

# Cloud-Based Vending Machines Quickly Responding to Market Needs

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## ABSTRACT

Vending machines are being required to quickly respond to dramatically changing needs as the market is growing outside Japan, notably China. To meet these needs, Fuji Electric has developed a cloud-based vending machine. We replaced some common functions of vending machines, such as payment and the display of product samples and their prices with functions on smartphones and cloud-based servers. Equipped with a minimum set of software, such as for product dispensing and heating and cooling, the vending machine helps significantly increase operational efficiency, despite the low price.

## 1. Introduction

The vending machine market in Japan has entered a mature stage, whereas the market is expected to grow outside of Japan, mainly in China and Southeast Asia. The Chinese market, in particular, sees a shipment of more than 100,000 units in FY2016. The growth rates in recent years have exceeded 10% and a similar figure is expected also in the future.

Fuji Electric has been providing a line-up of high-quality products, centered on beverage vending machines, to the Japanese market. In China, however, due to the low unit prices of beverages, we need to offer a line-up of low-price vending machines with minimum functions to meet the market needs (see Fig. 1).

In addition to this fact, the installation locations are scattered over a wide area in China, so that route sales staff need much time to travel around. Coupled with the rising labor costs and labor shortages due to

a robust economy, there is demand for more efficient operations.

The vending machine market in China is in a growing stage. Vending machines need to quickly respond to the dramatically changing market needs and this requires about three times faster development speed compared with the Japanese market.

To meet such needs, Fuji Electric has developed a cloud-based vending machine that can quickly respond to changing market needs.

## 2. Features

Fuji Electric has developed a cloud-based vending machine having the following features:

(1) Lower price through system optimization

We achieved a lower price by optimizing the functions of the entire system including cloud-based servers.

(2) Open structure for shorter development lead time

In order to respond to changes in factors such as consumer preference and consumption behavior, we renovated the software structure so that items can be added or changed easily. We mounted a communication module (communication terminal device) using a general-purpose OS, Linux\*<sup>1</sup>. This has allowed vending machine operators (companies that install and operate vending machines) to shorten the development lead time by changing software.

(3) Efficient operation through the use of cloud-based servers

We improved operation efficiency by using cloud-based servers to manage product price and other data which had been managed on individual vending ma-

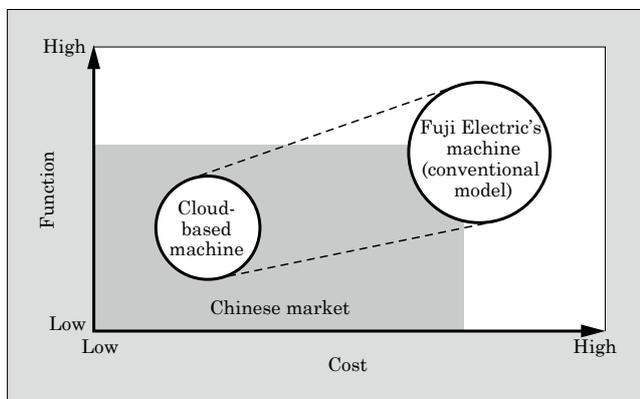


Fig.1 Positioning of cloud-based vending machines

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\*1: Linux is a trademark or registered trademark of Linus Torvalds in Japan and in other countries.

chines.

### 3. Overview of Cloud-Based Vending Machines

#### 3.1 Lower price through system optimization

When a consumer reads the QR code\*2 attached on the cloud-based vending machine with a smartphone (user scan method), information of product images and prices is sent from a cloud-based server and displayed on the smartphone. When the consumer selects a product from the images, the payment is processed on the server and the product is dispensed.

As shown in Table 1, this machine replaces the standard functions of typical vending machines used in Japan, such as the display of product samples and their prices and payment settling system (coin validator, bill validator and card reader) with functions on smartphones and cloud-based servers. As a result, the vending machine itself can be made up of minimum

Table 1 Comparison of functions between typical vending machines in Japan and cloud-based vending machines

Operation	Required function	Required equipment	
		Typical vending machines in Japan	Cloud-based vending machines
Selling	Product confirmation	Product sample display	Smartphone
	Price confirmation	Price display	
	Product selection	Product selection button	
	Payment	Payment system (Coin, bill, card)	Smartphone + Cloud-based server
Installation	Product registration	Setting device	Cloud-based server
Maintenance	Sold-out product and failure check	Setting device	Smartphone

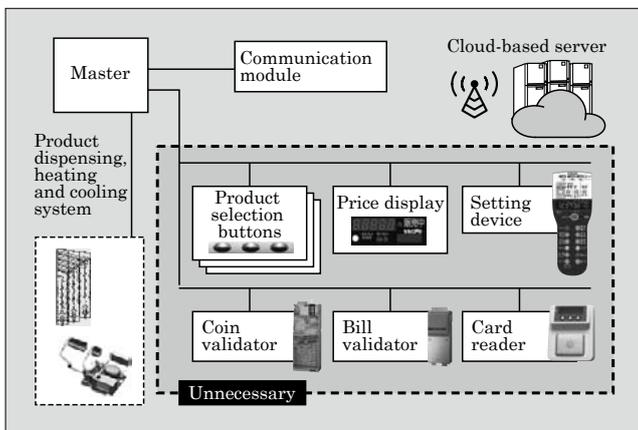


Fig.2 Control system configuration of cloud-based vending machine

\*2: QR code is a trademark or registered trademark of Denso Wave Incorporated.

control systems (see Fig. 2).

#### 3.2 Open structure using general-purpose OS and vending machine SDK

Fuji Electric has been used an embedded OS in conventional vending machines due to the need for a real-time response. Handling an embedded OS requires a dedicated development environment and specialist skills, therefore it is considerably difficult for vending machine operators to develop vending machine application software.

To solve this problem, we divided the functions into two groups: one that requires a real-time response and the other that does not. We made the functions that require a real-time response be operated on the embedded OS as before and made the functions that do not require a real-time response be operated on a general-purpose OS mounted on the communication module. We selected Linux as the general-purpose OS and prepared a vending machine software development kit (SDK) to allow our customers to develop applications (IoT applications) more easily (see Fig. 3).

#### 3.3 Renovation of software structure for easy modification (global platform)

The software for conventional vending machine was developed on the basis of vending machine software designed for the Japanese market, and functions were added repeatedly to meet each request from customers. Consequently, there were problems of large size, complexity and much time needed for adding functions. Since the software structure was different for each machine model, even an attempt at applying an identical function to several models required the development of software for every model, which was another problem. To solve these problems, Fuji Electric

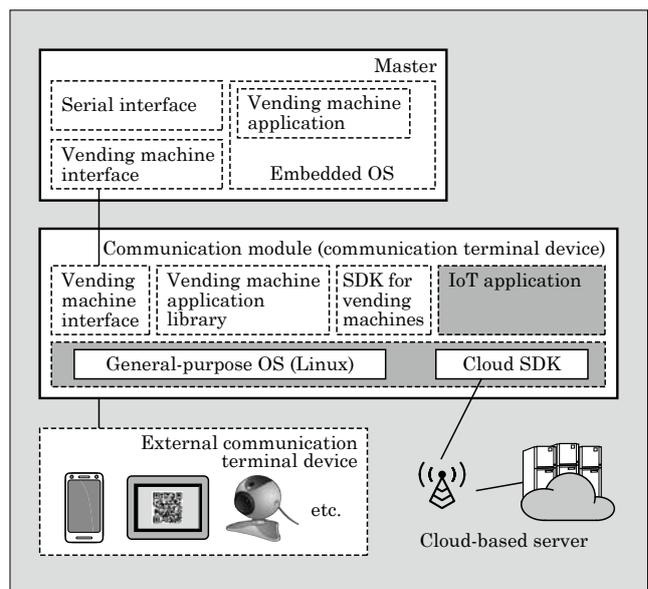


Fig.3 Communication terminal device using general-purpose OS (Linux)

renovated the structure of vending machine software by braking the software into modules, redefining the role of each module, and then setting up the rules for the connection between the modules (see Fig. 4).

After that, we divided the software modules into ones that are common to all models and variable modules that vary with models. For example, we designed the specifications of the module interface for variable modules such as the product dispensing function to be common to all models. This makes it easy to replace variable software modules with those appropriate to individual models (see Fig. 5).

Such common design of the module interface for variable modules has enabled vending machine opera-

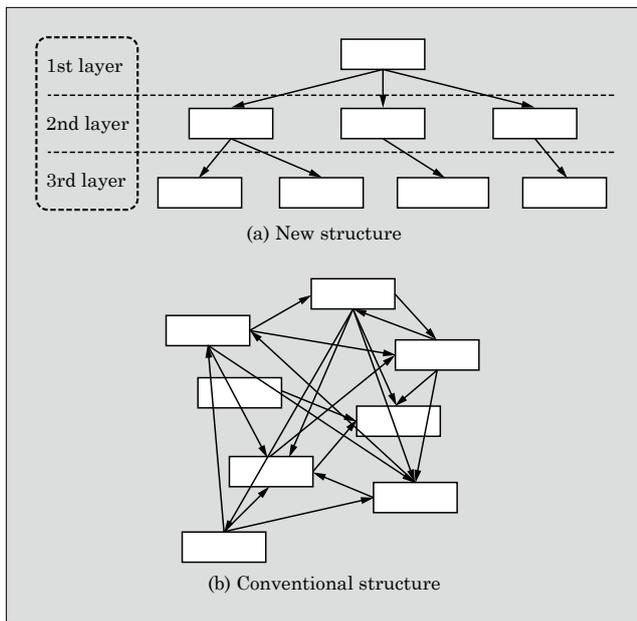


Fig.4 Renovation of software structure (global platform)

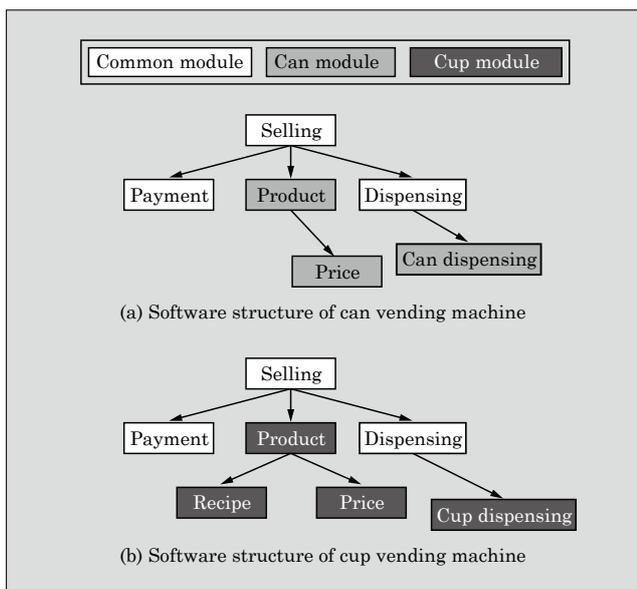


Fig.5 Implementation of common and variable modules for each model

tors to achieve the necessary functions within a short period.

### 3.4 Software structure for easy support of cloud-based servers specified by customers

It is vending machine operators that select a cloud-based server used for the management and payment service of their vending machines. Consequently, the software for the communication part of the vending machine must support the specifications that vary among cloud providers. Developing that software in accordance with individual cloud-based servers would take much time. We thus designed the software so that it allows loading of cloud SDKs provided by cloud providers. When a vending machine needs to access a server of a different server provider, the operator can load the SDK with the one supporting that provider (see Fig. 6).

### 3.5 Increasing operation efficiency by using cloud

Figure 7 shows the data management of a cloud-based vending machine. With conventional vending machines, when products were replaced for the season, operators used a simple setting device to change the setting data such as product prices on individual vending machines. This required a large amount of time.

With cloud-based vending machines, all vending machines can be set from the cloud-based servers. Vending machine operators can use a dedicated PC screen to change the settings of all vending machines under their management collectively from their offices. This has made it possible to save a significant amount of time. The status of individual vending machines can

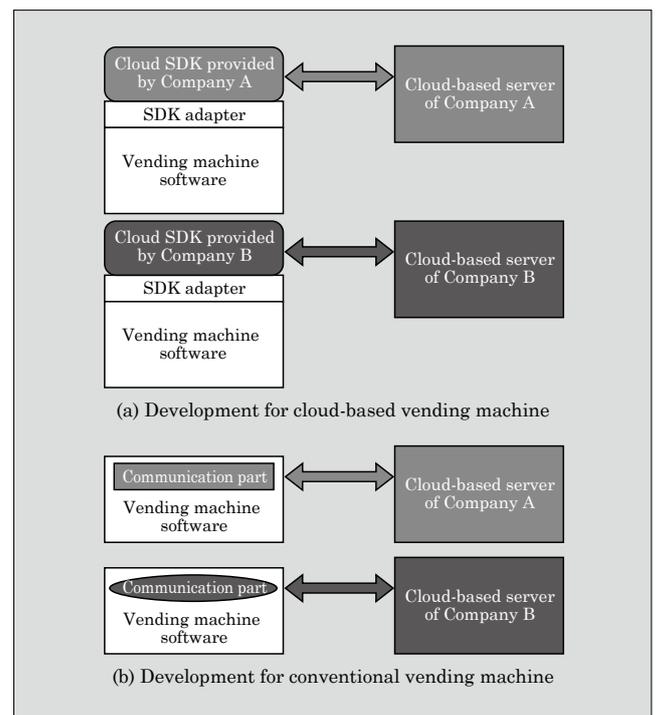


Fig.6 Cloud-based server connection method (with adapter)

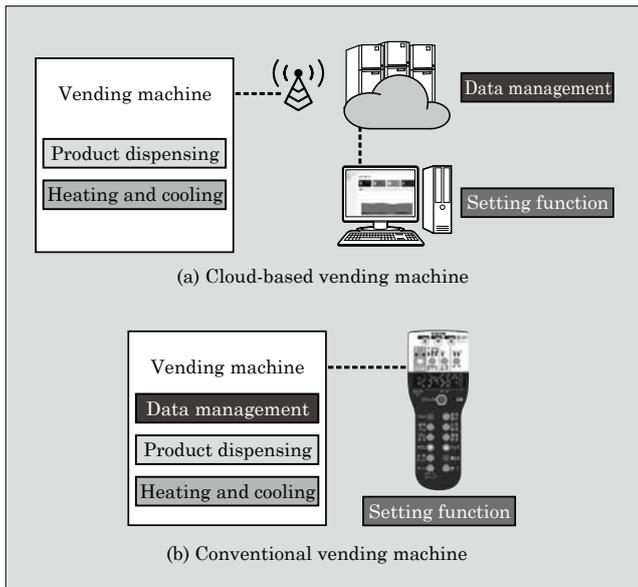


Fig.7 Data management of cloud-based vending machine

also be checked in real time. Failures, sold-out products and other operational information of all machines can be managed on the cloud-based servers. Furthermore, remote recovery from some failure is also possible, and this greatly improves operation efficiency.

#### 4. Postscript

This paper described a cloud-based vending machine that can quickly respond to market needs. ICT-capable vending machines have been spreading in China and other overseas markets. They are expected to spread more rapidly and widely including their expansion into the Japanese market.

Fuji Electric is determined to improve customer value further by developing more sophisticated vending machines that can meet the customer needs in and outside Japan.





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