Remote on-line Data Processing and its Communication Needs

Remote on-line data processing is at a very early stage of practical achievement, so it is perhaps necessary to justify the making of long-term predictions, which are necessarily speculative. Long-term predictions may be valuable because they may indicate the future need for new kinds of communication service. The development of the telephone/telegraph system is constrained by present-day economics and by the inertia to change due to the need for all equipment to fit into the existing system. If new services are needed, or better ways of providing the present services can be foreseen, requiring major changes, then planning well ahead is needed so that changes affecting the whole system can be started many years before they can be justified by immediate economics. It may also prove the research should be started now to determine how best to provide new services in, say, ten years' time.

This note contains some very tentative predictions, intended to show the sort of considerations that might go into a more prolonged and detailed study.

Remote, On-line Data Processing

In this kind of data processing the computer system handles all the records in a well developed file-store and communicates at about 10 characters per second with people working at keyboards with simple printers and, eventually, cheap tabular and other displays. (The displays must have local storage to keep the communication rate economically feasible.) Since data is not accumulated at stations, faster transmission using paper tape cards or magnetic tape is not a requirement.

Larger users might have their own computers, which carry out simpler parts of the work, giving some immediate feedback to the users, and collect the data so that it can be transmitted for major processing jobs. This would need a higher transmission rate.

If the use of individual stations becomes economic, and this depends on the efficiency of communication, this kind of traffic will be greater than that between satellite computer and central service, because many more small organisations will be able to afford the simple equipment.

Already the few such services in existence (such as computation, stock exchange and airline reservation) show that they can be economical. Improvements in the economics of computers seem to be continuing, therefore the expansion of such services will not be limited by the cost. The security of the information is a problem, however, which leads to a subject of research:

Security of data in doing business via a national network. (This refers to security against unauthorised access rather than against loss of data.)

Forecast of the Traffic

A typical transaction will consist of about 50 characters sent at typewriting speed to the computing centre, and a reply of about the same size sent rather faster. These messages include identifying numbers and names, the request, confirmation of the request and reply.

The greatest traffic could only come if the public used this means for everyday purposes such as shopping. It is doubtful whether the public can work accurately and confidently enough in a fixed format, and whether the £100 terminal cost (present-day prices with allowance for mass production) would be acceptable. There may be limited use of tone-button dials for simple transactions, but this needs no addition to the telephone service to provide it. Ultimately, looking further ahead, speech recognition and natural-language analysis might give the telephone system these new applications.

The big traffic/keyboard messages will be from professional operators. For example the staff dealing with the public in banks, post offices and government offices will use them. Here the fixed format is not a difficulty. Other users will also be specialists in their job, such as designers using computational tools. People sending enquiries and placing orders for goods of all kinds will make up a large section of the traffic.

Suppose, however, that 10% of all the working population or 2% of the whole population makes frequent use of these keyboards, sending 100 messages a day each. This might compare with non-business use of the telephone amounting to several telephone calls per head per day. Business use of the telephone may be reduced by the growth of the kind of service we contemplate.

The overall result is that telephone calls and short data-messages will not be very different in number. Since any sensible engineering solution should pack a data message into the equivalent of a fraction of a second of a telephone channel, we can predict that the communications needs of data for on-line remote processing will be small compared with those of the telephone network.

We are assuming that the adoption of on-line data processing will largely remove the need for fast transmission of a considerable amount of data. Large quantities of data for transmission have either been accumulated over a period in the wrong place or generated by a computational process in the wrong place or generated by data-acquisition machinery. The sort of situation

where a large experiment generates data which must be transmitted for reduction elsewhere can be assumed to be exceptional, and not necessarily to require the most economical provision for communication.

Qualities of the Service Needed

It is important to remark that, though its volume will be small, the short message traffic will be vital to the country. It will, in fact, carry more information than the telephone network. Corresponding to its much lower redundancy, its requirement for noise-free transmission will be greater.

Each station sends and receives data at a low rate and sporadically. The unit message of about 50 characters probably takes 10 seconds to send to the centre and the reply takes 5 seconds to return. A delay of up to one second in each transmission might be permitted if it saved money.

When a station has connected with a certain data processing service, and the service centre has identified the station, subsequent messages should be passed through the communication system without further red-tape, but only occupying channel capacity when the keyboard is being used. Thus a keyboard could be permanently ‘connected’ to a distant service but only be occupying the minimum of local exchange equipment. The ‘connection’ would simply be an entry in a table in the controlling computer.

The accuracy worth striving for where humans generate and receive the data is limited, but one error in 10,000 characters would be a desirable goal. For those cases needing greater accuracy the system could provide for transmission by two paths and comparison, but the terminals would in that case need special attention in order not to add their own errors.

For security, the system might provide from a third source to each end of a transmission path a ‘one time pad’ on demand. This would ensure that nowhere in the network was the data in clear. There would, of course, be a limit to the degree of security that a public service could offer.

Accuracy of routeing is important and verification of the station’s identities to each other is a service that will certainly be needed. This leads to a subject of research: The details of the interaction between the users and the system in such a message network (as distinct from the interaction between the two parties to a call).

Means of Providing a Short-Message Data Service

There has been some experience with digital transmission for P.C.M. speech over junctions. This shows that, using regenerators at the spacing normally used for loading coils, two pairs of wires can carry 1.5×10^6 bits/second. The reduction of cost as compared with the transmission of digital data over a speech path is about 25:1 (Hartley and Thomas, IEE Colloquium, October 1965).

The channel capacity provided is embarrassingly large. If 10^6 people in the London area sit at keyboards for an 8 hour day and send 100 calls per day on average, each of 50 characters, this amounts to 1.4×10^6 bits per second on average. Thus the capacity of a single P.C.M. junction would not be used on any one route.

Since there must be independent channels to allow for fault immunity, it seems likely that digital data will share the transmission equipment provided for speech. It will not necessarily influence speech towards the universal adoption of P.C.M., in fact data might always have to be carried less efficiently than is technically feasible to suit the economics of speech transmission. Further speculation on the means of transmission is unnecessary since the cost of transmission can easily be seen to be very low.

The packing of the short messages onto a digital path at 10^6 bits per second is possible by short-term storage with very small delays. For smaller capacities, down to about 10^4 bits per second there will be no problem, but since delays may occur at each switching centre they must be individually no more than 100 milliseconds. This implies that 10^4 bits second is about the lowest total transmission capacity between two switching centres which is allowable without partitioning the message into smaller pieces. Already at 50 characters the overhead due to routeing information will be relatively large and further partitioning seems undesirable.

A problem will arise in giving economical service in areas with a low concentration of data stations, such as residential areas. Apart from this, the cost of transmission will be very low, and it may happen that the capital cost of the computers handling the storage and multiplexing at each switching centre dominate the cost. This leads to a research topic: the system design and programming of message switching computers for the public network. Several examples of private systems exist, but there is, I believe, no British firm in the business.

Other uses for a Short-Message Data Service

Such a system could take over the telegraph and telex services and make them more convenient because the other applications would cover the cost of many more sets of terminal equipment. The interaction with the system might have to be simplified so that anyone used to the keyboard could send messages as well as operate his own specialised services.

Ultimately the control of the switching system for telephones might use messages carried via the message network. This would be potentially cheaper and more reliable than using various forms of modulation on the telephone channels, and it would fit in with computer control. It would also allow more complicated automatic interactions with the telephone system such as personal calls set up via keyboards.

D. W. Davies
10th November, 1965