

# Emergency disposal of urban rail transit based on distributed workflow

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**Abstract.** Under the background of the network operation of urban rail transit, the rapid expansion of rail network structure in various cities, on the one hand, has promoted the rapid development of rail transit industry. On the other hand, it put tremendous pressure on the daily operation and management of rail transit operators. The traditional centralized disposal mode is not in a position to meet the increasingly complex network and passenger demand any more. In this paper, based on the distributed workflow theory, a distributed multi-aircraft collaborative system framework is established for emergency management of urban rail transit and an emergency response model, using Oracle database management system as the main technical to realize the digital management of contingency plans, the theory is finally applied in practice, and the design of the urban rail transit emergency response system for OCC layer is realized.

## 1. Introduction

With the development of the society, urban traffic is under tremendous pressure. Under such circumstances, urban rail transit has become the direction and the first choice for the future development of the transportation with its advantages of high safety, high traffic volume and high speed, not occupying the ground space and riding comfortably.

In the case of rapid development of rail transit, the number of rail transit operations is continuously increasing. China's urban rail transit has entered a networked operation era. Compared with single-line operation, routes of networked operation are more complicated and operation equipment is more diversified, which make transport more efficient. But it also makes the capacity of rail transit network traffic volume more prominent contradictions, and the potential safety problems of the facilities are outstanding. Under such circumstances, it is particularly important to enhance the resilience of urban rail transit to emergencies. This requires that the urban rail transit emergency response mechanism must be able to carry out timely and efficiently in advance, and also during and after the incident: the prevention phase of the plan should be perfect and well documented; the disposal phase should achieve timely detection and rapid, correct disposal.



The existing mode of emergency treatment of rail transit is centralized disposal mode, with unified command and step-by-step responsibility[1]. In the disposal, the OCC director dispatching, will give instructions in a unified manner and then delegate the command to other departments because this method is not a command at the scene, only through the feedback of two command to understand the scene, leading to difficult to grasp the best handling of emergencies. With the increasingly complicated network structure, the drawbacks of centralized disposal have become increasingly obvious.

Based on the above situation, this paper proposes an urban rail transit emergency disposal system based on distributed workflow, with a view to improving the existing defects of centralized disposal. Based on the standardization and digital management of emergency response plan of rail transit, based on workflow theory, urban rail transit emergency disposal mechanism, organizational structure, disposal workflow and so on to model and redesign, to build distributed collaborative work system, the use of distributed collaborative system to achieve multi-position information, multi-point linkage, co-processing and improve the efficiency and reliability of the entire emergency disposal operations [2], in order to solve the future network operation under the conditions of the safety of urban rail transit proposed a new solution.

Xu G [3] carried out simulation model of passenger flow evacuation at metro stations and established a model using cellular automata technique. The results can be applied to station layout evaluation and optimization, passenger flow evacuation scheme design and optimization. Xu R H, et al [4] at present, the emergency management plan of urban rail transit is deficient, and the emergency plan computer integrated and multi-media management system is designed. This research can solve the problem of decentralized management, such as the system structure, the working mode and the work flow of the system, including the comprehensive inquiry, plan management, linkage and command Event evaluation, decision support and emergency communications. Hoogendoorn M [5] demonstrated the method of using TTL language (Temporal Trace Language) to establish contingency plan model. Gadowski A M [6] found other use of case-based reasoning methods and decision-making theory for disposal programs generated based on the research results, Liu S G [7] compared the commonly used document processing method models in the six studies to solve the shortcomings of the existing case processing systems. Based on the improved petri net distribution processing framework and workflow model.

## **2. Emergency disposal characteristics of rail transit based on distributed workflow**

The concept of distributed workflow is relative to earlier centralized workflow management systems. To date, many companies and institutions both at home and abroad have conducted fruitful research and put forward many models and assumptions. The distributed workflow system uses a specific protocol to synchronize the execution of each workflow machine. When choosing different workflow products, each workflow machine needs a common standard to generate process instances, and can transfer processes and activities among heterogeneous workflow machines to support common management functions.

When applying distributed workflow to emergency response process, all participants in each process of emergency response can operate according to the disposal process. When an emergency occurs, all relevant departments and personnel receive the operation instruction of emergency information at the same time, as well as the system to automatically match the solution and disposal programs to ensure that all relevant departments to receive information at the first time and conduct targeted operations, improved rail transit between the various departments and staff information exchange methods have improved the efficiency of collaborative work among members. In this work environment, the members of the group conduct activities such as mutual communication and coordination around the solution of the same emergency. The business process shows geographical distribution, asynchronous synergy, synchronous synergy and process rationality Sexual characteristics, which respectively reflect the geographical space, time space and behaviour space characteristics of the emergency disposal process based on distributed workflow.

### *2.1. Regional cooperation*

Regional synergy reflects the spatial distribution of emergency response process. Including the distribution of the execution location during the disposal and the distribution of the location of the participants. In particular, the distribution of disposal execution positions reflects the characteristics of the distribution of the execution at different locations in multiple disposal processes in an urgent situation. In the process of emergency response of rail transit, when an emergency occurs, different personnel in different geographical locations such as dispatching centre OCC and station need to exchange data, information and knowledge by using network communication technology in different spatial locations for the same disposal event collaborative disposal.

### *2.2. Asynchronous synergies*

Asynchronous synergy reflects the synergy of collaboration and the asynchronous nature of collaboration time. Each participant performs the work process together, but each participant is an independent individual, and each participant has its own goal. For the time characteristics of the collaborative process, the asynchronous nature of the collaborative time reflects the time difference in the collaborative process. The participants in the business process collaborate on the same task at different times. Through the design of disposal methods and disposal process, different staff in different departments of rail transit such as dispatching centre, communication and signal centre and station control desk make different processes and procedures of different time and place at the same time according to the decision instruction given by the different aspects of asynchronous operation in time.

### *2.3. Synchronization synergies*

Synchronization Synergy reflects the synergy of collaboration and collaboration features of the synchronization time. Synergy is described in Section 2.2. Specifically, in synchronous collaboration, multiple participants can work on the same data model in real time, and the data model is consistent, allowing each participant to communicate with each other in real time during the operation. For the emergency treatment of rail transit, the advantages are spatially dispersed participants of each emergency response can communicate face-to-face in a virtual workspace which can reduce the traditional transmission of information such like by telephone, and eliminating the time and Spatial barriers between participants which contribute to the efficiency of emergency response work.

### *2.4. Process rationality*

Process rationality reflects the orderliness of the process operation. Each participant in the disposition process has a clear responsibility to accomplish the identified tasks and there is a definite implementation dependency between the participants. At present, with the rise of the Internet and the development of distributed computing technology, the characteristics of the distribution, heterogeneity and autonomy of modern enterprise information systems have become increasingly obvious. Such an information system environment is referred to as the HAD environment [8]. The centralized workflow model can no longer meet the needs of the ever-increasing number of resources in the enterprise and the urgent need for collaboration among enterprises.

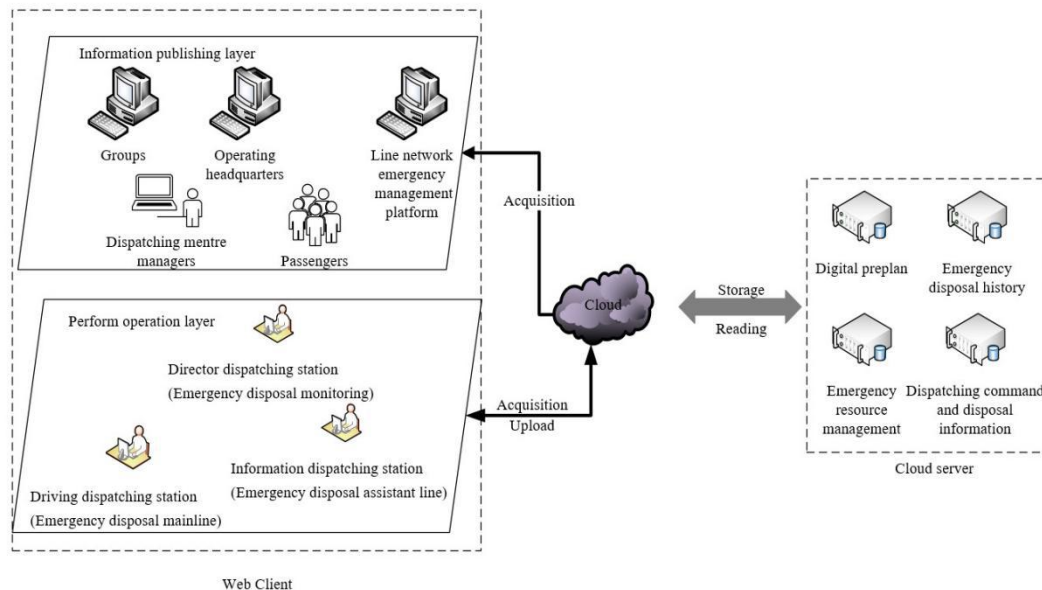
## **3. Modelling of emergency response system for rail transit based on distributed workflow**

### *3.1. Distributed multi-machine collaborative architecture*

Based on the current development of urban rail transit, this paper proposes to apply the concept of "distributed coordination" to the system. Computer-based platform designed and implemented collaborative work system through the computer to achieve the exchange of information to ensure that all small groups within the working group, timely and accurate transmission and sharing to create an efficient and virtual work space, improve the accuracy of information transmission and enhance the coordination of emergency response work, so as to ensure that the urban rail transit operation and

management department can meet the requirements of handling "safe" and "efficient" emergency operations [9].

For the four-layer and eight-level distributed multi-machine collaborative architecture established in this paper, controlled-level government, enterprises and the network of three control levels through the cloud access to data, command-level lines and on-site command level through the cloud access to the accident and the disposal of instructions issued to the cloud, after the implementation of the rescue level downloaded emergency treatment, as show in figure 1.



**Figure 1.** Data transfer between web client and cloud server.

### 3.2. Rail transit emergency system organizational structure

In this paper, the UML language is used to model the organizational structure of a rail transit emergency response system based on distributed workflow. As shown in figure 2, the organizational structure of the emergency system to rail transit is divided into the control command module and the emergency execution module.

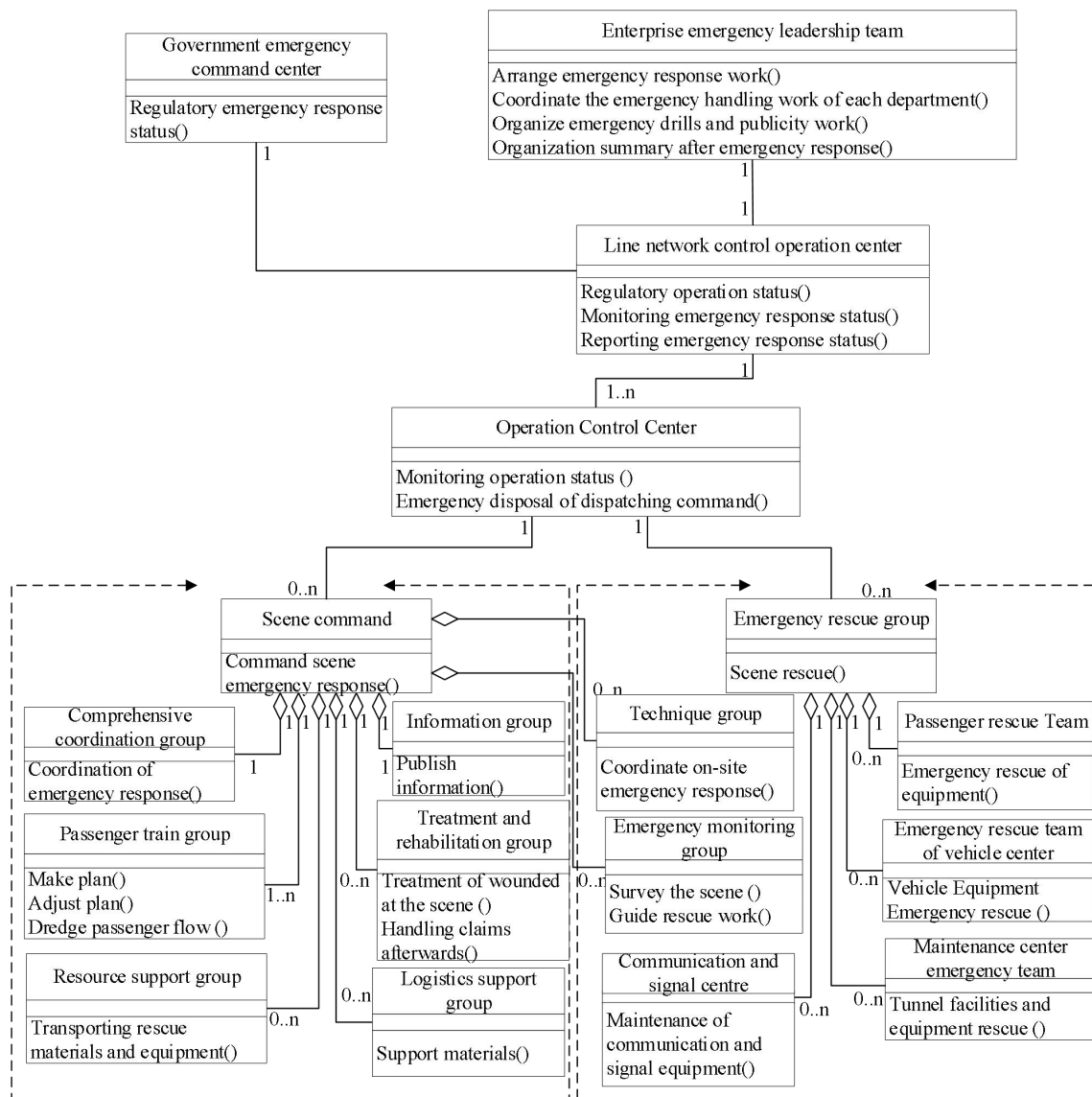
In the control and command module, the network operation control center is responsible for overseeing the operation status of the entire rail transit network, supervising the emergency disposal status and reporting the emergency disposal status. When an emergency occurs, the emergency operation leading group is mainly responsible for arranging emergency response work for emergencies and coordinating emergency response work among various departments. In order to improve the ability to cope with emergencies and unexpected incidents, the leading group organizes emergency drills and publicity and education work. Line network operation control center corresponds to a number of affiliated operations control center, compared to the network operation control center, its monitoring range is small, usually a line or a regional operating status.

The emergency management module is connected with the control command module through the operation control center. The on-site command department is in charge of directing the emergency work at the scene. The comprehensive coordination group is responsible for coordinating the on-site emergency treatment.

### 3.3. Rail transit emergency system disposal process

At the time of the accident, the station pre-treated the accident and at the same time, the witness alerted the OCC through the emergency disposal system. After dispatching the alarm, the characteristic information of the accident was sorted out and the situation of the accident was

monitored. If the accident did not lead to traffic delays, start the relevant emergency plan and accept the scheduling order until the disposal of the end. If the driving delay has been caused, the emergency plan will continue to be activated within three minutes and the site will be treated for disposal. If the disposal has not been completed within three minutes, the traffic dispatch will start to be adjusted and the station will continue to dispose of the accident along with the traffic adjustment. So far the emergency treatment of rail transit basically ended.



**Figure 2.** Urban rail transit emergency response organizational structure.

#### 4. Design and implementation of emergency response system

The system mainly faces the OCC scheduling level to realize the digitalization, standardization and standardized integration and management of the existing contingency plans. The carding and clarification of the emergency disposal process, the intelligent quick connection alarm, the accurate judgment of the event grade, the disposal plan and the automatic scheduling command Generate and issue, the process of recording and post-summary evaluation and other key functions.[10]

At the time of the accident, the witness first carried out the alarm through the mobile phone directly, and then through the alarm window of the emergency disposal system, selected the line where the



current accident occurred, the direction of the up and down direction and the specific accident contents and released the information and displayed it in the system Interface. Station control room and dispatch command center receive the accident information through the emergency system interface, the dispatcher command station control room to deal with the accident.

Based on the system, any participant can log in to the system to know the specific content and location of the emergency in real time. When the accident occurred, the expert system established based on the historical data command the dispatcher and the station control room. Disposal orders, the completion of the processing time and other information will be displayed in the module below in the system. The system defines the disposition time for each incident as 180 seconds, when the time is over, all departments and personnel stop the operation immediately and start the next step to rescue.

## 5. Conclusion

In this paper, we analyze the working principle and working characteristics of distributed workflow and establish a distributed multi-machine collaborative architecture framework with four levels and eight levels. We apply the idea of distributed workflow and established a model of the emergency disposal process of rail transit. Finally, it is applied to the practical application, combined with the expert database, developed an emergency response decision support system of urban rail transit, the traditional emergency measures have been improved and perfected.

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