Developing Core Software Technologies for TI's OMAP™ Platform

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Texas Instruments OMAP™ platform for wireless handsets offers a powerful hardware and software foundation for the development of innovative 2.5G and 3G wireless applications. A key element of the OMAP platform strategy includes core software technologies, which provide drop-in functionality and ready-to-use capabilities for a variety of applications. With the aid of the core software technologies, OMAP developers can create media-rich software products that provide an outstanding user experience and are portable across a variety of OMAP processors and devices. The OMAP platform architecture provides a structure for the implementation of these technologies; enabling OMAP developers to create software efficiently that can add value in the next-generation wireless handsets.

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The OMAP platform

As the wireless industry moves into a new era of differentiated services, developers are increasingly choosing Texas Instruments' (TI) OMAP™ platform for innovative 2.5G and 3G wireless applications. The OMAP platform combines a high-performance, power-efficient processor with an easy-to-use, open software architecture backed by a comprehensive support network. These features provide a powerful hardware and software foundation for the development of innovative applications, and they help simplify development and save time-to-market for new wireless products.

The OMAP platform's software infrastructure contains key elements including core software technologies, software modules optimized for the OMAP platform that provide easy-to-implement differentiation for applications. For application developers, these fundamental software pieces are building blocks that create drop-in functionality and ready-to-use streaming media, security, biometrics, voice recognition, advanced audio and other capabilities. Core software technologies for the OMAP platform also enable application developers to take full advantage of the OMAP processor's performance without specific knowledge of the underlying hardware architecture.

For all these reasons, OMAP developers play a vital role in the success of the OMAP platform, providing specialized expertise and capabilities that enhance the OMAP software environment. TI works closely with OMAP Developer Network members to help them create their products and establish business relationships with device manufacturers.

TI's OMAP platform, the most flexible platform in the industry for personal devices, offers the best solution for developers who want to take the next step into the future of wireless communications. OMAP processors support many types of applications that complement voice services, including speech processing, location-based services, security, gaming, enterprise, mobile commerce, personal management and multimedia.

The flagship processor of the OMAP platform is the OMAP1510 device, which integrates an ultra-low power digital signal processor (DSP) for accelerating applications, with a TI-enhanced ARM925 for control, and high-level operating system (OS) functions. The dual-core hardware architecture of the OMAP1510 device provides exceptionally high processing performance without sacrificing battery life. Complementing the processor is the OMAP1510 open software architecture, which is designed to keep the dual-core hardware transparent to the user so that it is easy to program and integrate into a multifunctional product.

Two single-core products, the OMAP710 and OMAP310 processors, integrate only the TI-enhanced ARM925, providing an alternative platform for wireless devices with less processing-intensive applications that do not require DSP performance. The OMAP310 and OMAP710 processors are code-compatible with the TI-enhanced ARM925 on the OMAP1510 processor, allowing developers to port software applications to personal products that target different markets. With these processors, OMAP technology offers the high performance, low power consumption and programming flexibility needed for developing 2.5G and 3G multimedia wireless instruments.

Advantages of the OMAP platform's core software technologies

Core software components of the OMAP platform allow applications to take advantage of the DSP for accelerating signal processing tasks, thus creating a more compelling user experience. The user can interact with the OS running on the TI-enhanced ARM925 while simultaneously using the DSP to accelerate multimedia, speech, security or other capabilities. With the optimized underlying software, the DSP performs the signal processing tasks associated with these capabilities in a more power-efficient manner, promoting longer battery life and smaller devices.

For application developers, the OMAP platform's core software technologies provides a mechanism for using the functionality of the DSP without having knowledge of the DSP or signal processing. Developers have easy access to DSP-accelerated algorithms via high-level, easy-to-use Application Programmer Interfaces (API). The same API set can be designed to function across OMAP platforms, with or without a DSP, promoting code reuse and enabling developers to port software to devices aimed at different market segments.

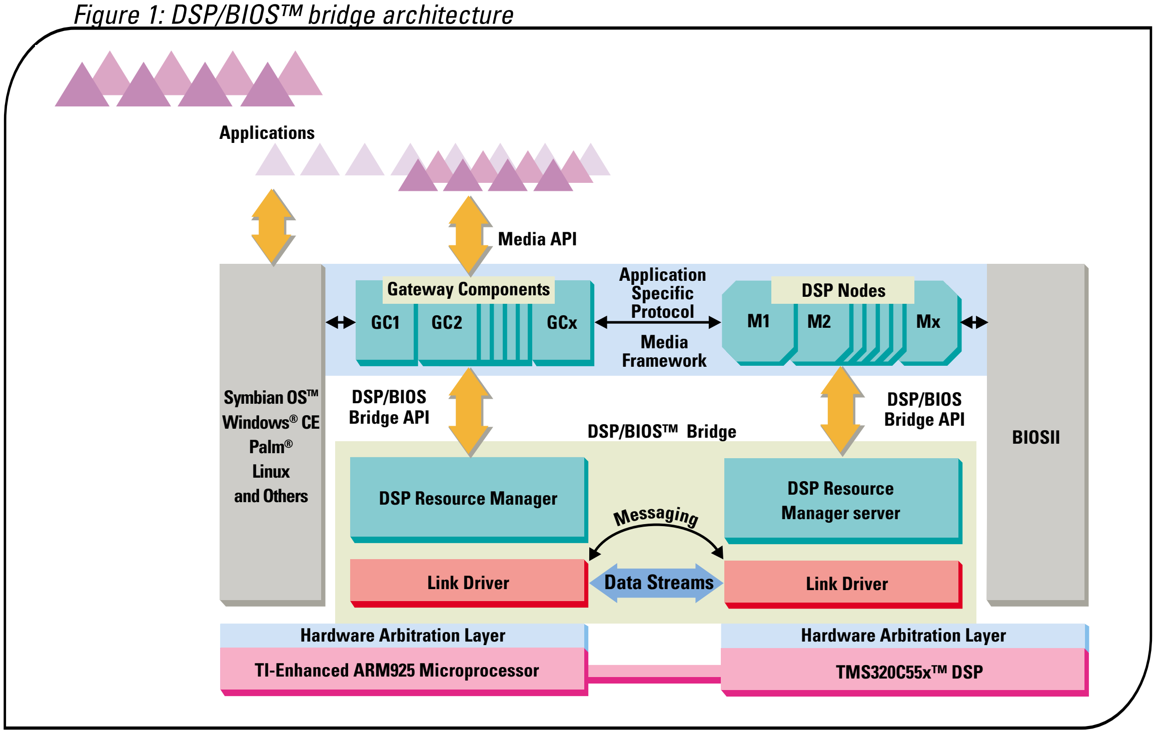
To keep programming straightforward, APIs are based on existing OS APIs whenever possible. A core technology component is typically implemented as a shared library so that multiple applications can take advantage of the functionality provided. Core technology can thus be distributed as a collection of libraries and header files, simplifying application programming and protecting the intellectual property of the OMAP developers.

DSP/BIOS™ bridge

The OMAP platform's core software technologies are developed using the DSP/BIOS bridge, the feature of the OMAP platform that enables asymmetric multiprocessing on the DSP and TI-enhanced ARM925. The DSP/BIOS bridge links the DSP OS and TI-enhanced ARM925 OS, enabling applications to communicate data and messages in a device-independent, efficient manner. The DSP/BIOS bridge also allows developers to reuse their core technologies across multiple OMAP-based platforms.

The DSP/BIOS bridge and its relationship to the OMAP platform are illustrated in Figure 1.

Figure 1: DSP/BIOS™ bridge architecture



Components of DSP/BIOS™ bridge

TI-enhanced ARM925:

- OS – The OS that runs on the TI-enhanced ARM925, such as Linux®, Nucleus™, Palm OS®, Symbian OS™, Windows® CE.
- Link Driver – The low-level communications driver.
- DSP Resource Manager – The DSP node management module that controls the low-level instantiation of DSP Nodes.
- DSP/BIOS™ Bridge API – The set of exported APIs that are used by the gateway components to interact with the DSP/BIOS bridge. These include DSP node management APIs as well as data transfer APIs.
- Gateway Components – These abstract the functionality provided by the DSP nodes into a simple set of APIs available to the application developer.
- Applications – The applications that are available to the end user, such as e-mail, media player, etc.

DSP:

- TMS320C55x™ DSP – The high-performance, extremely power-efficient TI DSP in the OMAP1510 device.
- DSP/BIOSII – The real-time OS for the DSP.
- Link Driver – The low-level communications driver.
- DSP Resource Manager Server – The module that invokes, activates and destroys DSP nodes.
- DSP Nodes – DSP nodes control the processing needed on the DSP to perform the function of the core software technology.

TI-enhanced ARM925 communication and DSP nodes

A core software technology consists of one or more Gateway Components and DSP nodes, with communications between the TI-enhanced ARM925 and DSP facilitated by the DSP/BIOS bridge. The Gateway Component exports a simple set of APIs to the application layer and implements those APIs as a series of calls to the DSP/BIOS bridge API. For example, an MP3 Gateway Component would use the DSP/BIOS Bridge API to pass messages and data to the DSP that would decode the data and output to the hardware digital-to-analog converter.

The OS uses the DSP/BIOS Bridge API to:

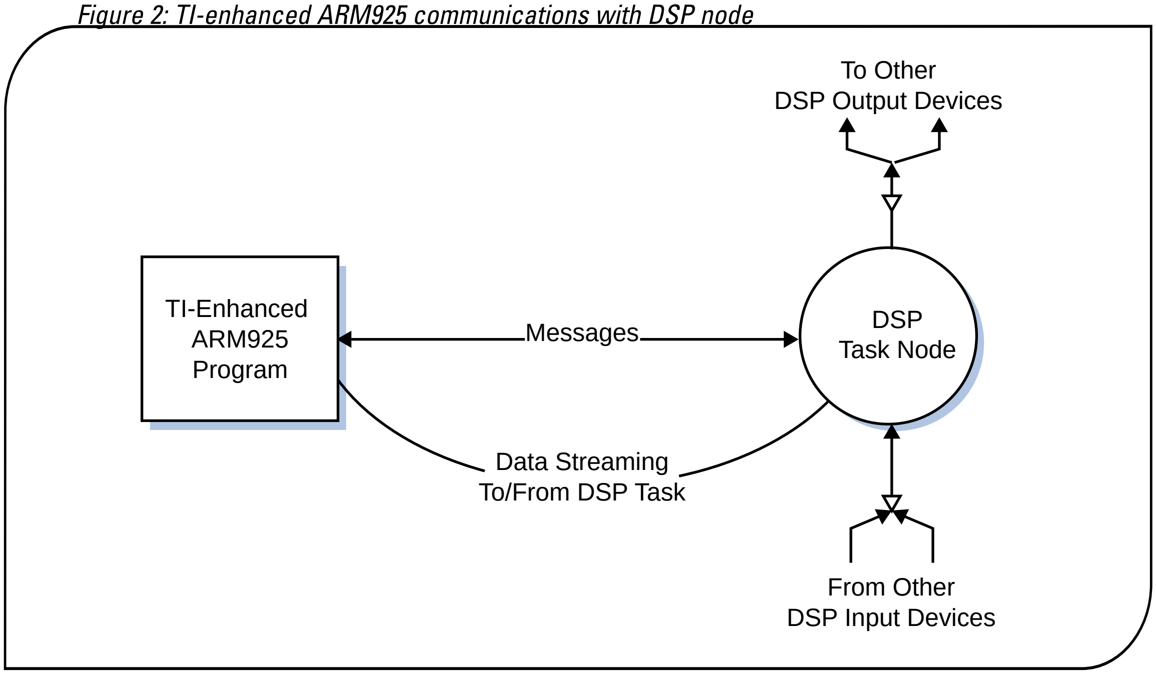
- Initiate signal processing tasks on the DSP
- Exchange messages with DSP tasks
- Stream data buffers to and from DSP tasks
- Pause, resume and delete DSP tasks
- Perform resource status queries.

TI-enhanced ARM925 communication and DSP nodes

(continued)

A DSP node consists of one or more xDAIS-compliant algorithms that perform the signal processing tasks, along with a wrapper that controls the node's operations. For more information on xDAIS algorithms, see http://dspvillage.ti.com/xdais The DSP node wrapper follows a specific task model with C-callable functions that create, execute and delete the node within a task environment established by the resource manager. Figure 2 shows the relationship between the TI-enhanced ARM925 application program and the DSP node.

Figure 2: TI-enhanced ARM925 communications with DSP node



Architecting a core software technology

There are four steps involved in architecting a core software technology for xDAIS-compliant algorithms:

1. *Define the end-user APIs*
2. *Define the messaging and data streaming needs*
3. *Wrap the xDAIS algorithm(s) in a DSP Node*
4. *Implement the Gateway Component*

Define the end-user APIs

Whenever possible, it is best to implement or extend standard OS APIs for the set of functionality the core software technology will provide. If no appropriate OS APIs are available, developers should be careful to implement a set of APIs that are clear, concise and extendable.

When designing the APIs, the developer should keep in mind when the node will be created, when it will enter its execute phase, the types of operations the node will perform, and when the node will be deleted.

Define the messaging and data streaming needs

There are two links for transferring data across the DSP/BIOS bridge:

- Messaging is used to pass small commands across the bridge. Each node has one message queue.
- Streaming provides an efficient method to transfer large quantities of data between the DSP and TI-enhanced ARM925. A stream is unidirectional and each node can have any number of input and output streams.

Each link operates independently of the other and delivers its messages or streams in the order they are received. The developer should determine what the data transfer needs are by defining each message that must be transferred and the number of input and output streams.

Wrap the xDAIS algorithm(s) in a DSP node

The xDAIS algorithm(s) must be wrapped in a DSP node by writing the create, execute and delete functions of the node's wrapper.

The create function allocates any memory needed for the node's processing, including the xDAIS algorithm(s). It also allocates the node's context block, a structure that is passed to the execute and delete functions if there are any node-specific data or pointers. The create function instantiates and activates the xDAIS algorithm(s) and initializes any data or parameters that must be initialized prior to task execution.

The execute function is the main dispatch function. Memory and other resources may not be allocated during this phase. The execute function typically contains a message processing loop that blocks on the function and waits for either messages or streaming data to be received from the TI-enhanced ARM925. The node then dispatches these to the appropriate xDAIS control or processing tasks. The execute function checks for a special message sent by the DSP/BIOS bridge that indicates the function should exit. Then it checks for custom messages or streaming data and processes these messages appropriately.

The delete function cleans up any resources allocated by the create function, including the context block and the streams. The delete function must also deactivate the algorithm and free memory and other resources allocated for the node.

Implement the gateway component

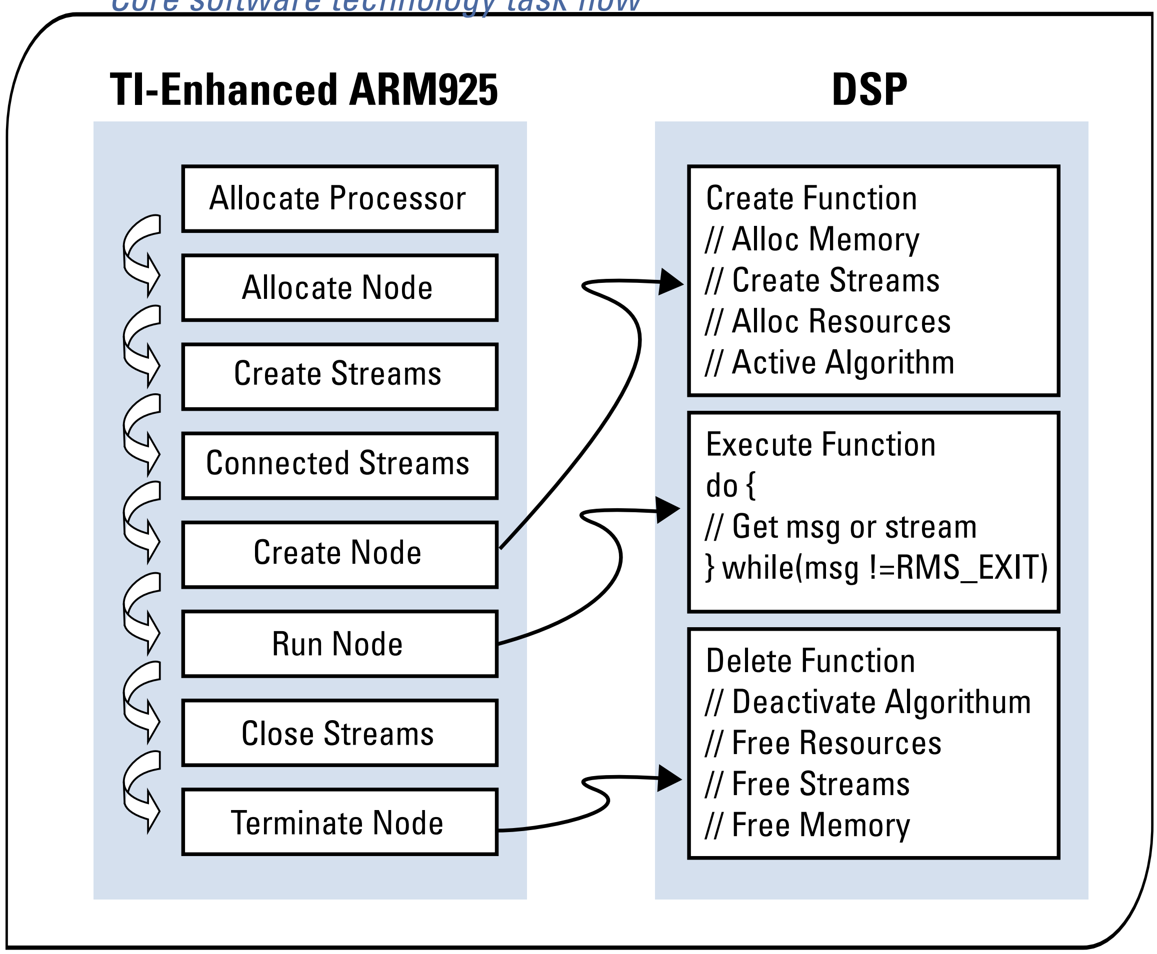
The final step in creating a core software technology is to implement the Gateway Component. The Gateway Component is responsible for initializing the DSP/BIOS bridge and the DSP node as well as setting up the data streams to and from the DSP. The Gateway Component is also responsible for shutting down the DSP node and freeing memory.

Architecting a core software technology

continued

OMAP developers play an important role in the growth of OMAP platform software, since they produce and license software modules that can be integrated into high-level applications for product differentiation. Optimized core software modules also enhance application performance and functionality by leveraging the DSP performance inherent in the OMAP1510 device.

Core software technology task flow



This diagram shows the generic task flow of a core software technology component.

TI's OMAP Developer Network

TI's OMAP Developer Network provides tools, training and support that help OMAP developers and device manufacturers bring their products to market quickly. Tools include the Code Composer Studio™ integrated development environment (IDE) for the OMAP platform, which integrates all host and target tools in a unified environment to simplify DSP configuration and optimization. The Innovator™ Development Kit for the OMAP platform, shown in Figure 3, is a hand-held expandable development platform for TI´s OMAP processors that enables developers to create 2.5G and 3G applications and mobile devices for multiple market segments. Full support is also available from TI and third parties for high-level OS and programming languages such as Java™ (J2ME™), Linux®, Microsoft® Windows® CE, Nucleus™, Palm OS®, and Symbian OS™.

Figure 3:
The Innovator™ Development Kit for the OMAP™ Platform

The OMAP Developer Network is as much about business development as it is about product development, helping developers with:

- Channel development
- Marketing and promotion
- Strategic relationships.

As an interactive, collaborative community of creative developers, the OMAP Developer Network facilitates the ongoing exchange of ideas and information that lead to new business relationships. The network provides opportunities for developers to interact with device manufacturers and each other through activities such as developer conferences, on-line forums, a secure extranet, an electronic newsletter and other forms of communication. Everyone benefits from the network, including end users, who enjoy more sophisticated, more differentiated wireless services created by OMAP developers with the enabling capabilities of OMAP platform core software technologies.

Enabling differentiated wireless services

Combining a high-performance, power-efficient processor with an easy-to-use, open software architecture and a comprehensive support network, the OMAP platform provides a powerful hardware and software foundation for the development of innovative 2.5G and 3G wireless applications. Core software technologies are a key element in the OMAP platform strategy, offering drop-in functionality and ready-to-use streaming media, security, biometrics, voice recognition, advanced audio and other capabilities.

The OMAP platform enables application developers to use these advanced capabilities without having an in-depth knowledge of the DSP or algorithm. With the aid of foundational software, application developers can create media-rich software products that provide an outstanding user experience and are portable across a variety of OMAP processors and devices. Core software technologies add significant value to the OMAP platform as it enables wireless communications to quickly advance to the next generation of differentiated mobile services.

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