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<td><strong>Author(s)</strong></td>
<td>Davey, Graham J</td>
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Trends In Telecommunications And Their Implications For Social-Economic Development

By

Graham J Davey
TRENDS IN TELECOMMUNICATIONS
AND
THEIR IMPLICATIONS FOR SOCIO-ECONOMIC DEVELOPMENT

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ITU Regional Office for
Asia and the Pacific
Abstract

Advances in telecommunications technology accompanied by decreasing prices for telecommunications services have radically changed the efficiency of providing information.

These trends are only beginning and continued technological development providing greater information capacity, carrying more highly-processed information, and a greater and ever more innovative range of services at continuously decreasing prices will prevail for many years into the future. Many would suggest, into the indefinite future.

The ubiquity and utility of information will dramatically alter the way we do business, the way we manage and participate in our social institutions, and the way in which we entertain ourselves.

The "information revolution" and the "information age" is only just beginning, but is proceeding at an accelerating rate.
The Demand for Information

To understand the dramatic developments taking place in the information sector, we need to first understand the nature of the demand which is driving the present trends.

Few things which we do are based on instinct and most of what we do is based on information. The more information which we have, the more information which we can absorb and process, and the more information we need -- "The more we know, the more we know that we know not". Philosophically and from hard evidence, we can therefore deduce that information is an investment with an exponential growth in demand. Since the demand growth at a personal level is exponential, it is not surprising that for a population group or a nation, the exponential growth in demand for information is at a higher rate than population growth.

There are usually some natural limiting factors to continued exponential growth and, in the case of information, one obvious limitation is time. There are only 24 hours in each day for us to absorb and send information. This constraint establishes the need for increased demand to be met more efficiently, i.e., more information in less time. To achieve this we require more processed information with more of the raw data being computer processed to give us less quantity but higher quality answers. Another outcome of the constraints of the time domain has been the need for communications availability wherever we are at any time, i.e., mobile or personal communications rather than to a fixed location.

In summary, it is this exponential demand for information which has driven and is driving the convergence of computers and communications, the R&D for ever-wider band width higher capacity systems, to carry ever more refined or concentrated information, with greater efficiency, to more people over more of the time available and at ever lower prices in real terms.

**Trend 1 Increased Transmission Capacity**

The increase in capacity of transmission systems from copper pair cables to carrier systems both analogue and digital over pair cables, to coaxial cable systems to optical fibre cable systems, has progressively increased capacity with cost reductions of the order of 20% per annum over the last decade. We can expect to see continued capacity increases at ever lower prices and noting the relatively low raw material cost of optical fibre systems, existing technology has room for considerable further cost reduction with further economies of scale.
Radio transmission bearer systems have continued to expand in capacity by utilising ever higher carrier frequencies and more efficient modulation techniques.

Capacity has also been increased with "bandwidth compression" techniques which essentially focus on transmitting the minimum amount of information necessary in the most efficient manner possible to obtain acceptable levels of quality of information at the receive end. Over the last decade, video information in particular has seen a bandwidth compression of 200% (i.e., only 1/4 of what used to be sent) to achieve comparable quality.

Satellite systems continue to provide very large area coverage at higher frequencies with higher capacity and lower costs with significant improvements in small aperture earth station technology, better satellite antennae gain, all leading to higher capacities and lower costs.

**Trend 2**  
The technology of digitalisation which was a cross-fertilisation of the computer and communications industry has opened the way for integration of a whole range of services previously carried by separate networks. Video, voice, data, etc., are all digitised and are transmitted, routed and can be processed if need be at points along the way. This has led to economies of scope and scale.

Digital technology for telecommunications itself has led to dual use by the computer and communications industry of many of the technologies and components and this has further led to a continued high level of R&D in microprocessing, digital storage and VLSI circuit technology. Prices of semi-conductor memory capacity, for example, have been reducing by half every 2 years and the trend is continuing.

**Trend 3**  
To continue to refine information and better utilise precious human time, more and more raw data and semi-refined information is being transmitted between computers in LANs and WANs before final summary information is provided to the customer. Computer evolution is placing ever more capacity at the "desk top" or the "lap top" and software to match this evolution is not only providing more usable programmes for more applications, but is being applied to harness greater hierarchial and parallel processing using the combined power of the computers. The days when computers were used exclusively as isolated and independent islands of information enhancement are long gone. Again, computing power is continuing at the PC level to reduce in price from around US $10,000/MIPs in 1980 to US $1,000/MIPs in 1990 -- An order of cost reduction in a decade -- and by the year 2000 is on track for US $100/MIPs.
Trend 4  Digital Switching  

Along with computer technology, digital switching costs have reduced significantly and are currently reducing at around 10% per annum. Increasingly, networks are being processed by switching architectures using more decentralised micro-pressers and more elegant software to provide ever more features and customer services and a further trend is to provide highly-flexible features and services by overlay computer systems connected to, but outside of, the switches.

Optical switching with very large capacity was considered a distant future technology only a decade ago, but breakthroughs over the last five years have advanced its likely application for major information highway nodes to the year 2000.

Trend 5  Mobile Services  

From cumbersome expensive technology installed in vehicles only a few years ago, the development of cellular radio systems has advanced rapidly to today’s convenient mobile phones and pagers. There is now a recognition that there is a huge demand for information to a person, rather than a place -- the proposed new Personal Communication Services (PCS) or Future Public Land Mobile Telephone Services (FPLMTS) as this category of services is termed in ITU parlance. Spectrum has been allocated for the service, new global numbering schemes are being developed and the technological race is on in earnest to get a global system in place which will provide a ubiquitous service to any person wherever he or she might be.

In parallel with the terrestrial technologies, satellite systems such as Iridium, Inmarsat System 21, and others are looking to provide satellite-based global mobile PCS at the earliest possible time to meet this demand.

The very high levels of demand and the intense competition can be expected to bring prices down very quickly to affordable levels for the median income earner in the developed world and to rapidly expand telecommunications penetration in many developing countries.

Trend 6  Services and Facilities  

The services and facilities which will be available in tomorrow’s information age will be limited only by the imagination of the vendors to meet customer needs. Most of the professional information-based services for which we physically travel or visit today will be available to us at home. With dial-up services, we will not only be able to buy, to sell, to book airline tickets, to do our banking, etc., but we will be able to expertly design our own yacht, to expertly design our own house and furnish it, and so
on. For entertainment, the same applies. We will no longer need to physically travel to the video retailer, or the video games parlour, or the TV host show, or etc. We will have interactive or passive entertainment at our fingertips.

Access to databases and database directories will be routine and the access to computing and artificial intelligence processing to answer questions and solve problems will be extensive. (Children’s homework may be an interesting exercise in the skills of using the information systems.)

Trend 7 Software, Firmware, and Hardware

Already in the computer industry, the value and price of the software far exceeds the value of the hardware. In the media industry, the costs of firmware and software greatly exceeds the cost of hardware. So in the integrated information systems of the future, the value and price paid for the information provided by the network will greatly exceed the value of the network itself -- the hardware. In short, the high-level corporate profits will be made in the future by providing the information and services -- the software, rather than the hardware, and with ever greater capacity at ever reducing costs of the hardware, we can expect to see whole new institutional arrangements between the software and hardware vendors. The present tentative trends of vertical integration are but the early and I believe first steps to prepare corporately for the new multi-media environment.

Conclusion

The rapid expansion of communications services in both scope and scale will accelerate with continued reduction in price leading to greater ubiquity, particularly in the lower teledensity developing countries.

The high growth rates and rapid growth will continue to make the information industry the growth industry of the present and foreseeable future.

The rapid evolution of the information age will, however, place major stresses on our legal and social institutions which are at present structurally unable to adapt as quickly as technological development.
TYPICAL MIX OF AGGREGATES FOR RAPID ECONOMIC DEVELOPMENT

- Information: 50%
- Capital: 25%
- Labour: 25%

Relative Input of Aggregates for Maximum Growth

GDP/CAP.
ELECTRONIC MEMORY PRICES, EXPRESSED IN UNITED STATES CENTS PER BIT OF DYNAMIC RANDOM ACCESS MEMORY (D-RAM)
1971-89

US cents per bit of RAM
(Logarithmic scale)

Source: US Industrial Outlook, 1984

US $20 could buy:

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<tr>
<td>RAM</td>
<td>65Kb</td>
<td>250Kb</td>
<td>1Mb</td>
<td>4Mb</td>
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COST DECLINE OF MEMORY

COST HALVING EVERY 2 YEARS.

RAM

SAM


FOR $20:

RAM: 65K 1/4M 1M 4M
SAM: 1/4M 1M 4M 16M

1 MEGABYTE BY END OF 1980'S
With the price/performance gap between micros and mainframes expected to widen even further in the years ahead, new application deployment will continue its radical shift to microbased systems throughout the decade.

Source: The Gartner Group
SHIFT IN I.S. AND HUMAN RESOURCES

Source: The Gartner Group
### INTELSAT HALF CIRCUIT PRICES

<table>
<thead>
<tr>
<th>Year</th>
<th>$ per year</th>
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<tbody>
<tr>
<td>1965</td>
<td>32,000</td>
</tr>
<tr>
<td>1966-70</td>
<td>20,000</td>
</tr>
<tr>
<td>1971</td>
<td>15,000</td>
</tr>
<tr>
<td>1972</td>
<td>13,000</td>
</tr>
<tr>
<td>1973</td>
<td>11,000</td>
</tr>
<tr>
<td>1974</td>
<td>9,000</td>
</tr>
<tr>
<td>1975</td>
<td>8,500</td>
</tr>
<tr>
<td>1976</td>
<td>8,000</td>
</tr>
<tr>
<td>1977</td>
<td>7,000</td>
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<tr>
<td>1978</td>
<td>6,500</td>
</tr>
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<td>1979</td>
<td>6,000</td>
</tr>
<tr>
<td>1980</td>
<td>5,000</td>
</tr>
<tr>
<td>1981-90</td>
<td>4,440</td>
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FIBRE OPTICS/COPPER PRICE TRENDS

![Graph showing price trends for fibre optics and copper cable over years 1979 to 1987. Key points include:
- 1979: (45 Mb/s) Fibre Optic Cable, (90 Mb/s) Copper Cable
- 1981: (135 Mb/s) Fibre Optic Cable, (810 Mb/s) Copper Cable
- 1985: (405 Mb/s) Fibre Optic Cable, (560 Mb/s) Copper Cable
- 1987: (405 Mb/s) Fibre Optic Cable, (560 Mb/s) Copper Cable

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<tr>
<th>Year</th>
<th>Cable</th>
<th>Technology</th>
<th>Cost $m</th>
<th>Capacity in voice paths</th>
<th>Cost per voice path</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956</td>
<td>TAT-1</td>
<td>Coaxial</td>
<td>49.6</td>
<td>89</td>
<td>557,000</td>
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<tr>
<td>1959</td>
<td>TAT-2</td>
<td>Coaxial</td>
<td>42.7</td>
<td>98</td>
<td>435,700</td>
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<tr>
<td>1963</td>
<td>TAT-3</td>
<td>Coaxial</td>
<td>50.6</td>
<td>178</td>
<td>289,143</td>
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<tr>
<td>1965</td>
<td>TAT-4</td>
<td>Coaxial</td>
<td>50.4</td>
<td>138</td>
<td>365,217</td>
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<tr>
<td>1970</td>
<td>TAT-5</td>
<td>Coaxial</td>
<td>70.4</td>
<td>1,440</td>
<td>48,889</td>
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<tr>
<td>1976</td>
<td>TAT-6</td>
<td>Coaxial</td>
<td>197.0</td>
<td>8,000</td>
<td>24,625</td>
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<tr>
<td>1983</td>
<td>TAT-7</td>
<td>Coaxial</td>
<td>194.6</td>
<td>8,400</td>
<td>23,167</td>
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<tr>
<td>1988</td>
<td>TAT-8</td>
<td>Fibre Optic</td>
<td>335.4</td>
<td>37,800</td>
<td>8,873</td>
</tr>
<tr>
<td>1989</td>
<td>PTAT-1</td>
<td>Fibre Optic</td>
<td>475.0</td>
<td>85,000</td>
<td>5,588</td>
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**Planned or under construction**

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<thead>
<tr>
<th>Year</th>
<th>Cable</th>
<th>Technology</th>
<th>Cost $m</th>
<th>Capacity in voice paths</th>
<th>Cost per voice path</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>TAT-9</td>
<td>Fibre Optic</td>
<td>450.0</td>
<td>80,000</td>
<td>5,625</td>
</tr>
<tr>
<td>1992</td>
<td>PTAT-2</td>
<td>Fibre Optic</td>
<td>500.0</td>
<td>85,000</td>
<td>5,882</td>
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<tr>
<td>1993</td>
<td>TAT-X</td>
<td>Fibre Optic</td>
<td>450.0</td>
<td>150,000</td>
<td>3,000</td>
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Attn. 8
Forcing suppliers to pass on technology cost reductions

10% per annum technology cost reductions

Source: Bell Atlantic
Decline in Real Term Costs of Telecom Technology

1. Information Storage and Computing
   Costs declined 50% every 2.2 years.
   Anticipated cost declined 50% every 2 years.

2. High Capacity Transmission
   Voice circuit equivalent costs declined:
   Satellite systems -- 10% per annum
   Optical fibre -- 50% in 2 years

3. Mobile Services
   Costs declined 50% over last 5 years.
   Anticipated cost decline?

4. Switching
   Costs declined 50% over last 10 years.
   Anticipated 10% per annum future cost decline.