

METHOD FOR SIGNALLING TIME-SLICING PARAMETERS IN THE SERVICE INFORMATION

Field of the Invention

The present invention relates to a method of signalling in a communications
5 network, particularly, but not exclusively, to a method of signalling time-slicing
parameters in a digital video broadcasting (DVB) network.

Background Art

Mobile communications systems are known which can provide enough bandwidth
10 to allow streaming of video using advanced compression techniques, such as
MPEG-4. For example, a third generation mobile network has a maximum
bandwidth of 384 kilobits per second (kbps). However, this is not enough for some
types of services, such as file downloading.

15 Nevertheless, higher bandwidth transmission systems are known. For example, a
Digital Video Broadcasting (DVB) transmission system can provide bandwidth of
10 Mbps or more. Thus, it is possible to augment a mobile communications system
with a higher bandwidth transmission system.

20 DVB receivers are known in applications such as digital television. Usually, DVB
receivers are fixed and mains-powered. However, mobile handheld terminals are
usually battery-powered and so power is limited.

The average power consumption of a DVB receiver can be reduced by using a
25 scheme based on time division multiplexing (TDM). Such a scheme is called time
slicing.

If a service is requested, data can be transmitted using time slicing. Bursts of data
are sent using significantly higher bandwidth compared to the bandwidth needed to
30 send the data using static bandwidth. Each burst includes an indication of time to
the beginning of the next burst, which is referred to as "delta-t". Between bursts,
data is not transmitted, allowing other services to use the bandwidth allocated to the
service. Thus, the receiver need only stay active for a portion of time while

receiving bursts. Nevertheless, received bursts can be buffered and consumed at a relatively more uniform and lower rate.

However, time slicing suffers the problem that the receiver requires a sufficiently
5 large buffer. If the buffer is too small, then the receiver may begin receiving a burst before the previous burst has been consumed. The problem can be exacerbated if data needs to be decoded before consumption since decoding introduces a time lag.

The present invention seeks to provide a method of signalling in a communications
10 system.

Summary of the Invention

According to the present invention there is provided a method of signalling in a communications network, the method comprising providing a set of time-slicing
15 parameters for describing bursts of data, including the time-slicing parameters in service information and forming bursts according to the set of time-slicing parameters.

This can have the advantage that a device is enabled to determine whether it can
20 receive data bursts and/or to configure itself to receive the data bursts.

Providing the set of time-slicing parameters may comprise defining a minimum time between bursts, defining a desired output rate of a buffer for receiving and outputting a burst or defining a maximum average transfer rate over one time slicing
25 cycle.

Coupling the time-slicing parameters to service information may comprise including the set of time-slicing parameters in a descriptor. The method may further comprise including the descriptor in a table for describing service provided through the
30 communications network. The method may further comprise including the descriptor in a table for describing configuration of the network the communications network.

The bursts of data may comprise data segments, such as multiprotocol encapsualtion (MPE) sections, for example in the form of a multiprotocol encapsualtion-forward error correction (MPE-FEC) frame. The method may comprise encapsulating the MPE-FEC frame in at least one transport stream packet.

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The burst of data may comprise a set of sections. The method may comprise encapsulating the set of sections in at least one transport stream packet.

The communications network may be a digital video broadcasting (DVB) system.

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The method may comprise forwarding the bursts to a network element.

According to the present invention there is also provided a method of operating an element in a communications network, the method comprising receiving a set of
15 time-slicing parameters for describing bursts of data, coupling the time-slicing parameters to service information and forming bursts according to the set of time-slicing parameters.

According to the present invention there is further provided a method of operating
20 a receiving device for receiving bursts of data through a communications network, the method comprising receiving service information through the communications network and obtaining from the service information a set of time-slicing parameters for describing the data bursts.

25 The method may comprise determining whether the data bursts can be buffered and configuring a receiver to receive the data bursts.

The set of time-slicing parameters may include a minimum time between bursts and the method may further comprise determining whether a burst has not been
30 received and, if a burst has not been received, configuring a receiver to receive the data bursts using said minimum time or determining whether there is enough time to decode data received within a burst.

The set of time-slicing parameters may include a given output rate of a buffer and the method may further comprise determining whether the given output rate exceeds an actual output rate of a buffer.

- 5 According to the present invention there is also provided a computer program comprising computer program instructions for causing data processing apparatus to perform the method.

10 According to the present invention there is also provided a method of transmitting in a communications network, the method comprising providing a set of time-slicing parameters for describing bursts of data, coupling the time-slicing parameters to service information and forming bursts according to the set of time-slicing parameters.

- 15 The method may comprise transmitting the service information and transmitting the bursts.

20 According to the present invention there is still further provided a system of signalling in a communications network, the method comprising providing a set of time-slicing parameters for describing bursts of data, coupling the time-slicing parameters to service information and forming bursts according to the set of time-slicing parameters.

25 According to the present invention there is also provided a network element configured to receive a set of time-slicing parameters for describing bursts of data, couple the time-slicing parameters to service information; and form bursts according to the set of time-slicing parameters.

The network element may comprise a transmitter.

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According to the present invention there is still further provided a terminal comprising a receiver for receiving bursts of data through a communications network and a processor for controlling operation of said receiver, the terminal

being configured to receive service information from said communications network, to obtain from the service information a set of time-slicing parameters describing the data bursts and to control operation of the receiver in dependence upon the set of time-slicing parameters.

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The set of time-slicing parameters may comprise a maximum average transfer rate over one time slicing cycle.

Brief Description of the Drawings

- 10 An embodiment of the present invention will now be described with reference to the accompanying drawings in which:
- Figure 1 shows a communication system;
- Figure 2 shows a multiprotocol encapsulation (MPE) encapsulator which outputs transport stream packets ;
- 15 Figure 3 illustrates a transport stream packet;
- Figure 4 is a schematic diagram of a mobile telephone handset;
- Figure 5 is schematic diagram of a battery pack for a mobile telephone handset;
- Figure 6 shows a receiver and a time slicing buffer included in the mobile telephone handset shown in Figure 4;
- 20 Figure 7 is a process flow diagram of a first process performed by the MPE encapsulator shown in Figure 2;
- Figure 8 shows a process by which forward error correction data is calculated;
- Figure 9 shows datagrams being placed in datagram sections;
- Figure 10 illustrates a datagram section;
- 25 Figure 11 illustrates a burst;
- Figure 12 illustrates encapsulation of datagram sections in transport stream packets;
- Figure 13 is a process flow diagram of a second process performed by the MPE encapsulator shown in Figure 2;
- Figure 14 shows a process by which a table including a time slicing descriptor is segmented and encapsulated;
- 30 Figure 15 illustrates filling and emptying a time slicing buffer when no forward error correction decoding is used;

Figure 16 illustrates filling and emptying a time slicing buffer when forward error correction decoding is used

Figure 17 is process flow diagram of a first process performed by the mobile telephone handset shown in Figure 4;

5 Figure 18 is process flow diagram of a second process performed by the mobile telephone handset shown in Figure 4; and

Figure 19 is process flow diagram of a third process performed by the mobile telephone handset shown in Figure 4.

10 Detailed Description of the Invention

Communication system 1

Referring to Figure 1, a communication system 1 is shown. The communications system 1 includes a content provider 2 which has access to sources 3₁, 3₂ of content, such as audio-visual content, data files or images.

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Content 4 may be transmitted using internet protocol (IP) over a digital broadband network, such as a terrestrial Digital Video Broadcasting (DVB-T) network, as an IP datacasting (IPDC) service, to one or more receiving devices 5₁, 5₂. The receiving devices 5₁, 5₂, in the form of mobile telephones with video capabilities, are

20 configured to receive data from at least two different communication channels 6, 7.

Content data 4 is transmitted to a network element 8 which is a server configured to receive the content data 4 and to generate recovery data 9 for use in error correction of the content data 4. The content data 4 is transmitted to the receiving devices 5₁, 5₂ via a first communications channel 6. In this example, the first communications channel 6 is provided by a first communications network 10 in the form of broadcasting network, such as a DVB-T network, which includes a transmitter 11. Content data 4 is broadcast, multicast or unicast to receiving devices 5₁, 5₂ within a cell (not shown) associated with the first communication network 10.

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Recovery data 9 may be transmitted to the receiving devices 5₁, 5₂ via a second communication channel 7. In this example, the second communications channel 7 is provided by a second, different communications network 12 in the form of a

mobile network, such as a third generation (3G) mobile network, which include a transmitter 13. Recovery data 9 and other data, such a voice data, are transmitted to receiving devices 5₁, 5₂ within a cell (not shown) associated with the second communication network 12. The second communications network 12 may be a
5 second generation (2G) or a two-and-half generation (2.5G) network.

In Figure 1, the communication system 1 is shown in a simplified form. Other elements, such as further transmitters (not shown), network elements (not shown) or networks (not shown) may be included.

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The transmitters 11, 13 each provide a transmitter node for transmitting data to the receiving devices 5₁, 5₂, which constitute receiver or recipient nodes.

Network element 8

15 Referring to Figure 2, the network element 8 is a DVB multiprotocol encapsulation (MPE) encapsulator. The network element 8 receives IP datagrams 14 and service data 15, such as MPEG program specific information (PSI) and DVB service information (SI), and generates a transport stream 16 according to ISO/IEC 13818-1. The transport stream 16 comprises transport stream (TS) packets 17, typically 188
20 bytes long.

Referring also to Figure 3, the transport stream 16 is divided into a number of logical channels. The logical channel to which a TS packet 17 belongs is defined in a packet header 18 using a packet identifier (PID) 19. The packet identifier can be
25 used to identify contents of a TS packet payload 20.

For example, the contents of a first TS packet 17₁ may be identified as being video, audio or another type of data by specifying a PID value between 0x0030 to 0x1FFE (as hexadecimal number). The contents of a second TS packet 17₂ may be identified
30 as containing all or part of network information table (NIT) by specifying PID = 0x0010. As will be explained in more detail later, an NIT and other types of table may be used to signal time slicing parameters and other parameters relating to forward error correction to a receiving device 5₁, 5₂ (Figure 1).

The MPE encapsulator 8 also performs other functions and these will be described in more detail later.

5 *Receiving device 5₁, 5₂*

Referring to Figure 4, each receiving device 5₁, 5₂ is preferably in the form of a mobile telephone handset with a multimedia capability.

Each receiving device 5₁, 5₂ includes first and second antennae 21₁, 21₂, a receiver
10 22₁ and a transceiver 22₂. In this example, the first antenna 21₁ and receiver 22₁ are used to receive signals from the first communications network 10, in this case a DVB-T network. The second antenna 21₂ and transceiver 22₂ are used to transmit and receive signals to and from the second communications network 10. The receiver and transceiver 22₁, 22₂ each include respective r.f. signal processing
15 circuits (not shown) for amplifying and demodulating received signals and respective processors (not shown) for channel decoding and demultiplexing.

Each receiving device 5₁, 5₂ also includes a controller 23, a user interface 24, memory 25, a smart card reader 26, smart card 27 received in the smart card reader
20 26, a coder/decoder (codec) 28, a speaker 29 with corresponding amplifier 30 and a microphone 31 with a corresponding pre-amplifier 32.

The user interface 24 comprises a display 33 and a keypad 34. The display 33 is adapted for displaying images and video by, for instance, being larger and/or having
25 greater resolution than a display of conventional mobile telephone and being capable of colour images. Each receiving device 5₁, 5₂ also includes a battery 35.

The controller 23 manages operation of a receiving device 5₁, 5₂ under the direction of computer software (not shown) stored in memory 25. For example, the
30 controller 23 provides an output for the display 33 and receives inputs from the keypad 34.

Referring to Figure 5, the battery 35 and the first antenna 21₁ and the receiver 22₁ may be incorporated into a battery pack 36. By replacing a battery pack (not shown) of a conventional mobile telephone handset with battery pack 36 including receiver 22₁ and by also providing suitable software, a conventional mobile
5 telephone handset (not shown) may be modified to receive data via the first communications network 10. Alternatively, the first antenna 21₁ and the receiver 22₁ may be incorporated into a cover (not shown) for a conventional mobile telephone handset (not shown).

10 The receiving device 5₁, 5₂ may be modified providing a single receiver adapted to receive signals from the first and second communications networks 10, 12 (Figure 1) and a transmitter adapted to transmit signals to the second communications network 12 (Figure 1). Alternatively, a single transceiver for both communications networks 10, 12 may be provided.

15 Referring to Figure 6, the receiver 22₁ receives a signal 37 from the first communications network 10. The signal 37 is amplified, demodulated, channel decoded and demultiplexed. The resulting demultiplexed signal (not shown) is filtered so as to extract bursts 38 of datagrams. The datagram bursts 38 are fed into
20 a time slice buffer 39 which is provided by controller 23 and memory 25 so as to produce a stream 40 of datagrams which is not time sliced. Preferably, the datagram stream 40 is substantially continuous and/or at a substantially constant rate.

The time slice buffer 39 will be described in more detail later.

25 A receiving device 5₁, 5₂ may be a personal data assistant (PDA) or other mobile terminal capable of at least of receiving signals via the first communications networks 10. The receiving device 5₁, 5₂ may also be semi-fixed or semi-portable such as a terminal carried in vehicle, such as a car.

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Operation of the MPE encapsulator 8

The MPE encapsulator 8 performs a number of functions, some of which fall into two categories: processes which involve preparing and transmitting application data

in bursts and processes which involve preparing and signalling time slicing and forward error correction parameters.

Preparing and transmitting application data

- 5 Referring to Figures 7 and 8, a process by which the MPE encapsulator 8 (Figure 1) generates forward error codes and formats data, in this case using a Digital Storage Media Command and Control (DSM-CC) section format, is described.

The MPE encapsulator 8 (Figure 1) receives a stream of data packets 41₁, 41₂, 41₃,
10 41₄, in this case IP datagrams, from content provider 2 (Figure 1) and, if necessary, pre-processes them by arranging them in order and/or dropping selected datagrams, for example based on IP address (step S1). It will be appreciated that the MPE encapsulator 8 (Figure 1) may receive Ethernet frames (not shown) and thus, additional processing, such as removing Ethernet frame structure, may be required.

15

Optionally, forward error correction codes are calculated for the data packets 41₁, 41₂, 41₃, 41₄ (step S2).

The packets 41₁, 41₂, 41₃, 41₄ are stored in a coding table or array 42 (step S2.1).

- 20 The packets 41₁, 41₂, 41₃, 41₄ are stored sequentially in columns 43₁, 43₂, 43₃, 43₄ in a portion of the table 42 referred to as the application data table 44 which in this case occupies the left-most portion of the table 42. The contents of a packet 41₁, 41₂, 41₃, 41₄ can occupy one or more addressable storage locations of one or more columns 43₁, 43₂, 43₃, 43₄.

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Once a given number of packets have been stored or the application data table 44 has been filled, forward error correction (FEC) data 45₁, 45₂, 45₃ is calculated (step S2.2). The FEC data 45₁, 45₂, 45₃, preferably in the form of Reed-Solomon data, is calculated for each row 46₁, 46₂, 46₃ and entered into a portion of the table 42

- 30 referred to as the Reed-Solomon data table 47.

Preferably, the coding table 42 has 255 columns. For example, the application data table 44 may comprise 191 columns and the Reed-Solomon table 47 may comprise

64 columns. Preferably, the application data table occupies the left-most portion of table 42 and Reed-Solomon table occupies the right-most portion of the table 42. The coding table 42 may comprises a selectable number of rows, up to 1024 rows. Preferably, the table 42 comprises one-byte addressable elements. Thus, a table
 5 with 255 columns and 1024 rows may store up to 2 Mbits of data.

It will be appreciated that packets 41_1 , 41_2 , 41_3 , 41_4 may be stored sequentially in rows and FEC data 45_1 , 45_2 , 45_3 calculated for each column. In other words, rows and columns are interchangeable. It will also be appreciated that the length or size
 10 of packets 41_1 , 41_2 , 41_3 , 41_4 can vary. The packets 41_1 , 41_2 , 41_3 , 41_4 may be an uneven size. The application data table 44 may be filled with stuffing information, for example at the end of table. The stuffing information may be omitted when calculating FEC data 45_1 , 45_2 , 45_3 .

15 The packets 41_1 , 41_2 , 41_3 , 41_4 and FEC packets 48_1 , 48_2 are read out of the coding table (step S2.3). The FEC packets 48_1 , 48_2 are read out column by column. The packets 41_1 , 41_2 , 41_3 , 41_4 and FEC packets 48_1 , 48_2 are separated and formatted (step S3).

20 The MPE encapsulator 8 (Figure 1) preferably formats data in accordance with Section 7 of European Telecommunications Standards Institute (ETSI) Standard 301 192 "Digital Video Broadcasting (DVB); DVB specification for data broadcasting" V1.3.1 (2003-01).

25 Referring to Figure 9, the MPE encapsulator 8 places packets 41_1 , 41_2 , 41_3 , 41_4 into MPE datagram sections 49_1 , 49_2 , 49_3 , 49_4 compliant with the DSM-CC section format, using the syntax defined in Table 1 below:

Table 1

Syntax	No. of bits	Identifier
datagram_section() {		
table_id	8	uimsbf
section_syntax_indicator	1	bslbf
private_indicator	1	bslbf
reserved	2	bslbf

section_length	12	uimsbf
MAC_address_6	8	uimsbf
MAC_address_5	8	uimsbf
reserved	2	bslbf
payload_scrambling_control	2	bslbf
address_scrambling_control	2	bslbf
LLC_SNAP_flag	1	bslbf
current_next_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
MAC_address_4	8	uimsbf
MAC_address_3	8	uimsbf
MAC_address_2	8	uimsbf
MAC_address_1	8	uimsbf
if (LLC_SNAP_flag == "1") {		
LLC_SNAP()		
} else {		
for (j=0;j<N1;j++) {		
IP_datagram_data_byte	8	bslbf
}		
}		
if (section_number == last_section_number) {		
for (j=0;j<N2;j++) {		
stuffing_byte	8	bslbf
}		
}		
if (section_syntax_indicator == "0") {		
checksum	32	uimsbf
} else {		
CRC_32	32	rpchof
}		
}		

Referring still to Figure 8, the MPE encapsulator 8 places FEC packets 48₁, 48₂ into so-called MPE-FEC datagram sections 50₁, 50₂ using the syntax defined in Table 2 below:

5

Table 2

Syntax	No. of bits	Identifier
FEC_section () {		
table_id	8	uimsbf
section_syntax_indicator	1	bslbf
reserved_for_future_use	1	bslbf
reserved	2	bslbf
section_length	12	uimsbf
padding_columns	8	uimsbf
reserved_for_future_use	8	bslbf
reserved	2	bslbf
reserved_for_future_use	5	bslbf
current_nect_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
real_time_parameters()		
for(i=0; i<N; i++) {		
rs_data_byte	8	uimsbf
}		
CRC_32	32	uimsbf
}		

Referring to Figure 10, the general structure of an MPE section 49 or MPE-FEC section 50 is shown. An MPE/MPE-FEC section 49, 50 comprises a header 51, a payload 52 and a trailer 53. The payload 52 includes a packet 41₁, 41₂, 41₃, 41₄ (Figure 9) or a FEC packet 48₁, 48₂ (Figure 9) as defined in Table 1 or 2 above.

Referring to Figure 11, the MPE sections 49₁, 49₂, 49₃, 49₄ and MPE-FEC sections 50₁, 50₂ comprise a burst 54₁. As will be explained in more detail later, the burst 54₁ is delivered on an elementary stream, which is identified by a single PID. Between the burst 54₁ and a next burst 54₂ (Figure 15), no sections are transmitted in respect of the same elementary stream.

Referring to Figure 12, the first burst 54₁ comprising the MPE sections 49₁, 49₂, 49₃, 49₄ and MPE-FEC sections 50₁, 50₂ are placed in TS packets 55₁, 55₂, 55₃ (step S5).

In this example, a TS packet 55₁, 55₂, 55₃ may include plural MPE sections 49₁, 49₂, 49₃, 49₄ and MPE-FEC sections 50₁, 50₂. However, a MPE section 49₁, 49₂, 49₃, 49₄ or MPE-FEC section 50₁, 50₂ may be divided between a plurality of TS packets 55₁, 55₂, 55₃. The TS packets 55₁, 55₂, 55₃ are labelled with the same PID.

The burst 54₁ can indicate the start time of the next burst 54₂ within the elementary stream. This is achieved by signalling to the receiving devices 5₁, 5₂ that time slices

and/or FEC is being used and transmitting information relating to the following burst in the elementary stream.

Signalling involves including a data broadcast descriptor in a Service Description Table (SDT) transmitted using service description sections, which indicates that
 5 MAC_address 1 to MAC_address 4 fields are not being used to differentiate receivers within the elementary stream but are being used to carry real time parameters, such as delta-t. The service description sections and data broadcast descriptor is described in more detail in Sections 6 and 7 of ETSI EN 301 468
 10 "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems" V1.5.1 (2003-01).

Transmitting information relating to the following burst comprises including so-called real time parameters in MAC_address_1 to MAC address_4 fields of each
 15 header as defined in Table 1 or 2 above of each MPE section 49₁, 49₂, 49₃, 49₄ and each MPE-FEC sections 50₁, 50₂. For example, Table 3 below shows real time parameter syntax:

Table 3

Syntax	No. of bits	Identifier
realtime paramters() {		
delta_t	12	uimsbf
table_boundary	1	bslbf
frame_boundary	1	bslbf
address	18	uimsbf
}		

20

Use of the delta_t field depends on whether time slicing is used on the elementary stream concerned.

If time slicing is used, the delta_t field indicates the time to the next time slice burst
 25 within the elementary stream. Delta-t is included in all MPE/MPE-FEC sections 49₁, 49₂, 49₃, 49₄, 50₁, 50₂ within a burst 54₁ and the value may differ from section to section. Resolution of the delta-t is 10 ms. For example, a value 0xC00 (in hexadecimal) = 3072 (in decimal) indicates the time to the next burst is 30.72 s. The value 0x00 is reserved to indicate that no more bursts will be transmitted within

the elementary stream, in other word to indicate end of service. In such a case, all MPE/MPE-FEC sections 49₁, 49₂, 49₃, 49₄, 50₁, 50₂ within the burst 54₁ have the same value in this field. Delta-t is defined from the transport_packet carrying the first byte of the current MPE section 49₁, 49₂, 49₃, 49₄ to the transport_packet
 5 carrying the first byte of next burst. Therefore the delta-t may differ between MPE/MPE-FEC sections 49₁, 49₂, 49₃, 49₄, 50₁, 50₂ sections within a burst 54₁.

The time indicated by delta-t is beyond the end of the maximum burst duration of the actual burst. This helps to ensure that a decoder can reliably distinguish two
 10 sequential bursts within an elementary stream.

The burst 54₁ contains complete MPE/MPE-FEC sections 49₁, 49₂, 49₃, 49₄, 50₁, 50₂. In other words, MPE/MPE-FEC sections 49₁, 49₂, 49₃, 49₄, 50₁, 50₂ are not divided between bursts 54₁. The burst 54₁ contains complete datagrams 41₁, 41₂,
 15 41₃, 41₄, 48₁, 48₂. In other words, datagrams 41₁, 41₂, 41₃, 41₄, 48₁, 48₂ are not fragmented between bursts. Transmission of empty MPE sections, that it an MPE section with no payload, is preferably to be avoided.

Preferably, each burst 54₁ contains at least one MPE section 41₁, 41₂, 41₃, 41₄, 48₁,
 20 48₂ carrying a proper datagram 41₁, 41₂, 41₃, 41₄, 48₁, 48₂ containing network layer address (not shown). The address (not shown) is one of the addresses an IP/MAC Notification Table (INT) has associated with the elementary stream.

If time slicing is not used and MPE-FEC is used, the delta_t field supports a cyclic
 25 MPE-FEC frame index within the elementary stream. The value of the delta_t field increases by one for each subsequent MPE-FEC frame 42. After value "1111111111", the field restarts from "000000000000". If large portions of data is lost, this parameter makes it possible to identify to which MPE-FEC frame the any received section belongs.

30

The table_boundary field is a flag. When the flag is set to "1", it indicates that the current section is the last section of a table within the current MPE-FEC frame. If the section in question is an MPE section 49₁, 49₂, 49₃, 49₄, the flag indicates that

the section 49₁, 49₂, 49₃, 49₄ is the last section of the application data table 44 (Figure 8). A decoder not supporting MPE-FEC may ignore all subsequent sections until the end of the MPE-FEC frame 42, which is indicated using frame_boundary field. For each MPE-FEC frame 42, one MPE section 49₁, 49₂, 49₃, 49₄ is
 5 transmitted with this flag set. For each MPE-FEC frame 42 in which RS data 47 is transmitted, one FEC section 48₁ is transmitted with this flag set. If MPE-FEC is not supported on the elementary stream, the flag is reserved for future use. When not used, the flag is set to "0".

10 The frame_boundary field is a flag. When the flag is set to "1", it indicates that the current section is the last section within the current burst 54₁, if time slicing is supported, and within the MPE-FEC frame 42, if MPE-FEC is supported. For each time slice burst 54₁, one MPE section 49₁, 49₂, 49₃, 49₄ is transmitted with this flag set. For each MPE-FEC frame 42, one MPE/MPE-FEC section 49₁, 49₂,
 15 49₃, 49₄, 50₁, 50₂ is transmitted with this flag set.

The address field specifies a byte position in the corresponding MPE-FEC frame table 42 for the first byte of the payload carried within the section. All sections delivering data for any MPE-FEC frame table 42 are delivered in ascending order
 20 according to the value of this field. The bytes position is a zero-based linear address within an MPE-FEC frame table 42, starting from the first row of the first column, and increasing towards the end of the column. At the end of the column, the next byte position is at the first row of the next column.

25 The first section carrying data of a given MPE-FEC frame is an MPE section carrying the application data datagram at address "0". All sections carrying application data datagrams of a given MPE-FEC frame 42 are transmitted prior to the first section carrying RS-data of the MPE-FEC frame 42. In other words, sections 49₁, 49₂, 49₃, 49₄ carrying application data datagrams are not interleaved
 30 with sections 50₁, 50₂ carrying RS-data within a single MPE-FEC frame 42. All sections carried between the first and the last section of an MPE-FEC frame 42 carry data belonging to the MPE-FEC frame 42, i.e. only application data 44 and RS

data 47 is used. Sections delivering data of different MPE-FEC frames are not interleaved.

The section following the last section carrying application data datagram on an MPE-FEC frame 42 contain either the first section carrying the RS-data of the same MPE-FEC frame or the first application data section of the next MPE-FEC frame. In the later case, RS-data of the first MPE-FEC frame is not transmitted. For each MPE-FEC frame 42, one MPE section is transmitted with the address field set to "0". For each MPE-FEC frame 42 in which any RS data is transmitted, one FEC section is transmitted with the address field set to "0". Padding is not used within delivered application data in the application data table 44. Datagrams do not overlap in an application data table. Padding is not used within delivered RS data in the RS table 42.

Addressing starts from zero within each MPE-FEC frame table. If both time slicing and MPE-FEC are used on an elementary stream, each burst on the elementary stream shall contain exactly one MPE-FEC frame 42. In other words, the MPE-FEC frame 42 is not split over multiple bursts.

If MPE-FEC is not supported on the elementary stream, the address field is reserved for future use. When not used, the address field is set to 0x00.

Preparing and signalling time slicing and forward correction error parameters

Time slicing and MPE-FEC parameters may be advantageously signalled in order to help receiving devices 5₁, 5₂ (Figure 1) determine whether or not they are able to receive time-sliced transmissions and to process a time-sliced transmission, which may or may not employ forward error correction.

A number of parameters may be relevant to time slicing and, if applicable, forward error correction. Table 4 below lists these parameters:

Table 4

Parameter	Description
B _b	Bit rate for burst

R_{out}	Bit rate at the output of the time slicing buffer or MPE-FEC table
C_b	Average bit rate over one slicing cycle
B_d	Burst time (duration)
T_{min}	Minimum time between bursts
T_{out}	Time needed to empty buffer (=buffer leakage time)
B_s	Burst size
T_{FEC}	MPE-FEC decoding time

The MPE encapsulator 8 (Figure 1) transmits at least some of these parameters using a time slice identifier descriptor as part of the service information (SI).

5 Referring to Figures 2, 13 and 14, the MPE encapsulator 8 receives PSI/SI data 15 which specifies a minimum time between bursts (T_{min}) 56₁, required output bit rate (R_{out}) 56₂ of the time slicing buffer 39 (Figure 6) and maximum average bit rate over one time slicing cycle (C_b) 56₃ (step S6). Preferably, these parameters 56₁, 56₂, 56₃ are specified by the network operator. Briefly stated, they determine the frequency
10 and size of bursts 54₁.

The T_{min} , R_{out} and C_b parameters 56₁, 56₂, 56₃ will be described in more detail later.

The T_{min} , R_{out} and C_b parameters 56₁, 56₂, 56₃ are coupled to service information
15 which describes the delivery system, content and/or scheduling and timing of broadcast data streams by using a descriptor in tables used to signal service information to receiving devices 5₁, 5₂.

The parameters 56₁, 56₂, 56₃ are inserted into a time slice identifier descriptor 57.

20 The syntax of the time slice identifier descriptor 57 is given in Table 5 below:

Table 5

Syntax	No. of bits	Identifier
Time_slice_fec_identifier_descriptor () {		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
time_slicing	1	bslbf
mpe_fec	2	uimsbf
frame_size	5	uimsbf
max_burst_duration	8	uimsbf
max_average_rate	4	
min_off_time	3	
for(i=0; i<N; i++){		
reserverd_for_future_use	1	bslbf

}		
}		

According to Table 5 above, the descriptor_tag field is provided with a value agreed specified by a standards organisation. The descriptor_length field specifies the number of bytes immediately following the field. The time_slicing field indicates, whether the referred elementary stream is time sliced. A value "1" indicates that time slicing being used, while a value "0" indicates that time slicing is not used. The mpe_fec field indicates whether the referred elementary stream uses MPE-FEC and, if so, what algorithm is used. The mpe_fec field may be coding according to Table 6 below:

10

Table 6

Value	MPE-FEC	Algorithm
0x00	Not used	n/a
0x01	Used	Reed-Solomon (255, 191, 64)
0x02...0x03	Reserved for future use	Reserved for future use

According to Table 5 above, the frame_size field is used to give information that a decoder may use to adapt its buffering usage. The exact interpretation depends on whether time slicing and/or MPE-FEC are used. The max_burst_duration field is used to indicate the maximum burst duration in the concerned elementary stream. A burst does not start before T_1 and shall end not later than at T_2 , where T_1 is the time indicated by delta-t on a previous burst, and $T_2 = T_1 + \text{maximum burst duration}$. The indicated value for maximum burst duration preferably lies within a range from 20 ms to 512 s in 20 ms steps. The maximum burst duration = $\text{max_burst_duration} \times 20 \text{ milliseconds}$.

If time_slicing is set to "0", i.e. time slicing is not used, then this field is reserved for future use and is set to 0x00 when not used. If time_slicing is set to "1", i.e. time slicing is used, then this field indicates the maximum number of bits on section level allowed within a time slice burst on the elementary stream. Bits are calculated from the beginning of the table_id field to the end of the CRC_32 field.

If mpe_fec is set to "1", i.e. MPE-FEC is used, then this field indicates the exact

number of rows on each MPE-FEC frame on the elementary stream. When both time slicing and MPE-FEC are used on the elementary stream, both limitations (i.e. the maximum burst size and the number of rows) apply. Frame_size field may be coded according to Table 7 below:

5

Table 7

Size	Max Burst size	MPE-FEC frame rows
0x00	128 kbits	64
0x01	256 kbits	128
0x02	384 kbits	192
0x03	512 kbits	256
0x04	640 kbits	320
0x05	768 kbits	384
0x06	896 kbits	448
0x07	1 024 kbits	512
0x08	1 152 kbits	576
0x09	1 280 kbits	640
0x0A	1 408 kbits	704
0x0B	1 536 kbits	768
0x0C	1 664 kbits	832
0x0D	1 792 kbits	896
0x0E	1 920 kbits	960
0x0F	2 048 kbits	1024
0x10 to 0x1F	Reserved for future use	Reserved for future use

If the max_frame_size field indicates “reserved_for_future_use”, the receiver assumes that the maximum burst size is greater than 2 Mbits and MPE-FEC frame rows more than 1024.

10

In the event that time slicing is not used, i.e. MPE-FEC frames are transmitted without any time slicing, a field that supports a cyclic MPE-FEC frame index within the elementary stream can be used for control purposes. The value of the field increases by one for each subsequent MPE-FEC frame. After value “111111111111”, the field restarts from “000000000000”.

15

The max_average rate field is used to define the maximum average bit rate in MPE section payload 52 (Figure 10) over one time slicing cycle or MPE-FEC cycle. specifies R_{out} . The maximum average bit rate is given by:

20

$$C_b = \frac{B_s}{T_c} \quad (1)$$

where B_s is the size of the current time slicing burst or MPE-FEC frame in MPE section payload bits and T_c is the time from the transport_packet carrying the first byte of the first MPE section in the current burst/frame to the transport_packet carrying the first byte of the first MPE section in the next burst/frame within the same elementary stream. The field may be coded according to Table 8 below:

Table 8

max_average_rate	Description
0000	16 kps
0001	32 kps
0010	64 kps
0011	128 kps
0100	256 kps
0101	512 kps
0110	1024 kps
0111	2048 kps
1000-1111	Reserved for future use

- 10 If MPE-FEC is used, the RS data is not included in B_s . The max_average rate field may comprise fewer than 4 bits, for example 3 bits. It will be appreciated that different coding may be used.

The min_off_time field specifies T_{out} and a may be coded according to Table 9 below:

Table 9

min_off_time	Description
000	0 ms
001	50 ms
010	300 ms
011	1000 ms
100	3000 ms
101	5000 ms
110	7000 ms
111	9000 ms

It will be appreciated that different coding may be used.

20

The MPE encapsulator 8 preferably formats data in accordance with ETSI Standard EN 300 468 "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB broadcasting" V1.5.1 (2003-01).

Referring again to Figure 14, the time slice identifier descriptor 57 is used in a Network Information Table (NIT) 58 (step S8). The syntax of the NIT is shown in Table 10 below:

5

Table 10

Syntax	No. of bits	Identifier
network_information_section(){		
table_id	8	uimsbf
section_syntax_indicator	1	bslbf
reserved_future_use	1	bslbf
reserved	2	bslbf
section_length	12	uimsbf
network_id	16	uimsbf
reserved	2	bslbf
version_number	5	uimsbf
current_next_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
reserved_future_use	4	bslbf
network_descriptors_length	12	uimsbf
for(i=0;i<N;i++){		
descriptor()		
}		
reserved_future_use	4	bslbf
transport_stream_loop_length	12	uimsbf
for(i=0;i<N;i++){		
transport_stream_id	16	uimsbf
original_network_id	16	uimsbf
reserved_future_use	4	bslbf
transport_descriptors_length	12	uimsbf
for(j=0;j<N;j++){		
descriptor()		
}		
}		
CRC_32	32	rpchbf
}		

When located in the first descriptor loop, the descriptor applies to all transport streams announced within the table. The descriptor applies to all elementary streams having stream_type field value of 0x0D, which defines MPE coded data, on any of the transport streams.

When located in the second descriptor loop, the descriptor applies to the transport stream in question. The descriptor applies to all elementary streams having

15

stream_type field value of 0x0D. This descriptor overwrites possible descriptors in the first descriptor loop.

The descriptor 57 may be included in other types of table, such as in a IP/MAC
5 Notification Table (INT).

When located in the platform descriptor loop, the descriptor applies to all elementary streams referred to within the table. This descriptor overwrites possible descriptors in NIT.

10

When located in the target descriptor loop, the descriptor applies to all elementary streams referred within the target descriptor loop in question after the appearance of the descriptor. This descriptor overwrites possible descriptors in the platform descriptor loop and in NIT. In case an elementary stream is referred from multiple
15 locations within an INT, each contains the same signalling.

The table 58 is segmented (step S9) and table sections 58₁, 58₂, 58₃ are mapped TS packets 59₁, 59₂, 59₃, labeled in this case with PID = 0x0010 (step S10). The TS packets 59₁, 59₂, 59₃ are multiplexed into the transport stream 16 (Figure 2). PSI/SI
20 data is usually not time-sliced.

The receiving device 5₁, 5₂ usually only accesses an NIT when connecting to the network 10 (Figure 1). When changing from one transport stream 16 to another (not shown), the receiving device 5₁, 5₂ may need to read the content of an INT, but
25 usually not more than once. Changes in the INT can be signalled in PSI using a PMT table(not shown), thus ensuring that constant filtering of the INT is not required.

PSI tables are usually re-transmitted at least once in every 100 ms. If the duration of a burst is longer than 100 ms, the receiving device 5₁, 5₂ has access to all PSI tables while receiving a burst. For shorter bursts, the receiving device 5₁, 5₂ may choose to keep the receiver 22₁ on until all required PSI tables are received.
30

In summary, the MPE encapsulator 8 transmits data comprising MPE and MPE-FEC sections 49₁, 49₂, 49₃, 49₄, 50₁, 50₂ (Figure 12) which are arranged in bursts 54₁ and which are included in TS packets 55₁, 55₂, 55₃ (Figure 12) in an elementary stream labeled with one PID and signals time slicing parameters in service
 5 information included in a table 58 (Figure 14) which is included in TS packets 59₁, 59₂, 59₃ (Figure 14) labeled with another, different PID.

These time slicing parameters can be employed by receiving devices 5₁, 5₂ to help achieve better power savings and improve quality of service, as will now be
 10 described:

$$T_{min} \leq R_{out}$$

Referring to Figure 15, a first case is shown in which first and second bursts 54₁, 54₂ are transmitted by the MPE encapsulator 8 to the receiving devices 5₁, 5₂ and in
 15 which FEC decoding is not employed or where no MPE-FEC sections are transmitted.

The first burst 54₁ is transmitted at a bit rate B_b and has a burst time B_d . Thus, the burst size $B_s = B_b \times B_d$. When the first datagram 60₁ of the burst 54₁ is received by
 20 a receiving device 5₁, 5₂, the time slicing buffer 39 (Figure 6) can begin to output data 61₁.

The second burst 54₂ cannot be accommodated before the time slicing buffer 39 (Figure 6) is empty. It takes T_{out} to empty the buffer 39 (Figure 6). Thus, the
 25 limiting factor is the speed with which buffer 39 (Figure 6) can be emptied, i.e. the buffer leakage rate R_{out} . If the buffer is to be emptied before the second burst 54₂ arrives, then the average bit rate C_b over one time slicing cycle 62 must be equal to, or less than, R_{out} .

30 Referring to Figure 16, a second case is shown where FEC decoding is employed.

In this case, MPE-FEC decoding one the first burst 54_1 is received. However, there is a time lag, T_{FEC} , while data is decoded before it is output from the buffer 39.

Thereafter, it takes T_{out} seconds to empty the buffer 39 (Figure 6).

- 5 The effect of the decoding time T_{FEC} is to reduce the average bit rate C_b . A problem may arise, particularly if the burst size B_s is small. If no account of T_{FEC} is taken, then there is a danger that the time slicing buffer 39 (Figure 6) may not be emptied before the next burst 54_2 arrives. Therefore, it is advantageous to specify T_{min} in addition to C_b .

10

Thus, the receiving devices $5_1, 5_2$ may use T_{min} and processes which can be performed by receiving devices $5_1, 5_2$ will now be described:

- Referring to Figure 17, if a whole time slicing burst 54_1 is lost with consequential
 15 loss of a delta-t value, the receiver 22_1 (Figure 4) can still be turned off because the next burst 54_2 is not expected to arrive before T_{min} . Thus, the receiver 22_1 (Figure 4) can be turned on again after T_{min} (steps S11 to S14)

- Referring to Figure 18, the receiving device $5_1, 5_2$ can use T_{min} to determine whether
 20 there is enough the time to decode MPE-FEC frames (steps S11 & S15 to S20). If T_{min} is less than the actual decoding time T_{FEC} , the receiver 22_1 (Figure 4) may be able to support the service but not decoding (steps S17). The receiving device $5_1, 5_2$ can then indicate to the user and/or the network 10 (Figure 1) that quality of the service may fall and/or that the service is not supported.

25

Based on T_{min} , the receiving device $5_1, 5_2$ can decide what kind of handover procedure to use.

- For example, the receiving device $5_1, 5_2$ can measure signal strength at different
 30 frequencies and/or in different cells and calculate respective bit error rates. The receiving device $5_1, 5_2$ can decide which frequency and cell provide the best available conditions for receiving the current service. If T_{min} is long enough, a complete handover can be performed during one off time. Otherwise, handover is

performed over several off periods by taking a measurement of one frequency in one cell done during each off time.

During handover in which bursts from different cells (not shown) are synchronized with phase shift, the MPE encapsulator 8 (Figure 1) can set T_{min} to be long enough such that the receiving device 5₁, 5₂, while listening in given cell, can empty the buffer 39 (Figure 6) and synchronize to a new frequency in other cell before the next burst arrives.

Based on T_{min} , the receiving device 5₁, 5₂ can decide what other operations and/or functions can be performed or used during an off time.

The receiving devices 5₁, 5₂ may advantageously use R_{out} and processes which can be performed by receiving devices 5₁, 5₂ will now be described:

15

Referring to Figure 19, if the required R_{out} is greater than the actual leakage rate R_{out_actual} , the receiving device 5₁, 5₂ can indicate to the user and/or the network 10 (Figure 1) that the service is not supported (steps S11, S22 & S23).

If the required R_{out} is less than the actual leakage rate R_{out_actual} , there is extra time between bursts 54₁, 54₂ to perform other operations on the data and/or to use time slicing buffer output bus (not shown) for transmitting other data than the burst data. Thus, the buffer leakage does not have to start immediately (steps S24 to S26).

25

If there is enough buffer memory to support more than one time slicing channel/service, the receiving device 5₁, 5₂ can add up the required leakage rates R_{out} to determine whether the actual leakage rate R_{out_actual} can support all the channels.

30

Other parameters which could be signalled include the maximum off time T_{max} and a flag which indicates whether or not the burst interval is constant.

It will be appreciated that many modifications may be made to the embodiments described above. For example, fixed receiving devices may be used.

Claims

1. A method of signalling in a communications network, the method comprising:
5 providing a set of time-slicing parameters for describing bursts of data;
coupling said time-slicing parameters to service information; and
forming bursts according to said set of time-slicing parameters.
2. A method according to claim 1, wherein providing said set of time-slicing
10 parameters comprises:
defining a minimum time between bursts.
3. A method according to claim 1 or 2, wherein providing said set of time-slicing parameters comprises:
15 defining a desired output rate of a buffer for receiving and outputting a burst.
4. A method according to any preceding claim, wherein providing said set of time-slicing parameters comprises:
20 defining a maximum average transfer rate over one time slicing cycle.
5. A method according to any preceding claim, wherein coupling said time-slicing parameters to service information comprises:
including said set of time-slicing parameters in a descriptor.
25
6. A method according to claim 5, further comprising:
including said descriptor in a table for describing service provided through said communications network.
- 30 7. A method according to claim 5 or 6, further comprising:
including said descriptor in a table for describing configuration of said network said communications network.

8. A method according to any preceding claim, wherein:
said bursts of data comprise data segments.
9. A method according to any preceding claim, wherein:
5 said bursts of data comprise multiprotocol encapsualtion (MPE) sections.
10. A method according to any preceding claim, wherein:
a burst of data comprises a multiprotocol encapsualtion-forward error
correction (MPE-FEC) frame.
10
11. A method according to claim 10, the method comprising:
encapsulating said MPE-FEC frame in at least one transport stream packet.
12. A method according to any preceding claim, wherein:
15 a burst of data comprises a set of sections.
13. A method according to claim 12, the method comprising:
encapsulating said set of sections in at least one transport stream packet.
- 20 14. A method according to any preceding claim, wherein:
said communications network is a digital video broadcasting (DVB) system.
15. A method according to any preceding claim, the method comprising:
forwarding said bursts to a network element.
25
16. A method of operating an element in a communications network, the
method comprising:
receiving a set of time-slicing parameters for describing bursts of data;
coupling said time-slicing parameters to service information; and
30 forming bursts according to said set of time-slicing parameters.
17. A method according to claim 16, wherein said set of time-slicing parameters
includes a maximum average transfer rate over one time slicing cycle.

18. A method of operating a receiving device for receiving bursts of data through a communications network, the method comprising:
receiving service information through said communications network; and
5 obtaining from said service information a set of time-slicing parameters for describing said data bursts.
19. A method according to claim 18, wherein obtaining said set of time-slicing parameters comprises:
10 retrieving data relating to a maximum average transfer rate over one time slicing cycle.
20. A method according to claim 18 or 19, further comprising:
determining whether said data bursts can be buffered.
- 15 21. A method according to any one of claims 18 to 20, further comprising:
configuring a receiver to receive said data bursts.
22. A method according to any one of claims 18 to 21, wherein said set of time-slicing parameters includes a minimum time between bursts and the method further
20 comprises:
determining whether a burst has not been received and, if a burst has not been received, configuring a receiver to receive said data bursts using said minimum time.
- 25 23. A method according to any one of claims 18 to 22, wherein said set of time-slicing parameters includes a minimum time between bursts and the method further comprises:
determining whether there is enough time to decode data received within a
30 burst.
24. A method according to any one of claims 18 to 23, wherein said set of time-slicing parameters includes a given output rate of a buffer and the method further

comprises:

determining whether said given output rate exceeds an actual output rate of a buffer.

5 25. A computer program comprising computer program instructions for causing data processing apparatus to perform a method according to any preceding claim.

26. A method of transmitting in a communications network, the method comprising:

10 providing a set of time-slicing parameters for describing bursts of data;
coupling said time-slicing parameters to service information; and
forming bursts according to said set of time-slicing parameters.

27. A method according to claim 26, wherein said set of time-slicing parameters
15 comprises a maximum average transfer rate over one time slicing cycle.

28. A method according to claim 26 or 27, comprising:
transmitting said service information.

20 29. A method according to any one of claims 26 to 28, comprising:
transmitting said bursts.

30. A system of signalling in a communications network comprising:
providing a set of time-slicing parameters for describing bursts of data;
25 coupling said time-slicing parameters to service information; and
forming bursts according to said set of time-slicing parameters.

31. A system according to claim 30, wherein said set of time-slicing parameters
comprises a maximum average transfer rate over one time slicing cycle.

30

32. A network element configured to receive a set of time-slicing parameters for
describing bursts of data, couple said time-slicing parameters to service information;
and form bursts according to said set of time-slicing parameters.

33. A network element according to claim 32, which is a transmitter.

34. A network element according to claim 32 or 33, wherein said set of time-
5 slicing parameters comprises a maximum average transfer rate over one time slicing cycle.

35. A terminal comprising:
a receiver for receiving bursts of data through a communications network
10 and
a processor for controlling operation of said receiver;
said terminal being configured to receive service information from said communications network, to obtain from said service information a set of time-slicing parameters describing said data bursts and to control operation of said
15 receiver in dependence upon said set of time-slicing parameters.

36. A terminal according to claim 35, configured to obtain a maximum average transfer rate over one time slicing cycle from said set of time-slicing parameters.