Developing Products for HDMI® Specification 1.4

Vincent Hsia
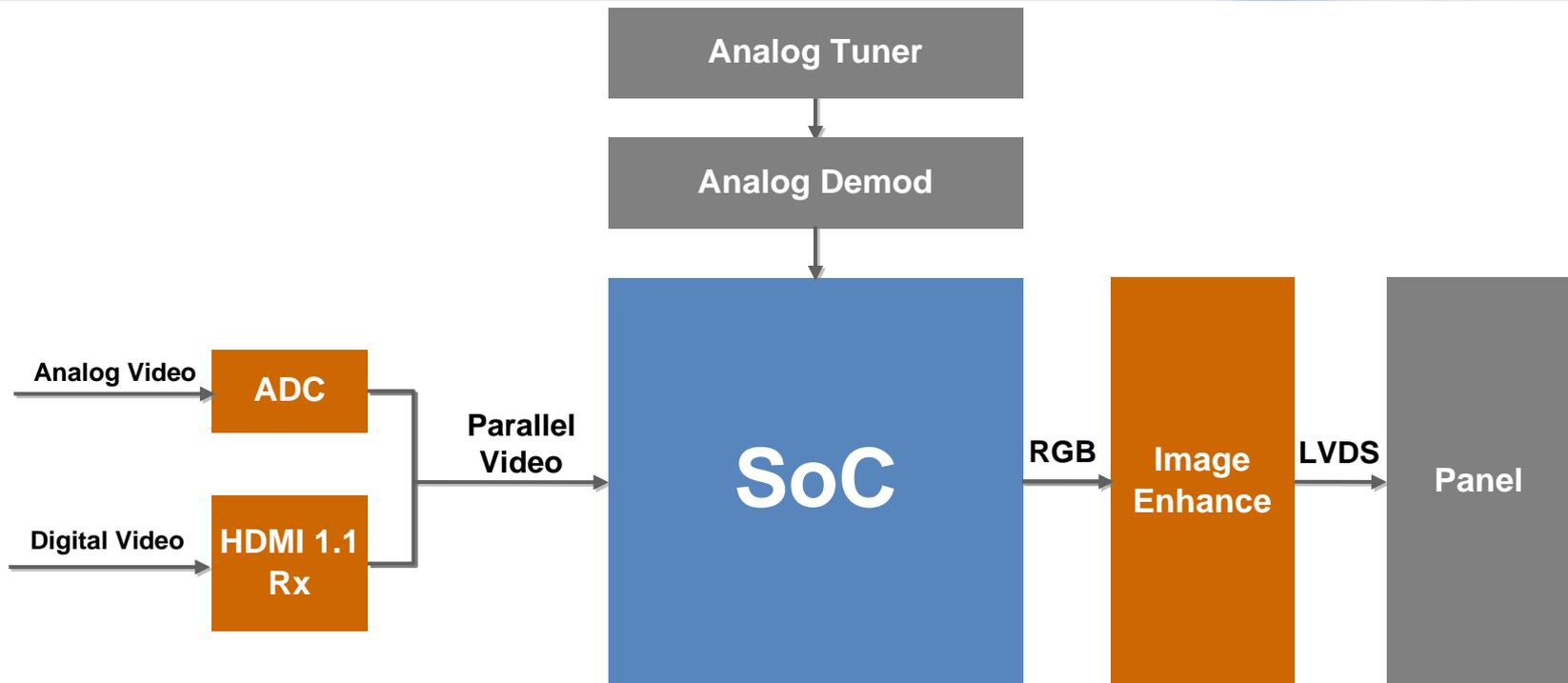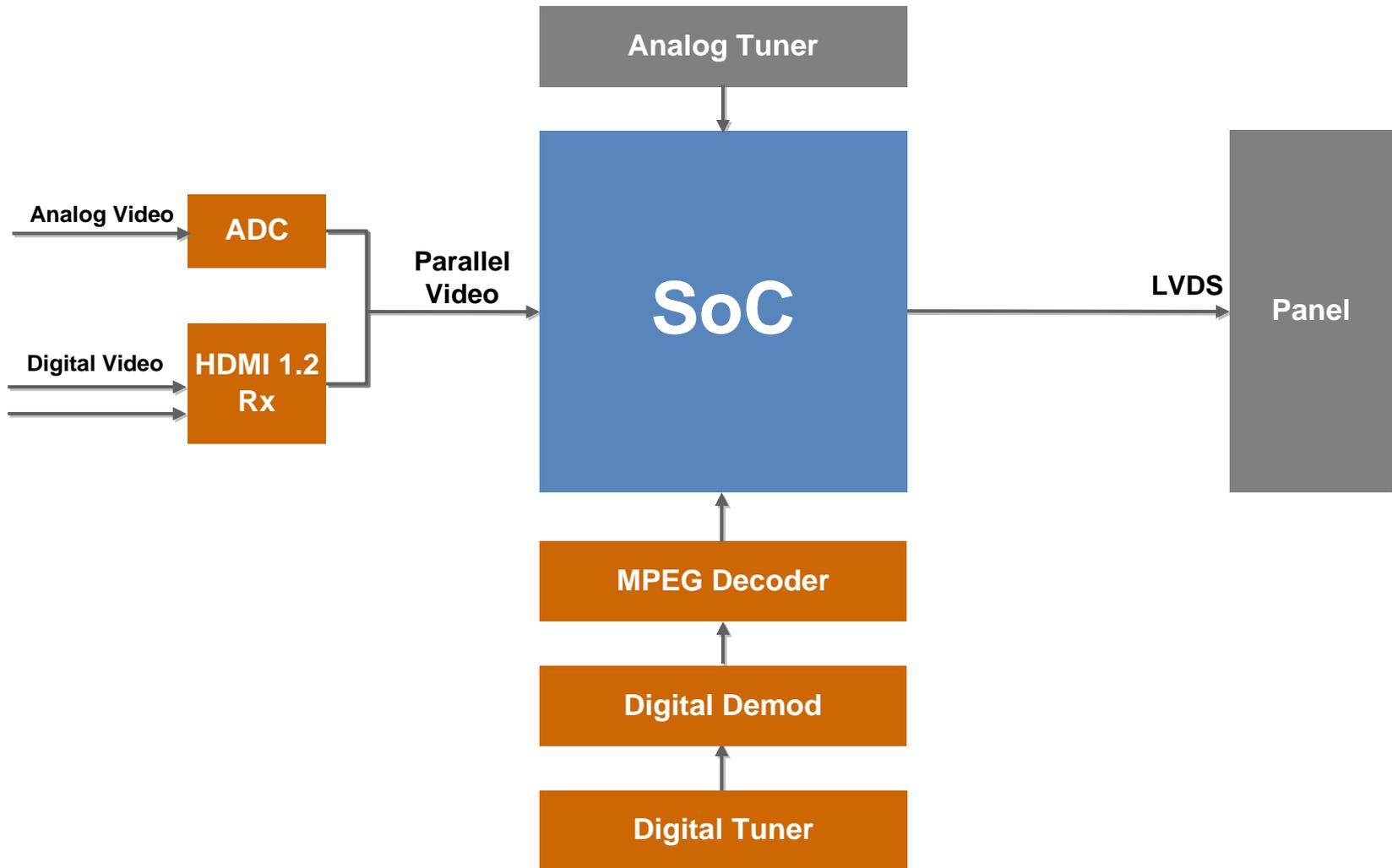
Silicon Image, Inc.

Who Needs Innovation?
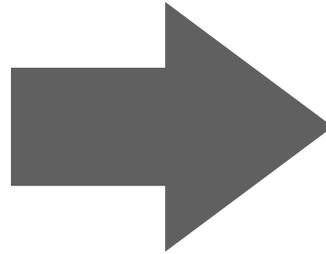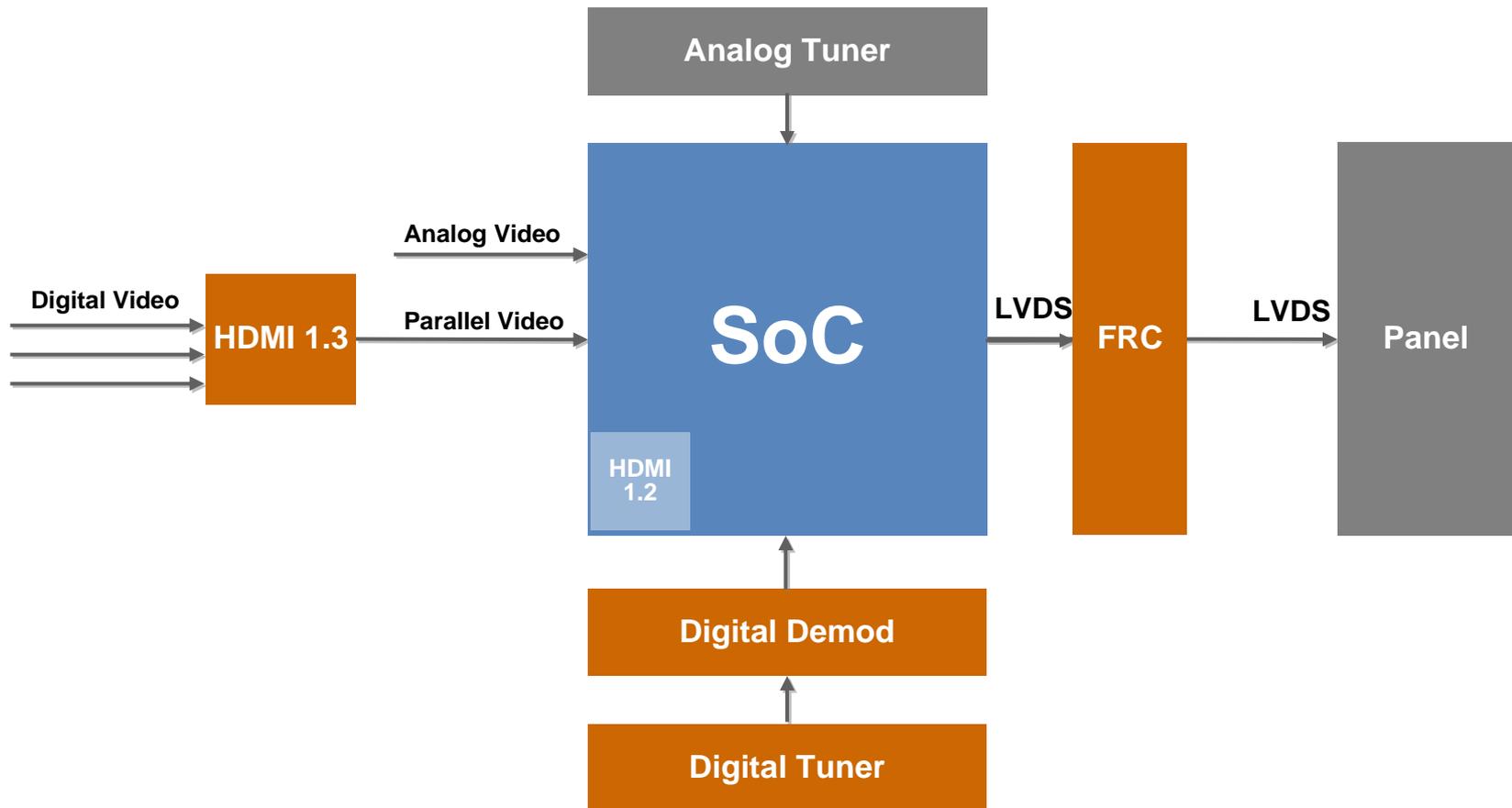
Innovations become checkbox items
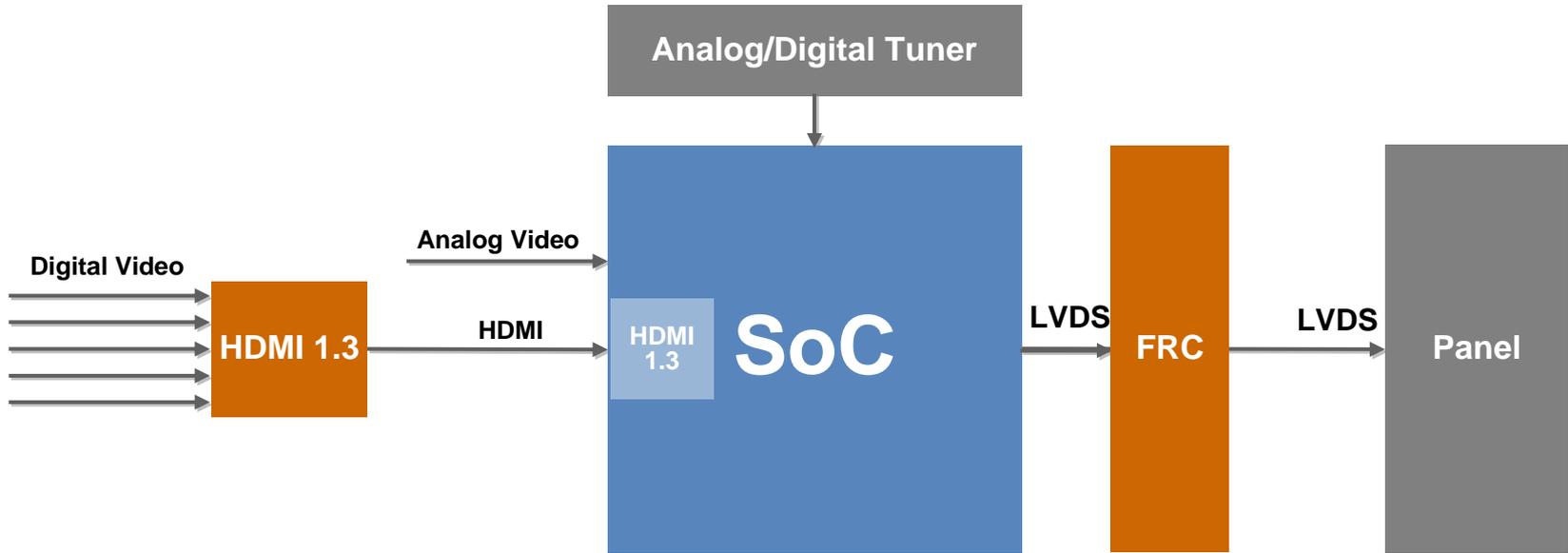
2005 Flat Panel TV

2006 Flat Panel TV

2007 Flat Panel TV

2008 Flat Panel TV

Digital Video → **HDMI 1.3** → HDMI → **SoC** (HDMI 1.3)

Analog Video → **SoC**

Analog/Digital Tuner → **SoC**

SoC → LVDS → **FRC** → LVDS → **Panel**

HDMI 1.4
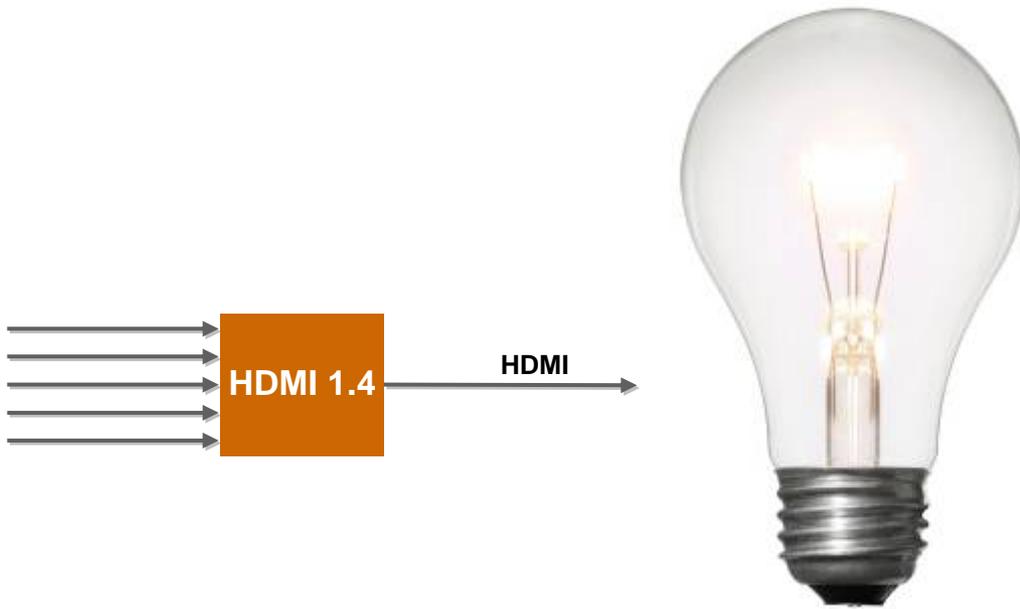
HDMI

A platform to introduce innovation

HDMI Has Become a Bus Within the DTV
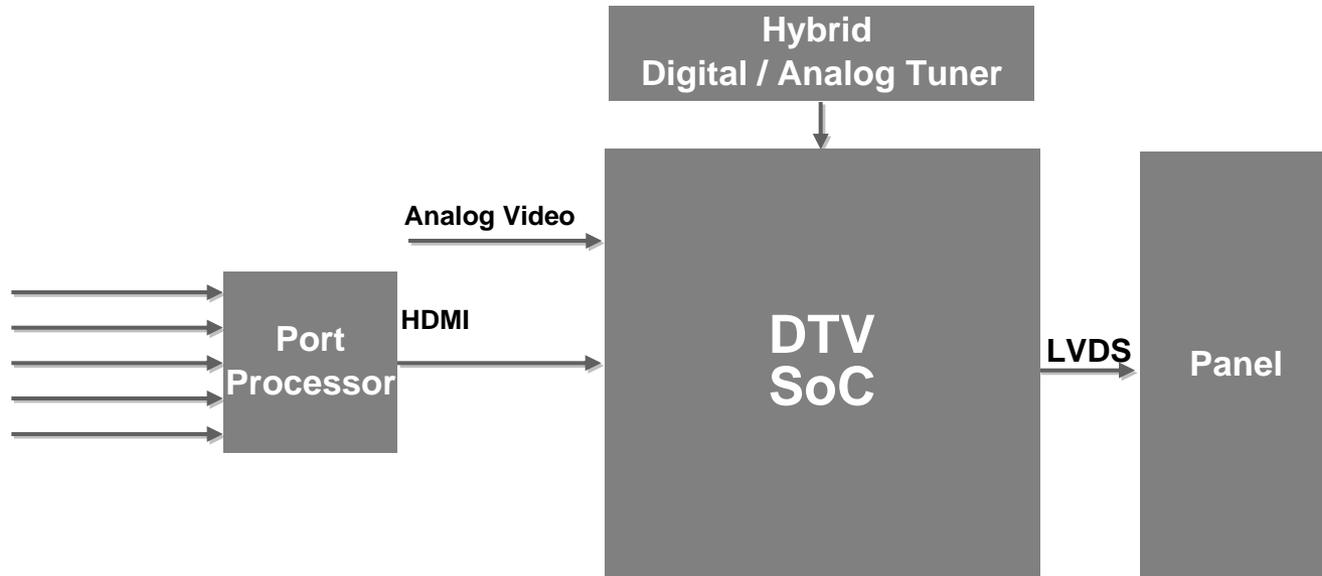
Three Sources of Innovation

Port Processor Innovation

Analog Tuner

Analog Video

Port Processor

HDMI

DTV SoC

LVDS

TCON

To Panel

Digital Tuner
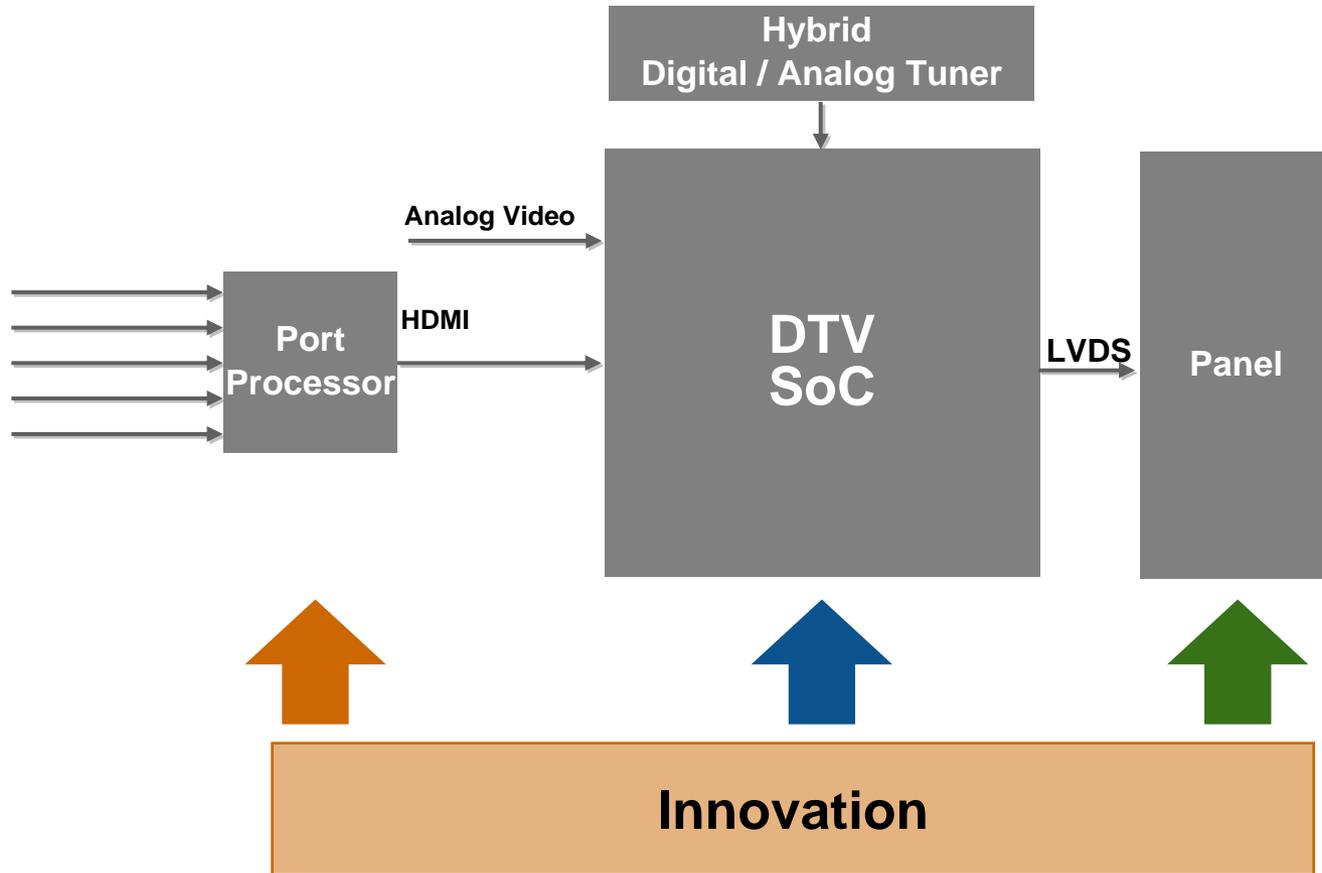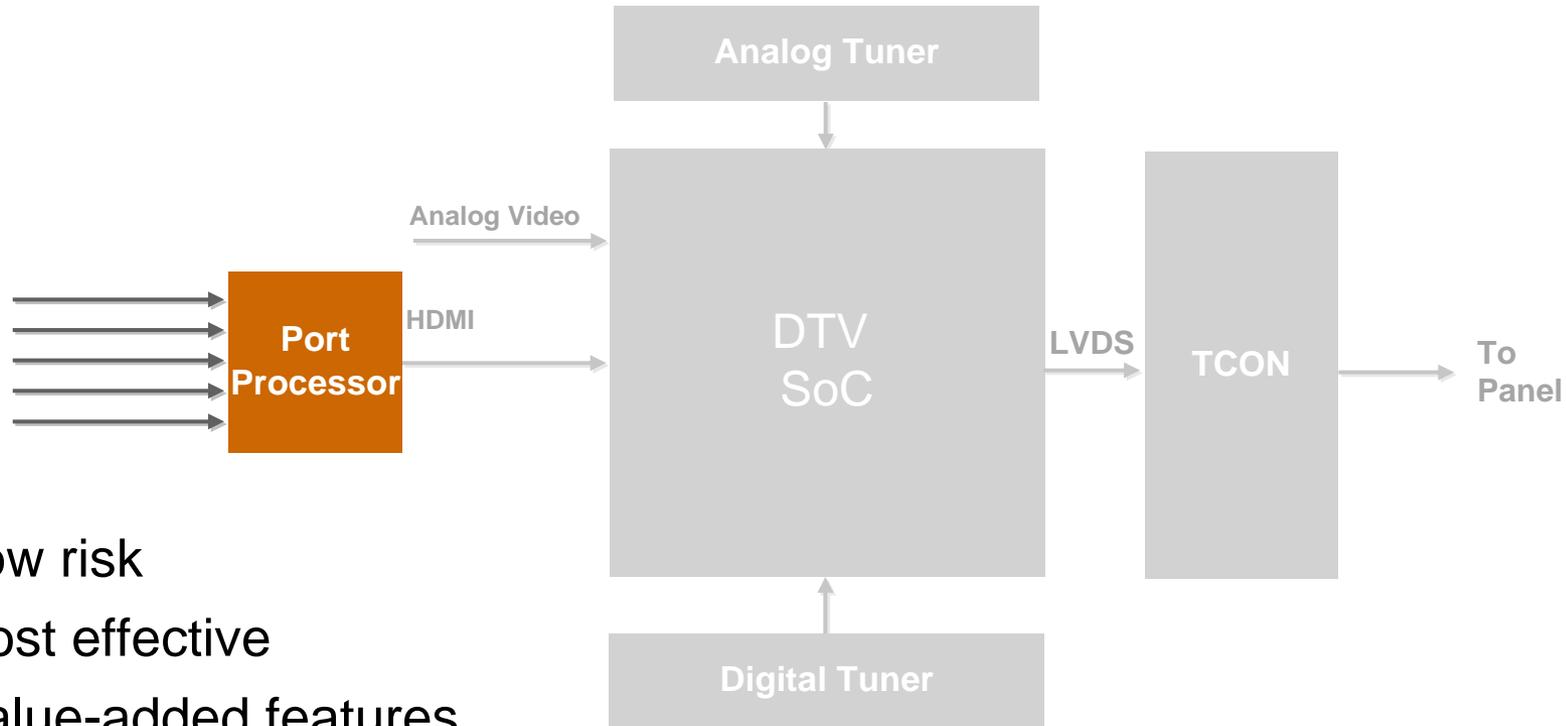
Low risk

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

New Features

Entry-Level

Products

Mid-Range / High-End

Products

More Integration
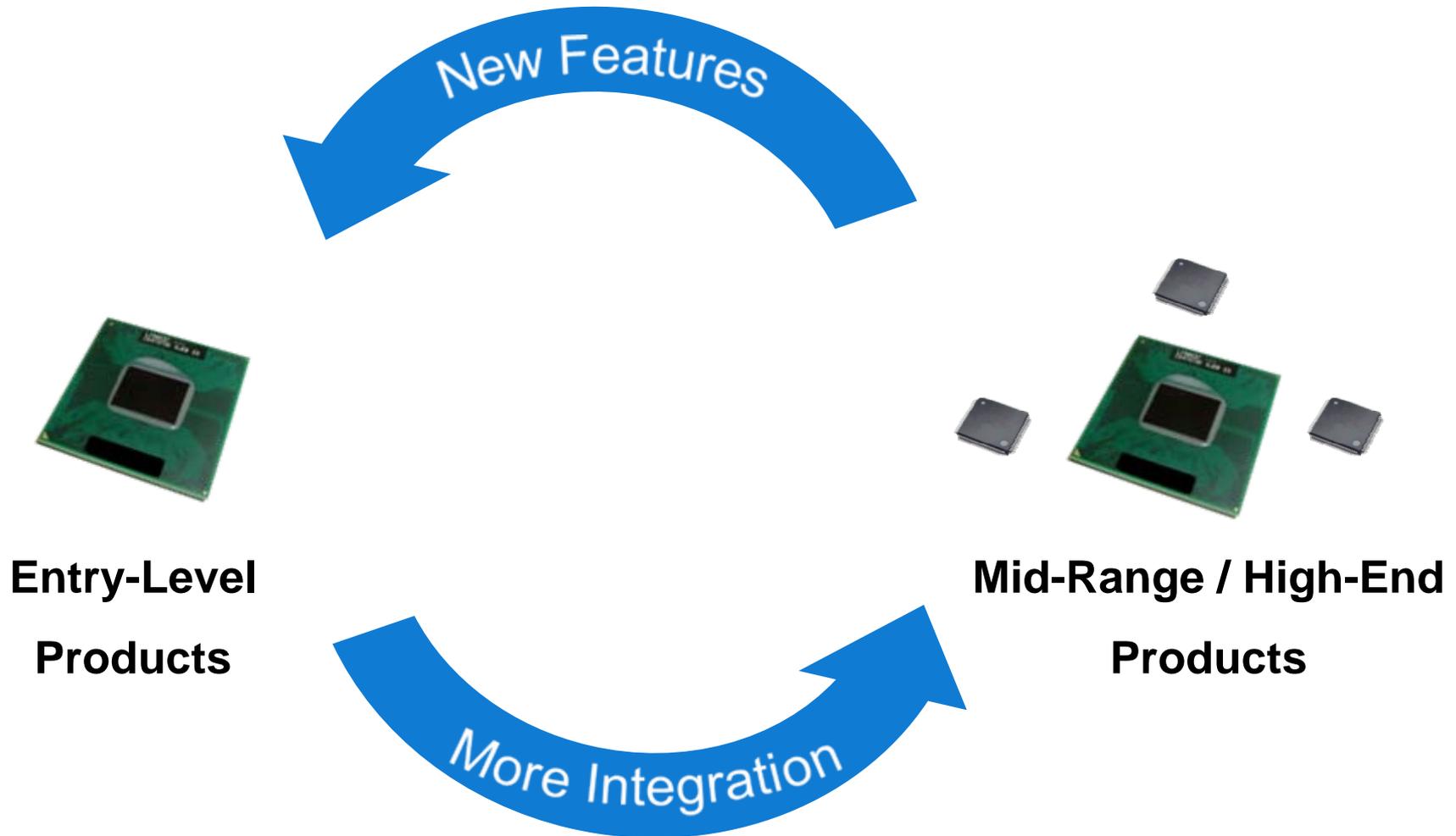
Examples of Port Processor Innovation

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: liquidHD™
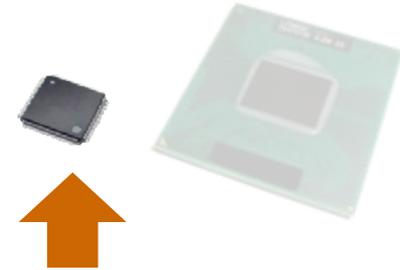
Port Processor

DTV SoC Requirements
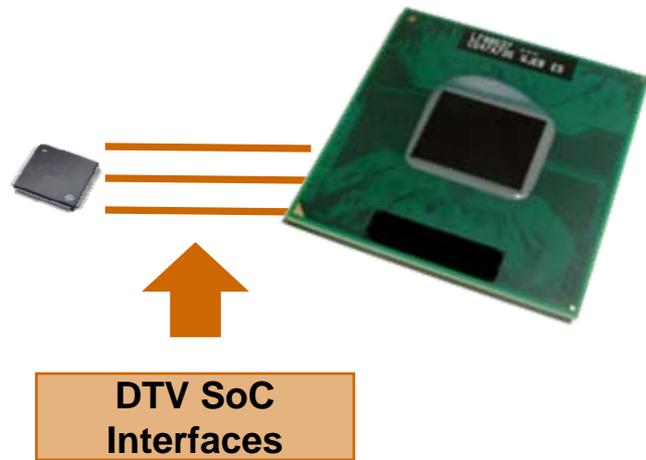
DTV SoC Interfaces

Interfaces

– HDMI

– Ethernet (PHY, RMII)

– Transport Stream

– I2S

– SPDIF

Simple communication protocol

– I2C

– Interrupts

DTV with SiI9389 Port Processor

SiI9389

HDMI

HDMI 1.4

SPDIF

Ethernet

HDMI

Audio DSP

Ethernet

HDMI Rx

Processor

Demodulator

Video Processing

Graphics

MPEG Decoder

FRC/ LVDS

LVDS

Panel

DTV SoC
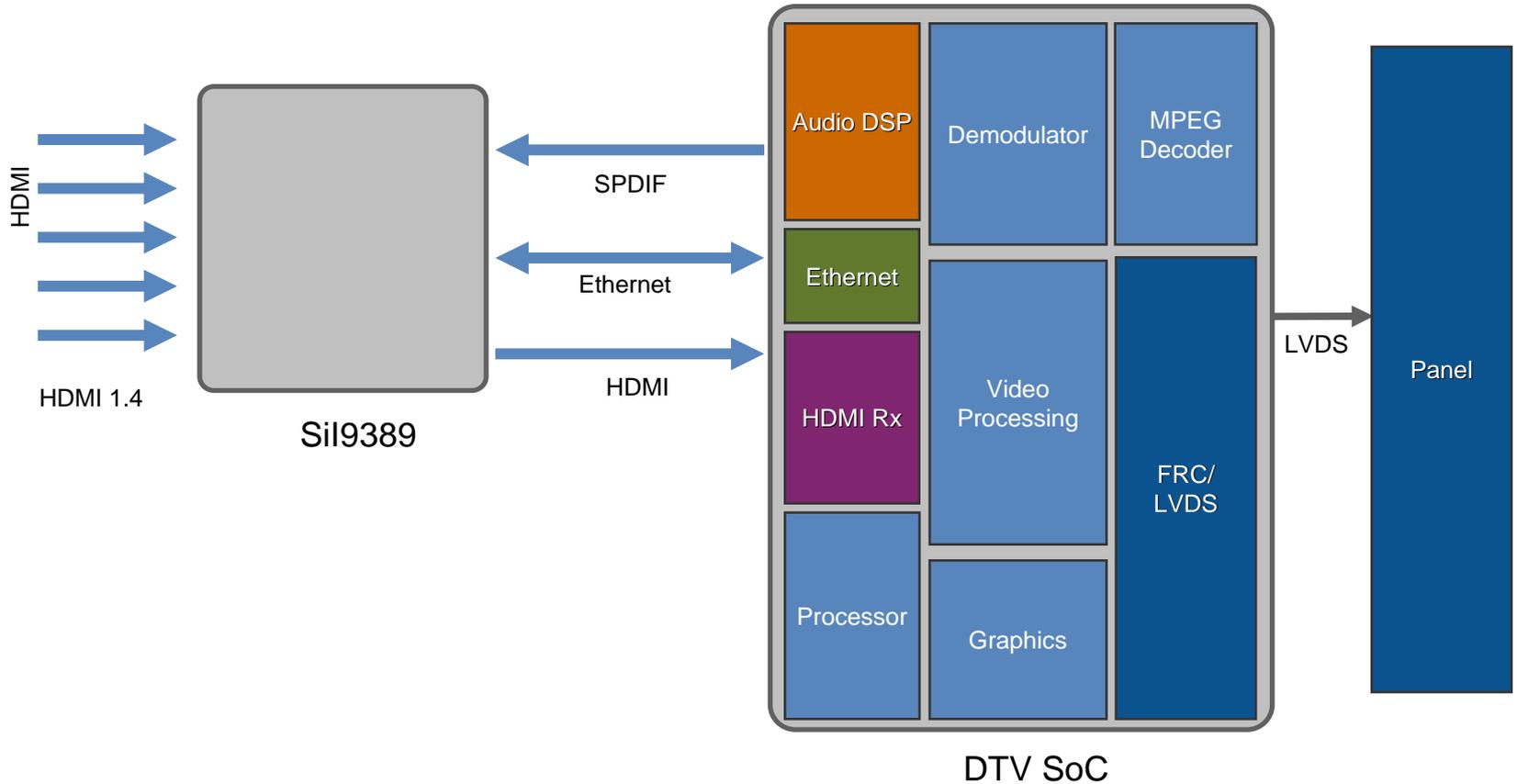
Implementing HDMI 1.4

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 SiI9387 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 SiI9389 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

AVR

TV

HDMI Source, Repeater

HDMI Sink

TMDS

CEC

Audio Return Channel
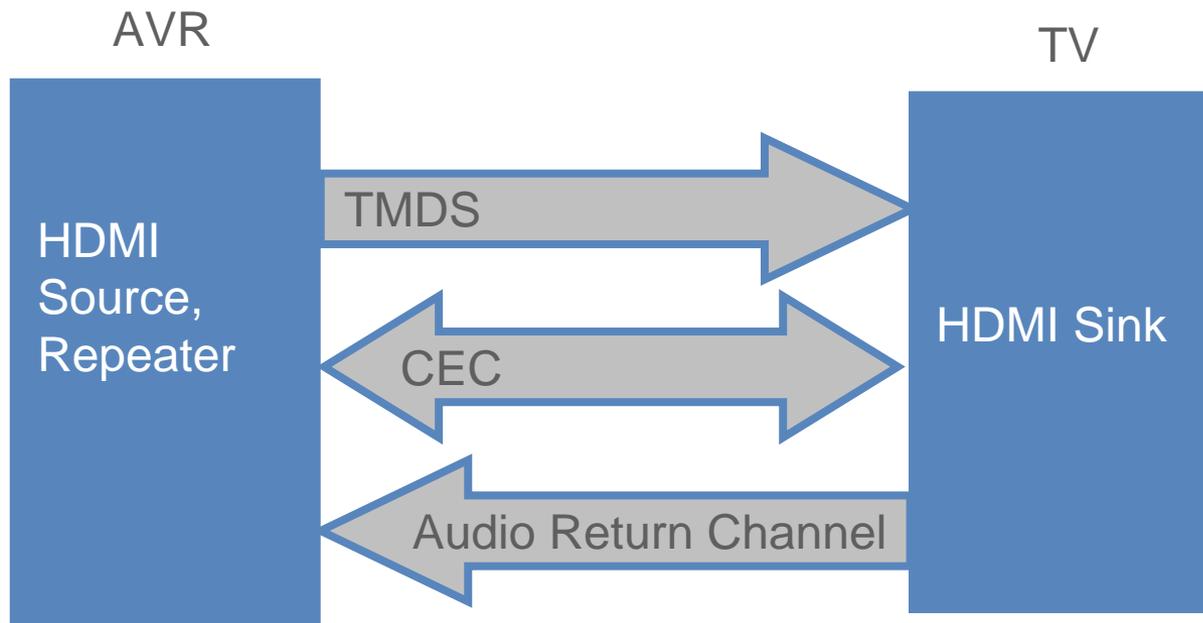
HDMI

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

HDMI

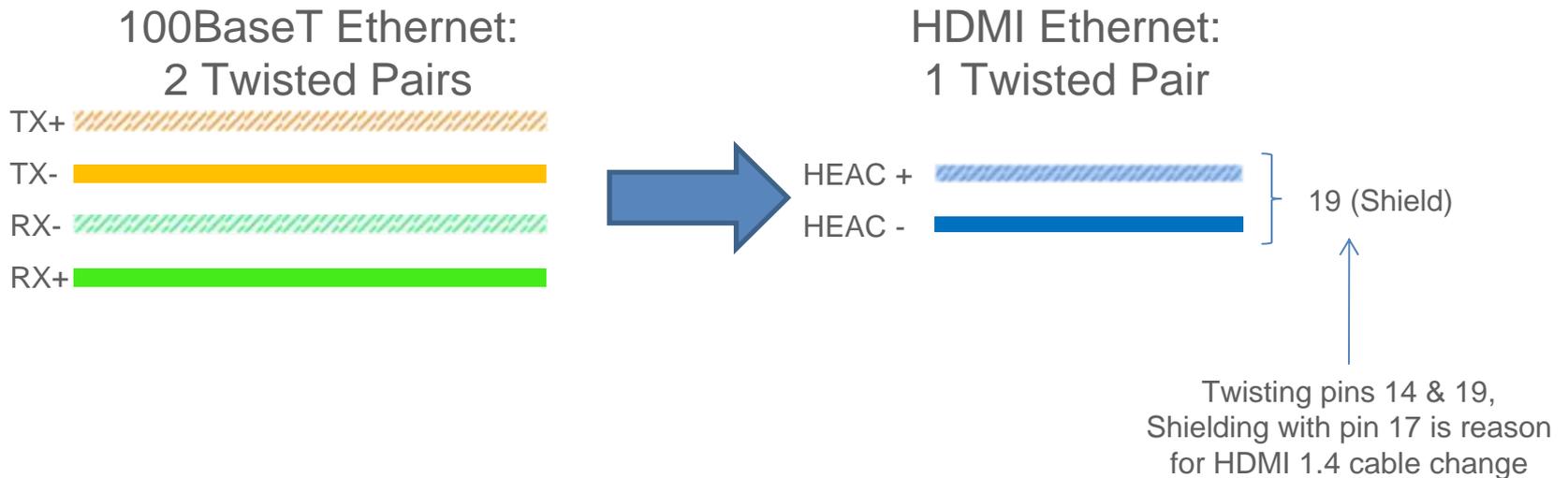# Audio Return Channel: One Pin or Two?

- 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
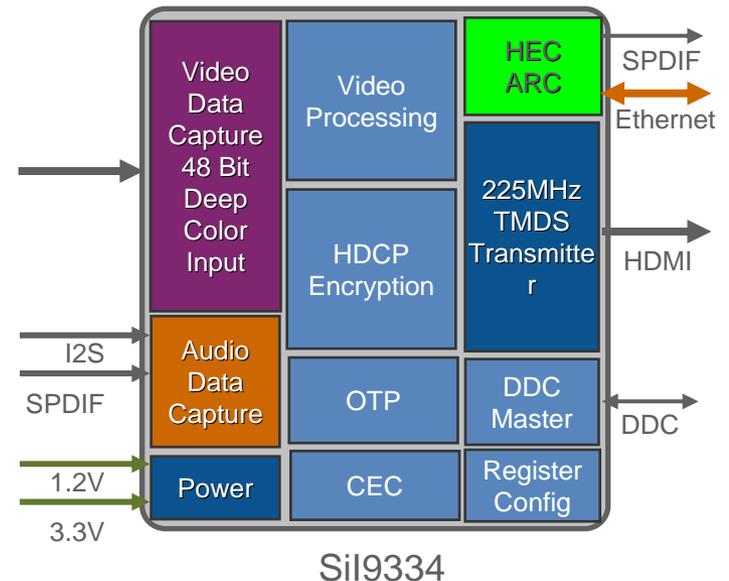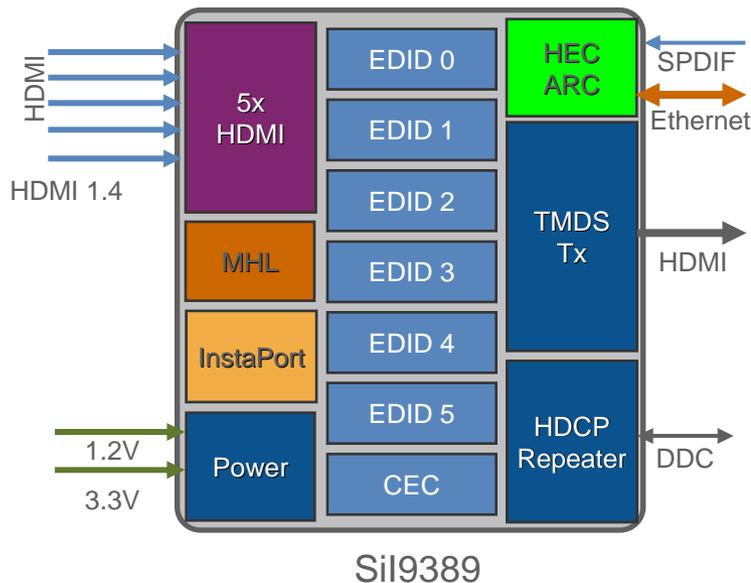
HDMI Ethernet Channel

- 100 Mb Ethernet

- Modulated over pins 14 and 19

- Software handshake, using HDMI capability discovery and control (CDC), must bring up link

100BaseT Ethernet:
2 Twisted Pairs

HDMI Ethernet:
1 Twisted Pair

TX+

TX-

RX-

RX+

HEAC +

HEAC -

19 (Shield)

Twisting pins 14 & 19,
Shielding with pin 17 is reason
for HDMI 1.4 cable change

HDMI™

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 SiI9389 HDMI Port Processor
    - Available on SiI9334 HDMI Transmitter


SiI9389

SiI9334

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

HDMI

HDMI

HDMI

HDMI (HEC)

Blu-ray Player

ARC   HDMI

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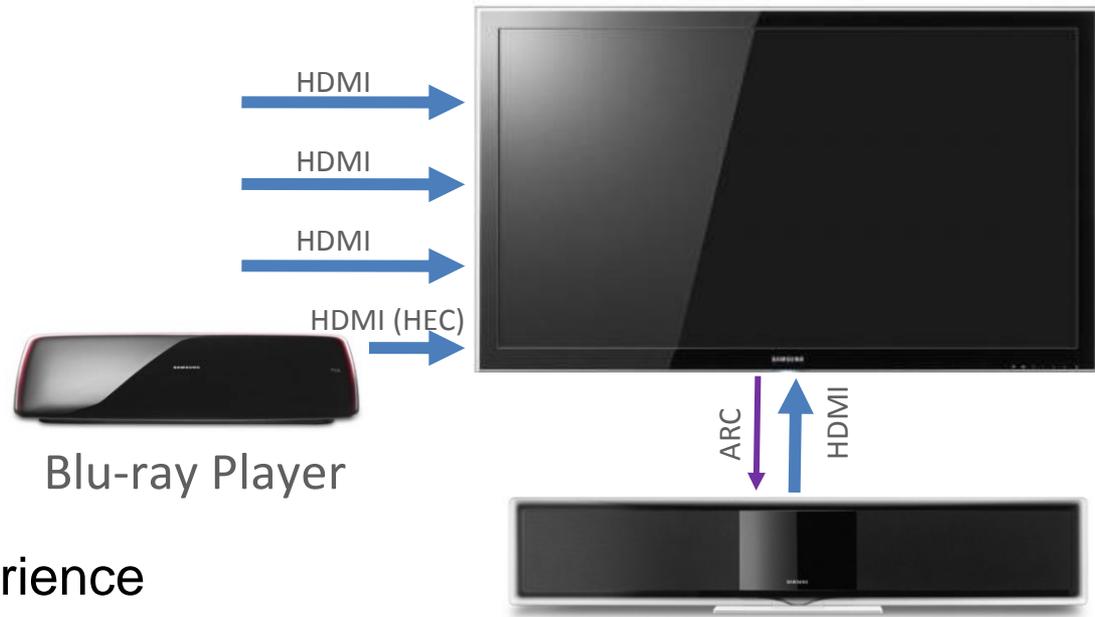
- Best consumer experience
- WiFi supports TV and Blu-ray Disc™ player
- TV controls sound bar
  - Power
  - Volume
  - Control sound field based on HDMI Content Bit values
  - Mute TV when sound bar is on
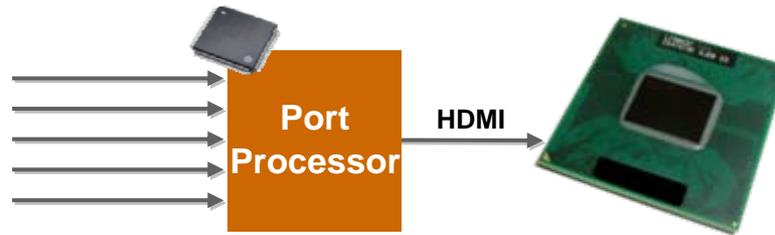 - Display message if sub-woofer is disconnected

HDMI

The Integrated Home

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

Port Processor Innovations

High Speed Port Switching
Innovating within the HDMI standard
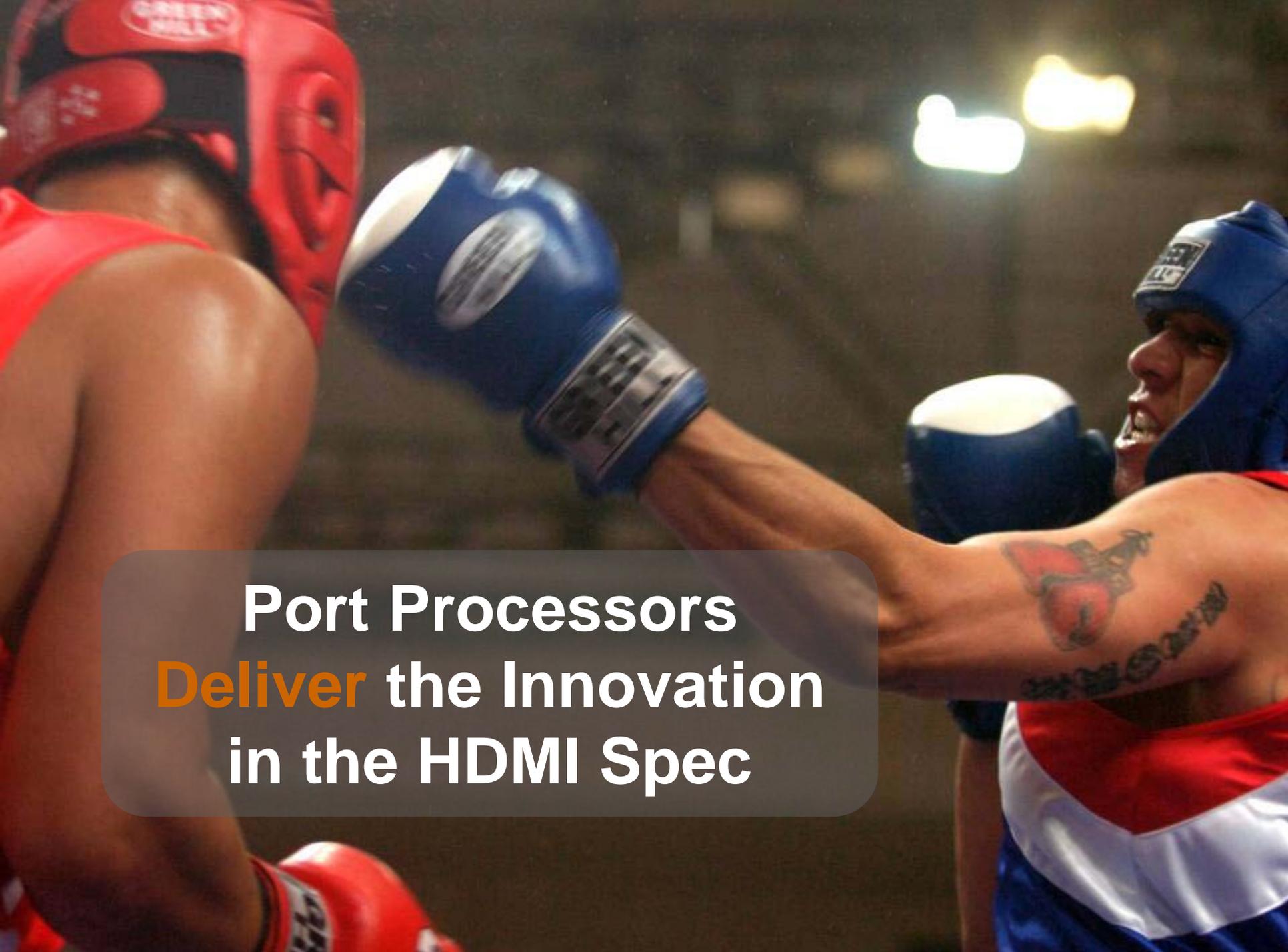
New Connectivity Technologies
Integrate the Living Room

Digital Entertainment Unleashed
Integrate the whole home

instaport™

*Audio Return
Channel*

*HDMI Ethernet
Channel*

liquid™HD

HDMI

Port Processors Deliver the Innovation in the HDMI Spec

Thank You!

Silicon Image, Inc.