Modeling War as a Business Process with the Assistance of Service Oriented Architecture

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Abstract— **The pace of war is increasing since militaries are adopting the ideas of Network Centric Warfare (NCW). Therefore, the process of war has to be modeled into the Business Process in order to benefit from available resources in real-time. There is an increasing need to automate command and control tools utilized in military operations because of the versatility and increased tempo of operations. Operations can be commanded and orchestrated with the assistance of Service Oriented Architecture (SOA). SOA is currently seen as a technology that can satisfy these needs of network centric operations (NCO). The Business Processes are chains of logic that request SOA services. This paper argues that in the case of a military setting, in order to achieve maximum impact with minimal effort (cf. downsizing), military operations need to be modeled as Business Processes (BP) (e.g., a dismounted company attack). This asks for using a Resource Manager (RM), a Scheduler and a Battle Secure Scheduler (BSS) in allocating the requested services (e.g. processing a fire support order). In the future, a single Future Force Warrior (FFW), an essential performer in military operations, can benefit from the Business Processes approach via enhanced performance, improved Situational Awareness (SA) and with decreased instances of fratricide.**

Keywords - Business Process; Service Oriented Architecture; Future Force Warrior

I. INTRODUCTION

The asymmetric nature of war requires improved capabilities in allocating available resources. This sets increasing demands for commanders executing operations in the battlespace. The requirement of precise data in location information, current data in performance capabilities of own troops and current operation status are only a few critical pieces of information commanders are depending on in military operations. The pace of war constantly increases and the need for accurate Situational Awareness is imminent and vital from the perspective of successive operations.

This paper examines how to model the phenomenon of a war as a business process assisted by means of Service Oriented Architecture. The contribution of this paper introduces a possible method to improve the overall performance of military operations by sequencing the combat services available in real-time. Typically these types of combat service sequencing systems are based on classified data. Therefore also this paper can only draw from sources available for non-restricted use.

Military commanders are depending on automatic data accruing processes and the tools to simplify complicated military maneuvers. A military operation has to be simplified into a form of an untestable Business Process (BP). This can be achieved with the successful use of Service Oriented Architecture (SOA). When an attack as an operation can be simplified in a form of a Business Process, Service Oriented Architecture can be used. The element named Resource Manager is a tool to be used in managing and allocating the existing resources.

The possibilities to compare various approaches for modelling a war as a business process assisted by means of Service Oriented Architecture are difficult to find. This is because by default value models of this kind fall in to the category of classified data. Thus the model introduced here is one of a kind. Comparing different models is out of the scope of this paper. Furthermore, the issues of network topology and energy remain outside the scope of this paper.

This paper is organized as follows: Section II discusses about the Military Operation as a process, Section III introduces Service Oriented Architecture, Section IV introduces the Business Process. Section V concentrates on combining the Business Process and the Resource Manager. Section VI explains the functions inside the Resource Manager and Section VII concentrates on security and the Scheduler. Section VIII examines benefits and drawbacks of this solution and Section IX concludes the paper.

II. MILITARY OPERATION AS A PROCESS

Military operations use real resources available. In the Business Process approach to Service Oriented Architecture, the services available correspond to existing real resources. Availability of real resources in a given place time is limited and needs to be carefully scheduled. Usually, SOA services are assumed to be independent of each other but this assumption is no longer valid if SOA services represent real resources. The Resource Manager is a necessary element in SOA architecture. An example of a demanding process, in which the timing and optimal use of resources is critical, is a dismounted company attack. Successful performance requires that the requested services (e.g., processing a fire support order) are allocated timely and accurately. This sets demands for

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enhanced Situational Awareness. In the utilization process of SOA, challenges of real-time SOA must be solved [1]. To successfully execute BPs, the Business Process Execution Language (BPEL) is required, as argued in [2].

III. SERVICE ORIENTED ARCHITECTURE (SOA)

Service Oriented Architecture promises to enable utilizing and operating complicated systems. SOA enables organizations and entities to enhance interoperability, collaboration, see [1], and foster the reusing of components and interfaces. SOA can be used in service collaboration. With the correct framework SOA allows publishing services in a service registry and exchanging data through the Simple Object Access Protocol (SOAP) [1]. SOA offers a flexible solution for systems integration, applications, protocols, data sources and processes to form a cohesive system that supports the execution of critical BPs [2]. SOA can be used as a collaboration tool in crises management and industrial environments if the challenges of real-time SOA [2] are solved.

In order to successfully execute BPs, the Business Process Execution Language (BPEL) is required, as argued in [3]. In military systems, the adoption of SOA principles can beneficially result in the overall improvement of system flexibility and maintenance. SOA provides the user with richer information sets via the ability of Web Services to reach out through the networks, see [4]. In the process of achieving greater interoperability, SOA can be used by utilizing service oriented migration and reuse technique, described in [5].

In Network Centric Warfare (NCW) contexts, SOA has been recognized to act as an enabler of services. SOA is an architecture style that encourages loose coupling between services to facilitate interoperability and the reuse of existing resources as described in [6]. SOA is seen as a tool in enabling agility to handle the changing dynamic evolution needed in network enabled capability, see [7]. The concept NCW can be viewed as an integration of assets to fulfil a mission objective, as discussed in [8]. NCW fosters SOA to achieve flexible forces, which are constantly ready and deployable, capable of dynamic changes and evolution to achieve realizable effects. To benefit from SOA in an optimal way, organizations require a comprehensive and applicable SOA governance framework to implement the management and control mechanisms in the system, as argued in [9].

It has been pointed out [10] that Shared SA is in central role for network-enabled capabilities, as described in [10]. In NEC, SOA is most commonly realized through Web Services GUIs, as discussed in [11], using Extensible Markup Language (XML) formatted documents, see [10]. As evident, XML WS have been recently used to implement SOA enabling the building of BPs by dynamically calling services from the World Wide Web.

SOA is an open concept and supports plug-and-play capabilities of heterogeneous software and hardware components, with the implementation of Web Services, which is probably so far the most popular implementation of SOA, as discussed in [12]. For this reason, SOA has been selected as the architectural solution for the C4I2SR systems for the Finnish Defence Forces [13]. SOA is seen as an enabler in crises management organizations for delivering data and services across political, organizational and cultural boundaries as well as addressing the issues of information sharing regardless of where required data is stored, as concluded in [14]. The global information grid is an essential vehicle in the execution of SOA and for the transformation of data.

In tactical operations, the significance of the real-time location data plays an important role. The tools available include different types of Tactical Battle Management Systems for the dismounted combat to produce the location information of own troops and precise target designation. Obviously, the tools for target designation and air-land coordination are necessary requirements for success in operations as described in [15]. Furthermore, air-to-ground communications are described in [16].

Requirements related to improved Situational Awareness, communications and networks are described in [17], grid computing in the battlespace plays an important role as described in [18], and enhancing squad communications with the assistance of smart phones is described in [19]. Lastly, multiplication of various technologies is introduced in [20]. Their overall purpose is to increase the performance of a Future Force Warrior. The inputs of all these tools and networks can be processed with the assistance of tools used in Business Processes and with the assistance of Service Oriented Architecture.

IV. BUSINESS PROCESS

Because of the central role of the business process in SOA, the main ideas concerning the BP are described in this and the following chapter. In a military environment, an example of utilizing a Business Process approach embedded to SOA is a military operation consisting of sequenced phases, for instance, in an operation labeled as a dismounted company attack, as illustrated in Fig. 1.

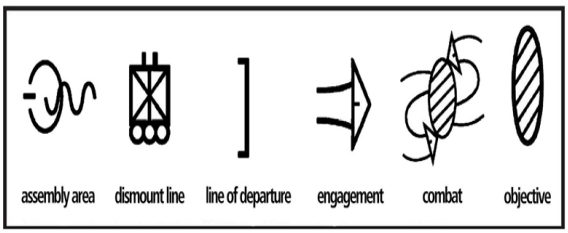

Figure 1. Dismounted company attack as a Business Process [21].

The variety of services used in BPs may be in operational use of a single unit or several units at the same time. This requires an efficient orchestration of services to maintain service control. SOA can be seen as an enabler in the process of executing military operations as BPs.

A planned dismounted attack usually starts from the assembly area, moves on to the dismount line, via a line of departure, advances to engagement, results in close combat

and ends when the set objective is reached. The SOA BP approach can increase the probability of success of an attack by empowering the human-based decision-making process by computers. This can enable an optimal use of resources, and thereby improve overall performance in operations.

The offered services during an advancing dismounted attack are listed in Table 1. Most of these services can be pre-programmed to concern the wanted product-line FFW level. The company commander utilizes various services (fire support orders, location services, medical care, resupply, evacuation, geographical information system -map-service, Blue Force Tracking) while executing the commanded attack from the assembly area to the objective. Table 1 illustrates possible services available for a dismounted company attack.

TABLE I. LIST OF PRE-PROGRAMMED AND ADDITIONAL SERVICES IN A DISMOUNTED COMPANY ATTACK.

Area of dismounted attack		*Basic services for the Warriors*	*Advanced services (platoon leaders and above)*
1	Assembly area	Location data, terminal guidance to the dismount line	Blue Force data, evacuation
2	Dismount line	Blue Force data, evacuation, resupply	Blue Force data, evacuation
3	Line of departure	Blue Force data, evacuation, resupply	Precision location data, fire support
4	Engagement	Precision location data, fire support	Air-strike
5	Combat	Reinforcement, evacuation, resupply	Air-strike, preparing instructions to the following mission
6	Objective	Evacuation, resupply, reinforcement, precise location data	Air-strike, next mission objective and its time-frame

Fulfilling a requested service asks for the requested service to be available and within range. When dealing with Fire Support Orders (FSO), the range limitations of artillery units are critical. An artillery unit has to be located within an appropriate range, and it has to be ready to intake Fire Support Orders and execute them in the required time frame, precisely as ordered.

V. THE BUSINESS PROCESS AND THE RESOURCE MANAGER

The orchestration of Business Processes requires a tool for allocating resources, the Resource Manager (RM). The tool has been described in [21]. The RM sorts out and lines up the requested services. As militaries implement the framework of network centric warfare with a continuing need to automate the command and control (C2) tools utilized in military, the tempo of operations must be taken into consideration. The collected data need to be processed, analyzed, verified, transmitted, and finally stored. SOA can be identified as a technology that can satisfy these needs of network centric operations. The starting point in the BP approach to SOA is that the main business operations of the organization are described by SOA BPs. The Business Processes are chains of logic that request SOA services. In case of a military setting, the Business Processes represent military operations as depicted in Fig. 2.

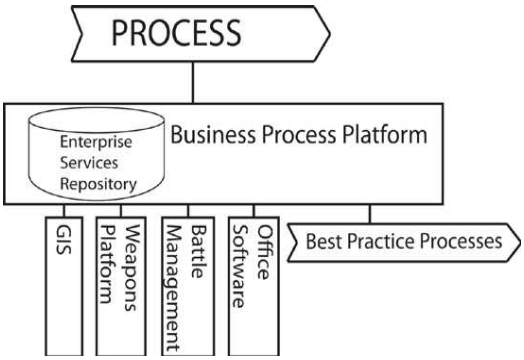

Figure 2. Business Process Platform as a service enabler.

SOA -technology involves assisting processes performed in military operations. Business processes are executed in a specific business process platform. Services and platforms, such as geographical information-services, weapons platforms, and battle management systems, are linked to the Business Process Platform to produce the best results to the ongoing processes. When an FFW can benefit from the possibilities offered by a successful adoption of BP and SOA, the result can be improved overall performance in military operations.

Fig. 3 describes how the Business Process approach can improve the performance of a Future Force Warrior (FFW). Several battlespace sensors gather data from the battlespace. The collected data are then automatically transmitted to be analyzed in a command post. Various battlespace sensors transmit data to a context-aware reasoning layer. In this layer, data are converted to context and an inference engine transmits the data to a ubiquitous main layer for analyzing purposes. The data are verified, analyzed and transmitted as information for the execution of the operation.

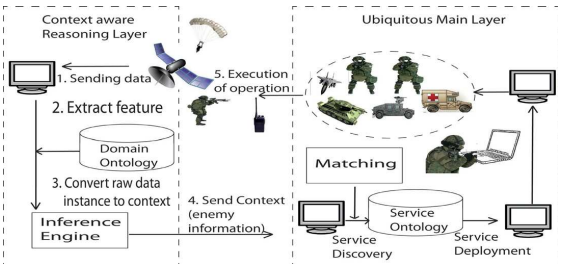

Figure 3. Increased FFW Performance can be gained via successful data utilization and analyzing process.

VI. INSIDE THE RESOURCE MANAGER

Several of the needed services require real-time resources. These services can be identified, for example, as collecting SA data and issuing fire support orders. Thus the services and their use must be scheduled and sequenced to sustain the processes. The RM sorts out and lines up simultaneous requests concerning the requested service. The

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RM serves as the element, which provides the needed services for User Groups (UGs). Services can be either pre-programmed on demand or be available on request basis. The RM as a tool is located at the battalion level. The user groups send a request for the demanded service. The UGs are then authenticated, and their privileges are verified, and then the request is transmitted to the RM. The key functions of the RM are: 1) to receive the request of a required service, 2) to organize the line of user groups in the correct order depending on the UGs' privileges and battle-situation, 3) to check whether the service is available and within range, 4) to provide the User Groups with the answer, which is either the requested service or a rejection of the service. Fig. 4 illustrates the process.

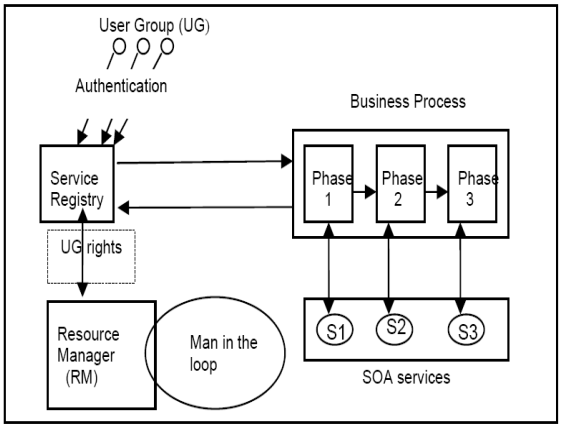

Figure 4. The main idea of the Business Process approach to Service Oriented Architecture.

The RM functions as a fully automated chain of functions in certain processes [21]. The key function of the person in the loop is to monitor the flow of events and to interfere to the chain of events if an unpredicted anomaly occurs in the process. As the RM is a critical resource, it must be physically protected against enemy actions.

The role of the RM is central in the allocating of resources in the BP process. The RM communicates with four intermodules. The RM graphical user interface provides the core interface between all the presented modules and the Local Area Network (LAN), as shown in Fig. 5. The LAN is utilized as a battlespace network or a community network as it can be used on wide area of networks. Yet, the sharing of networking environment and its resources remains challenging. Searching for information and asking for resources become challenging when lacking proper search mechanisms. Each module has pre-defined and precise functions. First, the file and resources sharing module communicates with the RM GUI in conjunction with the sharing and the download module. The file and resource transfer and download module supports and enables the transfer or download of the searched file or resource from the other node connected to the network. The shared files and resources are listed on the RM GUI, where the listed and downloaded files can be examined. It is obvious that the same identified services are requested simultaneously. Therefore, the composition of the RM needs to be stable and reliable. Fig. 5 illustrates the composition and function of the RM.

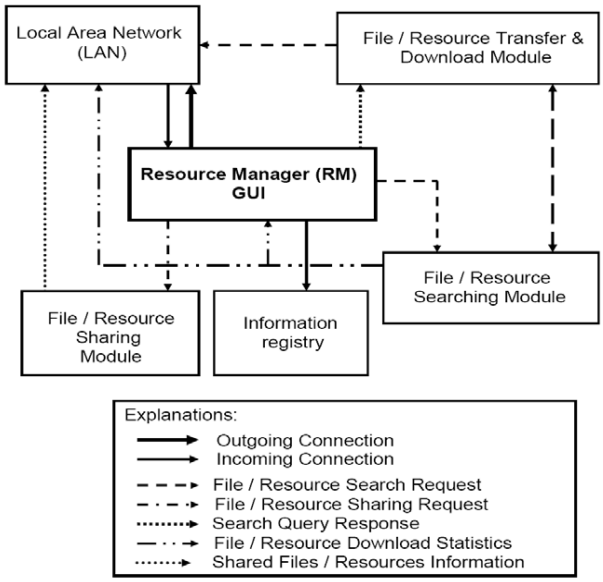

Figure 5. The composition and function of the RM.

The example below in Fig. 6 depicts the processing of fire support order requests inside the RM as an informal Specification and Description Language (SDL) diagram. This action performed by the RM is essential to proceed in the process of offering requested service/s [21].

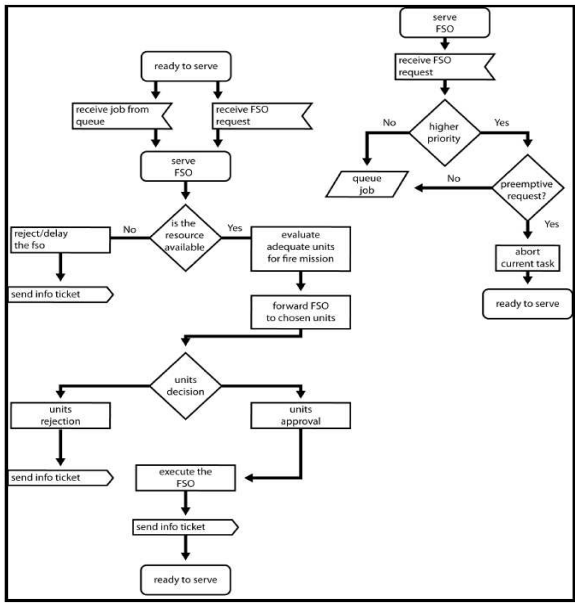

Figure 6. The processing of Fire Support Order requests in RM in an informal SDL diagram.

Each request has a time-stamp and own identification and the request also contains route data and is traceable whenever tracking data are required. Each request is categorized according to an urgency class and its execution process is monitored and evaluated continuously. Once the request has been executed, it will be filed as a completed task in the common database. The tracking data of the completed request can be retrieved for analyzing purposes at any time by the system operator.

VII. SECURITY AND SCHEDULER

To account for operational security, there are protocols to identify the credentials of the requester entity by applying a security, authentication and agreement tool embedded in the RM. Before any tasks are given to be executed or resources are allocated for use, the task or resource request goes via the described system, as presented in Fig. 7. An incoming task passes through a preliminary phase, in which it is checked and identified. Once the task has been verified and approved and sent from a trusted and secure cooperation entity, it will be processed via a series of approval and authorization policies.

Security issues remain vital also when dealing with unmanned aerial vehicles utilized in Network Centric Warfare at tactical level as described in [22]. The accrued data have to be secured to be intact and coherent when passing different interfaces from the sensor to the shooter.

The described process ends with a phase in which a common language and tools are selected and then the given request moves forwards inside the RM. The overall description of the whole concept consists of three major parts and functions: 1) SA comprehending the existing solutions and tools, 2) command and control tools, and, lastly, 3) information repository. These three together enable the command and control process and saving of logdata for further analyses. These functions presuppose the RM and the Scheduler to share and distribute the tasks and resources.

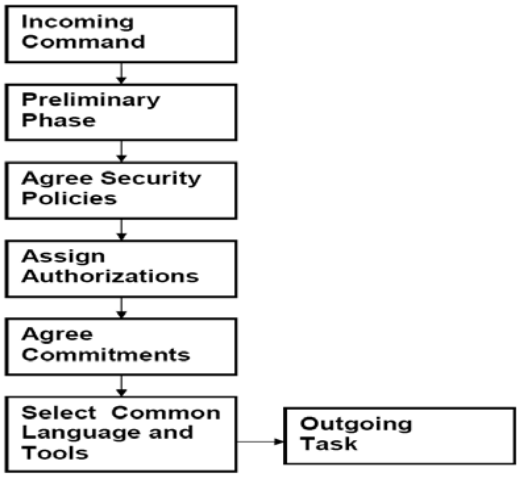

Figure 7. Security, authentication and agreement system.

To provide for the requested service, the RM requires one more component [21]. This critical component for the military use of SOA which relies on the utilization of the RM is called the Scheduler. The role of the Scheduler is to coordinate processes to maximize the performance of resources and to reduce fratricide and collateral damage. The Scheduler enables militaries to execute various operations simultaneously but still under a strict command and control. The issue of simultaneously operations is solved by the element named Battlefield Secure Scheduler (BSS). This component uses two different methods of sharing calendar, Pre Shared Scheduler (PSS) and Dynamic Schedule Update (DSU). The Scheduler functions together with the RM and utilizes SOA as a process. These elements can be recognized in Fig. 8, which introduces the process from an incoming command/task to an outgoing command/task.

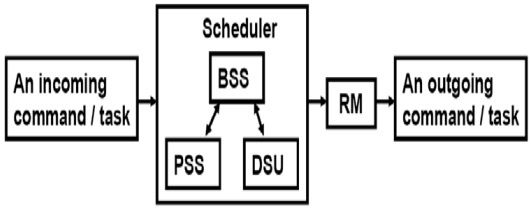

Figure 8. The elements inside the scheduler and the permeable command and control -process.

VIII. BENEFITS AND DRAWBACKS OF THIS SOLUTION

The delicate system introduced can malfunction for various reasons. Challenges related to energy have to be solved to enable the function of different processes. The orchestration of the system can also fail because of intentional enemy action (jamming, a virus, a worm). The system needs to be equipped with an analyzing program, which indicates when the system functions properly. If the system malfunctions and retrieving the capabilities becomes impossible, the system becomes useless for an FFW. This asks for an easily replaceable and fault-tolerant system with inbuilt check-in routines. Otherwise, traditional methods in orchestrating services need to be adopted.

By adopting SOA and embedding business processes into the existing command and control -system, the overall performance of military operations can be improved. With the assistance of the RM, limited military resources can be allocated more efficiently to the users requiring for services. When the new invented tool, the Scheduler is implemented together with the RM into the BPs, the performance of the system can be significantly increased. The allocated resources available can be used optimally. This means shorter execution times, and a higher amount of data for improved decision making. The overall system performance can be optimized with the assistance of these tools.

Offering a service of ubiquitous computing to battlespace commanders increases the possibility to utilize the resources available. This fosters a rapid decision-making process especially, when SOA can be embedded in the decision-

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making systems. As described in [14], SOA must deliver a solution that crosses existing boundaries as well as address the issues of information sharing regardless of where that information is stored. A BP -like orchestration of systems and services can improve the overall performance of military operations executed. This can result in improved overall performance capabilities while executing missions in the battlespace benefitting from SOA, the RM and the Scheduler.

By adopting these introduced new elements into BMS together with SOA, it may be possible to gain improved capability to execute operations. This can also mean reduction in time related to allocation of resources. This can result improved overall performance and minimal execution times of operations. Besides, with the improved level of SA, fratricide and collateral damage can be reduced.

The system presented here is free to be adopted and tested. To create a functioning, automated business process applicable for future battlespace purposes requires future work. This is briefly tackled in the ensuing section.

IX. FURTHER WORK

So far, this system has not been field tested for considerable funding is needed to execute the tests. One would hope such funding became widely available since the need for automated systems and allocation of ever limiting resources force militaries to discover the performance offered via SOA. When the process of war has been modeled to resemble a Business Process, the performance of FFWs can be optimized with the assistance of processes assisted with the SOA. The result of this can be seen as an agile and modular military performer with improved capabilities and improved Situational Awareness, and the capability to utilize ever diminishing resources more optimally with decreased instances of fratricide.

Further work related to modeling a war as a business process must concentrate on security issues of software. Worms and viruses pose an increasing threat in digitized battlespace. Issues such as adequate level of constant energy flow and protection against violations caused by electronic warfare must be studied, tested and finally solved before adoption of the system in operative use.

Funding and human resources are required to run the validity tests of the introduced system. Firstly, tens of thousands of simulation laps in each scenario type are required before implementing the introduced system/prototype into any real-time military exercise performed. Secondly, once resources have been invested in implementing the system introduced here, the follow-up paper cannot any longer be accessed in any public domain data sources.

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