



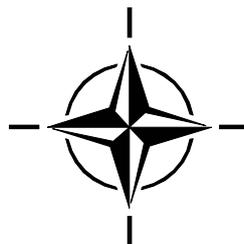
**RTO TECHNICAL REPORT**

**TR-SCI-189**

# **Validation and Verification of NATO Network Enabled Capabilities**

(Validation et vérification des capacités  
réseau de l'OTAN (NNEC))

Final Report of Workshop SCI-189.



Published July 2008





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(Validation et vérification des capacités  
réseau de l'OTAN (NNEC))

Final Report of Workshop SCI-189.

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# The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote co-operative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective co-ordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also co-ordinates RTO's co-operation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of co-operation.

The total spectrum of R&T activities is covered by the following 7 bodies:

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- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier co-operation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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Published July 2008

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ISBN 978-92-837-0061-6

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# Table of Contents

	<b>Page</b>
<b>Programme Committee / Participants</b>	<b>iv</b>
<b>Executive Summary and Synthèse</b>	<b>ES-1</b>
1.0 Introduction	1
1.1 Overview	1
2.0 Proceedings	1
2.1 Objectives	1
2.2 Preparation	2
2.3 Discussions	3
3.0 Summary	6

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# Validation and Verification of NATO Network Enabled Capabilities (RTO-TR-SCI-189)

## Executive Summary

NNEC is a priority for NATO. The 5 October 2005 Long-Term Capability Requirements (LTCR) Final Report lists both IS and the NNEC as two of seven Transformational Objective Areas. Furthermore, of the fifteen 2006 prioritized LTCR, eight are directly related to IS and NNEC: i.e., common operating picture; network centric reconnaissance, surveillance, and target assessment (RSTA); timely sensor-shooter connectivity; integrate maritime RSTA; improvements in tactical data exchange between national land, air, sea forces; interface between NATO and national systems; all weather, stand-off aerospace ground surveillance; and joint combat ID and targeting acquisition. Of these eight priorities, major support is provided to LTCR #2 (network centric reconnaissance, surveillance, and target assessment (RSTA)) in that successful delivery of any network-centric RSTA system requires a successful V&V.

The purpose of this Workshop (WS) was to bring together members from participating NATO countries to discuss the V&V of a NNEC. For this WS, verification is determining if the NNEC does what it is designed to do, and validation is determining if the NNEC does what it is supposed to do. In this context, V&V must be built into the development of network enabled capabilities in an iterative approach starting with the initial concept of operations. Furthermore, as an NNEC collects, processes, integrates and disseminates information, the V&V of an NNEC in essence feeds the research and development of that NNEC. Thus, the V&V of the NNEC is of tremendous interest to the System Concepts and Integration Panel.

The workshop was convened at Edwards AFB, California, USA on 11-14 Sep 2007. Workshop participating countries included Canada, Estonia, Italy, Netherlands, Spain, Turkey, UK, and USA.

The workshop defined the following items that make up a very top level roadmap to pursue for the future:

- Agreement on a working definition of NNEC for V&V;
- Identification of critical NNEC capabilities (including NII) requiring V&V;
- Definition of V&V capabilities needed to meet NNEC requirements;
- Definition of criteria to prioritize critical V&V capabilities;
- Identification of existing NATO and nations' V&V capabilities and shortfalls including M&S tools;
- Identification of NATO key players and organizational entities (both new and existing) and any NNEC initiatives currently in work;
- Identification of issues within and beyond scope of V&V that need to be addressed;
- Formulation of V&V guidelines for NNEC; and
- Building the approach or way ahead for V&V of NNEC (follow-up to this workshop).

It was agreed to initiate within Working Session C of the SCI panel the activities to address all of the above identified items. This effort should start with an immediate follow-on Task Group to work the details of a

V&V of NNEC roadmap. Products should include the use case(s) along the NNEC journey and assumptions to be used as a basis for all V&V of NNEC, the expectations from the approach – validate and verify systems are ready for NNEC operations, and a detailed roadmap with identified outputs consistent with the initial roadmap of the workshop. A TAP/TOR for initial task group should be submitted in Oct 2007 for start in April 2008.

# Validation et vérification des capacités réseau de l'OTAN (NNEC) (RTO-TR-SCI-189)

## Synthèse

Les NNEC constituent une priorité pour l'OTAN. Le rapport final sur les besoins en capacité à long terme (LTCR) du 5 octobre 2005, mentionne les Systèmes d'information (SI) et les NNEC comme deux des sept domaines d'objectifs de transformation. En outre, parmi les quinze LTCR définis comme prioritaires en 2006, huit sont directement liés aux SI et aux NNEC : c'est-à-dire, image opérationnelle commune, reconnaissance, surveillance et acquisition d'objectif en réseau (RSTA) ; connectivité détecteur-tireur en temps voulu ; intégration RSTA maritime ; améliorations des échanges de données tactiques entre forces terrestres, aériennes et navales nationales ; interface entre l'OTAN et les systèmes nationaux ; surveillance aérospatiale terrestre à distance, tous temps ; identification et acquisition d'objectif interarmées. Parmi ces huit priorités, un soutien important est apporté au LTCR n° 2 (reconnaissance, surveillance et acquisition d'objectif en réseau (RSTA)) dans la mesure où la réussite d'un système RSTA en réseau exige une validation et une vérification (V&V) correcte.

L'objectif de cet atelier consistait à réunir des membres des pays participants de l'OTAN en vue de discuter de la V&V d'une NNEC. Pour cet atelier, le postulat était que la vérification détermine si la NNEC réalise ce pour quoi elle a été conçue, et la validation détermine si la NNEC réalise ce qu'elle est supposé réaliser. Dans ce contexte, la V&V doit être intégrée au développement des capacités réseau selon une méthode itérative débutant dès le concept initial des opérations. En outre, étant donné qu'une NNEC recueille, traite, intègre et diffuse des informations, la V&V d'une NNEC nourrit par essence la recherche et le développement de cette NNEC. Par conséquent, la V&V de la NNEC présente un intérêt particulier pour la Commission sur les concepts et l'intégration des systèmes.

L'atelier s'est réuni sur la base Edwards AFB, Californie, Etats-Unis, du 11 au 14 septembre 2007. Les pays participant à cet atelier comprenaient le Canada, l'Estonie, l'Italie, les Pays Bas, l'Espagne, la Turquie, le Royaume-Uni et les Etats-Unis.

L'atelier a défini les sujets suivants, qui constituent une feuille de route généraliste à poursuivre dans l'avenir :

- Accord sur une définition de travail de NNEC pour la V&V ;
- Identification des capacités NNEC critiques (notamment NII) exigeant une V&V ;
- Définition des capacités V&V requises pour répondre aux besoins NNEC ;
- Définition de critères de priorité pour les capacités V&V critiques ;
- Identification des capacités V&V existantes au niveau de l'OTAN et des pays et des insuffisances, notamment outils M&S (modélisation et simulation) ;
- Identification des acteurs clés de l'OTAN et des organismes (nouveaux et existants) et de toutes initiatives NNEC en cours de travail ;
- Identification des problèmes internes et externes au périmètre de la V&V et devant être traités ;
- Formulation de directives de V&V pour les NNEC ; et
- Établissement de l'approche ou du cheminement pour la V&V des NNEC (suivi de cet atelier).

Il a été convenu de lancer dans le cadre de la session de travail C de la commission SCI, les activités de traitement de tous les sujets identifiés ci-dessus. Ce travail devrait débiter par un Groupe de travail de suivi immédiat destiné à préciser les détails d'une feuille de route de V&V de NNEC. Les produits doivent inclure le ou les cas d'utilisation lors du cheminement NNEC et les hypothèses à utiliser comme base pour toutes les V&V des NNEC, les attentes relatives à la méthode – valider et vérifier le fait que les systèmes sont aptes aux opérations NNEC, et une feuille de route détaillée avec des résultats identifiés cohérents avec la feuille de route initiale de l'atelier. Un TAP/TOR relatif au groupe de travail initial doit être soumis en octobre 2007 pour lancement en avril 2008.

# VALIDATION AND VERIFICATION OF NATO NETWORK ENABLED CAPABILITIES

## 1.0 INTRODUCTION

### 1.1 Overview

The methods by which NATO member nations are increasingly interacting with each other and other nations is rapidly changing from one-on-one lines of communication to one in which every nation is a subscriber and a publisher on a Global Information Grid (GIG). As NATO member nations respond to the full spectrum of NATO Response Force (NRF) missions – consequence management, counter-terrorism, peace enforcement, embargo operations, non-combatant evacuation operations, initial entry force, and demonstrative force packages – their equipment, people and information systems must produce a cost-effective capability or capabilities to accomplish these missions. These equipment, people and information systems include techniques and technologies across the full spectrum of platforms and operating environments to achieve Information Superiority (IS). IS means gaining access to more and better quality information than an adversary, possessing the tools and techniques to make the right decisions, and having in place the appropriate command organizations to act on these decisions faster and more effectively than an opponent. The key to achieving IS is the development of a NATO Network Enabled Capability (NNEC) to ensure the secure collection, processing, integration and dissemination of information. NNEC also encompasses the elements involved in linking collectors, effectors, and decision makers together to develop a NATO, network-centric, effects-based, operational capability.

NNEC is a priority for NATO. The 5 October 2005 Long-Term Capability Requirements (LTCR) Final Report lists both IS and the NNEC as two of seven Transformational Objective Areas. Furthermore, of the fifteen 2006 prioritized LTCR, eight are directly related to IS and NNEC (i.e., common operating picture; network centric reconnaissance, surveillance, and target assessment (RSTA); timely sensor-shooter connectivity; integrate maritime RSTA; improvements in tactical data exchange between national land, air, sea forces; interface between NATO and national systems; all weather, stand-off aerospace ground surveillance; and joint combat ID and targeting acquisition. Of these eight priorities, major support is provided to LTCR #2 (network centric reconnaissance, surveillance, and target assessment (RSTA)) in that successful delivery of any network-centric RSTA system requires a successful V&V.

The technical effort started with developing a mutually agreed upon terms of reference. Although mundane on the surface, one of the initial challenges of interoperability and network centrism is gaining a common understanding of the complex terms and relationships that everyone can agree to. Once everyone was clear in the definition of the terms, a systems engineering approach was applied in addressing the approach for verifying and validating an NNEC. The key product to be output from the workshop efforts was a top-level roadmap that follow-on activities could use as a guide to arriving at a complete set of guidelines for accomplishing V&V of NNEC.

## 2.0 PROCEEDINGS

### 2.1 Objectives

The SCI-189 Workshop on the Validation and Verification of NATO Network Enabled Capabilities met at Edwards AFB, California, USA, on 11-14 Sep 2007. Workshop participating countries included Canada,

Estonia, Italy, Netherlands, Spain, Turkey, UK, and USA. Support was provided by the host, Edwards AFB. The purpose of this Workshop (WS) is to bring together members from participating NATO countries to discuss the V&V of a NNEC. For this WS, verification is determining if the NNEC does what it is designed to do, and validation is determining if the NNEC does what it is supposed to do. In this context, V&V must be built into the development of network enabled capabilities in an iterative approach starting with the initial concept of operations. Furthermore, as an NNEC collects, processes, integrates and disseminates information, the V&V of an NNEC in essence feeds the research and development of that NNEC. Thus, the V&V of the NNEC is of tremendous interest to the System Concepts and Integration Panel. The objectives of the Workshop include:

- A) Coordinate, include and participate with all SCI panel members and other panels as appropriate;
- B) Review IS and NNEC policies;
- C) Develop an approach to defining the methodology for the V&V of an NNEC (i.e., the “how” to conduct the V&V of an NNEC);
- D) Build an roadmap to defining guidelines of a robust V&V approach for the developer of an NNEC architecture;
- E) Write an Executive Summary and assemble Meeting Proceedings;
- F) Support the SCI symposium on NEC in 2008;
- G) Brief and provide NNEC V&V guidelines as required; and
- H) Participate in future events such as Cooperative Demonstrations of Technology (CDTs) and Task Groups.

## **2.2 Preparation**

In preparation for the formal discussions in meeting the above objectives, a series of preliminary discussions were lead by various participants in the workshop. The discussion topics and leaders were as follows:

- Workshop expectations and products lead by Les Bordelon
- Results from the NNEC 2007 Conference lead by Les Bordelon
- Philosophy of V&V of NNEC lead by Les Bordelon and Brian Garone
- Past approaches to developing and building V&V guidelines, example FT3 lead by Dan Roth
- Application of the systems engineering approach lead by Nafiz Alemdaroglu
- Current NNEC Activities and ACT support lead by Ulf Boetcher
- US NNEC V&V activities
  - Test and Training Enabling Architecture (TENA) lead by Gene Hudgins
  - Joint T & E Methodology (JTEM) lead by Col Eileen Bjorkman
- Pragmatic considerations for V&V lead by Leo Motus
- NEC unique activities in the UK lead by Bharat Patel
- Tour of Edwards AFB NEC related capabilities and facilities lead by Les Bordelon

These preparatory discussions formed the initial foundation for the detailed discussions to follow.

### 2.3 Discussions

Detailed discussions identified a top-level roadmap to producing the products necessary to build a valid set of guidelines for V&V of NNEC. These discussions are identified in outline form below and form the initial set of criteria for this roadmap:

- 1) Agree on a working definition of NNEC for V&V
  - Essential Operational Capabilities
    - Timely force availability
    - Effective intelligence
    - Deployability and mobility
    - Effective engagement
    - Effective command, control, and communications
    - Survivability and force protection
  - NATO ACT Definition of NNEC and NII
  - UK Definition – Linking sensors, decision-makers and weapon systems so that information can be translated into synchronized and overwhelming military effect at optimum tempo
  - NEC is a journey within the Albert’s Square
  - Key desired NNEC outcomes
    - Enablement of Information and Decision Superiority
    - Assuring Information Coherence and Interoperability to all users
    - Increased NATO forces responsiveness
    - Increased NATO flexibility
- 2) Identify critical NNEC capabilities (including NII) requiring V&V
  - Operational performance
    - Command and Control
    - Machine to machine autonomy
    - Situational awareness
    - Informed decision making process
    - Flexible execution
    - Effective coordination
  - Technical performance
    - C4ISR Architecture
    - Information assurance and security
    - Integrity and timeliness of information flow
    - Machine to machine interface
    - Network management
    - Sensors management
    - Effectors management
    - Interoperability between nations
    - Human factors
    - Compliance to standards (including the NC3TA identified standards)
  - Governance compliancy for the Alliance
  - Acceptance Criteria
    - Normal operations
    - Minimally acceptable operations
  - The detailed definition of capabilities needs to be done by a separate forum – currently no such body exists

- 3) Define V&V capabilities needed to meet NNEC requirements
    - Test & Evaluation methodology
      - Develop T&E strategy
      - Characterize test
      - Plan Test
      - Implement LVC distributed environment
      - Execute test
      - Evaluate capabilities
    - V&V Capabilities
      - Translation of future operational requirements to V&V requirements
      - Representative test system
        - Asset access and availability
        - Schedule requirements
      - Multi-national distributed connectivity
        - Integrity and assurance
      - Compatible data exchange
      - Interoperable test tools
      - Interoperable analysis tools
      - Interoperable test planning tools
      - Interoperable LVC simulation tools
      - Multi-level security test tools
      - Compatible test and evaluation reporting
        - Automation considerations
        - Templates
        - Taxonomy
      - Test control
      - Appropriate data and information access and capture
        - Including test support resources and environment
      - Re-composable environment
    - The detailed definition of V&V capabilities needs to be done by a separate forum. Currently no such body exists
- 4) Define criteria to prioritize critical V&V capabilities
    - Compliance with health and safety requirements
    - Responsive to NNEC needs of the customer
    - Can be satisfied using core capabilities (as identified in list above)
      - Connectivity
      - Timeliness
      - Security
      - Interoperability
      - Test control
      - LVC simulation
      - ...
    - Can be exploited rapidly
    - Capabilities that are shared between customers
    - Has funding
    - The refining of the criteria and prioritization of V&V capabilities needs to be done by a separate forum – currently no such body exists

- 5) Identify existing NATO and nations' V&V capabilities and shortfalls including M&S tools
  - Define V&V capability taxonomy
  - Develop integrated catalogue of V&V capabilities across all nations
  - Conduct V&V capability gap analysis
  - This needs to be done by a separate forum – currently no such body exists
  
- 6) Identify NATO key players and organizational entities (both new and existing) and any NNEC initiatives currently in work
  - Key NATO players
    - ACT
    - NC3B
    - SCI
    - T&E Community across all nations
    - NIAG
    - NURC
    - ACO
  - Key national representatives
    - CNAD
    - Agile Mission Group (NRF)
    - Military Committee
    - Nations (customers)
  - Identification of NNEC initiatives and key players needs to be done by a separate forum – currently no such body exists
  
- 7) Identify issues within and beyond scope of V&V that need to be addressed
  - Issues include
    - Funding process needs to change
    - Culture of an NNEC environment
    - Governance
    - Acceptance criteria determining authority
    - Architectural framework for interoperability among the nations
    - Technology and NNEC maturity levels among nations
    - Concepts of use
    - Acquisition process not timely or comprehensive for NNEC, for example
      - Network capable key performance parameter needs to be added to all procurements
    - Training framework need to updated
    - Capability management to synchronize national contributions
    - Availability of test and evaluation personnel
    - Process needed to identify and adapt concepts that emerge through NNEC use
  - Identification of a comprehensive set of issues needs to be done by a separate forum – currently no such body exists
  
- 8) Formulate V&V guidelines for NNEC
  - Output from the above forums should provide the foundation for criteria for V&V guidelines
  - V&V for NNEC should be considered an evolutionary process aligned to the NNEC journey
  - Additional considerations for guidelines should include
    - Demonstrate interoperability

- Comply with standards
  - Demonstrate that mission requirements are met
  - Demonstrate that a system is net ready
  - Understand limitations of use
  - Harmonize T&E plans across nations for NNEC
  - Promote community of interest for T&E
    - Disseminate best practices and lessons learned
    - Provide education and training
  - Identification of these guidelines needs to be done by a separate forum – currently no such body exists
- 9) Build the approach or way ahead for V&V of NNEC (follow-up to this workshop)
- Define use case(s) along the NNEC journey and assumptions to be used as a basis for all V&V of NNEC
  - Define expectations from our approach – validate and verify systems are ready for NNEC operations
  - Develop a detailed roadmap and identify outputs consistent with the initial roadmap shown below
    - 1) Identification of NNEC initiatives and key players
    - 2) Detailed definition of NNEC capabilities
    - 3) Detailed definition of V&V capabilities
    - 4) Identification of existing NATO and nations' V&V capabilities and shortfalls
    - 5) Refinement of the criteria and prioritization of V&V capabilities
    - 6) Identification of a comprehensive set of issues that impact V&V
    - 7) Development V&V guidelines
  - Initiate within Working Session III activities to address all of the above identified items. This has some parallels with FT3 in both philosophy and purpose, although the structure, implementation, and products will be different. The initial activity should be a task group.
  - TAP/TOR for initial task group submitted in Oct 2007 for start in April 2008
  - Input from (outside of SCI)
    - ACT
    - IST
    - NMSG
    - SAS

### **3.0 SUMMARY**

The workshop discussions identified a top-level roadmap to arriving at guidelines for Validation and Verification of NATO Network Enabled Capabilities. This roadmap defines a path for the future that includes:

- Agreement on a working definition of NNEC for V&V;
- Identification of critical NNEC capabilities (including NII) requiring V&V;
- Definition of V&V capabilities needed to meet NNEC requirements;
- Definition of criteria to prioritize critical V&V capabilities;
- Identification of existing NATO and nations' V&V capabilities and shortfalls including M&S tools;

- Identification of NATO key players and organizational entities (both new and existing) and any NNEC initiatives currently in work;
- Identification of issues within and beyond scope of V&V that need to be addressed;
- Formulation of V&V guidelines for NNEC; and
- Building the approach or way ahead for V&V of NNEC (follow-up to this workshop).

It was agreed to initiate within Working Session C of the SCI panel actions to address all of the above identified items. This effort should start with an immediate follow-on Task Group to work the details of a V&V of NNEC roadmap as identified in Item 9. Products consistent with Item 9 above should include the use case(s) along the NNEC journey and assumptions to be used as a basis for all V&V of NNEC, the expectations from the approach – validate and verify systems are ready for NNEC operations, and a detailed roadmap with identified outputs consistent with the initial roadmap of the workshop. A TAP/TOR for initial task group should be developed and submitted in Oct 2007 for start in April 2008. It was further agreed that a status report on the progress of the detailed roadmap should also be presented to the SCI Symposium on NNEC in Amsterdam.



<b>REPORT DOCUMENTATION PAGE</b>			
<b>1. Recipient's Reference</b>	<b>2. Originator's References</b>	<b>3. Further Reference</b>	<b>4. Security Classification of Document</b>
	RTO-TR-SCI-189 AC/323(SCI-189)TP/210	ISBN 978-92-837-0061-6	UNCLASSIFIED/ UNLIMITED
<b>5. Originator</b>	Research and Technology Organisation North Atlantic Treaty Organisation BP 25, F-92201 Neuilly-sur-Seine Cedex, France		
<b>6. Title</b>	Validation and Verification of NATO Network Enabled Capabilities		
<b>7. Presented at/Sponsored by</b>	Final Report of Workshop SCI-189.		
<b>8. Author(s)/Editor(s)</b>	Multiple		<b>9. Date</b> July 2008
<b>10. Author's/Editor's Address</b>	Multiple		<b>11. Pages</b> 22
<b>12. Distribution Statement</b>	There are no restrictions on the distribution of this document. Information about the availability of this and other RTO unclassified publications is given on the back cover.		
<b>13. Keywords/Descriptors</b>	Operations research Interoperability Operational effectiveness Integrated systems Information systems International cooperation	Naval intelligence Ocean surveillance Systems analysis Systems engineering Models Requirements	Reviews Design Command and control V&V (Verification and Validation) Network Enabled Capability
<b>14. Abstract</b>	<p>The purpose of this Workshop (WS) was to bring together members from participating NATO countries to discuss the Verification and Validation (V&amp;V) of a NATO Network Enabled Capability. V&amp;V must be built into the development of network enabled capabilities in an iterative approach starting with the initial concept of operations. Furthermore, as an NNEC collects, processes, integrates and disseminates information, the V&amp;V of an NNEC in essence feeds the research and development of that NNEC. The workshop was convened at Edwards AFB, California, USA on 11-14 Sep 2007. Workshop participating countries included Canada, Estonia, Italy, Netherlands, Spain, Turkey, UK, and USA. The workshop discussed formulated a top level roadmap that included a working definition of NNEC for V&amp;V, definition and prioritization of V&amp;V capabilities, shortfalls, key players, initiatives, and future guidelines. It was agreed to initiate within Working Session C of the SCI panel the activities to address all of the above identified items. This effort should start with an immediate follow-on Task Group to work the details of a V&amp;V of NNEC roadmap. A TAP/TOR for initial task group should be submitted in Oct 2007 for start in April 2008.</p>		





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