# High-Speed Thin Client Technology for Mobile Environment: Mobile RVEC

● Masahiro Matsuda ● Kazuki Matsui ● Yuichi Sato ● Hiroaki Kameyama

**Thin client systems on smart devices have been attracting interest from mobile workers because they do not need to contain any important business data, leading to improved security and business efficiency. In order to use a virtual desktop smoothly in various mobile environments with fluctuating bandwidth and packet loss ratio, it is essential for smart devices to have a stable mechanism for transferring images over an unstable network and smooth touchscreen operation. To meet these requirements, Fujitsu Laboratories Ltd. has developed new technologies called Mobile RVEC. They consist of an adaptive image transfer mechanism that considers variations in network bandwidth on a real-time basis, a data transfer protocol for unstable networks, and a touchscreen-based user interface for mobile thin clients. These technologies promise to open up new applications such as interactive product demonstrations at customer premises on mobile thin clients.**

## 1. Introduction

Along with the recent rapid dissemination of smart devices such as smartphones and tablets and speed-up of the mobile communication environment, companies are increasingly using smart devices for business purposes in a mobile environment (**Figure 1**). Meanwhile, taking smart devices outside the company generates a risk of information leakage in the event that a device is lost or stolen. A thin client system, which does not require smart devices to contain business data from the server, is attracting attention as an effective solution in a mobile environment.

Fujitsu Laboratories has developed Remote Virtual Environment Computing (RVEC)[1), 2)] a high-speed thin client technology that improves the speed at which a device responds to user operations by reducing the amount of data transferred in handling video and high-definition images to about 1/10th than before in a virtual desktop, which is a desktop environment virtually deployed in a cloud and accessed from client devices. This technology is used as a core technology of Engineering Cloud.[3)]

Applying RVEC to smart devices and mobile communication environments requires a stable image transfer to be ensured even in networks with more packet losses and larger bandwidth variations as compared with wired networks. It also requires user interfaces that are suited for smart devices which integrate touchscreen-based interfaces.

This paper outlines Mobile RVEC,[4)] which is a high-speed thin client technology that extends RVEC, the virtual desktop high-speed thin client technology developed earlier, for adaptation to smart devices and mobile communication environments.

## 2. RVEC

RVEC is a high-speed thin client technology developed by Fujitsu Laboratories. It adopts a hybrid method in which frequently updated regions in the image are made into moving images, and differences between updates of other regions of the image are sent as still images (**Figure 2**).

Update frequencies are measured for the respective sub-regions resulting from division of the desktop image and high frequency sub-regions are extracted. Then, a rectangle that contains all of the extracted sub-regions is generated, and this forms the moving image region; the other regions are handled as still images. The regions are transferred to the client device by using methods that suit them respectively.


FUJITSU Sci. Tech. J., Vol. 49, No. 2, pp. 184–189 (April 2013)

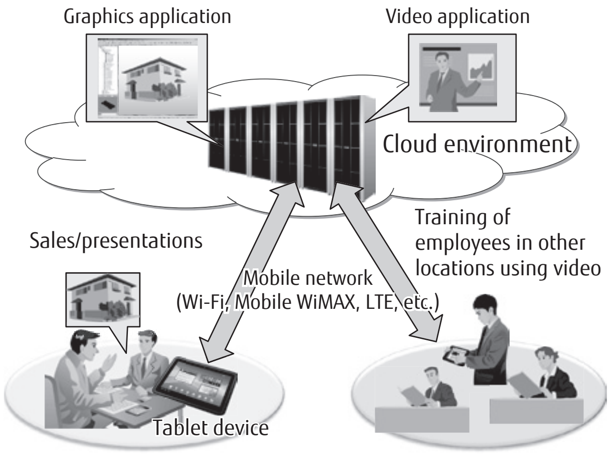


**Figure 1**
**Scenes of use cases for Mobile RVEC.**

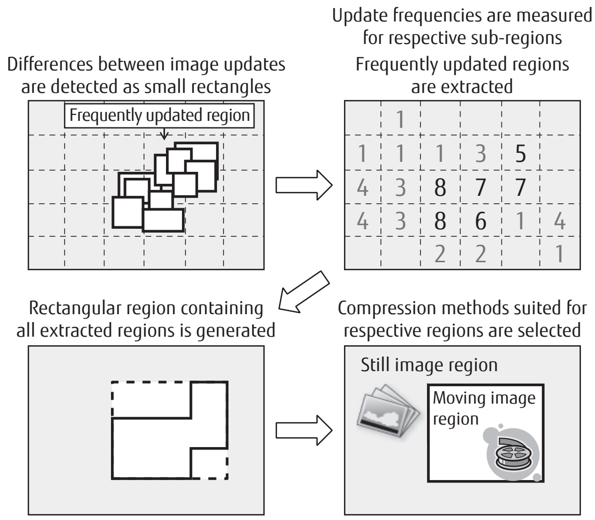


**Figure 2**
**Extraction of moving and still image regions.**

In the upper right part of Figure 2, the values for the respective sub-regions indicate the numbers of image updates made within a certain period of time. A larger value means more frequent image updates of the region and a larger amount of data as differences between image updates to be sent to the client.

Update frequencies are measured at regular time intervals according to the drawing frame rate to constantly adjust the moving and still image regions. This allows RVEC to minimize the amount of transfer according to the screen display. In addition, the moving image region has been limited to a portion of the desktop image to improve the processing efficiency, and this has made it possible to operate mobile devices only with software and eliminated the need to introduce dedicated hardware.

With RVEC, differences between image updates are classified into regions to be sent as moving images and those to be sent as still images according to the desktop update frequencies. For moving images, there are several compression methods including MPEG, for example. All these methods use the image data of the previous frame to compress data. This allows for a generally higher compression rate as compared with still image compression methods, which only use data of one image for compression processing.

At the same time, regions to be sent as still images may also cause an increase in the total amount of data to be transferred if the compression rate achieved by the still image compression method used is low. For that reason, the compression rate of still image compression must be increased as well. To address this issue, RVEC selects a suitable compression method according to the image characteristics.

**Figure 3** shows an overview of the RVEC architecture. The compression method is selected after the image update regions have been extracted, and classified into those to be sent as moving images and those to be sent as still images. For the regions classified as those to be sent as still images, the still image compression method is selected according to the image characteristics.

In the virtual desktop trial environment of Fujitsu Laboratories, the amount of data transfer for playing back a high-definition (HD) moving image (1280 × 720 dots) by using RVEC has been compared with that when using Remote Desktop Protocol (RDP), a conventional image transfer method. The results showed that the amount can be reduced to approximately 1/10th (0.93 Mb/s).

## 3. Technological challenges

As described earlier, the need for thin clients is increasing also in business operations using smart devices.

However, the amount of image data to be transferred when using thin clients poses an obstacle and, in a mobile environment, the responsiveness of thin clients is often significantly deteriorated as compared

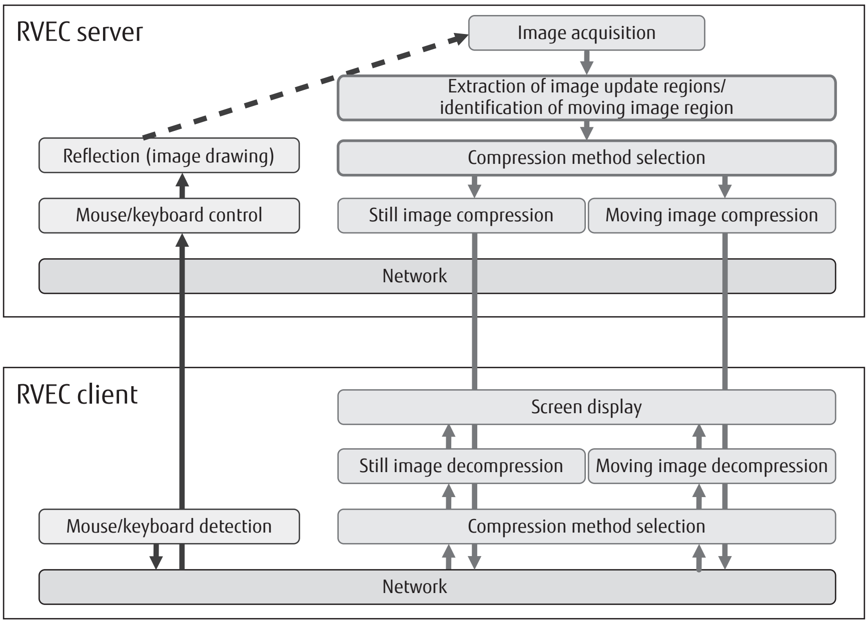


**Figure 3**
**RVEC architecture.**

with using them in a stable network environment such as an internal wired LAN. In addition, a mobile environment is often subject to considerable variations in traffic conditions ranging from a few hundred kb/s to a few Mb/s depending on the time and place. The network delay may also reach a few tens to 200 ms in terms of round-trip time for various reasons such as signal conditions.

In short, reducing the average amount of image data to be transferred has a certain level of effect in a mobile environment and improves the responsiveness of a device to operations, but new measures must be taken to address variations in the communication bandwidth that can be used (available bandwidth) and network delay.

Furthermore, while a mouse is often used to operate a PC, smart devices often do not have a mouse connected and are operated by touchscreen only. Accordingly, user interfaces that are premised on touchscreen operations and are easy to use for users are necessary in order for thin clients to be used on smart devices.

## 4. Developed technology

To overcome the challenges mentioned above and contribute to thin client solutions and services that use smart devices including tablets, we have extended RVEC, a technology we have developed up to now, so that it can be adapted to a mobile environment. We have developed Mobile RVEC, a high-speed thin client technology intended for a mobile environment. The following subsections describe the features of this technology.

### 4.1 Technology to reduce dynamically amount of image data

We have developed technology to reduce dynamically the amount of image data. In a virtual desktop environment, it adjusts the image quality and drawing frame rate when operating an application, in response to the available communication bandwidth, before sending data to the client. This has successfully speeded up the responsiveness of devices by up to about 10 times that of RDP, a conventional method (**Figure 4**).

This technology to reduce dynamically the amount of image data consists of technology to estimate the available bandwidth and technology to control the display frame rate.

With the technology to estimate the available bandwidth, the estimated data arrival time is calculated based on the average reception bit rate; then the excess delay time, which is the difference from the actual arrival time, is found and the available bandwidth is estimated with high accuracy based on the excess delay time. The reception bit rate for a large excess delay time (e.g., 300 ms or larger) is estimated as the marginal performance (available bandwidth) of the network.

With the technology to control the display frame rate, the bandwidth estimated by the technology to estimate the available bandwidth, as described above, and the present desktop update data volume is used as the basis for dynamically adjusting the transmission frame rate. If any excess delay is detected, the transmission timing is temporarily put off by a predefined period so as to eliminate the delay.

By using these technologies, even when the available bandwidth of the network fluctuates, an appropriate volume of image data can be sent to the client according to the available bandwidth at a given time. In this way, we can suppress any deterioration in operability caused by accumulated operational delays that result from image data that are sent by the server but not received by the client.

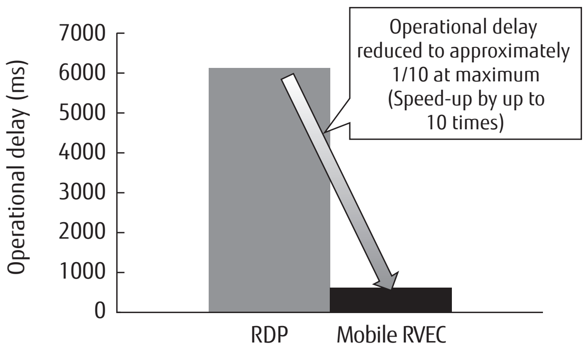


**Figure 4**
**Comparison of operational delay.**

## 4.2 Technology for high-speed data transfer

International connections or mobile environments may cause relatively high round-trip time and packet loss ratios. **Table 1** shows the result of actually measuring data transfer speeds in mobile environments by using SPEEDTEST.NET[5] at our office. To reduce operational delays on a virtual desktop in a network environment with high round-trip time and packet loss like these, we have developed technology for high-speed data transfer that makes use of our new proprietary protocol. By applying this technology, we have increased the data transfer speed by about six times with reference to the Transmission Control Protocol (TCP) used in the existing RVEC (network environment for measurement: used bandwidth of 4 Mb/s, round-trip time of 200 ms and packet loss ratio of 1%).

RVEC conventionally used the TCP for data transfer. The TCP returns a response called ACK for each data packet received and, when data are lost due to packet loss, resends the same data, thereby ensuring that data are delivered. One problem with the TCP is that, when the round-trip time is high, it takes longer before ACK is returned, which results in a lower transfer speed. In addition, after a packet loss is detected, it also takes longer before the lost packet can be resent. Accordingly, the transfer speed was severely reduced when packet losses occurred frequently, and this caused a significant deterioration in the operability of RVEC.

The new protocol is based on the User Datagram Protocol (UDP), a protocol used for streaming video relay, instead of the TCP. The UDP uses a transfer system of successively sending data without waiting for ACK and does not cause a speed reduction due to round-trip time or packet loss. However, it does not have a mechanism for resending data, which means that data delivery is not ensured. As opposed to this, the new protocol is equipped with a unique resending control system in which any packet loss is quickly

**Table 1**
**Actual measurements of wireless networks at Fujitsu's office.**

| Communication system | Standard | Actual measurement | |
|---|---|---|---|
| | | Round-trip delay (ms) | Packet loss ratio (%) |
| Wi-Fi | IEEE 802.11n | 10 max. | 10 max. |
| 3G | CDMA2000 1x | 100 | 1 max. |
| Mobile WiMAX | IEEE 802.16e-2005 | 70 | 0.5 max. |

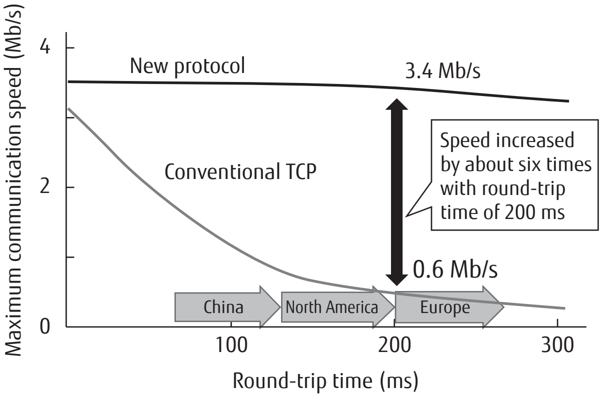


**Figure 5**
**Result of measurement in simulation environment (bandwidth 4 Mb/s, packet loss ratio 1%).**

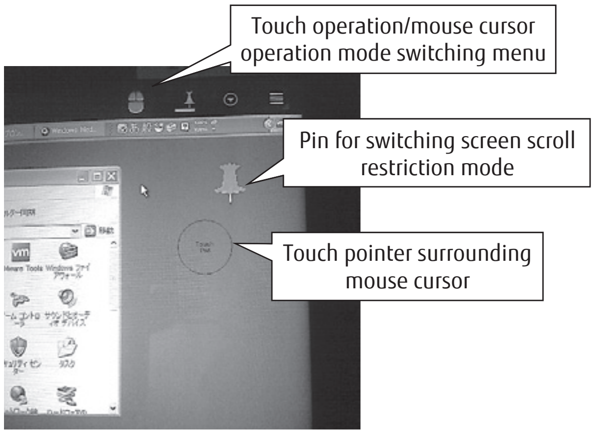


**Figure 6**
**Mobile RVEC client screen (Android device).**

detected and the lost packet(s) can be promptly resent.

As shown in **Figure 5**, the new protocol is less susceptible to the impact of round-trip time than the TCP and, if packet loss occurs frequently, the lost packets can be efficiently resent, preventing any reduction in data transfer speed. For that reason, RVEC can now be used without any deterioration in operability even in network environments with relatively high round-trip time and packet loss ratios, such as international connections and mobile environments.

## 4.3 User interface for smart devices

While a mouse is used for applications running on Windows on a PC, using a virtual desktop by means of a thin client on a smart device such as a tablet is done by touchscreen in place of a mouse, and this cannot be readily achieved. To achieve it, we have developed for Mobile RVEC the following new user interface features intended for smart devices (**Figure 6**).

1) Screen-scroll restriction mode

Moving a finger as a touchscreen operation inadvertently causes the virtual desktop screen to scroll and hinders operations originally intended by the user such as moving a window or folder icon. In the screen-scroll restriction mode, the selected object (such as a window or folder icon) is moved according to the movement of a finger as a touchscreen operation without moving the virtual desktop screen.

2) Mode switching between touchscreen and mouse cursor operation

When a more delicate operation than moving and selecting an object is required, this operation mode switching causes the mouse cursor to appear and allows operations similar to mouse operations to be achieved by touchscreen.

3) Touch pointer surrounding mouse cursor

To make it simpler to operate a mouse cursor by touchscreen, a touch pointer (circular area) is shown around the mouse cursor and the user can operate the mouse cursor by touching inside the circular area with a finger.

## 5. Future activities

Thin clients, such as a tablet running Android, are being used more and more in mobile environments. Meanwhile, the respective characteristics of various mobile networks including wireless LAN, Mobile WiMAX and LTE need to be considered when using them with thin clients. We are planning to develop a technology in which the thin client system automatically tunes various parameters rather than an administrator having to manually configure individual parameters.

## 6. Conclusion

This paper has presented Mobile RVEC, a high-speed thin client technology that improves the responsiveness of thin client systems in a mobile environment. In the future, we intend to further enhance this technology so that it can be applied to various mobile solutions, such as one that offers secure access to virtual desktops from a mobile environment.

## References


1) Fujitsu Laboratories: Fujitsu Develops High-Speed Thin-client Technology to Improve Responsiveness of Virtual Desktop (in Japanese).
*http://pr.fujitsu.com/jp/news/2011/05/2.html*
2) K. Matsui et al.: Virtual Desktop Display Acceleration Technology: RVEC. *Fujitsu Sci. Tech. J.*, Vol. 48, No. 4, pp. 469–475 (2012).
3) S. Saito et al.: Engineering Cloud: Flexible and Integrated Development Environment. *Fujitsu Sci. Tech. J.*, Vol. 47, No. 4, pp. 408–417 (2011).
4) Fujitsu Laboratories: Fujitsu Develops High-Speed Thin Client Technology for 10-Fold Improvement in Responsiveness.
*http://www.fujitsu.com/global/news/pr/archives/month/2012/20120515-05.html*
5) SPEEDTEST.NET.
*http://speedtest.net/*



**Masahiro Matsuda**
*Fujitsu Laboratories Ltd.*
Mr. Matsuda is currently engaged in research and development of mobile service platform technology and M2M platform technology.



**Kazuki Matsui**
*Fujitsu Laboratories Ltd.*
Mr. Matsui is currently engaged in research and development of mobile service platform technology and virtual desktop technology.



**Yuichi Sato**
*Fujitsu Laboratories Ltd.*
Dr. Sato is currently engaged in the research and development of a holistic simulation platform with the emphasis on *monozukuri* (design and manufacturing) and financial applications.



**Hiroaki Kameyama**
*Fujitsu Laboratories Ltd.*
Dr. Kameyama is currently engaged in the research and development of simulation technologies such as high-speed data transfer, parallelization and their applications.