Audio Subsystem Solutions
for Consumer SoCs

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Trends in audio

Internet-enabled devices
→ Support many audio formats

Multi-channel audio content
→ Support multi-channel audio formats

HD audio content
→ High sampling rates, 24-bit precision

Sound processing functions
→ Algorithms for improved audio quality

- Not a side activity on host processor
- Off-load to separate audio DSP

16-bit
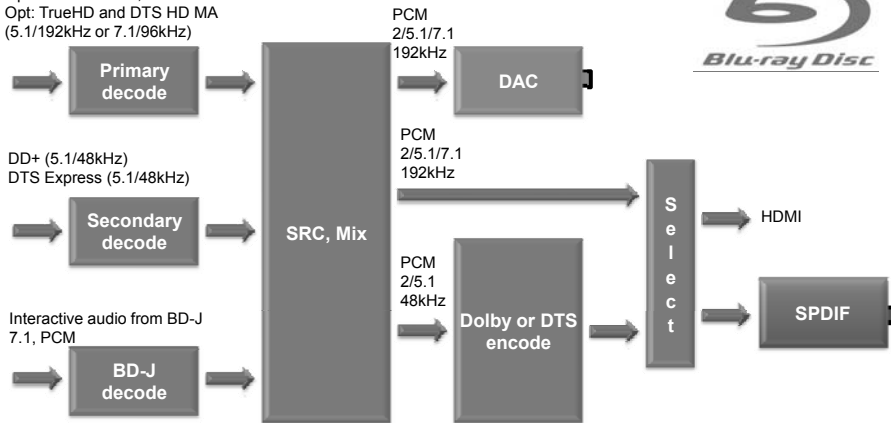Stereo
44.1kHz

1x

24-bit
7.1
192kHz

26x

Outline

- Audio subsystem solutions
  - Building   audio subsystems
  - Integrating   audio subsystems
  - Reusing   audio subsystems
- Conclusions
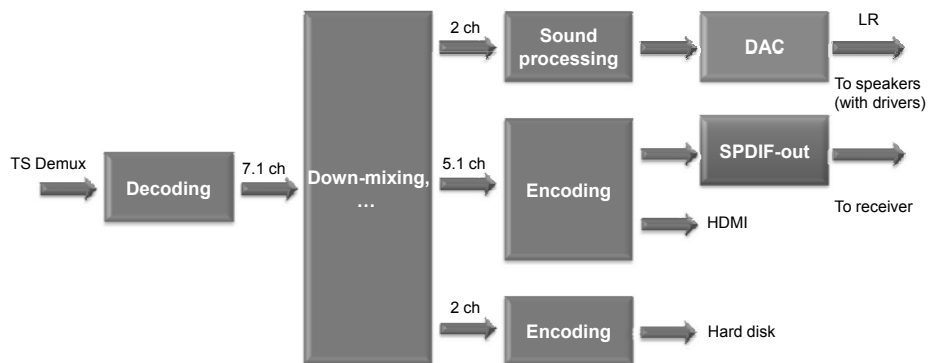
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Audio processing

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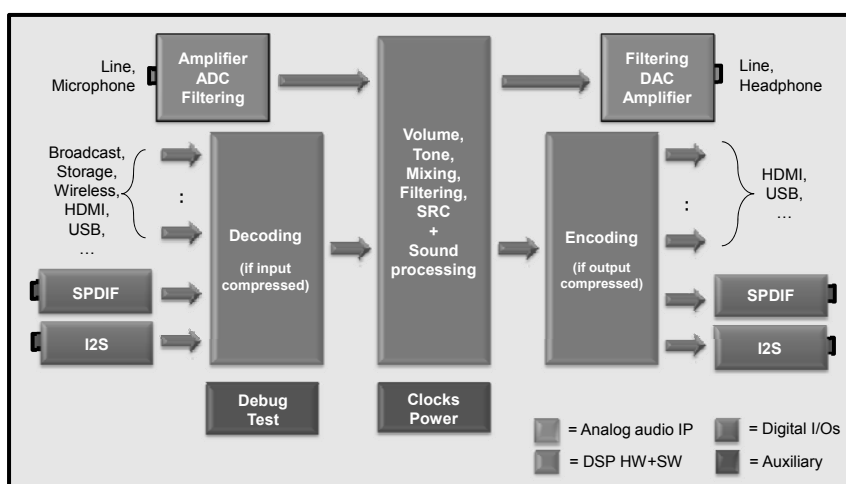
Use case Blu-ray playback

Mandatory: LPCM, DD, DTS
Opt: DTS HD HRA, DD+
Opt: TrueHD and DTS HD MA
(5.1/192kHz or 7.1/96kHz)

Primary decode

PCM
2/5.1/7.1
192kHz

DAC

DD+ (5.1/48kHz)
DTS Express (5.1/48kHz)

Secondary decode

SRC, Mix

PCM
2/5.1/7.1
192kHz

Interactive audio from BD-J
7.1, PCM

BD-J decode

PCM
2/5.1
48kHz

Dolby or DTS encode

Select

HDMI

SPDIF

Blu-ray Disc

DTV watch and record same channel

TS Demux

Decoding   7.1 ch

Down-mixing, ...

2 ch

Sound processing

DAC   LR

To speakers
(with drivers)

5.1 ch

Encoding

SPDIF-out

To receiver

HDMI

2 ch

Encoding

Hard disk

Including programmable delays for A/V sync

DTV watch and record different channels

TS Demux → **Decoding** → 7.1 ch → **Down-mixing, ...** → 2 ch → **Sound processing** → **DAC** → LR → To speakers (with drivers)

5.1 ch → **Encoding** → **SPDIF-out** → To receiver

HDMI

TS Demux → **Decoding** → 7.1 ch → **Down-mixing** → 2 ch → **Encoding** → Hard disk

Including programmable delays for A/V sync

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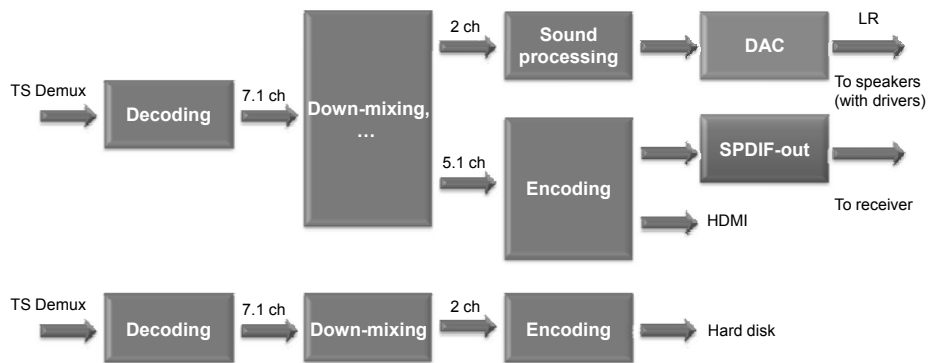
Building an audio solution from IP

DSP
Codecs
Sound processing
I2S
SPDIF
Analog front-end

DMA
Interrupts
Clocks
Reset
Drivers
OS / RTE
Media streaming framework
IPC
Host integration
Audio formats
APIs
Verification
A/V sync
Development platform

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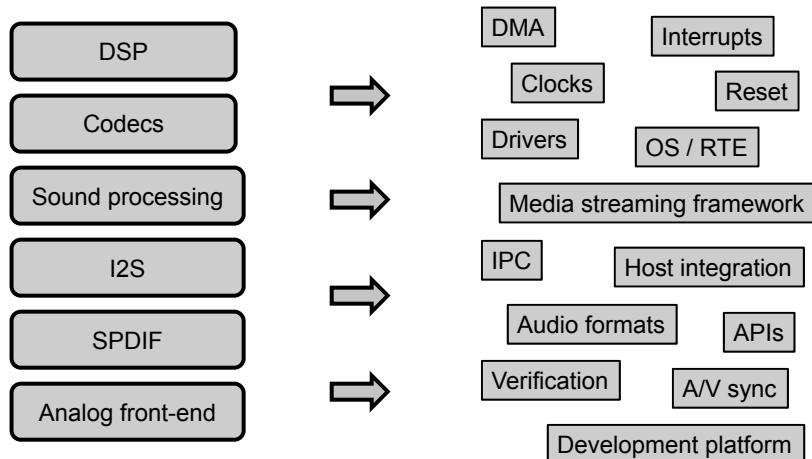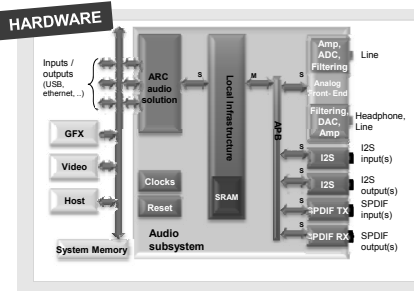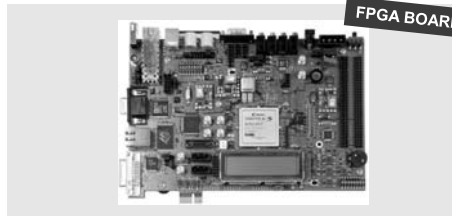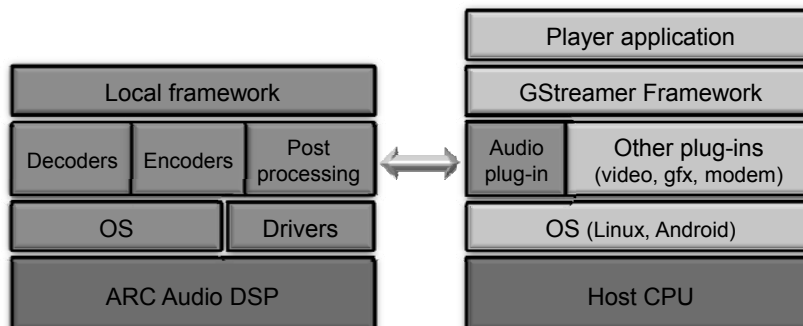
Alternative: audio subsystem

Complete Audio Solution:
- Software + Hardware
- Codecs + Sound Processing
- Digital + Analog Peripherals
- Host Plug-in Software
- Development Platform

FPGA BOARD

HARDWARE

Inputs / outputs (USB, ethernet, ..)

ARC audio solution

Local Infrastructure

APB

Amp, ADC, Filtering — Line

Analog front-End

Filtering, DAC, Amp — Headphone, Line

I2S — I2S input(s)

I2S — I2S output(s)

SPDIF TX — SPDIF input(s)

SPDIF RX — SPDIF output(s)

GFX

Video

Host

Clocks

Reset

SRAM

System Memory

Audio subsystem

SOFTWARE

Local framework

Decoders | Encoders | Post proc.

OS | Drivers

ARC Audio DSP

Player application

GStreamer Framework

Audio plug-in | Other plug-ins (open source, 3rd party)

OS (Linux, Android)

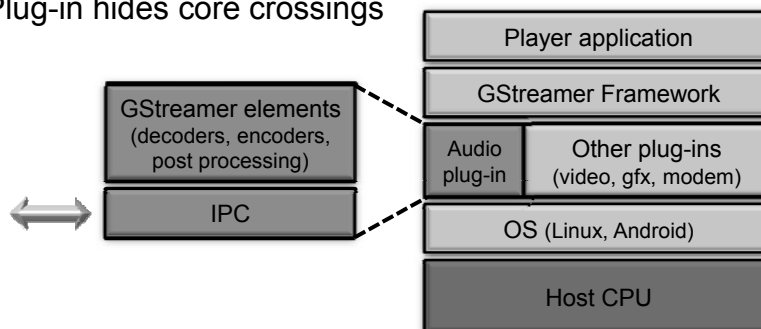Host CPU

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Host integration

- SW plug-in on Host CPU with standard API
- Audio functions visible on Host
- Build and execute use cases on Host (incl. audio, video, etc.)

Local framework

Decoders | Encoders | Post processing

OS | Drivers

ARC Audio DSP

Player application

GStreamer Framework

Audio plug-in | Other plug-ins (video, gfx, modem)

OS (Linux, Android)

Host CPU
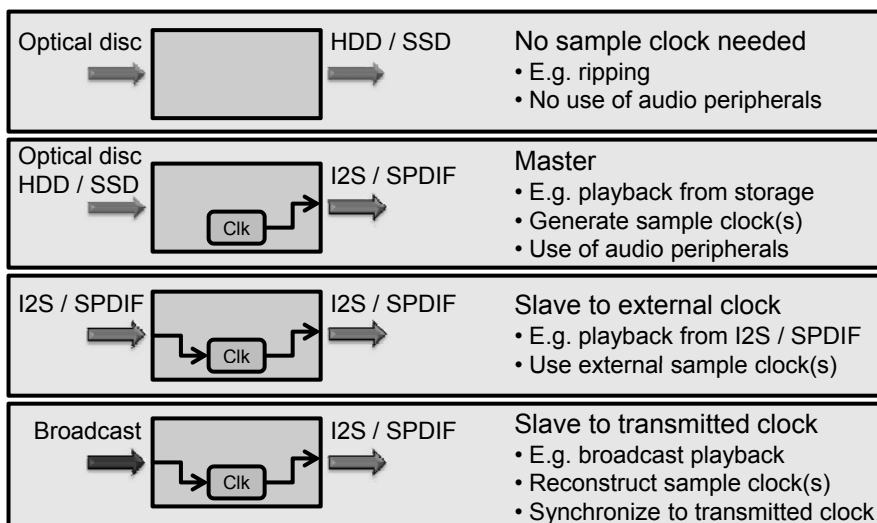
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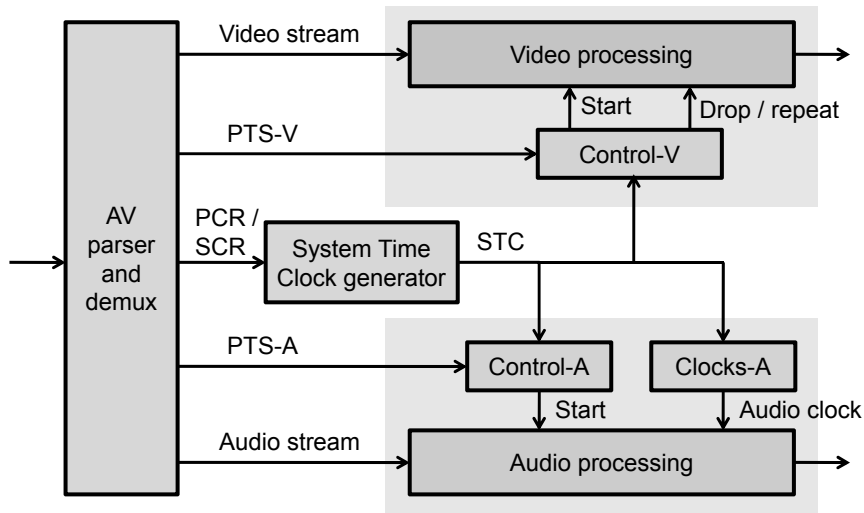
Host integration, SW plug-in

- SW plug-in implements small stubs for audio functions
- Audio functions can be created, started, stopped, etc.
- Audio functions can be hooked up in use cases
- Plug-in hides core crossings

| GStreamer elements (decoders, encoders, post processing) |
| IPC |

| Player application |
| GStreamer Framework |
| Audio plug-in | Other plug-ins (video, gfx, modem) |
| OS (Linux, Android) |
| Host CPU |

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Sample clocks

Optical disc → [ ] → HDD / SSD	**No sample clock needed** • E.g. ripping • No use of audio peripherals	
Optical disc HDD / SSD → [Clk] → I2S / SPDIF	**Master** • E.g. playback from storage • Generate sample clock(s) • Use of audio peripherals	
I2S / SPDIF → [Clk] → I2S / SPDIF	**Slave to external clock** • E.g. playback from I2S / SPDIF • Use external sample clock(s)	
Broadcast → [Clk] → I2S / SPDIF	**Slave to transmitted clock** • E.g. broadcast playback • Reconstruct sample clock(s) • Synchronize to transmitted clock	

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A/V synchronization (lip sync)

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Conclusions

- Audio subsystems have added value over a "bag of IP"
  - HW-SW integration, Clocks, Host integration

- Audio subsystem reuse
  - Instances derived from configurable template
  - Just like configurable IP

- Audio subsystems from external suppliers
  - Reduce development effort
  - Free-up engineering resources
  - Reduce time to market

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