

Network strategies for the new economy

In this paper we argue that the pace and scale of development in the information and communication technology industries (ICT) has had and continues to have major effects on the industry economics and competitive dynamics generally. We maintain that the size of changes in demand and supply conditions is forcing companies to make significant changes in the way they conceive and implement their strategies. We decompose the ICT industries into four levels, technology standards, supply chains, physical platforms, and consumer networks. The nature of these technologies and their cost characteristics coupled with higher degrees of knowledge specialisation is impelling companies to radical revisions of their attitudes towards cooperation and co-evolution with suppliers and customers. Where interdependencies between customers are particularly strong, we anticipate the possibility of winner-takes-all strategies. In these circumstances industry risks become very high and there will be significant consequences for competitive markets.



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The need for new strategic perspectives

The new information and communication technologies of the last decade are fundamentally transforming the operating methods of most manufacturing and service companies and are provoking wholesale reappraisal of the nature of support functions. These technologies have become institutionalised in the new ICT (information and communications technology) industry across the world and are now having an equally revolutionary effect on corporate strategy. Executives are rethinking the strategic fundamentals of business practices not just in technology and communications industries but also across the entire spectrum of industries.

Many of the component parts of this new ICT industry, such as telecommunications, the Internet, computing and software, are shaping significant parts of the corporate environment into a new 'network economy'. The essence of networks is the existence of multiple nodes, the interconnectivity between them, and the cooperative (as opposed to competitive) behaviour of the nodes. Thus, networks have increasing returns to scale characteristics. The dynamics of corporations and the new information economy will increasingly reflect these increasing returns to scale, and therefore understanding how such networks work is the key to developing a new set of strategies in this new information-based corporate landscape (Kelly, 1998).

The 'old world' was driven by economies of scale and scope where the benefits of size are moderated by eventual diminishing returns. The 'new world', spawned by information and communications technology, is not moderated by the normally powerful moderating influence of diminishing returns. Network effects, also known as network externalities, can result in 'winner-takes-all' phenomena (for example, the Wintel standard for PCs) and therefore result in new industry dynamics and new sets of corporate responses. (For a discussion of network effects see McGee and Sammut-Bonnici, 2002.)

The burgeoning growth and influence of the new ICT industry is making it possible for more individuals, corporations and companies to reap the benefits of the information economy. The Internet has provided a free infrastructure for this rapid exchange of information and is creating new distribution oppor-

tunities in regional and global economies. The development of the 'self-organising' web of new economy industries is affecting all elements of trade and brings commercial gains to regional and global economies. The Digital Planet 2002 report indicates the scale of this effect. At the regional level, Eastern Europe's spending grew faster in 2001 than the North America, Latin America, Middle East and Africa regions combined. Mature economies such as the US will become less dominant, as China, Poland and a host of other developing countries play an increasing role. At a more micro level, information industries are giving rise to geographic hot-spots of commercial activity, created from economic webs, corporate clusters, and commercial ecosystems. California's Silicon Valley, Taiwan and Tokyo are such examples. Local concentration of ICT activity may develop spontaneously or can be created by governments and regional planners. Malaysia is developing two of the world's first 'smart cities': Putrajaya, the new seat of government providing e-government facilities, and Cyberjaya, a city for multimedia industries, R&D centres, a multimedia university and operational headquarters of multinationals wishing to direct their trading activities using information technology. The underlying feature of smart cities is the high level of ICT infrastructure, on which the whole city is developed. Another example of regional growth due to the information economy is northern Virginia, USA. Its economy has boomed with the explosion of Internet and telecommunication companies. America Online, which set up in northern Virginia in 1985, employs over 13 000 people, and generates over \$1.5 billion in online revenues. The presence of a number of multinational companies such as AOL, UUNet and Worldcom MCI in the area attracts competitors as well as vendors through the normal multiplier effects. ICT industries have well-documented, substantial effects on the local, regional and global economies through the multiplier effect.

The extent to which the ICT industry and associated network industries have proliferated in the economy is a recent phenomenon. However, network effects have been recognised for some time since the onset of industrialisation but particularly with the advent of the first infrastructure industries (especially railroads) in Victorian times. Literature on network externalities dates back almost a century to the works of Young (1913), Knight (1924), and Ellis and Fellner (1943). Contemporary research on networks tends to be

econometric in nature (Shy, 2000) and charts industry evolution over time in a series of snapshots. We adopt Shapiro and Varian's (1999) strategic perspective on network industries and develop a strategic framework that transcends ICT and non-ICT companies. We start this journey by analysing the structure of network industries and looking at the dynamics endemic in each level within that structure.

Technology and network industry structure

Much of the popular discussion of technology and its effects makes powerful but general claims for the effect of technology but is less than clear about the underlying mechanisms. We observe four nested levels of infrastructure within network industries. Each of these levels has its own economic dynamics and each makes a contribution to the overall network (increasing returns characteristic). These levels are (i) technology standards, (ii) the supply chain driven by such standards, (iii) the physical platforms that are the output of the supply chains and are the basis from which the company delivers its product (e.g. the digital TV, the decoder, the satellite system, and the telephone lines that are the platform from which Sky TV delivers its programmes), and (iv) the consumer network (Figure 1). The economic characteristics of the first three levels are the prevalence of fixed costs and joint products coupled within economies of scale. Networks of interacting and interdependent customers provide the increasing returns characteristic

FIGURE 1: Strategic levels of network industries.



of networks. Then the whole can have such powerful positive feedback characteristics that the winner might be able to take all.

Each level displays distinctive economic characteristics of significance. Technology standards can be achieved either by rule or by emergence and in the latter case early mover advantages are important. The economics of modularity and the specialisation of knowledge shape the structure of supply chains. Physical platforms are a combination of standards and components in which modularity and the economics of substitution also play a significant role. Consumer networks, of course, require positive feedback effects for their full power to be gained. We use the mobile telecommunications business as a running example to show how these technological dimensions and strategy interact.

Technology and standards

The significance of the economics of information is attributed to two key factors: the continuing reduction in cost of information technology hardware products and the scale impact of global standards. Gordon Moore, founder of Intel Corporation, created a corporate empire on his eponymous Moore's law, which states that every year and a half processing power doubles while costs hold constant. Moore's foresight proved prophetic. He has been proved right and it appears that his law will hold for the foreseeable future. Computer memory, storage capacity and telecommunications bandwidth are all going through a similar pattern of cost reduction. This makes it very affordable for individuals and small businesses to be equipped with the electronic means to conduct commerce and transfer information as fast and freely as large corporations can. Hence, the demand for the products of the ICT industries continues to grow (in spite of the feast and famine evident in the telecommunications industry reminiscent of the fragility of corporate structures during the railway boom of the 1840s).

Network products rely on production technology as well as the prevailing operating technology standards for their respective industries. For example, automated teller machines across the world must work on an agreed standard to ensure customers can use one card in different countries. A technology standard becomes an important enabler to create wide reach and to capture a wide network of subscribers. With the globalisation of commerce, national and regional boundaries blur and the need for international standards becomes more prominent.

A new standard can be registered with organisations such as the British Standards Institute, the American National Standards Institute or the International Standards Organisation. But the process to determine the prevailing standard does not stop there. The path to achieving a *de facto* standard depends on three modes of selection strategies: market-based selection, negotiated selection and a hybrid selection process where both market competition and negotiation play a significant role.

Market-based standard selection is reminiscent of standards wars such as that between VHS and Betamax. In this case consumers decided on the dominance of the VHS standard. The marketing strategies of firms are key to which firm and standard is most likely to win. It is argued that VHS gained a decisive advantage from a strategy of wider distribution channels and a range of complementary products (Hollywood films in tape) as well as longer recording time than Betamax, in spite of other more advanced features available only on Betamax.

Negotiated standardisation is becoming more widespread. Organisations that determine prevailing standards are emerging to reduce the cost and the uncertainty associated with adopting new standards. Negotiated standard setting guarantees the smooth interchange of information, technical components and services along different networks. The telecommunications industry was able to keep up with the speed of technological development by opening up the negotiation process to market players (David and Steinmueller, 1994; David and Shurmer, 1996). Groupe Speciale Mobile (GSM), the current mobile technology in Europe, is an association of 600 network operators and suppliers of the mobile phone industry. The Universal Mobile Telecommunication System (UMTS) Forum is a similar association, developed to speed convergence between telecommunications, IT, media and content suppliers for the 3G industry. As with GSM, the name of the UMTS association is synonymous with the name for the industry technology standard.

The Internet has a different history of standardisation to telecommunications. Standards were completely open and established within the research communities of universities. As the Internet has become a commodity for the domestic and the commercial communities, other players are increasingly influencing its evolution.

Hybrid standard setting 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. Internet telephony is a typical example, where companies, standards organisations, and governments create a hybrid standard setting environment (Vercoulen and van Wegberg, 1998).

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 Rates for 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. The network of companies supporting the technologies will go through grades of service levels, in order to phase out older standards and introduce new ones (Figure 2). At the end of the life span of a standard the technology platform is decommissioned, with the exception of equipment and software that is forward compatible with the next generation of standards.

Software standards follow a similar versioning strategy. Microsoft publishes the 'Windows Desktop Product Lifecycle Guidelines' to provide advanced notice of changes in product availability and support. Microsoft makes Windows licences available for purchase for a minimum of five years and provides assisted support for a further four years. The

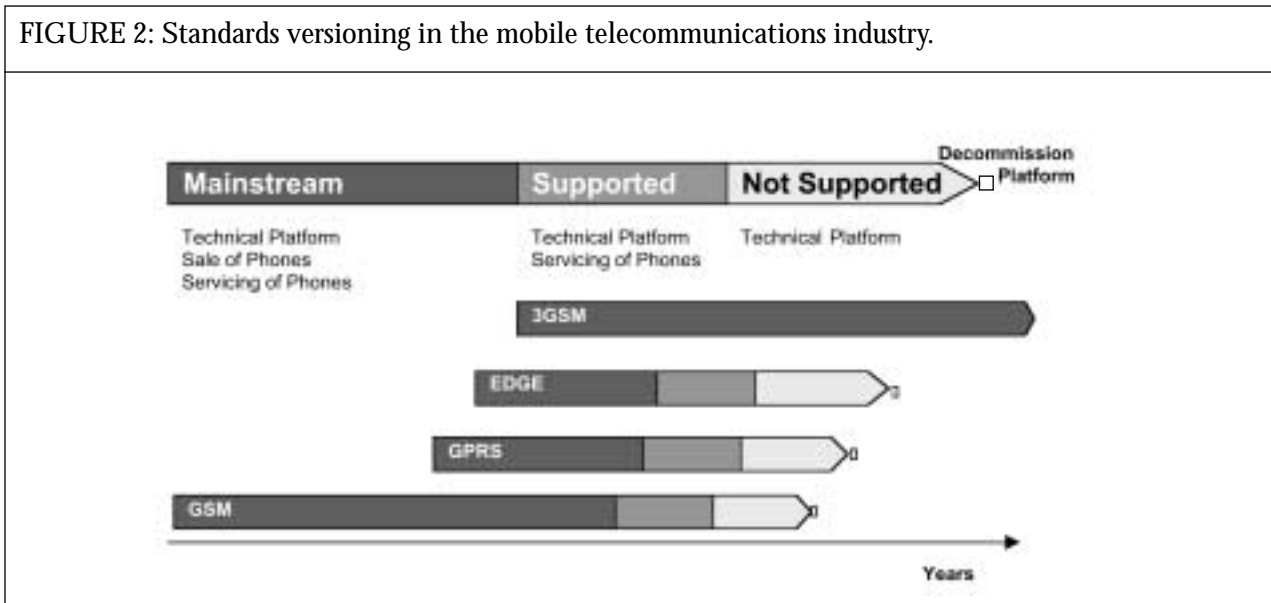
guidelines are important so that companies can plan their investment through software upgrades of Windows 98, NT, 2000, ME, and the latest version of Windows XP.

Switching costs are minimised when standards are designed to evolve from one another. The introduction of revolutionary standards, however, is costly. The pay-off is superior performance against the high cost of switching standards. The telling example is the price paid by mobile telephone operators to switch to third generation technology. 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 (but did they have to pay so much?). 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, all of which became the more significant as the market faltered and then stopped dead.

Supply chain

In the last twenty years, the structure of the information economy has evolved through the interaction of three factors: the increase in computational capacity for data mining; the growth of telecommunication networks both fixed and mobile; and the explosion of information sharing via the Internet.

FIGURE 2: Standards versioning in the mobile telecommunications industry.



These new information technologies created opportunities for all industries, including network industries, to take advantage of new ways of managing supply chains. How to integrate company functions became the key concern and Enterprise Resource Planning (ERP) systems provided the solution. Integration of the elements of the supply chain was seen as a move to dilute the boundaries of the rigid corporate departmental structures that were restricting business growth. The ERP era was the first wave of change in supply chain management. Deconstruction policies soon followed. Based on the example set by the automotive industry, many companies split their business processes and pushed some of them out to suppliers. Companies would retain the processes central to their strategic priorities and outsource the remainder. The elements of the supply chain would then be controlled through proprietary resources, which are difficult to replicate, such as a strong brand identity. MMO2, the UK mobile network provider that has faced upheaval in the past year, is deconstructing its value chain as a means of strengthening its position (Pesola, 2002). The company will move all its IT systems, including such functions as customer care, e-payments and billing, to IBM. The outsourcing agreement covers ten years and is worth £50 million in its first year. MMO2's tactics are an interesting pointer to how the European mobile industry is changing its operating model and emulating the US model.

With the outsourcing of functions and the need for specialist knowledge in handling electronic transactions, the number of organisations involved in the supply chain is increasing. As a result of integration and deconstruction, suppliers are developing modular structures with Lego-like snap-together interconnectivity. The complexity of the new supply chain structure is becoming akin to a business ecosystem of networked cooperation, rather than the traditional chain of competing suppliers, manufacturers and distributors.

Figure 3 depicts the modular structure of the ICT industries, which constitute the new 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.

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.

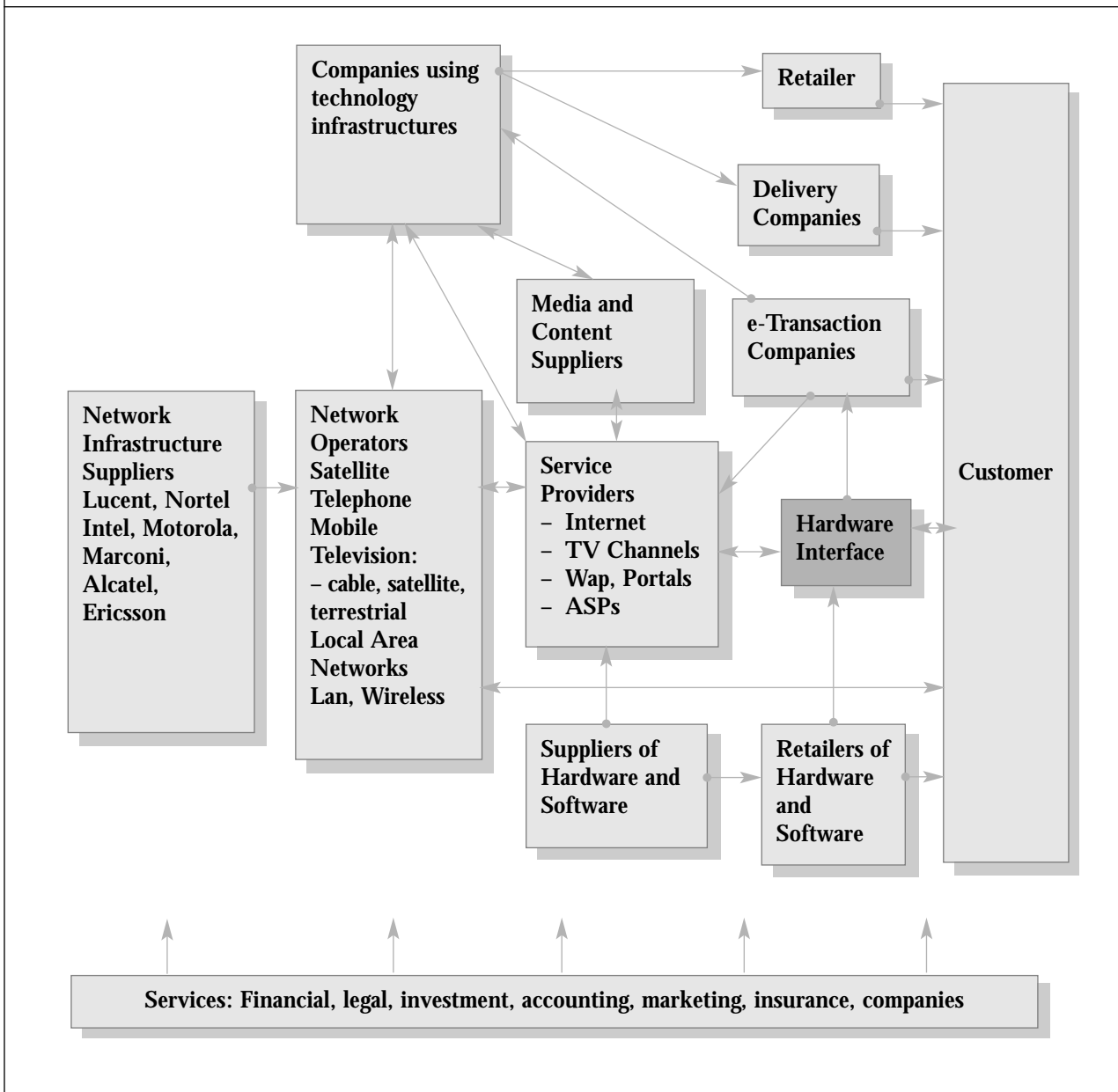
The network operators provide the basis of the exchange of information between companies and their customers. The medium they operate could be based on satellite, telephone, mobile, television or area networks. British Telecom, AT&T, Vodafone, T-Mobile offer landline and mobile telecommunications networks. 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 off-site 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. British Telecom set up BT to develop and manage such relationships. BT Wholesale sells its fixed network product to independent service providers: businesses who wish to provide telecom services to end consumers without owning their own networks. The independent service provider purchases the network facility from BT and other network operators, adding their own value and service brand.

Satellite networks provide the infrastructure for long distance television, telephony and data interchange transmission. SES GLOBAL, Gilat Satellite Networks and Alcatel Space/SkyBridge have formed a €200 million joint venture to provide two-way satellite broadband services in corporate and home office markets across Europe. The new company plans to cater for the growing demand for broadband communications services in Europe via advanced VSAT satellite technology.

Digital television networks operate on a host of platforms such as satellite, copper or optic fibre cable. Interactive television has opened a host of business opportunities for retailing. The use of two-way cable networks, or a return medium via a normal telephone line, is changing the way consumers use and respond to television content. The business model for this service implies a new form of supply chain, for a new form of retailing.

Internet service providers (ISPs) are part of a complex web that provides the supply chain of information to the Internet user. ISPs such as AOL and Fastnet convey Internet content over the infrastructure of the telecommunication companies. At the back-end of the supply web, ISPs receive web pages from various organisations. The owners of the web pages would be the media and content suppliers, or in many cases, they may have purchased the services of the media and content suppliers to create

FIGURE 3: The modular infrastructure of the ICT economy.



their web presence. At the front-end where the supply web touches the customer, ISPs have to collaborate or to conform to consumer interface manufacturers, which in the Internet scenario would be computer suppliers. The supply web for Internet is due for another major revolution with third generation (3G) mobile communication, which carries high speed Internet and video streaming. 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 and media content providers and the companies that own the web pages. The four

types of organisation have to ensure the compatibility of their services across the supply network.

The infrastructure of the information economy does not look like a normal, traditional and competitive supply chain in the 'old' industrial economy. Telephony and the Internet have made it possible for corporations to have commercial partnerships with many more companies. The notion of 'information is power' is turned on its head. As more companies have access to more information through communication, power is dissipated to more members in the supply chain. The increase in information exchange has become the overriding equaliser of power throughout the supply networks.

The basis of the new economy is the increase in connectivity among the various players in the chain. The connectivity level itself is rapidly evolving as communication and computational technologies become faster. The whole supply network is in a state of flux. Flexibility and adaptability have become essential strategic stances. Faster connectivity within the supply chain not only implies more interconnections between companies. It creates more volatile and replaceable interrelationships.

The concept of replaceable interrelationships has come about because companies are becoming 'isomorphic' or similar in nature. DiMaggio and Powell (1983, p. 149), drawing from Hawley (1968), define isomorphism as 'a constraining process that forces one unit in a population to resemble other units that face the same set of environmental conditions'. With the standardisation of technology, products are becoming more similar in design and quality. With the standardisation of internal operations, through materials resource planning (MRP), enterprise resource planning (ERP) and electronic customer relationship management (eCRM), the service levels of competing companies are becoming similar in content and in construction. The implication is that suppliers are easily replaced with similar companies that have similar products and similar delivery attributes.

The information economy is creating a web of companies that have lower barriers of entry, but fewer safety nets for retaining business. The older, hierarchical value chains of the industrial economy reinforced exclusivity whilst the information economy is more inclusive.

The rise of co-evolution and cooperation

The new web-like value chain gives rise to a 'self-organising' system. In nature flocking is a form of self-organisation. The formation of flocking birds is

a self-organising form of collaboration with simple goals of direction and velocity. Kevin Kelly (1998) gives a general overview of the future implications of adaptation. Companies organise and adapt their relationships with vendors and distributors. They select and substitute their partners in the value chain according to changes in the consumer market. Vendors and distributors in turn adapt to new market scenarios. For example, a wave of collaborative buying (when competitors join forces for purchasing) is counteracted by a wave of collaborative vending from vendors. The system eventually normalises the balance of power.

The 'self-organising' aspect 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' need leads to more business. Riding the new wave of co-evolution, companies are avoiding costly races against each other, in favour of a strategy of 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 two 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 providing a larger compatible technology network. Nokia and Siemens anticipate that other equipment vendors

will link up with them to minimise industry fragmentation.

Physical platforms

Physical platforms are the technical networks supporting telephones, satellites, digital TV and local area networks. Globalstar is an example of a physical platform. Globalstar provides mobile telecommunications using low earth orbiting (LEO) satellites. Its telephones look like mobile or fixed phones with the difference that they can operate in areas outside normal reach. The satellite platform picks up signals from the Earth's surface, and relays to the terrestrial gateway. Gateways distribute the calls to existing fixed and mobile networks. Terrestrial gateways are vital to integrate the company's services with existing local telephony networks. The size of a physical network does not guarantee success. Iridium had a larger physical platform of satellites than Globalstar, but faced marketing related difficulties at start-up. When it launched in 1998 it targeted the consumer users, who rejected the service because of its cost and bulky first generation phones. Iridium filed for bankruptcy in 2001 and planned to decommission its satellite platform. It was purchased by a consortium, which paid \$25 million for the inactive satellite system, which cost \$5 billion when it was built in 1998. Iridium has recuperated most of its losses by changing its marketing segmentation strategy. Its current major user is the US Department of Defense in line with its sales strategy to service large industrial users in remote locations (Weiss, 2001).

Managing interoperability

Physical platforms in the telecommunications industry are typically open platforms (like Wintel is for PCs). It is the interconnectivity with other telecom networks that adds value and creates network externalities. Open platforms have stipulated protocols, which are implemented by a large user base as in the case of IBM clones. Closed platforms or proprietary platforms make it difficult for others to interact properly with those systems. Microsoft software and Apple computers are examples of closed platforms.

Open networks require interconnections and compatibility with surrounding networks. Telecommunications platforms have had to cope with the complexity of interoperability among different systems, as well as the agility required to shift rapidly to newer standards. The dynamics of com-

plexity and agility used to be opposing forces (Vercoulen and Wegberg, 1998). A complex interconnected physical platform tends to develop slowly. Railway systems and the telecom networks in many countries show this inertia. Communications and technology firms progressively created a solution to these opposing dynamics of development. As in the supply chain case discussed earlier, companies divided their platform structure into separate modules, each with some degree of autonomy (Langlois and Robertson, 1992; Garud et al., 1995). Each module is designed with the flexibility for rapid change, such as the shift from ETACS (Extended Total Access Communication System) 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 network providers 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, network providers 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 (Vercoulen and Wegberg, 1998).

In architectural innovation, the modules are largely unchanged, but the architecture that connects them (the jointing system) is changed (Henderson and Clark, 1990). The speed of innovation can be fast, since a key part of the system, the modular structure, is retained. New joints between these modules are installed. In some cases, adopting new standards and installing some new modules that embody these standards creates an architectural innovation. The development of the Internet in the late 1990s is an example of an architectural innovation in a network platform. The main proponents of the Internet evolution are standard setting bodies such as the World Wide Web consortium and the Internet Engineering Task Force (Vercoulen and Wegberg, 1998).

Building alliances

The reach of a technical platform determines the size of the consumer base. For this reason, companies are building alliances to gain the rewards of positive feedback. Apple and Microsoft have collaborated to create a version of Office that operates on an Apple computer. The effect is to allow the Apple computer platform to overlap with the Microsoft Office platform. In the mobile industry, competing telephone manufacturers are clamouring to create a communications platform with a common operating system. Ericsson and Nokia use the Symbian operating system on their third generation mobile phones. Panasonic and Motorola are planning to introduce telephones with a joint software platform. Symbian will receive a total of \$17.95 million in funding from Nokia Corp., Motorola Inc., Panasonic, Sony Ericsson and Psion, to support its development (Evers, 2002).

The Ethernet is an earlier example of alliance formation intended to increase the size of a physical platform. In 1973 Metcalfe and Boggs invented Ethernet, the local area networking (LAN) technology that acts as a means to send vast amounts of data at high speed to the laser printers that Xerox was designing. Interestingly, the Ethernet came before the PC, yet it was to create a breakthrough in computer networking that would eventually tie together over fifty million PCs worldwide. The Ethernet quickly attracted Digital and Intel's interest to adopt the communication platform. Metcalfe had moved on to form 3Com but remained the key player in the discussions between Xerox, Digital and Intel. The DI3X group was formed named after the first letter of the company names. The alliance

lobbied for Ethernet to become a standard approved by the Institute of Electrical and Electronics Engineers (IEEE). Xerox agreed to license Ethernet to all users at a nominal fee of one thousand dollars. It realised that it would have to provide an open standard to get computer manufacturers to take on Ethernet as an interface to their printers. The strength of Ethernet was that it allowed PCs and workstations from different manufacturers to communicate by using an agreed standard, hence increasing the size of its physical platform and therefore its reach.

Consumer networks

The consumer network refers to interdependencies between consumers. In a consumer market there are two levels of value attached to a product. 'Autarky' value (Liebowitz and Margolis, 1990) refers to the value associated with a product irrespective of the number of other users. In marketing terms, this would be the 'core' value of a product. In economics this is the normal assumption and the theory of the firm is based on assumptions about the independence of individual consumer preferences. 'Synchronisation' value is the augmented value derived from being able to interact with other consumers. The latter fuels the dynamics of network effect discussed in McGee and Sammut-Bonnici (2002). The relative abilities of Microsoft, Symbian or other companies to capture synchronisation value will determine who will win the race to establish the new operating system for third generation mobile telephones. Customers will buy the 3G phones with the operating system they expect to be the most popular in the future. In this way they will be able to communicate and exchange video clips and photos with the widest possible set of users. The success of the winning operating system will depend on consumer choice, or it could depend on supply chain strategies. For example, Microsoft and Intel had cooperated to make Windows 95 exclusively compatible with Intel x86 microprocessor architectures and vice versa. The media coined the effect the 'Wintel advantage'. In the case of mobile operating systems, Symbian and Microsoft are rallying their respective sets of supporters to establish separate supply networks.

Lock-in and switching costs

The Wintel case led to a situation of lock-in for Windows users. The Wintel operating system

quickly gained critical mass through rapid adoption and it became the most popular system throughout the world. Lock-in arises whenever users invest in multiple complementary and durable assets specific to a particular information technology system and then find the costs of switching to alternatives to be prohibitive. Thus Windows users invested in complementary software such as the Microsoft Office suite. Lock-in then occurred on an individual level, company level and even a societal level. Thus individuals may face switching costs in adopting a rival to Microsoft software, but so also do companies in having to provide systematic retraining costs, and so might whole communities in having to move from one software product to another. The key is that it would be necessary to switch from one dominant product to another because of the interdependencies and complementarities between consumers. Private users were locked into the long-playing record technology because records could not be used on CD players (but were persuaded to switch when the benefits of the new products became sufficiently large). Note that the benefits of tape recording were never large enough to persuade customers to make a wholesale switch but the extra benefits of tapes (ability to record) were sufficient to persuade customers to invest in parallel systems. Companies became locked into Lotus 1-2-3 spreadsheets because their employees were trained in using the program command structure. On a societal level, millions of users throughout the world are locked into using Microsoft's Windows desktop operating environment, as it has become the standard software in offices around the world.

However, telecommunication systems providers have had to switch to new, superior technologies despite high switching costs. The industry has undergone three generations of technologies, TACS, ETACS and GSM, and is now in the early days of introduction of 3G, incurring significant investment costs. Switching becomes an exercise in investing in strategic advantage based on expectations about the value of future benefits.

Switching costs and lock-in at the consumer level are used as strategic tools to inhibit or, preferably, prevent consumers from adopting newer technologies or moving to alternative networks. Lock-in and switching costs in mobile communications are seen at the levels of service and technology. Users may switch to another service by going to a network provider with the same technology, but with a different price structure. They may

choose to switch to another technology when they replace their handsets with higher-level models. The strategies of the mobile telecommunication industry have focused on tangible and intangible consumer costs when switching networks. In the introductory phase customers were contractually bound to a network for a year. They had to pay a release fee to end the contract and a connection charge to go to the next network. In the later 1990s switching networks became easier with the introduction of pay-as-you-go cards. The intangible cost of switching remains irrespective of payment structures and Oftel's recent pressure to minimise switching cost in the industry. Customers resist the investment in the time required to get used to a new product and are further inhibited by the uncertainty about the quality of untested product. The influence of (psychological) brand loyalty remains significant. To the consumer, a very relevant switching cost is the loss of the mobile number when moving to another network (this was also a very big issue in the development of the telephone system in the US over a century ago). The subscriber's reluctance to give up a number urged the introduction of subsidised phones to attract a new user, and more competitive tariffs. The power of switching costs can be observed in the entry strategies against powerful incumbents. Vodafone and Cellnet, which started to operate in 1984, had a captive customer base by the time Orange and One2One entered the market in 1993 and 1994, respectively. The new entrants had to generate new customer-winning strategies with stronger branding and lower costs.

On a societal level economists observe that the practice of using lock-in strategies can have negative welfare effects as new superior technologies are suppressed. Liebowitz and Margolis (1990) discuss the fascinating example of typewriter keyboard layouts. In the 1870s the QWERTY configuration was selected by the creators of the TypeWriter brand in order to slow down typists to reduce jamming of the keys. The Dvorak layout patented in 1932 is a more efficient layout and allows faster typing. This would suggest that QWERTY should then give way to the more efficient keyboard layout. The phenomenon of sticking to the slower QWERTY system is explained in terms of switching costs. The collective switching costs are far higher than the individual switching costs because the coordination for mass switching to Dvorak is so difficult. With the advent of electric typewriters in the 1950s and

then computer keyboards the expectation is even stronger but QWERTY still remains.

Expectations management

Rival firms in the network industry influence consumers' expectations in order to increase their consumer base (Shapiro and Varian, 1999, p. 219). When competing to become market leaders in the mobile communications industry, consumer expectations were crucial. The mobile company that was expected to grow the fastest would gain most market share. The mobile industry has made consistent use of semiotics in expectations management through its media campaigns. In the early 1990s images, music themes and slogans were used to imply magnitude and leadership. Vodafone's UK corporate image campaign in its early days included heavily symbolic images of the Thames Barrier and the cliffs of Dover in the UK. Such symbols of national interests were used to give the subliminal message that Vodafone would succeed throughout the UK. The musical theme in the Thames Barrier campaign was from 'Close Encounters', implying additional universal reach. The Cliffs of Dover campaign involved the draping with material of a large section of the cliffs, by a contemporary artist. The message may have intended to address 'coverage' issues of radio transmission. Similarly, Orange has had one of the most famous slogans in UK media history: 'The future is bright, the future is Orange'.

Summary and conclusion

The rate of growth and now the sheer size of the ICT industry has been the progenitor of major changes in the economy. We have seen major effects on other industries through the new value possibilities that information technology offers and through the substantial fixed costs and minimum scales required for effective deployment of these technologies. When linked to networks of interdependent customers we see the potential emergence of 'winner-takes-all' strategies and the emergence of new monopolies.

We have decomposed the ICT industry into its component parts in order to see who the players are and how they interact with one another. In doing this we argue that we are beginning to see a new type of industrial order – one marked by networked complementarities and cooperation in place of the traditional model of hierarchy and competition. We have also decomposed the industry into four hori-

zontal levels, technology, supply chain, platform, and network, to show that these have different economic characteristics and therefore that corporate strategies have different dynamics. The examples quoted indicate the range and extent of the possibilities inherent in the new technologies and the nature of rivalry in the form of pre-emptive strikes and technology races. We note particularly the pervasive changes that are taking place in supply chains generally. The increasing importance of connectivity and modularity is forcing a shift from competitive mode towards cooperative mode. This raises industry parallels with self-organising systems and the notion of co-evolution, rather a long way from the search for and exercise of crude bargaining power. The sheer size and cost of physical platforms also creates new dynamics. The pervasive use of alliances is an obvious example. Less obvious is how the need for interoperability requires new attitudes towards complexity and requirements for agility in the formulation and speed of implementation of the strategies of firms.

Finally we remark on the significance of interdependence between consumers. This effect at its strongest completely shifts our thinking from the prevalence of oligopolistic competition (size matters but so do diminishing returns) to the possibility of winner-takes-all and the power of monopoly (size matters – full stop). Clearly such network effects are not always going to be so extreme but there is a real possibility that the combination of high fixed costs, significant economies of scale, and high degrees of knowledge specialisation will, when taken together with consumer bandwagons, create massive new corporate structures in which the major (and perhaps only) discipline will be further developments in technology. However, the analysis of consumer lock-in suggests the real possibility that switching costs might inhibit the adoption of valuable new technologies.

Thus the brave new world has a sting in the tail. The pervasive development of the ICT industries has resulted in and continues to promote very substantial consequential changes throughout the economy. In doing so, industry economics and dynamics do change and significant adaptations have to take place in making responses to avoid getting run down by the juggernaut. But changes are also needed in the nature of the corporate strategies and in the mindsets required. Where the conjunction of certain technological and consumer circumstances take place then the strategy game becomes a very direct race to capture dominant

position. Even where such games fail to achieve their objectives, the cost of unproductive investment could be enormous. Where they in fact succeed many others will nevertheless have failed and we would also face the difficulties in managing the consequences of *de facto* monopoly. The data available do not suggest that winner-takes-all is likely to be a frequent phenomenon. However, all the other indications suggest that various forms of scale-intensive, pre-emptive strategies will become much more common (see, for example, the telecommunications boom and bust). But as a counterpoint we can also see that there are very considerable forces promoting more cooperation and stronger incentives towards a much more subtle blending of cooperative and competitive modes of practice within industries in the future.

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