

NORTH ATLANTIC TREATY ORGANIZATION



RESEARCH AND TECHNOLOGY ORGANIZATION

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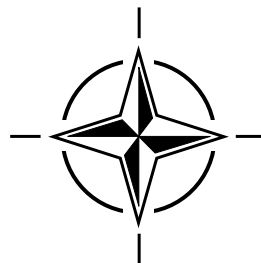
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containing the PowerPoint presentations.*

RTO MEETING PROCEEDINGS 49

New Information Processing Techniques for Military Systems

(les Nouvelles techniques de traitement de l'information
pour les systèmes militaires)

*Papers presented at the Information Systems Technology Panel (IST) Symposium held in Istanbul,
Turkey, 9-11 October 2000.*



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The Research and Technology Organization (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote cooperative 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 coordination 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 coordinates RTO's cooperation 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 initial cooperation.

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 Studies, Analysis and Simulation 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 cooperation 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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New Information Processing Techniques for Military Systems

(RTO MP-049 / IST-017)

Executive Summary

Information processing is a key factor for many military systems. Recent operations in Gulf-war, in Bosnia, and in Kosovo has made this requirement even more obvious. Advances in sensing and information processing/distribution technologies will enable highly innovative system concepts for achieving improvements in military mission capabilities. This Symposium essentially dealt with applications of new, promising, and unprecedented information processing techniques for military systems, where special emphasis was given to technology transfer from the commercial area. Military effectiveness requires the ability to acquire and process information in real time and to communicate this effectively on a wide front. With increasing NATO responsibilities in joint military operations involving many different national Communications and Information System (CIS) environments, the need for a unified approach to support information / data transfer services becomes more crucial. Topics addressed by the symposium were:

- Information filtering and information fusion
- Applications of soft computing (neural networks, fuzzy logic, genetic algorithms)
- Expert systems (including real-time aspects) and knowledge-based decision support
- Machine intelligence applied to future autonomous systems
- Techniques for efficient information management (including data dissemination)
- Situation analysis (incl. real-time interpretation of large amounts of battlefield information)
- Processing demands in information security (monitoring of systems and networks, incl. firewalls and intrusion detection)
- Modelling and simulation, visualisation and virtual environments
- Innovative architectures in the field of c2 systems
- Design methods for information systems and command centres
- Battlefield digitisation concepts

THE SYMPOSIUM

The three days of the symposium included 29 papers and two keynote addresses, which provide a good basis for further development. The first keynote address entitled "Autonomous Systems" (Dr. B. C. Williams, US) covered information processing onboard unmanned spacecraft. The second keynote address entitled "Model-Based Design of Information-Rich Command Organisations" (Dr. D. Serfaty, US) covered a description of team structure design based upon the team's mission. The feedback from 140 delegates was, in general, positive with the vast majority considering the contents relevant. The purpose of the symposium was to exchange information on state-of-the-art and state-of-the-practice in information processing techniques as applied to military systems. The scope of the symposium was intentionally very broad and was organised into multiple sessions.

SESSION I – INFORMATION SYSTEMS AND TECHNIQUES I

The initial two sessions consisted of eleven papers with various aspects of information systems and techniques that covered the spectrum from future revolutionary technology such as the quantum computer to fielded systems.

SESSION II – INFORMATION SYSTEMS AND TECHNIQUES II

A paper in this continuing session entitled “Battlefield Digitisation” (Gibson and White) addressed the broader range of requirements to achieve information security which, in addition to technology development and exploitation, also must consider changes to doctrine, command processes, organisations, user-requirements specification, architecture definition, procurement, training, and operational use.

SESSION III – SECURITY AND RELIABILITY

There were four papers in this session. The first paper (Serb and Patriciu) addressed the reliability of command and control systems in terms of fault tolerance capabilities provided by a cluster of networked nodes capable of fault detection and automatic reconfiguration such that the systems continue operation subsequent to the fault.

SESSION IV – COMMUNICATIONS

The communications session consisted of five papers. The first two papers (Berni and Mozzone; Rice) addressed wireless networks in the undersea environment. The undersea environment is particularly difficult for networks and typically involves one or more battery powered buoys to provide a gateway to the terrestrial node. Bandwidth limitations of military ships have resulted in much research into effective data compression algorithms, which enable de-compression by the receiver without loss of data quality.

SESSION V – DETECTION, FUSION, DECISION SUPPORT

Six papers were presented during this session beginning with an overview of information fusion (Whitaker). The major challenge to future Command and Control systems was highlighted. The Command and Control process is described by the Observe Orient Decide Act (OODA) Loop. Processing and fusion of electro-optical (EO) data was the subject of the next paper (Davies).

SESSION VI – VIRTUAL REALITY AND HUMAN-COMPUTER INTERFACE

This session included four papers. The first paper (Varga, McQueen, and Rossi) described the United Kingdom Master Battle Planner, which is an Air Tasking Order planning tool providing for visualisation of the scenario including showing the mission in motion.

CONCLUSIONS

The defense community has the opportunity to contribute to information technology through establishment of metrics and a theoretical/mathematical basis for information systems. This is an area where the Information Systems Technology Panel might consider an activity that would deal with military information performance requirements, modelling, simulation, and analysis.

les Nouvelles techniques de traitement de l'information pour les systèmes militaires

(RTO MP-049 / IST-017)

Synthèse

Le traitement de l'information est un élément clé pour de nombreux systèmes militaires. Les récentes opérations, guerre du Golfe, Bosnie et Kosovo n'ont fait que souligner son utilité. Les progrès réalisés dans les domaines des technologies du traitement et de la diffusion de l'information ainsi que des capteurs permettront d'élaborer des concepts de systèmes très novateurs dans le but d'améliorer l'efficacité des missions militaires. Ce symposium a traité essentiellement de la mise en œuvre de nouvelles techniques de traitement de l'information pour systèmes militaires, prometteuses et sans précédent,; avec une attention particulière pour les transferts de technologie avec le secteur commercial. L'efficacité militaire dépend de la capacité d'acquérir et de traiter des informations en temps réel et de les communiquer avec efficacité à une grande partie de la chaîne de commandement. Avec une implication toujours plus grande de l'OTAN dans des opérations interarmées mettant en jeu différents environnements nationaux de systèmes de communications et d'information (CIS), le besoin d'une approche unifiée pour le soutien des services de transfert de données et de renseignements se fait de plus en plus sentir. Les sujets abordés lors du symposium étaient les suivants :

- Le filtrage et le fusionnement des données
- Les applications de l'ingénierie des logiciels (les réseaux neuraux, la logique floue, les algorithmes génétiques)
- Les systèmes experts (y compris les aspects temps réel) et les aides à la décision basées sur l'expérience
- L'intelligence machine appliquée aux futurs systèmes autonomes
- Les techniques de gestion efficace des informations (y compris la diffusion des données)
- L'analyse de la situation (y compris l'interprétation en temps réel de grands volumes de données du champ de bataille)
- Les exigences en matière de traitement pour la sécurité de l'information (le contrôle des systèmes et réseaux, y compris les pare feu et les systèmes de détection d'intrus)
- La modélisation et la simulation, la visualisation et les environnements virtuels
- Les architectures novatrices pour systèmes C2
- Les méthodes de conception pour systèmes d'information et centres de commandement
- Les concepts de numérisation du champ de bataille

LE SYMPOSIUM

En tout, 29 communications et 2 discours d'ouverture ont été présentés lors des 3 journées de la conférence, ce qui constitue une bonne base pour de futurs travaux. Le premier discours d'ouverture, intitulé "Les systèmes autonomes" (par le Dr.B.C.Williams, US) concernait le traitement de l'information à bord de véhicules spatiaux non habités. Le deuxième, intitulé "La conception, à base de modèles, d'organismes de commandement riches en information" (par le Dr. D.Serfaty, US) était une description de la conception d'une structure pour une collaboration optimale basée sur la mission de l'équipe. Les commentaires des 140 délégués ont été, dans l'ensemble, positifs une grande majorité considérant les communications dignes d'intérêt. Le symposium a eu pour objectif d'échanger des informations sur l'état actuel des connaissances et des pratiques dans le domaine des techniques de

traitement de l'information au sein des systèmes militaires. Le portée du symposium était délibérément très large et la réunion a été divisée en un certain nombre de sessions.

SESSION I – SYSTEMES ET TECHNIQUES DE TRAITEMENT DE L'INFORMATION (I)

Les deux premières sessions étaient composées de 11 communications, portant sur différents aspects des systèmes et des techniques de traitement de l'information, allant des futures technologies révolutionnaires telles que l'ordinateur quantique aux systèmes déployés.

SESSION II – SYSTEMES ET TECHNIQUES DE TRAITEMENT DE L'INFORMATION (II)

L'une des communications présentées lors de cette session, "La numérisation du champ de bataille" (par Ms. Gibson & White) a examiné l'éventail plus large des spécifications en matière de sécurité de l'information, lequel, en plus du développement et de l'exploitation des technologies, devra aussi incorporer des changements concernant la doctrine, les processus de commandement, les organisations, la spécification des besoins des utilisateurs, la définition des architectures, l'approvisionnement, la formation et e la mise en œuvre opérationnelle.

SESSION III – SECURITE ET FIABILITE

Quatre communications ont été présentées. La première communication (par Ms. Serb et Patriciu) a examiné la fiabilité des systèmes de commandement et de contrôle du point de vue de la tolérance aux pannes offerte par une grappe de nœuds en réseau capables de détecter les erreurs et de reconfigurer les systèmes automatiquement afin que ceux-ci puissent reprendre leur activité rapidement après l'erreur.

SESSION IV – COMMUNICATIONS

La session sur les communications a permis la présentation de 5 communications. Les deux premières (par Ms. Berni et Mozzone ; puis M. Rice) concernaient les réseaux radio en environnement sous-marin. L'environnement sous-marin pose des problèmes particuliers pour les réseaux et généralement nécessite le déploiement d'une ou de plusieurs bouées fonctionnant sur piles pour fournir une passerelle au nœud terrestre. Les conditions limitant la bande passante utilisable par les bâtiments de guerre ont conduit à de nombreux travaux de recherche sur les algorithmes de compression de données, destinés à permettre la décompression par le récepteur sans perte de qualité.

SESSION V – DETECTION, FUSIONNEMENT, AIDES A LA PRISE DE DECISIONS

Six communications ont été présentées lors de cette session, commençant par un tour d'horizon du fusionnement des données (par M. Whitaker). La session a permis de mettre en relief les enjeux pour les futurs systèmes de commandement et contrôle. Le processus de commandement et contrôle est décrit par la boucle OODA (observer, orienter, décider, agir). Le traitement et le fusionnement des données électro-optiques (EO) a fait l'objet de la communication suivante (par M. Davies).

SESSION VI – LA REALITE VIRTUELLE ET L'INTERFACE HOMME - MACHINE

Cette session a été composée de 4 communications. La première, (par Ms. Varga, McQueen et Rossi) a présenté le Système Central de Planification de l'Engagement du Royaume-Uni, qui est un outil de planification des ordres de mission aérienne incorporant la visualisation du scénario, et montrant des images de la mission en cours d'exécution.

CONCLUSIONS

Les spécialistes de la défense ont la possibilité de contribuer aux technologies de l'information en établissant des paramètres et en jetant les bases théoriques/mathématiques de futurs systèmes d'information. Il s'agit d'un domaine pour lequel la commission sur la technologie des systèmes d'information pourrait envisager la création d'une activité portant sur les spécifications des performances, la modélisation, la simulation et l'analyse de l'information militaire.

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Theme

Information processing is a key factor for many military systems. Recent operations in Gulf-war, in Bosnia, and in Kosovo have made this requirement even more obvious. Advances in hardware and software technologies for sensing, integrating, processing, and distributing information will enable highly innovative system concepts for achieving improvements in military mission capabilities. This Symposium will essentially deal with applications of new, promising, and unprecedented information processing techniques for military systems challenges of the next 5 to 10 years, where special emphasis is given to technology transfer from and to the commercial area.

Today's and future military effectiveness requires the ability to acquire and process information in real time as well as to distribute and communicate this effectively on a wide front. This is also a very important requirement of operations as demonstrated by the recent conflicts. With increasing NATO responsibilities in joint military operations involving many different national Communications and Information System (CIS) environments, the need for a unified approach to support information / data transfer services becomes more crucial. This symposium is intended to cover a large but important operational area by viewing relevant aspects of military systems: processing performance; scalability, flexibility, and adaptivity of processing; system characteristics like robustness, reliability, and security; and other relevant factors.

TOPICS TO BE COVERED:

1. The various Processing Demands of the Command and Control Cycle (e.g., sensing, integrating/fusing, and distributing information on extended/global battlefields)
2. Situation Analysis (incl. real-time interpretation of large amounts of battlefield information)
3. Architectures and Processing Demands in the field of Command and Control Systems (especially Distributed Systems)
4. Applications of Soft Computing (neural networks, fuzzy logic, genetic algorithms)
5. Machine Reasoning (including real-time aspects) and Knowledge-Based Decision Support
6. Information Architectures and Processing Demands of Future Mobile Autonomous Systems
7. New Techniques for Efficient Information Management (including Data Dissemination)
8. Processing Demands of Information Assurance (Cryptography; Monitoring Systems and Networks, incl. Firewalls and Intrusion Detection Systems)
9. Information Processing in Enabling Technologies (e.g., Intelligent Collaboration, Modeling and Simulation, Visualization, and Virtual Environments)
10. Processing Demands of Image Understanding and Speech Technology / Human Language Systems

Thème

Le traitement de l'information est un élément clé de bon nombre de systèmes militaires. Les récentes opérations pendant la guerre du Golfe et en Bosnie n'ont fait que souligner l'utilité de ce moyen. Les progrès réalisés dans les domaines des technologies du matériel et des logiciels pour la détection, l'intégration, le traitement et la diffusion des données permettront prochainement d'élaborer des concepts de systèmes très novateurs dans le but d'améliorer l'efficacité des missions militaires. Ce symposium traitera essentiellement de la mise en oeuvre de nouvelles techniques, prometteuses et sans précédent, de traitement de l'information pour systèmes militaires, au cours des prochaines cinq à dix années; l'accent étant mis sur les transferts de technologie avec le monde du commerce.

Désormais, l'efficacité militaire dépendra de sa capacité à acquérir et à assimiler les informations en temps réel et à les communiquer avec efficacité à tous les niveaux de commandement. Cette capacité est aussi l'une des principales conditions requises pour la conduite des opérations, comme en témoignent les conflits récents. Avec la multiplication des responsabilités de l'OTAN dans des opérations interarmées mettant en jeu plusieurs environnements de communications et d'information (CIS), le besoin d'une approche unifiée du soutien des services de transfert de données et de renseignements se fait de plus en plus sentir. Ce symposium couvrira un grand domaine opérationnel qui est d'une grande importance, en traitant des aspects suivants des systèmes militaires : les performances en traitement, la variabilité d'échelle, la souplesse d'emploi, l'adaptativité du traitement, les caractéristiques des systèmes telles que la robustesse, la fiabilité, la sécurité et tout autre facteur approprié.

SUJETS A TRAITER :

1. Les différentes exigences du cycle de commandement et contrôle (par exemple, la détection, l'intégration/fusion et la dissémination des informations à travers des champs de bataille étendus/globaux)
2. L'analyse de la situation (y compris l'interprétation en temps réel de grands volumes de données du champ de bataille)
3. Les exigences en matière d'architectures et de traitement dans le domaine des systèmes de commandement et contrôle (en particulier les systèmes répartis)
4. Les applications de l'ingénierie des logiciels (les réseaux neuronaux, la logique floue, les algorithmes génétiques)
5. Le raisonnement machine (y compris les aspects temps réel) et les aides à la décision basées sur les connaissances
6. Les exigences en matière d'architectures d'information et de traitement des futurs systèmes mobiles autonomes
7. Les nouvelles techniques de gestion efficace des informations (y compris la diffusion des données)
8. Les exigences en matière de sécurité de l'information (la cryptographie, les systèmes et réseaux de surveillance, y compris les pare-feux et les systèmes de détection d'intrus)
9. Le traitement de l'information dans les technologies habilitantes (par exemple, la collaboration intelligente, la modélisation et la simulation, la visualisation et les environnements virtuels)
10. Les exigences en matière de traitement des technologies vocales et de compréhension d'image et de systèmes de traitement du langage naturel

Information Systems Technology Panel

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Information systems Data processing Military operations Battlefields Command and control Operational effectiveness Real time operations Interoperability Logistics Secure communication	Communications networks Data fusion Distributed systems Neural nets Fuzzy sets Decision making Man computer interface Situation analysis Genetic algorithms Virtual reality				
14. Abstract					
<p>This volume contains the Technical Evaluation Report, 2 Keynote Addresses and 29 unclassified papers, presented at the Information Systems Technology Panel Symposium held in Istanbul, Turkey, 9-11 October 2000.</p> <p>The papers were presented under the following headings:</p> <ul style="list-style-type: none"> • Information Systems and Techniques I • Information Systems and Techniques II • Security and Reliability • Communications • Detection, Fusion, Decision Support • Virtual Reality and Human-Computer Interface 					

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