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UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA

WESTERN DIVISION

K TECH TELECOMMUNICATIONS, INC., a Delaware corporation, Plaintiff, vs. TIME WARNER CABLE, INC., a Delaware corporation, Defendant.	Case No. CV11-09373 RGK (RZx) **FIRST AMENDED COMPLAINT FOR INFRINGEMENT OF UNITED STATES PATENT NOS. 6,785,903; 7,487,533; 7,761,893; AND 7,984,469.** **DEMAND FOR JURY TRIAL**

1. Plaintiff K Tech Telecommunications, Inc. ("K Tech"), a Delaware corporation, for its complaint, and demanding trial by jury under Rule 38, Fed. R. Civ. P., and Local Rule 38-1, alleges that Defendant Time Warner Cable, Inc. ("Time Warner"), a Delaware corporation, is infringing at least claim 24 of U.S. Patent 6,785,903 (the "'903 patent"); claim 13 of U.S. Patent 7,487,533 (the "'533 patent"); claims 1 and 9 of U.S. Patent 7,761,893 (the "'893 patent"); and claims 1, 5, 9, 12, and 15 of U.S. Patent 7,984,469 (the "'469 patent") (collectively "the K Tech patents"), by making, selling, and offering to sell, in this judicial district, systems and methods for modifying a major channel number, a minor channel

number, and/or a carrier frequency to identify a television program that infringe the K Tech patents.

2. This is a civil action for patent infringement and arises under, among other things, the United States Patent Laws, 35 U. S. C. section 10, et seq. Jurisdiction is therefore based upon 28 U. S. C. sections 1331 and 1338(a), providing for federal question jurisdiction of patent infringement actions and exclusive jurisdiction of patent infringement actions in the U. S. district courts.

3. Plaintiff K Tech is informed and believes, and thereon alleges, that venue in this court is proper under 28 U. S. C. section 1391 (c) and section 1400 (b) because the acts of patent infringement alleged herein took place, at least in part, within this judicial district.

4. Plaintiff K Tech is a Delaware corporation, and has its principal place of business in Chatsworth, California.

5. Defendant Time Warner is a Delaware corporation, and has its principal place of business in New York, New York.

6. On August 31, 2004, the U. S. Patent and Trademark Office duly and lawfully issued the '903 patent under the title *Digital Television Translator with PSIP Update*. A true and correct copy of the '903 patent is attached hereto as **Exhibit A**. On February 3, 2009, the U. S. Patent and Trademark Office duly and lawfully issued the '533 patent under the title *Digital Television Translator with PSIP Update*. A true and correct copy of the '533 patent is attached hereto as **Exhibit B**. On July 20, 2010, the U.S. Patent and Trademark Office duly and lawfully issued the '893 patent under the title *Digital Television Translator with PSIP Update*. A true and correct copy of the '893 patent is attached hereto as **Exhibit C**. On July 19, 2011, the U.S. Patent and Trademark Office duly and lawfully issued the '469 patent under the title *Digital Television Translator with PSIP Update*. A true and correct copy of the '469 patent is attached hereto as **Exhibit D**.

7. Time Warner has infringed the K Tech patents by making, selling, and offering to sell, in this judicial district, systems and methods for modifying a major channel number, a minor channel number, and/or a carrier frequency to identify a television program covered by one or more of the claims in the K Tech patents in this judicial district and elsewhere in the United States. The United States Congress mandated that June 12, 2009 would be the last day for full-power television stations in the U.S. to broadcast with analog signals. Since June 12, 2009, full-power television stations, such as CBS, ABC, NBC and FOX television networks, can only transmit digital television signals. Digital television signals carry multiple television programs over each, individual signal. Full-power television stations, such as CBS, ABC, NBC and FOX television networks, identify the individual television programs carried over a single digital television signal transmitted over the air using a major channel number, a minor channel number, and/or a carrier frequency. Under FCC rules, all digital television signals in the U.S. must follow ATSC specifications. These specifications require that a digital television signal be transmitted over-the-air and follow Program System Information Protocol ("PSIP") specifications. The PSIP specifications redefine a television program contained in the signal to be identified in a table called the Virtual Channel Table ("VCT") with a major channel number, a minor channel number, and a carrier frequency. The K Tech patents identify systems and methods for modifying a major channel number, a minor channel number, and/or a carrier frequency to identify a television program. In order to broadcast programs in a cable or satellite system, companies, such as Time Warner, must identify television programs with a channel number so that users can select the programs. These companies may also be using the carrier frequency to identify the programs. On information and belief, this infringement will continue unless enjoined by this court.

8. Exhibit E, attached hereto, is a photograph showing KCBS, received as an ATSC digital signal over the air, assigned to channel "2-1," as displayed in the

upper right-hand corner of the television screen.

9. Exhibit F, attached hereto, is a photograph showing the same KCBS digital signal reassigned to channel "402" in the Time Warner cable broadcast system, as displayed in the dialog box at the bottom of the television screen.

10. The channel number originated by the KCBS broadcaster for the program "Judge Judy," as shown in Exhibit E, is "2-1". However, Time Warner has modified the original channel number and assigned a new channel number, shown in Exhibit F as channel "402," for its cable TV customers to identify the same program, "Judge Judy," originally transmitted by KCBS off-the-air.

11. On information and belief, Plaintiff believes that Time Warner is utilizing the methods and systems protected by the K Tech patents to update the digital signals it receives, rather than using other non-infringing methods and systems, because Time Warner's channel reassignment appears to be covered by the K Tech patents, as stated above, raising an inference of infringement, which constitutes probable cause for the case, even though Time Warner holds in confidence the details of its channel reassignment methods/systems.

12. Time Warner's infringement of the K Tech patents has damaged K Tech in an unknown amount. These damages continue to grow as Time Warner's infringement continues. Under Section 284 of Title 35 of the United States Code, K Tech seeks damages adequate to compensate for this infringement in an amount no less than a reasonable royalty, together with interest and costs affixed by the Court.

13. Time Warner's continuing infringement of the K Tech patents has caused and continues to cause irreparable harm to K Tech, including impairing the value of the K Tech patents in an amount yet to be determined. Pursuant to Section 283 of Title 35 of the United States Code, K Tech seeks a preliminary and a permanent injunction against further infringement of the K Tech patents.

PRAYER FOR RELIEF

WHEREFORE, K Tech prays for the following relief from this court against Defendant:

1. An order, pursuant to 35 U.S.C. Sections 154(d) and 271, declaring that Time Warner has infringed one or more claims of the K Tech patents;

2. A preliminary and a permanent injunction against Time Warner, prohibiting Time Warner from further infringement of the K Tech patents;

3. An award of the actual damages K Tech has suffered by reason of the infringement charged in this Complaint, in an amount not less than a reasonable royalty on Time Warner's sales of the products charged with infringing the K Tech patents;

4. An award to Plaintiff K Tech of its costs of suit herein; and

5. Such other and further relief as the Court may deem just and proper.

Dated: February 27, 2012

Respectfully submitted,

WAGNER, ANDERSON & BRIGHT, PC

By: [signature]
Patrick F. Bright

Attorneys for Plaintiff

K TECH TELECOMMUNICATIONS, INC.

DEMAND FOR JURY TRIAL

Pursuant to Rule 38(b) of the Federal Rules of Civil Procedure, and Local Rule 38-1, Plaintiff K Tech does hereby demand trial by jury of each and every issue and claim as to which it is entitled to trial by jury under Rule 38(a) of the Federal Rules of Civil Procedure.

Dated: February 27, 2012

Respectfully submitted,

WAGNER, ANDERSON & BRIGHT, PC

By: /s/ Patrick F. Bright
Patrick F. Bright

Attorneys for Plaintiff
K TECH TELECOMMUNICATIONS, INC.

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true and accurate copy of the foregoing was filed with the United States District Court for the Southern District of California on February 28, 2012, and a copy was served, via first-class mail, on the following:

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Attorneys for Defendant Time Warner Cable, Inc.

Dated: February 28, 2012

Patrick F. Bright

EXHIBIT A

US006785903B1

(12) **United States Patent**
Kuh

(10) **Patent No.: US 6,785,903 B1**
(45) **Date of Patent: Aug. 31, 2004**

(54) **DIGITAL TELEVISION TRANSLATOR WITH PSIP UPDATE**

(75) Inventor: **Steve Kuh**, Northridge, CA (US)

(73) Assignee: **K Tech Telecommunications, Inc.**, Chatsworth, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/545,613**

(22) Filed: **Apr. 5, 2000**

(51) **Int. Cl.**[7] **H04N 5/58**
(52) **U.S. Cl.** **725/50**; 725/132; 725/118; 725/127; 725/148; 725/149; 725/152; 370/486
(58) **Field of Search** 725/50, 132, 142, 725/152, 118, 199, 120, 127, 128, 148; 370/486

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(List continued on next page.)

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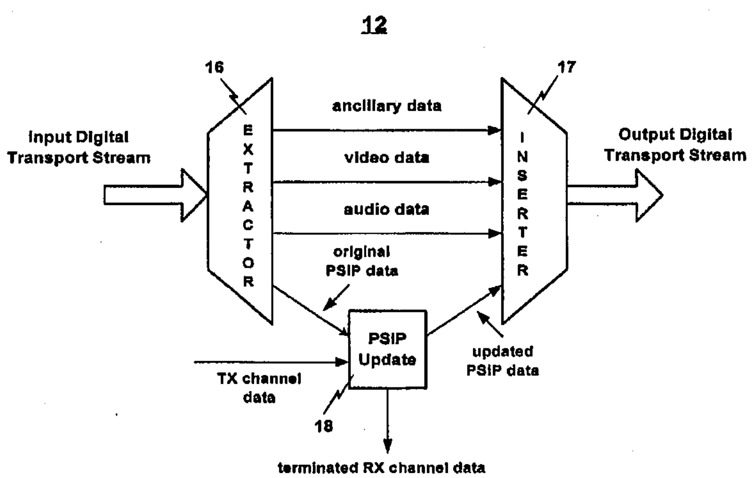
Assistant Examiner—Nathan A Sloan
(74) *Attorney, Agent, or Firm*—Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

A digital television translator includes a digital television receiver for receiving a first digital television signal at a first frequency and generating a digital transport stream from the first digital television signal. The digital transport stream can include original Program and System Information (PSIP) data having RX channel data that is indicative of the first frequency, the first major channel number, and/or the first minor channel number. The digital television translator also includes a PSIP update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data. The TX data is indicative of a second frequency, a second major channel number, and/or a second minor channel number. The digital television translator further includes a digital television modulator for converting the digital transport stream having the updated PSIP data into a second digital television signal at the second frequency, where the second frequency can be the same or different from the first frequency.

58 Claims, 4 Drawing Sheets



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Program and System Information Protocol for Terrestrial Broadcast and Cable, Doc. A/65, Dec. 23, 1997, Table of Contents and pp. 1–93.
ATSC VSB Translator Datasheet (Undated).

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Prior Art

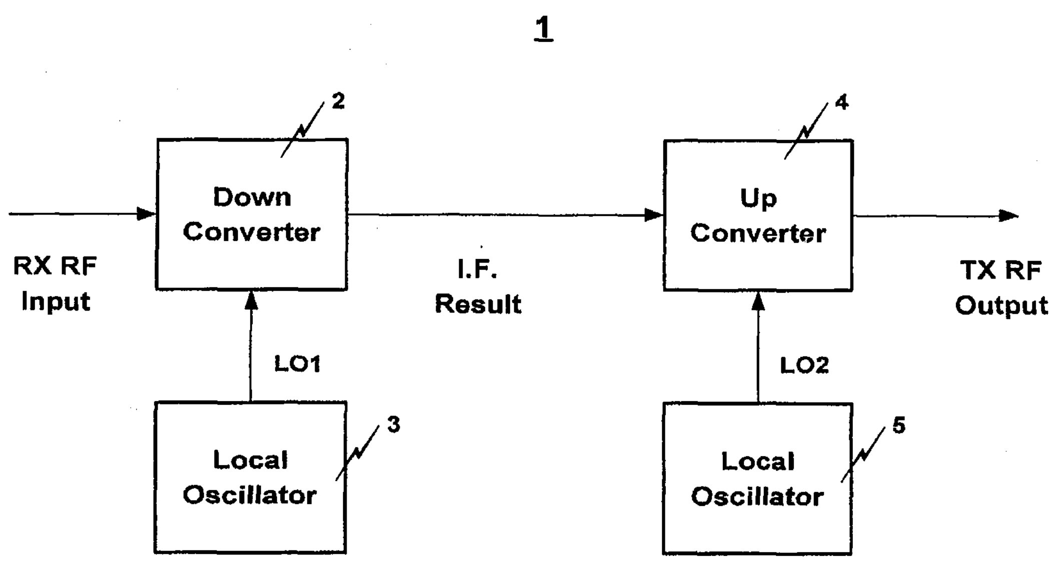


Fig. 1

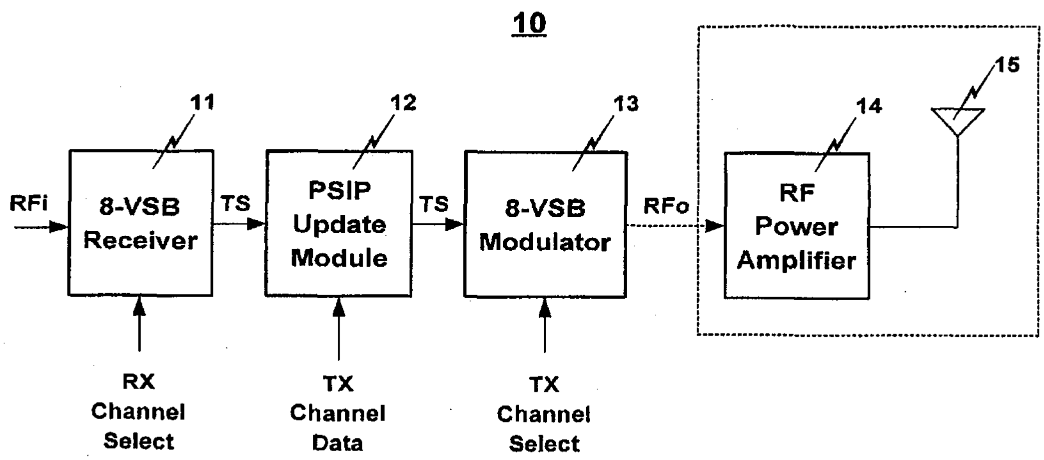

10
11
12
13
14
15
RFi
8-VSB Receiver
TS
PSIP Update Module
TS
8-VSB Modulator
RFo
RF Power Amplifier
RX Channel Select
TX Channel Data
TX Channel Select

Fig. 2

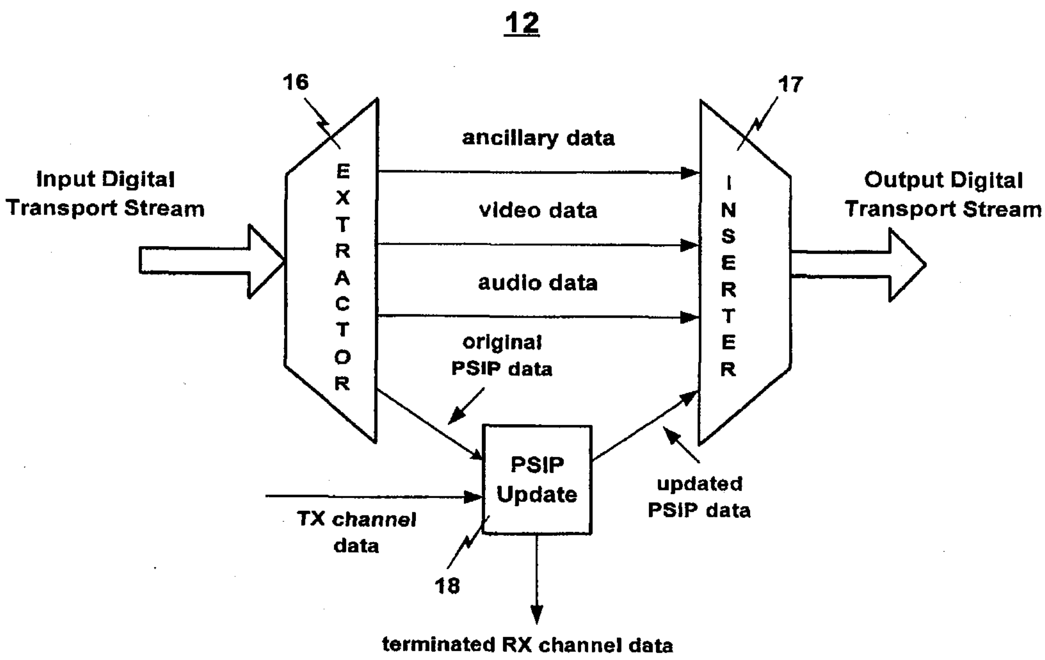

12
16
17
Input Digital Transport Stream
EXTRACTOR
ancillary data
video data
audio data
original PSIP data
INSERTER
Output Digital Transport Stream
PSIP Update
updated PSIP data
TX channel data
18
terminated RX channel data

Fig. 3

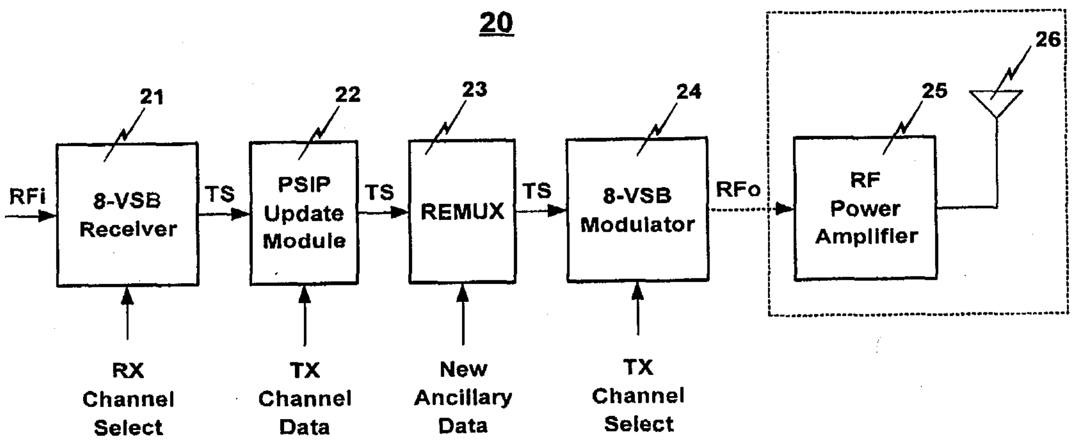

20
21
22
23
24
25
26
RFi
8-VSB Receiver
TS
PSIP Update Module
TS
REMUX
TS
8-VSB Modulator
RFo
RF Power Amplifier
RX Channel Select
TX Channel Data
New Ancillary Data
TX Channel Select

Fig. 4

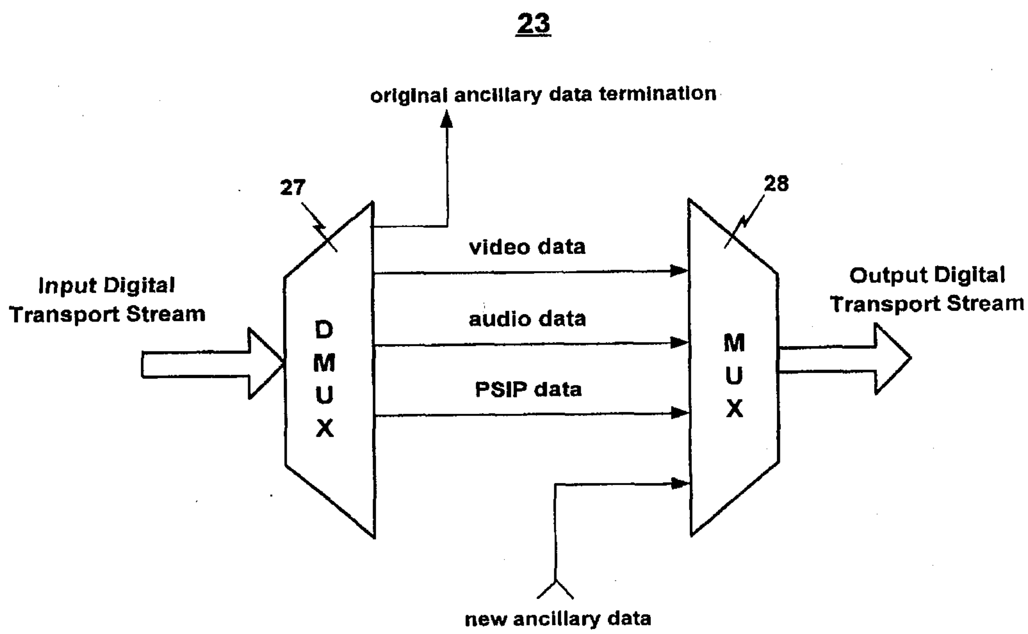
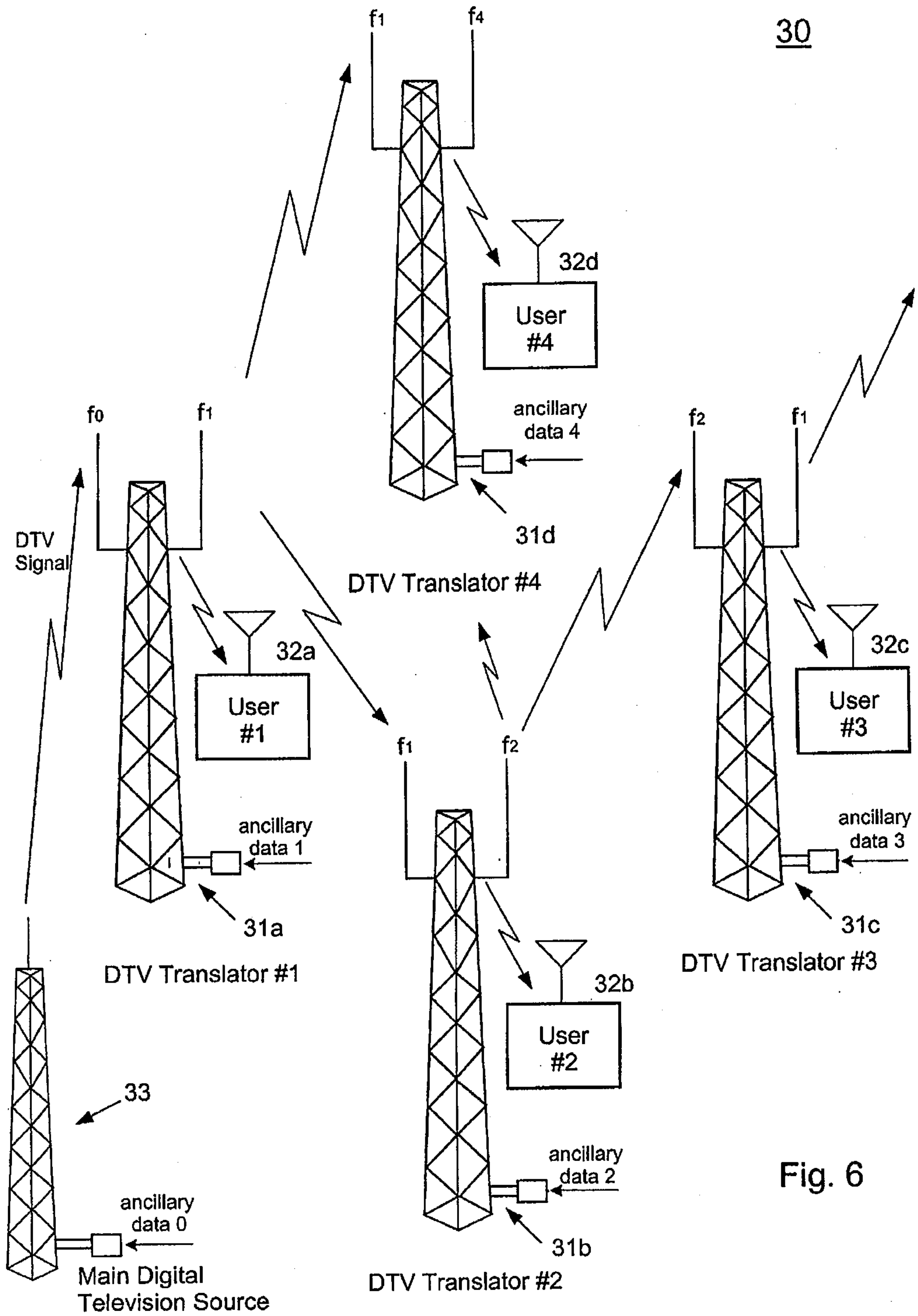

23
original ancillary data termination
27
28
Input Digital Transport Stream
D M U X
video data
audio data
PSIP data
M U X
Output Digital Transport Stream
new ancillary data

Fig. 5



30
f1
f4
32d
User #4
ancillary data 4
31d
DTV Translator #4
f0
f1
DTV Signal
32a
User #1
ancillary data 1
31a
DTV Translator #1
f2
f1
32c
User #3
ancillary data 3
31c
DTV Translator #3
f1
f2
32b
User #2
ancillary data 2
31b
DTV Translator #2
33
ancillary data 0
Main Digital Television Source

Fig. 6

DIGITAL TELEVISION TRANSLATOR WITH PSIP UPDATE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a digital television translator. More particularly, the present invention relates to a digital television translator that updates the program and system information protocol (PSIP) table with transmit (TX) channel data.

2. Discussion of the Related Art

Digital television (DTV) broadcasting systems are relatively new in the United States and offer many alternatives to traditional information and program distribution. In addition to traditional television programming, DTV systems offer the ability to distribute additional content in the form of data. This data can be any type of data including, for example, Internet data broadcast to one or more end users. Therefore, DTV broadcast systems offer great flexibility and diversity in the types of information they distribute. Like most conventional broadcast systems, DTV broadcast systems have a finite capacity limited by the bandwidth of its channels.

Additionally, as with other broadcast systems, such as analog television systems, the received DTV signal quality can vary greatly depending upon where the receiver is located. This problem is due to a number of adverse propagation effects such as multipath, interference, and simple attenuation. One solution to this problem is to use multiple low power repeaters (On-Channel boosters) and/or translators (Re-modulators) to improve reception in areas of poor DTV signal reception. For example, a repeater, placed in an area of poor signal reception, receives a transmitted signal from a high power DTV transmitter and re-transmits an amplified duplicate signal at the same frequency. Translators, on the other hand, can receive a transmitted signal from a high power DTV transmitter and re-transmit the signal at a frequency different than the received frequency. Repeaters and translators are also used to extend the coverage of a broadcast system incrementally, and economically, to specific geographical regions.

FIG. **1** shows an example of a conventional DTV translator **1**. The conventional DTV translator includes a down converter **2**, a first local oscillator **3**, an up converter **4**, and a second local oscillator **5**. A received DTV signal (RX RF input) is down converted to IF (intermediate frequency) by down converter **2**. The IF is determined by the difference between the frequency LO1 generated by the first local oscillator **3** and the RF frequency of the received DTV signal (RX RF Input). The IF signal is then up converted to RF by up converter **4**. The frequency of the up converted RF DTV signal (TX RF Output) is determined by the sum of the frequency LO2 generated by the second local oscillator **5** and the IF. The up converted DTV signal (TX RF Output) is then amplified and transmitted. With this arrangement, the transmitted signal contains the same information as the received signal, but is amplified. Further, when LO1=LO2, the transmit frequency is the same as the received frequency, and the apparatus operates as an on-channel booster. Alternatively, when LO1≠LO2, the transmit frequency is different than the received frequency, and the apparatus operates as a translator.

In the DTV American Television Systems Committee (ASTC) standard, a DTV signal contains a Program and System Information Protocol (PSIP) table, which is a collection of hierarchically arranged sub-tables for describing system information and program guide data. One of sub-tables in the PSIP table is the Virtual Channel Table (VCT), which contains a list of attributes for virtual channels carried in the digital transport stream (baseband information). VCT fields "major channel number" and "minor channel number" are used for identification. The major channel number is used to group all channels that are to be identified as belonging to a particular broadcast corporation (or a particular identifying number such as channel "12"). The minor channel number specifies a particular channel within the group. The VCT also contains a "carrier frequency" field, which is used to identify the frequency at which the DTV signal is transmitted and received. As discussed herein, TX and RX channel data include at least one of the following major channel number, minor channel number, carrier frequency, and/or other data necessary for generating a proper DTV signal.

When a RF DTV signal is translated to a new frequency by the conventional DTV translator **1** of FIG. **1**, the PSIP table no longer reflects the correct carrier frequency. In many DTV receivers, this discrepancy between the actual frequency of the received DTV signal and the carrier frequency data contained in the PSIP table prevents the receiver from properly receiving the DTV signal.

Also, a particular broadcast corporation may be assigned different major/minor channel numbers in geographical regions serviced by each translator. For example, Broadcast Corporation #**1** could be assigned major/minor channel **12/04** in region #**1** (served by a main DTV transmitter) and major/minor channel **37/04** in region #**2** (served by a translator translating the main DTV transmitted signal). The conventional translator of FIG. **1** therefore generates a translated DTV signal that contains an incorrect channel number for transmission into region #**2**.

Moreover, in region #**2**, major minor/channel **12/04** may have already been assigned to Broadcast Corporation #**2**. In that case, a single DTV receiver in region #**2** will receive two unique channels (Broadcast Corporation #**1** and Broadcast Corporation #**2**) each having the same major/minor channel number in each of their PSIP tables. While some DTV receivers overcome these anomalies by allowing users to select whether to ignore PSIP data or to display the VCT information, other DTV receivers do not have this capability and are unable to properly tune to the program(s) of one or both of the two Broadcast Corporations.

SUMMARY OF THE INVENTION

Accordingly, the present invention relates to a digital television translator, and more particularly to a digital television translator that updates the PSIP table with proper channel and carrier frequency information. To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, there is provided a digital television translator, comprising a digital television receiver for receiving a first digital television signal and generating a digital transport stream from the first digital television signal, the digital transport stream including original PSIP data having RX channel data; a PSIP update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data; and a digital television modulator for converting the digital transport stream having the updated PSIP data into a second digital television signal.

In another aspect of the instant invention, there is provided an information distribution network using digital television transmission, the information distribution network comprising a plurality of digital television transmission nodes including a main digital television signal source for generating a main digital television signal; and a plurality of digital television translators receiving a digital television signal from one of the plurality of digital television nodes, at least one of said plurality of digital television translators including a digital television receiver for receiving the digital television signal from one of the plurality of digital television nodes and generating a digital transport stream from the received digital television signal, the digital transport stream including original ancillary data and original PSIP data having RX data, a data update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data and for replacing the original ancillary data in the digital transport stream with new ancillary data, and a digital television modulator for converting the digital transport stream having the new ancillary data and the updated PSIP data into a transmitted digital television signal, wherein at least two of the plurality of digital television transmission nodes transmit at the same frequency and the total ancillary data of the information distribution network includes the new ancillary data from multiple digital television translators of the plurality of digital television translators.

Additional features and advantages of the present invention will be set forth in the description that follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention that together with the description serve to explain the principles of the invention.

In the drawings:

FIG. **1** shows an example of a conventional DTV translator;

FIG. **2** shows a first embodiment of a DTV translator of the present invention having PSIP table update capability;

FIG. **3** shows an example of a PSIP update module;

FIG. **4** shows a second embodiment of a DTV translator of the present invention having both PSIP table update capability and a re-multiplexor;

FIG. **5** shows an example of the re-multiplexor; and

FIG. **6** shows an example of an information distribution network of the present invention using multiple translators.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

To overcome the problems associated with the prior art, i.e., tuning problems with some DTV receivers due to incorrect PSIP table information, the PSIP table information is updated by the translator to properly reflect the new transmit carrier frequency and channel number.

FIG. **2** shows a first embodiment of a DTV translator **10** of the present invention having PSIP table update capability. The DTV translator **10** includes an 8-VSB receiver **11**, a PSIP update module **12**, an 8-VSB modulator **13**, an RF power amplifier **14**, and a transmitting antenna **15**. The receiver **11** receives an 8-VSB DTV signal (RFi) that may have been originally transmitted by a base station or another translator, over the air or by a cable. The receiver **11** processes the DTV signal according to ASTC DTV standards to produce a digital transport stream (TS) containing MPEG2 video data, audio data, ancillary data, and PSIP data. The PSIP data in the digital transport stream includes a major channel number, a minor channel number, and a carrier frequency, which together make up the RX channel data. As shown, the receiver **11** is controlled by an input (RX Channel Select) which informs the receiver **11** of which carrier frequency channel to tune.

The processing of the received DTV signal by the 8-VSB receiver **11** is in accordance with ATSC DTV standards and, accordingly, can include down conversion, digitization, carrier synchronization, symbol clock synchronization, frame and segment synchronization, matched filtering, equalization, bit-demapping, Trellis decoding, convolutional de-interleaving, Reed-Solomon forward error correction (FEC) decoding, and de-randomizing.

The digital transport stream (TS) is then input into PSIP update module **12**. The PSIP update module **12** extracts the PSIP table data and updates the RX channel data with TX channel data. Specifically, the major channel number, the minor channel number, and the carrier frequency contained in the PSIP VCT are updated. Updated major and minor channel numbers are those numbers assigned to the broadcaster associated with the transport stream content for the geographical region covered by the DTV translator. Sometimes the original and updated channel numbers will be the same, for example when the translator is being used to fill in a poor reception area of the geographical area covered by the main transmitter. At other times, the original and updated channel numbers will be different, for example, when the translator is being used to extend coverage into a geographical area not covered by the main transmitter. In this instance, the broadcaster may be licensed to broadcast in the translator's geographical area, but at a different channel.

Also, the carrier frequency of the DTV signal transmitted from the translator must be reflected in the PSIP VCT. In most instances, the translator will transmit at a different frequency than it receives, requiring the PSIP VCT to be updated with the new transmitted carrier frequency. In some instances, the carrier frequency of the DTV signal can be transmitted at the same frequency that it is received, such as when the translator system is being used as an on-channel booster. In either instance, the updated PSIP table is then reinserted back into the digital transport stream.

Once the PSIP data is updated, the transport stream containing the updated PSIP data is then input into the 8-VSB modulator **13**. 8-VSB modulator **13** processes the digital transport stream according to ATSC DTV standards to produce a DTV signal (Rfo) at the carrier frequency contained in the VCT of the updated PSIP table data. As shown, 8-VSB modulator **13** is controlled by input (TX Channel Select) which informs the 8-VSB modulator **13** at which frequency to transmit the DTV signal. Alternatively, the 8-VSB modulator can detect the carrier frequency information from the VCT of the DTV signal and transmit the DTV signal using the detected carrier frequency.

8-VSB modulator **13** processes the transport stream having the updated PSIP data according to ASTC terrestrial broadcast standards. Accordingly, this processing can include randomization, Reed-Solomon encoding, convolutional interleaving, symbol mapping, trellis encoding, and vestigial sideband filtering. After the digitally filtered signal is converted to an analog signal, the signal is up converted to a transmit RF signal (RFo) at the transmit frequency determined by TX channel select. The 8-VSB modulator **13** typically operates at a frequency of 54 MHZ–216 MHZ and 470 MHZ–806 MHZ and has a maximum output power of approximately 1 milliwatt. A power amplifier **14** and transmitting antenna **15** are usually added to the output of the 8-VSB modulator **13**.

FIG. **3** shows an example of PSIP update module **12**. The PSIP update module **12** includes an extractor **16** for extracting the original PSIP data, a PSIP update block **18** for replacing the major/minor channel number and carrier frequency contained in the PSIP table, and an inserter **17** for inserting the updated PSIP table data back into the transport stream. As shown, the PSIP table data is extracted by extractor **16** and input into the PSIP update block **18**. The PSIP update block **18** replaces the major/minor channel number and transmit carrier frequency contained in the VCT (a sub-table of the PSIP table) while retaining the other PSIP data. The PSIP update block **18** then substitutes an updated major/minor channel number and transmit carrier frequency into the VCT. Thereafter, the updated PSIP table data is re-inserted back into the digital transport stream via inserter **17**.

FIG. **4** shows a second embodiment of a DTV translator **20** of the present invention. The second embodiment includes an 8-VSB receiver **21**, a PSIP update module **22**, a re-multiplexor **23**, and an 8-VSB modulator **24**. Usually an RF power amplifier **25** and an antenna **26** are coupled to the 8-VSB modulator **24**. The structure and operation of the second embodiment is the same as the structure and operation of the first embodiment, except that a re-multiplexor **23** is added for introducing new ancillary data into the digital transport stream.

The digital transport stream containing original ancillary data and the updated PSIP table data is input into the re-multiplexor **23**. Re-multiplexor **23** substitutes new ancillary data in place of the original ancillary data in the digital transport stream. The digital transport stream is then sent to 8-VSB modulator **24** and converted into a DTV signal consistent with the operation as described in the first embodiment. In this way, each translator can distribute new ancillary data to user(s) in the translator's transmit range.

FIG. **5** is a block diagram of the re-multiplexor **23**, which comprises a demultiplexor **27** and a multiplexor **28**. As shown, the original ancillary data, video data, audio data, and updated PSIP table data is contained in the input digital transport stream, which is demultiplexed into separate bit streams by de-multiplexor **27**. The original ancillary data is terminated (discarded). The multiplexor **28** then combines the video data, the audio data, the updated PSIP data, and new ancillary data back into the output digital transport stream, which is then input to the 8-VSB modulator **24**.

The PSIP update step and the ancillary data insertion step are not required to take place in any particular order. For example, since the PSIP data has been separated into its constituent streams by demultiplexor **27** of re-multiplexor **23**, the PSIP table update step could take place in the re-multiplexor **23** by updating the major/minor channel number and carrier frequency. The updated PSIP table data could be reinserted into the digital transport stream by multiplexor **28**. Or, for example, the placement of the PSIP update module **22** and the multiplexor **23** could be reversed. Moreover, only a portion of the original ancillary data could be replaced with new ancillary data thereby allowing other portions of the ancillary data to be transmitted downstream by the translator.

The second embodiment allows DTV broadcasting stations to increase their data broadcasting capacity every time a DTV translator is added. For example, adding a DTV translator increases the number of users and increases the capacity for data transmission through employment of the new ancillary data, which permits the insertion of data, such as Internet data. Downstream Internet data can be inserted as new ancillary data by each translator and distributed to specific geographic regions and users without the need for additional bandwidth.

FIG. **6** shows an example of a third embodiment of the invention wherein an information distribution network **30** uses a plurality of translators to increase the data capacity of the network. As shown, a plurality of translators, collectively labeled **31*a*–31*d***, translate and distribute a DTV signal in both a star and daisy-chain configuration.

The first translator **31*a*** receives a DTV signal, from a main digital television source, containing original ancillary data **0**, such as Internet download data at a frequency fo. Translator **31*a*** inserts ancillary data **1** and discards original ancillary data **0**, and then retransmits the modified DTV signal having ancillary data **1** at a frequency f1. User **32*a*** receives ancillary data **1** from translator **31*a***. A second DTV translator **31*b*** receives the translated DTV signal from translator **31*a*** at a frequency of f1, substitutes ancillary data **2** for ancillary data **1**, and then retransmits at a frequency f2. User **32*b*** receives the DTV signal transmitted from translator **31*b*** along with ancillary data **2**. User **32*d*** also receives ancillary data **1** from translator **31*a***. A third DTV translator **31*c*** receives the translated DTV signal from translator **31*b*** at a frequency of f2, substitutes ancillary data **3** for the ancillary data **2**, and retransmits at a frequency f1. User **32*c*** receives the DTV signal transmitted from translator **32*c*** along with ancillary data **3**. DTV translators **31*a***, **31*b***, and **31*c*** are thus configured in a daisy-chain fashion with translators **31*a*** and **31*c*** being endpoints.

Further, a fourth DTV translator **31*d*** receives the translated DTV signal from translator **31*a*** at a frequency of f1, substitutes ancillary data **4** for ancillary data **1**, and then retransmits at a frequency f4. User **32*d*** receives the DTV signal transmitted from translator **31*d*** along with ancillary data **4**. DTV translators **31*a***, **31*b***, and **31*d*** are thereby configured in a star fashion with DTV translator **31** a configured as a hub. Moreover, a variety of translator topologies can be employed to transmit unique ancillary data to each of a very large number of users, or a group of users, without requiring an increase in the bandwidth of any single translator's transport stream or physical RF channel.

Even more efficient use of bandwidth can be achieved by allowing multiple translators to use the same transmit frequencies, as does translators **31*a*** and **31*c***. Translators can be placed in any number of configurations to increase the data capacity of the DTV distribution network. Furthermore, the use of a PSIP update model in each of the translators can insure proper DTV reception.

Moreover, while the embodiments described herein can be implemented via current ASTC standards, it is contemplated that other DTV standards or a modified ASTC standard could be readily employed to realize the present invention. Further, while the video data on the digital transport stream can be MPEG2 standard video data, as described herein, the invention contemplates using variations of MPEG2 standard data in the digital transport system.

As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the meets and bounds of the claims, or equivalence of such meets and bounds are therefore intended to be embraced by the appended claims.

What is claimed is:

1. A digital television translator, comprising:

a digital television receiver for receiving a first digital television signal and generating a digital transport stream from the first digital television signal, the digital transport stream including original PSIP data having RX channel data;

a PSIP update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data; and

a digital television modulator for converting the digital transport stream having the updated PSIP data into a second digital television signal,

wherein the RX channel data is associated with the first digital television signal and includes at least one of a major channel number, a minor channel number, and a carrier frequency, and the TX channel data is associated with the second digital television signal and includes at least one of an updated major channel number, an updated minor channel number, and an updated carrier frequency.

2. The digital television translator according to claim 1, further comprising a re-multiplexor for replacing original ancillary data in the digital transport stream with new ancillary data.

3. The digital television translator according to claim 2, wherein the re-multiplexor comprises:

a de-multiplexor for separating the digital transport stream into video data, audio data, one of the original PSIP data and the updated PSIP data, and the original ancillary data, and

a multiplexor for combining the video data, the audio data, the one of the original PSIP data and the updated PSIP data, and the new ancillary data into the digital transport stream.

4. The digital television translator according to claim 2, wherein the new ancillary data includes Internet data.

5. The digital television translator according to claim 1, wherein the digital television receiver processes the first digital television signal according to the USA terrestrial digital television broadcast standard, defined by the ATSC organization, to generate the digital transport stream, and the digital television modulator processes the digital transport stream according to the USA terrestrial digital television broadcast standard, defined by the ATSC organization, to generate the second digital television signal.

6. The digital television translator according to claim 1, wherein video data in the digital transport stream is MPEG2 video data.

7. The digital television translator according to claim 1, wherein video data in the digital transport stream is MPEG2 video data that conforms to the USA terrestrial digital television broadcast standard defined by the ATSC organization.

8. The digital television translator according to claim 1, wherein the first and second digital television signals are 8-VSB ATSC standard digital television signals.

9. The digital television translator according to claim 1, wherein the first and second digital television signals are 16-VSB ATSC standard digital television signals.

10. The digital television translator according to claim 1, wherein the second digital television signal is amplified by an RF power amplifier.

11. The digital television translator according to claim 1, wherein a frequency of the second digital television signal is approximately equal to a frequency of the first digital television signal.

12. The digital television translator according to claim 1, wherein a frequency of the second digital television signal is different from a frequency of the first digital television signal.

13. An information distribution network using digital television transmission, the information distribution network comprising:

a plurality of digital television transmission nodes including

a main digital television signal source for generating a main digital television signal; and

a plurality of digital television translators receiving a digital television signal from one of the plurality of digital television nodes, at least one of said plurality of digital television translators including

a digital television receiver for receiving the digital television signal from one of the plurality of digital television nodes and generating a digital transport stream from the received digital television signal, the digital transport stream including original ancillary data and original PSIP data having RX data,

a data update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data and for replacing the original ancillary data in the digital transport stream with new ancillary data, and

a digital television modulator for converting the digital transport stream having the new ancillary data and the updated PSIP data into a transmitted digital television signal, wherein at least two of the plurality of digital television transmission nodes transmit at the same frequency and the total ancillary data of the information distribution network includes the new ancillary data from multiple digital television translators of the plurality of digital television translators,

wherein the RX channel data is associated with the received digital television signal and includes at least one of a major channel number, a minor channel number, and a carrier frequency, and the TX channel data is associated with the transmitted digital television signal and includes at least one of an updated major channel number, an updated minor channel number, and an updated carrier frequency.

14. The information distribution network according to claim 13, wherein the data update module comprises:

a demultiplexor for separating the digital transport stream into video data, audio data, the updated PSIP data, and the original ancillary data, and a multiplexor for combining the video data, the audio data, the updated PSIP data, and the new ancillary data into the digital transport stream.

15. The information distribution network according to claim 13, wherein the new ancillary data includes Internet data.

16. The information distribution network according to claim 13, wherein the digital television receiver processes the received digital television signal according to the USA terrestrial digital television broadcast standard, defined by the ATSC organization, to generate the digital transport stream, and the digital television modulator processes the digital transport stream according to the USA terrestrial digital television broadcast standard, defined by the ATSC organization, to generate the transmitted digital television signal.

17. The information distribution network according to claim 13, wherein the video data in the digital transport stream is MPEG2 data.

18. The information distribution network according to claim 13, wherein the video data in the digital transport stream is MPEG2 video data that conforms to the USA terrestrial digital television broadcast standard defined by the ATCS organization.

19. The information distribution network according to claim 13, wherein the received and transmitted digital television signals are 8-VSB ATSC standard digital television signals.

20. The information distribution network according to claim 13, wherein the received and transmitted digital television signals are 16-VSB ATSC standard digital television signals.

21. The information distribution network according to claim 13, wherein the transmitted digital television signal is amplified by an RF power amplifier.

22. The information distribution network according to claim 13, wherein a frequency of the received digital television signal is approximately equal to a frequency of the transmitted digital television signal.

23. The information distribution network according to claim 13, wherein a frequency of the received digital television signal is different from a frequency of the transmitted digital television signal.

24. A method of translating a digital television signal, comprising the steps of:

receiving a first digital television signal and generating a digital transport stream from the first digital television signal, the digital transport stream including original PSIP data having RX channel data;

updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data; and

converting the digital transport stream having the updated PSIP data into a second digital television signal,

wherein the RX channel data is associated with the first digital television signal and includes at least one of a major channel number, a minor channel number, and a carrier frequency, and the TX channel data is associated with the second digital television signal and includes at least one of an updated major channel number, an updated minor channel number, and an updated carrier frequency.

25. The method of translating a digital television signal according to claim 24, further comprising the step of replacing original ancillary data in the digital transport stream with new ancillary data.

26. The method of translating a digital television signal according to claim 24, wherein the step of replacing the original ancillary data further comprising the steps of:

separating the digital transport stream into video data, audio data, one of the original PSIP data and the updated PSIP data, and the original ancillary data, and

combining the video data, the audio data, the one of the original PSIP data and the updated PSIP data, and the new ancillary data into the digital transport stream.

27. The method of translating a digital television signal according to claim 24, wherein the new ancillary data includes Internet data.

28. The method of translating a digital television signal according to claim 24, wherein the first digital television signal is processed according to the USA terrestrial digital television broadcast standard, defined by the ATSC organization, to generate the digital transport stream, and the digital transport stream is processed according to the USA terrestrial digital television broadcast standard, defined by the ATSC organization, to generate the second digital television signal.

29. The method of translating a digital television signal according to claim 24, wherein video data in the digital transport stream is MPEG2 video data.

30. The digital television translator according to claim 24, wherein video data in the digital transport stream is MPEG2 video data that conforms to the USA terrestrial digital television broadcast standard defined by the ATSC organization.

31. The method of translating a digital television signal according to claim 24, wherein the first and second digital television signals are 8-VSB ATSC standard digital television signals.

32. The method of translating a digital television signal according to claim 24, wherein the first and second digital television signals are 16-VSB ATSC standard digital television signals.

33. The method of translating a digital television signal according to claim 24, wherein the second digital television signal is amplified by an RF power amplifier.

34. The method of translating a digital television signal according to claim 24, wherein a frequency of the first digital television signal is approximately equal to a frequency of the second digital television signal.

35. The method of translating a digital television signal according to claim 24, wherein a frequency of the first digital television signal is different from a frequency of the second digital television signal.

36. An information distribution method using digital television transmission and increasing data capacity through frequency re-use, comprising the steps of:

generating a plurality of digital television signals each from one of a plurality of digital television transmission nodes, further comprising the steps of

generating a main digital television signal by one of the plurality of digital television transmission nodes; and

generating a plurality of translated digital television signals by the plurality of digital television transmission nodes, the generation of at least one of the plurality of translated digital television signals further comprising the steps of

receiving a digital television signal from at least one of the digital television transmission nodes and

generating a digital transport stream from the received digital television signal, the digital transport stream including original ancillary data and original PSIP data having RX channel data,

updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data, replacing the original ancillary data in the digital transport stream with new ancillary data, and

converting the digital transport stream having the new ancillary data and the updated PSIP data into a transmitted digital television signal, wherein at least two of the plurality of translated digital television signals are transmitted at a same frequency and the total ancillary data of the information distribution network includes new ancillary data from multiple digital television translators of the plurality of digital television translators,

wherein the RX channel data is associated with the received digital television signal and includes at least one of a major channel number, a minor channel number, and a carrier frequency, and the TX channel data is associated with a transmitted digital television signal and includes at least one of an updated major channel number, an updated minor channel number, and an updated carrier frequency.

37. The information distribution method according to claim **36**, wherein replacing the original ancillary data further comprises the steps of:

separating the digital transport stream into video data, audio data, one of the original PSIP data and the updated PSIP data, and the original ancillary data, and

combining the video data, the audio data, the one of the original PSIP data and the updated PSIP data, and the new ancillary data into the digital transport stream.

38. The information distribution method according to claim **36**, wherein the new ancillary data includes Internet data.

39. The information distribution method according to claim **36**, wherein the received digital television signal is processed according to the USA terrestrial digital television broadcast standard, defined by the ATSC organization, to generate the digital transport stream, and the digital transport stream is processed according to the USA terrestrial digital television broadcast standard, defined by the ATSC organization, to generate the transmitted digital television signal.

40. The information distribution method according to claim **36**, wherein video data in the digital transport stream is MPEG2 data.

41. The information distribution method according to claim **36**, wherein video data in the digital transport stream is MPEG2 video data that conforms to the USA terrestrial digital television broadcast standard defined by the ATCS organization.

42. The information distribution method according to claim **36**, wherein the received and transmitted digital television signals are 8-VSB ATSC standard digital television signals.

43. The information distribution method according to claim **36**, wherein the received and transmitted digital television signals are 16-VSB ATSC standard digital television signals.

44. The information distribution method according to claim **36**, wherein the transmitted digital television signal is amplified by an RF power amplifier.

45. The information distribution method according to claim **36**, wherein a frequency of the transmitted digital television signal is approximately equal to a frequency of the received digital television signal.

46. The information distribution method according to claim **36**, wherein a frequency of the transmitted digital television signal is different from a frequency of the received digital television signal.

47. The digital television translator according to claim **1**, wherein the RX channel data includes a major channel number and the TX channel data includes an updated major channel number.

48. The digital television translator according to claim **1**, wherein the RX channel data includes a minor channel number and the TX channel data includes an updated minor channel number.

49. The digital television translator according to claim **1**, wherein the RX channel data includes a carrier frequency and the TX channel data includes an updated carrier frequency.

50. The digital television translator according to claim **13**, wherein the RX channel data includes a major channel number and the TX channel data includes an updated major channel number.

51. The digital television translator according to claim **13**, wherein the RX channel data includes a minor channel number and the TX channel data includes an updated minor channel number.

52. The digital television translator according to claim **13**, wherein the RX channel data includes a carrier frequency and the TX channel data includes an updated carrier frequency.

53. The digital television translator according to claim **24**, wherein the RX channel data includes a major channel number and the TX channel data includes an updated major channel number.

54. The digital television translator according to claim **24**, wherein the RX channel data includes a minor channel number and the TX channel data includes an updated minor channel number.

55. The digital television translator according to claim **24**, wherein the RX channel data includes a carrier frequency and the TX channel data includes an updated carrier frequency.

56. The digital television translator according to claim **36**, wherein the RX channel data includes a major channel number and the TX channel data includes an updated major channel number.

57. The digital television translator according to claim **36**, wherein the RX channel data includes a minor channel number and the TX channel data includes an updated minor channel number.

58. The digital television translator according to claim **36**, wherein the RX channel data includes a carrier frequency and the TX channel data includes an updated carrier frequency.

* * * * *

EXHIBIT B

US007487533B2

(12) **United States Patent**
Kuh

(10) **Patent No.: US 7,487,533 B2**
(45) **Date of Patent: Feb. 3, 2009**

(54) **DIGITAL TELEVISION TRANSLATOR WITH PSIP UPDATE**

(75) Inventor: **Steve Kuh**, Northridge, CA (US)

(73) Assignee: **K Tech Telecommunications, Inc.**, Chatsworth, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 938 days.

(21) Appl. No.: **10/890,210**

(22) Filed: **Jul. 14, 2004**

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Related U.S. Application Data

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(51) **Int. Cl.**
H04N 7/173 (2006.01)

(52) **U.S. Cl.** **725/116**; 725/114; 725/115; 725/117; 725/118

(58) **Field of Classification Search** 725/114–118
See application file for complete search history.

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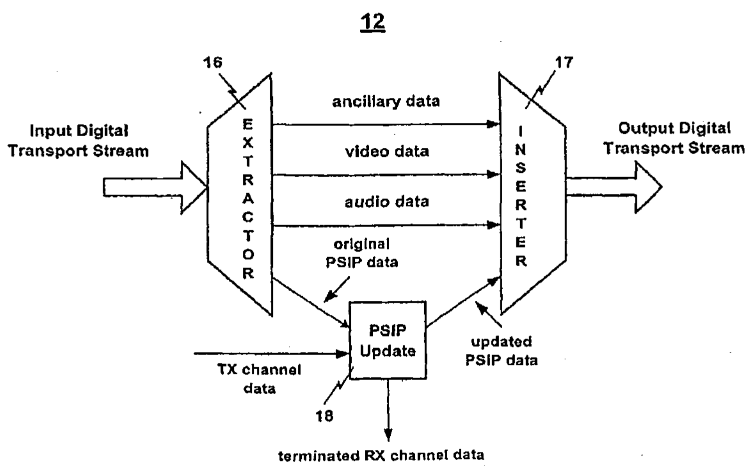
Primary Examiner—Hunter B. Lonsberry
(74) *Attorney, Agent, or Firm*—Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

A digital television translator includes a digital television receiver for receiving a first digital television signal at a first frequency and generating a digital transport stream from the first digital television signal. The digital transport stream can include original Program and System Information (PSIP) data having RX channel data that is indicative of the first frequency, the first major channel number, and/or the first minor channel number. The digital television translator also includes a PSIP update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data. The TX data is indicative of a second frequency, a second major channel number, and/or a second minor channel number. The digital television translator further includes a digital television modulator for converting the digital transport stream having the updated PSIP data into a second digital television signal at the second frequency, where the second frequency can be the same or different from the first frequency.

38 Claims, 4 Drawing Sheets



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Prior Art

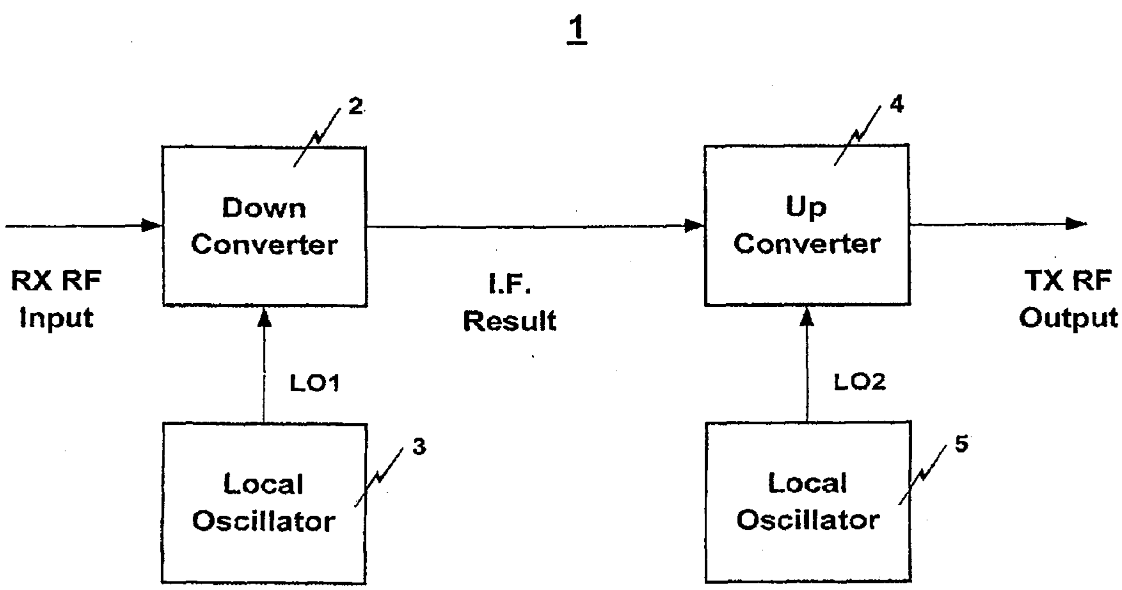
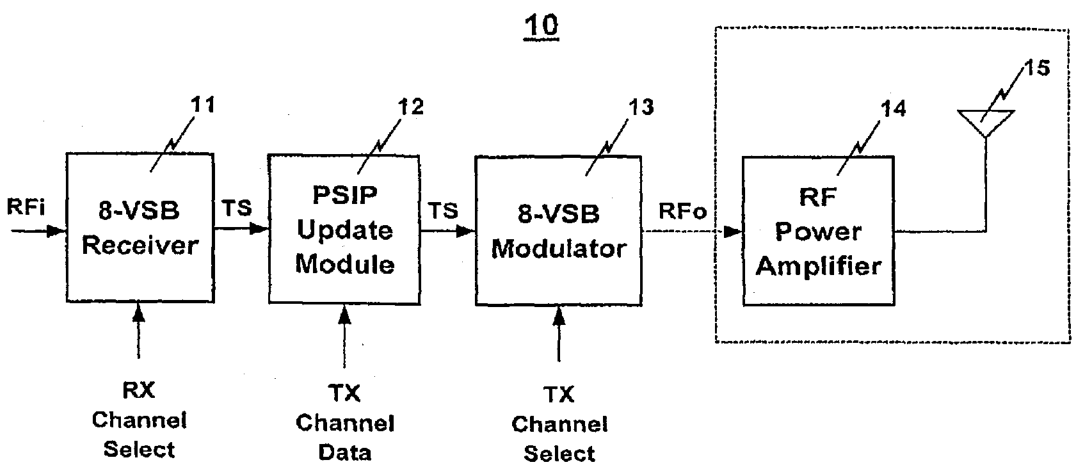
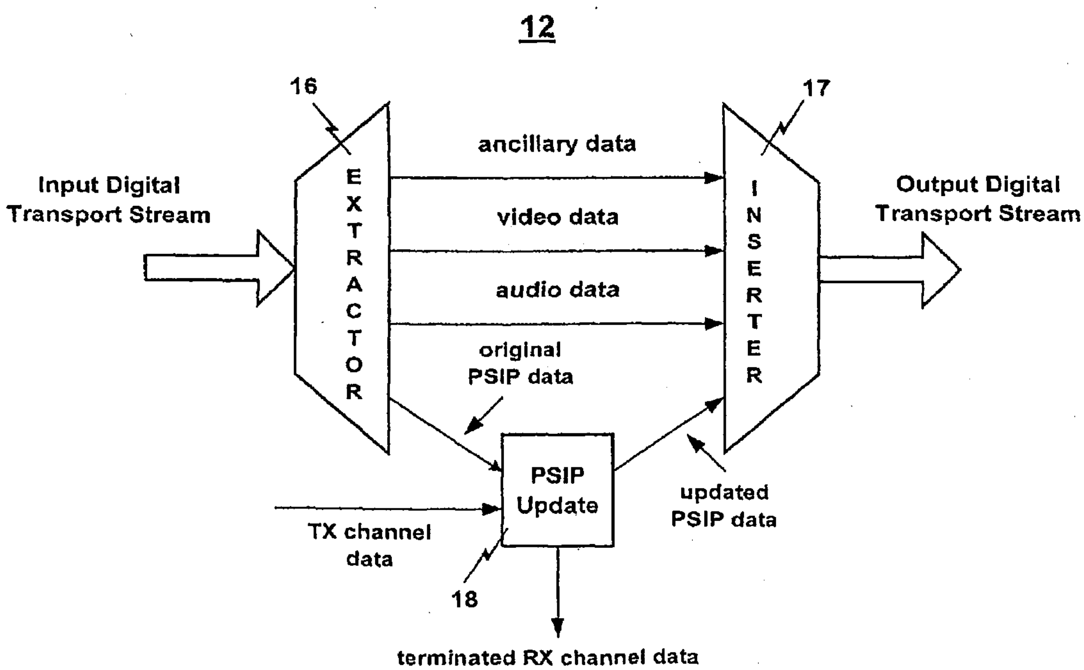


Fig. 1



10
11
12
13
14
15
RFi
8-VSB Receiver
TS
PSIP Update Module
TS
8-VSB Modulator
RFo
RF Power Amplifier
RX Channel Select
TX Channel Data
TX Channel Select

Fig. 2



12
16
17
Input Digital Transport Stream
EXTRACTOR
ancillary data
video data
audio data
original PSIP data
INSERTER
Output Digital Transport Stream
PSIP Update
updated PSIP data
TX channel data
18
terminated RX channel data

Fig. 3

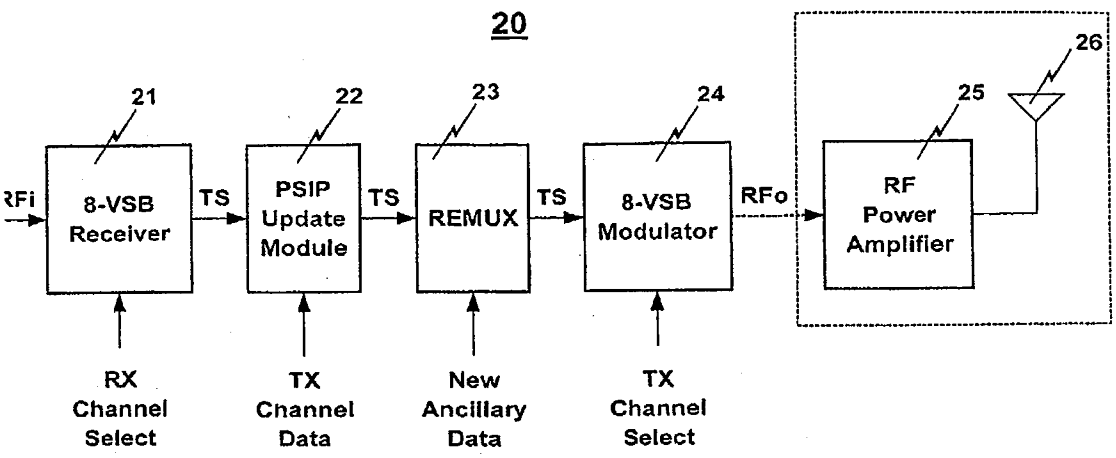

20
21
22
23
24
25
26
RFi
8-VSB Receiver
TS
PSIP Update Module
TS
REMUX
TS
8-VSB Modulator
RFo
RF Power Amplifier
RX Channel Select
TX Channel Data
New Ancillary Data
TX Channel Select

Fig. 4

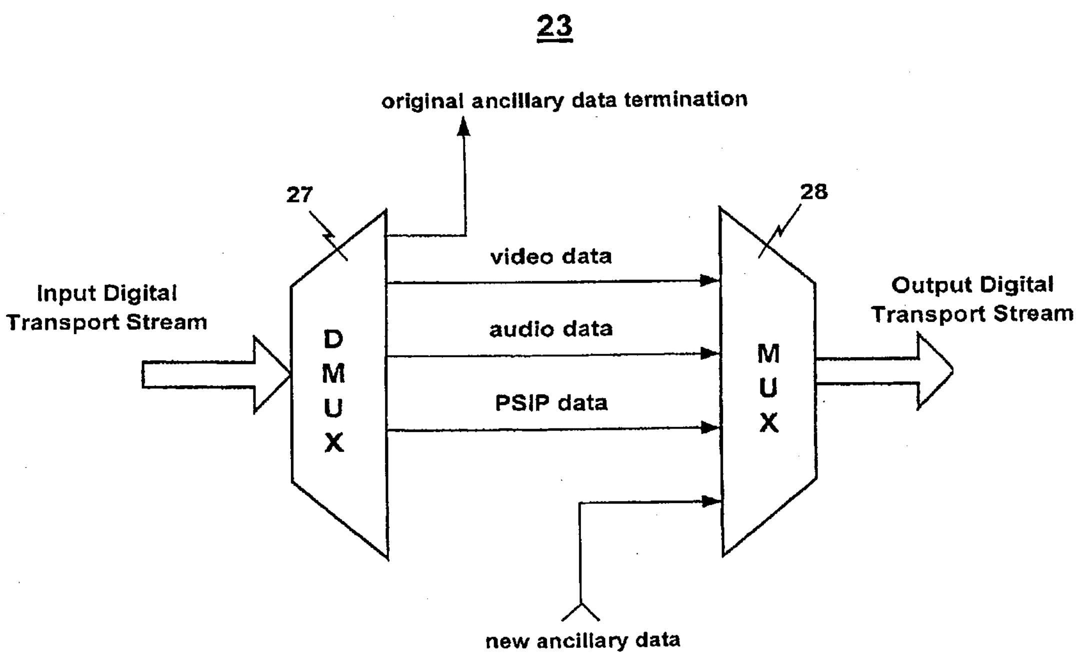
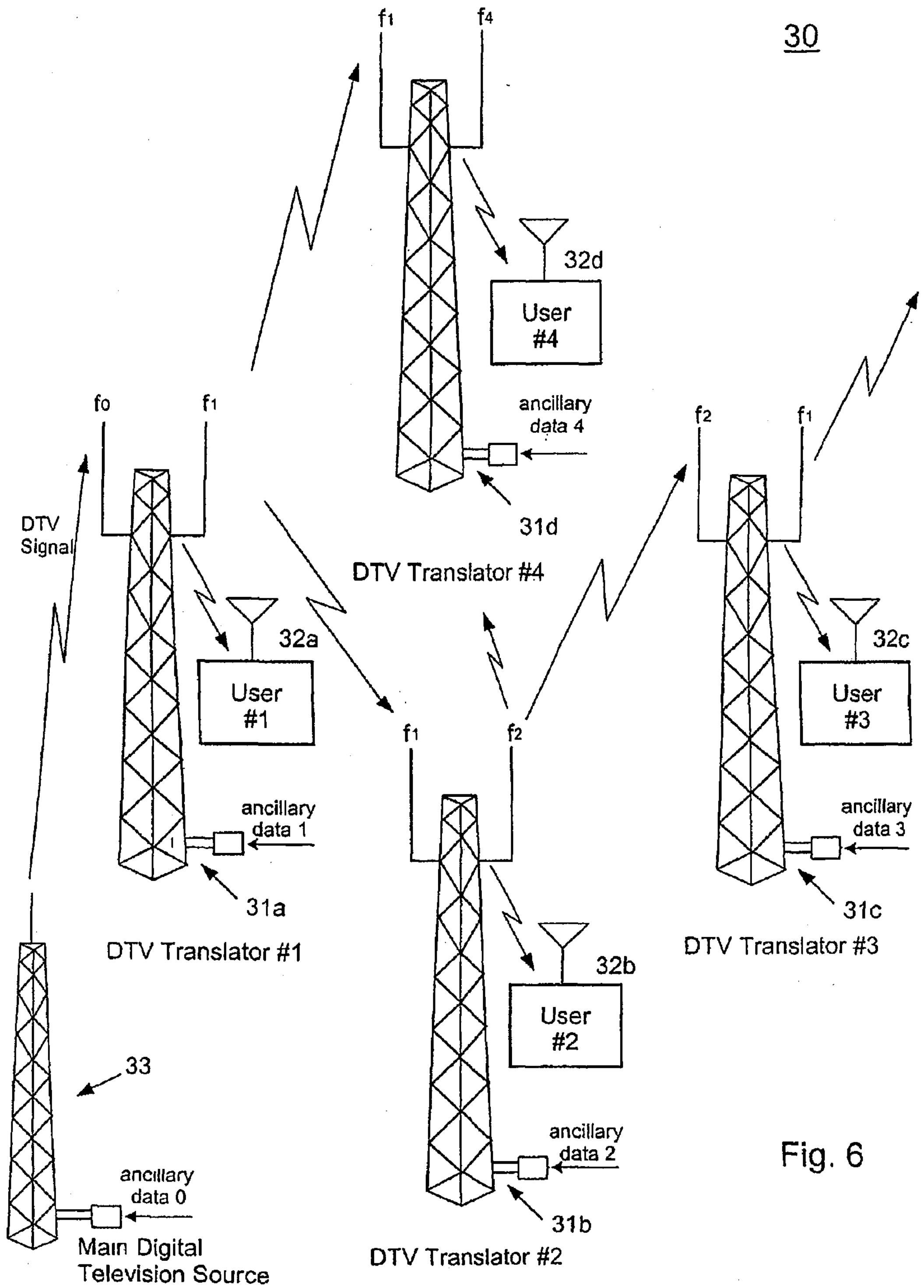

23
original ancillary data termination
27
28
video data
audio data
PSIP data
Input Digital Transport Stream
D M U X
M U X
Output Digital Transport Stream
new ancillary data

Fig. 5



30
f1
f4
32d
User #4
ancillary data 4
31d
DTV Translator #4
f0
f1
DTV Signal
32a
User #1
ancillary data 1
31a
DTV Translator #1
f2
f1
32c
User #3
ancillary data 3
31c
DTV Translator #3
f1
f2
32b
User #2
ancillary data 2
31b
DTV Translator #2
33
ancillary data 0
Main Digital Television Source

Fig. 6

DIGITAL TELEVISION TRANSLATOR WITH PSIP UPDATE

RELATED APPLICATIONS

This is a continuation application of prior U.S. patent application Ser. No. 09/545,613, filed on Apr. 28, 2000, now U.S. Pat. No. 6,785,903, issued on Aug. 31, 2004. The prior Application is incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a digital television translator. More particularly, the present invention relates to a digital television translator that updates the program and system information protocol (PSIP) table with transmit (TX) channel data.

2. Discussion of the Related Art

Digital television (DTV) broadcasting systems are relatively new in the United States and offer many alternatives to traditional information and program distribution. In addition to traditional television programming, DTV systems offer the ability to distribute additional content in the form of data. This data can be any type of data including, for example, Internet data broadcast to one or more end users. Therefore, DTV broadcast systems offer great flexibility and diversity in the types of information they distribute. Like most conventional broadcast systems, DTV broadcast systems have a finite capacity limited by the bandwidth of its channels.

Additionally, as with other broadcast systems, such as analog television systems, the received DTV signal quality can vary greatly depending upon where the receiver is located. This problem is due to a number of adverse propagation effects such as multi-path, interference, and simple attenuation. One solution to this problem is to use multiple low power repeaters (On-Channel boosters) and/or translators (Re-modulators) to improve reception in areas of poor DTV signal reception. For example, a repeater, placed in an area of poor signal reception, receives a transmitted signal from a high power DTV transmitter and re-transmits an amplified duplicate signal at the same frequency. Translators, on the other hand, can receive a transmitted signal from a high power DTV transmitter and re-transmit the signal at a frequency different than the received frequency. Repeaters and translators are also used to extend the coverage of a broadcast system incrementally, and economically, to specific geographical regions.

FIG. **1** shows an example of a conventional DTV translator **1**. The conventional DTV translator includes a down converter **2**, a first local oscillator **3**, an up converter **4**, and a second local oscillator **5**. A received DTV signal (RX RF input) is down converted to IF (intermediate frequency) by down converter **2**. The IF is determined by the difference between the frequency LO1 generated by the first local oscillator **3** and the RF frequency of the received DTV signal (RX RF Input). The IF signal is then up converted to RF by up converter **4**. The frequency of the up converted RF DTV signal (TX RF Output) is determined by the sum of the frequency LO2 generated by the second local oscillator **5** and the IF. The up converted DTV signal (TX RF Output) is then amplified and transmitted. With this arrangement, the transmitted signal contains the same information as the received signal, but is amplified. Further, when LO1=LO2, the transmit frequency is the same as the received frequency, and the apparatus operates as an on-channel booster. Alternatively, when LO1≠LO2, the transmit frequency is different than the received frequency, and the apparatus operates as a translator.

In the DTV American Television Systems Committee (ASTC) standard, a DTV signal contains a Program and System Information Protocol (PSIP) table, which is a collection of hierarchically arranged sub-tables for describing system information and program guide data. One of sub-tables in the PSIP table is the Virtual Channel Table (VCT), which contains a list of attributes for virtual channels carried in the digital transport stream (baseband information). VCT fields "major channel number" and "minor channel number" are used for identification. The major channel number is used to group all channels that are to be identified as belonging to a particular broadcast corporation (or a particular identifying number such as channel "12"). The minor channel number specifies a particular channel within the group. The VCT also contains a "carrier frequency" field, which is used to identify the frequency at which the DTV signal is transmitted and received. As discussed herein, TX and RX channel data include at least one of the following major channel number, minor channel number, carrier frequency, and/or other data necessary for generating a proper DTV signal.

When a RF DTV signal is translated to a new frequency by the conventional DTV translator **1** of FIG. **1**, the PSIP table no longer reflects the correct carrier frequency. In many DTV receivers, this discrepancy between the actual frequency of the received DTV signal and the carrier frequency data contained in the PSIP table prevents the receiver from properly receiving the DTV signal.

Also, a particular broadcast corporation may be assigned different major/minor channel numbers in geographical regions serviced by each translator. For example, Broadcast Corporation #1 could be assigned major/minor channel **12/04** in region #1 (served by a main DTV transmitter) and major/minor channel **37/04** in region #2 (served by a translator translating the main DTV transmitted signal). The conventional translator of FIG. **1** therefore generates a translated DTV signal that contains an incorrect channel number for transmission into region #2.

Moreover, in region #2, major minor/channel **12/04** may have already been assigned to Broadcast Corporation #2. In that case, a single DTV receiver in region #2 will receive two unique channels (Broadcast Corporation #1 and Broadcast Corporation #2) each having the same major/minor channel number in each of their PSIP tables. While some DTV receivers overcome these anomalies by allowing users to select whether to ignore PSIP data or to display the VCT information, other DTV receivers do not have this capability and are unable to properly tune to the program(s) of one or both of the two Broadcast Corporations.

SUMMARY OF THE INVENTION

Accordingly, the present invention relates to a digital television translator, and more particularly to a digital television translator that updates the PSIP table with proper channel and carrier frequency information. To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, there is provided a digital television translator, comprising a digital television receiver for receiving a first digital television signal and generating a digital transport stream from the first digital television signal, the digital transport stream including original PSIP data having RX channel data; a PSIP update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data; and a digital television modulator for converting the digital transport stream having the updated PSIP data into a second digital television signal.

In another aspect of the instant invention, there is provided an information distribution network using digital television transmission, the information distribution network comprising a plurality of digital television transmission nodes including a main digital television signal source for generating a main digital television signal; and a plurality of digital television translators receiving a digital television signal from one of the plurality of digital television nodes, at least one of said plurality of digital television translators including a digital television receiver for receiving the digital television signal from one of the plurality of digital television nodes and generating a digital transport stream from the received digital television signal, the digital transport stream including original ancillary data and original PSIP data having RX data, a data update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data and for replacing the original ancillary data in the digital transport stream with new ancillary data, and a digital television modulator for converting the digital transport stream having the new ancillary data and the updated PSIP data into a transmitted digital television signal, wherein at least two of the plurality of digital television transmission nodes transmit at the same frequency and the total ancillary data of the information distribution network includes the new ancillary data from multiple digital television translators of the plurality of digital television translators.

Additional features and advantages of the present invention will be set forth in the description that follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention that together with the description serve to explain the principles of the invention.

In the drawings:

FIG. **1** shows an example of a conventional DTV translator;

FIG. **2** shows a first embodiment of a DTV translator of the present invention having PSIP table update capability;

FIG. **3** shows an example of a PSIP update module;

FIG. **4** shows a second embodiment of a DTV translator of the present invention having both PSIP table update capability and a re-multiplexor;

FIG. **5** shows an example of the re-multiplexor; and

FIG. **6** shows an example of an information distribution network of the present invention using multiple translators.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

To overcome the problems associated with the prior art, i.e., tuning problems with some DTV receivers due to incorrect PSIP table information, the PSIP table information is updated by the translator to properly reflect the new transmit carrier frequency and channel number.

FIG. **2** shows a first embodiment of a DTV translator **10** of the present invention having PSIP table update capability. The DTV translator **10** includes an 8-VSB receiver **11**, a PSIP update module **12**, an 8-VSB modulator **13**, an RF power amplifier **14**, and a transmitting antenna **15**. The receiver **11** receives an 8-VSB DTV signal (RFi) that may have been originally transmitted by a base station or another translator, over the air or by a cable. The receiver **11** processes the DTV signal according to ASTC DTV standards to produce a digital transport stream (TS) containing MPEG2 video data, audio data, ancillary data, and PSIP data. The PSIP data in the digital transport stream includes a major channel number, a minor channel number, and a carrier frequency, which together make up the RX channel data. As shown, the receiver **11** is controlled by an input (RX Channel Select) which informs the receiver **11** of which carrier frequency channel to tune.

The processing of the received DTV signal by the 8-VSB receiver **11** is in accordance with ATSC DTV standards and, accordingly, can include down conversion, digitization, carrier synchronization, symbol clock synchronization, frame and segment synchronization, matched filtering, equalization, bit-demapping, Trellis decoding, convolutional de-interleaving, Reed-Solomon forward error correction (FEC) decoding, and de-randomizing.

The digital transport stream (TS) is then input into PSIP update module **12**. The PSIP update module **12** extracts the PSIP table data and updates the RX channel data with TX channel data. Specifically, the major channel number, the minor channel number, and the carrier frequency contained in the PSIP VCT are updated. Updated major and minor channel numbers are those numbers assigned to the broadcaster associated with the transport stream content for the geographical region covered by the DTV translator. Sometimes the original and updated channel numbers will be the same, for example when the translator is being used to fill in a poor reception area of the geographical area covered by the main transmitter. At other times, the original and updated channel numbers will be different, for example, when the translator is being used to extend coverage into a geographical area not covered by the main transmitter. In this instance, the broadcaster may be licensed to broadcast in the translator's geographical area, but at a different channel.

Also, the carrier frequency of the DTV signal transmitted from the translator must be reflected in the PSIP VCT. In most instances, the translator will transmit at a different frequency than it receives, requiring the PSIP VCT to be updated with the new transmitted carrier frequency. In some instances, the carrier frequency of the DTV signal can be transmitted at the same frequency that it is received, such as when the translator system is being used as an on-channel booster. In either instance, the updated PSIP table is then reinserted back into the digital transport stream.

Once the PSIP data is updated, the transport stream containing the updated PSIP data is then input into the 8-VSB modulator **13**. 8-VSB modulator **13** processes the digital transport stream according to ATSC DTV standards to produce a DTV signal (Rfo) at the carrier frequency contained in the VCT of the updated PSIP table data. As shown, 8-VSB modulator **13** is controlled by input (TX Channel Select) which informs the 8-VSB modulator **13** at which frequency to transmit the DTV signal. Alternatively, the 8-VSB modulator

can detect the carrier frequency information from the VCT of the DTV signal and transmit the DTV signal using the detected carrier frequency.

8-VSB modulator **13** processes the transport stream having the updated PSIP data according to ASTC terrestrial broadcast standards. Accordingly, this processing can include randomization, Reed-Solomon encoding, convolutional interleaving, symbol mapping, trellis encoding, and vestigial sideband filtering. After the digitally filtered signal is converted to an analog signal, the signal is up converted to a transmit RF signal (RFo) at the transmit frequency determined by TX channel select. The 8-VSB modulator **13** typically operates at a frequency of 54 MHZ-216 MHZ and 470 MHZ-806 MHZ and has a maximum output power of approximately 1 milliwatt. A power amplifier **14** and transmitting antenna **15** are usually added to the output of the 8-VSB modulator **13**.

FIG. **3** shows an example of PSIP update module **12**. The PSIP update module **12** includes an extractor **16** for extracting the original PSIP data, a PSIP update block **18** for replacing the major/minor channel number and carrier frequency contained in the PSIP table, and an inserter **17** for inserting the updated PSIP table data back into the transport stream. As shown, the PSIP table data is extracted by extractor **16** and input into the PSIP update block **18**. The PSIP update block **18** replaces the major/minor channel number and transmit carrier frequency contained in the VCT (a sub-table of the PSIP table) while retaining the other PSIP data. The PSIP update block **18** then substitutes an updated major/minor channel number and transmit carrier frequency into the VCT. Thereafter, the updated PSIP table data is re-inserted back into the digital transport stream via inserter **17**.

FIG. **4** shows a second embodiment of a DTV translator **20** of the present invention. The second embodiment includes an 8-VSB receiver **21**, a PSIP update module **22**, a re-multiplexor **23**, and an 8-VSB modulator **24**. Usually an RF power amplifier **25** and an antenna **26** are coupled to the 8-VSB modulator **24**. The structure and operation of the second embodiment is the same as the structure and operation of the first embodiment, except that a re-multiplexor **23** is added for introducing new ancillary data into the digital transport stream.

The digital transport stream containing original ancillary data and the updated PSIP table data is input into the re-multiplexor **23**. Re-multiplexor **23** substitutes new ancillary data in place of the original ancillary data in the digital transport stream. The digital transport stream is then sent to 8-VSB modulator **24** and converted into a DTV signal consistent with the operation as described in the first embodiment. In this way, each translator can distribute new ancillary data to user(s) in the translator's transmit range.

FIG. **5** is a block diagram of the re-multiplexor **23**, which comprises a demultiplexor **27** and a multiplexor **28**. As shown, the original ancillary data, video data, audio data, and updated PSIP table data is contained in the input digital transport stream, which is demultiplexed into separate bit streams by de-multiplexor **27**. The original ancillary data is terminated (discarded). The multiplexor **28** then combines the video data, the audio data, the updated PSIP data, and new ancillary data back into the output digital transport stream, which is then input to the 8-VSB modulator **24**.

The PSIP update step and the ancillary data insertion step are not required to take place in any particular order. For example, since the PSIP data has been separated into its constituent streams by demultiplexor **27** of re-multiplexor **23**, the PSIP table update step could take place in the re-multiplexor **23** by updating the major/minor channel number and carrier frequency. The updated PSIP table data could be reinserted into the digital transport stream by multiplexor **28**. Or, for example, the placement of the PSIP update module **22** and the multiplexor **23** could be reversed. Moreover, only a portion of the original ancillary data could be replaced with new ancillary data thereby allowing other portions of the ancillary data to be transmitted downstream by the translator.

The second embodiment allows DTV broadcasting stations to increase their data broadcasting capacity every time a DTV translator is added. For example, adding a DTV translator increases the number of users and increases the capacity for data transmission through employment of the new ancillary data, which permits the insertion of data, such as Internet data. Downstream Internet data can be inserted as new ancillary data by each translator and distributed to specific geographic regions and users without the need for additional bandwidth.

FIG. **6** shows an example of a third embodiment of the invention wherein an information distribution network **30** uses a plurality of translators to increase the data capacity of the network. As shown, a plurality of translators, collectively labeled **31***a*-**31***d*, translate and distribute a DTV signal in both a star and daisy-chain configuration.

The first translator **31***a* receives a DTV signal, from a main digital television source, containing original ancillary data **0**, such as Internet download data at a frequency fo. Translator **31***a* inserts ancillary data **1** and discards original ancillary data **0**, and then retransmits the modified DTV signal having ancillary data **1** at a frequency **f1**. User **32***a* receives ancillary data **1** from translator **31***a*. A second DTV translator **31***b* receives the translated DTV signal from translator **31***a* at a frequency of f1, substitutes ancillary data **2** for ancillary data **1**, and then retransmits at a frequency **f2**. User **32***b* receives the DTV signal transmitted from translator **31***b* along with ancillary data **2**. User **32***d* also receives ancillary data **1** from translator **31***a*. A third DTV translator **31***c* receives the translated DTV signal from translator **31***b* at a frequency of f2, substitutes ancillary data **3** for the ancillary data **2**, and retransmits at a frequency **f1**. User **32***c* receives the DTV signal transmitted from translator **32***c* along with ancillary data **3**. DTV translators **31***a*, **31***b*, and **31***c* are thus configured in a daisy-chain fashion with translators **31***a* and **31***c* being endpoints.

Further, a fourth DTV translator **31***d* receives the translated DTV signal from translator **31***a* at a frequency of f1, substitutes ancillary data **4** for ancillary data **1**, and then retransmits at a frequency f4. User **32***d* receives the DTV signal transmitted from translator **31***d* along with ancillary data **4**. DTV translators **31***a*, **31***b*, and **31***d* are thereby configured in a star fashion with DTV translator **31***a* configured as a hub. Moreover, a variety of translator topologies can be employed to transmit unique ancillary data to each of a very large number of users, or a group of users, without requiring an increase in the bandwidth of any single translator's transport stream or physical RF channel.

Even more efficient use of bandwidth can be achieved by allowing multiple translators to use the same transmit frequencies, as does translators **31***a* and **31***c*. Translators can be placed in any number of configurations to increase the data capacity of the DTV distribution network. Furthermore, the use of a PSIP update model in each of the translators can insure proper DTV reception.

Moreover, while the embodiments described herein can be implemented via current ASTC standards, it is contemplated that other DTV standards or a modified ASTC standard could be readily employed to realize the present invention. Further, while the video data on the digital transport stream can be

MPEG2 standard video data, as described herein, the invention contemplates using variations of MPEG2 standard data in the digital transport system.

As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the meets and bounds of the claims, or equivalence of such meets and bounds are therefore intended to be embraced by the appended claims.

What is claimed is:

1. A program information update module, comprising:

a demultiplexor, the demultiplexor separating a first program information table from video data and audio data contained in a first digital transport stream, the first program information table containing one or more attributes for a virtual channel of a digital television signal carried in the first digital transport stream;

a program information update unit, the program information update unit modifying the first program information table to form a second program information table, the second program information table including one or more new attributes for the virtual channel of the digital television signal carried in the first digital transport stream; and

a multiplexor, the multiplexor combining the second program information table with the separated video and audio data to form a second digital transport stream, wherein the second digital transport stream contains the one or more updated attributes for the virtual channel.

2. The program information update module of claim 1, wherein the first program information table is an ATSC PSIP table, wherein the program information update unit modifies a VCT table within the first program information table, and wherein the VCT table is in ATSC format.

3. The program information update module of claim 1, wherein the program information update unit modifies a virtual channel number within the first program information table.

4. The program information update module of claim 1, wherein the program information update unit modifies the first program information table by adding the one or more new attributes for the virtual channel to data from the first program information table to form the second program information table.

5. The program information update module of claim 1, wherein the program information update unit modifies the first program information table by replacing the one or more attributes for the virtual channel in the first program information table with the one or more new attributes for the virtual channel to form the second program information table.

6. The program information update module of claim 1, wherein the program information update unit modifies the first program information table by dropping the first program information table and inserting the second program information table including the one or more new attributes for the virtual channel, wherein the one or more attributes for the virtual channel identifies the digital television signal carried in the first digital transport stream.

7. The program information update module of claim 1, further comprising a remultiplexor, the remultiplexor inserting internet protocol packets arriving from an internet protocol network into one of the first and second digital transport streams.

8. The program information update module of claim 1, wherein the multiplexor combines new ancillary data with the second program information table and the separated video and audio data to form the second digital transport stream.

9. The program information update module of claim 1, further comprising a digital television receiver, the digital television receiver receiving a first RF television signal and converting the first RF television signal into the first digital transport stream.

10. The program information update module of claim 1, further comprising a digital television modulator, the digital television modulator receiving the second digital transport stream and converting the second digital transport stream into an RF modulated signal.

11. A digital television translator, comprising

a digital television receiver that generates a first digital transport stream from a first digital television RF signal;

a demultiplexor for separating original PSIP data from video data and audio data contained in the first digital transport stream;

a PSIP update unit, the PSIP update unit modifying a virtual channel table in the original PSIP data to form updated PSIP data;

a multiplexor for combining the updated PSIP data with the separated video and audio data to form a second digital transport stream; and

a digital television modulator that receives the second digital transport stream from the multiplexor and generates a second digital television RF signal.

12. The digital television translator of claim 11, further comprising an RF power amplifier for amplifying the second digital television RF signal.

13. A method of translating, comprising

separating a first program information table from video data and audio data contained in a first digital transport stream, the first program information table containing one or more attributes for a virtual channel of a digital television signal carried in the first digital transport stream;

forming a second program information table having one or both of a new carrier frequency and new virtual channel number;

combining the second program information table with the separated video and audio data to form a second digital transport stream;

modulating data from the second digital transport stream; and

generating a second digital television RF signal using the modulated data from the second digital transport stream.

14. The method of claim 13, further comprising generating the first digital transport stream from a first digital television RF signal.

15. The method of claim 14, further comprising receiving the first digital television RF signal over-the-air.

16. The method of claim 13, wherein the second program information table does not include a portion of data contained in the first program information table.

17. The method of claim 13, further comprising inserting internet protocol packets arriving from an internet protocol network into one of the first or second digital transport streams.

18. The method of claim 13, further comprising inserting ancillary data into one of the first or second digital transport streams.

19. A system for translating, comprising

a demultiplexor, the demultiplexor separating a first program information table from video data and audio data contained in a first digital transport stream, the first program information table containing one or more attributes for a virtual channel of a digital television signal carried in the first digital transport stream;

a program information update unit, the program information update unit replacing the first program information table with a second program information table, the second program information table including one or more new attributes for the virtual channel of the digital television signal carried in the first digital transport stream;

a multiplexor, the multiplexor combining the second program information table with the separated video and audio data to form a second digital transport stream.

20. The system for translating of claim **19**, further comprising a digital modulator that receives the second digital transport stream from the multiplexor and generates a second digital television signal.

21. The system for translating of claim **19**, further comprising a digital television receiver that generates the first digital transport stream from a first digital television signal, having ATSC PSIP tables.

22. The system for translating of claim **19**, wherein the one or more attributes for a virtual channel of a digital television signal carried in the first digital transport stream identifies the virtual channel number of the first digital television signal carried in the first digital transport stream.

23. The system for translating of claim **19**, wherein the one or more new attributes for a virtual channel of a digital television signal carried in the second digital transport stream identifies the virtual channel number of the digital television signal carried in the first digital transport stream.

24. The system for translating of claim **19**, wherein the one or more new attributes for a virtual channel of a digital television signal carried in the second digital transport stream identifies the virtual channel number of the digital television signal carried in the second digital transport stream.

25. The system for translating of claim **19**, further comprising:

a digital television receiver that generates the first digital transport stream from a first digital television signal, having ATSC PSIP tables; and

a digital modulator that receives the second digital transport stream from the multiplexor and generates a second digital television signal.

26. The system for translating of claim **19**, wherein Internet Protocol packets arriving from an Internet Protocol network are inserted into one of the first or second digital transport streams.

27. The system for translating of claim **19**, wherein the first digital transport stream includes ATSC PSIP Tables.

28. The system for translating of claim **20**, further comprising an RF power amplifier for amplifying the second digital television signal.

29. A system for translating, comprising

a demultiplexor, the demultiplexor separating a first program information table from video data and audio data contained in a first digital transport stream, the first program information table containing one or more attributes for a virtual channel of a digital television signal carried in the first digital transport stream;

a program information update unit, the program information update unit supplementing the first program information table with a second program information table, the second program information table including one or more new attributes for the virtual channel of the digital television signal carried in the first digital transport stream;

a multiplexor, the multiplexor combining the second program information table with the separated video and audio data to form a second digital transport stream.

30. The system for translating of claim **29**, further comprising a digital modulator that receives the second digital transport stream from the multiplexor and generates a second digital television signal.

31. The system for translating of claim **29**, further comprising a digital television receiver that generates the first digital transport stream from a first digital television signal, having ATSC PSIP tables.

32. The system for translating of claim **29**, further comprising:

a digital television receiver that generates the first digital transport stream from a first digital television signal, having ATSC PSIP tables; and

a digital modulator that receives the second digital transport stream from the multiplexor and generates a second digital television signal.

33. The system for translating of claim **29**, wherein Internet Protocol packets arriving from an Internet Protocol network are inserted into one of the first or second digital transport streams.

34. The system for translating of claim **29**, wherein the first digital transport stream includes ATSC PSIP tables.

35. The system for translating of claim **30**, further comprising an RF power amplifier for amplifying the second digital television signal.

36. The system for translating of claim **29**, wherein the one or more attributes for a virtual channel of a digital television signal carried in the first digital transport stream identifies the virtual channel number of the first digital television signal carried in the first digital transport stream.

37. The system for translating of claim **29**, wherein the one or more new attributes for a virtual channel of a digital television signal carried in the second digital transport stream identifies the virtual channel number of the digital television signal carried in the first digital transport stream.

38. The system for translating of claim **29**, wherein the one or more new attributes for a virtual channel of a digital television signal carried in the second digital transport stream identifies the virtual channel number of the digital television signal carried in the second digital transport stream.

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EXHIBIT C

US007761893B2

(12) **United States Patent**
Kuh

(10) **Patent No.: US 7,761,893 B2**
(45) **Date of Patent: Jul. 20, 2010**

(54) **DIGITAL TELEVISION TRANSLATOR WITH PSIP UPDATE**

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G06F 13/00 (2006.01)

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(58) **Field of Classification Search** 725/50, 725/114–118
See application file for complete search history.

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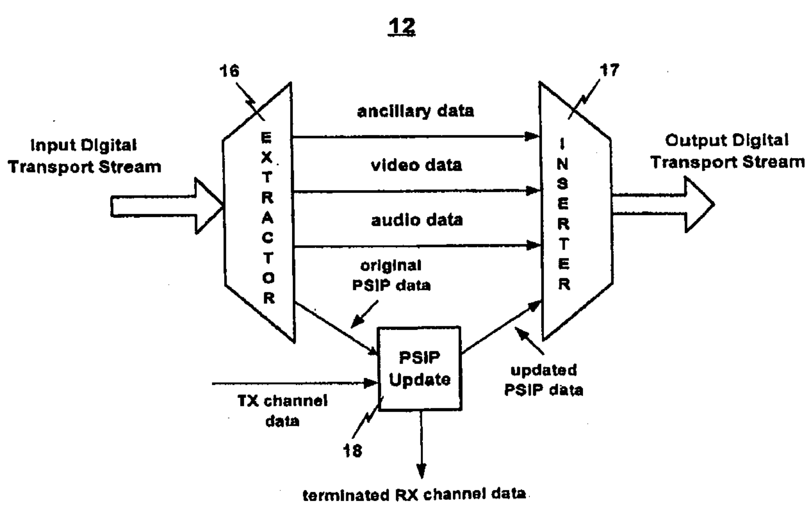
(57) **ABSTRACT**

A digital television translator includes a digital television receiver for receiving a first digital television signal at a first frequency and generating a digital transport stream from the first digital television signal. The digital transport stream can include original Program and System Information (PSIP) data having RX channel data that is indicative of the first frequency, the first major channel number, and/or the first minor channel number. The digital television translator also includes a PSIP update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data. The TX data is indicative of a second frequency, a second major channel number, and/or a second minor channel number. The digital television translator further includes a digital television modulator for converting the digital transport stream having the updated PSIP data into a second digital television signal at the second frequency, where the second frequency can be the same or different from the first frequency.

15 Claims, 4 Drawing Sheets



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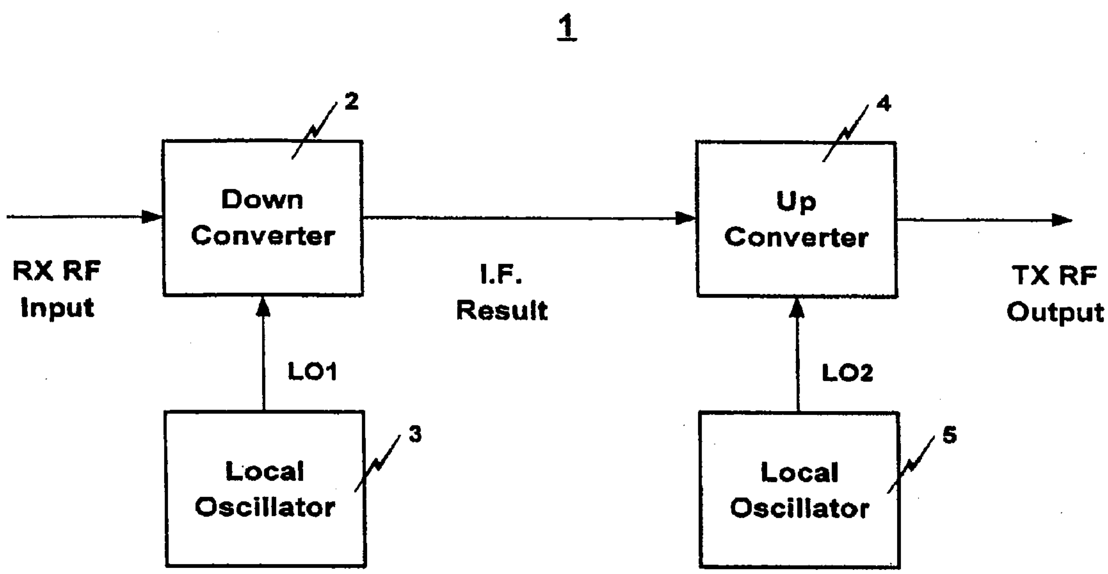


Fig. 1

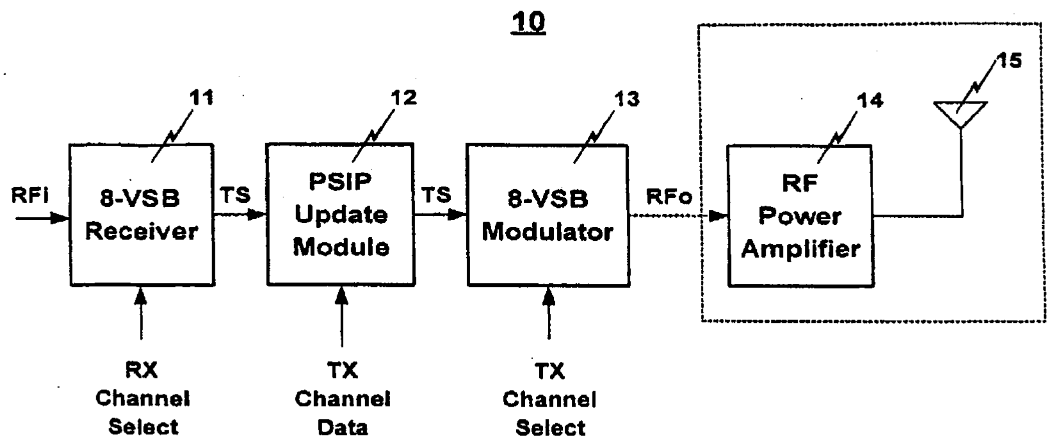

10
11
12
13
14
15
RFi
8-VSB Receiver
TS
PSIP Update Module
TS
8-VSB Modulator
RFo
RF Power Amplifier
RX Channel Select
TX Channel Data
TX Channel Select

Fig. 2

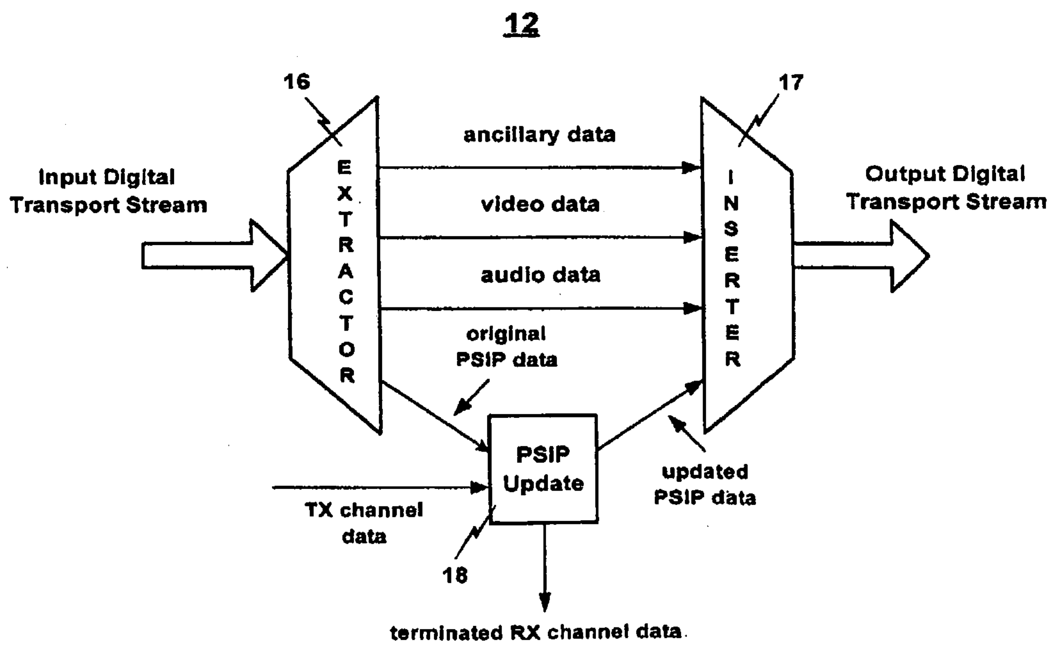

12
16
17
Input Digital Transport Stream
EXTRACTOR
ancillary data
video data
audio data
original PSIP data
INSERTER
Output Digital Transport Stream
PSIP Update
updated PSIP data
TX channel data
18
terminated RX channel data

Fig. 3

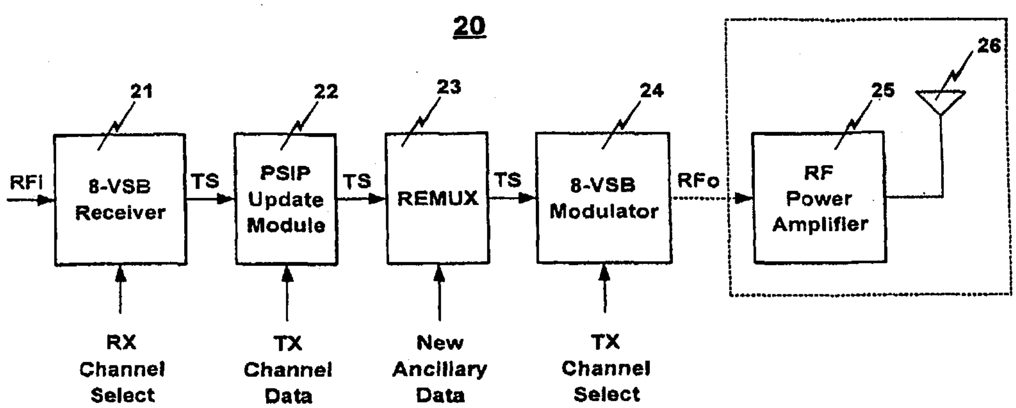

20
21
22
23
24
25
26
RFi
8-VSB Receiver
TS
PSIP Update Module
TS
REMUX
TS
8-VSB Modulator
RFo
RF Power Amplifier
RX Channel Select
TX Channel Data
New Ancillary Data
TX Channel Select

Fig. 4

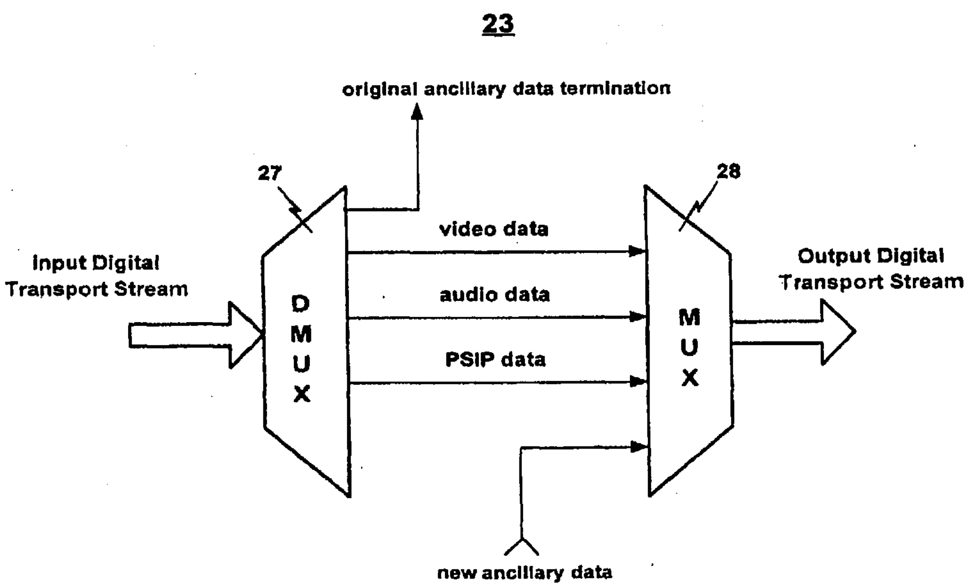
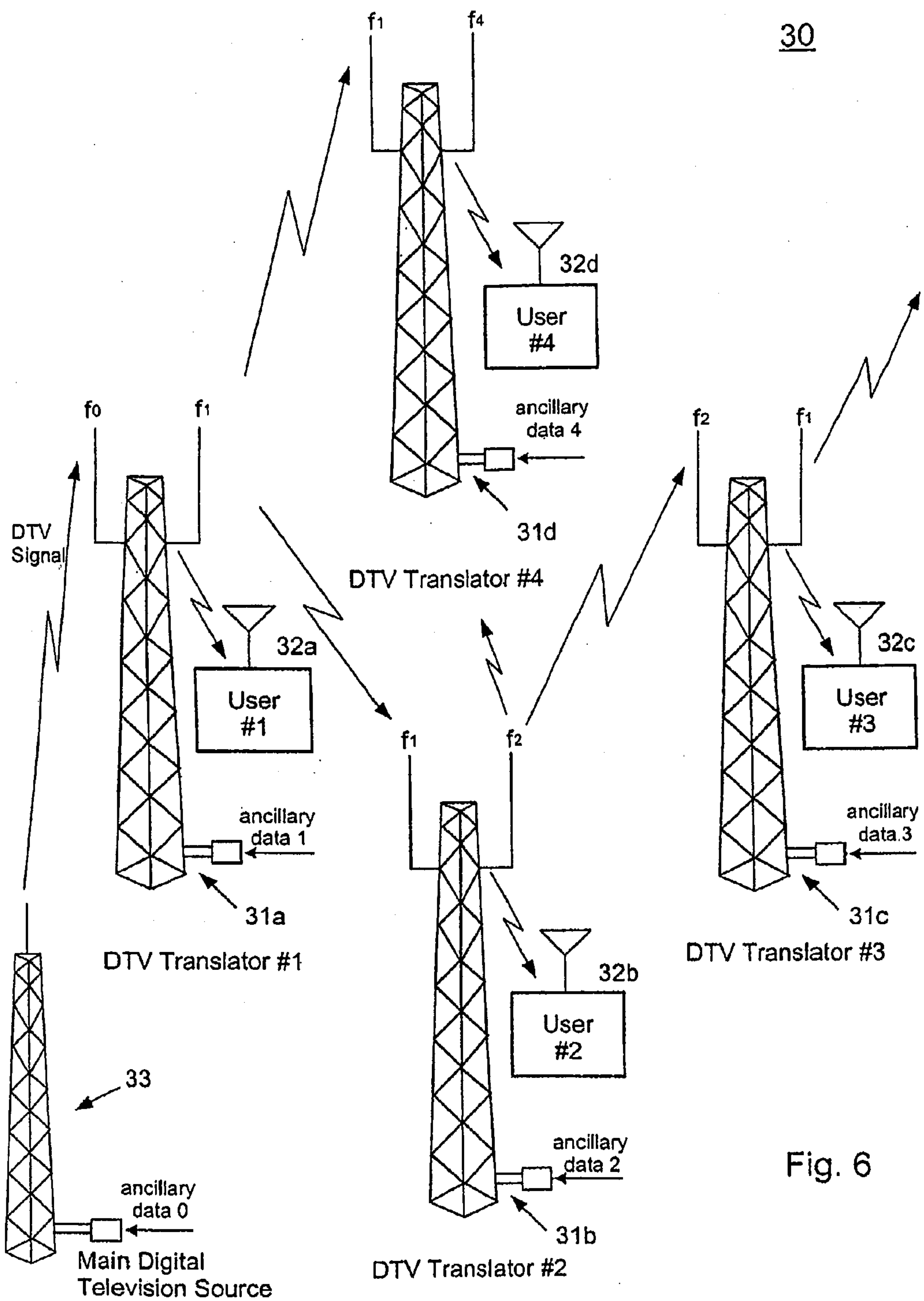

23
original ancillary data termination
27
28
video data
Input Digital Transport Stream
audio data
Output Digital Transport Stream
D M U X
M U X
PSIP data
new ancillary data

Fig. 5



30
f1
f4
32d
User #4
ancillary data 4
31d
DTV Translator #4
f0
f1
DTV Signal
32a
User #1
ancillary data 1
31a
DTV Translator #1
f2
f1
32c
User #3
ancillary data 3
31c
DTV Translator #3
f1
f2
32b
User #2
ancillary data 2
31b
DTV Translator #2
33
ancillary data 0
Main Digital Television Source

Fig. 6

DIGITAL TELEVISION TRANSLATOR WITH PSIP UPDATE

This application is a Continuation application of U.S. patent application Ser. No. 10/890,210 filed on Jul. 14, 2004, now U.S. Pat. No. 7,487,533, which is a continuation of U.S. patent application Ser. No. 09/545,613, filed on Apr. 5, 2000, now U.S. Pat. No. 6,785,903. The prior applications are incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a digital television translator. More particularly, the present invention relates to a digital television translator that updates the program and system information protocol (PSIP) table with transmit (TX) channel data.

2. Discussion of the Related Art

Digital television (DTV) broadcasting systems are relatively new in the United States and offer many alternatives to traditional information and program distribution. In addition to traditional television programming, DTV systems offer the ability to distribute additional content in the form of data. This data can be any type of data including, for example, Internet data broadcast to one or more end users. Therefore, DTV broadcast systems offer great flexibility and diversity in the types of information they distribute. Like most conventional broadcast systems, DTV broadcast systems have a finite capacity limited by the bandwidth of its channels.

Additionally, as with other broadcast systems, such as analog television systems, the received DTV signal quality can vary greatly depending upon where the receiver is located. This problem is due to a number of adverse propagation effects such as multi-path, interference, and simple attenuation. One solution to this problem is to use multiple low power repeaters (On-Channel boosters) and/or translators (Re-modulators) to improve reception in areas of poor DTV signal reception. For example, a repeater, placed in an area of poor signal reception, receives a transmitted signal from a high power DTV transmitter and re-transmits an amplified duplicate signal at the same frequency. Translators, on the other hand, can receive a transmitted signal from a high power DTV transmitter and re-transmit the signal at a frequency different than the received frequency. Repeaters and translators are also used to extend the coverage of a broadcast system incrementally, and economically, to specific geographical regions.

FIG. **1** shows an example of a conventional DTV translator **1**. The conventional DTV translator includes a down converter **2**, a first local oscillator **3**, an up converter **4**, and a second local oscillator **5**. A received DTV signal (RX RF input) is down converted to IF (intermediate frequency) by down converter **2**. The IF is determined by the difference between the frequency LO1 generated by the first local oscillator **3** and the RF frequency of the received DTV signal (RX RF Input). The IF signal is then up converted to RF by up converter **4**. The frequency of the up converted RF DTV signal (TX RF Output) is determined by the sum of the frequency LO2 generated by the second local oscillator **5** and the IF. The up converted DTV signal (TX RF Output) is then amplified and transmitted. With this arrangement, the transmitted signal contains the same information as the received signal, but is amplified. Further, when LO1=LO2, the transmit frequency is the same as the received frequency, and the apparatus operates as an on-channel booster. Alternatively,

when LO1.noteq.LO2, the transmit frequency is different than the received frequency, and the apparatus operates as a translator.

In the DTV American Television Systems Committee (ASTC) standard, a DTV signal contains a Program and System Information Protocol (PSIP) table, which is a collection of hierarchically arranged sub-tables for describing system information and program guide data. One of sub-tables in the PSIP table is the Virtual Channel Table (VCT), which contains a list of attributes for virtual channels carried in the digital transport stream (baseband information). VCT fields "major channel number" and "minor channel number" are used for identification. The major channel number is used to group all channels that are to be identified as belonging to a particular broadcast corporation (or a particular identifying number such as channel "12"). The minor channel number specifies a particular channel within the group. The VCT also contains a "carrier frequency" field, which is used to identify the frequency at which the DTV signal is transmitted and received. As discussed herein, TX and RX channel data include at least one of the following major channel number, minor channel number, carrier frequency, and/or other data necessary for generating a proper DTV signal.

When a RF DTV signal is translated to a new frequency by the conventional DTV translator **1** of FIG. **1**, the PSIP table no longer reflects the correct carrier frequency. In many DTV receivers, this discrepancy between the actual frequency of the received DTV signal and the carrier frequency data contained in the PSIP table prevents the receiver from properly receiving the DTV signal.

Also, a particular broadcast corporation may be assigned different major/minor channel numbers in geographical regions serviced by each translator. For example, Broadcast Corporation #1 could be assigned major/minor channel **12/04** in region #1 (served by a main DTV transmitter) and major/minor channel **37/04** in region #2 (served by a translator translating the main DTV transmitted signal). The conventional translator of FIG. **1** therefore generates a translated DTV signal that contains an incorrect channel number for transmission into region #**2**.

Moreover, in region #**2**, major minor/channel **12/04** may have already been assigned to Broadcast Corporation #**2**. In that case, a single DTV receiver in region #**2** will receive two unique channels (Broadcast Corporation #1 and Broadcast Corporation #**2**) each having the same major/minor channel number in each of their PSIP tables. While some DTV receivers overcome these anomalies by allowing users to select whether to ignore PSIP data or to display the VCT information, other DTV receivers do not have this capability and are unable to properly tune to the program(s) of one or both of the two Broadcast Corporations.

SUMMARY OF THE INVENTION

Accordingly, the present invention relates to a digital television translator, and more particularly to a digital television translator that updates the PSIP table with proper channel and carrier frequency information. To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, there is provided a digital television translator, comprising a digital television receiver for receiving a first digital television signal and generating a digital transport stream from the first digital television signal, the digital transport stream including original PSIP data having RX channel data; a PSIP update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data; and a digital television modulator for converting the digital transport stream having the updated PSIP data into a second digital television signal.

In another aspect of the instant invention, there is provided an information distribution network using digital television transmission, the information distribution network comprising a plurality of digital television transmission nodes including a main digital television signal source for generating a main digital television signal; and a plurality of digital television translators receiving a digital television signal from one of the plurality of digital television nodes, at least one of said plurality of digital television translators including a digital television receiver for receiving the digital television signal from one of the plurality of digital television nodes and generating a digital transport stream from the received digital television signal, the digital transport stream including original ancillary data and original PSIP data having RX data, a data update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data and for replacing the original ancillary data in the digital transport stream with new ancillary data, and a digital television modulator for converting the digital transport stream having the new ancillary data and the updated PSIP data into a transmitted digital television signal, wherein at least two of the plurality of digital television transmission nodes transmit at the same frequency and the total ancillary data of the information distribution network includes the new ancillary data from multiple digital television translators of the plurality of digital television translators.

Additional features and advantages of the present invention will be set forth in the description that follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention that together with the description serve to explain the principles of the invention.

In the drawings:

FIG. **1** shows an example of a conventional DTV translator;

FIG. **2** shows a first embodiment of a DTV translator of the present invention having PSIP table update capability;

FIG. **3** shows an example of a PSIP update module;

FIG. **4** shows a second embodiment of a DTV translator of the present invention having both PSIP table update capability and a re-multiplexor;

FIG. **5** shows an example of the re-multiplexor; and

FIG. **6** shows an example of an information distribution network of the present invention using multiple translators.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

To overcome the problems associated with the prior art, i.e., tuning problems with some DTV receivers due to incorrect PSIP table information, the PSIP table information is updated by the translator to properly reflect the new transmit carrier frequency and channel number.

FIG. **2** shows a first embodiment of a DTV translator **10** of the present invention having PSIP table update capability. The DTV translator **10** includes an 8-VSB receiver **11**, a PSIP update module **12**, an 8-VSB modulator **13**, an RF power amplifier **14**, and a transmitting antenna **15**. The receiver **11** receives an 8-VSB DTV signal (RFi) that may have been originally transmitted by a base station or another translator, over the air or by a cable. The receiver **11** processes the DTV signal according to ASTC DTV standards to produce a digital transport stream (TS) containing MPEG2 video data, audio data, ancillary data, and PSIP data. The PSIP data in the digital transport stream includes a major channel number, a minor channel number, and a carrier frequency, which together make up the RX channel data. As shown, the receiver **11** is controlled by an input (RX Channel Select) which informs the receiver **11** of which carrier frequency channel to tune.

The processing of the received DTV signal by the 8-VSB receiver **11** is in accordance with ATSC DTV standards and, accordingly, can include down conversion, digitization, carrier synchronization, symbol clock synchronization, frame and segment synchronization, matched filtering, equalization, bit-demapping, Trellis decoding, convolutional de-interleaving, Reed-Solomon forward error correction (FEC) decoding, and de-randomizing.

The digital transport stream (TS) is then input into PSIP update module **12**. The PSIP update module **12** extracts the PSIP table data and updates the RX channel data with TX channel data. Specifically, the major channel number, the minor channel number, and the carrier frequency contained in the PSIP VCT are updated. Updated major and minor channel numbers are those numbers assigned to the broadcaster associated with the transport stream content for the geographical region covered by the DTV translator. Sometimes the original and updated channel numbers will be the same, for example when the translator is being used to fill in a poor reception area of the geographical area covered by the main transmitter. At other times, the original and updated channel numbers will be different, for example, when the translator is being used to extend coverage into a geographical area not covered by the main transmitter. In this instance, the broadcaster may be licensed to broadcast in the translator's geographical area, but at a different channel.

Also, the carrier frequency of the DTV signal transmitted from the translator must be reflected in the PSIP VCT. In most instances, the translator will transmit at a different frequency than it receives, requiring the PSIP VCT to be updated with the new transmitted carrier frequency. In some instances, the carrier frequency of the DTV signal can be transmitted at the same frequency that it is received, such as when the translator system is being used as an on-channel booster. In either instance, the updated PSIP table is then reinserted back into the digital transport stream.

Once the PSIP data is updated, the transport stream containing the updated PSIP data is then input into the 8-VSB modulator **13**. 8-VSB modulator **13** processes the digital transport stream according to ATSC DTV standards to produce a DTV signal (Rfo) at the carrier frequency contained in the VCT of the updated PSIP table data. As shown, 8-VSB modulator **13** is controlled by input (TX Channel Select) which informs the 8-VSB modulator **13** at which frequency to transmit the DTV signal. Alternatively, the 8-VSB modulator

can detect the carrier frequency information from the VCT of the DTV signal and transmit the DTV signal using the detected carrier frequency.

8-VSB modulator **13** processes the transport stream having the updated PSIP data according to ASTC terrestrial broadcast standards. Accordingly, this processing can include randomization, Reed-Solomon encoding, convolutional interleaving, symbol mapping, trellis encoding, and vestigial sideband filtering. After the digitally filtered signal is converted to an analog signal, the signal is up converted to a transmit RF signal (RFo) at the transmit frequency determined by TX channel select. The 8-VSB modulator **13** typically operates at a frequency of 54 MHZ-216 MHZ and 470 MHZ-806 MHZ and has a maximum output power of approximately 1 milliwatt. A power amplifier **14** and transmitting antenna **15** are usually added to the output of the 8-VSB modulator **13**.

FIG. **3** shows an example of PSIP update module **12**. The PSIP update module **12** includes an extractor **16** for extracting the original PSIP data, a PSIP update block **18** for replacing the major/minor channel number and carrier frequency contained in the PSIP table, and an inserter **17** for inserting the updated PSIP table data back into the transport stream. As shown, the PSIP table data is extracted by extractor **16** and input into the PSIP update block **18**. The PSIP update block **18** replaces the major/minor channel number and transmit carrier frequency contained in the VCT (a sub-table of the PSIP table) while retaining the other PSIP data. The PSIP update block **18** then substitutes an updated major/minor channel number and transmit carrier frequency into the VCT. Thereafter, the updated PSIP table data is re-inserted back into the digital transport stream via inserter **17**.

FIG. **4** shows a second embodiment of a DTV translator **20** of the present invention. The second embodiment includes an 8-VSB receiver **21**, a PSIP update module **22**, a re-multiplexor **23**, and an 8-VSB modulator **24**. Usually an RF power amplifier **25** and an antenna **26** are coupled to the 8-VSB modulator **24**. The structure and operation of the second embodiment is the same as the structure and operation of the first embodiment, except that a re-multiplexor **23** is added for introducing new ancillary data into the digital transport stream.

The digital transport stream containing original ancillary data and the updated PSIP table data is input into the re-multiplexor **23**. Re-multiplexor **23** substitutes new ancillary data in place of the original ancillary data in the digital transport stream. The digital transport stream is then sent to 8-VSB modulator **24** and converted into a DTV signal consistent with the operation as described in the first embodiment. In this way, each translator can distribute new ancillary data to user(s) in the translator's transmit range.

FIG. **5** is a block diagram of the re-multiplexor **23**, which comprises a demultiplexor **27** and a multiplexor **28**. As shown, the original ancillary data, video data, audio data, and updated PSIP table data is contained in the input digital transport stream, which is demultiplexed into separate bit streams by de-multiplexor **27**. The original ancillary data is terminated (discarded). The multiplexor **28** then combines the video data, the audio data, the updated PSIP data, and new ancillary data back into the output digital transport stream, which is then input to the 8-VSB modulator **24**.

The PSIP update step and the ancillary data insertion step are not required to take place in any particular order. For example, since the PSIP data has been separated into its constituent streams by demultiplexor **27** of re-multiplexor **23**, the PSIP table update step could take place in the re-multiplexor **23** by updating the major/minor channel number and carrier frequency. The updated PSIP table data could be reinserted into the digital transport stream by multiplexor **28**. Or, for example, the placement of the PSIP update module **22** and the multiplexor **23** could be reversed. Moreover, only a portion of the original ancillary data could be replaced with new ancillary data thereby allowing other portions of the ancillary data to be transmitted downstream by the translator.

The second embodiment allows DTV broadcasting stations to increase their data broadcasting capacity every time a DTV translator is added. For example, adding a DTV translator increases the number of users and increases the capacity for data transmission through employment of the new ancillary data, which permits the insertion of data, such as Internet data. Downstream Internet data can be inserted as new ancillary data by each translator and distributed to specific geographic regions and users without the need for additional bandwidth.

FIG. **6** shows an example of a third embodiment of the invention wherein an information distribution network **30** uses a plurality of translators to increase the data capacity of the network. As shown, a plurality of translators, collectively labeled **31***a*-**31***d*, translate and distribute a DTV signal in both a star and daisy-chain configuration.

The first translator **31***a* receives a DTV signal containing original ancillary data **0**, such as Internet download data at a frequency fo. Translator **31***a* inserts ancillary data **1** and discards original ancillary data **0**, and then retransmits the modified DTV signal having ancillary data **1** at a frequency f1. User **32***a* receives ancillary data **1** from translator **31***a*. A second DTV translator **31***b* receives the translated DTV signal from translator **31***a* at a frequency of f1, substitutes ancillary data **2** for ancillary data **1**, and then retransmits at a frequency f2. User **32***b* receives the DTV signal transmitted from translator **31***b* along with ancillary data **2**. User **32***d* also receives ancillary data **1** from translator **31***a*. A third DTV translator **31***c* receives the translated DTV signal from translator **31***b* at a frequency of f2, substitutes ancillary data **3** for the ancillary data **2**, and retransmits at a frequency f1. User **32***c* receives the DTV signal transmitted from translator **32***c* along with ancillary data **3**. DTV translators **31***a*, **31***b*, and **31***c* are thus configured in a daisy-chain fashion with translators **31***a* and **31***c* being endpoints.

Further, a fourth DTV translator **31***d* receives the translated DTV signal from translator **31***a* at a frequency of f1, substitutes ancillary data **4** for ancillary data **1**, and then retransmits at a frequency f4. User **32***d* receives the DTV signal transmitted from translator **31***d* along with ancillary data **4**. DTV translators **31***a*, **31***b*, and **31***d* are thereby configured in a star fashion with DTV translator **31***a* configured as a hub. Moreover, a variety of translator topologies can be employed to transmit unique ancillary data to each of a very large number of users, or a group of users, without requiring an increase in the bandwidth of any single translator's transport stream or physical RF channel.

Even more efficient use of bandwidth can be achieved by allowing multiple translators to use the same transmit frequencies, as does translators **31***a* and **31***c*. Translators can be placed in any number of configurations to increase the data capacity of the DTV distribution network. Furthermore, the use of a PSIP update model in each of the translators can insure proper DTV reception.

Moreover, while the embodiments described herein can be implemented via current ASTC standards, it is contemplated that other DTV standards or a modified ASTC standard could be readily employed to realize the present invention. Further, while the video data on the digital transport stream can be MPEG2 standard video data, as described herein, the invention contemplates using variations of MPEG2 standard data in the digital transport system.

As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the meets and bounds of the claims, or equivalence of such meets and bounds are therefore intended to be embraced by the appended claims.

What is claimed is:

1. A system for translating a first digital transport stream containing one or more digital television programs carried in the first digital transport stream, comprising:

a program information update unit, the program information update unit supplementing one or more attributes for a virtual channel of a digital television program carried in the first digital transport stream; and

a multiplexor, the multiplexor combining the one or more attributes supplemented by the program information update unit and the first digital television program carried on the first digital transport stream to form a second digital transport stream.

2. A system for translating, comprising

an extractor, the extractor separating a first program information table from video data and audio data contained in a first digital transport stream, the first program information table containing one or more attributes for a virtual channel of a first digital television signal;

a program information update unit, the program information update unit replacing the first program information table with a second program information table, the second program information table including one or more new attributes for the virtual channel of the first digital television signal carried in the first digital transport stream; and

a combiner, the combiner combining the second program information table with the separated video and audio data.

3. The system for translating of claim **2**, wherein an inserter adds new data to the second program information table.

4. The system for translating of claim **2**, wherein an inserter adds Internet Protocol packets arriving from an Internet Protocol network to the separated video data and audio data.

5. The system for translating of claim **2**, further comprising a digital television receiver that generates the first digital transport stream from the first digital television signal, having ATSC PSIP tables.

6. The system for translating of claim **2**, wherein the one or more attributes for the virtual channel of the first digital television signal identifies the virtual channel number of the channel of the first digital television signal.

7. The system for translating of claim **2**, wherein the first digital transport stream includes ATSC PSIP Tables.

8. The system for translating of claim **2**, wherein the combiner combines the second program information table with the separated video and audio data to create a second digital transport stream.

9. A method for translating, comprising

separating a first program information table from video data and audio data contained in a first digital transport stream, the first program information table containing one or more attributes for a virtual channel of a first digital television signal;

replacing the first program information table with a second program information table, the second program information table including one or more new attributes for the virtual channel of the first digital television signal carried in the first digital transport stream; and

combining the second program information table with the separated video and audio data.

10. The method for translating of claim **9**, further comprising adding new data to the second program information table.

11. The method for translating of claim **9**, further comprising adding Internet Protocol packets arriving from an Internet Protocol network to the separated video data and audio data.

12. The method for translating of claim **9**, further comprising generating the first digital transport stream from the first digital television signal, having ATSC PSIP tables.

13. The method for translating of claim **9**, wherein the one or more attributes for the virtual channel of the first digital television signal identifies the virtual channel number of the channel of the first digital television signal.

14. The method for translating of claim **9**, wherein the first digital transport stream includes ATSC PSIP Tables.

15. The method for translating of claim **9**, further comprising combining the second program information table with the separated video and audio data to create a second digital transport stream.

* * * * *

EXHIBIT D

US007984469B2

(12) **United States Patent**
Kuh

(10) **Patent No.: US 7,984,469 B2**
(45) **Date of Patent: Jul. 19, 2011**

(54) **DIGITAL TELEVISION TRANSLATOR WITH PSIP UPDATE**

(75) Inventor: **Steve Kuh**, Northridge, CA (US)

(73) Assignee: **KTech Telecommunications, Inc.**, Chatsworth, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/777,108**

(22) Filed: **May 10, 2010**

(65) **Prior Publication Data**

US 2010/0218212 A1 Aug. 26, 2010

Related U.S. Application Data

(63) Continuation of application No. 12/314,078, filed on Dec. 3, 2008, now Pat. No. 7,761,893, which is a continuation of application No. 10/890,210, filed on Jul. 14, 2004, now Pat. No. 7,487,533, which is a continuation of application No. 09/545,613, filed on Apr. 5, 2000, now Pat. No. 6,785,903.

(51) **Int. Cl.**
H04N 5/445 (2006.01)
H04N 7/16 (2006.01)
G06F 13/00 (2006.01)
G06F 3/00 (2006.01)

(52) **U.S. Cl.** **725/50**; 725/115; 725/116

(58) **Field of Classification Search** 725/50, 725/114–118

See application file for complete search history.

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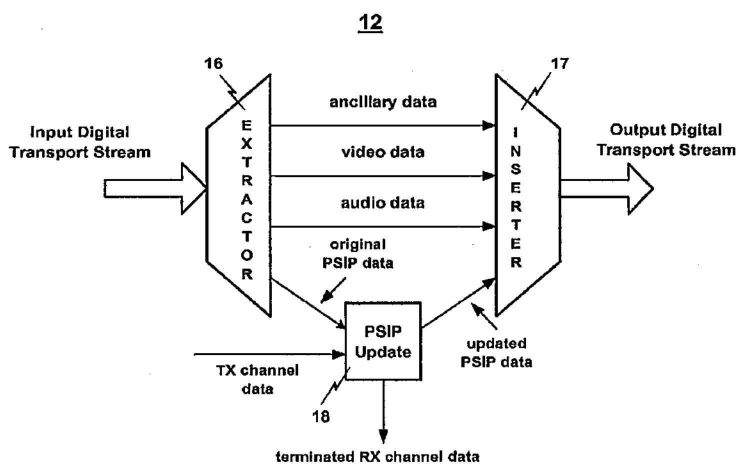
Primary Examiner — Hunter B Lonsberry
(74) *Attorney, Agent, or Firm* — Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

A digital television translator includes a digital television receiver for receiving a first digital television signal at a first frequency and generating a digital transport stream from the first digital television signal. The digital transport stream can include original Program and System Information (PSIP) data having RX channel data that is indicative of the first frequency, the first major channel number, and/or the first minor channel number. The digital television translator also includes a PSIP update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data. The TX data is indicative of a second frequency, a second major channel number, and/or a second minor channel number. The digital television translator further includes a digital television modulator for converting the digital transport stream having the updated PSIP data into a second digital television signal at the second frequency, where the second frequency can be the same or different from the first frequency.

21 Claims, 4 Drawing Sheets



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Prior Art

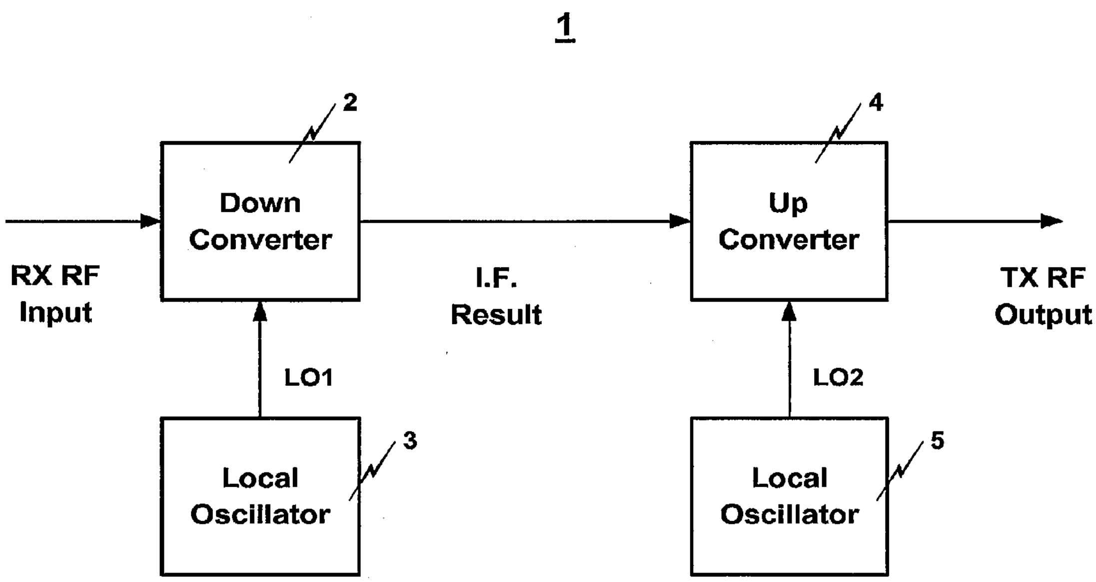

Fig. 1

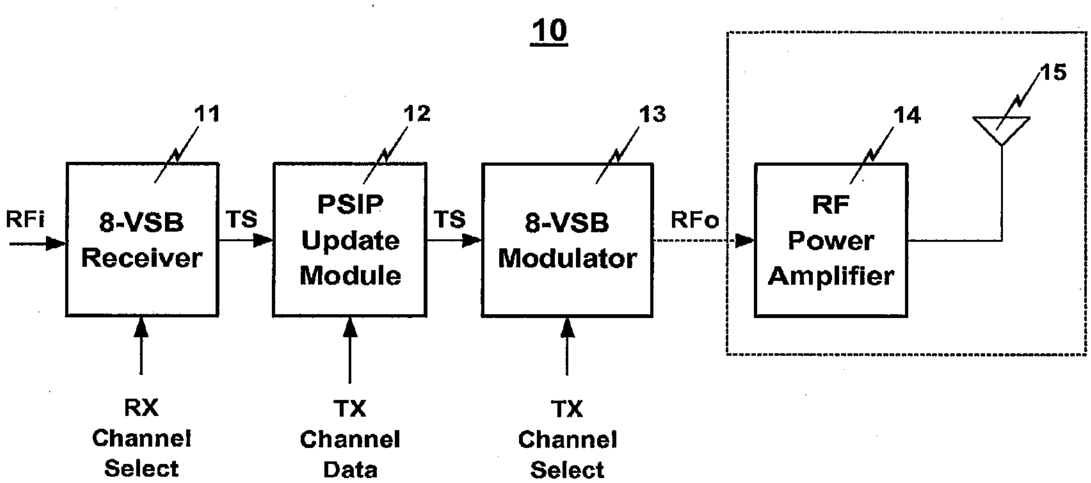
10
11
12
13
14
15
RFi
8-VSB Receiver
TS
PSIP Update Module
TS
8-VSB Modulator
RFo
RF Power Amplifier
RX Channel Select
TX Channel Data
TX Channel Select

Fig. 2

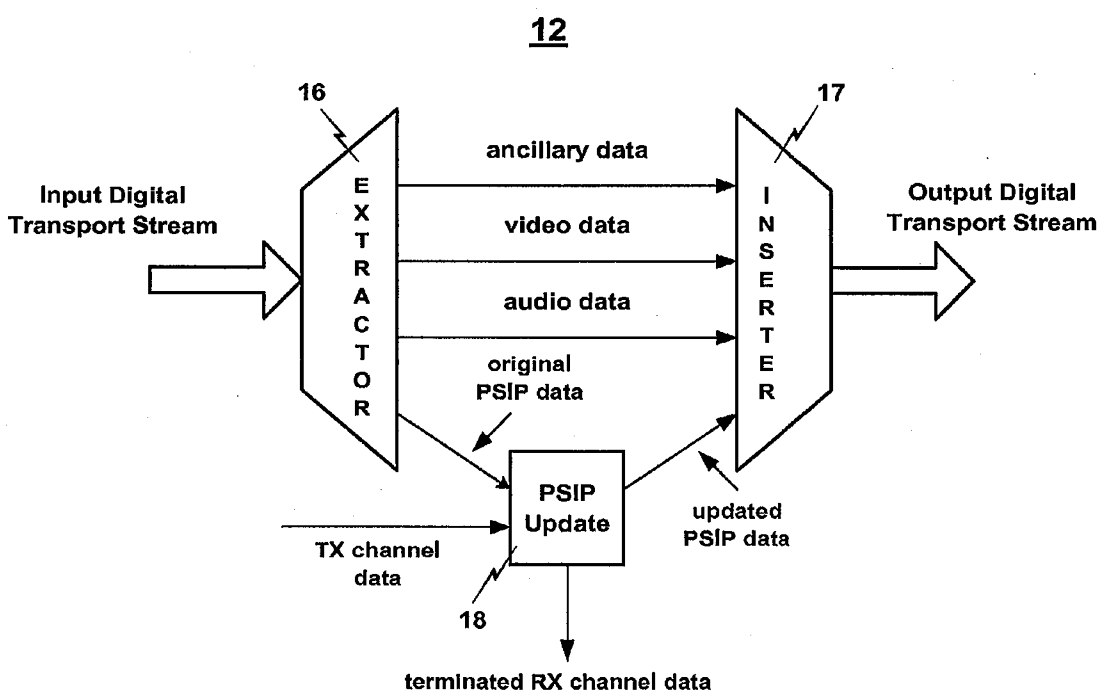
12
16
17
Input Digital Transport Stream
EXTRACTOR
ancillary data
video data
audio data
original PSIP data
INSERTER
Output Digital Transport Stream
PSIP Update
updated PSIP data
TX channel data
18
terminated RX channel data

Fig. 3

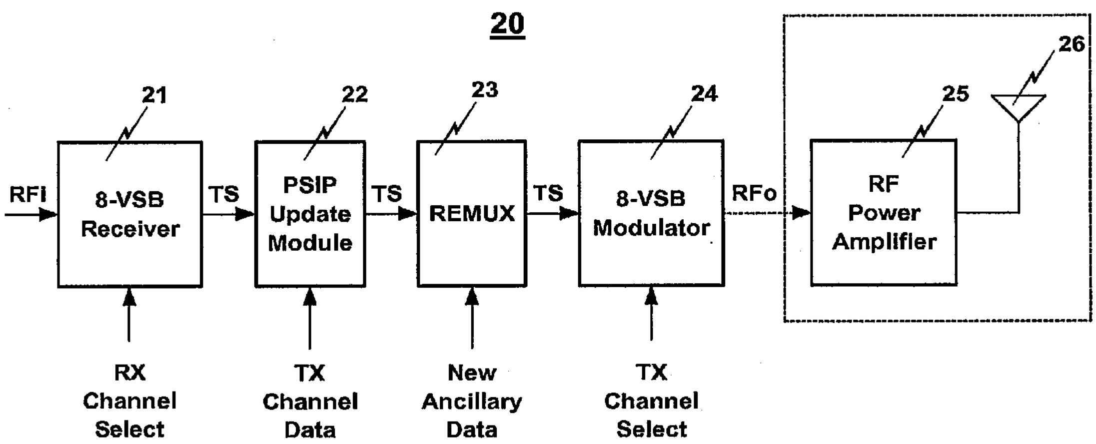
20
21
22
23
24
25
26
RFI
8-VSB
Receiver
TS
PSIP
Update
Module
TS
REMUX
TS
8-VSB
Modulator
RFo
RF
Power
Amplifier
RX
Channel
Select
TX
Channel
Data
New
Ancillary
Data
TX
Channel
Select

Fig. 4

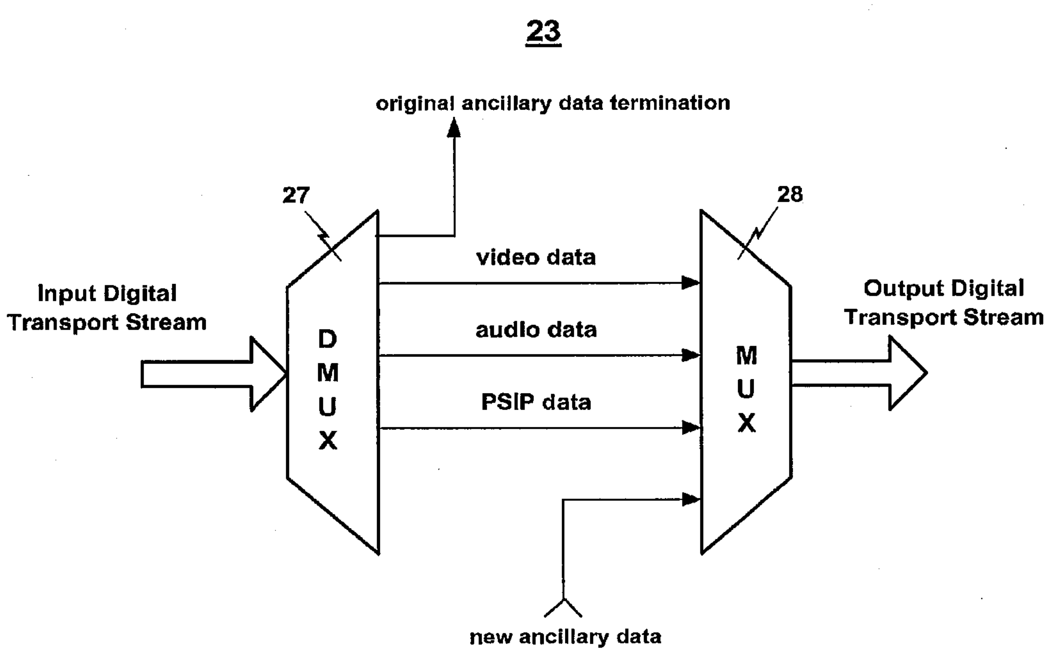
23
original ancillary data termination
27
28
video data
audio data
PSIP data
Input Digital
Transport Stream
D
M
U
X
M
U
X
Output Digital
Transport Stream
new ancillary data

Fig. 5

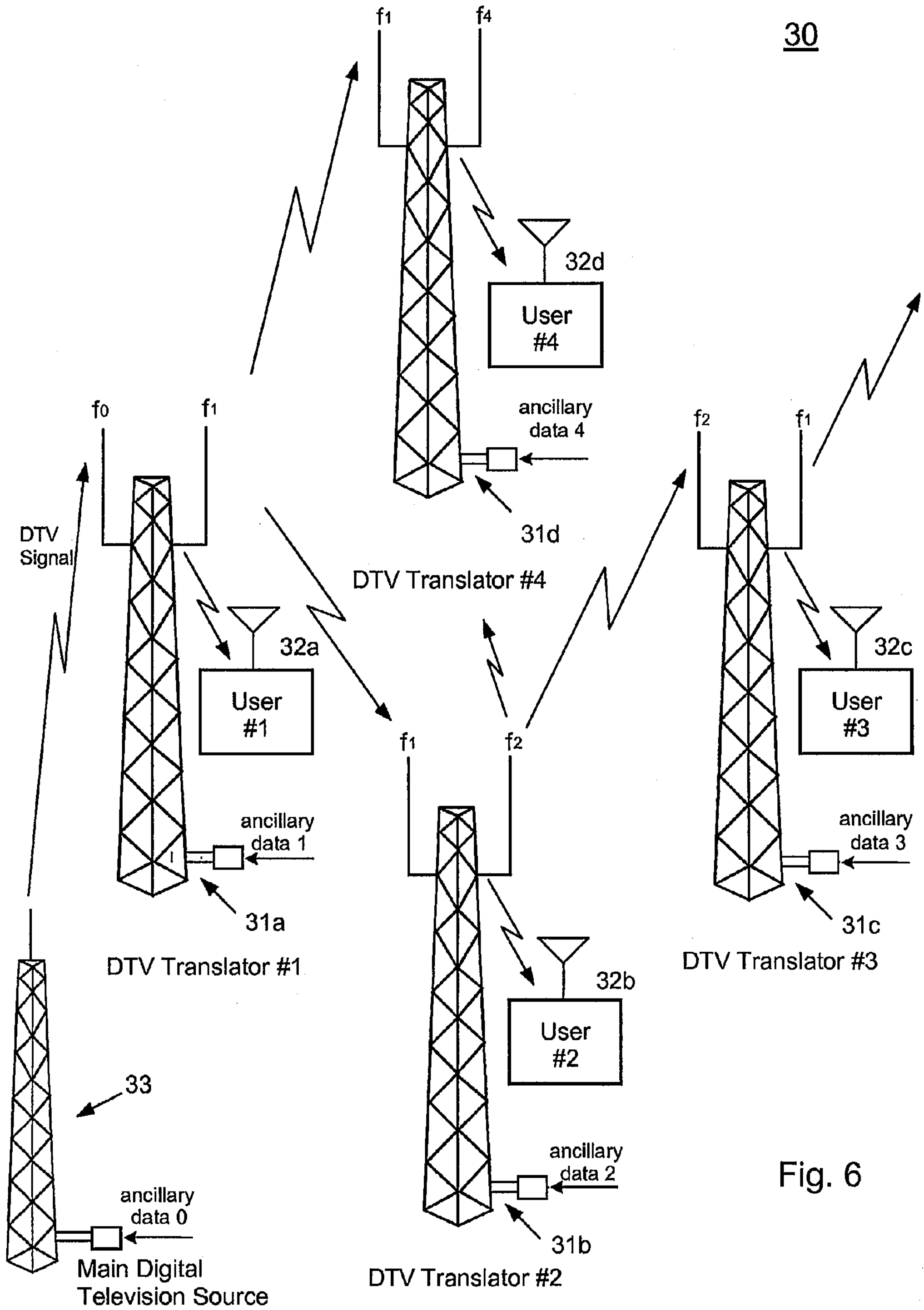
30
f1
f4
32d
User #4
ancillary data 4
31d
DTV Translator #4
f0
f1
DTV Signal
32a
User #1
ancillary data 1
31a
DTV Translator #1
f2
f1
32c
User #3
ancillary data 3
31c
DTV Translator #3
f1
f2
32b
User #2
ancillary data 2
31b
DTV Translator #2
33
ancillary data 0
Main Digital Television Source

Fig. 6

DIGITAL TELEVISION TRANSLATOR WITH PSIP UPDATE

This application is a Continuation application of U.S. patent application Ser. No. 12/314,078 now U.S. Pat. No. 7,761,893, filed on Dec. 3, 2008, which is a Continuation application of U.S. patent application Ser. No. 10/890,210, filed on Jul. 14, 2004, now U.S. Pat. No. 7,487,533, which is a Continuation application of U.S. patent application Ser. No. 09/545,613, filed on Apr. 5, 2000, now U.S. Pat. No. 6,785, 903. The prior applications are incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a digital television translator. More particularly, the present invention relates to a digital television translator that updates the program and system information protocol (PSIP) table with transmit (TX) channel data.

2. Discussion of the Related Art

Digital television (DTV) broadcasting systems are relatively new in the United States and offer many alternatives to traditional information and program distribution. In addition to traditional television programming, DTV systems offer the ability to distribute additional content in the form of data. This data can be any type of data including, for example, Internet data broadcast to one or more end users. Therefore, DTV broadcast systems offer great flexibility and diversity in the types of information they distribute. Like most conventional broadcast systems, DTV broadcast systems have a finite capacity limited by the bandwidth of its channels.

Additionally, as with other broadcast systems, such as analog television systems, the received DTV signal quality can vary greatly depending upon where the receiver is located. This problem is due to a number of adverse propagation effects such as multi-path, interference, and simple attenuation. One solution to this problem is to use multiple low power repeaters (On-Channel boosters) and/or translators (Re-modulators) to improve reception in areas of poor DTV signal reception. For example, a repeater, placed in an area of poor signal reception, receives a transmitted signal from a high power DTV transmitter and re-transmits an amplified duplicate signal at the same frequency. Translators, on the other hand, can receive a transmitted signal from a high power DTV transmitter and re-transmit the signal at a frequency different than the received frequency. Repeaters and translators are also used to extend the coverage of a broadcast system incrementally, and economically, to specific geographical regions.

FIG. 1 shows an example of a conventional DTV translator 1. The conventional DTV translator includes a down converter 2, a first local oscillator 3, an up converter 4, and a second local oscillator 5. A received DTV signal (RX RF input) is down converted to IF (intermediate frequency) by down converter 2. The IF is determined by the difference between the frequency LO1 generated by the first local oscillator 3 and the RF frequency of the received DTV signal (RX RF Input). The IF signal is then up converted to RF by up converter 4. The frequency of the up converted RF DTV signal (TX RF Output) is determined by the sum of the frequency LO2 generated by the second local oscillator 5 and the IF. The up converted DTV signal (TX RF Output) is then amplified and transmitted. With this arrangement, the transmitted signal contains the same information as the received signal, but is amplified. Further, when LO1=LO2, the transmit frequency is the same as the received frequency, and the apparatus operates as an on-channel booster. Alternatively, when LO1.noteq.LO2, the transmit frequency is different than the received frequency, and the apparatus operates as a translator.

In the DTV American Television Systems Committee (ASTC) standard, a DTV signal contains a Program and System Information Protocol (PSIP) table, which is a collection of hierarchically arranged sub-tables for describing system information and program guide data. One of sub-tables in the PSIP table is the Virtual Channel Table (VCT), which contains a list of attributes for virtual channels carried in the digital transport stream (baseband information). VCT fields "major channel number" and "minor channel number" are used for identification. The major channel number is used to group all channels that are to be identified as belonging to a particular broadcast corporation (or a particular identifying number such as channel "12"). The minor channel number specifies a particular channel within the group. The VCT also contains a "carrier frequency" field, which is used to identify the frequency at which the DTV signal is transmitted and received. As discussed herein, TX and RX channel data include at least one of the following major channel number, minor channel number, carrier frequency, and/or other data necessary for generating a proper DTV signal.

When a RF DTV signal is translated to a new frequency by the conventional DTV translator 1 of FIG. 1, the PSIP table no longer reflects the correct carrier frequency. In many DTV receivers, this discrepancy between the actual frequency of the received DTV signal and the carrier frequency data contained in the PSIP table prevents the receiver from properly receiving the DTV signal.

Also, a particular broadcast corporation may be assigned different major/minor channel numbers in geographical regions serviced by each translator. For example, Broadcast Corporation #1 could be assigned major/minor channel 12/04 in region #1 (served by a main DTV transmitter) and major/minor channel 37/04 in region #2 (served by a translator translating the main DTV transmitted signal). The conventional translator of FIG. 1 therefore generates a translated DTV signal that contains an incorrect channel number for transmission into region #2.

Moreover, in region #2, major minor/channel 12/04 may have already been assigned to Broadcast Corporation #2. In that case, a single DTV receiver in region #2 will receive two unique channels (Broadcast Corporation #1 and Broadcast Corporation #2) each having the same major/minor channel number in each of their PSIP tables. While some DTV receivers overcome these anomalies by allowing users to select whether to ignore PSIP data or to display the VCT information, other DTV receivers do not have this capability and are unable to properly tune to the program(s) of one or both of the two Broadcast Corporations.

SUMMARY OF THE INVENTION

Accordingly, the present invention relates to a digital television translator, and more particularly to a digital television translator that updates the PSIP table with proper channel and carrier frequency information. To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, there is provided a digital television translator, comprising a digital television receiver for receiving a first digital television signal and generating a digital transport stream from the first digital television signal, the digital transport stream including original PSIP data having RX channel data; a PSIP update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data; and a digital television modulator for converting the digital transport stream having the updated PSIP data into a second digital television signal.

In another aspect of the instant invention, there is provided an information distribution network using digital television transmission, the information distribution network comprising a plurality of digital television transmission nodes including a main digital television signal source for generating a main digital television signal; and a plurality of digital television translators receiving a digital television signal from one of the plurality of digital television nodes, at least one of said plurality of digital television translators including a digital television receiver for receiving the digital television signal from one of the plurality of digital television nodes and generating a digital transport stream from the received digital television signal, the digital transport stream including original ancillary data and original PSIP data having RX data, a data update module for updating the original PSIP data in the digital transport stream by replacing the RX channel data with TX channel data and for replacing the original ancillary data in the digital transport stream with new ancillary data, and a digital television modulator for converting the digital transport stream having the new ancillary data and the updated PSIP data into a transmitted digital television signal, wherein at least two of the plurality of digital television transmission nodes transmit at the same frequency and the total ancillary data of the information distribution network includes the new ancillary data from multiple digital television translators of the plurality of digital television translators.

Additional features and advantages of the present invention will be set forth in the description that follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention that together with the description serve to explain the principles of the invention.

In the drawings:

FIG. **1** shows an example of a conventional DTV translator;

FIG. **2** shows a first embodiment of a DTV translator of the present invention having PSIP table update capability;

FIG. **3** shows an example of a PSIP update module;

FIG. **4** shows a second embodiment of a DTV translator of the present invention having both PSIP table update capability and a re-multiplexor;

FIG. **5** shows an example of the re-multiplexor; and

FIG. **6** shows an example of an information distribution network of the present invention using multiple translators.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

To overcome the problems associated with the prior art, i.e., tuning problems with some DTV receivers due to incorrect PSIP table information, the PSIP table information is updated by the translator to properly reflect the new transmit carrier frequency and channel number.

FIG. **2** shows a first embodiment of a DTV translator **10** of the present invention having PSIP table update capability. The DTV translator **10** includes an 8-VSB receiver **11**, a PSIP update module **12**, an 8-VSB modulator **13**, an RF power amplifier **14**, and a transmitting antenna **15**. The receiver **11** receives an 8-VSB DTV signal (RFi) that may have been originally transmitted by a base station or another translator, over the air or by a cable. The receiver **11** processes the DTV signal according to ASTC DTV standards to produce a digital transport stream (TS) containing MPEG2 video data, audio data, ancillary data, and PSIP data. The PSIP data in the digital transport stream includes a major channel number, a minor channel number, and a carrier frequency, which together make up the RX channel data. As shown, the receiver **11** is controlled by an input (RX Channel Select) which informs the receiver **11** of which carrier frequency channel to tune.

The processing of the received DTV signal by the 8-VSB receiver **11** is in accordance with ATSC DTV standards and, accordingly, can include down conversion, digitization, carrier synchronization, symbol clock synchronization, frame and segment synchronization, matched filtering, equalization, bit-demapping, Trellis decoding, convolutional de-interleaving, Reed-Solomon forward error correction (FEC) decoding, and de-randomizing.

The digital transport stream (TS) is then input into PSIP update module **12**. The PSIP update module **12** extracts the PSIP table data and updates the RX channel data with TX channel data. Specifically, the major channel number, the minor channel number, and the carrier frequency contained in the PSIP VCT are updated. Updated major and minor channel numbers are those numbers assigned to the broadcaster associated with the transport stream content for the geographical region covered by the DTV translator. Sometimes the original and updated channel numbers will be the same, for example when the translator is being used to fill in a poor reception area of the geographical area covered by the main transmitter. At other times, the original and updated channel numbers will be different, for example, when the translator is being used to extend coverage into a geographical area not covered by the main transmitter. In this instance, the broadcaster may be licensed to broadcast in the translator's geographical area, but at a different channel.

Also, the carrier frequency of the DTV signal transmitted from the translator must be reflected in the PSIP VCT. In most instances, the translator will transmit at a different frequency than it receives, requiring the PSIP VCT to be updated with the new transmitted carrier frequency. In some instances, the carrier frequency of the DTV signal can be transmitted at the same frequency that it is received, such as when the translator system is being used as an on-channel booster. In either instance, the updated PSIP table is then reinserted back into the digital transport stream.

Once the PSIP data is updated, the transport stream containing the updated PSIP data is then input into the 8-VSB modulator **13**. 8-VSB modulator **13** processes the digital transport stream according to ATSC DTV standards to produce a DTV signal (Rfo) at the carrier frequency contained in the VCT of the updated PSIP table data. As shown, 8-VSB modulator **13** is controlled by input (TX Channel Select) which informs the 8-VSB modulator **13** at which frequency to transmit the DTV signal. Alternatively, the 8-VSB modulator

can detect the carrier frequency information from the VCT of the DTV signal and transmit the DTV signal using the detected carrier frequency.

8-VSB modulator **13** processes the transport stream having the updated PSIP data according to ASTC terrestrial broadcast standards. Accordingly, this processing can include randomization, Reed-Solomon encoding, convolutional interleaving, symbol mapping, trellis encoding, and vestigial sideband filtering. After the digitally filtered signal is converted to an analog signal, the signal is up converted to a transmit RF signal (RFo) at the transmit frequency determined by TX channel select. The 8-VSB modulator **13** typically operates at a frequency of 54 MHZ-216 MHZ and 470 MHZ-806 MHZ and has a maximum output power of approximately 1 milliwatt. A power amplifier **14** and transmitting antenna **15** are usually added to the output of the 8-VSB modulator **13**.

FIG. **3** shows an example of PSIP update module **12**. The PSIP update module **12** includes an extractor **16** for extracting the original PSIP data, a PSIP update block **18** for replacing the major/minor channel number and carrier frequency contained in the PSIP table, and an inserter **17** for inserting the updated PSIP table data back into the transport stream. As shown, the PSIP table data is extracted by extractor **16** and input into the PSIP update block **18**. The PSIP update block **18** replaces the major/minor channel number and transmit carrier frequency contained in the VCT (a sub-table of the PSIP table) while retaining the other PSIP data. The PSIP update block **18** then substitutes an updated major/minor channel number and transmit carrier frequency into the VCT. Thereafter, the updated PSIP table data is re-inserted back into the digital transport stream via inserter **17**.

FIG. **4** shows a second embodiment of a DTV translator **20** of the present invention. The second embodiment includes an 8-VSB receiver **21**, a PSIP update module **22**, a re-multiplexor **23**, and an 8-VSB modulator **24**. Usually an RF power amplifier **25** and an antenna **26** are coupled to the 8-VSB modulator **24**. The structure and operation of the second embodiment is the same as the structure and operation of the first embodiment, except that a re-multiplexor **23** is added for introducing new ancillary data into the digital transport stream.

The digital transport stream containing original ancillary data and the updated PSIP table data is input into the re-multiplexor **23**. Re-multiplexor **23** substitutes new ancillary data in place of the original ancillary data in the digital transport stream. The digital transport stream is then sent to 8-VSB modulator **24** and converted into a DTV signal consistent with the operation as described in the first embodiment. In this way, each translator can distribute new ancillary data to user(s) in the translator's transmit range.

FIG. **5** is a block diagram of the re-multiplexor **23**, which comprises a demultiplexor **27** and a multiplexor **28**. As shown, the original ancillary data, video data, audio data, and updated PSIP table data is contained in the input digital transport stream, which is demultiplexed into separate bit streams by de-multiplexor **27**. The original ancillary data is terminated (discarded). The multiplexor **28** then combines the video data, the audio data, the updated PSIP data, and new ancillary data back into the output digital transport stream, which is then input to the 8-VSB modulator **24**.

The PSIP update step and the ancillary data insertion step are not required to take place in any particular order. For example, since the PSIP data has been separated into its constituent streams by demultiplexor **27** of re-multiplexor **23**, the PSIP table update step could take place in the re-multiplexor **23** by updating the major/minor channel number and carrier frequency. The updated PSIP table data could be reinserted into the digital transport stream by multiplexor **28**. Or, for example, the placement of the PSIP update module **22** and the multiplexor **23** could be reversed. Moreover, only a portion of the original ancillary data could be replaced with new ancillary data thereby allowing other portions of the ancillary data to be transmitted downstream by the translator.

The second embodiment allows DTV broadcasting stations to increase their data broadcasting capacity every time a DTV translator is added. For example, adding a DTV translator increases the number of users and increases the capacity for data transmission through employment of the new ancillary data, which permits the insertion of data, such as Internet data. Downstream Internet data can be inserted as new ancillary data by each translator and distributed to specific geographic regions and users without the need for additional bandwidth.

FIG. **6** shows an example of a third embodiment of the invention wherein an information distribution network **30** uses a plurality of translators to increase the data capacity of the network. As shown, a plurality of translators, collectively labeled **31***a*-**31** *d*, translate and distribute a DTV signal in both a star and daisy-chain configuration.

The first translator **31***a* receives a DTV signal, from a main digital television source, containing original ancillary data **0**, such as Internet download data at a frequency fo. Translator **31***a* inserts ancillary data **1** and discards original ancillary data **0**, and then retransmits the modified DTV signal having ancillary data **1** at a frequency f1. User **32***a* receives ancillary data **1** from translator **31***a*. A second DTV translator **31***b* receives the translated DTV signal from translator **31***a* at a frequency of f1, substitutes ancillary data **2** for ancillary data **1**, and then retransmits at a frequency f2. User **32***b* receives the DTV signal transmitted from translator **31***b* along with ancillary data **2**. User **32***d* also receives ancillary data **1** from translator **31***a*. A third DTV translator **31***c* receives the translated DTV signal from translator **31***b* at a frequency of f2, substitutes ancillary data **3** for the ancillary data **2**, and retransmits at a frequency f1. User **32***c* receives the DTV signal transmitted from translator **32***c* along with ancillary data **3**. DTV translators **31***a*, **31***b*, and **31***c* are thus configured in a daisy-chain fashion with translators **31***a* and **31***c* being endpoints.

Further, a fourth DTV translator **31***d* receives the translated DTV signal from translator **31***a* at a frequency of f1, substitutes ancillary data **4** for ancillary data **1**, and then retransmits at a frequency f4. User **32***d* receives the DTV signal transmitted from translator **31***d* along with ancillary data **4**. DTV translators **31***a*, **31***b*, and **31***d* are thereby configured in a star fashion with DTV translator **31***a* configured as a hub. Moreover, a variety of translator topologies can be employed to transmit unique ancillary data to each of a very large number of users, or a group of users, without requiring an increase in the bandwidth of any single translator's transport stream or physical RF channel.

Even more efficient use of bandwidth can be achieved by allowing multiple translators to use the same transmit frequencies, as does translators **31***a* and **31***c*. Translators can be placed in any number of configurations to increase the data capacity of the DTV distribution network. Furthermore, the use of a PSIP update model in each of the translators can insure proper DTV reception.

Moreover, while the embodiments described herein can be implemented via current ASTC standards, it is contemplated that other DTV standards or a modified ASTC standard could be readily employed to realize the present invention. Further, while the video data on the digital transport stream can be

MPEG2 standard video data, as described herein, the invention contemplates using variations of MPEG2 standard data in the digital transport system.

As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the meets and bounds of the claims, or equivalence of such meets and bounds are therefore intended to be embraced by the appended claims.

What is claimed is:

1. A method of translating, comprising:

receiving an ATSC digital television signal over the air;

converting the ATSC digital television signal into a first digital transport stream, the first digital transport stream containing video and audio data of a program and a program information table, the program information table having a major channel number and a minor channel number;

generating a new program information table containing a new channel number, the new channel number identifying the program represented by the major channel number and the minor channel number; and

combining the video and audio data with the new program information table.

2. The method of claim 1, wherein combining includes inserting the new program information table into a transport stream containing the video and audio data.

3. The method of claim 1, wherein new ancillary data is combined with the video data, the audio data, and the new program information table.

4. The method of claim 3, wherein a portion of original ancillary data present in the first digital transport stream is combined with the video data, the audio data, and the new program information table.

5. A method of translating, comprising:

receiving an ATSC digital television signal over cable;

converting the ATSC digital television signal into a first digital transport stream, the first digital transport stream containing video and audio data of a program and a program information table, the program information table having a major channel number and a minor channel number;

generating a new program information table containing a new channel number, the new channel number identifying the program represented by the major channel number and the minor channel number; and

combining the video and audio data with the new program information table.

6. The method of claim 5, wherein the combining includes inserting the new program information table into a transport stream containing the video and audio data.

7. The method of claim 5, wherein new ancillary data is combined with the video data, the audio data, and the new program information table.

8. The method of claim 7, wherein a portion of original ancillary data present in the first digital transport stream is combined with the video data, the audio data, and the new program information table.

9. A method of translating, comprising:

receiving an ATSC digital television signal over the air;

converting the ATSC digital television signal into a first digital transport stream, the first digital transport stream containing video and audio data of a program and a program information table, the program information table having a major channel number and a minor channel number;

generating a new program information table containing a new channel number, the new channel number identifying the program represented by the major channel number and the minor channel number; and

multiplexing the new program information table, the video, and the audio data.

10. The method of claim 9, further comprising multiplexing new ancillary data with the new program information table, the video, and the audio data.

11. The method of claim 10, further comprising multiplexing a portion of original ancillary data present in the first digital transport stream with the new program information table, the video, and the audio data.

12. A method of translating, comprising:

receiving an ATSC digital television signal over cable;

converting the ATSC digital television signal into a first digital transport stream, the first digital transport stream containing video and audio data of a program and a program information table, the program information table having a major channel number and a minor channel number;

generating a new program information table containing a new channel number, the new channel number identifying the program represented by the major channel number and the minor channel number; and

multiplexing the new program information table, the video, and audio data.

13. The method of claim 12, further comprising multiplexing new ancillary data with the new program information table, the video, and audio data.

14. The method of claim 13, further comprising multiplexing a portion of original ancillary data present in the first digital transport stream with the new program information table, the video, and audio data.

15. A method of translating, comprising:

selecting a carrier frequency;

receiving an ATSC digital television signal at the selected carrier frequency;

down-converting the received ATSC digital television signal;

digitizing the down-converted ATSC digital television signal;

converting the digitized ATSC digital television signal into a first digital transport stream, the first digital transport stream containing video and audio data of a program and a program information table, the program information table having a major channel number and a minor channel number;

generating a new program information table containing a new channel number, the new channel number identifying the program represented by the major channel number and the minor channel number;

combining the new program information table, the video and audio data; and

transmitting the combined new program information table, video data, and audio data over an antenna.

16. The method of claim 15, wherein the combining includes inserting the new program information table into a transport stream containing the video and audio data.

17. The method of claim 15, wherein ancillary data is combined with the video data, the audio data, and the new program information table.

18. The method of claim 17, wherein a portion of original ancillary data present n the first digital transport stream is combined with the new program information table, the video and audio data.

19. A method of translating, comprising:

selecting a carrier frequency;

receiving an ATSC digital television signal at the selected carrier frequency;

down-converting the received ATSC digital television signal;

digitizing the down-converted ATSC digital television signal;

converting the digitized ATSC digital television signal into a first digital transport stream, the first digital transport stream containing video and audio data of a program and a program information table, the program information table having a major channel number and a minor channel number;

generating a new program information table containing a new channel number, he new channel number identifying the program represented by the major channel number and the minor channel number;

multiplexing the new program information table, the video and the audio data into a second digital transport stream;

converting the second digital transport stream into an analog signal;

up-converting the analog signal to an RF signal at a selected transmit frequency;

amplifying the RF signal; and

transmitting the RF signal over an antenna.

20. The method of claim 19, further comprising multiplexing new ancillary data with the video data, the audio data, and the new program information table to form the second digital transport stream.

21. The method of claim 20, further comprising multiplexing a portion of original ancillary data present in the first digital transport stream with the video data, audio data, and the new program information table.

* * * * *

EXHIBIT E

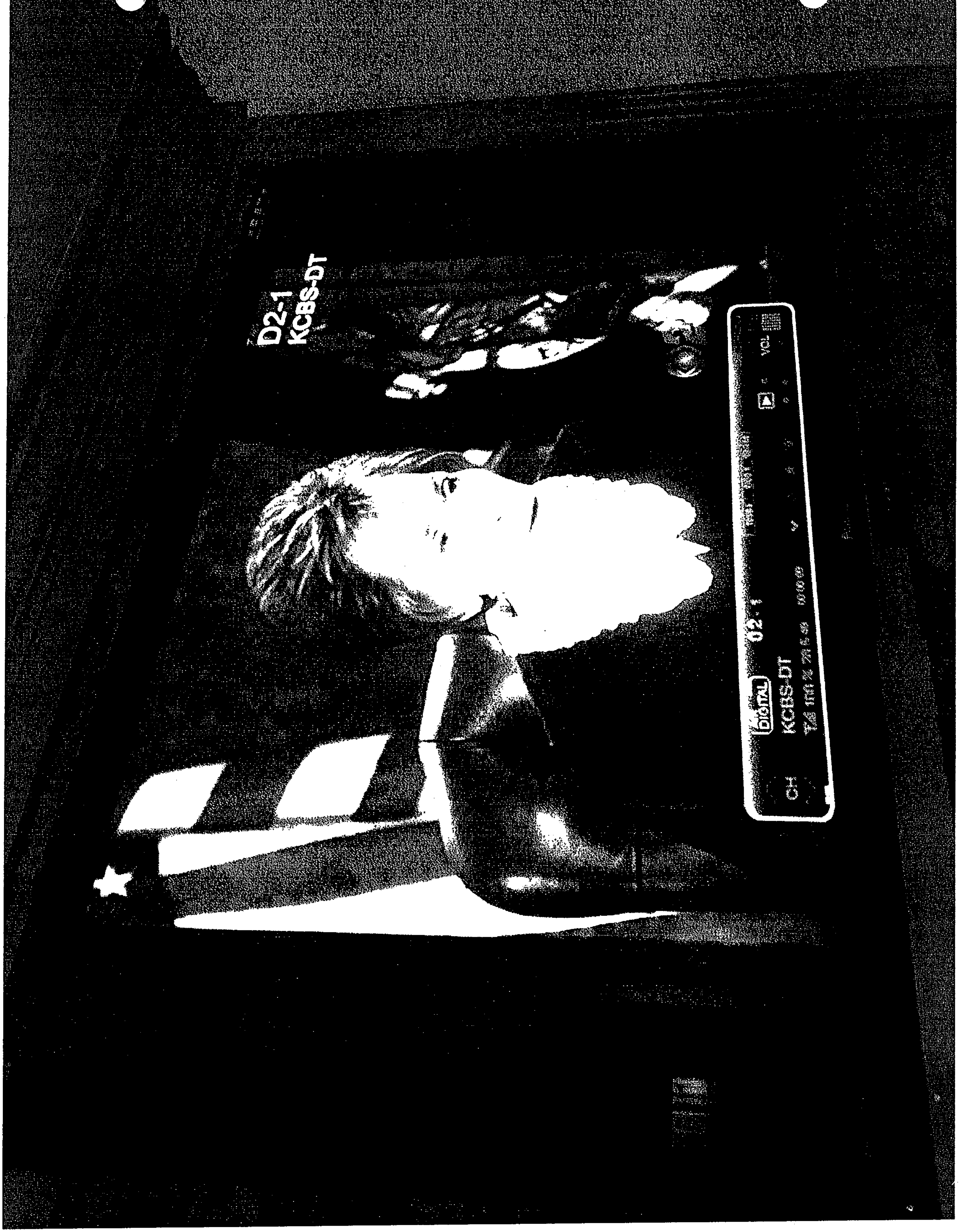
D2-1
KCBS-DT
DIGITAL
02-1
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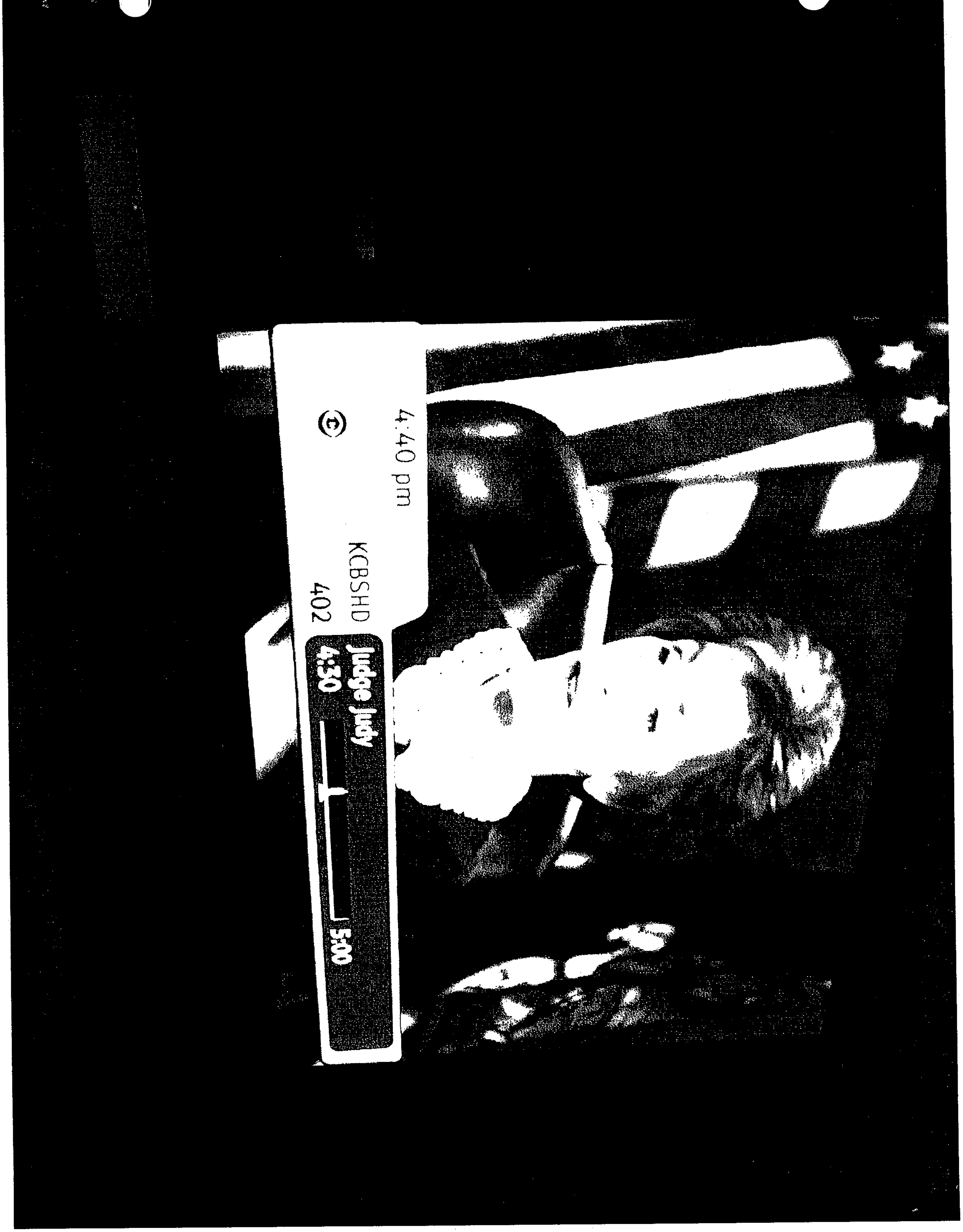
EXHIBIT F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Judge Judy
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