NMSG-039/TG-027 Preliminary Analysis of Tactical Data Link Representation in Extended Air Defence Simulation Federations

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ABSTRACT: *This paper presents the preliminary results of the NATO Modelling and Simulation Group 039 / Task Group 027 "Modelling and Simulation Support of Extended Air Defence Command and Control Interoperability". This activity is the second of three phases of NMSG Technical Activity Programs (TAP) that began with a feasibility study and will culminate with the implementation phase linked up and harmonized with the NATO Active Layered Theatre Ballistic Missile Defence (ALTBMD) program. The ALTBMD program will be supported by an Integrated Test Bed (ITB) for evaluation and validation purposes. MSG039 should produce results that support the ITB development by acting as a pathfinder for its requirements definition and implementation approach.*

The Task Group is comprised of members of six NATO nations (FR, NL, NO, TU, UK, US) and the NATO C3 Agency (NC3A) and is chartered to develop and demonstrate an initial simulation architecture for NATO Extended Air Defence C2 Interoperability. Central to the work of the TG is the development of the Federation Object Model (FOM) which is based on the Real-Time Platform Reference Federation Object Model (RPR FOM). The paper will discuss the trade-off between SISO TDL BOM and other methods of 'wrapping' TDL messages, such as STANAG 5602 (SIMPLE). The paper will also present the architecture of the MSG039 federation, which is scheduled for final demonstration in June 2006. The scenario represented in that demonstration will be a hypothetical future threat of different TBMs. The participants of the demonstration include federates representing the US Early Warning satellites, NATO Shared Early Warning (SEW), NATO Air Command and Control System (ACCS), Early Warning Radar systems, land and maritime weapon systems.

1. Introduction

Extended Air Defence (EAD) began with an appreciation of the risks posed to the NATO Alliance by the proliferation of NBC weapons and their delivery means, and recognition that NATO's new Strategic Concept necessitated the protection of (deployed) NATO forces, territory and population against ballistic missiles. Within NATO, some countries already have ATBM (Anti-TBM) capabilities, others are in the process of acquiring these capabilities.

One of the most important issues that must be addressed will be **interoperability** between all TBM defence architecture elements within NATO: especially the **Command and Control elements**; tactical and procedural co-ordination between combined and joint EAD forces; and deployment and contribution of future elements (for instance airborne laser). NATO and the nations can do something to improve Command & Control and **"turn individual weapon systems (point solutions) into a defence system".** The only way of knowing what Nations should do is to explore through simulation and progressively work to a situation where the simulated elements are replaced by real ones. This simulation environment could also provide a training framework for the future.

1.1 What is ALTBMD

NATO's concept of operations for theatre missile defence relies on three functional areas (pillars) : Conventional counter force, Active Defence and Passive Defence.

- Conventional counterforce seeks to destroy the aggressor's ability to launch TBMs.
- Active Defence aims to destroy TBMs while in flight.
- Passive Defence aims to provide sufficient warning about TBM impacts to allow for effective protection measures to be implemented.

The coordination of these three pillars is made through NATO BMC3I systems.

Active Layered Theatre Ballistic Missile Defence (ALTBMD) aims to destroy TBM's in all phases of flight, Boost, Exo- and Endo-atmospheric, to provide protection to deployed NATO forces.

NATO acknowledges TMD to be only a subpart of the Extended Air Defence mission, which must take advantage of all the systems deployed for the conventional air defence. The TMD assets and the TMD specific BMC3I functions must be seamlessly integrated into the current and future NATO C3 capabilities.

1.2 NATO's plan and vision

NATO will implement the ALTBMD Capability by increments. Each increment will be capable against certain types of threat, its capability resting on the integration of more and more effective weapons systems from more and more allied Nations.

Using existing systems, NATO possesses an embryonic TMD capability that will be enhanced when the National Upper Layer Systems become available to NATO.

The ALTBMD capability is nevertheless very dependant on the progress on National Programmes and the success of the development of National Systems. NATO traditionally provides only BMC3I capabilities, while sensors and weapons are provided by the Nations.

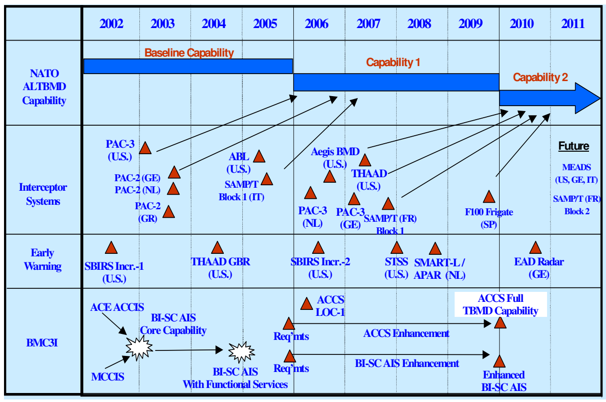

Figure 1 NATO ALTBMD Schedule

The NATO ALTBMD implementation plan is depicted in the diagram above. IOC will be in 2010 and FOC in 2012.

1.3 What is ITB

In order to achieve the integration of the most complex systems of systems that NATO has ever fielded, the

NATO Staff Requirements (NSR) [Ref. 1] identifies the need for a global risk reduction platform, on several grounds:

- Design & Experimentation platform, in order to test and validate technical solutions prior to the capability increment development,

- A formal Integration, test and validation platform, in order to verify the compliance of the TMD Architecture to its specifications,

- An operational risk reduction platform, enabling the refinement of the TMD CONOPS as well as providing training to TMD Operators.

This will be realized by the Integration Test Bed (ITB). The ITB shall be capable of all Technical Evaluation Tests necessary to verify that each NSR requirement has been met. The ITB shall be used to verify integration of the ALTBMD components into a single system to ensure that system-of-systems interoperability and end to end system performance requirements are met, implemented and validated. The ITB will have a core located at NC3A in the Hague and will be extended with remote applications linked-in through secure networks.

1.4 How does MSG-039 fit in

The NATO RTO Modelling and Simulation Group (NMSG) recognised the important role that interoperable simulations could play in the EAD field and set up the MSG006/TG006 Task Group (TG) to investigate this area. This Task Group produced a report [Ref. 2] which describes the issues relating to EAD and C2 (e.g. C2 interoperability within NATO), the current use of M&S to support the EAD field (e.g. training, research and analysis) and it identifies opportunities for improved support through M&S. The TG concluded that with respect to EAD, the weapon systems are likely, as usual, to do what they do. Nations and NATO can get the best value for money through the Command & Control and co-ordinate the weapons, provide warnings for passive defence, cue sensors, etc.

The findings of the study include the fact that although the High-Level Architecture (HLA) [Ref 3] is the accepted standard for M&S interoperability, many existing models and simulations can not effectively interoperate due to lack of compliancy either to HLA or to a standardised data model (i.e. FOM). The study group identified the need for standard FOMs that cover Tactical Data Links (TDLs) and recommended the TDL FOMs under development within the Simulation Interoperability Standards Organisation (SISO) [Ref 3].

The NMSG decided to set up a programme to demonstrate the possibilities of M&S to C2 interoperability in the EAD area. This Technical Activity MSG-039/TG-027 is dealing with the definition and planning/performing of a demonstration of such an environment. The MSG039 activity is carried out from 2004-2006 and depends on national programmes that serve as a framework. Activities and results of MSG039 should link with the NATO Active Layered Theatre Ballistic Missile Defence (ALTBMD) Feasibility Studies, managed by NC3A. MSG039 should produce results that support the ITB development and define its requirements and approach accordingly. The MSG039 will thus act as ‘pathfinder’ for ITB. The Task Group is comprised of members of six NATO nations (FR, NL, NO, TU, UK, US) and the NATO C3 Agency (NC3A).

The objectives of the MSG-039/TG-027 are to define, design and demonstrate an initial instantiation of a simulation environment to enable the demonstration of the possibilities of M&S to C2 interoperability in the EAD area. The MSG039/TG027 will define and demonstrate the NATO ‘Reference Testbed for EAD Implementation’ (READI), which will be based on the principles of HLA. This will require the creation of a detailed plan following the HLA Federation Development and Execution Process (FEDEP). Federates or systems may be contributions of the nations or NATO. MSG039/TG027 intends to develop the demonstrator in an incremental approach. Federation Increment 1 (READI-P) will be designed to test the federation infrastructures. Federation Increment 2 (READI) will implement the complete federation to perform the demonstration or exercise defined.

The demonstration objectives for MSG039/TG027 will focus on Integration, Validation & Qualification for ALTBMD integration into the ACCS infrastructure. The MSG039 activity of developing a Reference Testbed is to be seen as a ‘pathfinder’ for the NATO ITB development that provides guidance and recommendations which were tested in a limited experiment.

1.5 Test Case Selection

The TG proposed and discussed several Test cases which are representative for the research questions that may be investigated with an environment like the future ITB. The test case was intended to provide more specific guidance to the development of READI. Some examples of possible test cases are:

- Early Warning
  Enhanced SA using Early Warning, provide initial track from EW to right asset

- Engage on Remote
  Long range Radar used to fire missile before detection by weapons radar. Use the current systems, but show enhanced capabilities provided by NEC.
- Analysis on Link16 Reporting & Responsibility (R2) rules

Based on the TG's elaboration and ranking, the 'Early Warning' case was selected for the demonstration and provides the objectives and guidelines for the requirements, design and implementation of READI. The overall objective for the EW case is to evaluate the utility of EW and demonstrate EW quality trade-offs with respect to: space-based EW system (IR), 3-D EW radar and Over-The-Horizon radar. In addition, the demonstration will investigate issues like the Link16 Reporting & Responsibility (R2) rules and different radar search modes based on different qualities of shared EW.

1.6 Paper Organization

The remainder of the paper is organized as follows. Section 2 discusses the configuration of the federation, the associated simulated Link 16 network, and the approach to capturing and analyzing data. Section 3 will discuss the study associated with the selection of the SISO TDL BOM as the preferred method of representing Link16. Section 4 will discuss the technical approach to the February integration test and the report will conclude with the plans for the final experiment, scheduled for June 2006, and the team's expectations regarding the use of its results for NATO's ITB. Experiment Description

The experiment is intended to represent an operationally realistic EAD C2 architecture for NATO forces in the 2015 timeframe. Figure 2 represents the notional EAD C2 architecture used in the experiment.

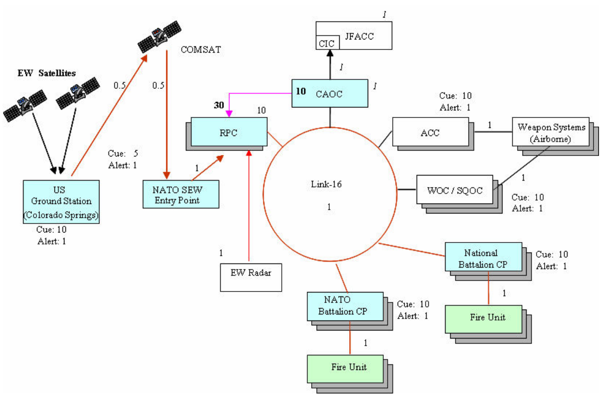

Figure 2: Notional EAD C2 Architecture.

Note there are contributions of several national sensor, command and control and weapon systems as well as the simulation of the NATO Air Command and Control System (ACCS).

2.1 Objective

The overall objective of the experiment is to connect several national and alliance sensors, command and control nodes and weapon systems and demonstrate and quantify the effectiveness of the SISO TDL BOM in representing the Link16 network within a distributed simulation environment. The approach taken is to perform an initial integration test at the simulation laboratories of TNO to verify FOM performance. This test is scheduled for 6-10 February 2006 during which the data collected will be analyzed and used in preparation for the final demonstration in June 2006 at NC3A.

The initial integration event will consider a subset of the final C2 architecture, omitting the CAOC and JFACC nodes and will examine the performance of the network connectivity between the various federates. In general, this testing will measure the latency (round trip timing) between the active nodes on the network. Message latency statistics will be collected but no communications delays or bandwidth limits will be injected into the demonstration.

The final demonstration will represent the full C2 architecture (CAOC and JFACC) and may inject representative data latencies into the postulated network topology. The final demonstration will fully exercise the data collection, reduction and analysis.

2.2 Scenario

MSG-039 decided to use a scaled-down version of the NATO Russia CPX 2004 scenario and adapt it for our purposes. That scenario was formally released to MSG-039, which was much appreciated since it saved time.

The nations Yellowland and Greyland are in dispute over Virtua, a region which is located between the two countries and offers precious metals and minerals. The conflict has lasted for decades and the political leadership of Yellowland is now taking military actions to reclaim Virtua from the Republic of Greyland. The actions are directed at destroying population centres, communication infrastructure, power stations and military capabilities in the Republic of Greyland.

In an attempt to restore stability in the region, a NATO peace keeping force has been deployed in Greyland. This force is known as the Greyland Force (GFOR). GFOR is comprised of three national NATO Brigades, NATO ACCS and early warning sensors. The national NATO Brigades B, C and D and their respective Areas Of Responsibility (AOR) are shown in the Defence laydown in Figure 3. There are two battalions equipped with Lower Layer systems, two regiments equipped with SAMP/T (Lower layer) and one battalion equipped with an Upper Layer System.

NATO ACCS can be viewed as a combination of components. A Combined Air Operations Centre (CAOC) has overall responsibility for planning and tasking. Tactical control of air missions is performed by the Air Control Centre (ACC). The Sensor Fusion Post (SFP) and Rap Production Centre (RPC) are responsible for injecting early warning data and producing the recognized air picture. Once an ACC, RPC and SFP are co-located then they become an ARS. A CAOC co-located with an ARS is collectively known as CARS. A Deployable CARS (DCARS) is deployed in the scenario as shown in Figure 3.

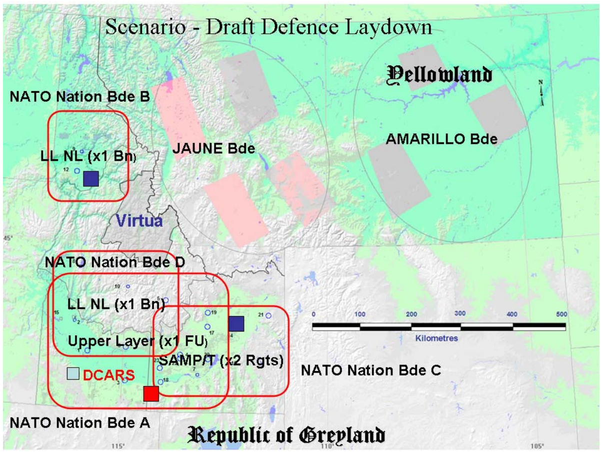

Figure 3 Defence Laydown

The two Yellowland surface-to-surface missile Brigades comprise of a short-range and a long-range brigade known as 'Jaune' and 'Amarillo' respectively. An attack with 22 missiles is launched against eleven assets in Greyland. The missiles are launched simultaneously, in minimum energy trajectories and there are no penetration aids (penaids) or countermeasures. The composition of the raid is outlined in Table 1.

Ballistic Missile Type (Range)	Brigade	Number of BNs	Total number of TELs	Number of Missiles
300 km	Jaune	1	5	**5**
500 km		1	4	**4**
600 km		1	5	**5**
600 km	Amarillo	1	4	**4**
1300 km		**1**	**4**	**4**

Table 1: TBM Characterization

2.3 Federation Design, Test and Integration

An outline of the Federation design and a pre-selection of candidate Federates/Components were established and are listed in Table 2 below. The notional Federation design for READI-P is shown in Figure 4 below. Mainly due to the limited timeframe, all Federates and Components have been based on available resources and modifications to existing resources have been minimized. Detailed requirements for the components and federates were derived based on the selected 'Early Warning' scenario.

The main purpose for developing READI-P is proof of concept and demonstration of flexibility. With this objective in mind, the TG chose to define 'Requirements' and also 'Recommendations for Implementation' for each of the elements of READ-P. This approach allows the distinction between how the test bed should ultimately be designed and how it will be realised within the limited

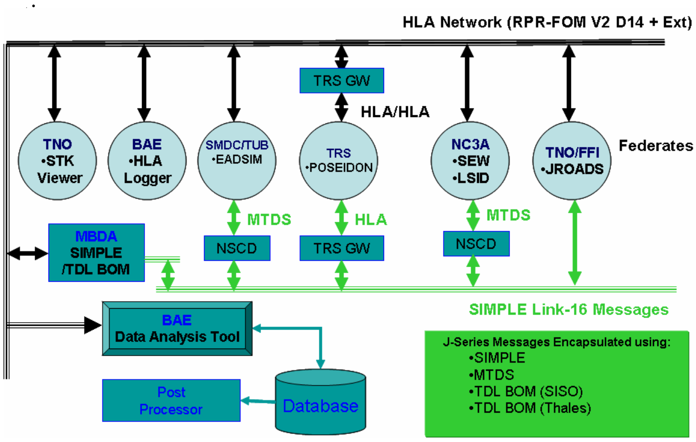

Figure 4 Notional Laboratory Configuration

An example of federate requirements are the real-world ‘Interactions’ that need to be supported between each of the Federates/Components. These were categorized and mapped onto available or new HLA message or data exchanges (Publishers & Subscribers). This data exchange includes the data link messages that are typically supported through Link16. The modelling of TDL is elaborated in section 3 below.

The federation design included the identification of tools that are not typically part of the simulated real-world, but are useful for analysis, monitoring or debugging purposes, for example 3D viewers and loggers. Events that are of interest include threat and interceptor launches, initial detections, authorization messages and missile and debris impacts etc. Where appropriate, events should be analysed in real-time during the run, to support Situational Awareness in the exercise control staff and enable immediate post-exercise debriefs. Analysis tools should, where possible, deduce events from existing HLA traffic rather than requiring specific notification from the federates.

Component Type	Real-World Component	Element	Model	Host
C2	JFACC	JFACC	PLATO	NC3A
	DCAOC	DCAOC	LSID/PLATO	NC3A
	ACC	ACC	LSID	NC3A
	RPC, SFP	RPC, SFP	POSEIDON	FR
Weapon Systems	GBAD & SBAD	Lower Tier (NL)	J-ROADS	NL
		Upper Tier	EADSIM	US-SMDC
		SAMP/T	POSEIDON	FR
		ADCF AEGIS	J-ROADS EADSIM	NL US-LMCO
Sensors	Early Warning	EW sensors	EADSIM	NC3A
			SEW Prototype	
	Long Range RADAR	M3R	POSEIDON	FR
Threat	BMs	300-1500Km	J-ROADS	NO

Table 2 Complete READI Components and Models for ‘Early Warning’ Testcase

An important element of the FEDEP is to define the ‘federation agreements’. This includes establishing the procedures for starting and controlling the exercise, managing time advancement and defining common algorithms for specific calculations so as to guarantee a consistent behaviour across federates. One example is methods by which the break-up of a BM is represented (booster, warhead, debris). Several concepts were discussed, one of the problems being that legacy simulations should still be able to play.

The TG selected the Mäk RTI as a common HLA interoperability layer. The vendor kindly permitted us to use some free licenses for those partners that did not yet have the toolset available. READI will use RTI V1.3 NG rather than the newer IEEE-1516 due to the fact that some legacy federates could not be upgraded within our timeframe.

The READI FOM that was specified is based on RPR-FOM V2 Draft 14 and extended with SISO TDL-BOM [Ref 4].

2.4 Data Collection, Reduction and Analysis

The approach to the experiment considers data collection, reduction and analysis requirements necessary to fully quantify the performance of the simulation C2 architecture. Systematic data collection will be conducted during the demonstration and a database will be populated that will facilitate data reduction and analysis in order to efficiently compute the metrics required to quantify system performance.

Early in the FEDEP process measures of merit (MOMs) and measures of effectiveness (MOEs) were prepared and integrated into the test design. We began with the definition of the Kill Chain and isolated relevant phenomena related to the elements of the Kill Chain. Below is the top-level description of the various metrics identified. For the FEDEP document, each of these items have been expanded to detail data collection, reduction and analysis (algorithms) necessary to compute the associated metric.

Kill Chain Definition

- Launch
- First detection
- Tracking
- Cueing
- Weapons allocation
- Engage
- Kill Assessment
- Consequence management

MOPs/MOMs

- Impact Point Prediction accuracy
- Launch Point Prediction accuracy
- Detection timelines
- Cueing delays
- Cueing accuracy
- Engagement timelines
- Number of leakers
- Altitude of destruction
- Weapons expended
- MOM (Input to model or simulation)
- Probability of Kill
- Probability of Detection

MOE's

- Number of TBMs intercepted
- Sensor coverage in theatre
- Missile coverage in theatre
- Number of leakers
- Weapons expended
- Average and standard deviation of altitude of destruction
- Average and standard deviation of detection time
- Average and standard deviation of cueing delays
- Average and standard deviation of cueing accuracy

A key component of the data collection, reduction and analysis capability is the use of real-time data mining, a technique brought in by our team member BAE Systems, which allows rapid computation of performance metrics.

3. TDL modelling trade off discussion

3.1 Challenges

Exchanging Tactical Data Link (TDL) messages is a key component in real world EAD. A consistent approach to the modelling of TDL, specifically Link16 [Ref 5], is therefore important to both the ITB and MSG.

MSG039 identified and compared several methods for disseminating Link16 messages in the NATO environment. The results of the comparison for the most relevant exchange methods are discussed below.

3.2 SIMPLE

The Standard Interface for Multiple Platform Link Evaluation (SIMPLE) is a Ground telecommunications-based network for platform interoperability testing of TDL. SIMPLE was developed by Digital Wizards/SPAWAR as a NATO initiative and was sponsored by NC3A. SIMPLE supports: TDL Messages, Scenario data (DIS PDUs), Test management and control data. Packet types include: Link4, Link11, Link16, Link22 and DIS PDUs. SIMPLE is available as STANAG 5602 (draft edition2).

3.3 SISO-STD-002-2006

The protocol described in SISO-STD-002-2006 [Ref 4] is to establish a standard for TADIL J message exchange and Link16 network simulation in the Distributed Interactive Simulation (DIS) and HLA interoperability frameworks.

The DIS simulation protocol for Link16 is described in terms of the established DIS Transmitter and Signal Protocol Data Units (PDUs). Link16 specific enumerations have been created to populate the standard fields and records. The implementation of Link16 exploits the fact that both these PDUs are variable length. In the case of the Transmitter PDUs, this protocol sets forth how the variable length "modulation parameter" fields must be populated. In the case of the Signal PDU, Link16 specific information is relegated to the variable length data fields.

The HLA instructions are presented in the form of a Base Object Model (BOM) that may be incorporated into a system Federation Object Model (FOM). Real-time Platform Reference (RPR)-FOM based simulations should be able to easily integrate the Link16 BOM into their FOMs. Furthermore, there is a straightforward mapping between the DIS PDU implementations and the corresponding BOM components.

In developing a protocol for simulating Link 16 in DIS and HLA, it is recognized that there are widely varying requirements for achieving fidelity among different users. This protocol attempts to establish procedures that may be used by the vast majority of users, by establishing discrete, scalable, interoperable levels of fidelity for different users. This, in turn, allows for low cost initial implementation with a path toward upgrading to detailed Link 16 emulation as requirements evolve.

That is a major difference and advantage for ITB. Future experiments will need the flexibility of the BOM to allow testing of bandwidth, propagation etc.

3.4 MITRE Multi-Link Translator and Display System (MTDS)

The MTDS, a joint development of the US Air Force (USAF) Electronic Systems Center (ESC) and MITRE, has evolved over many years. MTDS is a translator box or bridge that connects many incompatible communication systems together and provides them with common tactical data.

The interface format for the MTDS TDL protocol is very basic: every Link16 message has a header consisting of the byte-count and the source track number (JU-number), followed by the message data.

The source track number is unique for every participating unit on the link-16 network. The number is defined before the exercise/operation in the OPTASK LINK, which is the (scenario) document that contains all agreements concerning link management.

A version of the MTDS TDL protocol is used in NATO Exercise Joint Project Optic Windmill (JPOW) by JROADS however this is a variation on the MTDS TDL protocol used by Extended Air Defence SIMulation (EADSIM).

3.5 NC3A AGS Capability Testbed (NACT)

The NC3A AGS Capability Testbed (NACT) defined protocols for the exchange of Tactical Data. The Link16 protocol uses a header to wrap the Link16 messages in a similar way to the MTDS header. The messages are broadcast using UDP protocol.

3.6 Comparison

The following table compares the different methodologies of disseminating Link16 messages.

Measure of Merit	SIMPLE	DIS	SISO Link16 BOM	NACT	Mitre MTDS
Applicable Standard	STANAG 5602	IEEE 1278.1	SISO-STD-002-2006 RPR-FOM V1	None (NC3A)	None (Mitre)
Proliferation	High	High	Some	Some	High
TDL data	✓	*	✓	✓	✓
Scenario data	✓	✓	✓		
Experiment Control data	✓	✓	✓		

* Using Signal PDU

Table 3 Comparison Link16 exchange methods

The following table shows the TDL systems that are supported by each of the identified exchange methods.

TDL	SIMPLE	NACT	Mitre MTDS	SISO Link16 BOM
Link1	✓			
Link 11	✓		✓	*
Link 11B	✓		✓	*
Link 4	✓			
Link 16	✓	✓	✓	✓
Link 22	✓			*

* Supported in Future

Table 4 Support for TDL

3.7 READI-P Implementation

Gateways are required to exchange TDL messages between the HLA environment and SIMPLE .Extended Air Defence SIMulation (EADSIM) transmits Link16 using the MTDS header. However the MTDS header that EADSIM uses is not the same as used by JROADS and is more like the NACT header. This led to the development of an MTDS Gateway which takes the output of EADSIM, alters the header to make it NACT compatible and then rebroadcasts the data on a different port

Before a Link16 enabled version of EADSIM was released there was some preparatory work using the Extended Air Defence Test Bed (EADTB) together with the READI-FOM to verify the Link16 header properties and as a proof of principle for the federation envisaged in the integration test in February 2006.

The NC3A SIMPLE Compliant Device (NSCD) [Ref 6] acts as a Gateway between the messages encapsulated in the MTDS protocol header and SIMPLE.

MBDA have provided a gateway between SIMPLE and the TBL BOM.

The NC3A Analyzer for Networked TDL (ANT) [Ref 6] was used to verify the Link16 messages.

The Link16 SAMC2 Intelligent Decision maker (LSID) was used to display the Link16 information. LSID transmits and receives Link16 messages with either the NACT or the TNO J-ROADS version of the MTDS header.

3.8 Conclusions

The Federation shown in Figure 4 above reflects that there are many legacy systems in use and these systems have implemented different solutions for exchanging TDL data. In order to move towards a more standard solution it will be necessary in the interim to use converters such as the NSCD and the MBDA SIMPLE/TDL BOM gateway.

In an exclusive HLA environment, i.e. all the federates are simulations, using the SISO BOM together with the RPR-FOM is an effective solution.

In a mixed DIS & HLA environment DIS PDUs can be brought into the federation by using a DIS-HLA gateway. Alternatively, the NSCD can take the DIS PDUs and output native Link16 messages, so if the simulation is Link16 enabled then this is an effective solution.

Where the environment contains link16 enabled simulations and Link16 enabled ‘real’ systems, the recommended solution is to use NSCD together with the SIMPLE protocol to exchange TDL messages.

Using a tool such as ANT to verify and validate message format and content is vital due to the mix of headers and “standards” currently in use.

4. Initial Integration Test Event

The initial testing of the READI FOM is scheduled for February 2006 at the TNO facilities in The Hague, The Netherlands. This integration event will bring the various federates together for the first time and will systematically verify network and FOM performance.

4.1 Network Performance

The initial integration testing will examine the performance of the network connectivity between the various federates. In general, this testing will measure the latency (round trip timing) between the active nodes on the network. Message latency statistics will be collected but no communications delays or bandwidth limits will be injected into the demonstration. The network will be synchronized to the GPS time source using the Network Time Protocol (NTP) and the demonstration will run in real-time, based on the local stratum 2 time server. There will be no HLA time management operations conducted during the demonstration.

4.2 Federate Connectivity

The logical connectivity between the federates is depicted in Figure 2 and reflects the operational communications links. Additionally, simulation message traffic is exchanged amongst the participants. Integration testing for federate connectivity will verify that both the simulation control traffic is transmitted and received as well as the tactical messages.

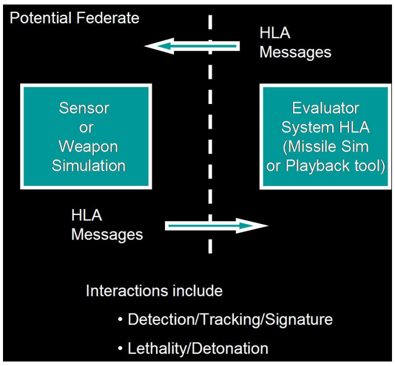

Figure 5: FedProxy Simulation Traffic Evaluation Tool

HLA Messages from the Evaluator are primarily the Entity State type messages. Those from the Sensor or Weapon are Lethality and Detonation.

FedProxy, a module from AEgis Technologies' HLA Lab Works suite, was used to construct an integration test federate to support MSG039. A modification was made to the FedProxy runtime libraries to allow its federates to be executed standalone, i.e. without the need for the FedProxy GUI.

This means that Evaluator federates can be produced to send and receive HLA objects and interactions and Link16 messages.

Any potential federates can be tested before integration into the READI.

4.3 Conformance

Upon verifying the exchange of simulation message traffic and the proper connectivity between federates, the next level of integration testing is to verify the conformance of the various J-Series messages to STANAG 5516 This conformance testing will be conducted using ANT to test bit boundaries within each of the message packets.

5. Way Ahead

5.1 Final Test

The final demonstration is scheduled for 26-30 June, 2006 and will expand on the initial integration test and fully exercise both the higher echelon C2 nodes (CAOC and JFACC) and compute the full set of metrics described in section 2.4 above. Prior to the June final demonstration a decision will be made on the implementation of data latencies based on analysis of the integration test results. Time management is also being considered for the June Final demonstration.

It is expected that valuable lessons will be learned in the execution of the full federation. Systems are engineered to their own program requirements but, when combined with other systems, those requirements are refined and new ones often emerge. This is the essence of system interoperability and the challenge of turning a collection of point solutions into a robust, dynamic system of systems.

5.2 MSG039 in Support of NATO ALTBMD ITB

The primary focus of the Task Group has been the implementation of the READI FOM and it is expected that this will represent the primary contribution to the NATO ALTBMD ITB. The FEDEP report will detail the processes, complex interactions and tools required to achieve interoperability amongst disparate simulations of sensors, weapon systems and command and control systems from several Alliance members. This should provide a solid starting point for the development of the ITB.

The assessment of the performance of the representation of tactical data links through the use of the SISO TDL BOM should also benefit the ITB. The accurate representation of tactical data links within distributed simulation standards has been an elusive goal of the simulation community and the recent work of the SISO community should prove to be robust enough to accommodate the emerging communications technologies that are currently challenging the simulation and test communities in the area of Air Defence system integration.

6. References

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