

## FP7 ICT-1-1.1: The Network of the Future

### EU-MESH: Enhanced, Ubiquitous, and Dependable Broadband Access using MESH Networks



### D7.3: Interim Report on Dissemination, Standardisation, and Exploitation Activities

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## Executive Summary

The goal of this work package is to disseminate the project's results and achievements, follow and contribute to relevant standardisation activities, and exploit specific project results.

This interim report covers the first 12 months of the project. Summary of EU-MESH partners activities and contributions to the WP is presented in this Executive Summary section.

The most of activities were related to dissemination of activities, results and achievements, specifically, EU-MESH partners:

- Participated in **six (6)** activities organised at programme level relating to the ICT Network of the Future area.
- Organized **four (4)** events, such as conferences, summer schools, etc.
- Published **two (2)** journal papers and **two (2)** were accepted for next year publication.
- Published **thirteen (13)** conference papers
- Participated in **sixty six (66)** Technical Programme Committees, and **seventeen (17)** Editorial Boards.

EU-MESH partners also publicized project vision, plans and activities by:

- Publishing **two (2)** articles in press and **four (4)** on line
- Delivering **three (3)** invited talks and
- Publishing **two (2)** Press Releases

One of the risks that EU-MESH is exposed to is the fact that wireless networking areas such as technology, business, standards, markets, are changing very fast. To minimize this risk for EU-MESH, continuing verification of business and technical validity is required. The same risk applies to business goals and objectives of industrial partners, in particular. This continuing verification was performed by participation in **ten (10)** key global industrial events, mainly by Proximity, and included speaking arrangements, both for product demonstration, and event sponsorships. As this verification is a part of regular business of Proximity, all the participation costs were covered by Proximity, with no charge to EU-MESH.

EU-MESH partners also participated in **five (5)** IEEE 802.11 Plenary and Interim Session, and submitted **one (1)** contribution.

Initial exploitation plans are being developed as well.

## **1 WP7 Description**

The goal of this work package is to disseminate the project's results and achievements, follow and contribute to relevant standardisation activities, and exploit specific project results

### **1.1 Dissemination**

The objective of dissemination work package includes creating a public web site and producing material (brochures, posters, CD) through which general information about the project is communicated. In addition EU-MESH's partners planned actively disseminate and publish the project's research and development results through a number of channels, such as:

- Papers at leading peer-reviewed conferences and journals.
- Participation in program committees and editorial boards
- Participation in forums and industrial oriented events.
- Dissemination of open source software prototypes.
- Dissemination of information through European integration activities and conferences.

### **1.2 Standardisation**

The objectives of EU-MESH standardization effort are to:

- Follow and align EU-MESH contributions with applicable and evolving standards such as IEEE 802.11s/k/v/u, IEEE 802.16j/g/m, IEEE 802.21, and ITU-T Next Generation Networks.
- Contribute to relative standardisation bodies, and mainly IEEE 802.11s/u, 802.16j/g/m, and 802.21

### **1.3 Exploitation**

The goal of the exploitation planning activities in the project is to ensure the continuity of the project's results and promote their future take-up and exploitation in the relevant market/industrial sectors and academic/research communities. As a final outcome of this group of activities, an exploitation strategy will be compiled to provide recommendations towards implementation and transfer of the technology developed within the project, maximizing the benefits for the project partners.

At this stage in the project's lifecycle only some preliminary exploitation planning has taken place, as there are no concrete results yet in the project. The focus during this period has thus been to carry out strategic planning activities through the identification of potential exploitation opportunities that may arise, and an initial market analysis to evaluate and quantify their impact.

## **2 Dissemination**

This section should describe all accomplishments and activities performed to meet WP7.1 goals and objectives.

## 2.1 Program Activities

Participation in the activities organised at programme level relating to the ICT Network of the Future area.

- [eu.1] Radio Access & Spectrum (RAS) cluster meeting, 11-12 March 2008, Brussels, Belgium, Vasilios Siris (FORTH)-participation
- [eu.2] Radio Access & Spectrum" cluster of 25 FP7-FP6 projects, 29-30 September 2008, Brussels, Belgium, Presentation of EU-MESH project by Ioannis Askoxylakis (FORTH)
- [eu.3] The ICT Mobile and Wireless Communications Summit (ICT-MobileSummit 2008) 10-12 June 2008, Stockholm, Sweden, Ioannis Askoxylakis (FORTH)-participation
- [eu.4] 2nd Concertation Meeting of ICT-FP7-FP6 The Network of the Future, 1 October 2008, Brussels, Belgium, Ioannis Askoxylakis (FORTH)-participation
- [eu.5] Future Internet Research and Experimentation (FIRE) working group, Marco Conti (CNR)-participation
- [eu.6] Wireless Mesh Networking Tutorial, September 2008, Cannes, France, Murad Abusubaih, Telecommunication Network Group (TKN), TU-Berlin-Participation

## 2.2 Organization of events

Project related scientific or other events organized by the partners such as summer schools, conferences, information days, etc

- [or.1] The 10th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks, June 15-19 2009, Kos, Greece, Silvia Giordano (SUPSI)-General Chair, Vasilios Siris (FORTH)-General Chair, Marco Conti (CNR)-Member of the Steering Committee, Ioannis Askoxylakis (FORTH)-Chair of the Local Arrangements Committee
- [or.2] ENISA-FORTH Summer School on Network and Information Security, September 15-19, Heraklion, Greece, Apostolos Traganitis (FORTH)-Member of the Advisory Committee, Ioannis Askoxylakis (FORTH)-Chair of the Local Arrangements Committee
- [or.3] CNR, together with TU-Berlin, is organizing the First International IEEE Workshop *on Hot Topics in Mesh Networking* (HotMESH'09), Kos, Greece – June 15, 2009 <http://cnd.iit.cnr.it/mesh09>. The workshop is organized by the EU-MESH project and is co-located with the 10th IEEE International Symposium on a "World of Wireless, Mobile and Multimedia Networks" (WoWMoM'09). Raffaele Bruno (CNR) is the workshop co-chair; Marco Conti (CNR) is member of the Steering committee
- [or.4] Marco Conti (CNR) has been the co-organizer of the The 2nd IEEE International Workshop on *Autonomic and Opportunistic Communications*, AOC 2008, 23 June 2008, Newport Beach (CA), USA.

## 2.3 Research Publications

### 2.3.1 Journal publications

Below is a list of publications:

- [j 1] Raffaele Bruno, Marco Conti, Enrico Gregori, "Throughput Analysis and Measurements in IEEE 802.11 WLANs with TCP and UDP Traffic Flows", *IEEE Transactions on Mobile Computing*, Vol 7, N. 2, February 2008, pp. 171-186.
- [j 2] J. Gross, M. Emmelmann, O. Puñal, and A. Wolisz. Enhancing IEEE 802.11a/n with Dynamic Single-User OFDM Adaptation. Elsevier Journal on Performance Evaluation, 2008, accepted for publication.

### 2.3.2 Journal Accepted Papers

- [j 3] Askoxylakis, I., Bencsáth, B., Buttyán, L., Dóra, L., Siris, V., Szili, D., Vajda, I.: Securing Multi-operator Based QoS-aware Mesh Networks: Requirements and Design Options. Wiley Wireless Communications and Mobile Computing (Special Issue on QoS and Security in Wireless Networks), accepted for publication, to appear in 2009.
- [j 4] E. Ancillotti, R. Bruno, M. Conti, and A. Pinizzotto, "Dynamic Address Autoconfiguration in Hybrid Ad Hoc Networks", *Pervasive and Mobile Computing Journal*, (to appear)

### 2.3.3 Conference Publications

- [c 1] O. Puñal, J. Gross, and M. Emmelmann. Implementing Frequency Selective Fading for OPNET's Wireless LAN Modules. In Proc. of OPNETwork 2008, Washington DC, USA, October 2008
- [c 2] M. Emmelmann, T. Langgärtner, and M. Sonnemann. System Design and Implementation of Seamless Handover Support Enabling Real-Time Telemetry Applications for Highly Mobile Users. In Proc. ACM International Symposium on Mobility Management and Wireless Access (MobiWac 2008), Vancouver, Canada, October 2008, pp. 1-8, ISBN 978-1-60558-055-5.
- [c 3] Abusubaih, M., Rathke, B., Wolisz, A.: Collaborative Setting of RTS/CTS in Multi-Rate Multi-BSS IEEE 802.11 Wireless LANs. In: 16th IEEE Workshop on Local and Metropolitan Area Networks, IEEE LANMAN08. IEEE Press, Cluj-Napoca, Romania, 2008.
- [c 4] Emilio Ancillotti, Raffaele Bruno, Marco Conti, "Experimentation and Performance Evaluation of Rate Adaptation Algorithms in Wireless Mesh Networks," Proc. 5th ACM workshop on Performance evaluation of wireless ad hoc, sensor, and ubiquitous (PE-WASUN 2008), Vancouver, British Columbia, Canada, October 28, 2008.
- [c 5] Abusubaih, M., Wolisz, A.: Interference-Aware Decentralized Access Point Selection Policy for Multi-Rate IEEE 802.11 Wireless LANs. In: 19th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, PIMRC 2008. IEEE Press, Cannes, France, September 2008.
- [c 6] Hervé Aïache, Laure Lebrun, Vania Conan, Stéphane Rousseau, "[A load dependent metric for balancing Internet traffic in Wireless Mesh Networks](#)". In Proc. of 2nd IEEE

- International Workshop on Enabling Technologies and Standards for Wireless Mesh Networking (Mesh Tech), Atlanta, September 2008.
- [c 7] M. Delakis and V. A. Siris, Channel Assignment in a Metropolitan Wireless Multi-Radio Mesh Network. In Proc. of 5th International Conference on Broadband Communications, Networks and Systems (Broadnets), London, September 2008.
  - [c 8] Nikolaos Petroulakis and Vasilios A. Siris, Real Time Collection of Electromagnetic Field Measurements using a Metropolitan Mesh Networks, in Proc of 12<sup>th</sup> Pan-Hellenic Conference on Informatics (PCI 2008), 28-30 August 2008, Samos, Greece
  - [c 9] M. Genetzakis and V. A. Siris, A Contention-Aware Routing Metric for Multi-Rate Multi-Radio Mesh Networks. In Proc. of Fifth Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks (IEEE SECON), San Francisco, USA, June 2008.
  - [c 10] V. Angelakis, S. Papadakis, N. Kossifidis, V. A. Siris, A. Traganitis, The Effect of Using Directional Antennas on Adjacent Channel Interference in 802.11a: Modeling and Experience With an Outdoors Testbed, 4th International workshop on Wireless Network Measurements (WiNMee 2008), Berlin, Germany, March 2008.
  - [c 11] M. Delakis, K. Mathioudakis, N. Petroulakis, V. A. Siris, Experiences and Investigations with Heraklion MESH: An experimental Metropolitan Multi-Radio Mesh Network. In Proc. of 4th Int'l Conference on Testbeds and Research Infrastructures for the Development of Networks & Communities (TRIDENTCOM), Innsbruck, Austria, March 2008.
  - [c 12] V. Angelakis, S. Papadakis, V. Siris and A. Traganitis, "Adjacent Channel Interference in 802.11a: Modeling and Testbed validation", IEEE Radio and Wireless Symposium (RWS2008), Orlando, FL, USA, January 2008
  - [c 13] Gallucci, D., Giordano, S.: QoS enabled mobility support. In: IQ2S 2009, The First International Workshop on Information Quality and Quality of Service for Pervasive Computing, Galveston, Texas, March 9-13, 2009

## 2.4 Committees & Editorial Boards

### 2.4.1 TPCs

EU-MESH partners were participating in the following technical program committees.

- [pc 1] 2<sup>nd</sup> IEEE Broadband Wireless Access Workshop, held in conjunction with IEEE CCNC 2008, Las Vegas, USA, January 2008, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 2] 9<sup>th</sup> IEEE Int'l Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM), Irvine, California, June 2008, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 3] IEEE ICC 2008, Wireless Networking Symposium, May 2008, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 4] 3<sup>rd</sup> IEEE Broadband Wireless Access Workshop, held in conjunction with IEEE ICC 2008, Beijing, China, May 2008, Vasilios Siris (FORTH)-Member of the Program Committee

- [pc 5] 16<sup>th</sup> International Workshop on Quality of Service (IWQoS 2008), Enschede, The Netherlands, June 2008, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 6] Technical Program Committee Co-Chair of 6<sup>th</sup> Int'l Conference on Wired/Wireless Internet Communications (WWIC), Helsinki, Finland, May 2008. Vasilios A. Siris (FORTH)-Program Committee co-chair
- [pc 7] 4th International workshop on Wireless Network Measurements (WiNMee 2008), March 2008, Berlin, Germany. In conjunction with WiOpt 2008, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 8] 16<sup>th</sup> IEEE Workshop on Local and Metropolitan Area Networks (LANMAN 2008), Cluj-Napoca, Romania, September 2008, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 9] 16<sup>th</sup> IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), Cannes, September 2008, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 10] 2<sup>nd</sup> IEEE International Workshop on Enabling Technologies and Standards for Wireless Mesh Networking (MeshTech 2008), September 29, 2008. Atlanta, GA, USA, co-located with IEEE MASS 2008, Vasilios Siris, PC member
- [pc 11] IEEE International Conference on Communications (ICC 2009), Wireless Networking Symposium, Beijing, China, May 2008, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 12] International Workshop on Advanced Internet Charging and QoS Technology (ICQT 2009), Aachen, Germany, May 2009, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 13] IEEE Globecom 2009, Wireless Networking Symposium, New Orleans, USA, November 2008, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 14] 17<sup>th</sup> International Workshop on Quality of Service (IWQoS 2009), Charleston, South Carolina, USA, July 2009, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 15] 7<sup>th</sup> International Conference on Wired/Wireless Internet Communications (WWIC 2009), University of Twente, The Netherlands, May 2009, Vasilios Siris (FORTH)-Member of the Program Committee
- [pc 16] The 10th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks, June 15-19 2009, Kos, Greece, Silvia Giordano-General Chair, Vasilios Siris (FORTH)- Member of the Program Committee
- [pc 17] The 2nd International Symposium on Forensics for Future Generation Communication environments (F2GC-08)" 13-15 December 2008, Hainan Island, China, Ioannis Askoxylakis (FORTH)-Member of the Program Committee
- [pc 18] The First International Workshop on Multimedia, Information Privacy and Intelligent Computing System(MPIS-08),December 9- 10, 2008, Jiaosi, Yilan, Taiwan, Ioannis Askoxylakis (FORTH)-Member of the Program Committee
- [pc 19] The Third International Conference on Systems and Networks Communications (ICSNC 2008), October 26-31 2008, Sliema, Malta, Ioannis Askoxylakis (FORTH)-Member of the Program Committee
- [pc 20] The Second International Conference on Emerging Security Information, Systems and Technologies (SECURWARE 2008),August 25-31, 2008 - Cap Esterel, France, Ioannis Askoxylakis (FORTH)-Member of the Program Committee

- [pc 21] The Fourth International Conference on Wireless and Mobile Communications (ICWMC 2008), July 27 - August 1 2008, Athens, Greece, Ioannis Askoxylakis (FORTH)-Member of the Program Committee
- [pc 22] The Fourth Advanced International Conference on Telecommunications (AICT 2008), June 8-13 2008, Athens, Greece, Ioannis Askoxylakis (FORTH)-Member of the Program Committee
- [pc 23] 2nd IFIP International Workshop on Information Security, Theory and Practices (WISTP2008), 13-16 May 2008, Sevilla, Spain, Ioannis Askoxylakis (FORTH)-Member of the Program Committee
- [pc 24] IEEE Int'l Conference on Pervasive Computing and Communications (PerCom 2008), Hong Kong, March 17-21, 2008 <http://www4.comp.polyu.edu.hk/~percom08/>. Marco Conti (CNR)-Member of the Steering Committee
- [pc 25] 9<sup>th</sup> IEEE Symposium on a World of Wireless Mobile and Multimedia Networks (WoWMoM 2008), Newport beach CA, USA, June 23-26, 2008. <http://wowmom08.ics.uci.edu/> Marco Conti (CNR)-Member of the Steering Committee
- [pc 26] 6th Annual IEEE Int'l Conference on Pervasive Computing and Communications (PerCom 2008), Hong Kong, March 17-21, 2008 <http://www4.comp.polyu.edu.hk/~percom08/>. Marco Conti (CNR)-Member of the Program Committee
- [pc 27] The 27<sup>th</sup> IEEE Conference on Computer Communications (INFOCOM 2008), Phoenix AZ, USA, April 13-18, 2008. <http://www.comsoc.org/confs/infocom/2008/> Marco Conti (CNR)-Member of the Program Committee
- [pc 28] 7th IFIP Annual Mediterranean Ad-Hoc Networking conference (MED-HOC-NET 2008), <http://medhocnet08.uib.es/>, Marco Conti (CNR)-Member of the Program Committee
- [pc 29] The First ACM International Workshop on Integrated Heterogeneous Sensor Networks (HeterSenet 2008), May 30 2008, co-located with ACM MobiHoc 2008, Hong Kong. <http://anyserver.cityu.edu.hk/HeterSenet/hetersenet.htm> Marco Conti (CNR)-Member of the Program Committee
- [pc 30] Second ACM Workshop on Sensor Actor Networks. co-located with ACM MobiHoc 2008, Hong Kong. <http://www.lifl.fr/POPS/SANET2008> Marco Conti (CNR)-Member of the Program Committee
- [pc 31] Ad-hoc and sensor networks Track of the Vehicular Technical Conference (VTC) 2008-Fall Calgary. <http://www.ieeevtc.org/vtc2008fall/cfp.php>. Marco Conti (CNR)-Member of the Program Committee
- [pc 32] 2nd IFIP Wireless Networking: Ad hoc and Sensor (WNAS) track, which is part of IFIP Wireless Days conference. Dubai, November, 2008. [http://www-phare.lip6.fr/Wireless\\_Days/](http://www-phare.lip6.fr/Wireless_Days/) Marco Conti (CNR)-Member of the Program Committee
- [pc 33] Second IEEE International Workshop on Enabling Technologies and Standards for Wireless Mesh Networking (MeshTech 2008), September 29, 2008, Atlanta, GA, USA. co-located with IEEE MASS 2008. <http://www.ing.unipi.it/meshtech08> Marco Conti (CNR)-Member of the Program Committee
- [pc 34] Second Annual Symposium on Middleware for Sensor Systems (MiSS 08) to be held in conjunction with the Fourth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP) 2008 will be held in Sydney, Australia

- during December 14-17, 2008, <http://www.issnip/~miss08>. Marco Conti (CNR)-Member of the Program Committee
- [pc 35] IEEE WoWMoM EXPONWIRELESS 2008 Workshop, Newport Beach (CA) June 2008. <http://nrl.iis.sinica.edu.tw/EXPONWIRELESS08> Raffaele Bruno (CNR)-Member of the Program Committee
- [pc 36] 9<sup>th</sup> IEEE Symposium on a World of Wireless Mobile and Multimedia Networks (WoWMoM 2008), Newport beach CA, USA, June 23-26, 2008. <http://wowmom08.ics.uci.edu/> Raffaele Bruno (CNR)-Member of the Program Committee
- [pc 37] The Fourth ACM International Workshop on Wireless Multimedia Networking and Performance Modeling (WMuNeP'08) October 2008, in Vancouver, British Columbia, Canada. <http://wmunep2008.mcmaster.ca>. Raffaele Bruno (CNR)-Member of the Program Committee
- [pc 38] IEEE Conference on Mobile Ad-hoc and Sensor Systems (MASS) 2008, October 2008 Atlanta Georgia <http://www.cse.psu.edu/IEEEEMASS08/> Raffaele Bruno (CNR)-Member of the Program Committee
- [pc 39] The Second IEEE International Workshop on Wireless Mesh and Ad Hoc Networks (WiMAN 2008), Beijing, China, June 20, 2008 Raffaele Bruno (CNR)-Member of the Program Committee
- [pc 40] PIMRC 2008, September 15-18, Murad Abusubaih, Telecommunication Network Group (TKN), TU-Berlin- Member of the Program Committee
- [pc 41] PIMRC 2008, September 15-18, Murad Abusubaih, Telecommunication Network Group (TKN), TU-Berlin, Chair of the MAC Performance Session.
- [pc 42] IEEE Globecom 2008, November 30 – December 4, Marc Emmelmann, Telecommunication Network Group (TKN), TU-Berlin-Member of the Program Committee
- [pc 43] IEEE ICC 2008, May 19-23, Marc Emmelmann, Telecommunication Network Group (TKN), TU-Berlin- Member of the Program Committee
- [pc 44] International Symposium on Wireless Pervasive Computing (ISWPC 2008), May 7-9, Marc Emmelmann, Telecommunication Network Group (TKN), TU-Berlin-Member of the Program Committee
- [pc 45] International Workshop on Computer Aided Modeling, Analysis and Design of Communication Links and Networks (CAMAD 2008), May 23, Marc Emmelmann, Telecommunication Network Group (TKN), TU-Berlin- Member of the Program Committee
- [pc 46] IEEE Workshop on Sensor Networks and Systems for Pervasive Computing (PerSeNS), Dallas, TX, USA, March 2009. Levente Buttyan (BME)-Member of the Program Committee
- [pc 47] ACM Conference on Wireless Network Security (WiSec), Zurich, Switzerland, March 2009. Levente Buttyan (BME)-Member of the Program Committee, Member of the Steering Committee
- [pc 48] IEEE INFOCOM 2009, Rio de Janeiro, Brazil, April 2009. Levente Buttyan (BME)-Member of the Program Committee
- [pc 49] International Symposium on Stabilization, Safety, and Security of Distributed Systems (SSS), Detroit, MI, USA, November 2008. Levente Buttyan (BME)-Member of the Program Committee

- [pc 50] IEEE Conference on Mobile Ad-hoc and Sensor Systems (MASS), Atlanta, Georgia, USA, October 2008. Levente Buttyan (BME)-Member of the Program Committee
- [pc 51] ACM Workshop on Vehicular Inter-NETworking (VANET), San Francisco, California, USA, September 2008. Levente Buttyan (BME)-Member of the Program Committee
- [pc 52] International Conference on Security and Privacy in Communication Networks (SecureComm), Istanbul, Turkey, September 2008. Levente Buttyan (BME)-Member of the Program Committee
- [pc 53] IFIP International Workshop on Security and Trust Management (STM), Trondheim, Norway, June 2008. Levente Buttyan (BME)-Member of the Program Committee
- [pc 54] ACM Conference on Wireless Network Security (WiSec), Alexandria, Virginia, USA, March 31 - April 2, 2008. Levente Buttyan (BME)-Member of the Program Committee, Member of the Steering Committee
- [pc 55] IEEE Workshop on Sensor Networks and Systems for Pervasive Computing (PerSeNS), Hong Kong, March 2008. Levente Buttyan (BME)-Member of the Program Committee
- [pc 56] PERCOM 2009, March 2009, Galveston - Texas, Silvia Giordano (SUPSI)-Program Vice-Chair
- [pc 57] PerSens 2009, March 2009, Galveston - Texas, Silvia Giordano (SUPSI)-Program Chair
- [pc 58] WOWMOM 2009, June 2009, Kos – Greece, Silvia Giordano (SUPSI)- General Chair
- [pc 59] WONS 2009, February 2009, Snowbird, Utah, Silvia Giordano (SUPSI)- Member of the Program Committee
- [pc 60] VTC 08-fall, September 2008, Calgary - Canada, Silvia Giordano (SUPSI)-Program vice-chair
- [pc 61] IJACI AdhocAmC'08, September 2008, Sophia Antipolis, France, Silvia Giordano (SUPSI)- Member of the Program Committee
- [pc 62] ACM MSWIM 2008, October 2008, Vancouver, British Columbia, Canada, Silvia Giordano (SUPSI)- Member of the Program Committee
- [pc 63] CHANTS 2008, September 2008, San Francisco- USA, Silvia Giordano(SUPSI)- Member of the Program Committee
- [pc 64] MASS 2008, October 2008, Atlanta, Georgia, Silvia Giordano (SUPSI)- Member of the Program Committee
- [pc 65] SANET 2008, May 2008, Hong Kong, China, Silvia Giordano (SUPSI)-Program Chair
- [pc 66] MCN'08, April 2008, Phoenix - Arizona, Silvia Giordano (SUPSI)-Publicity Chair

#### **2.4.2 Editorial boards**

EU-MESH partners were participating in the following editorial boards.

- [ed 1] Computer Communications, Elsevier, Vasilios Siris (FORTH)-Area Editor
- [ed 2] Journal of Internet Engineering, Vasilios Siris(FORTH)- Editor
- [ed 3] Computer Communications Journal (Elsevier), Marco Conti (CNR)- Editor in Chief

- [ed 4] Pervasive and Mobile Computing (PMC), Elsevier, Marco Conti (CNR)- Associate Editor in Chief
- [ed 5] IEEE Transactions on Mobile Computing. Marco Conti (CNR)- Area Editor
- [ed 6] Ad Hoc Networks Journal, Elsevier, Marco Conti (CNR)- Editorial Board member
- [ed 7] Wireless Ad Hoc and Sensor Networks: An International Journal, Old City Publishing, Marco Conti (CNR)- Advisory and Regional Editor (for Europe)
- [ed 8] the International Journal of Computers and Applications, ACTA Press, Raffaele Bruno (CNR)-Area Editor
- [ed 9] ACM/Springer Wireless Networks (WINET), Enrico Gregori (CNR), Area Editor
- [ed 10] Computer Networks Journal (Elsevier), Enrico Gregori (CNR), Area Editor
- [ed 11] Journal of Wireless Communications and Mobile Computing (WCM)- John Wiley & Sons, Ltd, August 2008, Murad Abusubaih, Telecommunication Network Group (TKN), TU-Berlin, Reviewer.
- [ed 12] IEEE Communication Letters, Marc Emmelmann, Telecommunication Networks Group (TKN), TU Berlin, Reviewer for open call for papers.
- [ed 13] Springer Journal on Wireless Personal Communications, Marc Emmelmann, Telecommunication Networks Group (TKN), TU Berlin, Reviewer for open call for papers.
- [ed 14] Springer Journal of Network and Systems Management, Walter Buga (Proximity), Editorial Advisory Board Member
- [ed 15] John Wiley and Sons, Communication Technology Editorial Board, Marc Emmelmann, Telecommunication Networks Group (TKN), TU Berlin, Reviewer for book proposals.
- [ed 16] IEEE Communications Magazine, Ad hoc and Sensor Network Series, December 2008, Silvia Giordano (SUPSI)-co-editor
- [ed 17] IEEE Communications Magazine, Ad hoc and Sensor Network Series, July 2008, Silvia Giordano (SUPSI)- co-editor

## **2.5 Participation in EU related events**

None at this period

## **2.6 Publicity actions**

EU-MESH partners created and participated in number of activities to promote the project (press releases, articles etc), as listed in the following sections.

### **2.6.1 Articles in Newsletters**

- [pr. 1] Vasilios Siris, Ioannis G. Askoxylakis, Marco Conti and Raffaele Bruno, "Enhanced, Ubiquitous and Dependable Broadband Access using MESH Networks". ERCIM Newsletter, Issue 73, pp 50-51, April 2008.
- [pr. 2] Vasilios Siris, Apostolos Traganitis and Ioannis Askoxylakis, "Wireless Mesh Networks: The Medium for a New Generation of Innovative Telecommunication Services", December 2007, The Economist (Greek edition by Kathimerini newspaper)

### **2.6.2 Press releases**

- [pr. 3] European Commission funded EU-MESH launched-Nine European Organizations Begin Collaboration on the Wireless Access Network of the Future, International Press Release, January 18, 2008
- [pr. 4] European Commission funded EU-MESH launched, National (Greek) Press Release, 22 January 2008

### **2.6.3 Articles in online news**

- [pr. 5] European Commission funded EU-MESH launched, National (Greek) Press Release, 22 January 2008
- [pr. 6] EU-MESH project launched, TotalTelecom, 23 January 2008
- [pr. 7] Europe in a Mesh, Unstrung News Feed, 23 January 2008
- [pr. 8] EU-MESH: European Commission Funded Eu-Mesh Project Launched; Nine European Organizations Begin Collaboration on the Wireless Access Network of the Future, TMCnet, 23 January 2008

## **2.7 Industrial Events**

One of the risks that EU-MESH is exposed to is the fact that wireless networking areas such as technology, business, standards, markets, are changing very fast. To minimize this risk for EU-MESH, continuing verification of business and technical validity is required. The same risk applies to business goals and objectives of industrial partners, in particular. This continuing verification was performed by participation in key global industrial events, mainly by Proximetry, and included speaking arrangements, booth for product demonstration, and event sponsorships. As this verification is a part of regular business of Proximetry, all the participation costs were covered by Proximetry, with no charge to EU-MESH.

Below is a list of participations in such events:

- [ie.1] WCA's International Symposium & Business Expo, November 4 - 6, 2008, San Jose. Proximetry (speaking)
- [ie.1] WiMAX World, October 1-3, 2008, Chicago USA. Proximetry (sponsorship, booth, speaking).
- [ie.2] WiNOG, September 28-30, Chicago USA. Proximetry (attending)
- [ie.3] CTIA Wireless IT & Entertainment 2008, September 10, 2008. Proximetry (attending)
- [ie.4] WAEA, September 8-10, 2008. Proximetry (booth)

- [ie.5] Nxtcomm (Supercomm), June 16-19, 2008, Las Vegas, NV, USA. Proximity (speaking)
- [ie.6] WiMAX World, May 19-21, 2008 Munich, Germany. Proximity (sponsorship, booth, speaking).
- [ie.7] Networkd + Interop 2008, April 29, 2008. Las Vegas USA Proximity (attending only)
- [ie.8] Wireless Innovations Conference, April 21, 2008. Redwood City, CA, USA. Proximity (speaking)
- [ie.9] WCA Convention, April 21-23, 2008, Washington, DC. Proximity (booth and speaking)
- [ie.10] CTIA, April 2008, Las Vegas, USA, Proximity (booth and speaking)

## 2.8 Open Source Projects

### 2.8.1 Open Source Projects: XIAN

In the highly dynamic and unpredictable environment of MANETs, cross-layer design is receiving growing interest but lacks experimental validation tools. This paper presents *XIAN* (Cross-layer Interface for wireless Ad hoc Networks), a generic framework for experimenting cross-layer designs in Linux testbeds with 802.11 wireless cards using the *MadWifi* driver and more recently with the *MadWifi-NG* driver. *XIAN* can be used as a service by other layers or system components to access MAC/PHY configuration and performance information. It provides experimenters with an open framework to create automatically complex metrics from both local and neighbour node measurements. The defined and implemented software architecture introduces the *XIAN Nano-protocol* and its automated management.

### 2.9 Other dissemination activities

In addition to activities listed in the above subsections, EU-MESH partners also provided invited talks and standard contributions, as listed below.

#### 2.9.1 Invited talks

- [oth. 1]Securing Wireless Mesh Networks-The EU-MESH example, Information day organized by the Hellenic Data Protection Authority with title: Self protection of users and subscribers & Security of Computers and Computing System, 1 December 2008, Heraklion, Greece, Ioannis Askoxylakis-Invited Speaker, Lecture title:
- [oth. 2]Security in wireless mesh and sensor networks, ENISA-FORTH Summer School on Network and Information Security (NIS), Crete, Greece, September 15-19, 2008, Levente Buttyan (BME)
- [oth. 3]Secure routing in multi-hop wireless networks. Workshop on Security of Autonomous and Spontaneous Networks, Loctudy, France, October 13-14, 2008, Levente Buttyan (BME)

## 2.9.2 Presentation at standardization bodies

[oth. 4] M. Emmelmann, S. Hermann, and O. Belfia. Topology Discovery and Coverage Area Approximation with 802.11k. 802.11 WNG SC Wireless Next Generation Standing Committee. Doc. 08/1358r1. IEEE 802.11 Plenary, Dallas, TX, USA, November 10 -- 14, 2008.

## 2.9.3 Other participations

[oth. 5] Marco Conti served as panelist for the Network Technology and Systems (NeTS) program of the National Science Foundation (NSF), Arlington, May 27-28, 2008.

# 3 Standardisation

EU-MESH's focus is on access networks, with the goals to enable its interoperability, utilization, mobility, and integration with NGN networks and services. Moreover, the new capabilities, such as the integration of multiple access technologies, the adaptation to higher layer functionality (e.g., QoS routing), and the access network independent security aspects, that are being developed within the EU-MESH will be contributed to various standard organizations to promote interoperability and to stimulate market acceptance, thus resulting in lower implementation, operational and maintenance costs.

The NGN (Next Generation Network) concept introduced (by both ETSI and ITU-T) is very relevant to EU-MESH objectives and architecture, as it takes into consideration the new realities in the telecommunications industry, such as competition among operators, explosion of digital traffic, increasing demand for new multimedia services and general mobility, convergence of networks and services, etc. However, NGN standards still did not address needs of wireless access technologies.

EU-MESH architecture is aligned with NGN standards, as a one of its options for access networks.

Here is the definition of access network provided by ETSI NGN.

*An access network comprises an access segment and an aggregation segment. The access segment (also known as "last mile segment" stretches from the customer premises to the first network node (also known as the "access node"). The aggregation segment comprises the transport network elements enabling one or more access nodes to be connected to a core network through an IP Edge Router.*

This is exactly what EU-MESH is. Specifically, EU-MESH has identified four different classes of EU-MESH nodes in its access network:

- High-speed backhaul mesh routers.
- Low-speed backhaul mesh routers.
- Connectivity-enhancing mesh routers.
- End terminals.

The EU Mesh aims to support heterogeneous access network, however its primarily focus is on wireless access technologies and to use a multi-radio multi channel mesh network to aggregate the capacity from both subscriber broadband access lines and provider fixed broadband links to form a virtual capacity pool. EU-MESH is addressing the following challenges:

- Utilization of multi radio and multi channel capabilities
- Spatial diversity
- Interference mitigation
- Power saving
- Transmit power optimization
- And more

EU-MESH is addressing these challenges primary using IEEE 802.11 technologies. The primary reasons for focus on IEEE 802.11 technologies are:

- Availability of open platforms, such Atheros drivers, Madwifi or Ath5k, for 802.11 devices to enable experimentation
- Low cost of 802.11 devices
- Possibility to standardize EU-MESH innovations

For a number of other access technologies such as xDSL, 3G, cable, wired Ethernet, or fiber, standards are already matured and well defined. IEEE 802.11 standards are still evolving to support new market and performance requirements and challenges, some of them applicable to EU-MESH needs.

### **3.1 IEEE 802.11 Standards Activities**

EU-MESH's objective for contribution to IEEE 802.11 standardisation has been pursued through the status of Proximity as a corporate member IEEE SA (Standard Association) and the IEEE 802.11 voting status of a member of TKN at TUB. Both partners actively participated in IEEE standardization activities by attending a number of IEEE 802 Plenary and 802.11 Interim sessions, including a submission of the following contribution:

1. M. Emmelmann, S. Hermann, and O. Belfia. Topology Discovery and Coverage Area Approximation with 802.11k. 802.11 WNG SC Wireless Next Generation Standing Committee. Doc. 08/1358r1. IEEE 802.11 Plenary, Dallas, TX, USA, November 10 -- 14, 2008.

It should be noted that Draft Standards are posted in the IEEE Member Private area, which is accessible to IEEE Working Group voting members only. In order to obtain a voting member status, participant must attend 2 of last 4 plenary sessions or 1 plenary and 1 interim. Attendance at a meeting must at least 75% presence. Voting member status can be cancelled if participant does not attend a series of meetings or fail to participate in the standard balloting process.

A short update on IEEE 802.11 task group activities and status is provided below.

In June 2007, the IEEE published the most recent revision of the IEEE 802.11 standard which includes the first nine amendments and the Corrigendum of 2001. Accordingly, IEEE 802.11a,b,d,g,h,i,j,i became obsolete. Apart from the wireless next generation standing committee (WNG SC), the 802.11 working group has currently a number of active task groups and one study group having the following objectives:

1. P802.11n – High

The scope of this project is to define an amendment that shall define standardized modifications to both the 802.11 physical layers (PHY) and the 802.11 Medium Access Control Layer (MAC) so that modes of operation can be enabled that are capable of much higher throughputs, with a maximum throughput of at least 100Mbps, as measured at the MAC data service access point (SAP).

As of November 2008, TGn Draft 7.0 passed recirculation ballot #136 by a 94% majority (75% required) with 276 votes to approve, 17 not approve, 21 abstain. The 48 comments from this recirculation ballot were resolved or withdrawn with no approved changes, and the working group approved a recirculation ballot on the unmodified text of Draft 7.0.

Final approval by the IEEE standards board is expected in January 2010.

## 2. P802.11p -- Wireless Access for the Vehicular Environment

The scope of the proposed project is to create an amendment of IEEE 802.11 to support communication between vehicles and the roadside and between vehicles while operating at speeds up to a minimum of 200 km/h for communication ranges up to 1000 meters. The amendment will support communications in the 5 GHz bands; specifically 5.850-5.925 GHz band within North America with the aim to enhance the mobility and safety of all forms of surface transportation, including rail and marine. Amendments to the PHY and MAC will be limited to those required to support communications under these operating environments within the 5 GHz bands.

As of September 2008, TGp completed most of the comment resolution process. The WAVE BSS feature was deleted from the draft resulting in a major revision. There was a desire to go to recirculation ballot in order to get WG review of such major changes which is the reason that some comments were given less than ideal time for review. The motion to go to recirculation ballot failed, so many comments will be subject to reconsideration to determine if a different resolution might be preferred.

The most recent version of the Draft is D4.02. Final approval by the IEEE standards board is expected in June 2010.

## 3. P802.11s -- Mesh Networking

This amendment describes an IEEE 802.11 Mesh network with an IEEE 802.11 Wireless Distribution System (WDS) using the IEEE 802.11 MAC/PHY layers that supports both broadcast/multicast and unicast delivery over self-configuring multi-hop topologies.

As of November 2008, TGs is working on resolving comments from 802.11 Letter Ballot #126. So far, 85% of the 1660 total comments are resolved. The task group is continuously having technical presentations mainly focusing on comment resolution issues and plans to go for recirculation ballot after the January meeting.

The most recent version of the draft is D2.02. Final approval by the IEEE standards board is expected in September 2010.

## 4. P802.11u -- InterWorking with External Networks

The purpose of this project is to provide amendments to the IEEE 802.11 PHY/MAC layers which enable interworking with other networks. This includes

enhanced protocol exchanges across the air interface and provision of primitives to support required interactions with higher layers for interworking.

As of November 2008, the TG works on resolving comments from letter ballot 137 targeting for re-circulation ballot in January 2009.

The most recent draft is D4.01. Final approval by the IEEE standards board is expected in May 2010.

#### 5. P802.11v -- Wireless Network Management

This amendment provides Wireless Network Management enhancements to the 802.11 MAC, and PHY, to extend prior work in radio measurement to effect a complete and coherent upper layer interface for managing 802.11 devices in wireless networks.

As of November 2008, the TG completed comment resolution for letter ballot 133 having failed the 75% criteria for approval (106 yes, 47 no, and 28 abstain votes). The task group is currently focusing on moving the draft forward to letter ballot.

The most recent draft is D4.0. Final approval by the IEEE standards board is expected in July 2010.

#### 6. P802.11w -- Protected Management Frames

The proposed project seeks to create enhancements to the IEEE 802.11 Medium Access Control layer to provide, as appropriate, mechanisms that enable data integrity, data origin authenticity, replay protection, and data confidentiality for selected IEEE 802.11 management frames including but not limited to: action management frames, deauthentication and disassociation frames.

As of November 2008, the TG completed the comment resolution process of the previous letter ballot voting on an updated draft to be resent for letter ballot.

The most recent draft is D6.0. Final approval by the IEEE standards board is expected in December 2009.

#### 7. P802.11.z -- Extensions to Direct Link Setup

This amendment defines a new Direct Link Setup (DLS) mechanism to allow operation with non-DLS capable access points and allow stations with an active DLS session to enter power save mode. The scope is specifically limited to modifications related to the DLS mechanism.

The Task group focuses on addressing topics deriving from comment resolution in order to finally proceed to sponsor ballot.

The most recent draft is D2.0. Final approval by the IEEE standards board is expected in September 2009.

#### 8. P802.11aa -- Video Transport Streams

This amendment specifies enhancements to the 802.11 MAC (Medium Access Control) for robust audio video streaming, while maintaining co-existence with other types of traffic. The MAC enhancements specified in this amendment enable:

- Graceful degradation of audio video streams when there is insufficient channel capacity, by enabling packet discarding without any requirement for deep packet inspection,
- Increased robustness in overlapping BSS environments,

without the requirement for a centralised management entity, • Intra-Access Category prioritization of transport streams by modifying EDCA timing and parameter selection without any requirement for deep packet inspection, • Improved link reliability and low jitter characteristics for multicast/broadcast audio video streams, • Interworking with relevant 802.1AVB mechanisms (802.1Qat, 802.1Qav, 802.1AS).

The task group is still in an early process currently focusing on technical presentations leading to an initial Draft Version 0.

The task group has not released a draft so far. Final approval by the IEEE standards board is expected in May 2011.

#### 9. P802.11ac -- Very High Throughput <6GHz

This amendment defines standardized modifications to both the 802.11 physical layers (PHY) and the 802.11 Medium Access Control Layer (MAC) that enable modes of operation capable of supporting:

- o A maximum multi-station (STA) throughput (measured at the MAC data service access point), of at least 1 Gbps and a maximum single link throughput (measured at the MAC data service access point), of at least 500 Mbps.
- o Below 6 GHz carrier frequency operation excluding 2.4 GHz operation while ensuring backward compatibility and coexistence with legacy IEEE802.11 devices in the 5 GHz unlicensed band.

The task group officially started its work in November 2008. It is currently agreeing on usage and channel models; functional requirements; and process issues regarding the selection of technical proposals.

A draft as well as an official timeline have not been released so far.

#### 10. P802.11ad -- Enhancements for Very High Throughput in the 60 GHz Band

The scope of this project is to define an amendment that shall define standardized modifications to both the 802.11 physical layers (PHY) and the 802.11 Medium Access Control Layer (MAC) to enable operation in the 60 GHz frequency band (typically 57-66 GHz) capable of very high throughput. The MAC and PHY specified in this amendment: Enables a maximum throughput of at least 1 Gbps, as measured at the MAC data service access point (SAP); enables fast session transfer between PHYs ; maintains the 802.11 user experience; supports mechanisms to enable coexistence with IEEE 802.15.3c and with other systems in the band.

The IEEE standards board approved the PAR in December 2008. The TG will officially start its work in March 2009.

### 3.1.1 Participation

TU Berlin is regularly participating in IEEE 802.11 standardization meetings having a Voting Member in its team. The work mainly focuses on participation in the Very High Throughput Study Group which now become TGad and TGac as well as in the Wireless Next Generation Standing Committee where also technical presentations in the context of EU-Mesh were given. TU Berlin participated in the following meetings:

- IEEE 802.11 Plenary, November 2008, Dallas TX, USA

- IEEE 802.11 Plenary, July 2008, Denver CO, USA
- IEEE 802.11 Interim, May 2008, Jacksonville FL, USA
- IEEE 802.11 Plenary March 2008, Orlando FL, USA

Proximetry is regularly participating in IEEE 802.11 standardization. Proximetry is also a corporate member of IEEE SA (Standards Association). Proximetry mainly focuses on participation in the TGs. Proximetry participated in the following meetings:

- IEEE 802.11 Interim, September 2008, Hawaii, USA
- IEEE 802 Plenary, July 2008, Denver CO, USA
- IEEE 802 Plenary March 2008, Orlando FL, USA

TU Berlin and Proximetry provided a number of reports and updates on IEEE 802.11 activities, and all current draft standards to all EU-MESH partners.

### **3.1.2 Planned Participation in 2009**

TU Berlin and Proximetry are planning to actively participate in IEEE 802.11 standard activities during year 2009.

Below is the current meeting schedule for IEEE 802 Plenary Sessions, in 2009:

- March 8-13 Vancouver, British Columbia CANADA
- July 12-17 San Francisco, California USA
- November 15-20 Atlanta, Georgia USA

Below is the current schedule of Interim Sessions for IEEE 802.11 WG for 2009:

- January 18th-23<sup>rd</sup> Los Angeles, CA, USA
- May 10th-15th Montreal, Canada
- September 20th-25th , Big Island, HI, USA

### **3.1.3 Planed IEEE Contributions**

1. M. Emmelmann, T. Langgärtner, and M. Sonnemann (TU Berlin): Fast Handover Support for Highly Mobile Users using COTS 802.11 Cards. 802.11 WNG SC Wireless Next Generation Standing Committee. Doc. 08/1346r1. IEEE 802.11 Interim, Los Angeles, CA, USA, January 18 -- 23, 2009.

Further technical presentations are planned by TU Berlin on topics concerning EU-Mesh's Topology and Link Control and Discovery. Additionally, presentations by TU Berlin on advanced MAC schemes employing dynamic OFDMA are planned to be given in TGad and TGac.

## **3.2 Other Broadband Access Standards Update**

EU-MESH access network will accommodate other access technologies, some of them mature, some of them evolving and some of them in very early stages of standardization.

In the following subsections, status on standardization activities and progress will be provided.

### **3.2.1 WiMAX**

IEEE 802.16, often referred to as WiMAX (Worldwide Interoperability for Microwave Access), is a set of standards aimed at providing wireless access over long distances to both fixed and mobile users. The 802.16-2004 enhanced the original standard by supporting point-to-multipoint communication, operation in channels below 10 GHz (both licensed and unlicensed), and non-line-of-sight. The IEEE 802.16e-2005 (also referred to as Mobile WiMAX) enhancement added support for mobility. IEEE 802.16e-2005 can achieve speed of 46 Mbps in the downlink and 14 Mbps in the uplink. There is no new activity for 802.16-2004 and 802.16-2005

IEEE 802.16m Task Group is working towards defining an advanced air interface targeting to support speeds above 130 Mbps in the downlink and above 56 Mbps in the uplink, utilizing 20 MHz channel bandwidth.

On December 11, 2008, 802.16m TG published its first draft of IEEE 802.16m Amendment Working Document.

IEEE 802.16 next meeting will be held on 12-15 January 2009 in the La Jolla community of San Diego, CA, USA. This will be very interesting interim session as it will include two new topics:

- Working Group Ad Hoc Committee on Network Robustness and Reliability (NRR)
- Working Group Reorganization Discussion

Proximity is planning to attend the above interim session, and to report its results to EU-MESH partners.

### **3.2.2 Femto Cells**

Femtocells are low-power wireless access points that operate in licensed spectrum to connect standard mobile devices to a mobile operator's network using residential DSL or cable broadband connections.

The Femto Forum, founded in 2007, is a not-for-profit membership organisation that promotes femtocell deployment worldwide.

The Forum is chartered to encourage the growth of a partner ecosystem committed to innovation in standards-based network infrastructure and to achieve high levels of collaboration and product interoperability.

On December 2, 2008, The Femto Forum has announced the results of its femtocell radio study. The study found that femtocells have the potential to deliver an order of magnitude more capacity than the macro network alone when used in dense deployments, even when occupying the same radio channel as the macrocells. It also identified numerous technological solutions that mitigate potential interference with the macro network to remove barriers to wide-scale deployment and maximize the capacity benefits.

The study looked at both femtocells using a separate carrier to the surrounding macro network and those using the same carrier – which pose the greatest interference challenge, but also the greatest opportunity for increased spectrum efficiency.

Although femtocells using a separate carrier were demonstrated to provide a simple means to essentially eliminate interference, many 3G operators do not have enough spectrum for this to be practical. The Femto Forum therefore identified technological solutions that mitigate the potential interference where femtocells share the same carrier as the macro network. These methods are already being developed for pre-standard femtocell solutions, and Femto Forum members are working to bring them within the standards framework. The key solutions are:

- Adaptive Pilot Power Control, whereby the femtocell dynamically adjusts its transmit power in response to the current level of signals from surrounding cells and the desired coverage area.
- Extended Tests for Dynamic Range, to ensure that femtocell designs are able to operate reliably even in the presence of nearby high power mobile phones connected to the macro network (this test has already been incorporated into the latest 3GPP Release 8 25.104 specification).
- Uplink power capping of the mobile phone when operating in the femtocell environment, ensuring that, even in difficult radio conditions, the phone hands-off to the macro network before its transmit power increases to the point where macro noise rise is a problem.
- Dynamic receiver gain management in the femtocell (Automatic Gain Control or adaptive attenuation), to ensure that femtocells can offer good service to both near and far mobile phones without unnecessarily increasing the phone transmit power, therefore keeping the noise rise to a minimum.

This particular study relates to WCDMA, but the Femto Forum represents the full range of radio standards and similar studies are underway for other air interfaces.

Some of the above approaches and solutions are also considered and researched by EU-MESH partners.

### 3.2.3 DSL

EU-MESH deliverable D1.2 provided overview and valuation of xDSL standards. There is not new activity to be reported.

### 3.2.4 LTE

3G LTE (Long Term Evolution) is an ongoing project of 3GPP that supports higher peak throughputs in higher spectrum bandwidth. In 2007, the LTE of the 3rd generation radio access technology – "E-UTRA" – progressed from the feasibility study stage to the first issue of approved Technical Specifications. It is expected the end of 2008, these specifications will be sufficiently stable for commercial implementation.

The ITU effort named IMT Advanced is to identify mobile systems whose capabilities go beyond those of IMT 2000. In order to meet this new challenge, 3GPP's Organizational Partners have agreed to widen 3GPP's scope to include systems beyond 3G.

In 2008 3GPP held two workshops on IMT Advanced, where the "Requirements for Further Advancements for E-UTRA" were gathered. The resulting Technical Report 36.913 is now published (June 08) and a liaison was sent to ITU-R covering the work in 3GPP RAN on LTE-Advanced towards IMT-Advanced.

Some of the key features of IMT-Advanced will be;

- Worldwide functionality & roaming
- Compatibility of services
- Interworking with other radio access systems
- Enhanced peak data rates to support advanced services and applications (100 Mbit/s for high and 1 Gbit/s for low mobility)

3GPP will be contributing to the ITU-R towards the development of IMT-Advanced via its proposal for LTE-Advanced.

### 3.3 Network Management Standards Update

#### 3.3.1 IETF CAPWAP

Deployment of WLANs introduced several problems in terms of (1)management, monitoring, and control of APs, (2)configuration consistency of APs in the WLAN, (3)wireless medium related parameter tuning, and (5)security as stated in RFC 3990. APs and AP control devices were implemented proprietary and could not interoperate. IETF CAPWAP (Configuration and Provisioning for Wireless Access Points) working group (WG) aimed at defining a standard interoperable protocol which will enable an Access Controller (AC) to manage a collection of Wireless Termination Points (WTPs).

IETF CAPWAP WG asked for existing WLAN vendors to submit a short description of their WLAN architectures. They investigated existing WLANs offered by the vendors and categorized WLAN architectures into three distinct families in RFC 4118 as (1)Autonomous, (2)Centralized, and (3)Distributed WLAN Architectures.

In the Autonomous WLAN Architecture, all the 802.11 functionality is implemented in a single WTP.

In the Centralized WLAN Architecture, network monitoring, management, and configuration functions are moved to one or more ACs. Interconnection between AC and WTPs may be (1)Direct, (2)Switched, or (3)Routed. According to the division of IEEE 802.11 MAC functions to AC and WTPs, three variants of Centralized WLAN Architecture is defined: (1)Local, (2)Split, and (3)Remote MAC. In the Local MAC, all of the 802.11 MAC reside on WTP. In the Remote MAC, all of the 802.11 MAC reside on AC. In the Split MAC, real-time functions stay in WTP and non-real-time functions stay in AC.

AC and WTP must follow the following steps before they start message exchanges according to RFC 4118. WTP must firstly discover AC (Discovery). Then, it must authenticate itself to AC (Authentication) and register to the AC (Association). Afterwards, WTP downloads firmware (Firmware Download). At the end, control channel is established (Control Channel Establishment) and AC may push configuration parameters to WTP (Configuration Download) before starting message exchange.

WMNs are put into Distributed WLAN Architecture in the categorization. In the Distributed WLAN Architecture, some CAPWAP functions can be implemented as distributed over the mesh nodes. There may be no central AC.

RFC 4564 defined requirements (i.e., objectives) for CAPWAP protocol as (1)Architecture, (2)Operation, and (3)Security. Architecture objectives deal with structural features of the protocol. Operation objectives deal with control and management functions. Security objectives deal with security issues like authentication. Each objective is given a priority value according to IETF CAPWAP WG discussions about their immediate significance.

Three priority levels are defined: (1)Mandatory and Accepted Objectives, (2)Desirable Objectives, and (3)Non-Objectives. These objectives are used in the evaluation of 4 candidate CAPWAP protocols in RFC 4565.

CAPWAP protocol is specified by the consideration of problem statement (RFC 3990), architecture taxonomy (RFC 4118), and CAPWAP objectives (RFC 4564). It is an Internet draft published at October 2008 and now in the RFC editor's queue.

The latest version of "CAPWAP protocol base MIB" is an active Internet draft which is published at November 2008.

The latest version of "CAPWAP protocol binding MIB for IEEE 802.11" is published also as an active Internet draft at October 2008.

### **3.3.2 Broadband Forum TR-069**

TR-069 "CPE WAN Management Protocol" is a DSL Forum (which was later renamed as Broadband Forum) technical specification for remote management of end-user devices.

It was developed primarily for DSL devices by it were also adopted for other access technologies. WiMAX Forum adopted TR-069 in addition to OMA-DM protocol for management of WiMAX devices.

On July 16, 2008, The Femto Forum has agreed to implement TR-069 as the basis for the management protocol for femtocells.

## **4 Initial Exploitation Plans**

In the following sections, the initial exploitation plans of the project partners are described. The content is structured according to the expertise of the partners and reflects what has been included in the technical annex.

### **4.1 Network Operators**

A determining factor for the successful exploitation of the project's results lies in the future proliferation of mobile broadband. A thorough analysis of relevant market trends is therefore necessary to predict, with satisfying accuracy, the project's exploitation potential. From the perspective of the network operators, the initial actions to assess the viability of the exploitation of the project's results involve the following aspects:

- Identification of exploitable project results;
- Market analysis;
- Identification of business opportunities;
- Identification of risks.

These considerations constitute preparatory actions towards the exploitation plan that will be delivered at the end of the project.

#### **4.1.1 Objectives**

Existing wireless mesh networks lack comprehensive QoS support and efficient resource utilization, which prohibit their large-scale deployment by network providers. EU-MESH's goal is to realize the full potential of mesh networks, facilitating network providers with a low-cost infrastructure which can easily adapt to changing demands in capacity and can

provide service to both fixed and mobile users. On the other hand, users will benefit from seamless mobility and QoS guarantees.

Mesh networks are not expected to replace standard internet access options but to supplement them. For a Network Operator, such as Forthnet, formulating a successful business model to uptake EU-MESH's results presents the possibility to differentiate itself from other ISPs by providing its customers with innovative services that offer a convenient and affordable way to access the Internet with a consistent quality of service while at home, at the office, or on the move. Thus, it stands to enjoy the traditional benefits of being first to the market.

We can identify the following generic success factors for such a venture:

- The introduction of an innovative service that is able to both expand existing markets and create new ones, and offer an affordable and convenient way for customers to access the Internet from a fixed or wireless line;
- A steady, disciplined pattern of growth in both sales revenue and infrastructure expansion.

#### 4.1.2 Market analysis

In this section we try to discover market trends and analyze their relevance. This analysis will aid in identifying scenarios and use cases where the envisaged project's results have potential applicability.

##### 4.1.2.1 Internet user driving forces

There are numerous factors that are driving the growth of the Internet. The key driving forces are summarized in the next table. The left column shows important factors that have been recently active and will continue to add growth to the Internet. The right column lists the factors that have emerged in the last few years, or are expected to emerge in the near future, and are likely to have a strong impact in the following years.

*Internet driving forces (source: etForecasts.com).*

1996-2005	2006-2010
Email proliferation	DSL & broadband connections
Free web browser	Handsets with Internet access
Content explosion	Home LANs for Internet access devices
Under \$1K PCs (1997)	Wireless Internet access points
Intranets for business users	Web Content for wireless devices
Web hosting services	Pre-paid internet access cards
e-commerce	Multifunction handheld devices
Declining & fixed ISP rates	Un-metered Internet access fees

Under \$500 PCs	Internet entertainment content
Internet cafes	\$50 handsets with Internet access
Cable modems & DSL connections	Wireless broadband (WiMax)

Low cost Internet access devices will continue to be a leading Internet user growth factor. The next generation cellular technology (3G) will be very important due to its “always-on” characteristics and its improved transfer rate. Several other broadband technologies may also have an impact on Internet access. Wireless LANs (Wi-Fi or IEEE 802.11) use an unlicensed frequency band in the 2.5 GHz range for local wireless communication to mobile devices. The growth of wireless access points that provide broadband Internet access to mobile devices using the IEEE 802.11 protocol is currently seeing exceptionally strong growth. WiMax (IEEE 802.16) is an emerging wireless technology that shows future potential for broadband connectivity. WiMax has a much larger range than Wi-Fi and may compete with 3G cellular networks.

Internet-enabled consumer electronics devices have an increasing impact on Internet usage. An increasing number of 2.5G and 3G cell phones will have Internet access capabilities and will extend the time and place of Internet access. Web-enabled handsets will also extend the number of Internet users—especially in developing countries where fixed phones lines are limited. Mobile and wireless Internet, and mobile broadband in particular, are expected to have an increasing impact on the Internet growth in the years to come. This impact is further explored in the following section.

#### 4.1.2.2 Mobile Internet and wireless Internet growth

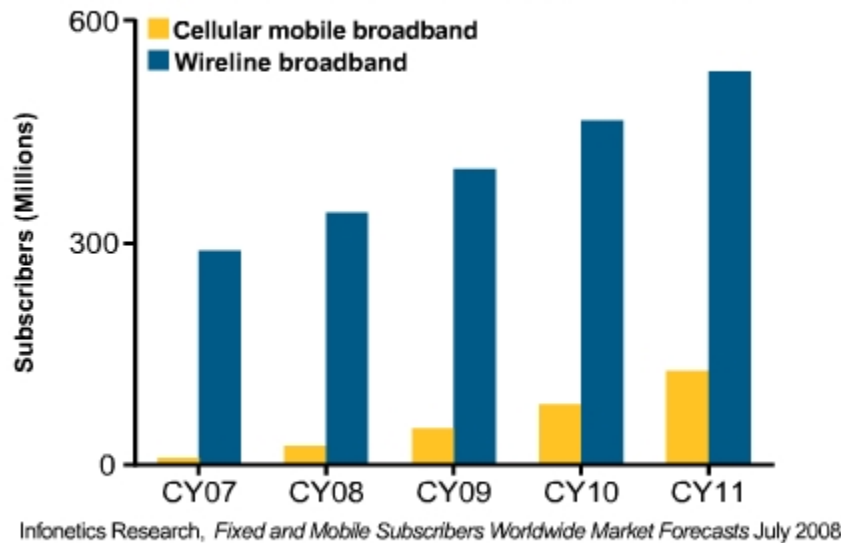
The next table summarizes the growth in worldwide Internet and wireless Internet users from 2001 to 2010.

*Internet growth (source: eTForecasts.com).*

	2001	2004	2010
<b>Worldwide Internet Users (#M)</b>	552	941	1781
<b>Worldwide Wireless Internet Users (#M)</b>	79	200	779
<b>Worldwide Wireless Internet User Share (%)</b>	14.4	21.2	43.8

These figures show that by 2010 there will be more than 1.7 billion Internet users worldwide. Furthermore, as stated on the same report, the worldwide telecom market is expected to grow to \$4.6 trillion by 2011, compared to about \$3.9 trillion in 2006.

According to the study’s results, the importance of mobile and wireless internet is steadily growing. Revenue from wireless services will experience strong growth over the next year (2009) despite the widespread economic gloom, predicts telecom and IT research firm Ovum. According to Ovum’s latest projections, mobile connections and revenues will grow by an estimated 6.3% in 2009 over 2008. Furthermore, cellular mobile broadband subscribers are forecast to grow at a 104% compound annual growth rate (CAGR) from 2007 to 2011. By 2011, there will be about 1 cellular mobile broadband subscriber for every 4 wireline broadband subscribers, as shown in the following figure.

**Broadband Subscribers: Wireline vs Cellular Mobile (Worldwide)**

Today, a number of mobile markets, both in developed and developing economies, are saturated or close to saturation, whereas broadband penetration rates are still relatively low in many countries. The combination of these two factors has given a major push to the rise of mobile broadband offerings over the last year. The number of mobile broadband subscribers reached 167 million at the end of 2007, driven by 18 per cent growth since 2006. The market is being stoked by robust competition among new and emerging technologies, such as the 2.5G and 3G, as well as the emerging “3.5 G” or 4G families of technologies: *high-speed packet access* (HSPA), WiMAX, and *long-term evolution* (LTE).

In terms of technology, HSPA is currently leading the market. The worldwide number of mobile broadband subscribers using HSPA has increased by 850 percent over the past year (2008), according to the GSM Association. There are now more than 32 million connections worldwide, compared to 3 million a year ago.

However, over the coming years, mobile WiMAX is set to bring coverage to metropolitan areas and developing markets. WiMAX is emerging as both a 3G mobile and a broadband wireline alternative. ARCchart predicts that WiMAX-enabled peripherals and devices will be the fastest growing technology category, reaching 81 million units by 2013.

Another big driver for mobile revenue over the past year has been the growth in mobile data services. With more carriers subsidizing smart-phones such as the iPhone and the BlackBerry Storm, mobile data revenues will see continued strong growth throughout 2009. “In their pursuit of higher average revenue per user (ARPU), network operators have become a key driving force” says Kaustubha Parkhi, ARCchart Senior Analyst. “Their willingness to subsidise the cost of devices such as data cards, laptops and Ultra Mobile PCs is making them affordable to a wider base of consumers”. ARCchart estimates that the service revenue generated by operators from these products will hit \$93 billion worldwide by 2013.

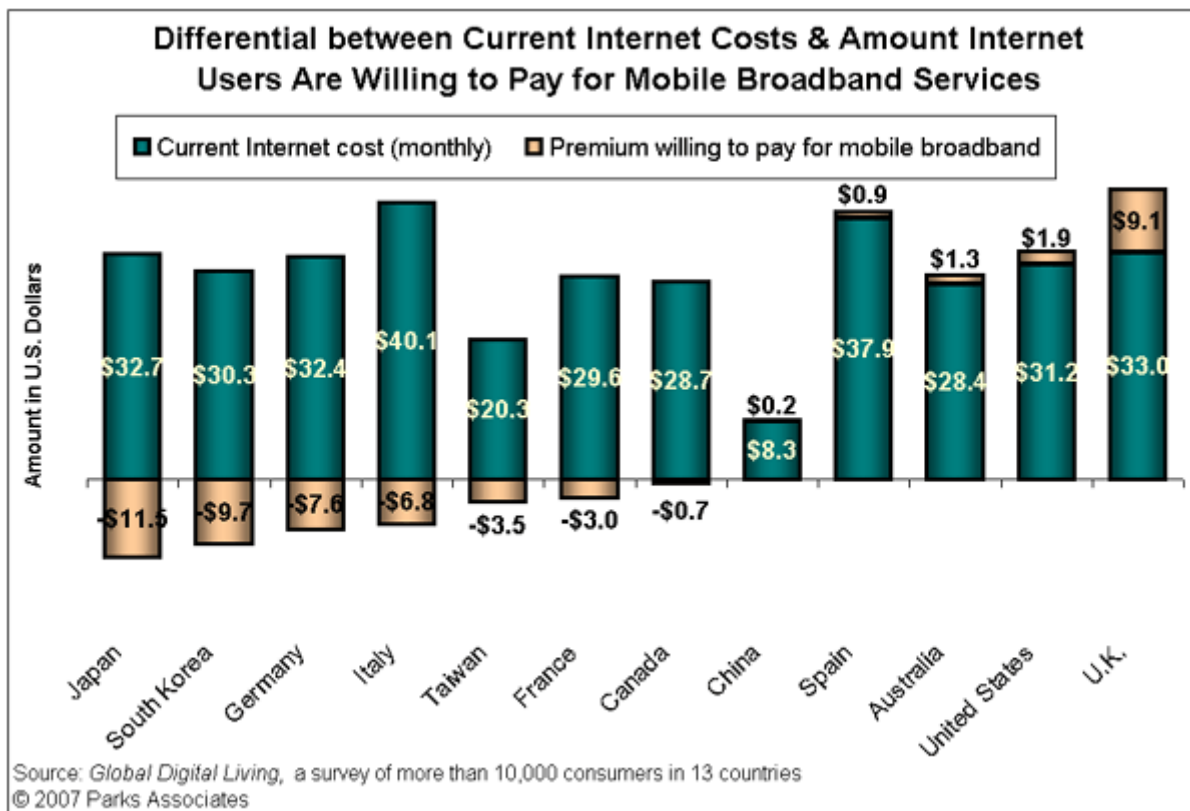
"Several recent developments are giving a boost to this market," says Richard Webb, wireless analyst for Infonetics Research. "Among the most significant developments:

- Cisco's acquisition of mobile WiMAX vendor NaviniNetworks;

- the market entrance of specialist ASN gateway vendor WiChorus;
- the launch of WiMAX phones and Ultra Mobile PCs; and
- the new Open WiMAX initiative, which promotes a disruptive, all-IP open WiMAX architecture, and should lead to best-of-breed solutions with inter-vendor interoperability."

The growth on all fronts is creating a virtuous circle in which mobile broadband is achieving greater economies of scale, driving down the cost of devices and attracting even more users, according to Rob Conway, CEO of the GSM Association.

The following figure shows the amount that users in 13 selected countries are willing to pay for mobile Internet services, in addition to their monthly Internet cost.



For operators, a big concern is capacity, both in mobile networks and backhaul. Capacity demand will also force carriers to look at other ways of building mobile and wireless networks. Mesh networks are well positioned to play an important role in this context, addressing capacity aggregation and enhanced coverage.

#### 4.1.3 Exploitation opportunities and risks

We explore the opportunities for exploiting the project's results as well as the potential risks through the SWOT analysis method. SWOT analysis is a strategic planning method used to evaluate the Strengths, Weaknesses, Opportunities, and Threats involved in a project or in a business venture. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favourable and unfavourable to achieving that objective. The initial SWOT analysis for the EU-MESH project's envisaged results is described next.

#### 4.1.3.1 Strengths

- Low cost deployment & maintenance;
- Architectural flexibility;
- Enhanced coverage;
- Symmetric & high downlink and uplink speeds;
- Seamless mobility;
- Multi-operator support for security and mobility.

#### 4.1.3.2 Weaknesses

- Coverage can be affected by users who switch off their mesh node.

#### 4.1.3.3 Opportunities

- Wireless networks can potentially be magnets for local and traveling professionals who desire to work or check their email messages away from the office.
- There is a demand in developing countries to provide broadband services in rural and decentralized public areas.
- As voice communication and wireline broadband services become commoditized telecoms must look for opportunities in untapped markets, i.e. offering mobile/wireless data services.
- A motivating example of an emerging application for telecoms could be equipping public transport vehicles (trains, buses) and taxis with Ethernet jacks that feed into the company's wireless network or with wireless Internet access over mobile networks. This service is expected to be quite popular with business users and as prices fall with other users as well. Such applications present telecoms with a chance to seize this window of opportunity and enter into profitable niche markets.
- Useful Internet content for the small displays of wireless devices is expanding, but much more is needed to further grow the wireless Internet user base. Potential growth will be due to millions of "dormant" web-enabled cell phones that are only used for voice services. As the wireless Internet user experience improves, an increasing portion of the dormant web-enabled phones will become active wireless Internet devices.

#### 4.1.3.4 Threats

- Will the popularity of the Internet (and mobile Internet) continue to grow?
- **Will there be a high demand for the services offered?**
- Will customers be willing to pay (and how much) for the service offered?
- Will the cost of accessing the Internet from home drop so significantly that the market for wireless Internet will shrink?

#### 4.1.4 Conclusions

Our increasingly mobile society means that a large percentage of users will access the Internet through mobile Internet devices. To be proactive and remain competitive it is imperative for

business travelers to have reliable high-speed access to e-mail, the Internet and corporate networks. For instance, it is becoming a standard for business travelers to stay only at hotels with high-speed Internet access and mobile Internet terminals.

People want access to the methods of communication and volumes of information now available on the Internet, at a cost they can afford, and in such a way that they aren't confined to a bedroom or office desk. Our goal is to provide the community with a convenient and affordable way to access the Internet from everywhere.

The attractiveness of convenience, combined with the growing interest in wireless Internet, has been proven to be a winning concept in other markets and is expected to produce the same results here as well.

## 4.2 Technology Providers

WiFi, WiMAX and wireless mesh networking standards are enabling the rapid proliferation of city-wide networks. These networks are complex, heavily utilized, require support of performance critical use cases and span diverse sets of users, devices, and applications. The greatest concern for network operators, municipalities and public safety agencies is how to efficiently and reliably operate and manage this new and complex breed of wireless infrastructure. AirSync, Proximetry's carrier-class software solution, is used to provision and manage these complex, mission critical, standards-based networks. AirSync's single integrated platform enables end-to-end resource and service (VoIP, video, telemetry) management in highly distributed multi-protocol wireless networks. EU-MESH technological advances will be used to enhance AirSync product to enable service providers and network operators to provision and manage EU-MESH based networks.

TCC's exploitation of the EU-MESH project's technological results will target the professional radio market and its evolutions towards including vehicular broadband networks as one of the future components of the Thales' product portfolio. In the Professional Mobile Radio market (PMR) Thales proposes a product range of TETRA networks, called Digicom25. TETRA is the European standard for PMR narrowband and wideband digital radio for professional usages (from public safety to railway networks). The Digicom25 product line is characterized by the native use of the IP protocol suite over the infrastructure network. The network is thus based on standard IP routers, instead of expensive proprietary switches. Similarly the functions of fleet management and centralised dispatchers are carried out over traditional PC platforms, running the MS suite. This cost effective product line has been deployed for customers worldwide since 1999. EU-MESH will support the extension of the Digicom25 to include rapid deployment of the small scale base stations ( $\mu$ BTS) on-board vehicles, and the integration of decentralized management of interoperable meshes of vehicles as considered in the future public safety communication scenarios of the MESA standards initiative (dealing with future broadband services for public safety communication).

## 4.3 Research Partners

None at this reporting period.