

OMAP™ Technology Overview

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INTRODUCTION

The wireless market is huge and growing. Just five years ago, only 0.5 percent of the worldwide market owned wireless telephones or related appliances. Sales amounted to only 20 million units. Today, market penetration is about nine percent, with annual sales of more than 400 million units. Dataquest estimates that, in just three more years, 18 percent of the worldwide market will own wireless appliances.

As demand grows, so do consumer expectations. The wireless revolution is moving rapidly beyond voice to include such sophisticated applications as mobile e-commerce, real-time Internet, speech recognition, audio and full-motion video streaming. As a result, wireless Internet appliances require increasingly complex mobile communications and signal processing capabilities. And while consumers expect state-of-the-art functionality, they continue to demand longer battery life and smaller, sleeker products.

To provide these seemingly paradoxical characteristics—processing power for sophisticated applications with no reduction in battery life—wireless Internet appliance OEMs require the highly efficient, power-stingy processing delivered by the Open Multimedia Applications Platform™ (OMAP™) architecture from Texas Instruments. OMAP hardware and software can decode data streams, such as MP3 audio and MPEG-4 video, in real time with just a fraction of the power required when using a best-in-class RISC processor (see Table 1).

Table 1 Comparative Algorithm Execution

	*RISC A	*RISC B	*C5510™	Unit Measurement
Echo cancellation/16 Bits (32 ms – 8 kHz)	24	39	4	Mcycle/s
Echo cancellation/32 Bits (32 ms – 8 kHz)	37	41	15	Mcycle/s
MPEG4/H263 decoding QCIF at 15 fps	33	34	17	Mcycle/s
MPEG4/H263 encoding QCIF at 15 fps	179	153	41	Mcycle/s
JPEG decoding QCIF	2.1	2.06	1.2	Mcycle/s
Average cycle ratio With C55x™	3.12	3.5	1	

* Information based on published data

The advanced OMAP architecture provides a system solution for the wireless market. It seamlessly integrates a software infrastructure, an ARM™ RISC processor, a high-performance, ultra-low-power TI TMS320C55x™ generation digital signal processor (DSP) and shared memory architecture on the same piece of silicon. The OMAP software infrastructure includes support for advanced operating systems and applications through standard APIs. TI's unique DSP/BIOS™ Bridge allows the developer to optimally partition tasks between the RISC and the DSP to maximize performance without sacrificing battery power.

In addition, the OMAP application environment is fully programmable. This programmability allows wireless device OEMs, independent developers, and carriers to provide downloadable software upgrades as standards change or bugs are found. Since there is no need to develop new ASIC hardware to implement changes, OMAP OEMs can respond to changing market conditions much more quickly than many of their competitors can.

Because it is an open architecture with a standardized interface, the OMAP architecture encourages third-party developers to create new applications or add functionality. It also encourages reuse because the standardized interface allows OEMs to move software easily from one platform to another. Reusing existing software and adding innovations from outside developers help OEMs get to market quickly with differentiated features.

The fact that the OMAP architecture can be ported to any wireless device operating system (OS) and is compatible with applications written for most OSs, including Symbian's EPOC™ and Microsoft Windows CE™, simplifies the development process for equipment makers seeking the broadest possible market. OEMs can maximize their investments by adapting in-house or third-party software to emerging operating systems. Third-party developers, in turn, can anticipate the largest possible markets for their innovations because their software need not be OS specific.

Integrating available third-party and OS native tools with TI's user-friendly Code Composer Studio™ integrated development environment (IDE) makes complete software development support available for the OMAP hardware and software architecture. Available tool kits allow developers to work with an OMAP device as easily as if it were a RISC processor alone while gaining the power/performance benefits of a dual processor. For OEMs and third-party developers, the fact that the tools eliminate the need to address the RISC and the DSP independently facilitates the creation of wireless multimedia applications and helps get them to market quickly.

With its unique ability to combine ultra-high performance with unmatched power conservation in wireless Internet appliances, the OMAP architecture today is emerging as the de facto standard for the industry. The world leaders in wireless telephones—Ericsson, Nokia, Sony, Handspring and other customers—have announced plans to base next generation wireless appliances on TI's OMAP architecture. With TI's network of more than 350 third-party companies developing hardware and software products for the TMS320™ DSP family, OEMs lap their competition in the time-to-market race with an array of algorithms and smart middleware already available.

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The DSP Advantage

As full-motion video for rich multimedia content or advertising, video conferencing, voice recognition, sophisticated security, and other applications are added to the wireless appliance, DSP technology becomes increasingly essential. Only by adding DSP functionality to the basic processing configuration of a wireless appliance can developers reproduce high-quality, real-time video within acceptable power consumption limits.

Similarly, TI DSPs and OMAP technology overcome problems that may arise with applications such as MP3 (MPEG Audio Decode, Layer 3) or AAC (Advanced Audio Coding) high-fidelity audio playback. A RISC processor cannot provide the signal processing power necessary for these applications without quickly sapping the battery. Programmable DSPs, on the other hand, allow developers to implement any available standard without creating unacceptable battery drain.

DSPs provide superior power/performance in such applications because video, like best-of-class audio playback, is fundamentally a signal-processing task. And DSPs, by design, are optimized specifically for signal processing. A DSP requires significantly less power per clock cycle than a RISC processor. More importantly, the DSP requires fewer instructions to implement a math-intensive, repetitive algorithm, and it carries out more instructions per clock cycle. The result is faster implementation with vastly less power consumption.

Many of the features beginning to appear in wireless equipment don't perform effectively in the typical end-user environment. The latest smart phones, for example, feature speech recognition capabilities that let the user speak basic instructions. In general, the speech recognition feature operates effectively in perfectly quiet surroundings. When a user attempts to issue voice commands in a crowded room or in a moving automobile, however, the speech recognition feature often fails.

The major reason for this failure is that makers of several well-known wireless handsets implement echo cancellation and noise suppression algorithms on a RISC processor. Often, this can be done successfully as long as the appliance operates, for the duration of a communication, as a telephone alone. But in the migration from telephone to 3G multimedia appliance, it is reasonable to expect users to play games or watch video as they issue voice commands and use the telephone capabilities of the appliance. The added processing power of the DSP allows these appliances to run concurrently with the noise suppression and echo cancellation algorithms, thus providing the environment to successfully use speech recognition.

With a RISC processor alone, the second application (i.e. the video) would display in fits and starts as the RISC interrupted its processing to handle smart phone functions. By coupling a DSP with a RISC processor in parallel, the OMAP architecture gives OEMs access to the capabilities of the DSP while also providing the command and control functions for which RISC processors are best suited. This approach provides at least two important benefits: it improves the quality of basic wireless telephony functions, and it permits true multimedia multitasking on the wireless appliance.

OMAP DSP/BIOS Bridge

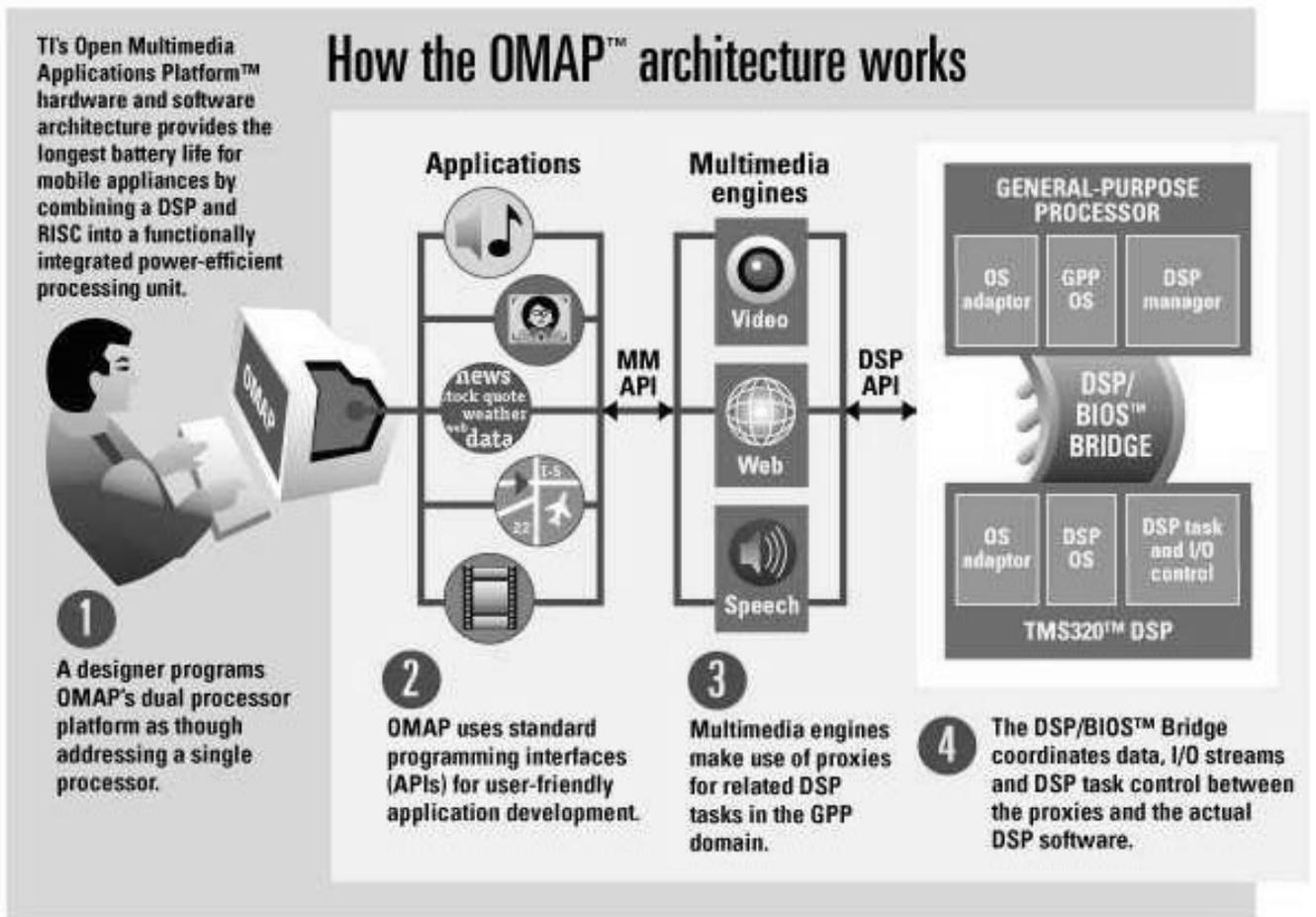
The DSP/BIOS Bridge is the key to OMAP architecture functionality and ease of use. It provides the application software developer a seamless, easy-to-use interface to the DSP. It allows the developer on the RISC to access and control the DSP runtime environment using a standardized application programming interface (API).

From the developer's perspective, using TI's Code Composer Studio IDE makes the OMAP devices appear to behave and respond as though a single RISC processor alone were handling all functions. There is no need for the developer to program for the two processors independently or to work in the more difficult language environments sometimes associated with DSPs. A skilled RISC developer can quickly and easily adapt those skills to take advantage of the OMAP architecture's superior power and performance characteristics.

In a RISC-only system, the OS kernel schedules operations to run on the processor. Subsystems such as graphic interfaces and gaming programs rely on the RISC to schedule the available processing power and optimize these demanding software functions without choking the RISC processor completely. Adding a DSP processor, which is ideally suited for these processing-intensive functions, relieves the concern that the RISC processor will be overloaded. Allocating parallel functions to the two processors greatly reduces the possibility that an application will halt in mid-execution because the RISC has diverted processing power to another activity.

In the OMAP platform, the RISC OS kernel serves the same function as it does in a system using RISC alone, but the DSP/BIOS Bridge allows software developers to reroute the processing-intensive functions to the DSP, where they run asynchronously with no load on the RISC kernel scheduling. In some cases, the RISC processor exercises only a limited number of command and control functions, while the DSP provides the processing muscle needed for the application. A media file will run asynchronously on the DSP without the interrupts and latencies inherent when a RISC processor performs signal processing, resulting in a more robust, user-acceptable implementation.

Figure 1 **OMAP Architecture**



Open Multimedia Applications Platform, OMAP, TMS320 and DSP/BIOS are trademarks of Texas Instruments.

The Value of Open Architecture

Perhaps the most important benefit of the OMAP open architecture is that it opens the field of wireless appliance programming to independent application vendors. Consequently, OEMs will have easy access to a wide variety of applications and features. Currently, the TI value web includes more than 350 third-party developers creating algorithms suited for wireless multimedia appliances. Other vendors, from entrepreneurial programmers to large corporations, can easily join this growing network because the underlying code is readily available.

This means that, using the OMAP architecture, OEMs can maintain their investment in optimized applications for a device using one protocol as they develop devices using other protocols. It also means that designers can maintain the optimized code as they create new applications for appliances using different operating systems as the code is developed using the DSP/BIOS Bridge API. Once an application is developed for OMAP using the standardized API, it will be compatible with future end equipments based on the OMAP architecture, maximizing reuse (see Figure 1).

Currently, the OMAP architecture is ported to the Microsoft Windows CE and Symbian EPOC operating systems. Ports to other operating systems are planned and will be available in the near future. In addition, the OMAP DSP/BIOS Bridge supports the OSE operating system for 3G mobile phones.

TI also aggressively supports Java™ in the OMAP architecture and will make the DSP/BIOS Bridge API accessible to developers of Java media players and the applications that make use of these players. The OMAP architecture substantially overcomes the performance degradation that is inherent in the Java by accelerating the processing of Java byte codes.

The Value of Programmability

Today's marketplace allows little time for design and manufacture of new silicon to accommodate new standards and protocols, provide innovative features and functionality, or eliminate bugs. The window of opportunity is too small to admit products from OEMs who need weeks—sometimes months—to improve ASIC-based equipments.

Because it is fully programmable, the OMAP hardware and software architecture allows OEMs to enhance existing systems and to sell new features without replacing basic hardware. End users can simply download software upgrades or completely new applications as they become available. OEMs can put their innovative energies into developing fourth and fifth generation equipment to serve new and emerging markets.

By the same token, independent designers can develop new applications with reasonable assurance that the marketplace will be big enough to reward their efforts. Rather than building product-specific applications, they can create for the broad range of OMAP-based OEMs and carriers who can, in turn, offer the new applications as downloadable enhancements.

Conclusion

Many factors drive the growth of wireless in today's market, but one of the most important is the proliferation of applications and the growing functionality of wireless Internet appliances. As speech recognition makes devices easier and more convenient to use, as video communications open the door to applications ranging from personalized consumer advertising to electronic babysitting, and as today's separate appliances merge into a single multimedia end equipment, demand will intensify.

Expected new applications—including MPEG4, text-to-speech, unified messaging, Internet audio, videoconferencing, video clip playback, and others—require more powerful processors that drain less battery power. They also create dramatic new opportunities for independent software developers who can provide leading-edge applications and features.

The OMAP architecture's parallel combination of DSP and RISC processing provides the flexibility to accommodate applications like these while preserving battery life. The open architecture makes it easy for third-party developers to create these and other wireless multimedia applications not yet even imagined. Technology available from TI today provides the gateway to huge new markets tomorrow.

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