

## MSG-052 Knowledge Network for Federation Architecture and Design

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**ABSTRACT:** *Development of distributed simulations is a complex process requiring extensive experience, in-depth knowledge and a certain skills set for the Architecture, Design, development and systems integration required for a federation to meet its operational, functional and technical requirements. Federation architecture and design is the blueprint that forms the basis for federation-wide agreements on how to conceive and build a federation. Architecture and design issues are continuously being addressed during federation development. Knowledge of "good design" is gained through hands-on experience, trial-and-error and experimentation. This kind of knowledge however, is seldom reused and rarely shared in an effective way. This paper presents an ongoing effort conducted by MSG-052 "Knowledge Network for Federation Architecture and Design" within the NATO Research and Technology Organisation (NATO/RTO) Modelling and Simulation group (NMSG).*

*The main objective of MSG-052 is to initiate a "Knowledge Network" to promote development and sharing of information and knowledge about common federation architecture and design issues among NATO/PfP (Partnership for Peace) countries. By Knowledge Network, we envision a combination of a Community of Practice (CoP), various organisations and Knowledge Bases.*

*A CoP, consisting of federation development experts from the NATO/PfP nations, will foster the development of state-of-the-art federation architecture and design solutions, and provide a Knowledge Base for the Modelling and Simulation (M&S) community as a whole. As part of the work, existing structures and tools for knowledge capture, management and utilization will be explored, refined and used when appropriate; for instance the work previously done under MSG-027 PATHFINDER Integration Environment provides lessons learned that could benefit this group.*

*The paper will explore the concept of a Community of Practice and reveal the ideas and findings within the MSG-052 Management Group concerning ways of establishing and managing a Federation Architecture and Design CoP. It will also offer several views on the concept of operations for a collaborative effort, combining voluntary contributions as well as assigned tasks. Amongst the preliminary findings was the notion of a Wiki-based Collaborative Environment in which a large portion of our work is conducted and which also represents our current Knowledge Base. Finally, we present some of our main challenges and vision for future work.*

## 1. Background

Modelling and Simulation (M&S) has been a cornerstone of NATO Research and Development (R&D) for analysis, education, and procurement since its beginning. While initially the focus was on Operational Research and analysis of a stable strategy and doctrine, this focus shifted to computer-assisted exercises (CAX) in the following years. New initiatives target Defence Capability Initiative as well as Concept Development, Experimentation and the Support of Operations.

The fall of the former Soviet Union and the Warsaw Pact and the integration of new members let NATO grow to 26 nations and requested new processes and procedures, but also a new NATO doctrine. The restructuring of NATO's organization resulting in the Allied Command Operations (ACO) in Brussels, BE, and the Allied Command Transformation (ACT) in Norfolk, VA, USA, are examples for the continuing process of reorientation and adaptation to the new requirements.

Also, as a result of ever-growing computer and network capabilities, the use of M&S became pivotal to NATO. The symposia on "C3I and M&S Interoperability" (2003, Antalya, Turkey) [1], "M&S to address NATO's new and existing Military Requirements" (2004, Koblenz, Germany) [2] and "Effectiveness of Modeling and Simulation – From Anecdotal to Substantive Evidence" (2005, Warsaw, Poland) [3] proved the growing importance of M&S in the alliance. The proceedings of these workshops are available and can be downloaded.<sup>1</sup>

A closer collaboration of NATO's M&S bodies with SISO is not only reflected in mutually presented papers, but also in supportive activities, such as the NATO MSG-048 group and SISO's Study/Product Development Group on "Coalition Battle Management Language" (C-BML). However, the most successful step is that SISO was recently recognized by NATO as a standardization organization, eligible to contribute to NATO Standard Agreements (STANAG), which means that SISO standards could become NATO standards.

### 1.2 Problem Description

Development of distributed simulations is a complex process requiring extensive experience, in-depth

knowledge and a certain skills set for the Architecture, Design, development and systems integration required for a federation to meet its operational, functional and technical requirements.

Furthermore, federation architecture and design are the most fundamental activities as they produce the blueprint that forms the basis for federation-wide agreements on how to conceive and build a federation. The architecture and design descriptions are also crucial for achieving higher levels of interoperability (ref LCIM ) [4] and reuse.

Common "proven" architectural and design principles or design patterns can be reused and applied when building new federations, to address common architecture and design issues. The resulting benefit from previous experiences will inevitably increase the likelihood of compatibility, performance, stability and interoperability between systems.

However, the fact that the knowledge of federation architecture and design is not readily available and is limited to the few expert practitioners of this field is a true obstacle in achieving reusable and interoperable M&S components.

There is no real lack of experience in the field. Architecture and design issues are continuously being addressed during federation development. Knowledge of "good design" is gained through hands-on experience, trial-and-error and experimentation. Instead, the problem continues to be how to make this knowledge available to the wider M&S community.

In our approach towards this problem, we have prioritized the development of a common understanding of federation architecture and design issues, best practices and the identification of common patterns for solving these issues as the first steps. Standardization through organizations like SISO can be seen as a natural continuation. It is however important to realize that most real experts in this domain are not volunteers, and even if they would like to participate on a voluntary basis, their organizations might have other prioritizations.

We will explore in this paper new ways and tools that lowers the threshold and level of effort needed to participate in a community of federation architecture and design experts. Reports from a series of workshops addressing federation architecture and design issues, e.g. agility, and federation agreements, etc, will be part of MSG-052 contribution to the wider M&S community.

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<sup>1</sup> See <http://www.rta.nato.int/Main.asp?topic=msg.htm> for downloadable versions of all reports.

## 2. MSG-052

MSG-052 is a Task Group within the NATO Modelling and Simulation Group (NMSG) focusing on establishing a Community of Practice (CoP) for building and sharing knowledge on federation architecture and design. See Figure 1 for MSG-052 organization within NATO RTO.

The MSG-052 task group is open for participation to all NATO/PfP (Partnership for Peace) nations. Currently the following nations and NATO organizations have signed up to participate in the management group with Sweden as the leading nation:

- ACT
- Belarus
- Canada
- France
- Germany
- NC3A
- the Netherlands
- Spain
- Sweden
- UK
- US

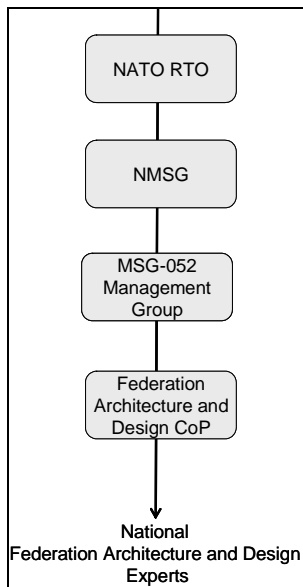


Figure 1. MSG-052 Organization

The management group is responsible for overall planning, prioritization and management of results. Resource allocation and appointment of experts to participate in the CoP are also made by the national representatives in the management group. The CoP currently consists of 41 experienced experts on

federation architecture and design from 8 different NATO/PfP nations (Figure 2).

MSG-052 is a 3 year project that started in 2006 and is scheduled to end in 2009.

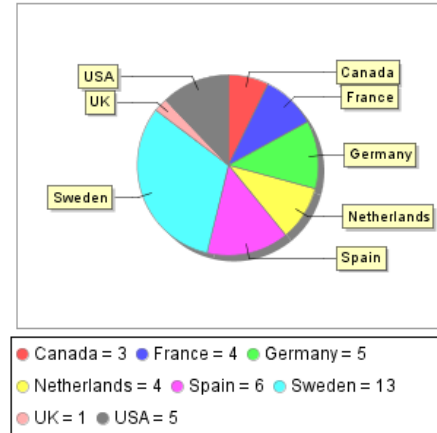


Figure 2. CoP Experts

### 2.1 Objectives

The focus of MSG-052 is on establishing a “Knowledge Network” as a forum where the real experts can meet, discuss, exchange and share knowledge on issues related to federation architecture and design. The main objective and sub-objectives are laid down below:

#### Main Objective

- Initiate a Knowledge Network for Federation Architecture and Design

#### Sub Objectives

- Establish a CoP, consisting of federation development experts from NATO/PfP nations – Federation development being understood as the actual architecture, design and development of the federation.
- Organize specialist Workshops where information about federation architecture, and design issues/solutions are discussed and when needed followed by experimentations.
- Document and share knowledge, via a Knowledge Base, and with the broader M&S community.

## 2.2 Federation Architecture and Design

One of the first topics to be covered by MSG-052 was to define and scope the problem domain. Basic definitions, concept relationships and a first version of taxonomy for identifying federation architecture and design topics and issues were developed. The taxonomy primarily serves as a common way to classify the issues as well as an ontology for characterizing and describing the architecture and design for existing and future federations.

Below is a subset of the current version of taxonomy still being developed in MSG-052. Topics are broken down into more concrete federation architecture and design issues.

- Federation Management Topic
  - Federation Configuration Topic
    - Data and Application Deployment Issue
    - Federate Configuration Issue
    - Network Configuration Issue
  - Federation Execution Control Topic
    - Create Federate Process Issue
    - Join Federate Issue
    - Initialize Federate Issue
    - Start Federate Issue
    - Pause Federate Issue
    - Resume Federate Issue
    - Stop Federate Issue
    - Resign Federate Issue
    - Terminate Federate Issue
    - Kill Federate Issue
    - Save/Restore Issue
    - CRC Process Creation/Termination Issue
    - Federation Execution Create/Destroy Issues
    - Synchronization Points Issues
  - Federation Execution Monitoring Topic
    - Network Monitoring Issue
    - Host Monitoring Issue
    - Application/Process Monitoring Issue
- Scenario Management Topic
  - Scenario Configuration Management Topic
  - Scenario Generation Topic
    - Common Scenario Format Issue
  - Scenario Allocation Issue
  - Scenario Initialization Topic
    - Centralized Scenario Initialization Issue
    - Distributed Scenario Initialization Issue
  - Scenario Execution Control Issue
- Execution Evaluation Topic

- Data Collection Topic
  - Data Logging Topic
  - Data Filtering Issue
  - Data Storing Topic
  - Common Data Format Issue
- After Action Review Topic
  - Replay Issue

This initial set of issues is far from complete, and anyone can realize that the amount of work required to completely define and describe solutions to all of these topics is too heavy for any NATO Task Group to undertake. Indeed, many of these issues have yet to be explored and further experimentation is needed to assess the proposed solutions. However, this list pretty much provides a concrete picture of some of the issues that have to be taken care of when putting together a federation, when too often projects do not build on previous experiences and acquired knowledge.

During the course of MSG-052 only a few of these topics will be addressed, but this will enable the experts in the CoP to test the proposed tools and processes. This will allow the management group to evaluate the viability of establishing a Knowledge Network for federation architecture and design.

## 3. Approach

### 3.1 Community of Practice

The Latin term "*communitatus*" from which the English word "community" comes, is comprised of three elements, "Com-" - a Latin prefix meaning with or together, "-Munis-" - ultimately Proto-Indo-European in origin, it has been suggested that it means "the changes or exchanges that link" (Both municipal and monetary take their meaning here), and "-tatus" a Latin suffix suggesting diminutive, small, intimate or local.

Examples of different types of communities:

- Community of Action
- Community of Circumstance
- Community of Interest
- Community of Position
- Community of Practice
- Community of Purpose

A Community of Interest (CoI) is a community of people who share a common interest or passion, such as rugby fans on Rugby365.com, or music lovers on MP3.com. These people exchange ideas and thoughts

about the given passion, but may know (or care) little about each others outside of this area.

Participation in a community of interest can be compelling, entertaining and creates a 'sticky' community where people return frequently and remain for extended periods.

The concept of a CoP refers to the process of social learning that occurs when people who have a common interest in some subjects or problems collaborate over an extended period to share ideas, find solutions, and build innovations.

The term CoP was first used in 1991 by Jean Lave and Etienne Wenger [5] who used it in relation to situated learning as part of an attempt to "rethink learning" at the Institute for Research on Learning.

In 1998, the theorist Etienne Wenger extended the concept and applied it to other contexts [6], including organizational settings. More recently, Communities of Practice have become associated with knowledge management as people have begun to see CoPs as ways of developing social capital, nurturing new knowledge, stimulating innovation, or sharing existing tacit knowledge within an organization. It is now an accepted part of organizational development (OD).

Social capital can be defined as "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" [7].

There are three primary dimensions to a CoP:

1. There must be a serie of connections that individuals have to others. In other words, individuals must perceive themselves to be part of a network (structural dimension).
2. A sense of trust must be developed across these connections (relational dimension).
3. The members of the network must have a common interest or share a common understanding of issues facing the organization (the cognitive dimension).

It is the task of the MSG-052 management group to initiate a "Knowledge Network" for federation architecture and design. In this knowledge network the CoP has a central role where all three of these dimensions must be addressed. In the case of MSG-052, the CoP is represented by assigned Federation Architecture and Design experts from each participating country. The knowledge network also consists of management and knowledge bases or

repositories. It is the responsibility of the management group to provide the necessary oversight, direction and support in terms of tools, processes, guidelines, experts, etc., to the CoP.

As a result of previous meetings, the following main tasks have been defined for the CoP:

- Identify, Categorize and Describe Architecture and Design Issues
- Prioritize Architecture and Design Issues
- Identify and Describe Common Solutions to Prioritized Issues
- Provide input to improve the way the CoP operates, including feedback on supporting tools & processes
- Document result from Workshops
- Report to Management Group

### 3.2 Process

One of the sub objectives of MSG-052 is to organize workshops where experts in the CoP can meet face-to-face in order to discuss and share knowledge related to specific topics.

A key factor for a successful CoP is getting its members to know their peers. Therefore, the intent is also that workshops will focus not only on knowledge sharing but will also foster networking. The majority of the actual work in capturing the knowledge should be conducted in preparation for the Workshops and as continued post-workshop experimentation and finalization activities. A collaborative working environment (CWE) is used by the CoP to support this process.

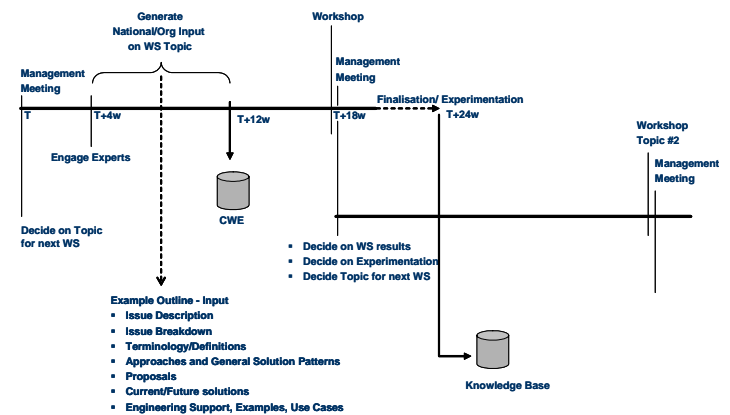


Figure 3. MSG-052 Process

### **Pre-Workshop Activities**

- All experts prepare input on selected topics
- Use of MSG-052 CWE to present, discuss and comment on topic input
- Experts prepare presentation for WS

### **During Workshop Activities**

- Presentations + Q&A
- Discussion on Topics
- Identification of Tasks and/or new Topics
- Practical Work (tasks, resolving comments)
- Discussion on CoP, tools, process and establishing a Knowledge Network
- Report key outcome/findings/recommendations to Management Group

### **Post-Workshop Activities**

- Finalization/Experimentation (Remaining tasks)
- Generate Workshop Report
- Further discussions on the topic using the CWE

## **3.3 Collaborative Working Environment**

A web-based collaborative writing and editing system was selected as the primary tool to support and implement the collaborative working Environment. It is a commercial Wiki [8] based system that provides a rich set of functions to manage access and privileges.

Basically, the system allows all users to edit and comment on a text more or less at the same time. As there is no concept of a document, the information is captured in (Web) pages consisting of text and images. Anyone with edit privileges can change the text produced by others, and this obviously raises a number of concerns for the protection of the entered information; here are some of the questions related to this problem:

#### **Who is the actual author?**

Basically all edits are traceable. All users must log in to the system and all edits are marked. However, the question is relevant if any single editor could claim authorship of a text. This also has relevance with respect to IPR issues discussed below.

#### **What happens if someone deletes what I have written?**

All changes are saved and can be reverted/retrieved.

#### **What if we do not agree?**

For each topic area the management group will appoint a moderator. It is the sole responsibility of the moderator to solve any disputes and report to the management group. However it is not unlikely that there will be cases where multiple views need to be captured.

#### **What about code of conduct?**

The management group has already agreed on and provided a set of guidelines that must be followed in order to implement a code of conduct. These also include the TOR for the moderators.

The collaborative working environment is an internal workspace for MSG-052 and is currently not open for public use. However all information in text or other format entered into the CWE is required to be NATO/PfP Unclassified and without Intellectual Property Rights (IPR) limitations in order to make future publications possible.

All text produced in the Wiki is considered draft/work-in-progress. Formal documents, reports, papers etc. are handled according to the NATO procedures for publication.

The CoP members are also encouraged to make use of other traditional tools for their collaboration, such as teleconferences, email etc.

## **3.4 Workshops**

A total of four workshops have been scheduled so far.

The 1<sup>st</sup> workshop was conducted 26-28 February 2007 in Stockholm, Sweden, and focused on the concept of Federation Agreements and the Taxonomy for federation architecture and design topics/issues. As a result of this workshop a paper on Federation Agreements was produced (07F-SIW-058) [9].

The 2<sup>nd</sup> workshop will be held 10-12 September in Suffolk, VA, USA. This workshop will run concurrently with the Live Virtual Constructive (LVC) Architecture Roadmap (LVCAR) Study workshop [10] organized by USJFCOM. Therefore, the topics for this workshop will be LVC influenced. Other topics include the definition of Federation Management and Federation Agility concepts.

Workshop 3 and 4 location and topics are TBD.

It is important to keep in mind that the main objective for MSG-052 is to establish a knowledge network for Federation architecture and design. The issues selected

within this area are the means by which the work in progress can provide useful content to the community, while ways for achieving a practical collaborative working environment to provide to the CoP are being explored.

## 4. Conclusions

### 4.1 Challenges

#### Cultural Changes

A change from a top-down team-oriented approach to a bottom-up community approach to knowledge acquisition and management is a major change in culture for some experts.

Publishing “unfinished thoughts” and ideas might be uncomfortable and unfamiliar for some experts, but, can be overcome in a CoP where all members are peers and respect and feel confidence for each other.

The culture in a CoP should pretty much build on the members’ willingness to develop and exploit the potential in every idea. Conversely, with the current culture we tend to dissect any statement and prove that it is wrong, because we are taught that it is the only way to be proven right, instead of trying to understand what the other really meant and perhaps reconcile different views.

Before the CoP gains a critical mass and strength it is also vital to identify a core set of experts that can generate meaningful contents, and act as moderators within the CoP. The MSG-052 management group is aware of this issue and has initially appointed moderators to lead the discussions on the various topics.

However, it is likely that a CoP in this domain (Federation Architecture and Design within NATO/PfP) for the time being have to be a cross-over between an ordinary team and a CoP as we intend it to be. Meaning that in order to keep the CoP running there has to be substantial efforts from the participating nations, e.g. moderators and main body of experts have to be assigned (read contracted) to participate. This does not exclude voluntary contribution, but the intent is that during the CoP’s development phase, the responsibility to organize and facilitate it should lay on a governmental organization, which in this case could be for example NATO MSCO.

It is also important to simplify the use of the collaborative environment as much as possible. Technical difficulties or simply complex or

complicated tools can quickly become a major obstacle for spontaneous contribution and every-day use of the knowledge network.

#### Knowledge Representation

Another important characteristic of the Wiki based CWE is that the structure of the content is less strict than in traditional repositories. Primarily, the Wiki consists of hyper-linked pages similar to a website, with the difference that new pages can be added by anyone, almost anywhere in the site.

The risk is of course that the content of the Knowledge Base becomes unstructured and hard to use. The advantage on the other hand is that the experts do not have to comply with a fixed format or structure. Simple text descriptions (sometimes even incomplete) and perhaps some graphical representations, take far less time for an expert to enter into the system than restructuring the knowledge to fit a pre-defined model.

Some guidance on how to structure the content has already been defined, but the basic principle is “if a guideline prevents you from describing what you want, ignore it”. In any case, it is the topic moderator that decides how the final text should be structured.

#### IPR and Publication

A major concern for the MSG-052 management group has been IPR and the possibility of publishing workshop results and knowledge bases.

Currently all reports are processed using NATO standard procedure and “Form 13” before being released. This requires that all contributing nations must agree and sign a release clearance form before any publication can be made. This can sometimes be a cumbersome and time consuming process but quite feasible when handled pragmatic. The preference is however, that any information be cleared when entered in the CWE.

### 4.2 Relationship with SISO

MSG-052 does not produce standards, nor does it recommend practices in SISO terms. Instead, it attempts to establish a community and forum where experts on Federation Architecture and Design join to meet, discuss and share lessons learned. MSG-052 encourages the members of the CoP to also engage in bringing some of the results from our work to SISO as papers and study groups. Once a topic gains enough consensus within the CoP the time might also be right to start standardization efforts. This is however outside the scope of MSG-052.

## 5. Acknowledgements

The authors would like to acknowledge all members of the MSG-052 Management Group and the members of the CoP for their work and contribution to this paper.

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