Developing Audio Multimedia Solutions on the TI Jacinto/DaVinci™ Platform

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TEXAS INSTRUMENTS

Agenda

Multimedia Development

- Current Trends

- Software Requirements

- Approaches to Development

- Developing with TI Jacinto/DaVinci™

Current Trends

Trend: Device Convergence

Trend: Personalization

– Information, content, and the in-car experience

- **Connectivity to personal electronics devices, content, and services**
- **Enhancement of devices, content, and services for the automotive interior:**
  - Large screen for PND or phone
  - Audio system for portable personal music, video, and hands free
  - Location-aware services, RSS feeds and weblogs
- **Customizable user interface, multimodal**

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Challenge: Quality

– Automotive/consumer availability, safety, reliability and quality

- Consumer technologies and services **– embedded systems must embrace the latest and greatest**

- Brand quality perception **– can not be impacted by devices, content, services of dubious origins**

- Automotive interior enhancements **– must increase convenience and safety (multimodal)**

- Fast rate of change in consumer technology **– embedded systems must keep pace**

- Future-proof **– How to predict the iPod of 2011?**

Challenge: Simplicity

– Simple to use yet elegant to operate

- Scalability **– from cost effective for broad deployment to high-end for differentiation of product lines (especially automotive)**
- Complexity **– speech recognition, wireless technologies and DRM**
- Simplicity **– technology should simplify complex operations**
- Regulation **– hands-free and e911**

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Software Requirements

Software Requirements

- **Feature-richness**
  - Meet consumer expectations
  - Keep pace with consumer world
- **Automotive-centric design**
  - Fast boot
  - Small footprint, high performance
  - Real-time
- **Reliability**
  - Constant uptime
- **Branding control**
  - Configurable HMI
  - Configurable device behavior and media management
- **Future-proofing and field upgradeability**
  - Easily add new feature
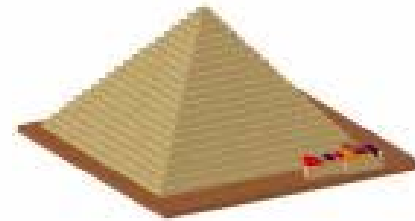 - Easily replace/upgrade software components
  - Network expansion

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Approaches to Development

Current Multimedia Development

- Build your own software
  - Take codecs (DSP) and add control logic
  - Can take many months/years of effort

Current Multimedia Development

- ## Use desktop Media Player SDK and modify/decompose to build embedded product
  - Involves removing many layers of software
  - Undetermined or unchangeable behavior
  - How to test for reliability?
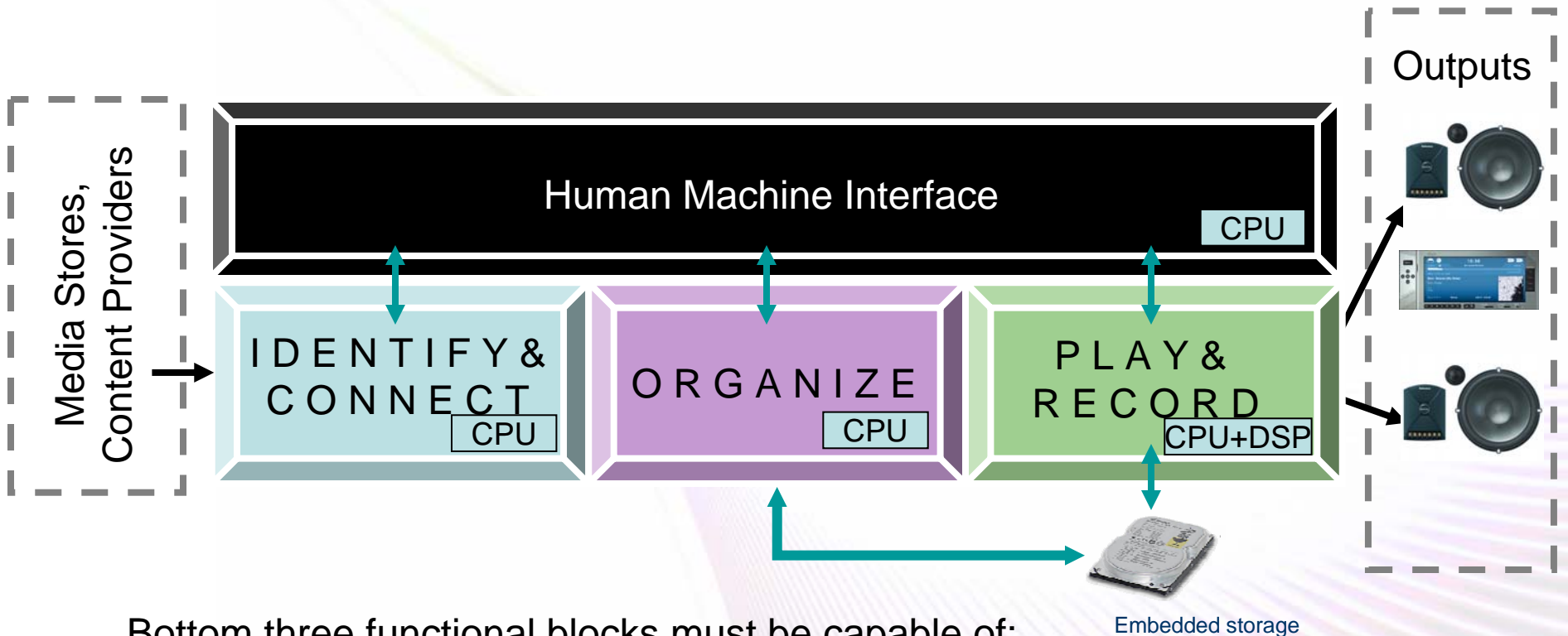 - Usually too large and slower than necessary

Development: A QNX / TI Approach

Multimedia Function Blocks

Outputs

Media Stores, Content Providers

Human Machine Interface
CPU

IDENTIFY & CONNECT
CPU

ORGANIZE
CPU

PLAY & RECORD
CPU+DSP

Embedded storage

Bottom three functional blocks must be capable of:
- Multiple simultaneous users / sessions / streams
- Being network ready
- Abstracting *hardware* dependencies from other blocks
- Abstracting *protocol* dependencies from other blocks
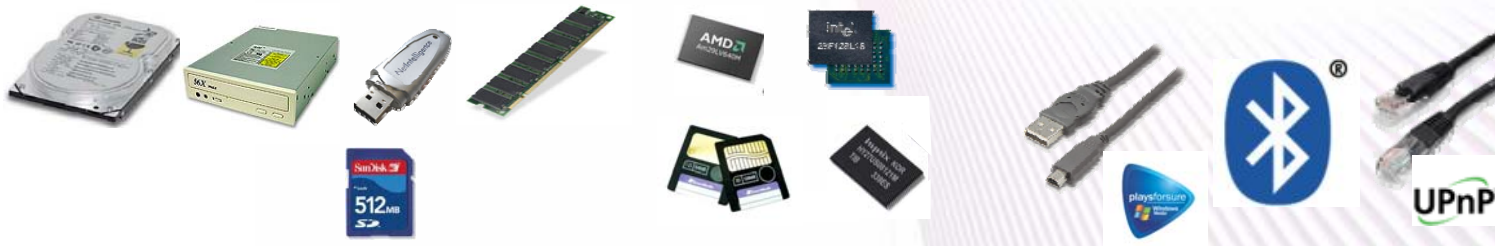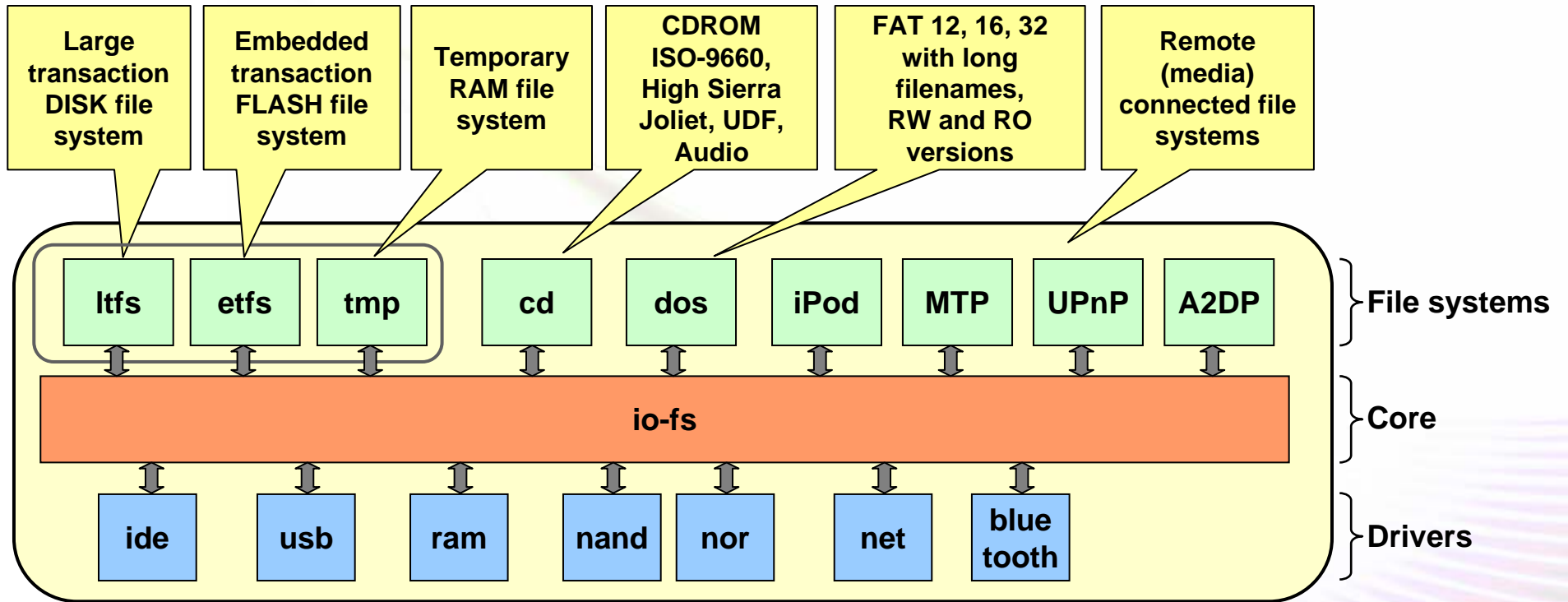
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TI | Developer Conference

Identify and Connect

Many different sources
     static and dynamic
Many different protocols
     iPOD Access Protocol
     Media Transfer Protocol (MTP)
     Some with DRM requirements
Many different file and stream formats
     DOS FAT32, UDF 2.01, RTP …

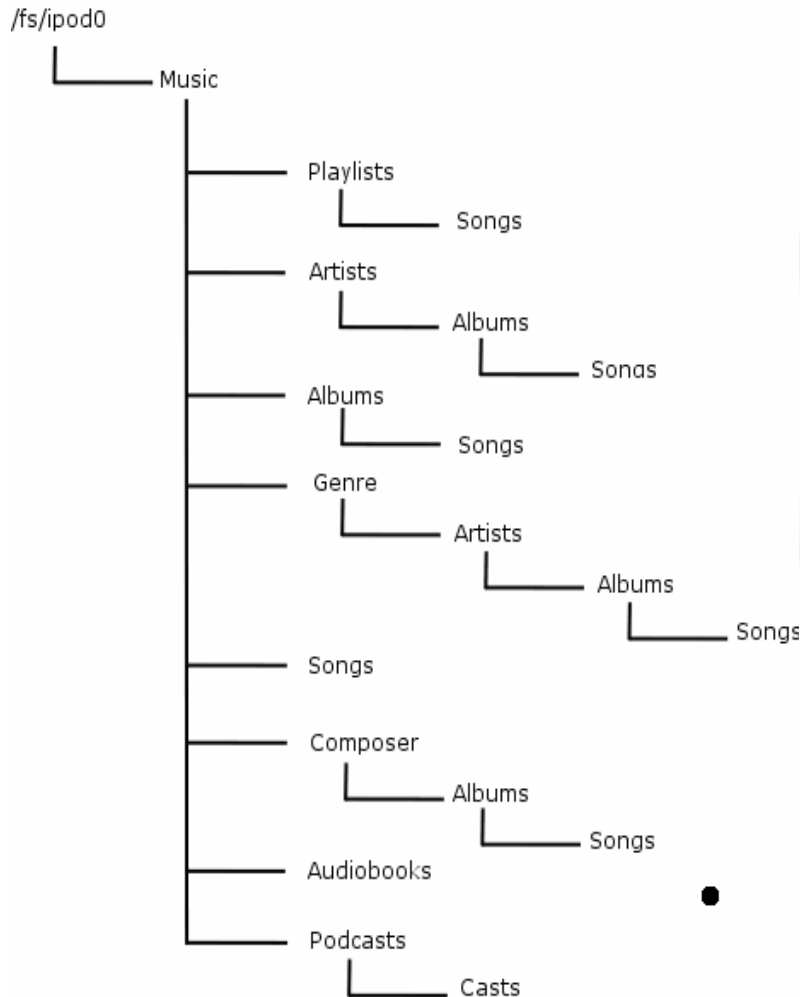Is there a way to unify yet allow expansion ?

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Io-fs: Unified File System

| Large transaction DISK file system | Embedded transaction FLASH file system | Temporary RAM file system | CDROM ISO-9660, High Sierra Joliet, UDF, Audio | FAT 12, 16, 32 with long filenames, RW and RO versions | Remote (media) connected file systems |

| ltfs | etfs | tmp | cd | dos | iPod | MTP | UPnP | A2DP | **File systems** |

| io-fs | **Core** |

| ide | usb | ram | nand | nor | net | blue tooth | **Drivers** |

Disks   USB   RAM   NOR/NAND   Device/Network

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Example: iPod

/fs/ipod0
 └── Music
      ├── Playlists
      │   └── Songs
      ├── Artists
      │   └── Albums
      │   └── Songs
      ├── Albums
      │   └── Songs
      ├── Genre
      │   └── Artists
      │   └── Albums
      │   └── Songs
      ├── Songs
      ├── Composer
      │   └── Albums
      │   └── Songs
      ├── Audiobooks
      └── Podcasts
           └── Casts

- POSIX file browsing of iPod contents
- Notification on insertion/removal
- Device Control (POSIX devctl)
  - DCMD_MEDIA_PLAY
    - Play selected track/playlist
  - DCMD_MEDIA_ARTIST
    - Get artist name
  - DCMD_MEDIA_NEXT_TRACK
    - Play next track

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Example: PlaysForSure

- POSIX file browsing of PlaysForSure contents
- Notification of insertion/removal
- Device Control (POSIX devctl)
  - DCMD_MEDIA_PLAY. Etc.
    - Play selected track/play list
- DRM extensions to MTP hidden in file system layer
  - Indirect license acquisition to obtain key
  - Periodic proximity check

/fs/pfs

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Io-fs is a 'Multimedia Filesystem'

- Cache is built for high throughput needs of multimedia
  - Uses logical cache instead of physical cache

- Cache units vary depending on file media type
  - E.g. mp3 uses 64K cache unit, mpeg uses 256K cache unit

- Cache rules vary depending on file media type
  - E.g. mp3 is set for sequential access with no cache re-use
  - Grow size of files is media type dependent
    - Reduces disk fragmentation

- Encryption options provide security for embedded storage
  - Encrypt on a global, disk partition or file basis

- Applications can reliably map cache blocks directly in to their own application space
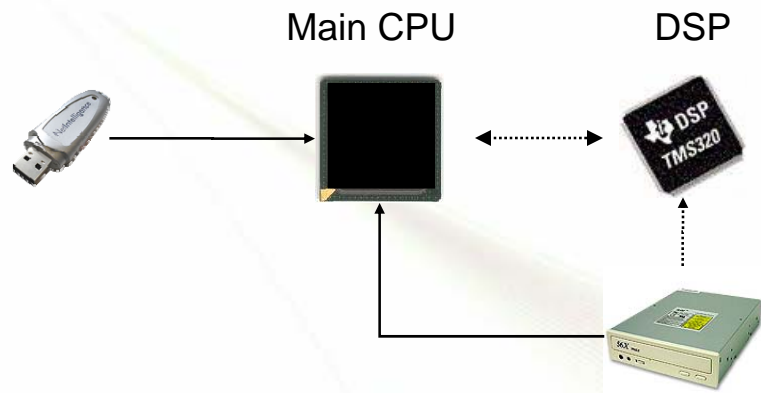 - Useful for high volume media streams requiring zero data copy from cache to application

Cache

Application

Direct Io DMA's directly into application buffer

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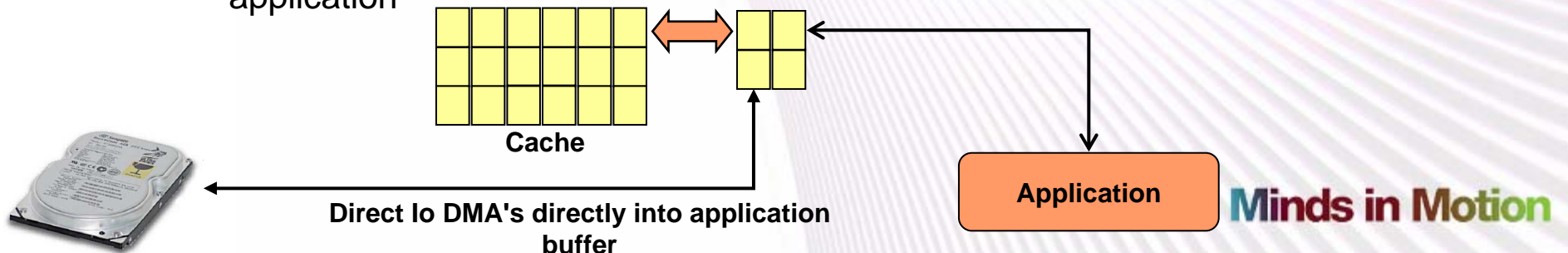
Play and Record

- ## Complexity of media types
  - Audio
    - MP3 [Standard, Pro]
    - WMA [9,10, Standard, Pro, Lossless]
    - AAC[+]
  - Video
    - MPEG-1, MPEG-2, MPEG-4, WMV, H.264, DivX and Xvid
  - Variants and specialty formats
    - Ogg Vorbis, FLAC, Dolby Digital, DTS and MLP
  - Containers and parsers
    - Mp2, mp3, aac, mp4, m4a, Wma, asf, Vob, wmv, mov and avi

- ## Complexity of usage case
  - Play and record at same time
  - Multiple simultaneous playback and record paths
  - Time-shifted playback

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Play and record: Io-media

Main CPU   DSP

- Abstracts hardware through use of 'graph' components
- Unified API to higher levels
  - Event notifications (timed and stream events)
- Supports dynamic graph creation and destruction

Io-media		
DSP assist	SW codecs	HW vendor framework

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Io-media Graph Components

Readers source data and place logical BOF and EOF markers in the stream.

- file reader
- cd reader
- http reader
- phone reader
- resmgr reader
- ring reader

Writers sink data to output devices

- file writer
- media writer
- resmgr writer
- ring writer

Decoders convert compressed formats into PCM.

- mp3 decoder
- wma decoder
- aac decoder
- ogg decoder

Couplings connect two graphs together

- c

Splitters take one input and produce one or more identical outputs.
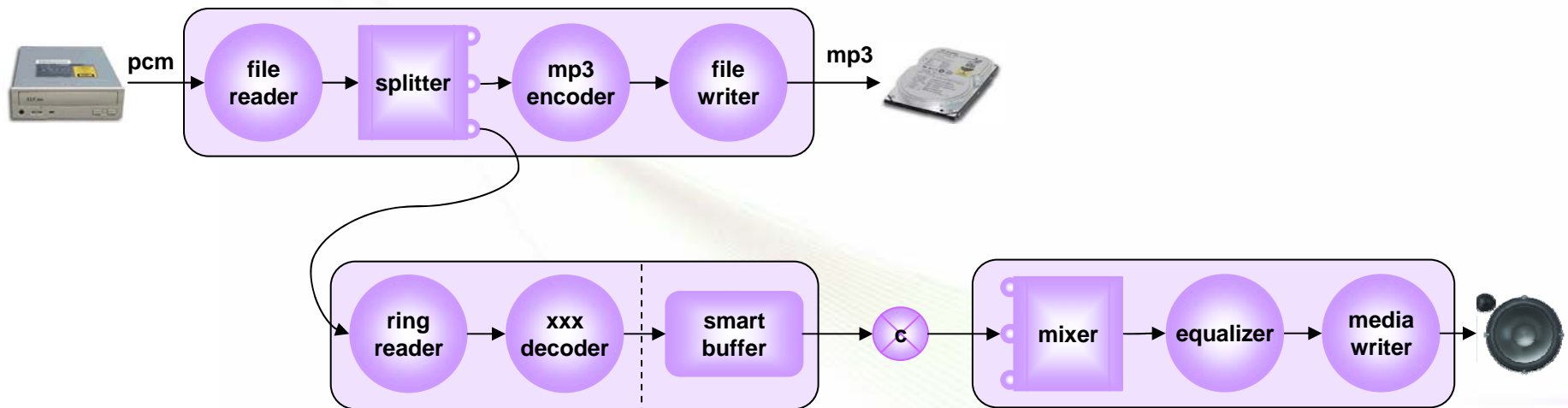
- splitter

Buffers buffer data and supports transitions of gap, gapless, fad-in/fad-out and cross-fade between songs.

- smart buffer

Mixers mix one or more inputs to a single output. If inputs have different clocks the mixer will upscale / downscale any input as needed for mixing. The output may also have a rate converter.

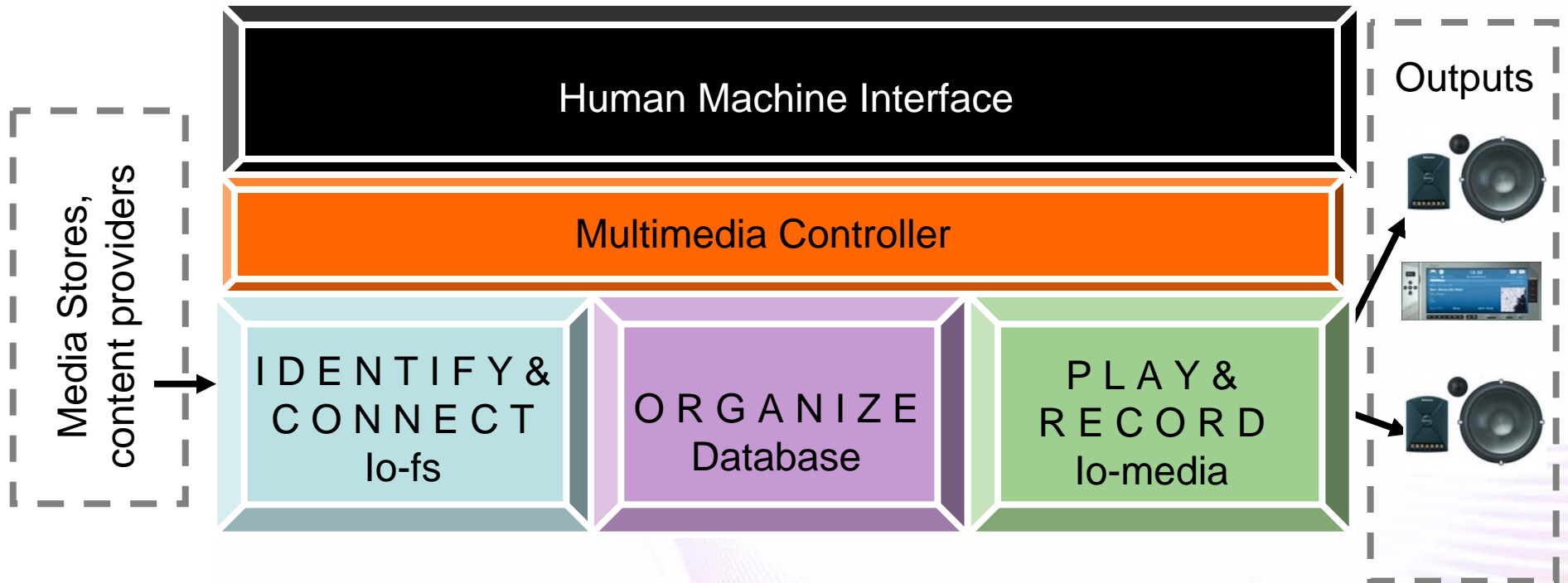- mixer

Example: Real Time Encode and Playback of Audio CD

- **Dynamic graph created in Io-media**
- **Splitter copies PCM to give to encoder as well as input to a playback graph**
- **Encode must be >= 1x playback**

- **(xxx decoder may be optional)**

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ORGANIZE

Organize

- ## Database
  - Ability to organize and quickly retrieve media storage device information and device contents

- ## QNX database services
  - Standards-based: ANSI SQL
  - Unicode UTF-8
  - Transaction-based
  - Synchronous safe writes
  - Concurrent access
  - Mix persistent storage and RAM
  - Corruption detection and auto correction after sudden power loss
  - Transparently place database(s) on transaction-based file systems with encryption
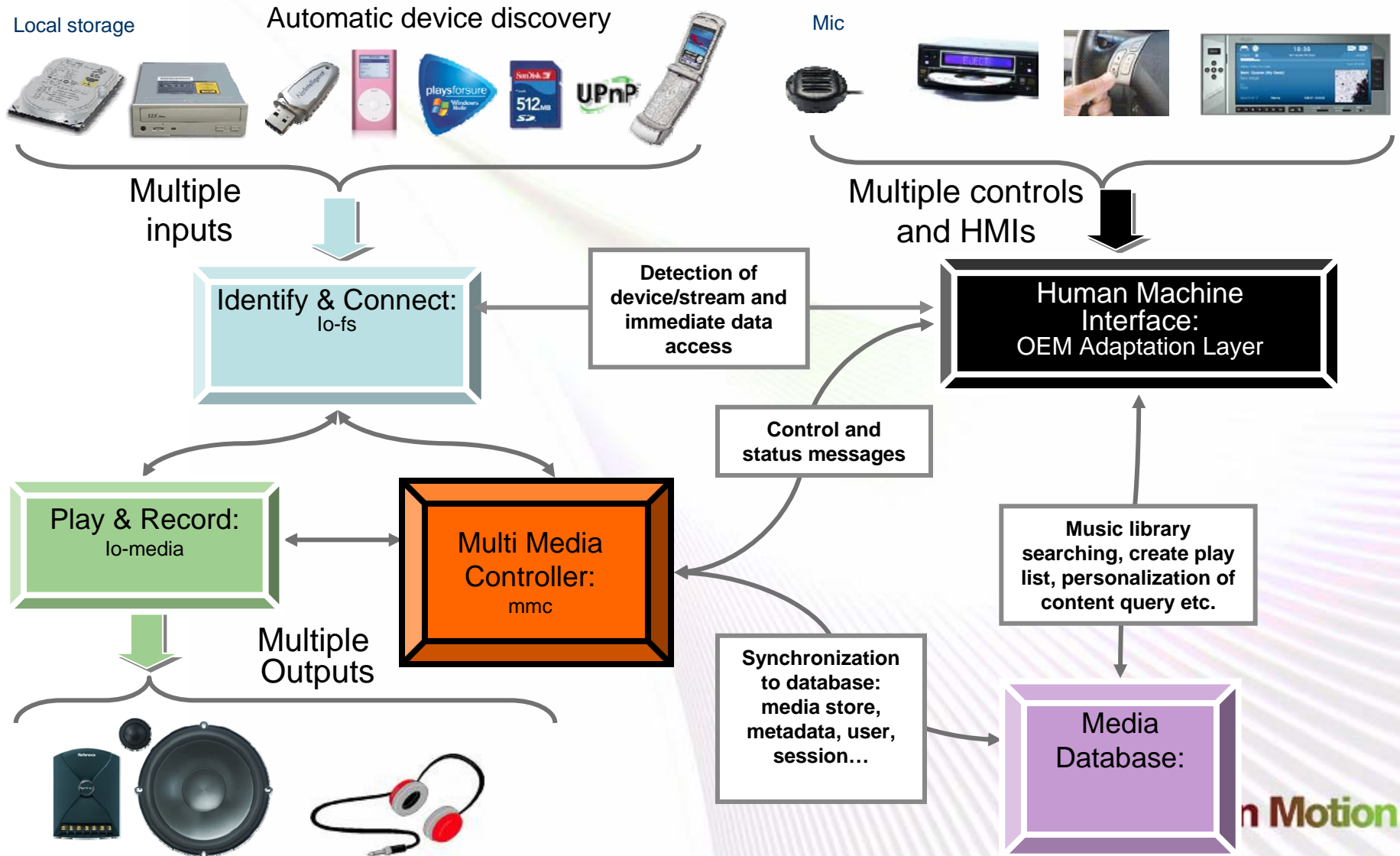
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Multimedia Controller

Human Machine Interface

Multimedia Controller

Media Stores, content providers

IDENTIFY & CONNECT
Io-fs

ORGANIZE
Database

PLAY & RECORD
Io-media

Outputs

- Multimedia Controller is the media player engine
  - Implements media player policy
  - Creates graphs automatically
  - Database synchronizers
  - Browsing of media storage devices
  - Copy media / transcode
  - High-level API to HMI

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Multimedia Components

Local storage

Automatic device discovery

Mic

Multiple inputs

Multiple controls and HMIs

Identify & Connect:
lo-fs

Detection of device/stream and immediate data access

Human Machine Interface:
OEM Adaptation Layer

Play & Record:
lo-media

Multi Media Controller:
mmc

Control and status messages

Music library searching, create play list, personalization of content query etc.

Multiple Outputs

Synchronization to database: media store, metadata, user, session…

Media Database:

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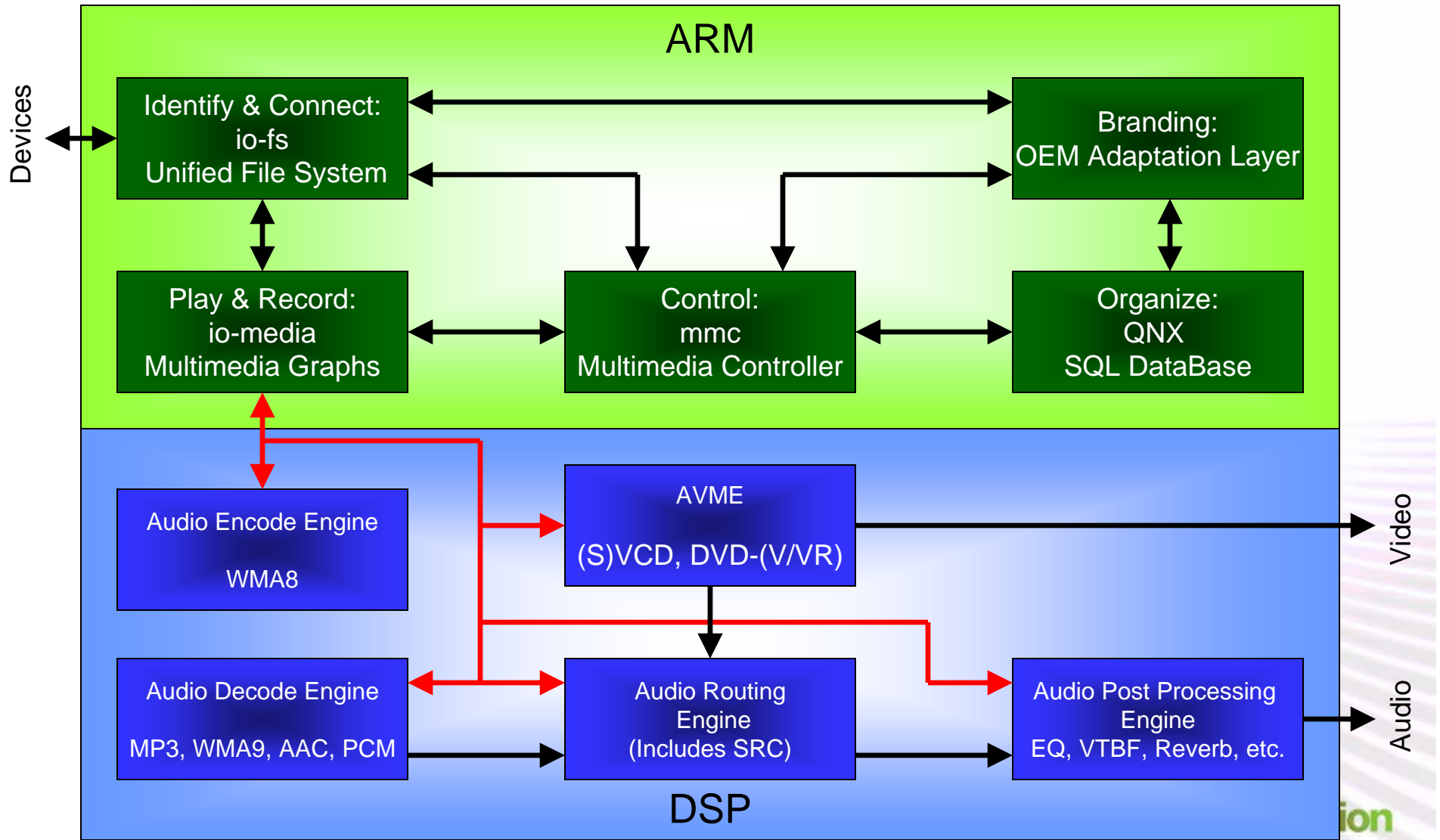# TI / QNX Implementation Specifics

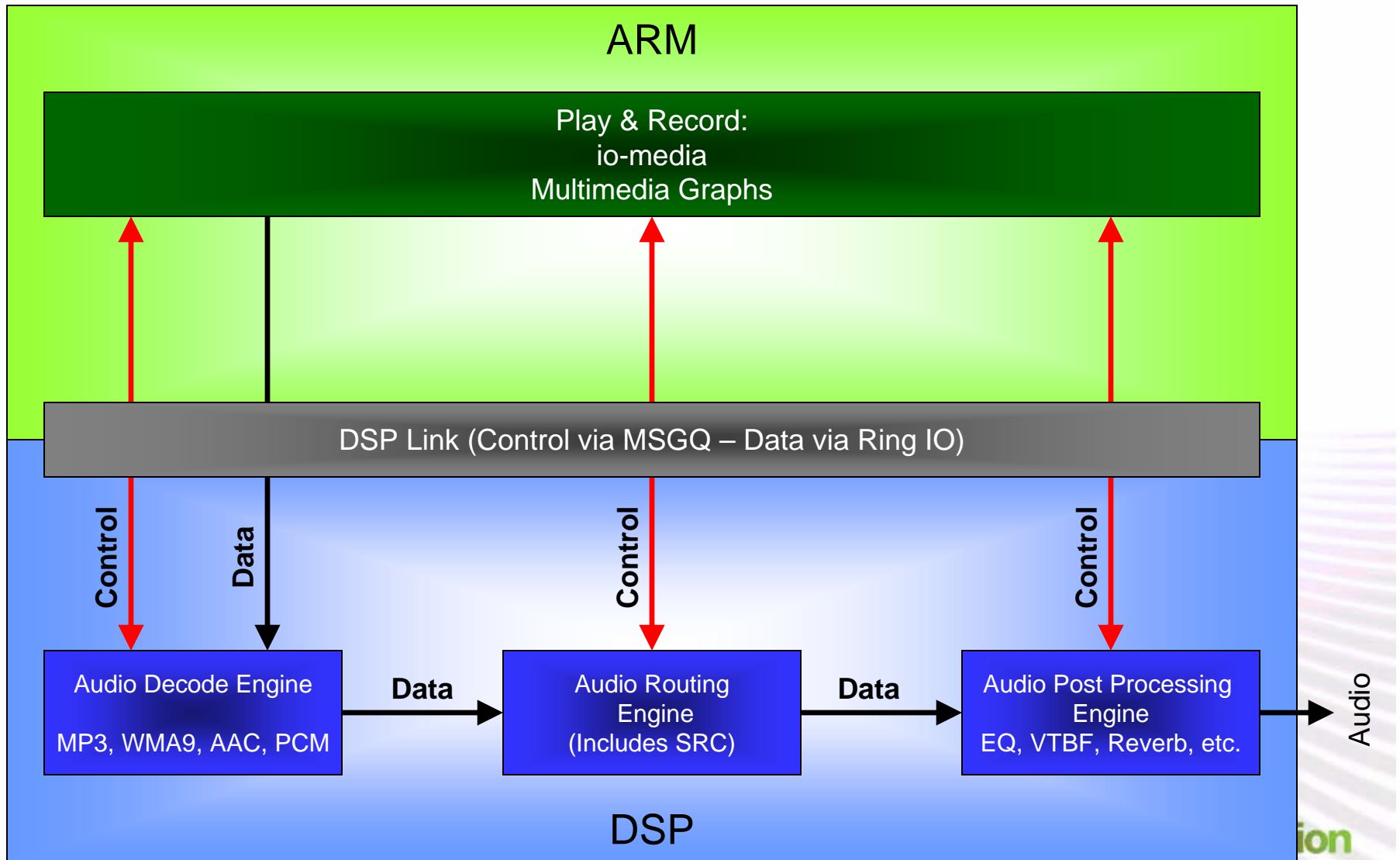# Many Solutions Available

- Generic CPU + TI DSP
    - Leverage DSP expertise and volume of code
- **Jacinto / DaVinci™**
    - Specifically targeted at automotive / consumer
- DARtE
    - Digital Audio Routing Engine (automotive-focused)
        - provides the interconnection between the MediaLB interface, up to six I2S digital audio ports, and TI's Digital Signal Processor (DSP).
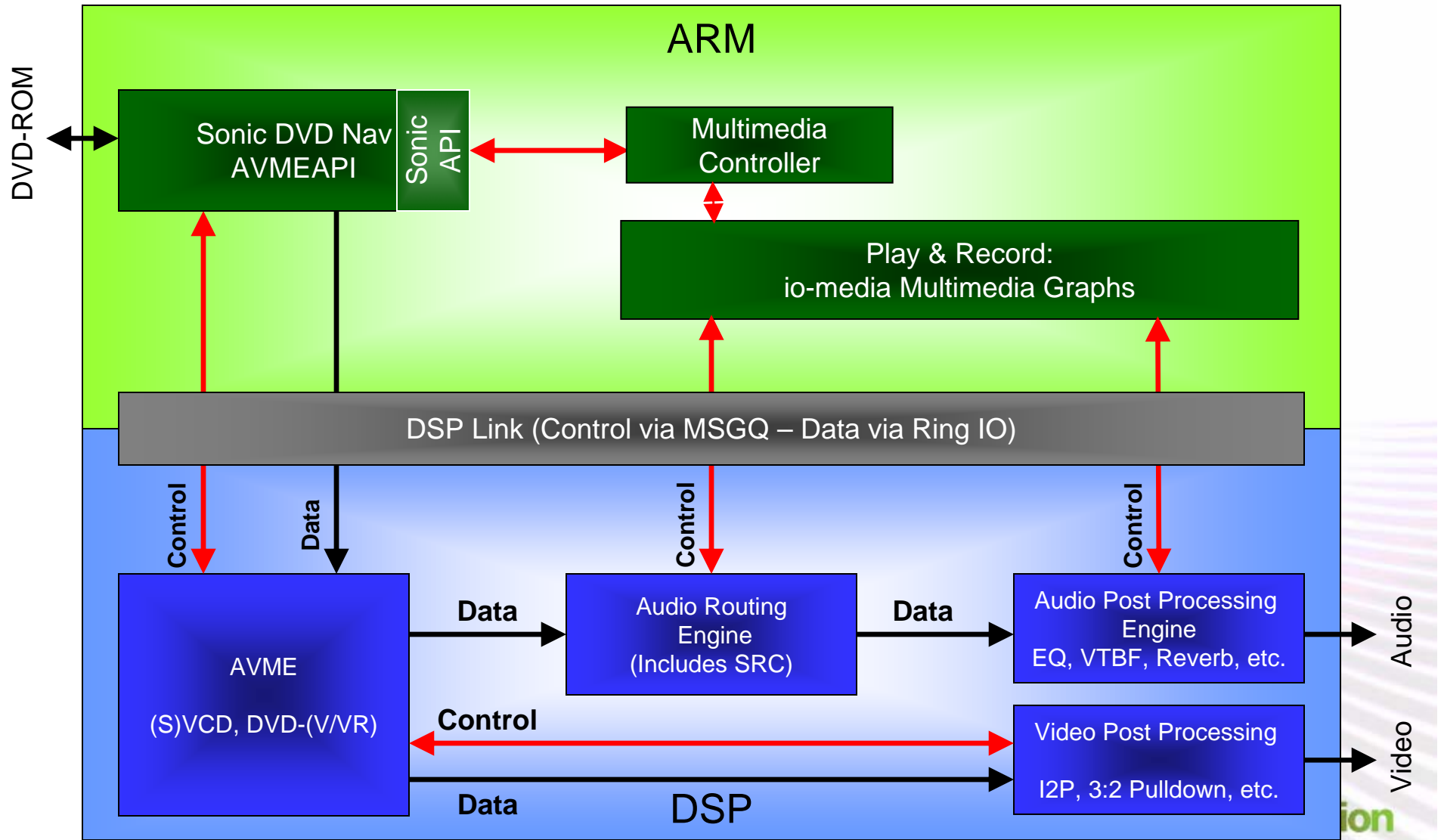
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QNX/TI Media Integration

Summary and Expansion Options

- QNX Multimedia Solution provides the flexibility / scalability and reliability on the main CPU side
- TI frameworks provide flexibility / scalability / performance and reliability on the DSP side
- Many Expansions Options
  - Add DSP-accelerated graphics (TES)
    - 2D (3D)
  - Add block-decoders for Serial CD
    - I2C to ARM, I2S to DSP
    - Drive control managed through filesystem layer on ARM
  - Support multiple DSP subsystems at same time
    - Multiple ADE / AVME
    - Multi-zone output

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