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(54) Method for automatic remote software upgrade of cable modems

Abstract:

This invention allows for the convenient and rapid automatic upgrade of software for cable modems in a cable network where at least two or more types of cable modems are mixed. The method of this invention includes the following processes: receiving an upgrade file corresponding to the type of cable modem to be upgraded, the IP (Internet Protocol) addresses of the cable modems that will execute the upgrade procedure, and the IP address of the TFTP (Trivial File Transfer Protocol) server from which the upgrade target cable modem will download the upgrade file. It further involves sequentially obtaining and analyzing each cable modem's MIB (Management Information Base) information using SNMP (Simple Network Management Protocol) to determine whether the type of the respective cable modem corresponds to the upgrade target. For those identified as upgrade targets, instructions are sent via SNMP to download the corresponding upgrade file from the TFTP server for upgrade.

Representative Drawing:

Figure 2

Keywords:

DOCSIS (Data-Over-Cable Service Interface Specification), cable modem network, software upgrade.

Detailed Explanation

Simple Explanation of the Diagrams

Fig. 1: Block diagram of the cable network where this invention is applied.

Fig. 2: Flowchart of the automatic remote software upgrade process for cable modems in the headend system according to the embodiment of this invention.

Fig. 3: Flowchart of the routine for determining whether or not a device is an upgrade target, as depicted in Fig. 2.

Fig. 4: Structure diagram of RFC 2669.

Fig. 5: Structure diagram of docsDevSoftware from RFC 2669.

Detailed description of the invention

Purpose of the invention

The technology to which the invention belongs and the existing technology in the field

This invention relates to a cable network that includes cable modems (CM) compliant with the DOCSIS (Data-Over-Cable Service Interface Specification) standard, specifically focusing on methods for remotely upgrading the software of cable modems from a headend system.

Cable modems used within HFC (Hybrid Fiber Coax) networks enable IP (Internet Protocol) traffic transmission between the Cable Modem Termination System (CMTS) at the headend of the cable network and the subscriber's PC (Personal Computer). These cable modems must function reliably to provide services under changing network conditions, and their operation is determined by the software installed on them, often referred to as firmware. If issues arise with this software, the cable modem may fail to perform its intended functions. To address such issues or to enhance quality, manufacturers remotely upgrade the software of cable modems through the headend system over the cable network.

According to the DOCSIS specification, there are two main methods for performing remote software upgrades. One method is utilizing the "Software Upgrade Filename" field within the configuration file received from a TFTP (Trivial File Transfer Protocol) server when the cable modem initializes. The other method is using SNMP (Simple Network Management Protocol) tools as part of an NMS (Network Management System) application.

When examining the method using a configuration file among the aforementioned two methods, the CMTS administrator specifies the name of the upgrade file corresponding to a type of cable modem in the CMTS's configuration file, i.e., the file name that the cable modem will download. Then, each cable modem included in the cable network will attempt to upgrade based on the upgrade file name specified in the configuration file received from the TFTP server during initialization. The type of cable modem is distinguished by the manufacturer and model, meaning that a cable modem of a particular model made by one manufacturer corresponds to one type.

According to the method using the configuration file as described above, only one upgrade file can be specified in the software upgrade file name field within the configuration file, so only one type of cable modem can be upgraded at a time. This approach is unsuitable for typical scenarios where there are many types or quantities of cable modems. In practice, many different types of cable modems coexist in cable networks, and if all types of cable modems are to be upgraded, it would require specifying a new configuration file for each type of cable modem every time, leading to inconvenience. Additionally, since only one type of cable modem is designated for upgrading, irrelevant cable modems may still be instructed to either download the file or cancel the download, resulting in unnecessary actions for the cable modems, which can increase network traffic.

Next, when examining the method of upgrading the software of cable modems using SNMP tools, the administrator designates one specific cable modem among all the cable modems for upgrading using the SNMP tool and issues a 'Set' command regarding the MIB (Management Information Base) item related to the upgrade. Then, the designated cable modem downloads the upgrade file from the TFTP server and executes the upgrade. This utilizes the specification that all cable modems adhering to the DOCSIS standard can be managed by the administrator via MIB, as defined in RFC (Request for Comments) 2669, which establishes the DOCSIS Cable Device MIB standard by IETF (Internet Engineering Task Force). In this way, when using SNMP tools, it is possible to specify only the target cable modem for the software upgrade; however, only one cable modem can be upgraded at a time. Consequently, the administrator must repeat the same task for the number of cable modems to be upgraded, requiring considerable manpower as they need to monitor the entire upgrade process closely.

Moreover, the two upgrade methods mentioned above can result in cases where the upgrade is not properly performed on the cable modem intended for the upgrade, or an unsupported cable modem is upgraded. In such situations, the cable modem often fails to operate normally. Therefore, reliability is not guaranteed during the upgrade process. Additionally, upgrades cannot be performed on cable modems that are powered off. As a result, administrators must repeatedly perform upgrades over long intervals, leading to significant time consumption in upgrading the overall cable modem software. Furthermore, if the administrator makes mistakes while operating the CMTS during the upgrade process, it could cause issues with the CMTS, which can have a huge impact on the entire network.

Especially when cable network operators start new services using DOCSIS 1.1 or higher, it is necessary to upgrade the software to ensure that existing cable modems can also support the service. However, upgrading the cable modem software using the conventional methods mentioned above will lead to significant time and cost issues, as well as confusion.

Technical challenges that the invention aims to address.

Therefore, the objective of this invention is to provide a method for conveniently and quickly automating the software upgrade of cable modems in a cable network where at least two or more types of cable modems are mixed.

Another objective of this invention is to provide a method that can enhance the reliability of normal software upgrades for cable modems.

Another objective of this invention is to provide a method that allows the automatic upgrade of software for cable modems that are powered off once power is restored.

Another objective of this invention is to provide a method that minimizes the burden of network traffic caused by software upgrades of cable modems.

Another objective of this invention is to provide a method that directs upgrade operations only to the targeted cable modem, ensuring that other cable modems are not affected.

Another objective of this invention is to provide a method that minimizes issues arising from mistakes made by administrators during CMTS operations.

Configuration and Action of the Invention.

The method of this invention for achieving the aforementioned objectives comprises:

a process of receiving an upgrade file corresponding to the type of cable modem to be upgraded, the IP (Internet Protocol) addresses of the target cable modems that will execute the upgrade procedure, and the IP address of the TFTP server from which the target cable modem will download the upgrade file;

a process of sequentially acquiring and analyzing the MIB information of the target cable modems using SNMP to determine whether the type of the cable modem corresponds to the upgrade target; and

a process of instructing the cable modems identified as upgrade targets to download the corresponding upgrade files from the TFTP server using SNMP.

Hereinafter, preferred embodiments of this invention will be described in detail with reference to the accompanying drawings. In the following description and the accompanying drawings, detailed explanations of known functions and configurations that may unnecessarily obscure the subject matter of this invention are omitted.

Fig. 1 is a block diagram showing an example of a cable network to which this invention is applied. It illustrates a headend system (100) of a cable network comprising a CMTS (108), a switch (110), a router (112), an upgrade server (114), and a server (116) connected to the Internet (106) through the router (112). A plurality of cable modems (102-1 to 102-N) are connected to the CMTS (108), and these cable modems (102-1 to 102-N) are connected to PCs (104-1 to 104-N). The switch (110) connects to the CMTS (108), enabling the cable modems connected to the CMTS (108) to access the Internet (106). Additionally, the switch (110) is connected to the upgrade server (114) and the server (116). The upgrade server (114) is used to upgrade the software of the cable modems (102-1 to 102-N). The server (116) operates various server programs necessary for configuring the cable network, including a TFTP server (118) for file downloads for the cable modems (102-1 to 102-N) and a DHCP (Dynamic Host Configuration Protocol) server (120) that assigns private IP addresses to the cable modems (102-1 to 102-N).

This invention enables the upgrade server (114) to automatically upgrade the software of the cable modems (102-1 to 102-N) using SNMP and the DOCSIS Cable Device MIB at the administrator's command, as described below. As a reference, communication using SNMP involves a manager and agents communicating based on MIBs with commands such as 'Get', 'Set', and 'Trap' to manage the network. 'Get' is used by the SNMP manager to query management information from the SNMP agent, 'Set' modifies the management information, and 'Trap' notifies the SNMP manager of exceptions from the SNMP agent. In the cable network depicted in Fig. 1, the upgrade server (114) corresponds to the SNMP manager, while the cable modems (102-1 to 102-N) correspond to the SNMP agents.

Fig. 2 illustrates the flow of the automatic remote upgrade processing of the cable modem software carried out by the upgrade server (114) of the headend system (100) according to an embodiment of this invention, shown in steps (200) to (218). When the administrator executes the upgrade program according to this invention on the upgrade server (114), the upgrade server (114) receives, in step (200), the upgrade file corresponding to the type of cable modem targeted for the upgrade, the IP addresses of the cable modems (102-1 to 102-N) that will execute the upgrade procedure, and the IP address of the TFTP server (118) from which the upgrade file will be downloaded. At this time, the upgrade server (114) displays the main screen of the cable modem software upgrade program on the monitor, prompting the administrator to input the upgrade file, IP addresses, etc. The IP addresses inputted are the private IP addresses assigned to the cable modems (102-1 to 102-N) by the previously mentioned DHCP server (120). The administrator specifies the cable modems that will execute the upgrade procedure using their IP addresses, either designating all IP addresses of the cable modems (102-1 to 102-N) or only some of the cable modems.

Once the administrator selects to execute the upgrade procedure, the upgrade server (114) responds at step (202) and selects the first cable modem among the target cable modems to execute the upgrade procedure in step (204). It then performs the upgrade target determination routine at step (206) for that cable modem.

Referring to Fig. 3, the upgrade target determination routine at step (206) can be broken down into steps (300) to (312). In steps (300) to (302), the upgrade server (114) utilizes SNMP to obtain and analyze the 'sysObjectID' information from the cable modem in order to identify the type of cable modem. Specifically, it retrieves the 'sysObjectID' information in accordance with RFC1213 MIB using a 'GET' command, thereby identifying the type of cable modem. The reason for distinguishing the type of cable modem is that different upgrade files need to be specified according to the manufacturer's model.

Generally, the structure of the 'sysObjectID' information takes the following form, where '***' represents the manufacturer, " represents the model, '%%' denotes the model version, and '@@' indicates the cable modem software version:

'iso.org.dod.internet.private.enterprises.***.%%.%%.@@.@@.@@'

Accordingly, the '***' value following 'enterprises' can be used to identify the manufacturer. For instance, '236' corresponds to Samsung, '9' corresponds to Cisco, '161' corresponds to Motorola, '3701' corresponds to Joohong, '5565' corresponds to Syswave, and '4928' corresponds to Crosstech.

After distinguishing the manufacturer, it is necessary to further differentiate between individual models. As an example for the manufacturer, here are six actual 'sysObjectID' examples for Samsung cable modems:

'iso.org.dod.internet.private.enterprises.236.100.1.1.1.206.1'

'iso.org.dod.internet.private.enterprises.236.110.11.1.1.1.5'

'iso.org.dod.internet.private.enterprises.236.110.11.20.2.0.8'

'iso.org.dod.internet.private.enterprises.236.120.12.30.1.1.2'

'iso.org.dod.internet.private.enterprises.236.110.11.20.2.0.8'

'iso.org.dod.internet.private.enterprises.236.110.11.1.1.1.8'

Here, if the manufacturer number '236' has a value of '100', the model name is identified as SCM100R; if it is '110', then it is SCM110R; for '120', it is SCM120R; and for '200', it is SCM200R. Additionally, for the SCM110R, if '@@' starts with '1', it is classified as SCM110R 2F, and if it starts with '2', it is categorized as SCM110R 1F.

Based on the information from 'sysObjectID', the types of cable modems are identified by their manufacturers and models. After confirming the type of cable modem, the corresponding MIB type is selected in step (304). To retrieve ('Get') or set ('Set') the MIB information of the cable modem using SNMP, a different MIB must be applied according to the model of the cable modem. This is because some devices require the MIB specified in RFC2669, while devices prior to RFC2669 use the old DOCSIS Cable Device MIB. For example, for Samsung cable modems, up until the SCM100R model, the old DOCSIS Cable Device MIB is applied, whereas the subsequent models use RFC2669. Other manufacturers will also have different MIBs applied depending on the model of their cable modems.

RFC2669 provides device information for cable modems. As shown in Figure 4, the structure of RFC2669 includes MIB information located under 'iso.org.dod.internet.mgmt.mib2.docsDev.docsDevMIBObjects,' providing seven groups: 'docsDevBase',

'docsDevNmAccessTable', 'docsDevSoftware', 'docsDevServer', 'docsDevEvent', 'docsDevFilter', and 'docsDevCpe.' According to RFC2669, the 'docsDevSoftware' information among these can be used to upgrade the software of cable modems.

On the other hand, the old DOCSIS Cable Device MIB refers to 'iso.org.dod.internet.experimental.docsDev.docsDevMIBObjects.' The difference between RFC2669 and the old DOCSIS Cable Device MIB is that RFC2669 is located at 'iso.org.dod.internet.mgmt.mib-2.docsDev,' while the old DOCSIS Cable Device MIB is situated at 'iso.org.dod.internet.experimental.docsDev.' For convenience, this is referred to as the old DOCSIS Cable Device MIB. Each of these MIBs must be appropriately applied corresponding to the model of the cable modem to ensure successful software upgrades.

The information regarding 'docsDevSoftware' in RFC2669, as mentioned above, consists of 'docsDevSwServer', 'docsDevSwFilename', 'docsDevSwAdminStatus', 'docsDevSwOperStatus', and 'docsDevSwCurrentVers'. 'docsDevSwServer' represents the IP address of the TFTP server from which the cable modem downloads its software. 'docsDevSwFilename' indicates the name of the software file for the cable modem. 'docsDevSwAdminStatus' contains information directing the cable modem regarding the software, with three statuses: 'upgradeFromMgt(1)' for instructing the cable modem to upgrade its software now, 'allowProvisioningUpgrade(2)' for allowing the cable modem software upgrade via a configuration file, and 'ignoreProvisioningUpgrade(3)' for disallowing the cable modem software upgrade through such a file. 'docsDevSwOperStatus' reflects the status of the cable modem software upgrade, consisting of 'InProgress(1)' for indicating that an upgrade is ongoing, 'completeFromProvisioning(2)' for confirming an upgrade completed from the configuration file, 'completeFromMgt(3)' for confirming an upgrade completed using SNMP, 'failed(4)' for when an error occurs during the software upgrade process, and 'other(5)' for other statuses. Lastly, 'docsDevSwCurrentVers' denotes the current version of the cable modem software.

Using the information mentioned above, if you want to upgrade the 'docsDevSwFilename' of the cable modem to a desired filename through SNMP by setting it with 'Set', and set 'docsDevSwAdminStatus' to 'upgradeFromMgt(1)' via SNMP, the corresponding cable modem will download the software from the TFTP server (116).

In addition, the existing DOCSIS Cable Device MIB's 'docsDevSoftware' has the same content, composition, and roles as RFC2669, only differing in its location.

As described earlier, after confirming the type of cable modem and selecting the appropriate MIB type, the upgrade server (114) will check the software information using the cable modem's 'docsDevSoftware' information in steps (306) to (312) to determine whether it is eligible for an upgrade. The 'docsDevSoftware', which provides the software status of the cable modem, exists in the same structure in both RFC2669 and the existing DOCSIS Cable Device MIB; thus, it can be used to verify the cable modem's software information and identify the target for upgrade. Initially, in step (306), it checks whether 'docsDevSwFilename' matches the upgrade filename corresponding to the type of cable modem. If they are identical, in step (308) it verifies whether 'docsDevSwOperStatus' is either 'completeFromMgt(3)' or 'completeFromProvisioning(2)'. If both pieces of information match the desired criteria, step (310) determines that the cable modem is not a target for the upgrade; otherwise, in step (312), it identifies the cable modem as a target for the upgrade. Once this determination is complete, the process proceeds to step (208) shown in Fig. 2.

In step (208), if the cable modem is determined not to be a target for an upgrade, the procedure continues to step (216) to select the next cable modem among those eligible for the upgrade procedure, followed by performing step (206) for that cable modem to assess upgrade eligibility. Conversely, for cable modems identified as upgrade targets, the process moves from step (208) to step (210) to instruct the software upgrade for the corresponding cable modem using the 'docsDevSoftware' information. At this point, 'docsDevSwServer' is set to the IP address of the TFTP server (118), 'docsDevSwFilename' is adjusted to the desired upgrade filename via SNMP using 'Set', and 'docsDevSwAdminStatus' is set to 'upgradeFromMgt(1)' through SNMP. Consequently, the corresponding cable modem will download the software from the TFTP server (118). After the upgrade is completed, step (212) verifies whether the upgrade was successful. If the upgrade is in a normal state, docsDevSwOperStatus should be set to completeFromMgt(3) and docsDevSwFilename should reflect the name of the upgrade target file. If the upgrade has successfully completed, docsDevSwAdminStatus should be set to allowProvisioningUpgrade(2) using SNMP, and then proceed to step (214). In contrast, if it is in a different state, an error has occurred, and you should return to step (210) to re-execute the upgrade.

In the above-mentioned step (214), it checks whether the cable modem among those targeted for the upgrade is the last one. If the upgrade procedure has been executed for all the targeted cable modems, it will terminate at step (218). Otherwise, it will proceed to step (216). If there are any cable modems powered off, since not all targeted cable modems have undergone the upgrade procedure, it will not terminate and will instead continue to step (216) to repeat the process. Consequently, when the corresponding cable modem powers back on, the software will undergo the upgrade.

Thus, the administrator only needs to specify the type of cable modem intended for the upgrade, the corresponding upgrade file, the targeted cable modems to execute the upgrade procedure, and the IP address of the TFTP server. The system will automatically check the types of the cable modems and perform the appropriate software upgrade accordingly.

While the above description provides specific examples of the invention, various modifications can be made without deviating from the scope of the invention. In particular, while the described embodiment checks the normal status after the upgrade is completed and executes the upgrade again in case of an error, which enhances stability and reliability, this may be omitted in actual applications. Therefore, the scope of the invention should not be determined solely by the described embodiments but also by the claims and their equivalents.

Effects of the Invention

The invention described above allows for the automatic upgrade of the software of various types of cable modems by a network administrator executing the process only once, making it quick and convenient. This significantly reduces manpower, time, and costs, while enhancing stability and reliability, thus ensuring service quality for cable modem subscribers. Additionally, it minimizes unnecessary network traffic and enables the software to be upgraded for cable modems that were powered off when power is restored. The process requires simple operations from the administrator, which helps reduce problems arising from operational mistakes in managing the CMTS (Cable Modem Termination System).

(57) Scope of claims

Claim 1.

A method for remotely upgrading the software of cable modems included in a cable network headend system comprising at least two or more types of cable modems according to the DOCSIS (Data-Over-Cable Service Interface Specification) standard, which comprises:

A process of obtaining and specifying an upgrade file corresponding to the type of the cable modem to be upgraded, the IP (Internet Protocol) addresses of the cable modems to which the upgrade procedure will be applied, and the IP address of the TFTP (Trivial File Transfer Protocol) server from which the upgrade target cable modem will download the upgrade file;
A process of sequentially acquiring and analyzing the MIB (Management Information Base) information of the cable modems targeted for the upgrade using SNMP (Simple Network Management Protocol) to determine whether the type of the cable modem corresponds to the upgrade target; and
A process of instructing the cable modems identified as upgrade targets to download the corresponding upgrade file for each type of cable modem from the TFTP server and perform the upgrade, using SNMP.

Claim 2.

The method according to Claim 1, further comprising a process of obtaining and analyzing the MIB information of the cable modem via SNMP after the upgrade of the cable modem is completed, and if the upgrade status is not normal, re-executing the upgrade instruction process.

Claim 3.

Claim 3.

The method according to Claim 1 or 2, wherein the above-mentioned determination process comprises:

A process of selecting one of the cable modems targeted for the upgrade;
A process of obtaining the 'sysObjectID' information from the MIB information using SNMP from the selected cable modem;
A process of analyzing the obtained 'sysObjectID' information to confirm the type of the selected cable modem;
A process of selecting the MIB type corresponding to the type of the selected cable modem;
A process of verifying whether the 'docsDevSWFilename' information in the 'docsDevSoftware' information of the selected cable modem is the same as the name of the upgrade file corresponding to the type of the selected cable modem and whether the 'docsDevSwOperStatus' information indicates 'completeFromMgt(3)' or 'completeFromProvisioning(2)';
A process of determining that the selected cable modem is an upgrade target if either the 'docsDevSWFilename' information does not match the name of the upgrade file or the 'docsDevSwOperStatus' information is not 'completeFromMgt(3)' or 'completeFromProvisioning(2)'; and
A process of determining that the selected cable modem is not an upgrade target if the 'docsDevSWFilename' information matches the name of the upgrade file and the 'docsDevSwOperStatus' information is 'completeFromMgt(3)' or 'completeFromProvisioning(2)';
wherein, the upgrade instruction process includes setting the 'docsDevSwServer' information in the 'docsDevSoftware' of the cable modem determined to be the upgrade target to the IP address of the TFTP server, setting the 'docsDevSWFilename' information to the name of the upgrade file corresponding to the type of the cable modem determined to be the upgrade target, and setting the 'docsDevSwAdminStatus' information to 'upgradeFromMgt(1)' using SNMP.

Claim 4.

Claim 4.

The method according to Claim 3, wherein the type of the cable modem is distinguished by the manufacturer and model of the cable modem.

Drawings

Fig. 1

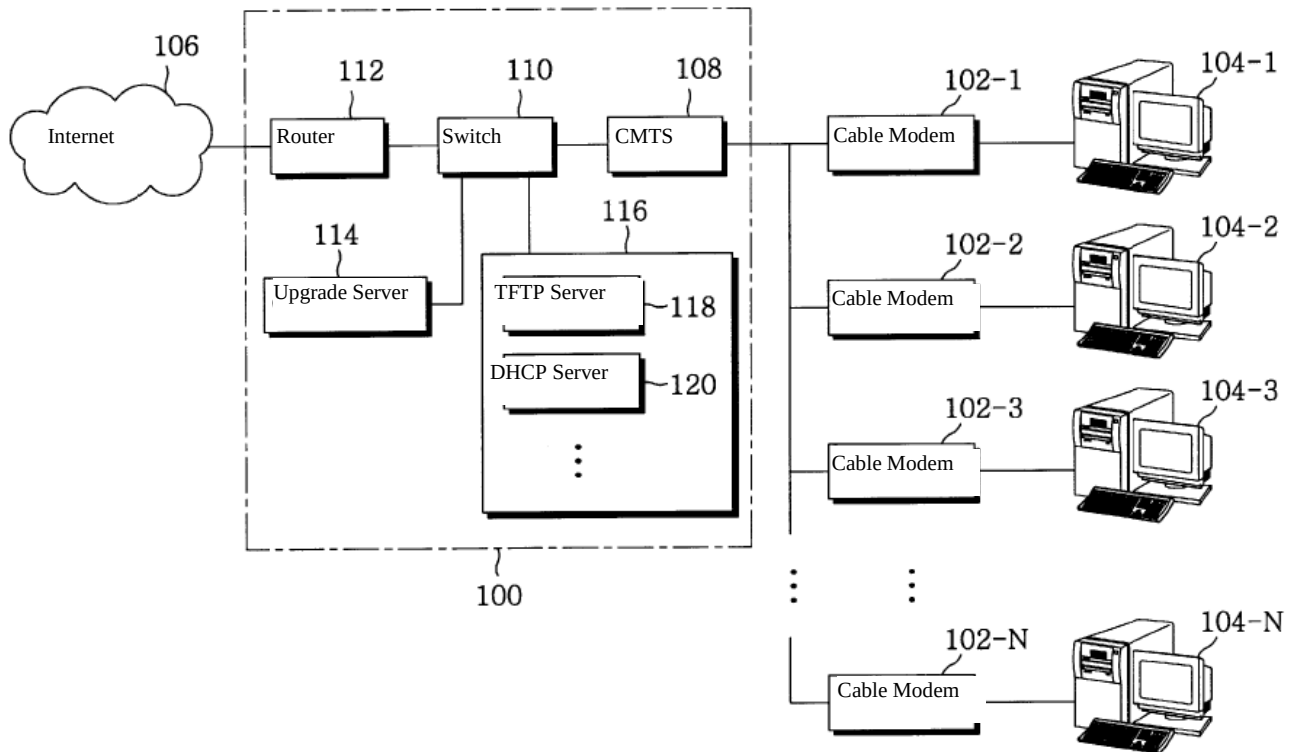


Fig. 2

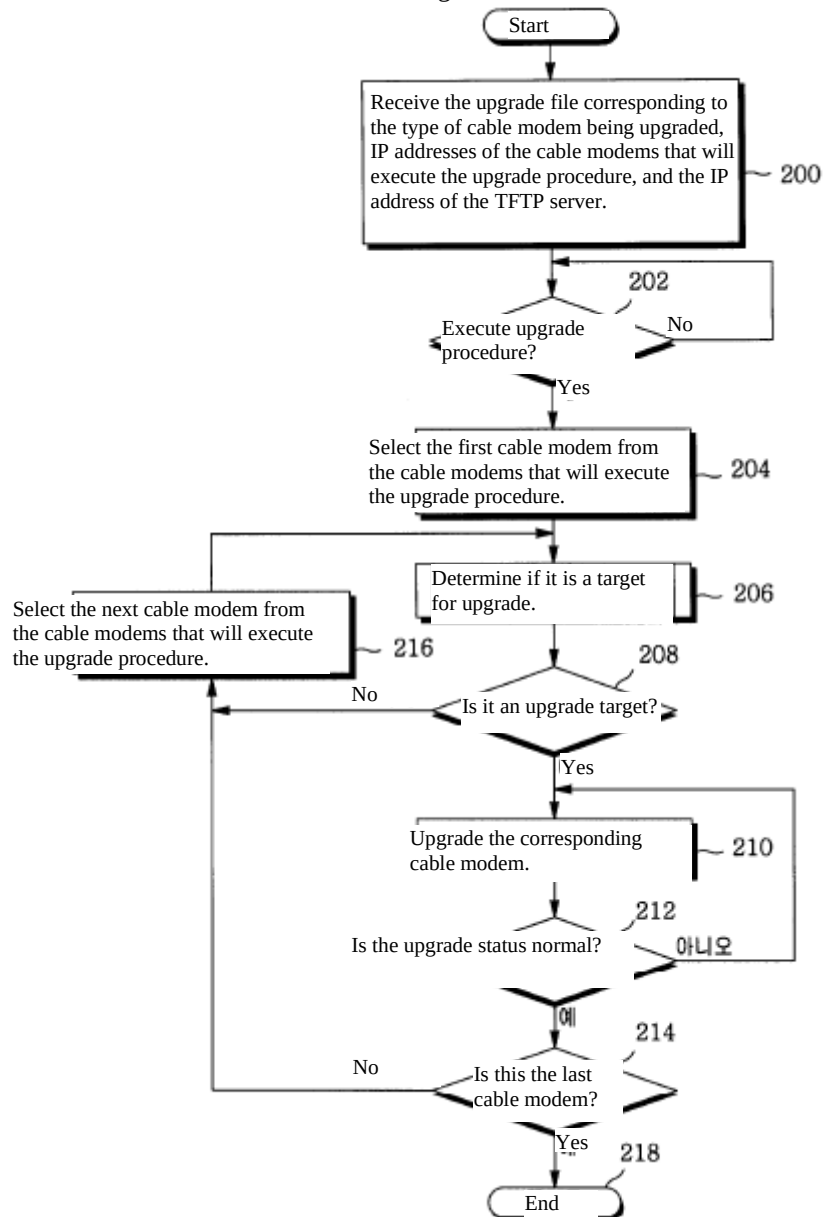


Fig. 3

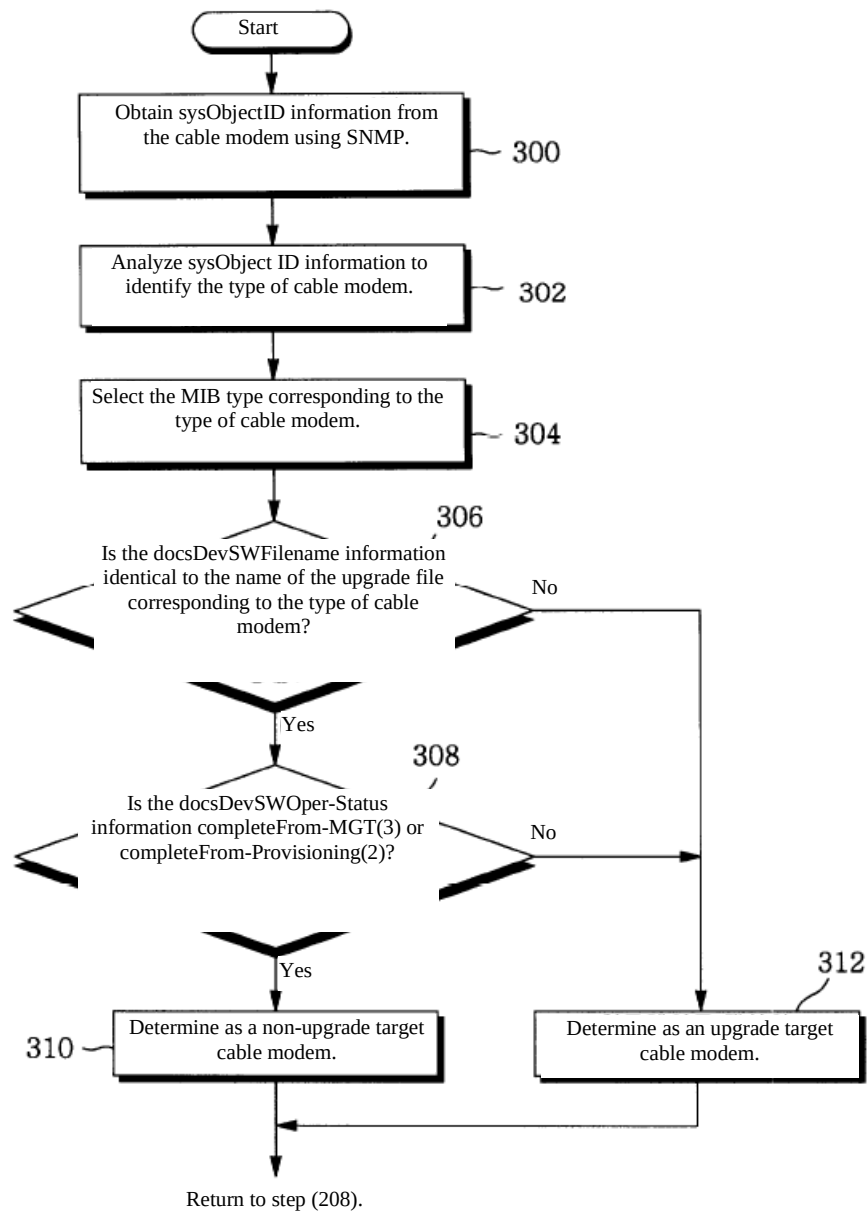


Fig. 4

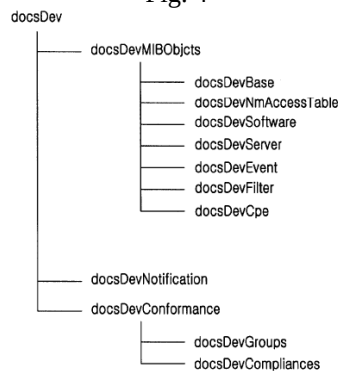
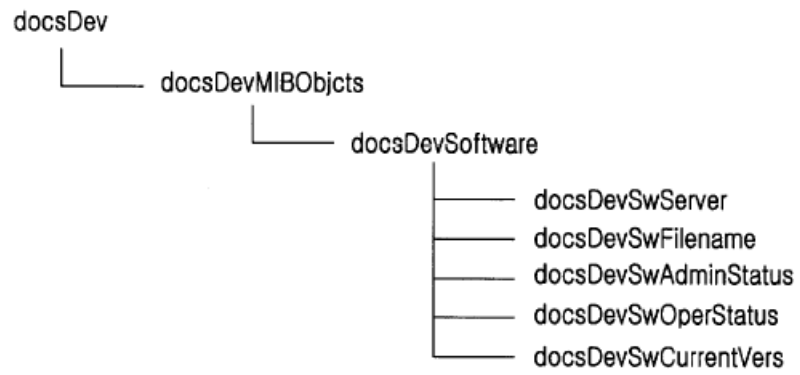


Fig. 5



DECLARATION

I, Nissan Ni, hereby declare as follows:

1. I am a translator employed by Nelles/legaltranslations.biz.

2. I have personal knowledge of the facts contained herein.

3. I am fluent in the English and Korean languages

4. I have been a translator for over 10 years, specializing in the Korean to English translation of patents and related intellectual property documents. For example, I have translated over 200 patent applications and 75 prior art reference patents from the Korean Language to the English language.

5. Attached to my declaration is the translation into English of Korean Patent No. 10-0414671 issued December 26, 2003. This translation is, to the best of my knowledge and belief, a true and accurate translation of Korean Patent No. 10-0414671 from the Korean language into the English language.

6. In signing this declaration, I have been warned and I understand that that willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. 1001).

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.



Executed on: 11/15/2024

Nissan Ni