SERVICE INFORMATION MODELING

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ABSTRACT

This paper deals with the transmission of signaling data associated to audio services, broadcast by Digital Audio Broadcasting (DAB) system. We speak about signaling data that are usually called service information. The problem, we are faced, is the transmission of signaling data. It is described and an algorithm, solving it, is proposed. A model of signaling channel building is described and the results obtained by simulation.

KEYWORDS

Digital Audio Broadcasting (DAB), multiplexing, signaling data, modeling, combinatorial problem.

INTRODUCTION

This article is concerned by Digital Audio Broadcasting (DAB). This system is aiming at broadcasting audio services to receivers. A receiver needs to get a description of the services and of the broadcasting network in order to access to a service. The subject of this article is the transmission of the signaling data associated to audio services (broadcast to receivers).

We describe the DAB system in the first part. The second part describes the problem of signaling channel building, give its constraints and settle the algorithm for building. In the last part, I will list algorithm model performance criteria and submit the results obtained by simulation of a model.

MULTIPLEX DIGITAL AUDIO BROADCASTING (DAB)

A new Digital Audio Broadcasting system (cf. Fig. 1) has been developed by the European Eureka 147/DAB Project (B. Le Floch, R. Lassale and D. Castellain, 1989; F. Kozamernik, 1994). It is capable of delivering services to fixed, portable and mobile receivers with a better quality reception than that is available with standard Frequency Modulation (FM).

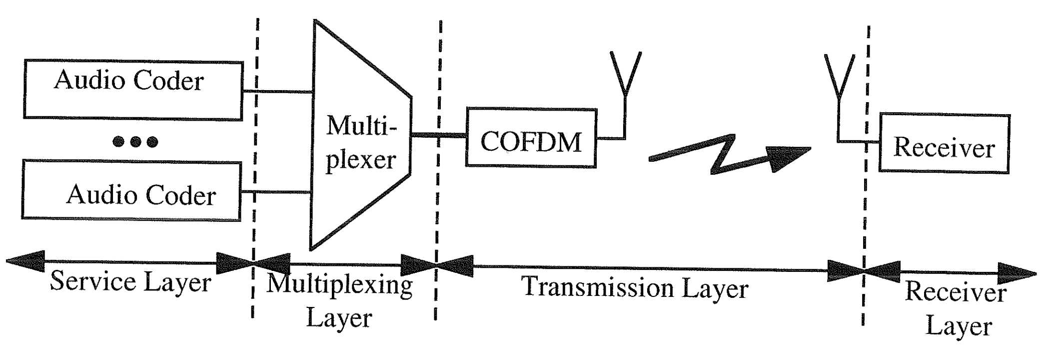

Fig. 1 : DAB System

The service layer consists in applying a digital audio bit rate reduction strategy to audio sources (Dehery, Lever and Rault; 1993). The transmission layer is the channel coding aspect of DAB, COFDM techniques (Alard and Lassalle, 1987). The multiplexing layer (Riley and Mc Parkand, 1994) organizes streams, built by the service layer and transmit them to the transmission layer. We limit this presentation of the DAB system to the description of the multiplexing principles and of the signaling channel.

The DAB system (ETSI, 1994) supports a multiplex of services, containing for example five stereo services. A service is composed of audio or data streams. The multiplexer organizes these streams in the form of a combined streams in order to broadcast it over a narrowband channel.

The principle of multiplexing is the transmission of a logical signal each 24 ms. The transmitted signal is built around a conceptual frame comprising two channels : a signaling channel and a useful data channel (cf. Fig. 2). In the DAB terminology, the useful data channel is called Main Service Channel (MSC) and the signaling channel, Fast Information Channel (FIC).

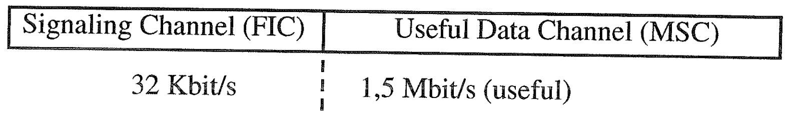

Fig. 2 : The DAB frame

The useful data channel is by far the largest part of the DAB frame and carries the audio or data streams. For that, this channel is divided into logical subchannels. An audio stream must be transmitted in one subchannel. Several data streams can be multiplexed into a same subchannel.

The main role of the signaling channel is the organization of DAB multiplex (description of services and streams, the position of each subchannel inside the useful data channel). If there is enough capacity in the signaling channel, this channel also carries data, which describe the services (label, program type, and so on). The capacity of the channel (32Kbit/s) is limited through the transmission of all service information traffic is needed. The service information is the set of DAB signaling data. The problem is the transmission of these data to receivers.

REPRESENTATION OF THE PROBLEM

For the following chapters, the DAB terminology is not used in this article. Questions to ask in order to solve this problem of signaling data are how to transmit the signaling data to receivers, how to limit the duration of the access time to receivers, how to define basic signaling data. The answers to these three questions allow to define the rules of signaling channel building and then the constraints of the problem.

BUILDING OF SIGNALING CHANNEL

Signaling data are divided into several transport units of variable length in order to transmit them in the signaling channel. A transport unit is composed of one header and of one useful data field (cf. Fig. 3). The maximum useful data capacity is 30 bytes long.

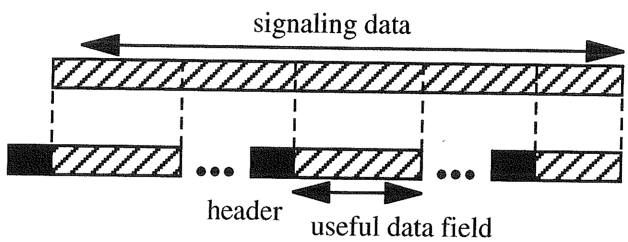

Fig. 3 : Transmission of signaling data

Receivers must have access to an audio service without too great a delay. For that, we must know where the streams of this service are settled inside the useful data channel. In order to limit the access time to services, the signaling data are transmitted repeatedly depending on the broadcast period. The biggest number of frames, needed for receivers to access to multiplex services is the access time. The transport units must be transmitted during the broadcast period (cf. Fig. 4).

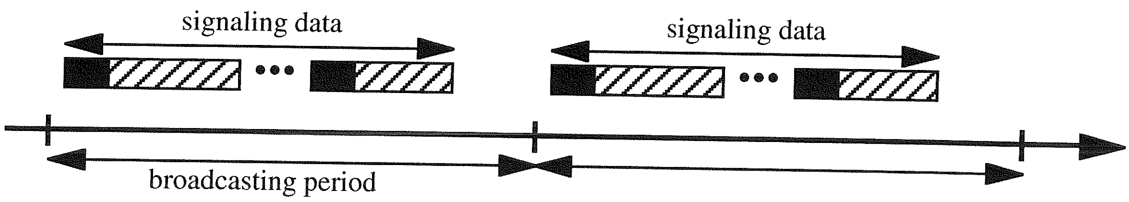

Fig. 4 : Cyclic broadcasting

If the broadcast period decreases, the access time decreases and the amount of signaling data transmitted increases. For example, if the broadcast period of the service description is 8 frames, the rate (necessary to describe 6 services) is 2.36 Kbit/s. If the broadcast period is divided by 2, the rate is multiplied by 2 (4.72 Kbit/s).

The capacity of the signaling channel is limited to 32 Kbit/s. It is not possible to insert each kind of signaling data depending on the broadcast period. The first goal is the access to service. Some parts of signaling data is basic to access to a service, e.g. the subchannel which carries the audio stream of the service and the position of this subchannel in the frame. The remaining signaling data are not basic to access to a service. But it give information about the content of services or of audio streams.

From the building of signaling channel, come out 3 constraints : the cyclic broadcasting of signaling data, the privileged position of sensitive data and the limited capacity of signaling channel.

CONSTRAINTS

Due to the cyclic broadcasting, we must define a priority order between the transport units. At the time of a signaling channel building, there are some transport units which have some priority rights if the deadline (the earliest insertion time plus theinsertion margin) is equal to the time of the signaling channel building. There are also some transport units which can be inserted in this signaling channel, if the time of thesignaling channel is contained between the earliest time of insertion and the deadline.

Due to the constraint of privileged position, the transport units of basic signaling data have priority over the other transport units.

The choice of the transmitted transport unit depends on its characteristics : the length, the earliest insertion time, the insertion margin and the privileged position. The length depends on the kind of signaling data. The earliest time of insertion is expressed in past broadcast period and in the first broadcast time. If the value of transport unit insertion margin is zero, the transport unit must be inserted exactly at the earliest time of insertion. We must add another level of priority order, a transport unit with no margin have priority over another transport unit (for the same value of insertion deadline). The privileged position parameter is necessary for the signaling data, which are basic to multiplex access.

Due to the signaling channel limited capacity, it is a problem of place optimization. We must find a combination of transport units (with variable length) to insert in a channel of constant length, in order to optimize the currently used capacity of the signaling channel. So it come out a combinatorial problem.

ALGORITHM

The first step of the algorithm is the selection of transport units to assign in a signaling channel depending on a priority order. This order depends on the insertion deadline, the margin and the privileged position of transport unit (cf Fig. 5). T_{MAKING} is the transmission time when the signaling channel is built.

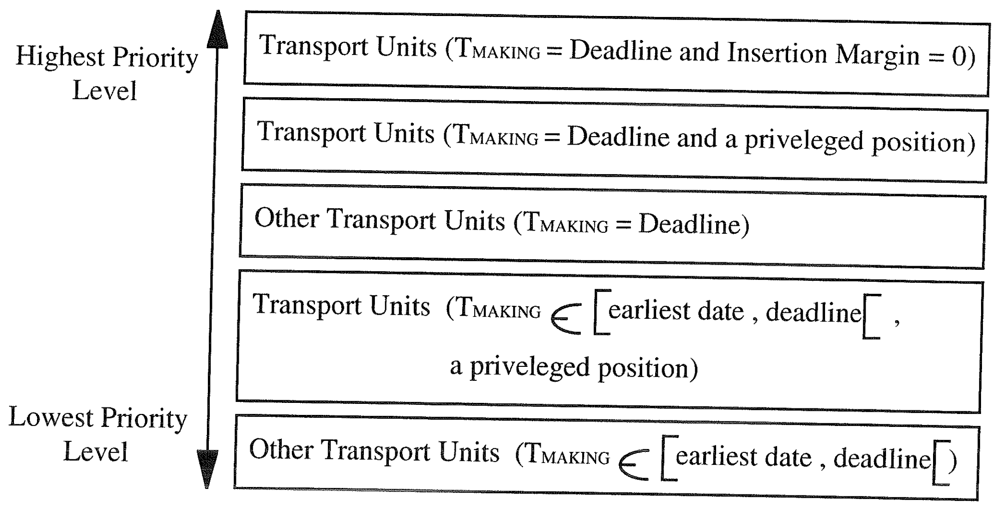

Fig. 5 : Priority order between transport units

The first criterion of priority order is the insertion deadline. The second one is the margin and the last, the privileged position. At each building of signaling channel, we must define five sets of transport units depending on the priority order. The first set (with the highest priority level) contains the signaling transport units which deadline of insertion is equal to T_{MAKING} and which value of insertion margin is zero. The second set contains the transport units which have some priority rights and a privileged position, the third one the other transport units which T_{MAKING} is equal to the deadline. The fourth set contains the transport units which can be inserted in this signaling channel and with a privileged position. The last one contains the other transport units which T_{MAKING} is bounded by the earliest insertion time and the deadline.

The second step is the insertion of each transport units set (depending on priority order) in terms of available place. The process, used to solve this aspect, consists in the research of the optimal combination of transport units among a set of combinations (Faure, 1988; Papadimitriou et Steizlitz, 1987).

MODEL

These are the principles of the signaling channel building algorithm. We will describe the model (cf. Fig. 6) which allows to evaluate the performances of this algorithm.

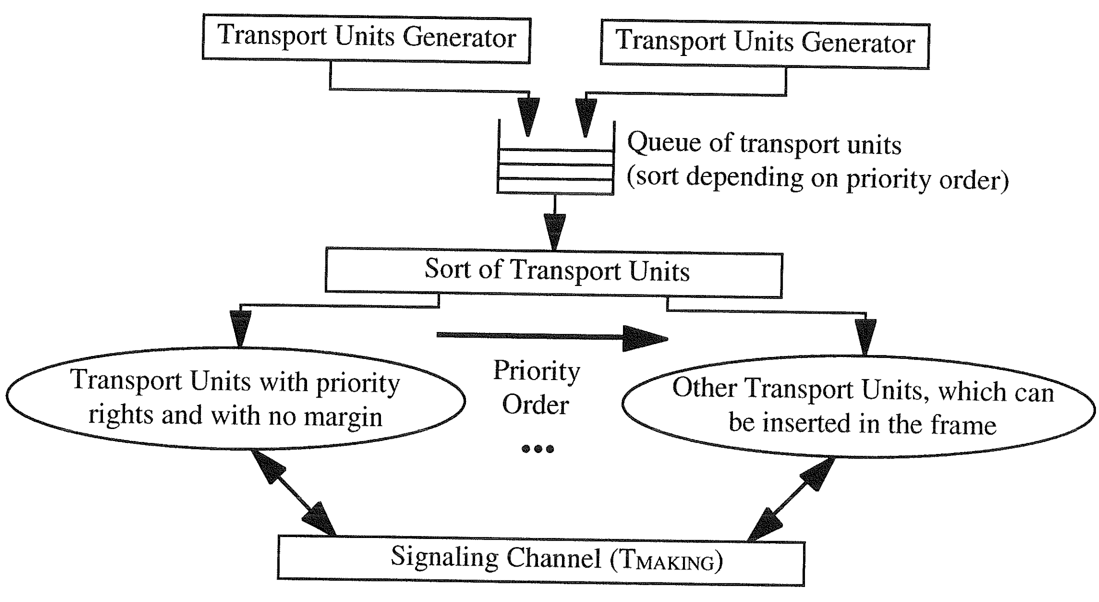

Fig. 6 : Model of Signaling Channel building

For that, it requires to define transport units generators. The generator builds the transport units from the characteristics of signaling data (broadcast period, length, margin of insertion). One kind of signaling data is associated to one transport units generator. The representation of the signaling channel is used to evaluate the performances of the model.

We need to define some performance criteria in order to measure these performances. The busy rate is the percentage of the signaling channel actual capacity used to transmit signaling data. The second criterion is the percentage of transport unit transmitted inside the signaling channel and fitted into a correct position. The third one is the percentage of transport unit transmitted in the signaling channel.

The second criterion measure is the most representative of the three. In fact, the number of transport units not transmitted (which have not been inserted in the signaling channel) is counted into the number of transport units, which have not been well fitted. The busy rate does not measure the incidence of the privileged position constraint.

SIMULATION

We submit the results obtained by model simulation. The simulation presented (cf. Fig. 7) is the incidence of broadcast period (for the basic signaling data). The number of subchannels depends on the number of services and is on the X-axis. The percentage of transport units, which are well fitted is on Y-axis. Six audio services have been defined. The broadcast periods of not basic signaling data are those, recommended in the guideline of DAB system. In order to measure the incidence of broadcast period (for the basic signaling data), several values for this broadcast period have been defined.

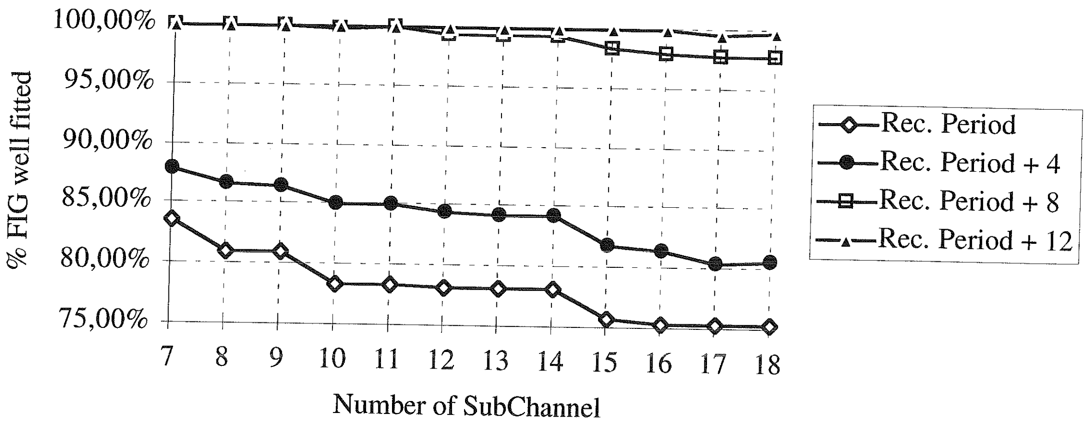

Fig. 7 : Incidence of broadcast period for the basic signaling data

The first curve concerns broadcasting period recommended in the DAB guidelines (equal to 4 frames). The second concerns the same period plus 4 frames. The third curve concerns the broadcast period recommended plus 8 frames and the last one plus 12 frames.

When we increase the duration of broadcast period, the percentage of well fitted transport units increases. We have more time to insert the same amount of signaling data, but the increase of the broadcasting period (for the basic signaling data) implies increasing of the access time to services. It is therefore a trade-off between access time and quality of service.

For a same value of the broadcasting period, when the number of subchannels increases, the quality of service decreases. In fact, if the number of subchannels increases, the amount of basic signaling data increases. Due to the limited capacity of signaling channel, the quality of service decreases.

CONCLUSION

We have presented a model of signaling channel building. This model was developed in order to valitime the implementation rules of DAB system (ETSI; 1995). The results obtained by model simulation allow to estimate the quality of service on multiplexer output. The performance criterion is the percentage of transport units well fitted. Other simulations have been conducted using this model, such the representation of service quality versus the number of subchannels and services, how it is affected by the privileged position constraint.

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