SEAMLESS CONTENT DELIVERY IN THE FUTURE MOBILE INTERNET

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The Internet is incontrovertibly a great success that has changed our social and economic world. Today, over one billion users access the Internet on regular basis, more than 100 million users have downloaded at least one (multi) media file, and over 47 million of them do so regularly, searching in more than 160 exabytes of content. The content is expected to rise to more than 990 exabytes before 2012, fueled mainly by the users themselves [1]. It is envisaged that in the near- to mid-term future, mobile Internet will provide the means to share and distribute (new) multimedia content and services with superior quality and striking flexibility, in a trusted and personalized way, improving citizens' quality of life, working conditions, edutainment, and safety.

However, the Internet was designed 40 years ago for purposes that bear little resemblance to today's usage scenarios and related traffic patterns. In the longer term, the exponential increase of user-generated multimedia content and the number of mobile users will raise numerous new challenges. In this respect the future mobile Internet will not simply be a faster way to go online. The future mobile Internet should be designed to overcome current limitations and address emerging trends, including network architecture, content and service mobility, diffusion of heterogeneous nodes and devices, mass digitization, new forms of (3D) user-centric/-generated content provisioning, emergence of software as a service, and interaction with improved security, trustworthiness, and privacy [2].

In this evolving environment, machine-to-machine communication (including radio frequency IDs [RFIDs]), rich 3D content as well as community networks and the use of peer-to-peer (P2P) overlays are expected to generate new models of interaction and cooperation, and be able to support new innovative applications "on the move," like virtual collaboration environments, personalized services/media, virtual sport groups, online gaming, and edutainment. In this context the interaction with content combined with interactive/multimedia search capabilities across distributed repositories, opportunistic P2P networks, and dynamic adaptation to the characteristics of diverse mobile terminals are expected to contribute toward such a vision. On the other hand, advances in scalable video coding and 3D video processing, dynamically adapted to network conditions, will give rise to innovative applications such as massive multiplayer mobile games, digital cinema, and virtual/augmented worlds, placing new types of traffic demands and constraints on mobile network architectures.

As depicted in Fig. 1, since 2002 research institutes and leading companies in the United States, Asia-Pacific region, and more recently in Europe have started to design the future mobile Internet, which will not only radically change the telecommunications and entertainment industries, but is also expected to stimulate and enhance creativity, professional productivity, and community relations.

The purpose of this special issue is to present to the magazine's audience a concise tutorial-oriented reference to the state of the art, and current and future research in seamless content delivery technologies, as well as challenges and trends in the future mobile Internet. From a very large number of very high-quality papers we received, we have selected seven, based not only on the importance of the work, but also trying to cover as many as possible dimensions of the multidisciplinary mobile Internet phenomenon.

The first article in our special issue is entitled "European Research on Future Internet Design" is authored by two European Commission Scientific Officers, Peter Stuckmann and Rainer Zimmermann. This article provides an excellent summary of the motivations for future Internet research in Europe. It provides the technical limitations and barriers of today's Internet, along with the changing business environment and the promising new opportunities of the future Internet era. Moreover, research activities that address the challenge of future Internet are introduced under three main lines:

- The future Internet architecture and network technologies
- Spectrum-efficient access to future networks
- The converged infrastructures in support of future networks

Following a bottom-up approach in the protocol layer stack, we continue with the second article, "A Middleware Architecture Supporting Seamless and Secure Multimedia Services across Inter-Technology Radio Access Network" by Jonathan Rodriguez, Michail Tsagaropoulos, Ilias Politis, Tasos Dagiuklas, and Stavros Kotsopoulos. This article presents a middleware architecture able to support multimedia services across intertechnology radio access networks in a secure and seamless manner. The proposed architecture uses the media-independent handover framework, where the handover decision function is based on triggering/ collecting statistics from physical, network, and application layers so that an ongoing multimedia session (e.g., video) can be transferred seamlessly and securely (using context transfer) across intertechnology radio access networks. The article also provides some interesting simulation results when a vertical handover from WiFi to Universal Mobile Telecommunications System (UMTS) and vice versa take place.

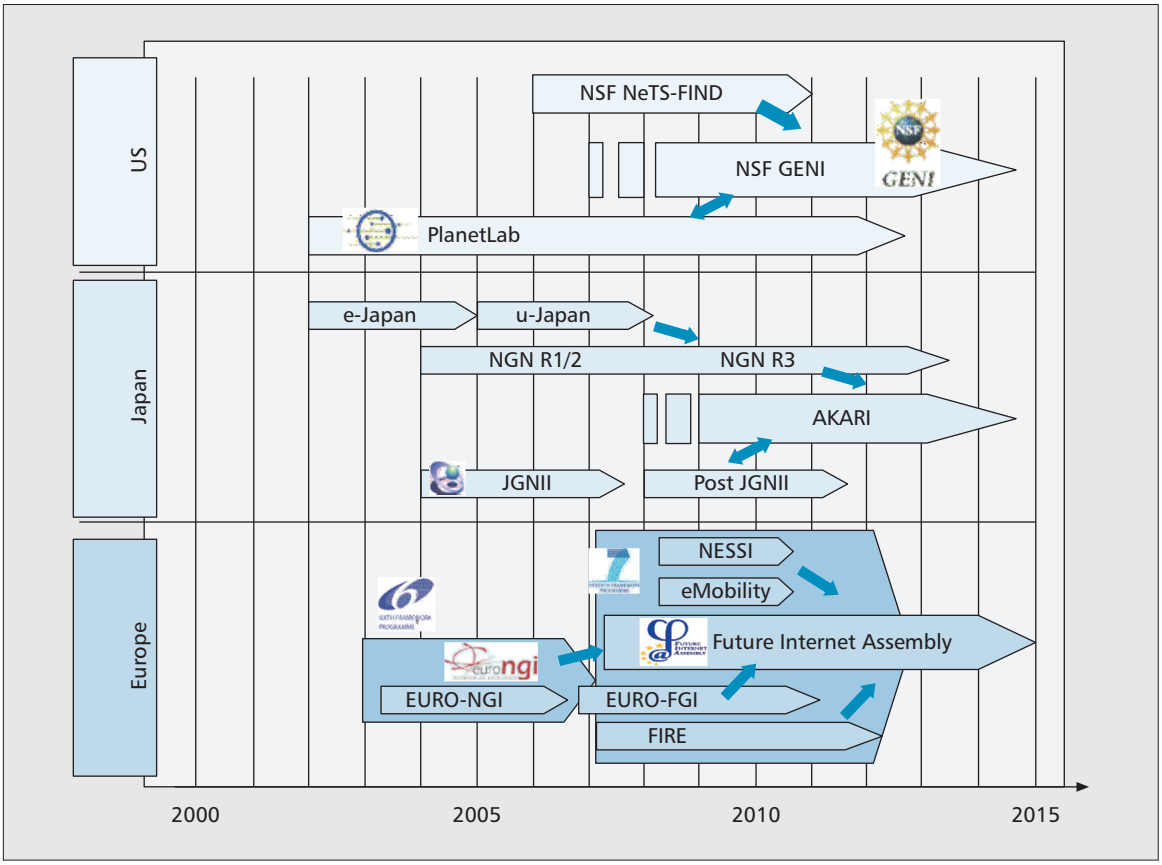

Figure 1. *Network evolution towards the future Internet.*

Handover is a key enabling function for seamless mobility and service continuity among a variety of wireless access technologies. Handovers within the same radio system (horizontal handovers) are addressed by the standardization bodies involved in the development of the corresponding technologies (e.g., Third Generation Partnership Project [3GPP], 3GPP2, IEEE, Digital Video Broadcast [DVB]), while handovers between heterogeneous systems (vertical handovers) are managed by protocols developed by the Internet Engineering Task Force (IETF). However, interoperability between radio access systems requires realizing the vision of Beyond 3G, calling for coordinated actions and integrated solutions combining individual strengths. This is the rationale also for the next article: "Seamless Service Provision for Multi Heterogeneous Access" by Lambros Sarakis, George Kormentzas, and Francisco Moya Guirao. The article reviews emerging protocols and architectures aiming to support intersystem handovers between next-generation wireless systems and presents a handover framework built around the functionality introduced by the IEEE 802.21 standard. Mapping of this framework to the entities of the 3GPP evolved system architecture is discussed, and handover procedures involving key entities of this architecture are presented.

Search and delivery of multimedia content will be of great importance in the future mobile Internet. Common data formats and appropriate architectures that will pave the way toward a solution for this challenging task have to be defined. The next article, "Search and Retrieval of Multimedia Objects over a Distributed P2P Network for Mobile Devices" by Dimitris Giakoumis, Michalis Lazaridis, Jernej Trnkoczy, Apostolos Axenopoulos, Gianluca Paravati, Andrea Sanna, Fabrizio Lamberti, Dimitrios Tzovaras, and George Hassapis, proposes a framework that enables mobile device users to search and retrieve multimedia objects over a distributed peer-topeer (P2P) network. The proposed concept is to develop a P2P-based application that, having as a basis the state of the art in the field of 3D content search algorithms, would be able to deliver search and retrieval functionalities to users on the move through mobile devices.

Another important issue in the future mobile Internet will be security and privacy. Delivering protected content services over heterogeneous mobile networks should be solidly sustained on top of future Internet architectures. The article entitled "Protected Seamless Content Delivery in P2P Wireless and Wired Networks" by Lara García, Laura Arnaiz, Federico Álvarez, José Manuel Menéndez, and Karsten Grüneberg describes novel forms of delivering seamless content services over P2P networks using multilayered/ multiview content coding techniques. Special focus is put on enabling content protection and lightweight asset management for secure and privacy-keeping content delivery.

Future media Internet will call for universal multimedia access (UMA): the ability to provide multimedia content at any time on any device at suitable quality. There has been a lot of effort in the multimedia research community to ensure that multimedia content can feasibly be adapted to suit these heterogeneous environments. In video coding, the most promising standard is Scalable Video Coding (SVC). SVC is an extension to the Advanced Video Coding (AVC) standard, which provides scalability in three dimensions — temporal, spatial and signal-to-noise ratio (SNR) — and allows a fully scalable bitstream to be created with no more than 10 percent of overhead in terms of bit rate as compared to a non-scalable AVC-encoded bitstream [2].

The next article, "An Interoperable Delivery Framework for Scalable Media Resources" by Michael Eberhard, Christian Timmerer, Emanuele Quacchio, and Hermann Hellwagner, proposes an interoperable framework for the delivery and adaptation of streamed content based on International Organization for Standards (ISO) MPEG-21 Digital Item Adaptation (DIA). In the proposed streaming framework, both the server and the clients implement the MPEG Extensible Middleware (MXM) and utilize the MPEG Query Format (MPQF) for querying the available media resources [3].

The last article of this special issue, "Scalable Video Coding (SVC) over RTP and MPEG 2 Transport Stream in Broadcast and IPTV Channels" by Thomas Schierl, Karsten Grüneberg, and Thomas Wiegand, again faces the issue of SVC stream distribution, but from a different viewpoint. It tackles the recently finalized SVC standards on transport over IP/RTP and MPEG-2 transport stream [4]. Moreover, contrary to the previous article, this article provides a very lightweight adaptation method, based on extensions to the IETF Session Description Protocol (SDP), which was recently proposed as a new IETF Request for Comments (RFC) [5] co-authored by one of the article authors.

Before we leave you to enjoy this special issue, as guest editors we would like to thank all authors, who invested a lot of work in their really valuable contributions, and also all reviewers, who dedicated their precious time to provide numerous comments and suggestions. Last but not least, we would also like to acknowledge the enlightening support of Editor-in-Chief Prof. Michael Fang and the publications staff.

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