

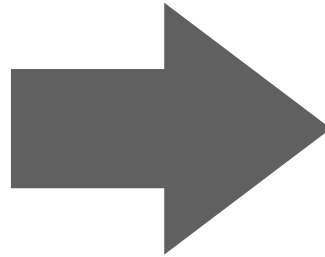


Developing Products for HDMI[®] Specification 1.4

Vincent Hsia

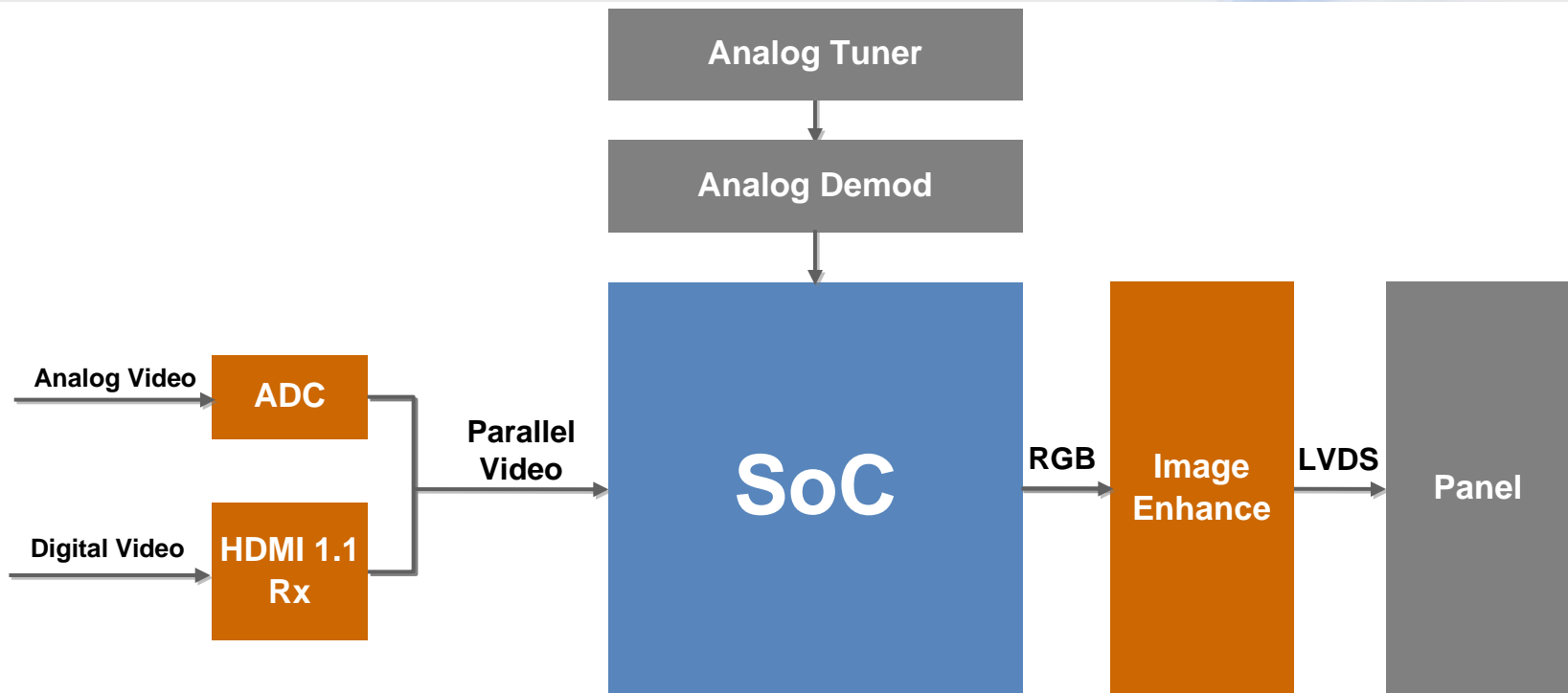
Who Needs Innovation?



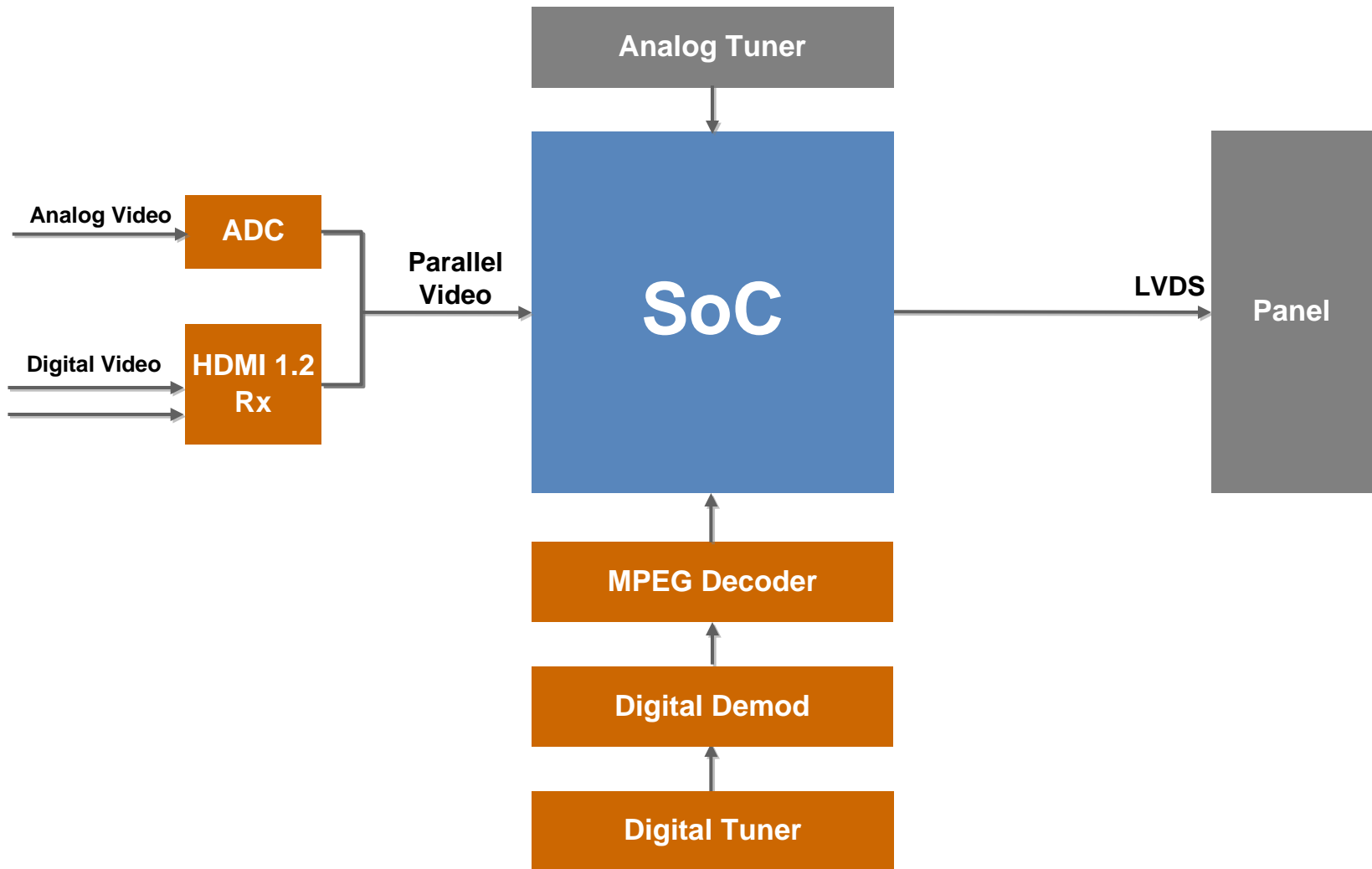


Innovations become checkbox items

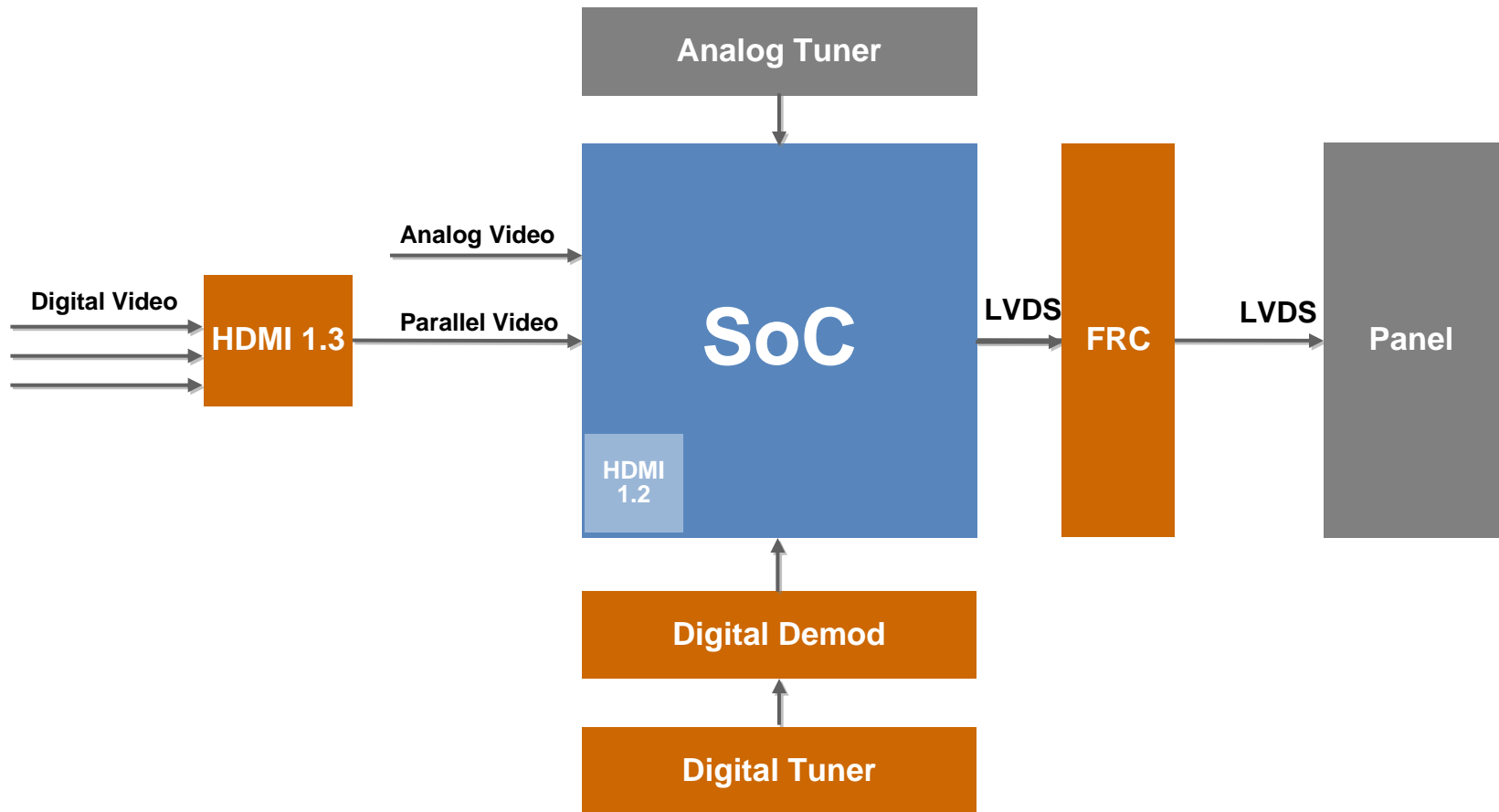
2005 Flat Panel TV



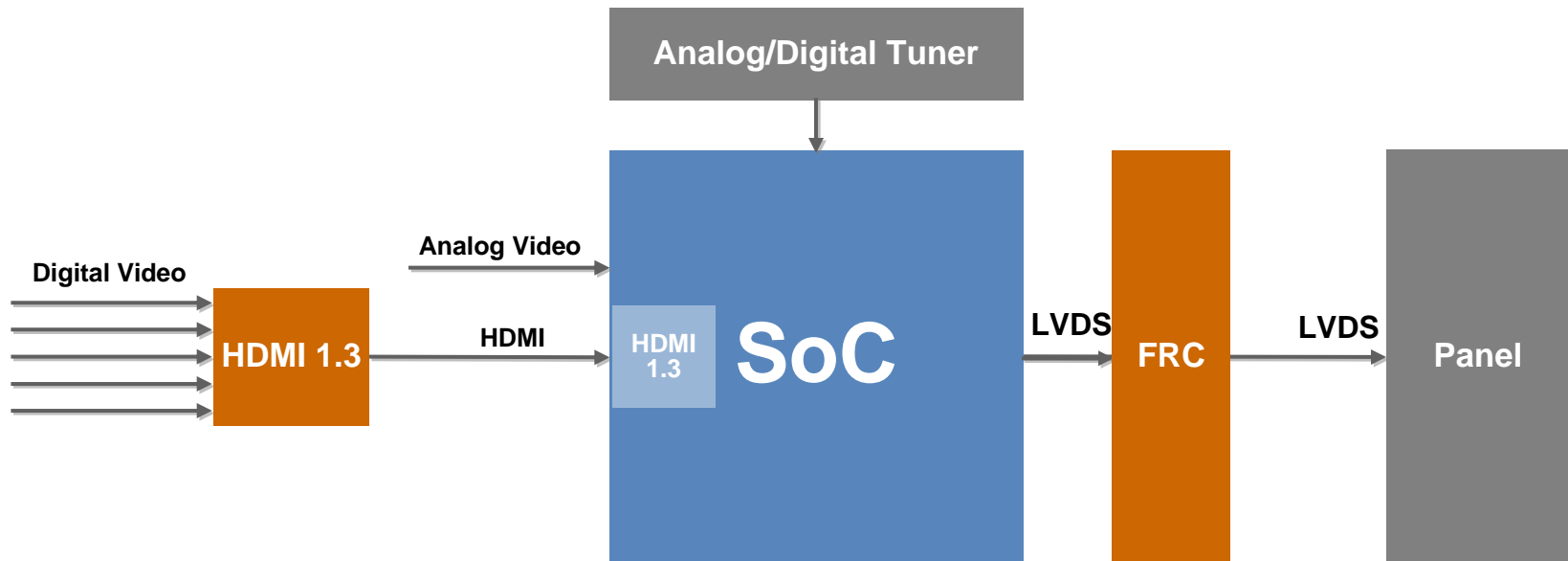
2006 Flat Panel TV

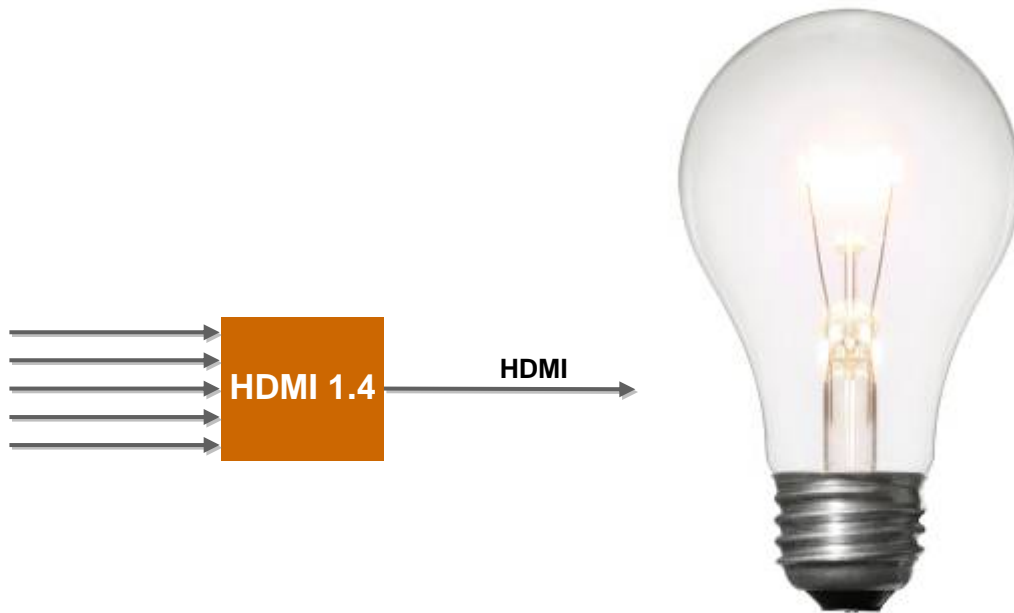


2007 Flat Panel TV



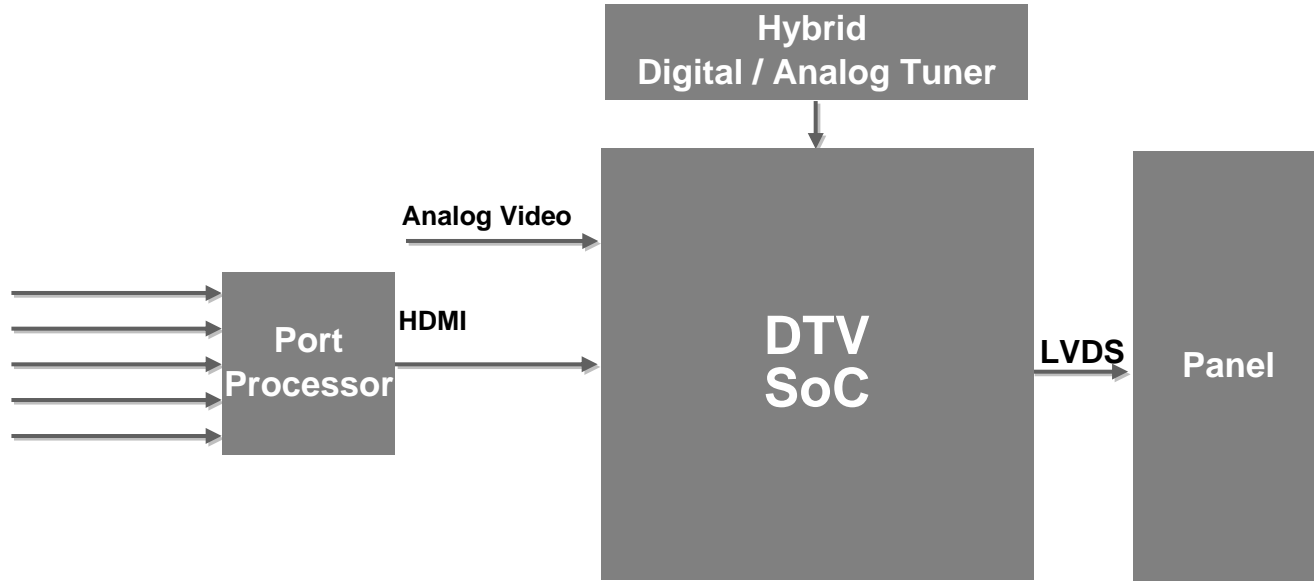
2008 Flat Panel TV



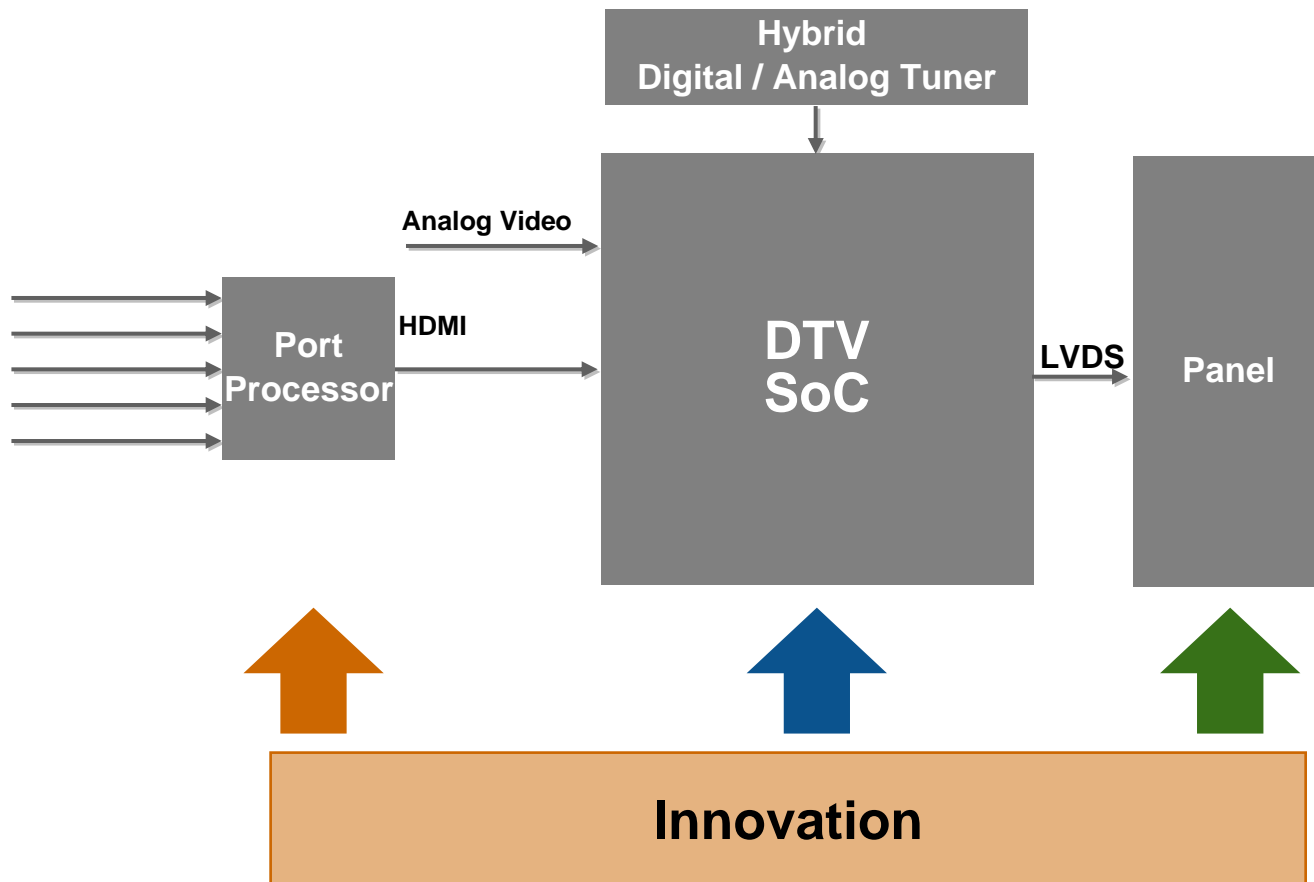


A platform to introduce innovation

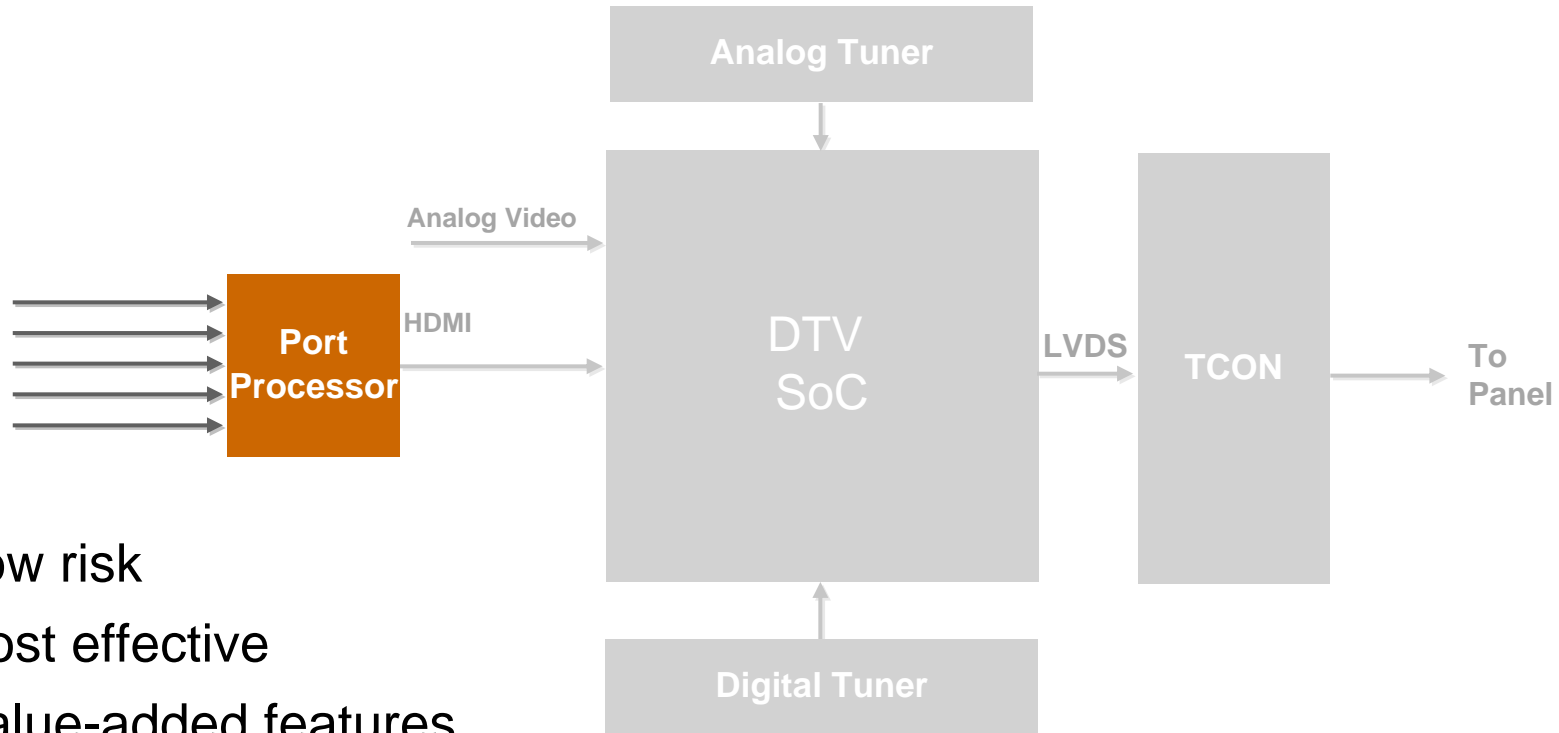
HDMI Has Become a Bus Within the DTV



Three Sources of Innovation



Port Processor Innovation



Low risk

Cost effective

Value-added features

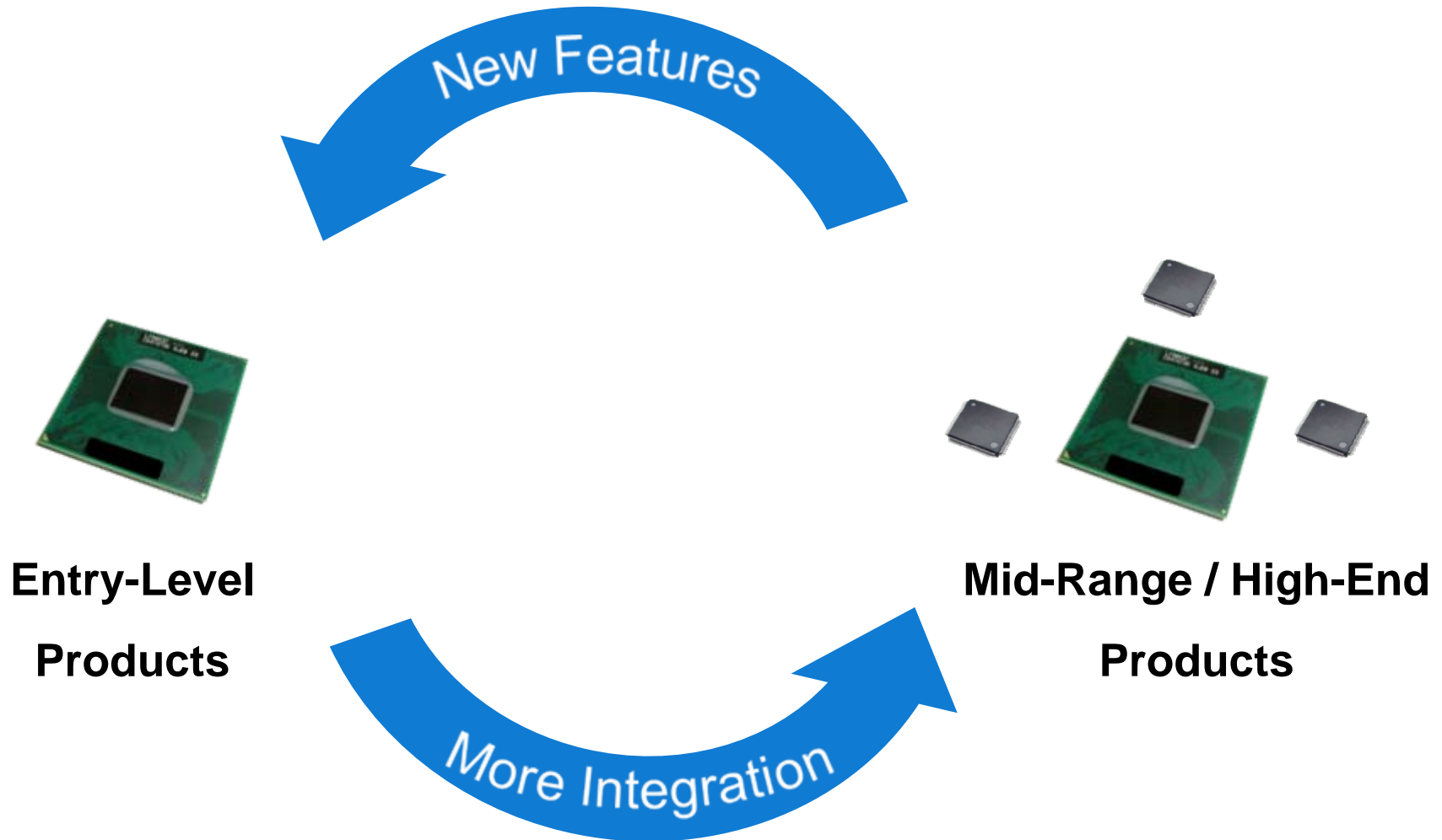
Creates differentiation across platforms

Uses standard interfaces to SoC

Minimal changes to system software, hardware design, and test

Faster response time to changing technology and standards

Port Processors: Scalable Innovation



Examples of Port Processor Innovation

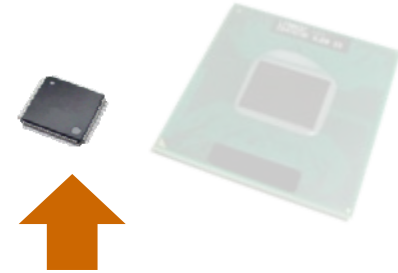
Deliver latest HDMI technology

- HDMI Ethernet Channel
- Audio Return Channel
- 3D over HDMI

Add more HDMI ports

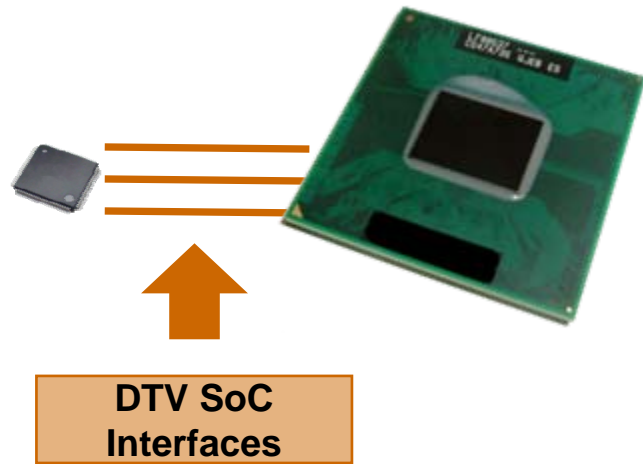
Improve system performance: *instaport*[™]

Whole home CE networking: *liquid*[™]HD



Port Processor

DTV SoC Requirements



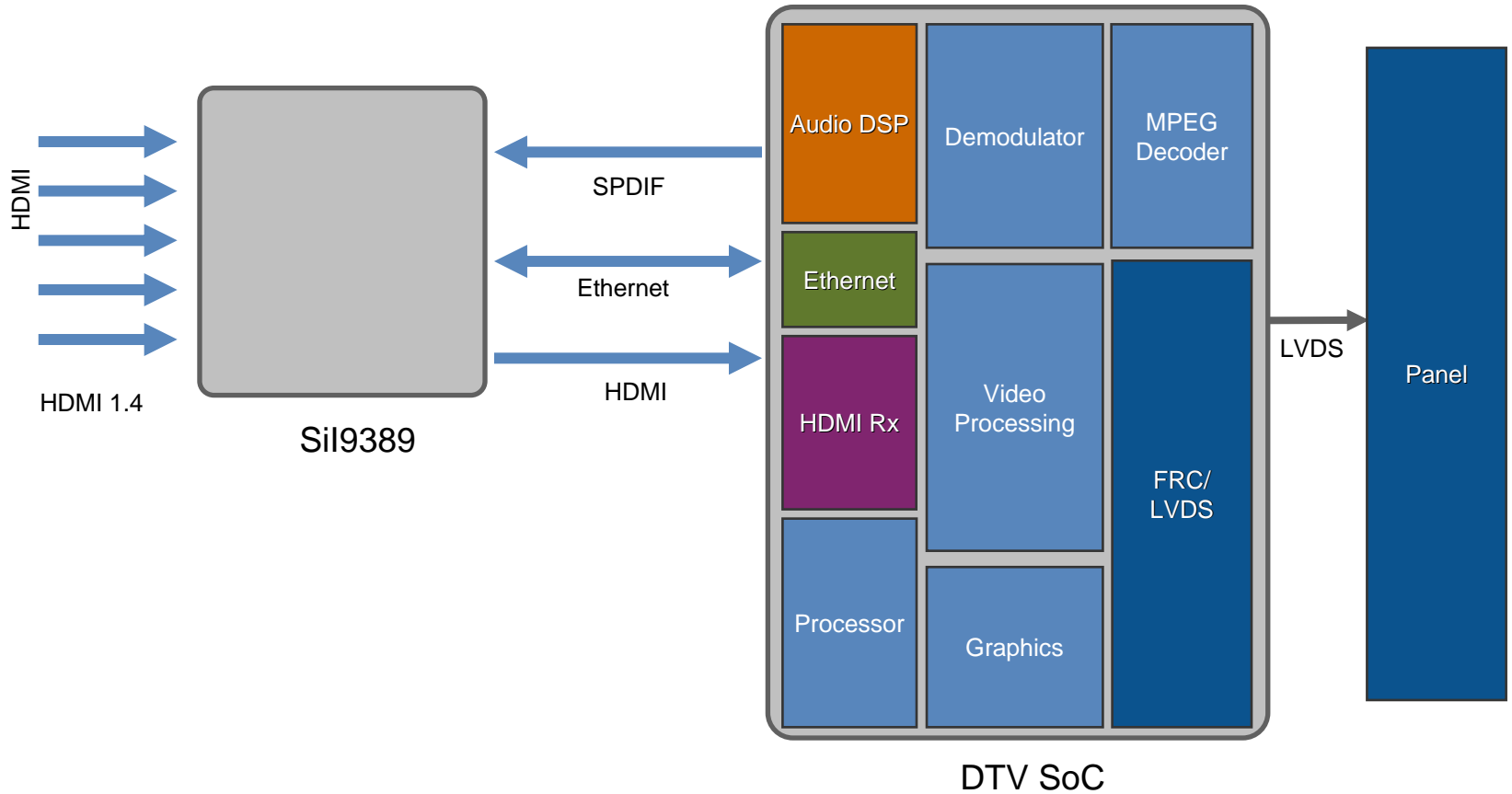
Interfaces

- HDMI
- Ethernet (PHY, RMII)
- Transport Stream
- I2S
- SPDIF

Simple communication protocol

- I2C
- Interrupts

DTV with Sil9389 Port Processor





Implementing HDMI 1.4

Key Features



Content Type Bits



3D Over HDMI



Audio Return Channel



HDMI Ethernet Channel

Content Bits: What is it?



- Television automatically configures its image processing to match content type:
 - Graphics (text): Disable filtering for sharpest text
 - Photo: Apply color matching & disable video processing
 - Cinema: Enable de-judder, FRC, etc.
 - Game: Engage lowest-latency video processing
- Colorimetry data can now provide photo color matching

Content Bits: How?



- Sink announces capabilities via E-EDID
- Source device inserts data in AVI InfoFrame
- Sink parses incoming AVI InfoFrames

Content Bits: Silicon Image Solution



- The Sil9387 and 9389 Port Processors automatically parse AVI InfoFrames
- Status stored in registers on Port Processor, accessible via I2C
- On change, Port Processor sends interrupt to CPU
- Result: Quick, simple, accurate implementation of new Content Type Bits and Colorimetry features

3D over HDMI: What is it?



- New formats for supporting 3D TV

Formats	Resolution	HDMI 1.4 3D	TMDS	SiI9389CTU
Frame Packing	1920x1080p @ 23.97 & 24Hz	Mandatory	225MHz	Yes
	1280x720 @ 59.940Hz & 60Hz	Mandatory	225MHz	Yes
	1280x720 @ 50Hz	Mandatory	225MHz	Yes
	1080p @ 50Hz/60Hz	Optional	300MHz	
Field Alternative	1080i @ 50/60Hz	Optional	225MHz	
	1080p @ 50Hz/60Hz	Optional	300MHz	
Line Alternative	1080i/720p @ 50/60Hz	Optional	225MHz	Yes
	1080p @ 50Hz/60Hz	Optional	300MHz	
Side-by-Side Full	1080i/720p @ 50/60Hz	Optional	225MHz	Yes
Side-by-Side Half		Optional	225MHz	Yes
L+Depth		Optional	225MHz	Yes

3D over HDMI: How?



- Very similar to Content Bits:
 - Sink announces capabilities via E-EDID
 - Source device inserts data in AVI InfoFrame
 - Sink parses incoming AVI InfoFrames
- Most 3D formats fall within bandwidth of 120 Hz TV
- TV vendor can use variety of methods to separate the frames:
 - Polarization multiplex
 - Wavelength multiplex
 - Active LCD shutter glasses, triggered via filtered LED on TV
 - Time varying polarization
 - Multi-view filter, etc...

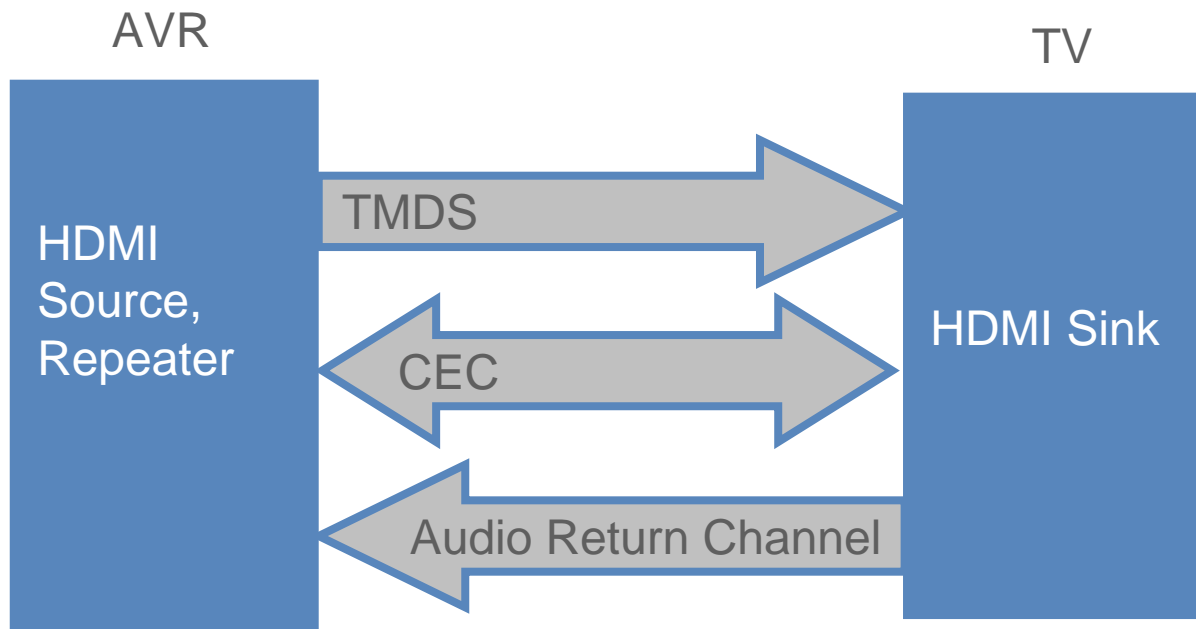
3D over HDMI: Silicon Image Solution



- The Sil9389 Port Processors automatically parse AVI InfoFrames for 3D content
- Status is stored in registers on Port Processor
- On change, Port Processor sends interrupt to CPU
- CPU reads Port Processor registers via I2C
- Result: Faster implementation of 3D solutions

Audio Return Channel: What is it?

- Ability for television (sink) to transmit SPDIF signal *backward*, to a source device (AVR or sound bar)
- Eliminates SPDIF cable from TV to amplifier



Audio Return Channel: How?



- SPDIF signal must be modulated over pins 14 and/or 19
- Software handshake, using HDMI capability discovery and control, must bring up link

OLD

PIN	Signal Assignment
1	TMDS Data2+
3	TMDS Data2-
5	TMDS Data1 Shield
7	TMDS Data0+
9	TMDS Data0-
11	TMDS Clock Shield
13	CEC
15	SCL
17	DDC/CEC Ground
19	Hot Plug Detect

PIN	Signal Assignment
2	TMDS Data2 Shield
4	TMDS Data1+
6	TMDS Data1-
8	TMDS Data0 Shield
10	TMDS Clock+
12	TMDS Clock-
14	Reserved (N.C. on device)
16	SDA
18	+5V Power

NEW

PIN	Signal Assignment
1	TMDS Data2+
3	TMDS Data2-
5	TMDS Data1 Shield
7	TMDS Data0+
9	TMDS Data0-
11	TMDS Clock Shield
13	CEC
15	SCL
17	DDC/CEC Ground / HEAC Shield
19	Hot Plug Detect / HEAC-

PIN	Signal Assignment
2	TMDS Data2 Shield
4	TMDS Data1+
6	TMDS Data1-
8	TMDS Data0 Shield
10	TMDS Clock+
12	TMDS Clock-
14	Utility / HEAC+
16	SDA
18	+5V Power

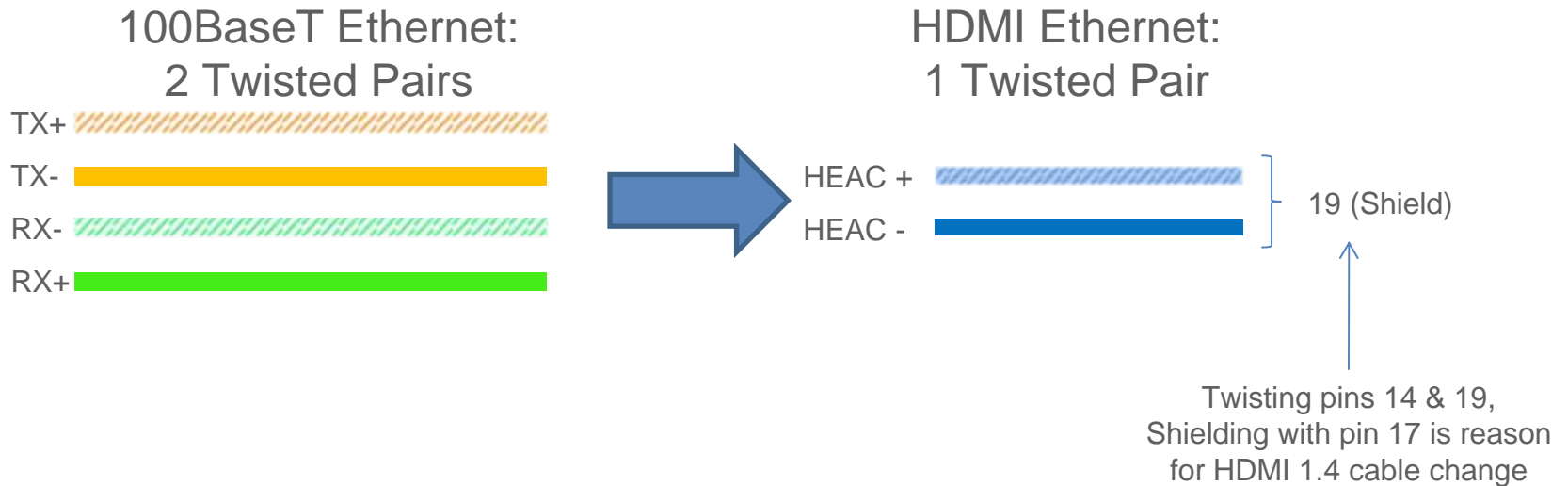
Audio Return Channel: One Pin or Two?

- Audio Return Channel can use one pin or two
- Single Mode: SPDIF over pin 14 only
- Common Mode: SPDIF over pins 14 *and* 19
- Common Mode used when HDMI Ethernet Channel is used
- ***Problem:*** If Common Mode device toggles hot plug (5v), audio and Ethernet will be dropped
- ***Solution:*** Use CDC_HPD, which can send a re-authenticate message when Common Mode is engaged

HDMI Ethernet Channel



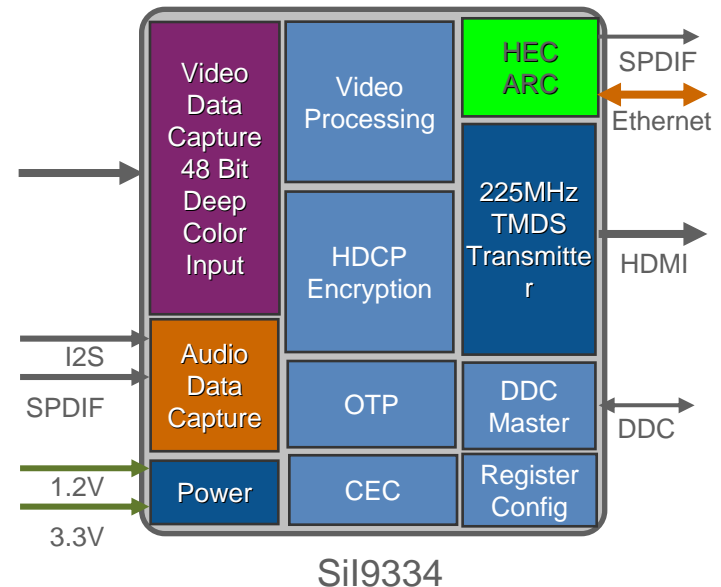
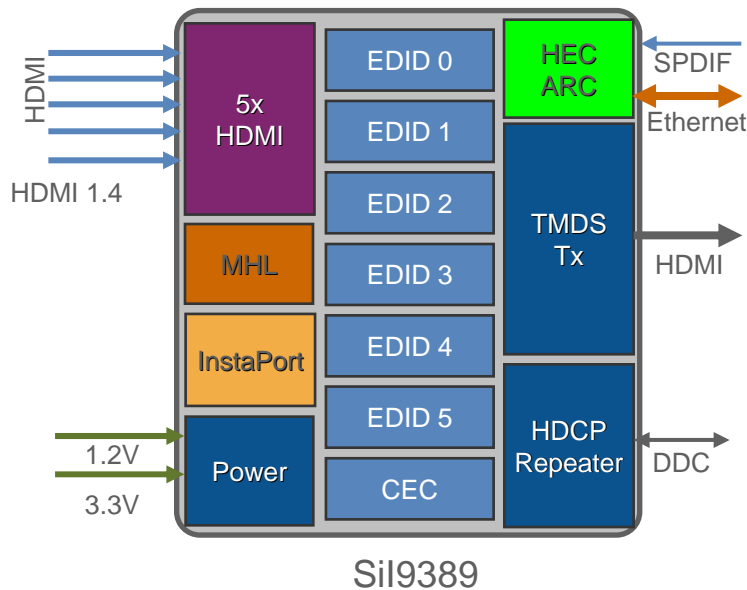
- 100 Mb Ethernet
- Modulated over pins 14 and 19
- Software handshake, using HDMI capability discovery and control (CDC), must bring up link



HDMI Ethernet Channel Hardware



- Ethernet must be switched; hubs are not allowed
- Silicon Image provides a hybrid PHY design:
 - Translates 4-pin Ethernet and SPDIF into HDMI Ethernet/Audio
 - Available on Sil9389 HDMI Port Processor
 - Available on Sil9334 HDMI Transmitter



HDMI Ethernet/Audio Channel Software

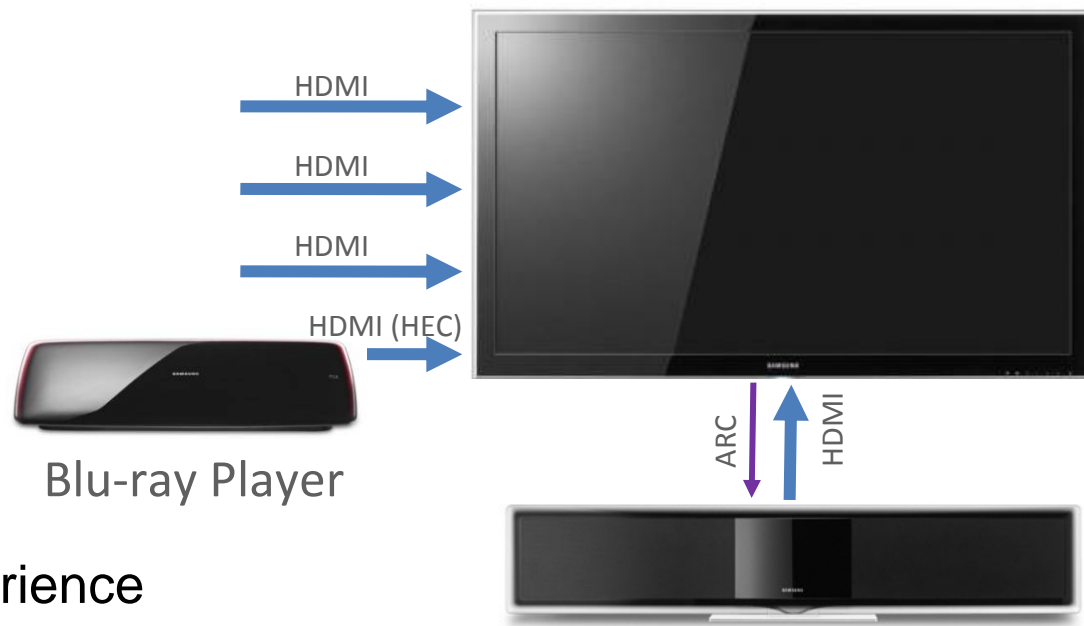


- HDMI 1.4 Spec mandates Capability Discovery and Control (CDC) software stack
- Silicon Image provides this software
- Silicon Image software built on drivers which insulate software developers from register changes across model years



Examples

The Integrated Living Room

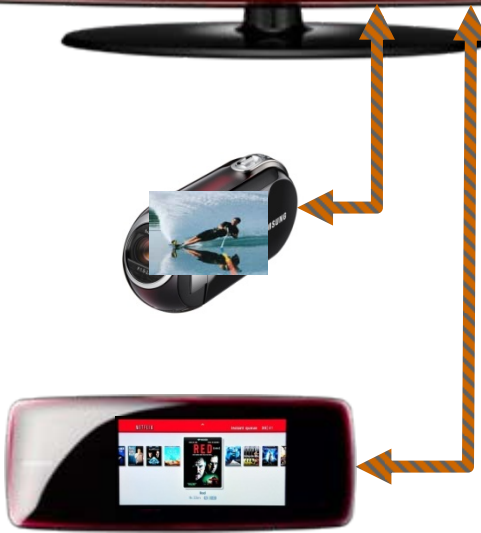


- Best consumer experience
- WiFi supports TV and Blu-ray Disc™ player
- TV controls sound bar
 - Power
 - Volume
 - Control sound field based on HDMI Content Bit values
 - Mute TV when sound bar is on
 - Display message if sub-woofer is disconnected

The Integrated Home

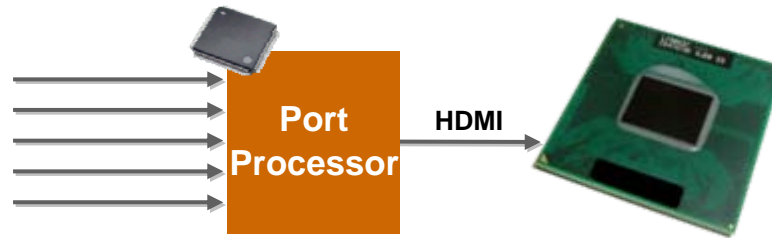


LiquidHD
HDMI 1.4



LiquidHD technology adds to HDMI 1.4, sharing content with **all screens** in the home

Port Processor Innovations



instaport™

High Speed Port Switching
Innovating within the HDMI standard

Audio Return

Channel

HDMI Ethernet

Channel

New Connectivity Technologies
Integrate the Living Room

liquid™ HD

Digital Entertainment Unleashed
Integrate the whole home

A photograph of two boxers in a ring. The boxer on the left is wearing red gear, including a red headgear with "GREEN HILL" visible. The boxer on the right is wearing blue gear, including a blue headgear and blue gloves with white accents. The boxer in blue is in the middle of a punch towards the boxer in red. The background is dark with some blurred lights. A semi-transparent grey box with white and orange text is overlaid on the lower left portion of the image.

Port Processors
Deliver the Innovation
in the HDMI Spec

HDMI[™]
HIGH-DEFINITION MULTIMEDIA INTERFACE



Thank You!

Silicon Image, Inc.