Engineering Cloud: Flexible and Integrated Development Environment

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Nowadays product development must be done speedily and in a way that can respond to changing business environments. Fujitsu has created a development environment that uses technical computing and is known as Flexible Technical Computing Platform (FTCP), on a cloud. Fujitsu is providing it as Engineering Cloud to its customers and Product Development Department. Based on an example of applying Engineering Cloud to mobile phones, this paper describes the characteristics of FTCP, an overview of Fujitsu's Engineering Cloud service and its merits, and technology for promptly displaying the results of large-scale simulations, which is important technology for achieving Engineering Cloud. Based on Fujitsu's know-how that it has accumulated during its in-house operation of Engineering Cloud, it has become possible to link the created FTCP and customers' existing development environments. This in turn raises hopes for a shortened product development time and higher product quality.

1. Introduction

Product development is now required to be speedy and responsive to changing business environments. Fujitsu has built on a cloud a development platform that uses technical computing. This platform offers improved development efficiency, reduced development time and improved design quality, achieved by linking the development assets across the company. In addition, this development platform built on a cloud is also offered to users both inside and outside the Fujitsu Group as Engineering Cloud.

This paper describes the characteristics of Fujitsu's development platform based on an example of applying it to mobile phones. It also describes the benefits of cloud-based development environments, and gives an overview of Fujitsu's Engineering Cloud service and the new technology that has been developed for promptly displaying the results of simulations. This technology is important for achieving Engineering Cloud.

2. Development platform that uses technical computing

To reduce product development time and improve design quality, the efficiency of input/output and analysis verification must be improved by using development tools in the respective design phases. In addition, an integrated development environment must be constructed that allows development assets to be shared across the entire life cycle including product planning, design, manufacturing and operation services. This environment should also enable individual departments to share their accumulated know-how.

Fujitsu has long been engaged in development by making use of electrical or mechanical simulations. However, the conventional simulations have been used in a supplementary manner and prototypes have been made to conduct evaluation and verification. This

has caused problems such as putting pressure on development times when there is development rework and giving rise to field failures when there is inadequate verification with prototypes.

To address these problems, Fujitsu built the Flexible Technical Computing Platform (FTCP) in 2004 as a development environment that makes use of technical computing. Simulations and design rule check (DRC) verifications are conducted in view of the entire product life cycle, from the product planning phase through design and manufacturing to operation services. They can then be incorporated in the development process, as shown in **Figure 1**. FTCP is intended not only for using simulations to optimize initial design values, but also identifying failures over the entire product life cycle. This needs to be done without making prototypes so that development time can be reduced and quality and performance improved, by taking advantage of technical computing.

The main points in improving design efficiency and sharing development information and know-how include:

1) Having an integrated design on FTCP (circuit design, printed board design, structural design and verification, manufacturability and maintainability, environmental burden calculation, manufacturing procedure, work instructions, etc.)
2) Visualizing technical challenges and identifying elemental technologies in the early stages
3) Using technical computing in conjunction with designs to enhance simulation and DRC verification

For the development of mobile phone handsets, simulations on FTCP and advance verification have been incorporated in the development process on a full-scale basis since 2004.[1)–4)]

Consequently, compared with models developed between 2004 and 2005, before the application of FTCP, the overall development time for models developed in 2008 was reduced to 10 months from 18 months, as shown in **Table 1**. In addition, person-hours for testing and taking the required measures to prevent electromagnetic

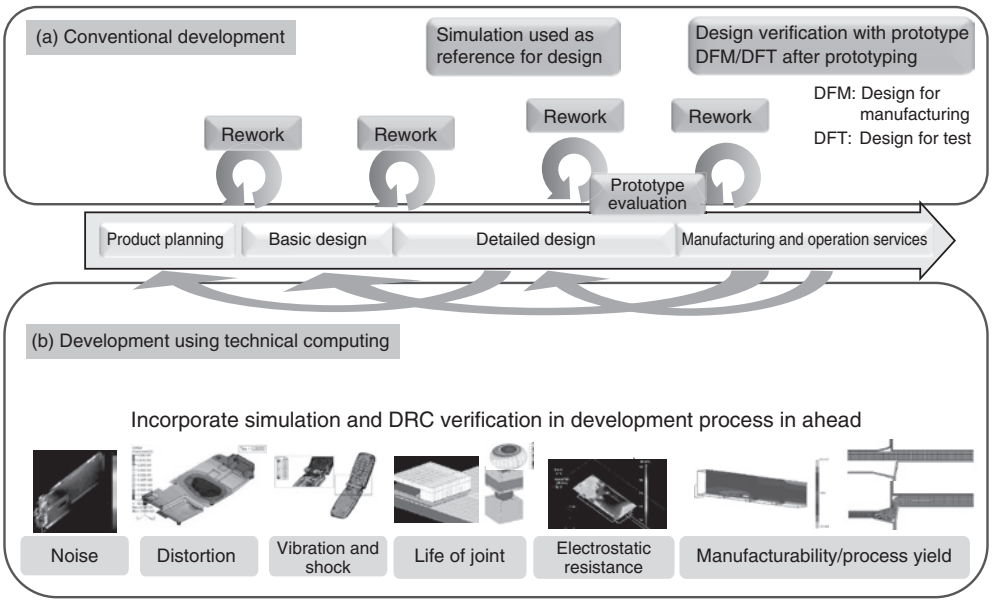


Figure 1
Development platform using technical computing.

interference (EMI) and electrostatic discharge (ESD) were reduced by 38% and 67% respectively. In the thermal design, the person-hours needed to prevent an increase in the temperature of the casing of mobile phone handsets, regardless of how much heat the components generate, have been reduced by 40%. Furthermore, costs required for dealing with field failures have also been reduced to one-fifth.[1)]

Table 1
Effect of application of technical computing (example of mobile phone handset).

Item	Before application (2004–2005)	After application (2008)
Design and development time (entire equipment)	18 months	10 months
Time required for EMI testing and taking measures	—	Down 38%
Time required for ESD prevention testing and taking measures	—	Down 67%
Thermal design (temperature rise due to heat generation of components)	—	Down 40%
Field repair costs	—	Down 80%

3. Need for Engineering Cloud and Fujitsu's response

In future development that uses technical computing, it will be necessary to address the increase in computational complexity resulting from multiscale or multiphysics modeling used for simulation and verification. Multiscale modeling leads to increased computational complexity because of the greater scope of simulation or the higher accuracy of simulations. Multiphysics modeling means integrating different types of simulations such as linking thermal and mechanical simulations at joints and linking chemical reaction and electrical simulations on batteries.

Figure 2 shows the increase in computational complexity due to multiscale modeling (using the example of an electromagnetic field simulation). In electromagnetic simulation, due to limitations in computational complexity, current efforts are aiming to simplify simulation models and margin design in view of improving the low accuracy of simulation. In order to model CAD-developed design data as they are for use

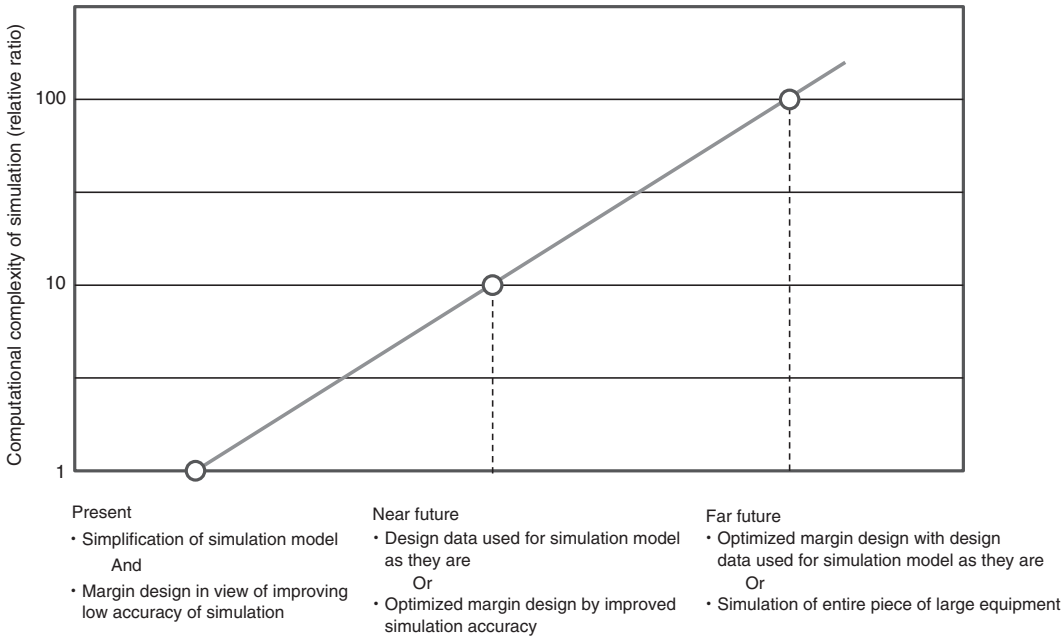


Figure 2
Increase in amount of calculations (example of electrostatic discharge simulation).

in simulations or improve simulation accuracy in the future, about 10 times more computational complexity will be required. To make simulations into models and have more accurate simulations or simulate entire pieces of large equipment, about 100 times more computational complexity will be necessary.

One challenge has been that preparing FTCP-exclusive resources for such increase in computational complexity requires a large amount of money to be invested.

On the existing FTCP, various simulation resources are centrally managed ready to be offered by an application service provider (ASP), but development data and know-how are managed by the respective departments. Furthermore, different simulations are linked by the development department that owns the development data, rather than by an ASP. For this reason, development data and know-how have been kept within the respective departments and it has been difficult to share them across the board.

To solve the problems related to increased computational complexity and company-wide sharing of development data and know-how, Fujitsu has built FTCP on a cloud. As shown in **Figure 3**, Fujitsu carried out a reform in 2000 in accordance with the changes in the development environments. The environments shifted from department-specific ones using department servers to ones with shared resources that used an in-house ASP. Since 2010, Fujitsu has intended to build FTCP on a cloud as Engineering Cloud from an in-house ASP to provide developers with development environments that integrate development data and know-how from the entire company.

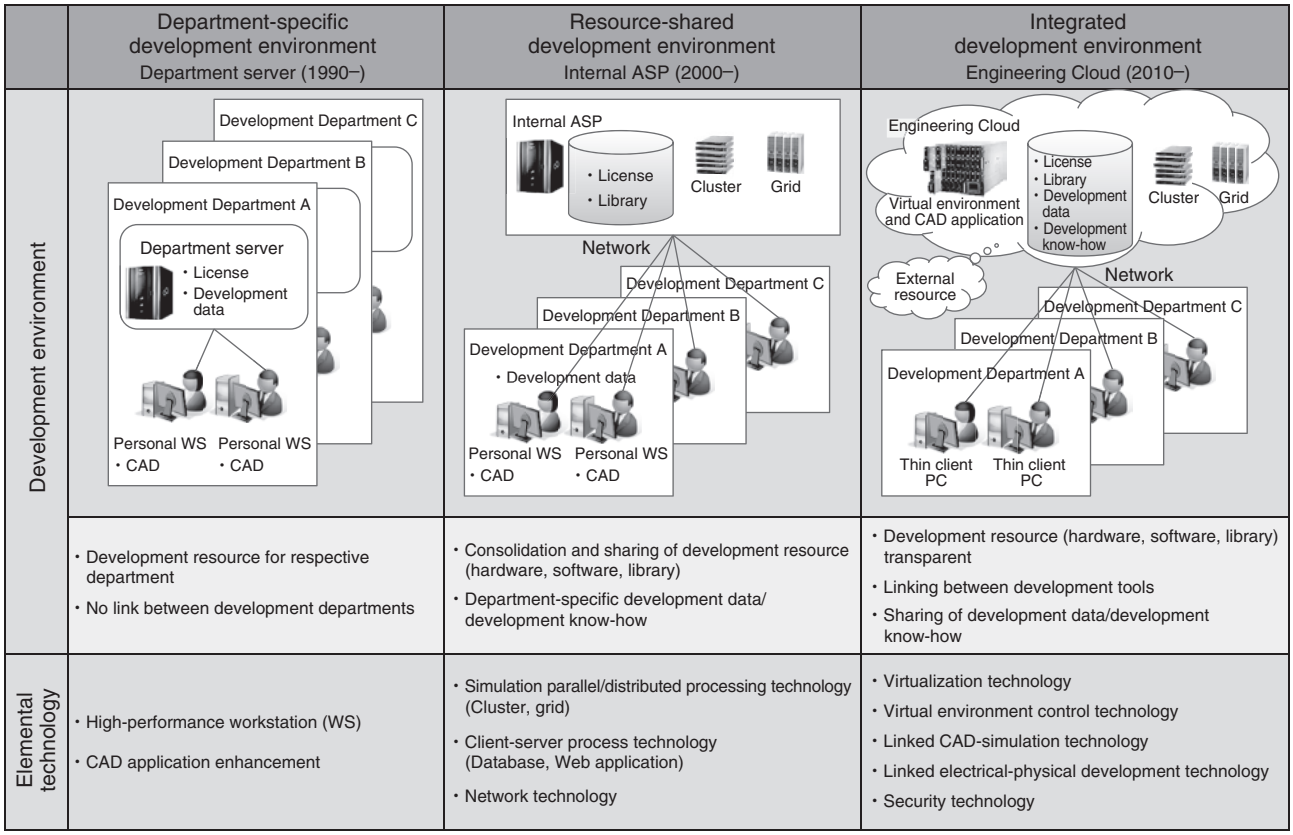


Figure 3
Revolution in Fujitsu's development environment.

4. Fujitsu's Engineering Cloud service

Figure 4 shows the Engineering Cloud development environment that Fujitsu aims to build.[5)–8)]

Using an application for simulation as it is, left on a cloud, by means of a remote client terminal will increase the data traffic between the client and cloud server. For example, displaying a large amount of data such as the results of an electromagnetic field simulation on a client terminal takes significantly longer than with the conventional desktop development environment.

With Fujitsu's Engineering Cloud, high-speed display technology suited for a cloud environment has been developed. This offers a development environment that allows developers to use development resources and data without stress, as they stay on the cloud. This in turn allows development data to be shared between departments and collaborations to be made with external parties without having to transfer development data or strategic applications to the outside. This helps improve security as well.

Fujitsu also intends to offer the Engineering Cloud development environment, cultivated through its in-house operations, to customers outside the Fujitsu Group as Engineering Cloud service. This will also allow customers to use FTCP as it is, an environment that has been built based on the know-how accumulated during Fujitsu's in-house operations. It also makes it possible to use Engineering Cloud to link FTCP to the customers' existing development environments or existing development data.

The characteristics of Engineering Cloud described above and merits of Fujitsu Engineering Cloud service offered to customers are shown below (**Table 2**).

1) All developers can use development environments of the same quality and

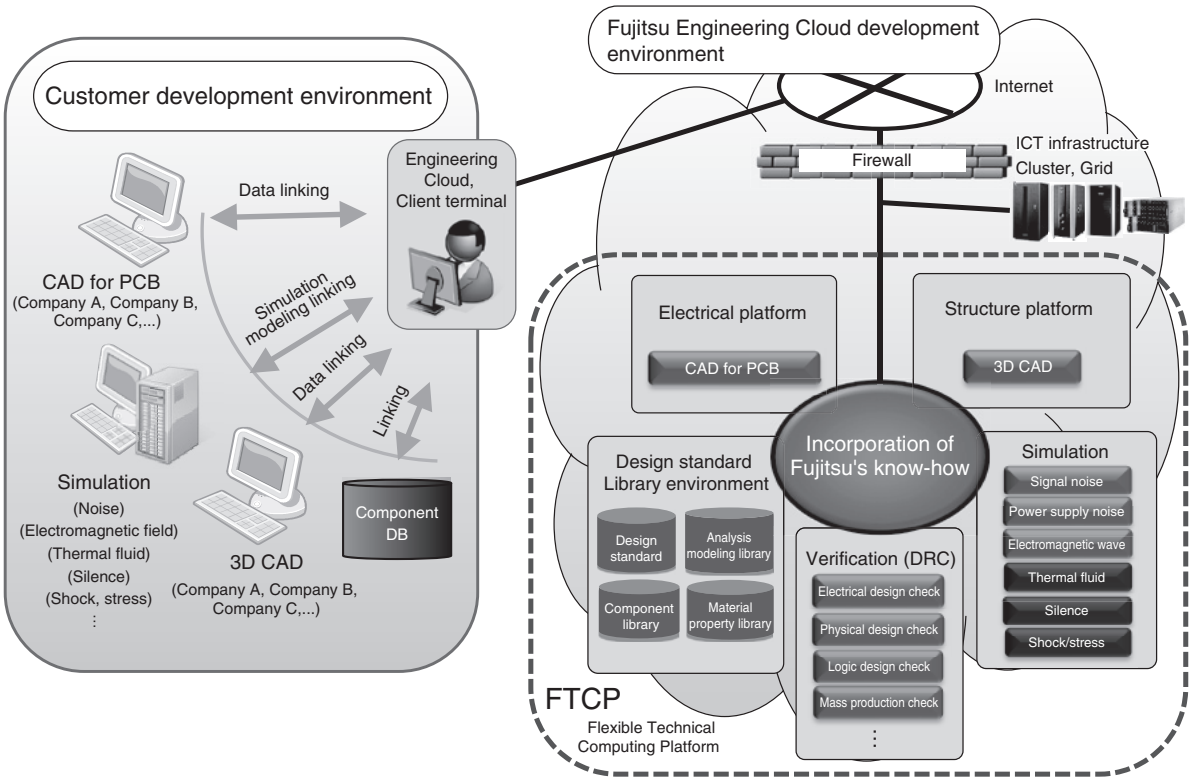


Figure 4
Link between Engineering Cloud environment and customers' development environment.

Table 2
Merits of Engineering Cloud.

Item	Merits of using cloud	Merits to users of Fujitsu's Engineering Cloud
Scalability	Availability of computer resources according to computational complexity required	Simulation requiring high computer capacity such as multiscale and multiphysics modeling is possible without making investments.
		New development projects can be quickly launched.
Immediacy	No need for advance hardware/software installation or system construction	Development environment verified through Fujitsu's in-house operation is readily available.
		Linking between electrical and mechanical design and between development tools and use of existing assets become possible.
Concurrency	Shareability and availability of latest design information anytime, anywhere and to anybody	Know-how accumulated by respective departments such as different development departments for different models and design, manufacturing and customer support departments can be integrated.
		Ease of use outside offices (during business trips or at home) helps smooth communication with people in other departments or with different working patterns.
		Design processes can be made visible for sharing excellent design assets and processes as property.
		Development in collaboration with cooperating companies and partners can be made easy.
Security	No need to take design data outside	Secure development environment can be built in which design data are not "exposed outside (not placed on developers' local environments)."

capabilities including use of high computer capacity for multiscale and multiphysics modeling.

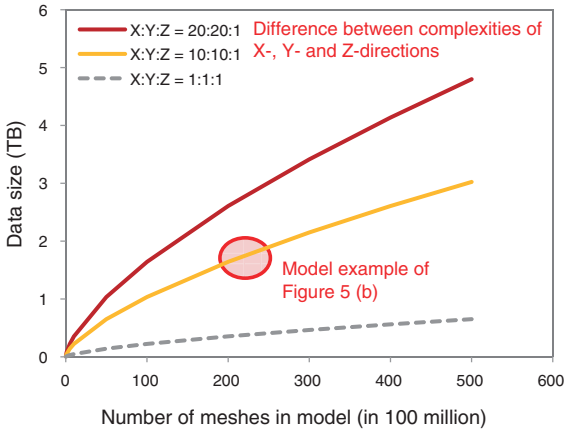
2) A development environment verified through Fujitsu's in-house operation is readily available.
3) It is possible to link between electrical and mechanical designs and between development tools and use existing development tools and development data.
4) A secure development environment (keeping know-how confidential) can be established, in which development data, development applications or content are not exposed to outside parties (not placed in developers' local environments).
5) It is possible to integrate know-how that has been accumulated by the respective departments such as different development departments for different models and planning, design, manufacturing and customer support departments.

5. High-speed display technology suited for Engineering Cloud

As explained earlier, Fujitsu's Engineering Cloud is intended to allow developers to use client terminals in a stress-free way. It can let them access development environments on a cloud via a network, with applications and development data remaining on the cloud.

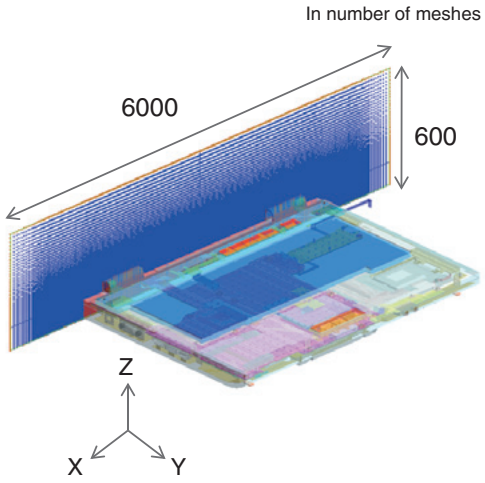
In such a cloud development environment, the response speed for displaying on the client a large amount of data from the results of a simulation executed on the cloud server becomes an issue.

The amount of data produced by an electromagnetic field simulation, for example, will vary depending on the number of meshes in the simulation model, difference between the complexities in the X-, Y- and Z-directions of the model, number of observation planes and number of observation times [**Figure5 (a)**]. Let's take the example of an ESD simulation for a notebook PC as shown in **Figure 5 (b)**. In this example, we assume there are 21.6 billion meshes in the model (X:Y:Z = 6000:6000:600), 10



Conditions) Number of observation planes = 10, number of observation times = 200 (10 ns at intervals of 50 ps)

(a) Number of meshes in model and data size of simulation result



(b) Model example (ESD simulation model for notebook PC)

Figure 5
Size of data produced by ESD simulation.

observation planes, and 200 observation times (10 ns at intervals of 50 ps). In this case, the amount of data produced by the simulation will be approximately 9 GB per observation time and 1.8 TB for the entire 200 observation times.

To display this simulation result as an image, reading the simulation result data for conversion into screen drawing data was a bottleneck in the display speed. Accordingly, high-speed display was difficult [**Figure 6 (a)**] even in the normal desktop development environment. The situation is even more adverse in a cloud development environment. This is because there is possible network congestion due to LAN/WAN connection and the difficulty of transferring a large amount of data and the network transfer rate causes a bottleneck in the display speed [**Figure 6 (b)**]. For this reason, displaying the example in Figure 5 takes approximately 3 seconds per observation time (0.3 frames per second) with the conventional display technology. To make a cloud development environment free of stress for developers, achieving a smooth image display has been a challenge.

To realize Engineering Cloud, high-speed display technology has been developed to solve this challenge. This technology compresses the traffic for model data and simulation result data to about one-hundredth of the conventional amount. This technology has the following functions.

1) Compresses drawing data when converting them from model and simulation results on the cloud server, sends the compressed data to a client via the network and extracts them on the client to restore screen drawing data [**Figure 6 (c)**].
2) For high-speed conversion to drawing data, which has high computational complexity, and data compression, it processes data with a data processing unit provided in the cloud server exclusively for drawing conversion and data compression (**Figure 7**).

The effect of this high-speed technology has been verified by operations in the actual cloud development environment. While the model and simulation results were displayed at a rate of only 0.3 frames per second with the conventional system, the technology has achieved a rate of 30 frames per second even in a cloud development environment with WAN, an improvement of 100

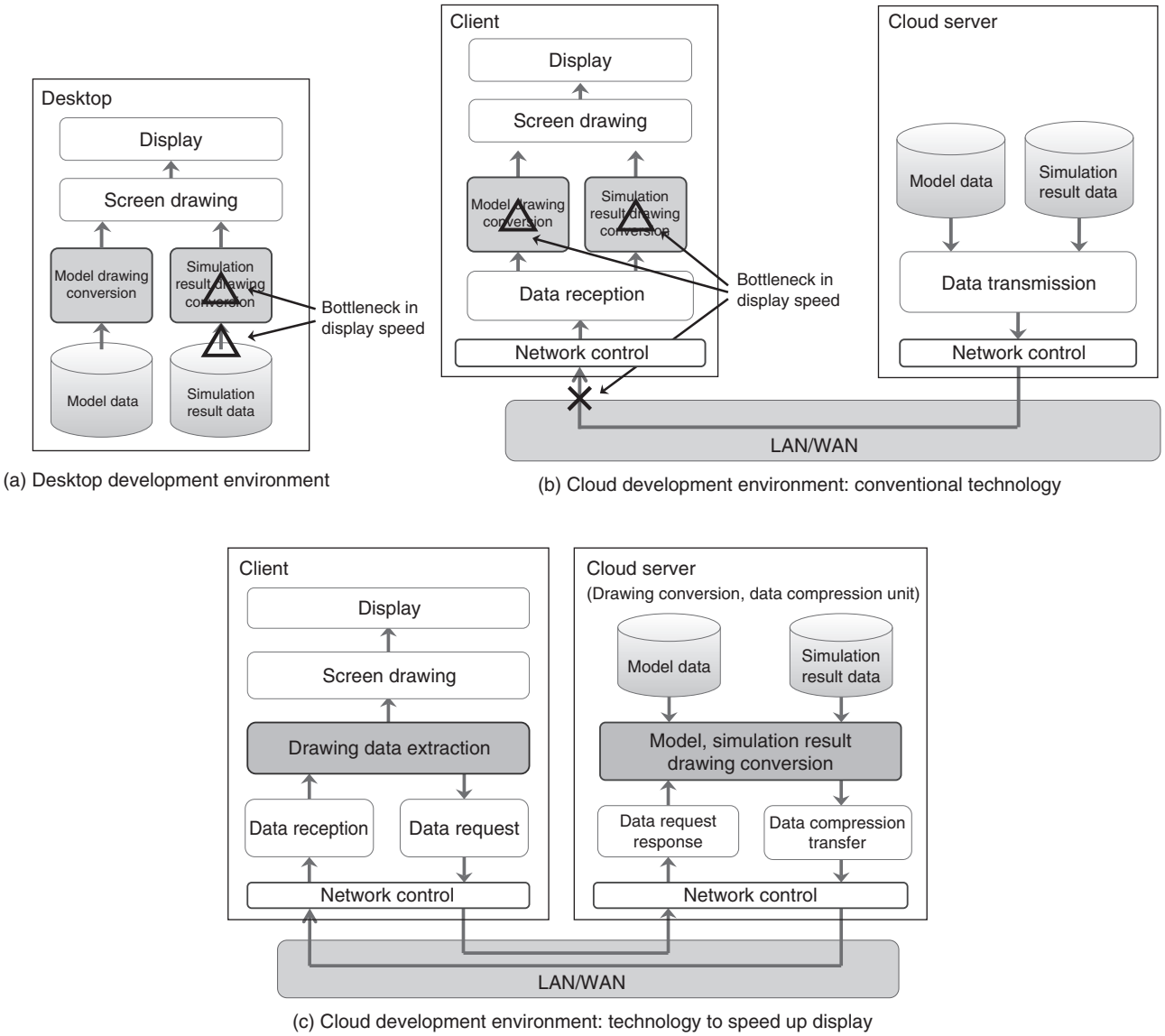


Figure 6
Technology to display results of ESD analysis.

times.

This technology allows stress-free use of applications such as electromagnetic field simulations, which generate a large amount of data, as they stay on Engineering Cloud.

6. Conclusion

This paper has presented the characteristics of FTCP, a development environment that uses Fujitsu's technical computing, based on a practical example of mobile phone handsets. The benefits of the Engineering Cloud development environment, which is an FTCP development environment built on a cloud, have also been described.

To allow developers to use a development environment without stress as applications and development data are left on the cloud, high-speed display of large data such as simulation results is required. Fujitsu has developed new high-speed display technology for converting drawings and compressing data on a cloud server

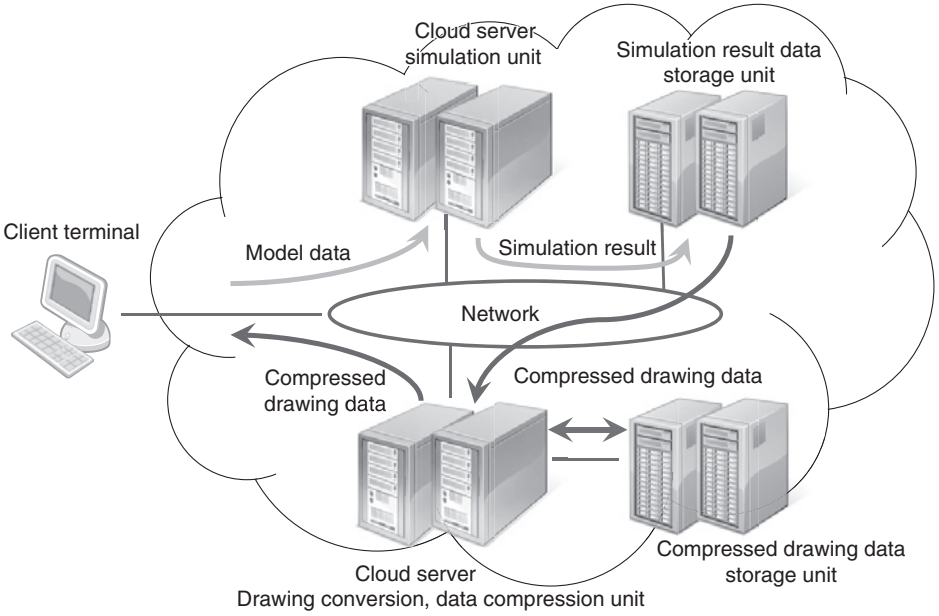


Figure 7
Overview of system to promptly display results of ESD simulation.

and verified the technology's ability to smoothly display data in an actual cloud development environment.

With this technology, customers outside the Fujitsu Group that use Fujitsu's Engineering Cloud service can immediately make use of FTCP, which has been built based on the know-how accumulated through Fujitsu's in-house operations. They can also link their existing development environments and existing development data on Engineering Cloud, which raises hopes for a shorter product development time and higher product quality.

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