

CDN Application with Terminal Remote Control System File Distribution Function

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NTT DOCOMO is providing OS and software update services for AndroidTM*1 terminals in our terminal remote control system, but it has recently become necessary to expand our download server due to security measures and increasing numbers of distribution files and users. We used an external solution called CDN to enable file distribution from external distribution servers. This has decreased the cost of equipment expansion and maintenance, and enabled flexible control of distribution performance according to need.

1. Introduction

Smartphones continue to spread and the share of smartphones in the mobile phone market increases yearly. Smartphone applications and OS are also advancing, and update files for them are increasing in size and frequency. To make these updates more convenient for users, NTT DOCOMO has been providing Android OS and software update services for some time and update files can be downloaded through the wireless network using NTT DOCOMO's remote control system.

However, with increasing demand in recent years

it has become necessary to increase the performance of the remote control system, and the download server that distributes update files in particular. Security measures have also become more important, and systems that communicate directly with terminals are requiring stronger security levels. Thus, implementing additional security measures such as an Intrusion Prevention System (IPS)*2 has resulted in greater loads on the remote control system.

However, expansion of server equipment based on peak traffic would result in surplus equipment when file distribution is not taking place, inflating costs.

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*1 AndroidTM: A software platform for smartphones and tablets consisting of an operating system, middleware and major applications. A trademark of Google Inc., United States.

These factors and the potential to support Internet of Things (IoT)^{*3} devices in the future suggest a need to implement distribution of update files more efficiently, to more terminals and more quickly.

To this end, NTT DOCOMO has used a Content Delivery Network (CDN)^{*4} solution to implement stable, flexible file distribution that is not affected by traffic fluctuating according to the needs of users. In doing so, we have implemented a remote control system able to handle the various needs described above. This article describes the new remote control system implemented by linking NTT DOCOMO's remote control system to the CDN, including an overview of CDNs.

2. CDN Architecture Overview

A CDN is a network solution optimized for stable delivery of high-volume content to many users at

high speed. **Figure 1** shows delivery of files before and after application of the CDN. With the network before applying the CDN, files were delivered directly from the “origin server^{*5}” where the original files were stored (Fig. 1 (a)). After applying the CDN, files to be delivered to users are cached^{*6} on the CDN distribution servers, which can distribute large files to many users, accelerating file distribution and reducing the load on the origin server (Fig. 1 (b)).

Distribution of video is one example of using a CDN. With this type of service, when many users are viewing a video distribution speed often drops, distribution is unstable, or distribution stops before completion. If a CDN is used to distribute the video, the load on the origin server is decreased and viewing conditions for users are improved. Delivery is also faster and more stable when an event is held causing access to Web pages to become congested.

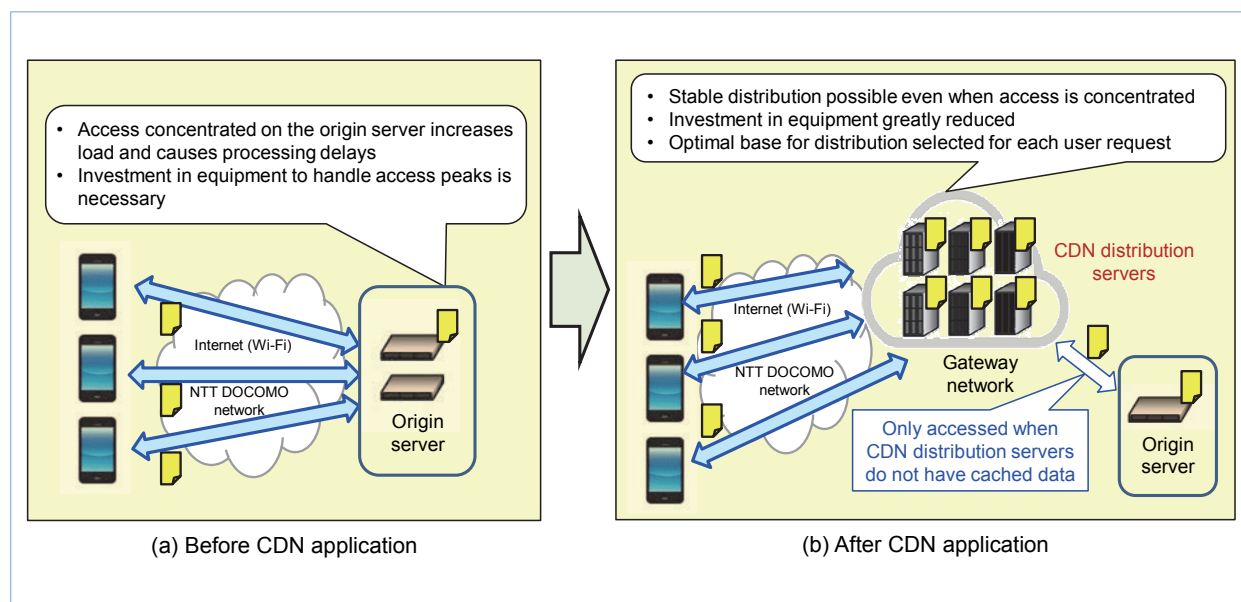


Figure 1 File distribution before and after CDN application

^{*2} IPS: An attack prevention system that detects unauthorized access by monitoring Internet communication on servers and networks.

^{*3} IoT: General term for a style of control and communication where various “things” are connected via the Internet or cloud services.

^{*4} CDN: A network solution optimized for fast and stable distribution of large files such as images and video.

^{*5} Origin server: A company's own server holding the company's content.

^{*6} Cache: Temporarily stored data to be distributed.

In the past, when server capacity had to increase due to increased demand or larger distribution files, equipment to accommodate peak traffic on the origin server increased costs, but this equipment was idle when no file distribution was being done. A CDN provides services to various companies and users, so costs can be kept lower than if NTT DOCOMO maintained all of the equipment. The CDN is also flexible in accommodating user demand for file distribution, enabling it to provide low cost, optimal file distribution.

Thus, a CDN has various benefits compared to only operating our own origin server.

CDNs can be divided broadly into centralized and distributed architectures. Centralized architectures limit the locations of CDN distribution servers, which facilitates distribution of large files. In contrast, distributed architectures have distribution servers spread over many locations. Distribution is

accomplished by selecting a distribution server for each user request, so transfer time can be reduced.

The main use of the system at NTT DOCOMO is for OS and software updates as mentioned earlier and in this case large files are distributed to many terminals at once, so we used a system with a centralized architecture.

3. Application of a CDN to the Remote Control System

The following sections describe features for switching to CDN application, for free-of-charge distribution, and for using general-purpose ports.

3.1 Implementation

The structure before and after CDN application is shown in **Figure 2**. On the network before CDN

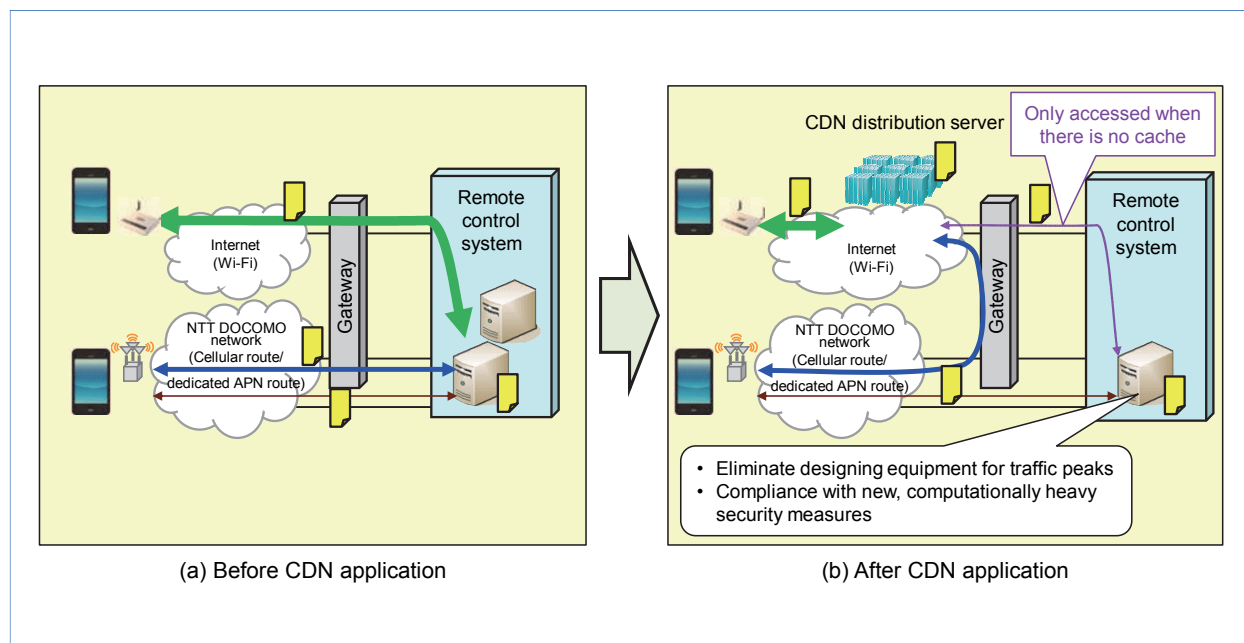


Figure 2 Remote control system structure before and after CDN application

application, terminals connected using Wi-Fi^{*7} and 3G/LTE to obtain files directly from the remote control system where the files were stored (Fig. 2 (a)). After CDN application, terminals connected as they did before, but obtain the files from a cache on a CDN distribution server on the Internet (Fig. 2 (b)). Once the file cache is created, unless the cache is deleted, files are distributed to terminals from the CDN distribution server, greatly reducing the load on the remote control system server. At the same time, the CDN is able to handle any increase in number of users or traffic in the future with flexibility, avoiding any drop in service level, such as distribution speed. Previously, the remote control system was maintained to meet peak traffic, but with application of the CDN, the amount of equipment can be reduced, along with costs.

3.2 Switching Method

OS and software updates are performed by the

remote control system in accordance with Open Mobile Alliance Device Management (OMA^{*8}-DM^{*9}) [1], and as shown in **Figure 3**, the service provider and maintainer perform update notifications, file distribution, version management and other tasks remotely on terminals.

File distribution can be divided mainly into a control phase and a distribution phase. When applying the CDN, the control phase specifies the server to connect to as with the existing system, and in the distribution phase, the terminal connects to a CDN distribution server or the origin server to get the files. In this way, the switch to using the CDN can be implemented without affecting existing terminals.

1) Process before CDN Application

The OS update process before applying the CDN is shown in **Figure 4**. Note that the process for software updates is almost the same.

When the remote control system receives a control

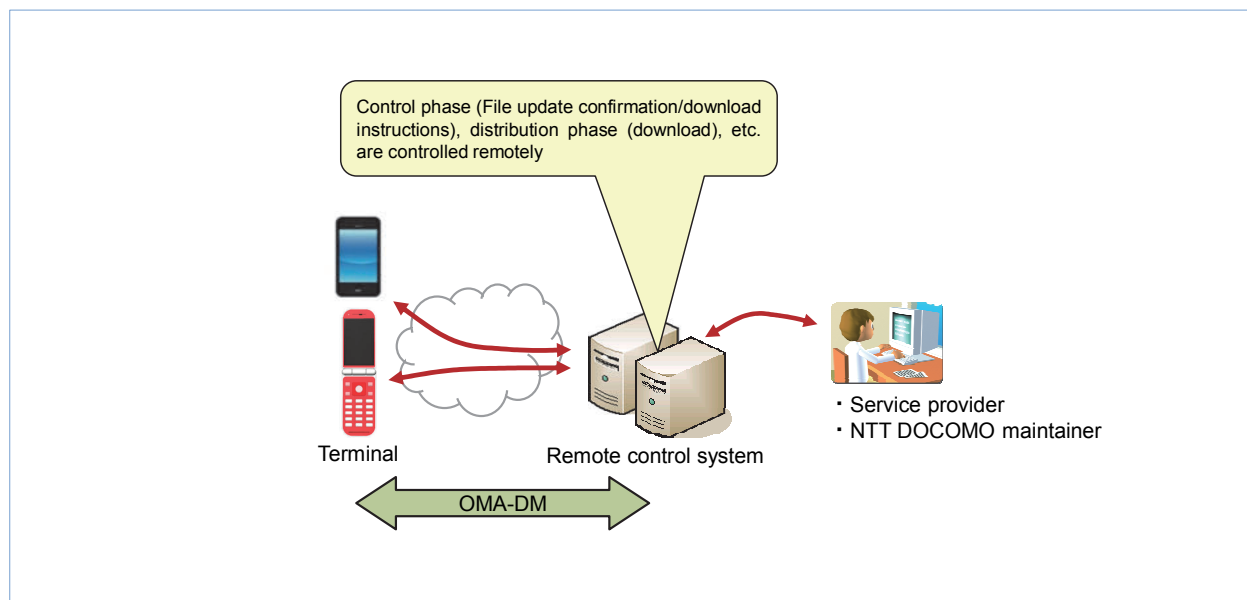


Figure 3 Remote control system overview

^{*7} Wi-Fi®: The name used for devices that interconnect on a wireless LAN using the IEEE802.11 standard specifications, as recognized by the Wi-Fi Alliance. A registered trademark of the Wi-Fi Alliance.

^{*8} OMA: An industry standardization organization that aims to standardize service and application technology and achieve interoperability in mobile communications.

^{*9} DM: Device management function.

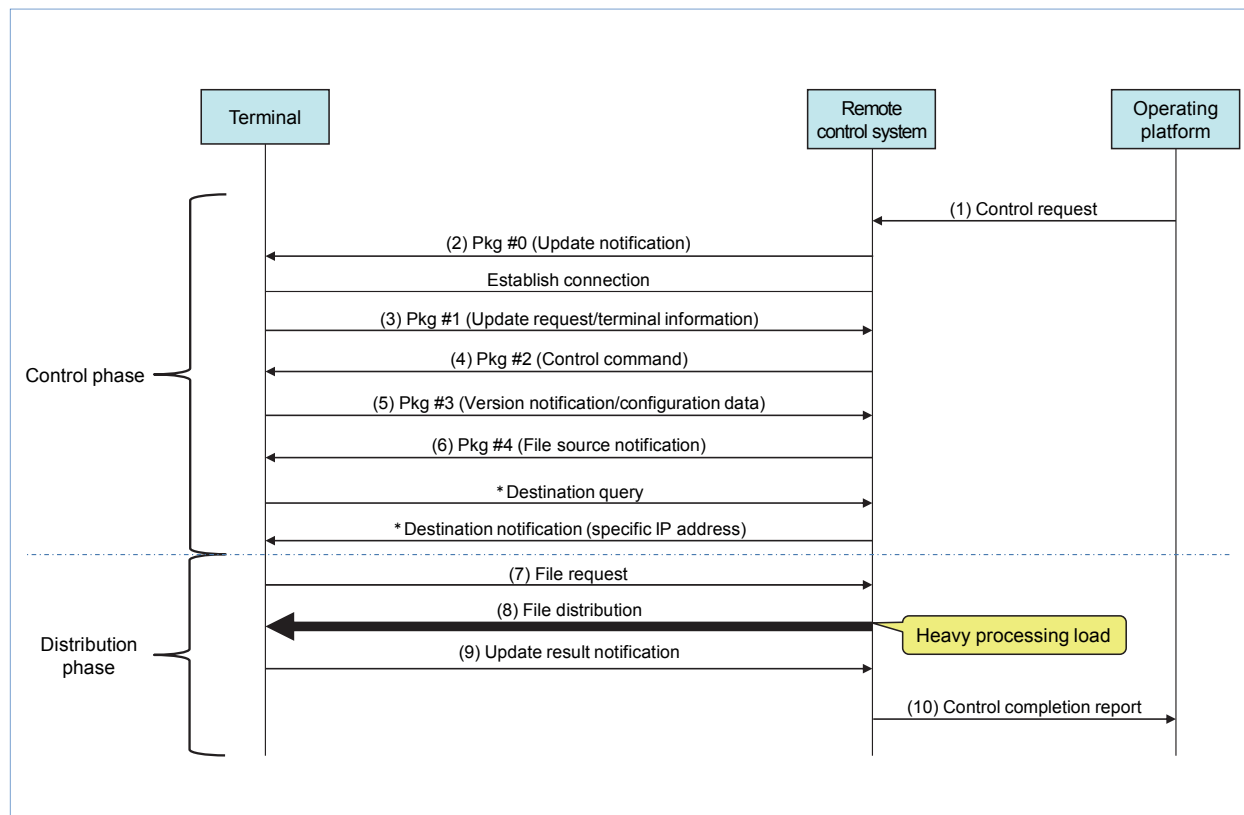


Figure 4 Process for OS update (before applying CDN)

request (Fig. 4 (1)) from the operating platform^{*10}, it sends an update request in the form of a Pkg#0 to the terminal (Fig. 4 (2)). After receiving the Pkg#0, the terminal establishes a connection with the remote control system using packet communication. Then, it sends Pkg#1 with update request/terminal information to the remote control system (Fig. 4 (3)). The remote control system then sends Pkg#2 with a control command to the terminal (Fig. 4 (4)) and the terminal sends Pkg#3 to the remote control system based on Pkg#2 (Fig. 4 (5)). The remote control system then sends Pkg#4 to the terminal, based on OS version and other information needed for the OS update in Pkg#3, indicating where to get the applicable files (Fig. 4 (6)). After receiving

Pkg#4, the terminal requests the necessary files from the specified location (Fig. 4 (7)), and downloads them (Fig. 4 (8)). After the update has completed, the terminal notifies the remote control system with the result (Fig. 4 (9)). After receiving this notification, the remote control system sends a control completion report to the operating platform, completing the control operation (Fig. 4 (10)).

2) Process Flow after CDN Application

The OS update process after applying the CDN is shown in **Figure 5**.

The process until Pkg#4 is the same as before applying the CDN, but then the terminal connects to a CDN distribution server to request the files (Fig. 5 (7)). This is implemented by indicating a CDN

^{*10} Operating platform: An operations system for service providers and operators to control terminals remotely through the remote control system.

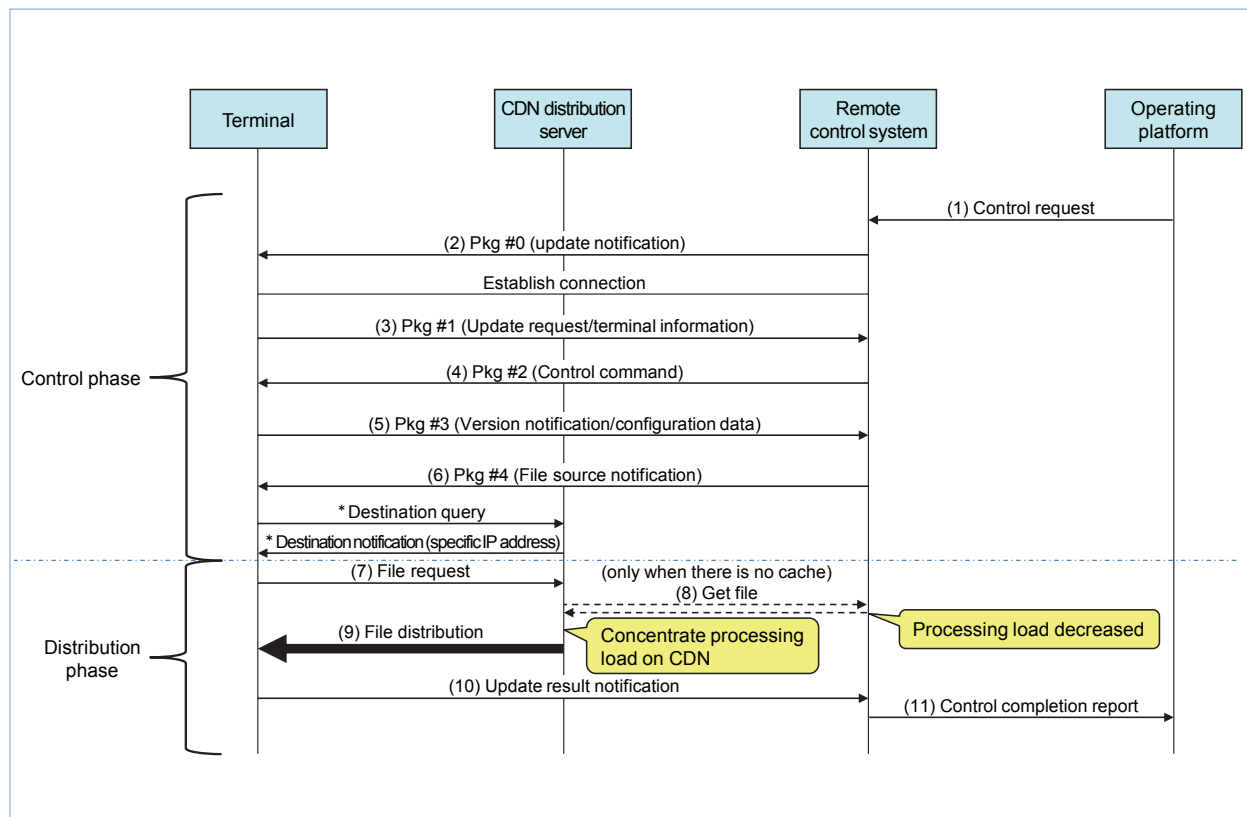


Figure 5 Process for OS update (after applying CDN)

distribution server instead of the remote control system, which was previously the source, when the remote control system notifies the terminal of the file source (Fig. 5 (6)). The control request sent from the operating platform can specify the file source that the remote control system indicates to the terminal on a per terminal basis (Fig. 5 (1)). This can be controlled for each terminal, including specifying that a terminal should request files from the remote control system in the conventional way, rather than from a CDN distribution server. This functionality makes it possible to control traffic.

When the CDN distribution server receives the file request, it checks whether it has the files in its cache and if it does, it sends the cached files to the

terminal (Fig. 5 (9)). If the cache does not contain the requested files, it gets the files from the remote control system (Fig. 5 (8)), and distributes them to the terminal while keeping them in its cache (Fig. 5 (9)). The load on the remote control system can be greatly reduced by having the CDN distribution servers handle distribution of large files that incur a greater processing load. The length of time files are saved in the cache can be set by the service provider or maintainer, but unless there is some shortage of resources on the distribution server, normally they remain in the cache until they are explicitly deleted by the service provider or maintainer.

3.3 Free-of-charge Feature

NTT DOCOMO OS and software updates are provided free-of-charge, regardless of how the client connects. Normally, communication with specific IP addresses^{*11} can be provided free-of-charge (Fig. 4*), but with the CDN, distribution is provided using access to many cache servers, so it is not well suited to providing free-of-charge service on a specific IP address. To implement a free-of-charge service even after applying the CDN, the CDN was customized so that all CDN distribution servers use a fixed destination address.

The system is designed to recognize NTT DOCOMO OS or software updates from the file source notification and the content of the file request in Pkg#4 (Fig. 5*), and to route the request to a particular CDN distribution server IP address. This enables traffic to the relevant IP address to be provided free-of-charge. A particular CDN distribution server receives the file requests and forwards them to another CDN distribution server deployed in a later stage. This arrangement has similar distribution capabilities as when not routing to the IP address of a particular CDN distribution server, while also allowing the communication to be identified as free-of-charge.

3.4 Use of General-Purpose Ports

Till now, the NTT DOCOMO remote control system has used proprietary port^{*12} numbers, mainly to identify different services. General-purpose ports were also intentionally not used for security reasons. However, with the application of the CDN, the system was changed to use general-purpose ports for two main reasons, as follows.

- (1) Changing perceptions of security. In the past,

non-regular ports were used as a way to make cyber-attacks more difficult, but attack methods have become more sophisticated and machine processing capabilities have increased, so that changing ports now has little effect in avoiding attacks. Conversely, by using only general-purpose ports, measures to strengthen security can be focused at specific locations, making security measures and security management easier for the overall system.

- (2) General-purpose ports are usually used with CDNs and are the same across CDN vendors. Thus, if for some reason there is a need to change vendors, it will be easier to switch vendors while keeping the same specifications. Also, by supporting ports common among vendors, it should also be possible in the future to implement a multi-CDN structure, using multiple CDN services at the same time. As our services diversify in the future, implementing a multi-CDN system would enable us to provide services according to various needs, using the different CDNs according to their respective merits. Note that when applying the CDN, we identify services by domain, so the service identification function is implemented the same as it was earlier, when services were identified by port.

4. Conclusion

This article has given an overview of CDN architectures and described features of their application to the NTT DOCOMO OS and software

^{*11} IP address: A unique identification number allocated to each computer or communications device connected to an IP network such as an intranet or the Internet.

^{*12} Port: In TCP/IP communication, a sub-address below an IP address used to specify different channels for communication on the same terminal.

update services. By applying a CDN to the remote control system, it is possible to distribute large files without expanding our download server equipment, and enabled us to deal with future increases in traffic demand. This will enable us to distribute update files more quickly to more users. We will also continue to implement service improvements

to provide services more quickly and to more users in the future.

REFERENCE

- [1] M. Wakui et al.: "Terminal Management and Control Platform System," NTT DOCOMO Technical Journal, Vol.11, No.3, pp.52-57, Dec. 2009.