Process modeling of area air defense and anti-missile based on OODA-BPMN

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ABSTRACT

Aiming at the problems of low control accuracy and low execution efficiency of air defense anti-missile concentrated fire shooting strategy, this paper studies the process mapping and execution method of air defense anti-missile concentrated fire based on the combination of OODA loop and BPMN. Firstly, the concentrated fire shooting model is established, and BPMN model of concentrated fire shooting process is built according to OODA loop Theory, then the process model is executed by Cloud Native Command and Control platform, and the execution efficiency and control precision of the model are analyzed. Compared with the traditional concentrated fire shooting scheme, the concentrated fire shooting process modeling with OODA-BPMN and Cloud Native theory has the characteristics of module replaceable, high control precision, fast response and multi-instance parallel execution.

Keywords: Concentrated fire shooting, boyd loop, business process modeling notation, cloud native

1. INTRODUCTION

The rapid development of stealth aerodynamics targets and hypersonic weapons poses a greater challenge for the surface-to-air missile to intercept targets more efficiently. As a multi fire unit cooperative shooting strategy, concentrated fire effectively enhances the intercepting ability of surface-to-air missile forces against air targets. In the Vietnam War, concentrated fire shooting provided the surface-to-air missile with an important means of countering air targets. Compared with common fire tactics, concentrated fire has stronger anti-jamming ability, higher kill probability, and the advantage of saturated anti-radiation missile and horizontal maneuvering target. The process of concentrated fire shooting is complex, and the time control of concentrated fire shooting is required. The traditional concentrated fire shooting operation usually adopts the method of manual operation and computer-aided calculation. The concentrated fire shooting control accuracy is not high enough and the automatic processing ability is poor. There are few researches on concentrated fire shooting. The model of concentrated fire shooting is studied in reference[1]. The selection of concentrated fire units and the calculation method of firing data are discussed. In reference[2], the problem of counter efficiency of concentrated fire is studied, and the problem of selecting the optimal number of fire units in concentrated fire is solved. But they have not solved the problem of how to carry out the concentrated fire shooting firing process efficiently, how to carry out the concentrated fire shooting firing process and how to transfer the process.[3]Studied the framework of Command and Control process modeling based on behavior tree. [4]Studied the modeling method of cross-organizational business process in cloud computing environment. [5]Compared several different modeling methods of Combat Command and Control process, these different modeling methods have their own advantages and disadvantages, such as complex modeling process, difficult for modelers to understand, poor learning ability and low decision accuracy. Technologies such as Business Process Modeling Notation (BPMN) and Cloud Native have been hugely successful on the Internet and are widely used in areas such as enterprise Business approval processes. This paper studies the execution method of concentrated fire shooting process based on the combination of Boyd Loop theory and BPMN, proposes a concentrated fire shooting model based on OODA loop, and maps the concentrated fire shooting process to BPMN flow diagram, each module in the process represents a service. At last, the Cloud Native Command and Control platform is used to realize the process layout and execution. The aim of this paper is to use the good ecology of BPMN to standardize the execution process of concentrated fire shooting, and to realize the expandability and maintainability of the process.

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2. PROCESS MODELING METHOD OF CONCENTRATED FIRE SHOOTING

Based on the characteristics of concentrated fire, the model of concentrated fire is built according to the OODA loop Theory. The model is then mapped to a visually strong and executable BPMN process. Following the idea of microservice, BPMN process uses Command and Control platform to realize service invocation and execution, and can store process to database, which provides support for flexible editing of tactical tactics of commanders. Finally, the fire shooting model and the BPMN process are adjusted according to the execution effect. The schematic diagram of integrated modeling of concentrated fire shooting process is shown in Figure 1.

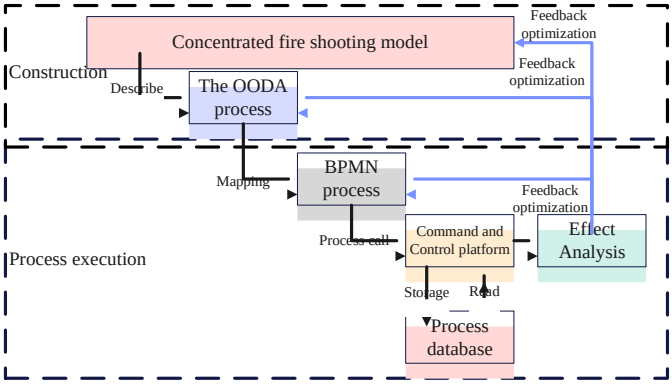

Figure 1. Schematic diagram of integrated modeling of concentrated fire shooting process.

3. COMBAT MODEL OF CONCENTRATED FIRE OODA LOOP

The OODA loop proposed by US Air Force Pilot Boyd provides an important theoretical basis for commanders to make battlefield decisions. Regional air defense and anti-missile operations are usually divided into four stages: Target Detection, threat judgment, command decision and strategy execution[6]. The target detection phase includes detecting, identifying and tracking the target, and transmitting the target information to the Command and Control platform to fuse the information. The phase of threat judgment includes threat estimation of targets and generation of corresponding tactics for decision-making by commanders. In the command and decision-making process, the commander makes decisions on judgment, assigns targets and fire units, calculates firing data and so on. Finally, the operational effectiveness is evaluated, and the target information is updated and the interception strategy is adjusted by feedback. The four steps of intercepting the target in anti-air and anti-missile operation correspond to the four steps of the OODA loop.

When there are multiple fire units to intercept the target, each fire unit intercepting flow forms OODA sub-loop, and multiple fire units form nested OODA loop. In order to improve the hit probability, the multiple fire units execute the OODA process to intercept the target when the concentrated fire strategy is needed. The OODA process for its collaborative interception target is shown in Figure 2.

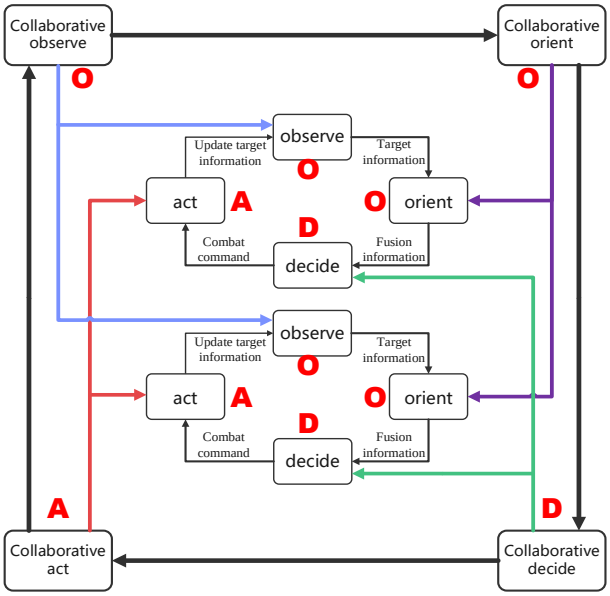

Figure 2. Nested OODA flow chart of multiple fire units intercepting targets.

4. MAPPING METHOD OF CONCENTRATED FIRE SHOOTING PROCESS BASED ON BPMN

BPMN is a common and standard language for process modeling to draw business process diagrams to better understand business processes and relationships between departments, to facilitate communication and understanding of business processes[7]. With it, modelers and developers can create process models that span multiple activities, systems, participants, and transactions. BPMN 2.0 adds a lot of constraints and semantics, so there is no need to translate the models into an execution language, just add the necessary implementation details and the model can be executed on the computer. BPMN is a set of symbols that describe the various events that occur in a business process. It describes a complete business process by drawing lines between these symbols. The modeling elements and symbols provided by BPMN 2.0 include flow objects, connection objects, swimlanes, data, and artificial information. The common elements are shown in Figure 3 below.

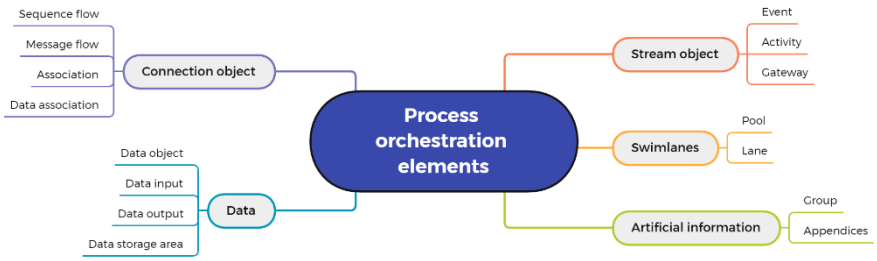

Figure 3. Classification of BPMN process orchestration elements.

Modeling language to be able to describe the integrity of the OODA loop process usually has a sequence, conditions, branches and cycles of four types of structure. BPMN modeling breaks down task processes into several different levels of fine-grained tasks and describes the entire task process through combinations of elements. With BPMN, the air defense and anti-missile operation process described by the OODA loop can be mapped into a language and symbol that the

machine can recognize and can be executed by the system. The start events in BPMN are usually mapped to the observations in the OODA loop to trigger the BPMN process. The BPMN process uses parallel gateways to determine the conditions. BPMN processes can also be chosen by an exclusive gateway to make decisions, with decision rules executed according to policy priorities or made manually. The user task is mapped to the decision-making of the commander, and the manual task is mapped to the human participation. Pool and Lane can also achieve different combat units to participate in the implementation of the process. In addition, each fire unit's OODA process can be mapped to a BPMN sub-process, the system runs several BPMN sub-processes in parallel to achieve multiple fire unit OODA loop, can achieve the target of firing.

5. CONCENTRATED FIRE SHOOTING EXECUTION METHOD BASED ON CLOUD NATIVE

Cloud Native is a way to build and run applications, a set of technical frameworks and methodologies. Cloud Native applications are typically containerized using an open source stack (K8S+Docker), microservice architecture-based for flexibility and maintainability, and continuous iteration and maintenance automation with agile methods and DevOps, elastic scaling, dynamic scheduling and Resource Utilization Optimization using cloud platform facilities[8]. BPMN combat process model is built for combat environment, the process is deployed into process engine in XML format, the XML format is parsed and transformed into process definition diagram structure, which is executed by process engine[9]. The business process modeling architecture is shown in Figure 4. Developers are responsible for building the atomic services that make up the basic policy, and the flexible scaling and dynamic scaling of the services can be achieved through the cloud's native Command and Control platform. The modeler is responsible for finding atomic services (composite services) from the system to model the process of a high-level policy composed of several basic policies. In the process model, each task (atomic service) shares the output data during the process execution, and the atomic service is invoked through gRPC. In the face of complex battle scene, BPMN breaks complex task flow into several sub-flow diagrams and executes them in parallel, which improves the execution efficiency of the process.

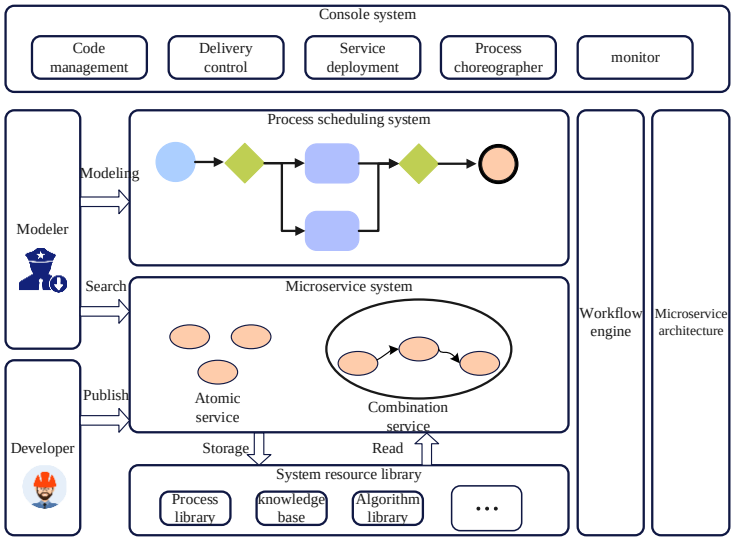

Figure 4. Business process modeling architecture diagram.

Through the modeling of air defense missile Command and Control process, improve the control precision of the assisted shooting operation and execution efficiency, speed up the their own OODA loop efficiency and speed of execution of the judgment and decision-making process, accelerate their own OODA loop iteration speed, so as to maintain a faster battlefield action rhythm, to delay or disrupt the opponent's OODA loop, achieves the initiative in the complex battlefield environment.

6. CONCLUSION

Modern warfare has gradually evolved into an information-based and intelligent war. Only when the enemy discovers, makes decisions and acts first can the initiative be won in the complex combat environment. By analyzing the research status of business process, this paper verifies the adaptability and flexibility of OODA loop and BPMN combined with Cloud Native technology with the help of regional air defense and anti-missile process, and proves that this method can improve the execution efficiency and decision-making efficiency of concentrated fire shooting.

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