

Satellite ATM Network Architecture



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The increasing interest in broadband satellite communications technology has positioned satellite networks to play an indispensable role in the Global Information Infrastructure. Satellites can provide wide geographic coverage to remote areas not connected to the terrestrial fabric. In areas of existing terrestrial connectivity, satellite systems can serve as an alternative to fiber optic networks. The inherent broadcasting capability of satellites facilitates multipoint communications. Satellite networks will be invaluable in providing ubiquitous connectivity for disaster recovery and military applications.

Numerous satellite systems are being designed for deployment in the near future. Although C-band and Ku-band systems continue to be developed, Ka-band is emerging as the frequency spectrum of choice. A significant number of the planned Ka-band satellite systems plan to use onboard switching and processing.

The design of satellite systems presents several architectural options and cost-performance tradeoffs. These options include the choice of orbit (GEO, MEO, LEO), processing and switching (onboard versus bent pipe), inter-satellite link design, as well as link layer technologies. Tradeoffs must be made with respect to the complexity, power and weight requirements for providing onboard buffering, switching and processing features on the satellite network. In addition to network architecture, protocols must be developed to efficiently support the peculiarities of satellite communications. Protocol design issues include media access techniques, routing, and traffic management for efficient network utilization.

A satellite network must support a wide variety of applications including data, voice, and video, both for unicast and multicast scenarios. As a result, while designing architectures and protocols, the nature and QoS requirements of applications must be considered. To facilitate design and deployment, various organizations including the ATM Forum, TIA, IETF and the ITU-T have established working groups to provide standards supporting the interoperability of satellite networks.

In this Feature Topic we have tried to bring together a set of articles that cover a range of architectural and protocol issues for designing multiservice satellite networks. The first article, "Next-Generation Satellite Networks: Architectures and Implementations" by Prakash Chitre and Ferit Yegenoglu presents an overview of the architectural issues in designing satellite networks. The article is based on standards specified in TIA TR34.1. The discussion breaks down the architectures into bent-pipe versus onboard processing systems, and considers mobility support for each type of system. The article concludes with

a discussion of the bandwidth management issues for satellite ATM networks.

Sankar Ray presents an excellent tutorial on the network mobility issues for ATM networks. His article, "Network Segment Mobility in ATM Networks," describes extensions to PNNI for support of network mobility and discusses both routing support and location management issues for a mobile network within a fixed ATM infrastructure.

The third article, "Protocol Architectures for Satellite ATM Broadband Networks" by Ioannis Mertzanis, Georgios Sfikas, Rahim Tafazolli, and Barry G. Evans presents two possible architectures for satellite networks. The article discusses requirements for future broadband satellite networks, and focuses on integration with terrestrial and mobile networks.

The next three articles focus on designing traffic management and media access techniques for broadband satellite networks. "Traffic Management for TCP/IP over Satellite ATM Networks," discusses techniques to optimize the transport of data traffic for long-delay satellite ATM networks. The article studies both end-system-based TCP policies, as well as switch-based ATM policies that improve throughput and fairness of TCP/IP over satellite ATM.

The article "Medium Access Control Protocols Performance in Satellite Communications," by Hassan Peyravi provides an excellent survey of the MAC techniques suitable for satellite networks. The study evaluates various protocols for the MARS Regional Network, and provides a performance comparison.

The final article by Dennis P. Connors, Bo Ryu, and Son Dao, is a study on modeling and analysis of MAC protocols for satellite networks. The authors describe potential applications and their QoS requirements. They then use a real-time video stream as a representative application and analyze its performance with four MAC protocols.

In summary, this feature topic should provide the reader with a good overview of the latest developments and issues in satellite architectures and protocols. In a future feature topic, we will present a set of articles discussing performance studies of various satellite network architectures.

We are grateful to the editor-in-chief, Andrzej Jajszczyk, for helping us complete this feature topic on time. We would like to thank the authors for their submissions, as well as the reviewers for their comments. We would also like to thank Guy Omidyar for independently handling the reviews for the article on traffic management.

BIOGRAPHIES

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RAJ JAIN [F '93] is a professor of computer and information science at The Ohio State University. He is an active member of the ATM Forum Traffic Management group and has influenced its direction considerably. He is a Fellow of IEEE, a fellow of ACM, and serves on the editorial boards of Computer Networks and ISDN Systems, Computer Communications (U.K.), and the Journal of High Speed Networks. He is the author of two popular books: "FDDI Handbook: High Speed Networking using Fiber and Other Media" published by Addison-Wesley and "The Art of Computer Systems Performance Analysis" published by Wiley. His publications and ATM Forum contributions and can be found at <http://www.cis.ohio-state.edu/~jain>

SASTRI KOTA [SM '86] 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 over 25 years of experience in network systems design, analysis and held technical and project management positions at SRI International, Ford Aerospace, XEROX, The MITRE, 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 during 1994-1995. He has served as technical co-chair and asst. 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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