Latency Measurement on Capture Encode Decode Display Demo

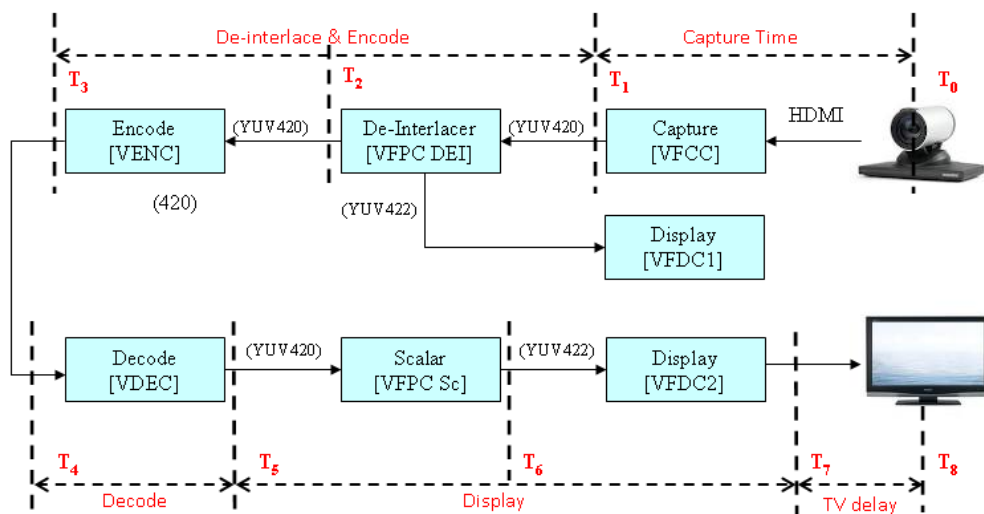## Latency Measurement for Capture Encode/Decode Display application

This is the latency measurements performed on the sample Capture encode/decode display demo delivered along with the EZSDK 5.x for DM816x and DM814x devices from TI. The demo is created with the chain **VFCC->DEI->VENC->VDEC->VFPC-SC->VFDC** . This demo is validated on EZSDK 5.03.01.15 and OMX components 5.02.00.30.

The latency numbers are measured for the following resolutions:

• 1080p60 (Capture, Encode, Decode and Display @ 1080p60)
• 1080p30 (Capture, Encode, Decode and Display @ 1080p30)
• 1080p60-30 (Capture Display @ 1080p60. Encode Decoder @ 1080p30)
• 720p60 (Capture, Encode, Decode and Display @ 720p60)

Usecase Description

The video data is captured by VFCC component from a HD camera source via HDMI . The captured data is fed to DEI.The DEI output is then encoded by VENC and decoded by VDEC component. The decoded frame is passed to Scalar component (VFPC Sc) , which does chroma conversion from YUV 420 to YUV 422 format. The scalar ouput is passed to VFDC and the output is displayed on the TV via via on-chip HDMI interface. The IL Client source code is available here Media:capture_encode_decode_display.tar.gz

Setup Details

DM816x Base EVM DM816x Rev-C with DDR3 attached with a Video Conferencing Expansion IO (EIO) Card interface. A video source (Tandberg 1080p60 Camera / Sony PS3) is connected to the daughter card via a HDMI interface. The on-chip HDMI out from the DM816x Base EVM is connected to a TV.

OMX Components Details

Following are the list of OMX components used in the usecase:

- VFCC (Video Frame Capture Component)
- VFPC-DEI (Video Frame Processing Component - Deinterlacer)
- VENC (Video Encode Component)
- VDEC (Video Decode Component)
- VFPC-SC (Video Frame Processing Component - Scalar)
- VFDC (Video Frame Display Component)

Measurement Procedure

1. The IL-client is executed on ARM side and the corresponding firmware binaries are loaded on the Video and VPSS media controller cores.
2. The HD camera is focused on a running stop watch video. Glass-to-Glass latency is measured by measuring the time difference between the source time stamp and the time stamp displayed on the TV display.
3. Timestamps corresponding to various OMX component events for consecutive frames are logged for latency measurements
4. T_0 - Start of capture. (start time for encode path)
5. T_1 - Timestamp when capture of frame is complete
6. T_2 - Timestamp when DEI processing is done
7. T_3 - Timestamp when VENC finish encoding the frame
8. T_4 - Timestamp when VDEC starts decoding the frame
9. T_5 - Timestamp when VDEC finish decoding the frame .
10. T_6 - Timestamp when VFPC scaling is done
11. T_7 - Timestamp when VFDC send the frame to HDMI output for display
12. T_8 - Timestamp when the frame is displayed on TV
13. From the above timestamps, Running average of various latency values are measured

- **Running average: Series of averages is calculated for a fixed window period (8 Frames) of different subsets of the full data set and final average is calculated from the average series**

Results

- Detailed latency performance results are available here Media:DM816x_Capture_Encode_Decode_Display_latency_performance_consolidated.zip

Summary

Metrics

1. Glass to Glass Latency $T_8 - T_0$ - Total delay observed in the system including TV delay
2. Capture-Encode Latency = Capture-Encode Path delay + Buffers in Capture Driver
3. Decode-Display Latency = Decode delay + Scalar delay + Display delay

Breakup

1. Buffers in Capture Driver - Delay due to buffers held in capure driver. Range is from 0.5 to 1 frame
2. Capture-Encode Path delay- $T_3 - T_1$
3. Buffer Hand Off to Decoder - Delay due to buffers held between VENC and VDEC components. Range is from 1 to 1.5 frames
4. Decode Delay $T_5 - T_4$
5. Scalar Delay $T_6 - T_5$
6. Scale/Chroma Con. Display Delay $T_7 - T_5$ - Cummulative delay for scaling, chroma conversion and display
7. TV/Monitor Delay - Delay due to the internal processing in the TV/monitor (8ms delay is observed in Samsung LCD TV)

metrics	1080p60		1080p30		1080p60-30		720p60	
	Average (ms)	Peak (ms)	Average (ms)	Peak (ms)	Average (ms)	Peak (ms)	Average (ms)	Peak (ms)
Glass-to-Glass Latency (Including TV delay 8ms)	140.00	172.00	242.00	280.00	162.00	181.00	126.00	150.00
Capture-Encode Latency (Excluding network delay)	36.30	46.04	42.34	62.71	33.80	42.41	23.20	32.54
Decode-Display Latency (Excluding TV Delay)	81.54	83.88	157.46	158.38	100.66	101.75	77.25	80.75
Details of the measurements								
Break up/Configurations	1080p60		1080p30		1080p60-30		720p60	
	Average (ms)	Peak (ms)	Average (ms)	Peak (ms)	Average (ms)	Peak (ms)	Average (ms)	Peak (ms)
Buffers in Capture Driver (0.5 to 1 FRAME)	8.33	16.66	16.66	33.33	8.33	16.66	8.33	16.66
Capture-Encode Path (MEASURED)	27.97	29.38	25.68	29.38	25.47	25.75	14.87	15.88
Buffer Hand Off to Decoder (1 TO 1.5 FRAME)	16.66	25.00	33.33	50.00	16.66	25.00	16.66	25.00
Decode Delay (MEASURED)	12.84	13.50	11.44	11.88	11.70	12.00	6.16	6.63
Scalar Delay (MEASURED)	12.02	12.25	10.70	10.70	10.49	10.75	6.37	6.63
Scale/Chroma Con. & Display Delay (MEASURED)	56.67	58.13	135.33	135.88	78.46	79.00	64.73	67.50
TV/Monitor Delay (MEASURED)	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Glass-to-Glass Delay (Including TV delay 8ms)	142.50	162.91	241.13	279.15	159.12	177.16	125.12	146.29

Download the Latest EZSDK

The latest EZSDK is available for download from http://software-dl.ti.com/dsps/dsps_public_sw/ezsdk/latest/index_FDS.html.

The current version is **5.03.01.15**. The supported platforms are DM816x [1] and DM814x [2].

EZSDK Support

DM816x E2E Support Forum   [3]

DM814x E2E Support Forum   [4]

Linux E2E Support Forum   [5]

BIOS E2E Support Forum   [6]

References

[1] http://www.ti.com/tool/tmdxevm8168

[2] http://www.ti.com/tool/tmdxevm8148

[3] http://e2e.ti.com/support/dsp/davinci_digital_media_processors/f/717.aspx

[4] http://e2e.ti.com/support/dsp/davinci_digital_media_processors/f/716.aspx

[5] http://e2e.ti.com/support/embedded/linux/default.aspx

[6] http://e2e.ti.com/support/embedded/bios/default.aspx

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