

## Preface

The Heterogeneous Next Generation Networks (H-NGNs) can be defined as networks which adopt different access technologies having packet-based architecture, supporting the provision of existing and emerging broadband services through an open and converged communications infrastructure (ITU-T definition). The convergence refers to the integration of the appropriate technical operational procedures based on advanced communication and computing functionalities for supporting voice, data, video and multimedia services on a seamless basis over various wireless telecom infrastructures and platforms. The advantage of the application of these networks is bringing forward a series of innovative opportunities but also a greater array of challenges, touching upon competition, interconnection agreements and new business models. The last few years, several worldwide scientific research teams in Universities, Institutes and R&D Manufacturers have started the try to combine the heterogeneous wireless systems under the same framework.

According to the All-IP convergence issue, the last years, the involved scientists in the wireless telecommunication science, are focused on the research, development and integration of Heterogeneous Wireless Networking platforms in order to both converge the existing technology and to deliver to the users multimedia services of high intrinsic and perceived Quality of Service (QoS). Actually, this integration refers to the evolution aspects from “one network – one service” to “one network – many services”. In this case, the philosophy of the combined heterogeneous wireless networking is one of the main technical features that are needed in order to develop new technologies suitable to support the demands of the Next Generation Networks (NGNs). It is noted that the researchers of the unified heterogeneous wireless networking platforms are committed to use the Internet Protocol (IP) as a core network by taking into account for each case the interoperability issues of the involved wireless networks (i.e: cellular networks, terrestrial and satellite broadcast networks, High Altitude Stratospheric Platforms and broadband access networks [WiFi, WiMAX]). Soft and hard handovering, location based techniques, stochastic channel characterization and mobility management become the main research focal point. In addition, there is a need for the multimode – multiband portable units to be transparent (seamless and inter-system roaming) to the involved heterogeneous wireless technologies of the telecom platform and also to co-op with the corresponding involved system’s complexity and the dynamics from the operational procedures point of view, of the NGNs. Due to the multimedia services, the possible packet loss could be a severe problem that reduces the end-to-end QoS. In this case, special strategies should be adopted in order to force the information through different and optimal heterogeneous wireless network platform’s routes by sensing the existing network’s under service traffic load, the local signal level of the user’s unit due to the possible occurred fading phenomena and the occurred possible Doppler drift due to the speed of motion of the user. Finally, macro-mobility and micro-mobility become very important research issue to the demanded convergence of the IP technology with the entities of the heterogeneous wireless network platform.

Based, on the advances in the heterogeneous network convergence issues that is characterized as the next major challenge in the evolution of the telecom industry, the present handbook contains a number of original and review contributions which direct the leading key technologies and technical issues in the next shortcoming years. From the technical point of view, the emphasis of the content of this work is focused on the NGN functions: the shared core network that contains the involved issues of the control and transport layer, the multiple access networks, the service layer, the terminal equipment, the multiple applications and the wireless channel characterization.

The scope of this handbook is to provide to the readers in detail the appropriate technical knowledge about NGNs with contributions received by known research teams. The reader should have a good background on telecommunication engineering.

The received technical studies are grouped into four (4) sections. A brief overall section synopsis for preliminary orientation is given in the following:

**Section I** deals with both the shared core network and the multiple access networks. The entities that are discussed here are: cross-layer design approaches and solutions, scheduling procedures under fading environments, security mechanisms and their inadequacies and finally, multiple access technologies comprising the heterogeneous networking environment. It is noted that the shared core network is the new converged network that has to be designed in such a way to carry voice, data, video and multimedia over the same physical network and by adopting appropriate protocol schemes. From the operator's point of view, there will be the ability for reducing the network elements and the maintenance costs. The used access technology will allow higher bandwidth demands to support telecom services and from the operator's point of view this depends on their existing infrastructure.

Dzmitry Kliazovich, Michael Devetsikiotis and Fabrizio Granelli give a detailed survey of the state-of-the-art and future directions in the usage of formal methods for cross-layer modeling and optimization of wireless networks. The cross-layer scheduling and resource allocation for wireless systems and an overview of some of the approaches and proposed algorithms are presented by Dimitris Toumpakaris and Jungwon Lee. The comparison of some of the existing security mechanisms and their inadequacies for providing efficient multicast security are analyzed by Prashant Pillai and Yim Fun Hu. Dense and coarse wavelength division multiplexing and their recent applications in optical networks are described by Nikos Merlemis and Dimitrios Zevgolis. The overview of Radio-over-Fiber technology, as an emerging infrastructure for next generation and fiber-based wireless access broadband networking are presented by Sotiris Karabetsos, Spiros Mikroulis and Athanase Nassiopoulou. Finally, Konstantinos Birkos analyzes the main technological aspects of the High Altitude Startospheric Platforms and their usage to increase the overall system's capacity under certain traffic and SNR levels by performing optimum handovering procedures.

In **Section II**, the service layer, service control and the quality of service (QoS) issues are presented. In the next generation era of the networks convergence of media information and the communication technology with the appropriate involved computing technology will lead to new wide scenarios of services having dynamic bandwidth issues. The service delivery will depend upon requested QoS classes. The service will allow: rapidness in the creation by using the appropriate software and control tools, mobility issues, management techniques, interoperability, security mechanisms, location-based techniques, QoS mechanisms and billing.

Dimitrios Lymberopoulos presents and analyzes the nowadays status and the fundamentals of the conventional and converged bundled and value added services, and then depicts their transformation in distributed NGNs services. The complexity and the arising problems in the NGN management plane and the introduction of a new framework that will solve many problems that operators face today, are analyzed by Konstantinos Kotsopoulos, Pouwan Lei and Yim Fun Hu. A thorough investigation of the QoS, energy conservation and mobility in 802.11 and 802.16 standards is presented by Ioannis Papapanagiotou and Georgios Paschos. The various applied mobile system architectures, showing the evolution path towards the IP convergence issue with the introduction of the IP Multimedia Subsystem (IMS) is described by Panagiotis Kasimatis and Dimitra Varla. The important issue of mobile positioning in wireless heterogeneous next generation networks is analyzed by Peter Brida, Peter Cepel and Jan Duha. Finally, Antony Ioannidis and Jorgis Kritsiotakis seek to assess whether an integrated bundled network can itself become the gateway for the efficient delivery of multimedia applications and services. Applying, the Resource – based View theory on the recent developments in the fixed mobile convergence space, the performed analysis concurs with industry-wide skepticism and provides guidelines for the fulfillment of the NGN promise.

**Section III** presents the technical equipment and the wireless channel issues. It is expected that the terminal equipment in the NGNs philosophy will be capable to support multiple types of access transport functions on a simultaneous basis. This means from one hand that converged operational and communication procedures should be implemented and from the other hand new techniques in the receiver front-end should be developed. In this case diversity techniques and smart antennae will be used to receive signals in problematic geographic areas where strong fading phenomena exist. Moreover, the user equipment should enable interface adaptation to vary

user requirements, including the convergence service for connection with commonly provided user interface and service platform.

Modern and future wireless communication systems such as UMTS and beyond 3G systems (B3G) are expected to support very high data rates to/from mobile users. This issue, poses important challenges on the handset design as these should be able to attain an acceptable operating bit error rate (BER) while employing a limited set of resources (i.e. low complexity, low power) and often, with tight processing delay constraints. According to the analysis of Costas Chaikalas and Felip Riera – Palou, simulation results are given demonstrating how receiver reconfigurability is a promising method to achieve complexity/delay efficient receivers while maintaining prescribed quality of service (QoS) constraints.

Multi-antenna systems incorporating smart antenna techniques present numerous advantages compared to their single antenna counterparts including capacity and range, by exploring spatial diversity. The current status and novel research directions in the framework of such array systems are presented by Apostolos Georgiadis and Carles Fernandez Prades. Furthermore, the application of nonlinear antenna arrays in the design of novel RF/microwave front-ends, that present compact, low cost and energy efficient solutions for smart antenna array applications is demonstrated.

Small-scale fading strongly affects the performance of a radio link; therefore radio channel simulation tools and models are broadly being used in order to evaluate the impact of fading. Furthermore, channel simulation tools and models are considered to be of utmost importance for efficient design and development of new products and services for Next Generation (Wireless) networks (NGNs and NGWNs). A description of the most popular and broadly accepted mobile radio channel models and simulation techniques are given by Stelios Mitilineos, Christos Capsalis and Stelios Thomopoulos, mainly with respect to small-scale fading.

The composite stochastic models, in which the diffuse component arises from three dimensional (3-D) multipath scattering are investigated by Petros Karadimas. That case occurs especially in dense scattering environments, in which the tall obstacles cause an arrival of multipath power in the elevation plane, besides that arriving in the azimuth one. Also the multipath components are assumed to arrive at the mobile receiver in specific angular sectors in the azimuth receiver's plane. The last is physically justified by multipath power blocking due to the channel obstacles (shadow fading), or/and lack of scattering objects at specific angular directions, or/and directional antennas utilization.

As a consequence of the growing interest in wireless communications systems, much effort is being devoted to the channel characterization and modelling. This is obvious since the performance depends fundamentally on the channels under consideration, so a communication system design must be preceded by the study of channel characteristics. Anastasios Papazafeiropoulos analyzes the propagation environment in which a wireless system operates. His work is focused on the characterization of radio links between the transmitter and the receiver antennae that will be modelled by randomly time-variant linear systems.

**Section IV** is devoted to the area of applications. The vision of “one network – many services and applications” depicts the necessity to access the appropriate technology on a neutral basis. Vertical integration of business models remain on the top of the interest area. This will lead to the evolution of the existing regulatory framework. E-government is a phenomenon of our times. E-business is becoming vital on both the private sector and the governmental Institutions. The use of Information and Communication Technology in order to change the structures and processes of government organizations is an attempt to allow the exchange of information with citizens, business and other arms of government for improving the efficiency, convenience and better accessibility of public services. The analysis performed by Fotis Kitsios, Spyros Angelopoulos and Giannis Zanetopoulos lead to answers to a number of arising questions during the implementation of the aforementioned application. In addition, Spyros Angelopoulos, Fotis Kitsios and Eduard Babulac present the current state-of-the-art in the world of telecommunications and Internet technologies, new technological trends in the Internet and automation industries, e-manufacturing, Ubiquity, convergence and the concept of the fully-automated future house. In order to survive in the marketplace, service organizations need to make the most of all of their resources in order to introduce new services to market ahead of the competition. The service innovation management issues are presented by Fotis Kitsios, Panagiotis Tzortzakos and Constantin Zopounidis. In the following, Dimitrios Emiris and Charis Marentakis analyze and match the properties of heterogeneous wireless networks and set the framework for the development of Reverse

M-auction based Marketplaces operating in a location sensitive contact with application in the freight transport market where potential suppliers are able to place bids for Less-Than-Truckload shipments. Achilles Kameas uses Gadgetware Architectural Style and presents a set of concepts, middleware and tools which enables engineers to compose Ubicomp applications by combining the services offered by artifacts and infrastructure. Finally, Ioannis Fraimis, Eduard Babulac, Konstantinos Ioannou and Athanasios Ioannou present a channel management scheme for a mobile communication system that supports services in Ubiquitous communications infrastructures for future transportation technologies and applications.

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