Warwick Business School **August 2005**

<u>CASE STUDY</u>

THE BATTLE FOR CRITICAL MASS IN THE UK MOBILE COMMUNICATIONS INDUSTRY

Case Study Abstract

This case outlines the growth of the UK mobile communications industry from its inception, and provides an overview of the events that transformed mobile telephony into a mass market commodity. Beginning in 1985, the case outlines the continuous evolution of T-Mobile, Orange, Vodafone and O2[i], the mobile network operators (MNOs) which were licensed to operate in the UK from 1985 to date. The case describes how Orange and T-Mobile rapidly gained market share over O2 and Vodafone, the industries incumbents that had set up ten years earlier.

The case tracks the network operator's initiatives into the mid 1990s as the market changed radically in terms of affordability, product choice, and customer cohorts. Finally the case describes strategic action in the late 1990s when the MNOs experienced exponential demand and the market hit critical mass.

The case focuses on the strong forces affecting the companies: rapid technological developments and the exponential rise in sales fuelled by the mechanism of network externalities. Besides describing the sales patterns of the mobile communications market, the case documents the jockeying for the leadership position, and the constant narrowing of the differences in market shares. The companies experienced powerful market forces which override strategic action and permit new entrants to rapidly gain ground. As a result the MNOs opted for copycat strategies in order to collectively benefit from network externalities, and to reduce the risk of allowing competitors to gain ground.

When used with the support readings on the mechanism of network externalities, the case becomes a powerful vehicle for studying a variety of new market issues including strategic herding and strategic collaboration.

[i] T-Mobile was previously branded at One 2 One. O2's earlier brand name was Cellnet, which wasa subsidiary of British Telecom, the UK fixed line operator.

THE BATTLE FOR CRITICAL MASS IN THE UK MOBILE COMMUNICATIONS INDUSTRY

(Tanya Sammut-Bonnici)

The mobile communications industry is a fascinating case of interacting forces each working to retain a threshold of power over the future of the networks. The mobile telecommunications industry is a highly interconnected industry. It is interconnected with the competitors and with its customers on a long-term basis. Industry players in the mobile communications market moderate their strategic behaviour and opt for strategies that imply a form of complex adaptive behaviour. The common goal becomes the collective survival of the firms in order to eliminate the probability that one firm will prevail and the rest will fail. A set of isomorphic (copy-cat) strategies emerges at the level of technical standards, network platforms and the consumer platform. As a result market shares of competing firms become almost equal and network externalities are reconfigured to act for the benefit of the whole industry.

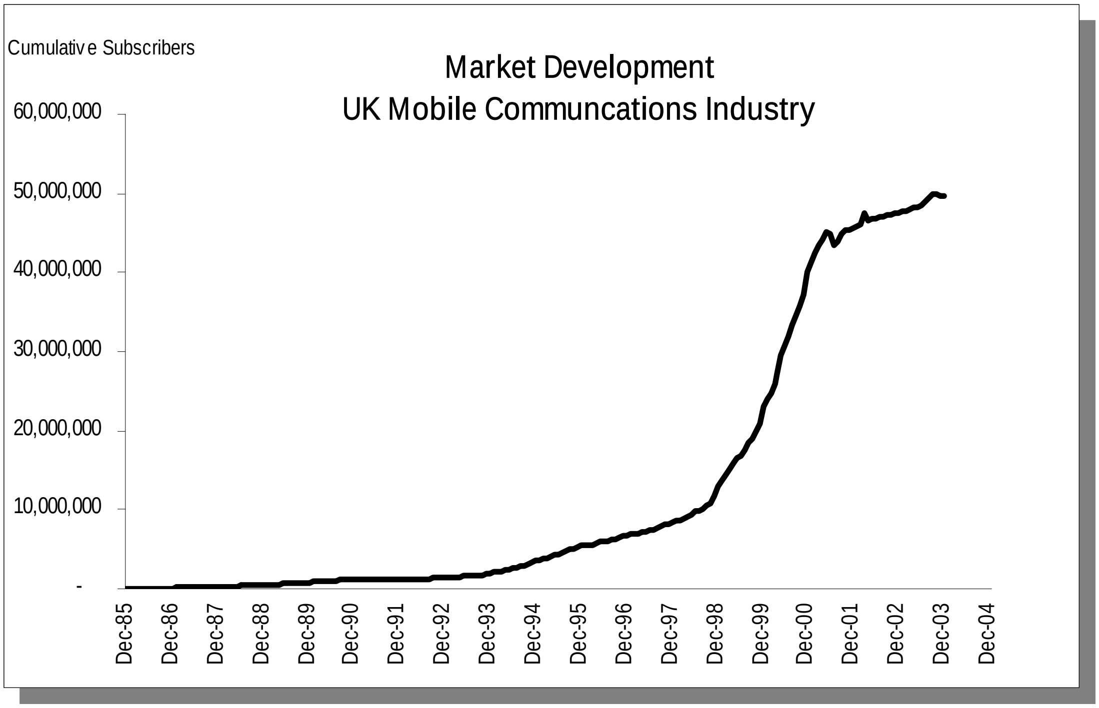
1. EMERGENCE OF THE MOBILE NETWORKS

The UK subscriber base increased to 50 million users from 1985 to 2004. Most of the industry's growth occurred from 1999 to 2000 when 30 million subscribers joined the four networks. This represents an increase of 66% of the subscriber base in just two years, out of a total industry life span of 17 years, as seen in Figure 1. The industry's history has been through a period of duopoly and a period of increased competition. Up to 1993 there were only two operators, Cellnet[ii] and Vodafone. The competitors were banned from selling directly to the public. A supply chain with an independent level of dealers and service providers sold mobile equipment and subscription airtime to consumers. One 2 One[iii] and Orange entered the market in 1993 and 1994, respectively.

The UK Government granted licences to Vodafone and Cellnet for the operation of mobile communications networks in 1983. Vodafone was initially owned by Racal Electronics and was later floated on the stock exchange as a separate company. Cellnet was 60% owned by British Telecom, and 40% by Securicor. The two companies launched their networks concurrently in 1985. Further licences were granted to One 2 One and Orange in 1993 and 1994 respectively. One 2 One, was originally owned by Mercury Personal Communications. Orange was created by the Microtel consortium led by British Aerospace, which was subsequently purchased by Hutchison Telecommunications. The industry started with analogue networks in 1985 and moved on to digital network in the 1990s. Vodafone and Cellnet switched on digital networks in 1992 and 1994. One 2 One and Orange entered the market with digital networks from their launch date.

[ii] Cellnet later became O2 in November 2001
[iii] One 2 One became T-Mobile in April 2002

Figure 1: Market Development – UK Mobile Communications Industry



2. INDUSTRY LEADERSHIP

Figure 2 summarises the network size of the four MNOs from 1985 to date. Three out of the four MNOs held the position of the largest networks at different periods. Only One 2 One failed to attain the largest subscriber base at any point in its history. Cellnet, Vodafone, and Orange became industry leaders in 1985, 1986 and in 2001 respectively.

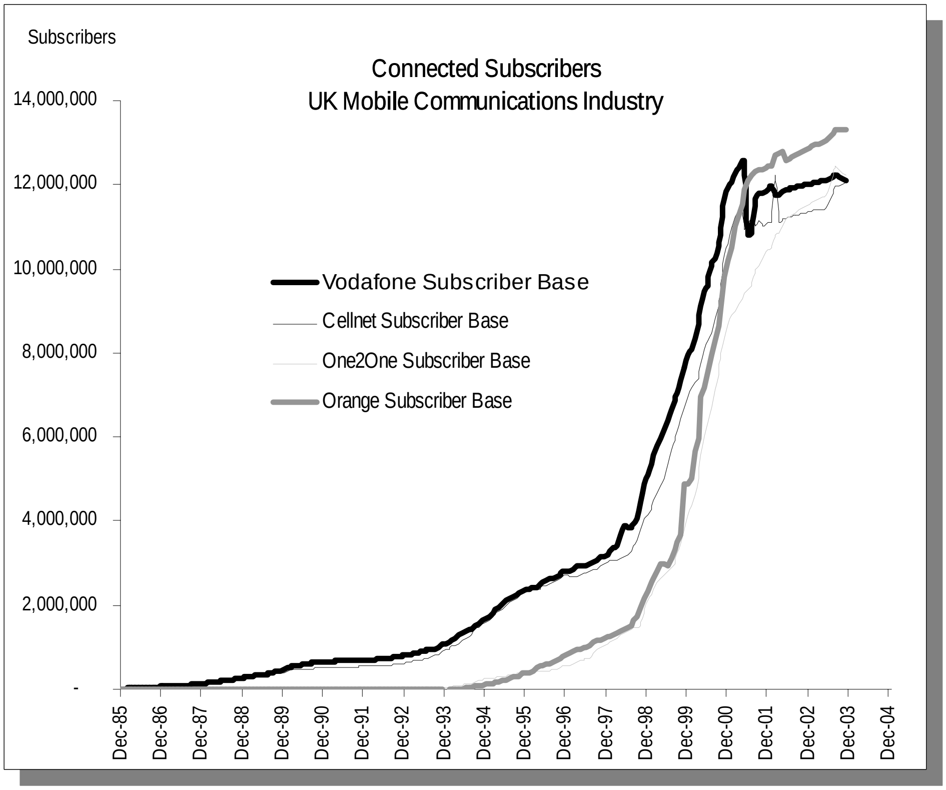
Cellnet was the industry leader up to the third quarter of 1985. The company never regained the lead position but came close to having the same market share as Vodafone in 1996 and in 2001. The Cellnet story defeats the idea of 'first mover advantage', and the concept of a seed value[iv] from the innovations diffusion literature.

Cellnet started to relinquish market share to Racal-Vodafone[v] in mid 1986. At that point, it had 32,000 subscribers, representing 54% of the UK mobile market. In just nine months, Cellnet made three price changes in fixed and variable rates. Its pricing structure was cheaper in the London areas, but more expensive in what were called the provincial areas. Growth in connections and traffic in the provincial areas was increasing in significance. Cellnet suffered because of real and perceived price differentials, and its miscalculation of growth potential of non-London territories.

[iv] The seed value, which is the initial size of a network, is thought to provide enough impetus for network to grow at an increasing rate, outstripping competitors.

[v] Racal and Vodafone demerged in September 1991.

Figure 2: Industry Network Performance



In an effort to protect margins, Cellnet attempted to increase its connection and standing charges in April 1986. It withdrew them only four days after they had been introduced. The move followed the decision by the rival operator, Racal-Vodafone, to hold its prices steady and to increase the usage charge. Racal-Vodafone's increase was confined to the London area. Cellnet increased all its call charges at the beginning of this month. Racal, which had 27,000 customers at the time, said that its move was not designed to put pressure on Cellnet. Its mix of charges was intended to meet its target of another 35,000 customers over the next year, and that it decided to hold down connection and standing charges. These types of charges were viewed as the 'most emotive issues' for customers. Vodafone intended to act according to the psychological response of the consumer.

The fact that Cellnet cancelled its plans to increase prices meant that it would not meet its planned target to reach break-even point by 1987. The company, which was 60% owned by British Telecom, thought that the proposed increases would be reasonable, and that they would have been acceptable to the market. The results showed otherwise, and new customers drifted slowly towards Racal-Vodafone. In spite of the freeze in prices, Cellnet continued to lose market share. It claimed that the average customer would pay 6% less than under Racal, but it believed that customers perceive the Vodafone offering to be better. As a result, Cellnet was losing out in provincial areas where Racal's charges were cheaper. At that point in the industry's timeline, Vodafone was getting about 60% of its traffic from outside London, while Cellnet got 40-50%.

By January 1987, the pressure from customers increased and Cellnet was forced to introduce a new price structure. The move marked an attempt by Cellnet to win back market share from Racal, which had gained 53% of the UK's 114,000 subscribers. Cellnet announced a decrease in price of its basic cell phone by £450 to £899. However, the company lost its opportunity to gain a price differential in the eyes of its customers because Racal-Vodac followed suit the next day. Cellnet had started another price war. When sales were slow in August 1986, Cellnet brought the price of its cheapest unit below £1,000 for the first time. This move was the subject of a complaint to Oftel, but it did not lead to an investigation since Cellnet put its prices up again after six weeks. In May 1987, Cellnet instigated another price war against Vodafone with the announcement that new subscribers to its network would only pay half the subscription price for the first six months.

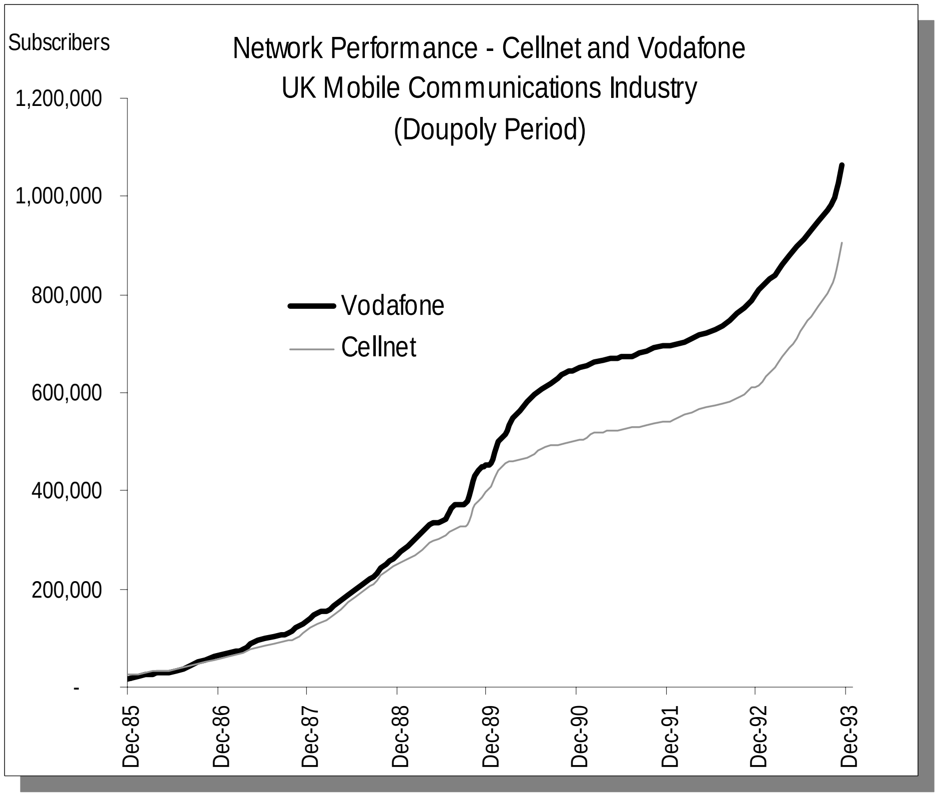
The competition battles were played through pricing strategies as well as advertising strategies. In May 1987, Cellnet unveiled a £5 million promotional drive, including a £1 million TV campaign through its agency Doyle Dane Bernbach. The campaign featured celebrities such as Joan Collins and Ian Botham. Vodafone rapidly took up battle in its fight with Cellnet for dominance in the UK mobile telephone market. It launched a £2 million TV campaign through Saatchi and Saatchi just two weeks after Cellnet's release. Interestingly Vodafone used its new campaign to push the other services it offered, besides the mobile telephone network. The move may have enhanced the image of Racal-Vodafone in terms of its size, reliability, experience in communications and its overall capability to build and sustain a mobile network. This drive to promote Racal-Vodafone's overall product offering was set to balance Cellnet's strong corporate image as a subsidiary of British Telecom.

Once Vodafone gained the position of the largest network in 1986 (Figure 3), Cellnet slipped into second place and remained there for the next twelve years. Orange challenged both Cellnet and Vodafone's positions in the year 2001 when it rapidly gained market share and became the largest mobile communications network. In July 2001 Vodafone's market share was seen to trail that of Cellnet and Orange. Vodafone slipped behind the two companies to become Britain's third largest mobile phone operator.

Orange was the last operator to enter the industry yet it grew rapidly to become the largest network to date. Orange's story defies all notions of first mover advantage as it challenged One 2 One, Cellnet, and finally Vodafone in its race for the largest portion of market share. Orange overtook One 2 One in 1996. Its strategy to overtake competitors started prior to the date it switched on its network. Its main strategies were: to set off with a network which had a larger coverage than its closest competitor; to offer better handsets; to offer simplified pricing structures.

When Mercury launched One 2 One in September 1993, Hutchinson was close to launching Orange. However, research had showed 50% coverage of the UK population to be the minimum level acceptable to customers. Whilst Mercury had a strong proposition, with new phones and cheaper calls, their 30% coverage of the UK market was not enough to challenge large operators. After the launch of One 2 One both Vodafone and Cellnet initially resisted calls to cut their prices. One 2 One felt the pressure to reduce its tariffs because it did not offer national coverage like its competitors. In view of the price cuts, Orange's launch was delayed further.

Figure 3: Cellnet and Vodafone Network Performance



Hutchinson felt that it was important to have a minimum of 50% coverage on entry into the UK Market and to rapidly achieve over 90% coverage. An investment of £450 million was allocated for 1994 when the service was to reach 70% of the population. This commitment required considerable capital outlay by Hutchinson, the owner of Orange. Commitment of capital outlay on this scale made the challenge of Orange to Vodafone and Cellnet of a different order to that of Mercury. It allowed Orange to take the process of change in the mobile telephone market forward, benefiting from the effect One 2 One had as an earlier catalyst of change.

The Orange network was attractive to consumers from the outset. Since it covered the main UK metropolitan areas and the connection motorways at launch, it immediately had a significant advantage over its closest rival One 2 One. From its launch period, Orange offered more benefits than One 2 One. Its Nokia handsets doubled as radio pagers, and had screens that could display voicemail and caller identification.

The target market for Orange was described by the head of product marketing Graeme Oxby as: "Not those right at the top of the corporate market, but the remaining 90% of the populace." Business customers were initially the principal target, predominantly middle managers and small business owners. The new target was largely ABCI customers and predominantly younger age groups attracted by the possibilities of digital technology. Orange was to benefit from the larger population of the new target segment.

In July 2001, Orange's network grew to 3.4 million subscribers, which challenged Vodafone's position as industry leader. Orange was attracting more customers on both the subscription and the pre-paid tariffs.

At the beginning of 2002, Orange and Vodafone were in dispute over market leadership claims. Orange claimed a lead over Vodafone, whilst calling for the industry to use the same definitions for 'active' customers. Orange did not include 'inactive' users in its calculations and was pressing for a common, industry wide definition of active customers. It said that if it used the industry's current definition of an active customer, it could add another 656,000 users to its 12.4 million UK customer base. Graham Howe, Orange's deputy chief executive and finance director, said: "I thought about using the industry definition but it just didn't make sense because you add in customers you know are inactive. I'm not saying the Orange definition is the perfect one but I think we need to get a group together to figure out what the industry definition should be."

The debate saw the rise in popularity of a most important acronym in the mobile industry: average revenue per user (ARPU). Operators in developed mobile markets were struggling to push up ARPU, even at the expense of growth in terms of subscriber numbers. Vodafone said it was still the UK's biggest mobile phone operator in terms of both revenue and profits and noted that the industry was now more focused on ARPU. Vodafone, which had 99.9 million customers worldwide in 2002, reported an average revenue per user of £274 in 2001. Orange, on the other hand, was reporting revenues alongside customer data. The company reported 2001 revenue up 25% at £8.3 billion. It added 8.8 million customers in that year, to take the total to 39.3 million, a 29% increase.

In the period under analysis there is no overall industry leader in the mobile communications industry. Vodafone is seen to have held the longest lead, from 1986 to 2001, yet Orange's meteoric rise is equally significant. The industry shows evidence of shifting patterns of leadership. This implies that the growth of MNOs is not a result of positive feedback from previous subscribers, but a result of other factors such as network externalities.

3. MARKET SHARE CONVERGENCE

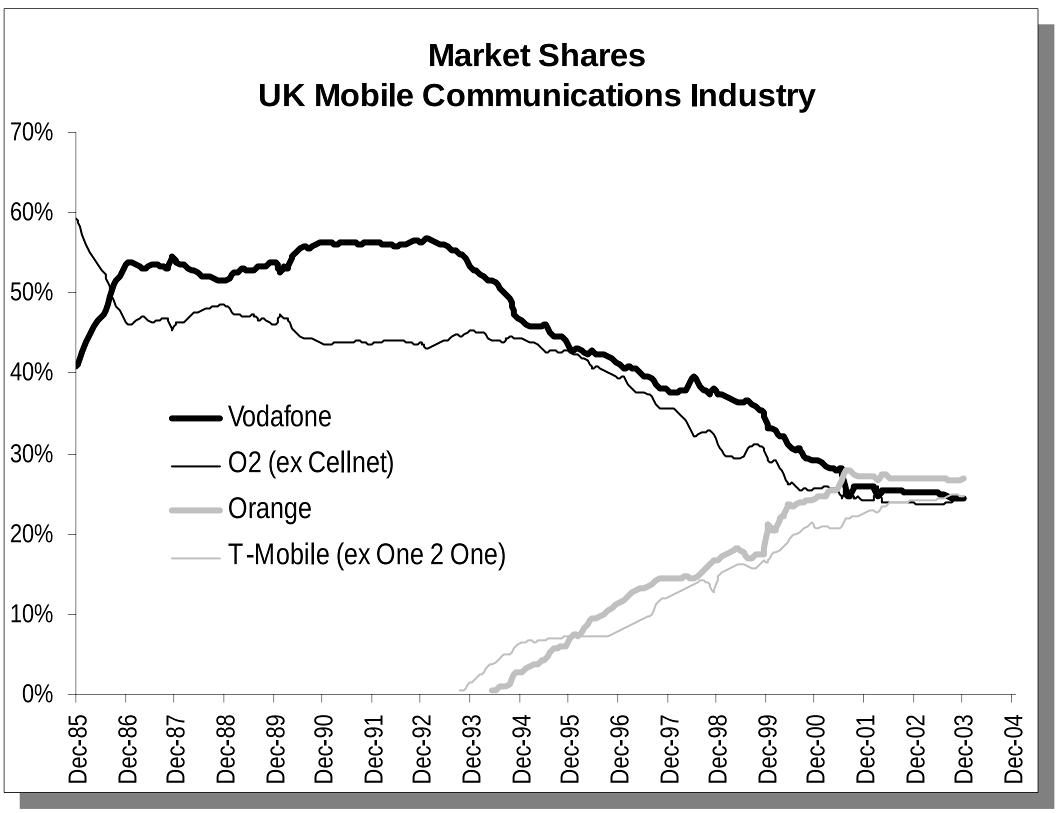
Figure 4 provides an interesting picture of the trends in market share of Cellnet, Vodafone, One 2 One and Orange. Cellnet started out with a high market share, relinquishing it to Vodafone over a period of 2 years. Vodafone and Cellnet held their positions at a stable level, until the entry of One 2 One and Orange in 1993 and 1994. At that point the market share of the older companies diminished as the new companies rapidly increased their hold on the market.

Cellnet held the highest market share from the start of the industry up to August 1985. Vodafone held the longest lead, from 1985 to 2001. Orange's dramatic growth moved it to the top position in 2001. The change in industry leadership clearly shows that winner-takes-all strategies, were not, or could not be exploited in this industry.

At the time when Orange overtook Vodafone, Cellnet's subscriber base dropped for the first time ever. Cellnet's subscriber base fell by 268,000 in accounting terms over the quarter to settle at 10.9 million in July 1 2001. The operator also saw a decline of 20,000 in its post-paid base. This decline was due to a move towards a three-month accounting standard similar to Vodafone. At this point Cellnet started to count only those customers who had used the phone at any point in the last three months. The new accounting measure reduced the bias on over inflation of subscriber figures.

Orange had the fastest growth rate in the industry. Orange saw its contract base increase by 222,000 net new customers to 3.4 million in the three months to the end of June, compared with 89,000 in the first quarter and with Vodafone's overall growth of 269,000. Orange, which allowed for 1 million inactive prepaid customers in its accounting, was outperforming Vodafone, even in the battle for more valuable post-paid customers.

Figure 4: Market Shares in the UK Mobile Communications Industry

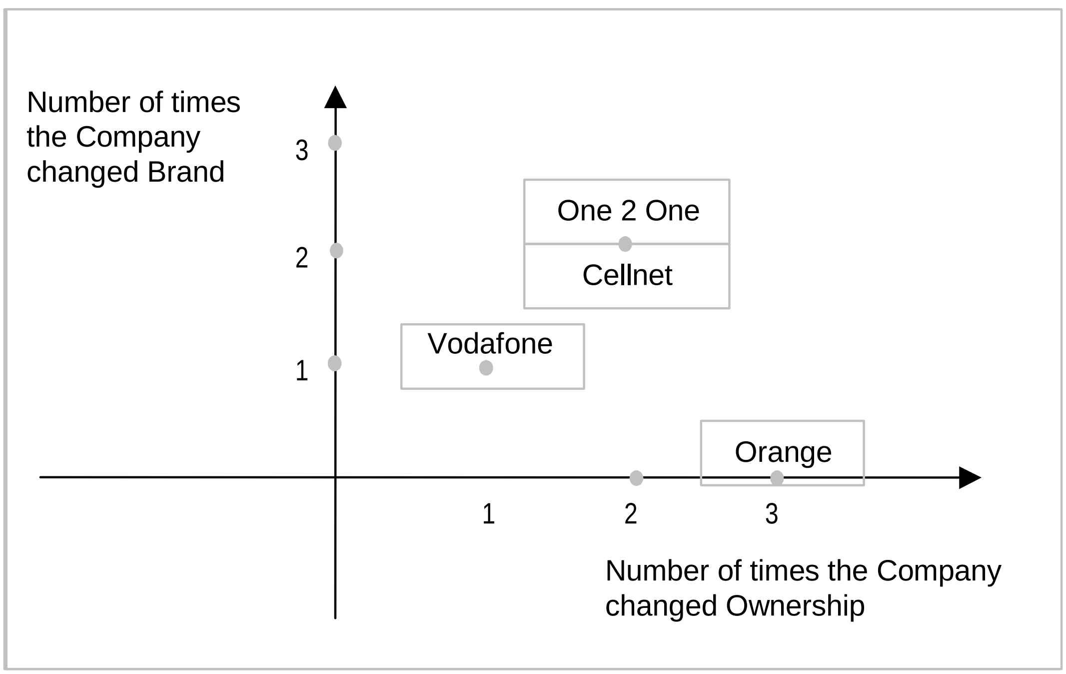


4. Brand Consistency

Figure 5 shows the number of times the companies changed ownership and brand names. It can be assumed that change in ownership does not have a direct effect on network growth. Orange underwent three ownership changes and it grew into the largest network. Vodafone had one change in ownership, when it separated from Racal and floated its stocks in 1991. Cellnet and One 2 One changed ownership twice. Orange was originally owned by Hutchison Whompoa and BAE, which shed its ownership in 1998. Mannesmann bought Orange in 1999. Orange was bought out again by France Telecom it in 2000, when Vodafone took over Mannesmann. Vodafone was the only network operator that was not bought out by third parties. Cellnet was originally owned by British Telecom and Securicor. It became wholly owned by British Telecom in 1999. Cellnet was demerged from British Telecom in the same year and floated on the stock exchange in 2001. One 2 One was originally owned by Cable and Wireless and US West Media Group. It was partly floated in 1997, and bought out by Deutsche Telekom in 1999.

From the four companies there is some indication that consistent branding can be linked to performance. Brand name consistency is the common characteristic of Orange and Vodafone, which have the highest brand equity in our research sample. They kept their brand name unchanged for the duration of their life span in mobile communications. Orange and Vodafone are almost equally successful. On the other hand, One 2 One was rebranded twice from Mercury One 2 One to One 2 One to T-Mobile. Cellnet was rebranded from BT Cellnet to Cellnet to O2.

Figure 5: Perceptual Map of Ownership vs. Brand Consistency



5. CRITICAL MASS AND MARKET GROWTH

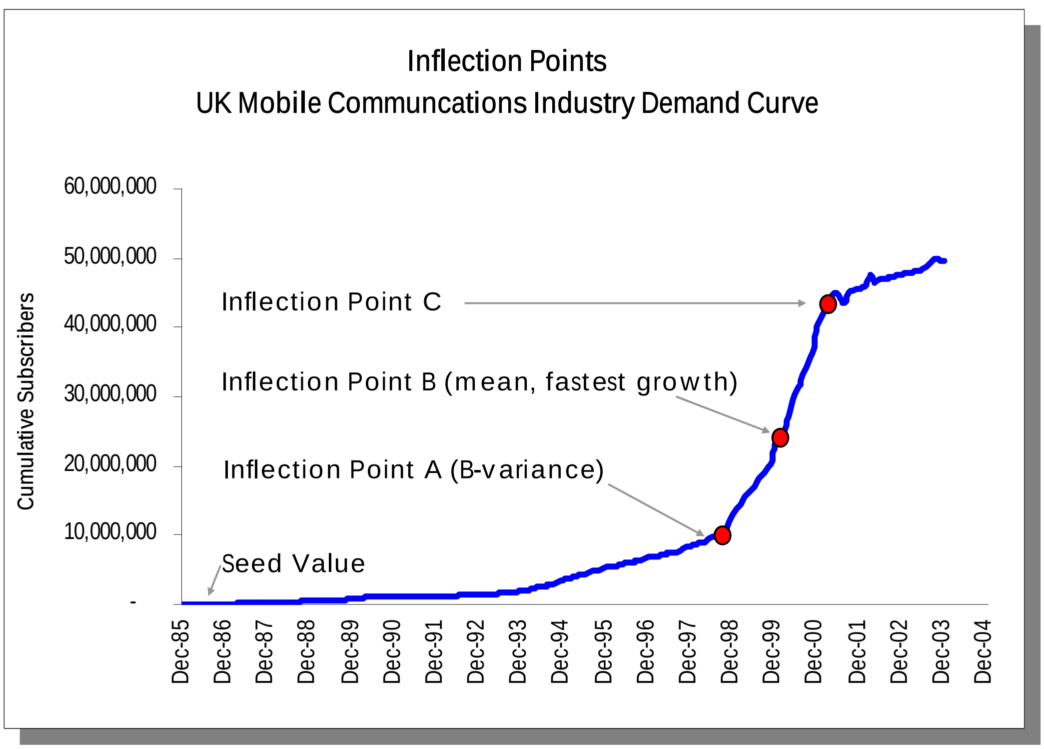
In the early days of the mobile communications industry, the achievement of a critical mass was a clearly stated goal. Vodafone and Cellnet, the pioneers in the industry, invested substantially to set the 'watershed' of subscribers in motion. The industry was striving to gain enough subscribers to move into an area of the demand function where it would be easier to attain more subscribers. In its objectives, the industry was verbalising the characteristics of a positive feedback system to reach a hyperactive state of development. Figure 6 illustrates important turning points in the mobile industries market development.

Critical mass may be evaluated in terms of inflection points on the demand function of mobile telephone subscribers. An inflection point occurs when the rate of change, or the gradient of the curve, changes in magnitude and direction. A typical diffusion of innovation curve has an s-shape with a first-order inflection and two second-order inflection points.[1]

- The first-order inflection point (Point B) occurs when the increase in the adoption rate is the fastest for the entire diffusion By and large, the first-order inflection point occurs when 50% of the population has adopted the innovation.

- The two other second-order inflection points occur when the rate of adoption switches from a slow rate to a faster one, and vice versa. The standard deviation of subscribers, gives the values of the second-order inflection points before and after the first-order inflection point.

Figure 6: Inflection Points



Inflection Point A (co-ordinates: 9.8 million subscribers, mid 1998) represents the most important turning point for the industry. The coefficient of determination for network externalities at that point was around 65%.[vi] At the same time important changes were taking place in pricing and distribution policies, which were to transform the industry's landscape. The mobile phone networks started to sell handsets in supermarkets nationwide. Furthermore, pre-paid phone cards were introduced which addressed potential users' apprehension of the subscription system.

Critical mass acts on the adoption of the MNO platforms in a similar manner for all companies. The deviations in the occurrences of critical mass are limited to a maximum of eighteen months, notwithstanding that the second set of MNOs entered the market a decade after the first set. The individual MNO network size has a small effect on the date of attainment of critical mass. The dates registered for Point A, the lower second-order inflection point, are in the order of the network size: Vodafone being the largest followed by Cellnet, Orange and One 2 One. The lag in the dates, however, has no relationship to the date of entry. The lag in attainment of inflection points diminishes through Point B and Point C, as the networks grow similar in size and market shares converge.

The exponential rise in demand was combined with a rapid reduction in cost in sales effort per subscriber. At Point A, the demand exceeds supply[vii] by a wide margin and the marketing strategies changed from a 'push' strategy, to one of distribution efficiency. Prior to the critical mass point, the companies had aggressive direct sales forces which sold mobile telephones on a door-to-door basis. In 1999, both Vodafone and Cellnet changed their sales strategy significantly. Post critical mass, the sales forces were transformed to support high street and supermarket distributors, where most of the sales were occurring on a cash and carry basis.

Marketing practitioners can readily identify when inflection Point A has been reached, but mathematical models and statistical techniques are required to forecast the other two inflection points.

Inflection Point B (co-ordinates: 23.5 million subscribers, end 1999) was less apparent to marketers when it occurred. It showed a very small decline in the rate of increase of demand. However in statistical terms it was a very important turning point, which could have predicted the arrival of the industry's downturn by the end of 2000. It takes the same increase in subscriber from Point A to B, as it takes from Point B to Point C.[2]

The occurrence of the first order inflection point (Point B) went largely unnoticed. The industry was going through the spectacular rise of text messaging which rose from 11 million to over 100 million messages per month in just one year.[3] The UK's SMS explosion is attributed to a number of factors, including the service's ease of use and its value for money. Another main factor was the breakthrough agreement on network interoperability, which was announced by the country's four operators at the beginning of April 1999.[4]

[vi] The correlation between number of new customers and network size was R=0.8. The coefficient of determination $R^2=0.65$ is a rough indication that 65% of the new subscriber data is attributed to network size. The value is a relative rule of thumb measure for the strength of network externalities.

[vii] The demand exceeds supply only temporarily, because supply was increased as a response to demand.

Furthermore, by the end of 1999, when the first signs of decline were noticeable, the industry was anticipating major upheaval with the impending government auctions of 3G licences and the announcement of Vodafone Airtouch's takeover of Mannesmann. The 3G auctions were to determine the future survival or lack thereof of Cellnet, Vodafone, One 2 One and Orange. The takeover was to affect two out of these network operators, as Mannesmann owned Orange at the time.

There was no reference to the small decrease in growth in a sample of 400 articles from industry publications and the general business media from November 1999 to October 2000. Even up to October 2000, just a few months prior to the slow down, the industry was still reporting signs of a growing market and record sales.

Inflection Point C: (co-ordinates: 37.1 million subscribers, end 2000) marked the start of the decline in growth of the UK mobile communications industry. The demise was not apparent for over two years later, when clear signs of saturation started to emerge. The decline in sales growth was picked up by the stock market. In May 2002, Vodafone shares closed below 100p, the lowest since February 1988. The weakness in mobile stocks spread across the sector. Analysts said investors were concerned about the short-term outlook for revenue growth, and the delays in bringing out commercial products and services related to GPRS and 3G.[5]

Another factor that affected the decline in the industry's growth was the population threshold at the current price level. A percentage of the population would never use mobile phones, which implies that the point of saturation occurs below the figure of the total population. The demand function is asymmetric and settles down faster at the later part of the industry's history.

6. IN SEARCH OF NEW CRITICAL MASS – PRODUCT LIFE CYCLE EXTENSION

Other forces that effect demand will come into play in the future of the UK mobile communications industry, and indeed similar industries around the world. The actual demand function will be dislodged further from an s-shape, as the characteristic of a subscriber changes. These changes are attributed to two factors: firstly, mobile phone users may own more than one telephone. The mathematical calculation of the s-curve would thus have to be adjusted, as the figure for the total population is no longer the upper limit of the demand curve. The upper limit would shift above the population threshold. Secondly, the mobile phone industry will expand its product life cycle by promoting subscriptions on automated equipment, which will relay consumption information through a mobile connection. The industry would thus push out of the population threshold even further, and extend its full potential to encompass individuals, as well as machinery.

As the statistical total population for the industry is pushed beyond the national population, the total potential population becomes less finite and more extendible. For example, a household with two adults has the potential to provide the mobile industry with a minimum of two subscriptions. The same household could also provide a number of additional mobile subscriptions for energy and water meters, feedback channels for satellite television channels, and remote operation of domestic appliances. M-commerce, which is commerce conducted via mobile telephony, has the potential to boost the sales figures even further. Wireless shopping, travel information, ticketing, mapping, banking, and trading are some of the applications that will see m-commerce revenues rise.

7. COPY CAT STRATEGIES

Isomorphism is a form of mimetic behaviour, or strategic herding that is in vogue in some of the most dynamic industries of the new information economy. The copy cat strategies between among Cellnet, Vodafone, One 2 One and Orange are a good example. Strategic isomorphism has strong appeal because of its risk reduction properties, which ensures the survival of more firms in the industry. However there are some serious caveats. Industry profit margins are likely to decline as shown in a study of the German mobile market.[6]

Deutsche Telekom's D1 and Mannesmann's D2 joined the incumbent C-Tel in 1992. Herding effectively removed divergence among the MNOs services, tariffs, and customer niches. When another MNO, E-Plus, emerged in 1994, it differentiated itself with pricing packages for low-volume private users, including students, families, and senior citizens. Within a few months, the other networks copied E-Plus's strategy, destroying its brave effort to increase differentiation in the industry. Nattermann's (1999) analysis of the impact of such crowding shows that a 10% decline in the wireless industry's SDI[viii] resulted in an 11.2% decline in profit margins. Between 1992 and 1998 the SDI fell by 83%, reducing margins down 50% from their maximum point. The reduction in strategic differentiation created by the incumbent operators was responsible for the lost earnings, which amounted to more than £495 million in 1998 alone. As strategic differentiation and margins decline, companies anxiously endeavour to reintroduce differentiation from competitors, typically by expensive brand enhancement campaigns and higher marketing spending.

A study by the Federal Reserve Bank in 2000 shows that the US personal-computer industry is another field which suffered a lowering in margins due to isomorphism.[ix] From 1976 to 1988 the PC industry's SDI went down by over 37% as companies copied the now dominant IBM-clone model. As a result of the decline, margins fell by 56%, representing £1.8 billion in destroyed margins by 1988. The increased herding effect in product design diminished "brand'' effects, which would have been developed over time from the firms' distinguishing characteristics. Brand effects, including such intangibles as reputation and image, are the drivers of price differentiation, which creates premium pricing margins. If isomorphism erodes distinctive brand characteristic, it will also erode the opportunity to charge for intangible factors.

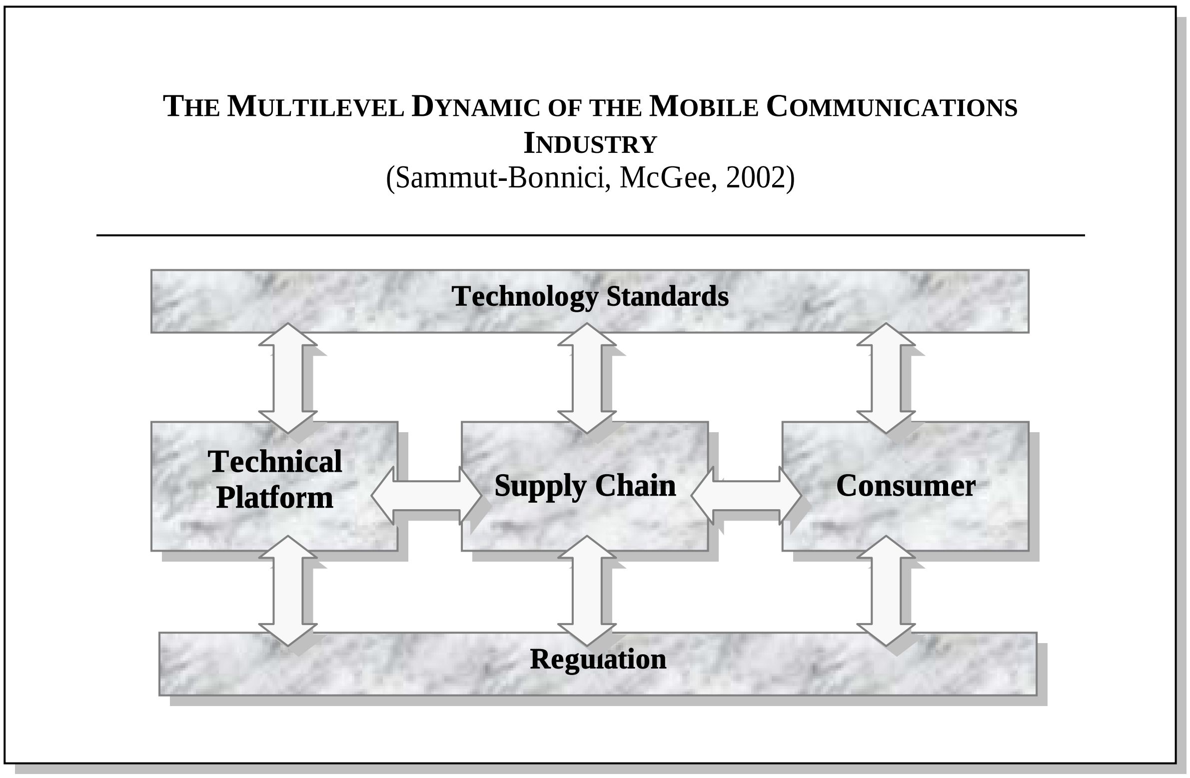
[viii] Strategic Differentiation Index. See Nattermann (1999).

[ix] The findings are summarised by Nattermann in McKinsey Quarterly (2000) Number 2, pp. 22—31.

8. INDUSTRY LANDSCAPE AND STRUCTURE

The mobile communications industry can be divided into five interacting levels. Each of the levels in our framework has its own economic dynamics and each contributes to the overall network, with technology and regulation in the background (Figure 7).

Figure 7: The Multilevel Dynamics of the Mobile Communications Industry



8.1 Regulatory Background

In the UK mobile communications companies fall under the UK Wireless Telegraphy Acts 1948-1967 and the UK Telecommunications Act 1984. The Radio Communications Agency has the authority to grant licences under the Wireless Telegraphy Act. The Department of Trade and Industry is responsible for the sector under the Telecommunications Act. The Office of Communications (Ofcom) is responsible for the enforcement of the licences issues.

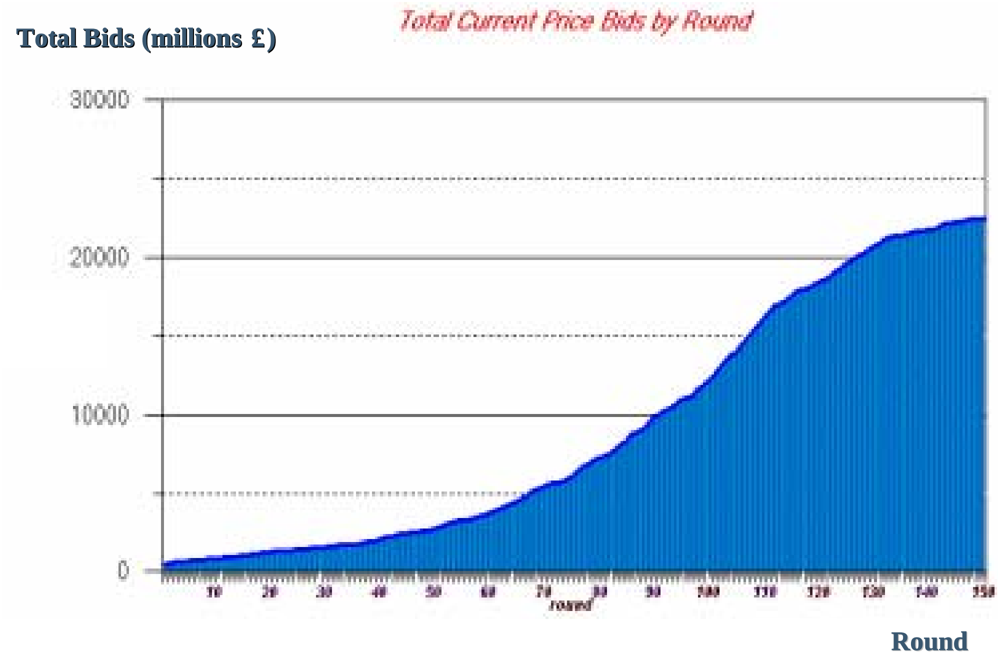
The regulatory institutions' main concern was to encourage and preserve competition. In order to stimulate the growth of a new supply chain, Cellnet and Vodafone were not allowed to market their services directly to the consumer from 1985 to the mid 1990s. The direct sales restriction was lifted when the third and fourth licences came into operation. Orange and One 2 One were not subject to such restrictions, as they were viewed to be at a disadvantage compared to earlier entrants.

The regulation of the UK MNOs of mobile networks has a balancing effect on how the mobile networks develop and on competition. Regulation is starting to match the demands of complex dynamic markets. Regulation is creating new forms of control that fall under the definition of self-organising systems. In this case the regulatory objective is to create self-correcting mechanisms that preserve competition. Although the original objective is maintained, the way of doing it is novel as the results are not entirely predictable.

A classical example would be the 3G spectrum auctions in the UK and across the globe. The auctions were designed to match the industry's predicted profitability of the introduction of a new generation of technology. The idea was that firms would bid to the maximum of the technology's feasibility. Thus governments found a way of introducing a licensing system that generated a self-correcting form of revenue, which gauged future profitability. However, as with all complex systems, the outcome was unpredictable and other factors took hold of the system. The auctions were essentially a taxation procedure on an infant industry, and a key factor to allow MNOs to continue operating. Prospective MNOs faced the situation of having to bid for their future existence, or give up their operation once and for all. Thus the bidding did not stop at the profitability limits, but moved into the limits of what the companies could borrow from their banks. The mobile spectrum in Europe generated £200 billion with Britain and Germany raising £22.5 and £60 billion respectively. The result was the depletion of cash flow, a delay in third generation launches and uncertainty in the stock markets.

Another form of self-correcting regulation is the concept of 'market influence' inbuilt into the licence agreements of the MNOs. The definition set in the Telecommunications Act licences implies that MNOs should not exploit price inelasticity that may arise for the demand-side of the market. Market influence behaves as a self-regulatory measure whereby MNOs keep their market strength in check, in order to preserve their licence agreements. As competition in the industry grew, the need for market influence mechanisms diminished and this form of regulatory control was reduced substantially throughout Europe.

Figure 8: The UK 3G Auctions (source: DTI)



8.2 Technology Standards

Mobile communications technology has evolved along a logical path, from the simple first-generation analogue products designed for business use to second generation digital wireless telecommunications systems being used in B2B, B2C and C2C markets.

TACS (Total Access Communication System) and ETACS (the extended version) formed the First Generation of mobile systems in Europe. The GSM (Global System for Mobile) standard is the Second Generation of mobile communication systems in Europe, supporting digital voice telephony, SMS text messaging and more recently WAP and GPRS. Throughout the 1990s, every country in Europe implemented cellular networks based on the GSM specification.

Third generation (3G) technologies come in two versions: CDMA2000 and WCDMA. The technology promises the introduction of video over and above what is already provided by second generation technologies: images, Internet, voice and data services. Japan was the first to launch 3G in October 2001. The UK followed in 2003. Europe and the US are following slowly. The launch of 3G has been delayed by major regulatory, technical and commercial barriers. This uncertainty about 3G occurred at a time when GSM penetration was approaching saturation in many European countries and when regulators were increasing pressure on operators to reduce excessive profits.

The licence for CDMA technology worldwide is owned by Qualcom. The company is facing an exceptional situation. Every operator in the word that uses 3G technology will have to pay licence fees to Qualcom. (As the names of the standards imply both CDMA2000 in the US and WCDMA in Europe and Asia use CDMA technology.)

The telecommunications standards we have today are a product of protracted market strife. Mobile technology has become widespread and practical only after going through a period of struggle between competing standards. The process is reminiscent of VHS vs. Betamax, and Microsoft vs. everyone else. As the wireless industry moves into 3G, it is going through the same arduous process.

The mobile telecommunications industry has also experienced hybrid standard setting. This type of standardisation emerges as private firms adopt strategies to undercut collaborative decisions taken in negotiated standardisation. They introduce new products, which initiate unprecedented developments, but also create incompatibilities, lock-in effects, and pockets of market power. Mobile Internet is a typical example, where companies, standards organisations, and governments create a hybrid standard setting environment.[7]

Standards organisations are playing an increasingly important role in the strategy for versioning standards. The GSM Association is guiding the evolution of the mobile industry through a family of wireless technology standards from today's standard through to GPRS (General Packet Radio Service), EDGE (Enhanced Data Rated of GSM Evolution) and 3GSM. Each subsequent standard offers a higher level of service. GPRS provides open Internet. EDGE facilitates faster data streaming, and 3GSM will provide video streaming.

Switching costs are minimised when standards are designed to evolve from one another. The introduction of revolutionary standards would be costly. The pay-off is superior performance against the high cost of switching standards. The example is the price paid by mobile telephone operators to switch to third generation licences. Mobile spectrum auctions earned European Governments £200 billion with Britain and Germany raising £22.5 and £60 billion respectively. The mobile operators had to bid. To renounce third generation spectrum was to sign their own death warrant. The outcome of these auctions left mobile operators no option but to increase debt to survive. The result was the depletion of cash flow, a delay in third generation launches and uncertainty in the stock markets.

8.3 Physical Platforms

Physical platforms in mobile communications are the technical networks connecting mobile phones, base stations, mobile exchanges and land line exchanges. The system extends from a national to an international level. Telecommunications platforms have had to cope with the complexity of interoperability among different systems, and to master the agility required to shift rapidly to newer standards.

Interoperability: As in the supply chain case discussed earlier, companies divided their platform structure into separate modules, each with some degree of autonomy.[8] Each module is designed with the flexibility for rapid change, such as the shift from ETACS to GSM. The complexity feature is retained because each module is interoperable with other modules to form a web-like complex system. The modules are therefore interdependent through the nodes, or joints between the modules. Interoperability between modules creates value for the user, as we observe in the ability to call overseas on a mobile telephone. Roaming of mobile telephones from country to country is another example.

Interoperability exists between platforms of different MNOs[x] in the same country, or different platforms in different countries. Physical platforms have evolved from the simple structures such as the older regional railway system, to a complex structure of interconnected sub-platforms.

For this reason, the joints between the sub-networks become the strength of the whole structure, or conversely it could be its Achilles heel. It is therefore vital to define standards for joints. The standards that govern how a system and its modules interact are called the network's architecture (Morris and Ferguson, 1993). Henderson and Clark (1990) review two kinds of dynamic processes in modular systems: modular innovation and architectural innovation.

The former type retains the architecture of the network including its joints, but modifies the modules. By preserving the basic architecture of a system, MNOs offer users enough compatibility to shift from one product generation to the next. The changes occur in the innovations and improvements of the modular components. They are fitted into the system when required, and will be removed when obsolete. The result is a hybrid dynamic of change that preserved the platform's architecture, whilst creating innovations within the module structure. A series of minor incremental modular changes can lead to an overall network platform that is radically new.

Capacity: A further aspect of network platforms concerns communication capacity and its expansion over time. Valletti and Cave (1998, p112) make some observations on how this is addressed in the UK industry: "On the one hand, there is the obvious investment decision of firms. As more cells are added, more subscribers can be supported by a network. Such a decision can be made by a firm on the ground of the optimal choice of coverage and capacity of its network. However, the choice is constrained by the regulatory requirement of 90% of the population being served by a certain date, assuming that there are no regulatory flaws. On the other hand, capacity has also increased over time, for technological reasons. Continuous improvements have allowed for a more efficient use of the existing spectrum so that more people can be handled by the same number of base stations. Finally, and equally important, the Government can decide to release significant amounts of additional radio spectrum for the mobile communications sectors".

Telecommunications networks fall under an 'integrative class' of complex networks, because of their tendency to integrate information from a large number of sources. Other networks that form part of this class are air traffic control and management systems, military command and control systems and electricity network sharing. The integrative class is characterised by: a large number of diverse information sources; the need to interoperate and integrate both equipment and information; the need to detect events in a complex network of connections; the need to operate across techno-socio barriers; and the need to operate as an open systems which includes interoperability, portability, scalability; and the need to evolve.

The interconnectivity in mobile communications hinges on two important factors: the interconnections in the networks and the sharing of call revenue. The original objective of

[x] Vodafone, Cellnet, Orange and One 2 One are Mobile Network Operators (MNOs).

operating an open platform determined the survival of all the competing mobile platforms, which could evolve from one generation of transmission standards to the next in a concerted effort. Call revenue sharing ensured that the interconnectivity was kept at a high level of reliability across all the networks, in order to preserve revenue streams.

Interconnectivity in the information economy leads to the concept of 'co-evolution'. Evolving to meet the needs of other members in the value chain, is becoming a more effective strategy than satisfying the company's own needs. Adapting to meet other companies' needs leads to more business. Riding the new wave of co-evolution, companies are avoiding costly races against each other, in favour of a strategy to joining forces to gain more customers. We are observing this effect in NEC and Siemens who have joined forces to supply the networks for Hutchison 3G, which will be a key network provider for third generation telecommunications in Europe.

Co-evolution and collaboration are even more relevant in industries where network externalities are a vital part of corporate success. The more customers join a network, such as a telecommunications service, the higher is the incentive for other customers to join. This effect is causing companies to collaborate on issues of compatibility. With 3G mobile phones on the horizon for Europe and the US, the standards war for a mobile Internet operating system has begun. Microsoft, Linux, Symbian and Openwave are in the race to establish a widely accepted standard. This is an example of old style competition, but it has caused a wave of co-evolution in another layer of competitors.

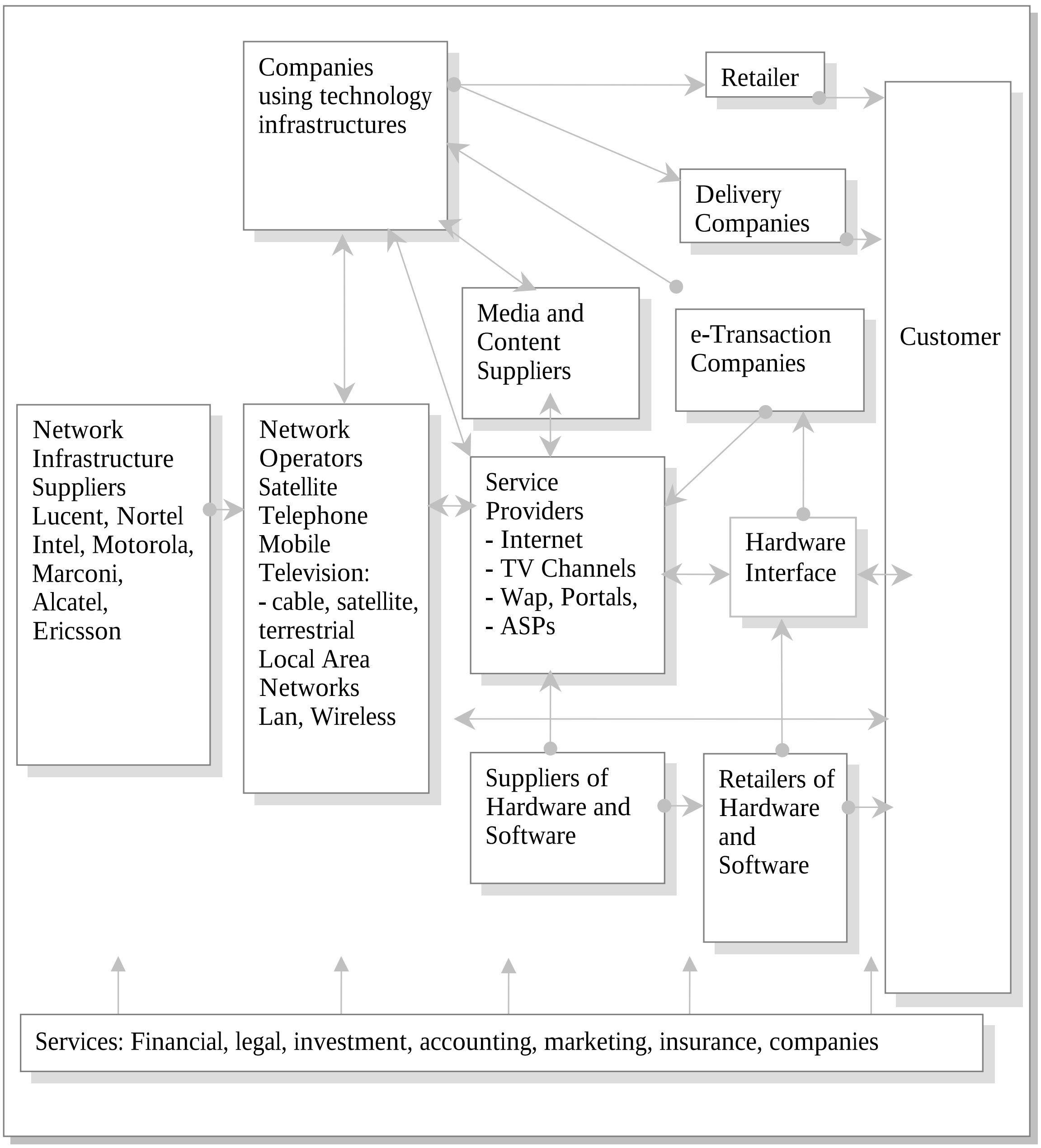
The issue of standards has motivated Nokia and Siemens, Europe's largest manufacturers of mobile phones, to collaborate. They have teamed up to accelerate the introduction of third generation mobile services. The collaboration of the companies will guarantee that Nokia and Siemens handsets can communicate with each other seamlessly. In this way the two companies, which have a combined global market share of 45%, will benefit from network externalities and the positive feedback generated from a larger compatible technology platform. Nokia and Siemens anticipate that other equipment vendors will link up with them to minimise industry fragmentation.[9]

Image phones gave the Japanese market a boost similar to when DoCoMo introduced I-Mode wireless web service. DoCoMo, which had planned to concentrate on the introduction of 3G system with video capabilities, still bolstered its line of second generation phones with a camera phone called the I-shot. DoCoMo President Keiji Tachikawa said: "we recognise there is strong demand for cellular phones with cameras, so we will increase the number of current-generation camera models." Companies saw their revenue from basic voice phone services decline, while sales of those equipped with cameras and related services were bringing in more money. The new models were reinvigorating a market that was becoming sluggish.

In Figure 12 the y-axis are normalised to reflect the penetration of the population by the UK and the Japanese mobile networks. The S shape pattern of diffusion remains largely similar. This time UK's superior population diffusion rates are seen to be much higher than Japan's, although the comparison is not entirely on the same level as larger populations would have different economic demographics.

Japan was one of the first countries in the world to introduce the 3G standard, almost two years before it appeared in Europe. DoCoMo led the world in starting 3G services in October 2001, followed by KDDI in April 2002, and J-Phone in December 2002, so all three have a 3G presence. The European market gradually saw 3G services coming online in 2003 and 2004.

Figure 9: Mobile Communication Industry in the Information Economy



8.4 Supply Chain

The mobile communications industry occupies an important position in the information economy. The structure is built on layers of communication network companies, hardware and software manufacturers, Internet service providers, e-commerce transaction companies, and media and content companies, and the myriad of service companies (Figure 9).

The network infrastructure suppliers are companies such as Alcatel, Nortel Networks, Motorola, and Ericsson that provide communications networking equipment. Intel and 3Com form a sub set of companies in this category, which supply interfacing hardware and software.

The network operators provide the basis of the exchange of information between companies and their customers. The medium they operate could be based on satellite, telephone, mobile, television or area networks. British Telecom, AT&T, Vodafone, T-Mobile offer landline and mobile telecommunications networks. The operation of these companies is interconnected with other companies. For example, Vodafone uses BT’s network. Credit card companies use Vodafone’s mobile network for offsite credit verification. Vodafone has sold fixed line telephone services from Energis and Racal Telecom networks. The interoperability of different telecom networks has become a complex business operation.

The 3G telephone, which will become the new customer interface, would dictate a change in Internet transmission management and the nature of media content, all the way down the supply chain. The supply chain in the information economy shown in Figure 3 takes the form of a web-like network where each member may have to collaborate with all the other members. Inter-collaboration is necessary partly because of software and hardware compatibility. An example of this web-like structure is the relationship between e-transaction companies, ISPs, media content providers, and the companies that own the web pages.

The nature of the supply chain of the UK mobile communications industry changed dramatically as the network operators became more powerful.

When the UK mobile licences were granted Cellnet and Vodafone were not allowed to sell direct to the customer. The regulators posed this restriction to create two tiers of firms in the industry that would balance each other’s power. The first tier was the network operators (Cellnet and Vodafone) that were to have an engineering orientation and would focus on the technical platform. The second tier of firms consisted of distributors and service providers, which would market the product to the public. In spite of the regulators intention to equalise power in the supply chain the network operators grew more and more powerful. They progressed to the top of a hierarchical distribution pyramid in just a few years, through a deliberate strategy of controlling the supply chain population. This was achieved through the three stages described below.

1. Buyouts and Mergers of Distributors and Service Providers: By reducing or freezing prices Vodafone and Cellnet eroded the margins of hardware retailers. Survival of distributors and service providers became a direct function of market share. The larger companies were able to stay in business whilst the smaller ones were forced to merge or to sell-out. In the late 1980's there were the takeovers of National Radiophone, Advanced Car Telephone, and the sale of a 40% in Air Call. Takeovers continued through the 1990's. The service provider arm of Robert Bosch, Hi-Time, MCP, and Excell were the next companies to be bought out of the supply chain, by competitors in their own tier.

2. Acquisition of Suppliers by Vodafone and Cellnet: In the mid 1990's, acquisitions changed in nature. This time the MNOs started to buy into the supplier tier, further strengthening their power in the supply chain. Vodafone bought Hawthorn Leslie and Peoples Phones. It acquired shares in Astec Communications, Martin Dawes, and Talkland. By the end of 1996, Vodafone had direct control of the 70% of the customers connected to its network. Cellnet joined the acquisitions game in the late 1990's. In 1997, it bought shares in The Link and acquired Martin Dawes, and DX Communications in 1999. It bought The Mobile Phone Store in 2000.

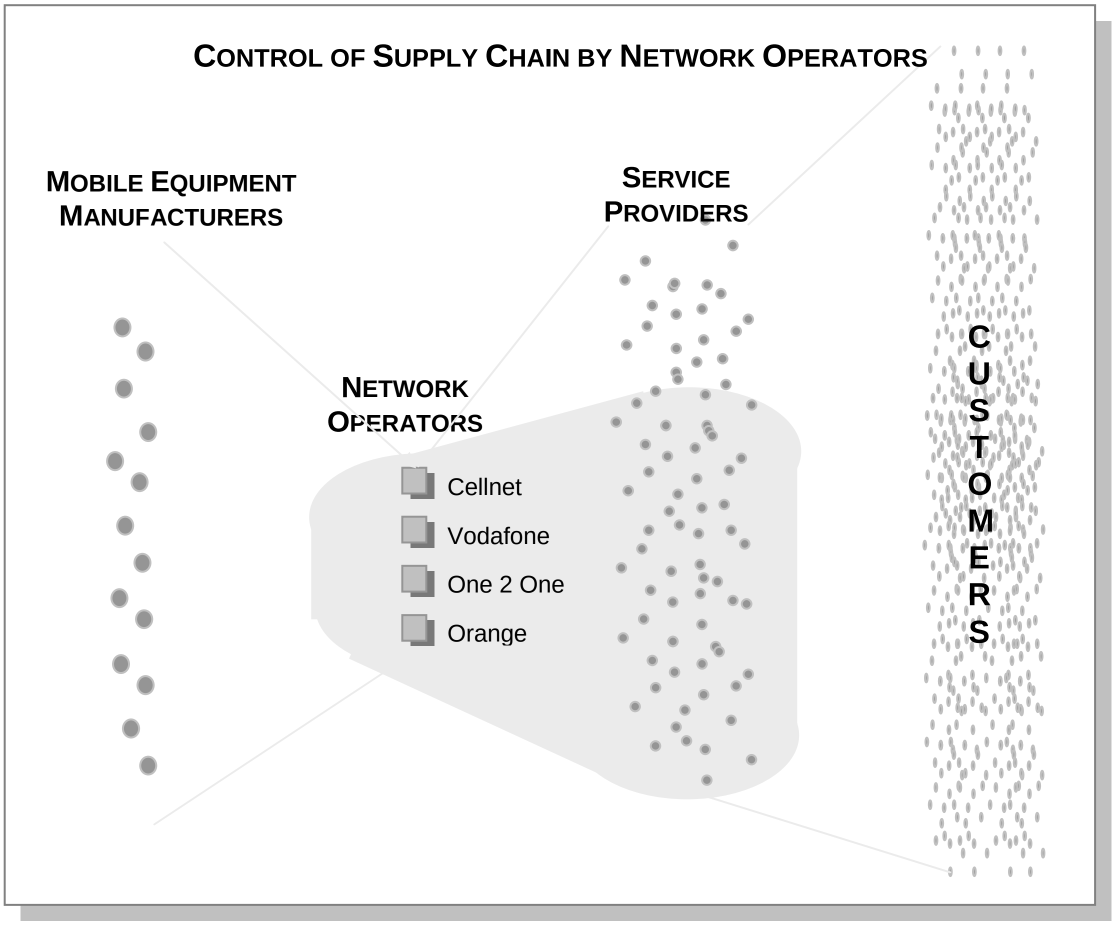
3. Supply Chain Control Strategies: In the history of mobile communications, we see repeated evidence of the mobile operators determining the prices of phones and tariffs, even though the regulator intended that service providers would have some market power.

In 1992, the Federation of Communications Services (FCS), the mobile communications industry criticised Vodafone for quoting prices in its advertising. At the time, Vodafone was not allowed to sell its service direct to the customer. Oftel issued a report on unfair practices by Vodafone and Cellnet against independent providers. The companies were cross-subsidised BT Mobile Communications, Securicor Cellular Services and Vodac, which were daughter companies. The regulator concluded that cross-subsidies were in contravention of the Cellnet and Vodafone licences.

Over the years, in spite of Oftel's efforts to moderate market power, the market share of the independent cellular service suppliers continued to diminish. By 1996, the network operators owned 10 service providers that captured 77.5% of the market.

A determining factor of the power of the network operators was that they controlled the bottleneck of the supply chain (Figure 10). The number of network operators that could enter the market was determined by government licences and limited to four firms. On the other hand, the suppliers to the left and the right of the network operators in the figure, operate in a competitive market with no controls on entry and exit.

Figure 10: Control of the Supply Chain



8.5 Consumer Networks

The consumer network is the final level of interacting dynamics in the mobile communications industry. The behaviour of consumers is affected by regulation (choice and pricing), technology standards (service offering), physical platforms (reliability) and the supply chain (retail access). Nonetheless, the consumer network exhibits strong characteristics of its own, such as network externalities.[xi] Consumers affect each other's buying behaviour in a positive feedback loop, resulting in critical mass effects and exponential growth.

Network externalities are a powerful force in the UK mobile communications industry. The correlation between number of new customers and network size was R=0.8. The coefficient of determination R2=0.65 is a rough indication that 65% of the new subscriber data is attributed to network size. The value is a relative rule of thumb measure for the strength of network externalities.

Network externalities affect the individual firms from the industry's total installed base and not the individual network platforms. This is the main difference between competing platforms that are independent (VHS and Betamax) and communications platforms that are typically interconnected (telecommunications). This effect shows us how and why market share converge in the presence of strong network externalities and how market shares become similar for the four companies over the long run.

The increase in subscribers is interdependent with the utility of the whole network as well as with the utility of competing networks. The utility of other networks has a similar stronger effect on new subscribers to a company's own utility. Thus we can start to understand why market shares converge even in the presence of strong network externalities.

9. Comparison of UK and Japanese Market Development

The model of market development for the UK mobile market is replicable in other environments. The UK's demand curve exhibits the characteristics of an S curve with a mixed influence model of diffusion. The diffusion of the product is determined by external and internal influences. The external influences are derived from the demand side characterised by network externalities and critical mass. Internal influences in the UK market are marketing effects determined by product, price, distribution and promotion policies.

The internal and external influences are present in mobile industries around the world. Network interconnectivity, technology and regulation are experienced to varying degrees in all countries. As a consequence marketing strategies are similar to the UK scenario, and internal influences on consumer demand are also similar. External influences, largely driven by network externalities, are a mathematical function of network adoption and operate irrespective of geographical location.

[xi] Network externalities are observed in products where the possession of a product by one consumer, affects the value of product for some other consumer. Telecommunications is a classic example where the value of the telephone for any individual depends on the number of colleagues, friends, and relatives in possession of a telephone.

Japan's population is 122 million, just over double that of the UK. The market for mobile phones in its current state is nearly saturated as in the UK industry. There are still possibilities for growth in automated mobile commerce, and in the new 3G technology that will allow video transmission. With 60% of the Japanese population (around 73 million subscribers) using mobile phones by 2003, companies can no longer expect rapid growth of the overall market. Towards the end of our data collection period competition had started to show signs of recovery with the introduction of 3G.

The main difference between the UK and the Japanese diffusion processes is that Japan's industry started in 1980, five years earlier, and that 3G was introduced in 2001 two years earlier than the UK. We shall discuss the implications of these differences and whether they affect the similarity in the diffusion processes of the two countries. Figure 11 illustrates the UK and Japan adoption curves, normalised by the number of years of operation of the industry.

In the Figure 12we see the UK and Japanese diffusion functions following an S curve shape, typically of mixed influence models of diffusion. Interestingly critical mass is reached at the same period within thirteen years from the date of introduction of the mobile industry. Although this means that Japan approached critical mass in 1993, five years before the UK, it is striking that the market dynamics retained the same time frame to move into exponential growth.

Whilst the two countries' diffusion models are similar in their general trend and nature, earlier technological adoption on the part of the Japanese introduces interesting differences. Whilst Europe and the US were experiencing a downturn in sales in 2000, Japan's market was undergoing an upturn. The growth in e-mail photo services started with J-Phone's launch in November 2000 of its Sha-mail model. KDDI followed in April 2001, followed by NTT DoCoMo in June 2001. Image telephones were so fashionable during the year that demand exceeded supply. The demand for the phones even outstripped the production of digital cameras. The industry sold 15 million camera phones by the end of 2002.

Figure 11: UK and Japan Adoption Curves – Normalised by Years in Operation

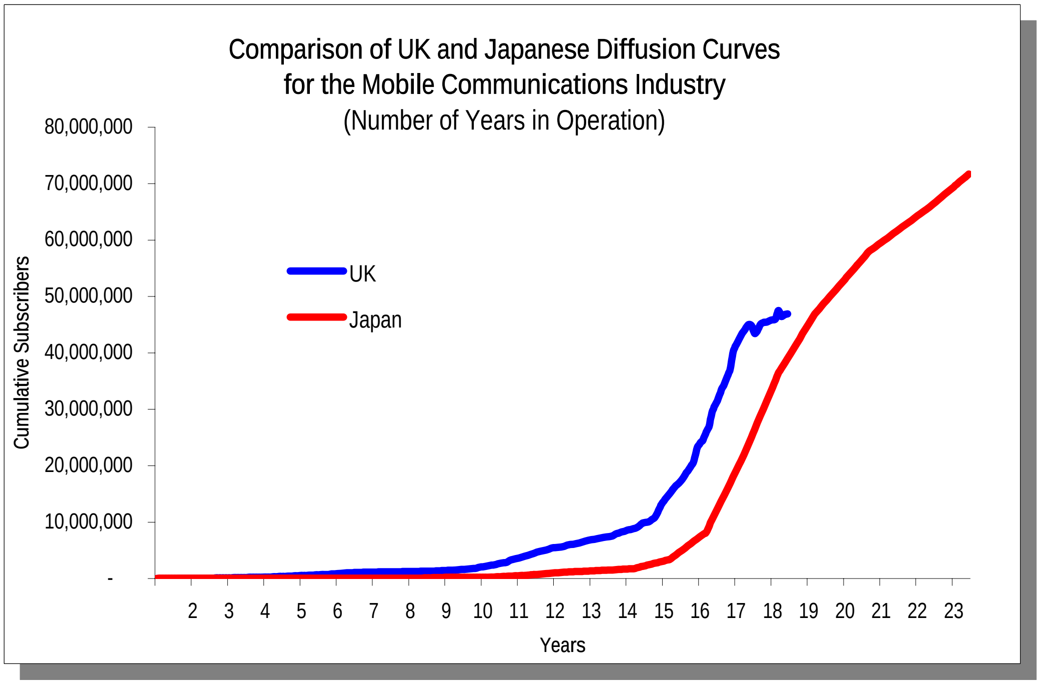
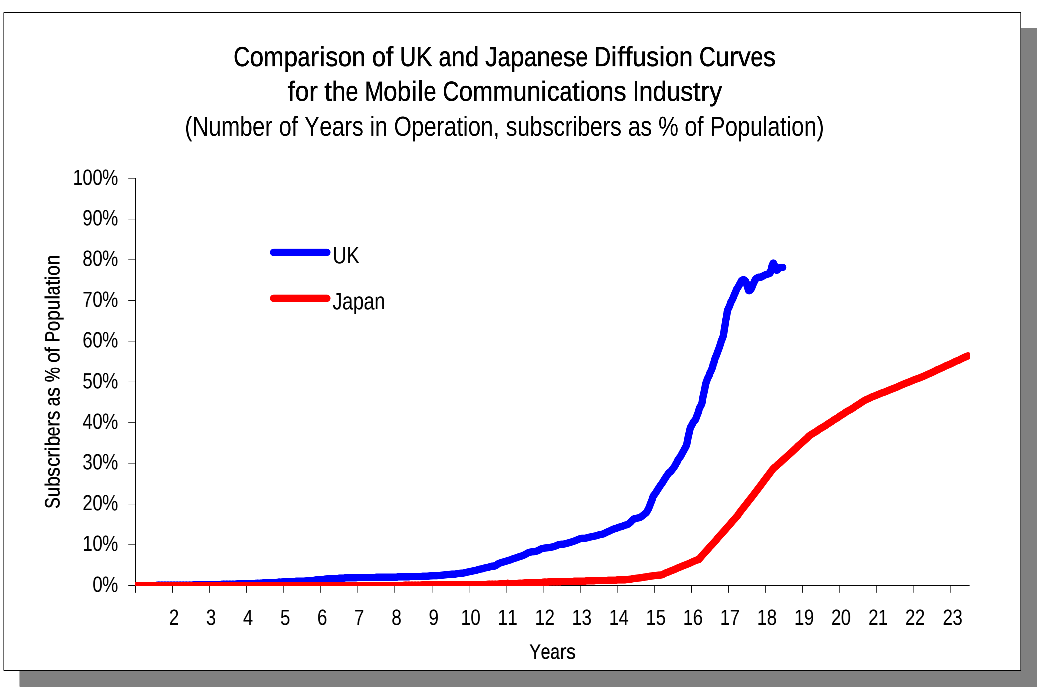


Figure 12: UK and Japan Adoption Curves – Normalised by Years in Operation and Penetration



10. THE FUTURE OF THE MOBILE COMMUNICATIONS INDUSTRY

The future of mobile telephony lies beyond picture and video transmission promised by third generation technology. It will depend on the development of technical capability that generates a personal transaction environment that supports identity and payment.

Digital money transacted through electronic cash payments and billing will have a revolutionary impact on the industry. The industry is moving towards multi-application SIM cards integrated with network services. The technology opens up opportunities for non-telecom applications whereby a mobile phone would act as a bank payment card. New technologies will sustain electronic identity through public key infrastructure (PKI) and biometrics. Identification of users will be integral to ordering, and paying through a mobile phone. Data transmission of wireless will increase dramatically and information exchange protocols such as XML are expected to evolve accordingly.

Voice recognition and synthesis technologies are expected to create the next wave of usage in mobile communications. The lack of space for a keyboard on a mobile handset has limited its range of use. Voice recognition would open up new possibilities for the mobile industry as the capability of a mobile phone moves closer to that of a personal computer. The impact of voice technologies is expected to increase mobile usage dramatically, as it opens the channels for people to speak directly to machines, without a keyboard interface.

Mobile network operators, such as Vodafone, T-Mobile, O2 and Orange will need to adapt their business models as they progressively move from a model that is based on the economics of utilities to a business model that is rooted in the wireless economy.

11. STRATEGIC CHALLENGES

The challenge for future mobile phone products and services lies in the significance of interdependence between consumers and networks. Network externalities need to be addressed directly rather than tacitly as the evolution from one technological generation to another will follow in rapid success. New products face the challenge of having to replace older platforms. Each new product faces the gradual climb towards critical mass, a period of exponential growth and the limitation of market size. The strategies to be adopted are wide and varied. Should the strategy of open platforms be retained? When is the best time for a network operator to introduce a new service? What is the role of innovation and process efficiency in the quest for new subscribers? Would the current copy-cat strategies lead to a reduction in innovation, or would the equipment providers balance out this factor?

REFERENCES

[1] Valente, T. (1995). Network Models of the Diffusion of Innovations. Hampton, VA: Hampton Press Communication Series.

[2] Valente, ibid p. 9.

[3] Mobile Communications Nov 11, 1999.

[4] Mobile Communications, 261/3.

[5] Financial Times, May 4, 2002

[6] Nattermann, P.M. (2000). 'The German Cellular Market: A Case of Involuntary Competition?' McKinsey Quarterly, 2, pp. 22-31.

[7] Vercoulen, F., Wegberg, M. (1998) Standard Selection Modes in Dynamic, Complex Industries: Creating Hybrids Between Market Selection and Negotiated Selection of Standards. Maastricht: Nibor Working Paper, Nib98006.

[8] Langlois, R.N., Robertson, P.L. (1992) Networks and Innovation in A Modular System: Lessons from the Microcomputer and Stereo Component Industries. Research Policy 21(4) 297–313.

[9] Sammut-Bonnici, T., Wensley, R. (2002). Darwinism, Probability and Complexity - Transformation and Change Explained through the Theories of Evolution, International Journal of Management Reviews, 4, pp. 291-315.