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**The Rôle of Networking - Electronic and Human**  
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**Introduction**

The development of high speed telecommunication constitutes a threat and an opportunity for developing countries in Africa. This short paper is intended to introduce some of the considerations that are vital if African, and other developing, countries are to share in the benefits of this new technology.

The paper begins by giving a little about my own background which will serve to explain, if not excuse, any prejudice and omissions in what follows. It will then go on to list the main developments that are changing the way in which information is spread around the globe from company to company and from university to university. There follow some ideas gleaned from personal experiences of the effects of these developments. Turning to the development theme, the paper outlines the situation as far as I know it in Africa in general and in East Africa, in particular. Finally there is an effort to explain the role of computing, especially computer networks, in helping to build and sustain the more complex and much more important human networks that are the basis for any social and economic development.

**Background**

I am currently Professor of Information Technology at the University of Limerick. Limerick is a small city in the south west of Ireland but its University has earned a national and indeed an international reputation as location for innovation technology and industrially relevant research. The university has about 6,000 students, lies on a beautiful 1,000 acre campus on the banks of the river Shannon, and has highly developed computing infrastructure which is equal to that in most universities in

Europe or North America. Uniquely, among Irish universities, every undergraduate student must spend a 6 to 8 month period of employment in an industrial or commercial setting.

Some time ago, about 16 years in fact, I worked in Zambia, training computer programmers and systems analysts, and helping to make efficient use of the available computer technology within the vital Zambian mining industry. At that time I experienced at first hand the frustrations and achievements involved in transferring "first world" technology to a "third world" context. Not least among the obstacles was the lack of external linkages, to local institutes, to nearby countries and to the wider world of commerce and research.

### **The Networking Revolution**

It has been asserted [1] that "internetworking is one of the most revolutionary technologies of the twentieth century... indeed it may perhaps be the most revolutionary human communications medium that has ever emerged". This seems to be a remarkable and exaggerated claim but a review of some simple statistics will be enough to convince us that the growth of computer networking is a remarkable phenomenon and has exceeded that of any other previous technology to-date. The reasons for this are many and varied. Principle among them, however, must be the fact that the development of telecommunications systems, telephones, microwave links and satellite stations has been driven, not by computers, but by the need to transmit voice, fax and more recently, video information. In its development, computer networking has been able to piggy-back on the available infrastructure. As soon as it became possible for computer systems to dial one another automatically using the normal telephone network it was feasible to transmit text messages from one computer user to another. Over twenty years ago users of UNIX<sup>¶</sup> based systems were using "uucp mail" to transmit messages around the world using a marvellously simple version of "package switching". Addresses, at this time, consisted of the names, in sequence, of all the computers through which the message would have to be relayed to its final destination. This approach was crude but effective and was still being used up to the mid 80's. However, uucp mail was soon to be overtaken by the development of the much more ambitious and sophisticated Arpanet. Arising out of a US government funded experimental network, Arpanet began in 1970. In 1983 the standard interconnection protocol (IP) was established and this meant that any network that adhered to this protocol could connect to Arpanet which was shortly thereafter renamed the Internet. In fact the Internet was the almost inevitable merging

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<sup>¶</sup> UNIX is a trademark of AT&T Bell Laboratories

of the many sub-networks which grew up over the 10/15 years of Arpanet operation. So what we have now is a large number of Internet protocol (IP) networks that, besides connecting all their own users to each other, can also communicate to other networks over the Internet.

If we look at the growth of the Internet connectivity we will see that by mid-1993 there were over 13,000 networks connect to the Internet and an increasing number of these were outside the US. In fact the rate of growth outside the US exceeds that in the US by such an amount that it is estimated that by the end of 1994 there will be more non-US networks than US networks connect to the Internet (all statistics from [2]). It is in this context that we must consider the plan by the US government to establish an "information super-highway". This idea, first mooted by vice-president Gore during the presidential election, is to create a high capacity, public utility for data transmission. Accepting the transport or infrastructure metaphor, we might reasonably ask who is going to benefit from this information super-highway. Perhaps we should look at the road highways that are built all over the developing world as a contribution to development and to improve the lot of the people living there. How do these function and what effects do they have? The main point about them is that they lead to considerable regional disparities because those who are near to the highways benefit unduly, especially if they own cars or trucks. Will it be the same with the information super- highway? Will it contribute to greater inequality of access? Will it emphasise the power of those who can use it, over those who can't ? Of course conventional highways can be used by public transport and thus benefit everyone. So it is reasonable to ask if the Information super-highway can become a means of increasing the general level of communication within countries and most especially between countries. The answers to all these questions will surely depend on the networks that we build and on our ability to absorb them into worthwhile and realistic development contexts.

### **Using the Internet**

What is all this communication used for? There are basically five main purposes to which it is put and, starting with the most popular, we will deal with them in turn. (This material is summarised from [3]) We will also look at how each use can assist in promoting industrial and university development .

***Electronic mail.*** This is by far the most widespread use and is available in the majority of the countries of the world through one form or another. It allows users to send text messages that are fairly short, and not too sensitive to small amount of data

loss, over almost any quality of telephone network. Typically it is available to all workers in the computer industry, to many administration personnel and, increasingly, to national and international organisations. There is even a café-cum-laundrette called Brain Wash, in San Francisco, which offers an Internet terminal while your washing is being done! [4] It is cheaper, quicker and more reliable than a letter; easier to arrange than a phone call and more likely than either to obtain a response.

***Mailing Lists and News Groups.*** This is the next most common usage of the Internet. Typically, mailing lists allow users to send copies of their messages to a large number of people whom they believe will be interested in their messages. It is a form of broadcasting and can be used to publicise products, seek collaborators or issue invitations. News groups are a slightly more organised mechanism where discussions are moderated to a greater or lesser extent by a central person who reads edits, forwards and files messages as appropriate. This can be used to conduct discussion between geographically distributed people who share a common interest.

***File transfer.*** The third type of usage for the Internet is file transfer or ftp. This allows users to access, and take copies of, files belonging to other users who have made them publicly available. In many cases this can be done without identifying yourself and this is referred to as ftp-anon. Many research reports, product descriptions and software fixes are available in this way. Students of mine have found valuable research documents and even software prototypes in this manner.

***Telnet.*** The fourth type of usage, closely resembling ftp but extending it a little, is telnet. This allows the remote user not only to access files, but also to log on as an actual user on a remote machine. So, for example, a person may try out programs that are available on a computer at the other side of the world and see the response on their own machine. This allows industry to have access to powerful computers without having to meet the capital costs of buying them.

***Information Servers.*** The final and probably the most revolutionary development has been the growth of information servers. These are highly sophisticated application programs which are designed to use the Internet as a distributed electronic library. Programs such as wais - the Wide Area Information Server, gofer, and www - the World Wide Web - are capable of searching many different remote computer sites for topics that match particular patterns specified by a user. All of these services are improving constantly and their use grows even more rapidly than that of the Internet itself. For the industrial or academic researcher, in any discipline, this promises to

revolutionise the way they access data. In the words of Prof. John Sheppard of the University of Zimbabwe "A full connection to the Internet provides a wonderful, efficient and stimulating tool to break the isolation imposed by distance, costs and poor other means of communication".[5]

### **Experience With Networks**

It might be useful to summarise my own experience with computer networks over the past 20 years. When I lived in Zambia, access to telecommunications was limited to a very unreliable phone service which had to go through a number of manual exchanges between Ndola and Dublin in Ireland. Indeed my own parents had only obtained a telephone for the first time while I was living abroad. This is a far cry from electronic mail and even further from the information super-highway.

Over the intervening years the social use of networks and electronic mail has been very common in the developed world. I have found that many of my former students around the world keep in contact with me and with one another through the Internet system. Quite recently one of my friends was in Los Angeles during the earthquake and a quick email was enough to establish that she had survived the 'quake with the loss of just a few pieces of Waterford crystal! On a broader scale an enterprising Irishman has set up a news services called the Irish Emigrant which produces an electronic newsletter every week. This is sent to 2,300 subscribers in almost every country around the world and will shortly become a fully commercial operation. We should not underestimate the social and economic impact of services like this. Frequently it is through this form of communication that qualified people working abroad discover that there are employment opportunities in Ireland or that the technology that they are developing is now relevant to a company based at home.

However, the most serious uses of computer systems are always for research and the development of research proposals, papers, projects. Students, especially graduate students, make extensive access of the on-line databases that are placed in public directories all over the world and frequently can download substantial pieces of software, documentation or previously published theses. The fact that they can do so almost instantly and for a fraction of the cost of an interlibrary loan is a major advantage. Many papers are written in this way. Recently, one of my colleagues wrote an entire, successful, research proposal over email collaborating with a number of researchers - some of whom he had never met - in universities and companies around Europe. Other ways the network is used include placing research publications on external directories or developing publicity material. Nowadays the latter can include

at least black and white photographs and in the not too distant future perhaps colour graphics and video will be added. Even in the preparation of this short paper I made extensive use of electronic mail and would especially like to acknowledge the assistance received, in this way, from Wendy White at the National Academy of Sciences in Washington DC.

### **The Situation in Africa**

It may not be quite true to describe sub-tropical Africa as "a technological desert", as was done in a recent article in one of the most prominent computing journals [6]. But who can argue with the assertion that "As we enter the age of global electronic communication, more than half the world's population has no access even to the phone network that is the basis of the new information networks. Global division - between the "information-rich" and the "information-poor" is now more sharply defined than ever." [7] Indeed even the "desert" article included the seeds of hope, describing, as it did, the potential of electronic mail and networks in developing countries to counter the feeling of isolation and the lack of access to the most up-to-date technical material in journals and technical newsletters. Nevertheless, a quick glance at the map for international connectivity on the Internet shows clearly that, while the northern hemisphere and substantial portion of Latin America, Australia and India are now connected to the Internet, large portions of Africa have little or no access to international connectivity. In fact the most common form of access is through the ubiquitous Fidonet. Where FIDONET got its name, I'm not sure, but it provides a simple and robust phone dialup linkage allowing electronic mail to be sent from place to place over the most basic telephone system. The problem is, by and large, that networking in Africa has to contend with a very unreliable and out of date telecommunications infrastructure. (see e.g. [8]) It is this lack, rather than in an inherent difficulty in building computer networks, that prevents general access to the Internet.

Efforts are being made however, such as those of the KCINET (Kenya Computer Institute) which is a world-wide association to connect people from Kenya and surrounding countries into the International network. KCINET was established in June 1991 and has members in many countries around the world as well as Kenya. One major objective is, in the words of Shem Ochuodho of the Institute of Computer Science in the University of Nairobi, to "help bootstrap Kenya and adjoining regions into the network world" [9]. KCI plans to establish research and consultancy services; to maintain national and regional resources database and bibliographies; to publish a technical journal; to participate in the formulation of policies, standards and to help

establish centres of excellence. All of these measures would greatly aid both the availability and efficiency of computer networking in Kenya and eastern Africa in general. There are also ESANET (Eastern and South African Network) and HEALTHNET (funded by SatelLife). ESANET plans to link universities in Kenya, Zambia, Uganda, Tanzania and Zimbabwe by electronic mail over Fidonet. HEALTHNET is a medically oriented email service that uses satellite packet radio.

### **A Rôle for Computer Networks in the Process of Development?**

The first point that should be emphasised is that networking, in spite of its tremendous and impressive growth, strength and power is only an enabling technology. Its primary purpose is to support people in what they could do in any event by allowing them to do their work more rapidly and with greater geographic dispersion than would otherwise be possible. The first task therefore is to make the technology generally available. That can be the rôle of government, NGO's and international aid agencies. Computer networking is not, of itself, sufficient reason to invest in an advanced telecommunications infrastructure. But since such an infrastructure is required in any event to help build successful commerce and industry, it would be but a small extra cost to make the networking facilities available at the same time.

The second and very important step is to provide the education, training and support necessary to encourage people to use the network to its fullest advantage. Once people anywhere get even an email service they enthusiastically ask for more [10]. However, given that, in many developed countries, only a small percentage of the population are actually using, or even aware of, the Internet and its facilities, we should not be surprised if it takes some time to spread the gospel of the Internet to other people and to other countries. Nevertheless, full Internet access would provide membership of the world community of researchers, not just in the formal sense by making published journals and scientific material available easily but also in the far more important informal sense by allowing people to take full membership of the community of researchers and developers around the world. It is this access, counteracting the feeling of isolation, overcoming "information poverty" [11] and encouraging people to make use of the latest knowledge relevant to their own personal situation, that will greatly assist, in my opinion, the development of Africa.

In the future, with increasing bandwidth and the ability to transmit more data than ever at higher speeds, it may be possible to transmit multi-media documents, support video conferencing or to provide dialup access to sample educational material which

could otherwise never be economically justified in remote and poor locations. This possibility, in particular in the health care, equipment maintenance and agricultural areas, is being explored by a number of pilot projects at present but, as far as I am aware, it has yet to make its first definite contribution to the struggle for development.

### **Cautions and Conclusions**

Before finishing with some conclusions, a few words of caution are in order. Firstly, the Internet is an organic, self-regulating social organism. It is vulnerable to many potential threats ranging from government censorship, through commercial abuse, to possible takeover by telecommunications multinationals. If it falls into exclusive ownership then the information super-highway will become the information toll road and most of the developing world will not be able to use it. Secondly, the development of a country depends on many factors of which networking is just one. But the provision of a reliable and widely affordable telecommunications system is crucial to development and, with that, can come the added benefit of networking. Thirdly, and most important of all, computers don't network - people do! The Internet is just an enabling technology. It is people working in groups, and sharing a common purpose, who alone can transform the underdeveloped economies and societies. The embryonic African networks can help to forge these national and regional links and, through training and experimentation, build strong and capable groups that are linked to, but no longer reliant upon, the more developed countries of the world.

This paper has given a brief summary of the Internet's facilities. It has argued that this is a potential aid to development in a number of different ways but that an accessible and reliable telecommunications infrastructure is an essential prerequisite. There are encouraging signs that African countries are developing the expertise, the knowledge and the infrastructure that will gradually allow electronic networking to grow. With some external support, appropriate government policies and a determined education campaign to convince potential users, there is no doubt that electronic networks can foster the human networks that will bring industry and academia together in a common effort for sustainable social and economic development.

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