

By
J.B. Fowler,
SoC Product Marketing Manager
Texas Instruments

Transcoding with TI's DaVinci™ Technology Drives Video Market Evolution

Executive Summary

As the accelerating digital video market widens its range, users are demanding easy access to video content throughout the home, at the office and on the go. Multi-format transcoding with TI's TMS320DM6467 digital media processor and DaVinci technology will enable the seamless transmission of video content between all types of video devices.

Digital video continues to gain momentum in the market, enabled by the availability of advanced display and storage technology and cost-effective digital signal processors (DSPs). Digital TV (DTV), especially high-definition TV (HDTV), is the most noticeable application, but any system that can be used for video reception or playback may eventually need to accept input from a DTV source, whether it can display the picture at full resolution or not. The communication and entertainment networks in homes are rapidly becoming more connected, so that video from various sources will be received and recorded in a number of formats and shared with devices with different capabilities in terms of resolutions and compression schemes. Enterprises are also making increased use of video conferencing, video security and other forms of digital video that require multiple formats, frequently in multiple simultaneous channels.

With the many potential variables, evolving video systems will often have to accept content input one way, and then shift it to the appropriate output. In other words, systems will have to be capable of *transcoding*—of changing resolutions, encoding schemes and data rates in real time. Transcoding has long been familiar in network infrastructure equipments, but its importance is only beginning to be felt in set-top boxes (STBs), DTVs, digital media adapters (DMAs), DVD and personal video recorders (PVRs), video cell phones and portable media players. In video conferencing, transcoding is often required to handle communications among different types of displays, or on networks with different bandwidths. Video security systems may need to display at one resolution while recording at another, and in addition to performing transcoding tasks, security systems may need to analyze the video to detect motion or recognize objects.

As system developers look for processing solutions for video transcoding in these and other products in the evolving market, they need to bear in mind both the performance requirements of transcoding and the necessary flexibility to support multiple video formats. All video has high data rates and throughput for HD is several times greater than for standard definition (SD, the digital equivalent of traditional analog TV), so that HD transcoding systems will need to be designed to provide even more memory and computations while taking into account cost constraints. Programming flexibility is essential in order to support evolving coding-decoding (codec) algorithms and to adapt to different codecs on the fly as inputs change.

The TMS320DM6467 digital media processor from Texas Instruments is designed to handle the high data rates and varied codecs of transcoding systems. The DM6467 processor provides an exceptionally high level of computational performance and programming flexibility, as well as peripheral integration that helps keep designs affordable. Transcoding systems that are built using the new processor will realize 10× the performance of previous solutions at one-tenth the cost. Based on TI's most advanced DSP architecture, the DM6467 processor is one of a family of media processors that form the hardware foundation of TI's DaVinci™ technology for digital video applications. DaVinci technology offers comprehensive solutions for advanced digital video, including not only processors, but also in-depth video software, development tools and support that simplify development and speed time to market. Video systems based on the DM6467 processor and DaVinci technology will be able to handle video performance loads while adapting to the growing need for transcoded content that can shift across standards.

Matching Inputs to Outputs

DTV provides for multiple formats, including both HDTV and SDTV, the latter with North American NTSC and European PAL/SECAM digital equivalents, and all with multiple refresh rates expressed in frames per second (fps). While the HDTV formats offer high resolution and a wide aspect ratio, the better picture quality comes at a cost in bandwidth. Compared to the NTSC-equivalent format (often expressed as 480i60, meaning 704×480 pixels at 60 interlaced fps), the commonly broadcast HDTV 1080i60 (1920×1080) format requires 6× the number of bits per second for uncompressed video, and the HDTV 720p60 (1080×720 with progressive fps) format requires 5.33×. HDTV systems must be capable of supporting this high level of throughput and, if necessary, rescaling display outputs in real time.

But DTV represents only the beginning of the wide range of content source and digital display formats. At the lower end of resolutions is CIF, which with its subdivisions such as

QCIF is widely used in streaming video and provides the basis for divided screen applications on DTVs. There are also computer displays, including a group of HD formats that are used at times for entertainment systems, too, and range from WXGA (1366×768 pixels) on up. Format conversions between source content resolutions and the target display resolution need to cover a wide range, including scaling down HD video for low-resolution displays and scaling up low resolution content for HD displays.

Add to this complexity the enormous data rates involved in all video, but especially HD. An uncompressed 1080i60 HDTV signal with YCbCr 4:2:0 color sampling requires 746.5 megabits per second (Mbps) to transmit, and 336 gigabytes (GB) to store a 60-minute video. To deal with such vast amounts of data, the well-established MPEG-2 codec achieves compression ratios between about 30:1 and 50:1 on varied content, while more advanced codecs such as H.264/MPEG-4 part 10/AVC and WMV9/VC-1 effectively double these ratios. Migration to the more advanced codecs is taking place gradually, so transcoding for backward compatibility with MPEG-2 will be a key requirement. For instance, MPEG-4 AVC transmissions will have to be transcoded for playback on legacy set-top boxes and DTVs. MPEG-4 AVC-capable STBs and DVD recorders can leverage transcoding to reduce the amount of storage required for HD MPEG-2 broadcast content.

In home networks, it will be necessary to transcode not only in order to shift content bit rates and rescale formats, but also to convert ownership protection methods between the TV industry (various forms of conditional access) and the PC world (digital rights management, or DRM). Video conferencing and security systems in enterprises have transcoding requirements that often involve handling multiple channels, and support for multi-channel operation is critical for infrastructure equipments in video head ends that feed programming to subscribers. Video systems that are forced to deal with the varied combinations of coded inputs, display outputs and channel densities will require processing solutions that are fast, flexible and affordable.

***TI's TMS320DM6467
Processor and
DaVinci™
Technology***

By design, DSPs supply the high computational performance needed for video data streams and real-time codec algorithms. Multi-core processors have the added advantage of being able to partition performance between a DSP for signal processing and a RISC for control, communications and software applications. Programmability provides the flexibility needed to support varied transcoding needs, and it also allows the system to be scaled readily, so that the same basic design can support different market segments. A comprehensive, easy-to-use software platform with audio-video application programming interfaces (APIs) simplifies development, and system-on-a-chip (SoC) integration helps keep system costs down.

TI's DaVinci™ technology offers all these features, from high-performance DSP-based hardware, to programmer-friendly system software, to a full range of application modules designed for transcoding. The hardware foundation of DaVinci's transcoding solution is the TMS320DM6467 digital media processor, which is specifically tuned for real-time simultaneous encoding and decoding of multiple video formats. The DM6467 processor delivers a 10× performance improvement over previously available solutions in formats up to 1080p30, the highest specified HD resolution and refresh rate. Moreover, the processor's high level of integration and optimization delivers this performance at as little as one-tenth the cost of previous application systems. The flexibility and efficiency of the device can benefit consumer and business applications that need transcoding, such as STBs, DMAs, multi-point control units, media gateways and multi-conferencing units; video telephony, which requires simultaneous HD encoding and decoding; video security, where simultaneous transcoding of multiple SD channels is important; and even video infrastructure equipments, which demand the full range of multi-channel, multi-format transcoding capabilities.

The DM6467 processor integrates a 600-MHz TMS320C64x+™ DSP and an ARM926EJ-S RISC processor core, along with a High-Definition Video/Imaging Co-Processor (HD-VICP), video data conversion engine, video port interfaces and high-speed communications. The HD-VICP offers more than 3 GHz of DSP-equivalent processing power through dedicated accelerators for MPEG-4, MPEG-2, VC1 and H.264 high-profile transcoding. The HD-VICP's high throughput means that less than half of the DSP core's performance is needed to manage multi-format video transcoding, leaving the remainder for additional applications. The video data conversion engine manages video processing tasks, including downscaling, chroma sampling and menu overlay functionality that reduce the load on the DSP. The video ports simplify design and save interface components, and PCI bus, Gigabit Ethernet and ATA interfaces provide industry-standard high-speed connectivity.

Multi-conferencing units that in the past have been based on several DSPs can now be built using a single DM6467 processor, lowering the cost per channel, requiring less operating power and reducing the number and expense of system components. Video security systems see similar savings, as well as gaining the flexibility to implement multi-format multi-channel encode (up to four channels of MPEG-4/H.264 MP D1 plus four secondary channels of MPEG-4/H.264 MP CIF) or decode (up to six channels of MPEG-4/H.264 MP D1) for hybrid digital video recorder (DVR) and server (DVS) systems. The integrated C64x+™ DSP core provides headroom for video analytics and proprietary video processing algorithms, whereas the ARM9 core, together with connectivity interfaces, enable a single-chip DVR/DVS system by eliminating the need for an external host processor.

With its open platform, the new DM6467 processor simplifies programming while taking full advantage of TI's proven DaVinci™ development environment. Support includes the DM6467 digital video evaluation module (DVEVM), which comes with MontaVista Linux, industry-standard and DaVinci application programming interfaces (APIs), the DaVinci Codec Engine and DSP/BIOS™ Link. Also included are standard video, imaging, speech and audio codecs, as well as new transcoders, such as MPEG-2 to H.264, which have been designed to improve system efficiency and maintain high picture quality. Additional application-specific software and design expertise is available from TI's DSP Developer Network. System developers will find that TI's DaVinci solution for high-performance transcoding not only provides performance and flexibility but also simplifies development, saves expense and speeds time to market.

Overcoming Video Complexity in an Evolving Market

As video appliances become more connected, the sheer number of standards for video display, compression, transmission and storage threatens to swamp users. Video systems that are capable of transcoding can overcome the complexity problem, allowing content to be shared automatically while using bandwidth and storage as efficiently as possible. For designers creating products in the evolving market, TI's DM6467 digital media processor offers the performance they need for video transcoding, plus the flexibility to introduce additional standards or upgrade existing ones—all at an affordable system cost. TI's DaVinci technology brings together the hardware and software needed for rapid development of cost-efficient video systems that not only handle HD-level throughputs, but also allow users to shift content among standards easily through transcoding.

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