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INFORMATION PROCESSING APPARATUS, INFORMATION PROCESSING METHOD, AND NON-TRANSITORY RECORDING MEDIUM

Abstract

An information processing apparatus includes circuitry and a memory that includes first and second storage areas. The first storage area includes multiple firmware storage partitions each storing firmware and multiple application storage partitions each storing an application. The firmware is executed at startup of the apparatus. The second storage area stores flag information including information of which one of the firmware storage partitions is to be selected to start the firmware. The circuitry executes first and second activators. The first activator starts the firmware stored in one of the firmware storage partitions based on the flag information. After the first activator starts the firmware stored in the one of the firmware storage partitions, the second activator starts the application stored in one of the application storage partitions based on the flag information. The one of the application storage partitions is associated with the one of the firmware storage partitions.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application is based on and claims priority pursuant to 35 U.S.C. § 119(a) to Japanese Patent Application No. 2024-024041, filed on Feb. 20, 2024, in the Japan Patent Office, the entire disclosure of which is hereby incorporated by reference herein.

BACKGROUND

Technical Field

[0002] The present disclosure relates to an information processing apparatus, an information processing method, and a non-transitory recording medium.

Related Art

[0003] A related-art information processing apparatus recovers from a situation in which a system of the information processing apparatus fails to start due to damage to firmware. For example, the information processing apparatus includes, in a flash read only memory (ROM), a plurality of blocks storing basic input/output system (BIOS) data and rewrites the BIOS data in a block different from a block used in the startup of the system.

SUMMARY

[0004] In one embodiment, there is provided an information processing apparatus that includes, for example, a memory and circuitry. The memory includes a first storage area and a second storage area. The first storage area includes a plurality of firmware storage partitions each storing firmware and a plurality of application storage partitions each storing an application. The firmware is executed at startup of the information processing apparatus. The second storage area stores flag information including information of which one of the plurality of firmware storage partitions is to be selected to start the firmware. The circuitry executes a first activator and a second activator. The first activator starts the firmware stored in one of the plurality of firmware storage partitions based on the flag information. After the first activator starts the firmware stored in the one of the plurality of firmware storage partitions, the second activator starts the application stored in one of the plurality of application storage partitions based on the flag information. The one of the plurality of application storage partitions is associated with the one of the plurality of firmware storage partitions.

[0005] In one embodiment, there is provided an information processing method performed by an information processing apparatus that includes a memory including a first storage area and a second storage area. The first storage area includes a plurality of firmware storage partitions each storing firmware and a plurality of application storage partitions each storing an application. The firmware is executed at startup of the information processing apparatus. The second storage area stores flag information including information of which one of the plurality of firmware storage partitions is to be selected to start the firmware. The information processing method includes, for example, starting the firmware stored in one of the plurality of firmware storage partitions based on the flag information, and after starting the firmware stored in the one of the plurality of firmware storage partitions, starting the application stored in one of the plurality of application storage partitions based on the flag information. The one of the plurality of application storage partitions is associated with the one of the plurality of firmware storage partitions.

[0006] In one embodiment, there is provided a non-transitory recording medium storing a plurality of instructions which, when executed by one or more processors on an information processing apparatus, causes the processors to perform the above-described information processing method.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] A more complete appreciation of embodiments of the present disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

[0008] FIG. **1** is a diagram illustrating a hardware configuration of an information processing apparatus according to an embodiment of the present disclosure;

[0009] FIG. **2** is a diagram illustrating a software configuration of the information processing apparatus according to the embodiment;

[0010] FIG. **3** is a block diagram illustrating a hardware configuration of a controller of the information processing apparatus according to the embodiment;

[0011] FIG. **4** is a functional block diagram of the controller of the information processing apparatus according to the embodiment;

[0012] FIG. **5** is a diagram illustrating a method of starting partitions in an information processing apparatus according to a comparative example;

[0013] FIG. **6**A is a diagram illustrating a method of starting partitions in the information processing apparatus according to the embodiment when flag information indicates a first value;

[0014] FIG. **6**B is a diagram illustrating a method of starting partitions in the information processing apparatus according to the embodiment when the flag information indicates a second value;

[0015] FIGS. **7**A and **7**B are tables illustrating a method of starting partitions in the information processing apparatus according to the embodiment when firmware is successfully updated;

[0016] FIGS. **8**A and **8**B are tables illustrating a method of starting partitions in the information processing apparatus according to the embodiment when the firmware update fails;

[0017] FIG. **9** is a flowchart illustrating operations of a first activator and a second activator in the information processing apparatus according to the embodiment;

[0018] FIG. **10** is a flowchart illustrating an operation of an update unit in the information processing apparatus according to the embodiment;

[0019] FIG. **11** is a flowchart illustrating an operation of a notification unit in the information processing apparatus according to the embodiment; and

[0020] FIG. **12** is a flowchart illustrating an information processing method according to the embodiment.

[0021] The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted. Also, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

[0022] In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve a similar result.

[0023] Referring now to the drawings, embodiments of the present disclosure are described below. As used herein, the singular forms “a,” “an,” and “the” are intended to include the plural forms as

well, unless the context clearly indicates otherwise.
[0024] Typically, an information processing apparatus selects a firmware storage partition based on boot entry information in a unified extensible firmware interface (UEFI). The firmware storage partition is an area storing a system including a bootloader and a kernel. In the startup of the information processing apparatus, the UEFI is first started. The UEFI then boots the bootloader and the kernel, for example, and the kernel starts an application. The UEFI, which is a type of software for starting an operating system (OS), functions as an interface between the OS and hardware. The UEFI initializes the hardware and starts the bootloader for the OS. The UEFI is firmware expanded as a successor to BIOS.
[0025] The information processing apparatus is therefore able to determine the firmware storage partition to start the bootloader, which is a process started by the UEFI, but is unable to select an application storage partition to start an application stored therein. In case of failure to update the firmware storage partition, therefore, recovery is limited to the firmware. Similarly, in case of failure to update the application storage partition, recovery is limited to the application.
[0026] In view of the above, the present disclosure described herein provides an information processing apparatus that recovers from both a failure to update firmware and a failure to update an application.
[0027] FIG. **1** is a diagram illustrating a hardware configuration of an information processing apparatus **1** according to an embodiment of the present disclosure. The information processing apparatus **1** includes a memory **2**, a controller **3**, an external memory **4**, and an operation device **5**. The information processing apparatus **1** is communicably connected to a network server **6** via network lines such as the Internet.
[0028] The memory **2** includes a first storage area **21** and a second storage area **22**. The memory **2** is implemented by a hard disk (HD), a hard disk drive (HDD) **104**, and programs executed by a central processing unit (CPU) **101** (see FIG. **3**), for example.
[0029] The first storage area **21** includes a plurality of firmware storage partitions each storing firmware **12** and a plurality of application storage partitions each storing an application **18** (see FIG. **2**). The firmware **12** is executed at startup of the information processing apparatus **1**. When one of the firmware storage partitions is started, one of the application storage partitions that is associated with the one of the firmware storage partitions is also started.
[0030] More specifically, the first storage area **21** includes a first firmware storage partition storing first firmware **12** and a second firmware storage partition storing second firmware **12** (sec FIGS. **6**A and **6**B). The first storage area **21** further includes a first application storage partition storing a first application **18** and a second application storage partition storing a second application **18**. The first application storage partition is associated with the first firmware storage partition, and the second application storage partition is associated with the second firmware storage partition.
[0031] Hereinafter, the first firmware storage partition or the second firmware storage partition will be simply referred to as the firmware storage partition where the distinction therebetween is unnecessary. Further, the first application storage partition or the second application storage partition will be simply referred to as the application storage partition where the distinction therebetween is unnecessary. The firmware storage partition may also be referred to as the extensible firmware interface (EFI) system partition.
[0032] In the following description, it is assumed that the first firmware storage partition and the first application storage partition are associated with each other, and that the second firmware storage partition and the second application storage partition are associated with each other.
[0033] The first storage area **21** is also referred to as the system boot storage, for example. The first storage area **21** is implemented by an embedded multimedia card (eMMC™), for example.
[0034] The second storage area **22** stores flag information **10** (see FIG. **2**) including information for selecting a partition to start. The second storage area **22** is also referred to as the boot flag storage, for example. The second storage area **22** may be provided in an external storage device. The second

storage area **22** is implemented by a non-volatile random access memory (NVRAM), for example. The external storage device serves as a storage area used as connected to the information processing apparatus **1**.

[0035] The controller **3** controls overall operation of the information processing apparatus **1**. The controller **3** starts the firmware **12** in the firmware storage partition and the application **18** in the application storage partition. The controller **3** further updates the flag information **10** when the firmware **12** is successfully updated. If the update of the firmware **12** fails, the controller **3** transmits an error notification to the operation device **5**.

[0036] The external memory **4** is a secure digital (SD) card, for example. The external memory **4** stores update files to newly write to the first storage area **21**. The update files may be stored as compressed files.

[0037] The operation device **5** may include input means for receiving an input from a user and display means for presenting information to the user. In response to receipt of an error notification from a notification unit **14** (see FIG. **2**), the operation device **5** may cause the display means to display an error message. The network server **6** stores update files to newly write to the first storage area **21**.

[0038] The information processing apparatus **1** may be a projector (PJ), an interactive whiteboard (IWB) with an electronic whiteboard function enabling interactive communication, an output device such as digital signage, a head-up display (HUD), an industrial machine, an image capturing device, a sound collecting device, medical equipment, a network home appliance, a connected car, a laptop personal computer (PC), a mobile phone, a smartphone, a tablet terminal, a gaming machine, a personal digital assistant (PDA), a digital camera, a wearable PC, or a desktop PC, for example.

[0039] FIG. **2** is a diagram illustrating a software configuration of the information processing apparatus **1** according to the embodiment. The information processing apparatus **1** includes the flag information **10**, a UEFI **11**, the firmware **12**, an update unit **13**, the notification unit **14**, a firmware update file **15**, an application update file **16**, an OS **17**, and one or more applications **18** (hereinafter simply referred to as the applications **18**).

[0040] The flag information **10**, which includes the information for selecting the partition to start, indicates a first value or a second value. The first value and the second value may be set to, but are not limited to, 0 and 1 or 1 and 0, respectively. The flag information **10** is stored in the second storage area **22**.

[0041] In the information processing apparatus **1**, the UEFI **11** reads a file stored in a partition with particular specifications called “EFI system partition.” Based on the information of the read file, the UEFI **11** boots installed firmware including a bootloader and a kernel.

[0042] The UEFI **11** includes a first activator **11***a*. The first activator **11***a* is implemented by the UEFI **11**, for example. If the flag information **10** indicates the first value, the first activator **11***a* starts the first firmware **12** stored in the first firmware storage partition. If the flag information **10** indicates the second value, the first activator **11***a* starts the second firmware **12** stored in the second firmware storage partition. Hereinafter, a partition to start will also be referred to as the boot partition, and a partition to update will also be referred to as the update partition.

[0043] The firmware **12** includes the bootloader **12***a* and the second activator **12***b*. The second activator **12***b* is a kernel, for example. The firmware **12** is included in the first firmware storage partition and the second firmware storage partition. After the firmware storage partition is started, the bootloader **12***a* starts the second activator **12***b*.

[0044] After the first activator **11***a* starts the firmware **12** stored in the firmware storage partition, the second activator **12***b* starts the application **18** stored in the application storage partition associated with the firmware storage partition based on the flag information **10**.

[0045] If the flag information **10** indicates the first value, the second activator **12***b* starts the first application **18** stored in the first application storage partition. If the flag information **10** indicates

the second value, the second activator **12***b* starts the second application **18** stored in the second application storage partition.
[0046] The update unit **13** is also referred to as the firmware update application, for example. The update unit **13** updates the firmware update file **15** and the application update file **16**, which are targets to update. Specifically, if the firmware **12** is successfully updated, and if the flag information **10** indicates the first value, the update unit **13** updates the first value to the second value. If the flag information **10** indicates the second value, the update unit **13** updates the second value to the first value. If the update of the firmware **12** fails, the update unit **13** retains the current value of the flag information **10**.
[0047] If the update unit **13** successfully updates the firmware **12**, the first activator **11***a* starts the firmware **12** stored in the firmware storage partition based on the updated flag information **10**, and the second activator **12***b* starts the application **18** stored in the application storage partition based on the updated flag information **10**.
[0048] The notification unit **14** is also referred to as the error notification application. If the update unit **13** fails to update the firmware **12**, the notification unit **14** outputs an error notification.
[0049] The firmware update file **15** and the application update file **16** are files used in the update of the firmware **12**.
[0050] The OS **17** controls the entire information processing apparatus **1**. The applications **18** are started and executed at system startup. Each of the applications **18** is a program executed in the corresponding application storage partition.
[0051] The firmware **12** and the applications **18** are stored in the first storage area **21**. The firmware update file **15** and the application update file **16** may be stored in the external memory **4**.
[0052] The network server **6** includes a firmware update file **60**, an application update file **61**, and an OS **62**. The firmware update file **60** and the application update file **61** are downloaded by the information processing apparatus **1**. The OS **62** performs overall control of the network server **6**.
[0053] FIG. **3** is a block diagram illustrating a hardware configuration of the controller **3** of the information processing apparatus **1** according to the embodiment. The controller **3** includes the CPU **101**, a read only memory (ROM) **102**, a random access memory (RAM) **103**, the HDD **104**, and an input and output interface (I/F) **105**, which are electrically connected to each other via a bus **109**.
[0054] The CPU **101** controls the operation of the controller **3**. The ROM **102** stores programs executed by the CPU **101**, for example. The RAM **103** is used as a work area of the CPU **101**. The HDD **104** stores various data such as programs. The input and output I/F **105** is an interface for outputting and inputting various signals and data to and from an external device.
[0055] Functions of the CPU **101** may be entirely or partially implemented by an electronic circuit such as an application specific integrated circuit (ASIC) or a field programmable gate array (FPGA).
[0056] FIG. **4** is a functional block diagram of the controller **3** of the information processing apparatus **1** according to the embodiment. The controller **3** includes the first activator **11***a*, the second activator **12***b*, the update unit **13**, and the notification unit **14**. The first activator **11***a* and the second activator **12***b* are stored in the first storage area **21**.
[0057] The first activator **11***a* starts the firmware **12** based on the flag information **10** stored in the second storage area **22**. If the flag information **10** indicates the first value, the first activator **11***a* starts the first firmware **12** stored in the first firmware storage partition. If the flag information **10** indicates the second value, the first activator **11***a* starts the second firmware **12** stored in the second firmware storage partition.
[0058] Based on the flag information **10** in the second storage area **22**, the second activator **12***b* starts the application **18** stored in the application storage partition associated with the started firmware storage partition.
[0059] If the flag information **10** indicates the first value, the second activator **12***b* starts the first

application **18** stored in the first application storage partition. If the flag information **10** indicates the second value, the second activator **12***b* starts the second application **18** stored in the second application storage partition.

[0060] The update unit **13** updates the firmware update file **15** and the application update file **16**, which are the targets to update. Specifically, if the firmware **12** is successfully updated, and if the flag information **10** indicates the first value, the update unit **13** updates the first value to the second value. If the flag information **10** indicates the second value, the update unit **13** updates the second value to the first value. If the update of the firmware **12** fails, the update unit **13** retains the current value of the flag information **10**.

[0061] The notification unit **14**, which is also referred to as the error notification application, transmits the error notification to the operation device **5** when the update of the firmware **12** fails.

[0062] FIG. **5** is a diagram illustrating a method of starting partitions in an information processing apparatus **9** according to a comparative example. In the information processing apparatus **9** of the comparative example, firmware **96** and partitions are stored in the same storage area. The firmware **96** stores flag information. The partitions include a first firmware storage partition, a second firmware storage partition, and a first application storage partition. The first firmware storage partition and the first application storage partition are associated with each other.

[0063] In the information processing apparatus **9** of the comparative example, a UEFI **99** reads the flag information (step S**901**), and loads and starts the first firmware storage partition (step S**902**). In the first firmware storage partition, a bootloader starts a kernel (step S**903**). The started kernel mounts a root file system (rootfs) in the first application storage partition, and the rootfs starts an application (step S**904**).

[0064] According to the partition staring method performed in the information processing apparatus **9** of the comparative example, the firmware storage partition to start in a storage area is determined based on the flag information stored in the firmware **96** in the same storage area. Therefore, the firmware **96** determines the firmware storage partition to start, which limits the application storage partition to start. That is, the partition to start to start the application is not changeable.

[0065] Further, according to the partition staring method performed in the information processing apparatus **9** of the comparative example, there is no duplication of the application storage partition, while the firmware storage partitions are duplicated, i.e., two firmware storage partitions are provided. Therefore, if the first firmware storage partition fails to start due to unsuccessful update of the firmware **96**, for example, the application stored in the application storage partition also fails to start.

[0066] FIG. **6**A is a diagram illustrating a method of starting partitions in the information processing apparatus **1** of the embodiment when the flag information **10** indicates the first value. Herein, the first firmware storage partition and the first application storage partition are associated with each other. Further, the second firmware storage partition and the second application storage partition are associated with each other. The first activator **11***a* of the UEFI **11** reads the flag information **10** from the second storage area **22** and determines the firmware storage partition to start.

[0067] The UEFI **11** reads the flag information **10**, which indicates the first value (step S**101**), and starts the firmware **12** in the first firmware storage partition (step S**102**). The bootloader **12***a* in the first firmware storage partition starts the second activator **12***b* (step S**103**). The started second activator **12***b* reads the flag information **10** from the second storage area **22** (step S**104**), and mounts a rootfs of the first application storage partition (step S**105**). The rootfs then starts the application **18**.

[0068] FIG. **6**B is a diagram illustrating a method of starting partitions in the information processing apparatus **1** of the embodiment when the flag information **10** indicates the second value. The configuration of the partitions in FIG. **6**B is similar to that in FIG. **6**A. Similarly as in the case in which the flag information **10** indicates the first value, the UEFI **11** reads the flag information **10**

from the second storage area **22** in the external storage device, and determines the firmware storage partition to start.

[0069] Similarly as in the example of FIG. **6**A, the UEFI **11** reads the flag information **10**, which indicates the second value (step S**201**), and loads and starts the second firmware storage partition (step S**202**). The bootloader **12***a* in the second firmware storage partition starts the second activator **12***b* (step S**203**). The started second activator **12***b* reads the flag information **10** from the second storage area **22** (step S**204**), and mounts a rootfs of the second application storage partition (step S**205**). The rootfs then starts the application **18**.

[0070] As described above with FIGS. **6**A and **6**B, the flag information **10** is stored in the second storage area **22**, which is a separate area from the first storage area **21** storing the UEFI **11**. Therefore, the second activator **12***b* different from the first activator **11***a* in the first storage area **21** is made usable. Further, the second activator **12***b* in the firmware storage partition reads the flag information **10** and starts the application **18** in the application storage partition associated with the firmware storage partition. Consequently, the firmware storage partition and the application storage partition start in conjunction with each other.

[0071] In case of failure to update the firmware **12** in the firmware storage partition, therefore, the information processing apparatus **1** recovers the firmware storage partition. Further, in case of failure to update the application **18** in the application storage partition, the information processing apparatus **1** recovers the application storage partition. That is, the information processing apparatus **1** is recoverable from both the failure to update the firmware storage partition and the failure to update the application storage partition, performing a recovery process with duplicated partitions to start the firmware storage partition and the application storage partition in conjunction with each other.

[0072] FIGS. **7**A and **7**B are tables illustrating a method of starting partitions in the information processing apparatus **1** of the embodiment when the firmware **12** is successfully updated. FIG. **7**A illustrates a state before the update of the firmware **12**, and FIG. **7**B illustrates a state after the update of the firmware **12**.

[0073] The example of FIGS. **7**A and **7**B includes path names of mount destinations to which the partitions are mounted. If the flag information **10** indicates the first value, the first firmware storage partition is a boot partition, and the application **18** in the first application storage partition is started. If the flag information **10** indicates the second value, the second firmware storage partition is a boot partition, and the application **18** in the second application storage partition is started.

[0074] In the example of FIGS. **7**A and **7**B, the partitions to start are mounted with names “/boot” and “/app” to allow software to handle files. In the example described below, the flag information **10** indicates the first value. In this case, the first firmware storage partition and the first application storage partition are the boot partitions. Therefore, the first firmware storage partition is mounted with the name “/boot,” and the first application storage partition is mounted with the name “/app.”

[0075] The second firmware storage partition and the second application storage partition are the update partitions. Therefore, the second firmware storage partition is mounted with a name “/boot_update,” and the second application storage partition is mounted with a name “/app_update.”

[0076] The update unit **13** updates the firmware **12** in the update partition. If the firmware **12** is successfully updated, the update unit **13** updates the flag information **10** in the boot flag storage and changes the boot partitions and the update partitions for the next startup.

[0077] A process after the restart of the system will be described.

[0078] The mount destinations of the partitions are changed, as illustrated in FIG. **7**B. Specifically, the boot partitions are changed to the second firmware storage partition and the second application storage partition. Therefore, the mount destination of the second firmware storage partition is set to “/boot,” and the mount destination of the second application storage partition is set to “/app.”

[0079] Further, the update partitions are changed to the first firmware storage partition and the first

application storage partition. Therefore, the mount destination of the first firmware storage partition is set to "/boot_update," and the mount destination of the first application storage partition is set to "/app_update."

[0080] When the system is restarted, the firmware **12** before being updated is temporarily placed in the partition with the mount destination "/boot," and then the process switches to the update partition. Thereafter, the firmware **12** in the update partition is updated. A backup of the firmware **12** may be saved at this stage. After this process, the updated system starts normally.

[0081] FIGS. **8**A and **8**B are tables illustrating a method of starting partitions in the information processing apparatus **1** of the embodiment when the update of the firmware **12** fails. FIG. **8**A illustrates a state before the update of the firmware **12**, and FIG. **8**B illustrates a state after the update process is suspended. In the example described below, the flag information **10** indicates the first value, similarly as in the example of FIGS. **7**A and **7**B. The state of FIG. **8**A is similar to that of FIG. **7**A, in which the flag information **10** indicates the first value.

[0082] If the update unit **13** fails to update the firmware **12** in the update partition, the update unit **13** suspends the update process. As illustrated in FIG. **8**B, after the suspension of the update process and the restart of the system, the mount destinations of the partitions remain the same as those used in the initial startup. If the update unit **13** fails to update the application **18** in the application storage partition, the current value of the flag information **10** is retained similarly as in the case of failure to update the firmware **12** in the firmware storage partition. Consequently, each of the firmware **12** and the application **18** starts the update process again, i.e., redoes the update process, to recover the system.

[0083] FIG. **9** is a flowchart illustrating operations of the first activator **11***a* and the second activator **12***b* in the information processing apparatus **1** of the embodiment. The first activator **11***a* reads the flag information **10** from the second storage area **22** (step S**301**). If the flag information **10** indicates the first value (YES at step S**302**), the first activator **11***a* mounts the first firmware storage partition and the first application storage partition as the boot partitions (step S**303**). If the flag information **10** indicates the second value (NO at step S**302**), the first activator **11***a* mounts the second firmware storage partition and the second application storage partition as the boot partitions (step S**304**).

[0084] At steps S**101** and S**102** in FIG. **6**A, the mount destination of the first firmware storage partition is "/boot," and the mount destination of the second firmware storage partition is "/boot_update." Further, the mount destination of the first application storage partition is "/app," and the mount destination of the second application storage partition is "/app_update."

[0085] FIG. **10** is a flowchart illustrating an operation of the update unit **13** in the information processing apparatus **1** of the embodiment. The update unit **13** reads the firmware update file **15** and the application update file **16** from the external memory **4** (step S**401**). The update unit **13** then updates the firmware update file **15** (step S**402**).

[0086] If the firmware update file **15** is successfully updated (YES at step S**403**), the update unit **13** updates the application update file **16** (step S**404**). If the update of the firmware update file **15** fails (NO at step S**403**), the update unit **13** notifies the notification unit **14** of the occurrence of an error (step S**405**).

[0087] If the application update file **16** is successfully updated (YES at step S**406**), the update unit **13** updates the flag information **10** (step S**407**). If the update of the application update file **16** fails (NO at step S**406**), the update unit **13** notifies the notification unit **14** of the occurrence of an error (step S**405**).

[0088] FIG. **11** is a flowchart illustrating an operation of the notification unit **14** in the information processing apparatus **1** of the embodiment. In response to receipt of the error notification from the update unit **13**, the notification unit **14** transmits an error notification to the operation device **5** to cause the operation device **5** to display an error message for the user to recognize the error (step S**501**).

[0089] FIG. **12** is a flowchart illustrating an information processing method according to the embodiment. The information processing method is performed in the information processing apparatus **1**.
[0090] The UEFI **11** is first started (step S**601**). Then, the first activator **11***a* starts the firmware **12** stored in the firmware storage partition based on the flag information **10** (step S**602**).
[0091] Based on the flag information **10**, the second activator **12***b* starts the application **18** stored in the application storage partition associated with the started firmware storage partition (step S**603**). The update unit **13** updates the firmware **12** (step S**604**).
[0092] If the firmware **12** is successfully updated (YES at step S**605**), and if the flag information **10** indicates the first value, the update unit **13** updates the first value to the second value (step S**606**). If the flag information **10** indicates the second value, the update unit **13** updates the second value to the first value (step S**606**). If the update of the firmware **12** fails (NO at step S**605**), the notification unit **14** transmits an error notification to the operation device **5** (step S**607**).
[0093] The information processing method of the embodiment is performed with the processes of these steps. The information processing method of the embodiment may include another process as appropriate.
[0094] In the information processing apparatus **1** of the embodiment, the flag information **10** is stored in the second storage area **22**, which is a separate area from the first storage area **21** storing the UEFI **11**. Therefore, the second activator **12***b* different from the first activator **11***a* in the first storage area **21** is made usable. Further, the second activator **12***b* in the firmware storage partition reads the flag information **10** and starts the application **18** in the application storage partition associated with the firmware storage partition. Consequently, the firmware storage partition and the application storage partition start in conjunction with each other.
[0095] In case of failure to update the firmware **12** in the firmware storage partition, therefore, the information processing apparatus **1** recovers the firmware storage partition. Further, in case of failure to update the application **18** in the application storage partition, the information processing apparatus **1** recovers the application storage partition. That is, the information processing apparatus **1** is recoverable from both the failure to update the firmware storage partition and the failure to update the application storage partition, performing a recovery process with duplicated partitions to start the firmware storage partition and the application storage partition in conjunction with each other.
[0096] The above-described embodiments are illustrative and do not limit the present invention. Thus, numerous additional modifications and variations are possible in light of the above teachings. For example, elements and/or features of different illustrative embodiments may be combined with each other and/or substituted for each other within the scope of the present invention. Any one of the above-described operations may be performed in various other ways, for example, in an order different from the one described above.
[0097] The functionality of the elements disclosed herein may be implemented using circuitry or processing circuitry which includes general purpose processors, special purpose processors, integrated circuits, application-specific integrated circuits (ASICs), digital signal processors (DSPs), field-programmable gate arrays (FPGAs), and/or combinations thereof which are configured or programmed, using one or more programs stored in one or more memories, to perform the disclosed functionality. Processors are considered processing circuitry or circuitry as they include transistors and other circuitry therein. In the disclosure, the circuitry, units, or means are hardware that carry out or are programmed to perform the recited functionality. The hardware may be any hardware disclosed herein which is programmed or configured to carry out the recited functionality.
[0098] There is a memory that stores a computer program which includes computer instructions. These computer instructions provide the logic and routines that enable the hardware (e.g., processing circuitry or circuitry) to perform the method disclosed herein. This computer program

can be implemented in known formats as a computer-readable storage medium, a computer program product, a memory device, a record medium such as a CD-ROM or DVD, and/or the memory of an FPGA or ASIC.

[0099] The present disclosure relates to the following aspects, for example.

[0100] According to a first aspect, an information processing apparatus includes a memory, a first activator, and a second activator. The memory includes a first storage area and a second storage area. The first storage area includes a plurality of firmware storage partitions each storing firmware and a plurality of application storage partitions each storing an application. The firmware is executed at startup of the information processing apparatus. The second storage area stores flag information including information of which one of the plurality of firmware storage partitions is to be selected to start the firmware. The first activator starts the firmware stored in one of the plurality of firmware storage partitions based on the flag information. After the first activator starts the firmware stored in the one of the plurality of firmware storage partitions, the second activator starts the application stored in one of the plurality of application storage partitions based on the flag information. The one of the plurality of application storage partitions is associated with the one of the plurality of firmware storage partitions.

[0101] According to a second aspect, in the information processing apparatus of the first aspect, the plurality of firmware storage partitions in the first storage area of the memory include a first firmware storage partition storing first firmware and a second firmware storage partition storing second firmware. The plurality of application storage partitions in the first storage area of the memory include a first application storage partition storing a first application and a second application storage partition storing a second application. The first application storage partition is associated with the first firmware storage partition. The second application storage partition is associated with the second firmware storage partition. When the flag information indicates a first value, the first activator starts the first firmware stored in the first firmware storage partition, and the second activator starts the first application stored in the first application storage partition. When the flag information indicates a second value, the first activator starts the second firmware stored in the second firmware storage partition, and the second activator starts the second application stored in the second application storage partition.

[0102] According to a third aspect, the information processing apparatus of the second aspect further includes an update unit to update the firmware. When the update unit successfully updates the firmware, the update unit updates a current value of the flag information from the first value to the second value or from the second value to the first value.

[0103] According to a fourth aspect, in the information processing apparatus of the third aspect, when the update unit successfully updates the firmware, the first activator starts the firmware stored in one of the plurality of firmware storage partitions based on the updated flag information, and the second activator starts the application stored in one of the plurality of application storage partitions based on the updated flag information.

[0104] According to a fifth aspect, the information processing apparatus of the third or fourth aspect further includes a notification unit. When the update unit fails to update the firmware, the notification unit outputs an error notification.

[0105] According to a sixth aspect, in the information processing apparatus of one of the third to fifth aspects, when the update unit fails to update the firmware, the update unit retains the current value of the flag information.

[0106] According to a seventh aspect, in the information processing apparatus of one of the first to sixth aspects, the second storage area of the memory is provided in an external storage device.

[0107] According to an eighth aspect, an information processing method is performed by an information processing apparatus that includes a memory including a first storage area and a second storage area. The first storage area includes a plurality of firmware storage partitions each storing firmware and a plurality of application storage partitions each storing an application. The

firmware is executed at startup of the information processing apparatus. The second storage area stores flag information including information of which one of the plurality of firmware storage partitions is to be selected to start the firmware. The information processing method includes starting the firmware stored in one of the plurality of firmware storage partitions based on the flag information, and after the start of the firmware stored in the one of the plurality of firmware storage partitions, starting the application stored in one of the plurality of application storage partitions based on the flag information. The one of the plurality of application storage partitions is associated with the one of the plurality of firmware storage partitions.

[0108] According to a ninth aspect, a non-transitory recording medium stores a plurality of instructions which, when executed by one or more processors on an information processing apparatus, cause the processors to perform an information processing method. The information processing apparatus includes a memory that includes a first storage area and a second storage area. The first storage area includes a plurality of firmware storage partitions each storing firmware and a plurality of application storage partitions each storing an application. The firmware is executed at startup of the information processing apparatus. The second storage area stores flag information including information of which one of the plurality of firmware storage partitions is to be selected to start the firmware. The information processing method includes starting the firmware stored in one of the plurality of firmware storage partitions based on the flag information, and after the start of the firmware stored in the one of the plurality of firmware storage partitions, starting the application stored in one of the plurality of application storage partitions based on the flag information. The one of the plurality of application storage partitions is associated with the one of the plurality of firmware storage partitions.

Claims

1. An information processing apparatus comprising: a memory including a first storage area including a plurality of firmware storage partitions each storing firmware and a plurality of application storage partitions each storing an application, the firmware being executed at startup of the information processing apparatus, and a second storage area storing flag information including information of which one of the plurality of firmware storage partitions is to be selected to start the firmware; and circuitry configured to execute a first activator and a second activator, the first activator being configured to start the firmware stored in one of the plurality of firmware storage partitions based on the flag information, and the second activator being configured to, after the first activator starts the firmware stored in the one of the plurality of firmware storage partitions, start the application stored in one of the plurality of application storage partitions based on the flag information, the one of the plurality of application storage partitions being associated with the one of the plurality of firmware storage partitions.

2. The information processing apparatus of claim 1, wherein the plurality of firmware storage partitions in the first storage area of the memory include a first firmware storage partition storing first firmware and a second firmware storage partition storing second firmware, wherein the plurality of application storage partitions in the first storage area of the memory include a first application storage partition storing a first application and a second application storage partition storing a second application, the first application storage partition being associated with the first firmware storage partition, and the second application storage partition being associated with the second firmware storage partition, wherein when the flag information indicates a first value, the first activator starts the first firmware stored in the first firmware storage partition, and the second activator starts the first application stored in the first application storage partition, and wherein when the flag information indicates a second value, the first activator starts the second firmware stored in the second firmware storage partition, and the second activator starts the second application stored in the second application storage partition.

3. The information processing apparatus of claim 2, wherein the circuitry is further configured to execute an update unit to, when the firmware is successfully updated, update a current value of the flag information from the first value to the second value or from the second value to the first value.
4. The information processing apparatus of claim 3, wherein when the firmware is successfully updated, the first activator starts the firmware stored in one of the plurality of firmware storage partitions based on the updated flag information, and the second activator starts the application stored in one of the plurality of the application storage partitions based on the updated flag information.
5. The information processing apparatus of claim 3, wherein the circuitry is further configured to execute a notification unit to, when the firmware fails to be updated, output an error notification.
6. The information processing apparatus of claim 3, wherein when the firmware fails to be updated, the update unit retains the current value of the flag information.
7. The information processing apparatus of claim 1, wherein the second storage area of the memory is provided in an external storage device.
8. An information processing method performed by an information processing apparatus that includes a memory including a first storage area and a second storage area, the first storage area including a plurality of firmware storage partitions each storing firmware and a plurality of application storage partitions each storing an application, the firmware being executed at startup of the information processing apparatus, and the second storage area storing flag information including information of which one of the plurality of firmware storage partitions is to be selected to start the firmware, and the information processing method comprising: starting the firmware stored in one of the plurality of firmware storage partitions based on the flag information; and after starting the firmware stored in the one of the plurality of firmware storage partitions, starting the application stored in one of the plurality of application storage partitions based on the flag information, the one of the plurality of application storage partitions being associated with the one of the plurality of firmware storage partitions.
9. A non-transitory recording medium storing a plurality of instructions which, when executed by one or more processors on an information processing apparatus, cause the processors to perform an information processing method, the information processing apparatus including a memory that includes a first storage area and a second storage area, the first storage area including a plurality of firmware storage partitions each storing firmware and a plurality of application storage partitions each storing an application, the firmware being executed at startup of the information processing apparatus, and the second storage area storing flag information including information of which one of the plurality of firmware storage partitions is to be selected to start the firmware, and the information processing method comprising: starting the firmware stored in one of the plurality of firmware storage partitions based on the flag information; and after starting the firmware stored in the one of the plurality of firmware storage partitions, starting the application stored in one of the plurality of application storage partitions based on the flag information, the one of the plurality of application storage partitions being associated with the one of the plurality of firmware storage partitions.