WHITE PAPER

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OMAP™ 3 architecture from Texas Instruments opens new horizons for mobile Internet devices

Introduction

Mobile Internet Devices (MIDs) are an emerging group of products that combine wireless communications with computing. MIDs aim to be more portable than notebook PCs while offering larger displays than smartphones.

MIDs provide all-day mobile operation and offer no-compromise Internet connectivity through wireless LAN (WLAN) and cellular networks, plus other compelling features for consumers and businesspeople.

As with other portable systems, the key concerns for manufacturers in choosing silicon solutions are getting the most performance out of the least power consumption; keeping board size, battery size and weight low; and minimizing system cost. MID manufacturers also look to speed development by relying on complete hardware and software integration, excellent support, and a well-defined roadmap to future product generations.

TI's OMAP™ technology satisfies all of these requirements, combining advanced hardware and software in a complete solution. OMAP 3 hardware integrates a high-performance ARM® Cortex™-A8 processor along with digital signal processing technology and multimedia acceleration for imaging, video and graphics.

Derived from generations of successful solutions for mobile phones, the OMAP™ 3 platform represents the culmination of TI process and design expertise in obtaining the highest performance from the least power so that MID users can enjoy advanced applications with the longest possible battery life between charges. Compared to solutions scaled down from the PC market, the OMAP 3 platform enables manufacturers to build products that are smaller, lighter in weight, more affordable and capable of being used all day without recharging. System developers can turn to OMAP 3 technology today for proven high-performance solutions that are ready to enable the full range of emerging MID products.

A new market space for mobile communications

One of the hottest areas of development for personal communications today is in products with displays larger than smartphones but with more mobility than notebook PCs. Although not all of the applications of this emerging market segment are well-defined, it is clear that at the very least these systems must provide Internet service over cellular or WLAN networks and be capable of all-day mobile operation.

A product in this segment is referred to as a mobile Internet device (MID), which aptly describes the mid-range market between high-end phones and notebook PCs. Defining features of MIDs are:

- No-compromise Internet, including a full-featured browser with all plug-ins and fonts.
- Broadband and personal connectivity through a combination of WiFi, WiMAX, 3G cellular and *Bluetooth®*.
- High-resolution displays that can show a full Web page.
- An intuitive user interface using touchscreen technology.
- Full-day operation on a single battery charge.

Many manufacturers will combine these capabilities with consumer, computer and communications functions. Other features that will be common in MIDs include:

- Cellular voice services.
- Web 2.0 one-click interaction, providing a delivery framework for content and services.
- High-definition (HD) media players, camcorders and high-resolution still cameras.
- Productivity tools such as e-mail and unified communications via instant messaging, voice and video, along with the capability to read and edit standard PC documents.
- Navigation tools such as GPS-enabled maps, traffic updates and driving directions.
- Rich, interactive gaming with 3-D graphics.

MID end equipment spans segments and feature sets, including mobile phones, portable media players, portable navigation tools and e-books, with no-compromise Internet capability, wireless-enabled netbooks, mobile digital TVs, mobile social networking devices and virtual world systems. Because the market is still emerging, many other MID applications may yet appear.

Although most MIDs are targeted at consumers and business users, the flexibility of the products makes them attractive for vertical markets as well. Applications include retail kiosks and portable point-of-sale, doctor pads and personal medical monitoring, and varied uses for education, business, transportation, government and defense. As advancing technology makes MIDs more portable and versatile, these products will increasingly change the lifestyles of on-the-go consumers and businesspeople.

Three groups of MIDs

In general, three groups of MIDs are emerging, distinguished by size and volume as well as functionality. Prices will vary depending on functionality, but systems tend to be in the $300 range.

The first group – pocket MIDs – are appearing with displays of about 3 to 5 inches and weights of about a quarter pound (~100 grams). These systems provide phone service, as well as offering full Web browsing, multimedia, cameras and other features suitable to a small form factor.

Pocket MIDs represent an upscaling of smartphone technology, with phone market volumes in the hundreds of millions anticipated. Today, the majority of smartphones on the market are enabled by TI's OMAP technology, based on power-efficient ARM microprocessors and TI's leadership digital signal processing technology. Pocket MIDs are taking advantage of new developments in the underlying silicon to offer even greater functionality, along with full-day operation without recharging.

At the high end of the size range are scaled-down PC notebooks, or netbooks, with computer market volumes in the tens of millions anticipated. These systems, with displays of about 7 or more inches, weigh as much as a pound (~450 grams) and offer full Internet and multimedia functionality, as well as full office productivity

capabilities. The functionality of these systems is not dependent in any way on a legacy PC architecture, as is demonstrated by the exceptional Web browsing and multimedia offered by ARM-based pocket MIDs.

Between pocket MIDs and netbooks are various tablet MIDs, featuring displays of about 4 to 7 inches and weighing about a half pound (~220 grams). Many tablets are likely to combine MID functionality with consumer products such as still cameras, camcorders, navigation systems, media players and game players.

Even more than the other groups, the tablet group is still being defined, so it offers great opportunity for new product innovation. Tablets that can take advantage of the power optimization of silicon solutions from the wireless phone market will be able to offer a high degree of mobility without sacrificing performance or functionality. Figure 1 shows the defining and optional features for the three groups of MIDs.

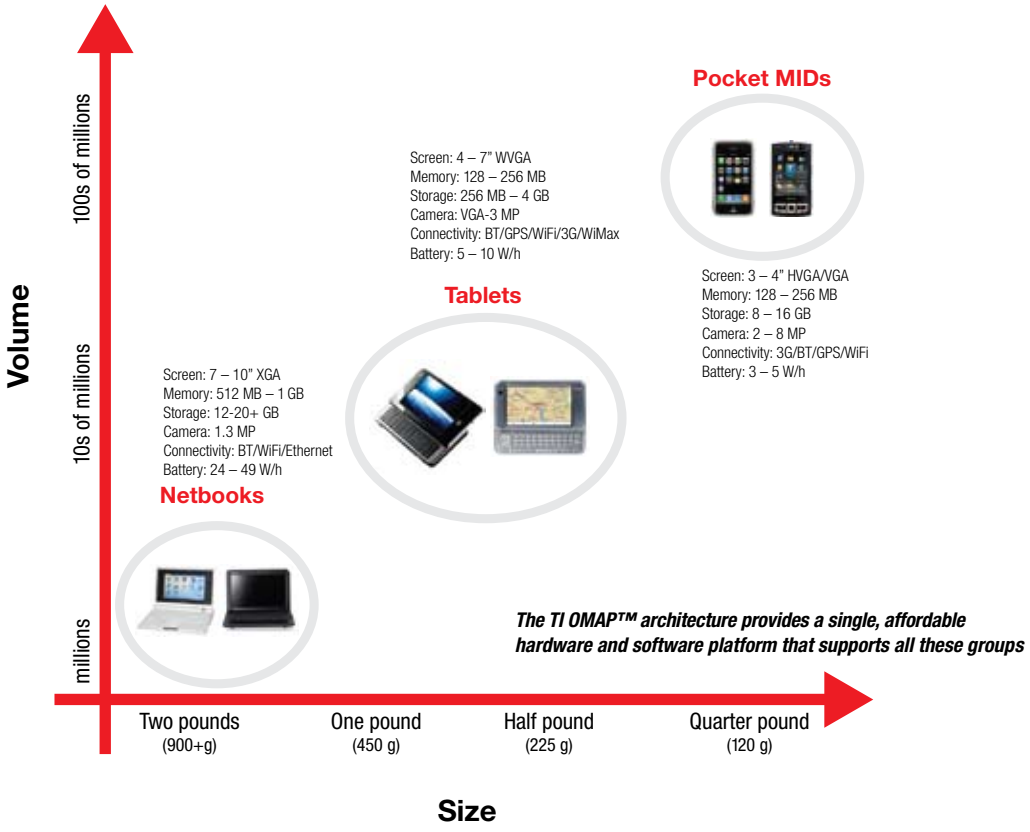

Figure 1 – *MID groups and features*

MID system requirements

Because MIDs offer a robust set of features, they have high performance requirements. For instance, MIDs that add Internet connectivity to consumer applications not only need to provide for basic communications; they also need to meet the established expectations of consumers for these applications.

For digital still cameras (DSCs), these requirements include an 8- to 12-megapixel imager, optical zoom, autofocus and less than one second shot-to-shot delay. Camcorders require image stabilization and HD recording and playback; 3-D graphics are needed in gaming consoles; media players must support all audio and video formats and offer a high-resolution display; users of navigation systems demand GPS-based directions and real-time traffic updates; and Web browsers must support full-page displays and all plug-ins and fonts. These requirements are only the beginning; other consumer applications may yet appear.

To offer consumers the most seamless user experience, MIDs must offer the optimal mix of broadband and personal connectivity. A combination of wide-area and personal-area network technologies – including Wi-Fi, WiMAX, 3G cellular and Bluetooth wireless technology – ensures multi-mode operation and access to a variety of wireless network connections. GPS navigation technology also delivers access to fast and accurate location-based services within asynchronous and synchronous cellular networks. With the right mix, consumers can connect, entertain, stay informed, and be productive anytime, anywhere.

Although MID systems can meet these performance requirements, they also have to be as small and light-weight as possible and provide long periods of operation and standby from a single battery charge. With units directed at price-conscious consumer markets, MID manufacturers must also look for the most cost-efficient means to execute their designs. In a fast-paced market, developers must be able to bring their initial designs to market quickly, execute new spins on existing products to keep up with new demands, and have a clear migration path to future product development.

Silicon is key to MID success

The underlying silicon solution is essential to meeting MID system design requirements. The solution must provide specialized processing and dedicated engines to achieve the communications and multimedia tasks users demand.

To keep board size and manufacturing expense under control, the processor must offer system-on-chip (SoC) integration that includes multiple processing cores, ample memory and all necessary system peripherals. The manufacturing process and circuit design must enable the greatest performance-per-unit of power consumed during active operation and negligible leakage during standby periods.

The power saved allows manufacturers to use smaller batteries in the system for reduced size and weight, while the smaller system and battery requirements in turn give manufacturers greater flexibility for creating sleek form factors that appeal to consumers.

In addition, the processing solution must be programmable and must include essential system and application software, as well as easy-to-use tools, in order to speed development and simplify upgrades and design modifications.

Finally, silicon suppliers must provide a roadmap to future devices that offer even greater performance at lower power, plus higher integration and wider functionality – all designed to allow system manufacturers to fully leverage existing software development work in next-generation products.

Because of the nature of the wireless communications market, TI has been building processing solutions for mobile phones for more than 15 years to meet these requirements; by now, these products have evolved through many steadily improving generations.

By contrast, PC solutions have not been primarily designed to meet mobility requirements, and PC solution suppliers must now come up with an appropriate technology almost from scratch. MID system developers are better off looking for solutions that have proven successful in smartphones over notebook PCs, since the issues for gaining high performance from low power while keeping space and cost low have already been addressed for wireless handsets, but are still being assessed for carry-around computers.

OMAP 3 platform: beneficial for MIDs

TI's latest development of technology for mobile systems is the OMAP 3 generation of application processors, which is specifically designed to meet the requirements of MID systems. The OMAP 3 platform is the industry's first application processor to be based on the superscalar ARM Cortex-A8, the most advanced ARM processor to date, with the industry's highest ratio of processing to power consumption and a boost in performance as much as four times over that of the previous-generation ARM11 core.

The ARM Cortex-A8 was designed with input from TI specifically to enable full-featured Web browsing, laptop-level productivity applications, a fast boot time of about five seconds and other capabilities vital for MIDs.

The multicore OMAP 3 platform also integrates TI's industry-leading TMS320C64x™ DSP, video-imaging acceleration and a dedicated graphics engine. As a result of these enhancements, OMAP 3 processor performance on multimedia reaches new heights, with up to four times the graphic, twice the camera and four times the video capability of previously available OMAP platform products, plus the capability of playing and recording 720p HD video. Figure 2 shows the internal blocks of an OMAP3440 processor, together with its connection to the remainder of the system.

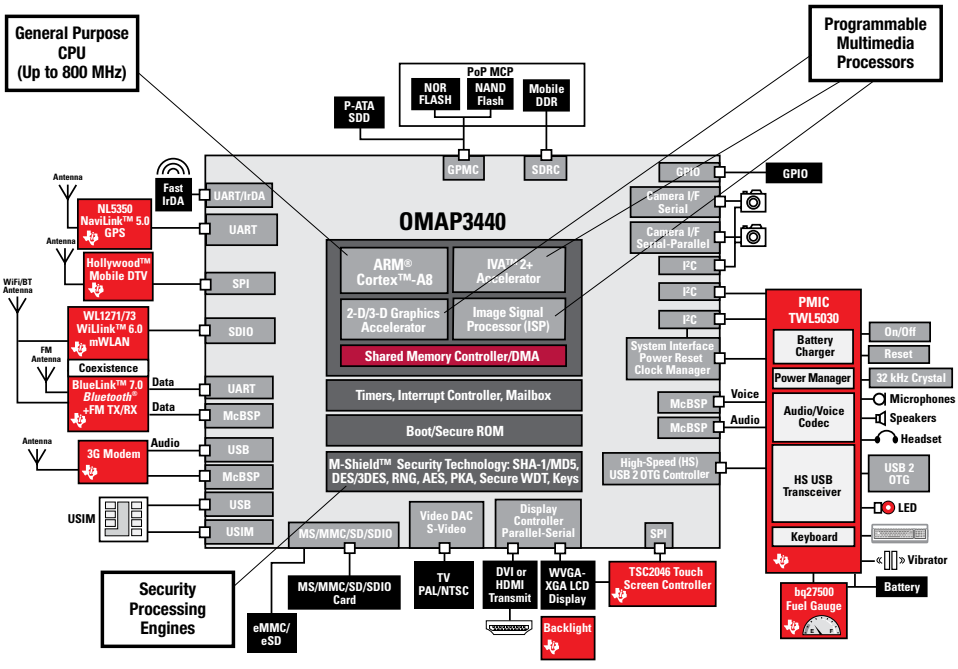

Figure 2 – *OMAP3440 processor with MID system connections*

Affordable high performance with low power

Compared to PC-centric x86 solutions that have been scaled down for MIDs, the OMAP 3 platform offers big advantages in size, affordability and power-efficiency. OMAP 3 architecture integrate all core performance, memory and system peripherals in a single device, saving more than three-fourths[1] the chip space required for the best PC-centric x86 solution, which divides its functionality between two chips – the CPU and a chipset that includes the memory controller, video decoder, graphics engine and I/O.

Unlike the best x86-based core, the OMAP 3 Cortex-A8 core is a single-chip solution with stacked memory support that together saves 90 percent board space[2] which is important to reduce product size.

Even though the best x86 solution boasts a 45-nm CMOS process for the CPU only, the required companion system controller hub is implemented in 130-nm. Since the CPU's 45-nm process was targeted to meet the requirements of the PC market, it does not offer the same performance-to-power efficiency as TI's 65-nm process, which was developed for the requirements of the mobile wireless market.

Even with a smaller-geometry process, the x86 solution requires twice the die size of an OMAP 3 processor and draws much greater power for comparable performance. Smaller die sizes combined with high wireless market volumes also make a difference in cost: the single-chip OMAP 3 platform costs less than half as much as the best x86 solution, resulting in much less expensive end equipment.

The OMAP 3 platform is designed to produce power-efficient high performance, leveraging TI's manufacturing process innovations and proprietary SmartReflex™ power and performance software. The worst-case power consumption for the integrated OMAP 3 processor at 800 MHz is 750 mW, compared with roughly 3 to 5 W (four to more than six times as much) required for the two-chip x86 solution.[3]

With similar power consumption for the rest of the system, TI's solution yields up to three times the battery life for Web browsing and video playback. In fact, this scenario may be understating the advantage, since during average operation the OMAP 3 processors draw only 25.6 mW, about 11 to 16 percent as much as the 160 to 220 mW required by the best x86 solution in similar conditions.[4]

Some of this advantage derives from the OMAP 3 platform's power-conserving active operation and the Cortex-A8 providing over 30 percent better power efficiency per MHz over the best x86 processor. But an even greater advantage comes from the OMAP 3 processors' low-power modes, where TI process and design technologies keep leakage current to a minimum.

(1) TI package area is 12x12 mm (144 sq. mm). Atom package area consists of two devices which are 13x14 mm and 22x22 mm (666 sq. mm). Intel data is from datasheets available at: ***http://www.intel.com/design/chipsets/embedded/SCHUS15W/techdocs.htm***

(2) Based on PCB area used by Atom modules such as shown in ***http://www.linuxdevices.com/files/misc/congatec_atom.jpg*** *Centrino Atom PCB area for processing and memory is 1420 sq. mm. versus 144 sq. mm. for TI OMAP 3 solution.*

(3) Intel Z500 running at 800 MHz has TDP power, which is less than worst-case power, of 0.65 W. The SCH maximum TDP power is specified to be 2.3 W. 2-chip Atom solution is 2.95 W maximum power versus 0.75 W for OMAP 3. Intel Z5xx CPU power is documented at: ***http://download.intel.com/pressroom/kits/events/idfspr_2008/IntelAtom_processor_skus.pdf****. The detailed power specifications are available on intel.com. SCH chipset power is documented at: http://www.intel.com/design/chipsets/embedded/SCHUS15W/techdocs.htm*

(4) Based on TI analysis using Intel CPU power data for power states C0/C1/C2/C4/C6 and respective active duty cycles of 5 percent in each except C6 at 80 percent. Same duty cycle profile was used for comparable TI OMAP3430 Cortex-A8 CPU power numbers.

In fact, when the OMAP 3 processor is in deep sleep mode, it draws almost no current at all, yet is ready to respond quickly to user demand. By contrast, the best x86 solution draws some 80 to 100 mW in power-saving mode, so that in many usage scenarios an OMAP 3 device can be fully active on the same amount of power that the x86 solution uses when it is asleep.[5]

In terms of hours, an OMAP 3 platform-based system can operate all day without recharging as it performs Web browsing, multimedia and other intensive tasks, whereas a system based on the best x86 solution lasts only a few hours. In standby mode, while a system based on the best x86 solution needs to be recharged several times a day, an OMAP 3 processor can last a week or more before needing recharging.

Different levels of power consumption must be supported by different batteries. Reference designs for MIDs based on the x86 solution call for batteries that are two to three times the size and weight of those in OMAP 3 designs, so the end equipment cannot be nearly as compact.[6]

Advanced system software and development tools

For all of these reasons, emerging MID applications can benefit from OMAP 3 platform-based hardware. Future OMAP technology products – some already in development and others planned – will continue offering greater performance from less power with higher levels of integration.

Manufacturers can also turn to TI for help in fast development of MID systems. The OMAP 3 platform includes system software, a multimedia framework and support for the widely used Linux, Microsoft Windows Mobile and Symbian operating systems. Manufacturers can turn to TI's large network of developers for proven algorithms and application modules that speed development and assist with compatibility within the system. Figure 3 shows how the entire platform fits together.

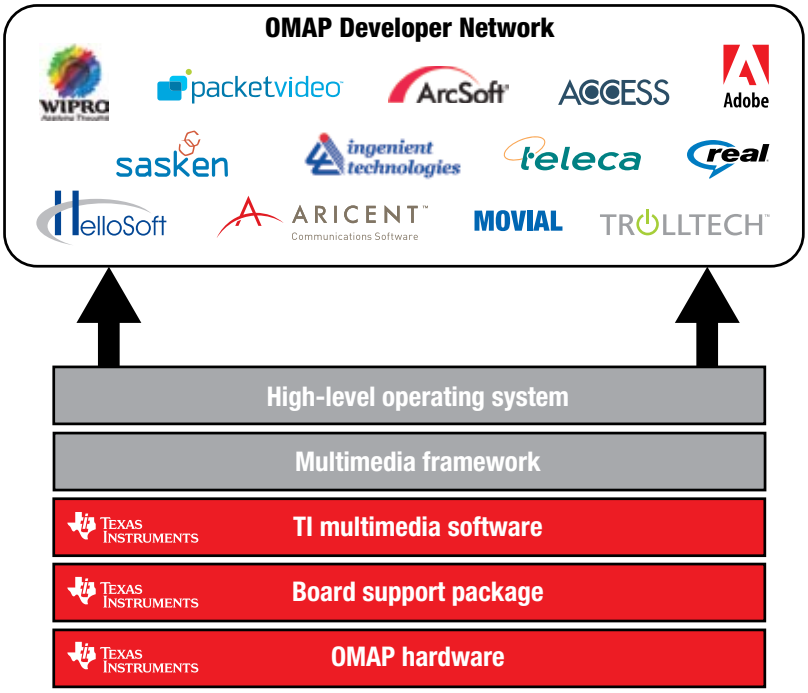

Figure 3 – *MID hardware and software reference design*

TI is unique among MID solutions suppliers in offering a complete hardware and software reference design that eliminates much of the time involved in creating a system and allows device manufacturers to get to market quickly.

Among other resources that help simplify development is the Zoom mobile development kit (MDK), a cost-effective platform that can be used with a variety of operating systems and with features that are continually being extended. Based on the OMAP3430 applications processor, the Zoom MDK includes TI's wireless connectivity technology, a 3 megapixel camera sensor, 3.7-inch VGA TFT touchscreen display, TV output and other features. The production-quality software reference design includes TI base drivers and TI multimedia framework and codecs and a full third-party application suite and UI for Linux, Windows Mobile and Symbian software systems.

TI has a robust developer network comprising more than 400 software developers. TI's OMAP Developer Network continues to provide innovative applications, services and multimedia modules for TI's wireless technologies. Coming from an extensive range of third-party software developers and hardware manufacturers, optimized OMAP software and algorithms deliver the latest, most compelling applications for handsets and MIDs.

Using the complete OMAP 3 hardware and software platform, together with tools and modules available from TI and their partners, manufacturers can speed time to market for new MID products.

Even though MID products – pocket MIDs, tablets and netbooks – are only beginning to emerge, they are already changing the way we use the Internet, entertain ourselves, communicate with each other and increase our productivity. Consumers demand that these products be extremely mobile and affordable, as well as offering robust Internet, multimedia and other applications.

MID solutions for the future

MID system manufacturers must look for solutions that reduce size and weight, prolong battery use between charges and keep costs low – all while providing a high level of performance and advanced features.

The OMAP 3 platform brings together TI's in-depth expertise in process manufacturing, circuit design and mobile communications to meet these challenges for MIDs. Future OMAP platform-based developments will continue this leadership.

(5) Intel Z5xx CPU power is documented at: ***http://download.intel.com/pressroom/kits/events/idfspr_2008/IntelAtom_processor_skus.pdf***
TI OMAP3430 standby power is 100 microwatts.

(6) Example Intel Atom product specifications are documented at ***http://www.umpcportal.com/products/*** *(such as GigaByte M528 MID) Example is Asus Eee PC901 with 49 W/h battery* ***http://www.umpcportal.com/products/product.php?id=212***

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