

FIBRE OPTICS, DATA COMPRESSION, AND TELECOMMUNICATIONS TECHNOLOGY ISSUES

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Abstract: During the 1990's the general availability of high bandwidth global and local area networks will increase dramatically. This paper reviews the current state of development of the main global and local communications media and its impact on the graphics arts industry.

Some techniques for data reduction to improve the utilisation of available communications bandwidth are considered.

The impact of open systems, open standards and open product architectures is reviewed.

To appreciate the 'technical innovation' reported in this paper anyone unfamiliar with the role of system engineering should read the appendices.

Introduction

New technology promises to revolutionise the publishing and pre-press industry yet again. At many levels, eg:

Silicon and computer component technology advances are creating building blocks that enable cheaper, faster, higher functionality products to be specified and built, extending the practical application of technology to more and more users.

Interconnection technologies, particularly networking system components, enables the interconnection of 'electronic' users to form tightly coupled production systems. This 'enabling' of integrated systems now extends to wide area networks as well as local area networks, providing some interesting opportunities for pre-press co-operation.

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But the greatest impact of 'technology' that is already revolutionising the way that future products and systems are being defined is in the area of open systems and open standards. Particularly in the way that the major Information Technology (IT) vendors themselves have embraced 'openness' and begun to support the development of products, services and systems that will support and deliver pre-press ready or pre-press quality components.

This is not to say that the IT vendors will directly compete with the traditional pre-press vendors. Rather that together they will develop applications that are truly mainstream open applications systems.

This paper develops this theme with particular reference to new interconnection technologies and techniques, both for local and wide area 'networking' focusing on applications rather than the detailed technology.

The Problem of Image Data Volumes

It is common knowledge that interconnecting functions in a graphic pre-press system involves large volumes of data. Assuming that 'high quality' reproduction is required for a page area similar to this page a half tone colour image will require about 30 Mbytes of data and a 'line art' raster image even more. (Both without data compression.) This volume of data has represented one of the hurdles for developing integrated pre-press systems in the past.

The table below illustrates the size of the problem for various interconnection speeds, relating them to some 'equivalent' communications technology.

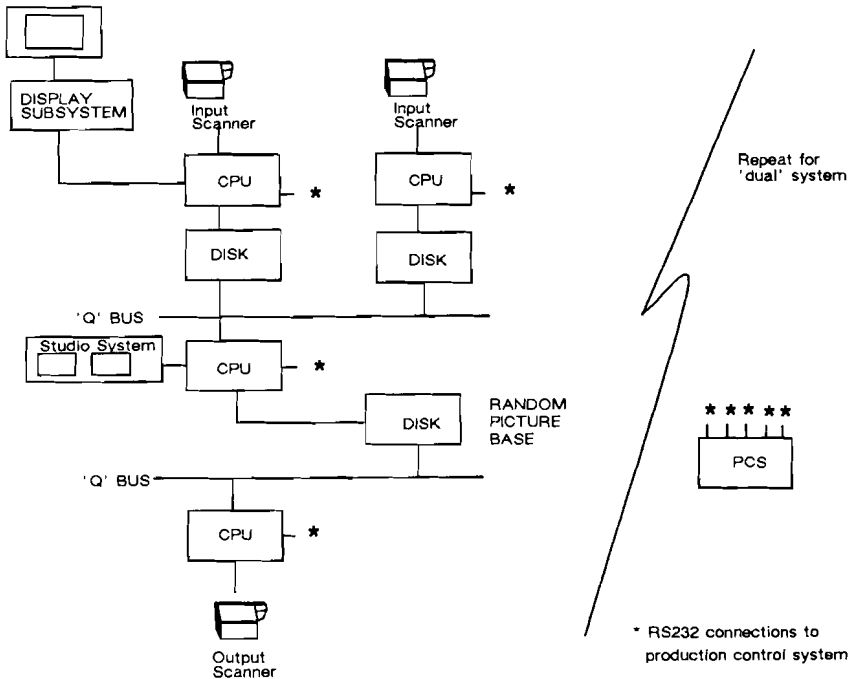
DATA RATE	TRANSFER TIME	TRANSFER TIME WITH 10:1 COMPARISON	TECHNOLOGY EQUIVALENT
300 bps	200 hours	20 hours	Telex Data Rate
2400 bps	27.5 hours	2.75 hours	Telephone Modems
64 kbps	62.5 mins	6.25 mins	Basic ISDN rate
1 mbps	4 mins	24 secs	Typical Ethernet Node
2 mbps	2 mins	12 secs	IBCN (See Telecomm)
10 mbps	24 secs	2.4 secs	Typical FDDI Node
80 mpbs	3 secs	0.3 secs	FDDI II Node

Clearly as the newer technology has emerged the ability to interconnect via standard networks has become practical.

The Evolution of Pre-Press Systems

Until recently many pre-press systems have been integrated using a variety of techniques varying from moving images on film or paper (which is what many newspapers do today) through moving the digital image storage media in the form of removeable disk packs or tape (which is common in the graphics pre-press industry) to specialised, dedicated, configurations of computer buses, parallel interfaces and intercommunications techniques such as that illustrated in figure 2. This is a particularly innovative system configuration (produced by Crosfield!) that would have worked but (unfortunately?) was not accepted by the publishing house that it was designed for.

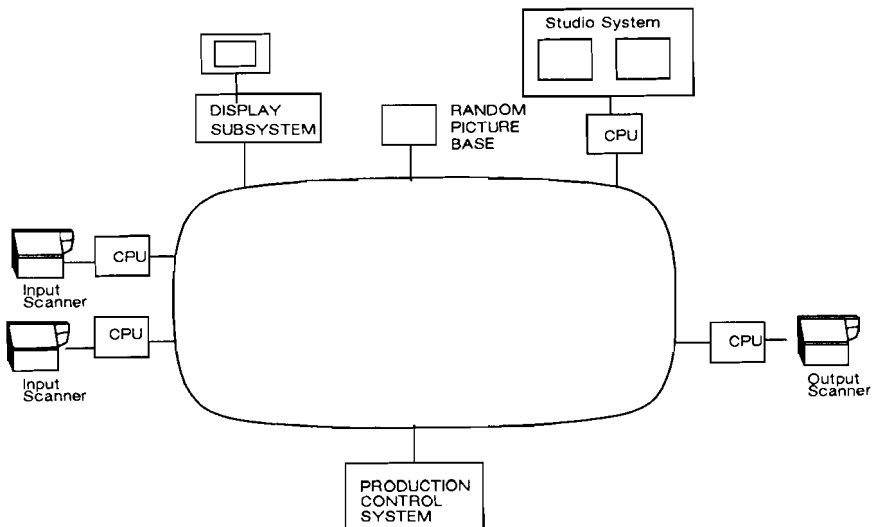
Integrated system configuration circa May 1986 (part only)
Note the mixture of shared disk, CPU bus and RS232 communications technologies.



The introduction of Fibre Optics

During the 1980's the introduction of fibre optical 'cable' technology promised a solution to this interconnection requirement with a possibility of a network achieving tens or even hundreds of Mbits per second. The overriding benefit of the fibre cable was to be these relatively high data rates achieved with the flexibility of relatively large distances between nodes and relatively low costs of connection to the network. In practice one of the best implementations (to date) of optical fibre is the ANSI FDDI local area network. Based on this technological promise the system diagram for the same publishing system illustrated in figure 2 was transformed to that shown in figure 3, which is somewhat simpler to imagine and to engineer. However, (apart from the physical distance between nodes) the performances and costs to connect the 'bus' version of figure 2 and the fibre version of figure 3, are/were comparable.

Integrated system configuration using Graphics Arts Local Area Network (part only - not including repeat 'dual' system)

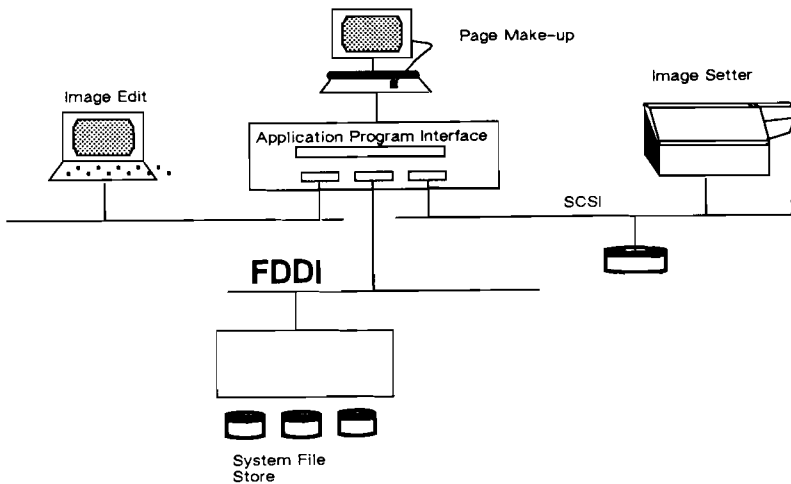


The real advantage of the FDDI 'optical' solution is that it is 'open', supported by many vendors. This offers the system engineer multiple platforms and components to build the system from, giving the user a system product with more choices of system components and a longer life.

And although 'optical' technology is a key part of the FDDI standard it should be noted that electrical cable is also capable of achieving similar data rates. It is the adoption of the FDDI standards by many vendors that has achieved the dominance of FDDI in forward planning applications. Over the next two to three years it will become apparent that the choice of FDDI verses say Ethernet or SCSI will itself become somewhat transparent to the system designer, as the system elements become adaptable to several network systems including FDDI.

Figure 4 illustrates in a system level diagram the concurrent use of Ethernet, SCSI and FDDI.

The use of different network services - in one work station



Whatever the merits of the technology, using FDDI as an example, a system engineer today can anticipate that within two to three years many, if not most, computing engines, workstations, etc will be able to connect to one or more common standard networks offering a data transfer capacity of 10 Mbytes per second or more. This means that, without data compression, an image the size of this page could take only three seconds to transfer. IF there was no other contending network traffic and IF all of the supporting components such as network interfaces, and their protocol and addressing system and the disks to transfer the data to and from were able to sustain the data rate. In practice fibre optics has solved its part of the technology problem - for now.

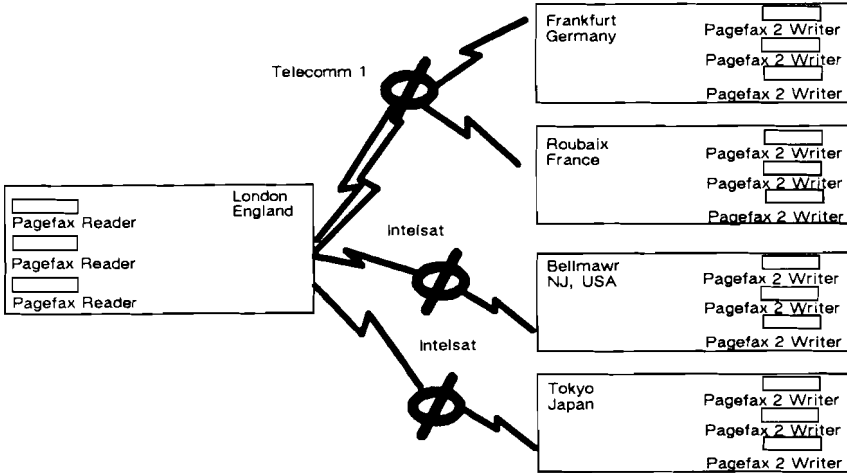
Telecommunications and Wide Area Networks

For wide area networks fibre optics competes with several other broad band communications technologies, notably cable, satellite based microwave, direction focused microwave and line of site modulated laser. These technologies are being deployed and integrated to provide services by the telecommunication companies, the large private carriers in some countries or the PTTs. Without going into detail about the capabilities, merits and problems with each technology (bandwidth, contamination/interference, security, cost of installation, running costs, etc) it is worth pointing out that higher capital investment cost is able to achieve significantly higher bandwidth over fibre optics bundles and the other technologies creating network 'backbones' of tens or even hundreds of gigabytes so that in a few years time, the system engineer can reliably anticipate wide area wide band network capabilities virtually anywhere to anywhere.

Within Europe, for example, the European Community Commission is firmly committed to supporting the development and introduction of an integrated broadband communications network IBCN that will evolve through ISDN and B-ISDN. The IBCN will take some years to fully develop to its stated goal where most businesses and many domestic users are interconnected by a broad band wide area telecommunications network but some of the interim steps such as concentrated fibre optics networks over small areas to form metropolitan area networks (MANs) and/or interconnected local metropolitan area networks via satellite to establish true broadband WANs will occur in

the near future. In fact, the use of satellites (or dedicated allocation of cable, fibre, microwave, etc) to form broad band private networks such as that installed for the Financial Times (figure 5) have already started in this technology direction.

FINANCIAL TIMES PAGEFAX NETWORK



The change coming over the coming few years is exemplified not only by Europe's IBCN but also by Japan's Information Network System (INS) or the equivalent interconnection between local and long distance telephone companies in the USA. It won't be just the large capitally powerful users who will be able to participate in projects or business opportunities using broad band communications but also smaller users and service suppliers including valued added network suppliers.

There will be a cost, much as telephones today, involving start up/capital costs, a fixed cost per month and a cost per measurement of time or data. But it can be anticipated that the total cost of say 1 Kbit today will be similar to 1 Mbit in an IBCN.

Data Compression

With all this bandwidth becoming available it may appear that data compression doesn't have a place. This is probably a false assumption because data compression can reduce data volumes by one or even two orders of magnitude which has positive benefits on not only network bandwidth requirements but also data storage and handling volumes.

Data compression techniques have been talked about in the graphics arts industry for years, implemented even. At Crosfield we have data compression software and hardware products for high resolution contone images, high resolution line art and text images, low resolution images, etc. Most of these are 'Crosfield proprietary' using our own algorithms based on well established and known techniques such as the discrete cosine fourier transform for contone colour images or adaptive, predictive run length encoding for line art and text images but with the final parameters selected and tuned by Crosfield and kept a closely guarded secret. But this 'closed' world of data compression is also changing. The work of CCITT on compression algorithms for facsimile data transmission and the more recently started Joint Photographic Evaluation Group of CCITT and ISO defining data compression for contone images is rapidly developing quality algorithms in the open world so that it is becoming practical to include compressed data in open system design, without having noticeable image degradation

When considering applying data compression it should be recognised that any time data is compressed it will cost time and probably money. It may be that both the time and money are hidden by other overheads or requirements but not always. It should also be recognised that for image processing and final production the data will normally have to be decompressed. Often during a pre-press production process an image is 'viewed' and 'processed' several times and the cost of data compression in time and capital processing power outweighs the cost reduction achieved through the use of compression technology.

Data Reduction

One alternative technique to data compression in a system is to define the system architecture to reduce the amount of data transferred between system elements. This technique is clearly employed when low resolution 'view files' are used to show an operator the image to be

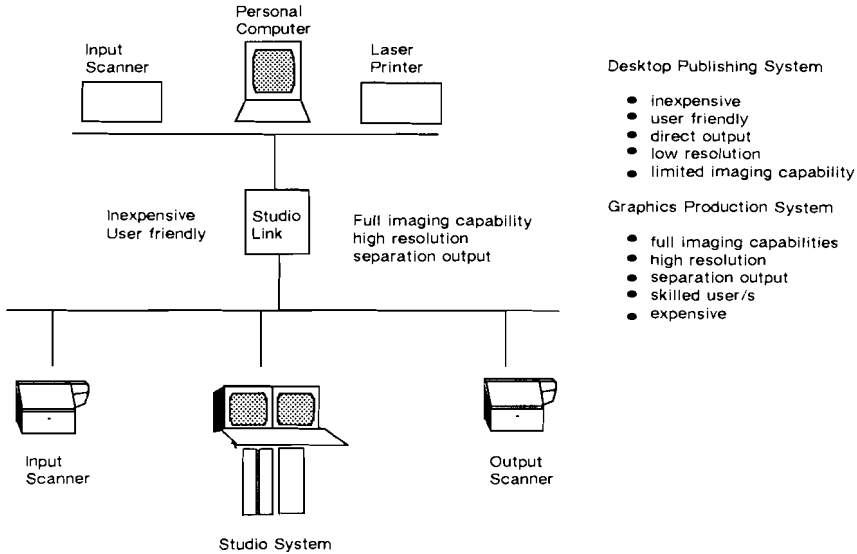
processed or selected without the high resolution image itself being transferred to the operators viewing terminal. In Crosfield systems we regularly use low resolution images in this way ranging right down to 'postage stamp' pictures of only 64 x 64 bytes to form part of the index to a high resolution image that could be 6,000 x 6,000 bytes.

An effective 'compression' of 10,000:1.

A more interesting and very practical application of data reduction techniques is the system design for Crosfield's Studio Link III, which itself is common in its overall design concepts to similar product configurations from several pre-press vendors.

Studio Link III is designed to offer desk top publishing applications the capability of high resolution, high quality colour production. Figure 6 illustrates the system configuration.

Studio Link III



In the Studio Link III application the high resolution image is input to the system using a conventional high quality colour scanner and the digital image stored in a conventional studio system. A suitable low resolution

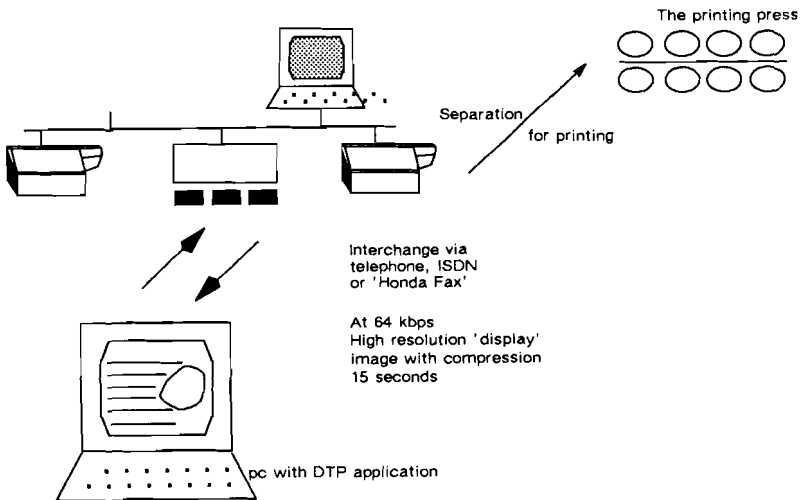
version of the high quality image is derived and made available via an Ethernet local area network, replacing the scanned image normally produced for desktop publishing. The conventional DTP product will use this low resolution, low quality image as a component of its page make up and produce a DTP quality page. Instead of sending the DTP page to a conventional image setter the output ready postscript file is transferred back to the studio system where the postscript component is rasterised at a suitable high resolution and the low resolution images are replaced by the original high resolution images. Any image processing such as crop, rotate, resize, etc is defined by the DTP package using a Crosfield page plan format. The studio system will perform the appropriate image processing before assembling the final page. Hence, the studio system becomes an image, image process and print server to the DTP client in an equivalent of a client/server architecture.

Using this low resolution image serving technique the amount of data handled by the networks and the DTP products/platforms is reduced by typically 20:1 compared to using the high resolution image. This makes the use of the lower cost DTP products practical when handling high resolution page layout and/or design. The DTP product can cost almost an order of magnitude less than an equivalent 'conventional' high resolution workstation and although it can't be used for all of the detailed image processing functions that a conventional workstation could handle the DTP product will very effectively supplement the high resolution unit and in some applications can replace it (provided the image's processing 'server' is present).

Although Studio Link III is implemented using Crosfield's proprietary page plan format this format is in the public domain and is published in Crosfield's Freeway Open System Interface Manual. For the future the page plan itself could be based on a true open standard, such as DDES IT8.3, SGML, SPDL or a suitable derivative making this type of application truly open.

Figure 7 illustrates an interesting extension to the Studio Link III system product, the concept of a high resolution 'publishing bureau' that supports DTP products. Interconnection between the bureau and the DTP product could be via LAN, WAN or floppy disk, combining most of the concepts mentioned in this paper so far to form an attractive commercial application - high resolution publishing services for personal computers.

Affordable, Achievable, Telecommunications Applications
The Publishing Bureau - a value added network service

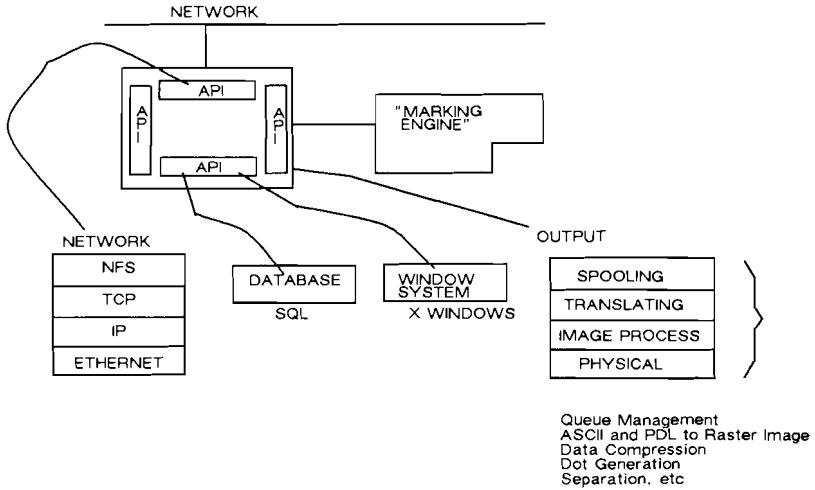


Open System Standards

One other idea that has consistently been mentioned throughout this paper has been that of open system standards. The ISO OSI 7 layer model for open systems has received much publicity and attention over the past few years. The use of this model to interconnect system elements using standard open components is well understood, especially the possibility and practicality of implementing graphic pre-press systems using products from several vendors.

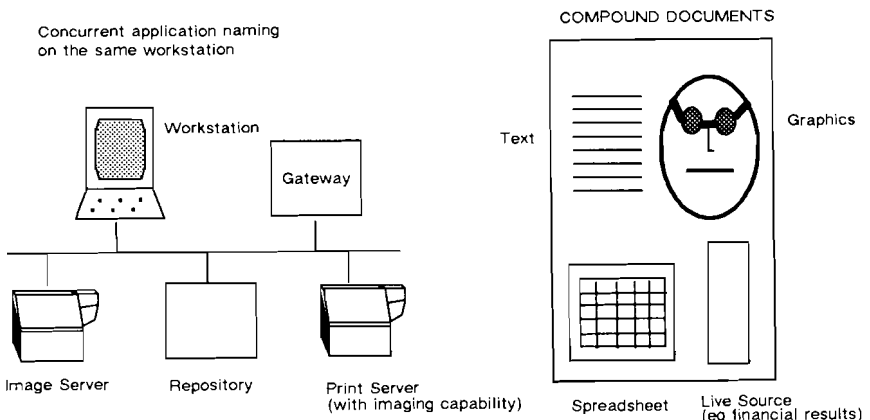
What may be less well recognised by the graphic arts industry is the progress being made by IT platform vendors and the various national and international standards organisations in defining a common application environment for IT application. An application environment that includes definitions of the necessary hardware and software products to allow pre-press systems to be built on open platforms, interconnected by open system standard networks, etc and served by input and output image servers capable of producing output material suitable for printing. Figure 8 illustrates the concept of the application engineering environment.

**Inside the 'IMAGE SETTER'
The Application Program Interface API**



Not only are the IT vendors developing the platform products and interconnection standards to enable this open system application to be developed, they are extending their scope to define the applications architecture, the user interfaces and application integration in such a way that a system of the near future will be able to integrate a number of applications to produce a publishable document. Figure 9 illustrates the hardware components that would be included for a publishing application. Note the use of a spreadsheet product and a wire service in the page.

'Office' Documentation System



Also note that for such a publication it is already practical to define the application so that the spreadsheet figures are themselves derived from an application, such as a Manufacturing Resource Planning product, which itself is coupled via DDIS standards to another application to derive the price quoted from a remote supplier. This vision of the future is almost defined today in terms of standards and system architectures. It is important that vendors such as Crosfield engineer products and applications to conform to these standards and offer integrated opportunities in the future.

Conclusion

Fibre optics, telecommunications and data compression are important components. But only components in a common application environment where publishing and graphics images are becoming mainstream IT application components.

In defining these architectures there is much work going on under the auspices of office documentation, digital document interchange multi-media information systems, high definition television etc. There are several major projects underway sponsored by trade associations ISO, CCITT, etc. MAPS, TOPS, CGATS, CALS, etc all represent standard architecture endeavours in the respective fields of manufacturing, office automation, graphic arts, purchasing document interchange.

Two projects of significant importance in the field of fibre optics telecommunications and graphic arts pre-press systems are being run under the European Community RACE projects.

The first, the RACE-BERKOM project states that its aim is 'to insure and support the development of future telecommunication services and end-devices for broadband ISDN and IBCN. Within BERKOM there are demonstrator projects focusing on telemedicine, telepublishing, broadband information systems, Computer Integrated Manufacturing and Multi-media document communication.

It is based on a 140 Mbits Metropolitan Area Network and has extensive links with other European Community Communications Projects.

The second, the RACE-DIMPE is defining a Distributed Integrated Multi-media Publishing Environment with the stated aims of developing pilot applications to:

- * stimulate the publishing market and create new opportunities for improving current products and providing new services.
- * compile a complete specification for distributed publishing.
- * provide widely acceptable publishing standards.
- * develop an open publishing architecture.
- * include desktop publishing, multimedia products and broadband communications.
- * assemble a complete list of publishers' requirements for the future European broadband network.

To ensure that we understand, follow or even influence the rapidly developing standards and IT world is a difficult challenge. In IBM, or Digital Equipment Corporation for example, they each have over 250 engineers actively involved in representing them in defining open standard systems and standard architectures. Few of us could match that. Perhaps our only choice is to subscribe to one or more to the excellent journals that offer the service of shadowing the standards world. And for vendors such as Crosfield to ensure that our products and applications exist in this open systems standards world. Hopefully, they do.

Alan E Locke
30th March 1990

Commercial Networks Based on OSI

Office Manufacturing Graphic Arts

ISO Layer	TOP	MAP	?
7	FTAM-DS-VTP-MNS	FTAM-DS-MMS	THE CHALLENGE
6	OSI 8823	OSI 8823	FOR THE GRAPHICS
5	OSI 8827	OSI 8827	ARTS INDUSTRY IS
4	OSI 8073	OSI 8073	TO ESTABLISH
3	OSI 8473	OSI 8473	SIMILAR STANDARDS
2	OSI 802.2	OSI 802.2	VIA ANSI IT8?
1	802.3/802.5 ETHERNET OR TOKEN PASSING RING	OSI 802.4 TOKEN PASSING BUS	ETHERNET OR FDDI?

(TOP is not to be confused with SUN Microsystem's TOPS)

FTAM: File Transfer and Access Management includes primitives to connect to a file store, select a file, create a file, open or close a file, delete a file, etc.

Extension to networking standards and technology

LION: 140 Mbits/sec optical network (European Community ESPRIT)

QDSX: Dual 155 Mbits/sec Metropolitan Area Network (Telecom Australia)

MAX: 600 Mbits/sec prototype Metropolitan Area Communications system (European Community ESPRIT)

FDDI2: 1 Gbyte/sec Multimedia (ANSI X3T9.5)

Further reading:

John McConnell - Internetworking Computer Systems (Prentice-Hall 1988)

Gary Y Kim - Broadband LAN Technology (Artech House Inc 1988)

Andrew S Tanenbaum - Computer Networks 2nd Edition (Prentice-Hall 1988)

For more information on the European Community Race Project DIMPE, contact the DIMPE Project Office (Telephone: +44 223 420651 or Fax: +44 223 420608).