Enabling Wireless Firmware Update for SimpleLink™ Bluetooth® low energy Applications

1 OAD Overview

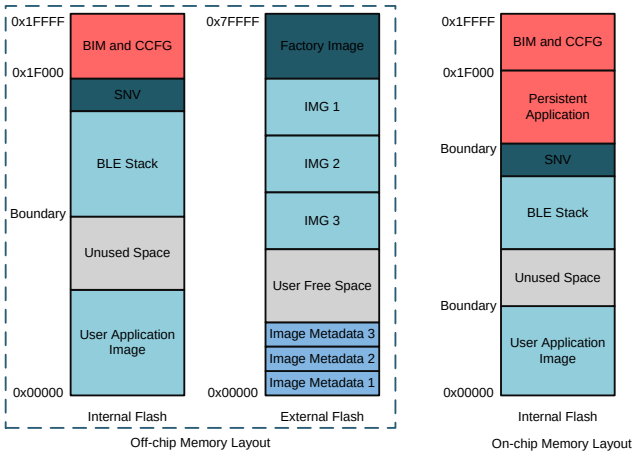
Bluetooth® low energy Over the Air Download (OAD) refers to the process of wirelessly updating the firmware on a device. This feature helps extend a product's lifecycle by providing a mechanism for feature improvements or bug fixes on devices already deployed in the field. The advantage that an OAD has over a wired firmware update is no physical connection is required to provide a new image – the update can be delivered via a mobile device. However, in poor RF conditions, the OAD process can be less reliable than a wired Device Firmware Update (DFU). The enhanced Texas Instruments OAD Profile seeks to eliminate the reliability problems that may affect an OAD. This profile can be found in the BLE-Stack component of the SimpleLink™ CC2640R2 SDK.

During an OAD, one device—the OAD Downloader—will send another device—the OAD Target—a new image to run. To begin, the OAD Downloader provides a summary of the new image to the OAD Target. If the image specifications are acceptable (size, version, and the identification are all valid), the OAD will begin. The image is broken up by the OAD Downloader and sent in blocks over the air. Each block contains the block number and the corresponding image payload for that block. Block size is determined by the Maximum Transmission Unit (MTU) agreed on by the devices. The OAD Target requests an image block by sending a Generic Attribute Profile (GATT) Notification to the OAD Downloader with a block number and the status of the previously received block. The OAD Downloader then sends the requested block to the OAD Target in an Attribute Protocol (ATT) Write Command. This process of requesting a block by number and reporting status ensures that all blocks will be received and reassembled correctly by the OAD Target. After the OAD process is complete, the Cyclic Redundancy Check (CRC) of the image is calculated and compared to the expected value to verify that the image is the same before and after transmission.

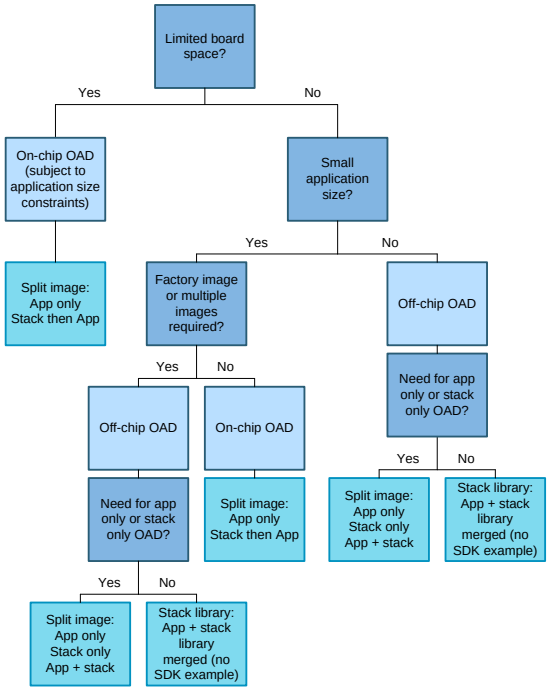
During the entire OAD process, from exchange of image details to copying the image into internal flash, error checking has been put in place to ensure that the new image is received correctly.

2 OAD Options and Selection

There are two main types of OAD: On-chip and Off-chip. As implied by the names, the biggest difference between the two types is where the image is stored before execution. In an On-chip OAD, the image is written to internal flash, over the existing user application. This requires a permanent image to remain on the device to complete the OAD process and to recover in the event of a failed OAD. The existence of this Persistent Application limits the amount of flash available to the user application in an On-chip OAD. This also means that the user application will be unavailable during the OAD process. If you require user app functionality during an OAD, you must use Off-Chip OAD. An Off-chip OAD requires an external flash part to store the image that is sent over the air. Because the new image gets stored in external flash and is verified before being copied into internal flash, there is no need for a Persistent Application therefore more flash is available for the user application.



The major decisions determining which OAD is right for your design are summarized in the tree below. The most limiting factors are board space and application size.



3 Board Space or Cost Concerns

If Bill of Materials (BOM) cost or board space is the most important design consideration, On-chip OAD is the best option because it does not require an external flash part. However, because the Persistent Application is permanently resident in the internal flash, larger user applications require Off-chip OAD.

4 Flash Constraints

The TI BLE-Stack-On-Chip OAD example application is ideal for small BLE applications. If the out of box example does not provide enough space, refer to the OAD User Guide for information on flash optimizations. If the user application does not fit within the space available in On-chip OAD, you must use Off-chip OAD with an external flash part. If more flash is required than what is available in the Off-chip OAD out of box example, you may need to convert from a split image project to a stack library project. For more information on split image versus stack library, see the BLE-Stack User Guide.

7.1 Trademarks

SimpleLink is a trademark of Texas Instruments. Bluetooth is a registered trademark of Bluetooth SIG.

5 Factory or Multiple Image Support

Even if the user application is within the bounds for an On-chip OAD, an Off-chip OAD may still be more desirable if multiple image support is required. Multiple image support may be required for users who wish to preserve a usable image as a backup, in case issues are discovered with the image in internal flash.

6 Selecting an Image Type for OAD

On-Chip and Off-Chip OAD support different image types. On-chip OAD has the option to update the user application and keep the existing stack image (App Only) or to update the stack image in a two-step process (Stack then App). On-chip OAD requires the two-step process for a Stack upgrade because it uses the user application space to store the new stack image. After validation, it is copied into the space allocated for the stack image and the user application must be sent over the air to run with the new stack. Images that combine the application image and the stack image (App + Stack Merged or App + Stack Library Merged) are not available with On-chip OAD due to flash limitations.

Off-chip OAD can accept all types of OAD, including Stack Only without a follow up App Only OAD. This is because images in the internal flash do not get copied over until the OAD process is complete. The only limitation to the number and types of images stored is the size of the external flash part. Sending an App + Stack Merged or an App + Stack Library Merged image will take more time than a App Only or Stack Only OAD so it may be preferable to send only what is necessary to update. If an App+Stack Library Merged image currently exists on the device. It can only be followed by an OAD of another App + Stack Library Merged image or an App + Stack Merged Image.

7 Related Documentation

The OAD User's Guide contains more detailed information about the OAD process including the details of the TI OAD Profile itself.

For design guidance to add an external flash part to your board, refer to the *SimpleLink LAUNCHXL-CC2640R2 Design Files*.

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