The Online Integrated Development and Management Environment for Smart Phone Satellite

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In recent years, smart phone satellite has been widely concerned. It shows much potential ability, for example, miniaturization, low cost and high effect and so on. The smart phone satellite provides a new possibility for the Atmospheric and Climate Sciences, the Earth Sciences, communicate technology and other space-based applications. Predictably, micro satellites which take the phone satellite as the main body may become a development direction in the field of satellite in the future. We take soft components which are suitable for phone satellite as the research object; take on-board smart phone cluster as the target platform; study the typical aerospace applications and finally build the Online Integrated Development and Management Environment for Smart Phone Satellite. The purpose of the Online Integrated Development and Management Environment for Smart Phone Satellite proposed in the paper is to make every ordinary coder can quickly and efficiently build safe and reliable aerospace software, and reduces the satellite system building cycle and cost at the same time.

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1. Introduction

On April 21, 2013, the Orbital Sciences Corporation in the United States launched the Antares carrier rocket successfully for the first time at the launch site which on the Wallops Island and belongs to the United States NASA. The rocket carried three low-cost smart phone satellites. They may be the lowest cost space vehicles. NASA to develop phone satellite mission is to hope to be able to determine whether consumer smart phones which cost very low can be used as a main load satellite.

Smart phone satellite has been widely concerned. It shows much potential ability, for example, miniaturization, low cost and high effect and so on. The smart phone satellite provides a new possibility for the Atmospheric and Climate Sciences, the Earth Sciences, communicate technology and other space-based applications. Phone satellites transmit their running status information to the ground by radio in order to verify they could work normally as ordinary satellites in space. [1]

Predictably, micro satellites which take the phone satellite as the main body may become a development direction in the field of satellite in the future.

2. The Online Integrated Development and Management Environment for Smart Phone Satellite

Through study of the research of the online integrated development environment, we find the following questions: Firstly, the function of the existing environment is simple. It is mainly because providing the same functions on the web is more complex than on the local machine. Secondly, local environment is for single user but online environment is for multiple users. Thirdly, the security of the online integrated development is more outstanding. Finally, how to make full use of the advantage of online development is also a problem that needs to solve. [2]

The development of the smart phone satellite software has bigger difference with other software. Firstly, developers who develop space applications need to have more professional knowledge. Secondly, space applications need a higher reliability than other applications. Finally, it is hard to get a real verification environment for the developers.

We take soft components which are suitable for phone satellite as the research object; take on-board smart phone cluster as the target platform; study the typical aerospace applications and finally build the online integrated development and management environment for smart phone satellite (hereinafter referred to as the OIDMESPS). The OIDMESPS contains client development environment and server software management service system. For different hardware system of satellite we build different projects, and the server software management service system works in the form of a cloud platform. It provides users with the corresponding software tools and simulation running environment, stores user source and related documentation and is responsible for reviewing and testing the software developed by users. Distributed users use the client development environment for development, debugging and simulation test of the software. The software that passes the test and review is uploaded to the satellite system. Updating software on-orbit makes full use of the verification on board and reduces the time of verification on the ground effectively.

The online integrated development and management environment for smart phone satellite is not only a tool for developers to create applications, but also a tool which help developers to complete a high reliability software project better and faster. Therefore, the integrated development and management environment consists of the following parts.

1. Software project planning and management platform;
2. Software design platform;
3. Software development platform;
4. Test and performance tools platform;
5. Software release and deployment platform;
6. Software maintenance platform;
7. Service support.

OIDMESPS adopts the thin client mode which implements operations and business logic on the server. The client is an internet-based application which contains a browser, and the browser is responsible for the interpretation, display and processing graphical user interface and data of the application. The client sent the input to the server for processing, and the server again to send processing results back to the client for display. Different clients can log on to the server at the same time and run the application software on the server directly by the central data services in order to realize the centralized, High security and reliable management of the software application.

2.1 Software Project Planning and Management Platform

2.1.1 Determine the Engineering Requirements

For an application of smart phone satellite, there are two methods to determine the engineering requirements: the least common multiple method and the custom method.

When using method of least common multiple, it is need to better design the application to run smoothly in a variety of devices. In this case, the main target device should usually be with the least amount of properties. Only the requirements which match all equipment will be added to the specification in order to adapt to the target device at maximum range.

When using custom method, applications will be cut for a specific device. This method is used in developing for the specific target device.

Developers can use the "software project planning and management platform" to select the requirements that the application needs to conform (Specific target device or a collection of several kinds of target devices). When developers determine the project requirements the satellite platform is identified accordingly.

2.1.2 Implement Software Configuration Management

Because of the influence of many factors, it is difficult to give or define the complete software requirements once. It inevitably leads to dynamic, ever-changing software requirements, and that brings great difficulty in software development. In order to adapt to this kind of situation, it requires good modifiability in the software development phase. Therefore, in the process of software development needs to execute software configuration management in order to make software development process be controlled and state of software technology be controlled. [3]

We use the relational database to store the source code and take function as the smallest unit of check-in and check-out. It is better for the version control for large-scale collaborative development environment. In addition, we make the behaviour of add, delete and modify to source code correspond to add, delete and modification operations to database. By this way, the developer can not only back to a history version but also can get a new version branch by choosing small history operations.

2.1.3 Reliability Assurance

Consequences caused by software failure is not to be ignored as well as the hardware, even may lead to disastrous consequences, especially in the aerospace system The reliability of the software should be paid more attention.[4-7]

It is well known that the earlier to find software error means that the less cost, so the software project planning and management platform uses the code standard inspection tools to check out as much as possible software programming errors and external input errors.

In the smart phone satellite, a cold standby reliability system was selected which composed of several identical backup units. The units will converted by the control switch and the system will working just needs one of all the units is normal operation. The expression of system reliability was shown as follow:

$$\text{MTTF} = \frac{n}{\lambda}$$

(2.1)

$$R(t) = e^{-\lambda t} \cdot \sum_{i=0}^{n} \frac{(\lambda \cdot t)^{i-1}}{(i-1)!}$$

(2.2)

$$\theta_s = \int_{0}^{\infty} R(t)dt$$

(2.3)

Where n is the number of backup units, is a constant which means the proportion between disabled parts and all parts, MTTF is mean time to failure, R(t) is the probability of normal operation from the system starting to t, is the mean of system life.

2.2 Software Design Platform

The application designer should consider how to interact with other applications of satellite platform. When designing the application should consider the following questions: 1) Whether the application depends on the data of other applications; 2) Whether the data is installed on the satellite platform; 3) Whether the application will produce the data that other applications need? What data will it provide? 4) Whether the applications rely on third-party services or optional components; 5) how will the application deployed to a satellite platforms?

Software design platform provide the function of searching optional components, components and applications that can provide data within the same project by using the central repository for designers. It also provided users with a modelling tool to assist users to complete the software design.

2.3 Software Development Platform (Component-based development)

Platform provides to the user the finished software component with well-defined interfaces to provide a specific function to be integrated into the software. Component refers to valuable, almost independent and replaceable parts of a system; it can complete a certain function well in good definition architecture.

Developers check requirements to determine which subset of the system can be done by direct assembly rather than structure. Developers ask the following questions for every system requirements: 1) whether the existing components can realize the requirements. 2) Whether the interface of the available component is compatible with the system architecture to be built.

Components can be obtained from reusable library, or develop according to the special needs. Therefore, the task flow of component-based development has two paths. When components that in reusable library may be integrated into the system structure, it must do qualification inspection and adaptive changes on them. When need a new component, it is need to be developed; the new component is integrated into the architecture and do comprehensive test.

The developers who just come into the field of smart phone satellite software development may not know about which resources (i.e. component, module and so on) can be used, even do not know how to start. The system recommends the related components and modules in the field which the developer chose before. Which resources are recommended depend on the initial settings of the system and the mining and analysis of the code which the other developers in the same filed developed.

2.4 Test and Performance Tools Platform

Because of the different between the software on satellite and the software on ordinary smart phone, it is hard for users to build a test environment in ordinary smart phones. This needs to provide a set of simulation testing environment and testing tools to test the functionality and performance of the software in the simulation environment. Simulation test tool can also be as a presentation tool to provide perceptual knowledge for users to understand works of the software on the satellite

For using the simulator or physical simulation to test, we will encounter a dilemma: on the one hand, it is need to provide users with a simulation test environment that close to the real; On the other hand, the platform cannot make a lot of distributed customers do physical simulation at the same time. For a developer, the most of his test run on the simulator, however, the real test can only be conducted on a physical device. Because of limited physical simulation resources, for a user, his test is not arbitrary. Before physical simulation test, the user needs to submit a test plan, and the system will distribute test resources according to the test plan.

2.5 Software Release and Deployment Platform

An application that can be used in phone satellite must be safe. When users are ready to release their application, they have to sign the application with their private key first. After signing the application, package source code into a package and upload it to the server in order to wait for review and certification.

2.6 Software Maintenance Platform

After Software is submitted, the subsequent version update, database update work will take place in the software maintenance platform.

User will also get the results that whether the software that they submitted has passed review and certification from the software maintenance platform.

After the software uploaded to the satellite, user can get the data of application on satellite and monitor the running status of application from the software maintenance platform.

2.7 Service Support

The main functions of the service support are considered from the following aspects:

2.7.1 The Central Repository

Central repository is the database as software information gathering and storage center. Besides being "warehouse" store user source code and related documentation, the central repository is the basis of implementing software configuration management.

The central repository has the following features:

1. Data backup: provide the basic data backup function.

2. Data integrity: including login in the central repository; ensure consistency between related object; when an object's changes lead to other objects have to be modified, it can automatically complete the "cascade" modify.

3. Information sharing: Provide a mechanism for sharing information between different developers, and it is able to manage and control the multi-user access to the data.

4. Standardization of document: it is the definition of objects in the database; it gives a method to create software documentation standards directly.

We use the relational database to store the source code. For OOP language, the storage unit is no longer a file but a member variable or a member function. For developers, they don't need to write the header file and consider the function declaration order any more even using c++ language. In the process of collaborative development, the developers can find whether the modules/components that they call have been changed and whether it impacts on them. On the other hand, the clear structural relationships could quickly locate the problems to a minimum range and find the modules which are related the problem.

2.7.2 The Reusable Library

(1) Classification and Retrieval of Component

Consider a large component warehouse, where stores tens of thousands of reusable components. How to find the component that developer needs? To answer this question, there was another problem: How can we use unambiguous terms to describe software component?

We take the 3C model to describe the components of a reusable library: concept, content and the condition.

● Concept: means "the description of what component does". Make a complete description of components' interface, and identify the semantics (using the context with preconditions and postconditions). Concept conveys the component's intentions.

● Content: describe how the concept is implemented. In essence, the content is hidden information for the common user, only those who are trying to modify or test components need to know.

● Condition: put the reusable software component in their application field, that is to say, condition allows the developer to find the right components that meet the application requirements.

In order to use in a real environment, the concept, content and condition must be converted to the specific specification model. The OIDMESPS using the method of library and information science classify reusable components.

(2) Environment

Reusing software component must have the support of environment; the environment consists of the following elements:

1. The component library that can store software components;

2. The necessary classification information for finding these components;

3. Provide a library management system to access component library;

4. Software component retrieval system;

5. The tool that supports the reuse components to be integrated into the new design or implementation.

3. Results

The experimental of the system testing will explain from two respects, system performance and system reliability and the data acquired by statistical method. All the result will compared with the index which published by QSM United Co. Ltd. As it is shown in Figure 1.
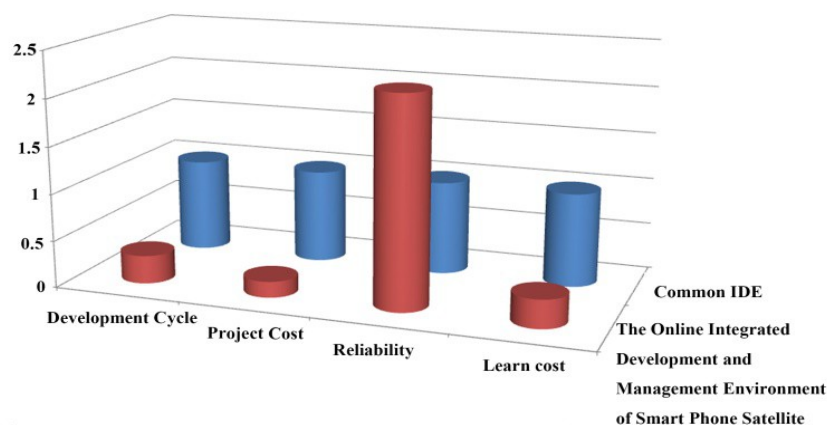

Figure 1: Compare with Common IDE and OIDMESPS

4. Conclusion

We naturally come to the conclusion as follows:

1. Easy to use, low cost to learn. OIDMESPS maintain the basic satellite environment, and providing a developer with a lot of reusable components, and enables developers can develop high quality aerospace applications without spending a lot of time learning aerospace applications.

2. Component-based development brings huge benefits to the software engineer;

3. Provide users with software project planning and management tools in order to utilize the automation tool to the best advantage to ensure software quality;

4. Reduce the build cycle and cost of satellite system.

5. The software development model based on network can support the developer of various network client develop all-weather multipoint in parallel.

6. Using the thin client form to provide users with a large number of tools, make small customers also can use expensive tool software that is not easy to get.

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