

## Chapter 17

# Hybrid Wireless Networks for E-Learning and Digital Literacy: Testing and Evaluation

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### ABSTRACT

*Today, satellite communication networks are being integrated into the infrastructure of modern Terrestrial communication networks and becoming popular for the delivery of educational content and data, as well as education-centric services, including information, tele-conferencing, entertainment, or “edutainment” services. With fresh demand for new services and applications, it is becoming essential that wireless network architecture seamlessly interoperate with new and existing technologies, protocols and standards. This paper presents recent work on the use of hybrid wireless network infrastructures for delivering tele-education and e-learning applications to remote communities by combining a variety of satellite, terrestrial and wireless technologies, and provides the results from live scenarios carried out employing various methods of interoperability testing. The analysis of the results examines a number of different issues such as delay, jitter, packet loss, latency, throughput measurement, and bandwidth. By combining satellite and terrestrial (wireless) technologies, full coverage and high capacity can be achieved for true broadband services for delivering educational content. The interoperability among such diverse networks imposes a number of challenges regarding service provision and management.*

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## **1. INTRODUCTION**

Satellite communications systems have a prominent role in the global information infrastructure (Chitre & Henderson, 1995). Based on today's challenging requirements, satellite network communications should be viewed as an integrated part of the global telecommunications infrastructure rather than as an individual entity (Evans et al., 2005). In a related context, Sugarbroad (1990) shows roaming possibilities between satellite and terrestrial networks. The study explains in detail the technical framework requirements to realize satellite and terrestrial roaming and its advantages to the end user. Accordingly, it highlights that fully proven network components that can make global satellite roaming practical and valuable feature are available within the 2.5G and 3G operator's service portfolio. Having this in mind, the author Shave (2002) predicts that the trend will continue into the 3G networks and multi-standard handsets where data services and especially Internet-based services become increasingly important.

From a more theoretical perspective, another study (Abuelma'atti, Merabti, & Askwith, 2006) aims to design wireless networked appliances interoperability architecture. In their approach, the interoperability is associated with many operational phases including: Coexistence, Internetworking, System Interoperability and End-to-end Interoperability. An OSI-based interoperability architecture for managing hybrid networks confirms that interoperability could be investigated at various levels of the OSI network model (Evans et al., 2005) e.g. coexistence problem caused by the interference of devices that use same frequency and/or end-to-end interoperability issues due to application communication protocol mismatch.

The aim of our investigation in this paper is to investigate this interoperability problem in hybrid wireless networks at application level, within the context of delivering tele-education and e-learning services across a wide area network (WAN) which is targeted towards meeting the needs of communi-

ties situated in geographically remote areas, and thus towards bridging the related geographical and digital gaps.

In our interoperability evaluations, we assume that there is no coexistence problem at the physical level. Therefore, a series of testing has been carried out in order to establish the interoperability requirements for hybrid wireless network technology with the objective to take live measurements from various scenarios by using appropriate measurement and analysis tools. The aims of this testing are firstly to identify any interoperability issues and secondly to ensure that the performance requirements from the perspective of the end user are met. Thus the needed capabilities and challenges for the seamless operation of the heterogeneous satellite-terrestrial wireless networks are identified. Various traffic data, files, packets and traces were captured and filtered.

The paper is organised as follows: Section 2 describes the various services deployed on the developed hybrid communications platform, including virtual classroom service, Learning content management service, Tele-conference Service, Webinar/Webcast Service Clix, and Isabel applications; Section 3 shows the test set up for interoperability testing with different scenarios; Section 4 analyses the test data and evaluated the findings and results; finally Section 5 provides the conclusions from this research.

## **2. TELE-EDUCATION NETWORK SERVICES**

There are a number of different software tools with various protocols that are available to use in applications related to tele-education, including audio, video, web conferencing, white board, VOIP, application sharing, application remote control and instant messaging. In the following subsections, different services such as virtual class room, learning content management service, tele-conference services and webinar/webcast services

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