INFORMATION SOCIETY TECHNOLOGIES
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PROGRAMME

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Shared-cost RTD

Annex 1 - "Description of Work"

Project acronym: MOBILEMAN
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1 PROJECT SUMMARY

Objectives

This project investigates the potentialities of the Mobile Ad hoc NETwork (MANET's) paradigm. Specifically, the project aims to define and develop a metropolitan area, self-organizing, and totally wireless network that we call Mobile Metropolitan Ad hoc Network (MobileMAN). The main technical outputs of this proposal can be summarized as follows. i) Development, validation, implementation and testing of the architecture, and related protocols, for configuring and managing a MobileMAN. We conduct this research spanning all layers in the networking hierarchy. Our research combines advanced communications and networking research with basic research. ii) Physical implementation of this architecture for lowers layers (i.e., wireless technologies). This will be done by improving the existing IEEE 802.11 wireless technologies for dealing in bursty access environments as self-organized networks. iii) Integration of applications on top of our self-organized network. iv) Validation of the self-organizing paradigm from the social and economic standpoint.

Description of the work

The new technical, economic and social paradigm makes MANETs a challenging area in itself, which arises new challenging issues. However, even if this area is beginning to be widely researched, the current research is mainly based on traditional approaches. We strongly believe that traditional approaches cannot exploit all the characteristics of this area and that the new paradigm of MANETs requires new technical ideas for taking advantage of the potentialities of this new paradigm. We therefore propose a new approach based on the following key ideas:

i) Bursty-responsive MAC. In MANETs the channel burstiness comes either from bursty data transmission as in other mobile networks, as well as from (high-level) control messages. Therefore standards as the 802.11 cannot be adopted without collapsing the network. Our approach is, thus, to study and deploy a new exponential backoff scheme for stabilizing the network under bursty access condition.

ii) Social-operated Networking. Traditional MANETs routing does not exploit certain characteristic of these networks (e.g. cooperation and relationship among nodes). Our approach for the network layer is based on the social behaviour of people in real life. To this aim, the network is modelled as a small world graph, and nodes maintain routes not only to nodes discovered by the routing protocol (short connections), but also to other nodes (long connections) that are considered interesting to them.

iii) Security of all network functions to reduce the system sensitivity to node misbehavior and to stimulate the cooperation.

iv) The P2P paradigm of MANETs allows the development of services without using any central server, but using communications among nodes. Our approach is to introduce the cooperation as basis of the middleware services, in order to provide a collaborative environment to applications.

v) Evaluation of the social impact of the self-organizing paradigm by exploiting virtual communities of real users.

Milestones and the expected results

· A fully functional MobileMAN where users can communicate and run applications with no cost for communication itself. The challenges of building a totally self-organized, highly dynamic and completely decentralized network are addressed by a layered networking architecture (Bursty-responsive MAC, Social-operated Networking, secure networks services, P2P middleware) integrated with applications to assess its validity.

· A socio-economic evaluation of the effectiveness of the mobile ad hoc paradigm, and its market access.

2 PROJECT OBJECTIVES

The emerging concept of Ambient Intelligence (AmI) provides a vision of the information society where the emphasis is on support for human interactions. The emergent communication and relation behaviours in the AmI raise the following issues [47]: i) Human communication has to come first; ii) Relations are in the network; iii) Cohesion is a political goal in a 'mosaic society': being together, sharing knowledge and information. iv) AmI may be a way of offering services to an ageing population. This view of the information society heavily relies on the wireless technology [14], [15], [16]. Specifically, advances in wireless communication will enable a radical new communication paradigm: **self-organised information and communication systems** [1]. In this new networking environment, the users' mobile devices *are* the network and they must co-operatively provide the functionality that is usually provided by the network infrastructure (e.g. routers, switches, and servers). The proposed project will advance this new paradigm of **a wireless self-organised network**, focusing on **immersive communication** in a (possibly large) metropolitan area. This environment has the potentiality of supporting in a revolutionary way:

1) **The Integration Of Existing And New Services For Supporting "Innovative Applications**". Until the telecommunication investment is driven by the "first hop" linkages, it is mandatory to find killer applications to enter the market. As opposite, in MobileMAN environment, the users' benefits gained with the use of this technology could make the difference. The **content-orientated services and applications could become killer** by exploiting the self-organising paradigm of the supporting environment, as it happened to SMS.

2) **Novel Forms Of Interaction.** MobileMAN promotes both a free and community-supported information access, and a free and self-organised, ubiquitous communication among people**: (a) Novel forms of interaction between people and information:** MobileMAN will increase information sharing in society by providing free, ubiquitous, and user-friendly support for local communications. A MobileMAN supports a kind of "citizen's network" which can reduce communication costs and complexity and improve people's ability to share information anywhere and anytime. Additionally, the access to information will benefit by the fact that it will likely happen through other member of the same group. **(b) Novel forms of interaction among people:** MobileMAN will enable the self-organisation of people that share common interests (e.g. students at a school) into virtual ad-hoc networks in which they can freely communicate, and, even more, self-organise the communication services. This extends to larger networks the concept of a spontaneous network [18], which is formed when a group participates in some collaborative activity and the necessary service infrastructure is built around their interactions. For users, of course, any communication network is truly interesting only in terms of the activities it supports, or may support in the future. This potentiality, in a MobileMAN, is fully in the users' hands.

3) **Novel Business Process:** MobileMAN is highly conducive to rapid, innovative development, both technical and in the business model. The new paradigm of a low cost self-organised local network communication can effectively promote new business activities and complement the services available in wireless infrastructure. (**a) Integration of new generation technologies in original way**: MobileMAN is not intended as a replacement for current infrastructure based (wired and wireless) networks. It is intended to complement them and to enable new application scenarios in which a centralised infrastructure is impossible, undesirable or unnecessary. **(b) Low cost-barrier environment for novel business processes**: The deployment of new developments does not require involvement from major infrastructure players, significantly reducing the cost-barriers to creating services on a temporary or experimental basis, especially by small-medium enterprises and start-ups.

The **objectives** of this project are therefore twofold:

- **technical solutions**: invent and demonstrate solutions that make the self-organisation paradigm effective. This will be reflected into develop the architecture and protocols for a self-organised network, integrated with the lower and upper layers.

- **business and social impact**: to exploit the self-organisation paradigm for supporting innovative applications (in terms of novelty of the services context onto which the applications are integrated and novelty of the way they are offered to the users), which will improve the life quality of people that are traditionally the last to be reached by communication technologies;

To achieve these objectives relevant results both from a technical and socio-economic perspective need to be achieved. The main **technical outputs** of this proposal can be summarised as follows:

- The validation of the **self-organised paradigm** from the technological standpoint, i.e., its technical feasibility.

- Development, validation, implementation and testing of the **architecture, and related protocols, for configuring and managing self-organised wireless networks**. We will conduct this research spanning all layers in the networking hierarchy combining advanced communications and networking research with basic research [13]. As detailed in Section 5, innovative results are expected in self-organised networking, security, and location.

- **Physical implementation of this architecture for lowers layers** (i.e., wireless technologies). This will be done by improving the existing IEEE 802.11 wireless technologies for dealing in bursty access environments as self-organised networks.

- Integration and validation of **popular services**, (such as SMS and chatting) on top of our self-organised network, as well as the extensions of these services into new realms, such as multimedia messaging, spontaneous electronic collaboration and wireless interactive games.

The main **business and social outputs** of this proposal can be summarised as follows:

- Creation of **virtual communities of users** (e.g. youth, elderly, disadvantaged) that share knowledge and resources for work, education or leisure. These users will have, for the first time, the opportunity to **self-organise their own network with no (or low) cost**, which will be thus close to their needs and will give them the opportunity to satisfy their expectations for a better quality of life.

- The validation of the self-organised paradigm from the social and economical point of view.

- Creation of an environment for promoting new business activities and processes.

In addition, the project will provide a **co-operation model** that encourages and **enforces mutually beneficial behaviours in a self-organising network**. This model has both a technical (e.g., cooperation of the terminals users to route the traffic inside the network) and social (co-operation of the users to create VCs) level.

Although ad hoc networking is a “hot topic”, currently, only specific problems have separately been addressed and no full real solutions exist. Moreover, at the best of our knowledge, no study exists on the users’ acceptance of this revolutionary networking paradigm. Specifically, as far as the ad hoc networking technical issues are concerned, most of the results are related only to the “ad hoc routing” problem. Furthermore, in most cases, only simulative tools have been used to validate the achieved results. In few cases, also small-scale testbeds, with less then 10 nodes, have been used. Real testbeds are essential for making further progress and achieving key results. MobileMAN is unique and important in proposing solutions at all levels of the protocol stack (from network technologies up to the application layer), and the eventual development of a fully functioning testbed in which non-expert participants can experience using mobile applications.

The high degree of innovation contained in the MobileMAN project necessarily implies relevant risks that make difficult to define metrics for the project success. The achievement of some results is dependent on the potentialities (to be investigated in the project) of the ad hoc networking paradigm itself. A set of steps (levels) can be, however, identified to measure the project success. The achievement of the success at one level constitutes the basis for the success in the next level. Therefore, the project will measure its progress and success at several levels:

- The development, and validation, of effective solutions for the relevant technical issues of self-organizing networks: routing and medium access control protocols, power management, security, and location.
- The hardware/software implementation of the above solutions.
- The integration of the developed solutions in a fully functioning testbed.[1]
- Measures (on the real testbed) of the users' satisfaction of the ad hoc networking paradigm.
- Large-scale testbed with a large users' community.
- Exploitation of the MobileMAN solutions for the creation of start-ups.

To manage the technical risks that may occur during this highly innovative project, the project is organized in **incremental steps.** At each step, we will develop solutions that will be immediately validated. The validation will be performed either in a simulated environment or by implementing prototypes. The feedbacks of this validation phase (including, whenever possible, the users evaluations) constitute the inputs for a **self-assessment procedure**. The self-assessment procedure will measure the project successes already achieved, and/or identify the actions required to mitigate the emerging risks that may compromise the further levels of project successes.

The results of the **self-assessment procedure** (by modifying if necessary the system model and the technical solutions) constitute the inputs for the next step of the project. The objectives of this next step being dependent on the results of the self-assessment procedure. Specifically, we will start with the target to develop a MobileMAN solution for quasi-static configurations (users move slowly) on a relatively small campus-wide. Then we gradually increase the users' speed, as well as the network size and density to study the relationship between these factors and network behaviour. At each step we will perform integration and validation that will be achieved when the system satisfies the user expectations. This will be supported by monitoring the social construction and human behaviour of the users and the technical constraints and limitations of the system. Even if our efforts to create a fully functional MobileMAN are not completely successful, with this incremental approach, many piecewise contributions will still prove very useful.

[1] For each technical issue we provide an alternative operational solution in order not to bind the full prototype to the success in the solution of all the individual technical issues.

3 PARTICIPANT LIST

List of Participants

Partic. Role*	Partic. no.	Participant name	Participant short name	Country	Date enter project**	Date exit project**
C	1	Consiglio Nazionale delle Ricerche	CNR	I	Start of project	End of project
P	2	University of Cambridge	UCAM-CLAB	UK	Start of project	End of project
P	3	Institut Eurecom	EURECOM	F	Start of project	End of project
P	4	Helsinki University	HUT	FIN	Start of project	End of project
P	5	NETikos	NETikos	I	Start of project	End of project
P	6	Scuola Universitaria Professionale della Svizzera Italiana	SUPSI	CH	Start of project	End of project

- CNR (CO1) is the project co-ordinator with a well-consolidated expertise for all the networking aspects. CNR will mainly concentrate on MAC, routing and transport protocols.
- UCAM-CLAB (CR2) is the expert for all Internet related networking problem ranging from scaleable multicast routing, practical approaches to traffic management, and the design of deployable end-to-end protocols.
- EURECOM (CR3) is the expert of the network security research, including security in ad hoc networks.
- HUT (CR4) is the expert of location and addressing in cellular and ad hoc networks.
- NETikos (CR5) is an SME with consolidated expertise in development and integration of applicative software for mobile environments.
- SUPSI (CR6) contributes to the project with two departments: DIE and DSL. SUPSI-DIE is the microelectronics expert that will lead the development of the network interface cards. SUPSI-DLS is the expert for social studies that will lead the validation of the self-organised paradigm from the social perspective.

3.1 MobileMAN Industrial Advisory Board

The project will form an Industrial Advisory Board, whose membership will represent a cross-section of technology and service providers; regular meetings with the Board will help us in revising, where necessary, the objectives of the project. We have received expression of interest from several companies that include: British Telecom Exact Technologies (interests in middleware services, transport layer for wireless, in particular incentives to co-operate on QoS, and on end-system controlled QoS mechanisms); ST Microelectronics (interests in Bursty MAC protocol); Nokia and Compaq (interests in ad hoc networking paradigm). The full membership will be established in time for the initiation of the project.

4 CONTRIBUTION TO PROGRAMME/KEY ACTION OBJECTIVES

MobileMAN contributes to the key objectives of FP5 and to EU long-term research (FP6 and beyond). Specifically, MobileMAN addresses the objective of FP5 WP 2002 to place "**the citizen's needs**" as central to the programme. According to the WP, IST services should promote **a ubiquitous and user-friendly vision of the information society**, satisfying citizens' expectations for a better quality of life by enabling the creation of **communities that share knowledge and resources** for work, education or leisure. We believe that MobileMAN can play a key role in advancing the information-society **user-centric** view. The MobileMAN objective is to exploit the **self-organise networking paradigm** to provide an infrastructure-less multimedia network that provides a flexible, inexpensive networking solution built around co-operative interactions among users, supporting free and seamless information sharing. In addition, MobileMAN is centred onto the **self-organisation and co-operation of communities of users**, termed **Virtual Communities** (VCs). VC concept is foreseen to be a powerful communication system for **social inclusion** of **persons with special needs (e.g. disabled and elderly)** that are traditionally the last to be reached by technology improvements. MobileMAN aims to offer them **low cost** (thus solving the price-barrier problem) and **equal opportunities** for full participation in society (e.g. more social contact opportunities, friendly communication access to services and information for independent living).

The success of the MobileMAN approach will improve **information access** in areas where it is currently limited by high cost and bandwidth constraints. The objective of MobileMAN's unique approach is to provide a novel way to access **popular services**, such as SMS and net chatting, and to extend them into new realms, such as multimedia messaging, spontaneous electronic collaboration and wireless interactive games. This will strengthen **social interactions** starting from the **young generations**. These objectives make MobileMAN aligned with the objectives of EU long-term research (see ***ISTAG Recommendations for FP6).*** The IST Advisory Group (ISTAG) has just completed the report "Scenarios for Ambient Intelligence in 2010". Four scenarios have been worked out. Among these scenarios, the ***"Dimitrios" -Digital me (D-Me)"*** *scenario* is closely related to the MobileMAN approach. Specifically, "Digital me" is a scenario in which a person is supported by a D-Me personal assistant to individually but sociably build and **maintain relations**. The emphasis is on **play and social interaction rather than efficiency**. Lead markets may emerge first amongst "alternative or **youth cultures**." D-Me is aimed: i) to support existing relationships (friends, family, community, etc.) ii) creating new relations (chatting on the net, net games, etc.); iii) participating virtual relations. Furthermore, D-Me is a people based, ad hoc networking. It is aimed at facilitating **socially based networking and relations**. ISTAG recognises that price could be a barrier to a mass market. In addition, **new e-learning systems**, based on MobileMAN VC paradigm, are expected to provide a technological support to the "Social learning" scenario (the fourth scenario identified by ISTAG). This scenario is aimed to *"connecting people and creating a community"* by creating challenging and interacting social learning environments. MobileMAN virtual communities provide a technology through which group of students and mentors engage in collaborative tasks. To summarize, MobileMAN addresses research issues that in the ISTAG time-framework are scheduled for 2007 and beyond. Therefore, the results of MobileMAN will represent the basis for the future EU R&D activities on Ambient Intelligence.

Through research and industrial efforts, Europe has established world-renowned leadership in infrastructure-based mobile communications. **Next generation mobile systems** are recognised as a priority of the EU research to maintain and re-enforce the European leadership in the mobile market. MobileMAN addresses this by investigating how a **secondary wireless market** can be built up by exploiting the self-organising paradigm. Finally, ISTAG recognises a need to **build knowledge and research skills** related to the mobile and wireless technologies. MobileMAN will increase the number of **students** trained in the field. Within the consortium, there are already a number of Ph.D. students working on topics in mobile ad hoc networking. We expect that the MobileMAN project will attract even more good students, increasing the number of European specialists in this area.

5 INNOVATION

MobileMAN is aimed to explore the (technical, social and market) effectiveness of the ad hoc networking paradigm. The new technical, economic and social paradigm makes mobile ad hoc networks a challenging area in itself, which arises new challenging issues. However, even if this area is beginning to be widely researched, the current research is mainly based on traditional approaches. We strongly believe that traditional approaches cannot exploit all the characteristics of this area and that the new paradigm of MANET requires new technical ideas for taking advantage of the potentialities of this new paradigm. To this end the project need to define innovative solutions for the issues that are peculiar of the self-organising paradigm. Specifically, the issues can be subdivided in two classes: i) technical, and ii) socio-economical. Technical innovations focus on constructing an information delivery service on an ad hoc platform, while the latter are mainly related with methods and tools to estimate the users' satisfaction. Although it is clear that MobileMAN is a totally new architecture, we perceive the major innovation of MobileMAN in terms of new concepts and paradigms, novel forms of interaction, technical and business innovation, as well as novel technical approaches as described below.

5.1 Technical Innovations

In a MobileMAN all the main functionalities of the network and transport layers need to be re-designed to cope with a self-organizing, dynamic, volatile, peer-to-peer communication environment. The first element to construct a MobileMAN is a wireless local (or personal) area network (WLAN) technology that supports the ad hoc operating mode. This technology provides single hop ad hoc communications and is the network building block. The performance of this technology is fundamental in determining the overall system behavior. Given the variability of an ad-hoc network, stability and avoidance of congestion collapse are important design objectives. The MobileMAN project exploits innovative ideas to **optimise the WLAN performance** (see 5.1.1). If the MobileMAN users are outside the communication range of the same WLAN, high-level networking functionalities are required to make the communication possible. First of all, the users position inside the network must be identified. The purpose of the **location mechanism** is to dynamically map the terminal logical address to its current location-dependent address (see 5.1.2). Once a user is located, **packet-forwarding algorithms** must be provided to route the information through the MobileMAN (see 5.1.3). Unlike networks using dedicated nodes to support basic functions like packet forwarding, routing, and network management, in ad hoc networks, these functions are carried out by all the available nodes. This very difference is at the core of the increased sensitivity to node misbehaviour in ad hoc networks. Apart from special cases like military networks whereby an "a priori" trust exists in all nodes, the nodes of an ad hoc network cannot be trusted for the correct execution of critical network functions. Essential network operations assuring basic connectivity can be heavily jeopardised by nodes that do not properly execute their share of the network operations like routing, packet forwarding, name-to-address mapping, etc. **Security of all network functions** is therefore a primary concern of ad hoc networks (see 5.1.4). Peer-to-peer computing allows the development of services without using any central server, but using communications among nodes. This makes peer-to-peer the natural paradigm for mobile ad hoc applications (see 5.15). Hereafter, we will present our novel ideas to tackle the above issues, and hence define the foundations for implementing a **fully functional prototype of a large ad hoc network.**

5.1.1 Bursty Mac

IEEE 802.11 is the standard for Wireless Local Area Networks (WLANs) promoted by the Institute of Electrical and Electronics Engineers [2]. The IEEE 802.11 WLAN is a promising technology for constructing multihop mobile ad-hoc networks [1]. However, some characteristics of ad hoc networks—dynamic topologies, limited bandwidth, energy-constrained operations, and wireless vulnerabilities—are not adequately managed by IEEE 802.11. The ad hoc environment is characterized by extreme variability in the number of users belonging to the same WLAN. Consider a group of users who all move together into the same meeting room, carrying their

mobile devices. This generates a sharp increase in the traffic that produces temporary congestion in the WLAN. This situation is critical from both the bandwidth utilization and the battery consumption standpoint (see publications in Section A.2.1). IEEE 802.11 shows inefficient utilization of the wireless channel with bursty users and dynamic configurations generate severe problems when using IEEE 802.11 in multi-hop mobile ad-hoc networks ([1], [39], [40]). Several authors have investigated how to enhance the standard IEEE 802.11 protocol to increase the protocol stability and to optimise the power consumption in a high dynamic environment with bursty users. In this framework, relevant results have been obtained by CO1 (see the list of publication in Section A.2.1). Results obtained define the theoretical limits (from the throughput and power consumption) of random access WLANs. By exploiting these theoretical results, CO1 researchers have defined and validated a feedback-based mechanism for enhancing the IEEE 802.11 standard protocol behavior to achieve its theoretical performance. The designed mechanism can be seen as an extension of the standard protocol that adds new functionalities to the protocol state machine. For this reason the enhanced protocol can interoperate with existing IEEE 802.11 network interfaces. Finally, it is worth noting that wireless technologies in the LAN environment are becoming increasingly important, and hence enhancing the IEEE 802.11 (the most relevant technology in the field) has a value that goes beyond ad hoc networking but applies to several other contexts, e.g., infrastructure-based WLANs.

5.1.2 Location

We will address both nodes and services location. In general two approaches can be adopted to locate mobile terminals. The first one is based on flooding location information through the network. This approach is only suitable to limited size networks where frequently flooded packets have only limited impact on network performance. In other mobile networks (e.g. GSM, Mobile IP), a fixed server is used (HLR/VLR or Home Agent/Foreign Agent) to track the position of the mobile terminal. This is an efficient approach for networks with a fixed infrastructure. In a mobile ad hoc metropolitan area network, these solutions are not useful and a new approach has to be found for mobility management. We intend to adopt a new and original approach for mobility management that avoids both large flooding and servers or directory services. We start from the observation that metropolitan area network has one or more areas where the nodes density is higher than in the average. Some of these areas, which can be statistically detected or identified in network planning (e.g. for a city network), take the role of Virtual Hot Spot (VHS). These hot spots can be used for efficient hierarchical management of location information, leveraging the geographic routing facilities of our protocol. We intend to verify this approach both for nodes and services location. Location services are a widely addressed topic in ad hoc networking [41], with [42] being one of the best known. A proposal, similar to our described above, is proposed in the GRID project [43]. In addition to that the distributed location service described above, we need to define the type of the information that is distributed and how it is managed. The management of this information has to be consistent and distributed among the location servers. This information changes rapidly with the topology and needs to be exchanged using a routing protocol as part of the routing data.

5.1.3 Routing

The Internet Engineering Task Force (IETF) working group on Mobile Ad-hoc NETworks (MANET) is standardising routing in ad-hoc networks. The group studies routing specifications, with the goal of supporting networks scaling up to hundreds of routers [5]. The work inside MANET relies on other existing IETF standards such as mobile-IP and IP addressing. Most of the currently available solutions are not designed to scale to more than a few hundred nodes. Additionally, these algorithms are based on the traditional IP routing approach and do not emphasise characteristics, such as self-organisation and co-operation that are new to the ad hoc environment. Another large class of ad hoc routing protocols uses positional or geographic information to route traffic and provide location services; a survey of such techniques is found in [41]. The MobileMAN approach benefits from self-organisation and co-operation between nodes.

This approach (see publications in C7.1) introduces anchored paths and friend assisted path discovery. In contrast with traditional routing algorithms, an anchored path does not consist of a list of nodes to be visited for reaching the destination. An anchored path is a list of fixed geographic points, called anchors. In traditional paths made of lists of nodes, if nodes move far from where they were at the time when the path was computed, the path cannot be used to reach the destination. Given that geographic points do not move, the advantage of anchored paths is that an anchored path is always "valid". In order to forward packets along anchored paths, the source needs to acquire them by means of path discovery methods. The Friend Assisted Path Discovery (FAPD) enables the source to learn the anchored path(s) to the destination requesting it to, so-called, friends, nodes to which the source already knows how to route packets.

A key aspect of this approach is the issue of the metric used for establishing the nodes' neighbourhood. In a MobileMAN there is not an objective notion of nearness or proximity. Positioning mechanisms like GPS, if available, only provide the notion of spatial proximity. Due to the varying nature of the territory, or the lack of communication resources on a given path, spatial proximity does not necessarily imply communication proximity. A qualitative notion of nearness is therefore needed. We plan to add to MobileMAN a qualitative metric of nearness (based on the availability of resources such as bandwidth, battery power, users' mobility, etc.) and to evaluate this metrics from the analysis of the system's evolution. The metric is appropriately updated as the system evolves.

5.1.4 Security

Basic security services as encryption and privacy, among the others, are not addressed in our proposal because their solution represent little, though challenging, innovation with respect to the security problems closely related to the ad hoc environment. Promoting cooperation among the nodes of a MANET by means of a robust security mechanism rises particular issues that can not be found in "dedicated" networks: this problem and its solution is particularly innovating thus pertinent to the FET type of European Projects.

A social, self organizing network can exist only if cooperation is enforced and a security scheme that is able to prevent attacks carried out by malicious and selfish nodes is the first issue to be addressed in order to make MANET work.

Security mechanisms that solely enforce the correctness or integrity of network operations would thus not be sufficient in MANET. A basic requirement for keeping the network operational is to enforce ad hoc nodes' contribution to network operations despite the conflicting tendency of each node towards selfishness as motivated by the scarcity of node power. The self-organising environment introduces new security issues that are not addressed by the basic security services provided for dedicated networks: nodes misbehaviour can take the form of a denial of collaboration to the network operation both due to malicious and/or selfish intentions. However, very few researchers focus on the selfishness problem in MANET and existing work in this area is still in its infancy ([43], [44]). We propose an innovative mechanism to enforce node co-operation based on a collaborative monitoring technique. We suggest it as a generic mechanism that can be integrated with any network function like packet forwarding, route discovery, network management, and location management. The innovative aspects of our methodology are highlighted by the self-organising and co-operative techniques applied to the security issues related to ad hoc routing. (1) Misbehaving nodes are stimulated to contribute to the network operations in order to be able to use network services. (2) The mechanism can be integrated with several network and application layer functions whereas the watchdog-path rater scheme is specifically designed for routing. (3) The Mobile MAN reputation mechanism does not allow a node to distribute negative ratings about other nodes, so unlike the path rater technique [43], it can resist to simple denial of service attacks exploiting this vulnerability

5.1.5 Peer-to-Peer Information Delivery

Peer to peer systems are a highly attractive way to build dis-intermediate content services. However, resilient mechanisms that have emerged in the p2p community from the persistent

storage of freenet and eternity, and via Content Addressable Networks have weird effects on network utilization [48] and are prohibitive for wireless ad hoc networks. We propose to select some of these mechanisms, such as CAN, Chord, Pastry, and Mixnet, Publius Xenos, and Mojonation and mitigate these effects. This will be achieved by (1) making them "load aware", (2) distributing load information and implementing a distributed congestion control scheme [38]; (3) adding a topographical metric based on location specification and using anycast.

Most current 2nd generation Peer-to-peer overlay systems use content request routing schemes that relay on arbitrary hash functions to map from some attribute (content) to node identifier - in the case of CAN there are as many hash functions as there are dimensions on the hyperspace. In the case of Chord and Pastry, there are hash functions that are Bloom filters on the content key, or similar (e.g. sometimes content is split using Rabin fingerprints first making similar content hash to similar locations). None of these takes account of actual location. These functions are largely aimed at providing robust and anonymous content location, and a high degree of cooperative, but distributed indexing. There have been some attempts to modify schemes to take account of actual Node proximity to the clients/requesting nodes. Freenet and other systems migrate copies in a manner similar to Web demand caching. We intend to use actual location information and scope information to modify the content key to node hash functions so that content is initially placed and requests are routed to copies that have proximity on a number of QoS axes - these would be delay and potentially throughput and loss based, but could also include battery budget considerations for wireless users. Thus the distribution of replicas in the service infrastructure would evolve to meet the MobileMAN user demand distribution, optimising use of the scarce wireless resources to better match user concerns. Note that some of the resulting algorithms and heuristics serve a dual purpose: They can be used for the actual packet routing decisions too. The duality between ad hoc self organizating P2P content location and routing, and ad hoc wireless routing has been commented on in the past, but not directly exploited to our knowledge. We believe that the resulting work will thus represent radically useful and new knowledge!

5.2 Socio-Economic Innovations

MobileMAN will define and implement novel methods and tools for evaluate the socio-economic effectivness of the ad hoc paradigm. Moreover, it will investigate how economic valuable services can be built by exploiting this paradigm.

5.2.1 Socio-Economic Evaluation

Our methodological approach for monitoring the evolution of MobileMAN and evaluating its socio-cultural and economic potential builds upon a solid body of social science studies of information technology and society. It is based on the following key issues and conceptual foundations. ***The inter-dynamics of technological innovation and societal change.*** Technological change is not to be seen as the driver for social evolution, as an autonomous and irresistible force to which society has to adapt. **Social and technical issues are always intertwined** ([21], [22], [23]). In order to capture the dynamic interplay between technology and social life, new information technologies must be understood both in relation to other technologies, as well as in relation to the social context of their creation and use ([24], [25]). Different social groups transform, adapt and reinterpret technologies in ways often not anticipated by the technical system and policy designers [27]. ***Real vs. Virtual Communities.*** As pointed out by Smith and Kollock [37], the effects of advanced information technologies on community are still to be understood in their full complexity and hence call for further systematic research. ***Impacts and responses to technological innovations: the importance of social heterogeneity.*** Communities are not constituted by socially homogeneous groups of people. It is necessary to underline the importance of social heterogeneity and to recognise that new information technologies have generated diversified responses. We assume that within different groups there are different 'pacesetters' in adopting advanced information technologies who distinguish themselves demographically, socio-economically, culturally and attitudinally. Understanding who are the 'innovators', the 'non-adopters', the 'resisters', the 'adapters' and the 'alienated' and what characterises them is one of the objectives of the socio-economic model.

The above points constitute the bases of our **methodology for evaluating the social, anthropological and economic potential** of MobileMAN. This methodology will be mainly based on a new *participatory design, which will put the user at the centre of the architecture, in order* to anticipate users' needs and concerns. A large population of users will be provided with MobileMAN terminals and through the developed methodology their satisfaction will be evaluated. This will avoid traditional misunderstandings between information technology designers and their recipient groups. In addition to the field-trial evaluation, some empirical research with a relatively large population (based on forms to be filled) will be used to gain perception of the system's potentials and limits in broadening people's network of social relationships.

5.2.2 Service Provides and ad hoc networks

Ad hoc technology is seen as competitive to legacy wired and wireless networks. In particular, traditional keepholders as telecom operator and service providers are seen to loose their control on the market with the upcoming of MANETs.

The innovative idea is to realise a secondary (with respect to the cellular market) wireless market based on the ad hoc paradigm. There are two main reasons to go in this direction: i) the **low cost-barrier** for a service provider to enter in the market (no expensive infrastructure is required to start with); and ii) the emerging tendency (mainly in USA) **to deregulate the spectrum environment** to create a secondary market. The approach will be based on a policy-based approach, where policies are used to classify the users requirements (mainly in terms of usage patterns). This allows bidding for the relevant spectrum and code division or other scheme to use it. This approach will be further powered by (1) mechanisms for controlling the requests versus the network provisioning, (2) mechanisms for grouping multiple requests, and (3) mechanisms for selling. As logic, a "service provider" of this secondary market, mainly based on nodes with wireless interfaces, needs to increase the reliability for selling services. Our approaches to that point range between increasing the number of nodes in the system and their geographical dispersity in order to achieve maximal coverage, versus increasing the traffic redundancy in order to maximize the probability of a successful delivery.

6 COMMUNITY ADDED VALUE AND CONTRIBUTION TO EC POLICIES

In the European Council held in Lisbon (March 2000), the European Union set itself a new strategic goal for the next decade: "to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion." However, it was recognized that there were several obstacles to achieve this. Business and citizens in the EU have been slow to embrace the opportunities of the knowledge-based society. Consequently, EU is lagging behind the United States in important areas such as investment in new technology, R&D and Internet penetration. To facilitate the transition to the knowledge-based society, a set of initiatives are scheduled. The major part of those initiatives affects technology or social aspects of communication. The V-th and VI-th Framework programme are totally in line with this overall EU vision. In particular, FET Open Programme, "as the 'nursery' of novel and emergent ideas, some of which may become the mainstream topics of the future" aims to open new possibilities and set new trends for future research programmes. The high risks of innovation are expected to be compensated by major advances and economic, industrial or societal impact.

The MobileMAN project fits with the goal of exploring and validating novel technologies, applications, architectures and practices to support future communication society. Specifically, MobileMAN would contribute to address the EC policies in this matter, by tackling the following priorities (see, eEurope Action plan[1]:):

- **Investing in people**. Specifically, the Lisbon European Council requested to make a visible progresses:

  · to integrate the European **youth into the digital area**;

  · to guarantee the participation for all in the knowledge-based economy to foster social inclusion.

- **Improving skills** and qualifications to address both the lack of highly qualified ICT personnel and to improve the basic skills of populations.

- **Stimulate the use of Internet** through a cheaper Internet access.

- **Investing in people and guaranteeing participation for all**

  The focus of future generation of IST is to bring application and services to everybody (including disadvantaged people, youth and elderly) for a more **user-centred society**. The transformation of society, from being industrial-based to information-based is sustained by rapid technological change and by convergence in the use of same technologies by different society sectors. Evidence of this trend in the recent years can be seen in the exploitation of Internet and all of the technologies and tools around it and the parallel increase in existing network capabilities. Both factors lead to a cultural change, to new social dynamics, to new forms of living and communicating. Under this concept, communication among individuals has changed, and the objective is to enable citizens to communicate and access the information whenever they want, whoever they are, and wherever they are. As addressed in MobileMAN, the trend is **for ubiquitous and equalitarian communication systems**. Derived from the previous statement, it can be said that a new user requirement is growing, and needs to become a reality for any user: "How can I communicate (and access information) whenever I need at the moment that I need it!" The solution MobileMAN proposes is based on a user-centred communication paradigm that exploits the self-organisation aspect of ad hoc networks. Users self-organise themselves in a co-operative network. The networking aspects become part of the communication process, and people collaborate to support other people communications.

[1] eEurope 2002 "An Information Society For All" Council and European Commission (June 2000).

- **Improving skills in IST**

  The IST Advisory Group (ISTAG) recognizes a need to **build knowledge and research skills** related to some Key Enabling Technologies (KET). MobileMAN will increase the number of **students** trained in one the most relevant KET: "**IP mobile and wireless**". Within the consortium, there are already a number of Ph.D. students working on topics in mobile ad hoc networking. We expect that the MobileMAN project will attract even more good students, increasing the number of European specialists in this area. In addtion, the direct involvement of large communities of university students in the MobileMAN field trials will make a large community of technicians and users aware of the mobile-ad-hoc paradigm potentialities.

- **Stimulate the use of Internet**

  Most customers access the Internet via local lines, where, due to insufficient competition, prices have not sufficiently decreased to stimulate the widespread use of Internet. The Lisbon European Council has fixed a reduction in costs as a priority. Furthermore, the mobile communication market is rapidly becoming the most relevant part of European telecommunications. Hence, **mobile Internet access** constitutes a European priority. The evolution of this market will inevitably be very price sensitive and will require the highest possible level of competition. MobileMAN addresses this by investigating how a **secondary wireless market** (with respect to the cellular market) can be built up by exploiting the self organising paradigm. There are two main reasons to go in this direction: i) the **low cost-barrier** for a service provider to enter in the market (no expensive infrastructure is required to start with); and ii) the emerging tendency **to deregulate the spectrum environment** to create a secondary market.

MobileMAN perfectly fulfils the scientific and technological objectives and broad lines of the activities recently published by the commission of the European Communities for the sixth multiannual framework programme (COM(2001) 709 final). In the annex1, it states that "research activities will be based on an integrated and, where relevant, trans-disciplinary approach, incorporating as appropriate innovation and socio-economic dimensions". The self-organisation paradigm is a stimulating laboratory for studying and exploiting new paradigms of the integration between the technology and the socio-economic aspects, which is becoming a must for any future research and application. The self-organisation paradigm will allow the proliferation of citizen networks, where people organise and manage themselves their own network, which they create because they want and need, and they do not have to request any external intervention. In a citizen network, a user finds other users, people like him, which can help and support his communication process. In the document cited above the following paragraph exactly fits with the MobileMAN vision. "With a view to exerting maximum impact in economic and social terms, effort should focus on the future generation of those technologies in which computers, interfaces and networks will be more integrated into the everyday environment and will render accessible, through easy and 'natural' interactions, a multitude of services and applications. This vision of 'ambient intelligence' seeks to place the user, the human being, at the centre of the future development of the knowledge-based society." The mobile ad hoc technology is seen as an important component for an "ambient intelligence" system. The MobileMAN contribution in this is the definition of an **immersive communication environment** that promotes **both economic and business processes**, as well as **the integration of disadvantaged users** in the society by reducing traditional communication gaps and barriers. This will be based on a **cooperation model** that encourages and **enforces mutually beneficial behaviours in a self-organising network**, and will be evaluated on a **fully functional prototype** mobile ad hoc network where users can communicate and run **innovative applications with no cost for communication itself**.

Through research and industrial efforts, Europe has established world-renowned leadership in infrastructure-based mobile communications. Long-term research in infrastructure-less mobile communications has the potential for technological innovation that will allow Europe to continue being an actor in future generation mobile systems. Currently, the US drives research this area, mainly in the context of defence-related projects. On the other hand, currently, in Europe the research on the mobile ad hoc paradigm is still in its infancy and relevant competencies are

scattered among different countries. It is therefore important that this project be carried out at the **European** level, bringing together complementary expertises and heterogeneous user requirements and overcoming geographical barriers that could negatively affect the significance of results obtained at the national level. The project can produce a common European approach toward self-organized networks that can balance the current US leadership in this area.

7 CONTRIBUTION TO COMMUNITY SOCIAL OBJECTIVES

Concern for Community social objectives strongly motivates the aims of the IST programmes.[1] [2] MobileMAN, has an important role in contributing to the Community's social objectives.[3] Namely, it can bring improvements in several aspects including, but not limited to: the quality of life and social cohesion, European humanitarian action, employment and customer benefits.

- **Quality of life, social cohesion, and inclusive knowledge society**

  MobileMAN will pay specific attention to the social implications of IST technology on "equal opportunities and quality of life".

  The quality of life of the people is today intimately connected to their ability to access information, despite their geographical location, transportation facilities, etc. Furthermore, this view can be enriched by considering the ability to access both information and services, and to the ability to access them "anytime-anywhere".

  The solution provided by this project is based on new and traditional technologies and techniques (wireless access, mobile ad-hoc, self-organisation, Internet) glued together by a social-oriented approach: the people are the users and the network at the same time and they group together because of common interests or needs. In fact MobileMAN offers a new method of communicating that enables individuals to create their own network and to use it for communicating, accessing information, playing, etc. This will generate a more **equal society**, where disadvantaged people has the same opportunities for communicating, socialising and improving their quality of life.

  The move towards greater communication and sharing of information should also lead to the introduction of strategies that bring together people, processes and technology, transforming the society culture into one that values co-operating and sharing. The MobileMAN project will contribute in its application field, to breaking the existing barriers and building a culture based on the co-operation and sharing values. The culture of trust and empowerment encourages the fulfilment of the full potential of an organisation's people and fosters **the involvement of everyone**. MobileMAN aims to offer to everyone the possibility of being part of the society by simply being part of a self-organised network centred on her/him and on people like her/him. This is expected to be especially relevant for some categories of people that are generally forgotten because they represent a limited the market. However, when the technology and the user become one entity, as in MobileMAN, the evolution is no more driven simply by the market as in the traditional economic models, but by the people themselves. This characteristic offers to the people the possibility of increasing the quality of their life. In fact, a friendly support in accessing information, the communication with people with similar ideas, problems and needs, as well as the fact of being always (everytime and everywhere) connected with someone else, decrease the probability of several kinds of diseases (like depression, loneliness, stress). These are factors for life dissatisfaction that can be reduced when the people can rely on external social support augmenting the subject's own feeling of being not alone.

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[1] Information Society Technologies - 2002 Work programme - A programme of Research, Technology Development & Demonstration under the 5th Framework Programme

[2] COMMISSION OF THE EUROPEAN COMMUNITIES (Brussels, 22.11.2001) - Modified proposal for a DECISION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL CONCERNING THE SIXTH MULTIANNUAL FRAMEWORK PROGRAMME 2002- 2006 OF THE EUROPEAN COMMUNITY FOR RESEARCH, TECHNOLOGICAL DEVELOPMENT AND DEMONSTRATION ACTIVITIES AIMED AT CONTRIBUTING TOWARDS THE CREATION OF THE EUROPEAN RESEARCH AREA

[3] COMMISSION OF THE EUROPEAN COMMUNITIES - Brussels 7.2.2001- SEC (2001) 222 - COMMISSION STAFF WORKING DOCUMEN Benchmarking Report following-up the "Strategies for jobs in the Information Society" [with the support of the High Level Group "Employment and Social Dimension of the Informat ion Societ y" (ESDIS)]

MobileMAN conveys other people expertise, insight and knowledge to all citizens. This is especially important for disadvantaged people, which are more sensitive to the feeling of having the same opportunities of everybody else, without asking for any special support.

Finally, MobileMAN provides an answer to the Union priority of ensuring that less-favoured regions can fully participate in the information society. MobileMAN low-cost technology potentially solve the concern about accessing the information from less developed (and possibly remote) areas.

- **Civilian and environmental crises management**

  Traditionally, the mobile ad hoc technology has **humanitarian relevance.** For MobileMAN this can be particularly true in this moment, considering Europe's increasing role providing aid during conflicts and natural disasters. A MobileMAN can support **post crisis management of natural or man made risks by providing a solution to** local emergency communications, without relying on expensive and vulnerable infrastructure.

- **Employment and consumer benefits**

  Accelerating reforms in product markets is essential for higher growth and employment and increased consumer benefits. Action is needed to increase competition and speed up the opening of markets for network industries. The MobileMAN approach could contribute to further opening the telecommunication market by fostering competition in the local accesses to Internet and in creating a secondary wireless market.

On one end, it complements existing wireless communications services with efficient, low-cost local multimedia services. It offers a solution to the problem of "wireless operator as kingmaker" by introducing a new technical, economic and social model of a self-organized network. Because the cost barriers for deploying new services are very low, the MobileMAN environment will be a fertile field for rapid technical and business innovation, especially by small-medium enterprises and start-ups. On the other hand, it also define a secondary market for introducing telecom operators and service providers in the ad hoc networks communications, with beneficial effects for the users.

8 ECONOMIC DEVELOPMENT AND S&T PROSPECTS

This section describes a preliminary analysis of possible business and technological opportunities derived from MobileMAN.

The MobileMAN consortium consists of partners whose role and competence fill the complete chain of scientific, technological, and industrial skills required realising a fully functional mobile-ad-hoc-network terminal prototype. The project will also produce a new socio-economic model for mobile-ad-hoc networks enabling both the profiling of applications, and services and the analysis of the MobileMAN technology social impact.

The consortium approach is to make a market analysis, to use dissemination to create awareness around the solution provided by MobileMAN, and to define and execute an exploitation plan. During the project execution, a specific work-package (WP5) has been planned to face with this important aspect.

The strategic importance and the high innovation of MobileMAN have been recognised by several industries, which expressed the interest in being part of the Advisory Board of the project, and in some case, proposed also to support the project with their technologies.

8.1 Dissemination

Dissemination is the previous activity to exploitation and could be considered as the market strategy to create awareness around MobileMAN. For this reason, different dissemination channels have been identified as potentially important.

- Publications in leading peer-reviewed research conferences and journals. This is the primary way in which we intend to disseminate the project results. Considering the target customers, the more relevant areas of interest for this activity are: Information Technology, Wireless and Mobile Technologies, Communication Networks, Knowledge Management, Personal Communication, Socio-economic Aspects of Network Technologies. A list of the moist relevant conferences and journals is given in Section C8.4. Most of the members of the consortium have already published extensively (see Section C7 and ANNEX1)

- Participation in program committees and editorial boards. This is important for team members who can in this way play a role in setting the agenda (e.g. defining special conference sessions) and defining key areas of interest for the research community. Examples of such committees and boards are: INFOCOM, GlobeCom, Networking (IFIP), MobiHoc, IEEE Communication Magazine, Cluster Computing, Internet Architecture Board (IAB), Kluver Grid computing.

- Participation in strong industrially orientated events. While offering fewer opportunities for scientific dissemination, they are very important in terms of technological evangelism, contacts and lobbying. Examples of such events are: WCNC, ICC and Emerging Technologies conferences.

- Organisation of small, highly directed workshops. These, focusing on MobileMAN and related work, will provide an excellent way to disseminate results and receive feedback.

- Distribution of free (open source) software prototypes. Because software distribution plays an integral role in disseminating the project results, active participation in the free software community (e.g. Usenix-Freenix, Linux, BSD-Con, ...) will also be important. Some members have also had experience with participation in the free software community (e.g. EPFL Linux kernel)

- Participation in international standardisation bodies. The project results, especially the experiences in performance measurement, will provide valuable input to standards organisations, in particular the MANET and ZEROCONF Working Groups of the IETF. Another area of great interest are the IEEE standardisation committees for the new wireless technologies; this since the project will address the known limitations of the 802.11a and 802.11b in the mobile-ad-hoc networks and propose a more suited solution. If successful, the

project results could even lead to the proposition of a new IEEE 802.11x standard (PHY and MAC levels) for MobileMAN.

- Dissemination trough personal mobility. Students who will perform M.Sc. or Ph.D. thesis work in the context of the MobileMAN project will carry its ideas into their future workplaces and academic institutions.

- Co-operation with other mobile ad hoc projects. For examples: HUT Mobile Ad Hoc Routing Testbed - MART (http://www.cs.hut.fi/~mart/), EPFL Terminode project (http://www.terminode.org/), INRIA HIPERCOM Project (http://hipercom.inria.fr/), University of Mannheim Fleetnet Projec (http://www.informatik.uni-mannheim.de/).

- Harmonisation with EC Accompanying Measures. The project consortium will pay a specific attention to those initiatives scheduled inside the IST Work-programmes. Best Practice, Thematic Networks and Take-up Actions should be an important dissemination channel. The consortium will pay specific attention to these future initiatives to take advantage of the co-ordination and synergies that these actions will aim to fulfil. For instance, ERCIM, of which CNR is members, is an additional mechanism for supporting collaborative activities within Europe

- Web. The project web-site will constitute a key communication and dissemination mechanism both for consortium members and non-members. It will contain general project information as well as information about project results, news, consortium members, software distributions, etc…

8.2 Economic development

Given both the consortium nature and composition (research institutes mainly affiliated to universities) and the project goals (functional terminal prototype), the economic promotion and development of the project results will mainly performed through the indirect way of dissemination (see above). Moreover, a direct commercialisation of the projects technical results (by mean of an intense industrialisation phase of the hardware, low-level software and middleware) is premature; much more will have to be done for the applications and services. However, economical benefits may arise in the near future since the project represent (one of) the first *complete* realisation of MobileMAN; this gives strategic advances to both the consortium members and to the Community in general:

- First to market opportunity. MobileMAN will open new possibilities to enter the market for:

- Start-ups and SME developing some of the MobileMAN innovative solutions

- System Integrators aiming to offer application and services onto this new environment

- Service Providers, exploiting the new market based on the spectrum regulation approach.

- Best technology. MobileMAN is not based on a simple reuse of WLAN or other existing standards with some small modifications, it is a totally new and perfectly adapted technology with several independent innovative solutions.

- Competitors. Main competitors of MobileMAN project can be found in research project founded by DARPA, NSF, as well as European projects as mentioned above. However, has the unique characteristic of aiming both to develop a fully functional prototype and to validate the self-organising paradigm as new paradigm for people communications. In order to fulfil so ambitious goals, we will import other people results. Thus, MobileMAN will not compete, but rather collaborate and exchange solutions and ideas with other projects.

- Socio Economic impacts. A more direct exploitation of the project results is given by the newly created MobileMAN socio-economic modelling: the developed methodology can

benefit a large spectrum of potential users, allowing the analysis and profiling of a many new or already existing technologies and applications. It is important to note that the methodology will benefit the MobileMAN domain as well as the general Information Society domain, where often, a lack of analysis means lead to sub-optimal applications and services.

8.3 Future possibilities

Mobile-Ad-hoc-Networks is a very active research field: several projects in the domain are done at this moment in the EU, in USA and in Japan/Asia. However, most of these projects deal with theoretical aspects of MobileMAN and will lead at best to computer simulations and models. MobileMAN deal instead with both the theoretical and practical aspects of MobileMAN; this will enable some unique future possibilities:

- In the scientific-technique domain, the project result will give access to a new effective technology for MobileMAN. This will open the way to the study and realisation of a whole new class of algorithms and technologies: Internetworking *for MobileMAN*, Quality-of-Service *for MobileMAN*, Ergonomics *for MobileMAN*, Applications *for MobileMAN*, etc ...

- In the economic domain, the high potential of the MobileMAN, due to the novelty of the approach, will give a strong stimulus to the creation of new companies (or to the expansion of existing companies), as explained above. Not only new hardware should be provided, but also low-level software, middleware and above all a whole new class of applications and services. Service providers will for instance have the opportunity to create new business channels reviving their stagnating Internet operations.

- In the social domain, MobileMAN relies on high interplay between technology and social life. This goes in the direction of reducing traditional barriers between technology and customers, making possible the creation of a new class of network users that is also “part of the network”.

8.4 Dissemination issues

The following is a list of some of the main events (conferences and journal CFP) that are relevant to the MobileMAN topic and where the MobileMAN partners intend to be present with articles for disseminating their results.

8.4.1 Scientific conferences

ACM International Conference on Mobile Computing and Networking, Mobicom; Communication Networks and Distributed Systems Modeling and Simulation Conference CNDS; European Conference for the Advancement of Assistive Technology AAATE; European Wireless; IEEE Conference on Mobile and Wireless Communications Networks MWCN; IEEE Globecom; IEEE International Conference on Networks ICON; IFIP International Conferences; International Conference on Disability, virtual reality and Associated technologies, ICDVRAT; International Conference on Information Networking ICOIN; International Conference on Pervasive Computing, Pervasive; International Conference on Technology Policy and Innovation; International Conference on Wireless Networks ICWN; Netties conference; International Network Conference INC; MobiHoc; The International Conference on Dependable Systems and Networks DSN; Western Multiconference WMC

8.4.2 Workshop and Industrial Oriented Conferences

ERCIM Workshop; EURESCOM Summit; German Workshop on Mobile Ad Hoc Networks; IEEE Conference on Open Architectures and Network Programming OPENARCH; IEEE International Conference on Communications ICC; IEEE International Symposium on Personal, Indoor and Mobile Radio Communications PIMRC; IEEE Symposium on Ad Hoc Wireless networks SAWN; IEEE Wireless Communications and Networking Conference WCNC; IEEE Workshop on Mobile Computing Systems and Applications WMCSA; IETF meeting; International Conference on 3G

Wireless and Beyond; International Symposium on Wireless Personal Multimedia Communications WPMC; International Workshop on Global and Peer to Peer Computing on Large Scale Distributed Systems at IEEE International Symposium on Cluster Computing and the Grid CCGrid; International Workshop on Intelligent Multimedia Computing and Networking IMMCN 2002; International Workshop on Peer to Peer Systems IPTPS

8.4.3 Journals

ACM Baltzer Mobile Networks and Applications MONET; ACM Baltzer Wireless Networks WINET; ACM Mobile Computing and Communications Review; ACM SIGMetrics Performance Evaluation Review; Baltzer Telecommunication Systems; Elsevier Computer Communications; Elsevier Computer Networks; Elsevier Performance Evaluation; IEEE Communications Letters; IEEE Communications Magazine; IEEE Communications Surveys; IEEE Journal on Selected Areas in Communications JSAC; IEEE Network; IEEE Personal Communications; IEEE Transactions on Communications; IEEE Transactions on Mobile Computing; IEEE Transactions on Networking; IEEE Transactions on Wireless Communications; Journal of High Speed Networks; Wiley Wireless Communications and Mobile Computing

9 WORKPLAN

9.1 General description

The aim of this project is to tackle the open research issues of a self-organising network to show that this is a suitable and effective technology to construct the **citizens' network**. Specifically, our citizens' networks will be tested to verify its suitability to support the **co-operation and the self-organisation (inside a metropolitan area) of some specific virtual communities**:

- The *virtual community of the university students (VC1)*. By adopting the MobileMAN technology, the students will have a wireless multimedia network that enable a ubiquitous co-operation between them at no cost (at least from the communication standpoint). The students will be able to share all the "precious" knowledge related to the courses, or to perform group assignments, etc introducing so a new e-learning paradigm. VC1 will be also used as sample of the more general virtual community of young people, for analysing the social and economic impact of self-organising and free communication among youth.

- The *virtual community of the disabled and elderly (VC2).* These people, traditionally last in the society, will have the opportunity to set up and maintain their own free and ubiquitous network (in the metropolitan area) for communicating, exchanging and retrieving information, play distributed games, send alarms, etc… VC2 will be also used as sample of the more general communities that are last to be reached, for analysing the social and economic impact of self-organising and ubiquitous communication for equal opportunities and quality of life.

The project is unique in proposing fully functional testbeds. Although ad hoc networking is a "hot topic", we only know of small-scale testbeds, mostly examining routing performance. Real testbeds are essential for making further progress and achieving key results.

An effective solution to several challenging research and technical issues must be provided before the MobileMAN technology can be successfully proved. The MobileMAN complete architecture is presented in Figure 1. However, given the wide coverage of this proposal, which span all layers, we concentrate the work in areas where **our contribution can be innovative and effective**, rather then trying to cover the whole area. Specifically, we will concentrate on the novel concepts that are peculiar of the self-organising paradigm, and hence fundamental to verify its effectiveness. In order to produce a full solution, we will complete our results with existing code and ideas wherever possible (avoiding not-invented-here attitude).

The MobileMAN architecture is composed by two main parts: the **system part**, and the **users' part.** The system part includes the access technologies, the networking functionalities and the networking services. The users' part groups covers all the aspects that somehow affect the people using this system: applications, socio-cultural and economic aspects of MobileMAN, and new services that can be sold to the MobileMAN users.

In the following, we present these two parts, highlighting the work and the overall methodology that we will use to achieve our objectives, which exploits the innovative concepts presented and discussed in Section 5. As already said, we also use, whenever it is possible, existing results for completing the MobileMAN solution. Our work, in this case, will consist in integrating and validating these elements in the MobileMAN environment (see WP1 and WP5 descriptions).

9.1.1 System Part

The System includes all the communication aspects, ranging from the physical up to the network services that are offered for supporting the applications. As shown in figure1, there are two aspects, which affect the whole system, and which will be used in the global design of the MobileMAN:

- Energy management. Battery power is a strategic resource for each mobile device. Therefore, MobileMAN devices, as they not only must perform their own tasks but also contribute to the management of the whole network, must have strategies both for power saving and to modify

their behaviour under low power conditions. This means that, for example, a device could decide to keep active functions as transmission or location, but refuses to forward other devices' packets. Energy management works at several layers and is a complex process that will be addresses in all MobileMAN System functionalities, i.e., from the wireless ad hoc technologies to the co-operation model.

· Co-operation Model. A self-organising network must be based on the incentive to the users to collaborate. There must be a mechanism that encourages users to behave as "good citizens" by i) letting their device relay packets for the benefit of other users, ii) making their data available, and iii) providing support to the other computations. Our approach to stimulate such behaviour is introduced at location, routing and service (security) level (see Section 5).

The horizontal layers that constitute the System part are: the wireless ad hoc technologies (physical and data link layer), the routing and transport layer (self-organising network and transport), and the network services layer (secure and co-operative services).

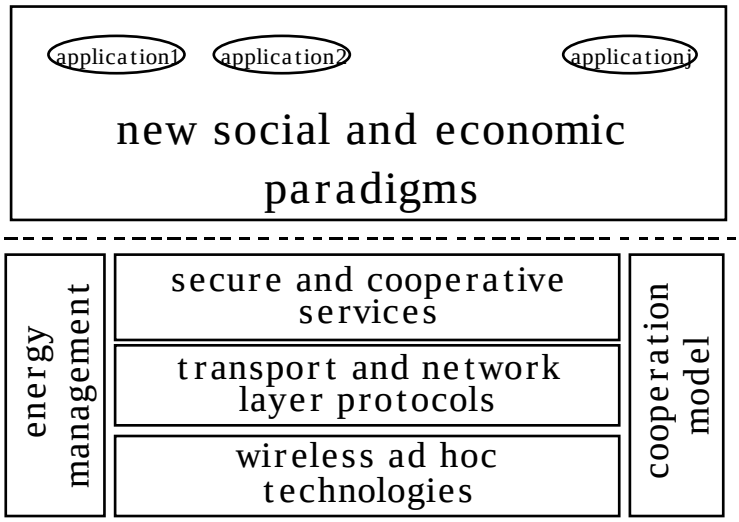


Figure 1MobileMAN Architecture

Wireless Ad Hoc Access Technologies

As first, the access to the media has characteristics of burstiness as several devices concur to transmit on the same channel. The existing IEEE 802.11 versions solve the problem of the access to the media in situations of low concurrent accesses, but severe instability problems occur in the network with high number of simultaneous accesses (bursty users). Bursty users may occur in an ad hoc network due to the flooding of routing-protocol control information. In addition, problems may occur in adopting current IEEE 802.11 cards in an ad hoc environment due to hidden terminals. We will introduce new schemes for improving the IEEE 802.11 **wireless technology** to better support self-organised networks (see Section 5). This activity will exploit the analysis of the existing IEEE 802.11 wireless technology carried out by CO1 (see Section 5). Specifically, we will extend the analytical framework to optimise the IEEE 802.11 performance in a mobile ad-hoc environment. This study will identify solutions for improving the IEEE 802.11 wireless technology to better support self-organised networks. These solutions will be physical implemented for offering an enhanced 802.11 version for optimal support to concurrent access in ad hoc networks. The hardware will be based, wherever possible, on a off-the-shelf 802.11 chipset whith ad-hoc programmed firmware.

The ad hoc network presents a uniquely dynamic and failure prone connectivity environment. There is almost no knowledge or experience on the effectiveness of current wireless technology to create large or dense ad hoc networks. Therefore, we will consider users terminals with **multiple network interfaces**. Specifically, a terminal can have both the ad-hoc network interface and some infrastructure-based interface(s), e.g., GPRS. In the case of partitioning of the ad hoc network, the infrastructure-based network can bridge the ad hoc traffic. We believe that this hybrid-model can represent the natural way to extend the cellular model with ad hoc networking functionalities. The hybrid model creates the possibility to introduce free or low-cost information services to the cellular users.

An alternative way that we will explore to increase the reliability of the ad hoc paradigm is based on the introduction of some fixed nodes with wireless interfaces. For example, an information service provider could participate to the ad hoc network with some fixed nodes in order to deliver its information (advertisements, cultural information, public information) to the users. At the same time, this would provide a) coverage support to the MobileMAN and b) the access to **Internet** for MobileMAN terminals.

Self-Organising Network and Transport

In a MobileMAN all the main **network** functionalities need to be re-designed to cope with a self-organising, dynamic, volatile, peer-to-peer communication environment. The use of spatial location information is crucial for many services at different layers. It can be used for routing purposes and for supporting the applications. In the case of ad hoc networks the location information is even more relevant in terms of routing purposes. The purpose of the **location mechanism** is to dynamically map the terminal logical address to its current location-dependent address, and its innovative details are described in Section 5. Once a user is located, **packet-forwarding algorithms** must be provided to route the information through the MobileMAN. In ad hoc infrastructures the classic routing algorithms such as Link State or Distance Vector are lacking the basic requirements of reliability or enough bandwidth required for creating the link state tables or flooding the routing requests. To address this problem, MobileMAN will be based on the new concepts of *anchored paths* and *friend assisted path discovery* (as described in Section 5). The solutions will take into consideration the fact that spatial proximity does not necessarily imply communication proximity. Hence, we need a different notion of "nearness" as **metric**.

The low reliability of communications (and the possibility of network congestion) requires an analysis of the transport layer mechanisms. If this analysis indicates severe problems in using legacy TCP solutions in the MobileMAN, for addressing this issue, we will refer to some of the existing implemented proposals. (For example: End-to-end "TCP-friendly" congestion control). It is not out intention to design and implement our own TCP solution.

Secure and Co-operative Services

MobileMAN will deal with the services required to support the introduction of (existing) applications inside the virtual communities with benefits for the users. Key aspects are the **nodes co-operation** and the **security**, in order to provide a collaborative and safe environment to the application layer. The self-organising environment introduces new security issues that are not addressed by the basic security services provided for dedicated networks: nodes misbehaviour can take the form of a denial of collaboration to the network operation both due to malicious and/or selfish intentions. Security mechanisms that solely enforce the correctness or integrity of network operations would thus not be sufficient in MANET. A basic requirement for keeping the network operational is to enforce ad hoc nodes' contribution to network operations despite the conflicting tendency of each node towards selfishness as motivated by the scarcity of node power. We will perform a security analysis of a MobileMAN environment (including the robustness to malicious attacks) for providing authentication, privacy, and robustness in a MobileMAN by defining a mechanism that encourages users to behave as "good citizens". This innovative mechanism (see Section 5) to enforce node co-operation based on a collaborative monitoring technique that can be integrated with any network function.

In order to achieve efficient peer-to-peer information distribution, we will use some of the existing peer-2-peer technology, such as Gnutella, Can, etc…, and will introduce traffic load information at different levels, such that the information is shared and distributed optimising (see 5.1.5) the global utility function of the network.

9.1.2 Users' Part

In the MobileMAN, people come together, and create the network, for some collaborative activity. The human interactions associated with the activity are key aspects in order to establish services and infrastructures [18]. The technical work relies on this concept. The reaction of the users to this new philosophy, which impacts the application level as well, is an important measurement tool for tuning and modifying the ad hoc networking paradigm. At the same time, this activity is essential for discovering the ad hoc networking potentiality in terms of users needs and requirements, as well as social and economic input. For that reason, the integration of the technical components and the evaluation of the MobileMAN paradigms in terms of users' satisfactions are strongly correlated. In fact, the MobileMAN technology aim to be a suitable and effective technology to construct the **citizens' network**: communicating people sharing common interests or problems, which self-organise their own network by simply co-operating. In particular, MobileMAN can be seen as the technology that compensate for the fact that traditional communication technologies do not take in account the difficulties of some groups of persons to access the communication facilities. For example, for youth, it is difficult to communicate as they would and could do, because of the communication costs. Similarly, for people with special needs that are often alone, a free communication systems that provide them a continuous connection with the society is fundamental for maintaining an acceptable level of social life, and thus providing an increase in their quality of life. For example, it can be used for sharing information, or for communicating with people with similar problems and interests, or even for spending their time by playing games. Therefore, once the full system is integrated, it is necessary to validate it in this perspective. The validation will include two steps: identification of the applications to test, and validation of the self-organising paradigm with users.

Applications

The self-organisation paradigm needs to be validated (and maybe adapted) by the users' needs and advantages. It is thus a key aspect to **identify existing applications that can become a customer advantage**, when run on top of MobileMAN, compared to traditional technologies. This will allows for discovering the ad hoc networking potentiality in terms of users needs and requirements, as well as social and economic input. In order to do that and to address exploitations issues, it is essential to offer some interesting applications to the users. We strongly believe that the killer application for MobileMAN is killer not in terms of the application itself, but rather because the replacement of existing services become a customer advantage. In other worlds, we think that the added value of ad hoc networking paradigm can be shown by the novel way existing services are provided rather than finding novel (killer) applications for it. For this reason we will port on MobileMAN some existing applications like messaging exchange and net chatting for showing that: (1) the self-organised paradigm works and is effective for the citizens; (2) the technical innovations are valid; and (3) there is a new market for existing applications.

Socio-Economic Potential

The identification of the processes through which VCs emerge (common needs, common interests, socio-economic characteristics) and of how they constitute themselves (modalities of aggregation, degree of exclusivity) provides both the measure of the social and economic potential and information for technical realisation. As explained in the Section 5, we will develop **a methodology for evaluating the social, anthropological and economic potential** of the self-organised paradigm.

Participatory Design (Phase I) There are significant **socio-cultural distances** between user communities and communication technology designers that may impede to anticipate users' needs

and concerns. This calls for the development of a participatory design methodology, a more open and inclusive design strategy that goes beyond the manipulative involvement of stakeholders [20]. We thus recognise the importance of linking contrasting modes of knowledge, the so-called 'expert' knowledge and the 'peoples' knowledge. By organising regular encounters among the various stakeholders we aim at facilitating communication between information technology designers and their recipient groups.

Monitoring and Evaluating pilot uses of MobileMAN (Phase II) The MobileMAN prototype will be pilot tested by a group of people associated to the designers whose uses, adaptations and problems encountered will be closely monitored. During this pilot implementation phase we aim at helping to **identify technology-driven problems, opportunities** and **new uses for MobileMAN** to better ensure that the technology advances promote and improve the general welfare.

Evaluating the socio-cultural and economic potential of MobileMAN (Phase III) In a third phase the socio-cultural and economic potential of MobileMAN will be tested by means of empirical research with a relatively large population as to gain a broad perception of the system's potentials. We envision to testing MobileMAN with a virtual community of university students and a virtual community of disabled and aged people. Our aim is to assess how these diverse groups incorporate MobileMAN into their everyday lives at work, home, university and play and how it influences the social relationships associated to these various domains. Ultimately we intend to find out **MobileMAN's potentials and limits** in broadening people's network of social relationships.

New Wireless Market

The existence of a de-regulated secondary wireless market (see B.5.2.B) requires to investigate economic way to dynamically assign the spectrum to service provider or to users communities. We propose to investigate a market-based mechanism by which spectrum can be sold to given sets of users, based on ability to pay relative to a proposed set of usage policies and proposed network topologies. Although the mechanisms we propose are somewhat generic, we believe that in order to be of maximum use, it is necessary to explore them in an environment that is as close to that likely to exist in the medium term as we can achieve.

9.2 Risks mitigation

The high degree of innovation contained in the MobileMAN project necessarily implies relevant risks. Below is a list of such potential risks (related to the high innovation of this proposal) as perceived by the partners together with the mitigation action already taken. In addition, in order to manage the technical risks that may occur during the project, we have explicitly devised tasks in WP4 to address them.

· Project scope

MobileMAN is unique and important in proposing the eventual development of a fully functioning prototype. There is risk due to the interdependency of so many new technical elements, ranging from media access to applications.
ACTION _1: Steal code and ideas wherever possible (avoid not-invented-here attitude).
ACTION _2: Develop prototype and proof-of-concept implementations as early as possible. Build test environments (e.g. in fixed networks), which allow us to make progress on higher layer elements, even before lower layer elements are complete. We also note that the downside risk is limited. Even if our efforts to create a fully functional MobileMAN are not completely successful, many piecewise contributions will still prove very useful.

· Large number of users

To have an effective test of the technical MobileMAN solutions, we need to evaluate it up to its technological limit, which is expected to be larger than hundred users. Disorder and testing problems are also expected to increase exponentially with the number of users and this could make impossible to perform any activity on the MobileMAN by adopting generic users.
ACTION_1: Use expert users, as the university students with a strong information technology expertise (VC1), whenever is required a large number of users. Specifically, in the large testbeds our users will be computer engineering students.

· Economic and social model

A MobileMAN is self-organising, dependent on the ability and willingness of users to co-operate for mutual benefit. MobileMAN includes technologies, which attempt to encourage or enforce good behaviour. However, it is unclear how users will react to this economic and social model.

ACTION_1: This risk can be mitigated by making an effort to consider user issues throughout and to incorporate user feedback. We also note that, over time, people do seem to adapt well to new communication technology and develop appropriate -- and often generous -- customs.

ACTION_2: Address class of users that are traditionally left "in a corner" by communication technologies, benefiting by their wish of being integrated.

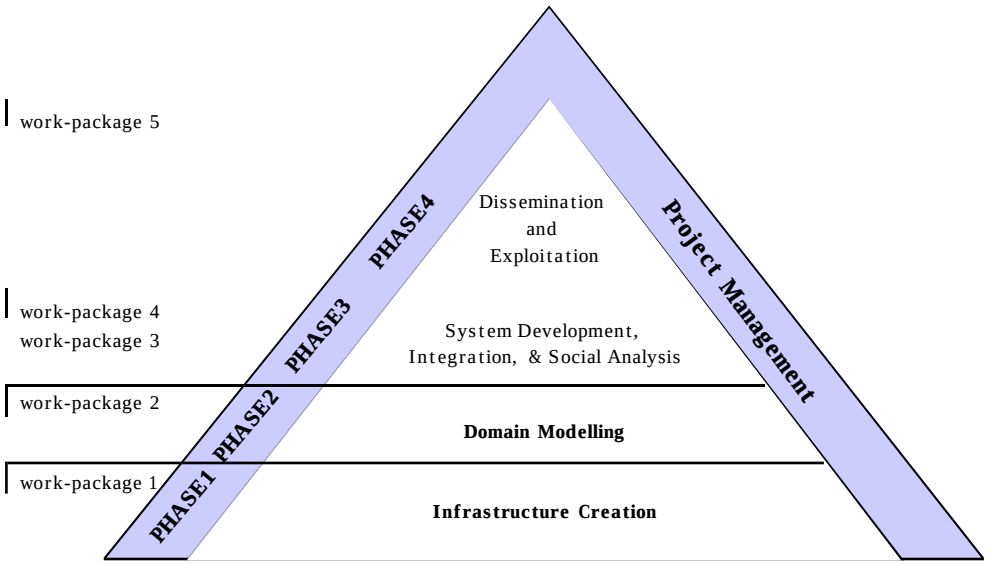


FIGURE 2 PROJECT PHASES AND WORKPACKAGES

9.3 Work-packages list

The overall structure of the project work-plan could be divided into four logical and partially overlapping phases, co-ordinated by management activities that aim to guarantee the harmonisation of the partners' activities.

Phase 1 Infrastructure Creation: The objective of this phase is to ensure that the goals for the different project partners are aligned with project goals and to create the infrastructure for a successful communication among project partners.

Phase 2 Domain Modelling: The objective of this phase is to address the virtual community and to formalise the technologies and services necessary in order to model our solution on the users' needs.

Phase 3 System Development: The objective of this phase is to develop the hardware and the software components that will constitute the MobileMAN solution.

Phase 4 Integration, Social Analysis, and Exploitation: The objective of this phase is to integrate, in the proper way, the MobileMAN solution developed and analyse the impact of its usage at the users' side in terms of application novelty and effectiveness. This phase define also how the project partners will participate in the MobileMAN solution dissemination and exploitation.

The work described above will be conducted in four work-packages: a common baseline for the project activities (WP1), Domain Modelling (WP2), System Development (WP3) and Integration, Evaluation and Social Analysis (WP4). On top of them, we introduce a work-package for the project management (WP0). An additional work-package will deal will all aspects of exploitations

and dissemination (WP5). Figure 2 shows the correspondence among project phases and work-packages, which are presented thereafter.

WORKPAKAGE LIST

WP N.	WP Title	WP Leader	Person Months	Start Month	End Month	Phase	Deliverable N.
WP0	Project Management	CNR	17	1	36		1
WP1	Baseline	CNR	23	1	36	1	2,3,4, 9,20
WP2	Domain Modelling	EURECOM	59	2	30	2	5, 7, 10, 13
WP3	System development	SUPSI-DIE	106	6	32	3	6, 11, 12,14
WP4	Integration, Evaluation and Social Analysis	CNR	85.4	16	35	3	8,16,17
WP5	Dissemination, and Exploitation	UCAM-CLAB	27.3	12	36	4	15, 18, 19
	TOTAL		**317.7**				

Note: The difference between the Person Months (PMs) in the Technical Annex (317.7 PMs) and in the Contract Preparation Forms (300 PM) is due to the permanent staff of AC partners (UCAM-CLAB: 4.3 PMs; HUT: 6 PMs; SUPSI: 7.4 PMs).

9.4 Workpackage Description

WP0 - Project Management

The way the work-plan will lead the project participants to achieve the project objectives will be implemented in the Project Management work-package and it will be mainly focused on:

- identifying self-standing activities to be performed, expected outputs, relationships with others' activities;
- defining the task responsible and the partners involved for each of the identified activities, with the goal of giving responsibility to the most competent and interested partner. This should increase the deliverable quality and the timeliness of the deliveries;
- giving complete ownership to those responsible, regarding the performances to be achieved;
- verifying and validating performances. This important control tool will be used at two levels: the person in charge of each task will be responsible for close control of the activities performed in each work-package; the prime contractor will be in charge of the overall project control. Overall project control will be assured by using the measures associated with each project objective, together with the normal project tracking and overseeing measures.

Project documentation will be in English, using MS Word and MS Excel for financial tables, etc… Documents will be identified with project acronym, contract number, date, unique document name and number. A change control system will be defined for those project deliverables considered as key deliverables for the project. A strong focus on communication between the project partners and on the exploitation of the results obtained are two underpinning principles that span the entire project. For this reason the normal communication channels (meetings, e-mails, etc) will be supported by the creation of a project web-site. The person in charge of each work-package is responsible for deciding the best way of creating real teamwork, and optimising and sharing

results. The overall responsibility for producing deliverables as contracted, rests with the project co-ordinator. Work package leaders are responsible in providing and evaluating the technical content of the documents related to their work package. The work package leader decides who will produce the deliverables of the work package, depending on the nature of it.

WP1 - Baseline

The project co-ordinator will be the WP leader (CO1). This work-package is responsible for establishing a common baseline for the project activities to be accomplished during its lifetime, ensuring that all consortium partners have a clear understanding and agree with respect to project goals, planning, success criteria and results exploitation policy. The WP will also define the methods and tools used in the project (code, ideas, HW and SW platforms, trials activities planning, etc…), providing to the rest of the project a common working base. This is of high importance in a project as MobileMAN where high innovation components and external components will be integrated together in the fully functional MobileMAN prototype.

Special attention will be put in the hardware and software solution development process in order to ensure that the solution developed is the optimum for satisfying users needs.

This WP will define the **success criteria** that will be adopted through the project **for the self-assessment of the project success**. These criteria will be applied at the end of each year of the project to evaluate the evolution of the project and its alignment to the final goals. To this end, a **self-assessment procedure** is implemented in the task T1.5 of this work-package. Specifically, this task takes as inputs the results produced during the simulation, development, integration and the operation of the MobileMAN solutions (as appropriate depending on the phase of the project), and --by a deep criticism and analysis of the evolution of the project based on the evaluation of the quality of what has been produced, and the comparison with the project goals -- will evaluate the achievements of the project goals and control the next step of the project. The follow up of this task is the activation (if required) of specific tasks in WP2, WP3 and WP4 (i.e., T2.9, T3.6 and T4.6, respectively) to correct the defects found, and to mitigate the emerging project risks. Specifically, to reduce the project risks we will follow a cycle based on incremental model/prototype, testing, validation, and self-assessment. In this way, we will quickly identify the changes in functionalities already existing (and their implementation), and/or new functionalities needed in the final solution.

WP2 - Domain Modelling

CR3 will lead this work-package. The goal of this work-package is to harmonise different elements that compose the MobileMAN domain: the technical elements, which converges into the MobileMAN architecture and protocols as in Figure 1, and the socio-cultural and economic elements, which are reflected by the different group of users. In this work-package we will perform the ***MobileMAN architecture definition*** with the communication flows among different activities and the integration of vertical issues. In addition, this worpackage will be responsible of the design the networking protocols required to implement the MobileMAN architecture (MAC protocol, location and forwarding protocols, security and co-operation). The developed technical solutions will be immediately validated (before they are implemented) by adopting simulative and analytic techniques (as appropriate).

The expected final result of this work-package will be a model of the domain that can be used for the implementation work-packages (WP3), as well as basis for the integration and evaluation (WP4).

As said before, the MobileMAN project will be based on feedbacks generated by performance evaluation (using simulative an analytical techniques, as appropriate), the prototyping process, and by users'testing. These feedbacks analyzed and elaborated by the self-assessment task (T1.5) will activate (when required) the task T2.9 *Domain model refinement and risk reduction*. The objective of task T2.9 is the refinement of the domain model to take into account the feedbacks and to mitigate the emerging risks. Once, T2.9 has completed its actions, it will activate (if not already

activated by T1.5) the task T3.6 and T4.6. In this way the effects of the domain model changes propagate to the system implementation, integration, and testing phases.

WP3 - System development

CR6 will be the work-package leader. This WP implements the innovative elements of the MobileMAN networking architecture (MAC, Routing and Location, Security, etc.). The work to be done regarding these components includes all the phases of the HW/SW development lifecycle, from requirements analysis to testing (verification testing).

This WP includes a task, T3.6 (*System development refinement and risk reduction*) that is activated (if required) after the self-assessment phase to refine the development solutions, and to manage the project risks related to complexity of the selected solutions. Task T3.6 can also be activated by the task T2.9 to take into account the changes in the domain modelling.

WP4 - Integration, Evaluation and Social Analysis

In the MobileMAN, people come together, and create the network, for some collaborative activity. The human interactions associated with the activity are key aspects in order to establish services and infrastructures [18]. The technical work relies on this concept. The reaction of the users to this new philosophy, which impacts the application level as well, is an important measurement tool for tuning and modifying the ad hoc networking paradigm. At the same time, this activity is essential for discovering the ad hoc networking potentiality in terms of users needs and requirements, as well as social and economic input. For that reason, the integration of the technical components and the evaluation of the MobileMAN paradigms in terms of users' satisfactions are strongly correlated. Therefore, once the full system is integrated, it is necessary to validate it in this perspective. The **socio-cultural and economic potential** of MobileMAN will be also investigated by means of empirical research with a relatively large population as to gain a broad perception of the system's potentials. Our aim is to assess how these diverse groups **incorporate MobileMAN into their everyday lives at work, home, university and play** and how it **influences the social relationships** associated to these various domains. Ultimately we intend to find out MobileMAN's **potentials and limits** in broadening people's network of social relationships.

MobileMAN is unique and important in proposing the eventual development of a fully functioning testbed in which non-expert participants can experience using mobile applications. There is risk due to the interdependency of so many new technical elements, ranging from media access to applications. Therefore it is essential to develop prototype and proof-of-concept implementations as early as possible in an incremental way. Build test environments (e.g. in fixed networks), which allow us to make progress on higher layer elements, even before lower layer elements are complete. We also note that the downside risk is limited. The main tasks to be performed in WP4 (integration and acceptance) will be addressed at **two incremental phases**. In this way, even if our efforts to create a fully functional MobileMAN are not all successful, with the incremental approach, many piecewise contributions will still prove very useful.

We will start from quasi-static configurations (users move slowly) on a relatively small campus-wide MobileMAN. Then we increase the users' speed, as well as the network size and density to study the relationship between these factors and network behaviour. In each phase we will perform integration and validation, that will be achieved when the system satisfies the user expectations. This will be done by monitoring the social construction and human behaviour of the users and the technical constraints and limitations of the system**.**

In this WP, we will also study (via simulation) the integration of MobileMAN networking components with other relevant elements as the connection to Internet, as well as congestion control and error recovery mechanisms to optimise the utilization of the resources.

This WP has potentially associated several risks. Risks are associated both to the integration, and to the testing phase with users. Integration risks are associated to the integration of components separately developed by the project partners. This type of risks will be controlled by

developing prototypes (even if, with a reduced set of functionalities) as early as possible. The testing, performed by the project partners, on these prototypes, will provide the input to the self-assessment procedure, and can lead either to a refinement of the MobileMAN model (T2.9), and/or to a re-design to some of its components (T3.6).

The users' testing phase is associated with disorder and testing problems (software alignment on a large number of machines, coordination of a large number of users, etc.) that are expected to increase exponentially with the number of users. To manage the risks associated to the user-testing phase, we implement in the WP 4 a specific task: T4.6 Risk reduction in the system testing and validation. This task will be activated all the times the users interact with the MobileMAN prototypes. This task can be also activated by the self-assessment procedure to redefine the approach and methods used to involve real users in the MobileMAN testing.

CO1 will be the work-package leader, ensuring that incremental model/prototype testing and validation, as well as regular customers participation allows the identification of changes in functionalities already existing and/or new functionalities needed in the final solution.

WP5 - Dissemination, and Exploitation

This work-package performs a dissemination of results and a preliminary analysis of possible business and technological opportunities derived from MobileMAN. The consortium approach is to make a socio-economic analysis, to use dissemination to create awareness around the solution provided by MobileMAN and to define and execute an exploitation plan. MobileMAN aims also to provide a demonstration that social approaches (self-organisation, co-operation) can be easily adapted and used in the technical field of communications. It will also be demonstrated that these mechanisms are facilitators for overcoming existing barriers as a result of different learning and/or geographical cultures. In the framework of this WP we will identify the project innovations for which a patent is worth.

CR2 will be the work-package leader and will have to ensure that project results are disseminated as broadly as possible and that the roles of the different project partners for the project solution exploitation are clearly defined.

9.4.1 WP0 – Project Management

WP Number:		**WP0**				
Start date or starting event:		**1**				
Participant number:	**CO1**	**CR2**	**CR3**	**CR4**	**CR5**	**CR6**
Person months:	**5**	**2**	**3**	**2**	**1**	**4**

Objectives: Guarantee: the successful completion of the project within agreed time, cost and quality, compliance with the EC standard and procedures for the project management and tracking, an effective communication channel among the consortium partners.

Description of work: This WP will coordinate the production of the five technical WPs (reports, prototype, etc.). The technical contents of these reports will be provided by the other workpackages. The main tasks to be performed in this work-package are:

T0.1 *Infrastructure Provision*: Establish a common baseline for: task and responsibility allocation; verification and validation plan; measurement plan; project web-site.

T0.2 *Administrative Issues Management*: Guarantee the on-time provision of the periodic management reports, payments, final cost statement and handling of the EC project reviews. Establish associate contracts with each project partner.

T0.3 *Tracking*: Take measures for project performance control and validation and verification of project results. Ensure that plans are fulfilled and take corrective actions if necessary.

T0.4 *Communication*: Use the project web-site as the repository for the project assets and as the mechanism for problem solving. Participate in the periodic steering board meetings and technical committee. **(input to D1)**

WP0 leader will be the project leader (CO1), being responsible of providing the entire infrastructure for administrative and communication needs and of managing the project.

Deliverables:

D1: Project web-site set up

In addition, this WP is responsible for the production of the yearly progress reports, final report, and Technology implementation plan.

Milestones and expected result:

Regular technical and management project meetings per year

9.4.2 WP1– Baseline

WP Number:		**WP1**				
Start date or starting event:		**1**				
Participant number:	**CO1**	**CR2**	**CR3**	**CR4**	**CR5**	**CR6**
Person months:	**6**	**3**	**4**	**3**	**2**	**5**

Objectives: Establish a common baseline for the project activities to be accomplished during its lifetime, ensuring that all consortium partners have a clear understanding and agree with respect to project goals, planning, success criteria and results exploitation policy.

Description of work: The main tasks to be performed in this work-package are:

T1.1-Goals Alignment and Agreement: Reach an agreement on project goals and ensure that goals assigned to the different consortium partners are aligned to project goals. Obtain commitment from all consortium partners**. (input to D2)**

T1.2-Project Plan and Measurement Plan Definition and Approval: Define detailed project's plan and get its approval from all project partners. Define the *baseline for assessing project success* in terms of project execution and final result effectiveness **(input to D2**).

T1.3-Methods and Tools: Define the external methods and tools (e.g. code, ideas, HW and SW platforms) that will be used for the MobileMAN architecture at the integration phase (WP5) in order to build up a fully functional prototype. **(input to D2**).

T1.4-Dissemination and Exploitation Rules Definition and Agreement: Define how project results could be disseminated and used, and, when there are potentialities, exploited and the way each consortium partner will participate in that. Get an agreement from all the partners on rules defined **(input to D3**).

T1.5- Self-assessment procedure and risks mitigation: This task will start at month 11 to monitor the project activities. It yearly implements the project self-assessment procedure: i) to verify the alignment with the project goals; ii) to control the quality of what is produced; and iii) to identify and manage the project risks. To this end it takes as inputs the results produced during the simulation, development, integration, and the operation of the MobileMAN solutions and compare them with the project success criteria. The outputs of the self-assessment procedure are the reports delivered at the month 12, 24 and 36 that contain a deep critical analysis of the project results compared with the expected one. Whenever the self-assessment procedure shows that the project deviates from the expected results, and to mitigate emerging risks, the output of this task is the activation of appropriate tasks in WP2 (T2.9), WP3 (T3.6) and WP4 (T4.6). **(input to D4, D9, D20)**

WP1 leader will the project leader (CO1) and will be responsible for providing to the rest of the partners a first draft of Project Plan and Measurement Plan for discussion and approval. A kick-off meeting will be held at project beginning to perform the core activities for this work-package. A wrap-up meeting will be held to confirm project objectives achievement and identify deviations and lessons learned.

Deliverables:

D2: Project Plan

D3: Dissemination and Use Plan

D4: Project intermediate evaluation report

D9: Project intermediate evaluation report

D20: Project final evaluation report

Milestones and expected result:

This WP will monitor the project by analysing the quality of the has been produced and the project alignment with the project goals.

M1 – Month 6: Analysis of the correct project start up and of partners' alignment for methods and tools. First meeting with the Industrial Advisory Board to present and discuss the project goals

M2 – Month 12: First year analysis of the project status

M3 – Month 24: Second year analysis of the project status

M4 – Month 36: Analysis of the project results

9.4.3 WP2 – Domain Modelling

WP Number:		**WP2**				
Start date or starting event:		**2**				
Participant number:	**CO1**	**CR2**	**CR3**	**CR4**	**CR5**	**CR6**
Person months:	**12**	**11**	**14**	**9**	**2**	**11**

Objectives: The aim of this WP is to define the MobileMAN architecture and protocols, in line with the needs virtual communities (VC). Applications relevant for our VC will be identified.

In addition, the WP will provide models and methods for investigating the socio and economic value of the ad hoc networking paradigm.

In order to evaluate the project successes and to the reduce the risks, after a first domain model definition, the WP's work will proceed with continuous feedback from users (WP4). Specifically, Self assessment phases will be performed at months 12 and 24 to compare and contrast the project results versus the project success criteria defined in WP1.

Description of work: This workpakage will provide the overall system model, and the methods for analysing the users acceptance.

The system model includes: the design and the simulative/analytic validation of the MobileMAN architecture, protocol and services. Specifically, at the MAC layer the main tasks to be performed in this work-package concern the definition of a bursty-responsive version of 802.11 for supporting the traffic of ad hoc networks (T2.3). At network layer, concern the definition of location and packet forwarding mechanisms and protocols based on self-operation and co-operation (T2.3 and T2.4). As key element of the innovation of this architecture, this WP deals also with security (T2.5) and P2P information delivery (T2.6). Power saving will be a key criteria in the design of network protocols.

Simulative/analytical techniques (as appropriate) will be used in tasks: T2.3- T2.6.

T2.1 New applications and services: Identify existing applications that can become a customer advantage, when run on top of MobileMAN, compared to traditional technologies. Define the services that we need to provide for efficiently supporting some applications. **(input to D5)**

T2.2 MobileMAN architecture definition: Definition of the complete architecture with the communication flows among different activities and the integration of vertical issues as energy awareness for identifying strategies, which work at several layers, both for power saving and to modify nodes' behaviour under low power conditions. **(input to D5)**

T2.3 Bursty-responsive MAC Specification of new MAC protocol supporting bursty communication. The aim will be the definition of a MAC protocol that mazimizes the channel capacity by minimizing (at the same time) the energy consumption. **(input to D5)**

T2.4 Definition of networking services: Define location and packet forwarding schemes that exploit innovative social characteristics of ad hoc networks as self-organisation and co-operation. Design of the protocols required for supporting the networking services. The design will be based on a trade-off between power consumption and throughput. **(input to D5)**

T2.5 Security and Co-operation Model and Mechanisms: Security analysis of a MobileMAN environment (including the robustness to malicious attacks). Solutions for providing authentication, privacy, and robustness. Define a mechanism that encourages users to behave as "good citizens". Definition of new threats based on the self-organisation paradigm: analysis of the effects of the security exposures in terms of network throughput, delay and power consumption. Simulative validation of the security mechanisms, and analysis of their performance on top of a basic routing protocol. **(input to D5)**

T2.6 P2P information delivery: This work will select some of the resilient mechanisms that have emerged in the p2p community (such as CAN, Chord, Pastry, and Mixnet, Publius Xenos, and Mojonation), and introduce location information and scope information so that content is initially placed and requests are routed to copies that have proximity on a number of QoS axes - these would be delay and potentially throughput and loss based, but could also include battery budget considerations for wireless users. **(input to D5)**

T2.7 Socio-economic modelling: Develop a methodology for evaluating social, anthropological and economic potential of MobileMAN. The communication paradigm is tested by means of enquiry on a relatively large population in order to have a broad perception of the system potentials. **(input to D7)**

T2.8 *Economic driven modelling*: investigate market based mechanisms for exploiting the self-organised paradigm. Specifically, we propose to investigate mechanisms by which the spectrum can be sold to given set of users based on ability to pay relative to a proposed set of usage policies and proposed network topologies **(input to D5, D10, D13)**

T2.9 *Domain model refinement and risk reduction*: This task will be activated, if required, by the self assessment procedure to mitigate the risks and to correct the defects in the system model emerging during the simulation, development, integration and the operation of the MobileMAN solutions. **(input to D10, D13)**

CR3. will be the WP leader.

Deliverables

D5: MobileMAN architecture, protocols and services preliminary report.

D7: Socio-economic research methodology.

D10: MobileMAN architecture, protocols and services intermediate report.

D13: Domain modelling final report.

Milestones and expected result

This WP provides the overall model of the MobileMAN. In addition it designs and evaluates all the MobileMAN protocols.

M5 Month 10: Preliminary definition of the MobileMAN architecture, protocols, and services to be used as input for WP 3

M6 Month 16: Preliminary definition of the overall MobileMAN domain model to be used as input for WP 3 and WP 4. Meeting with the Industrial Advisory Board to present and discuss the MobileMAN domain model.

M7 Month 28: Refinement of the MobileMAN domain model to be used as input for WP3 and the second phase of WP 4

9.4.4 WP3 – System Development

WP Number:		**WP3**				
Start date or starting event:			**6**			
Participant number:	**CO1**	**CR2**	**CR3**	**CR4**	**CR5**	**CR6**
Person months:	**24**	**10**	**17**	**14**	**4**	**37**

Objectives: The aim of this WP is to implement the MobileMAN innovative components at networking and service layer of the architecture as defined by WP2.

Description of work: The innovative elements of the networking architecture of MobileMAN consist of the MAC, Routing and Location components. At service level the main components is the security one. The work to be done regarding these components includes all the phases of the HW/SW development lifecycle, from requirements analysis to testing (verification testing).

T3.1 Bursty-responsive MAC Develop new MAC protocol and hardware supporting bursty communication. The hardware will be based, wherever possible, on a off-the-shelf 802.11 chipset whit ad-hoc programmed firmware. **(input to D12)**

T3.2 Implementation of Location Protocols: Develop new location and discovery protocols based on the nearness metric. Implementation of it for the Linux operating system. **(input to D6, D11, D14)**

T3.3 Routing and forwarding: Develop routing and forwarding protocols for the self-organised and co-operative communications of MobileMAN. Implementation of them for the Linux operating system, in co-operation with the task on security (T3.4). **(input to D6, D11, D14)**

T3.4 Security and Co-operation Model: Implementation of the collaborative reputation mechanism (CORE) proposed to solve ad hoc node misbehaviour. Implementation of the CORE mechanism for the Linux operating system, in co-operation with the task dedicated to the definition and implementation of the routing algorithm adopted by MobileMAN (T3.3). **(input to D11, D14)**

T3.5 P2P delivery mechanisms: Implementation of the P2P mechanisms designed in Task T2.6. **(input to D11, D14)**

T3.6 Risk reduction in the system development: This task will be activated, if required, by the self assessment procedure to tackle the risks emerging during the implementation of the system solutions. The objective of this task is the identification of alternative solutions for implementing the system solutions when adopted approaches are too complex and risky. **(input to D11, D12, D14**

CR6 will be WP·leader. CR6 will be responsible for optimising the necessary interchanges among the developers, minimising potential problems and guaranteeing appropriate communication flow.

Deliverables:

D6: Delivery of the software implementing a minimal set of location and forwarding functionalities

D11: Delivery of the software implementing an enhanced set of networking (self-organising forwarding, location protocols, security mechanisms), and middleware functionalities.

D12: Prototype of the network card

D14: Delivery of the software implementing all the MobileMAN networking and middleware functionalities.

Milestones and expected result

This WP provides the hardware/software implementations of all the MobileMAN components (MAC card, location/forwarding/routing protocols, security mechanisms, p2p middleware).

M8 – Month 16: Preliminary version of the basic set of MobileMAN functionalities. First Check on the status of the implementation of all MobileMAN components;

M9 – Month 28: Delivery of a preliminary version of all the components of a MobileMAN. Check on the status and quality of what has been produced.

9.4.5 WP4 – Integration, Evaluation and Social Analysis

WP Number:		**WP4**				
Start date or starting event:		**16**				
Participant number:	**CO1**	**CR2**	**CR3**	**CR4**	**CR5**	**CR6**
Person months:	**18**	**8**	**14**	**14**	**12**	**19.4**

Objectives: This WP will integrate the HW/SW developed into the final system; install the integrated architecture in each node, make the installed solution operational (with some "innovative" applications) for the selected virtual communities, and collect and analyse the impact in the different virtual communities. Qualitative study of the social and anthropological consequences of the utilization of the system. The collected information through the test with the selected VC allows a revision of the experimental methodology for evaluating the social, anthropological and economic potential of MobileMAN previously designed (WP2).

Description of work: Given the high challenges of this WP, the main tasks to be performed in it (integration and acceptance) will be addressed at two different area scales: campus-wide area scale (T4 .2 and T4 .3) and large area scale (T4 .4 and T4 .5).

T4 .1 Small Area Scale Integration: Integrate part of the HW/SW developed (reduced networking and services capabilities), and install it in each node in a small and test this system in order to identify HW or simple networking problems and integration errors. Fix problems/errors found verifying that the system operates correctly. **(input to D8)**

T4 .2 Small Area Scale Validation and Analysis: Validate the small scale MobileMAN from a technical (i.e., the technical constraints and limitations of the system), and social standpoint. The latter will be performed by measuring the acceptance -- from Virtual Communities (VCs) of users -- of the MobileMAN system when running some simple application(s). This will task will also monitor the social construction and human behaviour of the VCs. **(input to D8, D17)**

T4.3 Evaluation of MobileMAN Networking: Simulative study of the integration of MobileMAN Networking components with other relevant elements as the connection to Internet, as well as congestion control and error recovery mechanisms to optimise the utilization of the resources. **(input to D16)**

T4 .4 Final Integration and Testing: Integrate the HW/SW developed, and install it in each node in a metropolitan area (e.g. in a campus or in a town) and test this system in order to identify networking or services problems and integration errors. Fix problems/errors found verifying that the system operates correctly. **(input to D16)**

T4 .5 Large Area Scale Validation: Get acceptance from the VC of the MobileMAN system when running some advanced applications. This will be achieved when the system satisfies the user expectations. Monitoring of the social construction and human behaviour of the VC and of the technical constraints and limitations of the system. Analysis of the innovation of the MobileMAN environment in terms of applications. **(input to D17)**

T4.6 Risk reduction in the system testing: This task is aimed to manage problems and risks that may occur when interacting with large users communities. This task can be activated (if required) by the self-assessment task (T1.5) to redefine the approach and methods for controlling the users testing phases. In addition this task is automatically activated all the times users are involved in testing the MobileMAN solutions. **(input to D16)**

CO1 will be the WP leader and ensuring that incremental model/prototype testing and validation, as well as regular customers participation allows the identification of changes in functionalities already existing and/or new functionalities needed in the final solution.

Deliverables

D8: MobileMAN first phase

D16: MobileMAN technical evaluation.

D17: Socio-economic evaluation report

Milestones and expected result

M10 – Month 20: Preliminary version of a small scale MobileMAN

M11 – Month 30: Preliminary version of a large scale MobileMAN

9.4.6 WP5 Dissemination and Exploitation

WP Number:		**WP5**				
Start date or starting event:		**12**				
Participant number:	**CO1**	**CR2**	**CR3**	**CR4**	**CR5**	**CR6**
Person months:	**4**	**6.3**	**4**	**4**	**3**	**6**

Objectives: Analyse the market for the MobileMAN solution, define the exploitation plan and disseminate the project results in different forums.

Description of work: The main activities to be performed in this task are:

T5.1 Dissemination: Promote project results at the widest possible basis. This will include collaboration with Network of Excellence and/or Take-up action in program, written and electronic publications and presentation of the project results in events. Participation to standardisation bodies such as ITU, IETF, IEEE, and others. In addition, this task will focus to: promote MobileMAN results to potential virtual communities of users such as socially disadvantaged users; **(input to D15)**

T5.2 Exploitation Plan Definition: Prepare the exploitation plan, which includes intellectual property rights and data privacy and security issues. Define a contract for the solution exploitation among consortium members. **(input to D19)**

T5.3 Market Access: Based on the results of testing applications, study the market possibilities for a solution like MobileMAN (or part of it) in order to i) define how ad hoc based services can be sold to given sets of users; ii) identify classes of applications that will be revolutionary with this technology; and iii) analyse and define how the MobileMAN technology could be used for start-ups, promoting European economy and market. **(input to D18)**

CR2 will be the WP leader and will have to ensure that project results are disseminated as broadly as possible and that the roles of the different project partners for the project solution exploitation are clearly defined.

Deliverables

D15: Workshop for the MobileMAN Presentation

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

D19: Exploitation plan

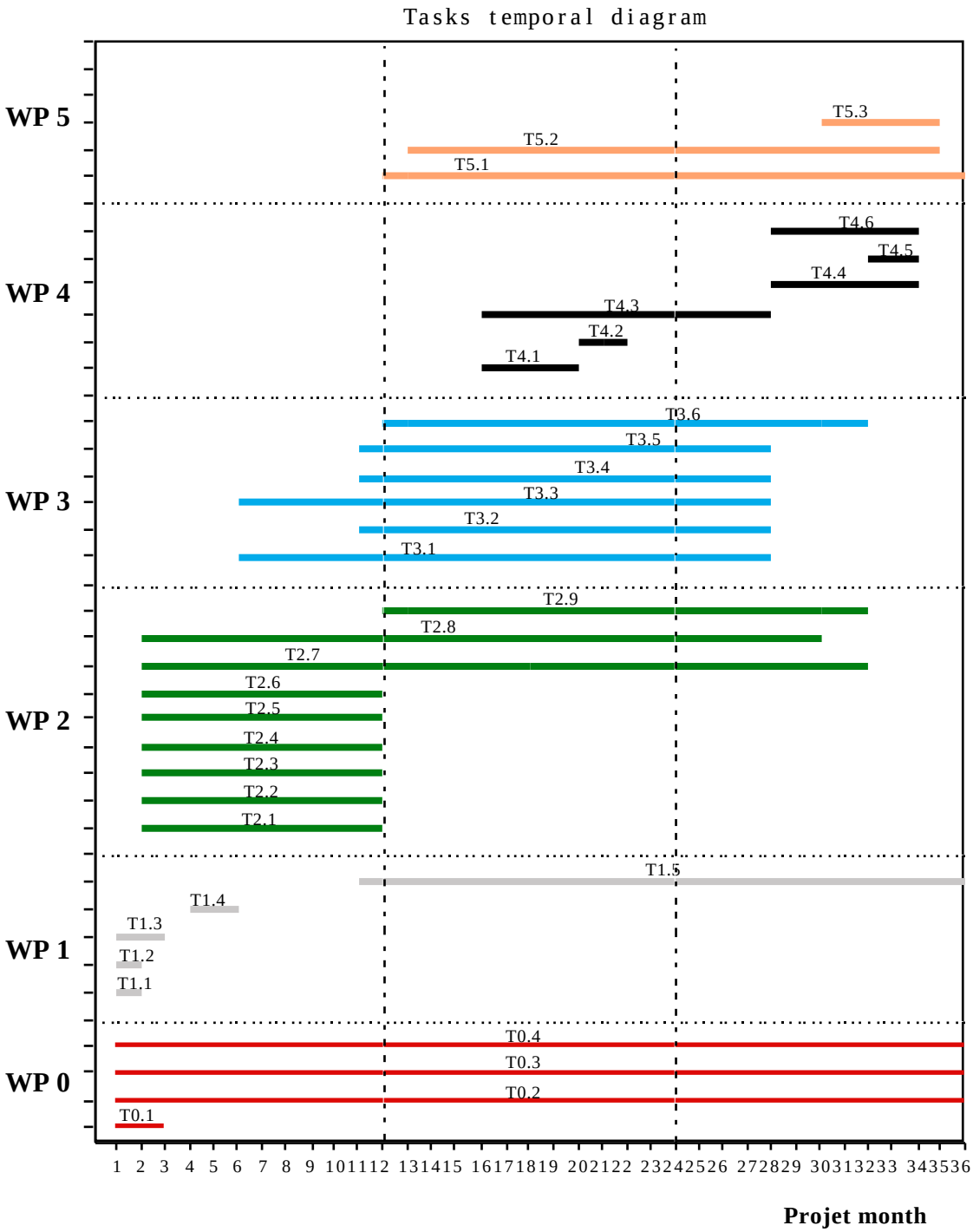
Milestones and expected result

M12 – Month 24: Analysis of the MobileMAN dissemination activities

M13 – Month 30: Meeting with the IAB to evaluate the MobileMAN economic value

9.5 Tasks temporal diagram

The following diagram presents a graphical description of the start/stop time of each task. Tasks are grouped per WP.



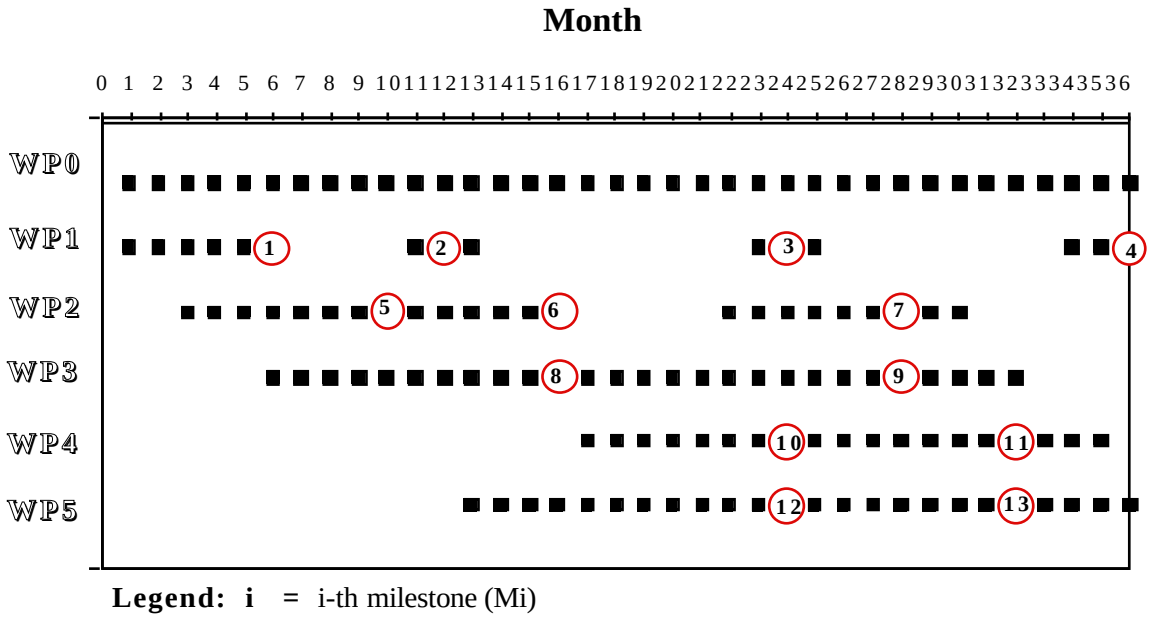
9.6 Deliverables List

Deliverables list

Del. no.	Deliverable name	WP no.	Lead participant	Estimated person-months	Del. type*	Security **	Delivery (proj. month)
D1	Project web-site set up	0	CNR	2	Prototype	Pub.	3
D2	Project Plans	1	CNR	3	Report	Pub.	3
D3	Dissemination and Use Plan	1	CNR	2	Report	Pub.	6
D4	MobileMAN intermediate evaluation report	1	SUPSI-DIE	5	Report	Pub	12
D5	MobileMAN architecture, protocols, and services first report	2	EURECOM	32	Report	Pub	12
D6	MobileMAN functionalities – a minimal set	3	CNR	18	Prototype	Pub	13
D7	Socio-economic research methodology	2	SUPSI-DLS	9	Report	Pub	18
D8	MobileMAN first phase	4	CNR	25	Report	Pub.	22
D9	MobileMAN intermediate evaluation report	1	SUPSI-DIE	6	Report	Pub	24
D10	MobileMAN architecture, protocols, and services intermediate report	2	EURECOM	8	Report	Pub	24
D11	MobileMAN functionalities – enhanced set	3	HUT	40	Prototype	Pub	25
D12	MobileMAN network card	3	SUPSI-DIE	34	Prototype	Pub.	28
D13	MobileMAN domain modelling	2	EURECOM	10	Report	Pub.	30
D14	MobileMAN functionalities – final set	3	HUT	14	Prototype	Pub.	32
D15	MobileMAN Presentation	5	UCAM-CLAB	8	Workshop	Pub.	32
D16	MobileMAN technical evaluation	4	EURECOM	49	Report	Pub.	34
D17	Socio-economic evaluation	4	SUPSI-DLS	11.4	Report	Pub.	34
D18	Economic value of self-organisation paradigm and market access	5	UCAM-CLAB	14	Report	Pub.	35
D19	Exploitation Plan	5	NETikos	5.3	Report	Pub.	35
D20	Project final Report	1	CNR	7	Report	Pub.	36

9.7 Project planning and time table

The project lasts for 36 months, with an estimated overall effort of 317.7 person months. Given the high degree of structured and complex tasks involved in the project, the aforementioned strategy of dependency and inter-relationship between/among tasks, and the number of partners, a number of activities will have to be carried out in parallel. This is shown in the following chart (Figure 3).



Legend: i = i-th milestone (Mi)

FIGURE 3: PROJECT GANTT CHART

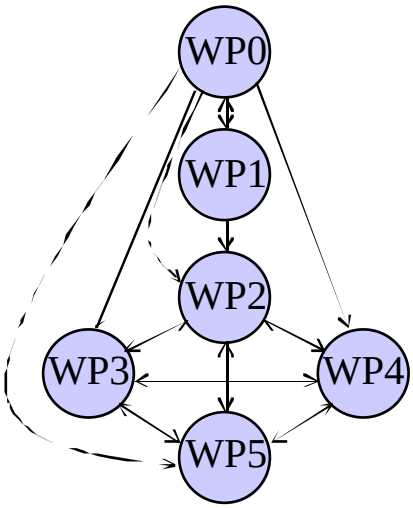


FIGURE 4: PROJECT PERT CHART

9.8 Graphical representation of project's components

As explained before, the MobileMAN development will be based on feedbacks generated by performance evaluation (using simulative an analytical techniques, as appropriate), the prototyping process and by users'testing. Model and prototypes versions are validated and tested with users (WP4), and the result of the validation/trial is used for modifying either the model (WP2) or the implementation (WP3), or both. Hence, the life-cycle of the MobileMAN development is based on a continuous feedbacks among WPs. The Figure 4 represents how the project work-packages are related.

9.7 Project Management

On the basis of the experience gained by the partners in previous multi-cultural and multi-national projects, the management structure proposed in MobileMAN, is based on the roles/mechanisms explained below. Moreover, all the project management activities will be supported by e-facilities to minimise travel necessities and to speed the decision taking process.

Project Manager (PM): provided by CNR. It is responsible for: leadership of the whole project and of the Steering Board; technical development; organisation of Steering Boards meetings; liaison between the Consortium and EC for any contractual issue.

WP Leaders (WPL): they will be responsible for: technical co-ordination and supervision of the work related to their assigned Work Packages; checking of the results of the work carried out in each WP and identification of possible problems; the preparation of the planned deliverables on time and with the agreed level of quality.

Steering Board (SB): chaired by the Project Manager; it includes a representation of each project partners at management level; it doesn't include any subcontractor. The SB will meet in a pre-scheduled way (according to the project plan) and whenever necessary during the process life cycle (the first steering board meeting will be the kick-off meeting of the project and the last will be the Project wrap-up meeting). The SB will be responsible for: decisions on project, dissemination-exploitation strategies (see Advisory Board below), to guarantee their mutual consistency; monitoring of the project progress, achievements and costs; problem solving and conflict resolution if this has some impact on project strategies, resources and achievements.

Industrial Advisory Board (IAB): The project will form an Industrial Advisory Board, whose membership will represent a cross-section of technology and service providers; regular meetings with the Board will help the SB in revising, where necessary, the objectives of the project, defining the dissemination plans and the market access. IAB will meet with SB at least once per year.

Technical Committee (TC): this committee includes a representative of each project partner at technical level and the PM. Its responsibilities are mainly related to the software development and integration aspects, how these could affect the project schedule and the users software platforms. It will meet once during the kick-off meeting, at least twice during the software development activities and once during the integration phase.

e-Facilities: this support infrastructure will be set-up by PM and will consist of at least: project web-site, instant message e-mails, white board and ad hoc discussion forums. They will be the facilitator mechanism for: fostering communications among the project partners and between the Consortium and the Project Officer; minimising travel necessities, speeding the decision taking process. Responsibility for creating and maintaining this mechanism falls to the Project Manager. A moderated (by the prime contractor) forum will put in place, to foster the problem resolution process and to facilitate the administrative work.

According to the above identified roles and mechanisms, the project management main flow is shown in Figure 5:

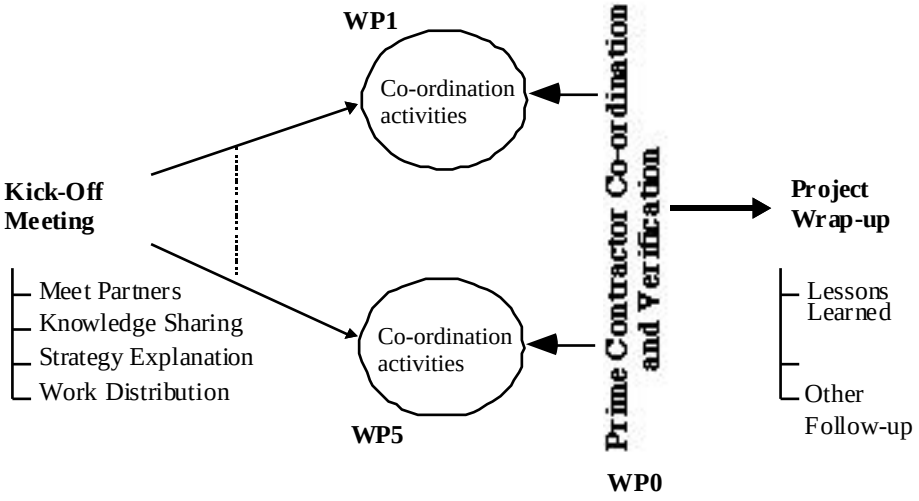


FIGURE 5

Decision Making structure: The project will apply in SB, AB and TC the same conflict resolution process. It will be handled and solved mainly by achieving a consensus; if this is not possible, a majority vote will be used (each partner holds one vote and if necessary, the Project Manager will count as a decisive vote). In case of persistent dispute among project partners, the Project Officer will be informed.

Communication Flow: this will be implemented at two levels:

- At WP level: the responsibility falls to the WP Leaders; they should guarantee the appropriate communication flow among the partners involved in the task and among the Leaders of those tasks directly related to it (see Pert diagram in Figure 4), in order to guarantee the fulfilment of the task goals

- At Project level: the responsibility falls to the Project Manager, using the mechanisms described before and mainly: the Steering Board, the Technical Committee and the e-Facilities but also any other mechanism considered appropriate, in order to fulfil the project goals.

Quality Assurance and Risk Management: The quality of project results will be established according to the following criteria:

- Contribution to the project objectives

- Usability and usefulness of the software solution for the end-users

- Correspondence of solution with end-user expectations

- Correspondence with the plans (time and constraints)

Each task leader is responsible for assuring the quality of the task deliverables and for performing the most appropriate quality assurance activities in order to contribute to the fulfilment of the overall project objectives. Further, the Project Manager is responsible for assuring the quality of the overall project results and the project goals, by collecting and managing the measures of success and of quality, whose indicators will be defined in the project plan (WP1).

10 CLUSTERING

No cluster activities are foreseen.

11 OTHER CONTRACTUAL CONDITIONS

Dissemination issues

The following is a list of some of the main conferences and workshops that will be relevant to the MobileMAN topic and where the MobileMAN partners intend to be present with articles for disseminating their results:

ACM International Conference on Mobile Computing and Networking (Mobicom); ACM MobiHoc; ACM Workshop on Wireless Mobile Multimedia (WoWMoM); IEEE INFOCOM, IEEE Globecom, IEEE International Conference on Communications ICC; IEEE International Symposium on Personal, Indoor and Mobile Radio Communications PIMRC; IETF meeting; IFIP-TC6 Networking, IPIF WG 6.8 PWC.

Most of these conferences occur outside the Europe. We estimate that each partner should participate to 2-3 conferences per year to disseminate the project results.

CNR durable equipment

The workstation requested by CNR will be used i) to implement the project web site; ii) to store all the project administrative and technical documentation; iii) to run the simulative models.

The three laptops will be used in the technical development of the MobileMAN solution. For this work, hardware mobility is a must, and the laptops provide several functionalities that are not directly available (or are difficult to implement) on PDAs:

- Tools, e.g., DBMS, for monitoring the performance figures (throughput, packet losses and delays) of the MobileMAN;
- "easy" to manage double-network-card (IEEE 802.11 and GPRS) terminals.

In addition, by removing several constraints of the PDAs development environment, the laptops provide the environment for the quick development and testing of MobileMAN solutions. Only after this preliminary testing, the solution will be implemented on PDAs. PDAs will be the final environment for developing and testing the MobileMAN solutions.

CNR rental costs

CNR requests a 25000 EURO in the third year of the project for renting the equipment necessary for the large-scale MobileMAN validation (see *T4 .5 Large Area Scale Validation*). This validation will be performed by exploiting the Virtual Community (VC) of the Pisa University students (see also subcontractors). To be effective this validation will involve 70-100 students that will move around the university campus with PDAs that implement the MobileMAN solution. The requested budget is therefore necessary to rent the required PDAs with wireless interface to be adopted during the MobileMAN campus-wide validation.

UCAM-CLAB consumable costs

UCAM-CLAB requests 700 EURO per year to cover the expenses related to GPRS communications. GPRS will be used to buy pre-paid GPRS SIMs to be used in the MobileMAN experiments in which terminals with two wireless cards (WLAN and GPRS-based WAN) are used.

subcontractors

Subcontractor of CNR will be The "Dipartimento di Ingegneria dell'Informazione" (DII) of the University of Pisa. The project will benefit from researchers of the Information Engineering group leaded by Prof. **Giuseppe Anastasi,** which is an Associatate Professor of Computer Engineering. This group will highly contribute to the Large Scale MobileMAN testing. Specifically, the DII group will contribute to set up the VC of the university students, and to monitor this phase of the MobileMAN validation.

12 APPENDIX A

A.1. CONSORTIUM DESCRIPTION

According to the project challenges and objectives, we have established a project consortium of six partners. The consortium's roles discussed in this section have been identified as mandatory for fulfilling the project goals.

The project will be co-ordinated by the Computer Networks Department of the Istituto di Informatica e Telematica (IIT). IIT is an Institute of the Italian National Research Council –CNR, Italy (**CNR**). The other partners of the consortium are:

CR2- the Computer Laboratory at University of Cambridge, England (**UCAM-CLAB**),

CR3 the Institut Eurécom, France (**Eurecom**),

CR4 the Networking Laboratory At Helsinki University Of Technology, Finland (**HUT**),

CR5 Netikos SPA, Italy-Finland (**Netikos**),

CR6 Scuola Universitaria Professionale della Svizzera Italiana, Switzerland (**SUPSI**). SUPSI participates with two departments: the Department of Computer Science and Electronics (**SUPSI-DIE**), and the Department of Social Work (**SUPSI-DLS**).

The partners of this consortium provide a complementary and consolidated expertise that is required for meeting the project objectives. As detailed in the part B, the **objectives** of this project are twofold: **technical solutions** and **business and social impact.** To achieve them we have identified a set of activities (innovative solutions) that must be performed.

Hereafter, for each partner, taking into consideration his expertise, we define the activities of the project where it will mainly contribute. However, since all the partners of the consortium have a consolidated expertise in networking and distributed systems, we can expect that the partners will be able to provide contributions also to the other parts of the project, particularly to the two global issues (energy management and co-operation model).

The project is unique in proposing **fully functional prototype**. In order to achieve this, **new access technologies** for a MobileMAN need to be defined using methodologies designed and validated for stabilising the behaviour of random access protocols under a large population of users **(CNR)**. Then these technologies need to be **developed and implemented** in hardware and low-level software (**SUPSI-DIE**). The networking paradigm is totally modified with respect to the legacy Internet: nodes collaboration and social oriented approaches, as well as the introduction of the nodes position, are fundamental for the design and development of new schemes for **routing, addressing and location** in MobileMAN (**CNR, HUT**). Key elements of the service infrastructure needed to support MobileMAN applications include: security and service location, discovery and management. Security requirements must then be taken into account at the very early stages of the design for network mechanisms, in order to develop new **security schemes**. The deployment of a generic collaborative security scheme based on reputation is necessary in order to prevent malicious behaviour by gradually isolating misbehaving ad hoc network components (**Eurecom)**. This allows running applications with a certain degree of security, despite the unregulated mobile environment. Moreover, the design and evaluation of **location-aware service discovery** functions will be used for supporting location-aware GPS-based applications for mobile users (**HUT**). Significant contribution to the MobileMAN system is expected also from **peer-to-peer information delivery** mechanisms (**UCAM-CLAB**): peer to peer systems are quite an old idea (IP routing is a peer to peer system, and is over 20 years old). However, through the ubiquity and connectivity of the Internet, the end user has taken control of her fate, and this has made these systems a highly attractive way to build dis-intermediate content services.

All partners will collaborate to integrate the fully functional platform following a development life-cycle based on prototyping. Incremental model/prototype testing and validation, as well as regular customers participation will allow the identification of changes in functionalities already existing and/or new functionalities needed in the final solution. The **Netikos** group, which has consolidated expertise in the mobile applications market, will provide and integrate potentially valid and promising applications for studying the effectiveness and the benefits of the self-organisation paradigm for the users, as well as for exploiting the service market for ad hoc networking.

The MobileMAN testbed will be mainly used for testing the self-organisation paradigm with the virtual communities of university students (VC1) and disadvantaged people (VC2). They will represent examples of **large communities** that will make possible to find out **MobileMAN's potentials and limits** in broadening people's network of social relationships. This phase will be co-ordinated by **SUPSI-DLS**, which has consolidated expertise in **social science**.

Finally, we will exploit the economic aspects of MobileMAN by investigating a **market-based mechanism** by which spectrum can be sold to given sets of users, based on ability to pay relative to a proposed set of usage policies and proposed network topologies (**UCAM-CLAB**).

A.2. DESCRIPTION OF PARTICIPANTS

A.2.1. Consiglio Nazionale delle Ricerche (CNR)

The Italian National Research Council will participate to the project with the *Computer Networks Group* (*CNG*). This group started in the 1970 with the design and implementation of the first Italian packet switching network (RPCNET). In the 1980 it was responsible for designing the first European packet satellite network, named STELLA (Satellite Transmission Experiment Linking Laboratories). CNG also significantly contributed to the definition of the OSI standards and to the interoperability project of the OSI product released by several computer manufacturers (OSIRIDE Intertest project). Since the mid 1980s up to mid 1990s CNG has been working in the field of broadband packet switching networks by focusing on design analysis and performance evaluation of architecture and protocols for high speed. This activity was carried out mainly within the framework of *Progetto Finalizzato Telecomunicazioni* (a national five years project) and within the RACE – ESP project. In the framework of these activities, CNG was one of the promoters (1989-1993) of the broadband network of Tuscany (Tuscany MobileMAN). From 1993 to 1998, CNG was also involved in several national and international projects aimed to support real-time multimedia applications on packet switching networks.

Since 1999, the *Computer Networks* group is involved in a three-year national project ”Mobile Systems Evolution towards UMTS” focusing on the use of the UMTS technology for a high-speed wireless access to Internet. Currently, the group is also involved in the trilateral (Australia-Italy-USA) project “QoS Provisioning in Mobile Computing Environments” funded by the Australian Research Council, and in the NATO Collaborative Linkage Grant project “Wireless Access to Internet exploiting the IEEE 802.11 technology“.

CNG has received a grant from the European Science Foundation (ESF) to organise an Exploratory Workshop “Is Mobile Ad Hoc Networking Part of The Future of Mobile Networking in Europe?” (La Spezia Italy, September 2002).

CNG staff includes beyond five permanent CNR researchers, several M.Sc. and Ph.D. students and a number of researcher assistants all in the fields of computer and telecommunications networks. CNG’s research is reflected in numerous publications in archival journals and conference proceedings. Some of these publications, relevant for the scope of the project, are listed below. The CNG researchers regularly participate to the Technical Program Committee of International conferences on wireless and mobile communications such as: IEEE INFOCOM, IFIP Networking, ACM WoWMoM, ACM MobiHoc, European Wireless, etc.

Recent Publications Relevant for the project

F. Calì, M. Conti, E. Gregori, “Dynamic IEEE 802.11: design, modeling and performance evaluation”, *IEEE Journal on Selected Areas in Communications*, 18(9), September 2000. pp. 1774-1786.

F. Calì, M. Conti, E. Gregori, “Dynamic Tuning of the IEEE 802.11 Protocol to Achieve a Theoretical Throughput Limit”, *IEEE/ACM Transactions on Networking*, Volume 8, No. 6 (Dec. 2000), pp. 785 - 799.

L. Bononi, M. Conti, L. Donatiello, “A Distributed Mechanism for Power Saving in IEEE 802.11 Wireless LANs” *ACM/Baltzer Mobile Networks and Applications Journal*, Vol 6. N.3 (2001) pp. 211-222.

R. Bruno, M. Conti, E. Gregori, “WLAN technologies for ad hoc networks”, Proc. HICSS-34 Maui, Hawaii, January 3-7, 2001.

R. Bruno, M. Conti, E. Gregori, “A Simple Protocol for the Dynamic tuning of the backoff mechanism in IEEE 802.networks”, Computer Networks, Vol 37 Iss 1. pp 33-44

R. Bruno, M. Conti, E. Gregori, “Traffic integration in personal, local and geographical wireless networks”, Chapter 7 of *Handbook of Wireless Networks and Mobile Computing* (I. Stojmenovic Editor), John Wiley & Sons, New York, 2002.

R. Bruno, M. Conti, E. Gregori, "Bluetooth: architecture, protocols and scheduling algorithms", *Cluster Computing Journal, Special issue on Mobile Ad-hoc Networking (to appear)*.

L. Blazevic, L. Buttyan, S. Capkun, S. Giordano, J-P. Hubaux, J-Y. Le Boudec, "Self-Organization in Mobile Ad-Hoc Networks: the approach of Terminodes", *IEEE Communication Magazine*, June 2001

L. Blazevic, , S. Giordano, J-Y. Le Boudec, "Self-Organized Terminodes Routing", *to appear in Cluster Computing – Kluver*, 2001

S. Giordano, "Mobile Ad-Hoc Networks", book chapter on "Handbook of Wireless Networks and Mobile Computing", John Wiley & Sons

L. Blazevic, S. Giordano, J-Y. Le Boudec, "Self-Organized Routing in large networks", *to appear in proceedings of Globecom2001*

S. Giordano, "Some Aspect of Mobile Ad-hoc Networks:Terminodes Networks", *proceedings of Netties2001*, Friburg , 2001

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Curriculum vitae of key persons

Marco Conti received the Laurea degree in Computer Science from the University of Pisa, Italy, in 1987. He is a senior researcher of the Italian National Research Council (CNR). He has written over 90 research papers on computer-network architectures and protocols, and has participated and coordinated national and international projects on the same topics. He is coordinating the NATO CLG project "Wireless Access to Internet exploiting the IEEE 802.11 technology". He is the Technical program chair of Networking 2002, the IFIP TC6 networking conference. He is co-author of the book "Metropolitan Area Networks" (Springer, London 1997). He was the coordinator of two minitracks ("Mobile ad-hoc networking" and "QoS in Web Services") at the HICSS-34 conference. He is serving as a co-guest editor for journals special issue: *IEEE Transactions on Computers* ("Quality of Service issues in Internet Web Services"), *ACM Mobile Networks & Applications* ("Mobile Ad hoc Networks") and *Cluster Computing* ("Mobile Ad hoc Networking"). He is member of IEEE and IFIP WG 6.3 and WG 6.8.

Enrico Gregori received the Laurea in electronic engineering from the University of Pisa in 1980. He joined CNUCE, an institute of the Italian National Research Council (CNR) in 1981. He is currently a CNR research director. In 1986 he held a visiting position in the IBM research center in Zurich working on network software engineering and on heterogeneous networking. He has contributed to several national and international projects on computer networking. He has authored a large number of papers in the area of computer networks and has published in international journals and conference proceedings. His current research interests include: Wireless access to Internet, Wireless LANs, Quality of service in packet-switching networks, Energy saving protocols, Evolution of TCP/IP protocols. He is on the editorial board of the *Cluster Computing* Journal. He is member of the IEEE.

Silvia Giordano received her Ph.D. early 1999 from EPFL, Lausanne. She is currently working as senior researcher at the ICA institute at EPFL, and, since October 2001, as scientific collaborator at CNUCE, Pisa. She has written more than 30 research articles in the areas of quality of services, traffic control, and mobile ad-hoc networks. She participated to several European ACTS/IST projects and was one of the main contributors to the NIG-G3, NIG-G9 and NIG-G12 Chains. Since 1999 she is Editor of IEEE Communication Magazine. She was already co-editor of some Special issues of IEEE Communication Magazine, and Baltzer MONET and Cluster Networks on "Mobile ad-hoc networking" and "QoS networking". She was in the executive committee and in the TCP of several international conferences, and has served as reviewer on Transaction journals, as well as for several important conferences. She is member of IEEE and IFIP WG 6.8. Her current research interests include traffic control and mobile ad-hoc networks.

A.2.2. University of Cambridge -Computer Laboratory (UCAM-CLAB)

Systems Research Group is the largest research area in the Computer Laboratory covering hardware, communications hardware and software, operating systems and distributed systems. Past systems developed here include Edsac, the Titan operating system, the Cambridge Ring and the Cambridge Distributed Computing System. The Systems Research Group (SRG) has some 40 members, and is divided into a number of subgroups: the Opera group, the Networks and Operating Systems group, and the Self-Timed Logic group. The first two are most relevant here. The thrust of the Opera Group is open distributed processing with an object orientated approach. We look to support emerging distributed applications in which users and devices may be mobile and may have multimedia presentation requirements. Current themes are asynchronous (event) extensions to synchronous middleware and an access control architecture, Oasis. Networks and Operating Systems group's relevant sub-projects involve Disk QoS Enforcing Quality of Service in Storage Systems, Efficient Network Routeing, Next Generation Inter-AS Routeing, Xenoservers - Accountable Execution Of Untrusted Program.

Recent Publications Relevant for the project

Bhrat Patel and Jon Crowcroft, Ticket Based Service Access for the Mobile User, ACM Mobicom 97, Budapest, 1997.

L. Vicisano, L. Rizzo and J. Crowcroft, TCP-Like Congestion Control for Layered Multicast Data Transfer, in Proceedings of the Conference on Computer Communications (IEEE Infocom), (San Francisco, California), March/April 1998.

J.Crowcroft, I.Kouvelas, V.Hardman ,Self Organising Transcoders, NOSSDAV, 1998.

Philippe Oechslin, J Crowcroft, Weighted Proportional Fairness and Pricing for TCP ACM CCR, Volume 28, Number 3 (July 1998).

J. Crowcroft, Herding Cats - Modelling the Internet, Royal Society, Philosophical Transactions, 1999.

Colin Perkins and Jon Crowcroft, Effects of Interleaving on RTP Header Compression, in Proceedings of the Conference on Computer Communications (IEEE Infocom), (Tel Aviv, Israel), Mar. 2000.

Brian Neil Levine, Jon Crowcroft, Christophe Diot, J. J. Garcia-Luna-Aceves and James F. Kurose, Consideration of Receiver Interest for IP Multicast Delivery, in Proc. of the Conference on Computer Communications (IEEE Infocom), (Tel Aviv, Israel), Mar. 2000.

Ghosh, Fry & Crowcroft, An Architecture for Application Layer Routing, in Yasuda, H. (Ed), Active Networks, LNCS 1942, Springer, pp 71-86. ISBN 3-540-41179-8 Springer-Verlag.

Curriculum vitae of key persons

Jon Crowcroft is just moving from being a professor of networked systems in the Department of Computer Science University College London, to being the Marconi Professor of Communications Systems at the Computer Lab, Cambridge University. Jon's recent/current projects at UCL include the BT funded active networks project ALPINE, and the Learnet Infrastructure as well as helping the funded Internet 2 projects on ipv6 the bermuda triangle, a DARPA funded project on radio-active networks, the EU FV Traffic Engineering for the Internet (Tequila), FV Federated Organisations Management (Form). Sprint, Nortel (UK and Canada) fund some Internet Telephony and IETF activities. Jon is a member of the ACM, a member the British Computer Society, a fellow of the IEE and the royal academy of engineering and a Senior Member the IEEE. He is also on the editorial team for Computer Networks, IEEE/ACM Transactions on Networking, IEEE Networks, Monet , and Cluster Computing. Jon is on the Internet Architecture Board.

A.2.3. Institut Eurécom (Eurécom)

Institut Eurécom was founded in1991 by EPFL and the Ecole Nationale Supérieure des Télécommunications (ENST) in Paris. Located on the Technopole of Sophia Antipolis in the South of France, Eurécom is a GIE (Groupement d'Intérêt Economique), a consortium under French Law. Its members currently include, in addition to EPFL and ENST, Swisscom, Ascom AG, Thalès, CEGETEL, MOTOROLA Inc., France Telecom, HITACHI Europe and Texas Instruments, ST Microelectronics, Bouygues Telecom, and two additional academic partners, Politecnico di Torino and Helsinki University of Technology.

Eurécom is a graduate-level research school that offers a 3-semester program in the area of Communication Systems. About 100 students at master level are accepted each year from 8 European schools. Moreover, more than 30 PhD students are presently preparing their work at the Institute where teaching and research are undertaken in three Departments :

- the Corporate Communications Department with a focus on network security, network management and agent technologies, protocols for high speed networks and Internet.
- the Multimedia Communications Department with a focus on multimedia networking, Web and Internet technologies, automatic indexing of multimedia documents, speech recognition, video representation and video coding.
- the Mobile Communications Department with a focus on digital signal processing for mobile communications, multi-user information theory and 3rd generation system, wireless access to Data Networks.

The Institute has an approximate budget of 41 million French Francs of which 5 million are from contracts. It has some 75 employees among which 50 are scientists (9 teachers, 8 teaching and research assistants, 7 engineers, 31 PhD. students) whereas 20 constitute the administrative staff.

Institut Eurécom has participated in several European projects (BETEL, BETEUS, NICE, SUZIE, WEB4GROUPS, WAND, ESW) in the ACTS, Telematics and TEN TELECOM Programmes and is currently involved in the MOBYDICK and WITNESS projects of the IST programme, and the 3W3S project as part of the Safer Internet Action Plan. The Institute is also actively involved in a number of national research projects supported by the French RNRT programme: SEVA, ICARE, PAESTUM, AUBE, COBASCA, SAMU, ERMITAGES, PLATON, ANTIPODE, @IRS++.

Recent Publications Relevant for the project

[MM02] Pietro Michiardi, Refik Molva. Simulation-based Analysis of Security Exposures in Mobile Ad Hoc Networks**,** submitted to the European Wireless Conference, Florence, February 2002.

[LMP01] Sergio Loureiro, Refik Molva, and Alain Pannetrat. *Secure Data Collection with Updates. Electronic Commerce Research Journal*, 1/2:119-130, February/March 2001.

[MR00] Refik Molva and Yves Roudier. A Distributed Access Control Model for Java. In Proceedings of ESORICS 2000 (European Symposium On Research In Computer Security), Toulouse, France, October 2000.

[MP00] Refik Molva and Alain Pannetrat. Scalable Multicast Security with Dynamic Recipient Groups. ACM Transactions on Information and System Security, 3, August 2000.

[LM00] Sergio Loureiro and Refik Molva. Mobile Code Protection with Smartcards. In 6th ECOOP Workshop on Mobile Object Systems, Cannes, France, June 2000.

Curriculum vitae of key persons

Refik Molva is a professor at Institut Eurécom since 1992. He is leading the network security research group that currently focuses on multipoint security protocols, multi-component system security, and security in ad hoc networks. His past projects at Eurécom were on mobile code protection, mobile network security, anonymity and intrusion detection. Beside security, he worked on distributed multimedia applications and was responsible for the BETEUS European project on CSCW over a trans-European ATM network. Prior to joining Eurécom, he worked for five years as a Research Staff Member in the Zurich Research Laboratory of IBM where he was one of the key designers of the KryptoKnight security system. He also worked as a network security consultant in the IBM Consulting Group in 1997. He is the author of several publications and patents in the area of network security and has been part of several evaluation committees for various national and international bodies including the European Commission.

Pietro Michiardi received the Laurea in electronic engineering from the Politecnico di Torino in 2001. He was granted a scholarship by the European Union to take part in a program in advanced telecommunications engineering at the Eurecom Institute where he got a diploma in Multimedia Communications. In January 2000 Pietro joined the Eurecom Institute as a research engineer working on a project for the development of advanced security services for business transactions. Since September 2001 Pietro has been a Ph.D. student at the Eurecom Institute working on routing security for Mobile Ad Hoc Networks.

A.2.4. Networking Laboratory at Helsinki University of Technology (HUT)

Networking Laboratory is part of the Department of Electrical and Communications Engineering at Helsinki University of Technology (HUT). Our Laboratory has three main areas of operation; Switching technology and intelligent networks, broadband and teletraffic theory and Networking protocols, software and services. Networking Technology covers both circuit and packet switching technology, including traditional telecommunications networks, the Internet and other packet networks. The Networking Laboratory is interested in the technology, engineering, functional, aspects of the areas of communications services and switching such as; signalling in circuit and packet based networks, routing in circuit and packet switched networks. The objectives include Internet routing protocols, methods, mechanisms, algorithms for internetworking, performance and quality of service, and fault-tolerance techniques.

The tremendous growth of the Internet and Mobile networks has addressed the focus of our current research projects towards traffic classification, class and constraint based routing, interoperable numbering infrastructure and telephony signalling over IP.

The laboratory is actively involved in the communications research area, and it is composed with relevant professors in the research community, PhD and various Master Thesis students.

The different projects carried on at the laboratory have been focused in different technology areas, since year 1997 Helsinki University of Technology Laboratory of Telecommunications Technology Laboratory built up a research network for IP/ATM research. Therefore, the laboratory is involved in the research areas of routing and addressing and interoperability.

Recent Publications Relevant for the project

R Kantola, J M Costa Requena and Nicklas Beijar:"An Architecture for an SCN/IP Telephony routing testbed", The first IP Telephony Workshop, Berlin, April 2000.

R Kantola, J M Costa Requena and Nicklas Beijar:"A Common Numbering Infrastructure for IN and IP Telephony", presented at IN2000, Cape Town, South Africa, May 2000.

H Tang and J Costa Requena: "Serving Spatial Location over Internet". Proceedings of the ACM 2nd International Conference on Mobile Data Management, Springer, pp.246-251, Jan. 2001

R Kantola, Jose Costa Requena, Nicklas Beijar: "Interoperable routing for IN and IP Telephony", Computer Networks Journal.

P. Zhang, R. Kantola, Z. Ma: "Design and Implementation of A New Routing Simulator**",** (SPECTS'2K). July 16-20, 2000, Vancouver, Canada.

Curriculum vitae of key persons

Jose Costa-Requena graduated with M.Sc. in Telecommunications Engineering in Polytechnic University of Valencia (Spain) in April 1999 having done his Master's project at Helsinki University of Technology (HUT), Finland. Jose joined HUT to work on SCN/IP telephony Interoperability architecture in 1998. Since 1999 Jose has been a Ph.D. student at the Networking Laboratory leading a group of M.Sc. students on the routing testbed project. In 1999 Jose started working on SIP matters and he has been actively involved in standardisation and security issues on UMTS networks.

Raimo Kantola graduated with a M.Sc. in Computer Science in Leningrad Electrotechnical Institute in 1981. He received the Doctor of Technology degree in Computer Science from Helsinki University of Technology in 1995. Dr. Kantola worked for Nokia for more than 15 years on Switching R&D and Product marketing and joined HUT as a professor of Telecommunications Technology in 1996.

A.2.5. Netikos

Netikos SpA is a ICT Company launched in the year 2000 by IT Telecom (Telecom Italia Information Technology) with the objective of providing IP based innovative mobile value added services to enterprises and administrations.

Netikos offers its services in that market segment where information is a critical factor for services/products quality and originality, and for a successful management of company processes (value chain). NetIkos services will be particularly focused on the vertical segments of m-business, Media and Entertainment, Telecommunications, Healthcare, Public Administration, Tourism, as well as solutions to e-procurement and vertical virtual marketplaces, exploiting direct channels, technology partnerships, and commercial agreements. Netikos success strategy is based on the competences of its professionals and on qualified technological/commercial partnerships. Netikos is currently distributed on Rome, Pisa and Helsinki.

The lab in Pisa was previously part of Finsiel-Telecommunication Division and part of Telecom Italia Group). Since early 80's, this lab is being involved in European RTD Projects like ATMAN, COMICS, DIANA. In the DIANA project, that aimed to set up an architecture for integration of signalling between ATM and IP, Finsiel was responsible to set up an application (video streaming) supported in the defined architecture.

The Lab in Helsinki is mainly focused on the development of products on wired and wireless technology running on Linux and UNIX platforms.

Netikos has developed products for accessing and management of bulletin board via WAP or SMS, multicasting application on wired or wireless network, network management on wired and wireless network, location systems etc. Detailed information is available on http://www.netikos.com

Netikos team will be leaded by Piergiorgio Cremonese.

Recent Publications Relevant for the project

P.Cremonese et al. "A framework for Policy based management of QoS aware IP networks" accepted by IFIP, Networking 2002, Pisa 2002 (Italy)

S.Giordano, P.Cremonese et al. "A Model for Dynamic QoS Negotiation Applied to an MPEG4 Application" Multimedia Nerworking: Technology, Management and Applications (ed. by Rahman) Idea Group Publishing (2001)

P. Cremonese et al. "An example of traffic-accomodating application." Proceedings of IEEE SOFTcom 2000, Split

P.Cremonese, S.Giordano "An example of dynamic QoS negotiation" IASTED Nassau

P.Cremonese et al. "IP and ATM Co-existence Trials" IDC, Madrid 1999

E. Mannie (edt), J. Corridoni, P. Cremonese, S. Giordano, et al. "IP and ATM Integration" Telecom'99 - ITU-T Geneva 1999 - proceedings

W. Almesberger, S. Giordano, P. Cremonese, H. Filnck, J. Loghney, M. Lorang "A Framework for the QoS Based Integration of IP and ATM in the DIANA Project" , SSC Technical Report no. 98/028

Curriculum vitae of key persons

Piergiorgio Cremonese graduated in Computer Science at University of Pisa in 1985 with laude. He worked in Tecsiel, an Italian company part of TelecomItalia from 1989. This company became part of Netikos, a new company owned by TelecomItalia born in 2001. He was involved in several European projects on networking like IDEA, EIONET, DIANA, CADENUS and others. He was also member of ATM Forum. He was technical responsible of several activities for TelecomItalia like the internal Intranet or caring service on Internet.

A.2.6. Scuola Universitaria Professionale della Svizzera Italiana (SUPSI)

The "Scuola Universitaria Professionale della Svizzera Italiana" is the University of Applied Sciences of Southern Switzerland and is mainly located in the surroundings of Lugano, the principal town of Swiss Italian-speaking canton Ticino. The overriding goal of SUPSI is the promotion of technological development and technological transfer. SUPSI consist in five departments and three institutes. Besides basic education, SUPSI offers postgraduate courses and applied research facilities to local, national and international industries. SUPSI consists to date of about 750 students and 200 staff members (professors and lecturers, assistants, technical and administrative officers.

SUPSI institutes and laboratories successfully participated in a number of EU projects within the scope of the 4th (ENAPS, iTTi, ...) and 5th (EURO-SHOE, SWARM-BOTS, MOSCA, SIRTAKI, ...) framework programs, and within the special research actions: EUREKA (FORSYS, MobileMANUFUTURING, ...), IMS (INCOMPRO, GNOSIS, ...), MEDEA (IM4DTTV), DGVII (PLATFORM). Moreover, SUPSI is founded trough regular national programs (FNSRS, CTI, MICROSWISS) and trough direct applied-research grants from the industry.

Among the applied research facilities, the LME (Laboratory of Microelectronics) offers a broad range of services in both applied research and technological transfer in the all fields related to integrated electronics. In past and present projects, electronics circuits ranging from microcontroller based implementations, to FPGA based developments or even full-custom ASICs (analog, digital or mixed signal) have been realised. Other activities of particular interest for the MobileMAN project, are the research activities in the general area of telecommunications (fieldbusses, Internet, ATM, wireless-communications, ...); during which, several solutions for specific problems (ad-hoc busses, protocol stacks for newly developed hardware platforms, ...) have been developed.

The Department of Social Work of the SUPSI trains social workers through lectures and seminars and through long periods of training and work in social institutions. Its Institute of research activity deals with issues stemming from social policy programs in the public sector as well as in social private institutions.

Recent Publications Relevant for the project

R. Gardoni and I. Defilippis: "iTTi: Interactive Terrestrial Television Integration", *proceedings of Technology Leadership Day 2000*, Rapperswil, October 2000.

Curriculum vitae of key persons

Silvano Balemi was born in Muralto, Switzerland on May 6, 1962. He received the degree in electrical engineering (Dipl. El. Ing.) from the Swiss Federal Institute of Technology (ETH) in 1987, the M.S. degree in electrical engineering from the California Institute of Technology in 1988, and the Ph.D. degree in electrical engineering from the Swiss Federal Institute of Technology (ETH) in 1992. From 1987 to 1988 he was with the California Institute of Technology. From 1988 to 1991 he was with the Information Systems Laboratory, Stanford University. From 1990 to 1993 he was with the Automatic Control Laboratory, ETH Zurich. From 1993 to 1996 he was with Steria Informatic, where he participated in the development project for the traffic control system of the Swiss national railways. From 1996 to 1998 he was with Invertomatic Technology where he participated in the Development of a trafoless UPS system. Since 1998 he is with the SUPSI-DIE where he is manager of R&D and technology transfer in electrical engineering. Dr Balemi is a reviewer for IEEE Transactions on Automatic Control; Mathematics of Control, Signal and Systems; ACC; CDC; IFAC.

Ivan Defilippis was born in Lugano, Switzerland on October 26, 1959. He received the degree in electrical engineering (Dipl. El. Ing.) from the Swiss Federal Institute of Technology (ETH) in 1983. From 1984 to 1998 he was with the Institute of Microtechnology of the University of Neuchâtel (Switzerland) where he worked on several research projects in the domains of Digital Signal Processing and microelectronics, with particular emphasis on VLSI architectures for DSP algorithms. Since 1995 he is with the Department of Computer Science and Electrical Engineering (DIE) of SUPSI where he teaches DSP and microelectronics, and where is active within the Laboratory of Microelectronics (LME) leading and participating in various applied research projects.
Among others, he was working on the ACTS-123 iTTi project where he was involved in the development of the base-band SFDMA modulator for the return channel of the Digital Terrestrial Television (DVB-T).

Christian Marazzi was born in Lugano, Switzerland, on June 8, 1951. He received the degree in Political Sciences from the University of Political Sciences of Padua in 1974. In 1984 he obtained the PhD. In Economics from the City University of London (UK). He has taught Political Economy at the State University of New York (1979-1980) and Social Research at the University of Social and Political Sciences of Lausanne and Geneva (1989-1995). From 1985 to 1997 he has worked in the Department of Social affairs of the Swiss-Italian government. Since 1997 he is professor of socio-economics at the SUPSI and director of the Institute of social research at the Department of social work. He is author of many publications in the social, economic and political fields.

13 RELEVANT WORK

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