A RING LOCAL NETWORK WITH INTEGRATED VOICE AND DATA TRAFFIC

G. Benelli, E. Del Re, R. Fantacci, G. Garigliani, R. Pieroni

Dipartimento di Ingegneria Elettronica,
Università di Firenze,
Florence, Italy

ABSTRACT

In this paper the integration of voice and data in a ring network is considered. Some different strategies for the subdivision of the channel capacity between the two types of traffic are presented. The first strategy utilizes the circuit switching both for voice and data. The other strategies utilize hybrid switching: circuit switching for voice and packet switching for data. Comparisons between the different models, obtained through computer simulations, are presented.

1. INTRODUCTION

The development of communication networks with integrated services has received increasing attention over the last years for reasons of economy and flexibility. In this way, it is possible to implement digital networks with high reliability, performance and rate of transmission [1],[2].

One of the most important problems is the integration of voice and data. These two types of traffic present very different characteristics; therefore, it is difficult to find an optimal common strategy. In fact, circuit switching is optimum for voice communication in order to achieve a constant and negligible delay, while packet switching is suitable for data transmission.

These problems are very topical in local networks where the technological state of art permits the integration of the services more easily than in the geographical respect.

In this paper, we consider the integration of voice and data in a local network with a ring structure.

This architecture presents, with respect to other similar solutions, a higher flexibility and permits a higher number of possible solutions for the integration of the different types of traffic. We have considered many different strategies and switching methods in order to make the two types of traffic coexist on the same network. In particular, both fixed and adaptive solutions have been examined for sharing out the channel capacity between voice and data. Circuit and packet switching, and hybrid switching are examined. A new strategy for the assignment of channels to the data traffic, particularly suitable for the ring structure is also described. This strategy permits to reduce significantly the average delay for data transmission.

Through computer simulations, the performance of these different strategies is evaluated for different traffic conditions. Our results show that these techniques can be very advantageous, particularly in the case of adaptive strategies.

2. ARCHITECTURE OF LOCAL NETWORKS

The well-known structures for local networks are the star, the bus, and the ring structures. In the star structure, all the stations are connected through a central switching node (Fig. 1a). In this structure the peripheral nodes are very simple to implement; nevertheless, such networks are critical as to the reliability of the system when failures in the central node occur. The other two structures are more flexible and, at the same time, they permit more efficient and reliable solutions. In the bus network, the stations are connected through a bidirectional link (Fig. 1b); the main problem is the access to the communication channel in order to avoid interferences between different users. In the third architecture, the ring network, the stations are connected through a monodirectional close path (Fig. 1c). In the ring network, the traffic flows in only one direction around the ring from station to station. These stations can be subdivided in three types, denoted in Fig. 1c with the letters A, B, and C. The A stations are called the 'supervisor'. They control the traffic flow in the network, handle the transmission errors by killing the unrecognized packets and ensure the synchronization of the network. The B stations are the normal nodes at which the users are connected, and the C stations handle the exchanges between the ring network and the external communication systems.

3. INTEGRATION OF VOICE AND DATA IN A RING NETWORK

In this section we describe some strategies for the integration of data and voice traffic in a ring network. The ring networks have been extensively studied for data transmission and in particular for computer networks [3]-[6].

The two well-known strategies are the 'control token' and the "register insertion'. These two strategies and the others seem suitable for transmission of 'bursty' traffic, characterized by high values of the peak/average ratio. Therefore, these strategies are not suitable for transmission of continuous signals as, for example, voice or continuous data traffic.

In this paper we analyze some different strat egies in order to obtain a sufficient quality of service both for data and voice.

In the first analyzed model we utilize circuit switching both for voice and data transmission (method CC); the time is subdivided in frames with length equal to T = 125 μsec and each frame contains $N_S = T \cdot V_S$ channels, where V_S is the rate of transmission. Any channel contains 8 bits. The first N_V channels are utilized for voice and the others $N_D = N_S - N_V$ for data. This structure requires a supervision station; the other stations communicate their request of service to the supervisor through a reserved channel. The supervisor assigns the channels following the time sequence of requests. This method has been very simple to implement because it uses the same switching technique for voice and data. Moreover, the centralized structure, due to the need of the supervisor, is more sensitive to failures and supervisor breakdowns. In order to avoid this drawback, we have considered two other models which utilize more decentralized structures. In these two models too, the voice utilizes circuit switching, which is the simplest and most suitable technique for this type of traffic. Therefore, the main differences between the two strategies are the protocols used for data transmission. Packet switching is used for data; every packet contains the address of both the transmitting and receiving stations. In both the models the channel capacity is subdivided in a fixed way between voice and data traffic.

In the first model (indicated in the following as CP1), when a station must transmit a message, it can use only a time-slot in any frame and each time-slot contains a packet. At the beginning of each time-slot there is a flag indicating whether the following packet slot is empty or full. A station senses this flag and acts accordingly. In a full packet, address bits follow the occupancy flag. If a station senses its own address, the packet is removed from the line. The same station can use the empty slot to transmit a packet to a station placed between it and that one which has set the occupancy flag. When the slot is busy the station places the packets in a buffer; the transmission is sent with a FIFO criterion.

The second model (indicated in the following as CP2) differs from the previous one for the possibility of utilizing two or more, empty time-slots for the transmission of a long message in each frame. This feature is introduced in order to increase the performance of the ring network.

4. RESULTS

In this section we present some results obtained through computer simulations for the performance of the ring structures described in the previous section. The traffic was assumed having a Poisson distribution, while the interarrival time in the ring is distributed exponentially with average time ET. In this way, the results obtained are independent from the particular number of stations in the ring.

The mean time duration for the voice signals is assumed equal to 180 sec, while for data traffic it varies between 100 msec and 1 sec.

We have also assumed that a phone, when it finds all the channels busy, waits only for 10 sec.

The two main parameters computed are:

i) The probability of blocking for the phone calls.

ii) The delay time for data traffic.

We present the performance of the first model described in Sect. 3. In Fig. 2 the probability of blocking P_b as a function of the mean interarrival time is shown. We have considered two different numbers of channels $N_V = 28$ and $N_V = 58$ while the data always have 2 channels. In Fig. 3 the average time delay for data is reported for the case $N_D = 1$ and $N_D = 2$. The average time duration for the data is assumed equal to 300 msec. It can be noted that the delay time is satisfactory for a high set of values of ET, but it rapidly increases when ET is low. In Fig. 4 the delay time is shown as a function of the average time duration. Also in the other considered models, the voice signals utilize circuit switching and, therefore, their performance is equal to that shown in Fig. 2. In Fig. 5 the delay time for the data obtained through the second strategy is shown for 1 channel. The delay time is depicted in Fig. 6 as a function of the average time duration. The two strategies present a similar behaviour. The first strategy has a slightly lower time delay, but it has the drawback of requiring a non-negligible set-up time necessary for circuit connection and channel assignment. This delay must be added to that shown in the previous figures. Fig. 7 shows the delay time for data when the third strategy is used. This strategy gives a better performance than the first one for low and mean average interarrival times.

5. CONCLUSIONS

In this paper we have considered the problem of voice and data integration in a ring network. This technique is particularly suitable for local networks having small or medium dimensions. In fact, their particular structure allows many interesting and flexible solutions to be implemented for the subdivision of the channel capacity between the different types of traffic. A ring network using circuit switching both for voice and data traffic is described first; then two different models in which circuit switching is used for voice and packet switching for data are presented. The results, obtained through computer simulations, show that all the analyzed models present a satisfactory and similar performance. Moreover, while the network utilizing circuit switching is simpler to implement with respect to the other solutions, it has a centralized structure and therefore can be more sensitive to failures.

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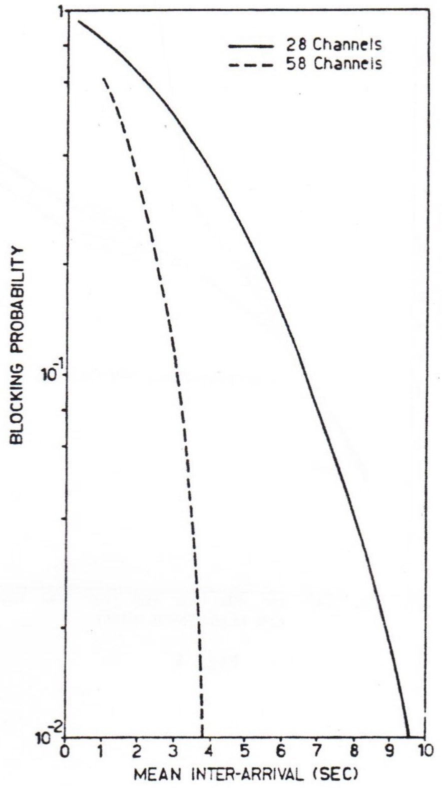

Fig. 2

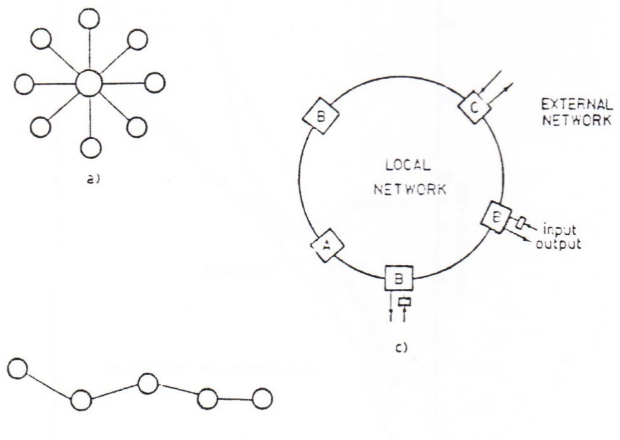

Fig. 1

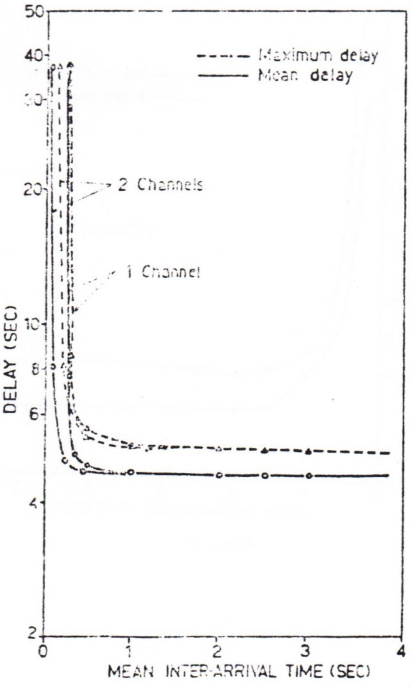

Fig. 3

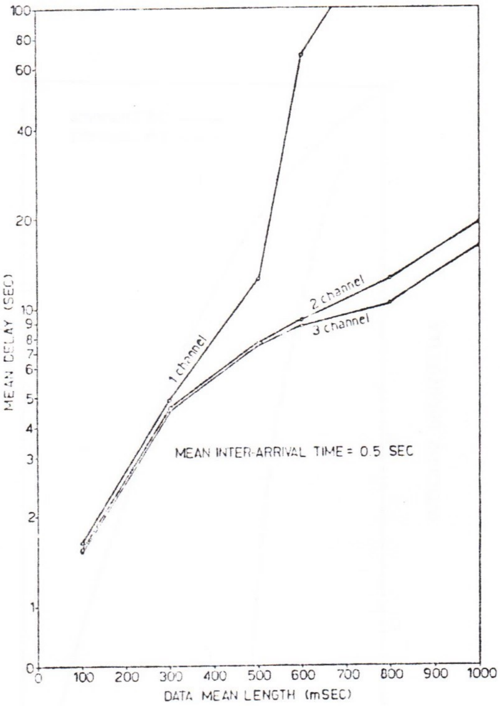

Fig. 4

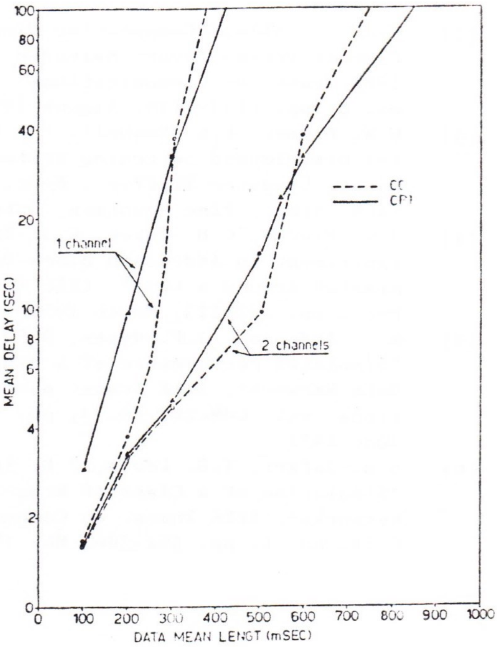

Fig. 6

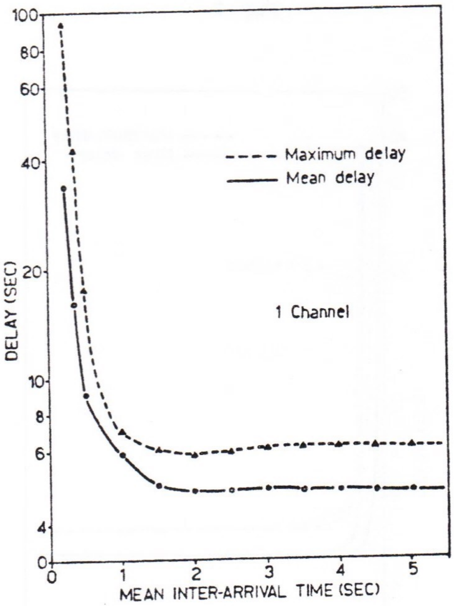

Fig. 5

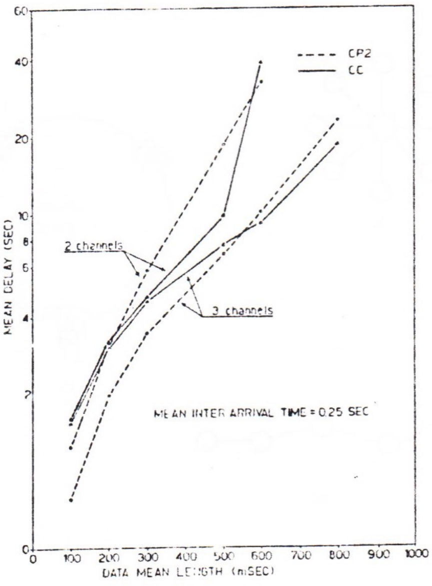

Fig. 7