Title: A CICAM SYSTEM FOR PROCESSING MULTIPLE PROGRAMME TRANSPORT STREAMS

Abstract: The present invention allows for bandwidth-efficient processing of multiple programme transport stream broadcasts in a watch-and-record configuration within a system using Common Interface-type conditional access module to process the encrypted broadcasts. The goal of the invention is achieved through management of the selected programmes either through pre-processing of the multiple programme transport stream and efficient management of the information to be sent through the CI+ interface.
A CICAM SYSTEM FOR PROCESSING MULTIPLE PROGRAMME TRANSPORT STREAMS

TECHNICAL DOMAIN

The present invention pertains to the domain of reception, decryption and display of conditional access digital media content, especially in systems configured to operate according to a Common Interface Standard such as CI+.

STATE OF THE ART

Figure 1 shows a state of the art system for receiving and decrypting conditional access content for display and/or storage of the decrypted conditional access content. In this case a transport stream is received via a tuner, the transport stream comprising multiple programmes. For simplicity Figure 1 shows the transport stream comprising two programmes. As is known in the state of the art, the transport stream comprises data packets, the data packets having a header and a payload. The content is comprised in the payload and information allowing the packet to be identified is comprised in the header, an example of such information being a process ID (PID).

The tuner may be part of a host device for rendering the content and as such the host device may further comprise a de-multiplexer and a display device. In this example the host device further comprises a storage device to store decrypted content. A conditional access module (CICAM) may be connected to the host device to allow the content to be decrypted. The connection may be compliant with one of the generally known Common Interface Standards such as CI+.

The tuner receives the MPTS transport stream (Multiple Program Transport Stream) and sends the MPTS to the CICAM which decrypts the programme which is currently selected by the host device, say P1. The CICAM returns the MPTS but with the selected programme (P1) decrypted. According to the CI+ Standard the decrypted programme may be protected using the CI+ so-called “Link Protection”.

The MPTS is then sent to the de-multiplexer, which selects the appropriate tracks or packets which are related to the selected programme, thanks to the PIDs.
The selected tracks are sent for display on the display device. The same tracks may also be recorded on the storage device.

The architecture thus described in Figure 1 is therefore subject to the disadvantage that only the programme selected for viewing can be viewed. Such a system is disclosed in United States Patent Application Publication number US2006143448A.

Other systems are known in the state of the art, which offer so-called watch-and-record features. A system such as this is illustrated in Figure 2. In this system the host device comprises two tuners. Each of the tuners can receive a MPTS. One way to use the system is to multiplex the two received MPTS together and to send the multiplexed transport streams to the CICAM. This type of operation is known and is currently implemented in systems designed to comply with an M-Card Standard.

In Figure 2 a first tuner and a second tuner are shown. Generally these tuners would be comprised in a host device. As is typical for such systems, it further comprises a conditional access module (CAM), a storage means (HDD) and a display. Generally the display would be comprised within the host device and the CAM would be comprised within a module which is detachable from the host device. The first tuner receives a first multi programme transport stream (MPTS) and the second tuner receives a second (MPTS). A first programme to be viewed is available from the first tuner (i.e. within the first MPTS) and a second programme to be recorded, different from the first programme, is available from the second tuner. The host therefore receives a command to select the first and second programmes for viewing and for recording, respectively. The system further comprises a module called an M-Muxer, which allows two MPTS to be multiplexed together. The M-Muxer is generally part of the host device. The first and second MPTS are multiplexed together using the M-Muxer and the thus multiplexed MPTSs are sent to the CAM. The CAM descrambles the programme selected for viewing and the programme selected for recording and returns the descrambled multiplexed MPTSs to the host device where a M-deMuxer is available to split the multiplexed MPTSs back into two M-deMuxed MPTSs. Since in a standard host device adapted to display a programme from an MPTS a demux is required to filter the selected programme for display, the host device in Figure 2 comprises two demuxes, one for each M-
deMuxed MPTS. The first programme to be viewed is then selected by a first demux from the first M-deMuxed MPTS and sent to the display while the second programme to be recorded is selected from the second M-deMuxed MPTS by a second demux and sent to be recorded onto the HDD.

The M-Muxer adds overhead to each transport packet. This overhead comprises the identification of the MPTS to which the transport packet pertains. This allows for PID collisions to be avoided. This overhead also includes some timing information which allows for accurate MPTS deconstruction at the output of the M-DeMuxer. A system incorporating the solution thus described is commercially available in chipsets such as “CiMax+”, marketed by SmarDTV.

Unites States Patent Application Publication number US2009016349A describes a system such as the one illustrated in Figure 2.

Systems such as the one shown in Figure 2 do however present a problem in that the overall bandwidth required over the CI+ transport stream interface is twice the maximum bit-rate of the MPTS available from the tuner output. With first generation broadcast Standards such as DVB-T, DVB-C and DVB-S, for example, the MPTS maximum bit-rate is around 40Mbits/s for a single transport stream, which allows for two transport streams to cross the CI+ TS interface (96Mbits/s). Next generation broadcast Standards such as DVB-T2, DVB-C2 and DVB-S2, for example, can operate at up to 140Mbit/s for a single MPTS thereby breaching by far the maximum capabilities of the CI+ transport stream interface.

BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to overcome at least some of the problems which exist in the present day solutions for recording and watching at least one programme from a multiple programme transport stream broadcast.

According to a first aspect of the present invention, provision is made for a system for selecting and decrypting at least a first encrypted programme content and a second encrypted programme content, said contents being selected from at least a first transport stream and a second transport stream, each of the transport streams complying with a multi-programme-per-transport-stream specification, the first
transport stream comprising the first encrypted programme and a third encrypted programme, the second transport stream comprising the second encrypted programme and a fourth encrypted programme, the system comprising:

a host device; and

a conditional access module to decrypt the selected encrypted programme contents;

the host device comprising:

a first tuner to receive the first transport stream;

a second tuner to receive the second transport stream;

a first demultiplexer; and

a second demultiplexer;

the system **characterised in that:**

the first demultiplexer is configured to select the first encrypted programme content from the first transport stream; and

the second demultiplexer is configured to select the second encrypted programme content from the second transport stream;

the conditional access module thereby receiving only the selected programme contents.

According to a second aspect of the present invention, there is provided a method for selecting and decrypting at least a first encrypted programme content and a second encrypted programme content, said contents being selected from at least a first transport stream and a second transport stream, each of the transport streams complying with a multi-programme-per-transport-stream specification, the first transport stream comprising the first encrypted programme and a third encrypted programme, the second transport stream comprising the second encrypted programme and a fourth encrypted programme, the method using a system comprising a host device for receiving the first and second transport streams and a conditional access module for decrypting the selected encrypted programme contents, the method comprising:

selecting, in the host device, the first encrypted programme content;

selecting, in the host device, the second encrypted programme content;

sending only the selected encrypted programme contents to the conditional access module for decryption.
According to a first embodiment of the present invention, only the programmes of interest are sent through the CI+ (Common Interface Plus) TS interface (transport stream interface). According to this embodiment, the two MTPSs are first demuxed to give two single programme transport streams (SPTS), each having being filtered by their respective demuxes to include only the programmes of interest. The M-Muxer is then used to multiplex the two programmes of interest, which are sent through the CI+ interface to the CAM. The M-DeMuxer is then used to separate the first programme for viewing from the second programme for recording.

According to a second embodiment of the present invention, the TS CI+ interface is shared over time between the programmes to be decrypted. As in the first embodiment, the idea is to have SPTSSs rather than MTPSs being sent across the CI+ interface, but instead of using M-Muxer to multiplex the SPTSSs (after demuxing the received MPTSSs as above), a scheduler is used to schedule injection of either the first or the second SPTS through the CI+ interface at a given time.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The present invention will be better understood thanks to the detailed description which follows and the accompanying drawings, which are given as non-limiting examples of embodiments of the invention, namely:

- Figure 1, which shows a state-of-the-art configuration for handling two MPTSSs;
- Figure 2, which shows an alternative state-of-the-art configuration for handling two programmes from two MPTSSs;
- Figure 3, showing a system in which an embodiment of the present invention may be deployed; and
- Figure 4, showing a system in which a further embodiment of the present invention may be deployed.

**DETAILED DESCRIPTION**

Figure 3 shows a system in which a first embodiment of the present invention may be deployed. As can be seen, the system makes use of a M-Muxer (MMUX) and a M-DeMuxer (MDMX), as does a known system such as the CiMax+ system of the state-of-the-art. However, according to the embodiment, these modules are used to process two single programme transport streams (SPTS) instead of two multiple
programme transport streams (MPTS). This is made possible because the system includes the demuxes at the beginning part of the chain, after the reception of the MPTS broadcasts by the two tuners, to perform a first filtering of the MPTSs in order to select only the programmes of interest, thus allowing for a more efficient use of the available bandwidth of the CI+ interface.

As shown in the system of Figure 3, the system comprises two tuners (T1, T2), usually comprised in a host device, a first tuner (T1) to receive a first multiple programme transport stream broadcast (MTPS1) and a second tuner (T2) to receive a second multiple programme transport stream broadcast (MTPS2). Two demuxes (D1, D2) are used, one for each transport stream (MPTS1, MPTS2), to filter out a first programme (P1.1E) selected by a viewer for watching and a second programme (P2.0E) selected by the viewer for recording for example. The selected, encrypted programmes (P1.1E, P2.0E) comprised in what are effectively two single programme transport streams (SPTS), are sent to an M-Muxer (MMUX) to create a M-Mux comprising the two programmes which is then sent to the conditional access module (CAM). After decryption of the two encrypted programmes by the CAM, the two decrypted programmes (P1.1D, P2.0D) are sent to an M-DeMuxer (MDMX) which separates the two programmes and sends one to the display (DISP) and one to a recorder to be stored in a storage device (HDD).

The embodiment thus described provides for efficient use of the CI+ bandwidth since only a mux of two single programme transport streams comprising only the content of interest is made over the CI+ interface rather than a mux of multiple programme transport streams comprising programmes which are not of interest.

Figure 4 shows a system in which a second embodiment of the present invention may be deployed. According to this embodiment, the two demuxes (D1, D2) are used to filter out the first programme (P1.1E) for watching and the second programme (P2.0E) for recording, just as was done in the previous embodiment. However, instead of using the M-Muxer to multiplex the two SPTSs the systems comprises a first injection scheduler to switch from one SPTS to the other SPTS, injecting the two programmes into the CI+ interface towards the CAM, thereby sharing the use of the interface by the two programmes. A first buffer (B1) and a
second buffer (B2) are used between the demuxes and the first injection scheduler to store the SPTSs ahead of the scheduler. The first scheduler is configured to decide when to switch from one SPYS to the other when injecting into the CI+ interface. In order to compensate for any jitter in the viewing programme which may be introduced using the method adopted by this system, the system further comprises a third buffer, downstream from the CAM and after the CI+ interface, to store the decrypted programme for viewing and yet further comprises a regulator (REG) configured to reproduce a PCR-accurate SPTS for display. Reproducing a PCR-accurate SPTS may involve re-timing by overwriting at least some of the PCR values in the data packets within the SPTS.

As shown in Figure 4, the system comprises a first tuner (T1) and a second tuner (T2) to receive a first MPTS (MPTS1) and a second MPTS (MPTS2), respectively. The first tuner output is demuxed by a first demux (D1) to give a first SPTS (SPTS1) comprising the encrypted first programme, selected for viewing (P1.1E), without any other programmes. The second tuner output is demuxed by a second demux (D2) to give a second SPTS (SPTS2) comprising the encrypted second programme, for recording (P2.0E), without any other programmes. The output of the first demux is stored in a buffer (B1), preferably a FIFO buffer, and the output of the second demux is stored in a second buffer (B2), also preferably a FIFO buffer. A first host injection scheduler monitors the filling level of the two buffers and thereby determines when to switch injection to the CI+ transport stream interface between the first buffer and the second buffer. The CAM receives the injected transport stream via the CI+ interface and decrypts the programmes comprised therein, namely P1.1E and P2.0E to give a decrypted first programme, for viewing (P1.1D) and a decrypted second programme for recording (P2.0D). A second injection scheduler separates the two decrypted programmes from the transport stream coming from the CAM and stores the second programme into the storage device (HDD). The scheduler further sends the first decrypted programme to a third buffer (B3), again preferably a FIFO buffer. A host regulator takes the programme content from the third buffer for display on the display unit (DISP) and provides any corrections necessary on the PCR values within the data packets in the programme in order to provide a PCR-accurate SPTS to the display unit. It is to be understood that the first and second injection schedulers may form part of one single injection
scheduler module performing the functions of injection scheduling as described above.

The solution provided by this embodiment has the advantage that the system does not require the use of an M-Muxer or a M-DeMuxer, both of which may be rather complex. The solution is compatible with the present specifications of CI+ and so an off-the-shelf CAM capable of performing dual programme decryption may be used.

In the case that the two programmes to be decrypted have overlaps in the list of process IDs (PID) in the data packets, then the injection scheduler forces a simulated channel change each time it switches from one SPTS to the other. This is because the decryption keys (control words) are associated with the PIDs. The channel change forces the CICAM to re-evaluate the PMT and thereby to re-programme the decryption modules with the keys corresponding to the selected programme.
CLAIMS

1. A system for selecting and decrypting at least a first encrypted programme content and a second encrypted programme content, said contents being selected from at least a first transport stream and a second transport stream, each of the transport streams complying with a multi-programme-per-transport-stream specification, the first transport stream comprising the first encrypted programme and a third encrypted programme, the second transport stream comprising the second encrypted programme and a fourth encrypted programme, the system comprising:
   a host device; and
   a conditional access module to decrypt the selected encrypted programme contents;

   the host device comprising:
   a first tuner to receive the first transport stream;
   a second tuner to receive the second transport stream;
   a first demultiplexer; and
   a second demultiplexer;

   the system characterised in that:
   the first demultiplexer is configured to select the first encrypted programme content from the first transport stream; and
   the second demultiplexer is configured to select the second encrypted programme content from the second transport stream;

   the conditional access module thereby receiving only the selected programme contents.

2. The system according to claim 1, wherein the host device further comprises a multiplexer to multiplex the selected encrypted programme contents into a third transport stream for sending to the conditional access module, the third transport stream complying with the multi-programme-per-transport-stream specification.

3. The system according to claim 1, wherein the host device further comprises a first buffer and a second buffer to store the selected first and second encrypted programme contents, respectively, the host further comprising a scheduler to alternatively schedule part of the stored selected first encrypted programme content
and part of the stored selected second encrypted programme content, respectively, for decryption by the conditional access module.

4. A method for selecting and decrypting at least a first encrypted programme content and a second encrypted programme content, said contents being selected from at least a first transport stream and a second transport stream, each of the transport streams complying with a multi-programme-per-transport-stream specification, the first transport stream comprising the first encrypted programme and a third encrypted programme, the second transport stream comprising the second encrypted programme and a fourth encrypted programme, the method using a system comprising a host device for receiving the first and second transport streams and a conditional access module for decrypting the selected encrypted programme contents, the method comprising:

selecting, in the host device, the first encrypted programme content;
selecting, in the host device, the second encrypted programme content;
sending only the selected encrypted programme contents to the conditional access module for decryption.

5. The method according to claim 4, the method further comprising multiplexing the selected encrypted programme contents into a third transport stream complying with the multi-programme-per-transport-stream specification for sending to the conditional access module.

6. The method according to claim 4, the method further comprising:
buffering the selected first encrypted programme content in a first buffer;
buffering the second encrypted programme content in a second buffer; and
alternatively selecting encrypted content for sending to the conditional access module from the first buffer and the second buffer, respectively.
Figure 1: PRIOR ART

Figure 2: PRIOR ART
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. H04N21/426  H04N21/434  H04N21/436

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:
  - "A" document defining the general state of the art which is not considered to be of particular relevance
  - "E" earlier application or patent but published on or after the international filing date
  - "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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  - "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- "Z" document member of the same patent family

Date of the actual completion of the international search: 12 July 2013

Date of mailing of the international search report: 19/07/2013

Name and mailing address of the ISA/European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-3040, Fax: (+31-70) 340-3016

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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
<tr>
<td>A</td>
<td>JAE-GON KIM ET AL: &quot;DESIGN AND IMPLEMENTATION OF AN MPEG-2 TRANSPORT STREAM MULTIPLEXER FOR HDTV SATELLITE BROADCASTING&quot;, 19980801, vol. 44, no. 3, 1 August 1998 (1998-08-01), pages 672-678, XP011083659, section III.C figure 1</td>
<td>3,6</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
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<tr>
<td>EP 1463320 A2</td>
<td>29-09-2004</td>
<td>CN 1543216 A</td>
</tr>
<tr>
<td>EP 1463320 A2</td>
<td>29-09-2004</td>
<td>GB 2399972 A</td>
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<tr>
<td>GB 2399972 A</td>
<td>29-09-2004</td>
<td>KR 20040084828 A</td>
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<tr>
<td>KR 20040084828 A</td>
<td>06-10-2004</td>
<td>US 2004252833 A1</td>
</tr>
<tr>
<td>WO 03058950 A1</td>
<td>17-07-2003</td>
<td></td>
</tr>
<tr>
<td>US 7508454 B1</td>
<td>24-03-2009</td>
<td>NONE</td>
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