Challenges, Solutions and Benefits of Integrating Wireless Drivers in UEFI Firmware

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Hemanth Venkatesh Murthy

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Meet the Presenter

Hemanth Venkatesh Murthy
Software Senior Principal Engineer
Dell Technologies

25+ years of experience working on embedded software stacks. Member of Dell Technologies Client BIOS & Firmware Architecture team with focus on Connectivity use cases.
Agenda

• Introduction
• Need for Wireless in BIOS
• BIOS FW Challenges
• Solutions
Introduction

• UEFI Firmware
  – Part of BIOS
  – Initialization of the system

• BIOS
  – Dedicated Flash device
  – Independent of Storage drive
  – Capable of initializing the system even if storage drive is not present

• Talk focusses on utilizing BIOS capabilities for improving serviceability
Bare Metal Operating System (OS) Recovery

- OS Recovery Scenarios
  - Corrupted OS
  - Malware infection
  - Storage Drive Replaced
  - Motherboard Replaced
  - Remote IT Admin
- Above scenarios BIOS is unaffected
- BIOS can be used to recover OS by downloading from Internet
- Wi-Fi is the preferred connectivity option
Bare Metal Firmware Update

- Firmware Update Scenarios
  - Motherboard replaced in field
  - Manufacturing process in factory
  - OS agnostic firmware update for users
Storage Space Challenges

- **Platforms support**
  - 32 MB or 64MB Flash Chip

- **Wireless Components**
  - SNP DXE Driver
  - Supplicant DXE Driver
  - Firmware
  - Rest of Network stack part of EDK II

- **Features & Typical size**
  - WPA3 and Wi-Fi 6/6E
  - Personal & Enterprise Network Support
  - ~1.5 – 2.5 MB uncompressed
  - Business Logic for OS Recovery and Firmware-Over-The-Air (FOTA)
Platform Variant Challenges

• Typically, platform variants share same BIOS
• There could be multiple variants of a particular platform that support different vendor chipsets
• In such scenarios multiple Wi-Fi Drivers need to be integrated into BIOS
Boot Time Impact Challenges

- Expectation is to have minimum BIOS Boot time
- Only components required for normal boot to be loaded and initialized
- Wi-Fi Controller initialization not required in UEFI during normal boot process
Security Challenges

- BIOS is root of trust for the system
- If BIOS is compromised, whole system could be compromised
- Wi-Fi connectivity should not become target for backdoor attacks
Separate Wireless Region

- BIOS flash map layout shown
- FV_MAIN
  - DXE Drivers
  - Dispatched during normal boot
- Wireless FV
  - Wireless Drivers
  - Not Dispatched during normal boot
  - Only Dispatched during Recovery or FW update
  - Optimizes boot time

[Diagram of FLASH DEVICE with areas labeled Primary IBB, Secondary IBB, OBB, FV_MAIN, Wireless FV]
Cloud BIOS

- **Split BIOS**
  - Flash Components
  - Cloud Components

- **UEFI Applications for OS Recovery & FOTA**
  - Not required during normal Boot
  - Hosted on Cloud
  - Downloaded and executed during OS Recovery & FW update

- **Network Connectivity Drivers**
  - Integrated in Flash Device

- **Storage Space & Boot time Optimization**

- **Easy and quick upgrade for UEFI Application**
  - Does not require BIOS update on the system

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Cloud BIOS Security

- Flash Device Tamper Protection
  - Intel BIOS Guard
  - RPMC
  - Secure Boot Trust Chaining
- Cloud Components Tamper Protection
  - HTTPS Host name verification
  - Catalog Signature verification
  - Secure Boot Verification
Wireless Drivers in ESP

- Wireless Drivers hosted in Encapsulating Security Payload (ESP)
  - Security verification
  - Loaded and dispatched on demand

- Pros Vs Cons
  - Lower SPI Flash size
  - All required drivers are compiled into the image on ESP
  - Wireless feature not available when Storage Drive replaced
  - Wireless feature not available when Storage Drive is fully formatted & re-imaged

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FLASH DEVICE

Primary IBB

Secondary IBB

OBB

FV_MAIN

STORAGE DRIVE ESP PARTITION

Wireless FV
(Multiple Wireless Drivers)
Wireless Drivers in Flash

- Wireless Drivers embedded in Flash Device
  - Multiple Drivers embedded as required for the platform BIOS

- Pros Vs Cons
  - All required drivers are compiled into the BIOS image and flashed
  - Wireless feature are available when Storage Drive replaced or re-imaged
  - Larger Flash Drive requirement since multiple drivers need to be embedded
  - For any new feature to be added like UEFI BLE Support, the storage size requirement gets compounded
Applying Lazy Algorithm

- **Premium Variant**
  - Vendor 1 Wi-Fi Chip
  - Compile all Drivers into BIOS ROM
  - Common BIOS Release

- **Budget Variant**
  - Vendor 2 Wi-Fi Chip
  - Common BIOS ROM without Wireless Driver
  - Determine during Flash time right driver required

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Applying Lazy Algorithm

FLASH DEVICE

Primary IBB
Secondary IBB
OBB (FV_MAIN)
Wireless FV (Single Wireless Driver)

BIOS FLASHING

Wireless FMP Driver
(Loaded from BIOS IMAGE or FV_MAIN)

Choose the right payload based on PCIe enumeration data

BIOS IMAGE
(Multiple Wireless Payloads)

Flash only the required driver

• Delaying the decision to Flashing time from compile time
  – Wireless FMP Driver can determine the Wi-Fi chipset installed using PCIe enumeration data
  – Wireless FMP Driver Flashes only the required driver
  – Can include Both Wi-Fi & BLE UEFI Drivers
  – Satisfies Bare Metal recovery requirements

• Factory Process Updated
  – Manufacturing Process updated to Flash Wireless Drivers during production
  – All systems coming out of factory will have the right wireless driver in FV Region
Challenges & Solutions: Summary

1. Cloud BIOS
2. Lazy Algorithm
3. Separate Wireless Region
   - Lazy Algorithm
4. Flash Tamper Protection
5. Cloud BIOS
   - Separate Wireless Region

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Questions?
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