Subtitles with ATSC3.0 in Korea

Yunhyoung Kim, KBS (Korean Broadcasting System)
Table of Contents

• Introduction
  • about KBS
  • Subtitles before ATSC3.0

• UHD Closed Captioning System
  • Format Conversion
  • Caption Stream Generation

• Difficulties faced during Implementation
  • timeBase
  • Transport Delay
  • UTC time

• Implementation Results

• Summary and Future Work
Introduction : KBS

• Public Broadcaster in South Korea

Content Production + Platform Operation

KBS1TV

KBS2TV

KBS1TV

KBS2TV

• Future Technology Research Institute

<table>
<thead>
<tr>
<th>UHD Broadcasting</th>
<th>Production Technology</th>
<th>Convergence Service</th>
<th>Standardization &amp; Strategy</th>
</tr>
</thead>
</table>
Introduction: Subtitles before ATSC3.0

- Subtitle with ATSC1.0 (2006)
  - ATSC A/53 CEA-708
  - DTV A/V (HD-SDI)
  - Live Stenography
  - Caption Encoder
  - HD-SDI w/ 334M VANC captions

Terrestrial broadcasters should provide subtitles for every TV program.

- Subtitle Delivery to Pay-TVs (2011)
  - KBS, MBC, SBS, EBS
  - SK broadband, UP TV,olleh TV, SkyLife, CJ, cable & more

Guaranteeing that pay-TV viewers can watch subtitles in terrestrial TV programs.
Introduction: Subtitles before ATSC3.0

- Subtitles without Captioning Delay (2015)

The Results

Timing adjustment system based on speech recognition

Audio of target program

Timely-Aligned Subtitles

Dialogue 1
Dialogue 2
Dialogue 3

Subtitles (Delayed)

Timing Adjustment

KBS
Introduction

- Terrestrial UHDTV is officially aired in South Korea (May, 2017)

Closed caption service in the terrestrial broadcasting: Mandatory

Who cares the closed caption service in the UHDTV?

→ Public Broadcaster

ATSC A/53
CEA-708
Bit Stream
Contained in Picture Header
Do not need timing information

HD → UHD

ATSC A/343
IMSC1
XML
Delivered as a Separate Service
Need timing information

Subtitles are not considered before Nov. 2016
Introduction

- Terrestrial UHDTV is officially aired in South Korea (May, 2017)

Captioning System for UHD should be implemented quickly

→ Good news: “Simulcast”
We can exploit subtitles in HD
UHD Closed Captioning System: Overview

- UHD Video/Audio Source
- 4K AV Encoder
- Closed Caption Data from HD Closed Captioning System
- AV Timing
- MMT/ROUTE
- UHD Closed Captioning System
- IP MUX
- Network Switch
- PTP Sync. Generator
- Terrestrial UHD Broadcasting IP Stream
- Signaling Data MMT/ROUTE
- ESG Data MMT/ROUTE

UHD Closed Captioning System

- Caption Data
- Format Conversion
- Caption Generation
- UHD Captions
UHD Closed Captioning System

• Format Conversion

Transform caption data into IMSC1 format

1. Buffers caption data from the DTV caption system
2. Insert timing information (incomplete)
3. Periodically generates IMSC1 captions (style attributes)

appear
disappear

00:01 03:01 Hello World!
01:13 04:13 Hello Everyone!!
02:05 05:05 Good bye!

Hello World!
Hello Everyone!!
Good bye!
UHD Closed Captioning System

- Caption Stream Generation (1/2)

1. Complete captions and generate caption stream

```xml
<div>
  <p begin="418175:17:43:01" end="418175:17:45:00">Hello World!</p>
  <p begin="418175:17:44:13" end="418175:17:45:00">Hello Everyone!!</p>
</div>
```

Calculate exact caption representation time based on System Time from PTP
UHD Closed Captioning System

• Caption Stream Generation (1/2)

  Complete captions and ② Generate caption stream

Caption Stream Generation

MMT/ROUTE Caption Service Stream

A/V Service Stream

IP MUX.

UHD TV

MMT/ROUTE packets from caption service and A/V service at the same point should have the same media decode time

UHD receiver drops caption packets with far difference from current A/V media decode time

Packet header: media decode time

IMSC begin

IMSC end

UHD receiver represents captions according to timing information given in IMSC documents
Difficulties faced during implementation

1. TimeBase
2. Transport Delay
3. UTC time
Difficulties faced during implementation

1. TimeBase
- Specify the temporal coordinate system
- `ttp:timeBase`
  : “media” | “clock” | “smpte” (default is media if not specified)

`ttp:timeBase = media` ➔ relative to the start time of a current media (program)

When is the start time?
Where can we find the information?

No appropriate information field
In ATSC3.0 Standard

Our choice

`ttp:timeBase “clock”`
➔ Timing information is the time captions are shown
Difficulties faced during implementation

2. Transport Delay
- Need to calculate exact presentation time of the captions
  ATSC3.0 A/V media stream specify “Network Delay Information”

Timing information should be corrected in IMSC documents

We find the delay by trial-and-error
Difficulties faced during implementation

3. UTC time
- The whole UTC time is large (6 characters for ‘hours’ in timeExpression)
- Suggestion in TTML:
  “UTC time with respect to the most immediately prior midnight”
  (not accepted due to a concern of discontinuity in displaying captions spanned over a midnight)

```xml
<div>
  <p begin="418175:17:43:01" end="418175:17:45:00">Hello World!</p>
  <p begin="418175:17:44:13" end="418175:17:45:00">Hello Everyone!!</p>
</div>

<div>
  <p begin="418175:17:45:00" end="418175:17:46:01">Hello World!</p>
  <p begin="418175:17:45:00" end="418175:17:47:00">Hello Everyone!!</p>
  <p begin="418175:17:45:05" end="418175:17:47:00">Good bye!</p>
</div>
```

Whole UTC is used
Implementation Results

• UI of the captioning systems

Format Conversion
(pop-up for setting attributes)
Implementation Results

• Setting Caption Service (ROUTE, adding a LCT session)
Implementation Results

- IP Mux Output Monitoring

<table>
<thead>
<tr>
<th>Name</th>
<th>Protocol</th>
<th>Type</th>
<th>IP</th>
<th>Port</th>
<th>NIC Address</th>
<th>ID</th>
<th>Action</th>
<th>Enabled</th>
<th>Status</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Level Signalinco</td>
<td>ROUTE</td>
<td>Inout</td>
<td>239.255.7.10</td>
<td>5000</td>
<td>192.168.7.120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50.512</td>
</tr>
<tr>
<td>LLS Data</td>
<td>LLS</td>
<td>Outout</td>
<td>224.0.23.60</td>
<td>4937</td>
<td>192.168.7.121</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50.474</td>
</tr>
<tr>
<td>Linear A/V service</td>
<td>ROUTE</td>
<td>Inout</td>
<td>239.255.7.12</td>
<td>5000</td>
<td>192.168.7.120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>120</td>
</tr>
<tr>
<td>Signal Data</td>
<td>ROUTE</td>
<td>Inout</td>
<td>239.255.7.14</td>
<td>5000</td>
<td>192.168.7.120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>120</td>
</tr>
<tr>
<td>AV Data</td>
<td>ROUTE</td>
<td>Inout</td>
<td>239.255.7.17</td>
<td>5000</td>
<td>192.168.7.120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Audio Data</td>
<td>ROUTE</td>
<td>Outout</td>
<td>239.255.7.24</td>
<td>5000</td>
<td>192.168.7.121</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>ESG Service</td>
<td>ROUTE</td>
<td>Inout</td>
<td>239.255.7.13</td>
<td>5000</td>
<td>192.168.7.120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>ESG Data</td>
<td>ROUTE</td>
<td>Outout</td>
<td>239.255.7.23</td>
<td>5000</td>
<td>192.168.7.121</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>

BW of Caption Data : 7K~19Kbps
Implementation Results

• IP Mux Output Monitoring
Implementation Results

• Commercial Receivers
Summary and Future Work

- Implementation of ATSC3.0 UHD Captioning System (IMSC1-based)
  - Format Conversion
  - Caption Service Stream Generation

- Difficulties on Implementation: Mainly on Timing Information

- Successfully developed and used in the broadcasting system

- We plan to provide advanced caption service based on the powerful functions of IMSC1