Final Report on Dissemination, Regulation, Standardization, Exploitation & Training – D6.3

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Abstract

In D6.1 deliverable project dissemination, exploitation and training plans, as well as standardization & regulatory approach strategy was presented. The D6.2 reported on the necessary updates of these strategies and the actions taken by the partners in line with them, as well as the obtained results. In this D6.3 deliverable, a full set of project dissemination activities, standardization & regulatory contributions as well as an operator's "cook book" outlining steps necessary for full deployment of ON functionality and services, are presented.

Keywords List

OneFIT, Dissemination, Standardisation, Regulation, Conferences, Papers, Posters, Workshops, Web Site

Executive Summary

This deliverable presents the final report on OneFIT dissemination, exploitation, impacts and contributions to standardization and regulatory bodies. The OneFIT project has carried out a wide range of research covering architecture, control channel design and algorithm development to the validation of the developed concepts on hardware platforms. Furthermore, the major features developed during the project have been actively promoted to standardization and regulation forums to allow the introduction of opportunistic networks with cognitive management systems.

The main dissemination activities identified for the OneFIT project included publications in books, journals and conferences, demonstrations, presentations at concertation and cluster meetings, and participation in standardization and regulation. In terms of highlights, apart from significant body of journal and conference publications, the project contributions towards the following are noteworthy:

- On the standardization front, the OneFIT consortium initiated efforts and created a Work Item in ETSI RRS titled “Feasibility Study on Control Channels for Cognitive Radio Systems”. The work culminated in ratification of TR 102 684 “Reconfigurable Radio Systems (RRS); Feasibility Study on Control Channels for Cognitive Radio Systems”, in 2012.
- OneFIT partners also joined an initiative (Work Item) in 3GPP dedicated to the “proximity-based services” on the basis of device-to-device communications as an enabler of the concept of Opportunistic Networks. Consortium members provided Contributions related to device-to-device communication (D2DC) towards TR 22.803 “Feasibility Study for Proximity Services (ProSe)”
- The OneFIT partners have been active in contributing and participating to ITU-R WP5A meetings and promoting control channel related topics in the report tentatively called “Cognitive radio systems [(CRS) applications] in the land mobile service”.
- On the regulatory front, the European Commission (EC) organized a Workshop on Software Defined Radio and Cognitive Radio standardization at the Joint Research Centre in Ispra, Italy. The purpose of this workshop was to identify the main steps needed to drive the development and use of SDR and CR technologies in Europe, including the elements of a future standardization mandate as well as related regulatory and certification issues, and to define a roadmap to that purpose. The OneFIT partners contributed to the Workshop organisation and prepared presentations to the Workshop. The outcome of the Workshop is that the EC has issued a common standardization mandate, including SDR and CR requests, collectively named Reconfigurable Radio System (RRS), for civil security/military and commercial applications. This EC Mandate is a major achievement to serve as basis for the development of Harmonized Standards to be used for conformance declaration of Software Defined Radio and Cognitive Radio with the essential requirements of the R&TTE Directive.

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Table of Acronyms

Acronym	Meaning
3G	3rd Generation
3GPP	3rd Generation Partnership Project
4G	4th Generation
ACM	Association for Computing Machinery
ANDSF	Access Network Discovery and Selection Function
AP	Access Point
ARIB	Association of Radio Industries and Businesses
ATIS	Alliance for Telecommunications Industry Solutions
BNetzA	Bundesnetz agentur
BROADNETS	International ICST Conference on Broadband Communications, Networks, and Systems
BS	Base Station
BWA	Broadband Wireless Access
C4MS	Control Channels for the Cooperation of the Cognitive Management Systems
CA	Consortium Agreement
CAPEX	Capital Expenditure
CCR	Cognitive Control Radio
CCSA	China Communications Standards Association
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardization
CEPT	European Conference of Postal and Telecommunications Administrations
CMON	Cognitive Systems for Managing the Opportunistic Networks
CN	Cognitive Network
COGCLOUD	Workshop on Cognitive Wireless Cloud Networks
CPC	Cognitive Pilot Channel
CPG	Conference Preparatory Group
CPM	Conference Preparatory Meeting
CR	Cognitive Radio
CRS	Cognitive Radio System
CSCI	Cognitive Management Systems for Coordinating the Infrastructure
DG INFSO	Information Society and Media Directorate General
DSA	Dynamic Spectrum Access
DySPAN	IEEE symposia on Dynamic Spectrum Access Networks

EC	European Commission
ECC	Electronic Communications Committee
EDGE	Enhanced Data Rates for GSM Evolution
ETSI	European Telecommunications Standards Institute
EU	European Union
FA	Functional Architecture
FDD	Frequency Division Duplex
FI	Future Internet
FIA	Future Internet Assembly
FM	Frequency Management
FP	Framework Programme
FuNeMoS	Future Networks and Mobile Summit
GA	General Assembly
Globecom	IEEE Global Communications Conference
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
GW	Gateway
HS	Harmonised Standard
HSDPA	High Speed Downlink Packet Access
ICANN	International Conference on Artificial Neural Networks
ICST	Institute for Computer Sciences, Social Informatics and Telecommunications Engineering
ICT	Information and Communication Technologies
ICC	IEEE International Conference on Communications
IEEE	Institute of Electrical and Electronics Engineers
IET	Institution for Engineering and Technology
IMT	International Mobile Telecommunications
IPR	Intellectual Property Right
ISART	International Symposium on Advanced Radio Technologies
ISWCS	International Symposium on Wireless Communication Systems
ITU	International Telecommunications Union
ITU-D	ITU Development
ITU-R	ITU Radiocommunication
ITU-T	ITU Telecommunication
KPI	Key Performance Indicator
LAN	Local Area Network

LTE	Long Term Evolution
M2MC	Machine to Machine Communications
MAC	Medium Access Control
MAN	Metropolitan Area Network
MoU	Memorandum of Understanding
NDC	National Documentation Center
NPRM	Notice of Proposed Rule Making
OA&M	Operations, Administration and Maintenance
OJEU	Official Journal of the European Union
ON	Opportunistic network
OP	Organizational Partner
OPEX	Operational Expenditure
PAR	Project Authorization Request
PC	Project Coordinator
PCG	Project Co-ordination Group
PHY	Physical Layer
PIMRC	Personal, Indoor, and Mobile Radio Conference
PMT	Project Management Team
QoS	Quality of Service
QMR	Quarterly Management Report
R&D	Research and Development
RA	Regulatory Affairs
RAN	Radio Access Networks
RAS	Radio Access and Spectrum Management
RAT	Radio Access Technology
RF	Radio Frequency
RRM	Radio Resource Management
RRS	Reconfigurable Radio Systems
RSPG	Radio Spectrum Policy Group
R&TTE	Radio Equipment and Telecommunications Terminal Equipment
SA	Services and System Aspects
SCC	Standards Coordinating Committee
SDR	Software Defined Radio
SDRF	Software Defined Radio Forum
SE	Spectrum Engineering

SG	Study Group
SIG	Special Interest Group
SM	Spectrum Manager
TC	Technical Committee
TCAM	Telecommunications Conformity Assessment and Market surveillance
TDD	Time Division Duplex
TLA	Temporary Licensing Agreement
TM	Technical Manager
TMN	Telecommunication Management Network
TO	Technical Organization
TOC	Table of Contents
TR	Technical Report
TS	Technical Specification
TSG	Technical Specification Groups
TTA	Telecommunications Technology Association
TTC	Telecommunications Technology Committee
UE	User Equipment
UHF	Ultra High Frequency
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
VTC	IEEE Vehicular Technology Conference
wCDN	wireless Content Delivery Network
WCNC	IEEE Wireless Communications and Networking Conference
WG	Working Group
WiFi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WINF	Wireless Innovation Forum
WLAN	Wireless LAN
WP	Workpackage/ Working Party of ITU-R
WPL	Workpackage Leader
WRC	World Radio communication Conference
WRAN	Wireless Regional Area Network
WWRF	Wireless World Research Forum

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1. Introduction

The OneFIT project has aimed at developing and validating a vision of opportunistic networks that are managed and coordinated by the infrastructure, based on an advanced cognitive management system and new functionalities. This deliverable, the final in the series for WP6, describes full set of the dissemination and exploitation activities carried out during the lifetime of the project, including publications in books, journals and conferences, presentations at concertation and cluster meetings, workshops, and participation in standardization and regulation. This deliverable highlights the major dissemination forums/contributions and outlines the efforts made to communicating the OneFIT concepts and results into the various forums.

This deliverable is organized as follows. Chapter 2 presents complete set of OneFIT dissemination activities including e.g. publications, presentations, and demonstrations. Chapter 3 presents the training and workshop contributions. Standardization & regulatory contributions are covered in Chapters 4 and 5. Partner exploitation outcomes are given in Chapter 6. In Chapter 7 an operator recipe (“cook-book”) for deployment of ON services and OneFIT architecture is presented. Finally, Conclusions are drawn in Chapter 8.

2. OneFIT Dissemination Status & Plans

2.1 Dissemination Activities

The dissemination of OneFIT results to the research and standardization communities has been one of the key goals of the consortium. To achieve this, OneFIT partners followed a dissemination strategy which encompasses a number of different means, in order to ensure the highest possible impact.

The strategy covered aspects relevant intellectual property rights (IPR) identification and issue, to promote the project results and ensure project awareness within the European information and communication technology (ICT) and the global research community. The OneFIT Dissemination Approach, Reporting and Mechanism have already been presented in D6.1 [1] and are also in D6.2 Annex I. The following sections describe the dissemination activities conducted by the OneFIT partners during the 2010-2012 period.

2.1.1 Journal and Book Contributions

OneFIT has aimed to achieve dissemination activities in journals and magazines of all the main editorial houses, namely IEEE, Association for Computing Machinery (ACM), Elsevier, Springer, and Wiley. OneFIT also targeted contributions towards special issues in journals and chapters in books. The journals targeted are summarized in the following list:

Annals of Telecommunications (Springer)
Communications Magazine (IEEE)
Computers & Electrical Engineering (Elsevier)
Computer Networks Journal (Elsevier)
EURASIP Journal on Wireless Communications and Networking (SpringerOpen)
Journal of Communications (Institution for Engineering and Technology (IET))
Journal of Green Engineering (River Publishers)
Journal of Network and Systems Management (Springer)
International Journal of Communication Networks and Distributed Systems (Wiley)
International Journal of Digital Multimedia Broadcasting (Hindawi)
International Journal of Network Management (Wiley)
Mobile Networks and Applications (Springer)
Pervasive and Mobile Computing Journal (Elsevier)
Telematics and Informatics (Elsevier)
Transactions on Communications (IEEE)
Transactions on Emerging Telecommunications Technologies (Wiley)
Transactions on Systems, Man and Cybernetics – Part C (IEEE)
Vehicular Technology Magazine (IEEE)
Wireless Communications and Mobile Computing Journal (Wiley)
Wireless Personal Communications Journal (Springer)

2.1.1.1 Actions done

The OneFIT members have made the following submissions to Journals and Books. More publications are currently under preparation, in order to showcase the research done and the results produced within OneFIT.

Table 2-1: OneFIT Journal papers and Book Chapters Submitted/Accepted [Period: 01.07.2010 – 31.12.2010]

Author(s)	Contribution Title	Journal Name	Status
K.Tsagkaris, M.Logothetis,	Investigation of the QoS Provision Potentials of the	Ad Hoc & Sensor Wireless Networks (AHWSN), Old City	Accepted / Published

P.Demestichas	Exploitation of Infrastructure-less Segments by Composite Wireless Infrastructures	Publishing	
K. Tsagkaris, A. Bantouna, P. Demestichas	Self-organizing maps for advanced learning in cognitive radio systems	Computers & Electrical Engineering, Elsevier. Vol. 38, no.4, pp. 862-881, 2012, Elsevier.	Accepted / Published
A. Georgakopoulos, K. Tsagkaris, P. Demestichas	Efficient opportunistic network creation in the context of Future Internet	The Future Internet: Achievements and Technological Promises, vol. 6656, pp. 293-306, 2011, Springer-Verlag	Accepted / Published
K. Tsagkaris, M. Akezidou, A. Galani, P. Demestichas	Evaluation of signalling loads in cognitive network management architecture	International Journal of Network Management, Wiley. Col. 22, no. 3, pp. 235-260, 2011.	Accepted / Published
T. Baykas, M. Mueck, S. Filin, M. Kasslin, P. Ruuska, J. Wang	Standardization Activities Related to TV White Space: Co-existence and Dynamic Spectrum Access Standards	TV White Space Spectrum Technologies: Regulations, Standards, and Applications, pp. 173-208, 2011, CRC Press.	Accepted / Published

Table 2-2: OneFIT Journal papers and Book Chapters Submitted/Accepted [Period: 31.12.2010 – 31.12.2011]

Author(s)	Contribution Title	Journal Name	Status
K.Tsagkaris, M.Logothetis, P.Demestichas	Investigation of the QoS Provision Potentials of the Exploitation of Infrastructure-less Segments by Composite Wireless Infrastructures	Ad Hoc & Sensor Wireless Networks (AHWSN), Old City Publishing	Accepted / Published
D. Boskovic, F. Vakil, S. Dautovic, M. Tosic	Greening of Video Streaming to Mobile Devices by Pervasive Wireless CDN	Journal of Green Engineering, River Publishers	Accepted / Published
A. Georgakopoulos, K. Tsagkaris, V. Stavroulaki, P. Demestichas	Efficient opportunistic network creation in the context of Future Internet	Future Internet Book 2011, Springer	Accepted / Published
K. Tsagkaris, M. Akezidou, A. Galani, P. Demestichas	Evaluation of signalling loads in cognitive network management architecture	International Journal of Network Management, Wiley	Accepted (available online)
K. Tsagkaris, S. Filin, J. Gebert, M. Mueck, P. Vlacheas, G. Athanasiou, V. Stavroulaki, H. Harada	Autonomics in wireless network management: Advances in standards and further challenges	IEEE Network Magazine	Accepted / Published
M. Logothetis, K. Tsagkaris, P. Demestichas	Application and Mobility Aware Integration of Opportunistic Networks with Wireless Infrastructures	Computers & Electrical Engineering Journal	Accepted / To Appear

V. Stavroulaki, K. Tsagkaris, M. Logothetis, A. Georgakopoulos, P. Demestichas, J. Gebert, M. Filo	Opportunistic Networks: An approach for exploiting cognitive radio networking technologies in the Future Internet	IEEE Vehicular Technology Magazine	Accepted / Published
V. Stavroulaki, K. Tsagkaris, P. Demestichas, J. Gebert, M. Mueck, A. Schmidt, R. Ferrús, O. Sallent, M. Filo, C. Mouton, L. Rakotoharison	Cognitive Control Channels: From concept to identification of implementation options	IEEE Communications Magazine, Network & Service Management Series	Accepted / Published
K. Tsagkaris, G. Athanasiou, M. Logothetis, Y. Kritikou, D. Karvounas, P. Demestichas	Introducing Energy Awareness in the Cognitive Management of Future Networks	Green Engineering Journal	Accepted / Published
V. Stavroulaki, K. Tsagkaris, M. Logothetis, A. Georgakopoulos, P. Demestichas, J. Gebert, M. Filo	Opportunistic Networks: An approach for exploiting cognitive radio networking technologies in the Future Internet	IEEE Vehicular Technology Magazine	Accepted / Published
A. Bantouna V. Stavroulaki Y. Kritikou K.Tsagkaris P. Demestichas K. Moessner	An Overview for Learning Mechanisms for Cognitive Systems	EURASIP Journal on Wireless Communications and Networking, Special Issue on "Ten Years of Cognitive Radio: State of the Art and Perspectives"	Accepted / Published
A. Bantouna K. Tsagkaris V. Stavroulaki P. Demestichas	Machine Learning applied to Cognitive Communications	Cognitive Communications: Distributed Artificial Intelligence (DAI), Regulatory Policy & Economics, Implementation. H. Zhang and D. Grace, J. Wiley and Sons.	Accepted / To Appear
A. Bantouna K. Tsagkaris V. Stavroulaki P. Demestichas	Learning Techniques for Context Diagnosis and Prediction in Cognitive Communications	Cognitive Communications: Distributed Artificial Intelligence (DAI), Regulatory Policy & Economics, Implementation. H. Zhang and D. Grace, J. Wiley and Sons.	Accepted / To Appear
A. Georgakopoulos, D. Karvounas, V. Stavroulaki, K. Tsagkaris, M. Tosic, D. Boscovic, P. Demestichas	Scheme for expanding the capacity of wireless access infrastructures through the exploitation of opportunistic networks	Mobile Networks and Applications (MONET), vol.17, no.4, pp. 463-478, 2012 Springer.	Accepted / Published

D. Karvounas, A. Georgakopoulos, V. Stavroulaki, N. Koutsouris, K. Tsagkaris, P. Demestichas	Resource allocation to femtocells for coordinating capacity expansion of wireless access infrastructures	EURASIP Journal on Wireless Communications and Networking: Special Issue on Femtocells in 4G Systems.	Accepted / To Appear 2012

Table 2-3: OneFIT Journal papers and Book Chapters Submitted/Accepted [Period: 31.12.2011 – 31.12.2012]

Author(s)	Contribution Title	Journal Name	Status
A. Bantouna V. Stavroulaki Y. Kritikou K.Tsagkaris P. Demestichas K. Moessner	An Overview for Learning Mechanisms for Cognitive Systems	EURASIP Journal on Wireless Communications and Networking, Special Issue on "Ten Years of Cognitive Radio: State of the Art and Perspectives", Vol: 22, No: 1, January 2012	Accepted / Published
A. Georgakopoulos, K. Tsagkaris, V. Stavroulaki, P. Demestichas	Efficient opportunistic network creation in the context of Future Internet	Future Internet Book 2011, Springer	Accepted / Published
D. Karvounas, A. Georgakopoulos, D. Panagiotou, V. Stavroulaki, K. Tsagkaris, P. Demestichas	Achieving energy efficiency through the opportunistic exploitation of infrastructures comprising cells of various sizes	Journal of Green Engineering, Special Issue "Special Issue on Exploiting ICT for a Sustainable Green World". Vol: 2, No: 3, pp.: 233-253, May 2012	Accepted / Published
D. Karvounas, A. Georgakopoulos, V. Stavroulaki, N. Koutsouris, K. Tsagkaris, P. Demestichas	Resource allocation to femtocells for coordinated capacity expansion of wireless access infrastructures	EURASIP Journal on Wireless Communications and Networking, Special issue on Femtocells in 4G Systems	Accepted / Published
K. Tsagkaris, M. Akezidou, A. Galani, P. Demestichas	Evaluation of signalling loads in cognitive network management architecture	International Journal of Network Management, Wiley	Accepted / Published
K. Tsagkaris, S. Filin, J. Gebert, M. Mueck, P. Vlacheas, G. Athanasiou, V. Stavroulaki, H. Harada	Autonomics in wireless network management: Advances in standards and further challenges	IEEE Network Magazine	Accepted / Published
K.Tsagkaris, M.Logothetis, P.Demestichas	Investigation of the QoS Provision Potentials of the Exploitation of Infrastructure-less Segments by Composite Wireless Infrastructures	Ad Hoc & Sensor Wireless Networks (AHWSN), Old City Publishing	Accepted / Published
M. Logothetis, K. Tsagkaris, P. Demestichas	Application and Mobility Aware Integration of Opportunistic Networks with Wireless Infrastructures	Computers & Electrical Engineering Journal	Accepted / Published
V. Stavroulaki, K. Tsagkaris, M. Logothetis,	Opportunistic Networks: An approach for exploiting cognitive radio networking technologies in	IEEE Vehicular Technology Magazine	Accepted / Published

A. Georgakopoulos, P. Demestichas, J. Gebert, M. Filo	the Future Internet		
V. Stavroulaki, K. Tsagkaris, P. Demestichas, J. Gebert, M. Mueck, A. Schmidt, R. Ferrús, O. Sallent, M. Filo, C. Mouton, L. Rakotoharison	Cognitive Control Channels: From concept to identification of implementation options	IEEE Communications Magazine, Network & Service Management Series. Vol: 50, No: 7, pp.: 96-108, July 2012	Accepted / Published
X. Chen, H. Zhang, T. Chen, M. Lasanen, J. Palicot	On Improving Energy Efficiency within Green Femtocell Networks: A Hierarchical Reinforcement Learning Approach	IEEE Journal of Selected Topics in Signal Processing Special Issue	Submitted
M. Kiviranta, A. Mämmelä	Receiver structure and estimation of the modulation index for tamed frequency modulated (TFM) signals	IEEE Transactions on Broadcasting	Submitted
H. Sarvanko, M. Matinmikko, J. Del Ser M. Mustonen	Spectrum band and channel selection scheme for heterogeneous traffic and multi-RAT systems	Wiley Journal Transactions on Emerging Telecommunications Technologies (ETT) special issue on: Cognitive Radio in Emerging Communications Systems – Small Cells, Machine-to-Machine Communications, TV White Spaces, and Green Radios	Submitted
R. Ferrús, O. Sallent, J. Pérez-Romero, R. Agustí	A Solution Framework to Provide Management Services for Wireless Communications in the Digital Home	IEEE Communications Magazine, November, 2012, pp. 132-141.	
F. Bouali, O. Sallent, J. Pérez-Romero, R. Agustí	A Fittingness Factor-based Spectrum Management Framework for Cognitive Radio Networks	Wireless Personal Communications, Springer	Accepted, June 2012.
F. Bouali, O. Sallent, J. Pérez-Romero, R. Agustí	A Cognitive Management Framework for Spectrum Selection	Computer Networks, Elsevier	Submitted, July 2012.
D. Karvounas, A. Georgakopoulos, V. Stavroulaki, K. Tsagkaris, P. Demestichas, J. Pérez-Romero, O. Sallent, F. Bouali, J. Gebert	Opportunistic networks and cognitive management systems for efficient spectrum selection and expansion of cellular infrastructures	IEEE Wireless Communications Magazine	Submitted, October, 2012
H. Lee,	Radio Resource Management for	IEEE Communications Surveys	Submitted,

S. Vahid, K. Moessner	Carrier Aggregation in LTE-Advanced System: A Survey	& tutorials	October, 2012
G. Alnwaimi, S. Vahid, K. Moessner	On Dynamic Heterogeneous Learning Games in Distributed LTE Femtocells for Opportunistic Access	IEEE Transactions on Communications	Submitted, October, 2012
M. Riaz, S. Vahid, K. Moessner	Topology Control for Mobile Ad Hoc Networks	IEEE Communications Surveys & tutorials	Submitted, Dec, 2012
M. Riaz, S. Vahid, K. Moessner	Optimal, Fault-tolerant SINR based Topology Control	IEEE Transactions on Communications	Submitted, Dec, 2012
D. Karvounas, P. Vlacheas, A. Georgakopoulos, V. Stavroulaki, P. Demestichas	Enriching Self-Organizing Networks Use Cases with Opportunistic Features: A Capacity and Coverage Optimization Paradigm	International Journal of Network Management, Wiley	Submitted, Dec, 2012
D. Karvounas, A. Georgakopoulos, V. Stavroulaki, K. Tsagkaris, P. Demestichas	Evaluation of signaling load in control channels for the cognitive management of Opportunistic Networks (tentative title)	Transactions on Emerging Telecommunications Technologies, Wiley	To be Submitted, Jan, 2013
S. Shariat, S. Vahid, R. Tafazolli	A Survey of Spectrum-aware Routing Protocols in Cognitive Ad-Hoc Networks	IEEE Communications Surveys & tutorials	To be Submitted, Jan, 2013

2.1.2 Conference Contributions (Papers, Presentations, Posters)

2.1.2.1 Actions done

The OneFIT partners have made significant number of contributions and presentations at major conferences. More specifically, the OneFIT conference contributions (papers, presentations and posters) that have been made are listed in Table 2-4, Table 2-5 and Table 2-6:

Table 2-4：OneFIT Conference Activities [Period: 01.07.2010 - 31.12.2010]

Author	Presentation Title	Conference Name	Loc.	Date	Ref.
K. Tsagkaris, M. Logothetis, P. Demestichas	Studies on the potentials of the exploitation of infrastructure-less segments by composite Wireless networks	OpnetWork 2010	Washington, USA	31.08-02.09.2010	Paper/ Presentation
A. Bantouna, K. Tsagkaris, P. Demestichas	Self-Organizing Maps for Improving the Channel Estimation and Predictive Modelling Phase of Cognitive	ICANN2010	Thessaloniki, Greece	18.09.2010	Paper/ Presentation

	Radio Systems				
P. Demestichas, K. Tsagkaris, V. Stavroulaki	Cognitive Management Systems for Supporting Operators in the Emerging Future Internet Era	PIMRC2010	Istanbul, Turkey	26-27.09.2010	Presentation
P. Demestichas, K. Tsagkaris, V. Stavroulaki, Y. Kritikou, A. Georgakopoulos	Technical Challenges for Merging Opportunistic Networks with Respective Cognitive Management Systems in the Future Internet	PIMRC2010	Istanbul, Turkey	26-27.09.2010	Paper/ Presentation
K.Tsagkaris, M.Akezidou, A.Galani, P.Demestichas	Signaling load evaluations for policy-driven cognitive management architectures	7th International ICST Conference on Broadband Communications, Networks, and Systems (BROADNETS 2010)	Athens, Greece	25-27.10.2010	Paper/ Presentation
A. Bantouna, K. Tsagkaris, P. Demestichas	Self-Organizing Maps for Improved Learning in Cognitive Radio Systems	1st International Conference for Undergraduate and Postgraduate Students in Computer Engineering, Informatics, related Technologies and Applications 2010 (Eureka! 2010)	Patras, Greece	14-15.10.2010	Paper/ Presentation
V.Stavroulaki, N.Koutsouris, K.Tsagkaris, P.Demestichas	A Platform for the Integration and Management of Cognitive Systems in Future Networks	IEEE International Workshop on Management of Emerging Networks and Services (MENS) – IEEE GLOBECOM 2010 Workshop on Management of Emerging Networks and	Miami, Florida, USA	06-10.12.2010	Paper/ Presentation

		Services			
M. Mueck, A. Schmidt, K. Tsagkaris, V. Stavroulaki, P. Demestichas, R. Ferrús, O. Sallent, S. Delaere, P. Ballon, C. Saradhi, A. Rahim Biswas, S. Kandeepan, G. Baldini, J. Gebert, T. Haustein	Cognitive Control Channels: From Myth to Reality - Implementation Options	DySPAN2011. Dynamic Spectrum Access Networks 2011	Aachen, Germany	03-06.05.2011	Paper/ Presentation
A. Georgakopoulos, K. Tsagkaris, V. Stavroulaki, P. Demestichas	Efficient node selection in the context of opportunistic network creation in the Future Internet	ICC2011 – IEEE International Conference on Communications 2011 Workshop on Future Network (FutureNet IV)	Kyoto, Japan	05-09.06.2011	Paper/ Presentation
A. Georgakopoulos, V. Stavroulaki, K. Tsagkaris, P. Demestichas	Specification and assessment of a fitness function for the creation of opportunistic networks	Future Network and Mobile Summit 2011	Warsaw, Poland	15-17.06.2011	Paper/ Presentation
A. Georgakopoulos, V. Stavroulaki, J. Gebert, O. Moreno, O. Sallent, M. Matinmikko, M. Filo, D. Boskovic, M. Tosic, M. Mueck, C. Mouton	Opportunistic Networks for efficient application provisioning in the Future Internet: Business Scenarios and Technical Challenges	Future Network and Mobile Summit 2011	Warsaw, Poland	15-17.06.2011	Paper/ Presentation

Table 2-5: OneFIT Conference Activities [Period: 31.12.2010 – 31.12.2011]

Author	Presentation Title	Conference Name	Loc.	Date	Ref.
P. Demestichas, K. Tsagkaris, G. Athanasiou, Y. Kritikou	Green Footprint of Cognitive Management Technologies for Future Networks	ECO-ICT FOR ENERGY EFFICIENCY AND SUSTAINABILITY in the context of	Opatija, Croatia	23-27.05.2011	Paper/ Presentation

		MIPRO2011			
A. Georgakopoulos, K. Tsagkaris, V. Stavroulaki, P. Demestichas, K. Moessner, J. Gebert, O. Sallent M. Filo	Opportunistic Networks and Cognitive Management Systems for Efficient Application Provisioning in the Future Internet: An Overview	CrownCom2011	Osaka, Japan	31.05-03.06.2011	Paper/ Presentation
A. Georgakopoulos, V. Stavroulaki, J. Gebert, O. Moreno, O. Sallent, M. Matinmikko, M. Filo, D. Boskovic, M. Tosic, M. Mueck, C. Mouton	Opportunistic Networks for efficient application provisioning in the Future Internet: Business Scenarios and Technical Challenges	Future Network & Mobile Summit (FNMS) 2011	Warsaw, Poland	15-17.06.2011	Paper/ Poster
A. Georgakopoulos, K. Tsagkaris, V. Stavroulaki, P. Demestichas	Specification and assessment of a fitness function for the creation of opportunistic networks	Future Network & Mobile Summit (FNMS) 2011	Warsaw, Poland	15-17.06.2011	Paper/ Presentation
A. Georgakopoulos, K. Tsagkaris, V. Stavroulaki, P. Demestichas	OneFIT Demonstration Booth	Future Network & Mobile Summit (FNMS) 2011	Warsaw, Poland	15-17.06.2011	Paper/ Presentation
M. Bourdellès, S. Pega	Routing Pattern Selection for opportunistic network management	2011 Wireless Innovation Forum European Conference on Communications Technologies and Software Defined Radio (WinnComm Europe SDR'11)	Brussels, Belgium	22-24.06.2011	Paper/ Presentation
M. Logothetis, K. Tsagkaris, P. Demestichas	Performance evaluation of the suitability of opportunistic networks for the Future Internet	ISCC 2011	Corfu, Greece	28.06-01.07.2011	Paper/ Presentation
J. Gebert, A. Georgakopoulos, V. Stavroulaki, K. Tsagkaris, R. Ferrús, P. Demestichas	Cognitive Control Channels for the Cooperation of Opportunistic and Composite Wireless	EUSIPCO 2011	Barcelona, Spain	29.08-02.09.2011	Paper/ Presentation

	Networks				
M. Logothetis, K. Tsagkaris, P. Demestichas	Performance evaluation of the suitability of Opportunistic Networks in the Wireless World	IEEE 74th Vehicular Technology Conference – VTC2011 Fall	San Francisco, United States	05-08.09.2011	Paper/ Presentation
M. Logothetis, V. Stavroulaki, A. Georgakopoulos, D. Karvounas, N. Koutsouris, K.Tsagkaris, P. Demestichas, M. Tosic, D. Boskovic	Opportunistic Network Creation Schemes for Capacity Extension in Wireless Access and Backhaul Segments	3rd International ICST Conference on Mobile Networks and Management MONAMI	Aveiro, Portugal	21.-23.09.2011	Paper/ Presentation
J. Pérez-Romero, O. Sallent, R. Agustí	On the Role of Spectrum Selection to Improve Coverage Extension through Opportunistic Networks	14th International Symposium on Wireless Personal Multimedia Communications (WPMC)	Brest, France	03-06.10.2011	Paper/ Presentation
F. Bouali, O. Sallent, J. Pérez-Romero, R. Agustí	A Framework Based on a Fittingness Factor to Enable Efficient Exploitation of Spectrum Opportunities in Cognitive Radio Networks	14th International Symposium on Wireless Personal Multimedia Communications (WPMC)	Brest, France	03-06.10.2011	Paper/ Presentation This paper received the best student paper award in the conference
H. Sarvanko, M. Mustonen, M. Matinmikko	Modular Decision Flow Approach for Selecting Frequency, Bandwidth and Radio Access Technique for Opportunistic Network	4th International Conference on Cognitive Radio and Advanced Spectrum Management (CogArt 2011)	Barcelona, Spain	26.-29.10.2011	Paper/ Poster
M. Matinmikko, M. Mustonen, T. Rauma, J. Del Ser	Decision-Making System for Obtaining Spectrum Availability Information in Opportunistic Networks	4th International Conference on Cognitive Radio and Advanced Spectrum Management (CogArt 2011)	Barcelona, Spain	26.-29.10.2011	Paper/ Presentation

J. Gebert, A. Georgakopoulos, D. Karvounas, V. Stavroulaki, P. Demestichas	Management of Opportunistic Networks through cognitive functionalities	9th International Conference on Wireless On-demand Network Systems and Services (WONS 2012)	Courmayeur, Italy	09-11.01.2012	Paper/ Presentation
M.Mueck T.Hausstein P.Bender	Digital and Dynamic Certification in the Framework of the novel revised R&TTE Directive in Europe	Crowncom 2011	Osaka, Japan	01-03.06.2011	Paper/Presentation
D. Karvounas, A. Georgakopoulos, V. Stavroulaki, N. Koutsouris, K. Tsagkaris, P. Demestichas (tentative)	Opportunistic capacity extension of wireless access infrastructure by exploiting femtocells	IEEE International Conference on Communications (ICC 2012)	Ottawa, Canada	10-15.06.2012	Paper/ Submitted
D. Karvounas, A. Georgakopoulos, N. Koutsouris, K. Tsagkaris, V. Stavroulaki, P. Demestichas	Femtocell-based capacity extension of wireless access infrastructures	Future Networks & Mobile Summit 2012	Berlin, Germany	04-06.07.2012	Paper (Submitted)
A. Georgakopoulos, D. Karvounas, V. Stavroulaki, M. Tosic, D. Boscovic, J. Gebert, W. Koenig, P. Demestichas	Cognitive cloud-oriented wireless networks for the Future Internet	IEEE Wireless Communications and Networking Conference (WCNC 2012)	Paris, France	01-04.04.2012	Paper (Submitted)
R.Liebler P.Bender	Cornerstones of a forward-looking regulatory framework – How to foster investment and innovation	DySPAN2011	Aachen, Germany	03.-06.05.2011	Submitted
P.Bender	A View on the Regulatory context of SDR and Cognitive Radio	European Commission Workshop on Software Defined Radio and Cognitive Radio standardization	ISPRA, Italia	17.-18.11.2011	Submitted

Table 2-6: OneFIT Conference Activities [Period: 31.12.2011 – 31.12.2012]

Authors	Presentation Title	Conference Name	Loc.	Date	Ref.
J. Gebert, A. Georgakopoulos, D. Karvounas, V. Stavroulaki, P. Demestichas	Management of Opportunistic Networks through cognitive functionalities	9th International Conference on Wireless On-demand Network Systems and Services (WONS 2012)	Courmayeur, Italy	09-11.01.2012	Accepted/ Presented
A. Georgakopoulos, D. Karvounas, V. Stavroulaki, M. Tosic, D. Boscovic, J. Gebert, W. Koenig, P. Demestichas	Cognitive cloud-oriented wireless networks for the Future Internet	IEEE Wireless Communications and Networking Conference (WCNC 2012)	Paris, France	01-04.04.2012	Accepted/ Presented
D. Karvounas, A. Georgakopoulos, D. Panagiotou, V. Stavroulaki, K. Tsagkaris, P. Demestichas	Opportunistic exploitation of resources for improving the energy-efficiency of wireless networks	IEEE International Conference on Communications (ICC 2012)	Ottawa, Canada	10-15.06.2012	Accepted/ Presented
D. Karvounas, A. Georgakopoulos, N. Koutsouris, K. Tsagkaris, V. Stavroulaki, P. Demestichas	Femtocell-based capacity extension of wireless access infrastructures	Future Networks and Mobile Summit (FNMS) 2012	Berlin, Germany	04-06.07.2012	Accepted/ Presented
J. Gebert, R. Fuchs	Probabilities for opportunistic networking in different scenarios	Future Networks and Mobile Summit (FNMS) 2012	Berlin, Germany	04-06.07.2012	Accepted/ Presented
M. Tosic, M. Cirilovic, O. Ikovic, D. Kesler, S. Dautovic, D. Boscovic	Impact of different content placement and delivery strategies on content delivery capacity of the wireless mesh network	AdHoc Now 2012	Belgrade, Serbia	09.-11.07.2012	Accepted/ Presented
M. Bourdellès, N. Ménégale	Routing optimization with network coding	International Symposium on Wireless Communication Systems 2012 (ISWCS 2012)	Paris, France	28-31.08.2012	Accepted/ Presented
A. Georgakopoulos, P. Demestichas, V. Stavroulaki, K. Tsagkaris,	Mechanisms for Information and Knowledge Sharing in	9th International Symposium on Wireless	Paris, France	28-31.08.2012	Accepted/ Presented

A. Bantouna	Wireless Communication Systems	Communication Systems (ISWCS) 2012			
H. Sarvanko, M. Mustonen, M. Matinmikko, M. Höyhtyä, J. Del Ser	Spectrum band and RAT selection for infrastructure governed opportunistic networks	IEEE International Workshop on Computer-Aided Modeling Analysis and Design of Communication Links and Networks (CAMAD) 2012	Barcelona, Spain	17.-19.09.2012	Accepted/ Presented
J. Pérez-Romero, O. Sallent, F. Bouali, H. Sarvanko, M. Mustonen, M. Matinmikko, H. Lee, S. Vahid, K. Moessner	A Spectrum Selection Framework for Opportunistic Networks	Future Network & Mobile Summit 2012 (FUNEMS 2012)	Berlin, Germany	04-06.07.2012	Accepted/ Presented
J. Pérez-Romero	OneFIT: Algorithms for Opportunistic Network Management and Infrastructure Coordination	Network Federation Workshop at the Future Network & Mobile Summit 2012 (FUNEMS 2012)	Berlin, Germany	06.07.2012	Presentation
H. Lee, S. Vahid, K. Moessner	Adaptive Utility-based Dynamic Spectrum Aggregation algorithm in Cognitive Radio Networks	EKC2012, EU-KOREA Conference on Science and Technology	Berlin, Germany	26-28.07. 2012	Accepted/ Presented This poster received the best student poster award in the conference.
H. Lee, S. Vahid, K. Moessner	Utility-based Dynamic Spectrum Aggregation algorithm in Cognitive Radio Networks	IEEE 76th Vehicular Technology Conference (VTC 2012-Fall)	Quebec city, Canada,	03-06.09.2012	Accepted/ Presented
A. Raschellà, A. Umbert, J. Pérez-Romero, O. Sallent	On Demonstrating Spectrum Selection Functionality for Opportunistic Networks	2nd International Conference on Mobile Services, Resources, and Users (MOBILITY)	Venice, Italy	21-26.10.2012	Accepted/ Presented
M. Mueck	Presentation	C-PMSE Project Workshop on	Hannover, Germany	15.11.2012	Presentation

		Realization of Cognitive PMSE Systems			
M. Mueck	Beyond 4G	B4G Workshop	Paris, France	29.11.2012	Presentation
J. Pérez-Romero, A. Raschellà, O. Sallent, A. Umbert	Multi-band Spectrum Selection Framework based on Partial Observations	IEEE International Symposium on a World of Wireless Mobile and Multimedia Networks (WoWMoM 2013)	Madrid, Spain	04-07.06.2013	Submitted paper
H. Lee, S. Vahid, K. Moessner	Impacts of Dynamic Spectrum Aggregation approaches on Spectrum Utilization and Fragmentation in Cognitive Radio Networks	IEEE 77th Vehicular Technology Conference (VTC 2013)	Dresden, Germany	02-05.06. 2013	Submitted paper
G. Alnwaimi, T. Zahir, S. Vahid, K. Moessner	Machine Learning based Knowledge Acquisition on Spectrum Usage for LTE Femto-cells	IEEE International Conference on Communications, ICC2013	Budapest, Hungary	09-13.06.2013	Submitted paper

2.1.3 Presentations in Concertation and Clusters Meetings

The OneFIT members have participated and provided contributions at the following cluster and concertation meetings, as shown in Table 2-7, Table 2-8 and Table 2-9:

Table 2-7: OneFIT Contributions to Concertation and Clusters Meetings [Period: 01.07.2010 - 31.12.2010]

Author	Presentation Title	Concertation/ Cluster	Location	Date	Ref.
K. Tsagkaris	Participation and OneFIT preparation	RAS Cluster Meeting and eMobility Workshop, in the context of Future Networks and Mobile Summit 2010	Florence, Italy	15.06.2010	Participation
V. Stavroulaki	Wireless Access and Mobility in the Future Internet through Opportunistic Networks and Cognitive Management	Future Internet Workshop and Cluster Meeting, in the context of Future Networks and Mobile Summit	Florence, Italy	15.06.2010	Poster

	Systems	2010			
K. Arshad (presenter), UPRC members, ALUD members	OneFIT Overview - Opportunistic networks and Cognitive Management Systems for Efficient Application Provision in the Future InterneT	Wireless Innovation Forum (WInF) and European Reconfigurable Radio and Technologies Workshop and Product Exposition	Mainz, Germany	21-23.06.2010	Presentation
P. Demestichas, J, Gebert	OneFIT - Research Project Opportunistic Networks and Cognitive Management Systems for Efficient Application Provision in the Future Internet	Future Networks 6th FP7 Concertation Plenary Session	Brussels, Belgium	18-20.10.2010	Presentation
P. Demestichas, J, Gebert	OneFIT - Research Project Opportunistic Networks and Cognitive Management Systems for Efficient Application Provision in the Future Internet	Future Networks 6th FP7 Concertation Radio Access & Spectrum (RAS) cluster	Brussels, Belgium	18-20.10.2010	Presentation
P. Demestichas, J. Gebert	OneFIT - Research Project Opportunistic Networks and Cognitive Management Systems for Efficient Application Provision in the Future Internet	Future Networks 6th FP7 Concertation Future Internet (FI) cluster.	Brussels, Belgium	18-20.10.2010	Presentation

Table 2-8: OneFIT Contributions to Concertation and Clusters Meetings [Period: 31.12.2010 - 31.12.2011]

Author	Presentation Title	Concertation/ Cluster	Location	Date	Ref.
P. Demestichas, J. Gebert, A. Georgakopoulos, V. Stavroulaki	Information and Execution Automation between the Service and Network planes – The OneFIT Perspective	Future Networks 7th FP7 Concertation	Brussels, Belgium	10-11.02.2011	Presentation

K. Tsagkaris, M. Goldhamer, M. Mueck	Working with ETSI: ISG or Technical Committees	Future Networks 7th FP7 Concertation (Plenary Meeting)	Brussels, Belgium	10-11.02.2011	Presentation
K. Tsagkaris, P. Demestichas	E3 Impact on Standards–	Future Networks 7th FP7 Concertation (Plenary Meeting)	Brussels, Belgium	10-11.02.2011	Presentation
P. Demestichas, J. Gebert, K. Tsagkaris, V. Stavroulaki, A. Georgakopoulos Y. Kritikou	Overview of Green Footprint of the OneFIT Technologies–	Future Networks 7th FP7 Concertation (RAS Cluster Meeting)	Brussels, Belgium	10-11.02.2011	Presentation
O. Sallent (presented by P. Demestichas)	Achievement: Spectrum opportunity identification & selection	Future Internet (FI) Cluster meeting	Brussels, Belgium	6.10.2011	Presentation
M. Tosic, D. Boscovic, A. Georgakopoulos, P. Demestichas	Management of the Cloud: Opportunistic resource aggregation in the backhaul	Future Internet Cluster Meeting	Brussels, Belgium	06.10.2011	Presentation

Table 2-9: OneFIT Contributions to Concertation and Clusters Meetings [Period: 31.12.2011 - 31.12.2012]

Author	Presentation Title	Concertation/ Cluster	Location	Date	Ref.
M. Matinmikko, K. Tsagkaris, P. Demestichas	Flexible and Shared Spectrum Use: General Considerations on Technical Status, Benefits and Next Steps	FlexSUS Workshop	Brussels, Belgium	13.02.2012	Presentation
K. Tsagkaris, M. Matinmikko, P. Demestichas	Flexible and Shared Spectrum Use for Enabling Operator Governed Opportunistic Use of Resources	FlexSUS Workshop	Brussels, Belgium	13.02.2012	Presentation
K. Tsagkaris, V. Stavroulaki, A. Georgakopoulos, P. Demestichas	Cognitive Control Channels: Current status and implementation options	Radio Access and Spectrum (RAS) Cluster Meeting	Brussels, Belgium	13.02.2012	Presentation
UPRC partners	Opportunistic Networks and Cognitive Management Systems for	FIA Aalborg "Standards brokerage event"	Aalborg, Denmark	10-11.05.2012	Presentation

	Efficient Application Provision in the Future Internet				
A. Georgakopoulos	Cognitive Management Systems and Control Channels for Versatile Networking	3rd Workshop of the COST Action IC0902	Ohrid	12-14.9.2012	Presentation
OneFIT partners	OneFIT overall Presentation	Future Networks 10th FP7 Concertation meeting	Brussels, Belgium	10.10.2012	Presentation
P. Demestichas	Future Internet Technologies Cluster Standardisation survey	Future Internet Technologies Cluster		10.2012	Survey response
M. Matinmikko, K. Tsagkaris, P. Demestichas	"Why do we need to share spectrum"	Radio Access and Spectrum "A white paper on spectrum sharing"		To be published in October 2012	Contribution to the white paper

2.1.4 Organization of Demonstrations

2.1.4.1 ServiceWave 2010; 13-15 December 2010

ONEFIT partners showcased demos of FI architecture that included following elements: opportunistic networks and heterogeneous network infrastructure, cognitive systems for managing opportunistic networks and control channel for their cooperation.

2.1.4.2 FIA 2010; 2010

At the FIA (Future Internet Architectures) event in Gent on 16-Dec-2010, OneFIT showed a preliminary demo building on an early integration of equipment. The contribution was entitled "Future Internet Architectures and Scenarios by means of Opportunistic Networks and Cognitive Management Systems".

2.1.4.3 Future Network and Mobile Summit; 2011

During the 20th Future Networks and Mobile Summit (Warsaw, Poland from 15 to 17 June 2011), the OneFIT members staffed a demonstration booth in order to show the featured platform. The main aim of the platform is to address issues regarding the opportunistic coverage extension and the opportunistic capacity extension. In other words, it provides an initial validation of the ON paradigm to the Future Internet Architectures and Scenarios.

The main concept of the opportunistic capacity extension through the use of a maximum flow algorithm scenario is to show how nodes/ terminals are capable of forming an ON in an ad-hoc manner in the case where one or more Macro Base Stations (BSs) experience congestion issues, hence users can be re-routed to alternate infrastructure elements. The benefits of the opportunistic capacity extension through the use of a maximum flow algorithm concept are that service provisioning remains possible in an acceptable QoS even when a BS experiences congestion issues. Moreover, during the demonstration was shown that as soon as congestion is resolved in the problematic BSs and traffic is re-routed to neighboring, alternate BSs, the BSs that acquired the

traffic did not become congested themselves. As a result, an ON is formed in order to support the operator's infrastructure without shifting the problem from one BS to another. Furthermore, in the Future Networks and Mobile Summit in Warsaw, Poland, evolved scenarios regarding the opportunistic coverage extension and the opportunistic capacity extension through femtocells were demonstrated. Specifically, the main concept of the opportunistic coverage extension scenario is to show how nodes/ terminals are capable of forming an ON in the case of a Macro Base Station (BS) failure, in order to gain access to another, distant infrastructure element, or while the terminals are in motion, they enter into a blind spot which is not covered by the operator's infrastructure, thus, an ON is needed in order to ensure that the out of infrastructure coverage nodes gain access to the infrastructure again. The benefits of the opportunistic coverage extension concept are that service provisioning remains possible even when the infrastructure cannot directly support the node/ terminal. As a result, an ON is formed in order to support the operator's infrastructure.

Finally, the opportunistic capacity extension through femtocells scenario handles congestion issues via the introduction of the DSONPM entity. According to this scenario, when an infrastructure element experiences overloading conditions, the DSONPM agent is notified in order to redistribute load to ONs (such as femtocells, which are present in the area). To that respect, QoS is benefited as overloading is resolved and traffic is re-assigned to non-congested ONs.

2.1.4.4 Service Wave 2011 in the context of Future Internet Week

During the ServiceWave 2011 event which was held in Poznan, Poland in conjunction with the Future Internet Week, October 2011, an enhanced version of the demonstration platform was presented by adding some extra functionality to the opportunistic capacity extension scenarios. Specifically, actual terminals were used as a proof-of-concept in order to show the selection of the network, before and after the utilization of the algorithms. The communication between the main platform and the terminals relies on JADE (Java Agent Development Framework) and the utilization of wireless (Wi-Fi) links. In addition, release messages for the opportunistic network were introduced as part of the termination phase of an ON.

The scenarios are supported by the demonstrated platform and are subject to further development. Further progress and detailed planning related to demonstrations will be reported as the project progresses. Specifically, regarding the capacity extension through femtocells scenario, a new algorithm has been introduced (the Dynamic Resource Allocation –DRA algorithm) which takes into account the acquisition of users and the energy consumption of each femtocell in order to provide the capacity extension of the network solution. To that respect, future demonstrations are expected to feature enhanced versions of the platform which at the same time will be aligned with the overall OneFIT scenarios and system architecture work and will also be in close linkage to the system definition.

2.1.4.5 Bell Labs Open Days 2011

Results of the OneFIT Research made inside Alcatel-Lucent's Bell Labs Germany has been presented during the Bell Labs Open Days 2011. The presentation included posters, a demonstration of the simulations of opportunistic networking and a demonstration of the prototype where different devices have been connected dynamically and spectrum selection was made based on information from the Dynamic Spectrum Manager and from live spectrum sensing data.

2.1.4.6 ACM MobiOpp 2012

During the ACM MobiOpp 2012 event which was held in Zurich, Switzerland in 15-16 March 2012, an enhanced version of the demonstration platform was presented compared to the ServiceWave 2011 event, by adding some extra functionality to the opportunistic capacity extension through femtocells and capacity extension through neighbouring terminals scenarios. Specifically, for the capacity

extension through femtocells, new features include the assignment of power levels and users according to a specific algorithm developed for OneFIT called Dynamic Resource Allocation (DRA). The assignment of power levels is also visualized on the prototyping platform by increasing or decreasing the radius of the coverage area of the femtocell (Figure 2-1). E.g. the increased coverage area is translated also to increased power level, but only until the point it is needed in order to find and serve some nearby users. This means the power level is adjusted through the DRA execution and it is not increased continuously. Also, regarding the capacity extension through neighbouring terminals, specific ON release mechanisms have been introduced in order to be able to select specific ONs that the operator designates that should be released. This is also an extra step towards the strengthening of the operator governance notion, where the operator has the actual control of the created ONs according to the OneFIT specified architecture and concepts. The scenarios are supported by the demonstrated platform and are subject to further development. Further scenarios will be also demonstrated as the project progresses.

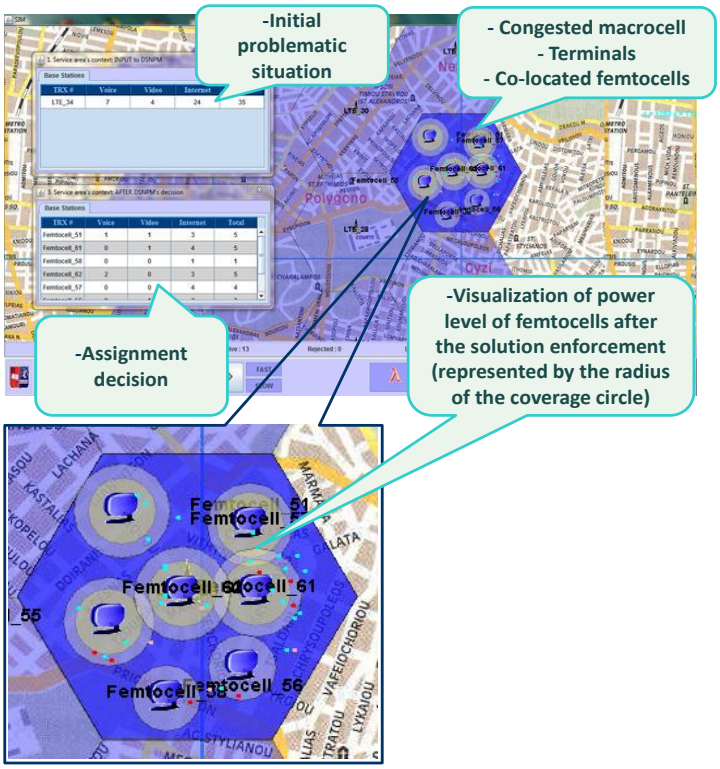
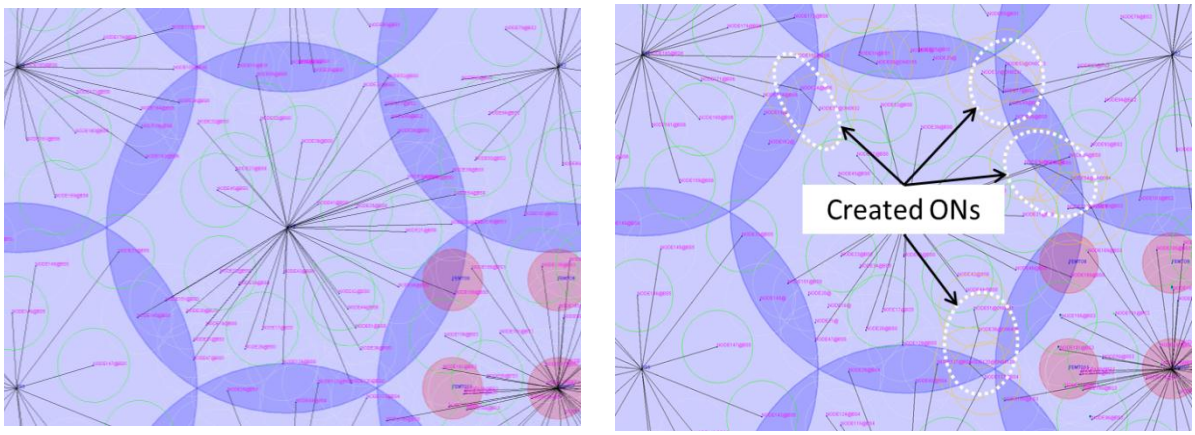


Figure 2-1: Implementation of power allocation to femtocells in the OneFIT prototyping platform

2.1.4.7 Future Network and Mobile Summit; 2012

A demonstration booth was organized by the OneFIT members during the Future Network and Mobile Summit 2011 that was held in Berlin, Germany, from 04 to 06 July 2012, in order to show the featured platform. The main aim of the demonstration was to showcase the elaboration and the expansion of the initially identified OneFIT scenarios.

To this end, UPRC, LCI and NTUK participated to the demonstration booth, elaborating on different work areas. More specifically, UPRC's demonstration focused on the selection of nodes and routes in the wireless access (Figure 2-2), both providing capacity extension through neighbouring terminals and through femtocells. Furthermore, this demonstration also focused on novel management techniques of ONs through the implementation on the Opportunistic Network Environment (ONE), with the use of JADE agents and Wi-Fi AP for distributed execution of demo components.



(a) (b)

Figure 2-2: Implementation of capacity extension through neighbouring terminals to the prototyping platform for the management of opportunistic networks

LCI has provided demonstration of its application aware multipath routing in Wireless Mesh Networks (WMNs). Furthermore, the demonstration of LCI focused on the selection of nodes and routes in the backhaul segment, as shown in Figure 2-3.

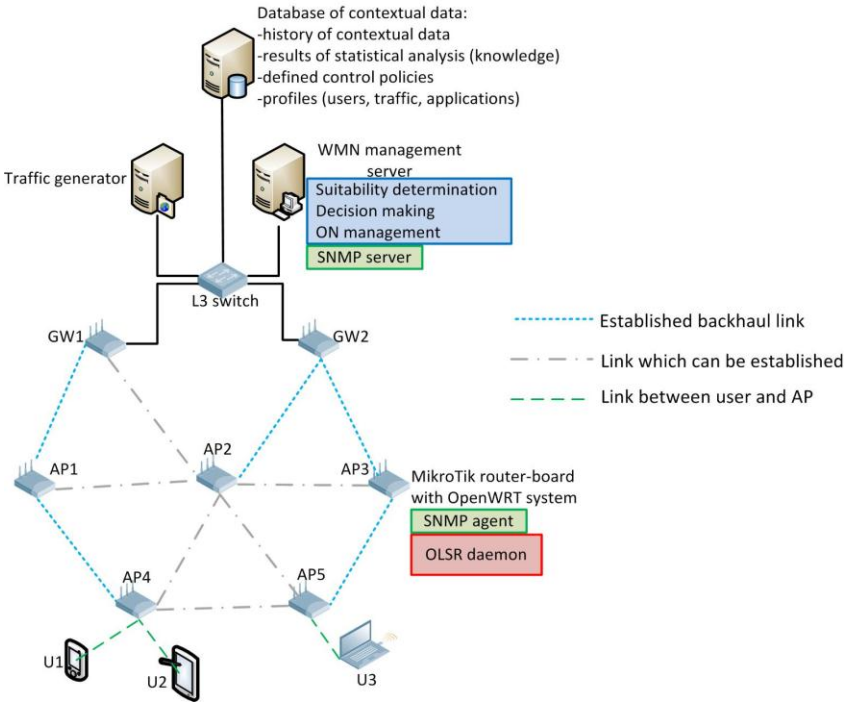


Figure 2-3: Open platform WMN test-bed

Finally, the demonstration focusing on infrastructure supported on Direct D2D communication was developed by NTUK. More specifically, NTUK made available commercial equipment (femtocell and smartphones), in order to demonstrate live connectivity of the femtocell connected with a smartphone, acting as a Gateway and also connectivity between smartphones, as presented in Figure 2-4.

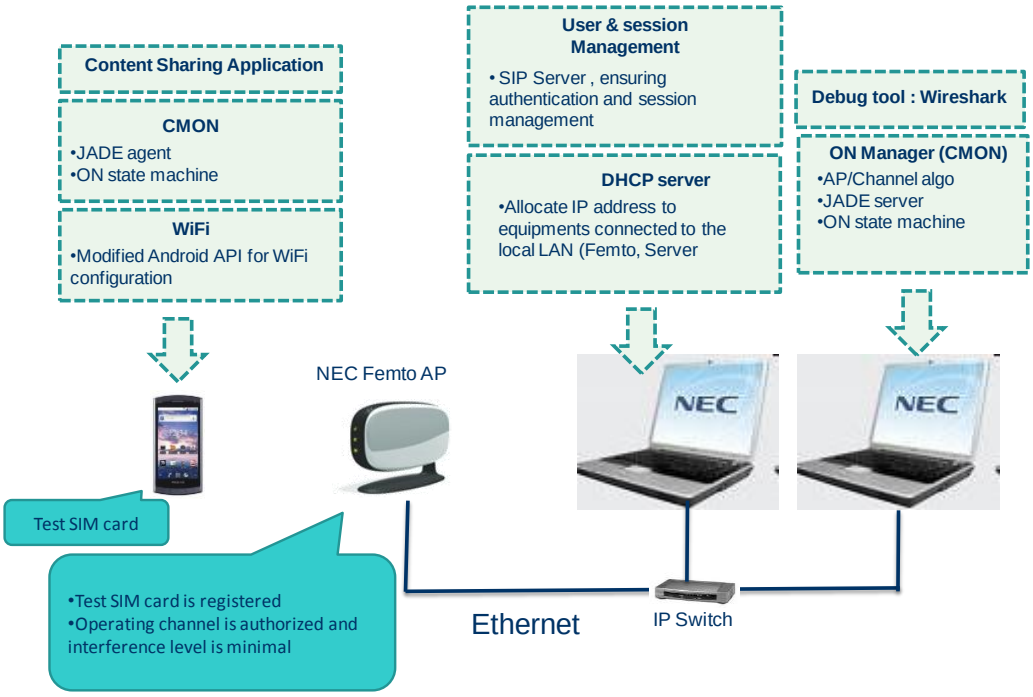


Figure 2-4: User-to-user direct path: Building Blocks and Components

Further to the demonstration, OneFIT partners presented a number of publications in the context of the ICT Future Network and Mobile Summit. Also in the same event a Workshop on Federation issues was co-organized with the project UniverSelf (a liaison has been made with this project), as a continuation of the respective Workshop organized in 2011.

2.1.4.8 ETSI RRS Workshop; 2012

UPRC participated to the ETSI RRS Workshop that was held in December 2012. The demo presented focused on the exploitation of multi-homing features of mobile devices. The main goal is to be able to provide enhanced Quality of Experience to users, targeting at the same time to lower various cost factors like OPEX for the Operator or fees for the customers and to protect the environment by taking green decisions. All these can be achieved by enriching devices with cognitive management capabilities that allow them to control their Radio Access Technology receiver chains and to decide dynamically on which is the optimal traffic routing approach to follow, depending on the application needs. The setup of a so-called Opportunistic Network is also considered in several cases as a perfectly good solution. A management software featuring all the aforementioned capabilities was demonstrated in the ETSI RRS workshop in Cannes, France, December 2012.

2.1.5 OneFIT Referencing and Vision Propagation

The OneFIT PMT has analysed the project impact and the worldwide propagation of the vision. Three sources were used:

- References to the OneFIT in articles, forum reports…;
- References to the OneFIT papers/authors in papers (e.g. IEEE papers…);
- Consultation and access to the OneFIT web site.

2.1.5.1 OneFIT Public and Private Websites

The OneFIT website contains a public part that has been accessible to all web users and always provides current information on the progress of the project to external community, and a private part dedicated to the OneFIT consortium partners and only accessible using specific credentials.

The project public web site (http://www.ict-OneFIT.eu/) was launched in July 10th 2010. It displays the project goals, approach, achievements, dissemination documents, public deliverables, press releases, partners' news, and all late-breaking progress and information to be easily and widely publicized. Sections are also addressing training, interviews, workshops, and symposium. The references to the site by other websites are monitored. The management platform of OneFIT and the different tools (Reporter, Reflectors, etc) are accessible from the OneFIT website front page (Partners log in). The different OneFIT web-based tools are developed by UPRC. The project management platform and tools have been successfully adopted and used by the consortium members.

The OneFIT private platform, restricted to the consortium partners, has been available from the public website or directly at http://tns.ds.unipi.gr/bscw. It has been on-line since July 10th 2010. Access to the Private Section via the public website through a secure connection is supported with each Partner being identified by unique username and password.

2.1.6 OneFIT Interactions with other Forums and Institutes

Worldwide forums and institutes which OneFIT has technically interacted with, in order to propagate its vision, results and recommendations, are:

- Wireless Innovation Forum (WInF);
- Wireless World Research Forum (WWRF);
- Cost Actions.

2.1.6.1 The Wireless Innovation Forum (WINF, aka SDR-Forum)

Established in 1996, the Wireless Innovation Forum™ (WINF) is a non-profit "mutual benefit corporation" dedicated driving technology innovation in commercial, civil, and defence communications around the world. Forum members bring a broad base of experience in Software Defined Radio (SDR), Cognitive Radio (CR) and Dynamic Spectrum Access (DSA) technologies in diverse markets and at all levels of the wireless value chain to address emerging wireless communications requirements through enhanced value, reduced total life cost of ownership, and accelerated deployment of standardized families of products, technologies, and services. The Forum acts as the premier venue for its members to collaborate to achieve these objectives, providing opportunities to network with customers, partners and competitors, educate decision makers, develop and expand markets and advance relevant technologies. It was previously known as SDR Forum.

The OneFIT project collaborated with the WINF. Information provided by OneFIT consortium members correspond to data part of public project deliverables (PU deliverables, according to EC contract) and OneFIT dissemination (publication, standardization contributions, training material). Infineon participated in the SDR'10 Technical Conference on 30-Nov-2010 to 3-Dec-2010 in Washington, USA. In particular, Infineon gave a tutorial and a paper presentation of the current European Telecommunications Standards Institute Reconfigurable Radio Systems (ETSI RRS) status including information related to cognitive control channels as currently studied in the framework of ETSI RRS. The level of interest was huge and the comments received were encouraging to further pursue this working direction.

2.1.6.2 WWRF

WWRF is a global organization, which was founded in August 2001 [2]. Members of the forum are manufacturers, network operators/service providers, research and development (R&D) centres, universities, small and medium enterprises. Specific WG6 (Cognitive Wireless Networks and Systems) meetings are held during each WWRF meeting. The WWRF WG6 was identified as an

appropriate platform to help propagate the system vision of “cognitive wireless networks and systems”.
The OneFIT consortium members contributed to the WWRF meeting 25, in London, UK, the WWRF meeting 26, in Doha, Qatar, and the WWRF meeting 29 in Berlin, Germany, and also participated to the WWRF meeting 27, in Dusseldorf, Germany.

Table 2-10: OneFIT Participation to WWRF meetings

Author	Title	Conference Name	Loc.	Date	Ref.
A. Georgakopoulos	Cognitive Networks and Systems for a Wireless Future Internet	WWRF 25	London, UK	15-18.11.2010	Presentation
A. Georgakopoulos, K. Tsagkaris, V. Stavroulaki, P. Demestichas	Opportunistic Network Creation for Efficient Application Provisioning in the Wireless Future Internet	Wireless World Research Forum #26	Doha, Qatar	11-13.04.2011	Paper/ Presentation
M. Matinmikko	Spectrum requirement estimation for IMT	WWRF 29/ Wireless World 2020 workshop	Berlin, Germany	24.10.2012	Presentation
P. Demestichas, A. Georgakopoulos, D. Karvounas, K. Tsagkaris, V. Stavroulaki	Elaboration on the Necessity for Further Advancements on Cognitive Network Management for Future Wireless Infrastructures	29th meeting Wireless World Research Forum	Berlin, Germany	23-25.10.2012	Paper/ Presentation
P. Bender	Regulation issues and challenges towards the increasing market's needs for radio resources	29th meeting Wireless World Research Forum Wireless World 2020	Berlin, Germany	23-25.10.2012	Panel Session

2.1.6.3 COST Actions

Two COST Actions have been launched in the field of cognitive radio systems. The following paragraphs elaborate on the two actions and underline the OneFIT partners’ activities within these actions.

2.1.6.3.1 COST Action IC0902

The main objective of the COST Action IC0902 "Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Networks" [3] is to integrate the cognitive concept across all layers of communication systems, resulting in the definition of a European platform for cognitive radio and networks. The action proposes coordinated research in the field of cognitive radio and networks. The cognitive concept applies to coexistence between heterogeneous wireless networks that share the electromagnetic spectrum for maximum efficiency in resource management. Several efforts are currently in place in European research centers and consortia to introduce cognitive mechanisms at different layers of the communications protocol stack. This action goes beyond the above trend by integrating the cognitive concept across all layers of system architecture, in view of

joint optimization of link adaptation based on spectrum sensing, resource allocation, and selection between multiple networks, including underlay technologies.
The OneFIT mainly contributed to the WG4 "Definition of mechanisms for intersystem coexistence and cooperation", which is led by the project's coordinator, Prof. P. Demestichas. Table 2-11 below depicts the activities within COST Action IC0902.

Table 2-11: OneFIT Participation to COST Action IC0902 Activities

Author	Contribution Title	Event Name	Loc.	Date	Ref
K. Tsagkaris, A. Georgakopoulos, P. Demestichas	OneFIT Project: Envisaged scenarios and challenge	COST Action IC0902: Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Networks MC Meeting and Workshop	Bologna, Italy	23-25.11.2010	Presentation
V. Malbasa, D. Boskovic, M. Tosic	Predictions for Opportunistic Multi-Path Routing in Wireless Mesh Networks	COST Action IC0902: Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Networks SIG 2: Learning and Artificial Intelligence	Barcelona, Spain	06-07.10.2011	Paper/ Presentation
IMC partners	Workshop on Cognitive Radio and Software Defined Radio	COST/ECC	Mainz, Germany	02-03.05.2012	Organisation of the workshop
A. Georgakopoulos	Cognitive Management Systems and Control Channels for Versatile Networking	3rd Workshop of the COST Action IC0902	Ohrid	12-14.9.2012	Presentation

2.1.6.3.2 COST Action IC0905

The COST Action IC0905 started in 2010 to complement IC0902. The COST Action IC0905 "Techno-Economic Regulatory Framework for Radio spectrum Access for Cognitive Radio/Software Defined Radio – TERRA" was established to consider techno-economical and regulatory aspects of software defined radio (SDR) and cognitive radio systems (CRS) [4].

OneFIT project had made contributions in WG1 (Deployment Scenarios) and WG2 (CR/SDR co-existence studies). WG1 aims at developing and selecting plausible deployment scenarios for CR/SDR, based on results from a range of technological R&D activities. WG2 is doing research into coexistence and developing technically feasible regulatory options pertaining to CR/SDR under these

deployment scenarios. Several members of the OneFIT project consortium are also Management Committee members of COST TERRA and participate actively there. In addition, a key note speech on recent ITU-R activities on IMT spectrum and cognitive radio systems has been given at COST TERRA meeting. Table 2-12 presents the contributions of OneFIT members to COST Action IC0905.

Table 2-12: OneFIT Participation to COST Action IC0905 Activities

Author	Contribution Title	Event Name	Loc.	Date	Ref
M. Mustonen, M. Matinmikko, P. Demestichas, J. Gebert, M. Filo, O. Sallent, M. Mueck, K. Moessner, D. Boskovic	Scenarios for Opportunistic Networks from OneFIT Project	COST Action IC0905 WG1&WG2 meeting	Brussels, Belgium	30-31.08. 2010	Document
M. Matinmikko	Scenarios for Opportunistic Networks from OneFIT Project	COST Action IC0905 WG1&WG2 meeting	Brussels, Belgium	30-31.08. 2010	Presentation
M. Matinmikko	Recent ITU-R activities on IMT spectrum matters and cognitive radio systems	COST Action IC0905 meeting	Brussels, Belgium	26-28.11. 2012	Presentation

3. Training Activities

During the course of the OneFIT project, partners and consortium as a whole, have organized a series of internal and external trainings. The idea of the internal trainings was to facilitate knowledge exchange between the OneFIT partners so that collaboration within the project is streamlined. The purpose of the external trainings was to raise the ICT community awareness about the OneFIT technologies and increased project visibility.

3.1 Internal Training Activities

Internal trainings have been held among OneFIT project partners. These trainings were aimed at knowledge exchange between consortium partners and took the form of tutorials on relevant technology enablers and their implementation and usage for different use cases.

3.1.1 List of internal training events

Internal training took place during the second OneFIT meeting in Munich in October 2010, hosted by Infineon. The training activity took form of a one day hands-on session which allowed interested partners to receive detailed training on Infineon XMM 6160 HSPA Smart Modem Solution. Partners who signed temporary licensing agreement (TLA) received demo kits for further experimenting.

3.2 External Training Activities

During and after the course of the OneFIT project, the consortium has:

- Organized Public workshops - Presentation of the OneFIT project achievements, key features and training of interested individuals and organizations outside of the consortium;
- Generated Remote learning material - By publishing the materials (presentations/tutorials) on the OneFIT official web page, project achievements will be brought closer to ICT community;

- Devised academic seminars/courses - The academic partners could include some of the OneFIT aspects in their academic program;

In addition, OneFIT consortium partners also actively participated in:

- International mobile communication conferences - through the presentation of public tutorials and trainings at the Future Network and Mobile Summit, DySPAN, WINF Technical Conferences, etc.;
- Joint workshops – organized common workshops that provided venues for interactive exchange of ideas.

3.2.1 List of external training events

3.2.1.1 International Symposium on Advanced Radio Technologies (ISART)

The presentation on the OneFIT project has been given in the context of ISART 2010. The presentation depicted the project objectives, considered scenarios, proposed solutions and the envisioned validation methods of the project results. The event took place in Boulder, USA on July 27-30 2010. The presentation aimed at enabling the ICT community outside of the EU to get familiar with the OneFIT project.

3.2.1.2 Future Networks 6th FP7 Concertation 2010

The results and achievements of the OneFIT project have been presented during the Concertation meeting organized by the Future Networks Unit within the Information Society and Media Directorate General (DG INFSO) of the European Commission in Brussels on October 18-20 2010.

3.2.1.3 Workshop at Suples, Paris 2010.

In the framework of a Workshop related to CR and SDR standardization and industrial activities at Supelec, Paris, France on 17-Dec-2010, OneFIT results were presented and discussed. In particular, ETSI RRS related activities related to cognitive control channels, etc. were detailed and discussed with all participants.

3.2.1.4 Future Network and Mobile Summit 2011 Demonstration

The OneFIT work has been demonstrated in the context of Future Network and Mobile Summit 2011, as detailed in Section 2.1.4.1.

3.2.1.5 Future Internet Week – ServiceWave 2011

The results and achievements of the OneFIT project have been presented during the ServiceWave 2011 organized by the Future Internet Week that took place in Poznan, Poland on October 24-28 2011, as presented in Section 2.1.4.4.

3.2.1.6 OneFIT Workshop in the context of MobiHoc 2012:

In order to maximise dissemination and impact of the project, OneFIT is planning to organize a workshop in the context of Mobihoc 2012. The workshop is envisioned to present the OneFIT project achievements, key features and demonstrate its results.

3.2.1.7 Future Networks and Mobile Summit (FuNeMS) 2012:

OneFIT helped to co-organize a workshop during Future Networks and Mobile Summit (FuNeMS) 2012. The workshop was the continuation of the Federation workshop that was realised in the context of FuNeMS 2011, co-organised by OneFIT, UniverSelf and ONE projects.

3.2.1.8 IEEE International Dynamic Spectrum Access Networks 2011:

OneFIT organized organize a panel session at DySPAN which held in Aachen, Germany, from May 3rd-6th, 2011. The panel session was related to the key features of the OneFIT project.

3.2.1.9 WARP Training in CWC Oulu, Finland

During this activity UNIS extended its research in relation to development of L1 > L2 + L2 > L3 device driver development on WARP boards. The WARP boards (out of the box) come only with PHY layer and no more, so in order to experiment/develop further, the MAC/Network layer functionalities needs to be added on, plus all the drivers that would enable communication between L1 > L2 > L3 – UNIS has been developing these drivers in-house, however, since CWC-Oulu had done some more advanced work on the WARP boards, UNIS collaborated with them to iron-out some issues on deployment of network-layer functionality and device drivers on the WARP boards.

4. OneFIT Standardization Contributions

This section elaborates on the OneFIT standardisation contributions.

As described in [5] to influence most relevant standardization by impacting with the OneFIT consortium proposals, has been an essential element of the OneFIT strategy. In this context, the intention is to concentrate on standards with a focus on cognitive radio/networks and architecture aspects as well as convergence and interworking of heterogeneous wireless systems. It is also a stated goal of the OneFIT not to focus on standards of a single region only, but to ensure the coverage of the most relevant standardisation bodies across the globe, in particular ETSI, 3GPP and IEEE.

4.1 Contributions towards ETSI RRS

Table 4-1, Table 4-2 and Table 4-3 contains the list of all the documents prepared and presented by OneFIT partners in support of the above actions.

Table 4-1: OneFIT Standardization Contributions towards ETSI RRS [Period: 01.07.2010 – 31.12.2010]

Author	Contribution Title	Event Name	Loc.	Date	Ref
M. Akezidou, K. Tsagkaris, P. Demestichas, V. Stavroulaki	WI#2 UPRC Contribution on `Federation` action point	ETSI/ AFI #6 Meeting	Sophia Antipolis, France	28-30.07.2010	AFI(10)0023 Contribution
V. Stavroulaki (presenter) and OneFIT partners (UPRC, ALUD, TID, IFX, NTUK, EIT+, VTT, UPC, UNS)	RRS(10)0098 Reporting of Activities in the OneFIT project Scenarios Overview.ppt	ETSI RRS #11	Sophia Antipolis, France	07-09.09.2010	RRS(10)0098 Presentation
M. Mueck (presenter), A. Schmidt, P. Demestichas, V. Stavroulaki, M. Filo	RRS(10)0099 Discussion on Implementation of the in-band CPC or extensions (C^4MS, etc.)	ETSI RRS #11	Sophia Antipolis, France	07-09.09.2010	RRS(10)0099 Presentation
ALUD, UPRC	RRSWG1(10)0074r1_CR Combining Adhoc with Wireless Access	RRS1-RRS3#12	Sophia Antipolis, France	09-10.09.2010	RRSWG1(10)0074r1 Change Request

EIT+, UPRC, ALUD	RRSWG1(10)0075r1_CR Operator_Governed_AdhocNetworking	RRS1-RRS3#12	Sophia Antipolis, France	09-10.09.2010	RRSWG1(10)0075r1 Change Request
ALUD, UPRC, EIT+, Infineon, NTUK	RRS(10)0139r2 New WI on Control Channels for RRS	ETSI RRS	PhC	15.10.2010	Phone Conference
V. Stavroulaki	Opportunistic networks and Cognitive Management Systems for Efficient Application Provision in the Future InterneT (OneFIT)	ETSI open workshop on Machine to Machine Communications	Sophia Antipolis, France	19-20.10.2010	Poster
UPRC, Alcatel-Lucent, INFINEON TECHNOLOGIES,EIT+,NEC Technologies (UK) LTD,DAC-UPC,INTERDIGITAL COMMUNICATIONS	RRS(10)0161r7 Feasibility Study on Control Channels for Cognitive Radio Systems	ETSI RRS #12	Munich, Germany	23.-25.11.2010	RRS(10)0161r7 New Work Item
V. Stavroulaki (presenter) and OneFIT partners (UPRC, ALUD, TID, IFX, NTUK, EIT+, VTT, UPC, UNS)	RRS(10)0163 Reporting of Activities in the OneFIT project: Overview of technical challenges and system requirements	ETSI RRS #12	Munich, Germany	23.-25.11.2010	RRS(10)0163 Presentation
IFX	RRSWG1(10)0118 CCC_Input_v0.2	RRS1-RRS3-Joint Meeting	Munich, Germany	22.-23.11.2010	RRSWG1(10)0118 Presentation
Alcatel-Lucent	RRSWG1(10)0119 References and Editorial Updates for TR102907	RRS1-RRS3-Joint Meeting	Munich, Germany	22.-23.11.2010	RRSWG1(10)0119 Change Request
UPRC, ALUD, IFX, EIT+	Feasibility Study on Control Channels for Cognitive Radio Systems	RRS1-RRS3-Joint Meeting	Munich, Germany	22.-23.11.2010	Approved Work Item

Table 4-2: OneFIT Standardization Contributions towards ETSI RRS [Period: 31.12.2010 – 31.12.2011]

Author	Contribution Title	Event Name	Loc.	Date	Ref
V. Stavroulaki	Reporting of Activities in the OneFIT project: Overview of Functional Architecture	ETSI RRS #13 Meeting	Maison Alforts, France	08-10.02.2011	Presentation
Alcatel-Lucent Deutschland AG,NEC Technologies (UK) LTD,DAC-	RRSWG3(11)0011r1 Contribution to Draft ETSI TR 102 684	RRS1-RRS3-Conf call	Phone conf.	21.4.2011	Approved Change Request

UPC,UPRC,EIT+					
EIT+, Alcatel-Lucent, UPRC, IMC	RRSWG3(11)0017 CR Network Management based CCC	RRS1-RRS3-Conf call	Phone conf.	4.5.2011	Approved Change Request
EIT+, Alcatel-Lucent, UPRC, IMC	RRSWG3(11)0030r1 Bluetooth based implementation option	RRS1-RRS3-Conf call	Phone conf.	23.09.2011	Approved Change Request
V. Stavroulaki	Participation to the meeting	ETSI RRS1-RRS3/ ETSI RRS#15 Meeting	Sophia-Antipolis, France	05-07.09.2011	
K. Tsagkaris OneFIT Partners	AFI(11)0029 Reporting of activities of the OneFIT project to the AFI WI#3 branch: Autonomicity-enabled Ad-Hoc, Mesh and Sensor Network architectures	ETSI AFI ISG	Sophia-Antipolis, France	27-30.09.2011	Presentation
EIT+, Alcatel-Lucent, UPRC, IMC	RRSWG3(11)0036 WiMedia UWB based implementation option	RRS1-RRS3-Conf call	Phone conf.	24.10.2011	Approved Change Request
ALUD	RRSWG3(11)0040 Control Channel to access geo-location database for retrieving information on available white spaces	RRS1-RRS3-Joint Meeting	Ispra, Italy	21.-23. 11.2011	Approved Change Request
ALUD	RRSWG3(11)0041, 41r1 Location Tracking by Proxy	RRS1-RRS3-Joint Meeting	Ispra, Italy	21.-23. 11.2011	Approved Change Request
EIT+, UPRC	RRSWG3(11)0042 Overall assessment of implementation options for Control Channels	RRS1-RRS3-Joint Meeting	Ispra, Italy	21.-23. 11.2011	Presentation
ALUD	RRSWG3(11)0045 CR for section 7.1.5 IETF PAWS based approach	RRS1-RRS3-Joint Meeting	Ispra, Italy	21.-23. 11.2011	Approved Change Request
UPRC, ALUD	RRS(11)0171 Reporting of Activities in the OneFIT project	RRS Plenary	Ispra, Italy	24.-25. 11.2011	Presented

Table 4-3: OneFIT Standardization Contributions towards ETSI RRS [Period: 31.12.2011 – 31.12.2012]

Author	Contribution Title	Event Name	Loc.	Date	Ref
V. Stavroulaki (UPRC)	Contribution for TR 102 684 Section [7.4 Overall assessment of implementation options]	RRS WG1/WG3	Phone conf.	17.1.2012	Contribution
V. Stavroulaki, OneFIT Partners	Reporting of Activities in the OneFIT project	ETSI/RRS #17	Maison Alforts, France	01-02.03.2012	Presentation

M. Mueck, OneFIT Partners	Reporting of Activities in the OneFIT project	ETSI/RRS #18	Chengdu, China	10-11.05.2012	Verbal information on progress and reception of feed-back
M. Mueck, OneFIT Partners	Reporting of Activities in the OneFIT project	ETSI/RRS #19	St Petersburg, Russia	13-14.09.2012	Verbal information on progress and reception of feed-back
M. Mueck, OneFIT Partners	RRS(12)019026_RRS19_OneFIT_Report.pptx	ETSI/RRS #19	St Petersburg, Russia	13-14.09.2012	Presentation
M. Mueck, OneFIT Partners	Reporting of Activities in the OneFIT project	ETSI/RRS #20 meeting	Sophia Antipolis, France	13-14.12.2012	Verbal information on progress and reception of feed-back
BNeztA and IMC	Technical Report concerning "Use Cases for Dynamic Declaration of Conformity Dynamic Declaration of Conformity"	ETSI/RRS #20 meeting	Sophia Antipolis, France	10-14.12 2012	Participation and support
M. Mueck, OneFIT Partners	Reporting of Activities in the OneFIT project	ETSI/RRS #20 meeting	Sophia Antipolis, France	13-14.12.2012	Verbal information on progress and reception of feed-back

4.2 Contributions towards 3GPP

The following Table presents the OneFIT partners' contributions towards 3GPP.

Table 4-4: OneFIT Standardization Contributions towards 3GPP

Author	Contribution Title	Event Name	Loc.	Date	Ref
NEC Technologies (UK)	Use cases for Proximity-based Services study	TSG-SA1 Meeting #56	San Francisco, CA (US)	14-18.1.2011	S1-113148
IMC	Enabling Proximity services in a LTE network under operator control	TSG-SA1 Meeting #56	San Francisco, CA (US)	14-18.1.2011	
IMC	Enabling Proximity services with inter-RAT capabilities	TSG-SA1 Meeting #56	San Francisco, CA (US)	14-18.1.2011	
IMC	Use Case: Proximity Services Enabled MTC scenarios	TSG-SA1 Meeting #56	San Francisco, CA (US)	14-18.1.2011	
IMC	Range extension scenarios for Proximity services	TSG-SA1 Meeting #56	San Francisco, CA (US)	14-18.1.2011	
NEC Technologies	use case and associated	TSG-SA1	Chicago	08.2012	

(UK)	requirements for extending 3GPP network coverage by using a user terminal acting as a relay node. Contribution to the 3GPP SA1 #59 Meeting, for the work item ProSe (Proximity services)	Meeting #56	(US)		

4.3 Other standardisation contributions

As presented in Table 4-5, OneFIT partners made contributions to other standardisation bodies as well.

Table 4-5: OneFIT other Standardization Contributions

Author	Contribution Title	Event Name	Location	Date	Ref
UPRC partners	Opportunistic Networks and Cognitive Management Systems for Efficient Application Provision in the Future Internet	FIA Aalborg "Standards brokerage event"	Aalborg, Denmark	10-11.05.2012	Presentation
VTT partners	Support of activities	ITU-R WP5A	Geneva, Switzerland	22-31.05.2012	Support of activities
UPRC	Participation	2nd FIA Roadmapping Open Workshop	Brussels, Belgium	25.06.2012	Participation
OneFIT partners	Standardisation survey	Future Internet Technologies Cluster		09.2012	Survey
P. Bender	WG FM concerning the Licensed shared Access (LSA) in the 2,3-2,4 GHz Band.	CEPT WG FM PT 52 meeting	Copenhagen, Denmark	29-30.10.2012	Participation and support of the work
VTT partners	Support of activities	ITU-R WP5A	Geneva, Switzerland	05-15.11.2012	Support of activities

5. OneFIT Regulatory Contributions

This section elaborates on the OneFIT regulatory contributions.

5.1 Overall Plan for OneFIT contributions to Regulatory Bodies

The creation and maintenance of opportunistic networks is determined by regulatory aspects and may have regulatory implications. Targets will be European wide initiatives and national initiatives. Work and outcomes will be used to inform the regulation authorities about the technological options and aim to lead to the rules for a more dynamic and flexible allocation of spectrum resources, as well as to corresponding rules towards certification and licensing of (opportunistically behaving) equipment. Also, OneFIT targets will be European regulation authorities (i.e., one of which

is a consortium member) but also wider initiatives in EU and international bodies like International Telecommunication Union (ITU).

Partners from the OneFIT consortium have previously participated in spectrum regulatory frameworks e.g. European Conference of Postal and Telecommunications Administrations (CEPT) and ITU Radio communication sector (ITU-R). This will assist to build the necessary links between the spectrum regulatory domain and the OneFIT project ensuring that the latest regulatory information influencing the OneFIT system is available for the project.

- Specific exploitation steps are: Information about and proposals how dynamic spectrum access may impact service providers and network operators will be fed into Working group Frequency Management (WG-FM) and WG – Spectrum Engineering (WG-SE), respectively.
- OneFIT will propose solutions and enablers for dynamic spectrum access, and provide contributions to relevant regulatory bodies (CEPT, ITU-R, etc.).

It has to be noted that ITU is considered by the OneFIT as both standardization body (the ITU Standardization (ITU-T) is responsible for the standardization of telecommunications) and regulatory body (with ITU-R, overall regulatory work). OneFIT will report plans and contributions to ITU under "Regulation".
The OneFIT consortium includes the German regulator Bundesnetzagentur (BNetzA) working on and facilitating this envisaged exploitation. In terms of regulatory activities, OneFIT intends to help shape the regulatory framework for cognitive enabled equipment and distributed decision-making systems. The OneFIT has achieved this by raising awareness within the relevant regulatory bodies and by feeding relevant project results into the discussions within these.

5.1.1 Summary of the Regulatory Contributions

Table 5-1 contains the list of all ITU-R, CEPT ECC and EC regulatory contributions by the OneFIT project partners.

Table 5-1: OneFIT Regulatory Contributions

Author	Contribution Title	Event Name	Location	Date	Ref
C. Mouton (presenter), P. Demestichas, J. Gebert	OneFIT Project Presentation	Regulatory and Technological Requirements for Cognitive Radio, in the context of ICT 2010	Brussels, Belgium	28.09.2010	Presentation
Germany	Germany proposed changes to the CEPT Brief (Annex 1) and a draft new ITU-R Resolution [CRS] (Annex 2).	CPG PTA meeting	Tallinn	01.-04.06.2010	1.Proposal for modification of draft CEPT Brief AI 1.19 2.Proposal for an ITU-R Resolution This Document was the base for the Proposal for a draft ITU-R Resolution

					on Studies on the implementation and use of cognitive radio systems (CR) in Relation to WRC-12 agenda item 1.19 to ITU-R WP 1B meeting in June 2010
Germany (Federal Republic of), France, Italy, Netherlands (Kingdom of the) and Sweden	PROPOSED draft ITU-R Resolution on Studies on the implementation and use of cognitive radio systems (CRS) In Relation to WRC-12 agenda item 1.19	ITU-R WP 1B meeting	Geneva	21.-28.06.2010	Proposal for an ITU-R Resolution for CRS This document is the base for a proposal to ITU-R WP1B meeting in June 2011, to call for a development of an ITU-R Resolution to provide a framework in order to facilitate studies on the technical and operational consideration related to the implementation of CRS technologies in the radio communication services.
ETSI TC RRS Chairman plus One fit members (M. Mueck, P. Bender, J. Gebert)	Information of ETSI RRS discussion on revision of R&TTE Directive	TCAM		10.12. 2010	Comments related to SDR/CR with regard to planned Revision of the R&TTE Directive

BNetzA together with other administration developed an update at the CPG PTA meeting in Copenhagen (29.-31.03.2011) for of the proposal of an ITU-R Resolution for Cognitive Radio. The Proposal was submitted to the ITU-R WP 1B meeting in Geneva which took place from 25.05.2011-01.06.2011. BNETZA participated also in the ITU-R WP1B Meeting.	PROPOSED draft ITU-R Resolution on Studies on the implementation and use of cognitive radio systems (CRS) In Relation to WRC-12 agenda item 1.19	CPG PTA	Copenhagen	29.-31.03.2011	
BNetzA together with Infineon and Alcatel Lucent	ETSI Work Item(WI) Use Cases for Dynamic Declaration of Conformity Dynamic Declaration of Conformity". This technical report will define RRS Use Cases related to the introduction of mechanisms to enable the dynamic declaration of conformity with the essential requirements. In particular, this work is tailored to the potential needs of the future version of the R&TTE Directive, which is currently in preparation	TC-RRS	Aachen, Germany	11-12.05.2011	

Germany (BNetzA)together with other CEPT administration	PROPOSED draft ITU-R Resolution on Studies on the implementation and use of cognitive radio systems (CRS) In Relation to WRC-12 agenda item 1.19	ITU-R WP1B	Geneva	25.05.2011 - 01.06.2011	
BNetzA together with other administration has further developed the proposal for the CPG PTE meeting in Copenhagen (03.-04.10.2011) for an ITU-R Resolution for Cognitive Radio to be submitted to the ITU-R Radio Assembly 2012(RA12), which will take place at 16.-20. January 2012 in Geneva.	PROPOSED draft ITU-R Resolution on Studies on the implementation and use of cognitive radio systems (CRS) In Relation to WRC-12 agenda item 1.19	CPG PTE	Copenhagen	03.-04.10.2011	
BNetzA together with other administration has further developed the CEPT position (CEPT Brief)with regards to WRC 12 concerning SDR and CRs	Draft CEPT Brief concerning WRC 12 A.I. 1.19 SDR and CR	CPG PTA	Copenhagen	05.-07.10.2011	
BNetzA together with other administration has further developed the proposal for the CPG PTE meeting in Copenhagen (03.-04.10.2011) for an ITU-R Resolution for Cognitive Radio to be submitted to the ITU-R Radio Assembly which will take place at 16.-20. January 2012 in Geneva.	PROPOSED draft ITU-R Resolution on Studies on the implementation and use of cognitive radio systems (CRS) In Relation to WRC-12 agenda item 1.19	CPG	Bucharest	1-4.11.2011	Proposal adopted at CPG-8

P.Bender	A View on the Regulatory context of SDR and Cognitive Radio	European Commission Workshop on Software Defined Radio and Cognitive Radio standardization	Ispra, Italy	17.-18.11.2011	Submitted
ETSI TC RRS Chairman plus One fit members (M. Mueck, P. Bender, J. Gebert)	Building Standards For SDR and CRS by ETSI TC RRS	European Commission Workshop on Software Defined Radio and Cognitive Radio standardization	Ispra, Italy	17.-8.11.2011	Submitted
P. Bender	ITU-R Resolution 58, Studies on the implementation and use of cognitive radio systems	Radio communication Assembly 2012	Geneva, Switzerland	16-20.01.2012	Participation and support of the work
P. Bender	Cognitive Radio (WRC 12 Agenda Item 1.19)	World Radio communication Conference 2012 (WRC 12)	Geneva, Switzerland	23.01-17.02.2012	CEPT Coordinator
M. Matinmikko	Chairmanship of CRS studies at ITU-R WP5A	ITU-R WP5A	Geneva, Switzerland	22-31.5.2012	
P. Bender	WG FM concerning the Licensed shared Access (LSA) in the 2,3-2,4 GHz Band.	CEPT WG FM PT 52 meeting	Copenhagen, Denmark	29-30.10.2012	Participation and support of the work
M. Matinmikko	Chairmanship of CRS studies at ITU-R WP5A	ITU-R WP5A	Geneva, Switzerland	05-15.11.2012	

Table 5-2: Summary and Time plan of opportunities exploited for Regulation Contributions

Event Name	Location	Date	Description of opportunity
ITU-*R Radiocommunication Assembly*	Geneva	16-20 January 2012	Possible adoption of PROPOSED draft ITU-R Resolution on Studies on the implementation and use of cognitive radio systems (CRS)
World Radiocommunication Conference 2012 (WRC-12)	Geneva	23.01-17.02.2012	Adoption of a global position concerning Agenda item 1.19 SDR/CR
2nd Public CEPT workshop on cognitive radio and software defined radio.	To be confirmed	05. 2012	Presentation of OneFIT activities.
WP5A	Geneva, Switzerland	22.05-01.06.2012	Contributions on control channels to draft ITU-R report on cognitive radio systems in the land mobile service.

WP5A	Geneva, Switzerland	05-16.11.2012	Contributions on control channels to draft ITU-R report on cognitive radio systems in the land mobile service.

6. OneFIT Exploitation of Project Outcomes

6.1 Partner Exploitation Outcomes

In this section every partner reports on the identification and subsequent exploitation carried out relevant to their business and in accordance to their individual plans.

6.1.1 Commercial Exploitation

Specific exploitation strategies differ for the various partners in the OneFIT project, since different markets/segments are addressed. In the sequel, the specific exploitation of results by the industrial partners is described in further detail:

6.1.1.1 Alcatel-Lucent Deutschland AG.

Work in the OneFIT is motivated by the need to enhance wireless service provisioning and extending the access capabilities in the Future Internet era. The OneFIT solution envisages a cognitive, context-aware system approach that allows higher resource utilization with lower costs and a more efficient management.

As a vendor for mobile access systems, ALUD is interested to support technologies such as those developed in the OneFIT Project for the efficient application provision in the Future Internet. ALUD will exploit the common system architecture, the protocols and the algorithms for the coordination of the nodes in an opportunistic network to provide new functionalities in 3GPP based networks.

The results from OneFIT are expected to provide new functionalities for products like Base Stations and Femto Access Points for an efficient coordination of opportunistic networks in different use cases and scenarios, such as opportunistic capacity extension, opportunistic coverage extension and opportunistic device-to-device communication e.g. for proximity based services.

6.1.1.2 Intel Mobile Communications GmbH

Intel Mobile Communications is mainly interested in Mobile Device chipset related innovations that are developed in the framework of OneFIT. In particular, it is obvious that the market currently moves to a tight integration of connectivity technologies (WLAN, 3G, etc.) and it will be a challenge for the major competitors to provide solutions that distinguish the various solutions offered to customers.

Differentiators for INTEL are expected to comprise the following domains:

- Optimization of 3G/4G/4G-Adv by exploitation of Opportunistic-Network features, which will lead to an intelligent Smart-Phone;
- In the tablet segment, Opportunistic-Network features will be exploited in order to enable a Smart-Home environment controlled by one device, such as an intelligent Tablet;
- Besides reference platforms, the INTEL offer is focused on smart/intelligent device / chip-set for mobile phones, tablets, computers with connectivity, etc. ;
- Corresponding features and technologies may be included into CPU/processor devices which will strengthen the market position for INTEL.

While the definition of the concerned Radio Access Technologies (RATs) is done by standards and leaves little room for differentiation on an end-user application level, the combined exploitation of a multitude of RATs leads to a different picture.

Indeed, the optimized selection of a RAT among a multitude of available choices is most likely going to be implemented by vendor-specific solutions. Along the same lines, the combined usage and exploitation of a multitude of available RATs is a major field for vendor specific solution. In the latter case, the users will for example benefit from the simultaneous usage of multiple RATs, which enables users to fully exploit all resources (spectrum, power, etc.) that are available within the Mobile Device and the surrounding network infrastructure.

IMC currently is considering including solutions developed by OneFIT into proof-of-concept test-beds for future Mobile Device generations. In particular the directions which call for vendor specific approaches (see above) are of specific interest. The platform developed by IMC in the framework of the project will furthermore serve as a base-line for corresponding tests. Finally, the most viable solutions and algorithms that are evaluated on those platforms will be considered for integration into next generation Mobile Device chipsets products.

6.1.1.3 The Market Situation

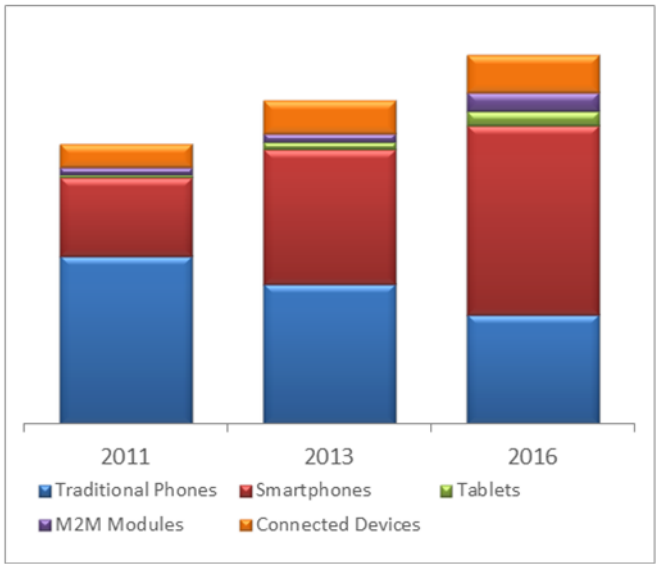
The key market for OneFIT results and of interest to INTEL are in the following domain:

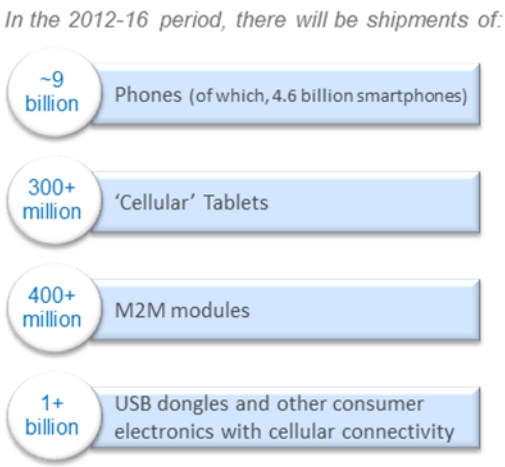
- Chipsets for traditional Mobile Phones,
- Chipsets for Smartphones,
- Chipsets for Tablets,
- Chipsets for M2M modules.,
- Chipsets for Connected Devices.

In total, it is expected that there will be a ~11 Billion Unit Opportunity in 2012-2016 for the Wireless industry. The corresponding vision of the inherent Eco-System is outlined by the below-mentioned graph.

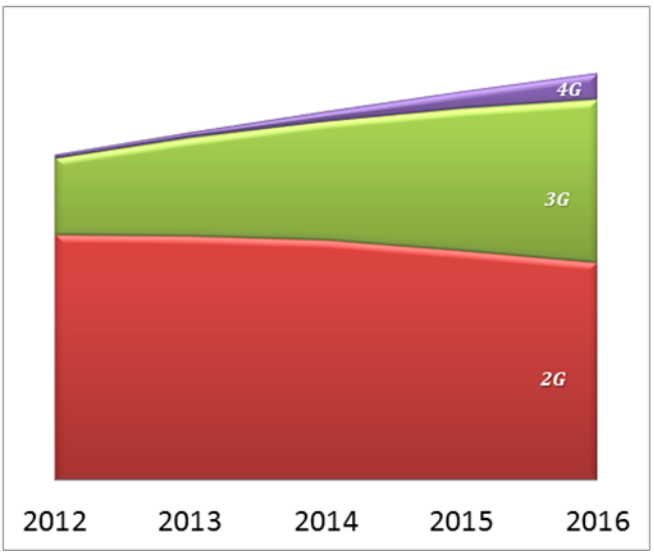
In this context, INTEL's vision is to connect the world with leading-edge secure and seamless wireless solutions as illustrated below.

More detailed market estimates are indicated in the graphs below.
As discussed above, the key contribution of OneFIT will relate to the efficient exploitation of a massively diverse wireless communication environment. Since the corresponding solutions will be rather vendor specific (and not standards driven) distinguishing technologies as the ones elaborated by OneFIT will be of key importance.





On the cellular technology side, LTE is expected to play an increasingly important role by 2016, but 3G and 2G will still represent a large portion of the cake. Corresponding estimates are highlighted below.



In the 2012-16 period, cellular subscriptions are anticipated to:

- 71% Growth in 4G cellular subscribers
- 54% Market Share for 2G into 2016
- 21% Growth in 3G cellular subscribers
- 7% Market Share for 4G subscribers limited to developed markets

6.1.1.4 Corresponding IMC product portfolio

For the markets indicated above, the below mentioned INTEL products are of key relevance. Please note that the "protocol & speed" indications in the table below relate to 3GPP standards only. However, the final products will of course address the full heterogeneous, multi-RAT environment requiring solutions that lead to the most efficient exploitation possible of such a context.

Intel® Cellular Products		
Product	Protocol & Speed	Form Factor
Intel® XMM™ 7160	4G - LTE 10 Band (100 Mbps)	Slim-Modem Solution
Intel® XMM™ 6260	3G - HSPA+ Penta Band (21 Mbps)	Slim-Modem Solution
Intel® XMM™ 2150	2G - EDGE Tri-Band (1 Mbps)	Single SoC
Intel® XMM™ 1180	2G - GSM/GPRS (80 Kbps)	Single SoC

6.1.1.5 Product Exploitation

The product exploitation of OneFIT results will be mainly focused on next generation Mobile Device chipsets which are follow-ups of the existing device solutions indicated above. Corresponding INTEL reference platforms are indicated below:

- The "Medfield Platform", i.e. the INTEL SmartPhone reference design and
- The "CloverTrail Platform", i.e. the INTEL Tablet reference design.

A key component is the proof-of-concept environment that was set-up in OneFIT. In particular, the JAVA environment enabling an efficient testing will be used as a base-line for the testing of algorithms and approaches for next generation chipsets.

Most importantly, this platform will allow for validation of advanced algorithms in a multi-RAT environment. In particular, efficient RAT selection can be tested and evaluated in a realistic

environment and based on Intel's XMM platforms. Also, the simultaneous operation of multiple RATs is possible which is expected to be a main driver for innovative features in Mobile Devices in the future.

On the algorithm side and related to the test-bed environment detailed above, OneFIT results will be considered for next generation Mobile Device solutions in the area of RAT selection and simultaneous operation of multiple RATs. In the latter case, dramatically improved user experience will be delivered due to the bundling of all available resources across technologies, spectral bands, etc.

Furthermore, a power consumption evaluation of multiple Mobile Device configurations has been performed within OneFIT. The corresponding results are of key interest to INTEL in order to provide intelligent RAT selection mechanisms in future generation chipsets. Indeed, a direct comparison of power consumption for LAN, WLAN and 3G in various configurations provides key metrics that will feed corresponding selection algorithms in the chipsets.

6.1.1.6 NEC Technologies (UK) Limited.

The research work performed by NTUK in OneFIT has set the ground in NEC for the development of terminal- and network-based technologies that will be required in the short-term future. The completion of OneFIT coincide with the very start of system design in 3GPP to support the so-called device-to-device (or "proximity") communications, based on requirements coming from commercial mobile networks, but also from the new and ambitious field of LTE-based Public Safety Broadband Networks currently driven by US authorities.

NEC, as a terminal and network equipment provider, is actively involved in the development of the required technologies and NTUK is leading the way for NEC in this field for research, standardization and early prototyping of solutions.

So the exploitation of OneFIT results will be direct in the already started standardization phase of network-controlled device-to-device communications, as well as in the development of simulations and prototypes. When the industrial development phase will start, it is expected that NEC will try and address the market with solutions for terminals and network equipments.

6.1.1.7 Telefónica Investigación y Desarrollo, SAU.

The role of Telefónica I+D is to research and develop new technologies, products, applications and services for the business units of the other companies in the Telefónica Group, mainly the network operator. Therefore, in the scope of the OneFIT project, Telefónica I+D has been promoting the benefits of deploying a cognitive opportunistic system over the underlying mobile network infrastructure. Moreover, Telefónica I+D will release proposals to update some of the applications in the Telefónica portfolio so that they can capitalize on the new features provided by opportunistic networks, as well as suggest novel services that could not be implemented without the support of opportunistic mechanisms.

The physical deployment of opportunistic systems over Telefónica's network infrastructure will not be immediately undertaken, and instead it will probably be delayed until commercial solutions are provided by industrial manufacturers, supporting user terminals are ready and a solid business model for the exploitation of this technology is developed.

6.1.1.8 La Citadelle Inzenjering

Delivery of multimedia content over wireless networks became a significant challenge in modern IP networks. User's mobility, diversity of fielded devices and ever increasing demand for high quality multimedia create a need for context driven media delivery. To that end and through participation in the OneFIT project, LCI has developed a novel method for creation of a contextually aware and opportunistic network overlay to manage available resources across plurality of participating nodes/networks. The network overlay consists of intelligent access points, contextual information repository and autonomic management algorithms and instantiates a wireless Content Delivery Network (wCDN) capable of handling high temporal and spatial variations in the multimedia traffic. Goal of the wCDN overlay is to provide the highest level of resource utilization, which increases useful capacity of the underlying wireless system, and also to ensure required level of quality of service to the end users. The wCDN system exploits contextual intelligence for user and content profiling and for detection/prediction of overall traffic composition, network performance and content distribution. This contextual intelligence of the wCDN system is captured in two LCI's patents that have been filed with European Patent Office (please refer to Table 6-2).

Industry experts are unanimous in their assessment that wCDNs over proper cellular infrastructure is not the most viable option due to the associated technical and cost issues. Nevertheless, notion of mobile CDNs is important and offloading traffic to other networks such as WiFi has been identified as the most promising path forward. In line with this strategic direction LCI plans to establish production capability for professional/industrial grade WiFi infrastructure based on its intellectual property rights (IPR) and knowledge and expertise obtained through participation in the OneFIT project. By investing into wCDN product line the company aims at improving its competitiveness and its ability to supply superior WiFi infrastructure for broadband solutions, in the beginning within the South East Europe region (this market is identified as the one in need of professional yet affordable wireless solutions) and later the product will be brought to the wider European market. The proposed wCDN solution consists of three main building blocks whose development is in LCI's business plan for the forthcoming period:

- Family of professional/industrial grade access points (LCI_APs) with intelligent agents for context gathering and automatic reconfiguration. The family of access points consists of regular APs (LCI_rap), mesh APs (LCI_map) and wireless bridge APs (LCI_bap). All LCI_APs are based on the commercial-of-the-shelf (COTS) router board HW and open source SW stack which can be configured to work in one of the three possible modes. The components selected for LCI_APs meet all necessary European radio regulatory specifications and are tested to operate over an extended range of environmental conditions. Furthermore, LCI_bap and LCI_map will be capable of dynamically switching between single and multi-path routing operational modes (based on LCI's OneFIT algorithm "Application cognitive multipath routing in wireless mesh networks") under the control of our Autonomic intelligence system which gives them a competitive advantage relative to exploitation of wCDN functionalities.
- Contextual data base (LCI_DB) is used to store contextual parameters regarding wireless infrastructure (radio aspects, routes, links, temporal infrastructure overlays - ONs), anonymized usage data (mobility patterns, preferred services, requests for content, used devices) and content information (length, number of chunks, type, genre, temporal and spatial popularity). These contextual data are subjected to proprietary machine learning (ML) algorithm (whose development started under the OneFIT project, but will be continued after the project end) to derive user mobility patterns and traffic profiles in terms of its temporal and spatial distribution in order to classify operating condition into easily recognizable patterns which are in turn used to trigger the need, or lack of it, for a wCDN overlay. Additionally, user friendly API interface will be developed opening LCI_DB to third party developers.

- Autonomic management system (LCI_AM) is based on ML algorithms and is responsible for decision making and contextual pattern derivation. Patterns relevant to wireless media delivery are derived on basis of supervised and unsupervised machine learning techniques of regression, regularization and clustering. LCI_AM selects nodes to participate in the wCDN ON, then triggers and supervises necessary reconfiguration of these nodes. The main part of this autonomic management system is LCI's algorithm (developed within the OneFIT project) "Content conditioning and distributed storage virtualization/aggregation for context driven media delivery". From business perspective, LCI_AM system will be offered as an advance service available to wireless providers deploying LCI's WiFi infrastructure.

6.1.2 Regulatory Exploitation

The overall goal of BNetzA is to increase the efficient use of Spectrum. One imported option to do this is by increasing the flexible use of the available Spectrum. We believe that Heterogeneous- and opportunistic networks will be very important elements to achieve that goal. The work in the OneFIT Project helped us to be confident in these technical approaches and to support them to be introduced in the regulatory domain. For Example:

- From the global perspective it was very import for us that at WRC 12 not restriction/limitations for the use of Cognitive Radio were introduced in the Radio Regulation. That is achieved.
- Furthermore BNetzA ensured that am ITU-R Resolution was adopted at the Radio Assembly in January 2012 aiming for Studies for a global approach on the implementation and use of cognitive radio systems.
- One the European level we support the technical implementation of the Licence shared access (LSA) Concept.
- To cover in the revision of the R&TTE explicit SDR requirements in order to allow for flexible Radio equipment and the development of relevant Harmonised Standards and related technical specification in ETSI
- The development of future PPDR Systems.

6.1.3 Research Exploitation

Research institutions involved in the OneFIT have played prime roles as providers of advanced technology solutions to industrial players. Hence, generation of industrially relevant results and IPR in the commercially promising area of cognitive radio and networks for future heterogeneous communication systems has been the most important motivation for their involvement in the OneFIT. Detailed exploitation outcomes of EIT+, VTT and academic partners are provided in the following.

6.1.3.1 Wroclawskie Centrum Badan EIT+ Sp z o.o

As a highly dynamic and innovative research institute, EIT+ seeks to apply the results of its research in industrially relevant contexts. Hence, within the framework of OneFIT, EIT+ focused on exploiting result identified as potentially relevant to the European industry to strengthen the European position in the field of Opportunistic Networks. Foremost, EIT+ focused on pre-standardization activities within ETSI RRS (related to solutions for interconnection of dynamic opportunistic networks to infrastructure networks, i.e., C4MS) to raise the awareness of European industry and thus potentially shorten the time which is necessary for the industry to recognize, accept and deliver concepts/solutions to the market. In order to achieve that EIT+ contributed towards two technical reports (i.e. TR 102 684 and TR 102 907) and its representative actively participated in ETSI RRS meetings and phone conferences. Furthermore, the results obtained during the project allowed EIT+ to contribute to the dissemination of OneFIT through publications to journals and conferences and fuel further R&D activities in the direction of developing Opportunistic Network solutions which may

result in generating IPR. Additionally, R&D activities of EIT+ in OneFIT led to building critical mass of know-how and experience in the field of Opportunistic Networks which allowed forging new collaboration with the industry and academia. This will definitely contribute towards enhancing project acquisition capacity of EIT+ an increase its technology base.

6.1.3.2 VTT Technical Research Centre of Finland

VTT has developed knowledge of spectrum selection for opportunistic networks. VTT exploits this knowledge to support the mobile communications industry which aims at accessing new (possibly shared) spectrum bands to respond to the growing data rate demand predicted for the next decade. Developed techniques for spectrum selection and the experience gained in the spectrum regulatory activities are transferred to industry by establishing joint projects to accomplish specific short term goals. Doctoral theses are being prepared in the project to educate researchers.

6.1.3.3 Academic Exploitation Plans

During the last 20 years UPC has considerably reinforced its technical background and expertise as well as its potential to carry out innovative research in mobile radio communications through its participation in European research projects as well as projects carried out in co-operation with national mobile operators. As a result, the Mobile Communications Research Group has been able to support doctoral and post-doctoral research of a large number of engineers thus supplying the mobile communications sector in Spain and Europe with highly qualified engineers. Therefore, UPC, as a reference institution in Spain, is going to exploit its participation in OneFIT in order to further strengthen its ability to pursue research, development and teaching activities both for its own benefit and for the benefit of its country and the EU in general. The obtained expertise can potentially be transferred to network operators, as this kind of technology is an open door to innovation and to support new services. Besides, UPC is currently in charge of postgraduate and customized training courses, so that the participation in OneFIT will also improve teaching skills facilitating the convergence between research departments and public or private companies. Finally, disseminating main results of the project by participating in conferences as well as publications in relevant magazines and journals is further expected.

UPRC's involvement in such an innovative, research project ensures that it stays competitive for future research initiatives. Participation and contribution to the success OneFIT project helps to stimulate spin-off projects with industrial partners. Moreover, UPRC acted as a rapporteur and contributed towards the TR102.684 [13], which is something that gives further experience to the institution in the area of control channels. Also, constructive collaboration with industrial partners has led to joint publication in international conferences, workshops, fora and international journals/magazines and book chapters. The exploitation plans from UPRC involve supervision of PhD theses on areas related to the OneFIT project; enhancement teaching scope and quality by introducing new findings and technologies into the curriculum; presentation of project results and demonstrations to students and university staff in seminars and tutorials; utilization of the project results/learning to make adjustments to the current research directions and position for better cooperation with industrial partners.

The Centre for Communications Systems Research (CCSR) as a leading European research group on mobile communications has been able to support master's level training and doctoral research of a large number of engineers and provide the mobile communications sector in UK and Europe with highly qualified engineers. CCSR is going to exploit its participation in the project through extending current lines of research, development and teaching activities based on expertise gained during the project and through continuation/extension of some of themes developed in OneFIT. Results and participation in OneFIT will also improve teaching skills facilitating the convergence between research departments and public or private companies. Finally, further dissemination of main results of the project by participating in conferences as well as publications in relevant magazines and

journals is expected. The exploitation plans of CCSR involve supervision of PhD theses on areas related to the OneFIT project (currently 4); enhancement teaching scope and quality by introducing new findings and technologies into the curriculum; presentation of project results and demonstrations to students and university staff in seminars and tutorials.

6.2 On Identification and Generation of IPRs

6.2.1 Patents issued and applied/pending

Table 6-1: OneFIT IPR Contributions

Author	Patent Title	Loc.	Submission Date	Ref	Extension expected
M. Bourdellès, S. Pega	Procédé pour optimiser les capacités d'un réseau de télécommunications de type ad-hoc	France	07.04.2011	67419	Yes
D. Boscovic, M. Tosic, O. Ikovic, M. Cirilovic	Method and Apparatus for Managing a Wireless Network	European patent office	24.08.2012	*EP1218 1759.7*	No
D. Boscovic, M. Tosic, O. Ikovic, M. Cirilovic	Method and Apparatus for Providing Content Delivery over a Wireless Mesh Network	European patent office	24.08.2012	*EP1218 1758.9*	No
A.Bagayoko, D.Panaitopol, C.Mouton	Communication system	Intellectual Property Office (UK)	06.06.2012	1209953.7	yes

7. Operator Recipe/cook book

7.1 Motivation for using/exploiting ONs

Operator-governed ONs seem a promising solution for operators which would like to provide e.g. coverage/capacity extension to their access network or aggregation of resources to the backhaul network etc. The ONs are able to cover specific needs of an operator (e.g. instant traffic load surge) at a specific place for a limited timeframe. In that case, the operator does not have to invest in expensive infrastructure installations/deployments in order to satisfy temporary demand in focused areas. Operator benefits and challenges have been elaborated in OneFIT's D2.1 [8]. Also benefits for other stakeholders in the ON value-chain (apart the operators), namely end-users, service providers, manufacturers have been also identified for each scenario that OneFIT solves through the deployment of ONs. Figure 7-1 summarizes graphically a potential roadmap for the implementation/ deployment of ONs.

It is foreseen that in future OneFIT-like systems most of the functional entities (e.g. CSCI, CMON) and technical solutions (control channels – C4MS, algorithms etc.) will be provided through standardized solutions. What is important to mention here is that in order to examine the feasibility of operator-governed ONs, specific business models for operators need to be defined. To that respect, OneFIT has documented in [8] that in order to draft a feasible business model, the revenue sources should be identified. The main revenue in a mobile service comes from user billing, so an operator should ensure that proper billing mechanisms are developed. Another source of revenues for operators which has been identified is advertising/sponsoring (in situations where ONs are oriented to offer localised services). Moreover, another important aspect which should be taken into account is that for the success of ONs, users must agree to be part of them. Network operators and/or service

providers need to find mechanisms to encourage their customers to join (or create) ONs. These mechanisms would range e.g. from direct discounts on the customer's bill to tradable point and social networking rewards. And of course, trust among various parties needs to be established in order to make the system trustworthy. The more the users trust the ON or the services offered over it, the more the success of the ON and the possibility to offer services that require more robustness and availability will be.

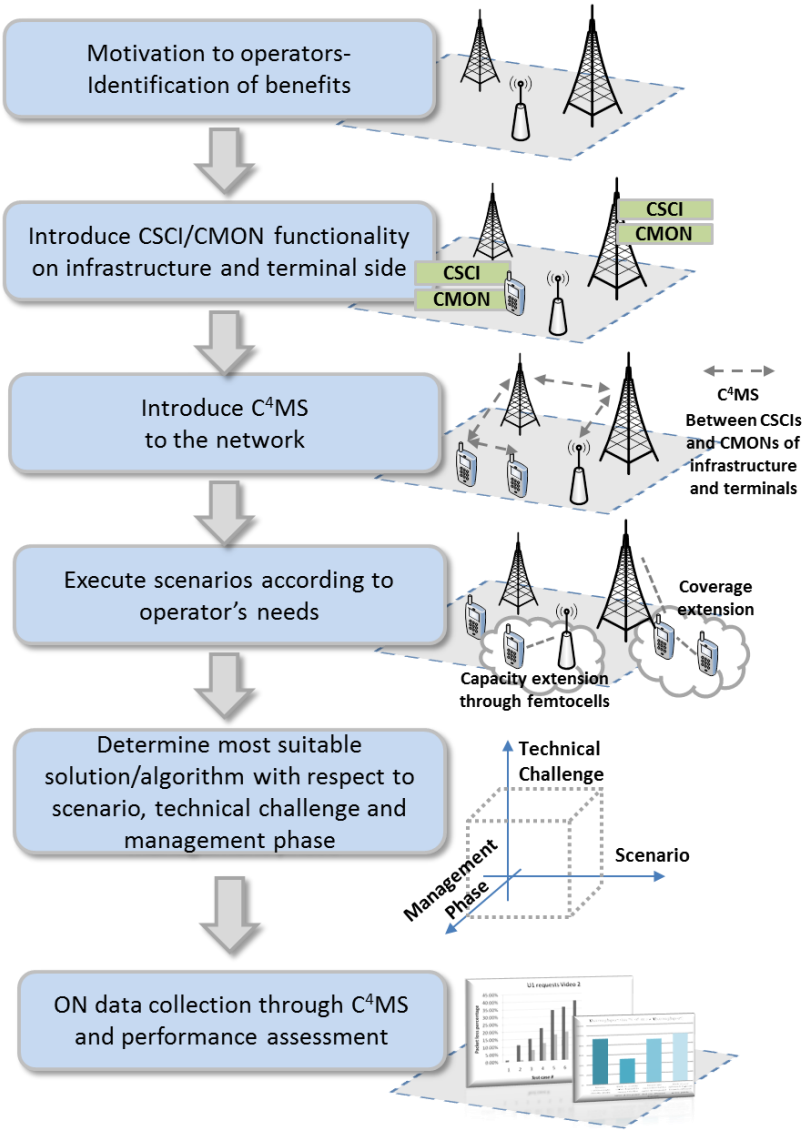


Figure 7-1: Potential roadmap for the implementation/deployment of ONs by operators

7.2 Introducing CSCI/CMON functionality to infrastructure and terminal side

Since OneFIT's D2.2 [9] there has been extensive elaboration on the functionalities that the CSCI and CMON entities can provide to the ON. The functional split of the CSCI and the CMON is also represented graphically to the following figure. In the experiments conducted during the project, the CSCI and CMON functional entities were developed and simulated in order to satisfy each scenario's needs. In a real environment through, an operator would need to use the specifications of CSCI and CMON so as to update the software of the infrastructure elements in order to be able to support the

creation, management and termination of ONs through CSCI and CMON. The software update could be done via remote or local focused intervention onto the infrastructure.

At this point it is useful to mention that the CSCI and CMON functional entities are coming as an extension on top of the existing ETSI/RRS functional architecture as proposed in [10]. Figure 7-3 comes from D2.2.2/D6.4 [11] and shows the actual placement of CSCI and CMON to the OneFIT Functional Architecture along with the interactions among legacy entities (e.g. the DSONPM, JRRM, DSM etc.).

	CSCI	CMON
Coordination with the infrastructure	YES	-
Coordination with other nodes in ON	-	YES
Detection of situations where an ON may be useful	YES	-
ON suitability determination	YES	-
Execution of ON establishment/creation	-	YES
Maintenance of ON, e.g. reconfiguration	-	YES
Termination decision when ON is no longer suitable	-	YES
Execution of ON termination	-	YES

Figure 7-2: Functional split of CSCI and CMON

Regarding the terminal side, in every conducted experiment/simulation it is assumed that terminals are ON-capable, thus the CSCI and CMON functionalities are pre-loaded. To that respect, newly manufactured devices would need to support ON functionality through the integration of CSCI and CMON to their software. Also, WiFi-Direct technologies and the tethering concept can be exploited in order to allow manufacturers to capitalize on the development knowledge of already standardized solutions and make integration of CSCI and CMON easier. Also, solutions of software updates to already circulated devices could be considered as means from the device manufacturers, wherever applicable, in order to enable ON capabilities to even more devices.

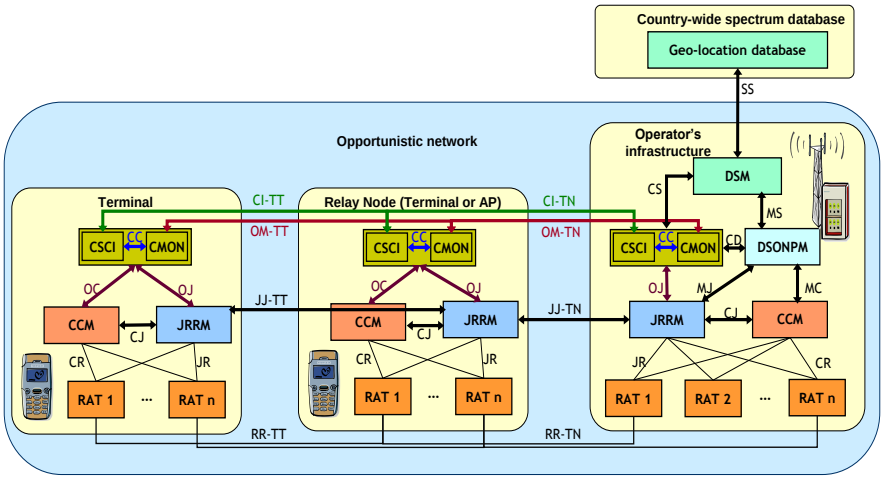


Figure 7-3: Placement to the functional architecture of CSCI and CMON

In summary, it is expected that the CSCI/CMON functionality would be deployed following standardization and as part of BS/device upgrade procedures (mainly on the software side).

7.3 Introducing C4MS to the network

For the communication of the cognitive management entities (i.e., CSCI and CMON) in the OneFIT system, a specific control channel has been introduced. The interface is called control channel for the cooperation of cognitive management systems or C4MS. The C4MS is defined as a logical channel which conveys the elements of necessary information facilitating the operations of ONs and can be seen as an enabler for providing information from the network to the terminals or between the terminals, e.g., frequency bands, available RATs, and spectrum usage policies. The C4MS interfaces include the CI interface (communication between CSCIs) and the OM interface (communication between CMONs). Specific details on the interfaces are given in the OneFIT's D2.2.2/D6.4 [11].

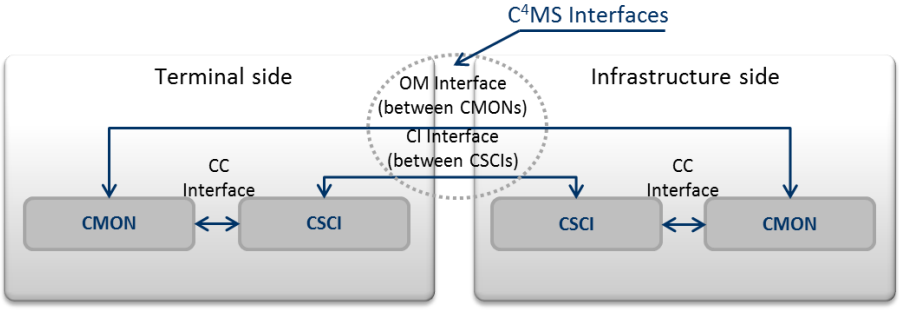


Figure 7-4: C4MS interfaces

In order to enable the transferring of information through C4MS, specific data structures have been defined, modelled and evaluated as proposed in D3.3 [12]. Moreover, RAT-independent and RAT-dependent implementation options have been exploited in order to assess which option would be the most suitable for ONs. The assessment of these implementation options has been also published in a technical report of ETSI/RSS as designated in [13].

Therefore, an operator should need to implement such a cognitive control channel as C4MS in order to enable exchange of ON messages between CSCIs and CMONs of various elements (infrastructure or terminals). Moreover, in the OneFIT project in order to be able to answer what would be the overhead of the extra control data that the C4MS proposes, specific analytical and experimental evaluations have been conducted among the partners. Results have been extensively reported in the OneFIT's D3.3 [12] and D3.4 [14]. An overall conclusion that is extracted from the evaluation studies is that the imposed signalling related to the messages even in networks of 7 base stations and 40 terminals attached to a problematic (e.g. congested) base station (from which 12 terminals switch to ON) is limited to around 45KB in total. Even in networks of 7 BSs and 160 terminals attached to a problematic BS (from which 48 terminals switch to ON) the signalling load is around 120KB.

Likewise CSCI/CMON functionality (Section 7.2), the C4MS would be deployed following standardization and as part of BS/device upgrade procedures.

7.4 Execution of scenarios according to operator needs

As soon as an operator deems necessary that an operator-governed ON would be able to address a specific problem in a specific region (e.g. capacity, coverage extension etc.), then the following phases shall be executed in order to cover the lifecycle of the ON:

- Suitability determination;
- Creation;
- Maintenance;
- Termination/ release of resources

These phases have been extensively elaborated since OneFIT's D2.1 [8]. Therefore, each one of the identified scenarios and use cases in the project uses the aforementioned phases in order to be properly executed. An operator needs to be aware of the identified phases, in order to be able to address execution issues related to each phase.

Figure 7-5: ON management phases

It is worth mentioning that having deployed the OneFIT features and the C^{4}MS, it will be possible for operators to use the underlying functionalities not only for the already specified scenarios namely i) coverage extension; ii) capacity extension; iii) infrastructure supported opportunistic networking for the provision of localized services; iv) traffic aggregation in the access network and v) resource aggregation in the backhaul but also for new, novel scenarios that may suit the concept of opportunistic networking. Context, measurement and other parameters that have been selected in the OneFIT can still be applied by other scenarios as well. To that respect, operators are not limited to use specific scenarios but flexibility is possible, as long as specific architectural aspects and functionalities of the OneFIT-system are taken into account.

7.5 Determining most suitable solution/algorithm with respect to scenario, technical challenge and management phase

Work package 4 of the OneFIT has defined specific algorithms in order to address various problems that an ON may face in various phases and scenarios according to three main technical challenges which are:

- Spectrum opportunity identification and selection;
- Selection of nodes and routes in the wireless access network;
- Selection of nodes and routes in the backhaul network.

It is worth mentioning that, selection of specific algorithms to address particular challenge & configuration/settings of parameters of each individual algorithm is of course vendor dependant and performance of these algorithms will by itself be a source of service differentiation amongst operators. Regarding the first challenge the following algorithms (as shown in Figure 7-6) have been identified, developed and assessed:

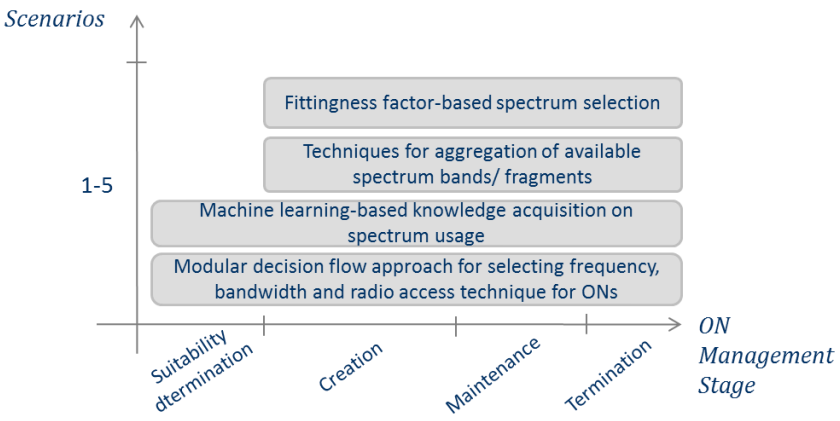


Figure 7-6: Spectrum opportunity identification and selection

Regarding the second and third challenges the following algorithms (as presented in Figure 7-7) have been identified, developed and assessed:

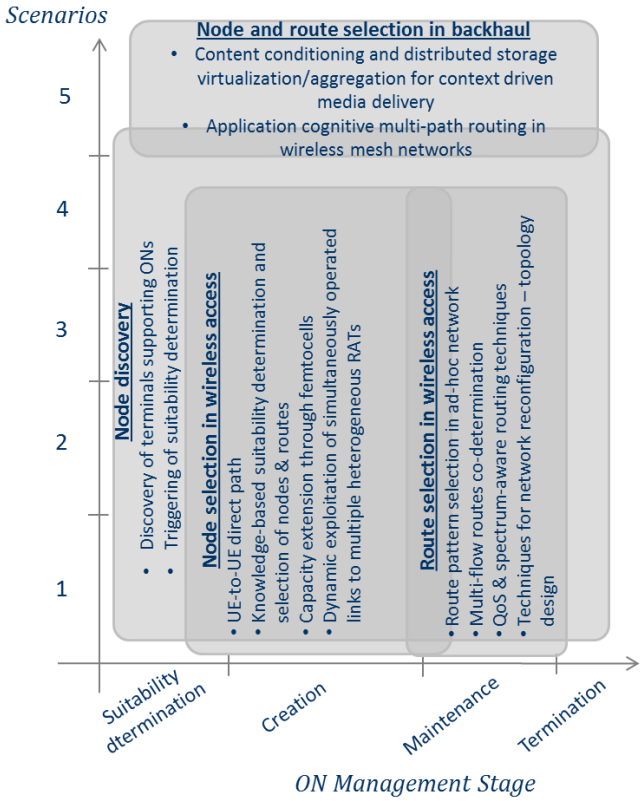


Figure 7-7: Selection of nodes and routes in the wireless access and backhaul networks

According to this synthesis of various solutions, specific synergies have been sought during the project. Results of these synergies and the impact/benefits to the operation of an ON, have been also analysed in OneFIT's D4.2 [15] and D4.3 [16]. Therefore, main aim of this subsection is to show to the prospective operators what would be the benefits in terms of key KPIs e.g. energy consumption, throughput etc. from such synergic operations. According to the problem we are trying to solve each time (e.g. extra capacity, extra coverage, resource aggregation etc.), the

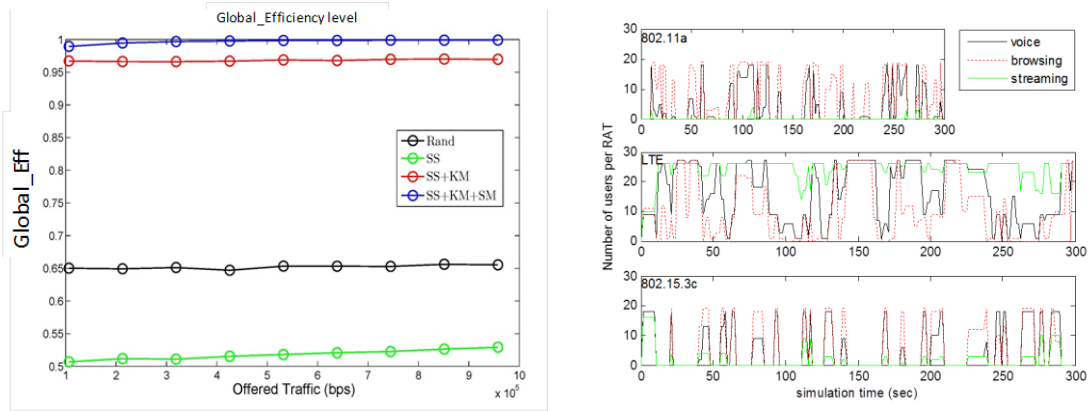
operator can find through the synergic opportunities what would be the most suitable algorithm for the solution of its problem. The following benefits have been identified for the "spectrum opportunity identification and selection":

- Benefits of using utility functions;
- Benefits of applying knowledge management to historic information;
- Benefits of including operator preferences in the spectrum selection;
- Benefits of providing adaptability to algorithmic solutions;
- Benefits of considering a reliability tester for non-stationary environments;
- Benefits of the joint consideration of the RAT in the spectrum selection problem.

Indicatively, the following KPIs have been assessed with respect to "spectrum opportunity identification and selection":

- Global efficiency level;
- Dissatisfaction probability;
- Spectrum handover rate;
- RAT selection for different data types.

Figure 7-8a and Figure 7-8b, provide some indicative results on the aforementioned KPIs. Results have been derived from experiments/simulations that partners have conveyed for the assessment of specific solutions. Detailed analysis of the results is available in OneFIT's D4.3 [16]. Figure 7-8a plots the global efficiency as a function of the total offered traffic load. Note that this metric, integrates the effect of the dissatisfaction probability, the regret and the usage metrics. Focusing in this sub-section on the comparison between Rand (i.e., implementing only the spectrum selection at ON creation and performing a random selection among available pools), SS (i.e., Spectrum Selection only) and SS+KM (i.e., Spectrum selection supported by Knowledge Manager), the results show that the introduction of KM (i.e., Knowledge Manager) leads to a very important increase of the global efficiency level with respect to both the random and the SS approaches. Also, Figure 7-8b represents selected RAT for each traffic type during the maintenance phase (i.e., after the ON creation phase) of an ON. Browsing users mainly utilize 802.11.a and 802.15.3c. LTE is mainly reserved for streaming users to meet their high data rate requirements. During simulations LTE on TV bands has also been utilized. From such results, an operator would be able to have a first view on what to expect by using operator-governed ONs.



(a) (b)

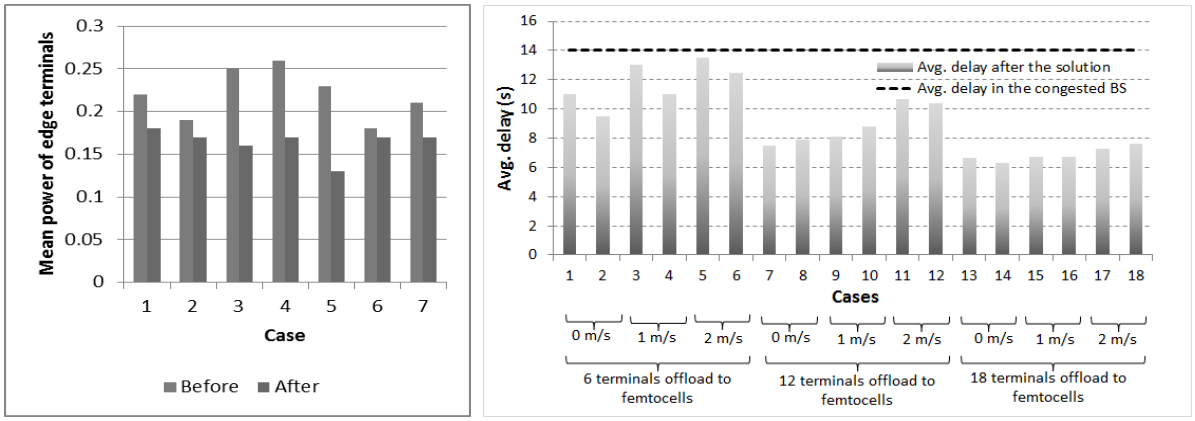
Figure 7-8: (a) Global efficiency level for the specific approaches, (b) RAT selection for different data types

Additionally, the following benefits have been also identified for the "selection of nodes and routes in the wireless access and backhaul networks":

- Benefits in energy consumption of the infrastructure;
- Benefits in energy consumption of the terminals;
- Communication benefits through the exploitation of ONs;
- Resource utilization benefits in terms of increased capacity of the underlying network.

Indicatively, the following KPIs have been assessed with respect to "selection of nodes and routes in the wireless access and backhaul networks":

- Average energy consumption;
- Average end-to-end delay to transmit a full message of variable size of 64KB to 1024KB;
- Average throughput.



(a) (b)

Figure 7-9: (a) Average energy consumption in terminals which switch to ON, (b) Average end-to-end delay to transmit a full message of variable size of 64KB to 1024KB

Figure 7-9a and Figure 7-9b, provide indicative results on KPIs and more specifically the average energy consumption and the average end-to-end delay to transmit a full message of variable size of 64KB to 1024KB. Results have been derived from experiments/simulations that partners have conveyed for the assessment of specific solutions. Detailed analysis of the results is available in OneFIT's D4.3 [16]. For example as Figure 7-9a suggests, benefits in energy consumption of terminals which switch to ON is clear due to the fact that these terminals are connected to closer neighbors compared to their previous connection to a distant BS. Therefore, the power that is needed for the communication among the terminals is lower (around 25% reduction) than the one that is needed for the communication with the distant BS. Also, as Figure 7-9b suggests, the average end-to-end delay tends to drop (around 30% reduction) after the creation of an operator-governed ON, since terminals are connected to non-congested infrastructure elements (compared to the situation before the ON creation, where terminals were connected to a congested BS and degradation in the quality of communication was observed).

As mentioned earlier, expanded explanations of these KPIs and their values are available in [16]. What is important to mention from an operator's point of view is that operator-governed ONs are promising solutions which can deliver extra coverage or capacity or resource aggregation to the network, upon request, temporarily and in a specific place, without making the operator to invest to expensive equipment/elements in order to satisfy temporary only demand. In addition, according to the business models discussed in [8] and also briefly in Section 7.1 of this document, operators can have extra revenue from such operations, as they exploit the opportunities of the environment and the willing of the users (users who assist others and they consume energy, can be compensated for their participation in ONs, as already analysed in [8]. So, a win-win situation is observed.

7.6 ON data collection through C4MS structures and performance assessment

It is likely that a number of new KPIs need to be defined and monitored based on information/ measurements collected via the C4MS. Such indicators are key to understanding and tuning ON formations and provide operators with means to assess the gains of using an ON solution, to check if existing KPIs need updating as well as costs associated with supporting ON services.

Measurements can be collected via the C4MS which uses specific fields for ON-related information. As specified in D3.3 [12], such fields include:

- Profiles;
- Context;
- Policies;
- Decisions;
- Knowledge.

Each of these data groups carries specific information related to the BSs, terminals and the operation of the ONs. Indicatively, some ON-specific parameters have been introduced in the C4MS in order to enable the better monitoring and more efficient decisions related to ON creation, management and termination:

- ON_Status
  - Supported_ONs (including ON_Characteristics);
  - Potential_ONs (including neighbouring nodes with ON capabilities that could potentially join an ON);
  - Etc.
- User_Class
  - Quality_Level;
  - Behaviour_Aspects (including number of requests; usage characteristics; estimated session duration; estimated data volume transferred);
  - Etc.
- Context
  - Interfaces_Used;
  - Spectrum_Used;
  - Etc.

To that respect, the C4MS is introduced from OneFIT in order to assist to the collection of necessary data for the operation of ONs through the communication of the cognitive management entities (namely the CSCIs and CMONs) as specified and analysed in [12].

8. Conclusion and Perspectives

The goal of the OneFIT project is to develop and validate the vision of opportunistic networks that are managed and coordinated with the infrastructure, by advanced cognitive systems. To realize the expected gains of opportunistic networks in terms of enhanced wireless service provision and extended access capabilities for the Future Internet, through higher resource utilization, lower costs, and management decisions with a larger "green" footprint, a wide range of dissemination activities have been carried out.

This deliverable has collected the major dissemination activities of the OneFIT project together with the results produced during the lifetime of the project. Dissemination activities included publications in books, journals and conferences, demonstrations, presentations at concertation and cluster meetings, training, and contributions to standardization bodies and regulatory forums. A large number of dissemination activities have been carried out and although providing inputs to standardization and regulation forums are a sign of practical applicability of the OneFIT project results and a practical first step, active participation of members resulted in:

- Ratification of TR 102 684 "Reconfigurable Radio Systems (RRS); Feasibility Study on Control Channels for Cognitive Radio Systems", in 2012 by ETSI RRS, driven for the most part by the OneFIT consortium.
- Contributions related to device-to-device communication (D2DC) towards TR 22.803 "Feasibility Study for Proximity Services (ProSe)" as part of 3GPP WI on "proximity-based services", on the basis of device-to-device communications as an enabler of the concept of Opportunistic Networks.
- Contributions towards European Commission (EC) organized workshop & roadmap on Software Defined Radio and Cognitive Radio standardization, collectively named Reconfigurable Radio System (RRS), for civil security/military and commercial applications.

The OneFIT partners also remained active in ITU-R WP5A meetings and help promote control channel related topics in the report titled "Cognitive radio systems [(CRS) applications] in the land mobile service".

The project has been successful in promoting its vision and ideas through interactions with the other key players in the area. The OneFIT consortium managed to fulfil majority/all of the planed dissemination activities. Also the OneFIT project raised awareness regarding the operator governed ONs and benefits behind them.

9. References

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