TB3176

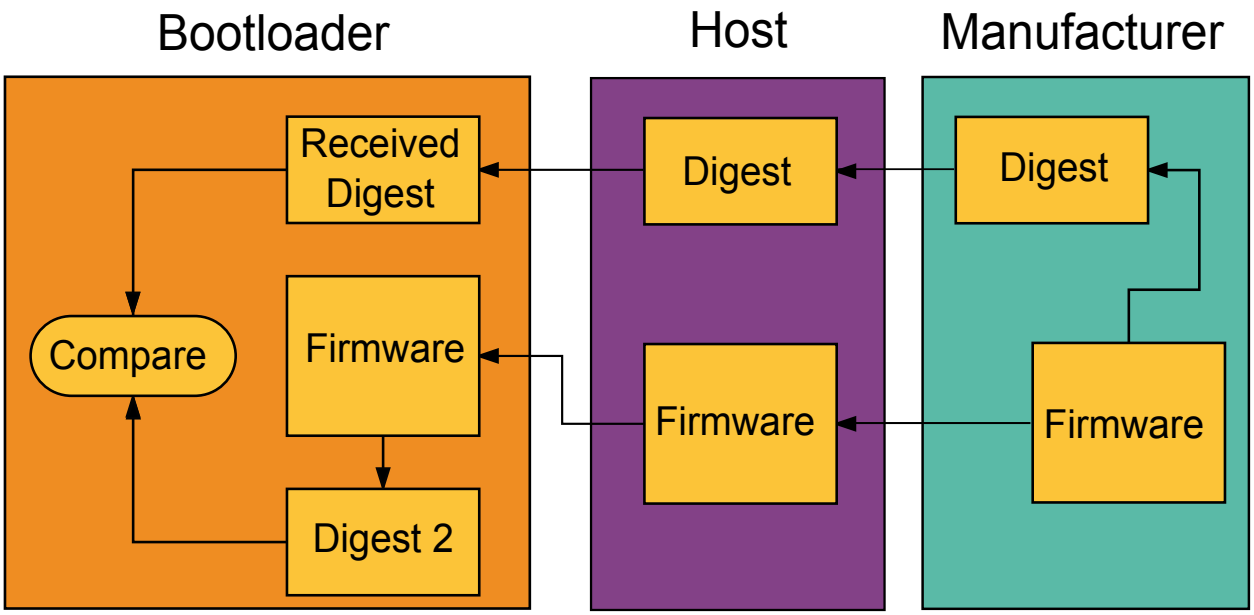
What is ICM? How to Use the ICM For Cryptography

Introduction

The Integrity Check Monitor (ICM) is a DMA controller that performs hash calculation on multiple memory regions using the transfer descriptors located in the memory (ICM Descriptor Area) of Cortex™ M7 MCUs. The ICM integrates a Secure Hash Algorithm Engine (SHA) for hashing. The SHA based hashing is suitable for password validation, challenge hash authentication, anti-tamper, and digital signatures.

Secured Image Verification: The hash function produces a message digest for a piece of data. Conversely, this means to an error detection code, every piece of data must have its own unique digest. To verify the integrity of a firmware, the digest is calculated and verified after the programming is complete. This is used in the secured bootloader, which after receiving the firmware and its fingerprint, recomputes the digest, and compares it to the original digest. If both are identical, the firmware has not been altered and is suitable for programming.

Figure 1. Secure Image Verification



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1. Concept

A cryptographic hash function is a special class of hash function that has certain properties, which makes it suitable for use in cryptography. A cryptographic hash function is a mathematical algorithm that maps data of an arbitrary size to a bit string of a fixed size (a hash function). The cryptographic hash is designed to be a one-way function, that is, a function that is impossible to invert and retrieve the original message.

If *f(x)* represents the data set to be hashed, and *Y* is the *SHA* hashed finger print, then:

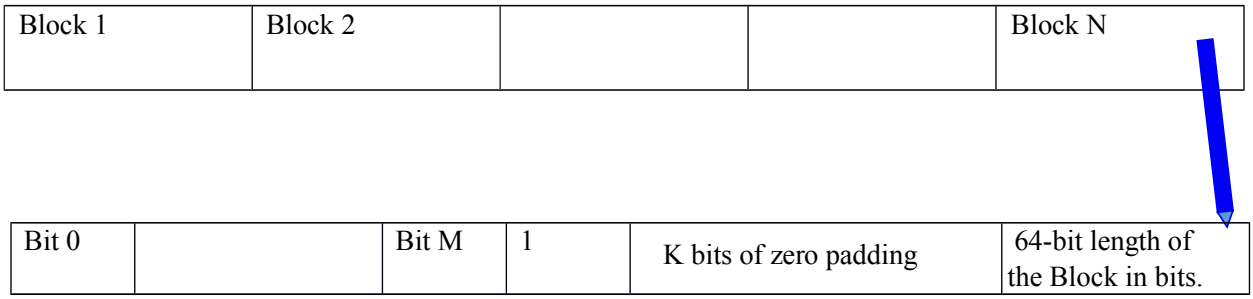
$Y = sha\_hash(f(x))$

$f(x) \neq any\_function(Y)$

2. Solution/Implementation

The ICM requires a message to be updated in the FIPS 180-2 standard. As per the FIPS 180-2 standard, for SHA-256, the message to be hashed needs to be of a maximum size 264 – 1 bits. The SHA-256 crypto engine requires the message to be divided into multiple blocks, where each block is 512 bits in size.

Figure 2-1. FIPS180-2 Message Format



Each Block has a 512 bit width, the last block format is shown above, where K= 448-X-1.

For a message less than 512 bits, one block is sufficient.

For the message: “abc” => {0x61, 0x62 and 0x63}.

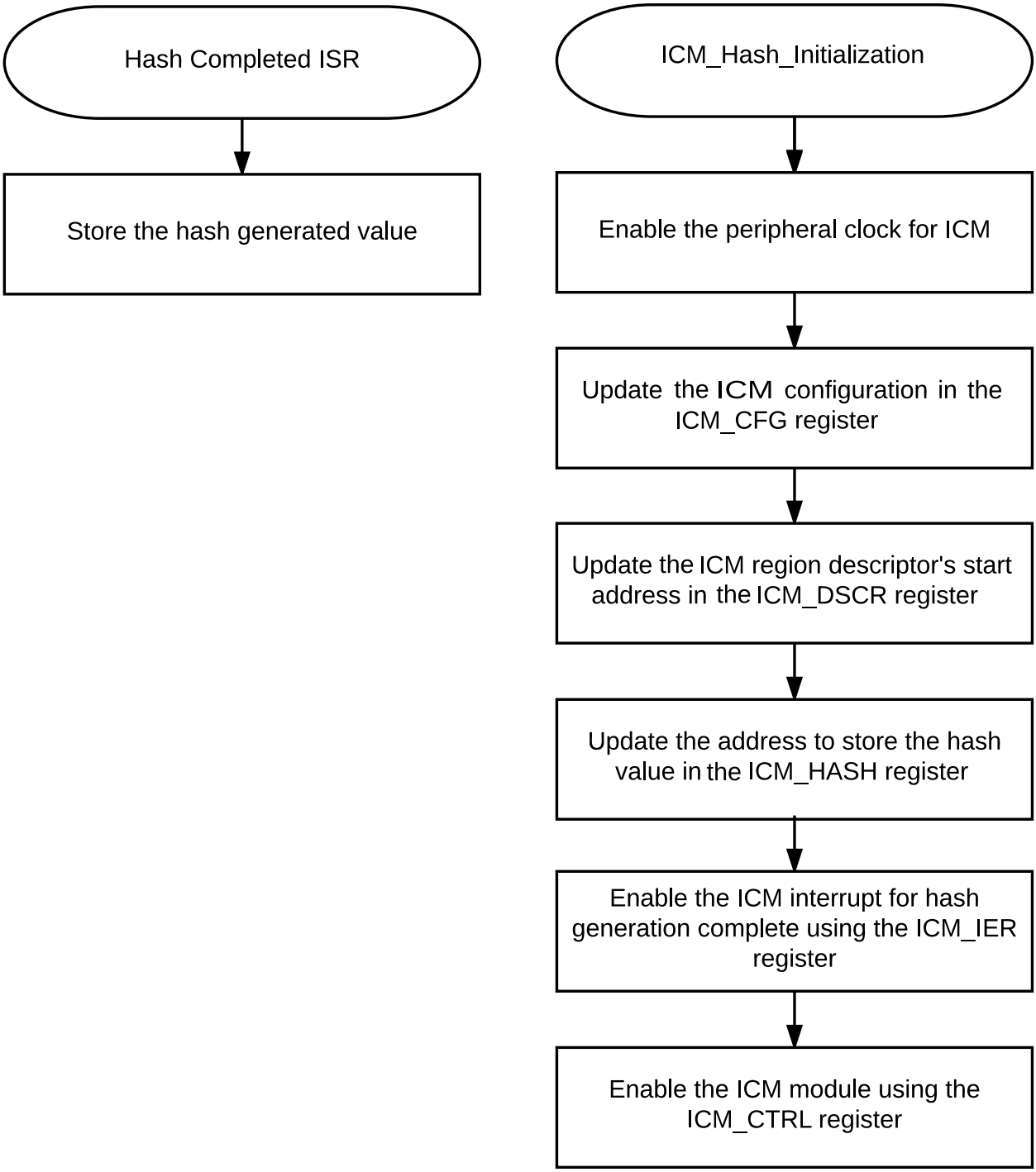
Bit 0 – Bit 23 filled with the previous message, Bit 24 = 1 (as per FIPS 180-2) Bit 25-447 = 0 (K zero bits).

Bit 448-Bit 511 = 0x0000000000000018 (64-bit length of message).

Configuration of ICM in Cortex-M7 MCUs:

To generate the SHA-256 hash value in ICM, follow the configuration sequence shown in the following figure.

Figure 2-2. ICM Configuration Sequence



Tip: For ICM Configuration:

1. The hash value address needs to be stored in the ICM_HASH register. The address must be a multiple of 128 bytes.
2. The region descriptor content needs to be filled based on FIPS180-2 as explained previously, and the start address needs to be assigned to the ICM_DSCR register.

Tip: For ICM Hashing: When using ICM in the digital signature, the hash value needs to be generated first, then verified by the MCU using ICM's hashing feature. To generate the SHA-256 hash value for a given string in Linux, use the below command.

- `echo -n <String> | sha256sum` should give you the SHA-256 hash value of the string.
- For the message example used above ("abc"), the command is: `echo -n abc | sha256sum`

Tip: Output Hash Value:
`ba7816bf8f01cfea414140de5dae2223b00361a396177a9cb410ff61f20015ad`

This value should match with the hash value generated using the ICM.

3. Relevant Resources

- AT12869: ICM Usage on SAM S/E/V70/71 Microcontrollers http://www.atmel.com/Images/Atmel-42703-ICM-Usage-on-SAM-S7-E7-V7-Microcontrollers_ApplicationNote_AT12869.pdf
- http://www.atmel.com/Images/Atmel-42782-SAM-V70-E70-Ethernet-Bootloader_ApplicationNote_AT17629.pdf
- http://asf.atmel.com/docs/latest/same70/html/sam_drivers_icm_quick_start.html
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- http://csrc.nist.gov/publications/fips/fips180-2/fips180-2withchangenotice.pdf

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