New Middleware as a Driver of Innovation

● Masaya Yamada

Looking to the future, all manner of things will come to be connected to the Internet, resulting in the exchange of massive amounts of information. In that world, innovative approaches to converting constant streams of information into real value will play a major role in growing a company's business and promoting social development. Believing that the three management resources of people, information, and infrastructure are the key elements driving innovation, Fujitsu has announced a Mobile Initiative, Big Data Initiative, Cloud Initiative, and Security Initiative as a system for providing information and communications technology (ICT) products that integrate and use those elements. In this system, middleware—the foundation of solutions and systems—will be given the role of coordinating and integrating a wide variety of services, networks, and mobile devices and of achieving safe and easy-to-manage operations. It will also have the role of supporting innovation in the field for corporate business. Fujitsu is leveraging the know-how it has accumulated in implementing systems both inside and outside the company to promote the further evolution of middleware. This paper describes Fujitsu middleware that supports these four initiatives.

1. Introduction

People and things in the real world are becoming increasingly intertwined and mutually dependent in complicated ways, and they are becoming interconnected via the Internet, creating a massive exchange of information. At the World Economic Forum, this is called a "hyperconnected world," which is expected to have major implications for the future. In such a world, it is thought that changing this massive amount of continuously moving information into new value through innovation will be an important factor in the growth of corporate business and the development of society.[1]

Against this background, Fujitsu has presented its vision of a Human Centric Intelligent Society and has undertaken the development of information and communications technologies (ICTs) toward systematic innovation as a Fujitsu Technology and Service Vision.[2] Fujitsu considers the three management resources of people, information, and infrastructure to be the key elements driving innovation in society. It has proposed ICT products and services that can merge and effectively use these three elements as described below (**Figure 1**).

1) People

The creativity and productivity of people can be raised through the power of ICT. Fujitsu's system engineers have the technical know-how to optimally integrate technologies and services in a way that drives innovation in the customer's enterprise. In addition, mobile devices—which have become just about everyone's favorite productivity tool—enable ICT to support people in making decisions and taking appropriate actions anytime and anywhere. In this way, ICT facilitates truly open collaboration that extends beyond organizational and regional boundaries.

2) Information

Cutting-edge technology and advanced data analysis techniques support the accumulation of useful knowledge from big data and stimulate innovation in the workplace. Furthermore, as reliability becomes increasingly important in the use of information, Fujitsu supports customers in operating a safe and secure ICT environment based on the three pillars of robust authentication, privacy protection, and security intelligence (which has been defined as "the real-time
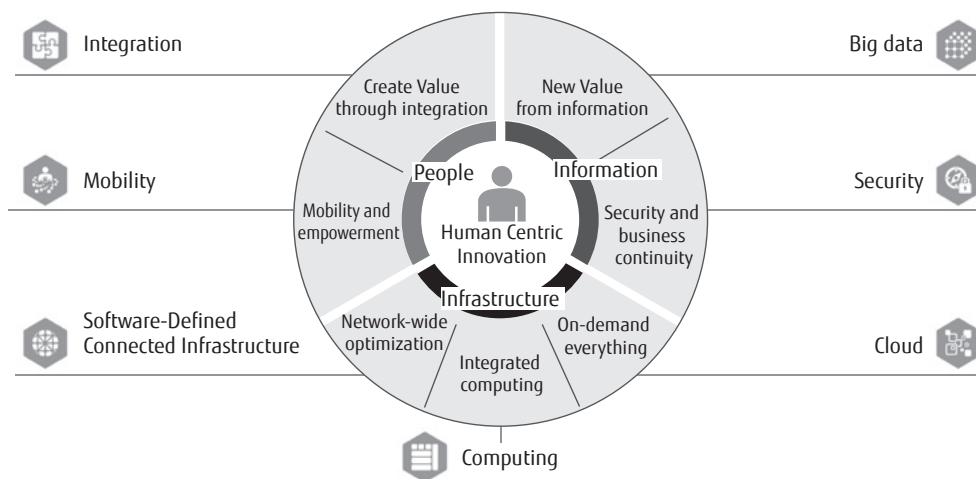
Figure 1
Key elements driving innovation.

collection, normalization, and analysis of the data generated by users, applications and infrastructure that impacts the IT security and risk posture of an enterprise".[3]

3) Infrastructure

In the era of the Internet of Things (IoT), in which all manner of things will be connected to the Internet, Fujitsu will provide an ICT environment that can link these things with the social infrastructure and respond to change in a flexible and agile manner. Fujitsu is focusing on the cloud as a platform that can interconnect people, information, and things and promote mutual interaction. To this end, Fujitsu will provide highly automated systems and data centers optimized in terms of power consumption and environmental load. Additionally, on the basis of its concept of a Software-Defined Connected Infrastructure (SDCI), Fujitsu will optimize a wide-area distributed computing environment spanning multiple areas from data centers to wide-area networks and mobile devices to provide customers with coherent services.

Fujitsu is developing and enhancing the above technologies and services throughout the company through a system that it has sequentially announced in the form of a Mobile Initiative, Big Data Initiative, Cloud Initiative, and Security Initiative. Each of these initiatives comprises solution offerings, consulting, and applications as well as clouds, middleware, services, and hardware as platforms for the four initiatives.

This special issue describes the middleware and associated technologies included in each of the initiatives that Fujitsu has so far announced. In the past, middleware was required to have a level of robustness that can support a company's mission-critical systems and a level of performance that can handle a huge volume of transactions in a stable manner.[4] From here on, however, middleware will also have the role of supporting business innovation in a company's on-site operations. To meet this need, Fujitsu has been promoting the evolution of middleware by incorporating know-how that it has gained through actual projects both inside and outside the company. This paper presents an overview of this new form of middleware.

2. Middleware supporting Mobile Initiative

To help people become more creative and productive and to achieve a transformation to a more efficient and comfortable work style, the need has grown for using personal mobile devices to support people in their decisions and actions both inside and outside the office. The key to meeting this need is to enable information in business systems to be used from mobile devices while protecting the system from threats and risks such as information leaks, which can be caused by cyber attacks from the outside or simply by carelessness or accidents.

For example, thanks to the rapid proliferation of smartphones and tablets in society, the use of mobile devices has become a reality in a variety of scenarios.

In addition to being used for accessing scheduling, e-mail, and other office systems while on the go, they have also come to be used for improving the quality of proposals and presentations when visiting customers and for raising the efficiency and productivity of work in the field such as maintenance and checking tasks. The need has consequently arisen for referencing and updating customer data, inventory data, maintenance records, etc. in business systems from mobile devices. However, in many on-site usage scenarios, simply being able to access and use the screens generated by conventional systems from a mobile device via a thin client does not necessarily make it easy to use those systems. It is essential that applications and services be specially created for mobile devices.

Fujitsu developed the FUJITSU Mobile Initiative system (**Figure 2**) to meet these customer needs. This system of products and services provides optimal solutions for using mobile devices in the field.[5] Its middleware provides functions for using business data efficiently from anywhere while ensuring a safe working environment. The following describes how this middleware provides customers with new value.

2.1 AR for enhancing quality and speed of work on-site

Augmented reality (AR) is a technology that extends and intensifies human perception by overlaying digital information onto information obtained via the five human senses (reality). For example, during maintenance and checking of facilities, AR can be used to overlay the temperature and pressure obtained from sensors on the image of a pipe captured using the camera of a mobile device as well as the repair history and messages/notes concerning that pipe. Fujitsu provides FUJITSU Software Interstage AR Processing Server as an AR technology integration platform for solving work problems in the field in areas such as manufacturing, distribution, and data center management.

2.2 Mobile-oriented application platform middleware

Scenarios that involve the use of mobile devices require applications that have superior user interfaces. Ease-of-use for on-site and mobile operations is, of course, a key requirement in fieldwork, but there is also a need for sufficient security to prevent data leaks, for push notifications to guarantee timely arrival of messages, and for productivity improvements that enable
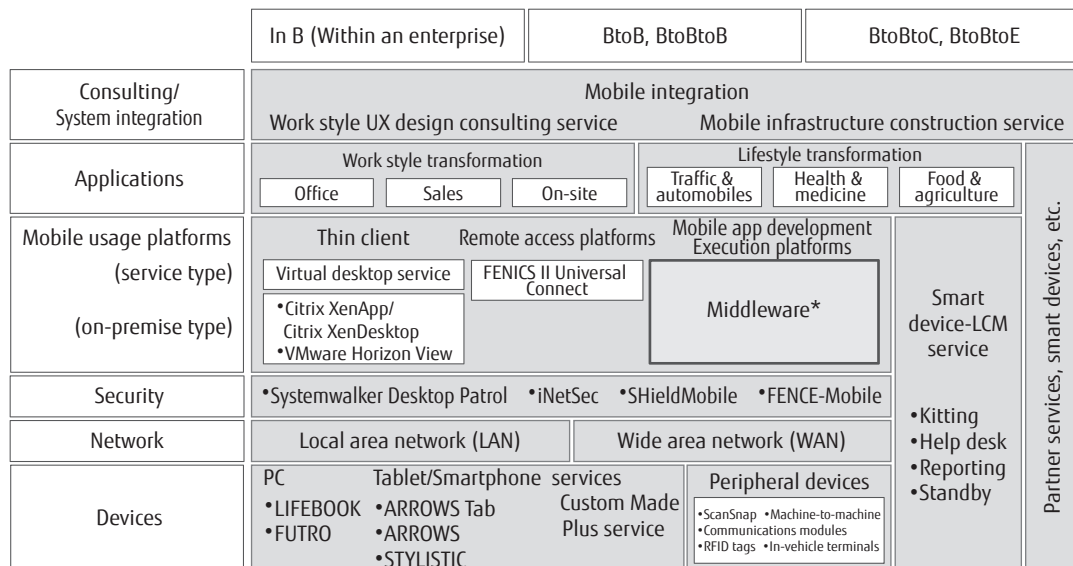
*Middleware: FUJITSU Software Interstage AR Processing Server
FUJITSU Software Interstage Mobile Application Server
FUJITSU Cloud PaaS MobileSUITE (MobileSUITE)
FUJITSU Software WSMGR for Web middleware

Figure 2
FUJITSU Mobile Initiative system.

common development across various types of devices.

These requirements have arisen because mobile devices are much easier to carry around and to lose than PCs. Moreover, they must operate in various environments, such as in a moving vehicle or underground complex, where radio signals are not stable. Furthermore, it is essential to keep up with the frequent provision of new models and operating systems (OSs) due to fast evolving hardware and software.

To meet these special needs for mobile devices, Fujitsu provides FUJITSU Software Interstage Mobile Application Server as a mobile-oriented application platform for enhancing usability and development productivity while ensuring security and FUJITSU Cloud PaaS MobileSUITE (MobileSUITE) as a service platform.

2.3 Mainframe use from mobile environment

When conducting business outside the office using a mobile device such as to check inventory, check delivery status, place orders, or issue a repair completion report, there are many cases in which the company's conventional business systems must be accessed. Many of these business systems run on mainframe computers, and using mobile devices to access data on those systems can be problematic. For example, when allowing access from the outside, the mismatch between mainframe terminal screens and the user interface of a mobile device and the need to guarantee security are two key issues that need to be addressed.

3. Middleware supporting Big Data Initiative

It is becoming increasingly important for a customer's business to create new value from the huge amount of information that is being generated on a daily basis. That is, in addition to the various types of data generated and stored within a company including that of its mission-critical systems, all types of data such as external data from social networking sites (SNSs) and information from mobile devices and sensors need to be combined and analyzed to uncover buried knowledge that can be helpful in improving corporate and business processes.

Fujitsu created the FUJITSU Big Data Initiative system (**Figure 3**) to meet this need. This system of

products and services maximizes the use of big data.[6] It specifies, in particular, an optimal lineup of products and services for each big data usage theme. The middleware used provides functions that combine open standards and Fujitsu technologies to enable high-speed and hassle-free use of massive amounts of data. The following describes how this middleware provides new value.

3.1 Big data usage solutions

"Big data usage" refers to the analysis and use of large volumes of diverse types of data such as business data, external data, and sensor data. Big data usage began with the application of certain technologies to existing data processes in information systems departments such as to speed up batch processing. Now, however, big data usage is coming to be required in business in an increasing number of ways. For example, the people in charge of sales, marketing, and other business departments must be able to analyze data on their own, processes must be improved through trial and error and simulation, and marketing policies must be formulated in response to real-time changes.

Fujitsu provides FUJITSU Business Application Operational Data Management & Analytics as a solution for executing sophisticated big data analysis combining internal and external data without having to know how to operate specialized ICT tools.

3.2 Integration of diverse data and real-time use of information

To enable individual business departments to use information in real time, it must be possible to quickly prepare and easily manage huge amounts of various types of data for analysis purposes. This data can range from existing mission-critical data to in-house data such as daily reports and open, external data from SNSs and elsewhere.

To this end, Fujitsu provides FUJITSU Integrated System Analytics Ready as a hardware appliance product that customers can start to use immediately. It features data storage that can collect and store data in diverse formats from a variety of data sources, a high-speed, column-store type of database engine for data warehousing, data processing tools based on an intuitive graphical user interface (GUI), and the integration of data management functions including operation
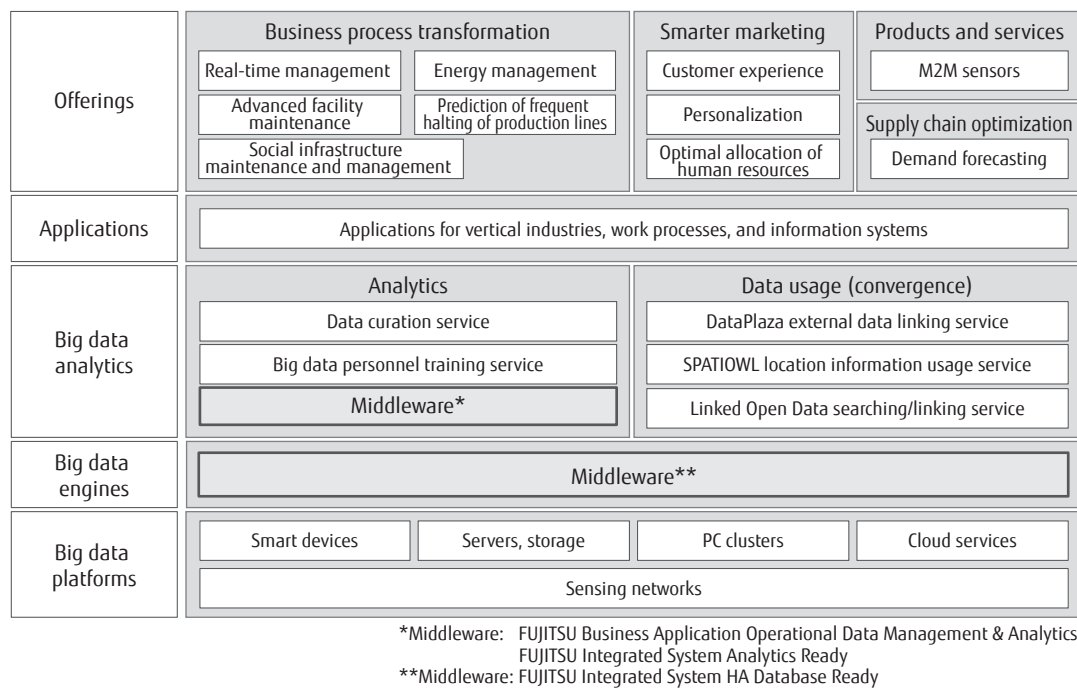
Offerings	Business process transformation		Smarter marketing	Products and services
	Real-time management	Energy management	Customer experience	M2M sensors
	Advanced facility maintenance	Prediction of frequent halting of production lines	Personalization	Supply chain optimization
	Social infrastructure maintenance and management		Optimal allocation of human resources	Demand forecasting

Applications	Applications for vertical industries, work processes, and information systems

Big data analytics	Analytics	Data usage (convergence)
	Data curation service	DataPlaza external data linking service
	Big data personnel training service	SPATIOWL location information usage service
	Middleware*	Linked Open Data searching/linking service

Big data engines	Middleware**

Big data platforms	Smart devices	Servers, storage	PC clusters	Cloud services
	Sensing networks			

*Middleware: FUJITSU Business Application Operational Data Management & Analytics
FUJITSU Integrated System Analytics Ready
**Middleware: FUJITSU Integrated System HA Database Ready

Figure 3
FUJITSU Big Data Initiative system.

and management software for the above components.

3.3 Vertically integrated database system

Database systems that can perform high-speed and reliable storage and processing of huge volumes of data are finding widespread use. Recent advances in the processing speed and capacity of CPUs, memory devices, storage equipment, and networks have resulted in significant improvements in database performance and ease-of-use. Nevertheless, constructing a high-performance database that can accommodate the input and processing of huge amounts of data and operating that database continuously while ensuring data security on a daily basis requires advanced skills. Specifically, know-how is needed for optimally combining hardware and database software and for designing backup and recovery procedures for various scenarios.

FUJITSU Integrated System HA Database Ready is a vertically integrated database that combines advanced hardware with database technologies cultivated by Fujitsu over many years through its experience in constructing databases for mission-critical systems. It features high-performance and high-availability operation and can be easily implemented, configured,

and operated even by business departments.

3.4 Ultra-high-speed data processing using InfiniBand

Data generated by a Web system such as an e-commerce site are typically targeted for big data analysis. A Web system that receives an unpredictable number of processing requests via the Internet must be able to process those requests accurately without making users wait even if the volume of requests should suddenly escalate. To meet this need, Fujitsu provides ultra-high-speed in-memory data management software using an InfiniBand network communications technology, which has been used extensively in supercomputers and other fields. This middleware can achieve transaction processing with low latency (of the order of several hundred microseconds).

4. Middleware supporting Cloud Initiative

A service infrastructure in the IoT era as typified by the cloud will enable people, information, and things to become interconnected and information and services to be used whenever needed. This capability is called

FUJITSU Sci. Tech. J., Vol. 51, No. 2 (April 2015)

7

"on-demand everything." The cloud, which enables a system to be quickly and easily added or altered in accordance with rapidly changing business requirements, is fast becoming an important infrastructure for driving innovation in business and society. However, given the need for application design that can be scaled out and for operations that take into account the occurrence of hardware and software failures, it has become clear that the know-how gained from only the construction, operation, and testing of conventional on-premise business systems is insufficient for developing and supporting a cloud infrastructure.

Fujitsu responded to this problem by creating the FUJITSU Cloud Initiative system (**Figure 4**). This system of products and services provides customers with optimal solutions for using the cloud.[7] Its middleware, based on open standards, provides cloud operation functions that feature high reliability and a high degree of flexibility for accommodating changes in the business environment. The following describes how this middleware provides customers with new value.

4.1 Cloud resource management using OpenStack

Fujitsu has been providing FUJITSU Software ServerView Resource Orchestrator as resource management middleware to support the cloud. The technology behind this product has been applied in conjunction with FUJITSU Cloud IaaS Trusted Public S5, a public cloud provided by Fujitsu.

Recent years, though, have seen much activity in the use of open-source software (OSS) in the cloud domain, and typical of this software is OpenStack. Fujitsu is an active participant in the OpenStack community, to which it makes technology-related contributions.

From here on, many cloud infrastructure mechanisms should become usable through open standards, and the portability of customer assets should increase. In line with this trend, Fujitsu plans to incorporate OpenStack technology in ServerView Resource Orchestrator and to provide open application programming interfaces (APIs). It also plans to construct a highly reliable, easy-to-use cloud infrastructure that incorporates simplified settings, resource visualization, and other technologies that Fujitsu has developed.

Cloud type	Customer		Data center		
	Private cloud (on-premise)	Private cloud (hosting service)	Public cloud		
	Customer-specific	Customer-specific	Customer-specific		
Operation	Cloud Integration services (multi-vendor, hybrid, integrated operation, business-specific)				
Implementation					
Applications (SaaS)	Various SaaS (about 100 types)				
Platforms (PaaS)	FUJITSU Software		FUJITSU Cloud PaaS		Partner clouds
	Middleware*		MobileSUITE	RunMyProcess	
			Smart Biz Connect	A5 for Microsoft Azure	
Infrastructure (IaaS)	Dynamic Integrated Systems		FUJITSU Cloud IaaS		NIFTY Cloud
	Cloud Ready Blocks	Private Hosted	Trusted Public S5	A5 for Microsoft Azure	HyConnect open public cloud
	HA Database Ready		S5 Dedicated service	Office computer service	
Data centers/Security	Data center/FUJITSU Security Solution				
Networks	FUJITSU Managed Infrastructure Service FENICS				
Devices	PCs/Tablets/Smartphones				

*Middleware: FUJITSU Software Systemwalker Software Configuration Manager
FUJITSU Software Systemwalker Service Catalog Manager
FUJITSU Software Systemwalker Runbook Automation
FUJITSU Software PRIMECLUSTER

Figure 4
FUJITSU Cloud Initiative system.

4.2 Flexible and easy-to-operate clouds based on SDN

Software defined network (SDN) technology that can dynamically control network configurations and settings in software is a core technology for enhancing the flexibility of resource deployment in the cloud.

Fujitsu achieves flexible and easy-to-operate cloud systems and data centers by combining its ServerView Resource Orchestrator cloud infrastructure management software based on the FUJITSU Intelligent Networking and Computing Architecture (FINCA), an SDN architecture, with appropriate hardware (CFX, IPCOM VX). Going forward, Fujitsu plans to develop an SDN ecosystem using a public cloud in collaboration with independent software vendors. Furthermore, to make it easier to determine the relationship between the physical and virtual networks and to gauge the impact of a network problem on the system, Fujitsu will contribute improvements to cloud operation by enabling the visualization of physical and logical networks and enhancing self-service capabilities tailored to the user.

4.3 Lifecycle management of hybrid clouds

As the use of clouds progresses in the corporate world, hardware resources and their operation are increasingly being consolidated in data centers. This means that the operations manager of a data center must be able to cope with dramatic increases in items targeted for management and with the frequent addition or modification of operating requirements. This can lead to a substantial increase in workload, so the need for a drastic improvement in operations efficiency that surpasses conventional operation improvements has arisen.

To meet this need, Fujitsu provides FUJITSU Software Systemwalker Software Configuration Manager as lifecycle infrastructure middleware for integrated management of the hardware making up the cloud and the diverse types of middleware making up a variety of business systems. It also provides FUJITSU Software Systemwalker Service Catalog Manager, which can create a user-oriented portal for a hybrid-cloud environment consisting, for example, of on-premise clouds, private clouds, and various public clouds.

4.4 Automated operation to respond flexibly to changes in business environment

Consolidating systems in a cloud environment means an increasingly larger infrastructure of servers, OSs, and middleware to be operated and managed. As a result, operation by manual techniques based on conventional procedural manuals is reaching its limits. There is therefore a need to create automated mechanisms that can prevent operating loads from increasing even in the case of an expanding infrastructure. However, all sorts of hardware and middleware come to be intermingled when consolidating systems in a cloud environment, and this mixture hinders automation.

To solve this problem, Fujitsu provides FUJITSU Software Systemwalker Runbook Automation as a system that can absorb differences in hardware models and OS/middleware software so that automated processes can be described in a common format. Also provided is a function for flexibly suspending or resuming operation at any point in the process so that unexpected events can be easily dealt with.

4.5 High-reliability/High-availability cluster system for clouds

A common method for ensuring server availability in the cloud is to implement a redundant server configuration between independent data centers. However, there are also business systems in the cloud for which it is imperative that a switchover to a standby system be achieved in a very short period of time if the primary server should fail. This is needed to minimize the impact of a business interruption and prevent the loss of business opportunities. There is therefore a need for a high-reliability mechanism that can detect failures immediately and ensure business continuity. The middleware that meets this need is FUJITSU Software PRIMECLUSTER.

5. Middleware supporting Security Initiative

As mobile devices and cloud computing proliferate throughout society, it has become possible to access data that one needs for business not only from the office but also from just about anywhere. This is very convenient for employees, but targeted cyber

attacks that are carried out with the specific intention of data diddling or system crashing have become quite sophisticated, posing a great risk to security. It is feared that a sluggish response to such attacks will open up a company to the worst-case scenario in which information leaks from mobile devices and attacker-initiated system halts become unmanageable. How quickly an attack can be thwarted after a threat has been detected is therefore a key issue.

Fujitsu has been developing and providing security-related products and services for some time. The FUJITSU Security Initiative system (**Figure 5**) provides products and services that reflect the operational know-how we have accumulated and integrates measures for enhancing the customer's systems and operations with education and training.[8] The middleware provides security management functions based on Fujitsu's own in-house practices. The following describes how this middleware provides customers with new value.

5.1 Anti-cyber-attack technology based on practical understanding

Measures for preventing intrusions are of course necessary for dealing with cyber attacks, which are becoming increasingly sophisticated on a nearly daily basis. However, it is also necessary to keep in mind that the occurrence of intrusions cannot be completely prevented even with good defensive measures. It is therefore essential that a definite response be taken quickly to halt the spread of damage in the system once an intrusion has been detected.

At Fujitsu, we have improved the quality of dealing with security breaches by specifying the steps to take when our own systems fall victim to cyber attacks. Furthermore, by automating these steps, we have shortened the time it takes to mount an initial response and have reduced the effort required. FUJITSU Software Systemwalker Security Control middleware incorporates these response processes and a mechanism for automating them.

5.2 Terminal management technology for preventing information leaks

There are many types of cyber attack that exploit known vulnerabilities in OSs and middleware, so it is essential that updates and repairs (patches) be applied to all ICT resources such as servers and PCs that
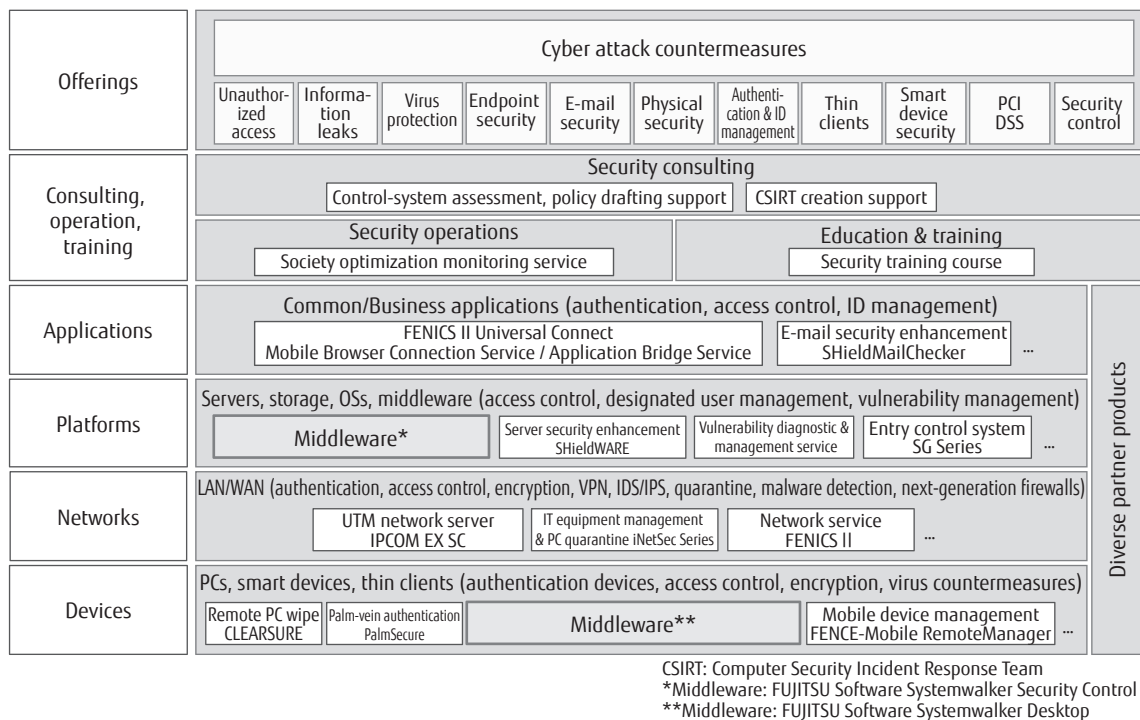

Figure 5
FUJITSU Security Initiative system.

use software. In addition, the proliferation of mobile devices has made it difficult to prevent a bring-your-own-device (BYOD) work style, in which individuals use their personal devices at work for business purposes, or to dissuade the practice of acquiring applications from online app stores for use on company-supplied equipment. The types of devices and applications targeted by attacks have been increasing steadily, and it has become extremely difficult for system managers to apply patches quickly and to detect and remove applications at risk.

Fujitsu has been providing the FUJITSU Software Systemwalker Desktop series of middleware to prevent information leaks, mostly from PCs used in business. To solve the above problems and provide an even higher level of security, it was decided to improve this middleware by adding functions for managing mobile devices and defensive functions for dealing with targeted threats.

6. Conclusion

The environment surrounding middleware has changed drastically. Now, in addition to robustness and high performance as traditionally required of mission-critical systems, the need has arisen for an infrastructure that incorporates new technology elements such as mobility, big data, the cloud, and security and that can be used in a safe, secure, and straightforward manner to drive on-site business innovation.

The middleware and solutions introduced in this paper meet these requirements by improving system functionality and ease-of-use. They merge open technologies with the high-reliability and high-performance technologies that Fujitsu has cultivated over many years. Going forward, we plan to continue providing our customers with middleware to support business innovation by incorporating know-how obtained through actual practices into our products and by making ongoing improvements, all centered about Fujitsu's Mobile, Big Data, Cloud, and Security initiatives.

References

1) World Economic Forum: Hyperconnected World.
    http://www.weforum.org/projects/ hyperconnected-world
2) Fujitsu: Fujitsu Technology and Service Vision.
    http://www.fujitsu.com/global/vision/index.html
3) Security Intelligence: Defining Security Intelligence.
    http://securityintelligence.com/ defining-security-intelligence/
4) Fujitsu: Middleware.
    http://www.fujitsu.com/global/products/software/ middleware/
5) Fujitsu: Fujitsu Mobile Initiative (in Japanese).
    http://jp.fujitsu.com/solutions/mobileinitiative/
6) Fujitsu: Fujitsu Big Data Initiative (in Japanese).
    http://jp.fujitsu.com/solutions/bigdata/
7) Fujitsu: Fujitsu Cloud Initiative (in Japanese).
    http://jp.fujitsu.com/solutions/cloud/concept/
8) Fujitsu: Fujitsu Security Initiative (in Japanese).
    http://jp.fujitsu.com/solutions/safety/security-initiative

Masaya Yamada
Fujitsu Ltd.
Mr. Yamada is engaged in middleware market analysis and product planning.

FUJITSU Sci. Tech. J., Vol. 51, No. 2 (April 2015)

11