[White Paper]

Firmware vs Software
- What is the Testing Difference ? -

2024. 7
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Soft4Soft
RESORT Code Analysis

DNV
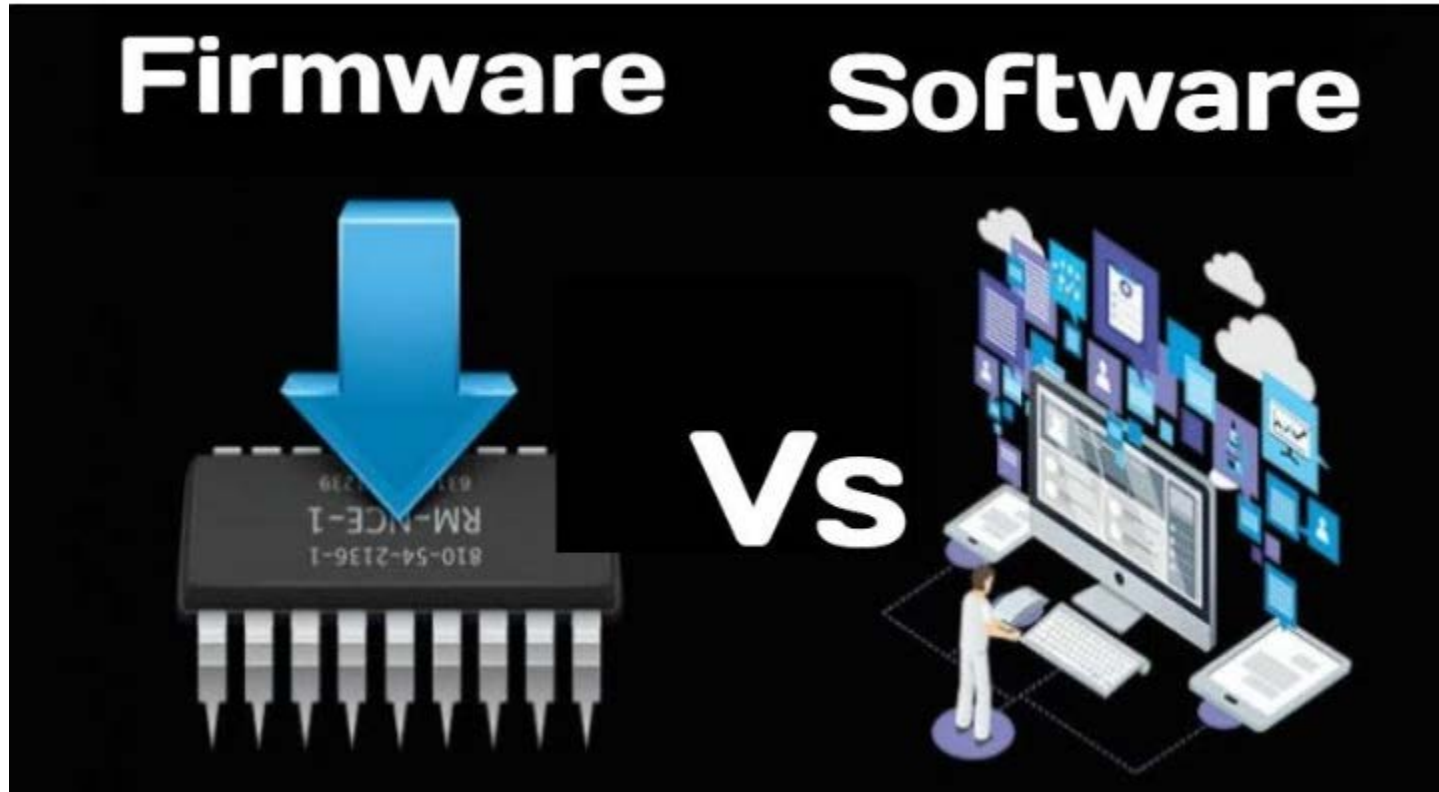DNV GL BUSINESS ASSURANCE

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1. Firmware vs Software

Firmware and software are both types of computer programs, but they serve different purposes and are stored and executed in different ways.

1. Understanding Software vs. Firmware

◆ **What is Software?**

➢ **Software is a program that enables a computer to perform a specific task**

✓ **Software runs on top of the operating system and has no direct interface with hardware**

✓ **Storage: Software is typically stored on hard drives, SSDs, or other types of non-volatile storage**

➢ **Time: More time to create software than firmware**

◆ **What is Firmware (= FIRM softWARE) ?**

➢ **Firmware is specialized software embedded into hardware devices**

✓ **Firmware is low-level software that stands between the hardware and the operating system.**

✓ **Types of Firmware: Firmware can be found in various electronics, including televisions, washing machines, microwaves, and cameras**

✓ **Storage: Firmware is stored in non-volatile and stable memory devices such as ROM, flash memory, or EPROM**

➢ **Cost: More cost to create firmware than software**

2. Difference between Software vs. Firmware Testing

◆ **Software Testing**

- ➢ **Software testing is a process of validating and verifying software products and applications**
  - ✓ **Runs on: Software**
  - ✓ **Interaction: User**
- ➢ **Software Test: Testing software on a specific platform**
  - ✓ **Testing System: Windows, Linux**
  - ✓ **Tested System: Windows, Linux, Web, Mobile apps, GUI Application, etc.**

◆ **Firmware Testing**

- ➢ **Firmware testing is the process of testing software that provides control of the hardware**
  - ✓ **Runs on: Software + Hardware**
  - ✓ **Interaction: Communication protocol between devices**
- ➢ **Firmware Test: Testing software embedded into hardware devices**
  - ✓ **Testing System: Windows**
  - ✓ **Tested System: ROM, Flash Memory, etc.**

RESORT Firmware Test

3. RESORT Firmware Test

◆ **(Target) Firmware Test (SW+HW+UART)**
  ➤ **Firmware Test using Communication Protocol on Target Board**
    ✓ **Analysis of Statement, Branch, MC/DC Coverage based on CPU operation**
  ➤ **Integration with IAR Embedded Workbench: Uninterrupted Workflow**

Firmware Test Methods	Commercial SW(Black-box) Test	RESORT Firmware Test	Manufacturer: System Test	Remarks
Test Environment	Tool or Host	Target	Target	Tool dependency: (Target)no vs. (Host)compile compatibility
(IDE)IAR Workflow	Interrupted	Uninterrupted	N/A	Interrupted Workflow: Test Time & Effort
Runs on	SW(code)+HW(virtual test environment)	SW(exe)+HW(MCU board)+UART	Electronic Devices/Products	Interaction verification between SW & HW HW: MCU, ECU, Sensor etc. Semiconductor
	Test Simulation	N/A	N/A	Hard to Simulate in Real-world
Test Design	Manual Test Case Design	UART Protocol based Test UI Design	Device/System Requirements	Test Case Design: Time & Effort Protocol-based Test Time: 10~100x Faster
	Firmware Specification Analysis	UART protocol Scenario Design	Device/System Requirements Scenario	Protocol-based UI Test: RS-232, 422, 485 UART protocol Scenario: Inter-device Link
Test Results	Test Coverage	Test Coverage	Response Time	Statement, Branch, MC/DC Coverage
Safety Verification	Non-verification	SW & HW Safety	HW Safety	Firmware Requirements: Functional safety
Responsibility Verification	Non-verification	SW Responsibility	HW Responsibility	Real-time Processing Requirements: Response Time for Device or System

The program is not completed even when all source code is written up with no compiling errors.
You have to confirm that the actual hardware being used is working correctly with the program generated.

3. RESORT Firmware Test

◆ **Comparison of Firmware Test**

> **Importance of Firmware Software Testing?**
>
> ✓ The application of ECU/MCU firmware is expanding to the role of weight reduction and automation in electronic products
>
> ✓ Therefore, ECU/MCU firmware needs to be tested for the functional safety of software and hardware on the HW device environment
>
> **Comparison of Main Features of Firmware Test**
>
> ✓ RESORT Firmware Test (RFT: white-box test, Target: SW + HW + UART) vs.
>
> ✓ Traditional Software Test(TST: black-box test, Host: SW + Test Simulation)
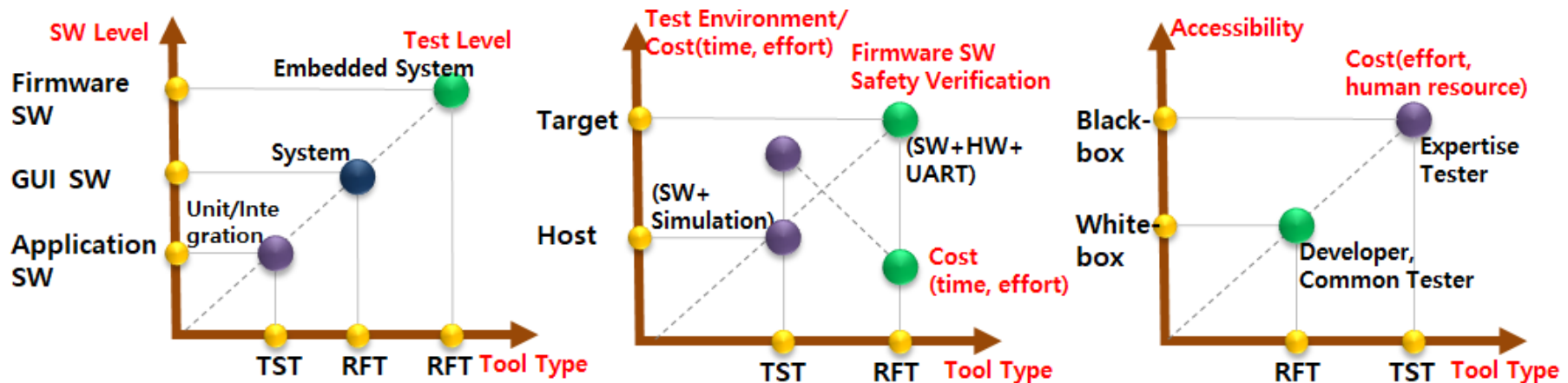
If you cannot MEASURE it, you cannot IMPROVE it

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