Towards a new NATO certification capability for HLA interoperability

José Ruiz
DGA/DS/CATOD, France
jose.ruiz@intradef.gouv.fr

Horst Behner
Bundeswehr Joint Materiel Office (BAAINBw P2.3), Germany
horstbehner@bundeswehr.org

Reinhard Herzog
Fraunhofer IOSB, Germany
reinhard.Herzog@iosb.fraunhofer.de

Jan Hodicky
NATO M&S COE, Italy
jan.Hodicky@seznam.cz

Björn Löfstrand
Pitch Technologies, Sweden
bjorn.lofstrand@pitchtechnologies.se

Stefan Vrieler
WTD 91, Germany
stefanVrieler@bundeswehr.org

Keywords:
HLA, Certification, NATO

ABSTRACT: *The integration of distributed simulations and tools into interoperable federations is a complex and time consuming task requiring extensive testing of individual components, interfaces and the integrated solution. To support this task, NATO (North Atlantic Treaty Organization) relies on standards and agreements on their use. The Allied Modelling and Simulation Publication "NATO M&S Standards Profile" (AMSP-01) provides a list of recommended M&S related standards and best practices. Efficient interoperability using the HLA (High Level Architecture) standards requires compliance with a shared reference data exchange model (Federation Object Model), a federation agreement and the ability to certify conformance. The modular RPR FOM (Real-time Platform Reference FOM) and the more recent NETN FOM (NATO Education Training Network FOM) provide building blocks for creating federation agreements and FOMs. Prior to the arrival of the HLA IEEE 1516-2010 standard, the United States provided to NATO and nations a tool for federate HLA certification at the API (Application Programming Interface) level and SOM (Simulation Object Model) conformance checking. This paper presents the current work of NMSG-134 (NATO Modelling Simulation Group) responsible for defining the new NATO distributed simulation certification process and tools. This includes the CONOPS (Concept of Operations), the design and development of the IVCT (Integration Verification & Certification Tool) and test cases for distributed simulation interoperability. The concept of capability badges will be introduced to capture the interoperability requirements, test cases sequencing and conformance statements.*

1. Background

The integration of distributed simulations and tools into interoperable federations is a complex and time consuming task requiring extensive testing of individual components, interfaces and the integrated solution. A certification service provides an unbiased compliance testing against standard sets of interoperability requirements based on the conformance statement provided by the owner of the simulation under test. Certificates are provided by authorized certification entities and are tokens of achieved compliance with interoperability requirements as specified in conformance statements. Simulation components are required to get or obtain certificates, in order to be candidates for procurement or as acceptance test requirements as specified in Standardization Agreement (STANAG) 4603 [1].

The following added value will become a common requirement:

- **Improving Federate Tool Quality**: By using a certification tool in the development phase of a simulation tool, the federate developer is provided with a high quality and well accepted testing tool. It supports the tool developer and the quality assurance. In such a case, the certification tool can be downloaded and used at a test laboratory independently.
- **Proving Federate Compliance**: By certifying a federate against a conformance statement, the federate developer improves the value of the federate by being able to provide proof of interoperability. Such a certification must be done by an independent and trusted certification service.
- **Compliance Label**: By establishing a compliance label, the user of a federate receives a solid statement about the quality of a federate. Such a label reduces the risk of using faulty software and incompatible federates. This concept will be further developed as the concept of interoperability capability badges.
- **Federate Integration Assistance**: By using the monitoring and testing capabilities of a certification tool, a federation integrator is provided with better control, diagnostic and documentation functions. Essentially, it will be easier to identify federates behaving outside their conformance statements. The certification tool will also facilitate the integration of certified federates in an overall new federation.
- **Federate Verification Assistance**: By using the test cases definition and execution framework of a certification tool, federate users can verify the application behavior. In simple cases, this can be done by using the given standard use cases. But in more complex tests, the generic test case development framework can be used to create specific validation test cases for specific application logic.

The following effects by using a certification tool are anticipated in distributed synthetic environments based on pretested and verified simulation components with certified interoperability capabilities:

- Reduced Cost of Integration of Distributed Simulation,
- Reduced Risk in Integration of Distributed Simulation,
- Reduced Integration Time,
- Overall Increased level of Interoperability of Distributed Simulators.

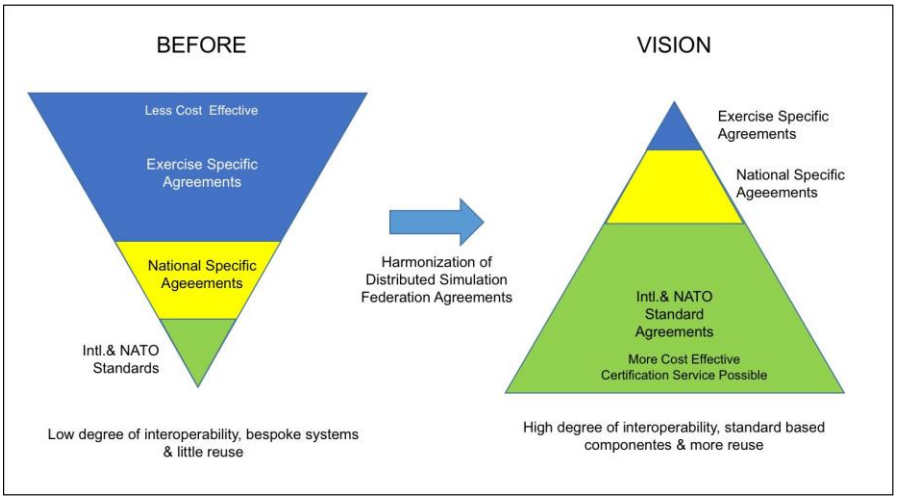

Figure 1.1: Increased Interoperability, Reusability and Cost Effectiveness

Using the HLA (High Level Architecture) interoperability standard provides the rules of building federations but, unfortunately, it doesn't deliver the process and tools to check the proper compliance to the standard. So, in addition to this standard, a certification process and tools were developed by the United States:

- **FTMS** (Federate Test Management System): this Web tool allows users to request a certification by uploading all documents associated to the candidate (also called *FuT - Federate under Test*).
- **FCTT** (Federate Compliance Testing Tool): this tools first checks in static mode the content of the federate document (SOM – Simulation Object Model, FOM – Federation Object Model…). After these checks, FCTT analyzes in dynamic mode, inside the federation, the publication, the subscription and the HLA service management performed by the FuT.

This certification process is available for the HLA versions 1.3 and IEEE1516-2000.

With the release of the new version of the standard (IEEE 1516-2010 [2] & [3], also called HLA Evolved), in 2009, the US discontinued the software support and did not work on the necessary adjustments to the certification tool suite to take into account the extensions of the standard.

Some nations, especially under the umbrella of the NATO Modelling and Simulation Group (NMSG), were interested to maintain the certification capability. NMSG-134 started work in October 2014 and is in charge of developing the new certification process and to deliver the first release of the enhanced certification tool. This group is supported by NATO nations (Canada, France, Germany, Italy, Spain, United Kingdom and United States), Partnership for Peace Nations (Belorussia, Bulgaria, Romania and Sweden) and NATO Centers (Modelling and Simulation Center of Excellence, and Crisis Management and Disaster Response Center of Excellence).

In the legacy certification, the process only focuses on the technical interoperability (FOM check, HLA service conformance…). To exceed these limitations to the semantic interoperability, it is necessary to stimulate the FuT in reference test cases containing predefined sequences of publication / subscription of HLA objects and interactions. An experimentation was done in France in 2010 to draft this process (see paper [4]).

During NMSG-068 (2008-2010) and MSG-106 (2012-2014), NATO has developed a reference FOM called NETN FOM (NATO Education and Training Network FOM). This modular FOM is based on RPR-FOM [5] and is extended with additional modules such as Logistics, C-BML (Coalition Battle Management Language) and CBRN (Chemical, Bacteriological, Radiological and Nuclear). It was selected as reference FOM for the test cases of NMSG-134, but **the new certification process could be useful with any other FOM**.

This paper will now explain:

- The purpose of the reference FOM for the certification process and how to describe the standardized federation agreement,
- The process of certification described in a CONOPS (Concept of Operation) document,
- The architecture of the new certification tool and the associated test cases,
- The way forward of the certification process in NATO.

2. Reference model for certification (AMSP-04 - NETN FAFD)

The NETN Federation Architecture and FOM Design (FAFD) document is a reference document intended to provide architecture and design guidance for developing NATO nations' and NATO partners' distributed simulation and training systems. The document is scheduled to be published in 2016 as a NATO Allied Modelling and Simulation Publication (AMSP-04) covered by a NATO Standardization Recommendation (STANREC). The terms NETN FAFD, FAFD, AMSP-04 and NETN FOM are used almost interchangeably.

The guidance provided in AMSP-04 has been developed to support the NATO Allied Command Transformation (ACT) vision of an Education and Training Network and is applicable to NATO Computed Assisted Exercise (CAX), national CAX and to distributed modelling and simulation in general.

"*To deliver to NATO and Partners a persistent, distributed combined/joint training capability able to support training from the operational to the tactical level across the full spectrum of operations, through leveraging existing national expertise and capabilities.*" - NATO ACT NETN Vision.

The FAFD focuses mainly on technical interoperability issues and is not a complete guide on how to design a distributed simulation to support CAX. However, it provides key architecture and design patterns and proposed solutions. As a reference document, the FAFD is not intended to replace design and agreements documents authored to support each particular instance of federation development and use.

The first version of the FAFD was developed by NATO NMSG Task Group MSG-068. This group represented a broad community of practice with respect to federation architecture and design. The harmonized national input on federation architecture and design agreements formed the first draft version of NETN FAFD. The second version of these federation agreements were developed by NMSG-106 "Enhanced CAX architecture, design and methodology - SPHINX" and became the first AMSP-04 Draft. Currently the AMSP-04 is maintained by NMSG-134 on behalf of NATO NMSG Modelling and Simulation Standards Subgroup (MS3).

AMSP-04 is basically an extension to the RPR-FOM v.2.0 (final) and provides entirely new modules as well as modules that subclass existing RPR-FOM classes. The modules have inter-dependencies and have been designed to maximize re-use and interoperability both with respect to legacy systems, existing standards and to requirements for new patterns of simulation interoperability. The NETN FOM is the complete set of NETN modules and all other modules they depend on (i.e., RPR-FOM v2.0 modules). A NETN Federation defines the modules that are relevant and each simulation system only loads those modules it requires.

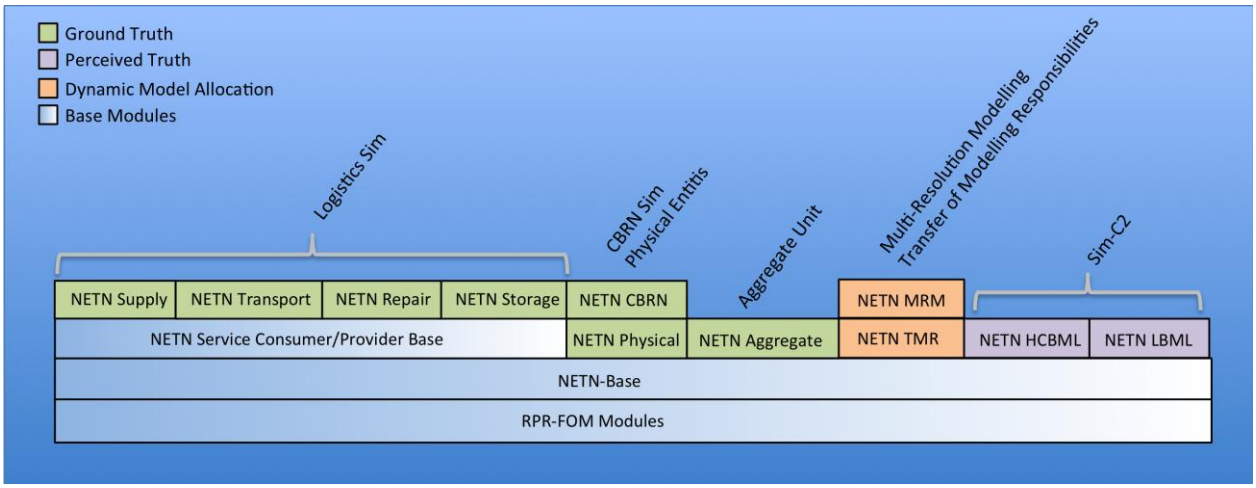

Figure 2.1: The NETN FOM modules

Transfer of Modelling Responsibility (TMR) Module - In advanced distributed simulation the modelling and simulation responsibilities may change during the execution of the federation. The NETN FAFD provides a recommended design pattern for dynamic transfer of modelling responsibilities (TMR). The TMR pattern is a general purpose pattern that supports multiple federation designs to handle situations where dynamic change of modelling responsibility is required or requested. TMR works at the attribute level and can include all or a subset of attributes for a simulated entity.

Multi-resolution modelling (MRM) Module - The NETN FAFD supports multi-resolution modelling (MRM) by providing an MRM pattern for aggregation and disaggregation of simulated aggregate units and physical entities.

Extended Representation of Aggregate and Physical Entities - The NETN FAFD representation of aggregate entities, such as military units, and physical entities, such as platforms, is based on the RPR-FOM v2.0 standard. The NETN FOM Module extends the RPR-FOM with NETN-Aggregate and NETN-Physical which include addi-

tional attributes for unique identification of simulated entities. The unique identification has been included to provide better support for initialization, TMR and other advanced design patterns requiring unique pre-defined identifiers for simulated entities. NETN federations still allow pure RPR-FOM based federates in the federation but with limited ability to interoperate in some NETN design aspects.

Simulation-C2 System Interoperability (SIMC2) Modules - The purpose of SIM-C2 interoperability is to automate the process of interaction between Command & Control (C2) systems and simulations and is primarily based on the Coalition Battle Management Language (C-BML) standard [6].

Service Oriented Modelling and Simulation Modules - The NETN FAFD includes a design pattern for allowing a federate to provide or request modelling and simulation services to or from other federates. This is not a transfer of responsibility between federates but rather a service provided by one federate and consumed by another. The NETN Service-Consumer FOM Module is a base module that allows federates to request, provide and consume services. This design pattern is also used in the NETN Logistics FOM module for logistics related services.

Logistics Modules - The NETN Logistics services are based on the NETN Service Consumer-Provider Pattern including the following services:

- **Supply service** is provided by a facility, a unit or entity with consumable materials supply capability. Resources are transferred from the providing unit to the consuming unit.
- **Storage service** is provided by a facility, a unit or entity with consumable materials storage capability. Resources are transferred from the providing unit to the storage.
- **Repair service** can be performed on equipment (i.e., non-consumables items such as platforms) by facilities or units capable of performing requested repairs. Modelling responsibility is by default not transferred from the consuming unit (e.g., a damaged platform) to the application with modelling responsibility for the providing unit (i.e., repairing facility). Modelling responsibility can be transferred by introducing the Transfer of Modelling Responsibility (TMR) pattern.
- **Transport service** is provided by a facility, a unit or entity with transportation capability of non-consumable materials (units). Transported units are embarked, transported and disembarked. Modelling responsibility is by default not transferred from the consuming unit (transported unit) to the application with modelling responsible for the providing unit (transporter). Modelling responsibility can be transferred by introducing the Transfer of Modelling Responsibility pattern.

CBRN Module - The NETN FAFD includes a FOM Module designed to add specific support for CBRN modelling and simulation. NETN Federations modelling CBRN events and effects are recommended to make use of the NETN FAFD CBRN design.

MSDL - NETN federations are also advised to use Military Scenario Definition Language (MSDL) [7] and propose a NETN extension of MSDL to provide federates with initial scenario settings including ORBAT.

In the context of NATO Certification and the work of NMSG-134, these modules and associated federation agreements represent an additional level of verification compared to the previous HLA Certification that focused only on the use of HLA services. By providing a certification capability that tests, verifies and certifies individual simulation systems' compliance with AMSP-04, the level and degree of certified interoperability can be increased.

3. Process of certification

The Concept of operation (CONOPS) as one of the NMSG-134 deliverables is the key document describing the business model of the proposed Integration Verification & Certification Tool (IVCT) software and the execution of the certification process and the individual roles and responsibilities and the proposed way of the implementation in the NATO and Nations.

The **certification process** must not be managed and executed by a single entity. The certification has to be standardized and has to be easily understood by non-professionals. The whole certification process is depicted in figure 3.1.

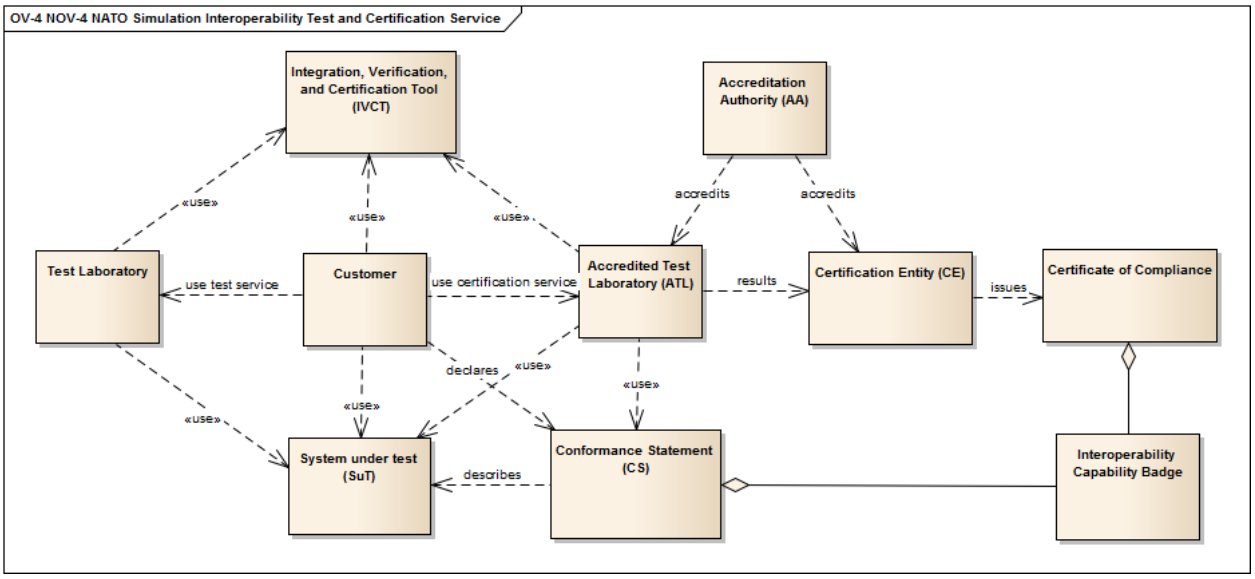

Figure 3.1: The Certification process and the Main actors

The highest authority in the certification process is the Accreditation Authority (AA). It accredits the Test Laboratories as qualified entities to perform a test suitable for certification, and the Certification Entities as qualified centers with the authority of deciding whether a System under Test (SuT) has passed the certification test. AA defines RTIs, Federation Object Models (FOMs), Federation Agreements (FAs) to be supported by IVCT. AA is responsible for maintaining the Certification Business Model. AA collects and defines NATO and National M&S interoperability requirements, prioritizes them, and identifies Badges that covers these requirements.

The Certification Entity (CE) issues the Certificate of Compliance based on the results of the tests. The Certificate of Compliance requires a specific set of awarded Badges. This entity also maintains the version number of the IVCT. CE delivers the latest version of the IVCT to Accredited Test Laboratories (ATL) and Test Laboratories (TL). CE provides a list of all ATLs and Badges that are accredited. CE sets up a profile of requirements for a certification depending on the Customer's needs and informs the Customer of available ATLs.

The ATL is accredited by AA. The task of the ATL is to conduct the certification test on behalf of the CE. The ATL delivers the test results to the CE. The relationship between CE and ATL is a client-service construction. ATL supports CE in maintenance tasks according to the business model set by AA. ATL negotiates the cost of the certification with the Customer and proposes changes for the next version of IVCT.

The TL is an organization that uses the IVCT to conduct tests for reasons other than certification (integration, verification…). It might be any NATO's or Partners' Laboratory. The TL must be recognized by CE.

The **Conformance Statement** is part of the contract between the Customer and the ATL. It determines on which sets of Interoperability Requirements the System under Test should be certified. AA identifies NATO's and National Interoperability Requirements and its priorities. These Interoperability Requirements are captured by Capability Badges. Therefore the Conformance Statement should explicitly declare only the following:

- System Under Test
- SOM containing explicit list of HLA services
- FOM
- Date of certification request
- Company
- Contact Information
- Set of Capability Badges, including name, type and year of each Badge

The concept of using **badges** to indicate achievements is nothing new. It can be found in many domains from scouts to military. In on-line gaming, badges are frequently used to display the individual gamers' skill, accomplishments and level of play. The semantics associated with badges and how they are used vary between different domains and even within a single domain you can find different types of badges showing skill, quantitative and qualitative achievements, specific mission badges, and badges showing general maturity or level. Applying the badges concept to Interoperability Capabilities has been explored in research activities in the United Kingdom. In this research, an Interoperability Capability Badge is defined as "a token of achievement in terms of passing testing related to interoperability". For NATO, the badges are based on the NETN FOM but **the badge concept is available for any FOM**.

As already explained, the AA identifies NATO's and National Interoperability Requirements and its priorities. These Interoperability Requirements are covered by Capability Badges. Requirements are grouped into Categories of Requirements. The initial set of NATO Interoperability Requirements Categories defined by NMSG-134 is here:

ID	Name	Description
BP	Best Practice Conformance	Requirements related to best practices for distributed simulation
DOC	Documentation Conformance	Requirements for documenting interoperability capabilities
IP	Interoperability Pattern Conformance	Requirements related to patterns of simulation interplay
SOM	Simulation Object Model Conformance	Requirements related to the Conformance of a SuT to the SOM provided in CS

As a first example of an individual Interoperability Requirement the "Best Practice Category" (BP) has been chosen by NMSG-134:

ID	Category	Description
IR-BP-0001	BP	SuT shall provide attribute updates for the requested attributes owned by the SuT
IR-BP-0002	BP	SuT shall create a federation before joining, if it does not already exist
IR-BP-0003	BP	SuT shall join a federation with only those FOM modules that are used by SuT

The initial set of Capability Badges has been identified by NMSG-134:

ID	Dependency	Description
HLA-BASE-2016		Basic CS/SOM and Best Practices compliance
NETN-AGG-2016	RPR-AGG-2016	NETN-FOM v2.0 Aggregate FOM Module
NETN-ENTITY-2016	RPR-ENTITY-2016	NETN FOM v2.0 Physical FOM Module
NETN-MRM-2016	NETN-TMR-2016	NETN FOM v2.0 MRM FOM Module
NETN-TMR-2016	HLA-BASE-2016	Basic support for NETN TMR pattern (AMSP-04 Ed A). SuT is able to respond to TMR requests.
RPR-AGG-2016	HLA-BASE-2016	RPR-FOM v2.0 Aggregate FOM Module
RPR-ENTITY-2016	HLA-BASE-2016	RPR-FOM v2.0 Physical FOM Module support. GRIM compliance wrt. Platforms, Lifeforms etc. representation of required attributes.

To receive the HLA-BASE-2016 Capability badge from CE, ATL must run all Test Cases (i.e., sequence of mandatory tasks such as join the federation, publish an interaction…) which have to comply with all three previously defined Interoperability Requirements; IR-BP-0001, IR-BP-0002 and IR-BP-0003.

The IVCT tool and the whole certification process must financially be self-sustaining. A transparent and well elaborated **business model** is depicted in figure 3.2.

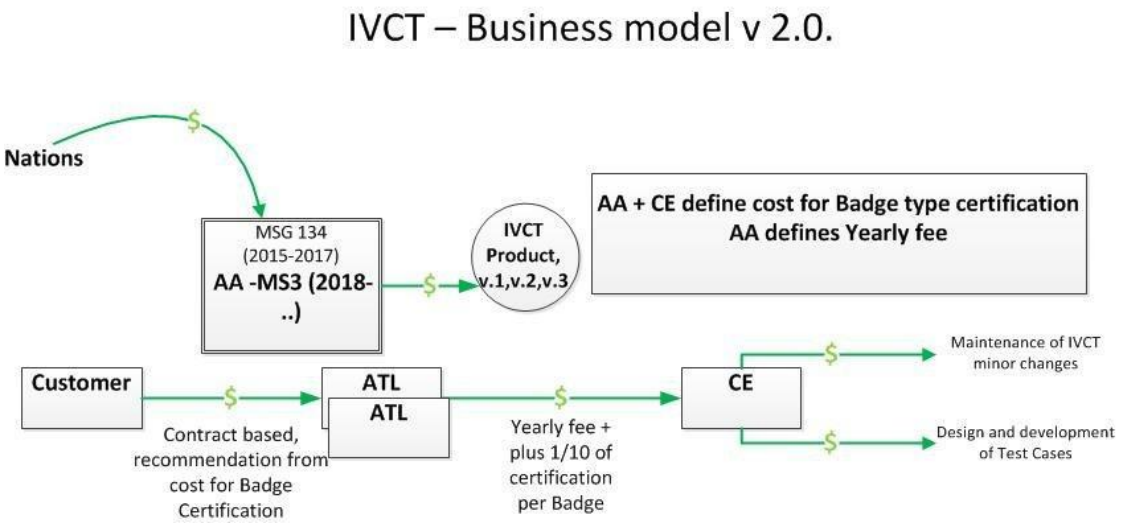

Figure 3.2 Business Model of the IVCT

The first release of the IVCT tool and the first set of implemented Test Cases are sponsored by Nations participating in NMSG-134. When the group's work is finished, the maintenance of the IVCT and the updating of the Test Cases will be done by the CE, the NATO Modelling and Simulation Centre of Excellence in Rome. ATLs will provide feedback and will make proposals for updates on the IVCT to the CE. CE will maintain the list of IVCT requirements and get approval from the AA for IVCT updates. CE may conduct updates by itself or participate in collaborative efforts initiated by the AA.

NMSG-134 will implement the first set of Abstract Test Cases and corresponding executable Test Cases based on a prioritization coming from the NATO MS3.

When the group's work is finished, AA represented by MS3 will be responsible for managing all Capability Badge definitions. The CE will be responsible for the development of the Abstract Test Cases and for corresponding executable Test Cases. The AA will support the CE by providing SMEs to help defining Abstract Test Cases for particular Badges.

The IVCT maintenance and the Test Case development will be funded by a yearly fee. The AA together with the CE has to set the yearly fee for the Badge Certificate to be paid by the ATLs. The ATLs have to set the cost of certification testing to be paid by their customers.

4. Tool Development

4.1 Certification requiring Testing

Interoperability is not only a matter of compliance rules and certification processes, it also requires testing. The implementation of federates to be compliant to rules within sometimes complex interoperability patterns, is certainly a failure prone process. The rules can be misinterpreted or simply implemented in a different way, and the resulting federate is not compliant. Without testing, there is a high risk that such compliance faults are detected too late, or even worse, not at all. Even if the federate implementers are also implementing their own tests, there is still the risk that these tests contain the same implementation or interpretation faults. In these cases, the federate implementation will pass the internal quality control process, but it is still not compliant.

For these reasons it is essential to provide a complete test framework along with the compliance rules, to be used:

- by every federate developer to test the implementation to be fit for the integration into a federation,
- by every federate user to test the valid behavior,
- and finally by the certification authority to award compliance badges.

To support these three use cases, the NMSG-134 working group started the development of the Integration, Verification and Certification Tool.

4.2 Interoperability Testing is a Community Effort

The implementation of a testing tool is often considered to be an unavoidable burden. It is something everybody needs to use to create reliable code, but nobody likes to invest into it. But, in many cases, it can be very beneficial for the programmer, to first focus on the tests before writing any application code, because the tests are actually the requirements for the application. And it is always a good idea to first understand the requirements, before you start to implement them (the term "Test-driven development" is used to describe that approach, see https://en.wikipedia.org/wiki/Test-driven_development). This is especially true for the implementation of an interoperability patterns. Such patterns define the rules and procedures how a certain task shall be done in a federation of interworking simulation systems.

In the HLA community, such patterns are traditionally being defined in a more or less formal textual description. In most cases, these definitions are implemented within existing federates before being released, in order to test if the patterns work as expected. Most of the NETN patterns have been developed in such way: a NMSG identified the demand for certain functionality, then a concept was developed as an interoperability pattern to implement this functionality and finally the group proved the correctness and practicability of the pattern by developing a prototype. This process was conducted to define the NETN FOM during the NMSG-068, and later the NMSG-106.

After the pattern is finalized and released, these prototype developments are normally abandoned. The NMSG-134 would like to change this process by providing the IVCT framework to everybody who is developing an interoperability pattern, in order to get a framework to implement the tests described above in a reusable way, so that following developers of the new pattern will have a testing capability. Such a testing capability will make the adoption of an interoperability pattern much easier for developers, and it will benefit the overall interoperability because the tests are unambiguous and as complete as possible.

4.3 Availability and Open Source

The efficiency of an HLA federation strongly depends on the interoperability of all of the involved federates. If one federate fails to be compliant, the complete federation is compromised. So, it is in the benefit of everybody in the federation, that each single federate is thoroughly tested. To make this possible, the NMSG-134 decided to make the IVCT as available as possible, by adopting the Open Source Software model to all core elements and to all test cases for public interoperability patterns.

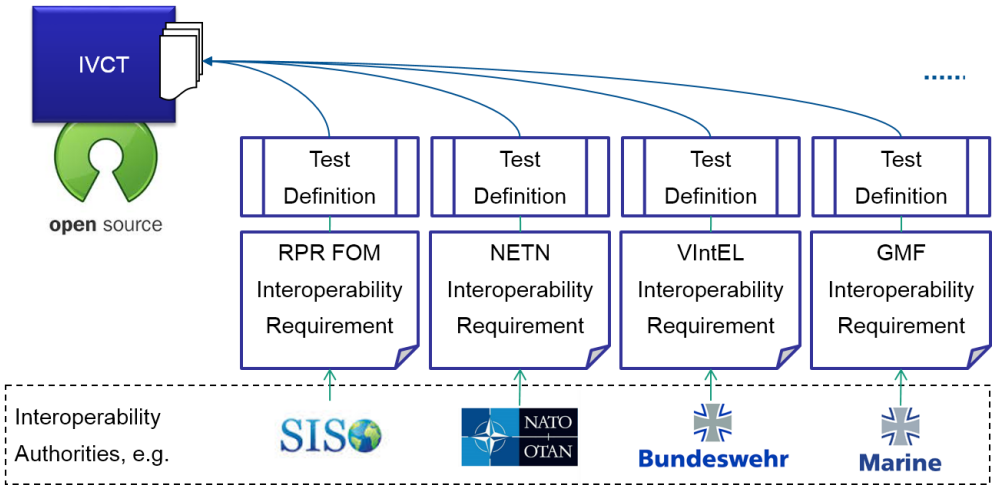

Figure 4.1: Community provided test definitions

The main idea is that each authority that provides public interoperability definitions, shall deliver test cases along with their conceptual definitions within the framework of IVCT. These test cases shall be used as basis to test all of the interoperability requirements within a particular interoperability definition.

The selected license model for the IVCT framework is the Apache 2.0 (see http://www.apache.org/licenses/). It shall be possible to use the IVCT software in a very unrestricted way, in order to foster its usage in as many environments as possible. The Apache 2.0 license supports a commercialized usage and extension of the software in many possible ways. This is intended to enable different business cases using the IVCT software to broaden the users' community and to invite software development resources to use and to support it. To make sure that all contributions to the core elements will be made available as open source in order to avoid vendor lock-in situations, the IVCT ownership will be transferred to NATO affiliated entity. The details about this transfer are still to be decided.

4.4 Current Planning

The current plans for the IVCT development are aligned with the NMSG-134 work plan. It foresees a draft version of the IVCT framework along with several test case implementations for the RPR-FOM and the NETN-FOM interoperability definitions. This draft version will be evaluated within the context of a major interoperability experiment in 2017. The NMSG-134 will finalize its work by the end of 2017 and this will be also the date for the version 1.0 of IVCT. This version is planned to be used for the implementation of the certification test procedures as described in the CONOPS.
The development of IVCT is available for early adopters via a Github repository (https://github.com/MSG134). As a disclaimer it must be mentioned, that this is work in progress and does not provide a complete or stable version.

The current architecture of the IVCT framework is shown in figure 4.2. It essentially contains two different parts, which are the "System under Test Ecosystem" (SuTE) and the "Integration, Verification and Certification Tool" (IVCT). In the SuTE, the "System under Test" (SuT) is the actual target of the testing, and possibly additional components as the "Auxiliary Federate" (AuxF) or the "Auxiliary Service" (AuxS) could be required to operate the SuT. The IVCT is contains a "Test Engine" (TE) with an "Configuration and Reporting" Component, and a "Graphical User Interface for Federation Execution Control" (GUI/FedExecCtl). The "(High Level Architecture) Run Time Infrastructure" (RTI) connects the IVCT with the SuTE.

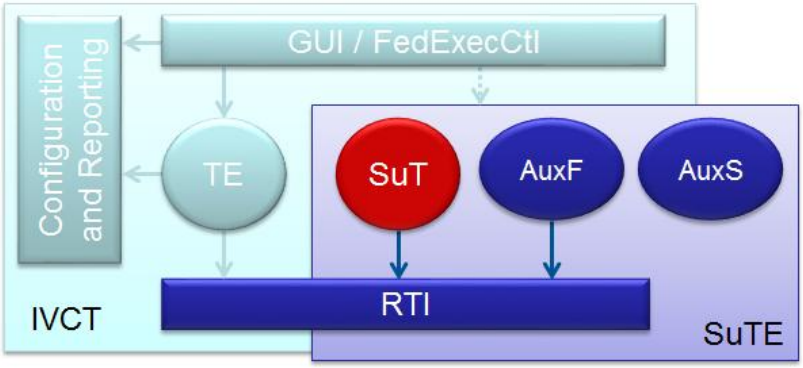

Figure 4.2: Certification architecture

The test cases which are currently under development are the following:

Test cases series	Modules
HLA-BASE Test Cases	• Test Case::HLA OMT Compliancy • Test Case::HLA Declaration Management Test • Test Case::HLA Object Management Test • Test Case::HLA Services Verification

RPR Test Cases	• Test Case::RPR2 Enumerations • Test Case::RPR2 Warfare • Test Case::RPR2 Communication • Test Case::RPR2 SIMAN

5. Way Forward

Again, the essential objectives of NMSG-134 are:

- the maintenance of NATO Education and Training Network Federation Architecture and FOM Design Document (NETN FAFD)
- the development of an integration, verification and certification tool
- the provision of a persistent test and integration network to support FAFD development and test, verification and certification activities

After the publication of NETN FAFD as AMSP-04 the maintenance will also be done by NMSG-134 for the duration of the group. This includes updates and releases of new versions of the technical specification and the dissemination through presentations, papers and standardization activities within NMSG, SISO and at other venues.

An initial goal of IVCT is to create a first set of well approved test cases which could be used as a first step in the direction of a fully interoperable simulator for a specified distributed simulation environment. Therefore the context of the distributed simulation should not be forgotten.

NMSG-134 is planning to initiate the certification service as a proof-of-concept during CWIX 2017. For this case NMSG-134 will operate as the Accredited Test Laboratory. If all participants of the M&S Focus Area use IVCT, this would be a good start to get a feedback from users outside the NMSG-134 working group.

The recommendation of NMSG-134 is to establish the Modelling and Simulation Standards Subgroup (MS3), which is tasked to create and maintain the NATO M&S Standards Profile, as the Accreditation Authority (AA). The subgroup would be responsible for managing all capability badge definitions. The role of the Certification Entity is seen at the M&S CoE. It is responsible for abstract test cases development and for corresponding executable test cases.

For the future it is a stringent necessity that participating nations agree to utilize the HLA compliance certification process and that they agree to enforce the HLA Certification Process on a national level**. This allows NMSG-134 to accomplish its mission to deliver certification processes and tools to enable cost effective and reliable Plug & Play of multinational simulations for the warfighter.**

6. Main acronyms

AA (Accreditation Authority), AMSP (Allied Modelling and Simulation Publication), ATL (Accredited Test Laboratory), C-BML (Coalition Battle Management Language), CAX (Computed Assisted Exercise), CBRN (Chemical, Bacteriological, Radiological and Nuclear), CE (Certification Entity), CONOPS (Concept of Operations), FAFD (Federation Architecture and FOM Design), FCTT (Federate Compliance Testing Tool), FTMS (Federate Test Management System), IVCT (Integration Verification & Certification Tool), MRM (Multi-resolution modelling), NATO (North Atlantic Treaty Organization), NETN (NATO Education Training Network), NMSG (NATO Modelling Simulation Group), SuT (System under Test), STANAG (Standardization Agreement), STANREC (Standardization Recommendation), TL (Test Laboratory), TMR (Transfer of Modelling Responsibility)

References

[1] STANAG 4603, “Modelling and Simulation Architecture Standards for Technical Interoperability: High Level Architecture (HLA)”, Edition 2, 2015.

[2] IEEE Std 1516.1^{TM}-2000, "IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA) - Federate Interface Specification", 2000.

[3] SISO-STD-004.1-2004, "Standard for Dynamic Link Compatible HLA API Standard for the HLA Interface Specification (IEEE 1516.1 Version)", 2014
[4] "Towards operational interoperability: NATO FOM and certification of simulation interoperability within the French Ministry of Defense", Jose Ruiz, Jean-Gabriel Herbinet, Jean-Pierre Faye, SISO Fall Simulation Interoperability Workshop, 2011.
[5] SISO-STD-001.1-2015, "Standard for Real-time Platform Reference Federation Object Model (RPR FOM)", 2015.
[6] "The improvement of simulation interoperability by introducing the C-BML (Coalition Battle Management Language) benefits into the HLA world", Jose Ruiz, SISO Fall Simulation Interoperability Workshop, 2012.
[7] SISO-STD-007-2008, Simulation Interoperability Standards Organization, "Standard for: Military Scenario Definition Language", 2008.

Author Biographies

JOSE RUIZ is a technical and operational research manager at the CATOD Center, French Ministry of Defense, Arcueil, France. After his engineer studies, he arrived in the French Ministry of Defense to conduct studies on weapon systems by using simulation support. Since sixteen years, he is in charge of simulation interoperability projects dedicated to joint exercises and experiments, in both national and international context. He regularly participates in NATO M&S Working Groups since 2007 (NMSG-068, NMSG-106, NMSG-134 and ET-046). He is member of SISO since 2001.

HORST BEHNER is Technical Officer at the Bundeswehr Joint Materiel Office (BAAINBw) in Koblenz, Germany. He received his M.Sc. degree in Physics from the University of Karlsruhe, Germany. The first five years he was responsible for the development of the trainer of the German Anti-Aircraft-Tank GEPARD (Cheetah) in Bavaria. Then he participated in the Exchange Program for Engineers and Scientists with the USA and worked as a Lead Engineer for one year with the US Navy at NAVAIR in Orlando, Florida. Back in Germany he became German Speaker and Chairman in several NATO MSGs. From 2005 to 2011, he was the German Liaison Officer for C4ISR at CERDEC in Fort Monmouth, New Jersey, and at the Center of Excellence Team C4ISR in Aberdeen Proving Ground, Maryland. Since fall of 2011, he is again German Speaker with several NATO MSGs and CapTech National Coordinator with the European Defense Agency (EDA).

REINHARD HERZOG is leading the research group "Modelling and System Networking" at the Fraunhofer IOSB. He is responsible for the development of conformance test systems for various communication protocols and the design of communication infrastructures and integration middleware systems. Since 2012 Reinhard Herzog has been member of the NATO Modelling and Simulation Group "Enhanced CAX architecture, design and methodology (MSG-106) and was chairman of the NATO Modelling and Simulation Exploratory Team "Development of HLA Federates Compliance Testing Tool" (MSG-ET-035).

LTC JAN HODICKY was appointed in February 2013 as Doctrine Education and Training Branch Chief in NATO Modelling & Simulation Centre of Excellence in Rome, Italy. In 2003 he advocated his thesis on Modeling and Simulation to support optimization of Targeting in Autonomous Weapon System. From that time LTC Hodicky became a member of Communication and Information Department (CTD) responsible for education in the Computer Science domain. His research activity have been focused on the Modelling and Simulation aspects in the military, namely the interoperability between Command and Control Systems and Modelling and Simulation assets and use of Virtual Reality in military training.

BJÖRN LÖFSTRAND is a senior systems architect in the area of modelling and distributed simulation design. Mr. Löfstrand has been engaged in national, international (SISO) and NATO M&S standardization activities for over 15 years participating in the development of standards like High-Level Architecture and engaging in MSG projects such as MSG-027, MSG-052, MSG-068 and MSG-106. Currently Mr. Löfstrand is the NMSG-134 FAFD activities lead. Mr. Löfstrand has a M.Sc. in Computer Science from the University of Linköping (Sweden) and he is the Services and Training Manager at Pitch Technologies.

STEFAN VRIELER is a civil servant at the Technical Center for Weapons and Ammunition (WTD 91), a test facility of the German Federal Armed Forces. As an engineer, he is responsible for R&D projects in the area of distributed simulation systems. Stefan Vrieler was involved in activities of NMSG-086. He is a SISO member since 2013.