



EUROPEAN COMMISSION
Communications Networks, Content and Technology
Future Connectivity Systems



ANNEX 1 (part A)

Research and Innovation action

NUMBER — 645124 — UMOBILE

Table of Contents

| | |
|--|----|
| 1.1. The project summary..... | 3 |
| 1.2. The list of beneficiaries..... | 4 |
| 1.3. Workplan Tables - Detailed implementation..... | 5 |
| 1.3.1. WT1 List of work packages..... | 5 |
| 1.3.2. WT2 List of deliverables..... | 6 |
| 1.3.3. WT3 Work package descriptions..... | 9 |
| Work package 1..... | 9 |
| Work package 2..... | 12 |
| Work package 3..... | 16 |
| Work package 4..... | 21 |
| Work package 5..... | 25 |
| Work package 6..... | 29 |
| Work package 7..... | 35 |
| 1.3.4. WT4 List of milestones..... | 36 |
| 1.3.5. WT5 Critical Implementation risks and mitigation actions..... | 38 |
| 1.3.6 WT6 Summary of project effort in person-months..... | 40 |
| 1.3.7. WT7 Tentative schedule of project reviews..... | 41 |

1.1. The project summary

| | | | |
|---|---|------------------------------|---------|
| Project Number ¹ | 645124 | Project Acronym ² | UMOBILE |
| One form per project | | | |
| General information | | | |
| Project title ³ | Universal, mobile-centric and opportunistic communications architecture | | |
| Starting date ⁴ | 01/02/2015 | | |
| Duration in months ⁵ | 36 | | |
| Call (part) identifier ⁶ | H2020-ICT-2014-1 | | |
| Topic | ICT-05-2014 Smart Networks and novel Internet Architectures | | |
| Fixed EC Keywords | | | |
| Free keywords | Delay Tolerant Networking, Information Centric Networking, Free Internet access | | |
| Abstract ⁷ | | | |
| <p>Cars, sensors, home appliances, every device in the daily life of citizens is becoming a constituent in Future Internet, adding to the need to reconsider requirements and assumptions in terms of network availability and affordability to support the ever increasing traffic demand. Still, the current Internet can only evolve adequately, if its infrastructure can be devised to accommodate the emerging services. The increased cost of adding new infrastructure and capacity has a drastic effect on rural and remote communities as well as nomadic users as they become marginalized by not gaining access to crucial Internet services. Our goal is to make the Future Internet universally pervasive supporting a diverse set of services. To achieve this, we develop a universal mobile-centric and opportunistic communications architecture, which integrates the principles of Delay Tolerant Networking (DTN) and Information Centric Networking (ICN) in a common framework. We utilize the benefits of both ICN and DTN to enable resource exploitation at minimal bandwidth, opportunistic access to information and more localized access to information through novel caching strategies. UMOBILE focuses on assisting users in getting access to the content they want or content that may be of shared interest to their trust circles. By relying on an instance of the UMOBILE architecture, users are able to share information directly with other peers without relying on infrastructure or expensive connectivity services. The proposed architecture targets the mobile part of the networks, extends Internet connectivity to regions that are not typically covered enhancing network resilience and is fully backward compatible with the current Internet architecture. We will validate our architecture in a real world trial as well as participate strategically in carefully planned dissemination, standardization and exploitation activities to ensure that our architecture transcends from the lab to real world deployments.</p> | | | |

1.2. List of Beneficiaries

| | | | |
|-----------------------------|--------|------------------------------|---------|
| Project Number ¹ | 645124 | Project Acronym ² | UMOBILE |
|-----------------------------|--------|------------------------------|---------|

List of Beneficiaries

| No | Name | Short name | Country | Project entry date ⁸ | Project exit date |
|----|---|----------------|----------------|---------------------------------|---|
| 1 | ATHENA RESEARCH AND INNOVATION CENTER IN INFORMATION COMMUNICATION & KNOWLEDGE TECHNOLOGIES | Athena RC | Greece | 07/12/2016 | |
| 2 | UNIVERSITY COLLEGE LONDON | UCL | United Kingdom | | |
| 3 | THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE | UCAM | United Kingdom | | |
| 4 | COPELABS - ASSOCIACAO PARA A INVESTIGACAO E DESENVOLVIMENTO EM COGNICAO E COMPUTACAO CENTRADA NAS PESSOAS | COPELABS-COFAC | Portugal | | |
| 5 | FUNDACION TECNALIA RESEARCH & INNOVATION | TECNALIA | Spain | | |
| 6 | TEKEVER II AUTONOMOUS SYSTEMS LDA | TEKEVER AU | Portugal | | |
| 7 | SENCEPTION LDA | Senception | Portugal | | |
| 8 | FON TECHNOLOGY SL | Fon Technology | Spain | | |
| 9 | AFA SYSTEMS SRL | AFA Systems | Italy | | |
| 10 | DEMOCRITUS UNIVERSITY OF THRACE | DUTH | Greece | | the day after the notification of termination |

1.3. Workplan Tables - Detailed implementation

1.3.1. WT1 List of work packages

| WP Number ⁹ | WP Title | Lead beneficiary ¹⁰ | Person-months ¹¹ | Start month ¹² | End month ¹³ |
|------------------------|---|--------------------------------|-----------------------------|---------------------------|-------------------------|
| WP1 | Project Management | 1 - Athena RC | 27.12 | 1 | 36 |
| WP2 | System requirements and specifications | 3 - UCAM | 54.48 | 1 | 30 |
| WP3 | System and node architecture development | 1 - Athena RC | 135.52 | 6 | 30 |
| WP4 | Services enablement | 7 - Senception | 70.73 | 6 | 30 |
| WP5 | Overall platform integration and validation | 8 - Fon Technology | 125.01 | 18 | 36 |
| WP6 | Dissemination, exploitation and standardisation | 9 - AFA Systems | 51.99 | 1 | 36 |
| WP7 | Ethics requirements | 1 - Athena RC | N/A | 1 | 36 |
| Total | | | 464.85 | | |

1.3.2. WT2 list of deliverables

| Deliverable Number¹⁴ | Deliverable Title | WP number⁹ | Lead beneficiary | Type¹⁵ | Dissemination level¹⁶ | Due Date (in months)¹⁷ |
|--|---|------------------------------|-------------------------|--------------------------|--|--|
| D1.1 | Project Handbook | WP1 | 10 - DUTH | Report | Confidential, only for members of the consortium (including the Commission Services) | 3 |
| D1.2 | External Liaison Overview | WP1 | 10 - DUTH | Report | Public | 6 |
| D1.3 | Project management reports (1) | WP1 | 10 - DUTH | Report | Confidential, only for members of the consortium (including the Commission Services) | 18 |
| D1.4 | Project management reports (2) | WP1 | 1 - Athena RC | Report | Confidential, only for members of the consortium (including the Commission Services) | 36 |
| D2.1 | End-user requirements report | WP2 | 3 - UCAM | Report | Public | 5 |
| D2.2 | System and network requirement specifications (1) | WP2 | 3 - UCAM | Report | Public | 14 |
| D2.3 | System and network requirement specifications (2) | WP2 | 3 - UCAM | Report | Public | 30 |
| D2.4 | System and Network Deployability Design | WP2 | 3 - UCAM | Report | Public | 30 |
| D3.1 | UMOBILE architecture report (1) | WP3 | 10 - DUTH | Report | Public | 16 |
| D3.2 | UMOBILE architecture report (2) | WP3 | 1 - Athena RC | Report | Public | 30 |
| D3.3 | UMOBILE ICN layer abstraction initial specification | WP3 | 1 - Athena RC | Report | Public | 12 |
| D3.4 | UMOBILE ICN layer abstraction final specification | WP3 | 1 - Athena RC | Report | Public | 30 |
| D4.1 | Flowlet Congestion Control – Initial Report | WP4 | 7 - Senception | Report | Public | 12 |
| D4.2 | Flowlet Congestion Control – Final Report | WP4 | 7 - Senception | Report | Public | 30 |

| Deliverable Number¹⁴ | Deliverable Title | WP number⁹ | Lead beneficiary | Type¹⁵ | Dissemination level¹⁶ | Due Date (in months)¹⁷ |
|--|--|------------------------------|-------------------------|--------------------------------|--|--|
| D4.3 | Name-based Replication Priorities | WP4 | 7 - Senception | Report | Public | 24 |
| D4.4 | Set of QoS interfaces and algorithms | WP4 | 7 - Senception | Other | Public | 30 |
| D4.5 | Report on data collection and inference models | WP4 | 7 - Senception | Report | Public | 30 |
| D5.1 | Validation methodology and evaluation report (1) | WP5 | 8 - Fon Technology | Report | Public | 24 |
| D5.2 | Validation methodology and evaluation report (2) | WP5 | 8 - Fon Technology | Report | Public | 36 |
| D5.3 | Proof-of-Concept (1) | WP5 | 8 - Fon Technology | Other | Public | 24 |
| D5.4 | Proof-of-Concept (2) | WP5 | 8 - Fon Technology | Other | Public | 34 |
| D5.5 | Report on the validation of the deployment trial | WP5 | 8 - Fon Technology | Report | Public | 36 |
| D6.1 | Dissemination Plan | WP6 | 9 - AFA Systems | Report | Public | 6 |
| D6.2 | Dissemination Report (1) | WP6 | 9 - AFA Systems | Report | Public | 18 |
| D6.3 | Dissemination Report (2) | WP6 | 9 - AFA Systems | Report | Public | 36 |
| D6.4 | Exploitation Plan | WP6 | 9 - AFA Systems | Report | Public | 18 |
| D6.5 | Exploitation Report | WP6 | 9 - AFA Systems | Report | Public | 36 |
| D6.6 | Standardisation Plan | WP6 | 9 - AFA Systems | Report | Public | 12 |
| D6.7 | Standardisation Report | WP6 | 9 - AFA Systems | Report | Public | 35 |
| D6.8 | Awareness and Wider Societal Implications | WP6 | 9 - AFA Systems | Report | Public | 36 |
| D6.9 | Final plan for the Use and Dissemination of Foreground | WP6 | 9 - AFA Systems | Report | Public | 36 |
| D6.10 | Data Management Plan | WP6 | 9 - AFA Systems | ORDP: Open Research Data Pilot | Public | 6 |
| D7.1 | OEI - Requirement No. 3 | WP7 | 1 - Athena RC | Ethics | Confidential, only for members of the consortium (including the Commission Services) | 1 |
| D7.2 | POPD - Requirement No. 2 | WP7 | 1 - Athena RC | Ethics | Confidential, only for members of the consortium | 20 |

| Deliverable Number¹⁴ | Deliverable Title | WP number⁹ | Lead beneficiary | Type¹⁵ | Dissemination level¹⁶ | Due Date (in months)¹⁷ |
|--|--------------------------|----------------------------------|-------------------------|--------------------------|---|--|
| | | | | | (including the Commission Services) | |

1.3.3. WT3 Work package descriptions

| | | | |
|---|--------------------|---------------------------------------|---------------|
| Work package number ⁹ | WP1 | Lead beneficiary ¹⁰ | 1 - Athena RC |
| Work package title | Project Management | | |
| Start month | 1 | End month | 36 |

Objectives

The basic purpose of WP1 “Project Management” is to ensure the proper level of coordination and cooperation amongst the project consortium members. Additionally, WP1 includes the day-to-day management of the project, ensuring that contractual obligations are met, payments are made, cost statements are filled correctly, handling any contract amendments, liaising with the Commission, supporting the technical work packages by following and assessing the project’s progress. In particular, the objectives of WP1 are:

- O1.1: To guarantee the non-technical and administrative coordination among all activities involved in the project (e.g. IPR, consortium management, contractual issues, project costs, reporting).
- O1.2: To ensure proper level of cooperation, communication, knowledge diffusion and consensus among project partners.
- O1.3: To organise and participate in project administrative meetings.
- O1.4: To ensure visibility of results to other projects and organise cooperation with other projects or other interested parties.

The outcome of WP1 is the timely handling and execution of all administrative activities of the project.

Description of work and role of partners

WP1 - Project Management [Months: 1-36]

Athena RC, UCL, UCAM, COPELABS-COFAC, TECNALIA , TEKEVER AU, Senception, Fon Technology, AFA Systems, DUTH

This work package encompasses all the internal project management tasks as well as the interaction with external partners and the coordination with the European Commission.

Task 1.1: Project Handbook

This activity provides the project management handbook that contains all related information such as milestones, deliverables, templates to be used, communication platform details and procedures to be followed. It also provides the details of all partners’ co-ordinates as a one-stop information source. This project handbook should include best practices to monitor the progress and quality of the deliverables as well as the guidelines to track and report problems as well as the process to solve them. This task will also ensure and foster communications between the partners to be ensured at all levels and coordinate the interaction within the project.

This task will also carry out the preparatory work at the beginning of and throughout the project. On the formal side, this includes defining the reporting templates, establishing and maintaining meeting schedules, and managing the process to ensure participation from each partner. It will define the process for conflict resolution and the action plan for risk management.

Task 1.2: Project Administration

This activity is devoted to document archival, cost control, and overall financial management including cost and reporting coordination and consolidation. All actions relating to EC payments (such as distribution, coordination, and follow-up) will be carried out.

Task 1.3: Periodic Management Reports

This activity provides the deliverable documents containing the project activities summarizing the key issues addressed in the project, achievements and open issues on an annual basis. Interim and Annual reports will be prepared for the European Commission. This includes collecting quarterly reports from partners in written form listing the achievements of the last reporting period, work items planned for the next, and the progress on specific work items, including showstoppers or problems that affect the progress. This task will schedule conference calls with all participants if necessary. The project coordinator will collect all reports and will create a single report including individual reports from each partner and listing actions and decisions taken to handle the problems identified from each partner. The implementation of the project work plan will be controlled. Milestones control to be established. Deliverables deadlines to be respected.

Task 1.4: Coordination of External Liaison

This activity carries out all IST technical horizontal coordination and consensus building activities.

Role of contributing partners

ATHENA will be the coordinator of the project, taking responsibility for the overall project management, interaction with the European Commission, coordination with other projects and concerted efforts as appropriate, and for the proper operation of the consortium as a whole including the in-time delivery of results. All other partners will participate in the management meetings and in reviews with the European commission.

Other partners will contribute with reports and participation to the scheduled meetings or conference calls.

Participation per Partner

| Partner number and short name | WP1 effort |
|-------------------------------|--------------|
| 1 - Athena RC | 3.00 |
| 2 - UCL | 2.00 |
| 3 - UCAM | 2.00 |
| 4 - COPELABS-COFAC | 2.00 |
| 5 - TECNALIA | 2.00 |
| 6 - TEKEVER AU | 2.00 |
| 7 - Senception | 2.00 |
| 8 - Fon Technology | 2.00 |
| 9 - AFA Systems | 2.00 |
| 10 - DUTH | 8.12 |
| Total | 27.12 |

List of deliverables

| Deliverable Number ¹⁴ | Deliverable Title | Lead beneficiary | Type ¹⁵ | Dissemination level ¹⁶ | Due Date (in months) ¹⁷ |
|----------------------------------|--------------------------------|------------------|--------------------|--|------------------------------------|
| D1.1 | Project Handbook | 10 - DUTH | Report | Confidential, only for members of the consortium (including the Commission Services) | 3 |
| D1.2 | External Liaison Overview | 10 - DUTH | Report | Public | 6 |
| D1.3 | Project management reports (1) | 10 - DUTH | Report | Confidential, only for members of the consortium (including the Commission Services) | 18 |
| D1.4 | Project management reports (2) | 1 - Athena RC | Report | Confidential, only for members of the consortium (including the Commission Services) | 36 |

Description of deliverables

D1.1 Project Handbook [M03]

This deliverable provides all project management related information, serving as a single management information source.

D1.2 External Liaison Overview [M06]

Liaison within and outside of the H2020 Programme.

D1.3/D1.4 Project management reports [M18/M36]

This deliverable summarizes the key issues addressed in the project, achievements and open issues on each reporting period.

D1.1 : Project Handbook [3]

This deliverable provides all project management related information, serving as a single management information source.

D1.2 : External Liaison Overview [6]

Liaison within and outside of the H2020 Programme.

D1.3 : Project management reports (1) [18]

This deliverable summarizes the key issues addressed in the project, achievements and open issues on each reporting period.

D1.4 : Project management reports (2) [36]

This deliverable summarizes the key issues addressed in the project, achievements and open issues on each reporting period.

Schedule of relevant Milestones

| Milestone number¹⁸ | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|--------------------------------------|--------------------------|-------------------------|-----------------------------|--|
| MS1 | Project kick-off meeting | 10 - DUTH | 1 | Project kick-off meeting successfully held |
| MS2 | End of project | 10 - DUTH | 36 | Final technical and project reports have been delivered to the EC. |

| | | | |
|---|--|---------------------------------------|----------|
| Work package number ⁹ | WP2 | Lead beneficiary ¹⁰ | 3 - UCAM |
| Work package title | System requirements and specifications | | |
| Start month | 1 | End month | 30 |

Objectives

The objective of WP2 is to define the requirements and the specification of the overall platform in terms of user requirements, network and system design and deployability. In this WP, we will:

- O2.1 Define the system requirements from the perspective of the network and the end-users.
- O2.2 Analyze the operational requirements and deployability aspects of UMOBILE platform.
- O2.3 Align application and protocol requirements with validation scenarios.

The outcome of WP2 will be utilized in WP3 and WP4 to derive and develop the platform architecture and enable multiple services.

Description of work and role of partners

WP2 - System requirements and specifications [Months: 1-30]

UCAM, Athena RC, UCL, COPELABS-COFAC, TECNALIA, TEKEVER AU, Senception, Fon Technology, AFA Systems, DUTH

The activities included in WP2 are organised in the following three tasks:

Task 2.1: User Requirements (UCAM, COPELABS, TECNALIA, FON Technology, ATHENA, DUTH, SENCEPTION)

During this task we will define the requirements of the system from the perspective of the end-users. This task will also work on the alignment of DTN and ICN requirements for end-users and will specify the user-specific requirements in order to support information- or data-centricity. These requirements will need to be incorporated in the protocol stack of user devices.

This task will include typical accessibility scenarios and requirements in different environments (urban vs. remote areas) with different devices. Members of our team have been assessing the user scenarios and requirements of ICT users and will, therefore, bring a wealth of experience to this activity by providing information on the uptake of services, what services/application people use most, and what services they would like to use in the future. The requirements of new content and knowledge dissemination approaches based on social interaction approaches derived from contacts between citizens, not necessarily acquainted, will be identified. Moreover, different applications and services will see different user requirements, which we seek to understand based upon our extensive experience in working with and designing ICN, DTN and mobile opportunistic applications.

Task 2.2: System and Network Requirements (COPELABS, ATHENA, DUTH, UCL, UCAM, TECNALIA, TEKEVER, AFA, FON Technology)

Having defined end-user requirements through Task 2.1, we will focus in Task 2.2 on the architectural requirements of our system, providing the input for the specification of the proposed platform. For this, we will investigate the requirements for the different subsystems that will be integrated, the interfaces that need to be implemented in order for these subsystems to cooperate, the interfaces to integrate fixed and mobile networks, the requirements for developing applications on top of our architecture, the exploitability of mobile networks etc.

Opportunistic communications and satellite or UAV-assisted backhaul links will be exploited to reach areas that are not typically covered. Moreover, DTN technology will increase network reach in space and time by exploiting the delay tolerance and the store-carry-forward paradigm inherent to DTN. For reaching out in space, we will explore the architectural requirements arising from using low-cost fixed and mobile nodes that are not “always on” as data relays. For reaching out in time, we will investigate delayed data forwarding strategies for utilizing otherwise capacity as less-than best effort service. Information-Centric Networking will be utilised here in terms of both in-network and end-user caching and content resolution. The related network-specific requirements will be determined.

Beyond plain extensions to networking (storage, forwarding, in-network caching, retrieval), we will also assess if applications can be supported by (local) processing content in network elements or associated devices in order to allow cloud-based applications and services to remain available even when connectivity disappears. We will also consider the resource constraints of mobile devices, in terms of CPU, memory, bandwidth, and energy. We address these requirements independently for the different classes of devices (sensor nodes, embedded routers, solar-powered relays, mobile phones, etc.) affected.

A key underlying aspect to be observed relates with the integration of social trust computation aspects, i.e., ways to allow devices to automatically exchange information based on circles of trust that are automatically set due to incentives to cooperate, as well as due to rewarding good behavior concerning dissemination of information.

Task 2.3: System Deployability Design (TEKEVER, FON Technology, AFA, SENCEPTION, TECNALIA)

This task involves the operational requirements of our platform. Focus will be given in analysing how our system can be easily deployable, fully operational and extensible. We will investigate the requirements stemming from such deployment analysis and identify the various components that need particular attention in order to ensure that all utilized systems and technologies will be fully supported and extended in the long-term. An individual site or area should be able to deploy the developed architecture locally with minimal “backend” support required. This is crucial for motivating early adopters and for truly exploiting every communication opportunity as our architecture puts forward. Although our vision includes use of disruptive technologies, such as incorporation of information-centricity into the proposed system, our architectural and structural design will guarantee smooth migration from today’s IP-centric network stack to a service-layer oriented and focused stack that natively supports information-centricity.

Moreover, since one of the key characteristics of UMOBILE platform is its applicability in critical situations, we will analyze multiple critical scenarios in order to ensure that the platform can be deployed, extended and operated even in environments with no fixed infrastructure. The task will also describe a detailed deployment plan for validation in WP5.

Role of contributing partners

DUTH and ATHENA will contribute to the definition of system and network requirements from the perspective of delay-tolerant networking. They will also utilise their experience in providing less-than-best-effort to users for the definition of user requirements.

UCL will focus on the requirements needed in order to integrate ICN-specific features into the proposed architecture. UCL has been leading the architectural and the network developments in the ICN area with the EU FP7 COMET architecture being one of the flagship projects in the area. Through this experience, UCL will specify the related requirements, which will guarantee fully backwards-compatible architecture and a smooth migration path towards its realisation.

UCAM will lead WP2 and utilise its expertise in QoS, radio resource management and ICN to contribute to the tasks T2.2. UCAM will also utilise its previous experience from projects related to broadband provisioning and GAIA IRTF group to lead T2.1.

COPELABS will lead task 2.2. COPELABS will also contribute to task 2.2 with knowledge concerning opportunistic dissemination approaches, both in regards to DTNs as well as in regards to data-centric architectures, such as ICN. Specific contributions relate with work developed by COPELABS in IRTF DTNrg working group, as well as middleware development for DTNs in remote regions such as Amazonia. The core of the interconnection between the different approaches, and having in mind pervasiveness, is work developed in the context of social trust computation developed in the context of a previous European project (EU IST FP7 ULOOP, User-centric Wireless Local Loop) as a way to seamlessly allow information to be disseminated without the need for complex structures and yet allowing liability to the ones involved.

TECNALIA will participate in tasks T2.2 and T2.3, focusing on the definition of network topology requirements and the overall system deploy ability. TECNALIA will offer expertise in the design of an efficient opportunistic network which involves content oriented deployment and configuration, also from the user’s perspective. This work will include the contribution to requirement specification for routing strategies incorporating an ICN scheme that can be deployed as modular and extensible.

TEKEVER will participate in T2.2 and will lead T2.3. In T2.2, TEKEVER will focus on the definition of technical requirements, namely device related (SWAP – Size, Weight and Power), mobility support, and satellite/UAV specific requirements. In T2.3 TEKEVER will coordinate and lead the activity of deriving suitable deployability requirements taking into account technical, operational and regulatory aspects.

SENCEPTION will participate in tasks 2.1 and 2.3. In regards to 2.1, SENCEPTION shall participate in the definition of user requirements, having in mind applicability of UMOBILE in smart trusted circles (e.g. family) across the scenarios to be defined. In regards to 2.3, SENCEPTION shall bring requirements concerning system deployability based on realistic operational settings, based on its open-source platform PerSense requirements, currently being tailored to be applied to personal cloud systems, e.g. NAS boxes.

FON Technology will participate in the definition of user requirements in task 2.1, providing its experience as a connectivity provider for the definition of uses cases, offering its knowhow from the perspective of the network and the end-users that are using its WIFI infrastructure. According to this, FON Technology will also participate in tasks 2.2 and 2.3 in the definition of specifications in order to ensure the “integrability” of resulting UMOBILE platform into existing WiFi infrastructure.

AFA will participate in tasks 2.2 and 2.3. Its extensive knowledge of the “open-source hardware” platforms as well as of the available wireless platforms (Hiperlan, etc.) will help to set requirements that can be achieved with no additional effort except the one strictly related to the proposal objectives.

Participation per Partner

| Partner number and short name | WP2 effort |
|-------------------------------|--------------|
| 1 - Athena RC | 1.50 |
| 2 - UCL | 4.00 |
| 3 - UCAM | 12.00 |
| 4 - COPELABS-COFAC | 6.00 |
| 5 - TECNALIA | 5.00 |
| 6 - TEKEVER AU | 3.00 |
| 7 - Senception | 4.00 |
| 8 - Fon Technology | 6.00 |
| Fon Labs | 3.00 |
| 9 - AFA Systems | 3.50 |
| 10 - DUTH | 6.48 |
| Total | 54.48 |

List of deliverables

| Deliverable Number ¹⁴ | Deliverable Title | Lead beneficiary | Type ¹⁵ | Dissemination level ¹⁶ | Due Date (in months) ¹⁷ |
|----------------------------------|---|------------------|--------------------|-----------------------------------|------------------------------------|
| D2.1 | End-user requirements report | 3 - UCAM | Report | Public | 5 |
| D2.2 | System and network requirement specifications (1) | 3 - UCAM | Report | Public | 14 |
| D2.3 | System and network requirement specifications (2) | 3 - UCAM | Report | Public | 30 |
| D2.4 | System and Network Deployability Design | 3 - UCAM | Report | Public | 30 |

Description of deliverables

D2.1 End-user requirements report [M05]

This document reports the requirements of the mobile end-users that will be considered during the design of the platform.

D2.2/D2.3 System and network requirement specifications [M14, M30]

This document reports the system and network requirements of the developed platform. It will incorporate the details of the validation scenarios and the final document will document all refined requirements and policies.

D2.4 System and Network Deployability Design [M30]

This document covers the full specification for the system, including refined assumptions, requirements, as well as design choices. It shall include technology to be applied from previous/related work, as well as clearly indicate the contributions to be provided by UMOBILE.

D2.1 : End-user requirements report [5]

This document reports the requirements of the mobile end-users that will be considered during the design of the platform.

D2.2 : System and network requirement specifications (1) [14]

This document reports the system and network requirements of the developed platform. It will incorporate the details of the validation scenarios and the final document will document all refined requirements and policies.

D2.3 : System and network requirement specifications (2) [30]

This document reports the system and network requirements of the developed platform. It will incorporate the details of the validation scenarios and the final document will document all refined requirements and policies.

D2.4 : System and Network Deployability Design [30]

This document covers the full specification for the system, including refined assumptions, requirements, as well as design choices. It shall include technology to be applied from previous/related work, as well as clearly indicate the contributions to be provided by UMOBILE.

Schedule of relevant Milestones

| Milestone number¹⁸ | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|--------------------------------------|--|-------------------------|-----------------------------|--|
| MS3 | End-user and system requirements defined | 3 - UCAM | 14 | The basic requirements of the system will be defined before proceeding with WP3 and WP4. Requirements will be refined throughout the evolution of the project. |
| MS4 | Requirements of the validation scenarios defined | 3 - UCAM | 30 | The details and the requirements of the two validation scenarios will be defined, prior to their deployment. |

| | | | |
|---|--|---------------------------------------|---------------|
| Work package number ⁹ | WP3 | Lead beneficiary ¹⁰ | 1 - Athena RC |
| Work package title | System and node architecture development | | |
| Start month | 6 | End month | 30 |

Objectives

The core activity of WP3 is the design and implementation of the UMOBILE platform. Departing from the existing properties of DTN and ICN, we will establish an architectural framework that extends connectivity options by being delay-tolerant and exposing a common information-centric abstraction to applications. In particular, the objectives of WP3 are to:

- O3.1: Design adequate delay-tolerant interfacing for underlying protocols that efficiently utilises the available resources for a challenged and opportunistic network environment.
- O3.2: Provide service abstraction to applications by incorporating the notion of information-centric networking and named-data contents.
- O3.3: Establish an overall network and system architecture.
- O3.4: Implement an integrated prototype platform that can be used for the various deployment alternatives.

The outcome of WP3 is a proof-of-concept implementation of the platform.

Description of work and role of partners

WP3 - System and node architecture development [Months: 6-30]

Athena RC, UCL, UCAM, COPELABS-COFAC, TECNALIA, TEKEVER AU, Senception, AFA Systems, DUTH
The objective of WP3 to develop a prototype implementation of UMOBILE architecture is divided into the following tasks.

Task 3.1: DTN overlay design and convergence layers for underlying protocols (ATHENA, DUTH, COPELABS, TECNALIA, TEKEVER)

Based on existing DTN implementations and taking into consideration the system requirements defined earlier, during Task 3.1 we will design and implement the required set of protocols that will allow for interconnecting devices of different types and incorporating heterogeneous policies. Today's smartphones have the capability to communicate directly via Bluetooth or WiFi without requiring any supporting network infrastructure. This facilitates the exploitation opportunistic communications (e.g., P2P mobile communications) where alerts and messages are transferred from phone to phone, even in the harshest conditions. In areas where there is no Internet connectivity available or in situations where the network infrastructure is partially or totally destroyed (for example by natural forces like earthquakes or floods), online services may be completely inaccessible. Opportunistic networking can uphold communications in such situations by allowing the direct exchange of messages between smartphones. Intermediate users can be used to store data received from opportunistic contacts and carry them on behalf of other users to the Internet. Even in well-connected environments, opportunistic communications can offload significant amount of data from expensive 3G communications.

DTN, as overlay architecture, has the ability to communicate with a wide variety of underlying protocols. However, in order to achieve successful communication, convergence layers need to be developed. During this task, we will design and implement convergence layers for several underlying technologies, like 802.11, TinyOS (for sensors), cellular, satellite, Bluetooth communication. The minimum set of technologies comprises 802.11, TinyOS, as well as one example of UAV communication, as these technologies are the ones already presented in the UMOBILE first scenarios. Then, the project will build upon existing implementations and define extensions to those platforms where necessary to provide the adequate support to meet the requirements arising from different usage scenarios. The architecture will also be enhanced by implementing DTN node functions that support autonomous operation of the applications when disconnected.

The convergence- and service-layer protocols will be based on an ICN abstraction and will therefore be operating based on content names and exploiting principles of using content names as the primary means for routing. However, unlike conventional ICN that is primarily designed to support name-based routing in an infrastructure-based environment, here we will design name-based replication (rather than just routing) techniques (see [PSA14]) to operate in an infrastructure-less environment. The design challenges of a name-based replication scheme are: (i) to identify what are the parameters that help differentiate between the various messages; (ii) to choose which of the parameters that influence message replication to include in the name and which to include as attributes; and (iii) to identify and understand the resulting trade-offs.

Task 3.2. Providing service-abstraction to applications through content-centric approaches (UCL, UCAM, SENCEPTION, ATHENA, DUTH)

Despite the considerable amount of effort that has been invested to date by the research community on the specific topic of location-independent routing based on content names (e.g., [GHO11a], [JAC09]), a widely acceptable solution is yet to be found [GHO11b]. The main point of concern among researchers is scalability. That is, any naming scheme would have to be able to accommodate more than 10⁹ unique content objects, possibly 10¹² or even 10¹⁵ in the very near future. Although naming may not be a problem in itself (i.e., it is possible to assign a unique name to every piece of content), content resolution and routing based solely on content names raises serious scalability concerns, due to the weak aggregation properties of content names and also due to the anycast required to address in-network cached copies [CHA11].

Instead of radical and risky approaches to ICN, which require redesign of the whole protocol stack [JAC09], application redesign and “flag-days” for switching to an ICN-based Internet [CAE06], here we propose a more realistic route to exploit the advantages of the Information-Centric Networking concept. In particular, according to our proposal, the first stage of communication between the user and the content source, i.e., the content resolution stage, follows the approach of the current Internet and uses search engines, with the URL containing the name of the primary content server. This approach is in contrast to location-independent content resolution approaches, whose scalability is questionable. Instead, to take advantage of the features that ICN brings, we introduce a “content layer” that intercepts communication, produces unique location-independent names for requested content and stores the latter within the network according to sophisticated caching policies. Content is accessed in an anycast fashion using ICN style of operation which is overlaid over IP, exploiting the existence of scalable IP-based routing, maintaining full backwards compatibility and protecting current investment.

The proposed approach will take advantage of the location-independent content resolution at the content layer (and not at the IP layer) and will incorporate user-, server- and content-mobility in order to operate smoothly in infrastructure-less environments.

The common principle concerning the UMOBILE service abstraction relates with the partial capability of current or future applications to predict as well as to store in advance different categories of data that can be requested by users of such applications, as this is one crucial aspect in delay tolerant networks. Therefore, one key aspect to address relates with the capability of this service abstraction middleware to capture and to infer personal data usage and consumption patterns seamlessly, over time.. This corresponds to the development of specific usage contextualization and systems personalization.

A starting point is the usage contextualization approach defined by the PersSense solution of SENCEPTION, as a complement to the guidelines that are currently being provided by the community, namely, the IRTF Global Access to the Internet of All (GAIA) working group.

Task 3.3: Smart routing based on social interaction approaches (TECNALIA, COPELABS, ATHENA, DUTH, AFA)

UMOBILE platform will also integrate novel principles of social aspects such as trust and social interaction, to improve reachability based on opportunistic transmission. New content and knowledge dissemination approaches based on social interaction approaches derived from contacts between citizens, not necessarily acquainted, will be developed.

As a starting point, UMOBILE shall consider three different routing approaches, two of which are directly related with DTN (HURRY; DLIfe) and one related with ICN for opportunistic networks (SCORP).

The HUMAN Routines optimize Routing (HURRY) protocol, defined by TECNALIA as part of FP7 SAIL project defines a probabilistic routing approach which infers and benefits from the social behaviour of nodes in disruptive networking environments [URT14]. This mechanism is intended for human carried devices (e.g. mobile phones interacting as DTN nodes), so that the dynamics and mobility of those DTN nodes can be translated into people’s social behaviour that the routing protocol is able to use.

Dlife (Opportunistic routing based on daily routines), by COPELABS, is currently being standardized in the IRTF DTNrg. A version is being implemented for Android and tested in the context of the Amazonia region (socialDTN). Dlife is a routing algorithm that captures the network dynamics (social interaction based on duration of contacts and of inter-contact times), represented by time-evolving social ties.

SCORP (Social-aware Content-based Opportunistic Routing Protocol), also by COPELABS, is a protocol that considers the user’s social interaction in terms of duration of contacts and inter-contacts time. In comparison to Dlife, SCORP is a receiver-driven solution, which considers also user’s interest on data to take advantage of data dissemination opportunities.

We will show how several smart phones present in a large crowd scenario could act as integrated ICN-DTN nodes in such a way that whenever a user initiates a request (Query) for a multimedia content (i.e. photo or video file), the application interface sends an ICN request, and the best service solution to serve that request is selected. An enhanced behavior relates with the capability to prefetch data in the context of social trust computation based on the definition and concepts of usage data contextualization defined in task 3.2.

Role of contributing partners

ATHENA will lead WP3. ATHENA and DUTH will define the architectural framework of Bundle Protocol (BP) within UMOBILE platform and built the required convergence layers for underlying protocols. Given its experience on developing routing mechanisms for delay-tolerant networks, ATHENA will also contribute to the development of the smart routing mechanism.

UCL will focus on the design and implementation of the ICN functionality through the extra content layer and will work to make communication between nodes transparent to the current Internet infrastructure. That is, although changes to the protocol stack will be needed in order to support ICN-DTN style of operation, the changes proposed here will be fully backward compatible. UCL will contribute to Tasks 3.1 and 3.2, but will also take into account the findings of Task 3.3 in order to accommodate social interactions in the proposed content layer communication platform.

UCAM will specifically contribute to task 3.2 and 3.3 through developing forwarding and topology management functions as well as design and implement the interfaces for QoS. In terms of QoS, UCAM will design strict quality of service separation and priority queuing mechanisms for both uplink and downlink.

COPELABS will contribute with its expertise concerning social-aware and interest-based routing for the design and implementation of protocols. COPELABS supports the interfacing design based on knowledge being provided in the IETF; brings social trust computation to task 3.2 and new routing approaches (SCORP and Dlife) to task 3.3.

TECNALIA will participate in task T3.1 and will lead task T3.3. Tecnalia has been working on smart routing approaches for DTN deployments for several years, trying to focus on the optimization of content delivery from different perspectives. TECNALIA defined the already mentioned HURRY protocol, incorporating contact duration to probabilistic routing based of frequency of contacts, and also performed some light testing on the integration of ICN-based content delivery in a DTN overlay design, as proof-of-concept for the aforementioned FP7 SAIL project.

TEKEVER will focus its contributions on task 3.1 working with other partners on the development of the convergence layers, especially considering underlying technologies' applicability and feasibility for use in aerial platforms with all the constraints deriving from this point (e.g. SWAP – Size, Weight And Power). This work will focus on ensuring that the architecture and protocols developed under WP3 can be successfully applied and used in aerial platforms contributing to assessing the contribution to the geographic and scalability dimensions and enabling the scenario testing of WP5.

SENCEPTION focuses its contribution in this WP in task 3.2, where it shall support both conceptual and deployment work concerning usage data contextualization, and system personalization on-the-fly.

AFA will provide in task 3.3 its expertise on dynamic and on-the-fly evaluation of the physical layer performance. It has been consolidated during a previous research project (called “Smart Node” and funded by a national program) aimed at finding overall metrics (as a combination of RTT, one-way delay, jitter, packet loss and band estimation) useful to calculate overlay optimal paths (with respect to a set of services) over IP networks.

Participation per Partner

| Partner number and short name | WP3 effort |
|-------------------------------|---------------|
| 1 - Athena RC | 15.00 |
| 2 - UCL | 21.00 |
| 3 - UCAM | 23.00 |
| 4 - COPELABS-COFAC | 17.00 |
| 5 - TECNALIA | 20.00 |
| 6 - TEKEVER AU | 2.00 |
| 7 - Senception | 5.00 |
| 9 - AFA Systems | 8.00 |
| 10 - DUTH | 24.52 |
| Total | 135.52 |

List of deliverables

| Deliverable Number¹⁴ | Deliverable Title | Lead beneficiary | Type¹⁵ | Dissemination level¹⁶ | Due Date (in months)¹⁷ |
|--|---|-------------------------|--------------------------|---|--|
| D3.1 | UMOBILE architecture report (1) | 10 - DUTH | Report | Public | 16 |
| D3.2 | UMOBILE architecture report (2) | 1 - Athena RC | Report | Public | 30 |
| D3.3 | UMOBILE ICN layer abstraction initial specification | 1 - Athena RC | Report | Public | 12 |
| D3.4 | UMOBILE ICN layer abstraction final specification | 1 - Athena RC | Report | Public | 30 |

Description of deliverables

D3.1/D3.2 UMOBILE architecture report [M16, M30]

This deliverable includes an open source implementation of the architecture (core platform, APIs etc.), as well as all developed convergence layer protocols. The implementation is accompanied by documentation on the code. The first version of this report [M16] will include work on the core architecture implementation so far, while the final version [M30] will include the final implementation, as well as all implemented mechanisms.

D3.3 UMOBILE ICN layer abstraction initial specification [M12]

This deliverable covers the initial specification for the developed content-centric layer abstraction of UMOBILE platform.

D3.4 UMOBILE ICN layer abstraction final specification [M30]

This deliverable details the final specification for the developed content-centric layer abstraction of UMOBILE platform.

D3.1 : UMOBILE architecture report (1) [16]

This deliverable includes an open source implementation of the architecture (core platform, APIs etc.), as well as all developed convergence layer protocols. The implementation is accompanied by documentation on the code. The first version of this report [M16] will include work on the core architecture implementation so far, while the final version [M30] will include the final implementation, as well as all implemented mechanisms.

D3.2 : UMOBILE architecture report (2) [30]

This deliverable includes an open source implementation of the architecture (core platform, APIs etc.), as well as all developed convergence layer protocols. The implementation is accompanied by documentation on the code. The first version of this report [M16] will include work on the core architecture implementation so far, while the final version [M30] will include the final implementation, as well as all implemented mechanisms.

D3.3 : UMOBILE ICN layer abstraction initial specification [12]

This deliverable covers the initial specification for the developed content-centric layer abstraction of UMOBILE platform.

D3.4 : UMOBILE ICN layer abstraction final specification [30]

This deliverable details the final specification for the developed content-centric layer abstraction of UMOBILE platform.

Schedule of relevant Milestones

| Milestone number¹⁸ | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|--------------------------------------|--|-------------------------|-----------------------------|--|
| MS5 | UMOBILE ICN layer abstraction specifications have been defined | 10 - DUTH | 30 | We have developed the content-centric layer abstraction of UMOBILE platform. |
| MS6 | UMOBILE architecture implemented | 10 - DUTH | 30 | The proposed architecture has been developed, all necessary parameters have been investigated and a prototype of the communication system has been set-up. |

| | | | |
|---|---------------------|---------------------------------------|----------------|
| Work package number ⁹ | WP4 | Lead beneficiary ¹⁰ | 7 - Senception |
| Work package title | Services enablement | | |
| Start month | 6 | End month | 30 |

Objectives

The main objective of WP4 is to enhance UMOBILE architecture in terms of QoS and QoE and enable solutions that take advantage of the unique features of the developed architecture. This WP will use the architecture developed during WP3 to provide a set of services. The objectives of the WP summarized as follows:

- O4.1: To enable services which fully exploit the inherent opportunistic nature of communication.
- O4.2: To enable the “Internet” experience as many people know it, with applications such as web, email, and the like. The challenge here lies in dealing with the inherent disconnectivity of challenged environments by catering to the network challenges and/or adjusting the expected user experience.
- O4.3: To develop mechanisms for processing of sensor data through context understanding.
- O4.4: To provide different levels of QoS depending on the needs of each user/network ranging from less-than-best-effort to guaranteed services.

The outcome of WP4 will be the enablement of services that support the key characteristics of the developed platform; delay-tolerance and content-centricity.

Description of work and role of partners

WP4 - Services enablement [Months: 6-30]

Senception, Athena RC, UCL, UCAM, AFA Systems, DUTH

This work package will provide the framework for the design of services that will exploit the characteristics of UMOBILE platform.

Task 4.1: Providing different levels of QoS and flow control (UCAM, ATHENA, DUTH, UCL)

UMOBILE platform will support a variety of network types, devices and users. Depending on the characteristics of each network, multiple levels of QoS need to be supported. In this task, we will focus on providing services that range from less-than-best-effort to guaranteed services. Enabling various levels of QoS guarantees will create new access models for supporting a wide range of applications from transmitting IoT data to provide low cost mobile services.

In addition, given that our proposed approach maintains the host-to-content ICN nature of communication, with contents cached and retrieved from within the network, or from other participating devices in a P2P manner, we argue that end-to-end flows do not exist, being instead replaced by flowlets [SIN04], i.e., flows that transfer content fragments from potentially different locations. In this context, and in addition to end-to-end transport, which needs to evolve to deal better with in-network caching, we propose a rate-regulation scheme for flowlets that allows ISPs to have full control of the traffic within their networks. Flowlet control algorithms will need to guarantee stability, but also efficiency and fairness.

Task 4.2: Data collection and contextual inference (SENCEPTION, AFA, ATHENA, DUTH)

This activity is devoted to the collection of data from sensors and other sources, its processing by understanding their context and the dissemination of the processed data to parties that are interested, such as governments and local organisations. A key aspect of this task is the notion of usage contextualization and service personalization. A second key aspect relates with the capability to infer specific data usage context to assist in data prefetching.

A starting point is SENCEPTION’s PerSense platform, which is one of the first proposals for a full sensing platform that integrates three main modules: data capture and sensing; usage contextualization and behavior inference; pervasive data sharing. Pervasive data sharing concerns WP3 and hence is out of the scope of this task.

Concerning data collection (capture), UMOBILE shall consider as starting point two solutions: Maestro and MOT . Maestro, provided by COPELABS, is sensing middleware that captures data via a multitude of sensors that exist in a specific device, or that are borrowed (virtual sensors) from trusted neighboring devices. MOT (Mobile Object Tracking) is a component of the SENCEPTION’s PerSense open-source platform, that is capable of capturing data from a specific device and infer some usage aspects in regards to visited wireless networks. These available and cross platform solutions are to be analyzed in the context of the UMOBILE scenarios, and whenever required, tuned to the needs of the project. Concerning contextual inference, UMOBILE shall follow a filtering model to interpret collected data based on specific parameters (user and network based) as well as specific utility (e.g. QoE) functions. Context modelling is based

on time and space correlation, i.e., it takes into consideration location and proximity aspects. Examples of specific contextualization that can result from such filtering are: roaming context; entertainment context; well-being context.

Task 4.3: Name-Based Replication Priorities (UCL, SENCEPTION)

UMOBILE will support a mobile name-based replication system, where message replication is limited by time and space, that is, within a certain geographic area and with specific life expectancy. Replication will be optimised by prioritisation rules, integrated within the information message's name to favor spreading of the most important messages. For example, in case of an emergency in a disaster area, we consider messages from first responders as more important than messages between friends. We focus on cases where the mobile network infrastructure is not available and therefore messages have to be stored, carried and forwarded by mobile devices.

Role of contributing partners

ATHENA and DUTH will contribute to the provisioning of multiple levels of QoS. ATHENA and DUTH will also use their experience on data dissemination over DTN towards achieving the dissemination of local knowledge in Task 4.2. UCL will contribute to Tasks 4.1 and 4.3. In particular, UCL will work on flowlet congestion control in order to incorporate multi-recipient transfers (similarly to P2P), but in an infrastructure-less environment. Furthermore, UCL will design priorities for name-based replication in mobile environments between participating nodes, but also between edge-network caches. Our contributions in WP4 will take input from the developments and design proposals of WP3. UCAM will contribute to T4.1 exploiting their extensive application and QoS experience. UCAM will devise QoS strategies that will enable multiple levels of service including less-than-best effort services.

SENCEPTION leads this WP as well as task 4.2. SENCEPTION brings knowledge concerning pervasive sensing as well as data capture and usage contextualization, both from a conceptual, validation, as well as implementation perspective. AFA will support the WP through task 4.2, preparing to collect data from sensors and video surveillance IP cameras, and providing the contextual inference methods to trigger the relevant instances (i.e. early detection of risk scenarios).

Participation per Partner

| Partner number and short name | WP4 effort |
|-------------------------------|--------------|
| 1 - Athena RC | 5.00 |
| 2 - UCL | 12.00 |
| 3 - UCAM | 20.00 |
| 7 - Senception | 15.00 |
| 9 - AFA Systems | 10.00 |
| 10 - DUTH | 8.73 |
| Total | 70.73 |

List of deliverables

| Deliverable Number ¹⁴ | Deliverable Title | Lead beneficiary | Type ¹⁵ | Dissemination level ¹⁶ | Due Date (in months) ¹⁷ |
|----------------------------------|---|------------------|--------------------|-----------------------------------|------------------------------------|
| D4.1 | Flowlet Congestion Control – Initial Report | 7 - Senception | Report | Public | 12 |
| D4.2 | Flowlet Congestion Control – Final Report | 7 - Senception | Report | Public | 30 |
| D4.3 | Name-based Replication Priorities | 7 - Senception | Report | Public | 24 |
| D4.4 | Set of QoS interfaces and algorithms | 7 - Senception | Other | Public | 30 |

List of deliverables

| Deliverable Number¹⁴ | Deliverable Title | Lead beneficiary | Type¹⁵ | Dissemination level¹⁶ | Due Date (in months)¹⁷ |
|--|--|-------------------------|--------------------------|---|--|
| D4.5 | Report on data collection and inference models | 7 - Senception | Report | Public | 30 |

Description of deliverables

D4.1 Flowlet Congestion Control – Initial Report [M18]

This document includes the initial specification of the rate-regulation scheme for flowlets that allows ISPs to have full control of the traffic within their network.

D4.2 Flowlet Congestion Control – Final Report [M30]

This document defines the final specification of the rate-regulation scheme for flowlets that allows ISPs to have full control of the traffic within their network.

D4.3 Name-based Replication Priorities [M24]

This document describes the mobile name-based replication system.

D4.4 Set of QoS interfaces and algorithms [M30]

This report describes the different level of services provided by UMOBILE platform.

D4.5 Report on data collection and inference models [M30]

This deliverable includes all processes developed throughout UMOBILE project that involve data collection, context understanding and data dissemination, depending on the requirements of each scenario as well as the defined priorities.

D4.1 : Flowlet Congestion Control – Initial Report [12]

This document includes the initial specification of the rate-regulation scheme for flowlets that allows ISPs to have full control of the traffic within their network.

D4.2 : Flowlet Congestion Control – Final Report [30]

This document defines the final specification of the rate-regulation scheme for flowlets that allows ISPs to have full control of the traffic within their network.

D4.3 : Name-based Replication Priorities [24]

This document describes the mobile name-based replication system.

D4.4 : Set of QoS interfaces and algorithms [30]

This report describes the different level of services provided by UMOBILE platform.

D4.5 : Report on data collection and inference models [30]

This deliverable includes all processes developed throughout UMOBILE project that involve data collection, context understanding and data dissemination, depending on the requirements of each scenario as well as the defined priorities.

Schedule of relevant Milestones

| Milestone number¹⁸ | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|--------------------------------------|--|-------------------------|-----------------------------|---|
| MS7 | QoS interfaces and mechanisms for data handling have been integrated within UMOBILE platform | 7 - Senception | 30 | All required mechanisms for UMOBILE platform have been developed. |

Schedule of relevant Milestones

| Milestone number¹⁸ | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|--------------------------------------|--------------------------------------|-------------------------|-----------------------------|--|
| MS8 | Flowlet Congestion Control developed | 7 - Senception | 30 | The specifications of the rate-regulation scheme for flowlets have been defined. |

| | | | |
|---|---|---------------------------------------|--------------------|
| Work package number ⁹ | WP5 | Lead beneficiary ¹⁰ | 8 - Fon Technology |
| Work package title | Overall platform integration and validation | | |
| Start month | 18 | End month | 36 |

Objectives

WP5 aims at evaluating our platform through simulations, emulations and real field trials. In particular, the objectives of WP5 include:

- O5.1: To practically demonstrate the overall platform of the project.
- O5.2: To quantitatively evaluate the outcomes of WP3 and WP4, by using existing tools, such as simulators, emulators and network testbeds.
- O5.3: To implement scenarios with increasing complexity in the number of deployed assets and covered area.
- O5.4: To transition lessons learned from the first deployments to operational procedures for performance improvement.
- O5.5: To test the limits of the system and of its operational capabilities.

The outcome of WP5 will be an overall technological validation of UMOBILE platform, including a working proof-of-concept.

Description of work and role of partners

WP5 - Overall platform integration and validation [Months: 18-36]

Fon Technology, Athena RC, UCL, UCAM, COPELABS-COFAC, TECNALIA, TEKEVER AU, Senception, AFA Systems, DUTH

This WP aims at the evaluation of the solutions developed in the project. The evaluation will be given in terms of performance and scalability, based on a set of performance parameters, which will be defined in the respective tasks. A proof-of-concept is expected, based on the software developed during validation.

Task 5.1: Definition of the validation setup (FON Technology, ALL)

The work to be carried within task 5.1 involves the definition of the validation setup of the overall system. This entails defining the setup and assets involved in the validation scenarios, use cases, operational and environmental conditions, measures of performance, and measures of effectiveness. There will be component and system-level validations.

Task 5.2: Evaluation through Simulation and Emulation (ATHENA, DUTH, UCL, UCAM, COPELABS)

In this task, the platform will be evaluated through a series of planned simulations and emulations before moving on to trials in Tasks 5.4 and 5.5.

The performance improvements provided by the ICN abstraction will be carried out using simulations in the initial stage. We will use our own Icarus simulator, which we have built specifically to address the need for a simulator of ICN in-network caching environments [SAI14] and we have made publicly available in: <http://icarus-sim.github.io/>. We will work to extend the functionality of Icarus to mobile and infrastructure less environments, always keeping in mind the need for transparent name-based resolution and delivery. The flowlet-specific evaluation will be carried out in a more realistic setting using MiniNet (<http://mininet.org/>).

The DTN simulations will be carried out using the ONE simulator and the DTN agent for ns-2, developed by researchers at DUTH and ATHENA. We will further evaluate the ability of UMOBILE platform using the state-of-the-art DTN testbed hosted at the premises of DUTH. The testbed consists of fifteen rack-mounted servers, each of which is currently configured to act as a standalone DTN node implementing the full DTN stack.

Contributions of this task shall be provided as modules for the ONE simulator, and shall be designed based on the requirements and technology selected on WP2. This ensures that some selected modules can be easily integrated into the UMOBILE proof-of-concept.

Task 5.3: Proof-of-Concept (AFA, ALL)

This task concerns the integration of the architecture and services, developed in WP3 and WP4 with different components, such as mobile nodes, sensor nodes, backhaul links of different type, WiFi infrastructure/equipment etc. A prototype implementation of UMOBILE platform will be available by M34, when all required mechanisms are in place. The proof-of-concept software shall integrate selected modules derived from results developed in WP2, WP3, as well as WP4. For instance, specific applications developed in the course of the project shall be considered as part of this prototype. The proof-of-concept is to be created based on a set of specific demos and not necessarily based on a single prototype, as time-wise integration of the innovative concepts developed may not be possible. This is therefore a set

of independent technological demonstrations based on software developed during UMOBILE, and which shall rely on the use-cases selected in WP2. Whenever feasible, and based on the dissemination plans of WP6, these demos shall be used not only to provide project results, as well as to collect data in different events (e.g. conferences), data which can then be provided to the community to enhance further studies.

Task 5.4: Deployment Trial (FON Technology, TEKEVER, COPELABS, ATHENA, DUTH, UCAM)

In this task, the actual preparation, setup, dry-running and execution of testing for the less-than-best effort Internet access scenario will take place. These activities will include obtaining the necessary permits and authorizations, inviting and briefing entities to witness the tests and to participate in the tests; mapping of validation setup results into specific scenario scripts to run the tests; deployment of all relevant equipment; dry-running of tests; execution of tests; measurements of performance parameters and post-processing of data collected during the tests. Prior to this task, simulations will be carried out using partner simulators for the aerial platforms combined with networking simulators.

Role of contributing partners

ATHENA and DUTH will participate in the evaluation of UMOBILE platform through simulations (using Opportunistic Network Environment simulator and NS-2 DTN agent), emulations (using SPICE DTN testbed), as well as field trials in Tasks 5.4 and 5.5.

UCL will work on the implementation and evaluation of ICN features for infrastructure-less environments. As mentioned above, we will extend our Icarus simulator to fit to mobile environments, maintaining the ICN benefits of location-independence and in-network (or edge-network) caching. UCL will also work on the evaluation of flowlet control to prove and guarantee stability, efficiency and fairness.

UCAM will contribute to the evaluation scenarios and technology evaluation tasks by undertaking simulation/emulation exercises. In Task 5.4, UCAM will evaluate the benefits of caching provided by the UMOBILE platform to enable better access to content and hence a better user experience to free Internet users who are on Less than Best Effort (LBE) access. Such methods will not only enhance the experience of free Internet users but will also benefit paid users who are currently sharing their Internet connection. For example, important content accessed by free Internet users will be cached, enabling the paid user to access the content more quickly. UCAM will also evaluate the QoS and queue management issues.

COPELABS will contribute to tasks 5.1, 5.2, by providing simulation support as well as extensive validation, based on modules specifically developed for the ONE simulator. Whenever feasible, COPELABS shall provide emulation based on realistic end-user equipment. COPELABS commits also to setting a database to collect data during technological demonstrations.

TECNALIA will deploy the necessary testbeds over the envisaged scenarios in order to validate and integrate its developments within WP3 together with other partners' implementations according to the user requirements defined in WP2. Tecnalia will perform proof-of-concept validation within task T5.3 and define a simple service or application to serve the testbed if required.

TEKEVER will contribute to tasks 5.1, 5.3 and 5.4. Under 5.1, TEKEVER will collaborate to identify KPIs to measure during validation, vignettes to test, and steps/actions that need to be taken to carry out the scenario of 5.4 (e.g. permissions to fly, temporary test licenses for spectrum usage, etc.) In WP5.3, TEKEVER will integrate radios and nodes compliant with the UMOBILE architecture and protocol stack on its UAVs and carry out functional testing to ensure there is no interference with other UAV systems (e.g. flight control system or the datalink). Finally in WP5.4, TEKEVER will provide significant support to the execution of the scenario by obtaining all necessary permissions, authorizations and complying with all regulations for deploying and operating UAVs as backhaul links, testing the applicability and feasibility of developed services over aerial means and testing the application of UAVs as data mules between isolated clouds. Measurements will be collected during the trials, analysed and reported on D5.3.

SENCEPTION will contribute to tasks 5.1, 5.2, and 5.3 aiming to provide a solid proof-of-concept concerning scenarios related with remote and smart trusted circles. SENCEPTION shall support the proof-of-concept in regards to specific application deployment, and shall contribute with measurement data collected both locally as well as during the project, via technological demos.

FON Technology will lead this Work Package and will focus its work on tasks 5.1, 5.3 and 5.4. FON Technology will provide its experience in deploying the testing assets, given its important presence at the end of the value chain in the market of communications service provision, just before the final users, and its large experience in the development, management and operation of WiFi networks and services. FON Technology will assure that the project experimentation and validation activities are carried out within meaningful conditions and that the results can be checked against parameter measurements coming from in the real world.

AFA will support the WP by leading task 5.3 and contributing to order and systematize all the logical modules (as software and even hardware components), to get a consistent and deployable ecosystem. A significant contribution will come from the integration and validation of the network infrastructure based on the UNodes.

Participation per Partner

| Partner number and short name | WP5 effort |
|-------------------------------|---------------|
| 1 - Athena RC | 17.00 |
| 2 - UCL | 5.00 |
| 3 - UCAM | 17.00 |
| 4 - COPELABS-COFAC | 15.00 |
| 5 - TECNALIA | 14.00 |
| 6 - TEKEVER AU | 16.00 |
| 7 - Senception | 10.00 |
| 8 - Fon Technology | 11.00 |
| Fon Labs | 7.00 |
| 9 - AFA Systems | 11.00 |
| 10 - DUTH | 2.01 |
| Total | 125.01 |

List of deliverables

| Deliverable Number ¹⁴ | Deliverable Title | Lead beneficiary | Type ¹⁵ | Dissemination level ¹⁶ | Due Date (in months) ¹⁷ |
|----------------------------------|--|--------------------|--------------------|-----------------------------------|------------------------------------|
| D5.1 | Validation methodology and evaluation report (1) | 8 - Fon Technology | Report | Public | 24 |
| D5.2 | Validation methodology and evaluation report (2) | 8 - Fon Technology | Report | Public | 36 |
| D5.3 | Proof-of-Concept (1) | 8 - Fon Technology | Other | Public | 24 |
| D5.4 | Proof-of-Concept (2) | 8 - Fon Technology | Other | Public | 34 |
| D5.5 | Report on the validation of the deployment trial | 8 - Fon Technology | Report | Public | 36 |

Description of deliverables

D5.1/D5.2 Validation methodology and evaluation report [M24, M36]

This will provide the validation setup for the system and its individual components. The report will also include the results of the detailed evaluation of the platform through simulations.

D5.3/D5.4 Proof-of-Concept [M24, M34]

This reports and provides the proof-of-concept software. It shall include also data methodology aspects, and a section dedicated to each of the demos that integrate the proof-of-concept. The proof-of-concept shall be first described on M24, already with an envisioned set of first demos. Then, in M34, the full aspects concerning the proof-of-concept and software availability are to be described.

D5.5 Report on the validation of the deployment trial [M36]

This reports the results of the less-than-best-effort Internet access scenario, discusses lessons learned, and describes the experiments that took place during the validation.

D5.1 : Validation methodology and evaluation report (1) [24]

This will provide the validation setup for the system and its individual components. The report will also include the results of the detailed evaluation of the platform through simulations.

D5.2 : Validation methodology and evaluation report (2) [36]

This will provide the validation setup for the system and its individual components. The report will also include the results of the detailed evaluation of the platform through simulations.

D5.3 : Proof-of-Concept (1) [24]

This reports and provides the proof-of-concept software. It shall include also data methodology aspects, and a section dedicated to each of the demos that integrate the proof-of-concept. The proof-of-concept shall be first described on M24, already with an envisioned set of first demos. Then, in M34, the full aspects concerning the proof-of-concept and software availability are to be described.

D5.4 : Proof-of-Concept (2) [34]

This reports and provides the proof-of-concept software. It shall include also data methodology aspects, and a section dedicated to each of the demos that integrate the proof-of-concept. The proof-of-concept shall be first described on M24, already with an envisioned set of first demos. Then, in M34, the full aspects concerning the proof-of-concept and software availability are to be described.

D5.5 : Report on the validation of the deployment trial [36]

This reports the results of the less-than-best-effort Internet access scenario, discusses lessons learned, and describes the experiments that took place during the validation.

Schedule of relevant Milestones

| Milestone number¹⁸ | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|--------------------------------------|---|-------------------------|-----------------------------|---|
| MS9 | Integration completed, system evaluated and proof-of-concept is available | 8 - Fon Technology | 36 | Output components from WP3 and WP4 have been integrated to form UMOBILE platform and initial evaluation through simulations has been performed. |
| MS10 | Deployment trial successfully completed | 8 - Fon Technology | 36 | Less-than-best effort Internet access scenario has been validated in our system. |

| | | | |
|---|---|---------------------------------------|-----------------|
| Work package number ⁹ | WP6 | Lead beneficiary ¹⁰ | 9 - AFA Systems |
| Work package title | Dissemination, exploitation and standardisation | | |
| Start month | 1 | End month | 36 |

Objectives

This Work Package aims to guide the project towards a viable exploitation and dissemination strategy as well as manage the projects standardization activities. This includes:

- O6.1: To widely disseminate the project concept, developments and findings to all key actors in the field in an interactive way, integrating their feedback at key points of the specification, design, development and evaluation work.
- O6.2: To develop a project dissemination and communication strategy.
- O6.3: To monitor and contribute to standardization activities related to our concept.
- O6.4: To develop an interactive and user friendly website to inform the general public and relevant stakeholders about the project.
- O6.5: To organize and/or publish results in international conferences and workshops to inform the scientific community about the project, its goals and achievements and to gather valuable information on related issues.
- O6.6: To issue exploitation plans for key project results within the project and beyond.

The outcome of this WP will comprise of a set of dissemination and standardisation activities that will take place throughout the duration of the project, as well as a clear exploitation plan for the developed platform after the end of the project.

Description of work and role of partners

WP6 - Dissemination, exploitation and standardisation [Months: 1-36]

AFA Systems, Athena RC, UCL, UCAM, COPELABS-COFAC, TECNALIA , TEKEVER AU, Senception, Fon Technology, DUTH

The activities within WP6 are divided into three separate tasks.

Task 6.1: Dissemination (AFA, ALL)

This task will deal with coordinating dissemination activities. It includes the dissemination strategy, the consolidation of dissemination information, and the preparation of dissemination material when needed. In particular, the following activities are planned:

- **Project logo:** A project logo will be designed and used in all documents and publications of UMOBILE. The design will be done in a way that the logo will be representative of UMOBILE concept and vision.
- **Public project summary:** This is a public description of the project that includes its main goals, the key issues being addressed by the project, the technical approach taken, and the final outcome and achievements. This document is intended for publication on the Commission websites and the project's website. It will also be the basis for creating other dissemination material such as leaflets and posters.
- **Leaflets and Posters:** Two sets of leaflets and posters will be designed and produced. The first set early in the project will disseminate the objectives, concepts and vision of UMOBILE. The second during the third year of the project will additionally disseminate public results, outcomes and findings from UMOBILE research. This material will be used in all public events (conferences, workshops, exhibitions, etc.), where UMOBILE partners will participate.
- **Website:** A fully functional and user friendly web site will be designed and will serve as a major dissemination tool. A collaborative portal, accessible only to authorised members, will assist the communication between project partners. Social networks such as LinkedIn and Facebook will also be exploited.
- A project scenario video will be filmed and exposed in media channels as YouTube, in order to better promote UMOBILE project.
- European events and workshops that will be organised through the UMOBILE consortium will also serve as important dissemination activities. Based on the extensive scientific expertise of project partners and the focus of the UMOBILE project, the following conferences have been identified as suitable for hosting our workshop: (1) ACM Sigcomm, (2) ACM MobiCom, (3) ACM CoNext, (4) IEEE CCNC. In particular, a workshop or set of seminars on UMOBILE platform will be organised towards the end of the project, with the successful completion of the field trials and all simulation/emulation activities. Goal of the project will be the further promotion of UMOBILE platform and its applicability in diverse environments, as well as the multiple applications that can be supported by the platform. The workshop will attract the interest of other research projects on the field, industry and stakeholders. The duration of the

workshop will be two days and it will be open to all interested parties. All links established throughout the duration of the project will be exploited.

- A large number of publications is expected in prestigious international conferences, workshops and journals, based on the concept, vision, design and implementation results of UMOBILE, all managed through a concise and constantly updated publications plan. Most of the project partners have an excellent publication record and are well embedded in many top-journal communities and high-standing conferences. Based on this, the following journals and conference will be targeted in particular: (1) IEEE/ACM Transactions on Networking, (2) Computer Networks, (3) IEEE Communication Magazine, (4) ACM Sigcomm, (5) ACM MobiCom, (6) ACM Sigmetrics, (7) IEEE Infocom, (8) ACM CoNext, (9) ACM IMC, (10) PAM, (11) IEEE CCNC, etc The papers themselves will be written in the framework of the relevant work packages.
- Coordination of lecturing and presentation material on topics relevant to UMOBILE, for use by the academic partners in their standard courses and by the commercial partners and research institutes for guest lectures.
- Open source distribution of relevant software developed by the project. This also includes the publication of public APIs to the final UMOBILE integrated system to enable third parties to develop services on top of the UMOBILE platform.

Task 6.2: Exploitation (FON Technology, SENCEPTION, AFA, ALL)

This task includes all activities that foster the successful application of project results that enables the partners to draw benefit after the project lifetime. A feasibility study of commercial operation of UMOBILE results will be carried out. The exploitation plan of UMOBILE will be devised with full orchestration of all partners and will describe how the project will exploit envisioned results. The presence of industrial partners makes the process of devising such a plan important. Industrial partners would like to match results to their ongoing activities on commercializing new services and products. For the commercial partners the main focus lies on the development of a consortium marketing strategy for core results (products). In an Exploitation Plan the foundations of the individual business plans will be defined and general issues like ownership, sustainability, applicable licensing schemes, and markets will be investigated and documented. Academic partners will primarily aim at exploitation of results for educational and research purposes.

During the launch of the deployment trials, we will invite local government members, the public, press and media to promote the vision of UMOBILE and demonstrate the project's technology and findings in engaging hands-on ways.

Task 6.3: Standardisation (UCAM, UCL, ATHENA, DUTH, COPELABS)

The objective of this task is to monitor and possibly steer as well as contribute to ongoing work in standardization bodies and ensure that UMOBILE research activities are aligned with the existing trends. Several project partners are actively participating in various standardization bodies such as the European Telecommunication Standards Institute (ETSI), Consultative Committee for Space Data Systems (CCSDS) and the Internet Engineering Task Force (IETF) as well as the Internet Research Task Force (IRTF). Candidates for a focused contribution are current efforts in the IETF and IRTF to position DTN and ICN as an exploitable technology. With both communities being somewhat disjoint at this point, the UMOBILE objectives in joining ICN with DTN concepts can directly influence the communities' thinking in both areas. We plan, for instance, to actively contribute to scenario and research challenges definitions as well as position the UMOBILE functional components as a possible approach for traversing ICN, DTN and traditional IP deployments. For example, members of the UCL team have already been active in the IRTF ICNRG group and have been contributing to the initial documents produced by the group. Our two standardisation groups of interest are the ICNRG and GAIA groups, both under the umbrella of IRTF, as is the norm with research projects.

Specific activities will include contributing to specifications, taking initiative in designing system and protocols aspects as applicable. The timing is excellent because (1) the work of the ICN group only started recently and the partners have been actively involved in discussions and contributions and (2) the DTN group is presently considering launching work towards a version 2 of the bundle protocol specification, which will allow UMOBILE key concepts to be incorporated into the core design. Moreover, one of the DTNRG GAIA co-chairs is within the UMOBILE consortium.

Standardization will be supported by open source implementations of the UMOBILE concepts so that a community can thrive around the development and we will be able to "recruit" third parties both as supportive voices and active contributors. Both are crucial for mid-term buy-in by the other players to socialize the UMOBILE ideas in the respective standards bodies.

Role of contributing partners

ATHENA and DUTH will contribute to scientific exploitation and incorporation into education. ATHENA and DUTH will undertake the responsibility to participate in conference keynotes and related panels. Moreover, they will participate to the CCSDS meeting series as well the IRTF GAIA group meetings, in order to follow standardisation procedures of DTN technology. DUTH will also disseminate the UMOBILE results as well as adopting these in academic courses.

UCL will follow the developments and contribute to the IRTF ICNRG group which is the main standardisation body which the community is building

UCAM will support the dissemination to other international initiatives in relevant areas, support the dissemination activities to user communities as well as develop academic courses in relevant areas. UCAM will also engage through its central role at the IRTF GAIA as well as and UK policy makers through UCAM's Centre for Science and Policy (CSaP), which embeds senior civil servants in the university as visiting fellows.

COPELABS will contribute in T6.3 with standardization efforts on the IRTF DTN research group as well as on the IRTF GAIA working group. COPELABS envisions also contributions on the IRTF ICNRG working group, where it already actively participates.

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 FP7 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.

SENCEPTION will support both dissemination and exploitation aspects, expecting to expand its PerSense solution with results derived from its participation in UMOBILE.

TEKEVER will support dissemination activities across Europe and in Portugal in particular and specifically with user communities of interest such as emergency responders and public safety entities. Development of a business case for the integration of UMOBILE results in TEKEVER's UAV line of products under WP6.2.

FON Technology will promote project visibility and dissemination of results throughout the whole project life. In particular, FON Technology will lead the description of the exploitation of UMOBILE, developing the set of measurable outputs and expected results led by these activities

AFA will lead the WP and provide the web identity and presence for the project, with logo(s), website (including blog and wiki), social presence, and provide support for the on-line authoring of the project handbook. Through workshops, and possibly a permanent demo infrastructure, AFA will inform the regional Civil Protection Agencies, based in Italy, to demonstrate the UMOBILE architecture, inviting the public, press and media. A letter of support has already been received from the relevant authorities and is attached at the end of Sections 4-5. AFA will take this opportunity to engage with the public to showcase the different applications/services developed during the UMOBILE project and raise the general level of awareness on the ability of the UMOBILE project to provide digital inclusion. AFA will also participate in key tradeshow and related events to showcase the emergency applications (for example, video streaming apps that support delay tolerant transfer).

Participation per Partner

| Partner number and short name | WP6 effort |
|-------------------------------|--------------|
| 1 - Athena RC | 2.50 |
| 2 - UCL | 4.00 |
| 3 - UCAM | 7.00 |
| 4 - COPELABS-COFAC | 9.00 |
| 5 - TECNALIA | 2.00 |
| 6 - TEKEVER AU | 1.00 |
| 7 - Senception | 3.00 |
| 8 - Fon Technology | 4.00 |
| Fon Labs | 3.00 |
| 9 - AFA Systems | 10.00 |
| 10 - DUTH | 6.49 |
| Total | 51.99 |

List of deliverables

| Deliverable Number¹⁴ | Deliverable Title | Lead beneficiary | Type¹⁵ | Dissemination level¹⁶ | Due Date (in months)¹⁷ |
|--|--|-------------------------|--------------------------------|---|--|
| D6.1 | Dissemination Plan | 9 - AFA Systems | Report | Public | 6 |
| D6.2 | Dissemination Report (1) | 9 - AFA Systems | Report | Public | 18 |
| D6.3 | Dissemination Report (2) | 9 - AFA Systems | Report | Public | 36 |
| D6.4 | Exploitation Plan | 9 - AFA Systems | Report | Public | 18 |
| D6.5 | Exploitation Report | 9 - AFA Systems | Report | Public | 36 |
| D6.6 | Standardisation Plan | 9 - AFA Systems | Report | Public | 12 |
| D6.7 | Standardisation Report | 9 - AFA Systems | Report | Public | 35 |
| D6.8 | Awareness and Wider Societal Implications | 9 - AFA Systems | Report | Public | 36 |
| D6.9 | Final plan for the Use and Dissemination of Foreground | 9 - AFA Systems | Report | Public | 36 |
| D6.10 | Data Management Plan | 9 - AFA Systems | ORDP: Open Research Data Pilot | Public | 6 |

Description of deliverables

D6.1 Dissemination Plan [M06]

This report will include details on the dissemination plan that will be followed during the execution of the project.

D6.2/D6.3 Dissemination Report [M18, M36]

This report lists information on all dissemination actions throughout the duration of the project. All meeting agendas, presentations and list of participants will also be included.

D6.4 Exploitation Plan [M18]

Exploitation Plan report includes information on the exploitation roadmap defined by the consortium.

D6.5 Exploitation Report [M36]

Final exploitation report lists all exploitation actions for the project.

D6.6 Standardisation Plan [M12]

This deliverable constitutes the plan of the consortium for all standardisation activities.

D6.7 Standardisation Report [M35]

This report documents the standardisation activities carried out throughout the duration of the project.

D6.8 Awareness and Wider Societal Implications [M36]

This report includes information on any awareness and wider societal implications that have arisen during the project. The results of the evaluation are intended to help consortium partners and all other interested parties make better decisions about future research, research management and research policy.

D6.9 Final plan for the Use and Dissemination of Foreground [M36]

This report consists a final plan for the use and dissemination of foreground acquired throughout the duration of the project. This report summarises our strategy and concrete actions to protect, disseminate and exploit the foreground generated by UMOBILE project.

D6.10 Data Management Plan [M06]

UMOBILE will participate in the "Pilot on Open Research in HORIZON 2020". A Data Management Plan will be determined by M06 to explain which of the generated research data will be made open.

D6.1 : Dissemination Plan [6]

This report will include details on the dissemination plan that will be followed during the execution of the project.

D6.2 : Dissemination Report (1) [18]

This report lists information on all dissemination actions throughout the duration of the project. All meeting agendas, presentations and list of participants will also be included.

D6.3 : Dissemination Report (2) [36]

This report lists information on all dissemination actions throughout the duration of the project. All meeting agendas, presentations and list of participants will also be included.

D6.4 : Exploitation Plan [18]

Exploitation Plan report includes information on the exploitation roadmap defined by the consortium.

D6.5 : Exploitation Report [36]

Final exploitation report lists all exploitation actions for the project.

D6.6 : Standardisation Plan [12]

This deliverable constitutes the plan of the consortium for all standardisation activities.

D6.7 : Standardisation Report [35]

This report documents the standardisation activities carried out throughout the duration of the project.

D6.8 : Awareness and Wider Societal Implications [36]

This report includes information on any awareness and wider societal implications that have arisen during the project. The results of the evaluation are intended to help consortium partners and all other interested parties make better decisions about future research, research management and research policy.

D6.9 : Final plan for the Use and Dissemination of Foreground [36]

This report consists a final plan for the use and dissemination of foreground acquired throughout the duration of the project. This report summarises our strategy and concrete actions to protect, disseminate and exploit the foreground generated by UMOBILE project.

D6.10 : Data Management Plan [6]

UMOBILE will participate in the "Pilot on Open Research in HORIZON 2020". A Data Management Plan will be determined by M06 to explain which of the generated research data will be made open.

Schedule of relevant Milestones

| Milestone number ¹⁸ | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|--------------------------------|--|------------------|----------------------|--|
| MS11 | Public & Internal Web Site has been set up | 9 - AFA Systems | 1 | A Website dedicated to the project has been developed. The website will contain information on the project, the consortium, news, public results, upcoming events etc. A restricted internal section of the website will also be available for document sharing purposes among partners. |
| MS12 | Dissemination plan available | 9 - AFA Systems | 6 | The dissemination plan of the project has been defined. |
| MS13 | Contribution to standards reported | 9 - AFA Systems | 35 | All contribution to standards throughout the |

Schedule of relevant Milestones

| Milestone number¹⁸ | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|--------------------------------------|---------------------------------------|-------------------------|-----------------------------|--|
| | | | | project duration has been documented. |
| MS14 | Workshop on UMOBILE project organised | 9 - AFA Systems | 34 | Workshop on the developed architecture and scientific results has been successfully organised. |

| | | | |
|---|---------------------|---------------------------------------|---------------|
| Work package number ⁹ | WP7 | Lead beneficiary ¹⁰ | 1 - Athena RC |
| Work package title | Ethics requirements | | |
| Start month | 1 | End month | 36 |

Objectives

The objective is to ensure compliance with the 'ethics requirements' set out in this work package.

Description of work and role of partners

WP7 - Ethics requirements [Months: 1-36]

Athena RC

This work package sets out the 'ethics requirements' that the project must comply with.

List of deliverables

| Deliverable Number ¹⁴ | Deliverable Title | Lead beneficiary | Type ¹⁵ | Dissemination level ¹⁶ | Due Date (in months) ¹⁷ |
|---|--------------------------|-------------------------|---------------------------|--|---|
| D7.1 | OEI - Requirement No. 3 | 1 - Athena RC | Ethics | Confidential, only for members of the consortium (including the Commission Services) | 1 |
| D7.2 | POPD - Requirement No. 2 | 1 - Athena RC | Ethics | Confidential, only for members of the consortium (including the Commission Services) | 20 |

Description of deliverables

The 'ethics requirements' that the project must comply with are included as deliverables in this work package.

D7.1 : OEI - Requirement No. 3 [1]

The applicant must explicitly confirm that the existing data are publicly available. In case of data not publicly available, relevant authorisations must be provided.

D7.2 : POPD - Requirement No. 2 [20]

Copies of ethical approvals for the collection of personal data by the competent University Data Protection Officer / National Data Protection authority must be submitted to the Commission. Detailed information must be provided on the procedures that will be implemented for data collection, storage, protection, retention and destruction and confirmation that they comply with national and EU legislation. Detailed information must be provided on the informed consent procedures that will be implemented.

Schedule of relevant Milestones

| Milestone number ¹⁸ | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|---------------------------------------|------------------------|-------------------------|-----------------------------|------------------------------|
|---------------------------------------|------------------------|-------------------------|-----------------------------|------------------------------|

1.3.4. WT4 List of milestones

| Milestone number ¹⁸ | Milestone title | WP number ⁹ | Lead beneficiary | Due Date (in months) ¹⁷ | Means of verification |
|--------------------------------|--|------------------------|--------------------|------------------------------------|--|
| MS1 | Project kick-off meeting | WP1 | 10 - DUTH | 1 | Project kick-off meeting successfully held |
| MS2 | End of project | WP1 | 10 - DUTH | 36 | Final technical and project reports have been delivered to the EC. |
| MS3 | End-user and system requirements defined | WP2 | 3 - UCAM | 14 | The basic requirements of the system will be defined before proceeding with WP3 and WP4. Requirements will be refined throughout the evolution of the project. |
| MS4 | Requirements of the validation scenarios defined | WP2 | 3 - UCAM | 30 | The details and the requirements of the two validation scenarios will be defined, prior to their deployment. |
| MS5 | UMOBILE ICN layer abstraction specifications have been defined | WP3 | 10 - DUTH | 30 | We have developed the content-centric layer abstraction of UMOBILE platform. |
| MS6 | UMOBILE architecture implemented | WP3 | 10 - DUTH | 30 | The proposed architecture has been developed, all necessary parameters have been investigated and a prototype of the communication system has been set-up. |
| MS7 | QoS interfaces and mechanisms for data handling have been integrated within UMOBILE platform | WP4 | 7 - Senception | 30 | All required mechanisms for UMOBILE platform have been developed. |
| MS8 | Flowlet Congestion Control developed | WP4 | 7 - Senception | 30 | The specifications of the rate-regulation scheme for flowlets have been defined. |
| MS9 | Integration completed, system evaluated and proof-of-concept is available | WP5 | 8 - Fon Technology | 36 | Output components from WP3 and WP4 have been integrated to form UMOBILE platform and initial evaluation through simulations has been performed. |
| MS10 | Deployment trial successfully completed | WP5 | 8 - Fon Technology | 36 | Less-than-best effort Internet access scenario has been validated in our system. |
| MS11 | Public & Internal Web Site has been set up | WP6 | 9 - AFA Systems | 1 | A Website dedicated to the project has been developed. The website will contain information on the project, |

| Milestone number¹⁸ | Milestone title | WP number⁹ | Lead beneficiary | Due Date (in months)¹⁷ | Means of verification |
|--------------------------------------|---------------------------------------|------------------------------|-------------------------|--|--|
| | | | | | the consortium, news, public results, upcoming events etc. A restricted internal section of the website will also be available for document sharing purposes among partners. |
| MS12 | Dissemination plan available | WP6 | 9 - AFA Systems | 6 | The dissemination plan of the project has been defined. |
| MS13 | Contribution to standards reported | WP6 | 9 - AFA Systems | 35 | All contribution to standards throughout the project duration has been documented. |
| MS14 | Workshop on UMOBILE project organised | WP6 | 9 - AFA Systems | 34 | Workshop on the developed architecture and scientific results has been successfully organised. |

1.3.5. WT5 Critical Implementation risks and mitigation actions

| Risk number | Description of risk | WP Number | Proposed risk-mitigation measures |
|-------------|--|------------------------------|---|
| 1 | (TR) Faulty requirements or architectural design | WP2 | Previous experience in ICN, DTN and opportunistic communications helps minimising this risk. Partners will perform qualitative analysis of the design and iterate the design process, taking corrective action as needed. The proposed hardware devices, networking substrate and application functionality will be subject to extensive early prototype during the design process to validate the ideas and, if necessary, take corrective action, thus, reducing the risk. |
| 2 | (TR) Performance of architecture or protocol not adequate | WP3, WP4, WP5 | The architecture will be carefully designed to avoid any surprises based on our previous experiences. The iterative design - implementation - evaluation cycle approach allows correcting possible mistakes in the next iteration. |
| 3 | (TR) The implementation effort grows unexpectedly beyond the amount of work that can be achieved within the project budget. | WP5 | The project will reuse existing ICN, DTN components as a basis so as to minimise this risk. Partners have already carefully estimated the project's workload, as well as the required budget for equipment purchase. However, in case the implementation effort grows unexpectedly, partners will utilise their own resources, if necessary, and/or acquire extra national or internal funding in order to successfully complete the project. Combination of UMOBILE project with EC's structural funds has also been foreseen. |
| 4 | (TR) Availability of appropriate resources (such as test equipment) to validate and demonstrate the UMOBILE system is missing. | WP5 | WP2 focuses on the definition of the requirements of UMOBILE system in terms of end-users, network, architecture, use case scenarios, and deployability. These requirements will outline the necessary components for the validation of our platform. Moreover, partners will exploit their own equipment such as UAVs, testbeds, mobile devices etc. for testing purposes. |
| 5 | (PR) Underestimation of the required effort | WP1, WP2, WP3, WP4, WP5, WP6 | The consortium consists of experts in the areas addressed by UMOBILE architecture. Careful workload distribution has been performed and tasks have been thoroughly studied, so that all partners will contribute to their area of expertise. In case extra effort is needed, partners will contribute with own resources and/or acquire national and/or internal additional budget. |
| 6 | (PR) Withdrawal of partner | WP1 | The Project Coordination Committee (PCC) will decide if either other partner(s) take over activities, or to initiate the process for replacement as soon as possible. |
| 7 | (PR) Key staff or skills leaving the project | WP1 | Get early indication of possible withdrawal of key staff from partner if not internally replaceable. Contact all partners to seek similar competencies. Otherwise initiate adding a new partner to the |

| Risk number | Description of risk | WP Number | Proposed risk-mitigation measures |
|--------------------|--|------------------------------|--|
| | | | consortium. Shift the budget to the other(s) partner(s) that provides the competencies. |
| 8 | (PR) Underperforming partner | WP1 | The project manager continuously controls the project plan with its milestones and critical paths. In addition, there is internal monthly reporting, which ensures that the management is aware of potential problems on a monthly basis, and can initiate countermeasures long before a problem becomes violent. The tight control both at work package level and at project management level ensures that solutions will be available in time. However, our project schedule has been set to consider possible delays; in the utmost case we will adapt our work plan. In case, the issue is not resolvable, we will get partner to focus or replace people. Otherwise contact all the other partners to seek similar competencies. Shift the budget from the defaulting partner to the other(s) partner(s) that achieve the committed work. |
| 9 | (PR) Delays in key milestones or critical deliverables | WP1, WP2, WP3, WP4, WP5, WP6 | Carefully monitor progress, by means of project milestones and regular meetings, so as to detect quickly any delay. Prioritize workload and shift resources by reducing effort on non-critical tasks, even if this implies a shift of resources between partners. |
| 10 | (PR) Conflict between partners | WP1 | See Section 3.2.2 on decision making process and conflict resolution procedures. |
| 11 | (PR) Lack of internal communication | WP1 | The regular meetings, appropriate tools (including website, mailing list) and the reporting and communication flow process described above should provide the right level of internal communication. Adapt communication tools and meeting calendar if needed. |
| 12 | (PR) Change in general direction of technology and/or business | WP6 | Arrange a Project Coordination Committee meeting to reach agreement on project changes. Propose and negotiate changes with the European Commission. |

1.3.6. WT6 Summary of project effort in person-months

| | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 | Total Person/Months per Participant |
|----------------------------|--------------|--------------|---------------|--------------|---------------|--------------|-----|--|
| 1 - Athena RC | 3 | 1.50 | 15 | 5 | 17 | 2.50 | | 44 |
| 2 - UCL | 2 | 4 | 21 | 12 | 5 | 4 | | 48 |
| 3 - UCAM | 2 | 12 | 23 | 20 | 17 | 7 | | 81 |
| 4 - COPELABS-COFAC | 2 | 6 | 17 | 0 | 15 | 9 | | 49 |
| 5 - TECNALIA | 2 | 5 | 20 | 0 | 14 | 2 | | 43 |
| 6 - TEKEVER AU | 2 | 3 | 2 | 0 | 16 | 1 | | 24 |
| 7 - Senception | 2 | 4 | 5 | 15 | 10 | 3 | | 39 |
| 8 - Fon Technology | 2 | 6 | 0 | 0 | 11 | 4 | | 23 |
| · Fon Labs | 0 | 3 | 0 | 0 | 7 | 3 | 0 | 13 |
| 9 - AFA Systems | 2 | 3.50 | 8 | 10 | 11 | 10 | | 44.50 |
| 10 - DUTH | 8.12 | 6.48 | 24.52 | 8.73 | 2.01 | 6.49 | | 56.35 |
| Total Person/Months | 27.12 | 54.48 | 135.52 | 70.73 | 125.01 | 51.99 | | 464.85 |

1.3.7. WT7 Tentative schedule of project reviews

| Review number ¹⁹ | Tentative timing | Planned venue of review | Comments, if any |
|-----------------------------|------------------|-------------------------|------------------|
| RV1 | 18 | Brussels | Period 1 |
| RV2 | 36 | Brussels | Period 2 |

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

2. Project acronym

Use the project acronym as given in the submitted proposal. It can generally not be changed. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

3. Project title

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB : entry into force = signature by the Commission). Please note that if a fixed starting date is used, you will be required to provide a written justification.

5. Duration

Insert the duration of the project in full months.

6. Call (part) identifier

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Abstract

8. Project Entry Month

The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

9. Work Package number

Work package number: WP1, WP2, WP3, ..., WPn

10. Lead beneficiary

This must be one of the beneficiaries in the grant (not a third party) - Number of the beneficiary leading the work in this work package

11. Person-months per work package

The total number of person-months allocated to each work package.

12. Start month

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

13. End month

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

14. Deliverable number

Deliverable numbers: D1 - Dn

15. Type

Please indicate the type of the deliverable using one of the following codes:

- R Document, report
- DEM Demonstrator, pilot, prototype
- DEC Websites, patent filings, videos, etc.
- OTHER
- ETHICS Ethics requirement

16. Dissemination level

Please indicate the dissemination level using one of the following codes:

PU Public
CO Confidential, only for members of the consortium (including the Commission Services)
EU-RES Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)
EU-CON Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)
EU-SEC Classified Information: SECRET UE (Commission Decision 2005/444/EC)

17. Delivery date for Deliverable

Month in which the deliverables will be available, month 1 marking the start date of the project, and all delivery dates being relative to this start date.

18. Milestone number

Milestone number: MS1, MS2, ..., MSn

19. Review number

Review number: RV1, RV2, ..., RVn

20. Installation Number

Number progressively the installations of a same infrastructure. An installation is a part of an infrastructure that could be used independently from the rest.

21. Installation country

Code of the country where the installation is located or IO if the access provider (the beneficiary or linked third party) is an international organization, an ERIC or a similar legal entity.

22. Type of access

VA if virtual access,
TA-uc if trans-national access with access costs declared on the basis of unit cost,
TA-ac if trans-national access with access costs declared as actual costs, and
TA-cb if trans-national access with access costs declared as a combination of actual costs and costs on the basis of unit cost.

23. Access costs

Cost of the access provided under the project. For virtual access fill only the second column. For trans-national access fill one of the two columns or both according to the way access costs are declared. Trans-national access costs on the basis of unit cost will result from the unit cost by the quantity of access to be provided.