EUROTECH

Video Performance Comparison

PXA and IMX Processors for Various CODECs

Whitepaper

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Abstract

Media for small, embedded devices is in our future. We ran some quick tests on the leading PXA (Marvell) and i.MX (Freescale) CPU architectures to see where the current and likely future price/performance leader is. The operating system, across the board, was Windows CE. We ran the same media file, compressed four different ways, on three CPUs with three different media players. Performance differences of greater than two to one were seen; however these differences are small compared to the potential effect of application-specific features that exist with these highly specialized CPUs.

Introduction

Media for low power devices has been on the horizon ever since Intel purchased the “StrongARM” assets of Digital Equipment Corporation (DEC) and began a program of serious investment. Now called the PXA product line and under the stewardship of Marvell, the investment continues based on an ARM4 core with special enhancements originally engineered by DEC and now exclusive IP of Marvel. Notable media devices like the Motorola Q and several media and MP3 players are based on PXA or PXA derivative CPUs. The PXA architecture has been transferred from Intel’s technology foundries to Marvel’s with minimum changes to the existing designs.

The Freescale i.MX series, based on earlier Motorola technology, is also a popular 32-bit low power system and powers such high-profiled devices as Microsoft Zune. Eurotech ran media tests with the i.MX31, based on an ARM11 core, which has significant add-on processing power in the form of vector floating point and native Java bytecode execution.

Both of these technologies are mainstays of the Eurotech product line, and both have been packaged in the popular Bitsy 3x5 inches form factor with production grade BSPs for Linux and Windows CE. The PXA320 is sold as part of our Graphics Client product line, as the GCM. In the course of our normal business activity, we have been asked many times to compare the various processors, and this paper is the result of one such comparison.

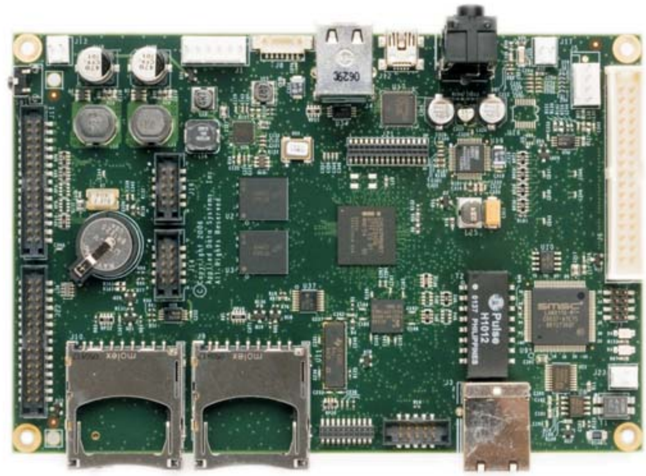


Figure 1- The PXA320 Powered GCM.

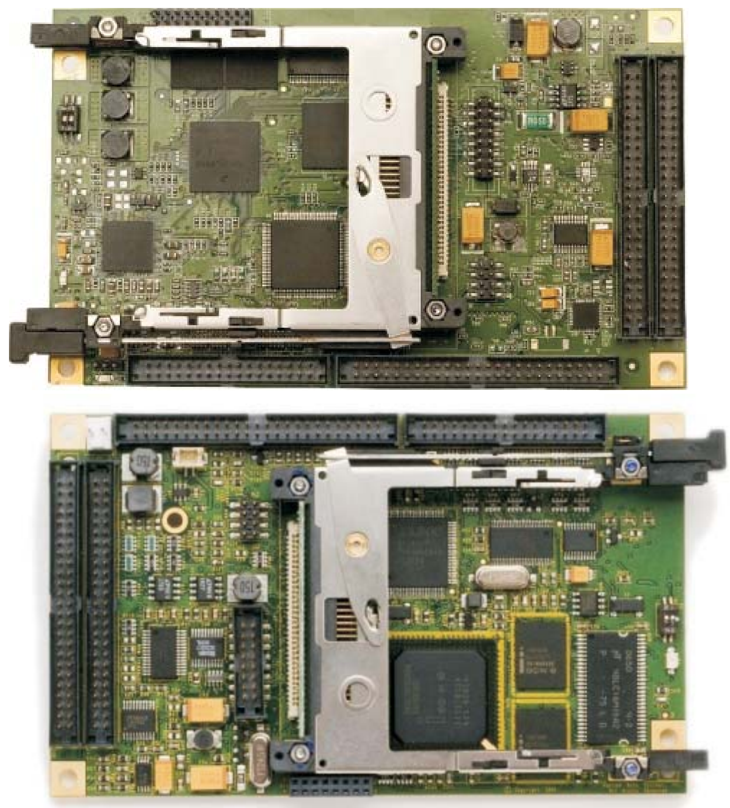


Figure 2- BitsyG5 and BistyXb - Same form factor & pin out

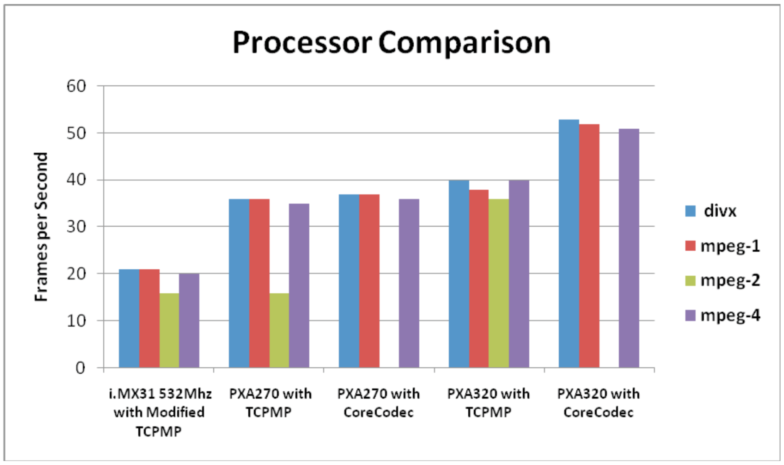
Test Platform

The tests were performed on the Eurotech system platform; this included the product single board computer, connector board, and a display subsystem. A mouse and keyboard were plugged in for test, and the display in all cases was VGA resolution with 16-bit color depth. The Freescale i.MX31 and and Marvell PXA270 configurations used Eurotech's popular Bitsy form factor, specifically the Bitsy G5 and BitsyXb respectively. The Marvell PXA320 was tested in the Eurotech GCM product, with a 4x6 inch form factor. In all cases, the OS was Windows CE and was the current product level build from Eurotech. Power management was available but not used for these tests. Code was compiled with the standard Microsoft compiler, not the Microsoft secure compiler or various 3rd party high speed compilers. Notably, the PXA320 is our first system based on NAND Flash and this required substantial changes to the BSP to allow boot and efficient suspend/resume. Since this test was run from dynamic memory, we think the use of NAND Flash had no effect on results. The i.MX31, PXA270, and PXA320 BSP offers the same API to the application programmers. Most of the platform-specific implementation details such as splash screen and display resolution are saved in specific modules that we preserve across architectures. The vector floating point IS active in the i.MX31 BSP, but we do not believe it is used by the tested media player.

For media decompress/display we used different versions of the 3rd party media player, Core Codec. This codec has been optimized for specific supplier silicon (Marvell Wireless MMX) and has proven to be better than the Microsoft Media player which uses only the basic ARM instruction set. We modified TCPMP, the open source version of CoreCodec, to attempt to level the playing field by using i.MX hardware for portions of the video decode. In particular we used i/MX Hardware for the color correction operation which requires the solution to compute multiple linear equations for each color of each pixel in the image. Please note that this test is full VGA (640 x 480) so is not far from the HDTV resolution of 720p. Most battery operated media players (Zune, iPod) are nominally only QVGA or half VGA.

Test Results

File Format	File Size	i.MX31 532Mhz with Modified TCPMP (fps)	PXA270 with TCPMP (fps)	PXA270 with CoreCodec (fps)	PXA320 with TCPMP (fps)	PXA320 with CoreCodec (fps)
divx	3,255 Kb	21	36	37	40	53
mpeg-1	4,314 KB	21	36	37	38	52
mpeg-2	4,402 KB	16	16	Not supported	36	Not supported
mpeg-4	3,395 KB	20	35	36	40	51



To measure processor performance, these tests were run with the 24 fps media streams decompressing and running as fast as possible. The same content was used for each compression format. Frame per second rates slower than 24 fps mean that in realtime applications, some frames would be dropped. Frame rates faster than 24 fps mean there is spare processor power available. In short "big numbers are better."

Discussion

Clearly, the PXA320 was the highest performing option tested, but that might be expected. The Codec was optimized for the MMX instructions in that hardware set. Indeed, for mpeg-1, the upgraded commercial CoreCodec was 27% faster that its open source progenitor TCPMP. Since the test took CoreCode/TCPMP as a 'given' it could be claimed that results were 'stacked' against the i.MX31. Also, the real Freescale competitor to the PXA320 is the recently announced, but not yet in full production, i.MX51. Also untested were a couple of i.MX 'silver bullet' features like hardware assisted vector graphics (consider the impact on gaming!) and native Java bytecode execution.

The real message here is that two radically different architectures benchmarked within fifty percent of each other, with the difference almost certainly attributed to software. The take away message is that a fast CPU is not enough. Good media performance at low power requires close coordination between hardware features and software. The difference might be wider if the benchmark was not just performance, but performance per unit of power. An operation like video offers tremendous scope for improvement by active power management. A device with proper power management can step down into lower power modes during the 42 milliseconds used to display a frame, thereby potentially reducing its energy consumption by 40% or more. It is this type of feature, not just CPU hardware, that extends the battery life of devices to practical levels such as longer than a feature length movie.

Developers of battery-powered media devices might want to heed the advice of Microsoft's VP Todd Peters: "I'd rather have fewer devices and be more focused, we get better integration." (New York Times, Jan 8, 2009)