

INFORMATION TECHNOLOGY - THE GROWTH OF COMMUNICATIONS

(Or, the race to capacity and beyond)

For some unknown reason I had always had an urge to be connected with the sea and to the fields of radio communications and telecommunications. Whether this had anything to do with a relative, an uncle, I had never met or known, he was a Marconi Radio Officer in the early part of the 20th century and was killed in Halifax Bay, Nova Scotia in December 1917 at the time of the First World War, I have no idea. But, in 1962, I joined the Royal Navy as a Radio Operator Third Class. I was taught the Morse code, how to use transmitters and receivers, cryptographic equipment, how to operate voice and telegraph circuits including electro-mechanical and electronic teleprinters and modems, all forms of portable radio equipment and visual signalling and the use of electronic warfare equipment. I was, eventually, commissioned from the ranks in 1972 and pursued a very successful career in the management, organization, administration and strategic planning of operational naval, military and commercial fixed and mobile radio and telecommunication networks, systems and manpower requirements.

The pinnacle of my career was, probably, being appointed in the mid 1980's to the job of Director (Network Operations) in the Ministry of Defence (Navy). In that appointment I was responsible for the day to day and short to medium term operational availability, effectiveness and efficiency of a multi-billion pound interconnected Naval Shore Telecommunications Network; and also for the world-wide strategic and tactical radio communications equipment and networks covering the frequency spectrum and supporting the Royal Navy's Fleet, surface and sub-surface, from Hong Kong to the Falkland Islands and covering the world's oceans.

I digress. During the 19th century, and following the growth of railway networks in Britain, the United States and Australia, telegraph networks sprung up so that information could be relayed between stations along the tracks and between railway and law authorities in towns along the routes. We have all seen examples of early systems of telegraph communication in films of the Wild West but information was passed along telegraph wires using a combination of dots and dashes to indicate letters, figures or characters and referred to as the Morse code.

Of course, as people, not just business people and authorities but ordinary people, realised the importance of relaying information electronically, as opposed to the various postal systems that relied on manual collection and delivery, the Pony Express springs to mind, the demand for electronic communications grew. However, even the most proficient operators could not manage to operate, that is transmit or receive messages because the circuits were simplex and only allowed traffic one way at a time, at more than 25 to 30 words per minute.

This was fine when message were short but frustratingly slow when message got longer and longer and soon we had the first communication overload. This may have been the time that one of those well-known laws that states demand increases to fill the available capacity began to take root. Whatever, it was pretty soon recognised that ways and means of increasing both speed and capacity on telegraph networks had to be developed, and preferably through the use of automation, in order to cater for the increase in demand.

It was round about the turn of the 19th/20th century that a French electrical engineer and inventor, Emile Baudot, devised a 5-unit, or 7½-unit, code that could be read by a series of pins on a machine. This code is known as the 'Baudot' or 'Murray' code but was not widely used until the introduction of teleprinters some 2 or 3 decades later. Another standard code, defined by the American National Standards Institute (ANSI), was developed as a 7-bit code plus a 'parity' or 'check' bit making an 8-bit code and called the American Standard Code for Information Interchange or ASCII. This became the International standard for data over telecommunication networks and the basis for the exchange of information on the Internet system.

The 20th century saw the introduction of telephones, telex, radio broadcasting, facsimile, television, computers, telecommunication networks for data transmission, mobile radios and, towards the end, an explosion in the provision of public and private networks for connection through Internet Service Providers (ISPs) to sources of information.

Until the 1970's connection between users on telecommunication networks, whether telephone, telegraph or data transmission was normally carried over copper cables, copper being one of the best if not the best conductor of electrical pulses which is what the information being carried along a network is converted into. However, to keep pace with the ever-increasing demand for communication connectivity and circuit capacity the standard copper cable, and in some cases aluminium cable, has gradually been replaced by optical fibre cables.

There is some doubt, still, as to whether Alexander Graham Bell invented the telephone or whether it was Elisha Gray. Whatever the merits of one over the other the US courts upheld Mr Bell's right to the patent because he, allegedly, filed his patent just a few hours before Mr Gray on the same day, 14 February 1876. However, the first telephone systems were all manually controlled in that connectivity was achieved through small local exchanges manned by telephone operators or telephonists.

Again, as business realised the importance of long-distance communication the demand for more and more lines and more and more connections grew and eventually spread to shops and to individual's homes. This was, probably, the second phase of information overload. Today's telephone exchanges are mostly digital direct dial in systems with little or no operator intervention; indeed, there is hardly a place on earth nowadays that cannot be reached by some form of radio communication using landline or satellite communication channels. The telephone tends to be the primary method of communication between businesses and among the members of extended families.

The life of the teletypewriter or teleprinter, to provide hard copies of messages transmitted over telecommunication networks, lasted about 60 years. Although Baudot developed his code at the turn of the century it wasn't until the 1930's or 1940's that widespread use was made of teleprinters to replace Morse and telegraph circuits. Greater use of private directly connected circuits was achieved by using punched tape machines to produce tapes of the 5-unit coding system. These tapes were then fed through tape readers, or auto-heads, and circuit transmission speed was usually 50 baud, or 66 words per minute, and in some cases 75 baud or 100 words per minute and 110 baud or 150 words per minute.

The telex machine and system was similar in that it employed the same code but allowed individual machines to dial-up direct connections much like a telephone. Once the connection was made and the transmitting machine received back the code of the receiving machine to which it wanted to send information then the message or messages were sent. All these systems allowed for duplex or simultaneous two-way transmission and reception.

The basic technology for facsimile machines was available in the 1930's. For much of the next 50 years facsimile systems were used mainly for transmitting drawings and diagrams between organizations and for sending weather charts and maps to ships at sea via radio broadcast systems. The system was developed and enhanced by the Japanese during the 1970's mainly because of the complexity of their symbolic language characters and because the standard QWERTY keyboard was designed, mainly, for less complex European languages. However, the postal strikes in UK during the 1980's led to the increased use of FAX systems and nowadays most organizations and many private individuals have a facsimile machine to exchange information.

We are all familiar with Television and probably know that by moving from analogue to digital transmission we will be offered a greater number of channels thus increasing the availability of knowledge. In the near future we will be able to communicate through the TV. But, do we want those additional means of communication, will we need all those channels and will it, again, lead to another form of communication overload?

Computers, as most of us probably know, really began with the English mathematician Charles Babbage who recognized a connection between mathematics, mathematical tables and machines. There are many other inventors, mostly American, who progressed, during the 19th and early 20th centuries, the concept of punched-cards inputs to process results culminating, during 1943, with the development of the British Colossus machine to decode German communication messages.

And, in 1944, the US Government and various University teams built machines that were capable of storing programmes and data electronically. But, it was the invention of the transistor that changed the face of computers and the development of the integrated chip that combined components on a silicon disk that led to today's growth of desktop, laptop and palmtop computers.

During the 1960's and co-incidental with the growth of computers, which at this time tended to be built and operated in Universities, the US Military sought to establish a resource sharing network connecting the many contractors who worked on military projects. The result was the Advanced Research Projects Agency (ARPA) and the nodal network connecting the various hardware and software packages at individual American Universities was known as the ARPANET. It was designed such that if any part of the network was lost the system would continue to operate. By the early 1970's some 23 Universities were on this interconnected network.

The commercial aspect of a freely available interconnected computer network (INTERNET) grew because in accordance with US procurement policies the contract to provide pieces of the network went out to tender and encouraged larger scale involvement. This was the beginning of the world-wide web which in a few decades has grown to provide a remarkable source of information.

The explosion in Internet services was triggered by two events; firstly, a bill was pushed, allegedly, through Congress that changed the form of operational funding for US Universities from the US government to purely commercial means. And, secondly research in the Central European Research Network (CERN) in Geneva helped to create the technology for the Internet system.

What we now have is a world-wide freely available and accessible network system of interconnectivity that allows companies, organizations and individuals to access information stored in a plethora of data bases and computer systems. However, for security reasons some governments are, allegedly, seeking to introduce legislation to regulate and centralize control of information exchanged over the Internet system. Allegedly there is desire to introduce some form of protectionism based on a fear, real or otherwise, that political, economic, social and financial corruption could well occur. The important point for legislators to recognize and accept during their deliberations is that they should not diminish or stifle progress and entrepreneurship.

Mobile radio communication systems are yet another area of considerable development and growth. The need to maintain some form of management and control over rapid and some not so rapid transport systems, cars, coaches, trains, ships and planes is important. Throughout the 20th century radio communication systems were developed covering much of the frequency spectrum, from Very Low Frequencies (VLF) for submarines to Very High and Ultra High Frequencies (V/UHF) for aircraft and on to Super High and Extra High Frequencies (S/EHF) for satellite communication channels. Many forms of commercial systems were built to provide communications between company headquarters and large scale truck delivery systems including the Citizens Band (CB) radio channels.

The use of mobile cellular telephone systems began to grow during the 1960's and 1970's. However, there was no standardized agreement on the frequency band to use and the type of equipment and transmission technique such that individual countries tended to develop their own networks based on the availability of national frequency allocations. In 1982 the European Commission (EC) issued a directive that required member countries to reserve the frequency band around 900 Megahertz (MHz) for a Groupe Speciale Mobile (GSM) system. This title was later changed to Global System for Mobile Communications (GSM) that would allow mobile cellular phone users to roam, in the first instance, throughout the EC. The first GSM networks were in place and operational in 1991 and by 1999 there were an estimated 170 million GSM users worldwide.

Equipment manufacturers and network operators are now beginning to provide a third generation of cellular systems called the Universal Mobile Telecommunication System (UMTS). The first services will be available in 2001 and will offer high-capacity broadband information delivering pictures, graphics and video as well as voice and data low cost services with data rates up to 2 MB per second. The latest technology in this area is known as Wireless Application Protocol (WAP) and provides the connection between other mobile systems, desktops, laptops and palmtops and other radio communication devices. It is designed to offer mobile communication users with access to information and services, such as graphics and pictures from the Internet, as well as voice circuits. This has resulted in yet another growth area of strategic alliances or partnerships between the ubiquitous dotcoms, computer companies and telecommunication network operators to provide these services.

However, the Japanese have, yet again, apparently stolen a march over their global competitors. Whilst European and American radio and telecommunications industry and manufacturers have discussed, deliberated and negotiated a standard for the WAP system for Internet services the Nippon Telephone and Telegraph (NTT) company have quietly introduced a third-generation network that provides audio, video and data as required albeit currently at slower speeds.

However, the Japanese mobile phone operator DoCoMo expects to increase the data rate by 40 times in the next 12 months. This proves, once again, the importance of investment in research and development and the necessity of being fleet-footed when it comes down to new technology.

In today's high-speed, high technology, high productivity and high output global marketplace communication is, and has been for the last 2 decades at least, the fastest growing area of business. This is particularly prevalent in two areas, the design and manufacture of telecommunications equipment and optical fibres and cables, and in the provision and operation of highway networks to meet the growth in Internet connectivity. Management, in this area of business, has been turned upside down for the simple reason that operational, as opposed to strategic, decisions have to be taken quickly and staff much further down the management tree is given responsibility for responding to changes in circumstances and demands from customers for information and action relating to their products or services.

In the first area, research and development of communications network equipment, an almost continual battle for mergers and acquisitions is creating yet another race for domination. The field is led by the likes of Lucent Technologies, the former research laboratory and manufacturing arm of the American Telephone and Telegraph (AT&T) Company, Canada's Nortel, Alcatel of France and an American/Canadian company JDS Uniphase. All these companies design, develop, manufacture and distribute ranges of active and passive components, test instruments and interconnecting devices in the fibre optic communications area for the telecommunications and television industries.

Unfortunately, and perhaps regrettably, there are no British companies at the forefront of technology in the development of fibre optic networks and the associated interconnecting active, passive and optoelectronic devices; and, also regrettably is the fact that our Universities are not producing the electronic engineer graduates that are being taught in countries like India and China. Perhaps that is why many IT jobs are rapidly disappearing to those countries and with them future prospects of employment in this area. Nonetheless, it is paramount that every effort is made to provide at least basic training course in information technology not just for students of all ages but also for adult learners to understand basic IT systems and procedures.

However, some companies have spent, literally, billions of \$'s buying start-up companies involved in the design and manufacture of active and passive optical fibre interconnecting passive, active and optoelectronic devices. This area is moving so rapidly that soon people might run out of ideas as to what to develop next to improve the bandwidth, capacity, speed of transmission and connectivity of equipment and networks to companies and individual households.

In the latter area, connecting people and companies via networks to computers in order to access, download and print information, there is a steady growth because of the gradual increase in demand as more and more individuals, as well as companies, have access to personal computers and digital data information. And, importantly, this area will continue to grow and expand as more and more people are connected to the world-wide web as the demand for such areas as on-line shopping and banking also grow.

In addition, the fact that people will have access to a great many databases of information will mean that ordinary people will become increasingly informed on political, social, economic and technological issues and that will mean, necessarily, that they will increasingly ask or even demand answers from politicians, companies and organizations when they fail to meet their demands. So, companies be warned, you need to ensure that your staff are up-to-speed with any and all IT systems and will be in a position to deal with increasing customer demands.

This area of business tends to be dominated, yet again, by American companies, two of the most active and fastest growing being Cisco Systems and Juniper Systems both led by dynamic individuals. The CEO of Cisco systems, John Chambers, estimates that some 40 per cent of employees own shares in the company. Initially he thought that giving shares and allowing share purchases was, allegedly, a form of socialism but believes, instead, that it is the ultimate form of capitalism where everyone who works for an organization has a stake and a vested interest in the company they work for. It appears to work because the share price has increased phenomenally. The result is a very highly motivated workforce committed to the continued success of the company.

The question has to be, where to next? Undoubtedly the capacity of computers and computer systems will continue to expand and costs must, necessarily, come down such that they are very widely available. However, there are already various forms of communication technologies, systems and networks, for example e-mail, facsimile and mobile phones, such that most of us are already contactable 24 hours a day.

There is, probably, a maximum speed that data and other forms of information can be transmitted across the current networks using present day technology, medium and terminal equipment. Therefore, it will be essential for technology companies to consider returning to the principle of retaining a greater share of profits for re-investment, to keep ahead of the game, rather than shuffle more and more money out of the door to shareholders. It is only through continuous investment in innovation and design that companies in the high-tech fields can remain competitive.

I was always taught, during communication operator training, that a circuit should operate at the speed of the slowest operator and in this instance it is the ability of human beings, in general, to read, understand, absorb and respond to what they are being asked to do. Many of us using PCs with network interconnectivity and e-mail systems are, already, suffering from information overload, therefore not a great deal can be achieved by pushing more and more data down more and more networks at faster and faster speeds.

So, even though advances in multiplexing, a process that allows for the transmission of different messages down the same circuit simultaneously, allows for greater use of capacity the information has to end up somewhere and be dealt with by a person or a machine.

Perhaps one changes written and numerical information into graphics and presents the human element with pictures? I have noticed at International and National meetings I attend that some people use laptops to access information so perhaps we may lose the ability to communicate with one another and may even lose the use of the written word? Whatever, human beings are, by nature, gregarious, we need the company of others socially and professionally and we need to communicate in one form or another so it is my belief that systems of communication will continue to expand.

The real challenges are to provide people with all the devices they require for this future area of mass communications but also to teach them how to make the best use of equipment and systems to meet their own needs and demands and be aware of shifting global conditions and circumstances likely to affect them and their futures.

(3430 words)

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