



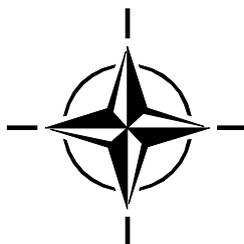
RTO TECHNICAL REPORT

TR-IST-035

Awareness of Emerging Wireless Technologies: Ad-hoc and Personal Area Networks Standards and Emerging Technologies

(Sensibilisation à l'émergence des technologies sans fil :
Technologies émergentes et normes de
réseaux personnels et ad-hoc)

This Technical Report represents the Final Report of IST-035/RTG-015
submitted by the members of IST-035/RTG-015 for the RTO
Information Systems Technology Panel (IST).



Published April 2007





RTO TECHNICAL REPORT

TR-IST-035

Awareness of Emerging Wireless Technologies: Ad-hoc and Personal Area Networks Standards and Emerging Technologies

(Sensibilisation à l'émergence des technologies sans fil :
Technologies émergeantes et normes de
réseaux personnels et ad-hoc)

This Technical Report represents the Final Report of IST-035/RTG-015
submitted by the members of IST-035/RTG-015 for the RTO
Information Systems Technology Panel (IST).

Prof. George Stassinopoulos (Greece), Editor

Contributions in national alphabetical order:

L. Boucher (CA), M. Churavy (CZ), T. Plesse (FR), D. Marquart (GE),
G. Stassinopoulos (GR, Chair IST-035), S. Kyriazakos (GR),
N. Papaoulakis (GR), D. Nikitopoulos (GR), T. Maseng (NO)

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.

The content of this publication has been reproduced directly from material supplied by RTO or the authors.

Published April 2007

Copyright © RTO/NATO 2007
All Rights Reserved

ISBN 978-92-837-0052-4

Single copies of this publication or of a part of it may be made for individual use only. The approval of the RTA Information Management Systems Branch is required for more than one copy to be made or an extract included in another publication. Requests to do so should be sent to the address on the back cover.

Table of Contents

| | Page |
|--|-------------|
| List of Figures | vii |
| List of Tables | viii |
| Glossary | ix |
| Information Systems Technology Panel | xii |
| | |
| Executive Summary and Synthèse | ES-1 |
| | |
| Chapter 1 – Introduction | 1-1 |
| | |
| Chapter 2 – Ad-hoc Networking | 2-1 |
| 2.1 MANET Operational Employment | 2-1 |
| 2.2 MANET Routing | 2-1 |
| 2.2.1 Overview | 2-1 |
| 2.2.2 Concepts Developed by MANET | 2-2 |
| 2.2.2.1 Hierarchy of MANET Routing Protocols | 2-2 |
| 2.2.2.2 Classification of Routing Protocols | 2-3 |
| 2.2.2.3 Proactive Protocols | 2-3 |
| 2.2.2.4 Reactive Protocols | 2-4 |
| 2.2.2.5 Hybrid Protocols | 2-4 |
| 2.2.3 Examples of Existing Protocols | 2-4 |
| 2.2.3.1 Reactive Protocols | 2-4 |
| 2.3 Conclusion | 2-9 |
| 2.4 Technical Specifications of a French MANET Testbed | 2-9 |
| 2.4.1 Introduction | 2-9 |
| 2.4.2 MANET/OLSR Demonstrator Features | 2-9 |
| 2.4.3 Demonstrator Overview | 2-12 |
| 2.4.4 Network Configuration | 2-12 |
| 2.4.5 Wireless Network Specification | 2-12 |
| 2.4.6 Ad-hoc Mode | 2-13 |
| 2.4.7 Systems Technical Specification | 2-14 |
| 2.4.7.1 OLSR Router Specification | 2-14 |
| 2.4.7.2 Linux Laptop Specification | 2-14 |
| 2.4.7.3 Linux PDA Specification | 2-15 |
| 2.4.8 Software | 2-16 |
| 2.4.8.1 Overview | 2-16 |
| 2.4.8.2 OLSR | 2-16 |
| 2.4.9 References | 2-17 |
| 2.4.9.1 Demonstrator Architecture (Scenario) | 2-17 |
| 2.4.9.2 INSC Interconnection Architecture | 2-18 |
| 2.5 French PR4G SAP Ad-hoc Network | 2-18 |

| | | |
|---------|---|------|
| 2.5.1 | Introduction | 2-18 |
| 2.5.2 | SAP/PAS Network Oriented Mode | 2-18 |
| 2.5.3 | Packet Radio Mode | 2-19 |
| 2.5.3.1 | Principles | 2-19 |
| 2.5.3.2 | Advantages | 2-19 |
| 2.5.3.3 | Implementation | 2-19 |
| 2.5.4 | PRNET with PR4G | 2-19 |
| 2.5.5 | Packet Radio Application (Routing) | 2-20 |
| 2.5.6 | Packet Radio Application Providing Routing Adaptivity | 2-20 |
| 2.5.7 | Synchronization and User Traffic Principles | 2-21 |
| 2.5.8 | Routing Principles | 2-21 |

Chapter 3 – WLAN Technologies **3-1**

| | | |
|-------|--|------|
| 3.1 | The IEEE 802.11 Family of Standards | 3-2 |
| 3.1.1 | IEEE 802.11b | 3-3 |
| 3.1.2 | IEEE 802.11a | 3-5 |
| 3.1.3 | Bridge Operation Procedures with 802.11c | 3-6 |
| 3.1.4 | Global Harmonization with 802.11d | 3-7 |
| 3.1.5 | Enhancements for QoS with IEEE 802.11e MAC | 3-7 |
| 3.1.6 | An Inter Access Point Protocol with IEEE 802.11f | 3-7 |
| 3.1.7 | Higher Rate Extensions in the 2.4 GHz Band with IEEE 802.11g | 3-8 |
| 3.1.8 | Spectrum Managed 802.11a with 802.11h | 3-8 |
| 3.1.9 | MAC Enhancements for Enhanced Security with 802.11i | 3-9 |
| 3.2 | A Backup Wireless LAN for the Czech Army | 3-9 |
| 3.2.1 | Introduction | 3-9 |
| 3.2.2 | WLAN Step 1 – What is Available on the Market? Choosing COTS (Commercial Off The Shelf) Technology | 3-11 |
| 3.2.3 | WLAN Step 2 – Distance and Reliability Measurement of Chosen Technology | 3-12 |
| 3.2.4 | WLAN Step 3 – Realization Details | 3-14 |
| 3.2.5 | Conclusion | 3-15 |
| 3.3 | An 802.11b Related Experiment at FFI in Norway | 3-18 |
| 3.3.1 | Measurements | 3-19 |
| 3.3.2 | Specifications | 3-19 |

Chapter 4 – Overview of 802.16 – Military Relevance **4-1**

| | | |
|-------|---|-----|
| 4.1 | Broadband Wireless Access | 4-1 |
| 4.1.1 | Frequency Bands for BWA | 4-2 |
| 4.1.2 | Broadband Wireless Access Standards History | 4-2 |
| 4.1.3 | Broadband Wireless Access in ETSI BRAN | 4-2 |
| 4.2 | The 802.16 Standards, Projects and Activities | 4-3 |
| 4.2.1 | Scope of the IEEE 802.16 | 4-3 |
| 4.2.2 | Overview of the 802.16 Standards, Projects and Activities | 4-3 |
| 4.3 | Some of the Technical Considerations of 802.16-2001 (10 – 66 GHz) | 4-6 |
| 4.3.1 | Properties of IEEE Standard 802.16-2001 | 4-6 |
| 4.3.2 | More Technical Details | 4-6 |
| 4.4 | Amendment Project IEEE 802.16a – Air Interface for 2 – 11 GHz | 4-6 |

| | | |
|--|--|------------|
| 4.4.1 | P802.16a PHY Alternatives | 4-7 |
| 4.4.2 | Key P802.16a MAC Features | 4-7 |
| 4.5 | Comparison of Key Features of 802.16-2001 and P802.16a | 4-7 |
| 4.6 | Recommended Practice for Coexistence of Fixed Broadband Wireless Access Systems – IEEE 802.16.2 and P802.16.2a | 4-9 |
| 4.6.1 | 802.16.2-2001 | 4-9 |
| 4.6.2 | P802.16.2a | 4-9 |
| 4.7 | Interoperability Testing and Test Protocols for 802.16 | 4-9 |
| 4.7.1 | P802.16c (System Profiles for 10 – 66 GHz) | 4-9 |
| 4.7.2 | P802.16d System Profiles for 2 – 11 GHz | 4-9 |
| 4.7.3 | P1802.16.1 Test Protocols for 10 – 66 GHz | 4-9 |
| 4.7.4 | P1802.16.2 Test Suite Structure and Test Purposes | 4-10 |
| 4.8 | Mobile Broadband Wireless Access for 802.16a | 4-10 |
| 4.9 | WiMAX Forum | 4-10 |
| 4.9.1 | What’s Next for 802.16 | 4-11 |
| 4.9.2 | 802.16 Commercial Products | 4-11 |
| 4.9.3 | Security and Encryption in 802.16 | 4-11 |
| 4.10 | Conclusions | 4-12 |
| 4.10.1 | Physical Layer | 4-13 |
| 4.10.2 | MAC Layer | 4-13 |
| 4.10.3 | General Conclusions | 4-13 |
| Chapter 5 – Wireless Personal Area Networks (WPANs) | | 5-1 |
| 5.1 | An Elaboration of the MultiSphere Reference Model | 5-1 |
| 5.2 | The “Spheres of the Model” | 5-1 |
| 5.3 | MultiSphere Level 1 – The PAN | 5-1 |
| 5.3.1 | WPAN Devices and Data Rates | 5-2 |
| 5.3.2 | Meshed Nodes with Hierarchy within the WPAN | 5-2 |
| 5.3.2.1 | The Virtual Device | 5-2 |
| 5.3.2.2 | The WPAN Consisting of Virtual Devices | 5-3 |
| 5.4 | MultiSphere Levels 3 & 4: Instant Partners | 5-3 |
| 5.5 | MultiSphere Level 5 (Interconnectivity) – The CAN | 5-4 |
| 5.5.1 | Gate Keeping Functionality – Security Considerations | 5-4 |
| 5.6 | Third Level: The Wide Area Network (WAN) | 5-5 |
| 5.7 | MultiSphere Level 6: CyberWorld | 5-5 |
| 5.8 | Overview of Relevant Standards | 5-5 |
| 5.8.1 | IEEE 802.15 | 5-5 |
| 5.8.2 | Architecture of the 802.15 and Relation with Bluetooth | 5-6 |
| 5.8.3 | (UWB) 802.15.3a – Main Characteristics | 5-6 |
| 5.9 | Security Requirements | 5-7 |
| 5.10 | Functions of Lower Layer Protocols | 5-7 |
| 5.10.1 | RF Layer | 5-7 |
| 5.10.2 | Baseband Layer | 5-7 |
| 5.10.3 | Link Manager | 5-7 |
| 5.10.4 | Logical Link Control and Adaptation Protocol (L2CAP) | 5-8 |
| 5.10.5 | Differences of the WPAN (802.15) from the WLAN (802.11) | 5-8 |

| | | |
|---|---|-------------|
| 5.10.6 | 802.15 WPAN Task Group 1 | 5-8 |
| 5.10.7 | 802.15 WPAN Task Group 2 | 5-8 |
| 5.10.8 | 802.15 WPAN Task Group 3 | 5-8 |
| 5.10.9 | 802.15 WPAN Task Group 4 | 5-8 |
| 5.11 | References | 5-8 |
| 5.12 | PAN in the Context of Wireless Technologies Standards | 5-10 |
| Chapter 6 – Command Post and Urban Operations | | 6-1 |
| Chapter 7 – Soldier Network | | 7-1 |
| Chapter 8 – Military Relevance: Security, Interceptability, ECM Issues | | 8-1 |
| 8.1 | General Security Issues | 8-1 |
| 8.2 | Security Considerations for 802.11 | 8-1 |
| 8.3 | The Standards/Systems | 8-2 |
| 8.4 | Interceptability | 8-3 |
| 8.5 | ESM and ECM for the IEEE 802.16 Standards | 8-4 |
| 8.6 | ECM Issues | 8-5 |
| 8.7 | Military Relevance | 8-6 |
| Chapter 9 – NATO Requirements Matrix | | 9-1 |
| 9.1 | Command and Control: Deployability of Command, Control, Communications and Information Systems (C3I) – Flexibility of Mobile Forces | 9-1 |
| 9.2 | Command & Control: Rapid Environmental Assessment (e.g.: for warriors) | 9-2 |
| 9.3 | Command & Control: C2 Network Architectures | 9-2 |
| 9.4 | Command & Control: Interoperability of C3I Systems (Allied Forces / Maritime, Air and Land Operations) | 9-3 |
| 9.4.1 | Maritime, Air Operations Serving Land Operations | 9-3 |
| 9.4.2 | Interoperability of Allied Forces | 9-3 |
| 9.5 | Command & Control: Capacity of Communication Channels (Bandwidth, Frequency Spectrum) | 9-3 |
| 9.6 | Command & Control: Security of Wireless Communications | 9-3 |
| 9.7 | Improvements of Communications and Consultations between Military and Civil Organizations (Peace Support Operations) | 9-4 |
| 9.8 | Improvements in the Capacity to Operate in Extreme Weather Conditions (Peace Support Operations) | 9-4 |
| 9.9 | Sustainability & Logistics | 9-4 |
| 9.10 | Survivability of Forces and Infrastructure | 9-4 |
| Chapter 10 – Recommendations | | 10-1 |
| Chapter 11 – References | | 11-1 |
| Annex A – The PHY and MAC Layers of 802.16-2001 | | A |
| Annex B – Commercial Products | | B |

List of Figures

| Figure | | Page |
|---------------|--|-------------|
| Figure 2-1 | Hierarchy of MANET Routing Protocols | 2-2 |
| Figure 2-2 | MPR Tree | 2-3 |
| Figure 2-3 | An Example of Route Searching in TORA | 2-5 |
| Figure 2-4 | OLSR Protocol | 2-6 |
| Figure 2-5 | ZRP Functioning | 2-8 |
| Figure 2-6 | MANET/OLSR Demonstrator | 2-10 |
| Figure 2-7 | OLSR Implementation: The OLSR Daemon | 2-11 |
| Figure 2-8 | OLSR Router | 2-14 |
| Figure 2-9 | A WEB Interface to the OLSR Daemon (python_olsrd) | 2-16 |
| Figure 2-10 | Demonstrator Architecture | 2-17 |
| Figure 2-11 | INSC Architecture | 2-18 |
| Figure 2-12 | SAP/PAS | 2-19 |
| Figure 2-13 | Packet Radio Application Routing | 2-20 |
| Figure 2-14 | Packet Radio Routing | 2-20 |
| Figure 2-15 | PR4G SAP | 2-21 |
| Figure 3-1 | WLAN Range | 3-6 |
| Figure 3-2 | Battalion TOC LAN External Segment Layout (Simplified) | 3-11 |
| Figure 3-3 | Diagram of Apparatus in the Terrain | 3-13 |
| Figure 3-4 | Detail View of Omni-Directional Antenna for WLAN on the Roof of Staff Shelters | 3-16 |
| Figure 3-5 | External Cable Panel with Connected FO Cable (on the reel) | 3-16 |
| Figure 3-6 | External Cable Panel – Detailed View | 3-17 |
| Figure 3-7 | Connection of External Notebook GETAC with Data Projector to Shelter Cable Panel | 3-17 |
| Figure 3-8 | WLAN Experiment in FFI | 3-18 |
| Figure 3-9 | FFI Experiment | 3-19 |
| Figure 3-10 | FFI Experiment – Route | 3-20 |
| Figure 5-1 | The Virtual Device (VD): A Small Standalone Network – A Master with its Accompanying Slave Terminals | 5-3 |
| Figure 5-2 | The Personal Area Network: A Network of Terminals | 5-3 |
| Figure 5-3 | The Community Area Network: A Local Network of PANs | 5-4 |
| Figure 5-4 | The Wide Area Networks (WANs) – PANs/CANs Communicating through External Networks | 5-5 |
| Figure 5-5 | IEEE 802.15.1 Protocol Stack | 5-6 |

List of Tables

| Table | | Page |
|--------------|--|-------------|
| Table 1-1 | Context of IST-035/RTG-015 Work | 1-1 |
| Table 3-1 | WLAN Layered Model | 3-3 |
| Table 3-2 | IEEE 802.111/b Characteristics | 3-6 |
| Table 4-1 | Summary of 802.16 Standards, Projects (P) and Activities | 4-5 |
| Table 4-2 | Comparison of Key Features of 802.16-2001 and 802.16a | 4-8 |
| Table 5-1 | PAN Specifications | 5-9 |
| Table 5-2 | Comparison of PAN with other Technologies | 5-11 |

Glossary

| | |
|-------|---|
| AAS | Advanced Antenna System |
| ACK | ACKnowledgement |
| AMRIS | Ad-hoc Multicast Routing protocol utilizing Increasing id numberS |
| AODV | Ad-hoc On-demand Distance Vector (MANET routing protocol) |
| ARQ | Automatic Repeat reQuest |
| ATM | Asynchronous Transfer Mode |
| | |
| BE | Best Effort |
| BPSK | Binary Phase Shift Keying |
| BRAN | Broadband Radio Access Networks |
| BS | Base Station |
| BWA | Broadband wireless access |
| | |
| C3I | Command, Control, Communications & Information |
| CBC | Cypher block chaining |
| CBR | Constant bit-rate |
| CBRP | Cluster Based Routing Protocol (MANET routing protocol) |
| CEDAR | Core Extraction Distributed Ad-hoc Routing (MANET routing protocol) |
| CID | Connection ID |
| COTS | Commercial Off The Shelf |
| | |
| DF | Direction finding |
| DFS | Dynamic frequency selection |
| DREAM | Distance Effect Algorithm for Mobility |
| DSDV | Destination Sequenced Distance Vector routing |
| DSR | Dynamic Source Routing |
| DSRP | Dynamic Source Routing Protocol (MANET routing protocol) |
| | |
| EMCON | EMission CONtrol |
| ESSID | Extended service set identifier |
| ETSI | European Telecommunications Standards Institute |
| EW | Electronic Warfare |
| | |
| FDD | Frequency-division duplex |
| FSR | Fisheye State Routing |
| | |
| HSR | Hierarchical State Routing |
| | |
| IARP | IntrAzone Routing Protocol |
| ICMP | Internet Control Message Protocol |
| IEEE | Institut of Electrical and Electronic Engineers |
| IERP | IntErzone Routing Protocol |
| IETF | Internet Engineering Task Force |
| IGMP | Internet Group Management Protocol |
| INRIA | Institut National de la Recherche en Informatique et Automatique |
| IP | Internet Protocol (now v4, in future v6) |
| IST | Information Systems Technology |

| | |
|--------|--|
| LMDS | Local Multipoint Distribution Service |
| LOS | Line of sight |
| LPD | Low probability of detection |
| MAA | MANET Authentication Architecture |
| MAC | Medium Access Control |
| MAC | Medium access control layer |
| MANET | Mobile Ad-hoc NETwork |
| MMDS | Multichannel Multipoint Distribution System |
| MPR | Multi Point Relay node |
| NC3O | NATO Consultation Command & Control Organization |
| NRL | Navy Research Laboratory |
| nrtPS | Non-real-time Polling Services |
| OFDM | Orthogonal frequency division multiplex |
| OFDMA | Orthogonal frequency division multiple access |
| OLSR | Optimized Link State Routing (MANET routing protocol) |
| OSPF | Open Shortest Path First (Internet routing protocol) |
| PAN | Personal Area Network |
| PAR | Project Authorization Request |
| PDU | Protocol Data Unit |
| PHY | Physical layer |
| PICS | Protocol Implementation Conformance Statement |
| PKM | Privacy Key Management |
| QAM | Quadrature Amplitude Modulation |
| QOS | Quality of Service |
| QoS | Quality of Service |
| QPSK | Quadrature Phase Shift(ed) Keying |
| RDMAR | Relative Distance Microdiscovery Ad-hoc Routing Protocol |
| RDN | Reliable Delivery Neighbourhood |
| RID | Routeur IDentifier |
| RTG | RTO Task Group |
| RTO | Research & Technology Organization |
| rtPS | Real-time Polling Services |
| SC | Single-carrier modulation |
| SDU | Service Data Unit |
| SFs | Service flows |
| SSs | Subscriber Stations |
| TBRPF | Topology Broadcast based on Reverse Path Forwarding (MANET routing protocol) |
| TC | Topology Control |
| TCP | Transfer Control Protocol (TCP/IP) |
| TCP/IP | Transmission Control Protocol/Internet Protocol |
| TDD | Time-division duplex |
| TDMA | Time Division Multiple Access |
| TORA | Temporally Ordered Routing Algorithm (MANET routing protocol) |
| TTL | Time To Live |

| | |
|-------|---|
| UDP | User Data Protocol (UDP/IP) |
| UGS | Unsolicited Grant Services |
| UHF | Ultra High Frequency radio (300 – 3000 MHz) |
| VHF | Very High Frequency radio (30 – 300 MHz) |
| VoIP | Voice over IP (Internet Protocol) |
| VPN | Virtual Private Network |
| WEP | Wired Equivalent Privacy |
| WG | Working Group |
| WiMAX | Worldwide Interoperability for Microwave Access |
| WLAN | Wireless Local Area Network |
| WLAN | Wireless Local Area Network |
| WMAN | Wireless Metropolitan Area Networks |
| WPAN | Wireless Personal Area Network |
| ZR | Zone Radius |
| ZRP | Zone Routing Protocol (MANET routing protocol) |

Information Systems Technology Panel

CHAIRMAN

Prof. Ann MILLER
Distinguished Professor of Electrical and
Computer Engineering
University of Missouri-Rolla
125, Emerson Electric Co. Hall
Rolla, MO 65409-0040
UNITED STATES

DEPUTY CHAIRMAN

Prof. Marek AMANOWICZ
Ministry of Defence
Military Communications Institute
05-130 Zegrze
POLAND

IST-035 TASK GROUP CHAIRMAN

Prof. George STASSINOPOULOS
National Technical University of Athens
GREECE
E-mail: stassin@cs.ntua.gr

PANEL EXECUTIVE

From Europe:

RTA-OTAN
Lt.Col. P. PRODHOMÉ, FAF
IST Panel Executive
7 rue Ancelle, BP 25
F-92201 Neuilly-sur-Seine Cedex
FRANCE

Tel: +33 (1) 5561 2280 / 82 – Fax: +33 (1) 5561 2298 / 99 – E-mail: prodhomép@rta.nato.int

From the USA or CANADA:

RTA-NATO
Attention: IST Executive
PSC 116
APO AE 09777

| REPORT DOCUMENTATION PAGE | | | |
|--|--|---------------------------------------|---|
| 1. Recipient's Reference | 2. Originator's References | 3. Further Reference | 4. Security Classification of Document |
| | RTO-TR-IST-035 AC/323(IST-035)TP/32 | ISBN 978-92-837-0052-4 | UNCLASSIFIED/ UNLIMITED |
| 5. Originator | | | |
| Research and Technology Organisation North Atlantic Treaty Organisation BP 25, F-92201 Neuilly-sur-Seine Cedex, France | | | |
| 6. Title | | | |
| Awareness of Emerging Wireless Technologies: Ad-hoc and Personal Area Networks Standards and Emerging Technologies | | | |
| 7. Presented at/Sponsored by | | | |
| The Final Report of IST-035/RTG-015 submitted by the members of IST-035/RTG-015 for the RTO Information Systems Technology Panel (IST). | | | |
| 8. Author(s)/Editor(s) | | | 9. Date |
| Multiple | | | April 2007 |
| 10. Author's/Editor's Address | | | 11. Pages |
| Multiple | | | 122 |
| 12. Distribution Statement | | | |
| 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. | | | |
| 13. Keywords/Descriptors | | | |
| Commercial equipment | LAN (Local Area Network) | Secure communication | |
| Communication and radio systems | MANET | Standardization | |
| Communications management | Military communication | Wireless communications | |
| Communications networks | Models | Wireless networks | |
| Data processing security | Protocols | WLAN (Wireless Local Area Network) | |
| Data transmission | QoS (Quality of Service) | WPAN (Wireless Personal Area Network) | |
| Electronic countermeasures | Routing protocol | | |
| Interoperability | Scenarios | | |
| 14. Abstract | | | |
| <p>The context of the IST-035 Task Group work is centered on a broad categorization of technologies and military application areas, such as: WirelessLAN, WirelessPAN, Ad-hoc Network, Command, Post and Vehicles, Soldier Network, Military Relevance, Interoperability, Urban issues.</p> <p>The present document presents for each technology architecture, security, QoS, performance and frequency aspects. As a reference document it not only discusses technology, but also positions it in the context of the relevant operational deployment. For that reason, the document will be able to take as a starting point the classification of the operational use of COTS systems, made by the SCI-107 WG.</p> <p>This document is structured around 9 chapters, referring to: ad-hoc networks focusing on MANET; an overview of WLAN technologies; broadband wireless access technologies and protocols; a general approach of a Personal Area Network; Command post and urban operation; the soldier network; Security, ECM and ESM issues.</p> | | | |





BP 25
F-92201 NEUILLY-SUR-SEINE CEDEX • FRANCE
Télécopie 0(1)55.61.22.99 • E-mail mailbox@rta.nato.int



DIFFUSION DES PUBLICATIONS
RTO NON CLASSIFIEES

Les publications de l'AGARD et de la RTO peuvent parfois être obtenues auprès des centres nationaux de distribution indiqués ci-dessous. Si vous souhaitez recevoir toutes les publications de la RTO, ou simplement celles qui concernent certains Panels, vous pouvez demander d'être inclus soit à titre personnel, soit au nom de votre organisation, sur la liste d'envoi.

Les publications de la RTO et de l'AGARD sont également en vente auprès des agences de vente indiquées ci-dessous.

Les demandes de documents RTO ou AGARD doivent comporter la dénomination « RTO » ou « AGARD » selon le cas, suivi du numéro de série. Des informations analogues, telles que le titre et la date de publication sont souhaitables.

Si vous souhaitez recevoir une notification électronique de la disponibilité des rapports de la RTO au fur et à mesure de leur publication, vous pouvez consulter notre site Web (www.rta.nato.int) et vous abonner à ce service.

CENTRES DE DIFFUSION NATIONAUX

ALLEMAGNE

Streitkräfteamt / Abteilung III
Fachinformationszentrum der
Bundeswehr (FIZBw)
Gorch-Fock-Straße 7, D-53229 Bonn

BELGIQUE

Etat-Major de la Défense
Département d'Etat-Major Stratégie
ACOS-STRAT – Coord. RTO
Quartier Reine Elisabeth
Rue d'Evère, B-1140 Bruxelles

CANADA

DSIGRD2 – Bibliothécaire des ressources du savoir
R et D pour la défense Canada
Ministère de la Défense nationale
305, rue Rideau, 9^e étage
Ottawa, Ontario K1A 0K2

DANEMARK

Danish Acquisition and Logistics
Organization (DALO)
Lautrupbjerg 1-5
2750 Ballerup

ESPAGNE

SDG TECEN / DGAM
C/ Arturo Soria 289
Madrid 28033

ETATS-UNIS

NASA Center for AeroSpace
Information (CASI)
Parkway Center, 7121 Standard Drive
Hanover, MD 21076-1320

FRANCE

O.N.E.R.A. (ISP)
29, Avenue de la Division Leclerc
BP 72, 92322 Châtillon Cedex

GRECE (Correspondant)

Defence Industry & Research
General Directorate
Research Directorate
Fakinos Base Camp, S.T.G. 1020
Holargos, Athens

HONGRIE

Department for Scientific Analysis
Institute of Military Technology
Ministry of Defence
P O Box 26
H-1525 Budapest

ISLANDE

Director of Aviation
c/o Flugrad
Reykjavik

ITALIE

Centro di Documentazione
Tecnico-Scientifica della Difesa
Via XX Settembre 123
00187 Roma

LUXEMBOURG

Voir Belgique

NORVEGE

Norwegian Defence Research
Establishment
Attn: Biblioteket
P.O. Box 25
NO-2007 Kjeller

PAYS-BAS

Royal Netherlands Military
Academy Library
P.O. Box 90.002
4800 PA Breda

POLOGNE

Centralny Ośrodek Naukowej
Informacji Wojskowej
Al. Jerozolimskie 97
00-909 Warszawa

PORTUGAL

Estado Maior da Força Aérea
SDFA – Centro de Documentação
Alfragide
P-2720 Amadora

REPUBLIQUE TCHEQUE

LOM PRAHA s. p.
o. z. VTÚLaPVO
Mladoboleslavská 944
PO Box 18
197 21 Praha 9

ROUMANIE

Romanian National Distribution
Centre
Armaments Department
9-11, Drumul Taberei Street
Sector 6, 061353, Bucharest

ROYAUME-UNI

Dstl Knowledge Services
Information Centre
Building 247
Dstl Porton Down
Salisbury
Wiltshire SP4 0JQ

TURQUIE

Milli Savunma Bakanlığı (MSB)
ARGE ve Teknoloji Dairesi
Başkanlığı
06650 Bakanlıklar – Ankara

AGENCES DE VENTE

NASA Center for AeroSpace Information (CASI)

Parkway Center, 7121 Standard Drive
Hanover, MD 21076-1320
ETATS-UNIS

The British Library Document Supply Centre

Boston Spa, Wetherby
West Yorkshire LS23 7BQ
ROYAUME-UNI

Canada Institute for Scientific and Technical Information (CISTI)

National Research Council
Acquisitions, Montreal Road, Building M-55
Ottawa K1A 0S2, CANADA

Les demandes de documents RTO ou AGARD doivent comporter la dénomination « RTO » ou « AGARD » selon le cas, suivie du numéro de série (par exemple AGARD-AG-315). Des informations analogues, telles que le titre et la date de publication sont souhaitables. Des références bibliographiques complètes ainsi que des résumés des publications RTO et AGARD figurent dans les journaux suivants :

Scientific and Technical Aerospace Reports (STAR)

STAR peut être consulté en ligne au localisateur de ressources uniformes (URL) suivant:

<http://www.sti.nasa.gov/Pubs/star/Star.html>

STAR est édité par CASI dans le cadre du programme NASA d'information scientifique et technique (STI)
STI Program Office, MS 157A
NASA Langley Research Center
Hampton, Virginia 23681-0001
ETATS-UNIS

Government Reports Announcements & Index (GRA&I)

publié par le National Technical Information Service
Springfield

Virginia 2216

ETATS-UNIS

(accessible également en mode interactif dans la base de données bibliographiques en ligne du NTIS, et sur CD-ROM)



BP 25

F-92201 NEUILLY-SUR-SEINE CEDEX • FRANCE
Télécopie 0(1)55.61.22.99 • E-mail mailbox@rta.nato.int



**DISTRIBUTION OF UNCLASSIFIED
RTO PUBLICATIONS**

AGARD & RTO publications are sometimes available from the National Distribution Centres listed below. If you wish to receive all RTO reports, or just those relating to one or more specific RTO Panels, they may be willing to include you (or your Organisation) in their distribution.

RTO and AGARD reports may also be purchased from the Sales Agencies listed below.

Requests for RTO or AGARD documents should include the word 'RTO' or 'AGARD', as appropriate, followed by the serial number. Collateral information such as title and publication date is desirable.

If you wish to receive electronic notification of RTO reports as they are published, please visit our website (www.rta.nato.int) from where you can register for this service.

NATIONAL DISTRIBUTION CENTRES

BELGIUM

Etat-Major de la Défense
Département d'Etat-Major Stratégie
ACOS-STRAT – Coord. RTO
Quartier Reine Elisabeth
Rue d'Evère
B-1140 Bruxelles

CANADA

DRDKIM2
Knowledge Resources Librarian
Defence R&D Canada
Department of National Defence
305 Rideau Street, 9th Floor
Ottawa, Ontario K1A 0K2

CZECH REPUBLIC

LOM PRAHA s. p.
o. z. VTÚLaPVO
Mladoboleslavská 944
PO Box 18
197 21 Praha 9

DENMARK

Danish Acquisition and Logistics
Organization (DALO)
Lautrupbjerg 1-5
2750 Ballerup

FRANCE

O.N.E.R.A. (ISP)
29, Avenue de la Division Leclerc
BP 72
92322 Châtillon Cedex

GERMANY

Streitkräfteamt / Abteilung III
Fachinformationszentrum der
Bundeswehr (FIZBw)
Gorch-Fock-Straße 7
D-53229 Bonn

GREECE (Point of Contact)

Defence Industry & Research
General Directorate
Research Directorate
Fakinos Base Camp
S.T.G. 1020
Holargos, Athens

HUNGARY

Department for Scientific Analysis
Institute of Military Technology
Ministry of Defence
P O Box 26
H-1525 Budapest

ICELAND

Director of Aviation
c/o Flugrad, Reykjavik

ITALY

Centro di Documentazione
Tecnico-Scientifica della Difesa
Via XX Settembre 123
00187 Roma

LUXEMBOURG

See Belgium

NETHERLANDS

Royal Netherlands Military
Academy Library
P.O. Box 90.002
4800 PA Breda

NORWAY

Norwegian Defence Research
Establishment
Attn: Biblioteket
P.O. Box 25
NO-2007 Kjeller

POLAND

Centralny Ośrodek Naukowej
Informacji Wojskowej
Al. Jerozolimskie 97
00-909 Warszawa

PORTUGAL

Estado Maior da Força Aérea
SDFA – Centro de Documentação
Alfragide
P-2720 Amadora

ROMANIA

Romanian National Distribution Centre
Armaments Department
9-11, Drumul Taberei Street
Sector 6, 061353, Bucharest

SPAIN

SDG TECEN / DGAM
C/ Arturo Soria 289
Madrid 28033

TURKEY

Milli Savunma Bakanlığı (MSB)
ARGE ve Teknoloji Dairesi Başkanlığı
06650 Bakanlıklar – Ankara

UNITED KINGDOM

Dstl Knowledge Services
Information Centre
Building 247
Dstl Porton Down
Salisbury, Wiltshire SP4 0JQ

UNITED STATES

NASA Center for AeroSpace
Information (CASI)
Parkway Center
7121 Standard Drive
Hanover, MD 21076-1320

SALES AGENCIES

**NASA Center for AeroSpace
Information (CASI)**

Parkway Center
7121 Standard Drive
Hanover, MD 21076-1320
UNITED STATES

**The British Library Document
Supply Centre**

Boston Spa, Wetherby
West Yorkshire LS23 7BQ
UNITED KINGDOM

**Canada Institute for Scientific and
Technical Information (CISTI)**

National Research Council
Acquisitions
Montreal Road, Building M-55
Ottawa K1A 0S2, CANADA

Requests for RTO or AGARD documents should include the word 'RTO' or 'AGARD', as appropriate, followed by the serial number (for example AGARD-AG-315). Collateral information such as title and publication date is desirable. Full bibliographical references and abstracts of RTO and AGARD publications are given in the following journals:

Scientific and Technical Aerospace Reports (STAR)

STAR is available on-line at the following uniform resource locator:

<http://www.sti.nasa.gov/Pubs/star/Star.html>

STAR is published by CASI for the NASA Scientific and Technical Information (STI) Program
STI Program Office, MS 157A
NASA Langley Research Center
Hampton, Virginia 23681-0001
UNITED STATES

Government Reports Announcements & Index (GRA&I)

published by the National Technical Information Service
Springfield
Virginia 2216
UNITED STATES
(also available online in the NTIS Bibliographic Database or on CD-ROM)