

ADVANCING SIMULATION REUSABILITY – REPORT ON NATO MSG-042 FINDINGS

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ABSTRACT

In many cases, the training and decision support needs of military users are urgent; operations cannot wait and missions have to be accomplished. Simulators, wargames scenarios and experiments should be ready 'yesterday'. New kinds of operations, environments, tactics, equipment and force configurations challenge our simulation capacities. To mitigate the cost impact and meet the time sensitive requirements, the M&S community has to be 'ready in advance'. This objective may be brought nearer by reusing resources that have been previously developed, possibly by external organizations, and reconfiguring and assembling these resources according to the current needs. Today, more than ever, warfighting excellence is related to the level of reusability of M&S resources.

The NATO Modelling and Simulation Task Group MSG-042 (part of the NATO Research and Technology Organization, RTO) is focused on fostering simulation resource reusability within NATO and partners. Seven nations (Canada, Germany, France, The Netherlands, Spain, UK and USA) participate in this effort.

MSG-042 is studying and analysing the factors that can enable a shared and common framework in which reuse of modelling and simulation resources will be supported. Our focus is not only on technical issues but also on organizational and cultural aspects that, as we have discovered, have a great impact on the capability of sharing resources, especially at multinational level.

MSG-042 recommendations will address three different aspects: reusability actors (Authorities, Producers, Consumers and Custodians), resources (any kind of item useful for simulation) and repositories (containers of resources). MSG-042 will also recommend a common architecture for connecting repositories and sharing resources.

This paper presents and discusses the findings of the MSG-042, including the conclusions drawn from the workshop that was held in The Hague (10th-12th May 05) on "Simulation reusability challenge within NATO".

ABOUT THE AUTHORS

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Lt. Sabas González-Godoy is a serving Polytechnic Engineering officer with over 15 years of service in the Spanish Army. In the last 5 years, he has been actively involved in the procurement and development of simulation systems for training. He is currently the Technical Program Manager of the SIACOM project, a member of the NATO Modelling and Simulation Group Technical Activity Program MSG-027 "Pathfinder" and co-chairman of the MSG-042 "Framework for Simulation Resources Reusability (FSRR)". He received his MSc degree in Computer Science from the Carlos III University in Madrid, Spain.

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Ms. Wanda Wharton currently leads the US Army's Modeling & Simulation Resource Repository (MSRR) effort. She has been a civilian for the US federal government for over 25 years, working for the US Army for the last 15 years. She has been involved with the US MSRR effort since its inception, over 10 years ago, in the Army Modeling & Simulation Office. She is also responsible for the management of various websites, databases, and repositories; as such, she was selected as the US representative for the MSG-042.

Ms. Lana E. McGlynn, founder of McGlynn Consulting Group (MCG), has over 30 years of hands-on experience in technical and leadership positions. She offers comprehensive consulting in the fields of modeling and simulation (M&S), testing, logistics, acquisition, and studies and analyses. Ms McGlynn has lead various domestic and international working groups and task forces, to include serving as the Vice Chair of the NATO Modeling and Simulation Group. Prior to retirement from federal service, she served as the Special Assistant to the Deputy Under Secretary of the Army for Operations Research (DUSA (OR)) for Modeling and Simulation (M&S). She is a member of the Army Acquisition Corps and was certified as an Acquisition Professional, Level III, functional specialty of Program Management. She is a graduate of Harvard's JFK School of Government Senior Executive Fellows Program April 2001, the Federal Executive Institute's Leadership for a Democratic Society Program August 1996, and the course at U.S. Army War College June 1993.

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INTRODUCTION

Background

This paper intent is to describe the findings and final products of the NATO Task Group MSG-042 on the definition of a “Framework for Simulation Resources Reusability” (FSRR). The task group has presented several interim reports to the simulation community. The first report was issued during the NATO Modelling and Simulation Group (NMSG) Symposium 2005 (San Jose & Martinez 2005). Latter, the group provided a presentation during the ITEC 2006 conference (Martinez et al 2006). In this paper we will give details on our final conclusions and recommendations.

For the reader to understand better where this Task Group sits, we first introduce the Research and Technology Organization (RTO) and the NATO Modelling and Simulation Group (NMSG). Then, we will discuss our objectives and working method. Finally, we will report in our results, including and introduction to the proposed FSRR.

Research & Technology Organization (RTO) – NATO Modelling & Simulation Group (NMSG)

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote cooperative research and information exchange. The objectives are to support the development and effective use of national defence research and technology, to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The total spectrum of R&T activities is covered by the following 7 bodies:

- SAS: Systems, Analysis and Studies Panel
 - IST: Information Systems Technology Panel
 - SCI: Systems Concepts and Integration Panel
 - AVT: Applied Vehicle Technology Panel
 - SET: Sensors and Electronics Technology Panel
 - HFM: Human Factors and Medicine Panel
 - NMSG: NATO Modelling and Simulation Group
- MSG-042 is a Task Group under the NMSG. The Mission of the NMSG is to promote the coherent management and coordination of M&S across all Alliance activities.

The scope of activity under the NMSG is M&S policy management and Management and coordination of the long-term strategy for NATO M&S activities. NMSGs

task is to identify and coordinate opportunities for M&S activities across the whole of the Alliance. The NMSG will be a systems engineering support organisation fostering M&S interoperability and reuse

NMSG Task Group MSG-042 on the definition of a Framework for Simulation Resources Reusability (FSRR)

NATO awareness of the advantages of simulation has been the driving force behind the establishment of the NATO Modelling & Simulation Group (NMSG) under the Research Technology Organization (RTO). Besides, simulation is considered to be an essential tool for the Allied Command Transformation (ACT) to perform its tasks.

The uncontrolled increase of the use of simulation has produced dispersion and duplication of Simulation Resources (SR) and efforts, frustrating any possible reusability. NATO has taken a first step forward by adopting the High Level Architecture (HLA), a standard for interconnecting simulators and for improving simulation software reusability. However, the adoption of the HLA standard does not solve all problems related to simulations reusability within NATO.

Conscious of this fact, in 2001, the NMSG commissioned the MSG-012 working group on "Recommendations on the Establishment of a NATO Simulation Resource Library" (MSG-012, 2003). This task group studied the technical aspects related to the establishment of a NATO Simulation Resource Library as required by the NATO M&S Master Plan (NATO, 1998), considering it was clearly a first step to promote SR reusability within the alliance.

The MSG-012 provided a specification document for the establishment of a Simulation Resource Library (SRL) for NATO and partner nations. The RTA has already started the development of a SRL at its facilities in Paris. The NATO SRL will be available for NATO and partner nations use by the end of 2006. The final design of this SRL has been greatly influenced by the MSG-042 recommendations.

The MSG-42 has a different purpose and a more ambitious objective than MSG-012 and should not be considered as a follow-on of MSG-012. Nevertheless the MSG-012 final report provides a vision which is a useful input to the overall objective of MSG042.

On the other hand, the Western European Union (WEU) has also undertaken the SR reusability problem through several initiatives. The most recent and outstanding is the program EUCLID RTP 11.13 "Realizing the Potential of Networked Simulation in Europe". EUCLID RTP 11.13 has produced a variety of prototype tools for developing simulations using the Synthetic Environment Development & Exploitation

Process (SEDEP), similar to the HLA FEDEP (IEEE 1516.3 standard April 2003).

NATO nations have also initiated very interesting projects. The USA has built a network of simulation repositories that link the repositories of the different services and others. UK, The Netherlands, Spain, Germany and other nations have also studied the issue of reusing simulation resources and, in some cases, developed local repositories.

In spite of these excellent technical initiatives (from NATO, WEU and nations), simulation reusability has not yet been established for NATO and partner nations. The MSG042 believes that this is due to the lack of a common framework to support SR sharing and spread simulation experiences and know-how within the simulation community to ensure that efforts will be neither duplicated nor wasted.

This common framework has to be created using a phased approach, to provide NATO and partner nations with a greater capability in simulation by improving reusability with the development of new policies and tools.

Rationale & Objectives of the MSG-042

Objectives

The principal goal of the MSG-042 is to foster simulation reusability within NATO and partner nations. This group is studying organizational and technical issues and identifying the categories of sharable resources that might provide the Framework for Simulation Resources Reusability (FSRR).

For the scope of this work, the term Simulation Resource includes conceptual models, data, simulation software, tools, individual know-how (in particular subjects or techniques) and any other kind of item useful for the development, control, implementation and execution of simulation projects. Also for the scope of this study, the terms resource and asset are considered synonymous; we will use mainly the term resource to avoid confusion.

Determining the structure and initial components of the FSRR is the main duty of the MSG- 042. However, this group can only provide a first set of components; there are issues or solutions we are not aware of and, also, the collection of issues and solutions will evolve over time. For these reasons, we consider FSRR as a living tool that should be extended and modified by the community in the future or adapted for local use in nations, corporations or organizations.

This effort should also be considered within the context of the NATO PATHFINDER concept (NMSG/ACT, 2001); a NMSG support project that determines NATO objectives for distributed simulation and recounts NMSG activities on this field. Figure 1,

Workshop

One of the most important and fruitful events of the group was the workshop on “Simulation reusability challenge within NATO” held at TNO Defence, Security and Safety, The Hague, The Netherlands (10th – 12th May 2005).

The goals for this workshop were:

- Present the objectives and activities of the MSG-042 to other organizations (NATO agencies, Military Staff, Industry, Academy...)
- Identify required capabilities for simulation reusability within NATO,
- Obtain input from participants on the requirements, possible solutions, implementation and usage of the FSRR
- Discuss, with experts outside the task group, the state-of-the-art and trends in resource reusability, from different points of view: Organizational aspects, Technical aspects and Users' view.

Participants from seven different countries (Canada, France, Germany, Spain, The Netherlands, The United Kingdom and The United States of America) provided presentations. All of them introduced new ideas and had a very high quality level. These presentations generated much interest and discussion.

There were a total of 36 attendees from eight different countries, those listed before plus Sweden. These attendees came for industry, government and academia. The NC3A (the NATO Consultation, Command and Control Agency) was also represented.

The workshop was organized in four sessions: FSRR Required Capabilities Session, Organizational Issues Session, Technical Issues Session and Way Ahead Session. The presentations in each session generated much interest and discussion.

As a general result, we concluded that the Model & Simulation community is greatly concerned about the reusability issue.

The following general conclusions were reached:

- FSRR is a wider concept than Simulation Resource Repository. A common approach to reuse is a ‘force multiplier’
- Organizational issues are paramount
- Technology is not the issue. Technology is good enough to provide partial solutions
- Emerging technologies could enable new solutions (e.g. resource characterization or smart resource search)
- Reusability demands a change in the Simulation development and exploitation business model

This workshop had great influence in the final recommendations of the group

Demonstration

To show and test the results of the MSG-042 a Demonstration of the Concept will be given during the NMSG fall meeting in Rome (Oct 2006). By the time this paper was submitted (June 2006) the demonstration had not been done yet.

The MSG-042 is collaborating with other NMSG groups on this demonstration, for example the MSG-027 (“Integration Environment for Multi-Purpose Application of Distributed Network Simulations”). The NATO Research and Technology Agency (RTA) will also participate in the demo providing its portal as a principal node for the demonstration. In addition, some nations, like Spain, Germany and USA, will participate in the demonstration with their local repositories or libraries.

We aim to apply all the lessons learned during our study for this demonstration and also test our recommendations for the future. Some of the lessons are:

- Technical problems are not the main barrier for reusability.
- Standards help to convert stand-alone repository systems into an interoperable network of simulation repositories. A future NATO Network of Interoperating Simulation Repositories (NISR) is feasible

MSG-042 RESULTS

Challenges

The challenges for the application and development of Modelling and Simulation tools (as presented by Lehmann 2004, McClure 1995, SICSEI 2004, etc.) are:

- Increasing complexity of systems and models
- Increasing development cost, decreasing budgets
- Increased need for VV&A (e.g. decision making, training transfer)
- Increased need for user-friendliness of models

The recommended approach to tackle these issues is a more hierarchical development process that reuses existing components by either making them interoperable (e.g. DIS, HLA) or allow the developer to fully integrate these components. The advantages for reuse of resources (either software or other resources like scenarios or databases) and possible benefits have been listed by SICSEI 2004 and others:

- A substantial increase in quality, reliability, trust & confidence in the use of a thoroughly tested reusable component
- Reduced risk in the use of existing components

- Increased productivity due to less development time
- Lower costs in reusing existing tried and tested components
- Improved maintainability of component and overall system

So, if reuse is such an obvious way of reducing cost and improving the development of products, why has it not become more widespread? In practice, it has proven to be difficult and risky to implement reuse in organizations.

McClure, 1995, pointed out as reasons for reuse failures the following:

- Not-Invented-Here Syndrome
- Lack of understanding about why to practice reuse
- Belief that reuse is counter-creative
- Lack of long-term commitment and support from management, management not convinced about the business value of reuse
- No reuse champion within the organization
- No methodology support for reuse
- Corporate culture and reward system discourage reuse
- No reuse training or experience in practicing reuse
- Unwilling to change current way of working
- View reuse as a high-risk technology
- No tools to support the practice of reuse
- Nothing to reuse; no software reuse library available

However, the potential benefits of software reuse (smaller budgets, short development time, validated models etc) are still pushing companies and organizations to strive for more reuse of existing resources.

Fortunately, the experiences of a few corporations and organizations that have successfully pioneered reuse programs in their corporations can be used to define a corporate, national or NATO-wide reuse program. These pathfinders have identified the common reuse obstacles mentioned above, the recurring mistakes and the measures to avoid them.

The MSG-042 has developed a common and flexible format utilizing all the previous knowledge gathered from these corporations and organizations. The format also provides possible solutions for all identified issues. We have compiled our recommendations in the FSRR that we will explain in the next paragraphs.

The FSRR

The Framework for Simulation Resources Reusability (Figure 2) is the most important product of the task group and is composed of:

- A Business Model that describes the proposed process to reuse resources, that is, the reusability cycle.
- An Issue/Solutions Matrix that compiles all identified issues and proposed a series of solutions or alternatives for each one
- A recommended Architecture for the NATO NISR.

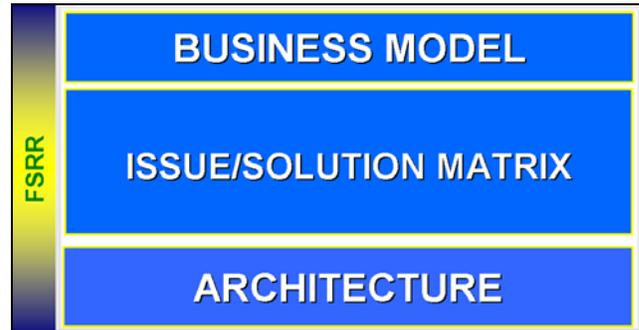


Figure 2. The FSRR Structure

We describe these elements in the following paragraphs.

The Business Model

The MSG-042 believes that to foster reusability a new business model has to be followed by organizations and companies for developing and exploiting simulations and for performing research in the M&S field. We will, first, identify the actors involved in the reusability cycle and, then, depict a generic scenario of the reusability cycle through use-cases.

Actors

The following actors have been identified by the members of the MSG-042 as the principal players in the reusability cycle. It should be noted that in a real case a single person can take on more than one role and the responsibilities of a role can be conducted by more than one person. We have included examples of these actors within the NATO community to illustrate their meaning:

- **Authority.** - Directs and enables reuse cycle and policies. In NATO, an authority could be the NMSG, the R&T Agency (RTA) and, above them, the R&T Board (RTB), Conference of National Armament Directors (CNAD) or the Military Committee (MC).
- **Provider.** - Provides a releasable resource for reuse. A provider could be any NATO nation or agency that provides resources to a node of the

NISR. For example, the NATO Command, Control and Consultation Agency (NC3A) or the NATO Underwater Research Centre (NURC) or any RTO working group (like the AVT-107 “NATO Reference Mobility Model” or the MSG-024 “M&S Support to Non-Article 5 Operations”)

- **Custodian.** - Manages the Reuse Repository. For example, the RTA-Modelling and Simulation Coordination Office (MCO) Help Desk will be the NATO SRL custodian.
- **User.** - Uses a resource, possibly after modifying it. If the reusability cycle is in place this user is really the provider producing new resources. In NATO, a user is any person authorized to access the NATO NISR; this could be a NATO nation or Partner member.

Other important elements of this scenario are:

- **The Network of Interoperating Simulation Repositories (NISR).**- NISR represents a conceptual network in which all repositories willing to share resources are connected and have means to interchange information. The term NISR is inspired in the term NIRL (Network of Interoperating Reuse Libraries) described in the standard IEEE 1430-1996 (1996). Inside an implementation of NISR it maybe impossible to share real resources for security, releasibility, intellectual property or other reasons. However,

what it is important about building a NISR is to share information about resources; being aware of the existence of these resources.

- **Local NISR Node.** – The local NISR node is the local system that contains information about resources and, possibly, the resources themselves. It maybe composed of a repository or data base, a web portal and the necessary software to communicate with the NISR. As we have mentioned, resources could either be directly accessible to the repository user or the repository only provides information (meta-data) about known resources.

Reusability Cycle Scenario

This scenario (Figure 3) shows actors interacting within their own systems and in the NISR. This is a scenario intended to serve as a starting point and reference model for organizations to identify their gaps in reusability and to build the necessary elements (at organizational and infrastructural level) to improve reusability in their business processes. The following use-cases compose this scenario:

- **Establish Reuse Policy:** The authority establishes the reuse policy that rules the interactions and restrictions of the reusability cycle. Any actor may provide feedback on the policies to the authority. The reusability policy is necessary to overcome

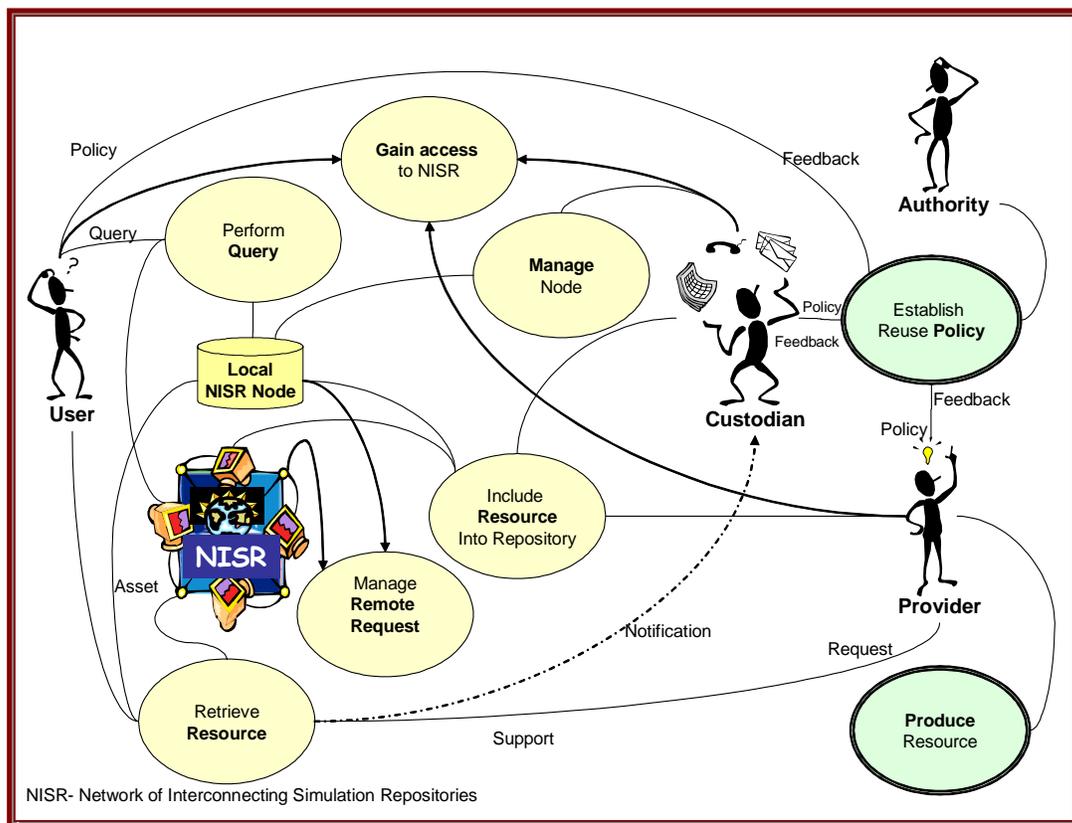


Figure 3. Reusability Cycle Business Model

the organizational issues that are the main cause of the failure of the reusability cycle. We consider reuse policy a key enabler for the reusability cycle to succeed.

- **Produce Resource:** The provider creates a resource. The provider first has to become a user of this reusability cycle. So the policy should force or encourage potential providers to develop resources following this reusability cycle
- **Gain Access to NISR:** Somehow the user has to gain access to the local node and the NISR.
- **Include Resource Into Repository:** The provider should be able to submit resources in the local node of the NISR. We recommend the custodian be invested with the responsibility of approving or rejecting the candidate resources that have been submitted by a provider.
- **Manage Node:** The Custodian should be able to control and administer the local repository and users
- **Perform Query:** Users should be provided with a tool, usually a search engine located in a web portal, to submit their queries and obtain results not only from their own local systems but from other nodes of the NISR as well.
- **Manage Remote Request:** This Use-Case will be executed when a request from another node of the NISR is received. Answering an external query could require a transformation of data model both of the input query and of the output local results. The proposed architecture that we will discuss later, recommends a particular approach to tackle this problem.
- **Retrieve Resource:** Once the user is presented with a list of matching resources, the user can (when available) download resources or get adequate contact information of the providers.

This business model can be used for organizations or corporations to develop their own local policies and repositories. Actually, RTA has utilized this Use-Case as a starting point and reference model for the definition of the NATO Simulation Resource Library (NSRL).

The Issue/Solutions matrix

This tool provides guidelines for authorities, custodians, providers and users for fostering reusability during the development process.

Structure

Issues are classified by two dimensions or factors (Figure 4):

Aspects identify the main reusability entity affected by the issue. Aspects are considered for this work entities present in the reuse process:

- **Strategy & Policy:** Process and procedures issued by the Authority to govern the development cycle
- **Resources:** Any kind of entity or information that can be used to develop simulation projects or studies in the area of Modelling and Simulation.
- **Repository:** A container of resources

Areas relate the issue with a specific topic set. We have identified the following areas:

- **Organizational:** Study which organizational issues obstacle simulation resources reusability. Determine and give recommendations of new procedures and organizational entities to foster reusability within the simulation community
- **Technical:** Study the technical issues that can affect reusability.
- **Security:** Issues related to the protection of the information
- **Economic:** Financial benefits and disadvantages relative to the reuse cycle

Once the issue is classified, a set of alternatives or suggestions are offered.

We consider this structure flexible and useful for the final reader. Of course, other classifications and dimensions are possible, but we have chosen these because they seem to help to find the issues of interest easily. Future use of this matrix will teach us if we need to change its structure.

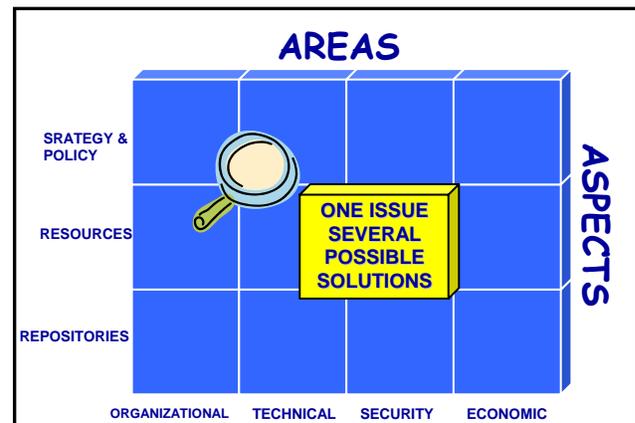


Figure 4. Issue/Solutions Matrix Structure

An example of the Matrix

Figure 5 shows the issue/solutions matrix populated with the keywords already shown in the paragraph above on “Topics covered by the MSG-042”. This is only to illustrate our point, but in the real matrix the

	ORGANIZATIONAL	TECHNICAL	SECURITY	ECONOMIC
STRATEGY & POLICY	Roles	Training		Savings
	Awareness	Standards Responsibility	Access control	Incentives
	Authority		Accreditation	ROI
	Education	New Techs		MOE
RESOURCE	Ownership	Pack for reuse		Cost
	Types	Tech Standards	IPR	
	Configuration	Legacy	Classification	MOE
	Characterization	Characterization		
REPOSITORY	Releasability	Functionality	Access Control	Funding
	Management	Implementation	Host Security	
	Maintenance	Flexibility	Network	Affordability
	Liability	Consistency		

Figure 5. Issue/Solutions Matrix Keywords

elements are issues with their possible solutions as we will illustrate in the next paragraphs.

The beauty of this approach is that anyone interested in a particular subject does not have to go over all of them to find the area or aspect that is relevant for him/her. The matrix is just a tool to find information easily.

Figure 6 shows an example of how to look in detail into an issue relative to Technical Standards (Aspect: Resources and Area: Technical, in red in Figure 5)

For every issue, a description and a set of possible solutions is available; like in the example of Figure 6.

The current population of the matrix

To illustrate further what kind of issues we are talking about, the following list shows all issues populating the

matrix so far (only the name of the issue is provided). It should be note that in Figure 5 the matrix appears populate with possible general keywords related with every type of issue, but the following list is a specific implementation of the matrix so these keywords do not need to be explicitly mention here:

- Strategy & Policy
 - Organizational Issues
 - Support of strategic goals of the organization
 - Policy/criteria for whether to build for reuse
 - Policy/criteria for building reusable resources
 - Policy/criteria for whether to employ reuse
 - Awareness

		TECHNICAL			
		Technical Standards Standards ⇒ higher level of interoperability. Which standards are required to foster reuse?			
STRATEGY & POLICY	Area	Interoperability	DIS/ HLA, FOMs	Savings	
	Model description languages		UML, MDA PIMs	Incentives	
	Data exchange formats		XML schemas, IEEE 1420	ROI	
	Synthetic Natural Environment data		Openflight, SEDRIS DRM	MOE	
RESOURCES	Simulator / C2 communications		C2IEDM, CBML	Reusability Cost	
	MOE	
REPOSITORY				Funding	
				Affordability	

Figure 6. Issue/Solutions Matrix EXAMPLE

- Incentives and disincentives for creating a reusable resource and providing the resource information.
 - Financial incentives and disincentives for employing reusable resources
 - Technical Issues
 - Lack of technical knowledge to design for reuse
 - Ease of access to repositories
 - Security Issues
 - Access and Information protection
 - Classified imbedded data
 - Release of information
 - Economic Issues
 - Cost of reusability in the development process
 - Potential Intellectual / Industrial Property Rights (IPR) Benefit
- Resources
 - Organizational Issues
 - Standards Development
 - Taxonomy Development
 - Configuration Management
 - Continuity of Configuration Management
 - Verification and Validation Information
 - Technical Issues
 - Enhancing reuse by making resources configurable
 - Levels of maintenance
 - Design Documentation
 - User Documentation, provision and testing
 - Packaging for Reuse
 - Technical Standards
 - Utilizing legacy models
 - Tools
 - Security Issues
 - Classification of models
 - Economic Issues
 - Is it worth reusing a legacy model?
 - Is it worth making new models reusable?
- Repository
 - Organizational Issues
 - Common ontologies
 - Authorized resources
 - Data validation and updating process
 - Relationship between users and asset stored in SRL's
 - Measures of effectiveness of repositories
 - Technical Issues
 - Query/response requirements
 - Asset characterization flexibility
 - Tool homogeneity

- Repository management
 - Repository evolution
 - System performance
 - Interoperability between repositories
 - Security Issues
 - Protection of repositories
 - Need for different profiles to access repositories
 - Secure interoperability between repositories
 - Access to remote repositories
 - Economic Issues
 - Cost for development of NISR
 - Cost of local repositories
 - Cost of access to remote repositories

Finally, for the reader to have a taste of what this matrix will look like, Table 1 details an individual issue as it appears in the matrix. The example shows an organizational issue of mainly strategy & policy aspect.

Table 1. An example of a particular issue and possible solutions

ID	S&P.Org.02
Name	Policy/criteria for whether to build for reuse
Description	It may not be apparent to producers that there will be benefits to the organization from making a resource reusable. Thus, there is a need for clearly stated policies and associated criteria on which to assess the benefits of reuse in order to determine that a resource should be made reusable.
Possible Solutions	<ul style="list-style-type: none"> ○ Create a central policy and associated criteria on which to base determination whether or not a resource should be made reusable. ○ Each organization will create policy and associated criteria on which to base determination whether or not a resource should be made reusable. ○ Reuse determined by interested parties on ad hoc basis. Resources made available as developed for original purpose.
Keywords	Reuse policy, reuse criteria
Actors Involved	Authority, Producer
Related Issues	N/A

This matrix will be part of the final report of the MSG-042 that will be available in the RTO website. The group is considering alternatives of more suitable ways to present this matrix (actually, the whole FSRR) to the community.

Architecture

Finally, we propose an architecture (Figure 7) for interconnecting repositories in the NATO NISR. This architecture is based in proven technologies like web-services, XSL, SOAP and so on. We plan to test this architecture during our demonstration in October 2006. A prototype is in development and several national and NATO repositories will be connected to provide the user with multiple nodes hits in the queries.

is feasible using agreed upon standards and providing the necessary organizational elements to make it possible.

Demonstration Results

As we have already mentioned, by the time this paper was submitted (June 2006) the demonstration had not been performed yet. We plan to present the conclusions drawn from this demonstration in future

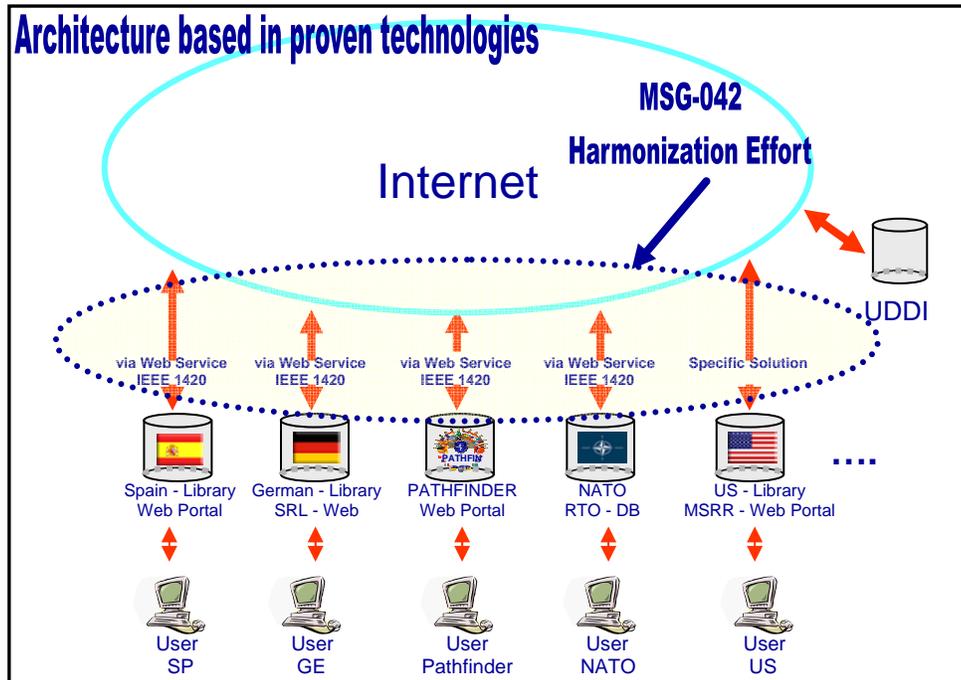


Figure 7. Recommended architecture for the NATO NISR

For this prototype we will use a common interchange data model based on IEEE 1420: "IEEE Standard for Information Technology—Software Reuse— Data Model for Reuse Library Interoperability: Basic Interoperability Data Model (BIDM)". We are aware that this standard is very general, so the level of detail of the information to transfer and the possibility to do advanced searches is very limited. For future work we propose to extend this IEEE 1420 Data Model for simulation purposes.

We advocate for a Service Oriented Architecture (SOA) based on Web Services for it is a mature technology and easy to implement once the technical details have been agreed upon. This approach is in parallel with the architecture Tolk (2006) described for the Pathfinder Web Portal developed for MSG-027.

Although Universal Description, Discovery and Integration (UDDI) services appear in Figure 7, we will not use them for the demonstration. The objective for this demonstration is to show that creating a NISR

papers.

CONCLUSIONS & FUTURE WORK

Conclusions

- Resource reusability for M&S has potential for NATO. Success factors are more organisational than technical in nature
- The FSRR provides a structured 'Reference Book' to improve simulation development and exploitation environments
- MSG-042 proposes a new Business Model for exploitation and development of reusable M&S resources
- MSG-042 has outlined a recommended architecture for the NATO NISR for interchange of information on reusable resources.

The MSG042 report will discuss these important issues related to resource reuse and present possible solutions.

Future Work

As recommendations for future activities in the NMSG, The MSG-042 plan to propose:

- Extend the IEEE 1420 BIDM for specific use for simulation resources based in the previous study of the MSG-012 and other sources.
- Study the benefits of new technologies, like ontologies, agents or semantic web, study them and developing prototypes to show their use in the reusability cycle.
- Study how to better maintain and expand the FSRR for the NATO and partners community.
- Undertake the effort of specifying the NATO NISR architecture in detail to become an STANAG or recommendation. Note that MSG-042 will only produce a prototype.

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GLOSSARY

ACT	Allied Command Transformation
BIDM	Basic Interoperability Data Model
CNAD	Conference of National Armament Directors (NATO)
DIS	Distributed Interactive Simulation
EUCLID	European Collaboration for the Long term In Defence
FEDEP	Federation Development Process
FSRR	Framework for Simulation Resources Reusability
HLA	High Level Architecture
IEEE	Institute of Electrical and Electronics Engineers
MC	Military Committee (NATO)

MSCO	M&S Coordination Office
MSG	Modelling and Simulation Group
NATO	North Atlantic Treaty Organisation
NC3A	NATO Consultation, Command and Control Agency
NISR	Network of Interoperating Simulation Repositories
NMSG	NATO Modelling & Simulation Group
NSRL	NATO Simulation Resource Library
NURC	NATO Underwater Research Centre
RTA	Research and Technology Agency
RTB	Research & Technology Board (NATO)
RTO	Research & Technology Organization
RTP	Research and Technology Programme
SEDEP	Synthetic Environment Development & Exploitation Process
SICSEI	Simulation Interoperability within Common SE Infrastructures
SOAP	Simple Object Access Protocol
SR	Simulation Resources
SRL	Simulation Resource Library
SRL	Simulation Resource Library
UDDI	Universal Description, Discovery and Integration
VV&A	Verification, Validation, and Accreditation
WEU	Western European Union

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