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

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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

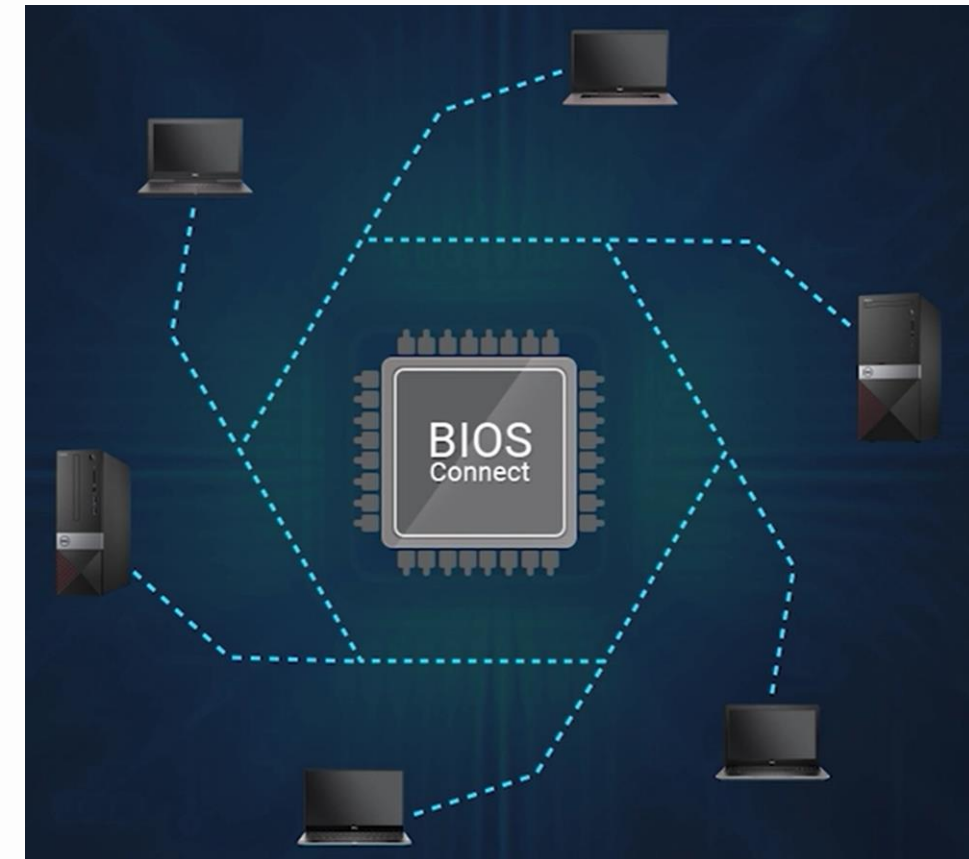


- Introduction
- Need for Wireless in BIOS
- BIOS FW Challenges
- Solutions

Introduction



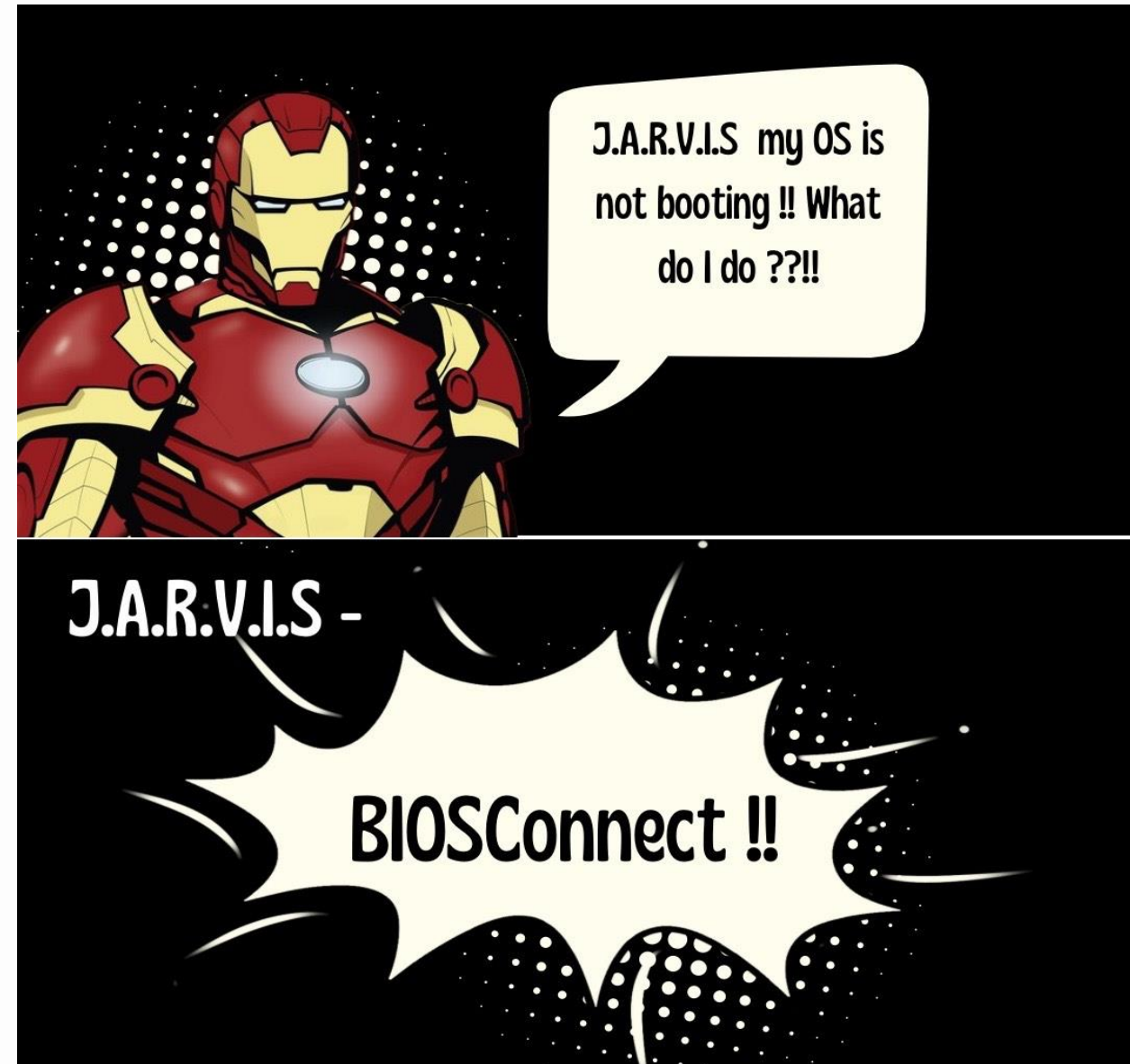
- UEFI Firmware
 - Part of BIOS
 - Initialization of the system
- BIOS
 - Dedicated Flash device
 - Independent of Storage drive
 - Capable of initializing the system even if storage drive is not present
- Talk focusses on utilizing BIOS capabilities for improving serviceability



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

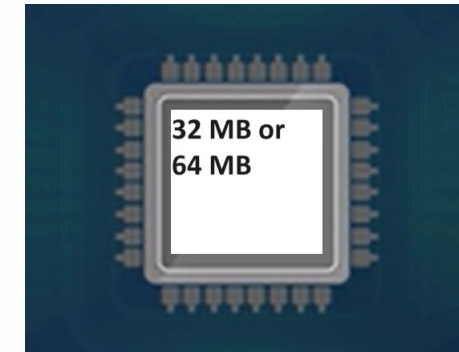


- Firmware Update Scenarios
 - Motherboard replaced in field
 - Manufacturing process in factory
 - OS agnostic firmware update for users

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)

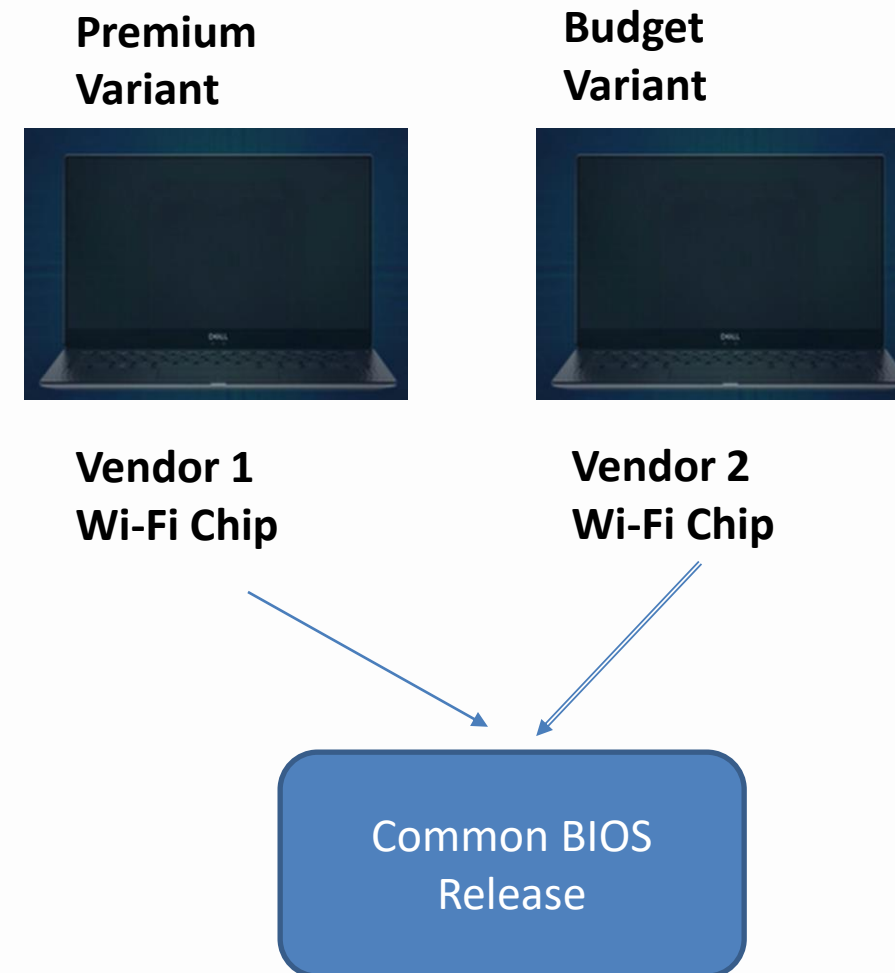


```
07-02-2024 02:03 PM <DIR> ..
09-01-2024 01:07 PM      459,864 IntelFmacDxe.efi
09-01-2024 01:07 PM      549,148 IntelFW.bin
09-01-2024 01:07 PM      117,848 IntelSupplicantDxe.efi
09-01-2024 01:07 PM     1,329,810 QcaFW.bin
09-01-2024 01:07 PM      280,952 QcaWifiDxe.efi
09-01-2024 01:07 PM     1,051,736 QcaWlanSupplicantDxe.efi
```

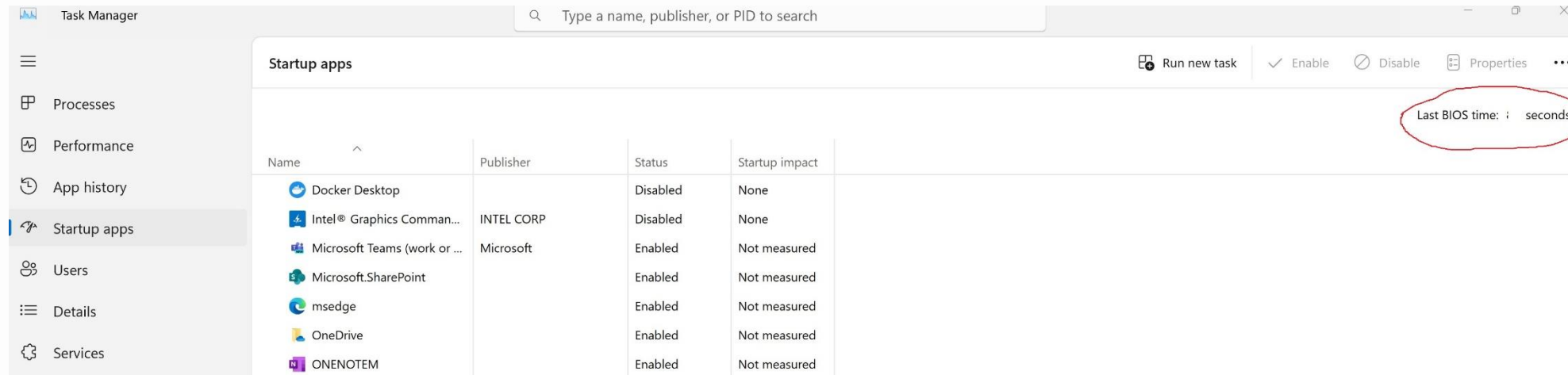
Platform Variant Challenges



- 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

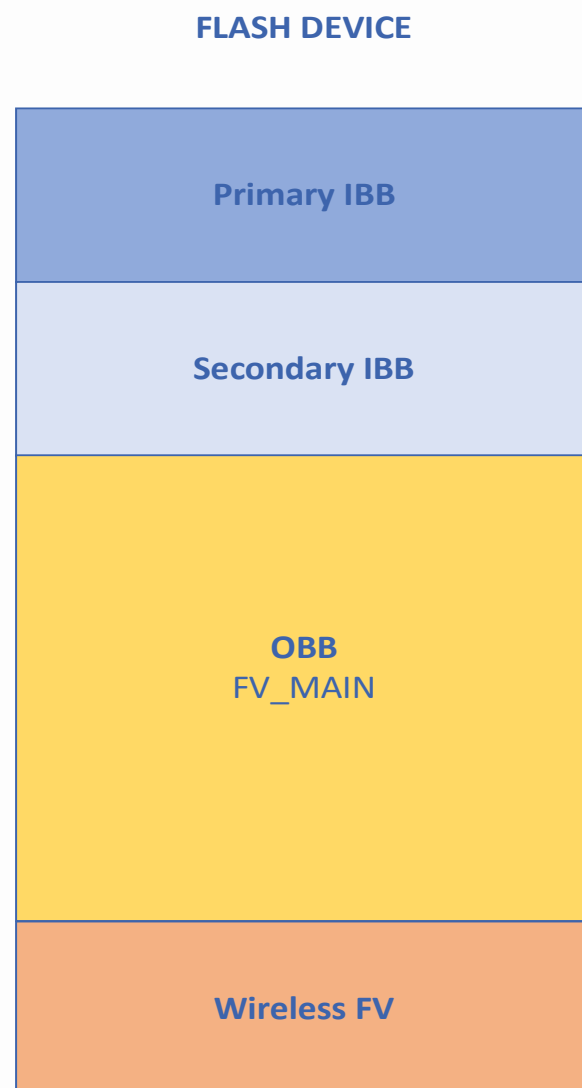
Security Challenges



- 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

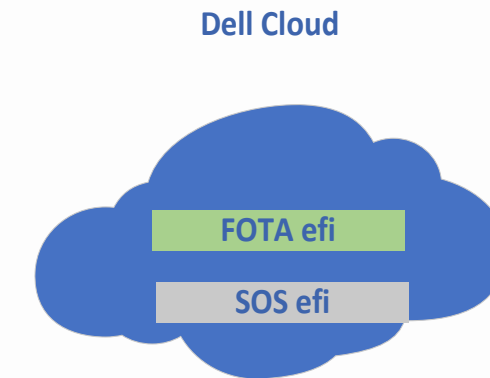
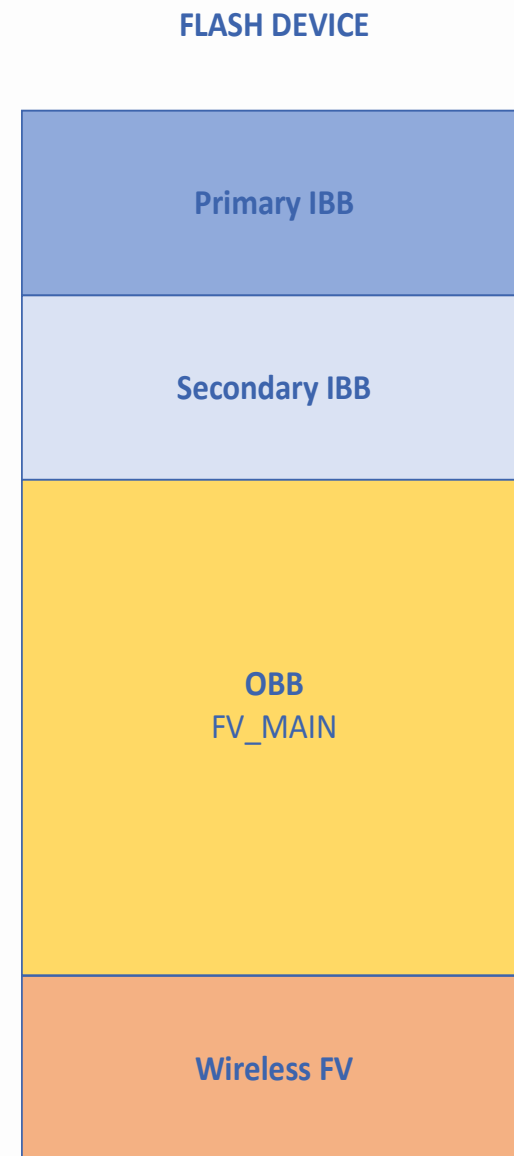


- BIOS flash map layout shown
- FV_MAIN
 - DXE Drivers
 - Dispatched during normal boot
- Wireless FV
 - Wireless Drivers
 - Not Dispatched during normal boot
 - Only Dispatched during Recovery or FW update
 - Optimizes boot time

Cloud BIOS



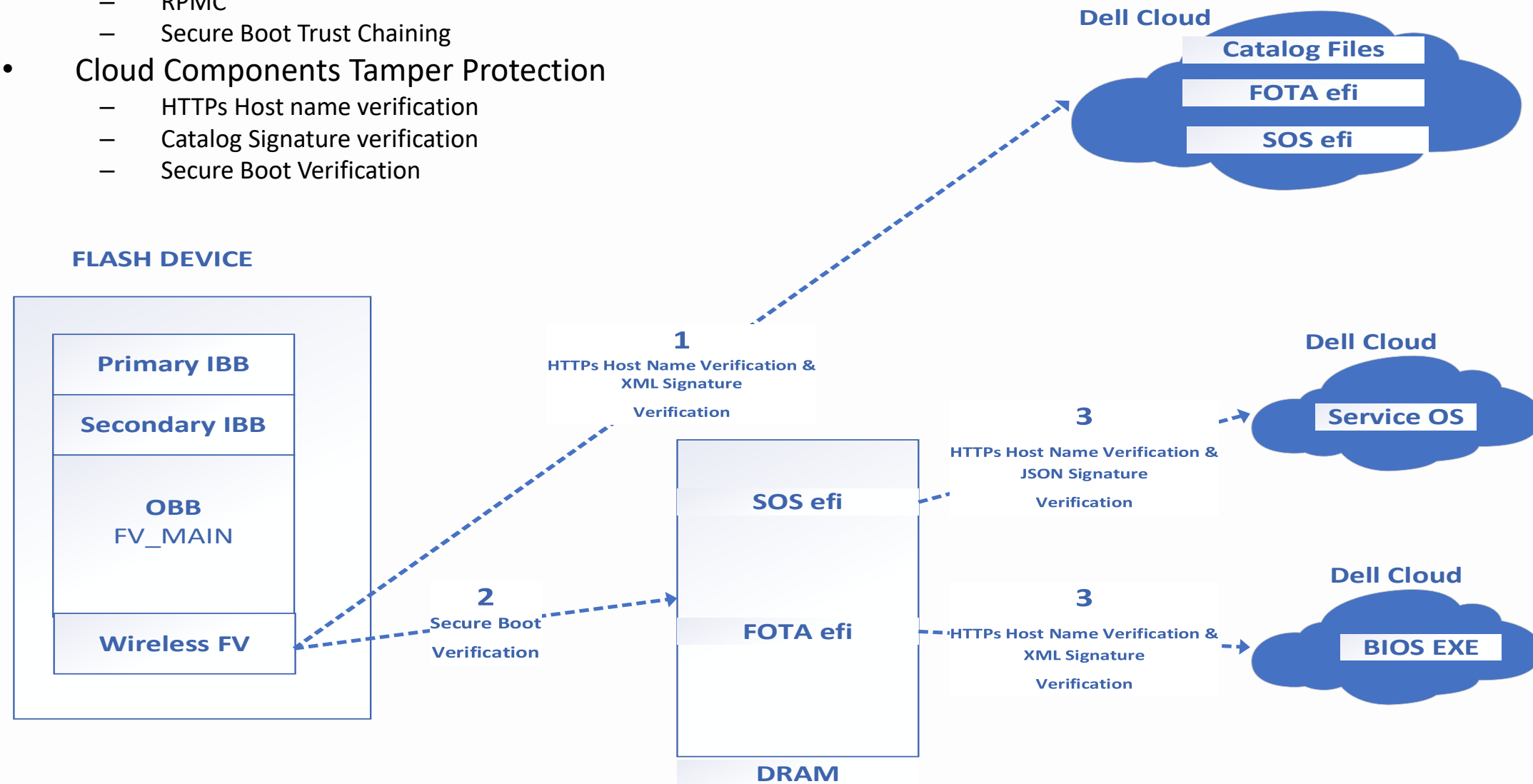
- Split BIOS
 - Flash Components
 - Cloud Components
- UEFI Applications for OS Recovery & FOTA
 - Not required during normal Boot
 - Hosted on Cloud
 - Downloaded and executed during OS Recovery & FW update
- Network Connectivity Drivers
 - Integrated in Flash Device
- Storage Space & Boot time Optimization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



Cloud BIOS Security



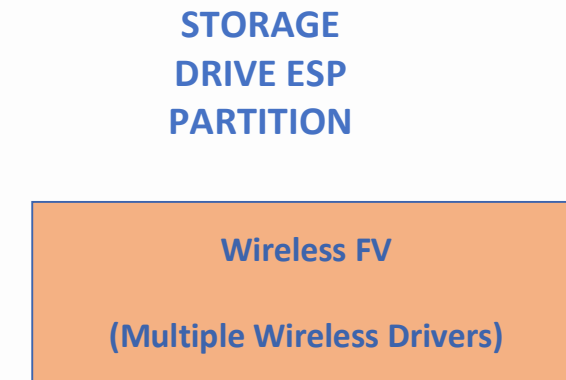
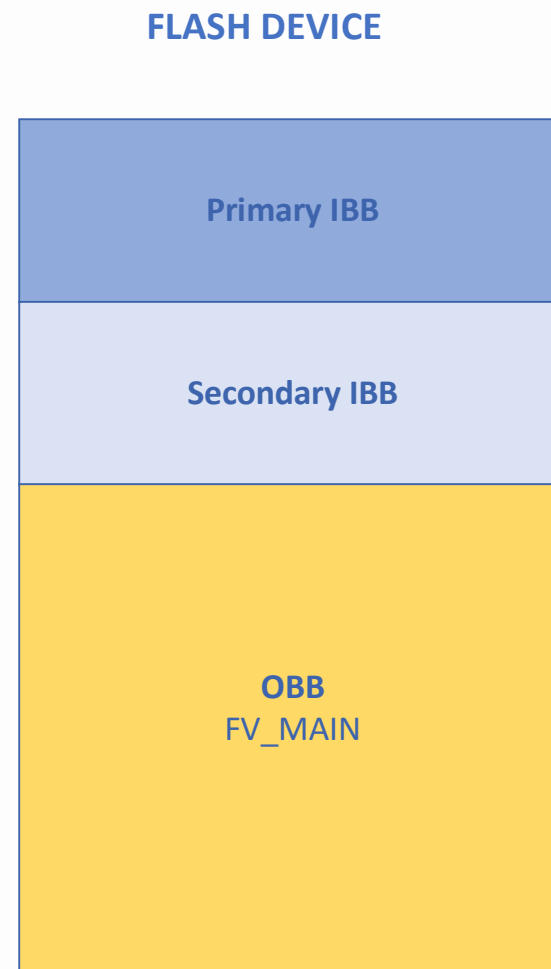
- Flash Device Tamper Protection
 - Intel BIOS Guard
 - RPMC
 - Secure Boot Trust Chaining
- Cloud Components Tamper Protection
 - HTTPs Host name verification
 - Catalog Signature verification
 - Secure Boot Verification



Wireless Drivers in ESP



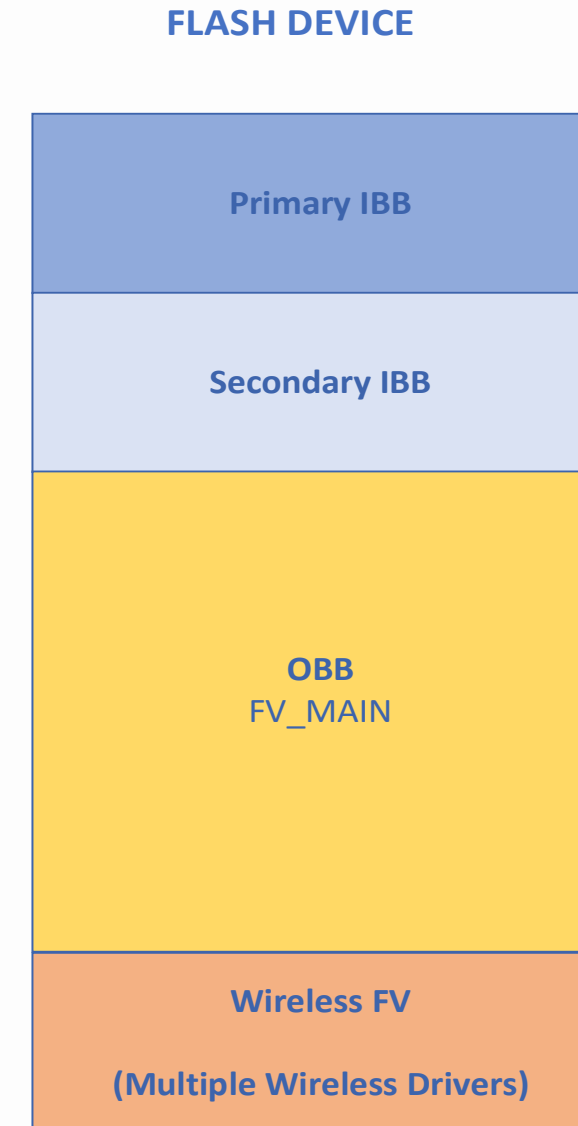
- Wireless Drivers hosted in EFI System Partition (ESP)
 - Security verification
 - Loaded and dispatched on demand
- Pros Vs Cons
 - Lower SPI Flash size
 - All required drivers are compiled into the image on ESP
 - Wireless feature not available when Storage Drive replaced
 - Wireless feature not available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



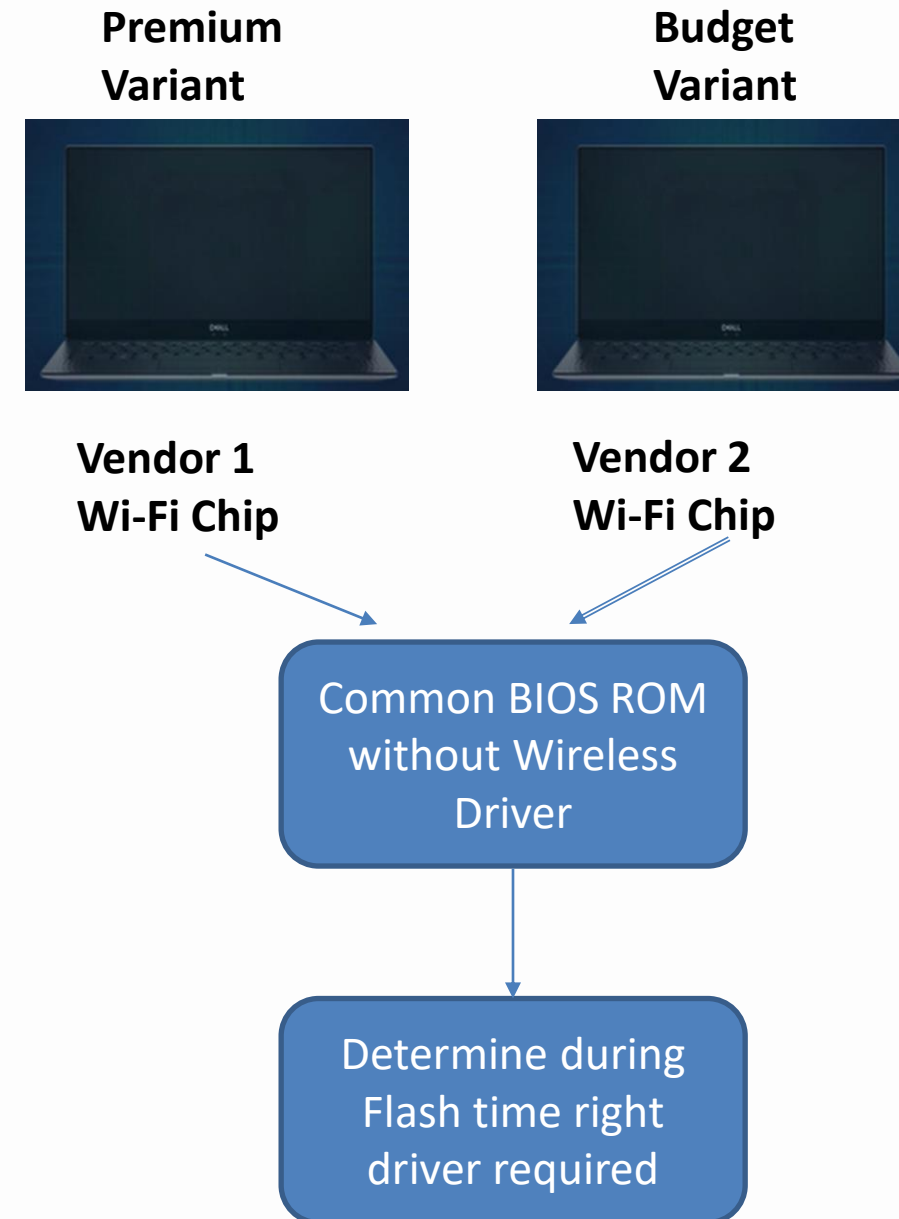
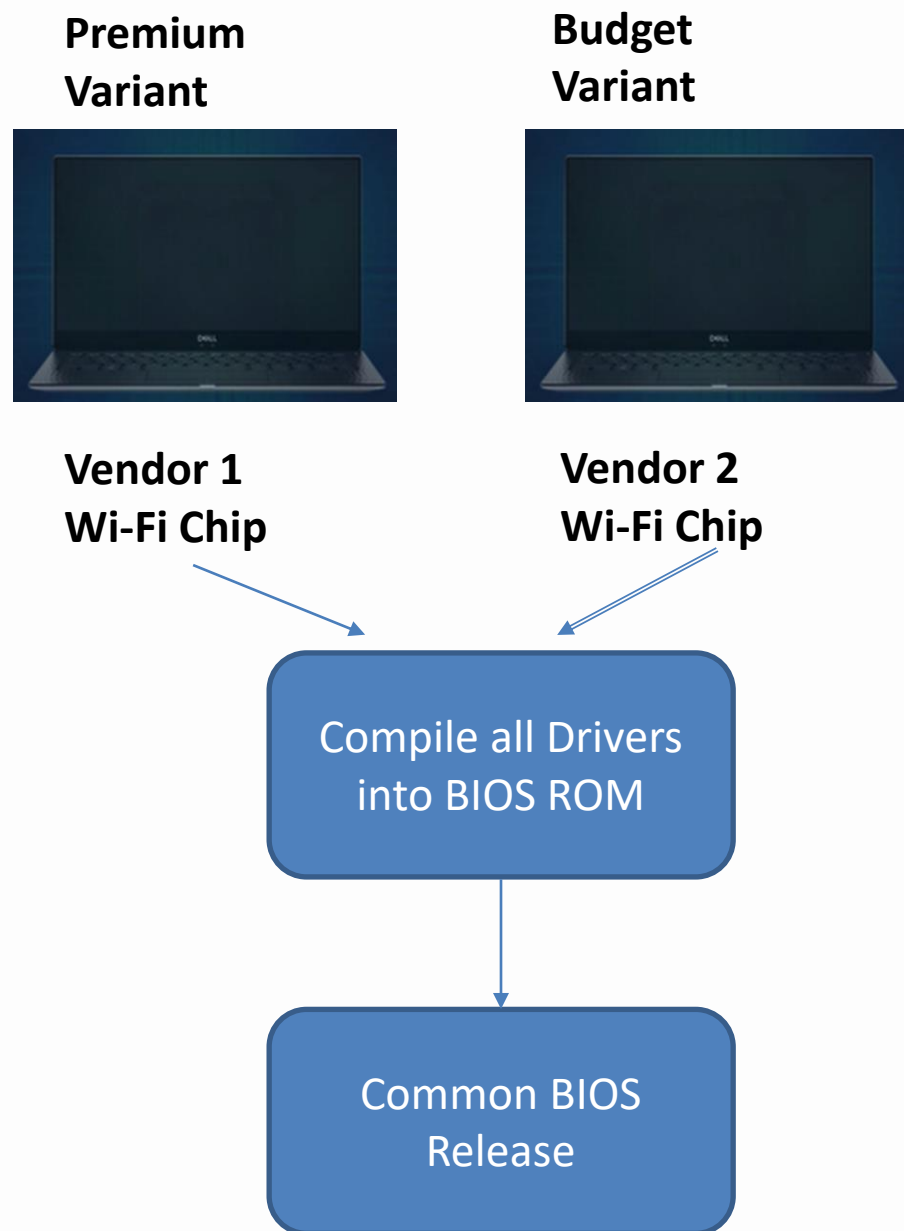
Wireless Drivers in Flash



- 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

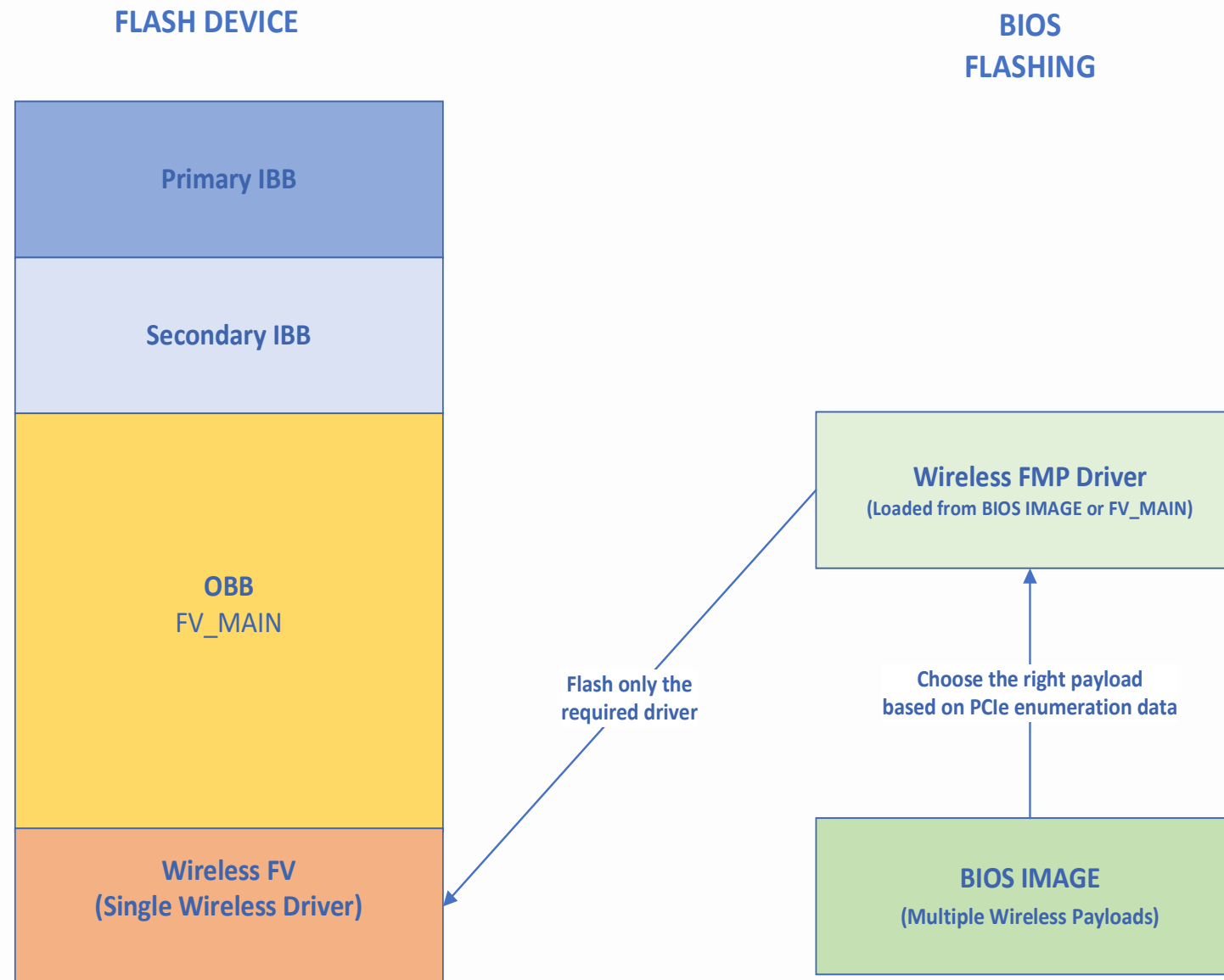


Applying Lazy Algorithm



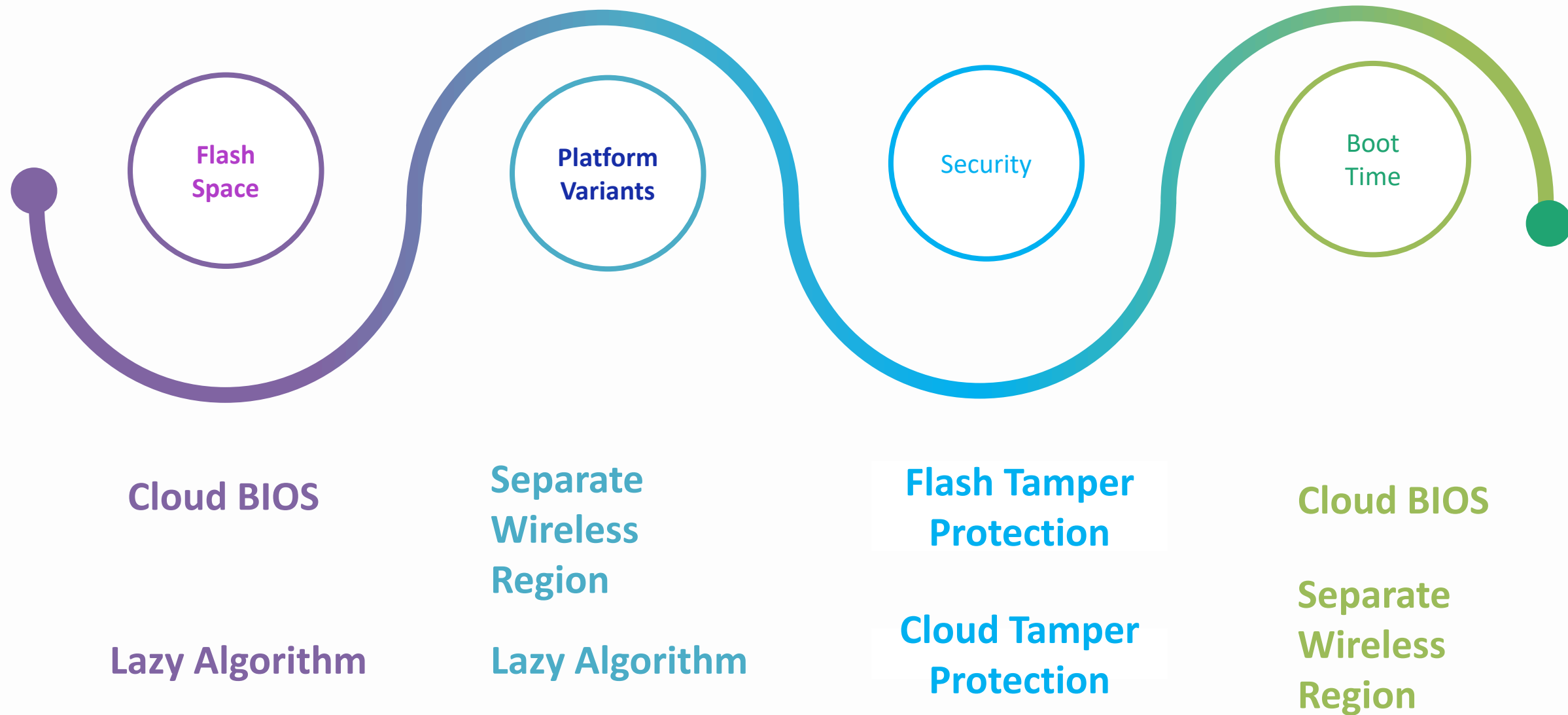


Applying Lazy Algorithm



- 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





Questions?

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