

# Chapter 10

## Advancements on Packet Scheduling in Hybrid Satellite–Terrestrial Networks

**Hongfei Du**

*Simon Fraser University, Canada*

**Jiangchuan Liu**

*Simon Fraser University, Canada*

**Jie Liang**

*Simon Fraser University, Canada*

### ABSTRACT

*The past years have seen an explosion in the number of broadcasting network standards and a variety of multimedia services available to the mobile mass-market. Satellite communications has been gaining phenomenal growth and increasing interest over the last decade in its complementary but essential role for offering seamless broadband service coverage to potential users at every inch of the earth's surface. However, mobile satellite network often feature unidirectional and long-latency, a great deal of research effort has been attempted for this bottleneck. Given the absence of feasible power control mechanism and reliable feedback information, the role of packet scheduling in such a network with large delay-bandwidth product is extremely challenging. In fact, an optimized media access control (MAC) layer protocol is essential for cost-efficient satellite networks to compete with other terrestrial modalities. In particular, the integration and convergence between satellite network and conventional terrestrial backbone infrastructure offers promising solutions for next generation service provisioning. In this chapter, the authors give a survey on the state-of-the-art on packet scheduling in hybrid satellite-terrestrial networks (HSTN). A whole range of issues, from standardization, system to representative scheduling methodologies as well as their performance trade-offs have been envisioned. Moreover, the authors investigate viable solutions for effectively utilizing the limited/delayed feedbacks in resource management functions. They examine the flexibility and scalability for the alternative schemes proposed in this context, and analyze the performance gain achievable on essential QoS metrics, channel utilization, as well as fairness.*

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## INTRODUCTION

The proliferation of digital multimedia broadcasting (DMB) transmission technology and the increasing demand for resource-consuming rich-media and streaming video applications entail that the future generation wireless network should be capable of supporting heterogeneous multimedia provisioning over an extensive range of underlying network standards and protocols. Due to the unique broadcast nature and ubiquitous coverage of satellite communication system, the broadband satellite network, whilst concurrently integrating with terrestrial backbone infrastructures, has been gaining importance and provides immense brand new opportunities for delivering point-to-multipoint (p-t-mp) multimedia content to a large number of mobile audiences spreading over extensive geographical area. It is expected that the satellite component will play not only a complementary, but also essential role in delivering multimedia data to those areas where the terrestrial high-bandwidth communication infrastructures are, either economically prohibitive or technically unreachable.

A variety of multimedia broadcasting initiatives, such as the Multimedia Broadcast/Multicast Services (MBMS), Digital Video Broadcasting-Handheld (DVB-H), and terrestrial/satellite-DMB (T-/SDMB), Media Forward Link Only (MediaFLO) and Digital Terrestrial/Television Multimedia Broadcasting (DTMB) have been envisioned as viable solutions to provide one-to-many content distribution to mobile/portable devices. The 3rd Generation Partnership Project (3GPP) within the MBMS framework (3GPP, 2008) defines a unidirectional point-to-multipoint mode for the provisioning of multimedia services and thereby optimizes the available capacity in cellular networks. DVB-H (ETSI, 2004), as initiated by the DVB forum implements additional features based on the DVB-T standard to address the specific constraints associated with mobile handheld terminals. At the same time, MediaFLO (TIA, 2006)

developed by Qualcomm was recently approved by the Telecommunications Industry Association (TIA) as a new air interface standard for multicast delivery, aimed at delivering high-quality multimedia services to the U.S. mobile market. As the largest single digital communication market in the world, the Chinese government recently announced its national DTTB (Digital Terrestrial Television Broadcasting) standard and it has been widely expected that the massive deployment in China will begin in 2008 (GB, 2006). DTMB, the non-official acronym of the DTTB standard, is attracting a great deal of attention within the broadcasting community (Song, et al, 2007) as a cost-effective approach for delivering multimedia services over the Chinese market. Meanwhile, large number of research projects have been conducted to investigate viable solutions for facilitate the multimedia services provisioning via the so-called hybrid satellite-terrestrial network (HSTN), where terrestrial gap fillers are employed as the key functional element to provide the missing coverage when the direct LOS (line-of-sight) signals from satellite are temporarily unavailable. Mobile satellite networks often feature unidirectional and long-latency, which have posed challenging research barrier and attracted a great deal of research effort for this bottleneck. Given the absence of feasible power control mechanism and reliable feedback information, the role of packet scheduling is becoming a challenging task. In fact, an optimized design on media access control (MAC) layer protocols is essential for cost-efficient satellite networks to compete with other terrestrial modalities.

The rest of the chapter is organized as follows. We continue with an introduction of packet scheduling issues in HSTN. An overview of standardization issues and radio resource management (RRM) functions in multimedia broadcasting over HSTN are analyzed in the following section. In Section III, we review research and development efforts on packet scheduling schemes in satellite multimedia broadcasting drawn from existing

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