Architecture design of disaster risk assessment and warning system based on UML

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***Abstract*—China is one of the few countries which suffer worst natural disasters in the world and it is an urgent need for effective monitoring methods. Small satellite constellation for environment and disaster monitoring and forecasting is the first small-satellite constellation dedicated to environment and disaster monitoring and forecasting of China.**

Disaster risk assessment and warning system for environmental and disaster monitoring and forecasting is one of the core systems of small satellite constellation ground system, it undertakes the task of disaster risk analysis and evaluation. Based on the Unified Modeling Language (UML) technology, this paper defines the system's function requirement and the non-function requirement and the business concepts and their relationships of system through the requirement analysis and domain modeling, and refines the system architecture design through the logical structure design and physical architecture design. The practice proved that architecture design based on UML is very useful for specifying the business objectives, business functions and constraints limit in disaster risk assessment and warning system and guiding the late technical development work.

Keywords-UML; Architecture Design; Requirement Analysis; Domain Modeling

I. INTRODUCTION

China's location at the unstable weather conditions zone of mid-latitude area, and the strong new tectonic movement of the area, the complex terrain, as well as the profound influence of the long history of human activity, favor the formation of various types of disasters, making it one of the countries in world most severely affected by national disasters. The main natural disasters are earthquakes, storms, floods, typhoons, dust storms, cold damages, snow storms and other weather and climate disasters, landslides, mudslides, collapses and other geological disasters; Biological disasters such as pests and disease of crops and forest; forest fires etc. [1, 2, 3]. There are several characteristics of the national disasters across China, which are: multi-variety, high frequency, wide range and severe damage.

Compared with the grave situation of natural disasters in China, our overall technological level of disaster reduction is still low, monitoring technology and methods are still relatively backward, mainly depends on routine monitoring of natural disasters on the ground to monitor, forecast and assess national disasters, this is far from satisfying the actual requirements of the relief and reduction of national disasters. In this case, in order to improve our national capability of monitoring, forecasting and assessment of environment and disaster events, Fangyun Chen academicians proposed the construction ideas of the "small satellite constellation for environment and disaster monitoring and forecasting" in the early 90s 20 th.

Small satellite constellation for environment and disaster monitoring and forecasting is the first small-satellite constellation dedicated to environment and disaster monitoring and forecasting in China. In September 2002, the State Council formally approved the starting of the project of the small satellite constellation for environment and disaster monitoring and forecasting. When the satellite constellation is put into use, it will be able of realize all-weather, all-time, dynamic monitoring of national disasters. Ministry of Civil Affairs and the National Committee for Disaster Reduction as the co-owner, will make requirements as the foundation for the design of the performance parameter index of the sensor according to disaster and environment business needs, and implement the establishment and management of the ground system, and manage the business operation of the satellite [4, 5].

Disaster risk assessment and warning system for environmental and disaster monitoring and forecasting is one of the core systems of small satellite constellation ground system, it undertakes the task of disaster risk analysis and evaluation: extracting the remote sensing data of the small satellite constellation for the environment and disaster monitoring and forecasting, other satellite remote sensing data, GIS vector data, business data, as well as economic and social data from the database management subsystem, then from the remote sensing data taken by the processing of the feature parameters inversion, hazard information extraction, after the analysis processing of the remote sensing data based on system package for disaster risk assessment and warning model, generating disaster risk assessment products and disaster warning products, these products will be submitted to the database management subsystem, the subsystem for

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decision support analysis, emergency response sub-systems, and damage assessment subsystem etc. will conduct re-display and re-analysis.

From the disaster risk assessment and warning system construction point of view, and based on UML technology, this paper thoroughly demonstrates the design of system framework.

II. INTRODUCTION OF UML

UML is a standard language which conducts Visualizing, Specifying, Constructing, Documenting to software system, and it is an industry standard of object-oriented modeling language which is developed by its collection of the best of a variety of object-oriented techniques [6, 7]. UML has matured significantly since UML 1.1 (Fig. 1).

The goal of the UML:

- Define an easy-to-learn but semantically rich visual modeling language;
- Unify the Booch, OMT, and Objectory modeling languages;
- Include ideas from other modeling languages;
- Incorporate industry best practices;
- Address contemporary software development issues;

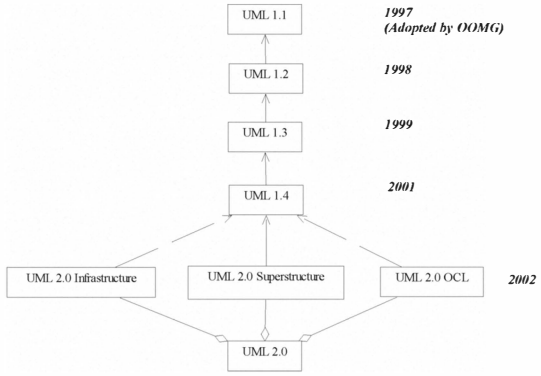

Figure 1. OMG UML Evolution

- Scale, distribution, concurrency , etc.;
- Provide flexibility for applying different processes;
- Enable model interchange and define repository interfaces.

UML mainly includes basic models as the following:

- Use Case Diagram: the relationship between the operator outside the system and various use cases of the system, which is to describe the system's function from the point of view of the operator outside the system, providing a standardized means for the requirement analysis;
- Static Diagram: Class diagram-show the static structure of the class in the system; Object graph-an instance graph of the class diagram; Package diagrams-the grouping mechanism of class diagrams;
- Behavior Diagram: State diagram-describes all possible states and their metastasis of a certain class of objects; Activity diagram-shows the implementation process of various activities in the system;
- Interactive Map: Sequence diagram-shows a dynamic collaboration between objects; Cooperate diagram-shows the dynamic collaborative relationships among objects from another angle ;
- Implementation Diagram: Component diagram-shows the physical structure of the code of the show program; Configuration diagram-shows the configuration relations of the software in the hardware environment (especially in the case of distributed and network relations).

UML includes 5 categories and 10 model diagrams, provides a standard method from different perspectives to observe and display system's various features, different types of systems, and the systems in different areas will use different models or a combination of several models, the software design, usually describes the system in the perspective of using case diagram, class diagram and behavior diagram.

When using object-oriented design system, the design process of the framework of the system based on UML includes: first, describe the demand, followed by the establishment of the system's the static model according to demands, so as to construct the structure of the system; the third step is to describe the behavior of the system [8, 9].

III. ARCHITECTURE DESIGN OF DISASTER RISK ASSESSMENT AND WARNING SYSTEM BASED ON UML

The architecture is a basic structure of a system, with components, the relationship between components, and the relationship between components and the environment as its content, as well as principles guiding the design and evolution of the above mentioned content (Fig. 2). In the absence of its framework, the construction of any structure of high complexity is reckless.

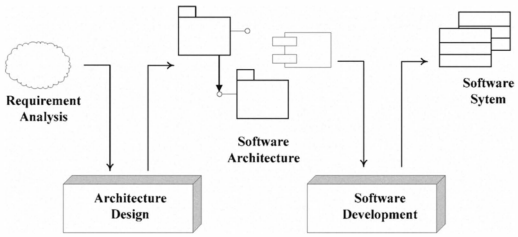

Figure 2. Role of the Architecture Design

This paper thoroughly demonstrates the design process of the architecture of disaster risk assessment and warning system based on UML technology.

A. Requirement Analysis

A requirement describes a condition or either derived directly from user needs, or stated in a contract, standard, specification, or other formally imposed document.

Disaster risk assessment and warning model computing is the core function of the disaster risk assessment and warning system. The system provides the functionality of the disaster

risk assessment and warning of floods, droughts, fires, snowstorms, ice storms, geological disasters, and etc. Meanwhile, in order to effectively integrate with other systems of the ground system, the system provides task management, log management and etc.

Meanwhile, in order to facilitate the implementation of the actual operation, the system provides users with data pretreatment, thematic map production and disaster statistics functions in the form of kits (Fig. 3).

B. Domain Modeling

Domain modeling is the process of establishing the domain model. Domain modeling is dedicated to analyzing the problem domain itself, exploring important business domain concept, and establishing the relationship between business domain concepts.

1) Analysis of Sequence Diagram of system

Through demand research, conduct in-depth analysis on disaster risk assessment and warning system operation ways.

Operational staff's daily work: according to actual needs, draft risk assessment and warning tasks; according to types of disasters, region, accuracy, overall system operation makes task list in the transport management system. On the condition of confirming that there's no problem with the task list, use the model corresponding to the disaster risk assessment and warning modules to produce products. In addition, the system provides data processing and analysis capabilities for helping the user complete the relevant data preprocessing and post processing of the products, including: clipping raster data, field computing, disaster statistics and so on (Fig. 4).

2) Design of the class diagram of the system

Disaster risk assessment and warning software package mainly consists of the following six basic classes: DRSEW Application class, Disaster Model class, Disaster Assessment Model class, Disaster Warning Model class, Log Management class, Utility Management and Task Management class (Fig. 5).

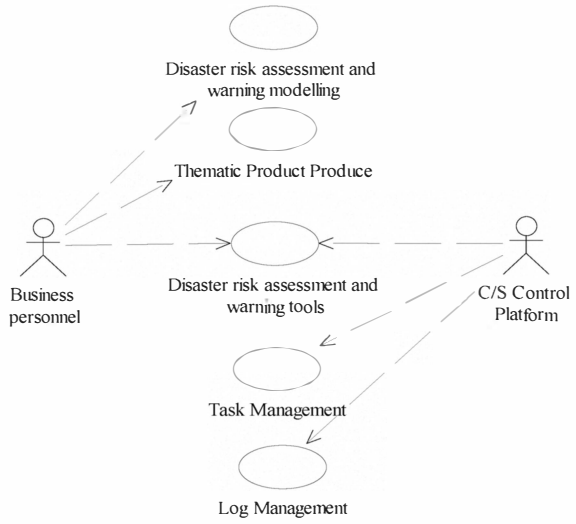

Figure 3. Use case of the system

C. Architecture Design of the system

On the basis of requirements analysis and domain modeling analysis as well as multi-view method, conduct the design for the architecture of disaster risk assessment and warning system. Logical structure design mainly focuses on the division of acts or duties, not only includes user-visible functions, but also includes "auxiliary function modules," which is essential to achieve the user function. In the end, the different responsibilities are assigned to the logical layer, function modules, classes of logic units; physical architecture describes the computer, networking and hardware, etc. in which the software operates, as well as describes how to deploy the software package to these hardware resources, and their runtime configuration; development of framework follows closely the actual software module organization in software development environment, specifically involving source files, configuration files, source package, compiled object files and third-party library files.

1) Logic Structure Design of the system

System logic involves following the three-tier structure model, dividing the hazard risk assessment and warning into the client browse tier (also known as the show floor), logic implement tier and data tier (Fig. 6).

Data tier, provides data support for the system, that is, provides the data I/O operations for the data adaptation layer. Meanwhile， The function of data adoption tier is shielding the structural information of the data tier from the logic implement tier, packaging the resource application and release agreement, provides the data view or data manipulation interfaces for the logic implement tier, the design of all these interfaces is in full accordance with the functional needs of the logic implement tier.

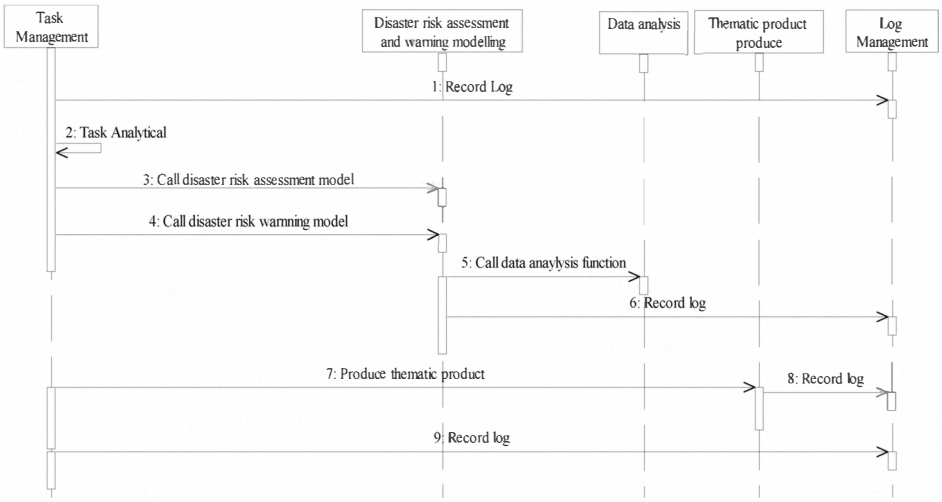

Figure 4. Sequence diagram of the system

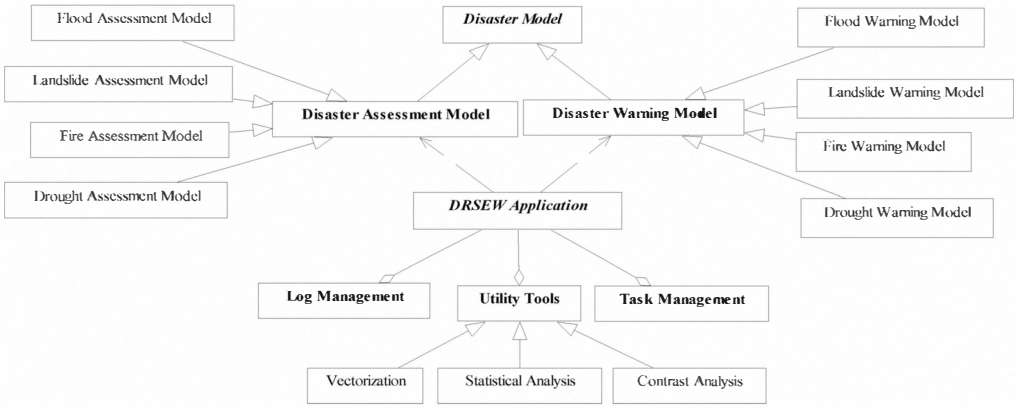

Figure 5. Classes diagram of the system

Logic implement tier, functional parts of the component development system capabilities should achieve functional independence and convenient coordination of scheduling functions.

Client browse tier, organically integrate all the basic functions of the logic implement tier, builds individual software of the system.

2) Physical architecture design of the system

The physical architecture prescribes the physical elements of the composition of software systems, the relationship between these physical elements, and the strategy of deploying them to the hardware. Reflect the organization when the software system dynamically operates.

The hardware operation environment of disaster risk assessment and warning software package, includes workstations, optical switches, and disk storage devices. All software features are deployed on the workstation, disk data storage equipment services storage case data, log data and model data, then the database management server will manage these data. Optical switch is mainly responsible for the data exchange processing between the server and workstation (Fig .7).

IV. CONCLUSION

UML is a standardized general-purpose modeling language in the field of software engineering. UML combines techniques from data modeling (entity relationship diagrams), business modeling (work flows), object modeling, and component modeling. It can be used with all processes, throughout the software development life cycle, and across different implementation technologies. It is proved that UML has powerful functions in analyzing the requirement demand, business

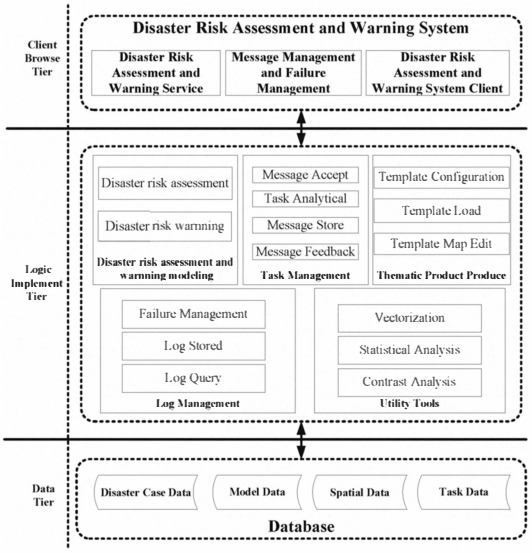

Figure 6. Logic structure of the system

logic and designing the architecture design from multi-aspects in the construction of disaster risk assessment and warning system.

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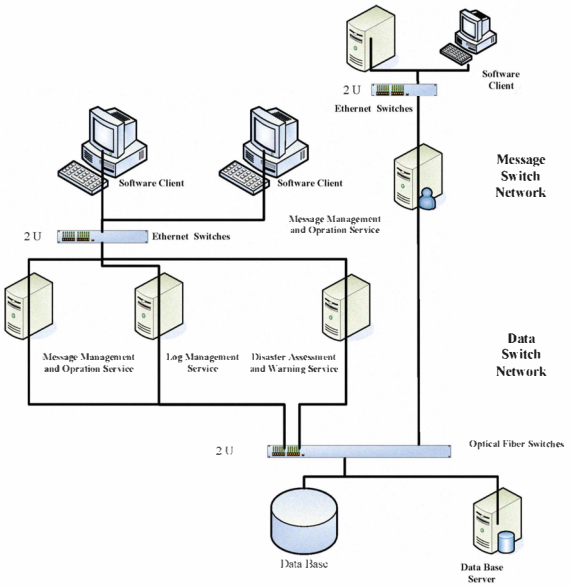

Figure 7. Physical architecture of the system

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