Research on the Design of Network Ordering System for Distribution Network Operation Order

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Abstract. The command issuing and executed feedback of dispatching operation order in distribution network is hanging from traditional telephone mode to network mode. Based on the event driven architecture, this paper implements a network ordering system for distribution network operation order, which can be flexibly configured and deployed. It is compatible with intranet site, mobile app, artificial intelligence voice and other command modes, and it supports real-time telemetry data verification of Distribution Automation System. Asynchronous and low coupling design between command channels reduces the overall logic complexity of the system, and improves the adaptability to requirements.

1. Introduction
Distribution network dispatching operation order is the basis of electrical operation of distribution network. In the traditional telephone mode, dispatchers send dispatching operation instructions to the on-site operation and receive the reply message by telephone. There are some problems in the traditional dispatching mode, such as low efficiency, congestion during peak business hours, and confusion of near words. Especially in the busy business stage, if the power grid fails at the same time, the telephone channel for accident handling is likely to be occupied by normal maintenance operation and inquiry, which indirectly affects the safety of the distribution network.

The command issuing and execution feedback of dispatching operation order sheet in distribution network is changing from traditional telephone mode to network mode. In the network issuing mode, the dispatcher issues dispatching operation instructions to the field operators through the intranet website and mobile operation app and receives the reply. Li Xinhang developed a regional power grid dispatching network system to realize the networked transfer of dispatching instructions, and enhanced the security of power grid dispatching operation through error proofing(1). Cao Huabin realized the transfer of dispatching instructions through the integrated data network, replacing the traditional telephone order mode(2). Qiu ZeJian uses mobile operation app to issue orders instead of PC terminal network, so as to solve the transmission timeliness problem of distribution network dispatching operation order ticket caused by the scattered distribution operation location(3). With the development of artificial intelligence technology in recent years, there are virtual artificial intelligence (AI) distribution network dispatchers supported by voice synthesis, speech recognition, semantic understanding and knowledge Graphs. The virtual dispatcher system is similar to other networked command modes. After the command conditions are met, it automatically dials the field operator's phone to complete the process of issuing, repeating and returning the operation instructions. In the above literature, integrated data network, mobile operation, virtual dispatcher and other technologies are applied to build a diversified command channel for communication between distribution network dispatcher and On-site operators. However, in the same system, how to deal with the same scheduling
instructions in parallel and how to complement each other to form multi-party confirmation information? In this paper, the event driven architecture (EDA) is applied to develop the distribution network dispatching operation order network issuing system. The system realizes multi-channel parallel network issuing, has the automatic execution engine of operation order, improves the efficiency of distribution network operation order and improves the security of distribution network dispatching operation.

2. Event Driven Architecture

Event driven architecture (EDA) mode is a distributed asynchronous architecture mode, which is often used to build highly scalable applications. Event driven architecture consists of a series of highly decoupled components with a single responsibility to receive and process events asynchronously. Event driven architecture has many advantages: Asynchronous - the event based architecture is asynchronous and does not block, and EDA allows events to be queued or buffered to prevent the event processing service from exerting pressure on or blocking the event generating service; Loose coupling - services do not need to understand or rely on other services; Easy extension - services are decoupled in an event driven architecture, usually performing only one task; Recovery support - event driven architectures with queues can recover lost work by "replaying" past events.

3. Design of Network Ordering System for Distribution Network Operation Order

In the network issuing system of distribution network dispatching operation ticket, Web terminal, mobile terminal app and artificial intelligence voice issuing (AI) all have relatively independent processing logic. The processing units are driven by the same event, so the event driven architecture mode can effectively aggregate these processing logic together. As shown in the figure, each component is independent of each other and related to each other through the command engine.

![Message sequence diagram of a single Dispatching operation instruction.](image)

For any dispatching operation instruction in the dispatching operation ticket of distribution network, the dispatching engine sends the operation instruction message to each execution unit through the event manager after obtaining the dispatcher's authorization. After the web receiving unit receives the operation instruction message, the pop-up box at the web end reminds the operator that there is a new operation instruction to accept; after receiving the operation instruction message, the app receiving unit will remind the field operators by message push. The on-site operation and maintenance personnel shall open the interface for receiving the operation instructions according to the prompts, supplement and repeat the online text options of the dispatching operation instructions, and confirm the receipt of the operation instructions. After receiving the operation instruction, AI receiving unit automatically calls the on-site operator, and reads the instruction content to the on-site operator through voice synthesis technology. The on-site operator repeats the operation instruction according to the prompt.
AI receiving unit checks through voice recognition technology, and completes the task of repeating and receiving the instruction after checking. After each receiving unit receives the order successfully, it sends the receiving success message to the ordering engine through the message manager. At the same time, the executive monitor in the Distribution Automation System starts to monitor the telemetry and remote signal of the equipment to be operated after receiving the operation command.

After receiving the dispatching operation instruction through a single or multiple channels, the field operator carries out field operation according to the operation instruction. After the operation is completed, the field operator sends a reply message through the event manager at the corresponding terminal. Both the ordering engine and the DAS monitor subscribe to various types of call back messages. Once the DAS monitor receives the call back message, it ends monitoring and analyzes the monitoring results for the ordering engine's reference.

4. Advantages
The design of network ordering system fully embodies the advantages of Event Driven Architecture (EDA):

First, the processing logic of the ordering engine and the processing logic of each receiving unit are decoupled: On the one hand, there is no inevitable connection between the web command receiving unit and the app command receiving unit and the AI command sending unit. They independently complete the function of receiving, repeating and returning orders; On the other hand, the ordering engine is decoupled from the receiving processing logic. The ordering engine does not need to know the specific execution of each processing unit accurately, but only needs to obtain the receiving or returning message according to the configured rules, which reduces the complexity of its business logic.

Second, the system has the ability of easy expansion and flexible assembly: Because each processing unit is of loose coupling structure, the whole system can maintain the ability of easy expansion and flexible assembly on the premise of maintaining stable module function. If a deployment environment lacks one or two of the web, app and AI commands, the system does not need refactoring. Only part of the logic configuration of the ordering engine needs to be modified.

Third, the whole process is asynchronous and non blocking: The operation instruction, the receiving and returning messages are asynchronous messages, which leads to a non blocking system. If the ordering engine fails to receive the expected reply and execution result message within the specified time, the system will draw the conclusion that the automatic ordering proceed failed and transfer to manual processing. This non blocking design keeps the system smooth.

5. Summary
In this paper, by analyzing the application requirements of dispatching operation instruction ticket issuing business in distribution network, applying event driven architecture, decoupling the networked issuing components, forming the design of the networked issuing system of distribution network operation ticket, effectively solving the problem of multi-terminal parallel processing operation instructions.

6. References
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