New Applications

Group 4 FAX — Facsimile Transmission for Document Delivery

Andrew Braid,
The British Library Document Supply Centre.

Abstract

Although first developed 150 years ago, it is only within the last 25 years that facsimile transmission has had widespread use. Its use for document supply is limited to the last 10 years when the CCITT group III standard was ratified. The British Library Document Supply Centre (BLDSC) carried out a trial in 1983 and subsequently added facsimile document transmission as part of its Urgent Action Service. Group III transmission has limitations for document delivery applications. These are discussed along with the advantages and disadvantages of group IV transmission. Details are also given of a trial of group IV transmission between BLDSC and University College in London.

Part 1 - Background

History of Facsimile Transmission

Facsimile transmission is one of the oldest surviving examples of electronic communication technologies. (It is possibly the oldest still to enjoy increasing use.) It was developed, in the early 1840s, by the Scottish physicist Alexander Bain. Bain was attempting to solve one of the pressing communication problems of the day. This concerned the communication between railway signal-boxes. In its earliest form facsimile transmission had to rely on the telegraph network. The development of the telephone and the telephone network was more than 30 years later.

Consequently, early use of facsimile transmission was extremely limited. It was used over the developing radio network in the early 1900s. Its first commercial use over the telephone network was not until 1925. Even then, use was limited to specialised applications, mainly for the transmission of newspaper pictures, weather maps and for military applications. It was not until the 1960s that any real progress was made. This was mainly due to the Japanese. As well as their expertise in office equipment, the Japanese realized the benefits of facsimile encoding for electronic transmission of the Kanji alphabet. This is difficult to convert into character encoding. From the mid-1960s onwards developments in facsimile transmission took place at a tremendous rate. After over a century of virtual inactivity in just 12 years (1968 to 1980) there were no fewer than three international standards developed and implemented. A fourth recommendation followed 4 years later. Today there are so many facsimile machines in the world that nobody counts them any more - probably approaching 10 million in total. The vast majority are manufactured in the Far East, mainly in Japan, and almost half of them are also used there. The simultaneous development of the public switched telephone network (PSTN) on a world wide scale, with automatic switching, means that it is now possible to transmit documents to any one of the millions of facsimile machines now in existence.

The CCITT Group III Facsimile Standard

It was inevitable that facsimile transmission should be used for document delivery. The first use is not recorded but it was probably not until the late 1960s. It was little used: it was slow and expensive in transmission as well as equipment costs. The quality of an image in facsimile encoding is directly related to the volume of data used to define that image. A typical page in a learned journal contains far more textual, and often non-textual, information than letters or memos that are transmitted by office facsimile machines. Journal articles are typically

several pages long; up to 10 pages is quite common. There are often small sub- and super- script characters in scientific and technical articles. These require finer definition than normal text.

The introduction of Group III machines in the early 1980s was the first universal standard. Machine prices began to fall and transmission times improved. There is a lot of confusion about transmission times. Most manufacturers base it on a "standard" page. The pages of learned journals have far more data per page which increases the transmission time. Many experiments with the use of group III machines took place in the early 1980s. A typical experiment was that between BLDSC and Chalmers University of Technology in Gothenburg, Sweden. In the first quarter of 1983 over 1,000 pages were transmitted. Transmission time averaged 2 minutes per page and about 25% of pages had to be retransmitted because of quality problems. The machines used were expensive, over £5,000 each.

Today, the use of group III transmission for document delivery purposes has increased. For example, BLDSC is transmitting over 1,000 pages per week to customers all over the world. But there are inherent disadvantages in the use of group III facsimile machines for document delivery purposes. These include:

1. Transmission times still in excess of one minute per page and transmission is, therefore, expensive for multi-page articles.
2. Most machines work on the hopper feed principle and it is necessary to make a photocopy of articles from bound books. This is time consuming, adds additional expense and leads to loss of quality.
3. The majority of machines use thermal paper in the printer. The archival qualities of this paper are very limited.
4. The normal resolution is 200 lines per inch by 100 lines per inch (although 200 by 200 lines per inch, fine resolution, can be supported). Even the fine resolution is not adequate for some of the small text, particularly sub- and super-scripts in formulae.
5. Until recently there was no error correction; even now it is limited.

Machines are now available which will overcome some of these problems, eg. machines with laser, as opposed to thermal, printers and machines with flat-bed platens. The problems of speed and resolution have not yet been overcome except in a proprietary way. Error correction and detection have now been added to the group III standard, although not all machines are able to support these improvements.

The CCITT Group IV Facsimile Standard

The group IV facsimile standard was ratified by the CCITT in 1984. It has several advantages as far as document delivery is concerned. A page is transmitted in about 10 seconds. The machines use laser printers as standard. 200 by 200 lines per inch is the minimum resolution which is supported and resolution can be up to 400 by 400 lines per inch. Full error correction is incorporated in the protocol. In combination the result of these improvements means that the quality of a transmitted page is indistinguishable from a photocopy.

A major disadvantage of the group IV standard is that it requires a digital rather than analogue transmission medium. This is available on a private point-to-point basis or on the infant Integrated Services Digital Network (ISDN). It will be some years before ISDN becomes widely available, but prototype networks have been available in limited areas for some time. In the UK a pilot network, IDA, became available in 1985. The BLDSC decided to experiment with group IV machines using the IDA network. The first page was transmitted from BLDSC at Boston Spa in Yorkshire to University College, London, in September 1986. This was probably the first commercial use of group IV facsimile transmission over a public switched network anywhere in the world. The objectives of this first trial were very limited. The basic question to be answered was "would it work?"

At that time group IV transmission had never been used for document delivery purposes. Also, whilst it was known that it did perform satisfactorily on a short term basis it had not been used over an extended period of time. The trial suffered many problems in the first 9 months of operation. But results were encouraging when the system was operational. Upgraded network terminating equipment was installed in Summer 1987 and there was an immediate improvement. Trials continued for over 12 months with UCL but

the general introduction of ISDN did not occur as quickly as originally expected. In Autumn 1988 the British Library upgraded its internal telephone network. This resulted in the inability to support the group IV facsimile machine. An interim solution (which is still in use) was found by the end of the year. This involves the use of a third machine which acts as a bridge between the British Library's internal ISDN and the public ISDN. The trials with UCL continued. It was not until 1989 that a second trial took place, this time with ICI C&P at Runcorn. This trial is the subject of the second part of this presentation.

ISDN is now also available in the UK from Mercury Communications Ltd. (MCL). In an attempt to overcome the limitations of the BT ISDN and the necessity of using the bridging machine, the British Library in September 1989 obtained a connection via MCL ISDN. To date the two networks do not interconnect, but it is predicted that they will by the end of 1990. There will be wider availability when this does occur.

An alternative way of providing a digital channel is to use satellite communication. BLDSC became involved in the joint European Commission and European Space Agency APOLLO project as long ago as 1984. This got as far as an impressive demonstration of the system at Boston Spa in early 1987 but in 1988 the project came to an end for financial and political, rather than technical reasons. Direct broadcast satellites (DBS) offer a cheaper alternative to the relatively expensive APOLLO system. DBS systems use small, inexpensive receiving equipment for television signals. It is possible to transmit data with the DBS TV signals in much the same way as teletext operates in conjunction with normal TV signals. In this way it will be possible to reach sites in the UK which do not have ISDN connections and also sites in Europe where it will be some years before interconnections are made.

The Future of Facsimile Transmission

Apart from its high quality, a further attraction of group IV is its low transmission cost. In the UK at present, ISDN has the same tariff as PSTN, although connection charges are higher for ISDN. The effect of this is that an average 10 page article can be transmitted over ISDN for the same cost as a single page using group III transmission. Depending on circumstances this means that an article can be transmitted more cheaply than using conventional methods. In the UK the transmission cost of a 10 page article in the local call area at off-peak rates using group IV facsimile is £0.05. At peak rate and long distance, the cost rises to about £0.50. For comparison, the cost of postage and packing of a photocopy at BLDSC is about £0.75. The cost benefit of group IV is such that in spite of the high cost of machines (currently almost three times the price of group III machines with comparable features) and the high cost of connection and line rental of ISDN still make it financially attractive compared to group III transmission, and even the use of postal services, provided the volumes are high.

The ability to scan and transmit high volumes must be resolved before group IV transmission can be used extensively for document supply applications. Most group IV machines currently on the market are simply duplicates of group III machines from an operating point of view. The potential of group IV allows far more than just scanning a document, transmitting it and printing it at the receiving end. Group IV machines work on the store and forward principle. All the pages of a document are scanned into the memory of the machine before transmission begins. Thus, transmission is not dependent upon the time taken to scan a page. Similarly, at the receiving end, the printing takes place after the whole document has been received. This mode of operation allows for scanning, transmission and printing to be separated to a much greater degree than is possible with the method of operation of most group III machines.

The problem of a flat-bed platen has only recently been resolved with the introduction of a Fujitsu machine in place of the NEC machines used originally in the trials at BLDSC. But it is not necessary for the scanner to be physically linked to the printer. It is theoretically possible to use a scanner attached to a processor and buffer store and have a similar arrangement at the receiving end with a laser printer in place of the scanner. This arrangement is now possible with group III transmission and a fax card. To date fax cards have not been developed for group IV transmission.

By using this method of working it should be possible to reduce the equipment cost. Group IV facsimile machines are three or four times more expensive than their group III equivalents. However, the group IV protocol is over specified. It gives error-corrected transmission over an error-free transmission medium. It should be possible to use file transfer, rather than facsimile protocols over ISDN. This is about to be tested by UCL assisted by a BL Research & Development Department grant. If it does prove successful then the cost of high quality facsimile transmission should be reduced considerably.

Conclusion

Group IV facsimile transmission, or at least some variation of it, offers great promise for the future. Experience to date, of which you will hear more in the next presentation, has led us to believe that it could replace delivery for all photocopies despatched to all medium and large customers of BLDSC. There is a long way to go before we reach that state and many more frustrations to suffer.

There are further possibilities. The facsimile delivery of documents is the final part of a complex chain of document supply. There are developments in other links in the chain in the electronic requesting and the electronic storage of documents. Although interesting in their own right, there is much greater scope when the three elements are combined. This may be the subject of a separate presentation to a future UKSG Conference.

Reference

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