

Deconstructing 3G and reconstructing telecoms?

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It is hard to credit the telecommunications industry with getting things so wrong as the third generation (3G) mobile licence fiasco in Europe during the summer of 2000. European governments may have been culpable for shortsighted policies of gouging the industry, but at the end of the day high auction prices were the responsibility of those who bid them. 'Nobody but a fool bids more in an auction than he thinks the licence is worth' was how one of the UK's principal advisors put it.³ The story would be a telling cautionary tale at the best of times, but it has added significance owing to two factors. It comes at a time when the industry as a whole is nose-diving due to the decline of revenues from international and mobile services, and it adds risk to the already high degree of uncertainty within the industry as it steers towards broadband. The result has been an involuntary restructuring of some of the major names in the industry, and their withdrawal from markets.⁴

The outstanding example is British Telecom or just BT. In the mid-1990s BT was promoting itself as a world telecommunications company, forging a joint venture named Concert with AT&T to provide worldwide services, and investing heavily in companies in the fast-growing Asia-Pacific region. The millennium has seen a complete reversal of fortune. Concert has been dissolved, although for reasons not directly connected with 3G, BT is selling its investments across Asia,⁵ the UK mobile operations have been spun-off making them available for a sell-off, and BT's chairman and CEO have both resigned following the 3G disaster. As Sir Peter Bonfield, BT's CEO frankly admitted to the *Sunday Times*, London, 18 February 2001, 'We spent £10 billion too much'.

In Hong Kong the allocation of 3G licences has avoided the mistakes of Europe and their consequences. After heated local debate, Hong Kong adopted an innovative approach to auctioning to avoid burdening the industry with large debt. The method used was a proposal from myself⁶ to run an auction based upon the royalty payment an operator

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² I wish to thank James Rhyu who gave invaluable help with the business modelling for this paper.

³ Ken Binmore, Leverhulme research professor of economics at University College, London in Hong Kong's *South China Morning Post*, 26 March 2001.

⁴ Restructuring was forced upon the industry in Europe even ahead of the bidding as regulators demanded the unraveling of cross-ownership. For example, when Vodafone bid for Germany's Mannesmann it was required to divest its holding of its subsidiary Orange.

⁵ For example, BT has sold off interests in Japan Telecom, Maxis (Malaysia), Bharti Cellular (India), Clear Communications (New Zealand), Mobile One (Singapore) and is looking for a buyer of its stake in Smartone (Hong Kong).

⁶ 'Response to OFTA's Consultation Paper on 3G' John Ure, May 2000 at: www.trp.hku.hk/trp_papers.html and www.ofta.gov.hk

would commit themselves to paying on the relevant turnover of their licensed business. A reserve auction price was fixed at 5 per cent, or HK\$50 million whichever was the larger, for each of the first five years, rising gradually over the remaining ten years of the licence. In the event, the investment climate dictated there were only four bidders for four licences and the spectrum was assigned at the reserve price.

In this paper I consider the issue of restructuring in the context of uncertainty as the industry moves into the world of broadband Internet, and in particular the unanticipated implications of the 3G auctions for the largely involuntary restructuring that followed. I use the case of Hong Kong where my own proposal for a royalty-based auction was adopted to illustrate the issues.

Restructuring

What exactly do we mean by the term ‘restructuring’? In the most general sense any kind of reorganization is a kind of restructuring, so the first delineation that makes sense is to distinguish between ‘internal’ and ‘external’ restructuring, where ‘internal’ can refer to any reorganization within a company’s setup. This is an entirely usual event unless it reflects a significant shift of power within an organization and/or of the external focus of the company. The abandonment of a major project or opportunity would be one such example. In Hong Kong there were only four bidders for four 3G licences, yet six licensed local mobile operators. Of the two that did not bid, one belongs to local conglomerate that has financial problems of its own and is generally considered a weak player in the telecommunication market. Of the other, also considered a weak player, it is understood the decision not to bid was made at the request of one of its major shareholders, the Dutch telecommunications carrier KPN also heavily indebted owing to its 3G bidding in Europe.⁷ OFTA, the Hong Kong regulator, has issued licenses conditional upon up to 30 per cent of the network’s capacity being made available to mobile virtual network operators (MVNOs) so the decision not to bid for a licence does not exclude these companies from entering the 3G market as MVNOs at some future date. Seen in this light, their failure even to test the bidding process is no big deal, but it does reflect the dramatic reversal of investor sentiment from just one year previously when the European auctions took place.

I use the term ‘external’ restructuring to refer to the transfer of ownership of major assets of a company, either as part of a bid-buy deal or as part of a closure or even bankruptcy. At the margin, the distinction in significance between ‘internal’ and ‘external’ can be slight. For example, during the height of the bear market in the late 1990s many companies would spin-off successful and growing areas of business to take advantage of low-cost financing. This was a primary motivation, and restructuring was a response to opportunity. Since the bear market of 2000-2001 and the debt overhang that rapidly

⁷ Among KPN’s disposals are Eircom (Ireland), Telkomsel (Indonesia), Pannon (Hungary), Cesky (Czech Republic), UMC (Ukraine) and its stake in the KPNQwest data network. According to the *Financial Times* 5 November 2001, DoCoMo (Japan) posted an extraordinary loss of US\$2.5 billion for the first half of 2001 following a revaluation of its investment in KPN.

became a debt hangover for the telecommunications sector, the sale of assets has been more of a retrenchment strategy.

Restructuring Debt

Over US\$100 billion was spent on acquiring 3G licences in Europe, and several times that amount has since been wiped off telecoms equities on the stock markets. According to the *Financial Times* stock market valuations of telecommunication companies had fallen by an average of 60 per cent by September 2001 from their high point, and taking into account write-offs, bankruptcies and closures worldwide ‘probably \$1,000 billion has gone up in smoke.’⁸ The Government windfall of US\$100 billion in Europe now has to be offset by a far greater loss of wealth, and a loss of taxation revenues. Only over time, as 3G-network investment kicks in, will some of these losses be recoverable.

Probably a further US\$100 billion needs to be spent on rolling out the networks, but vendor finance of the kind reportedly offered by Nokia to Orange in April 2000 of US\$1.7 billion is not likely to be available in the future as the vendors themselves struggle to finance research and development and marketing. The shortfall, like the current debt, can only be financed for the time being by selling off assets, or from bank lending, the corporate bond market and from the future flow of earnings. But the debts are too large for the banking system alone. The four largest debtors in Europe⁹ are illustrated in the table below.

Debt and Ratings Problems in Europe 2000-2001

Company	Debt	Moody’s Ratings	S&P Ratings
British Telecom	US\$43 billion	Aa1 [®] ð A2 [®]	AA+ [®] ð A [®]
Deutsche Telecom	US\$44 billion	Aa2 [®] ð A2	AA- [®] ð A- [®]
France Telecom	US\$62 billion	Aa2 [®] ð A3	AA- [®] ð A- [®]
KPN	US\$31 billion	Aa2 [®] ð Baa2	AA [®] ð BBB+ [®]

Sources: *Asian Wall Street Journal* 30 August 2000, *Financial Times* 19 February 2001

Telefonica and Vodafone could be added with debts of US\$14 billion and US\$10 billion a piece according the *Financial Times* 3 November 2000, but they attracted A2/A+ and A2/A ratings because their proportions of debt-to-ebitda were 1.4 per cent and 2.3 per cent respectively, compared with 4.5, 4.6 and 5.2 respectively for DT, BT and FT. KPN’s debt ratio stood at 7.1 per cent. By no means all this debt arose from 3G licence costs,¹⁰ but according to *The Economist* 5 May 2001, around US\$13 billion was directly

⁸ ‘The Telecoms Crash Part 1’ *Financial Times*, 5 September 2001.

⁹ ‘DT, BT, France Telecom and KPN account for 50 per cent of Barclays Capital’s telecom bond index. Vodafone and Tecnost/Olivetti account for another 17 per cent each.’ International Capital Markets 2, *Financial Times*, 21 June 2001.

¹⁰ Market segmentation has been a feature of the industry since liberalization, and one sector that has been particularly hard hit by the bursting of the dot.com bubble are ‘big pipe’ carriers, such as 360 Networks, Level 3, Global Crossing, Qwest and Worldcom who planned capacity in anticipation of a continuing surge in Internet traffic.

attributable in the cases of BT, DT and FT, about US\$8 billion in the case of KPN and Telefonica, and US\$21 billion in the case of Vodafone.

Financial regulators were so concerned they issued special warnings to banks to exercise caution in their lending, as in Europe and the UK (*Financial Times*, 29 September 2000 and 8 December 2000) and in Hong Kong (*South China Morning Post*, 4 November 2000). Corporate bond issue, taking advantage of low interest rates, became the principle vehicle of debt restructuring for the industry after the stock markets dived south. Finally securitization caught up with the telecoms market when, according to *The Economist* 12 May 2001, Telecom Italia with a debt of US\$17 billion proposed to back a corporate bond with future revenues from its fixed line voice phone business. Ironically, one result of the need to restructure debt seems to be the temporary deflection of interest from traditional merger and acquisition activity, although not entirely. Companies that got out of the mobile business, such as Cable & Wireless, and companies that totally specialize in it, like Vodafone, have continued to buy. The traditional incumbent all-service providers in Europe have their fixed voice revenues to fall back on, and some, like DT, have continued to make important acquisitions abroad like VoiceStream in the US, but for the most part they have retrenched. As long as they have cashflow, they can buy time to restructure.

In Asia the picture is slightly different as incumbents such as Hongkong Telecom and Singapore Telecom, Telstra and NTT push towards greater regionalism. Cable & Wireless's restructuring included the sale for cash and a share swap of Hongkong Telecom to Pacific Century Cyberworks (PCCW) an Internet start-up founded by Richard Li, number two son of Li Ka-Shing, one of Hong Kong's richest billionaires and boss of HKT's main rival, Hutchison Telecom. It was fortuitous timing just before the dot.com bubble burst, so PCCW can now service its massive debts from HKT's revenues.¹¹ Part of the debt restructuring included assigning the assets of Hongkong Telecom International (HKTI) to Reach, a 50:50 regional joint venture with Telstra, and HKT's wireless assets to the joint venture Regional Wireless, this time as junior partner to Telstra. Telstra has also acquired Clear Communications, New Zealand's second fixed line operator. Singapore Telecom, having had its bid for HKT vetoed in Beijing and its bid for Time Telecom vetoed in Kuala Lumpur, finally came good with the purchase of Optus from Cable & Wireless in Australia to add to its numerous regional investments. NTT's mobile operator, DoCoMo has also branched out, buying into Hutchison's 3G ventures in Hong Kong and the UK, KPN in The Netherlands and Germany, and AT&T Wireless in the USA as a means of spreading the iMode protocol and its 3G successor. In none of the above Asia-Pacific cases have the 3G parts of the business been landed with debt problems. (See below.)

Deconstructing the 3G Debt Issue

The debt that broke the camel's back arose from the auction process adopted in Europe. The argument for auctions in the allocation of radio spectrum for mobile

¹¹ PCCW's resort to the debt market has not been all straight sailing. See 'How PCCW's Strategy Irked Bond Investors' *Asian Wall Street Journal*, 11 December 2001.

telecommunication services rests essentially upon two points. First, economic efficiency may be enhanced. Second, they are a cost-effective way to raise funds for the national treasury. These issues are both raised by Paul Klemperer¹² who was one of the principal designers of the highly successful UK auctions for 3G licences that raised £22.5 billion (US\$33.75 billion), approximately 2.5 per cent of GDP.

A Windfall for Treasury

Of the two issues, the second, raising funds for the national treasury, is the more dubious as there should be good cause why the taxation levied on one industrial sector is higher than upon all others. The purely pragmatic argument is simply that the chance arises, but the more sophisticated argument goes along the lines that monopoly rents or abnormal profits may arise from the commercial exploitation of a *scarce* public resource, such as radio spectrum. In this case, taxing these monopoly rents for the public purse will cause no common harm. But radio spectrum for public mobile telecommunications is a widely *re-usable* resource subject to enlargement through capital expenditure on cell sites and other equipment, and through technological innovation. Indeed, the more persons on the network the more valuable the network becomes to everyone including the network operator and this provides a strong incentive to invest. Through the continuous and direct application of capital investment into mobile systems, additional to the initial capital outlays on building the core networks, competition for subscribers is immediately transmitted into widespread public gain.¹³ Taxing the industry for the public purse is therefore a highly dubious market-distorting economic policy that threatens to be little more than taking money from one public pocket and putting it into another. There may be independent reasons for wanting to do this, such as taxing the rich to pay the poor, but the days are long gone when mobile cellular systems were luxury items. In a growing list of countries the mobile phone is more common than the fixed line phone, and heading the list with a ratio of almost 8:1 is Cambodia, one of the poorest countries on Earth.¹⁴

Although the early European auctions were regarded as successful in raising money for the national treasuries, by 24 November 2000 at editorial in the London *Financial Times*¹⁵ was admitting, ‘mobile telephone services have quickly gone from a potential pot

¹² ‘What Really Matters in Auction Design’, www.nuf.ox.ac.uk/economics/people/klemperer.htm

¹³ It is estimated that the overall saving to consumers in Hong Kong from falling handset prices, monthly rentals and airtime charges between 1995 – 1997 was in the order of HK\$6.63 billion. See J. Ure (1998) *The Economic Benefits of Telecoms Liberalization in Hong Kong*, paper for PECC, www.trp.hku.hk.

¹⁴ David Butcher & Associates (2001) ‘Cambodia: Networks, Services and Regulatory Reform’ Telecommunications Research Project seminar paper, 7 December 2001, www.trp.hku.hk/trp_papers.html

¹⁵ *Financial Times* columnist Martin Wolf was an early and ardent advocate of the British auction. Writing on 25 June 2000 he lambasted the critics: ‘When critics complain about such auctions, they have to be saying one (or more) of four things: that the government should have made a present of the excess profits – or, more exactly, of the scarcity value of the spectrum – to the likes of Vodafone AirTouch and British Telecommunications; that the managers and owners of these companies are incapable of working out what a licence is worth to them; that taxpayers should protect shareholders against their own irrational exuberance; or that the interests of

of gold to a cauldron of ruin'. A year later governments faced with national carriers deep in debt began returning some of their gains. In June 2001 the German regulator, RegTP, agreed to allow sharing of 3G infrastructure which according to KPN (Netherlands) would cut their network capital costs by US\$1.2 billion, and according to Sonera (Finland) and Telefonica (Spain) would cut their capex by up to 40 per cent.¹⁶ In October 2001 the French Government cut the upfront payments from US\$4.6 billion to just US\$570 million. The UK and German auctions raised the spectre of serious over-bidding which partly explains the relative failure of subsequent auctions, but poor design and the failure to back them up with effective anti-collusion measures were also criticized. Paul Klemperer in the *Financial Times* 26 July 2000, commented on the dismal failure of The Netherlands auction that raised less than one-third its anticipated outcome, achieving US\$159 per capita in comparison with US\$580 per capita in the UK. The auction flopped he argued because of poor design. It failed to reserve one licence for a newcomer who could force up the bidding, and it failed to top the multiple-round ascending 'Anglo' auction process with a sealed 'last and final' bid 'Dutch' auction which would prevent incumbents with deep pockets knowing what they need to bid to clinch the licence. The subsequent Italian auction bordered on the chaotic, collapsing after two days, raising only half the US\$23 billion expected and with Italian officials calling on the Commission in Brussels to investigate allegations of collusion following raids on over twenty company offices. Similar raids were later carried out in Germany and the UK.

Auction designers have one view in mind, to raise as much money as possible for their client, and for themselves if they are on a commission basis or are looking for commendation and future work. But the best-designed auction cannot drive prices above certain logical limits, or can it? Bidding exuberance, or what the auction literature calls 'eliminating immediate regrets', can get the better of a punter, especially when share price seems to hang on it. There are hidden premiums also, such as the scarcity of existing spectrum. For the most part 3G will be a continuation of a 2G business, not a start-up, and operators running up against the limits of their existing spectrum assignments see 3G spectrum as a way forward. The other side of the coin is that failure to win a licence sends all the wrong signals, or so it was thought in Europe where a third factor was at play, the opportunity of providing end-to-end roaming and, fourth, the chance to grab a European Community-wide audience for a Internet mobile portal. Share price was a short-term issue. Spectrum a long-term issue. Roaming a guaranteed revenue earner now. A mobile portal a revenue hopeful for the future. Any one of these factors could be used to justify exuberant bidding, together they were powerful, until the doubts and the debts factored in.

taxpayers should be sacrificed to those relatively well-off consumers. These propositions are ridiculous, outrageous, or both.'

¹⁶ 'But the German regulator's relaxation of the rules goes too far. In effect it eliminates competition over the quality of the 3G networks. The regulator even says it would be happy if each company's network covered only 8 per cent of Germany, allowing it to reach its target of 50 per cent national coverage by 2005.' Editorial, *Financial Times*, 6 June 2001.

The auctions in the Asia-Pacific came later than in Europe and the investment climate was already turning sour. They bombed badly in Australia (US\$600 million) and New Zealand (US\$60 million). In both Singapore and Hong Kong the auction process aborted when insufficient bidders turned up.¹⁷ By this time the dot.com bubble had well and truly burst, the bears replaced the bulls, venture capital was once again nowhere to be seen, and bank lending for the mobile business hard to come by. For instance, Sunday Communications Ltd of Hong Kong was unable to take up the 3G licence awarded by Singapore for lack of bank guarantees. Then in Norway, on 10 August 2001 came the return of a licence when Broadband Mobile - a joint venture with Sonera (Finland) and Enitel (Norway) - became the first company to relinquish 3G spectrum owing to financing difficulties.¹⁸

Government Options

Under these circumstances, there is a more satisfactory way to tax monopoly rents in the event they should arise, which in the highly competitive world of mobile telecommunications seems unlikely. There is also a more satisfactory way to raise money from the use of spectrum. At this stage 3G, unlike 2G, is a high risk and highly uncertain business. Whereas 2G operators could forecast with reasonable certainty what their revenue streams would look like, what subscriber growth would look like, what future handset prices might be, and so on, 3G operators are entering uncharted waters. Uncertainty, unlike risk, cannot be insured against. For example, all mobile operators run the risk their technology will be outdated by other advances, but they can spread the risk by buying into other networks or other technologies. 3G is a broadband Internet industry, immature and highly uncertain in almost all its aspects. It is not just high risk (insurable) but a high gamble. The only known way to cope with it is through the use of options, basically keeping as many open as possible, including the option of exit or of non-entry.

The Government also has an option, to identify a threshold level of profits beyond which a tax on monopoly rent will kick in. Operators fortunate enough to face that situation would then have the choice of paying the excess profits tax or lowering prices to benefit the public and improve their own competitive grip on the market. A good option to exercise. This was one of my two proposals¹⁹ to the Hong Kong Government. The other, eventually adopted, was to have an auction on royalty payments based upon turnover.

¹⁷ Singapore reduced the auction reserve price by 50 per cent for four licences, eventually raising just US\$30million for two licences. The reserve price of 5 per cent of turnover in Hong Kong raised US\$130 million from four licences for the first 5 years and a rising percentage for the remaining ten years.

¹⁸ Both the USA and India have had similar experiences with 2G spectrum auctions. In the US, NextWave was unable to pay the \$4.7 billion it bid for PCS spectrum in 1996. The FCC re-auctioned the spectrum for \$15.8 billion in 2001 but litigation put the deal on hold. A settlement was reached assigning the spectrum to AT&T and Cingular for \$10 billion with the remaining \$5.8 billion going to NextWave for relinquishing the spectrum, not a bad investment for non-payment! Subsequently even that deal was halted and the spectrum was to be re-auctioned.

¹⁹ 'Response to OFTA's Consultation Paper on 3G' (May 2000) <http://www.ofta.gov.hk/3g-licensing/3G-consultation-hku.pdf> and www.trp.hku.hk/trp_papers.html.

Turnover would be on assessed income from the provision of licensed 3G access services, not content and applications. The advantage of this approach is to synchronize the need to pay with the ability to pay, thus avoiding a large upfront debt to be financed. A reserve auction price can guarantee a minimum return to the Treasury if this is an irresistible pressure.

Economic Efficiency

The most common argument for auctions is that they ensure that spectrum will go to those companies who value it most. Indeed, if the auction is well designed the statement is a tautology, but this argument cannot prove that society will value most the way those companies use the spectrum. Once spectrum is issued the alternatives are history and therefore are not available to the public to choose or to value. Only a genuinely free market in trading spectrum could overcome this difficulty, an ideal that has many practical impediments. So the economic efficiency argument rests upon an article of faith that the value the successful bidders place upon an auction is well grounded. But unless *also* the outcome of the auction is a competitive market that will drive the failures *out* and allow new comers *in*, the issue of efficiency is itself not well grounded. So market structure is vitally important. As Professor William Melody has pointed out, spectrum is sold by the state, a monopolist, and bought by a network, an oligopolist,²⁰ which is hardly the stuff of perfect competition, but is the stuff of collusion, gaming and industrial restructuring. This means the regulator is likely to be around in this neck of the woods for a long time to come.

The second efficiency issue the 3G debate threw up was the over-simple view that high auction prices represented sunk costs that could have no bearing on future network charges as the latter were determined in a competitive market by incremental or forward-looking costs. That is what textbook economic theory teaches us, and in abstract it is not wrong.²¹ But it does ignore the fact that the lowest *common* cost among the auction bidders can be passed on as amortized cost and they have an incentive to do just that unless, as in a game of poker, one or two of the players are financially resourceful enough to drive the others out of the game entirely. That would be restructuring with a vengeance and it is unlikely regulators would allow it to happen. It also ignores the fact that high auction prices have raised the cost of financing considerably. Forward-looking costs will reflect that. It also ignores the point that as financial risk rises 3G networks are less likely to be built out to marginal areas, and more areas are likely to be considered marginal. But even ignoring all these qualifiers, it is the simple truth that sunk costs have to be paid or the company is sunk. One way to pay is to sell off other assets, and that has been the major consequence, a dramatic restructuring of licence winners, the so-called 'winner's curse.' Liquidating positions in overseas markets, like BT, is one aspect of it, clearly a reversal of fortune. Spinning off mobile operations into separate units is another aspect of

²⁰ See William Melody's review of spectrum assignment and pricing debates in 'Third Generation (3G) Auctions for Hong Kong? The Lessons from Overseas' *Telecommunications InfoTechnology Forum*, 18 September 2000 at www.trp.hku.hk/tif.

²¹ I have elaborated this argument elsewhere. See 'Licensing third generation mobile: a poisoned chalice?', *Info*, v.3.1, February, pp. 011-013 .

it, one that probably makes a lot of sense even if the timing was under duress. Disposing of the mobile units would signal distress more than duress.

Auction Prices and Uncertainty

What methods can be used to estimate the possible value of a 3G licence when the uncertainty surrounding the industry is so great? They fall into two types. First is the benchmarking approach that compares markets. Second, estimates of discounted future revenue flows arising from a 3G licence, with or without an option.

The problem with either of these approaches in the case of 3G is complete uncertainty of the nature of the business. For example, many in the industry believe that voice revenues will continue to be a source of earnings well into the decade, while others expect them to disappear quite quickly into a morass of packet-switched 'data'. Many in the industry believe that monthly access charges will be sustained, while others believe they will not. Many in the industry believe that the demand for wireless Internet content and applications will rocket, often quoting the experience of DoCoMo's iMode phone in Japan,²² but others are entirely skeptical of this trend as a major source of revenues for access providers. In particular there are divided opinions as to the respective market power of access and content providers. If access providers have market power they may be able to commit content providers to exclusive agreements and revenue-sharing arrangements, whereas if content providers have the power they will sell to anyone across any network.

Regulation is another unknown. Will 3G operators be required to give their customers digital codes so they can unlock themselves from the 3G server? BT and France Telecom have been required to do so.²³ And just how sustainable is the 'closed garden' approach to capturing a subscriber in an Internet world?²⁴ How many alternative networks will be licensed? Will they include the use of 2G spectrum? Will the ITU promote the release further spectrum? Will satellites using spot beam technology one day provide a serious alternative for urban areas? Will broadband wireless Ethernet 802.11 provide an effective substitute, for example in areas such as shopping precincts, airports, residential and business complexes where hand-off is not required? What kind of access devices will be permitted and what frequencies will they use? All manner of alternative mini-computer access devices may become available, including those that provide machine-to-machine communications for installation in homes, offices, and vehicles. Will wholesaling be

²² DoCoMo 'has now admitted it will not post a profit for the next four years.' Tough times lie ahead. *South China Morning Post*, 16 October 2001. A ring of *déjà vu*?

²³ From the *Financial Times*, 22 June 2000: 'BT Cellnet last night backed down by offering to provide customers with a four-digit code they may use to "unlock" their mobile internet handsets and switch to a rival portal.' Also: 'Last month France Telecom lost a landmark court case in France ... The court forced France Telecom to release a four digit code allowing customers to reprogram their phones and unlock portal restriction.' (p.8)

²⁴ 'A worrying sign for the cellular network providers has been that big handset manufacturers have been signing deals with wireless ISPs, such as Yahoo and AOL Europe. This may allow these ISPs to gain a direct presence on the handsets, thus directing users to their sites.' *Jardine Fleming Research: Regional Telecommunications*, May 2000, p.29.

mandated? Will MVNOs steal the market, or will predatory pricing drive retail prices below wholesale to keep them out, and if so what effect will that have on the value of the business? The answers to these and similar questions remain uncertain both for regulators and for those they regulate.

For these reasons there is no firm foundation upon which to build a business model of 3G, so business plans can be not much more than punts. During the bull run on the stock market the use of real option theory was muted. Real option theory uses the Black-Scholes model to estimate the value of a business according to the options a business plan holds for future management. If the option to choose a different technology, or to partner or merge with another player, or to shift markets are available then they bestow value on the business.²⁵ The model requires a highly theoretical and highly mathematical application to the data and in most markets was unlikely to be employed by anyone but academics²⁶ and consultants,²⁷ but since stock markets turned south real option value has been virtually extinguished.²⁸

Benchmarking

Comparing across countries of disparate wealth, population size, landmass and so forth is an exercise fraught with difficulties. It is important to compare like situations, for example countries such as Britain, France and Germany, or metropolitan city areas such as New York, Hong Kong, Seoul, Shanghai, Singapore, Taipei and Tokyo. In the case of 3G such benchmarking is speculative because the size and number of franchises issued will vary across markets.

A compromise is to compare the per capita price per market and weight the results according to criteria such as per capita income, population densities, penetration ratios, etc. In fact no two sources use exactly the same metrics, or exchange rates for expression in US dollars. The following table provides some indicators and estimates from industry sources of the cost of 3G licences.

²⁵ See James Alleman and Eli Noam, eds., 1999, *The New Investment Theory of Real Options and its Implication for Telecommunications Economics*, Kluwer Academic Publishers.

²⁶ Students of finance professors Jia He and Larry Lang at the Chinese University of Hong Kong estimated a 3G option value 13 per cent above NPV for one of Hong Kong's mobile operators, 1.5 per cent and 1.3 per cent above NPV for two others. 'What Price 3G?' *Working Paper*, 2000, CUHK.

²⁷ Credit Suisse/First Boston estimated the option value of PT Indosat as having a 59 per cent premium over its net cash balance, and of PT Telkom as having a 19 per cent premium over its asset value. *Indonesian Telecoms Sector*, 28 November 1999, CSFB (Hong Kong) Ltd.

²⁸ By 2001 my own estimates of the option value of the 3G market in Hong Kong were rendered nonsensical by the extraordinary variance in stock market values. Stock price variance is a crucial component of the Black-Scholes model.

Some 3G Metrics for Selected Economies

Economy	3G Licence Fees	Price per capita	Price per capita/2x5Mhz
France	US\$9.3 billion	US\$180	US\$9.2
Germany	US\$46.2 billion	US\$562	US\$46
Italy	U\$10.1 billion	US\$175	US\$21.2
The Netherlands	US\$2.5 billion	US\$160	US\$13.3
UK	US\$35.4 billion	US\$595	US\$52.8
EU Total	US\$105 billion	US\$200	
Australia	US\$600 million	US\$32	US\$0.78
New Zealand	US\$55 million	US\$16	US\$3.3
Hong Kong	US\$26 million pa +	US\$34-59 ¹	US\$7.6
South Korea	US\$2.9 billion	US\$76	US\$5
Singapore	US\$56 million	US\$30	US\$4.5

Sources: ITU, Analysts Reports, UMTS Forum. Note: 1. Analyst estimates of NPV using different rates of discount on royalty payments over 4 x 15 year licences.

The UMTS report used in this table ²⁹ suggests that by plotting the per capita costs and costs per 2 x 5MHz spectrum it appears that price increases with the size of the market. But it is also the case that investment sentiment changed dramatically from the time the UK and German auctions took place. It is interesting to note that the critics of Deutsche Telekom argued that the price for the control of the US mobile operator VoiceStream, surely operating in a large market, was excessive at US\$245 per capita.³⁰ Given these disparate prices, which must be seen against rapidly changing investor sentiment over the period in question, deriving conclusions from a benchmarking exercise seems rather futile.

A report by Salomon Smith Barney may illustrate the point.³¹ The benchmarking approach was used to estimate what auction prices might reach in a number of Asian economies. The analysis was based on the UK auction prices adjusted to take into account (a) the size of the population in the coverage areas, and (b) local variations in existing ARPU's to take account of 'the difference in subscriber quality across boundaries'. Their estimates came to US\$2.84 billion for Hong Kong and US\$13.2 billion for South Korea. The figures calculated on a population coverage basis made the licence fee worth US\$451 per capita for Hong Kong and South Korea, out by a factor of at least 6.

Discounted Flow of Future Earnings

Estimation of net present value (NPV) or some variant such as the internal rate of return on capital investment (IRR) is standard procedure for commercial organizations deciding

²⁹ *Licensing costs of 3G licences*, UMTS Forum, 19 October 2001.

³⁰ See 'It Still Looks Like a Dear Deal, Mr Sommer' and a contrary view from R.I.Reis, 'Letters to the Editor', *Financial Times*, 25 July 2000.

³¹ *Asian Circuits: The 3G Auctions Debate*, Salomon Smith Barney, 19 June 2000

on the wisdom of investment. In cases where investment involves a high degree of innovation, as is frequently the case involving ICTs, the standard procedures can often lead to conservative conclusions because the costs involved are often reasonably self-evident but not the future benefits that have a high degree of uncertainty attached to them. Further, the literature of business and management schools is full of examples of unforeseen and unplanned for benefits. For these reasons, the 'animal spirits' of the entrepreneur and the innovating manager add a big chunk of subjective 'judgement' to the investment decision.³² We saw above how real options theory acquired a small following in the later 1990s to handle this problem.

Building a business case or 'model' is like painting by numbers, it is a highly limited form of art. The technique is taught in every business school and is easily replicated, but deciding on the revenue forecasts is a devil of a detail, not least in the highly uncertain world of 3G mobile communications. The crucial factor that seems to have been completely ignored, or overlooked, by those making the bidding in Europe is the simple fact that a 3G licence offers no more in principle than the right to operate an access network.³³ Offering content and applications does not require a licence, and in the world of the Internet no state could police such a restriction for long. As convergence between fixed and mobile gathers pace, users will use mobile devices to request downloads over fixed networks and vice-versa, and content and applications providers will come from many different directions. An access network does offer one big potential advantage, that of billing the customer, although 'billing' and 'owning' the customer are not the same things. Mobile number portability, the use of pre-paid cards and customer churn even throw doubt on the ability to bill, and the intrusion of MVNOs into the picture casts further doubt over who does the billing. So when operators bid for 3G licences, their business models should have been restricted to their revenue-generating ability arising from (a) their ownership of spectrum, and (b) their right to build an access network, and the options arising from these real assets.

Spectrum offers option value in addition to offering a 3G business if the spectrum can be resold or reused. Otherwise the 3G business model runs entirely upon the anticipated revenue earned through the provision of access. Any additional business revenues are not strictly revenues arising from the ownership of the licence.³⁴ The additional revenue

³² Another well-known driver of risky investment decisions are management motives that arise when status, remuneration and stock options are attached to company growth, especially in cases where managers are frequently head-hunted and do not stick around to pick up the consequences of their decisions.

³³ The writing was on plenty of walls. 'In the old world, 70 per cent of the value remained with the telco; in the new world, 75 per cent of the value will belong to content providers, content creators and service providers.' 'Creating the New World Wireless Operator' KPMG, 2000, p.2 at <http://www.webcity.com.au/kpmg/page2.html>. Even that underplayed the situation according to Lucent's director of wireless Steve Spencer: 'if you are just a transport play, you are playing in about 10 per cent of the value chain.' Quoted in *Jardine Fleming Research: Regional Telecommunications*, May 2000, p.26

³⁴ For this reason a royalty payment should exclude them.

source most frequently cited by financial analysts was the mobile portal.³⁵ When all else failed, a high value was assigned to the potential of a portal, but if there is one lesson to be learned from the bursting of the dot.com bubble it is that most portals will fail. The reason is simple, portals work on the basis of there being just a few that successfully aggregate websites that people wish to visit. Like shopping malls or broadcast satellites, every seller wants to locate in the most visited portal. There is a difference insofar as on the Web customers can visit many portals with few transaction costs involved such as time and money, but do they and will they? How many portals can the market sustain? The most likely answer is many around the world in different languages, but not so many that every 3G operator can confidently factor portal revenues into their business model. Most will fail, and if the DoCoMo model is anything to go by the revenues of access networks will come from their micro-billing activities that depend entirely upon volume. As in all commodity businesses, mass becomes critical.

From the millennium Hong Kong was debating these issues in earnest, with one eye on the outcome of the European auctions, and every securities house in town was producing their own business models and forecasts of what 3G licences would be worth locally. For reasons just stated I was a skeptic, so I too joined the fray. It is instructive to review, albeit very briefly, the business model assumptions and outcomes because they do throw light upon the process that led the industry astray and which has resulted in the debt and restructuring problems of companies like BT, KPN and many others.

It is commonly acknowledged that the two key variables producing wide variations in net present value estimates of 3G licences are (a) the assumed market penetration rate, and (b) the forecast average revenue per user.³⁶ Assumptions regarding the former varied considerably. The UMTS study used a saturation rate for Europe of 80 per cent market penetration by 2010, while reports in Asia used higher forecasts. The range of forecasts for ARPU, and its various components, varied even more wildly. Reflecting on the exuberance of service providers and vendors during 2000, the *South China Morning Post*, 2 May 2001, reported that 'to make a profit after 10 years, phone operators envisaged average revenue per user (ARPU) soaring from today's US\$20 to US\$30 for voice and limited data capability to US\$80 to US\$100 in a 3G multimedia world.' By contrast, the *Financial Times*, 1 May 2001, quoted Forrester Research as suggesting 'A 15 per cent drop in average revenue per user by 2005 will destroy profits, unleashing major business

³⁵ 'For wireless carriers, we believe that transformation from simply voice to data and Internet portals will provide an enormous boost to revenues and profits... AOL of the US has a net profit margin of 18%, 3 times that of the Japanese wireless carriers. Importantly, as the wireless carriers increasingly become Internet portals, it is logical to believe that their profit margins will move towards the level of AOL.' (*Revolution Next: 3G and the Wireless Internet conference highlights*, 'Opening speech by the director of Japanese Telecommunications Equity Research', Credit Suisse/First Boston, Tokyo, Japan, 1-2 March 2001.)

³⁶ The UMTS Forum Model (*A Regulatory Framework for UMTS: Report no.1*, 1998: www.umts-forum.org) found 'An increase in subscriber revenue of 20 per cent would double the IRR, while a reduction of 20 per cent would reduce IRR to less than half the initial value.' The model also found an increase of 30 per cent in network costs would reduce IRR by 40 per cent with the implication that delayed network build-out and infrastructure cost sharing would avoid this consequence.

failures and industry consolidation.’³⁷ Following interviews with twenty-six operators Forrester concluded ‘revenue per customer from voice and text messaging will fall 36 per cent in five year’s time to €13 (US\$297m).’ But during 2000 security analysts were under pressure to come up with optimistic findings. The following paragraph taken from Jardine Fleming Research looking at TIW,³⁸ one of the UK auction winners is as transparent as it gets.

What we leave as the key driver is the EBITDA per subscriber. As our base case, we look at Vodafone today, which has the highest annual EBITDA per subscriber in the UK market at around US\$300 per subscriber... if we assume that TIW can only gain US\$300 EBITDA per subscriber, the company would be massively destroying value over the first 10 years of existence, with a terminal representing 603% of the total enterprise value of US\$815. Hardly a winning prospect. Surely, TIW must be targeting a better return, so we go back to the model and start tweaking up the EBITDA per subscriber assumption. However, if it necessary to assume an EBITDA per subscriber of US\$725- - 14% higher than current to reach a point where any value is created in the first 10 years of operation.

The question is: Is a 14% rise in EBITDA per subscriber achievable in view of the new revenue streams coming down the line with 3G? As we have shown earlier in the report, we see ample evidence that EBITDA per subscriber can grow significantly in the coming years, but believe that in a competitive cellular provision environment, a rise of this magnitude is too aggressive and that TIW overpaid. Nevertheless, our current forecasts look extremely stingy in the light of the aggressive gambles just undertaken by the world’s leaders in cellular. We find the fact that these operators are ponying up here and now a major comfort factor as we view our cellars.’

So despite sensible data, equity analysts found it hard to resist the confidence of those taking the ‘gambles’ and looked towards ARPUs of at least US\$725 per annum or nearly US\$60 per month. Admittedly by Hong Kong standards in 2001 where average rates stand around US\$30 per month these rates by 2010 may not sound outlandish, but in Hong Kong where the land cost of base stations is over 50 per cent of network costs and population is below 7 million, is it generally acknowledged that today an ARPU of US\$40 is required to breakeven. This was achieved by just one of the six operators of the eleven mobile networks in Hong Kong. In the same report, Jardine Fleming anticipated for one of the Hong Kong operators who did eventually win a 3G licence an ARPU of HK\$479 (US\$61.5) by 2009. In what follows I have used this optimistic forecast as an upper limit in a business model test case for Hong Kong.

³⁷ The UMTS Forum Model (*A Regulatory Framework for UMTS: Report no.1*, 1998: www.umts-forum.org) assumed monthly ARPU fell from around US\$50 in 2000 to US\$45 by 2010.

³⁸ *Jardine Fleming Research: Regional Telecommunications*, May 2000, p.34.

The 3G Case in Hong Kong

The debate in Hong Kong centred on the likely value of 3G licences in the case of a UK-style auction. The benchmarking approaches varied from the simplistic extrapolation of the percentage of GDP raised by the UK auctions to the case of Hong Kong, suggesting a windfall of over US\$6 billion,³⁹ to the more sophisticated modelling of Salomon Smith Barney (see above) whose estimate was less than US\$3 billion. NPV estimations were less in evidence and as the Jardine Fleming report cited above suggests analysts were more concerned to use NPV as a benchmark for deriving the ARPU necessary to provide a rationale for European auction prices than vice-versa. To give the most liberal interpretation possible, my own initial NPV estimate in August 2000 assumed a substantial leap in ARPU from US\$38.50 to US\$77 from 2001 to 2010, and a saturation rate of 110 per cent. Otherwise the assumptions were moderate regarding population growth, customer acquisition costs, financing and network costs, based on past experience. Net present value on the base case came to US\$1.1 billion or less than one-third the lowest benchmarked figure.⁴⁰ The base case assumed five licences, not four. NPV to increased to US\$1.3 billion with four licences. Lowering the penetration rate to the European level of 80 per cent reduced NPV to US\$360m.

This result was not at all surprising in light of the UK experience. According to the Smith Group of consultants who advised the UK government, a conventional NPV approach valued the licences at the equivalent of US\$2 – 3 billion, or 10 per cent of the realized auction price. As a percentage of GDP this corresponds to around US\$390m in Hong Kong, and on this evidence the simple extrapolation procedure may have some merit, but only because the valuation method has rationality behind it which is more than can be claimed for the auction bidding in the UK.⁴¹

Towards end 2000 OFTA, the Hong Kong regulator, who had previously been under intense pressure to hold a UK-style auction, opted for my proposal of a royalty-based auction, and called in much the same team that had designed the UK auction procedures. By September 2001 the bidding was immanent and I was engaged in a dummy run on behalf of one of the bidding companies. The business model was reworked with new assumptions, such as four licences, a later network start-up date,⁴² and a revision of

³⁹ *South China Morning Post* columnist Jake van der Kamp sparked off the debate with one central issue, 'simply the money involved.' *SCMP* 5 April 2000. Using a crude per capita comparison with the UK, 'an auction in Hong Kong could bring us a windfall revenue of up HK\$50 billion (US\$6.4 billion).' *SCMP* 22 May 2000.

⁴⁰ 'The Case Against Auctions in Hong Kong' at www.trp.hku.hk/trp_papers.html. Professors Jia He and Larry Lang at the Chinese University of Hong Kong independently reached a similar result, adding a further US\$800m for real option value in 2000. See footnote 14 above.

⁴¹ 'We are now beyond all reasonable predictions of what a licence may go for. The threat for the bidders is that they are in a lose-lose situation. If they fail to win a licence they will be penalized for losing the opportunity. If they win, they will be penalized because of the size of the investment.' Nick Graham-Rack, CTO of the Smith Group, at: <http://else.econ.ucl.ac.uk/elseco/press/prizes.htm>.

⁴² OFTA requires 3G licence holders to build a network covering 50 per cent of Hong Kong's population by December 2003.

APRU forecasts and 3G penetration rates. The table below is a reworked and highly summarized version of this exercise. None of the data below relates directly to any of the bidders, and a market share of 25 per cent has been assumed such that these figures could in principle apply to any of the four licence holders.

The key variables, as before, are ARPU and 3G market penetration which in this table is expressed as the percentage of the total mobile market (2G + 3G) taken by 3G in 2010. ARPU cumulative average growth rates of 3 per cent and 6 per cent are assumed taking monthly ARPU by 2010 to US\$54 and US\$62 respectively. The latter is in line with Jardine Fleming's estimate (cited above) of what TIW in the UK would need if 'any value is created in the first 10 years of operation.' The table demonstrates NPV according to various combinations of 3G penetration and ARPU, expressed in US dollars.

Net Present Value of Licence in Hong Kong for One of Four 3G Operators with 25% Market Share

NPV per ARPU/3G:2G	40:60 (3G:2G)	75:25 (3G:2G)	100:0 (3G:2G)
ARPU 103% CAGR	US\$93m	US\$230m	US\$346m
ARPU 106% CAGR	US\$118m	US\$275m	US\$406m

In this analysis the penetration rate elasticity of revenue ranges from 1.3 to 0.8, and the ARPU elasticity of revenue from 1.3 to 1.1, where elasticity is the percentage change in revenue divided by the percentage change in the penetration rate or ARPU. It would seem that, for the most part, revenues are sensitive in equal measure.

In the event only four players turned up to the auction in September 2001 and each was charged the reserve price of HK\$50 million per annum or 5 per cent of turnover, which is the higher, for the first five years of their licence, and a rising percentage of turnover thereafter. In NPV terms over the lifetime of the four licences this comes to around US\$240m, close to the US\$230m in the table. The interesting issue for a bidder is how far would they have gone had there been a contest. Clearly each operator has their own valuation based upon, for example, the market share they think they can capture. But what happens in the case of a tied bid? Depending upon the rules of the auction, the tied bidders have to make a choice. One of the interesting results of the dummy exercise I participated in simulated a tied bid. Having anticipated such an eventuality I assigned probabilities to reaching a certain share of the 3G market by 2010 and thus determined a percentage of royalty above my base case I was prepared to bid. This was not the only option available, but it did introduce an element of rationality at a moment in the bidding process when emotion could take over. Is that what happened in the UK auctions?

For the record, my estimation in September 2001 of what a licence was worth varied according to the current 2G strength of the bidder, with maximum 'rational' bids mostly within the 7 per cent range for royalty payment on turnover. This is equivalent a NPV per licence over ten years varying between HK\$580 million (US\$74m) and HK\$745m (US\$94m) or for the market-as-a-whole HK\$3 billion (US\$400m) at the outside.

Reconstructing Telecoms?

The 3G debt issue has brought to a head in Europe many of the trends already in evidence within the entire value chain of the telecommunications sector. In the analogue era telecommunications and information technology (IT) were essentially separate businesses. The digital era promised convergence at the technological level, but did little to deliver synergy at the business level. Rather than becoming partners in the telecoms business, IT companies joined traditional vendors in selling their hardware and software products to carriers. In the Internet era, with its promise of e-commerce, IT companies are looking expectantly for business synergies, and carriers have tentatively examined options for promoting 'business solutions' to corporate and SME customers in the hope of generating data traffic. Helping this process along has been the liberalization of the telecommunication markets with new entrants tending to specialize on different market segments and a weakening of links between incumbents and their traditional vendors. All the above has occurred within a world of narrowband communications. That is now changing.

A world of broadband communications upsets all the certainties of narrowband economics⁴³ and 3G is a perfect example of it. Two consequences are particularly noteworthy. First, as this paper has argued, no one knows how to value future business prospects. Second, the role of competitive alliances is growing. They form along the entire (vertical) value chain, from hardware and software designers and manufacturers to carriers to end user access devices, and across it (horizontal), for example set-top box manufacturers, multimedia companies, cable TV and telecom networks. These alliances are all about companies with firm-specific advantages trying to leverage their standards, their systems, their products and services through alliances with partners along the value chain in competition with similar alliances, where members of one alliance may be involved with members of a competing alliance in some other area of standards or products. These alliances go beyond just the usual joint agreements to share R&D or marketing, as they are an attempt to establish a particular *direction* for the industry, such as the adoption of WCDMA as opposed to CDMA-2000 for example.

Microsoft is clearly the master of this game as it now eyes the broadband mobile Internet market. Its early alliance with Intel was a classic of its kind. Microsoft has gone from competing with Apple (fixed line computer operating system) to Netscape (fixed line browsing) to Palm (handheld computing operating system) and the Symbian alliance (Epoc handheld and Quartz pen-based operating systems) to Nokia (mobile browsing) to the latest assault with Intel and Compaq on Sun and Unix systems and the corporate server market. The next wave identified by Microsoft is the consumer electronics market and home networking. The launch of Xbox in direct competition with Sony's PlayStation is not about marketing games, it is about networking which is where consumer electronics meets telecommunications.

⁴³ I have explored this theme in John Ure "The era of international simple resale: not waving but drowning?" *Telecommunications Policy*, v.23.2, February 2000, pp.9-30

Competitive alliances produce countervailing tactics and strategies, and Nokia's response is illustrative. Microsoft's assault on Nokia's position was well captured in the following exchange between Peter Martin and Andrew Gowers writing in the *Financial Times* 9 December 2001, and Bill Gates: 'he thinks that the battle for high-powered "cool phones" is between Microsoft's Stinger software and the Palm operating system. Surely Nokia is a potential competitor here too? "Nokia's primarily a hardware company," he replies. Isn't it spending zillions on its push into software? Mr Gates's competitive streak, under control until now, breaks out: "They can't afford to spend zillions – I'm the one spending zillions, five to be exact.'" Nokia's response is to go for open ground as fast as possible by taking the Linux route to open its software code to partners under licence who have the right to re-licence any improvements they make.

How does this affect the network operators, apart from giving them more choice of hardware and software? In the short run it adds to uncertainty as technological standards remain in flux, but it also adds a new dimension to regulatory uncertainty. This point can be illustrated with reference to Hong Kong. Should 3G operators invest in an IP or a circuit switched infrastructure? The 3G.IP alliance of carriers like AT&T, BT, Telenor and vendors like Rodgers Cantel, Ericsson, Lucent and others formed in 2001 are promoting the IP standard, but most vendor's tried and tested products are circuit-switched. In Hong Kong, which operators a mobile party pays (MPPs) system, interconnection for circuit-switched mobile calls and Internet traffic from ISPs is charged differently. MPP may not be sustainable or desirable if fixed-mobile convergence is to be facilitated in Hong Kong, and this raises a further uncertainty.

The theme of uncertainty runs throughout this paper as the *lieamotifiv* of the Internet era of telecommunications as it enters the age of broadband, and much of the current restructuring of the sector can best be understood in this context. A final illustration comes from the most widely quoted 'success story' of the mobile Internet business, the DoCoMo model in Japan. In a recent study of DoCoMo, Jeffrey Funk⁴⁴ argues that reach rather than richness of content is the ingredient of success for 2.5G and 3G alike.

Most service providers have focused on business-related contents like news, travel, etc and they have aimed their WAP phones at business users... This book argues that the mobile Internet is very different from the fixed-line Internet... The mobile Internet contents must be simple due to the small screens and keypads. Young people are the major users of the most portable device like portable music players and they will most likely be the major users (at least initially) of portable, i.e., mobile Internet phones.' (Chapter 1, p.1)

Keiji Tachikawa, president of DoCoMo, seems to hold a contrary view. Arguing that European operators should rethink their strategies for 3G services, 'I would like everyone to change their view [of 3G]...initially it will be for business users, so there won't be a

⁴⁴ Jeffrey L. Funk (2001) *The Mobile Internet: How Japan Dialed Up and the West Disconnected*, ISI Publications, Hong Kong. (<http://www.rieb.kobe-u.ac.jp/~funk/index.html>)

mass market.' ('DoCoMo warns of slow 3G take-up' *Financial Times* 13 March 2001.)
In October 2001 DoCoMo launched the world's first 3G service, named Forma, with a target of 150,000 users by March 2002, coupled with the marketing of leased lines to connect the service to corporate networks. Its future remains uncertain.

Appendix 1: Summary valuation tables of 3G investment, EBITDA, net and cumulative cashflows at various estimated NPVs for Hong Kong

Note there is negative cumulative cashflow at least until 2008.

Cash Flow @ NPV of HK\$722 million (US\$93m):
40% Penetration of Mobile Market – ARPU CAGR 103%

HK\$ (millions)	2003	2004	2005	2006	2007	2008	2009	2010
Investment	(500)	(500)	(500)	(45)	(46)	(47)	(48)	(49)
EBITDA/Cashflow	-	21	64	177	318	624	1,182	1,659
Net Cash In/Out	(500)	(479)	(436)	132	272	577	1,134	1,610
Cumulative Cashflow	(500)	(979)	(1416)	(1284)	(1012)	(435)	699	2309

Cash Flow @ NPV of HK\$1,793 million (US\$230m):
75% Penetration of Mobile Market – ARPU CAGR 103%

HK\$ (millions)	2003	2004	2005	2006	2007	2008	2009	2010
Investment	(500)	(500)	(500)	(45)	(46)	(47)	(48)	(49)
EBITDA/Cashflow	-	21	64	173	427	1,009	1,842	3,111
Net Cash In/Out	(500)	(479)	(436)	128	381	962	1,794	3,062
Cumulative Cashflow	(500)	(979)	(1416)	(1288)	(907)	55	1,849	4,911

Cash Flow @ NPV of HK\$2,695 million (US\$346m):
100% Penetration of Mobile Market – ARPU CAGR 103%

HK\$ (millions)	2003	2004	2005	2006	2007	2008	2009	2010
Investment	(500)	(500)	(500)	(45)	(46)	(47)	(48)	(49)
EBITDA/Cashflow	-	21	64	173	569	1,302	2,763	4,148
Net Cash In/Out	(500)	(479)	(436)	128	523	1,255	2,715	4,099
Cumulative Cashflow	(500)	(979)	(1416)	(1288)	(764)	490	3,205	7,305

Cash Flow @ NPV of HK\$917 million (US\$118m):
40% Penetration of Mobile Market – ARPU CAGR 106%

HK\$ (millions)	2003	2004	2005	2006	2007	2008	2009	2010
Investment	(500)	(500)	(500)	(45)	(46)	(47)	(48)	(49)
EBITDA/Cashflow	-	21	64	184	337	680	1,326	1,915
Net Cash In/Out	(500)	(479)	(436)	137	291	633	1,278	1,866
Cumulative Cashflow	(500)	(979)	(1416)	(1279)	(988)	(355)	923	2,789

Cash Flow @ NPV of HK\$2,136 million (US\$275m):
75% Penetration of Mobile Market – ARPU CAGR 106%

HK\$ (millions)	2003	2004	2005	2006	2007	2008	2009	2010
Investment	(500)	(500)	(500)	(45)	(46)	(47)	(48)	(49)
EBITDA/Cashflow	-	21	64	178	452	1,099	2,066	3,591
Net Cash In/Out	(500)	(479)	(436)	133	406	1,052	2,018	3,542
Cumulative Cashflow	(500)	(979)	(1416)	(1283)	(876)	176	2,194	5,737

Cash Flow @ NPV of HK\$3,161 million (US\$402m):
100% Penetration of Mobile Market – ARPU CAGR 106%

HK\$ (millions)	2003	2004	2005	2006	2007	2008	2009	2010
Investment	(500)	(500)	(500)	(45)	(46)	(47)	(48)	(49)
EBITDA/Cashflow	-	21	64	178	603	1,419	3,100	4,789
Net Cash In/Out	(500)	(479)	(436)	133	557	1,372	3,052	4,740
Cumulative Cashflow	(500)	(979)	(1416)	(1283)	(726)	646	3,698	8,437

Appendix 2: Spreadsheet summaries of business model assumptions according to 3G percentage of total mobile market by 2010 (40 per cent, 75 per cent and 100 per cent) and NPVs based upon ARPU cumulative annual growth rates of 3 per cent and 6 per cent.

See attached sheets 1-3