MOBILEMAN

IST-2001-38113

Mobile Metropolitan Ad hoc Networks

Periodic Progress Report N°:4

Covering period 1.10.2005-31.12.2005

Draft version for review meeting

Report Delivery Date: February 2005

Actual Date of Delivery:

Estimated Person Months:

Number of pages: 43

Classification: Internal circulation within project

Project Coordinator: Consiglio Nazionale delle Ricerche (Italy)

Contributing Partners: University of Cambridge (UK), Institut Eurecom (France), Helsinki University of Technology (Finland), NETikos (Italy), Scuola Universitaria Professionale della Svizzera Italiana (Switzerland)

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Project funded by the European Community under the "Information Society Technologies" Programme (1998-2002)

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1. EXECUTIVE SUMMARY

The MobileMAN project, according to the refinement of its objectives during the first and second year of the project, focuses on the Implementations Integration, and Experimentation of realistic ad hoc networks *within* the current technology limits. The aim is to define a full protocol stack, tuned on the unique features of mobile ad hoc networks, to evaluate current limits and potentialities of this emerging networking paradigm. Furthermore, during the project activities a new challenge was identified: the organization of a MobileMAN by exploiting the cross-layer principle. To explore potentialities of this new approach, new objectives were added to the project with the aim of showing, through proof-of-concept prototypes and via simulation, the benefits of the cross-layer approach. To complete all the project activities, including cross layering, and to better disseminate the project, we requested the three-month extension of the project duration, which is covered by this report.

From a technical standpoint, the three extra months have been used to refine the software modules, complete the testing activities, and prepare the final version of Deliverable D16 related to the validation of our solutions. In addition to the technical limits and potentialities, social acceptance and the possibility to build market business cases, constitute the other dimensions that need to be investigated for evaluating the success of this networking paradigm. During the reporting period we revised and completed the socio-economic activities already described in Progress Report N.3, and we summarized the achieved results in Deliverables D17 and D18, respectively. Furthermore, as the results of the social analysis indicated that it is difficult for the users to interact with a technology for which they have not direct experiences, CNR started a Laurea thesis[1] in cooperation with Social Communications department of University of Siena to analyze the mobile ad hoc paradigm with the group of students that participated to the MobileMAN experimentation, and hence had direct experiences of what ad hoc networks are.

During the reference period the project partners refined the strategies they have implemented (and will continue to implement after the project end) to exploit the project results, and prepared the Exploitation Plan (see Deliverable D19).

[1] P. Andronico, "Collaborative storytelling to envision new applications perspective for MobileMAN technology", Laurea Thesis, University of Siena, 2006 (in preparation).

According to the project tradition, also in the last three months of the project, the partners performed extensive dissemination activities in different international fora (see Section 5 for details):

- Cambridge and CNR worked hard to establish the REALMAN workshop (which can be considered a trademark of MobileMAN) as an official ACM SIGMOBILE event. Indeed by showing the high-quality of the first edition and the relevance of ad hoc networking experimental activities, we were able to obtain the full ACM SIGMOBILE sponsorship.
- We worked to organize the two books devoted to MobileMAN. Specifically, in order to give a world-wide visibility to our experimental results we organized the book "Mobile Ad Hoc Networks: from Theory to Reality" mixing MobileMAN chapters with contributions from world-wide experts. Indeed, in addition to several contributions from European colleagues, the book will also contain contributions from main USA universities (MIT, University of Berkeley, University of Illinois, and SUNY).
- The project coordinator has been invited to prepare a proposal for a special issue of EURASIP Journal on Wireless Communications and Networking (WCN) on MobileMAN topics. The special issue entitled "MobileMAN (Mobile Multi-hop Ad hoc Networks): From Theory to Reality" is now open http://www.hindawi.com/journals/wcn/si/osi.html
- A MobileMAN demo "Bringing Group-Communication Applications to MANET Users through Cross-Layer P2P Technologies" has been accepted for presentation at IEEE PerCom 2006. In addition, a demo proposal "P2P support for Group-Communication Applications: a Cross-Layer approach for MANET Environments" has been submitted to IEEE INFOCOM 2006.
- CNR is preparing a paper for the IST 2006 summit; the paper will summarize MobileMAN results and establish the link with the HAGGLE project.
- The partners have been involved in the organization of several high-quality scientific events closely related with the project (e.g., IEEE PerCom 2006 (CNR), IEEE WoWMoM 2006 (CNR), ACM MobiHoc 2006 (CNR, SUPSI), ACM

SIGCOMM 2006 (CNR), IEEE TSPUC 2006 (Eurecom), IEEE ACC 2006 (SUPSI), IEEE MDC 2006 (Cambridge, CNR), IEEE PerSEns (SUPSI, CNR)).

2. WORK PROGRESS OVERVIEW

As explained in the previous progress report, at the end of the third year, the project has defined an architecture for Mobile Ad hoc NETworks (MANET's) that can either operate according to the legacy model, or exploit cross-layer interactions (among layers) to optimize its performance. This architecture and its protocols have been extensively validated via simulation. In addition, by integrating the software modules we implemented with existing hardware/software, we developed a set of prototypes that have been used to perform experimental tests of MobileMAN ideas and solutions. The three-month extensions of the project length have been used to:

i. refine the software modules we have developed taking into account the experimentation feedbacks;

ii. complete the extensive validations of the MobileMAN solutions from a technical, social and economic standpoint;

iii. disseminate the project results; and

iv. complete all the remaining project deliverables.

As explained, hereafter, by implementing the above activities we have been able to fulfill the success criteria for this period as defined in the Progress Report N.3.

2.1 Achieved Objectives during the Reporting Period

Hereafter, we first report the success criteria for the reporting period, and then we describe what we have really achieved to meet it.

Success Criteria: A realistic (with respect to the current technology) "large-scale" testbed with (whenever possible) a community of student as users.

Our Achievements:

As indicated in the Progress Report N.3, this objective was almost achieved at the end of the 3rd year of the project by implementing in the CNR campus a 23-node MobileMAN testbed in which we involved, as users, Computer-Engineering students of Pisa University. During the reporting period we completed the

experiments, analyzed the collected data and prepared a report of this activity which is part of Deliverable D16.

Success Criteria: Measures (whenever possible on the real testbed) of the users' satisfaction of the ad hoc networking paradigm.

Our Achievements:

As documented in D17, we implemented several activities that involved different classes of users (businessmen, elderly, students, etc.) to evaluate with them the mobile ad hoc paradigm, and possibly identify scenarios in which the use of MANET technologies can improve their activities and/or lives. In all cases, it emerged that real experiences in everyday life with a new technology are necessary to understand and evaluate it. For this reason, we also involved in the social evaluation the University of Pisa students that participated in the MobileMAN experimentations. Also in this case, we observed the users difficulty to understand the possible impacts of a technology on their lives without its use in the everyday activities. This, apparently negative result, indicates that only by using a pragmatic approach in mobile ad hoc network design (based on developing prototypes in realistic users scenarios) can help to attract the users, and to identify possible killer applications for mobile ad hoc networks. It is worth noting that MobileMAN represents a first step in this direction.

Success Criteria: Exploitation of the MobileMAN solutions for: i) the creation of start-ups, and ii) novel business processes.

Our Achievements:

As documented in D18, we developed and analyzed several scenarios in which the use of MANET technologies is the basis for the development of services valuable for end users, and a cost-effective solution for the service providers. In the deliverable we give examples of how re-engineering existing applications based on the MANET paradigm allows to i) reduce the maintenance costs for the service providers, ii) reduce the entry barriers for new competitors, and thus iii) reduce the

costs for end users. In Deliverable D19, we defined a sustainable exploitation strategy for the creation of novel business opportunities.

Success Criteria: To study, by exploiting our NS-2 extensions, the cross layer interactions between: middleware, transport and network layer.

Our Achievements:

As reported in Deliverable D16, we have developed a simulation framework, which extends the Network Simulator NS-2 (v. 2.27) with a cross-layer interface (XL-interface) that standardizes vertical interactions among protocols according to the MobileMAN cross-layer architecture. This simulation framework has been used to validate our cross-layer solutions (e.g., see *Reliable Forwarding* and cross-layer optimization of the *Gnutella protocol*) .

2.2 Deliverables during the Reporting Period

During the reporting period five deliverables were produced; see the Deliverables' Table below. All of them, except Deliverable D19, will be public available on the web site of the project (http://cnd.iit.cnr.it/mobileMAN).

DELIVERABLES TABLE

Project Number: IST-2001-38113

Project Acronym: MOBILEMAN

Title: Mobile Metropolitan Ad hoc Networks

Del. No.	Revision	Title	Type[1]	Classification[2]	Due Date	Issue Date
D16		MobileMAN technical evaluation	Report	Pub.	31 October 2005 (*)	18 November 2005
D17		Socio-economic evaluation	Report	Pub.	31 October 2005 (*)	31 October 2005
D18		Economic value of self-organisation paradigm and market access	Report	Pub.	31 October 2005 (*)	31 October 2005
D19		Exploitation Plan	Report	Int.	30 November 2005 (*)	11 January, 2006
D20		Project final Report	Report	Pub.	31 December 2005 (*)	--

(*) new schedule approved by the Project Officer after the three-month extension of the project length

Herafter, we briefly introduce the contents of the deliverables produced in the reporting period.

2.2.1 D16: MobileMAN technical evaluation

The aim of this deliverable is to present the validation results of the architecture, protocols and services designed for the MobileMAN project. This deliverable therefore represents the complement of Deliverable D13. Specifically, D13 presents the MobileMAN architecture and protocols, while in this deliverable the solutions we devised are validated. The deliverables follows a bottom up approach from wireless technologies up to the applications. The deliverable ends with a section reporting the experimental evaluation of a MobileMAN medium-size mobile-ad-hoc network (up to 23 nodes), which integrates the solutions we have developed.

Specifically, in Section 1, after discussing the performance modeling techniques, we present the characteristics of the simulation framework, which extends the Network Simulator NS-2 (v. 2.27) with a cross-layer interface (XL-interface) that standardizes vertical interactions among protocols according to the MobileMAN cross-layer architecture. This simulation framework has been used in successive sections to validate our cross-layer solutions (e.g., see *Reliable Forwarding* and cross-layer optimization of the *Gnutella protocol*).

In Section 2 we analyze and compare the performance (in multi-hop ad hoc networks) of 802.11 cards with those of the enhanced card we designed and implemented. First we present a simulation study that shows the effectiveness of our solutions in several scenarios that (in the literature) are known as critical for 802.11 cards. Then we present experimental results obtained in a 4-node network. In this network the nodes use either the 802.11 card or our enhanced card. Experimental results confirm previous simulation studies. In addition, they point out additional advantages of the enhanced card when used in a real environment with highly variable channel conditions.

Section 3 is devoted to analyzing MobileMAN networking protocols that use the one-hop transmission services provided by the network interface card to construct end-to-end (reliable) delivery services. Specifically, we first present our experimental results related to OLSR and AODV in small scale networks with node mobility. These results complete the study reported in Deliverable D8. Secondly, we report the performance

results of our mechanism for reliable forwarding which exploits cross layer interactions (REEF). This study has been performed via simulation by exploiting our extension of the NS-2 environment. The section ends presenting experimental results of our transport protocol, TPA. Experimental results confirm the observations obtained via simulation and reported in Deliverable D13.

Section 4 is devoted to the interconnection of MobileMAN islands to the Internet. Our solutions have been briefly described in Deliverable D14 where we presented the software developed to support the interconnection. For completeness in this deliverable we first present a refined description of our solution and then we report the experimental results that confirm the effectiveness of our approach.

Section 5 addresses the enforcement of cooperation within a MANET. Specifically, the section presents an in depth analysis of CORE, i.e., our mechanism to address cooperation issues. The features of CORE are analyzed in terms of simulation metrics that we deem relevant to assess the basic properties of a cooperation enforcement mechanism: the energetic cost beard by CORE-enabled nodes and the efficiency of the detection and punishment mechanisms used in CORE. Simulation results are used to understand if and when a mechanism to distribute reputation information could be necessary in order to improve punishment efficiency: reputation distribution is an optional feature of the CORE mechanism and constitutes to discriminate between CORE and other reputation-based cooperation enforcement mechanisms.

Section 6 deals with the MobileMAN middleware platforms. Performance studies are used to show the effectiveness of the cross-layer optimizations. Specifically, we considered two well-known p2p platforms, Gnutella and Pastry, which represent un-structured and structured overlays, respectively. In the case of Gnutella the study has been performed via simulation; while for Pastry, which is part of the MobileMAN architecture, we performed an experimental study. Specifically, in the Pastry case, we present a set of experimental results obtained by comparing in a small testbed the performance of Pastry with those of *CrossROAD*. CrossROAD is our proposal to enhance Pastry by exploiting cross-layer interactions. Both Gnutella and Pastry studies clearly pointed out that cross-layer optimization are mandatory to achieve good performance in a mobile ad hoc network.

In Section 7 we investigate the quality of service experienced by the three applications we selected to test the MobileMAN architecture: UDDI, a whiteboard application (WB) and a VoIP session. In all cases we evaluated the application performance when running on top of a small MobileMAN testbed. In the case of UDDI and WB, we tested both the legacy and cross-layer architecture.

Section 8 concludes the deliverable by investigating the behavior and performance of a medium-scale MobileMAN network made of (up to) 23 nodes.

2.2.2 D17: Socio-economic evaluation

This deliverable presents the social evaluation activities about ad hoc networks that were carried out within the MobileMAN project. We describe all the steps that we made to determine the variables that ad hoc networks and MobileMAN need to consider when providing this technology to the public of potential end-users. In the first part of the deliverable we review and refine our methodology, while in the second part we present the activities we implemented for the social evaluation. The first activity is a participatory design experiment with a group of students at HUT. We describe the scenarios and applications they developed by working in groups either through a *wiki* website that we set up for this activity, or through traditional paper. We also present some results from a questionnaire we gave them after the activity. Following this, we present and discuss the results from the comparative study of mobile phones and ad hoc networks' devices. Then, we go through the second comparative study of public WLANs and ad hoc networks. Afterwards, we present the interviews of the elderly to investigate their relationship with technology, in particular with communication technology. We investigated their use of technology, their opinions and ideas towards it. We tried to find out what types of needs the elderly have that MobileMAN could address, to enhance the quality of life of the elderly. Last activity we did was the observation of a group of students testing an ad hoc network of small-medium size (22 nodes). We present the discussions we undertook with some of them and some conclusions about ad hoc networks and MobileMAN.

2.2.3 D18: Economic value of self-organisation paradigm and market access

This document explores the potentialities of Mobile Metropolitan Ad hoc Networks from an economic point of view. In this document we present several scenarios in which the use of MANET technologies is the basis for the development of services valuable for end users, and a cost-effective solution for the service providers. We give examples of how re-engineering existing applications based on the MANET paradigm allows to i) reduce the maintenance costs for the service providers, ii) reduce the entry barriers for new competitors, and thus iii) reduce the costs for end users. Moreover, we present scenarios in which MANETs allow to develop brand-new applications and services. Finally, we discuss further potentialities that arise by extending the MANET paradigm towards two main directions, i.e., *mesh networks* and *opportunistic networking*. For clarity of presentation, this document is made up of three sections. Section 1 analyses the *legacy* MANET networking scenario, i.e., a scenario where the MANET is purely infrastructure-less, and no pre-existing infrastructure is used to build the mobile network. Several usage scenarios are presented, and evaluated from a technical/economic point of view. The approach taken in this analysis is original. Specifically, we envision *novel* application scenarios that *leverage* the key MANET features in order to provide value to the end user. The required networking solutions come in a second stage, in order to address the real needs of these scenarios. Such a top-down approach has been often neglected by the research community, while we believe that it represents a key avenue to successfully bring MANET technologies into the market. Finally, since a key element for evaluating the proposed scenarios is the user mobility pattern, Section 1 also presents realistic models of user mobility. Section 2 is devoted to analyzing Mesh Networks by presenting usage scenarios, and surveying both proprietary and open solutions that are being developed in the market. Examples are systems for intelligent public transportation and public safety, and system providing Internet access to rural and scarcely populated areas. Finally, section 3 focuses on MANET evolution in a longer time frame. We envision *opportunistic networking* as one of the most intriguing scenarios from this standpoint. In such scenario, each device forwards data in an opportunistic way, i.e., by exploiting any possible contact with other devices. For example, a contact opportunity is represented by two people walking in the same corridor. Opportunistic networking may thus be envisioned as a building block of future, heterogeneous, networks. The user will be able to seamlessly switch between

different networking technologies, and will dynamically choose the one that better suits her needs.

2.2.4 D19: Exploitation Plan

The purpose of this document is to summarize the main results of the MobileMAN project and document the strategies MobileMAN partners have implemented (and will continue to implement after the project end) to exploit the project results. Specifically, this document is addressing the schemes for the dissemination of know-how and knowledge gained during the project, ways to promote the utilization of our system, and ultimately to plan and identify possible routes for the full exploitation of MobileMAN results, be it for future commercial or new research activities.

Given both the consortium nature and composition (mainly research and academic institutions) and the project goals, the promotion and development of the project results has been mainly performed through the indirect way of dissemination, and as feedback of the social analysis. However, the successful fulfillment of the project goals produced a set of results that constitute a solid basis for economical exploitation. Therefore, this document also defines a sustainable exploitation strategy to be implemented after the project ends with regard both the creation of start-ups and novel business processes. This document plays a strong attention to partners' interest, role and benefits in the exploitation.

To make this document self-contained, before presenting our dissemination and exploitation strategies, we present the motivations and aims of the MobileMAN project and summarize the achieved results that constitute the basic elements of our exploitation strategy.

2.2.5 D20: Project final Report

This deliverable presents a summary of the objectives and main achievements of the project; The deliverable provides a comprehensive view of the results obtained, the methodologies and approaches employed, changes in the state-of-the-art since the project was contracted. Specifically we elaborate on the degree to which the project objectives have been reached. In addition, we also discuss the socio-economic impact of the project.

2.3 Work Accomplished during the Reporting Period

During the reference period the project technical activities concentrated on work-packages 4 and 5. In addition, some efforts were spent on WP0 and WP1, too. WP0 included all the project management activities, while WP1 activities concentrated on Task *T1.5- Self-assessment procedure and risks mitigation* to analyze the project results and preparing the final project report. Hereafter, we present WP4 and WP5 activities.

2.3.1 **WP4 Activities**

During the reference period, WP4 activities concentrated on T4.3, T4.4 and T4.5.

2.3.1.1 T4.3 Evaluation of MobileMAN Networking

The activities of this task covered the third year of the project and have been completed during the reference period with the production of Deliverable D16 that presents the validation results of the architecture, protocols and services designed for the MobileMAN project. Among the activities performed during the reference period it is worth remembering: i) the testing of the enhanced MAC card in multi-hop configurations; ii) exhaustive tests, under different conditions and routing protocols, of the VoIP applications running on iPAQs, to analyze jitter, delay, etc. iii) the experimental evaluation of our architecture, and related mechanisms, for the interconnection of ad hoc "islands" to the Internet.

2.3.1.2 T4 .4 Final Integration and Testing

As highlighted in the progress report for the third year, this task has turned out to be one the most important to evaluate the effectiveness of the cross-layer architecture in supporting Group-Communication Applications. Therefore, we devoted to this task some additional man months allowed by the project extension. We have completed the comparison between the Legacy and the Cross-layer architectures. We have analysed the performance of the P2P system from two complementary standpoints: i) the end-user satisfaction, and ii) the network-resource utilisation. We have used indices such as the packet delay and loss probability to evaluate the former, and indices such as the throughput and the link stress to evaluate the latter. These indices form a standard set for evaluating group-communication systems. To be completely fair, during this period we have ported

our software implementing the legacy P2P substrate (FreePastry 1.4) to the latest available distribution. We have measured significant improvements with respect to former software releases. Nevertheless, we still measured significant improvements brought by the cross-layer approach, mainly in term of reduced throughput. This testifies that the advantages of the cross-layer approach rely in the system-design choices rather than in the software implementation.

2.3.1.3 T4 .5 Large Area Scale Validation

The aim of this task is to evaluate the ad hoc networking technology with users, and all planned activities were completed at the end of the 3rd year. During the reporting period we analyzed the results obtained and completed Deliverable D17. In addition, after the MobileMAN testing phase, a Laurea thesis was jointly lunched by CNR and University of Siena (Social Communications department) to perform a social evaluation of the mobile ad hoc networking paradigm by exploiting as users the students that participated to the experimental evaluation:

P. Andronico, "Collaborative storytelling to envision new applications perspective for MobileMAN technology", Laurea Thesis, University of Siena, 2006 (in preparation).

2.3.1.4 T4 .6 Risk Reduction in the system testing

The activities described with respect to task 4.4 have still been carried out in the framework of the collaboration between the junior researchers of Cambridge and CNR involved in the Project. The strong link between members of this group has proved to be a key factor in the success of the software refinement and tests.

2.3.2 **WP5 Activities**

2.3.2.1 T5.1 Dissemination

During this period, we have disseminated the project results through publications, talks during scientific meetings, participation in International Conferences Committees, attending conferences and collaborating with colleagues of academia and industry, as detailed below. As indicated in Section 1, the main results of these activities during the

reporting period have been: i) the organization of the 2nd ACM/SIGMOBILE REALMAN workshop; ii) the EURASIP Journal on Wireless Communications and Networking (WCN) special issue entitled "MobileMAN (Mobile Multi-hop Ad hoc Networks): From Theory to Reality"; iii) two books; and iv) presentation of demos in main international conferences.

2.3.2.2 T5.2 Exploitation Plan Definition

In the framework of this task, during the reporting period we completed the Deliverable D19 which contains the exploitation plans for the MobileMAN results. For details, see D19 description in Section 2.2.4.

2.3.2.3 T5.3 Market Access

During the reporting period we completed the analysis of the market access potentialities of mobile ad hoc networks and summarized the achieved results in Deliverable D18 that was completed during this reporting period.

2.3.3 **Effort used and Planned for the Reporting Period**

Table 1 report the efforts spent during the reporting period. As this extra period was not included in the original project plans, the efforts of this period were not in the project planning, and hence the planned and the real effort coincide.

Table 1-I. Effort for the reporting period per WPs/Tasks (person months)

	CNR				Cambridge				Eurecom			
	Period		Total		Period		Total		Period		Total	
WP/Task	Est	Act	Est	Act	Est	Act	Est	Act	Est	Act	Est	Act
WP0	0.5	0.5	6	6	0.1	0.1	1.6	1.6	0.1	0.1	2.2	2.2
WP1	0.5	0.5	5	5	0.2	0.2	1.7	1.7	0.2	0.2	2.9	2.7
WP2			2.5	2.5							6.0	6.0
Task 2.1							0.5	0.5				
Task 2.2			1.0	4.0			0.6	0.6			0.5	0.5
Task 2.3			7.0	15.0								
Task 2.4			5.0	2.5							1.0	1.0
Task 2.5											9.3	9.3
Task 2.6			1.0	1.0			4.5	4.5				
Task 2.7												
Task 2.8							9.0	8.5				
Task 2.9			4.5	8.5			1.0	1.0			4.0	5.3
WP 3			2.5	2.5								
Task 3.1												
Task 3.2			3.5	1.0								
Task 3.3			4.5	4.5								
Task 3.4											18.7	17.6
Task 3.5				3.0			7.5	7.5				
Task 3.6			1.0	1.0			0.5	0.5				
WP 4	0.5*	0.5	1.5	1.0								
Task 4.1			1.0	1.0			0.6	0.6			1.0	1.0
Task 4.2			2.5	4.5			0.5	0.5			1.0	1.0
Task 4.3	0.5	0.5	8.5	11.0			1.0		1.7	1.7	3.7	3.7
Task 4.4	1	1	9.0	10.0 (+7.8)	1.5	1.5	3.5	4.7			3.0	3.0
Task 4.5	0.5	0.5	0.5	0.5								
Task 4.6	0.0	0.0	0.5	0.1			0.5	0.1				
WP 5 *	0.5	0.5	1	1								
Task 5.1	0.5	0.5	3.0	3.5	0.5	0.5	3.5	4.0	0.5	0.5	3.5	3.5
Task 5.2	0.5	0.5	1.5	1.5	0.2	0.2	1.5	1.5	0.3	0.3	1.8	1.7
Task 5.3	0.3	0.3	0.8	0.8	0.5	0.5	1.5	2.0	0.2	0.2	0.7	0.2
TOTAL	5.3	5.3	73.3	91.4 (+ 7.8)	3	3	39.5	39.8	3.0	18.5	59.3	58.7

* WP coordination and deliverables management.

+ Application level software development.

Table 1-II. Effort for the reporting period per WPs/Tasks (person months)

	HUT				Netikos				SUPSI			
	Period		Total		Period		Total		Period		Total	
WP/Task	Est	Act	Est	Act	Est	Act	Est	Act	Est	Act	Est	Act
WP0	0.1	0.1	1.6	1.6	0.1	0.1	1.2	1.3	0.5	0.5	3.9	4.0
WP1	0.4	0.4	2.1	2.1	0.2	0.2	1.3	1.4	0.5	0.5	4.0	4.0
WP2											1.0	1.0
Task 2.1							2.5	2.5			0.5	0.5
Task 2.2			0.5	0.5			0.2	0.2			0.5	0.5
Task 2.3											3	3
Task 2.4			1.0	1.5								
Task 2.5												
Task 2.6												
Task 2.7											11.9	12.4
Task 2.8												
Task 2.9			1.0	1.0							1.7	1.7
WP 3			1.0	4.0			6	7.5				
Task 3.1											36.7	38.5
Task 3.2			5.0	6.0								
Task 3.3			17.2	12.5 (+ 15)***								
Task 3.4												
Task 3.5												
Task 3.6												
WP 4									0.5	0.5	3.5	3.5
Task 4.1			2.0	2.0			5.6	6.0				
Task 4.2			3.0	3.0			1.0	2.0			1.0	2.0
Task 4.3	1	1	1.0	1.0					3	3	3.0	3.0
Task 4.4	0.5	0.5	3.5	4.5	0.5	0.5	2.5	3.0				
Task 4.5												
Task 4.6											3.0	3.0
WP 5 *												
Task 5.1	0.5	0.5	2.5	2.5	0.3	0.3	1.0	1.0	0.5	0.5	3.0	3.0
Task 5.2	0.5	0.5	1.5	1.5	1.0	1.0	3.5	3.5	0.5	0.5	1.5	1.5
Task 5.3			0.5	0.5	0.4	0.4	0.9	0.9	0.5	0.5	1.0	1.0
TOTAL	3.0	3.0	43.4	44.2 (+ 15)***	1.5	1.5	25.7	29.3	6.0	6.0	79.2	82.6

* WP coordination and deliverables management.

+ Application level software development.

*** The 15 man months are related to master students and are not charged on the project costs

2.4 World-wide state-of-the-art Update

Extensive analysis of changes in the state of the art are reported in Progress Reports N1, N2 and N3; during the last three months of the project we can only remark the increasing interest of the ad hoc networking research community for mesh networks and opportunistic networking.

2.5 Assessment of Project Results and Achievements

SCIENTIFIC AND TECHNOLOGICAL ACHIEVEMENTS OF THE PROJECT. The project has proposed a system architecture that introduces cross-layer optimizations and, at the same time, permits the use of legacy protocols without changes. The design and implementation of a cross-layer architecture and protocols for ad hoc networks is novel and very relevant for future research in the area. In addition, measurements, simulation and analysis have been used to characterize the ad hoc networks environment and to design the MobileMAN protocols. A detailed presentation of project achievements is reported in Deliverable D20.

IMPACT ON SCIENCE AND TECHNOLOGY - SCIENTIFIC PUBLICATIONS AND PARTICIPATION TO CONFERENCES/SYMPOSIUM/WORKSHOPS OR OTHER DISSEMINATION EVENTS. During the reporting period the project partners continued to heavily disseminate the project results by organizing and participating to international conferences/workshops (also as invited speakers), participation to the journals editorial boards, and the organization of journals special issues, and producing a large number of technical documents (Journal papers, Conferences presentations, books, books chapters, theses, etc.). A detailed presentation of these activities can be found in Section 5.

TRAINING. The technological challenges of the MobileMAN project attracted several good students and this contributes to increase the number of European specialists in mobile and wireless technologies. Currently, within the consortium, there are several PhD students working on MobileMAN issues. Furthermore, a large number of Master-level students completed (and others are currently working to complete) their theses in the framework of

the project. The details of these training activities have been reported in the previous progress report. Hereafter, we present only the new training activities started during the reporting period.

CNR

In the last three months of the project, Marco Conti has been invited as co-advisor for the Ph.D thesis of Habiba Skalli which is currently a PhD candidate at the Institute for Advanced Studies located in Lucca, http://www.imtlucca.it/. Her Ph.D thesis will investigate mesh networks, and MobileMAN results will constitute the basis for this thesis.

In addition, Marco Conti has been invited as co-examiner of the Ph.D thesis of Vincent Lenders (ETH, Zurich) that is working to apply the concept of field-based routing for different purposes including service discovery in MANETs.

IMPACT ON INNOVATION AND MICRO-ECONOMY. The economic impact of MobileMAN results is discussed in Deliverable D19 and it is not worth repeating the discussion here.

3. PROJECT MANAGEMENT AND CO-ORDINATION

The activities of the last three months have been monitored by continuous communications among partners via e-mail and video-conference. Indeed we reserved physical meetings to the testing activities involving junior researchers.

3.1 Cooperation with other projects

During the reporting period the project partners started their cooperation with three projects approved under the IST – FET proactive call "Situated and Autonomic Communications" http://www.cordis.lu/ist/fet/comms-sy.htm:

- HAGGLE http://www.haggleproject.org/
- BIONETS http://www.create-net.org/create-net/bio-nets/
- CASCADAS http://netmob.unitn.it/cascadas/index.html

These project activities started at the beginning of 2006, and constitute a natural way to exploit the MobileMAN results.

Cambridge

In the framework of the projects within the Cambridge-MIT Institute, Cambridge researchers are involved in TIME Project, http://www.cambridge-mit.org/industry/transport. The taxi cabs scenario represents a relevant area of cooperation between TIME and MobileMAN.

Eurecom

Eurecom researcher exploit MobileMAN results inside the the *ACI Splash project* granted from French National Funding. Inside this project they are investigating Message authentication for dynamic networks that they plan to implement on the MobileMan test-bed as part of future research.

4. COST BREAKDOWN

The costs (in Euro) incurred for the reporting period are not yet available.

5. PROMOTION, INFORMATION AND DISSEMINATION

5.1 Publications

This section contains the list of books, book chapters, conference/workshop papers that have been accepted for publication during the reporting period and not yet reported in previous Progress Reports.

5.1.1.1 Book

B.1. Marco Conti, Jon Crowcroft and Andrea Passarella, "Mobile Ad Hoc Networks: from Theory to Reality", published by Nova Science Publishers (USA), 2006.

B.2. Marco Conti "Mobile Multi-hop Ad hoc Networks (MobileMAN)", Springer 2006.

B.3. Marco Conti, Chatschik Bisdikian, Jadwiga Jndulska, Franco Zambonelli, Proceedings of IEEE PerCom 2006.

5.1.1.2 Book Chapters

BC.1. M. Conti, "Principles and Applications of Ad Hoc and Sensor Networks", in The Hanbook of Computer Networks, Volume II, Hossein Bidgoli (Editor), John Wiley & Sons inc. 2006

Journals

J.1. G. Anastasi, M. Conti, E. Gregori, C. Spagoni, G. Valente, "Motes Sensor Networks in Dynamic Scenarios: an Experimental Study for Pervasive Applications in Urban Environments", Journal of Ubiquitous Computing and Intelligence (JUCI) Vol 1. N.1, 2006.

5.1.1.3 Conference Proceedings

C.1. J. Costa-Requena, R. Kantola and N. Beijar "Ad Hoc Networks Scalability", ICAS'05 and ICNS'05", October 05.

C.2. Emilio Ancillotti, Raffaele Bruno, M. Conti, E. Gregori, Antonio Pinizzotto "A Layer-2 Architecture for Interconnecting Multi-hop Hybrid Ad Hoc Networks to the Internet", Proc. Third Annual Conference on Wireless On demand Network Systems and Services .

C.3. Pietro Michiardi, Refik Molva, "Identity-based Message Authentication for Dynamic Networks" Accepted for publication to IFIP SEC 2006.

C.4. J. Costa-Requena, R. Kantola and N. Beijar, "AODV-OLSR Scalable Ad hoc Routing Proposal", ISWPC 2006 International Symposium on Wireless Pervasive Computing 2006.

5.1.1.4 Tutorial, Invited Talks, Conference Presentations

- Jon Crowcroft, "Flying Cars" Cambridge-MIT Connected Car Event, Cambridge (UK), October 2005
- Jon Crowcroft, "Peer-to-Peer: Still Useless?" SOSP 2005, Brighton, UK, November 2005.
- Jon Crowcroft, Cambridge-MIT Workshop "The future of wireless is wired, the future of wired is wireless", Cambridge (UK), December 2005.
- Andrea Passarella, "MobileMAN Project: building Campus-Wide MANETs through Cross-Layering", 4th Cost 290 Management Committee Meeting, Wuerzburg, Germany, 16 October 2005
- Andrea Passarella, "Ad hoc and Sensor Netowrk Design: it's All about Cross-Layering", University of Parma, Italy, 7 November 2005
- Andrea Passarella, "From MobileMAN to Haggle", University of Cambridge Computer Lab Open Research Associate Day, December 14, 2005.

5.1.1.5 Conference Demos & Posters

- Franca Delmastro, Andrea Passarella, and Jon Crowcroft, "Bringing Group-Communication Applications to MANET Users through Cross-Layer P2P Technologies", demo accepted for presentation at PerCom 2006.
- Marco Conti, Jon Crowcroft, Franca Delmastro, Andrea Passarella, "P2P support for Group-Communication Applications: a Cross-Layer approach for MANET Environments", demo proposal submitted to Infocom 2006.

5.1.1.6 Paper Submitted and Technical Reports

R.1. E. Borgia, M. Conti, F. Delmastro, E. Gregori and A. Passarella, "Multi-hop Ad hoc Networks Perspective: Current and Forthcoming Technologies", to be submitted to the 15th IST Mobile & Wireless Communications Summit, Mikonos, Greece, 4-8 June 2006.

R.2. J. Costa-Requena, R. Kantola and N. Beijar, "Presence and Service Discovery in Ad Hoc Networks", MDC06 International Workshop on Mobile Distributed Computing.

5.1.1.7 Other Dissemination Activities

Newspapers Interviews

It is worth mentioning the article appeared on

La Repubblica – Affari e Finanza 7 November 2005

http://www.repubblica.it/2005/j/sezioni/scienza_e_tecnologia/wifi/senzaintern/senzaintern.html

that establishes a relationship between MobileMAN and the HAGGLE project.

In addition, during the reporting period there have been some interviews related to the new laboratory, jointly lunched by IIT-CNR and the department of computer engineering of University of Pisa. The laboratory, called PerLab (Pervasive Computing and Networking) had the MobileMAN project as one of its main activities, and MobileMAN experimental activities (carried out in Pisa) have been performed in the framework of this laboratory. Among these interviews it is worth remembering:

Almanacco della Scienza Rivista on line del Consiglio Nazionale delle Ricerche

N. 20, 21 dicembre, 2005
http://150.146.47.106/rivistaonline/documenti/lentecnr/05_20_2005.htm

that also appeared, among others, on

TG COM http://www.tgcom.mediaset.it/tgtech/articoli/articolo290152.shtml

The web site of the main Italian private TV

Interaction with University Students

During the reporting period we involved as MobileMAN users the Pisa-university students that participated to the large-scale MobileMAN testbed. Specifically, CNR promoted in collaboration with the Social Communications department of the University of Siena a thesis (by Patrizia Andronico which is a member of CNR team) for social evaluation of MobileMAN technologies with the involvement of Pisa-university students. To this end two meetings were organized to present the activity to the students, and to collect their feedbacks. In addition we set up a blog http://mobilemanstorytelling.blogspot.com/ for supporting students interactions. The results of this testing phase, collected at the end of December, are currently under evaluation, but confirm the users' difficulties to evaluate the impact of a technology on their lives without using it extensively during their normal activities.

5.2 Journal Editorial Boards and Conference Committees

5.2.1 Journal Boards

- M. Conti is **Associate Editor** of *Pervasive and Mobile Computing (Elsevier);* **Advisory and Regional Editor** (for Europe) of *Wireless Ad Hoc and Sensor Networks: An International Journal;* **Area Editor** of the following journals: *Ad Hoc Networks Journal* (Elsevier) and *IEEE Transactions on Mobile Computing.*

- J. Crowcroft is on the **editorial board** of the following journals: *Computer Networks, IEEE Networks, Internet Protocol, Grid Computing, Cluster Computing, and Mobile Applications and Networks.*

- S. Giordano is on the **editorial board** of *IEEE Communications Magazine*. Editor of the Series on *Ad hoc and Sensor Networks, and* **Area Editor** of *Ad Hoc Networks Journal* (Elsevier).

- E. Gregori is on the **editorial board** of the following journals: *Computer Networks Journal*, *Cluster Computing Journal*, *ACM/Springer WINET Journal.*

- R. Molva is on the **editorial board** of *Pervasive and Mobile Computing (Elsevier).*

5.2.2 Journals Guest Editors

- EURASIP Journal on Wireless Communications and Networking (WCN), Special issue on "MobileMAN (Mobile Multi-hop Ad hoc Networks): From Theory to Reality" http://www.hindawi.com/journals/wcn/si/osi.html (**Guest Editor**: M. Conti).
- *Pervasive and Mobile Computing (Elsevier);* Special issue on IEEE PerCom 2006 (**Guest Editor**: M. Conti).

5.2.3 Conference Executive Committees

- Marco Conti is **Program Chair** of the 4th IEEE PerCom Conference 13-17 March, 2006, Pisa, Italy URL: http://cnd.iit.cnr.it/percom2006

- Marco Conti is **Program Co-Chair** of the 7th ACM/SIGMOBILE Symposium MobiHoc 2006, 22-26 May, 2006, Florence, Italy URL: http://www.sigmobile.org/mobihoc/2006

- Marco Conti is **General Co-Chair** - The 7th IEEE Symposium on a World of Wireless Mobile and Multimedia Networks (WoWMoM 2006), Niagara Falls, USA June 2006. http://www.ieee-wowmom.org

- Marco Conti is **Tutorial Chair** – ACM SIGCOMM 2006, Pisa September 2006.

- Marco Conti is **General Chair** of the 2nd ACM/SIGMOBILE Workshop on Multi-hop Ad hoc Networks: from theory to reality (REALMAN 2006), May 26, 2006, Florence, Italy URL: http://www.cl.cam.ac.uk/realman

- Jon Crowcroft is **Program Chair** of the 2nd ACM/SIGMOBILE Workshop on Multi-hop Ad hoc Networks: from theory to reality (REALMAN 2006), May 26, 2006, Florence, Italy URL: http://www.cl.cam.ac.uk/realman

- Andrea Passarella is **Program Vice Chair** of the 2nd ACM/SIGMOBILE Workshop on Multi-hop Ad hoc Networks: from theory to reality (REALMAN 2006), May 26, 2006, Florence, Italy URL: http://www.cl.cam.ac.uk/realman

- Andrea Passarella is **Program Vice Chair** of the 4th IEEE International Workshop on Mobile Distributed Computing (MDC 2006), Niagara-Falls/Buffalo, NY, USA, June 26, 2006.

- Silvia Giordano is **Workshop Co-Organizer** of the 2nd IEEE WoWMoM Workshop on Autonomic Communications and Computing (ACC 2006), http://www.autonomic-communication.org/acc/index.html

- Silvia Giordano is **Workshop Co-Organizer** of the 2nd IEEE PerCom Workshop on Sensor Networks and Systems for Pervasive Computing (PerSeNS 2006), http://www.ing.unipi.it/persens2006/

- Refik Molva and Pietro Michiardi are **Workshop Co-Organizers** of the 2nd IEEE WoWMoM Workshop on Trust, Security and Privacy for Ubiquitous Computing (TSPUC2005) http://www.iit.cnr.it/TSPUC2006

- Jon Crowcroft is **Program Co-Chair** of 4th ACM/SIGCOMM Workshop on Hot Topics in Networks (HotNets-IV), November 14 & 15, 2005, in College Park, Maryland, USA

5.2.4 **Conference Technical Program Committees** (partial list)

- The Third Conference on Wireless On-demand Network Systems and Services (WONS 2006), (TPC member: M. Conti, J. Crowcroft E. Gregori, S. Giordano)

- Fourth IEEE Conference on Pervasive Computing and Communications (PerCom) 2006. URL: http://www.percom.org. (TPC member: A. Passarella, P. Michiardi)

- 7th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WOWMOM 2006), Niagara-Falls, Buffalo-NY, USA, 26-29 June, 2006, (TPC member: A. Passarella)

- International Symposium on Wireless Sensor Network (ISWSN 2006): Program Committee Member, (TPC member: A. Passarella)

- International Conference on Wireless and Mobile Communications (ICWMC 2006), July 29-31, 2006, Bucharest, Romania (TPC member: A. Passarella)

- 4th IEEE International Workshop on Mobile Distributed Computing (MDC 2006), Niagara-Falls/Buffalo, NY, USA, June 26, 2006, (TPC member: J. Crowcroft)

- 2nd IEEE WoWMoM Workshop on Autonomic Communications and Computing (ACC 2006), (TPC member: M. Conti, R. Molva)

- NETWORKING 2006: The 5th International IFIP-TC6 Networking Conference, (TPC member: M. Conti)

- ACM/SIGMOBILE Workshop on Multi-hop Ad hoc Networks: from theory to reality (REALMAN 2006), (TPC member: P. Michardi, S. Giordano, E. Borgia).

5.3 Participation at Conferences and Workshops

MobileMAN project members attended the following conferences during the reference period:

- The 20th ACM Symposium on Operating Systems Principles (SOSP 2005), October 23-26, 2005, The Grand Hotel, Brighton, United Kingdom (Participant: Jon Crowcroft)

6. PROJECT'S ASSESSMENT FICHE

(to be updated)

Questions about project's outcomes	Number	Comments
1. Scientific and technological achievements of the project (and why are they so ?)		
Question 1.1. Breakthrough or "real" innovation		The area of ad hoc networking is of long-term nature. Furthermore, the project is still in the phase in which solutions are developed and tested. However, preliminary results show good potentialities from the innovation and economic standpoint. Specifically, a) the pragmatic approach of the project to develop, and implement innovative solutions for MANETs in realistic scenarios (small scale networks with legacy applications) is working towards lowering the barriers for ad hoc networking; we believe that this has to become a prime objective of MANET research to make it successful in everyday life. b) We have defined and investigated scenarios in which the use of ad hoc networking solutions have a market value. The city cab scenario, i.e., the use of 802.11 ad hoc networks to replace the currently used taxi radio dispatch systems is viable both economically and technically. c) The extensive experimental activities performed in the framework of the project contribute to remove a set of simplifying assumptions commonly used in simulative studies that caused a lack of credibility in most of the results so far obtained. In addition, experimental activities pointed out problems that have no been previously identified. d) The implementation of a proof-of-concept prototype for a cross layer MANET architecture will provide a preliminary understanding of the benefits of this new approach in MANET design. e) The algorithm designed and evaluated for the enhanced 802.11 card is very promising both from a scientific and economic standpoint. • it provides a formal basis to the activities of TG 802.11n that is working toward higher throughput for 802.11 networks. Indeed, AOB extended with the credit mechanism provides an optimized and efficient solution to the multiple transmissions approach currently under study in TGn. • It provides an efficient solution to fix 802.11 unfairness in multi-hop scenarios • The widespread usage of the 802.11 technology, and its economic value in the wireless market, open to our solution (which is compatible with existing standards) extremely interesting opportunities for creating business opportunities. However, it must be pointed out that the development of the new card implementing the enhanced algorithm is still ongoing and hence, economic exploitation of this output of the project will be better evaluated after field tests of the

		new card. f) The usage of VoIP on top of Ad Hoc networks has interesting potentialities. After a MobileMAN presentation for Nokia Networks representatives, Nokia shows the interest to launch a project on this topic. g) We have identified new applications that can leverage the ad hoc technology to provide valuable services to the user. The city cab scenario (i.e., the use of 802.11 ad hoc networks to replace the currently used taxi radio dispatch systems) is the most promising one. We have found that in this scenario, an ad hoc networking system is viable both economically and technically. h) Mesh networks constitute a short-term direction to turn mobile ad hoc networks in a commodity by providing a flexible and "low cost" extension of wired infrastructure networks.
2. Impact on Science and Technology: Scientific Publications in scientific magazines		
Question 2.1. Scientific or technical publications on reviewed journals and conferences	15	Title and journals/conference and partners involved 1) R. Bruno, M. Conti, E. Gregori, "Mesh Networks: Commodity Multi-hop Ad Hoc Networks", *IEEE Communications Magazine*, March 2005, pp.123-131. (partner(s): CNR) 2) A. Anastasi , E. Borgia, M. Conti, E. Gregori, A. Passarella, "Understanding the Real Behavior of Mote and 802.11 Ad Hoc Networks: An Experimental Approach", *Pervasive and Mobile Computing* Journal, Vol 1, N. 2, June 2005. (partner(s): CNR) 3) M. Conti, E. Gregori, and G. Maselli, "Reliable and Efficient Forwarding in Ad Hoc Networks", *Ad Hoc Networks* Journal, (to appear). (partner(s): CNR) 4) M. Conti, G. Maselli, G. Turi, "A flexible cross-layer interface for ad hoc networks: Architectural and Implementation issues", *Ad Hoc & Sensor Wireless Networks: An International Journal* (Old City Publishing), (to appear). (partner(s): CNR) 5) M. Conti, E. Gregori, G. Turi, "A Cross Layer Optimization of Gnutella for Mobile Ad hoc Networks", Proc. ACM MobiHoc Symposium, Urbana-Champain, May 2005, pp.343-354. (partner(s): CNR) 6) E. Huang, W. Hu, J. Crowcroft, I. Wassell, "Towards Commercial MobileAd Hoc Network Applications: A radio Dispatch System" Proc. ACM MobiHoc Symposium, Urbana-Champain, May

2005, pp. 355-365. (partner(s): Cambridge)

7) G. Anastasi, E. Ancillotti, M. Conti, and A. Passarella, "TPA: A Transport Protocol for Ad hoc Networks", Proc. 10th IEEE Symposium on Computers and Communications, June 2005. (partner(s): CNR)
8) M. Conti, G. Maselli, and G. Turi, "Design and evaluation of a flexible cross-layer interface for ad hoc networks", Proceedings Fourth Annual Mediterranean Ad Hoc Networking Workshop (Med-Hoc-Net 2005), June 2005 (21-24) Ile de Porquerolles (France). (partner(s): CNR)
9) Ralf Bernasconi, Raffaele Bruno, Ivan Defilippis, Silvia Giordano, and Alessandro Puiatti, "Experiments with an enhanced MAC architecture for multi-hop wireless networks", Proc. 1st IEEE ICPS Workshop on Multi-hop Ad hoc Networks: from theory to reality (REALMAN 2005), July 14, 2005, Santorini, Greece (partner(s): CNR and SUPSI)
10) Franca Delmastro and Andrea Passarella, "An Experimental Study of P2P Group-Communication Applications in Real-World MANETs", Proc. 1st IEEE ICPS Workshop on Multi-hop Ad hoc Networks: from theory to reality (REALMAN 2005), July 14, 2005, Santorini, Greece (partner(s): CNR and Cambridge)
11) E. Borgia, M. Conti, F. Delmastro, E. Gregori, "Experimental comparison of routing and middleware solutions for mobile ad hoc networks: legacy vs cross-layer approach", ACM SIGCOMM Workshop on Experimental Approaches to Wireless Network Design and Analysis (E-WIND) August 22, 2005 - Philadelphia, PA. (partner(s): CNR)
12) M. Conti, E. Gregori, G. Maselli "Improving the performability of data transfer in mobile ad hoc networks", Proc. Second IEEE International Conference on Sensor and Ad Hoc Communications and Networks (SECON), Santa Clara, CA, September 2005. (partner(s): CNR)
13) Raffaele Bruno, Claude Chaudet, M. Conti, E. Gregori, "A Novel Fair Medium Access Control for 802.11-based Multi-Hop Ad hoc Networks, Proc. 14th IEEE Workshop on Local and Metropolitan Area Networks, Chania, Greece, September, 2005. (partner(s): CNR)
14) Altman, Eitan; Kherani, Arzad; Michiardi, Pietro; Molva, Refik, "Non cooperative forwarding in ad hoc networks", Proc. IFIP Networking 2005 (partner(s): Eurecom)
15) Altman, Eitan; Borkar, Vivek; Kherani, Arzad; Michiardi, Pietro; Molva, Refik "Some game-theoretic problems in wireless ad hoc networks" Proc. EURO-NGI 2005. (partner(s): Eurecom)

Question 2.2. Scientific or technical publications on non-reviewed journals and conferences	0	Title and journals/conference and partners involved
Question 2.3. Invited papers published in scientific or technical journal or conference.	4	Title and journals/conference and partners involved 1) M. Conti, F. Delmastro, T. Turi, "Peer-to-peer Computing in Mobile Ad Hoc Networks", in *Mobile Middleware,* Antonio Corradi and Paolo Bellavista (Editors), CRC press (To appear) . (partner(s): CNR) 2) Raffaele Bruno, Claude Chaudet, Marco Conti and Enrico Gregori, "Fair MAC Protocols for 802:11-based Multi-Hop Ad hoc Networks: Challenges and Solutions" in *Performance Analysis of Mobile Ad Hoc Networks*, Chita Das, Yi Pan Chansu Yu (Editors) Nova Science Publishers Inc. (to appear) . (partner(s): CNR) 3) M. Conti, Peer-to-peer Computing in Mobile Ad Hoc Networks, in *Mobile Middleware* Antonio Corradi and Paolo Bellavista (Editors), CRC Press (to appear) . (partner(s): CNR) 4) P. Michiardi, R. Molva, "Ad hoc network security"Chapter in Book: Handbook of information security IEEE Press, Wiley & Sons (to appear) . (partner(s): Eurecom)
3. Impact on Innovation and Micro-economy		
A - Patents		
Question 3.1. Patents filed and pending	0	When and in which country(ies): Brief explanation of the field covered by the patent*:

Question 3.2. Patents awarded	0	When and in which country(ies): Brief explanation of the field covered by the patent* (if different from above):
Question 3.3. Patents sold	0	When and in which country(ies): Brief explanation of the field covered by the patent* (if different from above):
Questions about project's outcomes	**Number**	**Comments or suggestions for further investigation**
B - Start-ups		
Question 3.4. Creation of start-up	No	If YES, details: - date of creation: - company name: - location: - headcount: - turnover: - profitable : yes / no
Question 3.5. Creation of new department of	Yes	Name of department:

research (ie: organisational change)		A Joint laboratory has been created between IIT-CNR and the University of Pisa: *Pervasive Computing & Networking Lab*. (PerLab); http://www.perlab.it Currently, the procedures for the creation of a research association "ANTARES: Association for NeTworking Advanced RESearch" between IIT-CNR and Univeristy of Pisa are ongoing.
C – Technology transfer of project's results		
Question 3.6. Collaboration/ partnership with a company ?	Yes	Which company : BTexact Technologies, Nokia, Siemens, ST Microelectronics What kind of collaboration? Project Industrial Advisory Board Which company : Intel Reseach, Thomson, Telecom Italia What kind of collaboration? Project activities
4. Other effects		
A - Participation to Conferences/Symposium		
Question 4.1. Active participation[2] to Conferences in **EU** (specify if one partner or "collaborative" between partners)	6	Names/ Dates/ Country: - The Second Conference on Wireless On-demand Network Systems and Services (WONS 2005), Saint Moritz (Switzerland) January 19-21, 2005 (partner(s): CNR, SUPSI). - The 6th IEEE Symposium on a World of Wireless Mobile and Multimedia Networks (WoWMoM 2005), Taormina, Italy June 2005. (partner(s): CNR).

[2] 'Active Participation' in the means of being an invited speaker or organising a workshop / session / stand / exhibition directly related to the project (apart from events presented in section 2).

Programme Area: IST FET	**Date of filling: 18/12/2005**
Project Acronym: MOBILEMAN	

		- The 1st IEEE ICPS Workshop on Multi-hop Ad hoc Networks: from theory to reality (REALMAN 2005), July 14, 2005, Santorini, Greece (partner(s): CNR, Cambridge). - 1st Conference on Wireless Internet (WICON 2005), Budapest, Hungary, 10-15 July 2005 (partner(s): Cambridge). - 1st IEEE WoWMoM Workshop on Autonomic Communications and Computing (ACC 2005), (partner(s): CNR, SUPSI). - 1st IEEE WoWMoM Workshop on Trust, Security and Privacy for Ubiquitous Computing (TSPUC2005) (partner(s): Eurecom).
Question 4.2. Active participation to Conferences outside the **EU** (specify if one partner or "collaborative" between partners)	3	Names/ Dates/ Country: - Third IEEE Conference on Pervasive Computing and Communications (PerCom) 2005, Kauai, Hawaii, March 8-12, 2005. (partner(s): CNR). - Special track on *Energy Management in Mobile and Pervasive Computing Systems* at the 38th Annual Hawaii International Conference on System Sciences, 2005. (partner(s): CNR). - Fourth Workshop on Hot Topics in Networks (HotNets-IV), November 14-15, 2005 College Park, MD USA (partner(s): Cambridge).
B – Training effect		
Question 4.3. Number of PhD students hired for project's completion	7	In what field : Computer Science Computer Engineering Telecommunications

Questions about project's outcomes	Number	Comments or suggestions for further investigation
C - Public Visibility		
Question 4.4. Media appearances and general publications (articles, press releases, etc.)	10	References*: **Almanacco della Scienza** Rivista on line del Consiglio Nazionale delle Ricerche 8 Giugno, 2005 http://150.146.47.106/rivistaonline/documenti/storiadicopertina/06_8_2005.htm **La Nazione** (national newspaper)– Firenze 23 May, 2005 (page 16) "Ecco il cellulare gratuito. Crea la rete da solo e può avere mille usi" - not available on line Il **Tempo** (national newspaper)– Roma 9 August 2005 "Mobileman» la rete senza fili e infrastrutture" http://www.iltempo.it/approfondimenti/index.aspx?id=746320&editionId=5&SectionId=4 **La Repubblica** – Affari e Finanza 7 November 2005 http://www.repubblica.it/2005/j/sezioni/scienza_e_tecnologia/wifi/senzaintern/senzaintern.html - The web site of the Italian public TV: • http://www.rai.it/accessibile/news/articolonews/0,9217,107754,00.html

		• http://www.raifiction.rai.it/news/articolonews/0,9217,107754,00.html – Adnkronos news agency web site http://www.adnkronos.com/Speciali/Scienza/NotizieManuali/01_2504.html – Portals devoted to ICT technologies • http://www.i-dome.com/flash-news/pagina.phtml?_id_articolo=8559 • http://www.heos.it/tecno_05/tecno_12.htm • http://www.weekit.it/index2.php?option=com_content&do_pdf=1&id=36334
Question 4.5. Web-pages created or other web-site links related to the project	8	References*: http://cnd.iit.cnr.it/mobileMAN/ http://mobileman.projects.supsi.ch http://keskus.hut.fi/tutkimus/MobileMan/ http://www.cl.cam.ac.uk/Research/SRG/netos/sla/mobileman/mobileman.pdf http://www.ti.edu.ch/servizi/ricerca/ricerca_attualita/progettomese/2/ricerca_progetto.htm http://www.aramis-research.ch/d/17406.html http://pi.ijs.si/ProjectIntelligence.Exe?Cm=Project&Project=MOBILEMAN

Question 4.6. Video produced or other dissemination material	0	References*:
Question 4.7. Key pictures of results	0	References*:
D - Spill-over effects		
Question 4.8. Any spill-over to national programs	Yes	If YES, which national programme(s): CNR: Virtual Immersive Communications (VICOM) is a three years Italian project (Nov. 2002 – Nov. 2005) funded by the Italian Ministry for Research (MIUR) in the FIRB framework Italian Ministry for Research - three-year Italian national plan for research (2005-2008). Eurecom : CNRS / ACI SPlaSH: Sécurisation des ProtocoLes dans les réseAux mobileS ad Hoc. HUT : national projects: *Project AHRAS (http://www.netlab.hut.fi/tutkimus/ahras/)* concentrates on the routing and other traffic related issues in wireless ad hoc networks. The project started in 2001 and it is funded by the Finnish Defence Forces Technical Research Centre. *Project NAPS (Networking and Architecture for Proactive Systems)* is a 3 year project (2003-2005) funded by the Academy of Finland. It is part of the research programme on Proactive Computing

		(PROACT). http://www.netlab.hut.fi/tutkimus/naps/
Question 4.9. Any spill-over to another part of EU IST Programme	Yes	If YES, which IST programme(s): **WIDENS**: WIreless DEployable Network System, Proposal acronym, The project is supported by the European Commission under the IST Framework Programme 6. http://www.widens.org/ **E-NeXT:** Network of Excellence Emerging Network Technologies http://www.ist-e-next.net/ E-NEXT is an FP6 Network of Excellence **HAGGLE:** IST – FET proactive "Situated and Autonomic Communications" project http://www.haggleproject.org **BIONETS:** IST – FET proactive "Situated and Autonomic Communications" project http://www.create-net.org/create-net/bio-nets/
Question 4.10. Are other team(s) involved in the same type of research as the one in your project ?	Yes	If YES, which organisation(s): **EQUATOR.** This is a six-year Interdisciplinary Research Collaboration (IRC) supported by The Engineering and Physical Sciences Research Council (EPSRC) of the UK Government. http://www.interaction.rca.ac.uk/equator/ **MMAPPS:** *Market Management of Peer to Peer Services*. The MMAPPS project started on March 1st, 2002 with funding from the EU Fifth RTD Framework Programme. http://www.mmapps.org/

		ROMANTIK: ResOurce Managment and AdvaNced Transceiver algorIthms for multihop networKs (IST-2001-32549) funded from the EU Fifth RTD Framework Programme. http://www.ist-romantik.org/ **UCAN**: Ultra-wideband Concepts for Ad-hoc Networks (**IST-2001-32710**), funded from the EU Fifth RTD Framework Programme http://www.ucan.biz/ **BROADWAY:** The way to broadband access at 60GHz (**IST-2001-32686**) funded from the EU Fifth RTD Framework Programme. http://www.ist-broadway.org/ **6HOP**: Protocols for Heterogeneous Multi-Hop Wireless IPv6 Networks (**IST-2001-37385**) funded from the EU Fifth RTD Framework Programme. http://www.cwc.oulu.fi/projects/6hop/ **WIDENS:** WIreless DEployable Network System, Proposal acronym () The project is supported by the European Commission under the IST Framework Programme 6. http://www.widens.org/