Satellite-Based Mobile Multiservices Platform

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INTRODUCTION

The future fourth generation (4G) of the satellite-based wireless and mobile communications is particularly important for global providing of the mobile broadband global information technologies (IT) multi-services and mobile e-applications (m-applications) for geographically dispersed mass users in support of anytime, anywhere, and any required quality of service (QoS) capabilities in a low-cost way. The recent broadband satellite systems described in Ivancic et al. (1999), Evans et al. (2005), Skinnemoen, Vermesan, Iuoras, Adams, and Lobao (2005) are based mainly on *centralized low-meshed architecture* with very high traffic concentration. Such structure is not adequate in context of the traffic topology for *rural, remote, and difficult for access* (RRD) regions. Markhasin (2001) noted that the cost of centralized systems is unacceptably large for deployment of future mass broadband communications in RRD regions (North Siberia, Scandinavia, Greenland, Canada, Alaska, Central and South East Asia, South America, Australia, etc.).

As it was shown in Markhasin (2001, 2004), the future low-cost IT multi-service platforms for RRD regions can be built optimal on a mix of the terrestrial and satellite-based mobile and wireless communications with *radically distributed* (*neural-like) all-IP/ATM architecture* that requires breakthrough steps for search advanced satellite, mobile, and wireless 4G technologies. Markhasin (1996) and Frigon, Chan, and Leung (2001) noted that the improvement of medium access control (MAC) protocols has a dominant effect on ensuring the breakthrough features of future QoS-aware mobile and wireless technologies. The survey and analytical comparison of the fundamental principles of QoS-oriented MAC protocols were described in Markhasin, Olariu, and Todorova (2004, 2005). The radically novel *multi-functional MAC technology* (MFMAC) for long-delay space mediums with fully distributed dynamic control of QoS, traffic parameters, and bandwidth resources was proposed in Markhasin (2001, 2004). This article will be focused on future QoS-aware, satellite-based, fully distributed, mesh, and scalable mobile IT multi-service and m-Applications platform's networking technology 4G for RRD regions.

BACKGROUND

Fundamental Challenges

The fundamental challenges of the future 4G technologies provide answers to the following questions:

1. Can it be true everywhere the 4G declaration "Mobile broadband for all anytime, anywhere, any QoS, any bandwidth?"
   - In fact: Now it can be ensured only for urban regions with big population density.
2. Evolutionary or revolutionary way?
   - The technological restrictions and "rudiments" of outdated generations will be a burdensome "pay" for evolution way.
3. Multimodal (heterogeneity, the "Babel" of MAC protocols) or multi-functional (homogeneity, universal, scalable, adaptable, the "Esperanto" of MAC protocols)?
   - The big-cost's of the multimodal solution prevails up to this time.
4. IP or ATM?
   - It will effectively integrate the merits of both these perspective technologies on the base of the developing next generations of asynchronous transfer mode (ATM) and multi-protocol label switching (MPLS) technologies based on breakthrough QoS and space-aware MAC protocols.
5. Centralized, hierarchic or decentralized, distributed, peer-to-peer?
   - The cost of centralized systems is unacceptably large for deployment of future mass broadband communications for RRD regions, which include many geographical distributed customers.
6. Ultrahigh bit rates and local areas (wireless technology, WiMAX) or middle bit rates and global areas (mobile technology, 4G)?
   - The characteristics of the traditional known broadband MAC protocols depend strongly on wireless area distances, and degrade quickly, if this area is increasing (Markhasin, 2001; Markhasin et al., 2004).

This article will be focused on these 4G fundamental challenges.

Integration of IP and ATM Technologies

What is the most promising telecommunication technology of the future global wireless multimedia communication environment 4G: Internet Protocol (IP) technology or ATM? We suppose that an integration of next generations of these two leading technologies will provide the most promising basis for the near future. The *IP over ATM* integration technologies (IP/ATM, for short) have emerged as advanced concepts that are expected to provide broadband multi-service to the end users by making the best utilization of the advantages of IP (packet switching, adaptive routing, heterogeneous flexibility, scalability, etc.) and of QoS-oriented MAC-based ATM (soft QoS provisioning; fully distributed; dynamical traffic engineering and resource allocation; multimedia; high speed; guarantying; etc.) in a cost-efficient way.

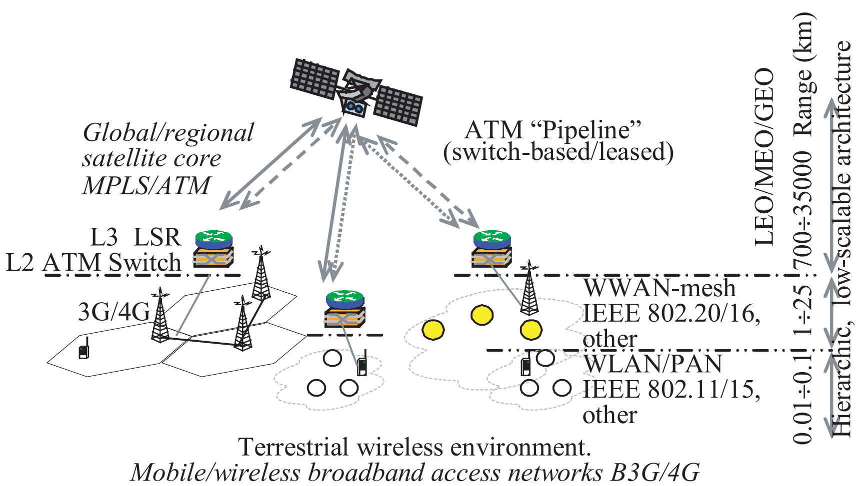
As it was described in Ivancic et al. (1999), Peyravy (1999), and many other authors, the widespread global wireless IP/ATM multimedia systems are based mainly on switch-based centralized architecture (Lawrence, 2001) with very high traffic concentration (see Figure 1). This global/regional satellite core networks domain will be built upon the big ATM switching/*label switch routing* (LSR) nodes, which are conned via satellite switch-based or leased "pipelines." Such structure is adequate to high urban areas especially. The wireless and mobile access networks domain may include the personal (WPAN), the local (WLAN), wide (WWAN), vehicular (VAN) area networks levels, and also cellular systems (B3G/4G, UMTS, S-UMTS). Salkintzis (2004) and many authors of the Special Issue "Migration Toward 4G Wireless Communications" (2004) define a key role of integration of the previously listed wireless and cellular technologies in the 4G of mobile data networks.

The another concept *IP-VAN over Digital Video Broadcast Satellite* of satellite-based broadband access VAN system (DVB-S) was proposed in Oh, Kim, Song, Jeon, and Lee (2005). Its satellite access channel consists of forward and return links having asymmetric star topology. The time division multiplexing (TDM) based forward link is transmitted over DVB-S channels where vehicle's IP packets are encapsulated into MPEG2-TS packets. The return links are composed of multi-frequency multiple access channels with time division (MF-TDMA) or code-division (MF-CDMA) based on Digital Video Broadcast-Return Channel Satellite (DVB-RCS) standard. Unfortunately, the DVB-S/RCS channels' opportunities limited the dynamical control of the QoS, symmetry, and other required characteristics of the VAN system.

MPLS over ATM

The MPLS over (MPLS/ATM, for short) were proposed as very promising extensions to the existing IP/ATM technique (Lawrence, 2001). Lawrence noted that the recent MPLS/ATM is based mainly on routing, switching, and also on further developing the IP capabilities. Switch-based MPLS/ATM's *label distribution protocol* (LDP) supports *hop-by-hop label routing* through the network. Switch-based (L3 LSR) up to date have been based on ATM switches. The ATM cell forwarding mechanism supports also *hop-by-hop ATM label switching*. In Markhasin (2001, 2004) it was

Figure 1. Switch-based MPLS on ATM centralized global satellite/mobile/wireless hierarchic architecture



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