## **Encoder Software Implementation**



Updated 8/27/09

The Caption Encoder connects to the Digital Cinema Server over Ethernet. Commands are sent by the DCS using SMPTE 430-10 v 0.91. Based on commands received from the DCS, the caption encoder fetches and parses one or more Auxiliary Resources Presentation Lists (SMPTE 430-11 v 0.51) and Timed Text files (SMTPE 428-7) as constrained by SMPTE 428-10.

The general operation and flow of data is as follows:

- 1. The system has four FIFO buffers and a linear buffer. Three of the FIFO buffers hold caption packets ready for transmission over IR, IEEE 802.11, or Rear Window. These include the text of the caption along with various attributes, such as time in, time out, and the playout ID of the RPL that was used in fetching the caption. The packet transmission code uses time in and time out to determine when to transmit a packet. A caption packet is transmitted from the time out of the previous caption to the time out of the current caption. If the timeline playout ID does not match the playout ID in a particular caption packet, that packet is discarded. This repeats until a caption packet with a playout ID that matches the playout ID in the timeline messages is present. The fourth FIFO holds RPL records. An RPL record may be either an RPL URL (received in a CSP message), or may be a resource file URL and associated data (timeline offset, etc.) that was parsed from an RPL. Over 1,000 RPL records can be held in this FIFO.
- 2. The system watches for data to be present in the RPL FIFO. If there is data, it fetches the RPL record. If the RPL record holds an RPL URL (which was put in the FIFO by the CSP code), the system fetches the RPL referenced by the URL, parses the file, putting the resulting RPL records back in the RPL FIFO. Note that these RPL records also have a playout ID that was received during the CSP transmission of the RPL URL. Prior to parsing an RPL, the file is scanned for language references for the resource files. Caption streams (and caption FIFOs) are assigned in the order based on the language priority set in the system configuration screen. The stream number (corresponding to a language) is stored in the RPL record when that is a timed text record.
- 3. If, after fetching an RPL record from the RPL FIFO, the system finds the record holds a resource file URL (the URL of a timed text file), the referenced file is fetched and parsed. The parsed output is caption packets that go to one of the three caption FIFOs, the decision of which is based on the language associated with the file.
- 4. The Timed Text file is parsed in to individual captions. Packets for transmission are formed for each caption. These packets include, along with the text and text formatting info, the Time In, Time Out, language, and Playout ID (from the RPL). These packets are put in a separate FIFO for each language. Parsing is held off when a particular FIFO is half full.
- 5. At the Time Out of a caption, the next caption is transferred in to the final transmit buffer for that language. There is a linear buffer for each language plus another buffer for the transmission of timeline information. When a caption is transferred in to the buffer, the current transmission is abandoned (since the buffer contents changed mid-transmission). A break is sent to tell the receivers to abandon reception of the current packet. Transmission resumes with the transmission of the timeline packet followed by a packet for each language. This sequence is repeated until another caption is transferred in to the final packet buffer.

The overall flow of data can be interrupted in two ways. The first method is a discontinuity in the timeline. It is possible for the DCS to cause the timeline to jump. The timeline may jump backwards if a program is looping. The timeline may jump forwards to exit a loop. In either case, the next caption packet in the packet FIFO is not the appropriate one to transmit.

If the timeline jumps back, the FIFO output pointer is reset to point to the oldest packet that has already been transmitted but is still in the FIFO. Operation returns to normal where each packet is put in the final output buffer, then overwritten by a new one until the appropriate caption packet is in place for transmission. There is a possibility that the caption is too old to remain in the FIFO. In that case, the RPL FIFO would be reset and each timed text file reloaded to refill the packet FIFO. This seems unlikely to be required, though. Current testing indicates the packet FIFO can hold about four reels of captions for three languages before the FIFOs are half full. The FIFO would not discard any data until it is half full of data to be sent and half full of data that has been sent, with the current position in the middle. Using the four reel figure, with each reel being about 20 minutes, we can loop back 80 minutes without having to reload the FIFO.

If the timeline jumps forward, the system acts normally, loading the transmit buffer from the FIFO, looking at the Time Out, then loading the next record from the FIFO. Normally this happens every second or two. With a forward timeline jump, it happens very quickly until the current timeline position is less than the Time Out of the currently loaded caption packet.

The second method the flow of data can be interrupted is due to a change in the Playout ID presented in the update timeline CSP (Content Synchronization Protocol) message.

Each caption packet in the packet FIFOs (and the transmit buffers) includes the Playout ID that was read from the RPL that caused this caption file to be loaded.

If, after moving the packet from the FIFO to the transmit buffer, the Playout ID in the transmit buffer matches the Playout ID in the latest update timeline message, the "transfer time" is set to the Time Out of this packet. The transfer time is the edit unit (frame) count when we will next move a caption from the FIFO to the transmit buffer. We do this at the Time Out of the current caption.

If, however, the Playout ID does not match, the transfer time is set to zero. This results in packets being transferred from the FIFO to the transmit buffer, then immediately getting overwritten with another caption from the FIFO. This continues until there is a Playout ID match. As the caption packet FIFO is drained, it will be filled again from additional timed text files as referenced by RPL records still in the RPL FIFO. A log message indicates discarded IR packets due to playout ID mismatch.

The system is designed to allow a LARGE number of RPLs (over 1,000 RPL records from one or more RPL files) to be stacked in the system. The system is largely driven by the RPL FIFO. If there is data, it is fetched. This results in either the fetching and parsing of an RPL (with results going back in to the RPL FIFO), or fetching and parsing of a timed text file (with results going in the caption packet FIFOs).

Each time an RPL record is fetched, the playout ID of that record is compared to the last abandoned playout ID. The abandoned playout ID is set when to the playout ID of a caption packet when it is discovered that it does not match that of the timeline. Since playout IDs are not required to be in order, we cannot rely on a lower playout ID meaning it refers to older content. When we're outputting captions and the timeline playout ID suddenly changes, we know the old one was abandoned. RPL records with a playout ID that matches the abandoned playout ID are discarded before loading either the referenced RPL or timed text file. If abandonment of all fetched data is desired, it is suggested that the DCS send a Terminate Lease request.

In response to a status request message, the caption encoder will return one of the following codes

0	RRP Success, captions ready
4	Lease has expired
10	ACS Processing. This is the case if captions are not ready for all assigned languages. The text describes what the ACS is doing.

All CSP responses include a status word and a text string. The text string in USL ACS responses starts with a hex number indicating the overall status of the system. This is a bitmap of the status. The bits are assigned

of the status. The bits are assigned		
0	Connected to server	
1	Announce request received	
2	Lease active	
3	Fetching RPL	
4	Parsing RPL	
5	Fetching timed text	
6	Parsing timed text	
7	Stream 0 assigned	
8	Stream 1 assigned	
9	Stream 2 assigned	
10	Language 0 captions ready	
11	Language 1 captions ready	
12	Language 2 captions ready	
13	Caption transfer (toggles every time a caption is transferred into the transmit buffer)	

```
14 Output mode enabled
```

## Below are some USL ACS responses

Note that the hex number included in the status string is 0x0003. The two lsb are set indicating we are connected to the ACS and the announce message has been received.

Note that the hex number is 0x0007. The three lsb are set indicating we are connected to the ACS, the announce message has been received, and we have an active lease.

This is the response to a set output mode to disabled request. The status word is still 0x07.

The hex number is 0x4007. Bit 14 has been set, indicating that the output mode has been enabled.

Here, bit 14 and the 3 lsb are set. The output mode is enabled, we have a valid lease, we have received the announce message, and we are connected to the server.

Bits 14, 3, 2, 1, and 0 are set. The output mode is enabled, we are fetching an RPL, the lease is active, the announce request has been received, and we are connected to the server.

Bits 14, 2, 1, and 0 are set. The output mode is enabled, the lease is active, the announce request has been received, and we are connected to the server. Note that we have stopped fetching the RPL. We we are probably checking the RPL to make sure it is complete (has an end tag).

Bits 14, 9, 8, 7, 4, 2, 1, and 0 are set. The output mode is enabled, streams 2, 1, and 0 are assigned (language tracks have been assigned to these IR data streams), the RPL is being parsed, the lease is active, the announce request has been received, and we are connected to the server.

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Bits 14, 9, 8, 7, 5, 2, 1, and 0 are set. The output mode is enabled, all three streams are assigned, a timed text file is being fetched, the lease is active, the announce request has been received, and we are connected to the server.

```
00000285 06 0e 2b 34 02 05 01 01 02 07 02 02 0b 00 00 00 ...+4.... 00000295 83 00 00 21 00 0a 25 db 00 83 00 00 18 30 78 34 ...!..% .....0x4 000002A5 33 38 37 20 54 69 6d 65 6c 69 6e 65 20 75 70 64 387 Time line upd 000002B5 61 74 65 64 00
```

Bits 14, 9, 8, 7, 2, 1, and 0 are set. The output mode is enabled, all three streams are assigned, the lease is active, the announce request has been received, and we are connected to the server. Note that we are no longer fetching the timed text file. We are probably checking to make sure we got the full file.

Bits 14, 9, 8, 7, 6, 2, 1, and 0 are set. The output mode is enabled, all language streams are assigned, we are parsing the timed text, the lease is active, the announce request has been received, and we are connected to the server.

```
00000F5B 06 0e 2b 34 02 05 01 01 02 07 02 02 0b 00 00 00 ...+4.... 00000F6B 83 00 00 21 00 0a 26 57 00 83 00 00 18 30 78 34 ...!.&W .....0x4 00000F7B 66 63 37 20 54 69 6d 65 6c 69 6e 65 20 75 70 64 fc7 Time line upd 00000F8B 61 74 65 64 00 ated.
```

Bits 14, 11, 10, 9, 8, 7, 6, 2, 1, 0 are set. The output mode is enabled, streams 1 and 0 are ready (data is in their output buffers), all three streams have assigned languages, timed text is being parsed, the lease is active, an announce message has been received, and we are connected to the server.

Bits 14, 12, 11, 10, 9, 8, 7, 6, 2, 1, and 0 are set. The output mode is enabled, streams 2, 1, and 0 are ready (data in output buffers), all three streams have assigned languages, timed text is being parsed, the lease is active, we have received the announce message, and we are connected to the server.

## **Status Responses**

The ACS generally responds with a status code as per 6.4.1 of the CSP specificatio for that particular Request Response Pair. This is done since it is not possible to return more than one status at a time. The above described hex codes allow for the return of multiple status bits, giving a full indication of the status of the system. However, the response to a GetStatus request (0x02, 0x04), returns either 0 (RRP Successful) or 0x0a (Processing - ACS busy getting or interpreting resources). A 0 is returned if the ACS is ready for the movie to start. An RPL with a PlayoutID corresponding to the PlayoutID in the timeline messages has been fetched and parsed. The Timed Text files specified in the RPL have been fetched and parsed (depending on how many captions and languages there are, the number of Timed Text files fetched and parsed varies - it's typically about two reels for each of three languages). Once captions are ready for transmission for each of the assigned languages, the ACS returns 0 (RRP successful) to a GetStatus request. Sample transactions are shown below.

```
0000038E 06 0e 2b 34 02 05 01 01 02 07 02 02 05 00 00 00 ...+4.... GetStatus response (0x02, 0x05)
0000039E 83 00 00 24 00 00 35 7f 0a 83 00 00 1b 30 78 34 ...$..5. .....0x4 ResponseKey=0x0a, Processing
000003AE 33 38 37 20 57 61 69 74 69 6e 67 20 66 6f 72 20 387 Waiting for 0x4387 indicates we are not ready. Text tells why.
000003BE 52 50 4c 20 55 52 4c 00
                                                RPL URL.
DCS Request -
00000806 06 0e 2b 34 02 05 01 01 02 07 02 02 04 00 00 00 ..+4.... GetStatus request (0x02, 0x04)
00000816 83 00 00 04 00 00 35 a9
ACS Response -
00000822 06 0e 2b 34 02 05 01 01 02 07 02 02 05 00 00 00 ...+4....
00000832 83 00 00 23 00 00 35 a9 0a 83 00 00 1a 30 78 34 ...#..5. .....0x4 ResponseKey=0x0a, Processing
00000842 37 63 37 20 50 61 72 73 69 6e 67 20 54 69 6d 65 7c7 Pars ing Time Note that the first language is ready, but the others are not
00000852 64 20 54 65 78 74 00
                                                d Text
DCS Request -
00001ED6 06 0e 2b 34 02 05 01 01 02 07 02 02 04 00 00 0...+4.... GetStatus request (0x02, 0x04)
00001EE6 83 00 00 04 00 00 02 8c
ACS Response -
00001EE6 66 38 37 20 43 61 70 74 69 6f 6e 73 20 72 65 61 f87 Capt ions rea 0x7f87 indicates all three assigned languages ready.
00001EF6 64 79 00
```

With the system configured for three languages, the first language comes up about 33 seconds after the system receives the RPL URL. The second language comes up 1:20 after the system receives the RPL URL. The third language comes up 2:00 after the system receives the RPL URL.

These status words are also sent to the log (such as the RS232 logging output) to further analyze system operation. Typical log data is shown below:

```
0x0000 New IP Address: 192.168.1.159
0x0000 TCP connected to 192.168.1.151:4170
0x0003 Announce DCS: USL Content Server Version_0.5148
0x0003 Announce Time: 1250637110 Tue Aug 18 23:11:50 2009
0x0007 GetNewLease: 4294967295 seconds
0x0007 Output mode set to disabled
0x4007 Output mode set to enabled
0x4007 Received RPL URL of http://192.168.1.151:8080/ResourcePresentationList?id=urn:uuid:86d8d4cb-5480-483d-824d-7613639d4d98, PlayoutID=1155
0x4007 ResourceMapFifo contains 234 bytes and has 174528 bytes free
0x4007 Loaded RPL URL with PlayoutID=0x1155
0x400f Connecting to http://192.168.1.151:8080/ResourcePresentationList?id=urn:uuid:86d8d4cb-5480-483d-824d-7613639d4d98
0x400f Timeline set to 2006
0x400f Disconnected from http://192.168.1.151:8080/ResourcePresentationList?id=urn:uuid:86d8d4cb-5480-483d-824d-7613639d4d98
0x400f Got 7137 bytes from http://192.168.1.151:8080/ResourcePresentationList?id=urn:uuid:86d8d4cb-5480-483d-824d-7613639d4d98 after deleting duplicate spaces
0x4007 RPL /ResourcePresentationList found
0x4087 Stream 0 assigned language: en-us - English (United States)
0x4187 Stream 1 assigned language: fr - French (Standard)
0x4387 Stream 2 assigned language: ja - Japanese
0x4397 RPL Parsed OK. RplPlayoutID=0x00001155.
0x4397 ResourceMapFifo contains 4212 bytes and has 170550 bytes free
0x4397 ResourceMapFifo contains 4212 bytes and has 170550 bytes free
0x4397 Loaded Timed Text RPL record with PlayoutID=0x1155
0x43a7 Connecting to http://192.168.1.151:8080/GAME1.en.4287.xml
0x43a7 Disconnected from http://192.168.1.151:8080/GAME1.en.4287.xml
0x43a7 Got 72411 bytes from http://192.168.1.151:8080/GAME1.en.4287.xml after deleting duplicate spaces
0x4387 Found /SubtitleReel... Parsing file.
0x67c7 PacketFifo 0 contains 23973 bytes and has 150789 bytes free
0x6787 ResourceMapFifo contains 3978 bytes and has 170784 bytes free
0x6787 Loaded Timed Text RPL record with PlayoutID=0x1155
0x67a7 Connecting to http://192.168.1.151:8080/game_plan_428-7_test_files_french_v04/GAME1.fr.4287.xml
0x47a7 Disconnected from http://192.168.1.151:8080/game_plan_428-7_test_files_french_v04/GAME1.fr.4287.xml
0x47a7 Got 76383 bytes from http://192.168.1.151:8080/game_plan_428-7_test_files_french_v04/GAME1.fr.4287.xml after deleting duplicate spaces
```

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```
0x4787 Found /SubtitleReel... Parsing file.
0x4fc7 PacketFifo 1 contains 26347 bytes and has 148415 bytes free
0x4f87 ResourceMapFifo contains 3744 bytes and has 171018 bytes free
0x4f87 Loaded Timed Text RPL record with PlayoutID=0x1155
0x4fa7 Connecting to http://192.168.1.151:8080/game_plan_428-7_test_files_japanese_v04/GAME1.ja.4287.xml
0x4fa7 Disconnected from http://192.168.1.151:8080/game_plan_428-7_test_files_japanese_v04/GAME1.ja.4287.xml
0x4fa7 Got 77469 bytes from http://192.168.1.151:8080/game plan 428-7 test files japanese v04/GAME1.ja.4287.xml after deleting duplicate spaces
0x4f87 Found /SubtitleReel... Parsing file.
0x7fc7 PacketFifo 2 contains 26257 bytes and has 148505 bytes free
0x7f87 ResourceMapFifo contains 3510 bytes and has 171252 bytes free
0x7f87 Loaded Timed Text RPL record with PlayoutID=0x1155
0x7fa7 Connecting to http://192.168.1.151:8080/GAME2.en.4287.xml
0x5fa7 Disconnected from http://192.168.1.151:8080/GAME2.en.4287.xml
0x5fa7 Got 92806 bytes from http://192.168.1.151:8080/GAME2.en.4287.xml after deleting duplicate spaces
0x7f87 Found /SubtitleReel... Parsing file.
0x5fc7 PacketFifo 0 contains 52981 bytes and has 121781 bytes free
0x5f87 ResourceMapFifo contains 3276 bytes and has 171486 bytes free
0x5f87 Loaded Timed Text RPL record with PlayoutID=0x1155
0x5fa7 Connecting to http://192.168.1.151:8080/game_plan_428-7_test_files_french_v04/GAME2.fr.4287.xml
0x7fa7 Disconnected from http://192.168.1.151:8080/game plan 428-7 test files french v04/GAME2.fr.4287.xml
0x7fa7 Got 98381 bytes from http://192.168.1.151:8080/game_plan_428-7_test_files_french_v04/GAME2.fr.4287.xml after deleting duplicate spaces
0x5f87 Found /SubtitleReel... Parsing file.
0x7fc7 PacketFifo 1 contains 51787 bytes and has 122975 bytes free
0x7f87 ResourceMapFifo contains 3042 bytes and has 171720 bytes free
0x7f87 Loaded Timed Text RPL record with PlayoutID=0x1155
0x7fa7 Connecting to http://192.168.1.151:8080/game_plan_428-7_test_files_japanese_v04/GAME2.ja.4287.xml
0x5fa7 Disconnected from http://192.168.1.151:8080/game_plan_428-7_test_files_japanese_v04/GAME2.ja.4287.xml
0x5fa7 Got 99697 bytes from http://192.168.1.151:8080/game_plan_428-7_test_files_japanese_v04/GAME2.ja.4287.xml after deleting duplicate spaces
0x5f87 Found /SubtitleReel... Parsing file.
0x7fc7 PacketFifo 2 contains 51143 bytes and has 123619 bytes free
0x7f87 ResourceMapFifo contains 2808 bytes and has 171954 bytes free
0x7f87 Loaded Timed Text RPL record with PlayoutID=0x1155
0x7fa7 Connecting to http://192.168.1.151:8080/GAME3.en.4287.xml
0x5fa7 Disconnected from http://192.168.1.151:8080/GAME3.en.4287.xml
0x5fa7 Got 93531 bytes from http://192.168.1.151:8080/GAME3.en.4287.xml after deleting duplicate spaces
0x7f87 Found /SubtitleReel... Parsing file.
0x5fc7 PacketFifo 0 contains 80802 bytes and has 93960 bytes free
0x5f87 ResourceMapFifo contains 2574 bytes and has 172188 bytes free
0x5f87 Loaded Timed Text RPL record with PlayoutID=0x1155
0x5fa7\ \ Connecting\ \ to\ \ http://192.168.1.151:8080/game\_plan\_428-7\_test\_files\_french\_v04/GAME3.fr.4287.xml
0x5fa7 Disconnected from http://192.168.1.151:8080/game_plan_428-7_test_files_french_v04/GAME3.fr.4287.xml
0x5fa7 Got 99082 bytes from http://192.168.1.151:8080/game_plan_428-7_test_files_french_v04/GAME3.fr.4287.xml after deleting duplicate spaces
0x5f87 Found /SubtitleReel... Parsing file.
0x7fc7 PacketFifo 1 contains 75917 bytes and has 98845 bytes free
0x7f87 ResourceMapFifo contains 2340 bytes and has 172422 bytes free
0x7f87 Loaded Timed Text RPL record with PlayoutID=0x1155
0x7fa7 Connecting to http://192.168.1.151:8080/game_plan_428-7_test_files_japanese_v04/GAME3.ja.4287.xml
0x5fa7 Disconnected from http://192.168.1.151:8080/game plan 428-7 test files japanese v04/GAME3.ja.4287.xml
0x5fa7 Got 100494 bytes from http://192.168.1.151:8080/game_plan_428-7_test_files_japanese_v04/GAME3.ja.4287.xml after deleting duplicate spaces
0x7f87 Found /SubtitleReel... Parsing file.
0x5fc7 PacketFifo 2 contains 76194 bytes and has 98568 bytes free
0x5f87 ResourceMapFifo contains 2106 bytes and has 172656 bytes free
0x5f87 Loaded Timed Text RPL record with PlayoutID=0x1155
0x5fa7 Connecting to http://192.168.1.151:8080/GAME4.en.4287.xml
0x5fa7 Disconnected from http://192.168.1.151:8080/GAME4.en.4287.xml
0x5fa7 Got 96068 bytes from http://192.168.1.151:8080/GAME4.en.4287.xml after deleting duplicate spaces
0x5f87 Found /SubtitleReel... Parsing file.
0x1fc7 Output mode set to disabled
Ox1fc7 Time looped back. Searching buffers from start.
0x1fc7 PacketFifo 0 contains 113849 bytes and has 60913 bytes free
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```
0x1fc7 PacketFifo 1 contains 92759 bytes and has 82003 bytes free
0x1fc7 PacketFifo 2 contains 95867 bytes and has 78895 bytes free
0x7fc7 Output mode set to enabled
0x7fc7 Received RPL URL of http://192.168.1.151:8080/ResourcePresentationList?id=urn:uuid:86d8d4cb-5480-483d-824d-7613639d4d98, PlayoutID=1158
0x7fc7 Dumped IR packets. TimelinePlayoutID = 1158, PacketPlayoutID = 1155
0x67c7 PacketFifo 0 contains 14123 bytes and has 160639 bytes free
0x6787 ResourceMapFifo contains 2106 bytes and has 172656 bytes free
0x6787 Dumping RPL record with abandoned PlayoutID=0x1155
0x6787 Loaded RPL URL with PlayoutID=0x1158
0x678f Connecting to http://192.168.1.151:8080/ResourcePresentationList?id=urn:uuid:86d8d4cb-5480-483d-824d-7613639d4d98
0x678f Disconnected from http://192.168.1.151:8080/ResourcePresentationList?id=urn:uuid:86d8d4cb-5480-483d-824d-7613639d4d98
0x678f Got 7137 bytes from http://192.168.1.151:8080/ResourcePresentationList?id=urn:uuid:86d8d4cb-5480-483d-824d-7613639d4d98 after deleting duplicate spaces
0x6787 RPL /ResourcePresentationList found
0x6487 Stream 0 assigned language: en-us - English (United States)
0x6587 Stream 1 assigned language: fr - French (Standard)
0x6787 Stream 2 assigned language: ja - Japanese
0x6797 RPL Parsed OK. RplPlayoutID=0x00001158.
0x6797 ResourceMapFifo contains 4212 bytes and has 170550 bytes free
0x6797 ResourceMapFifo contains 4212 bytes and has 170550 bytes free
0x6797 Loaded Timed Text RPL record with PlayoutID=0x1158
0x67a7 Connecting to http://192.168.1.151:8080/GAME1.en.4287.xml
0x67a7 Disconnected from http://192.168.1.151:8080/GAME1.en.4287.xml
0x67a7 Got 72411 bytes from http://192.168.1.151:8080/GAME1.en.4287.xml after deleting duplicate spaces
0x6787 Found /SubtitleReel... Parsing file.
0x67c7 PacketFifo 0 contains 40437 bytes and has 134325 bytes free
0x6787 ResourceMapFifo contains 3978 bytes and has 170784 bytes free
0x6787 Loaded Timed Text RPL record with PlayoutID=0x1158
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