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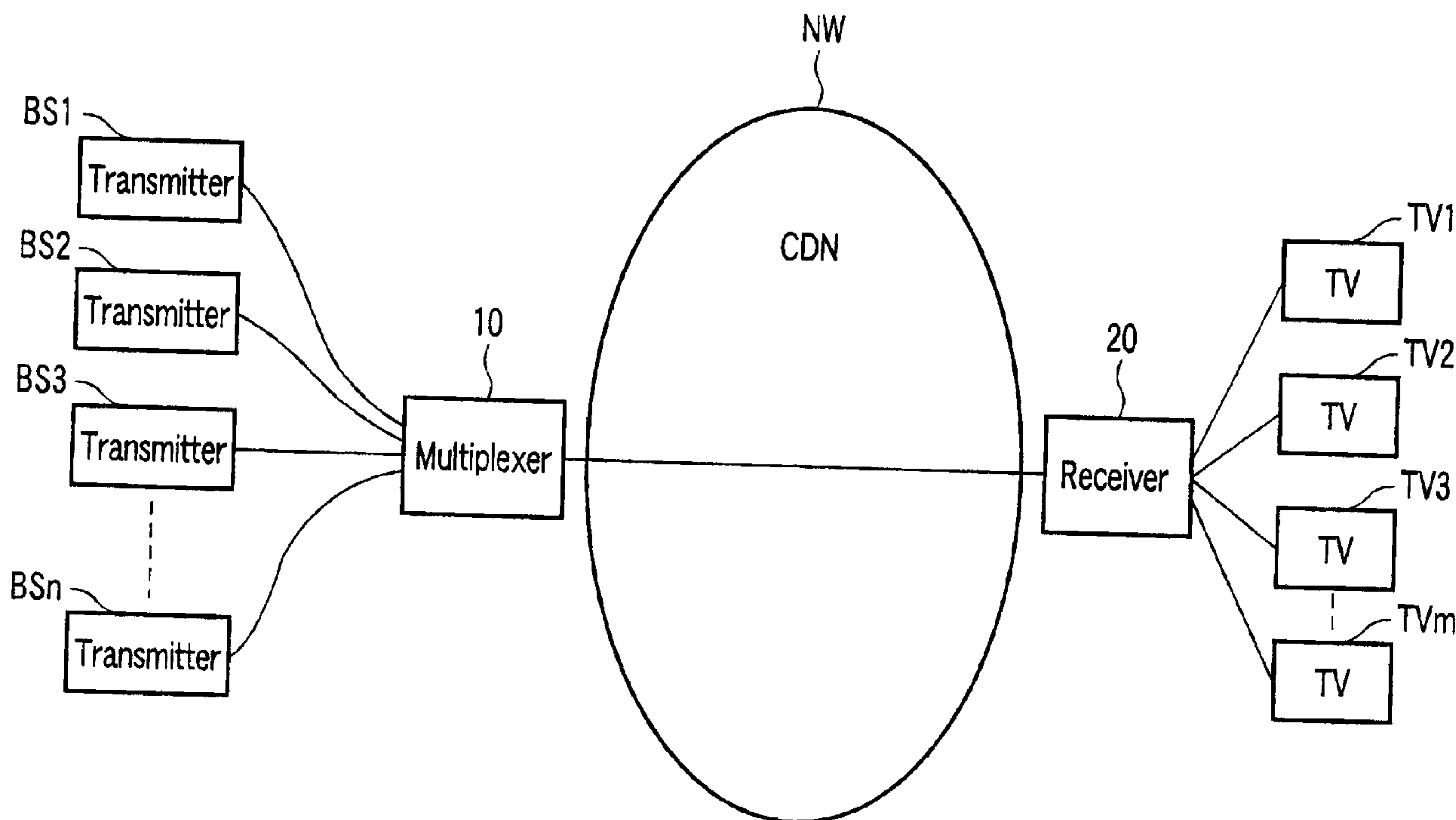
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(54) Title: IP BROADCAST SYSTEM, AND MULTIPLEXER, RECEIVING APPARATUS AND METHOD USED IN IP BROADCAST SYSTEM



(57) Abrégé/Abstract:

An IP broadcast system includes a transmitting side and a receiving side connected to the transmitting side through a broadcast network on an IP network. The transmitting side includes a multiplexer which generates a standardized multiplex frame including at least a header field and an information field by multiplexing a plurality of RTP packets. The receiving side includes a buffer which temporarily holds the multiplex frame from the broadcast network and a program reproducer which retrieves and analyzes the multiplex frame from the buffer, extracts a reproduction clock shared by a plurality of programs, demultiplexes a plurality of TSs for each program from the multiplex frame, and based on the reproduction clock, reproduces the programs from each TS.

ABSTRACT OF THE DISCLOSURE

An IP broadcast system includes a transmitting side and a receiving side connected to the transmitting side through a broadcast network on an IP network. The transmitting side includes a multiplexer which generates a standardized multiplex frame including at least a header field and an information field by multiplexing a plurality of RTP packets. The receiving side includes a buffer which temporarily holds the multiplex frame from the broadcast network and a program reproducer which retrieves and analyzes the multiplex frame from the buffer, extracts a reproduction clock shared by a plurality of programs, demultiplexes a plurality of TSs for each program from the multiplex frame, and based on the reproduction clock, reproduces the programs from each TS.

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TITLE OF THE INVENTION

IP BROADCAST SYSTEM, AND MULTIPLEXER, RECEIVING
APPARATUS AND METHOD USED IN IP BROADCAST SYSTEM

BACKGROUND OF THE INVENTION

5 The present invention relates to an IP broadcast
system for broadcasting a TS (transport stream) of a
plurality of programs through an IP broadcast network
from a broadcast station to a broadcast receiver, and a
multiplexer, a receiving apparatus and method used in
10 the IP broadcast system.

 In recent years, the use of an IP broadcast system
has extended for transmission of the broadcast contents
to the users of the broadcast receivers through an IP
network in addition to the transmission of the
15 broadcast contents on a broadcast wave to the broadcast
receivers from a broadcast station. Also, in the IP
network, a large-capacity quality-controlled wide-area
broadcast network called contents distribution network
(CDN) or next-generation network (NGN) has come to be
20 used widely. In these networks, the coded data of
high-definition images are transmitted, and
applications include video on demand (VOD) and IP
broadcast programs.

 Normally, a user datagram protocol (UDP) stream
25 independent for each program is transmitted without
multiplexing. In this case or especially in the case
where a plurality of simultaneous programs are received

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by a set-top box (reproducing apparatus) for the IP
broadcast, the requirement must be met for the process
of simultaneous reception of a plurality of UDP
streams, and the set-top box is correspondingly
5 complicated, leading to an increased cost.

Although a method of multiplexing a plurality of
programs using a transport stream (TS) according to
Moving Picture Experts Group 2 (MPEG2) is available,
the simultaneous processing of programs is complicated
10 and a delay is caused.

In the normal network, the packet length is
limited. In CDN or NGN, on the other hand, packets of
some length have come to be transmitted as they are. A
long packet can improve the throughput (transmission
15 efficiency). The conventional packet length of about
1500 bytes, however, cannot exhibit the network
performance sufficiently.

In the prior art, a communication terminal device
(Jpn. Pat. Appln. KOKOAI Publication No. 2006-60631)
20 and a network relay device (Jpn. Pat. Appln. KOKOAI
Publication No. 2002-9832) are available for reducing
the network load by multiplexing and transmitting a
plurality of packets in one frame.

In the communication terminal device and the
25 network relay device described above, a plurality of
packets are multiplexed in one frame for communication
but the TSs of a plurality of programs are not

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multiplexed as in the IP broadcast system described above.

BRIEF SUMMARY OF THE INVENTION

In view of this, an object of this invention is to
5 provide an IP broadcast system, a multiplexer and a
receiving apparatus and method used in this IP
broadcast system which improve the network throughput
and can suppress the complication of the process at the
receiving end of a broadcast system for broadcasting
10 the TS of a plurality of programs through the IP
network.

The present invention provides an IP broadcast
system comprising: a transmitting side which converts a
plurality of transport streams (TSs) into real-time
15 transport protocol (RTP) packets for IP network
transmission, and transmits the converted RTP packets
to a broadcast network on an IP network, the TS
including packet structures different in program and
reproduction clock; and a receiving side which receives
20 the plurality of RTP packets from the broadcast
network, extracts a reproduction clock from each of the
RTP packets, and reproduces a program from the TS in
each RTP packet based on the reproduction clock,
wherein the transmitting side comprises a multiplexer
25 which multiplexes the plurality of RTP packets to
generate a standardized multiplex frame including at
least a header field and an information field, and the

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receiving side comprises: a buffer which temporarily holds the multiplex frame from the broadcast network; and a program reproducer which retrieves and analyzes the multiplex frame from the buffer, extracts the reproduction clock shared by the plurality of programs, demultiplexes a plurality of TSs for each program from the multiplex frame and reproduces the program from each TS based on the reproduction clock.

The present invention also provides a multiplexer used on a transmitting side of an IP broadcast system, the transmitting side converts a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for IP network transmission, and transmits the converted packets to a broadcast network on an IP network, the TS including packet structures different in program and reproduction clock; the multiplexer comprising: a frame generator which generates a standardized multiplex frame including at least a header field and an information field by multiplexing the plurality of RTP packets.

The present invention also provides a receiving apparatus used on a receiving side of an IP broadcast system, the IP broadcast system converts a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for IP network transmission, and transmits the converted packets to a broadcast network on an IP network, the TS including packet structures

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different in program and reproduction clock, the receiving apparatus comprising: a receiving unit to receive a multiplex frame from the broadcast network, the multiplex frame including at least a header field and an information field by multiplexing the plurality of RTP packets in a transmitting side of the IP broadcast system; a buffer which temporarily holds the multiplex frame; and a program reproducer which retrieves and analyzes the multiplex frame from the buffer, extracts a reproduction clock shared by the plurality of programs, demultiplexes the plurality of TSs for each program from the multiplex frame, and reproduces the program from each TS based on the reproduction clock.

The present invention also provides a method of converting a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for internet protocol (IP) network transmission and transmitting the converted RTP packets to a broadcast network on the IP network, the TS including packet structures different in program and reproduction clock, the method comprising: designating a program including the highest transmission rate as a master program among a plurality of programs to be transmitted to the broadcast network; determining a delay amount for the master program and for each of a plurality of programs following the master program; judging whether the delay amount is

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larger than a target delay amount; storing a plurality of the corresponding RTP packets in an output buffer with regard to the program including a delay amount larger than the target delay amount; storing a
5 plurality of the corresponding RTP packets and dummy data for a deficient part in the output buffer with regard to the program including a delay amount not larger than the target delay amount; and generating and outputting a standardized multiplex frame including at
10 least a header field and an information field based on the plurality of RTP packets stored in the output buffer.

In one aspect, the invention provides an internet protocol (IP) broadcast system, comprising:

15 a transmitting side which converts a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for IP network transmission, and transmits the converted RTP packets to a broadcast network on an IP network, the TS including packet structures different in
20 program and reproduction clock; and

a receiving side which receives the plurality of RTP packets from the broadcast network, extracts a reproduction clock from each of the RTP packets, and reproduces a program from the TS in each RTP packet based on the
25 reproduction clock, wherein:

the transmitting side comprises a multiplexer which multiplexes the plurality of RTP packets to generate a standardized multiplex frame including at least a header field and an information field;

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the receiving side comprises:

a buffer which temporarily holds the multiplex frame from the broadcast network; and

a program reproducer which retrieves and analyzes
5 the multiplex frame from the buffer, extracts the reproduction clock shared by the plurality of programs, demultiplexes a plurality of TSs for each program from the multiplex frame and reproduces the program from each TS based on the reproduction clock;
10 and

the multiplexer comprises:

a plurality of input buffers which temporarily hold the plurality of RTP packets for each program;

an arithmetic unit to determine a delay amount
15 from a buffer occupation amount of each of the plurality of input buffers, read out a plurality of RTP packets from the plurality of corresponding input buffers based on the delay amount;

a header generator which generates data of the
20 header field of the multiplex frame based on the plurality of RTP packets; and

an output buffer which stores the plurality of RTP packets and the data in the header field of the multiplex frame, to output the multiplex frame.

25 In one aspect, the invention provides a multiplexer used on a transmitting side of an internet protocol (IP) broadcast system, the transmitting side converts a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for IP network

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broadcast system, the transmitting side converts a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for IP network transmission, and transmits the converted packets to a broadcast network on an IP network, the TS including packet structures different in program and reproduction clock;

the multiplexer comprising:

10 a frame generator which generates a standardized multiplex frame including at least a header field and an information field by multiplexing the plurality of RTP packets, wherein the frame generator comprises:

a plurality of input buffers which temporarily holds the plurality of RTP packets for each program;

15 an arithmetic unit to determine a delay amount from a buffer occupation amount of each of the plurality of input buffers, read out a plurality of RTP packets from the plurality of corresponding input buffers based on the delay amount;

20

a header generator which generates data of the header field of the multiplex frame based on the plurality of RTP packets; and

25 an output buffer which stores the plurality of RTP packets and the data in the header field of the multiplex frame, to output the multiplex frame.

In one aspect, the invention provides a receiving apparatus used on a receiving side of an internet protocol

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(IP) broadcast system, the IP broadcast system converts a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for IP network transmission, and transmits the converted packets to a broadcast network on an IP network, the TS including packet structures different in program and reproduction clock, the receiving apparatus comprising:

5 a receiving unit to receive a multiplex frame from the broadcast network, the multiplex frame including at least a header field and an information field by multiplexing the plurality of RTP packets in a multiplexer in a transmitting side of the IP broadcast system, wherein the multiplexer includes a plurality of input buffers, which temporarily hold the plurality of RTP packets for each program, and an arithmetic unit which determines a delay amount from a buffer occupation amount of each of the plurality of input buffers, and reads out a plurality of RTP packets from the plurality of corresponding input buffers based on the delay amount;

20 a buffer which temporarily holds the multiplex frame; and

a program reproducer which retrieves and analyzes the multiplex frame from the buffer, extracts a reproduction clock shared by the plurality of programs, demultiplexes the plurality of TSs for each program from the multiplex frame, and reproduces the program from each TS based on the reproduction clock.

In one aspect, the invention provides a method of converting a plurality of transport streams (TSs) into

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real-time transport protocol (RTP) packets for internet
protocol (IP) network transmission and transmitting the
converted RTP packets to a broadcast network on the IP
network, the TS including packet structures different in
5 program and reproduction clock, the method comprising:

designating a program including the highest
transmission rate as a master program among a plurality of
programs to be transmitted to the broadcast network;

determining a delay amount for the master program and
10 for each of a plurality of programs following the master
program;

judging whether the delay amount is larger than a
target delay amount;

storing a plurality of the corresponding RTP packets
15 in an output buffer with regard to the program including a
delay amount larger than the target delay amount;

storing a plurality of the corresponding RTP packet
and dummy data for a deficient part in the output buffer
with regard to the program including a delay amount not
20 larger than the target delay amount; and

generating and outputting a standardized multiplex
frame including at least a header field and an information
field based on the plurality of RTP packets in the output
buffer.

25 In another aspect, the invention provides a method of
converting a plurality of transport streams (TSs) into
real-time transport protocol (RTP) packets for internet
protocol (IP) network transmission and transmitting the
converted RTP packets to a broadcast network on the IP

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network, the TS including packet structures different in program and reproduction clock, the method comprising:

designating a program including the highest transmission rate as a master program among a plurality of programs to be transmitted to the broadcast network;

determining a delay amount for the master program and for each of a plurality of programs following the master program;

judging whether the delay amount is larger than a target delay amount;

storing a plurality of the corresponding RTP packets in an output buffer with regard to the program including a delay amount larger than the target delay amount;

storing a plurality of the corresponding RTP packets and dummy data for a deficient amount of a capacity of the output buffer with regard to the program including a delay amount not larger than the target delay amount, wherein the deficient amount of the capacity of the output buffer corresponds to a difference between a delay amount of the program and the target delay amount; and

generating and outputting a standardized multiplex frame including at least a header field and an information field based on the plurality of RTP packets in the output buffer.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

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BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a diagram showing a general

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configuration of an IP broadcast system according to an embodiment of the invention;

FIG. 2 is a block diagram showing a specific configuration of a multiplexer shown in FIG. 1;

5 FIG. 3 is a block diagram showing a specific configuration of a receiver shown in FIG. 1;

FIG. 4 is a diagram showing a general configuration of a previously conceived IP broadcast system;

10 FIG. 5 is a diagram showing an example of the frame structure before and after multiplexing according to the same embodiment; and

FIG. 6 is a flowchart showing the processing steps of a multiplexing scheduler according to the same
15 embodiment.

DETAILED DESCRIPTION OF THE INVENTION

An embodiment of the invention will be explained in detail below with reference to the drawings.

FIG. 1 is a diagram showing a general
20 configuration of an IP broadcast system according to an embodiment of the invention. Reference characters BS1 to BS_n (n: natural number) designate transmitters installed for the respective broadcast stations or service providers, characters TV1 to TV_m (m: natural
25 number) television (TV) receivers.

First, the transmitters BS1 to BS_n transmit by converting broadcast programs independent of each other

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from the TS to RTP packets for network (CDN) transmission. These RTP packets are supplied to a multiplexer 10, which in turn multiplexes a plurality of RTP packets and, thus generating a Ethernet (registered mark) frame specified for IP network transmission, sends out the Ethernet (registered mark) frame to the network NW.

The Ethernet (registered mark) frame is sent to a receiver (sets of STB (set-top box) and the existing TV receiver) 20. The receiver 20 has arranged therein TV receivers TV1 to TVm through a wired or a wireless channel. The receiver 20 receives the Ethernet (registered mark) frame from the network NW and, in accordance with the select operation by a remote controller (not shown), for example, separates the TS packets of a selected program and outputs them to the TV receivers TV1 to TVm. In each of the TV receivers TV1 to TVm, the TS packets are demodulated and output by reproduction.

FIG. 2 is a block diagram showing a configuration of the multiplexer 10.

Specifically, the multiplexer 10 includes a program selector 101, rate detectors 102, input buffer memories 103, a packet selector 104, an output buffer memory 105, a multiplexing scheduler 106 and a Ethernet (registered mark) frame header generator 107.

The RTP packets output from the transmitters BS1

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to BSn are arbitrarily selected by the program selector 101, and with the rate detected for each program by the corresponding rate detector 102, supplied to and temporarily held in the corresponding input buffer memory 103.

The multiplexing scheduler 106 analyzes each RTP packet, based on the rate information for each program from the rate detectors 102 and the buffer occupancy amount for each program in the input buffer memories 103, and then transfers the corresponding RTP packet to the output buffer memory 105 by switching the packet selector 104. The Ethernet (registered mark) frame header generator 107 calculates the contents of the header section of the Ethernet (registered mark) frame based on each RTP packets in the output buffer memories 105, and then writes the contents of the header section of the Ethernet (registered mark) frame in the output buffer memory 105.

The output buffer memory 105 generates and appropriately outputs the Ethernet (registered mark) frame by storing a plurality of RTP packets transferred from the input buffer memories 103 through the packet selector 104 and the header section of the Ethernet (registered mark) frame from the Ethernet (registered mark) frame header generator 107. In the process, the program having the highest transmission rate is determined as a master program, and a plurality of the

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corresponding RTP packets are multiplexed into a Ethernet (registered mark) frame at the rate equal to the product of the master program transfer rate and the number of programs.

5 FIG. 3 is a block diagram showing the configuration of the receiver 20.

In the receiver 20, the Ethernet (registered mark) frame that has arrived from the network NW is temporarily held in a receiving buffer 201. The
10 Ethernet (registered mark) frame held in the receiving buffer 201 is introduced into a packet analyzer 202. The packet analyzer 202 analyzes the RTP packets, calculates the header contents of the Ethernet (registered mark) frame, and transfers the RTP packets
15 to a TS demultiplexer 203 while at the same time outputting time stamp information constituting the header contents to a clock extractor 204.

The TS demultiplexer 203 separates a plurality of the TS packets from the input RTP packets, and outputs
20 the result to the TV receivers TV1 to TVm.

In the clock extractor 204, on the other hand, an offset adder 2041, which holds the difference between the clock of the past master program and the clock of the present master program, adds the clock difference to
25 a new time stamp as an offset. After that, the output of the offset adder 2041 is supplied, through an LPF 2042, to a clock oscillator (OSC) 2043 and each of the

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TV receivers TV1 to TVm as a program reproduction clock.

Next, the operation of the configuration described above will be explained.

FIG. 4 is a diagram showing the configuration of the previously-conceived IP broadcast system. In FIG. 4, the same component parts as those in FIG. 1 are designated by the same reference numerals, respectively, and not described again.

The data from the transmitters BS1 to BSn arrive at the receiver 30 as a plurality of independent streams on the network NW. The receiver 30 activates the network receiving devices in parallel in order to reproduce a plurality of programs at the same time. As a result, the circuit size is increased in hardware and so is the processing load in software, thereby necessitating a high-speed CPU.

The simultaneous reception of a plurality of programs has the advantages that the program switching speed is increased and the network band unified. In view of the fact that the previous program stream may not stop immediately at the time of switching the program, an attempt to receive only a program specified to be viewed would result in a plurality of program streams reaching the receiver 30 temporarily and causing the instability of the network band.

According to this embodiment, the data from the transmitters BS1 to BSn are multiplexed into a single

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stream by the multiplexer 10 and sent out as they are to the receiver 20.

Each program is input to the multiplexer 10 in the form of a RTP packet including plural MPEG2-TS packets of 188 or 204 bytes, and each RTP packet is configured of a maximum of 7 TS packets not to exceed the maximum frame length of 1518 bytes of the network NW.

Once the maximum frame length of the network NW is exceeded, the frame would be segmented into 1518 bytes or less to deteriorate the transmission efficiency. In the case where the transmission of the frame length having more than 1518 bytes called the Ethernet (registered mark) frame is tolerated in CDN, however, the transmission efficiency is improved by lengthening the frame to the maximum length on the network NW. This characteristic makes possible the transmission with the normal frame length before the multiplexer 10 and in the Ethernet (registered mark) frame only in CDN.

In the case where the maximum frame length tolerated in CDN is 9600 bytes, for example, the original six frames can be accommodated in one Ethernet (registered mark) frame. A conflict on the network NW would reduce the transmission efficiency. A small number of transmitters, therefore, causes the conflict less often for an improved efficiency and reduces the jitters of the time of arrival at STB due to queuing.

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The program selector 101 is changed based on the program structure determined by the service provider. In the case where the broadcast contents are changed by area, the program selected is changed for each area, and the viewing can be limited by each stream designated for multiplexing in the access list of the router in the CDN.

The access list is for setting the router and determines which stream is to be distributed to which area. The packet selector 104 controls each packet so that a given packet staying for the longest time in the input buffer memory 103 is output in priority. By doing so, the multiplexing process can be executed with a minimum delay. The output buffer memory 105 suppresses a burst (short-time concentrated) output to prevent the overflow from the receiving buffer 201 of the receiver 20.

FIG. 5 shows an example of the frame structure before and after the multiplexing process.

The Ethernet (registered mark) frame is generally standardized according to IEEE802.3, and from the front end, configured of a header section, a data section and an frame check sequence (FCS) in that order. The header section is configured of a preamble, a destination address, a transmitter address and the length. The data section is configured of RTP packets. A plurality of TS packets are stored in a payload

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section of the RTP packet. The header section of the RTP packet has a Payload Type field and an SSRC field. By setting these fields for each program, a particular program with which the RTP packet is associated can be identified. The programs, if identical in input rate, can be arranged and multiplexed sequentially from the RTP packet head. Incidentally, a master program index is attached at the head of the plurality of RTP packets.

10 In the long term, however, a measure against the accumulation of input rate errors is required. The multiplexing rate, therefore, is set in accordance with the program having the highest input rate, and a dummy data is output for the deficient program portion. The program having a determined output rate as a master program is indicated at the head of the data section, thereby permitting the receiving end to judge which time stamp is to be referred to.

FIG. 6 is a flowchart showing the processing operation of the multiplexing scheduler 106.

The multiplexing scheduler 106 determines the index of the program having the highest rate as a master program index from the rate information by program obtained from the rate detector 102 (step ST6a) and then selects a program yet to be checked (step ST6b). Then, the buffer occupation amount divided by the rate information of the input buffer memory 103

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holding this selected program is calculated thereby to determine the delay amount (step ST6c).

5 The multiplexing scheduler 106 then judges whether the delay amount of the selected program is larger than the target delay amount or not (step ST6d). In the case where the delay amount of the selected program is larger than the target delay amount, i.e. the delay amount determined from the jitter amount of each input program (YES), the multiplexing scheduler 106 switches
10 the packet selector 104 and writes by transferring the corresponding RTP packet to the output buffer memory 105 (step ST6e).

In the case where the delay amount of the selected program is not larger than the target delay amount
15 (NO), on the other hand, the multiplexing scheduler 106 writes dummy data in the deficient portion of the output buffer memory 105 (step ST6f). After that, the multiplexing scheduler 106 determines that the selected program has been checked (step ST6g), and judges
20 whether all the programs held in the input buffer memory 103 have been checked or not (step ST6h). In the case where they have not yet been completely checked (NO), the multiplexing scheduler 106 executes the process of steps ST6b to ST6h repeatedly until all
25 the programs have been completely checked. Upon complete checking of all the programs (YES), the multiplexing scheduler 106 clears the entire check

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operation (step ST6i), followed by transferring to the process of step ST6a. After the Ethernet (registered mark) frame header generator 107 writes the contents of the header section of the Ethernet (registered mark) frame in the output buffer memory 105.

The receiver 20 reproduces by extracting the TS for each program from the multiplexed streams. In the case where the programs are multiplexed in fixed order by the multiplexer 10, the processing is a simplified one to read from a predetermined position. For reproduction, however, the clock is required to be extracted from the time stamp of the RTP header. In the case where the master program determined on the multiplexer 10 side is changed, therefore, the time stamp referred to is changed on the receiver 20 side.

Incidentally, the repeated clock extraction causes the provisional suspension of the receiving operation. Thus, the difference between the clock of the past master program and the clock of the present master program is held in the offset adder 2041, and added as an offset to the new time stamp. In this way, the receiving operation is continued without repeating the clock extraction. The LPF 2042 is used for absorbing the clock jitters and can absorb the shock of the change in the master program as well as the fluctuation of the network. The dummy data inserted in the multiplexer 10 is discarded at the time of receiving

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operation.

As described above, according to this embodiment, the RTP packet including the TS of a plurality of programs is held for each program in the input buffer memory 103 of the multiplexer 10, and the multiplexing scheduler 106 reads the RTP packet of an arbitrary program from the corresponding input buffer memory 103 by switching the packet selector 104. The RTP packet is then stored in the output buffer memory 105 and coupled to the data section of the Ethernet (registered mark) frame. Further, the data of the header section of the Ethernet (registered mark) frame is generated from the RTP packets and stored in the output buffer memory 105 by the Ethernet (registered mark) frame header generator 107. Thus, the Ethernet (registered mark) frame is generated and sent out to the receiving device. Specifically, the delay between the plural programs is minimized at the transmitting end, and therefore, the programs can share the receiving buffer 201 and the clock extractor 204 in the receiving device 20.

In the case where the TS of plural programs is broadcast through the network NW, therefore, the throughput of the network NW can be improved while at the same time eliminating the need of preparing separate reproduction units for the programs at the receiving end. As a result, the multiplexer 10 is

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simplified, and the receiving process of the receiver 20 at the receiving end can be unified.

Also, according to this embodiment, plural RTP packets are multiplexed in the Ethernet (registered mark) frame together with the master program having the highest transmission rate at the transmitting end, and therefore, the clock extractor 204 of the receiver 20 is simply required to refer to the time stamp of the master program.

Further, in the multiplexer 10 according to this embodiment, multiplex transmission is possible by changing the combination of plural programs for each receiving area. Therefore, not only can the optimum broadcast service be realized for each receiving area but also the viewing can be limited for each receiving area.

The invention, though explained above with reference to an embodiment, is not limited to this embodiment, but can be embodied by modifying the component elements without departing from the scope of the invention. Also, various inventions can be achieved by appropriately combining the plural component elements disclosed in the aforementioned embodiment. For example, several ones of all the component elements included in the embodiments may be deleted.

Additional advantages and modifications will

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readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various
5 modifications may be made without departing from the scope of the general inventive concept as defined by the appended claims and their equivalents.

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The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An internet protocol (IP) broadcast system, comprising:

a transmitting side which converts a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for IP network transmission, and transmits the converted RTP packets to a broadcast network on an IP network, the TS including packet structures different in program and reproduction clock; and

a receiving side which receives the plurality of RTP packets from the broadcast network, extracts a reproduction clock from each of the RTP packets, and reproduces a program from the TS in each RTP packet based on the reproduction clock, wherein:

the transmitting side comprises a multiplexer which multiplexes the plurality of RTP packets to generate a standardized multiplex frame including at least a header field and an information field;

the receiving side comprises:

a buffer which temporarily holds the multiplex frame from the broadcast network; and

a program reproducer which retrieves and analyzes the multiplex frame from the buffer, extracts the reproduction clock shared by the plurality of programs, demultiplexes a plurality of TSs for each program from the multiplex frame and reproduces the program from each TS based on the reproduction clock; and

the multiplexer comprises:

a plurality of input buffers which temporarily hold the plurality of RTP packets for each program;

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an arithmetic unit to determine a delay amount from a buffer occupation amount of each of the plurality of input buffers, read out a plurality of RTP packets from the plurality of corresponding input buffers based on the delay amount;

a header generator which generates data of the header field of the multiplex frame based on the plurality of RTP packets; and

an output buffer which stores the plurality of RTP packets and the data in the header field of the multiplex frame, to output the multiplex frame.

2. The IP broadcast system according to claim 1, wherein:
the multiplexer further comprises a rate detector which detects a transmission rate of each of said plurality of RTP packets; and

the arithmetic unit determines a program including the highest transmission rate as a master program among the plurality of programs based on a detection result of the rate detector, and multiplexes a plurality of corresponding RTP packets at a rate equal to the product of the transmission rate of the master program and a number of programs.

3. The IP broadcast system according to claim 2, wherein the program reproducer executes a reproduction process by extracting the reproduction clock of the master program.

4. The IP broadcast system according to any one of claims 1 to 3,

wherein the multiplexer changes a combination of a plurality of programs to be multiplexed, in accordance with a receiving area of the broadcast network.

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5. A multiplexer used on a transmitting side of an internet protocol (IP) broadcast system, the transmitting side converts a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for IP network transmission, and transmits the converted packets to a broadcast network on an IP network, the TS including packet structures different in program and reproduction clock;

the multiplexer comprising:

a frame generator which generates a standardized multiplex frame including at least a header field and an information field by multiplexing the plurality of RTP packets, wherein the frame generator comprises:

a plurality of input buffers which temporarily holds the plurality of RTP packets for each program;

an arithmetic unit to determine a delay amount from a buffer occupation amount of each of the plurality of input buffers, read out a plurality of RTP packets from the plurality of corresponding input buffers based on the delay amount;

a header generator which generates data of the header field of the multiplex frame based on the plurality of RTP packets; and

an output buffer which stores the plurality of RTP packets and the data in the header field of the multiplex frame, to output the multiplex frame.

6. The multiplexer according to claim 5, wherein:

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the frame generator further comprises a rate detector which detects a transmission rate of each plurality of RTP packets; and

the arithmetic unit determines a program including the highest transmission rate as a master program among the plurality of programs based on a detection result of the rate detector, and multiplexes a plurality of corresponding RTP packets at a rate equal to the product of the transmission rate of the master program and a number of programs.

7. The multiplexer according to claim 5,

wherein the frame generator changes a combination of a plurality of programs to be multiplexed, in accordance with an area of the broadcast network.

8. A receiving apparatus used on a receiving side of an internet protocol (IP) broadcast system, the IP broadcast system converts a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for IP network transmission, and transmits the converted packets to a broadcast network on an IP network, the TS including packet structures different in program and reproduction clock, the receiving apparatus comprising:

a receiving unit to receive a multiplex frame from the broadcast network, the multiplex frame including at least a header field and an information field by multiplexing the plurality of RTP packets in a multiplexer in a transmitting side of the IP broadcast system, wherein the multiplexer includes a plurality of input buffers, which temporarily hold the plurality of RTP packets for each program, and an arithmetic unit which determines a delay amount from a buffer occupation amount of each of the plurality of input

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buffers, and reads out a plurality of RTP packets from the plurality of corresponding input buffers based on the delay amount;

a buffer which temporarily holds the multiplex frame;
and

a program reproducer which retrieves and analyzes the multiplex frame from the buffer, extracts a reproduction clock shared by the plurality of programs, demultiplexes the plurality of TSs for each program from the multiplex frame, and reproduces the program from each TS based on the reproduction clock.

9. The receiving apparatus according to claim 8,

wherein the program reproducer executes a reproduction process by extracting the reproduction clock for a master program designated by the transmitting side.

10. A method of converting a plurality of transport streams (TSs) into real-time transport protocol (RTP) packets for internet protocol (IP) network transmission and transmitting the converted RTP packets to a broadcast network on the IP network, the TS including packet structures different in program and reproduction clock, the method comprising:

designating a program including the highest transmission rate as a master program among a plurality of programs to be transmitted to the broadcast network;

determining a delay amount for the master program and for each of a plurality of programs following the master program;

judging whether the delay amount is larger than a target delay amount;

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storing a plurality of corresponding RTP packets in an output buffer with regard to the program including a delay amount larger than the target delay amount;

storing a plurality of the corresponding RTP packets and dummy data for a deficient amount of a capacity of the output buffer with regard to the program including a delay amount not larger than the target delay amount, wherein the deficient amount of the capacity of the output buffer corresponds to a difference between a delay amount of the program and the target delay amount; and

generating and outputting a standardized multiplex frame including at least a header field and an information field based on the plurality of RTP packets in the output buffer.

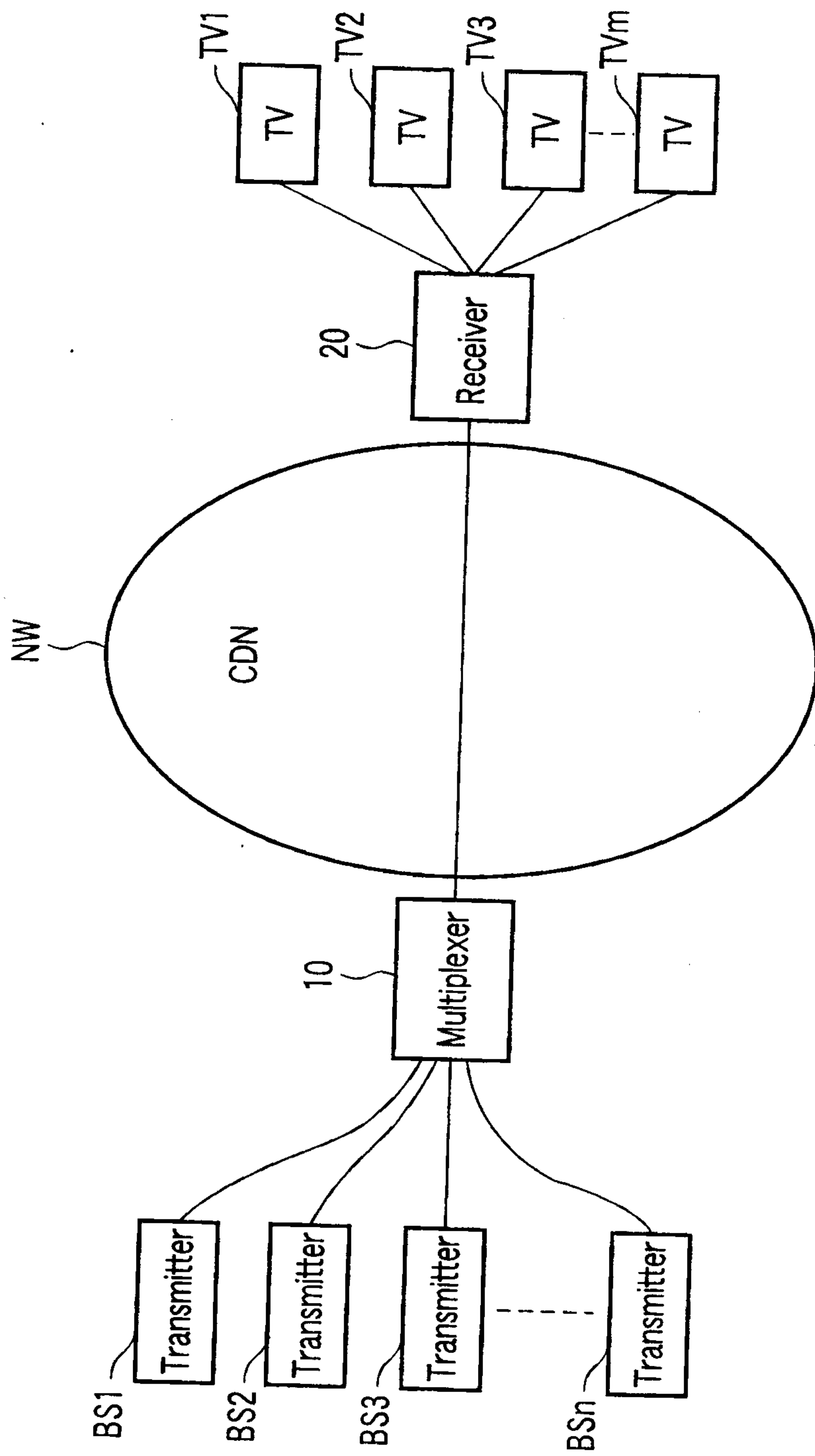


FIG. 1

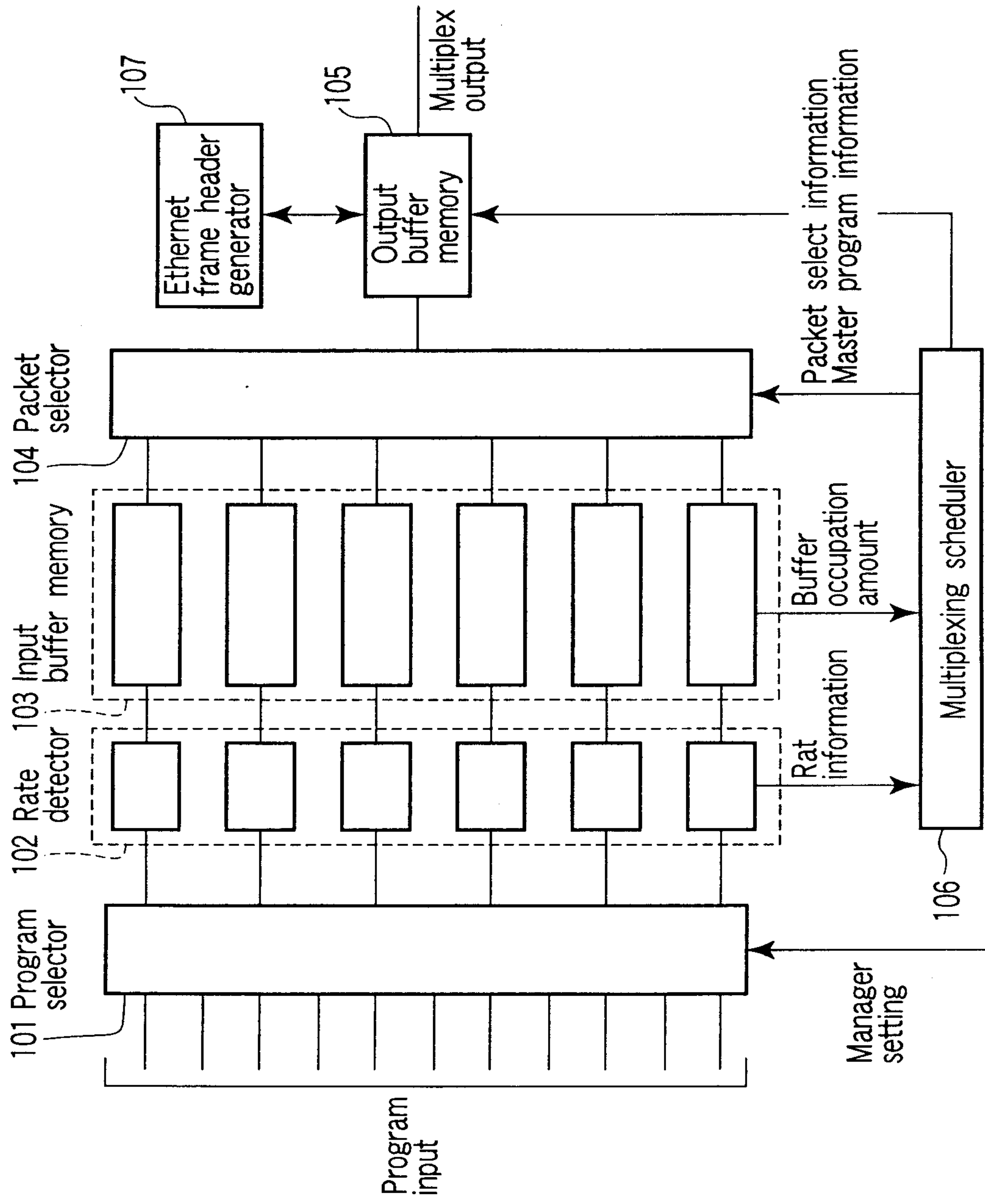


FIG. 2

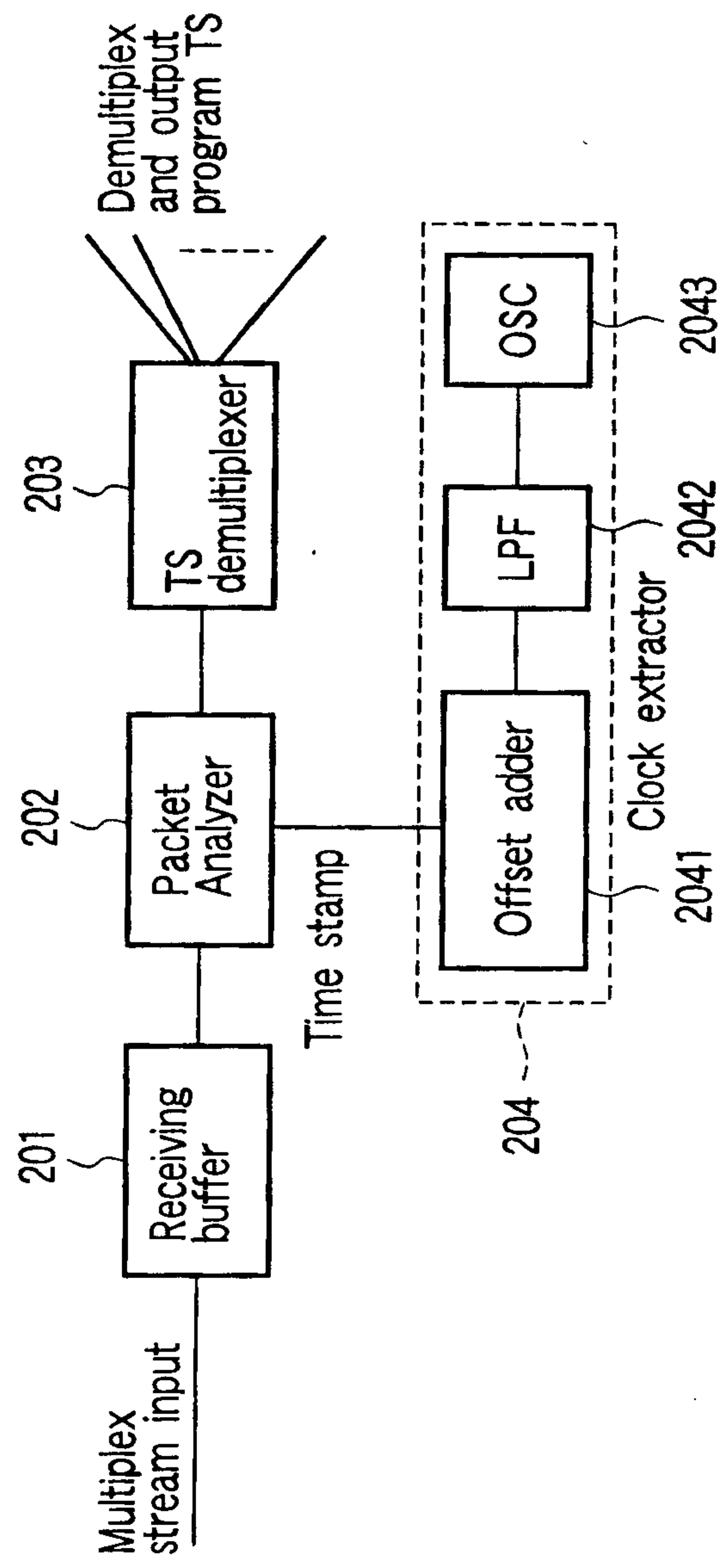


FIG. 3

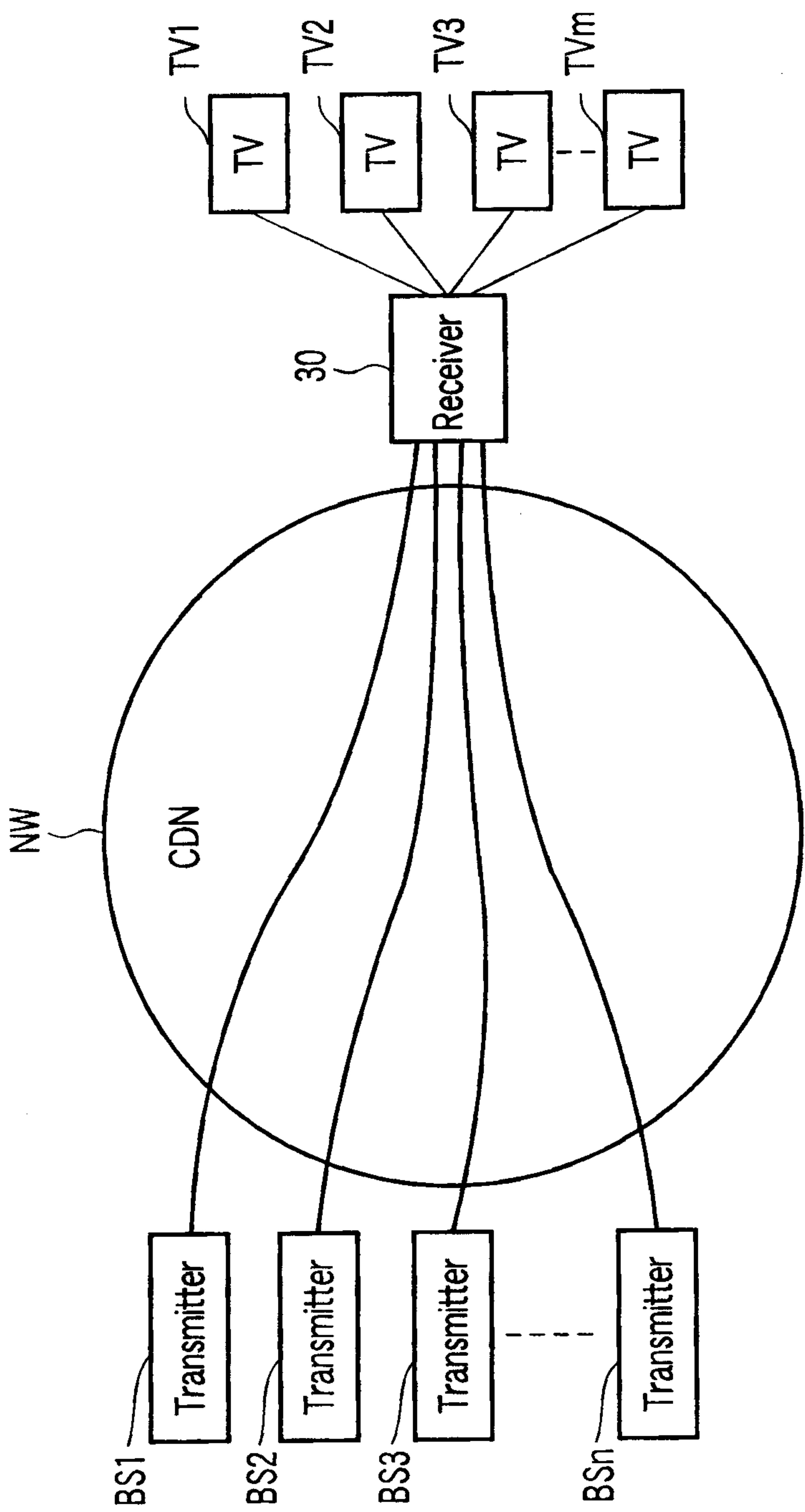


FIG. 4

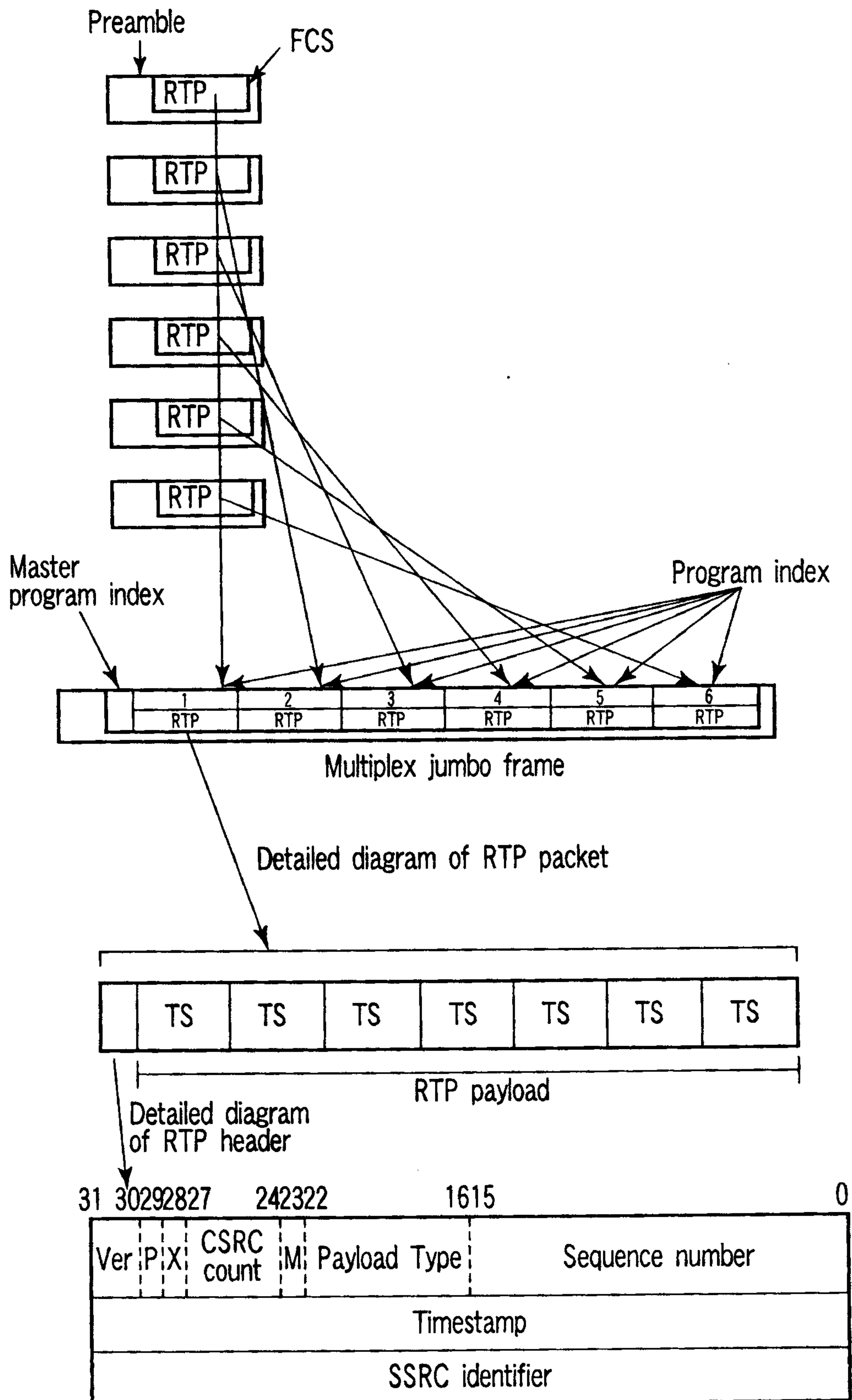


FIG. 5

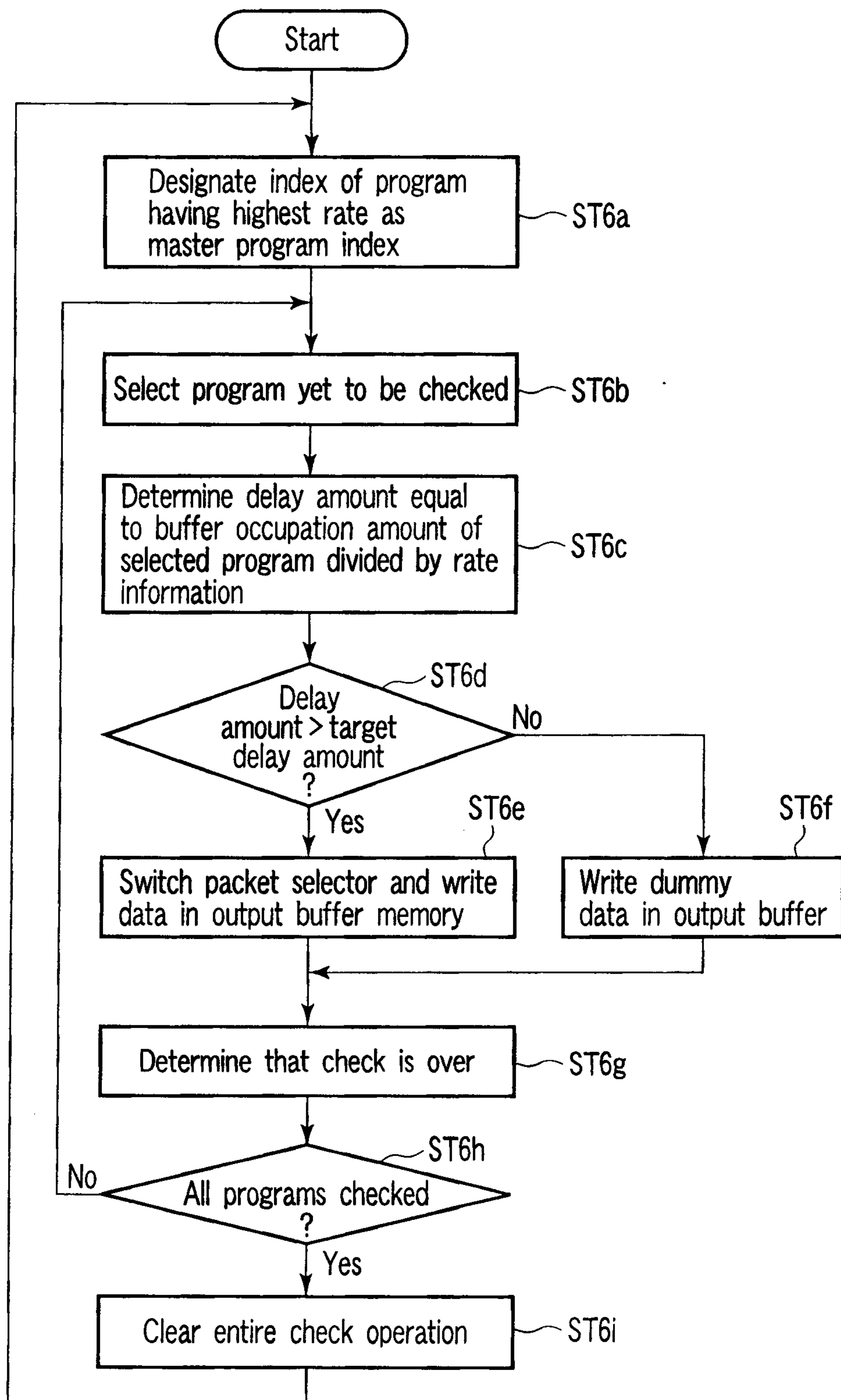


FIG. 6

