



(86) Date de dépôt PCT/PCT Filing Date: 2008/06/16
 (87) Date publication PCT/PCT Publication Date: 2009/04/02
 (85) Entrée phase nationale/National Entry: 2009/12/04
 (86) N° demande PCT/PCT Application No.: IB 2008/003587
 (87) N° publication PCT/PCT Publication No.: 2009/040680
 (30) Priorités/Priorities: 2007/06/15 (US60/929,170);
 2007/06/15 (US60/929,169)

(51) Cl.Int./Int.Cl. *H04J 3/06* (2006.01)
 (71) Demandeur/Applicant:
 BARGAUAN, MICHELE, IT
 (72) Inventeur/Inventor:
 BARGAUAN, MICHELE, IT
 (74) Agent: VALADARES LAW GROUP LLP

(54) Titre : RE-HORODATAGE DE REFERENCE D'HORLOGE DE PROGRAMME DETERMINISTE POUR UNE ADAPTATION DE DEBIT BINAIRE SYNCHRONESUR LA BASE D'UN PAQUET D'INITIALISATION DE MEGAFRAME

(54) Title: DETERMINISTIC PROGRAM CLOCK REFERENCE RE-STAMPING FOR SYNCHRONOUS BIT RATE ADAPTATION BASED ON MEGA-FRAME INITIALIZATION PACKET

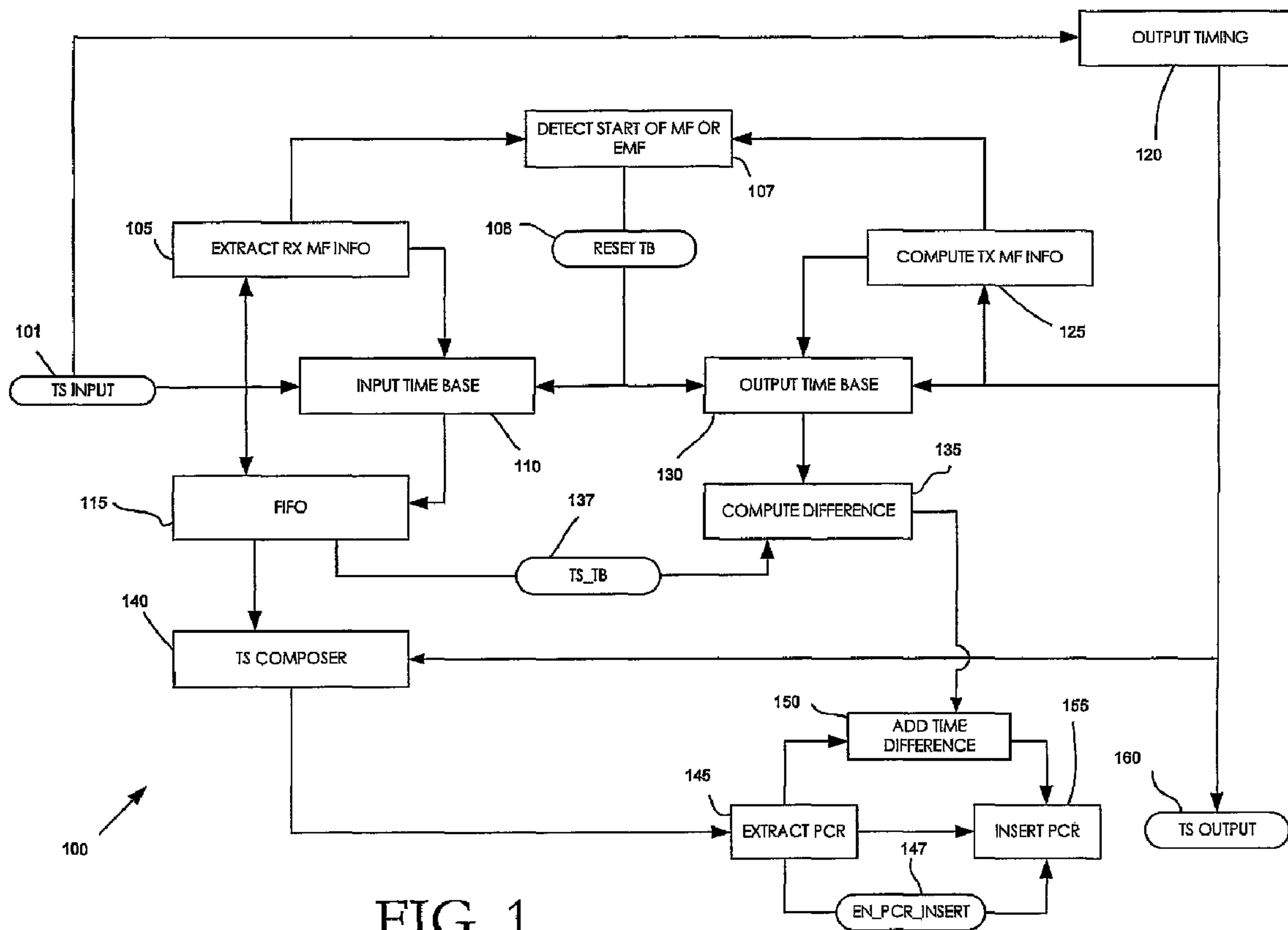


FIG. 1

(57) Abrégé/Abstract:

A system and processes create a transport stream carrying several encapsulated contents, watermarks, and other ancillary data. The transport stream is re-multiplexed while keeping synchronous and deterministic operation. Synchronous deterministic

(57) **Abrégé(suite)/Abstract(continued):**

operation allow each derived transport stream to be broadcasted in Single Frequency Networks, as all re-multiplexers have the same signal at the input and selecting the same content generates exactly the same stream in multiple locations.

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 60/929,169
5 titled “Deterministic Program Clock Reference Re-stamping for Synchronous Bit Rate
Adaptation based on Mega-frame Initialization Packet” filed on June 15, 2007 in the U.S.
Patent and Trademark Office, and of U.S. Provisional Application No. 60/929,170 titled
“Mega-frame Initialization Packet Generation and Synchronous Re-generation with Bit
10 Rate Adaptation for Single Frequency Networks with Multiple Modulation Schemes”
filed on June 15, 2007 in the U.S. Patent and Trademark Office, of which the entire
disclosures of both applications are herein incorporated by reference in their entirety for
all purposes.

TECHNICAL FIELD

15 The following description relates generally to a system useful in Single Frequency
Networks, and in particular to a system useful in Single Frequency Networks for DVB-
T/H complying with European Telecommunications Standards Institute (ETSI) EN 300
744 and ETS 101 191, and related international standards. The systems and method
described herein are also applicable in any other system that requires bit rate adaptation
20 with PCR re-stamping and delivers a deterministic and identical bit stream at all
participating equipment.

BACKGROUND

European Telecommunications Standards Institute – European Standard ETSI EN
25 300 744 describes a broadcasting system for terrestrial distribution based on Orthogonal
Frequency-Division Multiplexing COFDM (a digital multi-carrier modulation scheme
that uses a large number of closely-spaced orthogonal subcarriers) and MPEG2 (encoding
and transport data system, for example, as defined by ISO/IEC 13818-1.MPEG)
technologies. Application of the European Telecommunications Standards Institute –
30 Technical Specification ETSI ETS 101 191 extend the user of this system to Single
Frequency Networks (SFN), for example, as defined by ETS 101 191 and in Advanced
Television Systems Committee (ATSC) A110.

The extension to SFN is accomplished by periodically adding one packet
including synchronization time stamps and modulation parameters information to the

transport stream (e.g., as defined by ISO 138181-1) of all transmitters broadcasting in a SFN area. The packet that is added to the transport stream is a Mega-frame Initialization Packet (MIP). The MIP is an MPEG2 transport stream compliant packet that carries mega-frame and modulation parameters, for example, as defined by ETS 101 191.

5

SUMMARY

In one general aspect, a method of providing a fixed and deterministic bit rate adaptation for an output transport stream is described below. The method includes receiving an input transport stream of packets; deriving output timing from the input transport stream; determining an input time stamp for each packet of the input transport stream; determining a corresponding output timestamp for each outgoing packet of the output transport stream; determining the difference between the input timestamp and the output timestamp; extracting a program clock reference (PCR) for the output transport stream; adding the determined difference to the PCR; and adding the PCR to the output transport stream.

15

The method also may includes receiving the input stream of packets includes a time mark packet; determining a period from the time mark; determining the input time stamp and output time stamp for each packet within the period; and resetting the timestamps at the end of each period.

20

The time mark may be a mega-frame initialization packet (MIP) and the period is a mega-frame. The time mark also may be a mega-frame initialization packet (MIP) and the period is an extra long mega-frame.

The method may further include the output transport stream from the input transport stream packets by inserting or eliminating null packets to perform rate adaptation based on the output timing.

25

The time base sampling frequency may be 34,292,160 MHz for a reference clock of 27MHz and the difference is divided by 1,270,080.

The time base sampling frequency may be 5,670 MHz for a reference clock of 8MHz and the difference is divided by 210.

30

In another general aspect, a system for providing a fixed and deterministic bit rate adaptation for an output transport stream is described below. The system may include an input to receive an input transport stream of packets; a timer to provide output timing derived from the input transport stream; a counter to determine an input time stamp for each packet of the input transport stream; a counter to determine a corresponding output

timestamp for each outgoing packet of the output transport stream; a processor to determine the difference between the input timestamp and the output timestamp, extract a program clock reference (PCR) for the output transport stream; add the determined difference to the PCR; and add the PCR to the output transport stream; and an output to
5 output the transport stream according to the derived output timing.

The input stream may include a time mark packet used to determine a period, the input time stamp and output time stamp are determined for each packet within the period; and the timestamps are reset at the end of each period. The time mark may be a mega-frame initialization packet (MIP) and the period is a mega-frame. The time mark also
10 may be a mega-frame initialization packet (MIP) and the period is an extra long mega-frame.

The system also may include a composer to create the output transport stream from the input transport stream packets by inserting or eliminating null packets to perform rate adaptation based on the output timing.

15 The time base sampling frequency may be 34,292,160 MHz for a reference clock of 27MHz and the difference is divided by 1,270,080. The time base sampling frequency also may be 5,670 MHz for a reference clock of 8MHz and the difference is divided by 210. Other features will be apparent from the detailed description, drawings, and claims.

20

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exemplary block diagram of a system for single frequency networks.

DETAILED DESCRIPTION

Transport streams suitable for DVB SFN systems are defined by ETSI standard.
25 The standard defines a bit rate and a synchronization packet (MIP) for each set of four parameters: channel Band Width (BW), Guard Time interval (GT), Constellation (CON), and Forward Error Correction ratio (FEC). The SFN transport stream must be the same (i.e., all bits in the stream must be equal bit after bit) at all transmitters broadcasting in an SFN area. However, some examples where the parameters require changing are as
30 follows:

- receiving an 8MHz BW incoming signal which must be broadcast to an area where a 7MHz channel is required (e.g., often the case in Italy and Germany where channels have mixed BW);

- receiving an $1/4GT + x/xFEC$ incoming signal (e.g., where $1/4GT$ is used in a main transmitter for optimum SFN performance) which must be broadcast to an area where a smaller GT (e.g., $1/32GT$, used in small area coverage) may be used and a more robust $y/yFEC$ provides increased signal protection for a lower power transmitter; and
- receiving a $1/32GT + x/xFEC$ incoming signal (e.g., $1/32GT$ is used in main transmitter where SFN operation is not required) which must be broadcast to SFN mode where an improved GT (e.g., $1/8GT$, used in medium area SFN coverage) may be used and a less robust $y/yFEC$ provides a similar payload.

In these examples, when the transport stream changes from one set of parameters to another, the change in the transport stream bit rate, MIP, and PCR information must be determined. In a conventional system, the change in bit rate is made in a random way by inserting or subtracting null packets from an incoming transport stream and inserting a new MIP packet in a new random position. However, this random process does not guarantee that the bit stream at two different locations will be exactly the same in each bit (i.e., bit exact). In addition, the PCR re-stamping is typically made by modifying PCR information based on time-of-arrival and time-of-departure difference of transport stream packets. However; within the network there may be small differences due to jitter and equipment delays. Even the time-of-arrival itself is not a finite quantity. Furthermore, these small differences in PCR correction values are normally made between different locations. As a result, different systems are not able to generate the same bit sequence. The following description provides a process and system for determining PCR re-stamping that produces a bit stream that is bit exact at any participating system, even in two different locations.

Fig. 1 shows an example 100 of a basic block diagram of a system 100 for deterministic program clock reference re-stamping for synchronous bit rate adaptation using an MIP. The input signal may be any a transport stream 101, for example, as provided for in the ISO/IEC 13818-1 standard. The transport stream may include packets include packets grouped into a mega-frame, which is a group of a integer number of TS packets, for example, as specified by ETS-101 191. The transport stream 101 is supplied to detector 105, time stamp generator 110, and memory 115.

The detector 105 processes the transport stream 101 to extract received mega frame information, such as the MIP parameters and related transport stream parameters, mega frame time boundaries, and, when available, extra-long mega frame time

boundaries of the received tr. The detector 105 provides the receive time frame boundaries to detector 107.

The time stamp generator 110 computes input time stamps or an input time base for each incoming packet of the transport stream. The time base count is incremented linearly at every input packet. The count is reset by the signal Reset TB 108 provided every time at the end of a Mega Frame or of an Extra-Long Mega Frame.

The memory 115 stores each input transport stream packet with a related time stamp computed by the time stamp generator 110. In one example, the memory may be implemented using a First In - First Out (FIFO) memory, where the first data written in are the first data read.

The transport stream also is provided to output timing generator 120. The output timing generator 120 generates an output timing signal based on the input transport stream bit rate. Since input and output transport streams are linked by a fixed ratio, all pulses and timing signals required to build the output transport stream are derived from the input transport stream bit rate, as is known to those skilled in the art.

Processing block 125 computes the transmit mega-frame information for the outgoing transport stream, such as the mega frame time boundaries, and, when available, extra-long mega frame time boundaries. The transmit time frame boundaries are provided to detector 107.

The Detector 107 detects the end/start of each mega frame in the transport steam, or, in the case that the input and the output mega frame do not have the same length, detects the end of an extra-long mega frame. When the detector 107 detects the end of a mega frame or extra-long mega frame, the detector generates the signal reset TB 108.

The output time stamp generator 130 computes the output time stamps or time base for each outgoing packet. The output time base count is incremented linearly at every output packet. The base count is reset by the signal reset TB 108 provided at the end of every mega frame or extra-long mega frame.

Block 135 determines the difference between the output time stamp provided by generator 130 and the input time stamp TS_TB 137 computed by the input time stamp generator 110 that is stored with each associated packet in the FIFO memory 115. The received packets are output from the FIFO memory 115 to the transport stream composer 140. The transport stream composer 140 is provided with the output timing and performs bit rate adaptation of the transport stream by determining whether to eliminate or insert null packets in the transport stream. The transport stream is provided to the extractor 145.

Extractor 145 detects if any of the packets of the transport stream have an adaptation field with a PCR. If a PCR is detected, the extractor 145 extracts the PCR and sets a flag EN_PCR_INSERT 147. Any extracted PCR is provided to adder 150 which adds the time difference generated by block 135 to the extracted PCR to provide the recalibrated PCR. Inserter 155 re-inserts any recalibrated PCR into the transport stream when EN_PCR_INSERT flag is set. The adapted transport stream is delivered to output connector TS OUTPUT 160.

According to the systems and methods described herein, the input and output transport streams have a fixed and deterministic bit rate, even if ruled by a fractional ratio, and an input transport stream carries a time mark, such as the MIP packet, which may be used to identify a time period. The time period allows determination of a periodical starting point common to input and output transport streams by indicating where to reset the PCR adaptation process. To have comparable exact input and output time stamps at any possible input and output transport stream rate identified in EN 300 744, the time base sampling frequency of 34,292,160 MHz may be used as a virtual reference clock.

Table 1 shows a packets period expressed in cycles of time base sampling frequency for every combination of guard time (e.g. as defined by EN 300 744), constellation, Forward Error Correction (FER) in an 8 MHz channel. It may be noted that all values are integers and exact.

Table 1

QPSK	1/4	1/8	1/16	1/32
1/2	10363852800	9327467520	8809274880	8550178560
2/3	7772889600	6995600640	6606956160	6412633920
3/4	6909235200	6218311680	5872849920	5700119040
5/6	6218311680	5596480512	5285564928	5130107136
7/8	5922201600	5329981440	5033871360	4885816320
16 QAM	1/4	1/8	1/16	1/32
1/2	5181926400	4663733760	4404637440	4275089280
2/3	3886444800	3497800320	3303478080	3206316960
3/4	3454617600	3109155840	2936424960	2850059520
5/6	3109155840	2798240256	2642782464	2565053568
7/8	2961100800	2664990720	2516935680	2442908160
64 QAM	1/4	1/8	1/16	1/32
1/2	3454617600	3109155840	2936424960	2850059520
2/3	2590963200	2331866880	2202318720	2137544640
3/4	2303078400	2072770560	1957616640	1900039680
5/6	2072770560	1865493504	1761854976	1710035712
7/8	1974067200	1776660480	1677957120	1628605440

Stamping with an exact value each input or output packet inside the reference period, the period of one Mega Frame or one Extra-Long Mega Frame allows the difference between the arrival time and the departure time of the transport stream to be determined. In addition, the computation is independent of any eventual jitter found in an incoming transport stream.

MPEG2 systems are based on an MPEG reference clock (a reference clock is used by transport stream system target decoder, for example, as defined by ISO/IEC 13818-1). The MPEG reference clock has a frequency of 27MHz. To express a computed delay in the number of the reference clock, the difference is divided by 1,270,080, which is the ratio between the time base reference clock and the MPEG reference Clock. Addition of the computed time difference to the PCR value is performed using dual modulus arithmetic, as described in ISO13818-1. The time base sampling frequency is only one example, and that many others may be computed according to the teachings herein.

For example, much lower frequencies may be found if only a subset of possible combinations is required like that shown in Table 2, which is based on the time base sampling frequency of 5,670 MHz. In this example, the flexibility is reduced compared to that of the first value, but for applications dealing with channel bandwidth of only 8MHz it is sufficient. For this table and time base sampling frequency, the computed delay difference is divided by 210 to get the value added to the PCR.

Table 2

QPSK	1/4	1/8	1/16	1/32
1/2	1713600	1542240	1456560	1413720
2/3	1285200	1156680	1092420	1060290
3/4	1142400	1028160	971040	942480
5/6	1028160	925344	873936	848232
7/8	979200	881280	832320	807840
16 QAM	1/4	1/8	1/16	1/32
1/2	856800	771120	728280	706860
2/3	642600	578340	546210	530145
3/4	571200	514080	485520	471240
5/6	514080	462672	436968	424116
7/8	489600	440640	416160	403920
64 QAM	1/4	1/8	1/16	1/32
1/2	571200	514080	485520	471240
2/3	428400	385560	364140	353430
3/4	380800	342720	323680	314160
5/6	342720	308448	291312	282744
7/8	326400	293760	277440	269280

This process gives examples of a way to implement a deterministic program clock reference re-stamping in Digital Video Broadcasting for Handheld Mobile/Terrestrial Television DVB-T/H (e.g., as defined in EN 300 744 and in TR 102 377DVB-T/H) systems where mega-frame initialization packet or extra-long mega frame watermarking is present. The processes described above guarantee that any equipment having the same signal at the input and having the same output bit rate, and generates exactly the same stream (bit exact) in multiple locations. As a result, the system and methods described herein allow the use of the embedded Mega-frame Initialization Packet to achieve a high precision and deterministic PCR re-stamping that can be applied at the input of each transmitter of an SFN network, thereby maintaining the SFN requirements of identical bit stream at every transmitter and being fully compliant with above-mentioned standards.

A number of exemplary implementations have been described. Nevertheless, it will be understood that various modifications may be made. For example, suitable results may be achieved if the steps of described techniques are performed in a different order and/or if components in a described components, architecture, or devices are combined in a different manner and/or replaced or supplemented by other components. Accordingly, other implementations are within the scope of the following claims.

WHAT IS CLAIMED IS:

1. A method of providing a fixed and deterministic bit rate adaptation for an output transport stream, the method comprising:

- 5 receiving an input transport stream of packets;
 deriving output timing from the input transport stream;
 determining an input time stamp for each packet of the input transport stream;
 determining a corresponding output timestamp for each outgoing packet of the
output transport stream;
10 determining the difference between the input timestamp and the output timestamp;
 extracting a program clock reference (PCR) for the output transport stream;
 adding the determined difference to the PCR; and
 adding the PCR to the output transport stream.

15 2. The method of claim 1 further comprising:

- receiving the input stream of packets includes a time mark packet;
 determining a period from the time mark;
 determining the input time stamp and output time stamp for each packet within the
period; and
20 resetting the timestamps at the end of each period.

3. The method of claim 2 wherein the time mark is a mega-frame initialization packet (MIP) and the period is a mega-frame.

25 4. The method of claim 2 wherein the time mark is a mega-frame initialization packet (MIP) and the period is an extra long mega-frame.

5. The method of claim 1 further comprising composing the output transport stream from the input transport stream packets by inserting or eliminating null packets to perform rate
30 adaptation based on the output timing.

6. The method of claim 2 wherein the time base sampling frequency is 34,292,160 MHz for a reference clock of 27MHz and the difference is divided by 1,270,080.

7. The method of claim 2 wherein the time base sampling frequency is 5,670 MHz for a reference clock of 8MHz and the difference is divided by 210.

8. A system for providing a fixed and deterministic bit rate adaptation for an output
5 transport stream, the system comprising:

an input to receive an input transport stream of packets;

a timer to provide output timing derived from the input transport stream;

a counter to determine an input time stamp for each packet of the input transport
stream;

10 a counter to determine a corresponding output timestamp for each outgoing packet
of the output transport stream;

a processor to determine the difference between the input timestamp and the
output timestamp, extract a program clock reference (PCR) for the output transport
stream; add the determined difference to the PCR; and add the PCR to the output

15 transport stream; and

an output to output the transport stream according to the derived output timing.

9. The system claim 8 wherein the input stream includes a time mark packet used to
determine a period, the input time stamp and output time stamp are determined for each
20 packet within the period; and the timestamps are reset at the end of each period.

10. The system of claim 9 wherein the time mark is a mega-frame initialization packet
(MIP) and the period is a mega-frame.

25 11. The system of claim 9 wherein the time mark is a mega-frame initialization packet
(MIP) and the period is an extra long mega-frame.

12. The system of claim 8 further comprising a composer to create the output transport
stream from the input transport stream packets by inserting or eliminating null packets to
30 perform rate adaptation based on the output timing.

13. The system of claim 9 wherein the time base sampling frequency is 34,292,160 MHz
for a reference clock of 27MHz and the difference is divided by 1,270,080.

14. The system of claim 9 wherein the time base sampling frequency is 5,670 MHz for a reference clock of 8MHz and the difference is divided by 210.

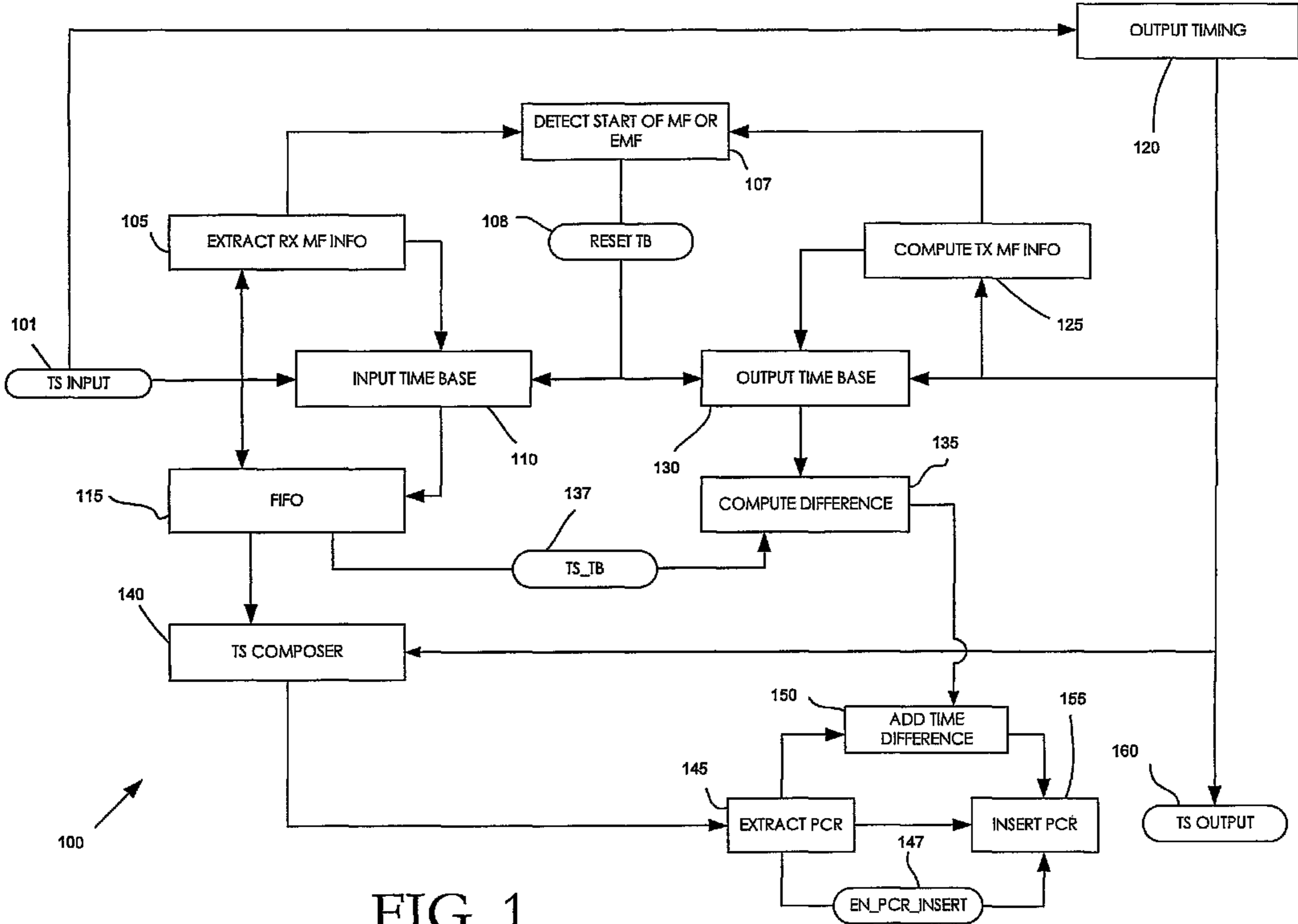


FIG. 1