

“TOWARD THE GLOBAL INTERNET INFRASTRUCTURE”

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For governments, industry and consumers, the communications revolution is extending far beyond the boundaries of the communications sector, with the widespread availability of powerful but affordable communications having a profound effect on the pattern of world-wide commercial, economic and social development. Electronic networks place established business strategies, market structures, regulatory constructs, even notions of national sovereignty under enormous strain. Adapting to the stresses and distresses of a global network economy is the stuff of business survival. Yet nowhere is the trauma of adjustment being felt more keenly than within the communications industry itself. After more than a century of stable development, the structure of the telecommunications value chain is undergoing total transformation, and it is happening in real time.

Like today's telecommunications value chain the key to the multimedia value chain of tomorrow will be in maintaining control of the customer - the ability to understand customer requirements and trends, the ability to control the distribution of value along the chain. Where the telecommunications and multimedia value chains differ, however, is that infrastructure owners, in most cases the incumbent telecommunications operators, will no longer command exclusive channel to the customer. Rather, it will be shared among network operators, content providers, systems integrators, and multiple market entrants. Even today digital technology and the arrival of competition have rendered the structure of the existing telecommunications value chain and its pricing methodologies incoherent. Yet those vestiges that remain are increasingly denying the benefits of next generation networks to individual and corporate consumers alike.

The central paradox of the convergence era is that while the telecommunications operators are the investors, owners and gatekeepers of the vast, global fibre optic network that has grown up over the past decade, the content and computing conglomerates are basing their expansion plans on the assumption that bandwidth will be free and access open. This stark clash in cultures is indicative of a huge power play among industrial interests, the outcome of which will set the pace and character of the communications revolution. Already, multimedia applications are emerging that can only profitably be handled by tomorrow's pricing and delivery mechanisms. But until the relics of the old telecommunications order are swept away - relics of pricing, ownership, regulation and technology - the goal of a truly Global Information Infrastructure (GII) will remain elusive.

The Twilight of Telecommunications: Toward the Global Internet Infrastructure

The world of communications in the late 1990s is in a state of upheaval. In less than a decade, the spread of digital technology, the mass market phenomena of wireless telephony and the Internet, and the liberatisation and privatisation of telecommunications markets have led to a revolutionary shift in the economics of the sector. We live in an age where the cellular telephone is an icon of contemporary culture, where sales of personal computers outstrip those of

televisions, where more electronic than postal mail is delivered, and where cross-border traffic over the Internet exceeds that on the telephone network. Next generation networks centred around low cost telecommunications and information technologies are modelling the nervous system for the new world economy.

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The concept of the GII was first presented by United States Vice President Albert Gore in March 1994, In his keynote address at the International Telecommunication Union's (ITU) World Development Conference in Buenos Aires, he proposed the linking of National Information Infrastructures around a common set of principles, and the accelerated introduction of communication and information technologies in both developed and developing countries. Backed by strong growth in the U.S. semiconductor, software, computing and networking industries, he argued that liberalizing telecommunications markets and promoting use of the

Internet would bring significant increases in output and productivity, at low incremental cost, and boost world-wide economic development.

This vision has since been spectacularly realised in the U.S., with Department of Commerce estimates that computing and communications now generate between 25-40% of U.S. real economic growth. While the U.S. continues to outpace its international trading rivals in the use of information technology, dramatic progress has been made at the global level in the shift toward private sector ownership, with five billion people living in market economies compared to only one billion less than ten years ago. In many cases, privatisation of state owned telephone companies has kick started local stock markets, reinforcing the trend towards telecommunications competition. And 1998 is likely to mark a watershed in market liberalisation with the implementation of the World Trade Organisation's (WTO) 'Basic Telecommunication Agreement', the breakthrough of commercial Internet protocol (IP) telephony services, and the launch of the first generation of Global Mobile Personal Communications by Satellite Systems.

Next Millennium Networks

As we enter the next millennium, the advent of global communications networks like the Internet, the Global System for Mobile (GSM), and the new low earth orbit (LEO) satellite systems will lead to an explosion in the world's wired population. Today there are some 750 million telephone users in the world, 120 million Internet users, and 150 million GSM cellular phone users. According to the ITU, by the year 2001 there will be some 10 million host computers connected to the Internet, implying a user base of around 300 million. That would put the number of Internet users only marginally behind the number of cellular telephone users (estimated at around 400 million) and it would imply that the majority of personal computers in that year (estimated to be some 450 million) would also be connected to the Internet. Put another way, at the start of 1997, there were an estimated 8.6 million users for every 100 main telephones. By the year 2000 there will be some 30 Internet users for every 100 main telephones (see Figure 1 - Next Millennium Networks).

Effectively putting an end to telecommunications scarcity, the significance of this growth goes far beyond the simple number of connections. Fibre optic technology has already transformed the world's long distance and transoceanic networks by providing superabundant communications capacity (bandwidth), reducing marginal costs to near zero, and undermining the basis for today's distance dependent pricing. Now, wireless and cable television technologies are challenging the scale economics of the existing local exchange network based on wireline technology and buried copper. The old utility model of natural monopoly is rapidly being replaced by the delivery of new, alternative access technologies through competing providers of local telecommunications services. Increasingly, providing as much potential for telecommunications competition as possible will become the focus for structural reform within the sector, as opposed to the simple transfer of the monopoly telecommunications company from the public to the private sector, as is too often the case today.

For its part, the Internet is forcing major changes in the structure of the telecommunications value chain. And it is also emerging as a prototype of the new economy: lowering barriers to market entry, stripping out layers in the distribution chain, and greatly increasing the tradability of services across frontiers. In this environment, employment, wages, taxation, and productivity will all be determined by the new economics of distributed information. By the year 2001, the Internet will have created a single market of 300 million computer literate consumers worldwide. Electronic commerce will be an inevitable consequence of the U.S. and Europe's proposals a "duty free" cyberspace, transforming traditional business and life patterns as both the size and location of a firm become less relevant. Both small and large businesses can benefit from reduced transaction costs, improved customer service and new sales opportunities.

The corollary will be the emergence of new competitors from unexpected directions and inequalities between countries able and willing to exploit new opportunities and those that are not. For developing countries the stakes could not be higher. The World Bank estimates that emerging economies will need to invest \$60-70 billion annually just to catch up with demand, more than twice as much as is being spent today. And that is just for basic telephone service.

The disparities between regions of the world for data communications and Internet access are much greater than for voice service, and also much greater than for mobile voice service. North America has the same number of telephone lines as all of Asia and it has twice as many cellular telephones, but North America has ten times the number of Internet connections as all of Asia. In the medium term, next generation networks may at last offer a new development trajectory for emerging economies and help to bridge the huge gap between information rich and poor.

Ultimately, the radical nature of fibre optic, wireless and Internet technologies is set to deliver the unique benefits of universal broadband access. Low cost access to high capacity communications wherever and whenever demand arises will be essential in meeting the needs of the multimedia marketplace. Why universal? Universal coverage is well matched to key development trends in the global economy, national economies and society as geographic location declines as an indicator of wealth and communications requirements. Why broadband? Broadband capability is suited to the virtuous circle of increasing communications functionality and increasing customer expectations for communications functionality. Why access? Access is, and will continue to be, the key bottleneck in telecommunications, even at a time when the local access market is sustaining its financial value, as the long distance and international market is threatened by the erosion of historical cross subsidies.

Few dispute the foundations of a successful GII: a ubiquitous, low-cost, reliable, safe, public Internet; predictable, non-stop, self healing corporate networks (intranets); and, free market telecommunications in local, long distance and international networks. The problem is how to get from here to there. The massive decline in the cost of communicating, the increase in the power of computing, and the shift to digital technology have been immensely positive forces for economic growth and change. At the same time, they have created deep seated confusion and uncertainty within the traditional telecommunications community. The knock-on effects have been investment paralysis in advanced broadband facilities, defensive strategies aimed

more at protecting market share than stimulating consumer demand, and delay in the cross industry acceptance of the Internet as the next generation telecommunications infrastructure. Without adequate efforts to alter these trends the GII is set to fall far short of expectations.

The World Turned Upside Down

The natural inertia of the telecommunications industry can be seen most clearly in its sluggish response to the communications phenomenon of the century, the Internet. Currently, about 120 million users are navigating the Internet with the number of domain name registrations having passed 2 million. Traffic is doubling every 100 days on the Internet, while the growth rate in Internet hosts has been close to 90 percent per year during the last seven years, reaching a total of 30 million Internet host computers by the beginning of 1998. This unprecedented growth, dwarfing models like Moore's law, has meant Internet related technologies have already achieved critical mass in the marketplace, and become the focus of attention of investment for software developers and equipment manufacturers world-wide. Increasingly, the Internet will become the principal focus for the world's intellectual capital.

The rate of progress has accelerated dramatically now that it is widely accepted that open Internet standards are the way forward. The Internet protocol is now the preferred protocol for most new corporate networks, so-called intranets, and the World Wide Web standards have become the preferred tools for most new corporate wide-area applications. Perhaps more important, though the Internet has traditionally been used to provide services which are complementary to those of the telecommunications operators such as electronic mail or browsing of remote servers, increasingly it is also being used to provide services which are in direct competition to those of the telecommunications operators such as voice telephony, facsimile, or data transfer. Along with the wireless revolution, this trend heralds an historic dislocation in the structure of the telecommunications industry more profound even than the computing industry's shift from mainframes to PCs.

Perhaps not surprisingly many telecommunications operators continue to view the Internet as too small in relation to the telephone network, with some 750 million users and \$763 billion gained from the provision of public telecommunications services in 1998, to pose a serious threat to current revenues and investments. Partly this is a result of ingrained chauvinism. As the brain-child of the computing and networking industries, the Internet comes from beyond the sphere of influence and control of the telecommunications industry, and directly challenges the market dominance on which that industry has traditionally based its strength. Partly it is a symptom of congenital myopia. For the overwhelming significance of the Internet for telecommunications operators and manufacturers lies not in where it is today but where it will have evolved in five to ten years time.

Fundamentally, the Internet marks the beginning of the great discontinuity of technological convergence between telephone, television, and computer. Reversing the relationship between quality, functionality and price, the Internet turns telecommunications orthodoxy on its head (see Figure 2). Today, the Internet is being run on top of the telephone network. Tomor-

row, telephony may end up running on top of the Internet. Not only is a completely unregulated network threatening to topple its highly regulated predecessor, but the Internet also embodies many of the key characteristics of the future telecommunications marketplace - the arrival of local-global telephony, the separation of networks and service provision, the availability of affordable mass access, and the provision of scaleable broadband communications. All of these position the Internet at the vanguard of the communications revolution.

But if it provides a compelling and attractive model for the future evolution of both the communications sector and the GII, the Internet is also perceived as undermining the very operational and economic foundations of the public telephone network. Growth of the public Internet, for example, largely based on flat rate charges, challenges the usage-based charging structure of voice telephony, while the proliferation of intranets is seen as cannibalising current leased line revenues from large corporations. Similarly, the "full circuit" pricing regime responsible for the spectacular international expansion of the Internet subverts the "half circuit" regime of the established international settlement and accounting rate system. The telecommunications giants are justifiably nervous that the Internet will eliminate much of their existing sources of profit and competitive advantage.

This trepidation extends to capital investment. The telecommunications industry is investing billions of dollars in infrastructures and acquisitions to implement strategies for change. However, many of these investments carry high risks, particularly the upgrading of national, narrowband access networks to deliver broadband services, due to the low rate of return and high market, risk attached to these programmes. The problem is further complicated because the existing communications infrastructure based on circuit switched economics is ill matched to an Internet -dominated future based on packet switching. The stark choice is either to find new ways to use that existing infrastructure or embrace a strategy of creative destruction with the massive write-off of billions of dollars in stranded investments.

Overall, the Internet has become a prime source of uncertainty and instability in the telecommunications world. Lowering barriers to market entry, it offers all the raw materials needed by competitors to create new products and services with guaranteed quality of service. Yet through fear and inertia the telecommunications operators and manufacturers have become trapped in a mindset of Internet denial: resisting the dissection of their markets and services, and continuing to sell end-to-end integrated solutions whenever possible; delaying the introduction of innovative pricing schemes to stimulate multimedia demand; stalling investment in broadband capacity and new local access technologies. The irony is that looking at the threat the telecommunications industry is apt to miss the opportunity - to overhaul its decrepit pricing models and to load its networks with killer Internet applications.

Chaotic Transition

Yet despite its success the Internet is still work in progress and very much at the start of its growth curve. The high market valuations placed on Internet Service Providers contrasts with the lack of a viable business model for the medium, and initial areas of weakness such as

quality of service and security must be addressed to ensure mainstream commercial acceptance. These problems will find solutions. The major challenge now is making the leap to the next generation Internet that will deliver the multimedia future of low cost, universal broadband access. Increasingly, however, it is evident that without a radical breakthrough in the price performance characteristics of today's telecommunications networks this leap will fail to occur. Where that breakthrough will come is not yet clear, but the concern is that the telecommunications industry will delay rather than hasten its arrival.

Still short of being a wholly mass-market phenomenon, the Internet is probably the closest the information industries will come to convergence during this millennium. For all intents and purposes the Internet is the Global Information Infrastructure. As the precursor to the mainstream communications medium of the next decade it will continue to blur traditional distinctions between the various communications sectors. All industry players will be forced to rethink their strategies, as market structures and value chains are transformed. So in this period of chaotic transition from today's telecommunications value chain to tomorrow's multimedia value chain what scenarios can be generated? What strategic and investment choices will be faced by government, industry and consumers? Specifically, what challenges and opportunities await the incumbent telecommunications operators?

A key challenge already being faced by telecommunications operators is increased competition in infrastructure provision: from access technologies such as fixed radio access and low earth orbit satellites; from economies of scale in core transmission such as increased backbone capacity; and, of course, from reduced margins in their core voice telephony business. The opportunity is to act as gatekeeper, effectively "owning" the customer through local access and backbone domination, and retaining more value compared to service provision and content packaging. A more nascent challenge is increased competition from non-facilities-based service providers where regulation favours service competition with network unbundling, service unbundling, and service packaging by value-added resellers. The opportunity is in value added services, offering system integration for businesses, diversifying into value added services, bundling value added services with network services - all expanding the value of the infrastructure.

But by far the most serious challenge for the telecommunications operators is the threat of dominance by content providers. In the context of computing and communications, this will occur when processing at the edge of the network with generic software results in more value extracted by content packagers, infrastructure becomes a commodity, and operators lose control of the customer. The opportunity is to package content with access, extending residential focus, or linking infrastructure with content via alliances or buyouts. In the context of mass media and communications, the convergence of telecommunications and digital broadcasting will see the take up of Web TV and interactive television applications, with interconnection between television and telephone networks, and concentration of political and media power. Alternatively, the continued separation of telecommunications and digital broadcasting will lead to proprietary set top boxes, few killer applications, and political sensitivity to media issues with cultural exceptions on content.

A number of uncertainties from the demand side will affect these outcomes. Foremost will be the mass or niche market take up of broadband services. Other factors will include mobility, economic growth and Internet usage. Mass market penetration of broadband services will require a sophisticated customer base and a wide range of applications ranging from electronic commerce to health applications. Niche market uptake is likely to result from poor security perception with viruses and black-outs, delays in new broadband delivery mechanisms like digital subscriber loop (xDSL), satellites and fibre optics, and limited use of private business networks. Mobility will be predicated on evolution versus revolution. Evolution through compromise on next generation mobile standards, sub-optimal spectrum availability, limited demand for fixed-mobile convergence, and demand for restricted mobility such (DECT and PHS). Revolution will result from the proof of code division multiple access (xDMA) spectral efficiency, active secondary markets for spectrum, and the fast take up of dual mode satellite services.

In a cycle of sustained economic growth, political stability, an increase in services within economic production, the impact of communications on productivity, and “IT society” type of government programmes will all prevail. Crisis conditions will result from financial uncertainties, growth concentrated in urban areas, and failure of infrastructure development programmes. Last but certainly not least, the Internet. With regard to Internet usage, widespread Internet use will rely on strong multi-lingual content creation, good perception on quality with mechanisms for prioritizing traffic, and voice over IP. Niche usage will see the residential Internet remaining a toy, congestion due to lack of regional backbones, usage pricing inhibiting take up, and strong content regulation.

From Teleway to Netway

Given these diverse factors it is possible to project slow, medium and fast scenarios for the development of the GII: “Teleway”; “Highway”; and ‘Netway’ (see Figure 3).

1. Teleway will see success for cellular operators with telecommunications operator alliances focusing on fixed-mobile convergence. Fixed wireless access and low earth orbit satellites experience slow take up, and Internet security issues remain unresolved such that broadband networks are limited to business applications. Incumbent telecommunications operators continue to dominate residential markets with only slow upgrades to existing networks. Data rates increase only slowly. And we see the possible marginalisation of developing countries.
2. Highway will see global alliances between infrastructure operators, network interconnection replacing Internet peering arrangements and favouring network concentration for backbone capacity, and Internet applications enjoying widespread take up with electronic commerce rather than multimedia entertainment becoming dominant. Security is assured by the network owner with metropolitan area networks and corporate networks developed for the business community, and XDSL proving successful for residential broadband.

3. Netway will see intense competition for operators with many second operators licensed and the success of broadband terrestrial wireless and satellites. Bottlenecks are removed in local access. The Internet is perceived as secure and commercial multimedia applications become widespread. But network operators lose control on bandwidth that is ceded to the user's side and to the content originator's side. Infrastructure becomes commoditised and users pay for content rather than usage.

This Netway, or next generation Internet, scenario is likely to be the most desirable outcome in the context of the global economy. The market is already shifting under the feet of the telecommunications giants. As telecommunications traffic moves decisively from the telephone network to the Internet around the turn of the century, the economics of the sector will be transformed. Bandwidth is likely to become a tradable commodity, with 'capacity futures' bought and sold in spot markets. The ownership and control of infrastructure will decline dramatically in importance. As new, 'virtual' players enter the market with near zero cost bases, incumbents will struggle to compete with oversized workforces and outdated equipment. In this twilight world the future of the telecommunications companies looks decidedly bleak.

Alternatively, the Teleway and Highway scenarios will see the collision between the new world of the Internet based on flat rate charges and packet switched technology and the more traditional world of voice telephony based on usage charges and circuit switched technology becoming a major roadblock to change. Niche players will struggle to take on existing brands or force the break-up of vertically integrated telecommunication businesses. Liberalisation and globalisation will lead only to a world of super-carrier economies of scale. No breakthrough in the price performance characteristics of today's telecommunications networks will be forthcoming. Incumbents will covet the role of gatekeeper and continue to dictate pricing trends. The Internet, the fastest growing network in the history of communications, will be frustrated in its full potential.

In this regard, pressure will intensify for a radical rethink of the existing framework of telecommunications regulation. Against a backdrop of limited liberalisation, the great infrastructure project of the 1980s was the digitalisation of the world's narrowband telephone network. During the 1990s, increased liberalisation, the roll out of competing national cellular networks, and the proliferation of long distance and transoceanic fibre optic networks has led to tumbling prices for voice communications and greater choice for consumers. However, if the goal for the information infrastructure of the coming decade is low cost, universal broadband access, a very different regulatory framework embracing voice, data and video will be required. Fundamentally, that framework will need to establish the necessary incentives to stimulate investment and technical innovation in local access.

For more than one hundred years access to communications networks has largely been dictated by wealth- the wealth of a nation, a corporation or an individual. With the end of telecommunications scarcity and the arrival of the Internet, it has at last become possible to reverse this bias. All countries, even the poorest among them, today face a rising competitiveness

threshold due to the communications revolution. Yet telecommunications and Internet access offer unprecedented opportunities for developed and developing countries to play in a Global Internet Infrastructure. The stakes are high. For without watchful management and new thinking by government, industry and consumers, the digital gatekeepers will ensure that this opportunity remains the privilege not of the many but the few.

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