Preparation for the NRD Meeting of November, 1970

The German approach to the new data communication network, based on the Siemens EDS switch and their concept of ‘transparency’ is entirely opposed to the approach taken by the U.K. Post Office. Although we may not expect to change the views of the Germans and those who have adopted their approach, I believe that we should state our views strongly and clearly in the hope of persuading others not to adopt the German approach. World agreement on the German network would put back the realisation of a useful data network by 20 years.

This paper is an attempt to state the argument against the German proposals. The argument must start from first principles because it is at a basic level that our views differ. I apologise, therefore, for making several elementary points in the paper, but I think it would be a good thing to have, written down, a statement which (I hope) the whole UK delegation will endorse.

Representation of Digital Data

Digital data may be represented in many ways, but the basic representation is as a sequence of binary digits. This sequence of digits is not related to time, and may be stored in various ways or transmitted in various ways. In transmission, waveforms related to time are usually (but not universally) employed. The time aspect is introduced for transmission purposes.

The essence of the representation of digital data by time-dependent waveforms is that the time dependence should be accurately known. For example, in traditional start stop the speed is fixed and so is the format (start bit, information bits and stop bits). This allows the information contained in the waveform to be extracted, even though the precise timing of the start bit, and hence the phase of the ‘clock’ is unknown before a group of bits (character) is started.

For the synchronous type of transmission now favoured, whenever possible, the phase is maintained but start stop feature can still be employed, whether or not the framing of bytes (characters) is maintained.

A variety of speeds and formats has, unfortunately, been established.

Regeneration

The characteristic of the digital representation of data which led to its adoption in computers was the possibility of complete regeneration of the signal to remove a small amount of noise and distortion. The same advantage is responsible for the introduction of PCM for speech

transmission and for the fact that all new methods of transmission are being developed around digital methods, with full regeneration.

Time Analogue Transparency

The various time-dependent representations of digital data require a knowledge of their speed and format so that they can be understood at the receiving end. The same knowledge is needed for regeneration.

For transmission without regeneration, a different approach is possible, according to which the speed and format is not known, the only restriction being that transitions should not be closer than a certain interval. Then the channel becomes, in a sense, an analogue channel, in spite of its binary signals, because transitions may occur at alternative instants which differ by small amounts. Regeneration is not possible and the accumulation of telegraph distortion is a problem. The direction of development of information technology has been away from such analogue representations.

To carry such a ‘time-analogue-transparent’ channel by a digital transmission system, the kind that will eventually replace most others, one must encode the transition time to sufficient accuracy to avoid distortion. The digital representation then produced is a double transformation of the original digits. Such transformations are inefficient. We have an example of this with a speech channel carrying at most 10,000 bits/second and encoded in the 56,000 bits/second of a PCM channel. Digital encoding of anisochronous data uses only about one third of the available bit rate; and adds its own component to the telegraph distortion.

Data Switching Development

For a large part of data traffic there are advantages in the packet-switching method. It is, for example, suitable for concentrating the traffic for large computer centres or multiplexed groups of terminals.

Any method of data representation which does not easily allow conversion to the simple digital form prevents the use of packet switching, with its various advantages.

Facsimile

Virtually the only example of a truly anisochronous communication requirement is the transmission of black-white pictures. The future of this method of transmission is uncertain. It

has not shown the very rapid increase that data communication traffic has shown. There are no heavy local concentrations of traffic like those at time sharing centres nor are there large private networks. In fact all the problems (such as error rate, response time, local concentration and proliferation of private networks) which a data network is designed to cope with are absent from facsimile transmission. It would be wrong, therefore, to distort the design of a data network to meet the requirements of facsimile. Modern facsimile developments designed to remove redundancy are resulting in a data-like representation which does not need an anisochronous channel, so the communication requirements of facsimile are not settled.

Summary and Conclusion

Digital information can be represented for transmission in many ways. The traditional start-stop method will have limited usefulness in the future, but is important today. Methods will be employed which allow efficient encoding on digital transmission channels, regeneration and packet interleaving. With a limited number of start-stop standards, conversion to digital form is possible. Transparency in the time-analogue sense may have temporary use for low speeds with current designs of terminal, but it should not be allowed to bring new modes of transmission into being which will later cause difficulties in conversion to true digital representation. Non-data traffic should not influence the design of a data network.

The disadvantages of the time-analogue transparent method for the operation of a data network can be summarised as follows.

i. Regeneration of the signal in the full sense is impossible. This gives rise to a kind of distortion (telegraph distortion) which cannot be corrected and accumulates through the path taken by a call. The trend of development in telecommunication is towards methods which allow complete regeneration.

ii. The transmission of time-analogue signals on the digital transmission paths which will predominate in the future is inefficient.

iii. The employment of data representations which, because their speed and format is uncontrolled, cannot be converted into true digital form prevents the introduction of packet-handling which has special advantages in communication between terminals and large central computers.

iv. For the higher speeds, efficiency considerations and the practice of synchronous transmission which is already established will lead away from the time analogue method.

Adaption of the time analogue for low speeds will result in two different principles, with entirely different switching methods, having to be accommodated in the telecommunication network.

All the indications of the past two decades point to the simple digital representation of digital data for transmission in digital line-systems, not a conversion to time-analogue and back to digital.

D. W. DAVIES
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