LSI Logic DoMiNo™
Network Media Processor
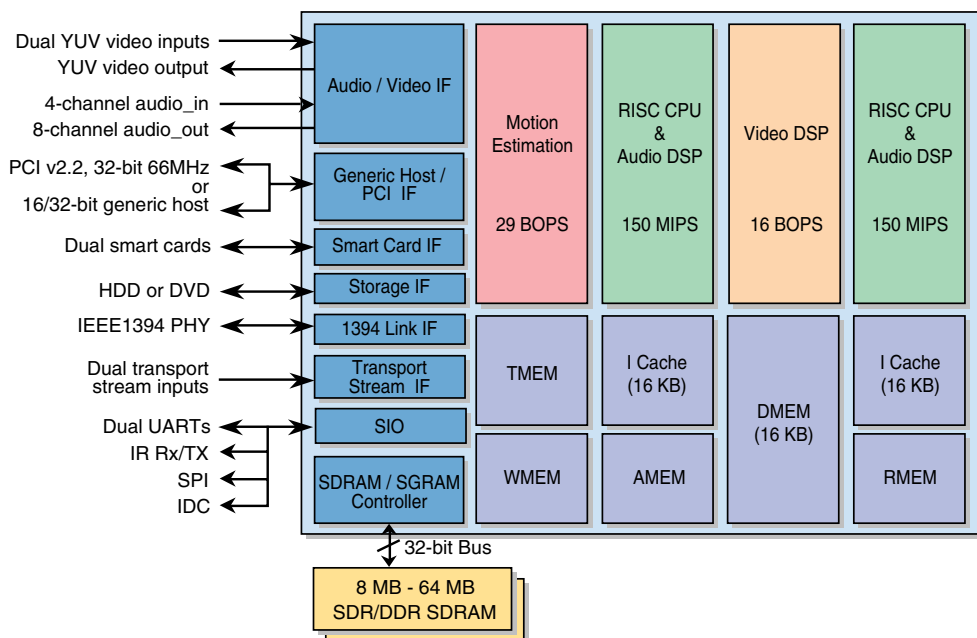
DoMiNo

OVERVIEW

The LSI Logic DoMiNo™ network media processor is the industry's first programmable, single-chip, multi-stream, multi-format, MPEG audio/video/system codec (encoder/decoder) architecture. This powerful and flexible architecture has been designed to trigger — very much like the domino effect — an endless variety of digital audio/visual (A/V) products for the consumer, prosumer and professional markets. The LSI Logic DoMiNo architecture brings distributed video and digital entertainment to the networked home in the Internet Age.

To deliver the industry's best quality HD and SD TV images, LSI Logic DoMiNo uses LSI Logic's award-winning PerfectView® MPEG-2 encoding algorithm in combination with its advanced motion compensated noise filtering for superior source noise reduction. Moreover, using LSI Logic's MPEG-4 (H.263+) encoder, LSI Logic DoMiNo brings streaming of sports and movies over the Internet on a wide-screen TV into the living room. For display, LSI Logic DoMiNo performs MPEG-2 (HDTV, SDTV) and MPEG-4 decoding. Format up-conversion of SD for large screen displays is performed using sophisticated Motion-Compensated De-Interlacing (MCDI) techniques.

LSI Logic DoMiNo is a true system-on-a-chip architecture, reducing cost, design complexity, power consumption, and time-to-market through its high level of system integration and its C-Ware™ high-level programming environment. LSI Logic DoMiNo has true multi-stream and multi-format A/V codec capabilities that enable unique features on digital set-top boxes (STB) and DVD recorders. These include, but are not limited to, dual-channel HD decode with picture-in-picture, quad-channel live preview for channel selections, digital and analog time-shifting, seamless channel and

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TARGET APPLICATIONS:

- Interactive, digital set-top boxes

- DVD recorder appliances

- Home media gateways

- Home media servers

- Multi-service network video head-end transraters and transcoders

- Non-linear editing (NLE) for the broadcast industry, including cable, satellite, and Internet

Architecture diagram inputs (left to right):
- Dual YUV video inputs → Audio / Video IF
- YUV video output
- 4-channel audio_in
- 8-channel audio_out
- PCI v2.2, 32-bit 66MHz or 16/32-bit generic host → Generic Host / PCI IF
- Dual smart cards → Smart Card IF
- HDD or DVD → Storage IF
- IEEE1394 PHY → 1394 Link IF
- Dual transport stream inputs → Transport Stream IF
- Dual UARTs → SIO
- IR Rx/TX
- SPI
- IDC → SDRAM / SGRAM Controller

Block columns:
- Motion Estimation — 29 BOPS
- RISC CPU & Audio DSP — 150 MIPS
- Video DSP — 16 BOPS
- RISC CPU & Audio DSP — 150 MIPS
- TMEM, WMEM
- I Cache (16 KB), AMEM
- DMEM (16 KB)
- I Cache (16 KB), RMEM

32-bit Bus → 8 MB - 64 MB SDR/DDR SDRAM

LSI Logic DoMiNo™ Network Media Processor Architecture

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video clip switching without frame freezes and audio muting, and concurrent execution of multiple tasks, such as recording a TV program while watching a DVD movie.

THE LSI LOGIC DOMINO ARCHITECTURE

LSI Logic DoMiNo integrates dual 150 MIPS RISC processors, an audio DSP, a flexible video and motion esti-mation processor, DRAM controller, cache and scratch pad memory, IEEE1394 link, transport-stream de-multiplexers, video and audio I/O, a flexible system bus, and all neces-sary system I/O, including smart card interfaces.

The dual RISC core provides the necessary horse-power to implement additional graphics and host functions. The VxWorks® RTOS from WindRiver® Systems provides real-time operating system services, while C-Ware provides signal processing specific services and high-level, applica-tion programming interfaces (APIs) for the development of applications.

The integrated I/O processor supports dual UARTs, IR receive and transmit, an inter-device connection (IDC) interface, and SPI bus for Flash memory devices like SmartMedia. The smart card interface supports up to two smart cards. LSI Logic DoMiNo can support multiple encryp-tion standards, including CPPM, CPRM, CSS, Multi-2, DES, and 5C.

The flexible system bus can be configured either as a 32-bit, 66 MHz PCI 2.2 compliant bus, or as a 16- or 32-bit generic host bus. It either operates in slave mode with an external host processor, or in limited master mode when using the on-chip dual RISC core as the host. This makes LSI Logic DoMiNo suitable for use in embedded as well as in PC-based applications.

The integrated DRAM controller supports 8 Mbytes to 64 Mbytes of single or double data rate (DDR) SDRAM. The 32-bit, 148.5 MHz memory bus has a bandwidth of 1.2 GigaBytes per second with DDR SDRAM to serve the most demanding applications.

LSI Logic DoMiNo has powerful signal processing capabilities that support multi-stream, multi-format A/V encoding and decoding, transcoding and transrating between different A/V formats and bit rates. The integrated

motion estimation processor supports Motion Compensated Temporal Filtering (MCTF) and MCDI for source noise reduc-tion and up-conversion to high-resolution display formats, respectively.

The video input interface supports up to two CCIR656 8-bit YUV video inputs, or a single 16-bit YUV video input. The video output supports CCIR656 16-bit YUV or 24-bit RGB video out. The audio input interface supports dual-stereo inputs, while the audio-output interface supports up to 8 channels of surround-sound audio. Dual transport-stream de-multiplexers are integrated for digital STB applications.

KEY LSI LOGIC DOMINO FEATURES

Single-Chip System Integration.
The integration of A/V codec, host, graphics, network, and I/O sub-systems, enable single-chip STB, DVD recorder, and video editing/production solutions. The high level of system integration drastically reduces system design complexity, component cost and time-to-market. The reduction of compo-nent count greatly increases system reliability and cuts power consumption significantly.
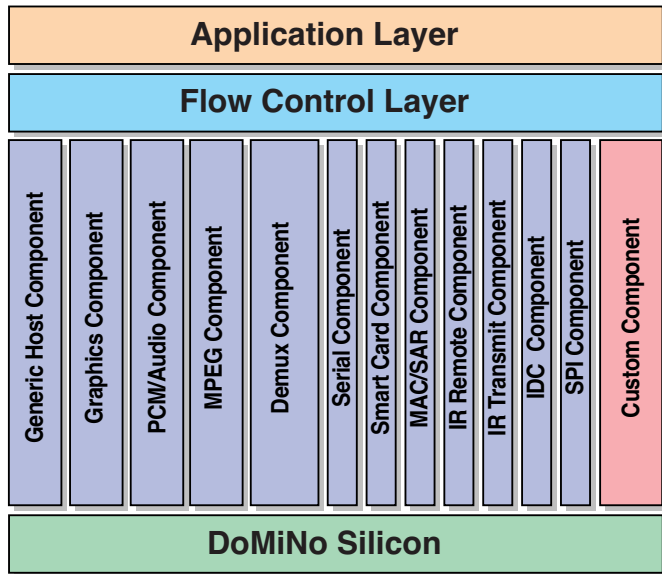
Built-in A/V Networking.
The integrated IEEE1394 link interface makes it easy for developers to add networking to consumer electronic devices, such as DV camcorders. The integrated transport-stream de-multiplexers provide connectivity with multi-service networks, such as digital cable and satellite, in combination with return channels implemented either via the integrated UARTs, or the flexible system bus.

Flexible System Bus.
The flexible system bus supports both 32-bit, 66MHz PCI and 16- or 32-bit generic host bus protocols in master or slave configurations. Various system configurations are therefore possible, giving designers the flexibility they need to optimize and expand system performance and functionality.

Large Memory Bandwidth.
The integrated memory controller supports 8 Mbytes to 64 Mbytes of single and DDR SDRAM. The 32-bit, 148.5 MHz bus has a maximum bandwidth of 1.2 Gbytes, able to meet

Application Layer

Flow Control Layer

Generic Host Component | Graphics Component | PCM/Audio Component | MPEG Component | Demux Component | Serial Component | Smart Card Component | MAC/SAR Component | IR Remote Component | IR Transmit Component | IDC Component | SPI Component | Custom Component

DoMiNo Silicon

C-Ware™ Component and Flow Controller Architecture

even the most demanding applications such as time-shifting on DVD-RAM, or dual-stream HD decoding.

Integrated Graphics Processor.

The integrated graphics engine can handle 24-bit RGB and 8-bit alpha blending. Up to 4 graphic planes are possible for support of On-screen Display (OSD), backgrounds and other applications. A flicker filter reduces flicker on interlaced TV screens for viewing Web sites. A video scaler properly scales 16:9 aspect ratio formats to letterbox format for viewing in a 4:3 aspect ratio.

Multi-Stream, Multi-Format A/V Codec.

The programmable audio DSP and flexible video processor, together with the RISC instruction set extensions make it possible to handle the encoding and decoding of a variety of video and audio formats, including:

- MPEG-2 MP@ML and MP@HL
- MPEG-1
- MPEG-4 (H.263+ with AAC audio and interlaced video support)
- DV
- DVD-Audio with Meridian Lossless Packing (MLP) and LPCM decoding
- MPEG-1 Layer I, MPEG-1 Layer 2, MPEG-1 Layer 3 (MP3), AC-3, DDCE, DTS, etc.

The sophisticated signal processing capabilities also support all the ATSC display formats and conversions between them. Through deployment of LSI Logic's proprietary MCDI up-conversion from 480i to 480p or higher resolutions result in sharper than usual images, especially for sports scenes and slow motion.

The multi-stream A/V codec enables a host of unique applications, such as time-shifting — or personal TV — simultaneous preview of up to four standard definition TV channels or decoding of two HDTV streams on digital STBs, and handling several streams simultaneously in DVD recorder video-editing applications.

Another unique feature is seamless switching between A/V streams, without the usual, annoying frame freezes and audio muting. Examples are switching channels on a STB, switching between alternative angle and main screen, or switching between video clips on a DVD recorder.

Video and Audio Streaming.

LSI Logic DoMiNo has a flexible architecture that provides support for MPEG-4 and MP3 streaming applications over broadband Internet connections. With LSI Logic's MPEG-4 (H.263+) implementation, LSI Logic DoMiNo delivers bit rates as low as 256 Kbps. It is capable of VHS quality for streaming movies and sports programs at 1.3 Mbps or lower on a 35" TV.

Transcoding and Transrating.

The powerful signal processing capabilities of LSI Logic DoMiNo include the ability to transcode and transrate between different encoding formats and bit rates, respectively, at faster than real-time speeds (high-speed dubbing). Transcoding enables a set of unique features, including, but not limited to:

- Digital time-shifting on STBs. Transcoding is required from MPEG-2 MP@HL to MPEG-2 MP@ML, or even MPEG-4 at 1.3 Mbps or lower.
- Recording from or to DV camcorders for editing, archival, or video-mailing purposes. Transcoding is required from DV to MPEG-2 or MPEG-1, or even MPEG-4, or vice versa.
- Recording digital music in MP3 format for playback with portable MP3 players. This requires transcoding from the original digital format to MP3 format.

Transrating similarly enables a set of unique features, such

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as the ability to make trade-offs between picture quality and storage requirements. Applications include, but are not limited to, video-mail, archiving, storage and space optimization.

Variable and Constant Bitrate Control (VBR and CBR).
LSI Logic DoMiNo supports both VBR and CBR MPEG video encoding to provide image and storage optimizations for a variety of applications:

- CBR encoding for recording and time-shifting capabilities on both DVD recorders and STBs
- Advanced single-pass and multi-pass VBR encoding for video-quality optimizations in DVD video and DVD recordable applications
- Statistical multiplexing for multi-channel broadcast applications

Programmability.
LSI Logic DoMiNo supports the C-Ware firmware architecture, which provides abstraction of hardware and signal processing flow dependencies through the use of components and flow controllers, respectively. This makes it easy for developers to build applications and maintain portability across LSI Logic DoMiNo and other LSI Logic-based products. C-Ware implementation in standard ANSI C, its object-oriented programming model, and its standardized set of APIs promotes application portability and code re-use. Furthermore, C-Ware has a rich set of components and flow controllers that drastically reduces firmware development schedules.

Summary of Specifications	
AV Codec	Dual-stream , full-duplex, SD/HDTV audio and video codec
Encode/Decode Formats	MPEG-2 MP@ML, MP@HL, MPEG-1, MPEG-4 (H.263+), DV, AC-3, DDCE, MLP, AAC
File System Support	DVD-VR (RTRW), DVD-V, UDE
Display Formats	NTSC (480i), PAL (576i), ATSC (480p, 720p, 1080i)
Encryption/Decryption	CPPM, CPRM, CSS, DES, 5C, etc.
Video I/O	Dual CCIR 656 YUV inputs, CCIR 656, 16-bit YUV or 24-bit RGB output
Audio I/O	Dual stereo audio inputs, dual 8 channel stereo audio outputs
Video Networking	Dual transport- stream inputs, IEEE1394 link interface
Graphics	32-bit RGBA with 8-bit alpha blending, multi-plane 2D graphics with OSD, flicker filter, video scaler
Memory Controller	8M-64MB SDR or DDR SDRAM, 32-bit, 148.5MHz, 1.2Gbytes/second
System Expansion Bus	32-bit, 66MHz PCI 2.2 or 16-/32-bit generic host bus, master or slave
System I/O	IDC, SPI, IR Tx/Rx, dual UARTs, dual smart card interfaces ATAPI/IDE and DVD
JTAG	IEEE1149.1 compliant boundary scan and PCB assembly testing
Input Voltages	3.3V (5V tolerant) I/O, 3.3V DRAM, 1.8V core
System Clock	13.5MHz or 27MHz
Package	388-pin or 308-pin BGA

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