Scientific Report

First name / Family name	Jonathan Ouoba
Nationality	Burkina Faso
Name of the *Host Organisation*	VTT Technical Research Centre of Finland
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Period of the fellowship	01/01/2014 to 30/06/2015

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

Research activities

- Pursuit of PhD work: it was related to the development of a multilevel (multi-technology) platform allowing a set of mobile terminals (mobile phones in particular) to securely communicate using the most appropriate technology depending on the context; two perspectives have been further explored, namely the analytical study of the content dissemination in Mobile Ad hoc Networks (MANets) to analyze the relevance of direct transmission and relay transmission and the local (at a node level) text-similarity comparisons to perform so that a given mobile terminal of the network can properly search for the information it may need.
- Exploration of other fields related to PhD work: the objective was to extend the perspective of PhD work related to the analysis of Device-to-Device interactions among (personal) smart wireless objects especially regarding a consistent and secure behavior of the considered objects; it has led to initiate research activities for a trust model that enables an autonomous reasoning of wireless objects in accordance to the behaviour of people in real life (based on the assumption that the personal objects can be considered as extensions of their owners and they are expect to operate accordingly)
- ICT for development: it was mainly related to the design of sensing methods dedicated to urban technological deserts of sub-Saharan Africa, to the proposal of mobile services for smart transportation by considering the specific context of cities in West Africa, to the analysis of Open Data issues according to the realities of West Africa and to the improvement of teaching experience regarding software engineering through the initiation of engaging and collaborative projects for students (in sub-Saharan regions).

Participation to a project

It concerns the involvement in the CDC (Connected Digital Cities) project in the framework of the EIT-ICT Labs. The goal of the CDC project is to deploy a platform that is able to collect, analyze and enrich the relevant information in order to provide a valuable aggregate of real-time data related to urban mobility. I have contributed to the design of the architecture for a data platform allowing the development/deployment of mobile services in the domain of smart urban transportation (multi-modal journey planner for end-users).

Preparation of a project

I have been involved in a project proposal (in the framework of Celtic-Plus). The goal of the project is to provide a simple and elementary solution for E2E security continuity over heterogeneous technologies that are operated by external entities in the context of the emergence of Big Data technologies and Cloud Computing applications with “On Demand Services” (so that is possible to deliver to every customer a dynamical, adaptive and contextual security solution). I have contributed to the definition of a WP dedicated to the development of an IoT-based realistic framework enabling D2D interactions (Object-to Object) and Trusted Clouds operations (Object-to-Cloud) for wireless smart objects (wearable objects, MEMs sensors, personal equipment). The proposal has received the Celtic-Plus label.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

- **Towards an Interoperability Evaluation Process for Mobile Contactless City Service** - Jonathan Ouoba, Serge Chaumette, Damien Dubernet, Erkki Siira, Tuomo Tuikka (The Eighth International Conference on Digital Society, Barcelona, Spain) - **published**

  ABSTRACT: Interoperability of mobile contactless city services has been emerging as a topic of discussion in many of the recent events by the representatives of industry and city organizations. In the real world, interoperability is a myth and it must always be built by considering the specificities of the

existing artefacts. This paper studies and defines interoperability in the context of mobile contactless city services. Based on this analysis, an interoperability framework is proposed first by delineating the set of relevant entities and then by presenting four dimensions of the interoperability issues between the entities. We believe that this framework helps finding other related elements to make a coherent picture of interoperability in this context. It also leads to the definition of a relevant evaluation process. The goal of the paper is: (1) to properly define interoperability in our context; (2) to propose a set of evaluation criteria; (3) to propose an overview of an evaluation process

- **Sensing in Urban Technological Deserts: A Position Paper for Smart Cities in Least Developed Countries -** Jonathan Ouoba, Tegawendé F. Bissyandé (1st International Workshop on Web Intelligence and Smart Sensing, Saint-Etienne, France) – **published**

  ABSTRACT: The technological progress in recent years has allowed to produce sensors, on macroscopic and microscopic scales, that are now essential to ubiquitous computing. This paradigm has made the concept of smart cities a reality that is now in synchrony with the needs and requirements for living in this era. Whether it concerns commuters in public transportations or users of existential services such as hospitals, the implementation of smart cities is equally important in developed countries than in the least developed countries. Unfortunately, in the latter, sensors and the associated technologies are not readily available to implement smart cities. It is therefore necessary to identify surrogate ways of sensing the ambient environment. In this position paper, we discuss the situation in least developed countries and the obstacles to common implementations of smart cities. We also provide a preliminary enumeration of how mobile-phones with SMS-based services and the cultural model can be leveraged to build smart cities in such urban technological deserts.

- **Direct transmission vs relay transmission for information dissemination in a MANET: an analytical study -** Jonathan Ouoba, Serge Chaumette (10th IEEE International Conference on Collaborative Computing: Networking, Applications and Worksharing, Miami, Florida, United States) – **published**

  ABSTRACT: We have developed a multilevel platform – the word multilevel refers to the difference in communication range between the communication technologies that are considered - the goal of which is to allow a set of mobile terminals to securely communicate in a peer-to-peer manner by using the most appropriate available technology according to the context at hand. Two approaches, direct transmission and relay transmission, are considered for the publication of a profile (information a node is willing to share with the other entities), the choice of the approach to use depending on both the available communication technologies and the dynamics of the network. In this paper, we first present the target environments that we consider and the approach that we have chosen to implement in our multilevel platform. We then focus on the publication of profiles and we highlight the two transmission modes (direct transmission and relay transmission) that we have chosen to consider. We analytically study and compare them in terms of the probability to successfully deliver a given message in the target context defined above.

- **A Multilevel Platform for Secure Communications in a Fleet of Mobile Phones -** Jonathan Ouoba, Serge Chaumette (6th International Conference on Mobile Computing, Applications and Services, Austin, Texas, United States) – **published**

  ABSTRACT: Solving the classical problem of content delivery in the context of MANets composed of mobile phones (where the nodes operate in a totally decentralized and unplanned manner) requires specific solutions based on models that are compatible with the real world mobility/behavior of mobile phone owners, like the opportunistic approach. In addition, one should also take into account the fact that the mobile phones that compose the network are possibly equipped with different wireless technologies. Therefore we have defined a dedicated platform. This multilevel platform takes into account the different characteristics of the technologies that are available on the considered equipment

so as to allow a set of mobile nodes to communicate securely in peer-to-peer mode using the most appropriate approach depending on the context. In this paper, we first present the characteristics that we consider significant to build a proper model of the system. We then give an overview of the multilevel platform that we have designed and we detail the solutions that we have proposed to solve the major issues that we have identified. Finally, we describe a mobile application that we have developed to illustrate the use of the platform and present the related performance analysis.

- **Bootstrapping Software Engineering Training In Developing Countries – Return on Experience at the University of Ouagadougou** (6th International Conference on e-Infrastructure and e-Services for Developing Countries, Kampala, Uganda) **- published**

  ABSTRACT: ICT4D research has the potential of drastically enhancing the daily life of millions of people in developing countries. However, this potential can only be realized if there is enough skilled professionals to transform research ideas into business opportunities. Thus, education in computer sciences is becoming a priority in many countries in Africa, although harsh conditions involving for example limitations in Internet bandwidth and strong academia staff, have negative impact on student motivation and teacher's as well. We discuss in this paper an experience at the University of Ouagadougou, Burkina Faso, for a software engineering course. We report on the subject and realization of an engaging project for collectively building a toolset for counting source lines of code in projects.

- **Matching Information Requests with Node Profiles in Opportunistic Mobile Networks -** Jonathan Ouoba, Tegawendé F. Bissyandé (12th International Conference on Advances in Mobile Computing & Multimedia, Kaohsiung, Taiwan) – **published**

  ABSTRACT: We have defined a multilevel platform for empowering a set of mobile terminals to securely communicate, in peer-to-peer mode, using the most appropriate technology according to the context. An application scenario has led us to identify the main operations to perform within the multilevel platform and, more particularly, to consider the specification of a set of targets. This operation is meant to allow the definition of a set of nodes to target so that an entity can look for the information it may need. Then, the objective is to propose an efficient solution for the specification of targets so that it can be performed in the most realistic way in the considered environment. In this paper, we first present the multilevel platform and the approach that we have devised for its design. We then focus on the specification of a set of targets to describe how it is performed within the multilevel platform. Finally, we detail some elements that highlight the realistic aspect of our approach from an analytical perspective and through the results of tests that we have conducted.

- **Many faces of mobile contactless ticketing** & **Interoperability of mobile contactless city service -** Jonathan Ouoba, Serge Chaumette, Damien Dubernet, Erkki Siira, Tuomo Tuikka (Smart City Research Highlights, VTT Research Highlights 12) – **published**

- **Pro-IoT: Improving the Productivity of Companies by Using the IoT** – Jonathan Ouoba, Heikki Ailisto, Nadine Pesonen, Pertti Raatikainen (ERCIM News Number 101, Special Theme: The Internet of Things and the Web of Things) - **published**

- **Towards Trust Models and Mechanisms for Consistent Behavior in a Social Network of Wireless Smart Objects -** Jonathan Ouoba, Tegawendé F. Bissyandé, Cyril Cassagnes (8th International Conference on Trust & Trustworthy Computing) – **pending**

  ABSTRACT: Smart wireless objects are now pervasive in our lives. As these devices are increasingly used in chain to deliver rich services to the user, the next trend will make them evolve in their own social network with the different challenges that it entails. In this paper, we focus on how trust can be modeled and managed in such a network to preserve user privacy and ensure the security of peer to

peer interactions. We propose to rely on light-weight machine-learning mechanisms to allow these devices, which can be perceived as people's extensions, to mimic the human behavior of their owners regarding trust.

- **Connecting Digital Cities: Return of Experience on the Development of a Data Platform for Multimodal Journey Planning** – Jonathan Ouoba, Janne Lahti, Jukka Ahola (International Conference on Smart Urban Mobility Services**) – pending**

  ABSTRACT: Smart wireless The multiplication of real-time data sources in urban areas creates a fragmented environment regarding the supply of mobile services for transportation. Thus, in order to support the deployment of smart mobility services with a more global view of the urban context, the available data must be appropriately handled through dedicated platforms. It is in this context that the Connecting Digital Cities (CDC) project has been initiated at European level. The goal of the project is to deploy a platform that is able to collect, analyze and enrich the relevant information in order to provide a valuable aggregate of real-time data related to urban mobility. This paper presents a first return of experience in the development of this platform. We first provide an overview of the CDC project and we detail the architecture of the platform intended to collect and process real-time data. For validation purposes, we then describe a mobile service for multimodal journey planning that has been deployed to interact with the CDC platform. Finally, we share the lessons learned in terms of reliability of the system and proper integration of the system into urban ecosystems.

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

- The Eighth International Conference on Digital Society, Barcelona, Spain – **ICDS 2014** (to present a paper) – March 2014
- **WIMA** Conference on NFC and Proximity Solutions, Monaco – April 2014
- **Celtic-Plus Event** (to present a project proposal) – June 2014
- First International Workshop on Web Intelligence and Smart Sensing, Saint-Etienne, France – **IWWISS14** (to present a paper) – September 2014
- 10th IEEE International Conference on Collaborative Computing: Networking, Applications and Worksharing, Miami, Florida, United States – **CollaborateCom 2014** (to present a paper) – October 2014
- Research visit at Aoyama Gakuin University – in the team of Prof. Yoshito Tobe (to present my PhD work and to discuss about potential collaborations) – November 2014
- 6th International Conference on e-Infrastructure and e-Services for Developing Countries, Kampala, Uganda – **AFRICOMM 2014** (to present a paper) – November 2014
- The 12th International Conference on Advances in Mobile Computing & Multimedia – **MoMM 2014** (to present a paper) – December 2014

IV – RESEARCH EXCHANGE PROGRAMME (REP)

- **SICS** (Stockholm, Sweden) – Markus Bylund (local scientific coordinator) – 12.10.2014 to 19.10.2014: presentation of PhD work, relevant feedbacks regarding my research activities, discussions about the research environment at SICS especially with the project related to Smart ICT for living and working in Stockholm Royal Seaport

- **SnT-University of Luxembourg** (Luxembourg) – Yves Le Traon (local scientific coordinator) – 30.11.2014 to 05.12.2014: definition of roadmap for future research collaborations in the domains of ICT4D (mobile services for smart cities in sub-Saharan Africa) and machine learning mechanisms for secure behavior of wireless smart objects