

Codec Engine Server Integrator User's Guide

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About This Book

The intended audience for this document is the Server Integrator, who creates a Codec Server for use by the Engine Integrator and thus the Application Author.

This manual tells what steps the Server Integrator should take to configure DSP/BIOS and other components to create a Codec Server.

Additional Documents and Resources

You can use the following sources to supplement this user's guide:

- ❑ Codec Engine API Reference.
CE_INSTALL_DIR/docs/html/index.html
- ❑ *Codec Engine SPI Reference Guide*.
CE_INSTALL_DIR/docs/spi/html/index.html
- ❑ Configuration Reference.
CE_INSTALL_DIR/packages/xdoc/index.html
- ❑ Example Build and Run Instructions.
CE_INSTALL_DIR/examples/build_instructions.html
- ❑ *Codec Engine Application Developer's Guide* (SPRUE67)
- ❑ *Codec Engine Algorithm Creator User's Guide* (SPRUED6)
- ❑ *xDAIS-DM (Digital Media) User Guide* (SPRU8)
- ❑ *TMS320 DSP Algorithm Standard Rules and Guidelines* (SPRU352)
- ❑ *TMS320 DSP Algorithm Standard API Reference* (SPRU360)
- ❑ *TMS320 DSP Algorithm Standard Developer's Guide* (SPRU424)
- ❑ *TMS320 DSP Algorithm Standard Demonstration Application* (SPRU361)
- ❑ *XDC User's Guide* and other XDC documents.
XDC_INSTALL_DIR/doc/index.html

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This document uses the following conventions:

- ❑ Program listings, program examples, and interactive displays are shown in a `special typeface`. Examples use a **bold version** of the special typeface for emphasis; interactive displays use a **bold version** of the special typeface to distinguish commands that you enter from items that the system displays (such as prompts, command output, error messages, etc.).
- ❑ Square brackets ([and]) identify an optional parameter. If you use an optional parameter, you specify the information within the brackets. Unless the square brackets are in a **bold** typeface, do not enter the brackets themselves.
- ❑ This manual uses an icon like the one to the left to identify information that is specific to a particular type of system. For example, this icon identifies information that applies if you are using Codec Engine on a dual-processor GPP+DSP system.



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Codec Engine Overview

This chapter introduces the Codec Engine.

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1.1 What is the Codec Engine?

From the application developer's perspective, the Codec Engine is a set of APIs that you use to instantiate and run xDAIS algorithms. A VISA interface is provided as well for interacting with xDM-compliant xDAIS algorithms.

The API is the same for all of the following situations:

- ❑ The algorithm may run locally (on the GPP) or remotely (on the DSP).
- ❑ The system may be a GPP+DSP, DSP only, or GPP only system.
- ❑ All supported GPPs and DSPs have the same API.
- ❑ All supported operating systems have the same API. For example, Linux, ProOS, VxWorks, DSP/BIOS, and WinCE.

This manual uses an icon like the one to the left to identify information that is specific to a particular type of system. For example, this icon identifies information that applies if you are using Codec Engine on a dual-processor GPP+DSP system.

A dark gray rectangular icon with the text "GPP+DSP" in white, slanted upwards from left to right.

xDM is the eXpressDSP Algorithm Interface Standard for Digital Media. It is sometimes referred to as xDAIS-DM.

Any xDM algorithm is compliant with the eXpressDSP Algorithm Interface Standard (xDAIS). Additionally, it implements the xDAIS-DM (xDM) interface, an extension to the xDAIS standard that provides support for digital media encoders, decoders, and codecs. The xDM specification defines APIs for digital media codecs by class, with extensions defined for video, imaging, speech, and audio codec classes.

The xDM interfaces divide codec algorithms into four classes: Video, Image, Speech, and Audio (VISA). VISA reflects this xDM interface. One set of APIs is provided per codec class. Thus, MP3 can be replaced with WMA without changing the application source code. Only the configuration needs to be changed.

The Codec Engine also supports real-time, non-intrusive visibility into codec execution. It provides APIs for accessing memory and overall CPU usage statistics and execution trace information.

The Codec Engine runtime is supplied in binary form. Thus, application libraries built with same Codec Engine release are always compatible.

1.2 Why Should I Use It?

The Codec Engine is designed to solve some common problems associated with developing system-on-a-chip (SoC) applications. The most significant problems include:

- ❑ Debugging in a heterogeneous processor environment can be painful. There are multiple debuggers and complex bootstrapping.
- ❑ Different implementations of the same algorithm, such as MP3, have different APIs. Changing to a more efficient algorithm involves significant recoding.
- ❑ Portability issues are compounded with two processors. You may want to port to a different board with a newer DSP or a newer GPP.
- ❑ Some algorithms may run on either the GPP or the DSP. To balance system load, “low complexity” algorithms can run on a GPP, but the definition of “low” changes over time. If changing the location where the algorithm runs were easy, you wouldn’t have to weigh performance issues against the difficulty of changing the application.
- ❑ For market success, most applications need to support multiple codecs to handle the same type of media. For example, an application might need to support three or four audio formats.
- ❑ Programmers with a GPP (general-purpose processor) view don’t want to have to learn to be DSP programmers. They don’t want to have to worry about a DSP’s complex memory management and DSP real-time issues.

GPP+DSP

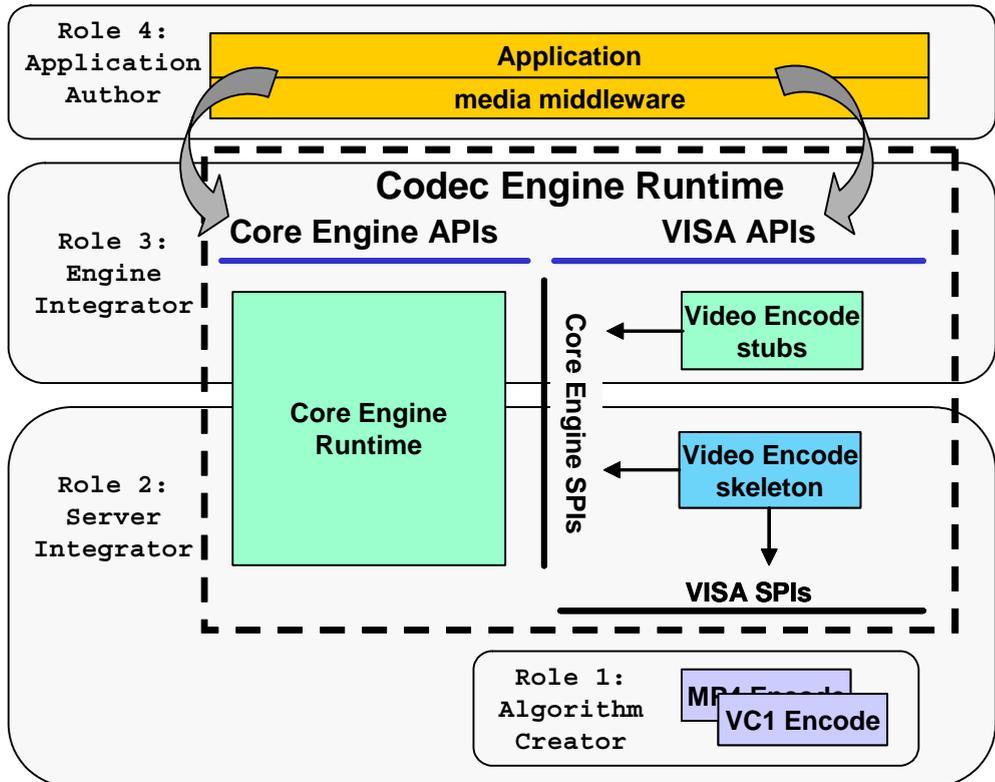
The Codec Engine addresses these problems by providing a standard software architecture and interfaces for algorithm execution. The Codec Engine is:

- ❑ **Easy-to-use.** Application developers specify what algorithm needs to be run, not how or where.
- ❑ **Extensible and configurable.** New algorithms can be added by anyone, using standard tools and techniques.
- ❑ **Portable.** The APIs are target, platform, and even codec independent.

1.3 Where Does the Codec Engine Fit into My Architecture?

The application code (or the middleware it uses) calls the Codec Engine APIs. Within the Codec Engine, the VISA APIs use stubs and skeletons to access the core engine and the actual codecs, which may be local or remote.

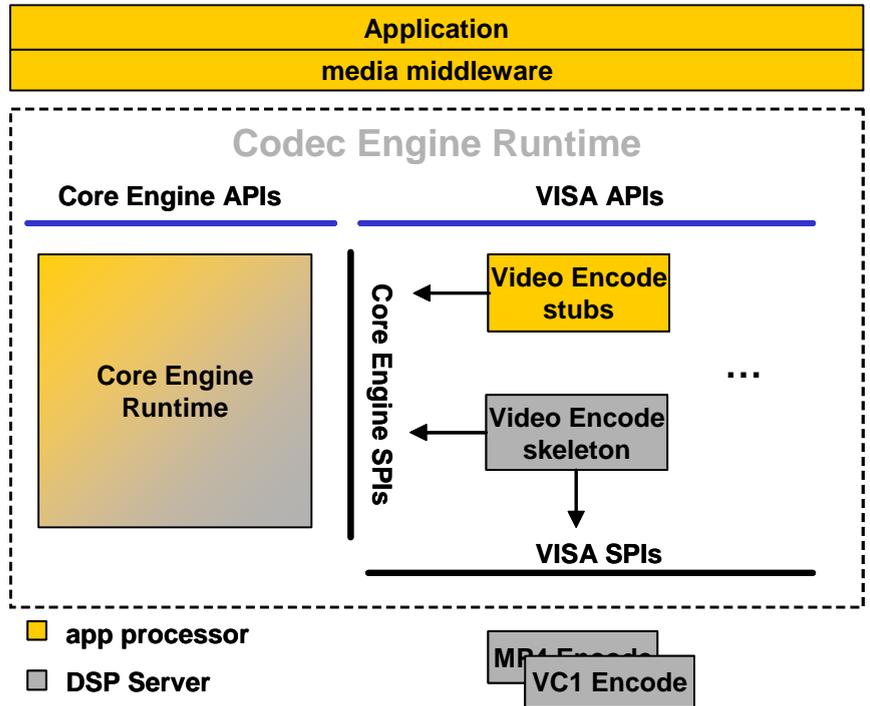
The following figure shows the general architecture of an application that uses the Codec Engine. It also shows the user roles involved in creating various portions of the application. See Section 1.4, *What Are the User Roles?* for more on user roles.



The application (or middleware it uses) calls the core Engine APIs and the VISA APIs. The VISA APIs use stubs to access the core engine SPis (System Programming Interfaces) and the skeletons. The skeletons access the core engine SPis and the VISA SPis. The VISA SPis access the underlying algorithms.

GPP+DSP

The following figure is a modification of the previous diagram that shows how this architecture is distributed in a GPP+DSP system. In this example, yellow portions run on the GPP, and grey portions run on the DSP. This is, the video encoder skeleton and the video encoder codecs are on the DSP and the application and video encoder stubs are on the GPP.



local only

Since Codec Engine is flexible, alternate diagrams could be shown for GPP-only and DSP-only systems.

1.4 What Are the User Roles?

The Codec Engine has several customer use cases, from GPP-side application developers to DSP-side codec authors. In some cases, these roles may be played by a single person. In other development environments, a different developer may be assigned each role. This topic describes the primary roles that Codec Engine users will play.

Because Codec Engine is very portable and configurable and can run in many different environments, the descriptions of these roles are intentionally generalized. When applicable, specific hardware and software environments are described after the general descriptions.

This document describes the APIs available to the Application Author. Other documents are referenced for the other roles.

1.4.1 Algorithm Creator

The Algorithm Creator is responsible for creating an xDAIS algorithm, and providing the necessary packaging to enable these algorithms to be consumed and configured by Codec Engine.

If the codec is xDM-compliant, Codec Engine's VISA APIs support remote execution without additional support. However, if the codec is not xDM-compliant, and the codecs support remote execution, the Algorithm Creator should supply Codec Engine skeletons and stubs.

The Algorithm Creator uses xDAIS and the XDC Tools, which includes a configuration kit. Using these, the Algorithm Creator generates a codec library with the iAlg and optional iDMA3 interface symbols exported. This person also implements the ti.sdo.ce.ICodec interface, referencing the exported symbols from the codec library.

The Algorithm Creator hands a released Codec package to the Server Integrator. This likely includes one or more libraries and the XDC package metadata.

The Algorithm Creator uses the following resources:

- ❑ *Codec Engine Algorithm Creator User's Guide* (SPRUED6)
- ❑ *xDAIS-DM (Digital Media) User Guide* (SPRUEC8)
- ❑ *xDM API Reference*. XDAIS_INSTALL_DIR/docs/html/index.html
- ❑ *TMS320 DSP Algorithm Standard Rules and Guidelines* (SPRU352)
- ❑ *TMS320 DSP Algorithm Standard API Reference* (SPRU360)
- ❑ *TMS320 DSP Algorithm Standard Developer's Guide* (SPRU424)
- ❑ Example codecs

1.4.2 Server Integrator

To support Engines with remote codecs, a Codec Server must be created. The Codec Server integrates the various components necessary to house the codecs (e.g. DSP/BIOS, Framework Components, link drivers, codecs, Codec Engine, etc.) and generates an executable.

There are two configuration steps that the Codec Server Integrator must perform, one to configure DSP/BIOS (through a Tconf script) and one to configure "the rest" of the components (through XDC configuration of Framework Components, Link, Codec Engine, etc).

The Server Integrator receives the various Codec packages from Algorithm Creators. This person uses Codec Engine and its dependent packages (DSP/BIOS, DSKT2, etc) along with the XDC Tools to create the following:

- ❑ A server configuration file (.cfg)
- ❑ A server DSP/BIOS configuration file (.tcf)
- ❑ A simple main() routine to do minimal initialization
- ❑ A DSP executable created by executing the configuration scripts, and compiling the output. This executable is a Codec Server.

The Server Integrator hands the DSP executable to the Engine Integrator (preferably as a Codec Server package. The Server Integrator should also provide a list of the codecs in the Codec Server.

The Server Integrator uses the following resources:

- ❑ This manual
- ❑ Configuration Reference.
CE_INSTALL_DIR/packages/xdoc/index.html
- ❑ Example Codec Servers

For applications that use only local algorithms, the Codec Server is not used, so this role is not required.

local only

1.4.3 Engine Integrator

The Engine Integrator defines various Engine configurations. This can include the names of the Engines, as well as the codecs and their names within each Engine, whether each codec is local or remote relative to the application, which groups each codec should be integrated into (for environments which support resource sharing), the name of the Codec Server image if a particular Engine contains remote codecs, etc. This is done via an XDC configuration script (*.cfg).

This script, when run, generates code and build instructions appropriate for the configuration.

The Engine Integrator receives the name of a Codec Server and a list of the codecs it contains from the Server Integrator. Using these, this person creates an Engine configuration file (.cfg) that may reference a Codec Server. (On local-only platforms, the Codec Server is not used.)

The Engine Integrator hands the Engine configuration file to the Application Author.

The Engine Integrator uses the following resources:

- ❑ Chapter 5 of *Codec Engine Application Developer's Guide* (SPRUE67)
- ❑ Configuration Reference.
CE_INSTALL_DIR/packages/xdoc/index.html
- ❑ Example Build and Run Instructions.
CE_INSTALL_DIR/examples/build_instructions.html
- ❑ Example configuration scripts (*.cfg)

1.4.4 Application Author

The application uses the Codec Engine APIs (Engine_, VISA, and other utility APIs) to create/delete preconfigured Engine instances, create/delete and interact with codecs, acquire buffers appropriate for the codecs, etc.

Since Codec Engine doesn't perform any I/O, the application is responsible for handling I/O. This includes such task as file access (for example, open/read/write/seek/close) and driver interaction (for example, open/close/ioctl and buffer management).

The Application Author is responsible for building the application code, and for linking "the appropriate content" into the executable image.

The Application Author receives the following:

- ❑ Various Codec packages from Algorithm Creators
- ❑ A Codec Server DSP executable from the Server Integrator if codec will run on a DSP
- ❑ An Engine config file (.cfg) from the Engine Integrator

The Application Author write application code, generates output from the Engine configuration file (.c and .xdl output files) using the XDC Tools, compiles the application code and generated files. This person then links the files, including the generated linker command file (.xdl) into an executable. The end result is the application executable.

The process for generating an application executable is highly dependant on the application's operating system. If the application runs on the DSP using DSP/BIOS, for example, a .tcf file is needed to configure the DSP/BIOS kernel as well. If the application runs on Linux, the application does not need to configure the operating system.

The Application Author uses the following resources:

- ❑ *Codec Engine Application Developer's Guide* (SPRUE67)
- ❑ Codec Engine API Reference.
CE_INSTALL_DIR/docs/html/index.html
- ❑ Example Build and Run Instructions.
CE_INSTALL_DIR/examples/build_instructions.html

1.5 Where Can I Get More Information?

The release_notes.html file at the top of the Codec Engine installation provides general information, information about changes in the latest version, devices supported and validation information, known issues, and links to online documentation provided with the Codec Engine. The online documentation provided with the Codec Engine is as follows:

- ❑ **Codec Engine API Reference.**
CE_INSTALL_DIR/docs/html/index.html
- ❑ **Configuration Reference.**
CE_INSTALL_DIR/packages/xdoc/index.html
- ❑ **Example Build and Run Instructions.**
CE_INSTALL_DIR/examples/build_instructions.html

For information about xDM, see the *xDAIS-DM (Digital Media) User Guide* (SPRUEC8).



Configuring a Codec Server

This chapter describes how the Server Integrator should configure a Codec Server for use by the Engine Integrator.

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2.2 Creating a Codec Server.....	2-7
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2.1 Overview

As described in Section 1.4.2, *Server Integrator*, the Server Integrator provides a Codec Server to the Engine Integrator. In practice, these roles may be shared by one person.

There are two configuration steps that the Server Integrator performs:

- ❑ Configure DSP/BIOS through a Tconf script
- ❑ Configure "the rest" of the components through XDC configuration of Framework Components, DSP/BIOS Link, the Codec Engine, etc.

The Server Integrator receives various Codec packages from Algorithm Creators, as well as packages of other components in the system (for example Framework Components and Codec Engine).

The Server Integrator uses Codec Engine and its dependent packages (DSP/BIOS, DSKT2, etc.) along with the XDC Tools to create the following:

- ❑ A server configuration file (.cfg)
- ❑ A server DSP/BIOS configuration file (.tcf)
- ❑ A simple main() routine to do minimal initialization
- ❑ A DSP executable created by executing the configuration scripts, and combining the various packages. This executable is a Codec Server.

The Server Integrator should also provide a list of the codecs in the Codec Server.

The Server Integrator hands the DSP executable to the Engine Integrator, who references it in the Engine configuration file. For example, the ceapp.cfg file might contain an Engine configuration and the following line to identify the Codec Server used by the Engine.

```
vcr.server = "./video_copy.x64P";
```

2.1.1 What is a Codec Server?

A Codec Server is a binary that integrates codecs, framework components, and system code. When the Codec Server is on a DSP, it uses DSP/BIOS as the DSP kernel.

GPP+DSP

In the context of the DaVinci DM644x platforms (and other GPP+DSP platforms), a Codec Server is a DSP binary. It includes a DSP/BIOS task thread that responds to requests from a client to create codecs, provide performance information (MIPS and MEM usage).

A Codec Server performs similarly to a web server. Just as the term "web server" can refer to the actual hardware, the configured software, or the executing daemon, the term "Codec Server" can refer to the DSP, the configured image loaded on the DSP, or the executing task.

The GPP application uses the VISA APIs to invoke remote codecs on the DSP. From the perspective of the GPP application, codec execution is completely transparent, and behaves the same whether the codecs are local (on the GPP) or remote (on the DSP). When remote, Codec Engine automatically manages the necessary creation, communication, invocation, and eventual deletion of codecs from the DSP.

2.1.2 What is the Execution Flow?

As an example of the execution flow, on a dual-CPU system, such as the DM644x device, the following steps summarize the execution flow when a GPP application uses a remote codec to perform audio encode on the DSP. After opening the engine, the application makes calls to the VISA APIs, which manage the three phases of remote codec execution as follows:

- 1) The application calls the VISA creation API (for example, `AUDENC_create()`) to create an algorithm instance on the DSP:
 - First, a generic instance object is created on the GPP to hold the necessary state, handles, function pointers, etc.
 - A local "node" object is created to receive communication from the "remote" node.
 - A "create" message is formed to signal the function dispatcher on the DSP to create the remote node instance.
 - The creation message is sent to the dispatcher on the DSP.
 - On the DSP, the dispatcher receives the "create" message. Some error checks are performed, and the DSP-side state objects are created and initialized.

- A message queue is created to allow the remote node to receive commands from the GPP.
 - The node-specific "create" function (for example, AUDENC_create()) is called to initialize the node state and algorithm-specific memory and resources. (Note that this call is made from within the dispatcher execution context.)
 - A dedicated execution thread (task) is created for the node. The new thread does not run yet, but is in a suspended state.
 - In the dispatcher thread, instance data for the new node is saved, and then the dispatcher sends a status response back to the GPP.
 - On success, the GPP-side instance object is updated with appropriate handles and data for the new "remote" node.
 - A "start" message is then formed and sent to the dispatcher on the DSP to start execution of the remote node.
 - Upon receiving the "start" command, the DSP-side dispatcher changes the priority of the node's thread from suspended to its configured execution priority. This change in priority causes the node's "execute" function to run in the newly created node's execution context. This function blocks, awaiting commands from the GPP.
- 2) The application calls the VISA process API (for example, AUDENC_process()), which results in a remote procedure call to the DSP:
- The GPP-side algorithm stub is invoked and performs some basic argument validation.
 - A message structure is allocated and filled in with marshalled arguments, including translated (DSP) physical addresses for buffers.
 - The "process" message is sent to the remote node's message queue on the DSP to invoke the remote algorithm.
 - On the DSP-side, the node's thread wakes upon receipt of the "process" message, and calls the algorithm skeleton.
 - The skeleton unmarshalls the arguments and input and output buffers and then invalidates the buffers from the DSP cache.
 - Any algorithm scratch memory is then "activated".
 - The algorithm's actual "process" function is invoked to do the encoding.

- Any algorithm scratch memory is then "deactivated".
 - The skeleton writebacks output buffers to ensure that CPU writes to the cache are flushed to external memory.
 - The node's thread then replies with the status back to the GPP and then blocks waiting for the next message.
 - Back on the GPP, the stub unmarshalls outArgs, the returned message is freed, and a status is returned to the application
- 3) When processing is complete, the application calls the VISA delete API (for example, AUDENC_delete()), which causes the algorithm instance on the DSP to be deleted:
- The GPP-side forms and then sends a message to the remote node on the DSP with a command to "exit".
 - On the DSP, the remote node wakes upon receipt of the "exit" message and sends an acknowledgement back to the GPP.
 - On the GPP, a node "delete" message is formed and then sent to the dispatcher on the DSP.
 - The dispatcher wakes up and deletes the remote node's execution thread.
 - The node-specific "delete" function (for example, AUDENC_delete()) is invoked to free algorithm resources and to do any node-specific cleanup. (Note that this call is from within the dispatcher execution context.)
 - The remaining DSP-side instance object is deleted, and a response is sent back to the GPP.
 - The remaining GPP-side instance objects are deleted, the remote node message queue is closed, and then a status is returned to the application.

2.1.3 What About Single-Processor Systems?

On systems where there are no "remote" codecs, there is no need to configure a Codec Server.

2.1.4 What Algorithms Can a Codec Server Integrate?

You can use any algorithm that is xDM-compliant in a Codec Server.

In addition, if you want to use a xDAIS-compliant algorithm that is not xDM-compliant, you can first implement your own stubs and skeletons for that algorithm, and then use that algorithm in a Codec Server. See the *Codec Engine Algorithm Creator User's Guide* (SPRUED6) for details.

The Codec Engine does not provide APIs for chaining algorithms. However, you may use an xDM- or xDAIS-compliant algorithm that, behind its exposed interface, chains algorithms together.

The xDM specification defines a uniform API for each class of algorithms. From an application perspective this means that the same API will be used for an H.264 and an MPEG-4 decoder.

The algorithm is identified by a unique string in the "create" function. Everything else should remain the same. Note that the application must be aware of the restrictions of the algorithm it is trying to invoke. For example TI video decoders expect one frame of data to work properly.

2.1.5 What Examples Exist?

You can use the Codec Servers as examples for creating your own Codec Servers. These servers are provided as part of the Codec Engine distribution.

- ❑ CE_INSTALL_DIR/examples/servers/all_codecs
- ❑ CE_INSTALL_DIR/examples/servers/video_copy

2.1.6 What is the Config Kit?

The XDC Config Kit is a set of configuration packages and tools that may be used to configure and build an executable. Some examples of such executables are:

- ❑ A DSP executable that contains remote codecs (for example, a Codec Server)
- ❑ A DSP executable that contains an application and local codecs (for example, a single processor Codec Engine application plus local codecs)
- ❑ A GPP executable that contains a Codec Engine, implying local and/or remote codecs (for example, a Codec Engine application)

2.2 Creating a Codec Server

To create a Codec Server, you perform the following configuration steps:

- ❑ Configure DSP/BIOS through a Tconf script
- ❑ Configure "the rest" of the components through XDC configuration (for example, Framework Components, DSP/BIOS Link, the Codec Engine, etc.).

You will modify the following files:

- ❑ **package.xdc**. The package definition file.
- ❑ **package.bld**. The build script.
- ❑ **servername.cfg**. The Codec Server configuration script.
- ❑ **servername.tcf**. The DSP/BIOS configuration script.

Optionally, you may modify the following additional files:

- ❑ **link.cmd**. An optional linker command file.
- ❑ **main.c**. Contains applications main() function.

To begin creating a Codec Server, use the steps in the following subsections. The examples in this section use the CE_INSTALL_DIR/examples/servers/video_copy example.

So long as the algorithms you want to use implement the xDM interface, the coding needed is limited to a simple main() routine in C code to initialize the Codec Engine. The rest of the integration is by providing configuration information to create the Codec Server.

2.2.1 Creating a Package

Follow these steps to set up environment variables to point to various tools used in the build process and to create a directory with files you will modify to create your server.

- 1) Optionally copy the entire CE_INSTALL_DIR/examples tree to a working directory. This step is optional but recommended so that you have a backup copy.
- 2) Edit the examples/user.bld file, which defines the locations of content on your development system. Make sure the paths in this file match your paths to the TI codegen tools and other compilers and OS tools referenced in the file. See examples/build_instructions.html for details.

- 3) Edit the examples/xdcpaths.mak file with a text editor to specify the CE_INSTALL_DIR, XDC_ROOT, and BIOS_ROOT variables. Again, see examples/build_instructions.html for details.
- 4) Make a duplicate of one of the Codec Server examples in the examples/servers directory. Each of these directories is a "package". Packages must have names that match their directory location. So, you should give your duplicate directory a path that follows the examples/my_company/my_project/my_server naming convention. You will name the package to match this location in the following section.

2.2.2 Editing the Package Definition

The package.xdc file is the package definition file, which defines your Codec Server's name and its dependencies.

Follow these steps to name your server package.

- 1) Edit the package.xdc file with a text editor. Rename the server package. For example, to call your server "my_server", change the bolded portion as follows:

```
package my_companyname.my_project.my_server
```

The package name must reflect the directory structure under the examples directory. For example, a package in the example/my_company/my_project/my_server directory must have a name of my_company.my_project.my_server. You should use this companyname convention to ensure that your server has a unique package name.

2.2.3 Editing the Codec Server Configuration Script

A file named *servername.cfg* configures the non-DSP/BIOS aspects of the Codec Server. To create this file for your own server, it is best to modify an existing example file.

The syntax used in this Server configurations is based on JavaScript, which is also used for the Tconf language used to statically configure DSP/BIOS. (See SPRU007 for details.)

Unlike the JavaScript used in web pages, an object model is provided to meet the needs of Engine configuration. This object model is documented in the Configuration Reference, which is available at CE_INSTALL_DIR/xdoc/index.html.

To see documentation for the attributes of the Server module, follow these steps:

- 1) Open `CE_INSTALL_DIR/xdoc/index.html` to see the Configuration Reference. Depending on your browser, you may need to enable active content to view the list of nodes on the left.
- 2) Click the link to the `ti.sdo.ce` package.
- 3) Click the link to the Server module.
- 4) You see the config params that you can set for this module.

Note: To navigate backward in this window, click the "**Back**" link in the upper-right corner of the window. The usual Back button in your browser does not function correctly in this online help system.

For example, you see that the `threadAttrs` structure has several fields. The following statements cause the Server module in the `ti.sdo.ce` package to be made available to the configuration script. It then sets the `threadAttrs.priority` attribute of the Server module to `Server.MINPRI`. This indicates that the task threads created by the Codec Server should run at the minimum priority level.

```
var Server = xdc.useModule('ti.sdo.ce.Server');
Server.threadAttrs.priority = Server.MINPRI;
```

To create your own `*.cfg` file for your server, follow these steps:

- 1) Rename the `*.cfg` file in your server directory to match the name of your server. For example, your file might be called `"my_server.cfg"`.
- 2) Edit the `servername.cfg` file with a text editor.
- 3) In order to allow application developers to use the `TraceUtil` module on the GPP side to gather DSP/BIOS log information, you must enable DSP/BIOS logging in your DSP server image. If the following line is not already in your server's configuration script, you should add it to enable DSP/BIOS logging:

```
var LogServer = xdc.useModule('ti.sdo.ce.bioslog.LogServer');
```

- 4) Modify the statements that get codec modules to reference the codec modules you want to use. Use the package name from your codec provider. Example codecs are available in the "examples" repository beginning with the "codecs" namespace (that is, the `examples\codecs` directory). Your codecs should be "well named" beginning with your company name to produce unique package names.

For example, these statements from the video_copy.cfg file have been modified (bold text) to reference the speech encoder/decoder.

```
/* get various codec modules; i.e. codec implementations */
var SPHDEC_COPY = xdc.useModule('codecs.sphdec_copy.SPHDEC_COPY');
var SPHENC_COPY = xdc.useModule('codecs.sphenc_copy.SPHENC_COPY');
```

- 5) Modify the attributes of the threadAttrs structure as desired. See CE_INSTALL_DIR/xdoc/index.html for details about these attributes.

```
Server.threadAttrs.stackSize = 2048;
Server.threadAttrs.priority = Server.MINPRI;
```

These settings configure the Server thread, which is used to create and delete codecs as well as to support requests for dynamic resource usage. We recommend that you use Server.MINPRI so you don't preempt real-time threads.

- 6) Specify the algorithms to be available in this Codec Server by modifying the Server.algs array. For example, statements from the video_copy.cfg file have been added and modified (bold text) to reference the speech encoder/decoder and to give audio processing a higher priority than video processing.

```
Server.algs = [
  {name: "viddec_copy", mod: VIDDEC_COPY, threadAttrs: {
    stackSize: 4096, stackMemId: 0, priority: Server.MINPRI + 1}
  },
  {name: "videnc_copy", mod: VIDENC_COPY, threadAttrs: {
    stackSize: 4096, stackMemId: 0, priority: Server.MINPRI + 1}
  },
  {name: "sphdec_copy", mod: SPHDEC_COPY, threadAttrs: {
    stackSize: 4096, stackMemId: 0, priority: Server.MINPRI + 2}
  },
  {name: "sphenc_copy", mod: SPHENC_COPY, threadAttrs: {
    stackSize: 4096, stackMemId: 0, priority: Server.MINPRI + 2}
  },
];
```

- 7) The example *.cfg files also configure the ti.sdo.fc.dskt2.DSKT2 and ti.sdo.fc.dman3.DMAN3 modules, which are part of Framework Components. DSKT2 is the xDAIS algorithm memory allocation manager, and DMAN3 is the DMA manager. See the Framework Components documentation in CE_INSTALL_DIR/xdoc/index.html for details on configuring these modules.

2.2.3.1 Controlling I/O Buffer Caching for xDM 0.9 Codecs

The DSP server's support—the "skeletons"—for remote execution of codecs written for xDM 0.9 always manages the cache for all codec I/O buffers exchanged with the ARM application.

This can be a performance problem for some video codecs, where the codec accesses the buffers exclusively via DMA, yet the generic skeleton invalidates and flushes those buffers anyway, thus wasting up to a few milliseconds for every frame. (In xDM 1.0 codecs, this cache management is negotiated automatically.)

To disable management for specific buffers, you need to determine the type of buffer and its number, then set the cache management field for the buffer to "false", as shown in the following example.

The first step is to determine the buffer type. Supported buffer types are: "in" and "out" for both video encoders and video decoders, "recon" (short for reconstruction) for video encoders, and "display" for video decoders.

Next, determine the number of the buffer you want to manage. Buffers are numbered 0 to 15. You're typically looking for buffer number 0 or 1.

Finally, set the buffer's cache management field to "false" as shown in this example:

```
var H264ENC = xdc.loadModule( "ti.sdo.codecs.h264enc.H264ENC" );
// don't cache-manage inbuf #0:
H264ENC.manageInBufsCache[0] = false;
// don't cache-manage outbuf #1:
H264ENC.manageOutBufsCache[1] = false;
// don't manage any of the reconstruction buffers:
H264ENC.manageReconBufsCache = [ false, false, false, false, false, false, false, false,
false, false, false, false, false, false, false ];
```

The cache management array names are:

- ❑ **For video encoder modules.** `manageInBufsCache[]`, `manageOutBufsCache[]`, `manageReconBufsCache[]`, each with elements 0..15.
- ❑ **For video decoder modules.** `manageInBufsCache[]`, `manageOutBufsCache[]`, `manageDisplayBufsCache[]`, each with elements 0..15.

Always check with a codec producer first to determine whether it is safe to turn off cache management for certain buffers. When it comes to cache mis-management, things might appear to work on your system for some data and in some configurations, but will not work for other data and configurations (that your customer may use).

2.2.3.2 Specifying "Scratch Group" and DMA Resources for a Codec

When you put together several codecs into a single DSP server, you may need to make them share memory and DMA resources.

Two codecs can share what is called a "scratch" memory. This is a working memory area, typically in fast internal memory, that is initialized before one frame of data is processed and discarded afterwards. The codecs can share this memory only if they run at the same priority. That is, one cannot preempt another and thus destroy the other codec's scratch area in the middle of its work.

Scratch area sharing is managed by the DSP algorithm memory manager called DSKT2, but you can affect how it manages the scratch areas by defining the optional `groupId` field for each algorithm in the array of `Server.algs[]` configuration.

If you do not set the `groupId` field, no sharing will take place. This is fine if you have enough internal/external memory. Otherwise, you can set it per algorithm, as is the case in the `video_copy` server example:

```
/* The array of algorithms this server can serve up.
 * This array also configures details about the threads
 * that will be created to run the algorithms
 * (e.g. stack sizes, priorities, etc.). */
Server.algs = [
  {
    name:          "viddec_copy", // C name for the of codec
    mod:           VIDDEC_COPY, // VIDDEC_COPY defined above
    threadAttrs: {
      stackMemId: 0, // BIOS MEM seg ID for task stack
      priority:   Server.MINPRI + 1 // task priority
    },
    groupId:      0, // scratch group ID (see DSKT2 below)
  },
  {
    name:          "videnc_copy",
    mod:           VIDENC_COPY,
    threadAttrs: {
      stackMemId: 0,
      priority:   Server.MINPRI + 1
    },
    groupId:      0,
  },
];
```

How you define the `groupid` field can affect performance or whether a codec can be created at all. For detailed information on shared scratch memory, see the Framework Components documentation. You may save some time by reading the commentary for the server configuration script in the `video_copy` example, which is in `<CE_install_dir>/examples/ti/sdo/ce/examples/servers/video_copy/video_copy.cfg`.

What is true for sharing memory is also true for sharing DMA resources among codecs. Again, for details, please check the Framework Components documentation or the commentary regarding the theory and practice of DMA configuration in the `video_copy` configuration example in the script referenced above.

2.2.3.3 More About the `groupid` Field

Note that although both the `Server.algs[]` and `Engine.algs[]` array have an optional `groupid` field, there is a distinction between the `Server.algs[]` and `Engine.algs[]` arrays. This makes sense, if you consider that DSP-based algorithms on a DM644x (DSP+ARM) are configured into a `Server`, while the same DSP-based algorithms on a DM643x (DSP only) are configured into an `Engine`.

`Server.algs[].groupid`

For each algorithm in the respective `algs[]` array, if the optional `groupid` is uninitialized, the algorithm will be configured into a group with other algorithms that have their `groupid` field uninitialized and run at the same priority. If no algorithms have both of these attributes, it will be in a unique `groupid`.

Exactly which `groupid` it will be assigned into is non-deterministic. Therefore, it's not possible to configure scratch resources (for example, DSKT2 scratch memory and DMAN3 DMA resources) for this non-deterministic `groupid`. It's important therefore, that if the system integrator intends for an algorithm's resources to be shared, the `groupid` field should be appropriately configured.

Also, if the `groupid` is non-deterministically assigned, and the algorithm requests scratch resources, these resources will be granted from (likely non-configured) resource pools!

For example, in DSKT2-based systems, DSKT2 grants such memory requests using the (likely non-configured) `DSKT2.DARAM_SCRATCH_SIZES[<nondeterministic-groupId>]` and `DSKT2.SARAM_SCRATCH_SIZES[<nondeterministic-groupId>]` memory blocks. This can lead to strange system behavior, including algorithms that sometimes can be created but other times fail.

Engine.algs[].groupId

For each local algorithm, if the optional groupId field is uninitialized, the algorithm is configured into its own, unique groupId. This is because we don't know what priority the algorithm will run at, so we place it into a unique group to prevent preemption by any other algorithm.

Note that for remote algorithms, the groupId field is ignored. In such cases, the algorithm is placed into the Server-configured groupId.

2.2.4 Editing the DSP/BIOS Configuration Script

The Codec Server runs as a DSP/BIOS application on the DSP. As such, it has a static DSP/BIOS configuration. This is created with a .tcf file as described in the *DSP/BIOS Tconf User's Guide* (SPRU007) and in the DSP/BIOS online help. The syntax used in Tconf configurations is based on JavaScript.

To create your own .tcf file for your server, follow these steps:

- 1) Copy all.tcf from CE_INSTALL_DIR/examples/servers/all_codecs to your server directory. Rename it to match the name of your server. For example, your file might be called "my_server.tcf".
- 2) Edit the *servername.tcf* file with a text editor.
- 3) Make any changes your Codec Server requires and save the file.

For the Codec Server, the task threads used to process algorithms are created dynamically at runtime. This configuration file statically configures several aspects of the DSP/BIOS kernel, including:

- The base DSP/BIOS kernel
- Memory section names, sizes, and locations
- Platform-specific attributes such as clock rates
- Enables the task manager and dynamic heap allocation
- Configures the C64+ L1 cache and corresponding memory segment

You can learn more about all of these modules and attributes in the DSP/BIOS online help or the *C6000 DSP/BIOS API Reference* (SPRU403).

You can add your own non-Codec Engine configuration items here if you need to add your own functionality to the Server. The settings have been tested for use with Codec Engine as is. You should be careful about changing the settings.

2.2.4.1 DSP/BIOS Threads and Module Use

Each “remote” algorithm instance that runs on the DSP executes in a DSP/BIOS thread whose priority is specified by a static configuration parameter (see `ti.sdo.ce.Server`). The stack size of the thread that runs a “remote” algorithm is specified by the algorithm’s implementation of the `ICodec` interface (see `ti.sdo.ce.ICodec`).

The initial release of the Codec Engine runtime starts a separate thread for each “remote” algorithm instance; thus, two instances of the same algorithm run in two separate threads (even though these threads have the same stack size and priority). Future releases may run these instances in a single thread. However, algorithm instances that require different priorities will always be run in separate threads.

Creation and deletion of algorithm instance threads is handled by a Resource Manager Server (RMS) thread. This thread is part of the Codec Engine Runtime and, by default, runs at the lowest possible priority so as to avoid affecting real-time processing performed by “remote” algorithm instances. The RMS thread also provides “resource monitoring” services to the Codec Engine Runtime. For example, it reports overall DSP CPU load to the GPP, transfers execution trace data from the DSP to the GPP, and controls the acquisition of DSP trace information based on GPP commands.

Although the Codec Engine uses the DSP/BIOS CLK services, the initial release does not require timer interrupts and configures the DSP/BIOS CLK interrupt to run once every 5 seconds. In the future, the Codec Engine may require interrupts rates as high as 1/second to support watchdog timers and recovery from IPC failures.

In order to support CPU load monitoring, the Codec Engine adds an idle function to DSP/BIOS’s idle loop. The current implementation allows other application-specified idle functions to also run. However, to support low power modes of the DSP, future implementations may idle the CPU, which prevents other idle functions from running.

Note that the changes mentioned in this section are not certain. We are simply pointing out areas of the implementation that may be subject to change in future releases.

2.2.5 Editing the Build Script

Edit the `package.bld` file with a text editor. This build script is run by the makefile. In addition to compiling code, the build script runs the DSP/BIOS and XDC configuration scripts and links the executables together.

Change the bold text in the following line to match your server name:

```
var serverName = "my_server";
```

When you have finished development, you may want to change "debug" in the following line to "release":

```
Pkg.attrs.profile = "release";
```

Do not edit package.mak, any files that begin with a period, or anything in the "package" directory. These files are generated when you build. Any modifications to these files are overwritten whenever you rebuild.

2.2.6 Editing the Linker Command File

If you want to specify any other DSP linker commands, add those commands to the link.cmd linker command file.

2.2.7 Editing the main.c File

You may add to the main.c source file as necessary. Since DSP/BIOS runs its threads after main() completes, you should only put initialization statements in main(), and main() must run to completion rather than looping.

2.2.8 Editing the makefile

The makefile should not require changes. However, you may need to add repositories to the XDC_PATH used in the makefile by modifying the xdcpaths.mak file.

2.3 Delivering a Codec Server

To distribute a Codec Server, you should deliver the package used to produce the server, including the server executable. The package contains the configuration scripts that produced the server. The package information also specifies the version of the compiler used to make the server and the versions of the codecs used to make the server.

When you distribute a Codec Server, you should provide documentation that includes the following information:

- Codec Server name
- Build options used for compiling and linking
- List of the algorithms available in the Codec Server

In addition to including the server executable in the server package, you must also add the generated package/info/* files to the package. These files contain information in text form about the codecs included in the server, the server's memory map, and other relevant information.

To create a deliverable package, we recommend you use the built-in method in XDC to create a .tar package archive, as shown in the following section.

2.3.1 Delivering Server Packages for Servers Built with XDC

If you built your server via XDC (that is, there is a "package.bld" file and the makefile is very short), you need to add the directory "package/info" to Pkg.otherFiles as follows to include the generated server info files in the release:

```
Pkg.otherFiles = [ ....., "package/info", ... ];
```

Also, modify the makefile to run the "xdc release" step as the main goal (differences shown in bold):

```
EXAMPLES_ROOTDIR := $(CURDIR)/../../../../../../../../..
```

```
include $(EXAMPLES_ROOTDIR)/xdcpaths.mak
```

```
# add the examples directory to the list of paths to packages
XDC_PATH := $(EXAMPLES_ROOTDIR);$(XDC_PATH)
```

```
# include $(EXAMPLES_ROOTDIR)/buildutils/xdcrules.mak
# run "xdc release" to create a tar file with the server(s)
all:
    $(XDC_INSTALL_DIR)/xdc release XDCPATH="$(XDC_PATH)" \
    XDCOPTIONS=$(XDCOPTIONS) $@ -PD .
```

When you type "make", a .tar file will be created. That is your server deliverable.

See ti/sdo/ce/examples/servers/all_codecs/package.bld for an example.

2.3.2 Delivering Server Packages for Servers Built with Configuro-based makefiles

If you built your server via Configuro (a utility that generates object and linker files from a user .cfg script) that is driven from a makefile (which is then not very short), you must add a step to the makefile to create a server package and an archive from it.

DSP servers built with Configuro do not require a package to build the server itself, but you must create one to produce a server deliverable. In that package, you must include both the server executable and the Configuro-generated "package/info/*" files.

While each Configuro-using makefile is different, here's an example of how the server package generation may look. Here we auto-generate an XDC package from the given package name `$(SERVER_PKG)`, given the server executable name `$(SERVER_EXE)`, and config name `$(CONFIGPKG)`, knowing that Configuro-generated files are in the `$(CONFIGPKG)` directory:

```
SERVER_PKG := ti.sdo.ce.examples.servers.video_copy.evmDM6446

SERVER_PKG_ARCHIVE := $(subst .,_,$(SERVER_PKG)).tar

# create server release package and archive it; the package
# contains the executable and some meta-info files
$(SERVER_PKG_ARCHIVE): $(SERVER_EXE)
    @echo "Creating server release:"
    @rm -rf package package.*
    @echo "package $(SERVER_PKG) {" > package.xdc
    @echo "Pkg.otherFiles = ['./$(SERVER_EXE)', 'package/info']" \
    > package.bld
    @mkdir package ; cp -R $(CONFIGPKG)/package/info package
    @$ (XDC_INSTALL_DIR)/xdc XDCPATH="$(XDC_PATH)" release
    @rm -f package.bld package.mak .[idle]*
```

For this example to work, the makefile and the server executable must be in a directory whose path ends with "ti/sdo/ce/examples/servers/video_copy/evmDM6446", because that is the name we have given to the server package.

See `ti/sdo/ce/examples/servers/video_copy/evmDM6446/makefile` for an example.

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