

Study on the Current Status and Future Vision of ROK-US Wargame Model Interoperability

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한미 워게임모형 상호운용성의 현실태 및 향후 비전에 관한 연구

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ABSTRACT

In this paper, we discuss the current status of ROK-US wargame model interoperability and propose the future federation architecture. ROK and US Armed Forces have made an effort to make their wargame model interoperable to fulfill operational requirements since 1999. Currently, they have achieved some degree of their final goals even though there is long way to go. ROK Armed Forces is now considering future federation architecture. We propose the future federation architecture of ROK-US wargame model interoperability considering technical advantages and system availability. It will be the next federation architecture led by ROK side for the ROK Armed Forces joint exercise and ROK-US combined exercise.

Key words : Modeling and simulation, Wargame, Combined exercise, HLA/RTI

요약

본 논문에서 한미 워게임 모델 상호운용성의 현 실태와 향후 비전에 대해 연구하고 미래의 페더레이션 구조를 제안한다. 한국군과 미군은 1999년부터 작전요구를 충족하기 위한 한미 워게임 모델의 상호운용성 향상을 위해 노력해 왔다. 현 상태에서 목표를 달성하기 위해 아직도 수행해야 할 과정이 더 남아 있지만 최종목표에 어느 정도 근접한 상태이다. 한미 워게임 체계의 기술적인 장점과 시스템 가용도를 고려한 향후 한미 워게임 체계 상호운용성 향상을 위한 시스템 구조를 제시한다. 이러한 새로운 체계는 한국군이 주도하는 향후 한미 연합연습과 한국군 자체 합동연습시 운용될 시뮬레이션 구조라고 할 수 있다.

주요어 : 시뮬레이션 구조, 연합연습, 워게임 상호운용성, HLA/RTI

1. Introduction

ROK(Republic of Korea) Armed Forces has had many challenges from the internal and/or external environment. Nowadays, not only the existing enemy is a threat but also resources including budget, training area, manpower and time can be constraints to the

defense system. To deal with these challenges, we have to seek more efficient, smart, fast and economic ways. In that sense, DM&S(Defense Modeling & Simulation) can be a quite suitable methodology. Modeling is the compact representation of systems and simulation is a time-based model implementing process. Wargaming is the realization tool of military simulation that is being used in various areas such as OPLAN(Operational Plan) analysis, force training, weapon system acquisition and warfighting experiments. Consequently the ROK Armed Forces is now constructing its own simulation capability for combined/joint exercises.

The simulation confederation connecting several models is inevitable since any single model cannot provide

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simulation support to achieve exercise objectives. Also, the simulation confederation is required for the use of simulation resources distributed geographically. To reuse of available simulation resources economically and efficiently, the simulation confederation is inevitable. By confederating several models, we can achieve the variety of operational requirements; moreover, we can develop the confederation technique. The simulation confederation is the necessity of times.

If we do not accept this tide, we cannot meet the operational requirement of the exercise players. To simulate the battlefield with fidelity, we think there are no other approaches except simulation confederation. In one model, we cannot simulate all component forces function such as doctrine, tactics, techniques and procedures. Even though the confederation needs a lot of resources and efforts with some difficulties, we have to go this direction. So, we discuss the current status of ROK-US wargame model interoperability and propose the future federation architecture.

In this paper, we will confine the discussion area within the training area. We discuss the ROK-US combined exercises and simulation architecture in chapter 2. We describe the overview of wargame model interoperability in chapter 3. We examine ROK Armed Forces effort to construct its own simulation system and the current status of ROK-US model interoperability in chapter 4. We propose the future vision of ROK-US model interoperability in chapter 5. Finally, chapter 6 concludes the paper.

2. ROK-US COMBINED EXERCISE

2.1 ROK-US Combined Exercises

UFL(Ulchi Focus Lens) and RSOI/FE(Reception, Staging, Onward movement and Integration/Foal Eagle) are representative ROK-US combined exercises. These exercises are designed to enhance the combat readiness posture on the Korean peninsula and are known as the most complicated simulation driven exercises in the world. Both in UFL and RSOI/FE exercises, the training audiences are commanders and staffs of army corps, navy fleet and air force wing and above hierarchical

levels. UFL and RSOI/FE exercise are simulation driven exercises. The main exercise players are commanders and staffs of the participating units. The OPFOR (Opposing Force) is a well-trained opposing force training the exercise players. The exercise players and OPFOR operate gamers to input orders into wargame models. The exercise controllers control all phase of the exercise to fulfill exercise goals and objectives. They control players and OPFOR using various control measures. The exercise players and OPFOR fight each other in the virtual battlefield simulated by various wargame models. Sometimes, the controllers use MSEL (Master Scenario Event List) for complementing the wargame model limitation. The observers and analysts observe all actions of the players, collect data and analyze what happened during the exercise. Finally the facilitator conducts an AAR(After Action Review) to draw lessons-learned from the exercise.

2.2 Simulation Architecture of ROK-US Combined Exercise

Since 1997 USFK(United States Forces in Korea) has taken in charge of simulation support while ROK Armed Forces reimburses the cost for exercise UFL and RSOI/FE. The CBSC(Combined Battle Simulation Center) and KBSC(Korea Battle Simulation Center) develop simulation support plans and provide simulation support. KBSC, under USFK, has full simulation support capability for combined exercises since it has various wargame models, WAN(Wide Area Network), LAN (Local Area Network), technicians and technical capability. More than 20 models are confederated to simulate the virtual battlefield during combined exercises. The wargame models consist of ground, naval, air, intelligence, combat service support and so on. Those models are confederated one another by connecting to distributed simulation centers through WAN.

One of the most important aspects in simulation support is to stimulate the C2(Command and Control) system operation as if used in wartime. The ultimate goal of simulation driven exercises is to construct a battlefield environment that is as real as possible. War fighters use C2 systems in wartime, so C2 systems

should be available during exercise, too^[1].

3. WARGAME MODEL INTEROPERABILITY

The simulation federation connecting several models is inevitable since any single model cannot provide whole battlefield simulation support to achieve exercise objectives. By distributing the confederated simulation geographically, we are able to use our resources more economically and efficiently. Confederating several models, we can achieve the variety of operational requirements. The simulation federation is a general trend and requirement.

3.1 History of Wargame Model Interoperability

For ROK-US combined exercise, CFC(Combined Forces Command) is now using HLA/RTI(High Level Architecture/Runtime Infrastructure) based federation system. The HLA/RTI concept is the advanced interoperability approach that is the current international standard.

Prior to the HLA/RTI concept, there were many attempts to make the simulation system confederated such as SIMNET(Simulation Networking), DIS(Distributed Interactive Simulation) and ALSP (Aggregated Level Simulation Protocol)^[2-5].

3.2 Actual Applications of Federation System

3.2.1 UFL and RSOI/FE Exercise Federation System (Low-Resolution)

The model federation is the inevitable way to meet operational requirement. There are many federation systems in the world. JTTI+K(Joint Training Transformation Initiative + KSIMS(Korea Simulation System) federation system is applied for ROK-US combined exercises such as UFL and RSOI/FE. In JTTI+K federation, more than 20 models are confederated. Many interfaces are used to stimulate the simulated data in JTTI+K to C2 systems.

The major models in JTTI+K are CBS(Corps Battle Simulation: US Ground Model), RESA(Research Evaluation and System Analysis: US Naval Model), AWSIM (Air Warfare Simulation: US Air Model), TACSIM

(Tactical Simulation: US Intelligence Model), LOGFED (Logistics Federation: US Combat Service Support Model), CJ21(ChangJo21: ROK Ground Model), CH (CheongHae: ROK Naval Model), CG(Chang Gong: ROK Air Model), CJB(CheonJaBong: ROK Amphibious Model), STAAR(System for Theater level After Action Review: ROK AAR Model), KFMT (Korea Federation Management Tool) and so on. All models in JTTI+K federation are low-resolution for theater level combined/joint exercise. In JTTI+K federation, there are two ground models(CJ21, CBS), two naval models

(CH, RESA) and two air force models(AWSIM, CG). This implies very important meaning to us because each of ROK and US ground, naval, air force depicts its own units in each country's models. OPFOR units should be in just one ground/naval/air model, and should be in US models considering data feeding to the real world C2 systems. Also, we have to consider the fair fighting issues seriously as well as technical issues when confederating two models for each of ground, naval and air operation^[1].

3.2.2 GCC Counterfire Exercise Federation System (High-Resolution)

Another example of an applied federation system is DBST(Digital Battlestaff Sustainment Trainer) for GCC(Ground Component Command) counterfire exercise. DBST system confederates several high-resolution models that simulates each howitzer level. The major models in DBST are FIRESIM(Fire Simulation) and JCATS (Joint Conflict And Tactical Simulation). FIRESIM model simulates OPFOR's long range artillery, Blue Force's counterfire TF(Task Force) units and TPQ-37 radars because their units should be communicated directly with JADOCs(Joint Automated Deep Operations Coordination System) and AFATDS(Advanced Field Artillery Tactical Data System). The other units of Blue Force and OPFOR are simulated in JCATS model. By using DBST, ROK Armed Forces has been carrying out counterfire training successfully.

3.2.3 JNTC Environment(Multi-Resolution)

US JFCOM(Joint Forces Command) is conducting

JNTC(Joint National Training Capability) program designed to enhance joint, multinational, interagency, intergovernmental and nongovernmental operations. It is also used for military training like UE(Unit of Employment) exercise and force transformation^[6].

4. CURRENT STATUS OF ROK-US MODEL INTEROPERABILITY

4.1 Effort for ROK-US Model Interoperability

ROK Armed Forces has made an effort to make ROK wargame models interoperable with US models. Figure 1 shows the overview of ROK Armed Forces efforts have done since 1999. ROK side raised interoperability necessity during the 2nd ROK-US Defense Modeling and Simulation Seminar hosted by KIDA (Korea Institute of Defense Analysis) and ODUSA/OR (Office of Deputy Under Secretary of the Army for Operations Research) in 1999. After the raising interoperability issue, ROK side has continuously submitted agenda regarding ROK-US model interoperability to MCM(Military Committee Meeting) as one of the CFC commander's military requirement since 2001. This is the first and unique agenda that the CFC commander requested to US Joint Chief of Staff, considering the

other agendas are required to ROK Joint Chief of Staff.

Simultaneously, ROK side accelerated wargame model development. CJ21 model was developed in 1998 and upgraded to embed the federation function in 2006. CH model was developed from 2002 to 2006. CG and CJB models are currently being developed; we expect them to be fielded in 2009. By the way, ROK side of CFC developed ROK federation systems called KSIMS in 2004. KSIMS is the first federation system of ROK Armed Forces.

From 2002, ROK and US sides conducted federation test together. They spend more than 95 days for conducting CFT(Combined Federation Test) and FT (Federation Test), and participating UFL and RSOI/FE exercises.

The CFT is a ROK side led test to identify the updated requirement of ROK and US models. It is usually held in May. ROK and US side have conducted eight times CFT since 2002. In 1st CFT, only one ROK model participated as a listener mode. However, in 8th CFT conducted on May, 2007, six ROK models participated as two ways communication or listener mode. The number of participating ROK models is getting increased. The focus of test also has been extended from the technical area to functional area. During CFT, we have found many correction factors to update and

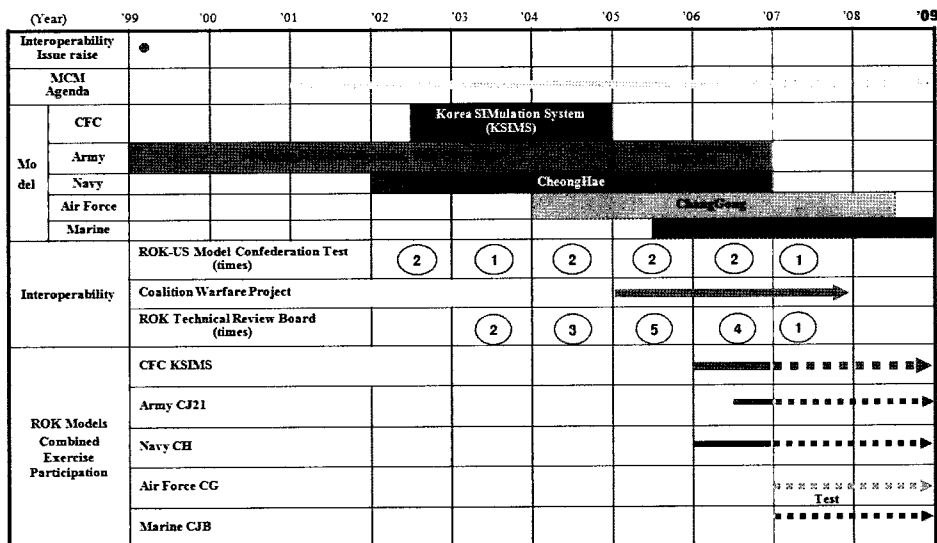


Fig. 1. Overview of ROK efforts to confederate

action items to solve for federation. Due to the CFT result, ROK side has requested US side to update US models to confederate with ROK models through MCM agenda.

The FT is US side leading test to certificate models that are supposed to be used in the next year combined exercises. US side conducted the FT in CONUS (Continental United States) before 2005 because there were no ROK models joining in combined exercises. As ROK models begin to be used in combined exercises, the FT was held in Korea for the first time as distributed manners in 2005. ROK models could get the certification that allows joining the combined exercise federation. For the 2006 FT held in 2005, 4.

ROK models and seven US models participated in the test and decided the scope of CJ21 and CH models participation. In the 2007 FT, CG and CJB models joined additionally even though they were in the development stage. By joining CFT and FT, the models under development could be verified in the federation module simultaneously.

CWP(Coalition Warfare Project) is the US DOD (Department of Defense) project for combined interoperability to federate with ROK models using US DOD budget. US DOD approved CWP four years later since ROK side had raised MCM agenda in 2001. The total CWP budget was 732,000 dollars for 2 years duration from 2005 to 2006. By applying CWP, CBS and RESA models were modified to confederate with ROK CJ21 and CH models. As the results of CWP project, CBS could ghost CJ21 objects partially during CJ21-CBS point-to-point test in January 2007. Also, CH and RESA models could confederate all functions.

ROK TRB(Technical Review Board) is the only existing ad-hoc organization in ROK Armed Forces for simulation based training. The primary mission of TRB is to ensure that all ROK models are interoperable and reusable for the various purposes. The major functions of TRB are to review technical issues, to introduce advanced technique, to advise wargame model development and so on. Since 2003, TRB has been held 15 times. We evaluate it has contributed a lot to the development of ROK federation system. ROK has

gradually expanded the ROK model participation scope in ROK-US combined exercises. In 2005, KFMT and STAAR began to participate in the exercise. CJ21 was used during 2006 UFL exercise for army aviation function only. ROK side wants CJ21 to participate in exercise with all functional area, but CBS is not ready to confederate with CJ21. Even though CWP is pursued, because CBS model is being used for many purposes in various US only exercises, the priority of CBS modification to make it interoperable with ROK model is low. During 2006 RSOI/FE exercise, CH model was used for 1st, 2nd, 3rd ROK Fleet and the result was very successful. CH model was used for all ROK navy functions including surface/ submarine/ anti-submarine/ undersea warfare and maritime patrol aircraft during 2007 RSOI/FE exercise.

4.2 Current Status of ROK-US Model Federation

We classify the interoperability phases into four parts; technical interoperability phase, functional interoperability phase, fair fighting phase and information security phase.

4.2.1 Technical Interoperability Phase

In technical interoperability phase, federation should be created stable and reliable. If we do not achieve federation stability, we cannot begin to operate federation for the operational requirement. Therefore, technical interoperability phase is the basic phase. In technical interoperability phase, synchronization point pause/resume, federation creation, federate join/resign, save/restore, refresh, object publish/subscribe, register, discover, remove, ghosting and time advance should be verified.

Table 1 shows the technical test result of Combined Federation Test conducted in 2007^[7].

ROK models were in a good condition to confederate with US models. The test items are setup, connectivity, class/attribute registration, object ownership, object ghosting and so forth.

4.2.2 Functional Interoperability Phase

Functional interoperability phase is the next step

Table 1. Technical federation status

G : Good I : Insufficient

Test Item	CJ21	CH	CG	CJB	KFMT	STAAR	CBS	RESA	AWSIM
Setup	G	G	G	G	G	G	G	G	G
Connectivity	G	G	G	G	G	G	G	G	G
Class/Attribute Reg	G	G	G	G	G	G	G	G	G
Time Management	G	G	G	G	G	G	G	G	G
Object Ownership	G	G	G	N/A*	N/A	N/A	G	G	G
Object Ghosting	G	G	G	G	N/A	G	G	G	G
Attribute Locking	G	G	G	N/A*	N/A	N/A	G	G	G
Save/Restore Ops	G	G	G	G	G	G	G	G	G
Object Interaction	G	G	G	G	G	G	G	G	G
Recovery	G	G	G	G	G	G	G	G	G
Robustness	G	G	G	G	G	G	G	G	G
Operator Interface	G	G	G	G	G	G	G	G	G
Diagnostics	G	G	G	G	G	G	G	G	G
Enumerations	G	G	G	G	N/A	G	G	G	G
Synch Points	G	G	G	G	G	G	G	G	G

* : On-Developing, N/A : Non Applicable

when technical interoperability phase is ensured. In this phase, we verify the functions defined on the FOM (Federation Object Model) such as objects and interactions. Table 2 shows current interaction status of engagement. It says there are no critical limitations in functionality.

As shown in Table 2, all functions are good enough to support simulation driven exercise except CBS close combat^[8]. ROK and US sides are now trying to correct CBS model functions. It also implies that we can add FOM interaction class when we want to describe other functions for federation.

4.2.3 Fair Fighting Phase

The next step of interoperability phase is fair fighting. It is related to the reality and reasonability of engagement. Therefore, it is a very important issue whenever we confederate models. Models would be developed by different agencies, by applying different methodology, for different purposes. The parametric data would be different, so the casualty result cannot be same. To resolve this problem, we can regard that the difference of terrain, weapon system and parametric

data as a stochastic variance in wargame models. Since most of training models adopt the stochastic casualty logics, we can accept the difference of casualties between two models as a probabilistic variance.

When a unit in a model attacks other unit in another model, combat set is made by each model's logic. Therefore, combat set can be varied by situation. Each model should evaluate the combat assessment for the owned objects. The model owned attacked unit evaluates the combat assessment by its own logic and sends back to the result to the model owned attacking unit. Therefore, we have to design to evaluate the reasonable combat assessment when a weapon system strikes a unit owned by other model. If the combat assessment is not acceptable by the model that does not own object or there is a big difference between two model's combat assessments, we can take the arithmetic average of two models' combat assessment. We believe that this is the right approach for federating the models of allies.

4.2.4 Information Protection Phase

The last interoperability phase is the information

Table 2. Functional federation status

[G]: Good [I]: Insufficient

FOM Interaction Class			Confederation State														
			CJ21		CH		CG		CJB		CBS		RESA		AWSIM		
			P	S	P	S	P	S	P	S	P	S	P	S	P	S	
Air	Supply	Supporting Unit	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	G	G	G	G
		Fuel	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	G	G	G
Engagement	Air to Air		N/A	N/A	G	G	G	G	N/A	N/A	N/A	N/A	N/A	G	G	G	G
	Air to Ground		G	G	G	G	G	G	N/A	G	G	G	G	G	G	G	G
	Air to Ship		G	N/A		G	G	G	N/A	G	G	N/A	G	G	G	G	N/A
	Ground to Air		G	G	N/A	G	G	G	G	G	G	G	N/A	G	G	G	G
	Ground	Artillery	G	G	N/A	N/A	N/A	N/A	G	G	G	G	N/A	N/A	N/A	N/A	N/A
		Close Combat	G	G	N/A	N/A	N/A	N/A	G	G	I	I	N/A	N/A	N/A	N/A	N/A
	Ground to Ship		G	N/A	N/A	G	N/A	N/A	G	G	G	N/A	N/A	G	N/A	N/A	N/A
	Ship to Air		N/A	N/A	G	G	N/A	G	N/A	N/A	N/A	N/A	G	G	N/A	G	G
	Ship to Ground		N/A	G	G	G	N/A	N/A	G	G	N/A	G	G	G	N/A	N/A	N/A
Ship to Ship		N/A	N/A	G	G	N/A	N/A	G	G	N/A	N/A	G	G	N/A	N/A	N/A	

P: Publish, S: Subscribe, N/A: Non Applicable

protection phase. If the technical, functional, fair fighting phases are reliable, we have to consider information protection seriously. The information protection means not only protection from outside intrusion but also exclusion of sensitive data for one party in federation. As described in chapter 2, currently US side provides simulation support for ROK-US combined exercises. Therefore, every ROK data such as the force structure, weapon system, unit location should be provided to US side. On the other hand, it is not easy for ROK side to review US data even though ROK side needs those to provide WHNS(Wartime Host Nation Support). That means ROK information is open to US side, but US information is not fully open to ROK side. We believe that it will be required to protect each country's information in the bilateral or multinational exercises.

5. FUTURE VISION OF ROK-US MODEL INTEROPERABILITY

5.1 Continuous Participation in Combined Exercises

To accelerate interoperability between ROK and US models, we have to force ROK models to participate

combined exercises continuously. ROK Armed Forces has to construct its own simulation system for the future vision. Therefore, ROK Armed Forces is trying to make its models interoperable one another and with US models no later than 2009. Fortunately, ROK air and amphibious models are supposed to be developed by the end of 2008. If the federation effort is successful, ROK Armed Forces can achieve its goal having its own simulation system which is interoperable with US simulation system even though it may be not fully completed and capable in all operational functional areas. Therefore, ROK Armed Forces has to have a master plan to expand the application scope gradually.

CJ21 model is supposed to be used in army aviation, air defense and a part of artillery functions according to CBS model modification in 2007. In 2008, the scope of application is going to be extended to full artillery function and to close combat function if every efforts are successful. CH model will be used in all functional areas from 2007. CG and CJB models will join in test federation partially from 2007 and will be fully applied from 2009. KFMT and STAAR will be applied as they were used to be. STAAR will be used for both ROK and US sides for the combined exercises^[9].

5.2 Way Ahead to the Hierarchical Architecture

As discussed in chapter 4, the current simulation architecture of combined exercises does not guarantee information protection. As shown on the left side in Figure 2, all federates are joined in a single federation on current simulation architecture. ROK and US models look separated, but actually they are joined just in a single federation.

Therefore, while US side manages all federation system and takes in charge of simulation support during ROK-US combined exercise, all information of ROK side is exposed to US side. On the other hand, it is not easy for ROK side to review US side information. And the current simulation architecture can have a serious weakness in data communication. It also has the complexity of federation management when the number of federates increases. As the number of federates increase, the amount of data traffic and complexity of federation increases exponentially. Due to the data traffic increase, it may not be possible to control data network. Another important thing is that whenever a US model or enumeration data is modified, all ROK models should be modified mandatorily. It is related to the federate maintenance problem especially for ROK side.

Therefore, ROK side proposes an Hierarchical Architecture as the future simulation architecture. It is the concept of system-to-system federation approach. This means ROK and US sides create their own federations

separately. Finally they confederate both federations using super FOM. The merit of the hierarchical architecture is that ROK and US sides can each protect their information. Through the CI(Confederation Interface), only necessary data flows from one federation to counterpart federation. Moreover, when a new federate joined in one federation, the data communication amount to counterpart federation is not much increased compared with current structure.

6. CONCLUSION

ROK and US wargame model interoperability is a very significant issue for ROK Armed Forces. We believe that there are no other alternatives substituting this approach for future simulation system of ROK Armed Forces. By achieving ROK and US model interoperability, ROK Armed Forces will have its own combined/joint exercise simulation system. ROK and US simulation federations have had many challenges since the project began. At initial stage there were some arguments about this approach. ROK Armed Forces has tried to accomplish this project because the meaning and rationale are too much clear. ROK and US models interoperability is the right approach to construct ROK only joint exercise simulation system and to achieve combined exercise system at the same time.

The ROK and US model interoperability project has

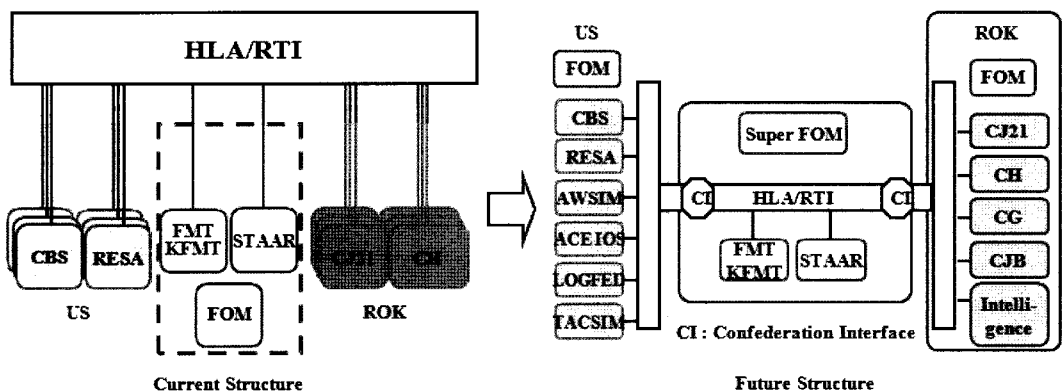


Fig. 2. Current and future architecture

not been completed and it is still on-going. ROK Armed Forces has made a great deal of effort Since 2001; raising MCM agenda, developing various models, conducting combined federation Test and Federation Test, carrying out CWP, operating ROK Technical Review Board and participating combined exercises continuously. The results of these efforts begin to be shown now. ROK Armed Forces can have the future vision in simulation area for force training and enhancing combat readiness posture.

The current status of ROK and US model interoperability is very successful. The availability of models is good enough to support exercises and the robustness and stability are verified. ROK Armed Force will participate in combined exercise and test to increase the interoperability capability. It will also try to improve the current federation architecture to the hierarchical architecture to ensure many benefit related to technical and policy perspective. We have to study the technical feasibility such as RTI support for the hierarchical architecture. ROK Armed Forces should construct its own simulation system that can support combined/joint exercise. This will be the ultimate vision of ROK and US wargame model interoperability.

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