Resource Planning For Heterogeneous Signal Processing Platform Based On Configuration Files

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Abstract. In order to solve the problem of the reasonable management and planning of complex hardware and software resources in heterogeneous signal processing platform, this paper researches and designs a resource-visualization model based on configuration files and a hierarchical resource management method. And more, experiments verify the visual task planning program of MFSK. Experiments show that the proposed scheme can efficiently abstract and manage the complex and heterogeneous hardware and software resources of heterogeneous signal processing platform and draw the corresponding plan for the corresponding application task.

1 Introduction

With the rapid development of wireless communication technology, communication means and technologies are characterized by complexity, diversification and hierarchy. To solve the problem of how to quickly and efficiently communicate, interconnect and interoperate with different communication technologies, J.Mitola proposed the concept of Software Defined Radio (SDR) [1] in 1992. SDR uses an platform that is open, scalable, and thin-provisioned hardware as a common platform to implement as many radio functions as possible using reconfigurable and scalable component software [2].

In heterogeneous signal processing platform, because of the larger and larger scale of hardware and more and more types of software applications, there is an urgent need for a unified Software Communication Architecture (SCA) [3], as well as a cross-platform resource scheduling and management module based on a unified software architecture, so as to implement distributed management, configuration and monitoring for device resources in a heterogeneous distributed environment. How to efficiently, quickly, reasonably model and manage large, diverse distributed heterogeneous hardware-software resources[4] and how to quickly, reasonably deploy processing-capable software components to the corresponding hardware resources[5], have become the focus and difficulty of the current communication system architecture.

At present, the modeling and management of heterogeneous platform reconfigurable hardware and software resources rely on the management tools provided by manufacturers. These tools are generally designed based on the actual characteristics of the device[6], lacking standard, open and flexible management approaches. In the SCA, the platform resources are described in Unified Modeling Language (UML)[3], and the various interfaces are described in a graphical design language. This paper draws on a database management method similar to [7], using the SCA design standards. The management method not only manages the waveform parameters of the platform parameters and the software components, but also conducts virtualized abstract models for hardware and software resource, based on the configuration files to form a uniform standard description. In this method, a relational database is used to provide a flexible and unified management and configuration of the hardware and software resources having the network topology connection relationship. It solves the difficult problem of reconfigurable resource management and configuration of heterogeneous platforms and further reduces the difficulty of resource management and task planning of heterogeneous platforms. In addition, in order to verify the validity and efficiency of the configuration file-based virtualization model and maximize the utilization of platform resources, this paper designs and implements the visual application component planning scheme then can generate the

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description files of resource management and waveform component planning.

2 Resource Model

The resources of Heterogeneous signal processing platform include hardware resources and software resources. Hardware resources include chassis, boards, processors, switching units, etc; Software resources include components with waveform capabilities [8], application-related software, software packages, communication protocols , etc.

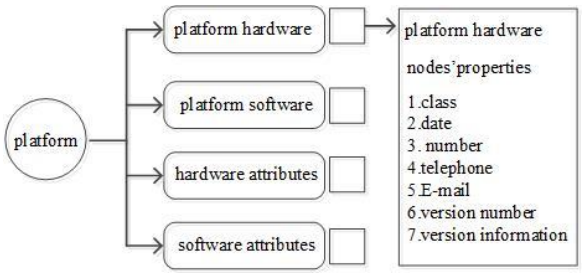

Figure 1. The Classification Diagram of Platform Resources

With referencing the standard of SCA, this paper uses a unified and standardized resource description file to abstract the heterogeneous platform resources , represented through a tree structure. In terms of functions and attributes, this paper divides platform resources into four parts, as shown in Figure 1, : platform hardware, platform software, hardware attributes and software attributes. The hierarchy of the tree is described hierarchically using a 16-bit binary number. The coding of hardware and software use the principle of "3,3,3,4,3" .

2.1. Hardware resource model

The hardware resource model of heterogeneous signal processing platform describes hardware devices, constituting the heterogeneous platform, equipment affiliation, connection, etc., which constitute composition of the hardware. Each node of the hardware stores the attributes of the hardware devices described by the node for providing standardized, open hardware and software attributes. In this paper, the hardware resources of heterogeneous signal processing platform are abstracted to four parts, board, platform and network platform and correspondingly encoded.

Board and the connection between the board form a platform; multiple platforms and the connection between the platform form a network platform system. And each level has a corresponding configuration file description. In the configuration file, hardware structure and properties of hardware resources provide a unified and standardized expression of devices. For example, the hardware structure of the board includes the board plug, the socket, the processor, the exchange unit, the communication node, and the bus connection in the board. The attributes of board hardware include board hardware's name, number, physical properties and so on.

2.2 Software resource model

The software resource model of heterogeneous signal processing platform describes the relevant components of the application tasks and the corresponding attribute definitions. According to the basic idea of SDR, platform application tasks can be composed of software components, software packages, platform applications and component model descriptions.

Software components are described by the port and the parameters. The ports of components generally contain input, output ports, control ports, etc; component parameters are set according to the needs of the application. The software component's attribute parameters are descriptions of the software components' capabilities. Software component properties include name, encoding, data type, processing method and so on. After the abstraction of software resource is completed, it is modeled based on the profile and will generate a software-component description file.

Software packages, that containing a list of components, firmware containers and source code engineering, are the function realization of components. The firmware container contains the lists of container port, the lists of direct-connection component and the lists of connections between containers; the source project contains a list of component files. The package's attribute parameter is a description of the package's performance. Package attributes include name, encoding, operating system, programming language, and more. After the package resource abstraction is completed, it is modeled based on the profile and will generate a package description file.

Platform applications consist of software components, components' connections, processors and others. The processor contains lists of related processes. Platform applications' attributes include name, code, domain name, platform number, board number, priority, transmission mode and so on. After platform application resources are abstracted, they are modeled based on configuration files and will generate platform application description files.

3 The resource management of heterogeneous signal processing platform

The resource models effectively abstract the platform's heterogeneous resources for virtualization. According to the characteristics of distributed heterogeneous resources, a management scheme based on domain segmentation and grading is proposed. In order to efficiently and flexibly configure resources, a visual development management model based on lightweight-SQLite relational database is adopted to achieve a efficient management on the distributed heterogeneous resources.

3.1Hierarchical abstract management

The platform application mode belongs to a complicated system in which networked multi-domain, multi-platform, multi-device and multi-application software concurrently running. The types of resources consumed by each application in the system are complex and diverse. In addition, because of the networked working mode and as the topology structure changes or a certain type of equipment changes from an available state to an unavailable state, the available resource information of the system also changes dynamically. This requires a fine and accurate control command to bring about the efficient management and flexible configuration of all types of boards, platforms, network platform resources.

Aiming at complex and layered platform resources, this paper designs a domain and hierarchical resource management model as shown in Figure 2.

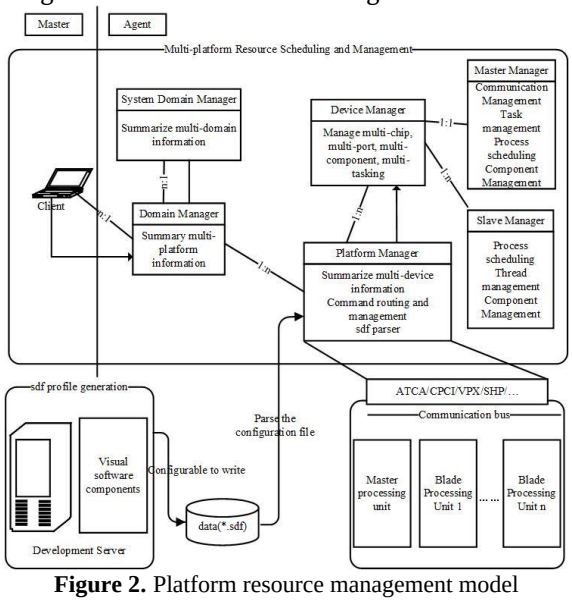

Figure 2. Platform resource management model

The model includes client, system domain manager, domain manager, platform manager, device manager, master / slave manager and so on, which can efficiently and flexibly configure and manage complex, heterogeneous platform resources in a hierarchical structure.

3.2. Resources' store and recall based on relational datdabase

In order to more efficient management and design for sub-domain and hierarchical management of platform resources, this paper designed and implemented, based on the relational database, visualized resource management as shown in Figure 3.

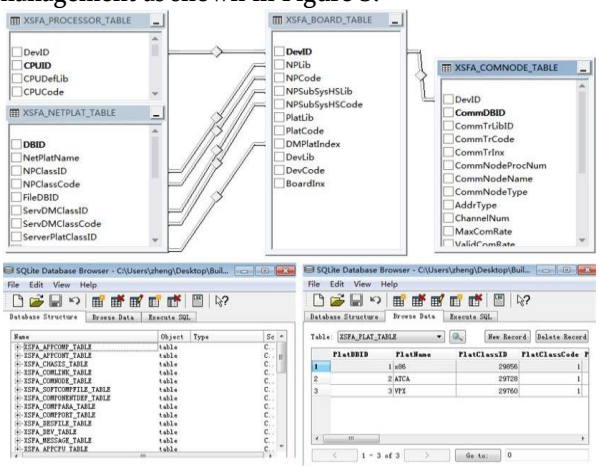

Figure 3. The Relational Database

The management steps of relational database are as follows:

(1) By relational database analyzing the configuration file of hardware and software resources in the platform, the corresponding database tables are generated in batches and stored in the database.

(2) And then associate with the resource table through a specific field to achieve the associated query. And, modify , delete the corresponding database table or table fields to modify the platform hardware and software resources.

(3) Read out the hardware and software resources from the database to the visual interface. Configure and modify the resources so as to realize the visual assembly, deployment and management of the hardware and software resources.

(4) Generate the script information of hardware device and the description file of resource planning.

(5) The platform manager parses the corresponding configuration file, so as to realize the development of application tasks in the heterogeneous signal processing platform.

4. Experiments

In order to verify the efficiency of resource abstraction and management of heterogeneous signal processing platform proposed in this paper, the experiment

visualizes and generates the corresponding resources profile for a heterogeneous signal processing platform composed of one X86 platform, ATCA platform and VPX platform and the application task of MFSK.

4.1. The examples of the resource management

In this paper, according to the characteristics of hierarchical heterogeneous signal processing platform, A tree structure is used to achieve a unified and standardized definition and description of the heterogeneous resources.

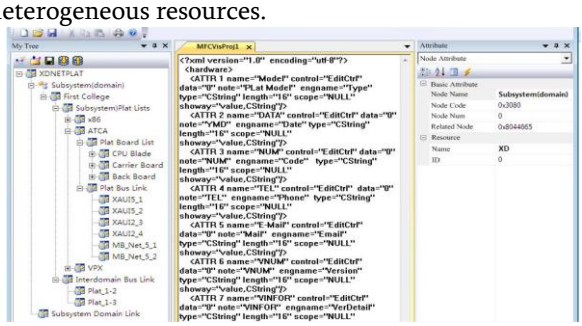

Figure 4. The tree of network platform resource

The visual management of heterogeneous signal processing platform is shown in Figure 4. There is a domain in the figure. The domain has three platforms, including ATCA platform consists of three boards. In addition, in order to facilitate the description of the hierarchical platform, this paper uses a lightweight-SQLite database to describe the resources. At last, read the corresponding fields from the database and generate the hardware configuration File.

In addition, in order to realize the function of the platform's signal processing and verify the validity of the configuration file of the hardware resource, the experiment is conducted by taking the setup and planning of MFSK as an example. According to the definition of software radio, the application tasks can be divided into a file-reading component, a resampling component, an MFSK demodulation component and a file-saving component. Based on the principle of software resource abstraction proposed in this paper, an application assembly view as shown in Fig.6 is established. At last, which provides resources for the planning and testing of application tasks, the map of the application assembly is saved into the lightweight-SQLite database.

4.2 Task planning test

After the application's assembly and development are completed, a reasonable mapping will be established between each component and different processors. And the configuration files are formatted. Finally the task is loaded and tested.

In the experiment, this paper uses the visual planning view as shown in Figure 7, to plan the components by using a combination of manual experience and automatic deployment solution.

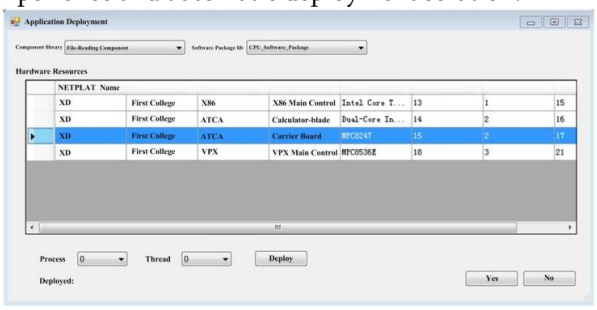

Figure 7. The components planning of MFSK

The reconfigurable task planning program in chapter 4 is used to plan MFSK components. Plan the file-reading components to Calculator-blade processor; plan the resampling component to the carrier board ; plan the MFSK demodulation components to the DSP board processor; plan the file storage components to the processor of the carrier board. Finally, store the planning's results of the application components into the database. The planning results are shown in Table 1:

Table 1. The results of MFSK components' planning

Component	Planning location
File-reading component	Calculator-blade
Resampling component	Carrier board
MFSK demodulation component	DSP
File-saving component	Carrier board

Using the visual development tools, the experiment generates the corresponding configuration files, based on the basic information of the platform and application components planning. Finally, resolve the corresponding configuration file in the operating environment and load each package onto the appropriate processor.

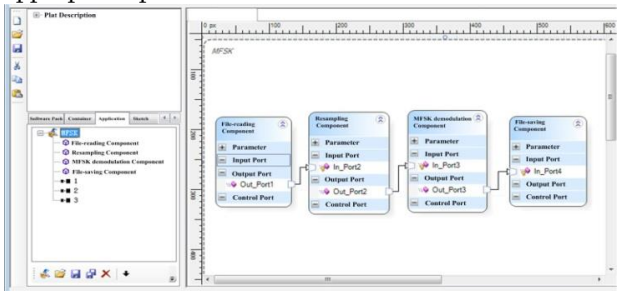

Figure 6. The application assembly diagram of MFSK

The experimental results show that the task planning of the distributed heterogeneous platform, based on configuration file, is a reliable and effective solution and can flexibly implement the development and planning of applications.

5 Conclusion

Aiming at how to model the hardware and software resources of the distributed heterogeneous signal processing platform and how to manage and plan them effectively, a configuration file-based modeling method is used to describe the hardware and software resources. Combining the characteristics of distributed heterogeneous platform resource, this paper design and achieve a sub-domain and hierarchical resource management methods to achieve efficient, flexible configuration and management of hardware and software resources. And then, based on relational database, we designed, implemented a visual task planning and obtained effective and reliable planning results.

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