

HDMI on OMAP4 PANDA

Design, Challenges and Lessons Learned

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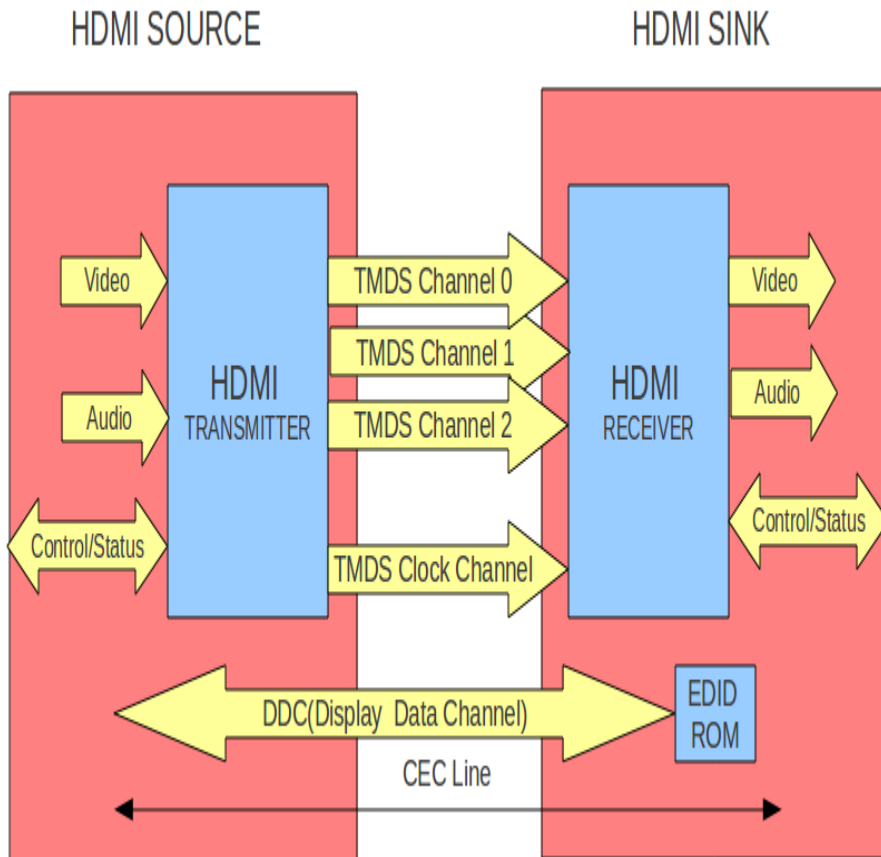
Agenda

- **HDMI in a Nutshell**
- **OMAP4 HDMI hardware**
- **High level software requirements**
- **Compliance dependent HDMI features**
- **Current software design**
- **Issues faced while enabling HDMI**
- **Possible Design Enhancements**



HDMI in a Nutshell

HDMI in a Nutshell - 1



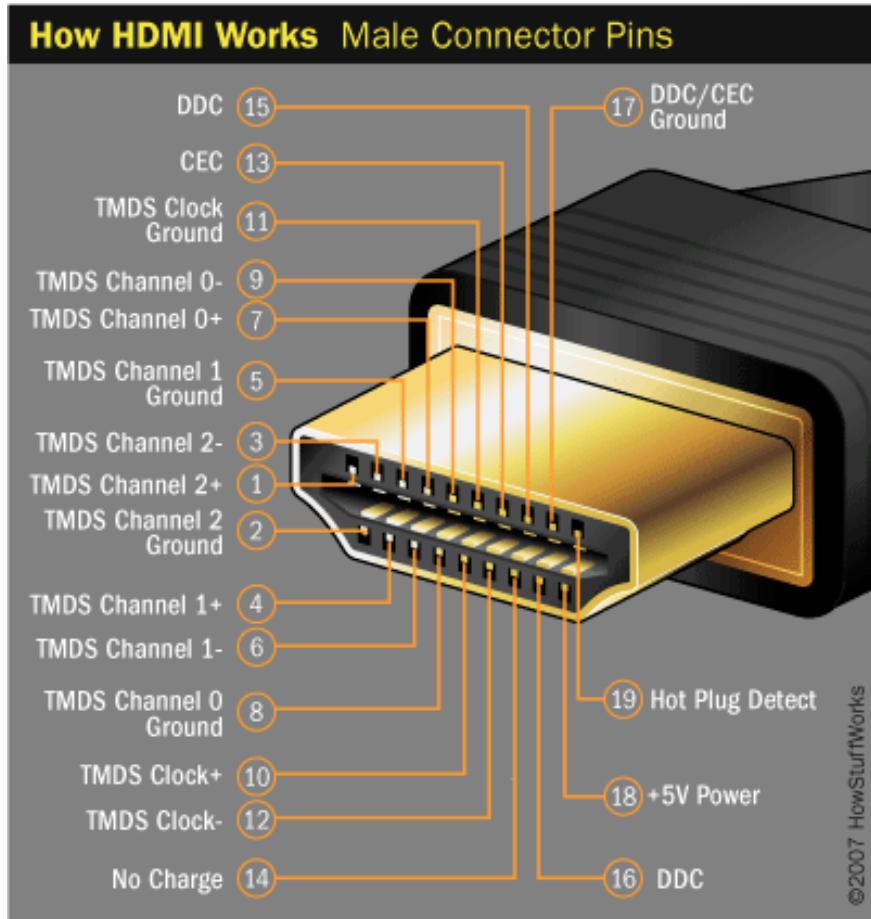
- **High-Definition Multimedia Interface**

- **Compact Audio/Video interface for transmitting digital data**

- **Backward compatible with DVI (Digital Visual Interface)**



HDMI in a Nutshell - 2



Three physically separated communication channels

- **DDC** - To read E-EDID information.
- **TMDS** – Carry video audio and auxiliary data at TMDS clock rate
- **CEC (Optional)** – high level control function across audiovisual products.



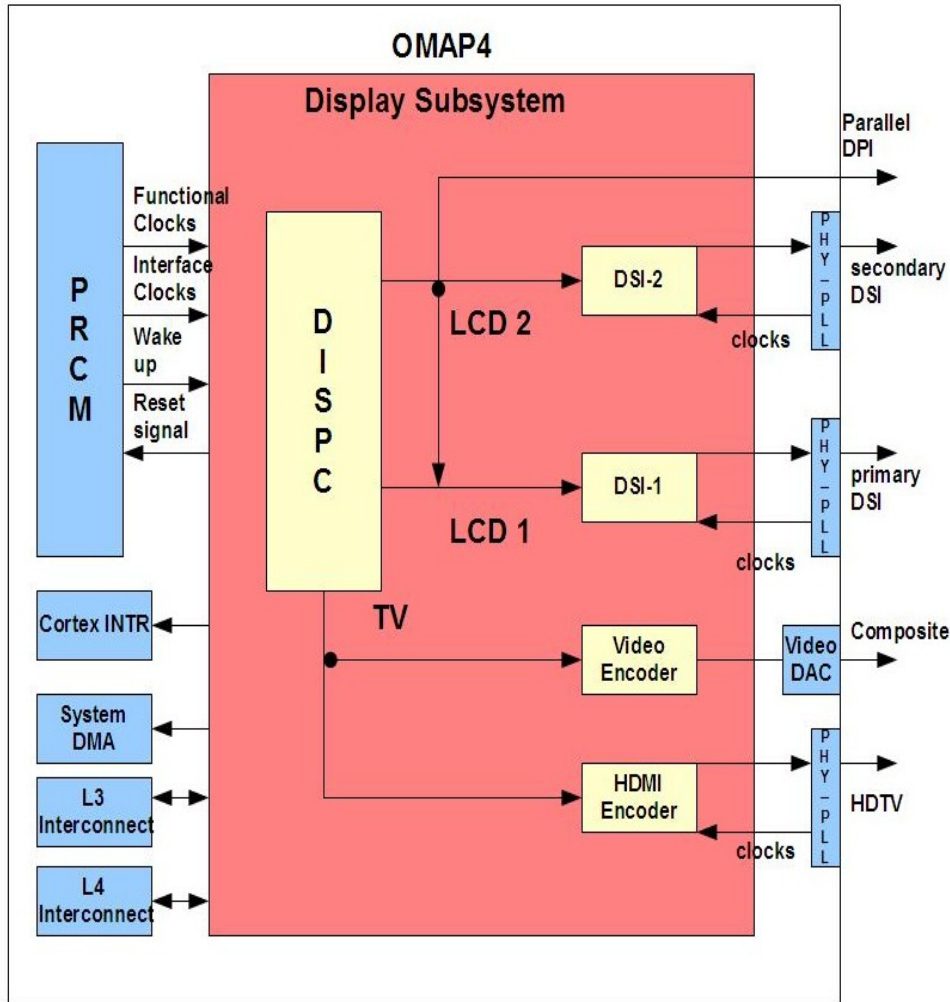
HDMI in a Nutshell - 3

HDMI version	1.0-1.2a	1.3	1.4						
Maximum clock rate (MHz)	165	340	340 ^[51]						
Maximum TMDS throughput per channel (Gbit/s) including 8b/10b overhead	1.65	3.40	3.40						
Maximum total TMDS throughput (Gbit/s) including 8b/10b overhead	4.95	10.2	10.2						
Maximum throughput (Gbit/s) with 8b/10b overhead removed	3.96	8.16	8.16						
Maximum audio throughput (Mbit/s)	36.86	36.86	36.86						
Maximum color depth (bit/px)	24	48 ^[A]	48						
Maximum resolution over single link at 24-bit/px ^[B]	1920×1200p60	2560×1600p75	4096×2160p24						
Maximum resolution over single link at 30-bit/px ^[C]	N/A	2560×1600p60	4096×2160p24						
Maximum resolution over single link at 36-bit/px ^[D]	N/A	1920×1200p75	4096×2160p24						
Maximum resolution over single link at 48-bit/px ^[E]	N/A	1920×1200p60	1920×1200p60						
				1.0	1.1	1.2 1.2a	1.3	1.3a 1.3b 1.3b1 1.3c	1.4
sRGB				Yes	Yes	Yes	Yes	Yes	Yes
YCbCr				Yes	Yes	Yes	Yes	Yes	Yes
8 channel LPCM, 192 kHz, 24 bit audio capability				Yes	Yes	Yes	Yes	Yes	Yes
Blu-ray Disc and HD DVD video and audio at full resolution ^[F]				Yes	Yes	Yes	Yes	Yes	Yes
Consumer Electronic Control (CEC) ^[G]				Yes	Yes	Yes	Yes	Yes	Yes
DVD-Audio support				No	Yes	Yes	Yes	Yes	Yes
Super Audio CD (DSD) support ^[H]				No	No	Yes	Yes	Yes	Yes
Deep Color				No	No	No	Yes	Yes	Yes
xvYCC				No	No	No	Yes	Yes	Yes
Auto lip-sync				No	No	No	Yes	Yes	Yes
Dolby TrueHD bitstream capable				No	No	No	Yes	Yes	Yes
DTS-HD Master Audio bitstream capable				No	No	No	Yes	Yes	Yes
Updated list of CEC commands ^[I]				No	No	No	No	Yes	Yes
3D Over HDMI				No	No	No	No	Yes	Yes
Ethernet Channel				No	No	No	No	No	Yes
Audio Return Channel				No	No	No	No	No	Yes
4k × 2k Resolution Support				No	No	No	No	No	Yes

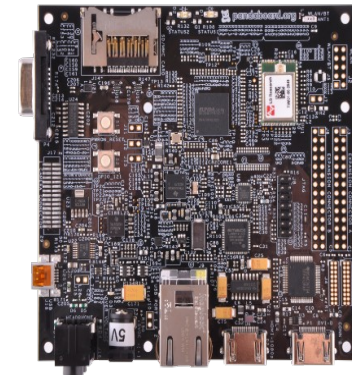
Table courtesy : Olivero, Fabrice" <f-olivero@ti.com>

OMAP4 HDMI Hardware

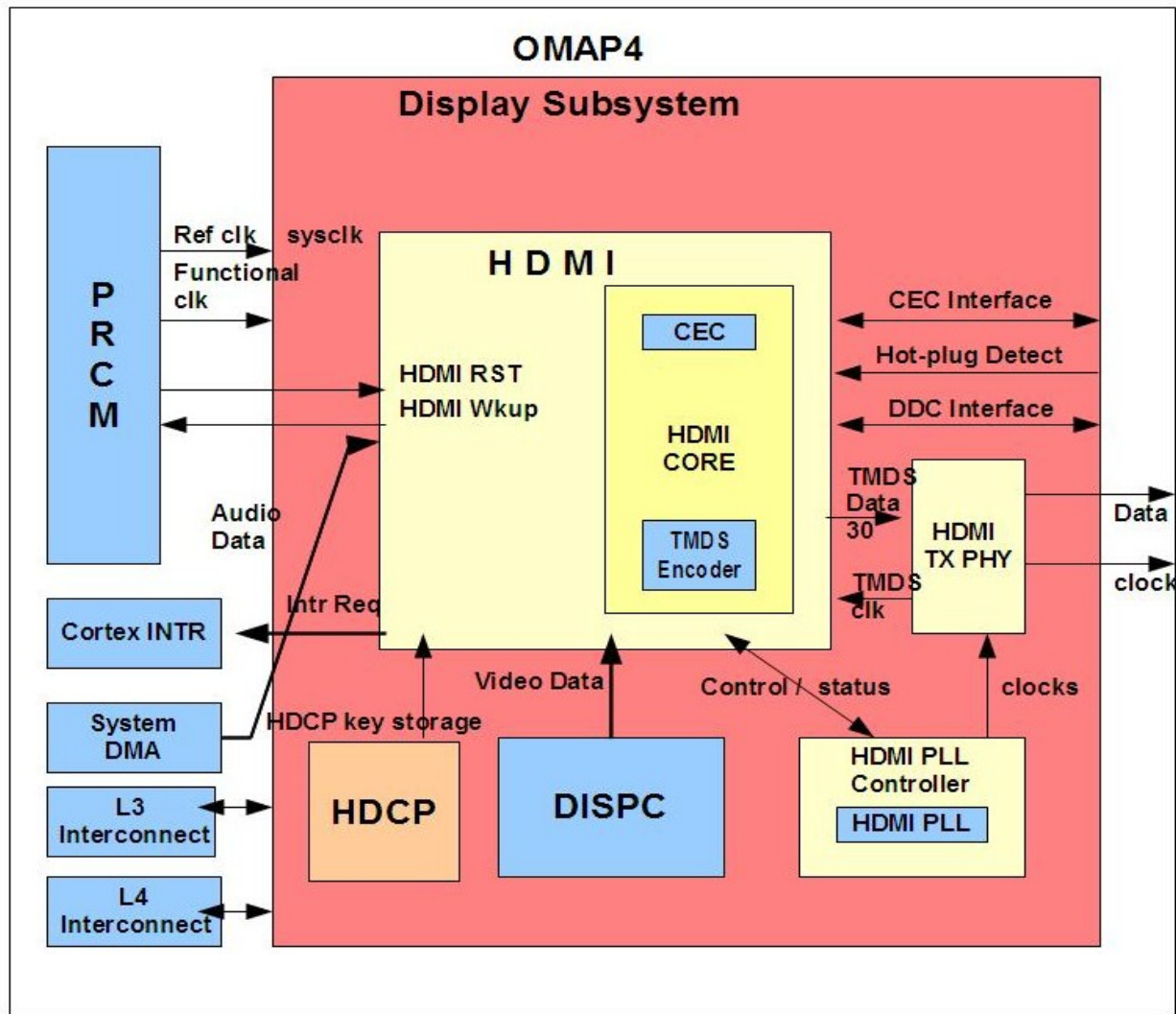
OMAP4 HDMI Hardware - 1



- Part of Display Sub-System (DSS) that provides the logic to display a video frame from the memory frame buffer on to TV / LCD.
- HDMI-PLL can generate the appropriate pixel clock using the reference clock(sysclk).

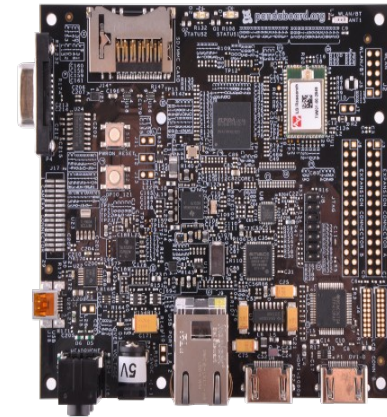


OMAP4 HDMI hardware - 2



OMAP4 HDMI hardware - 3

- Video Data Path
 - Display controller (DISPC)
 - HDMI module
 - HDMI complex input/output (I/O)
- Audio Data Path
 - Level 3 (L3) interconnect
 - HDMI module
 - HDMI complex input/output (I/O)



Software Requirements

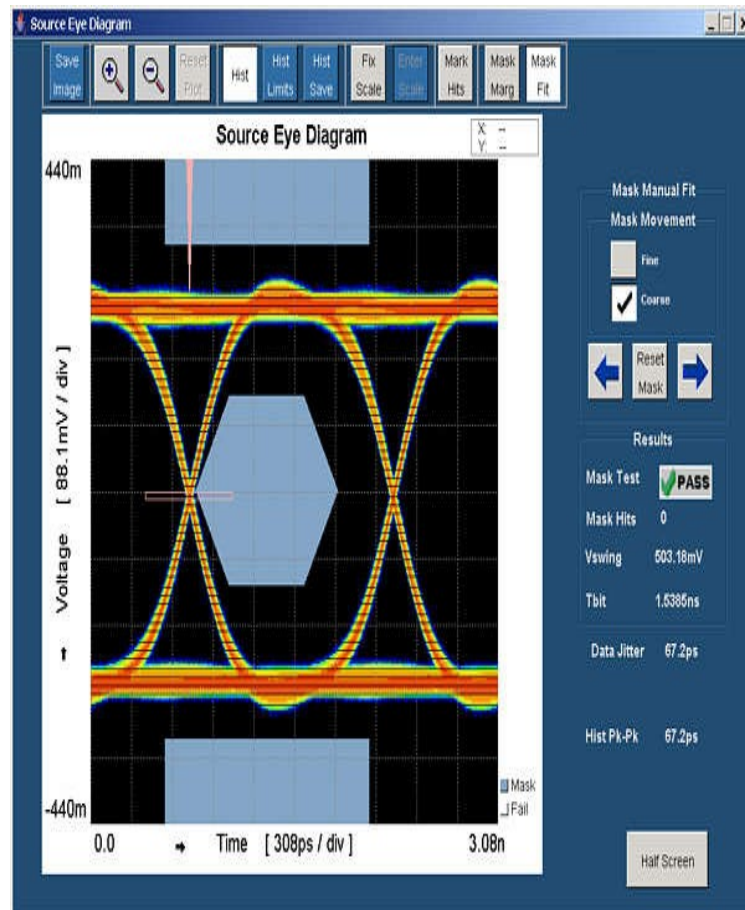
High Level Software Requirements

- Audio and video synchronization with respect to data, synchronization and power management
- Frame buffer and v4l2 support for video and graphics data
- Clock/PLL configuration (specific to SoC)



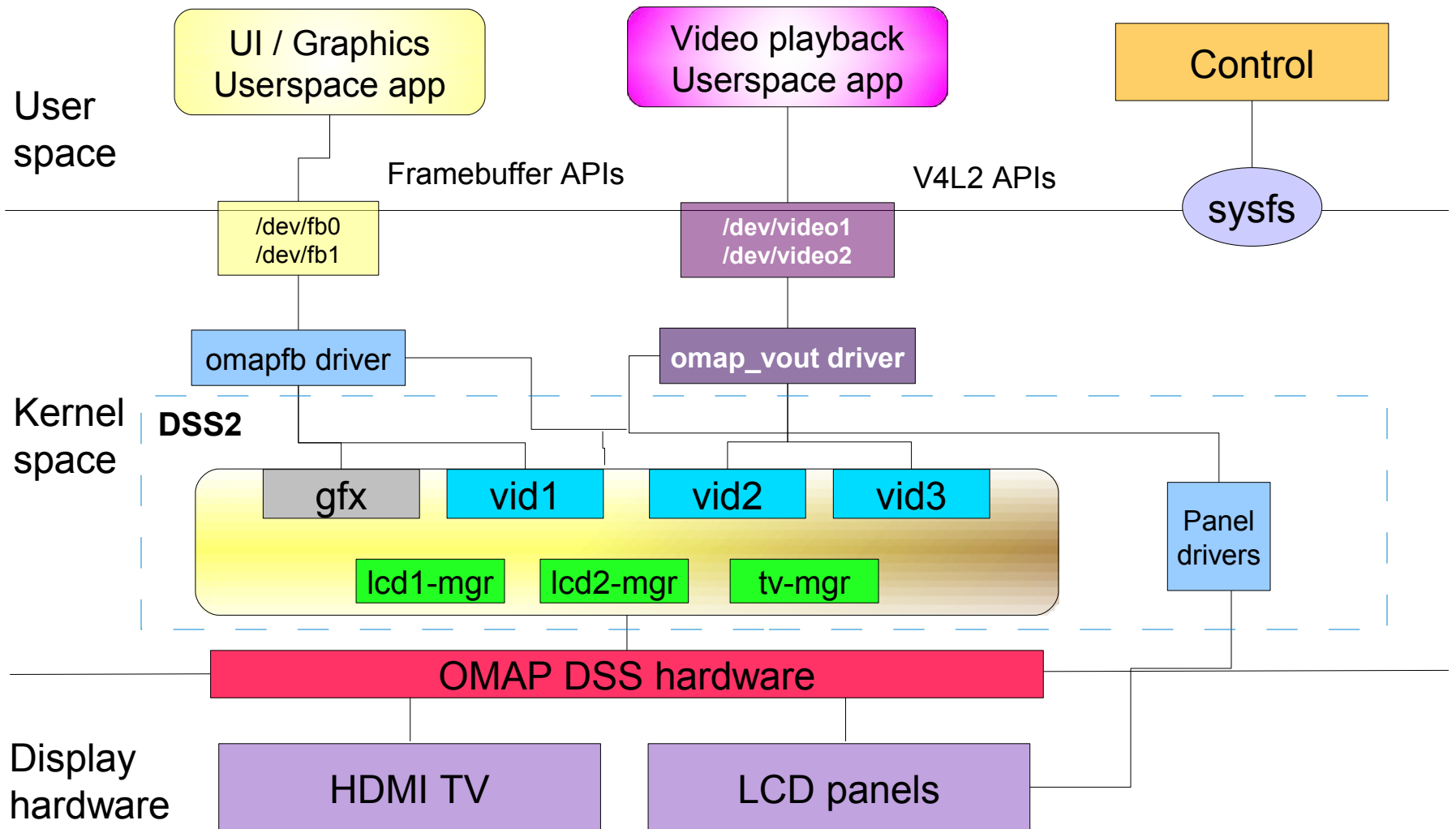
Compliance dependent HDMI features

- EDID parsing
 - Detailed/Established/
standard timings
 - Vendor specific data block
 - Audio data block
 - Video data block
- AVI Info-frame configuration/read
- Audio Info-frame configuration/read
- VSI Info-frame configuration/read
- CEC protocol
- Hot-plug detect/modify notification



HDMI Driver Design - OMAP4

DSS2 Software Design



HDMI Driver Design – OMAP4 -1

HDMI as a DSS driver

– HDMI Panel driver

- Acts as a Interface between HDMI interface driver and audio driver
- Provides generic API's to configure HDMI for A/V
- Sends user-space/Kernel Notification on suspend/Hot-plug

– HDMI Interface driver

- DSS specific clock computation
- DSS configuration

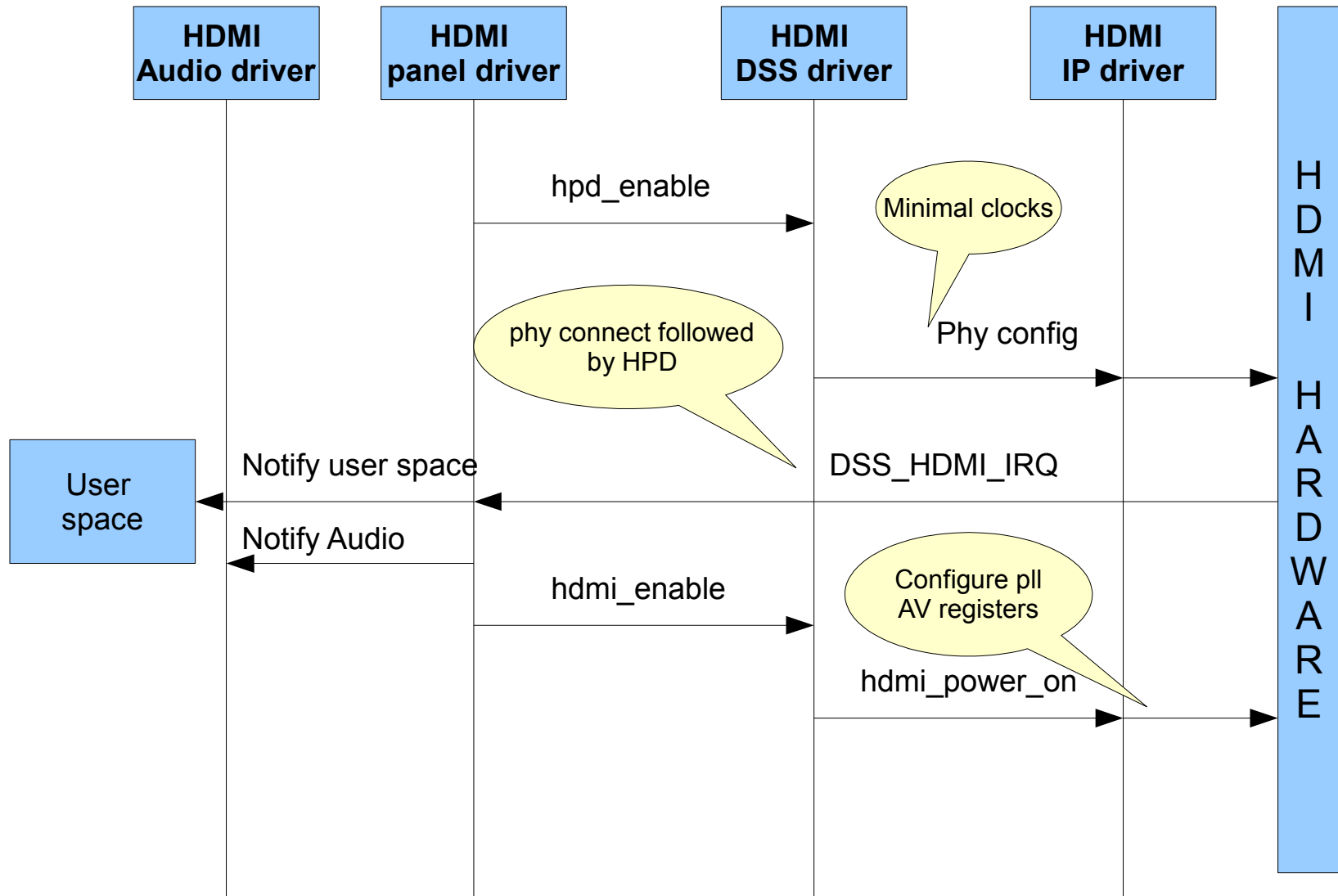


HDMI Driver Design – OMAP4 - 2

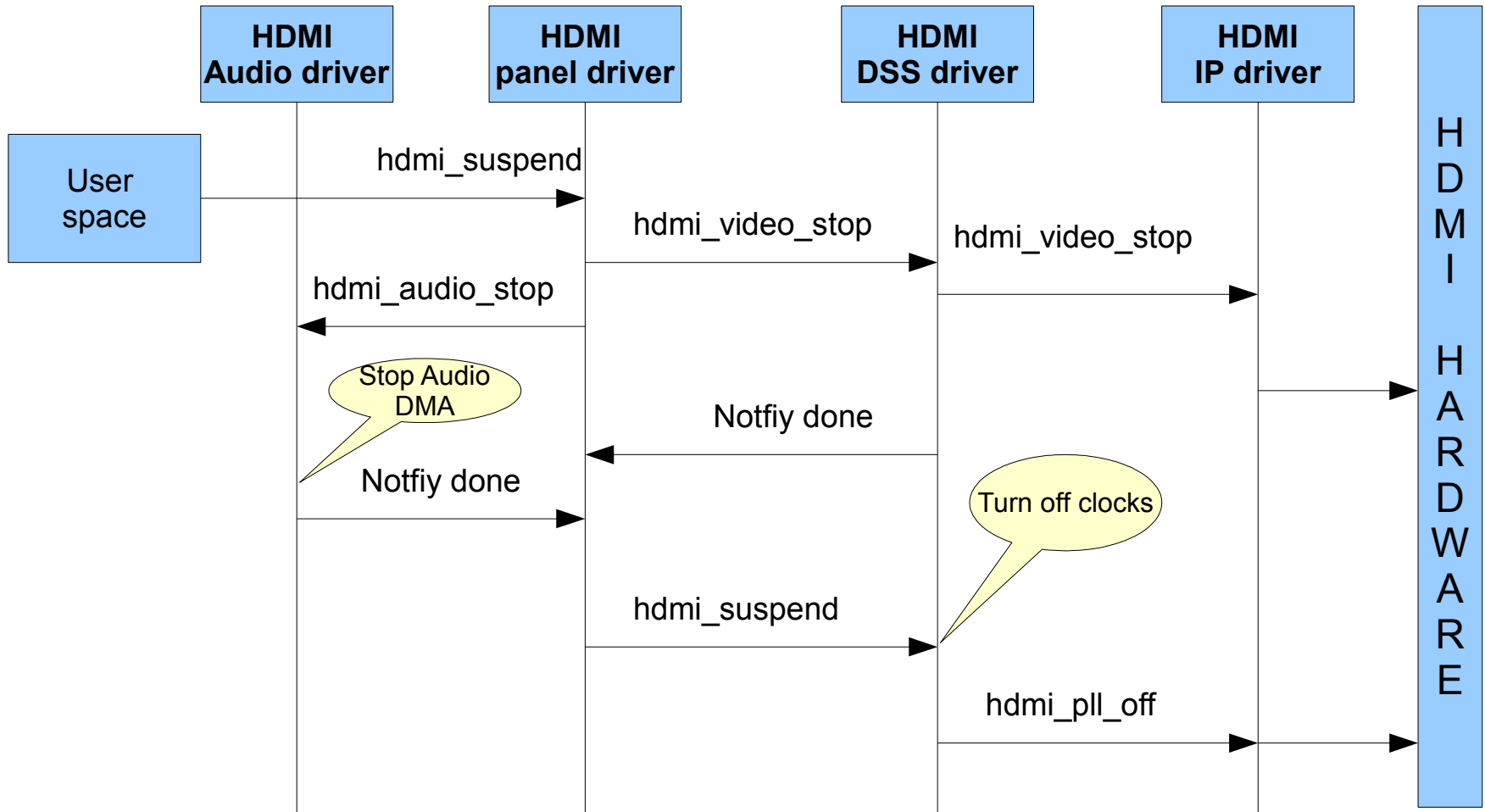
- HDMI IP driver
 - Configuration of HDMI h/w registers
 - Simpler to plug and play with different IP's
- EDID library
 - Parsing EDID for VESA / CEA extension
- HDMI Audio ASOC Driver
 - configuration for Audio transfer
 - configuration of sDMA



Use Case – HDMI Hot-plug Enable



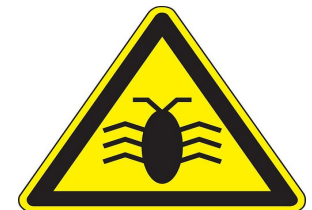
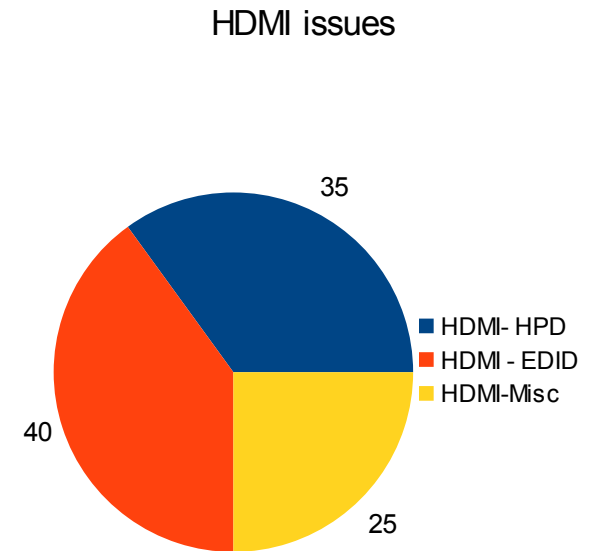
Use Case – HDMI Suspend



OMAP4 HDMI Issues

HDMI Issues OMAP4 - 1

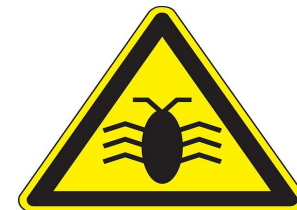
Issues	Problems	Solutions
1. Timing Issues	Wrong EDID read	Default to VGA if EDID is not valid
	No Audio over HDMI as DVI timing selected	If CEA extension + VSDB present select CEA timing.
2. Hot-plug	Multiple connect disconnect interrupts	Optimal debounce time to avoid jitter while avoiding delays.



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HDMI Issues OMAP4 - 2

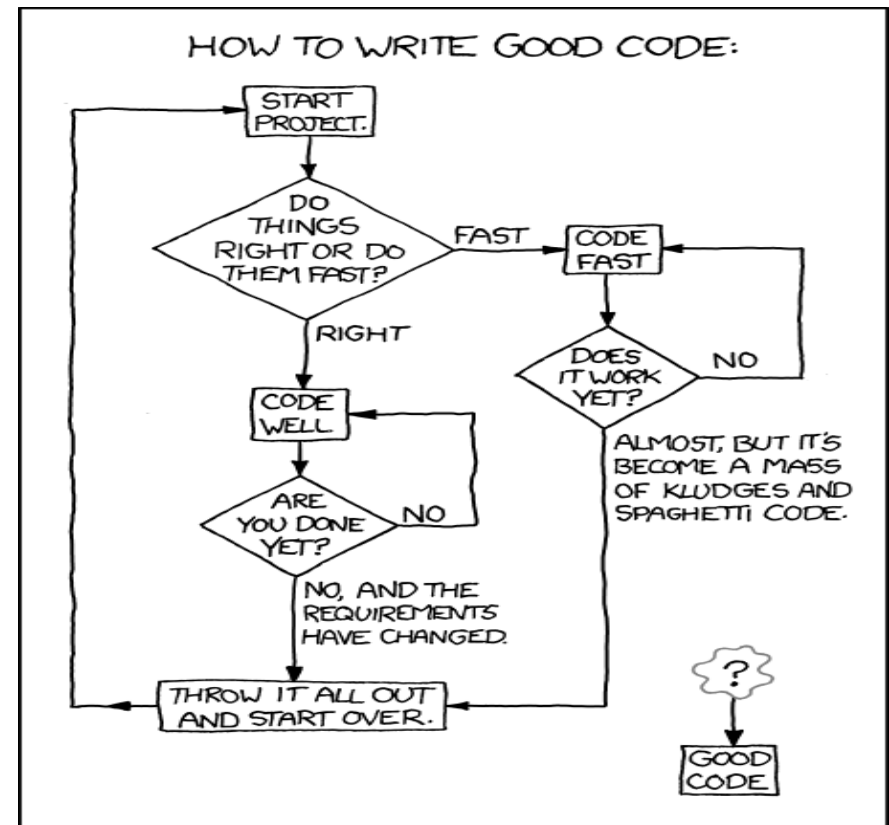
Issues	Problems	Solutions
3. Power management Audio Video sync	Audio crash as Video/Display shut- off clocks	<ul style="list-style-type: none">• Single controller to manage both Audio/Video power• Callback Notification from controller to Audio/Video on suspend/ Hot-plug disconnect before cutting clocks
4. Miscellaneous	Bandwidth/clocking issues	<ul style="list-style-type: none">• Manage FIFO thresholds• Tool to calculate pll for all supported timings.
	Code duplication	Common IP driver to make use of code across platforms



Possible Design Enhancements

Possible Design Enhancements - 1

- Common EDID parsing code across kernel
 - Reduce interoperability issues
 - Increase re-usability
 - Plug-and-play for any framework
 - Helps concentrate more on Actual driver than reinventing the wheel



Possible Design Enhancements - 2

- Standardize Hot-plug notification mechanism
 - To user space to have application interoperability
 - To kernel space to Notify Audio/Any dependent driver to shut off on Hot-plug disconnect/Suspend
- Standardize API's for Compliance dependent code
 - At the driver level
 - V4I2 API RFC for the same
 - Interoperability across supporting framework
DRM/ FB / V4I2



References

- **TI OMAP4 TRM**
<http://focus.ti.com/general/docs/wtbu/wtbudocumentcenter.tsp?templateId=6123&navigationId=12667>
http://omappedia.org/wiki/Main_Page
- **HDMI 1.3 specification**
<http://www.hdmi.org/learningcenter/faq.aspx>
- **EDID information**
http://en.wikipedia.org/wiki/Extended_display_identification_data
<http://www.hdmi.org/learningcenter/presentations.aspx>
(Implementing EDID that works)
- **Connector Diagram copyright**
<http://electronics.howstuffworks.com/hdmi2.htm>
- **V4I2 API RFC**
<http://permalink.gmane.org/gmane.linux.drivers.video-input-infrastructure/30401>
- **EDID Library RFC**
<http://www.mail-archive.com/linux-omap@vger.kernel.org/msg47259.html>

Q & A



**THANK
YOU**

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