Application Report
SPRAC56–November 2016

IPC FAQ for KeyStone™ Devices

ABSTRACT

This document is a collection of frequently asked questions (FAQ) about IPC on the KeyStone™ family of devices, along with some useful collateral and software reference links. Project collateral and source code discussed in this application report can be downloaded from the following URL: http://www.ti.com/lit/zip/SPRAC56.

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1 Guide on Building and Running IPC Examples of Processor SDK

The guide in the following link provides step-by-step instructions on how to bring up the target EVMs and how to run the IPC examples of processor SDK on target EVM (see *Guide Keystone II IPC examples*).

The guide provides steps on how to:

- Flash the u-boot and boot u-boot
- Flash the UBIFS image (Linux™ and root file system) into NAND and boot Linux
- Build the IPC package
- Build and run the IPC examples (ex02_MessageQ, ex44_compute, ex45_host, and ex46_graph) on the target EVM
- Real-time debug the DSP side programs using Code Composer Studio™ (CCS)

2 Where do I look for the list of IPC API reference documents?

Go to the *IPC API Reference* page to view the APIs. The IPC product contains the following APIs.

- GateMP (BIOS, Linux, QNX)
- HeapBufMP (BIOS)
- HeapMemMP (BIOS)
- HeapMultiBufMP (BIOS)
- Ipc (BIOS, Linux, QNX)
- ListMP (BIOS)
- MessageQ (BIOS, Linux, QNX)
- MultiProc (BIOS, Linux, QNX)
- NameServer (BIOS, Linux, QNX)
- Notify (BIOS)
- SharedRegion (BIOS)
- IpcPower (BIOS)

Some environments also provide a Multimedia RPC interface. Currently, this is limited to OMAP5 and DRA7XX devices running a high-level operating system (HLOS).

- MmRpc (Linux, QNX)
- MmServiceMgr (BIOS)

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3 How do you rebuild the IPC package and libraries?

The user guide that comes with the IPC package (under the documents folder) is sufficient to build the IPC package. The following steps are from the user guide. For building IPC package, users can use either Cygwin and command-line utility on a Windows® machine or a Linux machine; this cannot be built through CCS.

1. Install the mcsdk_bios_3_xx_xx_xx which will install the IPC package version (ipc_3_xx_xx_xx).
2. Go to the directory where the IPC package is installed.
3. Open the products.mak file and make sure the following parameters are set appropriately.

   For example (for IPC-Linux build):

```
PLATFORM = TCI6638
DESTDIR = /opt/ti/ipc_3_xx_xx_xx/ipc_3_xx_xx_xx_lib

XDC_INSTALL_DIR = /opt/ti/xdctools_3_xx_xx_xx
BIOS_INSTALL_DIR = /opt/ti/bios_6_xx_xx_xx
ti.targets.elf.C66 = /opt/ti/ccsv5/tools/compiler/C6000_7.4.5
```

The following are commands to input to the console to rebuild the package.

```
$cd /opt/ti/ ipc_3_xx_xx_xx
$make distclean
$make -f ipc-linux.mak config
$make
$make install
```

4 Is there any simple example to demonstrate IPC methods like message Q or notify for KeyStone™ II?

Please look at the ex44_compute.zip file in the :~/ti/ipc_3_3x_xx_xx/examples/TCI6638_linux_elf directory.

```
~/ti/ipc_3_3x_xx_xx/examples$ ls
C6472_bios_elf C6A8149_bios_elf DRA7XX_android_elf DRA7XX_linux_elf makefile TCI6638_linux_elf
TI814X_bios_elf C6678_bios_elf dosrc.bat DRA7XX_bios_elf DRA7XX_qnx_elf OMAPL138_linux_elf
TDA3XX_bios_elf
```

Please refer to the readme.txt file to run and build the example according to the target used. For K2, use the cluster ID as 0 instead of 18.

- perl patchExec.pl 0 compute_dspN.xe66 compute_dspN_patched.xe66
- lad_tci6638 -r 8 -n 9 -b 0 -l log.txt

5 For KeyStone™ II, are there any CCS based examples to demonstrate a simple communication between ARM® core to DSP?

No. There are only image processing demos. In MCSDK 3.x, the ARM® core only runs Linux kernel and user Space applications. There is not a Linux application example using CCS; an example like this would use Linux commands.

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6 In IPC packages, there are many test example (sample.c) codes given in the ~\ipc_3_3x_xx_xx\packages\ti\ipc\tests path, but there is only one command line option to build the whole IPC package. No option is available to build the test examples individually. It is time consuming to build the whole IPC package. Customers were asking for a CCS based environment to build and test as individual examples for DSP and ARM® core sides.

The IPC package has been developed to work on multiple platforms such as Linux, Android, QNX, and TI-RTOS (SYS/BIOS), so a command line build that is common across each of these platforms was selected and there is not a CCS based project for these examples.

7 For KeyStone™ II devices, where do I find the source code of the image processing demo and how do I rebuild them (using the ARM® core as a master, DSP cores as slaves)?

The tested version is mcsdk_bios_3_00_03_15. The Image processing demo was tested multiple times with this version and it works. The image processing demo source code can be found in the following path: C:\ti\mcsdk_bios_3_0x_0x_0x\demos\image_processing\ipc (master, slave, and common directories).

7.1 Building Slave Code

The project can be imported into CCS and can be rebuilt.

- K2E: ~\mcsdk_bios_3_0x_0x_0x\demos\image_processing\ipc\evm66ak2e\slave
- K2K: ~\mcsdk_bios_3_0x_0x_0x\demos\image_processing\ipc\evmtci6638k2k\slave
- K2L: ~\mcsdk_bios_3_0x_0x_0x\demos\image_processing\ipc\evmtci6630k2l\slave

7.2 Building Master Code

The master code can be built in the Linux environment using the makefile at ~\mcsdk_bios_3_0x_0x_0x\demos\image_processing\ipc\evm66ak2x\master\make which uses the makefile located at ~\mcsdk_bios_3_0x_0x_0x\demos\image_processing\ipc\master\src.

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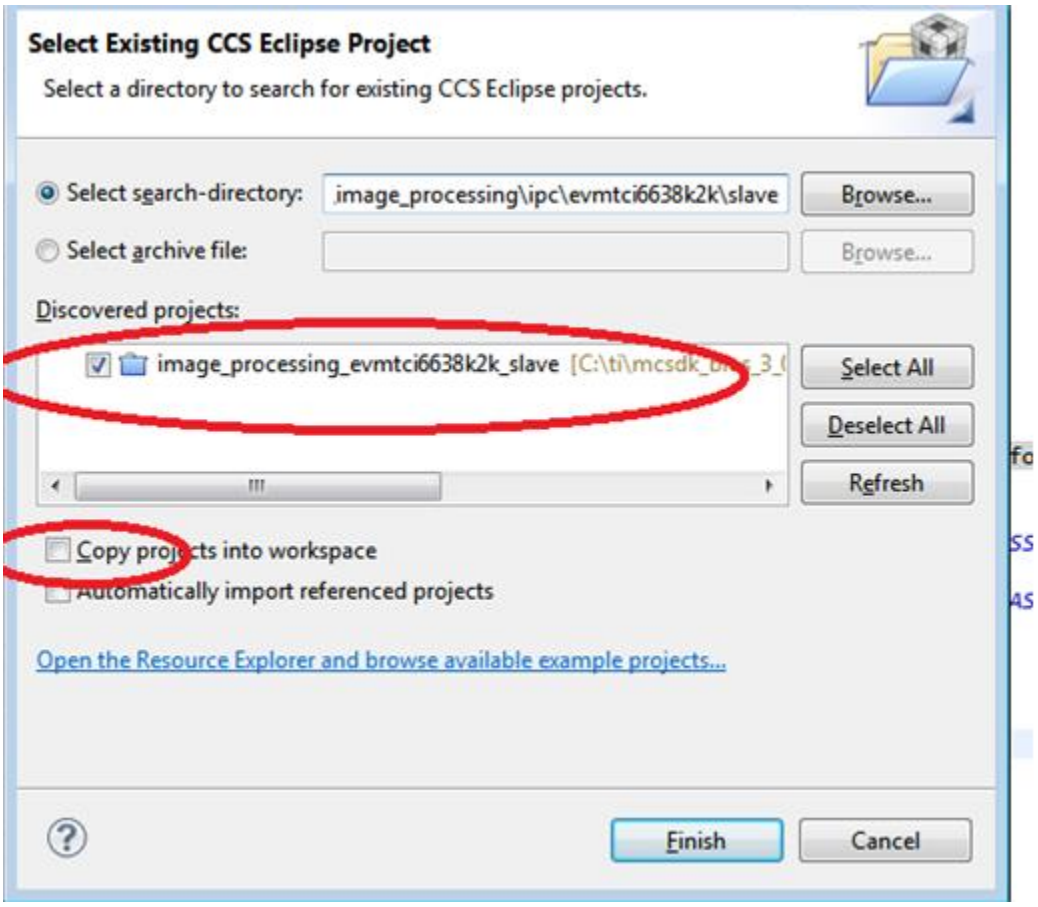
8 How do I import the slave code of the image processing demo and how do I build it?

Figure 1 shows the correct path that should be provided to pick up the project and its sources. The Copy projects into work space option should be unchecked.

Figure 1. Project and Source File Path



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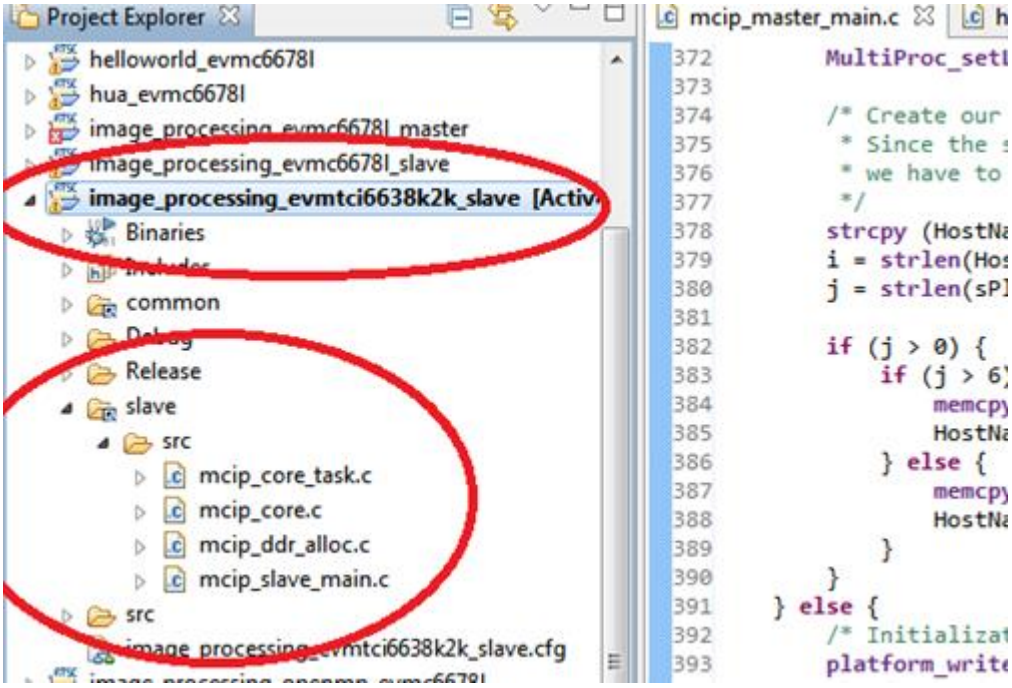
In the project explorer screen (Figure 2), check whether the slave → src → *.c files can be seen. Right click on the project and give build.

Figure 2. Project Explorer



9 After building the slave code of the image processing demo using CCS, where must it be replaced in the Linux™ file system?

Take the binary file (image_processing_evmtci66xxk2x_slave.out) and replace it in the path target Linux file system (/usr/share/matrix-gui-2.0/apps/demo_imageproc/bin/).

10 While building the ARM® core (master) side code of the image processing demo, I see a compilation error message about Std.h when I make it with or without BUILD_LOCAL=true. How do I resolve this?

Error message:

```
user@ubuntu:~/ti/mcsdk_bios_3_0x_0x_0x/demos/image_processing/ipc/evm66ak2x/master$ make

make[1]: Entering directory
`/home/user/ti/mcsdk_bios_3_0x_0x_0x/demos/image_processing/ipc/master/src'
mcip_mem_mgmt.c:53:24: fatal error: ti/ipc/Std.h: No such file or directory #include
<ti/ipc/Std.h> Compilation terminated.
```

There is an error in the makefile. The makefile must be updated to include the appropriate search path for Std.h. Users can find the path at ../ti/ipc_3_3x_0x_0x/linux/include.

Update the makefile located at mcsdk_bios_3_0x_0x_0x\demos\image_processing\ipc\master\src\makefile as shown in the following code snippet.

```
IPC_INSTALL_DIR := /opt/ti/ipc_3_xx_0x_0x
CFLAGS  := -Wall -I$(COMMON_INC) -I$(MASTER_INC) -I$(IPC_INSTALL_DIR)/linux/include -
I$(IPC_INSTALL_DIR)/packages -D_GNU_SOURCE
```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11 While building the ARM® core (master) side code of the image processing demo, I see a linker error message. How do I resolve this?

Error message:

```
/usr/bin/ld: skipping incompatible /opt/ti/ipc_3_35_01_07/examples/TCI6638_linux_elf
/ex44_compute_bkp/lib//libtitransportrpmsg.a when searching for -ltitransportrpmsg
/usr/bin/ld: cannot find –ltitransportrpmsg
usr/bin/ld: cannot find -ltiipcutils
collect2: error: ld returned 1 exit status
make: *** [../../master/image_processing_master.out] Error 1
root@e2e:/opt/ti/mcsdk_bios_3_0x_xx_xx/demos/image_processing/ipc/master/src#
```

For these errors, ensure the whole IPC package has been built and the libraries (such as transportrpmsg) have been installed in a destination directory. This destination directory should be given in the makefile to find those libraries.

For example, in the makefile located at mcsdk_bios_3_0x_xx_xx\demos\image_processing\ipc\master\src\makefile, reference the following code snippets.

```
IPC_INSTALL_DIR := /opt/ti/ipc_3_3x_xx_xx

#The location where the libraries are installed after building the IPC package
SIPC_LINUX_DIR := /opt/ti/ipc_3_3x_xx_xx/IPC_Linux_libraries

CROSS_COMPILE ?= arm-linux-gnueabihf-
CC            := $(CROSS_COMPILE)gcc
CFLAGS        := -Wall -I$(COMMON_INC) -I$(MASTER_INC) -I$(IPC_INSTALL_DIR)/linux/include -
I$(IPC_INSTALL_DIR)/packages -D_GNU_SOURCE
LFLAGS        := -lpthread -L$(SIPC_LINUX_DIR)/ -ltitransportrpmsg -L$(SIPC_LINUX_DIR)/ -ltiipc -
L$(SIPC_LINUX_DIR)/ -ltiipcutils
```

12 The image processing demo does not work on the version of MCSDK, V3.0x.xx.x on both the K2H and K2E EVMs. The earlier version of MCSDK works on both the EVMs. Will it be fixed on next version?

Ensure the u-boot environments are set to work on MCSDK 3.x as shown in the following code snippet.

```
u-boot# env default -f -a
u-boot# setenv mem_reserve 1536M
u-boot# saveenv
```

13 How do you build and run the qmssIpcBenchmark on the C6678 EVM?

13.1 Hardware Setup

Set the boot mode dip switch to no boot/EMIF16 mode, then connect the power and emulator to the C6678 EVM.

13.2 Software Setup

Use the following instructions to set up the software.

1. Power on the EVM.
2. Create and launch the target configuration file (.ccxml) for CCS debugging.
3. Group Core 0 and Core 1 in CCS.
4. Connect to both cores through the group.
5. Load the *evmc66xxl.gel* file to initialize the DDR.

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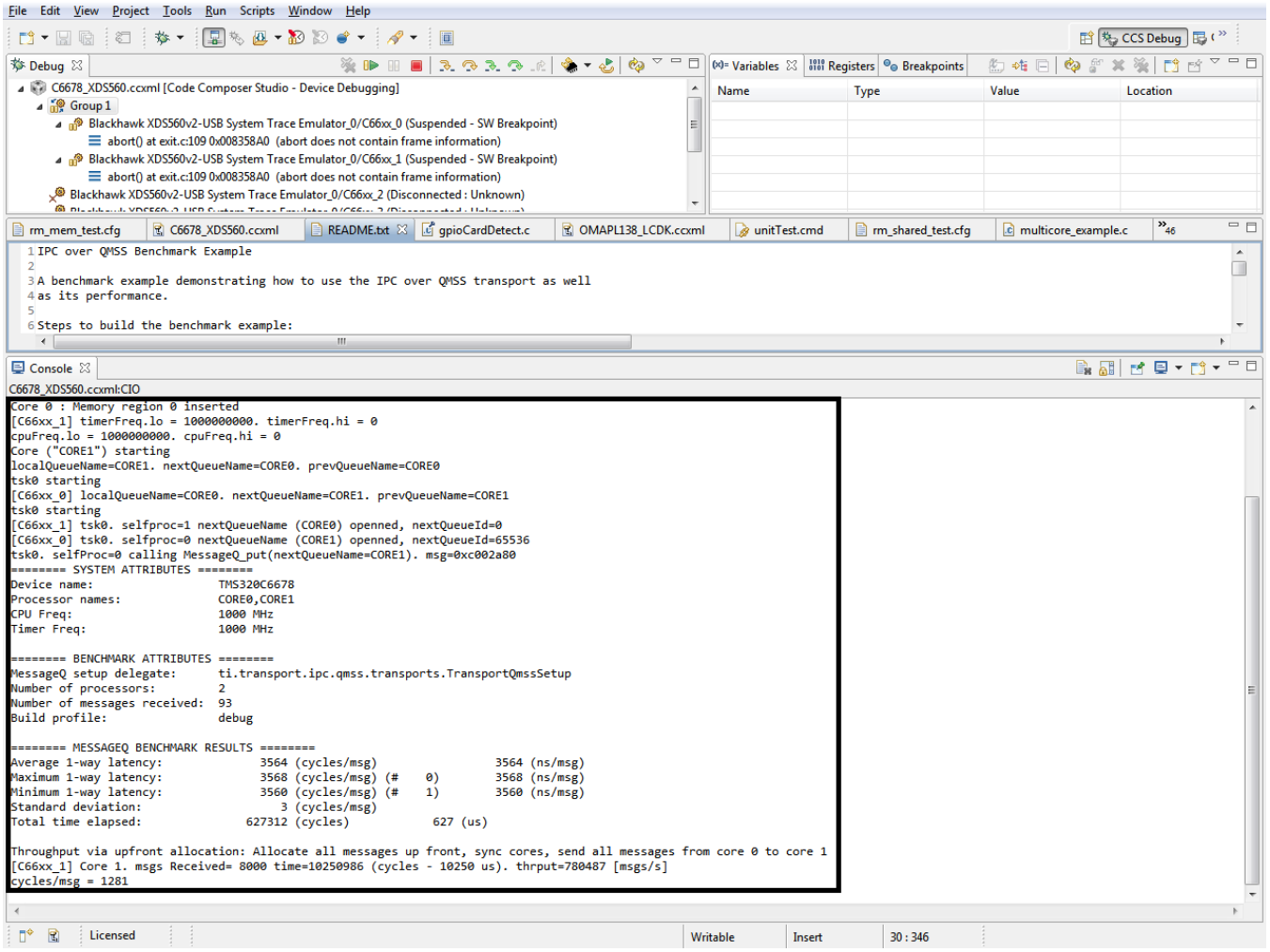
The GEL can be found in the CCS install dir"\ccsv5\ccs_base_x.x.x.xxxxx\emulation\boards\evmc66xxl\gel directory. Once the file is loaded:

6. Execute the default setup script on each core. In the CCS menu, go to Scripts → EVMC6678L Init Functions → Global_Default_Setup.
7. Highlight the group in the CCS Debug window, then load transport\ipc\examples\qmssIpcBenchmark\Debug\qmssIpcBenchmark_c66xx.out on each core (see Figure 3).
8. Highlight the group in the CCS Debug window, run the program in CCS on both cores simultaneously (see Figure 3).

   qmssIpcBenchmark_c66xx will send messageQ messages between the cores through the QMSS transport. The messages will be used to measure the performance of the transport. The test will be complete after the throughput (msg/s) has been calculated.

Figure 3. Debug Window



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14 How can I build the qmssIpcbenchmark of pdk_C6678_1_1_2_x pdk_C6678_1_1_2_x with the release build configuration?

The option *-mo -o3 -q -k -eo.o* works for building the IPC-QMSS transport library in release mode, and the option *-mo -g -q -k -eo.o* works for building the IPC-QMSS transport library in debug mode.

The common.bld script of the IPC does not create a release folder. By default, this script always creates the debug folder and dumps all of the binaries. By tweaking the common.bld file, a release folder can be made and the IPC-qmssIpcBenchmark project can be built in release mode.

14.1 How do you change the Common.bld file?

Use the following instructions to change the common.bld file.

1. Go to C:\ti\ipc_3_00_xx_xx\packages\ti\sdo\ipc\build\Common.bld.

   NOTE: Go to the IPC version used for building the transport library. Here, this is IPC version 3.00.4.29.

2. Modify the following code.

```
Line No:88 profiles[0] = "release";
Line No: 99 var libPath = "lib/ipc/release/";
```

3. Build with option *-mo -o3 -q -k -eo.o* in the *config.bld* file of the transport library (\ti\pdk_C6678_1_1_2_x\packages\ti\transport\ipc\qmss\transports).
4. Build the qmssIpcBenchmark project. Figure 4 shows a screenshot of the successful build.

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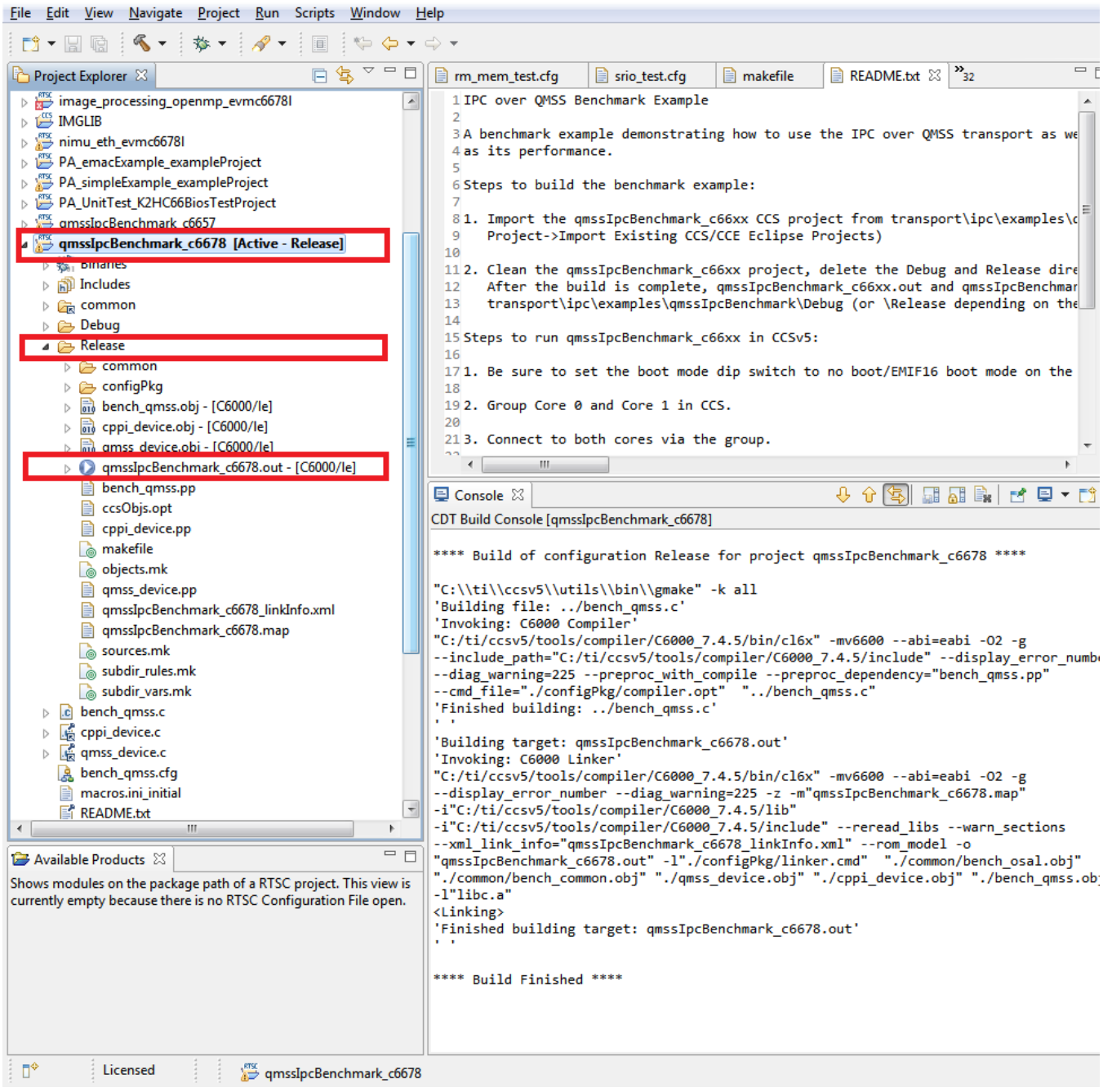
Figure 4. Successful Release Build



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15 How do you rebuild the IPC-QMSS transport library and generate ti.transport.ipc.qmss.transports.ae66?

After installing PDK, go to ~\ti\pdk_C6678_1_1_2_x\packages\ti\transport\ipc\qmss\transports, then use the following steps.

1. (Optional — required for single-step-debugging) Modify the*config.bld* file *C66LE/BE.ccOpts.prefix* of the transports library to remove optimization and add symbolic debug.
   - From: -mo -o3 -q -k -eo.o
   - To: -mo -g -q -k -eo.o
2. Navigate to the pdk\packages\ti\transport\ipc\(qmss or srio) directory by using a command prompt.
3. Configure the XDCPATH environment variable with the BIOS menu and IPC install locations.

   ```
   set XDCPATH=c:\ti\bios_w_xx_yy_zz\packages\
   set XDCPATH=%XDCPATH%;c:\ti\ipc_w_xx_yy_zz\packages\
   ```

4. Configure the XDCCGROOT environment variable with the compiler install path (using CGT 7.2.4 installed as part of CCS as an example).

   ```
   set XDCCGROOT=c:\ti\ccsv5\tools\compiler\c6000_7.2.4
   ```

5. Add the XDC tools to the system PATH.

   ```
   set PATH=%PATH%;c:\ti\xdctools_w_xx_yy_zz\
   ```

6. Clean the transport.

   ```
   >xdc clean -PR .
   ```

7. Build the transport.

   ```
   >xdc -PR .
   ```

Users should be able to build in release mode by using the previous steps.

NOTE: To allow single-step debugging of the IPC and BIOS source, rebuild the example projects with the following command added to the .cfg file of the example.

```
BIOS.libType = BIOS.LibType_Debug;
```


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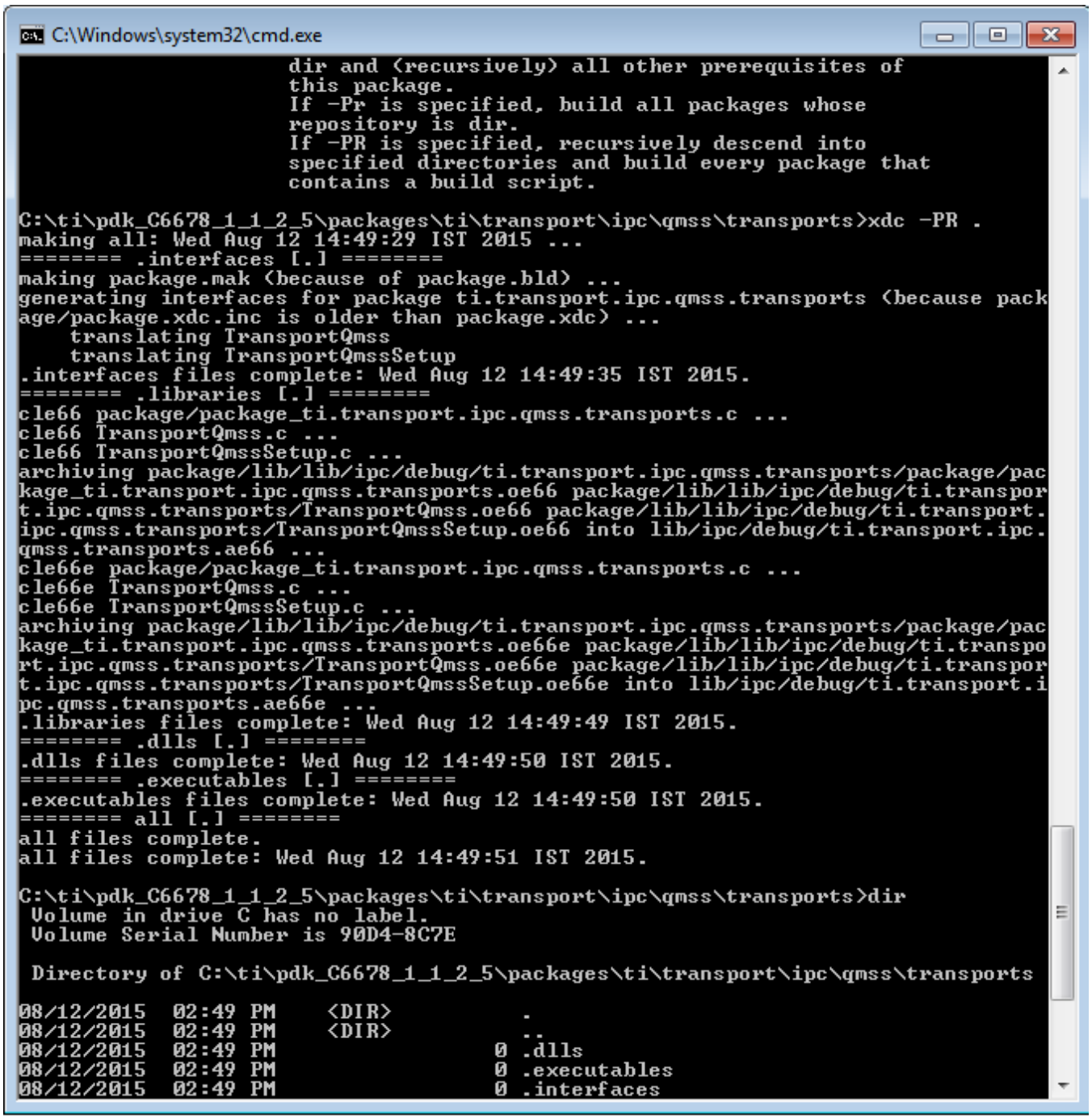
Figure 5 shows the build log.

Figure 5. Build Log



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