

# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

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<b>1. REPORT DATE</b> (DD-MM-YYYY) May 2011		<b>2. REPORT TYPE</b>		<b>3. DATES COVERED</b> (From - To)	
<b>4. TITLE AND SUBTITLE</b> Emerged/Emerging "Disruptive" Technologies (E2DT) (Technologies de rupture apparues/émergentes (E2DT))				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b>	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b>				<b>5d. PROJECT NUMBER</b>	
				<b>5e. TASK NUMBER</b>	
				<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> Research and Technology Organisation (NATO) BP 25, F-92201 Neuilly-sur-Seine Cedex, France				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b> RTO-MP-IST-099	
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b> Approved for Public release, distribution unlimited.					
<b>13. SUPPLEMENTARY NOTES</b> Supporting documents are attached to the report as separate files (MS Word, HTML, PDF).					
<b>14. ABSTRACT</b> Emerged/Emerging "Disruptive" Technologies (E2DTs) are technologies which are either disruptive, or deemed to be potentially disruptive, because of the profound impact they may have on capabilities in business sector(s), whether military or civil or both. Using sporting metaphors, that is potential to provide a game winning step change either from the opportunity it presents for obtaining a competitive edge or from the threat it poses by placing an edge in the hands of the competition. In the NATO military context the aim is for the Alliance to exploit the opportunity and be ready to defeat the threat so as to gain and maintain a winning edge over its current adversaries or potential adversaries in the future. The nature of the disruptive effect may not yet be fully identified. Nor with certainty the identification of the emerged/emerging technologies that are most likely to be disruptive. Hence it is a complex problem space where the capability to identify the right technologies that will have the right disruptive effect offers a superior advantage over ones adversaries and have profound impact on military operations. There are two important aspects of NATO Research & Technology Organisation (RTO) co-operation in E2DTs related to this complex problem space. One is the advances in method, tools and techniques that can be used to explore the space and identify with a degree of scientific rigour the E2DTs with the potential to impact future military Information Systems. The second is to explore					
<b>15. SUBJECT TERMS</b>					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b>
<b>a. REPORT</b> U	<b>b. ABSTRACT</b> U	<b>c. THIS PAGE</b> U			<b>19b. TELEPHONE NUMBER</b> (include area code)



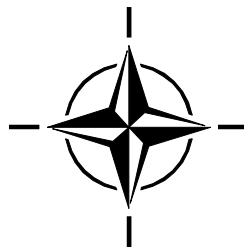
**RTO MEETING PROCEEDINGS**

**MP-IST-099**

# **Emerged/Emerging “Disruptive” Technologies (E2DT)**

(Technologies de rupture apparues/émergentes (E2DT))

Papers presented at the RTO Information Systems Technology Panel (IST)  
Symposium held in Madrid, Spain on 7 – 8 May 2011.



Published May 2011

# 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:

- AVT Applied Vehicle Technology Panel
- 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 May 2011

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ISBN 978-92-837-0147-7

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# **Emerged/Emerging “Disruptive” Technologies (E2DTs)**

## **(RTO-MP-IST-099)**

### **Executive Summary**

Emerged/Emerging “Disruptive” Technologies (E2DTs) is identified by NATO Research and Technology Board as a key strategic research theme to be addressed by the Panels. The Symposium was organised by the IST Panel in support of that endeavour and share information and knowledge on technical developments in various Nations, industry and academia. As a simple definition the call for papers defined E2DTs as technologies which are either disruptive, or deemed to be potentially disruptive, because of the profound impact they may have on capabilities in business sector(s), whether military or civil or both. Using sporting metaphors, that is potential to provide a game winning step change either from the opportunity it presents for obtaining a competitive edge or from the threat it poses by placing an edge in the hands of the competition. In the NATO military context the aim is for the Alliance to exploit the opportunity and be ready to defeat the threat so as to gain and maintain a winning edge over its current adversaries or potential adversaries in the future.

There are two important aspects related to this complex problem space that papers were requested to cover. One, smaller part of the Symposium, was to understand advances in the methods and approaches used for exploring and identifying the E2DTs such as horizon scanning and technology watch. The second major part was to understand selected E2DTs in detail, their applications and views (plan) on how they could be exploited. Examples of such technical areas provided were – Quantum Capabilities, Autonomous Intelligent Technologies, Ubiquitous Mobile Wireless Networking Technologies, Virtual and Augmented Reality and Cognitive Interfaces, Biology-Based Solutions, Internet-Enabled Social Networking, Complex Adaptive Systems and Visualisation, and Hyper-Computing.

Sessions covered by the Symposium and the keynotes were as follows:

- Session 1 Methodologies – Keynote 1 (Prof. Ricardo SANZ, Universidad Politecnica de Madrid, ESP): Autonomous systems and three papers on approaches in three nations to search for E2DTs.
- Session 2 Tools and Techniques – Keynote 2 (Prof. Seth BULLOCK, University of Southampton, UK): Complex Systems, papers on Scientometrics, SAS DTAG game and paper on 3D virtual cities and spectrum management.
- Session 3 Security and Robotics – Keynote 3 (Prof. Raymond LAFLAMME, University of Waterloo, CAN): Quantum Information Sciences, paper on QKD and biometrics, robotics as team members.
- Session 4 Human Dimension – Papers on social networks, semantic wiki, extract info from text and adaptive visualisation.

Overall the Symposium was considered a success and the outputs used by the IST Panel for future programme of work planning.

# Technologies « de rupture » innovantes/ émergentes (E2DTs) (RTO-MP-IST-099)

## Synthèse

Le Comité OTAN pour la Recherche et la Technologie (RTB) a identifié les technologies « de rupture » innovantes/émergentes (E2DTs) comme thème de recherche stratégique majeur à traiter par les divers panels. Le symposium était organisé par le panel IST (technologie des systèmes d'information) pour soutenir cette action et partager les informations et les connaissances relatives aux développements techniques dans divers états, industries et universités. L'appel à contributions a simplement défini les E2DT comme technologies qui sont soit de rupture, soit considérées comme étant potentiellement de rupture, du fait de l'incidence profonde qu'elles sont susceptibles de provoquer sur les capacités des secteurs industriels, qu'ils soient militaires ou civils, voire les deux. Pour utiliser des métaphores sportives, il est tout à fait possible d'adopter un changement de stratégie, soit en tirant parti de l'avantage obtenu sur ses concurrents, soit en tirant parti de la menace que représente l'avantage donné à l'adversaire dans la compétition. Dans le contexte militaire de l'OTAN, l'objectif de l'Alliance consiste à exploiter cette opportunité et à se tenir prête pour vaincre et conserver un avantage sur ses adversaires actuels ou ses adversaires potentiels futurs.

Les articles avaient à traiter deux aspects importants liés à ce problème complexe. Le premier aspect, la partie la moins importante du symposium, était de comprendre les avancées des méthodes et des approches utilisées pour explorer et identifier les E2DT, telles que l'analyse prospective et la veille technologique. La seconde partie du symposium, la plus importante, s'est attachée à comprendre dans le détail les E2DT sélectionnées, leurs applications et les perspectives (plans) relatives à la manière de les exploiter. Parmi les exemples de ces domaines techniques figuraient : les capacités quantiques, les technologies relative à l'intelligence artificielle et l'autonomie, les technologies des réseaux sans fil, mobiles et omniprésentes, les interfaces de réalité virtuelle et augmentée, et cognitives, les solutions basées sur la biologie, les réseaux sociaux disponibles sur Internet, la visualisation et les systèmes adaptatifs complexes, ainsi que l'hyper informatisation.

Le symposium proposait les sessions et les conférences majeures suivantes :

- Session 1 Méthodologies – Conférence n°1 (Prof. Ricardo SANZ, Université polytechnique de Madrid, ESPAGNE) : Systèmes autonomes, ainsi que trois articles sur les approches adoptées dans trois états pour mener des recherches sur les E2DT.
- Session 2 Outils et techniques – Conférence n°2 (Prof. Seth BULLOCK, Université de Southampton, R.U.) : Systèmes complexes, articles sur la scientométrie, le jeu SAS DTAG ainsi qu'un article sur les villes virtuelles en 3D et sur la gestion du spectre.
- Session 3 Sécurité et robotique – Conférence n°3 (Prof. Raymond LAFLAMME, Université de Waterloo, CANADA) : Sciences de l'information quantique, articles sur la distribution de clé quantique (QKD), la biométrie, et la robotique en qualité de membres d'une équipe.
- Session 4 Dimension humaine – Articles sur les réseaux sociaux, la sémantique wiki, extraits d'informations issus de texte et de visualisation adaptative.

L'ensemble du symposium a été considéré comme un succès et le panel IST en a utilisé les enseignements à des fins de planification de son programme de travail.