A Study on the Interconnection and Interoperability of Information Systems for the Digitized Battlefield

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ABSTRACT: The development of the digitized battlefield presents many challenges to the current and developing military information systems. The process of digitization of the battlefield is a process of adopting an integrated strategy towards those information systems, it will integrate new information technologies across multiple combat platforms and systems in order to get a common picture and acquire a shared situational awareness across all echelons of forces, so the interconnection and interoperability of the information systems for the digitized battlefield are the keys to success in this new territory. In this paper, after describing the background and objectives of this kind of interconnection and interoperability, we refer their technical implementation such as the construction of Common Operating Environment(COE), architecture and standardization strategy.
KEYWORDS: Digitized Battlefield, Interconnection, Interoperability, Information System, Common Operating Environment, Standardization, Architecture Strategy

1. Introduction

In this information age, the new wave of technological innovation has caused a series of revolutions in almost all areas of human society. Just like in other areas, a state of transmission is occurring in the defense and military scope, this will leverage almost all new technologies to enhance the capabilities of defense forces, and will determine the doctrine, organizations, training, sustainment, and equipment necessary to support decisive, full-spectrum, military operations, this is the development of digitized battlefield. Digitizing the battlefield is the application of information technologies to acquire, exchange, and employ timely digital information (audio, video, text, image, graph) throughout the battlespace, tailored to meet the needs of each decider (commander), shooter, and supporter allowing each to maintain a clear, accurate vision of the surrounding battlespace necessary to support both planning and execution. It mainly consists of three parts: digital C4ISR (Command, Control, Communications, Computers, Intelligence, Supervision and Reconnaissance) systems, digital weapon platforms and digital forces.

The digital battlefield is about interconnection and interoperability of those military systems. It horizontally and vertically integrates the army's diversified battlefield operating systems into an interlocking information exchange network by various information transmission ways (wire, wireless, fiber, and satellite) while also providing a heightened level of essential joint and combined interoperability within a multi-dimensional battle-space. The rapid sharing of enemy and friendly information among all digitized forces within that battlespace will provide near-real time situation awareness, enhance synchronization of combat power, and enable economy of force by making units more lethal and survivable.

The digitized battlefield seems to be a new revolution in the progress of modern army development. It depends on the degree of integration of the technical components such as computer processing, advanced software, display system, man-machine dialogue, sensor, communications networks, combat identification and positioning and navigating system. Obviously, the interconnection and interoperability of the information systems are essential to the process of digitization of the battlefield, only by this way, can the traditional cumbersome, stovepipe systems be converted to efficient systems to all users with complete integration of the applications, infrastructure, and operating environment, and can make it possible for all army, navy, airforces to accomplish a joint operation. Figure 1 shows how the traditional separate systems can be modified to satisfy the requirements of an integrated system by nearly seamless interconnection and interoperability. Specifically, by this way, digitization provides: a common picture of the battlespace in near-real time (situational awareness), shared data among and between battlefield operating systems, the ability to more effectively and decisively concentrate combat power, and high-speed data exchange. Correlation,

fusion and display of intelligence information to commanders at all levels.

Among the developed countries, the United States is the initiator and conductor of developing the digitized battlefield, its related project is called FORCE XII. There are a number of initiatives underway between the US army and other services leading toward joint digital interoperability. For example, the US Marine Corps has purchased the Army's Combat Service Support Control System (CSSCS) and Advanced Field Artillery Tactical Data System (AFATDS). They are also purchasing Single Channel Ground and Airborne Radio System (SINCGARS) and Enhanced Position Location Reporting System (EPLRS) radios, and are in the early stages of defining and developing a Tactical Internet, compatible with the Army's tactical network-centric capabilities. The Army has been working closely with the U.S. Air Force to develop the Situational Awareness Data Link, manage its fielding and develop joint doctrine.

2 Objectives And Basic Description

Generally speaking, interconnection is defined as communications between different networks, this kind of communications deals with the lower protocol layers, for example, according to ISO's the Open System Interconnection / Reference Model (OSI/RM), interconnection is related the physical layer, data link layer and network layer.

Interoperability is a state, which interconnected information systems can reach. Under that state,

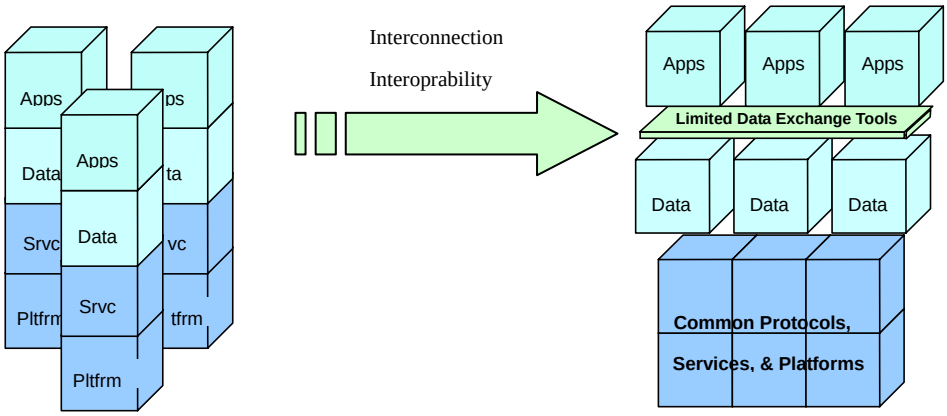

Fig. 1 The Evolution of Systems

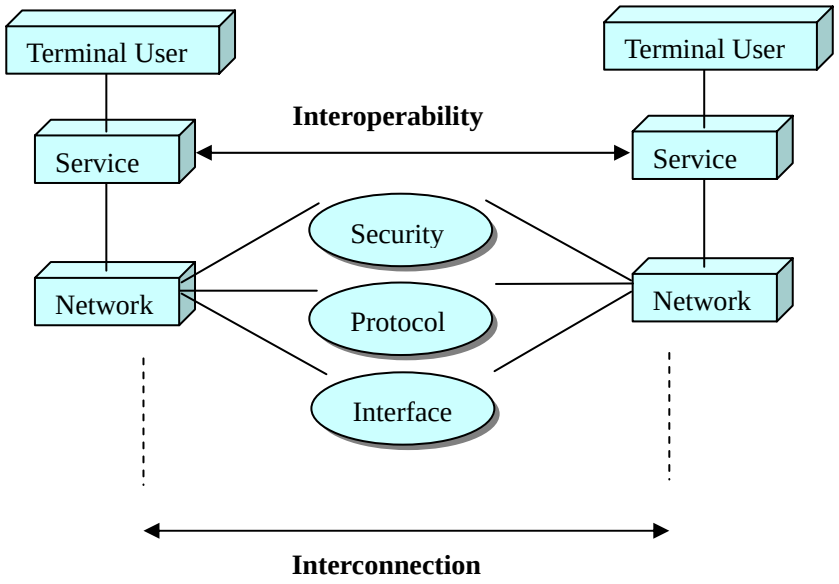

Fig. 2 Notional Explanation of Interconnection and Interoperability

different terminal users can exchange their services directly and with their satisfaction. Specially, the degrees of interoperability should be defined and given to the users. Interoperability is the communications from one active process to another active process, it deals with layers above transport layer when referring OSI/RM. In other words, interoperability refers to the ability of two systems to exchange data:

- with no loss of precision or other attributes,
- in an unambiguous manner,
- in a format understood by and native to both systems, and
- in such a way that interpretation of the data is precisely the same.

There are two significant differences between interoperability and interfacing. The first is that with interoperability the exchange of data is performed without the need to translate to an intermediate format. This leads to the second difference in that interoperable systems will produce exactly the same "answer" in the presence of identical data. Systems that are interfaced will not necessarily do so because of the potential loss of precision or data in the data exchange.

As shown in figure 2, from to point view of information systems' users, the networks must be interconnected, the services must be interoperable, and the information must be shared at a reasonable situation.

Listed in decreasing order, interoperability can be proposed four levels as follows:

Level A: Universal -- Virtual C4I System. This level represents the ultimate goal of full interoperability. Universal interoperability is characterized by the ability to globally share integrated information in a distributed information space. Another way to view Universal interoperability is as a way to globally share systems.

Level B: Advanced -- Integrated Systems. The Advanced level of interoperability is characterized by shared data between applications, including shared data displays, and information exchange through a common data model. This level provides for sharing of information in a distributed but localized environment and for sharing of applications.

Level C: Intermediate -- Distributed Systems. This level is characterized by a client/server environment with standardized interfaces and distributed computing services that allow for exchange of heterogeneous data (e.g., maps with overlays, annotated images), and advanced collaboration. This level of interoperability is achievable with implementation of "cut and paste" between applications, through World-Wide-Web technology, and through basic use of Defense Information Infrastructure Common Operation Environment (DII COE) features.

Level D: Basic -- Discrete Systems Interaction. A primitive level of interoperability characterized by peer-to-peer connected systems that allows basic exchange of homogenous data (e.g., email, formatted messages) and allows for basic collaboration. This level of interoperability is achievable by interfacing techniques described above and by use of standard office automation products that provide data import/export functions for handling data from another product.

So, in order to achieve higher level of interoperability from the lower, more advanced integration, modularity and stronger ability to share data are necessary.

3 Technical Implementation

To achieve the goal of interconnection and interoperability of different information systems, a strategy of adopting common hardware, software, standards and specifications architecture is the base. Take the US army for example, they propose many documents describing the detailed approaches of interconnection and interoperability for the building of military information system. One typical of these documents is Defense Information Infrastructure Common Operating Environment (DII COE), COE is kind of architecture and standardization strategy, is a reference implementation, and a system foundation, the integration of information systems must conform to the COE standards.

As shown in figure 3, the COE concept encompasses:

- an architecture and approach for building interoperable systems,
- an environment for sharing data between applications and systems,
- an infrastructure for supporting mission-area applications,
- a rigorous definition of the runtime execution environment,
- a reference implementation on which systems can be built,
- a collection of reusable software components and data,
- an automated process for software integration,
- an approach and methodology for software and

data reuse,

- ◆a set of Application Program Interfaces (APIs) for accessing COE components, and
- ◆ an electronic process for submitting/retrieving software and data to/from the DII repository.

In COE-based systems, all infrastructure and mission application software except the operating system and basic windowing software are packaged in self-contained units called segments. Segments are the most basic building blocks from which a COE-based system can be built and are defined in terms of the functionality they provide. The principles which govern how segments are loaded, removed, or interact with one another are the same for all segments, but COE component segments which are part of the COE are treated more strictly because they are the foundation on which the entire system rests. Only the segments required to meet a specific mission application need to be present, allowing a minimization of hardware and software resources required to support a COE-based system.

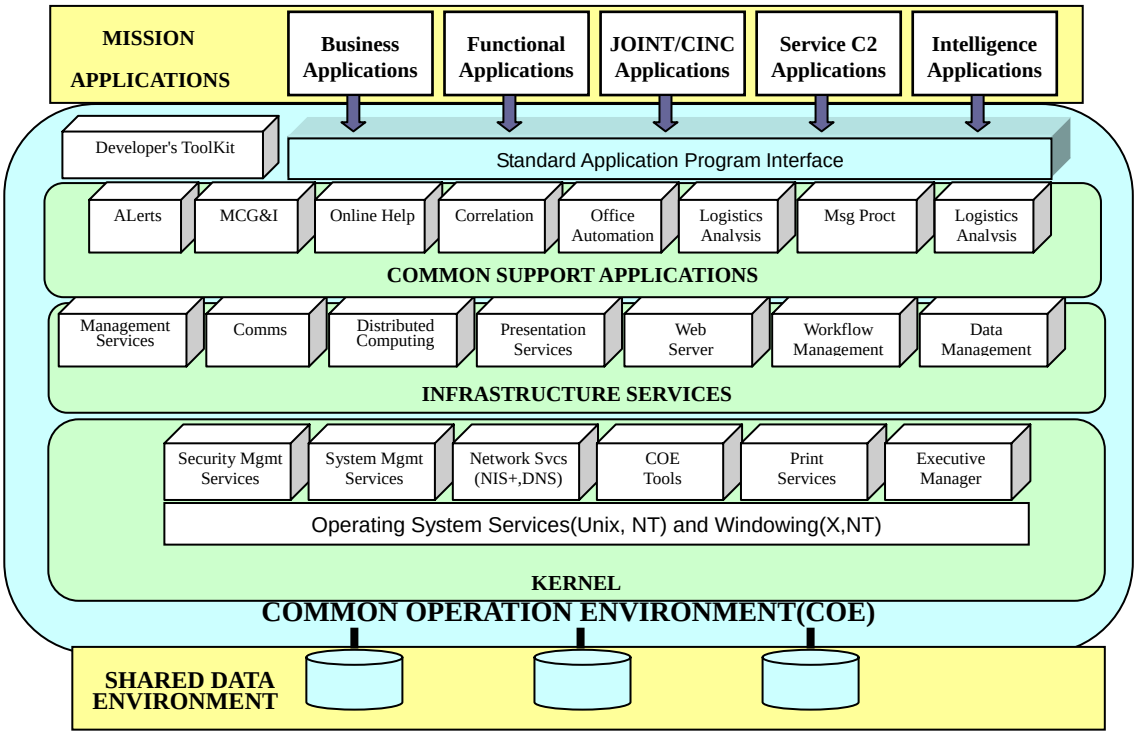

Fig. 3 Simplified DII COE Architecture

4 Conclusion

The implementation of information system's interconnection and interoperability is mainly about standards such as the information processing standards, data transport standards, information standards, human computer interfaces (HCI). The process of battlefield digitization must tackle these problems efficiently. Fortunately, the development of standard commercial information system can be used in almost every step of this process.

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