

A Web-Portal Based Approach for Knowledge Networks in Support of the Pathfinder Programme

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OVERVIEW

As part of the Pathfinder Programme, the technical activity program MSG-027 “Pathfinder Integration Environment” has the task of bringing the integration knowledge required to build a federation to whatever organization is charged with that federating task. The knowledge concerning an individual federate is often found to a level of great expertise within a localized organization. In order to effectively have all federates required by an organization forming a federation, that organization must have access to the knowledge required to work with these federates. The knowledge could be shared via training and education programs, however the number of systems that exist will make this sort of universal training program unrealistic. A better goal is to have that necessary information available to all eligible organizations that need access to it. This is a perfect problem for knowledge delivery via the modern internet, and such knowledge delivery will not only bring together information gathered in the past, such as from prior NMSG technical activities, but also from present organizations that are experts on the individual systems and methods, and for the future such knowledge delivery will help to guide not only the building of Federations but also other related MSG Pathfinder activities, or even NATO activities in general (such as study results from other panels, such as IST or SAS).

To satisfy the goals of Pathfinder Integration Environment (facilitate the integration of purpose-built Federations from different National Federates) the knowledge needed for that need to be captured and managed. It also requires the development and presentation of a web portal that will make all specialized information and knowledge required for federation development available. A web portal that can satisfy that description must have a number of different functional pillars. The first, of course, is a community of users that will rely on that portal for knowledge and information. The second is a community of subject matter experts (software manufacturers, national sponsors, etc.) who are willing to prepare their knowledge for presentation by the web portal; these are in many cases the same persons. The third pillar is a small staff to manage the knowledge, keep it manageable and up-to-date, and to ensure that it is presented from the subject matter experts, to the user community, in a very useful format. The Pathfinder Integration Environment activity (MSG-027) has sought to provide a web portal, as well as a series of tools to enable the management of the knowledge captured in the portal, and a proof of concept collection of useful knowledge. This paper will discuss the activities that have accomplished the structuring of such a portal, the means by which all three functional pillars of that portal can be supported, and the future of how such work can assist with other NATO MSG activities.

1 INTRODUCTION

NATO's Modelling and Simulation (M&S) Group (MSG) was established under the NATO Research and Technology Organization (RTO) as a permanent panel/group initialized by recommendations made within the NATO Modelling and Simulation Master Plan (NMSMP) [1]. The process of writing the NMSG was officially started in 1996, when the Conference of National Armament Directors (CNAD) established a Steering Group on Modelling and Simulation (SGMS), consisting of a Governmental Policy Subgroup (GPSG), a Military Policy Subgroup (MPSG), and an Industrial Policy Subgroup (IPSG), and tasked them with writing a plan to align and coordinate the M&S related activities better. The SGMS agreed on the Master Plan in July 1998, which was approved by the North Atlantic Council (NAC) in December 1998. This plan is still valid and the basis for NATO's M&S activities.

The NMSMP formulates five objectives for M&S agreed to by all nations after mutual consensus and various sub-objectives to be reached within NATO, shown in the Figure 1.



Figure 1: NATO M&S Master Plan Objectives

The experts of all contributing groups agreed that a common technical framework is the cornerstone for efficient aligned use of M&S within NATO. This means that the coherent and rigorous application of common standards is a necessary, but not sufficient requirement, as using technology without applying common processes and management is seldom objective driven. The second objective is therefore to establish common services for distribution of information and education on how to work with M&S. Furthermore, the use of common repositories for resources is needed. Developing and employing simulations for practical use are objectives three and four. Finally, technology never stands still. Therefore, observation and active participation in future technologies is a mandate for a viable organization and is summarized in objective five.

This means that NATO is interested in setting up its own means besides using and reusing the means of participating nations. Examples for current efforts are the activities around the Joint Warfighter Centre

(JWC) in Stavanger, Norway, the Joint Force Training Centre (JFTC) in Bydgoszcz, Poland, and the Joint Analyses and Lessons Learned Centre (JALLC) in Monsanto, Portugal.¹ These centres enable NATO to supports in efforts in transformation, training and experimentation using modern M&S technologies and methods.

The research side is supported by the NMSG. The NATO Pathfinder Program addresses all five objectives and is the flagship of the NMSG. The rest of the paper will give an overview on the Pathfinder programme and selected technical activities of the Pathfinder programme. Particular detail will be given for the web-portal solutions evaluated in the “MSG 027 Pathfinder Integration Environment” effort. Finally, we will make some recommendations on how to use the results reached so far can be generalized to improve the coordination of efforts in the Pathfinder programme and across interdependent RTO activities.

2 THE PATHFINDER PROGRAMME WITHIN THE NMSG

The overall vision of the Pathfinder programme, which is described in more detail in the Pathfinder vision document [2], is to provide the technical capability for federations of national models and decision support tools integrated and linked to NATO and eventually national operational command and control systems to exercise, train and support the Combined Joint Task Force Headquarters (CJTF) HQ staff and component commands in the analysis, planning and conduct of crisis response operations (CRO). As such, the Pathfinder programme can be considered as being the yardstick for all technical activities, defined by the following principles:

- NATO established the High Level Architecture as the common M&S standard as defined in the IEEE standard 1516. A Standardization Agreement (STANAG 4603) saying “when procuring or developing applicable new modelling and simulation systems, they will, based on their national requirements, ensure that the systems are compliant with the IEEE 1516 series of standards” has been ratified by several NATO countries..
- The technical activities support the Defence Capability Initiative as well as Concept Development and Experimentation.
- Training, Education, Analysis, Experimentation, Transformation, and Support of Operations are in the scope of the program.

This enumeration reflects that the Pathfinder programme supports the objectives summarized before. The vision of Pathfinder programme can be summarized by the following points.

- Instead of using one system, every nation brings their national systems that are then federated in a timely way into the common solution. The idea is that national ideas are nowhere better modelled than in the national simulation systems.
- M&S is only relevant when being applied to the benefit of the NATO user. To enable this, the convergence of operational systems and M&S is mandatory. Of particular interests are command and control systems. One of the recent M&S conferences focused on this aspect [3].
- Setting up a scenario should be done in days or hours, not in weeks or months. Rapid scenario development is therefore another necessity. Parts of these efforts are common initialisation resources and common resource access protocols.
- Effective and efficient reuse of existing solution is the last principle. NMSG activities within the Pathfinder programme shall support components being reusable beyond the borders of systems and nations, enabling synergistic reuse across the nations.

¹ See <http://www.act.nato.int/organization/hqsact.htm> for more information on these and related organizations.

The results of the Pathfinder efforts will support all parties in the long term, from developing better concepts via improved procurement to better education. It is obvious that such a program must comprise more than one expert group and more than one technical activity. It is also clear that the concept required a solid foundation of standards for processes and technical solutions. Within the last months, NATO and the Simulation Interoperability Standards Organization (SISO²) grow closer together to mutually support each other, e.g., SISO is in the process of getting accepted as a standardization body for NATO M&S standards. The next section will give some selected examples of technical activities conducted under the choreography of RTO and NMSG in support of Pathfinder. It will also show some of the supporting SISO activities of interest.

3 TECHNICAL ACTIVITIES IN THE PATHFINDER PROGRAMME

It is obvious that a vision as stated for the Pathfinder programme cannot be accomplished within a single technical activity. Several aspects of the challenge need to be evaluated and the different lessons learned and results need to be brought back together contributing to the overall programme. The orchestration and choreography of an aligned and harmonized activity plan is the task of RTO in general and NMSG in particular. This task should not be underestimated, as technical, procedural and sometimes even political gaps must be bridged in order to make the Pathfinder vision become a reality. Conducting this multi-year effort multi-nation programme requires state-of-the-art in engineering management know-how.

Figure 2 shows a selection of past, current, and recently initiated technical activities conducted under the aegis of the NMSG and contributing to the Pathfinder programme.

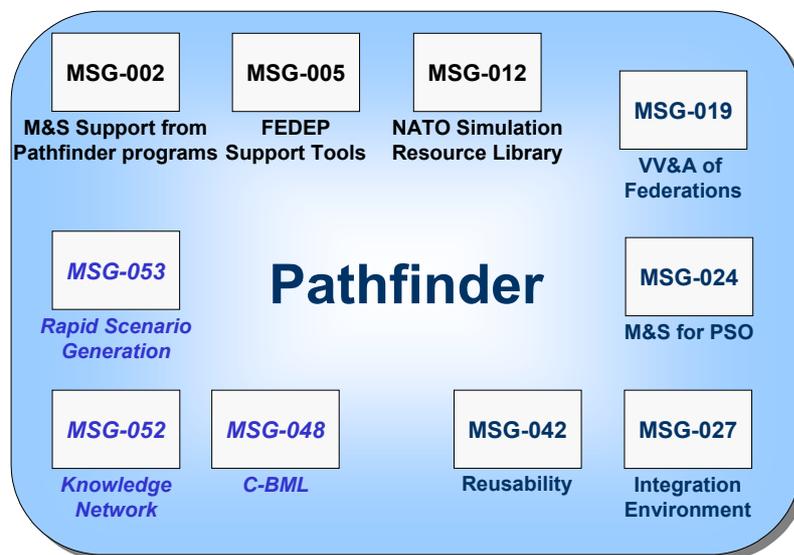


Figure 2: Selected Technical Activities within the Pathfinder Programme

The selection is based on contributions to the technical activity MSG-027 and is therefore neither complete nor exclusive. The interested reader is referred to the proceedings of the annual NATO M&S

² See SISO website: <http://www.sisostds.org> for information on workshops, proceedings, etc. SISO is the IEEE standardization organization for M&S standards.

Conferences published and distributed by the RTA. Other activities, such as MSG-025 and MSG-050, contribute additionally needed expertise, such as how to organize the certification process. Also, activities from other panels must be taken into account as well. The references in this paper have been dictated by the experiences of the authors and the length of the paper and are by no means an evaluation of the applicability for the Pathfinder programme.

Among the past technical activities of interest are those studies that evaluated the possibility to support the program with current M&S functionality, how the Federation Development and Execution Process (FEDEP) is supported by tools, and how NATO's M&S resources can be described in a common Simulation Resource Library (SRL). The results of these studies are recommendations and proposed standards to be used within the Pathfinder programme. Additionally, the feasibility of ideas was shown to make sure that no technically unachievable proposals are followed. The know-how transfer from these studies to the currently evaluating experts is mainly based on documentation in form of NATO reports as well as direct discussions with these experts. Unfortunately, those experts having conducted the earlier studies are not always available for current studies and the documentation captures mainly the results of studies, but not necessarily interim solutions or valuable findings leading to this discussions. These shortcomings are observed in the NATO Code of Best Practice for C2 Assessment [4] as well, which summarizes some findings of the NATO Systems, Analysis and Studies (SAS) panel.

Among the current activities of interest are the Verification, Validation and Accreditation (VV&A) of Federations. Together with experts of a similar group in SISO, the experts try to establish a procedure facilitating the harmonization of VV&A processes of nations and agreeing on common processes and tools to be used for VV&A. Another activity of interest evaluates the applicability of M&S for Peace Support Operations (PSO). Many military M&S applications were developed for scenarios involving the use of massive military force, as it was typical for the era of the Cold War. PSO are characterized by other parameters (which are also addressed in [4]). It is therefore not trivial that legacy M&S applications can support new requirements. NATO addressed these concerns in the 2004 M&S Conference [5]. Furthermore, the challenge on how to document reusable resources is addressed as well. As stated before, NATO needs to find common way to describe and publish national and NATO resources so that eligible users can find the descriptions and actually can realize that the described resource is a potential solution to their problem. To identify applicable standards is definitely not trivial.

The focus of the Pathfinder Integration Environment (MSG-027) will be described in more detail in the next section. Another contribution resulting from this activity is the recommendation section of this paper, although this was not in the focus of the expert group.

Three of the recently initiated technical activities depicted in figure 2 are directly connected with the idea of Pathfinder in general and with web-portal solutions in particular. The first one is the Coalition Battle Management Language (C-BML) activity. Technical details on this effort already have been published in support of the sister effort of SISO, the product development activity C-BML [6]. This activity uses the standard recommendations of SISO to conduct a feasibility study for NATO. If successful, it can become a muster example for collaboration in the course of identifying new solutions and standardizing them to ensure easier integration of solutions on the long term. Rapid Scenario Generation (MSG-53) is also connected with an ongoing standardization effort: Military Scenario Definition Language (MSDL) also being a product development group within SISO [7], although the connections are not yet as intense as with C-BML. Nonetheless, the standardization activity will support NATO's effort to identify a way to reuse scenarios and vignettes as reusable components in support of the Pathfinder programme. Finally, the Knowledge Network (MSG-052) activity must be mentioned, as one sub objective of this activity. Besides establishing a knowledge network and explore ways of capturing and share knowledge, it is intended to use up a web-based knowledge portal and populate it prototypically with knowledge of value to the Pathfinder programme. What MSG-027 is currently doing for the technical integration of federates into a federation – and the next section will explain the ideas in more detail – MSG-052 will generalize ensuring

the availability of information and knowledge independent from the availability of the originally assign expert. This address the challenges identified earlier in this section, that knowledge is currently only available in form of documents or human partners, not in form of information accessible in case of need by every eligible user.

4 WEB-PORTAL EXPERIMENTS AND DESGIN IN MSG-027

The objective of technical activity MSG-027 is the proof of feasibility to develop a common Pathfinder Integration Environment (PIE) enabling the timely access, configuration, and federation of simulation-based tools in support of the Pathfinder programme. This environment envisioned for the Pathfinder program shall be a web-based facility that will leverage NATO and national M&S integration expertise. NATO and national organizations responsible for the development and provision of simulation support to NATO are the targeted user group. PIE will be usable in a distributed environment and capable of supporting the collaborative federation development. To avoid unnecessary hurdles, current activities focus on the description of federates and federation tools in form of a knowledge portal. It is obvious that the final PIE needs to have access to federates and federation tools as well, as you need to have access to the software to use and/or to integrate or federate it. In the current feasibility study, however, we limited to access to publicly available products. The approach to use links and references to a point of contact to obtain the software has the additional advantage that commercial vendors can use the standard to describe the functionality and interfaces to their systems. This allows vendors to advertise their products and potential users to compare them.

In the current effort, we distinguish between structure and content. In the *PIE Knowledge* section, we describe how to apply resources to support the use case identified. In the *PIE Resource Description* section, we describe available M&S resources, such as tools, federates, and other software. In addition, we also describe documents with lessons learned, codes of best practice, etc. Finally, the *PIE Resource* section describes how and where to obtain the resource. Figure 3 shows the idea.

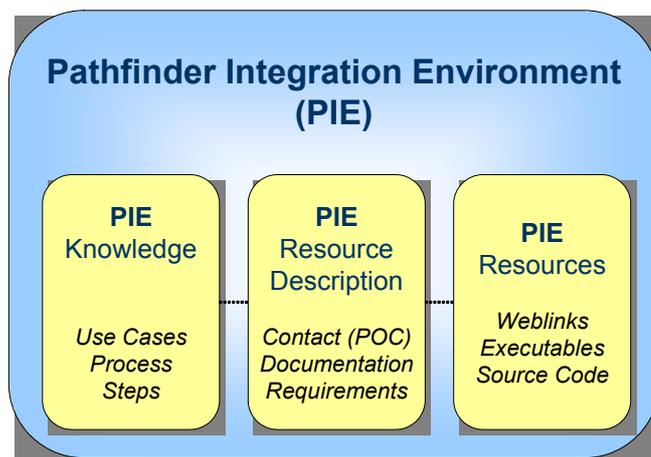


Figure 3: Components of the PIE Web Portal

In case of a publicly accessible source, a direct access is possible. As mentioned above, the more likely solution is a link to the website of a supporting vendor from which the tool or federate can be obtained. In order to build a federation, all three components are necessary: the knowledge about the resources, the

knowledge to apply them, and the resources themselves. While NATO and its nations have experience in describing the resources that have to be reused, the idea to separate the description of sources, the resources themselves, and the processes and use cases on how to reuse these components is new and was one of the main challenges in the expert team conducting the technical activity.

In the following subsection, we will focus on the design and management aspects of interest for later recommendations of the *PIE Knowledge* section and the *PIE Resource Description* section. Additional technical details are published in [8].

4.1 The PIE Knowledge Section

MSG-027 is among the first technical activities of NATO evaluating the possibility of web technology within a feasibility study. Earlier efforts, such as MSG-012 evaluating requirements and technical constraints for a Simulation Resource Library for NATO's M&S resources [9], contributed to the frame discussed by the MSG-027 experts, but prototypical implementations have not been evaluated for this purpose before. In addition, the idea to describe integration and federation knowledge in a web portal was known to the M&S community as well.

However, NATO has another activity which could be utilized: the Advanced Distance Learning (ADL) efforts used for education. At the NATO Summit in April 1999, the leading officials endorsed the Partnership for Peace (PfP) Training and Education Enhancement Programme (TEEP). They particularly stressed the potential of information and remote communication technologies. As a follow-on activity, the NATO Military Authorities recommended that MSG be tasked to evaluate existing and developing opportunities to build a NATO/PfP distributed learning and simulation system. The recommendation given in the resulting MSG report was that an "experimental prototype" of a distributed learning capability should be developed within limited resource constraints prior to implementation of a full ADL capability. In addition it was stressed that the use of ADL modelling and simulation, including distributed simulation-based exercises, can reach a much larger training audience with significant savings in resources. With a centralized body providing management and oversight, it will be possible to leverage the work of all the nations and share in the development of distributed learning courseware and learning management systems that can track and assess the education and training provided. The current website focuses on education, but the knowledge of MSG-027 can become an important part of this effort [10].

Within MSG-027, knowledge is restored in form of use cases. A use case is defined as the description of applying of knowledge and resources to solve a general problem or challenge of a user. To limit the scope to a feasible task, the current work is exclusively focusing on problems connected with the Federation Development and Execution Process (FEDEP), and within the FEDEP focusing on supporting Developing a Federation (Step 4) and Planning, Integrating, and Testing a Federation (Step 5) [11]. The supported structure, however, is able to cover not only the other steps of the FEDEP, but is likely to support related domains as well.

Every use case incorporates one or more processes. Each process comprises at least one step. If a process has more than one step, the steps are sequential. However, as each step can invoke another process, parallel processes can be modelled as well. Each process has a set of pre-conditions and a set of post-conditions. Each step can be connected with one – or more – resources that has/have to be applied in this step. This makes it possible that very detailed steps can be stored in the web portal. Alternatively, just one step can be used to describe a complex, tool-based procedure, which is connected with the tool itself as well as a guideline for the tool application (such as a getting-started manual or a complete user guide for the tool). The web portal ensures that every tool that is used in a step of a process of a use case has a valid description in the *PIE Resource Description* section.

4.2 The PIE Resource Description Section

The *PIE Resource Description* section is the part of the web portal, in which non-use-case specific information of M&S resources is stored. While the *PIE Knowledge* section focuses on describing the processes and steps necessary to describe a use case, all the other important information is captured here. The design was influenced by the recommendations of MSG-012 [9], but additional constraints – in particular from the sister activity MSG-042 working on reusability options – were taken into consideration. Finally, current research on meta models enabling the storage of content independent from a given format and therefore reconfigurable in case of need to suite different user needs was taken into account [12].

In principle, an entry in the *PIE Resource Description* section can describe everything that can be of use to another user of the PIE. It can be a document – such as a copy of a STANAG to be applied – or some lessons learned from an event or exercise applicable to solve problems of other users; it can be a tool to solve a special problem, such as a mapping tool or a visualization tool; it can be infrastructure software needed to build a federation, such as Runtime Infrastructure (RTI) implementations or converter tools mapping different versions of supported standards to each other; and it can be a federate, such as a simulation tool or decision support tool. On the long term, the PIE must not only comprise the description, but also the software and/or the document itself. If this is the case – and we have examples of lessons learned and public domain software stored like this to proof the feasibility of the underlying ideas – the M&S resource is stored in the *PIE Resource* section, which is more or less a categorized file system to store the data. In most cases, however, we support an external link to the provider, such as IEEE or industry partners.

Each of these entries in the *PIE Resource Description* section can be every format that can be described using XML. This allows maximal flexibility in the process of gathering information. In the extreme case, an entry can be a single paragraph in which all information is merged into one describing text. On the other side, we support structure as defined and standardized by international organizations, such as the IEEE 1420 standard for reusable software [13] as recommended by MSG-042. How the ideas published in [12] are implemented for the PIE has been published in [8] in more detail; in the scope of this paper it is sufficient to say that we defined a way to distinguish between the content of a resource description and the structure of the resource description. If two different structures are used to describe the same content, and if the structures are sufficiently similar enough to be mapped to each other, the *PIE Resource Description* section can be used as an information transfer support system. To proof the feasibility, we imported data structured in form of the US Modelling and Simulation Resource Repository (MSRR) and the NATO Simulation Resource Library (SRL) and use both entries as resource descriptions within PIE. This functionality was also applied to support a common demonstration of MSG-027 and MSG-042 to proof the broad applicability of ideas developed by the experts of both groups under the lead of the MSG.

It is necessary that every resource available via PIE has such a resource description. However, it should be pointed out that this does not imply that every resource described here must also be part of a use case described in the *PIE Knowledge* section. We decided to support this view to maximise the flexibility for solution providers to describe their tools and software without having to document all possible use cases as well. This allows vendors to display their solutions and gives users alternative options. If they select one of the tools not yet described in a use case, they only have to describe the use case and can simply refer to the already existent description.

In summary, the PIE Resource Description section is currently the richest section. While every tool of the PIE Resource section as well as every tool referred to in the PIE Knowledge section needs to be described in the PIE Resource Description section, it is possible to describe tools without having to store them or to use them in use cases. This concept maximises the flexibility of the PIE web portal. The open structure also allows every contributing nation – and individual vendor – to decide to what degree information can

be shared with others. As explained in [8], different user groups and access rights increase the flexibility of the use of the current PIE for NATO and its nations and allies.

5 RECOMMENDATIONS FOR THE NMSG

The work of MSG-027 shows a new way to share information and reuse results of earlier technical activities. Beside obvious reuse – such as in case of Pathfinder the reuse of information gathered earlier by MSG-002 “M&S Support from Pathfinder programmes” – additional information could be reused immediately – such as the tool evaluation conducted by MSG-005 “FEDEP Support Tools” and the identification of valuable metadata and database structures recommended by MSG-012 “NATO Simulation Resource Library”.

The work with other technical activities – in particular MSG-042 “Reusability” – was technically aligned to ensure that not two parallel feasibility efforts were conducted potentially resulting in contradicting recommendations. New technical activities, in particular the ideas around setting up a NATO Knowledge Network (MSG-052), can directly benefit from the results. Other activities – such as the Coalition Battle Management Language (MSG-048) or Rapid Scenario Generation (MSG-053) – can utilize the web portal and PIE to identify existing solutions and store their own results in a reusable way.

It is worth mentioning the objectives of MSG-052 “NATO Knowledge Network” in more detail. The main objective is, as mentioned earlier, to initiate a knowledge network for federation architecture and design and the following sub objectives has been identified:

- Establish a community of interest, consisting of federation development experts from NATO/PfP nations
- Organise specialist work shops where information about federation architecture- and design issues/solutions are discussed and when needed followed by experimentation.
- Document and share knowledge, via the knowledge base, with the modelling and simulation community in general.

The focus area of research is interoperability with scope limited to architecture and design of federations based on the High Level Architecture (HLA) standard for modelling and simulation. Examples of topics to be covered are:

- Categorization of architecture and design issues, applying design guidelines in the FEDEP
- Federation architectural styles, central services/servers, sharing of algorithms, transfer of control
- Federation and scenario management, states, initialization, runtime monitor and control
- Standardization and alignment of federation agreement documents with FEDEP
- Object model management and assembly (just in time, task focussed).
- Data collection, tracing/connecting events, preparing for analysis, distributed vs. central logging
- Live, virtual and constructive (LVC) simulation federation issues

The work will start with questions concerning how to categorize knowledge and how to make it useful. MSG-052 will be based on the previous work done in MSG-027 [14], the current work reflected in this paper and MSG-042 [15]. Results and expertise of both expert groups will be reused. MSG-052 will focus on the federation architecture in general to scope current work and to provide a basis for design workshops. Different approaches and initiatives for federation design reuse by the member nations will be presented and generalised solution will if possible be derived. The need for experimentation to verify

solutions or generalized ideas will be a vital part in this activity. This means that there is need for doing some serious work between the management meetings in order to keep them as “decision meetings” deciding on next step to go or next issue to dissect.

NMSG can benefit from this work in a more efficient way than before. The current NATO capabilities, in particular the web-based information solutions, are supported by web portals with a clear structure of knowledge content and resources. Every technical activity should identify use case to clearly state what problem they want to solve. This will reuse the ambiguity and the room for interpretation – in particular misinterpretation and, connected with this disappointment based on insufficient expectation management – significantly. In the same way, results can be stored in the web portal, in particular when the solutions utilizing tools or software. A close connection with resource libraries – in particular NATO’s Simulation Resource Library – is mandatory and migration paths have been demonstrated. The use of national resource repositories have been shown and are published in [8].

The implementation used in the feasibility evaluations of MSG-027 is not mature and operationally acceptable software; however, the implementation and supported protocols can easily be used by commercial supporters of NATO to migrate the prototypical implementation into a solution helping NATO to transform from a document-centric into a knowledge-centric era.

6 SUMMARY

We described the current prototypical implementation of PIE that already show the feasibility and flexibility of web-based knowledge- and resource repositories. Integration into the ADL efforts of NATO is technically feasible and conceptually aligned. The concept can be used to enhance the information flow between different technical activities within the MSG, between MSG and supporting organizations – such as other RTO panels or SISO –, and between MSG and supporting industry partners. Such a concept maximises the degree of information flow and reuse of results as identified as a major challenge in NATO Code of Best Practice [4] and addressed in many discussions in expert groups of NATO. It supports all objectives identified in the NMSMP, the better orchestration and choreography of technical activities across the panels and groups of the RTO and will support NATO organizations, in particular JWC, JFTC and JALLC.

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