OpenCore

Reference Manual (0.6.5.6)

[2021.01.11]

Warning: This feature is very dangerous as it passes unprotected data to firmware variable services. Use it only when no hardware NVRAM implementation is provided by the firmware or it is incompatible.

4. `LegacyOverwrite`
   Type: `plist boolean`
   Failsafe: `false`
   Description: Permits overwriting firmware variables from `nvram.plist`.

   Note: Only variables accessible from the operating system will be overwritten.

5. `LegacySchema`
   Type: `plist dict`
   Description: Allows setting select NVRAM variables from a map (`plist dict`) of GUIDs to an array (`plist array`) of variable names in `plist string` format.

   `*` value can be used to accept all variables for select GUID.

   WARNING: Choose variables very carefully, as nvram.plist is not vaulted. For instance, do not put `boot-args` or `csr-active-config`, as this can bypass SIP.

6. `WriteFlash`
   Type: `plist boolean`
   Failsafe: `false`
   Description: Enables writing to flash memory for all added variables.

   Note: It is recommended to have this value enabled on most types of firmware but it is left configurable for firmware that may have issues with NVRAM variable storage garbage collection or similar.

To read NVRAM variable value from macOS, `nvram` could be used by concatenating GUID and name variables separated by a `:` symbol. For example, `nvram 7C436110-AB2A-4BBB-A880-FE41995C9F82:boot-args`.

A continuously updated variable list can be found in a corresponding document: NVRAM Variables.

9.3 Mandatory Variables

Warning: These variables may be added by PlatformNVRAM or Generic subsections of PlatformInfo section. Using `PlatformInfo` is the ~~recommend~~ recommended way of setting these variables.

The following variables are mandatory for macOS functioning:

- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:FirmwareFeatures`
  32-bit `FirmwareFeatures`. Present on all Macs to avoid extra parsing of SMBIOS tables.
- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:FirmwareFeaturesMask`
  32-bit `FirmwareFeaturesMask`. Present on all Macs to avoid extra parsing of SMBIOS tables.
- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:MLB`
  `BoardSerialNumber`. Present on newer Macs (2013+ at least) to avoid extra parsing of SMBIOS tables, especially in `boot.efi`.
- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:ROM`
  Primary network adapter MAC address or replacement value. Present on newer Macs (2013+ at least) to avoid accessing special memory region, especially in `boot.efi`.

9.4 Recommended Variables

The following variables are recommended for faster startup or other improvements:

- `7C436110-AB2A-4BBB-A880-FE41995C9F82:csr-active-config`
  32-bit System Integrity Protection bitmask. Declared in XNU source code in csr.h.
- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:ExtendedFirmwareFeatures`
  Combined `FirmwareFeatures` and `ExtendedFirmwareFeatures`. Present on newer Macs to avoid extra parsing of SMBIOS tables.
- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:ExtendedFirmwareFeaturesMask`
  Combined `FirmwareFeaturesMask` and `ExtendedFirmwareFeaturesMask`. Present on newer Macs to avoid extra parsing of SMBIOS tables.

- `FW_FEATURE_SUPPORTS_UEFI_WINDOWS_BOOT` (`0x20000000`) - Without this bit it is not possible to reboot to Windows installed on a drive with EFI partition being the first partition on the disk.

3. `MaxBIOSVersion`
   Type: `plist boolean`
   Failsafe: `false`
   Description: Sets `BIOSVersion` to `9999.999.999`, recommended for legacy Macs when using `Automatic` PlatformInfo to avoid BIOS updates in macOS 11, Big Sur.

4. `SystemMemoryStatus`
   Type: `plist string`
   Failsafe: `Auto`
   Description: Indicates whether system memory is upgradable in `PlatformFeature`. This controls the visibility of the Memory tab in About This Mac.

   Valid values:

   - `Auto` — use the original `PlatformFeature` value.
   - `Upgradable` — explicitly unset `PT_FEATURE_HAS_SOLDERED_SYSTEM_MEMORY` (`0x2`) in `PlatformFeature`.
   - `Soldered` — explicitly set `PT_FEATURE_HAS_SOLDERED_SYSTEM_MEMORY` (`0x2`) in `PlatformFeature`.

   Note: On certain Mac models (namely `MacBookPro10,x` and any `MacBookAir`), SPMemoryReporter.spreporter will ignore `PT_FEATURE_HAS_SOLDERED_SYSTEM_MEMORY` and assume that system memory is non-upgradable.

5. `ProcessorType`
   Type: `plist integer`
   Failsafe: `0` (Automatic)
   Description: Refer to SMBIOS `ProcessorType`.

6. `SystemProductName`
   Type: `plist string`
   Failsafe: `MacPro6,1`
   Description: Refer to SMBIOS `SystemProductName`.

7. `SystemSerialNumber`
   Type: `plist string`
   Failsafe: `OPENCORE_SN1`
   Description: Refer to SMBIOS `SystemSerialNumber`.

8. `SystemUUID`
   Type: `plist string`, GUID
   Failsafe: OEM specified
   Description: Refer to SMBIOS `SystemUUID`.

9. `MLB`
   Type: `plist string`
   Failsafe: `OPENCORE_MLB_SN11`
   Description: Refer to SMBIOS `BoardSerialNumber`.

10. `ROM`
    Type: `plist data`, 6 bytes
    Failsafe: all zero
    Description: Refer to `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:ROM`.

10.3 DataHub Properties

1. `PlatformName`
   Type: `plist string`
   Failsafe: Not installed
   Description: Sets `name` in `gEfiMiscSubClassGuid`. Value found on Macs is `platform` in ASCII.

2. `SystemProductName`
   Type: `plist string`
   Failsafe: Not installed

11.3 Tools and Applications

Standalone tools may help to debug firmware and hardware. Some of the known tools are listed below. While some tools can be launched from within OpenCore, see more details in the Tools subsection of the configuration, most should be run separately either directly or from `Shell`.

To boot into OpenShell or any other tool directly save `OpenShell.efi` under the name of `EFI\BOOT\BOOTX64.EFI` on a FAT32 partition. In general it is unimportant whether the partition scheme is `GPT` or `MBR`.

While the previous approach works both on Macs and other computers, an alternative Mac-only approach to bless the tool on an HFS+ or APFS volume:

```
sudo bless --verbose --file /Volumes/VOLNAME/DIR/OpenShell.efi \
  --folder /Volumes/VOLNAME/DIR/ --setBoot
```

Listing 3: Blessing tool

Note 1: `/System/Library/CoreServices/BridgeVersion.bin` should be copied to `/Volumes/VOLNAME/DIR`.
Note 2: To be able to use `bless` disabling System Integrity Protection is necessary.
Note 3: To be able to boot Secure Boot might be disabled if present.

Some of the known tools are listed below (builtin tools are marked with *):

`BootKicker*`	Enter Apple BootPicker menu (exclusive for Macs with compatible GPUs).
`ChipTune*`	Test BeepGen protocol and generate audio signals of different style and length.
`CleanNvram*`	Reset NVRAM alternative bundled as a standalone tool.
`GopStop*`	Test GraphicsOutput protocol with a simple scenario.
`HdaCodecDump*`	Parse and dump High Definition Audio codec information (requires `AudioDxe`).
`KeyTester*`	Test keyboard input in `SimpleText` mode.
`MemTest86`	Memory testing utility.
`OpenControl*`	Unlock and lock back NVRAM protection for other tools to be able to get full NVRAM access when launching from OpenCore.
`OpenShell*`	OpenCore-configured `UEFI Shell` for compatibility with a broad range of firmware.
`PavpProvision`	Perform EPID provisioning (requires certificate data configuration).
`ResetSystem*`	Utility to perform system reset. Takes reset type as an argument: `ColdReset`, `Firmware`, `Shutdown`, `WarmReset`. Defaults to `ColdReset`.
`RtcRw*`	Utility to read and write RTC (CMOS) memory.
`VerifyMsrE2*`	Check `CFG Lock` (MSR `0xE2` write protection) consistency across all cores.

11.4 OpenCanopy

OpenCanopy is a graphical OpenCore user interface that runs in `External PickerMode` and relies on OpenCorePkg `OcBootManagementLib` similar to the builtin text interface.

OpenCanopy requires graphical resources located in `Resources` directory to run. Sample resources (fonts and images) can be found in OcBinaryData repository. Customised icons can be found over the internet (e.g. here or there).

OpenCanopy provides full support for `PickerAttributes` and offers a configurable builtin icon set. The default chosen icon set depends on the `DefaultBackgroundColor` variable value. For Light Gray `Old` icon set will be used, for other colours — the one without a prefix.

Predefined icons are put to `\EFI\OC\Resources\Image` directory. Full list of supported icons (in `.icns` format) is provided below. Missing optional icons will use the closest available icon. External entries will use `Ext`-prefixed icon if available (e.g. `OldExtHardDrive.icns`).

Note: In the following all dimensions are normative for the 1x scaling level and shall be scaled accordingly for other levels.

- `Cursor` — Mouse cursor (mandatory, up to 144x144).
- `Selected` — Selected item (mandatory, 144x144).
- `Selector` — Selecting item (mandatory, up to 144x40).
- `Left` — Scrolling left (mandatory, 40x40).
- `Right` — Scrolling right (mandatory, 40x40).

- `HardDrive` — Generic OS (mandatory, 128x128).
- `Background` — Centred background image.
- `Apple` — Apple OS (128x128).
- `AppleRecv` — Apple Recovery OS (128x128).
- `AppleTM` — Apple Time Machine (128x128).
- `Windows` — Windows (128x128).
- `Other` — Custom entry (see `Entries`, 128x128).
- `ResetNVRAM` — Reset NVRAM system action or tool (128x128).
- `Shell` — Entry with UEFI Shell name (for e.g. `OpenShell` (128x128).
- `Tool` — Any other tool (128x128).

Predefined labels are put to `\EFI\OC\Resources\Label` directory. Each label has `.lbl` or `.l2x` suffix to represent the scaling level. Full list of labels is provided below. All labels are mandatory.

- `EFIBoot` — Generic OS.
- `Apple` — Apple OS.
- `AppleRecv` — Apple Recovery OS.
- `AppleTM` — Apple Time Machine.
- `Windows` — Windows.
- `Other` — Custom entry (see `Entries`).
- `ResetNVRAM` — Reset NVRAM system action or tool.
- `Shell` — Entry with UEFI Shell name (e.g. `OpenShell`).
- `Tool` — Any other tool.

Note: All labels must have a height of exactly 12 px. There is no limit for their width.

Label and icon generation can be performed with bundled utilities: `disklabel` and `icnspack`. Please refer to sample data for the details about the dimensions. Font is Helvetica 12 pt times scale factor.

Font format corresponds to AngelCode binary BMF. While there are many utilities to generate font files, currently it is recommended to use dpFontBaker to generate bitmap font (using CoreText produces best results) and fonverter to export it to binary format.

11.5 OpenRuntime

`OpenRuntime` is an OpenCore plugin implementing `OC_FIRMWARE_RUNTIME` protocol. This protocol implements multiple features required for OpenCore that are otherwise not possible to implement in OpenCore itself as they are needed to work in runtime, i.e. during operating system functioning. Feature highlights:

- NVRAM namespaces, allowing to isolate operating systems from accessing select variables (e.g. `RequestBootVarRouting` or `ProtectSecureBoot`).
- Read-only and write-only NVRAM variables, enhancing the security of OpenCore, Lilu, and Lilu plugins, such as VirtualSMC, which implements `AuthRestart` support.
- NVRAM isolation, allowing to protect all variables from being written from an untrusted operating system (e.g. `DisableVariableWrite`).
- UEFI Runtime Services memory protection management to workaround read-only mapping (e.g. `EnableWriteUnprotector`).

11.6 Properties

1. `APFS`
   Type: `plist dict`
   Failsafe: None
   Description: Provide APFS support as configured in APFS Properties section below.
2. `Audio`
   Type: `plist dict`
   Failsafe: None
   Description: Configure audio backend support described in Audio Properties section below.