# Action full title:

# Universal, mobile-centric and opportunistic communications architecture

## Action acronym:

## UMOBILE



## Deliverable:

## D6.4 "Exploitation Plan"

### Project Information:

| | |
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## Deliverable Information:

This deliverable includes information of the exploitation roadmap defined by UMOBILE consortium at this stage (month 18). A final exploitation report will be provided by the end of the project (month 36) with all exploitation actions identified for UMOBILE.

| | |
|---|---|
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| **PU** | Public | X |
| **CO** | Confidential, only for members of the consortium (including the Commission Services) | |
| **CI** | Classified, as referred to in Commission Decision 2001/844/EC | |

## Document History:

| Version | Date | Description |
|---|---|---|
| Version 0.1 | 30/12/15 | Initial plan for exploitation |
| Version 0.2 | 31/05/16 | Circulate among partners first draft proposal and ask for input |
| Version 0.3 | 26/07/16 | Revised first version based on feedback |
| Version 1.0 | 29/07/16 | Final version ready for submission |

## Table of Contents

## List of Figures

## List of Tables

# 1. Executive Summary

**Background:** This Report is written in the framework of Task 6.2 "Exploitation" of UMOBILE project.

The ultimate objective of UMOBILE is to advance networking technologies and architectures towards the conception and realization of Future Internet. In particular, UMOBILE extends Internet (i) functionally – by combining ICN and DTN technologies within a new architecture -, (ii) geographically – by allowing for internetworking on demand over remote and isolated areas – and (iii) socially – by allowing low-cost access to users but also free user-to-user networking.

**Objectives:** This document is aimed at providing a clear description of the plan through which the project results will be effectively exploited up to and after its ending date. In fact, the consortium partners firmly believe that each activity of the project should be executed with a clear focus on the possibility to use the arising results.

The document starts in Section 2 with an overview of the current situation and an analysis of the UMOBILE solution within the market in terms of strengths, weaknesses, threats and opportunities. The rest of the document is organized as follows. Section 3 gives a comprehensive overview of the adopted exploitation strategy. Section 4 provides a summary of the main results of the project that will be used to open new markets, business applications, products and services. The business case analysis performed in task T6.2 is presented in Section 5. The detailed exploitation plan of each industrial and academic partner is elaborated in more details in Section 6. The conclusions are drawn in Section 7.

## 2. Overview

This Section provides an overview of the current mobile sector and emerging trends from a business perspective. The positioning of UMOBILE within the market of the new paradigm of opportunistic networks via internet centric networking and delay tolerant networks is also provided by means of a SWOT analysis (strengths, weaknesses, threats and opportunities). The whole content of this deliverable has to be considered as a preliminary version which will be updated and consolidated at the end of the third project year with the final exploitation report presented in D6.5.

### 2.1. Current mobile sector and emerging trends

Current internet bases on host-centric access, which hosts the traffic exchange of billions of devices reaching up to exabyte of data per year. However, nowadays more and more users want to get internet access everywhere, anytime, content-based and only when required. In addition, users' connectivity patterns have greatly evolved moving from very static scenarios to scenarios where mobility is the main actor and users are mainly interested in accessing big chunks of information, irrespective of its physical location. User demand is increasing through the use of mobile devices that present multiple connectivity options. Cisco VNI reports that Global mobile data traffic will increase nearly eightfold between 2015 and 2020 [1]. Mobile data traffic will grow at a compound annual growth rate (CAGR) of 53 percent from 2015 to 2020, depicted in Figure 1, reaching 30.6 exabytes per month by 2020.
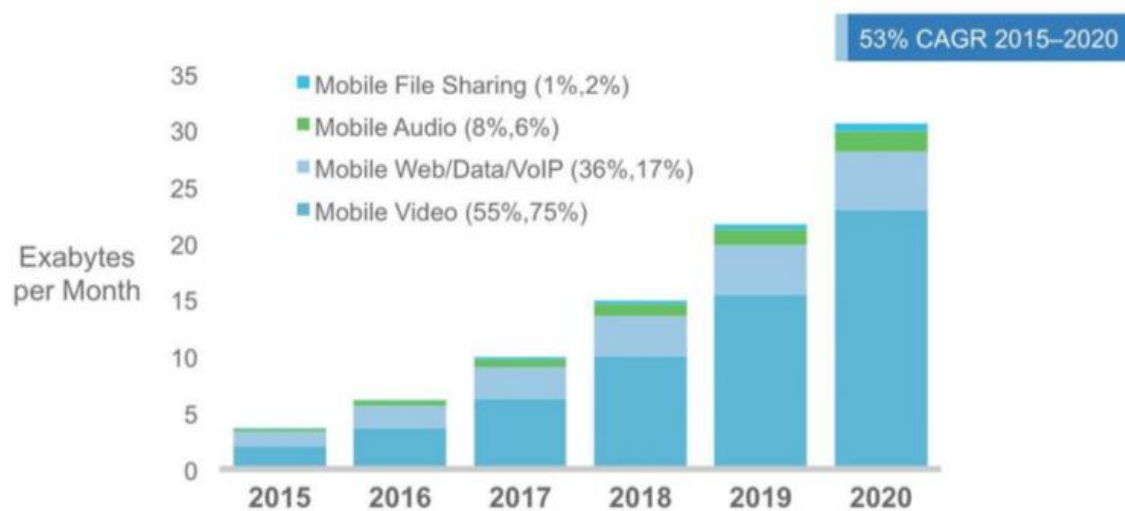


**Figure 1: Mobile Data Traffic prediction. Source Cisco VNI Mobile 2016.**

The number of mobile-connected devices per capita will reach 1.5 by 2020 [1]. There will be 11.6 billion mobile-connected devices by 2020, including M2M modules – exceeding the world's projected population at that time (7.8 billion). This will translate into an environment of fully connected devices that require an internet connection, making the Internet of Things a reality.
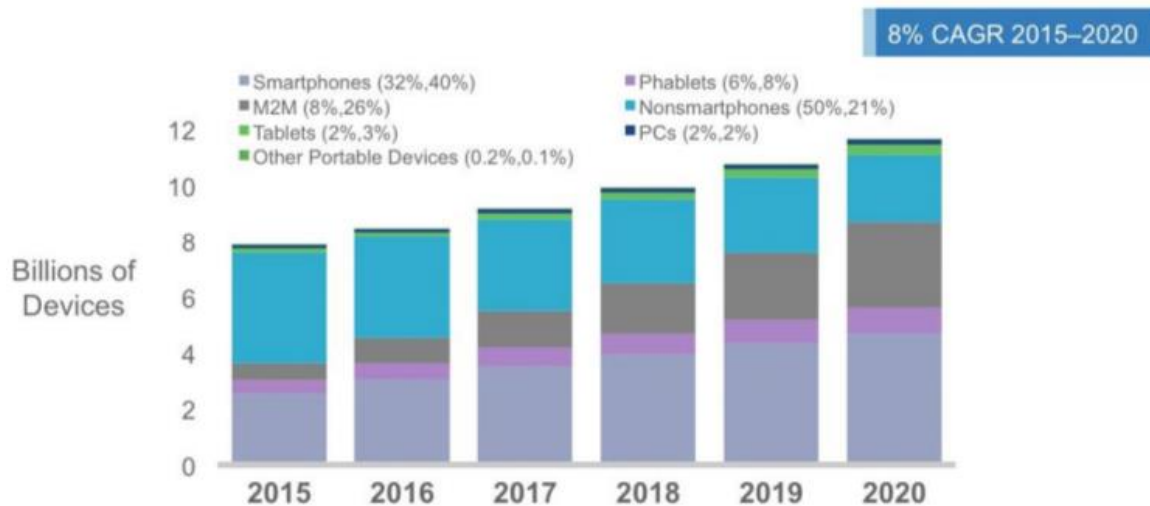
**Figure 2: Global Mobile Devices and Connections Growth. Source Cisco VNI Mobile 2016.**

This increased demand in content boosts Information Centric Networking (ICN) to emerge as a revolutionary solution introducing more flexibility and efficiency in the mechanisms for content dissemination among users.

In addition, as aforementioned, at this time there is a trend that users want to access to contents anywhere, only when required, and sometimes in isolated dynamic situations that will create opportunistic networks. Leveraging Delay Tolerant Networking principles (DTN), founded on a store-and-forward model with persistent storage, and jointly integrated with ICN, will support seamlessly mobility for extreme disruptions and also remove the need end-to-end connectivity between the user and the location context server.

The Gartner Hype Cycle [2], which allows identifying the maturity and adoption of specific technologies, finds Named Data Networking (NDN) at a very early stage with still more than 10 years foreseen to reach a plateau level. NDN, key component within the UMOBILE framework, represents a specific architecture design for the ICN solution. Figure 3 presents the Networking and Communications Hype Cycle 2015 where NDN is identified as a promising technology. This clearly states the importance of the UMOBILE project, which does not only approaches the definition of a unified ICN and DTN communication platform but also opens opportunities for new services and applications.
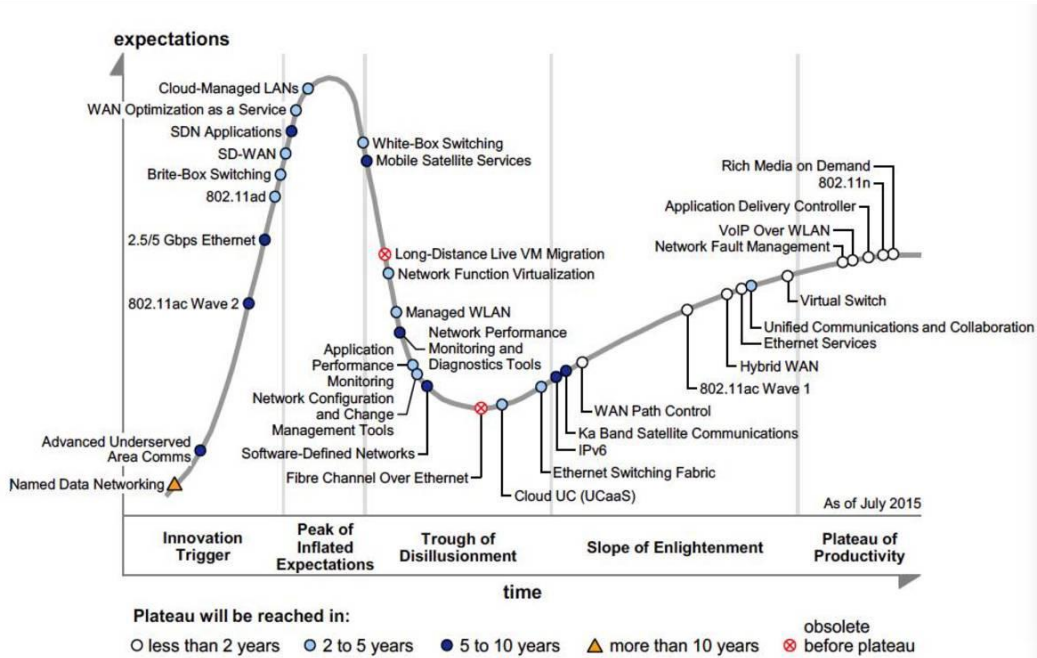
**Figure 3: Gartner Hype Cycle for Networking and Communications 2015. Source Gartner July 2015.**

## 2.2. SWOT Analysis

In this section, the proposed UMOBILE solution will be assessed within current mobile dissemination schemes and market. The objective of this comparison is to point out the benefits regarding the use of UMOBILE by mobile operators or other entities, and therefore, the exploitation opportunities for the partners.

**Table 1: SWOT of UMOBILE solution**

| | Strengths | Weaknesses |
|---|---|---|
| **Internal** | • Increases network coverage and enables communication of users in unconnected and remote areas.<br><br>• Saving costs in extending network infrastructure to reach rural and remote areas.<br><br>• Applicable to V2V communications and, similarly, to other "things".<br><br>• Approaches lack of WAN coverage scenarios.<br><br>• Use in disruptive networking environments to give Internet connectivity.<br><br>• Reinforcement of innovative use cases.<br><br>• Enable the wide-spread adoption of | • Shows dependencies on end-user terminals. These dependencies may require the collaboration with OS providers (e.g. Google, Apple, etc.).<br><br>• May entail higher battery consumption on terminals.<br><br>• May require standardization, mainly at the integration of DTN with ICN.<br><br>• Service guarantees depend on the UMOBILE penetration and adoption.<br><br>• Trust issues when the user becomes both consumer and producer of content.<br><br>• Limit adaption by service providers in the short term. |

| | content-centric networking solutions | |
|---|---|---|
| **External** | **Opportunities** <br><br> • Enables the development of new and innovative services and applications based on ICN and DTN paradigms (e.g., based on media sharing). <br><br> • Increased use of mobile devices: smartphones will reach percent of mobile data traffic by 2018. <br><br> • Increase access to traffic content as more areas will be covered. <br><br> • Popularization and boosting the well-known concept of smart cities. <br><br> • Increase social interaction. <br><br> • Guarantee connection service in emergency situations. | **Threats** <br><br> • UAV WiFi connectivity range may limit the Internet connection when used for emergency purposes. <br><br> • Government and public administrations may exclude themselves of adopting this new architecture. <br><br> • Legal issues regarding the UAVs flight that may limit UMOBILE operation. <br><br> • User may not perceive opportunistic communications as secure and stop using UMOBILE framework due to trust issues. <br><br> • Low adoption. |

## 3. Exploitation strategy

For being effective and successful, an exploitation strategy has to be considered from the very beginning of the project and has to be embedded in all its significant steps. This is the reason why the exploitation process depicted in Figure 4 has been applied to the consortium activities.

**EXPLOITATION PROCESS**

| Needs of project end users | Expected project results | Final/potential users/beneficiaries of the project's outcomes | Define WHAT / WHEN / WHO / HOW |
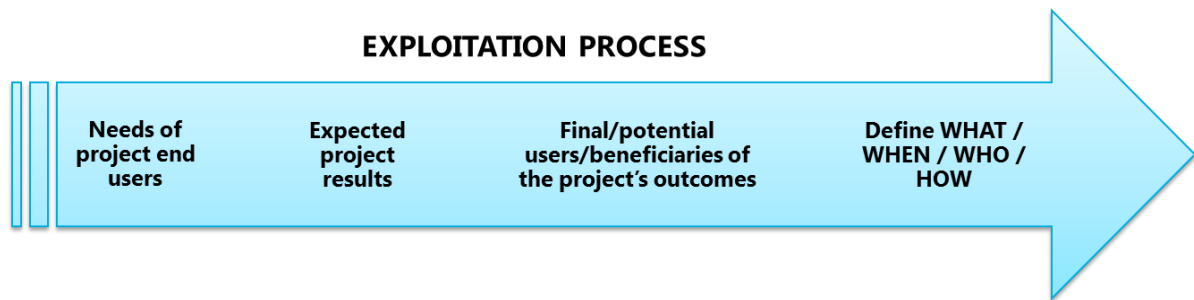
Figure 4: Exploitation process considered throughout the UMOBILE project

This exploitation process covers the whole project timeline and strives for being as proactive as possible by integrating participatory processes in each step. It is worth to be noted that the starting point of the whole process does not coincide with the beginning of the project activities. In fact, the consortium partners need to have clear in mind which the possible usages of the produced outcomes are during the design phase of the proposal. This is the reason why a clear exploitation plan for each involved partner has been already provided in the Description of Work, based on the expected project results also described in the same document. These results have to be focused on satisfying specific needs of identified end users.

The aforementioned two first steps characterize the design phase of the project and its first activities (i.e., all the phases in which the direction to be taken and the potential outcomes are still not steadily defined). Once it has been started and its first activities have been completed, the potential users and beneficiaries of the project's outcomes can be identified with much more confidence, up to arrive to their final definition when going deeper into the timeline and approaching the ending date.

After having clearly in mind which the final or at least potential end users of the project's outcomes are, it is necessary to identify all the details related to the exploitation activities. First of all it has to be decided which are the obtained results that can be exploited (i.e., WHAT). In fact, it is possible that not all the results obtained throughout the project are ready to be used directly or indirectly towards or after its end.

After that, each partner has to select the exploitable results of its interest and to identify which are the target users in their business (i.e., WHO). It has to be then decided how they can be addressed and which are the mechanisms and strategies to be used for each type of outcome (i.e., HOW). Also the time dimension has to be carefully planned, in order to cover the period of time before and after the end of the project (i.e., WHEN).

The last two steps depicted in Figure 4 can be iterated several times up to the end of the project in order to refine and to better detail each component.

# 4. Exploitable results

In this section we describe the results of the project which could be used directly or indirectly for further research activities other than those covered by itself, for developing, creating and marketing a product or process, or for creating and providing a service. Each partner can freely use all or a part of them, according to its exploitation plan later described into the document.

In general, the typical outcomes of a project can fall into one or more of the following categories, such as: process/process technology, method, models, algorithms, recommendations for standards, service/service technology, prototypes/pilots for a product, software codes, and intellectual property right (i.e., patent).

UMOBILE outcomes can be exploited as a technology solution or as a solution as a service. Each of them has specific features that are analysed in the following sub-sections.

## 4.1. UMOBILE as a technology solution

UMOBILE proposes an innovative architecture implemented using disruptive paradigms and technologies that is able to offer new enhanced services to the end user. This architecture merges information-centric networking with delay-tolerant networking in order to efficiently operate in different network situations, reaching disconnected environments and users and providing new types of services.

In addition, UMOBILE includes PerSense, an open-source sensing platform to sense the environment of a user and provide relevant services. This product encompasses the complete UMOBILE solution as a package, developed during the project execution. The commercialization of such product is exploited as a complete technology solution that can be sold (by a company providing this solution) to any entity that wants to deploy UMOBILE related services.

The UMOBILE solution can be also used to build services on top of it. In this case, a company can buy the UMOBILE solution in order to develop one or several services on top of the designed architecture.

## 4.2. UMOBILE solution as a service

Other potential utilization of the UMOBILE solution is the enablement of exploitation licenses for other entities to provide UMOBILE services as a product. This way, the complete solution can be provided to a client and this client can afterwards offer UMOBILE services to its clients. Therefore, UMOBILE solution is exploited as service. For instance, a "UMOBILE service provider" (e.g. an operator with UMOBILE technology solution) offers UMOBILE services to other entities willing to use UMOBILE.

The provided services by UMOBILE solution can be the ones developed during the project or can be new services built on top of the architecture.

# 5. Business models

## 5.1. UMOBILE Value Chain

The following figure depicts the value chain for a UMOBILE business ecosystem.
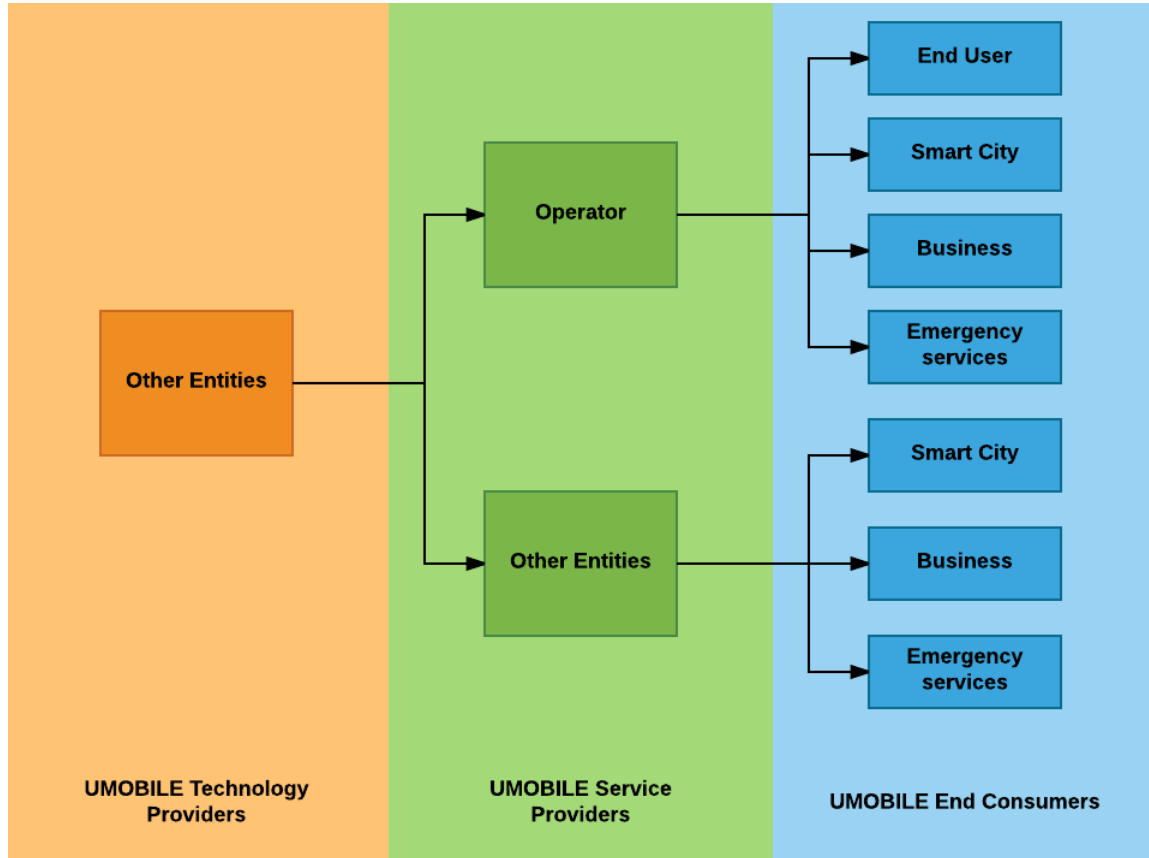


**Figure 5: UMOBILE Value Chain**

In the value chain, three main levels have been defined:

- *Technology providers:* these entities develop and offer UMOBILE technology. They can offer the technology developed during the project or they can build services on top of the platform developed during the project.

- *Service providers:* these entities offer services thanks to the technology provided by UMOBILE Technology Providers. Operators can take advantage of this technology in order to improve their networks and provide innovative services. On the other hand, other entities can provide services and build new business models.

- *End customers:* these entities consume UMOBILE services provided by UMOBILE service providers.

Within each level, several entities have been represented. Some entities can fit into different levels. For example, an entity can be a technology provider that develops the technology and can be, at the same time, a service provider as it provides services to end customers.

The next sections describe the business canvases for the main entities in the value chain.

## 5.2. Business Canvas for UMOBILE Technology Providers

A UMOBILE technology provider is an entity that develops UMOBILE technology for UMOBILE architecture and services. This entity sells this technology to UMOBILE service providers. It can also sell support, licensing, deployment of the network, maintenance or operation.

These entities can be existing companies or new ones that decide to build new business models thanks to UMOBILE technology.

**Table 2: Business Canvas for UMOBILE Technology Providers**

| Key Partners | Key Activities | Value Propositions | Customer Relationships | Customer Segments |
|---|---|---|---|---|
| UMOBILE Technology Providers.<br><br>They develop and offer UMOBILE technology including the architecture, the UAVs, the deployment and the associated apps. | Development, deployment, support, maintenance of UMOBILE Technology.<br><br>Technology provider sells the technology to UMOBILE service providers.<br><br>Technology Providers can also offer support, integration, operation and maintenance services on top of their technology. | Providing UMOBILE technology<br><br>Selling, licensing and authorizing the use of UMOBILE technology (software, architecture).<br><br>Deployment, maintenance and support services<br><br>Providing support services for the technology/architecture. | UMOBILE Service Providers<br><br>These entities purchase UMOBILE technology in order to provide services to other entities or to end customers. There are two groups:<br><br>Operators: they can improve their networks and provide innovative services.<br><br>Other entities: build new business models around this technology. | Operators<br><br>Telecommunications operators<br><br>Other entities<br><br>Entities that can build a new business models around UMOBILE technology buying it in order to provide innovative services. |
| | **Key Resources**<br><br>UMOBILE Technology<br><br>UMOBILE architecture, software and apps.<br><br>Support services<br><br>Support and maintenance of the architecture, software or deployment. | | **Channels**<br><br>Direct Marketing-B2B<br><br>Targeting customer segments (e.g. on line advertisement, workshops, etc.) | |

| Cost Structure | Revenue Streams |
|---|---|
| Fixed Costs | Fixed |
| -Personnel costs: developers of UMOBILE technology, personnel for deployment, maintenance and support services, etc. | Revenue from selling/ licensing/ renting/ fixing and supporting UMOBILE technology |
| -Fixed cost of Hardware and software cost for development of platform. | Variable |
| -Other general expenses such as renting and related infrastructure, financial, etc. | -Revenue sharing with operators, content providers and other entities respect to their sale growth. |
| Variable Costs | |
| - Variable Costs depend on number of customers, level (frequency and coverage) of maintenance and support needed. | -Variable revenue related to support and maintenance services of UMOBILE technology. |
| - Other general expenses like supplies | |

17

A UMOBILE service provider is an entity that provides services developed on top of UMOBILE technology. It buys UMOBILE technology to a UMOBILE technology provider.

**Table 3: Business Canvas for UMOBILE Service Providers**

| Key Partners | Key Activities | Value Propositions | Customer Relationships | Customer Segments |
|---|---|---|---|---|
| UMOBILE Service Providers.<br><br>They provide services that are built on top of UMOBILE technology. They can be operators that thanks to the technology purchased to UMOBILE technology providers improve their network. They can also be entities that acquire UMOBILE technology and build a new business case in order to provide services. | UMOBILE service providers buy UMOBILE technology to UMOBILE technology providers in order to provide services. They can provide the services to end customers or to other different entities.<br><br>UMOBILE service providers can, also, build new services on top of UMOBILE architecture and provide them.<br><br>UMOBILE service providers can provide the service and support. | Providing UMOBILE services<br><br>UMOBILE service providers provide UMOBILE related services exploiting UMOBILE technology.<br><br>Deployment, maintenance and support services<br><br>Providing support services for the technology/architecture.<br><br>Enhancing UMOBILE technology<br><br>Building new services on top of UMOBILE technology. | Emergency Services<br><br>UMOBILE architecture is able to provide services to emergency services.<br><br>Smart cities<br><br>Smart cities can receive services in order to provide access in some parts of the city where there is not coverage or where the macro-cells are not enough.<br><br>Business<br><br>Business of all kinds such as restaurants or shops can be interested in the information generated by UMOBILE. | End users<br><br>Emergency Services<br><br>Public administrations that manage this kind of services.<br><br>Smart cities<br><br>City councils<br><br>Business<br><br>Any kind of business |
| | **Key Resources**<br><br>UMOBILE Technology<br><br>UMOBILE architecture, software and apps.<br><br>Support services<br><br>Support and maintenance of the architecture, software or | | **Channels**<br><br>Direct Marketing-B2B<br><br>Targeting customer segments (e.g. on line advertisement, workshops, etc.) | |

|  | deployment. **UMOBILE Services** Services built on top of UMOBILE architecture and technology. They can be developed during the project or after it for a specific application. |  |  |  |
|---|---|---|---|---|

**Cost Structure**

Fixed Costs

-Personnel costs: developers of UMOBILE technology, personnel for deployment, maintenance and support services, etc.

-Fixed cost of Hardware and software cost for development of platform.

-Other general expenses such as renting and related infrastructure, financial, etc.

Variable Costs

- Variable Costs depend on number of customers, level (frequency and coverage) of maintenance and support needed.

- Other general expenses like supplies

**Revenue Streams**

Fixed

Revenue from selling/ licensing/ renting/ fixing and supporting UMOBILE services

Variable

-Revenue obtained from the new services developed.

-Variable revenue related to support and maintenance services.

- Variable revenue that operators obtain thanks to the improvement of their networks.

# 6. Exploitation plans per partner

In this section each partner provides its own exploitation plan in terms of products and/or services which can be provided by using the outcomes of the project. Each plan is structured as follows: A brief description of each company and an overview of the identified products and/or services are provided. After that, the exploitation plan and the already performed activities are described, together with the expected benefits of each identified solution.

## 6.1. DUTH

### Company profile

Democritus University of Thrace (DUTH) was established in July 1973. The Department of Electrical and Computer Engineering of DUTH was founded in 1975, in Xanthi, Greece. The Department is one of the leading European Departments in Space Technology and Internetworking and has significant expertise in various Computer Science fields such as Algorithms, Information Retrieval and Security.

The Internetworked Systems Lab (InterSys – www.intersys-lab.org) is the sole laboratory of the Software Division of the Department. It is directed by Prof. V. Tsaoussidis and consists of 7 faculty members, 2 technicians, 3 administrative assistants, 3 senior engineers and 17 engineers. The expertise of InterSys lies in Delay-tolerant Networking (DTN), design and evaluation of protocols for challenging environments, such as near and deep-space, or opportunistic terrestrial networks. InterSys research team also works on end-to-end protocols, security, load-balancing and energy-saving protocols. InterSys Lab established the first European "Space Internetworking Center - SPICE" (www.spice-center.org) in September 2010. Intersys Lab has received funding from ESA and FP7 and coordinates large projects (some of which were ranked first in their respective category), such as ESA's "Extending Internet into Space" and FP7 SPACE "Space-Data Routers" with a total budget over 5M Euros.

Apart from being the project coordinator, DUTH leads the incorporation of delay-tolerant characteristics into the Named Data Networking (NDN) architecture and contributes to the development of the smart routing mechanism. Given its expertise on DTN, DUTH's team will contribute to the evaluation of the UMOBILE architecture through simulations, emulations and real experiments.

### Product overview (value proposition)

As a university that is always interested in identifying and studying new research topics, the outcome of UMOBILE will provide to InterSys lab a new field of research that uses delay-tolerant networking as a starting point, but expands to information-centric networking, user mobility, smart routing mechanisms etc. At the end of the project, UMOBILE will provide:

- A unified DTN and ICN architecture;

- New mobile apps for this architecture;

- New types of services (such as push service);

- Smart routing mechanisms that also consider social interactions between users;

- Emergency communications for disrupted environments.

The aforementioned outcomes open up new fields of research that DUTH aims to exploit not only throughout the duration of the project, but also after UMOBILE project ends.

## Exploitation plans

DUTH aims to extend its expertise on DTN and actively contribute to its integration with ICN. All attempts on this field so far have been limited; DUTH aims to benefit from this gap and open up a new research field that leads to several research topics to be investigated and numerous collaborations with new partners on the field. In particular, we plan to exploit the developed UMOBILE architecture in two ways:

- Utilize the developed architecture to attract publicity and new collaborations in Greece, by promoting the work of a research team located in one of Greece's (and Europe's) convergence areas and

- Exploit UMOBILE architecture as a starting point to participate in more research proposals and projects at European level that are not only focused on DTN (which has been the case so far).

As a university with interest in the field of Computer Networks, we aim to include the UMOBILE platform as new material for the lab sessions of the Computer Networks I and II courses. Undergraduate and post-graduate students will become acquainted to the combination of these two emerging technologies (ICN and DTN) and the research areas that their integration opens up.

## Expected benefits

The main benefit that DUTH aims to exploit from UMOBILE project is the unified ICN and DTN architecture. Combined with the existing DTN testbed that DUTH has built at its premises, DUTH aims to become a key player in the field of information-centric networking by holding and providing to other interested parties a one-of-a-kind research infrastructure. The existing testbed is appropriate for evaluating Space and Internetworking protocols in challenging environments and includes satellite links, ground station hardware devices, and protocols for delay-tolerant networks as well as for telemetry/telecommand. Enhanced with UMOBILE architecture, the updated testbed will become a suitable platform for evaluating information-centric scenarios, as well.

Moreover, DUTH's research group will expand its research horizons from the delay-tolerant networking to include other emerging technologies and research fields.

### Company profile

University College London (UCL) is one of the premier universities in the UK and has been consistently ranked in the top 20 universities in the world. In the area of communications research, the Electronic Engineering department's activities span areas across all the layers of the communication protocol stack, ranging from radio, optical coding and transmission through routing, resource control and traffic engineering up to content-centric and peer-to-peer networking, multimedia applications and network/service management.

The Communications and Information Systems Group (CISG) within UCL EE department has a long history and expertise in the networking area, which has been obtained through its participation in a number of research projects in the areas of QoS, network/service management, content-centric networking content distribution, virtualization and future Internet, in which it has had a leading role. UCL's relevance expertise is also testified through numerous prestigious publications and the high standing in the networking research community of the relevant academics who will be involved in the project. Examples of recent related projects are TEQUILA, MESCAL, CONTEXT, AMBIENT, MCDN, AGAVE, EMANICS, AUTOI, ENVISION, COMET and GreenICN. COMET together with GreenICN has been some of the most successful projects in the area of content-networking and ICN. CISG at UCL is currently running a UK-funded EPSRC project on "Active Content Management at Internet Scale" (COMIT), which focuses on a smooth migration path towards the shift to Information-Centric Networking. Dr Ioannis Psaras has a personal EPSRC Early Career Fellowship, one of the most prestigious awards in the UK, to investigate the shift towards Information-Centric Networks and edge-/fog-computing.

### Research and Development

UCL will bring into the project its expertise in content resolution and delivery in ICN environments, naming systems and architectures and optimal server placement for content distribution to remote regions. More in particular, UCL will work on naming, content resolution and replication/caching of content close to the users in an environment, where direct access to the origin server is not possible. This will be achieved through smart content naming that allows for sophisticated and efficient replication based on content names. UCL will also participate in the design of energy efficient algorithms for disaster-tolerant scenarios, where battery-limited mobile devices are the main carrier of content.

### Exploitation plans

The team at UCL has been actively involved in the ICN-related IRTF group, called ICNRG, where members of the group contributed to the initial outputs of the group (see ICNRG ICN Research Challenges document). In particular, Dr Ioannis Psaras is attending most of

the ICNRG meetings and is a co-author of the "ICN Research Challenges" Internet Draft, which has now been approved as an RFC. Our results are disseminated in the ICNRG, but also in several research institutes, universities and conferences, through keynote talks.

Last, but not least, we are reforming our MSc modules to include Information-Centric Networking principles and related topics. We have allocated a dedicated slot on in-network caching, which we will update to include naming and addressing in Information-Centric Networks, as well as routing based on names.

In terms of software, we are continuing the development of our *Icarus* simulator, initially developed for the GreenICN project. Icarus has received wide interest and attention from the community and we are therefore, continuing the extension of the simulation tool to include more functionality. We will soon be announcing a mailing list dedicated to issues related to the code, in order to attract further interest.

## Expected benefits

We expect to produce high-impact publications in the area of Information-Centric Networks with a specific focus to mobile, opportunistic environments. We are already publishing high-quality papers, including papers in IFIP Networking 2016 and IEEE LANMAN 2016, where we also received the Best Paper Award. We hope that these papers will make an impact to the community and through our dissemination channels we will make the results of the UMOBILE project visible to the wider community.

## 6.3. UCAM

### Company profile

In this project, UCAM is a short name for University of Cambridge which is represented by the Networks and Operating Systems (NetOS) research group of its Computer Laboratory (Computer Lab, https://www.cl.cam.ac.uk).

NetOS is responsible for conducting teaching and research in topics including computer architecture, operating systems design, functional programming languages, network monitoring and protocol design, practical distributed systems and mobile communications. NetOS works closely with other groups of the Computer Lab and the University, as well as industrial partners such as Microsoft Research. The Computer Lab has an outstanding track record of start-ups and spinout companies. Likewise, it has motivated many large companies (for example Microsoft, ARM, Intel, Nokia, Broadcom) to base some of their main research laboratories and actual design teams in the area.

Directly involved in UMOBILE are members of the Networking for Development (N4D) research subgroup (https://www.cl.cam.ac.uk/~as2330/n4d/) which is included within NetOS and led by Dr. Arjuna Sathiaseelan.

In the N4D Lab we conduct research on understanding the fundamental challenges of providing universal Internet access and explore technological solutions to solve some of

the challenges. One of our research threads is the development of technology that can be deployed ad-hoc in emergency situations such as those affected by natural disasters and social instability. As such we have gained a substantial body of knowledge and expertise in related topics including Information Centric Networking, Mobile Opportunistic Networking and Satellite Networking. Our focus is on the development of innovative, experimental technology that we deploy in realistic scenarios for further debugging and evaluation. Our aim is to produce open source technology for the benefit of the society, as opposed to exploitation by means of direct commercialization. We will observe this principle in the exploitation of our UMOBILE results.

## Technology Development

UCAM will contribute to the UMOBILE architecture the following two technologies: **QoS mechanisms** based on monitoring and service migration and developing a low cost drone for delivering services in challenged environments. UCAM is currently developing the service migration functionality over the NDN platform with support for both push and pull services. This development will be one of the core services in UMOBILE architecture.

The drone prototype called the Cloudrone involves a lightweight micro cloud infrastructure deployed in the sky using indigenously built low cost drones, single board computers and lightweight Operating System virtualization technologies. Cloudrone will benefit from Information Centric Networking (NDN, specifically) to decouple the service from the location thus removing the need for the current end-to-end client server model such that the service and/or content can be served directly by any host that currently has the service/content. The integration of service migration with NDN will assist Cloudrone to perform such operations.

Regarding QoS mechanisms, UCAM is developing a service placement algorithm, called BASP (Bandwidth-aware Service Placement) that helps migrating services to enhance the QoS in challenged decentralized community networks. UCAM has carried out preliminary evaluations based on a small scale deployment in Guifi.net (which is the world's largest community network).

## Exploitation plans

UCAM will firstly integrate the service level QoS mechanisms based on migration/edge computing and cloudrone platform with the scenarios to be developed by the UMOBILE consortium as envisioned and documented in D2.1. This will serve as a preliminary test and an opportunity to measure and evaluate their basic features such as performance and scalability.

UCAM is currently trying to secure additional research funding to further develop, test, evaluate and exploit the QoS mechanisms and cloudrone platform independently from outcomes produced by other UMOBILE partners and beyond the expectations of the UMOBILE project. At UCAM, we are already using the preliminary results of our QoS mechanisms and cloudrone platform to apply for additional research funding to exploit our outcomes in situations where such technologies are needed to address actual

problems. We have already submitted some funding applications and are preparing others.

In this order, we have a long record of research collaboration with Thailand (a developing country liable to flooding).  For instance, we have helped them to build TakNet

 (http://interlab.ait.asia/TakNet/assets/player/KeynoteDHTMLPlayer.html),  the first community network in Thailand and located in a rural village of the Northern region of the country. At the N4D Lab, we regard Thailand as an ideal deployment scenario to test, evaluate and exploit the outcomes of the UMOBILE projects, namely, the cloudrone platform and QoS mechanisms. We are already discussing this possibility with the Asian Institute of Technology (AIT).

For instance and depending on the availability of additional funding, we will deploy the cloudrone platform in rural areas of Thailand to perform regular environmental monitoring, build early warning systems and ad-hoc systems to support rescue operations. We have already made some progress in this direction. We have discussed with the AIT our interest in exploiting the cloudrone in the emergency crisis such as landslide, tsunami. At the time of writing this D6.4 deliverable, discussions are ongoing with AIT team about using the cloudrone and/or UAVs in the emergency scenarios.

In July 2016, Dr. Arjuna Sathiaseelan was invited to give a talk about Cloudrone technology at the Techfugees Cambridge conference. Following this workshop, we have been contacted by some organisations who work as volunteers in refugee camps including the camp in Calais (France - UK border) to discuss the potential deployment of the cloudrone platform in refugee camps to provide Internet services to refugees.

For instance and subject to additional funding availability, we will help actionaid organisation  (https://www.actionaid.org.uk/blog/news/2015/12/14/on-the-front-line-of-the-refugee-crisis)  to deploy the cloudrone platform in one of the refugee camps in Greece like Kara Tepe, Moria, Sisto and Skaramanga or the Calais jungle in France (about 5 000 people, including 500 children) to provide Internet services to refugees. The idea is to use drones with embedded services that can fly between nearby cities and refugee camps carrying services from nearby cities to refugee camps and download them in local servers. We will provide these services with service migration facilities to re-locate them optimally to enhance QoE experienced by their users. The cloudrone platform instrumented with service migration mechanisms will support crucial services such as education contents, healthcare, social media, etc.

Likewise, drones will carry data (content) in both directions, such as news, films and educational material.

Depending on additional funding availability, we will deploy the QoS mechanisms in actual network such as the Guifi.net (https://guifi.net) community network to test them in actual working environment and to enhance the QoE (Quality of Experience) of guifi.net users. Guifi.net is currently the largest community network in the world and includes approximately 31 000 nodes.

In addition to producing research technology, the mission of UCAM is to train students and new researchers. In pursuit of this goal, we are already using the drone based application and QoS mechanisms mentioned above to train students from India (a developing country) who are currently visiting the N4D Lab for internships to collaborate with us in the building of the drones and the drone application (https://www.youtube.com/watch?v=cJjrxbB3mV4&feature=youtu.be) and QoS mechanisms such as service migration.

In the same order, in March 2016, UCAM and T/ICT4D Lab, The Abdus Salam International Centre for Theoretical Physics (ICTP) organized the Workshop on new Frontiers in Internet of Things at the International Centre for Theoretical Physics in Trieste, Italy. In this workshop, we already use our expertise in Information Centric Network technologies (e.g., NDN, PURSUIT), light weight virtualization technology (e.g., Docker), service migration, community network as well as the suitable platform for IoT (e.g., raspberry Pi) to train practitioners, researchers, engineers and regulators from several developing countries including Africa, Asian and South America. Figure 1 shows our activities during the trading session. The goal of the workshop was to transfer both our technologies and knowledge to the participants in the hope that they will deploy our or similar technologies in their countries. After the workshop, we have been working closely with some of the participants. For example, we have advised the Tunapanda Institute (http://www.tunapanda.org) in the deployment of a community network in Kibera, Kenya, to provide people living in slums with internet connectivity to gain access to educational content from their neglected houses. Another outcome of the workshop is the establishment of a collaboration link with regulators from Mozambique: they have expressed interest in using edge computing based applications to be deployed on their TV white space. In particular, we have been discussing the potential implementation of a micro data centre using a swarm of Raspberry Pi and Docker to create the regional database of TV whitespace. We emphasize that, these technologies are the same as those used in the cloudrone platform; consequently, we will re-use and exploit them in a different scenario.



**Figure 6: The training sessions lead by UCAM during the Workshop on new Frontiers in Internet of Things at the International Centre for Theoretical Physics in Trieste, Italy**

To make our research results widely available, we publish and present them in international leading venues such as ACM ICN and AINTEC where we have won best

26

paper awards. We hope that our findings will motivate the industry and research communities to exploit our results directly, that is, using the same solutions or inspire the development of new ones.

## Expected benefits

The deployment of the drone application would benefit a large section of the population of Thailand that regularly suffers from natural disasters. For instance, in 2011 alone, floods and landslide affected more than 2 million people. Similarly, the deployment of the QoS mechanisms in the community networks of Thailand would benefit 300 people. We clarify that Thailand is an attractive scenario for the deployment of our technology because it is a developing country with a population of 67 million where 50% of the population do not have Internet access. We expect that collaboration with the Asian Institute of Technology (AIT) not only accelerates the testing and experimentation capabilities of the UMOBILE project but also opens up opportunities for stakeholder engagement, specifically with local councils concerned with benefits and impacts of technologies developing under UMOBILE's project.

The deployment of the QoS mechanisms in Guifi.net would benefit community network of approximately 31 000 nodes. We intend to deploy the service placement algorithm (BASP) for migrating the service like video streaming and disk storage in the real community network while extensive experiments and evaluations will be carried out. The outcome of this evaluation will provide the better quality of service to the users in the community network.

A potential deployment of the cloudrone platform in refugee camps will benefit thousands of refugees. For example, it is known that at its peak, the refugee camps in Greece were home to thousands of migrants. Similarly, the Calais jungle in France is home to 5 000 people, including 500 children. We show these figures only as examples to support our arguments, sadly there are other refugee camps with larger populations and similar needs.

### 6.4. COPELABS

#### Company profile

COPELABS is a research unit of University Lusófona, Lisbon, Portugal, focused on the interdisciplinary study of cognitive functioning, social interaction and behaviour inference, to assist the study of networking and information science technology, as well as to support a better use of technology towards society. The ultimate goal of this dual approach is to promote societal well-being.

Our mission is to design, develop, and validate pervasive, low-cost, and user-friendly technological solutions that are both useful in the context of psychological and cognitive intervention as well as capable of placing the citizen in the heart of the social structure that today encompasses the Internet. Overall, COPELABS comprises 27 researchers, 16 of

each hold a PhD and have wide experience on project management and European initiatives. COPELABS integrates UMOBILE with the SITI group that is dedicated to informatics systems and technology; focus on pervasive wireless systems and social Internet design.

As research unit, COPELABS has a vast experience both in project development as well as in European project coordination, having been the most recently example of a coordinated project the FP7 IST ULOOP (gr 75148. Projects where COPELABS have previously been involved are: WiNeMo Cost; FP6 Ambient Networks; FP6 NOBEL II; FP6 6NET. COPELABS is an affiliate of the network of excellence on Internet Science, and actively engages in several technological platforms, such as the Future Internet Assembly, Net!Works.

Our list of results is openly available at http://copelabs.ulusofona.pt/scicommons/.

## Product overview (value proposition)

The outcome of the UMOBILE project will consolidate the international position of the SITI group of COPELABS, in the research field of opportunistic networks and data-centric networking. At the end of the UMOBILE project, COPELABS will be able to enforce its international position by providing scientific solutions based on social trust computation and social-based and interest-based communication approaches.

## Exploitation plans

COPELABS aims to extend its expertise on opportunistic networking as well as information centric networking by actively contributing for the adaptation of ICN paradigms, such as the Named-Data Networking (NDN) to operate in challenges networks, where data is exchanged by exploiting the communication opportunities created by wireless contacts among mobile devices.

COPELABS aims to benefit from the lack of contributions by the international scientific community to extend NDN operation over challenged networks, leading to several research topics to be investigated and creating significant collaboration opportunities among European institutions. Within COPELABS exploitation plan we may highlight the goal of strengthening the scientific ties between Europe and the United States of America, where a big investment on the Named-Data Networking architecture is being made.

In particular, COPELABS plans to exploit UMOBILE solutions in three ways:

- Develop new European collaborations aiming to exploit the integration of NDN and opportunistic networks to develop new solutions in the area of Internet-of-things.

- Contribute to the international scientific community by developing open-source tools and applications able of boosting the communication among people without relying on the presence of network infrastructure.

- Exploit UMOBILE architecture as a starting point to participate in more research proposals and projects at European level that are not focused only on ICN.

As a research unit associated with University Lusófona, we aim to make an UMOBILE prototype and test-bed available as a research lab to support practical courses of the informatics department. Moreover our expertise in the UMOBILE project will be used to update the pedagogical content of some courses of the NEMPS PhD program on New Media and Pervasive Systems.

## Expected benefits

We aim to expand the outcomes of UMOBILE project to the society with various partners, namely in the field of mHealth. This will be done in the context of a new COPELABS laboratory called Proxemics Data Lab. Within this laboratory we are working on behaviour correlation/inference via pervasive, non-intrusive technology as the one being developed within the UMOBILE project. The outcome of the UMOBILE project will support COPELABS work in two main areas: community/group dynamics and early detection of neuro/psychological disorders. One example is the usage of opportunistic networking solutions to study the proxemics effect in social cohesion and support.

## 6.5. TECNALIA

## Company profile

Fundación TECNALIA Research & Innovation (Tecnalia) is a private, independent, non-profit applied research centre of international excellence. Legally a Foundation, Tecnalia is the leading private and independent research and technology organisation in Spain and one of the largest in Europe, employing 1,378 people (164 PhDs). TECNALIA is committed to generate major impacts in economic terms, by means of innovation and technological development, addressed by 7 business divisions, covering economic sectors of Energy, Industry, Transportation, Construction, Health and ICT. TECNALIA has been granted over 250 patents and promoted more than 30 spin-off companies.

The Industry and Transport Division of TECNALIA participates in this project. This division is focused on the design, manufacturing, maintenance and end-of-life of industrial products and services, for the improvement of its clients' competitiveness in the following strategic sectors: foundry and steelmaking, machine-tool, automotive, aerospace, aeronautics, railway, construction, and de-manufacturing and food industry. Actually, the business area participating in the project is the Instrumentation & Smart Systems area, which focuses its activity in:

- Data analytics smart solutions development as support for decision-making systems.

- Indoor location and tracking systems for people and assets, based on hybrid wireless technologies and protocols.

- Instrumentation and data acquisition systems for industrial machinery and goods.

- Condition-based monitoring solutions for maintenance and products lifecycle management.

- Digital factory: production monitoring, optimization and optimal process control.

- Industrial safety and risk management systems.

- Energy efficiency solutions focused on consumption prediction models and decision making support tools.

Tecnalia participates in the High Level Group of European Technological Platform for Researching in Manufacturing (ManuFuture), coordinating the multi-annual work plan for the "Factories of the Future" JTI/PPP (Dr. Rikardo Bueno); and is represented in the executive board of the European Technological Platform for Researching in Robotics (EUROP), in the board of the European Robotics Research Network (EURON) and in the Advanced Research & Technology for Embedded Systems (ARTEMIS). Tecnalia participates also in the following Platforms: European Technological Platform for materials (EUMAT), European Association of Automotive Centres (EARPA), Intelligent Transport Systems Platform (ERTICO) and European Association for Sustainable Process Industry through Resource and Energy Efficiency (A. SPIRE Aisbl). Tecnalia is member of the European Association of Research and Technology Organisations (EARTO) and its Special Interest Group EUROTECH.

## Product overview (value proposition)

TECNALIA will support the dissemination focusing on Spanish relevant events and activities in the field, as well as will participate in other international initiatives through its extended connection network. Tecnalia will also support the dissemination activities to user communities and the general public. Tecnalia is participating in several Artemis and H2020 projects where the advances of UMOBILE will definitely be of key importance, and so we commit to spread the outcomes of the project in the expert communities we participate as members, conferences and relevant workshops.

As a Research Institute Tecnalia's exploitation goals are different, yet complementary to those of industrial partners. Technical developments will be integrated quickly into its research agenda giving to Tecnalia a competitive edge compared to other research institutions.

Specifically, Tecnalia will exploit the following results:

- Use the obtained know-how to go for real implementation of smart routing techniques that improve our current assets in the area of indoor location and tracking solutions, based on hybrid wireless technologies

On the other hand the UMOBILE developments will be incorporated to current and new ad-hoc personal communication devices for a more efficient routing and caching when these are mobile and/or highly constrained in terms of resources, such as memory, battery, or CPU.

## Exploitation plans

TECNALIA is the first leading private and independent research and technology organization in Spain. Tecnalia, performs Technology transfer to companies either via public funded projects (e.g. more than 264 participated European projects) or via private contracts. Additionally, TECNALIA has an organizational structure called VENTURES, to support the creation of Start-ups, entrepreneurship, business angels' networks, etc., and an instrument called Inspiring Business Forum (IBF) with associated organizations to promote innovation.

TECNALIA is expected to exploit the UMOBILE smart routing techniques, organizing and analysing all existing knowledge and experience within the context of next generation smart systems and solutions for several domains.

As an applied research centre, Tecnalia can use the different approaches in order to exploit the results derived from the work performed in the UMOBILE project:

- Royalties and licenses: being one of the missions of Tecnalia to transfer knowledge and innovation to companies, the results could be exploited by the creation of patents that can be licensed to third part companies.

- Services portfolio: the results and knowledge that Tecnalia acquires through the project UMOBILE will be included into the services that Tecnalia offers to advanced engineering companies, mainly in the regional scope but also at European level.

- Creation of spin-off companies: Tecnalia expects that a technology-based spin-off company can be created in order to exploit and further develop the product family of location and tracking solutions under development, and improved by knowledge originated within the project.

## Expected benefits

The main outcome that Tecnalia expects to obtain from the UMOBILE project is the development of an innovation and knowledge based smart routing framework that can be further evolved and incorporated into a former research area within the Instrumentation & Smart Systems Business Unit. The goal is to obtain a system at TRL 6 by the end of the project, which will position Tecnalia in an optimal situation in order to gain and retain its relevant role as innovation partner for many client and partner companies in the Basque Country eco-system. This position will foster Tecnalia's importance among its partnerships at European and international levels.

With the aim of transferring value to the society through innovation and technology, the Telecom and Electronics team shows a high degree of specialization and focus on: ad-hoc embedded hardware design and prototyping, multicore computing, advanced FPGA-based design, indoor location solutions based on hybrid wireless technologies, sensor and actuator networks, Radio Frequency (RF) design and GNSS RF-Frontends among others. The Telecom and Electronics team provides a response to market and research demands

in terms of capacity and velocity, competence, critical mass, qualified professionals, equipment and anticipation to technological changes. The expected benefits for this team within TECNALIA could be summarized as:

- Integration of results into localization and tracking product line.

- Expertise in social interactions applied to user safety and quality of experience.

- Interworking with companies to trigger innovative products via knowledge transfer.

## 6.6. TEKEVER

### Company profile

TEKEVER Autonomous is an SME, Original Equipment Manufacturer and provider of unmanned systems, in air, land and sea, tailored for the security, aerospace, civilian and commercial markets. TEKEVER Autonomous System was founded in 2007 as a spin-off of the TEKEVER Group activities in the robotic market and, as part of TEKEVER Group; it jointly explores and benefits from the group implementation worldwide. TEKEVER activities are product-driven and significant investment is dedicated to research activities leading to innovative technologies, in different fields, from flight control, payload exploitation, automatic planning to image processing, analysis and image features tracking. TEKEVER targets its markets in close collaboration with customers and establishing important partnerships to bring technology to a mature operating level and promote technological readiness driven by the market needs.

With subsidiaries in Europe, Asia, the United States and South America, TEKEVER leverages innovation technology, ensuring an unprecedented advantage to its clients and partners throughout the World, being based out of Portugal. TEKEVER has significant experience in collaborative research (FP6, FP7, ESA, EDA) having coordinated 8 FP7 projects and 1 H2020, and participated in numerous other European projects.

TEKEVER Autonomous Systems personnel are involved in several civil organization networks addressing the problematic of UAV's integration in the market, contributing to the development of standards, like EUROCAE. TEKEVER Autonomous Systems is also member and leading company of the R&D work group of the Portuguese FEEM organization, a hypercluster organization for the Economical Sustainable Sea Exploitation that aggregates industry, research centres, universities and governmental institutions acting in different sectors, from fishing to production, security, energy, biology and naval domains.

In UMOBILE, TEKEVER AS is mainly involved in the validation and testing of UMOBILE prototypes, especially through the demonstration of their possible operation in Unmanned Aerial Vehicles (UAV). In addition to defining the validation exercises and associated KPI to be measured, TEKEVER AS will be integrating UMOBILE enabled

communication systems on unmanned aerial platforms, providing, operating and deploying these platforms in validation exercises as backhaul add-ons and data mules.

## Product overview (value proposition)

The Air Ray Systems are the main products of TEKEVER Autonomous Systems. Air Ray Systems have been extensively and successfully field tested and battle proven by multiple Armed and Security Forces. From 4.000m+ mountains to active volcanos, Air Ray systems have been through the hardest operational conditions, assuring resilience and readiness for any type of situation.

TEKEVER Air Ray systems are designed to be simple to operate while delivering the highest performance. Simplicity lowers the amount of training required, with operators typically trained in less than one week, and helps delivers the best results in under pressure conditions. The Air Ray systems offer a wide array of payload types, including multiple types of EO, IR and thermal sensors, LiDAR, Radar or SAR. Additionally, and to provide the best operational support, all systems provide multi-platform support for system control and payload exploitation.

Communication relay is considered one of the core missions for TEKEVER systems: connectivity is provided for ground forces, support operations "over the hill" and support local forces (Foot soldiers and vehicles) with a local connections link or satellite link. Delay Tolerant Networking technologies have also been implemented in TEKEVER systems. However, current communication relay capabilities are focused on security and military scenarios. UMOBILE is an opportunity to extend the Air Ray system capabilities to missions with harsher requirements from the communications point of view, such as civil protection, emergency or social networking, enablement of connectivity to crowds, etc. Hence, UMOBILE will contribute to extend the set of Air Ray possible missions, opening the doors to other markets besides defence and security, such as civil, entertainment or the Internet of Things.

**Figure 7: Air Ray Communication Relay**

## Exploitation plans

The Air Ray Systems are fully developed in house by TEKEVER, from radios and flight controllers to structures. Hence, TEKEVER possesses the know-how to fully exploit the capabilities developed in UMOBILE, designing a path to market, through their integration in the current line of products, adding new capabilities and consequently opening new market opportunities. For that purpose, TEKEVER expects to:

1. Mature the developed technology in the short term, improving it with knowledge that will arise from the test campaigns, and ensuring the best adaptation to the company's line of products;

2. Test and validate the technology, in the short/medium term, in operational environments to be defined as strategic for the Air Ray Systems;

3. Transfer the knowledge from the research teams into the delivery teams, implementing and qualifying the developed capabilities into TEKEVER's systems;

4. Demonstrate and commercialize the results, including the definition and implementation of a marketing plan.

## Expected benefits

TEKEVER Autonomous Systems expects to benefit from the UMOBILE results through the addition of value to the company's Air Ray line of UAVs. This incorporation of innovation will expectedly increase revenues via:

- Current and new customers in markets, such as military and security entities, that could find value in increased Delay Tolerant Networking capabilities and Communication Relaying using UAVs;

- New customers in markets such as entertainment and media, civil protection, Internet of Things, commerce, industry and services, where UMOBILE related capabilities will possibly enable the successful introduction of TEKEVER products.

### 6.7. SENCEPTION

## Company profile

Senception is a Portuguese SME focused on developing technological solutions to improve the daily routine of citizens. We cherish the vision of improving the daily routine of citizens via the development of user-friendly technology. We build such vision via the mission of designing and producing pervasive technology that assists the capture and the inference of interactions among people, and their surroundings.

Senception's products have as value-add non-intrusive behaviour tracking and inference of user preferences as well as of social roaming habits. Our solutions are software-based, and available in the most used operating systems.

Senception incorporates a team that is strongly based on industrial research, being currently involved in several industrial research activities.

## Product overview (value proposition)

In the context of a nomadic citizen, the relevancy of innovative technology capable of assisting our daily routines has been increasing, often integrated into a context where data can be provided to the citizens. An additional aspect that is relevant to Senception is a better integration of technological solutions in the context of smart communities and cities, namely, a technological integration that promotes quality of living via non-intrusive, pervasive technology that can perform activity and behaviour recognition and inference, both from an individual and collective perspective.

Hence, our focus is on small and smart data analysis such as, for instance, technological solutions that may assist in better communication (and result in social cohesion) derived from shared interests, wishes and needs, as well as a better understanding concerning roaming patterns and spaces visited.

Senception builds technological solutions that are expected to improve societal aspects such as: social cohesion; better understanding of the use of specific spaces or environments (e.g. green spaces; sports).

Our solutions present several differentiating aspects. First and foremost, they are software based, low-cost and non-intrusive: they consider sensors that are available around the citizen. Data capture and analysis takes into consideration the need to ensure total privacy, and to keep data only with its user.

We are currently developing two distinct product lines that share the common goal of improving social routine of the vertical markets that they are being applied to, via a better understanding and inference of such routine. For that purpose, Senception relies on network mining solutions and data learning.

Being a strong believer in research and innovation, Senception offers to specific partners, in the context of industrial research, the possibility to explore light versions of its products, in the context of research.

## Exploitation plans

UMOBILE aspects that Senception is contributing to, namely, usage and user contextualization derived from network data capture and mining to improve the daily social routines of citizens are aspects that are highly relevant to the PerSense product line of Senception.

In the context of UMOBILE, PerSense Mobile Light is a service that has been developed to assist in performing network contextualization and which Senception has opened to research partners (industry and academia). Currently, PerSense Mobile Light captures information concerning a user's affinity network (contacts derived from Wi-Fi Direct and Bluetooth) as well as concerning roaming habits, over time and space (Wi-Fi). In a future

On a second phase Senception shall develop a "sociability forecasting" module in the context of UMOBILE (refer to D3.3) and shall integrate aspects such as user recommendations and estimation of conditions for social interaction to occur derived, e.g., from shared interests; affinities; wishes.

These are aspects that shall assist Senception in further evolving its product line PerSense, in the context of intermittent connectivity environments and Smart Cities.

Senception expects to exploit these aspects not only in terms of know-how and technological readiness, as well as in terms of scalability, by integrating UMOBILE use-cases and requirements into pilots that Senception is currently developing in Lisbon (LxFactory); Portimão. Furthermore, Senception expects to exploit the capability of its product in the context of industrial research by developing large-scale studies involving UMOBILE partners as well as external entities, in order to further study roaming habits of citizens and relation with spaces.

## Expected benefits

The data captured as well as the validation of contextualization are considered to be highly beneficial to an adequate development and positioning of the PerSense product of COPELABS in the context of smart cities and smart communities. Based on the validation and integration of the tool in UMOBILE scenarios, Senception expects to assist in reaching a quicker time-to-market as well as to address new types of customers and new types of vertical markets (e.g. tourism).

## 6.8. FON

## Company profile

FON is a company founded in 2006 by CEO, entrepreneur and Internet pioneer Martin Varsavsky with the goal of blanketing the world with WiFi that is free for everyone. Even though it is an SME, it has more than 20 million hotspots across the globe and partnerships with leading operators. This currently makes FON the world's largest WiFi network. In addition to operate its WiFi networks, FON develops its own technology, which includes among others: WiFi access points, service platforms and mobile apps.

FON's network usage has evolved from laptops to mobile devices (including game consoles) in the last few years. FON has integrated its network with heterogeneous networks and operators (both fixed and mobile), acquiring a very valuable expertise and building effective seamless networks for the users. This knowledge has allowed FON to develop and implement mechanisms, which ensure best user experience, into its technology.

In UMOBILE, FON provides expertise as WiFi network operator. In particular, FON participates in the definition of user requirements, system and network requirements and system deployability design in order to ensure an appropriate integration of the UMOBILE platform into the FON WiFi network. Moreover, FON leads the definition of the validation setup of UMOBILE and deployment trial activities. Furthermore, FON contributes in the preparation of the proof of concept used during the validation tasks of this project. Finally, FON also leads the exploitation task as a representative of the industrial partners.

## Product overview (value proposition)

One of the FON's main products and, maybe, the most famous one, is the community WiFi. FON signs agreements with operators so they can provide community WiFi service to their subscribers including FON's functionality in the CPE (Customer Premise Equipment) that they install in users' premises. This way, users are able to connect to any of the access points that propagates FON's signal all over the world without regard to the operator. The main value proposition that FON offers to mobile operators with this product is offloading between cellular network and WiFi network. Users receive an added value service as they are able to have Internet connectivity all around the globe.

However, this traditional offloading (i.e. from cellular to WiFi networks) is no longer sufficient to cover current and future scenarios. For example, it has been also unable to cope with crowded scenarios (e.g. stadiums) since Wi-Fi networks end up suffering from similar congestion symptoms than cellular networks.

UMOBILE has identified those scenarios and proposed a solution that solves the connectivity problems by combining different technologies. UMOBILE is an opportunity for FON to improve the community WiFi product, i.e. the offloading value proposition, that the company currently offers with an innovative complement for certain scenarios that cannot be properly covered by current solutions.

During the project, FON is working on the integration of UMOBILE platform into its network. FON may opt to convert access points to UMOBILE access points in order to offer a more complete offloading value proposition to operators. Regarding the app for the users, FON may offer UMOBILE's app in a first step and may integrate the functionality in its app if the operator want a more complete user experience.

On the one hand, FON will keep on targeting telecom operators by offering a more complete offloading method applicable to previously uncovered scenarios. On the other hand, new markets may be opened for FON by offering UMOBILE related services to specific venues (e.g., stadiums) or municipalities.
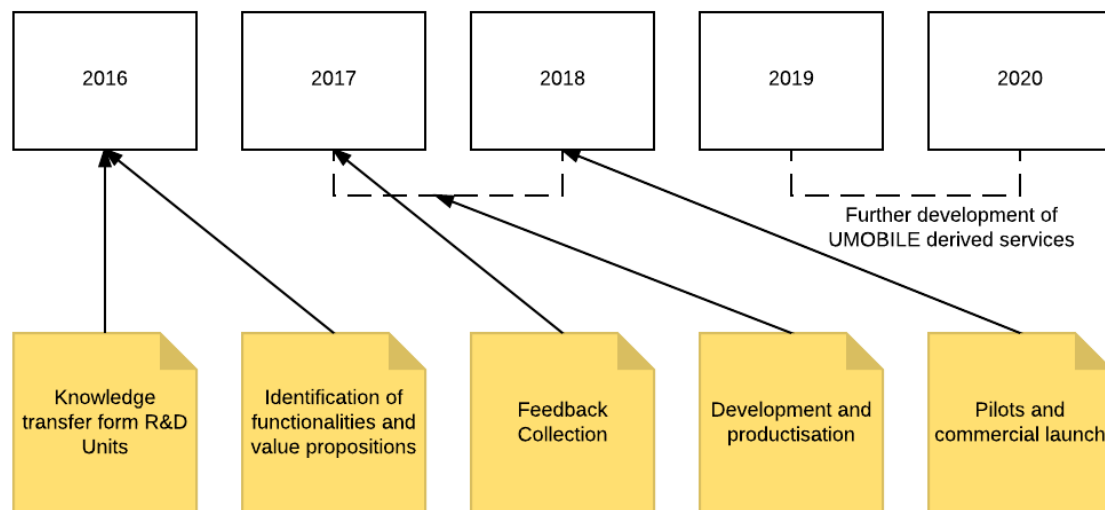
## Exploitation plans

FON develops its own technology, which includes access points, mobile apps and frontend and backend systems. Thereby, FON currently has the capabilities of "productising" a UMOBILE solution, taking as a starting point what is being developed during the project.

FON plans to go for the following phases to ensure proper project exploitation:

1. *Knowledge transfer from R&D unit to development units and business / marketing departments*: FON R&D unit will arrange and lead internal meetings to share UMOBILE concepts, project results and potential opportunities. Several presentations have been already arranged during the project.

2. *Identification of functionalities and value propositions*: Jointly with business and marketing units, features and value propositions derived from UMOBILE and subject to be integrated into FON services will be identified. Business case simulations covering the main value proposition have been performed. Those are also related to FON's current offering.

3. *Operator partners and other potential customers' feedback collection*: after value propositions identification, a process of feedback collection will be initiated to ensure that current FON operator partners perceive value on UMOBILE derived features. This feedback collection may also include new potential customers like venues or municipalities. Initial value propositions will be shaped by considering the collected feedback.

4. *Development and productisation*: reaching this phase means that a bundle of UMOBILE functionalities have been chosen for development, implementation and productisation into FON existing technology. An engagement with device vendors or OS providers may be required in this phase.

5. *Pilots and commercial launch*: final phase before commercial launch will cover a bundle of pilots with the aim of debugging pre-commercial versions of the solution and collect additional feedback.



**Figure 8: Fon Exploitation Plan**

## Expected benefits

UMOBILE opens opportunities in terms of new products and services. These new products and services could potentially provide new revenue streams by:

- Targeting current customers (i.e. operators) with an extended offer regarding offloading. Alternatively, UMOBILE service could be also incorporated into current business model as a value added service with no additional cost for the operator in order to improve customer retention and satisfaction.

- Targeting new potential customers (e.g. venues, municipalities). Business models can be implemented into offers that include UMOBILE platform use, UMOBILE platform integration services or UMOBILE terminal functionality licensing.

## 6.9. AFA

### Company profile

AFA Systems srl is an ICT SME, specialized in network solutions and advanced IP communications, based in Termoli (IT), with branch offices in Italy. The permanent staff has high qualifications and skills (master degrees and PhD) in information engineering, software engineering, computer science, economics, marketing, with different backgrounds ranging from network solutions to video-surveillance applications, biometrics systems and multimedia security. The company applies a comprehensive Quality Management System based on ISO 9001:2008 standard, in full compliance with international standards, using the most advanced equipment.

With its talented team, AFA Systems develop highly innovative projects in two interrelated and completing business units:

- AFA Industrial (production of a range of integrated IP platforms, for unified communication, IP security and VoIP, called MajorNet®).

- AFA Engineering (networking projects and system integration).

The Industrial business unit produces the MajorNet platform, a range of systems providing a complete set of IP services, from unified communication to local web-storage, demanded by business users, SMEs, public entities, schools, etc. The MajorNet platform aims at catching the massive market opportunity created by low cost broadband Internet access that generates demand for sophisticated, reliable, integrated and easy-to use IP services. MajorNet is distributed through a network of channel partners; there are currently thousands of MajorNet users, growing rapidly.

The Engineering business unit designs and installs large-scale wireless networks, telecommunication systems, video-surveillance systems and advanced IP networks, integrating the company's own infrastructures with the Telcos' infrastructures; over those heterogeneous IP networks, a general result is to grant a high "end to end quality".

The company currently operates many wide area networks (mainly wireless), from its dedicated NOC (Network Operations Center).

## Product overview (value proposition)

The current key points of the MajorNet platforms are the capability to cover a wide number of applicative cases and users' needs on the basis of a defined set of network models, in cost-effective way and with user-friendly configuration procedures.

The UMOBILE outcomes will directly increase the value of the MajorNet platforms. Whereas at the moment the MajorNet platforms are inherently a network element at the customer premises, the application of the UMOBILE logical modules from ICN and DTN will make the MajorNet platforms an element of the network infrastructure itself. A similar result will be produced by the adoption of the service migration paradigm, defined and studied during the UMOBILE project.

The MajorNet platforms will gain the role of smart UMOBILE-sed WiFi access points and in-networks smart service execution gateways (SEG), which run services pushed at the network edges. New applications will be covered where the MajorNet platforms will act as in-network-caching elements, dynamically hosting contents and services on the basis of the users' interests.

## Exploitation plans

In preparation of the real deployments, AFA Systems has designed the UMOBILE Lab as a complete testbed for both the network devices and user devices (e.g. smartphones). With a remote access to the UMOBILE Lab, each partner of the consortium will be able to upload new software modules and test functional architectures; the AFA Systems personnel will assist and operate if a physical connection needs to be modified.

In a later stage, AFA Systems will start to convert some of its wireless networks to the UMOBILE architecture. This is a way to exploit the UMOBILE components (AP, SEG, apps) as well as the UMOBILE architecture itself which consists in the techniques and strategies chosen during the early stages of the project (for naming, forwarding, routing storing).

A special exploitation action will be undertaken together with some of the Italian Civil Protection Agencies. At the moment we are planning the details with two of them (Regione Umbria, Regione Molise). At the beginning of June, other Agencies have shown their interest during the "Expo Emergenze" fair where we presented the UMOBILE project; we are going to evaluate how to collaborate with those Agencies.

## Expected benefits

At the end of the UMOBILE project, we expect to have at least system prototype demonstrations in operational environment. This is a promising starting point to extend the current application domain of the MajorNet; the platforms will gain unique characteristics improving the competitive position of both the product and the AFA Industrial business unit.

With the UMOBILE experience, the AFA Engineering business unit will innovate its principles of the network design, renewing its technological leading position. On the basis of both the UMOBILE systems and architecture, the company will enrich its portfolio of solutions offered to its customers as ISP and municipalities.

# 7. Conclusions

This document has been aimed at describing and planning the exploitation activities to be carried out up to and after the end of the UMOBILE project. It represents a draft version of the final exploitation report which will be released at the end of the third project year as deliverable D6.5.

The actual situation of the sector has been described in Section 2, together with the identification of the emergent trends. This section concludes that there are more and more devices connected to the internet and the data traffic is also increasing. Users consume more and more content and they want to consume it wherever they are. Mobility is becoming more important and in this scenario ICN networks has a lot to do. On the other hand, users want to access to the internet but only when required. So DTN networks have also relevance to complete the scenario. DTN and ICN technologies are seen as promising and, as it has been pointed out in section 2, are well aligned with the emerging trends so UMOBILE fits well with the current and future internet scenarios. UMOBILE can be considered an important project because it does not only approaches the definition of a unified ICN and DTN communication platform but also opens opportunities for new services and applications. After describing the situation of the sector and starting the analysis of the position of UMOBILE, section 2 includes a UMOBILE SWOT analysis in order to complete this analysis.

The exploitation strategy considered throughout the project has been described in Section 3. It covers all the project activities, starting from the design phase of the proposal lasting up to the end of the project with the aim of planning the successive real-world usage of the project outcomes.

Section 4 contains a first list of the results of the project which could be used directly or indirectly for further research activities, for developing, creating and marketing a product or process, or for creating and providing a service. This list will be eventually updated in the final release of the document (i.e., D6.5). By the moment, UMOBILE can be exploited as a technology solution that can be sold or as a service that can be provided. In the first case, an entity can buy UMOBILE solution to a UMOBILE technology provider and build services on the top of the solution. In the second case, once an entity has UMOBILE technology, it can become a UMOBILE service provider and provide the services designed and developed during the project or new services that can be developed on the top of the solution.

The business models applicable to UMOBILE solution have been presented in Section 5, for both technology and service providers. Moreover, business canvases have been described for both providers.

Each partner has provided its exploitation plan in Section 6, which contains a brief company profile, an overview of the identified products and/or services, the exploitation plan, the already performed activities and the expected benefits of each identified solution.

# 8. References

[1] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2015 2020

[2] Gartner Networking and Communications Hype Cycle 2015