Mass Customization Based-method for Datacenters Computer Room Monitoring System

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***Abstract*—To be able to satisfy the customized requirements for monitoring equipments and personalized monitoring interfaces, datacenter computer room monitoring system systematically provides a mass customization mechanism to give a quick response while reducing the manufacturing cost and meeting the users' needs. For this reason, we combine the theory of mass customization with the customization method of datacenter computer room monitoring system, and design a customization framework for datacenter computer room monitoring system based on mass customization, analyzing the development process as well. At last, we give out a specific implementation instance by taking a data center computer room monitoring system as an example. The result shows that it is efficient and simplifies the datacenter computer room monitoring system development remarkably.**

***Index Terms*—Mass Customization, Datacenter, Monitoring System, Case study**

I. Introduction

A data center is a facility used to house computer systems and associated components, such as telecommunications and storage systems. Datacenter Computer Room Monitoring System (DCRMS) mainly refers to a kind of monitoring and controlling system aiming at power equipments, environments, and security parameters of the datacenter computer room. Achieved through the implementation of specialized software, hardware and sensors, real-time monitoring and management platform for all interdependent systems across IT and facility infrastructures. Depending on the type of implementation, DCRMS can help datacenter managers identify and eliminate sources of risk to increase availability of critical IT systems.

Monitoring equipments have the characteristics of variety and diversity on quantity, type, brand and version. Under this consideration or for some other reasons such as commerce, technology and history there're some obvious differences in function, interfaces and protocols between different monitoring equipment from different manufacturers. Those differences force the whole DCRMS to set up on a heterogeneous platform, which makes it more difficult and complex for development [1][2][3][4].

Though there're differences between the monitoring frameworks for different industries, the system function modules (e.g. navigation module, data list and curve display module) are alike or even the same. Each interface element is the same, although the users' requirements for monitoring system software interface are different. Users' monitoring equipments are different, but the types and quantities of monitoring equipments are limited while the equipment communication protocols are mostly the same based on the common standard protocol. Mass Customization (MC) may provide great thought for the designing of Datacenter Computer Room Monitoring System Self-Customization (DCRMS-SC) to solve numerous rehandling problems exist in the process of application software development of DCRMS.

In this paper, we present a development method for DCRMS on mass customization. Our main objective is to provide a customization framework to understand the heterogeneous platform that development in more difficult and complex. We also point to future research directions, based on the mass customization.

The rest of this paper is organized as followed. Section 2 provides an overview of mass customization and its benefits. Section 3 surveys DCRMS-SC architecture based on MC. Section 4 discusses DCRMS-SC development process based on MC. Section 5 shows the application development case with the DCRMS. Finally, concludes the paper.

II. Mass Customiztion And Its Benefits

The concept of Mass Customization (MC) has been discussed in literature since the late nineteen eighties [5] [6] [7]. It early refers to a production pattern of offering customized products or services for a relatively large market, which product featured at low cost roughly and high efficiency just like mass production, to meet the personalized needs of users [8][9][10] [11].

By taking the advantages of individualization and diversity of customization as well as low costing and high speeding of mass production, but how to meet the custo-

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mer individualized requirements completely, which it the most critical and difficult problem. Mass production combines "mass" and "customized" together, which seemed contradictory but in fact efficiently [12]. For users, it is customized and personalized. And for the developers, products are from mass production.

According to the heterogeneity of data center monitoring devices and the requirements of interface diversity, the author proposed a Datacenter Computer Room Monitoring System Self-Customization (DCRMS-SC) technology, which means, while using the DCRMS software, users could, on a personalized basis, customize their monitoring devices and monitoring interface on their own, or even complete the personalized room monitoring system independently, through this software platform.

During this process, users are no longer need to rely on those experts or professional developers to help modifying the codes or redeveloping a software. The whole process is intelligent. DCRMS-SC technology is an inevitable trend of DCRMS development.

III. DCRMS - SC ARCHITECTURE BASED ON MC

Fig. 1 is the DCRMS-SC system architecture diagram based on MC. The system structure is composed of the Device Proxy Server (DPS), and the Surveillance management Server (SS). DPS helps SS to access the on-site equipment transparently, and helps different types of monitoring equipment to access the DCRMS software quickly. The system uses DPS equipment to acquisitive the accessing method, which is based on the OPC server model. Using the thought of Proxy agent service and mass customization, it's good for shielding the heterogeneity of monitor equipment while accessing to the monitor equipment underlying data resources in the same way. As a switching module between monitoring equipment and DCRMS management server or a computer network conversion, DPS is different from the simple data acquisition unit with a network interface and the network adapter NCAP in IEEE 1451 standard, it contains the network interface data collector and characteristics of NCAP.

DPS structure is composed of device interface component library, component manager, service application interface, equipment interface and data cache; SS consists of user customized device, human-computer interface component library, component manager, rule database, service application interface, human-computer interaction interface, operation and maintenance management module, database etc..

DCRMS-SC system includes device proxy server device customization and management server interface customization; and the basic function of the equipment customization includes monitoring software, such as equipment configuration, add and delete action; interface customization includes front-end monitoring equipment in engine room monitoring system graphics, and on-site simulation scene dynamic display graphical action, such as the monitoring object, graphics and curves.

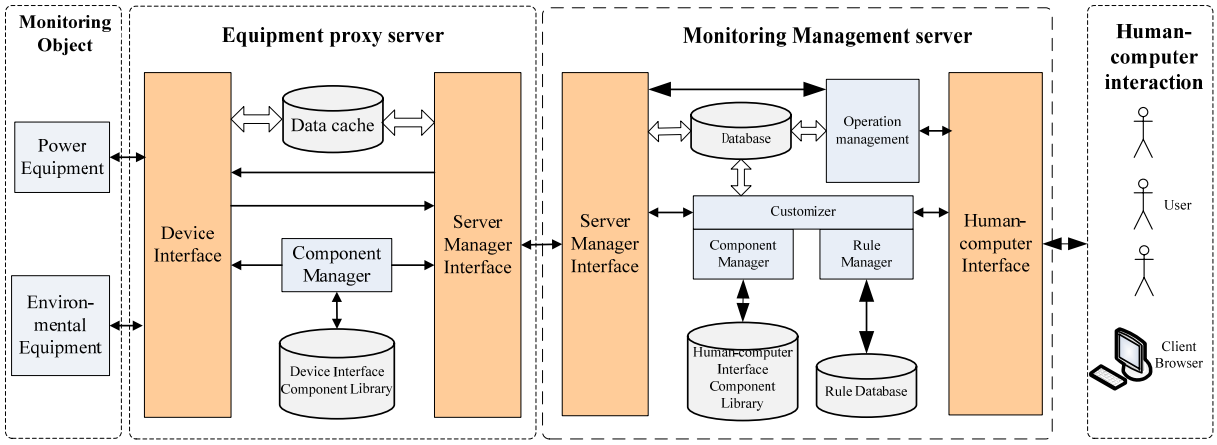

Fig. 1. **DCRMS-SC** architecture Based on **MC**

Through internal variables, the customized system builds relationship between equipment customization and interface customization. According to the actual situation, the customized system can adjust in real-time. Each device customization module in equipment monitoring system is not only independent relatively, but also cooperative while facing the other part of the monitoring system. To meet the requirements of the front-end monitoring, it shall realize the corresponding function of monitoring according to the structure the interface customization required by calling back device components at any time.

If the User Requirements (UR) and the Monitoring Device (MD) changed, the Device Customization (DC) and the Interface Customization (IC) will adjust itself synchronously to accomplish the function of Monitoring System (MS) Customization. Supposing the user demand set and the monitoring device set are respectively {UR}and {MD}, the monitoring device system set is {MS}, and the device customization function module and the monitoring management server interface customization module are respectively {DC} and {IC}, then the whole mathematical expression of the customized function response process is:

$$\begin{cases} \{\boldsymbol{MS}\} = \boldsymbol{A}\{\boldsymbol{DC}\} + \boldsymbol{B}\{\boldsymbol{IC}\} \\ \{\boldsymbol{MS}\} = \boldsymbol{a}\{\boldsymbol{UR}\} + \boldsymbol{b}\{\boldsymbol{MD}\} \end{cases} \Rightarrow \begin{aligned} \{\boldsymbol{MS}\} &= \boldsymbol{A}\{\boldsymbol{DC}\} + \boldsymbol{B}\{\boldsymbol{IC}\} \\ &= \boldsymbol{a}\{\boldsymbol{UR}\} + \boldsymbol{b}\{\boldsymbol{MD}\} \end{aligned} \quad (1)$$

In the expression above, *a* and *b* are one dimensional matching relation coefficient; ***A*** and ***B*** are two-dimensional matching matrix.

The customized function response process mathematical expression reflects, DCRMS monitoring system can response the change of user demand and monitoring device in real time to show the DCRMS customization features.

IV. DCRMS - SC Development Process Based On MC

The section describes the key technologies in the development process of the DCRMS-SC which mainly include the product platform designing and the user customized process.

A. Delevelopment Process Based on MC

The traditional DCRMS software development process provides fixed DCRMS software products to the users. The software implementation phase is divided into requirements analysis, design, coding, testing, delivery and some other serial processes. The standardized, modular, reusable component design and development of DCRMS-SC based on MC technology is aimed at product platform [13], in order to offer a DCRMS-SC product platform to the users and let their customized activities acts after the delivery in the DCRMS-SC product platform. Different users can reuse the same product platform for different customization. Also, give the right of ending product delivery to users. Therefore, the implementation of DCRMS-SC based on MC technology can be divided into two processes - the design of DCRMS-SC platform and the customization based on DCRMS-SC platform as shown in figure 2.

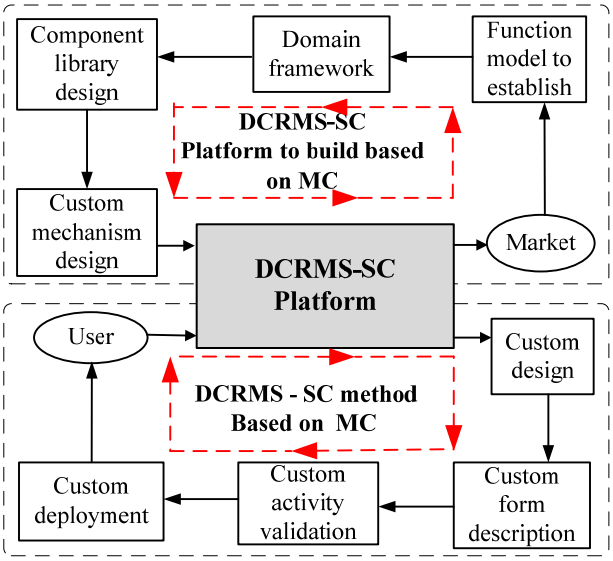

Fig. 2. DCRMS-SC technology development process based on MC

B. DCRMS-SC Product Platform Designing Process

DCRMS-SC platform is the foundation of customized computer room monitoring system. The DCRMS-SC product platform design is start from market. According to the market demand of today and future and through functional model analysis, developers put forward the public part of DCRMS User Requirements, define the functions, set up the framework of basic DCRMS, and design the reusable component library and the user customized mechanism in advance. As the customization came into being, the final formation of DCRMS-SC based on MC product platform will be formed. This whole process shall be completed by the developer. The required time of development is relatively long. The DCRMS-SC product platform will be put into the market at last.

C. User Customized Process Based on DCRMS-SC Product Platform

The final purpose of DCRMS-SC product platform designing is to provide user customized and personalized DCRMS products. Right after the DCRMS-SC product platform approached market, user could do some customized design on the basis of the platform. Then, aiming at user customization activities, the custom device of DCRMS-SC product platform will give some formal description and establish models before the validity inspection which ensures the customization of authorized party, to customize a satisfying personalized DCRMS product. This process is supposed to be done by user, and its development time is relatively shorter. The user customized DCRMS products can be used to monitor data center computer room.

As we can see from Figure 2, the implementation route of DCRMS-SC technology based on MC is actually two tangent ring cycles. The user customization process of product platform is established on the process of product platform designing. The two ring cycles supplement each other, while the DCRMS-SC product platform binds them together. Users, along with the market, will ceaselessly promote the alternation of the cycles as well as the completion of DCRMS-SC product platform.

V. Case Study

The following case study is an example combined with the development requirements of a computer room monitoring system, which elaborates the user customization method. This software is a DCRMS-SC product platform based on MC.

A. Working Flow of DCRMS-SC Product Platform

For a computer room monitoring system, it will work in a process as shown in Fig. 3. The DCRMS-SC product platform designing process is described as follows:

Step 1: After the product platform started, firstly read model of the last exit, and then judge the product platform working mode.

Step 2: If the last exit was happened in a deployment operation mode, it would autoload the human-computer interface and facility information customized last time, and will directly enter the sub-processes.

Step 3: If the last exit was happened in a custom edit mode, it will keep on judging so as to see if the last exit had customized something – if it had, then enter the sub-

processes of custom edit right after the restoration; or it could not enter the sub-processes directly.

Step 4: Judge whether it needs a custom deployment or not if it needs, ready to enter the sub-processes; or exit directly.

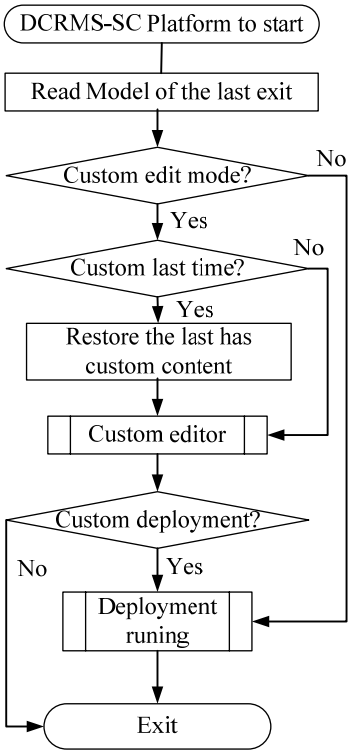

Fig. 3. Working flow of **DCRMS-SC** product platform

B. Custom Editor Implementation Process

In this case, the sub-process of custom edit is for customize devices, modify configurations and remove devices. The sub-process of custom edit is shown in Figure 4.

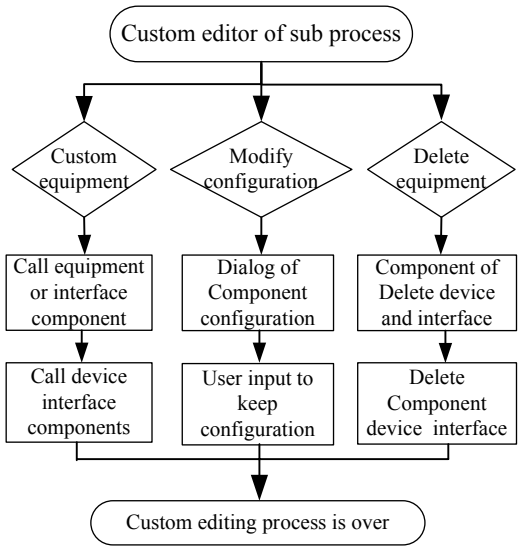

Fig. 4 Custom editor of sub process

C. User Custom Implementation Process

Login the DCRMS-SC product platform, and enter the user custom editing interface as shown in Figure 5.

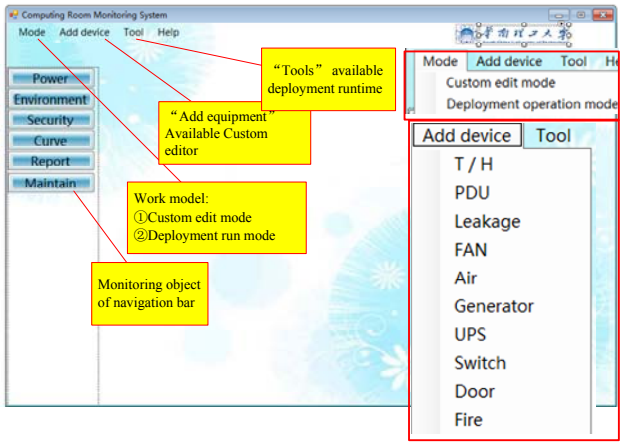

Fig. 5. Users to customize the editing interface

The interface mainly consists of menu bar, navigation bar, status bar, user custom editing area and so on. Select "Custom edit mode" or "Deployment operation mode" from the "Working mode" menu. The use of "Add device" menu during custom editing process is to provide monitoring object room which is commonly used. Use the "Tool" menu during deployment runtime to provide the install or uninstall tool of service. The "Help" menu provides DCRMS-SC product platform introduction and help information like user customization process guidance.

Click the "PDU" option in "Add device" menu to customize power monitoring. By invoking the dial component and the liquid column component, DCRMS-SC platform can create an electricity instrument interface which includes the three-phase voltage display, current dial display, frequency factor and power factor histogram display. Customization methods of the other equipments are similar. The information of user customization equipment presentation component and interface component is stored in database in accordance with options like the type of device (Object Style), the device name (Object Name), IP (Object IP), the device port (Object Port), the device address (Object Addr), sampling rates (Object Interval), the name of the table (Object Table), interface component abscissa (Object PosX), interface component ordinate (Object PosY), notes (Others).

VI. Conclusion

A Datacenter Computer Room Monitoring System Self-Customization method named DCRMS-SC is presented in this paper. The method has worked as follows:

This paper discusses the implementation of customization method of DCRMS based on a Mass Customization principle, and designs a DCRMS-SC method based on MC. The author has also designed the

architecture and the development process of DCRMS based on MC. It has certain significance to the intelligent design of DCRMS, and to the implementation of DCRMS based on MC as well. The results of applying mass customization principles include efficient and simplifies the DCRMS development remarkably.

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