each.

HSDPA

High Speed Downlink Packet Access (HSDPA) only requires a software upgrade to the existing WCDMA network. It enables a two-fold improvement in network capacity-enhancing download data speeds by more than five times the current WCDMA networks to 14Mbps and shortening the round-trip delay between the network and the terminal. These advances translate directly into improved service delivery performance and a superior user experience, especially for services such as video streaming and bandwidth-intensive downloads.

Many operators across the world are already trialing HSDPA, with large-scale deployments expected in 2006 when handsets become widely available. In its HSDPA trials in the Netherlands, T-Mobile has indicated the possibility of reaching ADSL speeds, which can blur the boundaries of user experience whether at home, office or while mobile.

HSUPA

High Speed Uplink Packet Access (HSUPA) is the next step in network enhancement to improve uplink speed performance, again requiring only a software upgrade. Peak uplink throughput increases to 14Mbps compared to 64Kbps on WCDMA/HSDPA. This means that real-time applications such as video telephony and voice, which are uplink-bandwidth–constrained on WCDMA and HSDPA data networks, can be made available on the packet data networks. This will be the first step to moving towards a converged network over which both voice and data services can be delivered.

HSUPA handsets and equipment are expected to be available for wide-scale deployment by 2008.

Super 3G

As the need for speed continues to grow, it is entirely plausible that in the not too distant future, consumer requirements will outstrip what HSDPA/HSUPA can deliver. To meet this challenge, a step-change in 3G evolution is being envisaged that integrates OFDM and CDMA. This upgrade, referred to as Super 3G, could deliver 100Mbps of peak data capacity with average speeds of 5–10Mbps and higher.

Super 3G aims to provide a smooth technological upgrade, leveraging the existing WCDMA infrastructure, such that operators will not need to build a new network from scratch.

Figure 5.2 below profiles HSDPA, HSUPA and Super 3G upgrades to WCDMA, illustrating that this mainstream evolution path is rapidly narrowing down the performance advantages currently enjoyed by other wireless technologies.

The argument over which technology wins, however, does not rest solely on performance advantages. The IT and communications industries are littered with examples of excellent technical solutions that failed commercially. In the next section, we assess the 3G and alternative wireless technologies on parameters that constitute commercial success.

The Battle for Commercial Success

To become mainstream, a wireless technology should be able to adequately perform on the factors that ensured GSM success. It must therefore be able to support seamless mobility and roaming across locations and geographies; it should have a smooth deployment path that enables integration with existing infrastructure investments; and it should offer affordable devices with similar appeal to GSM handsets. In this section, we evaluate how the alternative wireless technologies stand-up to these success factors and whether they pose a significant threat to WCDMA evolution.

Figure 5.2 WCDMA upgrades will match the performance of alternative wireless technologies

	WCDMA Evolution				Alternative Wireless Technologies			
	WCDMA	HSDPA	HSUPA	Super 3G	TD-CDMA	Flash-OFDM	Wi-Fi	WiMax (802.16e)
Network Availability	Available	2006	2007	2010	Now	Now	Now	2008
Theoretical Max. Data Speed/User	2Mbps	14.4Mbps	14.4Mbps	100Mbps	11Mbps	5.3Mbps	54Mbps	70Mbps
Average Data Speed/ User	150-200Kbps	1Mbps	2Mbps	5-10Mbps	1Mbps	1.5Mbps	>10Mbps	5-10Mbps
Latency	300ms	<200ms	<100ms	<25ms	<100ms	<50ms	>200ms	<100ms
VoIP Capability	No	No	Yes	Yes	Yes	Yes	Yes	Yes

Mobility and Roaming
GSM and now WCDMA offer a single, common standard for mobile networks to operators across the world. This standard enables consumers to be mobile from one location to another without dropping the call, as well as roam across operator networks and countries using the same device.

While most of the alternative wireless technologies have or are developing mobility capabilities, commercial availability of mobile services will depend on regulatory constraints. European regulators, for instance, do not allow fixed operators deploying wireless broadband technologies to offer mobile services. Regulators also mandate which technologies can be used to offer mobile services; for example only WCDMA and TD-CDMA are approved 3G technologies for deployment in Europe with dedicated spectrum allocation. Hence, operators wishing to deploy other wireless broadband technologies will have to purchase new spectrum and contend with the regulatory roadblock to offering mobile services.

In addition to mobility, roaming will also pose a significant issue for these alternative technologies. Unlike GSM/WCDMA, which has been embraced for deployment globally, the alternative wireless technologies suffer from the lack of large-scale support of operators or vendors. We expect only a few operators to deploy these technologies, which will limit their use to the home networks in select geographies. Even where deployed by mobile operators, these technologies are predominantly seen as complementing rather than competing with the current GSM/WCDMA investments.

Network Rollout Requirements
To deploy alternative wireless technologies, mobile operators with existing GSM and 3G investments will need to roll out a separate radio network and, in most cases, invest in a new core infrastructure as well. The integration and management of two networks will be far from easy.

Moreover, networks based on the alternative wireless technologies lack ubiquity and will require technological developments for seamless hand-over across GSM/WCDMA networks. Other than for Wi-Fi, this seamless inter-working when a user moves from one network to another is currently non-existent.

An upgrade to HSDPA/HSUPA, on the other hand, only entails a software upgrade to the WCDMA infrastructure and the specifications for inter-working and seamless handovers with GSM or WCDMA are well established.

Handset Availability
Existing cellular technologies have been in the market for nearly 15 years and consumer devices for these networks have gone through the various stages of the development cycle. GSM handsets today are affordable, small in size, lightweight and support long talk times. Consumer devices for alternative technologies will have to go through a concerted development effort to be able to achieve comparability with GSM devices for mass-market acceptance.

The mainstream GSM/WCDMA world enjoys the support of a multitude of handset vendors due to widespread acceptance of the technology, which in turn enables economies of scale and hence, more affordable devices. On alternative technologies, by contrast, only a handful of vendors are developing devices, hence limiting volumes and any scale economies. The technology vendors will have to develop partnerships with a broader set of handset vendors to encourage the development and mass production of consumer devices at affordable prices.

Moreover, with the exception of Wi-Fi, devices that seamlessly inter-work with GSM/WCDMA do not exist for the other alternative technologies. This will require operators to build nationwide networks providing ubiquitous coverage for customers to be able to use the same device anywhere, anytime. With HSDPA/HSUPA upgrades, on the other hand, the same device can work seamlessly across GSM/WCDMA without altering the customer experience.

Having considered the factors critical for commercial success, it becomes apparent that the WCDMA evolution path enjoys a clear edge. The factors that worked for wide-scale acceptance of GSM as the preferred cellular technology will continue to influence the success of 3G and its upgrade path.

As Figure 5.3 shows, with the HSDPA/HSUPA upgrades, WCDMA not only provides performance comparable to the alternative technologies, but also scores high on the other factors that are needed to ensure commercial success. While emulating WCDMA's advantages is hard for emerging wireless technologies, some of them may find their own niches. In the next section, we outline our recommendations on how mobile operators should position themselves to leverage some of these emerging technologies.

Recommendations to Mobile Operators

Each of the alternative technologies that we have evaluated brings its own specific strengths. However, the window of opportunity for these wireless technologies is small, because the planned WCDMA upgrades are set to close the performance gaps. As a result, the lack of a more compelling alternative, combined with the momentum that WCDMA evolution already enjoys, makes it the safest option for mainstream deployment. However, some of the alternative technologies can play an important role—but as a complement rather than a replacement to 3G deployments.

TD-CDMA
TD-CDMA is an approved 3G standard technology with allocated spectrum available to most European mobile operators. While it enjoys a clear performance edge over WCDMA, the imminent HSDPA upgrades will close this gap. Moreover, big question marks surround TD-CDMA deployment in light of the limited size of the spectrum that has been made available for it and the investment that is required to deploy new radio infrastructure and develop dual-mode TD-CDMA/WCDMA handsets.

With capacity currently not an issue on WCDMA and the prospect of 3G over GSM frequencies looming on the horizon, it is hard to see how the TDD spectrum could be gainfully deployed. Our recommendation to operators is to maintain focus on WCDMA evolution, rather than diverting attention and/or investment to TD-CDMA.

Flash-OFDM
Flash-OFDM suffers the drawback of being a proprietary technology and is also unlikely to be used for mobile service deployment in most European countries due to regulatory constraints. Additionally, a lack of support from most major vendors will translate into poor economies of scale and hence, an expensive and limited range of consumer devices.

However, Qualcomm's acquisition of Flarion, the company behind this technology, is setting the stage for OFDM's integration with CDMA, which may define the next step of 3G enhancement. As discussed earlier, OFDM is also being envisaged to be the basis of the WCDMA evolution to "Super 3G," implying that operators should wait for this next phase of 3G upgrades rather than investing in Flash-OFDM networks.

WiMAX
We consider WiMAX still to be at the hype stage, with its promise of high-speed mobile data access at least 3 years from realization. Backward compatibility of the future mobile WiMAX standard equipment with its fixed counterpart available today and the timeframe for availability of affordable consumer devices are the two main questions that remain unanswered.

Figure 5.3 Evaluation of HSDPA/HSUPA vs. Alternative Technologies

Wireless Technology	Commercial Availability	Mobility and Roaming Support	Ease of Network Roll-Out	Availability of Handsets
HSDPA/HSUPA	2006-7	●	●	●
TD-CDMA	Now	◔	◔	◑
Flash-OFDM	Now	◑	◑	◕
Wi-Fi	Now	○	◔	◔
WiMax	2009 (mobile version)	◕	○	○

● High
○ Low

Moreover, rolling out a consumer mobile WiMAX service will require building up a network from scratch, with a nearly equivalent cell density as the HSDPA/HSUPA networks—an expensive proposition for mobile operators with existing investments in 3G.

As things stand currently, we see mobile WiMAX as a relatively immature technology that lacks a clear business case compared to the WCDMA evolution path. However, due to its faster deployment and more favourable implementation economics compared to fiber, operators may consider fixed-WiMAX for point-to-point backhaul of cellular traffic.

Wi-Fi
Wi-Fi is a highly promising short-range wireless technology with many things working in its favour. Relatively cheap and easy to use consumer devices, increasing Wi-Fi enablement of homes and offices, and a clear operator interest are some of the factors contributing to its success.

Wi-Fi is also being integrated with cellular devices and specifications to allow seamless handover between the two networks have been finalised. Major vendors such as Motorola and Nokia are launching Wi-Fi/cellular dual mode devices, while operators such as NTT DoCoMo and BT amongst others are readying commercial launches of converged, seamless services.

The benefits of Wi-Fi for fixed operators are clear: an opportunity to stem and even potentially reverse the fixed-to-mobile substitution trend. Mobile operators are understandably less than keen on the service given its cannibalisation effect on their profitable mobile voice franchise. However, the momentum behind Wi-Fi is such that standing on the sidelines will soon not be an option. Mobile operators should therefore ready their response, adopting defensive measures to limit the revenue loss, if not a wholehearted move towards offering innovative, converged Wi-Fi/mobile services to capture a higher share of the customer wallet.

In summary, the best option for mobile operators is to invest in WCDMA upgrades rather than build new mobile networks based on TD-CDMA, Flash-OFDM or WiMAX. Only Wi-Fi, with the significant advances made in its integration with cellular networks, is well positioned to complement operators' existing investments, allowing them to offer converged services.

6 Growing Mobile Data Revenues: Opportunities in Infotainment

First published: November 2005

Objective of the study

Mobile data is key to the growth aspirations of mobile operators—but the challenge is to create viable new data revenue streams other than messaging.

This paper discusses which services have the best chance of succeeding and what mobile operators need to do to enhance their prospects.

While the core business of mobile operators remains the provision of a high-quality 2-minute phone call, as voice ARPUs steadily decline mobile data is key to the growth aspirations of many mobile operators. In Western Europe, mobile data currently accounts for about 17% of total service revenues and is expected to grow to 30% by 2009.[1]

Messaging has been the only significant revenue generator in the mobile data space over the past 5 years, currently contributing about 84% of data revenues. Within messaging, SMS accounts for the bulk of revenues—over 90%—and is expected to remain the single biggest contributor to data revenues in the near-term. However, SMS is under substantial pricing pressure, with prices having declined 65% between 2001 and 2004 and widely forecasted to continue to fall.

The challenge, therefore, for operators is to create viable new data revenue streams beyond messaging. This paper discusses which services have the best chance of succeeding and what mobile operators need to do to enhance their prospects.

Infotainment Will Drive Mobile Data Spending Growth

Mobile data revenues have been growing at 21% CAGR in Western Europe over the past 3 years. We expect this trend to continue with consumer spending growing across all data categories over the next four years (Figure 6.1).

While messaging will continue to form the bulk of data revenues in the near term, "infotainment"—the convergence of information and entertainment services-will become the main driver of growth, growing at 48% CAGR from 6% of data revenues today to 23% (~ €10 billion by our estimates) by 2009. In the absence of a standard definition of infotainment, for this study we included services that are not directly communication or transaction-related in this category. As such, mobile TV, video streaming, music, games, information, ringtones, graphics, internet browsing are all included, whereas messaging, m-commerce, data cards, etc. are not.

M-commerce and gambling-over-mobile,[2] together are projected to grow significantly as well. However, the margins retained by mobile operators after accounting for the revenue share to third parties, credit and retail firms, is relatively small. This makes it a less attractive service compared to mobile entertainment services.

In terms of the market potential of specific infotainment services (Figure 6.2), mobile TV stands out because of its mass-market appeal and the prospect of significant growth potential.

In the following sections, we discuss in more detail the prospects for mobile TV as well as the other main infotainment services-music and games. We explore: market potential of the services and outline the challenges and opportunities that operators face with respect to each one of them.

Mobile Music Will Remain a Niche Service

Mobile music has been instrumental in helping mobile operators create an exciting 3G story. However, despite the hype, mobile music is expected to account for only 2% of total data revenues by 2009.[3]

1 Ovum, "Global Mobile Statistics Forecasts", November 2004. 2 M-commerce and gambling revenues refer to the entire payment and bet amounts placed via the mobile, and hence is more than the actual revenue share retained by the mobile operator. 3 Credit Suisse First Boston, "CSFB Mobile Data Model", January 2005.

Figure 6.1 Mobile Data Revenue Evolution and Category Breakdown, Western Europe, 2004-2009, €billion

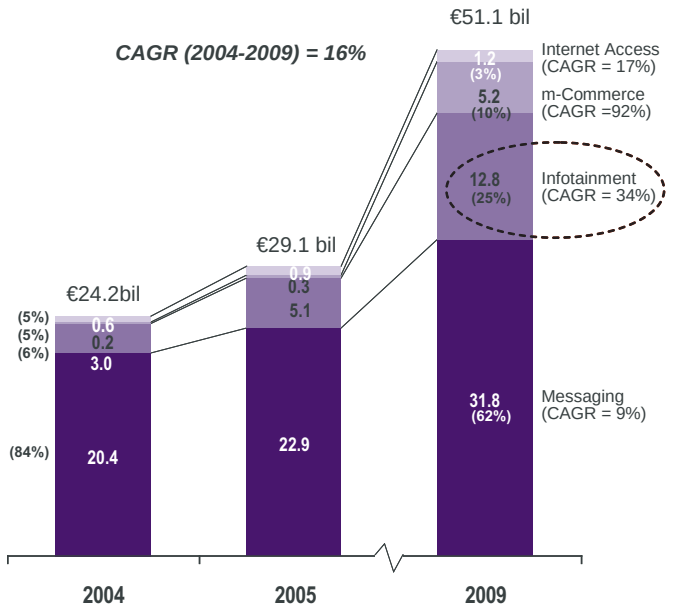
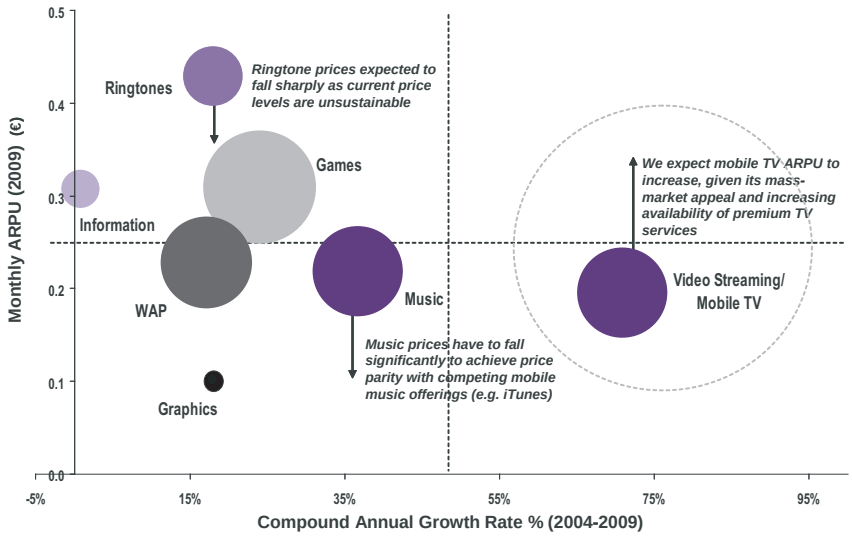


Figure 6.2 Market Potential of Services in the Mobile Entertainment Space, Western Europe, 2009



Note: Bubble size relates to forecasted 2009 data revenues. Source: Credit Suisse First Boston, "European mobile data trends, Q4 2004", April 2005.

Prices must fall for mobile music to be attractive…

To succeed with music, mobile operators have to significantly cut prices to come close to parity with substitute offerings like iTunes. Currently however, mobile music pricing is based on the flawed assumption that consumers will pay as much for a music track as for truetones or ringback tones,[4] which are selling well despite being three times the cost of an iTunes track. But this assumption fails to take into account that content for private entertainment consumption provides an inherently different value to consumers than that meant for customising a mobile phone.

While there can be a premium attached to displaying one's individuality, the same does not apply to privately consumed content like music. Consumer pricing expectation for music delivered over the mobile channel is, in part, defined by reference to the fixed online world (for which there is no equivalent in the ringtone market), and this continues to become ever more competitive on price. Thus far, consumers have proven unwilling to pay 2–3 times more than iTunes prices, which itself are expected to be reduced in 2006, implying that prices for music via the mobile channel will need to fall steeply.

But achieving price parity is difficult

Given the already thin margins at current prices, operators will need to significantly reduce their costs to be able to materially cut pricing. The only viable option to achieve lower costs is to re-negotiate for more favourable revenue-share arrangements with content providers. This is possible for top-tier players like Vodafone, which can leverage its scale in negotiations. But the inherent higher cost associated with mobile bandwidth will continue to constrain operators' ability to match fixed Internet-based prices.

Emergence of iPod-like phones makes the future even gloomier

The future for mobile music is further threatened by handset manufacturer

4 Truetones are high quality ringtones made from the original soundtrack while ringback tones are short clips of real music that replace the standard ring when called.

moves to develop iPod-like phones and form alliances with online music stores to potentially bypass the mobile operator's network. Next-generation iPod-like phones will eradicate traditional problems associated with the limited battery life and memory. In addition, they encourage consumers to download songs with ease and at a lower cost via the Internet onto their PCs, which can then be transferred via USB cable or Bluetooth onto their handset. Nokia, for example, has developed the N91, which has an integrated 4GB hard disk capable of storing up to 3,000 songs in a variety of digital music formats. Users can synchronise the device with their computers via USB 2.0 and create and manage playlists that, in turn, can be shared with others via Bluetooth.

So whilst music on a mobile handset may carry a strong appeal, the demand for premium-priced music downloads over the air is far less obvious. Given the difficulty in achieving price parity, at current pricing levels mobile music will continue to appeal only to a select group of music lovers with high willingness-to-pay and to consumers who are prepared to pay a premium when impulsively buying music-on-the-go.

Mobile Gaming: A Challenging Path to Higher Revenues

Mobile games are projected to be a big revenue generator in the mobile infotainment segment, but their long-term growth potential is limited. The limitation is imposed by the niche segment appeal of the service and the growing complexity and escalating costs associated with game development, which make it difficult to establish a clear ROI.

Big investments and efforts required to ensure mass-market readiness

Mobile game developers have to customise the games to work with the multitude of handset models in the market. For example, Gameloft currently targets 250 different models and translates each game into 5 to 8 languages. This means that there can sometimes be more than 700 versions of the same game. Moreover, with the advent of features like 3D displays, location-based and multiplayer games, the development budgets for high-end games are touching $250,000 and fast approaching the $4 million plus production budgets associated with PC/console games. Realizing the ROI on such investments will be a challenge in the mobile gaming market, which remains smaller in size and scope compared to the console or online market.

Low consumer awareness and ineffective purchase experience

In 2004, while a third of the European mobile users were playing games pre-installed on their handsets, only 5% were downloading games. A major reason for this disparity is that consumers don't know about the games provided by their service provider. This, in turn, is due to the limited space on operators' portals to promote games.

Moreover, it is a challenge to convince consumers to shell out €5 on a game that they can see only a picture of. Operators' websites and to some extent their mobile portals, therefore, should provide details of the game, demos to help consumers decide, and a review section that allows users to rate the games.

Mobile gaming caters to a different taste from PC/consoles

An average mobile gamer is different from the one playing games on a console or over the PC. The relatively poor experience on mobile handsets, due to screen size and button placement, keeps the hardcore console/online gamers away. Surveys show that the majority of people interested in playing games on their handsets are casual gamers who play games to kill time. Therefore, it's the easy-to-play games with low learning curves that have attracted a user base. In fact, the games currently topping the UK charts are old arcade game favourites such as Tetris, Pac-Man and Space Invaders. Anticipating this trend, Jamdat paid $137m in April 2005 to secure a 15-year exclusive wireless telephony rights licence for Tetris.

Females make up about 50% of the mobile gamers but this segment remains under-targeted by the operators with most

Figure 6.3 Amount consumers are willing to pay for mobile TV, by age group (€)

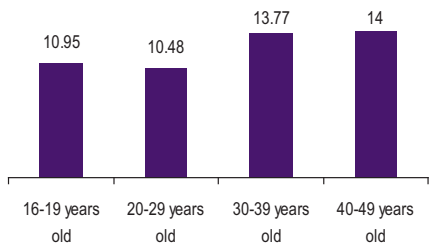
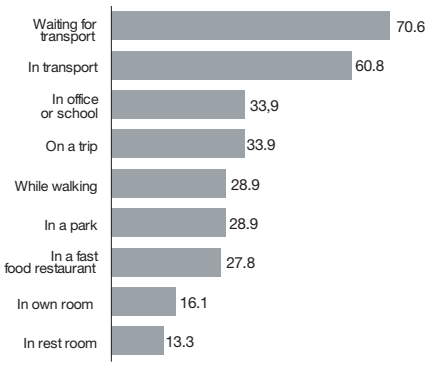


Figure 6.4 User occasions for watching TV on mobile handsets (% Respondents)



of the games being male focused. Recognizing the opportunity, game developer, In-Fusio, has come out with "Fruit Factory", a game with a female lead character.

Operators face widely diverse preference profiles exhibited by the mobile gamers with regards to different game genres, and they are offering an increasingly vast array of games to cater to this diversity. O2 offered just ten games on two devices in 2003 but now offers 300 games on sixty devices.

With the amount of operator effort going in for the gaming segment, it is imperative that operators fine tune their strategies to realise the projected potential. Choosing the right content, widening the marketing channels and moving into new target segments, will be key to making a success out of the gaming category.

Mobile TV Could Be the Star Performer in Infotainment

Mobile TV is emerging as a key service driven by its mass market appeal and intuitive usage. Surveys have found 40–60% of European mobile phone users to be interested in receiving TV on their mobile phone. More importantly, users are willing to pay €8–12 per month for it (according to a survey conducted as part of the BMCO project in Germany).

Operators are already finding success with Mobile TV

Orange France is offering live TV services with over 42 channels on 3G and EDGE. Six months after launch, 50% of Orange's 3G users are watching TV on their mobile, with the average user logging in 25–30 minutes of usage in 10–14 sessions per month. Similarly, TV represents 50% of 3G data traffic for SFR.

Operators are finding the mobile TV service to be a compelling mechanism for communicating the 3G value proposition to consumers. As a result, some operators have also repositioned their 3G video streaming offerings as Mobile TV, which has found favour with consumers who can more easily relate the new service with their normal TV viewing habits.

Start with offering Mobile TV on 3G, but plan ahead to DVB-H

Operators should plan the launch of mobile TV services as a matter of priority, addressing issues of proposition design and implementation of the relevant technologies and IT infrastructure. However, given bandwidth limitations, 3G is not the preferred medium for mobile TV delivery in the long term. Instead, broadcast technologies like DVB-H or DMB for mobile TV offer a better solution. So concurrently with launching a 3G-based service, operators also need to start formulating their plans for DVB-H.

Operators are already trialling and even launching mobile TV services using these alternative technologies. SK Telecom in Korea, for instance, has recently launched DMB-based mobile TV via satellite to handsets. The service bypasses the phone network and is priced at around €13/month.

Get the business model right

The business model for broadcast solutions, however, is more complex compared to 3G-based offerings, as it introduces a new entity in the value chain—the TV broadcaster—which has implications for how revenue as well as capital investment shared.

The model finding favour in many of the current worldwide trials is one that envisages a TV broadcaster distributing content over its DVB-H network, with the mobile operator managing the customer relationship, and controlling authentication, authorisation, and billing. The subscription and usage-based revenues are shared by the value-chain players, e.g. for the DMB-based mobile TV service in South Korea, SK Telecom retains 25% of revenues with content providers getting 35%. Additionally, in this model, the mobile operator also controls the return path and the revenues resulting from consumers using this path for services related to the transmitted program like voting, information, downloads, etc.

We see TV heralding considerable revenue opportunities in the mobile space, necessitating concerted efforts from mobile operators to quickly get their mobile TV strategy defined in terms of the customer proposition, handset management, content and partnership models.

Conclusions and Implications for Mobile Operators

The core business of mobile operators remains the provision of a high-quality 2-minute phone call, yet mobile data is key to the growth aspirations of many mobile operators. Messaging has been the only significant revenue generator in the mobile data space over the last five years, but the picture is set to change. Infotainment-the convergence of information and entertainment-services are emerging as a key driver for the next phase of mobile data growth and are expected to generate €10 billion in revenue by 2009.

Taking a position on the market's evolution and defining a corresponding infotainment strategy is therefore crucial for operators. We believe that mobile operators should take the following steps:

Ensure their strategies emphasise mass market appeal

It is tempting to focus on specific customer niches, but this will limit opportunity when customer demand is not clearly established. As such, central to strategy design should be a clear emphasis on mass-market appeal, focusing on and embracing the commonalities across segments, rather than continuing to more finely slice the market and developing services to address those niches. The main ingredients to mass market appeal in turn remain simplicity, ease of use, and attractive pricing.

Contrary to much prevailing opinion, we do not believe that mobile music is likely to yield sustainable benefits for operators due to a combination of factors. We are putting our money on Mobile TV.

Embrace the short-term opportunity represented by 3G-based Mobile TV and plan ahead for DVB-H

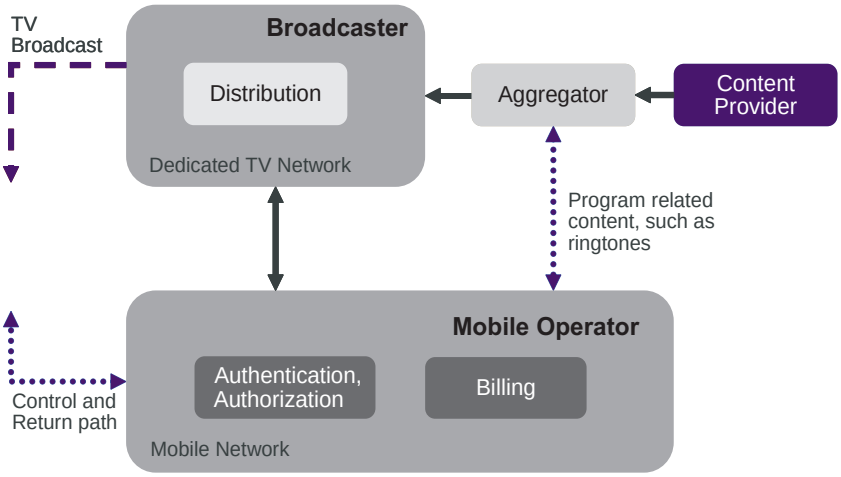
We see mobile TV as a potential Infotainment star. The business case is fuelled by its mass-market appeal and proven consumer willingness to pay for

the service. Given the rapid pace at which the mobile TV space is evolving, operators can scant afford to delay work on developing their business model and customer proposition. A key first next step for operators is to develop a detailed business case to serve as a basis for approaching potential partners. Time-to-market is key for this service, so the process of forging partnerships with broadcasters and content owners needs to be set in motion quickly. On the customer front, the key next step is the design and testing of the value propositions to ascertain consumer interest and propensity to pay for the service.

Be realistic about the nature of the opportunity in mobile music and focus efforts elsewhere

Mobile music on the other hand will remain a niche service despite the hype, as the consumer propensity to spend and current operator pricing are currently disjointed. There could be an upside for music on the mobile if prices approach parity with fixed-line alternatives, but that is unlikely given the already thin margins and the inherently higher cost associated with mobile bandwidth. If significant cost reduction proves impossible, a key next step is for operators to question the validity of their current mobile music strategy and its associated planned investments, and consider a re-channelling of resources towards higher revenue potential Infotainment services.

Figure 6.5 Illustrative business model for mobile TV broadcast over alternative technologies



About the Authors

Jawad Shaikh led the TME Strategy Lab from 2003 to 2005. He recently co-authored with INSEAD a study on mobile innovation, and with French analysts IDATE a joint report on exploring the hurdles faced by the European telecoms industry. He closely follows the rollout of 3G and the uptake of advanced mobile services, and is often called on to speak at industry conferences/events on these and other telecom and media related topics.

Jerome Buvat is the Global Head of the TME Strategy Lab. His recent studies include a review of the new DSL business models in Europe and an in-depth analysis of the home gateway market. Prior to joining the Lab, Jerome led a variety of strategy projects in the telecom sector; focusing particularly on the mobile, broadband and wholesale segments.

Priya Mehra is a Manager in the TME Strategy Lab. Her recent work includes evaluating the mobile VoIP threat, analyzing trends in the mobile content space and assessing the enterprise mobile segment. Prior to joining the Lab, Priya worked for a mobile operator where she was instrumental in launching voice and data products for the Enterprise market.

Erik Barstad Hovdkinn is a Senior Consultant in the Oslo office. He has worked extensively on channel strategies for mobile operators in Europe as well as evaluating entry strategies for the discount market.

Dinesh Jindal is a Senior Consultant in the TME Strategy Lab. His recent work includes analyzing developments in the Wi-Fi/WiMax technologies and VoIP Services. His current research focuses on the evolution of mobile networks. Prior to joining the Lab, Dinesh was responsible for tracking technology and industry developments in telecommunications for a research services organization.

Dillon Lim is a Senior Consultant within the London office of Capgemini's Telecom, Media & Entertainment practice. He has extensive experience in helping telecom operators in international marketing and branding issues, as well as co-authoring a recent in-depth study on MVNO (Mobile Virtual Network Operators) strategies.

Ashish Sidhra is a Senior Consultant in the TME Strategy Lab. His recent work includes a study on the disruptive potential of emerging telecom technologies and an analysis of trends in Mobile Content. His current research focuses on the fixed-mobile convergence arena.

About TME Consulting Services

The Telecom, Media & Entertainment (TME) Consulting Services practice is the leading global management consulting group dedicated to helping CEOs and senior executives in the converging communications industries address their most critical strategic and operational challenges. We combine functional expertise with industry knowledge around three core services: strategy formulation, business creation and launch, and operational excellence.

A number of principles make our practice unique:

- We are totally dedicated to consulting in the TME industries and have accumulated an extensive base of industry knowledge.
- We are committed to our clients' success through our focus on measurable engagement results.
- We are committed to investing in content and leading-edge insights to bring innovative thinking to our clients.
- We have a unique collaborative style of working with our clients, the Collaborative Business Experience, which forms a key part of our values.
- We employ people both with proven industry experience and from leading business schools and universities, all united by a passion for the communications industries.

The TME Strategy Lab

Telecom & Media Insights is published by the TME Strategy Lab, a global network of strategy consultants dedicated to generating content-rich insights into the telecom and media industries. The Lab conducts in-depth strategic research and analysis to generate leading-edge points of view on crucial industry topics that stimulate new ideas and help drive innovation for our clients.

Lab activities include:

- Research points of views on emerging industry trends: The Lab develops in-depth strategic research reports on emerging industry issues that are relatively under-explored, but have significant implications for players. The Lab conducts these studies independently or in collaboration with external partners.
- Monitoring key developments in the telecom and media market: The Lab closely monitors key developments relating to selected industry topical issues. This research is updated quarterly or bi-annually and generates data and insight-rich reports on the selected topics.
- Tailored research and analysis: The Lab delivers a variety of strategic research and analysis projects to clients ranging from market and competitor benchmarking analyses to monitoring specific services or technologies. The primary value-add from the Lab is in the analysis and insight-rich synthesis built on the foundations of solid research.

For more information about TME Consulting visit www.capgemini.com/tmeconsulting

About Capgemini and the Collaborative Business Experience

Capgemini, one of the world's foremost providers of Consulting, Technology and Outsourcing services, has a unique way of working with its clients, called the Collaborative Business Experience.

Backed by over three decades of industry and service experience, the Collaborative Business Experience is designed to help our clients achieve better, faster, more sustainable results through seamless access to our network of world-leading technology partners and collaboration-focused methods and tools. Through commitment to mutual success and the achievement of tangible value, we help businesses implement growth strategies, leverage technology, and thrive through the power of collaboration.

Capgemini employs approximately 60,000 people worldwide and reported 2004 global revenues of 6.3 billion euros.

More information about our services, offices and research is available at **www.capgemini.com.**

For more information contact:

Didier Bonnet
Managing Director
Telecom, Media & Entertainment
+44 (0)870 905 3189
didier.bonnet@capgemini.com

Jerome Buvat
Global Head
TME Strategy Lab
+44 (0)870 905 3186
jerome.buvat@capgemini.com

www.capgemini.com

Australia
Carrington House, Level 4
50 Carrington Street
Sydney NSW 2000
+61 2 9293 4000

China
Unit 1101-04 Azia Center
133 Yin Cheng Bei Road
Lijiazui, Shanghai
200120
+86 21 6105 3888

France
Tour Europlaza
20 ave. André Prothin
92927 La Défense Cedex
+33 (0)1 49 00 40 00

Finland
Niittymäentie, 9
02200 Espoo
Helsinki
+358 9 452 651

Germany
Hamborner Strasse 55
D-40472 Düsseldorf
+49 (0)211 470 68 0

Berliner Straße 76
D-63065 Offenbach am Main
+49 (0) 69 95 150

Italy
Via Nizzoli, 6
20147 Milano
+39 02 41493 1

Via di Torre Spaccata, 140
00169 Roma
+39 06 231 901

Netherlands
Papendorpseweg 100
3528 BJ Utrecht
Postbus 2575
3500 GN Utrecht
+31 30 689 00 00

Norway
Hoffsveien 1 D
0275 Oslo
+47 2412 8000

Spain
Edificio Cedro
Anabel Segura, 14
28100 Alcobendas - Madrid
+34 91 675 7000

Sweden
P.O.BOX 825SE-161
Gustavslundsvägen 131
161 24 Bromma
+46 8 5368 5000

United Kingdom
76-88 Wardour Street
London W1F 0UU
+44 (0)20 7734 5700

United States
Bank of America
600 Peachtree Street
Suite 3600
Atlanta
GA 30308
+1 404 806 4200

750, 7th Avenue
Suite 1800
New York
NY 10019
+1 212 314 8000

600 Memorial Drive
Suite 100
Cambridge
MA 02139
+1 617 768 5600

200 North Sepulveda Boulevard
Suite 1000
El Segundo, CA 90245
+1 310 727 8400