



Intel[®] Quark[™] SoC X1000

Board Support Package (BSP)

Build and Software User Guide

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1 *About this document*

This document, the Intel® Quark™ SoC X1000 Board Support Package (BSP) Build and Software User Guide, is divided into two major sections:

- **Part 1 Building the BSP Software** contains instructions for installing and configuring the Intel® Quark™ SoC X1000 Board Support Package sources.
- **Part 2 Using the BSP Software** provides information on BSP software features and functionality.

Use this document to create an image to boot on your Quark-based board, and to learn more about BSP software features.

The intended audience for this document are hardware/software engineers with experience in developing embedded applications.

This software release supports the following software and hardware:

- Board Support Package Sources for Intel® Quark™ SoC X1000 v1.0.0
- Intel® Galileo Customer Reference Board (CRB) (Fab D with blue PCB)
- Kips Bay Customer Reference Board (CRB) (Fab C with green PCB)
- Intel® Quark™ SoC X1000 Industrial/Energy Reference Design (Cross Hill)
- Intel® Quark™ SoC X1000 Transportation Reference Design (Clanton Hill)



Part 1 Building the BSP software

This section contains the following topics:

[Before you begin](#)

[Downloading software](#)

[Building the EDKII firmware](#)

[Building the GRUB OS loader \[Linux build environment only\]](#)

[Creating a file system and building the kernel using Yocto \[Linux build environment only\]](#)

[Building the Linux* cross compile toolchain using Yocto \[Linux build environment only\]](#)

[Creating a flash image for the board \[Linux build environment only\]](#)

[Patching flash binary files using platform data file](#)

[Programming flash on the board using serial interface](#)

[Programming flash on the board using DediProg](#)

[Booting the board from SD card](#)

2 Before you begin

Before you begin:

- You need a host PC running either:
 - Linux*; Intel recommends a 64-bit Linux system
 - Microsoft* Windows* 7, x64
- You need an internet connection to download third party sources.
- The build process may require as much as 30 GB of free disk space.
- To program the board you can use:
 - A serial interface using the UEFI shell or Linux* run-time (see [Section 10](#))
 - A DediProg* SF100 SPI Flash Programmer (or equivalent) and the associated flashing software (see [Section 11](#))
 - An Intel® Galileo IDE (Galileo board only; see the *Intel® Galileo Board Getting Started Guide* for details)

Note: Remove all previous versions of the software before installing the current version.

Individual components require very different environments (compiler options and others). **To avoid cross-pollution, the commands in each section below must be run in a new command line window every time.**



Before you begin

Note: If the commands fail or timeout, it may be due to your proxy settings. Contact your network administrator. You may find answers here:

https://wiki.yoctoproject.org/wiki/Working_Behind_a_Network_Proxy

This release has been tested with Windows* 7, 64-bit and Debian* Linux* 7.0 (Wheezy), but will work with most other Linux distributions.

Linux builds have been validated on 64-bit Linux systems and may need additional steps for operation on 32-bit systems.



3 Downloading software

Download the BSP sources zip file from the following location:

https://downloadcenter.intel.com/Detail_Desc.aspx?DwnldID=23197

Note: If you are using an Intel® Quark™ Reference Design board, see your Intel representative for the appropriate software download URL.

This release is comprised of:

- Board Support Package (BSP) sources:
 - Board_Support_Package_Sources_for_Intel_Quark_v1.0.1.7z (2.6 MB)

For customers using the Clanton Hill FFRD, additional CAN software must be downloaded from Intel Business Link (IBL). See your Intel representative for the URL. The CAN package comprises:

- Fujitsu CAN Firmware:
 - CAN_Firmware_for_Intel_Quark_v1.0.1.zip (36 kB)

If building on a Debian host PC, use the Debian-provided meta package called `build-essential` that installs a number of compiler tools and libraries. Install the meta package and the other packages listed in the command below before continuing:

```
# sudo apt-get install build-essential gcc-multilib vim-common
```



4 Building the EDKII firmware

You need to build the open source EDKII firmware for the Intel® Quark™ SoC. Additional details may be found here:

- www.tianocore.sourceforge.net
- http://sourceforge.net/apps/mediawiki/tianocore/index.php?title=Getting_Started_with_EDK_II

4.1 Dependencies

Linux* build environment dependencies:

- Python 2.6 or 2.7 (Python 3.x not supported)
- GCC and G++ (tested with GCC 4.3 and GCC 4.6)
- subversion client
- uuid-dev
- iasl (<https://www.acpica.org/downloads/linux>)
Note: An ACPI5.0 compatible version is required.

Windows* build environment dependencies:

- Python 2.6 or 2.7 (Python 3.x not supported)
- Microsoft* Visual Studio* 2008 Professional.
- The Intel® Quark™ SoC EDKII build is validated with the **Win7 x64 / VS2008x86** option shown in http://sourceforge.net/apps/mediawiki/tianocore/index.php?title=Windows_systems_ToolChain_Matrix

In addition, the `quarkbuild.bat` below enforces the x86 postfix onto the Visual Studio* option for building under x64 Windows.

- TortoiseSVN (1.4.2.8580 or later) installed with optional SVN command line tools.
- iASL Windows binaries (<https://www.acpica.org/downloads/binary-tools>)
Note: An ACPI5.0 compatible version is required.

4.2 Pre build setup

The following steps are done once to prepare the EDKII workspace directory with the required source code before commencing the actual firmware build.

1. Create the EDKII workspace directory and extract the contents of the Intel® Quark™ SoC EDKII BSP into this directory. The file will have the name `Quark_EDKII_<version>.tar.gz`. After the contents have been extracted the



files `quarkbuild.sh` and `quarkbuild.bat` should be in the root of the created workspace directory.

2. Fetch the upstream core EDKII packages using `svn_setup.py` and the SVN command line tool.
3. Optionally, if OpenSSL is required by the build configuration in [Section 4.3](#) or [Section 4.4](#) following, then perform the steps in the `CryptoPkg/Library/OpensslLib/Patch-HOWTO.txt` file.

4.2.1 Performing pre build steps in a Linux/gcc build environment

Open a new terminal session and enter the following commands:

```
# sudo apt-get install build-essential uuid-dev iasl subversion
# tar -xvf Quark_EDKII_*.tar.gz
# cd Quark_EDKII*
# ./svn_setup.py
# svn update
```

4.2.2 Performing pre build steps in a Windows build environment

Use a preferred tool to extract the `Quark_EDKII_*.tar.gz` to a user created EDKII Workspace directory and run the `cmd.exe` Windows command. Then, issue the following commands:

```
>cd %USER_SELECTED_EDKII_WORKSPACE_DIR%
>.\svn_setup.py
>svn update
```

Note: The `svn update` command can take a few minutes to complete depending on the speed of your internet connection.

Note: If these commands fail, it may be due to your proxy settings. Contact your network administrator. You may find answers about proxy settings here: https://wiki.yoctoproject.org/wiki/Working_Behind_a_Network_Proxy

Note: The examples above do not show the optional OpenSSL pre build step described in the `CryptoPkg/Library/OpensslLib/Patch-HOWTO.txt` file.



4.3 Building all the EDKII Firmware validated build configurations [Linux build environment only]

This section is only supported in Linux Build environments. The `buildallconfigs.sh` file is used to build all the validated EDKII build configurations. Open a terminal window and `cd` to the `Quark_EDKII*` directory created in Section 4.2.1 above.

The script has the following options:

```
buildallconfigs.sh [GCC43 | GCC44 | GCC45 | GCC46 | GCC47] [PlatformName]
```

`GCC4x` GCC flags used for this build. Set to the version of GCC you have installed.
Note: Validated with GCC43; tested on GCC46.

`[PlatformName]` Name of the platform package you want to build.

Example usage:

Create a build for an Intel® Quark™ SoC platform based on GCC version 4.6:

```
./buildallconfigs.sh GCC46 QuarkPlatform
```

Note: Ensure the selected version of GCC matches the one installed on the system by running the `gcc --version` command.

The build output can be found in the following directories:

- `Build/QuarkPlatform/<Config>/<Target>_<Tools>/FV/FlashModules/`
Contains EDKII binary modules
- `Build/QuarkPlatform/<Config>/<Target>_<Tools>/FV/Applications/`
Contains UEFI shell applications, including `CapsuleApp.efi`

Where:

- `<Config>` = PLAIN | SECURE
- `<Target>` = DEBUG | RELEASE
- `<Tools>` = GCC43 | GCC44 | GCC45 | GCC46 | GCC47

In [Section 8](#) you will run a script that creates a symbolic link to the directory where the EDK binaries are placed.



4.4 Building a single EDKII Firmware build configuration

This section is supported in Linux and Windows build environments. Use `quarkbuild.sh` in a Linux terminal window or `quarkbuild.bat` in a Windows command prompt (created by running `cmd.exe`) and the `cd` command to change directory to the root of the EDKII workspace directory created in [Section 4.2](#) above.

Build usage:

```
quarkbuild [-r32 | -d32 | -clean]
[GCC43 | GCC44 | GCC45 | GCC46 | GCC47 | subst drive letter]
[PlatformName] [-DSECURE_LD (optional)] [-DTPM_SUPPORT (optional)]
```

The following is the list of options for the `quarkbuild.sh` and `quarkbuild.bat` build commands:

<code>-clean</code>	Delete the build files/folders
<code>-d32</code>	Create a DEBUG build
<code>-r32</code>	Create a RELEASE build
<code>GCC4x</code>	LINUX ONLY: GCC flags used for this build. Set to the version of GCC you have installed. NOTE: Validated with GCC43; tested on GCC46.
<code>subst drive letter</code>	WINDOWS ONLY: <code>quarkbuild.bat</code> uses the letter specified here with the Windows <code>subst</code> command to associate a drive letter with the EDKII workspace directory path. Associating a drive letter with the EDKII workspace directory reduces flash space requirements for debug executables.
<code>[PlatformName]</code>	Name of the Platform package you want to build
<code>[-DSECURE_LD]</code>	Create a Secure Lockdown build (optional)
<code>[-DTPM_SUPPORT]</code>	Create an EDKII build with TPM support (optional) Note: This option has a one-time prerequisite described in the <code>CryptoPkg\Library\OpensslLib\Patch-HOWTO.txt</code> file. For more details on TPM (Trusted Platform Module), see the Intel® Quark™ SoC X1000 UEFI Firmware Writer's Guide.



Linux example usage:

Create a secure lockdown RELEASE build for an Intel® Quark™ SoC platform based on GCC version 4.3:

```
./quarkbuild.sh -r32 GCC43 QuarkPlatform -DSECURE_LD
```

Windows example usage:

Create a DEBUG build for a Quark platform. After executing quarkbuild.bat, a virtual drive S: is created which is rooted to EDKII workspace directory.

```
>.\quarkbuild.bat -d32 S QuarkPlatform
```

4.5 EDKII firmware build standalone output files

[Chapter 8](#) "Creating a flash image for the board" is not required if the user only requires EDKII firmware in the SPI Flash on Intel® Quark™ SoC Open SKU silicon. Sections 4.3 and 4.4 above create the following EDKII standalone output files:

- `.\Build\...\FV\FlashModules\Flash-EDKII-missingPDAT.bin`

Full 8 MB image for manufacture with just the EDKII SPI flash images. The user is still expected to use [Section 9](#) following to create the final image for the board. The platform data python script referenced in the [Section 9](#) can be used in Linux* or Windows* build environments.

- `.\Build\...\FV\RemediationModules\Flash-EDKII.cap`

Capsule with just EDKII flash images that can be used instead of the capsule file referenced in [Section 10](#). Applying this file only updates the EDKII components of the SPI flash (as provided in the capsule). All other SPI flash assets remain intact.

Note: If programming `Flash-EDKII.cap` on a board, it is required that the SPI Flash version of the target board is at production level V1.0.0 or later. (Provided by the `Flash-missingPDAT.cap` or `Flash+PlatformData.bin` files referenced in the sections following.)

- `.\Build\...\FV\RemediationModules\CapsuleApp.efi`

UEFI application referenced in [Section 10.1](#) following.

- `.\Build\...\FV\RemediationModules\FVMAIN.fv`

Recovery file that can be used in [Section 14](#) below. This version of the file only has the EDKII SPI flash images.



5 Building the GRUB OS loader [Linux build environment only]

Note: GRUB is provided in two places: inside the meta-clanton Yocto BSP or independently.

If you will run Yocto, skip this section and use the file output by Yocto in this directory: `yocto_build/tmp/deploy/images/grub.efi`

If you are only interested in building a Flash image without Linux and not in using Yocto, then proceed through this section.

Tip: If you want to build a Flash image without a Yocto Linux system (for example, because you plan to boot a larger Yocto Linux system from an SD card or USB stick), you should modify the appropriate `layout.conf` file and delete the sections for `bzImage` and `core-image-minimal-initramfs-clanton.cpio.gz`.

Dependencies:

- GCC (tested with version 4.3.4 and 4.6.3, and `libc6-dev-i386`)
- `gnu-efi` library (tested with version `>= 3.0`)
- GNU Make
- Autotools (`autoconf` and `libtool`)
- Python 2.6 or higher
- `git`
- `gcc-multilib`
- `texinfo`

This GRUB build requires the 32 bit `gnu-efi` library which is included with many Linux distributions. Alternatively, you can download the latest version from: <http://sourceforge.net/projects/gnu-efi/files>

Unpack and compile the `gnu-efi` library using the commands:

```
# tar -xvf gnu-efi*
# cd gnu-efi*/gnuEFI
# make ARCH="ia32"
# cd -
```

To build GRUB, **first open a new terminal session**, extract the grub package, and run the `gitsetup.py` script. The script downloads all the upstream code required for grub and applies the patch.

Note: If you are not using Debian and had to manually install `gnu-efi` in a non-system location, then you must point `GNUEFI_LIBDIR` at the location where `gnu-efi` was compiled or installed.



Run the following commands:

```
# sudo apt-get install git autoconf
# tar -xvf grub-legacy_*.tar.gz
# cd grub-legacy_*
# ./gitsetup.py
# cd work
# autoreconf --install
# export CC4GRUB='gcc -m32 -march=i586 -fno-stack-protector'
# export GNUEFI_LIBDIR=/full/path/to/gnu-efi-3.0/gnuefi/
# CC="${CC4GRUB}" ./configure-quark.sh
# make
# cd -
```

Note: If these commands fail, it may be due to your proxy settings. Contact your network administrator. You may find answers about proxy settings here:
https://wiki.yoctoproject.org/wiki/Working_Behind_a_Network_Proxy

The required output from this build process is the `work/efi/grub.efi` file.



6 Creating a file system and building the kernel using Yocto [Linux build environment only]

Dependencies:

- git
- diffstat
- texinfo
- gawk
- chrpath
- file

Note: git requires proxy configuration. If these commands fail, it may be due to your proxy settings. Contact your network administrator. You may find answers about proxy settings here: https://wiki.yoctoproject.org/wiki/Working_Behind_a_Network_Proxy

Use Yocto to create a root file system and kernel that boots the system from an SD card or USB key. Do not run any of the commands in this section as root.

Note: See [Section 7](#) to build development tools (gcc) for the Linux* operating system.

To avoid a known issue unzipping packages with long file paths, extract the meta-clanton tarball into a directory with a short path, for example /tmp.

First, **open a new terminal session**, extract the Yocto layer, and run the `setup.sh` script to download the external sources required for the Yocto build:

```
# sudo apt-get install diffstat gawk chrpath
# tar -xvf meta-clanton*.tar.gz
# cd meta-clanton*
# ./setup.sh
```

Note: The `setup.sh` script takes no parameters. To build the root file system and kernel for the Intel® Galileo board, see the commands below.

Next, source the `oe-init-build-env` command to initialize the Yocto build environment, and run `bitbake <target>` to build the root file system and kernel. You will use SoC-specific `<target>` commands described below.

Note: If you need to patch the Linux kernel (optional), skip to [Section 6.1](#) and apply the patch before running the `bitbake` command.



Two build methods are supported; the output is slightly different for each one. The commands are different for the Intel® Galileo board.

Note: You cannot perform the following build methods sequentially, they are mutually exclusive. If you want both builds, you must perform them on two completely different and isolated directories.

Build a small Linux for SPI Flash

For the Intel® Galileo board, run:

```
# source poky/oe-init-build-env yocto_build
# bitbake image-spi-galileo
```

For the Intel® Galileo board, output files are found in `./tmp/deploy/images/` and include:

- `image-spi-galileo-clanton.cpio.gz`
- `image-spi-galileo-clanton.cpio.lzma`
- `bzImage`
- `grub.efi`

For other supported boards (not Intel® Galileo), run:

```
# source poky/oe-init-build-env yocto_build
# bitbake image-spi
```

Output files are found in `./tmp/deploy/images/` and include:

- `image-spi-clanton.cpio.gz`
- `image-spi-clanton.cpio.lzma`
- `bzImage`
- `grub.efi`

Build a full-featured Linux for SD card or USB stick

Note: A complete Yocto build can take several hours to complete, depending on your internet connection speed and your machine's specifications.

For the Intel® Galileo board, run:

```
# source poky/oe-init-build-env yocto_build
# bitbake image-full-galileo
```

For the Intel® Galileo board, output files are found in `./tmp/deploy/images/` and include:

- `image-full-galileo-clanton.ext3`
- `core-image-minimal-initramfs-clanton.cpio.gz`
- `bzImage`
- `grub.efi`
- `boot` (directory)

For other supported boards (not Intel® Galileo), run `bitbake image-full` as shown below:

```
# source poky/oe-init-build-env yocto_build
# bitbake image-full
```

Output files are found in `./tmp/deploy/images/` and include:

- `image-full-clanton.ext3`
- `core-image-minimal-initramfs-clanton.cpio.gz`



- bzImage
- grub.efi
- boot (directory)

The kernel and root file system (bzImage and image-nnnn.gz, respectively) can be copied onto a USB stick or SD card and booted from grub. Also, the file grub.conf must be located in the /boot/grub/ directory of the USB stick or SD card.

6.1 Applying a custom patch to the Linux kernel using Yocto (optional)

If you need any customization of your kernel (such as additional debug statements or custom driver behavior), then you may need to patch the Linux kernel. This optional step must be done **before** you run the bitbake command.

1. For customization of Yocto source code, extract the updates to a patch from git using the `git diff` or `git format-patch` commands.
2. Copy the patch to the location below:

```
$ cp mypatch.patch /PATH/TO/MY_BSP/meta-clanton/meta-clanton-bsp/recipes-kernel/linux/files/
```
3. Locate the bitbake recipe file:

```
/PATH/TO/MY_BSP/meta-clanton-bsp/recipes-kernel/linux/linux-yocto-clanton_3.8.bb
```
4. Append the following line:

```
SRC_URI += "file://mypatch.patch"
```

For example:

```
printf '%s\n' 'SRC_URI += "file://mypatch.patch"' >> linux-yocto-clanton_3.8.bb
```

5. Return to [Section 6](#) and run the bitbake command to get new images.

More information can be found here:

- http://www.yoctoproject.org/docs/current/ref-manual/ref-manual.html#var-SRC_URI
- <http://www.yoctoproject.org/docs/current/dev-manual/dev-manual.html#platdev-appdev-devshell>



7 Building the Linux* cross compile toolchain using Yocto [Linux build environment only]

The steps to build the cross compile toolchain are the same as the steps for the Yocto root file system and kernel build as described in [Section 6](#), with the exception of the `bitbake` command arguments.

To build the tool chain, **open a new terminal session** and follow the steps in [Section 6](#) but modify the `bitbake` command as follows:

```
# bitbake image-full -c populate_sdk
```

The same files can be used for both builds, however, you **must** source the `poky oe-init-build-env yocto_build` every time you use a new terminal.

The output of the build process is a script that installs the toolchain on another system:

```
clanton-tiny-uclibc-x86_64-i586-toolchain-1.4.2.sh
```

The script is located in `./tmp/deploy/sdk`

Note: The script may change your environment significantly, thus breaking other, non-Yocto tools you might be using (including anything which uses Python). **You must open a new terminal session** to `source` the Yocto environment and run `make`, and run all your other commands in other terminal sessions.

When you are ready to compile your application, first run the `source` command below to define default values for `CC`, `CONFIGURE_FLAGS`, and other environment variables, then you can compile:

```
# source /opt/clanton-tiny/1.4.2/environment-setup-x86_32-poky-linux  
# ${CC} myfile.c -o myfile
```

or

```
# source /opt/clanton-tiny/1.4.2/environment-setup-x86_64-poky-linux  
# ${CC} myfile.c -o myfile
```

For general details, see the Yocto Application Development Toolkit (ADT) information: <https://www.yoctoproject.org/tools-resources/projects/application-development-toolkit-adt>

Instructions about adding a package to the Linux build may be found here: <http://www.yoctoproject.org/docs/current/dev-manual/dev-manual.html#usingpoky-extend-customimage-localconf>

Quark Linux uses `uclibc`, which is a C library optimized for embedded systems. This enables a very small Linux that can fit into SPI flash with the UEFI bootloader and Grub OS loader.



If you do not have any size constraints, you can change the C library to a more fully featured C library. Detailed instructions are here:

<http://www.yoctoproject.org/docs/current/mega-manual/mega-manual.html>

specifically how to change the `TCLIBC` variable selecting the C library to be used.

To build an `eglibc` image, overwrite the default value of the `DISTRO` variable as follows:

```
DISTRO="clanton-full" bitbake <image-name>
```



8 Creating a flash image for the board [Linux build environment only]

Dependencies:

- GCC
- GNU Make
- EDKII Firmware Volume Tools (base tools)
- OpenSSL 0.9.8w
- libssl-dev

8.1 Using the SPI Flash Tools

The SPI Flash Tools, along with the metadata and flash image configuration in the `sysimage` archive, are used to create a `Flash.bin` file that can be installed on the board and booted.

Open a new terminal session and extract the contents of the `sysimage` archive:

```
# tar -xvf sysimage_*.tar.gz
```

Extract and install SPI Flash Tools:

```
# tar -xvf spi-flash-tools*.tar.gz
```

Note: Extract all files to a directory that does not include the original tar files.

The `sysimage*` directory contains the following preconfigured `layout.conf` files:

- release build base SKU (non-secure)
- debug build base SKU (non-secure)
- release build secure SKU
- debug build secure SKU

Depending on what kind of image you want to build, you must be in either the `sysimage.CP-8M-debug` or the `sysimage.CP-8M-release` directory.

The `layout.conf` file defines how the various components will be inserted into the final `Flash.bin` file to be flashed onto the board. The `layout.conf` consists of a number of `[sections]` with associated address offsets, file names, and parameters. Each section must reference a valid file, so it is necessary to update the paths or create symbolic links to the valid files.



A script is provided that creates symbolic links. Run the script with the command:

```
# ./sysimage/create-symlinks.sh
```

Ensure there is no whitespace around the values defined in the `layout.conf` file.

Note: If you are using the Intel® Galileo board, you may need to modify the `layout.conf` file in the [Ramdisk] section from `image-spi-clanton.cpio.lzma` to `image-spi-galileo-clanton.cpio.lzma` to successfully generate your `.cap` file.

Once a valid `layout.conf` has been created, run the SPI Flash Tools makefile with the command:

```
# ../../spi-flash-tools*/Makefile
```

The output of this build is located in either the `sysimage.CP-8M-debug` or the `sysimage.CP-8M-release` directory (depending on what kind of image was selected).

The output of this build includes:

- `Flash-missingPDAT.cap` - standard capsule file.
Use this file to program your board using the serial interface by following the *Programming the Flash* instructions in [Section 10](#).
- `Flash-missingPDAT.bin` - flash file with no platform data.
Use this file to program your board with the platform data tool and a Dediprog, as described in [Section 9](#), then [Section 11](#).
- `FVMAIN.fv` - board-specific recovery file.
See [Section 14](#) for an overview of capsule recovery. If you are using the Intel® Galileo board, refer to the *Intel® Galileo Board User Guide* for details. For other boards, contact your Intel representative for details.

The capsule file contains a BIOS, bootloader, and compressed Linux run-time system to allow a Quark-based board to boot. Use the capsule update mechanism described in [Section 10](#) to program the SPI flash on your board.

Note: The same build process and same image files are used for both secure and non-secure board SKUs, however, secure SKUs have certain restrictions on where a capsule update can be performed. If you have a secure SKU board (Industrial/Energy or Transportation Reference Design), you **must** update your board using the Linux* run-time system ([Section 10.2](#)).

For experienced users, you can build all sysimages configuration in just one command by running the following command at the top-level directory of the sysimage package:

```
../../spi-flash-tools/Makefile [ -j ] sysimages
```

Note: Be aware of the plural `sysimages` in the command.
The `-j` option builds concurrently, which completes in a shorter time, however the output may be harder to read.



9 Patching flash binary files using platform data file

Note: This section is required for users who wish to update flash contents using flash programmers, for example, during a manufacturing process. The platform data file provides platform personality values such as platform type and board personality values such as Ethernet MAC addresses that must be patched into the previously mentioned `Flash-missingPDAT.bin` and `Flash-EDKII-missingPDAT.bin` files. This section is NOT applicable to `.cap / FVMAIN.fv` files programmed by firmware running on the target.

Platform data is part-specific, unique data placed in SPI flash. Every binary image flashed to the board must be patched individually to use platform data. A data patching script is provided in this release.

The platform data patching script (`platform-data-patch.py`) is stored in the `platform-data` directory within the `sbi-flash-tools` tarball in the Intel® Quark™ SoC BSP. The following text is written as if the user is executing the script on a Linux* build machine, but the script may also be run on a Windows* build machine which has Python 2.6 or Python 2.7 installed.

Before running the `platform-data-patch.py` script, open a new terminal session and copy and edit the `sbi-flash-tools/platform-data/sample-platform-data.ini` file to include platform-specific data such as MAC address, platform type, and MRC parameters.

On reference platforms, the MAC address to be programmed is printed on the product label.

Note: The Intel® Quark™ SoC X1000 contains two MACs and each must be configured with one address in the `platform-data.ini` file, even on boards (such as Galileo) that have only one Ethernet port.

For Galileo, MAC 0 is the only MAC wired out. The default MAC 0 address value in the `platform-data.ini` file is invalid and must be set to the value allocated to your system, typically this is identified on a sticker.

MAC 1 must also have a valid UNICAST MAC address and the `platform-data.ini` file contains a dummy but valid address for MAC 1.

If you do **not** set a valid MAC address, the following error message is returned:

```
HALT: Multicast Mac Address configured for Ioh MAC
```

Galileo / Kips Bay Fab D example is below, recommended values are shown in **bold** text:

```
[Platform Type]
id=1
desc=PlatformID
data.type=hex.uint16
# ClantonPeak 2, KipsBay 3, CrossHill 4, ClantonHill 5, KipsBay-fabD 6
data.value=6
```



Note: In the [Mrc Params] section below, the MRC data.value MUST correspond to the platform data.value used above.

```
[Mrc Params]
id=6
ver=1
desc=MrcParams
data.type=file
#data.value=MRC/clantonpeak.v1.bin
#data.value=MRC/kipsbay.v1.bin
#data.value=MRC/crosshill.v1.bin
#data.value=MRC/clantonhill.v1.bin
data.value=MRC/kipsbay-fabD.v1.bin

[MAC address 0]
id=3
desc=1st MAC
data.type=hex.string
data.value=001320FDF4F2 #replace with MAC address from sticker on board

[MAC address 1]
id=4
desc=2nd MAC
data.type=hex.string
data.value=02FFFFFFFF01
```

Next, run the script as follows:

```
# cd spi-flash-tools/platform-data/
# platform-data-patch.py -p sample-platform-data.ini \
  -i ../../sysimage_*/sysimage.CP-8M-release/Flash-missingPDAT.bin
# cd -
```

This creates a `Flash+PlatformData.bin` file to be programmed on the board, as well as a `sample-platform-data.bin` file containing the same data that was inserted in the Flash image.

To program your board using Dediprog, skip to [Section 11](#).



10 Programming flash on the board using serial interface

Dependencies: CapsuleApp.efi (built in [Section 4](#), located in Build/QuarkPlatform/<Config>/<Target>_<Tools>/FV/Applications/)

The BSP provides a mechanism to update SPI flash contents based on EDKII capsules. These capsules contain a BIOS, bootloader, and compressed Linux run-time system sufficient to boot a Quark-based board, such as the Intel® Galileo board.

The capsule update mechanism can be triggered from an EDKII shell ([Section 10.1](#)) or from a Linux* run-time system ([Section 10.2](#)). In both situations, you must have root privileges on the system.

If you have a secure SKU board (Industrial/Energy or Transportation Reference Design), you **must** update your board using the Linux* run-time system ([Section 10.2](#)).

10.1 Programming flash using UEFI shell

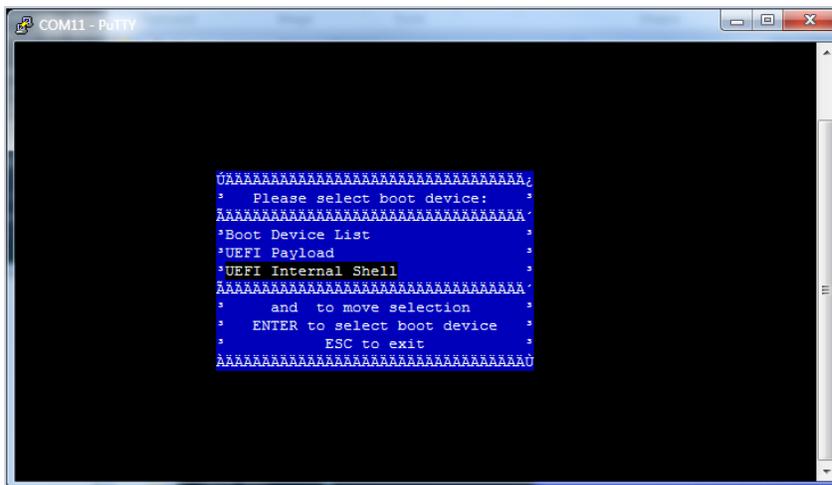
This procedure cannot be used for a secure SKU board (Industrial/Energy or Transportation Reference Design) because the UEFI shell is not available on secure SKU boards. Follow the [Section 10.2](#) procedure instead.

Perform the steps below:

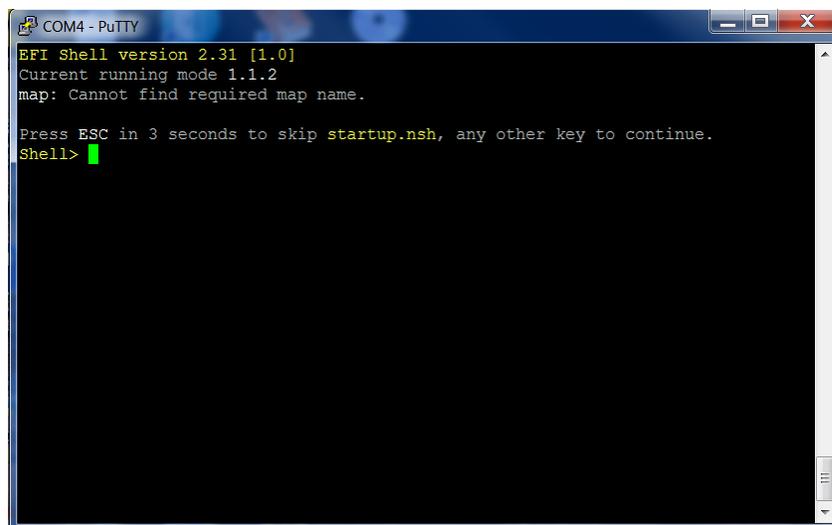
1. Use the files created in [Section 8](#).
2. Copy CapsuleApp.efi and Flash-missingPDAT.cap to a microSD card (or USB stick) and insert it into the slot on the board.
3. Connect the serial cable between the computer and the board. Set up a serial console session (for example, PuTTY) and connect to the board's COM port at 115200 baud rate.
4. Configure the serial console session to recognize special characters. For example, if you are using PuTTY, you must explicitly enable special characters. In the PuTTY Configuration options, go to the Terminal > Keyboard category and set the Function keys and Keypad option to SCO. You may also set Backspace to the Control-H key.
5. Power on the board. Enter the EFI shell before grub starts by pressing F7.



- The serial console displays a boot device selection box (below). Select UEFI Internal Shell.



You will see a display similar to this:



- You will see a print out, the top line of which looks like this:
fs0 :HardDisk - Alias hd7b blk0
This is your SD card. To mount it, type: fs0:
- Verify you are using the correct version of CapsuleApp.efi by using the -v option. You **must** use version 1.01 or later.
- Enter the following command:
CapsuleApp.efi Flash-missingPDAT.cap

Note: You must enter the full filename of the Flash-missingPDAT.cap file.



You will see a display similar to this:

```
COM4 - PuTTY
Transfer mode write = 0x37
SendCommand: Command Index = 18
Transfer mode read = 0x37
Transfer mode write = 0x37
SendCommand: Command Index = 18
Transfer mode read = 0x37
Transfer mode write = 0x37
SendCommand: Command Index = 18
Transfer mode read = 0x37
Transfer mode write = 0x37
SendCommand: Command Index = 18
Transfer mode read = 0x37
Transfer mode write = 0x37
Read(LBA=00007A00, Buffer=0E3C6010, Size=00010000)
SendCommand: Command Index = 18
Transfer mode read = 0x37
Transfer mode write = 0x37
CapsuleApp: creating capsule descriptors at 0xF1DE310
CapsuleApp: capsule data starts at 0xD655410 with size 0x740190
CapsuleApp: capsule block/size 0xD655410/0x740190
CapsuleImage Address is 000D655410, CapsuleImage Size is 740190
CapsuleFragment Address is 000DFCFE90, CapsuleInfo Address is 000DFCFF10
Start to update capsule image!
```

The CapsuleApp will update your SPI flash image. This process takes about 5 minutes.

Warning: DO NOT remove power or try to exit during this process. Wait for the prompt to return, otherwise your board will become non-functional.

9. When the update completes, the board will automatically reboot. You will see a display similar to this:

```
COM4 - PuTTY
[ 14.236101] pci spi probe(), enable_msi 1, mmio_base e0776000, dev c01bd000
[ 14.243984] MSI enabled, irq number is 44
[ 14.248040] ssp type is CE5X00 SSP
[ 14.251652] add_spi_dev_devices GPIO CS off
[ 14.312295] pxa2xx-spi pxa2xx-spi.0: master is unqueued, this is deprecated
[ 14.338110] pxa2xx-spi pxa2xx-spi.1: master is unqueued, this is deprecated
Starting Bootlog daemon: bootlogd.
Configuring network interfaces... [ 17.288952] eth0: device MAC address 00:13:20:fd:f4:60
udhcpd (v1.20.2) started
Sending discover...
Sending discover...
Sending discover...
No lease, failing
kernel.hotplug = /sbin/mdev
sh: %4Y%2m%2d%2H%2M: bad number
INIT: Entering runlevel: 5
Starting syslogd/klogd: done
Stopping Bootlog daemon: bootlogd.
/sketch/sketch.elf file does not exist or invalid permissions
clloader waiting to receive.
Poky 9.0 (Yocto Project 1.4 Reference Distro) 1.4.1 clanton /dev/ttyS1
clanton login: █
```



10.2 Programming flash using Linux* run-time system

If you are updating from an earlier release of the BSP software (0.7.5 and 0.8.0), you need a release-specific kernel module. Note that a 0.7.5 kernel module cannot be loaded on a 0.8.0 BSP and vice-versa.

Open a new terminal session and perform the following steps:

1. Use the files created in [Section 8](#).
2. Copy `Flash-missingPDAT.cap` from the `sysimage` directory onto an SD card (or USB stick) and insert it into the board.
3. **Release 0.7.5 and Release 0.8.0 only:**
Run the command:

```
# insmod /tmp/<release>/efi_capsule_update.ko
```

 where: `<release>` = 0.7.5 or 0.8.0
4. **Release 0.9.0, Release 1.0.0, and later:**
Run the command:

```
# modprobe efi_capsule_update
```
5. **All releases:**
Run the following commands:

```
# modprobe sdhci-pci
# modprobe mmc-block
# mkdir /lib/firmware
# cd /media/mmcblk0p1/
# cp Flash-missingPDAT.cap /lib/firmware/Flash-missingPDAT.cap
# echo -n Flash-missingPDAT.cap >
  /sys/firmware/efi_capsule/capsule_path
# echo 1 > /sys/firmware/efi_capsule/capsule_update
# reboot
```

Note: Make sure you use the `reboot` command; removing/reinserting the power cable will **not** work.

Warning: It is critical to ensure that the older `sysfs` entries used by Release 0.7.5 and Release 0.8.0 are **not** used due to known issues:

```
/sys/firmware/efi/capsule_update
/sys/firmware/efi/capsule_path
```

The capsule update method for Release 0.9.0 and later uses the following corrected entries:

```
/sys/firmware/efi_capsule/capsule_update
/sys/firmware/efi_capsule/capsule_path
```



11 Programming flash on the board using DediProg

You can use a DediProg* SF100 SPI Flash Programmer and the associated flashing software to program your board.

Note: These steps require the `Flash+PlatformData.bin` file that was created in [Section 9](#).

Once the software has been installed and the programmer is connected to the board, **open a new terminal session**, and run the DediProg Engineering application.

Use the following steps to flash the board:

1. Select the memory type if prompted when the application starts.
2. Select the File icon and choose the `*.bin` file you wish to flash.
3. Optionally select the Erase button to erase the contents of the SPI flash.
4. Select `raw` file format.
5. Select the Prog icon to flash the image onto the board.
6. Optionally select the Verify icon to verify that the image flashed correctly.

Note: Intel recommends that you disconnect the programmer before booting the system.



12 Booting the board from SD card

To boot your board from an SD card and enable persistent `rootfs`, follow these steps. You can also use this procedure to boot your board from a USB stick.

If you are using an Intel® Galileo board, this setup allows you to save your Arduino* sketch to the board, so it will be able to repeat sketches after board power-down. This also enables a persistent `/sketch` folder and `rootfs`.

Dependencies:

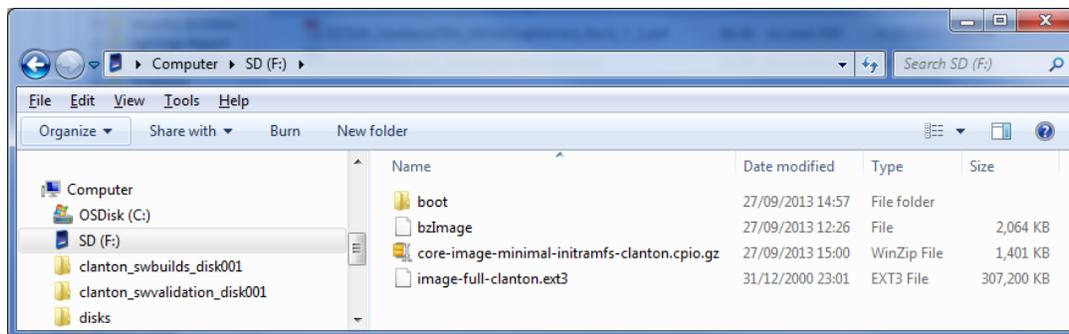
- You ran the command `bitbake image-full` in [Section 6](#) (or `bitbake image-full-galileo` if using an Intel® Galileo board)
- Your SD card must meet the following requirements:
 - SD card must be formatted as FAT or FAT32.
 - SD card size must be 32GB (or smaller) and SDHC format. SDXC format is **not** supported.

1. The output of the build process in [Section 6](#) is found in `./tmp/deploy/images/`

Copy the following kernel and root file system files to an SD card:

- `boot` (directory)
- `bzImage`
- `core-image-minimal-initramfs-clanton.cpio.gz`
- `image-full-clanton.ext3` **OR**
`image-full-galileo-clanton.ext3` for the Intel® Galileo board

Be sure to set up your SD card with the files and structure shown below.



2. Insert the SD card, then power on the board.

Note: The first time you boot the board may take several minutes. This is expected behavior due to the SSH component creating cryptographic keys on the first boot.



Troubleshooting tips:

To boot from SD/USB, the grub instance embedded in the SPI flash is hardcoded to search for a `boot/grub/grub.conf` file in partition 1 on the SD/USB card. This is compatible with the factory formatting of most SD/USB devices. By default, the UEFI firmware does not try to boot from SD or USB, it is handled by grub.

If you use an SD or USB device that has been reformatted after manufacturing, you might experience problems booting from it. First, try to boot with a different memory device and see if the problem goes away. If you isolate the problem to a specific SD card, you can restore the factory formatting using this tool from the SD association: https://www.sdcard.org/downloads/formatter_4/

It is not recommended to use normal operating system tools to format flash memory devices.



Part 2 Using the BSP Software

This section contains the following subsections:

[Capsule update](#)

[Capsule recovery](#)

[Signing files \(secure SKU only\)](#)

[Enabling the OpenOCD debugger](#)

13 Capsule update

The BSP software provides a mechanism to update SPI flash contents based on EDKII capsules. These capsules contain a BIOS, bootloader, and compressed Linux run-time system sufficient to boot a Quark-based board, such as the Intel® Galileo board. Capsule update is comprised of the following high-level steps:

- Building a `Flash-missingPDAT.cap` capsule file
- Connecting a USB key or SD card that contains this file to the board
- Running the capsule update mechanism as described in [Section 10.1](#) or [Section 10.2](#).

Note: If you have a secure SKU board (Industrial/Energy or Transportation Reference Design), you **must** update your board using the Linux* run-time system ([Section 10.2](#)).



14 Capsule recovery

The BSP software provides a mechanism for the SPI flash contents to be recovered if the board will not boot. For example, if power was lost during a normal SPI flash update, the board would be unbootable.

Capsule recovery is comprised of the following high-level steps:

- building a `FVMAIN.fv` recovery file
- connecting a USB key with this file to the board
- booting the board in recovery mode

Note: If you are using the Intel® Galileo board, refer to the *Intel® Galileo Board User Guide* for details. For other boards, contact your Intel representative for details on how to boot in recovery mode.

- waiting for the recovery firmware to update the SPI flash and reboot the board

Booting in recovery mode is board specific. Please refer to the board user guide for details.

Alternatively, the SPI flash contents can be recovered using a DediProg* SF100 SPI Flash Programmer and the associated flashing software to program your board as described in [Section 11](#).



15 Signing files (secure SKU only) [Linux build environment only]

This step is optional for most users; it is only needed for booting on a secure SKU.

Dependencies: `libssl-dev`

All files located by `grub` require signature files for verification. This includes kernel, `grub.conf`, `bzImage`, and `core-image-minimal-initramfs-clanton.cpio.gz`.

The SPI Flash Tools package includes the Asset Signing Toolset, an application used for signing assets for secure boot. Follow the steps below to compile the signing tool, then sign assets.

For complete details on the Asset Signing Toolset, including all of the command line options, refer to the *Intel® Quark™ SoC X1000 Secure Boot Programmer's Reference Manual* (see [Appendix A](#)).

Note: For convenience during development, the software release includes a default Private Key `key.pem` file. During development, all assets are signed with the default key that is stored in the `config` directory. The default key **cannot** be used in a production system; it is not secure due to its inclusion in the release package. Contact your Intel representative for details.

Open a new terminal session and use the following commands:

```
# cd spi-flash-tools
# make asset-signing-tool/sign
```

After compiling the signing tool, you can sign assets as shown in the following example:

```
# path/to/spi-flash-tools/asset-signing-tool/sign -i <input file>
-s <svn> -x <svn index> -k <key file>
```

The output for this example is a signed binary file called `<input file>.signed` in the same directory as the `<input file>`.

To create a separate signature file, pass the `-c` command line option which creates `<input file>.csbh` as output in the same directory as the `<input file>`.

To get a full list of command line options, run the signing tool with no option.

The signature files can be copied onto a USB stick or SD card and must comply with the following requirements:

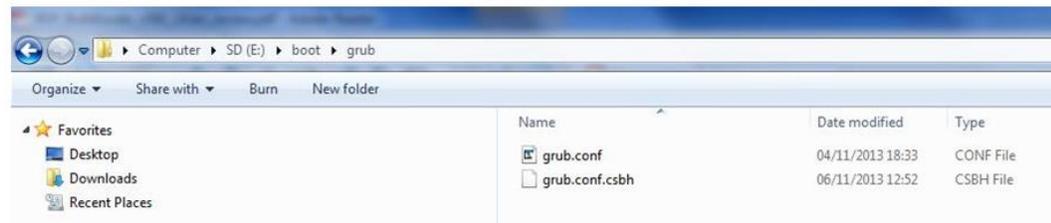
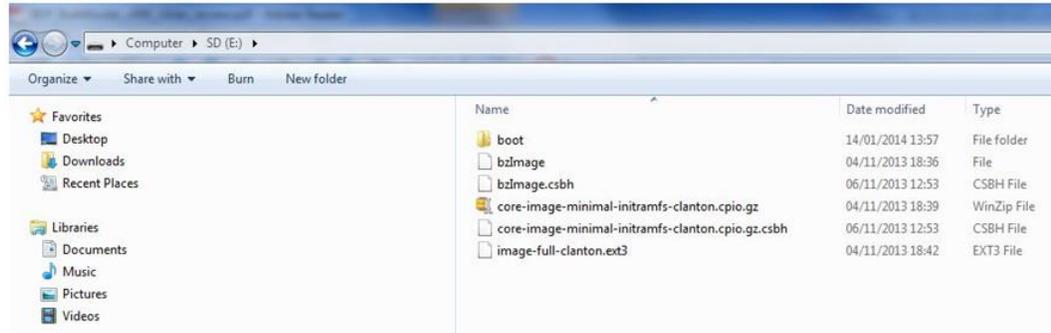
- Each `.csbh` file must be in the same directory as the corresponding non-signed file.
- `grub.conf` must be located in the `/boot/grub/` directory.
- Other files can be placed anywhere as long as `grub.conf` is configured with their location.



Signing files (secure SKU only) [Linux build environment only]

The screenshots below show an example SD card with signature files:

- Copy signature files `core-image-minimal-initramfs-clanton.cpio.gz.csbh` and `bzImage.csbh` to the root directory.
- Copy `grub.csbh` to the `/boot/grub/` directory.





16 Enabling the OpenOCD debugger

Complete instructions for using the OpenOCD debugger can be found in the *Source Level Debug using OpenOCD/GDB/Eclipse on Intel® Quark™ SoC X1000 Application Note*, see [Appendix A](#).



Appendix A Related documents

The documents below provide more information about the software in this release.

Document Name	Number
Intel® Quark™ SoC X1000 Board Support Package (BSP) Build and Software User Guide (this document)	329687
Intel® Quark™ SoC X1000 Software Release Notes	330232
Intel® Quark™ SoC X1000 Secure Boot Programmer's Reference Manual	330234
Intel® Quark™ SoC X1000 Linux* Programmer's Reference Manual	330235
Intel® Quark™ SoC X1000 UEFI Firmware Writer's Guide	330236
EDKII Update for Intel® Quark™ SoC X1000 Software Release Notes	330729
Source Level Debug using OpenOCD/GDB/Eclipse on Intel® Quark™ SoC X1000 Application Note https://communities.intel.com/docs/DOC-22203	330015
Intel® Quark™ SoC X1000 Datasheet https://communities.intel.com/docs/DOC-21828	329676
Intel® Quark™ SoC X1000 Core Developer's Manual https://communities.intel.com/docs/DOC-21826	329679
Intel® Quark™ SoC X1000 Core Hardware Reference Manual https://communities.intel.com/docs/DOC-21825	329678
Intel® Galileo Board User Guide https://communities.intel.com/docs/DOC-22475	330237



Revision History

Date	Revision	Description
16 June 2014	007	General updates to coincide with the EDKII Update 1.0.2 release including: Updated Section 4, Building the EDKII firmware (added Windows* build environment).
22 May 2014	006	General updates for software release 1.0.1 including: Updated Section 4, Building the EDKII firmware (added TPM). Added Section 6.1, Applying a custom patch to the Linux kernel using Yocto (optional) . Updated Section 9, Patching flash binary files using platform data file (corrected <code>platform-data.ini</code> filename). Updated Section 14, Capsule recovery (added DediProg information). Updated with trademarked term: Intel® Quark™ SoC.
04 March 2014	005	General updates for software release 1.0.0 including: Added Section 13, Capsule update . Added Section 14, Capsule recovery .
20 January 2014	004	General updates for software release 0.9.0 including: Added Section 4, Building the EDKII firmware . Added Section 10.2, Programming flash using Linux* run-time system . Updated Section 15, Signing files (secure SKU only) . Removed OpenOCD details because patch is now open source. Added Appendix A Related documents .
15 November 2013	003	Added <code>CapsuleApp.efi</code> to Section 3, Downloading software .
07 November 2013	002	General updates for software release 0.8.0 including: Added supported boards to list of hardware. Section 8 : Changed SPI Flash tools path from <code>clanton_peak_EDK2 to Quark_EDKII</code> Moved Signing files (secure SKU only) section to later in the document.
15 October 2013	001	First release with software version 0.7.5.



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