
Foreword

Every decade, telecommunications standards developers aspire to a new generation. Member companies in 3rd Generation Partnership Project (3GPP) identify and work towards an expansion of the telecommunication industry. Collectively, 3GPP* takes on the task, drawing on the aspirations and insights of individual experts, member companies, partner Standard Developing Organizations (SDOs) and external organizations. The formal focus of this activity is the ITU-R IMT program. With IMT-2000, IMT-Advanced and now IMT-2020, a vision and expression of the aspiration of the coming generation is established. The IMT goals are both commercial and more general; as telecommunications have become central to social and cultural development across the world. These programs establish criteria for the radio network which are met by qualifying submissions. 3GPP's 3rd generation was accepted for IMT-2000, and 4th generation for IMT-Advanced. 3GPP is hard at work now developing standards that will be submitted for the IMT-2020 program. The context and aspiration for 5G are well described in "Outlining the Roadmap to 5G" in this issue.

3GPP is a partnership project, bringing together SDOs from around the world. These SDOs formally transpose and release the standards specifications that 3GPP completes. This activity continually proceeds – maintaining existing standards through corrections and producing both new specifications and adding features to existing specifications to provide new features and functions. Different parts of the 3GPP organization work on the standards from different perspectives. Some working groups are further ahead, identifying requirements for new services and functions, others following by defining these features technically – maintaining compatibility with existing capabilities as necessary and not creating any incompatibilities, and still other working groups who complete the specifications at the protocol level. The partnership project therefore comprises committees at all phases of the work, simultaneously. Features are completed together as 'releases.' A release, beyond offering attractive new complete capabilities to the market, eases

*Information regarding 3GPP is available at <http://www.3gpp.org/>

coordination of standards development activities and makes comprehensive testing possible. In the end, a major aspect of what 3GPP standards' success lies in the emergence of equipment that is both compatible and compliant with the standard according to the specifications, initially when deployed and for years to come.

The first releases of 5G, leading to the IMT-2020 submission, are Release 15 (which is termed 5G Phase 1) and Release 16 (which is also called 5G Phase 2.) Release 16's functional freeze date – also termed 'stage 3 freeze' will occur at the time that the IMT-2020 submission will be sent. At the time of the publication of this special issue on 3GPP 5G Standardization, 3GPP will have frozen Release 15 and already have determined the focus for work on Release 16.

5G standardization is an extended program whose goals extend from the short to the long term. The article "5G Requirements and key performance indicators" provides the background and outcome of the extensive work 3GPP completed on normative standards and identifying the goals for 3GPP's 5G standardization program. 5G Phase 1 and Phase 2 description can also be found in this article.

The standards under development include the entire range of activity of 3GPP – across all TSGs and working groups. 3GPP will fully complete the standard sufficient to realize the IMT-2020 vision, though this will not occur in 5G Phase 1 and 2. The work will continue for several releases, extending the standard in compatible ways to satisfy ever more requirements. It is not yet fully clear what coming releases, past 5G Phase 2, will include. 3GPP continually re-examines and takes current market conditions and opportunities into account.

The articles in this special issue on "3GPP 5G Specifications" reflect the diverse progress and substance of the 5G standards. Some of these standards have already been completed and frozen – others are currently under development and will be finished over the coming months.

One area that greatly distinguishes each generation of 3GPP standards from the last is the innovation brought to the radio access network. "5G NR radio interface" provides an overview of this exciting new standard and how it relates to the IMT-2020 radio requirements. In addition, coexistence of NR and LTE is presented. The 5G Access Network (5G-AN) includes both LTE and NR radio access technologies. "NG Radio Access Network (NG-RAN)" takes a broader look at the 5G access system in which NR operates and in particular describes how the NG-RAN can be deployed in different scenarios to realize migration from LTE-based networks to 5G and NR. This paper also

considers the overall 5G radio access architecture and its key interfaces and protocols.

Another area of significant development is the 5G Core Network (5GC) and overall system. “The 5G System Architecture” offers an introduction and explains some of its key characteristics. In “Path to 5G: A Control Plane Perspective” some of the most significant system developments from earlier generations to 5G are considered in more detail. “RESTful APIs for the 5G Service Based Architecture” explores how the 5GC internal communication has been specified using a RESTful design, and explains how the protocols and interfaces developed provide opportunities for future integration with other systems.

Finally, three articles concern 5G standards development that involves most aspects of the system – including radio, network, and end-to-end service delivery aspects. “5G Multimedia Standardization” covers evolution of streaming services and media delivery architecture for 5G – including Virtual Reality 360° video streaming, real-time speech and audio communications VR evolution and user generated multimedia content. “3GPP 5G Security” presents security aspects as they differ from the 4G (LTE) system – including several major security enhancements achieved, applied to every aspect of the NG-RAN, 5G-AN and 5GC, as well as end to end communication made possible by the 5G system. “Management, Orchestration and Charging in the New Era” surveys the range of standards under development for management and orchestration of the access network and core network, with particular attention on management of network slicing.

Though the articles in this volume cover much of the standards included in Release 15 and to be included and enhanced in Release 16, this does not provide a complete overview of all work. The reader will learn essential aspects and advances to the 3GPP standard and be in an excellent position to follow work as it proceeds in the years to come.

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