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

UEFI 2024 Webinar Series

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Meet the Presenter

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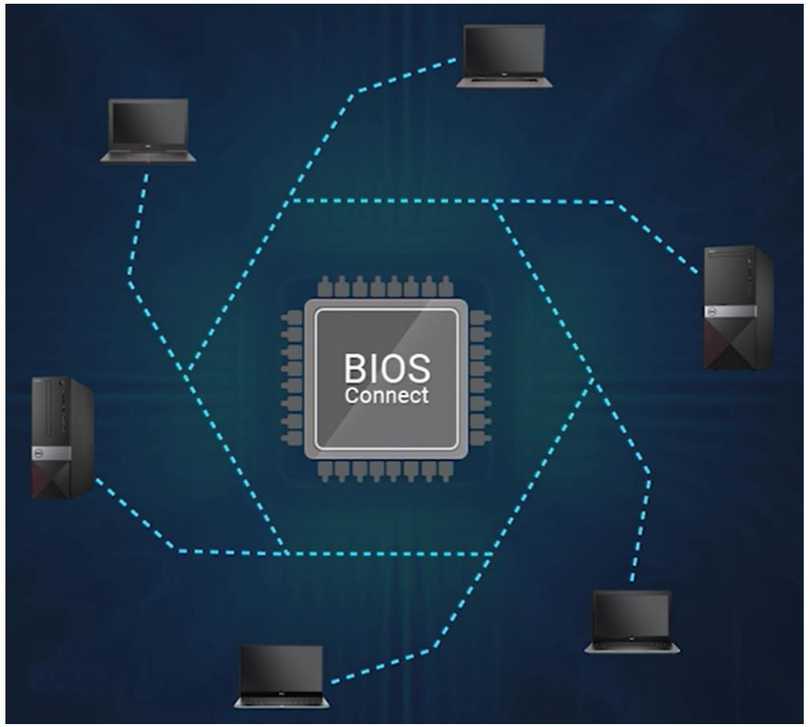
25+ years of experience working on embedded software stacks. Member of Dell Technologies Client BIOS & Firmware Architecture team with focus on Connectivity use cases.

Agenda

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

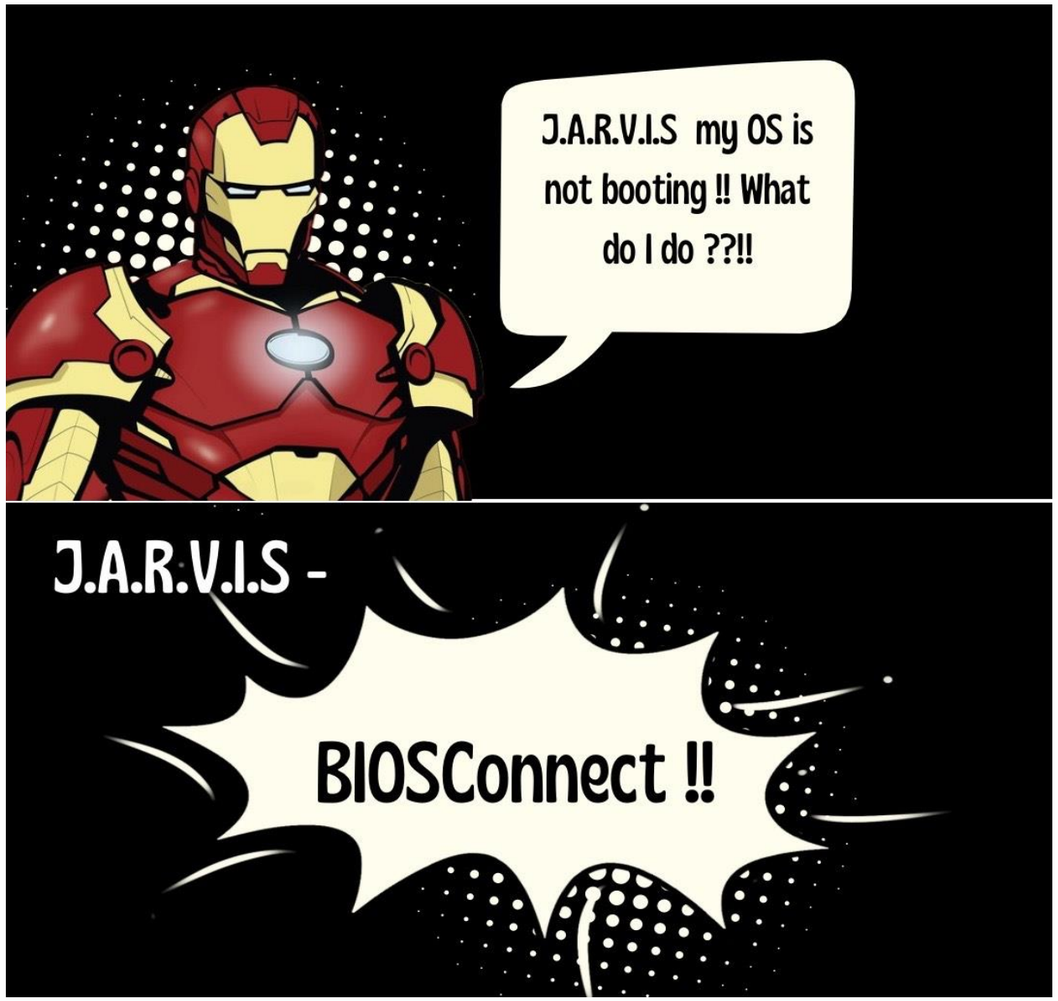
Introduction

- 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

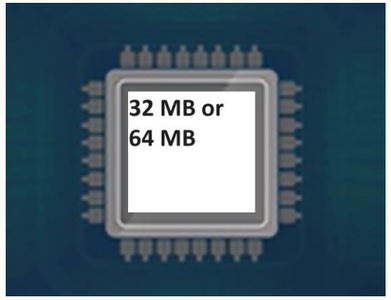


Bare Metal Firmware Update

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

Storage Space Challenges

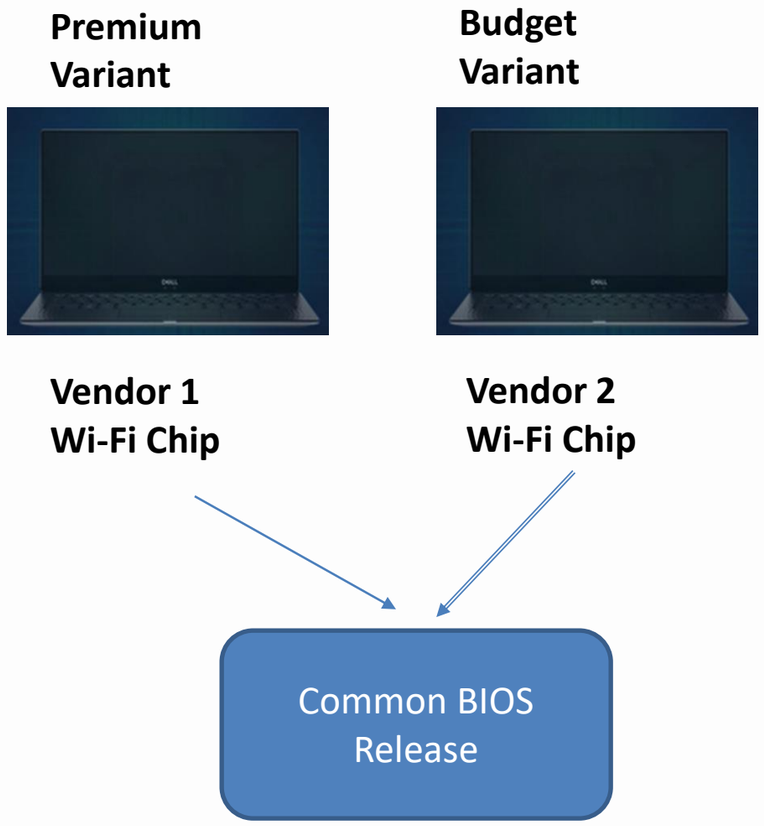
- Platforms support
  - 32 MB or 64MB Flash Chip
- Wireless Components
  - SNP DXE Driver
  - Supplicant DXE Driver
  - Firmware
  - Rest of Network stack part of EDK II
- Features & Typical size
  - WPA3 and Wi-Fi 6/6E
  - Personal & Enterprise Network Support
  - ~1.5 – 2.5 MB uncompressed
  - Business Logic for OS Recovery and Firmware-Over-The-Air (FOTA)



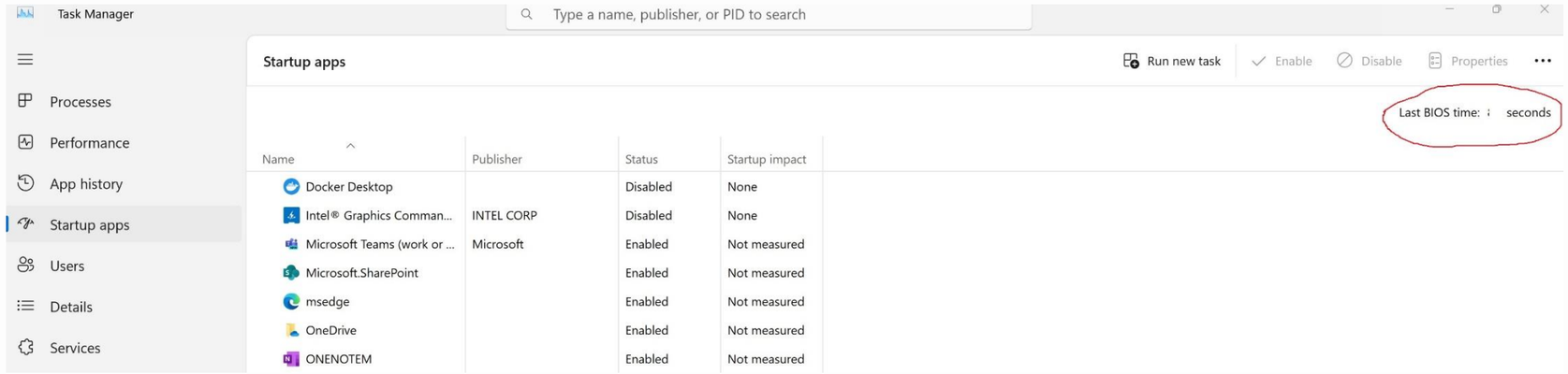

```
09-01-2024  01:07 PM          459,864 IntelFmacDxe.efi
09-01-2024  01:07 PM          549,148 IntelFW.bin
09-01-2024  01:07 PM          117,848 IntelSupplicantDxe.efi
09-01-2024  01:07 PM        1,329,810 QcaFW.bin
09-01-2024  01:07 PM          280,952 QcaWifiDxe.efi
09-01-2024  01:07 PM        1,051,736 QcaWlanSupplicantDxe.efi
```

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

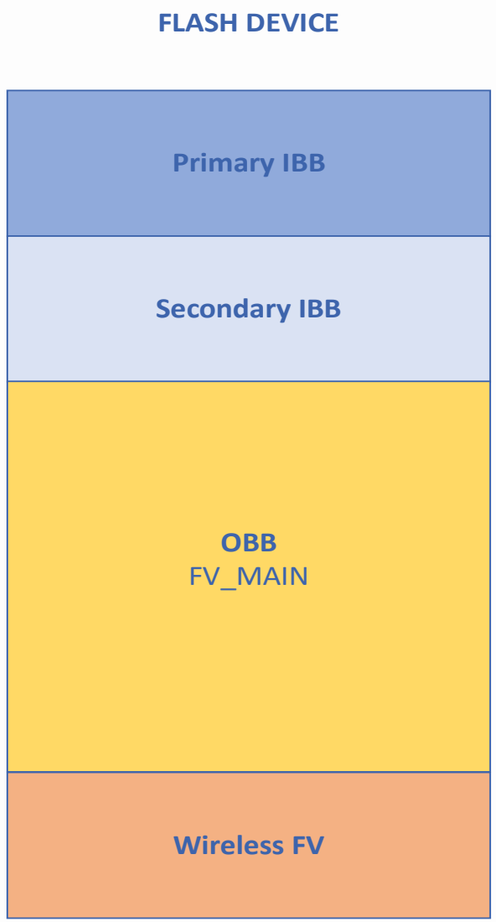


- Expectation is to have minimum BIOS Boot time
- Only components required for normal boot to be loaded and initialized
- Wi-Fi Controller initialization not required in UEFI during normal boot process

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

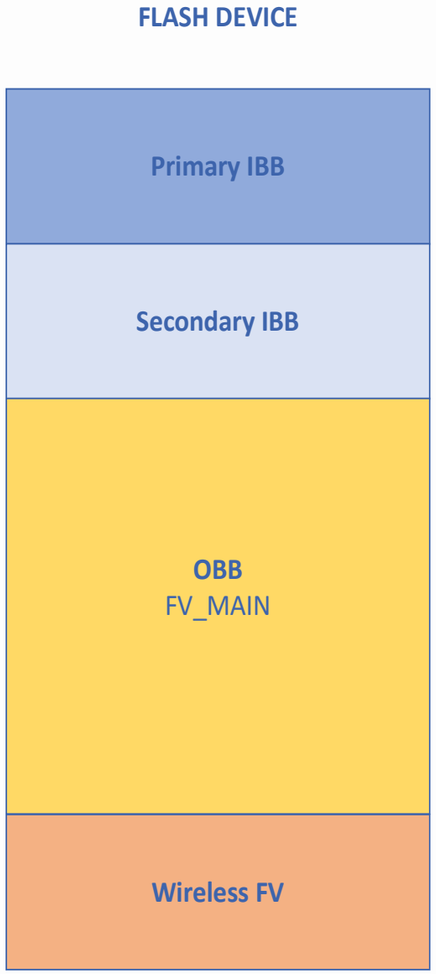
Separate Wireless Region

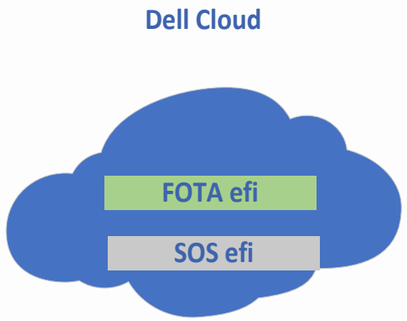


- BIOS flash map layout shown
- FV_MAIN
  - DXE Drivers
  - Dispatched during normal boot
- Wireless FV
  - Wireless Drivers
  - Not Dispatched during normal boot
  - Only Dispatched during Recovery or FW update
  - Optimizes boot time

Cloud BIOS

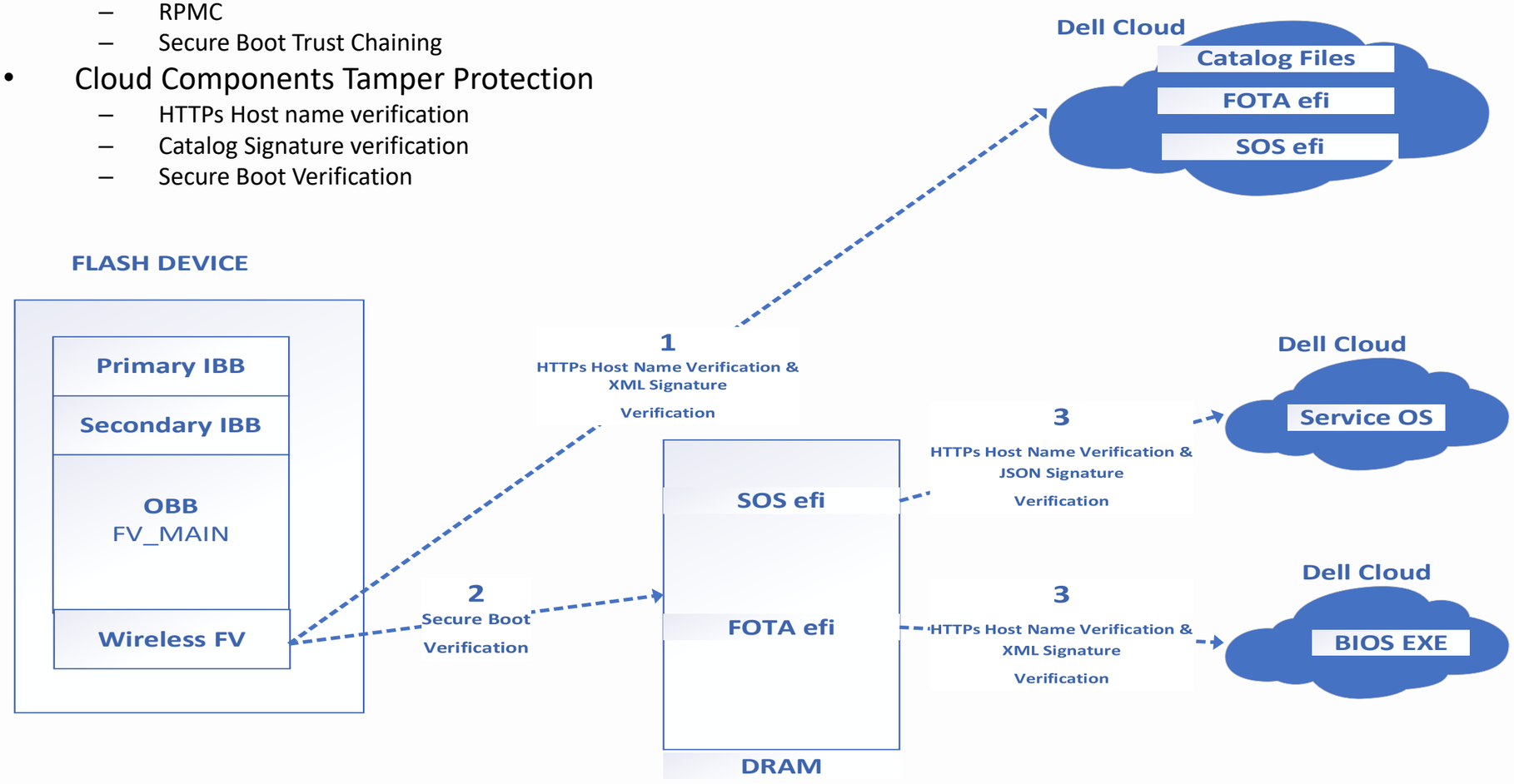
- Split BIOS
  - Flash Components
  - Cloud Components
- UEFI Applications for OS Recovery & FOTA
  - Not required during normal Boot
  - Hosted on Cloud
  - Downloaded and executed during OS Recovery & FW update
- Network Connectivity Drivers
  - Integrated in Flash Device
- Storage Space & Boot time Optimization
- Easy and quick upgrade for UEFI Application
  - Does not require BIOS update on the system





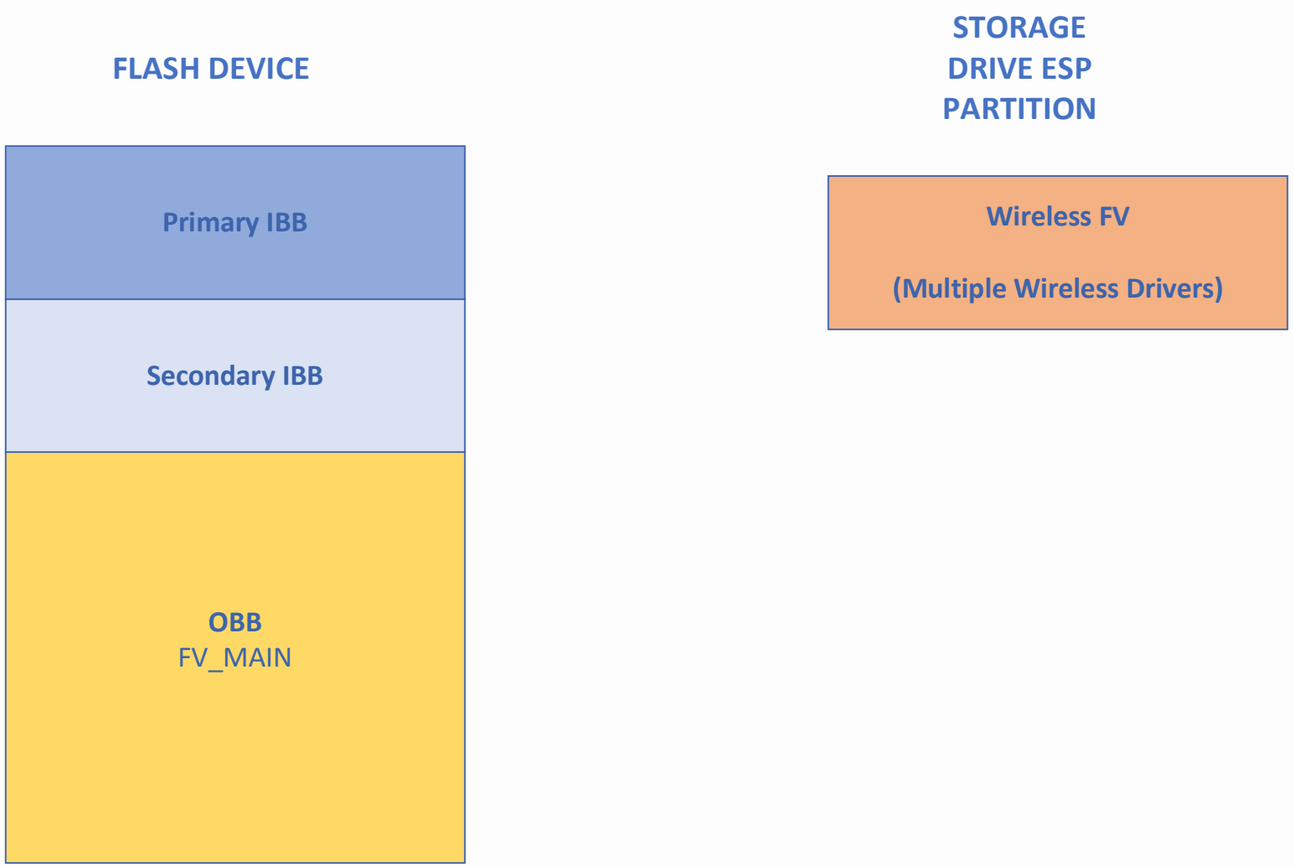
Cloud BIOS Security

- 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

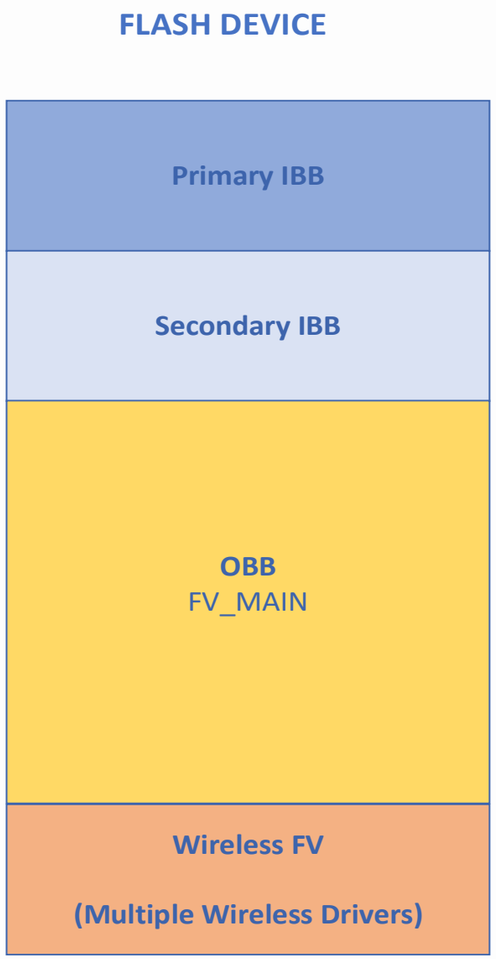
- Wireless Drivers hosted in Encapsulating Security Payload (ESP)
  - Security verification
  - Loaded and dispatched on demand
- Pros Vs Cons
  - Lower SPI Flash size
  - All required drivers are compiled into the image on ESP
  - Wireless feature not available when Storage Drive replaced
  - Wireless feature not available when Storage Drive is fully formatted & re-imaged



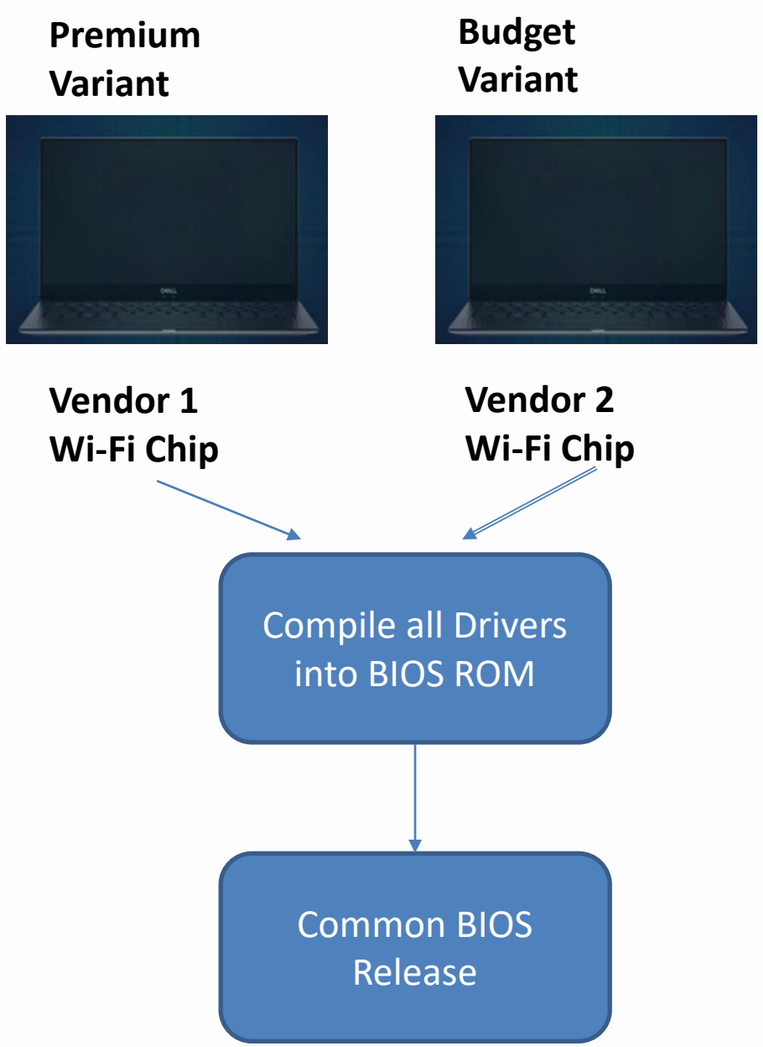
Wireless Drivers in Flash

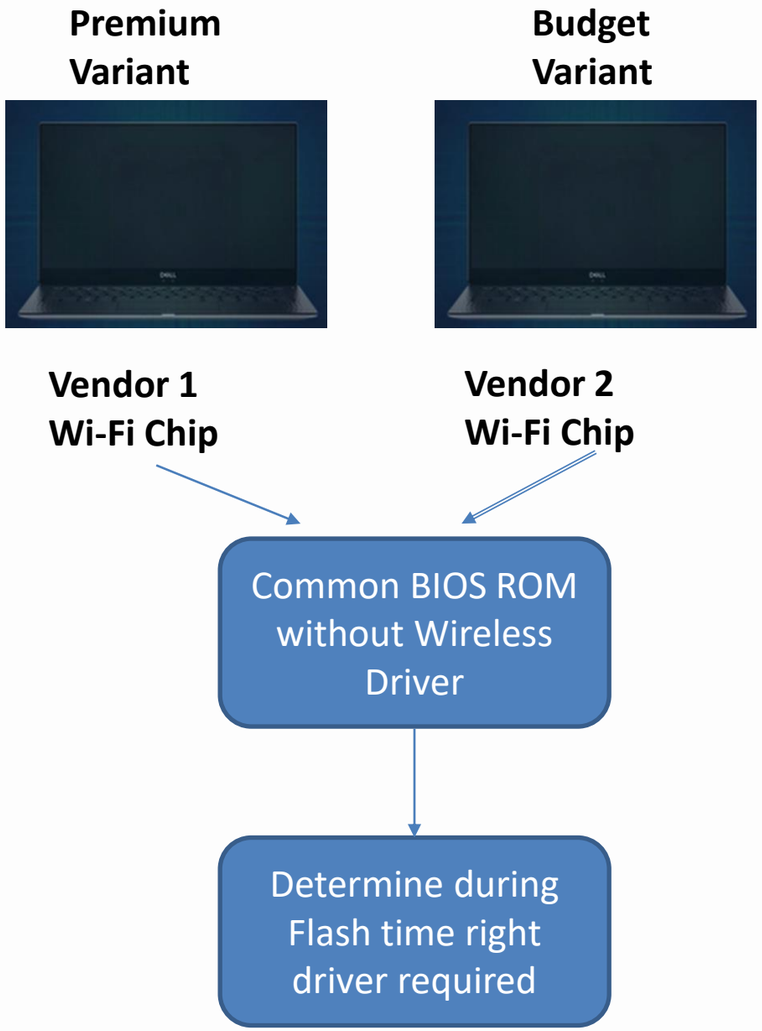
- Wireless Drivers embedded in Flash Device
  - Multiple Drivers embedded as required for the platform BIOS

- 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





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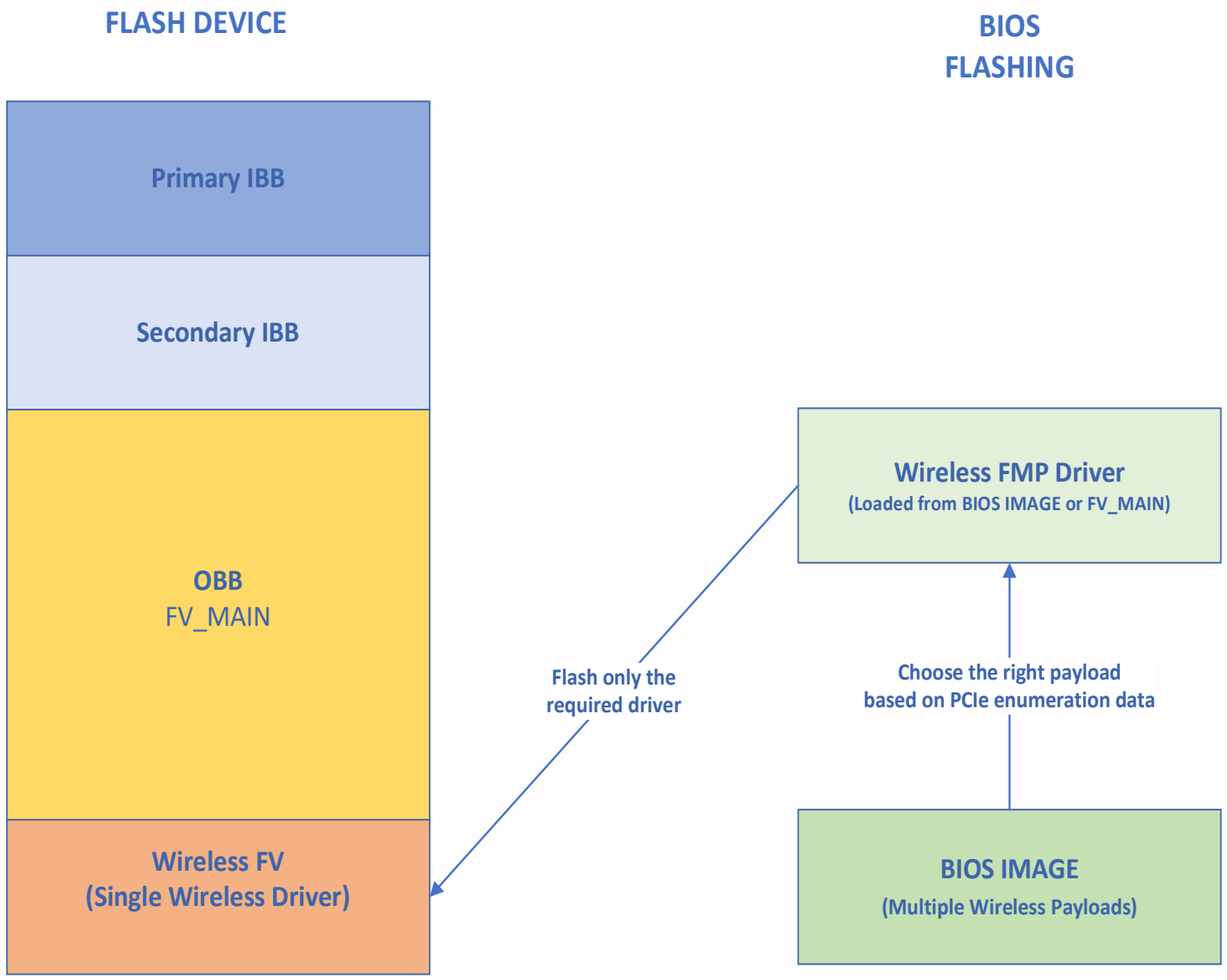
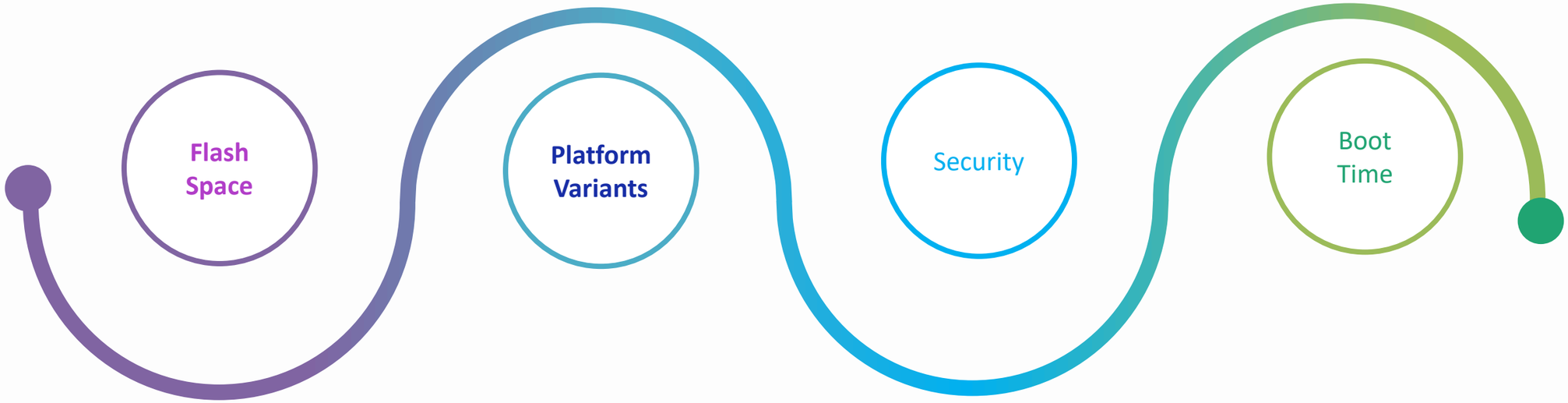


- Delaying the decision to Flashing time from compile time
  - Wireless FMP Driver can determine the Wi-Fi chipset installed using PCIe enumeration data
  - Wireless FMP Driver Flashes only the required driver
  - Can include Both Wi-Fi & BLE UEFI Drivers
  - Satisfies Bare Metal recovery requirements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



Flash Space

- Cloud BIOS
- Lazy Algorithm

Platform Variants

- Separate Wireless Region
- Lazy Algorithm

Security

- Flash Tamper Protection
- Cloud Tamper Protection

Boot Time

- Cloud BIOS
- Separate Wireless Region

Questions?

Thanks for attending a UEFI Forum 2024 Webinar

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