# System of Systems Supportability Assessment Model based on DoDAF

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***Abstract*—The System of System (SoS) supportability assessment problem has become more and more complicated and lacks of efficient means because there are multiple combatant tasks and numerous weapons and systems. In this study, the Department of Defense Architecture Framework (DoDAF) is used as a top-down perspective to analyze the SoS supportability problem. Moreover, the fundamental elements which are related to SoS supportability are categorized from a down-top perspective. With the two perspectives integrated, the SoS supportability assessment model is constructed which is comprised of the supportability composite parameters, the supportability design parameters and the supportability resource parameters.**

***Keywords—System of Systems, supportability, assessment, DoDAF***

## I. INTRODUCTION

With the concept of System of Systems (SoS) becoming important in national defense, the weight it has on defining the war has become bigger and bigger [1]. Many more factors and elements have come into sight when SoS is concerned and assessed. There are multiple attributes or qualities that are important for SoS to fulfill its mission, namely its combatant ability, command and control (C2) ability, the communicative ability and so on. One of those abilities which have been neglected is the supportability of SoS, which denotes the ability of SoS when it comes to repair, maintenance and keep SoS in full capacity.

The supportability has something to do with the reliability and technical status of the armory/weapon/systems, as well as the logistics of SoS. However, this is not all that matters because there are more factors that need to be taken into consideration, such as the combatant mission/task, personal, additional materials and/or certain equipments should be taken into consideration as well. In one word, it is more applicable to evaluate the supportability within the background of SoS instead of being restrained in the scope of a single system (even if it is a complex system) [2].

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Traditionally, a basic supportability assessment hierarchy could be constructed [3] [4]. However, there are two fundamental problems remained to be solved. First, there lacks of a SoS mission/task guidance [5]. To further explain, the SoS supportability assessment model is static with no reflection of whether and how well the mission/task can be fulfilled. Second, there lacks related studies on the correlations between the SoS supportability influential factors.

With this, the Department of Defense Architecture Framework (DoDAF) [6] [7] [8] is applied in this study to serve as a top-down SoS perspective, and another down-top elementary perspective is also deduced by analyzing the basic elements of SoS supportability. With the two perspectives unified, an integrated and comprehensive SoS supportability assessment model is constructed.

This study is organized as follows. Section II is to analyze the requirements for SoS supportability assessment. Section III is to analyze the basic elements which should be taken into condition. Section IV further elaborates on the top-down and down-top perspectives. Section V proposes the SoS supportability assessment model. This study is concluded in Section VI.

## II. DODAF-BASED SOS SUPPORTABILITY ASSESSMENT REQUIREMENTS ANALYSIS

The goal of DoDAF when applied in designing SoS structure is to build a chain of mapping relationships between different core elements, including the mission, the tasks, the capabilities and the systems (or weapons and equipment in the military background). With this in mind, this top-down analysis principle, as shown in the left part in Fig. 1, is applied to disintegrate the elements for SoS supportability analysis. The right part of Fig. 1 is directly connected with the combat mission as well as the combatant systems. To be more specific, in order to conduct a thorough SoS supportability analysis, there must be certain elements that embody the mission and the system. However, only these two types of elements are not enough because there are certain resources need to be taken into consideration, such as the personnel and the spare parts, etc. Also shown in Fig. 1, the SoS supportability can be recognized as an capability as well which is another paralleled element in SoS.

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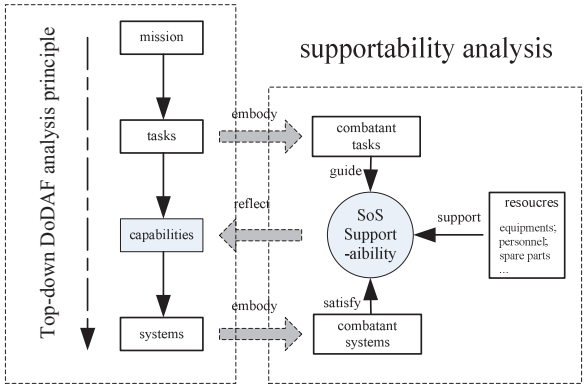


Fig. 1 DoDAF-based SoS supportability requirements analysis

### A. SoS supportability combatant task based on DoDAF

The SoS supportability combatant tasks refer to those tasks which provide certain equipments and spare parts for the weapon and systems, and also include the maintenance of the corresponding weapons and systems as well as all kinds of computers and communication devices. Followed by the DoDAF principles, the supportability tasks are also derived from the SoS mission by constructing certain mapping views and conducting the task activities analysis.

### B. SoS supportability combatant systems based on DoDAF

The SoS supportability combatant systems refer to the systems and equipments which are used in fulfilling the supportability tasks. More specifically, three aspects should be taken into consideration, the reliability, the testability and the maintenance.

### C. SoS supportability combatant resources based on DoDAF

In order to fulfill the combatant mission and tasks and also to meet the reliability, testability and maintenance requirements, many resources must be included in the assessment process, including the personnel, the supportive equipments, the technical materials and the spare parts.

## III. SoS SUPPORTABILITY RELATED ELEMENTS ANALYSIS

Modern informationized combatant conditions further complicated the structure and correlations of SoS by enriching SoS functions and supportabilities [9]. In order to construct a more comprehensive and effective model for SoS supportability analysis, many more elements within the scope of SoS should be taken into consideration, as shown in Fig.2 and further given in details as follows.

- technician & personnel

To conduct the specific supportability activities, the most essential elements are the technicians and personnel at all levels. They are the key for the implementation of supportability missions and tasks, as well as the guarantees for well conditions of numerous combatant systems and equipments.

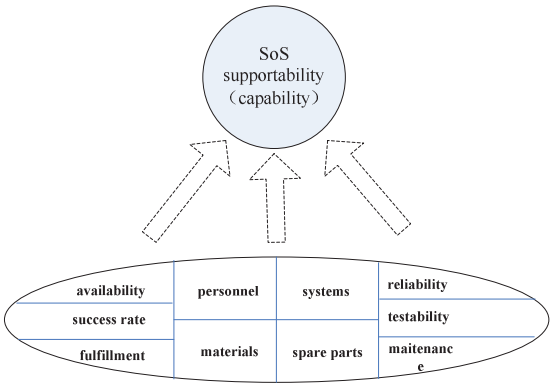


Fig. 2 DoDAF-based SoS supportability requirements analysis

- supportive equipments

Supportive equipments are necessary for the maintenance and support activities as well. Regarding on different mission, tasks and system requirements, different types of equipments are applied.

- technical materials

The technical materials include the instructions to use certain equipments or weapons or platforms or systems, the guidelines to carry out certain maintenance and testing procedures, and also the system usage logs, the conditions, the maintenance record and other materials of this kind.

- spare parts

The spare parts denote those are not used in daily training and fulfilling a task, but uses as backups in case any weapon or platform or system breaks down or become malfunction. The spare parts is very important for SoS supportability since it is indispensible for keeping the SoS being functioning at all time. It is also directly connected to the maintenance and reliability aspects of SoS.

- fulfillments

The fulfillment denotes that the conditions of a weapon or system being in its “ready to go” status because the weapon or system is in fact mostly in the storage status while the practical combatant conditions require that any weapon or system must be “ready to go” at all time. Practically, the fulfillment of SoS weapons and systems are directly connected to the malfunction or reliability decrease.

- mission success rate

The ultimate or essential goal of SoS is to achieve the success of a combatant mission at all cause. This is also the goal of the supportability construction of SoS.

- availability

The availability denotes that all weapons or systems in SoS can be used in an operation or training under any assumed condition.

- reliability

The reliability denotes that all weapons or systems in SoS can are "reliable" to fulfill a combatant mission or task within a restricted time and under such conditions. There are two types of reliability need to be taken under consideration. The first is the designed reliability which is the assumed reliability level by design, and the latter is the manufacturing reliability which is the actual reliability for an actual weapon or system. In this study, the reliability factor in SoS supportability analysis mainly refers to the designed reliability.

The reliability of SoS supportability is related to the testability and maintenance aspects.

- testability

The testability of SoS refers to use certain equipments or devices to test if there is a malfunction or breakdown in any weapon or system in SoS under any condition. The testability is directly connected to the specific malfunction under a specific condition.

The testability of SoS is also related to the reliability and maintenance aspects as well.

- maintenance

The maintenance of SoS refers to the protocols, the means, the devices and equipments, the personnel to carry out and fulfill certain maintenance tasks. Overall, this is a composite factor to analyze.

The maintenance of SoS is also related to the reliability and testability aspects as well.

## IV. CORREATIONS ANALYSIS OF SOS SUPPORTABILITY TOP-DOWN AND DOWN-TOP PERSPETIVES

Fig. 2 shows the correlations between the top-down and down-top perspectives on SoS supportability requirements analysis.

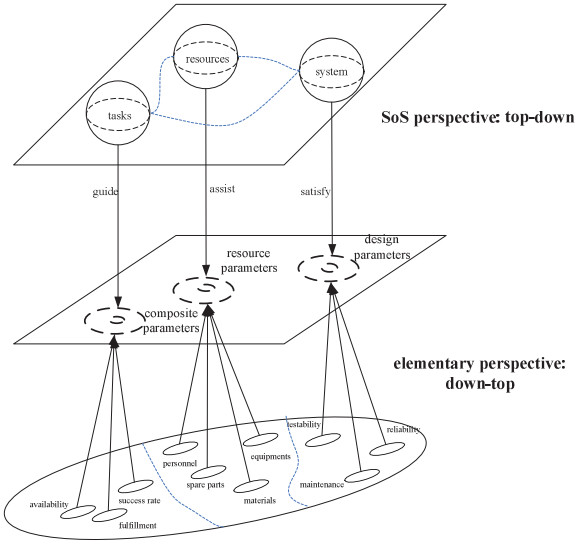


Fig. 3 DoDAF-based SoS supportability requirements analysis

### A. SoS supportability composite parameters and the tasks related factors

The SoS supportability composite parameters are directly connected with SoS combatant tasks.

Guided by the DoDAF principle, the SoS combatant tasks are embodiment of the tasks and can be further reflected by certain capability requirements. Furthermore, the SoS tasks can be divided into two categories, the SoS functional capability and supportability capability. The latter one is the focus and source of the SoS supportability composite parameters in this study.

Overall, the SoS supportability composite parameters can be interpreted as certain requirements by SoS to complete its mission and a series of tasks under both combatant and training conditions.

### B. SoS supportability design parameters and the combatant system related factors

The SoS supportability design parameters are directly connected with SoS combatant systems.

To fulfill the mission and tasks of SoS, it has been carried out by actual weapons and systems. With this, more combatant systems must pose different requirements to complete these supportability activities. To be more specific, there are certain SoS design requirements, e. g., (1) the reliability of certain system or weapon must maintain in good condition for a period of time, (2) the maintenance of certain weapon or system must meet certain criterion, (3) certain weapon or system can be tested when needed and (4) certain malfunction causes can be found.

### C. SoS supportability resouce parameters and the recource related factors

The SoS supportability resource parameters are directly connected with certain resources required by SoS.

To carry out certain supportability activities, multiple resources are needed, including the personnel, the materials, certain equipments and the spare parts as well. These resources are in concert with the combatant systems to fulfill the SoS mission and tasks, which is the key and the most important goal of SoS supportability model construction.

## V. SOS SUPPORTABILITY ASSESSMENT MODEL

Based on the above analysis, a SoS supportability assessment model can be constructed as in Fig. 4 which further shows three types of SoS supportability parameters, namely the design parameters, the composite parameters and the resource parameters, which are then further disintegrated into ten types of sub-parameters.

These sub-parameters in the far left part in Fig. 4 are in fact the elements being analyzed in Section III. With this, a comprehensive yet with a wide range of coverage of SoS mission/tasks requirements, system/equipments requirements and many supplementary resources requirements are considered and met, which is the very original motive and the most basic requirement of this study.

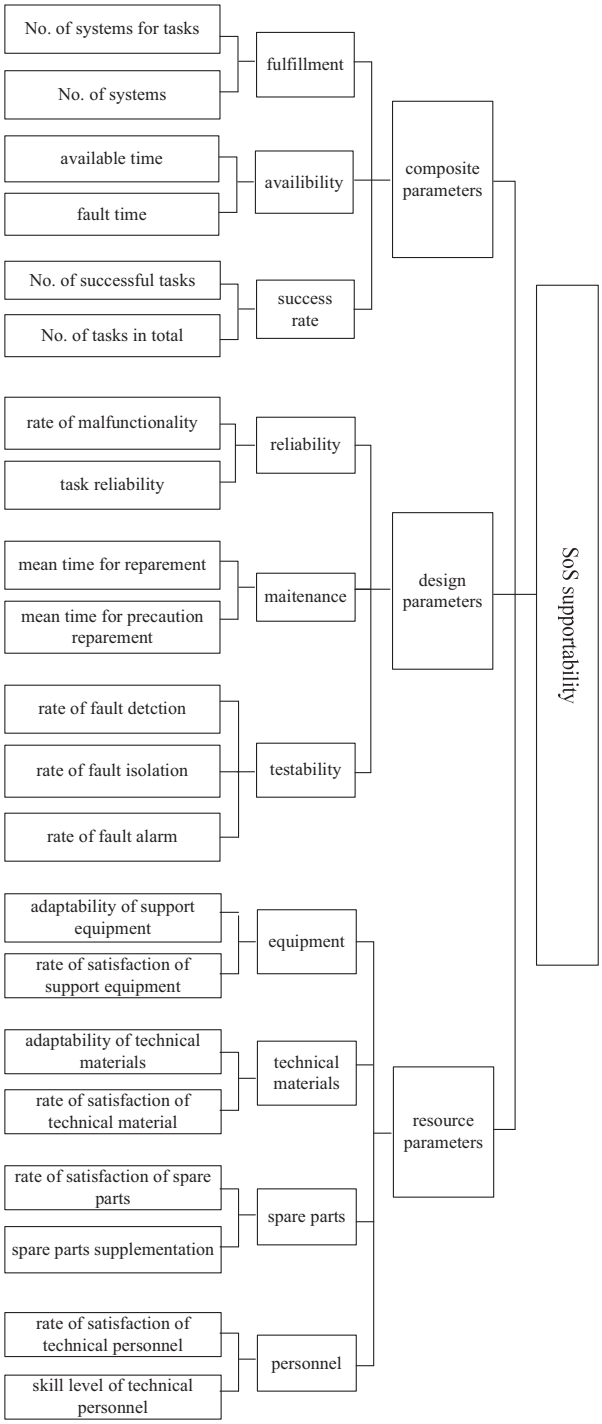


Fig. 4 a diagram of SoS supportability assessment model

The diagram of the SoS supportability assessment model in Fig. 4 is comprised of three layers, the basic parameters and the tasks/systems/resources and the perspectives/views. With the diagram, also a hierarchy, of the SoS supportability assessment model derived, further optimization work can be carried out.

## VI. CONCLUSIONS

This study is the first attempt to obtain a comprehensive and thorough SoS supportability model by taking both the SoS characteristics (SoS tasks and systems requirements) and multiple resources under consideration. The DoDAF-based top-down principle and the elementary-based down-top analysis perspectives form a feedback mechanism in a unified fashion. The greatest contribution and innovation of this study on analyzing SoS supportabilities is that it answered why the SoS supportability model should be constructed and how to derive these parameters from both a comprehensive as well as unified fashion.

The SoS supportability analysis principle and approach proposed in this study is applicable for other related studies within the scope of SoS and can be used as basis for proposing new and innovative approaches and techniques. Moreover, the optimization on the SoS supportability related research can be carried out based on the work of this study.

## ACKNOWLEDGMENT

This study is a continuous follow-up of the SoS design and assessment related researches, as well as its first attempt to expand the research scope into the field of SoS supportability assessment. This study is also the premise for a series of SoS reliability/maintenance/testability/safety.

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