Broadband Satellite Network Performance

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The globalization of the telecommunications industry and the exponential growth of the Internet are placing severe demands on the telecommunications infrastructure. During the next millennium, satellite systems will play a significant role in meeting these needs. Future satellite systems will provide interconnectivity and support a wide range of services to end users at homes and businesses.

There have been a number of filings for Ka-band satellite systems that plan to address broadband applications and interoperate with the current major technology developments in IP and ATM. These satellite networks will use onboard processing and switching to provide broadband services to and from earth stations. The rapid convergence of technical, regulatory, and business factors has increased the interest of system developers in Ka-band frequencies. Several factors have influenced the development of broadband satellite networks at Ka-band frequencies:

- Adaptive Power Control and Adaptive Coding technologies have been developed for improved performance by mitigating the impact of errors.
- A large bandwidth allocation to geosynchronous fixed satellite services (GSO FSS) and non-geosynchronous fixed satellite services (NGSO FSS) has made high data-rate services feasible.
- Development of low-noise transistors operating in the 20 GHz band and high-power transistors operating in the 30 GHz band have influenced the development of low-cost earth terminals. Space qualified higher efficiency traveling-wave tubes (TWTAs) and ASICs have improved the processing power. Improved satellite bus designs with efficient solar arrays and higher efficiency electric propulsion methods have resulted in cost effective launch vehicles.
- Demand Assignment Multiple Access (DAMA) algorithms along with traffic management schemes provide capacity allocation on demand, and global connectivity with intersatellite links and onboard processing.

Industry as well as research organizations are evaluating various technologies for broadband systems development and deployment. Performance studies using simulations and experimental testbeds have identified several key technologies and protocols to be used in future satellite networks. Standards bodies such as the ITU, the ATM Forum, the TIA, and the IETF are developing baseline specifications of the architecture, reference models, protocols, interfaces, and performance models. In this Feature Topic, we have tried to bring together the developments and results of such activity.

Our first goal is to present a series of studies on the performance issues of current and future broadband satellite networks. These articles not only discuss results of experiments, but also describe techniques for simulation, modeling, and analysis. The second goal is to discuss existing and proposed research and standards activities in satellite networking. A Feature Topic on "Satellite ATM Network Architectures" published in March 1999, presented a series of proposals on new architectures for satellite ATM networks. These two issues should provide the reader with a good understanding of the current status of satellite systems planning, standards development, and the potential areas of research.

The first article, "NASA's Broadband Satellite Networking Research," by William Ivancic, David Brooks, Brian Frantz, D. Hoder, Dan Shell, and David Beering is an overview of the various research activities organized by NASA on satellite research. The article discusses both standards activities, as well as recent experimental results conducted by the authors.

The second article by Bo Ryu, "Modeling and Simulation of Broadband Satellite Networks — Part II: Traffic Modeling," proposes techniques for modeling traffic on a satellite network. The article proposes three ways of modeling satellite traffic, and compares the techniques using statistical analysis of traffic traces.

The next two articles present performance results on TCP/IP over satellite networks. The article, "Performance Evaluation of TCP Extensions on ATM over High Bandwidth Delay Product Networks" by Charalambous Charalambos, Victor S. Frost, and Joseph B. Evans, presents performance results of TCP using the NASA ACTS satellite. The article presents comparative results over LAN, WAN and Satellite networks for TCP Reno, New Reno and SACK.

The article, "TCP/IP Enhancements for Satellite Networks" by Nasir Ghani and Sudhir Dixit, is a survey of recently proposed enhancements to the TCP protocol for satellite networks. The article also presents simulation results of various TCP enhancements over satellite links.

The next article by Enrique Cuevas, "The Development of Performance and Availability Standards for Satellite ATM Networks" discusses the standards being developed by the

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ITU-R on the performance of ATM over satellites and the availability objectives for ATM transport over satellites. The article also identifies several issues for future work related to on-board processing and intersatellite links.

The sixth article, "A Review of Error Performance Models for Satellite ATM Networks" by João Célio Brandão, Ernesto Leite Pinto, and Marco A. G. Maia presents statistical error models and their use for calculating the error performance parameters for satellite networks. Analysis of ATM layer QoS parameters in relation to BER statistics has also been presented.

The final article is an architecture article titled "A Satellite - switched CDMA System for Fixed Service Communications" by Diakoumis Gerakoulis, Evaggelos Geraniotis, Robert Miller, and Saeed Ghassemzadeh. The article proposes a multiple access and switching architecture for satellite systems, and presents several performance issues.

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BIOGRAPHIES

SASTRI KOTA [SM '86] (sastri.kota@lmco.com) is a technical consultant with Lockheed Martin Mission Systems in the areas of broadband networks, commercial and military satellite systems architectures, and standards and regulatory affairs. He has more than 25 years of experience in network systems design, analysis and held technical and project management positions at SRI International, Ford Aerospace, XEROX, The MITRE Corporation, and Computer Sciences Corporation. Currently he is very active in the telecommunications and networks standards development organizations and is an ATM Forum ambassador for wireless ATM and he is the ITU-R Working Party 4B Rapporteur for the New Recommendation "Performance of Satellite Systems operating Over 15 GHz." He has published and presented over 60 technical papers. He is the past chair of IEEE Aerospace and Electronics Society of the Bay Area (1994–1995). He has served as technical co-chair and assistant technical chair for MILCOM '97 and '90; conference chair for SPIE '90–'91; session organizer and chair for MILCOM '86, '90, and '92–'97. He holds a B.Sc. in physics from Andhra University, a B.E. in telecommunications from Birla Institute of Science and Technology, Pilani, an M.E. in electronics and communications from University of Roorkee, and an electrical engineer's degree from Northeastern University, Boston. He is a senior member of AIAA, and a member of ACM and SPIE. His research interests include broadband networks, wireless ATM, performance modeling and simulations, multiple access, traffic management, and QoS for Satellite ATM Networks.

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