Document Number: ATM Forum/98-0828
****

Title: A progress Report on the Standards Development for Satellite ATM Networks
****

Source:

Sastri Kota
Lockheed Martin Telecommunications
1272 Borregas Ave B/551
Sunnyvale, CA 94089
Voice: +1 408-543-3140
Fax: +1 408-543-3104
Email: sastri.kota@lmco.com

Raj Jain
Department of CIS
Ohio State University
395 Dreese Lab, 2015 Neil ave.
Columbus, OH 43210-1277
Voice: +1 614-292-3989
Fax: +1 614-292-2911
Email: jain@cis.ohio-state.edu

Thomas vonDeak
NASA Lewis Research Center MS: 54-6
21000 Brookpark Road
Cleveland, OH 44135
Voice: +1 216-433-3277
Fax: +1 216-433-8705
Email: tvondeak@lerc.nasa.gov

Ferit Yegenoghu
COMSAT Laboratories
22300 COMSAT Drive
Clarksburg, MD 20871
Voice: +1 301-428-4638
Fax: +1 301-601-5850
Email: ferit@ntd.comsat.com

****

DISTRIBUTION: ATM Forum Technical Committee
Wireless ATM Working Group

****

DATE: November 1998, Nashville, Tennessee

****

ABSTRACT: In this contribution, a brief progress report of the development of the Satellite ATM recommendations by ITU-R Working Part 4B, TIA and IETF standards organizations is presented. These deal with the performance objectives of ATM over satellite and with the availability objectives for ATM transport over satellite. In the subsequent contributions, several performance objectives for GSO and NGSO satellite networks at higher frequencies which plan to use on board ATM switching, processing and intersatellite links will be discussed.

****

****

1. Introduction

During the July 1998 ATM Forum meeting in Portland, it was decided to develop a work plan on the Subgroup of the Wireless ATM Working Group focussing on the Infrastructure mobility and Satellite Access networks using ATM and/or ATM like switching capabilities. The contribution ATMF 98-0735, presented in Gold Coast, Australia, addressed the work plan of the subgroup and eventually developed a baseline requirements and specification document. Two motions about the work items and the schedules were passed by the subgroup.[1]

The rapid globalization of the telecommunications industry and the exponential growth of Internet are placing severe demands on new global telecommunication network designs and development of international standards and regulatory affairs. This demand is further increased by the convergence of computing and communications and by the growth of new applications such as web surfing and desktop video conferencing. Existing terrestrial infrastructure can address such telecommunications needs; however, hybrid solutions involving satellites are necessary to achieve interconnectivity with distant/isolated nodes of the terrestrial networks. These integrated satellite/terrestrial networks can reduce traffic congestion problems and provide better quality of service to remote users where fiber-optic networking costs could be prohibitive.

With the widespread availability of multimedia technology, and an increasing demand for electronic connectivity across the world, satellite networks will play an indispensable role in the deployment of global networks. Multimedia satellites are the new generation communication satellites that will use on board processing and switching to provide full 2-way services to and from earth stations comparable in size to today's direct to home television receiving dish. The key technologies that make the new generation of multimedia satellites possible are a) multiple small high gain spot beam antennas, b) on board processing and switching and c) intersatellite links. Multimedia satellite communication systems are being developed to provide global, broadband communication services, including high data rate Internet access, private Intranets and TV broadcasting. Some ka band Low Earth Orbit (LEO), Medium Earth Orbit (MEO) and Geosynchronous Earth Orbit (GEO) satellites plan to implement ATM on board processing and switching capabilities and intersatellite links.[2]

Future technological challenges include interoperability between newly planned satellite systems with terrestrial networks and meeting user-required quality of service. To address these issues, several standards organizations are developing standards for satellite environment for the transport of ATM. This contribution offers a status report on the newly developing recommendation of the Working Party 4B of the ITU-Radiocommunication sector on the performance of ATM over satellite and on the availability objectives for ATM transport of satellites. In addition, the standards developing activities on Satellite ATM by TIA-TR34.1 and IETF-TCP over Satellite are discussed.

2. Standards for Satellite ATM

The following organizations are involved in developing the standards for ATM over satellite.

1. ITU-R Working Party 4B
2. TIA
3. ATM Forum
4. IETF
5. ETSI

2.1 ITU-R Working Party 4B

Working Party 4B of the ITU-Radiocommunications sector has started the development of two recommendations that are aligned with the Rec.I.356 "B-ISDN ATM Layer Cell Transfer Performance" and Rec.I.357 "B-ISDN Semi Permanent Connection Availability" respectively. These are Preliminary Draft New Recommendations S.ATM titled as "Performance for B-ISDN ATM via Satellite" and S.ATM-AV "Availability for ATM via Satellite". These recommendations are planned for approval by the ITU-R Study Group 4 by April 1999'.

2.1.1 S.ATM Recommendation

This new recommendation consists of two annexes: normative and informative. The normative section deals with a reference model for a satellite path, ATM performance objectives for satellite system, translation between TM layer and physical layer parameters and relationship between ITU-T Recommendations G.826 and I.356 Performance parameters. The informative section describes the simulated and measured performance of ATM over satellite, measured results of physical versus ATM layer performance, ATM application requirements and techniques to enhance performance of ATM over satellites.[3]

2.1.2 ATM Performance Objectives for Satellite Links

This section provides an interpretation of the performance objectives defined in ITU-T Recommendation I.356 and the corresponding requirements for the satellite portion(s) of an ATM connection.

The end-to-end ATM Layer network performance parameters and objectives for public Broadband Integrated Services Digital Network (B-ISDN) are defined in ITU-T Rec. I.356. To accommodate the characteristics and the requirements of various traffic types, I.356 defines various Classes of Service. Class-1 (Stringent Class) is a delay sensitive class and it is intended to support Constant Bit Rate (CBR) and real-time Variable Bit Rate (VBR) services such as telephony and videoconference. Class-2 (Tolerant Class) is a delay tolerant class and supports Available Bit Rate (ABR) and non-real-time Variable Bit Rate (VBR) services such as video and data. Class-3 (Bi-Level Class) supports VBR and ABR services such as high-speed data. Finally, Class-4 (Unspecified Class) supports Unspecified Bit Rate (UBR) services such as file transfers and email. Table 1 provides

the ATM Layer performance objectives for the various service Classes. These objectives may be revised in the future based on real operational experience.

Table 1 QoS class definition and network performance parameters

	CTD	**2-pt. CDV**	**CLR0+1**	**CLR 0**	**CER**	**CMR**	**SECBR**
Default Objectives:	no default	no default	no default	no	4*10-6	1/day	10-4
QoS Classes:							
Class 1 (stringent class)	400 msec.	3 msec.	3*10-7	none	default	default	default
Class 2 (tolerant class)	U	U	10-5	none	default	default	default
Class 3 (Bi-level class)	U	U	U	10-5	default	default	default
U class	U	U	U	U	U	U	U

The QoS class required by each application is part of the contract negotiation procedure between the user and the network. If the network can provide the requested service level, the connection will go through. If there is any performance objective that cannot be met, the connection will be denied. Once a connection is established, the network must ensure that the performance objectives of the QoS class are not exceeded during the connection.

2.1.3 ATM Performance Objectives for Satellite Systems

Numerical values of ATM performance parameters for satellite systems can be derived by applying the allocations given in Table 1 to the performance objectives given in I.356. As an illustration, the ATM Performance Objectives for a satellite link used in the international portion that provides Class-1 Service and does not contain switching or cross-connect functions is shown in table 2 .

Table 2: ATM Performance Objectives for Satellites (Class-1 Services)

Performance Parameters	ITU Objective End-to-end	ITU Objective Satellite	
CLR	3xE-7	7.5xE-8	
CER	4xE-6	1.4xE-6	
SECBR	1xE-4	3.0xE-5	
CTD	400 ms	320 ms (max)	
CDV	3 ms	Negligible	
CMR	1/day	For Further Study	

2.1.3 Impact of Satellite Characteristics on ATM Performance

To meet stringent objectives of ATM, satellite systems will need to meet special challenges. One characteristic of satellites is the impact of occasional burst errors that can adversely affect the application performance, either directly or indirectly, via the ATM Layer or the ATM Adaptation Layer Protocols. Since satellites are prone to noise and interference from various sources, it is imperative to develop adequate transmission plans. This includes considerations on the selection frequency, transmit and receive power levels, and appropriate coding mechanisms. In particular, robust coding mechanisms such as Reed Solomon codes can reduce the amount of errors that otherwise may pass uncorrected by conventional Forward Error Correction techniques like Convolutional Encoding and Viterbi Decoding. The informative section of the new recommendation on S.ATM describes simulation results of the concatenated coding.

2.1.4 QoS Requirements of ATM Services and Applications

To adopt the ATM Layer performance objectives shown in Table 1, various studies and measurement results of the Quality of Service (QoS) of ATM applications were submitted to the ITU Study Groups. The goal of these studies was to identify, for each ATM Layer network parameter, the performance objectives that would satisfy the service quality expected by the end-user.

Among the various contributions submitted to the ITU was a study conducted by AT&T and Telstra during the AT&T-KDD-Telstra (AKT) ATM Field Trial. One of the objectives of the AKT ATM Trial was to assess the feasibility of transporting ATM over a combination of fiber and satellite connections. The informative section of the S.ATM recommendation provides the AKT trial results on the physical and ATM layer performance of 45Mbps satellite facilities and on the QoS applications.

2.1.5 ATM Availability Considerations

ITU-T SG-13 has developed Rec.I.357 to address the availability of permanent virtual connections. Rec.I.357 establishes two types of availability parameters. The first parameter is the *Availability Ratio* (AR), well known by satellite engineers as the "satellite availability". The second parameter is the *Mean Time Between Outages* (MTBO), defined as the average duration of a continuous time interval during which the ATM network portion is available. At present, not enough is known about the MTBO exhibited by satellite systems, although existing propagation data could be used to investigate this and other statistics about the behavior of a satellite link during periods of degraded performance. Hence, the discussion on this section will be limited only to the *Availability Ratio* parameter. As opposed to fiber systems, satellites exhibit performance characteristics that are determined by changing atmospheric conditions that affect the signal propagation, the various sources of interference and the type of equipment used. Considering these aspects, ITU-R WP-4B has adopted the following expression to define the satellite system availability.[4]

$$A_{\text{Satellite Link}} = A_{\text{Propagation}} * A_{\text{Earth Station}} * A_{\text{Spacecraft}}$$

$A_{\text{Propagation}}$	Represents the availability due to rain attenuation and interference effects in the uplink and downlink
$A_{\text{Earth Station}}$	Represents the availability (equipment reliability) of all Transmit and Receive earth station equipment up to the terrestrial interface. It also includes sun interference effects and the availability of any ATM equipment that may be used in a satellite connection.
$A_{\text{Spacecraft}}$	Represents the total availability (equipment reliability) of the spacecraft including eclipse outages. It also includes the availability of any on-board ATM processing and/or switching equipment.
$A_{\text{Satellite Link}}$	Represents the product of all availability components on a satellite link.

In addition to the parameters mentioned, traffic congestion is being considered by ITU-T. As applied to satellite systems, this parameter may include availability due to traffic congestion or queuing from on-board ATM equipment and/or any satellite-specific ATM equipment used at the earth stations.

The recommendation on availability objectives for transmission of B-ISDN ATM; in the fixed satellite service by Geosatellite system; operating below 15GHz provides the satellite hypothetical reference digital path availability. In addition, the measurements of availability of satellite links carrying B-ISDN ATM traffic in terms of BER, CLR, CER versus percentage of time is described.

2.2 TIA

TR-34.1: Common Air Interface Working Group (CAI WG). Purpose of the working group is to develop a common air interface standard for GEO Mobile Satellite Service enabling interoperation with terrestrial GSM. The current subject of standardization is the satellite-mobile link in both the uplink and downlink directions. The requirements document for the Common Air Interface for GSM over GEO mobile systems has been finalized and will be issued by the TIA as TSB90. The working group is scheduled to meet again on November 17, 1998 at which time they will settle on the document format that is to be used for the specification.

Chair: Ferit Yegenoghu
COMSAT Laboratories
Voice: +1 301-428-4638
Fax: +1 301-601-5850
Email: ferit@ntd.comsat.com

TR-34.1: Wireless ATM Working Group. This working group produced the TIA Systems Bulletin - 91 (TSB-91) "Satellite ATM Networks: Architectures and Guidelines." in April, 1998. This document provides architectures and guidelines for satellite ATM networks. These architectures differ from one another in terms of required level of

mobility, supported data rates, supported terrestrial interfaces, and on board processing and switching requirements.

The ATM network architectures for bent-pipe satellites defined in TSB-91 are: i) SATATM 1.1 - Fixed ATM Network Access and Network Interconnect, ii) SATATM 1.2 - Mobile ATM Network Access, iii) SATATM 1.3 - Mobile ATM Network Interconnect. The ATM Network architectures defined for satellites with on-board ATM switches are: i) SATATM 2.1 - ATM Network Access, ii) SATATM 2.2 - ATM Network Interconnect, and iii) SATATM 2.3 - Full Mesh ATM. TIA TR 34.1 plans to use this document as a basis in developing the technical specifications for these SATATM networks.

The Wireless ATM working group of TIA TR34.1 has finished its task and no longer exists.

TR-34.1: The Satellite Over ATM Common Air Interface Working Group. This group began work in November, 1997 on developing a standard for ATM over geosynchronous satellite links. This work has involved establishing the ATM performance requirements that need to be met over the satellite link and choosing a technical approach which meets these requirements with the best benefit/efficiency trade-off. In Fall of 1998, the group has produced a preliminary specification for a Common ATM Satellite Interface (CASI)protocol which is defined such that interoperability is assured between various vendor implementations. This preliminary specification details the overall operation of the CASI, including specifying a frame format for transport of multiple ATM cells per frame over the satellite link; and forward error correction, which adapts to the satellite link condition, applied to each frame for maintaining ATM service quality. A final CASI specification is expected in December, 1998 for review.

Chair: Don Choi
DISA
choid@ncr.disa.mil

TR-34.1: Interoperability Reference Models. Purpose is to formalize the format and terminology used by the satellite community. This is to ensure compatibility with concepts put forth by other standards-making bodies. A draft document has been developed; TSB number and the completion date have not been assigned.

Chair: Kul Bhasin
NASA Lewis Research Center
Voice: +1 216 433-3676
Fax: +1 216 433-8705
E-mail: Kul.B.Bhasin@lerc.nasa.gov

TR-34.1: ATM Traffic Management. TSB nearing completion on “Traffic Management in ATM Networks over Satellite Links”. The TSB will provide a survey of the traffic management issues related to the design of satellite-ATM networks. While the main focus is on traffic management issues, several recommendations on the design options for

efficiently carrying data services over satellite-ATM networks are presented. Final editing is required before the TSB is distributed for ballot. Anticipated completion is November 1998.

Chair: Raj Jain
Ohio State University
Voice: +1 614-292-3989
Fax: +1 614-292-2911
Email: jain@cis.ohio-state.edu

TR-34.2: 2GHz Joint Working Group with TR-14.11 and NSMA. Purpose of group is to study MSS/FS sharing in the 2 GHz band. TSB 86, version 9.1 is nearing completion. This TSB will serve as a "handbook" for the determination of interference in the 2 GHz band between MSS and FS services. The specific interference criteria are currently under discussion and it is anticipated that the document will be submitted for ballot in December 1998. Concurrently, another report is being prepared that will address non-interference issues. A completion date has not been assigned to that report.

Chair: William Lye
Lucent Technologies
Voice: +1 325 593-6032
Fax: +1 325 593-0632
e-mail: bill.lye@allcomtech.com

TR-34.2: 18 GHz Joint Working Group with TR-14.11 and NSMA. Purpose of group is to study 1) FSS/FS sharing in the Ka GHz band and 2) blanket licensing of Earth stations in the Ka band. Output will be a TSB, completion date not yet assigned.

Chair: Jeffrey Binckes
ICO Global Communication Services
Voice: +1 202 887-8111 x223
Fax: +1 202 887-0889
E-mail:jeffrey.binkes@ico.com

The TIA TR-34 formed an ad hoc committee to participate in the US TG-8/1 Ad Hoc RTT Evaluation Group evaluation of Radio Telephone Transmission (RTT) proposals that had been submitted to the ITU regarding the role of satellites in next generation systems. The ad hoc committee reported that the proposals could not be properly evaluated for their efficacy because satellite related parameters were not included in the self-evaluation materials provided to the proposers. As a result the proposals were evaluated solely on the basis of whether they met the criteria of the submission guidelines.

2.3 IETF

The Internet Engineering Task Force (IETF) has a "TCP over Satellite Working Group." This group's goal is to produce two informational Request for Comments (RFCs) by January 1998. These RFCs are currently in the Internet Draft stage. The first I-D [5] describes IETF standardized mechanisms that enable TCP to more effectively utilize satellite links. The second I-D [6] describes similar mechanisms that are still in research stage.

Chair: Aaron Falk <adfalk@mail.hac.com>
Working Group Mailing List: tcpsat@lerc.nasa.gov
To Subscribe: majordomo@lerc.nasa.gov
In Body: subscribe <your_email_address>
Mail Archive: http://tcpsat.lerc.nasa.gov/tcpsat/mail.html

2.4 ETSI

[The information could not be obtained in time for this contribution. Will be supplied later in a separate contribution.]

3. Conclusions

Several standards organizations are actively working on issues related to Satellite ATM. In particular, activities at ITU-R, TIA, and IETF are described here.

References

1. Sastri Kota, Sankar Ray, Thomas vonDeak, Vijay Kapoor: “Infrastructure Mobility and Satellite Access Sub Group Work Plans”, ATM FORUM 98-0735, October 1998, Gold Coast, Australia.
2. Sastri Kota, “Multimedia Satellite Networks: Issues and Challenges”, Multimedia Systems and Applications Conference, SPIE International Symposium, 3 November 1998, Boston, MA.
3. ITU-R WP-4B Draft New Recommendation ITU-R S.[4B/XC] (S.ATM): “Performance For B-ISDN Asynchronous Transfer Mode (ATM) Via Satellite”, Document 4B/TEMP/25-E, 13 October 1998, Geneva, Switzerland.
4. ITU-R WP-4B Draft New Recommendation ITU-R S.[4B/XC] (S.ATM): “Availability Objectives For a Hypothetical Reference Digital Path When Used For the Transmission of B_ISDN Asynchronous Transfer Mode (ATM) in the Fixed-Satellite Service by Geostationary Orbit Satellite Systems Using Frequencies Below 15 GHz ”, Document 4B/TEMP/27-E, 13 October 1998, Geneva, Switzerland.
5. IETF, "Enhancing TCP Over Satellite Channels using Standard Mechanisms," September 1998, http://www.ietf.org/internet-drafts/draft-ietf-tcpsat-stand-mech-06.txt

IETF, "Ongoing TCP Research Related to Satellites," August 1998, http://www.ietf.org/internet-drafts/draft-ietf-tcpsat-res-issues-04.txt