Leverage the Training Effect in Staff Training by Automated Reporting

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ABSTRACT

This paper describes a concept and initial experiments regarding modelling and simulation as a service (MSaaS) for semi-automatic production of reports in computer assisted command post exercises (CAX).

Timely and accurate information is a critical resource in decision-making. In a wartime situation information is provided to a military staff by its subordinates. In training and mission rehearsal situations, real subordinates are often not present. The lower command is acted by a small group of personnel, whose major role, in a training situation, is to create the human to human interaction with the superior command in the staff. Adequate tools for supporting this staff is crucial, since high workload and competency requirements set constraints on the amount of information objects as well as quality of the products produced, in this case produced reports. Computerized systems play an important role to fulfill this need.

The aim has been to develop a tool for report generation as a service, independent of what simulation system used, in a way that the tool can generate reliable and believable textual reports as if they were produced by a human-manned staff, both in terms of their quality and quantity. Today several services, such as simulation systems for computer generated forces, are networked together in an information sharing federation. The prototype for the report generation service uses information from the federation and produces textual reports about the situations and activities in the simulated environment. These reports are expressed using standard formats and are to be automatically fed into the command and control system used by the trained staff.

Initial experiments at a staff exercise demonstrate validity and usefulness of the concept. The paper discusses methodological and technical requirements, such as information needed, additional federated services, and requirements on simulation systems, and points out important issues for further investigation.

ABOUT THE AUTHORS

Peter Hammar (PhD) is a scientist and project manager at Swedish Defence Research Agency. He has a MSc in Engineering Physics and a PhD in Theoretical Chemistry, both from Royal Institute of Technology, Stockholm, Sweden. His expertise lies in the field of modelling and simulation as well as decision support systems development. The focus of his work has been mainly on game-based training for both soldier and command level, regarding development of methods as well as simulation systems. Over the past 7 years he has been supporting the Swedish Joint Training Centre at the Swedish Armed Forces with development and evaluation of technical solutions for command post exercises. Recent research interests also includes exploring how computers can produce results resembling human creativity, and exploiting such techniques in enhancing decision support systems or training simulators, which is also a driving force behind the project presented in the present study.

Peter J. Lindskog (CPT) is a technical officer with the Swedish Armed Forces, stationed at the Command and Control Regiment in Enköping, Sweden. His main duty is to develop systems for computer assisted exercises (CAX) in the Armed Forces. He has been in service for 34 years and has experiences in many of the army services in the Swedish Armed Forces. He is primarily concerned with the future development of computer aided exercises, centered on one question: how to develop and adopt technical systems to improve the training effectiveness and particularly decision making skills in staff exercises. One of the challenges CPT Lindskog is trying to resolve is to reduce the amount of personnel in the training organization, such as the ones acting as lower command, and still feed the trained staff with the right information at the right time.

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INTRODUCTION

Timely and accurate information is a critical resource in all decision-making, especially critical in a war situation. A main source of information to a military staff is reports from its subordinates. In command post exercises (CPX) for training and mission rehearsal of commanding staffs, all subordinate personnel are not present. An exercise control staff is acting as qualified subordinates, or higher command. As such their tasks require military profession and include planning and execution of military activities as well as to create the human to human interaction with the superior command in the trained staff. Typically, a few persons form a response cell (RC) acting as a whole staff with all of its sections and functions.

Motivation

The response cells' high workload and the competency requirements set constraints on the amount and quality of produced intelligence reports. Command post exercises at the Swedish Armed Forces' Joint Training Centre, are facing the challenge to satisfy the information requirements from the trained staff (training audience, TA) to supply a large quantity of qualitative reports. This might result in a lack of information supply for some or all staff functions, with the consequence that training objectives (TO) cannot be met. If the challenge is not met, this might lead to negative training since the training audience learn a way of working with low quantities of information and non-realistic reports.

Information Flow in Command Post Exercises – Current Practice

The ultimate task of the response cells is to stage a realistic environment for the training and to provide means to influence the training audience in order to reach training objectives. The response cell has to act as a competent subordinated commander as well as act like a fully manned staff to role play every staff function. The response cell has to maintain a number of the ordinary staff processes, whereas other tasks with advantage can be automated reducing the workload of the RC personnel. In a computer assisted exercise (CAX), the troops on the ground are substituted with units in a simulation system.

The response cell work can be summarized as following. When the trained staff has formulated an order, it is sent to the response cell for implementation. The response cell has to reformulate the commander's intent to the RC's subordinates, i.e. to formulate instructions to the simulation system(s), but also take into account previous effects in the simulation systems and possible factors driving the game towards the training objectives. The simulation systems determine the effects of the given orders, driven also by the plan and operations of the opposing force. Each response cell has one or several simulator operators to input orders in the system and communicate the results and events happening in the simulation back to the rest of the RC staff. The commander of the response cell determines whether this information is necessary to act upon and in what way. Some of the activities are of high interest for the higher command (i.e. the training audience) to know at once, such as detected enemies, accidents and other relevant incidents. This information is sent to the higher command in special reports, such as event reports (EVENTREP), situation reports (SITREP) or intelligence reports (INTREP). The trained staff will also require periodic summarization own units' status and accomplished tasks as well as a summary description of enemy status and assessed course of action. This information will be sent in periodic reports, typically every 12 or 24 hours. Examples of such reports are logistics assessment (LOGASSESREP), intelligence summary (INTSUM) and situation summary (SITSUM).

Gathering the information necessary as well as drafting the actual reports, both for special and periodic reports, take up a significant amount of time and effort for the RC staff. The information is collected from several systems, requiring for the staff member both a general IT competence and dedicated training in the specific systems used in the exercise. Apart from the training audience command and control (C2) systems and possibly multiple simulation systems, there

are also exercise internal gaming control systems. Figure 1 summarizes staff work information flow as well as the general setup of the IT support systems. At the same time knowing what to report (and what not to report) and how to express it requires a high degree of military competence and experience on the command level of the response cell. In addition to this, the RC work including the reporting, has to be adjusted to match exercise goals, training objectives, suit the exercise game plan and create an effect within the trained staff to maximize their training. It is a challenge to find enough experienced military staff to fulfill response cell needs in command post exercises, and economy and manning issues constrain the number of system specialists that can be employed or trained to assist the military commanders and function experts.
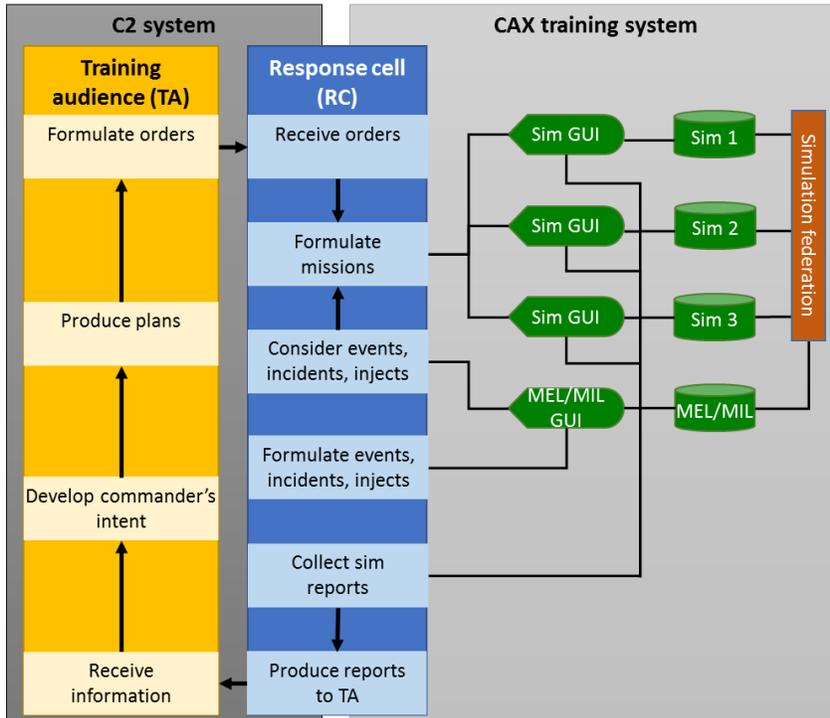
Figure 1. Current practice, with several CAX support systems. The response cell communicates with the training audience using their command and control system. The response cell manually draft reports to the training audience based on the information provided from multiple simulation systems, each with their own sensor reports and own graphical user interface. A MEL/MIL (main event list/main incident list) system is used to control the game towards training objectives.

Automated Report Generation Service to Support the Response Cell

This paper focuses on alleviating the reporting work in the response cells by introducing an automatic service that aids the collection of information as well as drafting the textual reports. A simulator independent report generation service would offer a high degree of automation and a new functionality to increase the gaming organization's efficiency in delivering information. It would also stress the information domain by delivering a high flow of information, with high realism regarding both when and how often reports are sent as well as regarding information content. Furthermore, reports would be formulated in a realistic and credible way. The use case focuses on the process of going from events in the simulation systems to a ready-to-send intelligence report. Instead of the manual process with a simulator operator interacting with possibly multiple simulation systems and convincing a staff member to start drafting a report, the response cell will be alerted when these events occur and a first draft of a report will be generated by the machine. The quality of the automatically generated report should be high enough for the report to be sent to the training audience with none or minimal editing. However, the response cell may wish to alter the message or delay or
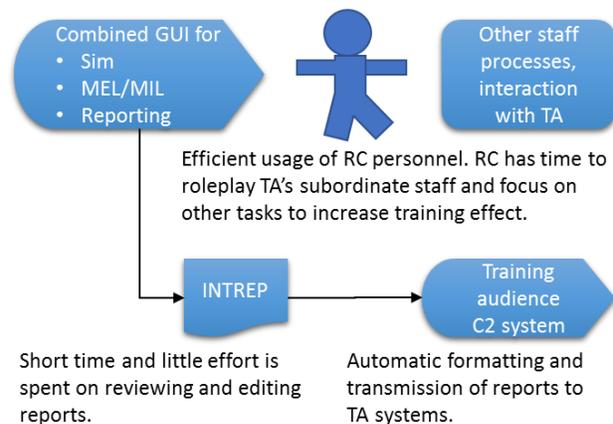
Figure 2. Use case. Envisioned RC mode of operation with the aid of a report generation service.

discard sending it to better support the training objectives. Further, the tool aims at decreasing the workload for the response cell staff so they can focus on qualified tasks instead (see Figure 2).

METHOD

Method of Investigation

Issues addressed in this paper partially concerns system development and partially concerns exercise organization and method development. Hence, the approach to address the system's and organization's maturing was a prototype driven development in close collaboration with different stakeholders. The work, including the modelling of a framework for a report generation service, requirements for the information needed for specific reports, and to design a working prototype to be used, evaluated and elaborated during a live exercises, has been iterative, explorative and user centered (Preece et al., 2002). Stakeholders include the staff in response cells, i.e. the military professionals that create reports that will give training to training audience, which have described their context and been part of the report service testing, as well as system owners and exercise managers, which have taken part in the prototype development process.

Requirements have been collected predominantly during command post exercises. During these events personnel with insight into the challenges are gathered together, thus providing access to this expertise. Hence, a combination of the prototype driven development on the technical and content aspects of the service, with the user centered approach focusing on investigating aspects of efficiency in RC exercise operation and methodology, was successful in that the two approaches inform one another. The prototype manifest technological possibilities regarding content and efficiency that the users can give feedback on, and the feedback is then digested to new prototype design decisions that in turn can invoke new aspects of usage to consider.

Current Simulation Systems Environment

The current training facility at Swedish Armed Forces' Joint Training Centre provides several CAX support tools for the gaming organization. The CAX systems are interconnected on a federation using high level architecture (HLA; IEEE 1516-2010, 2010). The federation and the simulators are designed and adapted to suit the training objectives and thus several simulators can be used to represent all domains in the scenario. The war gaming system for joint operations, CATS TYR, is used for land and maritime activities. This system has an internal model for discovery of enemy units that notifies the simulation operator of the observation by sending an alert to the simulation system user interface. The simulation view is automatically fed to the training audience into map layers in the command and control system (SitaWare). Perceived truth (as should be updated by subordinate units, i.e. the RCs) is managed by transferring observations of enemy (aggregated) units from the simulation to the C2 system using an additional simulation system specific component, specially developed for this task (SITCOM). The tailored SimC2 FOM is used for this information exchange on the federation. Location of own units are replicated to emulate a blue force tracking mechanism, and the positions of own (aggregated) units are fed into the training audience's C2 systems using NETNAggDeagg FOM real time updates.

Prototype Development, Technical Setup and Implementation

The prototype, developed in Java 8, was run in a federation together with the simulation systems. The architectural design of the prototype is divided into three main components, a *Report Generator*, a *Reporting Service* and a *Knowledge Base (KB)* (see also Figure 4). The main task of the Report Generator is to transform a HLA raw data package into a textual report, including computational techniques to reach "human level" realism and relevance. The reports are based on information from the simulation system, gathered by listening to HLA observation messages. During the exercises the SimC2 messages (as mentioned above) constitute the only information from the federation that is fed into the report generation service. Additional information is needed for the textual reports, and any such information is retrieved from the Knowledge Base where the information is stored and managed. Additional data sources were compiled by hand and imported from file into internal object classes, emulating a more competent KB as elaborated in the discussion. The Reporting Service handles the routing of reports to the right receiver, the response cells, as well as providing a user interface or any post processing services such as format selection.

The prototype handles special reports corresponding to events in the simulation. The flow of processing occurs as follows. A sensor model is triggered in a simulation system. The system publishes this as an observation message on the HLA federation. The Report Generator receives the message and determines whether this should be reported immediately, stored for inclusion in a later report, or not reported at all. (Areas and units to be covered by automatic reporting is configured pre-exercise.) If an event should be reported, the Report Generator creates or selects a general

layout of how to present the observation. The message texts are built using a base of paragraph level patterns of textual expression that are selected and put together depending on the topic of the report. Variations to each sub-pattern (paragraph scaffold) exist, and additional variation of wording is inserted. This text generation could possibly be done by more refined techniques (Paris et al., 2013; Kybartas and Bidarra, 2016). Depending on the types of entities observed and the information available, the harvested and gathered information is selected, processed and fed into the textual scaffold. The prototype employs an auxiliary HLA federate that transforms the aggregate-level observation to entity level information. The message is passed on to the Reporting Service module that determines the route of delivery, i.e. what RC shall overlook or further process the message (Figure 3).

Live Testing and Evaluation
To test the prototype's functionalities and evaluate the report service with users, the prototype was technically implemented in a two week live computer assisted exercise, Combined Joint Staff Exercise CJSE17. The prototype was running in the training system with constructive simulations. It was possible for RC staff to find the auto-generated reports in a dedicated storage space in the training system, though there was for the specific occasion no developed method to receive them in a graphical user interface. To assure that both the prototype testing and the evaluation was attended to, two researchers was present; one focusing on the prototype's functionality, backing up on any technical problems and implementing features, and the other focusing on the end users, through interviews with experienced staff and observations, inquiring needs and opinions and collecting requirements for further development.

RESULTS

The focus of this work has been on demonstrating the feasibility to create a report generation service, including production of human-level reports, and to understand the challenges and requirements associated with such a service. Requirements are of several types, methodological as well as technical. One perspective is what information is required to realize a report generation service, such information requirements are for clarity enumerated (by roman numbers) below. The following sub-sections summarize the experiences, both from users and the technical development.

Report Handling
The information needed to write reports is not easily accessible for the RC staff and several persons are engaged in the report procedure. To be more efficient, the RC staff would want to be notified that there is a report on an event. During the prototype testing, for every event and observation in the simulation system there was a report generated by the Report Generator. Consequently, there are many reports, some of which are relevant for the training goals and some that give no value, neither content wise nor quality wise, for human observers only a subset of all observations are normally reported to higher command. It would be efficient if the training management could set parameters for the report generation, e.g. the number of generated reports, the amount of information in different reports, and what observations that should be bundled into one report. Generated reports have to be logged so that training management can review and to assure traceability in the game, i.e. to see what reports or amount of reports triggered training audience to make a certain decision. If auto-generated reports were created with relation to training goals, it would provide means for tracing training performance. There is also a need for (i) defining reporting routes, i.e. which report (from what simulated unit) goes to which RC.

Report Type, Content and Information Requirements
There are different types of reports; regular periodical reports that are sent a certain time every day, e.g. summary reports, and irregular reports that report on a specific event or observation. The regular reports could use information

[Formatted and filled in meta data according to APP-11, for example "From: 53.MOTBN" "To: 5.MBN"]

Subject Description
Observation IVO Klintehamn.

At DTG 261747 a few persons were spotted at MGRS 34VCJ 31852 63439 close to Klintehamn. The people were marching west at low speed. Signs of Midan appearance.

Subject Assessment
It is probable that the observed people are a combat support military police. The unit probably belongs to the Midan National Front.

Figure 3. Example of output from the report generation service during Swedish Exercise CJSE17. The assessment is taken with some probability from the APP-06 symbol code that is specified in the SimC2 message. (Mida is a faction of irregular forces in the scenario.)

from the training simulation systems, inserted in a correct report template and sent "as is". That would require a Reporting Service interface supporting the RC staff to see the flow of reports. (Technical challenges for transforming such information to a report was not investigated.) Irregular reports would require the possibility for RC staff to edit: in relation to training goals and to what is happening in the scenario, the RC staff will create a report with deliberate insightful analysis and sometimes misinformation, using their military and exercise proficiency. To be able to give training audience relevant reports with the right content and right level of detail, human language is necessary. Irregular reports are dependent of the training goals, the game intensity and the "human touch". Although a simulation system can provide information of what has been observed, there are generally no information of how to describe if the observation was visually or auditory without the full or perfect knowledge of what had actually been observed. To be able to produce reports in a way that they could be judged as written by a human, including both a rich expressiveness regarding the content and regarding wording, additional information requirements have been noted. In case a report could also include citations of civilians reporting, both military language and ways of expressing observed military equipment and activity in layman's language would be necessary, i.e. adaptive semantics. In the prototype developed all observations are assumed to be done by military personnel. Text generation systems need to be complimented with (ii) military jargon and e.g. abbreviations used in military terminology.

Available Data on the Federation
There must be a trigger in the simulation system when an observation is being made, i.e. a sensor model, that publishes the observations on the federation. The simulation system used models observations on the unit level: a unit observes the whole of another unit, thus being aware of all contents of the other unit (where the unit's content, platforms, personnel, weapons etc. do not have any geographic extension). A SimC2 HLA message is published each time a unit's sensor model is triggered, including some of the information needed for the report generation: (iii) observation time, (iv) ID of observing unit, (v) ID of observed unit, (vi) position of observed unit, (vii) speed of observed unit, (viii) orientation (direction) of observed unit, (ix) faction and affiliation of observed unit. Furthermore, other information existent in the simulation system(s) would be of great importance to make reasonable conclusions regarding the observed unit. Those are the unit's (x) current activity and the (xi) orders that have been given to the unit. This information is available in NETN Aggregate FOM. SimC2 is not a NATO standard FOM such as the NETN Aggregate FOM.

Multiple Observation of the Same Unit
With the employed simulation system-specific model for discovery of enemy units, one HLA message is sent for every simulation entity (aggregated unit) discovered by every observing unit. If several enemy units are acting together, or several own units are working in the same area, this results in several HLA messages being sent all pertaining to the same event. The RC staff needs to fuse reports from the subordinate units in the simulation to one observation. Furthermore, the RC staff work would include selecting what to report, and summarize several related events into one report sent to higher command. This information fusion and summarization needs to be emulated by the report generation service.

Entity Resolution
In the constructive simulation any observation is on a unit level, whereas a real observation can only be of the platforms, personnel, weapon systems etc. The training audience is on a high level in the chain of command, thus expecting any reports on (assessed) enemy unit rather than the actual entities being observed. However, such a report does most often refer to the entity observations the report is built on ("Five BTR-60 observed… likely belonging to The Enemy's 5:th battalion."). A platform simulator would observe single platforms. In a federation of constructive simulation systems the same result could be achieved by employing a service that de-aggregates units into platforms. To mimic such a service the prototype implements in a very primitive way a random selection of a subset of the contents of the aggregated unit. In order to realize this, holdings information (all observable platforms, equipment and personnel within the units) is required. In the prototype this is provided from the initialization data of the simulation systems, but a de-aggregation service would need (xii) updated holdings information as the simulation progresses.

Entity Description: Platforms, Insignia, Call Sign and Organizational Habitat
An observer could have, by various sensors (sight, hearing, or by technical system), spotted a vehicle. Visually a troop-transport vehicle with some extra antennas on could have been seen, or a heavy tracked vehicle could have been heard without actually being seen. To count for this, there needs to be (xiii) a detailed description of all platforms and equipment. If dismounted personnel are of significance in the scenario, a visual description of these is also required. (In case of peace keeping missions or hybrid warfare this could for example be descriptions of what kind of people

participates in demonstrations.) It is advisable to have (xiv) an ontology (hierarchy, in addition to the descriptions) of platforms and equipment, to easily access information as to summarize different facts (BTRs and T-72s could collectively be called "armored vehicles"). Sighting a vehicle, markings could have been observed such as emblems or letter codes, but the person behind the eyes might not know what those symbols represent. Such information could be added by the information element within the staff sending the report ("a three-letter code, *probably an infantry battalion* [from The Enemy]"). To grasp this in the textual messages, (xv) a description of symbols and markings of factions within the scenario, as well as subsections of each faction (such as special symbols for a function unit) are required. In order to give a human touch to messages, any description of both faction description and description of platforms are helpful.

When making an assessment of enemy affiliation and what enemy unit the observed unit belongs to, (xvi) knowledge of the order of battle (ORBAT; as an intelligence officer would have) is required. As such the Report Generator could judge a reported unit (given the exact unit designator from the simulation system) as "a mechanized battalion" or "a unit within The Enemy's 5:th Brigade". The ORBAT information also should contain (xvi, contd.) alternative names of units, for example a drafter might use abbreviations or not, or radio call signs for own units could be used. This should also include the size of the units. Naming also includes labels of the training audience organization that receives the reports.

Scenario Geographical Details

In addition to information pertaining to entities in the simulation, there is a need for general information and facts regarding the scenario and context of the military conflict. In the prototype development and testing the most obvious information has been geographical. The simulation system gives coordinates of the observation as well as direction (degrees) if the unit is moving. If activity and orders were available from the simulation system, these might contain break points for routes or coordinates of future destinations (and what the unit is supposed to do there). In order to make a reasonable report, (xvii) additional GIS data is however required, named entities such as name of closest town ("in vicinity of [town] Uppsala", "approx. 4 miles from Uppsala"), names of roads ("heading south on Road 276"). Even if information about current and future activity of a simulated unit is given, a comprehensive assessment need to speculate on different options of enemy CoA, or give the ability to assess something different than the truth. Such a functionality would require (xviii) algorithms to calculate destinations of roads ("heading towards [town] Gävle"), and information regarding important infrastructure ("heading south … likely to attack [airport] Arlanda").

Figure 4. Proposed technical solution given the experiences from the tests. Report history service: store all reports produced on the federation and act as a common storage service for all uses (including the Report Generator's need of sent reports and Reporting Service needs). Multiple simulation systems have different and possibly non-coherent sensor models. A shared sensor model can supply everyone's needs. KB (Knowledge Base) supplies information needed, RG (Report Generator) produces drafts for reports and RS (Reporting Service) permits user interactivity, editing and sending the reports to the trained staff. The figure also suggests possible FOMs to use (NETN, CBML), where SimC2NY represent an unmet need for sensor-to-report information.

DISCUSSION

The prototype development and experimentation has expressed a number of technical and methodological challenges and considerations, which are discuss in this section.

Other or Additional Uses

Although the report generation service is developed to aid reporting in command post exercises, we envision that it can be used in other contexts as well. An example is to set up intelligence officer training based on a simulation with a fully automated report generation service.

It is also worth noticing that an automated logged report production can be used as a source for evaluating training audience's staff processes, possibly as a source to follow the exercise towards training objectives, and as a source for after action review (AAR). This could be done based on the reports produced, or, using the information already provided in the report generation, implementing additional functionality for tracking certain aspects of the game. This might need, or be helped by, tagging events or reports to specific training objective or other tagging.

Methodological Considerations

Problems Regarding Report Handling

How can the report handling process be design so that it actually lowers the burden of the RC personnel? Method for usage and the development must go hand in hand, since the RC staff procedures and requirements on reporting set constraints and requirements on a technical report service. A greater understanding is needed to develop a useful service, particularly since the service aims to ease the burden, not to provide yet another technical system. This also since the reporting influences both the RC internal work and the interface to TA, as well as a possibility to track the game.

Regarding Reporting Service, this needs to create an overview of the chain of events in order for the generated messages to be understood in their context in the RC, thus providing the aid the RC personnel need in their work. Further investigations into the handling of reports and reporting is required. The Reporting Service would likely need a graphical user interface permitting the user (RC) to display, edit, manually search and view previous messages, as well as controls for sending reports to TA. One specific outstanding questing is how best to notify the RC of a new report. The goal to start the process by internal triggers in order to generate periodic reports, has not been studied in the work described in this paper.

Organization and Method Challenges

The inclusion of a report generation service in an exercise does not alter the exercise control or gaming organization, the work processes in the RCs will generally remain intact. However, there is a potential that a report generation service can reduce the amount of people required in a response cell to produce the same effect, and furthermore affect the required competency among the RC staff. Although alleviating some of the burden of work from the response cells, introduction of an automated service will likely require more work pre-exercise, by specifying the data needed by the service. It may also incur additional overhead for technical maintenance.

Scripted vs. Dynamic Exercises

The progress of the game in computer assisted exercises can be dynamic, i.e. the events and effects in the simulation system completely determine the unfoldment of the conflict, or scripted, where a pre-defined script determines how the conflict develops, possibly overruling the simulation system in order to assure that certain training objectives will be met. The level of scripting or dynamics in an exercise affect the possibility for automation. In a scripted exercise, there is a need to control the information flow to the training audience in order to make sure the script is followed, whereas in a dynamic exercise there is no such need, thus providing an opportunity to fully automate tasks such as reporting. Further investigation is required to verify to what degree the reporting process can be automated.

Level of Processing

Depending on standard operating procedures and staff level or experience, there could be settings for different levels of staff processing and amount of reports. In some cases simulation events may be sent as event reports only specifying

the actual observables, whereas in other cases the events may be merged and augmented with assessments and additional comments.

It is worth considering how this type of settings are configured (for example if a response cell can themselves change the setting), since the amount and content of reports will affect the ability to trace the flow and use the information to follow the trained staff's work towards training objectives, or for example to use the reports for AAR.

Systems Level and Service Level Considerations

Report Formats
The proposed system enables automation from simulation systems to training audience's C2 systems, independent of what simulation systems or C2 systems are used (provided these do implement certain interfaces). In the use case considered in this paper, this would include that once the text message is produced, and possibly altered by the RC, the message needs to be packaged into the current format used by the training audience. In exercises at the Swedish Joint Training Center these include formats from the APP-11 (NATO NSO, 2015) message catalogue (or Swedish adoptions of these). Message delivery would furthermore need transmission formatting such as ADatP-3, which makes the messages possible to machine process for example by C2 systems. In case of the prototype, the current output consists of an APP-11 consistent text file, which needs manual processing to be entered into the training audience systems. Transmitting information from the exercise systems to training audience systems is potentially an issue that requires attention from a networking and information security perspective. ADatP-3 formatting is not investigated with the current prototype implementation.

Modelling and Simulation as a Service – MSaaS
We believe an important feature of future modelling and simulation (M&S) development (to reach training systems effectiveness) is solutions built on smaller components, and several components interacting to provide the final system solution. This is in line with the Modelling and Simulation as a Service (MSaaS) initiative run by NATO NMSG 131 and 136 (NATO Modelling and Simulation Group) (NATO STO, 2015). As discussed below this implies a report generation service that is independent of any particular simulation system and that can provide a consistent and reliable reporting despite a scenario that is distributed on several simulation systems. The major goals with MSaaS are (1) to provide a framework that enables credible and effective M&S services, (2) to make M&S services available on-demand to many users, (3) to make M&S services available in an efficient and cost-effective way and (4) to provide the required level of agility to enable convenient and rapid integration of capabilities.

Going from monolith systems to a federated solution with several interacting services introduces however challenges, such as, how an automated system or federation of systems can be supervised and controlled, how connectivity and information exchange between all systems on the federation can be realized and how to ensure and verify the quality in a federation with several participating systems. These challenges have not yet been addressed.

Service Requirements and Information Requirements
Humans have a huge amount of background information to be used when communicating with each other, this information must be supplied to a computerized system. As such, and to create a vendor/system independent solution, some requirements for additional services are noted. We propose that these should to some extent be realized as separate services (MSaaS) thus enabling sharing of this information among several future consumers.

An example of such services is a GIS service including a route planner that can be used by simulation systems as well as for intelligence assessment for reporting. Another example is an MSDL (military scenario definition language) federate that can initiate and keep updated simulation systems as well as a reporting function regarding order of battle, for example when a change in command occurs during the exercise.

A sensor model that triggers the report generation is vital. It is advisable that such a model should be simulation system independent, and the sensor model could be implemented as a separate service in the HLA federation. As such it can listen on the entity updates and republish discoveries or other events using an appropriate message (for example a development of the SimC2 message).

Using aggregate level simulation systems, it is recommendable to have a separate component/service that handles the de-aggregation to observable entities (platforms, equipment, personnel, etc.). However, such a service would need

models of unit formations and sensors, in order to make reasonable estimates of what platforms are actually observed. Since a constructive simulation in general does not have a way to remember what parts of a unit that has previously been observed, a de-aggregation service would need to keep a record of this for itself so that consecutive observations can be kept consistent.

There is a need to store reports, for several reasons. The text generation service needs knowledge of previous reports in order to refer to these, not to report same thing twice etc, and the Reporting Service needs means of displaying reports to the user.

Furthermore, as listed in the results section, there is a need for a number of information items to be available in order to realize the text generation. Some of this information might have future use elsewhere, thus suggesting packaging this into a Knowledge Base service separate from the report generation. Dividing apart the information storage could also make information update and assurance easier. Implementing a Knowledge Base as an MSaaS component, there is a need to further investigate how communication is best achieved between such a distributed knowledge service and a report generation module. The requirements of extra (as compared to the simulation systems only) data introduces challenges on how to provide and verify the quality of this information before an exercise. Some of the information will have a long life span (such as platform descriptions) that can be carried over from one exercise to the next, whereas other information is exercise scenario dependent and needs updates before every exercise.

Apart from scenario data, there is also the need to supply configuration data, for example of periodicity of reporting and level of summarization or aggregation of information into each report. To handle real time changes in task organization even roles may need to be reconfigured.

Information Fusion

Information fusion is the process of integrating multiple data sources to produce more consistent, accurate, and useful information than that provided by any individual data source. This is an active field of research to provide techniques for intelligence work and automated C2 functionality (for non-exercise applications).(Ahlberg et al, 2007, Hall et al, 2008, Llinas et al, 2004). The processes aimed to be aided by the report generation service introduced in this paper do in principle share the same need, and as such do need to leverage information fusion research. I the setting of the report generation this is to realize information filtering and information fusion in order to on one hand discard irrelevant information or reduce the amount of simulation reports to the number of reports that a real staff would generate, and on the other hand gather all relevant information from the different sources on the federation as well as additional background knowledge, and to infer comments and assessments relevant to the topic of the current report (e.g earlier reports in the same area, knowledge about the observed units, about the terrain, etc.).

Text Generation

The text generation process, where the information should be used to create human level text (believable that the text was actually written by a staff member and not computer generated), both in terms of content and relevance, and variation in ways of expression, there must be a large variety of textual and content expression. There is a continuous need to research into the task of understanding courses of events and make the chain of several related events understandable. Furthermore, more text generation techniques should be investigated. It remains an open question whether it is realistic to develop a report generation service that is competent enough to eliminate the human in the loop.

CONCLUSIONS

A report generation service has been developed and tested in a federation of simulation systems in a real exercise (progressively in several exercises). The test has provided valuable insight into the design requirements, and prompted further prototype development. As such, great experiences have been attained, including feedback on several aspects of the report generation process, service and results (generated reports). The usefulness of the report generation prototype has not been validated on a high process level, but experts' reviews of the concept, the generation process and the produced reports have been deemed useful. The prototype design and testing is considered a proof of viability of a simulator system/vendor independent automated text report generation service.

We propose that such a service could be designed with several components, each of which are compliant with the ideas behind Modelling and Simulation as a Service (MSaaS). These components include (I) a Report Generator creating

textual reports, which could be of different kind, or alternatively different services could be responsible for different types of reports. (II) A Reporting Service can shoulder the task of presenting a graphical user interface where reports can be edited and sent to the training audience. Finally, (III) different services are needed, provided separately or joint into a common Knowledge Base, to provide additional information needed for report generation. In the Results section, a number of requirements for these have been noted, and furthermore is discussed in the Discussion section. We foresee that the proposed concept with smaller components federated together (MSaaS) is a reasonable way to go about in the future.

Apart from designing new information source services, information requirements must be fulfilled by attaining simulators to publish more information (e.g. observations). This could be achieved by forcing the simulation systems to have open architectures with APIs that allow development of other systems to access their databases and give orders etc. or to develop and implement more HLA standards, e.g. C-BML.

There are a multitude of challenges and questions to further investigate. On a methodological level these include to explore how to deliver the reports to the users in response cells in a way that does increase their efficiency and enabling them to be easily be transferred to trained staff's command- and control systems, and whether it is possible and advisable to fully automate the process so that the messages do not need to be altered by the response cell personnel. Reporting ultimately supports effective training, as such exercise and training objectives may influence the work in a response cell, and a question is whether exercise and training objectives also could be used as a source to automatically adjust the report generation. On a technological level challenges to investigate include to handle other types of reports, consider implementing the transmission of messages with the right formats to the actual training audience information systems, to further increase the trustworthiness by generation of messages with the right feeling or flavor, and to connect to a federation with multiple simulation systems only using NATO standard protocols. The use case in this paper is focused on command post exercises. However, this type of report generation service can be used for other objectives, such as intelligence officer training.

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