Guest Editorial Ultra-Wideband Radio in Multiaccess Wireless Communications

THE remarkable development over the past ten years of commercial wireless communications, together with mobile users increased expectation of being offered with wireless broadband multimedia services, has led to the design of a multiplicity of wireless access systems. As a consequence, considerable effort for reconciling different standards, typically by using multimode terminals and interworking devices, is underway. Multimodality and interworking are one way for granting connectivity. This approach, however, does not have the potential to integrate the different access standards and make them appear to the user as one seamless and homogenous network. In fact, processing requirements in fact limit the number of access technologies in a multimode terminal, and handover between access modes remains a challenge. Last but not least, multimodality leads to fragmentation of spectrum resources and, therefore, to losses in flexibility and efficiency, and an increased complexity of the wired section of the network.

Software radio has been proposed as a possible solution for reducing processing requirements, but it addresses neither handover nor spectrum management optimization issues. The lack of seamless handover, together with spectral fragmentation and an increased complexity of the wired side, remain intrinsic limitations of this approach. The fast development of access networks and the increasing gap between different systems also impose strong limitations on the use of software radio.

The open radio access principle offers a different vision. This concept consists of designing an access network based on a versatile air interface which leads to flexibility in resource management. This is capable of satisfying different applications in various radio environments when combined with Internet protocol (IP)-based backbone networks. Potential operation at any frequency, scalable data rates, and access to very large bandwidths may indeed lead to the any-time, anywhere, any-service paradigm.

Within the design of a flexible air interface the whole spectrum should be regarded as one single resource pool; portions of the resource should be allocated on a geographical and temporal basis, as well as service and user-wise. Rigid cell and frequency planning schemes should be avoided, and auto-integration procedures for enabling new radio nodes to easily start operation without base-station control should be developed. Services should be mobile and geographically distributed according to requests in a time-varying fashion, leading to the possibility of a tailored performance profile coupled to the nomadic user. A user defined quality/cost profile may act on agents, which in turn may provide selection and download of differentiated products in terms of quality-of-service (QoS), security, and priority schemes.

Recent developments suggest that Impulse Radio, combined with time-hopping spread-spectrum (TH-SS) and pulse position modulation (PPM), leading to the most common version of ultra-wideband (UWB) radio, is an excellent candidate for the design of flexible multiuser wireless communication systems. UWB, a widely used technique in radar and remote sensing applications, has recently received attention for its applicability to wireless communication systems.

UWB has several potential advantages; it may allow simultaneous communication of several users at high data rates by distributed control of interference levels; it may provide robustness against fading given its ultrawide spectrum; it may improve resource management and routing strategies because of the high precision with which it can determine user position and provide better control of emitted power. An additional flexibility feature of UWB is its scalability; a shift of the operating frequency range can be obtained by modifying the UWB monocycle pulse shape.

UWB signals spread over very large bandwidths. In principle, these signals can coexist with existing and planned narrowband radio systems, such as global positioning system (GPS), terrestrial TV, and cellular communication, if the UWB power density is controlled and limited to appropriate levels. The Federal Communications Commission (USA) recently released UWB radio emission masks, and opened the way for the concept of coexistence with traditional and protected radio services. Under strategic spectrum planning and appropriate regulation, UWB may bring revolutionary changes in wireless communications. In this framework, the design of power efficient UWB networks is mandatory.

Together with the flexibility of the air interface, the open access network paradigm requires a redefinition of upper layers in the system architecture. In the same way IP has succeeded in gluing together heterogeneous networks, UWB and the open radio access paradigm may be capable of integrating heterogeneous *wireless* access networks. In order to reach this goal, it is mandatory to break the logical wires which still tie mobile users to networks, as well as adopt the following design concepts which are: 1) backward compatible with actual IP-based networks; 2) scalable; and 3) distributed. Resource management should provide an independent performance calibration (i.e., "tuning knobs") allowing network operators to set target levels, tailored on user needs, on a IP-based access interface.

Digital Object Identifier 10.1109/JSAC.2002.805240

In this framework, the provision of QoS aware, or even simply best-effort services, calls for innovative solutions in the areas of mobility and resource management.

The topic we proposed for this Special Issue is very innovative. A large number of papers were submitted. We attempted to select those papers that investigated UWB related topics in a specific way, rather than merely reapplying models and techniques available for other systems, such as code-division multiple access (CDMA), to UWB. The selected papers cover both physical transmission aspects, as well as system oriented issues. One of our main concerns was to address the design of UWB networks as a whole and, therefore, consider all the necessary components of a telecommunication system. As a matter of fact, some of the topics which we addressed in our Call for Papers remain uncovered. We refer in particular to geolocation and sensing, and UWB technology and components. We hope that this issue will trigger further interest and research in the above areas.

ACKNOWLEDGMENT

The Editors would like to acknowledge the individuals and organizations who made this special issue possible.

— We are very grateful to the reviewers for their invaluable effort in selecting the papers: without their dedicated effort this issue would not be appearing.
— Our sincere thanks go to all authors for contributing to the advances on this topic.
— The JSAC Editorial Board and in particular Bill Tranter, our Editor-in-Chief, are to be credited for giving the go ahead to the issue, and Larry Milstein deserves thanks for his role as mentor. The reviewers of our issue proposal really helped us in better focusing its topic and scope.
— Finally, we thank the Editorial Staff at IEEE for ultimately putting the issue together in its final form.

NICOLA BLEFARI-MELAZZI, *Guest Editor-in-Chief*
Universita' di Roma "Tor Vergata"
Dipartimento di Ingegneria Elettronica
Via del Politecnico, 1
Roma 00133 Italy

M. GABRIELLA DI BENEDETTO, *Guest Editor*
Università di Roma "La Sapienza"
Dipartimento INFOCOM
Roma, 00184 Italy

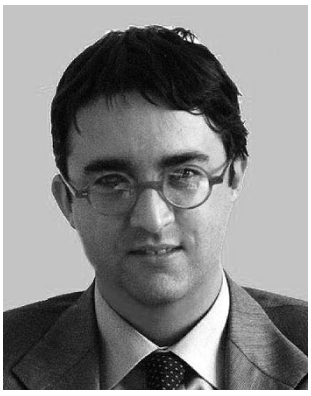
MARIO GERLA, *Guest Editor*
University of California, Los Angeles
Computer Science Department
Los Angeles, CA 90024 USA

H. LUEDIGER, *Guest Editor*
Institut fuer Mobil- und Satellitenfunktechnik GmbH
Carl-Friedrich-Gauss-Str. 2
Kamp-Lintfort, D-47475 Germany

MOE Z. WIN, *Guest Editor*
Massachusetts Institute of Technology
Laboratory for Information and Decision Systems
Cambridge, MA 02139 USA

PAUL WITHINGTON, *Guest Editor*
Time Domain
Huntsville, AL 35806 USA

LARRY MILSTEIN, *J-SAC Board Representative*



Nicola Blefari-Melazzi received the Laurea degree in electrical engineering (*magna cum laude*) in 1989, with publication of his thesis, and the Dottore di Ricerca (Ph.D.) degree in information and communication engineering in 1994, both from the University of Roma "La Sapienza," Italy.

In 1993, he joined the University of Roma "Tor Vergata," as an Assistant Professor. From 1998 to 2002, he has been an Associate Professor at the University of Perugia, Perugia, Italy. In 2002, he returned to the University of Roma "Tor Vergata" as a Full Professor of telecommunications. He has been involved in consulting activities and research projects, including standardization and performance evaluation work. His research projects have been funded by the Italian Ministry of Education, University and Research, by the Italian National Research Council, by industries, by the European Union and by the European Space Agency. He also reviewed research proposals and research projects. His research interests include the performance evaluation, design and control of broadband integrated networks, wireless LANs and satellite networks. He is also conducting research on multimedia traffic modelling, mobile and personal communications, quality-of-service guarantees and real-time services support in the Internet.

Dr. Blefari-Melazzi served as Reviewer, TPC Member, Session Chair and Guest Editor to the IEEE conferences and journals.