Set top boxes uncovered

BY JIM BOSTON

It has recently been said that set top boxes are the next hot Internet appliances. Some would argue a killer app is also required to make the set top box (STB) pervasive. Set top boxes today have a wide range of architecture that designers can choose from. Some rely totally on hardware and firmware while others take a polar opposite approach by implementing what increasingly looks like a classic PC. Many are in between, using ASICs to implement DSP-like functions with a microprocessor interface to accomplish the required tasks. Part of this diversification is due to the fact that the market is divided into three parts depending on the type of network: satellite, cable and terrestrial. No matter what approach is taken there are similar functional blocks in every STB.

Input

The input to the STB differs based on what transport mechanism delivers the data to the box. DTV requires 8VSB demodulation (at least for now), DVB needs COFDM decoding, cable needs QAM, etc. Many today can handle more than one flavor of modulated data. Up front though, regardless what the RF modulation looks like, is usually a tuner/channel equalizer ASIC.

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Behind that is the application specific demod, or demods, as just mentioned. Next comes the MPEG demux chip. This ASIC breaks the MPEG transport stream into its separate packetized elementary streams (PES). The desired sets of PES are then sent to an MPEG-2 decoder, which generally operates at MP@ML (Main Profile @ Main Level), and an AC-3 decoder for the audio. The decoder decodes the set of PES (at least one video PES and one audio PES) based on information found in the program allocation table (PAT), which vectors the decoder to the proper program map table (PMT). The PMT lists all the PES that comprise a program. The STB's system controller does this. The PAT containing the various PMTs indicating the associated PES are sent no more than 400ms apart.

From the video decoder the baseband video generally passes through a graphics controller that, depending on its complexity, is also known as a multimedia compositor. (See Figure 1.) Here is where menus, program guides and other services can be laid over decoded video. In fact many STBs today have modem ports or even network interface cards (NIC) to supply data that can be composed into a composite multimedia display that comes out the STB's video out.

Many boxes today have security sub-sections. The open cable folks like to call this section the *point of deployment* (POD) module. Non-

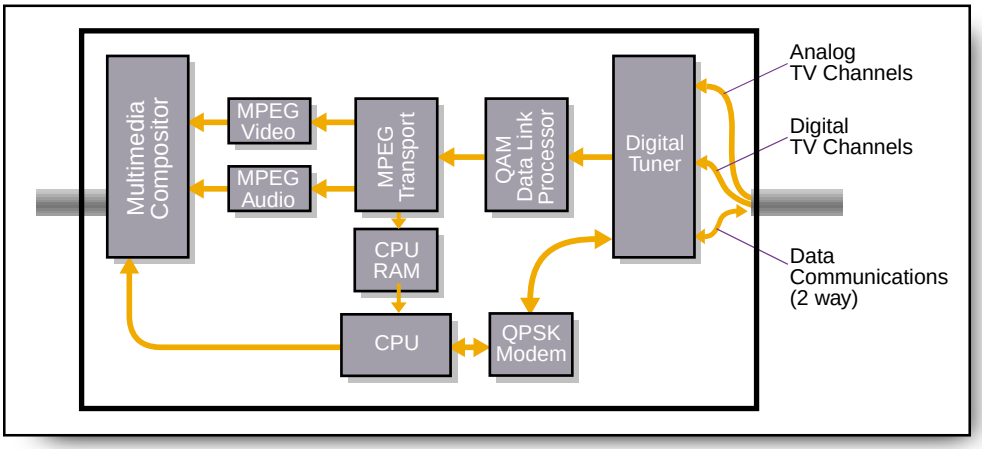

Figure 1. This simplified typical set-top box supports three types of cable signals: analog, digital and interactive digital transmission. The signals enter the digital tuner on the right, are demodulated and, if necessary, decrypted. Streams can be developed and routed to the multimedia compositor, an application-specific integrated circuit (ASIC) that develops the desired output signal format.

scrambled information is passed through the POD module to the MPEG-2 transport demultiplexer. The POD performs decryption, authorization, entitlement and key generation. Cable STBs receive control information, application code download and electronic program guide content by tuning to an out-of-band forward data channel. These forward out-of-band channels use the 70- to 130MHz band. These channels can use ATM cell or MPEG transport stream packet structure to transport information. The STB also sends data upstream via out-of-band reverse data channels. The upstream channel can utilize IP packets over ATM. These out-of-band channels use QPSK modulation. Their payload rate is about that of a T1 (1.5Mb/s). The in-band channels (54- to 864MHz) are known by the cable folks as the Forward Application Table (FAT). These channels carry MPEG-2 programs. They are 6MHz wide and carry 27- or 39Mb/s via QAM.

Rapid development

As functionality of STBs starts to increase with the rollout of interactive TV and the merging of television viewing and Internet browsing, the approach taken to control the box is rapidly evolving. Full-fledged operating systems (OS) from the likes of Microsoft, Sun and fairly new companies like Power TV have developed. (See Figure 2.) These OS have allowed an abstraction layer to be inserted between the STB hardware and the application software that runs on top. This allows for the rapid development of new applications and/or methods of STB control to be implemented quickly, and across multiple hardware layers in different boxes (if the drivers are available for a particular set of hardware). To facilitate this, most OS vendors provide software development kits (SDKs) as they do for other computer OS. These kits provide the APIs (and the other software layers below) for application support. Some of these even provide multimedia-authoring tools for taking full advantage of the STBs' graphical power. They are aimed at groups trying to blend advertisements and games and to facilitate home shopping on an STB.

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OS also provide logical control of tuning and network delivery methods, and will also establish and maintain

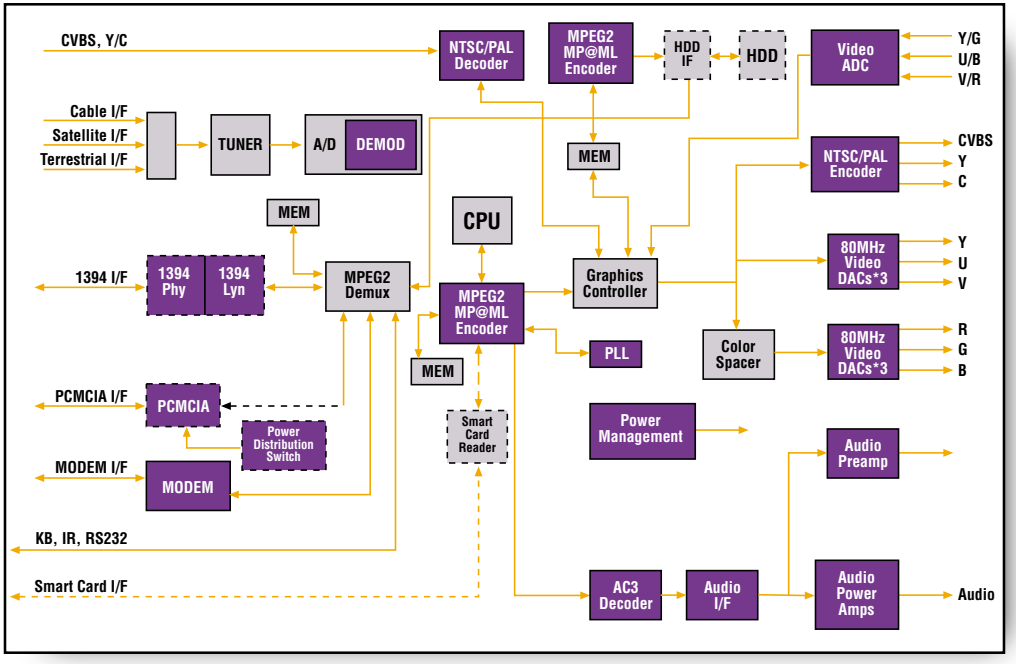

Figure 2. STBs usually rely on multiple ASICs with already well-defined roles. Note the typical ASIC technology above; DACs to drive displays, input DACs to accept external video inputs, audio drivers, AC3 decoder, 1394 interfaces and an NTSC/PAL decoder. Figure is of Texas Instruments' dig_vcr.

sessions between an STB as both a client and a content-provider server. The STB OS will also manage the memory in the box. In essence, a single set of hardware can take on extremely different personalities with different applications loaded by various DBS and cable providers. Actually, there is no technical reason why a broadcaster could not install their desired personality in a STB that looked out for the interest of the broadcaster.

The STB is a logical candidate for the portal into the networked house of the future. Applications that would allow the box to act as a firewall, router and hub of an internal home Ethernet are currently being developed. Boxes are currently available that have modem and 1394 (Firewire) ports. In the future, it could be technically possible to connect multiple STBs together over Ethernet or 1394. This could solve the must carry issue for both the broadcaster and the cable operator, or the local into local issue for the DBS and the broadcaster. ■

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