STMicro’s STI71xx SoC lowers RSE development costs

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For years, rear seat entertainment has been thought of as a DVD player for car passengers. Most systems come as a box with a DVD drive and a display either attached to the player or separated; to be mounted on the passenger seat. These systems have evolved, adding wireless infrared or Bluetooth head phones. Codec support increased, adding features like MP3 or DivX decoding, but the main data sources of these devices are DVDs and CDs.

Next-generation OEM and aftermarket rear seat entertainment systems will have to cover a much broader range of sources and offer more interactive support and better integration into the car infrastructure. Next-generation systems will also have to be priced to gain market acceptance and, as always, pricing depends in large part on the overall bill of materials and the cost of software development. This article will discuss both how to reach a low bill of materials and how to keep software development efforts low.

A good first impression of a product is important for widespread customer acceptance and this largely depends on the quality of the user interface. Showing slow or interrupted reactions to user commands will quickly eliminate even professional systems. Market leaders have proven that a fluid, fast-reacting user interface is key for the success of a product. Adding 3D multi-window support will improve the overall usability of the system; however, this requires additional graphics processing capability.

What features must a next-generation system support? Certainly, DVD-Video will be required for a long time. BluRay will be a second disk standard to be supported as some movies may be available in Blu-ray only, whether due to the format’s superior image and sound quality or its enhanced security, which can prevent playback of a disk on "hacked" players using black lists stored on the disk. The increased possibilities for games and other interactive content on Blu-ray players may also be a positive argument for increasing market acceptance.

Movie playback from other storage media such as SD cards, USB memory sticks and portable Hard Disk Drives using either USB or e-SATA connectors must be considered along with container formats including DivX, XviD, AVI, RealMedia, 3GP, ASV, MOV, and OGM.

Live content like TV broadcasting must also be considered. Most important are the terrestrial formats like DVB-T for Europe, ATSC in the U.S., ISDB-T for Japan, or DMB for China. Handheld TV formats like DVB-H for Europe, ATSC-M/H for USA, T-DMB for Korea, and CMMB for China must also be covered. New formats include satellite-based mobile TV broadcasting: DVB-SH, similar to satellite radio systems common in the USA, and live TV distribution channels that use the existing mobile phone infrastructure.

Many customers want interactive entertainment. Having a data link to the Internet provides access to YouTube, Twitter, Facebook and other social network applications. Web browsing and support for common plug-ins must be embraced by the architecture of an entertainment system, and these are mainly software issues, but they can enable many other services, like Web radio and Web TV. Adding the ability to access a home media streaming engine to provide remote access to the content recorded and stored at home removes the need to transfer or synchronize home and car media content. Such services require, at a minimum, EDGE- or HSDPA-like data transmission with provider data flat rates, which are available today. When it is used more widely, the existing infrastructure will need to be improved or replaced by the 4th mobile phone generation, LTE.

Rear seat entertainment systems combine professional living room entertainment equipment and mobile accessible media sources to provide a mobile living room that requires robust, well-implemented, flexible, and upgradable feature support.

How can a design team deal with so many features while keeping system development costs low? It must reuse existing platform architectures from the consumer world, providing high
end support for media playback combined with myriad interfaces connecting to the outside world. Strong price pressure forces manufacturers to provide efficient solutions in time with a well-fitted, proven feature set.

The STi71xx product family from STMicroelectronics is designed for entertainment applications; supporting up to high definition video decoding (1080i/p) and multi-channel audio decoding and post-processing. The main application runs on the ST40 processor, which is compatible with SH4 CPUs.

The main task of the ST40 is to run customer-specific applications and control audio and video processing. Audio and video decoding is off-loaded from the main CPU to two VLIW (Very Long Instruction Word) processors, one for audio processing and the other for video decoding. The separation of audio and video processing and the application CPU helps to reduce the system complexity while making the system more robust. The audio and video decoders can be easily reset if problems occur during the processing of corrupted data.

Flexibility is gained through the use of firmware on the two VLIW processors. Depending on the requested codec, one or more firmware modules can be loaded to allow for support for video (e.g., H.264, MPEG-2, VC-1 or AVS) and audio (MPEG-2, MP3, WMA, AAC, Dolby, DTS, OggVorbis and many other formats). The audio processor does audio signal mixing, sample rate conversion, stereo down-mixing, and other post-processing functions like surround sound.

Codec support can be upgraded by loading new firmware into the processors, ensuring that enhancements will be supported properly. The firmware is developed and provided by the chip manufacturer so the application developer does not have to bother with its development and maintenance. Moreover, a driver software package guarantees proper integration into the main application package. Due to this firmware flexibility, the decoders can also be used for the encoding of audio and video as well as transcoding, which changes the format and or the bit rate of an encoded data stream.

The three CPUs directly access the application memory, which is a single 32-Bit DDR2. This guarantees that the processors, which consume high bandwidth, have preferred access. Besides multiple CPUs, the 71xx system-on-chip provides a video output stage, audio output stage, and peripherals. The video output stage outputs video in analog and digital format.

Depending on the system architecture, CVBS, Y/C, or RGB can be used for analog connection, or RGB, YCrCb, or HDMI for digital. The 71xx family supports output of up to two independent video signals enabling applications with one decoder device and two left and right rear seat displays.

The audio output stage supports multi-channel digital I2S output with parallel stereo down-mix signal. In parallel, an on-chip DAC provides an analog stereo signal that can be used for a head-set plug without the need of external converters. Digital audio signals can be output over a car audio network like MOST to a remote audio amplifier. A multi-channel capable S/PDIF output is also available. A digital video and audio input is also available on the STi71xx, providing the possibility to connect other video and audio devices to the rear seat entertainment system like digital video cameras.

The concept of system-on-chip provides many commonly used peripherals. The STi71xx can provide two USB 2.0 ports with an embedded physical layer. The two ports can be used to connect many different devices, such as memory sticks, external hard disk drives, or UMTS/HSDPA sticks, etc. If additional host ports are required, an on-board hub can be used to extend the numbers of USB ports.

The STi71xx provides up to two SATA lanes for connecting internal hard disk drives or optical drives like Blu-ray or DVD. These ports also support e-SATA in order to connect external SATA devices to the system. A classical parallel ATAPI port for DVD drives is also offered on the EMI port, which is a 16-bit parallel data bus.
Internet access can be achieved externally, using a UMTS/HSDPA stick connected to the USB port, or internally, to an existing communication box via electrical or optical Ethernet that may be already in the car. An external UMTS/HSDPA option eliminates the need to certify the system for each country or region. If the end user attaches a USB-type module, the network compatibility and provider contract are his/her responsibility.

Bluetooth and WiFi access can be achieved easily by adding a combo device supporting one or both formats. The SDIO interface makes it possible to add a card reader supporting SD or MMC cards. Users can view images from their digital camera, for example, or increase the built-in memory for TV recordings. An on-chip infrared transceiver supports remote controls. Additional peripheral interfaces like I2C, SPI, UART, and GPIO are also available on-chip.

The STi71xx family provides more than three transport stream inputs for digital TV support. One or two can be used for live decoding and the third for background recording, channel scanning, or data services. Unlike home set-top boxes, an in-car TV must be prepared for alternative frequencies due to the movement of the car. To cope with the scrambled content, the STi71xx has an on-chip crypto-core capable of decrypting major copy protection formats, not only for TV applications but also DVD-Video, Blu-ray, and other streaming copy protection.

The two smartcard interfaces can be used to access the necessary keys for the decryption process. Alternatively, a conditional access module can be hooked-up to the chip to provide the flexibility to connect local crypto-modules to the system.

One single NAND flash can be used to store the application and the media files or TV recordings for time-shift viewing. This would replace a built-in hard disk drive without raising data access issues from shock and vibration of the car.

A single 30MHz oscillator is required to run the STi71xx. The device has on-chip frequency synthesizers and VCXO to generate internal frequencies independently for audio and video decoding, and systems clocks that can be used for synchronizing with a broadcaster’s clock. The single oscillator reduces the bill of materials compared to other solutions that require multiple clock sources.

The power supply has to provide four voltages: 1.2V for the core, 1.8V for DDR2, and 2.5V and 3.3V for the peripheral interfaces. Average power consumption, depending on the application executed, is about 2W. Lower consumption is planned for later generations. The “green” idea and the mobility of media processors will drive development in operation and in stand-by mode.

Developing a multimedia software stack from scratch is cost-prohibitive due to the high number of different codecs and container formats. STMicroelectronics provides a software stack that integrates all of the commonly used audio and video codecs described in this article. The driver interface provides a commonly known API to the system integrator. Other than the driver stack that attends to all of the hardware-specific items, a key factor in system development discussions is the operating system. The huge demand for enhanced media decoding features and online access applications requires access to an existing application pool providing big parts of the software application. These middleware software blocks can be provided either by a software company offering specific intellectual property, or by an open source communities.

The choice of the operating system becomes more important compared to a DVD-only rear seat entertainment system. Proprietary operating systems have the advantage in being small and efficient, but they require extensive development for hardware drives and applications. Using more commonly known operating systems like WinCE or Linux allows access to a variety of program applications and hardware drivers. Since the drivers are dedicated to the hardware they are running on, they have to be provided by the chip manufacturer in a software development kit. This kit includes all the ingredients to run applications – the operating system, drivers, and codecs. Some open source applications like WebKit browser or media players may be part of the package enabling fast application development. These
applications rely on the existence of a video API like V4L (Video for Linux) or ALSA (Advanced Linux Sound Architecture) in the case of Linux. On top of this API, other middleware software like DVD-Video or Blu-ray playback engine, MHEG, MHP, BML, or Java components can run and be easily implemented independently of the hardware device used.

Finally, the top application running the user interface will be the framework of the whole system. The system developer can put a lot of effort into it, gaining a unique selling point compared to competitive systems. The on-chip graphic core supports the developer in achieving a user-friendly and interactive capable user interface.

The next generation of rear seat entertainment systems will provide a huge number of features ranging from disk playback and external storage devices to live TV decoding and online streaming. Video formats will range from QCIF/QVGA to HD, as those will be available to the end user. Utilization of existing systems in terms of hardware and software is a key factor for fast development cycles and controlled cost efforts. The large amount of video and audio codes requires the long term experience of consumer devices already widely proven in the field.

STMicroelectronics is combining its strengthen in consumer entertainment with its competence in automotive applications. As one of the few IC manufacturers, STMicroelectronics is able to offer ICs that are worldwide field proven in applications and have undergone many certifications by content and codec provider. On top the products fulfill the strong requirements of automotive such as quality, qualification, extended operation temperatures and life time of product availability. ST can offering the standard package like PPAP documentation, ACE-Q qualification and 8D reporting. All those ingredients together are a strong competitive advantage and a good foundation for automotive rear seat entertainment systems.