SATELLITE AND SPACE COMMUNICATIONS SSC
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IEEE COMMUNICATIONS SOCIETY

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The Satellite and Space Communications (SSC) Committee is a volunteer group actively involved in advancing satellite and space communication technologies within the IEEE. This committee is approved by the IEEE Communications Society and is governed by the constitution and bylaws of the IEEE as well as the other twenty Technical Committees in the Society.

SATELLITE & SPACE

- JOIN US -

All conference attendees are welcome to join us in the SSC Committee meeting.

Hotel: San Francisco Marriott, CA, USA 5th floor
Room: Room Sierra B
Date: Wednesday, December 3, 2003
Time: Start Time: 12:00 PM End Time: 1:45 PM

Future SSC Meetings

June 2004	Paris, France
December 2004	Dallas, Texas, USA
May 2004	Seoul, Korea

GLOBECOM 2003 SSC Committee Activities

Workshops (Dec. 1 and 5, 2003)
W-5, "Multimedia Broadband Satellite Communications Systems", Salon 3, Dec, 5th, Half-day, Friday Afternoon.

Tutorials (Dec. 1and 5, 2003)
T-07, "Space-Time Signaling", Salon 2, Dec. 5th, Afternoon.
T-14, "Mobile Internet and the Network Security", Room A1, Dec. 1st, Afternoon.
T-16, "Emerging Technologies for Next Generation Networks", Room C1, Dec. 1st, Morning.
T-18, "Technologies for Next-Generation Wireless Internet", Room B2, Dec. 1st, Afternoon.
T-19, "Smart Antennas for Wireless Systems", Room B2, Dec. 5th, Afternoon.
T-24, "Applications of the Viterbi Algorithm or How I learned to love the Trellis", Salon 4, Dec. 5th, Afternoon.

Wireless Communications Symposium (Dec. 2 - 4, 2003)
WC-17, Room A2, "Reliable Transport in Heterogeneous Wireless Networks", Dec. 3rd, 2:00 pm - 5:00 pm.
WC-29b, Room A2, "Satellite & Space Communications", Dec. 4th, 2:00 pm - 5:00 pm.

General Conference (Dec. 2 - 4, 2003)
GC-1, Salon 13, "Performance and Optimization", Dec. 2nd, 9.00 am – 12.00 pm.
GC-2, Salon 14, "Modulation and Coding", Dec. 2nd, 9.00 am – 12.00 pm.
GC-12, Salon 15, "High-Speed Networks", Dec. 3rd, 2.00 pm – 5.00 pm.

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MESSAGE FROM THE CHAIR

Ron P. Smith

The Satellite and Space Communications (SSC) Technical Committee is an international volunteer organization governed by the IEEE Communications Society. SSC has been providing a forum for technical advancement of space borne communications since our founding in 1962. Please help us to continue our contributions to this exciting field by finding you own way to participate in our committee. SSC meets twice per year at ICC and Globecom conferences, and there are numerous ways to be active through the Internet by visiting our web site.

Our last meeting was at ICC 2003 in Anchorage, Alaska. I would like to thank our committee members who were able to attend, as well as those who have contributed electronically to conferences and publications as authors, organizers, editors and reviewers. Your volunteer efforts directly contribute the advancement of knowledge in the field of satellite and space communications.

SSC is actively involved in organizing sessions and workshops for major IEEE ComSoc conferences such as ICC and Globecom. You can help us by volunteering to serve as a technical program representative or as a paper reviewer. If you have suggestions for workshops or tutorials, you can submit your ideas directly to the conferences as well as coming to SSC for support. We are always interested in participating in other events cosponsored by the IEEE, such as the AIAA International Communications Satellite Systems Conference (www.aiaa-icssc.org), so please contact us if SSC can help with your favorite event.

In recent years there has been increasing convergence of technologies involved in satellite communication. SSC recognizes this as an opportunity to collaborate with our colleagues in other ComSoc TCs such as Communication Theory (CT), Personal Communications (PC) and Communications Systems Integration & Modeling (CSIM) TCs, as well as with other organizations such as the AIAA Technical Committee on Communications Systems and the IEE Satellite Communications Group. We have a number of liaisons with technical committees and publications listed on our web site. Please let us know of other sources of collaboration or volunteer to be one of our liaisons.

Publications are a major instrument in furthering our goals of advancing satcom technology and professional development in our field. The IEEE Communications Magazine is an excellent publication for reaching a wide technical audience and the IEEE Journal on Selected Areas of Communication provides a great opportunity for in depth examination of technical developments. Both

of these publications organize featured topics with multiple papers on a subject in a single issue. SSC members help to organize these features by submitting recommendations to the editorial boards and serving as guest editors and reviewers. SSC encourages publication by presenting the "Distinguished Contributions to Satellite Communications Award." Information about this award and the nomination procedure can be found on our web site. Please nominate one of your deserving colleagues for this award.

As you can see, there are numerous ways for you to participate with SSC to help advance our field and the professional careers of our members and yourself. I have found this to be a rewarding endeavor and invite you to join us.

Dr Ron P. Smith, Chair
Satellite and Space Communications
Technical Committee

SCANNING THE WORLD

Abbas Jamalipour

The satellite communications industry is apparently moving to a new direction from its traditional voice service to the emerging data communications. This can be seen from the recent growth in usage of Ku-band versus the C-band. According to a recent report from Futron Corp. (www.satmagazine.com), during the period of 2000 to 2003, C-band capacity has grown at 9% while at the same period the capacity of Ku-band had an increase of 20%. At the same time, capacity of Ka-band has fallen as much as 29%. The reason is mainly due to the growth in data and video application while the voice telephony application was down for almost half in 2003. The Internet service for home and corporate users as well as the increase in demand for HDTV are the main factors in increase of data and video applications over satellites in recent years.

While in the last three years the telephony service was down at 45.1%, the data was up at 6.6%, and video was up at 9%, the report also shows that the available capacity in the market has risen to 52.1%. That is, there are about 52% unutilized transponders in the sky, which is a result of huge increase in deployment of new transponders in recent years. New applications for satellites and new users in other locations on the globe than Europe and North America are the potential users of this available capacity.

Other than market growth in satellite communications industry, we have seen good increase in research activities in the field. Last year the IEEE Journal on Selected Areas in Communications called for paper submissions to a special issue on "Broadband IP networks via satellites" to be published in 2004. Such special issue on satellite has not been seen for some years in JSAC and therefore this illustrates new research directions in this important field of communications. The overwhelming response to the call-for-papers has resulted the issue to be published in two parts, February and May 2004. We have also seen more satellite-oriented papers submitted to international conferences in 2003 compared to the previous years.

The February 2004 JSAC issue will include 17 high-quality papers addressing mainly higher layers of the network protocol stack. The May issue will look at lower layers such as physical and link control for satellite communications.

As new applications for satellite communications, home and small business users especially in remote areas are getting advantage of high-speed downlink IP access through satellite systems. Efficient integration of satellite broadcasting and Internet access to individual users is seen as a driver for more progress in satellite communication industry. The in-flight high-speed and cost-efficient Internet access to users is also in the stage of development, with large amount of investment by airline companies. All in all the satellite industry finds its marketing and growth way through service paths that no other communications system could provide. This new trend is completely different from that was considered in early 90's where mobile satellite phone was the main service goal for the industry. A goal that has been resulted in failure of several satellite projects and slow down in overall industry.

Now let's see some more recent news about satellite's new applications. Interestingly, satellite radio becomes one of the most popular applications of satellites. Providing CD-quality from coast to coast, satellite radio has been adopted faster than all other entertainment systems such as local radio, cable TV, video recorder, CD, and MP3 player, with the exception of DVD player in US market. The next important application of satellite is the use of satellite as the backbone for Wi-Fi Internet access technology. A recent report by Northern Sky Research shows that

over a thousand satellite-based Wi-Fi hot spots have already deployed, with an increase market of 95,000 more over the next five years. HDTV remains as one of the main applications of satellites with increasing rate of satellite channels using HDTV technology. In-flight broadband Internet access comes to the next application with an increasing investment from Boeing and recent signed agreements with European and Asian airline companies. The service is to be stated in 2004 and will not limited to email and web browsing. Access to corporate intranets and networks will also be provided. Telemedicine is working hard to catch the growth in other satellite applications but it is still considered as an important application for satellite communications. (The author acknowledges the usage of SatMagazine's statistics in preparation of this article.)

Prof. Abbas Jamalipour, Vice Chair
Satellite and Space Communications
Technical Committee

FORTHCOMING GLOBECOM AND ICC CONFERENCES

ICC 2004
June 20 - 24, 2004,
Paris, France
The technical program will feature a unique set of technical symposia disseminating the latest research and development results in communications and networking, and business applications sessions and panels, where industry leaders will address the hottest topics in telecommunications and the future evolutions of this field. In addition, the program will include tutorials and workshops by internationally recognized experts, where engineers can learn about new technologies of their choice. ICC 2004 will thus feature a technical program equally attracting researchers from academia and engineers from industry, network operators, and service providers.

GLOBECOM 2004
Nov. 26 – Dec. 3, 2004,
Dallas, Texas, USA
The theme of Globecom '04 "Emerging Technologies Applications and Services" characterizes the continuing pervasiveness of telecommunications in all aspects of global society, industry, and government. The technical sessions of Globecom '04 will be presented in seven Symposia: Global Internet and Next Generation Networks, Wireless Communications, Networks and Systems, Communication Theory, Security and Network Management, Optical Communications, Networks, and Systems, Signal Processing for Communications, General Symposium. In addition Globecom'04 will feature keynote sessions presented by leaders of the industry, a full tutorial program, and a "Designers and Developers Forum" with papers, panels and exhibits of products that design and development engineers use in their activity on new products.

COSPONSORING / RELATED CONFERENCES AND WORKSHOPS

Milcom 2004
Oct. 31 – Nov. 3, 2004,
Monterey, CA, USA
MILCOM 2004 will focus on capabilities enabled by harnessing the power of new and emerging communications and information systems technologies. MILCOM 2004 is soliciting unclassified and classified papers (up to DoD SECRET and releasable to foreign nationals) relevant to communications and information system capabilities that address the 21st century challenges of national defense and homeland security.

ICSSC 2004
May 9 - 12, 2004,
Monterey, CA, USA
Conference Theme: Communications Transformation. ICSSC 2004 will focus on the dynamics of communications market and technologies. The conference is endorsed by SSC and co-sponsored by IEEE ComSoc and MTT societies

CONFERENCE CALENDAR

CONFERENCE	LOCATION	INFORMATION
GLOBECOM 2003 IEEE Global Communications Conference	Dec 1 - 5, 2003, San Francisco, CA, USA	http://www.globecom2003.com/
INFOCOM 2004 23rd IEEE International Conference on Computer Communications	March 7-11, 2004 Honk Hong	http://www.ieee-infocom.org/2004/
WCNC 2004 IEEE Wireless Communications and Networking Conference	March 21-25, 2004 Atlanta, Georgia, USA	http://www.comsoc.org/confs/wcnc/2004/index.html
NOMS 2004 IEEE / IFIP 2004 Network Operations and Management Symposium	April 19-23, 2004 Seoul, Korea	http://www.noms2004.org/
VTC 2004 Spring The 59th IEEE Semiannual Vehicular Technology Conference	May, 17-19, 2004 Milan, Italy	http://www.eee.strath.ac.uk/vtc2003/vtc2004spring/
ICC 2004 International Conference on Communications	June 20 - 24, 2004, Paris, France	http://www.icc2004.org/
VTC 2004 Fall The 60th IEEE Semiannual Vehicular Technology Conference	September 26-29, 2004 Los Angeles, CA, USA	http://www.aero.org/conferences/vtc2004fall/
ICSSC 2004 22nd AIAA International Communications Satellite Systems Conference	May 9 - 12, 2004, Monterey, CA, USA	http://www.aiaa.org/events/ICSSC
MILCOM 2004 IEEE/AFCEA Military Communications Conference	Oct 31 – Nov. 3, 2004, Monterey, CA, USA	http://www.milcom.org/2004/
GLOBECOM 2004 IEEE Global Communications Conference	Nov 29 – Dec. 3, 2004, Dallas, Texas, USA	http://www.globecom2004.org/
ICC 2005 International Conference on Communications	May 15 - 19, 2005, Seoul, Korea	http://www.icc05.org/
VTC 2005 Spring The 61st IEEE Semiannual Vehicular Technology Conference	May 29 – June 1 2005 Stockholm, Sweden	http://ewh.ieee.org/soc/vts/conf/vtsconf.html

To all SSC members: If your postal or e-mail addresses, telephone or fax numbers have changed, please update them with the committee secretary. You can review our current records on our web page at www.comsoc.org/socstr/techcom/ssc

PERSPECTIVE ARTICLE December 2003

Validation of IP real-time multimedia over geostationary satellite

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Introduction

Real-time applications impose strong quality requirements to the networks supporting them, especially in terms of delay, jitter and packet loss parameters values. It is highly attractive to offer IP services like multi-videoconference over geostationary satellite systems, due to their broadcast capabilities and global coverage. Double satellite hop must be avoided due to high delay caused by propagation distance. Also, small terrestrial paths pave the way for introducing service level guarantees. But the question is, is single hop architecture enough for ensuring good quality of service levels for real-time transmissions, with propagation delay of almost one-quarter of second? This article presents research work carried out within the FP5 IST ICEBERGS project related to the validation of a videoconference transmission over a mixed geostationary satellite and terrestrial network, in terms of quality of service of the audio and video flows.

Delay model to minimise delay contributions

Satellite high propagation delay is the main constraint in ICEBERGS project environment, and has important consequences on quality. Therefore a detailed delay model for multimedia services over geostationary satellites is derived. Delay contributions include that of codec processing plus algorithmic/lookahead, packetisation, satellite terminal queuing and serialisation, satellite propagation, satellite on board processing, dejittering buffer, *lip sinc* (for combination of audio and video), terrestrial network legs, and media mixing (for multiparty conferences). Overall delay can be reduced affecting the following factors: selection of codec, user application, employ of adaptive jitter buffer (or establishing the optimum dejitter buffer size), prioritisation of multimedia traffic in the satellite network, efficient assignment of slots at MAC layer for uplink transmission to reduce satellite terminal queuing, other aspects like dynamic audio sampling rate; dynamic components to use (e.g. only audio if videoconference quality is poor); audio traffic priorisation; dynamic modification of video parameters.

Starting from this, the objective of the tests is the set up and validation of an optimum architecture by configuring the selection of the codecs, user application, and dejitter buffer size that achieve a better performance in terms of quality (delay-related).

Videoconference QoS measurements

The QoS required by networked multimedia applications can be described in terms of technical parameters that characterise the system and identify the factors that influence quality [1]. The threshold values are defined by standardization bodies (ETSI-TIPHON, ITU). However, for determining the overall subjective it is convenient the use of quality standard methods:

- E-Model (audio): It maps network quality statistics to MOS (Mean Opinion Score, produced by a large group of people that evaluates subjectively the quality to yield a mean score)
- Perceptual methods: They perform mathematical calculations to compare signals in order to yield a MOS value.

Validation campaign

The measurement campaign extends the preliminary results described in [2] where VoIP over satellite was validated, but without any specific improvement technique. The aim of present work is to determine the best configuration of the system so that audio and video quality is optimised, and also to measure the QoS that is obtained for this optimum configuration and for the system network conditions. The tests were performed using both a laboratory emulator and a real environment with a satellite geostationary link. Quality was evaluated at application level in order to better approach end-user perception. As speech is the most important part of the videoconference transmission, two types of measurements were performed, using standard E-model [3] and perceptual (PESQ) [4] methods. Both network related and perceptual methods are employed in the tests for accuracy reasons; therefore we obtain complementary results that ensure a correct validation process. Audio tests were carried out to check the performance of a set of audio codecs under the system network conditions. An optimised dejittering buffer size was selected, minimising delay and packet loss (if it is set too small packet loss will be higher; if too large it will increase delay). Theoretical optimum size is between one and a half and twice the jitter value. Only codecs with low processing delay, which obtained acceptable quality level MOS values both for E-Model and PESQ, are appropriate for a system with geostationary satellites, like G.711 and Speex (not standard, open source) codecs, as shown in Figure 1.

At the present moment standardisation bodies have not completed the definition of video QoS yet. Also video perceptual QoS is just on its initial stages. Video tests were performed using one of the first available (for research purposes only) perceptual tools, VQM. It was employed a videoconferencing client that offers high number of customisable options to the user, allowing the control all of parameters like codec type. The two more usual codecs were tested: H.261 and H.263. Tests show sufficiently good scores for the selected video codec and format, degrading with packet loss, but maintained over acceptable scores even with a packet loss level of 10%. Generally, audio is enough for videoconference communication understanding, but video with bad quality audio is always useless. We have evaluated both audio and video flows separately, but the lip synchronisation parameter relates them and is very important in audio and video quality evaluation. In the laboratory tests real-time video and audio received in a videoconference are captured, providing desynchronisation measurements at application layer, i.e., like the final user would appreciate it. Tests results show that desynchronisation time depends on the videoconference client used (user application also influences quality). Some clients have high desynchronisation times, very much above the 80ms threshold, and therefore they are useless.

Conclusions

The quality results of the extensive measurement campaign carried out within the ICEBERGS project have shown the viability of a real-time multimedia over IP service carried over satellite links, despite high propagation delay. In this specific environment, care must be taken when selecting the optimum configuration so as to reduce delay effects to the minimum, as this constraint has a direct and relevant influence on quality.

Acknowledgments

The present paper is based on work undertaken in ICEBERGS (IP ConferEncing with Broadband multimedia ovER Geostationary Satellites), IST project (EC co-funded V Framework Programme), to whose consortium the authors want to acknowledge.

References

[1] Antonio Sánchez, M.A. Vázquez-Castro, F. Pérez-Fontán, Belén Carro, Haitham Cruickshank. “Multimedia Conference Services”. AIAA 2002-1841. May 2002

[2] Antonio Sánchez, Haitham Cruickshank, Belén Carro. “Voice over IP and Satellite”. IEEE SSC Newsletter. June 2001.

[3] ITU-T Recommendation G.107: “The E-model, a computational model for use in transmission planning”. July 2002.

[4] ITU-T Recommendation P.800: “Methods for subjective determination of transmission quality”.

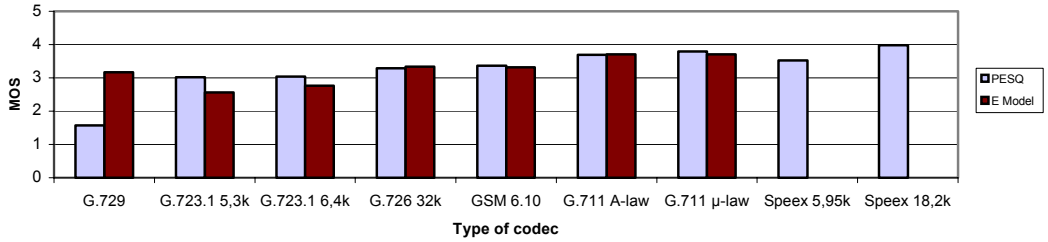

Figure 1. Audio codecs MOS results, for the predefined conditions

The missing protocol layer

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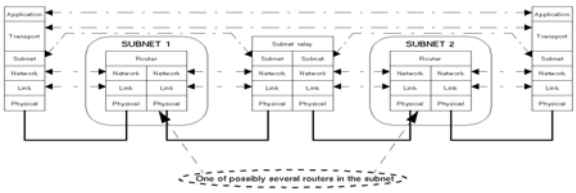
The idea

In the TCP/IP protocol stack, the IP layer operates at the level of each communication link, while TCP operates strictly end-to-end. This architecture has a number of important advantages: It is very resilient to failures and outages in the network. As long as a path exists between the communicating end systems, IP is likely to succeed in routing packets to their destination. TCP does not care which path a given packet took. Intermediate systems like routers need not keep any state information about TCP connections. The architecture works well as long a its underlying assumptions are not violated. One of the most important assumptions is that links and nodes are either working with good performance, or have failed. Bit error rates of links are expected to be low, so it can be assumed that any packet loss experienced is very likely due to congestion. These assumptions are generally met by the wired Internet. But with the advent

of wireless links, be it satellite or terrestrial mobile networks, the assumptions are challenged. Such links typically may exhibit significant bit error rate as well as intermittent link outages. In addition, they often have rather long propagation delays either in the form of a satellite hop or due to processing delay, and delay and available bandwidth may fluctuate. TCP was designed to cope with such a situation, but was not optimized for performance under this kind of conditions. A situation that frequently occurs is that the path of a connection traverses multiple sub-networks, each with its own characteristics. For example, a connection may originate in the LAN of a small company, then traverse a VSAT link, and terminate in a host on the wired Internet. An end-to-end transport protocol like TCP will have no knowledge of the heterogeneity of the path, and will have difficulty achieving good performance through it. Losses in one of the three sub-networks are bit error dominated while the two others are congestion dominated. Something seems to be missing. The idea proposed in this article is to introduce a new protocol layer between the end-to-end transport and the per-link network layer: A *sub-network layer* that operates across a homogeneous sub-network and interworks with the neighboring sub-networks through "relays". Sub-networks may use a different transport protocols, each optimized for the characteristics of its sub-network.

The proposed protocol model



The protocol layers of interest to this discussion are (names are tentative, but hopefully descriptive enough):

Network layer.

IP is maintained unchanged in the network layer.

Sub-network transport layer.

The scope of this layer is a homogeneous sub-network, such as a LAN, a satellite or mobile network, or the Internet. The term "homogeneous" is used for designating a sub-network that has some sort of common averall behaviour, for example bit error dominated losses or congestion dominated losses. In congestion loss dominated sub-networks, this layer could be TCP while a proprietary protocol could be used over a satellite or mobile network, optimized for the characteristics of the sub-network.

End-to-end transport layer.

Like TCP, this layer operates end-to-end. It would likely be a very "light" layer, involved mainly in connection setup, disconnection, and orderly cleanup in case of connection failure. It is open for discussion whether one can rely on the concatenation of sub-network transport connections for data integrity, or one needs a (simple) ARQ or at least error detection in the end-to-end transport layer. The end-to-end transport could present to the application a socket interface identical to a TCP socket, so that the change to the protocol stack could be transparent to applications.

Compatibility issues.

In order to benefit from the proposed architecture, both communicating end systems need to incorporate the new protocol stack. A compatibility mode can easily be introduced, enabling fall-back to standard TCP if one end system does not have the enhanced stack. Fallback to TCP may also be introduced for connections that do not pass through more than one sub-network, and therefore will not benefit from the new architecture.

What about TCP enhancers?

Various "TCP enhancers" or "performance enhancing proxies" have been proposed, and some are already deployed. Many of these use a "split TCP" approach that is more or less identical in concept to the concatenation of sub-network transports described above. The novelty of the approach proposed in this paper is the introduction of the end-to-end transport layer. This layer re-establishes the end-to-end context that was broken by the split-TCP.

ESA activities in this area.

The European Space Agency has commissioned two parallel studies of the proposed approach. One consortium chose a very light end-to-end transport layer, the other a heavier version with ARQ. The study and design phase of both contracts are completed. Currently, one consortium is implementing a prototype. The continuation of the work of the other consortium is under negotiation.

Preliminary results.

Simulations show very promising results. Significant improvements over standard TCP is seen in two areas:

TCP slow start is much faster because it operates in each sub-network separately and therefore only has to cope with the delay of that sub-network. The satellite sub-network has no slow-start. And the effect of bit error induced packet loss is mitigated largely within the satellite sub-network transport and therefore has much reduced impact on the end-to-end performance. A challenging area of research is the buffer sizing and management in the sub-network relays: Too small buffers may starve the satellite link; too large buffers may cause instability of a TCP-based sub-network feeding the relay. Another area still to be explored is the behavior and management of multiple aggregated flows

References

Erling Kristiansen, Roberto Donadio, "Multimedia over Satellite – The European Space Agency Perspective", *Proc. IEEE ICC 2002, New York, 2002.*