Supporting Collective Training & Thinking in Joint Project Optic Windmill

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ABSTRACT

In September 2008, the Missile Defence Group of the Royal Netherlands Air Force, together with the German Air Force and the US Missile Defence Agency, organised the 10th edition of Exercise Joint Project Optic Windmill (JPOW). Over the past decade JPOW has become a world leading Integrated Air and Missile Defence (IAMD) exercise, where next to collective training an important focus is on experimenting with novel air and missile defence concepts, new tactics, techniques and procedures, and testing future capabilities in a multinational live, virtual and constructive (LVC) environment. In 2008, over 1500 participants from seven nations joined JPOW X.

In this paper we will describe how JPOW has evolved over the past decade. We will then describe in more detail how JPOWX was organised and conducted. We will present the organisational, operational and technical challenges that need to be addressed to successfully host (distributed) multi-national and multi-level training events and how to address additional challenges that arise when LVC assets come together in an exercise environment. Also, the unique JPOW concept of combining an exercise (collective training) with experimentation (both in terms of new concepts and capabilities) will be addressed. From an organisational point of view we will then present the key lessons learned, both from the experimental and the actual mission execution phase of the exercise.

We will conclude this paper by describing how JPOW not only facilitates collective training but also supports the actual transformation on integrating air and missile defence and has led towards a comprehensive Dutch air and missile defence approach. In this approach simulation plays a central role. Also, the integration of an extensive body of research, and the establishment of a JAMD centre of excellence are seen as key factors for successfully implementing a comprehensive air and missile defence approach in the Netherlands.

ABOUT THE AUTHORS

Lesley Jacobs is a member of the scientific staff in the Defence, Security and Safety Division at TNO since 2001. As training and simulation specialist she has been involved in various (inter)national projects concerning Mission Training through Distributed Simulation (MTDS) and Joint Air and Missile Defence (JAMD). Since 2006, she is programme manager of the Dutch national research programme on Collective Mission Simulation. In 2008, Lesley was also project manager for the Italian Armed Forces participation in JPOW X, for which TNO provided, similar to the Dutch military support, scientific exercise and simulation support. Lesley holds a M.Sc. in Educational Science and Technology from the University of Twente in the Netherlands, with a specialization in Simulation.

Rob van de Wiel is a member of the scientific staff in the Defence, Security and Safety Division at TNO since 1999. As a project leader he worked at several air and missile defence related projects, including the design and testing of air defence simulation, -performance and -planning tools such as JROADS. Recently he supported the Netherlands Armed Forces in conducting missile defence exercises like JPOW and the NATO - Russian Federation "Command Post Exercise" with representative air defence system simulations. In 2008, Rob was the overall TNO project manager of the JPOW X/JROADS simulation support for the Dutch Armed Forces. Rob holds a M.Sc. in Aerospace Engineering form the Delft University of Technology in the Netherlands.

Major Jeroen Bosch was, after completing the Royal Military Academy in Breda in 1995, commissioned as a Tactical Officer on the PATRIOT Air Defence system in the Netherlands. Since 1995 he served in various functions on the Guided Missile Group. In 2003, he was sent to Turkey as a Tactical Director in support of the 2nd Gulf War. After this assignment he was assigned to different positions in the Royal Netherlands Air Force (RNLAF) Staff.

Currently, he is assigned to the GBAD and Force Protection Branch at the RNLAF Command as the Head of the Theatre Air and Missile Defence Bureau Air Defence Section and as the Program Manager for the exercise Joint Project Optic Windmill.

Major Rob Olthoff is currently working as Staff Officer Theatre Air & Missile Defence at the Royal Netherlands Air Force Command, section Guided Weapons & Force Protection Operations. Next to these duties, he is also the Project Officer for the exercise Joint Project Optic Windmill 2010 (JPOW 2010). He joint the Air Force in 1989 and is an experienced Air Defence Officer having served as a Tactical Officer HAWK, Battery Control Officer FLYCATCHER and Fire Platoon Commander PATRIOT and several other positions at Air Force Base De Peel. He was involved in the process of preparing the integration of the Army SHORAD into the Missile Group organization as an officer in the Joint Air Defence Centre (JADC). During the 2nd Gulf War he was assigned to the Advance Party in order to prepare the deployment of the 1NL-PATRIOT Detachment in Turkey (Diyarbakir and Batman) for the mission Tulip Guardian/Display Deterrence in 2003.

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GENERAL INTRODUCTION

From the 1st until the 19th of September 2008, the tenth edition of the European exercise Joint Project Optic Windmill (JPOW) took place. JPOWX was integrated with the US Strategic Command (USSTRATCOM) exercise Joint Project Optic Alliance (JPOA). Whilst JPOW focussed mainly on theatre and regional air and missile defence, JPOA focussed on global missile defence. Integrating JPOA and JPOW X into one exercise created a world-wide unique coalition training opportunity for upper-tear and lower-tear missile defence systems coordination. Over 1500 participants from seven nations and various other agencies, such as NATO, industry and national research institutes, joined the exercise, from three dispersed sites in The Netherlands and The United States, i.e. AFB De Peel, and NC3A in The Hague in The Netherlands, and Schriever AFB in the USA.

In this paper we will describe, first, how JPOW has evolved over the past decade. Second, we will go into more detail on how the last edition was organised and conducted, also presenting the key lessons learned, both from the experimental and the actual mission execution phase of the exercise. We will conclude this paper by describing how JPOW has supported the actual transformation on integrating air and missile defence concepts and has led towards a comprehensive Dutch Joint Air and Missile Defence (JAMD) approach.

JPOW - HISTORY AND EVOLUTION[1]

Missile defence plays a key role in minimizing the threat of ballistic and cruise missiles to NATO, especially for its deployed forces. Ballistic missiles present a problem from their destructive potential not only from a military aspect but also from a political aspect due to their potential as a terror weapon towards population centres and debarkation points. Countering this threat is a combined and joint endeavour.

Based on this evolving threat, the US and NATO organized several large scale missile defence exercises, such as US Roving Sands, with the Theatre Missile Defence (TMD) element Joint Project Optic Cobra, the NATO LIVEX Dynamic Guard 94, and Cold Fire 95. The main goal of these exercises was to train missile defence operations at an operational level.

Let's go Tactical…

In 1996, the Royal Netherlands Air Force (RNLAF), with support of US European Command (USEUCOM) in Stuttgart and the German Air Force (GAF), took the initiative, to organize a small scale Theatre Missile Defence (TMD) exercise, in addition to the large US and NATO exercises, called "Joint Project Optic Windmill". The goal of this initiative was to bring TMD operations to the lower tactical level, and equally as important, to exercise and maximize the interoperability achievements between the, at that time, three main Patriot users, the United States Army, the GAF, and the RNLAF.

Throughout the years, JPOW expanded its scope to Theatre Air & Missile Defence (TAMD), and evolved from a small scale initiative to the largest European TAMD exercise. It also acted as a test bed for many new developments on weapon-, sensor- and information systems, and it contributed to a better understanding of joint and combined interoperability. JPOW as such draw the attention of the US Ballistic Missile Defence Organization (BMDO), currently known as the Missile Defence Agency (MDA), who supports JPOW since 1997.

Multi-Level Training Audiences…

In 2000, JPOW V was recognized as the leading European TAMD exercise, where this time both operational and tactical level were able to experiment and train together, due to the integration of JPOW with the largest European live flying exercise "Clean Hunter 2000", executed by Air component Command (ACC)

[1] Information on the history and goals of JPOW were obtained from www.jpow.nl

AIRNORTH. During this event, in which NATO's Extended Air Defence (EAD) concept was executed, all pillars of missile defence were exercised. Using advanced distributed interactive simulations (DIS), linked with well orchestrated and synchronized live operations, JPOW's unique LVC exercise concept was exploited to the maximum extend.

Going Out of Region…

In 2001, the JPOW concept was exercised and demonstrated for the first time in a so-called "out of region" environment on the island of Sicily, Italy. The main focus of JPOW VI was on the integration of naval missile defence systems and exercising expeditionary missile defence task force operations. It featured the first deployment of Patriot Configuration III Ground Equipment in Europe, and it demonstrated full interoperability on TADIL-J / Link-16 with a US-Navy AEGIS Missile Defence capable Destroyer.

In 2002, the RNLAF conducted JPOW VII, in which the focus was on layered active missile defence and its associated BM/C4I. Passive defence and Counter Force Operations (CFO) / Attack Operations (AO) were also executed and exercised, but on a limited scale with mainly simulation assets.

JPOW VIII (2004) was exercised and demonstrated for the second time in a so-called "out of region" environment, this time on the island of Crete in Greece. The main focus was on the integration of both the operational and tactical level, as well as exercising the overall Layered Missile Defence concept of Ground-, Air- and Sea-based Missile Defence. It featured the full architecture of this concept, including the following systems: Terminal High Altitude Area Defence (THAAD), AEGIS Ballistic Missile Defence (AEGIS BMD), Airborne Laser (ABL) and Patriot. Another focus area formed the seamless integration and exploitation of both tactical data link networks, and command & control, and other information networks, in order to achieve a robust network, able to create a basic Single Integrated Picture, according to the Network Centric Warfare principle.

JPOW VIII preparations included, for the first time in the history of JPOW a high level "Integrated Missile Defence" seminar in which the senior leadership of participating nations and agencies were informed on the latest developments in missile defence. This seminar included a comprehensive workshop and war game, in which the senior leadership developed the guidance for the exercise execution phase. JPOW VIII also included new participants, such as the Hellenic Air Force (HAF) with its Patriot units, HQ AIRSOUTH and the US Joint Theatre Air and Missile Defence Organization (JTAMDO).

An increasing role for Simulation…

In 2002, the RNLAF, and the GAF supported NATO with missile defence operations during one of the largest Computer Aided Exercise (CAX) of NATO's JHQ CENT, called "Cannon Cloud". As a spin-off of the JPOW concept, called "Constructive Optic Windmill" (COW), the RNLAF and GAF supported HQ AIRNORTH with high fidelity Active Defence simulations as well as overall expertise in support of the overall campaign. All missile defence operations, including OPFOR, were coordinated through COW, in close coordination with HQ AIRNORTH. In 2005, the RNLAF, together with the GAF, and the Extended Air Defence Task Force (EADTF) supported NATO by organizing and facilitating the second in a series of Computer Aided Exercises (CAX), which were scheduled as part of NATO's cooperation with the Russian Federation on Missile Defence operations. During this CAX, called COW II, the RNLAF and the GAF supported NATO and the Russian Federation with high fidelity Active Defence simulations as well as overall expertise in support of the overall mission planning, execution and analysis. All Missile Defence Operations, including the political and military game plan, were coordinated through COW II, in close coordination with SHAPE.

Novel Concepts & Systems…

JPOW IX (2006) explored the MDA advanced concept of Integrated Missile Defence (IMD) of Boost, Midcourse and Terminal Missile Defence. NATO also played a major role by introducing elements of the future Air Command and Control System (ACCS) in the Missile Defence arena. Besides the traditional JPOW participants such as Patriot, THAAD, ABL and AEGIS BMD, new systems were introduced, such as: the US Command & Control, Battle Management and Communications (C2BMC), the RNLAF Patriot Advanced Capability Phase 3 (PAC-3) Capability and the German SAM Operations Centre (SAMOC). JPOW IX also focused on the evolving Cruise Missile Threat by introducing Army Organic Short Range Air Defence systems from Germany and the Netherlands and the advanced Norwegian NASAMS II, which were integrated with the Ground based- and Maritime Surface to Air Missile Systems. JPOW IX preparations, again, included a series of "Senior & Operational Leadership" seminars. JPOW IX concluded with a live firing, conducted by a Patriot System.

AN INTRODUCTION TO JPOW X

In 2007, the Royal Netherlands Chief of Defence Staff (CDS) tasked the RNLAF to organize the tenth edition of JPOW, together with its new partners: the USSTRATCOM Joint Functional Component Command for Integrated Missile Defence (JFCC IMD), the US European Command (USEUCOM), the United States Missile Defence Agency (MDA), the NATO Strategic Command's ACO and ACT, the German Armed Forces (Air Force, Army, Navy and Joint Forces), the Royal Norwegian Air Force (RNAF), the Spanish Army (ESP Army), the Italian Armed Forces (Air Force, Army, and Navy), the Extended Air Defence Task Force (EADTF), and the Royal Netherlands Armed Forces (Air Force, Army, and Navy).

The exercise architecture

The exercise concept combined weapon system simulations with a command post exercise supported by distributed interactive simulation with both dislocated and co-located participants over multiple time zones. The simulation architecture combined hardware in the loop with live, virtual, and constructive simulation models. Standardized tactical communications combined secure voice, data link and shared command and control networks made up the command control, communications structure.

Going Global…

For its tenth edition, JPOW was part of a collection of newly developed time synchronized Global Integrated Missile Defence training events of US STRATCOM JFCC IMD, gathered under the umbrella of Joint Project Optic Alliance (JPOA).

Going Distributed…

Facing new technical requirements and challenges of establishing a distributed training environment, with both dislocated and co-located participants, the RNLAF decided to minimize the risk to organize this new concept with the birthplace of JPOW as main exercise hub. This was the home base of RNLAF Ground based Air Defence Community, Air Force Base (AFB) De Peel (see Figure 1).

Figure 1: An overview of the exercise area at AFB De Peel

Growing Role of Experimentation

Concept Development & Experimentation (CD&E) as introduced in previous JPOWs, played a far more significant and dominant role in this edition. Prior to the mission execution phase, the participants were offered a unique experimentation environment to explore and experiment with near-term future system capabilities, novel concepts and tactics, techniques and procedures (TTPs), of which an example is shown in Figure 2.

Figure 2: Testing a Future Ground Based Air Defence System at JPOW X

During four days, 38 experiments were conducted in parallel over six different network lanes, with specifically designed experimentation scenarios and architecture for each single experiment.

New Participants

Besides the traditional JPOW participants such as Dutch and German Patriots, the Royal Netherlands Navy ADCF, the German F-124, the United States Army THAAD and Navy AEGIS BMD, new systems such as Ground Based Interceptor (GBI) and the Command, Control Battle Management and Communications (C2BMC) were introduced. Also, the

Spanish Army and the Italian Armed Forces participated for the first time in the JPOW exercise. Spain joined with a live Patriot system. The Italian Armed Forces participated with simulated capabilities of an AN/TPS-77 radar (Air Force), an Air Defence Ship Andrea HORIZON (Navy), and a SAMP/T unit (Army).

THE EXERCISE GOALS

JPOA-JPOW X was a combined and Joint Air & Missile Defence (JAMD) Initiative. The main emphasis of the exercise was to conduct a (virtual) large scale, out of region JAMD exercise, focusing on the four pillars of Missile Defence[2]:

- Passive Defence: *Passive Defence measures reduce vulnerability of friendly assets and minimise the effects of damage to friendly assets or population caused by a TBM attack;*
- Active Defence: *Active Defence measures are actions taken to destroy or mitigate the effectiveness of an enemy attack by intercepting TBMs in flight;*
- (Conventional) Counter Force Attack / Attack Operations: *Counter Force Operations or Attack Operations are initiated to destroy, disrupt or neutralise (i.e. suppress) enemy missile capabilities and infrastructure. In other words this prevents the launch of missile;*
- BMC4I: *Battle Management, Command and Control, Communications and Intelligence (and Early Warning) consists of the capabilities, processes, procedures and information for co-ordinating and synchronising both offensive and defensive measures* (Missile Defence, an overview, 2007)

Secondly, the validation of a unique defence concept with elements of the latest national and NATO Ballistic Missile Defence developments was conducted, with emphasis on the USA Ballistic Missile Defence System's (BMDS) Architecture, and the NATO Active Layered Theatre Ballistic Missile Defence (ALTBMD) Concept (refs).

The keyword of this exercise was "evolution". Based on the lessons learned, and using the robust infrastructure and architecture, of previous JPOW exercises, it explored the latest US advanced concept of "Ballistic Missile Defence Systems" (BMDS) of Boost, Midcourse and Terminal Missile Defence.

NATO also played a major role by introducing elements of the ALTBMD Capability One Architecture, such as the Air Command and Control System (ACCS) and Bi-Strategic Commands Automated Information System (Bi-SC AIS), together with the national Theatre Ballistic Missile Defence (TBMD) contributions to the Alliance task. They were organized in accordance with NATO's Combined Joint Task Force (CJTF) concept. NATO's vision and preliminary findings of its feasibility report on its concept of Territorial Missile Defence was explored and demonstrated in an extensive manner (ref: www.jpow.nl).

THE ROAD TO JPOW X

The preparation and organization of an exercise such as JPOW, is a lengthy and complex process, often taking up to two years of preparation time. A truly successful accomplishment of each exercise is often directly related to the amount and quality of work accomplished in the preparation phase, a clear focus on the exercise objectives, and sufficient coordination prior to the exercise between the exercise organisation *and* participating units.

Over the past decade, the JPOW Project Organisation (PO) designed (and continuously redesigns)[3] an exercise preparation cycle, comprising of various leadership seminars (senior, operational and tactical), planning conferences, and system accreditation events, which will be described in more detail in the remainder of this section.

Exercise Control Groups

Although many nations contributed to and supported the exercise, the preparation, organization and management is under control of the RNLAF, which gathered a team of specialists in the JPOW Project Office (PO). Together with several working groups the JPOW PO prepares each JPOW exercise. These working groups played a key role in the preparation, execution, and after action review. Manning of these working groups was done by participating nations and

[2] Additional pillars of Missile Defence can be: Proliferation Prevention and Deterrence. These are not exercised in the JPOW exercises.

[3] More information on observations and recommendations for the design, preparation, execution, analysis and assessment of JPOW exercises can be found in the JPOW X, from a didactic point of view report (Pikaar, A.A, Veldhuis, G.J & Rijk, R., 2008)

agencies, under supervision of the JPOW PO. Examples of the task and roles of these so-called exercise control groups are presented below.

The Operations Control Group (OPCG) was responsible for, amongst others, defining the C2 structure for JPOW X, coordination with JPOA, providing HICON during the exercise, and developing relevant operational products such as the Air Operations Directives (AOD), Air Tasking Orders (ATO), and Air Coordination Orders (ACO).

The Scenario, Intelligence, and Simulation Control Group (SISCG), was responsible for, amongst others, the development of the scenarios (38 individually tailored experimentation scenarios and an overall scenario for the mission execution phase), all intelligence products, the Simulation Interoperability Master Plan, and organising the accreditation -, risk reduction -, and integration tests.

The Combined Interoperability Control Group (CICG) was responsible for planning and preparing the Tactical Data Link (TDL) architecture, the network design, communications, and information management. For this purpose a Combined Joint Interface Cell (CJICC) was manned during the exercise.[4]

The Concept Development & Experimentation Control Group (CDECG) was responsible for the selection and facilitation of a final list of experiments, balancing the participating Nations and Organisations needs with the most recent JAMD developments and other CD&E (research) tracks.

The Analysis Control Group (ACG) was responsible for designing the Joint Analysis Team (JAT) structure, supporting the objectives specification, developing a data collection and assessment plan (DCAP), and providing training to the JAT members. During the exercise 115 JAT members and area coordinators supported the experimentation and mission/exercise analyses, assessment and facilitated the daily debriefs.

The Logistics and Support Control Group (LSCG) supported, on behalf of the Host Nation, the exercise with the planning and coordination of all transportation and storage of all kinds of equipment and goods, and the housing needs of the hundreds of personnel. Also the supply of fuel, drinks, meals, water and many litres of coffee were arranged by the LSCG.

The Combined Exercise Control Group (CECG) was responsible for the overall planning and coordination of both exercise preparation and execution. This group consisted of the respective chairmen of the previously listed control groups, senior representatives of participating nations and other agencies (e.g. White Cell), and the JPOW PO.

Leadership Seminars

To prepare the participants, operational staff and military/political decision makers, the JPOW PO organized two seminars focused on the information needs of the different levels in the hierarchy. In November 2007 a three day Senior Leadership Missile Defence seminar was conducted in Kalkar, Germany. On the first day of this seminar the senior and operational leadership of participating nations and agencies were informed on the latest developments of Missile Defence of both the United States and NATO. During the two final days of the seminar, a comprehensive workshop supported by a war game, enabled the participating leaders to develop and refine the guidance and directives for the execution phase for various complex MD scenarios.

Since 1997, The Defence Security & Safety Division of the Netherlands Organisation for Applied Scientific Research (TNO) provides scientific exercise and simulation support to the JPOW PO and the Royal Netherlands Armed Forces with the Joint Research On Air Defence Simulation (JROADS) Suite, (Stamm, M., Kuipers, E., & Hein, W., 2009). JROADS was also used for running and analyzing the scenarios in the war game during the Senior Leadership Seminar (SLS). A joint planning tool (Stoop, 2008), also part of the JROADS suite, was used in the Tactical Leadership Seminar (TLS), which was conducted at AFB de Peel in June 2008. The purpose of this event was to conduct the (preliminary) planning for the participating units and systems at the tactical level, based upon the guidance derived from the SLS, and final set of exercise objectives.

Planning Conferences

For a successful preparation of the exercise, JPOW PO organized three planning conferences. During these conferences all participants were, first, briefed into the objectives, procedures, logistics, and technical aspects of the exercise. Second, all control groups were refining and reviewing their (intermediate) products in

[4] For the first time in the history of JPOW the CICG had to develop a TDL architecture for a live Link-16 network, simulations, as well as long haul connections to CONUS.

various parallel hosted working sessions, followed by a plenary wrap up at the end of each conference. Various exercise control groups, such as the SISCG and ACG, also planned additional meetings between the planning conferences to ensure a timely delivery of their exercise products.

The first planning conference was the Initial Planning Conference (IPC), which was hosted at Air Base de Peel in the Netherlands. About 100 participants from the participating nations, units and organizations discussed and prepared their integration into the exercise. Main focus of the IPC was to gather, discuss and perform an initial breakdown of the main exercise and training objectives as well as the experiments proposals of all participating nations and organizations. Also, each participant could make initial assessments of the logistic footprint needed and start to make arrangements to ensure a technical, operational and logistic integration into the exercise.

During the Mid Planning Conference (MPC) in Berlin, Germany, over 200 participants from all nations and supporting agencies were working during a whole week on the successful preparation of the exercise. Main purpose of the MPC was to finalize the:

- Objectives for each participating unit,
- C2 structure and manning, and
- Coordination between JPOA and JPOW X.

The foreseen Final Planning Conference (FPC) was altered into a smaller Final Planning Review (FPR) for approximately 50 senior representatives of the exercise control groups, JPOW project office, participating nations and agencies, due to the fact that the final exercise preparations were on schedule. The FPR was conducted at the end of June at the Norwegian AFB in Bodo.

Systems Accreditation

The JPOW exercises are conducted with both 'live' hardware as well as simulations of air defence systems. To limit the risk involved and to ensure a flawless cooperation between the fielded systems and (conceptual) simulations, the simulations have to be tested and accredited by the JPOW organization before entering the exercise.

For this edition, Several Risk Reduction Tests (RRT) were completed to ensure a seamless integration over a long haul network. The first series of RRTs was to test NATO's CFBL network, and the second series of tests involved testing the individual simulations on Link-16 and DIS capabilities.

Prior to the start of the JPOW build up phase each simulation needed to be accredited both on the correct working of DIS and Link-16 protocols and behaviour. The simulations needed to adhere correctly to the functional and technical requirements as stated in the JPOA- JPOW X Simulation Interoperability Master Plan. The accreditation was done, on behalf of the JPOW PO, by two specialist firms responsible for the DIS and Link-16 networks on JPOW in two accreditation test weeks in May and June at AFB De Peel. After a successful accreditation the systems were allowed to join the final system integration test, which took place two weeks prior to the start of the exercise.

EXERCISE OVERVIEW

In this section a brief overview is given of the used exercise architecture and C2 structure, the daily exercise rhythm, an overview of the main participants and their objectives for joining JPOA-JPOW X, and a summary of the exercise flow.

Global Exercise Architecture Description

The distributed simulation concept of JPOW X required a link via the CFBL network with NATO ITB during the experimentation phase and a link, also via CFBL, to the US for the JPOA participation during the mission execution phase.

As in previous editions of the JPOW Series a federation of live, virtual, and constructive computer simulation applications were used to support the exercise using the DIS protocol. Link 16, Military Standard 6016, was used for tactical data link communications for all systems except the Long-Range Surveillance Sensors, which used the Radar Management Protocol to provide radar plot data to live German and Netherlands deployed CRC's.

Experimenting with two C2 Structures…

During former JPOWs, several options for the C2-Structure were used. For the mission execution phase of JPOW X, the C2 Structure has been coordinated with HQ CC-Air Ramstein, in order to reflect a possible real world deployment option for a Combined & Joint Task Force. For missions 1-4, the structure of a Combined & Joint Forces Air Component Command (CJFACC) Reach Back (RB) and a CJFACC Forward Deployed (FD), with an embedded Air Operation Centre (AOC) was established. For missions 5-8 a C2 concept structure was implemented for investigation and demonstration purposes. During this mission phase a

transfer of authority took place with regard to the US owned MD systems deployed in Europe. A NATO missile Defence component commander at CJFACC level became in charge over all TMD and MD capable units. The NATO Missile Defence Control Centre executed its mission through a NATO and US AOC.

Daily Ops…

A typical JPOA-JPOW X workweek comprised six days of action, from approximately 07:30 LT (e.g. CECG meeting, JAT and participants briefings) until 21.00 LT (end of daily debriefings). STARTEX for the experimentation and mission execution phase was 08:00 LT and ENDEX 17:00 LT. Daily debriefings started at 18.30 LT and could also be joined by remote sites via a VTC connection.

National Participation

Germany, Italy, Norway, Spain, The Netherlands, and The United States and NATO entities (such as NC3A) participated in the exercise as primary training audience (PTA)[5]. Next to these nations, Denmark, France and the UK participated as observing nations. Each of these nations developed their own objectives, with a main focus on collective experimentation and training, although experiments could also have a distinct national character. Based upon these objectives the experimentation scenarios and the overall mission scenario were carefully developed and scripted. Next to the so-called scripted events, the injection of additional events was, after a careful analysis, possible to ensure that each unit could sufficiently practice with a certain type of event. This required a thorough coordination between the HICON, white cell, and SISCG, and (national) JAT members, to ensure that an injected event would also be properly introduced into the AOC and appropriate mission planning cycles. An extensive and exemplary description of how two nations have participated in JPOW X and have been able to explore and train with novel concepts and capabilities in a complex NATO and US C2 environment can be found in two other IITSEC 2009 papers, describing the Italian Armed Forces participation (Jacobs, L.R.M.A, Nuvoloni, P., Cioli, C., Manca, C., Argiolas, G., Schavemaker-Piva, O., & Meijer, Y. ,2009) and the Royal Netherlands Army participation (Stamm, M., Kuijpers, E., & Hein, W., 2009).

NATO ALTBMD Participation

JPOW X was the first JPOW participation for the ALTBMD PO, and provided a unique opportunity for interaction with live systems and operators from a variety of NATO nations. It provided a rare opportunity for the NATO Active Layered Theatre Ballistic Missile Defence Programme Office (ALTBMD PO) to connect their Integrated Test Bed (ITB) Laboratory, located at the premises of NC3A in The Hague, The Netherlands to the JPOW network. In the ITB a prototype of ACCS is operational. It is able to connect to other locations via, amongst others, NATO's CFBL network. The PO is managing the NATO effort to create an integrated and layered theatre missile defence system to defend deployed troops in a theatre similar to the scene of JPOW. Central to the project is the integration of all air defence systems in the NATO C2 system that is currently under development: the Air Command and Control System (ACCS).

JPOA Participation

JPOA was executed simultaneously with JPOW XJPOW X to provide a regional-strategic complement to the more tactical, theatre-focussed JPOW. The primary objective of JPOA was to integrate the US ballistic missile defence capabilities with those of the emerging NATO ALTBMD system. The (mainly) simulated naval assets of Germany, Italy, The Netherlands, and the United States operated in JPOA under a US missile defence command and control structure, and it was the first time that the US C2 structure was incorporated into a USEUCOM-focussed missile defence scenario.

The Exercise Flow…

The JPOA-JPOW X exercise included 3 phases: "build up", experimentation, and mission execution, which will be described in more detail in the next sections. We will also present the key lessons[6] learned for each of these exercise phases from an exercise organisational point of view in relation to the primary exercise goals.

THE BUILD UP PHASE

The systems build up and the final systems integration phase, connecting for the first time all simulated and live assets, as well as the long haul facilities, took place from August the 19th until September, the 4th. During

[5] Both operational and technical operators are considered as PTA, given the strong focus of JPOW on exploring novel concepts and future architectures.

[6] The results in this paper are described at an unclassified level. More detailed results are described in the JPOA-JPOW X AAR Report, 2009.

this period over 30 live and virtual systems were physically brought to the exercise zone at the air strip of AFB De Peel. Contrary, to the usual JPOW experiences this time the integration time needed for live platforms exceeded the time needed for integrating the simulations. Due to diligent testing and close cooperation and problem solving by the CICG and all other involved parties, at the end of the experimentation phase all open standing issues were successfully resolved. Luckily, the experiments were not hampered by the additional testing that needed to be done during the experimentation phase.

THE EXPERIMENTATION PHASE

The Experimentation Phase took place from September the 5th until September the 9th, providing nations and agencies, four experimentation days. 38 experiments were run in parallel over six different experimentation lanes (networks). This required a lot of coordination between the CDECG, SISCG and CISG, especially since testing and finding solutions to integration issues that were found during the integration still continued. Of all experiments, only four were not able to (fully) accomplish their objectives; a very successful accomplishment. Another interesting thing to note is that based upon a successful outcome of the experiments both nations and NATO were allowed to bring in a new concept or capability directly into practice in the mission execution phase. Hence, closing immediately the gap between CD&E and training.

ALTBMD Experiments

ALTBMD participated in JPOW X only during the experimentation phase. An ACCS prototype was connected from the ITB facility in The Hague, into the JPOW infrastructure in De Peel. This represented the first distributed participation in a JPOW, validating the concept for future exercises.

One of the experiment lanes was used exclusively for the ALTBMD experiments. During the experimentation phase a total of 8 experiments were conducted successfully. These experiments involved interoperability issues and/or demonstrations between several live and virtual players and the ACCS prototype located in the ITB. During the ALTBMD experiments, the players were also stimulated by threat generated from the ITB.

ALTBMD Results

The JPOW participation was considered as an important milestone for the NATO ALTBMD project. The participation effectively supported the ALTBMD PO in their risk reduction efforts. The gained knowledge and experiences will be used for future ITB testing with the involved nations. Participation in JPOW participation will remain a central part of the ongoing ALTBMD test and evaluation efforts.

THE MISSION EXECUTION PHASE

The Mission Execution Phase took place from September the 6th until September the 18th and was for JPOW X, focussing on theatre and regional air and missile defence, and was divided in two distinct mission phases with two different C2 structures. The JPOA part of the exercise, focussing on global missile defence, took place from September the 10th until September the 18th. The redeployment of personnel, systems, and materials to their home locations started on September the 19th.

KEY LESSONS LEARNED

This section describes the unclassified key lessons learned from JPOA –JPOW X, mainly in terms of encountered challenges and successes, before summarizing the overall conclusions and recommendations in the remainder of this paper.

Challenges

From an operational and organisational point of view the following challenges were found:

- Manning issues, especially in the AOC and JAT hampered the execution of the exercise to its full extent. Commitments were not always adhered to, or personnel were sent without having the required expertise.
- Collective training and thinking challenges: experimenting and training at multiple levels, coupled with a growing number of participants, requires restructuring the analysis and assessment process (see also Pikaar et. al., 2009).
- Disclosure restrictions during the daily After Action Review (AAR) sometimes limited the value offered to the players. This calls for alternate disclosure policies and/or different daily debriefing set-ups for a next edition.
- Certain classified performance characteristics precluded sharing amongst all mission partners, reduced the realism of defence designs.

From a technical point of view, the main challenges were:

- Establishing a near real time data flow and interoperability between the three geographically separated sites.
- Recurrent Link-16 network issues.
- Effective realism considerations: the simulations supported the flow of the exercise events. However, some aspects degraded the realism of the play. In particular, unrealistic weapon system's capabilities and discrepancies in performance parameters should be avoided in the future.
- The functionality, commonality and reliability of the federation of simulations (including the live assets) were inadequate and should have been proven prior to accreditation and system integration. More extensive group accreditation and risk reduction tests for future JPOW exercises are mandatory.
- The delayed delivery of functioning simulation software for some weapon systems caused a severe delay during the build-up phase.

Successes

From an operational point of view it was learned that:

- JPOA was the first and successful effort to incorporate regional-strategic missile defence into multinational IAMD operations providing a baseline to address the distinct challenges associated with this mission.
- JPOA-JPOW X was also the first exercise to explore logistics issues and to incorporate logistics play across the international IAMD community.
- JPOW continued to be an essential part of NATO's prototyping and requirements capture activities in support of NATO ACT and PO ALTBMD. Having both the technical, tactical and operational communities in one single event it proved a unique opportunity to assess and analyze a wide range of functionality and interoperability issues.

From an organisational point of view it was shown that:

- Both C2 structures were successfully applied and tested.
- Intelligence support and Intelligence Preparation of the Battlefield (IPB) operations were greatly improved compared to previous JPOW editions. Pre-exercise workshops contributed to successful IAMD intelligence and IPB operations.

From a technical point of view the main successes were:

- A successful execution of a distributed LVC exercise design and execution.
- A successful integration of all live and simulated assets.
- The used Link-16 monitoring and visualization equipment improved area coverage and processing time by import of intercept data to support CBRN analysis.

AFTER ACTION REVIEW

After XJPOW X all participants contributed to the extensive overall JPOA-JPOW X AAR Report, detailing the Lessons Identified (LIs) and Lessons Learned (LLs), both from the exercise preparation and execution phases.

CONCLUSIONS & RECOMMENDATIONS

Overall Conclusions

JPOA/JPOW X contained one of the most ambitious and complex IAMD scenarios ever developed and executed. It was a unique environment, bringing together the tactical, operational and technical communities at one simultaneous event. This edition was the first major IAMD exercise combining regional-strategic missile defence missions, enabling the demonstration, practice and validation of the current status of the different Integrated Missile Defence programmes and concepts as developed by NATO and the US, as well as the TTPs in use or in development by all participating nations and services.

The exercise design successfully supported the assessment and analysis of a wide range of functionality and interoperability issues pertinent to air and (theatre) missile defence, and proved to be an excellent collective training environment for national and NATO personnel. Collective experimentation was the second pillar of success trough a substantial focus on exploration, development and validation of national and NATO documents, tools and risk reduction programmes, such as the ALTBMD programme. As a result, many valuable insights were gained into related technology and doctrine; development of tactics, techniques, and procedures and concept of operations.

Concept Development & Experimentation

This exercise contained the most ambitious Concept Development and Experimentation (CD&E) programs of any previous JPOW editions, and supported a

successful exploration of doctrinal and interoperability issues. Out of the 38 conducted experiments, only four experiments did not (fully) meet their objectives.

Exercise Organisation

From an organisational point of view the overall impression from the HICON perspective was very positive. The setup of the exercise, combining JPOA and JPOW X, implied a substantial risk. However, it turned out that these risks could be isolated in time. During the execution, the HICON setup accommodated the rapid modification of the scenario and simulation to provide the participants with on the spot changes in the exercise play. This maximized both the experimentation and exercise objectives fulfilment.

ALTBMD- Main Conclusions

JPOW offered a rare opportunity to test and assess the ALTBMD Capability 1 Initial Operational Capability (IOC) architecture using NATO's Integration Test Bed and provided invaluable operational feedback to PO ALTBMD, NACMA and the ACCS prime contractor, which cannot be acquired under normal circumstances. Future participation into JPOW will remain a central part of the ongoing ALTBMD test and evaluation efforts.

JPOA – Main Conclusions

JPOA included a Global Integrated Missile Defence (GIMD) scenario in which an experimental NATO Command and Control (C2) entity (the NATO Missile Defence Coordination Centre (MDCC)) established a strategic level MD C2 capability to defend NATO territory. The capability was built upon NATINADS and included OPCOM over assigned MD resources (planning and fire control). Although the NATO MDCC experiment successfully demonstrated a proof of concept, NATO's current vision to separate MD and TMD proved to be unrealistic. It was impossible to define an asset list for the European part of NATO. The principle of "no-impact" is therefore the basis for an integrated MD design. Finally, the developed MDCC SOP could serve as a first step for a CONOPS for a NATO MD C2 capability.

Recommendations

The merge of JPOA and JPOW X provided an excellent opportunity to gain an insight in Theatre, Regional and Global TMD/MD. The outcome of this exercise (when adapted) will have direct consequences for the discussion in NATO/EU with regard to MD of the NATO/European territory. The NATO MDCC Standard Operating Procedures form the basis for further discussion and concept development. In that sense, the combined JPOA – JPOW X endeavour truly wrote history.

JPOW still remains the only venue of its kind in Europe for tactical, operational and technical JAMD training and experimentation. To enhance the experience levels of participants further it was highly recommended to provide the AAR of the previous JPOW's to the participants prior to the start of the current one. This will also enhance the exercise level further during future editions.

TRANSFORMATION OF AIR & MISSILE DEFENCE IN THE NETHERLANDS

From the previous sections in this paper it becomes clear that enhancing collective training and thinking on Air and Missile Defence in exercises such as JPOW are seen as key enablers for a continuous development of a IAMD approach within the Netherlands and its coalition partners. Distributed Interactive Simulations, and the integration of LVC assets in multinational exercises are seen as essential means to provide both military and technical operators with sufficient exercise means in a cost effective manner. Also, the benefits of *gaining actual experience*s with novel IAMD concepts and architectures in a challenging, complex and realistic environment are seen as pivotal elements to maintain and improve the required skills and competencies.

During JPOW X, for example, the Royal Netherlands Armed Forces executed multiple national Joint CONOPS experiments, which have resulted in the development of a Joint Air & Missile Defence Task Force (JAMDTF) Concept for the Royal Netherlands Army & Air Force. This concept, drafted in June 2009, will be developed further trough a continuous flow of exercises and experimentation, and will lead to a Dutch Joint Air & Missile Defence Task Force (JAMDTF) CONOPS for the Netherlands contribution to NATO Reaction Forces (NRF) Mission 18. Prior to this foreseen deployment, a NATO OPEVAL for the Dutch JAMDTF will take place.

Air and Missile Defence is becoming more and more a truly joint effort within the Netherlands. The integration of the Dutch Army Ground Based Air Defence system and the Air Force's PATRIOT units is almost

completed at AFB De Peel. With the formation of a Joint Air and Missile Defence Centre of Excellence the Netherlands Navy will join the Army and Air Force in developing a joint approach.

In support of the Dutch MOD and in close cooperation with the Royal Netherlands Armed Forces, TNO is also conducting a multi year intense Joint Air and Missile Defence research programme. Additional studies regarding possible upgrades to the Patriot weapon system are ongoing. Knowledge from these studies are immediately applied for enhancing the JPOW exercise support and into supporting software (planning) tools, such as, for example, the Joint Planning Tool that is able to support the Armed Forces in deployment planning of e.g. Upper and Lower tier missile defence systems.

WAY AHEAD

With the next edition of JPOW coming up in the fall of 2010, it's the Royal Netherlands Armed Forces ambition to continue to improve the skills and knowledge in IAMD and M&S. Future JPOW editions will become even more challenging and technical advanced than the already impressive achievements to date, and require an up to date skill-set. Examples are the integration of more remote sites to the (simulation) networks, and the increased cooperation and involvement of NATO in the JPOW series.

The latter stresses the importance and impact in the international community with, as an example the milestone demonstration of the continuing development of the NATO ALTBMD ACCS system, both real time as non-real time.

REFERENCES

Jacobs, L.R.M.A, Nuvoloni, P., Cioli, C., Manca, R., Argiolas, G., Schavemaker-Piva, O., & Meijer, Y. (2009). Collective Training & Thinking in JAMD: The Italian JPOW X Experience. *Proceedings of I/ITSEC 2009.*

JPOW Website. About JPOW, http://www.jpow.nl

Royal Netherlands Air Force Project Office JPOW, 2008, After Action Report Joint Project Optic Alliance and Joint Project Optic Windmill X, HQ Royal Netherlands Air Force, Breda, The Netherlands

Pikaar, A.A., Veldhuis, G.J, & Rijk., R. (2008). *JPOW X from a didactical point of view: observations and recommendations for the design, preparation, execution, analysis and assessment of JPOW exercises*. TNO Report (in Dutch). TNO Defence, Security & Safety, Human Factors Division, Soesterberg, The Netherlands.

Missile Defence, an overview (2007*)*. TNO Handbook. TNO Defence, Security & Safety, The Hague, The Netherlands

Stamm, M., Kuijpers, E. & Hein, W. (2009). Collective Training - Collective Thinking: Using Innovative Adaptive Simulation in Exercises. *Proceedings of I/ITSEC 2009.*

Stoop, M;, Joint Planning Tool (2008). TNO Defence, Security & Safety, The Hague, The Netherlands.