Establishing a low cost National Training Network using established C2 and simulation standards

Birger Johansen
Systematic A/S
Søren Frichsvej 39
8000 Aarhus
DENMARK

bij@systematic.com

Henrik Voss
IFAD TS A/S
Østre Stationsvej 43, 2 tv
5000 Odense C
DENMARK

henrik.voss@ifad.dk

ABSTRACT

This paper and presentation will look at ways to bring Modelling and Simulation (M&S) from classrooms to large scale, joint, combined training networks with the use of minimum of efforts and at a low budget. We claim that most nations by using existing M&S and their existing or ready available COTS C2 solutions can build the necessary training facility, where the users work from own garrisons using their real C2 systems.

Such a federation of systems can use existing national military networks and exchange simulation information and events to run the realistic scenario in their C2-systems, which over the same networks share plans, orders, and situational picture just like in a live operation. Different environments can enter their specific information building a complete and realistic joint COP.

Everything is shared using international standards from the simulation world (MSDL, HLA, DIS) and from the C2 world (JC3IEDM, AdatP-3, Link16, NVG, NFFI) thereby creating a network open for different systems to join.

The presentation will include examples from Swedish Combined Joint Staff Exercise, CWIX and use in the Danish defence thereby proofing the possibilities and the potential of our efforts. We will suggest a roadmap for the continuation of this road towards a generic training network using existing systems and recognised standards

INTRODUCTION

During recent years a number of larger training and simulation network projects have been initiated. These

are both national and international initiatives. Many of the projects have been delayed or stalled, mostly due to uncertainties regarding the technical maturity of future standards or lack of funding. Furthermore the integration to real Command and Control (C2) systems has rarely been thought into the equation, meaning that the operational user often uses the simulation application to plan and execute his orders, thereby not following the principle "Train as you fight".

Through this paper, we will bring out some ideas for at low cost training network, which additionally connects the joint, combined operational network to the synthetic reality provided by the simulators.

We clearly believe that the C2 and Simulation societies are getting closer, and that there are only small steps and very little budget needed to create an overall success, which will increase training efficiency and bring out the necessary aids in a large scale with open connectivity to legacy and new systems.

USER CHALLENGE

We have during a number of larger exercises in Sweden and Demark observed some key pains among the user communities training military staffs. One area is the resources necessary to execute these exercises due to a need of many players in the control staff, and the need of high qualifications among them to use the simulation systems. At the latest Royal Danish Defence College exercise in Denmark almost 100 highly skilled officers were needed to give a trained audience of 80 persons a qualified game. The cost of bringing all these people to one site and accommodate them was another factor to extend the cost of the exercise. Therefore this exercise will be cancelled in 2013, until less resource demanding setups have been found.

Another challenge is the lack of real jointness. There is a need to connect all services' simulators and join their information into a Common Operational Picture (COP). Some efforts has been made during Swedish led Viking exercises to reach this, but it has still been necessary to bring the systems to one site, and have a very skilled technical support staff at site, including bringing in engineers from the system manufacturers. This also raises the cost of large scale simulation exercises.

For many years staff training has been performed only using simulation systems and basic office tools. These years automated C2-applications have found their way also into the Army. Air Force and Navy have for many years had automated systems connected either to real sensors or to simulated sensor feeds. When staff officers use C2-systems in their operational duties, they should clearly have the same tools as their user interface during exercises, and simulation systems should be hidden for the trained audience.

Therefore there is a growing need to interface the C2-systems and the simulated inputs, bringing more reality into exercises. It should also be possible to train from home garrisons and sites over national and international training networks.

THE FUNDAMENTALS CONCERNING C2 ARCHITECTURE

C2 systems have typically been developed to national or international specifications mainly taking the operational concepts and doctrine into account. NATO has pushed for a wide number of interoperability standards to be developed and used, and over the past decade these standards have found their way into the requirements. Also a common language – ontology, has been lacking, meaning that a mechanized infantry section could have quite different meaning in different user communities.

Even though many systems today claim to fulfil standards like AdtaP-3, C2IEDM, NVG etc. it is clear during exercises like CWIX that claiming compliance with these standards is not enough. Systems like ICC, NEC CCIS, and US TBMS have very similar Air Task Orders much in line with AdatP-3 version 11 C, but

they are still not able to exchange information without extensive engineering during tests.

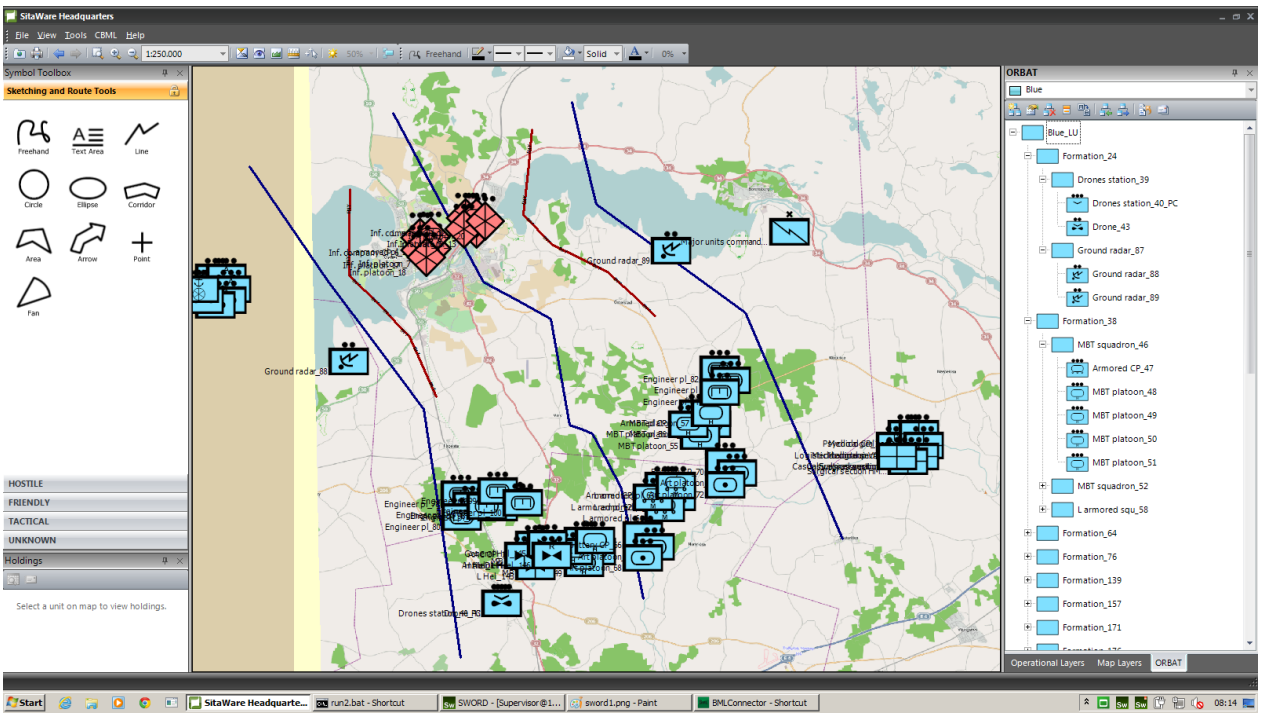

Figure 1, Example of a JC3IEDM C2-system with ORBAT and situation from Swedish Armed Forces exercise CJSE 2012. (Systematic SitaWare)

In the army domain, Multilateral Interoperability Programme (MIP) has gained quite some success by developing a common data model and thereby creating a shared understanding of battlefield objects. The related Data Exchange Mechanism (DEM) has proved its value during CWIX and recently also in ISAF on Afghanistan Mission Network. The main achievement has however been the common understanding of battlefield objects.

C2IEDM and JC3IEDM have also showed a number of deficiencies. The main ones being its lack of performance on tactical radio networks and the problem of security tagging objects to separate networks of different classification. The lack of performance has resulted in many systems only using the JC3IEDM as an interoperability gateway between coalition partners, and not as the internal data model in the national system. This is the case in Norwegian NORCCIS 2 and UK systems where Systematic SitaWare is used to provide the MIP gateway and mappings are created between the internal systems' databases and JC3IEDM. This is a quite good concept solving performance problems and at the same time ensuring coalition interoperability. The security issue has yet to be solved, but it seems that many nations will use much simpler interfaces than the MIP DEM.

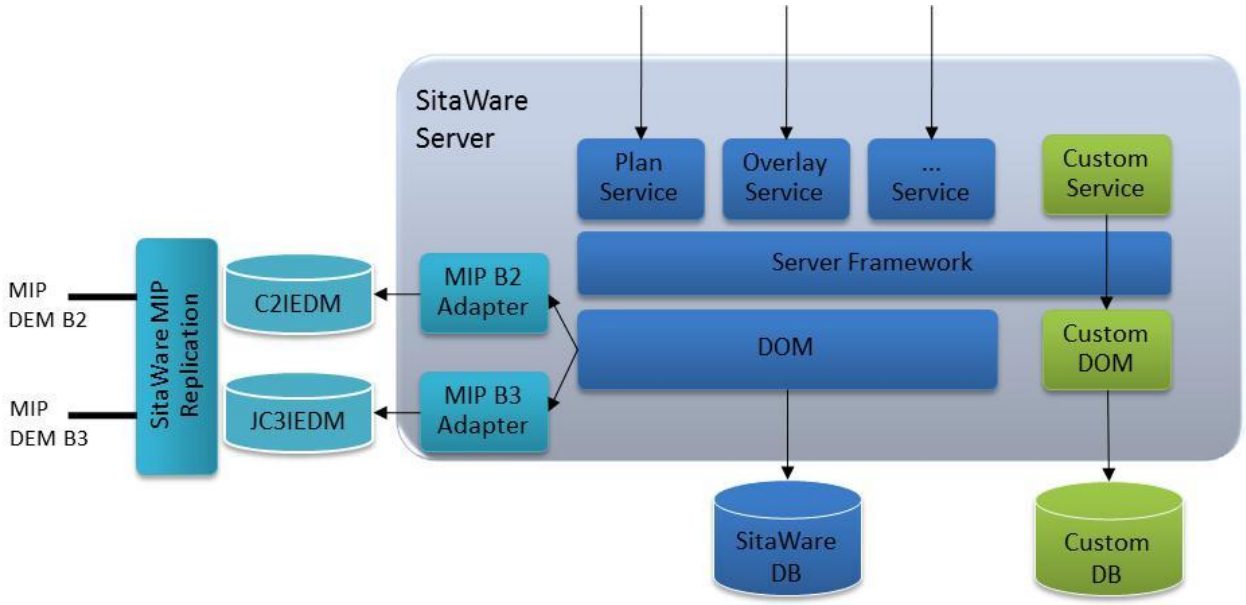

Figure 2, An example of an architecture with an external MIP interface and different ways to extend to eg. simulation systems

EXISTING TRAINING NETWORK STRUCTURES AND SYSTEMS (HV)

Training systems are normally composed by a combination of simulation systems, operational C2 systems and communications systems, and often with no integration or limited point to point integrations among them. The trend is that more and more systems are being added to the training networks, the complexity is increasing and the efforts and expertise needed to prepare and execute simulated training exercises are therefore high.

Simulation Systems

The simulation network is often based on internal simulator protocols and external gateways. A lot of legacy simulation systems support DIS and many also support various versions of HLA, HLA FOMs and even different vendor specific HLA run-time infrastructures (RTIs). Even though many simulation systems comply with DIS, it still takes a lot of work to integrate the systems into a coherent training exercise. The systems must use compatible enumerations of entities, weapons, monitions etc. but also filters might be needed in order to reduce the amount of entities for selected simulators.

Communication Systems

The simulation systems and gateways are often limited to run-time scenario data such as entities, weapons, emitters etc and do not address communications. As communications are vital in almost any training exercise communications are either done using live radios or separate communication networks. The communication networks are established for voice communication (radio and intercom), chat and tactical data communication. As the communication networks are often not based on standard simulation protocols, interoperability and distributed training is not possible.

C2 Systems

A C2 system structure is often established on a C2 network as under operational conditions. In order to obtain a true distributed training capability the C2 networks must be distributed as well, allowing replication of plans and orders as well as the tactical situation.

In some cases integration between simulation and C2 is accomplished using one or more bridges. However, often the bridges are point to point integrations using system specific interfaces requiring the systems to be placed at the same physical location. In a truly distributed environment the Simulator-C2 bridge must be based the distributed simulation standard used in the simulation network.

Danish Army foundation for Distributed Training

The Danish Army has addressed the above problems using DIS as interoperability standard for simulators and communications and C2 interoperability standards for replication among the C2 systems. Furthermore, a generic gateway between DIS and C2 using SitaWare was added. In this way the C2 systems are automatically fed with simulation data, information management on the two networks are handled independently, and the operational users interact with operational systems and networks as under operational conditions.

DIS was selected as an initial baseline for the simulation LAN as all simulators within the Danish Army already supported DIS directly or through gateways, and using DIS no initial investments in HLA infrastructures where needed. The first step enabled integration of the Danish Army CCIS (SitaWare HQ) and BMS (SitaWare Frontline) with all simulators in use.

For communications the Danish army used a combination of live VHF, a VHF-DIS interface system, and DIS based radio simulation and intercom on the simulation LAN. This communication infrastructure can be fully integrated in the simulation environment and distributed simulation including radio communication is enabled.

The training network using DIS and C2 has proven its value in daily use at several training sites within the Danish Army.

Using the above approach the Danish Army has established the foundation for distributed training as part of the Danish Defense vision of establishing a distributed national training network.

THE FUTURE TRAINING NETWORK

The existing training network structure calls for persistent WAN based distributed network infrastructure offering standard interfaces for connecting simulation systems, C2 systems and communications systems. The training network should facilitate ad hoc connectivity of systems as distributed services when needed.

Overview

The training network should be organized into a Simulation Network, a C2 Network and interface feeding simulation data to the operational C2 environment.

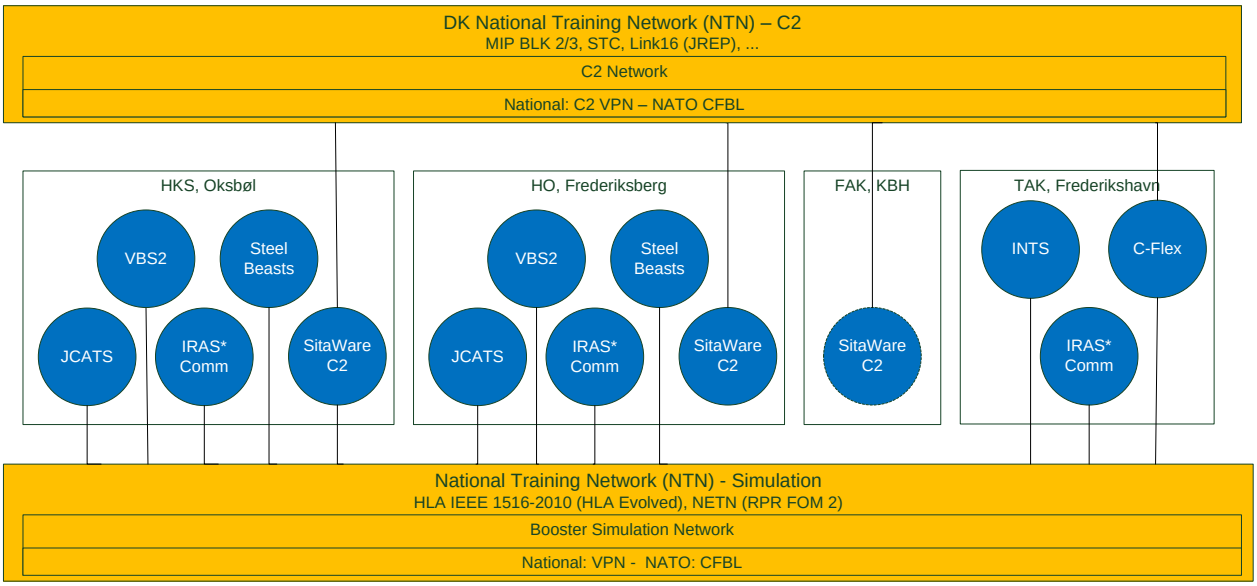

Figure 3, An example of a National Training Network composed by a distributed C2 Network and a distributed Simulation Network.

Simulation network

For the future simulation network it is recommended to use the standards, guidelines and recommendations of the NATO Education and Training Network (NETN) to support the long-term strategic goals to have joint and combined exercises supported by a variety of national training solutions connected to a distributed training network.

The current ongoing MSG-106 will expand and update the MSG-086 NATO Education and Training Network (NETN), which is already internationally applied and proven in e.g. the Swedish Defence National Training Network (SWE NTN), Snow Leopard and the VIKING exercise.

The objective is to establish a persistent distributed simulation network which is:

- Available 24-7-365
- Based on International Standards: HLA Evolved / NETN FOM (RPR FOM v2)
- Proven technology: Pitch RTI, Booster, Commander
- Secure: CFBL, IP Crypto (Internet)

The simulation network can be established using a stepwise approach:

- DIS – HLA Bridging: Using DIS with the legacy systems and DIS-HLA bridging to a HLA Booster based WAN training network.
- Stepwise transition of legacy systems from DIS to HLA and adding extended facilities of the NETN FOM.
- Stepwise adding booster nodes

Interface to the C2 network

Within a simulation environment the C2 system will typically receive simulation data through a gateway. The simulation to C2 gateway can either track and map run-time simulation data directly to the C2 database and/or stimulate the C2 system sensor interfaces.

Important characteristics of the simulation to C2 gateway are interoperability standards and flexibility.

The simulation to C2 gateway must connect to the simulation network using standard simulation protocol like DIS and HLA. Thus, the gateway must be simulator independent and having the distributed nature to be used where the C2 systems is placed. In the same way the gateway must support standard C2 protocols for interoperability into the C2 world. And finally the gateway must have configurable mapping rules from the simulation to C2 domain and allow for flexible setup of data to be tracked, like e.g. entity types, organizational levels, geographical regions etc.

As an example IFAD and Systematic has provided a simulation to C2 gateway to the Danish Army based on IFAD's DIS/HLA simulator interface and Systematic SitaWare. This solution provides a PC based simulation to C2 gateway as a standard COTS solution.

The gateway is based on configurable mapping rules from DIS enumerations to MIL STD 2525B objects in the SitaWare C2 Database. This concept allows to the use the gateway with various legacy simulators and either use SitaWare Tactical Communication (STC) to exchange data among HQs or use SitaWare as a simulation to C2 gateway via e.g. MIP.

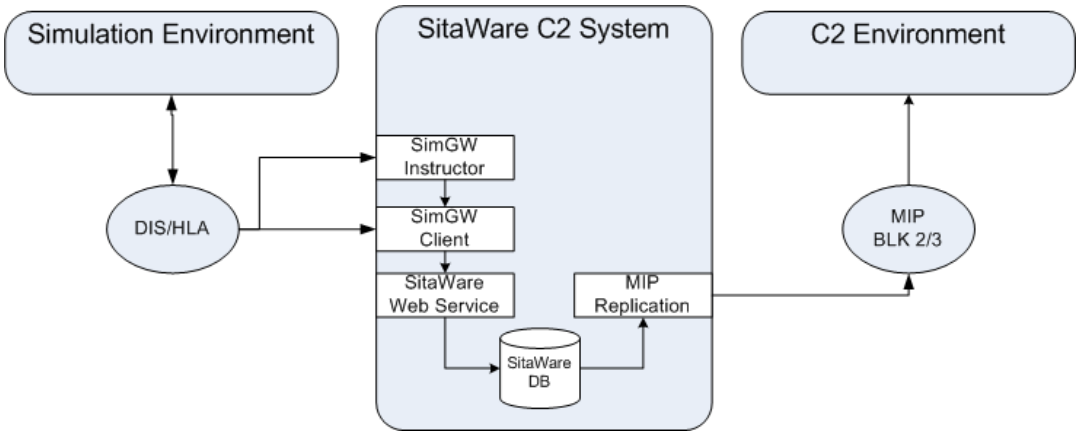

Figure 4, An example SitwWare SimGW based simulation to C2 gateway via MIP.

The Danish Army uses the generic SitaWare C2 gateway for automated tracking of simulated entities. The gateway is used from high level JCATS staff exercises with 40.000+ simulated entities down to Steel Beasts based tactical platoon level tactical exercises with 50+ entities.

C2 network

When coupling the simulation and C2 networks together it is important to make sure information from simulation has the right addressing information to be entered at right organization. Therefore naming conventions between the systems are important. If this happens the overall C2 network will automatically replicate or send to partners and other units with whom there is an information sharing agreement with. The filtering and distribution of information is essential for this network.

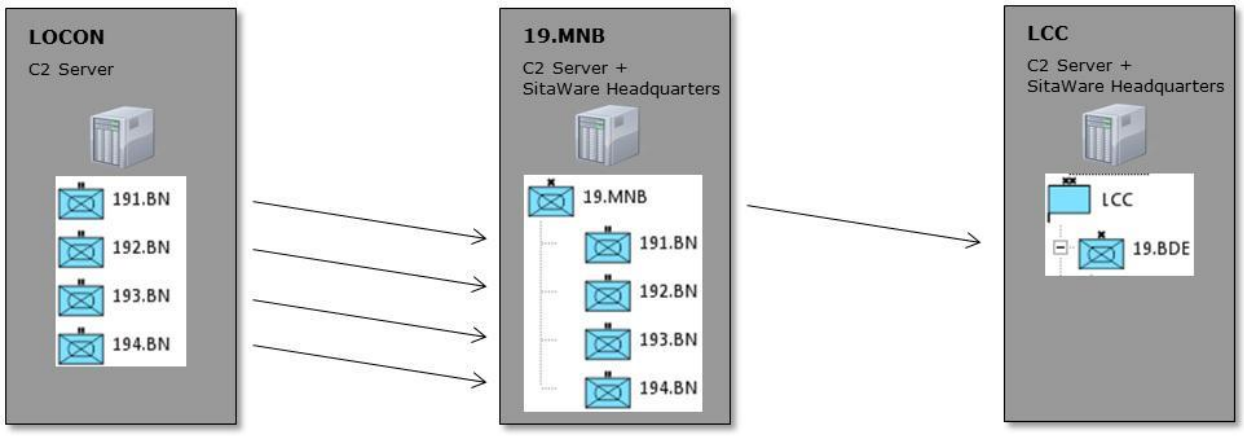

Figure 5, Distribution and insertion of information received from simulation system

Typically blue force tracking will be the most relevant and important information to be received, but also sensor tracking of opposing forces' units can be handled, and is realistic to automatically receive (red force tracking). In the C2 system distribution of information happens independently from simulation. This can be using numerous formats such as MIP DEM, AdatP-3, NFFI, Link 16 or proprietary formats.
As a result from a good reception from simulation, the C2 world (trained audience) will observe and can react on very realistic input. Ultimately information can also go the other way, so that plans prepared in C2 can be transferred as C-BML orders to simulation network and response can be automatically generated.

EXAMPLES FROM EXERCISES

The past years Systematic and IFAD together with industry partners (Pitch, BAE Systems, MASA and others) and military forces in Denmark and Sweden have implemented different variants of simple and efficient solutions to support quite large exercises, and we have gained a number of experiences.

CWIX 2012

During CWIX 2012, the Danish Navy simulator (IFAD Naval Tactical Simulator with Terma C-Flex as Link16 gateway) provided maritime tracks (Recognized Maritime Picture) in DIS, AIS and Link16 formats to the exercise network. These tracks were received in Simple J format by SitaWare Track server and from here send to SitaWare Headquarters database. SitaWare is then able to replicate the data through JC3IEDM MIP DEM to coalition partners. We experienced that the Simple J format was not ideal, so in the future JREAP will be used when transmitting Link 16 data in the system. CWIX will be an excellent environment to bring in other simulators and evaluate large scale combined simulation and C2 networks.

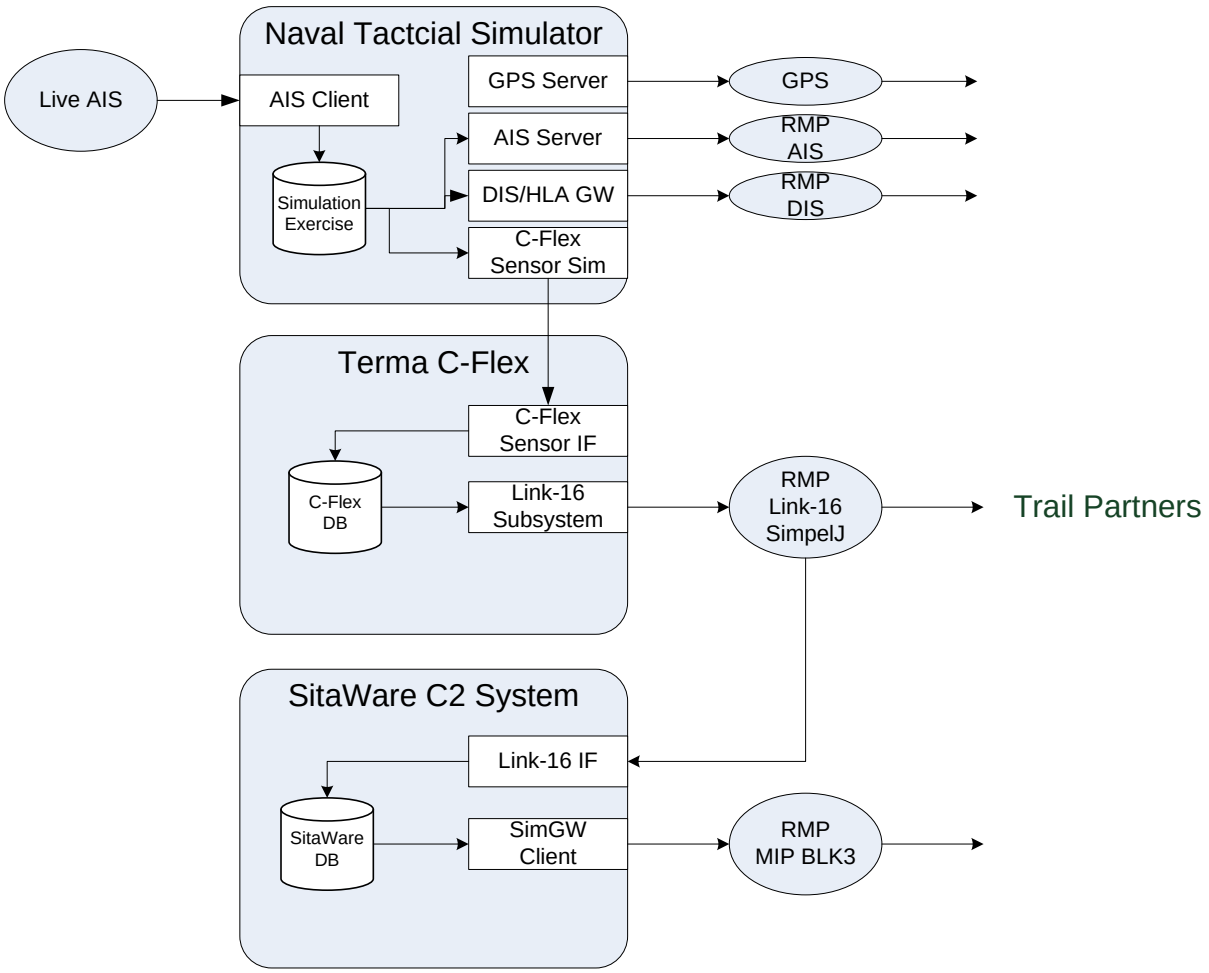

Figure 6, Simulation to C2 example from CWIX 2012 enabling the simulated maritime picture to be shared among joint coalition partners using MIP

Combined Joint Staff Exercise 2012

During exercise Viking 2011 a complex setup of numerous simulation and C2 systems were coupled, and situational pictured could be shared among a large number of users at several, geographically separated sites (3 Swedish sites, Georgia, Ukraine, Ireland, Germany). It was proven that simulated data produced in Sweden could be distributed using the C2 network. Viking Exercise setup became the basis for this years Combined Joint Staff Exercise in Sweden. For this exercise a special instance of the Swedish C2 framework, SWECCIS, was used, but the whole C2 integration from Viking was reused. The scenario in both exercises was a mixed military and humanitarian operation. The participating systems handled this complexity, and the exercise at the same time proved the value of SWECCIS to share information in the C2 World. The link from BAE Systems TYR to SWECCIS (SitaWare) is depicted in Figure 5. Furthermore Air Tracks from ICC Flames were received in Link 16 Simple J format and shown in SWECCIS (Sitaware Track Server) giving the trained audience both the air picture and land picture in a Joint COP.

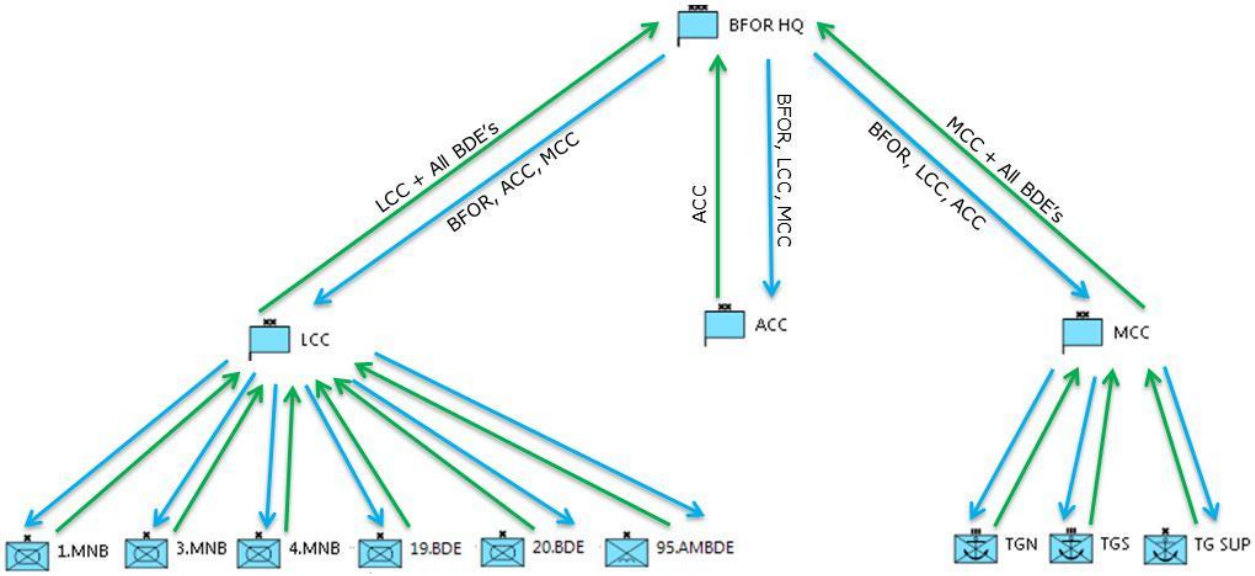

Figure 7, The information sharing in SitaWare during CJSE 2012

Danish Army Tactical Trainer

During several years Royal Danish Defence College together with other military educational institutions has run a large staff exercise in the Danish Army Tactical Trainer in Oksbøl. Initially this has been done using input from JCATS, which by a swivel chair interface was entered into the C2 applications or reported by radios or radio simulators from LOCON to trained audience. Since 2010 Systematic Sitaware was used as the C2 application for planning and execution of the operations in the staffs. The trained audience is usually a division staff and 3-4 brigade staffs. During the exercise in 2012, IFAD developed a DIS based interface allowing Friendly Force Tracking information to pass directly from JCATS to SitaWare, thus giving the simulated GPS position of own troops. The LOCON staff would then typically manually aggregate the input into their Battallion layers in Sitaware, and this information was then shared with superior staffs.

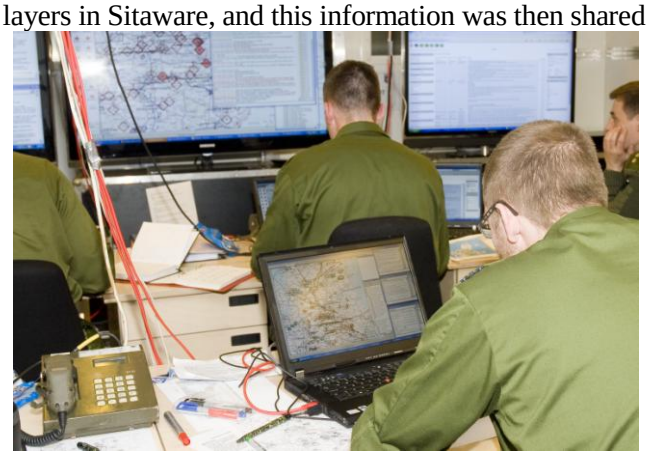

Figure 8, Students working with SitaWare during staff exercise in Denmark.

Some of the experiences from these exercises have been the number of LOCON's needed with JCATS skills to give input to the trained audience. It is approximately 1:1. Even though also LOCON learn from these exercises it is expensive to bring the personnel to the same physical location and only be able to engage half of the participants as main trained audience. Therefore this exercise will not take place in 2013. The Royal Danish Defence College is looking for more optimal ways of running such exercises. One way could be to have LOCON positioned at their home garrison and also to introduce simulators with

less need for operator training and also with significantly more automated input.

GAINED VALUE AND PERSPECTIVES

Through small steps and validations, we have – together with operational users and other industry partners – during the past years delivered C2 applications and additional training systems to the armed forces in Denmark and Sweden. Our experience is that this is a very fruitful way ahead, where operational and training experiences gradually are combined with technical achievements and it is tested during exercises and demonstrations – not using all capabilities from day one, but rather testing a subset. This has given confidence among users, and we are today in dialogue with Danish Defence concerning a further integration of systems in Denmark using technologies like the Pitch HLA based Booster network and others. The available standards such as MIP, link 16 (JREAP), AdatP-3 in the C2 environment and HLA and DIS in the simulation environment has proven to be a good basis for our work. C-BML is a standard not covered by this article, but it is in depth covered by the next presentation and article (9).

We see that the multitudes of C2 and simulation applications available are mostly open to interconnect, if they apply to the mentioned standards. Because the unavoidable different implementations of the standards, a comprehensive test effort is necessary before bringing the integrated product to the end-user community. CWIX is an ideal environment to do such test. Even though CWIX traditionally has been a forum for C2 applications and interoperability between those, a well defined exercise scenario, and simulated input would be valuable.

To continue this path, there is a need for nations to provide national networks with the appropriate security level, and to connect these to NATO, EU or other international organisations' infrastructure like in the NETN. It is important to have in mind that the national C2 systems very often are in another security domain than the training systems. A way around this could be – like in Sweden and Denmark – to deploy a similar C2-system as the operational one in the training environment, and accept the possible artificialities it could bring in. Once the network is established, the C2 and initial training systems can be connected, and the necessary basic data entered together with the initial scenarios. From the first simple Blue Force Tracking information entering the scene, the way ahead lies open.

It is obvious with the experiences gained until now and throughout the next few years, large scale training networks will become both affordable and interconnectable, and we look forward to follow the development